

4 ELECTRICITY-CAUSED FIRE

Victoria has a history of electricity assets causing bushfires. In 1969 and 1977 the failure of electricity assets—including the clashing of conductors, conductors contacting trees, and inefficient fuses—caused major bushfires. This history was repeated on 7 February 2009, when five of the 11 major fires that began that day were caused by failed electricity assets; among the fires was that at Kilmore East, as a result of which 119 people died. The Commission investigated the causes of each of those five fires and devoted a considerable amount of time to examining systemic factors associated with the reliability and safety of Victoria's electricity distribution networks.

Against this background the Commission recommends major changes to the state's electricity distribution infrastructure and its operation and management, to make the distribution system safer on days when fire risks are acute. There are two areas of major change: extending Energy Safe Victoria's mandate and resources to require and enable it to play a more active role in reducing the risk of electricity distribution infrastructure causing bushfires through strengthening its regulatory capacity and replacing ageing electricity distribution infrastructure with technology that delivers greatly reduced bushfire risk.

Knowing that these recommendations will take time to implement, the Commission also recommends some interim measures aimed at reducing the risk of electricity assets causing bushfires in the short term. These involve reducing the length of the inspection cycle, improving the efficacy of asset inspection, modifying the operation of automatic circuit reclosers (circuit breakers), retrofitting vibration dampers to longer spans of power line, and fitting spreaders to power lines to minimise clashing.

4.1 HISTORY OF ELECTRICITY-CAUSED IGNITIONS

Nine of the 16 major fires on 12 February 1977 were caused by electrical assets.¹ At the inquiry into those 1977 fires it was claimed that 1.5 per cent of the total annual fire ignitions in 'normal circumstances' were caused by electricity assets then owned by the State Electricity Commission of Victoria. Sir Esler Barber, chairman of the 1977 inquiry, observed, however:

This overall picture is in sharp contrast to what happens on days of extreme conditions, such as January 8th 1969 or February 12th 1977. On such days, the incidence of SEC fires rises dramatically.

The alarming aspect of these figures is that they tend to occur in widely separated places at approximately the same time and at the time of day when conditions are such that the rate of spread of fire is likely to be at its peak.²

The force of Sir Esler's observations was confirmed on Ash Wednesday, 16 February 1983: it appears that four of the eight major fires on that day were caused by electricity assets.³

On 7 February 2009 the pattern was repeated. Failed electricity assets caused five of the 11 major fires that began that day—Kilmore East, Beechworth, Coleraine, Horsham and Pomborneit–Weerite. The circumstances of each of these fires are discussed in detail in Chapters 3 to 14 of Volume I.

The importance of Victoria's electricity infrastructure to this Commission's investigations is highlighted by the devastation wrought by the Kilmore East fire: 119 lives were lost as a result of that fire, which was caused by electrical arcing after a conductor—which was probably 43 years old—on the Pentadeen Spur line broke.⁴

Mr Paul Fearon, Director of Energy Safe Victoria, said it was 'probably self-evident' that on days of extreme fire danger the percentage of fires caused by electrical distribution assets rises dramatically above the long-term average.⁵

The history of bushfire in Victoria since widespread introduction of electricity demonstrates that on days of dangerous bushfire conditions the failure of electrical assets can cause fires of great magnitude that result in much destruction and loss. The protection of human life demands a critical analysis of the Victorian electricity industry and recommendations that, when implemented, will lead to a material reduction in the risk of bushfire caused by the failure of electrical assets.

The Commission heard evidence on the state of health of existing infrastructure, on maintenance practices, on inspection regimes, and about a number of technical concerns. The aim was to explore options that would, in time, lead to a safer

distribution network that meets the needs of the community while substantially reducing the future risk of bushfire resulting from electrical failure.

The evidence before the Commission supports the conclusion that major changes should be made to Victoria's electricity distribution infrastructure, and its operation and management, if there is to be a substantial reduction in the risk to human life posed by bushfires on catastrophic fire days.

The Commission's recommendations are framed against the view that there is a serious risk that must be dealt with. Implementation of the recommendations will entail considerable cost. Some of that cost is inevitable because of the age and deteriorating state of the distribution network. Replacing much of the network in the short term is unavoidable: it is a question of what it is replaced with. The Commission is not, however, in a position to take into account cost implications and the impact on communities; those are matters for government to determine and assess.

Nevertheless, the seriousness of the risk and the need to protect human life are imperatives the Commission cannot ignore. The number of fire starts involving electricity assets remains unacceptably high—at more than 200 starts recorded each year. Although it is not possible to eradicate the risk posed by electricity assets altogether, the State of Victoria and the distribution businesses should take the opportunity to make changes aimed at substantially removing one of the primary causes of catastrophic fires in Victoria during the past 40 years.

Change such as this necessitates consultation and planning, but the threat of further catastrophic bushfires makes swift action essential. There need to be interim measures designed to ensure that distribution businesses and regulators take all practicable steps to reduce the bushfire risk in the transitional period.

THE ELECTRICITY DISTRIBUTION NETWORK

The Victorian electricity distribution network consists of approximately 1.2 million poles and 130,000 kilometres of lines operating at between 240 and 66,000 volts. It is made up primarily of 22,000-volt (or 22-kilovolt) distribution feeders and 12,700-volt SWER (single-wire earth return) lines.⁶

The main distributors of electricity in Victoria are, and were on 7 February 2009, SP AusNet and Powercor (see Figure 4.1).

The Powercor distribution network is about 82,653 circuit-length-kilometres on 528,000 poles of wood, concrete or steel. It includes SWER lines of approximately 21,813 route-length-kilometres. The SP AusNet distribution network is about 41,000 route-kilometres carried on approximately 379,104 poles of wood or concrete. It includes SWER lines of about 6,200 route-length-kilometres.⁷

Over the years the distribution networks have been a notorious cause of bushfires in rural areas. Mr Paul Adams, formerly general manager of SP AusNet's Network Services Group, stated that since 1997 an average of 4,800 fire starts have occurred each year on private property in the SP AusNet distribution area. He noted that, of all these fires, SP AusNet assets had been associated with 52.8 fire starts (1.1 per cent) each year.⁸

Figure 4.1 Victoria's electricity distributors coverage

[CLICK FOR IMAGE](#)

Source: Exhibit 237 – Statement of Lane.⁹

There appears to be some elasticity in these figures. In its November 2006 evaluation of the SP AusNet Bushfire Mitigation Plan, Energy Safe Victoria expressed concern that the figures represented a gross underestimate. SP AusNet's Five Year Cost Management Plan, dated 1 June 2005, stated that in the previous 10 years the organisation's network had experienced on average 90 fires annually.¹⁰

Powercor produced a graph of 'Powercor ground fires' up to 30 April 2009, which showed that, as a proportion of CFA fires in the Powercor area of operations, Powercor fires ranged from 1.63 per cent (41 fires) in 2004–05 to 4.53 per cent (113 fires) in 2008–09.¹¹

Although the long-term averages SP AusNet and Powercor refer to are similar to those the State Electricity Commission of Victoria claimed at the 1977 inquiry, on catastrophic fire days electrical assets are likely to cause a large proportion of the fires that start.¹²

The distribution businesses have long accepted that their assets have the capacity to start fires and that it is important to take steps to mitigate the risk of such fire starts. A variety of steps are now mandated by Victoria's *Electricity Safety Act 1998* and associated Regulations.

4.3 AGEING INFRASTRUCTURE

The evidence before the Commission suggests that the age of electricity distribution assets contributed to three fires on 7 February 2009:

- the Kilmore East fire—conductor failure caused by fatigue on a SWER line¹³
- the Coleraine fire—fatigue and corrosion leading to a broken tie wire and as a consequence a conductor starting a fire on a SWER line¹⁴
- the Horsham fire—fallen conductor caused by failed pole cap on a SWER line.¹⁵

The circumstances of those fires are discussed in detail in Part One of Volume I.

The Commission received from Mr Kim Griffith, who has extensive electricity industry experience with the State Electricity Commission of Victoria and as CEO of Ergon Energy, evidence that distribution businesses' capacity to respond to an ageing network is constrained by the existing regime for the industry's economic regulation. Mr Griffith said the regime favours the status quo and makes it difficult to bring about step change reform.¹⁶

As components of the distribution network age and approach the end of their engineering life, however, there will probably be an increase in the number of fires resulting from asset failures unless the State Government and the distribution businesses take urgent preventive steps.¹⁷ This poses an unacceptable bushfire risk to the state's residents.

The Commission considers that now is the time for a major change and a start in planning for the replacement of ageing infrastructure. Protection of human life must be the guiding principle for that reform.

4.3.1 CONDUCTORS

SP AusNet provided to the Commission the results of a study of its conductor fleet, which noted, among other things, 'The primary issue facing SP AusNet is the increasing age profile and deteriorating performance (2% p.a.) of steel and copper conductor through failure ...' SP AusNet's conductors have a regulatory life of 60 years, and its conductor fleet has an average age of 41 to 45 years. Most of its steel and copper conductors are now more than 50 years old; they account for all conductors of above-average age in its fleet. The failure of steel and copper conductors is the primary type of conductor failure attributed to end-of-life characteristics.¹⁸

The report of SP AusNet's conductor study also noted that the great majority of conductor failures on the organisation's network involved high-voltage conductors and that this represented a 'considerable risk to the business from a public safety and bushfire perspective'. The report said, 'In the absence of planned conductor replacement programs, failure rates may begin to increase at an exponential rate due to the increasing proportion of [the] conductor fleet approaching current failure age ranges'.¹⁹

SP AusNet's investigations demonstrated that individual steel and copper conductor sections were in poor condition. Lines were said to be 'annealed', 'corroded' or having 'a history of falling down'.²⁰

There is no reason to distinguish the SP AusNet network from the Powercor network when considering the impact of ageing infrastructure.²¹ Sinclair Knight Merz's report for Powercor, issued in October 2004, noted that 16 per cent of the overhead line distribution assets in the Powercor network are between 35 and 44 years old, 5 per cent between 45 and 54 years, 1 per cent between 55 and 64 years, and 1 per cent between 65 and 74 years.²²

The Commission heard evidence from Professor Nicholas Hastings, who has an international reputation in asset management and maintenance engineering, particularly reliability engineering. Professor Hastings noted the increasing proportion of assets in Powercor's network at or beyond regulatory life and told the Commission that in his opinion this would lead to a substantial increase in failure rates for electrical assets. Professor Hastings' opinion is supported by the SKM report, which pointed to a probable gradual trend from random failure to common failure as a consequence of ageing assets.²³ The Commission accepts Professor Hastings' evidence.

4.3.2 INSULATORS

Insulator failure can result in pole fires, cross-arm fires, conductor drops, conductor clashing, and conductor contact with the ground. Such incidents constitute bushfire risks.²⁴

The pin-type insulator's engineering life is 40 years. Pin-type insulators installed between 1930 and 1980 account for a considerable proportion (28 per cent) of SP AusNet's 22-kilovolt insulator fleet. In this regard Powercor is apparently in a position similar to that of SP AusNet.²⁵

An SP AusNet review of insulators found that between 2002 and 2007 insulator failures increased at a rate of 5 per cent a year and that its pin-type insulators would reach an average age of 40 years between 2011 and 2015. The review concluded that without 'proactive' replacement programs the incidence of pole fires would continue to increase.²⁶

4.3.3 POLES

The Energy Safe Victoria audit of SP AusNet's 2008–09 Bushfire Mitigation Plan pointed to age affecting electricity poles. In the auditors' opinion, the high number of pole stakings across the network 'would sometime in the future create a wave of pole replacement' and 'the number of existing staked poles that are now being temporarily supported until replacement indicates that this wave has now commenced'. SP AusNet itself acknowledged this upward trend.²⁷

Powercor's October 2004 submission to the Essential Services Commission's electricity distribution price review for 2006 to 2010 recognised that 'age and condition are closely correlated':²⁸

There is a substantial peak in the age of assets, indicated by the example of wood poles ... In 2004 there are 37,000 wood poles 50 years and older, however this will increase to approximately 62,000 by 2010 based on average replacement of 1,500 wood poles per year.²⁹

Degradation of pole-top attachments with age is also of concern. Energy Safe Victoria's bushfire mitigation audit of SP AusNet in July 2005 noted that five of 11 items found defective had been inspected in the previous two years, leading the auditor to conclude there 'may be an issue with pole top attachments lasting the full five-year inspection cycle'.³⁰

4.3.4 TIE WIRES

Metallurgist Dr Jeffrey Gates examined the circumstances of the tie-wire failure that led to the Coleraine fire on 7 February. Dr Gates told the Commission that the typical life span for zinc galvanising on tie wires of that kind is about 40 years and that the Coleraine tie wire was probably more than 40 years old. He noted the galvanising on that tie wire had been consumed by external elements, greatly increasing the corrosion rate and leading to pitting and the initiation of fatigue cracks on the tie wire.³¹

There is every reason to suspect that similarly aged tie wires are in similar condition and thus prone to failure, particularly in severe conditions. The SP AusNet inspection manual recognises zinc loss on a conductor or a tie wire as an end-of-life characteristic and says that from the time zinc is lost a conductor should have only 'a few more years of life' left. Dr Gates said it can be expected that 'a large proportion of tie-wires in the network will ... have their zinc layers largely consumed'.³²

Dr Gates also examined a small sample of Powercor's maintenance records and found they recorded a 'significant' tie-wire failure rate. He told the Commission the tie wires 'need to be replaced soon in order to avoid the risk of a larger number of failures occurring'.³³

In relation to the broader Powercor network, a spreadsheet prepared by Powercor recorded that on cyclical inspection at least 3 per cent of tie wires across its SWER network require maintenance (meaning they need to be replaced) and for tie wires installed in the 1950s and 1960s the proportion is as high as 10 per cent in some years.³⁴

Powercor submitted that the data show its maintenance regime is working because 'deteriorated assets are ... detected before they fail'. The Commission heard evidence, however, that in severe weather conditions (in particular, high winds) deteriorated tie wires carry real potential to cause fire and are an example of a 'hidden defect'.³⁵ As Professor Hastings stated:

'Hidden' doesn't mean that you can't see it. It just means that it doesn't become evident to the system operators when it happens.

[A broken tie is] a hidden defect because it is not an in service failure but it is in this degraded state. I think a lot of the issue with distribution networks and their situation in relation to high fire

danger days is related to keeping the number of these defects which have not yet progressed to failure under control or to a desirably low level.³⁶

The Commission accepts that the combination of high winds and days of high fire danger in Victoria accentuates the importance of detecting hidden defects, because those defects could under such conditions become system failures capable of causing fires.³⁷

4.3.5 THE SWER NETWORK

The SWER system is old, having been introduced by the State Electricity Commission of Victoria in the early 1950s to provide a means of electricity distribution to rural areas with low population densities and where small electrical loads need to be widely dispersed. The system could be rolled out relatively cheaply because of its simple design, which consists of a single lightweight, high-tensile conductor mounted on poles. Electricity travels to the customer along the single wire, the current returning through the earth rather than through a second wire.³⁸

The SWER design's simplicity offered some bushfire mitigation features because the single line could not clash with other lines and there were fewer poles and less associated infrastructure that could fail.³⁹

The SWER design limits a SWER line's maximum current, though, and thus the number of customers the line can service; on the SP AusNet network an average SWER line serves just 45 customers. SP AusNet recognises that the SWER network is reaching thermal capacity and that some SWER lines are already overloaded. This raises questions about the SWER system's capacity to meet present and future demand and maintain supply quality.⁴⁰

Mr Griffith told the Commission there were important limitations on the sensitivity of protection devices that can be used on SWER lines. He said, 'From a protection viewpoint it takes away 90 per cent of your opportunity to provide effective protection by having that return path through the ground'. So, if a fault with the potential to start a fire occurs on a SWER line, the line will remain 'live' for longer than if that fault were to occur on another type of line, increasing the likelihood of a fire starting.⁴¹

Powercor acknowledged the limitations on the sensitivity of SWER protection equipment in the context of the Coleraine fire. Mr Wayne McDonald, Powercor Senior Protection and Control Engineer, said that when the conductor on the Colfitz North Spur at Coleraine came into contact with tree branches 'the fuse detected the tree as a high resistance earth path and did not operate'. In other words, the tree provided a return earth path that was of slightly lower resistance than the SWER system's ordinary earth return. That meant the fault current was higher—but not much higher than the ordinary current and insufficient to blow the fuse. As this example demonstrates, a SWER conductor that comes off the pole can start a fire without protection equipment ever being engaged.⁴²

It is obviously undesirable that current can continue to flow down a power line that is hitting and arcing against a tree. That danger is, however, inherent in the SWER system and can be obviated only if SWER lines are replaced by other, safer technologies.

4.4 REPLACEMENT OPTIONS

The SWER and 22-kilovolt distribution networks constitute a high risk for bushfire ignition, along with other risks posed by the ageing of parts of the networks and the particular limitations of SWER lines.

The Commission agrees with the State of Victoria's submission that an ambitious period of innovation is required. The networks need to be replaced by the available distribution infrastructure technology, which can dramatically reduce the risk that the lines will cause bushfires.

The Commission also notes the high cost of replacement. It stresses, however, the potential for tragic consequences if the Victorian Government and distribution businesses do not take decisive action and explore the full range of alternatives.

Ms Marianne Lourey, Executive Director—Energy Sector Development in the Department of Primary Industries, informed the Commission that the Victorian Government intended to coordinate in April 2010 a national workshop with interested parties, to consider, in particular, options in connection with the ageing SWER lines.⁴³

The Commission commends this initiative and suggests that a taskforce be established to investigate the costs and benefits of the full range of replacement options. But this process must not delay real change. The taskforce should be required to

present its findings within six months of the date of issue of this report: this will allow the distribution businesses to carry out the replacements within the Commission's recommended time frames.

4.4.1 UNDERGROUND CABLE

The use of underground cable essentially eliminates bushfire risk associated with the provision of electricity. The cabling has a 40- to 80-year lifespan (depending on the voltage) and there are virtually no maintenance or inspection costs. Additionally, in most cases underground cable will survive a firestorm. The result of these features is that the interruptions to electricity supply that often accompany bushfires and can hamper firefighting activities are avoided, as is the need to replace infrastructure following a fire.⁴⁴

Mr Shane Breheny, CEO of Powercor, accepted the existence of the cost savings—such as maintenance, inspection and vegetation clearance costs—but said the savings were not significant when compared with the cost of placing the electricity supply underground.⁴⁵

Underground cabling is not new. For example, the State Electricity Commission of Victoria used it very effectively between Jamieson and Mt Hotham, and 8.29 per cent of the Powercor network is underground cable.⁴⁶ State regulations require undergrounding for the following:

- all new housing estates since 1988
- new connections on private land in rural areas
- any private electric lines in need of substantial reconstruction in areas of high bushfire risk.⁴⁷

The current regulations do not impose similar obligations on electricity distribution businesses, even when they are doing reconstruction work in areas of high bushfire risk.⁴⁸

4.4.2 AERIAL BUNDLED CABLE

Aerial bundled cable is superior to bare conductor because it greatly reduces the risk of bushfire caused by distribution infrastructure and overcomes other limitations of the SWER network, as discussed in Section 4.3. It has been very successful in reducing the number of fire starts and has been used in areas of high bushfire risk such as the Dandenong Ranges, the Macedon Ranges, Jan Juc, Daylesford and Woodend.⁴⁹

ABC is, however, much more expensive than bare conductor. It is heavier and needs to be supported by more poles. Specialist skills are often needed to repair it, and the repairs can take longer compared with bare conductors. Additionally, it might be necessary to replace ABC if it is damaged by fire. On the plus side, reduced maintenance is required for ABC, and clashing is eliminated.⁵⁰

4.4.3 AGE-BASED REPLACEMENT WITH EXISTING TECHNOLOGY

At present the distribution businesses manage their networks overwhelmingly on the basis of 'performance', which is determined by condition-based assessment—assets being replaced only when condition monitoring identifies defects or deterioration—rather than by age.⁵¹

The Commission heard the following evidence:

- Condition-based monitoring through regular, cyclical inspection is a substantial and significant part of prudent asset management, but it has limitations and should be used along with age-related management processes.⁵²
- Distribution businesses must have 'a very good system for predicting the end point of failure and the need for replacement' of assets. The alternative is to make arbitrary decisions about an asset's working life and replace it at that time, accepting that many assets will be replaced before they need to be. This must, however, be balanced against the possibility of a fire with enormous consequences.⁵³
- It cannot reasonably be concluded that either of the distribution businesses has a very good system for predicting the 'end point of failure'. With the exception of SP AusNet's conductor replacement program, neither SP AusNet nor Powercor conducts regular forensic analysis of the age characteristics of its conductors, tie wires or other assets.

- Assignment of a 'regulated life' is a sound guideline that network owners should follow in the absence of convincing evidence that the end of 'regulated life' should be extended. There is nothing to suggest the judgment in relation to the life of conductors in the distribution networks was wrong. That regulated life has now been, or will shortly be, reached for much of the network.⁵⁴
- Age-based replacement programs are particularly appropriate for network components that are hard to inspect or that have definite ageing characteristics—for example, conductors and tie wires.⁵⁵
- Professor Hastings examined the SP AusNet Conductor Study, in which SP AusNet concluded, 'It is prudent up to the end of 2015 to undertake the replacement of approximately 1,770 route km of steel conductor and 280 route km of copper conductor'. He concluded that the planned replacement was 'a major shortfall' compared with what was needed.⁵⁶
- Professor Hastings recommended that those parts of the network not covered by the Conductor Study or that are hard to inspect or deteriorate with age should be analysed for failure rates against age and other risk factors.⁵⁷
- The Conductor Study also recommended implementation of a forensic analysis process for conductors, improvements to visual assessment criteria for asset inspectors in the *Asset Inspection Manual*, and augmentation of asset management systems to support data capture, management and analysis 'for ... enhanced conductor assessment criteria'.⁵⁸

Having considered the current age of the steel conductors in SP AusNet's fleet, Dr Hastings came to the view that there were a significant number of assets in the 61-plus-years group for which there should already be a 'replacement plan in the pipeline, if not already implemented' and that '56 to 60 [years] which is 3,000 circuit-kilometres ... is where the plans should be very firmly in place to replace those in the near future'.⁵⁹

The Commission is satisfied that condition-based asset management is inadequate on its own to reduce the risk that latent or hidden defects will lead to fires starting on severe fire days. If distribution networks are not replaced by superior technology, there must be new programs for the replacement of assets on the basis of age and other risk factors. SP AusNet appears to have accepted the idea of such an approach.⁶⁰

FUNDING THE REPLACEMENT OF THE DISTRIBUTION NETWORK

Victorian electricity distribution businesses are subject to an incentive-based regulatory regime whereby an economic regulator sets the total amount of revenue each distribution business may receive in a specified period. Under the regime the economic regulator makes a revenue determination on the basis of submissions the distribution businesses make in relation to their forecast capital and operating expenditure. If the distribution businesses deliver their services at a cost that is lower than the revenue cap set by the regulator, they are rewarded with an increased return. This gives them an incentive to conduct their business efficiently.⁶¹

The economic regulator also sets the service standards the distribution businesses should achieve during the regulatory period in question. Those standards form the basis of an incentive scheme that imposes financial penalties on businesses that fail to meet the standards and rewards them financially if they meet the standards. This deters the distribution businesses from reducing expenditure at the expense of service and reliability.⁶²

The Essential Services Commission set the price and service levels applicable to Victorian electricity distribution businesses for 2006 to 2010, but this task has since become the province of the Australian Energy Regulator. Victoria's agreement to the transfer of the ESC's functions to the AER was recorded in the Australian Energy Market Agreement, and the transfer was effected by s. 23 of the *National Electricity (Victoria) Amendment Act 2007*.⁶³

If a distribution business wants to make a major investment to replace or modify its infrastructure, it must present to the economic regulator a persuasive case for that investment. The regulator's rejection of an application for funds for any particular proposal does not prevent a distribution business from making the investment: the business has discretion to allocate funds as it sees fit, and safety concerns might lead it to use its discretion to invest in projects not approved by the regulator.⁶⁴

If, however, the regulator does not approve a particular investment proposal, the distribution business is unlikely to implement it because it can do so only at the expense of the proposals it was able to persuade the regulator were necessary.

For that reason, the fact that distribution businesses do not control their own prices inevitably constrains the extent to which they invest in activities aimed at reducing bushfire risk.

In 2004 and 2005 Powercor presented compelling submissions to the Essential Services Commission, seeking revenue to place power lines in high-risk bushfire areas underground. Powercor referred to the fact that ‘undergrounding to protect against bushfire has been identified as an area of concern for customers in rural and semi-rural areas’ and noted that its service territory contained some of the most bushfire-prone land in the world. It also pointed out that, even when steps were taken that went beyond the action required by the Line Clearance Code, contact between vegetation and power lines could occur.⁶⁵

Powercor presented evidence suggesting that customers were willing to pay for the placement of power lines underground and that the economic benefits were material. It pointed out, however, that, although it would incur undergrounding costs, it would not capture all the benefits, including those delivered to the entire community. Powercor argued:

Each year ‘disaster-level’ bushfires (where the total insurance costs of the event are more than \$10 million) cost Australia an average of \$77 million ... overhead electrical assets can result in the ignition of a number of fires each year due simply to the existence of an energy source exposed to natural elements ...

It is difficult to accurately quantify the benefits associated with undergrounding to prevent fire hazards as the value of the benefit will vary depending upon location. Powercor Australia is not aware of any study that has been able to readily value the benefits associated with reducing fire hazard, including those prepared by other regulators. The difficulty in quantifying the benefits does not mean those benefits are not material.

Powercor Australia believes the [Essential Services] Commission has an obligation to investigate the benefits associated with undergrounding to reduce fire danger both from a stand point of ensuring it meets its own objectives, but also from a societal perspective given the benefits from undergrounding largely accrue to the community as a whole.⁶⁶

Mr Ken Gardner was the head of the state safety regulator, Energy Safe Victoria, when Powercor made the submission to the Essential Services Commission. He told the Bushfires Royal Commission that ESV did not make submissions supporting or opposing Powercor’s submission. Despite ESV knowing of Powercor’s submission, it appears there was no consultation between ESV and the ESC before the ESC’s rejection of the submission.⁶⁷

The ESC put forward a number of reasons for rejecting Powercor’s submission, among them the following:

- The distribution businesses had failed to quantify the benefit or reveal the amount and network type to be undergrounded.⁶⁸
- The costs of undergrounding should be paid by the customer.⁶⁹
- The regulatory framework’s incentive-based nature would ensure undergrounding where the benefits outweigh the costs.⁷⁰
- The Victorian State Government Powerline Relocation Scheme funded up to half the undergrounding cost when a community benefit would result, and this was a more appropriate mechanism for obtaining revenue where there was community benefit.⁷¹

The ESC’s assertion that undergrounding costs should be paid by the customer ignores the fact that many of the benefits of undergrounding—in particular, the reduction in bushfire risk—accrue to the entire community. The ESC’s approach also ignores the fact that those benefits, including the saving of lives, are less amenable to measurement in financial terms.

Accordingly, the ESC’s argument that distributors would use underground cabling where the overall benefits outweighed the costs is flawed. The Australian Energy Regulator’s Mr Chris Pattas, General Manager of the Network Regulation South Branch, agreed that a distribution business might target reliability in high-density areas because if it misses reliability targets in those areas it will be penalised more heavily than it would be for missing targets in low-density areas. The areas of highest risk of bushfire are, however, areas of low-density population, and Mr Pattas could not point to any incentive for a distribution business to focus on reliability in low-density areas. Similarly, Mr Fearon of Energy Safe Victoria stated that the ‘current generation’ of incentive arrangements go to average performance and that SWER lines are low-priority reliability targets.⁷²

Finally, the Commission notes that the ESC’s reliance on the Powerline Relocation Scheme was misplaced. The scheme concerns the undergrounding of power lines in areas where there is high pedestrian or vehicular activity or where

environmental or cultural factors justify such placement. Most projects under the scheme are for distances of between 100 and 400 metres, and the scheme is expressly not concerned with reducing bushfire risk. The Commission would welcome a scheme that is directed at undergrounding for the purpose of reducing bushfire risk.⁷³

Mr Paul Adams, SP AusNet former General Manager Network Services Group, said he believed the ESC's rejection of a similar undergrounding proposal from SP AusNet was based on the regulator applying the 'lowest cost technically acceptable' solution, which was, in the circumstances, overhead power lines. The Commission considers that on this criterion it would be difficult for a distribution business to obtain approval for any proposal to replace distribution assets with safer assets if it has a record of efficient supply in the area in question. In those circumstances 'like-for-like' replacement will be the 'lowest cost technically acceptable solution'.⁷⁴

The Australian Energy Regulator told the Commission it does not approve individual investment proposals, but in determining a distribution business's total allowance for capital expenditure it does consider a cross-section of the more substantial projects proposed against the criteria set out in the National Electricity Rules, which in substance provide that 'A capital expenditure proposal must achieve the capital expenditure objectives of meeting expected demand and a host of regulatory, technical and safety requirements in an "efficient and prudent manner".'⁷⁵

Mr Pattas told the Commission the AER does not take into account costs that are external to the distribution businesses—such as the costs borne by the community when a bushfire is caused by failed electricity assets. In the Australian Energy Regulator's view, whether such 'external' costs should be taken into account is a question for policy makers.⁷⁶

4.5.1 THE ECONOMIC REGULATORY REGIME AND SAFETY

The Australian Energy Regulator's failure to factor in the costs to human life and property arising from bushfire as part of its cost-benefit equation means that real and substantial costs to the community imposed by bushfire are left out of the price determination process.

The AER, and the Regulations under which it operates, should acknowledge that Victoria is one of the most bushfire prone places in the world and that major bushfires on the worst days are often caused by the failure of electricity assets. Protection of human life must become the priority when evaluating distribution businesses' expenditure proposals. The economic regulatory regime must include mechanisms for ensuring that safety-related matters are properly reviewed so as to minimise the risk of bushfire being caused by the failure of electrical assets.

Mr Pattas said the AER 'would be looking to [Energy Safe Victoria] to provide [to AER its] views about any safety issues or any safety aspects associated with the businesses' proposals'. Obviously, ESV has an essential role to play in ensuring that the AER is fully informed of the safety risks and benefits associated with the distribution businesses' investment proposals. Mr Gardner told the Commission ESV acknowledged that role and sought to be involved in the price review process.⁷⁷ Section 4.7.1 deals with ESV's role and the relationship between economic regulation and safety regulation.

4.5.2 A 'TRIGGER EVENT' LEADING THE AER TO ADJUST ITS DISTRIBUTION DETERMINATION

It is at the price review every five years that there is the greatest opportunity for 'significant step change in expenditure'.⁷⁸

Considerable expenditure will be required in order to implement the Commission's recommendations in relation to the electricity industry. The necessary revenue is unlikely to be available without an adjustment to the price determination that is now under way. The National Electricity Rules allow for adjustments to a price determination if specific 'trigger events' occur, enabling distribution businesses to seek additional revenue approval from the regulator.⁷⁹

Mr Pattas told the Commission that a serious fire causing death and massive destruction would not be a 'trigger event'; nor would a recommendation from the Commission that distribution businesses substantially increase their expenditure.⁸⁰

The Commonwealth submitted, however, that a 'trigger event' would be constituted by 'material changes, which either reduce or increase the likely costs to be incurred by the [distribution businesses]'—for example, administrative or regulatory change creating new obligations necessitating additional expenditure. The Commission considers the State should take steps to create a trigger event.⁸¹

4.5.3 A GOVERNMENT CONTRIBUTION TO THE NEW NETWORK

The distribution businesses and the State of Victoria submitted there is a large financial cost associated with any recommendation to replace Victoria's ageing electricity distribution network with technology that delivers a reduced bushfire risk. In the Commission's view, the cost of not renewing the network could be far greater. The costs of major bushfires fall on the entire community, and the Kilmore East fire alone demonstrates, in terms of loss of both life and assets, the potential magnitude of those costs.

The Commission makes its recommendations for the benefit of the entire community. For that reason it considers it inappropriate that electricity consumers bear the entire cost of implementing those recommendations.

The Victorian Government already accepts—through the Powerline Relocation Scheme—that the community should share up to half the power line relocation costs for visual or cultural reasons. Given the Commission's view that protection of human life should be the highest priority, the government should consider adopting a similar scheme to help defray the cost of replacing overhead power lines in order to reduce bushfire risk.

RECOMMENDATION 27

The State amend the Regulations under Victoria's *Electricity Safety Act 1998* and otherwise take such steps as may be required to give effect to the following:

- the progressive replacement of all SWER (single-wire earth return) power lines in Victoria with aerial bundled cable, underground cabling or other technology that delivers greatly reduced bushfire risk. The replacement program should be completed in the areas of highest bushfire risk within 10 years and should continue in areas of lower bushfire risk as the lines reach the end of their engineering lives
- the progressive replacement of all 22-kilovolt distribution feeders with aerial bundled cable, underground cabling or other technology that delivers greatly reduced bushfire risk as the feeders reach the end of their engineering lives. Priority should be given to distribution feeders in the areas of highest bushfire risk.

4.6 INTERIM MEASURES

In view of the size of the existing electricity distribution network, any replacement program will take years to complete. It is therefore necessary to consider interim measures aimed at reducing the risk that the current network will lead to further bushfires before its replacement. Among these measures are the following:

- reducing the length of the asset-inspection cycle
- improving the efficacy of asset inspection
- modifying the operation of automatic circuit reclosers
- retrofitting vibration dampers
- fitting spreaders.

4.6.1 ASSET INSPECTION

Improving the efficacy of inspection regimes is crucial to mitigating the bushfire risk created by the failure of electricity assets. Whether network components are repaired or replaced before they fail or are at risk of failing is determined in almost all cases on the basis of inspection results, and there is heavy reliance on cyclical inspections.⁸²

The inspection regimes generally

Standards for inspection are not specified by legislation. The inspection regimes of SP AusNet and Powercor do, however, form part of the distribution businesses' bushfire mitigation strategies. Energy Safe Victoria approves the inspection regimes and audits their implementation as part of its oversight of Bushfire Mitigation Plans and Electricity Safety Management Schemes.⁸³

With some exceptions, SP AusNet and Powercor generally inspect their distribution assets every five years. During these cyclical inspections, inspectors observe and record defects and allocate priorities for remedial action, in keeping with the business rules of the respective distribution business.⁸⁴

If an asset inspector reports a defect or deterioration, a qualified and experienced tradesperson carries out a technical assessment and might, for deteriorated conductors, assess the line at line height. Each distribution business also implements a limited number of specialised programs directed at particular parts of the network.⁸⁵

The distribution businesses prescribe the scope of and standards for the cyclical inspection program in their asset inspection manuals. Those manuals specify inspection intervals and procedures, priorities for maintenance and replacement, record-keeping standards, and standards for the training of inspectors.⁸⁶

The distribution businesses outsource most of their physical inspection work—SP AusNet to Utility Asset Management and Powercor to Electrix Pty Ltd. SP AusNet's rationale for outsourcing asset inspection is that this role differs considerably from that of its linesmen and that by outsourcing it is able to make use of specialist expertise.⁸⁷

There is some evidence that incorporating the inspection task in the work of linesmen, rather than outsourcing it, could result in better identification of defects since linesmen have often experienced the problems that become visible on inspection. The Commission accepts, however, that there would be difficulties associated with such an arrangement, although it did not hear detailed evidence about the restructuring required for linesmen to perform inspections. This underscores the fundamental importance of providing comprehensive training for inspectors: their role is pivotal to maintaining the safety of the distribution networks.⁸⁸

Both internal auditors and external consultants audit the work of asset inspectors. The purpose of the audits is to ensure that the quality of the work conforms to the requirements of the asset inspection manuals.⁸⁹

The length of the inspection cycle

The State Electricity Commission of Victoria introduced a three-year inspection cycle following the 1977 bushfires. In about 1995 a five-year cycle for areas that were not deemed a fire hazard was introduced. In 1999–2000 both Powercor and SP AusNet moved to a five-year cycle for fire hazard areas, having concluded they could conduct fewer inspections without increasing the level of risk; the rationale for this was the improved reliability of distribution assets and improved inspection processes. In contrast, both expert opinion and the network operators' analyses support a finding that shortening the inspection cycle would appreciably reduce the risk of assets failing in service and consequentially reduce the risk of bushfires starting as a result of failed assets.⁹⁰

International expert Professor Nicholas Hastings explained that an inspection regime's suitability for limiting asset failure should be assessed by reference to the extent to which the regime allows incipient failures to be detected before they proceed to full functional failure—that is, the asset failing while in service. The regime should take into account how the assets fail, how failures can be detected and the effect of failure. Some failure modes lend themselves to early identification by condition monitoring and allow time for remedial action before full functional failure. For other failure modes, however, there might be little or no practical or economic way of identifying potential failures.⁹¹

The risk that assets will fail during service is substantially determined by the length of the inspection cycle. This is because, assuming inspection effectiveness remains constant, the average number of degradation failures in the system will be proportional to the length of the inspection cycle.⁹²

Any reduction in the length of the inspection cycle will reduce risk, even if the effectiveness of inspection does not improve. Increasing the inspection cycle from three years to five years will cause a 66 per cent increase in random failures in the system by the time of inspections. Professor Hastings explained that with time network components degrade and that in the short to medium term it should be assumed that defects accumulate at a constant rate. Over three years, for example, the average number of defects in the system will be three times as high as for a one-year period (assuming no inspections during that time). Those results follow from the mathematical modelling supported by reliability-centered maintenance, or RCM, theory.⁹³

The likelihood of detecting degradation failures also increases if the effectiveness of the inspection methodology improves, thereby reducing the risk of in-service failure.⁹⁴

A 1997 RCM study of Powercor's network produced results consistent with Professor Hastings' conclusions. Powercor calculated it could reduce the frequency of inspections and maintain the existing level of 'acceptable risk' of in-service failures by increasing the assumed effectiveness of its inspections from 50 to 65 per cent. The study shows that reducing the number of degradation and in-service failures is demonstrably achievable by shortening the inspection cycle. A return to a three-year inspection cycle (even if inspection effectiveness does not improve) would result in a very substantial—about 70 per cent—reduction in the number of in-service failures.⁹⁵

The 1997 RCM study also showed that a substantial improvement in the effectiveness of asset inspection significantly reduces the risk of in-service asset failure. Powercor's analysis shows that, if the improvements in effectiveness foreshadowed in 1997 had been made without extending the inspection cycle, the projected number of in-service failures each year would have reduced from 500 to 84.⁹⁶

Energy Safe Victoria continued to approve five-year inspection cycles on the basis that there had been 'no obvious increase in failures' and that trends in in-service failures remained relatively consistent and 'at a relatively low level'.⁹⁷

Although either one of these two factors alone will considerably reduce the risk of in-service failure, the distribution businesses made a deliberate choice to offset improvements in one (the inspection effectiveness) with relaxation of the other (the inspection cycle). In practice, they have forgone an opportunity to improve safety in order to reduce costs.

It is not satisfactory that the distribution businesses can decide that a specific level of bushfire risk is 'acceptable' and rely on the benefit of improved processes and technology to maintain that risk level (instead of reducing it) in order to decrease their operating costs or increase their profits. Distribution businesses should take all reasonable opportunities to reduce bushfire risk. In particular, they should not trade improvements achievable by shortening the inspection cycle against those arising from improved inspection methods.

No inspection regime will detect all failures during inspections, and improvements in processes and equipment will always be limited by the effectiveness of inspections. Although it is evident that Powercor did improve the effectiveness of its inspection regime at the time it moved to a longer inspection cycle (as demonstrated by the absence of obvious increases in failure rates), even then it could assume that each inspection was only 65 per cent effective, meaning it assumed that about one-third of defects would still be missed by the improved inspection process. The report of the 1997 study observed, 'The cyclic program intervals are generally too long to be fully effective but significant risk reduction is provided by the reports which should be made'. The very same observation was made in a follow-up study in 2003, after the introduction of the five-year cycle.⁹⁸

Additionally, the rates of failure of some important network components are climbing as those components age. Increasing failure rates warrant increased opportunities for detection.

It is appropriate that the inspection cycle is responsive to differentiated risk. It is also important, however, to avoid complicating the inspection process with too many varying intervals. The Commission considers that a suitable balance would be achieved if a shorter inspection cycle were adopted in all areas of high bushfire risk, in keeping with the previous standard of a three-year interval, while directing specific programs at assets that are at high risk for other reasons.⁹⁹ The Commission also considers that the State should press the Australian Energy Regulator to allow distribution businesses an adjustment to their price determination on the basis that a move to a shorter inspection cycle is a material change in obligations and necessitates additional expenditure.

RECOMMENDATION 28

The State (through Energy Safe Victoria) require distribution businesses to change their asset inspection standards and procedures to require that all SWER lines and all 22-kilovolt feeders in areas of high bushfire risk are inspected at least every three years.

Conductors

It is not possible to do more than limited inspection of conductors from the ground. Yet the distribution businesses inspect at line height—by elevated vehicular platforms and other methods—only if a defect or deterioration is first detected from the ground. The capacity to inspect conductors thoroughly is an important part of a 'condition-based' asset management regime. But that capacity is limited because close inspection (for example, by using an elevated vehicular platform) is contingent on detection of a defect when the cyclic inspection occurs.¹⁰⁰

The report of the SP AusNet 2008 Conductor Study recommended that visual assessments (by asset inspectors in accordance with the *Asset Inspection Manual*) be supported by creating asset condition profiles through forensic analysis of conductors removed from service. SP AusNet considered such analysis would establish an asset's condition relative to a range of environmental and operational conditions—such as service age, geographical location, vibration damage, and mechanical and electrical loading.¹⁰¹ The Commission considers that network owners should conduct such forensic analyses with a view to developing asset condition profiles, at least by sampling in areas of high bushfire risk.

Improving inspection performance

Those who are charged with the important task of performing cyclical inspections must receive rigorous training and suitable materials and equipment. Additionally, the network owners must carefully monitor the inspectors' performance and the adequacy of their training.

SP AusNet and Powercor each have training and audit programs and detailed asset inspection manuals that are used to guide the inspectors as they work. The Commission considers, however, there is scope for improvement.

Training

The question of training arose during the hearings relating to the Kilmore East fire. The evidence was therefore focused on the training provided by Utility Asset Management on behalf of SP AusNet, whose assets were involved in that fire. The Commission also heard some evidence about the effectiveness of Powercor's training regime.

When UAM asset inspector Mr Jason Leech inspected pole 39 on the Pentadeen Spur line in February 2008 he did not detect a misaligned helical termination. The misaligned helical termination was said to be an uncommon fault and not a defect described in any inspection manual or the subject of specific instruction by UAM. The Commission was told, however, that it will now be specifically taken up in UAM's training.¹⁰²

The evidence about training had two facets: first, to recognise and understand the significance of a misaligned helical termination an inspector would have to be trained and have some understanding of metal fatigue; second, assuming such a defect could be seen, a properly trained inspector would not have missed it. The evidence highlighted the importance of equipping inspectors with sufficient grounding in the design and construction of electricity lines and the ways they can deteriorate.¹⁰³

Mr Kelven Barnbrook, a senior instructor with Gipps TAFE Energy Training Centre who has considerable experience in the electricity distribution industry, explained that inspection used to be done by linesmen with training (as apprentices) in the design and construction of distribution network assets. Mr Barnbrook said linesmen had experienced a range of problems throughout the system, had worked on faults caused by those problems, and were now more aware of the dangers the problems present. Professor Hastings made a similar observation, drawing on his experience.¹⁰⁴

Mr Maurie Braden, the UAM manager who conducted the organisation's training for asset inspectors, said UAM's inspectors were taught about known faults and mechanisms of failure and to look for 'anything loose, broken, unravelled, deteriorated, rusted or defective'. He agreed that the inspection of tie wires and other pole-top assets can require an asset inspector to make relatively sophisticated judgments about the condition of the infrastructure.¹⁰⁵

The UAM training course is made up of three days of classroom training, a competency test and 'several weeks' of field work under supervision. The field work includes a requirement to complete an on-the-job training package that is assessed by experienced inspectors. Inspectors receive annual refresher training covering 'some aspect of the asset inspection manual'. Mr Donald Ying, a manager with UAM, said the training was supplemented by half-day meetings, held at three- to six-month intervals, that 'provide an opportunity for issues to be raised by line inspectors'.¹⁰⁶

External auditors appointed by SP AusNet reported that UAM's Mr Leech had failed audits in December 2006 and December 2008. The audits compared the inspection work with 'first class professional competence' and concluded the work was not completed to the required standard at all sites and did not identify all electrical safety defects. UAM sent Mr Leech a warning letter in December 2008. Nevertheless, despite the failed audits, UAM's opinion was that Mr Leech was a reliable and competent inspector.¹⁰⁷

Mr Braden said he was satisfied with Mr Leech's training. Mr Braden's own asset inspection training had been limited to a four-day course in 2001, three weeks of field training, and a two-week course in 2002. His line inspection experience was also limited: he had been a labourer and trainee asset inspector 'on and off' for six months, an asset inspector for 18 months, and then an inspector and supervisor for 10 months in Queensland. It was Mr Braden who in 2006 determined the adequacy of the course outline and training materials for UAM's asset inspector course. The course content was derived from the SP AusNet *Asset Inspection Manual* and was, in Mr Braden's opinion, much the same as that of the courses taught by other distribution businesses and consistent with the training he himself had received in 2001. Mr Braden said he had been told (in preparation for giving evidence at the Commission) the materials had been sent to Mr John Costolloe of SP AusNet for review, but he (Mr Braden) had not communicated with SP AusNet about it before reviewing the course and starting to teach it.¹⁰⁸

The course outline contained the following instruction for the inspection of conductors:

Because conductors can deteriorate over the whole span, it is not practical for your work to pick up much in the way of general deterioration ... Steel is prone to single strands breaking and unwinding ... It usually happens well out in the spans, *so the best you can do is quickly scan along each span when you inspect the pole.*¹⁰⁹ [emphasis added]

Mr Braden of UAM, Mr Denis McCrohan, who was responsible for managing SP AusNet's contract with UAM, and Mr Adams, former General Manager of SP AusNet's Network Services Group, agreed that the instruction in relation to 'quickly scanning' the conductor was inappropriate. It is also inconsistent with the SP AusNet *Asset Inspection Manual*, which requires inspectors to 'regularly and methodically conduct detailed examinations of the distribution ... systems'. Mr Leech received the course outline as part of his training. Mr Braden, who said he had never personally given that instruction to trainees and did not distribute the course outline, had no reason to doubt Mr Leech's account. The contract between SP AusNet and UAM required that all training be provided by a registered training organisation unless SP AusNet had agreed otherwise. Mr McCrohan said SP AusNet required its contractor to have RTO status because 'we want the most competent workforce we can get. We want those people that are training inspectors to be registered and to meet national competency standards'.¹¹⁰

UAM is not, and was not at the relevant time, an RTO. Mr McCrohan was not aware of that. He was not able to say what steps, if any, SP AusNet took to determine whether UAM had met the contract standards. Mr Braden was not aware of the contractual requirement for an RTO or of any discussions with SP AusNet about UAM's status.¹¹¹

UAM maintained that Mr Leech had received sufficient training to enable him to do his job. It said that, had he seen the helical misalignment, Mr Leech would have reported it. It further argued that the helical misalignment was simply not visible from the ground.¹¹²

The Commission notes that Victoria Police is continuing to investigate the adequacy of training provided to asset inspectors and of the asset inspection regime. The Commission understands that the outcome of such investigations will probably be referred to the Coroner.

The Commission considers that SP AusNet's training regime suffers from several inadequacies:

- limited experience on the part of UAM personnel responsible for conducting the training and determining the content of the training course
- the limited nature of the theoretical training
- the training organisation not being an RTO, so there was no external audit of the content of its courses and the qualifications of its auditors¹¹³
- failure of the process for determining and checking course content to detect a serious inadequacy in the instructions relating to the inspection of conductors.¹¹⁴

Powercor's training regime was not subject to the same scrutiny in the Commission's hearings. Nevertheless, the Commission considers the Powercor training program to be superior to SP AusNet's in two main ways:

- Competency training in asset inspection is conducted by Gipps TAFE, an RTO. The training starts after two months of in-field training by a mentor who is a qualified asset inspector.
- Gipps TAFE assesses each inspector's competency for each training module and provides the results to Electrix. It also issues to competent trainees a field training module booklet. After the completion of all training modules the trainee returns to the field under the supervision of an experienced asset inspector. During the ensuing months the asset inspector assesses the trainee's ability to perform each of the tasks listed in the booklet. Once satisfied with the trainee's performance, the asset inspector 'signs off' on the training booklet. It is only then that an Electrix employee with training qualifications carries out a final competency assessment, which consists of a practical field test and a theory test. The results are provided to Gipps TAFE with confirmation from Electrix that the trainee has completed the practical elements of the qualification. If satisfied with the documentation it receives, Gipps TAFE issues to the trainee a certificate of competency.¹¹⁵

The observations that follow concerning the results of Energy Safe Victoria's audits underscore the need for constant review and improvement of inspection performance, even if the formal system of instruction is of a high standard.

The Commission notes that both SP AusNet and UAM support a review of their asset inspector training and support the creation of an industry group to review inspection processes and training standards. UAM also expressed support for a national standard for asset inspection.

Auditing inspection standards

The Commission is satisfied that SP AusNet's audit program is thorough in that the work of each inspector is subject to audit by UAM and by external auditors and each inspector is audited on average once a month. It considers, however, that there are shortcomings in the way the contractor 'checks' the results of external audits and communicates any disagreement to SP AusNet, which determines what results are valid without any further inspection of the work. This process has the potential to diminish the role and dilute the effectiveness of external audits.¹¹⁶

Energy Safe Victoria's audits

Energy Safe Victoria also audits the electricity distribution businesses' compliance with their inspection regimes as part of its compliance audit of bushfire mitigation plans. The audits highlight the importance of continual review of the ways of detecting defective assets and of efforts to improve the training of asset inspectors.

By December 2008 ESV had concluded that in general SP AusNet and Powercor were compliant with the regulatory regime and well prepared for the fire season. After the fires of 7 February, however, ESV began fresh audits of both distribution businesses. It said it was seeking a greater understanding of the two organisations' systems for detecting ageing and potentially defective assets.¹¹⁷

The 2008–09 Bushfire Mitigation and Line Clearance Audit, the report of which was presented to ESV in December 2008, concluded that Powercor had excellent policies and procedures for managing bushfire risk. ESV recommended, however, that Powercor strengthen its training and audit procedures for asset inspectors to ensure that all asset defects are identified and recorded during the asset inspection cycle. The recommendation followed a finding that most rusty ties and conductors were not being detected in Powercor's asset inspection process. Mr Gardner of ESV said 'there were instances where the auditor's observations weren't consistent with what was recorded' and that ESV had recommended that 'the way to address the issue of rusting ties is for there to be improved education of the inspectors'.¹¹⁸

New methods and technologies

The effectiveness of asset inspection can be further improved by the continual adoption of new inspection processes and technologies.

The Commission commends the distribution companies on their adoption of new technologies to date, among them the following:

- the use of digital cameras in cyclic inspections, which allows the inspection results to be analysed later¹¹⁹
- biannual thermal scanning and inspection by corona cameras on the Colac 6 and Colac 8 feeders, which run through the Otway Range¹²⁰
- the use of unmanned aerial vehicles and helicopters to photograph assets, with the intention of overcoming limitations on ground-level inspection of pole-top assets—particularly for detecting cross-arm failure¹²¹
- reviewing 8,000 randomised samples of conductor spans 'with a view to trying to see whether there are better mechanisms to identify conductor degradation'.¹²²

The Commission reiterates, however, that the distribution businesses should translate greater effectiveness in inspection into reduced bushfire risk. In particular, there is no evidence that either SP AusNet or Powercor intends or is in a position to materially change its processes or decrease its reliance on cyclic inspections.

RECOMMENDATION 29

The State (through Energy Safe Victoria) require distribution businesses to review and modify their current practices, standards and procedures for the training and auditing of asset inspectors to ensure that registered training organisations provide adequate theoretical and practical training for asset inspectors.

HAZARD TREES

Distribution businesses generally, and councils, DSE and VicRoads in limited areas, are required by Part 8 of the *Victorian Electricity Safety Act 1998* and corresponding Regulations—the so-called electric line clearance regime—to create and maintain a space free of vegetation in all directions around a power line. The required distance for this clearance space

varies, depending on factors such as the type of electric line and the area's bushfire risk rating. One practical requirement of maintaining the regulated clearance space is that vegetation in the 'regrowth space' must also be cleared, to ensure that vegetation does not grow into the regulated clearance space before the next cutting cycle.¹²³

Distribution businesses must annually prepare and submit to Energy Safe Victoria management plans for the clearance of electric lines. The plans outline how the businesses propose to discharge their obligation to keep the regulated clearance space free of vegetation.¹²⁴

Some trees, however, can stand outside both the regulated clearance space and the regrowth space yet still pose a risk of causing fires by contacting power lines when they break or fall. These are called 'hazard trees'. There is no express requirement for anyone to remove or otherwise make safe these trees, although the new electric line clearance Regulations do introduce the concept of hazard trees and permit pruning or removal in particular circumstances.¹²⁵

Contact between vegetation and power lines poses a considerable risk for causing fires to start. The Commission heard that, on average, vegetation contact causes about 19 per cent of fire starts associated with SP AusNet's distribution network. This risk increases dramatically in the environmental conditions that prevail on a total fire ban day.¹²⁶

It appears that fire starts caused by contact between vegetation and power lines arise in large part from hazard trees. This is not necessarily because hazard trees pose a greater risk; rather, the current regulatory regime focuses on maintaining the regulated clearance space and fails to squarely deal with hazard trees. In doing so, it encourages distribution businesses to concentrate their activities on the regulated clearance space.¹²⁷

SP AusNet has recognised the risk posed by hazard trees and has implemented two programs aimed at identifying them—despite the absence of an express requirement to do so under the electric line clearance regime. In the case of the first program, SP AusNet's vegetation assessors are required to inspect the hazard space in order 'to evaluate the potential hazards within that space' when performing their standard annual assessments of each span of power line in areas of high bushfire risk (and biennially in areas of low bushfire risk). Once a hazard tree is identified it is subject to a detailed assessment. The assessors are not, however, trained arborists and are responsible only for identifying hazard trees while carrying out their standard assessment tasks. They are not required to approach and check every tree and are instructed to look for 'obvious defects' and to 'take a closer look' when a defect is spotted.¹²⁸

SP AusNet's second program is targeted: it is carried out on selected parts of selected feeders, which are given priority according to the highest number of vegetation-related outages per customer. Qualified arborists thoroughly examine every tree in selected parts of the network that have the potential to affect SP AusNet's assets.¹²⁹

The Commission agrees with the State of Victoria's submission that SP AusNet's hazard tree programs constitute a positive step in management of the risks posed by hazard trees. It considers that all distribution businesses should be required to adopt—and document in their management plans for electric line clearance—measures aimed at reducing the risks created by hazard trees.¹³⁰

The Commission agrees, however, with some of the parties' submissions that this should not amount to prescribing the specific type of vegetation management practices individual distribution businesses should adopt. Nevertheless, if it were a regulatory requirement that distribution businesses adopt and document measures aimed at reducing the risks posed by hazard trees, distribution businesses should be able to obtain funding for such programs.¹³¹

Including this requirement in management plans for electric line clearance would also give Energy Safe Victoria a role in ensuring that distribution businesses are taking account of the risks posed by hazard trees, which is in keeping with the extended mandate for ESV, as discussed later in this chapter.

Submissions in relation to the Beechworth fire and evidence heard during the hearings dealing with roadside clearing highlighted the complexity of the current vegetation management schemes and the potential for confusion about responsibility for preventing fires caused by hazard trees contacting power lines. In the case of Beechworth, SP AusNet was responsible for maintaining the regulated clearance space around the line, DSE was responsible for Beechworth Historic Park (where the tree probably stood before it fell), and Parks Victoria was responsible for managing the park on DSE's behalf.¹³²

Public authorities—councils and VicRoads—have a broad obligation under s. 43 of the *Country Fire Authority Act 1958* to take all practicable steps to prevent and minimise fires, or the spread of fires, on land or roads under their control or management.¹³³ Yet, despite this obligation and the risks posed by hazard trees, it is apparent from the evidence about roadside clearing (discussed in Chapter 7) that road managers do not systematically check for, nor do they limit the risk of, hazard trees. This is important: many power lines run alongside roads. By virtue of their work, road managers are presented

with an opportunity to at least identify potential hazard trees. Information about the trees could then be relayed to the distribution businesses, to help them in their risk-reduction work.

Because of their role in developing municipal fire prevention plans in consultation with their municipal fire prevention committees—which are made up of representatives of local CFA brigades, municipal councils (including the municipal fire prevention officer), DSE, Parks Victoria and VicRoads—councils are in a good position to highlight the need for considering the risks posed by hazard trees.¹³⁴

Councils already identify bushfire risks and take steps to reduce those risks, the risks being documented in their municipal fire prevention plans (or municipal fire management plans, where implemented). But hazard trees do not appear to feature in these plans. Such trees are obviously a bushfire risk and should be identified and assessed through the same framework. This does not increase councils' responsibility for bushfire risk management: councils should be aware of the fire risks posed by hazard trees and should take all practicable steps to help mitigate those risks through their municipal fire prevention committees.¹³⁵

In the Commission's view, if a council has limited resources the most practical action might simply be to inform distribution businesses and other entities responsible for dealing with the risk that it (the council) has identified a hazard tree that requires attention.

RECOMMENDATION 30

The State amend the regulatory framework for electricity safety to require that distribution businesses adopt, as part of their management plans, measures to reduce the risks posed by hazard trees—that is, trees that are outside the clearance zone but that could come into contact with an electric power line having regard to foreseeable local conditions.

RECOMMENDATION 31

Municipal councils include in their municipal fire prevention plans for areas of high bushfire risk provision for the identification of hazard trees and for notifying the responsible entities with a view to having the situation redressed.

4.6.3 SETTINGS AND OPERATION OF PROTECTIVE DEVICES ON TOTAL FIRE BAN DAYS

Automatic circuit reclosers

The purpose of a protection system on an electricity distribution network is to minimise the risk of injury and damage from an electrical fault and to limit the interruption of supply caused by a fault. The protection system generally consists of a number of devices, among them distribution feeder circuit breakers, automatic circuit reclosers, sectionalisers and fuses.

When a fault occurs an ACR opens to break the circuit according to preset fault curves. It then automatically recloses the circuit after a specified amount of 'dead time', when no current is flowing.

Each time an ACR recloses the line is re-energised. If the fault has cleared (that is, is a transient fault) the ACR remains closed and normal current flow continues. If the fault remains (that is, is a permanent fault) the ACR will open again, re-breaking the circuit. That sequence will repeat a set number of times before the ACR 'locks out' and power is shut off until it is manually restored. ACRs are commonly set to reclose up to three times before they lock out.

The ACR fault curve setting determines the time the line remains re-energised on each reclose attempt. Different kinds of fault are governed by different fault curves.

For 'over-current faults' (that is, faults that result in a sharp increase in current), the higher the fault current the faster the ACR will operate to break the circuit. The over-current protection operates only if the fault current exceeds a specified level.

ACRs are often set to operate on two different over-current fault curves—a ‘slow curve’ and a ‘fast curve’. A slow curve allows a line to remain re-energised for longer before the ACR cuts power. This gives time for protection devices such as sectionalisers or fuses to operate to cut power to the network only in the area near the fault. The purpose of this is to reduce the number of customers affected by a fault and help linesmen isolate the fault location and quickly remedy the situation.

In addition to over-current faults, most ACRs used on the 22-kilovolt distribution feeder network (but not on the SWER network) can be set to operate when there is a current flow to earth—referred to as ‘sensitive earth protection’. Sensitive earth protection operates at much lower fault currents than over-current protection and cannot be used on SWER lines because a normal characteristic of such lines is that current flows to earth.¹³⁶

The incidence and types of ACR in the distribution network

ACRs are widely used in both the SP AusNet and the Powercor distribution networks in Victoria. They are installed on the great majority of three-phase 22-kilovolt distribution feeders, on about two-thirds of Powercor’s more than 1,000 SWER lines, and on 459 of SP AusNet’s 515 SWER lines. SP AusNet and Powercor use two kinds of ACRs.¹³⁷

Most ACRs used on the 22-kilovolt distribution feeders are digital electronic devices that have metering and remote supervisory control and data acquisition functions. The majority of ACRs of this type can be controlled remotely from the distribution business’s operations centre in Melbourne. It is possible to program the ACRs so as to modify their operation remotely on total fire ban days—for example, by suppressing the reclose function entirely, by reducing the number of reclose attempts, or by setting different fault curves.¹³⁸

Both SP AusNet and Powercor use a type of ACR—oil circuit reclosers—on their SWER networks. OCRs are mechanical hydraulic protection devices that cannot be controlled remotely and operate only according to the fault curves selected at the time of manufacture. SP AusNet’s OCRs are generally set to operate with two fast trips followed by two slower trips.¹³⁹

A suitably qualified linesman can manually disable the reclose function on the OCR. If the reclose function is disabled and a fault occurs, the OCR breaks the circuit in accordance with its fastest fault curve. That means the OCR is functionally equivalent to a fuse.¹⁴⁰

Since there are more than 1,000 OCRs in use in Victoria at present, it is not practicable to suppress the reclose function on all of them on every total fire ban day and then re-activate them. It would, however, be practicable to suppress the reclose function on all OCRs for the crucial period of every fire season—say, for six weeks in January and February, when bushfire risk is greatest—and then re-activate it at the end of this period.¹⁴¹

Transient and permanent faults

During the course of a year about 70 to 75 per cent of faults on a distribution network are transient. ACRs can improve the reliability of electricity supply by automatically clearing transient faults within a few seconds, rather than letting the faults interrupt supply for one to three hours while a field crew attends, manually replaces a blown fuse, and then patrols the line before restoring power.¹⁴²

ACRs do not improve the reliability of supply when the fault is a permanent one: the reclose attempts will not clear the fault, resulting in the ACR locking out and cutting power until it is restored manually.

Further, and importantly, in the case of permanent faults the ACR’s operation can substantially increase the risk of fire. This is because when a permanent fault occurs—such as a tree falling on a conductor or a conductor breaking or otherwise falling to the ground—the ACR will repeatedly restore high-voltage electricity to the conductor. This multiplies the fault current escaping in circumstances where the conductor might be close to flammable material.

On days when the large majority of faults are likely to be transient faults and the bushfire risk is low, the use of ACRs is justified by the greater reliability of supply.

The evidence suggests, however, that on high-risk bushfire days the proportion of permanent faults is much higher than the long-term average. On 7 February only 32 per cent of the faults (85 of the 264 outages) on SP AusNet’s three-phase ACR network were transient faults, in contrast with the long-term average of over 70 per cent. This was about triple the number of transient faults recorded on 1 February 2009, which was also a day of extreme fire risk. This means the majority of faults (68 per cent) on 7 February were permanent faults.¹⁴³

Powercor data for the past five years show that on an ordinary day circuit breakers operate an average of 4.24 times on the 22-kilovolt feeder network; of this number, 2.98, or 70 per cent, result in successful recloses. On total fire ban days, however, circuit breakers operate an average of 4.06 times, but only 2.17, or 53 per cent, result in successful recloses. These

figures are consistent with the experience of the State Electricity Commission of Victoria, as detailed in the report of the 1977 inquiry.¹⁴⁴

If the proportion of permanent faults that occur on a total fire ban day is higher than that for a normal day, it follows that on total fire ban days, as compared with normal days:

- ACRs provide fewer benefits in terms of ensuring reliability of supply.
- ACRs are more likely to operate by restoring high-voltage electricity to a line that has experienced a permanent fault.¹⁴⁵
- If the ACR restores electricity to a line that has experienced a permanent fault, the conditions are more likely to result in a fault causing a fire to start, and if such a fire does start it might be difficult or impossible to control.

Fault current flows and fire starts

When there is a permanent fault on a high-voltage power line and the ACR or OCR re-energises the line, this substantially multiplies the time that fault current is permitted to flow, which therefore multiplies the amount of fault energy released.

In the case of the Kilmore East fire, the OCR's operation on the Pentadeen Spur line resulted in electrical arcing at the site of the fallen power line for 18 times longer than would have occurred if the reclose function of the OCR had been suppressed. Because of the operation of the OCR, plasma at a temperature of 5,000°C was ejected on four occasions—at the time of the initial fault and then on each of the three recloses—for a total of 3.6 seconds instead of for 0.2 seconds, as would have been the case if the reclose function had been suppressed.¹⁴⁶

In the case of the Beechworth fire, the ACR's operation on the Myrtleford-7 feeder allowed about 200 amperes of fault current to flow for three times longer than it would have had the reclose function been suppressed. This probably extended the duration of the arcing between the energised conductor and the concrete pole the conductor was resting against. SP AusNet accepted that the operation of the ACR on that day increased the probability of a fire starting.¹⁴⁷

The contribution of ACRs to bushfire risk should not be treated lightly. The expert evidence before the Commission is that the Kilmore East fire probably would not have started had the reclose function on the OCR on the Pentadeen Spur line been suppressed.¹⁴⁸

SP AusNet's *Bushfire Mitigation Manual* acknowledges that a statistical survey has linked the potential fault energy with the likelihood of ignition. The amount of fault energy released can be reduced by decreasing the fault current and also by reducing the time the current flows. SP AusNet accepted that it is desirable to limit both the flow time and the level of fault current to reduce the likelihood of fires. The expert evidence before the Commission establishes that time is the most important factor determining whether an electrical fault will start a fire. Although protection engineers often use the formula $I^2 \times T$ (where 'I' is current and 'T' is time) to determine fault energy for many purposes, the formula does not accurately show the energy dissipated in an electrical arc, for which the correct formula is current multiplied by time (that is, $I \times T$).¹⁴⁹

Although the latter formula suggests that reductions in fault current and in the time the fault current flows are of equal significance, reducing the time the fault current flows is the more significant factor for two reasons:

- If the arc exists beyond a specific time the plasma is able to drive all water out of the flammable material and bring the material to the temperature at which it will ignite.¹⁵⁰
- Most protection systems will take longer to operate if current is reduced, which tends to offset the reduction in fault energy that might otherwise have resulted from a reduction in current.¹⁵¹

The fact that it is possible for a fire to start even if fault energy flows for only a short time does not constitute a logical argument against ACR suppression. The time for which fault current flows is a major contributor to the probability of a fire starting, and distribution businesses should take steps to reduce that time by adjusting ACRs on total fire ban days.¹⁵²

The electrical distribution industry's practice since at least the 1980s acknowledges that some ACRs should be suppressed on total fire ban days to reduce bushfire risk. As former Energy Safe Victoria head Mr Gardner accepted, it is 'not a contested fact within the industry' that if ACRs are left in operation on high-risk days that will increase the risk of fires. An SP AusNet document went further:

In the case of an ACR and those distribution feeder circuit breakers where multi-shot auto reclose is available it is possible to compromise by retaining one reclose attempt. Deciding on the net benefit of suppressing auto reclose is difficult especially where requirements for a reliable electricity supply for water pumping, communications, lighting etc are critical during periods of high

fire risk. However if a fire were to occur from a permanent fault with auto reclose left in service, defence of the situation would be difficult.¹⁵³

The suppression of ACRs: existing policies

In recognition of the risk that ACRs pose on high-risk fire days, distribution businesses have had policies for ACR suppression on total fire ban days for at least the last 20 to 30 years. The policies recognise that some reduction in reliability of supply is appropriate on high-risk days to reduce the chance that a fault will cause a fire.¹⁵⁴

The policies of the two main distribution businesses in Victoria are, however, very different.

Powercor

In relation to its 22-kilovolt distribution feeders, Powercor decides whether to suppress ACR reclose functions on feeders in high-risk bushfire areas on total fire ban days on a feeder-by-feeder basis. The policy is set out in the organisation's Operational Contingency Plan, which is attached to its Bushfire Mitigation Plan.¹⁵⁵

Whether the reclose function is suppressed depends on the maximum fault energy that can flow at that point in the distribution network. Powercor compares the maximum fault current at a particular location with a State Electricity Commission of Victoria table that analyses fire start data and the probability of fire starts at particular levels of fault energy. The table shows that at particular levels of fault energy there is an unacceptable bushfire risk. Powercor has been unable to locate the analysis underpinning the table, and without that analysis it is not possible to evaluate the appropriateness of Powercor's policy—especially given that climatic conditions have changed since the table was created.¹⁵⁶

Powercor does not suppress the operation of OCRs on its SWER network on total fire ban days because the maximum fault energy that is available on SWER lines is low (typically being equal to 0.1 megajoule or less) and, according to the SECV table, does not warrant the suppression of reclose functions.¹⁵⁷

Although the maximum fault energy levels on the SWER network are low, experience on 7 February 2009 demonstrates that faults on SWER lines are capable of starting fires. The operation of the OCR on the Pentadeen Spur line obviously contributed to the starting of the Kilmore East fire, even though the fault energy levels were low relative to those that would occur on a 22-kilovolt distribution feeder. The Coleraine and Horsham fires were also started by faults on SWER lines, evidence that the fault current is high enough to start fires on high-risk days, despite the fact that those fires were not associated with the operation of ACRs, which were not installed on either of the relevant SWER lines.

The experience of 7 February suggests that a policy of suppressing reclose functions solely on the basis of maximum fault energy levels might mean that distribution businesses are not taking steps—namely, suppressing reclose functions—that would reduce the risk of the SWER network starting bushfires.

SP AusNet

The SP AusNet Bushfire Strategy Plan provides that the 'Manager of Network Operations shall ensure auto reclose is suppressed on designated feeders supplying rural areas on Total Fire Ban Days'. There are 21 'designated feeders' (those being particularly high risk feeders) that run from six zone substations. But zone substations that have neutral earth resistors no longer require the feeders to be auto-reclose suppressed on total fire ban days. Similarly, feeders with ACRs and NER protection are not auto-reclose suppressed on such days.¹⁵⁸

SP AusNet suppresses the reclose function on ACRs on three-phase and SWER lines on total fire ban days only if no NER has been installed and the maximum fault current exceeds 3,500 amperes. If an NER is not functioning SP AusNet will consider suppressing reclose functions on circuit breakers and ACRs on total fire ban days on 22-kilovolt feeders in areas of hazardous fire risk.¹⁵⁹

Any evaluation of SP AusNet's policy requires an understanding of the operation of an NER.

Current flowing on a conductor increases as resistance decreases. The length of the conductor, which impedes current, is an important source of resistance. Faults close to substations can have extremely high fault current (for example, 3,500 amperes) because the current has travelled only a short distance on the conductor. Such high currents can melt equipment on pole tops, causing particles of molten metal to start fires.¹⁶⁰

To guard against this, distribution companies can install NERs at the zone substations to increase the resistance by a further 8 ohms and so decrease the current and the risk of damage to distribution equipment (and the potential for fires to start). The impact of an NER on maximum fault current reduces dramatically, however, the further away the fault is from the zone substation, thus limiting the NER's effectiveness. For example, if a fault occurs 24 kilometres from a zone substation, an

NER might reduce the total fault current by only about 80 amperes, still leaving a fault current of over 500 amperes. A fault current of that level could easily start a fire.¹⁶¹

In the light of this, SP AusNet's blanket policy of not suppressing ACRs on feeders if the zone substation has an NER installed is not justified. The NER does reduce the maximum fault current that can result from a fault, but it does not prevent fault currents of a magnitude sufficient to start a fire.

Considering that the time the fault current flows is the most important factor in determining whether the fault will cause a fire, the time during which that current flows should be reduced (by modifying ACR operation) on total fire ban days to the maximum extent reasonably possible, no matter whether an NER has been installed.

Conclusion: suppression of ACRs

There is no doubt that the operation of automatic circuit reclosers increases the amount of energy released when a fault occurs, with a consequential increase in the risk of that fault starting a fire. Whether the increased risk of fire is acceptable—having regard to ACRs' capacity to prevent transient faults from causing interruptions to the electricity supply—is ultimately a judgment for the community.¹⁶²

Any assessment of the costs and benefits of suppressing the reclose function on ACRs must take account not only of the potential inconvenience resulting from a reduction in the reliability of supply but also of the potentially catastrophic impact and cost of a bushfire if it starts on a high-risk day, when it might be difficult or impossible to control.¹⁶³

The decision to suppress reclose functions on ACRs should not be left solely to the distribution businesses—particularly since they have financial incentives that are determined in part by ensuring the reliability of supply. The Commission notes that, when asked for his opinion about the suppression of ACRs on high-risk days, Mr Adams (formerly of SP AusNet) said, 'With a bushfire mitigation hat on it is an easy decision: you do that. With a customer [hat on] and ramifications, you make the other call'. He went on to say he thought the balance could move in favour of more suppression of reclose functionality and that customers might be prepared to tolerate the inconvenience on days of very high risk.¹⁶⁴

The need for a policy change in relation to ACR suppression is graphically illustrated by the Kilmore East fire, which started because an ACR reclosed when there was a permanent fault on the line. That ACR was left in service in an effort to improve the reliability of supply on a SWER line that served just 20 customers, yet the resulting fire claimed the lives of 119 people.¹⁶⁵

The SWER network

Both SP AusNet's and Powercor's SWER networks are almost exclusively in CFA-designated high-risk bushfire areas. Much of the SWER network is now 50 to 60 years old and exhibiting end-of-life characteristics, so it can be expected that failures will occur on the network more regularly in future, particularly on days of extreme weather.¹⁶⁶

In these circumstances the operation of ACRs on days of high fire risk to improve the reliability of electricity supply to a small number of customers poses an unacceptable risk considering the bushfire risk it presents to those customers and to the broader community.

Because it is not practicable to suppress the operation of ACRs on the SWER network only on total fire ban days (suppression must be done manually), the Commission considers that a suitable balance would be for distribution businesses to suppress ACR reclose functions on SWER networks for the six most crucial weeks of every fire season. This would be an interim measure lasting only until the distribution businesses replace the SWER network with underground cable, aerial bundled cable or other technologies that deliver greatly reduced bushfire risk.

The suppression of oil circuit reclosers during part of the fire season will have some detrimental impact on the reliability of supply on the relevant SWER lines. That effect should not, however, be overstated:¹⁶⁷

- Even if the reclose function is suppressed for six weeks during the fire season, the reliability of the affected SWER lines during that time will be the same as it is on the 33 per cent of Powercor SWER lines and the 10 per cent of SP AusNet SWER lines that are not fitted with OCRs. Those lines are protected by an ordinary fuse—meaning that if a fault occurs power is lost until the fuse is manually replaced. It appears that reliability on those lines is considered acceptable.¹⁶⁸
- To the extent that there is a decrease in the reliability of supply to SWER line customers, there is a corresponding benefit to those same customers in that the likelihood of fire starting in their area will be reduced.

- SWER networks serve only about 4 per cent of SP AusNet’s customers and 4.6 per cent of Powercor’s customers. Any reduction in the reliability of supply to SWER lines will thus affect only a small proportion of the community. In contrast, the reduction in bushfire risk has benefits for the entire community.¹⁶⁹
- The main arguments against suppression of the reclose function on ACRs do not apply to SWER lines because SWER lines cannot carry sufficient power to service towns, making it unlikely that essential infrastructure such as hospitals, pumping stations and incident control centres would be affected if power were lost from SWER lines. Any customers who are critically dependent on power will have—or should have—alternative sources of power such as generators since power will be lost if there is a permanent fault in any event (regardless of the operation of ACRs).
- SP AusNet agreed that suppression of reclose functions on OCRs during the fire season warranted consideration.¹⁷⁰

Distribution businesses should tell their SWER customers about the potential for decreased reliability in the electricity supply because a policy to suppress ACRs for the six weeks of greatest risk in the bushfire season is to be introduced. This would allow those customers to ensure that their fire plans are not contingent on the availability of mains electricity. In this regard the Commission notes that there could well be a need for community education, so that customers are informed about any impacts ACR suppression might have on the reliability of their power supply.

If distribution businesses do not want to manually suppress OCRs on SWER networks for six weeks during the bushfire season, they could progressively replace the OCRs with ACRs that can be remotely controlled on total fire ban days (at a cost of about \$30,000 to procure and install each one).¹⁷¹

Introduction of a policy of suppressing OCRs for six weeks during the bushfire season would substantially reduce the risk that a fault will start a fire. In the Commission’s view, had such a policy been in operation on 7 February, it is unlikely that the Kilmore East fire would have occurred.

The three-phase 22-kilovolt network

A different approach is warranted in the case of the 22-kilovolt feeder network because most of the ACRs on that network can have their settings adjusted remotely, making it practicable to change ACR settings only on total fire ban days.

As a transitional measure, until the distribution businesses replace those 22-kilovolt feeders in the areas of highest bushfire risk, as the Commission recommends, the reclose functions on the ACRs should be changed on every total fire ban day to allow only one reclose attempt. This should apply regardless of whether or not a neutral earth resistor has been installed at the zone substation for the relevant feeder.

The single reclose attempt could be set on the ‘slow curve’ following the initial ‘fast curve’, to ensure that there is no loss of coordination between protection devices (allowing the location of a fault to be pinpointed), to prevent unnecessary interruptions for customers upstream from the fault, and to improve the reliability of supply on feeders that serve customers with a crucial need for supply—for example, patients on life support, hospitals, incident control centres, and water and sewage pumps.¹⁷²

Such an approach would at least halve the total amount of fault energy liberated during any permanent fault, with no impact on the sequencing of protection devices and with little, if any, impact on the reliability of supply. This low-cost initiative would substantially reduce the risk of a fault on the 22-kilovolt network starting a fire.¹⁷³

The Commission is satisfied that a policy permitting one reclose would have a minimal impact on the reliability of supply because most transient faults would be cleared during the initial reclose.¹⁷⁴ To the extent that there was an impact on the reliability of supply, the Commission notes the following:

- Partial suppression of the reclose function on ACRs is *not* equivalent to cutting off power. Even if reclose functions are partially suppressed, supply will continue as normal in the absence of a fault on a total fire ban day. Further, even if a fault does occur the partial suppression of reclose functions will affect supply only if the fault is a transient one that is not cleared by the first reclose. This would be a rare event: as SP AusNet stated in relation to its overhead 22-kilovolt network, ‘... on any given day and section of the network, few if any faults would be expected to occur’.¹⁷⁵
- The suppression of reclose functions would occur only on total fire ban days, so any impact on the reliability of supply would be limited to those days on which a fire is most likely to start and to be particularly difficult to control if it does.

- If, as seems the case, the proportion of permanent faults is higher on days of total fire ban than on ordinary days, ACRs offer less benefit in terms of reliability of supply on total fire ban days than on other days but a higher risk of fire starting.
- In connection with its 22-kilovolt network, Powercor has studied the effect of ACR suppression on the reliability of supply on total fire ban days. The studies do not appear to take account of the fact that for permanent faults power would have been lost regardless of whether the reclose function was suppressed. Nor do they consider the proposal that one reclose be allowed (rather than complete suppression), which would clear the great majority of transient faults and limit adverse impacts on the reliability of supply. Nevertheless, even the impact on supply suggested by Powercor's studies seems to be an acceptable trade-off if a substantial reduction in bushfire risk on total fire ban days is the result.¹⁷⁶

RECOMMENDATION 32

The State (through Energy Safe Victoria) require distribution businesses to do the following:

- disable the reclose function on the automatic circuit reclosers on all SWER lines for the six weeks of greatest risk in every fire season
- adjust the reclose function on the automatic circuit reclosers on all 22-kilovolt feeders on all total fire ban days to permit only one reclose attempt before lockout.

OTHER DEVICES FOR LIMITING FIRE RISK

Dampers

A damper is a relatively simple device used for minimising the effects of wind-induced vibration on power lines. Sustained vibration can lead to wearing and abrasion of a conductor and the ties near the connection point. It is for this reason that dampers are normally installed within a hand's width of where the conductor finishes at a pole.

Dampers are helically wound around the outside of the conductor and clamped at one end. As the vibrating conductor hits the inside of the damper coil the coil disturbs the build-up of natural frequency, thereby reducing vibration.¹⁷⁷

Cheap dampers have been available for a long time. In about 1992 the State Electricity Commission of Victoria introduced a requirement that dampers be fitted on all new conductors of a specified tension and on both ends of any span of 300 metres or more. Similarly, in June 2009 SP AusNet proposed that dampers be fitted to all conductors with a span greater than 300 metres.¹⁷⁸

SP AusNet has, however, no plan to retrofit dampers to old lines with spans exceeding 300 metres, ostensibly because, as Mr Paul Lane, Regional Manager for North Region of SP AusNet, explained, the volume of incidents in which fatigue is implicated does not warrant such a program. Even when the Pentadeen Spur line—the span of which is more than 1 kilometre—was restrung after the Kilmore East fire the linesmen did not fit dampers. Yet Mr Lane acknowledged that an absence of dampers can lead to a big reduction in conductor life as a result of fatigue, as demonstrated in documents prepared by the Energy Networks Association.¹⁷⁹

The Commission considers it illogical to agree, as Mr Lane did, on one hand that the fitting of dampers to new spans of line greater than 300 metres long is warranted yet not to embark on a retrofitting program for existing spans of that length or more.

As a transitional measure aimed at reducing the risk that the existing network will cause more bushfires before it has been replaced, dampers or other vibration-reducing devices such as shed insulators should be required to be fitted or retrofitted to conductor spans in excess of 300 metres in the areas of greatest bushfire risk.¹⁸⁰

Spreaders

The problem of clashing conductors and the consequent electrical arcing causing molten particles to start fires is not new. The State Electricity Commission of Victoria considered clashing in detail as early as 1969. Testing showed that clashing conductors could produce incandescent particles that in dry, hot conditions could start a fire.¹⁸¹

It was recognised in 1969 that, along with leaning poles and twisted cross-arms, ‘slack spans’ were a primary cause of clashing. The SECV had installed more than 100 fibreglass spreaders in the Barwon region before April 1969 to limit the risk of clashing where slack spans were suspected of causing faults.¹⁸²

Conductor clashing was also a major cause of fires in 1977, and Sir Esler Barber commented on this in some detail in his report. Among other things, he said, ‘There were many places, for example Beeac and Balliang East, where the LV [low-voltage] lines were exposed to high winds and where clashing occurred in consequence and this could have been avoided by the installation of spacers’.¹⁸³

Sir Esler also observed that in many instances spreaders had not been installed when they should have been but that the SECV had given its assurance that steps had ‘already been taken and that in future this danger will be eliminated’.¹⁸⁴ Regrettably, the danger has not been eliminated if the Colac–Camperdown line is a representative example. For further discussion of this, see the discussion of the Pomborneit–Weerite fire in Chapter 8 of Volume I.

Mr Vince Power, Powercor manager Network Safety, Environment and Compliance, gave evidence that Powercor intended to fit spreaders on specific spans of the Colac–Camperdown line and that a detailed survey of that line would be carried out in order to identify problems and obviate line clashes. It seems that this work has recently begun, although, considering that the Colac–Camperdown line has a long history of clashing, the work should have been done many years ago.¹⁸⁵

In relation to clashing and the use of spreaders, the Barber report stated:

As to such lines as are presently in existence, where any danger of clashing of conductors is possible, consideration should be given as to whether or not the line should be reinstalled. Where this is impracticable, then spreaders to avoid contact between the wires must be installed immediately.¹⁸⁶

As to the fitting of spreaders, the following recommendation by the Commission is as apt in 2010 as it was in 1977.

RECOMMENDATION 33

The State (through Energy Safe Victoria) require distribution businesses to do the following:

- fit spreaders to any lines with a history of clashing or the potential to do so
- fit or retrofit all spans that are more than 300 metres long with vibration dampers as soon as is reasonably practicable.

4.7 ENERGY SAFE VICTORIA

In the light of the foregoing discussion highlighting the need for major changes to reduce the bushfire risk posed by electricity assets, Energy Safe Victoria must have a more prominent role as safety regulator.

ESV is constituted under s. 4 of Victoria’s *Energy Safe Victoria Act 2005*. It was established when the Office of the Chief Electrical Inspector merged with the Office of Gas Safety. Among its functions are those conferred by the State’s *Electricity Safety Act 1998*, although most of these are not relevant to bushfires. This is reflected in the fact that, out of ESV’s 90 staff, the equivalent of two full-time staff are devoted to matters relating to bushfire mitigation.¹⁸⁷

Professor Graeme Hodge, Director of the Centre for Regulatory Studies in the Faculty of Law at Monash University, gave evidence that ‘the mandate of ESV appears weak and confused’. He said the Electricity Safety Act makes no explicit mention of fires originating from electrical assets and fails to give ESV any clear mandate in relation to things that might be construed as being outside the direct electrical safety area. He considered this to be partly why ESV devotes such limited resources to bushfire mitigation activity.¹⁸⁸

Among ESV’s bushfire-related functions are the following:

- investigating incidents that have implications for electricity safety—CFA investigators contact ESV if they consider a fire might have been caused by electricity, and an ESV inspector attends the fire with the CFA investigator in order to determine whether electricity was the fire’s cause¹⁸⁹

- monitoring and enforcing compliance with the Electricity Safety Act and its Regulations in relation to bushfire mitigation plans, line clearance plans and electricity safety management schemes.

Powers

Three legislative provisions give ESV power to ‘approve’ how distribution businesses propose to meet their obligation to operate and maintain their networks safely:

- Section 102(2) of the Electricity Safety Act gives ESV a power to ‘accept’ electricity safety management schemes, and it must do so ‘if it is satisfied that the ... scheme is appropriate for the supply network to which it applies and complies with this Act and the regulations relating to electricity’.
- Section 83A of the Electricity Safety Act confers on ESV the power to approve bushfire mitigation plans.
- The Code of Practice under the Electricity Safety (Line Clearance) Regulations 2010 (and previously under Electricity Safety (Line Clearance) Regulations 2005) gives ESV the power to approve line clearance plans submitted by distribution businesses.

Approval of electricity safety management schemes

Mr Gardner, former head of ESV, explained to the Commission that ESV ‘does not place a large degree of emphasis on the ESMS [Electricity Safety Management Scheme] system when it comes to regulating electricity distribution businesses who have assets in bushfire-prone areas’. It concentrates instead on assessing and auditing bushfire mitigation plans and line clearance plans as a means of regulating those matters.¹⁹⁰

The Commission notes that in the past ESV chose not to make use of the powerful tool that ESMSs represent, relying instead on statutory provisions that give it less capacity to influence distribution businesses’ behaviour. The ESMS regime has, however, undergone important changes. It is now compulsory for the distribution businesses to participate in the ESMS regime and specify how they will meet their obligations under s. 98 of the Electricity Safety Act.

Since December 2009 s. 98 of the Electricity Safety Act has required that each ‘major electricity company’—which includes the distribution businesses—design, construct, operate, maintain and decommission its supply network to minimise the following as far as practicable:

- hazards and risks to the safety of any person arising from the supply network
- hazards and risks of damage to the property of any person arising from the supply network.¹⁹¹

That obligation reflects the need for distribution businesses to balance the need to augment the safety of people and property against other objectives as far as ‘practicable’:

having regard to—

- (a) the severity of the hazard or risk in question;
- (b) the state of knowledge about the hazard or risk and any ways of removing or mitigating the hazard or risk;
- (c) the availability and suitability of ways to remove or mitigate the hazard or risk; and
- (d) the cost of removing or mitigating the hazard or risk.

ESV’s function in approving a distribution business’s ESMS allows it to influence how distribution businesses strike the balance between these competing considerations.

One consequence of the comprehensive ESMS regime is that the Electricity Safety (Management) Regulations 2009 strengthen the distribution businesses’ reporting requirements for electricity-related fires. ESV should be armed with data about the specific circumstances of all fires caused by failed distribution infrastructure so that it can identify trends that can be taken into account in the development of bushfire prevention strategies. To that end, it is important that ESV receives information about network failures that had the potential to cause a fire but did not. The Electricity Safety (Management) Regulations will go some way towards ensuring that ESV becomes aware of those ‘near misses’. The Regulations provide that, in addition to reporting ‘serious electrical incidents’ (those causing death, injury, significant property damage or disruption to the community), distribution businesses must now provide a quarterly statistical summary of ‘specified electrical incidents’ (relevantly, resulting in fire from an operator’s network or part of the network becoming dislodged from its supporting structure).¹⁹²

The Commission notes, however, that ESV's ability to effectively detect and analyse trends relating to electricity-related fires depends on the accuracy and detail of the data it receives—whether from the distribution businesses or from other sources such as its joint investigation with the CFA of electrical incidents. The Commission further notes that the quarterly statistical summary of 'specified electrical incidents' the distribution businesses are required to provide to ESV might not furnish sufficient data for ESV to carry out that important analysis. ESV should take an active approach to obtaining the requisite details—be it from the distribution businesses or the fire agencies—about the electricity failures of which it becomes aware.

Approval of bushfire mitigation plans

ESV has a very limited view of its power to refuse approval of bushfire mitigation plans. Mr Gardner explained to the Commission:

... The office assesses the plans against the criteria that are set out in the Regulations. We obviously discuss the content of the plans with the distribution businesses. Provided on the face of it they look adequate, then we are really obliged under the Regulations to approve the plans. There is no ability for us in terms of dealing with bushfire mitigation plans to go back and say, 'No, we are imposing a different standard'.¹⁹³

4.7.1 A WEAK REGULATOR

Mr Gardner explained that 'ESV regulates electricity infrastructure by focusing on the various systems by which regulated entities operate' on the basis that the organisation that creates the risk should be responsible for managing the risk. He declined to agree that ESV was better placed than the distribution businesses to make an objective judgment about what is an acceptable risk level. He did say, though, that in some circumstances decisions about safety need to involve a wider level of community consultation and that operators in the distribution businesses should not make that judgment.¹⁹⁴ He explained:

ESV attempts to adopt a co-regulatory approach to the regulation of the energy sector. In the area of electricity this means that the regulated entities will regulate their businesses in accordance with the various systems they have adopted. For its part, ESV seeks to collect information to inform itself on whether the particular regulated entity has adequate systems that are being properly applied and utilised.¹⁹⁵

The Commission endorses the view of Professor Hodge, who noted that, although co-regulation is a legitimate regulatory style in certain circumstances, as practised by ESV it appears to be nothing more than 'compliance ritualism'.¹⁹⁶ The focus is on ticking boxes rather than substantive matters:

- ESV eschews any role in making substantive judgments, taking the view that 'the whole regulatory system that is in place at the moment is designed to get the distribution businesses to make those decisions'.¹⁹⁷
- Although ESV will consider a policy's content to satisfy itself 'not only that the issues [have] been covered but at least on the face of it that they looked reasonable and that improvements were occurring', it believes it does have to approve a plan if the distribution business has dealt with all the areas that are covered in the Regulations.¹⁹⁸
- ESV does not judge how the distribution businesses should achieve the best safety outcomes, only challenging the businesses if their plan contains something that is wrong or 'wildly inconsistent with what everyone else [is] doing'.¹⁹⁹

Mr Gardner agreed that there would definitely be benefits in having a standard, at least in relation to certain areas.²⁰⁰

The Commission notes that ESV's weak position is apparent from the distribution businesses' responses to the criticisms raised by auditors ESV engaged to identify problems with bushfire mitigation plans. For example:

- Powercor simply rejected the auditor's conclusion that the majority of rusty ties and conductors were not being detected in the asset inspection process.²⁰¹
- SP AusNet chose to take no action in response to the shortcomings the auditor identified in relation to rust on conductors and tie wires in its network.²⁰²

ESV's lack of influence over the distribution businesses was similarly illustrated by the meeting the businesses had with ESV following the 7 February bushfires, at which Mr Gardner raised the possibility of introducing age-based asset replacement. His proposal was rejected by the distribution businesses as being expensive and at odds with the risk-based ESMS regime.²⁰³

Mr Gardner acknowledged that there were some difficulties in relation to audit compliance but said ESV had little power to sanction the distribution businesses:

... It may be necessary for ESV to issue a direction that a particular issue be rectified ... Whilst this power exists, it is rare for ESV to issue such directions in relation to issues identified by an audit. The reason for this is that the directions powers contained in the Electricity Safety Act are designed to deal with specific issues or failures by a regulated entity. The audits on the other hand are more focused on systemic regulatory considerations. For that reason, the issues identified by an audit will rarely be issues that can be rectified through issuing a direction.²⁰⁴

Mr Gardner told the Commission ‘there is certainly a case for, as assets get older, inspection frequency [to get] shorter and perhaps the inspection analysis required becomes more stringent’. He added, ‘ESV should be requiring their businesses to re-examine the inspection intervals for all of their components and to re-demonstrate what is an appropriate inspection interval, which may vary depending on the age of the asset’.²⁰⁵

Notwithstanding those views, there is no evidence before the Commission that ESV has ever tried to use its position as safety regulator to change the existing cycle or perform the necessary analysis to support an argument favouring either a three- or a five-year inspection cycle. ESV has never revisited the Office of the Chief Electrical Inspector’s decision in 1999–2000 to permit Powercor to move its standard inspection cycle from every three-to-three-and-a-half years to every five years, which then became the industry standard. ESV has since regularly approved bushfire mitigation plans with five-year inspection cycles, essentially on the basis that ‘there is no obvious increase in failures’.²⁰⁶

Professor Hodge said the regulator should be expert in relation to all the facts and matters that bear on the policy decisions in the areas it operates, so that there is an independent source of expert knowledge. In his opinion, ESV did not perform that role and nor did it try to. It did not have the ‘fierce analytical basis on which regulatory activities proceed’ that is characteristic of a strong regulator, operating instead as ‘more a bureaucratic regulatory checker’.²⁰⁷

That opinion was clearly supported by the evidence of Mr Fearon, Energy Safe Victoria’s Director. When asked about the ageing distribution network and its risk to safety, Mr Fearon said, ‘We would not see it as our role to assess the complex trade-off of cost, reliability and safety as it pertains to those technology options’, and that he did not believe ESV would ever be able to retain the sort of expertise to undertake such assessments.²⁰⁸ Mr Gardner echoed this sentiment:

In terms of getting the regulated entity to come up with the solutions, again that’s part of this process. They are large organisations. They have the expertise. They have the information. They know the state of their assets better than anyone else. So they are in a better position to make some of these judgments than anyone else as well.²⁰⁹

Professor Hodge did not accept that ESV was not able to retain the requisite expertise, noting that the expertise required by the distribution businesses was quite different from that required by the safety regulator but that regulators should never ‘have less intelligence’ than the entities they regulate. He also said he would expect a safety regulator, in its interactions with government and with the distribution businesses, to promote reforms that would improve safety:

An appropriate role of a regulator in this context might be to proactively examine technological options that would be available that would decrease risk and to explore the benefits and costs associated with those kinds of technologies and then to make recommendations to the businesses about them.²¹⁰

Even when the distribution businesses have used their expertise and resources to develop safety initiatives, ESV has not always supported their proposals to obtain revenue allowances to implement those initiatives. Earlier in this chapter the Commission notes that ESV did not make submissions in relation to Powercor’s 2005 revenue proposal to the economic regulator about underground cabling in areas of high bushfire risk. In that instance ESV was neither co-regulatory nor proactive in its approach: it simply did nothing.

The future role of ESV

The State of Victoria should reform ESV and fund it in such a way as to enable it to provide the analytical base necessary for proposing and evaluating safety reforms and advocating those reforms in submissions to the Australian Energy Regulator. The need for an independent body to perform those functions is strongly supported by the evidence before the Commission.

Since the February 2009 fires ESV has sought to gain a greater understanding of SP AusNet’s current asset management system, including by way of additional audit. Mr Gardner said the aim was to revisit the entire system—‘to take everyone

back to scratch and start again'. The Commission endorses ESV's plan to use the audit results to decide whether changes should be made to existing asset maintenance and bushfire plans.²¹¹

If ESV acquires a strong analytical basis and sufficient resources, it will have a foundation on which to use its powers to influence distribution businesses in a way that would reduce the risk of bushfires. For example, the Commission considers this would equip ESV to make judgments about the need to adopt other technologies and methodologies, such as the following:

- age-based replacement programs
- inspection programs that vary according to asset age or location
- underground or aerial bundled cables.

This would also enable ESV to determine whether the bushfire mitigation plans put forward by distribution businesses minimise fire risk to the greatest extent practicable.

The Commission is strongly of the view that a strengthening of ESV's regulatory powers is needed, including the ability to apply sanctions in relation to non-performance, so that it can take a more active role in monitoring and regulating the electricity distribution industry in Victoria.

RECOMMENDATION 34

The State amend the regulatory framework for electricity safety to strengthen Energy Safe Victoria's mandate in relation to the prevention and mitigation of electricity-caused bushfires and to require it to fulfil that mandate.