Electricity Transmission Revised Proposal

2008/09 – 2013/14

Appendix G

SAHA Valuation of Self-insurance Risks

SP AusNet
A member of Singapore Power Group

SAHA INTERNATIONAL

SP AusNet

Valuation of Self-Insurance Risks (Electricity Transmission)

February 2007

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DISCLAIMER

Saha International Limited (Saha) has prepared this report taking all reasonable care and diligence required. This report attempts to quantify the risks faced by SP AusNet in relation to their Electricity Transmission business. The proposal document (and accompanying correspondence) should be read to provide a clear understanding of the terms of reference and the limitations of the report.

In completing this review we have relied on documents and information provided to us by SP AusNet and other third parties for the purpose of our review. Saha has not checked information provided by third parties for accuracy as it is beyond our scope. It should be noted that if any of this information is inaccurate or incomplete, this report may have to be revised.

While Saha has used all reasonable endeavors to ensure the information in this report is as accurate as practicable, Saha, its contributors, employees, and Directors shall not be liable (whether in contract, tort (including negligence), equity or on any other basis) for any loss or damage sustained by any person relying on this document whatever the cause of such loss or damage.

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EXECUTIVE SUMMARY

SP AusNet is in the process of preparing to submit an application for the Australian Energy Regulator (AER) to determine its revenue cap for the regulatory period 2008 to 2013. SP AusNet owns, develops, operates and maintains Victoria's only high voltage electricity transmission network.

One of the issues in determining the revenue for the regulatory period is the cost of self-insurance to the Electricity Transmission business. SP AusNet notes that not only are they required to consider self insurance costs for risks not insured by a third party, they are also susceptible to addition cost (where they have to self insured for) even for their insured risks due to deductible, limit and exclusion conditions outlined in the current insurance policies.

Saha International Ltd (Saha) is engaged by SP AusNet to undertake a valuation of its self-insured risks. Saha is providing assistance to SP AusNet in the development of its argument to AER by quantifying the self insurance cost estimate.

This report constitutes the second phase of the project, where we have assessed SP AusNet self insurance in more detail and have substantiated the numbers for the purposes of SP AusNet further interaction with the AER.

In conjunction with SP AusNet, Saha had identified 13 key types of risk against which SP AusNet has significant self-insurance costs. These risks have been addressed in detail in separate sections of this report.

Our estimates of the costs of self-insured risks considered in this report are shown in Table 0-1 below:

Table 0-1 Summary of Estimated Risk Premiums for SP AusNet Self-Insured Risks (Electricity Transmission)

CATEGORY OF RISK	ANNUAL RISK PREMIUM	6 -YEAR RISK PREMIUM
Risk of Property Damage to Towers and Lines	$305,851	$1,835,106
Bushfire Liability Risk	$2,023	$12,138
Risk of Theft at Remote Stations	$125,000	$750,000
Risk of Power and Current Transformer Failure	$1,154,300	$6,925,800
Risk of Circuit Breaker Failures	$847,440	$5,084,640
Risk of GIS Failures	$27,155	$162,930
Risk of Bomb Threats, Extortion and Acts of Terrorism	$11,600	$69,600
Key Person Risk	$63,425	$380,550
Insurer's Credit Risk	$1,652	$9,912
Risk of Non-Terrorist Impact of Planes and Helicopters	$1,000	$6,000
Total Risk Premium	**$2,539,446**	**$15,236,676**

INTRODUCTION & SCOPE

SP AusNet is in the process of preparing an application for regulatory price reset for the period 2008 – 2013. As part of this application SP AusNet has engaged Saha to undertake a valuation of its self-insured risks for its Electricity Transmission business as part of their reset applications.

RELIANCES

In developing our views we have relied on information provided by SP AusNet and publicly available information (qualitative, quantitative, written and verbal) and our discussions with SP AusNet personnel. We have not independently verified or audited the data but we have reviewed it for general reasonableness and consistency. It should be noted that if any data or other information is inaccurate or incomplete, this report may need to be revised.

Due to the time constraint of the project, we have not had an opportunity to conduct a thorough analysis of some of the information provided. Therefore, any results or views presented in this report must be taken as indicative at this stage.

Where applicable, references have been given as to the source of the data and technical assumptions.

LIMITATIONS

This report has been prepared for SP AusNet for the purpose stated in the Introduction and Background section of the report. No other use of, or reference to, this report should be made without prior written consent from Saha International ("Saha").

Any queries on the meaning of any statements in this report should be referred to Saha. While due care has been taken in the preparation of the report, Saha accepts no responsibility for any action which may be taken based on its contents.

The statements in this report represent the results of calculations using assumptions and data from SP AusNet and public sources. As such these statements and any conclusions that may be drawn from them do not represent the advice of Saha. Saha accepts no responsibility for any use made of these statements.

WHAT IS A SELF-INSURED RISK?

Self-insured risk can be related to an approach where the risk of a negative event is carried entirely by the company, and it may also refer to the residual risk carried by a company before/after an insurance policy's excess, deductible or limit takes effect. Deductibles require the insured to pay the first portion of any claim. They are generally included in policies to encourage better risk management and to reduce an insurer's exposure to small claims (an administrative burden relative to claim size).

Therefore, although SP AusNet insures itself against a number of risks, it is still exposed to potential claim-related costs because most of the insurance coverage includes an excess or deductible. Further, SP AusNet is only covered to the extent of any insurance limit. This means that there is potential for SP AusNet to exhaust its cover and any claims cost in excess of the limit fall back on SP AusNet.

The occurrence of a self insured risk would result in a loss on SP AusNet returns when it would not be covered by the company's insurance policies due to deductible, limit and exclusions or insufficient funds set aside for self insurance purposes. This would result in SP AusNet receiving a lower than intended regulatory return because the annualised financial impact (when negative event occur) represents a real cost to SP AusNet.

In many cases SP AusNet would be able to obtain insurance for the self-insured risks we have valued in this report. However, sometimes this may not be feasible or efficient. Valid reasons for SP AusNet limiting the level of insurance purchased from private insurers or reinsurers include:

- SP AusNet believes the quoted insurance premium is excessive given the underlying risk level;
- the required insurance is not readily available;
- SP AusNet has sufficient resources to withstand the risks in question (for example, risks within the insurance 'deductible');
- SP AusNet has accepted an attractive premium on a 'standard' insurance policy which includes a range of exclusions, and the cost of 'writing back' the exclusions exceeds the SP AusNet's perceived value of the excluded risks; or
- the insurer requires SP AusNet to bear a reasonable share of each claim to incentivise it to manage its risks more effectively.

The efficiency of decisions taken around self-insurance by some utility businesses has been recognised in recent Australian regulatory decisions, where:

- the ACCC approved an allowance for self-insurance in the Powerlink transmission network revenue cap (2006), GasNet access arrangement (2003) and the SPI PowerNet revenue cap (2002); and
- in its *NSW Electricity Distribution Pricing 2004/05 to 2008/09, Final Report* (June 2004) IPART and the ACCC allowed EnergyAustralia self-insurance costs for the regulatory period.

While SP AusNet has insurance cover for many risks (e.g. public liability and material loss of assets such as substations) there remains a range of risks for which SP AusNet is not currently explicitly insured, for reasons such as those listed. All efforts to mitigate risk internally are taken, but some residual risk is present, leading to costs borne by the company should a negative event occur.

This is of particular concern for those events which have a low probability of occurrence – and thus are not specifically forecast to occur – but represent a very high (negative) impact on the business and/or customers should they occur. A key example of such an event would be a significant bushfire in the SP AusNet region and EMF claims.

The scope of the study was to quantify the key risk events identified during our investigations and estimate an equivalent annualised self insurance cost for them.

METHODOLOGY FOR THE VALUATION OF SELF-INSURED EVENTS

Our self insured risks valuation is carried out in two phases whereby phase 1 primarily focused on the identification of risks events in particular risks outside of SP AusNet normal operations and maintenance control. Phase 2 involved the detail quantification of the risk events identified under current insurance conditions.

Phase 1 of the study has been prepared following a number of meetings with SP AusNet staff and review of a number documents provided for our study. In this phase, we have identified the events and provided a preliminary financial impact estimate for the events with respect to magnitude of exposure.

Phase 2 of the study provides a comprehensive valuation of SP AusNet potential liabilities if these events are to occur during the regulatory period. The valuation involves a more detail quantification and justification of the initial estimates made in Phase 1.

In Phase 2, we have developed a methodology to analyse each event as they are different depending on type, impact on SP AusNet and the information we can source for the event. The basis of our approach to quantify the value of each event is to multiply the following two quantities:

- The estimated annual probability of that event occurring;
- The estimated financial consequences associated with that event occurring;

The determination of probabilities and financial consequences is derived from a variety of means. We have based our estimates from the information we received from SP AusNet, market information, information from other jurisdictions, statistics/data from reputable resources and our experience in the utility industry.

The (detail) means by which figures were calculated under the methodology developed for each risk are described in the next section.

PART 2 DETAILED FINDINGS

1. RISK OF PROPERTY DAMAGE TO TOWERS AND LINES

1.1 Introduction

Forming part of its regulated asset base, SP AusNet's electricity transmission network consists of over 6,500 km of transmission lines operating at voltages ranging from 66 kV up to 500 kV. Supported by 12,888 towers, the network carries electricity from power stations to electricity distributors and large customers around Victoria.

Table 1-1 below shows the number of SP AusNet transmission towers by operating voltage and tower type[1].

Table 1-1 Summary of SP AusNet Tower Types

NUMBER OF SP AUSNET TOWERS *According to Operating Voltage*			
VOLTAGE (kV)	TOWER TYPE		TOTAL
	Suspension	Strain	
500	2,392	353	**2,745**
330	1,283	493	**1,776**
275	167	17	**184**
220&66	6,867	1,316	**8,183**
TOTAL	**10,709**	**2,179**	**12,888**

1.2 Description of Risk

Although SP AusNet's ongoing operations and maintenance program will include a variety of reasonable measures to prevent the failure of any towers or lines, there is an inherent risk that an exogenous incident can cause the failure of a tower, or multiple towers, and/or damage to conductors. Historically, such incidents have been related to high wind conditions, failing trees and heavy vehicle causing direct or indirect damage to towers and conductors,.

In addition, there is also the probability of damage to towers and lines as the result of catastrophic incidents related to more extreme events, such as cyclones, severe storms, flooding, bushfires and earthquakes.

[1] Information provided by SP AusNet

1.3 Market Insurance Premiums

Prior to 30 November 2000, the towers and lines currently owned and managed by SP AusNet were insured for a total premium of $65,000 per annum. However, as a result of poor international experience the quoted premium for 2001 increased to $427,000. In 2007, the non-binding estimate insurance premium for towers and lines is $2,000,000[2] (shown in Table 1-2 below).

According to SP AusNet, there are only a limited number of insurers that are willing to cover towers and lines and consequently, there is significant deterioration of insurance terms. In addition there are stringent conditions whereby the insurer will only be insuring part of the total $1.8b asset value and exclusions that depend on the location of the asset and causes of damage.

As such, insurance for property risks associated with towers and lines was not renewed since 2001.

Table 1-2 Previous Tower & Lines Insurance Premiums

Period	30 Nov 2000 to 30 Nov 2001	Non-binding Estimate 2007
Premium	$427,500	$2,000,000
Limit	$10,000,000	Max of $20,000,000
Excess	$2,500,000	$1,000,000

1.4 Estimation of Self Insurance Risk Premium for Damage to Towers and Lines

The value of a risk premium associated with SP AusNet self-insuring for damage to its towers and lines is calculated as the sum of the following three components:

- Premium for the replacement/repair costs for towers;
- Additional allowance for Catastrophic events; and
- Additional allowance for damage to conductors.

The calculation of the value of each of these components is discussed in detail in the following sections.

1.5 Estimated Premium for the Replacement/Repair of Towers

1.5.1 Estimated Claim Size

Estimating the size of any claim for the failure of a transmission tower requires an estimation of the direct cost of replacing or repairing a damaged tower as well as any additional, or indirect, costs.

[2] Information provided by SP AusNet

Indirect Costs

Indirect costs of a tower failure are the costs (labour, materials and plant/equipment hire) associated with temporary by-pass works required to allow the transmission system to keep operating during the period over which the replacement/repair work is being undertaken. Based on information provided by SP AusNet, the estimated indirect costs associated with a tower failure incident is in the order of $150,000 per tower failure.

Direct Costs

The estimated direct cost to replace/repair any of SP AusNet's transmission towers is dependent on two main factors, being the voltage capacity and the type of tower (suspension or strain).

Based on the recorded incidence of tower failures, SP AusNet's 12,888 towers have been classified into towers constructed prior to 1965 and those constructed after 1965. Generally, towers constructed prior to 1965 were subject to lower design standards than post-1965 towers. In addition, strain towers are of stronger design and are less likely to fail. However, strain towers are significantly more expensive to construct than suspension towers.

Although some strengthening work has been undertaken over time to reduce the risk of failure in pre-1965 towers, all recorded tower failures in the SP AusNet transmission system since 1958 have involved towers constructed prior to 1965. In addition, all of these failures have involved suspension towers.

Table 1-3 below shows the distribution of SP AusNet's electricity transmission towers by voltage type and period of construction (i.e. pre-1965 or post-1965).

Table 1-3 SP AusNet's Transmission Tower Age Profile

SP AUSNET TRANSMISSION TOWERS AGE PROFILE BY TOWER TYPE AND OPERATING VOLTAGE									
VOLTAGE (kV)	Pre-1965 Construction			Post-1965 Construction			TOTAL		
	Suspension	Strain	Sub-Total	Suspension	Strain	Sub-Total	Suspension	Strain	Sub-Total
500	-	-	-	2,392	353	2,745	2,392	353	2,745
330	218	84	302	1,065	409	1,474	1,283	493	1,776
275	-	-	-	167	17	184	167	17	184
220&66	3,983	763	4,746	2,884	553	3,437	6,867	1,316	8,183
Total	**4,201**	**847**	**5,048**	**6,508**	**1,332**	**7,840**	**10,709**	**2,179**	**12,888**
≤ 330 KV	4,201	847	5,048	4,116	979	5,095	8,317	1,826	10,143
500kV	-	-	-	2,392	353	2,745	2,392	353	2,745

Table 1-4 below shows SP AusNet's estimated direct costs to replace/repair each type of transmission tower and the estimated costs of indirect temporary by-pass works likely to be incurred per incident. For simplicity, towers with an operating voltage of less than or equal to 330 kV have been grouped together.

Table 1-4 Estimated Cost of Tower Failure

SP AUSNET TRANSMISSION TOWERS ESTIMATED COST OF TOWER FAILURE*					
Voltage (kV)	Direct Costs		Indirect Costs	Total Costs	
	Suspension	Strain		Suspension	Strain
≤ 330 kV	150,000	480,000	150,000	**300,000**	**630,000**
500 kV	200,000	870,000	150,000	**350,000**	**1,020,000**

** Estimated cost per tower failure*

Based on the data in Table 1-3 and Table 1-4, a claim for an incident resulting in the failure of a post-1965 strain tower with an operating voltage of 500 kV is estimated to be in the order of 3.5 times that of a claim for an incident resulting in the failure of a pre-1965 suspension tower with an operating voltage of no more than 330 kV. However, in order to calculate an appropriate self-insurance premium it is necessary to determine the frequency of an incident affecting each type of tower.

1.5.2 Estimation of Incident Frequency

The frequency of incidents per annum, can be calculated as follows:

Incidents per Annum = Number of Incidents / Years of Exposure

Number of Incidents

The following historical information is available regarding tower failure incidents for the SP AusNet electricity transmission network:

- Since 1958, there have been 36 tower failures in 9 separate incidents translating to a data of 9 incidents in 49 years;
- All incidents have been associated with high wind conditions with the damage caused either directly by the force of the wind or by falling trees;
- All incidents have involved towers constructed prior to 1965 (which have lower design standards than towers constructed after 1965);
- There have been no incidents of tower failures for towers constructed after 1965;
- All incidents and tower failures have been associated with suspension towers;
- Since 1979, there have 11 tower failures in 4 separate incidents (the most recent occurring in 1999); and
- There have been no tower failure incidents since 1999.

There is no disaggregated information on the number of incidents according to the different operating voltages of the towers.

Although there are no recorded incidents of tower failure associated with SP AusNet transmission towers constructed after 1965, it would be incorrect to assume that there is no chance of an incident resulting in the failure of one of these towers. It is understood that other jurisdictions such as Queensland have experienced failures of towers of more recent designs[3]. The Queensland data indicated 2 incidents in 23 years (1980 - 2002) or 0.87 incidents every 10 years.

In addition, although the incident data indicates that all incidents to date have resulted in the failure of suspension towers, it is necessary to derive a factor for the probability of an incident causing failure of strain towers. This is because although strain towers are of stronger design, it is still possible that high winds or collisions with strain towers can cause the failure of strain towers. For this analysis we have assumed that the likelihood of a strain tower failure incident is approximately 1 in 6 years (16.7%) of the likelihood of a suspension tower failure incident.[4]

Based on the above information, we estimate the failure rate of suspension and strain towers shown in Table 1-5 below. The Queensland rate of failure has been used as the basis for post-1965 towers failure incident rates and reduced by 50% to take into account the differences in environmental conditions (eg. Terrain, storms, etc.), the larger network size in comparison to Victoria (approximately twice as many towers) and the fact there have been no recorded failures in Victoria of Post-1965 Suspension Towers.

Table 1-5 Transmission Tower Failure Incident Rate

SP AUSNET TRANSMISSION TOWERS FAILURE INCIDENT RATES		
	Pre-1965 Towers	Post-1965 Towers [3]
Suspension Towers		
Total Recorded Number of Incidents	9	2
Years of Exposure	49	23
Estimated Suspension Tower Incidence Rate (incident per annum)	**0.184**	**0.043**
Strain Towers		
Assumed likelihood of a tower failure incident (as % of estimated suspension tower incident)	16.7%	16.7%
Estimated Strain Tower Incidence Rate (incident per annum)	**0.031**	**0.007**

3 "A 220 kV transmission line with about 1,300 suspensions towers constructed in the early 1980's experienced 2 major failures at approximately seven years apart. The cause of failure was thought to be higher than expected wind loads." – Extraction from Queensland University 2003 Archived Civil Engineering Report (http://eprint.uq.edu.au/archive/00003103/01/TWS-Tower.pdf).

4. Although this assumption is somewhat arbitrary, the ratio of the total number of suspension towers in the SP AusNet transmission system (2,179) relative to the total number of transmission towers (12,888) is around 5 to 1 (i.e. 16.9%).

1.5.3 Estimation of Towers Affected per Incident

Generally, numerous towers can expect to be impacted in any one incident resulting in a tower failure. As already noted in Section 1.5.2, there have been 36 tower failures in 9 separate incidents affecting the SP AusNet transmission network since 1958. Of these incidents, 3 resulted in only 1 tower failure each incident, whereas there were 6 incidents which resulted in 3 or more tower failures each incident (refer to Table 1-6 below).

Table 1-6 SP AusNet Towers Affected per Reported Incident

SP AUSNET TRANSMISSION TOWERS AND LINES NUMBER OF TOWERS AFFECTED PER INCIDENT													
Year	Total Incidents	Mean	Median	Mode	Number of Towers Affected by Incident								
Pre 1979	5	5.00	6.00	1.00	1	1	6	7	10				
Post 1979	4	2.75	3.00	3.00	1	3	3	4					
Total Since 1958	9	4.00	3.00	1.00	1	1	1	3	3	4	6	7	10

The historical incident data implies that, on average, 4.0 towers have failed per incident. However, only 4 incidents have occurred since 1979, resulting in a total of 11 tower failures and an average of 2.75 tower failures per incident. This would appear to be an outcome of a range of works that have been undertaken to strengthen the towers constructed prior to 1965.

From looking at the information in Table 1-6 it can be seen that the number of towers affected per incident has reduced in recent times, however the incident that resulted in 10 towers being affected may still occur in the future and the cause of this incident may be a less frequent event than the incidents that result in lower tower failures. Therefore, to create the estimate of future towers affected by an incident we used the average of the mean and median for the overall data to give an estimate of 3.5 towers per incident.

In the event of a strain tower, there is no historical information provided on incidents or towers affected, however if an incident involved a strain tower then the associated number of tower failures would most likely be higher due to the nature of the strain towers in the network. For the purposes of this review the number of towers affected by a strain tower incident is assumed to be 5, as the strain tower could potentially bring the suspension towers surrounding the strain tower down.

1.5.4 Estimation of Self Insurance Risk Premium

Table 1-7 below shows the calculated estimate of a self-insurance risk premium for SP AusNet's electricity transmission towers. We calculate the real annual financing costs of SP AusNet capital expenditure (direct cost for tower replacement) base on a 6% WACC.

Table 1-7 Self-Insurance Calculation for Transmission Towers

SP AUSNET TRANSMISSION TOWERS AND LINES CALCULATION OF SELF-INSURANCE RISK PREMIUMS										
Tower Type	Tower Description	No. of Towers	Direct Cost	Financing Cost	Weighted Average Financing Cost	Indirect Cost	Average Claim Cost	Incident Rate Per Annum	Tower Failures Per Incident	Estimated Risk Premium
Pre-1965 Construction										
Suspension	<=330 kv	4201	$150,000	$9,000	n/a	$150,000	$159,000	0.184	3.5	$102,214
Strain	<=330 kv	847	$480,000	$28,000	n/a	$150,000	$178,000	0.031	5.0	$27,299
Estimated Self-Insurance Risk (Pre-1965 Towers)										**$129,514**
Post-1965 Construction										
Suspension	<=330 kv	4116	$200,000	$12,000	$10,103	$150,000	$160,103	0.043	3.5	$24,364
	550 kv	2392	$870,000	$52,200						
Strain	<=330 kv	979	$150,000	$9,000	$35,001	$150,000	$185,001	0.007	5.0	$6,716
	550 kv	847	$480,000	$28,800						
Estimated Self-Insurance Risk (Post-1965 Towers)										**$31,080**
Total Estimated Self-Insurance Risk Premiums										**$160,594**

1.6 Estimate of Additional Risk Premium for Catastrophic Events

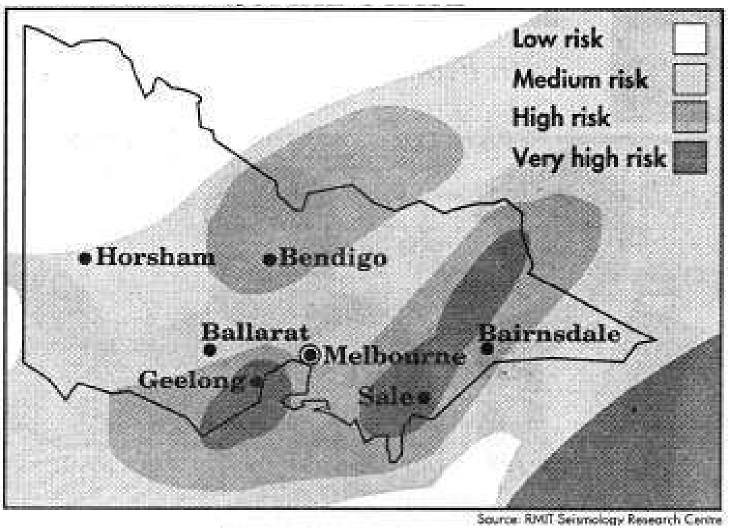
Victoria is not ordinarily prone to extreme or frequent catastrophic events (for example, earthquakes, bushfires, cyclones and severe storm) which can cause extensive and widespread damage to power transmission networks, as has been experienced in other parts of the world. Nevertheless, there is still a risk, albeit relatively small, that such catastrophic events could have an impact on SP AusNet's transmission network.

We have assumed that there are primarily 2 types of extreme events which could have catastrophic impacts on the SP AusNet electricity transmission network: (a) catastrophic bushfires and (b) catastrophic earthquakes. However, in this analysis, we have considered only the potential risk of an earthquake which has an epicentre close to SP AusNet's electricity transmission network assets.

In comparison to some other countries located close to tectonic zones, Australia is subject to a relatively small earthquake hazard. However, whilst the risk of an earthquake in Australia is small, the degree of damage can be significant, as demonstrated by the Newcastle earthquake in 1989 which killed 13 people and caused significant property damage.

Previous analysis undertaken by the RMIT Seismology Research Centre indicates that parts of Victoria are subject to earthquake risks comparable to Newcastle. As indicated in Figure 1-1 below, South Gippsland is one of Australia's earthquake hotspots with relative probability of an earthquake also occurring near Geelong and Echuca. Although most earthquakes in Victoria are too small and deep to be felt, an earthquake in Victoria similar to that in Newcastle could not be ruled out.

Figure 1-1 Victorian Earthquake Risk Zones



Unfortunately, quantification of earthquake risk is at best an imprecise science, particularly with the limited historical data available on Australian earthquake activity. However, for this analysis we have made the following assumptions:

- From the GeoScience Australia website, there were 12 earthquakes greater than 5 magnitude recorded in Victoria (there is no earthquake greater than 6) in the past 150 years, which translates to a 12 in 150 probability. However, these earthquakes occurred at the Alpine regions or at locations where they did not create catastrophic impact on SP AusNet transmission assets. We therefore, reduce the probability to 1 in 150.

- An earthquake of magnitude 5 and above could result in catastrophic destruction for distances of up to 14 kilometres from the epicentre[5], which equates to a diameter of 28 km. According to Figure 1, Latrobe Valley is considered a very high risk region. This is the Eastern Corridor that connects the greater Melbourne load centre to the electric generators in the Latrobe Valley. Regardless of tower types (220&66 – 500kv), there are at least 2 transmission lines (maximum of 6 lines) connecting SP AusNet terminal stations.

  Assuming an average estimated distance between transmission towers of 500m[6] an earthquake could impact at least 112 towers (2 lines, 28km each).

- Based on the number of towers for each type of tower shown in Table 1-3 and the estimated cost of a claim for each tower type shown in Table 1-4, the average weighted cost of a claim for a catastrophic event is estimated to be $375,756 (including capital cost) and $163,546 (excluding capital cost but including financing cost) per tower. We have chosen the latter for our calculation.

The estimation of an annual risk premium for a catastrophic event impacting on the SP AusNet electricity transmission network is calculated as follows:

5 http://www.ga.gov.au/urban/listquakes.php?month=05&year=2006 (Click on Oodnadatta SA – Magnitude 5.1)

6. Divide 13,000 towers by 6,500 km = 2 towers per km (500m between each transmission tower) - Source of 6,500km from SP AusNet 2006 annual report.

Probability of Catastrophic Event * Number of Towers Affected * Average Claim per Tower

***1/150 * 112 * 163,546 =* $122,114 per annum**

1.7 Estimate of Additional Risk Premium for Damage to Conductors

We have been able to ascertain a number of recorded conductor incidents. The following highlights some examples of damages to SP AusNet's conductor:

- Damage to a line at Keon Park costing approximately $350,000 – *Major Damage*.
- A conductor breakage which causes cross-arm damage on the YPS-ROTS 220KV line – Medium damage.
- Insulator pin failure on the KTS-GTS line causing a conductor to drop – Minor damage.

Determining the actual cost of any conductor damage incident can be difficult to quantify given the scope of possible incidents and related damage, ranging from minor conductor damage to major incidents of broken conductors which cause consequential tower damage. Nevertheless, Table 1-8 below indicates the estimated costs associated with a number of different incidents of conductor failure. We have assumed a 50:50 breakdown between capital (direct) and operating (indirect) costs for all levels of conductor damage and have calculated the annual financing costs of SP AusNet capital expenditure base on a 6% WACC. We have estimated an additional component for the self-insurance risk premium related to conductor failure of $23,143. This estimate is based on recorded evidence of actual occurrence at Keon Park, SP AusNet recorded evidence of cross arm incidents on the YPS-ROTS 220kV line on 12 May 2005 (2001 – 2006) report, and based on SP AusNet recorded evidence (2001 – 2006 report) of conductor and ground wires failure.

Table 1-8 Conductor Failure Self-Insurance Risk Calculation[7]

SP AUSNET TRANSMISSION NETWORK (TOWERS & WIRES) ADDITIONAL RISK PREMIUM - CONDUCTOR FAILURE							
Scenario	**Example**	**Likelihood**	**Estimated Replacement Cost**	**Direct Replacement Cost**	**Financing Cost**	**Indirect Cost**	**Estimated Premium**
Major Damage to Conductor	Corrosion	1 in 30	$350,000	$175,000	$10,500	$175,000	$6,183
Medium Damage to Conductor	Cross arm damage	1 in 5	$50,000	$25,000	$1,500	$25,000	$5,300
Minor Damage to Conductor	Insulators and fitting failures resulting in dropping of conductors and failure associated with ground wires	11 in 5	$10,000	$5,000	$300	$5,000	$11,660
TOTAL ESTIMATED RISK PREMIUM							**$23,143**

1.8 Total Estimated Tower and Wires Self-Insurance Risk Premium

Table 1-9 below summarises our estimate of the total self-insurance risk premium for SP AusNet's electricity transmission network in regards to property damage of its towers and wires. This estimated amount includes coverage for the risk of tower damage, including damage from catastrophic events, as well as conductor damage, but excluding any consequential losses.

Table 1-9 Towers and Wires Self-Insurance Risk Premium

SP AUSNET TRANSMISSION TOWERS & WIRES SELF-INSURANCE RISK PREMIUM	
Premium Component	**Premium Value**
Tower Damage	$160,594
Catastrophic Events	$122,114
Conductor Damage	$23,143
Total Self-Insurance Risk Premium	**$305,851**

[7] Major damage to conductor scenario is based on recorded evidence of actual occurrence at Keon Park.
Medium damage to conductor scenario is based on SP AusNet recorded evidence of cross arm incidents on the YPS-ROTS 220kV line on 12 May 2005 (2001 – 2006) report.
Minor damage to conductor scenario is based on SP AusNet recorded evidence (2001 – 2006 report) of conductor and ground wires failure.

The self-insurance is calculated to be $305,851 per annum and is a lot more cost effective than insuring the towers and lines, even with capital costs excluded, as the estimated premium is $2 million with an excess of $1 million per incident, and the insurance provided for towers and lines now have exclusions on incidents.

2. BUSHFIRE LIABILITY RISK

2.1 Introduction

Responsibility for its assets accidentally igniting catastrophic bushfires represents a significant exposure to SP AusNet. Generally, market insurance is available to cover the general liability for loss or damage to property caused by bushfires, but SP AusNet also needs to consider whether to self-insure for any residual exposure associated with the limit of liability and amount of deductible under the terms of the insurance policy.

In this section we assume a bushfire ignited by SP AusNet's electricity transmission assets may cause either a catastrophic bushfire or a minor (non-catastrophic) bushfire and we calculate a self-insurance risk premium to cover SP AusNet's liability associated with each type of event.

2.2 Description of Risk

There is an inherent risk that SP AusNet's electricity transmission assets will ignite a bushfire with consequential damage caused to other assets and third party property, as well as causing human fatality or serious human injury. Although there may be a range of causes, the probability of such a bushfire is related primarily to incidents where a line or conductor breaks and drops to the ground causing a fire, or through the combustibility of a transformer. With regards to conductor drops, factors such as drought conditions can significantly affect the probability of ignition.

It should be noted that the bushfire liability damage considered is this analysis is limited to general public liability for loss or damage to third party property and person injury but does not include any damages to SP AusNet's own assets.

Although SP AusNet does currently have general liability insurance cover, a $5,000,000 deductible for bushfires means that it has a residual risk where it is liable, up to the limit of the deductible, to cover the costs of any damage caused by bushfires that have been ignited by an SP AusNet asset.

2.3 Historical Incidence of Bushfires

2.3.1 Bushfires in Victoria

Historically, Victoria has proven to be the most bushfire prone state in Australia. Examples of some of the most devastating bushfires in Victoria include the following:

- "*Black Thursday*" in 1851 when fires covered as much as a quarter of Victoria (i.e. almost 5 million hectares). One million sheep, thousands of cattle and 12 human lives were lost in the fires;

- "*Black Friday*" in 1939 when fires affected almost every section of Victoria. From December 1938 to January 1939, fires burnt 1.5 to 2 million hectares, including 800,000 hectares of reserve forest and 4,000 hectares of plantations. 71 lives were lost and 650 buildings were destroyed, including the entire township of Narbethong;
- "*Ash Wednesday*" in 1983. Over 100 fires burnt 210,000 hectares and caused 49 fatalities. More than 27,000 stock and 2,240 houses were lost with as much as $250 million worth of damage caused by the fires;
- "*Alpine Fires*" in January 2003 when 87 fires were started by lightning in the north east of Victoria. Eight of these fires were unable to be contained and joined together to form the largest fire in Victoria since the 1939 "Black Friday" bushfires. The "Alpine Fires" burnt for 59 days between 7th January 2003 and 7th March 2003, before being contained, burning 1.3 million hectares, 41 homes and over 9,000 livestock, with thousands of kilometres of fencing also being destroyed; and
- *"Summer 2006/07 Fires"*. In the 69 days leading up to 6th February 2007, 1.1 million hectares of land had been burnt in Victoria. In addition, 33 houses, 153 sheds and outhouses, 2 tourism recreation structures, 2000 livestock, 3 bulldozers and other machinery were destroyed by the fires.

Table 2-1 below shows the number of catastrophic bushfires in Victoria during the period 1851-2006.

Table 2-1 Catastrophic Bushfires in Victoria

CATASTROPHIC BUSHFIRES IN VICTORIA 1851-2006	1851-2006	1968-2006
Number of catastrophic fires	21	10
Number of years	155	38
Probability of a catastrophic bushfire	14%	26%
Returns period of Catastrophic bushfire	7	4

The data in the table above is from the DSE website[8] however it includes the recent Summer 2006/2007 bushfires in Victoria. The data indicates that catastrophic bushfires have shown a returns period of 1 in 7 years during the period 1851-2006, while during the period 1968-2006 catastrophic bushfires have shown a return period of 1 in 4 years. This increase in incidence of catastrophic bushfires is probably as a result of the increased drought conditions in recent years. Increased drought conditions provide ample fuel for bushfires to spread quickly and hence increase the likelihood of a fire reaching catastrophic proportions.

[8] Source: http://www.dse.vic.gov.au/DSE/nrenfoe.nsf/LinkView/E20ACF3A4A127CB04A25679300155B04358FFCDA5CA1F43FCA256DA6000942C9. Note, after approximating damage costs for each fire we have excluded 6 bushfires from the table. These have been removed to remain consistent with the CIE threshold for major bushfires ($10 million) as discussed later. The approximation of damage costs was based on the location, land area burnt, property and assets destroyed, and lives lost.

Causes of Bushfires

Statistics published by the Victorian Department of Sustainability and Environment (DSE) indicate that, on average, almost 600 bushfires occur on Victorian public land each year. This is based on data collected over a 20-year period from 1976 to 1996, as shown below in Table 2-2.[9]

In general, causes of bushfires can be placed into two groups: natural causes and those caused by human activities. Lightning strikes are the cause of virtually all naturally occurring bushfires, accounting for approximately 26% of all bushfires on public land in Victoria. There are, on average, more fires started by lightning than any other individual cause. The remaining 74% of bushfires are started as a result of human activities, including both deliberate and accidental ignitions.

Table 2-2 Bushfires on Victorian Public Land

BUSHFIRES ON VICTORIAN PUBLIC LAND (1976/77 to 1995/96)			
Cause of Fire	NUMBER OF FIRES		
	Total Number	20 Year Average	% of Total
Lightening Strikes	3,024	151	25.9%
Deliberate Lighting	2,499	125	21.4%
Escapes - Burning	2,098	105	18.0%
Escapes - Campfire, BBQ	1,109	55	9.5%
Departmental Burns	232	12	2.0%
Public Utilities	224	11	1.9%
Machines	296	15	2.5%
Pipes, Cigarettes, Matches	913	46	7.8%
Miscellaneous	596	30	5.1%
Unspecified	685	34	5.9%
Total	**11,676**	**584**	**100.0%**

Table 2-2 shows that public utilities (a category which includes all fires identified as ignited by trains, electricity transmission, and electricity distribution assets) were the cause of approximately 1.9% of bushfires in Victoria over the 20-year period from 1976/77 through to 1995/96. However, during the 10 year period 1986/87-1995/96 public utilities were the cause of only 1.1% of fires, in our quantification we use the data from the latter period as discussed later in this section of the report. A subset of data from the same departmental database indicates that around 77% of public utility fires in Victoria were caused by electricity distribution and transmission assets over the 10-year period form 1974/75 through to 1983/84.[10] A split between distribution and transmission was not available here.

9. Research Report No.49 (October 1997), *Analysis of Fire Causes on or Threatening Public Land in Victoria 1976/77 to 1995/96*, Chris Davies, Fire Management Branch, Department of Natural Resources and Environment.

10. Research Report No.22 (October 1984), *Forest Fire Statistics 1974/75 to 1983/84*, B Rees, Fire Protection Branch, Department of Natural Resources and Environment.

Bushfire Incidents Involving Electricity Transmission Assets

Even though electricity transmission and distribution assets have been the source of ignition for bushfires in only a small minority of cases in Australia, they nevertheless pose a risk of bushfire. The ways in which this can occur include the following:

- Accidental contact between conductors and vegetation;
- Accidental contact between phases of one circuit or between different circuits;
- The expulsion of hot metal or sparks from conductors which ignite vegetation;
- Failure of insulators or clamping arrangements, allowing conductors to fall to the ground; and
- Failure of supporting structures.[11]

Whilst most of these incidents occur within distribution networks, it is possible for similar incidents to occur involving transmission lines. Table 2-3 below containing research undertaken for the ESAA, indicates the following events where ignition occurred in Australia involving transmission lines over the period 1989-1999. We do not use this information in our estimation of a risk premium; however, it serves as evidence that electricity transmission assets across Australia have been responsible for fire starts.

Table 2-3 Transmission Assets Fire Start Incidents

BUSHFIRE INCIDENTS INVOLVING TRANSMISSION ASSETS (1989-99)					
Type of Incident	**VIC**	**SA**	**QLD**	**NSW**	**WA**
Flashovers to Trees	2	2	1	4	1
Fire Starts	1	Burned Trees	1 Burnt Tree	Small grass fire & Burned Trees	Yes

2.3.2 SP AusNet's Bushfire Experience

In a 2002 report by insurers Marsh Australia on 'Insurance and Risk Management' that was prepared for GPU PowerNet as part of a due diligence process for the sale of SPI PowerNet, there was a review of incidents that had potential to cause bushfires. The report identified 3 incidents where a ground wire had fallen and 5 incidents where a conductor had fallen to the ground over the 12 year period leading up to 2002 (i.e. 1990-2002). SP AusNet has informed Saha International that there have been a total of 12 incidents since the commencement of 2002, six associated with ground wires and 6 with falling conductors. This information is summarised in Table 2-4 below.

11. ESAA Environmental Research Project: Risk management of Vegetation on Powerline Corridors – A Study for the Electricity Supply Association of Australia, CSIRO (Dr R L Correll & Dr B D Hatch) in association with D G Quick & Associates (K Richter), June 1999.

Table 2-4 SP AusNet Potential Fire Start Incidents

SP AUSNET ELECTRICITY TRANSMISSION POTENTIAL BUSHFIRE INCIDENTS						
Type of Incident	Number of Incidents			Fire Starts		
	Pre-2002	Post-2002	Total	Pre-2002	Post 2002	Total
Falling Ground Wires	3	6	9	0	1	1
Conductor Failures	5	6	11	0	0	0
Total	**8**	**12**	**20**	**0**	**1**	**1**

Data Sources: Marsh Australia (2002), *Insurance and Risk Management* & SP AusNet.

Table 2-4 indicates that over the 17-year period to 2006, there have been a total of 20 incidents related to falling ground wires and conductor failures which had the potential to cause a small bushfire. However, SP AusNet's records reveal that only one of these incidents actually caused a fire when, on 12 November 2003, a 66 kV ground wire incident ignited a small bushfire causing subsequent damage to a hectare of grassland and two vehicles. SP AusNet has no recorded insurance claims for bushfires ignited by its electricity transmission assets and no claim was made for this incident.

According to SP AusNet, the incidence of electricity transmission assets being the cause of bushfire ignition will remain low for the following types of improvements in its asset management practices:

- The incidence of "aged fitting or insulator" related failures will reduce in time, particularly in light of a significant insulator replacement program expected to occur over the coming 5 year period;
- The incidence of OPGW installation drops will also reduce given the inclusion of revised installation procedures identified as a result of prior incidents;
- Groundwire drops are also expected to decline as SP AusNet moves to implement improved condition assessment procedures and reporting mechanisms across the business; and
- Electrical bonds have been installed on critical groundwire termination assemblies to reduce the likelihood of current induced corrosion.

2.3.3 SP AusNet's Current Bushfire Mitigation Strategies

Apart from legal obligations on SP AusNet to prepare and submit a bushfire mitigation plan to Energy Safe Victoria (formerly known as Office of the Chief Electrical Inspector) for approval each year, SP AusNet actively seeks to mitigate the risk of bushfire liability. The SP AusNet 2006 Annual Report states that bushfire prevention is a constant focus for SP AusNet and audits of vegetation growing near its towers, poles, overhead lines and other assets occur annually. It notes that the company commits more than $18 million per annum to its bushfire mitigation program, incorporating maintenance and prevention work.[12]

Key components of SP AusNet's bushfire mitigation program include:

- Clearing of easements (scorched earth) so as to minimise the possibility that electrical arcing can ignite a fire;
- Audits of vegetation growing near its towers, poles, overhead lines and other assets. Vegetation on easements is restricted to 3 metres in height and density of the ground cover is restricted to 10%. Every span of transmission line is assessed annually and priorities from 1 to 4 are assigned. Priority 1 areas are maintained before the onset of the bushfire season, which is usually declared from December each year;
- Advice is offered to private land owners as to which species of plants are suitable for planting under lines. Assistance is also given in developing long term plans to gradually replace inappropriate plant types with more appropriate ones. In some cases, tube stock is provide to revegetate areas;
- Ongoing review and revision of operating and maintenance procedures. For example, electrical bonds have been installed on critical groundwire termination assemblies to reduce the likelihood of current induced corrosion;
- The 'Very Early Smoke Detection System' in substations;
- Undertaking a wide reaching media and community information campaign to educate property owners about keeping private powerlines clear of vegetation and remaining vigilant over the high risk summer periods; and
- Maintaining appropriate liability insurance with external insurance providers.

The costs of both the bushfire mitigation program and the market insurance premium are embedded in SP AusNet's base operating and capital budgets and are not included in our calculation of a premium for self-insurance against residual bushfire risk and liability.

12. SP AusNet Annual Report 2006, page 31.

2.3.4 Future Drought Conditions

A major factor that impacts on the incidence and severity of bushfires is the ongoing dry or drought conditions which lead to a build up of potential fuel sources. Based on information from CSIRO's website, our understanding is that it is difficult to forecast the possibility of drought conditions over an extended period of time with any reasonable degree of accuracy. However, we believe the current dry conditions prevalent in Victoria would have both increased the risk that SP AusNet causes a fire (through increased probability of ignition from conductor drops), and increased the severity of the fire in the event that one occurs (through the build up of fuel sources).

2.4 Estimates of Bushfire Damage Costs

In 2001 the Centre for International Economics (CIE) derived estimates of bushfire damage costs.[13] These costs were based on an analysis of 2 major sources of primary data, including a database called EMATrack[14] maintained by Emergency Management Australia, and various electronic records held by relevant agencies in each Australian state. The CIE analysis derived estimates of damage costs for both major bushfires and minor bushfires.

2.4.1 CIE Estimate of Damage Costs – Major Bushfires

Major bushfire events[15] will generally lead to various losses ranging from insured losses to property, assets, agricultural production, forestry damage e.g. to pine plantations, as well as human fatalities and injuries. Although the CIE analysis identified a range of costs that could arise from a major bushfire event, it focused on the following 3 main categories of costs that could be readily estimated:

- Damage to insured property, assets and agricultural production losses;
- Damage to timber assets in native forests and plantations; and
- The human cost of fatalities and serious (non-fatal) injuries.

According to the CIE analysis, insurance data shows that Australia experienced 23 major bushfires between 1967 and 1999 – equating to one event every 16 months. On average, each event caused $106 million of insured losses, which implies an annual insured loss due to major bushfires of around $70 million per annum.

13. CIE (Centre for International Economics), November 2001, *"Assessing the Contribution of CSIRO – CSIRO Pricing Review, Chapter 7 Project Vesta: Bushfire Management,* http://www.bbm.csiro.au/vesta/assets/pdf/Vesta_Final_Report.PDF.

14. EMATrack is a database of natural disaster events in Australia which has been compiled from various sources, including the Insurance Council of Australia and media reports. It relates to damage caused to property, assets and agricultural production.

15. CIE defined a major bushfire event as a bushfire causing in excess of $10 million of insured losses (prior to the inclusion of the cost of human fatalities and injuries).

In addition, loss of productive timber resources was estimated to be $7.3 million per year. The economic cost of human fatalities per major bushfire event was estimated to be $12.5 million (i.e. $8.3 million per annum) and the economic cost of serious human injury per major bushfire event was estimated at around $5.2 million (i.e. $3.5 million per annum).

Table 2-5 below shows that the total damage cost per annum due to major bushfires in Australia is estimated to be approximately $89.1 million.

Table 2-5 Damage Cost of Major Bushfires

Estimated Damage Cost of Major Bushfires[1]		
Type of Damage/Cost	Average Annual Cost	
	Australia	Victoria[2]
Insured Losses (e.g. property, assets & Agric production)	$70,000,000	$17,500,000
Damage to to timber assets	$7,300,000	$1,825,000
Cost of human fatalities	$8,300,000	$2,075,000
Cost of serious human injury	$3,500,000	$875,000
Total Estimated Damage Costs (per annum)	**$89,100,000**	**$22,275,000**

1. *Based on analysis undertaken by the CIE of the damage costs of major bush fire events in Australia.*
2. *Assuming 25% of the estimated overall damage of major bushfires in Australia occurs in Victoria.*

Based on records maintained by various State agencies, the CIE analysis estimated that, on average, around 440,000 hectares of forest is burnt in Australia each year by bushfires, and that approximately 110,000 hectares is burnt in Victoria each year by an average number of bushfires of 600 per annum (i.e. the area burnt in Victoria represents around 25% of the Australian total).[16]

Therefore, it could be inferred that 25% of the $89.1 million average overall damage cost per year due to major bushfires in Australia will occur in Victoria. This equates to an estimate of almost $22.3 million of damage costs in Victoria each year arising from major bushfires.

2.4.2 CIE Estimate of Damage Costs – Minor Bushfires

The CIE Analysis also derived an estimate of the unit cost associated with minor bushfire events (i.e. less than $10 million damage), expressed as losses per area burnt, by extrapolating information on the costs of major bushfire events contained in EMATrack to the minor events recorded in State fire databases.

16. The long-run annual average of 110,000 hectares of burnt forest each year indicated for Victoria was sourced from the 1998/99 Annual Report of the (then) Victorian Department of Natural Resources and Environment and is comparable to the 115,517 hectares shown in Table 2-2 as the 20-year average number of hectares of Victorian public land burnt between 1976/77 and 1995/96.

Per hectare losses were determined by estimating a functional relationship between insurance payouts and area burnt. A linear cost function was estimated using 48 bushfire events in Australia between 1967 and 2001 for which information on both damage costs and area burnt was available. This cost function predicted that a damage cost of $133,000 for every 1,000 hectares burnt by bushfires. Therefore, the total average annual cost in Australia for damage costs from minor bushfires was estimated to be in the order of $58.5 million per year.

Applying the same assumption that the area burnt in Victoria each year by bushfires represents around 25% of the Australian total, it can be inferred that the total average annual cost in Victoria for damage costs from minor bushfires is estimated to be in the order of $14.6 million per year.

2.5 Quantification of Self-Insurance Risk Premium for Bushfire Liability

For this analysis we have assumed that a bushfire ignited by SP AusNet's electricity transmission assets may cause either a major (catastrophic) bushfire or a minor (non-catastrophic) bushfire.[17] Therefore, the bushfire liability risk premium for SP AusNet's electricity transmission network is calculated as:

Bushfire Liability Risk Premium =
Risk Premium (Catastrophic Bushfire) + Risk Premium (Non-Catastrophic Bushfire)

2.5.1 Estimated Risk Premium for Catastrophic Bushfire Liability

A catastrophic bushfire is envisaged as causing considerable devastation over very large areas resulting in significant potential for liability for damages to be claimed against SP AusNet. For this analysis we define a catastrophic bushfire as a bushfire causing damage equal to or in excess of $10 million, which is consistent with the threshold used in the CIE analysis.

In principle, the $10 million threshold is used by Emergency Management Australia to define what events are recorded as 'disasters', although some events with estimated costs less than $10 million can be designated as a disaster by a relevant State authority. However, for the insurance industry, which defines a disaster according to the impact an event has on insurance claims and reserves, an event is not typically a disaster unless it results in insurance claims in excess of $50 million.[18]

17. The terms 'Catastrophic' and 'Non-Catastrophic' are synonymous with the terminology of 'major' and 'minor' used in the CIE analysis.
18. Bureau of Transport Economics, *Economic Cost of Natural Disasters in Australia*, Report No.103, 2001.

Alternatively, we could define a catastrophic bushfire as a bushfire causing sufficient damage for SP AusNet to make a claim under its general public insurance coverage. Given that its current policy has a deductible of $5 million for bushfire liability, the expected exposure to SP AusNet from a catastrophic bushfire caused by its electricity transmission assets is therefore capped at $5 million.

The risk premium for SP AusNet's electricity transmission network causing a catastrophic bushfire is calculated as follows:

Risk Premium (Catastrophic Bushfire) =
Probability that a Catastrophic Bushfire is caused by SP AusNet's transmission assets * Cost to SP AusNet

Probability of Catastrophic Bushfire caused by SP AusNet's transmission assets

In order to quantify the probability of a catastrophic bushfire being ignited by SP AusNet's electricity transmission assets (**P_C**), we have adopted the numbers in Table 2-6 below. The variables A_1, A_2, A_3, and A_4 all refer to Victoria.

Table 2-6 Probabilities Associated with SP AusNet Causing Catastrophic Bushfires

Variable	Description	Probability / Number
A_1	Average number of bushfires caused by public utilities (trains, as well as electricity distribution and transmission) in a year	6.42
A_2	Probability that a bushfire caused by a public utility was caused by power assets (distribution / transmission vs. trains)	77%
A_3	Probability that the power asset (distribution / transmission) that caused the ignition is owned by SP AusNet's transmission business	1.50%
P_0	**Probability that SP Ausnet's transmission assets cause a fire = (A_1 x A_2 x A_3) / Total Number of Bushfires per Year**	**0.013%**
A_4	Annual Probability that a catastrophic bushfire occurs	20.00%
P_C	**Probability that a catastrophic bushfire is caused by SP AusNet's electricity transmission assets = (P_0 x A_4)**	**0.0025%**

In relation to the information in Table 2-6:

- A_1: The variable A_1 has been derived from the information discussed in section 2.3.1. A_1 = Average number of bushfires caused by public utilities per year = Average number of bushfires in a year * % of bushfires caused by public utilities during the period 1986-1996. Note: we use 1.1% from the period 1986-96 and not 1.92% from the period 1976-96 as the percentage of fire starts due to public utilities shows a declining trend during the 20 year period. This is probably as a result of more stringent bushfire mitigation strategies.
- A_2: The variable A_2 has been derived from the information discussed in section 2.3.1
- A_3: The variable A_3 has been derived from the information discussed in section 2.3.2. The Average number of fires caused by power assets per year = A_1*A_2 = 6.42 * 77% = 4.94. Meanwhile, SP AusNet's transmission business has caused 1 fire in 17 years or 0.06 fires per year (section 2.3.2). Hence, the percentage of fire starts from transmission assets = (0.06/4.94)*100 = 1.2%. We have used a conservative 1.5% which allows for a margin or error.
- P_0: Probability that SP AusNet's transmission assets cause a fire = P_0 = A_1 * A_2 * A_3 / average number of bushfires per year = 6.42 * 77% * 1.5% / 584 = 0.013%. Note: this also implies that SP AusNet's transmission assets cause 0.07 bushfires per year (i.e. A_1 * A_2 * A_3).
- A_4: The variable A_4 has been derived from the information discussed in section 2.3.1. We have used 20% which falls in between the probabilities discussed in section 2.3.1
- P_C: Probability that a catastrophic bushfire is caused by SP AusNet's electricity transmission assets = Probability that SP AusNet's transmission assets cause a fire * Probability of a Catastrophic bushfire = P_0 x A_4 = 0.013% * 20% = 0.0025%. Note: this equates to 0.015 bushfires a year caused by SP AusNet's transmission assets.

Table 2-6 indicates that there is:

(a) A 0.013% probability that a bushfire will be caused by SP AusNet's transmission assets (P_0); and

(b) A 0.0025% probability that a catastrophic bushfire will be caused by SP AusNet's electricity transmission assets (P_C).

Expected Exposure to Catastrophic Bushfires

Given that SP AusNet has current insurance coverage with a deductible of $5 million for bushfire liability, the expected consequence to SP AusNet from a catastrophic bushfire caused by its electricity transmission assets is capped at the $5 million value of the deductible.

Estimation of Risk Premium for Catastrophic Bushfires

Based on the above information, the estimation of an annual risk premium for a catastrophic bushfire ignited by the SP AusNet electricity transmission network is calculated as follows:

Risk Premium (Catastrophic Bushfire) = 0.0025% *$5,000,000 = $125 per annum

Note that in the absence of the deductible this exposure would be very much higher.

2.5.2 Estimated Risk Premium for Non-Catastrophic Bushfire Liability

By definition, a non-catastrophic bushfire in this analysis is a bushfire that is not defined to be a catastrophic bushfire. Therefore, based on the definition of a catastrophic bushfire and remaining consistent with the threshold for minor bushfires used in the CIE analysis, a non-catastrophic bushfire is a bushfire causing damage of less than $10 million.

The risk premium for SP AusNet's electricity transmission network causing a non-catastrophic bushfire is calculated as follows:

Risk Premium (Non-Catastrophic Bushfire) =
Probability of SP AusNet's transmission assets causing a bushfire x Average damage caused by Non-Catastrophic bushfires in Victoria per annum

Probability of SP AusNet's transmission assets causing a bushfire

In Table 2-6 we calculated the probability of a bushfire being caused by SP AusNet's electricity transmission network as 0.013% (P_0). We use this same percentage for the Non-Catastrophic risk premium calculation.

Average damage caused by Non-Catastrophic bushfires in Victoria per annum

Based on the CIE analysis described in Section 2.4.1 we were able to show that, on average, the estimated cost of damages in Victoria arising from minor (non-catastrophic) bushfires is in the order of $14.6 million per annum. Therefore, it can be assumed that, on average, SP AusNet's transmission business will be responsible for 0.013% of this $14.6 million worth of damage in Victoria.

Estimation of Risk Premium for Non-Catastrophic Bushfires

Based on the above information, the estimation of an annual risk premium for a non-catastrophic bushfire ignited by the SP AusNet electricity transmission network is calculated as follows:

Risk Premium (Non-Catastrophic Bushfire) = 0.013% *$14,600,000
= $1,898 per annum

2.6 Summary - SP AusNet Bushfire Liability Risk Premium

Table 2-7 below summarises the total self-insurance risk premium in regards to its liability for damage caused by bushfires ignited by SP AusNet's electricity transmission network.

Table 2-7 SP AusNet Bushfire Liability Risk Premium

Risk Premium Component	
Catastrophic Bushfire Liability	$125
Non-Catastrophic Bushfire Liability	$1,898
Total Bushfire Liability Risk Premium	**$2,023**

3. RISK OF THEFT AT REMOTE STATIONS

3.1 Introduction and Description of Risk

SP AusNet has 44 transmission terminal stations located throughout Victoria. From our understanding, all of these terminal stations are unmanned, although there is a routine site inspection every couple of weeks.

Despite the security measures in place at the terminal stations, there are regular incidents of breaches of security involving damage to electricity assets and/or theft of assets by third parties. Common examples of assets that have been stolen include cables and computers.

For the purpose of this analysis, SP AusNet has provided a summary report of breaches to its transmission stations over the 9 month period from 1 April 2006 to 31 December 2006. This report also includes the cost of damage and theft associated with each security breach. We have used this information to calculate an appropriate self-insurance premium.

3.2 Historical Record of Theft at Remote SP AusNet Terminal Stations

The following briefly summarises a report provided by SP AusNet with respect to security breaches at its remote transmission terminal stations:

- The report itemises security incidents spanning the 9 months from April 2006 through to December 2006. Over this period, there were a total of 62 security incidents at 22 separate transmission locations, with 15 locations reporting more than one incident;
- The total cost of all recorded security breaches was $174,838 (an average of $2,819.97 per incident). The maximum value of a single incidence of damage or theft was $21,700 at the East Rowville sub-station;
- Theft of copper cable drums represented the majority of stolen assets, due primarily to the lucrative commodity value of copper cable; and
- Details of responsive, as well as proactive, actions highlighted in the report to mitigate future security breaches, include the installation of electric fences, mesh fences, closed circuit television (CCTV), additional patrols by Chubb Security and additional lighting. However, given the short period of time we have not been able to observe whether there will be any reduction in the occurrence of security breaches due to these actions.

Given the lack of extended data over a number of years, we have made a simple interpolation of the data provided to estimate the total annual costs associated with security breaches at remote transmission terminal stations. The total reported cost of $174,838 for the 9 months equates to an average cost per month of $19,424 and an annualised cost of $233,117.

3.3 Current Insurance Provisions

SP AusNet's current insurance policies do include coverage for loss or damage of property, including theft by third parties. However, there is a deductible of $250,000 for each claim.

Based on historical figures where the total value of the 62 incidents was $174,838 and the maximum value of a single security breach was $21,700 at East Rowville, it is reasonable to assume that the costs associated with future security incident will also fail to exceed the value of the deductible. As such, it is expected that every breach of security at a remote substation will be a direct liability for SP AusNet which is not claimable through its insurance coverage. Therefore, it is appropriate to make allowance for the costs of theft in its pricing submission.

3.4 Strategies to Mitigate Future Theft at Remote Terminal Stations

According to SP AusNet, they have developed and are implementing a significant program to mitigate potential security breaches, including all terminal stations and communications sites. We understand that this program includes the following works:

- Electronic access control to terminal stations and critical building;
- Interior intrusion detectors within critical buildings;
- Exterior building hardening;
- Remote controlled switchyard lightning;
- Closed Circuit Television (CCTV) surveillance cameras;
- Increased warning signage;
- Electric power boundary fences;
- Concrete plinths beneath boundary fences;
- Barbed tape on top of boundary fences;
- PIR beam intrusion detectors; and
- Increased patrol and guarding of critical sites (at a total cost of around $30,000 per month).

SP AusNet is confident that these measures will reduce the probability of future security incidents as they will provide a much improved deterrent affect, as well as making physical penetration into the stations and buildings much more difficult and providing more probability that offenders will be detected.

Although some of the new security measures have already been implemented in substations assessed as having the greatest security risk, the total program, at a total cost of around $32 million, is not expected to be fully rolled out until 2013.

3.5 Quantification of a Self-Insurance Premium

In the absence of the mitigation strategies outlined above in Section 3.4 and no observable reduction in the frequency of incidents over the 9 months of data we observed, we would have calculated a maximum self-insurance premium equivalent to the value of $250,000. Based on the historical data we observed, this essentially assumes a 100% probability that the same number of incidents will continue to occur in the future.

However, given the scope of mitigation strategies that have been outlined and the reported total cost committed to by SP AusNet to implement the program, we think it prudent to assume that the probability of security incidents occurring at remote substations in the future will reduce over time. Although the final probability of security incidents continue to occur could well be lower by the end of the next regulatory period, we have assumed a simple 50% probability factor given that the full implementation of the mitigation program is being staged through to 2013.

Therefore, the self insurance risk premium for costs associated with theft at remote stations is calculated as:

Current Estimated Annual Cost x Adjustment Factor for Risk Mitigation

= $250,000 * 50% = $125,000 per annum

4. POWER AND CURRENT TRANSFORMER FAILURE RISK

4.1 Introduction

Transformers are an integral part of a high-voltage electricity transmission system. Power transformers are used to adjust voltages to suitable levels to enable the transfer of power efficiently and instantaneously from high voltage electrical circuits to external, lower voltage, load circuits. Current transformers provide protection to the system and usually have back-up protection systems that can prevent further damage to the system in the event of failure.

4.2 Description of Risk

Failures of power transformers are different to failures of current transformers and are more likely to result in higher consequences as the power transformer is a critical component in the transmission system.

Transformer failures can be explosive, cause fires and damage protection equipment around the transformer. Typically, the risks associated with the failure of a transformer include:

- Damage to or destruction of the transformer;
- Consequential damage, within the vicinity of the transformer, to other property owned by the utility and other third party property damage; and
- Potential loss of supply to customers and the requirement to payout rebates to those customers.

Therefore, SP AusNet's potential exposure due to failure of a transformer can range from relatively low costs to extremely high costs, dependent on the extent of damage to property, including consequential damage, and the impact that damage has on the availability of the transmission network.

4.3 Common Causes of Transformer Failure[19]

International insurance data indicates that incidents of transformer failure can be related to a range of different causes. The leading cause of transformer failures is insulation failure, which encompasses inadequate or defective installation, insulation deterioration, and short circuits, but not exterior surges such as lightning and line faults. Other common causes of transformer failure include the following:

[19] The information in this section draws heavily on the following source: **Bartley, W.H. (2003)**, "*Analysis of Transformer Failures*", a paper presented to the 36th Annual Conference of the Association of Engineering Insurers in Stockholm. William Bartley works for a leading transformer insurance company in the United States – The Hartford Steam Boiler Inspection and Insurance Co.

- Design/Material/Workmanship
- Oil Contamination
- Overloading
- Fire/Explosion
- Line Surge
- Improper Maintenance/Operation
- Flood
- Loose Connections
- Lightning
- Moisture

The incidence of transformer failure in any network also tends to increase with the aging profile of transformers; that is, aging of transformers will contribute to the causes of failure of transformers. Bartley's paper indicates that the ageing of the transformer can lead to the typical causes of failure for transformers listed above and highlights the mechanisms that lead to increasing failures in older transformers.

> *"Aging of the insulation system reduces both the mechanical and dielectric-withstand strength of the transformer. As the transformer ages, it is subjected to faults that result in high radial and compressive forces. As the load increases, with system growth, the operating stresses increase. In an aging transformer failure, typically the conductor insulation is weakened to the point where it can no longer sustain mechanical stresses of a fault. Turn to turn insulation then suffers a dielectric failure, or a fault causes a loosening of winding clamping pressure, which reduces the transformer's ability to withstand future short circuit forces."*

The same paper reports the average age of transformers at failure and the leading cause of failure of transformers over a five year study period; the average age at failure was 18 years.

4.4 Current Insurance Provisions

SP AusNet's current insurance coverage for own property damage includes coverage for damage to transformers. This policy has a general deductible of $250,000, although as noted below, there are some exceptions to the value of the deductible dependent on the age and kVA rating of the transformer:

Exceptions to Policy Deductible – Transformers

The greater of AUD 2.50 per name plate kVA rating or AUD 250,000 combined all averages, except:

- the greater of AUD 3.00 per name plate kVA rating or AUD 250,000 combined all coverage's for transformers 20 years to 30 years old from the date of installation as new and first energised; or
- the greater of AUD 4.50 per name plate kVA rating or AUD 250,000 combined all coverage's for transformers older than 30 years old from the date of installation as new and first energised.

The policy also includes a range of principal exclusions, two of which are relevant as common causes of transformer failure (as already noted in section 4.3). These are *'rust, corrosion, erosion, wear and tear, inherent vice or latent defect'* and *'settling, cracking, shrinking, bulging or expansion'*.

Therefore, it is important for SP AusNet to cover the self-insurance costs for its exposure to damage to transformers associated with:

- The value of the deductible, where a claim is made for incidents which result in significant damage in excess of the value of the relevant deductible;
- The value of damage for less significant incidents where the damage falls below the value of the relevant deductible and no claim on insurance is possible; and
- The value of damage for incidents where no insurance is applicable because the cause of damage falls within the principal policy exclusions.

4.5 SP AusNet Historical Record of Transformer Failure

SP AusNet's experience with transformer failure includes 3 transformer failures in the past 6 years, and with an aging asset base could face further transformer failures in the future based on the information contained in the paper "Analysis of Transformer Failures" mentioned in Section 4.3. The international experience with transformer failure has been an increasing rate of transformer failure given the aging asset profile and the severity of these failures has ranged from relatively low costs to significantly high costs. SP AusNet's experience in the last six years with the cost of transformer failure has also ranged from $440,000 to $934,386. The transformer failure that resulted in costs of $934,386 incurred an insurance excess/deductible of $500,000 and the insurance did not fully recover the cost of the incident, SP AusNet estimated the short fall was in the order of $84,000 for their costs and $90,000 for equipment spares.[20]

From the previous regulatory period the information provided on transformer incidents for SP AusNet were:

> *"Recently there have been three such incidents for SPIP, two in December 2000 and an earlier one in 1996. (More recently (9 November 2001) the Melbourne CBD was without power for a number of hours due to an incident at a terminal station.)*
>
> *The first was a failed transformer at the Ballarat terminal station, which was believed to be caused by arcing, and had costs associated with it of approximately $1,000,000. The second was at the Dederang terminal station (cause unknown) that had costs of around $700,000. The 1996 occurrence was at the Springvale station and involved repair costs between $200,000 and $300,000. The damage took nine months to repair.*
>
> *In the latest two instances the costs are close to or greater than the $500,000*

[20] Source Email from Geoff Thorn Subject Transformer Failure Information dated 5/02/07

excess/deductible, while the 1996 claim is less than $500,000 (even after converting to 2001 dollar values).”[21]

Two of these incidents, the Ballarat Terminal Station and Dederang Terminal Station incidents were included in the three incidents supplied for the past 6 years, the latest incident not previously discussed in the Trowbridge report was an incident at Mount Beauty Terminal Station (MBTS). A single phase transformer failed in March 2004, and the country spare was relocated to the terminal station until the replacement transformer arrived. A second single phase transformer failed in early 2005, which required the use of the country spare transformer to ensure supply to the region. The costs for using the country spare transformer were around $440,000.

4.6 SP AusNet’s Mitigation Strategies for Transformers

The mitigation strategies employed by SP AusNet for transformers include the following key items:

- maintenance routines to carry out inspections of transformers;
- monitoring of transformer conditions (oil, gas, etc.);
- capital replacement program for assets;
- self-insuring to cover transformers that will not benefit from the overall insurance; and
- carrying adequate property damage insurance if failure of a transformer occurs.

Some spare transformers are also held to minimise any outage durations or system constraints and allow for quick restoration of the system to full capacity. These are short term measures to allow the system to continue to operate at full capacity and once the replacement transformers are acquired the spare transformers are removed from service and placed back in store. A transformer can take up to 12 months to procure, so having the country and metropolitan system spares enables quick restoration of the transmission system and minimises costs due to system losses.

Although mitigation strategies are in place, there is the potential of transformer failure still occurring and therefore a level of self-insurance is required to cover the excess/deductible on the property damage insurance as well as any transformer damage that is excluded from the property damage cover.

4.7 Quantifying a Self-Insurance Risk Premium for Transformers

4.7.1 Power Transformers

The Transmission Connection Planning Report for 2006 produced by SP AusNet and the Victorian Distribution businesses provides the major outage rate for transformers, the weighted average of major outage duration and the expected transformer unavailability

[21] Sourced from the Trowbridge Self Insurance Report 2001

due to a major outage per transformer year. The information is shown in Table 4-1 below.

Table 4-1 Major Outage Rate for Transformers

Major plant item: Terminal station transformer		Interpretation
Major outage rate for transformer	1.0%	*A major outage is expected to occur once per 100 transformer-years. Therefore, in a population of 100 terminal station transformers, you would expect one major failure of any one transformer per year.*
Weighted average of major outage duration	2.6 months	*On average, 2.6 months is required to repair the transformer and return it to service, during which time, the transformer is not available for service.*
Expected transformer unavailability due to a major outage per transformer-year	0.01 x 2.6/12 = 0.217% approximately	*On average, each transformer would be expected to be unavailable due to major outages for 0.217% of the time, or 19 hours in a year.*

Further to the information in Table 4-1 above, the Transmission Connection Planning Report contains information on each of the terminal stations, the number of transformers at each station, the expected unserved energy, the normal cyclic rating and the summer/winter N-1 station ratings, and the valuation of the expected unserved energy. This information can be used to determine the likely cost of a transformer failure at the station, along with the probabilities from Table 4-1, to determine the cost of unserved energy.

Table 4-2 Summary of SP AusNet's Power Transformers

Power Transformer Nameplate Rating (MVA)	Number of Assets	Avg. Age of Transformers	Avg. Insurance Deductible	Min. Insurance Deductible	Max. Insurance Deductible
18.3	77	47.22	$250,000.00	$250,000	$250,000
23.3	12	43.00	$250,000.00	$250,000	$250,000
26	2	2.50	$250,000.00	$250,000	$250,000
35	7	41.29	$250,000.00	$250,000	$250,000
50	5	14.40	$250,000.00	$250,000	$250,000
54	1	50.00	$250,000.00	$250,000	$250,000
60	1	0.00	$250,000.00	$250,000	$250,000
70	2	25.50	$282,500.00	$250,000	$315,000
75	11	28.18	$297,727.27	$250,000	$337,500
100	1	0.00	$250,000.00	$250,000	$250,000
112	1	35.00	$504,000.00	$504,000	$504,000
125	5	31.20	$450,000.00	$375,000	$562,500
140	1	0.00	$350,000.00	$350,000	$350,000
150	63	24.30	$570,238.10	$375,000	$675,000
165	7	38.00	$707,142.86	$495,000	$742,500
200	16	33.56	$787,500.00	$600,000	$900,000
225	2	13.50	$618,750.00	$562,500	$675,000
250	10	35.70	$1,125,000.00	$1,125,000	$1,125,000
300	2	15.00	$750,000.00	$750,000	$750,000
333	11	15.36	$938,454.55	$832,500	$999,000
600	1	26.00	$1,800,000.00	$1,800,000	$1,800,000
Weighted Avg. MVA	**Total Number of Transformers**	**Weighted Avg. Age**	**Avg. Deductible**	**Min. Deductible**	**Max. Deductible**
108.86	238	33.88	$485,000	$250,000	$1,800,000

Table 4-2 summarises the SP AusNet Power Transformers by Nameplate Rating MVA, which is important for the calculation of the insurance deductible. The table has been created using information provided by SP AusNet in an email on 14/02/07 which had the spreadsheet "list of transformers including RWTS and BLTS reactors Feb 07"[22]. The data from this spreadsheet was then rolled up to create Table 4-2 as the important factors for insurance excess/deductibles are the age of the transformer and the nameplate rating (MVA).

The weighted average deductible for the SP AusNet power transformers was calculated to estimate the average deductible that would be paid in the case of a power transformer failure and from the information provided by SP AusNet would result in a deductible of

[22] The data in this spreadsheet lists by terminal station and voltage level the number of three phase banks, the nameplate rating (MVA), phase, voltage ratio (phase to phase kV), manufacturer, tap changer, number of units, placed in service, spare transformer, spare winding, bushing kV and make, bushing reference, spares held and age.

around $485,000. However, it should be noted, the maximum deductible SP AusNet could face is for the 600MVA power transformer which would result in a $1,800,000 deductible.

The probability of failure of power transformers in the Transmission Connection Planning Report is 1 in 100 transformer years, which was equated in the report to 1 in 100 transformers, due to the number of transformers in SP AusNet's portfolio there will be on average 2.38 power transformer failures per year.

An article in IEE Power Engineer | April/May 2005[23], comments on the current US experience and predictions for the future.

"And the pressures on asset managers don't stop here. Power transformers are often situated at strategically critical locations in power supply systems, so the financial consequences of a failure can easily exceed actual asset value. Indeed, many countries have strict laws that control and regulate power supply, with penalties for non-delivery sometimes reaching one hundred times the price of the energy itself.

So, while asset management is clearly a critical industry issue, it is poised to get even more critical. Projections from one US insurance company indicate that today's average utility transformer failure and replacement rate of 1% per year will increase five-fold over the next 15 years. What's more, figures for industrial transformers tend to be even higher due to their specific applications and loading conditions."

The 1% failure rate being experienced in the US and the 1% failure rate identified in the Transmission Connection Planning Report 2006 have been used as the basis for the probability of power transformer failure for SP AusNet's assets on an annual basis.

However, based on the past experience of SP AusNet and the control, operations and maintenance practices in place for transformers this rate seems to be on the conservative side. Using the data provided from SP AusNet on power transformer incidents since 2000, there have only been 3 recorded failures in the 6 year period, which would suggest the actual transformer failure rate is closer to 0.5 per year instead of the 2.38 per year that results from the 1% per annum experienced in the US.

As there are a significant number of power transformers in the US, the sample size is more significant than the sample of SP AusNet's power transformers, and therefore the future expected transformer failure rate will move to the level experienced in the US and forecast in the Transmission Connection Planning Report. For this reason the probability of power transformer failure expected in the future is 2.38 per annum.

This takes into account that the number of transformers provided by SP AusNet for this report, the aging of the transformers (around forty are 40 years or older), and the international experience identifying an increase in transformer failures as the assets age (up to 3% failure rate in the US for the aging power transformer assets).

Depending on the transformer that fails could have serious consequences to SP AusNet as

[23] "Extend the lifetime of your transformers by using computer-modelling", Pierre Lorin, IEE Power Engineer, April/May 2005

some of the terminal stations were struggling to meet N-1 capacities and would result in load shedding scenarios if a transformer was to fail and a contingency plan couldn't be identified. With this in mind there would be a level of unserved energy that would also be outside the property damage insurance cover that would also need to be self-insured. The cost of relocation, erection, testing and commissioning and later dismantling and transport to storage for the spare transformer for the incident at Mount Beauty Terminal Station (MBTS)[24] in 2004 resulted in a cost to SP AusNet of around $440,000, which was not covered by the insurers. As the spare transformer costs are close to the average excess/deductible cost, even an uninsured incident for SP AusNet would cost in the order of the average excess/deductible for the power transformers and when you take into account an unserved energy component from the time out of service you would easily reach the average excess/deductible. Therefore the excess/deductible average cost has been used as the basis for the consequence of transformer failure. The expected self-insurance cost per annum would be:

Risk Premium (Power Transformer Failure) = ***Probability of Major Power Transformer Failure * Cost to SP AusNet***

Risk Premium (Power Transformer Failure) = ***(1% x 238 Transformers = 2.38 incidents per annum) * (Average Excess/Deductible per incident = $485,000)*** ***= $1,154,300 per annum***

4.7.2 Current Transformers

From the current transformer perspective SP AusNet provided information on two incidents, one occurred in April 2004 on a 220kV current transformer and the other occurred in December 2002 on a 500kV current transformer. From review of publicly available information it was difficult to determine the failure rates expected for current transformers and therefore the probability provided by SP AusNet has been used in determining the self-insurance required for current transformers.

SP AusNet stated in an email on the 25th July 2006[25] that the expected failure rate for 220kV current transformers is 1 in 6 years and the probability for a 500kV current transformer is also 1 in 6 years. The historical incidents provided by SP AusNet and their associated costs are highlighted below:

"JLTS FMJL 220 kV CT failure, estimated cost to remove and clean-up: The repairs at JLTS after the April 2004 incident were effected on jobs 10094617 and 10094618 for a cost of $51,001and $98,978 respectively, plus administration costs of $20,000.

MLTS Tyree 500 kV CT failures, estimated cost to remove and clean-up: Failure 21.12.02 ~$100k Asset Works Job V5A45120 $80,000, applies for repair of damage after CT failure 3/10/05."

[24] Email from Geoff Thorn, Transformer Failure Information, 05/02/07
[25] Email from Geoff Thorn, Recent Uninsured Events, 25/07/06

As can be seen from these incidents above the historical cost for a 220kV and 500kV current transformer was around $170,000, after taking into account inflation this becomes around $185,000. The potential is that the actual cost for a future current transformer incident is higher than this as the operations and maintenance costs have increased due to the resource shortage in the industry. Therefore the forecast consequence of a current transformer failure is in the order of $200,000.

Therefore the expected self-insurance cost per annum would be:

Risk Premium (Current Transformer Failure) =
Probability of Current Transformer Failure * Cost to SP AusNet

Risk Premium (Current Transformer Failure 220kV) =
(1 in 6 years = 0.1667 incidents per annum) * (Average Consequence per incident = $200,000)
= $33,333 per annum

Risk Premium (Current Transformer Failure 500kV) =
(1 in 6 years = 0.1667 incidents per annum) * (Average Consequence per incident = $200,000)
= $33,333 per annum

Total Risk Premium (Current Transformer Failure) =
Risk Premium Current Transformer Failure 220kV + Risk Premium Current Transformer Failure 500kV
=$66,667 per annum

As the level of the self-insurance risk premium for power transformers is higher than the current rate of failure experienced by SP AusNet and there will be a gradual increase in failure rate to the international experience and the forecast used in the Transmission Connection Planning Report. Therefore the self-insurance risk premium for current transformers is considered to be covered in the power transformers self-insurance risk premium, as the difference between the gradual increase anticipated in the next 6 years for the actual failure rate of power transformers and the 1% failure rate experienced internationally and used for planning purposes by SP AusNet will cover the $66,667 per annum required for current transformers.

The self-insurance risk premium therefore being applied to power and current transformers for SP AusNet has been determined as $1,154,300 per annum.

5. RISK OF CIRCUIT BREAKER FAILURE

5.1 Introduction and Description of Risk

Electrical power transmission networks are protected and controlled by high-voltage circuit breakers (CBs) designed to protect an electrical circuit from damage by overload or short circuit. A circuit breaker (CB) is a switching device that automatically opens an electrical circuit to interrupt the flow of electrical current when the rated current is exceeded due to an electrical overload or fault.

Circuit breakers are an integral part of the protection of an electrical system. When a fault or overload in an electrical system occurs, the protection system responds by activating circuit breakers to isolate defective components and stop the fault current flow before other unaffected components are damaged or destroyed. Fault currents can be significantly greater than the full load rating of components, generating extreme levels of heat and electromagnetic force which, in the event of a circuit breaker failing, can destroy cables, transformers and switchgear.

In the event of circuit breaker failure, not only is there potential risk of serious real property damage, but there is often an unplanned power outage which can affect the ability to supply power to customers with scope for significant financial loss.

5.2 Current Insurance Provisions

SP AusNet's current insurance policies include coverage for property and material damage to its own assets. However, one of the principal exclusions under this policy specifically excludes the most common or underlying causes of circuit breaker failures. The policy clause refers to *"rust, corrosion, erosion, wear and tear, inherent vice or latent defect"* as principal exclusions for a claim under this policy. On this basis, we have assumed that SP AusNet is unlikely to be able to make a complying claim under this policy for a circuit breaker failure incident.[26]

However, SP AusNet also has a separate general liability insurance policy covering all legal liability to pay compensation to third parties by reason of personal injury, loss or damage to property and financial loss. This policy has a total liability limit of $810 million, although there is a stand alone limit of $400 million. The value of the deductible is $100,000 for each and every claim.

5.3 Causes of Circuit Breaker Failure

A CB failure has been defined as the situation when a CB can no longer perform its fundamental function of protecting an electrical circuit from damage by overload or short circuit.

26. However, SP AusNet has indicated that whilst they are unlikely to be covered for the direct costs of a circuit breaker failure, they believe they are covered under this policy for any consequential property damages (i.e. damage to other equipment on site).

The most common causes of circuit breaker failures include:

- Problems with the tripping system – inoperative trip coils, mechanisms, control wiring, defective relays or incorrect protection settings meaning the circuit breaker will never trip (open a circuit) regardless of the signal it receives from the protection system;
- Decay of the insulation system - attributed to the operating environment and the frequency and severity of operation;
- Mechanical system stiffness – general mechanical failure of the trip, close and racking mechanism caused by wear and tear, contamination from a dirty environment or damage during maintenance. These can cause the circuit breaker to fail by becoming stuck shut, or stuck open, or become very sluggish in operation possibly allowing fault currents to flow for a much greater time than other equipment can withstand, leading to a potentially destructive failure;
- Power and control problems – resulting from a misalignment in the switchgear;
- Loss of insulating medium.

As with any other piece of equipment, circuit breakers are not failure proof, requiring an ongoing program of preventative maintenance to minimise circuit breaker failures.

5.4 SP AusNet Historical Record of Circuit Breaker Failures

SP AusNet has not been able to provide a detailed history of circuit breaker failure incidents for its electricity transmission network. However, it has provided the following information regarding three recent incidents:

Table 5-1 Recent SP AusNet Circuit Breaker Failures

Date	Decription of Incident	Total Cost*
12 May 2005	EPSY ABB LTB 220kV CB failure	$100,000
14 Aug 2005	RWTS Reyrolle 66kV CB failure	$50,000
25 Aug 2006	JW419 220kV CB failure	$300,000

We note that the costs in Table 5-1 above only include the removal and clean up costs associated with CB failure[27]. We also understand that SP AusNet plans to spend approximately $10 million over the next 6 years on preventative circuit breaker refurbishment work to reduce the risk of circuit breaker failure.

[27] Sourced from Email from Geoff Thorn dated 25/07/2006 Subject – Recent Uninsured Events

5.5 Quantifying a Self-Insurance Risk Premium for Circuit Breakers

We have estimated a self insurance risk premium for circuit breaker failures using the calculation methodology:

CB Failure Risk Premium = Number of CB x CB Failure Rate x Estimated Consequence per CB Failure

5.5.1 Number of SP AusNet Circuit Breakers

Table 5-2 below shows that as at the end of 2005, SP AusNet had 1,002 circuit breakers operating at voltages from 22 kV to 500kV installed in its electricity transmission network (i.e. excluding all 11 kV, 6.6 kV and 2.2 kV circuit breakers).

Table 5-2 SP AusNet Circuit Breakers by Type

CB Voltage	Number	% of Total
22 kV	114	11.4%
66 kV	451	45.0%
220 kV	339	33.8%
275 kV	6	0.6%
330 kV	21	2.1%
500 kV	71	7.1%
Total	**1,002**	**100.0%**

5.5.2 SP AusNet Circuit Breaker Failure Rate

Based on CIGRE data, we have assumed a circuit breaker failure rate of 0.72%. This number is derived from references which indicate that *"An international study of CB reliability found a rate of major failures of 0.72% per year";*[28] where major failures have been defined as a situation when the CB can no longer perform all of its fundamental functions.

Ideally, each particular type and voltage of CB should be assigned with an individual failure rate as CB failure rates vary with time and location. However, due to the lack of data, we have assumed that the failure rate of 0.72% stated above will apply to all CB voltages and types. The CIGRE failure rate of 0.72% is based on tests conducted on SF_6 CBs over a range of voltages of 60kV or greater[29]. Utilising this failure rate in our analysis will result in a more

28. Crisp, J and Birthwhistle, D, *"System Dynamics Modelling: Application Electricity Transmission Network Asset Management"*. This paper references the following CIGRE research - Janssen, A.L.J, Brunke, J.H., Heising, C.R. and Lanz, W., *"CIGRE WG 13.06 Studies on the Reliability of Single Pressure SF_6 Gas High Voltage Circuit Breakers",* IEEE Transactions on Power Delivery, vol.11, pp. 274-82.

29 Solver, C.E, "First results from the on-going CIGRE enquiry on reliability of high voltage equipment", CIGRE SC A3 & B3 Joint Colloquium in Tokyo, 2005.

conservative estimate of a risk premium as SF_6 CBs have an improved reliability and maintainability relative to the older technology CBs[30].

SP AusNet provided examples of circuit breaker incidences to enable determination of the consequence of circuit breaker failure and this gives an understanding of the scale of circuit breaker failures being experienced by SP AusNet. CIGRE data has been used for the determination of the failure rate of circuit breakers for this analysis.

5.5.3 Estimated Consequence per CB Failure

Apparent from the examples listed in Table 5-1, CBs of higher voltages are likely to incur larger costs associated with removal and clean-up. The estimated consequence due to failure, for different CB voltages, is depicted in Table 5-3.

For CBs of voltage 22kV, we have assumed that the estimated consequence would be 50% of that of the 66kV CB. Since we have an example that estimates the costs associated with a 66kV CB to be $50,000, we assume that estimated failure costs for a 22kV and 66kV CBs are $25,000 and $50,000 respectively. For CBs of voltage 220kV, we have taken an average of the two 220kV CB failure incidents stated in Table 5-1, this results in the estimated cost for 220kV CB failures being $200,000. For CBs of voltage 275kV to 500kV, we have limited the estimated consequence to the insurance deductible amount of $250,000. This is a conservative estimate based on the premise that the cause is a non-excluded event from the insurance, if this is not the case then SP AusNet would, in most circumstances, have to pay more than $250,000 for these circuit breaker failures.

5.5.4 Estimated Self-Insurance Risk Premium for Circuit Breaker Failures

Using the above information, we have estimated SP AusNet's self-insurance risk premium for circuit breaker failures to be valued at $847,440 per annum, as shown in Table 5-3 below:

30. National Centre for Scientific Research Website - Janssen, A.L.J, Brunke, J.H., Heising, C.R. and Lanz, W., "CIGRE WG 13.06 Studies on the Reliability of Single Pressure SF6 Gas High Voltage Circuit Breakers", IEEE Transactions on Power Delivery.

Table 5-3 Self-Insurance Risk Premium - Circuit Breaker Failures

CB Type	Number of CBs	Annual Rate of CB Failures	Estimated Exposure	Estimated Risk Premium
22 kV	114	0.72%	$25,000	**$20,520**
66 kV	451	0.72%	$50,000	**$162,360**
220 kV	339	0.72%	$200,000	**$488,160**
275 kV	6	0.72%	$250,000	**$10,800**
330 kV	21	0.72%	$250,000	**$37,800**
500 kV	71	0.72%	$250,000	**$127,800**
Total	**1,002**			**$847,440**

6. RISK OF GIS FAILURES

6.1 Introduction and Description of Risk

Electrical switchgear is a combination of electrical disconnects and/or circuit breakers used to isolate electrical equipment and protect an installation during an electrical fault incident. By controlling electricity flows, electrical switchgear serves to isolate specific electrical equipment, thereby allowing maintenance or other works to be performed and to allow clearance of downstream faults.

Gas Insulated Switchgear (GIS) contains a number of separate devices in adjoining compartments, each compartment being insulated by pressurised sulphur-hexafluoride gas (SF_6).[31]

A GIS Failure is defined as the situation in which a GIS can no longer perform its fundamental function of isolating electrical equipment, thereby be unable to protect an electrical installation during an electrical fault incident.

Although GIS failures generally have a low probability of occurrence, when such events do occur, the consequences to SP AusNet could be substantial. At best, a GIS failure may only result in disruption to the transmission of electricity. At worst, a GIS failure may cause a massive electrical explosion, fire and significant direct and consequential damage to property and people.

SP AusNet is exposed to the risk of GIS failure to the extent that a major GIS failure results in a claim exceeding the limits of liability of a relevant insurance policy as well as the extent to which minor GIS failures do not exceed the value of the insurance deductible. In these cases, it is prudent for SP AusNet to consider the cost of self-insurance risk premium.

6.2 Current Insurance Provisions

SP AusNet's current insurance policy includes coverage for property and material damage to its own assets. However, one of the principal exclusions under this policy specifically excludes the most common causes of GIS failures. The policy clause refers to *"rust, corrosion, erosion, wear and tear, inherent vice or latent defect"* as principal exclusions for a claim under this policy. On this basis, we have assumed that SP AusNet is unlikely to be able to make a complying claim under this policy for a GIS failure incident.[32]

31. Examples of the types of devices included in a GIS include circuit breakers, current transformers, disconnectors, earth switches, busbars, and line entry bushings.

32. However, SP AusNet has indicated that whilst they are unlikely to be covered for the direct costs of a GIS failure, they believe they are covered under this policy for any consequential property damages (i.e. damage to other equipment on site).

However, SP AusNet also has a separate general liability insurance policy covering all legal liability to pay compensation to third parties by reason of personal injury, loss or damage to property and financial loss. This policy has a total liability limit of $810 million, although there is a stand alone limit of $400 million. The value of the deductible is $100,000 for each and every claim.

6.3 Causes of GIS Failure

GIS failures can take a number of forms, ranging from a major failure where an internal flashover occurs and the equipment is damaged and has to be replaced, to more minor failures where the equipment ceases to function but flashovers do not occur.[33]

The main causes of GIS failure include internal component failure (electrical or mechanical), corrosion of enclosures resulting in leaks or moisture entry into the SF_6 compartments, and failure of a circuit breaker drive mechanism. Essentially, the main drivers for these causes of GIS failure include:

- Design problems;
- Manufacturing defects;
- Incorrect installation; and
- Operational and maintenance issues.

6.4 SP AusNet Historical Record of GIS Failures

Information provided by SP AusNet indicates that it has experienced a number of significant GIS incidents, including the following 3 GIS failures depicted below. The costs listed in Table 6-1 comprise of the removal and clean-up costs associated with GIS failure[34].

Table 6-1 Recent SP AusNet GIS Failures

Year	Decription of Incident	Total Cost
1998	SMTS BBC GIS - silicone injection flashover	$150,000
2004	SYTS M&G GIS - flashover	$300,000
2005	SYTS M&G GIS - internal flashover in CB pole	$150,000

33. In electrical power transmission, a flashover is an unintended high voltage electric discharge over and around an insulator, or arcing or sparking between two or more adjacent conductors.

34 Sourced from Email from Rob Lewis dated 29/01/2007 Subject – Electricity Transmission_GIS Failure Risk

6.5 Strategies to Mitigate GIS Failures

It is our understanding on advice from SP AusNet that they have a program of mitigation strategies intended to reduce likelihood of future GIS failures. In summary, this includes:

- Implementing significant GIS component replacement and refurbishment programs;
- Increased monitoring, including the use of x-ray imaging technology and on-line partial discharge sensors;
- Review of strategic spares holdings; and
- Fitting of SF_6 drying canisters to GIS compartments.

6.6 Quantifying a Self-Insurance Risk Premium for GIS Failures

We have estimated a self insurance risk premium for GIS failures using the calculation methodology:

GIS Failure Risk Premium = Estimated Consequence per GIS Failure X GIS Failure Rate X Number of GIS

Each of these components of the calculation is discussed further below.

6.6.1 Estimated Consequence per GIS Failure

Site Clean up Costs

GIS failures can result in high site clean-up costs due to the need to maintain high levels of cleanliness for the proper working of the internal components of a GIS. Even small levels of contamination from airborne dust or moisture have the potential to result in the subsequent failure of a GIS.

Furthermore, since SF_6 is a potent and persistent greenhouse gas, a GIS failure requires prompt preventive action to ensure that the release of any SF_6 gas is prevented or minimised.

Direct Costs of Replacement GIS

Although SP AusNet holds critical spares, a significant GIS failure may result in the urgent need to procure expensive parts from overseas manufacturers. The need to source the parts from overseas often adds to the already expensive cost of the switchgear components.

Costs of Consequential Property Damage

SP AusNet has indicated that whilst they are unlikely to be covered for the direct costs of a GIS failure, they believe they are covered under this policy for any consequential property damages (i.e. damage to other SP AusNet equipment on site). However, as the examples in Table 6-1 do not include the costs associated with consequential property damage, we have excluded such costs from our analysis.

Costs of Third Party Liability

There is also the potential for third party liability due to the harmful effects of SF_6 gas by-products. There has been research stating that certain SF_6 gas by-products are toxic and pose a threat to the health of people who came into contact with them. Whilst SF_6 gas is inert during normal use, when electrical discharges occur within equipment filled with SF_6 gas, toxic by-products can be produced that pose a threat to the health of workers who come into contact with them. However, since it is likely that most of such incidences would be covered under Workers Compensation, such third party liability has been excluded from the analysis.

Given the costs shown in Table 6-1 for the 3 most recent GIS failures refer only to the direct costs of repairs, removal and clean up and do not include costs for collateral damage to other equipment or third party liability, we have assumed that there will be no collateral damage as a result of a GIS failure.

Therefore, in determining the estimated cost of exposure for a GIS failure, we have assumed the average cost of $200,000 incurred for the 3 incidents that occurred over the past eight years.

6.6.2 GIS Failure Rate

An annual incident rate of GIS failures can be derived by calculating the number of reported GIS failures as a ratio of the total GIS years of exposure;

- The total GIS years of exposure has been defined as the sum of the ages for the total number of GIS equipment. We have been informed that there are 21 GIS equipment located at 5 terminal stations[35]. Furthermore, we have been provided with the age profiles of the GIS at each of the relevant locations. This provides a total GIS years of exposure of 464 years (depicted in Table 6-2 below);

35 Email from Geoff Thorn dated 16/02/2007 Subject – GIS installations – SP AusNet

Table 6-2 GIS Years of Exposure

Station	No. of GIS	Approx Installation Date	Years of exposure per GIS	GIS Years of Exposure per Station
ROTS	7	1983	23	161
SMTS	5	1982	24	120
SYTS	3	1983	23	69
NPS	4	1980	26	104
WMTS	2	2001	5	10
Total	**21**			**464**

- Therefore, using the 3 reported incidents of GIS failure highlighted in Table 6-1, the derived GIS failure incident rate is about 0.65% (i.e. 3 incidents / 464 years of GIS exposure). We understand that the 3 incidences in Table 6-1 do not refer to all GIS failure incidents. Therefore, it should be noted that the risk premium will be conservative as the failure rate used will be understated.

6.6.3 Estimated Self-Insurance Risk Premium for GIS Failures

Using the above information, we have estimated SP AusNet's self-insurance risk premium for GIS failures to be valued at $27,155 per annum:

GIS Failure Risk Premium = $200,000 x 0.65% x 21
= $27,155

7. RISK OF BOMB THREATS, EXTORTION AND ACTS OF TERRORISM

7.1 Introduction and Description of Risk

The destruction of the World Trade Centre in New York on 11 September 2001 meant that insurers and re-insurers sustained what had previously been considered unimaginable losses. This event changed the way insurers accounted for terrorism related risks, with the inclusion of new, more wide ranging terrorism exclusion clauses, more restrictive limits of liability and premiums rising dramatically with the view that terrorism risks had previously been covered virtually free of charge.

For the purposes of this analysis we assume that all malicious and/or deliberate acts of sabotage regarding SP AusNet's business are covered by the "bomb threat, extortion and terrorism" risk category, excluding all other incidents deemed to be accidental, such as the property damage to towers and wires caused by non-owned planes and helicopters, as discussed in Section 10.

As the owner and manager of infrastructure of national significance, SP AusNet is highly vulnerable to the risk of bomb threats, extortion and terrorism. Any number of threats, or acts committed to damage SP AusNet's assets or injure SP AusNet's staff could foreseeably result in consequences such as:

- A significant increase in costs over and above that forecast in regulatory budgets, involving capital replacement costs, additional costs of requiring contractors on standby and increased costs of purging the system;
- Business disruption and loss of supply resulting in a possible loss in revenues over the duration of the incident or the period required to recover from the incident; and
- Potential compensation payouts/rebates to customers for interruption of supply.

7.2 Terrorism Insurance Act

Following the changes in the insurance market the Australian Government had concerns with the resultant lack of comprehensive insurance cover for commercial property and infrastructure that could result in insufficient financing and investment in the Australian property sector and flow-on effects for the wider economy. Therefore, to provide reinsurance mechanisms for insurers who had suffered from the withdrawal of market reinsurance products, the *Terrorism Insurance Act 2003* was established.

The principle objective of Act is to make terrorism exclusion clauses ineffective for a range of insurance coverage. Essentially, insurers are required to meet eligible claims in accordance with other terms and conditions of their policies. In general, the terrorism insurance scheme covers all eligible insurance contracts applying to all commercial property in Australia including associated business interruption losses and public liability claims.

The Act provides an option for insurers to reinsure their terrorism risk exposure with the Australian Reinsurance Pool Corporation (ARPC), a statutory authority established by the Government to administer the scheme and to provide reinsurance cover for eligible terrorism losses. The ARPC covers eligible losses for any declared terrorist incident covered by an eligible insurance contract where the insurer has a reinsurance agreement with the ARPC.

7.3 SP AusNet Mitigation Strategies

As noted above, SP AusNet is eligible under the *Terrorism Insurance Act 2003*, to claim any loss or damage suffered to 'eligible property' as the result of a declared 'terrorist act', despite any policy exclusion which seeks to exclude such liability.

SP AusNet current insurance policy includes coverage for damage to property. The policy includes a deductible of $250,000 with a limit of liability for unnamed locations of $10,000,000 and for the remainder of SP AusNet's assets up to $2.2 billion.

In addition to the insurance provisions, SP AusNet has also implemented the following programs to reduce the chances of terrorist activities, bomb threats and extortion on their electricity transmission business;

- SPIRACS - (SP AusNet Integrated Response and Contingency System), describes the formation of Site Response Teams, Incident Response Teams, Emergency Management Teams, and Crisis Management Teams and how those teams communicate to each other and within the teams to deal with extraordinary events. SPIRACS covers Business Continuity, Security Management, Emergency Management and Crisis type events;
- Exercise Belladonna – An exercise held by SP AusNet to test their ability to respond to a terrorist activity, involving the presence of the Department of Infrastructure and Victorian Police; and
- SP AusNet has Business Continuity Plans which outline contingency plans to be enacted in response to these types of events. This covers options outlining such things as alternative sources of equipment to replace any damaged equipment and the use of temporary tower structures to reroute electricity around the problem areas.

These strategies reduce the estimated impact of the relevant risks, however they do not completely mitigate the SP AusNet's exposure to these types of incidents.

7.4 Quantification of Self-Insurance Premiums

7.4.1 Bomb Threats Concerning Electricity Transmission Assets

Consultations with SP AusNet revealed that the main cost a bomb threat to an electricity asset is the added cost of hiring security to man the assets until the threat is extinguished.

We have made the assumption that, on average, 10 security guards would need to be hired for 24 hours a day, for 2 days, at a cost of $50 per hour. We believe that 48 hours would allow SP AusNet and the appropriate authorities with the opportunity to investigate, monitor and remove the threat. This represents a total cost, or level of exposure, of $24,000.

Given that electricity transmission assets are reasonably accessible and exposed to such threats, we have assumed a 1 in 15 year probability that SP AusNet will be subject to a bomb threat of this nature (i.e. a probability ratio of 6.67%). This assumption is based on information obtained from the Australian Bomb Data Centre annual report from 2000 to 2004. The data contained in these reports suggests that 14% of bombings, attempted bombings and hoaxes are associated with government bodies and less than 1% of this is applicable to utilities (gas and electricity). It was also mentioned that 1 incident had occurred in the 1991-2000 10 year period, and no further incident has been reported up to the latest 2004 annual report. Based on this information the probability used was that only 1 incident has occurred in the last 15 years.

Therefore, the self insurance risk premium for costs associated with the bomb threat concerning SP AusNet's transmission assets is calculated as:

Level of Exposure x Probability of Occurrence

= $24,000 * 6.67% = $1,600 per annum

7.4.2 Acts of Terrorism Concerning Electricity Transmission Assets

As already noted, SP AusNet's applicable insurance policy includes a deductible of $250,000. We believe it is reasonable to assume that a declared act of terrorism will have significant consequences for SP AusNet, and that these consequences will be of far greater value than the deductible set in the insurance premium. Therefore, SP AusNet's self-insurnace level of exposure for an act of terrorism is expected to be the $250,000 deductible limit.

It is difficult to determine the probability with respect to how often SP AusNet's electricity transmission network may be subject to acts of terrorism. However, given the reasonable accessibility of the assets and the fact that electricity provides an integral input to all businesses and residential premises, the extent of interruption of their service that could be achieved makes it possible that electricity transmission assets could be a likely target for terrorists. This significantly increases the probability of a terrorist attack.

As reported in "Asian Political News" on the 26th April 2004, "Plot to bomb Australian power grid foiled", there was a terror suspect arrested in Australia with plans to bomb the national electricity grid in Sydney.

An article in "The Age" on the 26th of April 2004[36] reported on the arrest of four terror suspects but also mentioned the plot on the NSW electricity grid and made the following comments:

"Power industry representatives said the sector prepared for all sorts of unexpected events as part of its security planning and that any new threats would be examined thoroughly as a matter of course, and in conjunction with the Federal Government.
"The Australian community can be assured that the electricity industry is acutely aware of the need to protect the integrity of the electricity grid," association chief executive Brad Page said on Friday."

These articles highlight that the electricity grid is a potential target of terrorists in Australia and therefore is a risk for SP AusNet. Other potential targets in Australia that were mentioned previously in the media, were the Lucas Heights Nuclear Power Station in NSW and a cyber terrorism attack was reported in Queensland and an excerpt from the article is shown below[37].

"In November 2001, 49-year-old Vitek Boden was sentenced to two years in prison for using the Internet, a wireless radio and stolen control software to release up to 1 million litres of sewage into the river and coastal waters of Maroochydore in Queensland, Australia.
Boden, who had been a consultant on the water project, conducted the attack in March 2000 after he was refused a full-time job with the Maroochy Shire government. He had attempted to gain access to the system 45 times, and his last attempt proved successful, allowing allowed him to release raw sewage into the waterways."

[36] "Four arrested over false passports", Kerry-Anne Walsh, Jason Dowling, Kirsty Simpson, April 25, 2004
[37] "Safety: Assessing the infrastructure risk", By Robert Lemos, Staff Writer, CNET News.com, August 26, 2002

As the NSW plots were uncovered before any damage was done and there has been an event in recent history in Queensland, the threat of terrorism is increasing for all utilities and therefore a conservative probability of 1 in 25 years is proposed for terrorist attacks, this takes into account the long history of no terrorist activity in Australia but the heightened climate of terrorism we are now faced with.

Therefore, the self insurance risk premium for costs associated with an act of terrorism concerning SP AusNet's electricity transmission assets is calculated as:

Level of Exposure x Probability of Occurrence

= $250,000 * 4.0% = $10,000 per annum

7.4.3 Summary of Self-Insurance Risk Premium

Table 7-1 below summarises our analysis of the self-insurance risk premium of $11,600 required with respect to potential bomb threats, extortion and acts of terrorism involving SP AusNet's electricity transmission network.

Table 7-1 Self-Insurance Risk Premium for Bomb Threats, Extortion and Acts of Terrorism

Incident	Exposure	Probability of Occurrence	Risk Premium
Bomb Threat	$24,000	6.67%	**$1,600**
Act of Terrorism	$250,000	4.00%	**$10,000**
Total			**$11,600**

8. KEY PERSON RISK

8.1 Introduction

SP AusNet’s continued success is dependent on its ability to recruit, train, motivate and ultimately retain highly skilled employees. Competition for executive officers and skilled employees needed to perform the essential functions of SP AusNet’s business is currently extremely high in Australia, especially in the energy and infrastructure based industries.

Given a limited supply of skilled transmission and distribution workers, an inability to retain key employees could lead to increased labour costs. Even when key person may be able to be replaced, it often taken takes a considerable period of training before they possess the same level of skills required to work effectively with the complex and sometimes dangerous facilities used in SP AusNet’s business. Therefore, in addition to increased labour costs, there could be disruption of services and even financial losses.

8.2 Description of Risk

Key person risk represents the risk that SP AusNet could bear an adverse financial impact due to the sudden departure, or death, of a key employee. A key employee is an employee who has a specialised and/or unique skill, or specific level of expertise or experience, that is integral to the ongoing success of SP AusNet’s core business. This can be any employee throughout the business, ranging from executive or senior management through to operational and field staff.

Typically, SP AusNet would find it difficult to replace a key employee in the short-term, with the process of replacing a key employee likely to require a more intense recruitment process (i.e. if the skills, expertise and experience are not available locally and need to be sourced from overseas or interstate), which in turn incurs greater expense than would otherwise be the case for other non-key employees.

8.3 Current Insurance Provisions

Generally, key person insurance is available to a business to cover against business interruptions and costs arising from the sudden departure or death of a key employee. However, SP AusNet has not retained any external insurance arrangements, choosing instead to self-insure for exposure to key person risk.

8.4 Quantification of Self-Insurance Risk Premium for Key Person Risk

The calculation of a self-insurance risk premium associated with each identified key employee is based on the simple formula shown below:

Key Person Risk Premium = *{Financial Exposure x Probability of Leaving Service}*

Given that the SP AusNet executive management team is responsible for the management of the three separate businesses of the SP AusNet group, the calculated risk premium has to be proportioned between the different businesses. Based on our discussions with SP AusNet, the key personnel and the business that they worked in was identified, however for those personnel that worked across the businesses an allocation based on the average time spent in each of the businesses was provided by SP AusNet on the following basis:

SP AusNet (Electricity Transmission)	30%
SP AusNet (Electricity Distribution)	49%
SP AusNet (Gas Distribution)	21%

8.4.1 Identification of Key Persons

Employees should be regarded as key people to the extent that their sudden departure or death would adversely affect the financial position of the company due to the following reasons:

- Their replacement in the short-term is not likely due to the level of expertise or experience required;
- Their replacement is likely to be from overseas or interstate due to the limited availability of specialised expertise locally;
- It is expected that considerable additional expenses would be incurred in respect of recruitment, relocation and settlement costs; and
- Loss of income would follow from the disruption to the company's core business and the time required for the replacement to understand the company's processes and strategies.

By reference to the general criteria described above, it is our expectation that SP AusNet would be able to identify key employees within its executive management team as well as a number of other skilled employees such as senior engineers and operations managers. In the absence of such information being received from SP AusNet, we have identified, from public documentation, the members of SP AusNet's executive management team but we are not in an appropriate position to identify any other key employees within the organisation.

SP AusNet Executive Management

Pursuant to a Management Services Agreement, the Boards of Directors of each of SP AusNet Transmission, SP AusNet Distribution and the Responsible Entity have engaged SPI Management Services Pty Ltd (SP AusNet Management) (and through it, its employees) to provide administrative, managerial and other assistance in relation to SP AusNet's transmission and distribution businesses. The current executive management of SP AusNet Management are considered key personnel along with selected individuals from the business across core activities, e.g. specialist engineers, operators and senior technicians. A summary of SP AusNet's identified key personnel can be found in Table 8-1, including the average age profile for the key groupings.

Table 8-1 Summary of SP AusNet Key Personnel

TYPE OF POSITION	Number of People	Average Age
General Management	9	44.89
Team Leader	11	54.82
Manager	16	48.49
Specialist Engineer	11	55.87
Lead Engineer	6	51.57
Other Senior Officers	20	50.61
Total Key People	**73**	**50.94**

8.4.2 Exposure to Key Person Risk

The methodology used to determine the adverse financial affect on SP AusNet of the sudden departure or death of a key person considers three cost components:

- ***Standard Replacement Cost*** – an estimate of the typical, or average, cost of replacing an employee locally. It is considered that these costs should be captured within the administrative and/or operations and maintenance costs within the general cost of service framework and, therefore, have not been included in the calculation of the self insurance risk premium;
- ***Additional Replacement Cost*** – any additional costs, in excess of typical recruiting costs, involved with recruiting a replacement employee from abroad, from senior management or from candidates within a very specialised area of expertise; and
- ***Business Disruption Cost*** – an estimate of the specific costs related to the replacement employee's expected salary and any loss/reduction of business income in the initial period of employment when they are not fully operational, including any lost business opportunities

Using this methodology, the financial exposure of key person risk is calculated as follows:

Financial Exposure = *{Additional Replacement Cost + Business Disruption Cost}*

Based on the above information and assumptions, Table 8-2 below shows our estimate of SP AusNet's exposure to key person risk.

Table 8-2 Estimated SP AusNet Financial Exposure to Key Person Risk

TYPE OF POSITION	Average Salary	Average Recruitment Costs	Business Disruption Costs	Number of People	Estimated Financial Exposure
General Management	$ 212,384	$ 63,715	$ 194,444	9.00	$ 2,323,437
Team Leader	$ 97,947	$ 28,075	$ 28,396	11.00	$ 621,178
Manager	$ 178,906	$ 43,936	$ 41,613	16.00	$ 1,368,781
Specialist Engineer	$ 135,908	$ 37,254	$ 36,045	11.00	$ 806,290
Lead Engineer	$ 155,254	$ 40,508	$ 38,757	6.00	$ 475,591
Other Senior Officers	$ 107,657	$ 29,712	$ 29,760	20.00	$ 1,189,434
Total Key People	**$ 142,891**	**$ 38,799**	**$ 54,142**	**73.00**	**$ 6,784,712**

8.4.3 Probability of a Key Person Leaving SP AusNet

The probability of a key person leaving the service of SP AusNet can be calculated based on a combination of information relating to probabilistic rates of resignation, mortality and disablement. These rates are dependent on and vary with the age of each person.

We have derived the average probability of each member of the SP AusNet key person list leaving the service of SP AusNet using resignation, mortality and disablement factors referenced in an Actuarial Review of the Victorian Energy Industry Superannuation Fund (prepared by William M Mercer). These are shown in Table 8-3 below. Another risk that is harder to quantify for key personnel is the risk of staff being poached by other utilities, this risk is a reality for all the electricity companies as there are shortages of resources in key areas. Due to the difficulty in determining the rate of poaching amongst the utilities the probability used for this risk analysis is conservatively based on the resignation, mortality and disablement factors mentioned above.

Table 8-3 Key Person Risk - Probability of Leaving Service

TYPE OF POSITION	Average Age	Probability of Leaving Service
General Management	44.89	1.86%
Team Leader	54.82	1.96%
Manager	48.49	1.92%
Specialist Engineer	55.87	2.15%
Lead Engineer	51.57	1.87%
Other Senior Officers	50.61	1.86%
Total Key People	**50.94**	**1.93%**

8.4.4 Estimated Self-Insurance Premium - Key Person Risk

Based on the above information, we estimate the total self-insurance premium for SP AusNet's key person risk to have a value of $137,464. The detailed results are shown in Table 8-4 below.

Table 8-4 Estimated SP AusNet Financial Exposure to Key Person Risk

TYPE OF POSITION	Estimated Financial Exposure	Estimated Total Risk Premium	Allocation of Total Risk Premium		
			Electricity Transmission	Electricity Distribution	Gas Distribution
General Management	$ 2,323,437	$ 43,669	$ 13,101	$ 21,398	$ 9,170
Team Leader	$ 621,178	$ 13,634	$ 13,634	-	-
Manager	$ 1,368,781	$ 27,781	$ 11,991	$ 10,022	$ 5,768
Specialist Engineer	$ 806,290	$ 18,594	$ 5,578	$ 9,111	$ 3,905
Lead Engineer	$ 475,591	$ 9,604	$ 2,461	$ 4,019	$ 3,124
Other Senior Officers	$ 1,189,434	$ 24,183	$ 16,660	$ 5,703	$ 1,819
Total: Annual	**$ 6,784,712**	**$ 137,464**	**$ 63,425**	**$ 50,253**	**$ 23,786**
Total: 6-Year Period	$ 40,708,270	$ 824,786	$ 380,550	$ 301,517	$ 142,719

Using the parameters shown earlier in section 8.4 we have allocated the risk premium across the three main business groups as shown below.

SP AusNet (Electricity Transmission)	**30%**	**$ 63,425**
SP AusNet (Electricity Distribution)	49%	$ 50,253
SP AusNet (Gas Distribution)	21%	$ 23,786

9. INSURER'S CREDIT RISK

Insurer credit risk is faced by SP AusNet, where there is a possibility that its insurers may default. The effects for SP AusNet may be:

- The loss of the premium paid in respect of the unexpired period of cover. This is later referred to as the loss of premium paid risk; and/or

- Liability exposure, where an insurer who is unable to honour an insurance policy, leaves SP AusNet fully exposed to any outstanding claims (including any incurred but not reported (IBNR) claims). This is later referred to as the IBNR risk.

In recent years, Australia has seen the HIH collapse leave thousands of policyholders out-of-pocket. The collapse has lead to a wide range of businesses being exposed to retrospective product and public liability claims for many years into the future. This is because these types of insurance policies are traditionally written on an 'occurrence' basis, where an insured event which occurred during the year of coverage is met from that year's policy, even if the claim is made in the future.

In estimating the loss of premium risk, we have assumed that bankruptcies occur mid-way through the regulatory period; we have estimated the annual liability exposure risk as an insurance premium equivalent. This reflects expected loss experience. However, the exposure to loss could be considerably larger given the large insured loss limits.

The estimated risk premium is equal to the amounts at risk multiplied by probability of default. Probability of default was derived from the insurance companies' credit ratings. This is explained in more detail below.

9.1 Calculation of the average Insurance premium over the forthcoming regulatory period

Table 9-1 found below contains forecasted Insurance premiums for each Insurance provider and Insurance policy. The forecasts for FM Global, AEGIS, QBE, and Chubb were provided by SP AusNet. We have assumed that the premiums associated with the American Home Assurance Company and Atradius remain constant at the figure existent on 1st January 2007. The average figures for each insurer are used in the risk premium calculation.

Table 9-1 Insurance Premium Forecast

SP Ausnet Insurance Premium forecast					
Insurer	**Policy**	**2008 - 2009 ($)**	**2009 - 2010 ($)**	**2010 - 2011 ($)**	**2011 - 2012 ($)**
FM Global	Property	2,250,000	2,250,000	2,150,000	2,150,000
Chubb	Directors Liability	495,550	745,000	930,000	930,000
Chubb	Voluntary Workers	600	600	600	600
Chubb	Corporate Travel	5,350	5,350	5,350	5,350
Total Chubb		501,500	750,950	935,950	935,950
AEGIS Syndicate	General Liability & PI	1,850,550	2,035,600	2,240,000	2,463,000
QBE	Aviation Non-Ownership	6,250	6,250	6,250	6,250
QBE	Motor Vehicle	116,000	116,000	116,000	116,000
Total QBE		122,250	122,250	122,250	122,250
American Home Assurance	Bond Prospectus	305,607	305,607	305,607	305,607
Atradius Credit Insurer	Credit Risk	115,500	115,500	115,500	115,500
CGU Workers Com	Workers compensation	1,055,306	1,055,306	1,055,306	1,055,306

SP Ausnet Insurance Premium forecast				
Insurer	**Policy**	**2012 - 2013 ($)**	**2013 - 2014 ($)**	**Average**
FM Global	Property	2,150,000	2,150,000	2,183,333
Chubb	Directors Liability	930,000	930,000	826,758
Chubb	Voluntary Workers	600	600	600
Chubb	Corporate Travel	5,350	5,350	5,350
Total Chubb		935,950	935,950	832,708
AEGIS Syndicate	General Liability & PI	2,500,000	2,500,000	2,264,858
QBE	Aviation Non-Ownership	6,250	6,250	6,250
QBE	Motor Vehicle	116,000	116,000	116,000
Total QBE		122,250	122,250	122,250
American Home Assurance	Bond Prospectus	305,607	305,607	305,607
Atradius Credit Insurer	Credit Risk	115,500	115,500	115,500
CGU Workers Com	Workers compensation	1,055,306	1,055,306	1,055,306

9.2 Calculation of default probabilities for each Insurance provider

Table 9-2 below shows forecasted annual default probabilities for the forthcoming regulatory period for each Insurance provider. CGU has been excluded from our analysis as they are underwritten by the government and are hence considered to be default free.

Table 9-2 Risk Premium Calculation

Insurance Provider	Average Forecasted Premium ($)	Rating	Default probability	Risk Premium ($)	Rating Agency
FM Global	2,183,333	AA	0.0000	0	Fitch, USA
AEGIS Syndicate	2,264,858	A+	0.0011	2,491	Fitch, USA
QBE	122,250	A+	0.0011	134	S&P, Aus
Chubb	832,708	AA	0.0000	0	S&P, Aus
American Home Assurance Company	305,607	AA+	0.0000	0	S&P, USA
Atradius Credit Insurer	115,500	A	0.0011	127	S&P, USA
Total excluding CGU	**5,824,257**		**3,494,554**	**2,753**	

- The credit ratings in Table 9-2 above are the most recent ratings assigned to each of SP AusNet's Insurance providers, either by Standard and Poor's (S&P) or Fitch Ratings.

- In forecasting default probabilities in Table 9-2 above, we have used historical default rates from a Standard and Poor's default study document containing default rates for Australian and New Zealand firms during the period 1989-2005[38] (see Table 9-3 below). The table contains cumulative default probabilities for the period 1989-1999 for each rating category. We have used the average annual default rates during the period 1994-1999 to represent the probability of default during each of the six years of the forthcoming regulatory period. This is obtained by taking the difference between the cumulative probabilities in adjacent years in the table below and taking the average for the period 1994-1999. We have deliberately left out the probabilities from 1989 to 1993 due to the economic downturn that was in existence during that period[39].

[38] Default Study: Australia & New Zealand 2005 Annual Default & Rating Transitions, Standard and Poor's, September 2006

[39] Australian Macroeconomic Performance and Policies in the 1990s: http://www.rba.gov.au/PublicationsAndResearch/Conferences/2000/GruenStevens.pdf

Table 9-3 Default Probabilities

Table 3

Australia and New Zealand Cumulative Average Default Rates, 1989-2005 (%)

	—Time horizon—									
Rating category	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Yr. 5	Yr. 6	Yr. 7	Yr. 8	Yr. 9	Yr. 10
AAA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AA	0.00	0.00	0.00	0.27	0.57	0.57	0.57	0.57	0.57	0.57
A	0.15	0.32	0.50	0.50	0.50	0.74	1.03	1.03	1.03	1.03
BBB	0.18	0.38	0.61	0.88	1.21	1.62	2.16	2.88	3.93	5.64
BB	1.30	1.30	1.30	5.50	8.45	8.45	8.45	8.45	8.45	8.45
B	3.45	10.88	16.95	21.32	23.57	23.57	26.40	32.80	40.27	48.80
CCC/C	37.50	45.83	58.33	58.33	58.33	58.33	58.33	58.33	58.33	58.33
Investment grade	0.11	0.24	0.38	0.53	0.71	0.91	1.15	1.30	1.48	1.74
Speculative grade	7.55	11.72	16.36	19.89	21.99	21.99	23.52	27.25	31.80	37.05
All rated	0.74	1.20	1.70	2.13	2.45	2.64	2.97	3.38	3.90	4.59

Source: Standard & Poor's, and Australian Ratings.

9.3 Quantification of risk premium arising from the loss of premium risk

In quantifying this risk, we have assumed that:

- Bankruptcies occur midway through the year;
- In the event of bankruptcy, SP AusNet will need to purchase an additional insurance policy, over and above what was in their base operating costs, to cover the second half of the year; and
- The insurance premium incurred for the second half of the year and the years beyond is the same as what SP AusNet included in their base O&M forecasts, therefore there is no additional cost incurred by SP AusNet.

Hence, the annual risk premium for the 'loss of premium paid' risk is calculated as the mean insurance premium for the respective insurance provider over the regulatory period * average annual default probability associated with the respective insurance provider * 1/2 a year, summed over all the insurance providers.

9.4 Quantification of risk premium arising from the IBNR (Incurred But Not Reported) risk

The IBNR risk premium attempts to quantify the liability exposure that may arise from an insurance provider going bankrupt in any one year.

In quantifying this risk, we have assumed that:

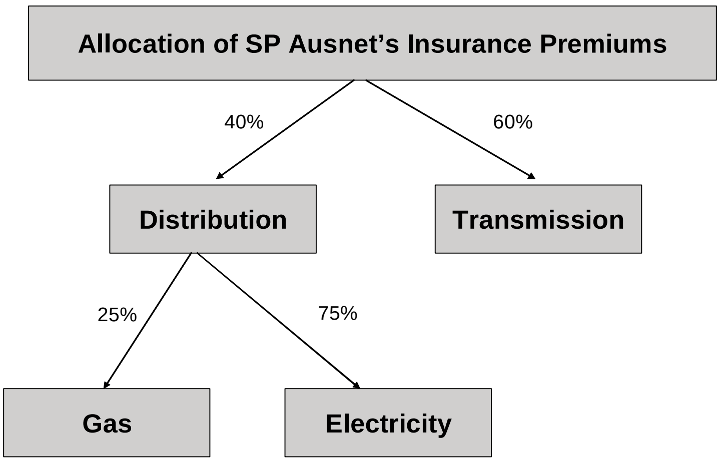
- Bankruptcies occur midway during the year;
- In the event of bankruptcy, SP AusNet may have outstanding claims from the first half of the year that cannot be recovered from the bankrupt insurance provider;
- The insurance premium charged by the provider represents their quantification of their risk exposure during that period, along with the addition of a small profit margin; and
- The premium charged for that half of the default year is a proxy for the IBNR exposure during that period, as the profit margin is generally small relative to the size of the premium.

Accordingly, the annual risk premium arising from the IBNR risk is identical to the risk premium arising from the loss of premium risk: mean insurance premium for the respective insurance provider over the regulatory period * average annual default probability associated with the respective insurance provider * 1/2 a year, summed over all the insurance providers.

9.5 Risk premium calculations

We obtained the data in the Figure 9-1 below from SP AusNet. The diagram contains an allocation of Insurance premiums between Distribution and Transmission, as well as Gas and Electricity.

Figure 9-1 Allocation of SP AusNet's Insurance Premiums



Source: SP AusNet

This equates to the allocations in Table 9-4 below.

Table 9-4 Allocation of Insurance Premiums

Allocation of the Insurance premiums between business divisions	
Gas Distribution	10%
Electricity Distribution	30%
Electricity Transmisison	60%
Total	**100%**

Source: SP AusNet

Therefore, the annual electricity transmission risk premium = Total risk premium excluding CGU (IBNR and loss of premium risk) * % of insurance premium allocated to electricity transmission = $2,753 * 60% = $1,652

10. RISK OF NON-TERRORIST IMPACT OF PLANES AND HELICOPTERS

10.1 Description of Risk

There is a risk that SP AusNet will be legally liable for any losses or damages to aircraft and third parties in the event that an aviation accident or incident, not related to an act of terrorism, impacts with SP AusNet's electricity transmission assets (i.e. non-terrorism wire strikes).

Wire strikes generally occur when an aircraft is operating in close proximity to the ground, including the landing and take-off phases of flight. However, on occasion, wire strikes have occurred over water where wire is strung between two high points. Wire strikes can cause significant damage to an aircraft resulting in loss of control and subsequent impact with the ground or water. Impact forces are likely to involve further aircraft damage and possibly injury or death to occupants of the aircraft.

10.1.1 Wire Strike Hazards[40]

Historical records indicate that wire strikes have impacted on powerlines of various configurations, ranging from multiple clusters of high voltage transmission wires to single wire earth return (SWER) pole distribution systems. However, it would appear that SWER systems can be particularly hazardous as both the pole and wire may be difficult to distinguish from the background environment. Furthermore, these wires are more commonly found across the approach path to a country paddock or airstrip. Guy wires used to secure a power pole in position can also be difficult for pilots to see, even when they know the general location of the wire.

A number of factors associated with powerlines, such as the number of wires, the height of the wires, and the general direction of the wire run, can determine whether or not a pilot sees a wire. Additionally, the material used to manufacture the wire can impact on visibility. For example, copper wire oxidises to a blue/grey colour which is often difficult to distinguish against the Australian eucalypt background. Single powerlines are possibly the greatest hazard as they can be extremely difficult to detect from the air and can be located in unexpected places in rural areas. Other factors restricting visibility include the position of the sun, changing light conditions, background camouflage, the obscuring effects of terrain, poor weather, and a dirty windscreen.

Even if electricity wires can be seen, the ability to judge its position accurately may be reduced by a number of factors. For example, the ambient temperature can change the location of the wire by causing the wire to sag or tighten, and windy conditions may cause sagging wires to be blown about.

40. Much of the material in this section is drawn from the following source: **ATSB (2006)**, '*Wire-strike Accidents in General Aviation: Data Analysis 1994 to 2004'*, Australian Transport Safety Bureau, Aviation Research and Analysis Report – B2005/0055, September 2006.

Finally, there are a number of human limitations that may contribute to a wire strike accident or incident, such as the ability to process information, stress, fatigue, fitness to fly and pilot distraction (visual, auditory, physical or cognitive).

10.2 Historical Record of Aviation Wire Strike Accidents and Incidents

10.2.1 ATSB Aviation Accident and Incident Database

In accordance with the *Transport Safety Investigation Act 2003*, all accidents and incidents related to flight safety in Australia or by Australian operators overseas must be reported to the Australian Transport Safety Bureau (ATSB). All reported occurrences that meet defined criteria are then entered into an ATSB database.

The ATSB has adopted definitions of an accident or an incident as determined by the International Civil Aviation Organisation (ICAO) which can be summarised as follows:[41]

- **Accident** – an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have embarked, in which:
  - a person is fatally or seriously injured;
  - the aircraft sustains damage or structural failure; or
  - the aircraft is missing or is completely inaccessible.
- **Incident** – an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.

Analysis of Aviation Wire Strike Accidents and Incidents - 1994 to 2004

In 2006, the ATSB released an Aviation Research and Analysis Report which analysed the accident and incident data for general aviation in the ATSB database related to wire strikes between 1994 and 2004.[42] Some of the more relevant facts from that study include the following:

- In total, there were 249 occurrences of an aircraft striking a wire between 1994 and 2004, an average of almost 23 per year. Of these occurrences:
  - 11 were identified where another critical event such as engine failure or simulated engine failure, fuel starvation, main rotor failure, occurred prior to the wire-strike event;
  - 217 reported wire strike accidents and incidents occurred during general aviation operations;
  - 21 reported wire strike accidents and incidents occurred during sport aviation operations; and

41. **ICAO (2001)**. '*Annex 13 to the Convention on International Civil Aviation: Aircraft Accident and Incident Investigation (Ninth Edition)*', International Civil Aviation Organisation.

42. ATSB (2006).

- No wire strike accidents or incidents were recorded for regular public transport operations or military aviation.[43]

- Of the 217 general aviation wire strike accidents and incidents, 98 were classified as incidents meaning that 119 were accidents involving a wire strike as the primary event (an average of almost 11 per year);
- There were 169 people involved in the 119 general aviation wire strike accidents, of which 109 (40%) received some degree of injury. This included 45 fatalities, 22 people with serious injuries, and 42 people with minor injuries;
- 74 general aviation wire strike accidents were related to agriculture operations (62%), 24 were recorded in the other aerial work category (20%), and the private/business flying category recorded 18 accidents (15%). The remaining 3 accidents related to flying training (2) and charter flights (1); and
- 68 (57%) of the general aviation wire strike accidents involved fixed-wing aircraft and 51 (43%) involved rotary-wing aircraft.

Analysis of Aviation Wire Strike Accidents - 1977 to 2006

Whilst the above data does give some insight into the incidence of aviation wire strikes in Australia, it does not indicate which State or jurisdiction the events occurred. However, we were able to obtain from the ATSB some additional data on all wire strike accidents recorded in the ATSB's OASIS aviation database for the 30-year period from 1 January 1977 through to 31 December 2006. The data is summarised in Table 10-1 below.

Table 10-1 Australian Aviation Wire Strike Accidents – 1977 to 2006

STATE	ACCIDENTS		HIGHEST INJURY LEVEL				LEVEL OF AIRCRAFT DAMAGE			
	No.	%	Fatal	Serious Injury	Minor or None	Total	Destroyed	Substantial Damage	Minor or None	Total
NSW	152	32.5%	29	38	85	**152**	54	97	1	**152**
Vic	76	16.2%	12	16	48	**76**	34	42	-	**76**
Qld	162	34.6%	34	30	98	**162**	63	97	2	**162**
WA	28	6.0%	10	5	13	**28**	15	13	-	**28**
SA	33	7.1%	4	5	24	**33**	11	21	1	**33**
Tas	15	3.2%	5	3	7	**15**	8	7	-	**15**
NT	2	0.4%	-	-	2	**2**	2	-	-	**2**
ACT	-	-	-	-	-	**-**	-	-	-	**-**
Total	**468**	**100.0%**	**94**	**97**	**277**	**468**	**187**	**277**	**4**	**468**

From our summary review of the data, we have ascertained the following points:

- There were 468 aviation wire strike accidents between 1977 and 2006, an average of approximately 15.6 wire strike accidents per annum;

43. For statistical purposes, the ATSB divides the Australian aviation industry into 4 primary groups: (a) Regular Public Transport (RPT) (divided into high capacity and low capacity operations), (b) general aviation (comprising charter, private, business and other aerial work (agriculture, flying training and aerial work)), (c) military aviation, and (d) sport aviation (which includes hang gliders, balloons, autogyros, gliders/sailplanes, ultralights and airships).

- With respect to the level of injury, there were 94 fatal accidents, 97 accidents resulting in serious injury, 92 accidents resulting in minor injury and 185 accidents with no reported injuries. Therefore, there were 191 aviation wire strike accidents (40.8%) resulting in fatalities or serious injury, with an average of 6.3 per annum;
- With respect to the level of aircraft damage, 187 accidents resulted in the aircraft being destroyed in addition to 277 resulting in substantial damage and 4 resulting in minor or no damage. Hence, 99.2% of all aviation wire strike accidents resulted in the aircraft being destroyed or substantially damaged; and
- There were 162 (34.6%) aviation wire strike accidents in Queensland, 152 (32.5%) in New South Wales, 76 (16.2%) in Victoria and 78 (16.7%) in the other 5 states and territories.

We have also ascertained the following points with respect to the number of wire strike accidents in Victoria over the 30-year period from 1977 to 2006 (summarised in Table 10-2 below):

- There were 76 aviation wire strike accidents between 1977 and 2006, an average of approximately 2.5 wire strike accidents per annum;
- With respect to the level of injury, there were 12 fatal accidents, 16 accidents resulting in serious injury, 17 accidents resulting in minor injury and 31 accidents with no reported injuries. Therefore, there were 28 wire strike accidents (36.9%) resulting in fatalities or serious injury, with an average of 0.9 per annum;
- With respect to the level of aircraft damage, 34 accidents resulted in the aircraft being destroyed and 42 resulting in substantial damage. Hence, all 76 reported aviation wire strike accidents in Victoria over the past 30 years have resulted in the aircraft being destroyed or substantially damaged; and
- 62 (81.6%) of the aviation wire strike accidents involved general aviation aircraft and 14 (18.4%) involved sport aviation aircraft. There were no accidents involving military aircraft or regular public transport aircraft.

Table 10-2 Victorian Aviation Wire Strike Accidents – 1977 to 2006

	HIGHEST INJURY LEVEL				LEVEL OF AIRCRAFT DAMAGE			
	Fatal	Serious Injury	Minor or None	Total	Destroyed	Substantial Damage	Minor or None	Total
Total Accidents	12	16	48	**76**	34	42	-	**76**
% of Total	15.8%	21.1%	63.2%	**100.0%**	44.7%	55.3%	-	**100.0%**
Annual Average	0.4	0.5	1.6	**2.5**	1.1	1.4	-	**2.5**

10.2.2 Wire Strike Accidents Involving SP AusNet Transmission Assets

Although the ATSB data indicates the State and even the location of each accident, the wire strike summary information refers only to contact with powerlines and makes no clear distinction between accidents involving electricity distribution or electricity transmission power lines. However, we are aware of at least the following 3 aviation accidents involving SP AusNet's transmission network:

8 Mar 2004 Ballarat Line - While carrying out powerline inspections, the aircraft was involved in a phase to phase electric flash over. The helicopter was landed heavily with full power. The crew and passenger sustained minor burns.

7 Feb 2004 Lake Eildon – On the morning of 7 February 2004, a private sightseeing flight struck a 220 kV power cable spanning Lake Eildon in Victoria. The cable was one of a group of six cables that form the transmission line linking Melbourne and Kiewa in North-East Victoria.

The force of the wire strike dislodged the left wing of the aircraft, and the aircraft descended out of control and impacted the water about 165m beyond and to the southeast of the cable that was struck. The aircraft was substantially destroyed because of the wire strike and the subsequent impact with the water. The four aircraft occupants were fatally injured by impact forces when the aircraft impacted the water.[44]

6 Jul 1989 Tolmie – The pilot reported at YMAY 0318 A080 YELW 0348. A clearance to enter CTA was issued at A080 and acknowledged by the pilot. No further contact with the pilot was established. Persons in the Tolmie region reported hearing an aircraft flying low over their houses, and then observed a flash of light and heard an impact sound. The aircraft wreckage was located early the following morning. Rime ice build-up was evident at the wreckage site.

10.3 SP AusNet's Current Insurance Provisions

SP AusNet's current insurance arrangements include an '*Aviation Non-Ownership Liability'* policy which provides the following insurance coverage for SP AusNet:

- Legal liability for loss or damage to non-owned aircraft;
- Legal liability to third persons (ex-passengers) for death or bodily injury caused by non-owned aircraft; and
- Legal liability to passengers for death or bodily injury caused by non-owned aircraft.

The policy is limited to low capacity aircraft with seating capacity for a maximum of nine passengers. The total limit of liability is $20 million, although there is a sub-limit of $5 million for aircraft hull damage. In addition, there is a deductible of $10,000 for claims related to hull damage.

Therefore, SP AusNet has a maximum residual risk exposure of $10,000 with respect to liability for any third party property losses/damages or personal fatality/injury in the event of an aviation accident/incident impacting on the electricity transmission network.

44. ATSB Report: 200400437, *Piper Aircraft Corp PA-28R-200, VH-TRZ, Eildon, Vic, 7 February 2004*. Canberra: Australian Transport Safety Bureau.

10.4 Quantification of Self-Insurance Risk Premium for Wire Strikes

Under the terms of its insurance policy, SP AusNet is potentially liable for a residual risk equivalent to the deductible (i.e. $10,000 per claim) for any losses or damages to aircraft and third parties in the event that a small aircraft or helicopter crashes into SP AusNet's electricity transmission assets. The estimate of a self-insurance risk premium for this risk is therefore calculated as follows:

Estimated Risk Premium (Non-Terrorist Impact of Planes and Helicopters) =
Probability of Non-Owned Aircraft Accident or Incident x$10,000

This estimated risk premium excludes any provision for damage to SP AusNet's own assets.

10.4.1 Probability of a Non-Owned Aircraft Incident

Based on the information set out in Section 10.2, we know that there has been, on average over the past 30 years, approximately 2.5 aviation wire strike accidents in Victoria per annum. We also know that in all 76 accidents to have been recorded over the period, the aircraft was either destroyed or substantially damaged. It is therefore reasonable to assume that this means that the cost of damage associated with each accident would exceed at least $10,000.

If all of the wire strike accidents had involved electricity transmission wires, we could therefore reasonably assume that SP AusNet could, on average, be exposed to 2.5 claims against its aviation non-ownership liability policy per annum. The self-insurance premium would therefore be $25,000 (i.e. 2.5 accidents per annum x $10,000 deductible per claim).

Logic would, however, lead to an expectation that a reasonable proportion of aviation wire strike accidents would also involve electricity distribution wires. An assumption of an even 50% split between distribution and transmission wire strikes would result in an average number of accidents involving SP AusNet's transmission wires of 1.25 per annum and potential liability exposure of $12,500. Although we have been unable to ascertain what proportion of accidents involved strikes against distribution or transmission wires, we believe the potential for wire strike hazards described in Section 10.1.1 means it would be reasonable to assume that more than 50% of the accidents involved distribution wires.

If the 3 accidents referred to in Section 10.2.2 are the only 3 aviation wire strike accidents impacting on SP AusNet's electricity transmission network in recent times, we could assume an average annual rate of 1 aviation wire strike accident every 6 years (3 accidents in the past 18 years since the Tolmie accident in 1989) – a probability of 16.67% per annum. If they are the only 3 such incidents in the last 30 years, we would assume 1 accident in every 10 years – a probability of 10% per annum.

For this analysis we have assumed that, on average, there will be 1 non-owned aircraft accident involving SP AusNet's electricity transmission assets every 10 years - a probability of 1 in 10, or 10% per annum. This implies that there would have been a total of 3 aviation wire strike accidents involving SP AusNet's electricity transmission assets over past 30 years. Therefore, based on the historical data discussed above, there is a 3.9% probability that an aviation wire strike accident occurring in Victoria will involve a transmission wire (i.e. 3/76), with the remaining 96.1% (i.e. 73/76) involving electricity distribution.

10.4.2 Estimated Aviation Non-Ownership Liability Self-Insurance Risk Premium

The estimation of an annual self-insurance risk premium for an aviation accident involving an aircraft not owned by SP AusNet impacting on its electricity transmission network is calculated as follows:

Probability of Aviation Wire strike * Deductible per Claim

= 1/10 * $10,000 = **$1,000 per annum**

Appendix 1 – Removed Self-Insurance Analysis

This appendix is the result of analysis that has been conducted by Saha International but due to concerns with the information has been removed from the main body of the report as the information cannot be validated to an acceptable level by Saha International. The sections removed from the main body of the report are:

- EMF,
- Easement Claims, and
- Landowner Complaints.

These risks are still believed to be of concern by Saha International for SP AusNet but quantification of these risks has proven to be difficult without further information, either comparable cases from other parts of the world or information from within Australia.

1. RISK OF ELECTRIC AND MAGNETIC FIELD CLAIMS

1.1 Introduction and Description of Risk

Wherever there is natural or man-made electricity, there are also electric and magnetic fields (EMFs). Natural electrical fields can be produced by static from a person's clothes or carpet in the home, and natural magnetic fields are produced by huge moving charges deep within the earth's core or by currents of lightning. Man-made electrical and magnetic fields are created whenever electricity is used, distributed, transmitted or generated.

Over the past 25 years there has been a growing concern amongst the public that EMFs could be the cause for cases of cancer, and in particular childhood leukaemia. However, to date no evidence of this risk has been established and no lawsuit has been successful in demonstrating a link between EMF and adverse health effects. Nevertheless, with approximately 6,500 kilometres of high voltage transmission lines travelling through regional as well as suburban areas of Victoria, SP AusNet needs to consider its potential exposure to the following main areas of EMF related risks:

- A successful lawsuit escalating into a chain of lawsuits, and therefore potentially constitute an enormous liability to SP AusNet;
- Costs of legal defence for unsuccessful EMF claims;
- Increased cost of EMF metering services and provision of information to the public on EMF risks, especially when articles and reports on the topic are made public; and
- Cost of more stringent EMF standards issued by the government or relevant regulatory authorities.

1.2 Electric and Magnetic Fields (EMFs)

1.2.1 Electric Fields

The electric charge or voltage of an object creates an electric field. As you move away from the charged object, the strength of the electric field reduces. Electric field strength is measured in volts per metre (V/m) or kilovolts per metre (kV/m). One kilovolt equals 1,000 volts.

The most common sources of man-made electric fields include overhead high voltage powerlines and other electrical equipment. The effects of outdoor electric fields usually stop at trees, fences or walls. Therefore, outdoor sources of electric fields are generally considered not to make a significant contribution to electric field levels inside a home. However, electrical wiring, lighting and electrical appliances, such as electric blankets and televisions, create small electric fields indoors.

1.2.2 Magnetic Fields

Whenever electric charges move, such as electric current flowing through a wire, a surrounding magnetic field is created. The strength of the magnetic field depends on the current. Magnetic fields also reduce as you move away from the current. However, unlike electric fields, magnetic fields do not stop at adjacent objects such as tress, fences or walls.

Magnetic fields are also described as magnetic flux densities, and are measured in units of the tesla (T) or the gauss (G). The more common smaller unit of measure is the milligauss (mG) which is equal to 0.001 gauss.

Common sources of magnetic fields include overhead powerlines, electrical wiring and electric appliances.

Table 1-1 below shows typical magnetic field strengths from a range of common sources, including electricity transmission and distribution powerlines.

Table 1-1 Typical Magnetic Field Strengths[45]

EMF Source	EMF Measurement (Milligauss)	
	Typical	Range
Transmission Power Lines (under lines)	20	10 to 200
Transmission Power Lines (edge of easement)	10	2 to 50
Distribution Power Lines (under lines)	10	2 to 20
Distribution Power Lines (8 metres away)	2	0.4 to 4
33 kV Underground Cables (directly above buried cables)	12	3
Major Zone Substation (at substation fence)	2	1 to 6
Modular Substation (at substation fence)	1.5	0.5 to 3
Pad Mounted Distribution Transformer	2	1 to 20
Hair Dryer	25	10 to 70
Electric Blanket	20	5 to 30
Electric Stove	6	2 to 30
Personal Computer	5	2 to 20
Television	1	0.2 to 2
Toaster	3	2 to 10
Kettle	3	2 to 10
Fridge	2	2 to 50

EMF levels for appliances are taken at normal user distance.

The data in the Table 1-1 is based on a consistent set of measurements undertaken by power authorities in Australia, using similar techniques and protocols to overseas measurements. However, owing to variations in the loadings on powerlines and the design of electrical appliances, measurements of the levels of magnetic fields shown in overseas publications may vary from those shown in the Table 1-1.

1.3 Magnetic Fields from Electricity Powerlines

Both high voltage electricity transmission powerlines and electricity distribution powerlines produce magnetic fields. However, in many cases, high voltage powerlines are constructed on easements where building and construction is not permitted.

The strength of magnetic fields associated with electricity powerlines depends on the amount of current flowing along the line and the distance from the line. Magnetic fields rapidly decrease in strength with distance from the source. Typically, magnetic fields from nearby powerlines are considered to be similar to that from wiring and appliances inside a house.

45. **Energy Networks Association (ENA)**, *'Electric and Magnetic Fields: What we Know'*, June 2006.

1.3.1 SP AusNet Measurement of Electric and Magnetic Fields

In 2000, in response to public and residential enquiries, SP AusNet measured electric and magnetic fields of electrical appliances and transmission lines in Victoria.

SP AusNet Measured Transmission Line Electric Fields

Electric fields measured beneath 500 kV transmission lines range from 2 to 8 kV/m, depending on the type of line, the ground profile, vegetation and the height of the conductors above ground level. SP AusNet's transmission lines are located on easements or rights of way, which are approximately 60 metres wide. At the edge of the easements, measured electric field levels ranged from 0.5 to 2 kV/m. Under 330 kV and 220 kV transmission lines, measured electric fields ranged from 1 kV/m to 5 kV/m.

The average electric fields measured for residential homes (i.e. electrical wiring and lighting) ranged from 0.001 kV/m to 0.05 kV/m, whereas the average electric fields for electrical equipment and appliances (e.g. electric blankets and televisions) ranged from 0.001 kV/m to 0.3 kV/m.

Table 1-2 Measured Electric Fields - SP AusNet Transmission Lines[46]

Transmission Line Voltage	Under Line	Edge of Easment
500 kV Transmission Lines	2 to 8 kV/m	0.5 to 2.0 kV/m
330 kV Transmission Lines	1 to 5 kV/m	0.1 to 1.0 kV/m
220 kV Transmission Lines	1 to 3 kV/m	0.1 to 1.0 kV/m

SP AusNet Measured Transmission Line Magnetic Fields

Under 220 kV, 330 kV and 500 kV transmission lines, typical magnetic fields ranged from 10 to 80 milligauss (mG), depending on the type of line, line current and height of the conductors above ground level.
At the edge of easements, the field levels ranged from 1 to 25 mG. These reduced to a range of 1 to 15 mG at about 50 metres from the centre line.

In houses located near transmission lines where residents asked for measurements, the home-average magnetic field levels ranged from 1 to 20 mG. However, in most residences, the home-average ranged from 1 to 5 mG. Home residences not located next to electricity transmission lines had a home-average magnetic field ranging from 0.5 to 5 mG, with most of the values within 1 mG.

Table 1-3 Measured Magnetic Fields - SP AusNet Transmission Lines[47]

Transmission Line Voltage	Under Line	Edge of Easment	At 50m Distance
500 kV Transmission Lines	20 to 120 mG	5 to 40 mG	2 to 20 mG
330 kV Transmission Lines	10 to 50 mG	5 to 10 mG	1 to 5 mG
220 kV Transmission Lines	10 to 80 mG	2 to 20 Mg	1 to 5 mG

46. **SP AusNet (2000)**,*"All About Electric and Magnetic Fields from Transmission Lines"*.

47. **SP AusNet (2000)**.

1.4 Research on the Health Effects of Exposure to EMF

The effects of electric and magnetic fields on people's health has been the subject of research since the late 1950s. Individual research publications and investigations have increased public attention on the possible health implications from exposure to man-made electric and magnetic fields.

Although scientific studies appear to have generally concluded that 50/60 hertz electric fields alone do not appear to pose a health problem, results of research on the effects of magnetic fields have been more controversial. The most controversial issues revolve around the question of whether electricity is associated with the occurrence of cancer and other adverse health effects. In recent years, many national and international committees and panels have evaluated research results on magnetic fields but have generally concluded that there is no convincing evidence that EMF cause immediate, permanent harm to human health or plays a causative role for cancers such as leukaemia and brain tumours.

Epidemiological studies[48] and laboratory experiments have suggested a possible connection between 50/60 hertz magnetic fields and adverse health effects, but a number of key organisations – including the World Health Organisation and the American National Academy of Sciences – have also concluded that a principle cause-and-effect relationship has not been sufficiently demonstrated. Ongoing research is being conducted in an attempt to resolve these issues.

1.4.1 Findings of Recent Scientific Reviews

Research into the health effects of EMFs has been conducted for more than 25 years. Whilst research is generally performed on both the electric and magnetic field components of EMF, the primary focus is usually on the magnetic field component as this has raised more issues than electric fields.

Bodies such as the World Health Organisation (WHO) and national health authorities continually review the results of experiments and research from all over the world. Two major reviews have been carried out recently:

US National Institute of Environmental and Health Sciences (NIEHS) [49]

In 1999, the NIEHS review found that:

48. Epidemiology is the study of possible causes of disease through the comparison of selected population groups.

49. **NIEHS (1999)**, '*NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields*', National Institute of Environmental Health Sciences/National Institute of Health, NIH Publication No.99-4493, 4 May 1999.

"The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak. The strongest evidence for health effects comes from associations observed in human populations with two forms of cancer, childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults. While the support from individual studies is weak, the epidemiological studies demonstrate for some methods of measuring exposure, a fairly consistent pattern of small increased risk with increasing exposure that is somewhat weaker for chronic lymphocytic leukemia than for childhood leukemia. In contrast, the mechanistic studies and the animal toxicology literature fail to demonstrate any consistent pattern across studies although sporadic findings of biological effects have been reported.

The lack of connection between the human data (epidemiological) and the experimental data (animal and mechanistic) severely complicates the interpretation of the results."

"The NIEHS concludes that ELF-EMF exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard."

"… passive regulatory action is warranted such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern."

UK National Radiological Protection Board (NRPB)[50]

(now part of the UK Health Protection Agency)

In 2001, the NRPB report also concluded:

"Laboratory experiments have provided no good evidence that extremely low frequency (ELF) EMFs are capable of producing cancer, nor do human epidemiological studies suggest they cause cancer in general. There is, however, some epidemiological evidence that prolonged exposure to higher levels of power frequency magnetic fields is associated with a small risk of leukemia in children",

But the report also goes on to say that

"...the epidemiological evidence is not strong enough to justify a firm conclusion that such fields cause leukemia in children."

In 2001, the International Agency for Research on Cancer (IARC), a part of the World Health Organisation, classified power frequency magnetic fields as a "possible carcinogen", based on recent epidemiological study findings which associate childhood leukemia with higher levels of exposure to residential magnetic fields. They comment that no scientific explanation has been established for the observed association.

50. **AGNIR (2001)**, '*ELF Electromagnetic Fields and the Risk of* Cancer', Report by the Advisory Group on Non-Ionising Radiation (AGNIR) to the UK National Radiological Protection Board, March 2001.

1.5 Australian Guidelines on Limits of Human Exposure to EMFs

There have been no Australian standards regulating limits of human exposure to EMFs. However, in 1989, the Australian National Health and Medical Research Council (ANHMRC) published the '*Interim Guidelines on Limits of Exposure to 50/60 Hz Electric and Magnetic Fields'*.[51] These guidelines are aimed at preventing immediate health effects resulting from exposure to EMFs. Table 1-4 below summarises the NHMRC limits of exposure.

Table 1-4 NHMRC Electric and Magnetic Field Limits[52]

Human Exposure Limits	Electric Fields	Magnetic Fields
General Public		
Occasional Exposure	10 kV/m	10,000 mG
Full-Time Exposure	5 kV/m	1,000 mG
Occupational		
Exposure of Limbs	n/a	250,000 mG
Short-Term Exposure	30 kV/m	50,000 mG
Whole Working Day Exposure	10 kV/m	5,000 mG

Occasional Exposure is for up to a maximum of 2 hours per day

1.5.1 New ARPANSA Standards

In Australia, the Australian Radiation Protection and Nuclear Safety Agency (APANSA), an arm of the Commonwealth Department of Health, is now responsible for the regulation of EMFs, including power frequencies. On 7 December 2006, ARPANSA released a new draft ELF/EMF Radiation Protection Standard for Australia.[53] It is currently subject to public comment for a period of 3 months.

The draft EMF Standard provides limits for public and occupational exposure to EMF and is intended to replace the 1989 NHMRC Interim Guidelines. It also provides guidance on matters related to a precautionary approach for EMF exposure issues. However, ARPANSA has recommended that the Standard be issued as an advisory guideline rather than a regulated standard.

The new draft Standard is stricter in its compliance requirements at 50Hz that the former NHMRC Guidelines. As such, there is expected to be some need for industry to change its management of the EMF issue, in terms of both public and occupational exposure.

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51. These interim guidelines were based on two Environmental Health Criteria on Electric and Magnetic Fields published in 1984 and 1987 under the joint sponsorship of the World Health Organisation (WHO), the International Labour organisation (ILO) and the International Radiation Protection Association (IRPA).
52. **Australian National Health & Medical Research Council (NHMRC) (1989)**, *"Interim Guidelines on Limits of Exposure to 50/60 Hz Electric and Magnetic Fields"*.
53. **ARPANSA (2006)**, *'Radiation Protection Standard: Exposure to Electric and Magnetic Fields – 0 Hz to 3 kHz (Public Consultation Draft)'*, Australian Radiation Protection and Nuclear Safety Agency, 7 December 2006.

1.6 SP AusNet Position on EMF

SP AusNet's website recognises that it has an obligation to provide electricity safely, reliably and economically, but because of continuing uncertainty about the effects of EMFs, SP AusNet pursues a *'careful course of action'*. Therefore, SP AusNet states that in accordance with the recommendations of the Energy Supply Association of Australia (ESAA) it:

- Operates its transmission system prudently within Australian health guidelines;
- Closely monitors high quality scientific research; and
- Takes community views into account when siting new facilities.

SP AusNet has produced the aforementioned booklet that sets out a range of information on EMF and its policy on EMFs associated with its transmission lines.[54] This policy includes a statement that it is prudent in its design of new installations as recommended by the ESAA, aiming to reduce the exposure of people to these fields where this can be achieved at a modest cost, without decreasing the reliability of the services to the community and without compromising other electrical safety considerations.

SP AusNet's policy also indicates that it will continue to monitor EMF levels associated with its installations and provide measurement services and information regarding the status of the EMF issues to its employees, customers and the public.

1.7 Potential SP AusNet Risk of Exposure to EMF Claims

SP AusNet is currently insured against EMF liability claims under the coverage of its general liability policy. The policy provides for a limit of liability of $810 million in the annual aggregate and includes a deductible amount of $100,000 on each claim.

Over the past 25 years, there have been numerous lawsuits against companies in the United States, United Kingdom and Australia alleging bodily injury and/or loss of property values as a result of exposure to EMF. To date, all of these claims have been successfully defended, primarily because the courts could not ignore the fact that the scientific community has not been able to establish a sufficient causal link between exposure to EMF and adverse health effects.

Despite the lack of success of claims to date, the inconclusive findings of the ongoing research into the issues means there is a need to fully consider the potential exposure to future EMF liability claims. With this in mind, previous discussions with SP AusNet and its insurers have indicated that the following risk assessments have been determined:

- The risk of a class action proceeding against SP AusNet based on exposure to EMF is relatively small. Proceedings are more likely to be by way of test cases. However, if one or more claims were successful, then SP AusNet would

54. SP AusNet (2000).

have a very large risk exposure. Consideration of recent determinations in relation to the tobacco industry indicates that SP AusNet's potential liability could well be in excess of SP AusNet's current annual insurance limit for EMF claims;

- Changes in social values and increased awareness of EMF related issues through information from the mainstream media and the internet (which is usually always negative in respect of the matter). The largest potential areas of risk in the short-to-medium term are likely to fall into the following areas:
  - Additional costs (in excess of current expected levels based on historical costs) needed to address community concerns, particularly increased measurement of EMFs at its facilities and installations and increased communications with residents living near transmission lines;
  - Modification of its network infrastructure or work practices due to more stringent standards issued by the relevant regulatory or advisory body (e.g. the draft ARPANSA standards), which could include raising the height of conductors or installing alternative underground cables in some areas;
  - Significantly increased costs arising from the possibility of a group of residents living near transmission lines petitioning their local government (or possibly going through the courts) in an attempt to force SP AusNet to lay underground cables, including additional EMF shielding, in affected areas.

Based on these risk assessments, we believe there are six potential EMF claim scenarios namely:

(1) Catastrophic Loss

(2) Insurer Default Claims in the Event of Catastrophic Loss

(3) EMF Test Cases

(4) Increased EMF Measurement and customer Service Costs

(5) More Stringent EMF Standards

(6) Prohibition of Live-Line Work

1.7.1 Catastrophic Loss

This relates to the event where one or more EMF test cases against SP AusNet is successful and a negotiated settlement for other plaintiffs with similar grievances across Victoria is required.

When confronted with lawsuits resulting from EMF related claims, plaintiffs often sue utility companies for the following:[55]

- Allegations that they have suffered bodily injury as a result of exposure to EMF and that this exposure has caused everything from emotional distress to cancer;

55. **Meyer, K. A. (1992)**, *"Securing Insurance Coverage for EMF Claims"*, referenced from the Energy Citations Database, U.S. Department of Energy (DOE) Office of Scientific and Technical Information (OSTI), www.osti.gov/energycitations.

- EMF has also caused property damage – usually as a fourth of a reduction in the value of their residence; and
- EMF constitutes a trespass and nuisance which has prevented plaintiffs from using their property to the fullest extent.

Level of Exposure

In the absence of any successful EMF claims over the last 25 years, it is extremely difficult to estimate the likely costs of a catastrophic EMF event. However, drawing on the settlement costs from more recent asbestos claims[56], a total settlement cost in respect of all affected Victorian residents could, conservatively be estimated to be in the order of $1.5 billion[57]. Assuming the full limit of liability under its insurance policy ($810M), SP AusNet could be left with a net liability of around $700M.

Alternatively, based on the Asbestos plaintiff settlements payable by James Hardie (refer to footnote), SP AusNet could face a cost for plaintiff settlements of approximately $8.6M per annum.[58]

Probability of Occurrence

The probability of a catastrophic EMF event is equally difficult to estimate, particularly given the lack of conclusive scientific evidence to suggest whether or not EMF exposure is actually harmful to human health. However, we estimate that the probability of such a catastrophic event in any given year during the next regulatory period is, at best, 1 in 5,000 (i.e. 0.02%).[59]

56. "Earlier this month, company shareholders (of James Hardie) agreed on a new compensation package worth more than US$4b over 40 years." – ABC News Online, Updated Thursday February 15 2007.

57 In 2006, the population of Victoria is about 5.07 million (Source: Department of Sustainability and Environment (DSE) website). We assume that 1% of the population (50,700 people) who live close (50m or less from the easement of transmission towers) may suffer from sickness due to EMF. However, we also have to consider the following: (1) The incubation period of an EMF induced disease (2) The period the resident has stayed in the area and most importantly (3) The resident is actually sick because of transmission induced EMF. Bearing the above considerations, we have further reduced the percentage to only 10% the assume population (5,070 people).

Australia KPMG draws on the case of CSR where asbestos claims to each individual is reduced to $300,419 and uses this information as a basis to assume the potential changes in claims when valuating asbestos related disease liabilities for JH. For the purpose of our analysis, we have adopted the same compensation figure.

Estimated settlement cost for EMF liabilities of all affected VIC residents = 5,070*300,419 ≈ $1.5b

58. James Hardie (JH) reported a US$550.8M gross profit in 2006 - JH Annual Report. The annual asbestos payout ($100M per annum) is approximate 18.15% of their profit. The recorded net profit after tax for SP AusNet transmission business is $47.5M during financial year 2006 – SP AusNet Annual Report – and assuming the settlement of EMF lawsuits for SP AusNet is of a similar percentage to JH, the payout is estimated to be 0.1815*47.5 = $8.6M p.a.

59. Probability is derived drawing on asbestos case. Asbestos was used for 5000 years until scientifically proven to be a health hazard the 1970s. Applying a similar principal, <u>EMF should not be considered a health hazard until proven scientifically</u>. From readings, asbestos were used for the past 5000 years before scientifically proven to be a health hazard – translating to a 1 in 5000 years occurrence. For the purpose of our analysis, we use a similar 1 in 5000 probability for EMF.

The level of exposure is $300,419 per individual, and the excess for insurance is $100,000 per incident. The total level of exposure for SP AusNet is therefore the estimated number of individuals affected by the $100,000 insurance excess.

The self insurance risk premium for a catastrophic EMF Loss is calculated as:

Level of Exposure X Probability of Occurrence

= $507 million * 0.02% = $101,400 per annum

1.7.2 Insurer Default Claims in the Event of Catastrophic Loss

This covers the event where insurer AEGIS (Associated Energy & Gas Insurance Services Limited) defaults the insurance claims when the described catastrophic scenario occurs (assume to be **1 in 5000 years**). The level of exposure for the insurance provider is the $300,419 per individual minus the excess that SP AusNet are required to pay. The annual exposure for the insurance company is $1,016,124,330 * 0.02% = $203,225.

AEGIS writes excess liability coverage for the companies that provide 99% of all electricity and natural gas supplied by investor-owned utilities in the United States[60] and has recently achieved an A+ Fitch rating[61].

Using Standards and Poor's Australian ratings for insurer average cumulative default rate from 1989 to 2005, the probability of AEGIS with an A+ rating defaulting is **0.74%** for a 6 years horizon[62].

The self insurance risk premium for insurer defaulting is calculated as:

Level of Exposure X Probability of Occurrence

= $203,225 * 0.74% = $1,504 per annum

1.7.3 EMF Test Cases

This scenario deals with the situation in which SP AusNet could be the subject of at least one unsuccessful EMF claim over the regulatory period. The total cost to SP AusNet relates to the cost of legal defence, expected to be no more than the insurance liability limit. Therefore, the net liability of SP AusNet would be the relevant insurance deductible of $100,000 for each claim.

According to SP AusNet, there have been claims against their predecessor (SECV) in relation to employee exposure to EMF though there have not been such claims against SP AusNet. However SP AusNet had considered the steady growth of urban development (schools and houses) near easement and as such, there is always a small risk of random small cancer/leukaemia cluster in the vicinity of transmissions assets, which can turn into a legal challenge between SP AusNet and the occupational and/or general public.

60 http://www.aegislink.com/portal/annual_report/assets/annual_report_05.do

61 http://www.aegislink.com/portal/annual_report/assets/am_best_rating_report.do

62 www.standardpoors.com/ratingsdirect

Assuming a 6-year regulatory period and just the one claim over this period, the probability of occurrence in this case is 1 in 6 years, or 16.67%.

The self insurance risk premium for EMF Test Cases is calculated as:

Level of Exposure X Probability of Occurrence

= $100,000 * 16.67% = $16,670 per annum

1.7.4 Increased EMF Measurement and Customer Service Costs

This refers to the additional costs associated with the provision of additional metering of EMF levels and the time taken to formally reply to an increasing number of individual concerns relating to EMFs, particularly when a new major research report or review on EMF is released. These operations/services are above and beyond normal day to day operations.

Following the release of the AGNIR report in the UK in 2001 (and subsequent local media commentary), the number of EMF enquiries increased about 1,200% over the monthly average of 7.5 enquiries. On-site EMF measurement requests also increased from about 1 to 20 per month. Overall, these increases tend to last for a period of about 5 months after the release of an EMF report/review.

It is estimated that the additional costs involved in the provision of EMF measurement and customer relations services would be in the order of $65,000[63] per annum.

We also estimate that at least 1 new major EMF report will be released over the next 6 year regulatory period (i.e. 16.67% probability of occurrence). Therefore, the self insurance risk premium for increased EMF measurement and customer service costs is calculated as:

Level of Exposure X Probability of Occurrence

= $65,000 * 16.67% = $10,830 per annum

1.7.5 More Stringent EMF Standards

As already noted in Section 1.5.1, the draft EMF Standard recently released by ARPANSA to replace the 1989 NHMRC Interim Guidelines are expected to provide stricter compliance limits for public and occupational exposure to EMF. As such, there is expected to be some need for industry to change its management of the EMF issue, in terms of both public and occupational exposure.

[63] No. of EMF enquiries = 7.5*12*5 = 450
No. of on site measurement request = 20*5 = 100 (assume inclusive of EMF enquiry)
Assume EMF enquiry is an administrative job costing the company $100 per enquiry and on-site measurement is a technical job costing the company $300 per call out.
Estimated cost due to addition service requests = 350*$150 + 100*$200 = $65,000

In a draft Regulatory Impact Statement released with the draft Standards, ARPANSA noted that that the most significant costs likely to be incurred by industry as a result of the implementation of the Standards, would relate to the cost of physically altering the environment around power cables such that any EMF risk to the general public is minimised. ARPANSA noted that the electricity industry foresaw costs of more than $1 billion if its new standards were adopted in legislation.

Under a scenario where Australia adopts a very stringent ARPANSA EMF standard or in light of new scientific findings on the effects of EMF on human health, SP AusNet may be forced to modify certain sections of its transmission network. This could include the following types of modifications:

- Raising towers to raise the height of the cables;
- Erecting fences;
- Purchasing land near areas of particular concern in order to restrict access; burying cables in trenches;
- Putting up warning signs; or
- Shielding of cables.

With relation to the draft release stage, SP AusNet will be complying with new requirements that are focused on managing procedures (i.e. signage on towers and stations) that do not incur a massive cost. Nonetheless, SP AusNet is aware that the standards may rise in status with more stringent modifications enforced in the near future.

We assume that the costs of some part or a majority of the above regulatory changes can be considered for a cost pass through to transmission network users. Clause 6A.7.3 of the new rules adopted by AER and ACCC outlines that in the event of a regulatory change, the negative financial impact that cannot be reasonably forecast by a TNSP (outside TNSP control) can be considered for cost pass through.

1.7.6 Prohibition of Line-Line Work

Currently SP AusNet uses bare-hand live-line techniques to carry maintenance work on its high voltage transmission lines. The technique involves "bonding on" to live conductors, where linesmen access live conductors using an insulated ladder and special live-line body suit to carry out maintenance work. These tasks include insulator replacement, replacement of split pins on suspension assemblies, mid-span work (previously performed using helicopters) and other routine maintenance works. In the event that EMF standards prevent such works on live-lines, then sections of the network must go off-line for work to be carried out. The costs associated with this event relate mainly to the payment of rebates paid by SP AusNet.

According to SP AusNet, they undertake approximately 200 hours of bare hand live line work per year. The cost for off-line maintenance varies from circuit to circuit, the amount of key equipment affected and the time of the day the outage is taken. These costs are reflected in the VENCorp Availability Rebate Scheme and AEWR Performance Incentive Scheme and can be as high as $13,290 per hour.

It is logical to assume that the majority of the current 200 hours p.a. live-line works are carried out on circuits that are under constraint (i.e. system cannot go off-line for maintenance due to N-1 criteria) where SP AusNet will be subjected to the maximum rebate of $13,290 per hour. Consequently this equates to a potential rebate of **$2.658M** p.a.

We estimate that the probability of this event occurring in any given year during the next regulatory period is **1 in 120**[64].

Level of Exposure x Probability of Occurrence

= $2,658,000 * 0.83% = $22,150 per annum

1.8 Self-Insurance Risk Premium for Exposure to EMF Liability

Table 1-5 below summarises our analysis of the self-insurance risk premium of $152,554 p.a. required with respect to potential EMF liability involving SP AusNet's electricity transmission network.

64 It is difficult to estimate to the probability of prohibiting bare hand live line work. One can argue that the concern over safety or the breach in safety procedures are more likely to result in the ban of live line work than the concern over to EMF induce disease.

The first transmission line was built in 1891. Since then, there were no prohibition of any transmission operations and maintenance procedures due to EMF concern (116 years until 2006), However, there might be such a possibility (for live line work) in the future due to more stringent EMF standards.

For the purpose of our analysis, we adopted a 1 in 120 year's probability (rounded off from 116 years).

Table 1-5 Summary of Calculation of EMF Self-Insurance Risk Premium

Claim Scenario	Amount at Risk	Probability of Occurrence	Risk Premium
Catastrophic Loss	$507,000,000	0.02%	$101,400
Insurer Default Claim	$203,225	0.74%	$1,504
EMF Test Cases	$100,000	16.67%	$16,667
Increased EMF Related Costs	$65,000	16.67%	$10,833
Prohibition of Live-Line Work	$2,658,000	0.83%	$22,150
TOTAL			**$152,554**

2. RISK OF EASEMENT CLAIMS

2.1 Introduction

SP AusNet's network of transmission towers and terminal stations support 6,574 kilometres of conductors (the wires) in Victoria covering a total land easement area of 17,580 hectares or 3,840 parcels in total. Easements are a right of way granted to a person or company for access to or over the owner's land. These easements secure a right of way to a corridor of land for existing or future lines. SP AusNet does not usually own the land within the easement, ownership of the land remains with the landowner, who has restricted use of the easement.

These easements are necessary to provide SP AusNet with access to land to install, add, upgrade, inspect, repair, maintain, replace, substitute, retain and operate electrical network infrastructure.

SP AusNet has a perpetual right of access to easements and well as certain ongoing obligations to land owner and the community under legislation.

2.2 Description of Risk

Compensation is paid to any landowner when an easement is created. The primary drivers of this calculation are the amount of land required and its cost. The cost of land had risen dramatically in the past 15 years which means the replacement cost of any easement is likely to be very expensive.

Further to this is the expanding 'city' areas significantly affecting land prices. Since the privatisation of the electricity industry it is becoming more difficult in dealing with land owners, who are more likely to fight any planning decisions made in respect of easement location or size, thus driving legal cost defending claims up. They are also seeking higher compensation for new easement. In most cases the transmission easement locations are known with future terminal station sites identified but any movement or change in size will be costly.

In the event of a successful claim against SP AusNet, SP AusNet may have to repurchase that easement or move the easement to an alternative location. SP AusNet may also be required to pay compensation or damages to the land owner on successful claims.

The majority of customer complaints and enquiries made to the Energy and Water Ombudsman Victoria on electricity distribution relate to land and easement issues.

2.3 Historical Impacts on SP AusNet's Operations

The historical impacts on SP AusNet's operations include costs associated with pursuing and responding to claims relating to land easements. These costs include engaging external legal counsel, payment of compensation/damages to land owners and any costs associated with moving easements including relocating any infrastructure.

Historical expenditure and payments made relating to easement claims is detailed in the table below. These are full costs which include an allocation of corporate overhead.

2.4 Current Insurance Provisions and Risk Mitigation Strategies

2.4.1 Market Insurance Premiums

Insurance coverage for this risk is not available in the market place.

2.4.2 Operating Practices

SP AusNet's policy is to acquire easements by voluntary agreement and in a manner that ensures all landowners are treated fairly and equitably, within the legal framework of compulsory acquisition to minimise any claims by land owners.

SP AusNet also follows its obligations under its Customer Charter and legislation such as the *Land Acquisition and Compensation Act 1986* to carry out a dispute resolution process to appropriately deal with the pursuit of any claims as well as dealing with any claims made by land owners.

2.5 Estimation of Self Insurance Risk Premium for Easement Claims

Due to the confidential nature of the potential costs related to easement disputes, details of quantifications of this risk are included in a separate document titled "Valuation of Non-Insured Risks, Confidential Documentation".

It is estimated that the annual cost of self insuring the risks associated with easement claims is $200,000.

3. RISK OF LAND OWNER COMPLAINTS

3.1 Introduction and Description of risk

In its normal course of operations SP AusNet requires access to private property and easements to undertake installation, additions, upgrades, inspections, repairs, maintenance, replacement, substitution and operations of its electrical network infrastructure. This can involve vegetation being altered or removed and earth works. At the conclusion of the works SP AusNet is required to complete restitution works to restore the land and the vegetation as best as practicable to similar condition prior to the commencement of the works.

SP AusNet incurs costs associated with investigating land owner complaints which cannot be resolved via the normal dispute resolution processes. These costs can include significant legal costs in defending claims and any direct settlement costs paid by SP AusNet to resolve the land owner complaint. Claims made against SP AusNet may include land owners suffering loss or damages due to SP AusNet's actions when accessing the land. Other examples include issues with tree clearance and damage to property caused by SP AusNet or its contractors.

In the event of a successful claim SP AusNet may have to pay damages or compensation to the land owner.

The majority of customer complaints and enquiries made to the Energy and Water Ombudsman Victoria on electricity distribution relates to land and easements.

3.2 Historical Impacts on SP AusNet's Operations

The historical impacts on SP AusNet's operations include costs associated with responding to claims relating to land owner complaints. These costs include engaging external legal counsel and payment of compensation/damages to land owners.

3.3 Current Insurance Provisions and Risk Mitigation Strategies

3.3.1 Market Insurance Premiums

Insurance coverage for this risk is available in the market place. However, SP AusNet has preferred to self insure for this risk due to the high deductible of $100,000 and high market premiums.

3.3.2 Operating Practices

SP AusNet has in place an operating procedure to follow when undertaking work on a third party's property, which includes undertaking a risk assessment prior to commencing work and considering vegetation management obligations including talking with the affected landowners.

SP AusNet's contracts with its contractors undertaking work on their behalf would have clauses to ensure obligations and responsibilities are clear including vicarious liability clauses.

SP AusNet's policy is to use its best endeavours to restore land and property as close as practicable to its condition prior to SP AusNet seeking access to it. This includes replacing any vegetation removed, replacing inappropriate with appropriate vegetation, restoring earth works and leaving gates in the same open or closed position that they were found in.

A complaints procedure is in place to deal with any land owner complaints to avoid or minimise costly processes to resolve disputes.

3.4 Estimation of Self Insurance Risk Premium for Easement Claims

It is estimated that the annual cost of self insuring the risks associated with easement claims is $100,000.

Appendix 2 – Footnote References

TABLE OF FOOTNOTES

1. Information provided by SP AusNet

2. Information provided by SP AusNet

3. “A 220 kV transmission line with about 1,300 suspensions towers constructed in the early 1980’s experienced 2 major failures at approximately seven years apart. The cause of failure was thought to be higher than expected wind loads.” – Extraction from Queensland University 2003 Archived Civil Engineering Report (http://eprint.uq.edu.au/archive/00003103/01/TWS-Tower.pdf).

4. Although this assumption is somewhat arbitrary, the impact of the assumption will be minimal as the ratio of the total number of suspension towers in the SP AusNet transmission system (2,179) relative to the total number of transmission towers (12,888) is around 5 to 1 (i.e. 16.9%).

5. http://www.ga.gov.au/urban/listquakes.php?month=05&year=2006 (Click on Oodnadatta SA – Magnitude 5.1)

6. Divide 13,000 towers by 6,500 km = 2 towers per km (500m between each transmission tower) - Source of 6,500km from SP AusNet 2006 annual report.

7. Major damage to conductor scenario is based on recorded evidence of actual occurrence at Keon Park.
   Medium damage to conductor scenario is based on SP AusNet recorded evidence of cross arm incidents on the YPS-ROTS 220kV line on 12 May 2005 (2001 – 2006) report.
   Minor damage to conductor scenario is based on SP AusNet recorded evidence (2001 – 2006 report) of conductor and ground wires failure.

8. Source: http://www.dse.vic.gov.au/DSE/nrenfoe.nsf/LinkView/E20ACF3A4A127CB04A25679300155B04358FFCDA5CA1F43FCA256DA6000942C9. Note, after approximating damage costs for each fire we have excluded 6 bushfires from the table. These have been removed to remain consistent with the CIE threshold for major bushfires ($10 million) as discussed later. The approximation of damage costs was based on the location, land area burnt, property and assets destroyed, and lives lost.

9. Research Report No.49 (October 1997), Analysis of Fire Causes on or Threatening Public Land in Victoria 1976/77 to 1995/96, Chris Davies, Fire Management Branch, Department of Natural Resources and Environment.

10. Research Report No.22 (October 1984), Forest Fire Statistics 1974/75 to 1983/84, B Rees, Fire Protection Branch, Department of Natural Resources and Environment.

11. ESAA Environmental Research Project: Risk management of Vegetation on Powerline Corridors – A Study for the Electricity Supply Association of Australia, CSIRO (Dr R L

Correll & Dr B D Hatch) in association with D G Quick & Associates (K Richter), June 1999.

12. SP AusNet Annual Report 2006, page 31.

13. CIE (Centre for International Economics), November 2001, "Assessing the Contribution of CSIRO – CSIRO Pricing Review, Chapter 7 Project Vesta: Bushfire Management, http://www.bbm.csiro.au/vesta/assets/pdf/Vesta_Final_Report.PDF.

14. EMATrack is a database of natural disaster events in Australia which has been compiled from various sources, including the Insurance Council of Australia and media reports. It relates to damage caused to property, assets and agricultural production.

15. CIE defined a major bushfire event as a bushfire causing in excess of $10 million of insured losses (prior to the inclusion of the cost of human fatalities and injuries).

16. The long-run annual average of 110,000 hectares of burnt forest each year indicated for Victoria was sourced from the 1998/99 Annual Report of the (then) Victorian Department of Natural Resources and Environment and is comparable to the 115,517 hectares shown in Table 2-2 as the 20-year average number of hectares of Victorian public land burnt between 1976/77 and 1995/96.

17. The terms 'Catastrophic' and 'Non-Catastrophic' are synonymous with the terminology of 'major' and 'minor' used in the CIE analysis.

18. Bureau of Transport Economics, Economic Cost of Natural Disasters in Australia, Report No.103, 2001.

19. The information in this section draws heavily on the following source: Bartley, W.H. (2003), "Analysis of Transformer Failures", a paper presented to the 36th Annual Conference of the Association of Engineering Insurers in Stockholm. William Bartley works for a leading transformer insurance company in the United States – The Hartford Steam Boiler Inspection and Insurance Co.

20. Source Email from Geoff Thorn Subject Transformer Failure Information dated 5/02/07

21. Sourced from the Trowbridge Self Insurance Report 2001

22. The data in this spreadsheet lists by terminal station and voltage level the number of three phase banks, the nameplate rating (MVA), phase, voltage ratio (phase to phase kV), manufacturer, tap changer, number of units, placed in service, spare transformer, spare winding, bushing kV and make, bushing reference, spares held and age.

23. "Extend the lifetime of your transformers by using computer-modelling", Pierre Lorin, IEE Power Engineer, April/May 2005

24. Email from Geoff Thorn, Transformer Failure Information, 05/02/07

25. Email from Geoff Thorn, Recent Uninsured Events, 25/07/06

26. However, SP AusNet has indicated that whilst they are unlikely to be covered for the direct costs of a circuit breaker failure, they believe they are covered under this policy for any consequential property damages (i.e. damage to other equipment on site).

27. Sourced from Email from Geoff Thorn dated 25/07/2006 Subject – Recent Uninsured Events

28. Crisp, J and Birthwhistle, D, "System Dynamics Modelling: Application Electricity Transmission Network Asset Management". This paper references the following CIGRE research - Janssen, A.L.J, Brunke, J.H., Heising, C.R. and Lanz, W., "CIGRE WG 13.06 Studies on the Reliability of Single Pressure SF6 Gas High Voltage Circuit Breakers", IEEE Transactions on Power Delivery, vol.11, pp. 274-82.

29. Solver, C.E, "First results from the on-going CIGRE enquiry on reliability of high voltage equipment", CIGRE SC A3 & B3 Joint Colloquium in Tokyo, 2005.

30. National Centre for Scientific Research Website - Janssen, A.L.J, Brunke, J.H., Heising, C.R. and Lanz, W., "CIGRE WG 13.06 Studies on the Reliability of Single Pressure SF6 Gas High Voltage Circuit Breakers", IEEE Transactions on Power Delivery.

31. Examples of the types of devices included in a GIS include circuit breakers, current transformers, disconnectors, earth switches, busbars, and line entry bushings.

32. However, SP AusNet has indicated that whilst they are unlikely to be covered for the direct costs of a GIS failure, they believe they are covered under this policy for any consequential property damages (i.e. damage to other equipment on site).

33. In electrical power transmission, a flashover is an unintended high voltage electric discharge over and around an insulator, or arcing or sparking between two or more adjacent conductors.

34. Sourced from Email from Rob Lewis dated 29/01/2007 Subject – Electricity Transmission_GIS Failure Risk

35. Email from Geoff Thorn dated 16/02/2007 Subject – GIS installations – SP AusNet

36. "Four arrested over false passports", Kerry-Anne Walsh, Jason Dowling, Kirsty Simpson, April 25, 2004

37. "Safety: Assessing the infrastructure risk", By Robert Lemos, Staff Writer, CNET News.com, August 26, 2002

38. Default Study: Australia & New Zealand 2005 Annual Default & Rating Transitions, Standard and Poor's, September 2006

39. Australian Macroeconomic Performance and Policies in the 1990s: http://www.rba.gov.au/PublicationsAndResearch/Conferences/2000/GruenStevens.pdf

40. Much of the material in this section is drawn from the following source: ATSB (2006), 'Wire-strike Accidents in General Aviation: Data Analysis 1994 to 2004', Australian

Transport Safety Bureau, Aviation Research and Analysis Report – B2005/0055, September 2006.

41. ICAO (2001). 'Annex 13 to the Convention on International Civil Aviation: Aircraft Accident and Incident Investigation (Ninth Edition)', International Civil Aviation Organisation.

42. ATSB (2006).

43. For statistical purposes, the ATSB divides the Australian aviation industry into 4 primary groups: (a) Regular Public Transport (RPT) (divided into high capacity and low capacity operations), (b) general aviation (comprising charter, private, business and other aerial work (agriculture, flying training and aerial work)), (c) military aviation, and (d) sport aviation (which includes hang gliders, balloons, autogyros, gliders/sailplanes, ultralights and airships).

44. ATSB Report: 200400437, Piper Aircraft Corp PA-28R-200, VH-TRZ, Eildon, Vic, 7 February 2004. Canberra: Australian Transport Safety Bureau.

45. Energy Networks Association (ENA), 'Electric and Magnetic Fields: What we Know', June 2006.

46. SP AusNet (2000),"All About Electric and Magnetic Fields from Transmission Lines".

47. SP AusNet (2000).

48. Epidemiology is the study of possible causes of disease through the comparison of selected population groups.

49. NIEHS (1999), 'NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields', National Institute of Environmental Health Sciences/National Institute of Health, NIH Publication No.99-4493, 4 May 1999.

50. AGNIR (2001), 'ELF Electromagnetic Fields and the Risk of Cancer', Report by the Advisory Group on Non-Ionising Radiation (AGNIR) to the UK National Radiological Protection Board, March 2001.

51. These interim guidelines were based on two Environmental Health Criteria on Electric and Magnetic Fields published in 1984 and 1987 under the joint sponsorship of the World Health Organisation (WHO), the International Labour organisation (ILO) and the International Radiation Protection Association (IRPA).

52. Australian National Health & Medical Research Council (NHMRC) (1989), "Interim Guidelines on Limits of Exposure to 50/60 Hz Electric and Magnetic Fields".

53. ARPANSA (2006), 'Radiation Protection Standard: Exposure to Electric and Magnetic Fields – 0 Hz to 3 kHz (Public Consultation Draft)', Australian Radiation Protection and Nuclear Safety Agency, 7 December 2006.

54. SP AusNet (2000).

55. Meyer, K. A. (1992), "Securing Insurance Coverage for EMF Claims", referenced from the Energy Citations Database, U.S. Department of Energy (DOE) Office of Scientific and Technical Information (OSTI), www.osti.gov/energycitations.

56. "Earlier this month, company shareholders (of James Hardie) agreed on a new compensation package worth more than US$4b over 40 years." – ABC News Online, Updated Thursday February 15 2007.

57. In 2006, the population of Victoria is about 5.07 million (Source: Department of Sustainability and Environment (DSE) website). We assume that 1% of the population (50,700 people) who live close (50m or less from the easement of transmission towers) may suffer from sickness due to EMF. However, we also have to consider the following: (1) The incubation period of an EMF induced disease (2) The period the resident has stayed in the area and most importantly (3) The resident is actually sick because of transmission induced EMF. Bearing the above considerations, we have further reduced the percentage to only 10% the assume population (5,070 people).
Australia KPMG draws on the case of CSR where asbestos claims to each individual is reduced to $300,419 and uses this information as a basis to assume the potential changes in claims when valuating asbestos related disease liabilities for JH. For the purpose of our analysis, we have adopted the same compensation figure.
Estimated settlement cost for EMF liabilities of all affected VIC residents = 10,140*300,419 ~ $1.5b

58. James Hardie (JH) reported a US$550.8M gross profit in 2006 - JH Annual Report. The annual asbestos payout ($100M per annum) is approximate 18.15% of their profit. The recorded net profit after tax for SP AusNet transmission business is $47.5M during financial year 2006 – SP AusNet Annual Report – and assuming the settlement of EMF lawsuits for SP AusNet is of a similar percentage to JH, the payout is estimated to be 0.1815*47.5 = $8.6M p.a.

59. Probability is derived drawing on asbestos case. Asbestos was used for 5000 years until scientifically proven to be a health hazard the 1970s. Applying a similar principal, EMF should not be considered a health hazard until proven scientifically. From readings, asbestos were used for the past 5000 years before scientifically proven to be a health hazard – translating to a 1 in 5000 years occurrence. For the purpose of our analysis, we use a similar 1 in 5000 probability for EMF.

60. http://www.aegislink.com/portal/annual_report/assets/annual_report_05.do

61. http://www.aegislink.com/portal/annual_report/assets/am_best_rating_report.do

62. www.standardpoors.com/ratingsdirect

63. No. of EMF enquiries = 7.5*12*5 = 450
No. of on site measurement request = 20*5 = 100 (assume inclusive of EMF enquiry)
Assume EMF enquiry is an administrative job costing the company $100 per enquiry and on-site measurement is a technical job costing the company $300 per call out.
Estimated cost due to addition service requests = 350*$150 + 100*$200 = $65,000

64. It is difficult to estimate to the probability of prohibiting bare hand live line work. One can argue that the concern over safety or the breach in safety procedures are more likely

to result in the ban of live line work than the concern over to EMF induce disease.
The first transmission line was built in 1891. Since then, there were no prohibition of any transmission operations and maintenance procedures due to EMF concern (116 years until 2006), However, there might be such a possibility (for live line work) in the future due to more stringent EMF standards.
For the purpose of our analysis, we adopted a 1 in 120 year's probability (rounded off from 116 years).