26 September 2011

# Quantification of the cost of specific low probability, high impact events and associated availability of commercial insurance

Grid Australia


MARSH

# Contents

# 1

# Summary of findings

Based on information provided by the transmission companies, Marsh's experience working in the transmission and distribution space, and discussions with Grid Australia, the following four scenario's were selected from all identified risks for high-level quantification in the first stage of the modelling process:

- Third party liability as a result of a single, discrete bushfire
- Property damage to towers and lines as a result of earthquake
- Property damage to towers and lines as a result of cyclone
- Non-terrorist impact of planes and helicopters.

The maximum foreseeable loss (MFL) estimates produced in the high-level quantification stage are as follows[1].

| Scenario | Loss estimate ($M) |
|---|---|
| Third party liability as a result of a single, discrete bushfire | 540 |
| Property damage to towers and lines as a result of earthquake | 31 |
| Property damage to towers and lines as a result of cyclone | 15 |
| Non-terrorist impact of planes and helicopters | 3 |

The high-level quantification shows that third party liability as a result of a single, discrete bushfire has the potential to result in losses significantly greater than the other modelled scenarios. In the second stage of the modelling process, this scenario was investigated in more detail, using Monte Carlo methods to model the uncertainty of various assumptions to provide more realistic loss estimates.

| Scenario | Minimum loss | Most likely loss | Maximum loss |
|---|---|---|---|
| Bushfire | $342,787,025 | $575,566,176 | $880,871,352 |

[1] All values presented throughout the report are in Australian Dollars (AUD), unless otherwise specified

The detailed risk modelling shows that, based on the input parameters used, the MFL from a single, discrete bushfire could be as high as $881M. If a number of bushfires burned in multiple locations, then the maximum loss could be much higher. As an example, the 2009 Victorian Bushfires Royal Commission estimated the cost of the Black Saturday bushfires to be in excess of $4.3B. These losses were attributed to fires in 12 different areas.

For these reasons, the MFL sustained from a single insurable bushfire event could reasonably be considered to be due to a minimum of three discreet bushfire events. Based on the results of this study, losses sustained in such an event could be in excess of $2.6B (ie $882M x 3 = $2.643B).

Based on our inquiries into the availability and cost of catastrophic bushfire liability insurance in the international insurance market, cover is available up to a certain amount beyond which it is either unavailable or uneconomical. Cover for general liability insurance is generally readily available, but again capacity in the international market is limited, and cover is only available up to a certain limit beyond which it unavailable or uneconomic.

Insurance cover for property damage to towers and lines is also quite limited and uneconomical beyond USD10M-20M. A catastrophic loss to these assets due to an earthquake or a severe tropical cyclone could reasonably be expected to exceed these limits.

# 2

# Introduction

## Background

Marsh understands that a number of complementary mechanisms are presently available to the Transmission Network Service Providers (TNSPs) under the National Electricity Rules (NER) to manage exposures to commercial risks that fall outside business as usual regulatory allowances. A review undertaken by the TNSP's concluded that the commercial risks associated with many low probability, high cost events are material, cannot always be insured at a reasonable cost, and are best addressed via cost event pass through adjustments.

## Scope

To assist Grid Australia in determining the magnitude of these risks Marsh Risk Consulting (MRC) was engaged to identify and quantify a range of low probability, high cost events.

Furthermore, MRC would also provide some commentary around the availability of insurance in the global market to insure the identified catastrophic loss events.

## Methodology

The methodology proposed by MRC involved two principal stages:

1. Determination of loss scenarios and high-level quantification of Maximum Foreseeable Loss (MFL) estimates
2. More detailed analysis of those scenarios identified in the first step with the greatest loss potential.

Based on the information provided by the transmission companies, MRC's experience working in the transmission and distribution space, and discussions with Grid Australia, a number of low probability, high consequence events would be identified and quantified at a high-level.

In the second stage of the assignment, the most costly scenarios identified in Stage 1 would be investigated in more detail, using stochastic modelling methods to model the uncertainty of various assumptions to provide a more complete understanding of the loss profile.

All values presented throughout the report are in Australian Dollars (AUD), unless otherwise specified.

# 3

# Detailed risk modelling

The high-level quantification indicates the following risk has the potential to result in losses significantly greater than the other modelled scenarios:

- Third party liability as a result of a single, discrete bushfire.

In this second stage of the modelling process, these two scenarios are investigated in more detail, using Monte Carlo methods to model the uncertainty of various assumptions to provide more realistic loss estimates. This methodology could also be used to model assumptions made in the other scenarios, for example the number of towers lost as a result of an earthquake or cyclone.

## Modelling Inputs

In the Monte Carlo modelling, assumptions and components of the loss estimate are modelled using a probability distribution instead of a single number. Based on information provided by the transmission companies, historical loss data, various publicly available sources and our own expert judgement, we have determined minimum, maximum and most likely numbers for components of the loss estimate. The value of each component of the loss is modelled using a PERT distribution. The PERT distribution uses the minimum, maximum and most likely values as inputs and generates a smooth distribution that more closely resembles a realistic probability distribution. This distribution favours the most likely value, like the triangular distribution, but places less emphasis on the extreme values than the triangular distribution. Assuming that many real-world phenomena are normally distributed, the appeal of the PERT distribution is that it produces a curve similar to the normal curve in shape, without knowing the precise parameters of the related normal curve. The PERT distribution is considered to best model potential outcomes which have been estimated using expert opinion[2].

While the Monte Carlo simulation is running, the model calculates and collects the results of each of the 10,000 iterations. Statistical analysis can then be performed on the

[2] Palisade, 2010

simulation output. For the bushfire scenario, the following input parameters have been used:

| Parameter | Minimum | Maximum | Most likely |
|---|---|---|---|
| # of houses loss | 300 | 1000 | 550 |
| Value per house | $400k | $600k | $500k |
| Contents value | $100k | $200k | $150k |
| # of fatalities | 11 | 35 | 20 |
| Value per life | $3.5M | $4.5M | $3.9M |
| # of injuries | 32 | 102 | 58 |
| Value per injury | $300k | $700k | $500k |
| BI & Infrastructure | $50M | $150M | $75M |

Table 1. Bushfire scenario input parameters

## Results

Full detailed results of the simulation are presented in Appendix C and are summarised in the following table:

| Scenario | Minimum loss | Maximum loss | Most likely loss |
|---|---|---|---|
| Bushfire | 342,787,025 | 880,871,352 | 575,566,176 |

Table 2. Summary of modelling results

The result of the Monte Carlo simulations is presented in terms of a Cumulative Frequency Distribution Line Graph in Figures 3 below.

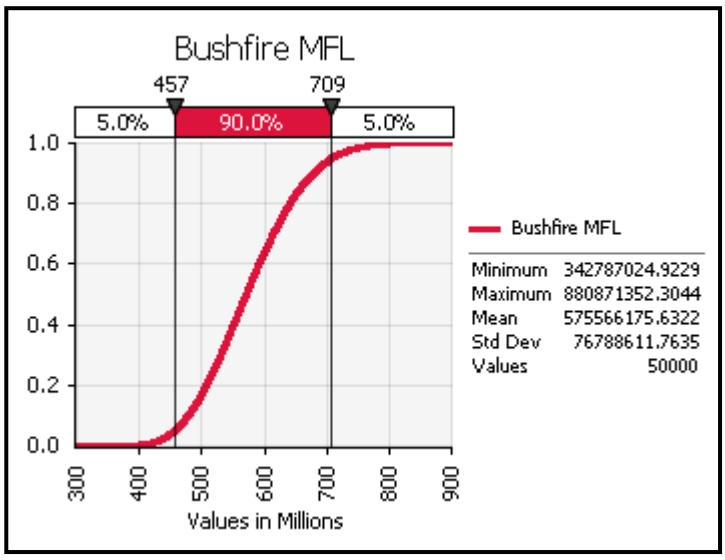



Figure 3. Cumulative Frequency Distribution Line Graph of bushfire loss estimate

The modelling results indicate that, based on the input parameters described earlier, the bushfire loss scenario has a maximum MFL of $881M and a most likely MFL of $576M.

# 4

# Insurance commentary

Bushfire liability is viewed by most Australian transmission companies as one of their most catastrophic risk exposures. Based on Marsh's inquiries into the availability and cost of catastrophic bushfire liability insurance in the international insurance market, cover is available up to a certain amount beyond which it is either unavailable or uneconomical.

Insurance markets for Australian liability risks include London companies and Lloyds, Australia, Bermuda and Singapore. Market capacity for this insurance will always be limited by a number of factors which can result in some volatility in terms of both cost and availability including:

- Underwriting philosophy and appetite of insurers for this specific exposure. This will be shaped by the insurer's
  - reinsurance arrangements,
  - catastrophe modelling,
  - own history of incurring similar claims which may have already had an impact on profits and/or capital, and
  - minimum return on capital requirements.
- Currency fluctuations (the current high valuation of the AUD has eroded some market capacity which is limited in USD)
- Specific risk factors related to the entity being insured (such as their history of effective risk management), localised geographical conditions (such as vegetation and topography), and their own loss history.

Pricing of Bushfire Liability cover will account for the bulk of General Liability premiums above a level of say $200M. Market conditions and the abovementioned factors will dictate to what upper limit cover can be purchased. Pricing of such upper limits can be expected to cost between $2,000 - $5,000 per million for larger / high risk entities. Our inquiries have shown that further capacity is sometimes available in the cross-over between insurance and capital markets but at higher rates of up to USD20,000 - USD50,000 per million.

Cover for general liability insurance is generally readily available, but again capacity in the international market is limited, and cover is only available up to a certain limit beyond which it is unavailable or uneconomic.

Property Damage and associated Business Interruption insurance is traditionally limited to assets other than towers and lines (e.g. terminal stations). Cover is normally provided under these policies for towers and lines up to 300m away from other insured assets. Due to the catastrophic exposure to transmission and distribution tower and lines, the insurance market's ability to provide coverage is very limited, with only a few players having any capacity due to restrictions imposed on insurers by the reinsurance market.

Exposures vary around the world, including bushfire and windstorm in Australia, ice and snow in Europe and North America, and windstorm on the east coast of USA.

Availability of standalone transmission and distribution line cover is generally very limited however sometimes available through reinsurance markets in support of a general property placement. Cover might be structured in blocks of USD10M, up to around USD20M. Most policies are multi-trigger or parametric based, that is damage is required in addition to another weather based metric being satisfied e.g. number of windy / cold / hot days. As such, detailed weather based modelling can often be a requirement for any submission to market.

In addition to limited capacity, a further barrier to such policies is the premium cost, with rates of between 10-20% of the desired limit.

# 5

# Conclusion

The detailed risk modelling shows that, based on the input parameters used, the MFL from a single, discrete bushfire could be as high as $881M. If a number of bushfires burned in multiple locations, then the maximum loss could be much higher. As an example, the 2009 Victorian Bushfires Royal Commission estimated the cost of the Black Saturday bushfires to be in excess of $4.3B. These losses were attributed to fires in 12 different areas caused by at least five different ignition sources.

For these reasons, the MFL sustained from a single insurable bushfire event could reasonably be considered to be due to a minimum of three discreet bushfire events. Based on the results of this study, losses sustained in such an event could be in excess of $2.6B (ie $882M x 3 = $2.643B).

Based on our inquiries into the availability and cost of catastrophic bushfire liability insurance in the international insurance market, cover is available up to a certain amount beyond which it is either unavailable or uneconomical. Cover for general liability insurance is generally readily available, but again capacity in the international market is limited, and cover is only available up to a certain limit beyond which it unavailable or uneconomic.

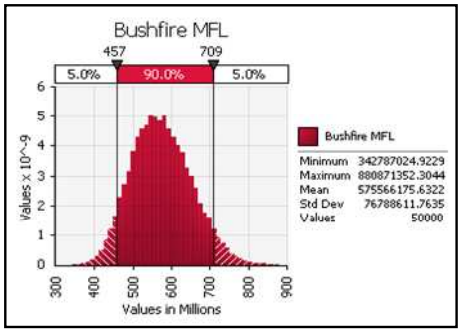
As also described in Section 4, insurance cover for property damage to towers and lines is also quite limited and uneconomical beyond USD10M-US20M. A catastrophic loss to these assets due a severe tropical cyclone or earthquake could reasonably be expected to exceed these limits.

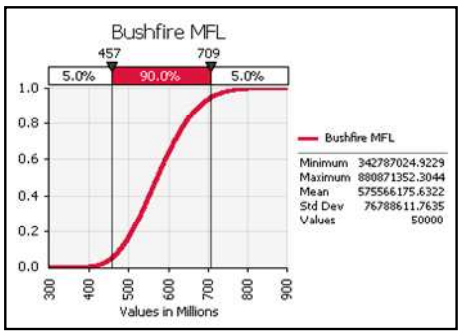
Appendix A

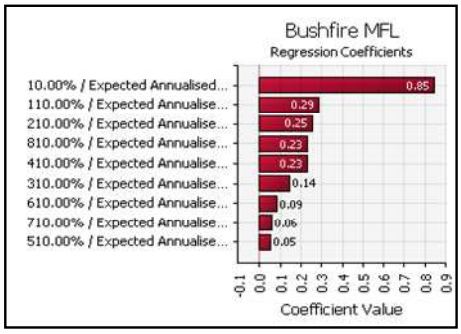
# @Risk simulation results

**@RISK Output Report for Bushfire MFL**

**Performed By:** Marsh, Inc.
**Date:** Thursday, 21 July 2011 11:29:57 AM




| Simulation Summary Information | |
|---|---|
| **Workbook Name** | GridAustralia_RG.xls |
| **Number of Simulations** | 1 |
| **Number of Iterations** | 50000 |
| **Number of Inputs** | 12 |
| **Number of Outputs** | 2 |
| **Sampling Type** | Latin Hypercube |
| **Simulation Start Time** | 7/21/11 12:27:11 |
| **Simulation Duration** | 00:00:20 |
| **Random # Generator** | Mersenne Twister |
| **Random Seed** | 1162790891 |

| Summary Statistics for Bushfire MFL | | | |
|---|---|---|---|
| **Statistics** | | **Percentile** | |
| **Minimum** | $342,787,025 | **5%** | $457,204,460 |
| **Maximum** | $880,871,352 | **10%** | $478,710,198 |
| **Mean** | $575,566,176 | **15%** | $494,932,566 |
| **Std Dev** | $76,788,612 | **20%** | $507,948,585 |
| **Variance** | 5.89649E+15 | **25%** | $519,524,067 |
| **Skewness** | 0.285081669 | **30%** | $530,368,613 |
| **Kurtosis** | 2.799329529 | **35%** | $541,050,612 |
| **Median** | $571,385,894 | **40%** | $551,038,835 |
| **Mode** | $546,108,890 | **45%** | $560,937,954 |
| **Left X** | $457,204,460 | **50%** | $571,385,894 |
| **Left P** | 5% | **55%** | $581,294,119 |
| **Right X** | $708,567,023 | **60%** | $591,676,795 |
| **Right P** | 95% | **65%** | $602,903,487 |
| **Diff X** | $251,362,562 | **70%** | $614,606,051 |
| **Diff P** | 90% | **75%** | $627,421,486 |
| **#Errors** | 0 | **80%** | $641,333,363 |
| **Filter Min** | Off | **85%** | $657,954,087 |
| **Filter Max** | Off | **90%** | $678,490,718 |
| **#Filtered** | 0 | **95%** | $708,567,023 |

| Regression and Rank Information for Bushf | | | |
|---|---|---|---|
| **Rank** | **Name** | **Regr** | **Corr** |
| 1 | 10.00% / Expecte | 0.846 | 0.841 |
| 2 | 110.00% / Expecte | 0.287 | 0.258 |
| 3 | 210.00% / Expecte | 0.254 | 0.242 |
| 4 | 810.00% / Expecte | 0.233 | 0.216 |
| 5 | 410.00% / Expecte | 0.229 | 0.224 |
| 6 | 310.00% / Expecte | 0.144 | 0.134 |
| 7 | 610.00% / Expecte | 0.085 | 0.081 |
| 8 | 710.00% / Expecte | 0.060 | 0.058 |
| 9 | 510.00% / Expecte | 0.052 | 0.046 |

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