Network Asset Criticality Framework

Summary

The Network Asset Criticality Framework outlines the manner in which consequences associated with network assets are assessed and quantified.

Revision no:	1	**HP TRIM No:**		**Approval Date:**	16 December 2016
Business function:	Strategic Asset Management			**Document type:**	Framework
Process owner:	Manager/Asset Strategy				
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Contents

1. Purpose

The purpose of the Network Asset Criticality Framework is to outline the manner in which consequences for network asset failures are consistently assessed and quantified across the business. This document supports:

> Effective and efficient risk based investment decision making

> Achievement of the asset management objectives and ultimately the corporate objectives.

2. Scope

The scope of the Network Asset Criticality Framework (NACF) is network assets including:

> Substation assets

> Transmission line assets

> Cable assets

> Secondary systems assets

> Security systems assets

> Network Property Assets.

The NACF provides more detail to support the principles set out in the Network Asset Risk Assessment Methodology.

3. Definitions

Table 3.1: Definitions

Term	Definition
Failure Mode	The specific manner in which a failure can occur.
Hazardous Event	An event that poses a potential threat to cause harm or damage to the assets, property, the environment, our workforce, the general public and/or the viability of the business.
Likelihood of Consequence (LoC)	The likelihood that the full value of the consequence eventuates given the hazardous event has actually occurred.
Risk Assessment	A systematic process of risk analysis and evaluation.
Risk Consequence	The outcome of an event expressed qualitatively or quantitatively, affecting TransGrid's objectives. There may be a range of possible outcomes associated with an event.
Probability of Failure (PoF)	The chance of a hazardous event occurring.

4. Framework principles

The NACF combines asset information, engineering knowledge, practical experience of the performance of the network assets, and consequence information to quantify in monetary terms the expected consequence of asset failures.

The outcomes from the NACF are used to support risk assessments completed at all stages of the asset lifecycle.

The NACF provides a view for assessment of a network asset failure consequence, which may be further refined by detailed assessment where this is required for project justification or a more detailed risk assessment.

5. Framework

The key elements of the NACF are:

> A definition of the applicable areas of criticality for each asset type
> Consistent quantification values for asset failure consequences based on the asset or site level as appropriate
> Where necessary, a likelihood based element to assess the likelihood of the worst case consequence occurring.

The Asset Manager explores the following factors when determining the likelihood of a consequence occurring:

- For people (safety) consequences:
  - Location of site (remote, rural, urban)
  - Frequency of person at site, including due to uncontrolled access (on an annual basis as a percentage of time)
  - Location of structure (public area, not accessible)
  - Line route (public area, not accessible, road crossing)
  - Cable route (accessible area, inaccessible area)
  - Frequency of person in near vicinity (on an annual basis as a percentage of time)
  - Effectiveness of preventative controls.
- For environment consequences:
  - Location of site, structure or line route and the sensitivity of the area around the site
  - Volume of contaminant
  - Type of contaminant
  - Effectiveness of control mechanisms
  - For bushfire consequences the bushfire proneness of the land and the likelihood of a flashover causing a major bushfire event.
- For reliability consequences:
  - Anticipated load restoration time
  - Availability of spare equipment
  - Contingent unplanned outage likelihood
  - Contingent planned outage likelihood.
- For market consequences (Financial):
  - Effect on TransGrid's Market Incentive Scheme
  - Effect on National Electricity Market (NEM) pool prices for consumers.

> For commercial/customer (Financial):
   - Effect on TransGrid's Market Incentive Scheme
   - Effect on NEM pool prices for consumers
   - Where known, the effect on Connection agreement penalties or third party telecommunications agreements.

The criticality of the asset with respect to TransGrid's Service Target Performance Incentive Schemes is included in the assessment for completeness. This is done as an aid for internal prioritisation and to inform strategies for operating the equipment only, since the incentive scheme costs do not form part of the investment decision.

Table 5.1 defines the areas of criticality that are defined for the NACF for each asset type.

Table 5.1: Asset Area of Criticality

Asset	Area of Criticality:					
	Safety	Environmental	Reliability	Market Impact	Service Incentive	Commercial / Customer
Transmission Line and Cable	✓	✓	✓	✓	✓	✓
Transformer			✓	✓	✓	
Substation Site	✓	✓				
Busbar			✓	✓		
Generator Connection Point				✓		✓
Third Party Switchbay (Load or Interconnector)			✓	✓		✓
Reactive Plant			✓	✓	✓	
Telecommunications Service			✓	✓	✓	✓

6. Accountability

Table 6.1: Roles, Responsibilities and Accountabilities

Role	Responsibilities and Accountabilities
EGM/Asset Management	> Implement the controls to manage asset risks in accordance with the corporate Risk Management Framework and Network Asset Risk Assessment Methodology > Oversight of the processes for the identification and management of asset risks, including the Network Asset Risk Assessment Methodology and Prescribed Capital Investment Procedure
Executive Asset Strategy Committee	> Review and endorse the Network Asset Criticality Framework
Manager/Asset Strategy	> Endorse and ensure the Network Asset Criticality Framework is fit for purpose > Ensure consistent, effective and efficient implementation of the Network Asset Criticality Framework > Monitor the development of Need Statements and investment options
Manager/Investment Strategy and Solutions	> Maintain the Investment Risk Tool to allow risk assessments with consequence values consistent with those defined in this document
Asset Performance and Systems Manager	> Develop and refine the Network Asset Criticality Framework
Asset Managers	> Identify key asset hazardous events and risks > Apply the Network Asset Risk Management Framework to assess and evaluate asset risk > Develop Need Statements > Develop investment options to address the asset risks

7. Implementation

The NACF will be implemented through:

- Discussions with business managers during the various asset management committee and working group meetings
- Development of Needs Statements and Option Evaluation Reports (OERs) including risk assessments consistent with this framework
- Consideration, analysis and evaluation of investment options through the Network Investment Process

- Development of the asset management strategies and plans
- Prioritisation and optimisation of capital expenditure at a portfolio level.

8. Monitoring and review

The NACF is reviewed by the Executive Asset Strategy Committee annually.

Asset criticality is monitored and reviewed by the relevant Asset Manager at least annually or in response to an emerging issue, incident, or improved methodology.

9. Change history

Table 9.1: Revision history

Revision no	Approved by	Date
0	Gerard Reiter, EGM/Asset Management	13 September 2016
1	Lance Wee, M/Asset Strategy	16 December 2016

10. References

Network Asset Risk Assessment Methodology

The approved values for each asset class are published on the Asset Management System SharePoint site:

http://thewire/projects/AMS/Criticality%20Framework/Forms/AllItems.aspx?RootFolder=/projects/AMS/Criticality%20Framework/Criticality%20Information

The methodology applied to each asset class is described in the following appendices:

Appendix A – Transmission Line and Cable Criticality

Appendix B – Transformer Criticality

Appendix C – Substation Site Criticality

Appendix D – Busbar Criticality

Appendix E – Generator Connection Criticality

Appendix F – Third Party Switchbay (Load or Interconnector) Criticality

Appendix G – Reactive Plant Criticality

Appendix H – Protection Systems Criticality

Appendix I – Telecommunications Service Criticality

Appendix J – Generic Risk Values

Appendix K – Quantification of Market Impact Risk

Appendix A – Transmission Line and Cable Criticality

For each asset the following criticality values are calculated:

Safety

- LoC value based on an assessment of the likelihood of people being in the vicinity when the hazardous event occurs
- Standard consequence values for Fatality/Injury.

The frequency of Routine Maintenance Scheduled Tasks (MSTs) associated with each transmission line was the basis for calculation of the LoC for each transmission line. Only Routine MSTs which involved staff traversing the ground area surrounding the transmission line were included in the calculation of the LoC for that transmission line. That is, aerial inspections and Light Detection and Ranging (LIDAR) MSTs were excluded from the calculation since these tasks do not involve staff traversing the ground area surrounding the transmission line.

The MST data for each transmission line was extracted from TransGrid's Enterprise Resource Planning Application, Ellipse.

Based on the MST data extracted from Ellipse, the LoC for each transmission line (TL) has been calculated by the following equation:

$$TL\ Safety\ LoC = \sum_{k=1}^{n} \frac{Standard\ Job\ Calculated\ Estimate\ \times 365}{Scheduled\ Frequency\ \times 8760} \tag{A.1}$$

where n is the number of Routine MSTs for the transmission line, $Standard\ Job\ Calculated\ Estimate$ is the number of hours taken to complete the MST and the $Scheduled\ Frequency$ of the MST is in number of days. It has been assumed that Easement Maintenance is undertaken by a crew size of one person.

This provides guidance towards the lower bound probability of staff being in the vicinity of the transmission line in any hour in any year.

To reflect the increased likelihood of a member of the public being in the vicinity of a transmission line which is close to publicly frequented areas (refer Public Electricity Safety Awareness (PESA) Plan), the LoC was increased based on an assumption of the number of hours in a year a member of the public may be in the vicinity of the transmission line. It has been assumed that members of the public may be in the vicinity of the transmission line for a cumulative approximate of one hour for every day of the year.

A value of $10,000,000 has been adopted for the standard consequence value for Fatality/Injury.

Environment (Bushfire)

- LoC value based on an assessment of the likelihood of a major bushfire event should the hazardous event occur
- Consequence value for the possible liability TransGrid may bear in the event the hazardous event results in a major bushfire.

The LoC for each transmission line (TL) has been calculated by the following equation:

$$TL\ Environment\ (Bushfire)\ LoC =$$
$$Likelihood\ of\ \ major\ NSW\ bushfire\ weather\ conditions\ \times$$
$$\frac{TL\ Fire\ Propagation\ Score + TL\ Environmental\ Impact\ Score}{Maximum\ Fire\ Propagation\ Score + Maximum\ Environmental\ Impact\ Score} \times$$
$$\frac{Average\ number\ of\ days\ with\ Bushfire\ Rating\ of\ Catastrophic, Extreme, Severe\ and\ Very\ High\ for\ TL\ NSW\ Fire\ Area}{365}$$

(A.2)

The 2009 Victorian Bushfires[1] is considered an extreme weather condition and should be further moderated using the bushfire experience of NSW. A review of major bushfire events (that is, bushfire events which have caused fatality/fatalities) was undertaken. Historical data from 1915 and 2003[2] suggests that extreme bushfire weather conditions occur in NSW once every five years. A moderating factor of 0.2 has therefore also been included in the LoC calculation.

Previous work undertaken by the Transmission Line Assets Group[4] has been the basis for the transmission line Fire Propagation Score and Environmental Impact Score. With respect to the terrain through which transmission lines traverse, the work considered Fire Propagation Factors such as the type of vegetation, ambient temperature (24 hour average temperature over three years), level of rainfall, slope of terrain and wind factors. For the Environmental Impact Factors, the work considered the proximity of a transmission line to National Parks and public places.

For the NSW Fire Area(s)[5] defined by the Rural Fire Service through which transmission lines traverse, an average number of days with a Bushfire Rating of Catastrophic, Extreme, Severe and Very High has been calculated based on historical data provided by the Bureau of Meteorology for the NSW bushfire periods from 2012 to 2015.

The 2009 Victorian Bushfires class action settlement[6] has provided a guide to the level of consequence that could result from a catastrophic bushfire. Survivors of the 2009 Victorian Bushfires secured a settlement of close to $500,000,000 in the class action raised against power distributor SP AusNet and asset managers Utility Services Group. SP AusNet agreed to pay $378,600,000 of the class action settlement. Utilities Services Corporation Ltd

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[1] Teague, B., McLeod, R. and Pascoe, S. (2010). *2009 Victorian Bushfires Royal Commission, Final Report.* Available at: http://www.royalcommission.vic.gov.au/Commission-Reports/Final-Report.html.

[2] Ellis, S. Kanowski, P. and Whelan, R. (2004). *National Inquiry on Bushfire Mitigation and Management*. Commonwealth of Australia, Canberra.

[4] Karimagako, R. (2012). *Transmission Line Bushfire Risk Ranking*. TransGrid

[5] See NSW Rural Fire Service (RFS) website: www.rfs.nsw.gov.au.

[6] Australian Broadcasting Corporation. (2014). "*Black Saturday bushfire survivors secure $500 million in Australia's largest class action payout*." Available at: http://www.abc.net.au/news/2014-07-15/black-saturday-bushfire-survivors-secure-record-payout/5597062.

payment towards the settlement was in the order of $12,500,000. Therefore, an Environment (Bushfire) dollar consequence of $400,000,000 has been nominated for the catastrophic failure of a transmission line.

Reliability

- A dollar per hour ($/hour) risk consequence for each transmission line and cable based on an assessment of the combinations of unplanned and planned outages of other transmission lines and cables which may result in an Energy Not Served (ENS) event during the duration of the hazardous event.

For the catastrophic failure of each transmission line and cable, assessment of the Reliability Risk $/hour involved evaluating its level of redundancy within the NSW High Voltage (HV) network and an estimate of the potential load at risk should the next worst contingency/contingencies on the network in terms of supply connections to load, system voltage management and system security, occur. A network load flow model of NSW with a level of demand of approximately 14500 MW formed the basis for this investigation.

Note, for transmission lines and cables connected within the strongly meshed sections of the NSW HV network, the level of redundancy of such transmission lines and cables potentially vary with the level of NSW demand on the network. Therefore, the level of Reliability Risk $/hour for such transmission lines and cables is generally not a static measure which applies to all potential network conditions. The Reliability Risk $/hour calculated in this work applies to what can be considered a ‘peak’ NSW demand condition, and therefore provides some guidance towards the maximum Reliability Risk $/hour borne for the catastrophic failure of the transmission line or cable.

The general form equation applied in this work to compute the Reliability Risk $/hour for the catastrophic failure of a transmission line (TL) or cable (C) with a redundancy level of two[7] is given by:

$$TL/C\ Reliability\ Risk\ \$/hour =$$

$$\sum_{k=1}^{n}\left(Outage\ Unavailability_x \times Outage\ Unavailability_y\right) \times Load\ at\ Risk\ \times Value\ of\ Customer\ Reliability \tag{A.3}$$

where x and y are the next wost transmission line or cable contingencies on the network and n represents the outage combinations of x and y.

Note, for the catastrophic failure of a transmission line or cable, there may be more than one combination of transmission line or cable contingencies which may result in an ENS. In such cases, the Reliability Risk for each combination has been calculated, and then summated, to provide the transmission line Reliability Risk $/hour.

Market Impact

- The estimated cost to consumers per hour during an outage of the transmission line or cable in the form of the expected change to the total amount payable from the consumers to the generators.

See Appendix K for the general form equation for computation of the Market Impact Risk $/hour.

[7] For the catastrophic failure of that transmission line or cable, there is a reliability risk held for the potential outage of two other transmission lines or cables.

Appendix B – Transformer Criticality

For each asset the following criticality values are calculated:

Reliability

- A $/hour risk consequence for each transformer given its level of redundancy and the unplanned outage unavailability of transformers.

For the catastrophic failure of each transformer, assessment of the Reliability Risk $/hour involved evaluating its level of redundancy within the NSW HV network and an estimate of the potential load at risk should the next worst contingency/contingencies on the network, in terms of supply connections to load, occur. A ratio of mean demand to peak demand of 0.65, based on 2015 NSW historical demand data, was applied in evaluation of the potential load at risk.

The general form of the equation to compute the Reliability Risk $/hour for each transformer (TX) is given by:

$$TX\ Reliability\ Risk\ \$/hour =$$

$$(TX\ Outage\ Unavailability\ )^{Level\ of\ TX\ Redundancy} \times Load\ at\ Risk\ \times Value\ of\ Customer\ Reliability \tag{B.1}$$

Market Impact

- The estimated cost to consumers per hour during an outage of the transformer in the form of the expected change to the total amount payable from the consumers to the generators.

See Appendix K for the general form equation for computation of the Market Impact Risk $/hour.

Appendix C – Substation Site Criticality

For each asset the following criticality values are calculated:

Safety

- LoC value based on an assessment of the likelihood of people being on site undertaking routine maintenance activities.

The frequency of Routine MSTs associated with each substation was the basis for calculation of the LoC for each substation. Note, only time-based Routine MSTs were included in the calculation of the LoC for each substation; Routine MSTs that were operations-based or both operations-based and time-based were not included in the calculation.

Based on the MST data extracted from Ellipse, the LoC for each Substation has been calculated by the following equation:

$$Substation\ Safety\ LoC = \sum_{k=1}^{n} \frac{Standard\ Job\ Calculated\ Estimate\ \times x}{Total\ Crew\ Size\ \times Scheduled\ Frequency\ \times 8760} \tag{C.1}$$

where n is the number of Routine MSTs for the substation included in the calculation, $Standard\ Job\ Calculated\ Estimate$ is the number of hours taken to complete the MST, $Total\ Crew\ Size$ is the number of staff required to complete the MST, $Scheduled\ Frequency$ of the MST is in either number of days or number or months and x = 365 if $Scheduled\ Frequency$ is expressed in days, or x = 12 if $Scheduled\ Frequency$ is expressed in months.

This provides guidance towards the lower bound probability of staff being present on site within a substation in any hour in any year.

A value of $10,000,000 has been adopted for the standard consequence value for Fatality/Injury.

Environment

- LoC value based on the chance of oil containment at the site failing to contain a major oil spill event
- A consequence value taking into account the environmental sensitivity of the site.

Factors considered for nomination of the LoC for each substation included the existence and condition of containment bunds, the existence and capacity of spill oil tanks and the existence of containment dams.

Factors considered for nomination of the consequence level for each substation included the surrounding land use, environmental sensitivity, the distance from the last line of containment to closest receiving water/waterway, the site slope and the slope of surrounding land. The consequence cost of an oil spill event is derived from the relevant costs associated with post incident geo-technical investigation, soil remediation and ground water remediation works. Work undertaken by the Property and Environment Asset Group and Substations Asset Groups has provided the basis for this analysis.

Appendix D – Busbar Criticality

For each asset the following criticality values are calculated:

Reliability

- A $/hour risk consequence for each busbar based on the assessment of an ENS event occurring during the duration of the hazardous event.

For the catastrophic failure of each busbar, assessment of the Reliability Risk $/hour involved evaluating its level of redundancy with respect to the network elements connected to it and an estimate of the potential load at risk should the next worst contingency/contingencies, in terms of supply connections to load, occur. A ratio of mean demand to 2015/2016 peak forecast demand of 0.65 was applied in evaluation of the potential load at risk. Previous work undertaken by the Network Operations Group provided a guide to identify which busbars hold an N level of redundancy.

Market Impact

- The estimated cost to consumers per hour during an outage of the busbar in the form of the expected change to the total amount payable from the consumers to the generators.

See Appendix K for the general form equation for computation of the Market Impact Risk $/hour.

Appendix E – Generator Connection Criticality

For Generator connection points, any penalties in the connection agreement should be used where these are applicable.

Appendix F – Third Party Switchbay (Load or Interconnector) Criticality

The equipment in each bay (for example, circuit breakers and current transformers) supplying a Distribution Network Service Provider (DNSP) line will have a reliability value based on the likelihood of the bay failure causing loss of load and the quantum of load.

Appendix G – Reactive Plant Criticality

For each asset the following criticality values are calculated:

Reliability

- A $/hour risk consequence for shunt reactors, shunt capacitors and Static VAr Compensators (SVCs) based on assessment of outages of other network elements which may result in an ENS event during the duration of the hazardous event.

For the catastrophic failure of each reactive plant, assessment of its Reliability Risk $/hour involved evaluating the next worst contingency/contingencies, in terms of system voltage management and system security, to occur, as well as the potential operational strategy to manage system voltage and system security in such circumstances.

Market Impact

- The estimated cost to consumers per hour during an outage of the reactive plant in the form of the expected change to the total amount payable from the consumers to the generators.

See Appendix K for the general form equation for computation of the Market Impact Risk $/hour.

Appendix H – Protection Systems Criticality

Reliability

The quantification of the reliability consequence of an uncleared fault on the NSW 500 kV and 330 kV network has been undertaken by the Secondary Systems and Communication Assets team. The Network Operations Group has provided guidance on the approach and on the scenarios to consider.

The impact of an uncleared or slow-to-clear fault is one of the main risks presented by TransGrid's protection systems to the primary transmission 500 kV and 330 kV network. The consequence of this risk can vary dramatically depending on a complex array of variables; the extreme result being a 'Black Start' – that is, the de-energisation of the entire NSW transmission grid. The extreme potential consequences and low likelihood nature of the risk, as well as the lack of relevant historical data to support the analysis, make this risk difficult to quantify.

In order to quantify the reliability risk associated with the failure of a protection system on the NSW 500 kV and 330 kV network, the following approach has been adopted:

> The concurrent failure of both independent protection systems was the only asset related scenario considered with the potential for causing an uncleared fault. Note, there is currently no record of this ever occurring on TransGrid's network.

> The potential for an uncleared fault to affect the wider network has been considered to be only present on protections systems of 500 kV and 330 kV assets.

> To simplify the analysis, the consequence cost presented by this reliability risk has been treated equally throughout the 500 kV and 330 kV network.

> The reliability consequence cost presented by the reliability risk has been solely considered to be within NSW. No consideration has been given to the wider NEM.

> The reliability consequence was modelled as a single value for load interruption over a single length of time.

The potential load loss (ENS event) for an uncleared fault on the 500 kV and 330 kV network were modelled for the following three scenarios:

> Low Impact Scenario:

- Loss of the two largest generating units on the NSW system (approximately 1220 MW)
- Load progressively restored over an 8 hour period
- Scenario LoC = 50%.

> Medium Impact Scenario:
  - NSW nominal average demand of 7876 MW in 2014
  - Large-scale load shedding of 60%, as per the requirements of the National Electricity Rules (NER) Clause 4.3.5 (a)
  - Load progressively restored over a 24 hour period
  - Scenario LoC = 40%.

> High Impact Scenario:
  - Complete loss of load ('Black Start'), for the NSW nominal average demand of 7876 MW
  - Load progressively restored over a 24 hour period
  - Scenario LoC = 10%.

A constant rate of restoration over an 8 hour period is assumed for the Low Impact Scenario.

For the Medium Impact and High Impact Scenarios it has been assumed that no load is restored for the first four hours immediately after the ENS event. Thereafter, load is progressively restored each hour at a decreasing rate.

The consequence impacts of the Low Impact Scenario, Medium Impact Scenario and High Impact Scenario formed the basis for development of a Consequence Model for the failure of protection systems. The Consequence Model Average Load Unsupplied is given by:

$$\begin{gathered} Consequence\ Model\ Average\ Load\ Unsupplied\ (MW) = \\ \frac{1}{8} \times \sum_{n=1}^{8} \left(Load\ Unsupplied_{Low\ Impact\ Scenario\ hour\ n}\right) \times Low\ Impact\ Scenario\ LoC \\ + \\ \frac{1}{24} \times \sum_{n=1}^{24} \left(Load\ Unsupplied_{Medium\ Impact\ Scenario\ hour\ n}\right) \times Medium\ Impact\ Scenario\ LoC \\ + \\ \frac{1}{24} \times \sum_{n=1}^{24} \left(Load\ Unsupplied_{High\ Impact\ Scenario\ hour\ n}\right) \times High\ Impact\ Scenario\ LoC \end{gathered} \tag{H.1}$$

The Consequence Model Average Duration of Unsupplied Load is given by:

$$Consequence\ Model\ Average\ Duration\ of\ Unsupplied\ Load\ (hours) =$$

$$\frac{1}{8} \times \sum_{n=1}^{8} n \times \ Low\ Impact\ Scenario\ LoC$$
$$+$$
$$\frac{1}{24} \times \sum_{n=1}^{24} n \times \ Medium\ Impact\ Scenario\ LoC$$
$$+$$
$$\frac{1}{24} \times \sum_{n=1}^{24} n \times \ High\ Impact\ Scenario\ LoC$$

(H.2)

A stylized representation of the Load Unsupplied result for the Low Impact Scenario, Medium Impact Scenario, High Impact Scenario and Consequence Model for the failure of protection systems is illustrated in Figure H.1 .

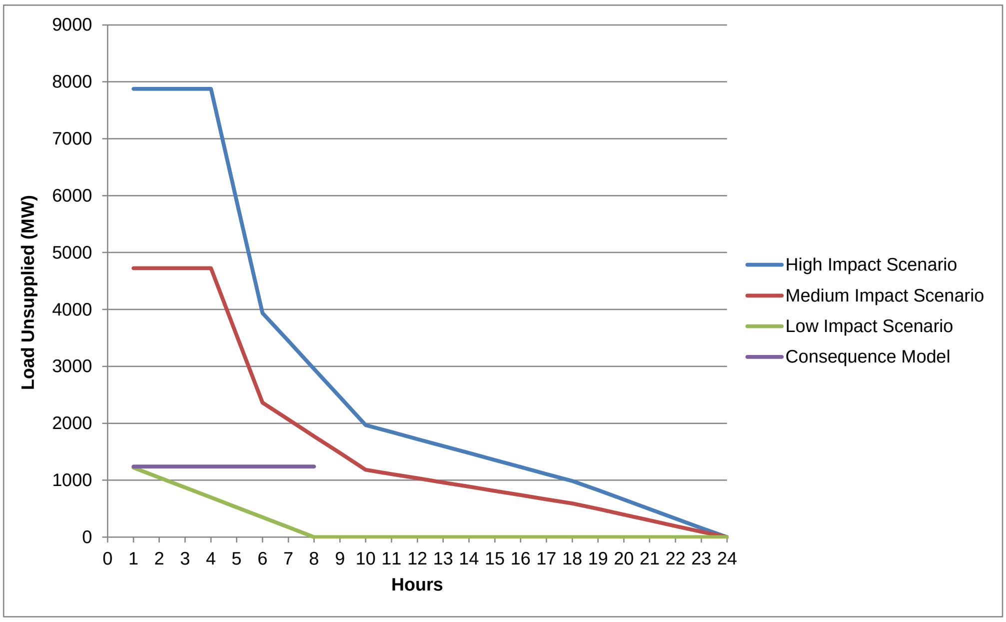

Figure H.1: Stylized Load Unsupplied result for the failure of protection systems

Appendix I – Telecommunications Service Criticality

The penalty costs of any third party telecommunications is used where known.

Appendix J – Generic Risk Values

The Investment Risk Tool (IRT) is configured with standard drop-down lists for consequence values, likelihood of consequence and other moderating factors. These values allow a consistent approach to determining the consequence of failure associated with individual assets.

Where specific values have been calculated in the manner described in the appendices above, the specific values should be used in preference.

An overview of the generic risk values and guidance on their selection is presented in the following tables.

Asset Repair Duration

Relevant Consequence Areas:

- Service Interruption (Telecommunications)
- Service Interruption (Electricity).

The values are set in hours.

Table J.1: Asset Repair Duration - standard values

Event	Typical Value
Transmission Line Structure Replacement	5 days
Transmission Line Fitting / Insulator / Conductor Failure	2 days
Circuit Breaker / Instrument Transformer	5 days
Major System Shutdown	16 hours
Transformer Catastrophic Failure	1 month
Significant Gantry Failure	3 months

Customer Type

Relevant Consequence Area:

- Service Interruption (Telecommunications)

Measure	Typical Value
$/hr	$50,000 to $100,000 to be determined by the individual customer affected

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Litigation Type

Relevant Consequence Areas:

- Service Interruption (Telecommunications)
- Service Interruption (Electricity)
- Bushfire
- Personal Injury.

The values are set in dollars.

Table J.2: Litigation Type - standard values

Level	Value	Typical Event
Insignificant – No Court Action	$0	Forced outage, short duration interruption
Minor – Magistrates Court	$20,000	Minor injury or property damage
Moderate – District / Magistrates	$50,000	Serious Injury
Major – Large financial consequences	$500,000	Fatality
Extreme – Supreme Court	$5,000,000	Catastrophic Bushfire Event Multiple Fatality due to negligence Major system disturbance

The values nominated in the table above are based on the outcomes of consultation with TransGrid's Legal Counsel and Workplace Health and Safety (WHS) consultant.

Following a fatality, it is likely that there will be the following three court cases:

1. Coronial Inquest in the fatality
2. A potential WHS prosecution by WorkCover NSW
3. Civil proceedings by relatives of the deceased.

Estimating the time, cost and resources required for litigation cases in the event of a fatality is a difficult task. The value of $5,000,000 for the Extreme – Supreme Court Level of Consequence is based on the following indicative costs for TransGrid's legal representation in such proceedings and the associated assumptions:

- Senior Counsel: approximately $8,000 - $10,000 per day
- Junior Counsel: approximately $5,000 per day
- Solicitor: approximately $3,000 - $4,000 per day
- Significant amount of time invested by TransGrid senior management and personnel
- The combined duration of the legal cases will likely cover a six to eight year period.

Media Coverage

Relevant Consequence Areas:

- Service Interruption (Telecommunications)
- Service Interruption (Electricity)
- Bushfire
- Personal Injury
- Environmental Incident.

The values are set in dollars and are an estimate of the direct media coverage costs of managing the incident.

Table J.3: Media Coverage - standard values

Level	Value	Typical Event
No Media Attention	$0	Low consequence incident
Board Request	$10,000	Fire event > 0.25 system minute event
Local Media	$30,000	Fatality Local fire event
State Media	$75,000	Fatality Large and obvious fire event
National Media	$150,000	Catastrophic Bushfire Event Multiple Fatality due to negligence Major system shutdown

The TransGrid Corporate and Regional Emergency Management Plan (CREMP), which aims to assist in managing emergencies which impact safety, reliability, the environment or TransGrid's business, has provided a guide to the possible level of media coverage which could result from an incident.

The following Incident Levels defined in the CREMP relate to the levels of media coverage listed in the table above:

- Level 1 - Board Request, involving management by the Corporate Communications team
- Level 2 - Local Media, involving management by the Corporate Communications team, the Executive and the Board
- Level 3 - State Media, involving management by the Corporate Communications team, the Executive, the Board and the Asset Monitoring Centre
- Level 4 and Level 5 - National Media, involving management by the Corporate Communications team, the Executive, the Board and the Asset Monitoring Centre.

Investigation Cost

Relevant Consequence Areas:

- Service Interruption (Telecommunications)
- Service Interruption (Electricity)
- Bushfire
- Personal Injury
- Environmental Incident.

The values are set in dollars and are an estimate of the cost of labour and management review time towards investigation of the incident.

Table J.4: Investigation Cost - standard values

Level	Value	Typical Event
Small Investigation	$10,000	Small ENS Local Fire Start
Medium Investigation	$50,000	Major Fire Event Large scale customer impact Major Environmental spill
Large Investigation	$250,000	Catastrophic Bushfire Event Multiple Fatality due to negligence Major system disturbance

Customer Consultation

Relevant Consequence Areas:

- Service Interruption (Telecommunications)
- Service Interruption (Electricity).

The values are set in dollars.

Table J.5: Customer Consultation - standard values

Level	Value	Typical Event
Nil	$0	Low consequence incident
Minimal e.g. media briefing / website	$3,000	< 0.25 system minute event
Moderate consultation e.g. letter drops	$30,000	Major customer impact
Major consultation e.g. door knocks	$75,000	Widespread area reliability event
Extensive Consultation	$100,000	Major system shutdown

Customer Contacts

Relevant Consequence Areas:

- Service Interruption (Electricity)

The values are set in dollars.

Table J.6: Customer Contacts - standard values

Level	Value	Typical Event
< 20% increase	$1500	Low consequence incident
20 to 50% increase	$3,500	< 0.25 system minute event
50 to 100% increase	$7,500	Major customer impact
100 to 250% increase	$15,000	Widespread area reliability event
> 250% increase	$25,000	Major system shutdown

Customer Type

Relevant Consequence Areas:

- Service Interruption (Electricity)

The values are set in dollars and are in accordance with AEMO (2014)[8].

Table J.7: Customer Type - standard values

Level	Value ($/ MWhr)
Residential	$26,930
Mixed / Unknown	$38,350
Large Commercial / Heavy Industrial	$44,720
Directly Connected Customer	$6,050
Agricultural	$47,670

In the majority of cases Mixed / Unknown is used apart from directly connected customers.

ENS Penalty

Relevant Consequence Areas:

- Service Interruption (Electricity)

The values are set in dollars.

Table J.8: ENS Penalty - standard values

Level	Value
System Minutes > 0.25	$2,200,000
System Minutes > 0.05	$1,100,000
System Minutes < 0.05	$0

[8] AEMO (2014). *Value of Customer Reliability Review: Final Report*. Australian Energy Market Operator.

Community Cost - Bushfire

Relevant Consequence Areas:

- Bushfire

The values are set in dollars.

Table J.9: Community Cost - Bushfire - standard values

Level	Value
Urban	$25,000,000
Bush - remote	$100,000,000
Rural	$100,000,000
Bush – Accessible	$200,000,000
Bush – Urban Fringe	$400,000,000

As stated in Appendix A: Transmission Line and Cable Criticality, the 2009 Victorian Bushfires[9] class action settlement[10] has provided a guide to the level of consequence that could result from a catastrophic bushfire. A value of $400,000,000 is therefore nominated for the Bush – Urban Fringe Level in Table J.9.

Compensation - Injury

Relevant Consequence Areas:

- Personal Injury

The values are set in dollars per casualty.

Table J.10: Compensation - Injury - standard values

Level	Value
Minor Injuries	$20,000
Moderate Injuries	$100,000
Extensive or Severe Injuries	$600,000
Fatalities	$10,000,000

The consequence value for Fatality/Injury has been based on the concept of the value of a statistical life, which evaluates trade-offs between money and fatality risks. The estimation of the value of a statistical life is generally based on econometric modelling approaches. Estimates of the value of a statistical life vary, based on context, the

[9] Teague, B., McLeod, R. and Pascoe, S. (2010). *2009 Victorian Bushfires Royal Commission, Final Report.* Available at: http://www.royalcommission.vic.gov.au/Commission-Reports/Final-Report.html.

[10] Australian Broadcasting Corporation (2014). "*Black Saturday bushfire survivors secure $500 million in Australia's largest class action payout*." Available at: http://www.abc.net.au/news/2014-07-15/black-saturday-bushfire-survivors-secure-record-payout/5597062.

explanatory variables of the developed econometric model and the data set being investigated. Therefore, the value of a statistical life cannot be considered as a single estimate with universal application[11]. Empirical studies relevant to Australia referenced by an Australian Government paper[12] estimates the value of a statistical life to range from $3,000,000 to $15,000,000. Estimates of the value of statistical life from studies reviewed by the Australian Safety and Compensation Council[13] (currently Safe Work Australia) ranged from $2,870,000 to $28,400,000. In the context of the electricity industry, Australian Standard AS/NZS 7000:2010 Overhead Line Design adopts a value of statistical life of $10,000,000 in an example which evaluates the risk associated with step and touch voltages.

A value of $10,000,000 has been adopted for the standard consequence value for Fatality/Injury.

[11] Viscusi, W.K. and Aldy, J.E. (2003). *The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World. Working Paper 9487.* National Bureau of Economic Research Working Paper Series. National Bureau of Economic Research.

[12] Department of the Prime Minister and Cabinet, Office of Best Practice Regulation (2014). *Best Practice Regulation Guidance Note: Value of statistical life*. Australian Government, Canberra.

[13] Australian Safety and Compensation Council (2008). *The Health of Nations: The Value of a Statistical Life*. Australian Government, Canberra.

Legislation Breach

Relevant Consequence Areas:

- Personal Injury
- Environmental Incident.

The value is set in dollars per event.

Table J.11: Legislation Breach - standard values

Level	Value
Minor Breach	$20,000
Moderate Breach	$50,000
Major Breach	$500,000
Extreme Breach	$5,000,000

Air Impact Costs

Relevant Consequence Areas:

- Environmental Incident

A value of $1000/kg is used for the release of SF6.

Land or Water Clean Up

Relevant Consequence Areas:

- Environmental

The values are set using a consequence value and a scaling factor.

Table J.12: Land or Water Clean Up - Oil Volume Scale Factors

Volume of Oil	Scale Factor
0- 30,000L	0.6
30,000 – 50,000L	0.8
50,000 – 100,000L	1.0
100,000L	1.2

Table J.13: Land or Water Clean Up - Impact Region Size Scale Factors

Impact Region Size	Scale Factor
Site Only	1
Localised Off Site impacts	5

Table J.14: Land or Water Clean Up – Site Sensitivity standard values

Site Sensitivity	Value
Low	$50,000
Medium	$150,000
High	$300,000
Extreme	$900,000

Appendix K – Quantification of Market Impact Risk

The quantification of Market Risk for an element has been based on information within the relevant Operating Manuals and historical data contained in the Australian Energy Market Operator (AEMO) Market Management System (MMS) database and/or Supervisory Control and Data Acquisition (SCADA) data. Approximately two years of historical data (from years 2013 to 2015) has been used for calculation of the Market Impact Risk $/hour.

The general form of the equation to compute the Market Impact Risk $/hour of an element is given by:

$$\begin{gathered} Element\ \ Market\ Impact\ Risk\ \$/hour = \\ Interconnector\ Import\ Power\ Displaced \times Max(0, Importing\ Region\ RRP - Exporting\ Region\ RRP) + \\ Interconnector\ Export\ Power\ Displaced \times Max(0, Importing\ Region\ RRP - Exporting\ Region\ RRP) + \\ Required\ Region\ FCAS\ Raise\ Dispatch \times Required\ Region\ FCAS\ Raise\ RRP + \\ Required\ Region\ FCAS\ Lower\ Dispatch \times Required\ Region\ \ FCAS\ Lower\ RRP \end{gathered} \tag{K.1}$$

where RRP is Regional Reference Price and $FCAS$ is Frequency Control Ancillary Services.

An average Market Impact Risk $/hour has been calculated using five-minute dispatch data from the sample period.