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Network Asset Risk Assessment Methodology (RAM)

Summary

The Network Asset risk Assessment Methodology outlines the way network asset risks are analysed and assessed, to support the investment decision making process.

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Contents

1. Purpose

The purpose of the Network Asset Risk Assessment Methodology (RAM) is to:

> Analyse and evaluate the network asset risks through a robust and rigorous methodology, in a systematic and consistent manner, to support the investment decision making process

> Map the key asset risks to their threats, consequence and controls

> Support timely, effective and efficient asset management investment decision making, to manage the changing risk

> Support the achievement of the asset management objectives, and ultimately the corporate objectives.

2. Scope

The RAM is applicable to the analysis and assessment of risk for network assets, including:

> Substation assets

> Transmission line assets

> Underground cable assets

> Secondary system assets

> Security system assets

> Network Property assets

3. Definitions

Table 1: Definitions

Term	Definition
ALARP	As Low As Reasonably Practicable (ALARP). For further details refer to Australian Standard 5577 – Electricity Network Safety Management System.
Conditional Failure	The inability of an asset to satisfy the operational/conditional limitations placed on it.
Functional Failure	The inability of an asset to perform its required function.
Failure Mode	The way in which a failure occurs.
Key Hazardous Event	An undesirable event that prevents the achievement of the corporate and asset management objectives.
Likelihood	The chance of something happening.
Risk	The effect of uncertainty on achieving TransGrid's objectives. Risk is measured in terms of impact and likelihood. Uncertainty can have positive and negative effects on objectives.
Risk Assessment	A systematic process of risk analysis and evaluation.
Risk Consequence	The outcome of an event expressed qualitatively or quantitatively, affecting

Term	Definition
	TransGrid's objectives. There may be a range of possible outcomes associated with an event; these could have a positive or negative impact on objectives. The outcomes are categorised as people, environment, system impact, reputation, compliance, and/or financial.
Risk Tolerance	The level of risk TransGrid is willing to accept, which is in accordance with the risk appetite of the Board.
SFAIRP	So Far As Is Reasonably Practicable (SFAIRP). For further details refer to Australian Standard 5577 – Electricity Network Safety Management System.

4. Background

The Asset Managers become aware of issues with their assets through a number of mechanisms, including:

> Inspection and test results
> Condition assessment reports
> Historical outage and failure data
> Historical defect and corrective maintenance data
> On-line condition monitoring data
> Historical operational and performance information
> Contextual information such as the location of the asset
> Anecdotal information such as irregularity reports, and advice from maintenance and operations staff
> Feedback from the various asset management committees and working groups.

Once the entire scope of the issue is captured, analysis and investigation (including risk assessment through the RAM) is undertaken to determine the need for, and justify investment.

The need and justification for investment includes any combination of the following considerations:

> Compliance obligation
> Risk reduction benefit
> Requirement to eliminate the source of the risk (the hazard) according to SFAIRP / ALARP
> Lifecycle cost benefits
> Obsolescence and end-of-technical life
> Stakeholder requirements
> Other benefits.

Based on the analysis and investigation, and need and justification for investment, the most appropriate course of action to address the issue is selected. These courses of action are outlined in the table below.

Table 2: Appropriate courses of action

Action	Definition
Do nothing	No further investigation is required. Continue with the current maintenance approach.
Asset Manager to undertake further review of the issue	Continue to inspect and monitor the identified issues through increased routine maintenance, and defect maintenance as required.
	Undertake a formal condition assessment through a detailed Network Asset Condition Assessment (NACA).
	Initiate non-routine urgent testing or corrective work through a Technical Work Request (TWR).
	Request broader investigation requiring input from other groups such as network planning, network operations or design.
Routine maintenance initiative	Implement appropriate refinements to the routine maintenance tasks and schedules, to address the identified issues.
Renewal Initiative	Develop the Need and Opportunity Statement (NOS) and initiate the investment process to evaluate options that will address the issue. A renewal initiative (refurbishment or replacement) forms part of the capital works program. The capital works program is managed by the Portfolio Management (PM) group.
Disposal	If the asset is no longer required it can be considered for decommissioning. Decommissioning's are also managed through the investment process by the Portfolio Management (PM) group.

It should be noted that only renewal and disposal initiatives form part of the capital works program, while the routine maintenance initiatives feed into the Maintenance Plan. The other courses of action proceed to alternate asset management process paths within TransGrid's Asset Management System (AMS), and lead to further review and investigation. This may ultimately lead to a maintenance, renewal or disposal initiative, depending on the outcome of the further review and investigation, and any new developments.

5. Principles

Risk can be simply defined as the uncertainty of meeting objectives, and is expressed as the combination of likelihood and consequence. The RAM combines an understanding of the failure behaviour of an asset (the likelihood), and the expected consequences of failure (the consequence), to value the risk associated with an asset in monetary terms. The key principles of the RAM are:

> A documented, systematic and consistent process for the analysis and assessment of asset risks

> Identification of Key Hazardous Events, that prevent the achievement of the corporate and asset management objectives, through consultation and engagement with subject matter experts

> Identification and modelling of terminal asset failures that could lead to the occurrence of a Key Hazardous Event, and their asset components, failure modes and associated root causes

> Asset Criticality that considers the consequences of a failure and the resulting Key Hazardous Event, in respect of safety, environment, financial, compliance, reputation and reliability consequence, and the likelihood of the consequence eventuating

> Mapping of the threats (asset components, failure modes and root causes) that could lead to the occurrence of a Key Hazardous Event, to its consequences, and the mitigating and preventative controls

> Quantification of asset risk to drive asset management investment decisions.

The risk assessment outcomes from the RAM are used:

> To support asset management investment decisions to manage risk

> As inputs to the asset management strategies and plans to deliver the asset management and corporate objectives

> As inputs to the development of the Need and Opportunity Statements. These Need and Opportunity Statements are the starting point for investment decision making as part of the investment process

> To facilitate the selection of the optimal investment option by quantitative comparison of the risk reduction benefit (and cost) of alternative investment options (maintenance, refurbishment, replacement, etc.) as part of the options analysis undertaken in the investment process, and determine the timing of investment

> To facilitate the application of the So Far As is Reasonably Practicable (SFAIRP) / As Low As Reasonably Practicable (ALARP) principle when managing network safety risks

> To allow prioritisation and optimisation of investment more broadly across the entirety of TransGrid

> To determine a view of the organisations asset risk profile, and utilise this to analyse the impact of different funding scenarios on the risk profile, and broadly estimate the long-term replacement expenditure.

The RAM plays an important role in the asset management activities as risk identification, assessment, and mitigation/control are fundamental to the ongoing safe and reliable operation of the electricity transmission network. The RAM is comprised of a number of elements, including:

> Key Hazardous Event identification

> Component, failure mode and root cause analysis

> Threat/control/consequence mapping

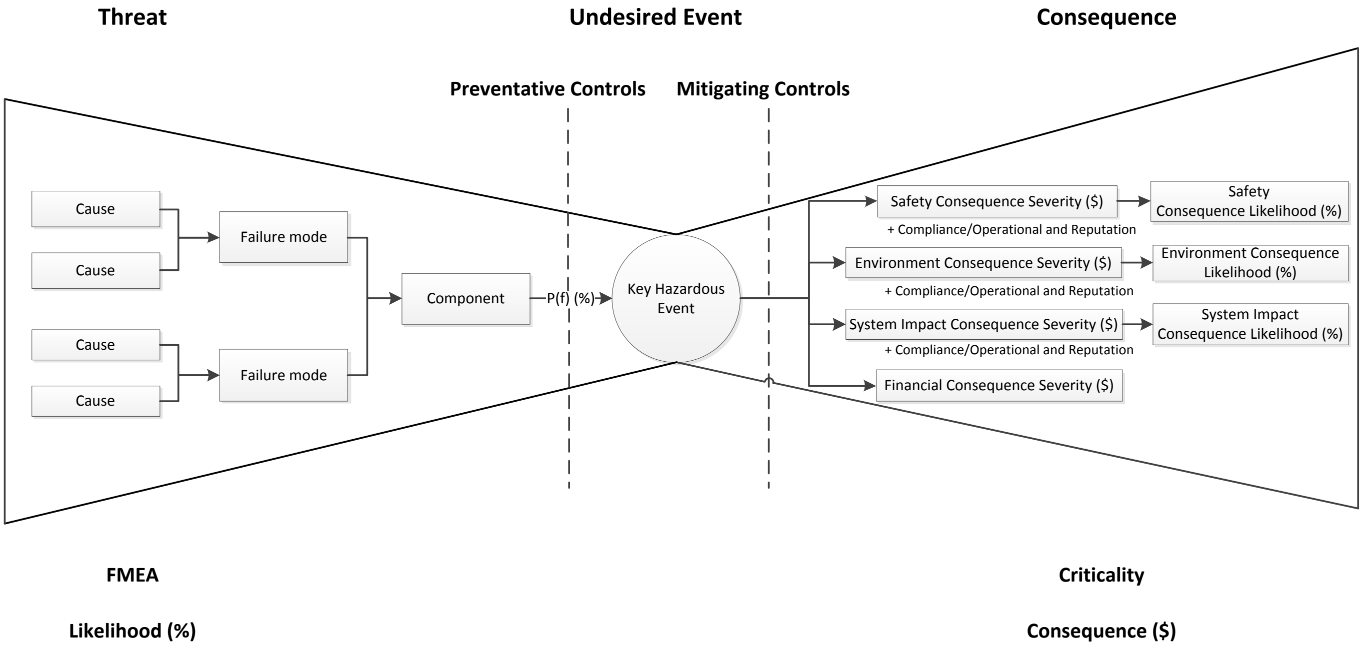
> Asset Health, historical failure information and likelihood of failure

> Asset Criticality and consequence of failure

> Data and tools to support its application.

The elements are shown in the diagram below, and described further in the sections below.

Figure 1: Elements of the RAM



5.1 Key Hazardous Event identification

Identification of the Key Hazardous Events associated with the assets that prevent the achievement of the corporate and asset management objectives is the basis for understanding the risks that need to be assessed and managed. Based on discussions and workshops with a cross section of stakeholders who have knowledge and experience with the assets, the Asset Managers have identified the Key Hazardous Events that pose an unacceptable risk, and need to be assessed and managed. The Asset Managers detail how they are managing the risk associated with the Key Hazardous Events in their renewal and maintenance strategies and plans.

The list of applicable network asset specific Key Hazardous Events is attached in Appendix A – Key Hazardous Events. This is a subset of the complete list of hazardous events outlined in the Asset Management Strategy and Objectives document. The Key Hazardous Events are aligned to the key organisational risks and broad areas of consequence.

5.2 Component, failure mode and root cause analysis

The Asset Manager, in combination with staff whom have detailed asset knowledge from the relevant asset Working Group, maintenance service provider, and other parts of the business, consider the range of the asset components, their failure modes and associated root causes that have the potential to result in a functional or conditional failure. Of particular concern is the combination of components, failure modes and root causes that could lead to the occurrence of the identified Key Hazardous Events. The Asset Manager manages the risk of the component/failure mode/root cause resulting in a Key Hazardous Event through their renewal and maintenance strategies and plans.

5.3 Threat/control/consequence mapping

The Asset Managers map the Key Hazardous Events to their threats, consequences and preventative and mitigating controls applicable to their assets. The threat is the asset components, failure modes and root causes that could result in the Key Hazardous Events. The consequences relate to the impact in respect of the broad areas of people, environment, system impact, financial, reputation and compliance. The mitigating controls are those to minimise the impact of the event, categorised in terms of the areas of consequence. The preventative controls are those measures in-place to prevent the Key Hazardous Event occurring. These are categorised by lifecycle stage, strategic asset management intervention, and administrative, physical and procedural actions.

The mapping exercise provides a visual representation of elements of the RAM and how they contribute to the overall risk assessment, and what controls are in place to manage the risk. The Asset Managers are then able to identify gaps and assess the effectiveness of the controls, and if necessary change or implement new the controls to manage the risks. A generic example of this mapping is provided in Appendix B – Threat/control/consequence mapping, and specific examples provided in Appendix C – Example threat/control/consequence mapping.

5.4 Asset Health

Asset Health is used to estimate the remaining life of an asset, and forecast the associated likelihood of failure of the asset now and into the future. The modelling takes input from current and historical asset information including, failure, defect, maintenance and condition data, and operational/performance information. The inputs to the Asset Health model are given weightings according to their significance to overall longevity of the asset. The failure behaviour of these asset is modelled by approximating the Weibull distribution and parameters that best fit the time to failure (or any other indicator of failure) of past failures, as determined by examining historical failure data. Asset Health is used as the likelihood input to the risk assessment.

The Asset Managers adopts a number of techniques to gather this information about the health of the assets, including:

- Inspection and test results
- Condition assessment reports
- Historical failure data
- Historical and planned defect work data
- On-line Condition Monitoring data
- Operational and performance history information
- Equipment nameplate information (such as year of manufacture)
- Contextual information, such as location of the asset, and asset criticality
- “Unstructured information”, for example anecdotal information such as irregularity reports, and advice from maintenance staff
- Feedback from the various asset management committees and working groups.

Furthermore, Asset Health leverages the component, failure mode and root cause analysis for the Key Hazardous Events, as these are vital to determining the longevity of the asset.

Asset Health supports TransGrid’s “leave no asset behind” philosophy by placing every major asset in a condition state by comparing its health information (such as nameplate information, condition information, inspection/test results, defect/corrective maintenance data, and advice from maintenance staff) to the end-of-life criteria and thresholds for the asset type. These criteria and threshold have been established from past experience with assets that have reached end-of-serviceable-life, expert advice and global best practice. The condition states map to an age (termed the effective age), and probability of failure, based on an understanding of the expected health of the asset at these ages, in respect of the end-of-life criteria and thresholds.

During the ‘as new’ phase of the assets’ life, the condition state simply maps to its numeric age. Not until the assets condition begins to deteriorate (as indicated by health information) and approaches end of life, is the condition state (and hence age and conditional probability of failure) of the asset adjusted in respect of the end-of-life criteria and thresholds for the asset type.

As the asset moves through its lifecycle (and Asset Health category), the type of investment required (i.e. preventative maintenance, defect maintenance, replacement) to optimise the cost of investment against the performance and risk associated with the asset changes. Furthermore, the forecasted likelihood of failure of an asset is a conditional probability based on its remaining life (and Asset Health category). A typical asset lifecycle health (and investment) profile and associated likelihood of failure distribution is shown in Figure 2 and Figure 3 respectively.

Asset Health is used by the Asset Managers to identify which assets require detailed risk assessment and analysis.

Figure 2: Typical network asset lifecycle investment profile

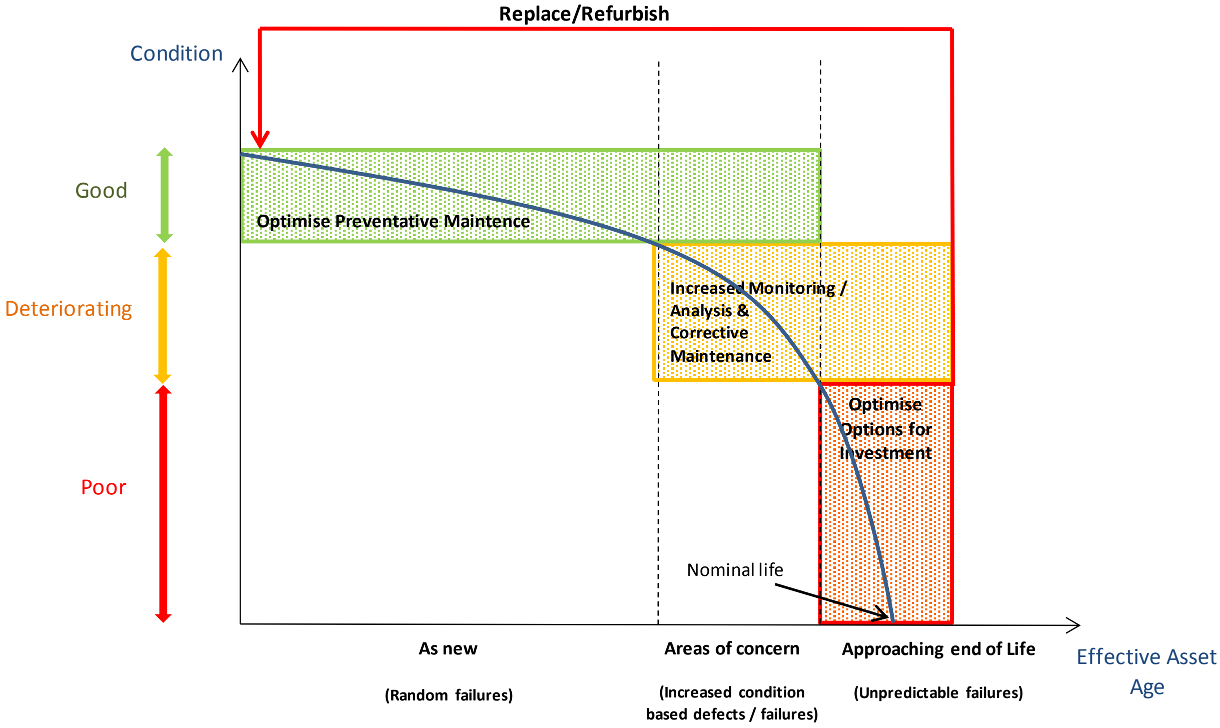
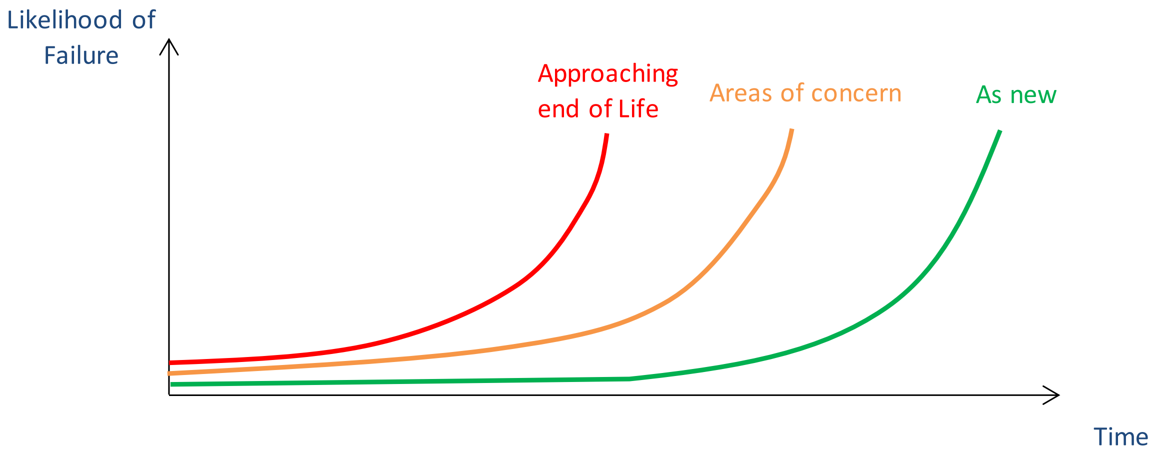


Figure 3: Likelihood of failure distribution



Asset Health is described in further detail in the Asset Health Framework document.

5.5 Asset Criticality

Asset Criticality considers the severity of the consequences of the Key Hazardous Event occurring, and the likelihood the consequence will eventuate. The analysis leverages experience with past events, accepted research/publications and best judgement to determine an economic value of the impact. Asset Criticality is used as the consequence input to the risk assessment.

The analysis of the severity of the consequence assigns an economic value to the expected worst case impact in respect of the areas of consequence the organisation is concerned about, including people, environment, system impact and financial. The analysis of the likelihood of the consequence is used to determine the probability of the impact eventuating for the safety, environment and system impact areas of consequence. This is to account for the fact that the Key Hazardous Event will not always result in the safety (such as death), environment (such as waterway contamination) and system impact (such as loss of electricity supply) consequences eventuating, however the financial consequence (such as repair/replacement cost) will always be realised.

Below is a description of the scope of each of the broad areas of consequence:

People

> This refers to the safety consequence to staff, contractors and/or members of the public of an asset failure resulting in the Key Hazardous Event. The monetary value takes into account the cost associated with a fatality or injury including compensation, loss of productivity, litigation fees, fines and any other related costs.

Environment

> This refers to the environmental consequence to the surrounding community, ecology, flora and fauna of an asset failure resulting in the Key Hazardous Event. The monetary value takes into account the cost associated with damage to the environment including compensation, clean-up costs, litigation fees, fines and any other related costs.

System impact

> This refers to the system reliability and security consequence to the network of an asset failure resulting in the Key Hazardous Event. The monetary value takes into account the amount of load at risk and duration of loss of supply (MWh) due to the failure and any subsequent actions, and a value per MWh of lost load for the customer type. The value per MWh of lost load is dependent on the economic impact to customers, and also takes into consideration the safety implications of the loss of supply, including those associated with the loss of supply to critical services such as hospitals and other essential infrastructure (traffic lights, communications, water, etc.).

Financial

> This refers to the financial consequence of an asset failure resulting in the Key Hazardous Event. The monetary value takes into account the cost associated with the financial impact not covered in any of the other areas of consequence such as disruption to business operations, any third party liability, and the cost of replacement or repair of the asset, including any temporary measures.

Compliance

> This refers to the regulatory/legislative (jurisdictional, federal and market) compliance (or non-compliance more specifically) consequence of an asset failure resulting in the Key Hazardous Event. The monetary value takes into account the cost associated with non-compliance including litigation fees, fines, the cost necessary to achieve compliance, and any other related costs. Compliance relating to people safety and environmental regulation/legislation is excluded from this area of consequence as it is addressed in the People and Environment consequence areas.

Reputation

> This refers to the reputational consequence of an asset failure resulting in the Key Hazardous Event. The monetary value takes into account the cost associated with liaison and engagement with media, the community and other stakeholders.

Note that the Compliance and Reputation impacts are unique to and considered individually under the broader consequence areas of People, System Impact and Environment.

The aim of defining the scope of each broad area of consequence is to ensure the impact of a consequence (including the attributed monetary value) is only considered once when determining the total consequence of a failure resulting in a hazardous event. This avoids inadvertent overstating of consequence and risk.

Asset Criticality is described in further detail in the Asset Criticality Framework document.

5.6 Tools and Data

The tools that support the application of the RAM include:

- Isograph Availability Workbench (AWB) for calculation of probabilities of failure based on conditional age
- Microsoft Access based Investment Risk Tool (IRT) for risk quantification, risk forecasting and register of risk assessments.

The data required to support the application of the RAM will need to be defined and captured to facilitate the use of these tools.

6. How risk is quantified

Risk is quantified by multiplying likelihood and consequence. The monetary value of risk (per year) for an individual asset failure resulting in a Key Hazardous Event, is the likelihood (probability) of failure (in that year with respect to its age), as determined through modelling the failure behaviour of an asset (Asset Health), multiplied by the consequence (cost of the impact) of the Key Hazardous Event occurring, as determined through the consequence analysis (Asset Criticality). Where multiple key hazards are applicable to an asset, the value of risk for each of these are summed to give the total value of risk associated with an asset. The equation for this quantitative risk assessment methodology is shown below.

Furthermore, by forecasting the likelihoods and consequence costs into the future, an annual forecast of the value of risk of an asset failure resulting in a Key Hazardous Event is determined.

$$\text{Monetised value of risk (\$)} = \sum_{K=0}^{\gamma} P(\alpha_K).(\$C_P.\beta_P + \$C_E.\beta_E + \$C_S.\beta_S + \$C_F)$$

Where:

$P(\alpha_K)\ is\ the\ likelihood\ of\ failure\ attributable\ to\ failure\ mode\ K$

$\$C_P is\ the\ people\ safety\ consequence\ cost$

$\$C_E\ is\ the\ envirnoment\ consequence\ cost$

$\$C_S is\ the\ system\ impact\ consequence\ cost$

$\$C_F is\ the\ financial\ consequence\ cost$

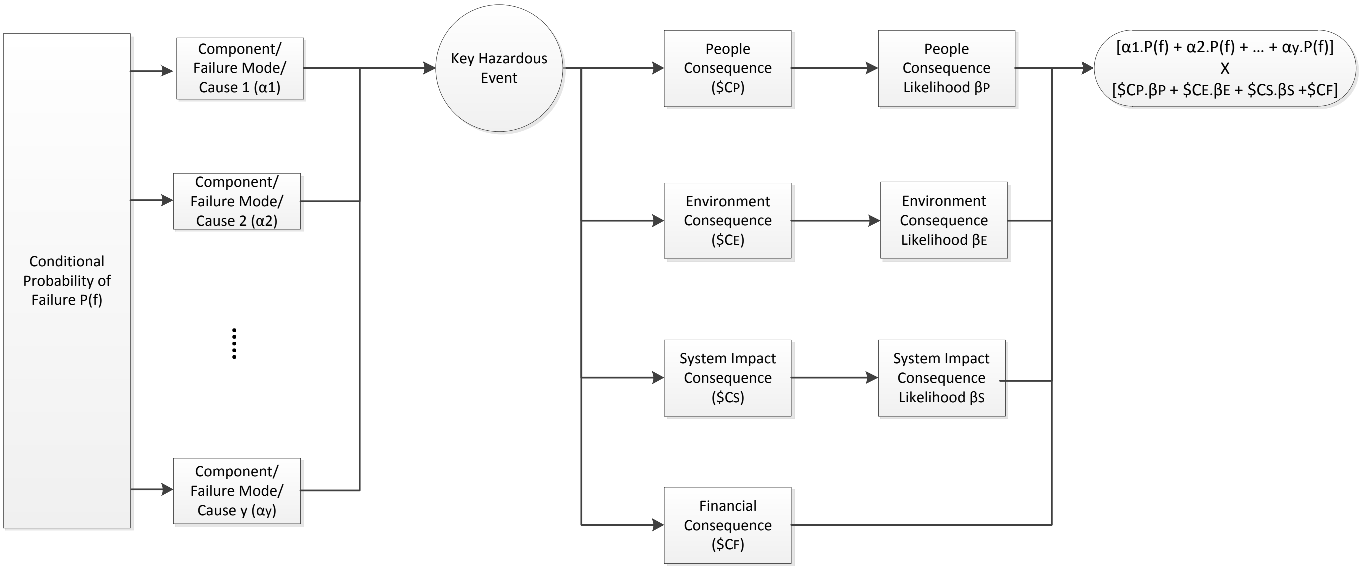
$\beta_P\ is\ the\ likelihood\ of\ the\ people\ safety\ consequence\ occuring$

$\beta_E\ is\ the\ likelihood\ of\ the\ environment\ consequence\ occuring$

$\beta_S\ is\ the\ likelihood\ of\ the\ system\ impact\ consequence\ occuring$

A diagrammatic representation of the equation is shown below.

Figure 4: Risk quantification methodology



The risk value is used by the Asset Managers to identify assets that require further attention and investigation, and determine the most suitable and timely investment option to manage the risk.

Also, by quantifying risk across all critical network assets, a view of the organisations asset risk profile can be determined. This can be utilised to analyse the impact on the risk profile of different funding scenarios, and broadly estimate the long-term replacement expenditure.

Furthermore, the risk value is also used as an input to prioritise and optimise capital investment at a portfolio level across TransGrid.

7. Sensitivity Analysis of the Risk Output

The risk outputs of the RAM methodology can be calibrated and checked for sensitivity as the asset class and portfolio level. This is achieved by varying the key inputs to the risk calculation simultaneously and observing the degree of variability within the risk output and also comparing the estimated number of failures and risk consequences with historical values.

Sensitivity of the risk output should be checked by developing suitable statistical distributions of the below key inputs:

- Value of customer reliability
- Value of statistical life
- Load forecast
- Disproportionality factors
  - SFAIRP/ALARP safety multiplier
  - SFAIRP/ALARP bushfire multiplier
- Probability of failure

These inputs are considered important as they predominantly drive the overall risk output. Distributions are to be developed based on actual samples although alternative methods are acceptable in case of insufficient data.

8. Integration with asset management strategies and plans

The asset management strategies and plans use a risk based approach guided by the Network Asset Risk Management Framework.

8.1 Maintenance strategies and plans

TransGrid's primary challenge in relation to its assets is the optimisation of risks against the direct costs of ownership (including undertaking maintenance work), and the performance of the assets. As such, the Asset Managers identify, assess and evaluate the risks associated with the asset through the consideration of its failure modes and root causes, likelihood of failure, performance, and consequence of failure. The asset risk is managed through the setting of appropriate maintenance activities and frequencies to control the risk to an acceptable level (according to the SFAIRP/ALARP principle for network safety risks).

A copy of the maintenance strategies and plans for the assets is available on The Wire.

8.2 Renewal and disposal strategies and plans

When the risk associated with an asset cannot be managed through maintenance activities, and has exceeded the organisations tolerance, the asset is identified for replacement, refurbishment or disposal if no longer required. The Asset Managers identify, assess and evaluate the risks associated with the asset through the consideration of its failure modes and root causes, likelihood of failure, performance, and consequence and criticality of failure. The asset risk is managed through the development of replacement, refurbishment and where applicable disposal options to control the risk to an acceptable level (according to the SFAIRP/ALARP principle for network safety risks). TransGrid generally prioritises replacement, refurbishment and disposal projects based on a descending order of risk.

Replacement, refurbishment and disposal initiatives are developed through the Prescribed Capital Investment Process.

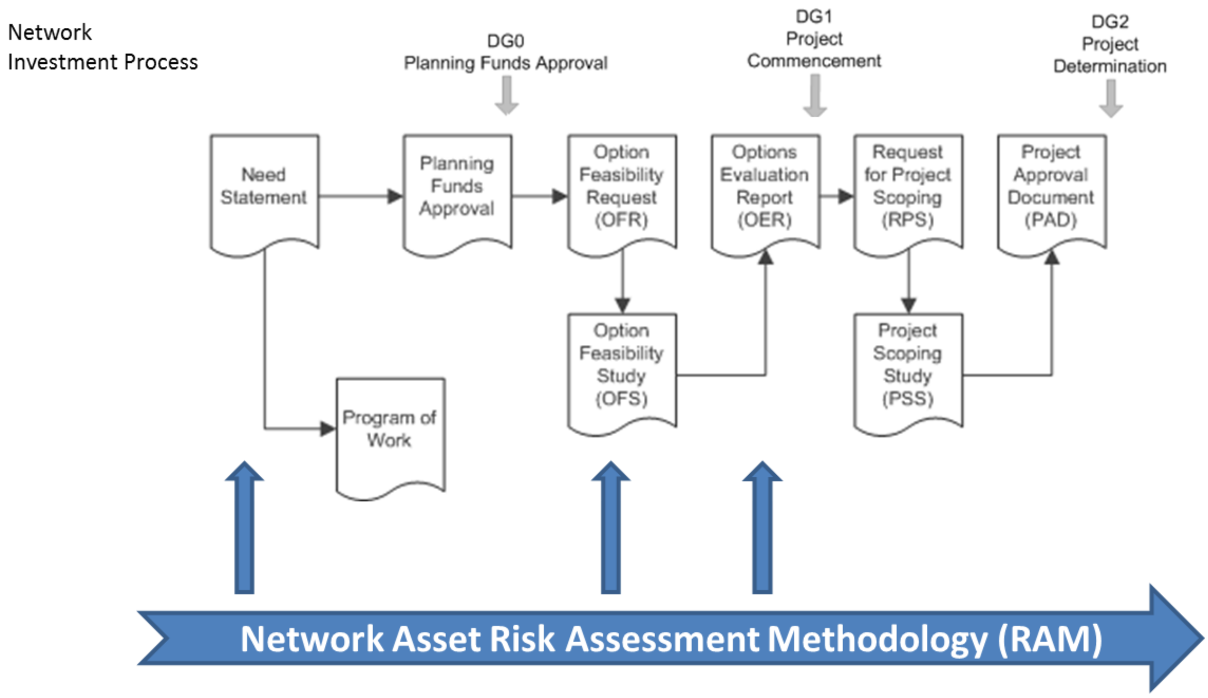
Generally assets are kept in service until the risk associated with their continued operation is unacceptable.

9. Interaction with the Prescribed Capital Investment Process

The RAM brings together the likelihood and consequence of failure to quantify the annual risk of an asset failure. The value of risk is used to identify assets where the risk becomes unacceptable, determine the suitability of investment options, and also demonstrate the application of the SFAIRP/ALARP principle (for network safety risks). Furthermore the value of the risk is used to determine a timeframe when investment is required. It is the responsibility of the Portfolio Management group to determine the exact date of delivery of the investment option within the specified timeframe based on the optimisation and prioritisation of risk, resources, workload and network availability. Generally, those assets with the highest risk are prioritised for actions first.

The interaction between the RAM and investment process is shown below in Figure 5.

Figure 5: Interaction between the RAM and the investment process



The Prescribed Capital Investment Process is used to manage all capital investment options (replacement, refurbishment or disposal) to mitigate/control asset risk. The risk associated with a current or emerging issue is assessed and evaluated according to the methodology in this framework, and used to identify where capital investment is required to manage the risk.

9.1 Need and Opportunity Statement

The identified risk is documented in a Need and Opportunity Statement (NOS). The NOS captures the risks associated with an asset, or group of assets, including the quantum of risk as determined through the methodology in this framework. In addition to the risk, the NOS considers a range of factors including:

> Condition and health of the asset
> Technical end of life or obsolescence of the asset, including availability of spares, ongoing manufacturer/supplier support
> Compliance with Regulations and standards, such as the National Electricity Rules, security, safety, environmental and reliability
> Operational and reliability performance of the asset, including maintenance and lifecycle costs, defects and faults
> Other benefits.

9.2 Investment options

The NOS is followed by an options identification and analysis process to evaluate options to address and/or mitigate the identified risks. The quantum of the risk reduction benefit (post investment risk minus the pre investment risk) for each option is determined through the methodology in this framework, and documented as part of each option.

The outcome of this process is the Options Evaluation Report (OER) and subsequent approval of the preferred option. The Asset Manager selects the preferred solution to address the identified risks, and other investment drivers. The preferred solution is considered to be that which meets TransGrid’s constraints, addresses the investment drivers, and balances the risk reduction benefit against the cost and performance of the investment option.

A Project Approval Document (PAD) is then prepared for approval of the proposed investment solution and commencement of the project.

9.3 So Far As Is Reasonably Practicable (SFAIRP)/As Low As Reasonably Practicable (ALARP)

As an electricity network operator in the state of New South Wales, TransGrid is required to comply with the Electricity Supply (Safety and Network Management) Regulation 2014 (the Regulation). The regulation requires that a network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation, maintenance and decommissioning of its network (or any part of its network) is safe. The objective of the regulation is to support:

> The safety of the public, and persons near or working on the network

> The protection of property and network assets

> Management of safety aspects arising from the protection of the environment, including protection from ignition of fires by electricity networks

> Management of safety aspects arising from the loss of electricity supply

The following should be used guide to the application of SFAIRP / ALARP.

Network safety risk is defined as:

> The safety risk due to asset failure such as explosive failure or conductor drop

> The bushfire risk, which is a subset of the environmental risk

> The safety risk to the community

Network safety risk should be calculated as:

$$Network\ Safety\ Risk\ (\$) = R \times \$Reliability\ Risk + S\ \times \$Safety\ Risk + B\ \times \$Bushfire\ Risk$$

The multipliers (S and B) represent the organisation's obligation to spend more than the value of the safety and bushfire risk avoided to reduce the risk, and the proportion that would be deemed reasonable by an objective third party (e.g. courts). For example, it may be deemed reasonable for an organisation to spend $3 for every $1 of risk reduction (a multiple of 3). The multiple also reflects the severity of the consequence of the risk. For example, a bushfire has the potential to cause extensive harm, including a great number of fatalities and extensive property damage, while an explosive plant failure in a substation has a much more limited potential impact. As such, it is not unreasonable to say an organisation would be expected to spend a greater multiple to reduce and manage the bushfire risk, as compared to the multiple used for the explosive plant failure risk.

The SFAIRP/ALARP concept will be consistently applied to decision making across all life cycle stages of network assets (plan, build, maintain, operate, and replace or decommission), in addition to other considerations such as legislation (Work Health and Safety Act), and industry guidelines and standards.

In the context of REPEX, the SFAIRP/ALARP test should be applied as a cost benefit analysis at the Options Evaluation Report stage and should be the first investment test applied to all options (ahead of the overall economic cost benefit analysis). The cost benefit analysis should consider the cost of each feasible option and the associated network safety risk reduction benefit (pre-investment risk minus post-investment risk). The pre and post-investment risk should be multiplied by the appropriate disproportionality multiplier according to the risk, and severity of the consequence of the risk. If the cost benefit analysis returns a positive result, the project should be undertaken to meet regulatory requirements.

It should also be noted that AS 5577 requires that the option that provides the greatest safety and bushfire risk reduction benefit should be progressed irrespective of cost, until an acceptable level of residual risk is achieved.

Furthermore, where greater than 50% of the pre-investment network safety risk is comprised of the safety risk associated with reliability, it is not necessary to apply the SFAIRP/ALARP test. This is because the overall economic cost benefit analysis inherently ensures that the network safety risk is being reduced to SFAIRP/ALARP in circumstances where the primary driver for investment is reliability risk.

In the capital works program, projects driven by the SFAIRP/ALARP requirement should be the highest priority. A project in the capital works program driven by the SFAIRP/ALARP requirement can only be removed, rescheduled or in any other way modified with the explicit instruction of the authorised officer.

10. Interaction with Portfolio Investment

The RAM guides a consistent and robust risk management process at the asset level. The outputs of the risk assessment and quantification are used as input to prioritise and optimise capital expenditure by balancing risk, cost, performance, value, capacity and constraints across the business, including the conflicting requirements of asset management, system planning, IT, fleet and logistics. As such, the risk assessment and quantification at the asset level is consistent and compatible with the broader portfolio level approach. This approach is further defined in the Prescribed Capital Investment Guidelines.

11. Accountability

Table 3: 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 > Oversight of the processes for the identification and management of asset risks, including the Network Asset Risk Management Framework and the investment process.
Executive Asset Strategy Committee	> Review and endorse the Network Asset Risk Management Framework > Oversight of the processes by which asset risks are managed > Monitoring the performance of the asset managers in managing the asset risks.
Manager/Asset Strategy	> Ensure asset risk is being effectively managed > Endorse and ensure the Network Asset Risk Management Framework is fit for purpose > Ensure consistent, effective and efficient implementation of the Network Asset Risk Management Framework > Monitor the development of Need and Opportunity Statements and investment options > Endorse Need and Opportunity Statements and investment options > Approve the asset management strategies and plans.
Asset Performance and Systems Manager	> Develop and refine the Network Asset Risk Management Framework > Develop the IT tools to facilitate the application of the Network Asset Risk Management Framework > Establish and maintain a register of asset risks.
Asset Managers	> Identify key asset hazardous events and risks > Apply the Network Asset Risk Management Framework to assess and

Role	Responsibilities and Accountabilities
	evaluate asset risk > Manage the asset risks > Develop Need and Opportunity Statements > Develop investment options to address the asset risks > Develop the asset management strategies and plans.

12. Implementation

The RAM will be implemented through:

- Discussions with managers during the various asset management committee and working group meetings
- Analysis and assessment of asset risk
- Development of Need and Opportunity Statements
- Consideration, analysis and evaluation of investment options through the investment process
- Development of the asset management strategies and plans
- Prioritisation and optimisation of capital expenditure at a portfolio level
- The Investment Risk tool (IRT).

13. Monitoring and review

The RAM is reviewed by the Asset Strategy Committee in accordance with the standard meeting schedule.

Asset risks are monitored and reviewed by the relevant Asset Manager at least annually via the refresh of the relevant Asset Renewal and Maintenance Strategy, or in response to an emerging issue, incident, or change in risk tolerance.

14. Change history

Table 4: Change history

Revision no	Approved by	Date
0	Gerard Reiter, EGM/Asset Management	15 December 2015
1	Lance Wee, Manger / Asset Strategy	16 December 2016

15. References

Corporate Risk Management Framework

Network Investment Process

Asset Management Strategy and Objectives

Network Asset Health Framework

Network Asset Criticality Framework

16. Attachments

Appendix A – Key Hazardous Events

Appendix B – Threat/control/consequence mapping template

Appendix C - Threat/control/consequence mapping

17. Appendix A – Key Hazardous Events

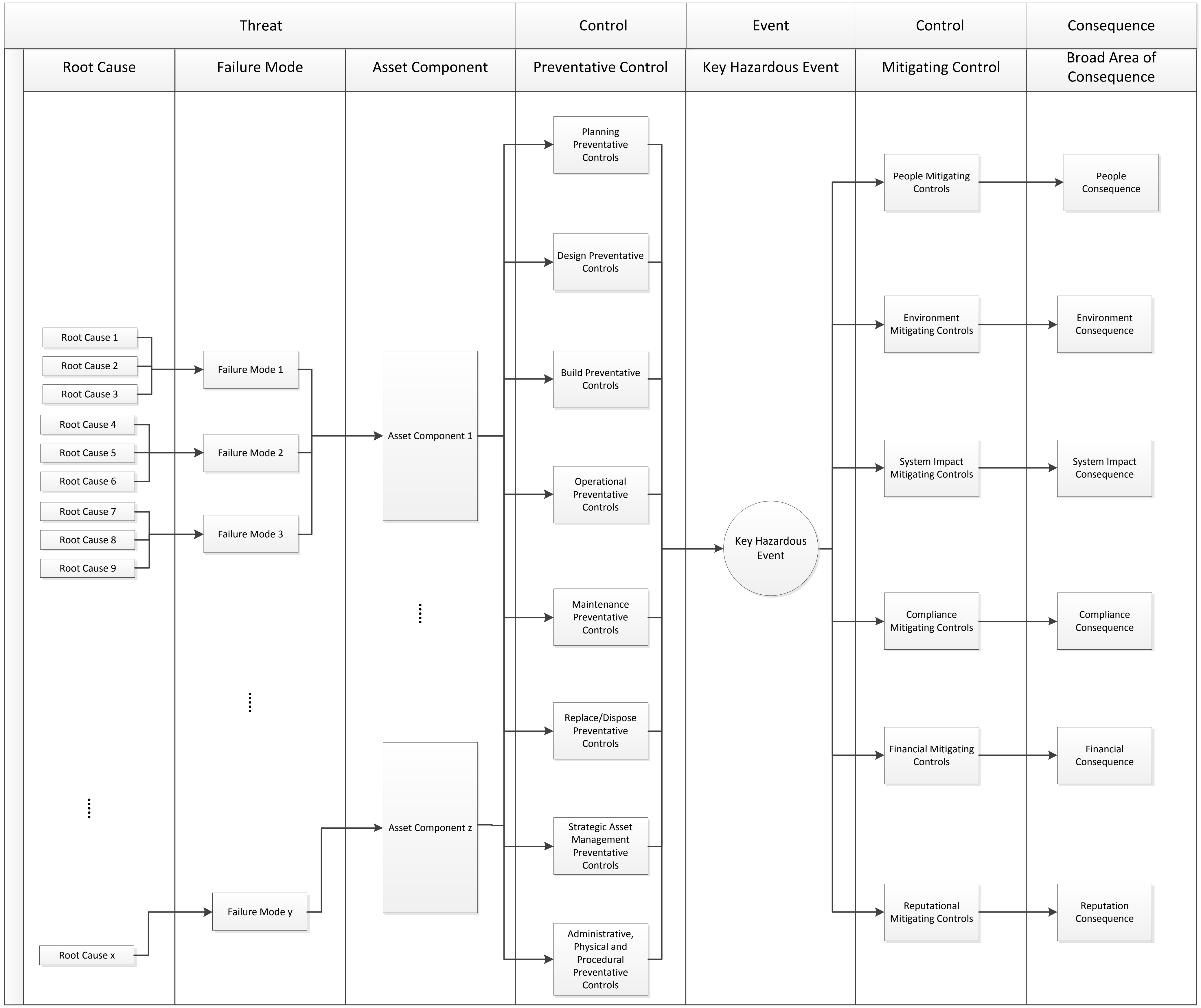
Table 5: Key Hazardous Events

Key Corporate Risks	Key Hazardous Event	Applicable to Asset Manager	Applicable Broad Area of Consequence
> Safety of people > Strategic asset management > Environmental management	Catastrophic failure of asset	> Substation > Secondary System	> Safety > Environment > Financial > System Impact > Reputation
> Compliance obligation > Environmental management	Contaminant or pollutant release, e.g. oil, SF_6 leak etc.	Substation	> Environment > Financial > Compliance > Reputation
Safety of people	Uncontrolled discharge or contact with electricity	> Secondary System. > Substation > Transmission Line and Cable	> Safety > Environment > Financial > Compliance > Reputation
> Safety of people > Compliance obligation > Strategic asset management > Critical IT/OT and communications > Environmental management	Conductor/earth wire/OPGW drop Structure failure	> Transmission Line and Cable > Secondary System	> Safety > Environment > Financial > System Impact > Reputation > Compliance
Compliance obligation	Failure to meet compliance obligations	> Secondary System > Substation	> Compliance > Financial > Reputation
Commercial performance	Failure to meet contractual obligations	Secondary System	> Financial > Reputation
> Safety of people > Strategic asset management > Critical IT/OT and communications	Unplanned outage of communication services	> Secondary System > Transmission Line and Cable	> Financial > Reputation > Safety > System impact
> Safety of people > Strategic asset	Unplanned outage of high voltage	> Secondary System.	> Financial > System

Key Corporate Risks	Key Hazardous Event	Applicable to Asset Manager	Applicable Broad Area of Consequence
management > Compliance obligation	equipment	> Substation > Transmission Line and Cable	Impact > Reputation > Compliance
Safety of people	Unauthorised access to sites	Security	> Safety > Reputation

18. Appendix B – Threat/control/consequence mapping

Figure 6: Threat/control/consequence mapping



19. Appendix C – Example threat/control/consequence mapping

Figure 7: Explosive failure threat/control/consequence mapping

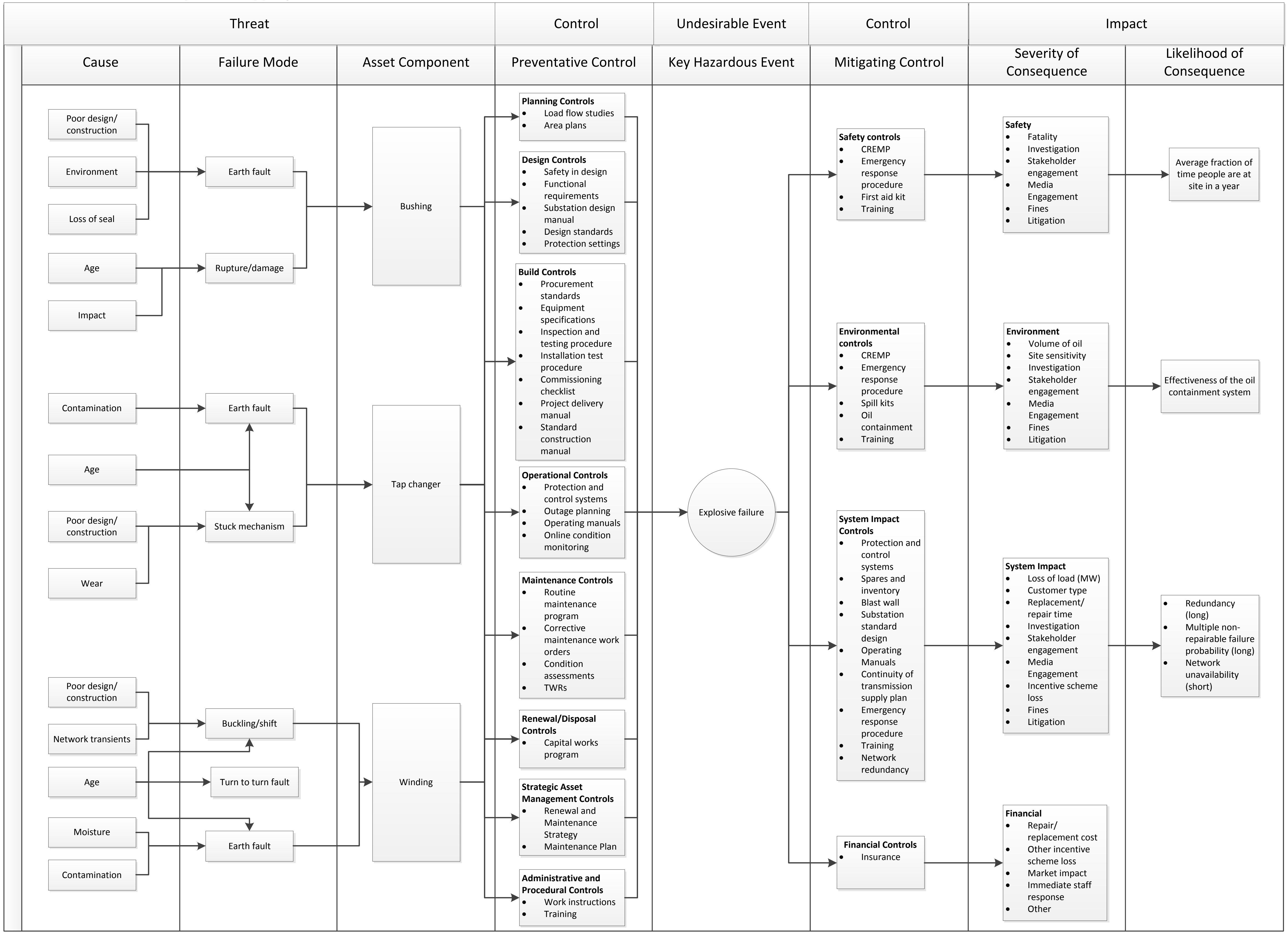


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Figure 8: Loss of electricity supply threat/control/consequence mapping