GUIDELINE

CONDITION BASED RISK MANAGEMENT (CBRM)

ELE GU 0005

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4	09/01/2025	Matthew Ch'ng, Nicole Walker	Updated CBRM output range.

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TABLE OF CONTENTS

1 INTRODUCTION

This document provides a summary of how Jemena utilises Condition Based Risk Management (**CBRM**) to justify future replacement volumes for distribution and zone substation assets. It outlines the different inputs required and their associated outputs and how these outputs are interpreted.

1.1 SCOPE

This document covers the CBRM models for the following distribution sub asset classes: Poles, Pole top structures, Gas switches and ACR's, Air break switches and Isolators, Ring Main Units, Pole transformers and Non Pole transformers.

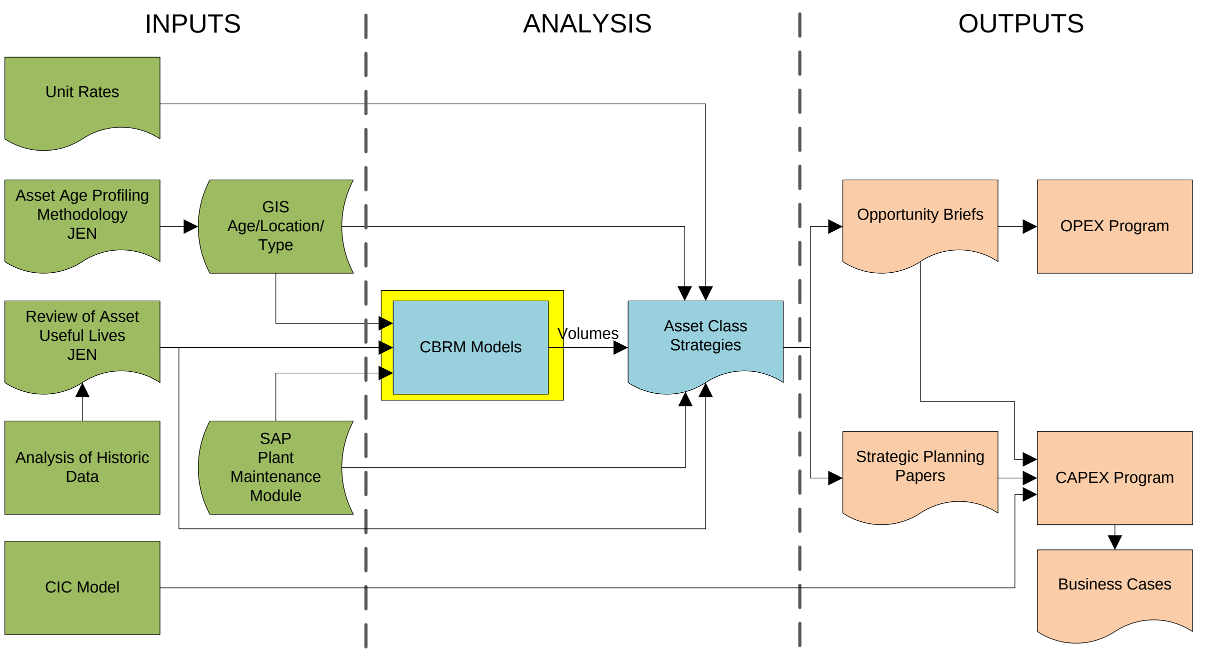
This document also covers the CBRM models for the following zone substation sub asset classes: Transformers, Circuit breakers and Isolators/Disconnectors.

It covers the required inputs, assumptions and the interpretation of the associated outputs.

2 CBRM FRAMEWORK

Figure 2–1 shows the Condition Based Risk Management (**CBRM**) framework. It outlines the inputs and analysis tools used to achieve the output documents that lead into the investment programs.

Figure 2–1: CBRM Framework Flowchart



3 CBRM FRAMEWORK

3.1 BACKGROUND

Condition Based Risk Management (**CBRM**) is a structured process that combines asset information, engineering knowledge and practical experience to define future condition, performance and risk for network assets.

Figure 3–1: Overview of CBRM Asset Management Process

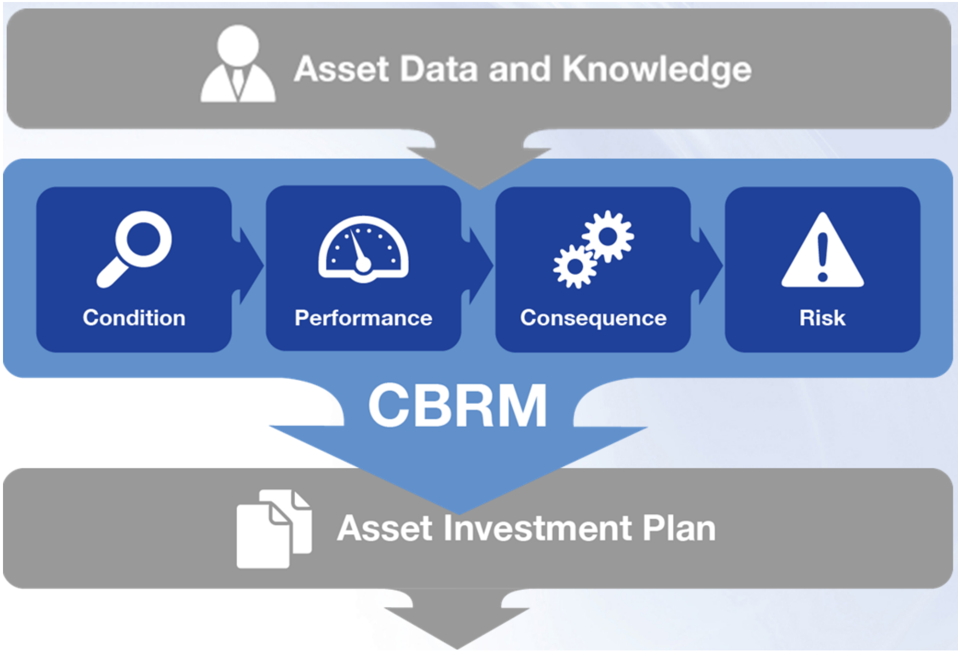


Figure 3–1 is an overview of the process. The process can be summarised by a series of sequential steps as follows:

1. **Define asset condition.** 'Heath indices' for individual assets are derived and built for different asset groups. Current health indices are measured on a scale of 0 to greater than 7, where 0 indicates the best condition and values above 7 the worst.

2. **Link current condition to performance.** Health indices are calibrated against relative probability of failure (**PoF**). The health index/PoF relationship for an asset group is determined by matching the health index profile with the recent failure rate.

3. **Estimate future condition and performance.** Knowledge of degradation processes are used to 'age' health indices. The ageing rate for an individual asset is dependent on its initial health index and operating conditions such as high pollution areas and distance to coastal environments. Future failure rates can then be calculated from aged health index profiles and the previously defined health index/PoF relationship.

4. **Evaluate potential interventions in terms of PoF and failure rates.** The effect of potential replacement, refurbishment or changes to maintenance regimes can then be modelled and the future health index profiles and failure rates modified accordingly.

5. **Define and weight consequences of failure (CoF).** A consistent framework is defined and populated in order to evaluate consequences in significant categories such as network performance, safety, financial and environmental. The consequence categories are weighted to relate them to a common monetary ($) unit.

6. **Build risk model.** For an individual asset, its probability and consequences of failure are combined to quantify risk. The total risk associated with an asset group is then calculated as the sum of the risk of the individual assets.
7. **Evaluate potential interventions in terms of risk.** The effect of potential replacement, refurbishment or changes to maintenance regimes can then be modelled to quantify the potential risk reduction associated with different strategies.
8. **Review and refine information and process.** Building and managing a risk-based process on the basis of asset specific information is not a one-off process. The initial application will deliver results based on available information and, crucially, identify opportunities for ongoing improvement that can be used to progressively build an improved asset information framework.

4 JEMENA'S CBRM MODELS

4.1 CBRM INPUTS

The specific inputs required for each CBRM model are derived from source data within Jemena's Works Management System (SAP) and Geographical Information System (**GIS**). Some inputs, such as environmental consequence costs were provided by EA Technologies (the Developers of the CBRM model).

Figure 4–1: CBRM inputs and outputs

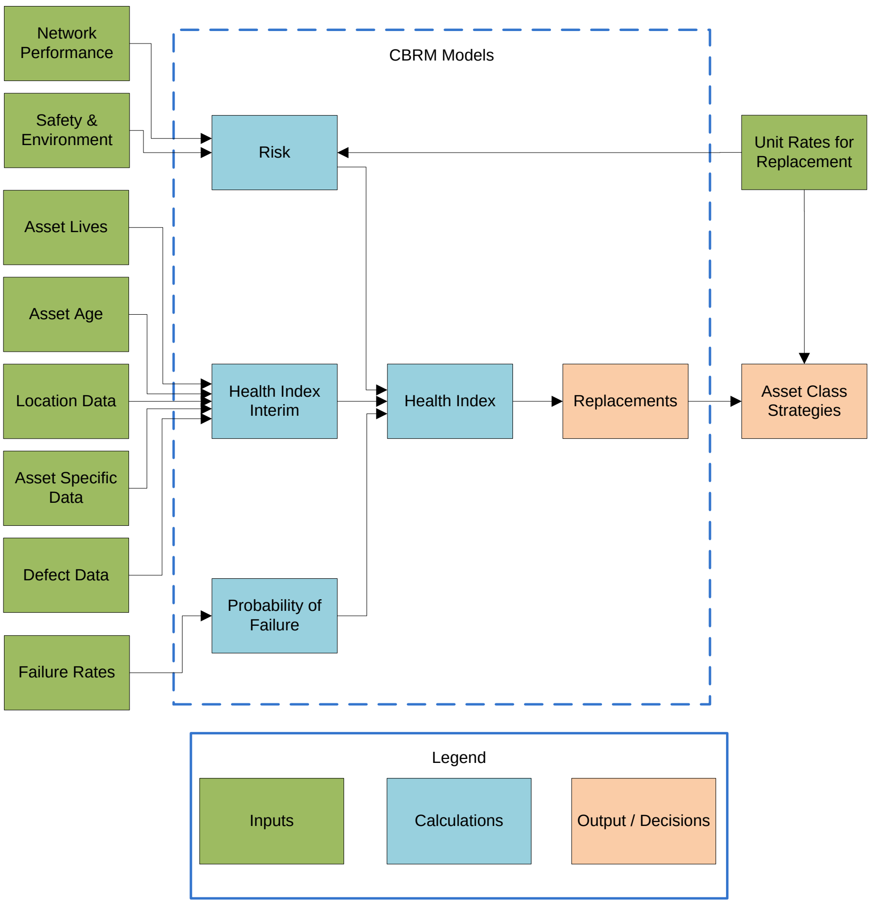


Figure 4–1 above shows further detail of the inputs and outputs from CBRM analysis. All of the models require different types of inputs; however, there are some generic inputs that are consistent across the models. These generic inputs include:

- Asset age;
- Asset life;
- Location factors (eg. distance to coast);
- Failure rates;
- Network performance (STPIS);
- Safety and environment figures;
- Asset condition; and
- Defect data

Asset specific data inputs supplement the above in order to calculate an overall Health Index for each asset and its risk to the network for a failure with associated consequences.

4.1.1 DISTRIBURION ASSET INPUTS

For distribution assets, the models use two inputs for age calculations. These two inputs are Asset age and Asset lives which form the basis of the Health Index for these assets.

The age of each individual asset is required to form an overall Asset Age profile. The source of this information is GIS.

The Asset life is defined as the useful life for a typical asset. Once an asset reaches this age, the asset is more likely to fail in service than for younger asset. For more information refer to ELE PR 0012 – Review of Asset Useful Lives.

4.1.2 ZONE SUBSTATION ASSET INPUTS

For zone substation assets, the different models use different inputs for the age related health index:

Transformers – The transformer model uses the asset life (an asset life of 60 years has been assigned for zone substation power transformers based on average historical usage), duty factor (loading/rating ratio) and the location factor (geographical location of the asset)

Circuit Breakers – The circuit breaker model uses the asset life (an asset life of 50 years has been assigned for zone substation circuit breakers, both indoor and outdoor, based on average historical usage), duty factor (based on the function of the CB, i.e. feeder CB, transformer CB etc.) and location factor (indoor/outdoor).

Isolators, Disconnectors and Buses – The isolator model uses the asset life (an average life of 50 years has been assigned for zone substation isolators, disconnectors and buses based on historical usage) and location factor (high pollution areas, indoor/outdoor).

These can be found in the “ELE PR 0012 Asset Useful Lives” documentation.

4.2 CBRM OUTPUTS

There are several approaches in which the CBRM model may be used to determine replacement volumes. A summary of the approaches can be seen below.

Table 4–1: CBRM and Asset Management Strategies

Approach	Basis of Forecast
Aged Based	Decisions and forecasts are made based on asset age profile.
Asset Health Based	Replacements based on a predefined Health Index. (Used by Jemena on Zone Substation Assets).
Target Failure Rate	CBRM used to predict failure rates. Forecasts based on achieving a target number of failures.
Target Risked Based	CBRM used to predict overall risk. Forecasts based on achieving a target risk. (Used by Jemena for Distribution Assets).
Financially Optimised	CBRM NPV optimisation. Balance of net present value of replacement versus risk.

4.2.1 TARGET FAILURE RATE REPLACEMENT FOR DISTRIBUTION ASSETS

Replacement volumes are determined based on predicted failure rates from the CBRM model. Each CBRM model for distribution assets predicts the failure rate in the current year and also the failure rate at the forecast year. The model assumes that there is no replacement of assets over the forecast period which will result in an increase in failures over that period.

Failures are placed into different categories. For distribution assets the categories are minor, significant, major and extreme. Minor failures are usually remedied by maintenance where the asset can continue to be utilised without replacement. The other 3 categories are a result of an asset failure where the asset can no longer be utilised and will require replacement.

The methodology behind the target failure rate replacement approach is to adjust the replacement volumes of an asset class to suit a targeted failure rate. Jemena's evaluation for distribution assets can be seen in section 5.1.2 below.

4.2.2 METHOD FOR REPLACEMENT OF ZONE SUBSTATION ASSETS

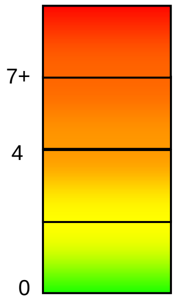
Zone substation assets replacements are determined by calculating an overall asset specific Heath Index (**HI**) for every asset class. Essentially, the health index of an asset is a means of combining information that relates to its age, environment and duty, as well as specific condition and performance information to give a comparable measure of condition for individual assets in terms of proximity to end of life (**EOL**) and probability of failure. The Health Index (**HI**) is based on the following factors:

- **Asset age related health index:** Age related health indices are determined for each asset class based on degradation process against the installation and operational conditions of the asset. The age related health index is then modified by incorporating reliability factor, defect factor and other asset specific condition factors such as bushing DLA results, PD results for switchgear etc. These condition indicators are assessed, and factors assigned to contribute to the asset overall Health Index calculation.
- **Failure rates:** Historical failure rates for each asset class are determined and then used to calibrate the CBRM model to allow for future predictions of failure rates. Three asset condition failure modes have been used in Jemena's CBRM model:
  - Minor: A defect that does not produce immediate equipment non-availability but will initiate a subsequent repair event;
  - Significant: A defect that results in a forced outage causing non-availability of equipment with secondary damage limited to the extent that repairs may be affected in-situ, within a maximum period of several days; and
  - Major: A defect that results in a forced outage, while producing credible worst case secondary damage.
- **Consequence and criticality:** Consequence and criticality of each asset class is calculated from the risk to the network performance (S-Factor impact), safety (potential of injury from asset failure), financial (capital and operational expenditures) and environment.

The final Health Index (**HI**) profile for each asset class is calculated at year 0 (current year) and at any other arbitrary year in the future to determine the asset replacement volumes for each specific asset class. This is illustrated schematically in Table 4–2 below.

Table 4–2: Concept of Health Indices

Condition	Health Index	Remnant Life	Probability of Failure
Bad		At EOL (<5 years)	High
Poor		5 - 10 years	Medium
Fair		10 - 20 years	Low
Good		>20 years	Very low



The health index represents the extent of degradation as follows:

- Low values (in the range 0 to 4) represent some observable or detectable deterioration at an early stage. This may be considered as normal ageing, i.e. the difference between a new asset and one that has been in service for some time but is still in good condition. In such a condition, the PoF remains very low and the condition and PoF would not be expected to change significantly for some time.
- Medium values of health index, in the range 4 to 7, represent significant deterioration, with degradation processes starting to move from normal ageing to processes that potentially threaten failure. In this condition, the PoF, although still low, is just starting to rise and the rate of further degradation is increasing.
- High values of health index (>7) represent serious deterioration, i.e. advanced degradation processes now reaching the point that they actually threaten failure. In this condition the PoF is now significantly raised and the rate of further degradation will be relatively rapid.

4.3 CBRM MAINTAINING AND UPDATING THE MODELS

The models will be updated every two and a half years for all assets. This is to align with EDPR submissions every five years and to ensure the replacement volumes are still aligned mid-way through the submission period.

5 REFERENCES

5.1 INTERNAL

- ELE PR 0012 – Review of Asset Useful Lives.
- ELE 999 PA IN 007 Electricity Distribution Asset Class Strategy
- ELE 999 PA IN 0008 Electricity Primary Plant Asset Class Strategy