DNO CNAIM V3.0 METHODOLOGY CHANGES EXPLAINED

May 2026

CNAIM v3.0 Changes Explained

This document explains the differences applied in v3.0 compared to v2.1 in detail with the required explanation and justification behind the need for the changes including worked examples where necessary.

Version Control

Version No.	Date	Description	Outcome
V0.1	Oct 2025	First draft to capture NEDWG proposals	Issue to NEDWG for review by proposal owners
v1.0	Mar 2025	Final version to support consultation	

Purpose of Document

The document sets out the detailed changes implemented in the revised version 3.0 of the Common Network Asset Indices Methodology (CNAIM). This document explains the detailed rationale and reasoning behind the changes as well as providing the justification and evidence by means of worked examples where appropriate to detail and explain these changes. This revision to CNAIM has been developed by all six GB DNO groups and NIE Networks for intended use during the price control regulatory period of ED3 (1 April 2028 to 31 March 2033) and onwards.

Minor editorial changes are not detailed within the scope of this document.

Contents:

1. Introduction

As part of their regulatory submissions to Ofgem, Distribution Network Operators (DNOs) provide information relating to the risk of condition-based failure for certain categories of distribution asset.

For each asset, this is expressed using three elements: -

- the Health Index: this provides information about the health of the asset and can be related to its probability of failure;
- the Criticality Index: this provides information about the consequences of an asset failure. These are quantified in terms of the impact upon the environment, network performance, safety and financial implications (e.g. repair costs); and
- the Risk Index: this is a monetised measure of the overall condition-based risk for the asset, which is derived using the Health Index and Criticality Index.

These three elements are collectively known in the RIIO-ED2 regulatory period as Network Asset Indices. They will perform a similar function in the RIIO-ED3 framework, as part of the Network Asset Risk Metric (NARM). However, as outlined in Ofgem's ED3 Methodology Consultation, Ofgem proposes that NARMs should be expanded to cover more Asset Register Categories. Proposals for these new models are detailed in section 3 of this document.

Also, throughout RIIO-ED2 DNOs have collectively reviewed the ongoing suitability of the existing methodology through the NARM ED Working Group (NEDWG). This working group has used the DNOs collective experience of implementing CNAIM to identify areas where improvements to the methodology can be made. This has resulted in the proposed changes that are outlined in section 4 of this document, for introduction within CNAIM v3.0.

DNO's ED3 Business Plan submissions will include provision of Network Asset Indices information for NARM. This consultation on CNAIM v3.0 is being undertaken at this time so that agreement to a CNAIM for ED3 can be reached in advance of the Final ED3 Business Plan submission in December 2026. This will enable a consistent methodology to be implemented in the Business Plan submissions and NARM targets to be defined that will then be reported against throughout ED3.

It should be noted that this consultation relates to the CNAIM v3.0 methodology, CNAIM v2.1 will continue to be used for reporting within ED2.

The draft version of CNAIM v3.0 used for this consultation states all financial values used in the derivation of consequences of failure in 2020/21 prices, which is the price base that was used in the RIIO-ED2 Business Plans. DNOs will update the price base used in CNAIM v3.0 (to 2025/26 prices) as part of a suite of global calibration updates later in 2026 that include for example the cost of carbon, once these have been agreed.

Several key cost parameters that are used in the derivation of the reference costs for determination of consequences of failure have not been updated in the draft version of CNAIM v3.0 used for this consultation. This is because agreement has yet to be reached with Ofgem over the appropriate values for usage in RIIO-ED3 cost assessment. DNOs intend to update these key cost parameters within CNAIM v3.0 once the appropriate values for use in RIIO-ED2 cost assessment are known.

2. Executive Summary

Following the creation and the operation of the Common Network Asset Indices Methodology (CNAIM) in RIIO-ED1 and RIIO-ED2, a number of enhancements to the methodology have been identified by both Ofgem and the seven DNOs who created the Methodology (including NIE Networks).

The review of the Methodology was carried out by a subcommittee of the Safety, Resilience and Reliability Working Group. This working group identified that there were two main drivers for the revision of the Methodology:

- **New models:** These regulatory driven changes focused on expansion of the framework. These changes are covered under section 3 and include proposals for:
  - EHV & 132kV Switchgear – Other
  - HV & EHV Pole Mounted Switchgear
  - Batteries
  - Overhead Line Conductors (Poles)
  - 132kV Poles
  - Pole Mounted Transformers
- **Changes to Methodology**: These are DNO driven enhancements to the existing methodology. These changes are covered under section 4 and are driven by factors including:
  - Better alignment to National and International Standards;
  - Revision of the Methodology modelling to align with changes in practice since the creation of CNAIM v2.1; and
  - Changes to the way Consequence of Failure values are calculated following changes to both practices and a reduced tolerance to the use of SF6 gas.

The DNOs have created this document to assist readers of the revised CNAIM in understanding the changes made and the drivers for the change.

2.1 Impact assessment

All proposed changes introduced in this document have been impact assessed based on the following criteria to indicate the scale of the changes as implemented in ED3 with the use of CNAIM v3.0. The basis of these assessments has been carried out by the Working Group and for each of the individual requirements or proposals, the assessment is shown in the summary table associated with that proposal.

No Impact	• No impact on the methodology • No impact or change to the calculated Risk Index Bands at this time
Very Low	• Affects a small population of assets and • Has a negligible impact on Risk Index Bands
Low	• Affects high proportion of assets **within** an asset group, and • Results in <5% movement between Risk Index Bands
Medium	• Affects high proportion of assets **within** an asset group, or • Affects multiple asset groups, or • Results in 5-10% movement in Risk Index Bands
High	• Affects a high proportion of assets **across** multiple asset groups or • Results in >10% movement in Risk Index Bands

2.2 Summary of the Proposed Changes

The following tables provides a summary of the proposed changes which if agreed, will be introduced for the ED3 period.

Further details of the changes are provided in the appropriate section of this document.

This will include

1. The asset categories impacted by the proposal
2. A full explanation of the changes
3. The CNAIM sections and tables that have been revised from v2.0 to v3.0
4. Any changes to, or additions of equations in v2.0

The Impact assessment, see section 2.1 above, is also summarised for each section of proposed change in the table.

Document Section	New Model or Methodology Change	Proposal	Description of Change	Impact Assessment for CNAIM v3.0
3.1	New Model	132kV & EHV Switchgear Other	Creation of full CNAIM model for 33kV Switchgear – Other, 66kV Switchgear – Other, and 132kV Switchgear – Other. Model to align with current structure of other ground mounted switchgear models. Evaluate POF and COF parameters.	**Medium**
3.2	New Model	EHV & HV Pole Mounted Switchgear	Creation of full CNAIM model for EHV and HV pole mounted switchgear category. Model to align with current HV Switchgear (GM) – Primary and HV Switchgear (GM) models.	**Medium**
3.3	New Model	Batteries	Creation of full CNAIM model for Battery System asset category. Model to mimic the methodology in place for Transformer and associated assets.	**Medium**
3.4	New Model	Overhead Line Conductors (Poles)	To create a model for overhead line pole conductors of voltages from LV to 132kV	**Medium**
3.5	New Model	132kV Poles	Creation of full CNAIM model for 132kV Pole asset category. Model to align with current EHV pole model. Evaluate 132kV Pole reference cost of failure.	**Low**
3.6	New Model	Pole Mounted Transformers	Creation of full CNAIM model for EHV and HV Transformers (PM) asset category.	**Medium**
4.1	Methodology	Oil Testing	Introduction of moisture, acidity and breakdown strength calibration tables for synthetic ester and natural ester filled transformers	**Medium**
4.2	Methodology	Dissolved Gas Analysis (DGA)	Update of calibration tables to align with international standard. Update of DGA divider value to align with calibration table updates. Consideration of synthetic ester and natural ester in DGA Test Modifier. Amendment of DGA Test Factor to enhance stability of the rate of change calculation.	**Medium**
4.3	Methodology	Transformer Furfuraldehyde (FFA).	Update FFA Test Collar calculation to reflect experience with FFA and DP. Update FFA Test Factor to consider percentage change.	**Medium**
4.4	Methodology	Ageing Adjustment (Climate) Factor	This proposal offers a means for making adjustments to future deterioration assumptions, through the application of new “ageing adjustment factor” into the calculation of future health.	**High**
4.5	Methodology	Forecast Ageing Rate	Add a collar to the calculation of Forecast Ageing Rate β2 with a minimum value of β1 x 0.5 for assets > 10 and β1 for assets <= 10	**High**
4.6	Methodology	Pole Fittings	Expansion to existing tables within CNAIM, GPG and RIGs to add a new condition factor for poles to reflect the condition of the fittings at the top of the pole	**Low**
4.7	Methodology	Pole Strengthening	Expansion to existing tables within CNAIM, GPG and RIGs to clarify the criteria for poles that have been strengthened	**Low**
4.8	Methodology	Financial Consequence Access Factor	Addition of new column to Financial Consequence Location Factor for OHL	**Low**
4.9	Methodology	Financial Consequence Type Factor – Inter-system Transformer	Addition of new type factor to account for the higher cost of inter-system transformers, reactors and regulators	**Low**
4.10	Methodology	Steel Tower Painting	Introduction of a Cap of 4.4 on the use of ‘Default’ in Observed Conditions	**Low**

Document Section	New Model or Methodology Change	Proposal	Description of Change	Impact Assessment for CNAIM v3.0
4.11	Methodology	Sub Cable	Text changes, definitions and additional condition inputs	**Low**
4.12	Methodology	Switchgear (Ground Mounted): Oil Leaks / Gas Pressure	Update description for Gas Leakage of Switchgear.	**Low**
4.13	Methodology	Pole Top Rot	Amendment to the Top Rot Factor and Collar	**Low**

3. New Models

3.1 EHV & 132kV Switchgear - Other

3.1.1 Summary of Proposal

Asset categories	33kV Switchgear – Other, 66kV Switchgear – Other, 132kV Switchgear – Other
Brief description of change	Creation of full CNAIM model for 33kV Switchgear – Other, 66kV Switchgear – Other, and 132kV Switchgear – Other. Model to align with current structure of other ground mounted switchgear models.
Tables affected	Existing tables to be modified: 1-3, 8, 12-16,19-21,26,32,217-220, 224, 228, 235 New tables required for new Observed and Measured Condition Inputs, and also for Initial Health Score Cap.
RIGs changes	Proposal includes definition changes and refurbishment activities
Overall impact	**Medium**

3.1.2 Details of the new model

A summary of the model parameters by table is provided in Appendix A.1. This includes three new Observed Condition Inputs and one new Measured Condition Input. Note that for these models, the Initial Health Score Cap proposed would be 8.0 as detailed in Appendix A.1 with the introduction of a new table.

In addition, for this asset category a RIGs definition change to exclude fuses from the definition of 33kV and 66kV Switchgear Other and to then introduce a new RIGs category for 33kV Fuses, Links and ASLs. It is further proposed to modify the refurbishment activity table to accommodate refurbishment activity associated with these new models. Details are provided in Appendix A.2.

3.2 HV & EHV Pole Mounted Switchgear

3.2.1 Summary of Proposal

Asset categories	6.6/11kV CB (PM), 6.6/11kV Switch (PM), 6.6/11kV Switchgear - Other (PM) 20kV CB (PM), 20kV Switch (PM), 20kV Switchgear - Other (PM) 33kV Switch (PM)
Brief description of change	Creation of full CNAIM model for EHV and HV pole mounted switchgear category. Model to align with current HV Switchgear (GM) – Primary and HV Switchgear (GM) - Distribution models.
Tables affected	Existing tables to be modified: 1-3,8,12-16,19-21,26,218,220,224,228,229,231,233,235 New tables required for new Observed and Measured Condition Inputs, and also for Initial Health Score Cap.
RIGs changes	Proposal includes definition changes and refurbishment activities
Overall impact	**Medium**

3.2.2 Details of the new model

A summary of the model parameters by table is provided in Appendix A.1. This includes two new Observed Condition Inputs and one new Measured Condition Input. Note that for these models, the Initial Health Score Cap proposed would be 8.0 as detailed in Appendix A.1 with the introduction of a new table.

A RIGs definition change is proposed as detailed in Appendix A.2. This includes excluding "line sectionalisers, links and fuses" from the definition of "6.6/11kV Switchgear - Other (PM)" and putting them into a new RIGs category for "6.6/11kV line sectionalisers, links and fuses", and similarly for 20kV. It is further proposed revise the definition of "33kV Switch (PM)".

Note that this document has been drafted on the basis that these proposed RIGs changes would be implemented and new CNAIM models will be created for the following RIGs categories – 6.6/11kV, 20kV CB (PM), 6.6/11kV, 20kV Switch (PM), 6.6/11kV Switchgear - Other (PM), 20kV Switchgear - Other (PM) and 33kV Switch (PM). No models will be created for the new RIGs category for 6.6/11kV and 20kV line sectionalisers, links, fuses etc.

3.3 Batteries

3.3.1 Summary of Proposal

Asset categories	Batteries at GM HV, 33kV, 66kV and 132kV
Brief description of change	Creation of full CNAIM model for Battery System asset category. Model to mimic the methodology in place for Transformer and associated assets.
RIGs change required	Revise definitions and modification of refurbishment tables.
Tables affected	Existing tables to be modified: 1-3, 8, 12-14, 16, 19-26, 217, 218, 221,224, 225, 227, 228, 233, 235. New tables for observed and measured condition inputs
Overall impact	**Medium**

3.3.2 Details of the new model

A summary of the model parameters by table is provided in Appendix A.1. This includes one new Observed Condition Input and one new Measured Condition Input for the Chargers whilst the Batteries have two new Observed Condition Inputs and three Measured Condition Inputs.

In addition, for this model group it is proposed that the initial health score cap be increased from 5.5 to 8 to reflect the limited condition data available for these assets and the increased reliance on age to determine asset health. This is covered within CNAIM v2.1 in Section 6.1.6 – "Initial Health Score is capped at a value of 5.5".

The proposal is for separate health scores to be calculated for charger and battery components and combined into an overall health score for the complete Battery System.

Finally, a RIGs definition change is proposed for Batteries at HV (GM), 33kV,66kV and 132kV as summarised below and details are provided in Appendix A.2:

- Propose a revision to the Repair & Maintenance activity description.
- Propose to add two new Refurbishment (NARM) activities.

- Propose a revision to the existing definition of Batteries.

3.4 Overhead Line Conductors (Poles)

3.4.1 Summary of proposal

Asset categories	Health Index Asset Category	Asset Register Category
	LV Main OHL Conductor	LV Main OHL Conductor
	HV OHL Conductor	6.6/11kV OHL (Conventional Conductor) 6.6/11kV OHL (BLX or similar Conductor) 20kV OHL (Conventional Conductor) 20kV OHL (BLX or similar Conductor)
	EHV & 132kV OHL (Pole Line) Conductor	33kV OHL (Pole Line) Conductor 66kV OHL (Pole Line) Conductor 132kV OHL (Pole Line) Conductor
Brief description of change	To create a model for overhead line pole conductors of voltages from LV to 132kV	
Tables affected	Existing tables to be modified: 1-3, 12-16, 19-26, 218-220, 224, 228, 233, 235. New tables for new observed and measured inputs.	
Overall impact	**Medium**	

3.4.2 Details of the new model

A summary of the model parameters by table is provided in Appendix A.1. This includes two new Observed Condition Inputs and one new Measured Condition Input (equivalent to the Inputs used for existing tower line conductor models).

In addition, for this model group it is proposed that the initial health score cap be increased from 5.5 to 8. This is to reflect the limited condition data available for these assets and the increased reliance on age to determine asset health. This is covered within CNAIM v2.1 in Section 6.1.6 – “Initial Health Score is capped at a value of 5.5”.

3.5 132kV Poles

3.5.1 Summary of proposal

Asset categories	132KV Pole
Brief description of change	Creation of full CNAIM model for 132kV Pole asset category. Model to align with current EHV pole model. Evaluate 132kV Pole reference cost of failure.
Tables affected	Existing tables to be modified: 1-3, 12,-16, 20, 26, 217-220, 224, 228, 235, 236-241. New tables for new observed and measured inputs.
RIGS Change	Modification of refurbishment tables.
Overall impact	Low

3.5.2 Details of the new model

A summary of the model parameters by table is provided in Appendix A.1. This includes five new Observed Condition Inputs and one new Measured Condition Input (equivalent to the Inputs used for existing pole models). Note that one of the five Observed Condition Inputs it itself a new Input, as described in Section 4.6.

It will also be necessary to update the refurbishment activity allocations in the RIGs.

3.6 Pole Mounted Transformers

3.6.1 Summary of proposal

Asset categories	Transformers (PM)
Brief description of change	Creation of full CNAIM model for EHV and HV Transformers (PM) asset category. It should also be noted that this Transformers (PM) model includes EHV and HV Transformers (PM), as well as pole mounted reactors and regulators.
Tables affected	Existing tables to be modified: 1-3; 8b,12-16; 19-21, 26, 217-219,221, 224, 228, 230, 231, 233, 236-241. New tables for new observed and measured inputs and a new Network Performance Protection Factor
Overall impact	Medium

3.6.2 Details of the new model

A summary of the model parameters by table is provided in Appendix A.1. This includes two new Observed Condition Inputs (no Measured Condition Inputs).

For a pole mounted transformer, how the asset is protected impacts on circuits network performance cost should a failure occur. As a result, a new table “Network Performance Protection Factor” is proposed to reflect this difference by way of an additional factor. This is detailed in Appendix 1.

4. Changes to methodology (DNO driven changes)

4.1 Oil testing

4.1.1 Summary of proposal

Asset categories	6.6/11kV Transformer (GM), 33kV Transformer (GM), 66kV Transformer (GM), 132kV Transformer (GM)
Brief description of change	Introduction of moisture, acidity and breakdown strength calibration tables for synthetic ester and natural ester filled transformers
Tables affected	Existing tables to be modified: 203, 204, 205
Overall impact	**Medium**

4.1.2 Driver for change

The Oil Test Modifier is derived from the oil condition information (moisture content, acidity and breakdown strength). In CNAIM v2.1, the calibration tables in Section B.7 are for mineral oil filled transformers. With the more prevalent use of synthetic ester and natural ester filled transformers, there is a need to update/expand these calibration tables.

4.1.3 Details of the proposed changes

Section 6.11 Oil Test Modifier

The current text is:

- "The Oil Test Modifier is derived from the oil condition information (moisture content, acidity and breakdown strength) [Ref. 3 & 4]."
- Where:
    - Ref. 3: BS EN 60422:2013 "Mineral insulating oils in electrical equipment — Supervision and maintenance guidance"
    - Ref. 4: Expert System for Assessing Transformer Condition, EA Technology Report No. 4969, Project S0446, (M Black, J R Brailsford, D Hughes & M I Lees Sept 1999)

The suggested amendment is shown below.

- "The Oil Test Modifier is derived from the oil condition information (moisture content, acidity and breakdown strength) [Ref. 3 - 6]."
- Where:
    - Ref. 3: BS EN IEC 60422:2024 "Mineral insulating oils in electrical equipment - Supervision and maintenance guidance"
    - Ref. 4: BS EN IEC 61203:2025 "Synthetic organic esters for electrical purposes - Guide for maintenance of transformer esters in equipment"
    - Ref. 5: BS EN IEC 62975:2021 "Natural esters – Guidelines for maintenance and use in electrical equipment"

- Ref. 6: Expert System for Assessing Transformer Condition, EA Technology Report No. 4969, Project S0446, (M Black, J R Brailsford, D Hughes & M I Lees Sept 1999)

This amendment reflects the latest version of BS EN IEC 60422 (mineral oil). Nonetheless, no changes are required to the moisture, acidity and breakdown strength condition state calibration tables. This is because the limit ranges for these three parameters are the same between the two BS EN IEC 60422 versions.

The suggested amendment also includes BS EN IEC 61203 which is the equivalent for synthetic ester filled equipment; and BS EN IEC 62975 which is the equivalent for natural ester filled equipment.

Apart from the suggested amendment above, right after Figure 16: Oil Test Modifier in CNAIM v2.1, the current text is:

- "The process for converting the results into a score and subsequently into an Oil Test Factor, an Oil Test Cap and an Oil Test Collar is as follows:

  i) The moisture, acidity and breakdown strength results are standardised by converting them into scores using the Condition State calibration tables; respectively TABLE 203, TABLE 204 and TABLE 205 in Appendix B.

The suggested amendment is shown below.

- "The process for converting the results into a score and subsequently into an Oil Test Factor, an Oil Test Cap and an Oil Test Collar is as follows:

  ii) The moisture, acidity and breakdown strength results are standardised by converting them into scores using the Condition State calibration tables; respectively TABLE 203, TABLE 204 and TABLE 205 in Appendix B. Note that these tables consider oil types, i.e. mineral oil, synthetic ester and natural ester. In the absence of oil type used in the transformer, the default oil type to be selected is mineral oil.

Section 8.4 Document References

The current text is:

- 3. BS EN 60422:2013 "Mineral insulating oils in electrical equipment — Supervision and maintenance guidance"
- 4. Expert System for Assessing Transformer Condition, EA Technology Report No. 4969, Project S0446, (M Black, J R Brailsford, D Hughes & M I Lees Sept 1999)

The suggested amendment is shown below. Note that the reference number may change depending on text amendments in other parts of the document.

- 3. BS EN IEC 60422:2024 "Mineral insulating oils in electrical equipment - Supervision and maintenance guidance"
- 4. BS EN IEC 61203:2025 "Synthetic organic esters for electrical purposes - Guide for maintenance of transformer esters in equipment"

- 5. BS EN IEC 62975:2021 “Natural esters – Guidelines for maintenance and use in electrical equipment”
- 6. Expert System for Assessing Transformer Condition, EA Technology Report No. 4969, Project S0446, (M Black, J R Brailsford, D Hughes & M I Lees Sept 1999)

Appendix B Calibration – Probability of Failure – B.7 Oil Test Modifier

The “Fair” condition ranges in BS EN IEC 60422 for Category B (>72.5kV and ≤170kV) and Category C (≤72.5kV), were used in the development of CNAIM v2.1. These “Fair” condition ranges were used as the values that would result in a score of 4 for any of the moisture, acidity and breakdown strength condition state calibration tables.

The value ranges for the rest of the condition state scores were then assessed accordingly, also considering higher voltage transformers typically have a more conservative range of values due in general to their greater criticality on the network.

Note that BS EN IEC 60422 is applicable to mineral oil filled transformers. To assess synthetic ester filled transformers, BS EN IEC 61203 is used. As for natural ester filled transformers, BS EN IEC 62975 is used. The same logic previously adopted in CNAIM v2.1 development will be used here to establish the equivalent value ranges for synthetic ester and natural ester filled transformers to be included in CNAIM v3.

For Table 203, the proposal is to append the synthetic ester and natural ester equivalent values, with the addition of an oil type identifier column on the left of the table to clearly differentiate between mineral oil, synthetic ester, and natural ester.

For Table 204, the proposal is also to append the synthetic ester and natural ester equivalent values, with the addition of an oil type identifier column on the left of the table. Note that in BS EN IEC 61203 (synthetic ester) and BS EN IEC 62975 (natural ester), the same “Fair” condition range of 0.5-1.0 mg KOH/g (synthetic ester) and 0.3-0.5 mg KOH/g (natural ester) are used for both Category B (>72.5kV and ≤170kV) and Category C (≤72.5kV); this means that the same 0.5-1.0 mg KOH/g (synthetic ester) and 0.3-0.5 mg KOH/g (natural ester) will be used for HV, EHV and 132kV Transformers filled with synthetic ester and natural ester, to correspond to an acidity score of 4. Any acidity values that are higher than 1.0 mg KOH/g (synthetic ester) and 0.5 mg KOH/g (natural ester) will then be subject to different ranges depending on the voltage level to correspond to acidity scores of 8 and 10, noting that higher voltage transformers are typically more critical.

Still on Table 204, a slight change is also proposed for mineral oil filled transformers. The existing table does not have values against an acidity score of 0 for HV Transformers. There is also a misalignment of the acidity ranges corresponding to a score of 2 for both HV and EHV Transformers; considering they both belong to Category C (≤72.5kV) in BS EN IEC 60422. Therefore, the proposal is to align the values for both voltage classes.

For Table 205, the proposal is just to add an oil type identifier column on the left of the table to clearly differentiate between mineral oil, synthetic ester, and natural ester. Other than that, the same set of values are applicable to all the three oil types.

The proposed table changes are shown in Appendix I.

4.2 Dissolved Gas Analysis (DGA)

4.2.1 Summary of proposal

Asset categories	6.6/11kV Transformer (GM), 33kV Transformer (GM), 66kV Transformer (GM), 132kV Transformer (GM)
Brief description of change	- Update of calibration tables to align with international standard. - Update of DGA divider value to align with calibration table updates. - Consideration of synthetic ester and natural ester in DGA Test Modifier. - Amendment of DGA Test Factor to enhance stability of the rate of change calculation.
Tables affected	Existing tables to be modified: 208-214
Overall impact	**Medium**

4.2.2 Driver for change

The DGA Test Modifier is derived from hydrogen, methane, ethane, ethylene and acetylene. In CNAIM v2.1, the calibration tables in Section B.8 for the five gases can benefit from aligning with the 90% typical gas concentration values in the latest version of the international standard IEC 60599 (BS EN IEC 60599). Correspondingly, the DGA divider value of 220 as shown in EQ. 24 will also benefit from an update.

In CNAIM v2.1, the calibration tables in Section B.8 are for mineral oil filled transformers.

With the more prevalent use of synthetic ester and natural ester filled transformers, there is a need to update/expand these calibration tables.

The DGA Test Modifier also considers the percentage change between two measurements to evaluate the DGA Test Factor. There are cases where this factor can be affected by high rate of change between two measurements, thereby leading to an overstatement of asset health, even though the absolute DGA measurements are not indicative of any real issues. Therefore, the stability of the calculation of this factor can be improved.

4.2.3 Details of the proposed changes

Section 6.12 DGA Test Modifier

The current text is:

- “The DGA Test Modifier is derived from the dissolved gas content in the oil [Ref. 5].”
- Where:
    - Ref. 5: BS EN 60599:1999 “Mineral oil-impregnated electrical equipment in service — Guide to the interpretation of dissolved and free gases analysis”

The suggested amendment is shown below.

- “The DGA Test Modifier is derived from the dissolved gas content in the oil [Ref. 7 - 8].”
- Where:

    - Ref. 7: BS EN IEC 60599:2022 “Mineral oil-impregnated electrical equipment in service — Guide on the interpretation of dissolved and free gases analysis”
    - Ref. 8: IEEE C57.155-2014 “IEEE Guide for Interpretation of Gases Generated in Natural Ester and Synthetic Ester-Immersed Transformers”

Right after Figure 17: DGA Test Modifier in CNAIM v2.1, the current text is:

- “The gas levels used to produce this modifier are calibrated to give a DGA Test Collar of 7 or greater if there is indication of a potential end of life fault. The result of this analysis is used to determine the DGA Test Collar and the DGA Test Factor.”

The suggested amendment is to replace those two sentences with the one shown below.

- “The gas levels used to produce this modifier are calibrated based on the 90% typical gas concentration values in the international standards [Ref. 7 - 8].”
- Where:
    - Ref. 7: BS EN IEC 60599:2022 “Mineral oil-impregnated electrical equipment in service — Guide on the interpretation of dissolved and free gases analysis”
    - Ref. 8: IEEE C57.155-2014 “IEEE Guide for Interpretation of Gases Generated in Natural Ester and Synthetic Ester-Immersed Transformers”

These amendments reflect the alignment with the latest version of BS EN IEC 60599 (mineral oil). The suggested amendments also include IEEE C57.155 which is the equivalent for synthetic ester and natural ester filled equipment.

Note that the reference number starts from 7 (instead of 5) here. This is due to the addition of another reference as mentioned previously in 1.3.1.

Apart from the text changes above, EQ. 24 in CNAIM v2.1 needs to be updated too. The current equation and the text right after the equation are shown below:

- DGA Test Collar = DGA Score ÷ 220
- “This value is chosen to give a Health Score of 7 at the point where DGA levels are indicative of severe degradation. In the absence of DGA records a default DGA Test Collar of 0.5 is used.”

The suggested amendment is to update the equation and replace the text right after the equation as shown below:

- DGA Test Collar = DGA Score ÷ DGA Divider
- “The DGA Divider is set to 260 regardless of oil type. This corresponds to a DGA Test Collar of 4. If this is the Health Score, it represents the tipping point where PoF starts to change (note that PoF is constant for a Health Score ≤ 4 as shown in Figure 3: HI Banding). The total DGA Score at this point is 1040, derived from having a condition state score of 4 for all five gases, multiplied by their respective importance values (i.e. 50 for hydrogen, 30 for methane, 30 for ethane, 30 for ethylene and 120 for acetylene). In the absence of DGA records a default DGA Test Collar of 0.5 is used.”

Next, we currently have the following text in CNAIM v2.1:

- For EHV and 132kV Transformers, the DGA Test Factor is then created by considering the trend with historical results (over a defined period) for the same asset. The percentage change is derived as shown in EQ. 25.

The suggested amendment to that is shown below.

- The DGA Test Factor is then created by considering the trend with historical results (annualised) for the same asset. The annualised percentage change is derived as shown in EQ. 25. For assets where DGA tests are not routinely undertaken or in the absence of two valid time stamped DGA tests, the DGA Test Factor is always set to 1. This prevents comparison with previous results.

EQ. 25 will need to be updated to reflect the annualised percentage change calculation.

$$\%\ \boldsymbol{Change} = \frac{DGA\ Score_{Latest} - DGA\ Score_{Prev}}{DGA\ Score_{Prev}} \times 100 \times \frac{365}{|Days\ between\ Latest\ and\ Prev\ DGA\ Test + 1|}$$

With the suggested amendment above, particularly the suggested text around cases where DGA tests are not routinely undertaken, the current text in CNAIM v2.1 shown below can be removed entirely.

Section 8.4 Document References

As per the suggested amendment in 1.3.2, the document references need to be updated.

- The current text is:
  - 5. BS EN 60599:1999 “Mineral oil-impregnated electrical equipment in service — Guide to the interpretation of dissolved and free gases analysis”
- The suggested amendment is shown below. Note that the reference number may change depending on text amendments in other parts of the document.
  - 7. BS EN IEC 60599:2022 “Mineral oil-impregnated electrical equipment in service — Guide on the interpretation of dissolved and free gases analysis”
  - 8. IEEE C57.155-2014 “IEEE Guide for Interpretation of Gases Generated in Natural Ester and Synthetic Ester-Immersed Transformers”

Appendix B Calibration – Probability of Failure – B.8 DGA Test Modifier

The 90% typical gas concentration values in BS EN IEC 60599 and IEEE C57.155 will be used to update the condition state calibration tables. BS EN IEC 60599 is used for mineral oil filled transformers; whereas IEEE C57.155 is used for synthetic ester and natural ester filled transformers. Note that “soybean” ester fluid type will be used to represent natural ester (as predominantly, FR3 liquid is used, and it is formed by soybean).

The table below shows the 90% typical gas concentration values in BS EN IEC 60599 and IEEE C57.155.

BS EN IEC 60599:2022 (Mineral Oil)	IEEE C57.155-2014 (Synthetic Ester and Natural Ester)

Table A.2 – Ranges of 90 % typical gas concentration values observed in power transformers, in µl/l

	C_2H_2	H_2	CH_4	C_2H_4	C_2H_6	CO	CO_2
All transformers		50 – 150	30 – 130	60 – 280	20 – 90	400 – 600	3 800 – 14 000
No OLTC	2 – 20						
Communicating OLTC	60 – 280						

Table 1—Threshold value for transformers with no previous sample history, summary of 90th percentile values [µL/L (ppm)] with 95% confidence interval from Annex A[g]

Ester Fluid Type	Number of Records		H_2	CH_4	C_2H_6	C_2H_4	C_2H_2	CO
Soybean	4,378	90th Percentile	112	20	232	18	1	161
		95% C.I.	(105–118)	(19–22)	(219–247)	(17–20)	(1–1)	(150–179)
High Oleic Sunflower	476	90th Percentile	35	25	58	16	0	497
		95% C.I.	(24–45)	(18–30)	(36–84)	(12–23)	(0–0)	(314–583)
Synthetic	157	90th Percentile	64	104	124	150	13	1344
		95% C.I.	(52–82)	(49–135)	(105–362)	(79–215)	(0–33)	(937–1526)

Note that for all the gases, the condition state calibration tables (TABLE 208, 209, 210, 211 AND 212) have five condition states; these are 0, 2, 4, 10 and 16. The only exception is TABLE 212 (acetylene), which has the five condition states as 0, 2, 4, 8, 10. The proposal is to change this to align with the rest of the tables. Full tables are shown below, along with other proposed changes to the values of the gases that correspond to these condition states.

Note also that the 90% values shown in the international standards are expressed in ranges. The lower end of the range, and the mid-point of that range, will be used as the range that corresponds to a condition state of 4. For the next higher condition state, i.e. a condition state of 10, this will be formed by the mid-point and upper end of that international standard range.

- As an example, for a mineral oil filled transformer and referring to BS EN IEC 60599, the 90% typical value range is 50 – 150 ppm for hydrogen. As a proposal, 50 – 100 ppm will be used to correspond to a hydrogen condition state of 4; where 100ppm is the mid-point between 50 ppm and 150 ppm. For a condition state of 10 (which is the next one up), 100 – 150 ppm of hydrogen will be used.

As for the condition state of 2, this will correspond to half of the lower end of the international standard range, to the lower end of that same range.

- In the example above, this means 25 – 50 ppm corresponds to a condition state of 2 for hydrogen in a mineral oil filled transformer.

As for the condition state of 0, this will just be from -0.01 to the lower end of the gas range that feeds into the condition state of 2.

- In the example above, this means -0.01 – 25 ppm corresponds to a condition state of 0 for hydrogen in a mineral oil filled transformer.

As for the highest condition state of 16, this will just be the upper end of that international standard range to 10,000 ppm.

- In the example above, this means 150 – 10,000 ppm corresponds to a condition state of 16 for hydrogen in a mineral oil filled transformer.

Note that for acetylene in synthetic ester filled transformers, IEEE C57.155 shows a range of 0 – 33 ppm. For CNAIM v3 development, the proposal is to use 2 – 33 ppm (instead of 0 – 33 ppm) as the reference range for forming the acetylene condition state calibration table for synthetic ester filled transformers.

Note that for acetylene in natural ester filled transformers, IEEE C57.155 shows a range of just 1 – 1 ppm. For CNAIM v3 development, the proposal is to use 0.5 – 1 ppm (instead of just 1 – 1 ppm) as the reference range for forming the acetylene condition state calibration table for natural ester filled transformers.

As mentioned in 2.1 and 2.2, the DGA Test Modifier also considers the percentage change between two measurements to evaluate the DGA Test Factor. There are cases where this factor can be affected by high rate of change between two measurements, thereby leading to an overstatement of asset health, even though the absolute DGA measurements are not indicative of any real issues.

The proposed table changes are shown in Appendix I.

The DGA Threshold is proposed to be set to 1040, which corresponds to the case with a DGA Test Collar of 4. If this is the Health Score, it represents the tipping point where PoF starts to change (note that PoF is constant for a Health Score ≤ 4 as shown in Figure 3: HI Banding).

Note that in 2.3.1, there is already a suggested text change that says that "For assets where DGA tests are not routinely undertaken, the DGA Test Factor is always set to 1. This prevents comparison with previous results". This makes it flexible in the sense that DNOs with routine measurements even for HV transformers can still use DGA Test Factor; whereas at the other end of the spectrum, if tests are not routinely undertaken (not just for HV, but also for EHV and 132kV transformers), the DGA Test Factor can always be set to 1.

4.3 Transformer Furfuraldehyde (FFA)

4.3.1 Summary of proposal

Asset categories	6.6/11kV Transformer (GM), 33kV Transformer (GM), 66kV Transformer (GM), 132kV Transformer (GM)
Brief description of change	- Update FFA Test Collar calculation to reflect experience with FFA and DP. - Update FFA Test Factor to consider percentage change.
Tables affected	Existing tables to be modified: 215. New table that shows the FFA change category calibration.
Overall impact	**Medium**

4.3.2 Driver for change

Through the experience of using CNAIM v1.1 and CNAIM v2.1, the industry realised that the FFA Test Collar is not flagging transformers with genuine concern of solid insulation degradation as indicated by FFA values.

Furthermore, it is understood from literature that FFA is a late ageing indicator and any rate of change or percentage change when FFA absolute value is high can be an indication of fast deterioration of a transformer's solid insulation.

4.3.3 Details of the proposed changes

Section 6.13 FFA Test Modifier

The current text is:

- "In a new transformer, the DP value is approximately 1000. When this is reduced to approximately 250, the paper has very little remaining strength and is at risk of failure during operation. For this reason, the FFA Test Collar is calibrated to give a value of 7

for a FFA value of 5; this empirical relationship has been mathematically described as shown in EQ. 26."

The suggested amendment is shown below.

- "In a new transformer, the DP value is approximately 1000. When this is reduced to approximately 350, the paper is aged; and when it is further reduced to approximately 250, it has very little remaining strength and is at risk of failure during operation. Using Chendong's equation that relates DP to FFA as a reference, the FFA Test Collar is calibrated to give a value of 8 for a FFA value of 2; this relation has been mathematically described as shown in EQ. 26."

Apart from the text changes above, EQ. 26 in CNAIM v2.1 needs to be updated too. The current equation is shown below:

$$FFA\ Test\ Collar = 2.33\ x\ S^{0.68}$$

The suggested amendment is to update the equation to:

$$\boldsymbol{FFA\ Test\ Collar} = \mathbf{10} \times \boldsymbol{e}^{(-\mathbf{2.9957} \times \boldsymbol{e}^{-\mathbf{1.2986} \times \boldsymbol{S}})}$$

After EQ. 26, the proposal is to add the following text to introduce the consideration of percentage change or rate of change of FFA.

- The FFA Test Factor is then created by considering the trend with historical results (annualised) for the same asset. The annualised percentage change is derived as shown in EQ. 27. For assets where FFA tests are not routinely undertaken or in the absence of two valid time stamped FFA tests, the FFA Test Factor is always set to 1. This prevents comparison with previous results.

Note that EQ. 27 in the proposed text above is a new equation.

$$\%\ \boldsymbol{Change} = \frac{FFA\ Score_{Latest} - FFA\ Score_{Prev}}{FFA\ Score_{Prev}} \times 100 \times \frac{365}{|Days\ between\ Latest\ and\ Prev\ FFA\ Test + 1|}$$

Right after the new equation, the proposal also includes adding the following text. Note table number for TABLE XXX will need to be identified. This table comes just before the existing TABLE 215.

- This is used to categorise the trend into one of five categories or bands (negative, neutral, small, significant or large), as depicted in calibration Table XXX in Appendix B.
- The category or band is then used to assign the FFA Test Factor, using the calibration Table 215 in Appendix B.

Appendix B Calibration – Probability of Failure – B.9 FFA Test Modifier

Currently in CNAIM v2.1, in addition to the FFA Test Collar, the FFA Test Factor (as shown in TABLE 215) is also evaluated based on an absolute FFA measurement value. There is currently no consideration of the percentage change or the rate of change of FFA. This can

be a crucial metric to pick up any fast deterioration of the transformer solid insulation especially during the later stages of ageing as FFA tends to rise exponentially.

The proposal here is hence to tweak the FFA Test Factor to be based on the percentage change. Just before the existing TABLE 215, there needs to be a table that shows the FFA change category calibration. Note the table number will need to be sorted out in the main document of CNAIM.

(PROPOSED) TABLE XXX: FFA CHANGE CATEGORY CALIBRATION

HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)		
> % Change	<= % Change	Change Category
-1,000.00	-5.00	Negative
-5.00	5.00	Neutral
5.00	25.00	Small
25.00	100.00	Significant
100.00	1,000.00	Large

Similar to the proposal for DGA Test Factor in 2.3.3, there can be cases where the proposed FFA Test Factor (that considers percentage change) can be affected by high rate of change between two measurements, thereby leading to an overstatement of asset health, even though the absolute FFA measurements are not indicative of any real issues.

Therefore, the stability of the calculation of this factor is important. This can be done by considering both the percentage change and absolute value of FFA.

(EXISTING) TABLE 215: FFA TEST FACTOR

HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)		
> FFA value (ppm)	<= FFA value (ppm)	FFA Test Factor
-0.01	4.00	1.00
4.00	5.00	1.10
5.00	6.00	1.25
6.00	7.00	1.40
7.00		1.60

(PROPOSED) TABLE 215: FFA TEST FACTOR CALIBRATION

HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)	
> % Change	FFATest Factor
Negative	1.00 - (0.1 x MIN (S ÷ FFA Threshold, 1))
Neutral	1.00
Small	1.00 + (0.1 x MIN (S ÷ FFA Threshold, 1))
Significant	1.00 + (0.2 x MIN (S ÷ FFA Threshold, 1))
Large	1.00 + (0.5 x MIN (S ÷ FFA Threshold, 1))

Note that “S” is defined in the text in CNAIM v2.1 Section 6.13 as the FFA value in ppm.

The FFA Threshold is proposed to be set to 0.9. This FFA value of 0.9 ppm corresponds to the case with a FFA Test Collar of 4. If this is the Health Score, it represents the tipping point

where PoF starts to change (note that PoF is constant for a Health Score ≤ 4 as shown in Figure 3: HI Banding).

4.4 Ageing adjustment (Climate) factor

4.4.1 Summary of proposal

Asset categories	All
Brief description of change	This proposal offers a means for making adjustments to future deterioration assumptions, through the application of new "ageing adjustment factor" into the calculation of future health.
Tables affected	Existing tables to be modified: 20: Normal Expected Life (additional column required that links to new table that will be added to the new section B.11 Ageing Adjustment Factor.
Overall impact	**High**

4.4.2 Driver for change

On 19 September 2024, the National Infrastructure Commission (NIC) published a report "Developing Resilience Standards in UK Infrastructure"[1]. One of the recommendations is related to network Asset Risk Metric (NARM):

"The energy transmission and distribution systems have a network asset risk metric which considers the future deterioration of the network to consider appropriate levels of maintenance. This metric should incorporate climate change driven deterioration in asset health."

Subsequently Ofgem stated in the ED3 Framework Decision (30 April 2025) that it is "important to embed climate resilience into existing regulatory tools" and Ofgem's proposal "*includes assessing whether climate change impacts the rates of asset deterioration and whether this can be embedded into NARM*."

The incorporation of climate considerations into NARM needs to be considered as two discrete tasks:

1. Assessing whether climate change impacts the rates of asset deterioration and
2. Whether this can be embedded into NARM

Whilst we are not currently observing trends of accelerated degradation due to climate change, and we are not aware of any evidence or study that would conclude this either, NEDWG has committed to continuing to review the need for incorporating the impacts of climate change on asset condition should further evidence become available.

Therefore, this proposal considers the second of the above two tasks, to understand if and how the impacts of climate can be embedded into NARM.

There are two main areas of CNAIM where deterioration assumptions are applied:-

- calculation of the age based Initial Health Score that is used in determining the Current Health Score; and

[1] https://nic.org.uk/app/uploads/NIC-Resilience-Standards-Report-Final-190924.pdf

- forecasting the Future Health Score.

Effects on Current Health Score

Climate change driven deterioration is already considered within CNAIM in the derivation of Current Health Score, primarily through the application of observed and/or measured condition factors. i.e. if degradation is present and can be observed or measured, CNAIM provides a framework for taking account of that in the derivation of the probability of failure for an asset.

An asset's probability of failure can also be varied to reflect greater expected ageing or deterioration, such as a revision of the Normal Expected Life of an asset or the mathematical constants used in the derivation of the probability of failure of an asset, or locational considerations such as distance from coast and the corrosion category. For example, changes to these asset lives could arise from considerations such as changes in specifications, manufacturing standards etc;, to the type of asset installed (e.g. changes in insulation types) or to the utilisation of assets (e.g. frequency of operation, loading). Climate change sits amongst these other considerations, as a potential factor in changing the Expected Life of an asset.

As the Current Health Score represents the health score (and hence Probability Of Failure) that would be expected from an asset in known condition today, this does not need to incorporate the anticipated effects of future climate change upon asset deterioration.

Future Health Deterioration in CNAIM

In forecasting the Future Health Score as per equation 12, the ageing rate is re-calculated to take account of the effects of the Health Score Modifier and Reliability Modifier on the Current Health Score:-

$$\text{Future Health Score} = \text{Current Health Score} \times e^{((\beta_2/r) \times t)}$$ eq.12

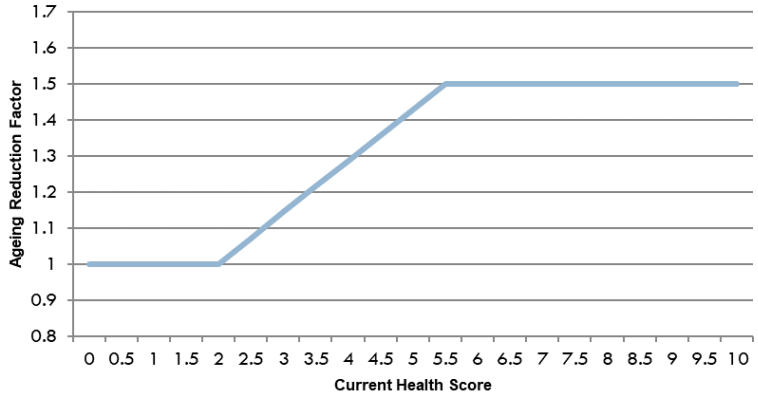
where β_2 is defined by equation 10:

$$\beta_2 = \frac{\ln\left(\frac{\text{Current Health Score}}{H_{new}}\right)}{\text{Age}}$$ eq10

and β_2 is capped such that

$$\beta_2 \leq 2 \times \beta_1$$ eq.11

and the ageing reduction factor r is determined from the Current Health Score:-



Whilst we are not aware of a study that would provide definitive evidence of the future impact of climate change on asset deterioration, it is conceivable that this evidence could become available in the near term. This proposal considers a number of approaches for incorporating climate impact into the future health calculations within CNAIM as detailed in the following sections:

4.4.3 Details of the proposed changes

There are three key elements to the proposed changes:

Modification of equation 12 (future health score)

Through a modification to equation 12, it is proposed to apply a multiplier to the ageing rate that is a function of time, to reflect changing deterioration rates due to incremental climate change effects over time. i.e. the ageing rate changes for each future year considered. The proposed equation is shown below:

$$Health\ Score_t = Health\ Score_{t-1} * e^{\left(\left(q_t * \frac{\beta_2}{r}\right) * 1\right)}$$

where

$q_t = q_{(t-1)} * c_{(y+t)}$, $q_0 = 1$, Health Score$_0$ = Current Health Score and y is the current year

For example consider the year-on-year deterioration rate changes described in the table below, where c_y is the change in deterioration rate in year y (e.g. in 2030/31 the ageing rate is 1.02 times the ageing rate in 2029/30):-

Regulatory Year	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34
y	2029	2030	2031	2032	2033	2034
c_y	1.01	1.01	1.02	1.01	1	1

t		Regulatory Year	y	y+t	C_{y+t}	q_t
0	Current year	2029/30	2030	2030	1.01	1
1	Future Year 1	2030/31		2031	1.02	1.02
2	Future Year 2	2031/32		2032	1.01	1.0302
3	Future Year 3	2032/33		2033	1	1.0302

New table to define "Ageing Rate Adjustment Sets" in a new appendix B11

Since qt is dependent on $c(y+t)$ as per the proposed equation 12, it is further proposed that $c(y)$ be defined by a new table to be added as a new Appendix, B11, as follows:

NEW TABLE: AGEING RATE ADJUSTMENT SETS

Regulatory Year	y	$c(y)$				
		Set 1	Set 2	Set 3	Set 4	Set 5
2028/29	2029	1	0.99	1.01	1.01	1
2029/30	2030	1	0.99	1.01	1.01	1
2030/31	2031	1	0.99	1.01	1.01	1
2031/32	2032	1	0.99	1.01	1.01	1
2032/33	2033	1	0.99	1.01	1.01	1
2033/34	2034	1	0.99	1.01	1	1.01
2034/35	2035	1	0.99	1.01	1	1.01
2035/36	2036	1	0.99	1.01	1	1.01
2036/37	2037	1	0.99	1.01	1	1.01
2037/38	2038	1	0.99	1.01	1	1.01
2038/39	2039	1	0.99	1.01	1	1.01
2039/40	2040	1	0.99	1.01	1	1.01
2040/41	2041	1	0.99	1.01	1	1.01
2041/42	2042	1	0.99	1.01	1	1.01
2042/43	2043	1	0.99	1.01	1	1.01
All future years*		1	1	1	1	1

** The adjustment values will default to 1 after the 2042/43 regulatory year.*

Modify TABLE 20 (to assign Asset Register Category Sub-divisions to a pre set adjustment profile)

It is proposed that all Asset Register Category Sub-divisions will be assigned an "Ageing Rate Adjustment Set" via the addition of column to the existing Table 20: Normal Expected Life. It is proposed to assign all Asset Register Category Sub-divisions a neutral set of factors ("Set 1") within CNAIM v3 pending evidence of the need for, and calibration of, more sets. Use of "Set 1" will not adjust the ageing rate assumptions from those used in CNAIM v2.

Additional sets are shown in the previous section for illustrative purposes but it is further proposed that only Set 1 is published at this time. The need for more sets will be reviewed as new evidence becomes available. An example of the proposed change is shown below:

TABLE 120: NORMAL EXPECTED LIFE

Asset Register Category	Sub-division	Normal Expected Life	Ageing Rate Adjustment Set
LV Poles	Concrete	60	Set 1
	Steel	50	Set 1
	Wood (water soluble copper salt treated; excluding CCA)	25	Set 1
	Wood (other)	55	Set 1

Asset Register Category	Sub-division	Normal Expected Life	Ageing Rate Adjustment Set
	Other (e.g. fibreglass)	80	Set 1

4.5 Forecast Ageing Rate

4.5.1 Summary of proposal

Asset categories	All asset categories
Brief description of change	Add a collar to the calculation of Forecast Ageing Rate β2 with a minimum value of β1 x 0.5 for assets > 10 and β1 for assets <= 10
Tables affected	None
Overall impact	**High** - Affects a high proportion of assets across multiple asset groups

4.5.2 Driver for change

For CNAIM v2.1, the Forecast Ageing Rate β2 is derived from the Current Health Score and the current age of the asset using EQ. 10 when the Current Health Score > 0.5. Where the Current Health Score = 0.5, β2 = β1.

EQ. 10

$$\beta_2 = \frac{\ln\left(\frac{\text{Current Health Score}}{H_{new}}\right)}{\text{Age}}$$

Where:

- • Age is the current age of the asset (i.e. the age used in the calculation of the Initial Health Score)
- • β2 is capped such that:-

EQ. 11

$$\beta_2 \leq 2 \times \beta_1$$

This Forecast Ageing Rate β2 formula does include a minimum value and as such, there are circumstances where the value can be too low to adequately reflect the Health Score of an asset.

For assets that are young and in excellent condition, the calculated Health Score Factor can achieve a value of <1 which can negate the impact of any aging thus far. Due to the calculation of Forecast Ageing Rate β2, there is negligible increase of the Future Health Score from the new position (Health Score 0.5). This is especially so when considering 10 or more years hence. To ensure that a reasonable value of the Forecast Ageing Rate β2 is achieved a collar

of the value of Initial Ageing Rate β1 can be used for assets up to and including 10 years old. From about 10 years old, assets tend to age in predictably with Health Score Factors indicating a better-than-expected result where appropriate.

A further phenomenon within the asset populations occurs for old assets which have surpassed their expected life. In the current year, there is a cap on the Current Health Score. In the future, as these assets age the Forecast Ageing Rate β2 becomes smaller leading to increasingly lower Health Scores and longer overall predicted lifespans. To ensure that a reasonable value of the Forecast Ageing Rate β2 is achieved a collar of the value of 0.5 * Initial Ageing Rate β1 can be applied.

The combined approach for the Forecast Ageing Rate β2 is to set a collar with a minimum value of β1 x 0.5 for assets > 10 and β1 for assets <= 10.

4.5.3 Details of the proposed changes

The combined approach for the Forecast Ageing Rate β2 is to set a collar with a minimum value of β1 x 0.5 for assets > 10 years old and β1 for assets <= 10 years old.

4.6 Pole Fittings

4.6.1 Summary of proposal

Asset categories	LV Poles, 6.6/11kV Poles, 20kV Poles, 33kV Pole, 66kV Pole, 132kV Pole
Brief description of change	Expansion to existing tables within CNAIM, GPG and RIGs to add a new condition factor for poles to reflect the condition of the fittings at the top of the pole
Tables affected	Existing tables to be modified: 12, 13, 217. New tables for observed and measured condition inputs.
Overall impact	**Low**

4.6.2 Driver for change

Overhead lines are made up of a number of constituent parts, usually defined as the “support”, the “conductor” and the “fittings”. In ED2 for tower lines, there are discrete asset categories for each of these constituent parts and methodologies within CNAIM for assessing risk and reporting intervention.

In ED2 wood pole overhead lines differ for two main reasons:

- Fittings is not a discrete asset category in its own right
- Interventions associated with the replacement of fittings and/or conductor on pole overhead lines is reportable as a non NARM refurbishment activity.

For wood pole overhead lines, a separate proposal (see section 3) covers the expansion of CNAIM to include the conductor associated with pole lines.

It is additionally proposed that fittings be added as a Condition Input to the respective pole categories, allowing the interventions to be tracked within the NARM framework therefore adding greater transparency of investment decisions and removing perverse incentives created by having a mixture of non NARM and NARM activities associated with schemes that are often planned to address some combination of the support, conductor and fitting categories.

4.6.3 Details of the proposed changes

It is proposed to add an additional Observed Condition Input as follows

LV/HV/EHV/132KV POLE: POLE FITTINGS CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	1.0	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1.1	10	0.5
Some Deterioration	Partial Loss of required Structural Integrity	1.3	10	4.0
Substantial Deterioration	Loss of required structural integrity	1.4	10	8.0
Default	No data available	1	10	0.5

Guidance would need to be added to the Good Practice Guide and worked examples created to include fittings in various condition states.

CNAIM Appendix C in conjunction with the Annex A of the RIGs outlines the principles which should be used for the recording of a refurbishment activity in the relevant pole categories.

The following changes would first be required to the RIGs:

Activity	Repair & Maintenance	Refurbishment (Non NARM)	Refurbishment (NARM)
Replacement of signs and notices	Yes		
Repair or replacement of pole earthing	Yes		
Remedial application of wood pole preservative (e.g. insertion of boron rods)	Yes		
Replacement of a complete set of insulators associated with an existing pole		~~Yes~~	*Yes*
Complete replacement of pole top steelwork (including associated insulators and fittings)		~~Yes~~	*Yes*
The complete replacement of stay wire and insulator (including stay block or anchor as necessary) at an existing pole		Yes	
Replacement of steelwork associated with pole mounted switchgear and equipment		Yes	
Pole Strengthening (e.g. clamping a steelwork supporting bracket to an existing pole)			Yes
Small footprint steel masts: Replacement of individual bolts	Yes		
Small footprint steel masts: Repairs to existing steelwork members (e.g. welding)	Yes		
Small footprint steel masts: Patch painting following steelwork repair	Yes		
Small footprint steel masts: Replacement of step bolts		Yes	
Small footprint steel masts: Replacement of individual steelwork members			Yes
Small footprint steel masts: Painting of mast		Yes	
Small footprint steel masts: Repairs to foundations	Yes		

The following new activity would be added to CNAIM Appendix C:

TABLE 217: INPUT DATA AFFECTED BY REFURBISHMENT INTERVENTIONS

Refurbishment Intervention Activity	Health Index Asset Category*	Asset Register Category	Input Data Affected by Intervention
Replacement of a complete set of insulators associated with an existing pole	LV OHL Support, HV OHL Support – Poles, EHV OHL Support – Poles, 132kV OHL Support - Poles	LV Poles, 6.6/11kV Poles, 20kV Poles, 33kV Pole, 66kV Pole, 132kV Pole	Reassess Health Score Modifier by reassessing Pole Fittings Observed Condition Input
Complete replacement of pole top steelwork (including associated insulators and fittings)			

** Note that there is a separate proposal as detailed in section 1.7 to expand CNAIM to include 132kV Pole*

i.e. on completion of an activity a reassessment of the Fittings Condition Input should be made.

TABLE 12 (OBSERVED CONDITION INPUTS) would need to reflect the new Condition Input .

All other parameters associated with the pole categories in CNAIM would remain unchanged.

4.7 Pole strengthening

4.7.1 Summary of proposal

Asset categories	LV Poles, 6.6/11kV Poles, 20kV Poles, 33kV Pole, 66kV Pole, 132kV Pole
Brief description of change	Expansion to existing tables within CNAIM, GPG and RIGs to clarify the criteria for poles that have been strengthened
Tables affected	Existing tables to be modified: 108, 112, 116, 192, 193, 194, 217
Overall impact	**Low**

4.7.2 Driver for change

Pole strengthening systems such as those shown below are available to network operators to prolong the life of a pole.

The systems are not necessarily new having been around for decades with widespread applications in other countries, but the sector within the UK has not adopted the practice on any significant scale to this point.

However, a number of UK DNOs are planning on increasing use of the solution from ED2. Therefore, the materiality of this intervention type within NARMs could become significant.

CNAIM Appendix C in conjunction with the Annex A of the RIGs outlines the principles which should be used for the recording of a pole strengthening (refurbishment) activity in the relevant wood pole categories.

TABLE 217: INPUT DATA AFFECTED BY REFURBISHMENT INTERVENTIONS

Refurbishment Intervention Activity	Health Index Asset Category*	Asset Register Category	Input Data Affected by Intervention
Pole Strengthening (e.g. clamping a steelwork supporting bracket to an existing pole)	LV Poles HV Pole EHV Pole 132kV Pole	LV Poles HV Pole EHV Pole 132kV Pole	Reassess Health Score Modifier by reassessing Pole Decay/Deterioration Measured Condition Inputs

** Note that there is a separate proposal as detailed in section 3.5 to expand CNAIM to include 132kV Pole*

i.e. on completion of an activity a reassessment of pole decay/deterioration should be made in accordance with the following tables (one table duplicated across the voltages):

TABLES 192/193/194: MEASURED CONDITION INPUT – LV/HV/EHV/ POLE: POLE DECAY / DETERIORATION

Condition Criteria: Degree of Decay/Deterioration	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
None	Zero measured loss of strength	0.8	5.4	0.5
No Significant Decay/Deterioration	Minor loss of strength	1	6.4	0.5
High	Significant loss of residual strength, still within acceptable level	1.4	10	5.5
Very High	Residual strength below acceptable level	1.8	10	8
Default	No data available	1	10	0.5

There is some limited additional guidance provided in section 2.4.1 of the Good Practice Guide (GPG):

5.4.1 Degree of Decay/Deterioration

Degree of Decay/Deterioration is defined by tables 192/193/194 in CNAIM v2.1, as shown below:

Table 358 – CNAIM v2.1 Degree of Decay/Deterioration Overhead Lines

Condition Criteria	Description
None	Zero measured loss of strength
No Significant Decay/Deterioration	Minor loss of strength
High	Significant loss of residual strength, still within acceptable level
Very High	Residual strength below acceptable level

In accordance with the requirements of each licensee's own inspection policies and guidance documents (e.g. frequency and type of inspection), assessments of the degree of decay/deterioration should be made in relation to the remaining residual strength of a pole.

The assessment of residual strength may be calibrated to the individual pole based on physical factors including pole location, grade, and function.

Application of an intervention and an individual company's intervention strategy should not be confused. It is at the company's own discretion as to which poles are targeted for the intervention, for example:

- Intervention of poles with "Degree of Decay/Deterioration" of "High" would typically present as movement from a HI4 band.
- Intervention of poles with "Degree of Decay/Deterioration" of "Very High" would typically present as movement from a HI5 band.
- The Health Index of the strengthened pole depends on each company's own judgement of the new residual strength of the pole (amongst other inputs such as age), whether that be informed through measurement or otherwise. For example, the post refurbishment Health Index would typically be HI2 if it assumed no loss of residual strength for strengthened poles, or HI3 if it is considered there is some loss of residual strength.

i.e. to summarise, pole strengthening could typically result in movement as significant as HI5 to HI2, or as little as HI4 to HI3.

As defined within CNAIM section 6.14 there is scope to apply a Reliability Modifier, at the discretion of the individual DNO, should they believe a strengthened pole asset to have a materially different PoF than would otherwise be expected. This could be in addition to, or at the expense of, the application of revised condition criteria.

Aside from how the intervention is reported, any future observational assessment is complicated for strengthened poles due to the absence of specific guidance within the existing CNAIM Condition Input tables and associated guidance (tables 108-119 within CNAIM v2.1).

4.7.3 Details of the proposed changes

It is proposed to expand the condition criteria descriptors within existing Condition Input tables within CNAIM as follows:

TABLE 192/193/194: MEASURED CONDITION INPUT – LV/HV/EHV POLE: POLE DECAY / DETERIORATION

Condition Criteria: Degree of Decay/Deterioration	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
None	Zero measured loss of strength	0.8	5.4	0.5
No Significant Decay/Deterioration	Minor loss of strength For “effectively” strengthened poles the installed pole truss allows the bending loads to effectively bypass the decayed or damaged ground line area of the pole, transferring the loads to sound wood foundation below ground line. It can therefore be assumed that the pole has no significant deterioration.	1	6.4	0.5
High	Significant loss of residual strength, still within acceptable level	1.4	10	5.5
Very High	Residual strength below acceptable level	1.8	10	8
Default	No data available	1	10	0.5

** For strengthened poles, consideration should be given to the residual strength of the remainder of the wood pole*

TABLE 108/112/116: OBSERVED CONDITION INPUT – LV/HV/EHV POLE: VISUAL POLE CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable	No significant defects observed. Pole may be new with no/few marks. May include poles with slight damage including (but not limited to) splits and general wear where no material impact on residual strength of pole. For “effectively” strengthened poles the installed pole truss allows the bending loads to effectively bypass the decayed or damaged ground line area of the pole, transferring the loads to sound wood foundation below ground line. It can therefore be assumed that the poles in this condition are Acceptable.	1	10	0.5
Some Deterioration	Minor wear on pole or physical damage that will lead to loss of strength, but the	1.3	10	4.0

	short-term integrity of the pole is not compromised.			
Substantial Deterioration	Severe damage to pole. Parts may be chipped off, rotten or disfigured. e.g. visible splits, cracks, major physical damage affecting strength.	1.8	10	8.0
Default	No data available	1	10	0.5

** For strengthened poles, consideration should be given to the location on the pole of any identified defect. For example, physical damage at the ground line that is mitigated by the system itself may be disregarded, and the visual assessment applied to the remainder of the pole.*

4.8 Financial Consequence Access Factor

4.8.1 Summary of proposal

Asset categories	LV OHL Support; HV OHL Support - Poles; EHV OHL Support - Poles; EHV OHL Support - Towers; EHV OHL Fittings (Tower Lines); EHV OHL Conductors (Tower Lines); 132kV OHL Support - Tower; 132kV OHL Fittings (Tower Lines); 132kV OHL Conductors (Tower Lines)
Brief description of change	Addition of new column to Financial Consequence Location Factor for OHL
Tables affected	Existing tables to be modified: 220
Overall impact	**Low:** Impacts a small number of assets within the existing overhead line asset classes

4.8.2 Driver for change

The current factor considers additional costs relating to the costs of dropping a conductor over a major road, railway or water course but does not consider difficulties in accessing the support structure itself due to aspects such as distance from roads, gradients, land sensitivity or being surrounded by other building which may preclude the use of heavy machinery.

4.8.3 Details of the proposed changes

An additional column 'Type B Criteria – Constrained Access' to is required in TABLE 220: CATEGORISATION OF ASSETS and existing Type B Access Factor should be re-labelled as Type C to maintain hierarchy.

	Access Factor		
Asset Register Category	Type A Criteria - Normal Access (& Default Value)	Type B Criteria – Constrained Access	Type C Criteria - Major Crossing (e.g. associated span crosses railway line, major road, large waterway etc.)
LV OHL Support	1	1.25	3
HV OHL Support - Poles	1	1.25	3
EHV OHL Support - Poles	1	1.25	3
EHV OHL Support - Towers	1	1.1	1.5
EHV OHL Fittings (Tower Lines)	1	1.1	2
EHV OHL Conductors (Tower Lines)	1	1.1	2
132kV OHL Support - Tower	1	1.1	1.5
132kV OHL Fittings (Tower Lines)	1	1.1	2
132kV OHL Conductors (Tower Lines)	1	1.1	2

The factor for pole lines has been set as 1.25 based on expert judgement as to the likely impact on the cost of replacement of the asset. As the cost of the asset is greater for tower

line assets, the impact of access costs is less, so this factor has been set at 1.1. This follows the approach taken in CNAIM v2 for Major Crossing cost factors.

4.9 Financial and Environmental Consequence Type Factor – Inter-system Transformer

4.9.1 Summary of proposal

This proposal is to add an additional type factor for HV Transformers to account for the higher cost of transformers used to transform between HV voltages such as 11kV-6.6kV or 20kV-11kV, and reactors and regulators.

Asset categories	HV Transformer (GM), EHV Transformer (GM), 132kV Transformer (GM)
Brief description of change	Addition of new type factor to account for the higher cost of inter-system transformers, reactors and regulators
Tables affected	Existing tables to be modified: 219, 230
Overall impact	**Low:** Impacts a small number of assets within the existing asset classes

4.9.2 Driver for change

Within the Regulatory Reporting Pack (RRP) asset categories, transformers which connect between two HV voltages (i.e. 6.6kV, 11kV or 20kV), regulators and reactors are categorised as HV transformers. However, the cost of replacement of these units is significantly higher than for HV/LV transformers and lead times much longer as each transformer is often bespoke to the site due to the small number on the network. The current criticality for these assets therefore doesn't adequately reflect the financial consequence of the loss of these assets.

In addition, these units tend to be significantly larger than other HV/LV transformers (often around 4MW) so the environmental factor understates the likely impact of any loss of oil and the waste generated as a result of an asset failure.

4.9.3 Details of the proposed changes

The following section details the changes required to each table in relation to CNAIM v2.1 documentation:

An additional row is required in TABLE 219: TYPE FINANCIAL FACTORS for inter-system transformers.

TABLE 219: TYPE FINANCIAL FACTORS

Asset Register Category	Type Financial Factor Criteria	Type Financial Factor
6.6/11kV Transformer (GM)	6.6/11kV - LV: ≥750kVA	1.15
	6.6/11kV - LV: ≥500kVA and <750kVA	1
	6.6/11kV - LV: <500kVA	0.85
	6.6/11 kV - 6.6/11 kV Inter-system transformers (HV/HV)	2
	Reactors & regulators	2
20KV Transformer (GM)	20kV - LV: ≥750kVA	1.15
	20kV - LV: ≥500kVA and <750kVA	1
	20kV - LV: <500kVA	0.85
	20 kV - 6.6/11 kV Inter-system transformers (HV/HV)	2
	Reactors & regulators	2

33kV Transformer (GM)	33/20kV, >20MVA CMR equivalent	1.25
	33/20kV, >10MVA and ≤20MVA CMR equivalent	1.1
	33/20kV, ≤10MVA CMR equivalent	1
	33/11 or 6.6kV, >20MVA CMR equivalent	1.1
	33/11 or 6.6kV, >10MVA and ≤20MVA CMR equivalent	1
	33/11 or 6.6kV, ≤10MVA CMR equivalent	0.9
	Reactors & regulators	2
66kV Transformer (GM)	66/20kV, >20MVA CMR equivalent	1.25
	66/20kV, >10MVA and ≤20MVA CMR equivalent	1.1
	66/20kV, ≤10MVA CMR equivalent	1
	66/33kV	1.1
	66/11/11kV	1.1
	66/11 or 6.6kV, >20MVA CMR equivalent	1.1
	66/11 or 6.6kV, >10MVA and ≤20MVA CMR equivalent	1
	66/11 or 6.6kV, ≤10MVA CMR equivalent	0.9
	Reactors & regulators	2
132kV Transformer (GM)	132/66kV, ≤60MVA	1.05
	132/66kV, >60MVA	1.15
	132/33kV, ≤60MVA	0.9
	132/33kV, >60MVA	1
	132/11/11kV	1.1
	132/11kV	0.85
	132/20kV	0.95
	132/20/20kV	1.1
	Reactors & regulators	2

This increases the financial consequence of failure so is more representative of the likely cost of the unit. An additional row is required in TABLE 230: SIZE ENVIRONMENTAL FACTOR for inter-system transformers.

TABLE 230: SIZE ENVIRONMENTAL FACTOR

Asset Register Category	Size Environmental Factor Criteria	Size Environmental Factor
6.6/11kV Transformer (GM)	≥2MVA	1.5
	≥750kVA and <2MVA	1
	≥500kVA and <750kVA	1
	<500kVA	0.6
20kV Transformer (GM)	≥2MVA	1.5
	≥750kVA and <2MVA	1
	≥500kVA and <750kVA	1
	<500kVA	0.6

This extends the range to cover the larger size of inter-system transformers which are typically 3-4MVA.

4.10 Steel Tower Painting

4.10.1 Summary of proposal

Introduction of an additional Cap of 4.4 on the Steel Tower models at 132kV and EHV to allow the application of a paint system to operate as intended not just for collected reporting of an 'acceptable' condition but also where the DNO reports by exception and utilises the 'Default' option in the observed condition inputs.

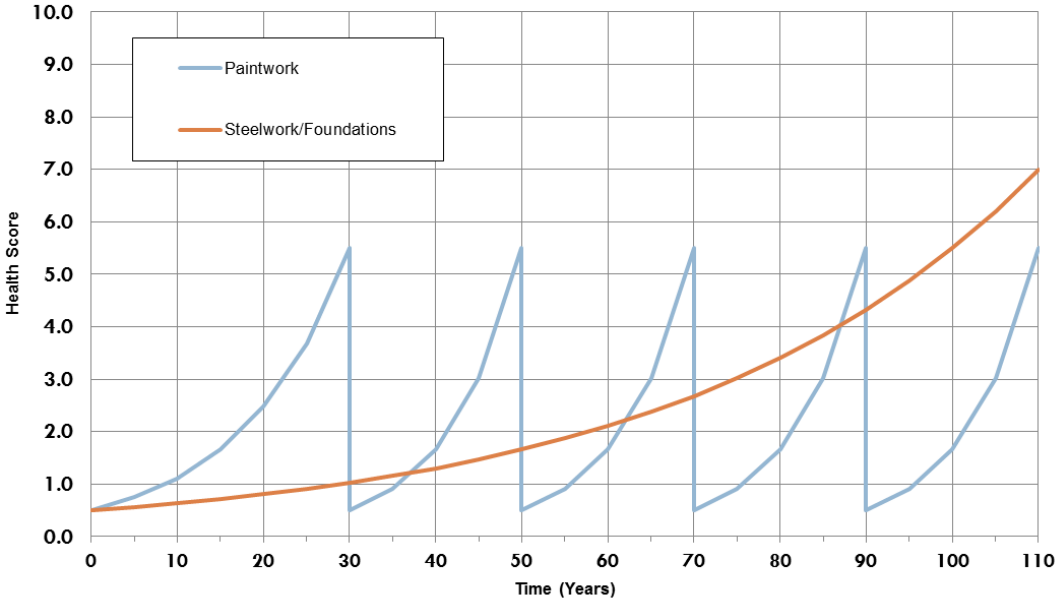
Asset categories	Steel Towers – EHV & 132kV
Brief description of change	Introduction of a Cap of 4.4 on the use of 'Default' in Observed Conditions
Tables affected	Existing tables to be modified: 120,12,122,123,125, 126,127, 128,129, & 131
Overall impact	**Low**

4.10.2 Driver for change

An inconsistency has been identified during the use of the revised model in RIIO-ED2 where a number of the DNOs report observed conditions by exception and utilise the 'Default' input where no specific observed condition has been recorded against the Foundation, Tower Legs, Cross Arms, Bracings or Tower Peak. When this is then used in the calculation of the Health Score where a tower has also been painted then the whole mechanism fails to achieve the desired effect which was introduced for the 'Acceptable' input during the revision for CNAIM v2.1. This proposal addresses this inconsistency by introducing the same controlling Cap in the calculation as the 'Acceptable' into achieves for other DNOs and rectifies the anomaly.

4.10.3 Details of the proposed changes

The derivation of PoF for a steel tower is defined under section 6.3 of CNAIM v1.1 whereby the steelwork, foundations and paintwork are considered separately due to the different characteristics of those three sub components, as illustrated by Figure 8:



A Health Score is determined for each component with separate Normal Expected Lives and Observed Condition Modifiers noting that for towers, there are no Measured Condition Modifiers.

The Current Health Score of the tower is then taken as the maximum of the Current Health Scores of the steelwork, the paintwork and the foundations. Note that as paintwork condition on its own does not instigate replacement of a steel tower, a cap of 6.4 is applied to the Current Health Score of the paintwork component. A similar approach is used in the derivation of the Future Health Score.

Typically, until a tower reaches an age of 50-80 years, the dominant component of the tower is the paintwork and regular intervention through preparation and treatment is evident through movement in the Health Score from a maximum of 6.4 (due to the cap) down to a minimum of 0.5 (depending on the Health Score of the Steelwork and Foundation).

In the period thereafter, the steelwork and/or foundation Health Scores become the dominant factor in the derivation of the Health Score. Therefore, in the scenario where a tower has been painted, and its Health Score reassessed in accordance with the requirements of CNAIM v2.1 Appendix C, there may be no observed movement in Health Score even where the steelwork and/or foundation components have no observed degradation due to the Current Health Scores increasing up to a value of 5.5 based on age alone. Just one years' worth of ageing will then push the overall Health Index of the tower into the HI3 band.

Given the interaction of the three tower components to one another – the purpose of the tower paint system is to protect the tower steelwork and prevent the onset of corrosion - it is considered that in the event that the tower steelwork is undamaged and structurally sound that a cap of 4.4 therefore be applied to the component Health Scores which, allowing for future ageing of the component Health Score over the planning period, would limit the Health Index

to HI2 unless either the steelwork and/or foundations are “Mechanically Unsafe” or due to the Health Score of the paintwork system itself.

This was agreed during the review and development of the CNAIM v2.1 revised methodology however it has become apparent that where a DNO reports by exception then it is fundamentally possible that the ‘Default’ condition input is used in the observed condition for; the Tower Legs; Bracings; Crossarms; and Tower Peak; where there is nothing abnormal to report and in a similar way in the Foundations observed condition input can be used. This was not considered during the revision in CNAIM v2.1 and has identified a flaw in the revision whereby assets which are regularly painted for to prolong their life cannot be managed in the calculation of the Health Score as intended.

To rectify this situation the option to include an additional Condition Input Cap for the ‘Default’ in these observed condition input to 4.4, the same as an ‘Acceptable’ input overcomes this discrepancy and resolves the issue where reporting by exception and utilising the ‘Default’ input in the option used by the DNO.

This then requires the updates as shown to the following tables for EHV and 132kV Steel Towers:

B.5.23 EHV Towers (Tower Steelwork component)

TABLE 120: OBSERVED CONDITION INPUT - EHV TOWER: TOWER LEGS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable		1	4.4	0.5
Mechanically Unsafe	Signs of wasting of steel cross-section, laminated rust, holes or loss of steel at edges, severe damage - requires urgent replacement	1.8	10	8
Default	No data available	1	~~10~~ 4.4	0.5

TABLE 121: OBSERVED CONDITION INPUT - EHV TOWER: BRACINGS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable		1	4.4	0.5
Mechanically Unsafe	Signs of wasting of steel cross-section, laminated rust, holes or loss of steel at edges, severe damage - requires urgent replacement	1.2	10	5.5
Default	No data available	1	~~10~~ 4.4	0.5

TABLE 2: OBSERVED CONDITION INPUT - EHV TOWER: CROSSARMS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable		1	4.4	0.5
Mechanically Unsafe	Signs of wasting of steel cross-section, laminated rust, holes or loss of steel at edges, severe damage - requires urgent replacement	1.8	10	8
Default	No data available	1	~~10~~ 4.4	0.5

TABLE 3: OBSERVED CONDITION INPUT - EHV TOWER: PEAK

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable		1	4.4	0.5
Mechanically Unsafe	Signs of wasting of steel cross-section, laminated rust, holes or loss of steel at edges, severe damage - requires urgent replacement	1.2	10	5.5
Default	No data available	1	~~10~~ 4.4	0.5

B.5.25 EHV Towers (Tower Foundation component)

TABLE 4: OBSERVED CONDITION INPUT - EHV TOWER: FOUNDATION CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.95	4.4	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	4.4	0.5
Some Deterioration	e.g. minor corrosion	1.4	10	4.0
Substantial Deterioration	Insufficient integrity to support tower loading	1.8	10	8.0
Default	No data available	1	~~10~~ 4.4	0.5

B.5.26 132kV Towers (Tower Steelwork component)

TABLE 5: OBSERVED CONDITION INPUT - 132KV TOWER: TOWER LEGS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable		1	4.4	0.5
Mechanically Unsafe	Signs of wasting of steel cross-section, laminated rust, holes or loss of steel at edges, severe damage - requires urgent replacement	1.8	10	8
Default	No data available	1	~~10~~ 4.4	0.5

TABLE 6: OBSERVED CONDITION INPUT - 132KV TOWER: BRACINGS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable		1	4.4	0.5
Mechanically Unsafe	Signs of wasting of steel cross-section, laminated rust, holes or loss of steel at edges, severe damage - requires urgent replacement	1.2	10	5.5
Default	No data available	1	~~10~~ 4.4	0.5

TABLE 7: OBSERVED CONDITION INPUT - 132KV TOWER: CROSSARMS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable		1	4.4	0.5
Mechanically Unsafe	Signs of wasting of steel cross-section, laminated rust, holes or loss of steel at edges, severe damage - requires urgent replacement	1.8	10	8
Default	No data available	1	~~10~~ 4.4	0.5

TABLE 8: OBSERVED CONDITION INPUT - 132KV TOWER: PEAK

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable		1	4.4	0.5
Mechanically Unsafe	Signs of wasting of steel cross-section, laminated rust, holes or loss of steel at edges, severe damage - requires urgent replacement	1.2	10	5.5
Default	No data available	1	~~10~~ 4.4	0.5

B.5.28 132kV Towers (Tower Foundation component)

TABLE 9: OBSERVED CONDITION INPUT - 132KV TOWER: FOUNDATION CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.95	4.4	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	4.4	0.5
Some Deterioration	e.g. minor corrosion	1.4	10	4.0
Substantial Deterioration	Insufficient integrity to support tower loading	1.8	10	8.0
Default	No data available	1	~~10~~ 4.4	0.5

4.11 Sub Cable

4.11.1 Summary of proposal

This proposal is designed to better represent the detailed information gathered from inspections considering the different aspects of Sub cables where the Shore Ends are inspected and potentially have different options for intervention. To facilitate this, all existing Sub cables can be re-classified by the different component parts as an individual record:

- Non-Marine: Lake/loch, estuary, river crossing, canal crossing; and,
- Submarine:
    - Shore End sections and
    - Marine Sections

Asset categories	Sub Cables – HV Sub Cable, EHV Sub Cable, 132kV Sub Cable
Brief description of change	Text changes, definitions and additional condition inputs
Tables affected	12, 13, 14, 19, 20, 21, 27, 28, 29, 107, 219, New Tables
Overall impact	**Low**

4.11.2 Driver for change

DNOs have identified an opportunity to provide more granularity between the Shore Ends and the Marine sections of the Sub cable asset category.

This proposal seeks to add new condition points as well as enhancements to the Normal Age Expectancy and Financial CoF.

The CNAIM v3 model will still be able to be used by DNO's in the same way as the CNAIMv2.1 model and will be able to elect as part of their Information Gathering Plan whether they will collect data for the new fields.

4.11.3 Details of the proposed changes

Overview of Sub Cable Model

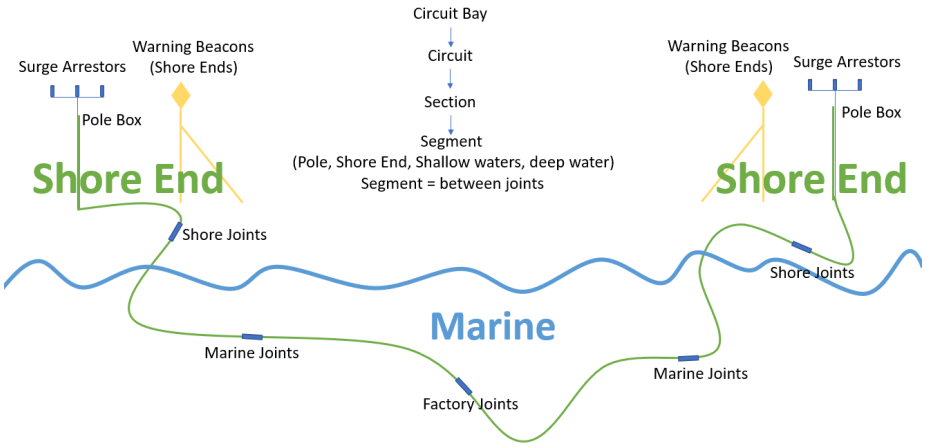


Diagram example of a Submarine Cable where the **circuit** refers to the entire functional asset, the **circuit bay** is where the submarine cable terminates at the substation and interfaces with switchgear, a **section** is a distinct physical segment of a cable circuit and a **segment** is a smaller, more granular slice of that section

Items in red are the new data points proposed.

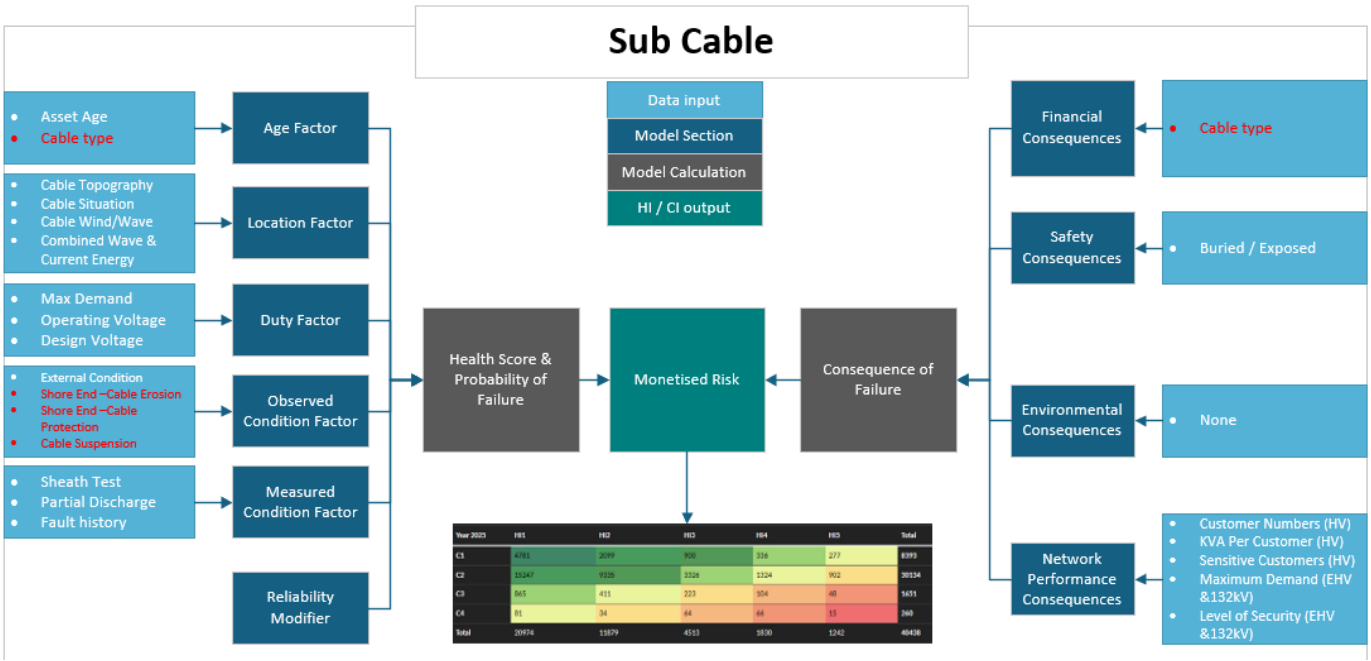


Table 10: Functional Failure Definitions

No proposed changes to the Functional failures of Sub cables, only change to Asset category to fall in line with RIGs changes

Asset Register Category	Function	Failure modes	Catastrophic Failure	Degraded Failures	Incipient Failures	Functional failures excluded
Submarine Cables	Carry load and fault current safely and reliably, without overheating or causing damage to the environment.	Cable Fault. Joint Failure.	Cable Fault. Joint Fault.	N/A	N/A	Sheath damage and or repair. Third party damages.

Appendix B Calibration

Probability of Failure – B1 Normal Expected Life

TABLE 20: NORMAL EXPECTED LIFE needs more detail to include Submarine and Non-Marine cable subdivisions and armour type. This proposal suggests that extra external protection, such as steel wire armour, could increase the expected lifespan of a cable section based on the level of protection during installation. Proposed table below:

Asset Register Category	Sub-division	Normal Expected Life
HV Sub Cable	Submarine Single Wire Armour	70
	Submarine Double Wire Armour	80
	Non-Marine cable	60
	Default	60
EHV Sub Cable	Submarine Single Wire Armour	70
	Submarine Double Wire Armour	80
	Non-Marine cable	60
	Default	60
132kV Sub Cable	Submarine Single Wire Armour	70
	Submarine Double Wire Armour	80
	Non-Marine cable	60
	Default	60

A Non-Marine cable is an ordinary, non-pressurised cable placed underwater, either on or under the sea bed, lake bed, river bed, or estuary bed.

Horizontal Directional Drilled (HDD) cables are considered Non-Marine when their entire marine crossing length is drilled. This classification arises because the cables are unaffected by sea conditions like waves, wind, and sea type factors that significantly influence failure probability. Consequently, Non-Marine HDD cables have a similar life expectancy to non-pressurised cables.

Probability of Failure – B2 POF Curve Parameters

TABLE 21: POF CURVE PARAMETERS is to remain as is

Functional Failure Category	K-Value	C-Value	Health Score Limit
Sub Cable	0.02%	1.087	4

Probability of Failure – B3 Location Factor

The Location Factor proposed to add additional situations to TABLE 28: SUB CABLE SITUATION FACTOR, the other factors remain unchanged. For reference it is made up of four factor inputs:-

TABLE 27: SUB CABLE TOPOGRAPHY FACTOR

Topography	Score (Sea)	Score (Land locked)
Low Detrimental Topography	1.25	0.5
Medium Detrimental Topography	1.5	0.6
High Detrimental Topography	2.25	0.9
Very High Detrimental Topography	3	1.2
Default	1.25	0.5

TABLE 28: SUB CABLE SITUATION FACTOR

New proposed types of situations added as in the table below.

Situation	Score
Laid on bed	1
Covered Surface Laid - Self Buried	0.95
Surface Laid - Stabilised	0.9
Partially Buried	0.85
Partially Buried -Stabilised	0.8
Buried	0.8
Default	1

Descriptions for the new situations added:

- Laid on bed – Cable has been surface laid from end to end and is visible in the majority of the route
- Covered – This has been amended to “Surface Laid – Self buried”. This is to allow distinguishing between Covered and Buried which could be interpreted as the same thing at present. Surface Laid - Self Buried - Cable has been directly laid on the surface of the sea bed or marine floor. No intentional burial has taken place but the cable has embedded its self in the marine floor sediment over time across the majority of the route and is not visible. Likely that the cable is in shallow burial just below the marine floor.
- Surface Laid – Stabilised - Cable has been directly laid on the surface of the sea bed or marine floor. No intentional burial has taken place. Cable has been pinned in place utilising one or more of the following techniques. Rock bag placement, rock dumping, cable pinning, concrete mattresses or split pipe protection.
- Partially Buried - The cable has been intentionally buried in significant portions of the route and left exposed in others. The cable may also be in partial burial along all of the route. i.e. the top of the cable is exposed on the sea bed but the remainder of the cable is embedded in the marine floor.
- Buried & Stabilised - The cable has been intentionally buried along portions of the route and surface laid in. Where surface laid the cable is stabilised utilising one or more of the following techniques. Rock bag placement, rock dumping, cable pinning, concrete mattresses or split pipe protection.
- Buried – The cable has been intentionally buried from end to end.

Clarifications on existing situations:

TABLE 29: SUB CABLE WIND/WAVE FACTOR

Rating	Description	Score
1	Sheltered sea loch, Wind <200 W/m2	1
2	Wave <15kW/m, Wind 200-800 W/m2	1.2
3	Wave >15kW/m, Wind > 800 W/m2	1.4
	Default	1

TABLE 30: COMBINED WAVE & CURRENT ENERGY FACTOR

Intensity	Scoring (Sea)	Scoring (Landlocked)
Low	1.1	1
Moderate	1.25	1.15
High	1.5	1.4
Default	1.1	1

Probability of Failure – B4 Duty Factor

Duty factor to remain as is:

DUTY FACTOR 1 (DF1)

Maximum % Utilisation under normal operating conditions	Duty Factor (HV)	Duty Factor (EHV & 132kV)
≤ 50%	0.8	1
> 50% and ≤ 70%	0.9	1.1
> 70% and ≤ 100%	1	1.3
> 100%	1.8	2
Default	1	1

DUTY FACTOR 2 (DF2)

Operating Voltage / Design Voltage	Duty Factor
≤ 40%	0.7
> 40% and ≤ 55%	0.8
> 55% and ≤ 70%	0.9
> 70%	1
Default	1

Probability of Failure – B5 Observed Condition

To amend the Observed Condition Modifier table to include new condition points for Shore End cable sections.

Current TABLE 11: OBSERVED CONDITION INPUT - SUBMARINE CABLE: EXTERNAL CONDITION ARMOUR

Condition Criteria	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Good	The asset component exhibits deterioration but is fit for continued service.	1	10	0.5
Poor	e.g. visible damage to armour	1.6	10	5.5
Critical	e.g. mechanical damage to cable armour, loss of armour	1.8	10	8
Default	No data available	1	10	0.5

Proposal here is to introduce additional Observation Condition inputs for ‘Cable Suspensions’ and for Shore End specifically ‘Cable Erosion’ and ‘Cable Protection’.

Many cables will be buried and not exposed or even some landings may be installed using Horizontal Directional Drilling (HDD) techniques and have no input to this condition point and set therefore to default.

Inclusion of 3 new Condition scores in TABLE 12 – OBSERVED CONDITION INPUTS:

Asset Register Category	Observed Condition Input
Sub Cable	External Condition Shore End* – Cable Erosion Shore End* – Cable Protection Cable Suspensions

*Shore End refers to cable section which is above water level as defined by the Mean Low Water Springs, which is the average height of low tides during spring tides. It's a long-term average of two successive low tides that occur during the period of greatest tidal range.

- External Condition – This is the existing condition score which can be used for the whole of the cable length whether Submarine or Non-Marine water or shore end.
- Cable Erosion – The Shore End cable section should be buried and therefore visibility of the cable / erosion around the cable can have an impact to the health of the Asset as it is exposed.
- Cable Protection – Additional protection of the cable – i.e. Mats. If these are deteriorated, this again impacts the health of the Shore End section itself.
- Cable Suspensions – A suspension is where the cable is suspended by higher points on the sea bed, these can cause more wear on the cable at the points where the Submarine cable is touching the sea bed. Additionally cable suspensions increase the risk to the cable of snagging with third parties such as fishing equipment or anchor snags.

TABLE 13: OBSERVED CONDITION MODIFIER – MMI CALCULATION PARAMETERS shows the parameters that are used when combining the Observed Condition Input Factors using the MMI technique.

Asset Register Category	Subcomponent	Parameters for Combination Using MMI Technique		
		Factor Divider 1	Factor Divider 2	Max. No. of Combined Factors
Sub Cable		1.5	1.5	4

Proposed TABLE 107: OBSERVED CONDITION INPUT - SUB CABLE: EXTERNAL CONDITION

Condition Criteria	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	Asset appears as new. No signs of deterioration or damage	1	10	0.5
Minor Deterioration	Small localised outer serving damaged or missing. Highlights abrasion points early. Cable crossings with no protection	1.2	10	0.5
Some Deterioration	Significant sections of outer serving missing Armour corrosion. Small sections of broken armour strands Boulder / objects pinning or damaging cable	1.6	10	5.5
Substantial Deterioration	Significant armour corrosion - effecting integrity of the cable. Significant sections of broken armour strands. Sections of armour missing / Exposed cores. Loops, Bends, Kinks exceeding cable bending radius Significant third party interactions - anchor drag, etc	1.8	10	8
Default	No data available	1	10	0.5

Two new Condition Factors for Shore End cable sections

TABLE NEW 1 – OBSERVED CONDITION INPUT – SUBCABLE SHORE END CABLE: CABLE EROSION

Condition Criteria	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Cable Not Visible	Shore end inspection identifies there is no erosion around the cable and so remains buried.	1	10	0.5
Cable Visible	Shore end inspection identifies there is erosion around the cable making cable visible and prone to greater deterioration	1.05	10	5.5
Default	No data available	1	10	0.5

TABLE NEW 2 – OBSERVED CONDITION INPUT – SUB CABLE SHORE END CABLE: CABLE PROTECTION

Condition Criteria	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	Cable not visible or cable protection is visible but has no damage.	1	10	0.5
Some Deterioration	Cable protection visible and is damaged	1.1	10	0.5
Default	No data available	1	10	0.5

TABLE NEW 3 – OBSERVED CONDITION INPUT – SUB CABLE: CABLE SUSPENSIONS

Condition Criteria	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
None / Minor	No suspensions recorded on Submarine cable or Suspension Present < 0.8m high or <10m long	1	10	0.5
Moderate	Suspension(s) Present 0.8m - 2m high or 10 - 25m long	1.05	10	0.5
Major	Suspension Present > 2m high or >25m Long	1.1	10	0.5
Default	No data available	1	10	0.5

Note - More significant criteria should be used where suspension falls between two descriptions. i.e. <0.8m but 15m long should go Moderate and not Minor.

Probability of Failure – B6 Measured Condition Factors

No changes proposed to the measured condition modifier. TABLE 14 shows the Measured Condition Inputs that are included in the determination of the Measured Condition Modifier for each Asset Category.

Asset Register Category	Subcomponent	Measured Condition Input
Sub Cable	N/A	1. Sheath Test 2. Partial Discharge 3. Fault history

The Fault History is to be in line with the Good practice guide of 3 years.

Condition Criteria: Fault Rate (faults per annum)	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No historic faults recorded	No recorded faults or failures in the period	1	5.4	0.5
<0.01 per km	The calculated fault rate for the asset in the period	1.3	10	0.5
≥0.01 and <0.1 per km		1.6	10	5.5
≥0.1 per km		1.8	10	8
Default	No data available	1	10	0.5

Appendix D – CALIBRATION

No proposed changes to reference costs as part of this proposal. New reference costs will be provided as part of the ED3 final calibration activity.

CONSEQUENCES OF FAILURE – D1 Financial

Proposal to include into TABLE 219: TYPE FINANCIAL FACTORS SUB CABLES WITH AN ARMOUR type criterion to reflect the increased costs for the types of armoured cable.

Asset Register Category	Type Financial Factor Criteria	Type Financial Factor
HV Sub Cable	Submarine Single Wire Armour	1
	Submarine Double Wire Armour	1.1
	Non-Marine cable	0.8
	Default	1
EHV Sub Cable	Submarine Single Wire Armour	1
	Submarine Double Wire Armour	1.1
	Non-Marine cable	0.8
	Default	1
132kV Sub Cable	Submarine Single Wire Armour	1
	Submarine Double Wire Armour	1.1
	Non-Marine cable	0.8
	Default	1

Consequences of Failure – D2 Safety

No Change proposed

Asset Register Category	PROBABILITY OF EVENT PER ASSET FAILURE			Reference Safety Cost of Failure*
	Lost Time Accident	Death or Serious Injury to public	Death or Serious Injury to staff	
HV Sub Cable	0.00000075	0.000000075	0.000000075	£2
EHV Sub Cable	0.00000075	0.000000075	0.000000075	£2
132kV Sub Cable	0.00000075	0.000000075	0.000000075	£2

Consequences of Failure – D3 Environmental

No Change proposed

Asset Register Category	Average volume of oil lost per failure (litres)			Average volume of SF6 lost per failure (kg)			Average probability that failure results in a fire			Average quantity of waste per failure (t)			Failures as % of all failures			Reference Environmental Consequence*
	I	D	C	I	D	C	I	D	C	I	D	C	I	D	C	
Sub-Cables	0	0	0	0	0	0	0	0	0	0	0	20	0%	0%	100%	£3,600

Consequences of Failure – D4 Network Performance

No Change proposed to the Network COF tables

Asset Register Category	Reference Number of Connected Customers	Proportion of connected customers restored through immediate (< 3min) switching	Proportion of customers restored after manual switching	Manual switching time (hours)	Typical repair time (hours)	Proportion of failures that result in interruption to supply	Reference Network Performance Cost (£)*
HV Sub Cable	800	40%	60%	2	18	100%	£190,344

Asset Register Category	Maximum Demand Used to Derive Reference Cost (MVA)	Load at Risk (MVA) as % of Maximum Demand			Time (hours)			Probability of a coincident fault per hr	Proportion of failures that result in an unplanned outage	Reference Cost for Assets in Secure Networks (£)*
		During T1 period	During T2 period	During T3 period	T1	T2	T3			
EHV Sub Cable	12	100%	100%	80%	0	3	30	0.05%	100%	£3,530
132kV Sub Cable	60	100%	100%	80%	0	3	30	0.05%	100%	£17,648

4.12 Switchgear (Ground Mounted): Oil Leaks / Gas Pressure

4.12.1 Summary of proposal

This proposal is to modify the current CNAIM methodology description concerning, gas insulated switchgear to clarify the inclusion of the historical record of gas leakage.

It should also be noted that this change affects.

Asset categories	HV Switchgear (GM) – Primary, HV Switchgear (GM) – Distribution, EHV Switchgear (GM), 132kV Switchgear (GM)
Brief description of change	Update description for Gas Leakage of Switchgear.
Tables affected	Tables 55,61,67,74;
Overall impact	**Low**

4.12.2 Driver for change

Previously, the initial international standards facilitated an allowable leakage rate of up to 1% per annum, as sealing technology was not sufficiently developed. However, the allowable leakage rate has been reduced to 0.1% per annum for modern circuit breakers, as sealing technology has improved. This has driven the below proposed clarification to ensure leakage is recorded under observed condition markers.

This change is only editorial to clarify the description on the observed condition input. Therefore, this is considered a minor change with no change to CNAIM values.

4.12.3 Details of the proposed changes

The following section details the changes required to each table in relation to CNAIM v2.1 documentation:

The description of TABLE 55: OBSERVED CONDITION INPUT – HV SWITCHGEAR (GM) – DISTRIBUTION: OIL LEAKS/GAS PRESSURE to be modified include highlighted text and remove stroked through text.

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	Oil: No Oil appears to be actively leaking from the component in question. This may include assets with minor stains or marks Gas: Gas pressure reading is within the expected limit and no or negligible levels of historical leakage	0.9	10	0.5
Superficial/minor deterioration	Oil: There is evidence of a small leak, but this is limited to staining of the asset or the ground around the asset AND oil still visible in the sight glass where fitted. Repairs / intervention to the asset (or a sub component) is not expected to be required between now and the next planned maintenance Gas: ~~Not used.~~ Requires occasional intervention; OR minimal historical leakage	1.0	10	0.5
Some Deterioration	Oil: There is evidence of a small active oil leak from the switchgear e.g. droplets or weeping beneath the fixed portion. Minor maintenance or refurbishment activities (as a minimum) are required to address the identified issue(s) Gas: Gas pressure outside of acceptable range; Requires regular intervention; OR some historical leakage	1.1	10	3.0
Substantial Deterioration	Oil: There is evidence of a significant oil leak from the switchgear e.g. pool of oil under/around the equipment, the switchgear may be draining or completely drained of oil and / or compound. Gas: Severe unrepairable leak; ~~or equipment requiring repeated top ups.~~ Requires frequent intervention; OR substantial historical leakage	1.3	10	8.0
Default	No data available	1.0	10	0.5

The same changes should be applied to the following tables:

- TABLE 61: OBSERVED CONDITION INPUT – HV SWITCHGEAR (GM) – PRIMARY: OIL LEAKS/GAS PRESSURE
- TABLE 67: OBSERVED CONDITION INPUT – EHV SWITCHGEAR (GM): OIL LEAKS/GAS PRESSURE
- TABLE 74: OBSERVED CONDITION INPUT – 132KV SWITCHGEAR (GM): OIL LEAKS/GAS PRESSURE

4.13 Pole Top Rot

4.13.1 Summary of proposal

Asset categories	LV Pole, HV Pole & EHV Pole (Also includes 132kV Pole, a new category proposed for CNAIM v3)
Brief description of change	Amendment to the Top Rot Factor and Collar
Tables affected	Existing tables to be modified: 109, 113, 117
Overall impact	**Low**

4.13.2 Driver for change

A review of the calibration of the 'Pole Top Rot' Observed Condition Input in the wood pole models has identified a material understatement of the impact on the health assessment when pole top rot is identified.

4.13.3 Details of the proposed changes

It is proposed to make two changes to the existing top rot tables:

- To change the name and description to recognise significant pole top rot.
- To increase the Collar from 0.5 to 8. This will push the asset to HI5 as a minimum.

Proposed table detailed below:

Condition Criteria: Significant Pole Top Rot	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No	No significant pole top rot observed	1	10	0.5
Yes (suspect)	Pole top rot is suspected but not confirmed	1.2	10	5.5
Yes (confirmed)	Significant Pole top rot is observed	1.3	10	8
Default	No data available	1	10	0.5

Appendix A

A.1 Summary of proposals by table

Below is a list of all tables that are either new tables, or existing tables that have been modified in some way, compared with CNAIM v2.1:

Table Number (CNAIM v2.1)	Table Number (CNAIM v3.1)	Table description
GENERAL INPUTS		
Table 1	Table 1	Categorisation Of Assets
Table 2	Table 2	Generic Terms for Assets under Switchgear
PROBABILITY OF FAILURE - GENERAL		
Table 8	Table 8	Duty Factor Methodology
New Table	New Table	Initial Health Score Cap
Table 19	Table 19	Functional failure definitions
Table 20	Table 20	Normal Expected Life
Table 21	Table 21	PoF Curve Parameters
Table 22	Table 22	Distance From Coast Factor
Table 23	Table 23	Altitude Factor
Table 24	Table 24	Corrosion Category Factor
Table 25	Table 25	Increment Constants. Using the same calibration.
Table 26	Table 26	Default Environment (indoor/outdoor)
Table 28	Table 28	Sub Cable Situation Factor
Table 32	Table 32	Duty Factor Lookup Table - Switchgear
Table 237	Table 237	Typical Pof Weightings For Health Indices Bands For Use In The Calculation Of In-Year Risk From Risk Matrices
PROBABILITY OF FAILURE – OBSERVED CONDITION FACTORS		
Table 12	Table 12	Observed Condition Inputs
Table 13	Table 13	Observed Condition Modifier – MMI Calculation Parameters
New Table	New Table	EHV SWITCHGEAR OTHER: Switchgear External Condition
New Table	New Table	132KV SWITCHGEAR OTHER: Switchgear External Condition
New Table	New Table	EHV SWITCHGEAR OTHER: Thermographic Assessment
New Table	New Table	132KV SWITCHGEAR OTHER: Thermographic Assessment
New Table	New Table	EHV SWITCHGEAR OTHER: Support Structures
New Table	New Table	132KV SWITCHGEAR OTHER: Support Structures
New Table	New Table	HV SWITCHGEAR (PM): Switchgear External Condition
New Table	New Table	EHV SWITCHGEAR (PM): Switchgear External Condition
New Table	New Table	HV SWITCHGEAR (PM): Oil Leaks / Gas Pressure
New Table	New Table	EHV SWITCHGEAR (PM): Oil Leaks / Gas Pressure
New Table	New Table	BATTERY SYSTEM: Batteries Visual Condition
New Table	New Table	BATTERY SYSTEM: Batteries Environment Temperature
New Table	New Table	BATTERY SYSTEM: Chargers Visual Condition
New Table	New Table	WOOD POLE LINE CONDUCTOR: Visual Condition
New Table	New Table	WOOD POLE LINE CONDUCTOR: Midspan joints
New Table	New Table	132KV POLE: Visual Pole Condition
New Table	New Table	132KV POLE: Pole Top Rot
New Table	New Table	132KV POLE: Pole Leaning
New Table	New Table	132KV POLE: Bird / Animal Damage
New Table	New Table	132KV POLE: Pole Fittings Condition
New Table	New Table	EHV POLE: Pole Fittings Condition
New Table	New Table	HV POLE: Pole Fittings Condition
New Table	New Table	LV POLE: Pole Fittings Condition
New Table	New Table	TRANSFORMER (PM) External Condition
New Table	New Table	TRANSFORMER (PM) Bushing Condition
New Table	New Table	Default Year for Age calculation Band
PROBABILITY OF FAILURE – MEASURED CONDITION FACTORS		
Table 14	Table 14	Measured Condition Inputs
Table 15	Table 15	Measured Condition Modifier – MMI Calculation Parameters
New Table	New Table	EHV SWITCHGEAR OTHER: Operational Adequacy
New Table	New Table	132KV SWITCHGEAR OTHER: Operational Adequacy

Table Number (CNAIM v2.1)	Table Number (CNAIM v3.1)	Table description
New Table	New Table	HV SWITCHGEAR (PM): Operational Adequacy
New Table	New Table	EHV SWITCHGEAR (PM): Operational Adequacy
New Table	New Table	BATTERY SYSTEM: Batteries Load/Conductance Test
New Table	New Table	BATTERY SYSTEM: Batteries Impedance Test
New Table	New Table	BATTERY SYSTEM: Batteries Specific Gravity Test
New Table	New Table	BATTERY SYSTEM: Chargers Low/No Output
New Table	New Table	WOOD POLE LINE CONDUCTOR: conductor sampling
New Table	New Table	132KV POLE: Pole Decay / Deterioration
Table 108	Table 108	LV/HV/EHV Pole: Visual Pole Condition
Table 109	Table 109	LV POLE: POLE TOP ROT
Table 112	Table 112	HV Pole: Visual Pole Condition
Table 113	Table 113	HV POLE: POLE TOP ROT
Table 116	Table 116	EHV Pole: Visual Pole Condition
Table 117	Table 117	EHV POLE: POLE TOP ROT
Table 120	Table 120	EHV Tower: Tower Legs
Table 121	Table 121	EHV Tower: Bracings
Table 122	Table 122	EHV Tower: Crossarms
Table 123	Table 123	EHV Tower: Peak
Table 125	Table 125	EHV Tower: Foundation Condition
Table 126	Table 126	132kV Tower: Tower Legs
Table 127	Table 127	132kV Tower: Bracings
Table 128	Table 128	132kV Tower: Crossarms
Table 129	Table 129	132kV Tower: Peak
Table 131	Table 1318	132kV Tower: Foundation Condition
Table 192	Table 192	LV Pole: Pole Decay / Deterioration
Table 193	Table 193	HV Pole: Pole Decay / Deterioration
Table 194	Table 194	EHV POLE: Pole: Pole Decay / Deterioration
Table 203	Table 203	Moisture Condition State Calibration
Table 204	Table 204	Acidity Condition State Calibration
Table 205	Table 205	BREAKDOWN STRENGTH CONDITION State Calibration
Table 208	Table 208	Hydrogen Condition State Calibration
Table 208	Table 208	Hydrogen Condition State Calibration
Table 209	Table 209	Methane Condition State Calibration
Table 209	Table 209	Methane Condition State Calibration
Table 210	Table 210	Ethylene Condition State Calibration
Table 210	Table 210	Ethylene Condition State Calibration
Table 211	Table 211	Ethane Condition State Calibration
Table 211	Table 211	Ethane Condition State Calibration
Table 212	Table 212	Acetylene Condition State Calibration
Table 212	Table 212	Acetylene Condition State Calibration
Table 213	Table 213	DGA Change Category Calibration
Table 214	Table 214	DGA Test Factor Calibration
NEW Table	NEW Table	Ageing Rate Adjustment Sets
Table 217	Table 217	Refurbishment Interventions
CONSEQUENCE OF FAILURE - GENERAL		
Table 16	Table 16	Reference Costs Of Failure.
Table 236	Table 236	Typical COF weightings for criticality index bands for use with risk matrices
CONSEQUENCE OF FAILURE - FINANCIAL		
Table 218	Table 218	Reference Financial Cost of Failure
Table 219	Table 219	Type financial factor
Table 220	Table 220	Access factor
Table 221	Table 221	Access Factor: Batteries, Switchgear & Transformer Assets
CONSEQUENCE OF FAILURE - SAFETY		
Table 224	Table 224	Reference Safety Probabilities And Cost Of Failure
Table 225	Table 225	Consequence Factor – Switchgear, Transformers & Overhead lines
Table 227	Table 227	Safety Risk Reduction Factor
CONSEQUENCE OF FAILURE - ENVIRONMENTAL		
Table 228	Table 228	Reference Environmental Cost of Failure
Table 229	Table 229	Type Environmental Factor
Table 230	Table 230	Size Environmental Factor
Table 231	Table 231	Location Environmental Factor
CONSEQUENCE OF FAILURE – NETWORK PERFORMANCE		

Table Number (CNAIM v2.1)	Table Number (CNAIM v3.1)	Table description
Table 233	Table 233	Reference Network Performance Cost of Failure for LV & HV Assets
Table 235	Table 235	Reference Network Performance Cost Of Failure For EHV & 132kV Assets (Secure)
New Table	New Table	Network Performance Protection Factor
New Table	New Table	Reference Network Performance Cost Of Failure For EHV & 132k Assets – Network Type
MONETISED RISK		
Table 238	Table 238	Risk matrix weightings - monetised in-year risk
Table 240	Table 240	Typical cumulative discounted POF weightings for health indices bands for use in the calculation of long term risk from risk matrices
Table 241	Table 241	Risk matrix weightings - risk index (long term risk)

The full list of table changes is provided below:

GENERAL INPUTS

TABLE 1: CATEGORISATION OF ASSETS

Table to be expanded to cover the new asset categories described in Section 3 as follows:

Health Index Asset Category	Asset Register Category
EHV Switchgear - Other	33kV Switchgear - Other
	66kV Switchgear - Other
132kV Switchgear - Other	132kV Switchgear - Other
HV Switchgear (PM)	6.6/11kV CB (PM)
	6.6/11kV Switch (PM)
	6.6/11kV Switchgear - Other (PM)
	20kV CB (PM)
	20kV Switch (PM)
	20kV Switchgear - Other (PM)
EHV Switchgear (PM)	33kV Switch (PM)
Battery System	Batteries at GM HV Substations
	Batteries at 33kV Substations
	Batteries at 66kV Substations
	Batteries at 132kV Substations
LV Main OHL Conductor (Pole Lines)	LV Main OHL Conductor
HV OHL Conductor (Pole Lines)	6.6/11kV OHL (Conventional Conductor)
	6.6/11kV OHL (BLX or similar Conductor)
	20kV OHL (Conventional Conductor)
	20kV OHL (BLX or similar Conductor)
EHV OHL Conductor (Pole Lines)	33kV OHL (Pole Line) Conductor
	66kV OHL (Pole Line) Conductor
132kV OHL Conductor (Pole Lines)	132kV OHL (Pole Line) Conductor
132kV Pole	132kV Pole
EHV Transformers (PM)	33kV Transformer (PM)
HV Transformers (PM)	20kV Transformer (PM)
	6.6/11kV Transformer (PM)

TABLE 2: GENERIC TERMS FOR ASSETS UNDER SWITCHGEAR

Table to be expanded to cover the new asset categories described in Section 3 as follows:

Generic Term		Health Index Asset Category
Switchgear		EHV Switchgear - Other
		132kV Switchgear - Other
		HV Switchgear (PM)
		EHV Switchgear (PM)
Batteries		Battery System
Overhead Line	Poles	132kV Pole
	OHL Conductor	LV Main OHL Conductor (Pole Lines)
		HV OHL Conductor (Pole Lines)
		EHV OHL Conductor (Pole Lines)
		132kV OHL Conductor (Pole Lines)
Transformers	Transformer (PM)	EHV Transformer (PM)
		HV Transformer (PM)

Notes:

The categories above will be removed from TABLE 3: Excluded Asset Register Categories

PROBABILITY OF FAILURE - GENERAL

TABLE 8: DUTY FACTOR METHODOLOGY

Table to be expanded to cover the new asset categories described in Section 3 as follows:

Asset Register Category	Duty Factor 1 (DF1)	Duty Factor 2 (DF2)
EHV & 132kV Switchgear Other	No asset-specific Duty Factor 1 (i.e. DF1 = 1)	N/A
HV & EHV Switchgear (PM)	Number of Operations	N/A
Batteries	No asset-specific Duty Factor 1 (i.e. DF1 = 1)	N/A
OHL Conductor	No asset-specific Duty Factor 1 (i.e. DF1 = 1)	N/A
Transformer (PM)	% Utilisation	N/A

NEW TABLE: INITIAL HEALTH SCORE CAP

This is a new table and unless otherwise specified the Cap would be 5.5:

Asset Register Category	Initial Health Score Cap
33kV Switchgear – Other	8.0
66kV Switchgear – Other	8.0
132kV Switchgear – Other	8.0
6.6/11kV CB (PM)	8.0
6.6/11kV Switch (PM)	8.0
6.6/11kV Switchgear - Other (PM)	8.0
20kV CB (PM)	8.0
20kV Switch (PM)	8.0
20kV Switchgear - Other (PM)	8.0
33kV Switch (PM)	8.0
Batteries at GM HV Substations	8.0
Batteries at 33kV Substations	8.0
Batteries at 66kV Substations	8.0
Batteries at 132kV Substations	8.0
LV Main OHL Conductor (Pole Lines)	8.0
HV OHL Conductor (Pole Lines)	8.0
EHV OHL Conductor (Pole Lines)	8.0
132kV OHL Conductor (Pole Lines)	8.0
6.6/11kV Transformer (PM)	7.5

20kV Transformer (PM)	7.5
33kV Transformer (PM)	7.5

TABLE 19: FUNCTIONAL FAILURE DEFINITIONS

Table to be expanded to cover the new asset categories described in Section 3 as follows:

Asset Register Category	Function	Failure modes	Catastrophic Failure	Degraded Failures	Incipient Failures	Functional failures excluded
EHV Switchgear Other	Ability to carry fault current. Ability to carry load current, where designed. Provide isolation, where designed. Maintain or interrupt voltage on all three phases, where designed. Provide earthing, where designed. To close when instructed by protection system to apply short onto a live busbar, where designed. Open and close when required to provide specific function.	Does not open or close correctly on command. Mechanical failure. Electrical failure (auxiliary & control). Electrical failure (main circuit). Failure of civil support structure.	Disruptive failure resulting from insulation breakdown. Civil support unsuitable to allow operation of main asset.	Failure of locking mechanism. Cracked metallic components i.e. U clamps. Loss of galvanization/ corrosion on metallic parts. Obsolescence. Contacts not fit for service (beyond repair). Civil support unsuitable for long term operation of the asset. Electrical failure of replaceable component - i.e. pot insulators. SOP preventing designed operation.	Heavy contamination of insulators. Contacts degraded (able to be dressed). Contact misalignment. Mechanism poor performance/ stiction.	
132kV Switchgear Other	Ability to carry fault current. Ability to carry load current, where designed. Provide isolation, where designed. Maintain or interrupt voltage on all three phases, where designed. Provide earthing, where designed. To close when instructed by protection system to apply short onto a live busbar, where designed. Open and close when required to provide specific function.	Does not open or close correctly on command Mechanical failure Electrical failure (auxiliary & control) - remove for 33kV, keep 132kV Electrical failure (main circuit) Failure of civil support structure	Disruptive failure resulting from insulation breakdown. Civil support unsuitable to allow operation of main asset.	Failure of locking mechanism. Cracked metallic components i.e. U clamps. Loss of galvanization/ corrosion on metallic parts. Obsolescence. Contacts not fit for service (beyond repair). Civil support unsuitable for long term operation of the asset. Electrical failure of replaceable component - i.e. pot insulators. SOP preventing designed operation.	Heavy contamination of insulators. Contacts degraded (able to be dressed). Contact misalignment. Mechanism poor performance/ stiction.	
HV Switchgear (PM)	Ability to carry fault current. Ability to carry load current. Make or break continuous load or fault current, where appropriate to its design/function.	Does not open or close on command (Where this is associated with the Breaker	Disruptive Failure Resulting from Insulation Breakdown.	SOP preventing operation. Failure to operate when required due to: - Failure of Mechanism - Protection module - CT Failure	Failure to operate when required due to: - Low Gas Lockout or Vacuum bottle condition.	Unable to withstand impulse voltage. Unable to contain the insulating medium.

Asset Register Category	Function	Failure modes	Catastrophic Failure	Degraded Failures	Incipient Failures	Functional failures excluded
	Maintain or interrupt voltage on all three phases, where designed. Measurement of current and voltage, where designed. Provide isolation, where designed. Open and close when required to provide specific function, where designed.	and not the control system). Mechanical Failure. Electrical Failure (Auxiliary & Control). Electrical Failure (Main Circuit).		- VT Failure - Stuck Breaker.	Heavy contamination of insulators Contacts degraded (able to be dressed) Contact misalignment Mechanism performance/ stiction	Does not allow switch tank to breath.
EHV Switchgear (PM)	Ability to carry fault current. Ability to carry load current. Make or break continuous load or fault current, where appropriate to its design/function. Maintain or interrupt voltage on all three phases, where designed. Measurement of current and voltage, where designed. Provide isolation, where designed. Open and close when required to provide specific function, where designed.	Does not open or close on command (Where this is associated with the Breaker and not the control system). Mechanical Failure. Electrical Failure (Auxiliary & Control). Electrical Failure (Main Circuit).	Disruptive Failure Resulting from Insulation Breakdown.	SOP preventing operation. Failure to operate when required due to: - Failure of Mechanism - Protection module - CT Failure - VT Failure - Stuck Breaker.	Failure to operate when required due to: - Low Gas Lockout or Vacuum bottle condition. Heavy contamination of insulators Contacts degraded (able to be dressed) Contact misalignment Mechanism performance/ stiction	Unable to withstand impulse voltage. Unable to contain the insulating medium. Does not allow switch tank to breath.
Battery System	Provide an electrical supply to load in the event of a mains power failure.	Aged, deteriorated batteries. High impedance, poor Specific Gravity batteries. Defective chargers with limited to no electrical output.	Failure of charger to charge batteries. Failure of battery to operate switchgear and/or protection systems.	Reduced capacity and/or voltage but does not prevent operation.	NA.	Ancillaries associated with Batteries and Chargers systems, including supply and cabling to these assets. Battery links.
Transformer (PM)	Step up or step down and provide a secondary output voltage which is within statutory limits. Carry full load current when required. Carry through fault current when required.	Bushing, windings, core, tank or insulation failure	Failure of the main tank or internal components – windings, core or insulation.	Failure of the bushing	Insulation Leaks	Civil or support structure related failures. Downleads or connectors.

Asset Register Category	Function	Failure modes	Catastrophic Failure	Degraded Failures	Incipient Failures	Functional failures excluded
OHL Pole Line Conductor	Carry load and fault current within the ESQCR clearance levels Maintain continuity under normal and fault conditions. Provide phase-phase and phase-earth insulation.	Flashover Corroded Conductor. Corroded Jumper	Full loss of integrity of the conductor, excluding any associated Pole mounted plant, such that the residual strength of the component required immediate intervention.	Loss of integrity of the conductor, excluding any associated Pole mounted plant, such that the residual strength of the component required intervention within a prescribed timescale.	Loss / damage of covering.	Loss of protection. Loss of plant. Earthing. Any issues relating to the support, safety notices and anti-climbing guards. Conductor icing which does not result in permanent damage to the conductor. Cable boxes and platforms (including sealing ends). Loss of Insulators / Fittings

TABLE 20: NORMAL EXPECTED LIFE

The table below details the normal expected lives proposed for the new asset categories. For Asset Register Categories not shown, the existing Normal Expected Lives in CNAIM v2.1 remain valid.

Asset Register Category	Sub-division	Normal Expected Life	Ageing Rate Adjustment Set
33kV Switchgear - Other	Non-motorised	50	Set 1
	Motorised	45	Set 1
66kV Switchgear - Other	Non-motorised	50	Set 1
	Motorised	45	Set 1
132kV Switchgear - Other	Non-motorised	50	Set 1
	Motorised	45	Set 1
6.6/11kV CB (PM)		40	Set 1
6.6/11kV Switch (PM)		40	Set 1
6.6/11kV Switchgear - Other (PM)		40	Set 1
20kV CB (PM)		40	Set 1
20kV Switch (PM)		40	Set 1
20kV Switchgear - Other (PM)		40	Set 1
33kV Switch (PM)		40	Set 1
Batteries at GM HV Substations	Batteries - Dry Cells	6	Set 1
	Batteries - Wet Cells	17	Set 1
	Chargers	17	Set 1
Batteries at 33kV Substations	Batteries - Dry Cells	6	Set 1
	Batteries - Wet Cells	17	Set 1
	Chargers	17	Set 1
Batteries at 66kV Substations	Batteries - Dry Cells	6	Set 1
	Batteries - Wet Cells	17	Set 1
	Chargers	17	Set 1
Batteries at 132kV Substations	Batteries - Dry Cells	6	Set 1
	Batteries - Wet Cells	17	Set 1
	Chargers	17	Set 1
LV Main (OHL) Conductor	PVCA	50	Set 1
	PVCCu	50	Set 1
	AL	60	Set 1
	Cad Cu	60	Set 1
	Cu	70	Set 1
	ABC	50	Set 1
	Other (FE)	50	Set 1
	Unknown	60	Set 1
6.6/11kV / 20kV OHL (Conventional Conductor)	ACSR - greased	55	Set 1
	PVCA	50	Set 1
	PVCCu	50	Set 1
	AAAC	60	Set 1
	Cad Cu	60	Set 1
	Cu	70	Set 1
	Other (FE)	50	Set 1
	Unknown	60	Set 1
6.6/11kV / 20kV OHL (BLX or similar Conductor)	BLX - XLPE	55	Set 1
	Unknown	60	Set 1
33kV / 66kV / 132kV OHL (Pole Line) Conductor	ACSR - greased	55	Set 1
	ACSR - non-greased	45	Set 1
	AAAC	60	Set 1
	Cad Cu	60	Set 1
	Cu	70	Set 1
	PVCA	50	Set 1
	PVCCu	50	Set 1
	Other (FE, XLPE, PVCA, AL)	50	Set 1
	Unknown	60	Set 1

132kV Pole	Concrete	60	Set 1
	Steel	50	Set 1
	Wood (water soluble copper salt treated; excluding CCA)	25	Set 1
	Wood (other)	55	Set 1
	Other (e.g. fiberglass)	80	Set 1
6.6/11kV Transformer (PM)	Transformer	55	Set 1
	Reactors & Regulators	40	Set 1
20kV Transformer (PM)	Transformer	55	Set 1
	Reactors & Regulators	40	Set 1
33kV Transformer (PM)	Transformer	55	Set 1
	Reactors & Regulators	40	Set 1
HV Sub Cable	Submarine Single Wire Armour	70	Set 1
	Submarine Double Wire Armour	80	Set 1
	Non-Marine cable	60	Set 1
	Default	60	Set 1
EHV Sub Cable	Submarine Single Wire Armour	70	Set 1
	Submarine Double Wire Armour	80	Set 1
	Non-Marine cable	60	Set 1
	Default	60	Set 1
132kV Sub Cable	Submarine Single Wire Armour	70	Set 1
	Submarine Double Wire Armour	80	Set 1
	Non-Marine cable	60	Set 1
	Default	60	Set 1
66kV CB (Air Insulated Busbars)(ID)(GM)		55	Set 1
66kV CB (Air Insulated Busbars)(OD)(GM)		50	Set 1

Notes

As described in section 4.4, it is proposed that all Asset Register Category Sub-divisions will be assigned an “Ageing Rate Adjustment Set” via the addition of column to the existing Table 20: Normal Expected Life. It is proposed to assign all Asset Register Category Sub-divisions a neutral set of factors (“Set 1”) within CNAIM v3 pending evidence of the need for, and calibration of, more sets. Use of “Set 1” will not adjust the ageing rate assumptions from those used in CNAIM v2.

For the new battery models, both the charger and wet cells typically have a useful life of 20 years while dry cells have a useful life of 8 years. The Normal Expected Life above has been calibrated such that a Health Score of 8 will be achieved when the charger and batteries reach the end of their respective useful lives.

Where DNO’s do not have age related data for the Conductors, a default age is provided to use as a means of aiding the calculation of the initial health score.

Asset Register Category	Sub-division	Default Year for Age calculation Band
LV Main (OHL) Conductor	PVCA	1980
LV Main (OHL) Conductor	PVCCu	1980
LV Main (OHL) Conductor	AL	1980
LV Main (OHL) Conductor	Cad Cu	1960
LV Main (OHL) Conductor	Cu	1955
LV Main (OHL) Conductor	ABC	1995
LV Main (OHL) Conductor	Other (FE)	1975
LV Main (OHL) Conductor	Unknown	1980
6.6/11kV / 20kV OHL (Conventional Conductor)	ACSR - greased	1975
6.6/11kV / 20kV OHL (Conventional Conductor)	PVCA	1980
6.6/11kV / 20kV OHL (Conventional Conductor)	PVCCu	1980
6.6/11kV / 20kV OHL (Conventional Conductor)	AAAC	1980
6.6/11kV / 20kV OHL (Conventional Conductor)	Cad Cu	1960
6.6/11kV / 20kV OHL (Conventional Conductor)	Cu	1955
6.6/11kV / 20kV OHL (Conventional Conductor)	Other (FE)	1975
6.6/11kV / 20kV OHL (Conventional Conductor)	Unknown	1970

Asset Register Category	Sub-division	Default Year for Age calculation Band
6.6/11kV / 20kV OHL (BLX or similar Conductor)	BLX - XLPE	1985
6.6/11kV / 20kV OHL (BLX or similar Conductor)	Unknown	1980
33kV / 66kV / 132kV OHL (Pole Line) Conductor	ACSR - greased	1985
33kV / 66kV / 132kV OHL (Pole Line) Conductor	ACSR - non-greased	1975
33kV / 66kV / 132kV OHL (Pole Line) Conductor	AAAC	1995
33kV / 66kV / 132kV OHL (Pole Line) Conductor	Cad Cu	1960
33kV / 66kV / 132kV OHL (Pole Line) Conductor	Cu	1955
33kV / 66kV / 132kV OHL (Pole Line) Conductor	PVCA	1980
33kV / 66kV / 132kV OHL (Pole Line) Conductor	PVCCu	1980
33kV / 66kV / 132kV OHL (Pole Line) Conductor	Other (FE, XLPE, PVCA, AL)	1975
33kV / 66kV / 132kV OHL (Pole Line) Conductor	Unknown	1970

TABLE 21: POF CURVE PARAMETERS

The table below details the normal expected lives proposed for the new Functional Failure Categories as well as modifications to existing Functional Failure Categories by exception. For categories not shown, the existing Normal Expected Lives in CNAIM v2.1 remain valid.

Functional Failure Category		K- Value	C-Value	Health Score Limit
EHV Switchgear - Other (33kV and 22kV assets only)		0.0167%	1.087	4
EHV Switchgear - Other (66kV assets only)		0.0167%	1.087	4
132kV Switchgear - Other		0.0167%	1.087	4
HV Switchgear (PM)		0.0067%	1.087	4
EHV Switchgear (PM)		0.0067%	1.087	4
Battery System		0.0500%	1.087	4
OHL Pole Conductor		0.0080%	1.087	4
Poles	LV/HV	0.0086%	1.087	4
	33/66/132kV	0.0143%	1.087	4
Transformer (PM)		0.0078%	1.087	4

TABLE 22: DISTANCE FROM COAST FACTOR

Modification required to the table below as highlighted in yellow:

Distance from Coast Banding	Switchgear	Transformers	Poles (Wood or Other)	Poles (Steel)	Poles (Concrete)	Towers (Structure)	Towers (Fittings)	Tower & Pole (Conductor)
≤ 1km	1.35	1.35	1	1.5	1.25	1.8	2	2
> 1km and ≤ 5km	1.1	1.1	1	1.2	1.1	1.45	1.5	1.5
> 5km and ≤ 10km	1.05	1.05	1	1.1	1.05	1.2	1.2	1.2
> 10km and ≤ 20km	1	1	1	1	1	1	1	1
>20km	0.9	0.9	1	1	1	0.85	1	1
Default	1	1	1	1	1	1	1	1

TABLE 23: ALTITUDE FACTOR

Modification required to the table below as highlighted in yellow:

Altitude from Sea Level Banding	Switchgear	Transformers	Poles (Wood or Other)	Poles (Steel)	Poles (Concrete)	Towers (Structure)	Towers (Fittings)	Tower & Pole (Conductor)
≤ 100m	0.9	0.9	1	1	1	0.9	0.95	0.95
> 100m and ≤ 200m	1	1	1	1	1	1	1	1
> 200m and ≤ 300m	1.05	1.05	1	1	1	1.15	1.05	1.05
> 300m	1.1	1.1	1	1	1	1.3	1.15	1.15
Default	1	1	1	1	1	1	1	1

TABLE 24: CORROSION CATEGORY FACTOR

Modification required to the table below as highlighted in yellow:

Corrosion Category Index	Switchgear	Transformers	Poles (Wood or Other)	Poles (Steel)	Poles (Concrete)	Towers (Structure)	Towers (Fittings)	Tower & Pole (Conductor)
1	0.9	0.9	1	0.9	0.9	0.75	0.95	0.95
2	0.95	0.95	1	0.95	0.95	0.9	0.95	0.95
3	1	1	1	1	1	1	1	1
4	1.1	1.1	1	1.15	1.05	1.3	1.05	1.05
5	1.25	1.25	1	1.35	1.1	1.6	1.2	1.2
Default	1	1	1	1	1	1	1	1

TABLE 25: INCREMENT CONSTANTS. USING THE SAME CALIBRATION

Modification required to the table below as highlighted in yellow:

Increment Constant	Switchgear	Transformers	Submarine Cables	Poles (Wood or Other)	Poles (Steel)	Poles (Concrete)	Towers (Structure)	Towers (Fittings)	Tower & Pole (Conductor)
INC	0.05	0.05	0.05	0	0	0	0	0	0

TABLE 26: DEFAULT ENVIRONMENT (INDOOR/OUTDOOR)

Table to be expanded to cover the new asset categories described in Section 3 as follows:

Asset Register Category	Default 'environment' to be assumed when deriving Location Factor
33kV Switchgear Other	Outdoor
66kV Switchgear Other	Outdoor
132kV Switchgear Other	Outdoor
6.6/11kV CB (PM)	Outdoor
6.6/11kV Switch (PM)	Outdoor
6.6/11kV Switchgear - Other (PM)	Outdoor
20kV CB (PM)	Outdoor
20kV Switch (PM)	Outdoor
20kV Switchgear - Other (PM)	Outdoor
33kV Switch (PM)	Outdoor
Batteries at GM HV Substations	Indoor
Batteries at 33kV Substations	Indoor
Batteries at 66kV Substations	Indoor
Batteries at 132kV Substations	Indoor
LV Main (OHL) Conductor	Outdoor
6.6/11kV OHL (BLX or similar Conductor)	Outdoor
6.6/11kV OHL (Conventional Conductor)	Outdoor
20kV OHL (BLX or similar Conductor)	Outdoor
20kV OHL (Conventional Conductor)	Outdoor
33kV OHL (Pole Line) Conductor	Outdoor
66kV OHL (Pole Line) Conductor	Outdoor
132kV OHL (Pole Line) Conductor	Outdoor
132kV Pole	Outdoor
6.6/11kV Transformer (PM)	Outdoor
20kV Transformer (PM)	Outdoor
33kV Transformer (PM)	Outdoor

TABLE 28: SUB CABLE SITUATION FACTOR

Situation	Score
Laid on bed	1
Covered Surface Laid - Self Buried	0.95
Surface Laid - Stabilised	0.9
Partially Buried	0.85
Partially Buried -Stabilised	0.8
Buried	0.8
Default	1

TABLE 32: DUTY FACTOR LOOKUP TABLE - SWITCHGEAR

No of Operations	Duty Factor
Normal/Low	1
High (e.g.: Auto-reclosers)	1.2
Default	1

TABLE 237: TYPICAL POF WEIGHTINGS FOR HEALTH INDICES BANDS FOR USE IN THE CALCULATION OF IN-YEAR RISK FROM RISK MATRICES

The table below presents the definitive set of Typical In-Year POF Weightings for Each Health Index Band, representing the net impact of the proposals outlined within this document (new Asset Register Categories are highlighted in yellow):

Asset Register Category	Typical In-Year POF Weightings for Each Health Index Band				
	H1	H2	H3	H4	H5
LV Main (OHL) Conductor	0.00228	0.002618	0.006002	0.009721	0.017175
LV Poles	0.002437	0.002798	0.006415	0.010389	0.018356
LV Circuit Breaker	0.001169	0.001342	0.003076	0.004982	0.008802
LV Pillar (ID)	0.001311	0.001505	0.003451	0.005589	0.009876
LV Pillar (OD at Substation)	0.001311	0.001505	0.003451	0.005589	0.009876
LV Pillar (OD not at a Substation)	0.001311	0.001505	0.003451	0.005589	0.009876
LV Board (WM)	0.001967	0.002258	0.005177	0.008384	0.014813
LV UGB	0.002195	0.00252	0.005777	0.009356	0.016531
LV Board (X-type Network) (WM)	0.001967	0.002258	0.005177	0.008384	0.014813
6.6/11kV OHL (Conventional Conductor)	0.00228	0.002618	0.006002	0.009721	0.017175
6.6/11kV OHL (BLX or similar Conductor)	0.00228	0.002618	0.006002	0.009721	0.017175
20kV OHL (Conventional Conductor)	0.00228	0.002618	0.006002	0.009721	0.017175
20kV OHL (BLX or similar Conductor)	0.00228	0.002618	0.006002	0.009721	0.017175
6.6/11kV Poles	0.002437	0.002798	0.006415	0.010389	0.018356
20kV Poles	0.002437	0.002798	0.006415	0.010389	0.018356
HV Sub Cable	0.005757	0.00661	0.015156	0.024545	0.043367
6.6/11kV CB (PM)	0.00191	0.002192	0.005027	0.008141	0.014384
6.6/11kV CB (GM) Primary	0.001482	0.001702	0.003901	0.006318	0.011164
6.6/11kV CB (GM) Secondary	0.00191	0.002192	0.005027	0.008141	0.014384
6.6/11kV Switch (PM)	0.00191	0.002192	0.005027	0.008141	0.014384
6.6/11kV Switchgear - Other (PM)	0.00191	0.002192	0.005027	0.008141	0.014384
6.6/11kV Switch (GM)	0.00191	0.002192	0.005027	0.008141	0.014384
6.6/11kV RMU	0.00191	0.002192	0.005027	0.008141	0.014384
6.6/11kV X-type RMU	0.00191	0.002192	0.005027	0.008141	0.014384
20kV CB (PM)	0.00191	0.002192	0.005027	0.008141	0.014384
20kV CB (GM) Primary	0.001482	0.001702	0.003901	0.006318	0.011164
20kV CB (GM) Secondary	0.00191	0.002192	0.005027	0.008141	0.014384
20kV Switch (PM)	0.00191	0.002192	0.005027	0.008141	0.014384
20kV Switchgear - Other (PM)	0.00191	0.002192	0.005027	0.008141	0.014384
20kV Switch (GM)	0.00191	0.002192	0.005027	0.008141	0.014384
20kV RMU	0.00191	0.002192	0.005027	0.008141	0.014384

Asset Register Category	Typical In-Year POF Weightings for Each Health Index Band				
	H1	H2	H3	H4	H5
6.6/11kV Transformer (PM)	0.002223	0.002552	0.005852	0.009478	0.016746
6.6/11kV Transformer (GM)	0.002223	0.002552	0.005852	0.009478	0.016746
20kV Transformer (PM)	0.002223	0.002552	0.005852	0.009478	0.016746
20kV Transformer (GM)	0.002223	0.002552	0.005852	0.009478	0.016746
Batteries at GM HV Substations	0.01425	0.016362	0.037514	0.060754	0.107343
33kV OHL (Pole Line) Conductor	0.00228	0.002618	0.006002	0.009721	0.017175
33kV Pole	0.004061	0.004663	0.010691	0.017315	0.030593
66kV OHL (Pole Line) Conductor	0.00228	0.002618	0.006002	0.009721	0.017175
66kV Pole	0.004061	0.004663	0.010691	0.017315	0.030593
33kV OHL (Tower Line) Conductor	0.00228	0.002618	0.006002	0.009721	0.017175
33kV Tower	0.015533	0.017834	0.04089	0.066222	0.117004
33kV Fittings	0.002736	0.003141	0.007203	0.011665	0.02061
66kV OHL (Tower Line) Conductor	0.00228	0.002618	0.006002	0.009721	0.017175
66kV Tower	0.015533	0.017834	0.04089	0.066222	0.117004
66kV Fittings	0.002736	0.003141	0.007203	0.011665	0.02061
33kV UG Cable (Non Pressurised)	0.018753	0.021532	0.049368	0.079952	0.141264
33kV UG Cable (Oil)	0.596913	0.685357	1.571374	2.544859	4.496404
33kV UG Cable (Gas)	1.283546	1.473727	3.378934	5.472225	9.668642
66kV UG Cable (Non Pressurised)	0.018753	0.021532	0.049368	0.079952	0.141264
66kV UG Cable (Oil)	0.596913	0.685357	1.571374	2.544859	4.496404
66kV UG Cable (Gas)	1.283546	1.473727	3.378934	5.472225	9.668642
EHV Sub Cable	0.005757	0.00661	0.015156	0.024545	0.043367
33kV CB (Air Insulated Busbars)(ID) (GM)	0.006356	0.007297	0.016731	0.027096	0.047875
33kV CB (Air Insulated Busbars)(OD) (GM)	0.006356	0.007297	0.016731	0.027096	0.047875
33kV CB (Gas Insulated Busbars)(ID)(GM)	0.006356	0.007297	0.016731	0.027096	0.047875
33kV CB (Gas Insulated Busbars)(OD)(GM)	0.006356	0.007297	0.016731	0.027096	0.047875
33kV Switch (GM)	0.006356	0.007297	0.016731	0.027096	0.047875
33kV Switchgear - Other	0.004767	0.005473	0.012548	0.020322	0.035906
33kV Switch (PM)	0.00191	0.002192	0.005027	0.008141	0.014384
33kV RMU	0.006356	0.007297	0.016731	0.027096	0.047875
66kV CB (Air Insulated Busbars)(ID) (GM)	0.014592	0.016754	0.038414	0.062212	0.10992
66kV CB (Air Insulated Busbars)(OD) (GM)	0.014592	0.016754	0.038414	0.062212	0.10992
66kV CB (Gas Insulated Busbars)(ID)(GM)	0.014592	0.016754	0.038414	0.062212	0.10992
66kV CB (Gas Insulated Busbars)(OD)(GM)	0.014592	0.016754	0.038414	0.062212	0.10992
33kV Transformer (GM)	0.012939	0.014856	0.034062	0.055165	0.097468
66kV Switchgear - Other	0.004767	0.005473	0.012548	0.020322	0.035906
66kV Transformer (GM)	0.012939	0.014856	0.034062	0.055165	0.097468
33kV Transformer (PM)	0.002223	0.002552	0.005852	0.009478	0.016746
Batteries at 33kV Substations	0.01425	0.016362	0.037514	0.060754	0.107343
Batteries at 66kV Substations	0.01425	0.016362	0.037514	0.060754	0.107343
132kV OHL (Pole Line) Conductor	0.00228	0.002618	0.006002	0.009721	0.017175
132kV Pole	0.004061	0.004663	0.010691	0.017315	0.030593
132kV OHL (Tower Line) Conductor	0.00228	0.002618	0.006002	0.009721	0.017175
132kV Tower	0.015533	0.017834	0.04089	0.066222	0.117004
132kV Fittings	0.002736	0.003141	0.007203	0.011665	0.02061
132kV UG Cable (Non Pressurised)	0.018753	0.021532	0.049368	0.079952	0.141264
132kV UG Cable (Oil)	0.596913	0.685357	1.571374	2.544859	4.496404
132kV UG Cable (Gas)	1.283546	1.473727	3.378934	5.472225	9.668642
132kV Sub Cable	0.005757	0.00661	0.015156	0.024545	0.043367
132kV CB (Air Insulated Busbars)(ID) (GM)	0.012284	0.014104	0.032337	0.05237	0.09253
132kV CB (Air Insulated Busbars)(OD) (GM)	0.012284	0.014104	0.032337	0.05237	0.09253
132kV CB (Gas Insulated Busbars)(ID) (GM)	0.012284	0.014104	0.032337	0.05237	0.09253
132kV CB (Gas Insulated Busbars)(OD) (GM)	0.012284	0.014104	0.032337	0.05237	0.09253
132kV Transformer (GM)	0.012939	0.014856	0.034062	0.055165	0.097468
132kV Switchgear - Other	0.004767	0.005473	0.012548	0.020322	0.035906
Batteries at 132kV Substations	0.01425	0.016362	0.037514	0.060754	0.107343

PROBABILITY OF FAILURE – OBSERVED CONDITION FACTORS

TABLE 12: OBSERVED CONDITION INPUTS

Table to be expanded to cover the new asset categories described in Section 3 as follows:

Asset Register Category	Subcomponent	Observed Condition Input
EHV Switchgear – Other	N/A	Switchgear external condition Thermographic assessment Support structures
132kV Switchgear – Other	N/A	Switchgear external condition Thermographic assessment Support structures
HV Switchgear (PM)	N/A	Switchgear external condition Oil leaks / gas pressure (insulation leaks)
EHV Switchgear (PM)	N/A	Switchgear external condition Oil leaks / gas pressure (insulation leaks)
Battery System	Batteries	Visual condition Environment temperature
	Chargers	Visual condition
LV Main OHL Conductor (Pole Lines)	N/A	Visual condition Midspan joints
HV OHL Conductor (Pole Lines)	N/A	Visual condition Midspan joints
EHV OHL Conductor (Pole Lines)	N/A	Visual condition Midspan joints
132kV OHL Conductor (Pole Lines)	N/A	Visual condition Midspan joints
132kV Pole	N/A	Visual pole condition Pole top rot Pole leaning Bird / animal damage
Transformer (PM)	N/A	Transformer external condition Bushing Condition
Sub Cable	N/A	External Condition of Armour Shore End* – Cable Erosion Shore End* – Cable Protection Cable Suspensions

TABLE 13: OBSERVED CONDITION MODIFIER – MMI CALCULATION PARAMETERS

Table to be expanded to cover the new asset categories described in Section 3 as follows:

Asset Category	Subcomponent	Parameters for Combination Using MMI Technique		
		Factor Divider 1	Factor Divider 2	Max. No. of Combined Factors
LV UGB	N/A	1.5	1.5	3
LV Circuit Breaker	N/A	1.5	1.5	1
LV Board (WM)	N/A	1.5	1.5	3
LV Pillar	N/A	1.5	1.5	3
HV Switchgear (GM) - Primary	N/A	1.5	1.5	3
HV Switchgear (GM) - Distribution	N/A	1.5	1.5	3
EHV Switchgear (GM)	N/A	1.5	1.5	3
132 kV Switchgear (GM)	N/A	1.5	1.5	3

Asset Category	Subcomponent	Parameters for Combination Using MMI Technique		
		Factor Divider 1	Factor Divider 2	Max. No. of Combined Factors
HV Transformer (GM)	N/A	1.5	1.5	2
EHV Transformer (GM)	Main Transformer	1.5	1.5	3
	Tapchanger	1.5	1.5	3
132 kV Transformer (GM)	Main Transformer	1.5	1.5	3
	Tapchanger	1.5	1.5	3
EHV Cable (Non Pressurised)	N/A	-	-	-
EHV Cable (Oil)	N/A	1.5	1.5	1
EHV Cable (Gas)	N/A	1.5	1.5	1
132 kV Cable (Non Pressurised)	N/A	-	-	-
132 kV Cable (Oil)	N/A	1.5	1.5	1
132 kV Cable (Gas)	N/A	1.5	1.5	1
Submarine Cable	N/A	1.5	1.5	4
LV Poles	N/A	1.5	1.5	2
HV Poles	N/A	1.5	1.5	2
EHV Poles	N/A	1.5	1.5	2
EHV Towers	Tower Steelwork	1.5	1.5	3
	Tower Paintwork	1.5	1.5	1
	Foundations	1.5	1.5	1
132 kV Towers	Tower Steelwork	1.5	1.5	3
	Tower Paintwork	1.5	1.5	1
	Foundations	1.5	1.5	1
EHV Fittings	N/A	1.5	1.5	3
132 kV Fittings	N/A	1.5	1.5	3
EHV Tower Line Conductor	N/A	1.5	1.5	1
132 kV Tower Line Conductor	N/A	1.5	1.5	1
EHV Switchgear (Other)	N/A	1.5	1.5	3
132kV Switchgear (Other)	N/A	1.5	1.5	3
HV Switchgear (PM)	N/A	1.5	1.5	2
EHV Switchgear (PM)	N/A	1.5	1.5	2
Battery System	Batteries	1.5	1.5	2
	Chargers	1.5	1.5	1
LV Main OHL Conductor (Pole Lines)	N/A	1.5	1.5	2
HV OHL Conductor (Pole Lines)	N/A	1.5	1.5	2
EHV OHL Conductor (Pole Lines)	N/A	1.5	1.5	2
132kV OHL Conductor (Pole Lines)	N/A	1.5	1.5	2
132kV Pole	N/A	1.5	1.5	2
Transformer (PM)	N/A	1.5	1.5	2

NEW TABLE: EHV/132kV SWITCHGEAR OTHER: SWITCHGEAR EXTERNAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration:	Visual assessment gives a positive indication of asset condition. There are no obvious signs of any deterioration such as corrosion, stains or markings.	0.9	10	0.5
Superficial/minor deterioration	There is little deterioration. The asset (or a sub component) is fit for continued service.	1	10	0.5
Some Deterioration	There is evidence of some degradation such as surface corrosion. The level of degradation may affect the operation of the asset if left untended (e.g. large patches of rust on the metalwork or handle or evidence of a minor mechanism defect).	1.2	10	3.0
Substantial Deterioration	The switchgear is corroded to the point that it affects the operation of the asset, or the switchgear operating mechanism is damaged beyond economical repair.	1.4	10	8.0
Default	No data available	1	10	0.5

NEW TABLE: EHV/132kV SWITCHGEAR OTHER: THERMOGRAPHIC ASSESSMENT

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Ambient or Below	At or below ambient temperature	0.9	10	0.5
Above Ambient	Above ambient temperature	1	10	0.5
Substantially Above Ambient	Operating above the manufacturers recommended maximum temperature	1.1	10	0.5
Default	No data available	1	10	0.5

NEW TABLE: EHV/132kV SWITCHGEAR OTHER: SUPPORT STRUCTURES

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	Visual assessment gives a positive indication of asset condition. There are no obvious signs of any deterioration such as corrosion or cracks.	0.9	10	0.5
Superficial/minor deterioration	Concrete Structures: Surface Deterioration Metal Structures: Minor localised surface corrosion Wood Pole Structures: No significant defects observed. May include poles with slight damage including (but not limited to) splits and general wear where no material impact on residual strength of pole.	1	10	0.5
Some Deterioration	Concrete Structures: Evidence of previous concrete repairs, repairs have begun to fail in places. This may include minor cracks and loss of section. Metal structures: some surface level corrosion. Wood Pole Structures: Minor wear on pole or physical damage that will lead to loss of strength, but the short term integrity of the pole is not compromised.	1.3	10	0.5
Substantial Deterioration	The support structure is corroded or damaged to the point that it can no longer fulfil its mechanical load carrying capacity. This may include: Concrete Structures: extensive cracking, areas of concrete spalled exposing reinforcement causing corrosion. Metal Structures: evidence of widespread or significant corrosion (e.g. perforation, holes in steelwork) or major physical damage. Wood Pole Structures: Severe damage to pole. Parts may be chipped off, rotten or disfigured. E.g. visible splits, cracks, major physical damage affecting strength.	1.5	10	5.5
Default	No data available	1	10	0.5

NEW TABLE: HV/EHV SWITCHGEAR (PM): SWITCHGEAR EXTERNAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial / minor deterioration	There is little deterioration. The asset may exhibit signs of ageing, surface level scratches,	1	10	0.5

	moss or lichen that can be brushed off. This has no material impact on the probability of failure for the asset.			
Some Deterioration	There is evidence of some degradation such as surface corrosion or minor compound leaks. The level of degradation may affect the operation of the asset if left untended (e.g. large patches of rust on the metal clad switchgear). Evidence of minor mechanism defects.	1.2	10	3.0
Substantial Deterioration	The switchgear is corroded to the point that it can no longer hold its oil / SF6 insulation, one or more metalwork supports are rusted through. Evidence of severe mechanism defects.	1.4	10	8.0
Default	No data available	1	10	0.5

"No deterioration" condition is not proposed because of the difficulty in distinguishing between that and superficial/minor deterioration, similar to Transformer Main Tank Condition.

NEW TABLE: HV/EHV SWITCHGEAR (PM): OIL LEAKS / GAS PRESSURE

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	Oil: No Oil appears to be actively leaking from the component in question. This may include assets with minor stains or marks Gas: Gas pressure reading is within the expected limit AND no OR negligible levels of historical leakage.	0.9	10	0.5
Superficial/minor deterioration	Oil: There is evidence of a small leak, but this is limited to staining of the asset or the ground around the asset AND oil still visible in the sight glass where fitted. Repairs / intervention to the asset is not expected to be required between now and the next planned maintenance Gas: Requires occasional intervention; OR minimal historical leakage	1.0	10	0.5
Some Deterioration	Oil: There is evidence of a small active oil leak from the switchgear e.g. droplets or weeping beneath the fixed portion. Minor maintenance or refurbishment activities (as a minimum) are required to address the identified issue(s) Gas: Gas pressure outside of acceptable range; Requires regular intervention; OR some historical leakage	1.1	10	3.0
Substantial Deterioration	Oil: There is evidence of a significant oil leak from the switchgear e.g. pool of oil under/around the equipment, the switchgear may be draining or completely drained of oil and / or compound. Gas: Severe unrepairable leak; Requires frequent intervention; OR substantial historical leakage.	1.3	10	8.0
Default	No data available	1	10	0.5

NEW TABLE: BATTERY SYSTEM: BATTERIES VISUAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No or Minor/Superficial Deterioration	No observed deterioration, minor/superficial Fit for purpose	1	10	0.5
Substantial Deterioration	Asset is compromised – damage / degradation / end of life. E.g. Case bulging / deformed, visible cracks or evidence of acid escape. Mossing on the plates.	1.5	10	8
Default	No data available	1	10	0.5

NEW TABLE: BATTERY SYSTEM: BATTERIES ENVIRONMENT TEMPERATURE

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable	Ambient temperature is at or below the rated value for the battery	1	10	0.5
Not Acceptable	Ambient temperature is persistently above the rated value for the battery	1.5	10	0.5
Default	No data available	1	10	0.5

NEW TABLE: BATTERY SYSTEM: CHARGERS VISUAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	No observed deterioration, performing as designed	1	10	0.5
Some Deterioration	The asset is fit for continued service. There is little deterioration, minor corrosion etc	1.2	10	0.5
Substantial Deterioration	Asset is compromised. External housing has severe corrosion, rust and/or signs of overheating observed	1.5	10	8
Default	No data available	1	10	0.5

NEW TABLE: POLE LINE CONDUCTOR: VISUAL CONDITION

Condition Criteria: Observed Condition - Visual Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No damage	No observed damage	1	10	0.5
Damaged	Conductor shows sign of damage and / or Insulation is damaged and exposing the conductor underneath	1.4	10	8
Default	No data available	1	10	0.5

NEW TABLE: POLE LINE CONDUCTOR: MIDSPAN JOINTS

Condition Criteria: Observed Condition - Midspan Joints	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
0	No joints in the span. A span includes all conductors in that span	1	10	0.5
1	1 joint in the span	1.05	10	0.5
2	2 joints in the span	1.1	10	0.5
>2	More than two joints in the span	1.2	10	5.5
Default	No data available	1	10	0.5

NEW TABLE: 132KV POLE: VISUAL POLE CONDITION

Note that this includes the proposed expansion of this condition point to accommodate pole strengthening as described in section 1.15.

Condition Criteria: Observed Condition	Description	Condition input factor	Condition Input CAP	Condition INPUT Collar
Acceptable	No significant defects observed. Pole may be new with no/few marks. May include poles with slight damage including (but not limited to) splits and general wear where no material impact on residual strength of pole For “effectively” strengthened poles the installed pole truss allows the bending loads to effectively bypass the decayed or damaged ground line area of the pole, transferring the loads to sound wood foundation below ground line. It can therefore be assumed that the poles in this condition are Acceptable.	1	10	0.5
Some Deterioration	Minor wear on pole or physical damage that will lead to loss of strength, but the short term integrity of the pole is not compromised.	1.3	10	4
Substantial Deterioration	Severe damage to pole. Parts may be chipped off, rotten or disfigured. e.g. visible splits, cracks, major physical damage affecting strength.	1.8	10	8
Default	No data available	1	10	0.5

** For strengthened poles, consideration should be given to the location on the pole of any identified defect. For example, physical damage at the ground line that is mitigated by the system itself may be disregarded, and the visual assessment applied to the remainder of the pole.*

NEW TABLE: 132KV POLE: POLE TOP ROT

Note that this includes the modification of the collar as described in section 1.21.

Condition Criteria: Pole Top Rot Present?	Description	Condition input factor	Condition Input CAP	Condition INPUT Collar
No	No pole top rot observed	1	10	0.5
Yes (suspect)	Pole top rot is suspected but not confirmed	1.2	10	5.5
Yes (confirmed)	Significant Pole top rot is observed	1.3	10	8
Default	No data available	1	10	0.5

NEW TABLE: 132KV POLE: POLE LEANING

Condition Criteria: Pole Leaning?	Description	Condition input factor	Condition Input CAP	Condition INPUT Collar
No	The pole is vertical	1	10	0.5
Yes	The pole is not vertical	1.2	10	0.5
Default	No data available	1	10	0.5

NEW TABLE: 132KV POLE: BIRD / ANIMAL DAMAGE

Condition Criteria: Bird/ Animal Damage?	Description	Condition input factor	Condition Input CAP	Condition INPUT Collar
No	There is no animal damage	1	10	0.5
Yes	There is animal damage	1.3	10	0.5
Default	No data available	1	10	0.5

NEW TABLE: TRANSFORMER (PM) EXTERNAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	Condition as new	0.9	10	0.5
Superficial/minor deterioration	The transformer may exhibit signs of ageing or marks (e.g. surface level scratches, moss or lichen). This has no material impact on the probability of failure for the asset. OR no recorded defects	1.0	10	0.5
Some Deterioration	The asset shows a level of deterioration such as surface corrosion spots. The level of degradation may affect the operation of the asset if left untended (e.g. large patches of rust on the metal work); and/or there is evidence of a small active oil leak (e.g. droplets or weeping).	1.25	10	3.0
Substantial Deterioration	There is evidence of major corrosion or historical oil leakage.	1.4	10	8.0
Default	No data available	1.0	10	0.5

NEW TABLE: TRANSFORMER (PM) BUSHING CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	N/A	N/A	N/A	N/A
Superficial / Minor Deterioration	There are no signs of any deterioration such as cracks, markings, compound leaks, discharge etc. The bushings may exhibit minor exterior stains or marks (e.g. surface level scratches, moss or lichen), but no damage or corrosion should be evident. No evidence of compound leaks, discharge, or deterioration of insulation. OR no recorded defects.	1.0	10	0.5
Some Deterioration	The bushings may exhibit minor damage or corrosion. No evidence of compound leaks, discharge, or deterioration of insulation.	1.1	10	0.5
Substantial Deterioration	Evidence of cracks, markings on bushings. Evidence of discharge, deterioration/ damage of insulation.	1.4	10	8.0
Default	No data available	1.0	10	0.5

PROBABILITY OF FAILURE – MEASURED CONDITION FACTORS

TABLE 14: MEASURED CONDITION INPUTS

Table to be expanded to cover the new asset categories described in Section 3 as follows:

Asset Register Category	Subcomponent	Measured Condition Input
EHV Switchgear – Other	N/A	Operational Adequacy
132kV Switchgear - Other	N/A	Operational Adequacy
HV Switchgear (PM)	N/A	Operational Adequacy
EHV Switchgear (PM)	N/A	Operational Adequacy
Battery System	Batteries	Load/Conductance Test Impedance Test Specific Gravity Test
	Chargers	Low/No Output
LV Main OHL Conductor (Pole Lines)	N/A	None
HV OHL Conductor (Pole Lines)	N/A	Conductor Sampling
EHV OHL Conductor (Pole Lines)	N/A	Conductor Sampling
132kV OHL Conductor (Pole Lines)	N/A	Conductor Sampling
132kV Pole	N/A	Pole decay / deterioration
Transformer (PM)	N/A	None

TABLE 15: MEASURED CONDITION MODIFIER – MMI CALCULATION PARAMETERS

Table to be expanded to cover the new asset categories described in Section 3 as follows:

Asset Register Category	Sub-component	Parameters for Combination Using MMI Technique		
		Factor Divider 1	Factor Divider 2	Max. No. of Combined Factors
EHV Switchgear – Other	N/A	1.5	1.5	1
132kV Switchgear - Other	N/A	1.5	1.5	1
HV Switchgear (PM)	N/A	1.5	1.5	1
EHV Switchgear (PM)	N/A	1.5	1.5	1
Battery System	Batteries	1.5	1.5	1
	Chargers	1.5	1.5	1
LV Main OHL Conductor (Pole Lines)	N/A	N/A	N/A	N/A
HV OHL Conductor (Pole Lines)	N/A	1.5	1.5	1
EHV OHL Conductor (Pole Lines)	N/A	1.5	1.5	1
132kV OHL Conductor (Pole Lines)	N/A	1.5	1.5	1
Transformer (PM)	N/A	N/A	N/A	N/A

NEW TABLE: EHV/132KV SWITCHGEAR OTHER: OPERATIONAL ADEQUACY

Condition Criteria: Measured Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable	The device can be operated safely	1	10	0.5
Unacceptable	The device cannot be operated safely	1.6	10	8
Default	No data available	1	10	0.5

NEW TABLE: HV/EHV SWITCHGEAR (PM): OPERATIONAL ADEQUACY

Condition Criteria: Measured Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Operable	The device can be operated safely	1	10	0.5
Inoperable	The device cannot be operated safely	1.6	10	8
Default	No data available	1	10	0.5

NEW TABLE: BATTERY SYSTEM: BATTERIES LOAD TEST

Condition Criteria: Measured Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Pass	No observed deterioration	1	10	0.5
Fail	Failed load/discharge test	1.5	10	8
Default	No data available	1	10	0.5

NEW TABLE: BATTERY SYSTEM: BATTERIES IMPEDANCE TEST

Condition Criteria: Measured Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Pass	No observed deterioration	1	10	0.5
Fail	Failed impedance test	1.5	10	8
Default	No data available	1	10	0.5

NEW TABLE: BATTERY SYSTEM: BATTERIES SPECIFIC GRAVITY TEST

Condition Criteria: Measured Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Pass	No observed deterioration	1	10	0.5
Fail	Failed specific gravity test.	1.5	10	8
Default	No data available	1	10	0.5

NEW TABLE: BATTERY SYSTEM: CHARGERS LOW/NO OUTPUT

Condition Criteria: Measured Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Pass	Rated output achieved or in the case where rated output is not achieved, the battery function is still maintained	1	10	0.5
Fail	Low/No Output	1.5	10	8
Default	No data available	1	10	0.5

NEW TABLE: POLE LINE CONDUCTOR: CONDUCTOR SAMPLING

Condition Criteria: Conductor Sampling Result	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Low	No obvious or minor deterioration	1	5.4	0.5
Medium/Normal	Wear is consistent with the duty and environment of the circuit	1.1	10	3
High	Wear indicated that an end of life condition exists	1.4	10	8
Default	No data available	1	10	0.5

NEW TABLE: 132KV POLE: POLE DECAY / DETERIORATION

Note that this includes the proposed expansion of this condition point to accommodate pole strengthening as described in section 1.15.

Condition Criteria: Degree of Decay/Deterioration	Description	Condition input factor	Condition Input CAP	Condition INPUT Collar
None	Zero measured loss of strength	0.8	5.4	0.5
No Significant Decay/Deterioration	Minor loss of strength For “effectively” strengthened poles the installed pole truss allows the bending loads to effectively bypass the decayed or damaged ground line area of the pole, transferring the loads to sound wood foundation below ground line. It can therefore be assumed that the pole has no significant deterioration.	1	6.4	0.5
High	Significant loss of residual strength, still within acceptable level	1.4	10	5.5
Very High	Residual strength below acceptable level	1.8	10	8
Default	No data available	1	10	0.5

** For strengthened poles, consideration should be given to the residual strength of the remainder of the wood pole*

TABLE 55/61/67/74: OBSERVED CONDITION INPUT – HV (DISTRIBUTION & PRIMARY)/EHV/132kV SWITCHGEAR (GM) - DISTRIBUTION: OIL LEAKS / GAS PRESSURE

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	Oil: No Oil appears to be actively leaking from the component in question. This may include assets with minor stains or marks Gas: Gas pressure reading is within the expected limit and no or negligible levels of historical leakage	0.9	10	0.5
Superficial/minor deterioration	Oil: There is evidence of a small leak, but this is limited to staining of the asset or the ground around the asset AND oil still visible in the sight glass where fitted. Repairs / intervention to the asset (or a sub component) is not expected to be required between now and the next planned maintenance Gas: ~~Not used~~ Requires occasional intervention; OR minimal historical leakage	1.0	10	0.5

Slight Deterioration	Oil: There is evidence of a small active oil leak from the switchgear e.g. droplets or weeping beneath the fixed portion. Minor maintenance or refurbishment activities (as a minimum) are required to address the identified issue(s) Gas: Gas pressure outside of acceptable range; Requires regular intervention; OR some historical leakage	1.1	10	3.0
Substantial Deterioration	Oil: There is evidence of a significant oil leak from the switchgear e.g. pool of oil under/around the equipment, the switchgear may be draining or completely drained of oil and / or compound. Gas: Severe unrepairable leak ~~or equipment requiring repeated top ups~~; Requires frequent intervention; OR substantial historical leakage	1.3	10	8.0
Default	No data available	1.0	10	0.5

TABLE 107: OBSERVED CONDITION INPUT - SUBMARINE CABLE: EXTERNAL CONDITION

Condition Criteria	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Good No Deterioration	The asset component exhibits deterioration but is fit for continued service. Asset appears as new. No signs of deterioration or damage	1	10	0.5
Minor Deterioration	Small localised outer serving damaged or missing. Highlights abrasion points early. Cable crossings with no protection	1.2	10	0.5
Poor Some Deterioration	e.g. visible damage to armour Significant sections of outer serving missing Armour corrosion. Small sections of broken armour strands Boulder / objects pinning or damaging cable	1.6	10	5.5
Critical Substantial Deterioration	e.g. mechanical damage to cable armour, loss of armour Significant armour corrosion - effecting integrity of the cable. Significant sections of broken armour strands. Sections of armour missing / Exposed cores. Loops, Bends, Kinks exceeding cable bending radius Significant third party interactions - anchor drag, etc	1.8	10	8
Default	No data available	1	10	0.5

NEW TABLE – OBSERVED CONDITION INPUT – SUB CABLE SHORE END CABLE: CABLE EROSION

Condition Criteria	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Cable Not Visible	Shore end inspection identifies there is no erosion around the cable and so remains buried.	1	10	0.5
Cable Visible	Shore end inspection identifies there is erosion around the cable making cable	1.05	10	5.5

	visible and prone to greater deterioration			
Default	No data available	1	10	0.5

NEW TABLE: OBSERVED CONDITION INPUT – SUBMARINE SHORE END CABLE: CABLE PROTECTION

Condition Criteria	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	Cable not visible or cable protection is visible but has no damage.	1	10	0.5
Some Deterioration	Cable protection visible and is damaged	1.1	10	0.5
Default	No data available	1	10	0.5

NEW TABLE: OBSERVED CONDITION INPUT – SUBMARINE CABLE: CABLE SUSPENSIONS

Condition Criteria	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
None / Minor	No suspensions recorded on Submarine cable or Suspension Present < 0.8m high or <10m long	1	10	0.5
Moderate	Suspension(s) Present 0.8m - 2m high or 10 - 25m long	1.05	10	0.5
Major	Suspension Present > 2m high **or** >25m Long	1.1	10	0.5
Default	No data available	1	10	0.5

Note - More significant criteria should be used where suspension falls between two descriptions. i.e. <0.8m but 15m long should go Moderate and not Minor.

TABLE 108: LV POLE: VISUAL POLE CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable	No significant defects observed. Pole may be new with no/few marks. May include poles with slight damage including (but not limited to) splits and general wear where no material impact on residual strength of pole. For “effectively” strengthened poles the installed pole truss allows the bending loads to effectively bypass the decayed or damaged ground line area of the pole, transferring the loads to sound wood foundation below ground line. It can therefore be assumed that the poles in this condition are Acceptable.	1	10	0.5
Some Deterioration	Minor wear on pole or physical damage that will lead to loss of strength, but the short term integrity of the pole is not compromised.	1.3	10	4.0
Substantial Deterioration	Severe damage to pole. Parts may be chipped off, rotten or disfigured. e.g. visible splits, cracks, major physical damage affecting strength.	1.8	10	8.0
Default	No data available	1	10	0.5

** For strengthened poles, consideration should be given to the location on the pole of any identified defect. For example, physical damage at the ground line that is mitigated by the system itself may be disregarded, and the visual assessment applied to the remainder of the pole.*

TABLE 109: LV POLE: POLE TOP ROT

Condition Criteria: Significant Pole Top Rot	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No	No significant pole top rot observed	1	10	0.5
Yes (suspect)	Pole top rot is suspected but not confirmed	1.2	10	5.5
Yes (confirmed)	Significant Pole top rot is observed	1.3	10	8
Default	No data available	1	10	0.5

TABLE 112: HV POLE: VISUAL POLE CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable	No significant defects observed. Pole may be new with no/few marks. May include poles with slight damage including (but not limited to) splits and general wear where no material impact on residual strength of pole. For “effectively” strengthened poles the installed pole truss allows the bending loads to effectively bypass the decayed or damaged ground line area of the pole, transferring the loads to sound wood foundation below ground line. It can therefore be assumed that the poles in this condition are Acceptable.	1	10	0.5
Some Deterioration	Minor wear on pole or physical damage that will lead to loss of strength, but the short term integrity of the pole is not compromised.	1.3	10	4.0
Substantial Deterioration	Severe damage to pole. Parts may be chipped off, rotten or disfigured. e.g. visible splits, cracks, major physical damage affecting strength.	1.8	10	8.0
Default	No data available	1	10	0.5

** For strengthened poles, consideration should be given to the location on the pole of any identified defect. For example, physical damage at the ground line that is mitigated by the system itself may be disregarded, and the visual assessment applied to the remainder of the pole.*

TABLE 113: HV POLE: POLE TOP ROT

Condition Criteria: Significant Pole Top Rot	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No	No significant pole top rot observed	1	10	0.5
Yes (suspect)	Pole top rot is suspected but not confirmed	1.2	10	5.5
Yes (confirmed)	Significant Pole top rot is observed	1.3	10	8
Default	No data available	1	10	0.5

TABLE 116: EHV POLE: VISUAL POLE CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Acceptable	No significant defects observed. Pole may be new with no/few marks. May include poles with slight damage including (but not limited to) splits and general wear where no material impact on residual strength of pole. For “effectively” strengthened poles the installed pole truss allows the bending loads to effectively bypass the decayed or damaged ground line area of the pole, transferring the loads to sound wood	1	10	0.5

	foundation below ground line. It can therefore be assumed that the poles in this condition are Acceptable.			
Some Deterioration	Minor wear on pole or physical damage that will lead to loss of strength, but the short term integrity of the pole is not compromised.	1.3	10	4.0
Substantial Deterioration	Severe damage to pole. Parts may be chipped off, rotten or disfigured. e.g. visible splits, cracks, major physical damage affecting strength.	1.8	10	8.0
Default	No data available	1	10	0.5

** For strengthened poles, consideration should be given to the location on the pole of any identified defect. For example, physical damage at the ground line that is mitigated by the system itself may be disregarded, and the visual assessment applied to the remainder of the pole.*

TABLE 117: EHV POLE: POLE TOP ROT

Condition Criteria: Significant Pole Top Rot	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No	No significant pole top rot observed	1	10	0.5
Yes	Significant Pole top rot is observed	1.3	10	8
Default	No data available	1	10	0.5

TABLE 192: LV POLE: POLE DECAY / DETERIORATION

Condition Criteria: Degree of Decay/Deterioration	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
None	Zero measured loss of strength	0.8	5.4	0.5
No Significant Decay/Deterioration	Minor loss of strength For "effectively" strengthened poles the installed pole truss allows the bending loads to effectively bypass the decayed or damaged ground line area of the pole, transferring the loads to sound wood foundation below ground line. It can therefore be assumed that the pole has no significant deterioration.	1	6.4	0.5
High	Significant loss of residual strength, still within acceptable level	1.4	10	5.5
Very High	Residual strength below acceptable level	1.8	10	8
Default	No data available	1	10	0.5

** For strengthened poles, consideration should be given to the residual strength of the remainder of the wood pole*

TABLE 193: HV POLE: POLE DECAY / DETERIORATION

Condition Criteria: Degree of Decay/Deterioration	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
None	Zero measured loss of strength	0.8	5.4	0.5
No Significant Decay/Deterioration	Minor loss of strength For "effectively" strengthened poles the installed pole truss allows the bending loads to effectively bypass the decayed or damaged ground line area of the pole, transferring the loads to sound wood foundation below ground line. It can therefore be assumed that the pole has no significant deterioration.	1	6.4	0.5
High	Significant loss of residual strength, still within acceptable level	1.4	10	5.5
Very High	Residual strength below acceptable level	1.8	10	8
Default	No data available	1	10	0.5

** For strengthened poles, consideration should be given to the residual strength of the remainder of the wood pole*

TABLE 194: EHV POLE: POLE: POLE DECAY / DETERIORATION

Condition Criteria: Degree of Decay/Deterioration	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
None	Zero measured loss of strength	0.8	5.4	0.5
No Significant Decay/Deterioration	Minor loss of strength For "effectively" strengthened poles the installed pole truss allows the bending loads to effectively bypass the decayed or damaged ground line area of the pole, transferring the loads to sound wood foundation below ground line. It can therefore be assumed that the pole has no significant deterioration.	1	6.4	0.5
High	Significant loss of residual strength, still within acceptable level	1.4	10	5.5
Very High	Residual strength below acceptable level	1.8	10	8
Default	No data available	1	10	0.5

** For strengthened poles, consideration should be given to the residual strength of the remainder of the wood pole*

TABLE 203: MOISTURE CONDITION STATE CALIBRATION

Oil Type	HV Transformer (GM) EHV Transformer (GM)			132kV Transformer (GM)		
	> Moisture (ppm)	<= Moisture (ppm)	Moisture Score	> Moisture (ppm)	<= Moisture (ppm)	Moisture Score
Mineral Oil (Default)	-0.01	15.00	0	-0.01	15.00	0
	15.00	30.00	2	15.00	20.00	2
	30.00	40.00	4	20.00	30.00	4
	40.00	50.00	8	30.00	40.00	8
	50.00	10000.00	10	40.00	10000.00	10
Synthetic Ester	-0.01	100.00	0	-0.01	50.00	0
	100.00	200.00	2	50.00	150.00	2
	200.00	400.00	4	150.00	350.00	4
	400.00	500.00	8	350.00	450.00	8
	500.00	10000.00	10	450.00	10000.00	10
Natural Ester	-0.01	100.00	0	-0.01	50.00	0
	100.00	200.00	2	50.00	150.00	2
	200.00	400.00	4	150.00	350.00	4
	400.00	500.00	8	350.00	450.00	8
	500.00	10000.00	10	450.00	10000.00	10

TABLE 204: ACIDITY CONDITION STATE CALIBRATION

Oil Type	HV Transformer (GM)			EHV Transformer (GM)			132kV Transformer (GM)		
	> Acidity (mg KOH/g)	<= Acidity (mg KOH/g)	Acidity Score	> Acidity (mg KOH/g)	<= Acidity (mg KOH/g)	Acidity Score	> Acidity (mg KOH/g)	<= Acidity (mg KOH/g)	Acidity Score
Mineral Oil (Default)	-0.01	0.10	0	-0.01	0.10	0	-0.01	0.05	0
	0.10	0.15	2	0.10	0.15	2	0.05	0.10	2
	0.15	0.30	4	0.15	0.30	4	0.10	0.20	4
	0.30	0.50	8	0.30	0.40	8	0.20	0.30	8
	0.50	10000.00	10	0.40	10000.00	10	0.30	10000.00	10
Synthetic Ester	-0.01	0.30	0	-0.01	0.30	0	-0.01	0.30	0
	0.30	0.50	2	0.30	0.50	2	0.30	0.50	2
	0.50	1.00	4	0.50	1.00	4	0.50	1.00	4
	1.00	1.50	8	1.00	1.30	8	1.00	1.20	8
	1.50	10000.00	10	1.30	10000.00	10	1.20	10000.00	10
Natural Ester	-0.01	0.15	0	-0.01	0.15	0	-0.01	0.15	0
	0.15	0.30	2	0.15	0.30	2	0.15	0.30	2

	0.30	0.50	4	0.30	0.50	4	0.30	0.50	4
	0.50	1.00	8	0.50	0.80	8	0.50	0.70	8
	1.00	10000.00	10	0.80	10000.00	10	0.70	10000.00	10

TABLE 205: BREAKDOWN STRENGTH CONDITION STATE CALIBRATION

Oil Type	HV Transformer (GM) EHV Transformer (GM)			132kV Transformer (GM)		
	> BD Strength (kV)	<= BD Strength (kV)	BD Strength Score	> BD Strength (kV)	<= BD Strength (kV)	BD Strength Score
Mineral Oil / Synthetic Ester / Natural Ester	-0.01	30.00	10	-0.01	40.00	10
	30.00	40.00	4	40.00	50.00	4
	40.00	50.00	2	50.00	60.00	2
	50.00	10000.00	0	60.00	10000.00	0

TABLE 208: HYDROGEN CONDITION STATE CALIBRATION

Oil Type	HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)		
	> Hydrogen (ppm)	<= Hydrogen (ppm)	Hydrogen Condition State
Mineral Oil (Default)	-0.01	25.00	0
	25.00	50.00	2
	50.00	100.00	4
	100.00	150.00	10
	150.00	10,000.00	16
Synthetic Ester	-0.01	26.00	0
	26.00	52.00	2
	52.00	67.00	4
	67.00	82.00	10
	82.00	10,000.00	16
Natural Ester	-0.01	52.50	0
	52.50	105.00	2
	105.00	111.50	4
	111.50	118.00	10
	118.00	10,000.00	16

TABLE 209: METHANE CONDITION STATE CALIBRATION

Oil Type	HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)		
	> Methane (ppm)	<= Methane (ppm)	Methane Condition State
Mineral Oil (Default)	-0.01	15.00	0
	15.00	30.00	2
	30.00	80.00	4
	80.00	130.00	10
	130.00	10,000.00	16
Synthetic Ester	-0.01	24.50	0
	24.50	49.00	2
	49.00	92.00	4
	92.00	135.00	10

	135.00	10,000.00	16
Natural Ester	-0.01	9.50	0
	9.50	19.00	2
	19.00	20.50	4
	20.50	22.00	10
	22.00	10,000.00	16

TABLE 21012: ETHYLENE CONDITION STATE CALIBRATION

Oil Type	HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)		
	> Ethylene (ppm)	<= Ethylene (ppm)	Ethylene Condition State
Mineral Oil (Default)	-0.01	30.00	0
	30.00	60.00	2
	60.00	170.00	4
	170.00	280.00	10
	280.00	10,000.00	16
Synthetic Ester	-0.01	39.50	0
	39.50	79.00	2
	79.00	147.00	4
	147.00	215.00	10
	215.00	10,000.00	16
Natural Ester	-0.01	8.50	0
	8.50	17.00	2
	17.00	18.50	4
	18.50	20.00	10
	20.00	10,000.00	16

TABLE 211: ETHANE CONDITION STATE CALIBRATION

Oil Type	HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)		
	> Ethane (ppm)	<= Ethane (ppm)	Ethane Condition State
Mineral Oil (Default)	-0.01	10.00	0
	10.00	20.00	2
	20.00	55.00	4
	55.00	90.00	10
	90.00	10,000.00	16
Synthetic Ester	-0.01	52.50	0
	52.50	105.00	2
	105.00	233.50	4
	233.50	362.00	10
	362.00	10,000.00	16
Natural Ester	-0.01	109.50	0
	109.50	219.00	2
	219.00	233.00	4
	233.00	247.00	10
	247.00	10,000.00	16

TABLE 212: ACETYLENE CONDITION STATE CALIBRATION

Oil Type	HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)		
	> Acetylene (ppm)	<= Acetylene (ppm)	Acetylene Condition State
Mineral Oil (Default)	-0.01	1.00	0
	1.00	2.00	2
	2.00	11.00	4
	11.00	20.00	10
	20.00	10,000.00	16
Synthetic Ester	-0.01	1.00	0
	1.00	2.00	2
	2.00	17.50	4
	17.50	33.00	10
	33.00	10,000.00	16
Natural Ester	-0.01	0.25	0
	0.25	0.50	2
	0.50	0.75	4
	0.75	1.00	10
	1.00	10,000.00	16

TABLE 213: DGA CHANGE CATEGORY CALIBRATION

HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)		
> % Change	<= % Change	Change Category
-1,000.00	-5.00	Negative
-5.00	5.00	Neutral
5.00	25.00	Small
25.00	100.00	Significant
100.00	10,000.00	Large

TABLE 214: DGA TEST FACTOR CALIBRATION

HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)	
> % Change	DGA Test Factor
Negative	1.00 - (0.1 x MIN (DGA Score ÷ DGA Threshold, 1))
Neutral	1.00
Small	1.00 + (0.1 x MIN (DGA Score ÷ DGA Threshold, 1))
Significant	1.00 + (0.2 x MIN (DGA Score ÷ DGA Threshold, 1))
Large	1.00 + (0.5 x MIN (DGA Score ÷ DGA Threshold, 1))

TABLE 215: FFA TEST FACTOR CALIBRATION

HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)	
> % Change	FFATest Factor
Negative	1.00 - (0.1 x MIN (S ÷ FFA Threshold, 1))
Neutral	1.00
Small	1.00 + (0.1 x MIN (S ÷ FFA Threshold, 1))
Significant	1.00 + (0.2 x MIN (S ÷ FFA Threshold, 1))
Large	1.00 + (0.5 x MIN (S ÷ FFA Threshold, 1))

NEW TABLE: FFA CHANGE CATEGORY CALIBRATION

HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)		
> % Change	<= % Change	Change Category
-1,000.00	-5.00	Negative
-5.00	5.00	Neutral
5.00	25.00	Small
25.00	100.00	Significant
100.00	1,000.00	Large

NEW TABLE: TABLE 215: FFA TEST FACTOR CALIBRATION

HV Transformer (GM) EHV Transformer (GM) 132kV Transformer (GM)	
> % Change	DGA Test Factor
Negative	1.00 - (0.1 x MIN (S ÷ FFA Threshold, 1))
Neutral	1.00
Small	1.00 + (0.1 x MIN (S ÷ FFA Threshold, 1))
Significant	1.00 + (0.2 x MIN (S ÷ FFA Threshold, 1))
Large	1.00 + (0.5 x MIN (S ÷ FFA Threshold, 1))

NEW TABLE: AGEING RATE ADJUSTMENT SETS

Regulatory Year	y	$c(y)$				
		Set 1	Set 2	Set 3	Set 4	Set 5
2028/29	2029	1	0.99	1.01	1.01	1
2029/30	2030	1	0.99	1.01	1.01	1
2030/31	2031	1	0.99	1.01	1.01	1
2031/32	2032	1	0.99	1.01	1.01	1
2032/33	2033	1	0.99	1.01	1.01	1
2033/34	2034	1	0.99	1.01	1	1.01
2034/35	2035	1	0.99	1.01	1	1.01
2035/36	2036	1	0.99	1.01	1	1.01
2036/37	2037	1	0.99	1.01	1	1.01
2037/38	2038	1	0.99	1.01	1	1.01
2038/39	2039	1	0.99	1.01	1	1.01
2039/40	2040	1	0.99	1.01	1	1.01
2040/41	2041	1	0.99	1.01	1	1.01

Regulatory Year	y	$c(y)$				
		Set 1	Set 2	Set 3	Set 4	Set 5
2041/42	2042	1	0.99	1.01	1	1.01
2042/43	2043	1	0.99	1.01	1	1.01
All future years*		1	1	1	1	1

** The adjustment values will default to 1 after the 2042/43 regulatory year.*

TABLE 217: REFURBISHMENT INTERVENTIONS

The following is a consolidated list of the additions required to table 217 as a consequence of the proposals described in sections 3 and 4:

Refurbishment Intervention Activity	Health Index Asset Category	Asset Register Category	Input Data Affected by Intervention
Complete replacement of the operating mechanism	EHV Switchgear - Other	33kV and 66kV Switchgear - Other	Reassess Health Score Modifier by reassessing relevant Observed Condition Inputs, Measured Condition Inputs and Reliability Modifier
Replacement of associated/supporting structures (e.g. wooden post, concrete or steel gantry)	EHV Switchgear - Other	33kV and 66kV Switchgear - Other	Reassess Health Score Modifier by reassessing relevant Observed Condition Inputs, Measured Condition Inputs and Reliability Modifier
Complete replacement of the operating mechanism	132kV Switchgear - Other	132kV Switchgear - Other	Reassess Health Score Modifier by reassessing relevant Observed Condition Inputs, Measured Condition Inputs and Reliability Modifier
Replacement of associated/supporting structures (e.g. wooden post, concrete or steel gantry)	132kV Switchgear - Other	132kV Switchgear - Other	Reassess Health Score Modifier by reassessing relevant Observed Condition Inputs, Measured Condition Inputs and Reliability Modifier
Replacement of battery charger	Battery System	Batteries at HV (GM), 33kV,66kV and 132kV.	Reassess Health Score Modifier by reassessing the relevant Observed and Measured Condition Inputs
Replacement of complete battery string	Battery System	Batteries at HV (GM), 33kV,66kV and 132kV.	Reassess Health Score Modifier by reassessing the relevant Observed and Measured Condition Inputs
Pole Strengthening (e.g. clamping a steelwork supporting bracket to an existing pole)	132kV Pole	132kV Pole	Reassess Health Score Modifier by reassessing Pole Decay/Deterioration Measured Condition Inputs
Small footprint steel masts: Replacement of individual steelwork members	132kV Pole	132kV Pole	Reassess Health Score Modifier by reassessing relevant Observed Condition Inputs and Measured Condition Inputs
Replacement of a complete set of insulators associated with an existing pole	LV OHL Support, HV OHL Support – Poles, EHV OHL Support – Poles, 132kV OHL Support - Poles	LV Poles, 6.6/11kV Poles, 20kV Poles, 33kV Pole, 66kV Pole, 132kV Pole	Reassess Health Score Modifier by reassessing Pole Fittings Observed Condition Input
Complete replacement of pole top steelwork (including associated insulators and fittings)			

CONSEQUENCE OF FAILURE - GENERAL

TABLE 16: REFERENCE COSTS OF FAILURE

The table below presents the definitive set of Reference Cost of Failure values, representing the net impact of the proposals outlined within this document (new Asset Register Categories are highlighted in yellow):

Asset Register Category	Financial*	Safety*	Environmental*	Network Performance*	Total*
LV Main (OHL) Conductor	£3,132	£26,561	£24	£3,037	£32,754
LV Poles	£1,337	£601	£90	£542	£2,570
LV Circuit Breaker	£4,070	£9,109	£22	£11,085	£24,285
LV Pillar (ID)	£5,669	£9,109	£22	£8,243	£23,042
LV Pillar (OD at Substation)	£6,170	£9,109	£22	£2,748	£18,048
LV Pillar (OD not at a Substation)	£3,429	£9,622	£22	£8,243	£21,316
LV Board (WM)	£7,833	£9,109	£22	£8,243	£25,206
LV UGB	£3,429	£9,622	£85	£2,748	£15,884
LV Board (X-type Network) (WM)	£9,244	£9,109	£22	£8,243	£26,617
6.6/11kV OHL (Conventional Conductor)	£4,386	£34,153	£24	£17,680	£56,243
6.6/11kV OHL (BLX or similar Conductor)	£6,902	£34,153	£24	£17,680	£58,760
20kV OHL (Conventional Conductor)	£5,678	£34,153	£24	£26,520	£66,375
20kV OHL (BLX or similar Conductor)	£8,763	£34,153	£24	£26,520	£69,460
6.6/11kV Poles	£1,913	£200	£90	£1,930	£4,133
20kV Poles	£2,295	£200	£90	£2,895	£5,480
HV Sub Cable	£181,996	£2	£3,600	£190,344	£375,942
6.6/11kV CB (PM)	£8,358	£5	£1,192	£4,825	£14,379
6.6/11kV CB (GM) Primary	£14,483	£23,502	£1,547	£47,334	£86,865
6.6/11kV CB (GM) Secondary	£9,510	£4,823	£1,486	£13,524	£29,343
6.6/11kV Switch (PM)	£6,213	£1,038	£1,192	£4,825	£13,268
6.6/11kV Switchgear - Other (PM)	£8,358	£1,030	£1,192	£4,825	£15,405
6.6/11kV Switch (GM)	£9,317	£4,823	£1,486	£13,524	£29,149
6.6/11kV RMU	£9,839	£4,823	£1,486	£13,524	£29,672
6.6/11kV X-type RMU	£13,314	£4,823	£1,486	£13,524	£33,147
20kV CB (PM)	£9,753	£1,038	£0	£7,238	£18,029
20kV CB (GM) Primary	£18,144	£23,502	£1,547	£47,334	£90,527
20kV CB (GM) Secondary	£9,702	£4,823	£1,486	£20,286	£36,297
20kV Switch (PM)	£4,785	£1,038	£1,192	£7,238	£14,253
20kV Switchgear - Other (PM)	£4,785	£1,038	£1,192	£7,238	£14,253
20kV Switch (GM)	£9,575	£4,823	£1,486	£20,286	£36,170
20kV RMU	£10,024	£4,823	£1,486	£20,286	£36,618
6.6/11kV Transformer (PM)	£3,107	£1,038	£2,063	£430	£6,639
6.6/11kV Transformer (GM)	£13,413	£4,823	£3,809	£5,072	£27,117
20kV Transformer (PM)	£4,004	£1,038	£2,063	£565	£7,670
20kV Transformer (GM)	£15,272	£4,823	£3,809	£5,072	£28,976
Batteries at GM HV Substations	£896	£5	£24	£16	£941
33kV OHL (Pole Line) Conductor	£8,437	£56,784	£24	£706	£65,951
33kV Pole	£2,466	£200	£90	£92	£2,847
66kV OHL (Pole Line) Conductor	£9,855	£56,784	£24	£1,830	£68,493
66kV Pole	£3,718	£200	£90	£225	£4,233
33kV OHL (Tower Line) Conductor	£17,793	£59,135	£96	£1,333	£78,357
33kV Tower	£6,749	£377	£186	£580	£7,893
33kV Fittings	£227	£1,508	£96	£267	£2,098
66kV OHL (Tower Line) Conductor	£23,600	£70,677	£96	£2,667	£97,040
66kV Tower	£12,647	£377	£186	£1,663	£14,873
66kV Fittings	£292	£1,508	£96	£533	£2,429
33kV UG Cable (Non Pressurised)	£31,644	£2	£726	£3,530	£35,901
33kV UG Cable (Oil)	£130	£2	£5,885	£4	£6,020
33kV UG Cable (Gas)	£317	£2	£54	£35	£407

Asset Register Category	Financial*	Safety*	Environmental*	Network Performance*	Total*
66kV UG Cable (Non Pressurised)	£64,021	£2	£726	£7,059	£71,808
66kV UG Cable (Oil)	£141	£2	£5,885	£7	£6,034
66kV UG Cable (Gas)	£519	£2	£54	£71	£645
EHV Sub Cable	£285,322	£2	£3,600	£3,530	£292,453
33kV CB (Air Insulated Busbars)(ID) (GM)	£27,707	£23,502	£4,356	£29,120	£84,685
33kV CB (Air Insulated Busbars)(OD) (GM)	£17,870	£23,502	£4,356	£14,740	£60,467
33kV CB (Gas Insulated Busbars)(ID)(GM)	£41,968	£23,502	£4,356	£29,120	£98,946
33kV CB (Gas Insulated Busbars)(OD)(GM)	£21,984	£23,502	£4,356	£14,740	£64,581
33kV CB (Gas Insulated Busbars)(OD)(GM)	£21,984	£23,502	£4,356	£14,740	£64,581
33kV Switch (GM)	£10,257	£23,502	£4,356	£14,740	£52,854
33kV Switchgear - Other	£4,788	£3	£8	£3,811	£8,610
33kV Switch (PM)	£4,012	£1,233	£2,391	£1,798	£9,434
33kV RMU	£25,347	£23,502	£4,356	£14,740	£67,944
66kV CB (Air Insulated Busbars)(ID) (GM)	£55,230	£23,502	£4,356	£29,120	£112,207
66kV CB (Air Insulated Busbars)(OD) (GM)	£46,252	£23,502	£4,356	£14,740	£88,849
66kV CB (Gas Insulated Busbars)(ID)(GM)	£99,608	£23,502	£4,356	£29,120	£156,586
66kV CB (Gas Insulated Busbars)(OD)(GM)	£52,176	£23,502	£4,356	£14,740	£94,773
66kV Switchgear - Other	£5,218	£3	£8	£3,811	£9,041
33kV Transformer (PM)	£2,649	£1,038	£2,169	£565	£6,421
33kV Transformer (GM)	£87,698	£23,502	£17,048	£28,940	£157,188
66kV Transformer (GM)	£134,796	£23,502	£17,048	£28,940	£204,285
Batteries at 33kV Substations	£3,765	£5	£38	£0	£3,808
Batteries at 66kV Substations	£3,765	£5	£38	£0	£3,808
132kV OHL (Pole Line) Conductor	£14,948	£102,047	£24	£5,164	£122,158
132kV Pole	£4,589	£200	£0	£608	£5,397
132kV OHL (Tower Line) Conductor	£20,408	£70,677	£96	£6,079	£97,259
132kV Tower	£14,623	£377	£186	£3,687	£18,873
132kV Fittings	£485	£1,508	£96	£1,216	£3,306
132kV UG Cable (Non Pressurised)	£109,244	£2	£1,086	£15,687	£126,019
132kV UG Cable (Oil)	£155	£2	£7,410	£16	£7,582
132kV UG Cable (Gas)	£802	£2	£81	£157	£1,041
132kV Sub Cable	£480,542	£2	£3,600	£15,687	£499,831
132kV CB (Air Insulated Busbars)(ID) (GM)	£154,812	£36,171	£21,756	£134,693	£347,432
132kV CB (Air Insulated Busbars)(OD) (GM)	£38,181	£36,171	£21,756	£34,033	£130,140
132kV CB (Gas Insulated Busbars)(ID) (GM)	£322,430	£36,171	£21,756	£134,693	£515,050
132kV CB (Gas Insulated Busbars)(OD) (GM)	£168,892	£36,171	£21,756	£34,033	£260,852
132kV Switchgear - Other	£10,587	£3	£29	£8,532	£19,151
132kV Transformer (GM)	£263,015	£36,171	£35,095	£201,681	£535,961
Batteries at 132kV Substations	£3,896	£5	£38	£2	£3,941

** - values rounded to nearest £ for presentation in this table*

TABLE 236: TYPICAL COF WEIGHTINGS FOR CRITICALITY INDEX BANDS FOR USE WITH RISK MATRICES

Asset Register Category	Typical COF Weightings for Each Criticality Index Band (£ at 20/21 prices)			
	C1	C2	C3	C4
LV Main (OHL) Conductor	£22,928	£32,754	£49,131	£81,886
LV Poles	£1,799	£2,570	£3,855	£6,424
LV Circuit Breaker	£17,000	£24,285	£36,428	£60,713
LV Pillar (ID)	£16,129	£23,042	£34,563	£57,605
LV Pillar (OD at Substation)	£12,634	£18,048	£27,072	£45,120
LV Pillar (OD not at a Substation)	£14,921	£21,316	£31,974	£53,289
LV Board (WM)	£17,644	£25,206	£37,810	£63,016
LV UGB	£11,118	£15,884	£23,825	£39,709
LV Board (X-type Network) (WM)	£18,632	£26,617	£39,926	£66,543
6.6/11kV OHL (Conventional Conductor)	£39,370	£56,243	£84,365	£140,608
6.6/11kV OHL (BLX or similar Conductor)	£41,132	£58,760	£88,139	£146,899
20kV OHL (Conventional Conductor)	£46,463	£66,375	£99,563	£165,938
20kV OHL (BLX or similar Conductor)	£48,622	£69,460	£104,190	£173,651
6.6/11kV Poles	£2,893	£4,133	£6,200	£10,333
20kV Poles	£3,836	£5,480	£8,221	£13,701
HV Sub Cable	£263,159	£375,942	£563,913	£939,854
6.6/11kV CB (PM)	£10,065	£14,379	£21,569	£35,948
6.6/11kV CB (GM) Primary	£60,806	£86,865	£130,298	£217,163
6.6/11kV CB (GM) Secondary	£20,540	£29,343	£44,014	£73,357
6.6/11kV Switch (PM)	£9,287	£13,268	£19,902	£33,169
6.6/11kV Switchgear - Other (PM)	£10,783	£15,405	£23,107	£38,512
6.6/11kV Switch (GM)	£20,405	£29,149	£43,724	£72,874
6.6/11kV RMU	£20,770	£29,672	£44,508	£74,180
6.6/11kV X-type RMU	£23,203	£33,147	£49,721	£82,868
20kV CB (PM)	£13,440	£19,199	£28,799	£47,998
20kV CB (GM) Primary	£63,369	£90,527	£135,790	£226,316
20kV CB (GM) Secondary	£25,408	£36,297	£54,445	£90,742
20kV Switch (PM)	£9,977	£14,253	£21,379	£35,632
20kV Switchgear - Other (PM)	£9,977	£14,253	£21,379	£35,632
20kV Switch (GM)	£25,319	£36,170	£54,255	£90,425
20kV RMU	£25,633	£36,618	£54,928	£91,546
6.6/11kV Transformer (PM)	£4,647	£6,639	£9,958	£16,597
6.6/11kV Transformer (GM)	£18,982	£27,117	£40,675	£67,792
20kV Transformer (PM)	£5,369	£7,670	£11,505	£19,175
20kV Transformer (GM)	£20,283	£28,976	£43,464	£72,440
Batteries at GM HV Substations	£659	£941	£1,411	£2,352
33kV OHL (Pole Line) Conductor	£46,166	£65,951	£98,926	£164,877
33kV Pole	£1,993	£2,847	£4,271	£7,118
66kV OHL (Pole Line) Conductor	£47,945	£68,493	£102,740	£171,233
66kV Pole	£2,963	£4,233	£6,349	£10,582
33kV OHL (Tower Line) Conductor	£54,850	£78,357	£117,536	£195,893
33kV Tower	£5,525	£7,893	£11,839	£19,732
33kV Fittings	£1,469	£2,098	£3,148	£5,246
66kV OHL (Tower Line) Conductor	£67,928	£97,040	£145,559	£242,599
66kV Tower	£10,411	£14,873	£22,309	£37,181
66kV Fittings	£1,701	£2,429	£3,644	£6,074
33kV UG Cable (Non Pressurised)	£25,131	£35,901	£53,852	£89,754
33kV UG Cable (Oil)	£4,214	£6,020	£9,030	£15,051
33kV UG Cable (Gas)	£285	£407	£611	£1,018
66kV UG Cable (Non Pressurised)	£50,266	£71,808	£107,712	£179,520
66kV UG Cable (Oil)	£4,224	£6,034	£9,051	£15,086
66kV UG Cable (Gas)	£452	£645	£968	£1,613
EHV Sub Cable	£204,717	£292,453	£438,680	£731,133
33kV CB (Air Insulated Busbars)(ID) (GM)	£59,279	£84,685	£127,027	£211,711
33kV CB (Air Insulated Busbars)(OD) (GM)	£42,327	£60,467	£90,700	£151,167
33kV CB (Gas Insulated Busbars)(ID)(GM)	£69,262	£98,946	£148,418	£247,364
33kV CB (Gas Insulated Busbars)(OD)(GM)	£45,206	£64,581	£96,871	£161,452
33kV Switch (GM)	£36,998	£52,854	£79,281	£132,135

Asset Register Category	Typical COF Weightings for Each Criticality Index Band (£ at 20/21 prices)			
	C1	C2	C3	C4
33kV Switchgear - Other	£6,027	£8,610	£12,915	£21,524
33kV Switch (PM)	£6,604	£9,434	£14,151	£23,585
33kV RMU	£47,561	£67,944	£101,916	£169,861
66kV CB (Air Insulated Busbars)(ID) (GM)	£78,545	£112,207	£168,310	£280,517
66kV CB (Air Insulated Busbars)(OD) (GM)	£62,195	£88,849	£133,274	£222,123
66kV CB (Gas Insulated Busbars)(ID)(GM)	£109,610	£156,586	£234,878	£391,464
66kV CB (Gas Insulated Busbars)(OD)(GM)	£66,341	£94,773	£142,159	£236,932
33kV Transformer (GM)	£110,031	£157,188	£235,781	£392,969
66kV Switchgear - Other	£6,328	£9,041	£13,561	£22,601
66kV Transformer (GM)	£143,000	£204,285	£306,428	£510,713
33kV Transformer (PM)	£4,495	£6,421	£9,632	£16,053
Batteries at 33kV Substations	£2,666	£3,808	£5,712	£9,521
Batteries at 66kV Substations	£2,666	£3,808	£5,712	£9,521
132kV OHL (Pole Line) Conductor	£85,527	£122,182	£183,273	£305,455
132kV Pole	£3,841	£5,487	£8,230	£13,717
132kV OHL (Tower Line) Conductor	£68,082	£97,259	£145,889	£243,149
132kV Tower	£13,211	£18,873	£28,309	£47,182
132kV Fittings	£2,314	£3,306	£4,958	£8,264
132kV UG Cable (Non Pressurised)	£88,213	£126,019	£189,029	£315,048
132kV UG Cable (Oil)	£5,308	£7,582	£11,374	£18,956
132kV UG Cable (Gas)	£728	£1,041	£1,561	£2,602
132kV Sub Cable	£349,882	£499,831	£749,747	£1,249,578
132kV CB (Air Insulated Busbars)(ID) (GM)	£243,203	£347,432	£521,149	£868,581
132kV CB (Air Insulated Busbars)(OD) (GM)	£91,098	£130,140	£195,211	£325,351
132kV CB (Gas Insulated Busbars)(ID) (GM)	£360,535	£515,050	£772,576	£1,287,626
132kV CB (Gas Insulated Busbars)(OD) (GM)	£182,596	£260,852	£391,278	£652,129
132kV Transformer (GM)	£375,173	£535,961	£803,942	£1,339,903
132kV Switchgear - Other	£13,406	£19,151	£28,727	£47,879
Batteries at 132kV Substations	£2,759	£3,941	£5,912	£9,853

** values rounded to nearest £ for presentation in this table*

CONSEQUENCE OF FAILURE - FINANCIAL

TABLE 218: REFERENCE FINANCIAL COST OF FAILURE

The table below presents the definitive set of Reference Financial Cost of Failure values, representing the net impact of the proposals outlined within this document (new Asset Register Categories are highlighted in yellow):

Asset Register Category	Relative Proportion of Failure Modes (as a % of total Functional Failures)			Likely Cost of Failure			Refe Fina Cos Fail
	I	D	C	I	D	C[4]	
LV Main (OHL) Conductor	0%	75%	25%	£0	£2,506	£5,012	£3,
LV Poles	20%	70%	10%	£163	£1,631	£1,631	£1,
LV Circuit Breaker	15%	25%	60%	£601	£1,502	£6,007	£4,
LV Pillar (ID)	15%	25%	60%	£837	£2,092	£8,367	£5,
LV Pillar (OD at Substation)	15%	25%	60%	£911	£2,277	£9,107	£6,
LV Pillar (OD not at a Substation)	15%	25%	60%	£506	£1,265	£5,061	£3,
LV Board (WM)	15%	25%	60%	£1,156	£2,890	£11,562	£7,
LV UGB	15%	25%	60%	£506	£1,265	£5,061	£3,
LV Board (X-type Network) (WM)	15%	25%	60%	£1,365	£3,411	£13,644	£9,
6.6/11kV OHL (Conventional Conductor)	0%	75%	25%	£0	£3,509	£7,018	£4,
6.6/11kV OHL (BLX or similar Conductor)	0%	75%	25%	£0	£5,522	£11,044	£6,
20kV OHL (Conventional Conductor)	0%	75%	25%	£0	£4,542	£9,085	£5,
20kV OHL (BLX or similar Conductor)	0%	75%	25%	£0	£7,011	£14,021	£8,
6.6/11kV Poles	20%	70%	10%	£233	£2,333	£2,333	£1,
20kV Poles	20%	70%	10%	£280	£2,799	£2,799	£2,
HV Sub Cable	0%	0%	100%	£3,640	£9,100	£181,996	£181
6.6/11kV CB (PM)	30%	20%	50%	£4,916	£9,832	£9,832	£8,
6.6/11kV CB (GM) Primary	45%	50%	5%	£3,448	£8,621	£172,422	£14
6.6/11kV CB (GM) Secondary	15%	25%	60%	£1,027	£2,567	£14,523	£9,
6.6/11kV Switch (PM)	30%	20%	50%	£3,654	£7,309	£7,309	£6,
6.6/11kV Switchgear - Other (PM)	30%	20%	50%	£4,916	£9,832	£9,832	£8,
6.6/11kV Switch (GM)	15%	25%	60%	£777	£1,944	£14,523	£9,
6.6/11kV RMU	15%	25%	60%	£1,452	£3,630	£14,523	£9,
6.6/11kV X-type RMU	15%	25%	60%	£1,965	£4,914	£19,652	£13
20kV CB (PM)	30%	20%	50%	£5,737	£11,475	£11,475	£9,
20kV CB (GM) Primary	45%	50%	5%	£4,320	£10,800	£216,007	£18
20kV CB (GM) Secondary	15%	25%	60%	£1,064	£2,662	£14,795	£9,
20kV Switch (PM)	30%	20%	50%	£2,815	£5,629	£5,629	£4,
20kV Switchgear - Other (PM)	30%	20%	50%	£2,815	£5,629	£5,629	£4,
20kV Switch (GM)	15%	25%	60%	£901	£2,253	£14,795	£9,
20kV RMU	15%	25%	60%	£1,479	£3,699	£14,795	£10
6.6/11kV Transformer (PM)	25%	25%	50%	£401	£4,009	£4,009	£3,
6.6/11kV Transformer (GM)	15%	25%	60%	£1,372	£3,431	£20,583	£13
20kV Transformer (PM)	25%	25%	50%	£517	£5,166	£5,166	£4,
20kV Transformer (GM)	15%	25%	60%	£1,563	£3,906	£23,436	£15
Batteries at GM HV Substations	0%	70%	30%	£0	£472	£1,887	£8
33kV OHL (Pole Line) Conductor	0%	75%	25%	£0	£6,749	£13,498	£8,
33kV Pole	20%	70%	10%	£300	£3,007	£3,007	£2,
66kV OHL (Pole Line) Conductor	0%	75%	25%	£0	£7,884	£15,768	£9,
66kV Pole	20%	70%	10%	£453	£4,534	£4,534	£3,
33kV OHL (Tower Line) Conductor	0%	85%	15%	£0	£15,472	£30,945	£17
33kV Tower	80%	20%	0%	£5,177	£12,942	£51,771	£6,
33kV Fittings	80%	15%	5%	£136	£339	£1,353	£2
66kV OHL Conductor	0%	85%	15%	£0	£20,522	£41,043	£23
66kV Tower	80%	20%	0%	£9,700	£24,251	£97,000	£12
66kV Fittings	80%	15%	5%	£174	£436	£1,742	£2
33kV UG Cable (Non Pressurised)	0%	0%	100%	£3,164	£7,911	£31,644	£31

Asset Register Category	Relative Proportion of Failure Modes (as a % of total Functional Failures)			Likely Cost of Failure			Refe Fina Cos Fail
	I	D	C	I	D	C[4]	
33kV UG Cable (Oil)	100%	0.09%	0.01%	£120	£7,911	£31,644	£1
33kV UG Cable (Gas)	99%	0.50%	0.50%	£120	£7,911	£31,644	£3
66kV UG Cable (Non Pressurised)	0%	0%	100%	£6,402	£16,006	£64,021	£64
66kV UG Cable (Oil)	100%	0.09%	0.01%	£120	£16,006	£64,021	£1
66kV UG Cable (Gas)	99%	0.50%	0.50%	£120	£16,006	£64,021	£5
EHV Sub Cable	0%	0%	100%	£5,706	£14,266	£285,322	£285
33kV CB (Air Insulated Busbars)(ID) (GM)	45%	50%	5%	£6,597	£16,492	£329,854	£27
33kV CB (Air Insulated Busbars)(OD) (GM)	45%	50%	5%	£8,122	£20,307	£81,224	£17
33kV CB (Gas Insulated Busbars)(ID) (GM)	45%	50%	5%	£9,993	£24,981	£499,620	£41
33kV CB (Gas Insulated Busbars)(OD) (GM)	45%	50%	5%	£9,993	£24,981	£99,924	£21
33kV Switch (GM)	45%	50%	5%	£4,662	£11,656	£46,621	£10
33kV Switchgear - Other	25%	25%	50%	£815	£2,037	£8,149	£4,
33kV Switch (PM)	30%	20%	50%	£2,360	£4,720	£4,720	£4,
33kV RMU	45%	50%	5%	£11,521	£28,804	£115,214	£25
66kV CB (Air Insulated Busbars)(ID) (GM)	45%	50%	5%	£13,150	£32,875	£657,492	£55
66kV CB (Air Insulated Busbars)(OD) (GM)	45%	50%	5%	£21,024	£52,559	£210,237	£46
66kV CB (Gas Insulated Busbars)(ID) (GM)	45%	50%	5%	£23,716	£59,291	£1,185,815	£99
66kV CB (Gas Insulated Busbars)(OD) (GM)	45%	50%	5%	£23,716	£59,291	£237,163	£52
66kV Switchgear - Other	25%	25%	50%	£888	£2,221	£8,882	£5,
33kV Transformer (PM)	25%	25%	50%	£342	£3,418	£3,418	£2,
33kV Transformer (GM)	45%	50%	5%	£39,863	£99,657	£398,629	£87
66kV Transformer	45%	50%	5%	£61,270	£153,178	£612,709	£134
Batteries at 33kV Substations	0%	70%	30%	£0	£1,981	£7,926	£3,
Batteries at 66kV Substations	0%	70%	30%	£0	£1,981	£7,926	£3,
132kV OHL (Pole Line) Conductor	0%	75%	25%	£0	£11,958	£23,916	£14
132kV Pole	20%	70%	10%	£560	£5,596	£5,596	£4,
132kV OHL (Tower Line) Conductor	0%	85%	15%	£0	£17,746	£35,493	£20
132kV Tower	80%	20%	0%	£11,216	£28,041	£112,163	£14
132kV Fittings	80%	15%	5%	£290	£724	£2,896	£4
132kV UG Cable (Non Pressurised)	0%	0%	100%	£10,924	£27,310	£109,244	£109
132kV UG Cable (Oil)	100%	0.09%	0.01%	£120	£27,310	£109,244	£1
132kV UG Cable (Gas)	99%	0.50%	0.50%	£120	£27,310	£109,244	£8
132kV Sub Cable	0%	0%	100%	£9,611	£24,027	£480,542	£480
132kV CB (Air Insulated Busbars)(ID) (GM)	45%	50%	5%	£36,860	£92,150	£1,843,004	£154
132kV CB (Air Insulated Busbars)(OD) (GM)	45%	50%	5%	£17,355	£43,387	£173,549	£38
132kV CB (Gas Insulated Busbars)(ID) (GM)	45%	50%	5%	£76,769	£191,923	£3,838,453	£322
132kV CB (Gas Insulated Busbars)(OD) (GM)	45%	50%	5%	£76,769	£191,923	£767,691	£168
132kV Switchgear - Other	25%	25%	50%	£1,802	£4,505	£18,020	£10
132kV Transformer	45%	50%	5%	£119,552	£298,880	£1,195,522	£263
Batteries at 132kV Substations	0%	70%	30%	£0	£2,051	£8,202	£3,

** - values rounded to nearest £ for presentation in this table*

TABLE 219: TYPE FINANCIAL FACTOR

Asset Register Category	Type Financial Factor Criteria	Type Financial Factor
6.6/11kV Transformer (GM)	6.6/11kV - LV: ≥750kVA	1.15
	6.6/11kV - LV: ≥500kVA and <750kVA	1
	6.6/11kV - LV: <500kVA	0.85
	6.6/11 kV - 6.6/11 kV Inter-system transformers (HV/HV)	2
	Reactors & regulators	2
20KV Transformer (GM)	20kV - LV: ≥750kVA	1.15
	20kV - LV: ≥500kVA and <750kVA	1
	20kV - LV: <500kVA	0.85
	20kV – 6.6/11kV Inter-system transformers (HV/HV)	2
	Reactors & regulators	2
33kV Transformer (GM)	33/20kV, >20MVA CMR equivalent	1.25
	33/20kV, >10MVA and ≤20MVA CMR equivalent	1.1
	33/20kV, ≤10MVA CMR equivalent	1
	33/11 or 6.6kV, >20MVA CMR equivalent	1.1
	33/11 or 6.6kV, >10MVA and ≤20MVA CMR equivalent	1
	33/11 or 6.6kV, ≤10MVA CMR equivalent	0.9
	Reactors & regulators	2
66kV Transformer (GM)	66/20kV, >20MVA CMR equivalent	1.25
	66/20kV, >10MVA and ≤20MVA CMR equivalent	1.1
	66/20kV, ≤10MVA CMR equivalent	1
	66/33kV	1.1
	66/11/11kV	1.1
	66/11 or 6.6kV, >20MVA CMR equivalent	1.1
	66/11 or 6.6kV, >10MVA and ≤20MVA CMR equivalent	1
	66/11 or 6.6kV, ≤10MVA CMR equivalent	0.9
	Reactors & regulators	2
132kV Transformer (GM)	132/66kV, ≤60MVA	1.05
	132/66kV, >60MVA	1.15
	132/33kV, ≤60MVA	0.9
	132/33kV, >60MVA	1
	132/11/11kV	1.1
	132/11kV	0.85
	132/20kV	0.95
	132/20/20kV	1.1
	Reactors & regulators	2
33kV Switchgear – Other	Motorised disconnector	1.5
	Non-motorised disconnector	1
	Earth switch	0.7
	Fault thrower	0.7
66kV Switchgear – Other	Motorised disconnector	1.5
	Non-motorised disconnector	1
	Earth switch	0.7
	Fault thrower	0.7
132kV Switchgear – Other	Motorised disconnector	1.5
	Non-motorised disconnector	1
	Earth switch	0.7
	Fault thrower	0.7
132kV Pole*	Pole (supporting conductor only)	1
	Small footprint steel masts	2
6.6/11kV Transformer (PM)	< 50kVA,1P	0.5
	≥ 50kVA, 1P	0.6
	< 50kVA, 3P	0.7
	≥ 50kVA and < 200kVA, 3P	0.8
	≥ 200kVA, 3P	1
	Reactors & Regulators	2
20kV Transformer (PM)	< 50kVA,1P	0.5
	≥ 50kVA, 1P	0.6
	< 50kVA, 3P	0.7
	≥ 50kVA and < 200kVA, 3P	0.8
	≥ 200kVA, 3P	1

Asset Register Category	Type Financial Factor Criteria	Type Financial Factor
	Reactors & Regulators	2
33kV Transformer (PM)	< 50kVA,1P	0.5
	≥ 50kVA, 1P	0.6
	< 50kVA, 3P	0.7
	≥ 50kVA and < 200kVA, 3P	0.8
	≥ 200kVA, 3P	1
	Reactors & Regulators	2
HV Sub Cable	Submarine Single Wire Armour	1
	Submarine Double Wire Armour	1.1
	Non-Marine cable	0.8
	Default	1
EHV Sub Cable	Submarine Single Wire Armour	1
	Submarine Double Wire Armour	1.1
	Non-Marine cable	0.8
	Default	1
132kV Sub Cable	Submarine Single Wire Armour	1
	Submarine Double Wire Armour	1.1
	Non-Marine cable	0.8
	Default	1

For LV Main (OHL) Conductor, the use of ABC type conductor is more costly compared to other conductor types. Therefore, to account for the increased expense, a factor of 1.5 should be applied when the LV Main (OHL) conductor type is ABC.

TABLE 220: ACCESS FACTOR: OHL

Asset Register Category	Access Factor		
	Type A Criteria - Normal Access (& Default Value)	Type B Criteria – Constrained Access	Type C Criteria - Major Crossing (e.g. associated span crosses railway, major road, large waterway)
LV Main (OHL) Conductor	1	1	3
6.6/11kV OHL (BLX or similar Conductor)	1	1	3
6.6/11kV OHL (Conventional Conductor)	1	1	3
20kV OHL (Conventional Conductor)	1	1	3
20kV OHL (BLX or similar Conductor)	1	1	3
33kV OHL (Pole Line) Conductor	1	1	3
66kV OHL (Pole Line) Conductor	1	1	3
132kV OHL (Pole Line) Conductor	1	1	3
132kV Pole	1	1.25	3
LV OHL Support	1	1.25	3
HV Switchgear (PM)	1	1.1	N/A
HV Transformer (PM)	1	1.1	N/A
HV OHL Support - Poles	1	1.25	3
EHV Switchgear - Other	1	1.1	N/A
EHV Switchgear (PM)	1	1.1	N/A
EHV Transformer (PM)	1	1.1	N/A
EHV OHL Support - Poles	1	1.25	3
EHV OHL Support - Towers	1	1.1	1.5
EHV OHL Fittings (Tower Lines)	1	1.1	2
EHV OHL Conductors (Tower Lines)	1	1.1	2
132kV OHL Support - Tower	1	1.1	1.5
132kV OHL Fittings (Tower Lines)	1	1.1	2
132kV OHL Conductors (Tower Lines)	1	1.1	2

TABLE 221: ACCESS FACTOR: BATTERIES, SWITCHGEAR & TRANSFORMER ASSETS

	Access Factor		
Asset Register Category	Type A Criteria - Normal Access (& Default Value)	Type B Criteria - Constrained Access or Confined Working Space	Type C Criteria - Underground substation
LV Switchgear	1	1.25	1.7
HV Transformer (GM)	1	1.25	2
HV Switchgear (GM) - Distribution	1	1.25	1.7
HV Switchgear (GM) - Primary	1	1.15	1.3
EHV Switchgear (GM)	1	1.1	1.25
132kV Switchgear	1	1.1	1.2
EHV Transformer (GM)	1	1.1	1.35
132kV Transformer (GM)	1	1.1	1.25
Batteries at GM HV	1	1.25	1.25
Batteries at 33kV, 66kV, 132kV	1	1.15	1.15

CONSEQUENCE OF FAILURE - SAFETY

TABLE 224: REFERENCE SAFETY PROBABILITIES AND COST OF FAILURE

The table below presents the definitive set of Reference Safety Cost of Failure values, representing the net impact of the proposals outlined within this document (new Asset Register Categories are highlighted in yellow):

Asset Register Category	PROBABILITY OF EVENT PER ASSET FAILURE			Reference Safety Cost of Failure*
	Lost Time Accident	Death or Serious Injury to public	Death or Serious Injury to staff	
LV Main (OHL) Conductor	0.008500000	0.002250000	0.000054400	£26,561
LV Poles	0.0008160	0.0000326	0.0000163	£601
LV Circuit Breaker	0.0000492	0.0004344	0.0003703	£9,109
LV Pillar (ID)	0.0000492	0.0004344	0.0003703	£9,109
LV Pillar (OD at Substation)	0.0000492	0.0004344	0.0003703	£9,109
LV Pillars (OD not at Substation)	0.0000519	0.0004589	0.0003912	£9,622
LV Board (WM)	0.0000492	0.0004344	0.0003703	£9,109
LV UGB	0.0000519	0.0004589	0.0003912	£9,622
LV Board (X-type Network) (WM)	0.0000492	0.0004344	0.0003703	£9,109
6.6/11kV OHL (Conventional Conductor)	0.003400000	0.003000000	0.000001088	£34,153
6.6/11kV OHL (BLX or similar Conductor)	0.003400000	0.003000000	0.000001088	£34,153
20kV OHL (Conventional Conductor)	0.003400000	0.003000000	0.000001088	£34,153
20kV OHL (BLX or similar Conductor)	0.003400000	0.003000000	0.000001088	£34,153
6.6/11kV Poles	0.0002720	0.0000109	0.0000054	£200
20kV Poles	0.0002720	0.0000109	0.0000054	£200
HV Sub Cable	0.0000008	0.0000001	0.0000001	£2
6.6/11kV CB (PM)	0.000017123	0.000000228	0.000000114	£5
6.6/11kV CB (GM) Primary	0.0002603	0.0001150	0.0019606	£23,502
6.6/11kV CB (GM) Secondary	0.0000260	0.0002300	0.0001961	£4,823
6.6/11kV Switch (PM)	0.000085616	0.000005708	0.000085616	£1,038
6.6/11kV Switchgear - Other (PM)	0.000085616	0.000005000	0.000085616	£1,030
6.6/11kV Switch (GM)	0.0000260	0.0002300	0.0001961	£4,823
6.6/11kV RMU	0.0000260	0.0002300	0.0001961	£4,823
6.6/11kV X-type RMU	0.0000260	0.0002300	0.0001961	£4,823
20kV CB (PM)	0.000085616	0.000005708	0.000085616	£1,038
20kV CB (GM) Primary	0.0002603	0.0001150	0.0019606	£23,502
20kV CB (GM) Secondary	0.0000260	0.0002300	0.0001961	£4,823
20kV Switch (PM)	0.000085616	0.000005708	0.000085616	£1,038
20kV Switchgear - Other (PM)	0.000085616	0.000005708	0.000085616	£1,038
20kV Switch (GM)	0.0000260	0.0002300	0.0001961	£4,823
20kV RMU	0.0000260	0.0002300	0.0001961	£4,823
6.6/11kV Transformer (PM)	0.000085616	0.000005708	0.000085616	£1,038
6.6/11kV Transformer (GM)	0.0000260	0.0002300	0.0001961	£4,823
20kV Transformer (PM)	0.000085616	0.000005708	0.000085616	£1,038
20kV Transformer (GM)	0.0000260	0.0002300	0.0001961	£4,823
Batteries at GM HV Substations	0.000017123	0.000000228	0.000000114	£5
33kV OHL (Pole Line) Conductor	0.003400000	0.005000000	0.000001088	£56,784
33kV Pole	0.0002720	0.0000109	0.0000054	£200
66kV OHL (Pole Line) Conductor	0.003400000	0.005000000	0.000001088	£56,784
66kV Pole	0.0002720	0.0000109	0.0000054	£200
33kV OHL (Tower Line) Conductor	0.0034000	0.0051000	0.0001088	£59,135
33kV Tower	0.0001360	0.0000054	0.0000272	£377
33kV Fittings	0.0005440	0.0000218	0.0001088	£1,508
66kV OHL Conductor	0.0034000	0.0061200	0.0001088	£70,677
66kV Tower	0.0001360	0.0000054	0.0000272	£377
66kV Fittings	0.0005440	0.0000218	0.0001088	£1,508
33kV UG Cable (Non Pressurised)	0.0000008	0.0000001	0.0000001	£2
33kV UG Cable (Oil)	0.0000008	0.0000001	0.0000001	£2

Asset Register Category	PROBABILITY OF EVENT PER ASSET FAILURE			Reference Safety Cost of Failure*
	Lost Time Accident	Death or Serious Injury to public	Death or Serious Injury to staff	
33kV UG Cable (Gas)	0.0000008	0.0000001	0.0000001	£2
66kV UG Cable (Non Pressurised)	0.0000008	0.0000001	0.0000001	£2
66kV UG Cable (Oil)	0.0000008	0.0000001	0.0000001	£2
66kV UG Cable (Gas)	0.0000008	0.0000001	0.0000001	£2
EHV Sub Cable	0.0000008	0.0000001	0.0000001	£2
33kV CB (Air Insulated Busbars)(ID) (GM)	0.0002603	0.0001150	0.0019606	£23,502
33kV CB (Air Insulated Busbars)(OD) (GM)	0.0002603	0.0001150	0.0019606	£23,502
33kV CB (Gas Insulated Busbars)(ID) (GM)	0.0002603	0.0001150	0.0019606	£23,502
33kV CB (Gas Insulated Busbars)(OD) (GM)	0.0002603	0.0001150	0.0019606	£23,502
33kV Switch (GM)	0.0002603	0.0001150	0.0019606	£23,502
33kV Switchgear - Other	0.000017123	0.000000100	0.000000114	£3
33kV Switch (PM)	0.000102740	0.000005708	0.000102740	£1,233
33kV RMU	0.0002603	0.0001150	0.0019606	£23,502
66kV CB (Air Insulated Busbars)(ID) (GM)	0.0002603	0.0001150	0.0019606	£23,502
66kV CB (Air Insulated Busbars)(OD) (GM)	0.0002603	0.0001150	0.0019606	£23,502
66kV CB (Gas Insulated Busbars)(ID) (GM)	0.0002603	0.0001150	0.0019606	£23,502
66kV CB (Gas Insulated Busbars)(OD) (GM)	0.0002603	0.0001150	0.0019606	£23,502
66kV Switchgear - Other	0.000017123	0.000000100	0.000000114	£3
33kV Transformer (PM)	0.000085616	0.000005708	0.000085616	£1,038
33kV Transformer (GM)	0.0002603	0.0001150	0.0019606	£23,502
66kV Transformer	0.0002603	0.0001150	0.0019606	£23,502
Batteries at 33kV Substations	0.000017123	0.000000228	0.000000114	£5
Batteries at 66kV Substations	0.000017123	0.000000228	0.000000114	£5
132kV OHL (Pole Line) Conductor	0.003400000	0.009000000	0.000001088	£102,047
132kV Pole	0.000272000	0.000010880	0.000005440	£200
132kV OHL (Tower Line) Conductor	0.0034000	0.0061200	0.0001088	£70,677
132kV Tower	0.0001360	0.0000054	0.0000272	£377
132kV Fittings	0.0005440	0.0000218	0.0001088	£1,508
132kV UG Cable (Non Pressurised)	0.0000008	0.0000001	0.0000001	£2
132kV UG Cable (Oil)	0.0000008	0.0000001	0.0000001	£2
132kV UG Cable (Gas)	0.0000008	0.0000001	0.0000001	£2
132kV Sub Cable	0.0000008	0.0000001	0.0000001	£2
132kV CB (Air Insulated Busbars)(ID) (GM)	0.0004164	0.0000575	0.0031370	£36,171
132kV CB (Air Insulated Busbars)(OD) (GM)	0.0004164	0.0000575	0.0031370	£36,171
132kV CB (Gas Insulated Busbars)(ID) (GM)	0.0004164	0.0000575	0.0031370	£36,171
132kV CB (Gas Insulated Busbars)(OD) (GM)	0.0004164	0.0000575	0.0031370	£36,171
132kV Switchgear - Other	0.000017123	0.000000100	0.000000114	£3
132kV Transformer	0.0004164	0.0000575	0.0031370	£36,171
Batteries at 132kV Substations	0.000017123	0.000000228	0.000000114	£5

TABLE 225: CONSEQUENCE FACTOR – SWITCHGEAR, TRANSFORMERS & OVERHEAD LINES

Safety Consequence Factor		TYPE RISK RATING		
		Low	Medium (Default)	High
Location Risk Rating	Low	0.7	0.9	1.2
	Medium (Default)	0.9	1	1.4
	High	1.2	1.4	1.6

TABLE 227: SAFETY RISK REDUCTION FACTOR

SAFETY RISK REDUCTION FACTOR	
LV UGB with Safety Blanket	0.5
All other assets – including LV UGB without Safety Blanket, Switchgear, Batteries, Transformers, Cables & Overhead Lines	1.0
Default (no data available)	1.0

CONSEQUENCE OF FAILURE - ENVIRONMENTAL

TABLE 228: REFERENCE ENVIRONMENTAL COST OF FAILURE

The table below presents the definitive set of Reference Safety Cost of Failure values, representing the net impact of the proposals outlined within this document (new Asset Register Categories are highlighted in yellow):

Asset Category	Average volume of oil lost per failure (litres)			Average volume of SF6 lost per failure (kg)			Average probability that failure results in a fire			Average quantity of waste per failure (t)			Failures as % of All Failures			Reference Environmental Consequence*
	I	D	C	I	D	C	I	D	C	I	D	C	I	D	C	
LV Main (OHL) Conductor	0	0	0	0	0	0	0	0.001	0.001	0	0.1	0.1	0%	85%	15%	£24
LV Poles	0	0	0	0	0	0	0	0	0.0005	0.5	0.5	0.5	49%	49%	2%	£90
LV Circuit Breaker	0	0	0	0	0	0	0	0.0002	0.005	0.01	0.1	0.25	50%	30%	20%	£22
LV Pillar (ID)	0	0	0	0	0	0	0	0.0002	0.005	0.01	0.1	0.25	50%	30%	20%	£22
LV Pillar (OD at Substation)	0	0	0	0	0	0	0	0.0002	0.005	0.01	0.1	0.25	50%	30%	20%	£22
LV Pillar (OD not at a Substation)	0	0	0	0	0	0	0	0.0002	0.005	0.01	0.1	0.25	50%	30%	20%	£22
LV Board (WM)	0	0	0	0	0	0	0	0.0002	0.005	0.01	0.1	0.25	50%	30%	20%	£22
LV UGB	0	0	0	0	0	0	0	0.0002	0.05	0.01	0.1	0.5	50%	30%	20%	£85
LV Board (X-type Network) (WM)	0	0	0	0	0	0	0	0.0002	0.005	0.01	0.1	0.25	50%	30%	20%	£22
6.6/11kV OHL (Conventional Conductor)	0	0	0	0	0	0	0	0	0.001	0	0	0.1	0%	0%	100%	£24
6.6/11kV OHL (BLX or similar Conductor)	0	0	0	0	0	0	0	0	0.001	0	0	0.1	0%	0%	100%	£24
20kV OHL (Conventional Conductor)	0	0	0	0	0	0	0	0	0.001	0	0	0.1	0%	0%	100%	£24
20kV OHL (BLX or similar Conductor)	0	0	0	0	0	0	0	0	0.001	0	0	0.1	0%	0%	100%	£24
6.6/11kV Poles	0	0	0	0	0	0	0	0	0.0005	0.5	0.5	0.5	49%	49%	2%	£90
20kV Poles	0	0	0	0	0	0	0	0	0.0005	0.5	0.5	0.5	49%	49%	2%	£90
HV Sub Cable	0	0	0	0	0	0	0	0	0	0	0	20	0%	0%	100%	£3,600
6.6/11kV CB (PM)	5	15	61	0.1	0.25	0.7	0	0.0005	0.01	0.2	0.2	0.2	10%	85%	5%	£1,192
6.6/11kV CB (GM) Primary	10	50	150	0.1	0.2	0.5	0	0.0005	0.01	0.1	0.2	0.5	65%	30%	5%	£1,547
6.6/11kV CB (GM) Secondary	10	50	150	0.1	0.1	0.4	0	0.0005	0.01	0.1	0.2	0.5	65%	30%	5%	£1,486
6.6/11kV Switch (PM)	5	15	61	0.1	0.25	0.7	0	0.0005	0.01	0.2	0.2	0.2	10%	85%	5%	£1,192
6.6/11kV Switchgear - Other (PM)	5	15	61	0.1	0.25	0.7	0	0.0005	0.01	0.2	0.2	0.2	10%	85%	5%	£1,192
6.6/11kV Switch (GM)	10	50	150	0.1	0.1	0.4	0	0.0005	0.01	0.1	0.2	0.5	65%	30%	5%	£1,486
6.6/11kV RMU	10	50	150	0.1	0.1	0.4	0	0.0005	0.01	0.1	0.2	0.5	65%	30%	5%	£1,486
6.6/11kV X-type RMU	10	50	150	0.1	0.1	0.4	0	0.0005	0.01	0.1	0.2	0.5	65%	30%	5%	£1,486
20kV CB (PM)	0	15	61	0.1	0.25	0.7	0	0.0005	0.01	0.2	0.2	0.2	10%	85%	5%	£1,170

Asset Category	Average volume of oil lost per failure (litres)			Average volume of SF6 lost per failure (kg)			Average probability that failure results in a fire			Average quantity of waste per failure (t)			Failures as % of All Failures			Reference Environmental Consequence*
	I	D	C	I	D	C	I	D	C	I	D	C	I	D	C	
20kV CB (GM) Primary	10	50	150	0.1	0.2	0.5	0	0.0005	0.01	0.1	0.2	0.5	65%	30%	5%	£1,547
20kV CB (GM) Secondary	10	50	150	0.1	0.1	0.4	0	0.0005	0.01	0.1	0.2	0.5	65%	30%	5%	£1,486
20kV Switch (PM)	5	15	61	0.1	0.25	0.7	0	0.0005	0.01	0.2	0.2	0.2	10%	85%	5%	£1,192
20kV Switchgear - Other (PM)	5	15	61	0.1	0.25	0.7	0	0.0005	0.01	0.2	0.2	0.2	10%	85%	5%	£1,192
20kV Switch (GM)	10	50	150	0.1	0.1	0.4	0	0.0005	0.01	0.1	0.2	0.5	65%	30%	5%	£1,486
20kV RMU	10	50	150	0.1	0.1	0.4	0	0.0005	0.01	0.1	0.2	0.5	65%	30%	5%	£1,486
6.6/11kV Transformer (PM)	10	35	150	0	0	0	0	0.002	0.05	0	0.3	0.3	50%	30%	20%	£2,063
6.6/11kV Transformer (GM)	20	100	300	0	0	0	0.0002	0.002	0.02	1	2	5	50%	40%	10%	£3,809
20kV Transformer (PM)	10	35	150	0	0	0	0	0.002	0.05	0	0.3	0.3	50%	30%	20%	£2,063
20kV Transformer (GM)	20	100	300	0	0	0	0.0002	0.002	0.02	1	2	5	50%	40%	10%	£3,809
Batteries at GM HV Substations	0	0	0	0	0	0	0.00	0.002	0.002	0.00	0.05	0.10	0%	70%	30%	£24
33kV OHL (Pole Line) Conductor	0	0	0	0	0	0	0	0	0.001	0	0	0.1	0%	0%	100%	£24
33kV Pole	0	0	0	0	0	0	0	0	0.0005	0.5	0.5	0.5	49%	49%	2%	£90
66kV OHL (Pole Line) Conductor	0	0	0	0	0	0	0	0	0.001	0	0	0.1	0%	0%	100%	£24
66kV Pole	0	0	0	0	0	0	0	0	0.0005	0.5	0.5	0.5	49%	49%	2%	£90
33kV OHL (Tower Line) Conductor	0	0	0	0	0	0	0	0	0.001	0	0	0.5	0%	0%	100%	£96
33kV Tower	0	0	0	0	0	0	0	0	0.001	0	0	1	0%	0%	100%	£186
33kV Fittings	0	0	0	0	0	0	0	0	0.001	0	0	0.5	0%	0%	100%	£96
66kV OHL (Tower Line) Conductor	0	0	0	0	0	0	0	0	0.001	0	0	0.5	0%	0%	100%	£96
66kV Tower	0	0	0	0	0	0	0	0	0.001	0	0	1	0%	0%	100%	£186
66kV Fittings	0	0	0	0	0	0	0	0	0.001	0	0	0.5	0%	0%	100%	£96
33kV UG Cable (Non Pressurised)	0	0	0	0	0	0	0	0	0.001	0	0	4	0%	0%	100%	£726
33kV UG Cable (Oil)	120	120	1200	0	0	0	0	0	0.001	0.8	0.8	40	45%	54%	1%	£5,885
33kV UG Cable (Gas)	0	0	0	0	0	0	0	0	0.001	0.2	0.2	10	45%	54%	1%	£54
66kV UG Cable (Non Pressurised)	0	0	0	0	0	0	0	0	0.001	0	0	4	0%	0%	100%	£726
66kV UG Cable (Oil)	120	120	1200	0	0	0	0	0	0.001	0.8	0.8	40	45%	54%	1%	£5,885
66kV UG Cable (Gas)	0	0	0	0	0	0	0	0	0.001	0.2	0.2	10	45%	54%	1%	£54
EHV Sub Cable	0	0	0	0	0	0	0	0	0	0	0	20	0%	0%	100%	£3,600
33kV CB (Air Insulated Busbars)(ID) (GM)	25	125	250	0.4	1	3	0	0.0005	0.01	0.2	0.5	2	70%	20%	10%	£4,356
33kV CB (Air Insulated Busbars)(OD) (GM)	25	125	250	0.4	1	3	0	0.0005	0.01	0.2	0.5	2	70%	20%	10%	£4,356
33kV CB (Gas Insulated Busbars)(ID)(GM)	25	125	250	0.4	1	3	0	0.0005	0.01	0.2	0.5	2	70%	20%	10%	£4,356
33kV CB (Gas Insulated Busbars)(OD)(GM)	25	125	250	0.4	1	3	0	0.0005	0.01	0.2	0.5	2	70%	20%	10%	£4,356
33kV Switch (GM)	25	125	250	0.4	1	3	0	0.0005	0.01	0.2	0.5	2	70%	20%	10%	£4,356
33kV Switchgear - Other	0	0	0	0	0	0	0	0	0	0.02	0.05	0.2	70%	20%	10%	£8
33kV Switch (PM)	10	25	80	0.25	0.5	1.5	0	0.0005	0.01	0.2	0.2	0.2	10%	85%	10%	£2,391

Asset Category	Average volume of oil lost per failure (litres)			Average volume of SF6 lost per failure (kg)			Average probability that failure results in a fire			Average quantity of waste per failure (t)			Failures as % of All Failures			Reference Environmental Consequence*
	I	D	C	I	D	C	I	D	C	I	D	C	I	D	C	
33kV RMU	25	125	250	0.4	1	3	0	0.0005	0.01	0.2	0.5	2	70%	20%	10%	£4,356
66kV CB (Air Insulated Busbars)(ID) (GM)	25	125	250	0.4	1	3	0	0.0005	0.01	0.2	0.5	2	70%	20%	10%	£4,356
66kV CB (Air Insulated Busbars)(OD) (GM)	25	125	250	0.4	1	3	0	0.0005	0.01	0.2	0.5	2	70%	20%	10%	£4,356
66kV CB (Gas Insulated Busbars)(ID)(GM)	25	125	250	0.4	1	3	0	0.0005	0.01	0.2	0.5	2	70%	20%	10%	£4,356
66kV CB (Gas Insulated Busbars)(OD)(GM)	25	125	250	0.4	1	3	0	0.0005	0.01	0.2	0.5	2	70%	20%	10%	£4,356
66kV Switchgear - Other	0	0	0	0	0	0	0	0	0	0.02	0.05	0.2	70%	20%	10%	£8
33kV Transformer (PM)	15	75	250	0.1	0.1	0.4	0	0.0005	0.01	0.1	0.2	0.5	65%	30%	5%	£2,169
33kV Transformer (GM)	50	250	2500	0	0	0	0.0002	0.002	0.02	0.2	3	30	50%	40%	10%	£17,048
66kV Transformer (GM)	50	250	2500	0	0	0	0.0002	0.002	0.02	0.2	3	30	50%	40%	10%	£17,048
Batteries at 33kV Substations	0	0	0	0	0	0	0.00	0.002	0.002	0.00	0.10	0.25	0%	70%	30%	£38
Batteries at 66kV Substations	0	0	0	0	0	0	0.00	0.002	0.002	0.00	0.10	0.25	0%	70%	30%	£38
132kV OHL (Pole Line) Conductor	0	0	0	0	0	0	0	0	0.001	0	0	0.1	0%	0%	100%	£24
132kV Pole	0	0	0	0	0	0	0	0	0.0005	0.5	0.5	0.5	49%	49%	2%	£90
132kV OHL (Tower Line) Conductor	0	0	0	0	0	0	0	0	0.001	0	0	0.5	0%	0%	100%	£96
132kV Tower	0	0	0	0	0	0	0	0	0.001	0	0	1	0%	0%	100%	£186
132kV Fittings	0	0	0	0	0	0	0	0	0.001	0	0	0.5	0%	0%	100%	£96
132kV UG Cable (Non Pressurised)	0	0	0	0	0	0	0	0	0.001	0	0	6	0%	0%	100%	£1,086
132kV UG Cable (Oil)	150	150	1500	0	0	0	0	0	0.001	1.2	1.2	60	45%	54%	1%	£7,410
132kV UG Cable (Gas)	0	0	0	0	0	0	0	0	0.001	0.3	0.3	15	45%	54%	1%	£81
132kV Sub Cable	0	0	0	0	0	0	0	0	0	0	0	20	0%	0%	100%	£3,600
132kV CB (Air Insulated Busbars)(ID) (GM)	50	250	1000	4	10	30	0	0.0005	0.01	0.3	2	10	70%	20%	10%	£21,756
132kV CB (Air Insulated Busbars)(OD) (GM)	50	250	1000	4	10	30	0	0.0005	0.01	0.3	2	10	70%	20%	10%	£21,756
132kV CB (Gas Insulated Busbars)(ID) (GM)	50	250	1000	4	10	30	0	0.0005	0.01	0.3	2	10	70%	20%	10%	£21,756
132kV CB (Gas Insulated Busbars)(OD) (GM)	50	250	1000	4	10	30	0	0.0005	0.01	0.3	2	10	70%	20%	10%	£21,756
132kV Switchgear - Other	0	0	0	0	0	0	0	0	0	0.03	0.2	1	70%	20%	10%	£29
132kV Transformer (GM)	100	500	5000	0	0	0	0.0002	0.002	0.02	0.5	10	100	50%	40%	10%	£35,095
Batteries at 132kV Substations	0	0	0	0	0	0	0.00	0.002	0.002	0.00	0.10	0.25	0%	70%	30%	£38

** values rounded to nearest £ for presentation in this table*

TABLE 229: TYPE ENVIRONMENTAL FACTOR

Type environment factor	Oil	SF6	Neither	Default
HV Switchgear (GM) - Primary	0.97	0.05	0.02	0.97
HV Switchgear (GM) - Distribution	0.98	0.04	0.02	0.98
EHV Switchgear (GM)	0.93	0.10	0.03	0.93
132kV Switchgear	0.79	0.24	0.03	0.79
HV Switchgear (PM)	0.74	0.44	0.18	0.74
EHV Switchgear (PM)	0.62	0.50	0.12	0.62

Default Type environmental factor of 1 if not otherwise specified above.

TABLE 230: SIZE ENVIRONMENTAL FACTOR

The following new factors are proposed, with a default of 1 applied if not otherwise specified.

Asset Register Category	Size Environmental Factor Criteria	Size Environmental Factor
6.6/11kV Transformer (GM)	≥2MVA	1.5
	≥750kVA and <2MVA	1
	≥500kVA and <750kVA	1
	<500kVA	0.6
20kV Transformer (GM)	≥2MVA	1.5
	≥750kVA and <2MVA	1
	≥500kVA and <750kVA	1
	<500kVA	0.6
6.6/11kV Transformer (PM)	< 50kVA,1P	0.4
	≥ 50kVA, 1P	0.7
	< 50kVA, 3P	0.4
	≥ 50kVA and < 200kVA, 3P	1
	≥ 200kVA, 3P	1.4
	Reactors & Regulators	1.5
20kV Transformer (PM)	< 50kVA,1P	0.4
	≥ 50kVA, 1P	0.7
	< 50kVA, 3P	0.4
	≥ 50kVA and < 200kVA, 3P	1
	≥ 200kVA, 3P	1.4
	Reactors & Regulators	1.5
33kV Transformer (PM)	< 50kVA,1P	0.4
	≥ 50kVA, 1P	0.7
	< 50kVA, 3P	0.4
	≥ 50kVA and < 200kVA, 3P	1
	≥ 200kVA, 3P	1.4
	Reactors & Regulators	1.5

TABLE 231: LOCATION ENVIRONMENTAL FACTOR

Asset Register Category	Proximity Factor				Bunding Factor	
	Not Close to Water Course (>120m) or No Oil	Moderately Close to Water Course (between 80m and 120m)	Close to Water Course (between 40m and 80m)	Very Close to Water Course (<40m)	Bunded	Not bunded
EHV Switchgear (GM)	0.8	1	1.5	2.5	0.5	1
132kV Switchgear	0.8	1	1.5	2.5	0.5	1
HV Switchgear (PM)	0.8	1	1.5	2.5	0.5	1

EHV Switchgear (PM)	0.8	1	1.5	2.5	0.5	1
HV Transformer (PM)	0.8	1	1.5	2.5	N/A	1
EHV Transformer (PM)	0.8	1	1.5	2.5	N/A	1
HV Transformer (PM)	0.8	1	1.5	2.5	N/A	1
EHV Transformer (PM)	0.8	1	1.5	2.5	N/A	1

CONSEQUENCE OF FAILURE – NETWORK PERFORMANCE

TABLE 233: REFERENCE NETWORK PERFORMANCE COST OF FAILURE FOR LV & HV ASSETS

The table below presents the definitive set of Reference Network Performance Cost of Failure values, representing the net impact of the proposals outlined within this document (new Asset Register Categories and any other changes to existing category inputs are highlighted in yellow):

Asset Category	Reference Number of Connected Customers	Proportion of connected customers restored through immediate (< 3min) switching	Proportion of customers restored	Manual switching time (hours)	Typical repair time (hours)	Proportion of failures that result in interruption to supply	Reference Network Performance Cost (£)*
LV Poles	30	0%	0%	1	5	10%	£542
LV Circuit Breaker	150	0%	85%	1	7	100%	£11,085
LV Pillar (ID)	150	25%	89%	1	7	100%	£8,243
LV Pillar (OD at Substation)	50	25%	89%	1	7	100%	£2,748
LV Pillar (OD not at a Substation)	150	25%	89%	1	7	100%	£8,243
LV Board (WM)	150	25%	89%	1	7	100%	£8,243
LV UGB	50	25%	89%	1	7	100%	£2,748
LV Board (X-type Network) (WM)	150	25%	89%	1	7	100%	£8,243
6.6/11kV OHL (Conventional Conductor)	1000	60%	94%	0.5	3	100%	£17,680
6.6/11kV OHL (BLX or similar Conductor)	1000	60%	94%	0.5	3	100%	£17,680
20kV OHL (Conventional Conductor)	1500	60%	94%	0.5	3	100%	£26,520
20kV OHL (BLX or similar Conductor)	1500	60%	94%	0.5	3	100%	£26,520
6.6/11kV Poles	1000	60%	94%	0.5	4	10%	£1,930
20kV Poles	1500	60%	94%	0.5	4	10%	£2,895
HV Sub Cable	800	40%	60%	2	18	100%	£190,344
6.6/11kV CB (PM)	1000	80%	94%	0.5	2	50%	£4,825
6.6/11kV CB (GM) Primary	3500	60%	94%	0.5	6	60%	£47,334
6.6/11kV CB (GM) Secondary	1000	60%	94%	0.5	6	60%	£13,524
6.6/11kV Switch (PM)	1000	80%	94%	0.5	2	50%	£4,825
6.6/11kV Switchgear - Other (PM)	1000	80%	94%	0.5	2	50%	£4,825
6.6/11kV Switch (GM)	1000	60%	94%	0.5	6	60%	£13,524
6.6/11kV RMU	1000	60%	94%	0.5	6	60%	£13,524
6.6/11kV X-type RMU	1000	60%	94%	0.5	6	60%	£13,524
20kV CB (PM)	1500	80%	94%	50%	2	50%	£7,238
20kV CB (GM) Primary	3500	60%	94%	0.5	6	60%	£47,334
20kV CB (GM) Secondary	1500	60%	94%	0.5	6	60%	£20,286
20kV Switch (PM)	1500	80%	94%	50%	2	50%	£7,238
20kV Switchgear - Other (PM)	1500	80%	94%	0.5	2	50%	£7,238
20kV Switch (GM)	1500	60%	94%	0.5	6	60%	£20,286
20kV RMU	1500	60%	94%	0.5	6	60%	£20,286
6.6/11kV Transformer (PM)	10	0%	0%	0.5	2	50%	£430
6.6/11kV Transformer (GM)	150	0%	85%	0.5	6	60%	£5,072
20kV Transformer (PM)	10	0%	0%	0.5	3	50%	£565
20kV Transformer (GM)	150	0%	85%	0.5	6	60%	£5,072
Batteries at GM HV Substations	1000	60%	94%	0.5	2	0.10%	£16
33kV Transformer (PM)	10	0%	0%	0.5	3	50%	£565

** values rounded to nearest £ for presentation in this table*

TABLE 235: REFERENCE NETWORK PERFORMANCE COST OF FAILURE FOR EHV & 132KV ASSETS (SECURE)

The table below presents the definitive set of Reference Network Performance Cost of Failure values, representing the net impact of the proposals outlined within this document (new Asset Register Categories and any other changes to existing category inputs are highlighted in yellow):

Asset Category	Maximum Demand Used To Derive Reference Cost (MVA)	Load at Risk (MVA) as % of Maximum Demand			Time (hours)			Probability of a coincident fault per hr	Proportion of failures that result in an unplanned outage	Reference Cost For Assets In Secure Networks (£)*
		During T1 period	During T2 period	During T3 period	T1	T2	T3			
33kV OHL (Pole Line) Conductor	12	100%	100%	80%	0	3	3	0.05%	100%	£706
33kV Pole	12	100%	100%	80%	0	3	5	0.05%	10%	£92
66kV OHL (Pole Line) Conductor	24	100%	100%	80%	0	3	5	0.05%	100%	£1,830
66kV Pole	24	100%	100%	80%	0	3	7	0.05%	10%	£225
33kV OHL (Tower Line) Conductor	12	100%	100%	80%	0	3	9	0.05%	100%	£1,333
33kV Tower	12	100%	100%	80%	0	3	24	0.05%	20%	£580
33kV Fittings	12	100%	100%	80%	0	3	9	0.05%	20%	£267
66kV OHL Conductor	24	100%	100%	80%	0	3	9	0.05%	100%	£2,667
66kV Tower	24	100%	100%	80%	0	3	36	0.05%	20%	£1,663
66kV Fittings	24	100%	100%	80%	0	3	9	0.05%	20%	£533
33kV UG Cable (Non Pressurised)	12	100%	100%	80%	0	3	30	0.05%	100%	£3,530
33kV UG Cable (Oil)	12	100%	100%	80%	0	3	30	0.05%	0.10%	£4
33kV UG Cable (Gas)	12	100%	100%	80%	0	3	30	0.05%	1%	£35
66kV UG Cable (Non Pressurised)	24	100%	100%	80%	0	3	30	0.05%	100%	£7,059
66kV UG Cable (Oil)	24	100%	100%	80%	0	3	30	0.05%	0.10%	£7
66kV UG Cable (Gas)	24	100%	100%	80%	0	3	30	0.05%	1%	£71
EHV Sub Cable	12	100%	100%	80%	0	3	30	0.05%	100%	£3,530
33kV CB (Air Insulated Busbars)(ID) (GM)	30	100%	100%	80%	0	2	200	0.05%	55%	£29,120
33kV CB (Air Insulated Busbars)(OD) (GM)	30	100%	100%	80%	0	2	100	0.05%	55%	£14,740
33kV CB (Gas Insulated Busbars)(ID) (GM)	30	100%	100%	80%	0	2	200	0.05%	55%	£29,120
33kV CB (Gas Insulated Busbars)(OD) (GM)	30	100%	100%	80%	0	2	100	0.05%	55%	£14,740
33kV Switch (GM)	30	100%	100%	80%	0	2	100	0.05%	55%	£14,740
33kV Switchgear - Other	30	100%	100%	80%	0	2	24	0.05%	55%	£3,811
33kV Switch (PM)	30	100%	100%	80%	0	2	10	0.05%	55%	£1,798

Asset Category	Maximum Demand Used To Derive Reference Cost (MVA)	Load at Risk (MVA) as % of Maximum Demand			Time (hours)			Probability of a coincident fault per hr	Proportion of failures that result in an unplanned outage	Reference Cost For Assets In Secure Networks (£)*
		During T1 period	During T2 period	During T3 period	T1	T2	T3			
33kV RMU	30	100%	100%	80%	0	2	100	0.05%	55%	£14,740
66kV CB (Air Insulated Busbars)(ID) (GM)	30	100%	100%	80%	0	2	200	0.05%	55%	£29,120
66kV CB (Air Insulated Busbars)(OD) (GM)	30	100%	100%	80%	0	2	100	0.05%	55%	£14,740
66kV CB (Gas Insulated Busbars)(ID) (GM)	30	100%	100%	80%	0	2	200	0.05%	55%	£29,120
66kV CB (Gas Insulated Busbars)(OD) (GM)	30	100%	100%	80%	0	2	100	0.05%	55%	£14,740
66kV Switchgear - Other	30	100%	100%	80%	0	2	24	0.05%	55%	£3,811
33kV Transformer (GM)	15	100%	100%	80%	0	2	400	0.05%	55%	£28,940
66kV Transformer	15	100%	100%	80%	0	2	400	0.05%	55%	£28,940
Batteries at 33kV Substations	15	100%	100%	100%	1	1	1	0.05%	0.10%	£0
Batteries at 66kV Substations	15	100%	100%	100%	1	1	1	0.05%	0.10%	£0
132kV OHL (Pole Line) Conductor	60	100%	100%	70%	0	3	7	0.05%	100%	£5,164
132kV Pole	60	100%	100%	70%	0	3	9	0.05%	10%	£608
132kV OHL (Tower Line) Conductor	60	100%	100%	70%	0	3	9	0.05%	100%	£6,079
132kV Tower	60	100%	100%	70%	0	3	36	0.05%	20%	£3,687
132kV Fittings	60	100%	100%	70%	0	3	9	0.05%	20%	£1,216
132kV UG Cable (Non Pressurised)	60	100%	100%	70%	0	3	30	0.05%	100%	£15,687
132kV UG Cable (Oil)	60	100%	100%	70%	0	3	30	0.05%	0.10%	£16
132kV UG Cable (Gas)	60	100%	100%	70%	0	3	30	0.05%	1%	£157
132kV Sub Cable	60	100%	100%	70%	0	3	30	0.05%	100%	£15,687
132kV CB (Air Insulated Busbars)(ID) (GM)	80	100%	100%	70%	0	1	400	0.05%	55%	£134,693
132kV CB (Air Insulated Busbars)(OD) (GM)	80	100%	100%	70%	0	1	100	0.05%	55%	£34,033
132kV CB (Gas Insulated Busbars)(ID) (GM)	80	100%	100%	70%	0	1	400	0.05%	55%	£134,693
132kV CB (Gas Insulated Busbars)(OD) (GM)	80	100%	100%	70%	0	1	100	0.05%	55%	£34,033
132kV Switchgear - Other	80	100%	100%	70%	0	1	24	0.05%	55%	£8,532
132kV Transformer	60	100%	100%	70%	0	1	800	0.05%	55%	£201,681
Batteries at 132kV Substations	60	100%	100%	100%	1	1	1	0.05%	0.10%	£2

** values rounded to nearest £ for presentation in this table*

NEW TABLE: NETWORK PERFORMANCE PROTECTION FACTOR

For a pole mounted transformer, how the asset is protected impacts on circuits network performance cost should a failure occur. As a result, the following new table is required to reflect the difference by way of an additional factor. This new table allows for the protection arrangement to be classified per asset.

NETWORK PERFORMANCE PROTECTION FACTOR

Protection Zone	Protection Zone Description	Network Performance Protection Factor
Locally	As this asset is directly protected (e.g. HV Fuses above HV pole mounted transformer), the failure of this asset will only effect downstream connected customers	1
Spur	As this asset is group protected by a spur, the failure of this asset will impact all customers connected downstream of the protection zone.	1.3
Sectionaliser/Reclosure	As this asset is group protected by a sectionaliser/reclosure, the failure of this asset will impact all customers connected downstream of the protection zone.	1.6
Source Circuit Breaker	As this asset is group protected by the source circuit breaker, the failure of this asset will impact all customers connected downstream of the protection zone.	2
Default	If the protection arrangement of the pole mounted transformer is unknown.	1

NEW TABLE: REFERENCE NETWORK PERFORMANCE COST OF FAILURE FOR EHV & 132KV ASSETS – NETWORK TYPE

Network type	Network Type Factor
Secure	2.5
Unsecure	1

MONETISED RISK

TABLE 238: RISK MATRIX WEIGHTINGS - MONETISED IN-YEAR RISK

Asset Register Category	Criticality Index Band	In Year Monetised Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
LV Main (OHL) Conductor	C1	52	60	138	223	394
	C2	75	86	197	318	563
	C3	112	129	295	478	844
	C4	187	214	491	796	1,406
LV Poles	C1	4	5	12	19	33
	C2	6	7	16	27	47
	C3	9	11	25	40	71
	C4	16	18	41	67	118
LV Circuit Breaker	C1	20	23	52	85	150
	C2	28	33	75	121	214
	C3	43	49	112	181	321
	C4	71	81	187	302	534
LV Pillar (ID)	C1	21	24	56	90	159
	C2	30	35	80	129	228
	C3	45	52	119	193	341
	C4	76	87	199	322	569
LV Pillar (OD at Substation)	C1	17	19	44	71	125
	C2	24	27	62	101	178
	C3	35	41	93	151	267
	C4	59	68	156	252	446
LV Pillar (OD not at a Substation)	C1	20	22	51	83	147
	C2	28	32	74	119	211
	C3	42	48	110	179	316
	C4	70	80	184	298	526
LV Board (WM)	C1	35	40	91	148	261
	C2	50	57	130	211	373
	C3	74	85	196	317	560
	C4	124	142	326	528	933
LV UGB	C1	24	28	64	104	184
	C2	35	40	92	149	263
	C3	52	60	138	223	394
	C4	87	100	229	372	656
LV Board (X-type Network) (WM)	C1	37	42	96	156	276
	C2	52	60	138	223	394
	C3	79	90	207	335	591
	C4	131	150	344	558	986
6.6/11kV OHL (Conventional Conductor)	C1	90	103	236	383	676
	C2	128	147	338	547	966
	C3	192	221	506	820	1,449
	C4	321	368	844	1,367	2,415
6.6/11kV OHL (BLX or similar Conductor)	C1	94	108	247	400	706
	C2	134	154	353	571	1,009
	C3	201	231	529	857	1,514
	C4	335	385	882	1,428	2,523
20kV OHL (Conventional Conductor)	C1	106	122	279	452	798
	C2	151	174	398	645	1,140
	C3	227	261	598	968	1,710
	C4	378	434	996	1,613	2,850
20kV OHL (BLX or similar Conductor)	C1	111	127	292	473	835
	C2	158	182	417	675	1,193
	C3	238	273	625	1,013	1,789
	C4	396	455	1,042	1,688	2,982
6.6/11kV Poles	C1	7	8	19	30	53

Asset Register Category	Criticality Index Band	In Year Monetised Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
	C2	10	12	27	43	76
	C3	15	17	40	64	114
	C4	25	29	66	107	190
20kV Poles	C1	9	11	25	40	70
	C2	13	15	35	57	101
	C3	20	23	53	85	151
	C4	33	38	88	142	251
HV Sub Cable	C1	1,515	1,739	3,988	6,459	11,412
	C2	2,164	2,485	5,698	9,227	16,303
	C3	3,246	3,727	8,547	13,841	24,455
	C4	5,411	6,212	14,244	23,069	40,759
6.6/11kV CB (PM)	C1	19	22	51	82	145
	C2	27	32	72	117	207
	C3	41	47	108	176	310
	C4	69	79	181	293	517
6.6/11kV CB (GM) Primary	C1	90	103	237	384	679
	C2	129	148	339	549	970
	C3	193	222	508	823	1,455
	C4	322	370	847	1,372	2,424
6.6/11kV CB (GM) Secondary	C1	39	45	103	167	295
	C2	56	64	148	239	422
	C3	84	96	221	358	633
	C4	140	161	369	597	1,055
6.6/11kV Switch (PM)	C1	18	20	47	76	134
	C2	25	29	67	108	191
	C3	38	44	100	162	286
	C4	63	73	167	270	477
6.6/11kV Switchgear - Other (PM)	C1	21	24	54	88	155
	C2	29	34	77	125	222
	C3	44	51	116	188	332
	C4	74	84	194	314	554
6.6/11kV Switch (GM)	C1	39	45	103	166	293
	C2	56	64	147	237	419
	C3	84	96	220	356	629
	C4	139	160	366	593	1,048
6.6/11kV RMU	C1	40	46	104	169	299
	C2	57	65	149	242	427
	C3	85	98	224	362	640
	C4	142	163	373	604	1,067
6.6/11kV X-type RMU	C1	44	51	117	189	334
	C2	63	73	167	270	477
	C3	95	109	250	405	715
	C4	158	182	417	675	1,192
20kV CB (PM)	C1	26	29	68	109	193
	C2	37	42	97	156	276
	C3	55	63	145	234	414
	C4	92	105	241	391	690
20kV CB (GM) Primary	C1	94	108	247	400	707
	C2	134	154	353	572	1,011
	C3	201	231	530	858	1,516
	C4	335	385	883	1,430	2,527
20kV CB (GM) Secondary	C1	49	56	128	207	365
	C2	69	80	182	295	522
	C3	104	119	274	443	783
	C4	173	199	456	739	1,305
20kV Switch (PM)	C1	19	22	50	81	144
	C2	27	31	72	116	205
	C3	41	47	107	174	308

Asset Register Category	Criticality Index Band	In Year Monetised Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
	C4	68	78	179	290	513
20kV Switchgear - Other (PM)	C1	19	22	50	81	144
	C2	27	31	72	116	205
	C3	41	47	107	174	308
	C4	68	78	179	290	513
20kV Switch (GM)	C1	48	55	127	206	364
	C2	69	79	182	294	520
	C3	104	119	273	442	780
	C4	173	198	455	736	1,301
20kV RMU	C1	49	56	129	209	369
	C2	70	80	184	298	527
	C3	105	120	276	447	790
	C4	175	201	460	745	1,317
6.6/11kV Transformer (PM)	C1	10	12	27	44	78
	C2	15	17	39	63	111
	C3	22	25	58	94	167
	C4	37	42	97	157	278
6.6/11kV Transformer (GM)	C1	42	48	111	180	318
	C2	60	69	159	257	454
	C3	90	104	238	386	681
	C4	151	173	397	643	1,135
20kV Transformer (PM)	C1	12	14	31	51	90
	C2	17	20	45	73	128
	C3	26	29	67	109	193
	C4	43	49	112	182	321
20kV Transformer (GM)	C1	45	52	119	192	340
	C2	64	74	170	275	485
	C3	97	111	254	412	728
	C4	161	185	424	687	1,213
Batteries at GM HV Substations	C1	9	11	25	40	71
	C2	13	15	35	57	101
	C3	20	23	53	86	151
	C4	34	38	88	143	252
33kV OHL (Pole Line) Conductor	C1	105	121	277	449	793
	C2	150	173	396	641	1,133
	C3	226	259	594	962	1,699
	C4	376	432	990	1,603	2,832
33kV Pole	C1	8	9	21	35	61
	C2	12	13	30	49	87
	C3	17	20	46	74	131
	C4	29	33	76	123	218
66kV OHL (Pole Line) Conductor	C1	109	126	288	466	823
	C2	156	179	411	666	1,176
	C3	234	269	617	999	1,765
	C4	390	448	1,028	1,665	2,941
66kV Pole	C1	12	14	32	51	91
	C2	17	20	45	73	129
	C3	26	30	68	110	194
	C4	43	49	113	183	324
33kV OHL (Tower Line) Conductor	C1	125	144	329	533	942
	C2	179	205	470	762	1,346
	C3	268	308	705	1,143	2,019
	C4	447	513	1,176	1,904	3,364
33kV Tower	C1	86	99	226	366	646
	C2	123	141	323	523	924
	C3	184	211	484	784	1,385
	C4	307	352	807	1,307	2,309
33kV Fittings	C1	4	5	11	17	30

Asset Register Category	Criticality Index Band	In Year Monetised Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
	C2	6	7	15	24	43
	C3	9	10	23	37	65
	C4	14	16	38	61	108
66kV OHL (Tower Line) Conductor	C1	155	178	408	660	1,167
	C2	221	254	582	943	1,667
	C3	332	381	874	1,415	2,500
	C4	553	635	1,456	2,358	4,167
66kV Tower	C1	162	186	426	689	1,218
	C2	231	265	608	985	1,740
	C3	347	398	912	1,477	2,610
	C4	578	663	1,520	2,462	4,350
66kV Fittings	C1	5	5	12	20	35
	C2	7	8	17	28	50
	C3	10	11	26	43	75
	C4	17	19	44	71	125
33kV UG Cable (Non Pressurised)	C1	471	541	1,241	2,009	3,550
	C2	673	773	1,772	2,870	5,072
	C3	1,010	1,160	2,659	4,306	7,607
	C4	1,683	1,933	4,431	7,176	12,679
33kV UG Cable (Oil)	C1	2,515	2,888	6,622	10,724	18,949
	C2	3,594	4,126	9,460	15,321	27,069
	C3	5,390	6,189	14,190	22,981	40,604
	C4	8,984	10,315	23,650	38,302	67,674
33kV UG Cable (Gas)	C1	366	420	963	1,560	2,757
	C2	523	600	1,376	2,229	3,938
	C3	784	900	2,064	3,343	5,907
	C4	1,307	1,501	3,441	5,572	9,845
66kV UG Cable (Non Pressurised)	C1	943	1,082	2,482	4,019	7,101
	C2	1,347	1,546	3,545	5,741	10,144
	C3	2,020	2,319	5,318	8,612	15,216
	C4	3,367	3,865	8,863	14,353	25,360
66kV UG Cable (Oil)	C1	2,521	2,895	6,637	10,749	18,993
	C2	3,602	4,136	9,482	15,356	27,133
	C3	5,403	6,203	14,223	23,035	40,699
	C4	9,005	10,339	23,705	38,391	67,831
66kV UG Cable (Gas)	C1	580	665	1,526	2,471	4,366
	C2	828	951	2,180	3,530	6,237
	C3	1,242	1,426	3,270	5,295	9,356
	C4	2,070	2,377	5,449	8,825	15,593
EHV Sub Cable	C1	1,179	1,353	3,103	5,025	8,878
	C2	1,684	1,933	4,432	7,178	12,683
	C3	2,525	2,900	6,649	10,767	19,024
	C4	4,209	4,833	11,081	17,946	31,707
33kV CB (Air Insulated Busbars)(ID)(GM)	C1	377	433	992	1,606	2,838
	C2	538	618	1,417	2,295	4,054
	C3	807	927	2,125	3,442	6,081
	C4	1,346	1,545	3,542	5,737	10,136
33kV CB (Air Insulated Busbars)(OD)(GM)	C1	269	309	708	1,147	2,026
	C2	384	441	1,012	1,638	2,895
	C3	576	662	1,518	2,458	4,342
	C4	961	1,103	2,529	4,096	7,237
33kV CB (Gas Insulated Busbars)(ID)(GM)	C1	440	505	1,159	1,877	3,316
	C2	629	722	1,655	2,681	4,737
	C3	943	1,083	2,483	4,022	7,106
	C4	1,572	1,805	4,139	6,703	11,843
33kV CB (Gas Insulated Busbars)(OD)(GM)	C1	287	330	756	1,225	2,164
	C2	410	471	1,080	1,750	3,092
	C3	616	707	1,621	2,625	4,638

Asset Register Category	Criticality Index Band	In Year Monetised Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
	C4	1,026	1,178	2,701	4,375	7,730
33kV Switch (GM)	C1	235	270	619	1,002	1,771
	C2	336	386	884	1,432	2,530
	C3	504	579	1,326	2,148	3,796
	C4	840	964	2,211	3,580	6,326
33kV Switchgear - Other	C1	29	33	76	122	216
	C2	41	47	108	175	309
	C3	62	71	162	262	464
	C4	103	118	270	437	773
33kV Switch (PM)	C1	13	14	33	54	95
	C2	18	21	47	77	136
	C3	27	31	71	115	204
	C4	45	52	119	192	339
33kV RMU	C1	302	347	796	1,289	2,277
	C2	432	496	1,137	1,841	3,253
	C3	648	744	1,705	2,762	4,879
	C4	1,080	1,239	2,842	4,603	8,132
66kV CB (Air Insulated Busbars)(ID) (GM)	C1	1,146	1,316	3,017	4,886	8,634
	C2	1,637	1,880	4,310	6,981	12,334
	C3	2,456	2,820	6,465	10,471	18,501
	C4	4,093	4,700	10,776	17,452	30,834
66kV CB (Air Insulated Busbars)(OD) (GM)	C1	908	1,042	2,389	3,869	6,836
	C2	1,296	1,489	3,413	5,527	9,766
	C3	1,945	2,233	5,120	8,291	14,649
	C4	3,241	3,721	8,533	13,819	24,416
66kV CB (Gas Insulated Busbars)(ID)(GM)	C1	1,599	1,836	4,211	6,819	12,048
	C2	2,285	2,623	6,015	9,742	17,212
	C3	3,427	3,935	9,023	14,612	25,818
	C4	5,712	6,559	15,038	24,354	43,030
66kV CB (Gas Insulated Busbars)(OD)(GM)	C1	968	1,111	2,548	4,127	7,292
	C2	1,383	1,588	3,641	5,896	10,417
	C3	2,074	2,382	5,461	8,844	15,626
	C4	3,457	3,970	9,102	14,740	26,044
66kV Switchgear - Other	C1	30	35	79	129	227
	C2	43	49	113	184	325
	C3	65	74	170	276	487
	C4	108	124	284	459	812
33kV Transformer (PM)	C1	10	11	26	43	75
	C2	14	16	38	61	108
	C3	21	25	56	91	161
	C4	36	41	94	152	269
33kV Transformer (GM)	C1	1,424	1,635	3,748	6,070	10,725
	C2	2,034	2,335	5,354	8,671	15,321
	C3	3,051	3,503	8,031	13,007	22,981
	C4	5,085	5,838	13,385	21,678	38,302
66kV Transformer (GM)	C1	1,850	2,124	4,871	7,889	13,938
	C2	2,643	3,035	6,958	11,269	19,911
	C3	3,965	4,552	10,438	16,904	29,867
	C4	6,608	7,587	17,396	28,173	49,778
Batteries at 33kV Substations	C1	38	44	100	162	286
	C2	54	62	143	231	409
	C3	81	93	214	347	613
	C4	136	156	357	578	1,022
Batteries at 66kV Substations	C1	38	44	100	162	286
	C2	54	62	143	231	409
	C3	81	93	214	347	613
	C4	136	156	357	578	1,022
	C1	195	224	513	831	1,469

Asset Register Category	Criticality Index Band	In Year Monetised Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
132kV OHL (Pole Line) Conductor	C2	279	320	733	1,188	2,098
	C3	418	480	1,100	1,782	3,148
	C4	696	800	1,833	2,969	5,246
132kV Pole	C1	16	18	41	67	118
	C2	22	26	59	95	168
	C3	33	38	88	143	252
	C4	56	64	147	238	420
132kV OHL (Tower Line) Conductor	C1	155	178	409	662	1,169
	C2	222	255	584	945	1,670
	C3	333	382	876	1,418	2,506
	C4	554	637	1,459	2,364	4,176
132kV Tower	C1	205	236	540	875	1,546
	C2	293	337	772	1,250	2,208
	C3	440	505	1,158	1,875	3,312
	C4	733	841	1,929	3,124	5,520
132kV Fittings	C1	6	7	17	27	48
	C2	9	10	24	39	68
	C3	14	16	36	58	102
	C4	23	26	60	96	170
132kV UG Cable (Non Pressurised)	C1	1,654	1,899	4,355	7,053	12,461
	C2	2,363	2,713	6,221	10,075	17,802
	C3	3,545	4,070	9,332	15,113	26,703
	C4	5,908	6,784	15,553	25,189	44,505
132kV UG Cable (Oil)	C1	3,168	3,638	8,340	13,507	23,866
	C2	4,526	5,197	11,915	19,296	34,094
	C3	6,789	7,795	17,872	28,944	51,141
	C4	11,315	12,992	29,787	48,241	85,234
132kV UG Cable (Gas)	C1	935	1,074	2,462	3,986	7,044
	C2	1,336	1,534	3,516	5,695	10,062
	C3	2,004	2,301	5,275	8,542	15,093
	C4	3,339	3,834	8,791	14,237	25,155
132kV Sub Cable	C1	2,014	2,313	5,303	8,588	15,173
	C2	2,878	3,304	7,575	12,268	21,676
	C3	4,316	4,956	11,363	18,403	32,514
	C4	7,194	8,260	18,939	30,671	54,190
132kV CB (Air Insulated Busbars)(ID) (GM)	C1	2,988	3,430	7,864	12,737	22,504
	C2	4,268	4,900	11,235	18,195	32,148
	C3	6,402	7,350	16,852	27,293	48,222
	C4	10,670	12,250	28,087	45,488	80,370
132kV CB (Air Insulated Busbars)(OD) (GM)	C1	1,119	1,285	2,946	4,771	8,429
	C2	1,599	1,835	4,208	6,815	12,042
	C3	2,398	2,753	6,313	10,223	18,063
	C4	3,997	4,589	10,521	17,039	30,105
132kV CB (Gas Insulated Busbars)(ID) (GM)	C1	4,429	5,085	11,659	18,881	33,360
	C2	6,327	7,264	16,655	26,973	47,658
	C3	9,490	10,896	24,983	40,460	71,486
	C4	15,817	18,161	41,638	67,433	119,144
132kV CB (Gas Insulated Busbars)(OD) (GM)	C1	2,243	2,575	5,905	9,563	16,896
	C2	3,204	3,679	8,435	13,661	24,137
	C3	4,806	5,519	12,653	20,491	36,205
	C4	8,011	9,198	21,088	34,152	60,342
132kV Switchgear - Other	C1	64	73	168	272	481
	C2	91	105	240	389	688
	C3	137	157	360	584	1,031
	C4	228	262	601	973	1,719
132kV Transformer (GM)	C1	4,854	5,574	12,779	20,696	36,567
	C2	6,935	7,962	18,256	29,566	52,239
	C3	10,402	11,943	27,384	44,349	78,359

Asset Register Category	Criticality Index Band	In Year Monetised Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
	C4	17,337	19,906	45,640	73,916	130,598
Batteries at 132kV Substations	C1	39	45	103	168	296
	C2	56	64	148	239	423
	C3	84	97	222	359	635
	C4	140	161	370	599	1,058

TABLE 240: TYPICAL CUMULATIVE DISCOUNTED POF WEIGHTINGS FOR HEALTH INDICES BANDS FOR USE IN THE CALCULATION OF LONG TERM RISK FROM RISK MATRICES

Asset Register Category	Typical Cumulative Discounted POF Weightings for Each Health Index Band				
	HI1	HI2	HI3	HI4	HI5
LV Main (OHL) Conductor	0.0566	0.2869	0.5334	0.7588	1.0451
LV Poles	0.0661	0.3694	0.6273	0.8605	1.1519
LV Circuit Breaker	0.029	0.147	0.2734	0.3889	0.5356
LV Pillar (ID)	0.0325	0.165	0.3067	0.4363	0.601
LV Pillar (OD at Substation)	0.0325	0.165	0.3067	0.4363	0.601
LV Pillar (OD not at a Substation)	0.0325	0.165	0.3067	0.4363	0.601
LV Board (WM)	0.0488	0.2475	0.46	0.6545	0.9014
LV UGB	0.0595	0.3327	0.565	0.775	1.0374
LV Board (X-type Network) (WM)	0.0488	0.2475	0.46	0.6545	0.9014
6.6/11kV OHL (Conventional Conductor)	0.0566	0.2869	0.5334	0.7588	1.0451
6.6/11kV OHL (BLX or similar Conductor)	0.0566	0.2869	0.5334	0.7588	1.0451
20kV OHL (Conventional Conductor)	0.0566	0.2869	0.5334	0.7588	1.0451
20kV OHL (BLX or similar Conductor)	0.0566	0.2869	0.5334	0.7588	1.0451
6.6/11kV Poles	0.0661	0.3694	0.6273	0.8605	1.1519
20kV Poles	0.0661	0.3694	0.6273	0.8605	1.1519
HV Sub Cable	0.1429	0.7245	1.3468	1.916	2.639
6.6/11kV CB (PM)	0.1166	0.4682	0.6479	0.8043	0.992
6.6/11kV CB (GM) Primary	0.0402	0.2247	0.3815	0.5234	0.7006
6.6/11kV CB (GM) Secondary	0.0518	0.2895	0.4916	0.6743	0.9027
6.6/11kV Switch (PM)	0.1166	0.4682	0.6479	0.8043	0.992
6.6/11kV Switchgear - Other (PM)	0.1166	0.4682	0.6479	0.8043	0.992
6.6/11kV Switch (GM)	0.0518	0.2895	0.4916	0.6743	0.9027
6.6/11kV RMU	0.0518	0.2895	0.4916	0.6743	0.9027
6.6/11kV X-type RMU	0.0518	0.2895	0.4916	0.6743	0.9027
20kV CB (PM)	0.1166	0.4682	0.6479	0.8043	0.992
20kV CB (GM) Primary	0.0402	0.2247	0.3815	0.5234	0.7006
20kV CB (GM) Secondary	0.0518	0.2895	0.4916	0.6743	0.9027
20kV Switch (PM)	0.1166	0.4682	0.6479	0.8043	0.992
20kV Switchgear - Other (PM)	0.1166	0.4682	0.6479	0.8043	0.992
20kV Switch (GM)	0.0518	0.2895	0.4916	0.6743	0.9027
20kV RMU	0.0518	0.2895	0.4916	0.6743	0.9027
6.6/11kV Transformer (PM)	0.0603	0.337	0.5723	0.7851	1.0509
6.6/11kV Transformer (GM)	0.0552	0.2797	0.52	0.7398	1.019
20kV Transformer (PM)	0.0603	0.337	0.5723	0.7851	1.0509
20kV Transformer (GM)	0.0552	0.2797	0.52	0.7398	1.019
Batteries at GM HV Substations	4.5384	6.4191	7.21	7.8598	8.5858
33kV OHL (Pole Line) Conductor	0.0566	0.2869	0.5334	0.7588	1.0451
33kV Pole	0.1101	0.6157	1.0456	1.4342	1.9198
66kV OHL (Pole Line) Conductor	0.0566	0.2869	0.5334	0.7588	1.0451
66kV Pole	0.1101	0.6157	1.0456	1.4342	1.9198
33kV OHL (Tower Line) Conductor	0.0618	0.3457	0.587	0.8052	1.0778
33kV Tower	0.3486	1.1834	2.4793	4.0732	6.3069
33kV Fittings	0.1671	0.6708	0.9283	1.1525	1.4213
66kV OHL (Tower Line) Conductor	0.0618	0.3457	0.587	0.8052	1.0778

Asset Register Category	Typical Cumulative Discounted POF Weightings for Each Health Index Band				
	HI1	HI2	HI3	HI4	HI5
66kV Tower	0.3486	1.1834	2.4793	4.0732	6.3069
66kV Fittings	0.1671	0.6708	0.9283	1.1525	1.4213
33kV UG Cable (Non Pressurised)	0.4207	1.0948	2.3609	3.9169	6.7741
33kV UG Cable (Oil)	13.4728	49.9907	103.5829	166.2452	249.7793
33kV UG Cable (Gas)	29.4028	120.1949	245.7313	379.4433	553.4414
66kV UG Cable (Non Pressurised)	0.4207	1.0948	2.3609	3.9169	6.7741
66kV UG Cable (Oil)	13.4728	49.9907	103.5829	166.2452	249.7793
66kV UG Cable (Gas)	29.4028	120.1949	245.7313	379.4433	553.4414
EHV Sub Cable	0.1429	0.7245	1.3468	1.916	2.639
33kV CB (Air Insulated Busbars)(ID) (GM)	0.1578	0.7998	1.4868	2.1152	2.9133
33kV CB (Air Insulated Busbars)(OD) (GM)	0.2001	1.1446	1.7968	2.38	3.1006
33kV CB (Gas Insulated Busbars)(ID)(GM)	0.1578	0.7998	1.4868	2.1152	2.9133
33kV CB (Gas Insulated Busbars)(OD)(GM)	0.2001	1.1446	1.7968	2.38	3.1006
33kV Switch (GM)	0.1724	0.9636	1.6362	2.2445	3.0044
33kV Switchgear - Other	0.1501	0.8585	1.3476	1.785	2.3254
33kV Switch (PM)	0.1166	0.4682	0.6479	0.8043	0.992
33kV RMU	0.1724	0.9636	1.6362	2.2445	3.0044
66kV CB (Air Insulated Busbars)(ID) (GM)	0.4594	2.628	4.1255	5.4645	7.1188
66kV CB (Air Insulated Busbars)(OD) (GM)	0.3957	2.2123	3.7568	5.1532	6.898
66kV CB (Gas Insulated Busbars)(ID)(GM)	0.3957	2.2123	3.7568	5.1532	6.898
66kV CB (Gas Insulated Busbars)(OD)(GM)	0.4594	2.628	4.1255	5.4645	7.1188
66kV Switchgear - Other	0.1501	0.8585	1.3476	1.785	2.3254
33kV Transformer (PM)	0.0603	0.337	0.5723	0.7851	1.0509
33kV Transformer (GM)	0.3213	1.6283	3.0269	4.3062	5.9312
66kV Transformer (GM)	0.3213	1.6283	3.0269	4.3062	5.9312
Batteries at 33kV Substations	4.5384	6.4191	7.21	7.8598	8.5858
Batteries at 66kV Substations	4.5384	6.4191	7.21	7.8598	8.5858
132kV OHL (Pole Line) Conductor	0.0566	0.2869	0.5334	0.7588	1.0451
132kV Pole	0.1101	0.6157	1.0456	1.4342	1.9198
132kV OHL (Tower Line) Conductor	0.0618	0.3457	0.587	0.8052	1.0778
132kV Tower	0.3486	1.1834	2.4793	4.0732	6.3069
132kV Fittings	0.1671	0.6708	0.9283	1.1525	1.4213
132kV UG Cable (Non Pressurised)	0.4207	1.0948	2.3609	3.9169	6.7741
132kV UG Cable (Oil)	13.4728	49.9907	103.5829	166.2452	249.7793
132kV UG Cable (Gas)	29.4028	120.1949	245.7313	379.4433	553.4414
132kV Sub Cable	0.1429	0.7245	1.3468	1.916	2.639
132kV CB (Air Insulated Busbars)(ID) (GM)	0.305	1.5458	2.8735	4.0881	5.6307
132kV CB (Air Insulated Busbars)(OD) (GM)	0.3868	2.2122	3.4728	4.6	5.9926
132kV CB (Gas Insulated Busbars)(ID) (GM)	0.305	1.5458	2.8735	4.0881	5.6307
132kV CB (Gas Insulated Busbars)(OD) (GM)	0.3331	1.8623	3.1624	4.3379	5.8067
132kV Switchgear - Other	0.1501	0.8585	1.3476	1.785	2.3254
132kV Transformer (GM)	0.3213	1.6283	3.0269	4.3062	5.9312
Batteries at 132kV Substations	4.5384	6.4191	7.21	7.8598	8.5858

TABLE 241: RISK MATRIX WEIGHTINGS - RISK INDEX (LONG TERM RISK)

Asset Register Category	Criticality Index Band	Risk Index or Monetised Long Term Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
LV Main (OHL) Conductor	C1	1,298	6,578	12,230	17,398	23,962
	C2	1,854	9,397	17,471	24,854	34,231
	C3	2,781	14,096	26,207	37,281	51,347
	C4	4,635	23,493	43,678	62,135	85,579
LV Poles	C1	119	664	1,128	1,548	2,072
	C2	170	949	1,612	2,211	2,960

Asset Register Category	Criticality Index Band	Risk Index or Monetised Long Term Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
	C3	255	1,424	2,418	3,317	4,440
	C4	425	2,373	4,030	5,528	7,400
LV Circuit Breaker	C1	493	2,499	4,648	6,611	9,105
	C2	704	3,570	6,640	9,445	13,007
	C3	1,056	5,355	9,959	14,167	19,511
	C4	1,761	8,925	16,599	23,611	32,518
LV Pillar (ID)	C1	524	2,661	4,947	7,037	9,694
	C2	749	3,802	7,067	10,053	13,848
	C3	1,123	5,703	10,600	15,080	20,772
	C4	1,872	9,505	17,667	25,133	34,621
LV Pillar (OD at Substation)	C1	411	2,085	3,875	5,512	7,593
	C2	587	2,978	5,535	7,874	10,847
	C3	880	4,467	8,303	11,812	16,270
	C4	1,466	7,445	13,838	19,686	27,117
LV Pillar (OD not at a Substation)	C1	485	2,462	4,576	6,510	8,968
	C2	693	3,517	6,538	9,300	12,811
	C3	1,039	5,276	9,806	13,950	19,216
	C4	1,732	8,793	16,344	23,250	32,027
LV Board (WM)	C1	861	4,367	8,116	11,548	15,905
	C2	1,230	6,239	11,595	16,498	22,721
	C3	1,845	9,358	17,392	24,746	34,082
	C4	3,075	15,596	28,987	41,244	56,803
LV UGB	C1	662	3,699	6,282	8,617	11,534
	C2	945	5,284	8,974	12,310	16,478
	C3	1,418	7,927	13,461	18,465	24,716
	C4	2,363	13,211	22,436	30,774	41,194
LV Board (X-type Network) (WM)	C1	909	4,611	8,571	12,195	16,795
	C2	1,299	6,588	12,244	17,421	23,993
	C3	1,948	9,882	18,366	26,131	35,989
	C4	3,247	16,469	30,610	43,552	59,982
6.6/11kV OHL (Conventional Conductor)	C1	2,228	11,295	21,000	29,874	41,146
	C2	3,183	16,136	30,000	42,677	58,780
	C3	4,775	24,204	45,000	64,016	88,170
	C4	7,958	40,340	75,000	106,693	146,949
6.6/11kV OHL (BLX or similar Conductor)	C1	2,328	11,801	21,940	31,211	42,987
	C2	3,326	16,858	31,342	44,587	61,410
	C3	4,989	25,287	47,013	66,880	92,114
	C4	8,314	42,145	78,356	111,467	153,524
20kV OHL (Conventional Conductor)	C1	2,630	13,330	24,783	35,256	48,558
	C2	3,757	19,043	35,404	50,365	69,369
	C3	5,635	28,565	53,107	75,548	104,053
	C4	9,392	47,608	88,511	125,913	173,421
20kV OHL (BLX or similar Conductor)	C1	2,752	13,950	25,935	36,895	50,815
	C2	3,931	19,928	37,050	52,706	72,593
	C3	5,897	29,892	55,575	79,060	108,889
	C4	9,829	49,820	92,625	131,766	181,482
6.6/11kV Poles	C1	191	1,069	1,815	2,490	3,333
	C2	273	1,527	2,593	3,557	4,761
	C3	410	2,290	3,889	5,335	7,142
	C4	683	3,817	6,482	8,892	11,903
20kV Poles	C1	254	1,417	2,407	3,301	4,419
	C2	362	2,024	3,438	4,716	6,313
	C3	543	3,037	5,157	7,074	9,469
	C4	906	5,061	8,595	11,790	15,782
HV Sub Cable	C1	37,605	190,659	354,423	504,213	694,477
	C2	53,722	272,370	506,318	720,304	992,110
	C3	80,583	408,555	759,478	1,080,457	1,488,165
	C4	134,305	680,924	1,265,796	1,800,761	2,480,276
6.6/11kV CB (PM)	C1	1,174	4,713	6,521	8,096	9,985
	C2	1,677	6,732	9,316	11,565	14,264
	C3	2,515	10,099	13,974	17,348	21,396

Asset Register Category	Criticality Index Band	Risk Index or Monetised Long Term Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
	C4	4,192	16,831	23,291	28,913	35,661
6.6/11kV CB (GM) Primary	C1	2,444	13,663	23,197	31,826	42,601
	C2	3,492	19,519	33,139	45,465	60,858
	C3	5,238	29,278	49,709	68,198	91,287
	C4	8,730	48,797	82,848	113,663	152,145
6.6/11kV CB (GM) Secondary	C1	1,064	5,946	10,097	13,850	18,541
	C2	1,520	8,495	14,425	19,786	26,488
	C3	2,280	12,742	21,637	29,679	39,731
	C4	3,800	21,237	36,062	49,464	66,219
6.6/11kV Switch (PM)	C1	1,083	4,348	6,017	7,470	9,213
	C2	1,547	6,212	8,596	10,671	13,162
	C3	2,321	9,318	12,894	16,007	19,742
	C4	3,868	15,530	21,490	26,678	32,904
6.6/11kV Switchgear - Other (PM)	C1	1,257	5,049	6,986	8,673	10,697
	C2	1,796	7,212	9,981	12,390	15,281
	C3	2,694	10,819	14,971	18,585	22,922
	C4	4,490	18,031	24,952	30,975	38,204
6.6/11kV Switch (GM)	C1	1,057	5,907	10,031	13,759	18,419
	C2	1,510	8,439	14,330	19,655	26,313
	C3	2,265	12,658	21,495	29,483	39,470
	C4	3,775	21,097	35,825	49,139	65,783
6.6/11kV RMU	C1	1,076	6,013	10,211	14,005	18,749
	C2	1,537	8,590	14,587	20,008	26,785
	C3	2,306	12,885	21,880	30,012	40,177
	C4	3,843	21,475	36,467	50,019	66,962
6.6/11kV X-type RMU	C1	1,202	6,717	11,407	15,646	20,945
	C2	1,717	9,596	16,295	22,351	29,922
	C3	2,576	14,394	24,443	33,527	44,883
	C4	4,293	23,990	40,738	55,878	74,805
20kV CB (PM)	C1	1,567	6,292	8,707	10,809	13,332
	C2	2,239	8,989	12,439	15,442	19,046
	C3	3,358	13,484	18,659	23,163	28,569
	C4	5,597	22,473	31,098	38,605	47,614
20kV CB (GM) Primary	C1	2,547	14,239	24,175	33,167	44,396
	C2	3,639	20,341	34,536	47,382	63,423
	C3	5,459	30,512	51,804	71,072	95,134
	C4	9,098	50,853	86,340	118,454	158,557
20kV CB (GM) Secondary	C1	1,316	7,356	12,490	17,132	22,935
	C2	1,880	10,508	17,843	24,475	32,765
	C3	2,820	15,762	26,765	36,712	49,147
	C4	4,700	26,270	44,609	61,187	81,912
20kV Switch (PM)	C1	1,163	4,671	6,464	8,024	9,897
	C2	1,662	6,673	9,234	11,463	14,139
	C3	2,493	10,010	13,851	17,195	21,208
	C4	4,155	16,683	23,086	28,658	35,346
20kV Switchgear - Other (PM)	C1	1,163	4,671	6,464	8,024	9,897
	C2	1,662	6,673	9,234	11,463	14,139
	C3	2,493	10,010	13,851	17,195	21,208
	C4	4,155	16,683	23,086	28,658	35,346
20kV Switch (GM)	C1	1,312	7,330	12,447	17,073	22,855
	C2	1,874	10,471	17,781	24,389	32,651
	C3	2,810	15,707	26,672	36,584	48,976
	C4	4,684	26,178	44,453	60,973	81,627
20kV RMU	C1	1,328	7,421	12,601	17,284	23,139
	C2	1,897	10,601	18,002	24,692	33,055
	C3	2,845	15,902	27,002	37,038	49,583
	C4	4,742	26,503	45,004	61,730	82,639
6.6/11kV Transformer (PM)	C1	280	1,566	2,660	3,648	4,884
	C2	400	2,237	3,799	5,212	6,977
	C3	600	3,356	5,699	7,818	10,465
	C4	1,001	5,593	9,498	13,030	17,442

Asset Register Category	Criticality Index Band	Risk Index or Monetised Long Term Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
6.6/11kV Transformer (GM)	C1	1,048	5,309	9,871	14,043	19,343
	C2	1,497	7,585	14,101	20,061	27,632
	C3	2,245	11,377	21,151	30,092	41,448
	C4	3,742	18,962	35,252	50,153	69,080
20kV Transformer (PM)	C1	324	1,809	3,073	4,215	5,642
	C2	463	2,585	4,390	6,022	8,061
	C3	694	3,877	6,584	9,033	12,091
	C4	1,156	6,462	10,974	15,055	20,151
20kV Transformer (GM)	C1	1,120	5,673	10,547	15,005	20,668
	C2	1,599	8,105	15,067	21,436	29,526
	C3	2,399	12,157	22,601	32,154	44,290
	C4	3,999	20,261	37,669	53,591	73,816
Batteries at GM HV Substations	C1	2,989	4,228	4,748	5,176	5,655
	C2	4,270	6,039	6,784	7,395	8,078
	C3	6,405	9,059	10,175	11,092	12,117
	C4	10,675	15,098	16,959	18,487	20,195
33kV OHL (Pole Line) Conductor	C1	2,613	13,245	24,625	35,030	48,248
	C2	3,733	18,921	35,178	50,043	68,925
	C3	5,599	28,382	52,767	75,065	103,388
	C4	9,332	47,303	87,945	125,109	172,313
33kV Pole	C1	219	1,227	2,084	2,859	3,826
	C2	313	1,753	2,977	4,084	5,466
	C3	470	2,630	4,466	6,126	8,200
	C4	784	4,383	7,443	10,209	13,666
66kV OHL (Pole Line) Conductor	C1	2,714	13,756	25,574	36,381	50,108
	C2	3,877	19,651	36,534	51,973	71,582
	C3	5,815	29,476	54,802	77,959	107,374
	C4	9,692	49,127	91,336	129,932	178,956
66kV Pole	C1	326	1,824	3,098	4,250	5,688
	C2	466	2,606	4,426	6,071	8,126
	C3	699	3,909	6,639	9,106	12,190
	C4	1,165	6,515	11,065	15,177	20,316
33kV OHL (Tower Line) Conductor	C1	3,390	18,962	32,197	44,165	59,117
	C2	4,842	27,088	45,996	63,093	84,453
	C3	7,264	40,632	68,993	94,640	126,680
	C4	12,106	67,720	114,989	157,733	211,133
33kV Tower	C1	1,926	6,538	13,698	22,505	34,846
	C2	2,751	9,341	19,569	32,150	49,780
	C3	4,127	14,011	29,353	48,224	74,670
	C4	6,879	23,351	48,923	80,374	124,450
33kV Fittings	C1	245	985	1,364	1,693	2,088
	C2	351	1,408	1,948	2,418	2,982
	C3	526	2,111	2,922	3,628	4,474
	C4	877	3,519	4,870	6,046	7,456
66kV OHL (Tower Line) Conductor	C1	4,198	23,483	39,874	54,695	73,212
	C2	5,997	33,547	56,962	78,136	104,589
	C3	8,996	50,320	85,443	117,204	156,884
	C4	14,993	83,866	142,406	195,341	261,473
66kV Tower	C1	3,629	12,320	25,811	42,405	65,660
	C2	5,185	17,600	36,873	60,579	93,800
	C3	7,777	26,400	55,310	90,868	140,699
	C4	12,961	44,000	92,184	151,447	234,499
66kV Fittings	C1	284	1,141	1,579	1,960	2,417
	C2	406	1,630	2,255	2,800	3,453
	C3	609	2,445	3,383	4,200	5,180
	C4	1,015	4,074	5,638	7,000	8,633
33kV UG Cable (Non Pressurised)	C1	10,573	27,513	59,332	98,436	170,240
	C2	15,104	39,305	84,760	140,622	243,200
	C3	22,656	58,957	127,139	210,933	364,800
	C4	37,759	98,262	211,899	351,556	607,999
33kV UG Cable (Oil)	C1	56,777	210,669	436,515	700,584	1,052,610

Asset Register Category	Criticality Index Band	Risk Index or Monetised Long Term Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
	C2	81,109	300,956	623,593	1,000,834	1,503,729
	C3	121,664	451,434	935,390	1,501,252	2,255,595
	C4	202,774	752,390	1,558,984	2,502,088	3,759,326
33kV UG Cable (Gas)	C1	8,383	34,270	70,063	108,187	157,797
	C2	11,976	48,957	100,089	154,551	225,422
	C3	17,964	73,435	150,134	231,828	338,136
	C4	29,940	122,392	250,223	386,380	563,558
66kV UG Cable (Non Pressurised)	C1	21,147	55,031	118,672	196,885	340,504
	C2	30,210	78,615	169,532	281,265	486,435
	C3	45,314	117,923	254,297	421,897	729,652
	C4	75,524	196,539	423,829	703,162	1,216,087
66kV UG Cable (Oil)	C1	56,909	211,161	437,534	702,220	1,055,068
	C2	81,299	301,658	625,049	1,003,172	1,507,241
	C3	121,948	452,487	937,573	1,504,757	2,260,860
	C4	203,247	754,146	1,562,623	2,507,929	3,768,101
66kV UG Cable (Gas)	C1	13,277	54,275	110,962	171,341	249,912
	C2	18,967	77,537	158,519	244,775	357,020
	C3	28,451	116,304	237,777	367,161	535,527
	C4	47,418	193,841	396,296	611,936	892,546
EHV Sub Cable	C1	29,254	148,318	275,713	392,239	540,249
	C2	41,792	211,882	393,876	560,341	771,785
	C3	62,687	317,824	590,814	840,511	1,157,677
	C4	104,479	529,706	984,691	1,400,852	1,929,461
33kV CB (Air Insulated Busbars)(ID) (GM)	C1	9,354	47,411	88,136	125,387	172,698
	C2	13,363	67,731	125,909	179,125	246,712
	C3	20,045	101,596	188,863	268,687	370,067
	C4	33,408	169,327	314,772	447,812	616,779
33kV CB (Air Insulated Busbars)(OD) (GM)	C1	8,470	48,447	76,053	100,738	131,238
	C2	12,099	69,210	108,647	143,911	187,483
	C3	18,149	103,815	162,970	215,866	281,225
	C4	30,248	173,026	271,617	359,777	468,708
33kV CB (Gas Insulated Busbars)(ID)(GM)	C1	10,930	55,396	102,979	146,503	201,781
	C2	15,614	79,137	147,112	209,290	288,258
	C3	23,420	118,705	220,668	313,934	432,387
	C4	39,034	197,842	367,781	523,224	720,645
33kV CB (Gas Insulated Busbars)(OD)(GM)	C1	9,046	51,743	81,227	107,591	140,167
	C2	12,923	73,919	116,039	153,702	200,239
	C3	19,384	110,879	174,058	230,553	300,358
	C4	32,306	184,798	290,096	384,255	500,597
33kV Switch (GM)	C1	6,378	35,651	60,536	83,042	111,156
	C2	9,112	50,930	86,480	118,631	158,795
	C3	13,668	76,395	129,720	177,946	238,192
	C4	22,780	127,325	216,200	296,577	396,987
33kV Switchgear - Other	C1	905	5,174	8,122	10,758	14,015
	C2	1,292	7,392	11,603	15,368	20,021
	C3	1,938	11,087	17,404	23,053	30,032
	C4	3,231	18,479	29,006	38,421	50,053
33kV Switch (PM)	C1	770	3,092	4,279	5,311	6,551
	C2	1,100	4,417	6,112	7,588	9,358
	C3	1,650	6,625	9,168	11,382	14,038
	C4	2,750	11,042	15,281	18,969	23,396
33kV RMU	C1	8,200	45,830	77,819	106,751	142,892
	C2	11,714	65,471	111,170	152,501	204,132
	C3	17,570	98,207	166,756	228,751	306,198
	C4	29,284	163,678	277,926	381,252	510,330
66kV CB (Air Insulated Busbars)(ID) (GM)	C1	36,083	206,416	324,036	429,208	559,145
	C2	51,548	294,880	462,909	613,154	798,778
	C3	77,322	442,319	694,364	919,731	1,198,167
	C4	128,870	737,199	1,157,273	1,532,886	1,996,945
	C1	24,610	137,593	233,652	320,501	429,018
	C2	35,158	196,561	333,789	457,858	612,882

Asset Register Category	Criticality Index Band	Risk Index or Monetised Long Term Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
66kV CB (Air Insulated Busbars)(OD)(GM)	C3	52,736	294,842	500,684	686,787	919,324
	C4	87,894	491,403	834,472	1,144,645	1,532,206
66kV CB (Gas Insulated Busbars)(ID)(GM)	C1	43,373	242,490	411,783	564,842	756,090
	C2	61,961	346,414	588,261	806,917	1,080,128
	C3	92,941	519,622	882,391	1,210,376	1,620,192
	C4	154,902	866,036	1,470,652	2,017,293	2,700,320
66kV CB (Gas Insulated Busbars)(OD)(GM)	C1	30,477	174,344	273,690	362,521	472,269
	C2	43,539	249,063	390,986	517,887	674,670
	C3	65,308	373,595	586,479	776,830	1,012,005
	C4	108,847	622,659	977,465	1,294,717	1,686,675
66kV Switchgear - Other	C1	950	5,433	8,528	11,296	14,716
	C2	1,357	7,761	12,183	16,137	21,023
	C3	2,035	11,642	18,274	24,206	31,534
	C4	3,392	19,403	30,457	40,343	52,557
33kV Transformer (PM)	C1	271	1,515	2,572	3,529	4,724
	C2	387	2,164	3,675	5,041	6,748
	C3	581	3,246	5,512	7,562	10,122
	C4	968	5,410	9,187	12,603	16,870
33kV Transformer (GM)	C1	35,353	179,164	333,054	473,817	652,618
	C2	50,504	255,949	475,791	676,881	932,311
	C3	75,757	383,923	713,687	1,015,322	1,398,466
	C4	126,261	639,871	1,189,478	1,692,203	2,330,777
66kV Transformer (GM)	C1	45,946	232,846	432,846	615,785	848,160
	C2	65,637	332,638	618,351	879,693	1,211,656
	C3	98,455	498,956	927,526	1,319,539	1,817,485
	C4	164,092	831,594	1,545,877	2,199,232	3,029,141
Batteries at 33kV Substations	C1	12,098	17,112	19,220	20,952	22,888
	C2	17,283	24,445	27,457	29,932	32,697
	C3	25,925	36,668	41,186	44,898	49,045
	C4	43,208	61,113	68,643	74,830	81,742
Batteries at 66kV Substations	C1	12,098	17,112	19,220	20,952	22,888
	C2	17,283	24,445	27,457	29,932	32,697
	C3	25,925	36,668	41,186	44,898	49,045
	C4	43,208	61,113	68,643	74,830	81,742
132kV OHL (Pole Line) Conductor	C1	4,841	24,538	45,620	64,898	89,385
	C2	6,916	35,054	65,172	92,712	127,692
	C3	10,373	52,581	97,758	139,068	191,539
	C4	17,289	87,635	162,930	231,779	319,231
132kV Pole	C1	423	2,365	4,016	5,509	7,374
	C2	604	3,378	5,737	7,869	10,534
	C3	906	5,067	8,606	11,804	15,801
	C4	1,510	8,446	14,343	19,673	26,334
132kV OHL (Tower Line) Conductor	C1	4,207	23,536	39,964	54,819	73,378
	C2	6,011	33,623	57,091	78,313	104,826
	C3	9,016	50,434	85,637	117,470	157,239
	C4	15,027	84,057	142,728	195,783	262,066
132kV Tower	C1	4,605	15,634	32,754	53,811	83,320
	C2	6,579	22,334	46,791	76,872	119,028
	C3	9,869	33,501	70,187	115,308	178,542
	C4	16,448	55,835	116,978	192,181	297,571
132kV Fittings	C1	387	1,552	2,148	2,667	3,289
	C2	552	2,217	3,069	3,810	4,698
	C3	829	3,326	4,603	5,715	7,047
	C4	1,381	5,543	7,671	9,524	11,746
132kV UG Cable (Non Pressurised)	C1	37,111	96,576	208,263	345,523	597,566
	C2	53,016	137,966	297,519	493,604	853,666
	C3	79,524	206,949	446,278	740,406	1,280,499
	C4	132,541	344,914	743,796	1,234,011	2,134,165
132kV UG Cable (Oil)	C1	71,510	265,336	549,788	882,381	1,325,756
	C2	102,157	379,051	785,411	1,260,544	1,893,937

Asset Register Category	Criticality Index Band	Risk Index or Monetised Long Term Risk Weighting (£ at 20/21 prices) For Each Health Index Band				
		H1	H2	H3	H4	H5
	C3	153,235	568,577	1,178,116	1,890,815	2,840,902
	C4	255,392	947,628	1,963,527	3,151,359	4,734,839
132kV UG Cable (Gas)	C1	21,420	87,561	179,013	276,421	403,177
	C2	30,599	125,087	255,733	394,887	575,966
	C3	45,900	187,631	383,601	592,334	863,955
	C4	76,499	312,718	639,334	987,220	1,439,922
132kV Sub Cable	C1	49,998	253,489	471,221	670,373	923,338
	C2	71,426	362,128	673,173	957,676	1,319,054
	C3	107,139	543,191	1,009,759	1,436,515	1,978,581
	C4	178,565	905,319	1,682,931	2,394,191	3,297,636
132kV CB (Air Insulated Busbars)(ID) (GM)	C1	74,177	375,943	698,843	994,237	1,369,401
	C2	105,967	537,061	998,347	1,420,339	1,956,288
	C3	158,950	805,592	1,497,521	2,130,508	2,934,432
	C4	264,917	1,342,653	2,495,868	3,550,846	4,890,719
132kV CB (Air Insulated Busbars)(OD) (GM)	C1	35,237	201,528	316,366	419,052	545,915
	C2	50,338	287,897	451,952	598,646	779,879
	C3	75,507	431,845	677,927	897,969	1,169,819
	C4	125,846	719,741	1,129,879	1,496,614	1,949,698
132kV CB (Gas Insulated Busbars)(ID) (GM)	C1	109,963	557,315	1,035,998	1,473,904	2,030,066
	C2	157,090	796,165	1,479,997	2,105,578	2,900,095
	C3	235,636	1,194,248	2,219,996	3,158,367	4,350,142
	C4	392,726	1,990,413	3,699,994	5,263,944	7,250,237
132kV CB (Gas Insulated Busbars)(OD) (GM)	C1	60,823	340,049	577,442	792,084	1,060,282
	C2	86,890	485,784	824,918	1,131,549	1,514,688
	C3	130,335	728,676	1,237,377	1,697,323	2,272,032
	C4	217,224	1,214,461	2,062,294	2,828,872	3,786,720
132kV Switchgear - Other	C1	2,012	11,509	18,066	23,930	31,174
	C2	2,875	16,442	25,809	34,185	44,535
	C3	4,312	24,662	38,713	51,278	66,802
	C4	7,187	41,104	64,521	85,464	111,337
132kV Transformer (GM)	C1	120,543	610,894	1,135,611	1,615,570	2,225,226
	C2	172,204	872,706	1,622,301	2,307,957	3,178,894
	C3	258,307	1,309,059	2,433,452	3,461,935	4,768,341
	C4	430,511	2,181,765	4,055,753	5,769,892	7,947,234
Batteries at 132kV Substations	C1	12,520	17,708	19,890	21,683	23,686
	C2	17,886	25,298	28,415	30,976	33,837
	C3	26,829	37,947	42,622	46,463	50,755
	C4	44,715	63,244	71,037	77,439	84,592

A.2 Recommended changes to RIGs for RIIO-ED2

As outlined in sections 3 and 4 of this document, as part of the proposals for CNAIM v3.0, the DNOs recommend changes to the classification of the RIGs to enable the changes proposed to CNAIM. These changes are shown below:

Document Section	Proposal	Description of RIGs Change
3.1	132kV & EHV Switchgear Other	Revise definitions and modification of refurbishment tables.
3.2	EHV & HV Pole Mounted Switchgear	Revise definitions.
3.3	Batteries	Revise definitions and modification of refurbishment tables.
3.4	Overhead Line Conductors (Poles)	None
3.5	132kV Poles	Modification of refurbishment tables.
3.6	Pole Mounted Transformers	None
4.1	Oil Testing	None
4.2	Dissolved Gas Analysis (DGA)	None
4.3	Transformer Furfuraldehyde (FFA).	None
4.4	Ageing Adjustment (Climate) Factor	None
4.5	Forecast Ageing Rate	None
4.6	Pole Fittings	Modification of refurbishment tables
4.7	Pole Strengthening	None
4.8	Financial Consequence Access Factor	None
4.9	Financial Consequence Type Factor – Inter-system Transformer	None
4.10	Steel Tower Painting	None
4.11	Sub Cable	Amendment of Refurbishment tables
4.12	Switchgear (Ground Mounted): Oil Leaks / Gas Pressure	None
4.13	Pole Top Rot	None

132kV & EHV Switchgear Other

The following RIGs updates for 33kV, 66kV and 132kV Switchgear Other are proposed:

1. Activity “Complete replacement of operating mechanism” is Refurb (Non NARM) currently. Propose to revise this activity to Refurbishment (NARM) similar to circuit breakers.
2. Propose to add new Refurbishment (NARM) activity for the “Standalone replacement of associated/supporting structures (e.g. wooden post, concrete or steel gantry)”.

In addition, for this asset category a RIGs definition change is proposed as follows:

Current definition:

- (33kV & 66kV) Includes - All other switchgear, e.g. Disconnectors, Fault throwers, Earthing switches, Fuses. Excludes - Circuit breakers. Any isolators and earth switches that are integral to a circuit breaker should not be counted as separate items of switchgear.
- (132kV) Includes - Disconnectors, Earthing Switches and Fault throwers. Excludes - Circuit Breakers. Any isolators and earth switches that are integral to a circuit breaker should not be counted as separate items of switchgear.

Proposed definition:

- Include all 33kV and 66kV pole mounted air break isolators in the definition of 33kV and 66kV Switchgear Other. This is proposed to be consistent with the definition of 6.6/11kV Switchgear - Other (PM).
- Exclude Fuses from the definition of 33kV and 66kV Switchgear Other.
- Introduce a new RIGs category for 33kV Fuses, Links and ASLs.

Propose to Ofgem the following RIGs update for 33kV, 66kV and 132kV Switchgear Other.

EHV & HV Pole Mounted Switchgear

Current definition:

- 6.6/11kV, 20kV CB (PM)
  - 6.6 or 11kV, 20kV Circuit Breaker (Pole Mounted)
  - Includes - all Pole mounted Circuit Breakers and Auto Reclosers.
- 6.6/11kV, 20kV Switch (PM)
  - Includes - 6.6 and 11kV, 20kV pole mounted switches that contain an insulation medium other than air.
  - Excludes - air break isolators, line sectionalisers, links, fuses and other pole mounted plant insulated only by air.
- 6.6/11kV Switchgear - Other (PM)
  - 6.6 and 11kV pole mounted switches that have only air as an insulation medium
  - Includes - air break isolators, line sectionalisers, links, fuses and other pole mounted plant insulated only by air.
- 20kV Switchgear - Other (PM)
  - 20kV pole mounted switches that have only air as an insulation medium
  - Includes - air break isolators, line sectionalisers, links, fuses and other pole mounted plant insulated only by air & Automatic Sectionalising Links'.
- 33kV Switch (PM)
  - 33kV (includes 22 & 25kV) Switch (Pole Mounted)
  - Includes - All Pole mounted Circuit Breakers, Switches and auto sectionalisers.

Proposed definition

- Exclude line sectionalisers, links and fuses from the definition of 6.6/11kV Switchgear - Other (PM).
- Introduce a new RIGs category for 6.6/11kV line sectionalisers, links and fuses.
- Exclude line sectionalisers, links, fuses and Automatic Sectionalising Links' from the definition of 20kV Switchgear - Other (PM)
- Introduce a new RIGs category for 20kV line sectionalisers, links, fuses and Automatic Sectionalising Links'.
- Propose revision to the current definition of 33kV Switch (PM) –
    - 33kV (includes 22 & 25kV) Switch (Pole Mounted)
    - Includes - All Pole mounted Circuit Breakers, Switches that contain an insulation medium other than air and auto sectionalisers.
    - Excludes: Air break isolators (*note: as these will be considered in the 33kV Switchgear – Other category*).

This document has been drafted on the basis that these proposed RIGs changes would be implemented. New CNAIM models will be created for the RIGs categories – 6.6/11kV, 20kV CB (PM), 6.6/11kV, 20kV Switch (PM), 6.6/11kV Switchgear - Other (PM), 20kV Switchgear - Other (PM) and 33kV Switch (PM).

No models will be created for the new RIGs category for 6.6/11kV and 20kV line sectionalisers, links, fuses etc

Batteries

A RIGs definition change is proposed as follows for Batteries at HV (GM), 33kV,66kV and 132kV:

- Propose a revision to the Repair & Maintenance activity description – "Replacement of individual battery blocks (a block comprise of multiple cells)".
- Propose to add two new Refurbishment (NARM) activities:
    - Standalone replacement of battery charger
    - Standalone replacement of the complete battery string (a string comprises of multiple blocks of cells)
- Propose a revision to the existing definition of Batteries as highlighted below:
    - Batteries at GM HV Substations

      The complete battery system comprising of a re-chargeable battery, together with its associated charger, comprising a number of individual blocks of cells which is used to provide power to operate switchgear and protective equipment at a HV Ground Mounted Substation.

    - Batteries at 33kV/66kV/132kV Substations

      The complete battery system comprising of a re-chargeable battery, together with its associated charger, comprising a number of individual blocks of cells which is used to provide power to operate switchgear and protective equipment at a substation whose highest voltage of operation is 33kV/66kV/132kV.

Pole Fittings

The following changes would first be required to the RIGs:

Activity	Repair & Maintenance	Refurbishment (Non NARM)	Refurbishment (NARM)
Replacement of signs and notices	Yes		
Repair or replacement of pole earthing	Yes		
Remedial application of wood pole preservative (e.g. insertion of boron rods)	Yes		
Replacement of a complete set of insulators associated with an existing pole		~~Yes~~	*Yes*
Complete replacement of pole top steelwork (including associated insulators and fittings)		~~Yes~~	*Yes*
The complete replacement of stay wire and insulator (including stay block or anchor as necessary) at an existing pole		Yes	
Replacement of steelwork associated with pole mounted switchgear and equipment		Yes	
Pole Strengthening (e.g. clamping a steelwork supporting bracket to an existing pole)			Yes
Small footprint steel masts: Replacement of individual bolts	Yes		
Small footprint steel masts: Repairs to existing steelwork members (e.g. welding)	Yes		
Small footprint steel masts: Patch painting following steelwork repair	Yes		
Small footprint steel masts: Replacement of step bolts		Yes	
Small footprint steel masts: Replacement of individual steelwork members			Yes
Small footprint steel masts: Painting of mast		Yes	
Small footprint steel masts: Repairs to foundations	Yes		

Submarine cable

The following changes would first be required to the RIGs:

HV / EHV / 132kV Sub Cable			
Activity	**Repair & Maintenance**	**Refurbishment (Non NARM)**	***Refurbishment (NARM)***
Invasive diagnostic testing requiring removal of covers or physical connections (e.g. partial discharge testing, sheath testing etc.)	Yes		
Sheath repairs	Yes		
Replacement of cable section, cable joints and terminations (including sealing ends) on Shore End Section		~~YES~~	Yes
Replacement of physical protection of submarine cable (e.g. split piping, backfill cover to exposed cables at shoreline etc.)	*Yes*		