DNO CNAIM V2.0 METHODOLOGY CHANGES EXPLAINED

01/09/2020

CNAIM v2.0 Changes Explained

This document explains the differences applied in v2.0 compared to v1.1 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
v1.0	01/09/2020	Final version to support consultation	Published
V1.1	09/09/2020	Edited reference to NAW & SDPR spreadsheet documents on Ofgem website – see Appendix A.1.3	Published

Acknowledgements

This document has been compiled by a dedicated Working Group comprising representatives from all six DNO Groups and NIE Networks:

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The Working Group has been informed by Ofgem's Safety, Resilience and Reliability Working Group (SRRWG) for RIIO-ED2 development.

Purpose of Document

The document sets out the detailed changes implemented in the revised version 2.0 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 RIIO-ED2 (1 April 2023 to 31 March 2028) 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-ED1 regulatory period as Network Asset Indices.

Requirements for reporting of Network Asset Indices were introduced within Standard Licence Condition 51 for RIIO-ED1. This licence condition required DNOs to jointly develop a Common Network Asset Indices Methodology, so that DNOs use a common approach to the derivation and reporting of Network Asset Indices. This resulted in the DNO Common Network Asset Indices Methodology (CNAIM) v1.1, which was approved by Ofgem in May 2017.

For RIIO-ED1, DNOs have agreed Network Asset Secondary Deliverables for delivery of a reduction in condition-based failure risk through their asset replacement and refurbishment activities. These are part of the RIIO-ED1 Network Output Measures (NOMs) and provide a measure of the effectiveness of DNO's replacement and refurbishment activities in managing the risk associated with condition-based asset failures. The DNOs individual targets for their Network Asset Secondary Deliverables, and measure of delivery performance, are expressed using the Network Asset Indices.

The RIIO-ED1 period ends on 31 March 2023 and the price control process for the following period, RIIO-ED2, will commence in 2021 with the submission of each DNO's Business Plans. The RIIO-ED2 price control period will operate between 1 April 2023 and 31 March 2028. Ofgem have already held initial working groups to develop their views on the role that Network Asset Indices shall play in RIIO-ED2. These working groups have helped inform Ofgem's views on the RIIO-ED2 methodology, which is the subject of an ongoing consultation (Ofgem's RIIO-ED2 Methodology Consultation) that runs between 28 July 2020 and 1 October 2020.

From discussions at Ofgem's RIIO-ED2 Safety, Resilience and Reliability Working Group (SRRWG) meetings, it is anticipated that Network Asset Indices shall continue to perform a similar function in the RIIO-ED2 framework, as part of the Network Asset Risk Metric (NARMs). However, as outlined in Ofgem's RIIO-ED2 Methodology Consultation, Ofgem

proposes that NARMs should consider long term risk within the measure of condition-based risk, whereas during RIIO-ED1 the Risk Index measure evaluated only 'in year' risk. Consideration of long term risk in RIIO-ED2 will require modifications to be made to CNAIM.

From discussions at the Safety, Resilience and Reliability Resilience Working Group (SRRWG) meetings, it is understood that Ofgem proposes that there shall be greater commonality between DNOs over the asset categories that shall be included within NARMs and that NARMs shall be specified using a more disaggregated level of asset category than used for RIIO-ED1. These proposals will also facilitate further changes to the existing CNAIM.

CNAIM shall, therefore, need to be modified to meet the changes in regulatory requirements that will be introduced for RIIO-ED2. The proposed changes, to be introduced in CNAIM for use in RIIO-ED2 will be initially known as version 2, to meet these regulatory requirements are outlined in sections 3 to 11 of this document. In addition, the DNOs have identified several enhancements to the methodology.

Since its approval, DNOs have gained significant experience in implementing and reporting against the existing CNAIM. DNOs have collectively monitored and reviewed the suitability of the existing methodology throughout RIIO-ED1 through meetings of the ENA[1] NOMs ED Working Group. 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 sections 12 to 22 of this document, for introduction within CNAIM v2.0.

DNOs RIIO-ED2 Business Plan submissions will include provision of Network Asset Indices information for NARMs. This consultation on CNAIM v2.0 is being undertaken at this time so that agreement to a CNAIM for RIIO-ED2 can be reached in advance of the RIIO-ED2 Business Plan submissions in 2021. If this is achievable, this will enable a consistent methodology to be implemented in the Business Plan submissions, definition of NARMs targets and reporting throughout RIIO-ED2. This will ensure that a clear and transparent linkage between allowances and the NARMs deliverable is maintained throughout the whole of the RIIO-ED2 period.

It should be noted that this consultation relates to the CNAIM v2.0 methodology, which is not proposed for use in RIIO-ED1. CNAIM v2.0 is intended to apply to the creation of RIIO-ED2 business plans and reporting against these during the RIIO-ED2 period only. DNOs propose to continue to use CNAIM v1.1 for the reporting of delivery against the RIIO-ED1 Network Asset Secondary Deliverables to avoid destabilising the output measure at a late stage in the regulatory period, by changing the view of delivery achieved to date.

The draft version of CNAIM v2.0 used for this consultation states all financial values used in the derivation of consequences of failure in 2012/13 prices, which is the price base that was used in the RIIO-ED1 Business Plans. DNOs will update the price base used in CNAIM v2.0 once the price base that is to be used for RIIO-ED2 Business Plan submissions is known.

[1] ENA is the Energy Networks Association, the Trade body for the Energy sector. All DNOs are members of this organisation.

Ofgem's current RIIO-ED2 Methodology Consultation indicates that this will be 2018/19 prices.

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 v2.0 used for this consultation. This is because agreement has yet to be reached with Ofgem over the appropriate values for usage in RIIO-ED2 cost assessment. These key cost parameters are identified in section 10 of this document. DNOs intend to update these key cost parameters within CNAIM v2.0 once the appropriate values for use in RIIO-ED2 cost assessment are known.

2. Executive Summary & Benefits

Following the creation and the operation of the Common Network Asset Indices Methodology (CNAIM) in RIIO-ED1, several enhancements to the methodology have been identified by both the Regulatory (Ofgem) and the 6 DNOs who created the Methodology. In preparation for the RIIO-ED2 regulatory period Ofgem have requested that the DNOs, who are responsible for the maintenance of the Methodology review its construction with a view to implementing several improvements for the RIIO-ED2 period.

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 basic drivers for the revision of the Methodology:

- Ofgem requirements for the RIIO-ED2 period and associated consequential revisions and
- DNO identified improvements driven by
    - better alignment to National and International Standards
    - Revision of the Methodology Modelling to align with changes in practice since the creation of V1.1
    - The introduction of Asset Condition modifiers, where these were omitted in earlier version.
    - Changes to the way Consequence of Failure values are calculate following changes to both practices and a reduced tolerance to the use of SF^6 gas

The DNOs have created this document to assist readers of the revised CNAIM Methodology in understanding the changes made and the rational and logic behind them. The document is effectively split into four sections.

1. Introduction and Executive Summary
2. Changes required by Ofgem
3. Changes proposed by the DNOs
4. An appendix containing proposed changes to the manner in which reporting may be carried out. These are for information only.

2.1 Impact assessment of Regulatory and DNO driven changes

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 RIIO-ED2 with the use of CNAIM v2.0 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 to create CNAIM v2.0

The following tables provides a summary of the proposed changes which if agreed, will be introduced for the RIIO-ED2 period, together with the organisation sponsoring the change (Regulatory or DNO).

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 form v1.1 to v2.0
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	Regulatory Requirement or DNO Proposal	Proposal	Description of Change	Impact Assessment for CNAIM v2.0
4	Regulatory	Alignment of reporting	Ofgem require that for the RIIO-ED2 period that all DNOs report against the full 61 Asset Register Categories in the Methodology	**No Impact**
5	Regulatory	Incorporate Long Term Risk to Risk Index	Assign new weightings to each Health Index Band, when deriving the monetised risk (or Risk Index) from the Risk Matrices, so that the value of monetised risk produced represents a longer-term view of the asset risk ('Long Term Risk''). The new weightings produce a value of risk that represents cumulative risk in the current year and all future years, in present value terms.	**Medium**
6	Regulatory (Consequential)	HI Banding Criteria Revision (Consequential change)	Revise the upper limit of the banding criteria for the HI1 Health Index Band	**Medium**
7	Regulatory (Consequential)	Revision of typical Health Score bandings to assign assets to HI bandings	Update the Health Score Used to Derive Average PoF	**Medium**
8	Regulatory (Consequential)	Changes to the Criticality Banding Criteria	Revise the method of allocating assets to Criticality Index Bands, such that banding is performed based upon a reference value that is common to each DNO.	**Medium**
9	Regulatory (Consequential)	Revision of Customer Numbers and Maximum Demands used in the Network Performance Cost of Failure	Revision to the typical Customer Numbers/ Maximum Demand used in the derivation of Network Performance Cost of Failure	**Medium**
10	Regulatory (Consequential)	Update all variable cost to the RIIO-ED2 price base	Current price base is 2012/13, revise to 2018/19	**No Impact**
11	Regulatory (Consequential)	Reclassification of Refurbishment Activities.	Reclassification of some refurbishment activities between Refurbishment (SDI) and Refurbishment (No SDI) categorisations	**Medium**
12	DNO	Safety Risk Reduction Factor	Introduction of new safety risk reduction factor	**Medium**
13	DNO	LV WMB and Pillar, revision to factor modifiers	Various updates to Condition Modifiers for LV Wall Mounted Boards (WMB) & LV Pillars	**Low**
14	DNO	Changes to the weightings associated with SF_6 gas	The values of gas lost for incipient, degraded and catastrophic failure from SF_6 switchgear have been updated to align with the latest industry understanding of failure types, gas lost and nominal gas volumes	**Low**
15	DNO	Align oil testing to the EHV model	To expand the HV Transformers methodology to include modifiers equivalent to those used for EHV & 132kV transformers, specifically for oil test, DGA and FFA.	**Medium**

Document Section	Regulatory Requirement or DNO Proposal	Proposal	Description of Change	Impact Assessment for CNAIM v2.0
16	DNO	Align EHV and 132kV Transformer oil testing values to the IEC Specification	Disaggregation of Oil Test Modifier by voltage and recalibration	Low
17	DNO	Copper Salt Treated Poles	New Normal Expected Life sub category for copper salt treated poles of 25 years	Low
18	DNO	Tower Painting Banding Revisions	Application of new caps and collars for various Tower Condition Modifiers	Medium
19	DNO	Revised condition inputs for pressurised Cables	Introduce a new observed condition input to capture issues with crystalline lead cable sheaths	Medium
20	DNO	Alignment of Cable Box condition assessments	Introduce an Observed Condition Input for cable boxes for all ground mounted switchgear and transformer assets.	Medium
21	DNO	Condition Collar application review	Introduce a collar of 3 or 4 to the condition level below the worst condition score of an asset with an existing collar of 8.	Medium
22	DNO	Observed Condition Modifier descriptor revision	A review of the descriptors used and V1.1 to remove ambiguity.	Low
A1	DNO	Revised BPDT for ED2	Provided for information only	**No Impact**
A2	DNO	RIG Annex A proposed changes	Provided for information only	**No Impact**

3. Existing Approach to Evaluating the Risk Index using Network Asset Indices

CNAIM determines a Health Index and Criticality Index for each individual asset where Network Asset Indices are reported.

The Health Index is a framework for collecting information relating to asset health and probability of failure. The Health Index consists of five bandings, HI1 to HI5. The HI1 banding represents assets with the lowest probability of failure and HI5 the highest.

The Criticality Index is a framework for collecting information relating to consequences of failure. The Criticality Index consists of four bandings, C1 to C4. Assets are currently allocated to a Criticality Index Band according to the relative magnitude of the consequences of failure for the individual asset compared to the Average Overall Consequences of Failure for the relevant Health Index Asset Category. The C1 banding represents assets with lower than average consequences of failure, whereas the C4 banding is used for those with significantly higher than average consequences of failure. In CNAIM, consequences of failure are assessed by considering four separate Consequence Categories: -

- Financial;
- Safety;
- Environmental; and
- Network Performance.

The Criticality Index banding is based on consideration of the overall consequences of failure, considering all four Consequence Categories.

For existing regulatory reporting, Network Asset Indices are reported using 5 x 4 matrices of Health Index against Criticality Index, such as the one shown below. These are known as Risk Matrices. Each reported asset is positioned in the Risk Matrix based upon its own Health Index and Criticality Index. Each position in the Risk Matrix is indicative of a different level of relative risk.

		Health Index				
Criticality		HI1	HI2	HI3	HI4	HI5
	C1					
	C2					
	C3					
	C4					

An annual submission of Network Asset Indices information to Ofgem is made using the Secondary Deliverable Reporting Pack (described within Ofgem's RIIO-ED1 Regulatory Instructions and Guidance Annex D). This includes separate Risk Matrices to show: -

- the distribution of assets across the Health Index Bands and Criticality Index Bands for the asset population;
- movements in the position of assets within the Health Index Bands and Criticality Bands due to changes in asset data (for example due to changes in age, new assessments of condition etc.);
- movements in the asset population arising from different DNO activities (for example separate Risk Matrices are used to show movements due to asset replacement activities, fault related activity etc.); and
- movements in the position of assets within the Health Index Bands and Criticality Bands due to certain refurbishment activities that are included within the Network Asset Secondary Deliverable.

These enables the condition-based risk within the population of each asset type to be derived, changes in this risk to be identified and related to the relevant driver for change (such as areas of DNO investment).

Where a Risk Matrix is used to show the distribution of a population of assets across the Health Index Bands and Criticality Index Bands, each portion of the matrix is populated to show the volume of assets that have the associated Health Index/ Criticality Index.

Where a Risk Matrix is used to show asset movements, the resulting change in volume of assets in each portion of the matrix is shown.

Within the RIIO-ED1 Secondary Deliverable Reporting Pack, separate sets of matrices are populated for each Regulatory Reporting Pack (RRP) Asset Register Category that is included within the DNO's own Network Asset Secondary Deliverables. These are the asset categories that are used in the annual regulatory Cost & Volume reporting (as specified within described within Ofgem's RIIO-ED1 Regulatory Instructions and Guidance Annex B).

The agreed Network Asset Secondary Deliverables for RIIO-ED1 have been specified using Health Index Asset Categories. For RIIO-ED1, DNO could elect which Health Index Asset Categories would be included within their own Network Asset Secondary Deliverables. Consequently, there are some differences between DNOs with regards to the categories considered.

The RIIO-ED1 Health Index Asset Categories are often an aggregation of several RRP Asset Register Categories that are used for Cost & Volume reporting. A Health Index Asset Category may include many RRP Asset Register Categories. For example, the HV Switchgear (GM) – Distribution Health Index Asset Category is used for reporting of Network Asset Indices relating to the following RRP Asset Register Categories: -

- 6.6/11kV CB (GM) Secondary;
- 6.6/11kV RMU;
- 6.6/11kV X-type RMU;
- 6.6/11kV Switch (GM);

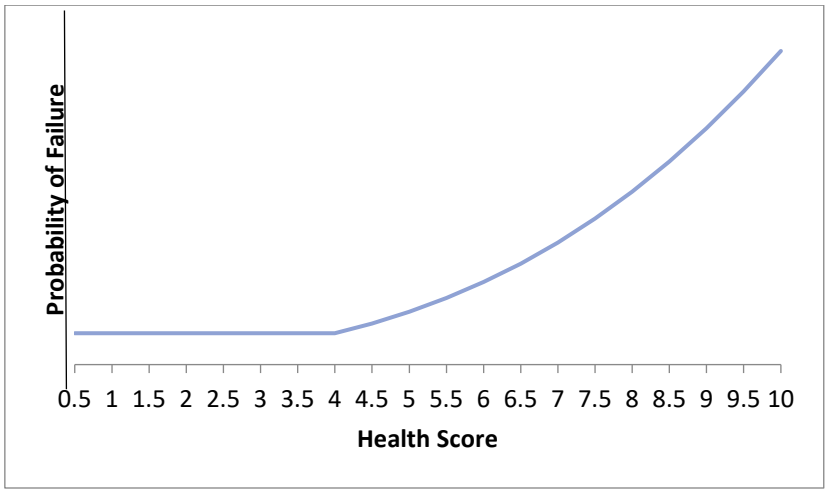
- 20kV CB (GM) Secondary;
- 20kV RMU; and
- 20kV Switch (GM).

The Health Index and Criticality Index Banding is performed in a way that enables the matrices for all the RRP Asset Register Categories within an individual Health Index Asset Category to be summated. This enables them to be compared with the agreed Network Asset Secondary Deliverable target for the Health Index Asset Category and is achieved by using consistent banding criteria within CNAIM v1.1 for all assets within a Health Index Asset Category.

To derive the Health Index for an asset, CNAIM evaluates the asset health by firstly determining a Health Score for the asset, using information about the asset such as age, location, duty, condition etc. Health Scores are assigned to assets using a continuous scale from 0.5 to 10 (which is extended to 15 when forecasting the future health of an asset). These scores are numerical representations of the condition of each asset in terms of the proximity to the end of the asset life. Higher values of Health Score represent assets that are closer to the end of life. The use of a continuous scale facilitates the modelling of degradation of asset health with time. Assets are assigned a Health Index Band based upon the value of Health Score associated with the asset. The following table illustrates the banding criteria used within CNAIM v1.1: -

Health Index Band	Health Index Banding Criteria	
	Lower Limit of Health Score	Upper Limit of Health Score
HI1	≥0.5	<4
HI2	≥4	<5.5
HI3	≥5.5	<6.5
HI4	≥6.5	<8
HI5	≥8	≤15

CNAIM also defines a relationship that enables the probability of condition-based failure (i.e. the likely number of condition based failures per annum) to be derived from the Health Score. This is illustrated below: -



This relationship can be used to determine a probability of failure value for each individual asset.

Within the Risk Matrix representation used for regulatory reporting of Network Asset Indices in RIIO-ED1, many assets may be represented within each Health Index Band, each with individual values of probability of failure. Typical values of probability of failure are assigned to each Health Index Band, so that a value of risk can be approximated for an asset based upon its position within the Risk Matrix and used within the evaluation of Network Asset Secondary Deliverables.

The assignment of typical values of probability of failure to a Health Index Band uses the relationship between probability of failure and Health Score that is defined within CNAIM. Through this relationship, a typical value of probability of failure is assigned to a particular Health Index Band that is defined as the probability of failure that would be determined if a typical value of Health Score within the Health Index Band is considered. The typical values of Health Score used for this purpose are defined within CNAIM. The table below illustrates how these are specified in CNAIM v1.1: -

Health Index Band	Health Score to be used to derive typical Probability of Failure
HI1	4
HI2	4.75
HI3	6
HI4	7.25
HI5	10

Different values for some of the factors deriving the probability of failure are used for different asset categories. Where Health Index Asset Categories contain multiple RRP Asset

Register Categories, it is possible in some cases for the relationship between probability of failure and Health Score to be different for the different RRP Asset Register Categories. Where this occurs, DNOs determine typical value of probability of failures for each Health Index Band, for use with all assets within the same Health Index Asset Category, based upon a weighted average that takes into consideration the population mix of the various RRP Asset Register Categories and their associated probabilities of failure. In such cases, the typical values of probability of failure assigned to the Health Index Bands are, by their nature, DNO specific.

For regulatory reporting of Network Asset Indices, typical values of consequence of failure for the relevant Health Index Asset Category are assigned to each Criticality Index Band in the Risk Matrices. These represent the impact of failure expressed in monetary terms (i.e. £). These are combined with the typical values of probability of failure for the Health Index Bands to determine the risk associated for each Health Index Band/ Criticality Index Band combination within the Risk Matrix.

The Criticality Index Bands are defined in terms of relative magnitude to the Average Overall Consequences of Failure associated with the Health Index Asset Category, as shown in the table below: -

Criticality Index Band	Criticality Index Banding Criteria	
	Lower Limit of Overall Consequence of Failure (as % of Average Overall Consequence of Failure for the Asset Category)	Upper Limit of Overall Consequence of Failure (as % of Average Overall Consequence of Failure for the Asset Category)
C1	-	< 75%
C2	≥ 75%	< 125%
C3	≥ 125%	< 200%
C4	≥ 200%	-

The Average Overall Consequences of Failure is determined, for each Health Index Asset Category, from the consequences of failure associated with the asset population that exists at a given point in time (e.g. for RIIO-ED1 this is the average for the population at the start of the period) within the DNO. This is then frozen as a reference point for the banding of asset criticality throughout the period. This ensures that Risk Matrices reported in each year are directly comparable with those reported in other years and comparable with the Network Asset Secondary Deliverable targets.

The Average Overall Consequences of Failure for each Health Index Asset Category are DNO specific values, recognising that differences exist in the typical level of impact of failure between DNOs. In part, these differences are driven by factors such as differences in usage, utilisation or location of assets. For example, the size of the impact of asset failure on network performance will be dependent on factors such as load / customer density and network topology, which will differ between each DNO. However, in some of the Health

Index Asset Categories, the range and mix of different types of RRP Asset Register Category within the Health Index Asset Category is a significant driver for differences in the Average Overall Consequences of Failure between DNOs.

The typical values of consequences of failure that are assigned to each Criticality Index Band are defined within CNAIM as a specified proportion of the Average Overall Consequences of Failure. This is shown in the table below: -

Criticality Index Band	% of Average Overall Consequences of Failure to be used to determine typical value of Consequences of Failure for the Criticality Band
C1	70%
C2	100%
C3	150%
C4	250%

The Risk Index for each Health Index/ Criticality Index combination within the Risk Matrices is the determined from the product of: -

- the typical value of probability of failure associated with the Health Index Band; and
- the typical value of consequence of failure associated with the Criticality Index Band.

This produces a monetised value of risk (£) for each of the Health Index/ Criticality Index combinations.

An overall value of monetised risk for an asset population can be derived by multiplying the asset volumes in each Health Index/ Criticality Index combination by the appropriate Risk Index value for the relevant portion of the matrix and summating for the whole of the matrix. In a similar way, the change in monetised risk caused by movements in the Risk Matrices, for example due to DNO investment, can be evaluated by multiplying the movement volumes by the appropriate Risk Index value for the relevant portion of the matrix. In this way, each DNO's RIIO-ED1 Network Asset Secondary Deliverable target has been derived and expressed as a monetised risk value.

The Network Asset Secondary Deliverable relates to the benefit in risk reduction that is delivered through the DNO's asset replacement activity and some refurbishment activities.

Asset replacement is the activity of whole replacement of an asset (or for linear assets, such as underground cables, a length of asset) predominantly driven by asset condition, obsolescence or safety. Within Ofgem's Regulatory Instructions and Guidance (RIG), refurbishment is a one-off activity undertaken on an asset that is deemed to be close to end of life or is otherwise not fit for purpose that extends the life of that asset or restores its

functionality. Refurbishment may involve replacement of a subcomponent of an asset, but does not include replacement of the whole asset, itself.

For RIIO-ED1 regulatory reporting, refurbishment is classified into two types: -

- Refurbishment (SDI) activities – these are refurbishment activities where any change in Risk Index delivered through these activities can be considered in the delivery against the Network Asset Secondary Deliverables target; and
- Refurbishment (No SDI) activities – these are refurbishment activities that, if undertaken, are not considered in the delivery of the Network Asset Secondary Deliverables.

Ofgem's Regulatory Instructions and Guidance Annex A allocates whether a specified refurbishment activity should be considered as Refurbishment (SDI) or Refurbishment (No SDI) activities. For example, within the guidance for a LV Pole: -

- 'Complete replacement of pole top steelwork (including associated insulators and fittings)' is classified as a Refurbishment (No SDI) activity; whereas
- 'Pole Strengthening (e.g. clamping a steelwork supporting bracket to an existing pole)' is classified as a Refurbishment (SDI) activity.

In allocating refurbishment activities between the two categories, consideration has been given to whether the activity delivers asset health benefits and whether any benefits delivered by the activity are measurable and capable of being reflected within the inputs provided to the calculation of Network Asset Indices. As Refurbishment (SDI) activities are included within the Network Asset Secondary Deliverable measure, it is important that CNAIM enables the risk improvement benefits associated with the activity to be quantified within the Network Asset Indices.

4. Commonality between DNOs for Asset Categories included within RIIO-ED2 Network Asset Risk Metric

For RIIO-ED1, each DNO could select the Health Index Asset Categories that were included in their Network Asset Secondary Deliverables. This resulted in dissimilar groups of Health Index Asset Categories being used by different DNOs for their agreed Network Asset Secondary Deliverables.

From discussions at Ofgem's RIIO-ED2 SRRWG meetings, it is understood that Ofgem require greater commonality in the asset categories that each DNO includes in the RIIO-ED2 NARMs. This will provide greater comparability between DNOs. However, it is not proposed to extend NARMs in RIIO-ED2 to asset categories that were not already covered by CNAIM v1.1. For this reason, the adoption of greater commonality of asset categories in RIIO-ED2 NARMs does not impact CNAIM v2.0.

Asset categories	N/A
Brief description of change	N/A
CNAIM section	N/A
Overall impact	**No impact** – reporting change only.

5. Incorporating Long Term Risk into the Risk Index

5.1 Summary of Proposal

A monetised Risk Index measure that quantifies the condition-based asset risk associated with the risk held in a single year is produced by CNAIM v1.1.

For RIIO-ED2, Ofgem require that the Network Asset Risk Metric should consider a longer-term view of risk, considering the value of the future risk associated with an asset.

The proposal is to change the basis for the weightings that are applied to the Health Index Bands, when deriving the Risk Index from the Risk Matrices so that the weighting factors produce a representation of the cumulative risk in the current year and future years, when combined with the typical values of consequences of failure for each Criticality Index Band.

Asset categories	All
Brief description of change	Assign new weightings to each Health Index Band, when deriving the monetised risk (or Risk Index) from the Risk Matrices, so that the value of monetised risk produced represents a longer-term view of the asset risk ('Long Term Risk''). The new weightings produce a value of risk that represents cumulative risk in the current year and all future years, in present value terms.
CNAIM section	Section 5 Risk Reporting
Equations affected	Equation 1 and 2 (EQ.1 & EQ.2)
Overall impact	**Medium:** The proposed change would apply to all assets across all RRP Asset Register Categories. Whilst this changes the basis on which the Risk Index is evaluated, these changes only impact the weighting applied to each Health Index Band within the Risk Matrices used in regulatory reporting. This change does not impact the determination of Health Score, Probability of Failure or Consequences of Failure. The methodology for placement of assets within Health Index Bands and Criticality Index Bands is also not impacted.

5.2 Driver for change

Within the Risk Matrices used for the regulatory reporting of Network Asset Indices, asset volumes are populated into the Health Index and Criticality Index portion of the matrix that represents the Health Index and Criticality Index that the asset has reached at a given point in time.

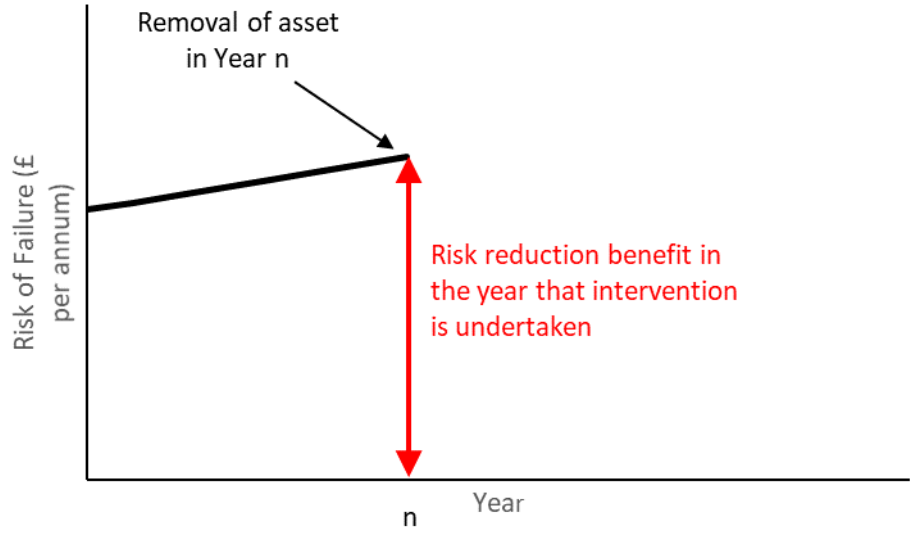
In CNAIM v1.1, a value of monetised risk (Risk Index) is derived from the position of an asset within the Risk Matrices by assigning: -

- a typical value of probability of failure (per annum) to all assets within the same Health Index Band (for a given Health Index Asset Category); and
- a typical value of Consequence of Failure to all assets within the same Criticality Index Band (for a given Health Index Asset Category).

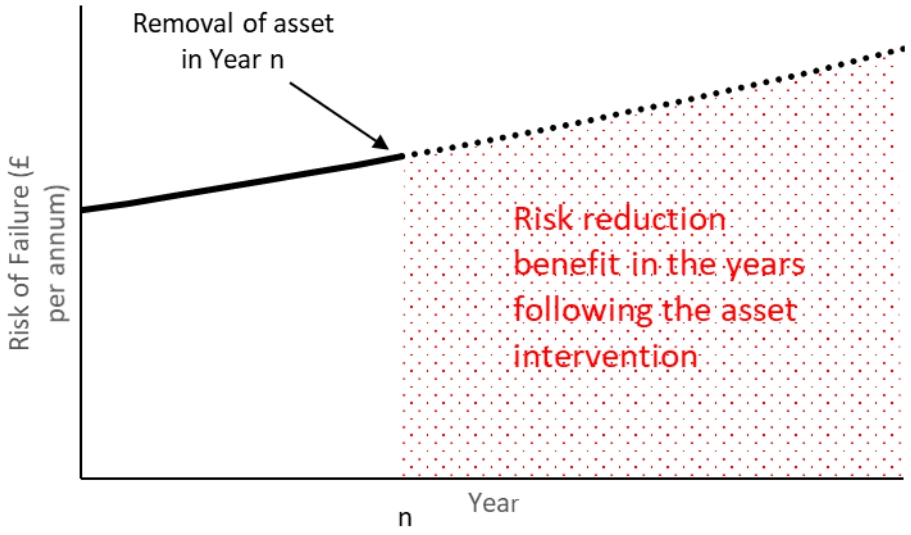
The Risk Index produced from these typical values represents a typical value of risk of failure (per annum) for an asset that has reached the relevant Health Index / Criticality Index at the point in time represented by the Risk Matrix. This is the measure of monetised risk

used in RIIO-ED1 Network Asset Secondary Deliverables. This represents the value of risk in a single year.

The Network Asset Secondary Deliverable relates to the risk reduction benefit that is delivered through asset replacement and certain refurbishment interventions. Where the risk reduction is assessed using the RIIO-ED1 Risk Index measure, this evaluates a monetised risk value representative of the risk reduction (in £ per annum) in the year represented by the relevant Risk Matrix. This produces a measure of risk reduction in a single year. The following diagram provides an illustration of what this measure is evaluating. The diagram shows a measure of risk reduction in a single year for an asset removed from the network in year n, based on a continuous time/ probability of failure curve: -



A measure that considers the risk in a single year does not consider the longer term risk associated with an asset. When an intervention is performed that reduces risk, this intervention does not only reduce the risk in the year that the intervention is undertaken, but also addresses the risk that would be held in future years if the intervention were not undertaken. This is illustrated in the diagram below, which again considers the risk reduction benefit associated with removal of an asset in year n.



The CNAIM v1.1 Risk Index provides an acceptable measure for use in assessing delivery against the Network Asset Secondary Deliverables targets, despite quantifying the risk reduction in terms of the risk reduction in a single year. This is because both the target and the delivery are evaluated on a consistent basis and can therefore be directly compared to assess whether the target has been delivered.

The monetisation of risk within the CNAIM v1.1 Risk Index does not quantify the reduction in future risk delivered by interventions and so it does not produce a measure of risk reduction benefit that enables comparison of the true value of the benefit delivered by an activity with the activity's associated cost. This means that it does not quantify risk in a way that facilitates evaluation of whether the expenditure on the activity is commensurate with the benefits that it delivers.

Ofgem proposes that the monetised risk measure used in the RIIO-ED2 Network Asset Risk Metric (NARM) should consider the long term condition based risk associated with assets. Long Term Risk provides a measure that that facilitates clearer visibility of the cost-benefit justification associated with interventions.

The requirement to consider Long Term Risk in the RIIO-ED2 NARMs requires changes to be introduced to CNAIM v2.0 to reflect this requirement within the Risk Index.

5.3 Details of the proposed changes

The Risk Matrix representation used in RIIO-ED1 regulatory reporting enables clear and transparent communication to all stakeholders about the health and criticality of high volume asset populations. Such populations are typical within the ED sector. Risk Matrices permit movements and changes (such as impact of investment, deterioration, material changes) to be clearly represented and understood, using terminology and presentation that has become well established and understood throughout the industry. The Risk Matrix representation and

Risk Index are now part of an established and mature regulatory reporting and assessment process for the ED sector.

It is proposed that a Risk Index measure reflective of long term future risk is introduced in CNAIM v2.0 that is an evolution of the existing Risk Matrix approach. This enables the benefits of the existing Risk Matrix approach and the established regulatory processes to be retained.

In CNAIM v2.0, it is proposed that the existing methodology for derivation and assignment of assets to Health Indices and Criticality Indices within the Risk Matrix is not changed. Long Term Risk will be recognised in CNAIM v2.0 by changes to the weighting that is applied to each Health Index Band when determining the value of the Risk Index. This weighting shall be changed so that it:-

- reflects the cumulative probabilities of failure in the current year and future years; and
- considers financial discounting so that the resulting Risk Index represents a monetisation of future risk that represents it in present value terms.

These weightings represent the 'cumulative discounted probability of failure' that is typical for each Health Index Band.

When the Health Index Band weightings are combined with the typical values of consequences of failure that are assigned to the Criticality Bands, the resulting Risk Index represents a quantification of the long-term risk in the current and future years that is expressed in present value terms. This enables any risk benefits delivered by interventions to be directly compared with the cost of intervention.

The weightings determined for each Health Index Band are derived based upon: -

- a typical value of current year Health Score for an asset within the Health Index Band;
- typical degradation forecasts for future asset health (based upon the existing principles used in determining future year deterioration in asset health for the derivation of Future Health Score within CNAIM); and
- financial discount rates consistent with HM Treasury Green Book guidance (2018).

To derive the weightings: -

- the forecast Health Score for each future year (starting with the typical value of current year Health Score) is determined using typical degradation assumptions based upon the calculations for Future Health Score within CNAIM; then
- a probability of failure for each of the years is derived from the forecast Health Score for the relevant year, using the relationship between Health Score and probability of failure that is defined in CNAIM; then
- a discounting factor, appropriate to the relevant year, is applied to the probability of failure for each year to create a 'discounted probability of failure' for each year; and finally

- the ‘cumulative discounted probability of failure’ weighting is determined by summating the ‘discounted probability of failure’ for each year.

Further information relating to the evaluation of Long Term Risk using the Risk Matrices can be found in section 5.5 of the draft CNAIM v2.0 document that accompanies this consultation.

6. Revision of Health Index HI1 Banding Criteria

6.1 Summary of proposal

Assets are allocated to a Health Index band based upon the Health Score of the asset.

The Risk Index is determined by allocating typical weightings to each Health Index Band and typical values of consequences of failure to each Criticality Band. The Risk Index is derived from the product of these typical values.

For RIIO-ED2 the Risk Index shall represent the Long Term Risk associated with assets, reflecting the cumulative current and future risk associated with assets. This is achieved by allocating typical weighting factors to each Health Index Band that represent the cumulative discounted probability of failure that is typical for each Health Index Band.

It is proposed to change the upper limit banding criteria for the HI1 band, in CNAIM v2.0, to better facilitate the use of a weighting factor for application to the HI1 Health Index Band that is reflective of the range of assets within the band, when Long Term Risk is considered.

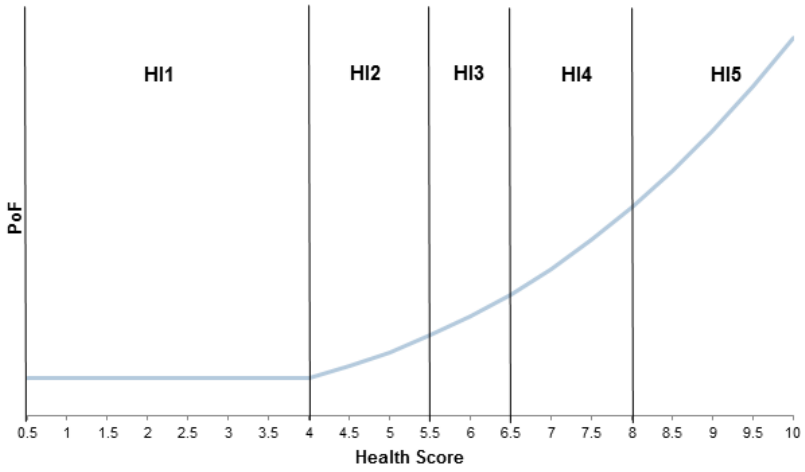
Asset categories	All
Brief description of change	Revise the upper limit of the banding criteria for the HI1 Health Index Band
CNAIM section	Section 5.3 Representation of Assets Within Risk Matrices
Tables affected	Table 5
Overall impact	**Medium:** The proposed change would apply to the representation of all asset groups within the Risk Matrices. This would reduce the volume of assets within the HI1 Health Index Band, compared to the allocation to this band using CNAIM v1.1. This proposal enables the weighting that is applied to the HI1 Health Index Band in CNAIM v2.0 to be more reflective of the range of assets within the band.

6.2 Driver for Change

Assets are assigned a Health Index Band based upon their Health Score. The figure below shows the bandings that are specified in CNAIM v1.1 and illustrates how they relate to the probability of failure curve that is generated from the Health Score.

When the Health Index (HI) banding criteria was developed for CNAIM v1.1, the HI1 band was defined as being applicable to all assets where the Health Score is less than 4. This was appropriate because the same value of probability of failure (per annum) is given to all assets, within the same asset category, that have a Health Score of 4 or below. This also enabled the Risk Index for the HI1 band to be derived using a typical probability of failure that would be the same as the probability of failure that would be calculated individually for all assets included within the band.

Based upon the age-based curve that underpins CNAIM's Initial Health Score calculation, assets would be expected to normally be in the HI1 band for a significant proportion of the lives. The HI1 band covers approximately 85% of the Expected Life of an asset, which is the point in an asset's life when the first significant signs of deterioration would be expected.



CNAIM is calibrated so that a Health Score of 5.5 represents the point that the first significant signs of deterioration would be expected. The HI2 band was defined so that it includes all remaining assets that have a Health Score below the calibration point of 5.5.

The calculations for Health Score use an exponential function and so assets normally transition more quickly along the 'tail' of the probability of failure curve. The remaining Health Index Bands were defined so that they provided a suitably granular view of an assets' transition towards the end of its life, taking into account that this is the portion of the curve that is normally examined when determining the timing of any condition-based interventions.

CNAIM v2.0 introduces a Risk Index measure that reflects Long Term Risk. This takes account of the cumulative risk in the current and future years and expresses this in present value terms. This is achieved by applying weightings to the Health Index Bands that represent the 'cumulative discounted probability of failure' that is typical for each Health Index Band. This is explained in section 5 of this document. These weighting factors are derived by considering the typical Health Score for an asset within each Health Index Band and the typical deterioration that would be expected in future years.

Due to the length of time that an asset takes to pass through the HI1 band (as defined in CNAIM v1.1), there would be considerable differences in the values of future risk that are associated with an asset at the beginning of the HI1 band compared to those for an asset that starts at the end of the HI1 band (i.e. Health Score 4), when considering future risk over a fixed period and taking account of financial discounting of the value of future risk. The differences arise because assets that start in the current year at the beginning of the HI1 band are at the start of the 'flat' portion of the probability of failure curve. Consequently, the probability of failure associated with such assets will not be forecast to rise until many years into the future have elapsed. However, the probability of failure for assets that start at the end of the HI1 band will increase in each forecast future year.

The scale of difference varies for each asset type, but typically the cumulative future risk, in present value terms, associated with assets that start from the end of the HI1 band could be 5 or 6 times greater than for assets that start from the beginning of the band. This range means that any value selected for a weighting factor for the HI1 Health Index Band, to be

used in the derivation of a Risk Index that considers Long Term Risk, may not be representative of assets at one or other end of the range of Health Scores within the band. For this reason, there is a need to revise the Health Index banding criteria for the HI1 band in CNAIM v2.0.

6.3 Details of the proposed changes

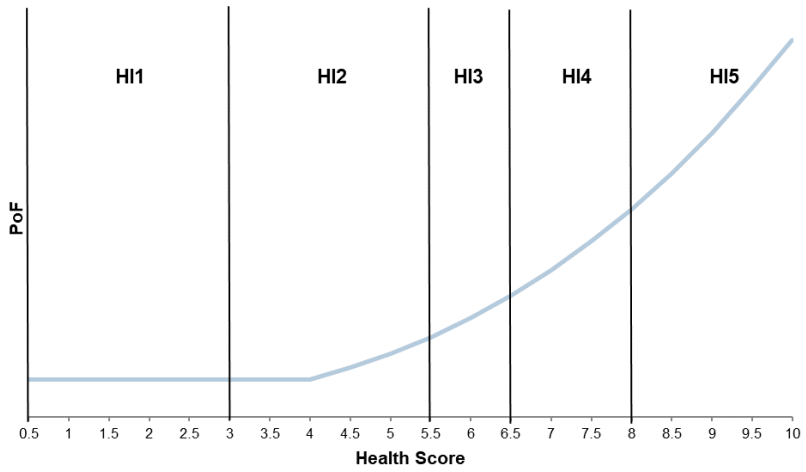
It is proposed to change the banding criteria for the HI1/ HI2 boundary in CNAIM v2.0 to a Health Score of 3. This is a reduction of the upper limit of the HI1 band, which was set at a Health Score of 4 in CNAIM v1.1.

The revised banding criteria is shown in the table below: -

Health Index Band	Health Index Banding Criteria	
	Lower Limit of Health Score	Upper Limit of Health Score
HI1	≥0.5	<3
HI2	≥3	<5.5
HI3	≥5.5	<6.5
HI4	≥6.5	<8
HI5	≥8	≤15

With the revised upper limit to the HI1 band, the range of cumulative future risk between assets at either end of the banding criteria is approximately half the size of the range where an upper limit of a Health Score of 4 is used. This enables a more suitable weighting factor to be applied to the HI1 band in CNAIM v2.0 that can be used in the derivation of the Risk Index to produce a value of Long Term Risk more typical for the range of assets within the Health Index band.

The figure below illustrates the revised banding criteria for CNAIM v2.0: -



7. Revision to the Typical Health Scores Used in Assigning Weightings to Health Index Bands for use in Derivation of the Risk Index

7.1 Summary of proposal

CNAIM provides a methodology for approximating and reporting the risk of failure associated with individual assets with reference to its position within the Risk Matrix. The methodology requires typical weighting factors to be assigned for all assets within the same Health Index Band that are used in the derivation of the Risk Index. In CNAIM v1.1, these weighting factors represented the typical probability of failure associated with an asset within the Health Index Band. In CNAIM v2.0, these represent typical values of cumulative discounted probability of failure, used to evaluate Long Term Risk. These weighting factors are defined within CNAIM based on typical values of Health Score. It is proposed that these values are updated; trued up to DNO data that was not available at the time CNAIM v1.1 was approved and to reflect other developments in the methodology as it evolved into CNAIM v2.0.

Asset categories	All
Brief description of change	Update the Health Score Used to Derive Average PoF
CNAIM section	Section 5.4 Risk Reporting
Tables affected	Table 7
Overall impact	**Medium:** The proposed change would apply to all assets across all asset groups although the overall impact of the change is small, affecting the risk score and no other aspects of the overall derivation of PoF.

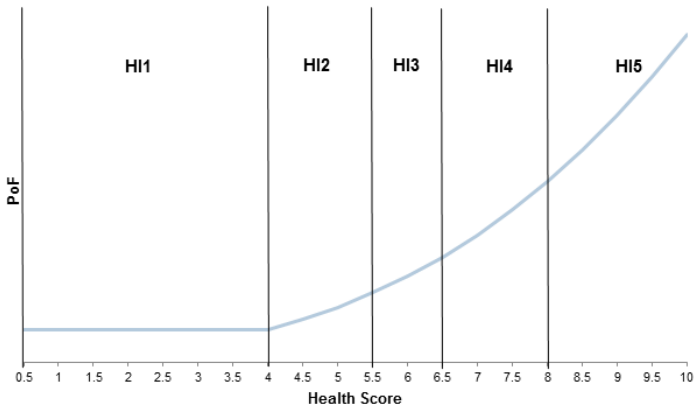
7.2 Driver for change

CNAIM derives a measure of monetised risk, the Risk Index, from the Risk Matrices that are used in regulatory reporting. This is achieved by assigning a weighting factor to each Health Index Band and a typical value of consequences of failure (in £) to each Criticality Index Band.

In CNAIM v1.1 the weighting applied to the Health Index Bands represents the typical probability of failure (per annum) for an asset within each band. When multiplied by the typical value of consequences of failure for each Criticality Index Band, a typical value of monetised risk (for a single year) for each Health Index/ Criticality Index combination within the matrix is derived. This is the CNAIM v1.1 Risk Index.

For CNAIM v2.0 the weighting applied to the Health Index Bands represents a typical ‘cumulative discounted probability of failure’ for an asset within the Health Index Band, as explained in section 5 of this document. When combined with the typical value of consequences of failure for the Criticality Index Band, the resulting Risk Index is a monetised value of long term cumulative current and future risk, in present value terms. This produces a measure of Long Term Risk as required by Ofgem for the RIIO-ED2 Network Asset Risk Metric (NARM).

In both CNAIM v1.1 and v2.0, there is a defined relationship between Health Score and probability of failure. This enables the weightings applied to the Health Index Bands for the derivation of the Risk Index to be specified in terms of typical Health Score. For example, in CNAIM v1.1 the typical probability of failure derived for a Health Index Band is the probability of failure that corresponds to a typical value of Health Score, as shown in the illustration and table (taken from Table 6 in CNAIM v1.1) below:-



Health Index Band	Health Score to be used to derive Average PoF
HI1	4
HI2	4.75
HI3	6
HI4	7.25
HI5	10

CNAIM v1.1 Table 6

Several changes are proposed for introduction in CNAIM v2.0 that may have a bearing on the selection of typical Health Score for use in the derivation of the weighting applied to each Health Index Band in the Risk Matrix. These include:-

- incorporation of Long Term Risk into the Risk Index, as required by Ofgem for the RIIO-ED2 NARMs (as outlined in section 5 of this document);
- revision to the upper banding criteria for the HI1 band (as outlined in section 6 of this document) in response to the introduction of a Long Term Risk measure.

In the context of these and other changes introduced in CNAIM v2.0, and with the experience gained from CNAIM v1.1 having now been implemented across the sector for several regulatory reporting years, it has been possible to compare these typical values to average values based on the known populations within each DNO. This analysis has considered the typical mid-point that is observed across the actual population of assets typically observed within each Health Index Band:

Health Index Asset Category	GB Average Health Scores by HI Band - With HI1 <4.0				
	HI1	HI2	HI3	HI4	HI5
Average across all DNOs	1.63	4.62	5.71	7.11	8.63
CNAIM v1.1 Table 6	4.00	4.75	6.00	7.25	10.0

As can be seen, there are some differences in the average “Health Score mid points” in comparison to Table 6 of CNAIM v1.1 particularly at the extremes of HI1 and HI5. The HI5 band can be sensitive to the use of collars for example and the HI1 band contains the greatest range and number of assets (from newly installed assets to good condition assets approaching its normal expected life).

It is noted that the HI1 band contains sensitivities to oil filled cables and towers. This must be considered in the context of how Risk Indices are used, specifically in relation to asset replacements whereby oil cable is replaced with solid cable (therefore no new assets will be installed, at a starting Health Score of 0.5). In the case of towers, these are often refurbished to a HI1 but not to a Health Score of 0.5. Therefore, the average "Health Score mid points" is additionally presented with the oil cable categories and towers removed:

Health Index Asset Category	GB Average Health Scores by HI Band - With HI1 <3.0				
	HI1	HI2	HI3	HI4	HI5
Average across all DNOs	1.26	4.17	5.71	7.09	8.62
CNAIM v1.1 Table 6	4.00	4.75	6.00	7.25	10.0

For the transitional Health Index Bands 2-4, these Health Scores compare well with the approach adopted previously in development of CNAIM v1.1 (i.e. to take the mid-point Health Score for the respective band).

The Health Index 5 band offers a complexity, in that the use of the band in regulatory reporting allows the Health Score to increase to a value of 15.0. However, the use of the future Health Index is changing in two key ways for ED2:

- Firstly, the regulatory period will be 5 years and not 8, and so the forecast Health Score will not increase to the levels that may have been seen in ED1.
- The introduction of Long Term Risk offers an alternative measure for assessing long term risk, rather than trying to value both current and future risk using the same risk matrix.

For comparison, the Health Score that corresponds to the point at which an asset would be at if it spent 50% of its time in a given HI band can be determined from Equation 6 (EQ.6) of CNAIM v2.0 as follows:

$$\text{Initial Health Score} = H_{new} \times e^{(\beta_1 \times age)} \qquad \text{EQ. 6}$$

Health Index Band	Health Index Banding Criteria		Health score that an asset would be at if it was 50% of its time in the HI Band
	Lower Limit of Health Score	Upper Limit of Health Score	
HI1	≥0.5	<3	1.23
HI2	≥3	<5.5	4.06
HI3	≥5.5	<6.5	5.74
HI4	≥6.5	<8	7.20
HI5	≥8	≤15	10.90 (8.94 * using HI limit of 10.0)

7.3 Details of the proposed changes

Because of the analysis that has been undertaken and with consideration of all the other ongoing development initiatives, it is proposed that

- Consistent with CNAIM v1.1, Health Score mid-points are used to determine the Average PoF Health Score for the transitional **Health Index Bands 2-4**.
- For **Health Index 1**, the Average PoF Health Score will be determined from the Health Score that an asset would be at if it spent 50% of its time in the HI1 band.
- For **Health Index 5**, an approximation between the two methods is proposed (noting the HI band has two Health Score limits of 10 and 15 depending on its application)

Therefore, the following changes to the Health Score that are to be used to derive Average PoF, for CNAIM v2.0, are proposed:

HEALTH SCORE USED TO DERIVE AVERAGE POF

Health Index Band	Health Score to be used to derive Average PoF (v1.1)	Health Score to be used to derive Average PoF (v2.0)
HI1	4.0	1.23
HI2	4.75	4.25
HI3	6.00	6.00
HI4	7.25	7.25
HI5	10	9.00

8. Changes to the Criticality Index Banding Criteria

8.1 Summary of proposal

In CNAIM v1.1, Criticality Index Bands are defined in terms of relative magnitude to a reference value that is the Average Overall Consequences of Failure associated with each Health Index Asset Category. The Average Overall Consequences of Failure are determined from the DNOs own asset populations and therefore are DNO specific, resulting in differences between DNOs in the allocation of assets to Criticality Index Bands.

Health Index Asset Categories will not be used for RIIO-ED2 Network Asset Risk Metric, which will be specified using RRP Asset Register Categories instead. As the range of consequences of failure for assets within a RRP Asset Register Category is generally smaller than the range within a Health Index Asset Category, it is possible for DNOs to adopt a common reference value for the allocation of assets into Criticality Index Bands in RIIO-ED2. It is proposed, in CNAIM v2.0, that the Total Reference Costs of Failure shall be used for this purpose.

Asset categories	All
Brief description of change	Revise the method of allocating assets to Criticality Index Bands, such that banding is performed based upon a reference value that is common to each DNO.
CNAIM section	Section 5.3 Representation of Assets Within Risk Matrices
Tables affected	Table 6 – headers only
Overall impact	**Medium:** The proposed change would apply to the representation of all asset groups within the Risk Matrices. This may change the distribution of assets across the Criticality Index Bands, and the typical weighting values used for each Criticality Index Band in the derivation of the Risk Index, but it introduces greater consistency between DNOs. This change does not impact the determination of Consequences of Failure for any individual asset.

8.2 Driver for change

The Network Asset Secondary Deliverables in RIIO-ED1 were specified using Health Index Asset Categories, which are categories of asset type that had been used in the RIIO-ED1 Business Plan submission. Some Health Index Asset Categories include several of the RRP Asset Register Categories that are used in the annual Cost & Volume regulatory reporting to Ofgem.

For the annual reporting of Network Asset Indices information to Ofgem in RIIO-ED1, the Secondary Deliverable Reporting Pack requires separate Risk Matrices to be populated for each RRP Asset Register Category that is within the Health Indices Asset Categories where the DNO has agreed Network Asset Secondary Deliverables. Reporting at this granularity of asset category permits a clearer view of the linkage between the Network Asset Indices information and the volume movements in the Cost & Volume reporting.

In recognition of the benefits of maintaining consistency in the presentation of Network Asset Indices information and Cost & Volume reporting, Ofgem has indicated during recent

SRRWG meetings that the Network Asset Risk Metric in RIIO-ED2 shall be specified, and reported against, using RRP Asset Register Categories.

The Health Index Asset Categories shall not be relevant to RIIO-ED2 and are therefore retained in CNAIM v2.0 only to assist presentation of the methodology where the same treatment is applied to multiple RRP Asset Register Categories.

The Risk Index is determined from the Risk Matrices by allocating typical weightings to each Health Index Band and typical values of consequences of failure to each Criticality Band. The Risk Index is derived from the product of these typical values.

In CNAIM v1.1, assets are allocated to a Criticality Index Band according to the relative magnitude of the consequences of failure for the individual asset compared to the Average Overall Consequences of Failure for the relevant Health Index Asset Category. The Average Overall Consequences of Failure for each Health Index Asset Category are DNO specific values, being derived from the DNO's own population of assets at a given reference point in time. This was required because of significant differences in the Average Overall Consequences of Failure observed between DNOs when the Criticality Index was first introduced into regulatory reporting. The range and mix of different types of RRP Asset Register Category within each Health Index Asset Category has been identified as a significant driver for differences in the Average Overall Consequences of Failure between DNOs.

As the Average Overall Consequences of Failure used in the banding of the Criticality Index for the RIIO-ED1 Network Secondary Deliverables are DNO specific, DNOs are not submitting Network Asset Indices that are banded on a consistent basis with other DNOs. An asset with a given value of consequences of failure in one DNO may be banded in a different Criticality Index to the same type of asset with the same consequences of failure in another DNO, because of the use of different Average Overall Consequences of Failure as the reference point for the banding.

By dispensing with the use of Health Index Asset Categories for specification of the Network Asset Risk Metric in RIIO-ED2, there is an opportunity to define the banding criteria for the Criticality Index in a way that achieves greater consistency in reporting between DNOs.

8.3 Details of the proposed changes

As Health Index Asset Categories will not be used for provision of Network Asset Indices information in RIIO-ED2, with all information being provided using separate matrices for each RRP Asset Register Category, it is appropriate that the Criticality Index Bands should be defined relative to reference values for each individual RRP Asset Register Category.

The range of consequences of failure values for assets within a RRP Asset Register Category is generally smaller than the range within a Health Index Asset Category which comprised of multiple RRP Asset Register Categories. Therefore, there is much less justification for DNO specific banding criteria to be applied in the allocation of assets to Criticality Index Bands.

It is proposed that a consistent reference value is used in the banding of Criticality Index Bands for the same RRP Asset Register Category in all DNOs. This will improve comparability of the Network Asset Indices between DNOs. The proposed reference values shall be the Total Reference Costs of Failure as shown in table 16 of CNAIM v2.0. The banding criteria for each Criticality Index Band shall be expressed in terms of proportions of the reference values as shown in the table below. The limits for each of the bands are consistent with those used for RIIO-ED1.

Criticality Index Band	Criticality Index Banding Criteria	
	Lower Limit of Overall CoF (as % of Reference Costs of Failure for the Asset Register Category)	Upper Limit of Overall CoF (as % of Reference Costs of Failure for the Asset Register Category)
C1	-	< 75%
C2	≥ 75%	< 125%
C3	≥ 125%	< 200%
C4	≥ 200%	-

9. Revision to Typical Customer Numbers and Maximum Demand used in the Derivation of Network Performance Cost of Failure

9.1 Summary of proposal

For CNAIM v2.0, the Total Reference Costs of Failure shall be used as the reference values for allocating assets to Criticality Index Bands as explained in section 8 of this document. For these to be suitable for this purpose, the Total Reference Costs of Failure needs to be reasonably representative of the typical consequences of failure observed across all DNOs.

The Network Performance Cost of Failure forms part of the Total Reference Costs of Failure for an asset category. The Customer Numbers and Maximum Demand values used in the derivation of the Network Performance Cost of Failure for different asset categories have been reviewed and changes to the values are proposed, so that the Network Performance Cost of Failure is more representative of the typical consequences of failure across all DNOs.

Asset categories	Most categories affected
Brief description of change	Revision to the typical Customer Numbers/ Maximum Demand used in the derivation of Network Performance Cost Of Failure
CNAIM section	Section D4 of Appendix D
Tables affected	Tables 16, 233, and 235
Overall impact	**Medium:** The proposed change would apply to the representation of all asset groups within the Risk Matrices. This may change the distribution of assets across the Criticality Index Bands, and the typical weighting values used for each Criticality Index Band in the derivation of the Risk Index. This change does not impact the determination of Consequences of Failure for any individual asset, other than where a default value is applied for network performance consequences of failure.

9.2 Driver for change

Section 8 of this document outlines a change to the reference values that are used in the allocation of assets to Criticality Index Bands. This is prompted by Ofgem's indication that Health Indices Asset Categories shall not be used in the specification of RIIO-ED2 Network Asset Risk Metric. It is proposed that the reference values used for banding into Criticality Index Bands shall be the Total Reference Costs of Failure shown in table 16 of CNAIM v2.0.

The Total Reference Costs of Failure are the summation of four separate types of reference costs used in the calculation of the consequences of failure for each individual asset. These four types of reference cost are:-

- the Reference Financial Cost of Failure;
- the Reference Safety Cost of Failure;
- the Reference Environmental Cost of Failure; and
- the Reference Network Performance Cost of Failure.

Within CNAIM, a value (in £) is specified for each asset category for each of these four types of reference cost. These relate to each of the four Consequence Categories considered within CNAIM. Asset specific costs, for individual assets, are determined by the application of modifying factors to these reference costs to reflect the consequences of failure associated with the individual asset in question. These reference costs also provide a default value for the relevant Consequence Category, where no asset specific data is available to produce modifying factors for an individual asset.

The proposal to use the Total Reference Costs of Failure for the banding of the Criticality Index requires the Total Reference Costs of Failure to be reasonably representative of typical overall consequences of failure for assets across all DNOs. This is required to achieve a distribution of assets across the Criticality Index Bands that provides a meaningful distinction between assets. For this reason, the Reference Network Performance Cost of Failure for each asset category has been reviewed to identify whether the values are suitably representative of those observed across the industry.

9.3 Details of the proposed changes

The derivation of the Reference Network Performance Cost of Failure for HV and LV assets includes an assessment of the typical number of customers that will be affected by a failure. The actual number of customers impacted by failure of an individual asset is used to produce a factor that adjusts the Reference Network Performance Cost of Failure so that the network performance consequences of failure for the individual asset are represented.

Similarly, the derivation of the Reference Network Performance Cost of Failure for EHV and 132kV assets includes an assessment of the typical maximum demand associated with each asset type. This is then adjusted by a factor based upon the actual demand associated with an individual asset to produce the network performance consequences of failure for the asset.

This is explained further in section D.4 in Appendix D of CNAIM v2.0.

For several asset categories, the customer numbers and maximum demand used in the derivation of the Reference Network Performance Cost of Failure have been revised in CNAIM v2.0 to better reflect the typical values seen across all DNOs.

When the customer and maximum demand values were determined for v1.1 this was based on best estimates and limited information available at the time. The implementation of CNAIM has resulted in better data becoming available and hence this informs the proposed changes.

Revision of these values produces reference costs that are more suitable for inclusion in the reference values that shall be used for the allocation of assets to Criticality Bands.

For asset categories where a change is proposed, the revised values are outlined in the tables below:-

Asset Category	Reference Number of Connected Customers used in CNAIM v1.1	REVISED Reference Number of Connected Customers used in CNAIM v2.0
LV OHL Support	80	30
HV OHL Support – Poles	800	1000
HV Transformer (GM)	200	150
HV Switchgear (GM) – Distribution	800	1000
HV Switchgear (GM) – Primary	1000	3500
LV Circuit Breaker	200	150
LV Pillar	200	150
LV UGB	80	50
LV Board (WM)	200	150

Asset Category	Maximum Demand Used To Derive Reference Cost (MVA) used in CNAIM v1.1	REVISED Maximum Demand Used To Derive Reference Cost (MVA) used in CNAIM v2.0
33kV Pole	9	12
66kV Pole	18	24
33kV Tower	9	12
66kV Tower	18	24
132kV Tower	36	60
33kV Fittings	9	12
66kV Fittings	18	24
132kV Fittings	36	60
33kV OHL (Tower Line) Conductor	9	12
66kV OHL Conductor	18	24
132kV OHL (Tower Line) Conductor	36	60
33kV UG Cable (Non Pressurised)	10.5	12
33kV UG Cable (Oil)	10.5	12

Asset Category	Maximum Demand Used To Derive Reference Cost (MVA) used in CNAIM v1.1	REVISED Maximum Demand Used To Derive Reference Cost (MVA) used in CNAIM v2.0
33kV UG Cable (Gas)	10.5	12
66kV UG Cable (Non Pressurised)	21	24
66kV UG Cable (Oil)	21	24
66kV UG Cable (Gas)	21	24
132kV UG Cable (Non Pressurised)	42	60
132kV UG Cable (Oil)	42	60
132kV UG Cable (Gas)	42	60
EHV Sub Cable	10.5	12
132kV Sub Cable	42	60
33kV Transformer (GM)	30	15
66kV Transformer	30	15
132kV Transformer	80	60

The Reference Network Performance Cost of Failure for each asset category, resulting from these changes, is shown in tables 233 and 235 of CNAIM v2.0.

10. Updating Key Cost Parameters

Several key cost parameters used in the determination of consequences of failure within CNAIM have not been updated in the draft version of CNAIM v2.0 that accompanies this consultation. This is because agreement has yet to be reached with Ofgem over the appropriate values for use in RIIO-ED2.

DNOs intend to use consistent values for these key cost parameters and price base assumptions, to those that will be used in the cost benefit analysis templates that will be developed to accompany DNO's RIIO-ED2 Business Plan submissions, where appropriate. This means that these values will be updated when Ofgem determines the appropriate values for use in RIIO-ED2.

These key cost parameters are:

- Safety:
    - Reference Cost of a Lost Time accident; and
    - Reference Cost of a Death or Serious Injury.
- Environmental:
    - Environmental cost per litre oil;
    - Environmental cost per kg of SF_6 lost;
    - Environmental cost of fire; and
    - Environmental cost per tonne waste.
- Network Performance:
    - Cost of CML;
    - Cost of CI; and
    - Value of Lost Load.

In addition, the values for the Reference Financial Cost of Failure for each RRP Asset Register Category, in this draft of CNAIM v2.0, are unchanged from the values in CNAIM v1.1. Ofgem's expert view of industry costs from RIIO-ED1 cost assessment was available for use in CNAIM v1.1, because it was developed after Ofgem had issued Final Determinations for RIIO-ED1. Ofgem's expert view of industry costs was used to inform the Reference Financial Cost of Failure for each asset category, because it represented an 'all industry' view.

As DNOs are seeking to implement CNAIM v2.0 so that it is available to inform their RIIO-ED2 Business Plan submissions, there will be no equivalent RIIO-ED2 view of industry cost available for incorporation into CNAIM v2.0 before Final Determinations. Hence, for CNAIM v2.0, it is proposed that the existing Reference Financial Cost of Failure for each RRP Asset Register Category from CNAIM v1.1 is retained but inflated to the new price base required for RIIO-ED2, once agreed.

11. Reclassification of Refurbishment Activities

11.1 Summary of proposal

Whilst considering the development of CNAIM v2.0, it was identified that a small number of activities were allocated as Refurbishment (SDI) activities in the Regulatory Instructions and Guidance, where the associated risk reduction benefit could not be readily assessed within CNAIM.

Also, it was identified that the categorisation in the Regulatory Instructions and Guidance for the activity of 'Replacement of cable box' is inconsistently applied across different RRP Asset Register Categories.

It is recommended that the categorisation of these refurbishment activities be revised in the RIIO-ED2 Regulatory Instructions and Guidance , to address these issues.

Asset categories	RRP Asset Register Categories representing:- • HV, EHV and 132kV switchgear and transformers; and • EHV and 132kV fluid filled cable
Brief description of change	Reclassification of some refurbishment activities between Refurbishment (SDI) and Refurbishment (No SDI) categorisations
CNAIM section	Appendix C
Tables affected	Tables 217
Overall impact	**Medium:** The proposed changes affect which refurbishment activities can be considered as contributing towards delivery against Network Asset Risk Metric in RIIO-ED2, for a small number of activities

11.2 Driver for change

The RIIO-ED1 Network Asset Secondary Deliverables consider the risk reduction improvement delivered by asset replacement interventions and some, but not all, refurbishment activities.

Refurbishment activities that are considered within the Network Asset Secondary Deliverables are referred to as Refurbishment (SDI) activities in regulatory reporting. Those that are not included in the delivery against the Network Asset Secondary Deliverables are referred to as Refurbishment (No SDI) activities. The allocation of refurbishment activities between these two categories is defined in Ofgem's Regulatory Instructions and Guidance Annex A. The allocation is based upon the activity type undertaken and is intended to ensure consistency between DNOs in the activities that DNOs consider when reporting delivery against the Network Asset Secondary Deliverables targets.

Where an activity is defined as a Refurbishment (SDI) activity, it is necessary for CNAIM to be able to reflect the improvement made to the asset health by undertaking the activity. This requires suitable inputs (such as one or more relevant condition inputs) to be available in CNAIM to measure and reflect the reduction in risk made by undertaking the activity.

Where a Refurbishment (SDI) activity is undertaken, the associated change in Health Index (or Criticality Index) due to this activity is reported in Ofgem's annual Secondary Deliverable Reporting Pack. The movement in the Network Asset Indices is reported in the year that the refurbishment activity occurs. This means that the inputs to CNAIM, which reflect the improvement in asset health delivered by the refurbishment, need to be able to provide a measure of the improvement at the time the activity is undertaken. Some condition inputs, such as leakage rates in fluid filled cable assets (e.g. 132kV UG Cable (Oil) assets) or fault history for non-pressurised cable assets (e.g. 132kV UG Cable (Non-Pressurised) assets), are lagging measures. These are measures that use information reliant on several years of history and are therefore not capable of measuring the benefit delivered by refurbishment activities at the time that the activities are undertaken. This is because insufficient time has elapsed to measure the effect of the refurbishment on the history required for these inputs.

The volumes used in the regulatory reporting of linear assets (i.e. underground cable or overhead conductor) relate to a length of asset (usually in circuit km). Where Refurbishment (SDI) activities are undertaken on linear assets, it is necessary to be able to not just quantify the benefit delivered, but also to be able to assign the improvement in risk to the associated length of asset impacted by the refurbishment. Some of the condition inputs used in CNAIM, such as leakage rates in fluid filled cable assets or fault history for non-pressurised cable assets are measures that collect information at circuit or hydraulic/ pneumatic section level. These inputs are not suitable for measuring improvements delivered by refurbishment works on smaller sections of asset than the level that these inputs are collected at, because the same input would be applied to all subsections that are unaffected by the works, as well as all the subsections that are affected by the works.

During the course of developing CNAIM v2.0, it has been identified that:-

- there are several refurbishment activities for fluid filled cable assets that are classified as Refurbishment (SDI) in RIIO-ED1, but the risk reduction benefit delivered cannot be reliably quantified in CNAIM because:-
    - the relevant condition inputs to CNAIM are lagging measures; and/or
    - the length of asset affected by the activity cannot be readily identified or reflected within the condition input measures;
- the activity of 'replacement of cable boxes' has been classified as a Refurbishment (SDI) activity in RIIO-ED1 when undertaken on most switchgear assets, but the same activity when undertaken on transformer assets has not been classified as a Refurbishment (SDI) activity even though for all switchgear and transformer assets, the activity of replacement of cable boxes is similar.

The regulatory treatment within the RIIO-ED2 NARMs for the above refurbishment activities needs to be aligned with the capability of CNAIM to provide a suitable reflective measure of the change in asset health delivered.

Similar refurbishment activities, for different asset categories, should also be given consistent regulatory treatment in regard to their contribution towards delivery against NARMs targets.

11.3 Details of the proposed changes

NEDWG recommends the reclassification of several refurbishment activities to be included within the Regulatory Instructions and Guidance for RIIO-ED2, so that the effects upon asset health for all activities classified as Refurbishment (SDI) are measurable within CNAIM and consistent across all assets where similar activities are undertaken.

11.3.1 Changes to classification of refurbishment activities undertaken on fluid filled cables

The following RRP Asset Register Categories represent fluid filled cables:-

- 33kV UG Cable (Oil);
- 33kV UG Cable (Gas);
- 66kV UG Cable (Oil);
- 66kV UG Cable (Gas);
- 132kV UG Cable (Oil); and
- 132kV UG Cable (Gas).

In the RIIO-ED1 Regulatory Instructions and Guidance the following activities are listed as Refurbishment (SDI) activities for these asset types:-

- Replacement of cable joints and terminations (including sealing ends);
- Remaking existing joints and terminations in situ; and
- Re-engineering (replacement/refurbishment/relocation) of pressurising system equipment with the objective of reducing the normal operating fluid pressure in the cable system.

It is recommended that for the RIIO-ED2 classification of activities, the activities of 'Replacement of cable joints and terminations (including sealing ends)' and 'Remaking existing joints and terminations in situ' should be removed and replaced with new activities that make a distinction between works at individual joint locations within a cable section and works to refurbish all joints on a section of cable. This is because where works are carried out on individual joints, the overall effect on the health of the cable section cannot reliably be determined. Cable sheath failures will in the worst case still result in leakage which is why the revision is proposed. This is further evidenced by the proposed change to include crystallised lead, see section 19 for further information. However, for the vast majority of interventions, it is reasonable to assume that if all joints within the cable section are replaced or remade then this would address any existing leakage issues, enabling an assumed improvement in leakage rate to be made when determining the Health Index for a refurbished cable section. The recommended new activity categories (and their classifications) are:-

- Replacement of an individual cable joint or termination (including sealing ends) {Refurbishment (No SDI)}
- Remaking an individual existing joint or termination in situ {Refurbishment (No SDI)}

- Replacement/remaking of all fluid filled cable joints and terminations (including sealing ends) within a hydraulic/pneumatic section – where undertaken as a single planned intervention {Refurbishment (SDI)}

The activity of Re-engineering (replacement/refurbishment/relocation) of pressurising system equipment with the objective of reducing the normal operating fluid pressure in the cable system' should be retained, but re-categorised for RIIO-ED2 as a Refurbishment (No SDI) activity, as the asset health benefit delivered cannot be readily measured until a reasonable period after the activity has been undertaken.

The recommended changes to the 'Refurbishment and Repairs & Maintenance Task Allocation Tables' in section 4 of Ofgem's Regulatory Instructions and Guidance Annex A are shown in Appendix A.2 of this document. This also requires corresponding changes to Appendix C of CNAIM, which outlines how the effect of refurbishment interventions are evaluated using CNAIM. These corresponding changes have been included in the draft CNAIM v2.0 document associated with this consultation.

11.3.2 Changes to classification of 'Replacement of cable box' activities undertaken on switchgear and transformer assets

In the RIIO-ED1 Regulatory Instructions and Guidance, the activity of 'Replacement of cable box' is included within the refurbishment activities listed for the following RRP Asset Register Categories:-

- 6.6/11kV CB (GM) Primary;
- 6.6/11kV CB (GM) Secondary;
- 6.6/11kV Switch (GM);
- 6.6/11kV RMU;
- 6.6/11kV X-type RMU;
- 20kV CB (GM) Primary;
- 20kV CB (GM) Secondary;
- 20kV Switch (GM);
- 20kV RMU;
- 6.6/11kV Transformer (GM);
- 20kV Transformer (GM);
- 33kV CB (Air Insulated Busbars)(ID) (GM);
- 33kV CB (Air Insulated Busbars)(OD) (GM);
- 33kV CB (Gas Insulated Busbars)(ID)(GM);
- 33kV CB (Gas Insulated Busbars)(OD)(GM);
- 33kV Switch (GM);
- 33kV RMU;
- 66kV CB (Air Insulated Busbars)(ID) (GM);
- 66kV CB (Air Insulated Busbars)(OD) (GM);
- 66kV CB (Gas Insulated Busbars)(ID)(GM);
- 66kV CB (Gas Insulated Busbars)(OD)(GM);
- 33kV Transformer (GM);
- 66kV Transformer (GM);
- 132kV CB (Air Insulated Busbars)(ID) (GM);

- 132kV CB (Air Insulated Busbars)(OD) (GM);
- 132kV CB (Gas Insulated Busbars)(ID) (GM);
- 132kV CB (Gas Insulated Busbars)(OD) (GM); and
- 132kV Transformer (GM).

The activity of 'Replacement of cable box' is classified as a Refurbishment (SDI) activity for all of the above RRP Asset Register Categories, with the exception of 6.6/11kV X-type RMU, 6.6/11kV Transformer (GM), 20kV Transformer (GM), 33kV Transformer (GM), 66kV Transformer (GM) and 132kV Transformer (GM) assets, where it is classified as Refurbishment (No SDI).

Given that for all the switchgear and transformer types, above, the works involved in the replacement of cable boxes are similar, as are the types and causes of failure, it is proposed that the activity of 'Replacement of cable box' is classified consistently for all of these RRP Asset Register Categories in the RIIO-ED2 Regulatory Instructions and Guidance. Cable box defects (e.g. compound voids, incorrectly made terminations etc.) can lead to major failures of plant assets and therefore it is recommended that the replacement of cable boxes is categorised consistently as a Refurbishment (SDI) activity.

The recommended changes to the 'Refurbishment and Repairs & Maintenance Task Allocation Tables' in section 4 of Ofgem's Regulatory Instructions and Guidance Annex A are shown in Appendix A.2 of this document. These corresponding changes have been included in the draft CNAIM v2.0 document associated with this consultation.

DNO driven changes

12. Safety Risk Reduction Factor

12.1 Summary of proposal

Following an increase in the failure rate of LV underground link boxes (LV UGB), an Energy Networks Association (ENA) recommendation was issued to install fire protection / suppression safety blankets at all link box installations. This has since led to established programmes across the sector to install such safety blankets.

CNAIM v1.1 recognises the relatively high safety risk within the link box Health Index category (refer to Table 16: Reference Costs of Failure); however, it pre-dates the work undertaken to identify the need and subsequent installation of these safety blankets. As a result, CNAIM v1.1 does not include any mechanism to adjust the Safety Consequences of Failure to reflect the impact of installing safety blankets.

It is proposed to introduce a Safety Risk Reduction Factor as an additional calculation step into determining the Safety Consequences of Failure. This enables the safety risk to be mitigated by utilising the safety blanket to specifically address the risk concerns for LV UGB assets in CNAIM v2.0.

Asset categories	All
Brief description of change	Introduction of new safety risk reduction factor.
CNAIM section	Appendix D.2 Calibration – Consequences of Failure (Safety)
Tables affected	Table 227
Equations affected	Equation 31 (EQ.31)
Overall impact	**Medium**: The change would apply to all link boxes and reduces risk (via a reduction in safety CoF) where safety blankets are installed. In some DNOs the whole population of link boxes would be impacted.

12.2 Driver for change

Due to several failures, concerns were raised from the Health and Safety Executive (HSE), Ofgem and DNOs with regard to the increased failure rate of LV UGB; especially the continuity of supply and safety risk to staff and members of the public.

In response to these issues, an ENA sponsored working group was convened looking at “best practice” asset management of these assets. This working group delivered an engineering risk mitigation recommendations report[2]. One of these recommendations was to install fire protection / suppression safety blankets at all link box installations since they

[2] Edif ERA 2015-0899 ENA Link Box Risk Assessment

would protect staff and members of the public from flames / fire linked to overheating. Additionally, any flames or fire from overheating would be instantly suppressed due to the safety blanket removing the required oxygen in air content.

12.3 Details of the proposed changes

The derivation of Safety Consequences of Failure (CoF) is detailed in section 7.4 and Appendix D.2 of CNAIM v1.1.

An associated reference safety probability has been derived based on applying the appropriate value (of preventing a loss time accident or death or serious injury) to the corresponding probability that each of these events occurs (for different scenarios including loss time accidents and fatalities). These values have been derived from an assessment of both disruptive and non-disruptive failure probabilities for these events based on bottom up assessments of faults, refer to Table 215 of CNAIM v1.1.

The Safety CoF can then be derived for individual assets by the application of a Type Safety Factor and/or a Location Safety Factor so that it reflects the characteristics of an individual asset. Within the assessment of the Reference Safety CoF and in the calibration of the Type and Location Factors, it has been assumed that no safety blanket has been installed.

The changes introduced to the CNAIM v2.0 document are:

- Update Section D.2.2.1 and add new Table 227
- Update Equation 31 (EQ.31)

The overall Safety CoF Factors for Switchgear, Transformers and Overhead Lines are determined by these Type and Location Risk Ratings as shown in Table 226 and then multiplied by the relevant Safety Risk Reduction factor as shown in Table 227.

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, Transformers, Cables & Overhead Lines	1.0
Default (no data available)	1.0

$$\text{Safety Consequences of Failure} = \text{Reference Safety Cost of Failure} \times \text{Safety Consequences Factor} \times \text{Safety Risk Reduction Factor}$$

EQ. 31

In the proposed CNAIM v2.0, although the Safety Risk Reduction Factor is applicable to all asset categories, it has only initially been utilised to adjust the Consequence of Failure for the LV UGB assets. The application to LV UGB is as a consequence in the need to take additional safety precautions associated with these assets. This is not applicable at this time to any other asset categories covered within the methodology.

13. Wall Mounted LV Boards & LV Pillars

13.1 Summary of proposal

Cable terminations are an integral component of the LV board assembly and their failure is typically catastrophic, necessitating replacement of the entire asset. This proposal is to increase the collar of the External Condition and Compound Leaks input to 5.5 for Substantial Deterioration condition criteria. The collar and factors for Compound Leaks will also be increased to reflect the higher probability of failures following significant compound leaks. These changes for Compound Leaks will also be made for LV Pillars due to the similarity between the LV Pillar and LV Board (WM) asset types. The proposal also includes the removal of Security from the Measured Condition Modifier for LV Board (WM).

Asset categories	LV Switchgear
Brief description of change	Various updates to Condition Modifiers for LV Boards & LV Pillars
CNAIM section	Chapter 6 (6.9.2) and Appendix B (B.5.4 and B.5.5)
Tables affected	Tables 12, 13, 14, 15, 42, 43, 45, 46, 47 and 49
Overall impact	**Low:** All wall mounted LV boards and LV pillars would be subject to the change. However, application of the new collars and factors would result in minimal change to the overall risk profile but improve the assessment for a specific subset of LV switchgear assets.

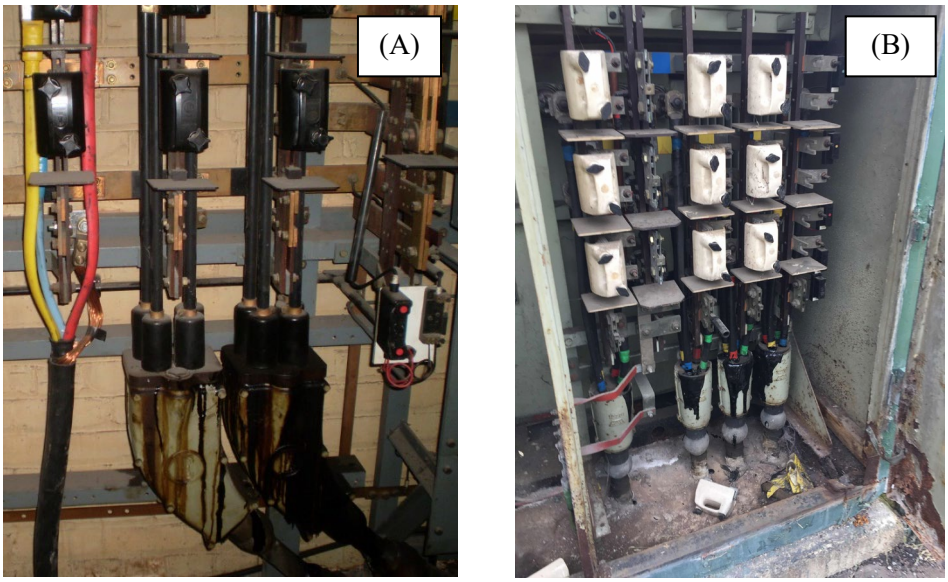
13.2 Driver for change

In CNAIM v1.1, LV Board (WM) has five condition modifiers:

- **Observed Condition Modifier:** External Condition, Compound Leaks, Internal Condition & Operation
- **Measured Condition Modifier:** Operational Adequacy, Security

It is considered that cable terminations are an integral component of the LV board assembly and failure of the cable termination is typically catastrophic, necessitating replacement of the entire asset. This proposal is to increase the collar of the External Condition and Compound Leaks input to 5.5 for Substantial Deterioration (at least HI3).

The condition input factors for Compound Leaks will also be increased. This is to reflect the higher probability of failures following significant compound leaks. These changes for Compound Leaks will also be made for LV Pillars due to the similarity between the LV Pillar and LV Board (WM) asset types as demonstrated in the figures below.



CABLE TERMINATION, (A) "BANANA BOX", (B) "BAGPIPE". BOTH VARIANTS HAVE BEEN ASSOCIATED WITH DISRUPTIVE FAILURE ARISING FROM COMPOUND TERMINATIONS

For LV Boards, three additional condition inputs are proposed to be added as part of LV Board (WM) Observed Condition to align the asset category and assessment with LV Pillars and improve the quality of the model. These are Insulation Condition, Signs of Heating and Phase Barriers.

The figure below demonstrates the value of additional input for Signs of Heating; failure may have been prevented by thermal inspection and condition assessment. Note that the three additional inputs proposed for LV Board (WM) are currently already included in CNAIM v1.1 for LV Pillars.

FAILED LV BOARD DUE TO THE LOOSE CONNECTIONS. THERMAL INSPECTION AND CONDITION ASSESSMENT MAY HAVE ENABLED EARLY DETECTION.

The proposal also includes the removal of Security from the Measured Condition Modifier for LV Board (WM). This has been reviewed and considered to overlap with the Operational Adequacy assessment which should capture the ability for the board/pillar to be secured as key to its functionality.

13.3 Details of the proposed changes

The changes introduced in CNAIM v2.0 are detailed below:

- Update to the collar for External Condition for LV Board (WM).

TABLE 42: OBSERVED CONDITION INPUT – LV BOARD (WM): 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) may exhibit signs of ageing, surface level scratches, moss or lichen that can be brushed off. This has no material impact on the probability of failure for the asset.	1	10	0.5

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
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 metalwork, door-hinges heavily rusted).	1.2	10	0.5
Substantial Deterioration	The switchgear is corroded to the point that one or more metalwork supports are rusted through, or the switchgear housing is damaged beyond economical repair.	1.4	10	5.5
Default	No data available	1	10	0.5

- Update to the factors and collars for Compound Leaks for LV Board (WM) and LV Pillars.

TABLE 43: OBSERVED CONDITION INPUT – LV BOARD (WM): COMPOUND LEAKS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	No leakage	1	10	0.5
Superficial/minor deterioration	Evidence of slight compound leak	1.1	10	0.5
Substantial deterioration	Significant compound leak or multiple compound leaks on the same board.	1.3	10	5.5
Default	No data available	1	10	0.5

TABLE 49: OBSERVED CONDITION INPUT – LV PILLARS: COMPOUND LEAKS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	No leakage	1	10	0.5
Superficial/minor deterioration	Evidence of slight compound leak	1.1	10	0.5
Substantial deterioration	Significant compound leak or multiple compound leaks on the same pillar.	1.3	10	5.5
Default	No data available	1	10	0.5

- Addition of Insulation Condition, Signs of Heating and Phase Barriers as additional inputs to the Observed Condition Modifier for LV Board (WM).

TABLE 45: OBSERVED CONDITION INPUT – LV BOARD (WM): INSULATION CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Satisfactory	No observed deterioration	0.9	10	0.5
Some Deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Substantial Deterioration	Degradation of insulation material	1.3	10	0.5
Default	No data available	1	10	0.5

TABLE 46: OBSERVED CONDITION INPUT – LV BOARD (WM): SIGNS OF HEATING

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	No obvious degradation	1	10	0.5
Minor Deterioration	Observed running higher than ambient	1.2	10	0.5
Major Deterioration	Evidence of overheating	1.5	10	5.5
Default	No data available	1	10	0.5

TABLE 47:OBSERVED CONDITION INPUT – LV BOARD (WM): PHASE BARRIERS

Condition Criteria: Phase barriers Present?	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Yes	Phase Barriers Present	1	10	0.5
Missing	Phase Barriers Not Present (in whole or part)	1.3	10	0.5
Default	No data available	1	10	0.5

- Removal of the Measured Condition Input for Security from the Measured Condition Modifier for LV Board (WM). This was included as Table 134 in CNAIM v1.1.
- Update to the Max. No. of Combined Factors in the MMI calculation for both Observed and Measured Condition Modifiers for LV Board (WM).

TABLE 13: OBSERVED CONDITION MODIFIER – MMI CALCULATION PARAMETERS

Asset Category	Subcomponent	Parameters for Combination Using MMI Technique		
		Factor Divider 1	Factor Divider 2	Max. No. of Combined Factors
LV Board (WM)	N/A	1.5	1.5	3

TABLE 15: MEASURED CONDITION MODIFIER – MMI CALCULATION PARAMETERS

Asset Category	Subcomponent	Parameters for Combination Using MMI Technique		
		Factor Divider 1	Factor Divider 2	Max. No. of Combined Factors
LV Board (WM)	N/A	1.5	1.5	1

N.B. Changes to the MMI for LV Pillars are not required as the number of inputs remains unchanged.

14. SF_6 Environmental Factors

14.1 Summary of proposal

This proposal is to update SF_6 Environmental Factors to better reflect the environmental risk and cost associated with SF_6 insulated equipment. The Net Zero context and growing relevance of sustainability legislation, including the development of SF_6 legislation, means it is critical for CNAIM to fully recognise the Consequence of Failure of SF_6 insulated assets.

Asset categories	HV Switchgear (GM) – Primary, HV Switchgear (GM) – Distribution, EHV Switchgear (GM), 132kV CB
Brief description of change	The values of gas lost for incipient, degraded and catastrophic failure from SF_6 switchgear have been updated to align with the latest industry understanding of failure types, gas lost and nominal gas volumes.
CNAIM section	7.2, D.3
Tables affected	Table 16, 228, 229, and 230
Overall impact	**Low:** The Environmental component of the Reference Consequence of Failure will be updated for HV – 132kV Switchgear. The relative impact on the risk profile of these asset categories will be greatest at the 132kV level but is still considered to be low. The overall effect will be to improve the risk assessment by refining reference criteria.

14.2 Driver for change

The ENA has produced an evaluation of SF_6 equipment which offers an improved view of the nominal mass of SF_6 by voltage and type of asset[3]. This has been reviewed and nominal values of SF_6 mass have been determined and updated for different switchgear voltage and types. An updated evaluation of the mass of gas lost for incipient, degraded and catastrophic failures has also been completed.

[3] ENA Engineering Report (EREP) 136, Issue 1 202 CONFIDENTIAL TO ENA MEMBERS, "Impact assessment report - Alternatives to SF6 switchgear"

14.3 Details of the proposed changes

14.3.1 Functional Failure Types & Associated Gas Leakage

Failure Types are defined in CNAIM v2.0 section 4.2.

Failure Type	Description	Nominal Gas Lost	Rationale
Incipient	Failure to operate when required due to: - Low gas lockout or vacuum bottle condition	10%	From evaluation, this represents a typical % of gas that would be lost by through minor gas leaks to trigger a low gas condition.
Degraded	SOP preventing operation. Failure to operate when required due to: - Failure of mechanism - Protection module - CT/VT failure - Stuck breaker	25%	From evaluation, this represents a typical % of gas lost due to major leak arising from gasket/tank integrity leak. Greater than lock-out, less than disruptive.
Catastrophic	Disruptive failure resulting from insulation breakdown	75%	From evaluation, this represents a typical % lost due to loss of integrity of gas chamber/ compartment, some gas is retained in alternative chambers and some residual gas is recovered.

14.3.2 Nominal Gas Mass and Average mass of SF6 lost per failure (kg)

Health Index Category	Nominal (kg)	Average mass of SF6 lost per failure (kg)		
		Incipient	Degraded	Catastrophic
HV Switchgear (GM) – Primary	0.7	0.1	0.2	0.5
HV Switchgear (GM) – Distribution	0.5	0.1	0.1	0.4
EHV Switchgear (GM)	4.0	0.4	1	3
132kV CBs*	40.0	4	10	30

**Nominal value is based on 132kV Air Insulated Busbar Variant*

Unlike equipment at lower voltages, for 132kV there is a much greater variation in mass of SF_6 within switchgear of different variants.

The typical mass of SF_6 in Air Insulated Busbar equipment (Dead Tank and Live Tank) is 40kg and has been utilised as the nominal mass for 132kV equipment, however this value is significantly greater for Gas Insulated Busbar equipment e.g. Indoor GIS, where the typical gas mass is 100kg.

To take account of this significant variation the Size Environmental Factor can be applied to scale the Environmental consequences proportionally.

14.3.3 Disaggregated Nominal Gas Mass (132kV) – Size Environmental Factor

Asset Register Category	Nominal Gas Mass	Size Environmental Factor
132kV CB (Air Insulated Busbars) (ID) (GM)	40kg	1
132kV CB (Air Insulated Busbars) (OD) (GM)	40kg	1
132kV CB (Gas Insulated Busbars) (ID) (GM)	100kg	2.5
132kV CB (Gas Insulated Busbars) (OD) (GM)	100kg	2.5

The changes introduced to the CNAIM v2.0 document are:

- Update mass of SF_6 gas released by Asset Category for incipient, degraded and catastrophic failures for all switchgear within Table 228.
- Update Type Environmental Factors for SF_6 within Table 229 to reflect the updated values in Table 228.
- Include Size Environmental Factors for 132kV CBs based on Asset Register Type within Table 230 to take account of gas mass variation by type.
- Update Table 16 – Reference Cost of Failure to include latest values for Environmental Cost of Failure.

N.B. All reference costs will need to be updated pending decision on adoption of revised reference costs for CoF factors.

TABLE 228: REFERENCE ENVIRONMENTAL COST OF FAILURE

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	
HV Switchgear (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%	£1,102
HV Switchgear (GM) – Distribution	10	50	150	0.1	0.1	0.4	0	0.0005	0.01	0.1	0.2	0.5	65%	30%	5%	£1,093
EHV Switchgear (GM)	25	125	250	0.4	1	3	0	0.0005	0.01	0.2	0.5	2	70%	20%	10%	£2,694
132kV CBs	50	250	1000	4	10	30	0	0.0005	0.01	0.3	2	10	70%	20%	10%	£8,794

TABLE 229: TYPE ENVIRONMENTAL FACTOR

Type environment factor	Oil	SF_6	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 CBs	0.79	0.24	0.03	0.79

TABLE 230: SIZE ENVIRONMENTAL FACTOR (PROPOSED ADDITION TO TABLE)

Asset Register Category	Size Environmental Factor Criteria	Size Environmental Factor
132kV CBs	132kV CB (Air Insulated Busbars)(ID) (GM)	1
	132kV CB (Air Insulated Busbars)(OD) (GM)	1
	132kV CB (Gas Insulated Busbars)(ID) (GM)	2.5
	132kV CB (Gas Insulated Busbars)(OD) (GM)	2.5

The environmental cost included in Table 16 for the reference costs have been updated to the values shown in the table below:

Asset Register Category	Environmental
6.6/11kV CB (GM) Primary	£1,102
6.6/11kV CB (GM) Secondary	£1,093
6.6/11kV Switch (GM)	£1,093
6.6/11kV RMU	£1,102
6.6/11kV X-type RMU	£1,093
20kV CB (GM) Primary	£1,094
20kV CB (GM) Secondary	£1,093
20kV Switch (GM)	£1,093
20kV RMU	£1,093
33kV CB (Air Insulated Busbars)(ID) (GM)	£2,694
33kV CB (Air Insulated Busbars)(OD) (GM)	£2,694
33kV CB (Gas Insulated Busbars)(ID) (GM)	£2,694
33kV CB (Gas Insulated Busbars)(OD) (GM)	£2,694
33kV Switch (GM)	£2,694
33kV RMU	£2,694
66kV CB (Air Insulated Busbars)(ID) (GM)	£2,694
66kV CB (Air Insulated Busbars)(OD) (GM)	£2,694
66kV CB (Gas Insulated Busbars)(ID) (GM)	£2,694
66kV CB (Gas Insulated Busbars)(OD) (GM)	£2,694
132kV CB (Air Insulated Busbars)(ID) (GM)	£8,794
132kV CB (Air Insulated Busbars)(OD) (GM)	£8,794
132kV CB (Gas Insulated Busbars)(ID) (GM)	£8,794
132kV CB (Gas Insulated Busbars)(OD) (GM)	£8,794

15. HV Transformer Oil Tests

15.1 Summary of proposal

Currently in CNAIM v1.1 for HV Transformers, acidity is the only oil test measurement input to the model. In order to improve the condition assessment of HV Transformers, it is proposed that a similar health score modifier methodology for EHV and 132kV Transformers is adopted for HV Transformers. This would involve the use of the Oil, Dissolved Gas Analysis (DGA) and Furfuraldehyde (FFA) Test Modifiers in CNAIM v2.0. The model has been calibrated for mineral insulating oil only.

Asset categories	6.6/11kV Transformer (GM), 20kV Transformer (GM)
Brief description of change	To expand the HV Transformers methodology to include modifiers equivalent to those used for EHV & 132kV transformers, specifically for oil test, DGA and FFA.
CNAIM section	Appendix B.7 'Oil Test Modifier', Appendix B.8 'DGA Test Modifier', Appendix B.9 'FFA Test Modifier', Section 6.8 'Health Score Modifier for EHV and 132kV Transformers'
Tables affected	Tables 203 – 215
Overall impact	**Medium:** The change will affect multiple asset groups though the overall impact is considered small with small movements between the lower HI bands (1-3) an expected consequence of the change.

15.2 Driver for change

In CNAIM v.1.1, the existing condition input tables relevant to HV Transformer are:

- **Observed Condition Modifier:** Transformer External Condition
- **Measured Condition Modifier:** Partial Discharge, Oil Acidity, Temperature Readings

Apart from oil acidity data, there are additional and useful oil condition data that can be obtained such as oil moisture content and oil breakdown strength. Such tests are either carried out on site or at a laboratory. Furthermore, DGA and FFA tests may also be carried out at a laboratory, though such tests are not routinely undertaken by DNOs on HV Transformers at present. The results from these additional oil tests can be utilised to assist the condition assessment of HV Transformers and help enable the DNOs to apply the most suitable intervention at the appropriate time.

15.3 Details of the proposed changes

It is proposed that a similar health score modifier methodology for EHV and 132kV Transformers is adopted for HV Transformers. This would require three key changes through an expansion of the existing tables used for EHV and 132kV transformers:

- **Introduce new Oil Test Modifiers** for HV Transformer. These are similar to the EHV Transformer, except for the Acidity Condition State Calibration (Table 204) and Oil Test Factor Calibration (Table 206). This is to ensure that similar results to those produced by CNAIM v1.1 are obtained if only the results from acidity tests are used. This would enable companies to maintain

status quo, i.e. if companies continue to carry out acidity measurements only, the oil test modifier would result in similar oil test factor/collar results as per CNAIM v1.1 without the moisture and breakdown strength input. The additional oil test parameters would provide companies with a means to undertake a more comprehensive assessment of the HV Transformer internal insulation condition once deterioration/issue is suspected, etc. where required.

- **Introduce new DGA Test Modifiers** for HV Transformer. These are similar to the EHV and 132kV Transformer requirements, except for the DGA Change Category Calibration (Table 213) and DGA Test Factor Calibration (Table 214). The DGA testing for HV Transformers is generally not carried out as frequently, or routinely, as EHV and 132kV Transformers, therefore the DGA Test Factor calibration which is based on a percentage change between test results is less meaningful for HV Transformers, due to the length, or unevenness of interval, between any tests. For this reason the DGA Test Factor is set to 1.

- **Introduce new FFA Test Modifiers** for HV Transformer similar to EHV and 132kV Transformers.

The changes introduced to the CNAIM v2.0 document are:

- Section 6.8 of CNAIM v1.1

6.8 Health Score Modifier for HV, EHV and 132kV Transformers

6.8.1 Main Transformer

The Health Score Modifier for HV, EHV and 132kV Transformers is derived in exactly the same way as…

6.8.2 Tapchanger (for EHV and 132kV Transformers only)

- Section 6.10.1 of CNAIM v1.1

For all Health Index Asset Categories, with the exception of EHV Towers, 132kV Towers, HV Transformers (GM), EHV Transformers and 132kV Transformers, a single Measured Condition Modifier is calculated for each asset.

The calculation of Health Score for assets in the EHV Towers, 132kV Towers, HV Transformers (GM), EHV Transformers and 132kV Transformers Health Index Asset Categories requires separate evaluation of the Health Score for subcomponents of these assets.

- Section 6.12 of CNAIM v1.1

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. In the case of HV Transformer only, the DGA Test Factor is set to 1.00 because DGA testing is generally not carried out at a testing frequency for the historical trending to be sufficiently robust. The DGA Test Cap is always set to 10.

The DGA Test Factor (EHV and 132kV Transformers only) 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.

$$\%\ \mathbf{Change} = \frac{\mathbf{DGA\ Score}_{\mathbf{latest}} - \mathbf{DGA\ Score}_{\mathbf{previous}}}{\mathbf{DGA\ Score}_{\mathbf{previous}}} \times \mathbf{100}\%$$

EQ. 25

- Appendix B, section B.7 in CNAIM

TABLE 203: MOISTURE CONDITION STATE CALIBRATION

HV Transformer (GM), EHV Transformer			132kV Transformer		
> Moisture (ppm)	<= Moisture (ppm)	Moisture Score	> Moisture (ppm)	<= Moisture (ppm)	Moisture Score
-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	10,000.00	10	40.00	10,000.00	10

TABLE 204: ACIDITY CONDITION STATE CALIBRATION

HV Transformer (GM)			EHV Transformer			132kV Transformer		
> 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
			-0.01	0.10	0	-0.01	0.05	0
-0.01	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	10,000.00	10	0.40	10,000.00	10	0.30	10,000.00	10

TABLE 205: BREAKDOWN STRENGTH CONDITION STATE CALIBRATION

HV Transformer (GM), EHV Transformer			132kV Transformer		
> BD Strength (kV)	<= BD Strength (kV)	BD Strength Score	> BD Strength (kV)	<= BD Strength (kV)	BD Strength Score
-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	10,000.00	0	60.00	10,000.00	0

TABLE 206: OIL TEST FACTOR CALIBRATION

HV Transformer (GM)			EHV Transformer, 132kV Transformer		
> Oil Condition Score	<= Oil Condition Score	Oil Test Factor	> Oil Condition Score	<= Oil Condition Score	Oil Test Factor
			-0.01	50	0.90
-0.01	250	1.00	50	200	1.00
250	500	1.10	200	500	1.05
500	1,000	1.20	500	1,000	1.10
1,000	10,000	1.40	1,000	10,000	1.20

TABLE 207: OIL TEST COLLAR CALIBRATION

HV Transformer (GM)			EHV Transformer, 132kV Transformer		
> Oil Condition Score	<= Oil Condition Score	Oil Test Collar	> Oil Condition Score	<= Oil Condition Score	Oil Test Collar
			-0.01	50	0.5
-0.01	250	0.5	50	200	0.5
250	500	0.5	200	500	0.5
500	1,000	0.5	500	1,000	0.5
1,000	10,000	5.5	1,000	10,000	5.5

TABLE 208: HYDROGEN CONDITION STATE CALIBRATION

HV Transformer (GM), EHV Transformer, 132kV Transformer		
> Hydrogen (ppm)	<= Hydrogen (ppm)	Hydrogen Condition State
-0.01	20	0
20	40	2
40	100	4
100	200	10
200	10,000.00	16

TABLE 209: METHANE CONDITION STATE CALIBRATION

HV Transformer (GM), EHV Transformer, 132kV Transformer		
> Methane (ppm)	<= Methane (ppm)	Methane Condition State
-0.01	10	0
10	20	2
20	50	4
50	150	10
150	10,000.00	16

TABLE 210: ETHYLENE CONDITION STATE CALIBRATION

HV Transformer (GM), EHV Transformer, 132kV Transformer		
> Ethylene (ppm)	<= Ethylene (ppm)	Ethylene Condition State
-0.01	10	0
10	20	2
20	50	4
50	150	10
150	10,000.00	16

TABLE 211: ETHANE CONDITION STATE CALIBRATION

HV Transformer (GM), EHV Transformer, 132kV Transformer		
> Ethane (ppm)	<= Ethane (ppm)	Ethane Condition State
-0.01	10	0
10	20	2
20	50	4
50	150	10
150	10,000.00	16

TABLE 212: ACETYLENE CONDITION STATE CALIBRATION

HV Transformer (GM), EHV Transformer, 132kV Transformer		
> Acetylene (ppm)	<= Acetylene (ppm)	Acetylene Condition State
-0.01	1	0
1	5	2
5	20	4
20	100	8
100	10,000.00	10

TABLE 213: DGA CHANGE CATEGORY CALIBRATION

EHV Transformer, 132kV Transformer		
> % Change	<= % Change	Change Category
-1,000.00	-5	Negative
-5	5	Neutral
5	25	Small
25	100	Significant
100	1,000.00	Large

TABLE 214: DGA TEST FACTOR CALIBRATION

EHV Transformer, 132kV Transformer	
> % Change	DGA Test Factor
Negative	0.9
Neutral	1
Small	1.1
Significant	1.2
Large	1.5

TABLE 215: FFA TEST FACTOR

HV Transformer (GM), EHV Transformer, 132kV Transformer		
> FFA value (ppm)	<= FFA value (ppm)	FFA Test Factor
-0.01	4	1
4	5	1.1
5	6	1.25
6	7	1.4
7		1.6

- Appendix B, section B.6 of CNAIM

As a consequence of these proposals, it is necessary to also remove the Measured Condition Modifier relating to Oil Acidity for HV Transformer (GM) Table 160 in CNAIM v1.1.

16. 132kV & EHV Transformer Oil Test Modifier

16.1 Summary of proposal

It is proposed to separate the EHV and 132kV transformer Oil Test Modifiers tables by voltage and to update the oil test value ranges within the tables to align with recommendations from IEC/BS EN 60422[4]. These changes can be implemented by modifying the calibration tables within CNAIM. The model has been calibrated for mineral insulating oil only.

Asset categories	EHV Transformer, 132kV Transformer
Brief description of change	Disaggregation of Oil Test Modifier by voltage and recalibration
CNAIM section	Appendix B.7 Oil Test Modifier
Tables affected	Tables 203, 204, 205 and 207
Overall impact	**Low:** The change would be applied to all EHV and 132kV transformers. However, application of the new calibrations would result in a minimal change to the overall risk profile. The change will improve the assessment for a specific subset of assets.

16.2 Driver for change

Within CNAIM v1.1, for both the main transformer and tapchanger components, the Health Score Modifier is derived using an Observed Condition Modifier, a Measured Condition Modifier and an Oil Test Modifier. The determination of these Modifiers is described in sections 6.9, 6.10, 6.11 of CNAIM.

For the main transformer sub-component, a Dissolved Gas Analysis (DGA) Test Modifier and Furfuraldehyde (FFA) Test Modifier are also used in addition to the Observed Condition Modifier, Measured Condition Modifier and Oil Test Modifier. These additional Modifiers are described in sections 6.12 and 6.13 of CNAIM.

The Oil Test Modifier includes a measure of moisture, acidity, and breakdown strength. Currently, both EHV and 132kV transformers are assessed using the same ranges for the three oil test parameters. However, DNO experience with managing transformer assets at different voltages and recommendations from IEC/BS EN 60422 Ed.4 – 2013 indicate that the expected values and ranges for these parameters vary at different operating voltages.

In addition, the current Oil Test Collar is considered to understate the impact that oil deterioration (high moisture and acidity) has on the overall life of a transformer, though not as severe as paper deterioration – this will still indirectly accelerate paper deterioration in addition to increasing the probability of a dielectric breakdown.

[4] "IEC 60422 Mineral insulating oils in electrical equipment - Supervision and maintenance guidance (Edition 4.0)," International Electrotechnical Commission (IEC) - Fluids for Electrotechnical Applications Technical Committee, p. 93, 2013.

16.3 Details of the proposed changes

It is proposed to separate the EHV and 132kV transformer oil test modifiers table by voltage and to update the oil test value ranges within the tables to align with recommendations from IEC/BS EN 60422. The changes introduced to the CNAIM v2.0 document are implemented by modifying Tables 203, 204, 205 and 207 as highlighted below. Full suite of updates to these tables (including HV Transformer) can be found in section 15 of this document.

TABLE 203: MOISTURE CONDITION STATE CALIBRATION

EHV Transformer			132kV Transformer		
> Moisture (ppm)	<= Moisture (ppm)	Moisture Score	> Moisture (ppm)	<= Moisture (ppm)	Moisture Score
-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

TABLE 204: ACIDITY CONDITION STATE CALIBRATION

EHV Transformer			132kV Transformer		
> Acidity (mg KOH/g)	<= Acidity (mg KOH/g)	Acidity Score	> Acidity (mg KOH/g)	<= Acidity (mg KOH/g)	Acidity Score
-0.01	0.10	0	-0.01	0.05	0
0.10	0.15	2	0.05	0.10	2
0.15	0.30	4	0.10	0.20	4
0.30	0.40	8	0.20	0.30	8
0.40	10000.00	10	0.30	10000.00	10

TABLE 205: BREAKDOWN STRENGTH CONDITION STATE CALIBRATION

EHV Transformer			132kV Transformer		
> BD Strength (kV)	<= BD Strength (kV)	BD Strength Score	> BD Strength (kV)	<= BD Strength (kV)	BD Strength Score
-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

N.B. It is proposed that the existing operator signs in the tables will remain (e.g. <= Moisture instead of < as per IEC/BS EN 60422).

As a further consequence of this proposal, it is recommended that the Oil Test Collar is updated from 3.0 to 5.5 for oil condition scores greater than 1000. This will ensure the resulting Health Index is a minimum of HI3:

TABLE 207: OIL TEST COLLAR CALIBRATION

> Oil Condition Score	<= Oil Condition Score	Oil Test Collar
-0.01	50	0.5
50	200	0.5
200	500	0.5
500	1,000	0.5
1,000	10,000	5.5

17. Copper Salt Treated Poles

17.1 Summary of proposal

The Normal Expected Life for a wood pole at all voltages in version 1.1 is 55 years, and is based on the Normal Expected Life of poles treated with creosote. DNOs have been installing non-creosote alternatives which offer significant safety and environmental advantages over creosote poles. Some treatments have demonstrated that they have a materially lower Normal Expected Life.

It is proposed that this should be recognised in CNAIM v2.0 through the inclusion of a specific Normal Expected Life for "Water Soluble Copper Salt Treated Wood Poles". The proposed Normal Expected Life has been informed from operational experience including other utilities and it is proposed to set it at 25 years.

Asset categories	LV Poles, 6.6/11kV Poles, 20kV Poles, 33kV Pole, 66kV Pole
Brief description of change	New Normal Expected Life sub category for copper salt treated poles of 25 years
CNAIM section	Chapter 2 (Acronyms), Appendix B.1 Normal Expected Life
Tables affected	Table 20
Overall impact	**Low:** A small proportion of the wood population (<1% of total population) would be subjected to the new Normal Expected Life.

17.2 Driver for change

In CNAIM v1.1, the Normal Expected Life for a wood pole at all voltages is 55 years based on the Normal Expected Life of creosote treated poles which account for most of the population in GB distribution networks. However, creosote is a biocidal, irritant and carcinogenic preservative and their replacement with non-creosote alternatives is increasing across the sector. For many years water soluble CCA (Chromated Copper Arsenate) preservative treatments were used by DNOs as an alternative to creosote. CCA poles are regarded in CNAIM as having the same Normal Expected Life as creosote treated poles. However, CCA poles can no longer be used for new installations, owing to the nature of the chemicals used in the preservative. Water soluble copper-salt treatments currently provide the industry with non-creosote alternatives. This type of pole preservative (also known as copper-salt or copper biocide) has been adopted on some GB networks in place of creosote treated poles, e.g. in areas of heavy footfall.

From industry experience, even with the addition of a protective sleeve to the pole, copper-salt poles have demonstrated a rapid decay below the ground line due to early fungal infestation caused by the preservative providing insufficient protection from moisture. Refer to the figure below.

The greater tendency of decay and shorter life of copper-salt poles was formally raised by Northern Powergrid in 2018 via the National Equipment Defect Reporting Scheme

NEDeRS[5]. Subsequent pole inspections by SPEN confirmed early deterioration in copper salt poles.

SEVERE POLE DECAY BELOW THE GROUND LINE

With the need to cease the use of creosote for wood pole preservative, an alternative to copper-salt (copper-oil) is being trialled. On completion of the trial a further proposal as to the Normal Expected life for the new preservative type will be added to the next revision of the methodology.

17.3 Details of the proposed changes

It is proposed that the single sub-division of Wood for poles of all voltage levels within CNAIM v1.1 is disaggregated into two sub-divisions for varying categories of wood preservatives in CNAIM v2.0.

The changes introduced to the CNAIM v2.0 document are:

- Section 2

SECTION 2 – ACRONYMS TABLE

Acronym	Description
CCA	Chromated Copper Arsenate

- Table 20 in Appendix B.1

[5] "SOP 2018/0409/00 Suspension of Operational Practice", Northern Powergrid (NPg), 2018.

TABLE 20: NORMAL EXPECTED LIFE (EXCRACT)

Asset Register Category	Sub-division	Normal Expected Life
LV Poles/	Concrete	60
	Steel	50
	Wood (water soluble copper salt treated; excluding CCA)	25
	Wood (other)	55
	Other (e.g. fibreglass)	80
6.6/11kV Poles	Concrete	60
	Steel	50
	Wood (water soluble copper salt treated; excluding CCA)	25
	Wood (other)	55
	Other (e.g. fibreglass)	80
20kV Poles	Concrete	60
	Steel	50
	Wood (water soluble copper salt treated; excluding CCA)	25
	Wood (other)	55
	Other (e.g. fibreglass)	80
33kV Poles	Concrete	60
	Steel	50
	Wood (water soluble copper salt treated; excluding CCA)	25
	Wood (other)	55
	Other (e.g. fibreglass)	80
66kV Poles	Concrete	60
	Steel	50
	Wood (water soluble copper salt treated; excluding CCA)	25
	Wood (other)	55
	Other (e.g. fibreglass)	80

18. Tower Painting Banding

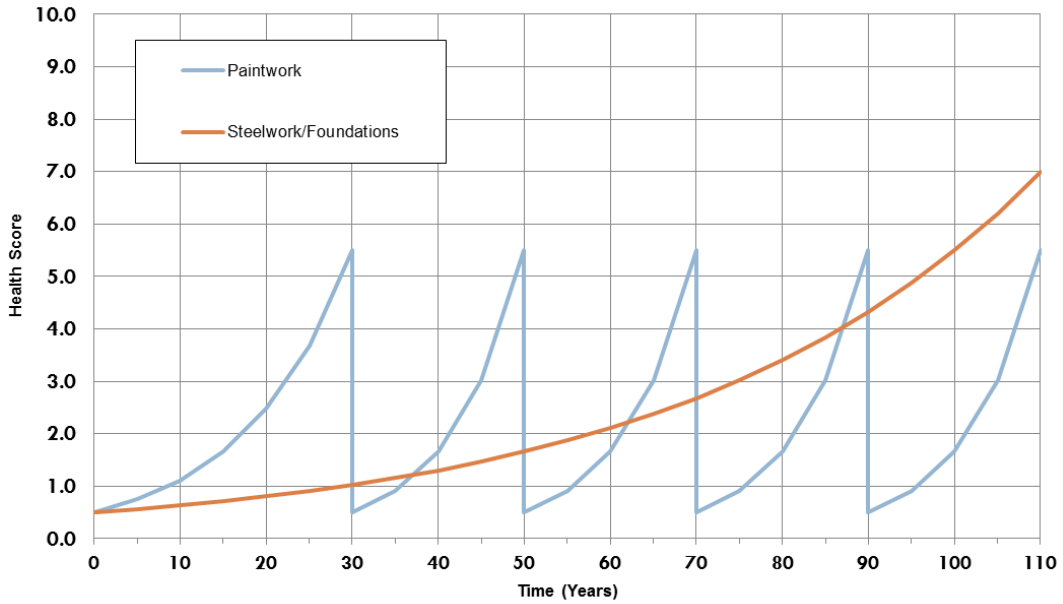
18.1 Summary of proposal

Under certain intervention scenarios, application of CNAIM v1.1 will result in no observed movement in Health Score for a Tower because of interdependences and sensitivities between the sub component Health Scores (paintwork, foundations and steelwork). To resolve this issue, specifically which impacts the risk improvement that is attributed, under the regulatory framework, to the painting of older towers, it is proposed to modify the Condition Input Caps and Collars relevant to several Tower Observed Condition Modifiers to correct an anomaly when towers with a high Health Index are painted.

Asset categories	33kV Tower, 66kV Tower, 132kV Tower
Brief description of change	Application of new caps and collars for various Tower Condition Modifiers
CNAIM section	Appendix B 'Calibration – Probability of Failure'
Tables affected	Tables 120-123, 125, 126-129 and 131
Overall impact	**Medium:** The change will affect multiple asset groups; however, application of the new caps and collars would result in minimal change to the overall risk profile but improve the assessment for a specific subset of tower assets.

18.2 Driver for change

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



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 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 (start of the HI3 band).

18.3 Details of the proposed changes

Given the interaction of the three tower components with 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.

The changes introduced to the CNAIM v2.0 document are as highlighted below:

TABLE 120/126: OBSERVED CONDITION INPUT – EHV/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	0.5

TABLE 121/127: OBSERVED CONDITION INPUT - EHV/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	0.5

TABLE 122/128: OBSERVED CONDITION INPUT - EHV/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	0.5

TABLE 123/129: OBSERVED CONDITION INPUT - EHV/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	0.5

TABLE 125/131: OBSERVED CONDITION INPUT - EHV/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	0.5
Substantial Deterioration	Insufficient integrity to support tower loading	1.8	10	8
Default	No data available	1	10	0.5

19. New Condition Input for Pressurised Cables

19.1 Summary of proposal

Experience has shown that most fluid leaks are found to be on the plumbs at joints, cable sealing ends and other cable accessories. In addition leaks might also occur where the lead sheath has become crystalline.

Crystalline or porous lead sheath found in pressurised oil-filled and gas-filled cables is irreparable and is usually not a localised condition. Therefore, replacement (or decommissioning) is the only practicable investment option for cable with such degraded lead sheath.

CNAIM v1.1 does not permit modification of the Health Score as a direct result of finding a cable with a crystallised sheath, although this is effectively an end of life condition. It is therefore proposed to introduce an additional Observed Condition Modifier in CNAIM v2.0 which will apply to the all fluid filled cable sections and types.

Asset categories	33kV Cable (Oil), 66kV Cable (Oil), 132kV Cable (Oil), 33kV Cable (Gas), 66kV Cable (Gas), 132kV Cable (Gas)
Brief description of change	Introduce a new observed condition input to capture issues with crystalline lead cable sheaths
CNAIM section	Section 6.9.2 'Observed Condition Factor', Appendix B 'Calibration – Probability of Failure'
Tables affected	Tables 12, 13, 103, 104, 105 and 106
Overall impact	**Medium:** The change will affect multiple asset groups; however, this would result in minimal change to the overall risk profile. The change will improve the assessment for a specific subset of cable assets.

19.2 Driver for change

Fluid-filled cables are constructed with either a lead sheath or an aluminium sheath. Lead sheath cables suffer from crystallisation of the sheath, which results in it becoming porous and discharging cable fluid into the environment. Refer to the figure below.

Crack in Lead Sheath caused by Crystallisation of the lead

When lead crystallisation occurs, it generally impacts the entire cable section and often beyond to the fluid section of the circuit.. Lead sheath crystallisation results in the rapid deterioration of the integrity of the cable, which cannot economically or efficiently be managed through repeated fault repairs. Crystalline or porous lead sheath is therefore effectively irreparable and is usually not isolated to a localised condition on the circuit. Replacement (or decommissioning in some rare cases) is the only practicable investment option for cable with degraded lead sheath. This description is further supported by section 9.2 of ENA Engineering Recommendation C135[6].

19.3 Details of the proposed changes

It is proposed to introduce a new observed condition input which will apply to the entire hydraulic or pneumatic section of the cable. The changes introduced to the CNAIM v2.0 document are:

[6] ENA Engineering Recommendation C135, Issue 1 2016, "Guidance for the operation and management of fluid filled cables".

TABLE 103: OBSERVED CONDITION INPUT – EHV CABLE (OIL): PRESENCE OF CRYSTALLINE LEAD

Condition Criteria: Lead Crystallisation Present?*	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No	Applicable to cables in the Lead sheath sub-division only: No lead crystallisation has been identified in the sheath of the cable or any other lead sheath cable within the same hydraulic section, on any occasion where the lead sheath of the cable has been exposed (e.g. during fault repair, leak location, construction works etc.).	1	10	0.5
Yes	Applicable to cables in the Lead sheath sub-division only: Evidence that lead crystallisation has been identified in the sheath of the cable or any other lead sheath cable within the same hydraulic section, on one or more occasions where the lead sheath of the cable has been exposed (e.g. during fault repair, leak location, construction works etc.).	1.8	10	8
Not applicable	This condition input is not applicable because the exposed cable within the hydraulic section is in the Aluminium sheath sub-division or the Lead sheath cable section has not been exposed.	1	10	0.5
Default	No data available	1	10	0.5

**This condition input is only collected by exception, i.e. when the cable section is uncovered for fault repair, leak detection, construction works etc.*

TABLE 104: OBSERVED CONDITION INPUT – EHV CABLE (GAS): PRESENCE OF CRYSTALLINE LEAD

Condition Criteria: Lead Crystallisation Present?*	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No	Applicable to cables in the Lead sheath sub-division only: No lead crystallisation has been identified in the sheath of the cable or any other lead sheath cable within the same pneumatic section, on any occasion where the lead sheath of the cable has been exposed (e.g. during fault repair, leak location, construction works etc.).	1	10	0.5
Yes	Applicable to cables in the Lead sheath sub-division only: Evidence that lead crystallisation has been identified in the sheath of the cable or any other lead sheath cable within the same pneumatic section, on one or more occasions where the lead sheath of the cable has been exposed (e.g. during fault repair, leak location, construction works etc.).	1.8	10	8
Not applicable	This condition input is not applicable because the exposed cable within the hydraulic section is in the Aluminium sheath sub-division or the Lead sheath cable section has not been exposed.	1	10	0.5
Default	No data available	1	10	0.5

**This condition input is only collected by exception, i.e. when the cable section is uncovered for fault repair, leak detection, construction works etc.*

TABLE 105: OBSERVED CONDITION INPUT – 132KV CABLE (OIL): PRESENCE OF CRYSTALLINE LEAD

Condition Criteria: Lead Crystallisation Present?*	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No	Applicable to cables in the Lead sheath sub-division only: No lead crystallisation has been identified in the sheath of the cable or any other lead sheath cable within the same hydraulic section, on any occasion where the lead sheath of the cable has been exposed (e.g. during fault repair, leak location, construction works etc.).	1	10	0.5
Yes	Applicable to cables in the Lead sheath sub-division only: Evidence that lead crystallisation has been identified in the sheath of the cable or any other lead sheath cable within the same hydraulic section, on one or more occasions where the lead sheath of the cable has been exposed (e.g. during fault repair, leak location, construction works etc.).	1.8	10	8
Not applicable	This condition input is not applicable because the exposed cable within the hydraulic section is in the Aluminium sheath sub-division or the Lead sheath cable section has not been exposed.	1	10	0.5
Default	No data available	1	10	0.5

**This condition input is only collected by exception, i.e. when the cable section is uncovered for fault repair, leak detection, construction works etc.*

TABLE 106: OBSERVED CONDITION INPUT – 132KV CABLE (GAS): PRESENCE OF CRYSTALLINE LEAD

Condition Criteria: Lead Crystallisation Present?*	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No	Applicable to cables in the Lead sheath sub-division only: No lead crystallisation has been identified in the sheath of the cable or any other lead sheath cable within the same pneumatic section, on any occasion where the lead sheath of the cable has been exposed (e.g. during fault repair, leak location, construction works etc.).	1	10	0.5
Yes	Applicable to cables in the Lead sheath sub-division only: Evidence that lead crystallisation has been identified in the sheath of the cable or any other lead sheath cable within the same pneumatic section, on one or more occasions where the lead sheath of the cable has been exposed (e.g. during fault repair, leak location, construction works etc.).	1.8	10	8
Not applicable	This condition input is not applicable because the exposed cable within the hydraulic section is in the Aluminium sheath sub-division or the Lead sheath cable section has not been exposed.	1	10	0.5
Default	No data available	1	10	0.5

**This condition input is only collected by exception, i.e. when the cable section is uncovered for fault repair, leak detection, construction works etc.*

- Section 6.9.2

There are currently no other Observed condition inputs for EHV or 132kV Cable (Oil/Gas) in CNAIM v1.1 and to implement the proposal it is necessary to also make amendments to Table 13 as shown below:

TABLE 13: OBSERVED CONDITION MODIFIER - MMI CALCULATION PARAMETERS (EXTRACT)

Asset Category	Subcomponent	Parameters for Combination Using MMI Technique		
		Factor Divider 1	Factor Divider 2	Max. No. of Combined Factors
EHV Cable (Oil)	N/A	1.5	1.5	1
132kV Cable (Oil)	N/A	1.5	1.5	1
EHV Cable (Gas)	N/A	1.5	1.5	1
132kV Cable (Gas)	N/A	1.5	1.5	1

20. Cable Box Replacement

20.1 Summary of proposal

For different asset types, 'Replacement of cable boxes' has been inconsistently allocated in the RIGs Annex A guidance and within CNAIM v1.1. To address this, it is proposed to introduce an Observed Condition Input for cable boxes in CNAIM v2.0, for all ground mounted switchgear and transformer assets.

Asset categories	All switchgear and transformer asset categories
Brief description of change	Introduce an Observed Condition Input for cable boxes for all ground mounted switchgear and transformer assets.
CNAIM section	6.9 'Observed Condition Modifier', Appendix B 'Calibration – Probability of Failure', Appendix C 'Interventions'
Tables affected	Tables 12, 13, 59, 65, 72, 80, 82, 87, 97, and 217
Overall impact	**Medium:** The change will affect multiple asset groups.

20.2 Driver for change

For most ground-mounted switchgear assets, the 'Refurbishment and Repairs & Maintenance Task Allocation Tables' in section 4 of the RIIO-ED1 RIG Annex A – Glossary define the refurbishment activity of 'Replacement of cable boxes' as a Refurbishment (SDI) activity. This means that for these asset categories, this activity is considered as contributing towards delivery of the Network Asset Secondary Deliverables in RIIO-ED1. For ground-mounted transformers, and 6.6/11kV X-type RMU assets, the same activity is classified as a Refurbishment (No SDI) activity, meaning that it is not considered when assessing delivery against the Network Asset Secondary Deliverables

As outlined in section 11 of this document, it is recommended that the activity of 'Replacement of cable boxes' is reclassified for RIIO-ED2 as being a Refurbishment (SDI) activity for all ground-mounted switchgear and transformer asset categories. This reflects the similarities in the works undertaken for this refurbishment activity, and the types and causes of cable box failure, across these asset categories.

As delivery against NOMs targets is determined from the risk improvement delivered through Asset Replacement and Refurbishment (SDI) activities, it is necessary for CNAIM to include sufficient condition observation / measurement points to enable the issues that drive Refurbishment (SDI) activities to be identified and correctly reflected within the health score of an asset. Without this, the benefit from Refurbishment (SDI) activities cannot be correctly evaluated.

For switchgear and transformer assets, CNAIM v1.1 only includes specific observed condition inputs relating to cable boxes in the Health Score calculations for 33kV Transformer (GM), 66kV Transformer (GM) and 132kV Transformer (GM) assets, even though, for these asset types, replacement of cable boxes is considered as a Refurbishment (No SDI) activity in the RIIO-ED1 RIGs. For the switchgear assets, where replacement of

cable boxes is considered a Refurbishment (SDI) activity in RIIO-ED1, there is no specific condition input relating to cable boxes in CNAIM v1.1. In such instances, to account for cable box condition in switchgear assets, it has been necessary for an individual DNO to reflect cable box condition in one of the other condition inputs.

20.3 Details of the proposed changes

To better facilitate classification of 'Replacement of cable boxes' as a Refurbishment (SDI) activity, it is proposed to introduce an Observed Condition Input for cable boxes in CNAIM v2.0, for all ground mounted switchgear and transformer assets. It is also proposed that a consistent calibration table (below) be used for all switchgear and transformer assets including EHV Transformer (GM) and 132kV Transformer (GM) assets (which already have a cable box condition input in CNAIM v1.1).

The calibration tables for the cable box condition input can be found in Appendix B section B.5 of CNAIM v2.0 for each asset type. These calibrations are shown in the table below:

- Appendix B, section B.5

OBSERVED CONDITION INPUT – SWITCHGEAR & TRANSFOMER: CABLE BOXES CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration*	There are no signs of any deterioration such as corrosion, stains, markings, compound leaks, discharge etc.	1	10	0.5
Superficial / minor deterioration*	The cable box may exhibit minor exterior stains or marks (e.g. surface level scratches, moss or lichen that can be brushed off), but no damage or corrosion should be evident. No evidence of compound leaks, discharge, signs of heating, or deterioration of insulation.	1	10	0.5
Some Deterioration	Minor corrosion (e.g. surface corrosion spots) or deterioration (e.g. minor breakthrough of paintwork but no loss of galvanising).	1.1	10	0.5
Substantial Deterioration	Evidence of significant corrosion and perforation (e.g. holes). Severe breakthrough of paintwork with some loss of galvanising. Major compound leaks. Evidence of discharge, signs of heating, deterioration/ damage of insulation.	1.3	10	0.5
Default	No data available	1	10	0.5

** - note: as both the 'No Deterioration' and 'Superficial/minor deterioration' Condition Criteria for this Condition Input are treated in the same way by the Methodology, the categorisations for these two Condition Criteria may be combined in individual implementations of the Methodology.*

The calibrations are based upon the existing cable box observed condition input calibration tables used for EHV Transformer (GM) and 132kV Transformer (GM) assets in CNAIM v1.1 but include enhanced description and revised terminology in the condition criteria. It is noted that for some switchgear and transformer asset types, other observed condition inputs can generate a Condition Input Factor of 0.9. The factor of 0.9 is used for condition observations that are indicators of slower ageing than would normally be anticipated. The minimum Condition Input Factor for the proposed Cable Boxes Condition Input is 1. A factor of 0.9 has not been included in the calibration table for the Cable Boxes Condition, as it is considered

that this observation will not provide an indicator that the overall asset may be ageing slower than normally anticipated.

- Section 6.9.2

Where multiple observed condition inputs are used in CNAIM, they are combined using the MMI technique described in section 6.7.2 of CNAIM. This takes account of the strongest factor associated with any of the condition inputs, augments the factor to reflect a further number of condition inputs, up to a 'Maximum Number of Condition Inputs', which is defined for each asset category within CNAIM. It is not proposed to increase the 'Maximum Number of Condition Inputs' combined together using the MMI method to create the Observed Condition Modifier in CNAIM for most of these asset types, because of the introduction of an additional input for cable box condition. However, the HV Transformer (GM) model has only one other observed condition input. Hence, it is proposed that the 'Maximum Number of Condition Inputs' used for the determination of the Observed Condition Modifier for this asset type be increased to two inputs, following the addition of the proposed cable box condition input.

TABLE 13: OBSERVED CONDITION MODIFIER - MMI CALCULATION PARAMETERS (EXTRACT)

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

21. Condition Collar Review

21.1 Summary of proposal

An asset will spend a significant proportion of its life in the HI1 band ("As New" or "No Deterioration" condition) if it experiences no detrimental/poor condition during that time. However, relatively young assets identified with the observed/measured condition "Some Deterioration" will not achieve the anticipated level of health score that is reflective of its actual condition, i.e. such assets may remain in the HI1 band. Hence, a collar of 3 or 4 is proposed for such condition inputs such that these young assets are progressed to the next HI band.

Asset categories	All asset categories
Brief description of change	Introduce a collar of 3 or 4 to the condition level below the worst condition score of an asset with an existing collar of 8.
CNAIM section	Appendix B.5 Observed Condition Factors and B.6 Measured Condition Factors
Tables affected	Tables 43, 46, 50, 51, 53, 55, 56, 58, 60, 61, 63, 66, 67, 69, 73, 74, 79, 80, 84, 89, 90, 95, 99, 103, 112, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 129, 133, 135, 192, 193, 194 and 195.
Overall impact	**Medium:** The change will affect multiple asset groups.

21.2 Driver for change

It has been identified that under CNAIM v1.1, relatively young assets with some deterioration identified during inspection/maintenance activities will only attain relatively low health scores, which do not reflect the likelihood of failure indicated by the observed/measured deterioration. This occurs because the initial health score is low for a young asset and hence the application of the condition input factor is insufficient to advance the health score to a value that reflects that actual observed/measured deterioration.

The purpose of the collars in the methodology is to ensure that an asset's health score represents the correct level to reflect the condition when the Condition Input Factors are not strong enough to achieve the correct anticipated level of health score. This is evident in the case for "Substantial Deterioration" where the condition score has in most cases a Collar of 8 which will push the assets Health Score to 8 if the factor is not strong enough on its own. This is to ensure that assets with Substantial Deterioration is correctly reflected in the Health Score and HI Banding (HI5). Example below:-

TABLE 50: OBSERVED CONDITION INPUT - HV SWITCHGEAR (GM) - PRIMARY: SWITCHGEAR EXTERNAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
As New	No observed deterioration	0.9	10	0.5
Normal Wear	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. Minor corrosion or evidence of low level oil leaks (If appropriate)	1.2	10	0.5
Substantial Deterioration	Severe corrosion (e.g. holes)	1.4	10	8
Default	No data available	1	10	0.5

TABLE 133: MEASURED CONDITION INPUT - LV BOARD (WM): OPERATIONAL ADEQUACY

Condition Criteria: Operational Adequacy	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Operable	The LV Board can be operated safely	1	10	0.5
Inoperable - Secure	The LV Board cannot be operated but is physically secure	1.3	10	0.5
Inoperable - Hazardous	The LV Board cannot be operated and presents a hazard to either operator, the public or both	1.5	10	8
Default	No data available	1	10	0.5

This document proposes changes to the methodology by introducing collars associated with certain condition scores which will overcome the problem identified. This will impact all models associated to CNAIM.

This proposal is linked to the change detailed under section 6 of this document whereby the banding criteria for the HI1/ HI2 boundary in CNAIM v2.0 is changed to a Health Score of 3. This is a reduction of the upper limit of the HI1 band, which was set at a Health Score of 4 in CNAIM v1.1. This puts the assets in the HI2 band earlier in their life and so fits in with this proposal to incorporate new collars to move younger assets with Some Deterioration from HI1 to HI2 but without accelerating significantly the future aging of the asset.

21.3 Details of the proposed changes

The proposal is to implement additional collars to the level below the worst condition scoring in each condition table that already has a collar for the highest level of recorded deterioration. This way we can ensure the HI for those assets that have “Some deterioration” are correctly represented in the HI2 band, as a minimum.

In CNAIM V1.1, there are several condition tables that already apply a collar for the second worst condition score. This proposal does not include these condition scores as these have already have a second collar applied that is relevant to that condition score. Furthermore, there are also several condition tables without any collars applied; these will also be excluded from this proposal.

From the review of the condition scores and collars used, the proposal is to introduce a collar for condition points:

- “**Some Deterioration**”,

- "**Inoperable - Secure**",
- "**Medium/Normal**" or
- "**Poor**"

where in V1.1 an existing Collar of **"8"** exists for:

- "**Substantial Deterioration**",
- "**Inoperable – Hazardous**",
- "**High**",
- "**Very Poor**" or
- "**Severe leak**".

When deciding what level of collar is to be used for "Some Deterioration" (or equivalent):

- Where the "Some Deterioration" Condition score factor is between 1.1 and less than 1.3 then apply a Health Score Collar of "3"
- Where Condition score factor is 1.3 or higher then apply a Health Score Collar of "4"

As part of the analysis, the aging rate of all the different asset categories was studied to understand if the proposed new collars of 3 or 4 will have an adverse effect on the Future Health score forecast. The study showed that the period to move an asset from a Current Health Score of 3 to a Future Heath Score of 8 (HI5) for the various assets was between 10-15 years which was deemed acceptable.

Below is the list of Observed and Measured condition inputs that are impacted by the introduction of new collars under this proposal.

Model Name	Table	Condition score	Condition Input Factor	Condition Input Cap	Condition Input Collar (v1.1)	NEW PROPOSED COLLAR (v2.0)
LV Switchgear and Other	Table 44: Observed Condition Input - LV Board (WM): Switchgear Internal Condition & Operation	No deterioration	1	10	0.5	
		Superficial/minor deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
LV Switchgear and Other	Table 50: Observed Condition Input - LV Pillars: Switchgear Internal Condition & Operation	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	

Model Name	Table	Condition score	Condition Input Factor	Condition Input Cap	Condition Input Collar (v1.1)	NEW PROPOSED COLLAR (v2.0)
HV Switchgear (GM) - Primary	Table 60: Observed Condition Input - HV Switchgear (GM) - Primary: Switchgear External Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
HV Switchgear (GM) - Primary	Table 61: Observed Condition Input - HV Switchgear (GM) - Primary: Oil Leaks / Gas Pressure	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.1	10	0.5	3
		Substantial Deterioration	1.3	10	8	
		Default	1	10	0.5	
HV Switchgear (GM) - Primary	Table 63: Observed Condition Input - HV Switchgear (GM) - Primary: Switchgear Internal Condition & Operation	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
HV Switchgear (GM) - Distribution	Table 54: Observed Condition Input - HV Switchgear (GM) - Distribution: Switchgear External Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
HV Switchgear (GM) - Distribution	Table 55: Observed Condition Input - HV Switchgear (GM) - Distribution: Oil Leaks / Gas Pressure	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.1	10	0.5	3
		Substantial Deterioration	1.3	10	8	
		Default	1	10	0.5	
HV Switchgear (GM) - Distribution	Table 57: Observed Condition Input - HV Switchgear (GM) - Distribution: Switchgear Internal Condition & Operation	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	

Model Name	Table	Condition score	Condition Input Factor	Condition Input Cap	Condition Input Collar (v1.1)	NEW PROPOSED COLLAR (v2.0)
EHV Switchgear (GM)	Table 66: Observed Condition Input - EHV Switchgear (GM): Switchgear External Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
EHV Switchgear (GM)	Table 61: Observed Condition Input - EHV Switchgear (GM): Oil Leaks / Gas Pressure	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.1	10	0.5	3
		Substantial Deterioration	1.3	10	8	
		Default	1	10	0.5	
EHV Switchgear (GM)	Table 69: Observed Condition Input - EHV Switchgear (GM): Switchgear Internal Condition & Operation	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
132kV Circuit Breakers	Table 73: Observed Condition Input - 132kV Switchgear (GM): Switchgear External Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
132kV Circuit Breakers	Table 74: Observed Condition Input - 132kV Switchgear (GM): Oil Leaks / Gas Pressure	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.1	10	0.5	3
		Substantial Deterioration	1.3	10	8	
		Default	1	10	0.5	
132kV Circuit Breakers	Table 76: Observed Condition Input - 132kV Switchgear (GM): Switchgear Internal Condition & Operation	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	

Model Name	Table	Condition score	Condition Input Factor	Condition Input Cap	Condition Input Collar (v1.1)	NEW PROPOSED COLLAR (v2.0)
HV Transformer (GM)	Table 81: Observed Condition Input - HV Transformer (GM): Transformer External Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Slight Deterioration	1.1	10	0.5	
		Some Deterioration	1.25	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
EHV Transformer	Table 83: Observed Condition Input - EHV Transformer (GM): Main Tank Condition	Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.4	10	0.5	4
		Substantial Deterioration	1.8	10	8	
		Default	1	10	0.5	
EHV Transformer	Table 88: Observed Condition Input - EHV Transformer (GM): Tapchanger External Condition	Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.4	10	0.5	4
		Substantial Deterioration	1.8	10	8	
		Default	1	10	0.5	
EHV Transformer	Table 89: Observed Condition Input - EHV Transformer (GM): Internal Condition	Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
132kV Transformers	Table 93: Observed Condition Input - 132kV Transformer (GM): Main Tank Condition	Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.4	10	0.5	4
		Substantial Deterioration	1.8	10	8	
		Default	1	10	0.5	
132kV Transformers	Table 98: Observed Condition Input - 132kV Transformer (GM): Tapchanger External Condition	Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.4	10	0.5	4
		Substantial Deterioration	1.8	10	8	
		Default	1	10	0.5	
132kV Transformers	Table 99: Observed Condition Input - 132kV Transformer (GM): Internal Condition	Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.2	10	0.5	3
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	

Model Name	Table	Condition score	Condition Input Factor	Condition Input Cap	Condition Input Collar (v1.1)	NEW PROPOSED COLLAR (v2.0)
LV OHL Support	Table 108: Observed Condition Input - LV Pole: Visual Pole Condition	Acceptable	1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.8	10	8	
		Default	1	10	0.5	
HV OHL Support - Poles	Table 112: Observed Condition Input - HV Pole: Visual Pole Condition	Acceptable	1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.8	10	8	
		Default	1	10	0.5	
EHV OHL Support - Poles	Table 116: Observed Condition Input - EHV Pole: Visual Pole Condition	Acceptable	1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.8	10	8	
		Default	1	10	0.5	
EHV OHL Support - Towers	Table 125: Observed Condition Input - EHV Tower: Foundation Condition	No deterioration	0.95	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.4	10	0.5	4
		Substantial Deterioration	1.8	10	8	
		Default	1	10	0.5	
132kV OHL Support - Tower	Table 131: Observed Condition Input - 132kV Tower: Foundation Condition	No deterioration	0.95	10	0.5	
		Superficial/minor deterioration	1	10	0.5	
		Some Deterioration	1.4	10	0.5	4
		Substantial Deterioration	1.8	10	8	
		Default	1	10	0.5	
EHV OHL Fittings	Table 132: Observed Condition Input - EHV Fittings: Tower Fittings Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1.1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	

Model Name	Table	Condition score	Condition Input Factor	Condition Input Cap	Condition Input Collar (v1.1)	NEW PROPOSED COLLAR (v2.0)
EHV OHL Fittings	Table 133: Observed Condition Input - EHV Fittings: Conductor Fittings Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1.1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
EHV OHL Fittings	Table 134: Observed Condition Input - EHV Fittings: Insulators - Electrical Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1.1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
EHV OHL Fittings	Table 135: Observed Condition Input - EHV Fittings: Insulators - Mechanical Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1.1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
132kV OHL Fittings	Table 136: Observed Condition Input - 132kV Fittings: Tower Fittings Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1.1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
132kV OHL Fittings	Table 137: Observed Condition Input - 132kV Fittings: Conductor Fittings Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1.1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	

Model Name	Table	Condition score	Condition Input Factor	Condition Input Cap	Condition Input Collar (v1.1)	NEW PROPOSED COLLAR (v2.0)
132kV OHL Fittings	Table 138: Observed Condition Input - 132kV Fittings: Insulators - Electrical Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1.1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
132kV OHL Fittings	Table 139: Observed Condition Input - 132kV Fittings: Insulators - Mechanical Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1.1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
EHV OHL Conductor (Tower Lines)	Table 140: Observed Condition Input - EHV Tower Line Conductor: Visual Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1.1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
132kV OHL Conductor (Tower Lines)	Table 142: Observed Condition Input - 132kV Tower Line Conductor: Visual Condition	No deterioration	0.9	10	0.5	
		Superficial/minor deterioration	1.1	10	0.5	
		Some Deterioration	1.3	10	0.5	4
		Substantial Deterioration	1.4	10	8	
		Default	1	10	0.5	
LV Switchgear and Other	Table 146: Measured Condition Input - LV Board (WM): Operational Adequacy	Operable	1	10	0.5	
		Inoperable - Secure	1.3	10	0.5	4
		Inoperable - Hazardous	1.5	10	8	
		Default	1	10	0.5	
LV Switchgear and Other	Table 147: Measured Condition Input - LV Pillar: Operational Adequacy	Operable	1	10	0.5	
		Inoperable - Secure	1.3	10	0.5	4
		Inoperable - Hazardous	1.5	10	8	
		Default	1	10	0.5	
EHV OHL Conductor (Tower Lines)	Table 199: Measured Condition Input - EHV Tower Line Conductor: Conductor Sampling	Low	1	5.4	0.5	
		Medium/Normal	1.1	10	0.5	3
		High	1.4	10	8	
		Default	1	10	0.5	

Model Name	Table	Condition score	Condition Input Factor	Condition Input Cap	Condition Input Collar (v1.1)	NEW PROPOSED COLLAR (v2.0)
EHV OHL Conductor (Tower Lines)	Table 200: Measured Condition Input - EHV Tower Line Conductor: Corrosion Monitoring Survey	Low	1	5.4	0.5	
		Medium/Normal	1.1	10	0.5	3
		High	1.4	10	8	
		Default	1	10	0.5	
132kV OHL Conductor (Tower Lines)	Table 201: Measured Condition Input - 132kV Tower Line Conductor: Conductor Sampling	Low	1	5.4	0.5	
		Medium/Normal	1.1	10	0.5	3
		High	1.4	10	8	
		Default	1	10	0.5	
132kV OHL Conductor (Tower Lines)	Table 202: Measured Condition Input - 132kV Tower Line Conductor: Corrosion Monitoring Survey	Low	1	5.4	0.5	
		Medium/Normal	1.1	10	0.5	3
		High	1.4	10	8	
		Default	1	10	0.5	

22. Observed Condition Modifiers

22.1 Summary of proposal

At present, each DNO carry out their respective inspection and maintenance activities to obtain the observed condition data that feeds into CNAIM's Observed Condition Inputs for the relevant assets.

In order to improve the consistency of the reported asset data and ensure better alignment across the DNOs on observed condition data such as external asset condition, leaks etc., it is proposed that the criteria and descriptors for a number of Observed Condition Modifiers are updated/enhanced as detailed within this proposal to provide the required clarity and reduce the level of subjectivity as far as is reasonably practicable.

Asset categories	All
Brief description of change	Update of the criteria and descriptors used for a number of Observed Condition Modifiers.
CNAIM section	Appendix B 'Probability of Failure'
Tables affected	**Switchgear** Switchgear External Condition: Tables 41/42/48/54/60/66/73 Oil Leaks / Gas Pressure: Tables 55/61/67/74 Switchgear Internal Condition & Operation: Tables 44/50/57/63/69/76 Indoor Environment: Tables 58/64/70/77 Support Structures (EHV & 132kV only): Tables 71/78 Compound Leaks (LV only): Tables 43/49 Air Systems (132kV only): Table 79 **Transformers** Transformer External Condition: Table 81 Main Tank Condition: Tables 83/93 Coolers / Radiator Condition: Tables 84/94 Bushings Condition: Tables 85/95 Kiosk Condition: Tables 86/96 **Tapchangers** Tapchanger External Condition: Tables 88/98 Tapchanger Internal Condition: Tables 89/99 Drive Mechanism Condition: Tables 90/100 Condition of Selector & Diverter Contacts: Tables 91/101 Condition of Selector & Diverter Braids: Tables 92/102 **Overhead Lines (poles)** Visual Pole Condition: Tables 108/112/116 **Overhead Lines (tower lines)** Paintwork Condition: Tables 124/130 Foundation Condition: Tables 125/131 Tower Fittings Condition: Tables 132/136 Conductor Fittings Condition: Tables 133/137 Insulators - Electrical Condition: Tables 134/138 Insulators - Mechanical Condition: Tables 135/139 Conductor Visual Condition: Tables 140/142 **Link boxes** Steel Cover & Pit Condition: Table 35 Bell Condition: Table 37 Insulation Condition: Table 38 Signs of Heating: Table 39
Overall impact	**Medium:** The proposed changes impact all asset categories; however they are expected to change the HI Band of a relatively small number of assets and primarily at the lower end of the HI bands (HI1-HI2).

22.2 Driver for change

Asset-specific Observed Condition Modifiers are used in the determination of the Health Score Modifier as described with section 6.9 of CNAIM v1.1.

The Observed Condition Modifier consists of three components:-

- Observed Condition Factor, which used in the derivation of the Health Score Factor;
- Observed Condition Cap, which is a maximum limit of Health Score that is used in the derivation of the Health Score Cap; and
- Observed Condition Collar, which is a minimum limit of Health Score that is used in the derivation of the Health Score Collar.

The calibration tables relating to each of the Observed Condition Inputs are detailed in CNAIM v1.1 Appendix B.5. DNOs are required to map their respective observed condition data to the criteria shown in these calibration tables, to determine the appropriate values for each of the Observed Condition Inputs.

To improve the consistency of application of CNAIM, a review of the Observed Condition Modifiers has been undertaken by the Network Output Measures ED Working Group (NEDWG). Several changes are recommended to the descriptions in order to reduce, as far as is reasonably practicable, the level of subjectivity within the criteria and associated descriptors. These are discussed in turn below for each functional asset group whereby the Condition Modifiers are equivalent across asset categories, e.g. Switchgear External Condition is applied consistently across HV Distribution, HV Primary, EHV and 132kV switchgear.

22.3 Details of the proposed changes

It is proposed that the following Observed Condition Modifiers are updated with revised criteria terminology, for e.g. “As New” revised to “No Deterioration” and expansion/enhancement of the existing description for each condition criteria.

Application of these enhanced descriptors will require changes to the following tables (noting that this excludes any other changes covered by other proposals, e.g. the review of caps and collars referred to in section 21 of this document).

22.3.1 Switchgear

- Switchgear External Condition: Tables 41/42/48/54/60/66/73
- Oil Leaks / Gas Pressure: Tables 55/61/67/74
- Switchgear Internal Condition & Operation: Tables 45/50/57/63/69/76
- Indoor Environment: Tables 58/64/70/77
- Support Structures (EHV & 132kV only): Tables 71/78
- Compound Leaks (LV only): Tables 43/49

- Air Systems (132kV only): Table 79

Note that no changes are proposed at this time to the following Observed Condition Modifiers that are also within the scope of this asset group: Thermographic Assessment (Tables 56/62/68/75) and Phase Barriers/Insulation Condition/Signs of Heating (LV only) (Tables 45/46/47/51/52/53). The required changes are detailed below:

TABLE 41: OBSERVED CONDITION INPUT - LV CIRCUIT BREAKER: 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) may exhibit signs of ageing, surface level scratches, moss or lichen that can be brushed off. This has no material impact on the probability of failure for the asset.	1	10	0.5
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 metalwork, door-hinges heavily rusted).	1.3	10	0.5
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, or the switchgear housing is damaged beyond economical repair.	1.6	10	0.5
Default	No data available	1	10	0.5

TABLE 42: OBSERVED CONDITION INPUT - LV BOARD (WM): 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) may exhibit signs of ageing, surface level scratches, moss or lichen that can be brushed off. This has no material impact on the probability of failure for the asset.	1	10	0.5
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 metalwork, door-hinges heavily rusted).	1.2	10	0.5
Substantial Deterioration	The switchgear is corroded to the point that one or more metalwork supports are rusted through, or the switchgear housing is damaged beyond economical repair.	1.4	10	5.5
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 48: OBSERVED CONDITION INPUT - LV PILLARS: 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) may exhibit signs of ageing, surface level scratches, moss or lichen that can be brushed off. This has no material impact on the probability of failure for the asset.	1	10	0.5
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 metalwork, door-hinges heavily rusted).	1.2	10	0.5
Substantial Deterioration	The switchgear is corroded to the point that one or more metalwork supports are rusted through, or the switchgear housing is damaged beyond economical repair.	1.4	10	5.5
Default	No data available	1	10	0.5

TABLE 54: OBSERVED CONDITION INPUT – HV SWITCHGEAR (GM) – DISTRIBUTION: 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) may exhibit signs of ageing, surface level scratches, moss or lichen that can be brushed off. This has no material impact on the probability of failure for the asset.	1	10	0.5
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 metalwork, door-hinges heavily rusted).	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, or the switchgear housing is damaged beyond economical repair.	1.4	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 60: OBSERVED CONDITION INPUT – HV SWITCHGEAR (GM) – PRIMARY: 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) may exhibit signs of ageing, surface level scratches, moss or lichen that can be brushed off. This has no material impact on the probability of failure for the asset.	1	10	0.5
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 metalwork, door-hinges heavily rusted).	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, or the switchgear housing is damaged beyond economical repair.	1.4	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 66: OBSERVED CONDITION INPUT – EHV SWITCHGEAR (GM): 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) may exhibit signs of ageing, surface level scratches, moss or lichen that can be brushed off. This has no material impact on the probability of failure for the asset.	1	10	0.5
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 metalwork, door-hinges heavily rusted).	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, or the switchgear housing is damaged beyond economical repair.	1.4	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 73: OBSERVED CONDITION INPUT – 132KV SWITCHGEAR (GM): 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) may exhibit signs of ageing, surface level scratches, moss or lichen that can be brushed off. This has no material impact on the probability of failure for the asset.	1	10	0.5
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 metalwork, door-hinges heavily rusted).	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, or the switchgear housing is damaged beyond economical repair.	1.4	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 55: OBSERVED CONDITION INPUT – HV 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	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	1	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	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.	1.3	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 61: OBSERVED CONDITION INPUT – HV SWITCHGEAR (GM) – PRIMARY: 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	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	1	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	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.	1.3	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 67: OBSERVED CONDITION INPUT – EHV SWITCHGEAR (GM): 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	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	1	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	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.	1.3	10	8.0
Default	No data available	1	10	0.5

TABLE 74: OBSERVED CONDITION INPUT – 132KV SWITCHGEAR (GM): 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	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	1	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	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.	1.3	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 44: OBSERVED CONDITION INPUT – LV BOARD (WM): SWITCHGEAR INTERNAL CONDITION & OPERATION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	No observed deterioration	0.9	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some deterioration	Minor corrosion (e.g. light rust) or evidence of a minor mechanism defect.	1.2	10	3.0
Substantial deterioration	Evidence of significant corrosion, missing, defective or damaged internal insulation (e.g. evidence of severe discharge activity or breakdown of insulation) or a severe mechanism defect that affects the operation of the asset.	1.4	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 50: OBSERVED CONDITION INPUT – LV PILLARS: SWITCHGEAR INTERNAL CONDITION & OPERATION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	No observed deterioration	0.9	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	Minor corrosion (e.g. light rust) or evidence of a minor mechanism defect.	1.2	10	3.0
Substantial Deterioration	Evidence of significant corrosion, missing, defective or damaged internal insulation (e.g. evidence of severe discharge activity or breakdown of insulation) or a severe mechanism defect that affects the operation of the asset.	1.4	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 57: OBSERVED CONDITION INPUT – HV SWITCHGEAR (GM) – DISTRIBUTION: SWITCHGEAR INTERNAL CONDITION & OPERATION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	Minor corrosion (e.g. light rust) or evidence of a minor mechanism defect.	1.2	10	3.0
Substantial Deterioration	Evidence of significant corrosion, missing, defective or damaged internal insulation (e.g. evidence of severe discharge activity or breakdown of insulation) or a severe mechanism defect that affects the operation of the asset.	1.4	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 63: OBSERVED CONDITION INPUT – HV SWITCHGEAR (GM) – PRIMARY: SWITCHGEAR INTERNAL CONDITION & OPERATION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	Minor corrosion (e.g. light rust) or evidence of a minor mechanism defect.	1.2	10	3.0
Substantial Deterioration	Evidence of significant corrosion, missing, defective or damaged internal insulation (e.g. evidence of severe discharge activity or breakdown of insulation) or a severe mechanism defect that affects the operation of the asset.	1.4	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 69: OBSERVED CONDITION INPUT – EHV SWITCHGEAR (GM): SWITCHGEAR INTERNAL CONDITION & OPERATION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	Minor corrosion (e.g. light rust) or evidence of a minor mechanism defect.	1.2	10	3.0
Substantial Deterioration	Evidence of significant corrosion, missing, defective or damaged internal insulation (e.g. evidence of severe discharge activity or breakdown of insulation) or a severe mechanism defect that affects the operation of the asset.	1.4	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 76: OBSERVED CONDITION INPUT – 132KV SWITCHGEAR (GM): SWITCHGEAR INTERNAL CONDITION & OPERATION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	Minor corrosion (e.g. light rust) or evidence of a minor mechanism defect.	1.2	10	3.0
Substantial Deterioration	Evidence of significant corrosion, missing, defective or damaged internal insulation (e.g. evidence of severe discharge activity or breakdown of insulation) or a severe mechanism defect that affects the operation of the asset.	1.4	10	8.0
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 58: OBSERVED CONDITION INPUT – HV SWITCHGEAR (GM) – DISTRIBUTION: INDOOR ENVIRONMENT

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Better than Expected	Air conditioned	0.9	10	0.5
As Expected	This is an environment which is typified as dry and has a degree of background heating or dehumidification which maintains this year round.	1	10	0.5
Deteriorated Environment	Heating or dehumidification faulty; room temperature is hotter than recommended by environmental policy; condensation evident in switch room etc.	1.3	10	0.5
Severely Deteriorated Environment	The substation is showing major signs of dampness such as definite water marks around the building, significant amount of flaking paint and/or mould growth. No environmental controls (such as heating or dehumidification) are installed, or the installed environmental controls are not functioning adequately; room temperature is excessively hot; roof or structure permits water ingress; water stands in trenches or free water is observed in the switch room.	1.5	10	0.5
Default	No data available	1	10	0.5

TABLE 64: OBSERVED CONDITION INPUT – HV SWITCHGEAR (GM) – PRIMARY: INDOOR ENVIRONMENT

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Better than expected	Air conditioned	0.9	10	0.5
As Expected	This is an environment which is typified as dry and has a degree of background heating or dehumidification which maintains this year round.	1	10	0.5
Deteriorated Environment	Heating or dehumidification faulty; room temperature is hotter than recommended by environmental policy; condensation evident in switch room etc.	1.3	10	0.5
Severely Deteriorated Environment	The substation is showing major signs of dampness such as definite water marks around the building, significant amount of flaking paint and/or mould growth. No environmental controls (such as heating or dehumidification) are installed, or the installed environmental controls are not functioning adequately; room temperature is excessively hot; roof or structure permits water ingress; water stands in trenches or free water is observed in the switch room.	1.5	10	0.5
Default	No data available	1	10	0.5

TABLE 70: OBSERVED CONDITION INPUT – EHV SWITCHGEAR (GM): INDOOR ENVIRONMENT

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Better than Expected	Air conditioned	0.9	10	0.5
As Expected	This is an environment which is typified as dry and has a degree of background heating or dehumidification which maintains this year round.	1	10	0.5
Deteriorated Environment	Heating or dehumidification faulty; room temperature is hotter than recommended by environmental policy; condensation evident in switch room etc.	1.3	10	0.5
Severely Deteriorated Environment	The substation is showing major signs of dampness such as definite water marks around the building, significant amount of flaking paint and/or mould growth. No environmental controls (such as heating or dehumidification) are installed, or the installed environmental controls are not functioning adequately; room temperature is excessively hot; roof or structure permits water ingress; water stands in trenches or free water is observed in the switch room.	1.5	10	0.5
Default	No data available	1	10	0.5

TABLE 77: OBSERVED CONDITION INPUT – 132KV SWITCHGEAR (GM): INDOOR ENVIRONMENT

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Better than Expected	Air conditioned	0.9	10	0.5
As Expected	This is an environment which is typified as dry and has a degree of background heating or dehumidification which maintains this year round.	1	10	0.5
Deteriorated Environment	Heating or dehumidification faulty; room temperature is hotter than recommended by environmental policy; condensation evident in switch room etc.	1.3	10	0.5
Severely Deteriorated Environment	The substation is showing major signs of dampness such as definite water marks around the building, significant amount of flaking paint and/or mould growth. No environmental controls (such as heating or dehumidification) are installed, or the installed environmental controls are not functioning adequately; room temperature is excessively hot; roof or structure permits water ingress; water stands in trenches or free water is observed in the switch room.	1.5	10	0.5
Default	No data available	1	10	0.5

TABLE 71: OBSERVED CONDITION INPUT – EHV SWITCHGEAR (GM): 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	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.	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.	1.5	10	5.5
Default	No data available	1	10	0.5

TABLE 78: OBSERVED CONDITION INPUT – 132KV SWITCHGEAR (GM): 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	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.	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.	1.5	10	5.5
Default	No data available	1	10	0.5

TABLE 43: OBSERVED CONDITION INPUT – LV BOARD (WM): COMPOUND LEAKS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	No leakage	1	10	0.5
Superficial/minor deterioration	Evidence of slight compound leak	1.1	10	0.5
Substantial deterioration	Significant compound leak or multiple compound leaks on the same board.	1.3	10	5.5
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 13

TABLE 49: OBSERVED CONDITION INPUT – LV PILLARS: COMPOUND LEAKS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	No leakage	1	10	0.5
Superficial/minor deterioration	Evidence of slight compound leak	1.1	10	0.5
Substantial deterioration	Significant compound leak or multiple compound leaks on the same board.	1.3	10	5.5
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 13

TABLE 79: OBSERVED CONDITION INPUT – 132KV SWITCHGEAR (GM): AIR SYSTEMS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	No observed deterioration	0.9	10	0.5
Superficial/minor deterioration	Minor surface corrosion observed on observable pipe work	1	10	0.5
Some Deterioration	Minor Air Losses – System runs excessively to maintain pressure	1.3	10	0.5
Substantial Deterioration	Major Air Losses – Loss of pressure pipe section observed. Air leaks can be found by inspection; Certification notes defects. Etc.	1.5	10	0.5
Default	No data available	1	10	0.5

22.3.2 Transformers

- Transformer External Condition: Table 81
- Main Tank Condition: Tables 83/93
- Coolers / Radiator Condition: Tables 84/94
- Bushings Condition: Tables 85/95
- Kiosk Condition: Tables 86/96

Note that Cable Boxes Condition (Tables 87/97) for transformers will be combined with switchgear cable box under a new proposal detailed in section 20. The required changes are detailed below:

TABLE 81: OBSERVED CONDITION INPUT – HV TRANSFORMER (GM): TRANSFORMER 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 that can be brushed off). This has no material impact on the probability of failure for the asset.	1	10	0.5
Slight deterioration	Minor localised surface corrosion. There may be evidence of a small leak, but it does not present a significant impact to the overall probability of failure for the asset, for example: - There is a small active leak from a sub component but this can be addressed through intervention of the sub component - A small inactive leak which is limited to staining of the asset or the ground around the asset.	1.1	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 metalwork); 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 a significant active oil leak (e.g. pools of oil collecting on the ground or plinth).	1.4	10	8
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 83: OBSERVED CONDITION INPUT – EHV TRANSFORMER (GM): MAIN TANK CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The transformer may exhibit signs of ageing or marks (e.g. surface level scratches, moss or lichen that can be brushed off). This has no material impact on the probability of failure for the asset. There may be evidence of a small leak, but it does not present a significant impact to the overall probability of failure for the asset, for example: - There is a small active leak from a sub component (e.g. a pressure relief device) but this can be addressed through intervention of the sub component. - The leak this is limited to staining of the asset or the ground around the asset.	1	10	0.5
Some Deterioration	The asset shows a level of deterioration such as surface corrosion spots or minor oil leaks. The level of degradation may affect the operation of the asset if left untended (e.g. large patches of rust on the metalwork); and/or there is evidence of a small active oil leak (e.g. droplets or weeping).	1.4	10	4.0
Substantial Deterioration	There is evidence of major corrosion or a significant active and unrepairable oil leak (e.g. pools of oil collecting on the ground or plinth).	1.8	10	8
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 93: OBSERVED CONDITION INPUT - 132KV TRANSFORMER (GM): MAIN TANK CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The transformer may exhibit signs of ageing or marks (e.g. surface level scratches, moss or lichen that can be brushed off). This has no material impact on the probability of failure for the asset. There may be evidence of a small leak, but it does not present a significant impact to the overall probability of failure for the asset, for example: - There is a small active leak from a sub component (e.g. a pressure relief device) but this can be addressed through intervention of the sub component. - The leak this is limited to staining of the asset or the ground around the asset.	1	10	0.5
Some Deterioration	The asset shows a level of deterioration such as surface corrosion spots or minor oil leaks. The level of degradation may affect the operation of the asset if left untended (e.g. large patches of rust on the metalwork); and/or there is evidence of a small active oil leak (e.g. droplets or weeping).	1.4	10	4.0
Substantial Deterioration	There is evidence of major corrosion or a significant active and unrepairable oil leak (e.g. pools of oil collecting on the ground or plinth).	1.8	10	8
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 84: OBSERVED CONDITION INPUT - EHV TRANSFORMER (GM): COOLERS / RADIATOR CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The asset (or a sub component) may exhibit signs of ageing, minor stains or marks (e.g. surface level scratches, moss or lichen that can be brushed off). This has no material impact on the probability of failure for the asset.	1	10	0.5
Some Deterioration	Localised areas of surface corrosion or evidence of oil leaks not associated with the transformer fins (e.g. manifolds and associated pipework, flanges, couplings, valves)	1.2	10	0.5
Substantial Deterioration	Widespread corrosion, loss of cross-sectional area or thinning or evidence of oil leakage from the fins.	1.4	10	5.5
Default	No data available	1	10	0.5

TABLE 94: OBSERVED CONDITION INPUT - 132KV TRANSFORMER (GM): COOLERS / RADIATOR CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The asset (or a sub component) may exhibit signs of ageing, minor stains or marks (e.g. surface level scratches, moss or lichen that can be brushed off). This has no material impact on the probability of failure for the asset.	1	10	0.5
Some Deterioration	Localised areas of surface corrosion or evidence of oil leaks not associated with the transformer fins (e.g. manifolds and associated pipework, flanges, couplings, valves)	1.2	10	0.5
Substantial Deterioration	Widespread corrosion, loss of cross-sectional area or thinning or evidence of oil leakage from the fins.	1.4	10	5.5
Default	No data available	1	10	0.5

TABLE 85: OBSERVED CONDITION INPUT - EHV TRANSFORMER (GM): BUSHINGS CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or evidence of a historic oil leak (e.g. stains) or minor damage (e.g. small chips or cracks). Bushings with high levels of pollution with associated evidence of localised discharge or tracking.	1.2	10	0.5
Substantial Deterioration	e.g. visible cracks, broken sheds, damage, surface degradation, widespread/significant discharge activity and/or active oil leak (e.g. droplets, pools of oil).	1.4	10	5.5
Default	No data available	1	10	0.5

TABLE 95: OBSERVED CONDITION INPUT - 132KV TRANSFORMER (GM): BUSHINGS CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or evidence of a historic oil leak (e.g. stains) or minor damage (e.g. small chips or cracks). Bushings with high levels of pollution with associated evidence of localised discharge or tracking.	1.2	10	0.5
Substantial Deterioration	e.g. visible cracks, broken sheds, damage, surface degradation, widespread/significant discharge activity and/or active oil leak (e.g. droplets, pools of oil).	1.4	10	5.5
Default	No data available	1	10	0.5

TABLE 86: OBSERVED CONDITION INPUT - EHV TRANSFORMER (GM): KIOSK CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The asset component exhibits some deterioration but is fit for continued service. There is no or little obvious signs of corrosion	1	10	0.5
Some Deterioration	The asset component 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 metalwork);	1.1	10	0.5
Substantial Deterioration	There is evidence of major corrosion or damage affecting the structural integrity	1.2	10	0.5
Default	No data available	1	10	0.5

TABLE 96: OBSERVED CONDITION INPUT - 132KV TRANSFORMER (GM): KIOSK CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The asset component exhibits some deterioration but is fit for continued service. There is no or little obvious signs of corrosion	1	10	0.5
Some Deterioration	The component 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 metalwork);	1.1	10	0.5
Substantial Deterioration	There is evidence of major corrosion or damage affecting the structural integrity	1.2	10	0.5
Default	No data available	1	10	0.5

22.3.3 Tapchangers

- Tapchanger External Condition: Tables 88/98
- Tapchanger Internal Condition: Tables 89/99
- Drive Mechanism Condition: Tables 90/100
- Condition of Selector & Diverter Contacts: Tables 91/101
- Condition of Selector & Diverter Braids: Tables 92/102

The required changes are detailed below:

TABLE 88: OBSERVED CONDITION INPUT - EHV TRANSFORMER (GM): TAPCHANGER EXTERNAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or evidence of low level oil leaks (If appropriate)	1.4	10	4.0
Substantial Deterioration	e.g. major corrosion or evidence of significant oil leakage	1.8	10	8
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 98: OBSERVED CONDITION INPUT - 132KV TRANSFORMER (GM): TAPCHANGER EXTERNAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or evidence of low level oil leaks (If appropriate)	1.4	10	4.0
Substantial Deterioration	e.g. major corrosion or evidence of significant oil leakage	1.8	10	8
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 89: OBSERVED CONDITION INPUT - EHV TRANSFORMER (GM): INTERNAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or evidence of low level oil leaks (If appropriate)	1.2	10	3.0
Substantial Deterioration	e.g. observed or potential mechanism defect, internal insulation, etc.	1.4	10	8
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 99: OBSERVED CONDITION INPUT - 132KV TRANSFORMER (GM): INTERNAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or evidence of low level oil leaks (If appropriate)	1.2	10	3.0
Substantial Deterioration	e.g. observed or potential mechanism defect, internal insulation, etc.	1.4	10	8
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 90: OBSERVED CONDITION INPUT - EHV TRANSFORMER (GM): DRIVE MECHANISM CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or wear to components	1.2	10	0.5
Substantial Deterioration	e.g. major corrosion or excessive wear in component and bearings	1.4	10	0.5
Default	No data available	1	10	0.5

TABLE 100: OBSERVED CONDITION INPUT - 132KV TRANSFORMER (GM): DRIVE MECHANISM CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or wear to components	1.2	10	0.5
Substantial Deterioration	e.g. major corrosion or excessive wear in component and bearings	1.4	10	0.5
Default	No data available	1	10	0.5

TABLE 91: OBSERVED CONDITION INPUT - EHV TRANSFORMER (GM): CONDITION OF SELECTOR & DIVERTER CONTACTS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.95	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or wear	1.1	10	0.5
Substantial Deterioration	e.g. major corrosion or excessive wear in component and bearings	1.3	10	0.5
Default	No data available	1	10	0.5

TABLE 101: OBSERVED CONDITION INPUT - 132KV TRANSFORMER (GM): CONDITION OF SELECTOR & DIVERTER CONTACTS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.95	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or wear	1.1	10	0.5
Substantial Deterioration	e.g. major corrosion or excessive wear in component and bearings	1.3	10	0.5
Default	No data available	1	10	0.5

TABLE 92: OBSERVED CONDITION INPUT - EHV TRANSFORMER (GM): CONDITION OF SELECTOR & DIVERTER BRAIDS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.95	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or wear	1.05	10	0.5
Substantial Deterioration	e.g. major corrosion or fraying of braids	1.1	10	0.5
Default	No data available	1	10	0.5

TABLE 102: OBSERVED CONDITION INPUT - 132KV TRANSFORMER (GM): CONDITION OF SELECTOR & DIVERTER BRAIDS

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.95	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. minor corrosion or wear	1.05	10	0.5
Substantial Deterioration	e.g. major corrosion or fraying of braids	1.1	10	0.5
Default	No data available	1	10	0.5

22.3.4 Overhead Lines (Poles)

- Visual Pole Condition: Tables 108/112/116

Note that no changes are proposed at this time to the following Observed Condition Modifiers that are also within the scope of this asset group: Pole Top Rot (Tables 109/113/117), Pole Leaning (Tables 110/114/118), Bird / Animal Damage (Tables 111/115/119). The required changes are detailed below:

TABLE 108: OBSERVED CONDITION INPUT - 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.	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
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 112: OBSERVED CONDITION INPUT - 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.	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
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 116: OBSERVED CONDITION INPUT - 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.	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
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

22.3.5 Overhead Lines (tower lines)

- Paintwork Condition: Tables 124/130
- Foundation Condition: Tables 125/131
- Tower Fittings Condition: Tables 132/136
- Conductor Fittings Condition: Tables 133/137
- Insulators - Electrical Condition: Tables 134/138
- Insulators - Mechanical Condition: Tables 135/139
- Conductor Visual Condition: Tables 140/142

Note that no changes are proposed at this time to the following Observed Condition Modifiers that are also within the scope of this asset group: Tower Legs (Tables 120/126), Bracings (Tables 121/127), Crossarms (Tables 122/128), Peak (Tables 123/129) and Conductor Midspan Joints (Tables 141/143). The required changes are detailed below:

TABLE 124: OBSERVED CONDITION INPUT - EHV TOWER: PAINTWORK CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration		1	6.4	0.5
Superficial/minor deterioration	Slight rust breakthrough - up to 5% of surface area affected.	1.1	6.4	0.5
Some Deterioration	Moderate rust breakthrough - between 5% and 20% of surface area affected, and/or pitted rust	1.6	6.4	0.5
Substantial Deterioration	Severe rust breakthrough - more than 20% of surface area affected, AND/OR damaged or bent steelwork, AND/OR any blistered paintwork with evidence of severe rust underneath, painting/attention required urgently.	1.8	6.4	5.5
Default	No data available	1	6.4	0.5

TABLE 130: OBSERVED CONDITION INPUT - 132KV TOWER: PAINTWORK CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration		1	6.4	0.5
Superficial/minor deterioration	Slight rust breakthrough - up to 5% of surface area affected.	1.1	6.4	0.5
Some Deterioration	Moderate rust breakthrough - between 5% and 20% of surface area affected, and/or pitted rust	1.6	6.4	0.5
Substantial Deterioration	Severe rust breakthrough - more than 20% of surface area affected, AND/OR damaged or bent steelwork, AND/OR any blistered paintwork with evidence of severe rust underneath, painting/attention required urgently.	1.8	6.4	5.5
Default	No data available	1	6.4	0.5

TABLE 125: 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
Default	No data available	1	10	0.5

* Also highlighted are the changes made to caps and collars as per Section 18

TABLE 131: 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
Default	No data available	1	10	0.5

* Also highlighted are the changes made to caps and collars as per Section 18

TABLE 132: OBSERVED CONDITION INPUT - EHV FITTINGS: TOWER FITTINGS CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	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
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 136: OBSERVED CONDITION INPUT - 132KV FITTINGS: TOWER FITTINGS CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	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
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 133: OBSERVED CONDITION INPUT - EHV FITTINGS: CONDUCTOR FITTINGS CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	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
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 137: OBSERVED CONDITION INPUT - 132KV FITTINGS: CONDUCTOR FITTINGS CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	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
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 134: OBSERVED CONDITION INPUT - EHV FITTINGS: INSULATORS - ELECTRICAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	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 electrical Integrity	1.3	10	4.0
Substantial Deterioration	Loss of required electrical integrity	1.4	10	8
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 138: OBSERVED CONDITION INPUT - 132KV FITTINGS: INSULATORS - ELECTRICAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	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 electrical integrity	1.3	10	4.0
Substantial Deterioration	Loss of required electrical integrity	1.4	10	8
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 135: OBSERVED CONDITION INPUT - EHV FITTINGS: INSULATORS - MECHANICAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	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
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 139: OBSERVED CONDITION INPUT - 132KV FITTINGS: INSULATORS - MECHANICAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	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
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 140: OBSERVED CONDITION INPUT - EHV TOWER LINE CONDUCTOR: VISUAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	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	e.g. minor corrosion	1.3	10	4.0
Substantial Deterioration	e.g. bird caging, broken strands, loss of section	1.4	10	8
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

TABLE 142: OBSERVED CONDITION INPUT - 132KV TOWER LINE CONDUCTOR: VISUAL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	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	e.g. minor corrosion	1.3	10	4.0
Substantial Deterioration	e.g. bird caging, broken strands, loss of section	1.4	10	8
Default	No data available	1	10	0.5

* Also highlighted is the change to the Condition Input Collar as described Section 21

22.3.6 Link boxes

- Steel Cover & Pit Condition: Table 35
- Bell Condition: Table 37
- Insulation Condition: Table 38
- Signs of Heating: Table 39

Note that no changes are proposed at this time to the following Observed Condition Modifiers that are also within the scope of this asset group: Water / Moisture (Table 36) and Phase Barriers (Table 40). The required changes are detailed below:

TABLE 35: OBSERVED CONDITION INPUT - LV UGB: STEEL COVER & PIT CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	10	0.5
Superficial/minor deterioration	The asset component is fit for continued service. There is little deterioration	1	10	0.5
Some Deterioration	e.g. Minor corrosion	1.2	10	0.5
Substantial Deterioration	e.g. Major corrosion	1.4	10	0.5
Default	No data available	1	10	0.5

TABLE 37: OBSERVED CONDITION INPUT - LV UGB: BELL CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No deterioration	No observed deterioration	0.9	10	0.5
Some Deterioration	e.g. Minor corrosion	1.2	10	0.5
Substantial Deterioration	e.g. Major corrosion	1.4	10	0.5
Default	No data available	1	10	0.5

TABLE 38: OBSERVED CONDITION INPUT - LV UGB: INSULATION CONDITION

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	No observed deterioration	0.9	10	0.5
Some Deterioration	Chips and advanced aging	1	10	0.5
Substantial Deterioration	Evidence of flashover or damage, or degradation of insulation material	1.3	10	8
Default	No data available	1	10	0.5

TABLE 39: OBSERVED CONDITION INPUT - LV UGB: SIGNS OF HEATING

Condition Criteria: Observed Condition	Description	Condition Input Factor	Condition Input Cap	Condition Input Collar
No Deterioration	No observed deterioration	0.9	10	0.5
Some Deterioration	Observed running higher than ambient	1	10	0.5
Substantial Deterioration	Evidence of overheating	1.5	10	5.5
Default	No data available	1	10	0.5

22.3.7 Submarine Cable

Note that no changes are proposed at this time to the only Observed Condition Modifier in this asset group: External Condition Armour (Table 107).

Appendix A

A.1 ED2 Templates – BPDTs, etc.

A.1.1 Summary of proposal

Several development initiatives have been identified which will necessitate changes to the existing regulatory reporting templates.

The ENA NOMS ED Working Group has developed initial proposals for changes to the existing regulatory reporting templates to meet the requirements for ED2. DNOs have committed to continue to work with Ofgem on the further development of these proposals. Details of the initial proposals are outlined in this Appendix. This provides information to support this consultation, by illustrating the reporting requirements that need to be met by CNAIM.

It should be noted that DNOs are not consulting on proposed changes to the reporting templates as they are outside of the scope of CNAIM and are under the governance of Ofgem's Regulatory Instructions and Guidance.

For RIIO-ED2, it is proposed that the reporting workbooks can both be expanded (to provide more information) and simplified (to reduce the reporting burden and to improve the quality of the information reported).

Asset categories	All
Brief description of change	Update to regulatory reporting tables
CNAIM section	Section 5.3 'Risk Reporting'
Tables affected	N/A
Overall impact	**High:** Affects all assets across multiple asset groups

A.1.2 Driver for change

For RIIO-ED1, DNOs are to report information relating to both Asset Health and Criticality (the Asset Risk Indices) in accordance with the requirements of SLC51. This reporting obligation in RIIO-ED1 is discharged through three key workbooks:

1. **Network Assets Workbook (NAW):** Formed part of the RIIO-ED1 BPDT and was used by DNOs to submit forecast data with/without their proposed interventions
2. **Monetised Risk Workbook:** Ofgem produced this by taking the NAWs and then adding calculations to it, to create the Network Asset Secondary Deliverables (NASD). It remained a separate file and formed part of the final proposals.

3. **Secondary Deliverables Reporting Pack (SDRP):** DNOs report actuals against their agreed NASD annually (in a slightly different format to what was in the NAW)

Several development initiatives have been identified as described within this document, notably in the context of regulatory reporting. This includes the development of the Long Term Risk measure. This proposal will necessitate changes to the existing reporting templates. For RIIO-ED2, it is proposed that the reporting workbooks can both be expanded (to provide more information) and simplified (to reduce the reporting burden and to improve the quality of the information reported) in the following ways:

- Additional calculations to translates volumes profiles into the proposed new Long Term Risk measure;
- Combine the NAW and Monetised Risk workbooks into a single workbook (the NAW);
- Simplify the structure to reduce the reporting burden;
- Provide additional granularity of asset movements, e.g. reporting at Asset Register Category level and split by asset replacement removals/additions; and
- Additional variance analysis built into workbook.

A.1.3 Details of the proposed changes

For RIIO-ED2, we propose this can be expanded and simplified into the following two workbooks:

1. **ED2 Network Assets Workbook (NAW)**
2. **ED2 Secondary Deliverables Reporting Pack (SDRP)**

These workbooks have been built and accommodate all the proposed changes described within this document. Copies of these workbooks can be found as part of the Ofgem consultation 'RIIO-ED2 draft Business Plan Data Templates and Associated Instructions and Guidance' via this link RIIO-ED2 Draft data templates and associated instructions and guidance.

A.2 Recommended changes to RIGs for RIIO-ED2

As outlined in section 11 of this document, as part of the proposals for CNAIM v2.0, the DNOs recommend changes to the classification of some Refurbishment activities in RIIO-ED2. This appendix identifies the changes required to the guidance that is currently contained in the 'Refurbishment and Repairs & Maintenance Task Allocation Tables' in section 4 of Ofgem's Regulatory Instructions and Guidance Annex A, when the equivalent guidance is produced for RIIO-ED2 (including Business Plan submission).

6.6/11kV X-type RMU			
Activity	Cost and Volume Table for Reporting of Activity		
	Repair & Maintenance	Refurbishment (No SDI)	Refurbishment (SDI)
Functional testing (trip tests, operation of interlocks etc.)	✓		
Diagnostic testing (insulation resistance testing, continuity testing, partial discharge testing, trip timing tests, oil testing, SF6 leak detection etc.)	✓		
Lubrication of moving parts	✓		
Renewal and replacement of insulation medium (e.g. SF6 and oil), whether reprocessed or not	✓		
Replacement of contacts (arcing contacts/ main contacts)	✓		
Replacement of crossjet pots (turbulator)	✓		
Replacement of individual gaskets and seals	✓		
Replacement of barriers	✓		
Replacement of individual components of the operating mechanism	✓		
Replacement of individual components of the drive rods and linkages	✓		
Replacement of cable boxes		✓	✓
Replacement of bushings (e.g. external bushings, cable box bushings etc.)	✓		
Repair/ replacement of earth bonding	✓		
Complete replacement of the operating mechanism			✓
Complete replacement of drive rods and linkages		✓	
Complete factory refurbishment			✓
Complete Refurbishment (factory or onsite) e.g. strip down & rebuild, replacing all worn parts			✓
Replacement of vacuum bottles (including replacement of associated seals)		✓	
Painting of plant	✓		
Repairs to interlocks	✓		

6.6/11kV Transformer (GM)			
Activity	**Cost and Volume Table for Reporting of Activity**		
	Repair & Maintenance	**Refurbishment (No SDI)**	**Refurbishment (SDI)**
Diagnostic testing (oil testing, partial discharge testing etc.)	✓		
Oil filtration and replacement	✓		
Painting	✓		
Sight glass replacement	✓		
Bolt tightening	✓		
General housekeeping (remove debris from radiator etc.)	✓		
Repair/ replacement of connections to earthing system	✓		
Minor repair to existing cooling radiators (rust/ leaks)	✓		
On site processing to recondition oil to remove moisture and acidity from windings			✓
Replacement of cooling radiators			✓
Replacement of conservator tanks		✓	
Replacement of bushings		✓	
Replacement of cable box		✓	✓
Installation of replacement windings			✓
Complete factory refurbishment			✓

20kV Transformer (GM)			
Activity	**Cost and Volume Table for Reporting of Activity**		
	Repair & Maintenance	**Refurbishment (No SDI)**	**Refurbishment (SDI)**
Diagnostic testing (oil testing, partial discharge testing etc.)	✓		
Oil filtration and replacement	✓		
Painting	✓		
Sight glass replacement	✓		
Bolt tightening	✓		
General housekeeping (remove debris from radiator etc.)	✓		
Repair/ replacement of connections to earthing system	✓		
Minor repair to existing cooling radiators (rust/ leaks)	✓		
On site processing to recondition oil to remove moisture and acidity from windings			✓
Replacement of cooling radiators			✓
Replacement of conservator tanks		✓	
Replacement of bushings		✓	
Replacement of cable box		✓	✓
Installation of replacement windings			✓
Complete factory refurbishment			✓

33kV UG Cable (Oil)			
Activity	Cost and Volume Table for Reporting of Activity		
	Repair & Maintenance	Refurbishment (No SDI)	Refurbishment (SDI)
Diagnostic testing (e.g. partial discharge testing, sheath testing etc.)	✓		
Sheath repairs	✓		
Replacement of an individual cable joint or terminations (including sealing ends)		✓	✓
Remaking an individual existing joint or terminations in situ		✓	✓
Replacement/remaking of all fluid filled cable joints and terminations (including sealing ends) within a hydraulic section – where undertaken as a single planned intervention			✓
Repressurising of cable fluid system (e.g. top up of oil or gas)	✓		
Resealing of pressurising equipment (e.g. resealing tanks)	✓		
Resoldering of pressurising equipment pipework	✓		
Replacement of pressurising equipment valves and/or gauges		✓	
Replacement of pressurising equipment pipework and/or tanks		✓	
Re-engineering (replacement/refurbishment/relocation) of pressurising system equipment with the objective of reducing the normal operating fluid pressure in the cable system		✓	✓

33kV UG Cable (Gas)			
Activity	Cost and Volume Table for Reporting of Activity		
	Repair & Maintenance	Refurbishment (No SDI)	Refurbishment (SDI)
Diagnostic testing (e.g. partial discharge testing, sheath testing etc.)	✓		
Sheath repairs	✓		
Replacement of an individual cable joint or terminations (including sealing ends)		✓	✓
Remaking an individual existing joint or terminations in situ		✓	✓
Replacement/ remaking of all fluid filled cable joints and terminations (including sealing ends) within a pneumatic section – where undertaken as a single planned intervention			✓
Repressurising of cable fluid system (e.g. top up of oil or gas)	✓		
Resealing of pressurising equipment (e.g. resealing tanks)	✓		
Resoldering of pressurising equipment pipework	✓		
Replacement of pressurising equipment valves and/or gauges		✓	
Replacement of pressurising equipment pipework and/or tanks		✓	
Re-engineering (replacement/refurbishment/relocation) of pressurising system equipment with the objective of reducing the normal operating fluid pressure in the cable system		✓	✓

66kV UG Cable (Oil)			
Activity	Cost and Volume Table for Reporting of Activity		
	Repair & Maintenance	Refurbishment (No SDI)	Refurbishment (SDI)
Diagnostic testing (e.g. partial discharge testing, sheath testing etc.)	✓		
Sheath repairs	✓		
Replacement of an individual cable joint or terminations (including sealing ends)		✓	✓
Remaking an individual existing joint or terminations in situ		✓	✓
Replacement/remaking of all fluid filled cable joints and terminations (including sealing ends) within a hydraulic section – where undertaken as a single planned intervention			✓
Repressurising of cable fluid system (e.g. top up of oil or gas)	✓		
Resealing of pressurising equipment (e.g. resealing tanks)	✓		
Resoldering of pressurising equipment pipework	✓		
Replacement of pressurising equipment valves and/or gauges		✓	
Replacement of pressurising equipment pipework and/or tanks		✓	
Re-engineering (replacement/refurbishment/relocation) of pressurising system equipment with the objective of reducing the normal operating fluid pressure in the cable system		✓	✓

66kV UG Cable (Gas)			
Activity	Cost and Volume Table for Reporting of Activity		
	Repair & Maintenance	Refurbishment (No SDI)	Refurbishment (SDI)
Diagnostic testing (e.g. partial discharge testing, sheath testing etc.)	✓		
Sheath repairs	✓		
Replacement of an individual cable joint or terminations (including sealing ends)		✓	✓
Remaking an individual existing joint or terminations in situ		✓	✓
Replacement/ remaking of all fluid filled cable joints and terminations (including sealing ends) within a pneumatic section – where undertaken as a single planned intervention			✓
Repressurising of cable fluid system (e.g. top up of oil or gas)	✓		
Resealing of pressurising equipment (e.g. resealing tanks)	✓		
Resoldering of pressurising equipment pipework	✓		
Replacement of pressurising equipment valves and/or gauges		✓	
Replacement of pressurising equipment pipework and/or tanks		✓	
Re-engineering (replacement/refurbishment/relocation) of pressurising system equipment with the objective of reducing the normal operating fluid pressure in the cable system		✓	✓

33kV Transformer (GM)			
Activity	Cost and Volume Table for Reporting of Activity		
	Repair & Maintenance	Refurbishment (No SDI)	Refurbishment (SDI)
Test operation of forced cooling (fans/ pumps)	✓		
Test Bucholz & winding temperature indicators/ relays	✓		
Diagnostic testing (oil testing, partial discharge testing etc.)	✓		
Change silica gel in breather	✓		
Oil filtration and replacement	✓		
Painting	✓		
Sight glass replacement	✓		
Bolt tightening	✓		
General housekeeping (remove debris from radiator etc.)	✓		
Repair/ replacement of connections to earthing system	✓		
Minor repair to existing cooling radiators (rust/ leaks)	✓		
Replacement of breather unit	✓		
Tapchanger diverter contact replacement	✓		
Tapchanger selector contact replacement	✓		
Replacement of individual fan motors	✓		
Replacement of pumps	✓		
Replacement of gaskets & seals			✓
On site processing to recondition oil to remove moisture and acidity from windings			✓
Replacement of cooling radiators			✓
Replacement of conservator tanks		✓	
Replacement of tap changers or full replacement of tap changer mechanism			✓
Replacement of bushings			✓
Replacement of cable box		✓	✓
Installation of replacement windings			✓
Complete factory refurbishment			✓

66kV Transformer			
Activity	Cost and Volume Table for Reporting of Activity		
	Repair & Maintenance	Refurbishment (No SDI)	Refurbishment (SDI)
Test operation of forced cooling (fans/ pumps)	✓		
Test Bucholz & winding temperature indicators/ relays	✓		
Diagnostic testing (oil testing, partial discharge testing etc.)	✓		
Change silica gel in breather	✓		
Oil filtration and replacement	✓		
Painting	✓		
Sight glass replacement	✓		
Bolt tightening	✓		
General housekeeping (remove debris from radiator etc.)	✓		
Repair/ replacement of connections to earthing system	✓		
Minor repair to existing cooling radiators (rust/ leaks)	✓		
Replacement of breather unit	✓		
Tapchanger diverter contact replacement	✓		
Tapchanger selector contact replacement	✓		
Replacement of individual fan motors	✓		
Replacement of pumps	✓		
Replacement of gaskets & seals			✓
On site processing to recondition oil to remove moisture and acidity from windings			✓
Replacement of cooling radiators			✓
Replacement of conservator tanks		✓	

66kV Transformer			
Activity	Cost and Volume Table for Reporting of Activity		
	Repair & Maintenance	Refurbishment (No SDI)	Refurbishment (SDI)
Replacement of tap changers or full replacement of tap changer mechanism			✓
Replacement of bushings			✓
Replacement of cable box		✓	✓
Installation of replacement windings			✓
Complete factory refurbishment			✓

132kV UG Cable (Oil)			
Activity	Cost and Volume Table for Reporting of Activity		
	Repair & Maintenance	Refurbishment (No SDI)	Refurbishment (SDI)
Diagnostic testing (e.g. partial discharge testing, sheath testing etc.)	✓		
Sheath repairs	✓		
Replacement of an individual cable joint or terminations (including sealing ends)		✓	✓
Remaking an individual existing joint or terminations in situ		✓	✓
Replacement/remaking of all fluid filled cable joints and terminations (including sealing ends) within a hydraulic section – where undertaken as a single planned intervention			✓
Repressurising of cable fluid system (e.g. top up of oil or gas)	✓		
Resealing of pressurising equipment (e.g. resealing tanks)	✓		
Resoldering of pressurising equipment pipework	✓		
Replacement of pressurising equipment valves and/or gauges		✓	
Replacement of pressurising equipment pipework and/or tanks		✓	
Re-engineering (replacement/refurbishment/relocation) of pressurising system equipment with the objective of reducing the normal operating fluid pressure in the cable system		✓	✓

132kV UG Cable (Gas)			
Activity	Cost and Volume Table for Reporting of Activity		
	Repair & Maintenance	Refurbishment (No SDI)	Refurbishment (SDI)
Diagnostic testing (e.g. partial discharge testing, sheath testing etc.)	✓		
Sheath repairs	✓		
Replacement of an individual cable joint or terminations (including sealing ends)		✓	✓
Remaking an individual existing joint or terminations in situ		✓	✓
Replacement/ remaking of all fluid filled cable joints and terminations (including sealing ends) within a pneumatic section – where undertaken as a single planned intervention			✓
Repressurising of cable fluid system (e.g. top up of oil or gas)	✓		
Resealing of pressurising equipment (e.g. resealing tanks)	✓		
Resoldering of pressurising equipment pipework	✓		
Replacement of pressurising equipment valves and/or gauges		✓	
Replacement of pressurising equipment pipework and/or tanks		✓	
Re-engineering (replacement/refurbishment/relocation) of pressurising system equipment with the objective of reducing the normal operating fluid pressure in the cable system		✓	✓

132kV Transformer			
Activity	Cost and Volume Table for Reporting of Activity		
	Repair & Maintenance	Refurbishment (No SDI)	Refurbishment (SDI)
Test operation of forced cooling (fans/ pumps)	✓		
Test Bucholz & winding temperature indicators/ relays	✓		
Diagnostic testing (oil testing, partial discharge testing etc.)	✓		
Change silica gel in breather	✓		
Oil filtration and replacement	✓		
Painting	✓		
Sight glass replacement	✓		
Bolt tightening	✓		
General housekeeping (remove debris from radiator etc.)	✓		
Repair/ replacement of connections to earthing system	✓		
Minor repair to existing cooling radiators (rust/ leaks)	✓		
Replacement of breather unit	✓		
Tapchanger diverter contact replacement	✓		
Tapchanger selector contact replacement	✓		
Replacement of individual fan motors	✓		
Replacement of pumps	✓		
Replacement of gaskets & seals			✓
On site processing to recondition oil to remove moisture and acidity from windings			✓
Replacement of cooling radiators			✓
Replacement of conservator tanks		✓	
Replacement of tap changers or full replacement of tap changer mechanism			✓
Replacement of bushings			✓
Replacement of cable box		✓	✓
Installation of replacement windings			✓
Complete factory refurbishment			✓