Common Network Asset Indices Methodology (CNAIM)

Secondary Deliverables Rebasing

01 Feb 2017 (Re-submission)

## Introduction

As part of the RIIO-ED1 price control review Northern Powergrid provided forecasts (via the Network Asset Workbook, NAW) of its asset health and criticality positions at the end of the RIIO ED1 price control period “with intervention” and “without intervention”. Ofgem used these to create Secondary Deliverable targets setting out the required improvement in asset health, criticality and monetised risk (the asset risk delta).

Standard License condition (SLC) 51 of the Licence requires Northern Powergrid (Northeast) Limited and Northern Powergrid (Yorkshire) plc (hereafter collectively referred to as Northern Powergrid), in conjunction with the other British electricity distribution network operators (DNOs), to develop and implement a Common Network Asset Indices Methodology (CNAIM).

Ofgem approved and Directed the Methodology in February 2016 which triggered a requirement to implement the changes to Northern Powergrid’s existing Methodology by 30 December 2016 as per Ofgem’s letter dated 01 February 2016.

Northern Powergrid was also directed to restate its NAW which permits the Asset Risk Delta due to investment to be rebased (“Rebased Network Asset Secondary Deliverables”[[1]](#footnote-1)) for the RIIO ED1 Period (April 2015 – March 2023).

* **Restatement:** Restatement of data previously reported within the NAW in accordance with the requirements under the CNAIM.
* **Rebased Network Asset Secondary Deliverables:** A revised set of Network Asset Secondary Deliverables in accordance with the CNAIM, which are trued up to take account of actual data up to and including 31 March 2015 and which remain equally as challenging as those set out in the NAW that was applicable at 01 April 2015.

Ofgem shall undertake an assessment in line with its Network Asset Secondary Deliverables rebasing requirements and assessment methodology, published 06 Dec 2016[[2]](#footnote-2), to determine whether the restated NAW for the licensees are as “equally challenging” compared to the original NAW.

This document presents Northern Powergrid’s self-assessment with respect to the “equally challenging” tests outlined in Ofgem’s methodology paper.

## Scope

The scope of this document is limited to commentary covering the rebasing process itself and the outputs of Northern Powergrid’s self-assessment with respect to the equally challenging tests. It covers:

* An overview of the process and methodology used to achieve a 01 April 2015 data set.
* An accompanying discussion about issues encountered during rebasing due to generic differences between the asset indices produced by CNAIM compared to the original Northern Powergrid methodologies.
* The process undertaken to produce the Network Asset Workbook rebasing submission in terms of the high level intervention methodologies deployed.
* A summary of the rebasing results produced from testing undertaken to establish if the CNAIM creates an equally challenging commitment by Northern Powergrid to the Secondary Deliverable targets originally agreed under the slow track settlement.

Out of scope is commentary that is not specific to the rebasing process itself such as:

* A description of the original Northern Powergrid methodology.
* Details of the CNAIM – this is available on the Ofgem website: <https://www.ofgem.gov.uk/system/files/docs/2016/10/dno_common_network_asset_indices_methodology_v1.0_0.pdf>
* A justification for Northern Powergrid’s entire investment strategy and choice of interventions – there is a well justified business plan (WJBP) available on Northern Powergrid’s website to support the original plan: <http://www.yourpowergridplan.com/#!>

## Process

Northern Powergrid in conjunction with other DNOs commissioned EA Technology Ltd to provide a CNAIM software tool using the same Condition Based Risk Management software technologies already tried and tested for many of the DNO’s existing methodologies. Northern Powergrid has produced the common network asset indices required under the common framework using the common software tool built by EA Technology Ltd.

### Data set establishment

Ofgem has provided a published document, NASD Rebasing Methodology, following a series of Reliability Working Group meetings involving all DNOs[[3]](#footnote-3) which details the methodology for establishing the data sets required for this Rebasing submission. The methodology requires that the data set used for the 2015/16 submission (ED1 Year 1 position) should form the basis of the ED1 Year 0 position.

Given that the CNAIM does not cater for “reverse ageing” it was necessary to establish an "artificial set of input data files”, as will be described below, within the industry common CNAIM Tool. This was deemed by Northern Powergrid to be the most appropriate approach in that it would:

1. Prove capable of pulling the health score back a year in line with the same degradation curves assumed for forwards ageing;
2. Ensure ensuring that condition related caps and collars were consistently applied; and
3. Ensure that condition measures being collected under CNAIM but not under the original Northern Powergrid methodology could be suitably captured for all but any assets intervened on during the period 2015/16.

Once the Year 0 data set had been established so as to reflect the younger age of the asset base it was necessary to then restore the old condition data for any assets that had been removed or refurbished during the period 2015/16. The approach to doing so is as follows.

#### Creating the artificial set of input data files

##### **For Asset Removals**

Where assets had been replaced in the reporting year 2015/16, it was necessary to add these assets back in to the data set in order to create a Year 0 position.

**Probability of failure (PoF):** Condition data for the removed assets was available in all cases where condition measures used in the health score calculation were common both to the previous Northern Powergrid methodology and to CNAIM. Where condition measures are used in CNAIM which were not in the Northern Powergrid methodology we have used the default values in accordance with CNAIM. Northern Powergrid’s Information Gathering Plan, published on 19 Dec 2016[[4]](#footnote-4), provides further detail on our assessment of our information requirements for achieving compliance with the CNAIM in accordance with Part E of Standard License Condition (SLC) 51

**Consequence of Failure (CoF):** Criticality information for the removed assets was based on the information obtained for the 2015/16 data set where possible, in that much of the criticality information was site specific rather than asset specific. This was the case for example with

* Substation loadings and customer numbers for the network performance criticality; and
* Proximity and site risk information for environmental and safety consequences.

Where a consequence was asset specific, such as transformer sizing or the use of oil as an interruption medium, then 2014/15 criticality information was used.

##### **For Asset Refurbishments**

Where assets had been refurbished in the reporting year 2015/16, it was necessary to restore the asset to its pre refurbished health position in order to create a Year 0 position:

**Probability of failure (PoF):** Condition data for the refurbished assets was available in all cases where condition measures used in the health score calculation were common both to the previous Northern Powergrid methodology and to CNAIM.

**Consequence of failure (CoF):** Criticality information for the refurbished assets was set to be the same before and after intervention, as there were no refurbishment activities affecting consequence of failure.

## Intervention methodology

In general Northern Powergrid’s approach to restating the ED1 forecast interventions (rebasing where appropriate) was as follows:

1. A principle was established that the original intervention volumes would not be altered in any way (exceptions relating to Riley and Neate masts are captured in Appendix III).
2. The original set of interventions associated with known named schemes was used for all asset categories except LV/HV assets. The first step was to restate the risk indices for the known schemes under CNAIM.
3. The results of the initial restatement were tested using Ofgem’s equally challenging methodology. Where Tests were failed then the interventions assumptions were re-assessed, for example if there were other candidate schemes of an equivalent volume then this was explored as a potential “replacement scheme”. Such modifications to our original intervention assumptions were targeted at schemes in later years in the planning period. Furthermore it would not be appropriate to make significant revisions to the plan prior to a deeper understanding of what is driving the change in results under CNAIM.
4. For LV/HV assets (e.g. poles and distribution switchgear and transformers) for which interventions are based on programmes of work rather than specific assets statistical approaches were used to ensure an equally challenging target.

### Named schemes

Where proportionate we always look to identify individual assets within our forecast intervention plans. All associated assets (such as towers, fittings and conductor on a 132kV tower line, or circuit breakers on a 33kV switchboard) are collectively formed into a scheme in our investment plan.

Individual asset components are assessed for replacement or refurbishment with a collective economic assessment then undertaken on an individual circuit/site basis (i.e. at a scheme level), primarily using health and criticality indices but also supplemented by other information as necessary.

For example, we may look to rebuild an overhead line due to condition which would be reflected by a high HI of individual poles. However issues relating to landowners (such as difficulties in obtained easements for a new route) would not be reflected within the models. In such scenarios we would make an assumption in our intervention plan to rebuild offline along a diverted route which would result in more (or fewer) pole additions than removals. The risk matrices reported as part of the NAW or restated NAW would not necessarily account of such scheme specifics; however our Well Justified Business Plan (WJBP) did provide scheme specific narratives for all relevant asset categories.

### Statistical approach

High volume lower cost asset categories such as LV and HV overhead lines and distribution plant are typically managed on the basis of work programmes rather than individual major projects due to the population size and asset criticality, using our health and criticality models as well as other forecasting tools.

It is these models that informed our intervention plans (volumes) for ED1. They offer a means of combining a range of information for a large volume of assets to give a comparable measure of risk. This understanding is then used to establish our asset renewal policy which can be represented as priorities or selection criteria for the relevant asset replacement programmes.

### Summary by Asset Category

The table below summarises the approach to forecasting our ED1 intervention assumption.

|  |  |  |
| --- | --- | --- |
| **Asset Category** | **Intervention Assumption** | |
| **NAW** | **Restated NAW** |
| LV OHL Support | Statistical | Statistical |
| HV Switchgear (GM) - Primary | Named schemes | Named schemes\* |
| HV Switchgear (GM) - Distribution | Statistical | Statistical |
| HV Transformer (GM) | Statistical | Statistical |
| HV OHL Support - Poles | Statistical | Statistical |
| EHV Switchgear (GM) | Named schemes | Named schemes\* |
| EHV Transformer | Named schemes | Named schemes\* |
| EHV UG Cable (Gas) | Mix\*\* | Mix\*\* |
| EHV UG Cable (Oil) | Mix\*\* | Mix\*\* |
| EHV UG Cable (Non Pressurised) | Mix\*\* | Mix\*\* |
| EHV OHL Support – Towers | Named schemes | Named schemes\* |
| EHV OHL Support – Poles | Named schemes | Named schemes\* |
| EHV OHL Fittings | Named schemes | Named schemes\* |
| EHV OHL (Tower Line) Conductor | Named schemes | Named schemes\* |
| 132kV CBs | Named schemes | Named schemes\* |
| 132kV Transformer | Named schemes | Named schemes\* |
| 132kV UG Cable (Gas) | Mix\*\* | Mix\*\* |
| 132kV UG Cable (Oil) | Mix\*\* | Mix\*\* |
| 132kV UG Cable (Non Pressurised) | Mix\*\* | Mix\*\* |
| 132kV OHL Support - Tower | Named schemes | Named schemes\* |
| 132kV OHL Fittings | Named schemes | Named schemes\* |
| 132kV OHL (Tower Line) Conductor | Named schemes | Named schemes\* |

*\* Wherever possible we have restated the same set of named schemes assumed within the original NAW. Where we considered that the restated NAW was not as “equally challenging” as the original NAW (for reasons including those summarised in Appendix I), we have rebased by identifying alternative candidates.*

*\*\* The level of work undertaken on EHV cable replacement is defined by the number of candidates that can be accurately identified as requiring replacement, the trigger for which being an electrical fault or gas/fluid leak. Therefore the need for a fault or leak to occur before this key condition information is obtained places a large reactive element to this programme. This characterises the later years of our investment programme, i.e. our short term plan is created on the basis of named schemes with a statistical approach used to forecast interventions later in the period (on the basis of an assumed fault/leak performance in future years using the degradation assumptions detailed in CNAIM).*

## Equally challenging testing

As one of the requirements for the rebasing of the NAW each DNO must perform a series of tests on the output from the above process. This is to establish whether the CNAIM creates an equally challenging output for the DNO when compared to its original RIIO-ED1 submission. The requirements of these equally challenging tests are described in the published document, NASD Rebasing Methodology, referenced earlier in Section 3.1.

### Summary of the Tests

#### Replacement

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Asset Category** | **RESULTS OF THE TESTS** | | | **Evidence** |
| **Test 1** | **Test 2** | **Test 3** |
| LV OHL Support | **Pass** | **Pass** | **Pass** | - |
| HV Switchgear (GM) – Primary | **Pass** | **Pass** | **Pass** | - |
| HV Switchgear (GM) – Distribution | **Pass** | **Pass** | **Pass** | - |
| HV Transformer (GM) | **Pass** | **Pass** | **Fail** | Appendix II-1 |
| HV OHL Support – Poles | **Pass** | **Pass** | **Pass** | - |
| EHV Switchgear (GM) | **Pass** | **Pass** | **Pass** | - |
| EHV Transformer | **Pass** | **Pass** | **Pass** | - |
| EHV UG Cable (Gas) | **Pass** | **Pass** | **Pass** | - |
| EHV UG Cable (Oil) | **Pass** | **Pass[[5]](#footnote-5)** | **Pass** | - |
| EHV UG Cable (Non Pressurised) | **Pass** | **Pass** | **Pass** | - |
| EHV OHL Support – Towers | **Pass** | **Pass** | **Pass** | - |
| EHV OHL Support – Poles | **Pass** | **Pass** | **Pass** | - |
| EHV OHL Fittings\* | **Pass** | **Pass** | **Pass** | - |
| EHV OHL (Tower Line) Conductor\* | **Pass** | **Pass** | **Pass** | - |
| 132kV CBs | **Pass** | **Pass** | **Pass** | - |
| 132kV Transformer | **Pass** | **Pass** | **Pass** | - |
| 132kV UG Cable (Gas) | **n/a** | **n/a** | **n/a** | No asset population |
| 132kV UG Cable (Oil) | **Pass** | **Pass** | **Pass** | - |
| 132kV UG Cable (Non Pressurised) | **Pass** | **Pass** | **Pass** | - |
| 132kV OHL Support – Tower | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV OHL Fittings\* | **Pass** | **Pass** | **Pass** | - |
| 132kV OHL (Tower Line) Conductor\* | **n/a** | **n/a** | **n/a** | No planned work |

*\* Appendix III describes how the fittings and conductor categories in the original NAW have been retrospectively disaggregated to facilitate the equally challenging testing.*

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Asset Category** | **RESULTS OF THE TESTS** | | | **Evidence** |
| **Test 1** | **Test 2** | **Test 3** |
| LV OHL Support | **Pass** | **Pass** | **Pass** | - |
| HV Switchgear (GM) – Primary | **Pass** | **Pass** | **Pass** | - |
| HV Switchgear (GM) – Distribution | **Pass** | **Pass** | **Pass** | - |
| HV Transformer (GM) | **Pass** | **Pass** | **Fail** | Appendix II-3 |
| HV OHL Support – Poles | **Pass** | **Pass** | **Pass** | - |
| EHV Switchgear (GM) | **Pass** | **Pass** | **Pass** | - |
| EHV Transformer | **Pass** | **Pass** | **Pass** | - |
| EHV UG Cable (Gas) | **Pass** | **Pass** | **Pass** | - |
| EHV UG Cable (Oil) | **Pass** | **Pass** | **Pass** | - |
| EHV UG Cable (Non Pressurised) | **Pass** | **Pass** | **Pass** | - |
| EHV OHL Support – Towers | **n/a** | **n/a** | **n/a** | No planned work |
| EHV OHL Support – Poles | **Pass** | **Pass** | **Pass** | - |
| EHV OHL Fittings\* | **Pass** | **Pass** | **Pass** | - |
| EHV OHL (Tower Line) Conductor\* | **Pass** | **Pass** | **Pass** | - |
| 132kV CBs | **Pass** | **Pass** | **Pass** | - |
| 132kV Transformer | **Pass** | **Pass** | **Pass** | - |
| 132kV UG Cable (Gas) | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV UG Cable (Oil) | **Pass** | **Pass** | **Pass** | - |
| 132kV UG Cable (Non Pressurised) | **Pass** | **Pass** | **Pass** | - |
| 132kV OHL Support – Tower | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV OHL Fittings\* | **Pass** | **Pass** | **Pass** | - |
| 132kV OHL (Tower Line) Conductor\* | **Pass** | **Pass** | **Pass** | - |

\* Appendix III describes how the fittings and conductor categories in the original NAW have been retrospectively disaggregated to facilitate the equally challenging testing.

#### Refurbishment

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Asset Category** | **RESULTS OF THE TESTS** | | | | **Evidence** |
| **Test 1**  **(ind.)** | **Test 1**  **(seq.)** | **Test 2** | **Test 3** |
| LV OHL Support | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| HV Switchgear (GM) – Primary | **Pass** | **Pass** | **Pass** | **Pass** |  |
| HV Switchgear (GM) – Distribution | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| HV Transformer (GM) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| HV OHL Support – Poles | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV Switchgear (GM) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV Transformer | **Pass** | **Pass** | **Pass** | **Pass** | - |
| EHV UG Cable (Gas) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV UG Cable (Oil) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV UG Cable (Non Pressurised) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV OHL Support - Towers | **Pass** | **Pass** | **Pass** | **Pass** | - |
| EHV OHL Support - Poles | **Fail** | **Fail** | **Pass** | **Pass** | Appendix II-2 |
| EHV OHL Fittings | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV OHL (Tower Line) Conductor | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV CBs | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV Transformer | **Pass** | **Pass** | **Pass** | **Pass** | - |
| 132kV UG Cable (Gas) | **n/a** | **n/a** | **n/a** | **n/a** | No asset population |
| 132kV UG Cable (Oil) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV UG Cable (Non Pressurised) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV OHL Support - Tower | **Pass** | **Pass** | **Pass** | **Pass** | - |
| 132kV OHL Fittings | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV OHL (Tower Line) Conductor | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |

* + - 1. Yorkshire

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Asset Category** | **RESULTS OF THE TESTS** | | | | **Evidence** |
| **Test 1**  **(ind.)** | **Test 1**  **(seq.)** | **Test 2** | **Test 3** |
| LV OHL Support | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| HV Switchgear (GM) - Primary | **Pass** | **Pass** | **Pass** | **Pass** |  |
| HV Switchgear (GM) - Distribution | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| HV Transformer (GM) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| HV OHL Support - Poles | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV Switchgear (GM) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV Transformer | **Pass** | **Pass** | **Pass** | **Pass** |  |
| EHV UG Cable (Gas) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV UG Cable (Oil) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV UG Cable (Non Pressurised) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV OHL Support - Towers | **Pass** | **Pass** | **Pass** | **Pass** |  |
| EHV OHL Support - Poles | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV OHL Fittings | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| EHV OHL (Tower Line) Conductor | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV CBs | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV Transformer | **Pass** | **Pass** | **Pass** | **Pass** |  |
| 132kV UG Cable (Gas) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV UG Cable (Oil) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV UG Cable (Non Pressurised) | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV OHL Support - Tower | **Pass** | **Pass** | **Pass** | **Pass** |  |
| 132kV OHL Fittings | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |
| 132kV OHL (Tower Line) Conductor | **n/a** | **n/a** | **n/a** | **n/a** | No planned work |

## **Appendix I** - Commentary relating to the Implementation of the Common Network Asset Indices Methodology

There are a number of key differences between the CNAIM methodology and the methodology we used in our original submission, all of which affect the “equally challenging” tests in some way. Furthermore there are some issues related to rebasing which also affect these tests. We have attempted to provide a summary of some of the key changes, focusing on those which have had a material impact in Northern Powergrid’s performance against the equally challenging tests.

Issues were encountered affecting both the current and the future health score without intervention positions.

#### **Base position from which forecasting takes place**

As with CNAIM, exponential ageing curves were used for forecasting future HI values in the Health and Criticality index models that underpin the NAW. The forecast position for year 8 of RIIO-ED1 was originally forecast from a base position at the time of the WJBP in 2012/13. Therefore the NAW had two more years’ worth of forecast uncertainty compared to the restated NAW which can increase modelling uncertainty compared with the Restated NAW, which forecasts eight years from 2014/15.

#### **Methodological changes in general**

One way of assessing how much change has occurred between the two methodologies in general terms is to look at the rate of movement of an asset category population through the PoF bands. That is done by calculating the cumulative profiles of the population as it progresses through the PoF bands. So for example with EHV transformers in Yorkshire 83% of the population are in PoF bands 1,2,3 or 4 by year 8 under the original methodology whereas under CNAIM they are only in bands 1,2 or 3. However the same test on LV poles shows over 80% of the population are in PoF bands 1,2,3 or 4 by year 8 under both methodologies. There could be various drivers behind this difference the mix of which alter across asset categories. In general though these drivers include:-

* PoF bands under CNAIM are based on different health scores to those in our original methodologies.
* Algorithm differences have an effect depending on what version of health index methodology was used in the original DNO models prior to CNIAM. For example the NPg HI models for overhead line assets and distribution plant are more recent and they use the same maximum plus multiple increments technique (MMI) as is used in CNAIM. On the other hand the NPg HI models for cables and primary plant are early models developed ten years ago and they use a different combination technique for calculating the current health score.
* There are differences concerning how collars are used between the original NPg methodologies and CNAIM. This is especially true for the plant categories where an approach based on taking the maximum of “condition modified by age” versus “age modified by condition” was preferred to an approach based on collars.
* There can be differences in engineering judgements about how much weight to put on certain factors. While there was already a high level of commonality across DNO’s about the relative importance of the various factors, none the less the non-common judgements have an impact. For example partial discharge in switchgear and transformers contributes more under CNAIM than under the original NPg methodologies.
* Improvement factors which pull back the health score are used differently between the original NPg methodologies and CNAIM. For example in the case of EHV and 132kV transformers and primary switchgear CNAIM uses location and condition improvement factors (factors <1.0 which lower the Health Score) – NPg’s previous methodology did not use factors <1.0 to the same extent. This has led to considerably lower health scores for old transformers which previously had an initial health score of 5.5 and a final health score high enough to put them forward as replacement candidates in situations where there were also condition issues.
* Location and duty factors are regarded differently in some cases. So for transformers and primary switchgear CNAIM puts a much larger weight on location factors than was attributed in the previous NPg methodology. This means that transformers in poor locations such as those outdoor in coastal areas are more likely to have worse health scores than previously and conversely transformers indoor and in good locations may have much better health scores than previously.
* Expected lives varied for different asset types in the original NPg models much more than they do under CNAIM. The use of the reliability modifier as a proxy to cater for the differences in expected lives does not entirely behave mathematically in the same way.
* There are more criticality factors in CNAIM than were included in the original NPg models and to compound matters they are calibrated differently. For example, proximity to water courses was an environmental factor for cables previously but was not considered for plant assets.
* There are then also a number of differences in the structure of some of the models. So in the case of EHV and 132kV transformers the sub- component approach for the tapchanger is new. Also the use of a rate of change factor for the DGA oil analysis is new compared to the previous NPg methodology and this is leading to changes in the health scores for a number of assets.

Below some more detail is given regarding some of these changes.

#### **Calibration of Probability of Failure (PoF) and Consequence of Failure (CoF)**

The value of an intervention simply based on its position within the reporting matrix has materially changed.

For example consider the replacement of a HI4 | C4 circuit breaker (Yorkshire HV primary switchgear):

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **NAW** | | | | | | | | | |
| **Risk Points** | | | | | **Rank**  **(of each Health & Criticality Band)** | | | | |
| **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** | **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** |
| 5 | 21 | 59 | 133 | 253 | 20 | 16 | 13 | 9 | 6 |
| 7 | 29 | 85 | 190 | 362 | 19 | 15 | 11 | 8 | 4 |
| 10 | 44 | 127 | 285 | 542 | 18 | 14 | 10 | 5 | 2 |
| 17 | 74 | 212 | 475 | 904 | 17 | 12 | 7 | 3 | 1 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **RESTATED NAW** | | | | | | | | | |
| **Risk Points** | | | | | **Rank**  **(of each Health & Criticality Band)** | | | | |
| **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** | **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** |
| 39 | 61 | 105 | 172 | 711 | 20 | 18 | 15 | 11 | 4 |
| 56 | 88 | 150 | 246 | 1,016 | 19 | 16 | 12 | 8 | 3 |
| 84 | 132 | 225 | 368 | 1,524 | 17 | 14 | 9 | 7 | 2 |
| 141 | 219 | 376 | 614 | 2,540 | 13 | 10 | 6 | 5 | 1 |

So in this example, an intervention on asset in the HI4 | C4 risk band is worth relatively less in the NAW (475 risk points, the third highest scoring risk band) compared with the Restated NAW (614 risk points, the fifth highest scoring risk band).

#### **Health Index Banding**

NPg have submitted materially more HI1-HI2 interventions in the Restated NAW compared with the volumes of HI1-HI3 in our original NAW. This was an expected result, and we therefore consider this appropriate, for a number of reasons including:

* Data changes in terms of the inspection information used to populate condition factors which can both increase or decrease the assessed health and or criticality of an asset:
  + the data used in the original NAW was collected up to 31/03/2013
  + the data used in the restated NAW was collected up to 31/03/2016
* Data changes in terms of the way that input data is translated into our Health and Criticality models (calibration)

A more fundamental and isolatable change though relates to the Health Index banding requirements of the CNAIM as per the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Health Score** | | **HI Band** | |
| **≥** | **<** | **NAW** | **Restated NAW** |
| 0.5 | 1 | HI1 | HI1 |
| 1 | 1.5 | HI1 | HI1 |
| 1.5 | 2 | HI1 | HI1 |
| 2 | 2.5 | HI2 | HI1 |
| 2.5 | 3 | HI2 | HI1 |
| 3 | 3.5 | HI2 | HI1 |
| 3.5 | 4 | HI2 | HI1 |
| 4 | 4.5 | HI3 | HI2 |
| 4.5 | 5 | HI3 | HI2 |
| 5 | 5.5 | HI3 | HI2 |
| 5.5 | 6 | HI3 | HI3 |
| 6 | 6.5 | HI4 | HI3 |
| 6.5 | 7 | HI4 | HI4 |
| 7 | 7.5 | HI4 | HI4 |
| 7.5 | 8 | HI4 | HI4 |
| 8 | 8.5 | HI5 | HI5 |
| 8.5 | 9 | HI5 | HI5 |
| 9 | 9.5 | HI5 | HI5 |
| 9.5 | 10 | HI5 | HI5 |

#### **Changes to input data**

The other significant change to mention for rebasing is that the data on which the schemes were selected has changed between 2012/13 and 2015/16.

Under the license conditions described under SLC 51 Part 1: Modification of the Common Network asset indices Methodology to rebase their RIIO-ED1 network asset indices, starting with a base data set describing the “year 0 position” on 1 April 2015.

These indices were originally submitted in 2012/13 using a Northern Powergrid specific methodology as part of the slow track settlement process for the regulatory reporting period covered under RIIO-ED1.

As this period is dated from 2015/16 to 2022/23 the original position for year 0 was initially forecast using the asset data available for 2012/13 and used in the BPDT (Business Plan Data Tables) that formed part of the overall Well Justified Business Plan submission for RIIO-ED1.

So the forecast now may be based on a starting point of poorer (or better) condition than previously. This has most impact for asset categories where there is a volatile condition factor. For example DGA results from transformer analysis can be volatile and this affects the forecast where that is so.

## **Appendix II** - Commentary by Asset Category (by exception)

This section provides further information relating to those asset categories where one or more of the equally challenging tests have ben failed.

### Northeast

#### **Northeast HV Transformer (GM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Replacement** | | | **Refurbishment** | | | |
| **Test 1** | **Test 2** | **Test 3** | **Test 1** | | **Test 2** | **Test 3** |
| **Independent** | **Sequential** |
| **Pass** | **Pass** | **Fail** | **-** | **-** | **-** | **-** |

We are satisfied that although our restated profile for this asset category leads to a failure of Test 3, it remains appropriate and “equally challenging” for the following reasons:

1. The Year 8 without intervention profiles are materially different between the NAW and Restated NAW submissions due to the implementation of CNAIM (and the associated changes in the assessment methodology as described in Appendix I)
2. Minor change in planning assumption regarding “associated assets”
3. We pass Test 1, which means the proportion of risk reduction in our rested NAW is higher than in the original NAW.

Please refer to Appendix III-4 Yorkshire HV Transformer (GM) where we have provided additional justification, all of which his applicable here.

#### **Northeast EHV OHL Support – Poles**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Replacement** | | | **Refurbishment** | | | |
| **Test 1** | **Test 2** | **Test 3** | **Test 1** | | **Test 2** | **Test 3** |
| **Independent** | **Sequential** |
| **Pass** | **Pass** | **Pass** | **Fail** | **Fail** | **Pass** | **Pass** |

We fail the Refurbishment Test 1 when run independently or sequentially to the replacement programme for this asset category. This is an expected result since our refurbishment programme is associated entirely with a population of ‘Riley and Neate’ supports which we believe to be unique to the Northeast.

These small lattice towers are analogous to the supports reported in the EHV OHL Support – Towers category (in terms of their design, failure modes and the type of interventions activities that could be undertaken on the assets); however we have reported these in the EHV OHL Support – Poles category following direction from Ofgem.

In terms of the results from Test 1, please see below:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Restated NAW** | | | | | | | | | | |
|  | **Planned interventions (replacements)** | | | | | **“Worst case” intervention profile** | | | | |
| **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** | **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** |
| **C1** | - | - | - | -73 | - | - | - | - | - | -17 |
| **C2** | - | - | - | -468 | - | - | - | - | - | -265 |
| **C3** | - | - | - | -3 | - | - | - | - | - | -5 |
| **C4** | - | - | - | -26 | - | - | - | - | -208 | -75 |
|  |  |  |  |  | **-570** |  |  |  |  | **-570** |

Risk points:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NAW** | | | **Restated NAW** | | |
| **Submitted risk point reduction** | **Maximum risk point reduction** | **% of maximum achievable** | **Submitted risk point reduction** | **Maximum risk point reduction** | **% of maximum achievable** |
| **-16,671** | **-26,925** | **62%** | **-69,734** | **-192,744** | **36%** |

Test 1 assumes that the proposed refurbishments may be undertaken on any particular asset in the category. However in this instance this is not a reasonable assumption. The HI4 and HI5 assets “picked” by Test 1 actually relate to wood poles and the refurbishments included in the original NAW relate to steel member replacement, the remaking of concrete foundations and the application of a protective paint system. In contrast the HI4/HI5 wood pole assets identified would be a candidate for replacement, rather than refurbishment (to a set of timescales appropriate to the particular characteristics of the pole, for example the location and extent of any pole decay, the location of the pole itself, the type of pole).

It is therefore necessary to isolate the Riley and Neate supports from the other wood poles in the asset category. By doing so, it is possible to re-run Test 1 purely on the population of Riley and Neate masts to which the proposed interventions are appropriate:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Restated NAW** | | | | | | | | | | |
|  | **Planned interventions (replacements)** | | | | | **“Worst case” intervention profile** | | | | |
| **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** | **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** |
| **C1** | - | 73 | - | -73 | - | - | 73 | - | -73 | - |
| **C2** | - | 468 | - | -468 | - | - | 468 | - | -468 | - |
| **C3** | - | 3 | - | -3 | - | - | 3 | - | -3 | - |
| **C4** | - | 26 | - | -26 | - | - | 26 | - | -26 | - |
|  |  | **570** |  | **-570** |  |  | **570** |  | **-570** |  |

Risk points:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NAW** | | | **Restated NAW** | | |
| **Submitted risk point reduction** | **Maximum risk point reduction** | **% of maximum achievable** | **Submitted risk point reduction** | **Maximum risk point reduction** | **% of maximum achievable** |
| **-16,671** | **25,592** | **65%** | **-69,734** | **-69,734** | **100%** |

Re-running the test in isolation shows that we are in fact refurbishing the highest risk assets that are available for refurbishment, i.e. all 570 supports. We are therefore satisfied that although our restated profile for this asset category leads to a failure of a number of the equally challenging tests, it remains appropriate and “equally challenging”.

### Yorkshire

#### **Yorkshire HV Transformer (GM)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Replacement** | | | **Refurbishment** | | | |
| **Test 1** | **Test 2** | **Test 3** | **Test 1** | | **Test 2** | **Test 3** |
| **Independent** | **Sequential** |
| **Pass** | **Pass** | **Fail** | **-** | **-** | **-** | **-** |

We are satisfied that although our restated profile for this asset category leads to a failure of Test 3, it remains appropriate and “equally challenging” for the following reasons:

1. The Year 8 without intervention profiles are materially different between the NAW and Restated NAW submissions due to the implementation of CNAIM (and the associated changes in the assessment methodology as described in Appendix I)
2. Minor change in planning assumption regarding “associated assets”
3. We pass Test 1, which means the proportion of risk reduction in our rested NAW is higher than in the original NAW.

**CNAIM methodology**

Firstly, in order to understand the considerable impact the implementation of CNAIM has had on our HV transformers, consider the following two sets of profiles:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year 8 Without Intervention Profiles** | | | | | | | | | | |  |
|  | **NAW** | | | | | **Restated NAW** | | | | |  |
| **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** | **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** |  |
| **C1** | 764 | 1,958 | 362 | 277 | 328 | 444 | 150 | 51 | 41 | 7 |  |
| **C2** | 499 | 6,059 | 1,209 | 1,160 | 1,223 | 9,638 | 3,270 | 337 | 256 | 40 |  |
| **C3** | 56 | 458 | 129 | 161 | 179 | 795 | 297 | 52 | 29 | 4 |  |
| **C4** | 4 | 304 | 68 | 71 | 91 | - | - | - | - | - |  |
|  | **1,323** | **8,779** | **1,768** | **1,669** | **1,821** | **10,877** | **3,717** | **440** | **326** | **51** |  |
|  | 9% | 57% | 12% | 11% | 12% | 71% | 24% | 3% | 2% | 0% |  |
|  | 11,870 | | |  |  | 14,494 | |  |  |  |  |
|  | **78%** | | |  |  | **95%** | |  |  |  |  |

95% of assets in our Restated NAW Year 8 (without intervention) profile now appear in the lower HI bands, HI1 and HI2. This is compared with 78% of assets in the lower HI bands in the NAW, HI1-HI3. This is primarily due to generic changes in the assessment methodology as described in Appendix II, and to a lesser extent changes in the inspection data used between the two submissions.

**Associated assets**

There are approximately 26,500 ground-mounted distribution substations on the Yorkshire and Northeast networks, around 90% of which are classified as indoor. Across these sites we manage over 90,000 individual items of LV & HV switchgear and distribution transformers with a wide range of ages, types and condition.

In considering our intervention assumptions for HV transformers we need to be mindful that the replacement of a transformer in a distribution substation may in fact be triggered by the health/criticality of one or more of these other assets inside the substation or even the building which houses the assets.

Our overall asset renewal strategy for distribution substations is driven by condition, risk and performance and its key aims are to:

* Extend the life of the assets, to maintain the overall fault rate of the population and to eliminate unsafe assets; and to
* Provide the lowest cost technically acceptable solution, on a site by site basis, taking into account the condition, risk and performance of the building and the substation plant.

In making investment decisions at each site we use a hierarchy of interventions solutions to manage our obligations and any risks associated with our assets.

* **Replace individual items of plant only:** Plant is identified for replacement through routine inspections along with targeting equipment with high failure rates or operational constraints.
* **Replace / refurbish all items of plant:** The decision to replace all the substation plant with a new indoor UDE is only made if all items of plant are considered to be unsuitable for the remainder of the planning period, or where it represents the only or lowest cost technically acceptable solution.
* **Replace all items of plant and the building:** The decision to replace the whole substation, including the building (with a new UDE in a GRP housing), is taken if there are significant issues with the existing building and its tenure since full replacement would be the most efficient solution in the medium term.

This strategy may therefore result in the replacement or relatively healthy transformers (in the HI2 band for example) where their associated equipment (i.e. the LV board and/or the HV switchgear and/or the substation building or enclosure) has been identified for replacement.

We did in fact underestimate this in our NAW and have made a correction for this in our Restatement.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Planned interventions (replacements)** | | | | | | | | | | |  |
|  | **NAW** | | | | | **RESTATED NAW** | | | | |  |
| **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** | **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** |  |
| **C1** | - | - | - | -39 | -164 | - | - | -21 | -26 | -5 |  |
| **C2** | - | - | - | -156 | -328 | - | - | -279 | -164 | -28 |  |
| **C3** | - | - | - | -24 | -39 | - | -197 | -41 | -19 | -2 |  |
| **C4** | - | - | - | -16 | -16 | - | - | - | - | - |  |
|  | **-** | **-** | **-** | **-235** | **-547** | **-** | **-197** | **-341** | **-209** | **-35** |  |
|  | 0% | 0% | 0% | 30% | 70% | 0% | 25% | 44% | 27% | 4% | **% of total removals** |

The 1 removal in HI2|C1, HI2|C3 and HI2|C4, offset by the 2 additions in HI2|C2 are the product of “rounding” in the original submission. More significantly, we did not include an assumption about replacing assets in relatively better health (HI2/HI3 assets) as part of wider decisions taken at the distribution substation level. In our restatement, we have allowed for a number of HI2 replacements based on analysis at the substation level that we have undertaken as part of:

* The CNAIM implementation;
* Preparation of the 2015/16 Secondary Deliverable reporting pack(s); and
* Other internal projects such as our NIA project on “Modelling Asset Risk” which explores enhanced risk modelling at an individual asset/site level including high volume asset categories such as distribution substation.

**Test 1 results**

Even accounting for this small proportion of HI2 removals, the above rebased interventions still results in the proportion of risk reduction in our rested NAW being higher than in the original NAW:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NAW** | | | **Restated NAW** | | |
| **Submitted risk point reduction** | **Maximum risk point reduction** | **% of maximum achievable** | **Submitted risk point reduction** | **Maximum risk point reduction** | **% of maximum achievable** |
| **-407,950** | **-620,303** | **66%** | **-108,143** | **-125,413** | **86%** |

This favourable Test 1 result is due to the high proportion of available HI3-HI5 assets that we are targeting through our restated profile:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Planned Intervention (replacements)** | | | | | | | | | | |  |
|  | **NAW** | | | | | **Restated NAW** | | | | |  |
| **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** | **HI 1** | **HI 2** | **HI 3** | **HI 4** | **HI 5** |  |
| **C1** | - | -1 | - | -39 | -164 | - | - | -21 | -26 | -5 |  |
| **C2** | - | 2 | - | -155 | -328 | - | - | -279 | -164 | -28 |  |
| **C3** | - | -1 | - | -24 | -39 | - | -197 | -41 | -19 | -2 |  |
| **C4** | - | -1 | - | -16 | -16 | - | - | - | - | - |  |
|  | **-** | **-1** | **-** | **-234** | **-547** | **-** | **-197** | **-341** | **-209** | **-35** |  |
|  | 0% | 0% | 0% | 14% | 30% | 0% | 5% | 78% | 64% | 69% | **% of HI band removals** |

The Restated NAW targets:

* 69% of available HI5 assets compared with 30% in the NAW
* 64% of available HI4 assets compared with 14% in the NAW
* 78% of available HI3 assets compared with 0% in the NAW

## **Appendix III** – Retrospective Disaggregation of the EHV/132kV Tower Line “Fittings” and “Conductor” Asset Categories

In the original NAW submission the asset categories of fittings and conductors (relating to EHV and 132kV tower lines) were amalgamated. The DNOs and Ofgem have agreed collectively that these assets should be disaggregated (into fittings and conductor) in order to overcome the issue with different units of measure and ensure consistency across DNOs.

In order to describe Northern Powergrid’s process for implementing this requirement, it is first necessary to explain how these (tower line) asset categories were amalgamated in the first place; a characteristic of both DPCR5 and of the ED1 NAW submission:

* They key data set for tower lines is a programme of high-resolution helicopter surveys which collected over 50 individual condition points per support / span. This is supplemented by additional ad-hoc surveys such as climbing patrols and conductor assessments.
* Using this condition data, plus static data from cooperate asset registers, each tower/span was assigned a Health and Criticality Index relating to the following sub components[[6]](#footnote-6):
  + Left phase fittings
  + Right phase fittings (for double circuit lines only)\*
  + Left phase conductors
  + Right phase conductors (for double circuit lines only)\*

*\* For double circuit lines, the left and right circuits are usually of the same vintage and in comparable condition. Therefore the Health Index for the left and right circuits would be expected to be equal.*

* A single “fittings and conductor” Health and Criticality Index is calculated based on the maximum of the four individual component Health and Criticality Indices. Its unit of measure is given as the length associated with the conductor.
* In order to model interventions and specifically the Health and Criticality profiles “after intervention”, the convention was to reset the Health Index of the sub component that would be addressed by the intervention, and to then recalculate the new maximum Health Index of the four sub components.

Therefore in order to disaggregate the NAW “fittings and conductor” category it was necessary to simply refer back to the pre-amalgamated Health and Criticality Index profiles.

1. Has the meaning given to that term in paragraph 5D.17 of CRC 5D Assessment of Network Asset Secondary Deliverables [↑](#footnote-ref-1)
2. <https://www.ofgem.gov.uk/publications-and-updates/network-asset-secondary-deliverables-rebasing-requirements-and-assessment-methodology> [↑](#footnote-ref-2)
3. This document is available on the Ofgem website: <https://www.ofgem.gov.uk/publications-and-updates/reliability-working-group> [↑](#footnote-ref-3)
4. <https://www.ofgem.gov.uk/publications-and-updates/dno-information-gathering-plans-decision> [↑](#footnote-ref-4)
5. We have corrected for a minor rounding error in the original NAW; which shows 16.3968kms of removal. The correct figure is 16.4kms. [↑](#footnote-ref-5)
6. Earthwire fittings and earthwire conductor are not reportable Health or RRP Asset Register categories; however they are used in Northern Powergrid’s internal asset management processes and we do have HIs against these additional sub components of the tower line. [↑](#footnote-ref-6)