



# **NGGT Network Asset Risk Metric (NARM) Methodology**

Long Term Risk & Network Risk Outputs Supporting  
Document

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nationalgrid

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# 1. Introduction

The purpose of this document is to describe how we have used the asset-level monetised risk valuations calculated using the Probability of Failure (PoF), Consequence of Failure (CoF) and Service Risk Framework (SRF) to set our Network Risk Output (NRO) targets. The same approach will be used to report the value delivered by investments and support cost benefit analyses (CBA) undertaken in support of plan justification for RIIO-2 close-out.

Network Asset Risk Metrics (NARM) are defined by Ofgem as: “*The Monetised Risk associated with a NARM asset or the Monetised Risk Benefit associated with a NARM Asset intervention*”. The definition of NARM and non-NARM assets is described in Section 3.

Furthermore a NRO is defined by Ofgem as: “*The risk benefit delivered or expected to be delivered by an asset intervention, and: is the difference between without intervention and with intervention Monetised Risk; can be measured over one year or over a longer period of time; and includes both direct (i.e. on the asset itself) and indirect (i.e. on adjacent assets or on the wider system) risk benefit*”.

Long-term Monetised Risk is defined by Ofgem as: “*the Monetised Risk measured over a defined period of time greater than one year from a given start date and equal to the cumulative Single-year Monetised Risk values over the defined period.*”

For the purposes of this document we use the concept of Long Term Monetised Risk Benefit (LTRB) to cover both NARM and NRO benefits. LTRB is defined and discussed in Section 4.

We also discuss how LTRB and intervention costs are used to define a further metric, the Unit Cost of (Long Term) Risk Benefit (UCR), which is used by Ofgem to assess the efficiency of the Baseline NRO (BNRO, which is the cumulative total of NROs for all items allocated to NARM assets) target which is defined in the RIIO-2 License (Special Conditions 3.1 and 9.2).

# 2. Overview

The document will follow the high level process, shown in **Error! Reference source not found.**, which describes how LTRB is calculated from individual asset level monetised risk values and the assumed life of an intervention<sup>1</sup>.

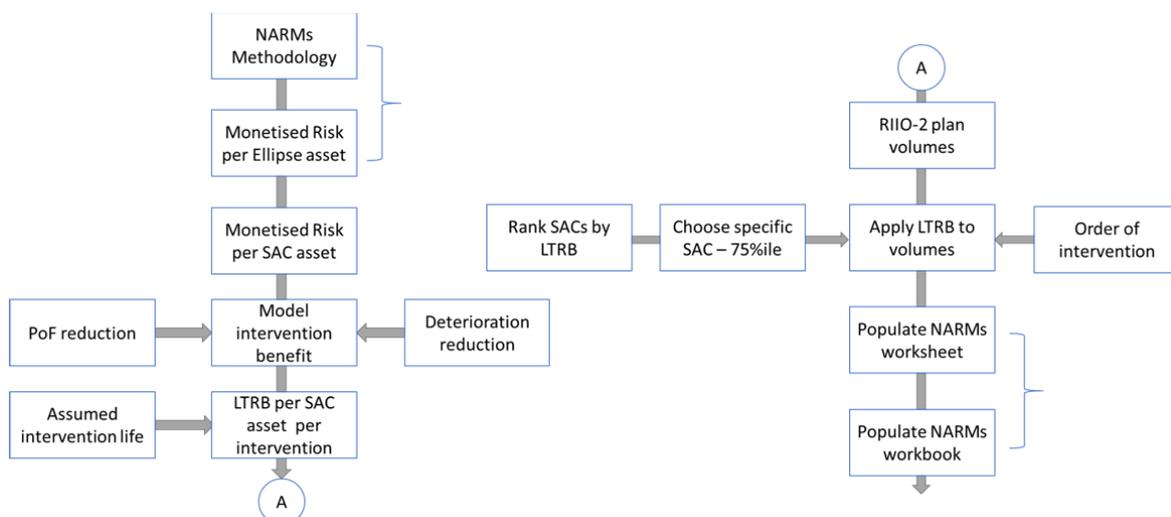


Figure 1 LTRB calculation high level process

<sup>1</sup> The elapsed time between an intervention and any subsequent intervention of the same type (e.g. time between major refurbishments)

### 3. NARMs Methodology & Monetised Risk

This section defines the scope of assets covered under the NARM mechanism and why specific asset types are excluded. At present, we are still using the concept of Secondary Asset Class (SAC) assets, as used during RIIO-1. This is to ensure constancy between:

- RIIO-1 monetised risk (NOMs) target rebasing
- RIIO-1 monetised risk outputs reporting and RIIO-1 close-out
- Cost benefit analyses presented with the RIIO-1 business plan
- Setting of BNRO targets for RIIO-2

In the future, NGGT are migrating to an ISO14224 standard asset definition (the Equipment Unit taxonomy), which will require a restatement of BNRO targets (see Section 0).

#### 3.1. NARM Assets

Through the restatement of the RIIO-1 Network Output Measures targets based on monetised risk, we agreed with Ofgem to include 37 of the 47 SAC asset types in the NARM category. These are predominantly assets that have condition/age driven failure modes, such as corrosion or wear. Assets whose primary purpose is the protection of a gas-carrying asset (e.g. civils assets; marker posts) are excluded. The 37 SAC asset types in scope for NARM are listed in Appendix A.

Of these, interventions of ten asset types are not included in our current BNRO and are either subject to a Non-Lead Asset Health Price Control Deliverable (PCD), or have been determined to be immaterial. Some of the 37 SACs are funded through a Cyber Security PCD for which interventions and associated NRO have been excluded from the NARM mechanism for RIIO-2 but could be included in the future. Some specific investment types have been allocated volume-based and Non Lead Asset Health PCD are not in the NARM mechanism for RIIO-2.

#### 3.2. Non-NARM Assets

These assets are excluded from the NARM mechanism as they do not have easily measurable, or have non-existent, relationships between condition and/or age and the likelihood of failure. Examples include, security fencing or pipe supports, where the relationship between a poor quality asset and a measurable service risk consequence is highly uncertain.

This category also includes assets which provide a “binary” benefit, for example marker posts or impact protection, where if the asset exists it generally provides the desired protection regardless of condition or age.

Electrical assets are currently included in the NARM mechanism, although their primary failure mode is obsolescence rather than condition or age. The deterioration curves assigned to electrical assets are calibrated to include assumed obsolescence risk.

Certain assets and interventions may also be excluded from the BNRO if they have specific volume or other outputs targets (defined as Non Lead assets).

The 10 asset types not in scope for NARMs are also listed in Appendix A.

### 4. Long Term Monetised Risk Benefit (LTRB)

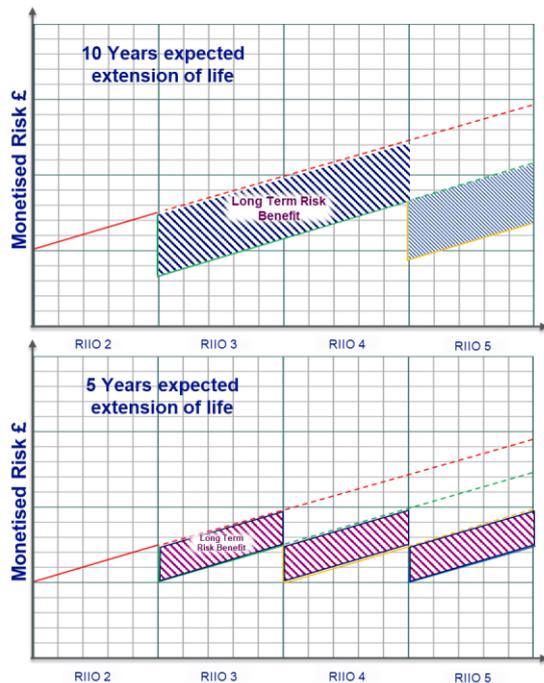
This section describes the approach NGGT has taken to estimate LTRB for asset health interventions. How assets are defined and grouped to enable interventions to be specified is discussed in Section 5.

## 4.1. Definition of LTRB

LTRB is defined as the **cumulative** monetised risk benefit over the life of an intervention, where an intervention is an activity which replaces an existing asset or extends the life of an existing asset.

Figure 2 illustrates the concept.

Please note, all charts show deterioration as linear. In reality, they are Weibull curves.



**Figure 2 Long term monetised risk benefit visualisation for 10- and 5-year interventions**

The upper chart illustrates the benefit of an intervention delivering a 10 year extension in asset life:

- The red line shows the deterioration in monetised risk (£), without intervention
- An intervention is carried out in the RIIO-2 period (benefits accrue from the end of RIIO-2)
- This intervention immediately delivers a reduction in the probability, or consequence, of failure (50% in this case) which reduces the monetised risk
- The intervened-upon asset then deteriorates (generally at a slower rate) on the blue line
- After 10 years it is assumed to be necessary to repeat the same intervention (in RIIO-4 in this example)
- The LTRB (£) is the cumulative difference between the with and without intervention monetised risk profiles, represented by the hashed area in Figure 2.

The lower chart shows the LTRB for a 5 year intervention. An intervention will be required in each RIIO period, the intervention delivers a reduced initial probability of failure reduction and the LTRB accrues over only 5 years. The difference between the LTRB for the 5 and 10- year intervention is the additional benefit delivered by (say) a major over a minor refurbishment. The LTRB does not take account the cost differences of these alternative interventions.

## 4.2. Interventions

The following interventions have been defined to calculate our LTRB:

- Replacement

- Major Refurbishment
- Minor Refurbishment
- Removal (condition driver)
- Survey

Each intervention has a specific impact on the probability of failure and/or deterioration of an asset post-intervention. These benefits are intervention and asset type specific. The currently defined intervention benefits are shown in Appendix B. Survey interventions do not deliver LTRB directly but are generally precursors to other interventions (e.g. inline inspection (ILI) survey leading to ILI dig).

As per Ofgem guidance, the LTRB benefits start to accumulate from the end of a specific regulatory period, regardless of in which specific year of the regulatory period the intervention was carried out.

## 5. Asset Groupings and Aggregation

### 5.1. Current

Monetised risk is calculated at individual equipment asset level, using data from our maintained asset register (Ellipse). The SAC asset used for RIIO-1 reporting (as retained to date for NARM to ensure consistency) is much less granular than the level we calculate monetised risk. Therefore, aggregation is required to create the SAC assets used as the basis for LTRB calculations. There is no direct correlation between a SAC asset and our asset register and assumptions, and gap filling is required. This process is documented<sup>2</sup> as part of our RIIO-1 monetised risk rebasing process and has been subject to full consultation and Ofgem approval<sup>3</sup> through the modification of RIIO-1 License Special Condition 7E.

### 5.2. Future

Our proposed ISO14224 asset taxonomy will allow us to define a standard asset as a basis for unit costing, project scoping and industry benchmarking. The interventions defined in our business plan and used for setting our BNRO targets are generally at a sub-SAC level of detail, more closely corresponding to our new Equipment Unit (EU) taxonomy.

An **Equipment Unit** is standard method of defining an asset in terms of its constituent parts (or components). A standard EU asset definition allows unit costs to be calculated consistently.

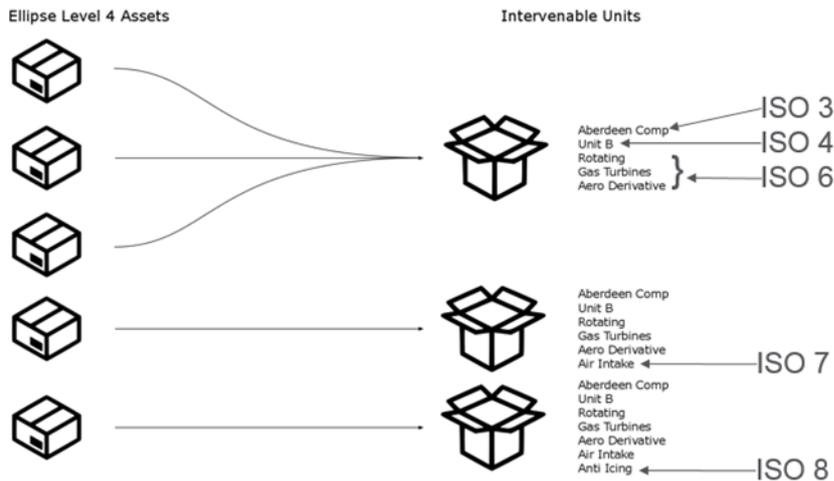
A core principle of our new RIIO-2 ways of working process is to allow investment engineers to scope out current and future investment projects using a recognisable and usable asset unit of measure, which comprises one or more Ellipse assets. We have termed this an **Intervenable Unit** (IU). An IU is a unique occurrence of an EU and relates to a physical asset (e.g. Actuator is an EU; Actuator 1234 at Aberdeen is an IU).

An IU can be formed in many ways depending on the nature of the investment. For example, an IU could be the whole site (ISO3), or intervention on a single component (ISO8). For the former example the IU could consist of many hundred Ellipse assets; for the latter only, a single Ellipse asset. An example of an Ellipse asset to IU aggregation is shown in Figure 3.

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<sup>2</sup> NGGT Rebasing Overview Report, 18<sup>th</sup> July 2019, Section 2.6

<sup>3</sup> <https://www.ofgem.gov.uk/publications-and-updates/decision-approve-rebased-network-replacement-outputs-and-modify-special-condition-7e-gas-transporter-licence-held-national-grid-gas-plc>



**Figure 3 Creation of intervenable unit asset definitions for investment planning**

All intervention volumes in our RIIO-2 BNRO target can be assumed to be IUs and the LTRB claimed through each asset improvement can be considered to relate to an IU. We have used the intervention benefits to convert between a SAC asset and IU asset unit of measure, where necessary (see Appendix B).

In the future IUs will replace SAC assets as the unit of measure for NARM analysis and reporting. The timescales for this have not yet been agreed with Ofgem.

## 6. Modelling Intervention Benefits

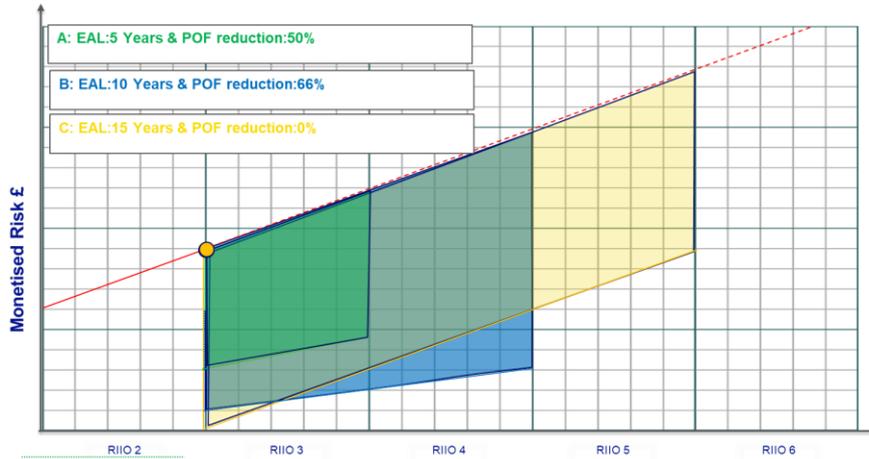
As discussed previously, the intervention benefits used to quantify LTRB assume two different (and coinciding) impacts on the intervened-upon asset:

- A reduction in the probability of failure delivered by the improved asset (one-off reduction in monetised risk)
- A change in the rate of deterioration of the improved asset (cumulative reduction in monetised risk)

A reduction in the consequence of failure would be treated in the same way as PoF reductions, but currently there are no interventions across our NARM assets that directly deliver CoF improvements.

### 6.1. Probability of Failure Changes

Figure 4 illustrates the effect of different PoF reductions on LTRB. This can be assumed to be the same asset undergoing alternative intervention types, each with a different intervention life.



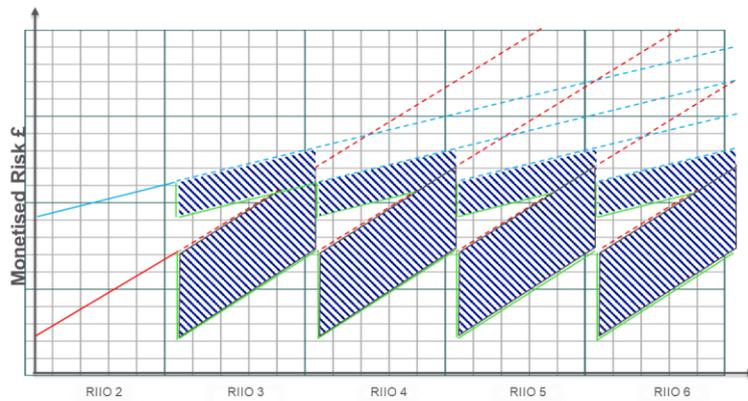
**Figure 4**

- The **yellow** intervention (corresponding to a replacement) shows a large reduction in PoF and has a 15 year intervention life. Correspondingly, the LTRB is largest for this intervention
- The **blue** intervention (corresponding to a major refurbishment) shows a smaller reduction in PoF and has a 10 year intervention life. Correspondingly, the LTRB is smaller than for a replacement.
- The **green** intervention (corresponding to a minor refurbishment) shows an even smaller reduction in PoF and has a 5 year intervention life. Correspondingly, the LTRB is smaller than for a replacement

Again, the LTRB does not consider the cost of intervention and a minor refurbishment may be the preferred economic option.

## 6.2. Asset Life Extension and Deterioration Changes

When comparing the LTRB of different assets and intervention types, the relationships can be less obvious. This is because different assets may have different initial PoF values and deterioration rates at the time of intervention. This is illustrated in Figure 5.



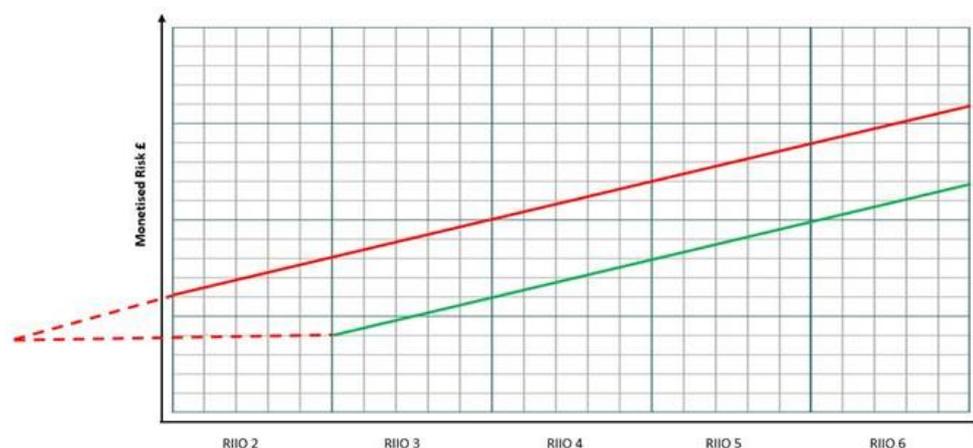
**Figure 5**

The blue and red lines represent the start PoF and deterioration rate of different assets. The blue asset has a higher likelihood of failure, but a slower deterioration rate. The red asset has a low likelihood of failure, but a faster deterioration rate. The same intervention (5 year life) applied to these different assets yields very different outcomes.

Despite the low initial PoF, the red asset delivers a greater LTRB for the same intervention because of the faster rate of deterioration. In general, interventions on assets with steeper deterioration curves

deliver more LTRB than interventions on assets with shallower deterioration curves. Again, the cost of delivering the intervention is not considered in these examples.

To estimate the change in deterioration, we define the end-date when the accumulation of monetised risk stops post-intervention (or the life of an intervention) when calculating the LTRB (see Section 7 – Intervention Long Term Risk Benefits). This is then applied as a reduction in the effective age<sup>4</sup> of the asset, which is asset and intervention dependent. This reduction in age is applied to the Weibull deterioration curves used for each elicitation group<sup>5</sup>. If this results in a negative age<sup>6</sup>, we simply assume the condition is as per a new asset (see Figure 6).



**Figure 6 Modelling new asset interventions (including negative age). Red is old asset, green is new asset. No PoF reduction or deterioration reduction shown (for clarity)**

## 7. Assessing Long Term Risk Benefits

### 7.1. Intervention Volumes & Units of Measure

The interventions used for determining the BNRO target are taken from the approved Asset Health Business Plan (Final Determination)<sup>7</sup>. For NGGT, these are currently stated using:

- Asset type (an IU)
- Secondary Asset Class (to which the IU belongs)
- Intervention type (replacement; major/minor refurbishment etc.)
- Volume of intervention (count of IUs intervened upon)
- Unit of measure per intervention (per asset; per site etc.)

At the time of agreeing funding for investment the specific site or asset to be intervened upon has not been defined. For example, the inline inspection (ILI) programme is reprioritised annually based on HSE-approved policy. The specific site and asset can only be confirmed following a site survey and prioritisation, based on assessed condition and risk.

<sup>4</sup> This is the condition-adjusted age – see Section 5.1.6 of the Probability of Failure Supporting Document

<sup>5</sup> Probability of Failure Supporting Document, Appendix D

<sup>6</sup> This is possible as our model tests the impact of intervention on all assets, not only old or poor condition

<sup>7</sup> [RIIO-2 Final Determinations NARM Annex \(REVISED\) \(ofgem.gov.uk\)](#)

Clearly, LTRB is sensitive to both the site (consequence of failure) and specific asset (probability of failure) chosen (which is not known at this stage) and so assumptions are made as to which site/asset may be intervened upon as a basis for target setting. Table 1 shows the base intervention data used to assess LTRB.

The unique identifier (UID) is a surrogate for a project name, and carries the total cost, unit cost, volume and LTRB values using for BNRO target setting and regulatory reporting.

**Table 1 Example of intervention definition for LTRB analysis**

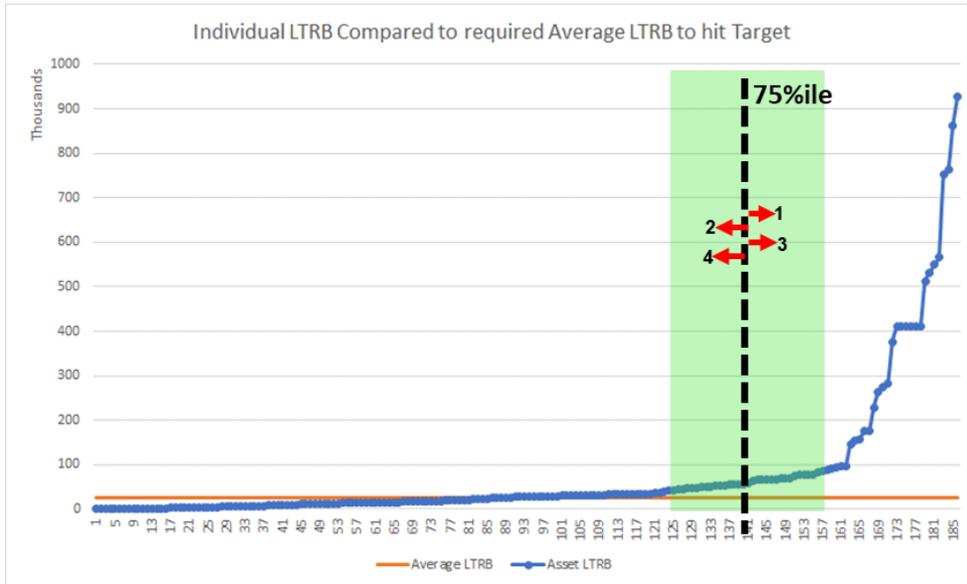
UID	Intervention Type	Unit	Option Name	Volume
A22.16.4.1	Minor Refurbishment	per Defect	Cathodic Protection (CIPS) Digs	429
A22.16.4.10	Major Refurbishment	per Asset	Cathodic Protection - AC mitigation	11
A22.16.4.12	Replacement	per Asset	Replace existing Transformer/Rectifier	58
A22.16.4.2	Minor Refurbishment	per Asset	Repair/Replace existing CP test posts	1719
A22.16.4.4	Major Refurbishment	per Defect	In Line Inspection Defect Digs	241
A22.16.4.7	Major Refurbishment	per Defect	OLI/4 Pipeline Defect Remediation	15
A22.16.4.9	Major Refurbishment	per Asset	Install new Transformer/Rectifier	24

## 7.2. Asset Selection

For below ground pipelines interventions we have modelled the LTRB associated with specific pipelines that will be intervened upon through an assumed ILI programme of work. As stated previously, this programme will change annually based on our policy of continually reassessing survey and intervention priorities based on assessed risk post ILI survey (run).

For other asset types, where the specific assets to be invested upon are not yet known awaiting completion of a condition survey, then we have assumed that we would prioritise investment based on upper quartile monetised risk. This is illustrated in Figure 7.

This shows that the assets are selected in order around the 75<sup>th</sup> percentile value for each UID intervention: the first intervention is the asset with the LTRB closest to, but higher than the 75<sup>th</sup> percentile value; the second intervention is the with the LTRB closest to, but lower than the 75<sup>th</sup> percentile value. Selection of assets continue until the volume agreed in the business plan is reached. If the maximum LTRB asset value is reached, asset selection continues in diminishing order of LTRB.



**Figure 7 Example of a profile of LTRB per asset for a single intervention type**

Each UID has a unique profile of LTRB values depending on specific asset and purpose/location (consequence of failure).

The upper quartile assumption for asset selection was chosen and agreed with Ofgem as a reasonable proxy for our asset investment decision making process and represents good value for customers.

### 7.3. Order of Intervention

Each UID in the plan is specified independently and no assumptions are made initially as to which projects, or which priority, will be assigned to each when planning investments. When the order of each UID intervention has been defined to replicate real-world business decision making as closely as possible:

The UIDs delivering the greatest reduction in age are selected first for each SAC asset category (e.g. a valve replacement intervention will be selected before an actuator replacement) If the expected intervention life is the same for multiple UID interventions on a specific asset within a single SAC category, then we assume the following sequence:

1. Minor refurbishment, followed by
2. Major refurbishment,

Where multiple interventions take place on the same asset (e.g. for a large asset such as a pipeline or compressor unit), modelling LTRB is complex. We currently assume that the LTRB of the first intervention includes the benefits of subsequent interventions and only count the LTRB of the first intervention to avoid double-counting. This results in a minor under-reporting of LTRB where multiple interventions take place on the same SAC asset. As the first intervention delivers most of the risk benefit this has a minor impact on the overall BNRO. This will be addressed as we migrate towards project-level (as opposed to UID-level) investment and outputs analysis.

### 7.4. Intervention Benefits

#### 7.4.1. Probability of Failure Reduction

An intervention will deliver a one-off reduction in the probability of failure (short-term benefit) and a long-term reduction in deterioration (long-term benefit). We have a limited time series of defect data to measure the PoF reduction following intervention, so we have assumed values in line with the RIIO-1

rebasing and RIIO-2 business plan CBA submission. Applied PoF reduction assumptions are shown in Table 2.

**Table 2 One-off probability of failure reductions following intervention**

<b>Intervention</b>	<b>Probability of Failure Reduction</b>
Replacement	90%
Major Refurbishment	50%
Minor Refurbishment	10%
Removal	100%
Survey	0%

These PoF reduction values are applied consistently to both the BNRO targets and outputs reporting and because of this any absolute errors will largely cancel out. As such they should be viewed as relative differences in the benefits delivered by alternative intervention types.

#### 7.4.2. Reduction in Deterioration and Life of an Intervention

The key assumption made when calculating LTRB for a specific asset and intervention is the time the intervention will persist until a follow-on intervention is needed. For the NARM metric, the type of follow-on intervention (i.e. a major refurbishment last 20 years, followed up by an asset replacement) is not relevant.

The reduction in effective age delivered by an investment (which modifies the deterioration curve) and the life of an intervention are assumed to be equivalent

An investment delivering a (say) 10 year reduction in asset life will have a new Weibull deterioration curves calculated, using the new effective age but retaining the same Weibull shape and scale coefficients that apply to the defined elicitation group<sup>8</sup>. This will result in a lower rate of deterioration, and the LTRB is the cumulative difference between the with- and without- intervention deterioration curves over the assumed life of the applied intervention (following the application of the one-off PoF reduction, as illustrated in Figure 4).

The life of an intervention has been determined using a combination of data sources and assumptions:

- The life of an asset (or life of replacement intervention) is taken from the deterioration curves applied to the initial probability of failure (Repairable Failure versus Age Model). These curves allow the point at which the PoF is equal to unity to be estimated, which we assume to be the end of life
- For major and minor refurbishments interventions, an intervention life is then estimated through consultation with SMEs using the asset life as a benchmark
- A minimum intervention life of 5 years is assumed (usually applied to minor refurbishments)
- All survey interventions deliver a zero reduction in deterioration (and no LTRB)

Currently assumed intervention lives are listed in Appendix B. Any material changes to these assumptions will require statement of BNRO targets and can be assumed to be constant.

<sup>8</sup> See Probability of Failure Supporting Document, Section 5.1.4 and Appendix D

### 7.4.3. Below Ground Pipelines

For below ground pipelines a different approach was followed, due to the sensitivity of LTRB to the assumed life of the intervention.

Below Ground Pipework and Coating contributes a high proportion (31%) of long-term NTS risk, but is currently reported as a single NARMS category

A possible enhancement would be to disaggregate the below ground pipelines into smaller sub-units for future risk and outputs reporting, such as by:

- Feeder, or
- Operational Area

Cathodic Protection (CP) intervention benefits are calculated using their modelled benefit on the pipeline the CP system protects (i.e. CP investment benefits is are modelled on the below ground pipeline rather than the CP system itself). This benefit is difficult to disaggregate from pipeline risk (as corrosion and CP protection are highly correlated) and is assumed to be a delta relative to a pipeline with good CP protection.

The expected intervention life of an ILI dig (to resolve corrosion defects) and CIPs dig (to resolve CP integrity issues) has been assumed to be 25 years. These resolve a corrosion defect and cathodic protection integrity issue respectively and involve major excavation works to expose the pipeline. 25 years was selected through sensitivity testing of a range of expected asset lives (Figure 8).

Modelling of the interaction between CP protection and the rate of pipeline corrosion growth shows an acceleration of corrosion deterioration due to the break down, and rapid deterioration of the protecting CP system. This causes LTRB to increase rapidly after 30 years. The actual intervention life of an ILI/CIPs dig will vary considerably depending on individual pipeline risk assessments (using Intervals2) and 25 years is proposed as a sensible compromise. This value is taken from the point of the sensitivity analysis just before LTRB begins to rise rapidly (Figure 8).

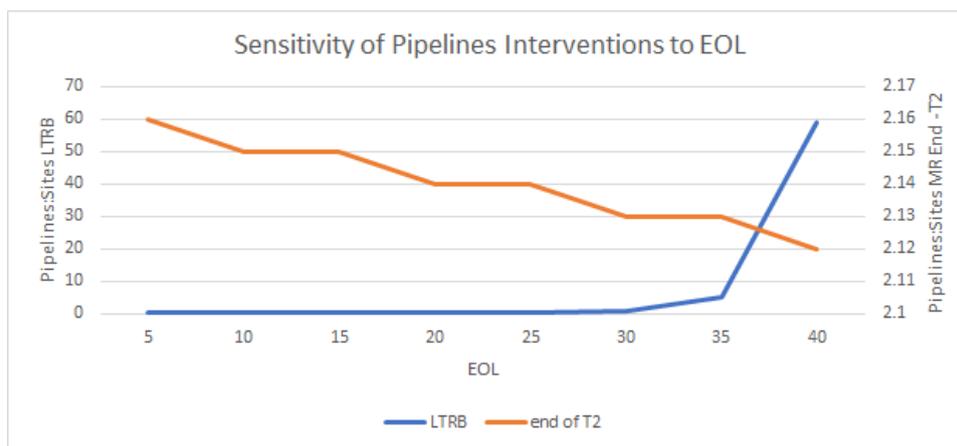


Figure 8 Sensitivity of applied EAL assumption on LTRB (blue) and end of RIO-2 monetised risk (orange)

### 7.5. Accounting for Future Uncertainty (Discounting of LTRB)

As per the Ofgem requirement, we discount all LTRB values using the same discount rate used for financial discounting in cost benefit analysis (3.5% in RIO-2). This is to effectively de-weight the LTRB in future years, based on the assumption that the magnitude of benefits delivery in future years is less certain. We have proposed to Ofgem that an improved process would be to define a range of LTRB outcomes per intervention (using a Monte Carlo analysis, or other method) based on the confidence in the input data feeding the LTRB analysis, including the fact that the rate of asset deterioration becomes less certain in future years.

## 8. BNRO Target Setting & Regulatory Reporting

In March 2021 Ofgem have consulted on their proposed NARM Handbook and NARM Workbooks<sup>9</sup> which detail the data requirements for BNRO reporting and RIIO-2 close-out and defines the targets for each network. These documents should be referenced to understand how the LTRB and UCR metrics calculated are to be used within the RIIO-2 NARM Funding Adjustment and Penalty mechanism. The reporting requirements for annual regulatory reporting pack (RRP) is still to be confirmed through RIGs. This section summarises how the data is presented to Ofgem to allow the NARM Funding Adjustment and Penalty mechanism to be applied and managed.

### 8.1. Long Term Risk Benefit

Using the process defined above, a LTRB value is calculated for every UID intervention approved through the RIIO-2 final determination. An example is shown in Table 3 for the Pipelines theme. Further details, including changes agreed during RIIO-2, can be found in the GT NARMs Workbook.

**Table 3 Example showing LTRB definition for selected Pipelines investments**

UID	Intervention Type	Unit of Measure	Option Name	Funded Volumes	LTRB Target £000m
A22.16.4.1	Minor Refurbishment	per Defect	Cathodic Protection (CIPS) Digs	429	7,039
A22.16.4.10	Major Refurbishment	per Asset	Cathodic Protection - AC mitigation	11	128
A22.16.4.12	Replacement	per Asset	Replace existing Transformer/Rectifier	58	756
A22.16.4.2	Minor Refurbishment	per Asset	Repair/Replace existing CP test posts	1719	31,366
A22.16.4.4	Major Refurbishment	per Defect	In Line Inspection Defect Digs	241	52,468
A22.16.4.7	Major Refurbishment	per Defect	OLI/4 Pipeline Defect Remediation	15	295
A22.16.4.9	Major Refurbishment	per Asset	Install new Transformer/Rectifier	24	272

### 8.2. Unit Cost of Risk Benefit

The UCR is calculated simply for each UID intervention by dividing the total intervention cost (not the unit cost) by the approved expenditure for that UID, adjusted for agreed efficiencies and RPE. As stated previously the UCR is a dimensionless metric that equates to the spend to deliver a unit reduction in LTRB. An example is shown in Table 4 for the Pipelines theme. Further details, including changes agreed during RIIO-2, can be found in the GT NARM Workbook.

**Table 4 Example showing the unit cost of monetised risk benefit for selected Pipelines investments**

UID	Option Name	Approved Funding	LTRB Target £000m	UCR
A22.16.4.1	Cathodic Protection (CIPS) Digs	62,427	7,039	8.87
A22.16.4.10	Cathodic Protection - AC mitigation	1,028	128	8.01
A22.16.4.12	Replace existing Transformer/Rectifier	563	756	0.74

<sup>9</sup> <https://www.ofgem.gov.uk/publications-and-updates/consultation-issuing-network-asset-risk-workbooks-and-network-asset-risk-metric-handbook>

UID	Option Name	Approved Funding	LTRB Target £000m	UCR
A22.16.4.2	Repair/Replace existing CP test posts	1,622	31,366	0.05
A22.16.4.4	In Line Inspection Defect Digs	35,320	52,468	0.67
A22.16.4.7	OLI/4 Pipeline Defect Remediation	2,292	295	7.78
A22.16.4.9	Install new Transformer/Rectifier	3,468	272	12.77

Ofgem have used the UCR per UID intervention to band different investments into separate risk sub-categories (High, Medium and Low). The NARM Funding Adjustment and Penalty mechanism will be applied independently to the separate risk sub-categories. The UCR has not been normalised (by dividing through by the intervention volume) prior to banding, which may over- or under-estimate the weighting of specific UIDs within the mechanism (especially those UIDs with high or low volumes).

## 9. Validation

Long-term risk benefit is a new metric and there is no historic data to validate the LTRB values per asset or UID intervention. However, the basis of LTRB is the monetised risk valuation and asset deterioration process, discussed extensively in the Probability of Failure, Consequence of Failure and Service Risk Framework supporting documents, which form part of the GT NARMs Methodology document suite. The limited validation we were able to carry out is summarised in Table 5.

**Table 5 Validation undertaken on LTRB calculations**

Validation Activity	Outcome
Initial development of SAC asset monetised risk values, with and without intervention	These are the same values used for the RIIO-1 rebasing exercise, which was tested by Ofgem through a series of “equally challenging” tests
Asset deterioration	These are the same Weibull curves used for RIIO-1 monetised risk and rebasing. A spreadsheet model was developed to ensure the same values were obtained as using our asset risk modelling decision support tools
Long-term risk benefits	The life of an intervention per asset type is as defined in Appendix B. A spreadsheet model was developed to compare with our risk modelling numbers to ensure the same LTRB values were produced
Upper quartile and order of intervention assumptions	Sensitivity tests were carried out to ensure the selection of the 75%ile and intervention sequence assumptions were not generating outlier levels of LTRB performance based on our assumed asset targeting strategy
Below ground pipelines expected intervention life	The above sensitivity analysis allowed us to set an expected intervention life for below ground pipeline interventions that did not result in excessive LTRB
Relative benefits of investments	A sensitivity test was carried out on all UID investments using assumed cost, volume and risk targeting efficiency values. This was sense checked to ensure the expected investments were delivering high/low LTRB

## Document Control

Version	Date of Issue	Notes
1.0	17 <sup>th</sup> May 2021	Draft NARMs Methodology version ready for public consultation updated following RIIO-2 business plan submission

## Appendix A

### 9.1.1. NARM risk categories by Secondary Asset Class

The scope of NARM is constrained to 37 of the RIIO-1 47 Secondary Asset Classes (SACs). Some UID interventions within the ten SACs marked in *italics* are in the A3<sup>10</sup> category (non-NARM) as they have been allocated separate (volume-based) Non Lead Asset Health PCD targets (e.g. Site Lighting). This is documented in the GT NARM Workbook.

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#### **A1 – Asset Health, Risk-tradable**

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14 - COMPRESSOR

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15 - CATHODIC PROTECTION

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18 - FILTER / SCRUBBERS

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21 - FLOW OR PRESSURE REGULATORS

---

23 - GAS GENERATOR

---

31 - PIG TRAP

---

32 - ABOVE GROUND PIPE COATING

---

33 - BELOW GROUND PIPE COATING

---

34 - POWER TURBINE

---

35 - PREHEATERS

---

42 - ELECTRICAL VARIABLE SPEED DRIVE

---

43 - LOCALLY ACTUATED VALVES

---

44 - NON RETURN VALVES

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45 - REMOTE ISOLATION VALVES

---

46 - PROCESS VALVES

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47 - SLAMSHUT SYSTEM

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*01 - CLADDING*

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<sup>10</sup> The different NARM funding categories (A1/A2/A3/B) are detailed in the NARM Annex of the Final Determinations [https://www.ofgem.gov.uk/system/files/docs/2021/02/final\\_determinations\\_narm\\_annex\\_revised.pdf](https://www.ofgem.gov.uk/system/files/docs/2021/02/final_determinations_narm_annex_revised.pdf)

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03 - AIR INTAKE

---

04 - EXHAUSTS

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06 - CAB VENTILATION

---

13 - FUEL TANKS & BUNDS

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16 - ELECTRICAL (INCLUDING STANDBY GENERATORS)

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17 - ELECTRICAL (SAFE SHUTDOWN)

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20 - FIRE SUPPRESSION

---

40 - STARTER MOTOR

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41 - VENT SYSTEM

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There are interventions covering ten SACs relating to Cyber Security, Control Systems, Gas Quality, Metering and Telemetry which are subject to different PCDs. These are in the A2 category and not funded through Asset Health or subject to the NARM mechanism for RIIO-2 (ring-fenced, non-asset health expenditure).

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**A2 – Non Asset Health, Non Lead PCD**

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05 - BOUNDARY CONTROLLERS

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19 - FIRE AND GAS DETECTION

---

22 - GAS ANALYSER

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27 - FISCAL METERING

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28 - FUEL GAS METERING

---

29 - NETWORK CONTROL AND INSTRUMENTATION

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30 - ODORISATION PLANT

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36 - STATION PROCESS CONTROL SYSTEM

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37 - UNIT CONTROL SYSTEM

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38 - ANTI-SURGE SYSTEM

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The remaining 11 SACs are excluded from NARM analysis and specific UIDs may or may not have separate Non Lead PCDs.

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**B – Asset Health, not Risk-tradable**

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02 - AFTER COOLERS

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07 - CIVIL ASSETS (DRAINAGE)

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08 - CIVIL ASSETS (ACCESS)

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09 - CIVIL ASSETS (BUILDINGS/ENCLOSURES)

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10 - CIVIL ASSETS (DUCTING)

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11 - CIVIL ASSETS (BRIDGES)

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12 - CIVIL ASSETS (PIPE SUPPORTS)

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24 - IMPACT PROTECTION

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25 - RIVER CROSSINGS

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26 - MARKERS

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39 – SECURITY

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## Appendix B

### 9.1.2. Probability of Failure Reduction and Intervention Life

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.03.1.1	Replacement of Failed IJson AGIs	Replacement	Above Ground Pipe and Coating	50%	40
A22.03.1.2	CP Investigations & Rectification	Major Refurbishment	Cathodic Protection	50%	10
A22.03.2.1	Minor remediation works	Minor Refurbishment	Civil assets - access	0%	45
A22.03.2.10	Minor remediation works	Minor Refurbishment	Civil assets - ducting	0%	40
A22.03.2.11	Monitoring of Structural Integrity Assets	Survey	Civil assets - ducting	0%	20
A22.03.2.12	Major remediation works	Major Refurbishment	Civil assets - ducting	0%	40
A22.03.2.13	Minor remediation works	Minor Refurbishment	Civil assets - pipe supports and pits	0%	45
A22.03.2.15	Monitoring of Structural Integrity Assets	Survey	Civil assets - pipe supports and pits	0%	45
A22.03.2.17	Major remediation works	Major Refurbishment	Civil assets - pipe supports and pits	10%	45
A22.03.2.18	Minor remediation works	Minor Refurbishment	Fuel tanks & bunds	0%	40
A22.03.2.19	Monitoring of Structural Integrity Assets	Survey	Fuel tanks & bunds	0%	40
A22.03.2.2	Monitoring of Structural Integrity Assets	Survey	Civil assets - access	0%	45
A22.03.2.20	Relifing or Replacement of Tank Bunds	Replacement	Fuel tanks & bunds	90%	40
A22.03.2.3	Major remediation works	Major Refurbishment	Civil assets - access	10%	45
A22.03.2.4	Minor remediation works	Minor Refurbishment	Civil assets - buildings/ enclosures	0%	30
A22.03.2.5	Monitoring of Structural Integrity Assets	Survey	Civil assets - buildings/ enclosures	0%	30
A22.03.2.6	Major remediation works	Major Refurbishment	Civil assets - buildings/ enclosures	10%	30
A22.03.2.7	Minor remediation works	Minor Refurbishment	Civil assets - drainage	0%	45
A22.03.2.8	Monitoring of Structural Integrity Assets	Survey	Civil assets - drainage	0%	45
A22.03.2.9	Major remediation works	Major Refurbishment	Civil assets - drainage	10%	45
A22.03.3.1	AGI Pipework Painting (Full, Partial or Patch)	Major Refurbishment	Above Ground Pipe and Coating	25%	15
A22.03.3.2	Filters PSSR Inspection & Major Overhauls	Major Refurbishment	Filters and Scrubbers (incl. Condensate Tanks)	50%	12

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.03.3.3	Fire water ringmain replacement	Replacement	Fire suppression	90%	30
A22.03.3.4	Preheater PSSR Revalidation, WBH Inspection & Major Refurbs	Major Refurbishment	Preheaters	50%	10
A22.08.1.1	Air Intake Major Refurb	Major Refurbishment	Air Intake	50%	15
A22.08.1.10	Exhaust Minor Refurb	Minor Refurbishment	Exhausts	10%	5
A22.08.1.11	Exhaust Replacement	Replacement	Exhausts	90%	25
A22.08.1.12	Cab Structure Major Refurbishment	Major Refurbishment	Civil assets - buildings/ enclosures	50%	10
A22.08.1.2	Air Intake Minor Refurb	Minor Refurbishment	Air Intake	10%	10
A22.08.1.3	Air Intake Replacement	Replacement	Air Intake	90%	25
A22.08.1.4	Cab Ventilation Major Refurb	Major Refurbishment	Cab Ventilation	50%	10
A22.08.1.5	Cab Ventilation Minor Refurb	Minor Refurbishment	Cab Ventilation	10%	5
A22.08.1.6	Cab Ventilation Replacement	Replacement	Cab Ventilation	90%	25
A22.08.1.7	Cab Structure Minor Refurb	Minor Refurbishment	Civil assets - buildings/ enclosures	10%	5
A22.08.1.8	Cab Structure Replacement	Replacement	Civil assets - buildings/ enclosures	90%	25
A22.08.1.9	Exhaust Major Refurb	Major Refurbishment	Exhausts	50%	10
A22.08.2.1	Fire Suppression Major Refurb	Major Refurbishment	Fire suppression	50%	10
A22.08.2.2	Fire Suppression Minor Refurb	Minor Refurbishment	Fire suppression	10%	5
A22.08.2.3	Fire Suppression Replacement of Electric Water Pump System	Replacement	Fire suppression	90%	25
A22.08.2.4	Fire Suppression Replacement of Nitrogen Bottle System (MAU)	Replacement	Fire suppression	90%	25
A22.10.1.1	Compressor Bearing & Coupling Major Refurb	Major Refurbishment	Compressor	50%	10
A22.10.1.3	Compressor Wet / Dry Seal Major Refurb	Major Refurbishment	Compressor	50%	10
A22.10.1.4	GG/PT/Compressor Oil System Major Refurb	Major Refurbishment	Compressor	50%	10
A22.10.1.5	Impeller Major Refurb	Major Refurbishment	Compressor	50%	30
A22.10.1.6	Instrument Air / N2 System Major Refurb	Major Refurbishment	Compressor	50%	10

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.10.1.7	Instrument Air / N2 System Replacement	Replacement	Compressor	90%	10
A22.10.2.1	Avon / RB211 Fuel Gas Conditioning Skid Installation	Minor Refurbishment	Gas Generator	10%	10
A22.10.2.11	Power Turbine Overhauls - Dresser Vectra	Major Refurbishment	Power Turbine	50%	25
A22.10.2.12	Power Turbine Overhauls - GE HSPT	Major Refurbishment	Power Turbine	50%	25
A22.10.2.13	Power Turbine Overhauls - GEC EAS1 / ERB1	Major Refurbishment	Power Turbine	50%	25
A22.10.2.14	Power Turbine Overhauls - Rolls-Royce RT48 / RT56	Major Refurbishment	Power Turbine	50%	25
A22.10.2.15	Power Turbine Overhauls - Siemens SGT400	Major Refurbishment	Power Turbine	50%	25
A22.10.2.2	Compressor Train Breakdown Budget (inc St Fergus)	Minor Refurbishment	Gas Generator	0%	0
A22.10.2.3	Gas Generator Overhauls - GE LM2500s	Major Refurbishment	Gas Generator	50%	25
A22.10.2.4	Gas Generator Overhauls - Rolls-Royce Avons	Major Refurbishment	Gas Generator	50%	25
A22.10.2.5	Gas Generator Overhauls - Rolls-Royce RB211s	Major Refurbishment	Gas Generator	50%	25
A22.10.2.6	Gas Generator Overhauls - Siemens SGT400s	Major Refurbishment	Gas Generator	50%	25
A22.10.2.8	Solar Titan Overhaul - GT & PT	Major Refurbishment	Gas Generator	50%	25
A22.10.3.10	Electric Drives - Harmonic Filter - Replacement	Replacement	Electrical Variable Speed Drive	90%	35
A22.10.3.11	Electric Drives - HV Motor & Exciter - Major Refurb	Major Refurbishment	Electrical Variable Speed Drive	50%	35
A22.10.3.12	Electric Drives - HV Motor & Exciter - Minor Refurb	Minor Refurbishment	Electrical Variable Speed Drive	10%	35
A22.10.3.14	Mopico Motor Compressor Replacement	Major Refurbishment	Electrical Variable Speed Drive	50%	15
A22.10.3.2	Electric Drives - Auxiliary Systems - Minor Refurb	Minor Refurbishment	Electrical Variable Speed Drive	10%	35
A22.10.3.3	Electric Drives - Converter Transformer - Major Refurb	Major Refurbishment	Electrical Variable Speed Drive	50%	35

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.10.3.4	Electric Drives - Converter Transformer - Minor Refurb	Minor Refurbishment	Electrical Variable Speed Drive	10%	35
A22.10.3.5	Electric Drives - Converter Transformer - Replacement	Replacement	Electrical Variable Speed Drive	90%	35
A22.10.3.6	Electric Drives - Frequency Converter - Major Refurb	Major Refurbishment	Electrical Variable Speed Drive	50%	35
A22.10.3.7	Electric Drives - Frequency Converter - Minor Refurb	Minor Refurbishment	Electrical Variable Speed Drive	10%	35
A22.10.3.8	Electric Drives - Frequency Converter - Replacement	Replacement	Electrical Variable Speed Drive	90%	35
A22.10.3.9	Electric Drives - Harmonic Filter - Minor Refurb	Minor Refurbishment	Electrical Variable Speed Drive	10%	35
A22.10.4.3	Modulating Vent Valve Overhaul	Major Refurbishment	Vent System	50%	30
A22.10.4.4	N2 Snuffing & Molecular Seal Major Refurb	Major Refurbishment	Vent System	50%	15
A22.10.4.6	Vent System Pipework Corrosion / P11 Major Refurb	Major Refurbishment	Vent System	50%	15
A22.10.4.7	Vent System Pipework Minor Refurb	Minor Refurbishment	Vent System	10%	5
A22.12.1.1	AGI Pipework Painting (Full, Partial or Patch)	Major Refurbishment	Above Ground Pipe and Coating	25%	15
A22.12.1.2	CM/4 Corrosion Defects Resolution	Major Refurbishment	Above Ground Pipe and Coating	50%	20
A22.12.1.3	Replace Cladding on on AGIs	Minor Refurbishment	Cladding	90%	15
A22.12.1.4	Replacement of Failed IJ on AGIs	Replacement	Above Ground Pipe and Coating	50%	40
A22.12.1.5	Resolve Existing AGI CP Priority 1 Defects	Major Refurbishment	Cathodic Protection	50%	10
A22.12.1.6	Resolve Existing AGI CP Priority 2 Defects	Minor Refurbishment	Cathodic Protection	10%	10
A22.12.2.1	Filters PSSR Inspection & Major Overhauls	Major Refurbishment	Filters and Scrubbers (incl. Condensate Tanks)	50%	10
A22.12.2.2	Replace Strainers with Filters/Separators	Replacement	Filters and Scrubbers (incl. Condensate Tanks)	90%	25
A22.12.2.3	Scrubber & Condensate Tank Internal Inspections & Estimated Major Refurbs	Major Refurbishment	Filters and Scrubbers (incl. Condensate Tanks)	50%	10
A22.12.2.4	Preheater AGI Boiler Replacement	Replacement	Preheaters	90%	20

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.12.2.5	Preheater Minor Refurb	Minor Refurbishment	Preheaters	10%	5
A22.12.2.6	Preheater PSSR Revalidation, WBH Inspection & Major Refurbs	Major Refurbishment	Preheaters	50%	10
A22.12.2.7	Preheater Upgrade - Compressor Fuel Gas @ Wooler	Replacement	Preheaters	90%	15
A22.12.3.1	Pressure Reduction - Flow Control Valve Upgrade	Replacement	Flow or pressure regulators	90%	10
A22.12.3.2	Pressure Reduction Offtakes - Regulator Replacement	Replacement	Flow or pressure regulators	90%	40
A22.12.3.3	Pressure Reduction Skid Replacement - Compressor Stations	Replacement	Flow or pressure regulators	90%	10
A22.12.3.4	Pressure Reduction Streams - Major Overhauls	Major Refurbishment	Flow or pressure regulators	50%	10
A22.12.3.5	Pressure Reduction - Flow Control Valve Upgrade	Replacement	Slamshut Valve	90%	40
A22.12.3.6	Pressure Reduction Offtakes - Regulator Replacement	Replacement	Slamshut Valve	90%	40
A22.12.3.7	Pressure Reduction Skid Replacement - Compressor Stations	Replacement	Slamshut Valve	90%	10
A22.12.3.8	Pressure Reduction Streams - Minor Overhauls	Minor Refurbishment	Slamshut Valve	10%	5
A22.14.1.1	Locally Actuated Valve - Block Valve Replacement	Replacement	Locally actuated valves	90%	30
A22.14.1.10	NRV Major Overhaul - 36" NRV	Major Refurbishment	Non Return Valve	50%	15
A22.14.1.11	NRV Replacement - 8" NRV	Replacement	Non Return Valve	90%	15
A22.14.1.13	Process Valve Actuator Replacement	Major Refurbishment	Process valves	50%	30
A22.14.1.14	Process Valve Replacement	Replacement	Process valves	90%	40
A22.14.1.15	Process Valve Stem Seal Replacement	Replacement	Process valves	10%	15
A22.14.1.16	Process Valve Vent & Sealant Line Major Refurb	Major Refurbishment	Process valves	50%	10
A22.14.1.17	Process Valve Vent & Sealant Line Replacement	Major Refurbishment	Process valves	50%	15

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.14.1.18	Remote Isolation Valve - DSEAR Actuator Replacement	Major Refurbishment	Remote Isolation Valves	50%	30
A22.14.1.2	Locally Actuated Valve - DSEAR Actuator Replacement	Major Refurbishment	Locally actuated valves	50%	30
A22.14.1.20	Remote Isolation Valve Actuator Replacement	Major Refurbishment	Remote Isolation Valves	50%	30
A22.14.1.21	Remote Isolation Valve Removal	Removal	Remote Isolation Valves	0%	0
A22.14.1.22	Remote Isolation Valve Replacement	Replacement	Remote Isolation Valves	90%	30
A22.14.1.23	Remote Isolation Valve Stem Seal Replacement	Replacement	Remote Isolation Valves	10%	15
A22.14.1.25	Remote Isolation Valve Vent & Sealant Line Replacement	Major Refurbishment	Remote Isolation Valves	0%	15
A22.14.1.4	Locally Actuated Valve Actuator Replacement	Major Refurbishment	Locally actuated valves	50%	30
A22.14.1.5	Locally Actuated Valve Replacement	Replacement	Locally actuated valves	90%	40
A22.14.1.6	Locally Actuated Valve Stem Seal Replacement	Replacement	Locally actuated valves	10%	15
A22.14.1.7	Locally Actuated Valve Vent & Sealant Line Minor Refurbishment	Minor Refurbishment	Locally actuated valves	50%	10
A22.14.1.8	Locally Actuated Valve Vent & Sealant Line Replacement	Major Refurbishment	Locally actuated valves	50%	15
A22.14.1.9	Locally Actuated Valves - Block Valve Removal	Removal	Locally actuated valves	0%	45
A22.16.1.1	Depth of cover (defect resolution)	Minor Refurbishment	Below Ground Pipe and Coating	5%	40
A22.16.2.1	Nitrogen Sleeve Remediation - Minor	Minor Refurbishment	Below Ground Pipe and Coating	5%	20
A22.16.2.2	Nitrogen Sleeve - Grouting	Replacement	Below Ground Pipe and Coating	5%	40
A22.16.2.3	Nitrogen Sleeve Remediation - Major	Major Refurbishment	Below Ground Pipe and Coating	5%	40
A22.16.3.1	Pig Trap PSSR Defect Resolution - Minor	Minor Refurbishment	Pig Trap	10%	5
A22.16.3.2	Pig Trap PSSR Major Inspection	Major Refurbishment	Pig Trap	0%	10
A22.16.3.3	Pig Trap PSSR Defect Resolution - Major	Major Refurbishment	Pig Trap	50%	10

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.16.4.1	Cathodic Protection (CIPS) Digs	Minor Refurbishment	Below Ground Pipe and Coating	20%	25
A22.16.4.10	Cathodic Protection - AC mitigation	Major Refurbishment	Below Ground Pipe and Coating	20%	20
A22.16.4.11	Cathodic Protection - remote monitoring	Survey	Below Ground Pipe and Coating	0%	20
A22.16.4.12	Replace existing Transformer/Rectifier	Replacement	Below Ground Pipe and Coating	10%	20
A22.16.4.2	Repair/Replace existing CP test posts	Minor Refurbishment	Below Ground Pipe and Coating	1%	10
A22.16.4.4	In Line Inspection Defect Digs	Major Refurbishment	Below Ground Pipe and Coating	50%	25
A22.16.4.5	In Line Inspection (Pipeline PSSR Inspection)	Survey	Below Ground Pipe and Coating	0%	10
A22.16.4.6	OLI/4 (Pipeline PSSR Inspection)	Survey	Below Ground Pipe and Coating	0%	10
A22.16.4.7	OLI/4 Pipeline Defect Remediation	Major Refurbishment	Below Ground Pipe and Coating	50%	25
A22.16.4.8	CIPS for Capital Refurbishment	Survey	Below Ground Pipe and Coating	0%	0
A22.16.4.9	Install new Transformer/Rectifier	Major Refurbishment	Below Ground Pipe and Coating	10%	20
A22.16.5.1	Watercourse crossings (defect resolution)	Major Refurbishment	Below Ground Pipe and Coating	10%	40
A22.16.5.2	Watercourse crossings (Duddon Estuary)	Major Refurbishment	Below Ground Pipe and Coating	50%	40
A22.18.1.1	Monitoring of Structural Integrity Assets	Survey	Civil assets - ducting	0%	10
A22.18.1.10	Relifing of Pipe Supports & Pits at Compressor Sites (Concrete)	Minor Refurbishment	Civil assets - pipe supports and pits	5%	45
A22.18.1.11	Relifing of Pipe Supports & Pits at Compressor Sites (Hydro Diam ; 1 in 5 Sleeve Repair)	Major Refurbishment	Civil assets - pipe supports and pits	25%	45
A22.18.1.12	Relifing of Pipe Supports & Pits at AGIs - Replace Concrete pipe supports	Minor Refurbishment	Civil assets - pipe supports and pits	5%	45
A22.18.1.13	Relifing of Pipe supports and pits AGI sites - Inspect, Remove Frame & Cover & Backfill	Minor Refurbishment	Civil assets - pipe supports and pits	5%	45
A22.18.1.14	Relifing of Pipe supports and pits AGI sites - Remove Chamber Walls, Inspect & Backfill	Major Refurbishment	Civil assets - pipe supports and pits	25%	45
A22.18.1.2	Minor remediation works	Minor Refurbishment	Civil assets - ducting	0%	5
A22.18.1.3	Relifing of Site Ducting	Major Refurbishment	Civil assets - ducting	50%	40
A22.18.1.4	Monitoring of Structural Integrity Assets	Survey	Civil assets - pipe supports and pits	0%	10

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.18.1.5	Minor remediation works	Minor Refurbishment	Civil assets - pipe supports and pits	0%	5
A22.18.1.6	Relieving of Pipe Supports & Pits at Compressor Sites (Steel)	Minor Refurbishment	Civil assets - pipe supports and pits	5%	40
A22.18.1.7	Relieving of Pipe Supports at AGIs – Replace Steel pipe supports	Major Refurbishment	Civil assets - pipe supports and pits	25%	40
A22.18.1.8	Replacement of Pipeline Spring Hangers at Compressor Sites	Replacement	Civil assets - pipe supports and pits	5%	30
A22.18.1.9	Mitigation of Settlement	Major Refurbishment	Civil assets - pipe supports and pits	50%	40
A22.18.2.1	Monitoring of Structural Integrity Assets	Survey	Civil assets - access	0%	10
A22.18.2.10	Minor remediation works	Minor Refurbishment	Security	0%	5
A22.18.2.11	Security - Fences and Gates - AGI (Minor Works)	Minor Refurbishment	Security	10%	20
A22.18.2.12	Security - Fences and Gates - Compressor	Replacement	Security	90%	60
A22.18.2.2	Minor remediation works	Minor Refurbishment	Civil assets - access	0%	5
A22.18.2.3	G2/G3 Access Platforms & Stairs Relieving	Major Refurbishment	Civil assets - access	10%	50
A22.18.2.4	Site Access Roads and Paths Major Refurb	Major Refurbishment	Civil assets - access	50%	25
A22.18.2.5	Monitoring of Structural Integrity Assets	Survey	Civil assets - buildings/ enclosures	0%	10
A22.18.2.6	Minor remediation works	Minor Refurbishment	Civil assets - buildings/ enclosures	0%	5
A22.18.2.7	Buildings & Enclosures at AGIs Major Refurb	Major Refurbishment	Civil assets - buildings/ enclosures	50%	20
A22.18.2.8	Relieving of Buildings & Enclosures at Compressor Sites	Major Refurbishment	Civil assets - buildings/ enclosures	0%	20
A22.18.2.9	Monitoring of Structural Integrity Assets	Survey	Security	0%	10
A22.18.3.1	Monitoring of Structural Integrity Assets	Survey	Civil assets - drainage	0%	10
A22.18.3.2	Minor remediation works	Minor Refurbishment	Civil assets - drainage	0%	5
A22.18.3.3	Damaged and Broken Drainage Assets at AGIs Minor Refurb	Minor Refurbishment	Civil assets - drainage	0%	5
A22.18.3.4	Replace Obsolete Sewage Treatment Assets at Compressor Sites	Replacement	Civil assets - drainage	50%	60
A22.18.3.5	Monitoring of Structural Integrity Assets	Survey	Fuel tanks & bunds	0%	40

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.18.3.6	Minor remediation works	Minor Refurbishment	Fuel tanks & bunds	0%	5
A22.18.3.7	Relifing or Replacement of TankBunds	Replacement	Fuel tanks & bunds	90%	40
A22.20.1.1	AGIs - Distribution Systems - Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.20.1.10	HV Switchgear Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.20.1.11	HV Switchgear Replacement	Replacement	Electrical - including standby generators	6%	30
A22.20.1.12	LV Distribution Boards Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.20.1.13	LV Distribution Boards Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.20.1.14	LV Distribution Boards Replacement	Replacement	Electrical - including standby generators	6%	30
A22.20.1.15	LV Switchboards Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.20.1.16	LV Switchboards Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.20.1.17	LV Switchboards Replacement	Replacement	Electrical - including standby generators	6%	30
A22.20.1.18	Other Equipment Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.20.1.19	Other Equipment Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.20.1.2	AGI - Distribution Systems Electrical Survey/Minor refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.20.1.20	Other Equipment Replacement	Replacement	Electrical - including standby generators	6%	30
A22.20.1.21	Site Lighting - Emergency - Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.20.1.22	Site Lighting - Emergency - Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.20.1.23	Site Lighting - Emergency - Replacement	Replacement	Electrical - including standby generators	6%	30
A22.20.1.24	Site Lighting - External Columns Major Refurb	Major Refurbishment	Electrical - including standby generators	1%	20
A22.20.1.25	Site Lighting - External Columns Replacement	Replacement	Electrical - including standby generators	14%	30
A22.20.1.26	Site Lighting - Internal - Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.20.1.27	Site Lighting - Internal - Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.20.1.28	Site Lighting - Internal - Replacement	Replacement	Electrical - including standby generators	6%	30
A22.20.1.29	Site Lighting External Task Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.20.1.3	AGIs - Distribution Systems - Replacement	Replacement	Electrical - including standby generators	6%	30
A22.20.1.30	Site Lighting External Task Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.20.1.31	Site Lighting External Task Replacement	Replacement	Electrical - including standby generators	6%	30
A22.20.1.32	Standby Generator - Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.20.1.33	Standby Generator - Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.20.1.34	Standby Generator Replacement	Replacement	Electrical - including standby generators	12%	30
A22.20.1.35	Transformers Minor Refurb	Major Refurbishment	Electrical - including standby generators	1%	10
A22.20.1.36	Transformers Major Refurb	Minor Refurbishment	Electrical - including standby generators	4%	20
A22.20.1.37	Transformers Replacement	Replacement	Electrical - including standby generators	6%	30

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.20.1.38	Electrical Survey/Minor refurb	Survey	Electrical - including standby generators	0%	10
A22.20.1.4	Auxiliary Equipment Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.20.1.6	Auxiliary Equipment Replacement	Replacement	Electrical - including standby generators	6%	30
A22.20.1.7	Earthing & Lightning Protection Systems Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.20.1.8	Earthing & Lightning Protection Systems Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.20.1.9	HV Switchgear Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.20.2.1	Batteries NiCad - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.20.2.10	Pillar Rotary UPS - Major Refurb	Major Refurbishment	Electrical - safe shutdown	7%	10
A22.20.2.11	Pillar Rotary UPS - Minor Refurb	Minor Refurbishment	Electrical - safe shutdown	4%	5
A22.20.2.12	Pillar Rotary UPS - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.20.2.13	UPS - Large - Major Refurb	Major Refurbishment	Electrical - safe shutdown	5%	10
A22.20.2.14	UPS - Large - Minor Refurb	Minor Refurbishment	Electrical - safe shutdown	1%	5
A22.20.2.15	UPS - Large - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.20.2.16	UPS - Small - Major Refurb	Major Refurbishment	Electrical - safe shutdown	5%	10
A22.20.2.17	UPS - Small - Minor Refurb	Minor Refurbishment	Electrical - safe shutdown	1%	5
A22.20.2.18	UPS - Small - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.20.2.2	Batteries VRLA - Large System - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.20.2.3	Batteries VRLA - Small System - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.20.2.4	DC Charger - Large - Major Refurb	Major Refurbishment	Electrical - safe shutdown	7%	10
A22.20.2.5	DC Charger - Large - Minor Refurb	Minor Refurbishment	Electrical - safe shutdown	1%	5
A22.20.2.6	DC Charger - Large - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.20.2.7	DC Charger - Small - Major Refurb	Major Refurbishment	Electrical - safe shutdown	7%	10

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.20.2.8	DC Charger - Small - Minor Refurb	Minor Refurbishment	Electrical - safe shutdown	1%	5
A22.20.2.9	DC Charger - Small - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.22.1.1	Cab Structure Minor Refurb	Minor Refurbishment	Civil assets - buildings/ enclosures	10%	5
A22.22.1.12	Fire water ringmain replacement	Replacement	Fire suppression	90%	30
A22.22.1.9	Cab Ventilation Minor Refurb	Minor Refurbishment	Cab Ventilation	10%	5
A22.22.2.2	Access Road Monitoring & Replacement	Replacement	Civil assets - access	90%	50
A22.22.2.4	Damaged and broken drainage assets - Replacement	Replacement	Civil assets - drainage	50%	15
A22.22.2.5	Damaged ducting covers - Replacement	Replacement	Civil assets - ducting	10%	40
A22.22.2.6	Relining or Replacement of Tank Bunds	Replacement	Fuel tanks & bunds	90%	40
A22.22.2.7	ISS software, cameras and monitors - Replacement	Replacement	Security	0%	15
A22.22.2.8	Minor remediation works	Minor Refurbishment	Civil assets - buildings/ enclosures	0%	5
A22.22.3.10	Electric Drives - HV Motor & Exciter - Minor Refurb	Minor Refurbishment	Electrical Variable Speed Drive	10%	15
A22.22.3.11	Electric Drives - HV Motor & Exciter - Major Refurb	Major Refurbishment	Electrical Variable Speed Drive	50%	35
A22.22.3.12	Electric Drives - Auxiliary Systems - Minor Refurb	Minor Refurbishment	Electrical Variable Speed Drive	0%	15
A22.22.3.21	Modulating Vent Valve Overhaul	Major Refurbishment	Vent System	50%	30
A22.22.3.24	Minor remediation works	Minor Refurbishment	Vent System	0%	5
A22.22.3.5	Electric Drives - Converter Transformer - Minor Refurb	Minor Refurbishment	Electrical Variable Speed Drive	10%	15
A22.22.3.6	Electric Drives - Converter Transformer - Major Refurb	Major Refurbishment	Electrical Variable Speed Drive	50%	35
A22.22.3.7	Electric Drives - Frequency Converter - Minor Refurb	Minor Refurbishment	Electrical Variable Speed Drive	10%	15
A22.22.3.8	Electric Drives - Frequency Converter - Major Refurb	Major Refurbishment	Electrical Variable Speed Drive	50%	35

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.22.3.9	Electric Drives - Harmonic Filter - Minor Refurb	Minor Refurbishment	Electrical Variable Speed Drive	10%	15
A22.22.4.10	Transformers Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.22.4.11	Transformers Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.12	Transformers Replacement	Replacement	Electrical - including standby generators	6%	30
A22.22.4.13	HV Switchgear Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.22.4.14	HV Switchgear Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.15	LV Distribution Boards Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.22.4.16	LV Distribution Boards Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.17	LV Distribution Boards Replacement	Replacement	Electrical - including standby generators	6%	30
A22.22.4.18	LV Switchboards Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.22.4.19	LV Switchboards Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.2	Auxiliary Equipment Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.20	LV Switchboards Replacement	Replacement	Electrical - including standby generators	6%	30
A22.22.4.21	Standby Generator - Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.22	Standby Generator Replacement	Replacement	Electrical - including standby generators	12%	30
A22.22.4.23	UPS - Large - Minor Refurb	Minor Refurbishment	Electrical - safe shutdown	1%	10
A22.22.4.24	UPS - Large - Major Refurb	Major Refurbishment	Electrical - safe shutdown	5%	20

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.22.4.25	UPS - Large - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.22.4.26	DC Charger - Large - Minor Refurb	Minor Refurbishment	Electrical - safe shutdown	1%	10
A22.22.4.27	DC Charger - Large - Major Refurb	Major Refurbishment	Electrical - safe shutdown	7%	20
A22.22.4.28	DC Charger - Large - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.22.4.29	BatteriesVRLA - Large System - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.22.4.3	Auxillary Equipment Replacement	Replacement	Electrical - including standby generators	6%	30
A22.22.4.30	BatteriesNiCad - Replacement	Replacement	Electrical - safe shutdown	6%	15
A22.22.4.31	Site Lighting External TaskMinor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.22.4.32	Site Lighting External TaskMajor Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.33	Site Lighting External TaskReplacement	Replacement	Electrical - including standby generators	6%	30
A22.22.4.34	Site Lighting - External ColumnsMinor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.22.4.35	Site Lighting - External ColumnsMajor Refurbishment	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.36	Site Lighting - External Columns Replacement	Replacement	Electrical - including standby generators	6%	30
A22.22.4.37	Site Lighting - Internal - Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.22.4.38	Site Lighting - Internal - Major Refurbishment	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.39	Site Lighting - Internal - Replacement	Replacement	Electrical - including standby generators	6%	30
A22.22.4.4	AGIs - Distribution Systems - Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.22.4.40	Site Lighting - Emergency - Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.22.4.41	Site Lighting - Emergency - Major Refurbishment	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.42	Site Lighting - Emergency - Replacement	Replacement	Electrical - including standby generators	6%	30
A22.22.4.5	AGIs - Distribution Systems - Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.6	Earthing & Lightning Protection Systems Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.22.4.7	Other Equipment Minor Refurb	Minor Refurbishment	Electrical - including standby generators	1%	10
A22.22.4.8	Other Equipment Major Refurb	Major Refurbishment	Electrical - including standby generators	4%	20
A22.22.4.9	Other Equipment Replacement	Replacement	Electrical - including standby generators	6%	30
A22.22.5.1	Pipework modifications - compressor surge issues	Minor Refurbishment	Above Ground Pipe and Coating	5%	0
A22.22.5.2	Resolve CAT4 CM/4 Defect on pipework	Major Refurbishment	Above Ground Pipe and Coating	75%	20
A22.22.5.3	Pipework modifications - Minor CAPEX	Minor Refurbishment	Above Ground Pipe and Coating	5%	0
A22.22.5.4	Above Ground Pipework Patch Painting	Minor Refurbishment	Above Ground Pipe and Coating	10%	15
A22.22.5.5	Replacement of CP system at St Fergus	Replacement	Cathodic Protection	90%	10
A22.22.6.1	Locally Actuated Valve Replacement	Replacement	Locally actuated valves	90%	40
A22.22.6.10	Remote Isolation Valve Stem Seal Replacement	Replacement	Remote Isolation Valves	90%	15
A22.22.6.11	Remote Isolation Valve Vent & Sealant Line Replacement	Major Refurbishment	Remote Isolation Valves	50%	15
A22.22.6.12	Remote Isolation Valve Actuator Replacement	Major Refurbishment	Remote Isolation Valves	50%	30
A22.22.6.14	NRV Replacement - 8" NRV	Replacement	Non Return Valve	90%	15
A22.22.6.2	Locally Actuated Valve Vent & Sealant Line Replacement	Major Refurbishment	Locally actuated valves	50%	15
A22.22.6.3	Locally Actuated Valve Actuator Replacement	Major Refurbishment	Locally actuated valves	50%	30

OFGEM UID	Option Name	Intervention	Secondary Asset Class	Δ PoF	Intervention Life
A22.22.6.4	NRV Major Overhaul - 36" NRV	Major Refurbishment	Non Return Valve	50%	15
A22.22.6.5	Process Valve Replacement	Replacement	Process valves	90%	40
A22.22.6.6	Process Valve Stem Seal Replacement	Replacement	Process valves	90%	15
A22.22.6.7	Process Valve Vent & Sealant Line Replacement	Major Refurbishment	Process valves	50%	15
A22.22.6.8	Process Valve Actuator Replacement	Major Refurbishment	Process valves	50%	30
A22.22.6.9	Remote Isolation Valve Replacement	Replacement	Remote Isolation Valves	90%	40

**Note** – where the delta PoF values are not equal to the standard 90%/50%/10% values, this is where the benefit has been adjusted to account for the difference between the SAC asset and RIIO-2 plan volume unit of measure. This predominantly applies to electrical assets, where a SAC asset is the whole site. These values were estimated in discussion with asset SMEs. Electrical assets only contribute a small amount to the overall BNRO target.

Another example is Actuator Replacement, which is considered a major refurbishment of the Valve SAC asset (which includes valve body, actuator and vent & sealant lines).

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