Network Asset Management Strategy

SP Energy Networks
RIIO-T3 Business Plan

1. Index

2. Annex Requirement Mapping

2.1. The following table provides a mapping of how the required elements of the business plan requirements can be found within this annex document.

Table 1 Business Plan Requirement Mapping Table

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<tr><th>BP Guidance Paragraph</th><th>Requirement</th><th>Relevant Section in Annex</th></tr>
<tr><td rowspan="3">5.2 - 5.3</td><td>Each company should submit a Network Asset Management Strategy alongside its Business Plan submissions; setting out what they are doing to ensure best in class asset stewardship.</td><td>This document.</td></tr>
<tr><td>The strategy should set out the asset management policy and strategy to promote asset health and long-term operational resilience across its assets, including lead and non-lead assets.</td><td>Policy: section 4
Strategy: 6.1 to 6.23</td></tr>
<tr><td>This should include a summary of the company's approach to the management of NARM and non-NARM assets on its networks, considering safety, compliance and risk management.</td><td>NARM: 6.24 to 6.41
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<tr><td>5.4</td><td>Business plans should set out the company's views on asset health, criticality and replacement priorities for:
The start of the price control period (the baseline view), effectively reflecting its view on asset health, criticality and risk of assets on the network.
The end of the price control period with no intervention, effectively reflecting its view on asset degradation over the period.
The end of the price control period with proposed interventions.</td><td>6.49 to 6.55</td></tr>
<tr><td>5.6</td><td>Companies should explain their long-term risk objectives and strategy, as well as the long-term benefits delivered by their proposed interventions.</td><td>6.32 to 6.55</td></tr>
<tr><td>5.7</td><td>Monetised Risk objectives should be informed by stakeholder engagement and cost benefit analysis (CBA) and demonstrate that selected investment options both efficiently meet their stakeholder-driven objectives and efficiently deliver sufficient net benefit for existing and future consumers.</td><td>7.14 to 7.20
Section 8</td></tr>
</table>

3. Introduction

3.1. SP Transmission's strategic asset management plan has been independently accredited against the ISO55001 standard and is a mature aspect of our operations, from strategic investment planning to daily operational activities. This Network Asset Management Strategy is structured around the Institute of Asset Management's Asset Management Anatomy to provide direct line of sight of how our routine processes align to the Institute of Asset Management's approach, allowing us to produce our RIIO-T3 business plan.

3.2. The development of the transmission system during the RIIO-T3 period will be truly transformational: the investment in network growth and operability to achieve the Clean Power 2030 objectives and enable progression towards Net Zero targets is at a scale not seen since the build of the supergrid system in the 1960s and early 1970s. Decreasing fuel diversity, as heating and transport are electrified, places still greater dependence on reliable electricity supplies. Our asset management activities have delivered outstanding levels of reliability. We will apply and adapt these successful principles to the new technology and operating paradigms that will come as energy transfers through our network multiply.

3.3. We have a clear, long-term vision for the management of our asset base to maintain reliability standards by applying robust operational practices and delivering appropriate investments at the appropriate time. This is the essence of our long-term risk objective: to intervene on assets before their condition results in intolerable risk to safety or network performance.

3.4. Investing in existing assets when there is such significant activity in connecting customers and increasing network capability requires very careful consideration. The risk to reliability increases during the works to reinforce the network and the availability of system access for asset management investments are inevitably constrained. Additionally, the decarbonisation of the electricity systems of the major global economies has, and will continue to, stretch supply chain capacity. Therefore, it is incumbent upon asset managers to take a whole system view when planning interventions in this environment. We will demonstrate how our plan achieves this objective.

3.5. Our system planning and asset management investment planning is a single process with a single business owner. We have consistently delivered investments which combine multiple drivers of need, ensuring that the best outcomes are delivered in the most efficient way. Our RIIO-T3 plans continue this strategy, where condition and risk-related investments have been re-programmed to allow the detailed requirements of reinforcement projects to become more certain, and thus, delivered in a coordinated fashion. We explain in this strategy where our reinforcement projects are also delivering network risk benefits.

3.6. Our plans for increasing network capacity are aligned with the 2024 Future Energy Scenarios Holistic Transition Pathway and further co-ordinated with SP Distribution's DFES. They will be influenced by the TM04+ connections reform and the UK Government's Clean Power 2030 plans. When planning asset management interventions to manage network risk, we test the proposed solutions against these scenarios to ensure that they are consistent with future generation and demand.

3.7. Our Network Asset Management Strategy provides information on our accredited asset management plan, our strategic objectives, the investment planning processes and the resulting investment plans for the RIIO-T3 period.

4. Our Asset Management Plan

4.1. Our independently accredited Strategic Asset Management Plan (SAMP) follows the six-box model as outlined in the Institute of Asset Management's Asset Management Anatomy Version 3. We are reviewing the new ten-box model published in July 2024 and how we transition our SAMP associated systems, guidance and asset strategies to align with this new model.

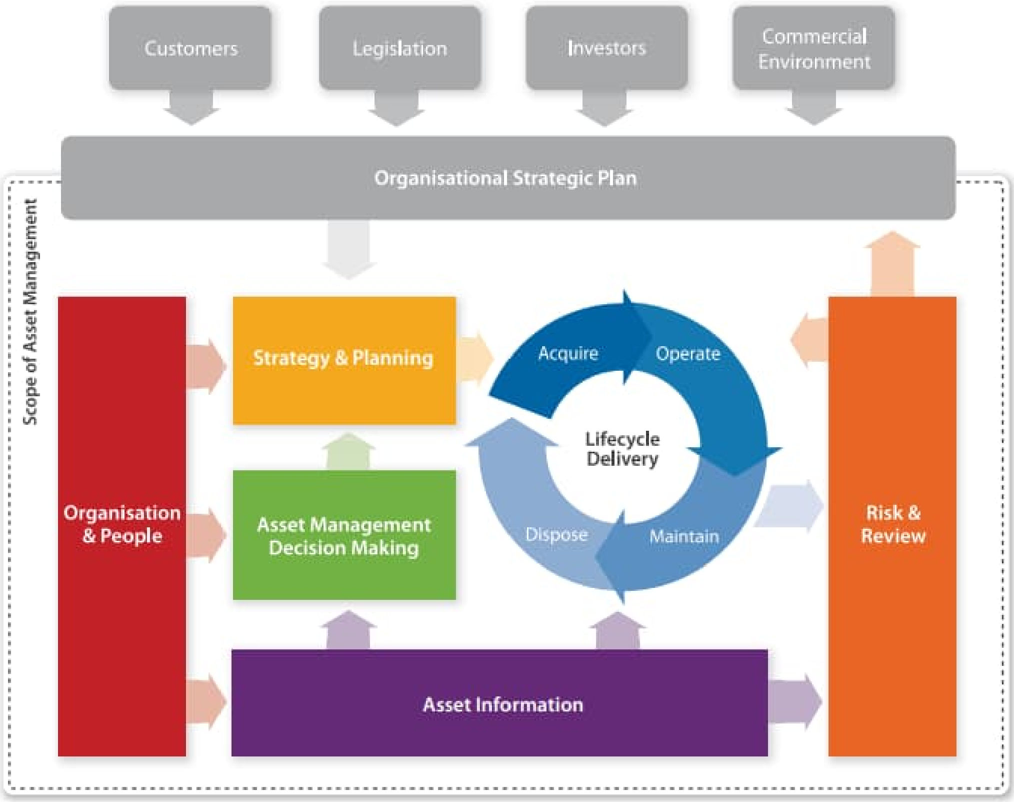

Figure 1 The IAM's Conceptual Asset Management model - IAM Anatomy Version 3[1]

Our six-box model considers the following criteria:

- Strategy and Planning:
  - We are the custodians of the transmission network in our licence area. It is therefore key that we have a long-term view of the condition of our assets and have appropriate interventions plans. We are also a RIIO focused business which means we review and develop our long term plan in line with our regulatory reporting periods. Our business plans are developed around the following aspects:
  - Strategic Planning & Analysis – develop organisational targets and commitment to our stakeholders considering our strategic objectives.
  - Justifications – perform option analysis on proposed projects including cost benefit analysis to develop engineering justification and demonstrate value to consumers.
  - Detailed Work Packages – develop solutions to manage network risk addressing current and emerging priorities.

[1] iam_anatomy_ver3_web-3.pdf

- Optimisation – ensure programmes of work are optimised between load and non-load activities to ensure asset intervention is carried out once.

- Asset Information:

    - The information we hold on our assets is essential to enabling our asset management activities and is used to inform our decisions as part of our risk-based approach. We are upgrading our core asset register and Geospatial Information Systems in line with industry best practice. We are also updating our mobile inspection technology to ensure our asset condition data is timely, accurate, complete and integrated with our core systems.

- Risk Based Decision Making

    - Risk based decision making is imperative to delivering a safe, reliable and secure electricity supply to our customers.
    - We implement the Network Asset Risk Metric (NARM) methodology which enables us to model our lead assets in a way which is with consistent with our regulatory licence requirements. Like the Common Network Asset Indices Methodology (CNAIM)[2], NARM takes into account the assets we have, how and where they are operated and the condition they are in, to determine a Probability of Failure (PoF) value. The NARM methodology uses the same Consequence of Failure (CoF) components as CNAIM but using sector-specific inputs and models to derive a suitable measure of asset criticality. PoF and CoF is combined to a monetised risk value which can be used to prioritise interventions now and in the future. The transmission regulatory framework leads us to evaluate the effect of asset intervention over a 45-year period where we consider the Long Term Risk Benefit (LTRB) of an intervention.
    - Transmission assets which are not currently included in the NARM methodology are known as non-lead or non-NARM assets[3]. They are assessed using a health-based approach, where the condition of the assets, both through measurement and inspection, is combined with asset insights from expert engineering review. Works are coordinated across asset types to ensure timely and efficient intervention which minimises the impact on the environment, connected customers and our stakeholders. Many of the non-lead asset types will be integrated into NARM during RIIO-T3.

- Asset Lifecycle:

    - Our approach to asset lifecycle addresses factors related to the acquisition, operation, maintenance and disposal of our assets. Development of and compliance with our asset design standards, system and network design requirements and our inspection and maintenance processes ensure our assets are managed throughout their whole life.
    - Our asset modernisation programmes, including asset replacement and refurbishment, are developed through cost benefit analysis to maximise value from the asset and perform the right intervention at the right time. The whole life value of our assets is considered from initial concept through to procurement and disposal and is reviewed as part of our asset management governance processes.

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[2] *The DNO Comment Network Asset Indices Methodology: Network Operator Common Network Asset Indices Methodology – Energy Networks Association (ENA)*

[3] *Reflecting common industry practice, we use the terms 'lead asset' and 'NARM asset' and 'non-lead asset' and 'non-NARM asset' interchangeably.*

- o People and Processes:
  - – Asset management practices and thinking is embedded in our culture and people, from senior management to operational engineers. The focus is to maximise the value of our assets and ensure the safe, reliable and secure operation of our network. We are actively developing our asset management expertise through an accredited training scheme to ensure we are upskilling our team and are developing our SAMP, and subsequent asset strategies, in line with the latest guidance and best practice.

5. Asset Class, Data Collection and Interrogation

5.1. It is the role of the asset manager to ensure they have strategies and processes in place to ensure they understand the condition of the assets in a manner that is appropriate for that asset type. We therefore have condition assessment regimes appropriate for associated asset classes; what is appropriate for a large power transformer is not appropriate for protection and control systems. During RIIO-T2, we have been investing in our tools to capture condition data and by the end of RIIO-T2 our condition data for our substation assets will feed directly into our corporate database and into *Invest,* the tool used to inform our decisions on asset interventions.

5.2. In addition to improving our tools for asset data, we must ensure we have a robust process for its collection. When we set our operational teams to work to carry out condition assessments, we need to make sure the question sets we are using are clear and consistent, so we review them regularly to ensure we are capturing the correct data. As this process is continuous, our teams are now very experienced in carrying out this activity. As the condition assessment data becomes available our experienced asset management engineers review the data to ensure consistency. We also carry out annual audits selecting a number of substations across our geographical area and one of our experienced asset management engineers, normally the one who sets the questions, will carry out a number of condition assessments and compare the results from this assessment with assessments carried out by our operational teams. We then feed our findings back to the operational teams. If there are some areas where we have found some inconsistencies, we will discuss this with them and provide some additional guidance. We also discuss the positive outcomes from the audits to ensure they maintain the quality of their condition assessments. This continual review and feedback process allows us to be confident in the quality of our condition assessments.

5.3. We have individual maintenance strategies designed to ensure we maximise the performance of, and extract the maximum possible life, from all our assets. These strategies consider the technology used by an individual asset. For example, we have many different types of transformers' tap changers and the technology employed informs the maintenance strategy: the strategy for an in-tank tap changer using vacuum technology is different from that of an in-tank tap changer using contacts under oil. In addition to maximising asset lives, maintenance activities also inform our understanding of assets' condition. This may be a combination of visual inspection of internal components or measurement and testing. Maintenance therefore is crucial, in both maintaining and informing, our understanding of an asset's condition. This process therefore provides the necessary insight into when an asset is approaching end of life and whether it requires to be replaced or refurbished.

5.4. We inspect and condition assess all our assets, lead, and non-lead, according to their characteristics. In the sections that follow, we describe what regimes are appropriate.

Substations

5.5. Substations contain many different asset types so our condition assessment regimes consider what is appropriate for each. We inspect all our substation assets for defects monthly. Annually, we carry out a visual condition assessment on all substation assets, whether lead assets like transformers and circuit breakers or non-lead asset like disconnectors and earth switches. The only exception to this annual visual condition assessment is when a substation is newly constructed or has had all assets replaced as part of refurbishment. In this case, a visual condition assessment is not carried out until the asset has been in service for ten years. This visual assessment scores the condition of each assets' individual components on a one to five scale, with one being as new and five being a condition that would indicate end of life. For example, on a gas-filled circuit breaker, we consider the condition of the hydraulic systems (if applicable), the condition of the mechanism cabinet, the condition of the bushings and metallic components of the circuit breaker tank along with the support structures. Instigating a programme of annual asset visual condition assessments and auditing the outputs has ensured that we understand the condition points being evaluated and that the reporting is consistent. We do, however, recognise that the change of these factors year on year is small. We are therefore reviewing the frequency of these surveys to ensure we capture the same quality of data more efficiently. In addition to this visual assessment, we carry out asset specific assessments.

5.6. Transformers and reactors are large assets with long lead times and high capital costs. In addition to visual condition assessment, we sample transformer main tank, and, if appropriate, tap changer oil annually. We carry out dissolved gas analysis and other testing of the transformer oil which allows us to gain an understanding of the overall health. This oil sampling may require us to take immediate action. For example, if high levels of ethylene are present it means something is getting very warm in the transformer. This could be a relatively minor issue that could be easily resolved or could be indicative of something more significant. In RIIO-T3 we are planning to complete our programme of replacement of 275/33kV transformers with the 'Bruce Peebles' type defect. We identified, through dissolved gas analysis, that certain 275/33kV transformers manufactured by Bruce Peebles, when heavily loaded, generate large amounts of ethylene gas, due to the design and poor execution of soldered joints on the 33kV side of the transformer during manufacture. As load increases, the connection gets increasingly hot and starts to generate ethylene in high quantities which led to a loading limitation being applied to the transformers. We also review the oil to allow us to understand the condition of the transformer's paper insulation system. Measuring the levels of 2-furfural present allows the degree of de-polymerisation of the transformer papers to be calculated. The degree of depolymerisation of the paper indicates the remaining life in the transformer insulation and when it is end of life. We also carry out 12-yearly oil testing and dissolved gas analysis on transformer bushings, but this may be carried out more frequently depending on the results from previous tests. We consider several other factors from our maintenance activities, including those considered to impact the operational adequacy of the asset. This analysis allows us to determine when assets require to be replaced or identify suitable candidates for refurbishment. When we identify an asset for refurbishment, we carry out additional electrical testing to ensure the additional life from refurbishment can be achieved, which is required for this to be a viable option.

5.7. When considering the condition assessment criteria for circuit breakers, the technology being assessed influences the process. By the end of RIIO-T2 gas filled circuit breakers will make up all but a handful of circuit breakers on SPT's 132kV, 275kV & 400kV networks. As outlined previously we consider various factors as part of our visual condition assessment for this circuit breaker type, and we also consider information gathered during maintenance on individual assets and our assessment of model types. Circuit breakers' contact systems, along with all other electrical apparatus, are critical. Gas circuit breakers' contacts are not readily accessible however we take steps to understand their condition by interrogating the circuit breaker timing performance and the contact resistance. The manufacturer will have prescribed values for these tests and if the test values are falling, outside the manufacturer's guidelines, then the condition rating for the circuit breaker will reflect this change. Another key factor is the condition of the gas. We record a number of factors when testing the gas and this is used when determining the asset's condition. When a gas circuit breaker operates, some of the gas within the circuit breaker will break down and form other substances. We expect the gas to recombine quickly or for the desiccant within the circuit breaker to absorb any byproducts. The presence of byproducts during gas testing, indicates that the circuit breaker's contact systems require to be investigated.

5.8. As part of our RIIO-T3 plan, we plan to refurbish the Protective Bypass switches associated with our Series Compensation platforms. A protective bypass switch is very much like a circuit breaker but rather than being fast opening, they are fast closing. On one of our units, testing has identified high contact resistance of contact systems and generation of SO_2, a byproduct of the decomposition of SF_6. This is indicative of an internal issue which is being monitored regularly with discussions ongoing with the manufacturer. Our anticipation is this condition may be common across this type of device, and therefore, we are planning an early mid-life refurbishment. Uncovering this issue, and its ongoing management, is demonstration of the effectiveness of our condition assessment regime.

5.9. An additional factor we consider is the leakage of insulating and interrupting gases, predominantly SF_6, and the number of leaks an asset has experienced in a five-year period, and hence, the number of repairs that have been undertaken. The consequence of a gas leak is not only of environmental concern but also operationally, as the loss of gas will draw in moisture and therefore potentially impact the asset's operation. We also consider the operational adequacy of circuit breakers as part of our assessment process. The operational adequacy assessment considers numerous factors including, but not limited to, if a Suspension of Operational Practice or Dangerous Incident Notification has been issued for each type, the support available from either the manufacturer or from recovered spares, and if the assets have issues that can be attributed to an asset family. In our RIIO-T3 plan we have a plan to replace assets from families which have a significant history of SF_6 leaks and, as much as the asset chosen for replacement may not be leaking now, all evidence suggests that they will in the future. This includes asset families where we have a large population with a common leakage point. We therefore plan to intervene and carry out modifications before leakage occurs.

5.10. Our methodology for assessing non-lead (non-NARM) primary plant assets is the same as what we apply for our lead assets, like circuit breakers. We carry out a visual assessment and then we gather condition data during maintenance. For example, for a disconnector we will record the condition of the contact system and the condition of the electrical and mechanical components of the disconnector. Our assessment of these components will consider relevant factors: can the asset be operated electrically and if not, can it be repaired? Are the mechanical components worn, is there cracking or any other damage to the insulator? In RIIO-T3, we have a planned programme of refurbishment on [redacted] 132kV disconnectors and earth switches. These disconnectors suffer from a number of issues which are present across the population. For example, the system that drives the auxiliary contacts, and therefore, the remote indication of the disconnector is not reliable and although these disconnectors are capable of independent remote operation, we need one of our team to be on site before we operate. This means when we want to carry out a busbar transfer, we need staff on site, whereas for other disconnectors this is not a requirement. The contact system can also be problematic: the disconnector contact is covered by an ice shield in the open position, the ice shield is opened when the disconnector moves to the closed position. Sometimes this ice shield becomes stuck closed and stops the disconnector from closing, leading to an unplanned outage.

5.11. To understand our assets, we must have strategies that are appropriate for that asset type. When we are assessing protection and control equipment, which are non-lead assets, the methodologies previously mentioned are not appropriate. Visual assessment of an Intelligent Electronic Device (IED), otherwise known as a protection relay, is unlikely to inform any decision making and as much as we maintain these devices, the maintenance will typically tell us if a device is functioning properly and requires to be replaced during maintenance, rather than inform future plans. We therefore consider a number of factors when considering a device's condition. One factor we consider is defects on the equipment, with us ranking their severity. For example, a 'major' defect would be a defect which causes a critical failure of critical elements inherent with the device's design. We also consider the level of support that remains for a device from its vendor and within the company, and if the device is compliant with policy from a technical perspective. We consider these factors on a per model basis, and therefore, each IED of a particular model will have the same condition rating as the same factors will apply. When considering our investment plans, we review the asset condition and other network activities that may impact the operation of assets. We plan for where IEDs are being replaced, as part of another scheme, but also where we can combine IED replacement into a wider protection system upgrade and therefore deliver multiple upgrades to protection and control equipment under the same outage.

Overhead lines

5.12. Our approach to the condition assessment of overhead lines is similar to that of substations, where we have a multi-layered approach designed to give us appropriate information at a level required to inform the appropriate intervention. We carry out an inspection of all overhead lines annually, fifty percent by foot patrol and fifty percent by helicopter. The aim of this inspection is to identify any defects present that may need immediate intervention. For example, is an anti-climber damaged and requires to be repaired? Has a bird nested that presents a hazard to the overhead line's continued operation? We carry out annual thermographic surveys of the Main Interconnected Transmission System along with fifty percent of the remainder of the network. This allows us to identify any hot spots on overhead line conductors or earth wires and arrange repair works accordingly. We also carry out a condition assessment of ten percent of our overhead line assets every year. This is a combination of a highly detailed visual inspection, using very high-resolution imagery in conjunction with testing. In RIIO-T2 we have instigated a programme to carry out overhead line visual condition assessment by unmanned aerial vehicle (drone), rather than helicopter. This migration to using drones has allowed us to get much closer to the overhead line assets and take images from angles not previously possible by helicopter. We have found images of a suspension insulator set at an upward angle very helpful to understand the condition of the cap and pin. This had not been available from helicopter images. In 2023, we resurveyed the [redacted] 132kV overhead line which had previously been surveyed by helicopter in 2017. The 2023 drone-based survey identified cap and pin insulators that were severely corroded but there was no sign of this corrosion on the 2017 helicopter survey. We took action to replace the corroded insulators at the earliest opportunity and reviewed the remainder of our population of this insulator type for corrosion. This along with other experiences, following our migration to drone based inspections, have led us to review the frequency of overhead line condition assessment. Our plan from RIIO-T3 onwards is therefore to assess twenty percent of our network per year. This change will allow us to identify any other issues, as was the case on the [redacted], in a timely manner and ensure our asset condition information is as up to date as possible. The current ten percent per annum regime means we are carrying out a condition assessment on individual assets every ten years. When an asset is new, it is unlikely that much degradation will occur in its first ten years of service, however after this period, conditions could change relatively quickly. The new regime will therefore not condition assess fully refurbished or new overhead lines for the first ten years of service. Following this, they will be condition assessed every five years.

5.13. We carry out a detailed visual condition assessment of the conductor, dampers and spacers, if appropriate, to establish the condition of fittings and conductors. This assessment allows us to identify fatigue or corrosion of the dampers, spacer damage, wear and damage, or potential slippage of the conductor system. In addition to this we carry out both non-intrusive and intrusive testing of the conductor system. On Aluminium Conductor Steel Reinforced (ACSR) conductor systems we start carrying out non-intrusive and intrusive testing after thirty years of service. The non-intrusive testing allows the assessment of the galvanisation of the steel core for any signs of degradation. We aim to replace the conductor before the steel core itself starts to corrode to allow us to use the old conductor to pull in the replacement using a process called Continuous Tension Stringing. In addition to the non-intrusive testing, we also carry out intrusive testing of the conductor. To do this we remove a sample from an identified span to send to a laboratory. At the laboratory we will strip the conductor down layer by layer and examine the condition of each layer of conductor and the associated grease. This allows us to understand the degradation of the aluminium and the steel core. We will then carry out torsion and tensile strength tests on individual conductor stands in line with BS EN 50182. This visual assessment (for damage and fatigue) and testing allows us to assign a condition rating and assess the replacement priority of the overhead line conductors. We have identified several routes for conductor replacement in RIIO-T3. One example is the [redacted], a 132kV overhead line in Greater Glasgow. We carried out non-intrusive testing which indicated degradation of the galvanisation of the conductor core; the follow up intrusive testing confirmed that the conductor system was in poor condition and required to be replaced. For All Aluminium Alloy Conductor (AAAC) there are no non-intrusive techniques available at present and therefore we plan to start carrying out intrusive testing after forty years of conductor life. We are currently developing, under an innovation project, a technique to allow non-intrusive testing of AAAC conductors. Our earliest AAAC conductors are only now at an age we will be starting testing, so we have no condition-based replacement plan in RIIO-T3.

5.14. We assess the condition of overhead line tower fittings by using high resolution imagery. This imagery permits the assessment of corrosion and wear on these components and the planning of interventions accordingly. When assessing the condition of overhead insulators, we consider their electrical and mechanical aspects. The electrical condition is assessed by a review of the condition of the glass or porcelain insulator dishes. If polymeric insulators are in use, we inspect the polymeric casing. This allows us to evaluate if the electrical performance of the insulator string may be compromised. When assessing the mechanical properties of glass or porcelain dishes, we review the condition of the cap and pin insulator that connects each dish together and assign a score based on the level of corrosion. For polymeric insulators, we consider the corrosion levels of the end fittings and any damage to the external casing of the insulator. In RIIO-T3 we have a programme to replace polymeric insulators on the [redacted], a 132kV wood pole line. The insulators on this route are damaged at the pole end of the insulator, potentially compromising the electrical and mechanical performance of the insulator sets.

5.15. The majority of an overhead line tower is steel and is above ground however we evaluate the condition of steelwork and the tower's foundations. When assessing the condition of tower steel we use high resolution imagery. We evaluate each section of the tower and score the tower legs, bracings, crossarms and tower peak. A score will be assigned to the overall surface area of these groups. We paint the steelwork to maintain its condition and in the RIIO-T3 plan we have identified towers requiring to be painted due to their steelwork condition. The painting process involves removing any corrosion and then overpainting with a base coat and topcoat. The purpose of painting is to maximise the life of the steelwork by removing or halting any corrosion.

5.16. We have identified routes in our RIIO-T3 plan for tower painting where the steelwork is still in very good condition. Tower steelwork is galvanised to protect it from corrosion and when first installed the galvanisation needs to weather to allow it to be painted successfully. We therefore have routes where the towers are new (2010-2020), the galvanisation has had a period to weather, and we are now planning to paint. Painting these routes will help to protect against the onset of corrosion and therefore extract the maximum economic life from the towers.

5.17. We also evaluate the condition of tower foundations on each route, testing five percent of our asset base annually. This assessment will dig down on two faces of each footing being investigated to its full foundation depth. We carry out dimensional checks on the foundation and remove a concrete core from each foundation and subject it to crush tests. A report for each foundation will be compiled and a condition score assigned.

5.18. The evaluation of tower non-lead assets, the earthwire and associated fittings, follows the same methodology as lead assets. We assess the earthwire in the same manner we assess the phase conductors, the main exception being for an earthwire we will test earthwire jumpers because taking a sample of the main span earthwire in most instances would require a double circuit outage, which is rarely practicable. In RIIO-T3, we have plans to replace the remainder of the earthwires where an optical fibre wrap is installed. We cannot test the fibre wrap as this would require a section to be removed which cannot be replaced. We have however taken samples of decommissioned fibre wrap that were a similar age, it was disassembled and tested. This has shown that these installations are now end of life, maintaining the communications services hosted by the fibre is essential to the effective operation of the network. We will replace the earthwire and fibre wrap with an Optical Ground Wire (OPGW). We no longer use fibre wrap because the service experience has been poor. The fittings associated with earthwires are reviewed for wear and corrosion using high resolution imagery and a condition rating applied.

5.19. Wood poles are also non-lead overhead line assets, we assess their condition using a variety of techniques. This includes visual assessment, hammer testing, prodding testing and Ultra-Sonic testing. The combination of these results allows us to assign a condition rating. In RIIO-T3 we have a scheme to replace a number of wood poles, due to woodpecker activity compromising the pole condition.

5.20. Overhead line assets typically do not require routine maintenance with the exception of painting towers, as they are simple components that wear over time and do not require intervention to maximise asset life. We do however carry out repairs that allow us to understand how these assets perform and the implications for other assets of this type on our network. We use this insight to inform our investment plans as a matter of routine. One example would be the replacement of conductor spacers that utilised an elastomer insert. Over time this insert becomes brittle. Once this happens the movement of the conductor damages the insert which then leads to the metallic components then damaging the conductor. We experienced this defect on a number of overhead line routes and therefore instigated a programme to remove all of this spacer type from our network.

Cables

5.21. The two cable technologies installed at voltages of 132kV and above are oil filled and cross-linked polyethylene (XLPE). Cable technology has developed from oil filled to XLPE and the last oil filled cables SPT installed were in 2008. The condition assessment regime for the different cable technologies is similar with specific tasks being carried out based on the technology. SPT carry out as a minimum an annual visual assessment of cable termination and cable routes and cables are maintained, including sheath tests, every three years.

5.22. A number of factors are examined when considering the condition of oil filled cables. The above ground sections are visually inspected at least annually with consideration being given to any damage on the cable terminations and oil system. Each circuit's oil leakage history and the number of top ups is also considered. The cable oil is tested in a similar manner to transformer oil along with additional testing for particulate contamination. The sheath of the cable is tested every three years during maintenance for any signs of deterioration and finally the fault history of the cable is considered. When oil filled cables are decommissioned a section is removed to a laboratory for testing. At the laboratory the cable is disassembled layer by layer. The outer serving is removed, and any reinforcing tapes and the surface of the metallic sheath are inspected. The metallic sheath is then removed and inspected for any signs of cracking or damage on the inside of the cable. The paper insulation layers are removed and examined for any signs of distress and the oil ducts are inspected for signs of corrosion. It is not practical or economic to take samples of in service cables therefore disassembling cables that have been removed from service gives a good indication of the condition of cables of a similar age and operating conditions. The locational risk of each cable is also considered when reviewing cable condition which influences the priorities for intervention. In RIIO-T3 we have plans to replace a number of oil-filled cables due to a combination of the foregoing factors. We have been considering, in general, how we support the population of oil filled cables moving forward. Oil filled cable is now only manufactured in very small quantities, and therefore, spare cable is only available from the strategic spare cable stock, and via a commercial agreement with a third party, for access to further spares. It must be considered that this stock will be exhausted with no replenishment available. SPT therefore have a long-term plan to replace oil filled cable circuits to ensure we can continue to support the remaining cable circuits and provide the level of service that our customers deserve.

5.23. XLPE cables follow a similar assessment regime to oil filled cables except for routine oil testing. SPT have experienced a significant number of cable terminations failing disruptively after a relatively short time in service. These failures present a risk to staff, contracting partners and the general public. We have therefore instigated a programme of annual partial discharge monitoring of cable terminations. If a termination fails, we remove it to a laboratory and perform layer by layer disassembly to understand the cause of the failure. SPT currently have a special working group convened to understand how we can reduce the number of XLPE cable termination failures being experienced. Similarly, when we have a fault on a cable section underground, and the fault is not associated with a joint or third-party damage, then we will remove a section to a laboratory for a layer by layer disassembly to understand the cause of the fault.

5.24. Our XLPE cable population is still relatively early in its life and typically wouldn't be part of our replacement plans however in RIIO-T3 we propose to replace four circuits. Two of the circuits are short lengths between a substation and a terminal tower where the cable terminations have condition issues that cannot be resolved. XLPE cable termination and joints are designed and tested to be jointed into specific cable types and we can no longer source the cable type or associated terminations which requires the replacement of the short sections. The other XLPE cable sections being replaced are due to a factor uncovered following the analysis of a faulted section. The cables being replaced were made by the same manufacturer, in the same factory, at the same time and installed on parallel circuits. The cable insulation can be seen to have burn marks in several sections which our independent analysis has concluded may be caused by irregularities in the corrugated aluminium sheath and irregular spacing between the cable and conductor and sheath. This irregular spacing is causing stress points on the cable which is damaging the insulation and led to the fault. As these irregularities are due to the manufacturing process, at the time, it is therefore highly likely this condition will be present on both circuits and the cables will continue to fault. Both circuits feed the same substations therefore if one circuit faults the substation is then being fed from the other cable experiencing this issue, and therefore, at a higher risk of faulting. We plan to replace these cables in RIIO-T3 and remove this failure mechanism and associated risk from the network.

5.25. On both of these cable technologies we carry out routine testing of the cable sheath and the electrical bonding arrangements. This allows us to understand the condition of the below-ground sections of the cable and to understand the degradation of the cable systems. We use the results of the tests to inform our intervention strategies.

6. Network Asset Strategy

6.1. Our strategic approach to asset management is designed to produce long term plans to manage the risk associated with NARM and non-NARM assets. These plans must, and do, adapt to the operating environment and wider constraints. The plans which cover the RIIO-T3 period have taken due account of global competition for resources, the system reinforcement works identified in the Pathway to 2030, Beyond 2030 and Clean Power 2030 publications (as achieved by our load-related plan) and the competing priorities for system access. This results in a balanced intervention proposal which is enabled by the mature and effective condition data collection strategy, detailed in section 5, and the risk prioritisation that we describe in this section. The strategies for the principal asset classes are described followed by a description of the current asset base and finally a view of the long-term risk strategy.

Asset Class Strategy

6.2. Our transmission network encompasses central and southern Scotland and plays a key role in the national infrastructure connecting significant volumes of renewable generation, while forming the routes for similar volumes in the SSEN Transmission (SSEN-T) area to flow to National Grid Electricity Transmission's (NGET) England and Wales transmission system. The Transmission Network operates at voltage levels of 400kV, 275kV and 132kV with volumes of assets operating at 220kV, 33kV, 25kV and 11kV. Our electricity transmission network incorporates:

- Over 4,363 kilometres of high-voltage overhead transmission line and underground cable operating at voltages of up to 400kV.
- Over 166 substations.
- 400kV, 275kV, 220kV and 132kV connections to the SSEN-T and NGET systems.
- The Western HVDC link, a 2,250MW ±600kV underground and subsea link from Hunterston to NGET's Flintshire Bridge converter station.
- The connection point for the Moyle interconnector to Northern Ireland.

6.3. Assets within scope: Our core business function is as the primary transmission network service provider. Assets that enable this function comprise of the majority of the assets within the scope of the Asset Management Strategy. The scope of this Asset Management Strategy includes all the network assets below, both lead and non-lead:

- Overhead line towers, conductors, fittings and civil works
- Underground cables and accessories
- Circuit-breakers
- Transformers and reactors

- o Overhead line poles
- o Substation electrical and auxiliary plant
- o Substation civil works
- o Substation protection, control and monitoring

6.4. The strategies for the principal asset classes are summarised here.

Overhead Lines

6.5. Transmission overhead lines comprise several major components, all of which perform their duty in dynamic and onerous environments, the combination of which affects the condition of the asset over time. The major components are the NARM assets: towers, phase conductor and insulators/fittings and the non-NARM assets: earth conductors and fittings, poles and foundations.

Towers

6.6. Steel towers have a design life of 80 years which can be extended if the tower is painted at appropriate intervals before significant degradation of the zinc coating protection and corrosion of tower steelwork occurs. Tower painting is prioritised by tower condition, recorded by the condition assessment programme, and is affected by the operating environment. The environment is dependent on a number of factors including proximity to the coast, altitude and proximity to other pollutants, such as thermal generation or industry. These factors drive investment frequency which can range from 10-15 years between painting cycles. Tower painting will usually be aligned with other investment work on the tower such as insulator or conductor replacement, recognising the financial and environmental efficiencies that can be gained by carrying out works concurrently. Steelwork which has corroded beyond the point of economic repair is replaced. This can range from individual bar replacement to, in extreme cases, complete tower replacement.

Conductors

6.7. The majority of the 132kV and 275kV transmission overhead network was constructed prior to, or during the 1960s utilising 175mm^2 "Lynx" or 400mm^2 "Zebra" Aluminium Conductor Steel Reinforced (ACSR) conductors. These types of ACSR conductor have an expected serviceable lifespan of between 50 and 65 years dependent on conductor grease specification and environmental class. 70mm^2 "Horse" ACSR was generally installed as an earth wire and is of a similar vintage to that of the phase conductors. However, this conductor ages quicker than the phase conductor, due to its smaller diameter and grease application and has an expected serviceable lifespan of between 35 and 40 years.

6.8. The method of conductor replacement (and associated costs) will depend on the residual strength of the original conductor. Normally, a new conductor would be installed by utilising the residual strength remaining in the original conductor using techniques called "Tension Stringing" and "Catenary Blocking". However, if a conductor is so badly corroded (i.e. the residual strength of the steel core cannot be assured) then the only option available may involve dropping the original conductor to ground level and removing it before installing a replacement. The costs associated with these processes increase as the residual strength of the existing conductor reduces, such that replacing conductors at end of life may be up to five times greater than at a point prior to where the residual strength starts to reduce significantly (the "knee" point). The optimum time for replacing conductor, therefore is when the residual strength of the existing conductor allows for tension stringing taking place. Our strategy is to replace ACSR conductors at the optimum point.

Insulators & Fittings

6.9. 132, 275 and 400kV overhead tower lines use glass or porcelain insulators, except in areas where corrosion poses a serious life limiting problem to traditional cap and pin insulators or where vandalism has occurred in the past. Glass and porcelain insulators are typically replaced as part of any conductor replacement work when the condition justifies intervention. Condition is the principal driver for the replacement of insulators & fittings, typically their life is shorter than the conductor system. We therefore have stand-alone programmes to replace insulators and fittings.

Foundations

6.10. Above ground foundations are considered for repair or replacement when the condition determines that intervention is required. The above ground foundations on routes considered for major investment, of any type, are considered for remedial works. The 'below ground' foundations are subjected to targeted assessment during, or before major works and routine sampling as part of the asset inspection regime, detailed in 5.17. The inspection carried out as part of major works include tower verticality assessments to checking for any signs of subsidence.

Wood Poles

6.11. Wood poles vary in age and design, but most poles are 'trident' design and range in age from 44 years to new. These routes were originally strung with Lynx ACSR conductor until around 2005 when equivalent AAAC conductors were used. The expected service life for a creosote treated wood pole is 60 years. Currently, all wood poles installed on the SPT network are creosote treated. The alternatives to creosote are in the early stages of deployment and are anticipated to produce a life expectancy of 50 years. Pole condition is monitored on a 6-year cycle (see 5.19) Where isolated pole decay or damage is detected, individual poles will be changed. If widespread pole decay is noted, and conductor condition is deteriorating, then consideration will be given to re-building the route.

Circuit-breakers

6.12. The population of air insulated (AIS) circuit-breakers has only a few remaining of the bulk-oil and air-blast types, all of which will be replaced during RIIO-T3. As a result, the majority are SF_6-type with an increasing number using alternative gases. The earliest SF_6 units have become difficult to maintain, due to their complex hydraulic/pneumatic operating mechanisms whilst vendor support is declining. Their long exposure to the environment has also increased the risk of gas leaks. Our strategy is to maintain, repair or refurbish where this is the most economical solution and to replace if the other options are not effective or efficient. The focus on the spring-mechanism type is to maintain them, undertaking works to prevent gas leaks and to repair as necessary. In all cases, the replacements will be with types employing alternatives to SF_6; SF_6 will only be used if a viable SF_6-free solution is not available.

6.13. Our population of Gas Insulated Switchgear (GIS) was mostly installed during RIIO-T1 with a single installation dating to the 1980s. The modern installations are all in good condition and are expected to have around another 40 years' service life. Our interventions are to prevent or repair gas leaks and we have proactive programmes to seal joints and to retro-fill Gas Insulated Busbars with alternatives to SF_6.

Transformers

6.14. The extensive condition assessment and monitoring regime described in section 5 is allied to a mature assessment and diagnostic framework, which is consistent with good industry practice. We aim to maximise the life of transformers through refurbishment, where possible, but plan for replacement, acknowledging the lead time and global competition for transformers.

External Condition

6.15. Our strategy is to continue to monitor external condition issues such as corrosion and oil leaks. When maintenance and repair activities are no longer sufficient, the units will be considered for refurbishment. We'll then undertake electrical testing to confirm that they are suitable for this life extending intervention.

Active Part and Bushing Condition

6.16. The information from oil analysis provides strong evidence for the condition of a transformer's active part. While not foolproof, it provides insight into developing faults and indicates the remaining life of the paper insulation. We use the oil analysis to estimate the remaining life and to programme replacements for units, where no further life extension is possible.

6.17. Bushings have a shorter life than the main transformer and based on our assessment of their condition, we'll replace them as part of the scope of a refurbishment.

Reactors

6.18. The extensive modernisation programme in RIIO-T1 and RIIO-T2 means that the population of reactors is modern and in good condition. Air-cored reactors are the majority of the units in service, and they are low maintenance with few intervention needs. We'll continue to monitor these and the oil-filled units (in a similar way to transformers) but we have no immediate plans for interventions.

Substation Plant

6.19. The non-lead, high voltage, assets in substations comprise disconnectors, earthing switches and instrument transformers. Combining interventions with the associated lead assets is often an effective and efficient strategy. There are occasions, however, where specific programmes are required to manage issues with individual types when the lead assets are not planned for works and these are included in the plan (see section 8).

6.20. The most critical auxiliary systems are the battery and charger systems that provide the critical supplies for protection and control systems and to operate the switchgear. We have a comprehensive monitoring and maintenance plan that ensures the systems remain available until they reach the end of their lives. The two main types of battery technology in use are Planté and Valve Regulated Lead Acid (VRLA). VRLA batteries have a shorter life than Planté and the battery cells need to be replaced on a well-understood time-based cycle. Planté cells have a much longer life but require additional facilities due to the gases that they vent and the volume of acid that they contain. We replace individual cells when they reach end of life, but we eventually need to undertake complete replacements.

Protection, Control and Monitoring

6.21. Protection devices have evolved from the original electromechanical relay technology, universal until the 1970s, through analogue electronic, computer-based (or 'numerical') devices introduced in the 1990s, to the current generation of Intelligent Electronic Devices (IEDs). IEDs combine multiple functions which required individual devices in previous generations but, like most computer-based devices, have relatively shorter lives. The whole-scheme replacement strategy before RIIO-T1 gave way to a more selective replacement programme, where the shorter life devices are replaced because those with longer lives (typically the auxiliary devices) are suitable for service for multiple IED lifecycles. Our health index methodology for the protection devices is based on a number of criteria suited to IEDs and we prioritise the replacement of health index 4 and 5 devices.

6.22.Substation control systems are often known as Remote Terminal Units (RTU) and will have useful lives consistent with computer-based technology. The majority of legacy RTUs use hardwired interfaces, whose hardware does have a longer service life, so we can normally upgrade the processors and communications interfaces through swapping out modules. There are a small number of remaining first generation RTUs that will be replaced as there is no longer support for those models. The most modern RTUs use data communications and the first generation of these are now at end of life and with manufacturer support coming to an end, we have experienced performance issues. In light of these factors, we will replace these units.

6.23. The extensive system monitoring population deployed across the network is increasingly critical as system characteristics undergo rapid change. New functionality is required as large numbers of complex inverter-based sources connect to the network and, like all such electronic devices, the hardware has a limited life. We have a range of generations of hardware and our strategy is to replace modules to deal with end of life components and to provide new capability, as far as possible. Eventually the hardware becomes unsupported, so we have a blended approach, upgrading where possible and replacing where necessary.

The Network Asset Risk Methodology

6.24. This section provides an overview of the Network Asset Risk Metric (NARM), its application in our asset management strategy and its relevance to our RIIO-T3 plan.

6.25. The Network Asset Risk Metric (NARM) Methodology provides a framework against which asset risk can be measured. The NARM Methodology is based upon a series of mathematical models which allow a measure of asset condition related risk to be calculated.

6.26. There are two components which combine to generate asset risk: a probability of failure (PoF) and the consequence of that failure (CoF). To calculate the PoF, an asset health measure is generated. This is referred to as an end of life (EoL) indicator and is expressed as a value between 0.5 and 15. A value of 0.5 represents an asset in a new condition. Assets with values above 8 require consideration of whether an intervention is required. An intervention can range from enhanced inspection and maintenance, through to refurbishment and asset replacement.

6.27.The consequence of failure considers four main impacts of an asset failure. These are:

- Environment – The impact of an asset's failure on the natural world around it.
- Safety – The consequence of assets failure on the public and staff.
- System – The electrical network impact of an asset not being available for service.
- Financial – The cost of replacing or repairing an asset in the event of a failure.

6.28. The CoF values are expressed in monetary terms using defined variables specified within the NARM Methodology. This statement of values then allows for the creation of a risk measure for an asset by combining the PoF and CoF terms. This combined term is referred to as the monetised risk of an asset. The monetised risk of an asset gives an indication of its relative failure risk, and this is expressed in pounds, because of the units used to express the CoF terms. The monetised risk is not proportional to the cost of asset intervention.

6.29. The NARM Methodology can be considered to be a type of Condition Based Risk Management (CBRM) approach.

6.30. The NARM Methodology in place at SPT covers seven lead asset types, these are:

- o Circuit Breakers
- o Transformers
- o Reactors
- o Underground Cable
- o Overhead Line Conductor
- o Overhead Line Fittings
- o Steel Towers

6.31. You can find out more about our NARM Methodology by reading our latest consulted NARM documents on our website: SPT NARM Methodology

Long Term Risk Objectives

6.32. Our Long Term Risk Objective is founded on the principle that we will intervene on assets before their condition results in a risk to safety or network performance that is intolerable. This objective is achieved by having a mature, effective asset condition assessment regime allied to historical perspectives on asset deterioration. This informs asset strategies that look beyond price control boundaries to ensure that the delivery of interventions can align with system reinforcement works and account for pressures in the supply chain and scarce system access opportunities.

6.33. The approach taken in the creation of the RIIO-T3 plan, supported by stakeholders, is to use the detailed understanding of each asset, and how they interact in the network, to identify priorities for intervention. For lead assets, this is correlated with the NARM models to provide confidence in the identification of risks. For non-lead assets, the asset health scores are combined with a holistic network view, aligned to the associated lead assets, to provide confidence in their qualitative risk. We describe the effect on monetised risk that results from the business plan, later in this section, and it is notable that we consider the plan in this way. We do not believe that a credible intervention plan results from the selection of a notional monetised risk target. Monetised risk is one element in the toolkit of investment decision-making. As we note in 6.45, the relationship between high-risk values and asset condition justifying intervention must be understood at an asset level, in order to make the correct decisions. A simplistic focus on an absolute risk value can result in the wrong investments being taken forward. Therefore, our monetised risk objective is determined by the intervention plan that achieves our long-term risk objective.

6.34. The asset strategies outlined in this section highlight that we have a continually evolving asset risk position as the network grows and assets journey through their expected lives. The long-term risk objectives must, then, similarly evolve to reflect the current asset base. At this point in time, the key objective stated in 6.32 has led to the creation of a RIIO-T3 intervention plan which recognises the reduction in risk that comes from the step-change in network capacity investments, primarily those which seek to maximise the utilisation of existing assets, before building new. The investments in the assets, which have no associated load-related drivers, are therefore more limited than would otherwise be the case.

6.35. For each of the non-load related projects which involved lead asset interventions within the RIIO-T3 programme, we have calculated the Long Term Monetised Risk benefit (LTRB) value for the feasible intervention proposals. This calculation involves forecasting PoF and CoF over the lifetime of the proposed intervention to determine the relative reduction of long-term monetised network asset risk.

6.36. The LTRB for the RIIO-T3 business plan is Lr£23.1bn. The composition of the planned LTRB by asset type is shown in Table 2.

Table 2 RIIO-T3 LTRB Composition by Asset Type

Asset Category	LTRB(Lr£bn)	LTRB(%)
Overhead Line Towers	5.83	25 %
Overhead Line Conductors	2.02	9 %
Overhead Line Fittings	12.08	52 %
Underground Cables	1.86	8 %
Circuit Breakers	0.17	1 %
Transformers	1.14	5 %
Reactors	0.00	0 %
Total	23.1	

Monetised Risk and Our Interventions

6.37. To determine the interventions that need to be planned, the first consideration is to identify those assets which may present a risk through their failure to perform the required function. The NARM Methodology allows the health of an asset to be assessed not only in the present day but also forecast into the future.

6.38. Health and risk bands have been specified as part of the regulatory reporting requirement of NARM. This allows the continuous numerical values of health and risk to be expressed in groups. The definitions of health bands are common across asset types, however, the risk bands have been determined for each asset category by voltage level. These risk band thresholds have been designed such that there is suitable differentiation of assets across the network. The risk thresholds are set out in our NARM business plan data tables. There are 10 health bands, from P1 to P10 where P1 represents the best health and P10 the worst health according to the NARM health models. R1 represents the lowest risk and R10 is the highest risk of assets in the population.

6.39. When planning for asset interventions in the RIIO-T3 period, it is important to consider the network we would have, if we did not intervene. To do this, we look at the distribution of assets on 31st March 2026. The impact of interventions remaining in the RIIO-T2 plan are modelled and then assets are assumed to deteriorate in line with the NARM Methodology, giving the position at the end of RIIO-T3 without intervention.

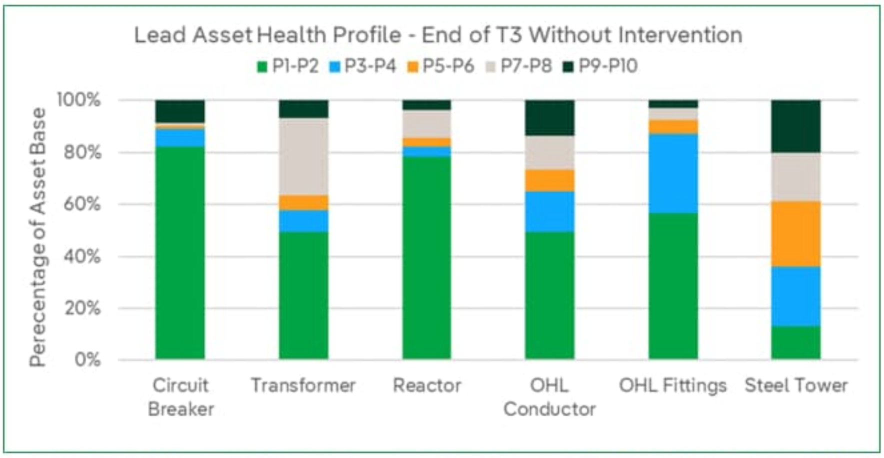

Figure 2 Graph showing network composition at the end of the RIIO-T3 period without intervention by P band.

6.40. Figure 2 shows large proportions of our network are in a low P Bands. As such they present a low probability of failure. These assets will not be targeted for intervention because their condition means that it would be unnecessary.

6.41. Steel towers differ from the remainder of the asset base because their principal condition point is the condition of the paint which protects the tower steelwork from corrosion. The comparatively short life of the paint system means that the distribution of asset health for steel towers has a greater spread across the P Bands, when compared to the other assets. Our tower refurbishment activities will address this by targeting tower painting on proportionately more assets, that will require intervention in RIIO-T3, than for other asset types. Our approach to tower painting is detailed in 6.6.

6.42. While we identify the need to intervene on an asset based on its PoF, we must also prioritise the interventions that we undertake. There are numerous factors which contribute to how an intervention is prioritised. This might include the availability of resource or our ability to secure network outages but also the risk presented by that asset. We use the risk of failure as part of our intervention prioritisation assessment.

6.43. The risk of an asset gives an indication of the likelihood of the impact which would materialise from the failure of that asset. Assets on our network have a wide range of risk values. The distribution of assets by R Band is shown in Figure 3

6.44. Given the calibration of the assets within the NARM Methodology, some asset types contribute a greater proportion of risk to the total network risk, than others. The type of asset and the operational risk that it presents must also be considered as part of the intervention planning. This means that we consider each of the asset types on their own merits and carry out interventions which target specific asset types based on their relative risks. The graph in Figure 4 shows the breakdown of asset risk at the end of the period without intervention by asset type.

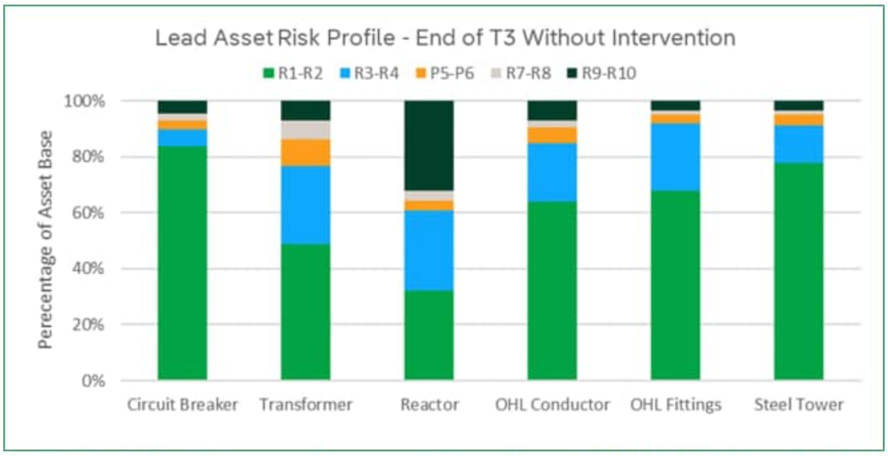

Figure 3 Graph showing network composition at the end of the RIIO-T3 period without intervention by R band.

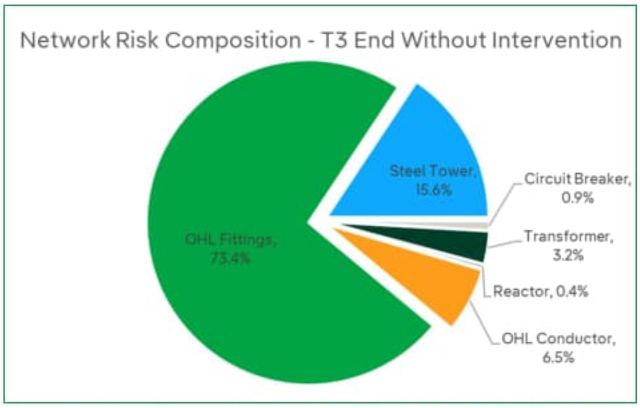

Figure 4 Composition of Network Risk at the End of RIIO-T3 Without Intervention.

6.45. Given that the risk of an asset is calculated based on the PoF and CoF, some assets will always have high levels of risk, even when in very good condition. This is because they have a large consequence of failure. While intervention on an asset with high CoF would generate a large value of risk reduction, compared to assets with lower CoFs, it does not necessarily mean that the probability of failure posed to the network would be equally reduced.

6.46. To account for these CoF assets with large risk values but which are in good health we introduce a health hurdle. This central part of our intervention planning ensures that we target those assets which are likely to result in the greatest reduction in PoF. Reduction of PoF reduces the potential for supply interruption and events compromising network capability. Minimising these events will ensure that we continue to have a network which has a high degree of availability. This is something which is important to our stakeholders.

6.47. To balance the condition of our assets and the risk that they pose, we take a multi-dimensional approach to the identification of assets where intervention may be required in the timeframes which are typical for capital transmission system projects.

6.48. The diagram in Figure 5 is a simplified representation of how the needs of asset health and risk are balanced when it comes to intervention planning. The diagram is a theoretical example of how interventions would be categorised in the absence of other relevant information. We present how our RIIO-T3 plans look in a similar format in Section 8.

Figure 5 Diagram Representation of Asset Health and Risk Intervention Approach

6.49. The graph in Figure 6 shows the forecast movement of total network asset risk on the SPT network under three scenarios. Each scenario has a starting risk position of R£2.97bn which represents our best view of the network as it will look at the start of the RIIO-T3 period. To model this view, we have included in the risk models the effect of load and non-load activities forecast to be completed at the end of RIIO-T2.

6.50. Without intervention in RIIO-T3 these assets will deteriorate, and we forecast that they would reach a network risk position of R£4.5bn. Our A1 Non-Load NARM intervention plan will reduce this to R£3.74bn. Load-related projects that include replacement of assets in poor health will further decrease our network risk position to R£3.25bn.

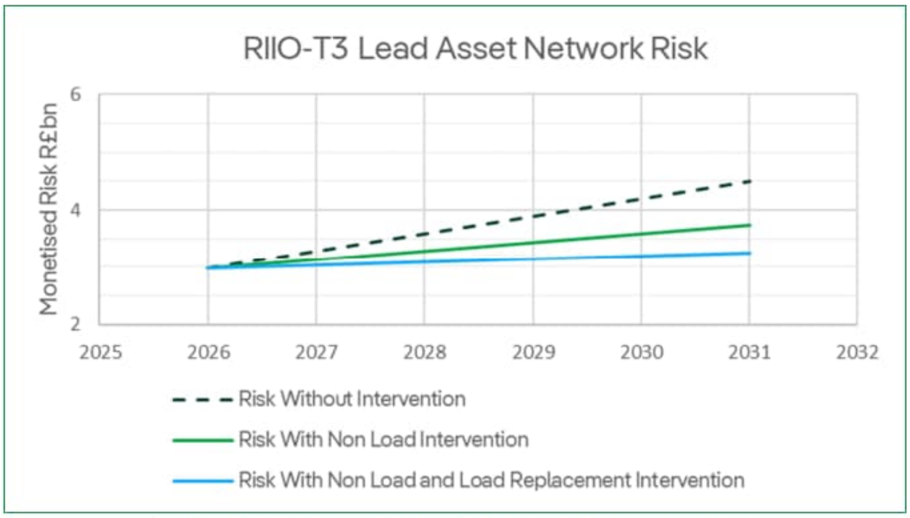

Figure 6 SPT NARM Network Risk Movement Over Time

6.51. As we have described, the RIIO-T3 investment plan focuses on assets whose PoF is forecast to be within bands P8 to P10 at the end of the period to ensure that the maximum value is extracted from the asset base. However, some assets are targeted based on our holistic approach to network management where the driver is not the condition of the lead asset itself. We describe in this annex how we have a detailed understanding of asset condition and a granular, asset level intervention strategy. This ensures that interventions are targeted at assets whose condition merits it and are prioritised by risk and not on a simplistic age-related basis. However, age, or rather the cumulative effect of environmental and duty factors, is a strong factor in asset deterioration so the general pattern of network asset condition is strongly correlated with the commissioning dates of the assets. The progressive investment programme which commenced in TPCR4 has broadly followed the development of the transmission network and the volume of assets in P8 to P10 now constitutes 13% of substation assets and 19% of linear assets. This means that 87% and 81% of assets are in a condition where no condition-based intervention is necessary in this period. Natural progression of this large number of assets through the P bands (while not in a condition that justifies intervention) will increase total network risk more than the reduction caused by the replacement or refurbishment of a much smaller number of assets. Further, as seen in Figure 4, the greatest proportion of network risk is in fittings. The expected life (as confirmed by detailed condition assessment) and prior investment cycles means that approximately 20% of fittings are entering mid-life where, according to the NARM models, their POF and hence risk begins to increase to material levels but still less than would drive intervention.

6.52. The figures show the effect of interventions whose sole driver is to manage network risk (classified as A1 in NARM reporting) and assets that have been directly replaced by projects whose main drivers are related to reinforcement (A2 in NARM). As explained in paragraph 6.51, the result of these interventions is that the risk remaining on the network after we have completed our plan will be greater than at the start of RIIO-T3.

6.53. We think it's important to also reflect our best view of what other asset replacements will occur and these are generally within the scope of connection projects' enabling works and Figure 6 also shows the effect of these replacements. Connections Reform and Clean Power 2030 represents a degree of uncertainty in whether these projects will proceed, according to a timeline consistent with the assets' condition. If these interventions do not occur we will review and either progress as over-delivery within the period or plan for early RIIO-T4.

6.54. Some asset types will experience an overall reduction in total network risk because of our intervention plans while for others there will be an increase. The asset type composition of the total network risk movement in RIIO-T3 is shown in Figure 7.

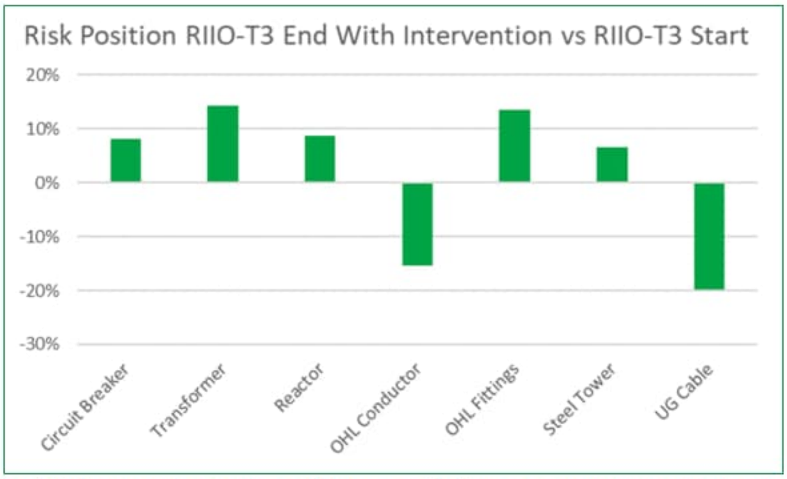

Figure 7 Total Network Risk Position with A1 and A2 Non Load and Load Intervention at RIIO-T3 End Relative to RIIO-T3 Start

6.55. The variance in risk movement as shown in Figure 7 is explained in Table 3 below:

Table 3 Asset Risk Movement Commentary

Asset Category	Commentary
Overhead Line Fittings	An increase in risk due to the ageing of mid-life assets which do not require intervention.
Overhead Line Conductors	Conductor replacement is dominated by the strategic reinforcement programmes. The non-load programme addresses routes not part of the system reinforcements, predominantly 132kV.
Overhead Line Towers	The risk movements reflect the painting cycles as explained in paragraph 6.41.
Underground Cables	The strategy and benefits of replacing fluid-filled cables with condition issues are highlighted with relatively low lengths of cable replacement contributing significant risk reduction.
Circuit Breakers	The natural deterioration of SF_6 assets through their operational life contributes to the risk increase. Risk reduction resulting from network reconfiguration in RIIO-T3 will reduce this risk.
Transformers	A targeted plan manages the risk of the poorest health assets with an increase in risk arising from background network ageing.
Reactors	We have invested in our reactor population during RIIO-T1 and RIIO-T2. Risk movements represent natural transit through the P bands.

Non-NARM Assets

6.56. We are preparing to add more asset types to the NARM Methodology but in the meantime we apply the same asset health philosophy to non-NARM assets. Here we present the principal assets as the population by health score at the start of RIIO-T3 and the population at the end of the period when we have delivered our plan. We don't yet have the means to forecast deterioration for these asset types but this will be developed as we integrate them into NARM. The figures that follow show the populations of the various asset types by their current health score and when we've completed our plan.

6.57. Figure 8 shows the change in population that results from the RIIO-T3 asset management interventions on protection devices. This demonstrates that the plan will effectively target the highest health index devices but there will be a residual number of health index 4 and 5 devices remaining at the end of the period. We have taken a risk-based approach to our intervention plan due to the volume of higher health index devices caused by type issues which have developed during RIIO-T2. We have prioritised the devices with more critical functions – such as transformer main protections and intertrips – because of their effect on network availability should they fail. Looking forward to RIIO-T4, we will turn our attention to the devices performing less critical functions such as backup protection and ancillary control.

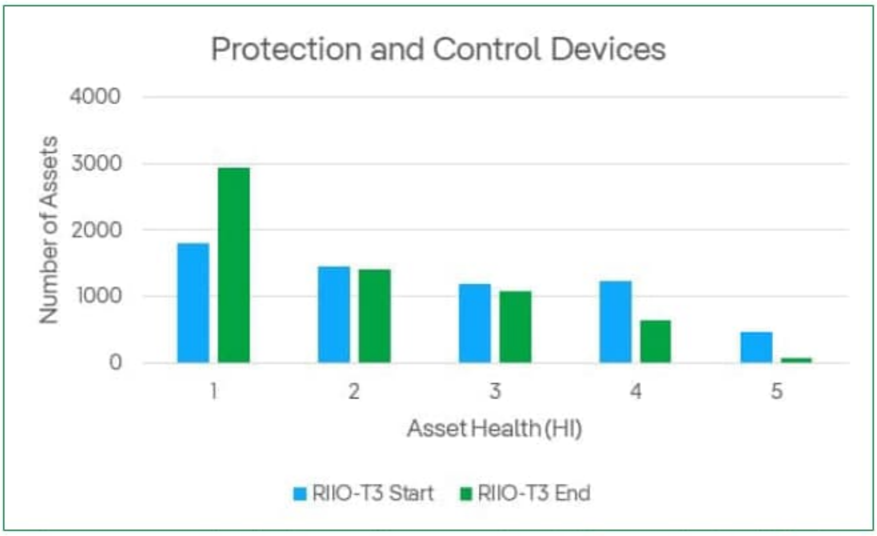

Figure 8 Protection devices at the start and end of RIIO-T3 by health index

6.58. In Figure 9, we've identified the instrument transformers that will be replaced during RIIO-T3. The distribution of the assets' health scores is reflective of the need to replace oil-filled assets by the end of 2025 to comply with the Persistent Organic Pollutants regulations. This means that the population is biased towards the lower health scores with limited interventions being necessary. There are two wider programmes targeting non-NARM assets that have associated CT and VT works at four 132kV substations (Westfield, Kilwinning, Meadowhead and Galashiels). These units can be seen in the changes in health scores P6, P3 and P1. For RIIO-T4 we don't foresee specific intervention requirements, but our view may change in the event of emerging condition or type issues.

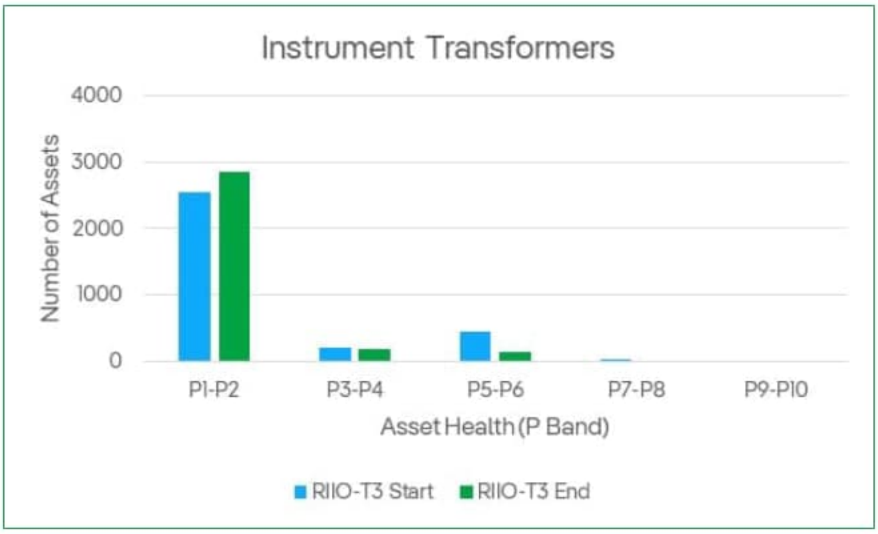

Figure 9 Instrument transformers at the start and end of RIIO-T3 by health score

6.59. Figure 10 is the distribution of disconnectors and earthing switches now and after our intervention plan. The interventions are both targeted at this type of switchgear and those being undertaken on projects where the main driver is another asset type. These projects will replace units at Westfield, Kilwinning, Meadowhead and Galashiels. We have a similar programme for units at Elderslie and Stirling and we have a refurbishment programme for the Acrastyle type of disconnectors, as noted in 5.10. Units will be replaced at Smeaton in a co-ordinated project with circuit-breaker replacement and at four substations where we are replacing transformers. A number of load-related projects will replace higher health score units and our RIIO-T4 plans will be determined by the ongoing inspection and condition assessment processes described in section 5.

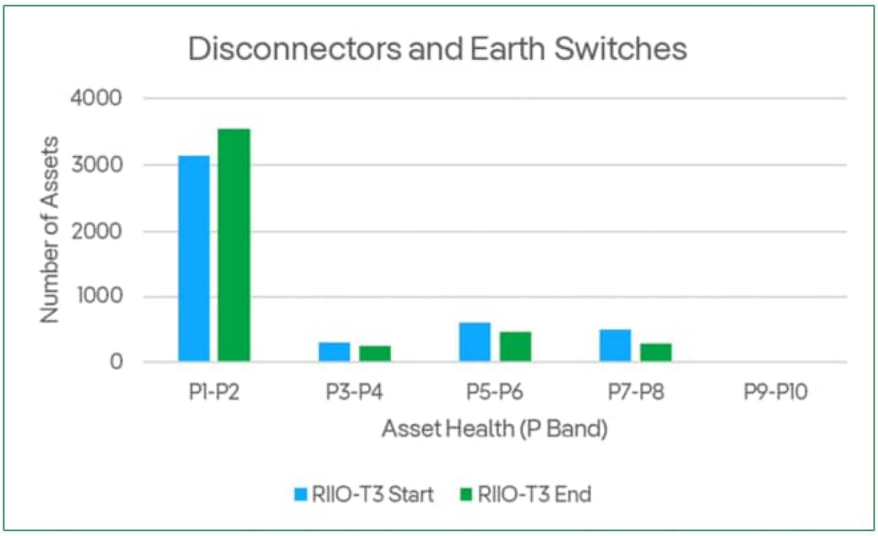

Figure 10 Disconnectors and earth switches at the start and end of RIIO-T3 by health score

6.60. When we commissioned 400kV Gas Insulated Switchgear (GIS) during RIIO-T1, there were no alternatives to SF_6 available on the market. The runs of Gas Insulated Busbars (GIB) contain the majority of the gas in a GIS substation and because much of the GIB is outdoor, tends to be part the most prone to leaks. While we have no concerns over the electrical performance of the installations, through NIA-funded and BAU innovation we have a works to mitigate the risk of future SF_6 leaks by retro-filling the GIB with an alternative gas with a lower global warming potential. This presents an environmental benefit (please see 8.39).

6.61. Civil assets are planned for inclusion in NARM with development work commencing prior to the end of RIIO-T2. We have a well-established inspection and assessment programme which has informed our RIIO-T2 and RIIO-T3 plans. The investment in concrete and steel structure refurbishment during RIIO-T3 has mitigated the risks associated with health index 4 and 5 structures and we will continue to assess the population's condition to inform the RIIO-T4 plan. The programme of transformer bund and oil separator works being delivered during RIIO-T2 continues in RIIO-T3 and, again, ongoing condition assessment will inform plans for future price control periods.

Information Management

6.62. In section 5, we explain the extent of asset and condition data that we gather and how we have automated the processes and plan to enhance the use of IT systems to leverage efficiencies and provide further benefits.

6.63. We employ an industry-standard asset management database which also acts as an integrated work management system. Our implementation of the NARM methodology's mathematical asset models interfaces directly with this system, ensuring that the live view models are regularly updated with new condition information and changes to the asset base.

6.64. Pillar 3 of our Non-Operational IT and Telecoms Strategy outlines the developments we have planned for our asset information systems.

7. Intervention Process

7.1. Assets are retired as they reach the end of their serviceable life. Our policies on asset inspections and interrogation are well embedded within the organisation and they underpin our capital investment process. This includes assessing the risk of asset failure and its impact on communities in terms of reliability, safety and environmental risks, as and when, new asset condition data is available.

7.2. Prioritisation of strategies aligned with the Business Plan and Asset Management Policy requires consideration of the performance, cost, and risk implications. Decisions are required to manage risks and opportunities at each stage in the development of the Investment Programme. We apply criteria to support these decisions facilitating delivery of the asset management objectives while balancing cost efficiency with asset performance at an acceptable level of risk.

7.3. The Network Asset Risk Methodology (NARM) describes how asset risks are assessed to inform capital investment decisions. This methodology is applied across all assets supported by several processes and tools to ensure:

7.4. Network asset risks are identified, assessed, and managed in a systematic and consistent manner across the asset base.

7.5. Root causes of potential failures and their consequences are understood to support justification in capital and operating expenditure.

7.6. Investments are prioritised and programmed to ensure that the intervention is completed before the assets reach a condition which compromises their operation. However, this must take due consideration of supply chain capacity and system access availability. We take care to align system outages with other project works and very often routine maintenance activities to minimise supply risk and the effect on the network. As discussed in section 6, planning of replacements is a single process with the planning of system reinforcements and connections. This has allowed us to programme some interventions to minimise system access. Just one example is the programming of major overhead line and substation interventions when strategic reinforcement projects were being developed. High confidence in our knowledge of asset condition was essential to permit the deferral of substation and overhead line asset replacement until the scope of projects to deliver major reinforcement of the B4 and B5 system boundaries known as ECUP, LWUP and TKUP had matured. The replacement works will proceed under these projects with scopes of work to provide additional capacity, ensuring that the right capacity was provided first time and minimising the outages required.

7.7. The output of the strategy is the asset management programme of works comprising two components.

7.8. Replacement initiatives: In section 8 we describe the planned replacements that our strategy has determined to be best delivered during RIIO-T3 to manage condition issues before they impact safety or network performance. These include overhead line conductors and fittings, fluid-filled cables, switchgear, transformers, protection, control and monitoring.

7.9. Refurbishment initiatives: We can refurbish some transformers whose inherent condition is good but where there are mainly external elements such as corrosion and deteriorated bushings which need to be addressed. We can also refurbish some aspects of our civil estate, and overhead line tower steelwork is remediated and painted.

7.10. Our Integrated Asset Management approach can be summarised by the asset life cycle stages shown below:

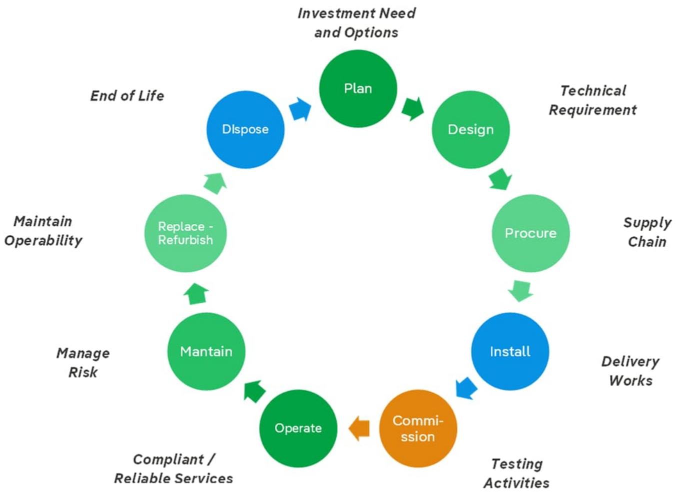

Figure 11 Asset Lifecycle

Intervention Opportunities

7.11. Key decisions assist to achieve the strategic objectives and decision making throughout the life cycle stages (refer to Figure 11). This includes decisions on capital investment and operational expenditure, resourcing, life cycle value realisation, risk and health and safety management.

7.12. Our asset management decision framework is fundamental in supporting the appraisal of future reinvestment needs, particularly in relation to:

- Monitoring and analysis of asset health, condition, and performance.
- Identifying the emerging needs for asset intervention to enable considered and prudent decision making.
- Consideration of all economic and technically feasible options.
- Assessment of benefits, risks, and costs.
- Whole of life cycle planning.

7.13. Reinvestment in assets approaching the end of their technical service life forms a substantial part of our future network investment plans across the 5-year period. Accordingly, the assessment of risk associated with the condition and performance of these assets is of particular importance. In order to inform such risk assessments, we undertake periodic reviews of network assets considering a broad range of factors, including physical condition, capacity constraints, performance and functionality, statutory compliance and ongoing supportability. This aspect is detailed in section 5

Cost Benefit Analysis

7.14. Cost Benefit Analysis (CBA) is a long-standing tool to inform investment decisions and we have employed it once again in the creation of our RIIO-T3 business plan. It is particularly useful where benefits can be monetised in a transparent and consistent way. This can be challenging in this sphere but the NARM LTRB is useful in quantifying relevant system, safety and environmental factors.

7.15. We have supplied a package of CBAs to support the individual investments where it provides a meaningful insight into the investment decision. Examples of where it is a useful tool are:

- Transformer refurbishment: where a transformer has condition issues but is suitable for refurbishment, we test the costs and benefits against an option to replace it. We also account for the potential future requirement to provide additional capacity in the assessment.
- Overhead line refurbishment: because conductors and fittings have different operational lives, a CBA can be used to guide the decision to retain or replace fittings when conductors are being replaced.

7.16. The CBAs employed in the compilation of the business plan are thus an important component of the monetised risk objective as they influence the level of risk remaining on the network at the end of the period and the LTRB that results from the intervention plan.

Stakeholder Engagement

7.17. The process to generate an asset management plan is highly complex (particularly the creation and application of monetised risk) and requires significant technical knowledge to fully appreciate it. We therefore focus our engagement with stakeholders who have a direct relationship with our network or who have the specialist insight to provide feedback.

7.18. We engage on a regular basis with our connected customers to provide information on our strategic plans as they relate to them and more generally. For example:

[redacted]

7.19. Our NARM methodology has a direct bearing on our monetised risk objective and we consult widely on updates and changes. The consultations are co-ordinated with those of the other onshore TOs and we share feedback to share best practice and consistency.

7.20. The Independent Net Zero Advisory Council (INZAC) provides robust review and challenge of our ongoing operations and for the RIIO-T3 business plan process, specific ‘buddy groups’ have been established to review and challenge the detail of the plan. This allows those members with the required technical background to review and challenge all aspects of the asset management plan. The skills and experience of this group are invaluable to provide the level of insight and feedback required. They support our proposals and our strategic approach.

Resilience

7.21. This strategy details how we manage the effects of asset age and condition. As a business we also plan how we manage the impacts of climate change, the cyber security and physical security environments.

Climate Resilience

7.22. We have a comprehensive climate resilience strategy that places significant emphasis on the protection of transmission assets from the impacts of climate change. The structured, detailed approach which aligns with national and international climate frameworks can be found in our Climate Resilience Annex.

Cyber Resilience

7.23. The effective functioning of the transmission network relies on the underpinning operational technology (OT); the efficient operation of the business is founded on best-practice IT systems. As an Operator of Essential Services, OT and IT are within the scope of the NIS regulations. Our comprehensive Cyber Resilience Business Plan details our strategy for the effective management of cyber risks related to our OT and IT networks.

Physical Security

7.24. The transmission network comprises assets and systems that are classed as Critical National Infrastructure (CNI) and other assets which, while not CNI, provide critical services to the nation. We are active participants in industry groups which define the level of threat being faced and we test our security measures against current requirements and good practice by employing independent assessors. We have provided confidential EJPs to explain our proposals for CNI and non-CNI assets and systems.

8. RIIO-T3 Strategy and Planning

8.1. Our plans aim to maintain the performance of the network as the assets continue to age and deteriorate. The investment plans are largely built up from targeted asset replacement programmes which will ensure ongoing efficient and reliable transmission services.

8.2. With significant development of the network occurring in the 1950s and 1960s, parts of the network are now beyond their original design lives and the condition of these assets has deteriorated. To ensure continued safe and reliable service, we have developed investment plans to intervene on deteriorated assets progressively where the risks to reliability and safety outweigh the cost of replacement or refurbishment. This is a continuously measured programme which ensures costs to current and future consumers are given appropriate consideration.

RIIO-T3 Programme

8.3. Managing the underlying risk of our network is a key pillar of our overall reliability strategy. A reliable network forms the basis for satisfying customers' current and future demands for electricity and expectations on its availability.

8.4. We have discussed our approach in this area with customers and stakeholders and explored their attitude to underlying network health and risk more generally. The strong feedback that we received was that we should at least look to maintain network risk at its current levels, given the increasing importance of electricity in the future with the Net Zero transition. Our plan looks to achieve just that, through a balanced portfolio of investment in our different asset types and through co-ordination with connections and reinforcement projects. The cost of this plan is also reduced through our use of techniques such as refurbishment, a number of which are the direct result of previous innovation programmes. Our Innovation Annex includes further details of proven innovations that we are deploying in RIIO-T3, e.g. High Temperature, Low Sag conductor.

8.5. In order to identify the appropriate mix of work, we have used our internal modelling tools supported by Cost Benefit Analysis (CBAs) of the different options by individual asset type. Our overall NARM proposal for RIIO-T3 is summarised in the table below. This shows our NARM target of LR£23.1bn which, when combined with the assumed incidental risk benefits of other planned investment programmes enables us to maintain the overall network risk position at an acceptable level across the RIIO-T3 period.

8.6. On the next pages we summarise our RIIO-T3 non load related intervention plans for lead assets. A detailed commentary on these plans then follows before we provide a narrative on our non-lead asset interventions. Case studies are provided with additional information.

Table 4 Summary of Overhead Line Projects' Costs and Risk Benefits

	Route	Data Collection	Evidence	Incremental Cost	Circuit Length (Km)	Delivery Year	Total Cost	Output	Monetised Risk Benefit
Major Refurbishment									
132kV	BE	Conductor sampling Foundation inspections	Presence of corrosion in conductor. Reduction ductility on Al Strands	AAAC Sycamore conductor. 10% towers foundation upgrades.	15.28	2029	£8.44m	Conductor Earthwire Fittings Tower	Lr£320.11m
	BV	Conductor sampling Foundation inspections	Corrosion on internal wires on earthwire	10% towers foundation upgrades	13.18	2027	£6.92m	Conductor Earthwire Fittings Tower	Lr£427.68m
	AZ	Conductor sampling Foundation inspections	Corrosion on internal wires	10% towers foundation upgrades	7.7	2027	£4.84m	Conductor Earthwire Fittings Tower	Lr£333.75m
	BT	Conductor sampling Foundation inspections	Cormon - partial and severe results Earthwire corrosion	AAAC Sycamore conductor. 10% towers foundation upgrades.	22.1	2030	£17.41m	Conductor Earthwire Fittings Tower	Lr£1285.59m
	CH	Detailed Condition Assessment	End of Life fibre wrap	Fiber Wrap on Earthwire. 10% towers foundation upgrades.	2.82	2029	£1.25m	Earthwire Fittings Tower	Lr£89.19m
275kV	XT	Conductor sampling Foundation inspections	Cormon - severe results. Reduction ductility on Al Strands	Fiber Wrap on Earthwire. 10% towers foundation upgrades.	3.08	2030	£2.91m	Conductor Earthwire Fittings Tower	Lr£249.09m
	XW	Conductor sampling Foundation inspections	Corrosion on internal wires	Fiber Wrap on Earthwire. 10% towers foundation upgrades	7.20	2028	£4.60m	Conductor Earthwire Fittings Tower	Lr£163.84m
	YF	Conductor sampling	End of Life fibre wrap.	Fiber Wrap on Earthwire. 10% towers foundation upgrades	8.54	2028	£5.51m	Conductor Earthwire Fittings	Lr£440.52m

		Foundation inspections						Tower	
	YK	Conductor sampling Foundation inspections	Reduction ductility on Al Strands	Fiber Wrap on Earthwire. 10% towers foundation upgrades	8.00	2028	£7.47m	Conductor Earthwire Fittings Tower	Lr£250.66m
Minor Refurbishment									
132kV	AF	Condition Assessment	Severe rust and wear earthwire fittings	-	32 Towers	2030	£0.11m	EW Fittings	-
	AH	Condition Assessment	Bent crossarm member	-	10 Towers	2030	£1.82m	Tower	-
	CG	Condition Assessment	Polymeric fitting damaged	Wood Pole Polymeric Insulators	37 Poles	2027	£0.89m	Fittings	-
	DD	Condition Assessment	Woodpecker damage on poles	Wood Pole	162 Poles	2028	£2.70m	Poles	-
	CN	Condition Assessment	Premature corrosion	-	17 Towers	2027	£0.59m	Fittings	-
Dismantling									
	XU	Condition Assessment	Network re-configuration	-	5 Towers	2029	£0.74m	-	-

Table 5 Table 5 Cable Project Costs and Risk Benefits

Cable Route / Voltage	**Cable Type**	**Intervention**	**Evidence**	**Cost Drivers**	**Volume (cct. Km)**	**Delivery Year**	**Total Cost**	**Monetised Risk Benefit**
Innerwick-Dunbar 1 and 2 / 132kV	Fluid Filled	Replacement	Continued leaks requiring significant repairs	Cable Route: engineering difficulties	8.96	2029	£17.92m	Lr£906.65m
Braehead Park - Erskine No.2 / 132kV	Fluid Filled	Replacement	Oil condition indicated acetylene (internal electrical arching)	Cable Route: engineering difficulties / Future Demand Forecast / Overhead Line works	6.40	2030	£12.71m	Lr£212.14m

Currie Gorgie 1 and 2 / 132kV	Mix Sections [Fluid Filled / XLPE]	Replacement	Deterioration copper reinforcing tape surrounding lead sheath	Cable Route: engineering difficulties / Urban Area	5.62	2031	£16.04m	Lr£479.07m
YB41A - Govan	XLPE	Replacement	Burning/tracking between corrugated sheath and semi-conductive screen	Cable Route: engineering difficulties / Urban Area	8.20	2028	£11.50m	Lr£329.28m
BW – Spango Valley	XLPE	Replacement	Moisture ingress in sealing ends. Cable manufacturer no longer exists.	Cable Route: engineering difficulties	0.40	2027	£3.2m	Lr£0.09m

Table 6 Circuit Breaker Project Costs and Risk Benefits

Substation Site	**Output**	**Intervention**	**Evidence**	**Cost Drivers**	**Volume (Each)**	**Delivery Year**	**Total Cost**	**Monetised Risk Benefit**
Smeaton 275kV	Circuit Breaker AIB (OD)	Replacement / In-Situ	Operational Adequacy	SF_6 Free / Disconnectors / Refurbish civils	5	2030	£4.92m	Lr£58.01m
Eccles 400kV	Circuit Breaker AIB (OD)	Replacement / In-Situ	Reyrolle SPL2: Duty issues and SF_6 gas leakage	SF_6 Free / Post Insulators / Refurbish civils	2	2029	£1.22m	Lr£21.11m
Strathaven 400kV	Circuit Breaker AIB (OD)	Replacement / In-Situ	Reyrolle SPL2: Duty issues and SF_6 gas leakage	SF_6 Free / Post Insulators / Refurbish civils	1	2030	£0.66m	Lr£16.87m
Cockenzie 275kV	Circuit Breaker AIB (ID)	Replacement / In-Situ	Reyrolle SPL2: Duty issues and SF_6 gas leakage	SF_6 Free / Refurbish civils	11	2030	£6.13m	Lr£56.38m
Westfield 132kV	Circuit Breaker AIB (OD)	Replacement / GIS	Operational Adequacy	GIS SF_6 Free	11	2028	£35.33m	Lr£24.72m

Table 7 Transformer replacement projects' costs and risk benefits

Substation Site	**Output**	**Intervention**	**Evidence**	**Cost Drivers**	**Volume (Each)**	**Delivery Year**	**Total Cost**	**Monetised Risk Benefit**
Cockenzie 275kV	Transformer – 275kV<240MVA	Replacement	Bruce Peebles: inherent type defect	In-Situ / EAT & NER / New plinths / 33kV Cable	1	2029	£7.60m	Lr65.26m

Kaimes 275kV	Transformer – 275kV<240MVA	Replacement	Bruce Peebles: inherent type defect	Offline / New plinths / EAT & NER / 33kV Cable	1	2030	£5.12m	Lr£106.08m
Kilbowie 132kV/60MVA	Transformer – 132kV<=90MVA	Replacement	Subsidence	90MVA unit / Layout / EAT & NER / New plinths / 33kV Cable	2	2031	£10.38m	Lr£93.55m
Devol Moor 132kV/60MVA	Transformer – 132kV<=90MVA	Replacement	Dissolved gases indicating thermal fault	90MVA unit / 33kV Cables	1	2029	£4.82m	Lr£66.03m
St Andrews Cross 132kV	Transformer – 132kV<=90MVA	Replacement	Type fault– short circuits	Indoor / Midel filled transformers / Disconnector	2	2031	£5.55m	Lr£213.79m
Crookston 132kV/60MVA	Transformer – 132kV<=90MVA	Replacement	Oil analysis - acidic results	90MVA unit / 33kV Cables	2	2029	£9.71m	Lr£50.28m
Coylton 132kV/60MVA	Transformer – 132kV<=90MVA	Replacement	Life span reduction due to dilution effect of top ups	90MVA unit / 33kV Cables	1	2029	£4.56m	Lr£18.43m
Hunterston 400kV	Transformer – 400kV<500MVA	Replacement	Wet insulation, high failure consequence due to tank design	New plinth	2	2031	£12.27m	Lr£98.37m

Table 8 Transformer refurbishment projects' costs and risk benefits

Substation Site	**Output**	**Intervention**	**Evidence**	**Cost Drivers**	**Volumes (Each)**	**Delivery Year**	**Total Cost**	**Monetised Risk Benefit**
Clydesmill SGT1	Transformer – 275kV <240MVA	Refurbishment	Bushing - Widespread corrosion Cooler Bank – Oil Pooling	In-situ / Wound refurbishment	1	2027-2031	£0.98m	Lr£309.89m
Clydesmill SGT2	Transformer – 275kV <240MVA	Refurbishment	Main & Selector Tanks - Significant weeps of oil	In-situ / Wound refurbishment	1		£1.01m	
Partick T2	Transformer – 132kV<=90MVA	Refurbishment	Bushing - Widespread corrosion Main & Cooler Bank – Oil Pooling	In-situ / Wound refurbishment	1		£0.69m	
Glenluce T2	Transformer – 132kV<=90MVA	Refurbishment	Earthing Tx – Severe Corrosion Main Tank – Severe Leakages	In-situ / Wound refurbishment	1		£0.77m	

Wishaw SGT7	Transformer – 275kV <240MVA	Refurbishment	Cooler Bank – Major widespread corrosion	In-situ / Wound refurbishment	1		£0.97m	
Wishaw SGT6	Transformer – 275kV <240MVA	Refurbishment	Main Tank - Corrosion	In-situ / Wound refurbishment	1		£0.96m	
Ayr SGT1	Transformer – 275kV <240MVA	Refurbishment	Bushing - Widespread corrosion	In-situ / Wound refurbishment	1		£0.97m	
Saltcoats T1A	Transformer – 132kV<=90MVA	Refurbishment	Main & Selector Tank – Oil pooling	In-situ / Wound refurbishment	1		£0.64m	
Glenluce T1	Transformer – 132kV<=90MVA	Refurbishment	Main Tank & Cooler Bank – Oil pooling	In-situ / Wound refurbishment	1		£0.64m	
Dunfermline T1	Transformer – 132kV<=90MVA	Refurbishment	Main Tank – Oil pooling Cooler Bank – Major corrosion	In-situ / Wound refurbishment	1		£0.65m	
Dunfermline T2	Transformer – 132kV<=90MVA	Refurbishment	Cooler Bank – Major corrosion	In-situ / Wound refurbishment	1		£0.69m	
Marshall Meadows T1	Transformer – 132kV<=90MVA	Refurbishment	Main Tank & Cooler Bank – Corrosion	In-situ / Wound refurbishment / Disconnector Replacement	1		£2.20m	Lr£47.32m
Marshall Meadows T2	Transformer – 132kV<=90MVA	Refurbishment	Main Tank & Cooler Bank – Corrosion	In-situ / Wound refurbishment / Disconnector Replacement	1			

Overhead Lines

8.7. In RIIO-T2, there was a large programme to refurbish 132kV overhead lines by replacing ACSR core-only greased conductors. Critical 400kV routes (ZA, ZO/ZR/XF) were also identified for conductor replacement. The plan was also complemented with an extensive conductor-fitting replacement programme aimed to avoid fatigue and therefore increase the life of the 1970s fully greased conductor population. Following the evidence obtained by condition assessment, a programme of tower painting was put forward to avoid steelwork deterioration and extend tower life expectancy.

8.8. In RIIO-T3, our programme continues to target ACSR core only greased conductors following even wider evidence captured during the RIIO-T2 period. By the end of RIIO-T3 all ACSR core only greased conductor will be removed, a continuation of the plan originally started in RIIO-T1. Targeted insulator and wood pole replacement will form part of the programme. A breakdown of the RIIO-T3 programme has been summarised below:

8.9. 132kV Major Refurbishment Programme: The strategy for RIIO-T3 is to replace the conductors and earthwire where we have evidence that their condition has reached the point where further loss of strength would lead to unacceptable safety and network availability risks. Where the fittings have significant life remaining, we will retain them as this is the most economical option. We have assessed the towers to have sufficient remaining life to justify their retention and the replacement of the conductor. However, we will need to do some remedial works, treating corroded steelwork where we can and replacing individual steel bars that can't be repaired. As anticipated in RIIO-T2 and proved by extensive site investigations, foundations of towers of a design known as PL16 were not installed as they should have been in the 1950s and 1960s. This will result in an average of 10% of foundations being upgraded on the routes we are refurbishing.

8.10. BE and BT Routes are ACSR Lynx planned to be replaced by AAAC Sycamore, and not AAAC Poplar (as standard like for like practice). AAAC Sycamore will introduce a 20% additional rating when compared with AAAC Poplar for a 5% incremental cost. This approach to Strategic Investment has been supported by stakeholders.

Figure 12 132kV Conductor Sample evidence on BE Route

8.11. 275/400kV Major Refurbishment Programme: Our strategy is to replace conductor and earthwire where there is condition-based evidence that intervention can't be deferred. We will refurbish towers using the same approach as for the 132kV network. The foundations don't have the same installation issue, but our experience in RIIO-T1 and RIIO-

T2 shows that we will need to refurbish 10% of foundations on average, including at critical tension towers. Only four routes (BE, XT, XW, AZ and BT) have core-only greased conductors and are included in the RIIO-T3 plan. The remaining routes with ACSR conductor are of the fully greased type, and our condition assessments have determined that these are fit for service until RIIO-T4 or beyond.

8.12. <u>Minor Refurbishment Programme</u>: These types of schemes do not include the replacement of phase conductor or earthwire. The programme is targeted on several routes where insulator fittings and poles have showed signs of deterioration as captured in route specific condition assessment.

8.13. <u>Tower Painting Programme:</u> This is a critical programme to the integrity of the ~6700 towers on the SPT network. Steel towers have a design life of 80 years which can be significantly extended if towers are painted at appropriate intervals before material degradation of the galvanic protection and corrosion of tower steelwork occurs. The painting of routes is prioritised by tower condition which is recorded by the condition assessment programme and is affected by the environment in which the tower operates. The environment is dependent on several factors including proximity to the coast, altitude and proximity to other pollutants such as thermal generation or industry. These factors drive investment frequency which can range from 10-15 years between painting of assets dependent on the environment. The design philosophy for this scheme is consistent with the RIIO-T3 strategy, seeking to efficiently upgrade the structural capability and reliability, whilst maintaining the good service condition of the towers during their 80+ years in operation.

8.14. Our RIIO-T3 overhead line intervention plan is shown diagrammatically in Figure 13. Conductors are shown as representative of the OHL portfolio given that this is the main driver for capital intervention in RIIO-T3. Other T3 Risk Management includes work under load mechanisms in addition to the wider works captured under NARM A2.

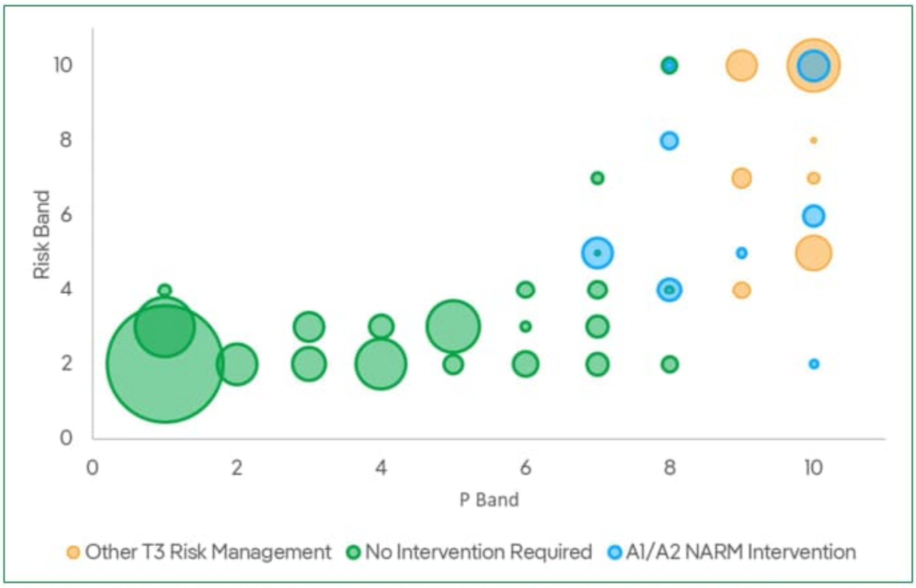

Figure 13 Overhead Line Conductor Interventions Showing Asset Volume by Asset Health and Risk

Underground Cables

8.15. Our asset intervention strategy is to replace the poorest condition, highest risk assets before failure occurs. In RIIO-T2 our focus was to refurbish fluid filled cable circuits in order to maximise their lives as far as possible. This refurbishment programme proved to be effective on the selected 275kV circuits and went ahead as planned. The costs associated with these refurbishments proved higher than anticipated due to wider market conditions and therefore can now be considered to be uneconomical compared to replacement when weighed against the delivered asset lives. As a result, the decision was taken to re-evaluate the 132kV fluid filled cable circuit refurbishments. The project to replace the 132kV cables between Gorgie and Telford Road substations is in progress and the remaining section of this cable circuit between Gorgie and Currie substations is planned for delivery in RIIO-T3. Replacing these cables has presented significant challenges due to the urban environment in which they are located. During RIIO-T2, a number of fluid filled circuits were selected for Perfluorocarbon Tracer (PFT) tagging. This technology has enabled faster and more efficient cable fluid leak detection improving network availability and reducing the environmental impact of leaks.

8.16. In RIIO-T3, our strategy therefore for fluid filled cables has moved from refurbishment to targeted replacement. In addition to the higher than expected cost, fluid filled cables are becoming difficult to support due to limited spares availability and the diminishing technical expertise to work on them. Repair and jointing works require specialist knowledge and equipment and this is now only available from a small number of contractors. The condition assessment programme carried out in RIIO-T2 has informed the priority of replacement candidates. Circuits have been chosen for replacement due to high leakage history or based on their condition an example of which is discussed in paragraph 5.24. We plan to continue our programme of PFT tagging in RIIO-T3.

8.17. Braehead Park – Erskine No.2: This cable was originally a refurbishment candidate in our RIIO-T2 plan. A number of factors have driven the decision to now replace it as mentioned in section 8.15 The principal driver for the replacement is the condition of the cable. This scheme takes into account the general condition of the cable accessories, the recent exposure of the cable at water course crossings and recent maintenance and sampling results where sheath faults and heightened levels of gassing in the cable fluid indicating poor internal condition have been detected. Several transmission reinforcements are contracted in this part of the network and as a result the Braehead Park – Erskine number 1 circuit is also being replaced to facilitate load growth. These projects are being considered holistically and the condition driven works on the number 2 circuit will match the rating of the new number 1 circuit. In addition, these circuits are hybrid in nature, including a section of overhead line. BZ route will be reconductored in order to match the rating of the new cable system. The new cable route in the proposal also allows rationalisation of the overhead lines in the Erskine area by facilitating the removal of 5 spans of BZ route.

8.18. YB041A – Govan: The cables between YB041A and Govan substation were installed in 2002 and are therefore an early design of XLPE cable. Following a cable fault in January 2024, investigations have found burning between the semi-conductive screen and the corrugated aluminium sheath. This burning has been found on a sample taken from an adjacent un-faulted phase, and as a result, the prediction is that this phenomenon will be present throughout both circuits between tower YB041A and Govan. This cannot be rectified and therefore both circuits need replaced to allow these circuits to operate reliably.

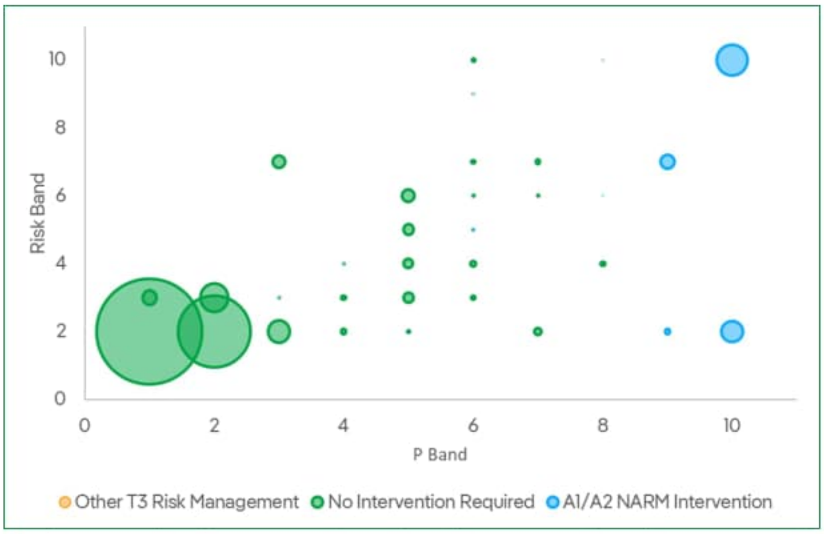

Figure 14 Underground Cable Interventions Showing Asset Volume by Asset Health and Risk

Substation Lead Assets

Circuit Breakers

8.19. Our asset intervention strategy is to replace or refurbish the poorest condition, highest risk assets. In RIIO-T2, our main priority was air blast and bulk oil circuit breakers. These assets were approaching end of life, were lacking in manufacturer support and were unsuitable for further work to extend their operational life. The replacement of these asset types also included the replacement of the associated non-lead and civil assets due to their condition. We initiated a programme of work on SF_6 circuit breakers with hydraulic and pneumatic mechanisms. The hydraulic systems' condition had worsened due to deterioration of the dynamic seal which can lead to mal operation of the circuit breakers. We have delivered a programme of refurbishment on 400kV circuit breakers as cost benefit analysis determined this was the most beneficial to consumers. At lower voltages we have replaced the assets. We increased our effort to minimise SF_6 leakage in a combination of asset replacement and asset refurbishment.

8.20. In RIIO-T3, our strategy remains the same and we will remove the last oil circuit breaker from our network at 132kV and above as part of our programme of works at Westfield 132kV substation. We will also remove the last air blast circuit breakers from our network at Longannet 275kV substation as part of the LWUP project.

8.21. Our focus remains the same on SF_6 circuit breakers and we plan to intervene on assets with hydraulic or pneumatic mechanisms. We have addressed the problematic assets we identified in our RIIO-T2 plan, however, problems continue to persist with hydraulic mechanisms and their sealing arrangements. We have considered refurbishment, but the support no longer exists to carry out the level of refurbishment required and therefore replacement is necessary. We have also reviewed the SF_6 leakage history of circuit breaker families. We have identified circuit breaker types with a family history of leakage, we know common leakage points and costs associated with remediation of gas leaks. We have identified circuit breakers which currently do not leak but there is compelling evidence that they will and when they start to do so the leakage will be substantial. We plan to replace these circuit breakers now to avoid leakage. In RIIO-T3 we plan we will install SF_6 free circuit breakers where this is viable, and our ambition is that all circuit breakers in our switchgear plan will be SF_6 free.

8.22. Westfield 132kV substation is a key node in the 132kV network in Fife with interconnection to Bonnybridge in the Central area. As part of our RIIO-T2 plan, there is an Ofgem approved project to replace the substation in RIIO-T3 due to the condition of the 132kV circuit breakers and the non-lead assets on site. Since then, we have had to accelerate the replacement of a number of the 132kV circuit breakers due to the assets exhibiting end of life conditions. We still have three of the remaining circuit breakers in service which we will retire in RIIO-T3. The civil assets on site are in an end-of-life condition. We have considered retaining and refurbishing the civil structures, however due to their condition any life extension would be short. We have considered in-situ replacement however this would require the substation to be extended and long outages (with resultant increased supply continuity risk) required to facilitate the replacement programme. Our preferred, and lowest cost, option is to build a new 132kV SF_6 free Gas Insulated Substation (GIS) in spare ground, currently available in the 275kV substation compound. This will allow the substation to be built off-line and have short duration outage to connect the new circuit. We will retain the circuit breakers we had to deploy in RIIO-T2 as strategic spares. On completion of the GIS works, we will demolish the existing 132kV substation and use the land for our strategics project planned for this area.

8.23. **Cockenzie 275kV** substation was built to facilitate the connection of Cockenzie Power Station to the 275kV network. The substation's circuit breakers were originally air blast and were subsequently replaced with SF_6 models in the early 2000s. Of the circuit breakers on site, eleven are Reyrolle SPL and this type is now experiencing significant issues with their hydraulic systems. If the deterioration continues the circuit breaker will eventually be unable to maintain hydraulic pressure and will be unable to operate. We have considered their refurbishment, but the Original Equipment Manufacturer cannot provide the level of support required to carry this out. Our preferred option is to replace them with a SF_6 free equivalent utilising the exiting foundation were possible. If this technology is not available, then we will replace with a modern SF_6 circuit breaker.

8.24. Figure 15 outlines the distribution of the circuit breaker portfolio at the end of the period, without intervention and the assets we plan to intervene on have been highlighted by category. For circuit breakers, asset risk mitigation in RIIO-T3 is managed by our A1 and A2 intervention programme alongside other works, typically wider works involving network reconfiguration and substation voltage uprating. Some lower health assets are subject to intervention and the driver for this is discussed as part of our Westfield 132kV substation rebuild works in paragraph 8.22.

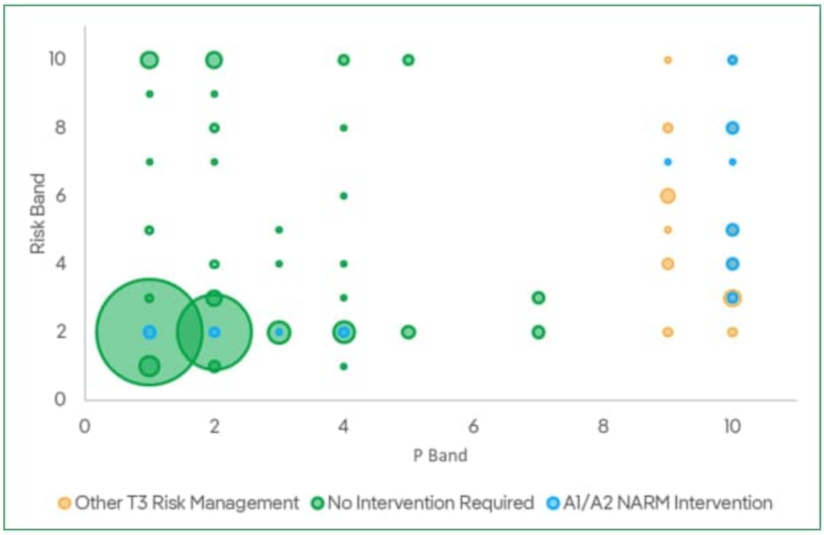

Figure 15 Circuit Breaker Interventions Showing Asset Volume by Asset Health and Risk

SF_6 Management Plan

8.25. In RIIO-T2 we made a commitment to install SF_6 free equipment, when it was technically viable, and we have upheld that commitment. We also instigated a programme to reduce gas leakage which was a combination of asset replacement, asset refurbishment and repairs. As RIIO-T2 has progressed, we have seen an overall reduction in leakage indicating the success of this programme. As expected, on some assets when we repaired a leak, the next weakest point, with regard to leakage, was exposed and therefore repairs continue, however, we are satisfied with the progress that has been made.

8.26. In RIIO-T3 we still plan to replace some leaking assets but typically there are additional factors driving their replacement. We will carry out any leak repairs as part of our business as usual inspection and maintenance programme.

8.27. Our SF_6 strategy is discussed in more detail in our environmental action plan, however, it constitutes four distinct initiatives. We plan to proactively intervene on assets which have known leakage points and make these repairs before they start to become a problem. We plan to replace gas density monitoring on a family of asset which are known to leak, in potentially multiple areas, to allow us to record gas density outputs on our System Health Map and respond quicker to any leakage. We also plan to install barrier protection on flanges and interface points on outdoor Gas Insulated Busbar (GIB). This barrier protection will stop water entering the sealing arrangement of GIB, therefore, reducing the likelihood of corrosion and associated leakage. We plan to retrofill SF_6 equipment which is discussed in more detail later in 8.39 and 8.40.

Transformers

8.28. Our aim is to always intervene on assets before failure and this is particularly important for transformers. They are typically large assets, full of flammable liquid with long lead times and we therefore ensure we have a detailed understanding of each asset. In RIIO-T2 our transformer plan was made up of transformer replacements and refurbishments. We have a number of 275/33kV assets manufactured by Bruce Peebles that suffer from a type fault. We have replaced these on a prioritised basis in RIIO-T1 and RIIO-T2 with two remaining on the system. Other candidates for replacement were based on either the dissolved gas signature or the level of depolymerisation of the paper insulation. When we remove a transformer from service, we carry out a detailed forensic examination. These examinations allow us to confirm the results of dissolved gas analysis, particularly around the remaining life of a transformer insulation system. Armed with this knowledge, we planned a transformer refurbishment programme.

8.29. Our programme in RIIO-T3 follows the same principle set out in RIIO-T2. We will make sure we have a detailed understanding of each asset and plan accordingly. We will replace the two remaining Bruce Peebles transformer that suffer from the type defect. We have continued to carry out forensic analysis of decommissioned transformers and have found , when assets have a history of severe oil leakage, our understanding of the asset can be compromised, particularly of the insulation condition. We have therefore identified assets for replacement as they have leaks that cannot be repaired on site. We also have concerns that the condition of the insulation system is very likely to be poorer than indicated by the DGA signature, due to dilution by oil top ups. We have also taken a number of other factors into account when building our plans in RIIO-T3. We have taken a view of what is the best overall solution for a substation. For example, when we are replacing a 60 MVA 132/33kV transformer we are choosing to replace with a 90MVA unit, the highest rating we have at this voltage level. We have taken this Strategic Investment approach as the incremental cost to increase the rating now is minimal and preferable to having to replace a new asset, well before its end of life, if the loading on the substation increases. We are also replacing assets a short time before they fully reach end of life, due to their ancillary components being in an end-of-life condition. Investment in the ancillary components now would be stranded when the main asset becomes end of life in RIIO-T4, however, investment in the ancillaries cannot be delayed further and we will make the most economically efficient decision and replace them now.

8.30. We will continue with the refurbishment programme in RIIO-T3, that we established in RIIO-T2. We have identified candidates from their oil results and then carried out electrical testing to confirm that they are suitable for refurbishment. When we refurbish a transformer, we carry out a number of different activities. Typically, we replace and upgrade the cooling systems, overhaul the tap changer, replace all of the transformer bushings, refurbish and paint the transformer steelwork amongst other activities. We aim to extend the life of a transformer by 20 years by carrying out a refurbishment.

Replacement Programme Overview

8.31. Kilbowie 132kV Substation is a grid supply point with four transformers, two 20MVA 132/11kV and two 60MVA 132/33kV. The 132/11kV transformers' cooler banks are suffering from subsidence and there is evidence that the 132/33KV transformer cooler bank are also starting to subside. Measures have been taken to try and remediate the subsidence issues, but they have been unsuccessful. The transformers are all in a similar condition and will be at, or around, end of life in RIIO-T4. 132/11kV transformers are relatively rare on the SPT network and at Kilbowie they were installed in place of a primary substation. The solution proposed for Kilbowie is to remove the 132/11kV transformers entirely. SP Distribution will create a new primary substation at Kilbowie and we will replace the 132/33kV transformers with 90MVA units to supply the new primary substation and to cater for future load growth. This will remove the subsidence issues and remove the 132/11kV transformers from the SPT network of which we have no strategic spares. SPT have designed this this solution in close co-ordination with SP Distribution.

8.32. St Andrews Cross 132kV Substation is a grid supply point which also supplies Network Rail. The substation is in a building which houses a significant amount of infrastructure, and a fire could have significant implications. Traction transformers have a particularly severe duty due to the nature of their cyclic loads and they are frequently subjected to short circuit events originating on the railway network. Between 2016 and 2022 T1B has been subject to 733 short circuit events or 122 per year and T2B subject to 988 in the same time frame or 164 per year. In 2004, T2B failed at St Andrews Cross following deformation of the lower voltage winding, it was presumed, after short circuits on the railway network. This transformer was a Bonar Long transformer and there has been a history of failures of this type of failure on other Bonar Long transformers. T1B at St Andrew Cross 132kV substation is also a Bonar Long traction transformer. The replacement for the failed T2B unit in 2004 was manufactured by SMIT, and in 2018, its sister unit suffered a catastrophic failure following a short circuit. Considering the failure history of these asset types and the indoor location, SPT plan to replace these assets with transformers with a high flash point oil to mitigate the fire risk at this site. The other transformers at this location are already filled with a high flash point oil. The Bonar Long unit will be scrapped, and the SMIT unit will be retained as a spare and installed in outdoor locations only.

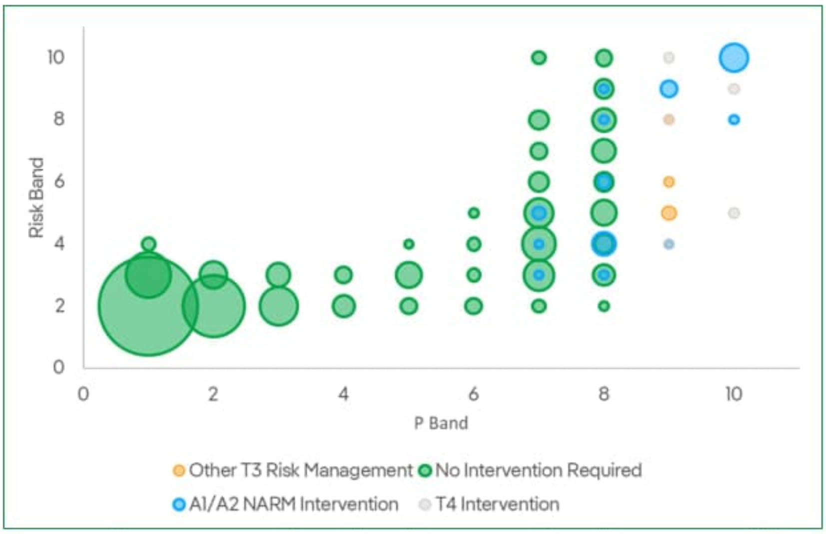

Figure 16 Transformer Interventions Showing Asset Volume by Asset Health and Risk

8.33. Figure 16 outlines the distribution of the transformer portfolio at the end of the period, without intervention, and our interventions have been highlighted by category. For transformers it can be seen that our refurbishment activities focus on extending the life of P7 and P8 assets, while a small number of P9 and P10 assets, not subject to intervention in RIIO-T3, are programmed for replacement in RIIO-T4.

Substation Non-Lead Assets

8.34. Substation Non-Lead Programme Overview

Work Programme	Activity	Delivery Year	Total Cost
SF_6 Retrofill			
Wishaw 400kV GIB Retrofill	Gas retro-fill	2028	£1.64m
Hunterston East 400kV GIB Retrofill		2029	£2.35m
Disconnectors and Earth Switches			
Elderslie and Stirling Disconnector & Earth Switch Replacement	Gas retro-fill	2027	£0.86m
Acrastyle Disconnector & Earth Switch Refurbishment Programme	Replacement	2030	£0.94m
Kilwinning and Meadowhead Instrument Transformer and Disconnector Replacement	Replacement	2028	£2.32m
Galashiels 132kV S/S: Replace all non-lead assets and structures	Replacement	2029	£2.99m
GSP Circuit Breaker Replacement Plan	Replacement	2031	£5.82m
Substation Civil and Buildings			
Environmental Civil Assets Upgrades	Refurbishment	2031	£15.94m
Building Energy Usage	Refurbishment	2031	£7.29m
HVDC			
Hunterston Converter Station Asset Replacement: Ancillary Asset Replacement	Refurbishment	2030	£3.51m

Table 9 Non-lead Asset Project Costs

8.35. The Environmental Civil Assets Upgrades project is proposed as a Price Control Deliverable (PCD). Ofgem has invited PCD submissions to allow for enhanced reporting and regulatory review for eligible allowances greater than £15m, ensuring that consumers only pay for the outputs they receive. Our approach to PCDs in RIIO-3 is to propose all eligible baseline investments over the £15m materiality threshold as a PCD.

Disconnectors and Earth Switches

8.36. As with all of our assets, understanding the condition of our disconnectors and earth switches is essential for the continued reliable operation of the network. To ensure we have this knowledge we carry out regular visual condition assessment and record condition issues during maintenance activities. In RIIO-T2, we identified disconnectors that were end of life and investigated to determine if refurbishment was possible. Due to the age and lack of manufacturers' support this was not the case, and we replaced a number of disconnectors as part of projects to replace lead assets. We didn't have a standalone programme for disconnectors and earth switches in RIIO-T2.

8.37. Our condition assessment process is continuous, therefore, we continue to identify assets that are in need of intervention. Our RIIO-T3 plan for disconnectors and earth switches is a combination of replacement and refurbishment which varies from RIIO-T2. We have larger programmes where we require to replace all the non-lead and civil assets in a substation due to condition, but we also have smaller standalone projects of disconnector replacement and refurbishment. This programme is due to the condition of the disconnectors compromising the operation of the associated substation. We have a disconnector & earth switch refurbishment programme which spans a number of substations where the assets were installed in the early 2000s and suffer from a number of issues, one being the remote indication of their position not being reliable. This disconnector type is still in production and full support is available. We are choosing to implement a refurbishment programme to remove the issues that make these assets unreliable.

8.38. **Galashiels 132kV Substation.** Our RIIO-T2 plan, approved by Ofgem, for Galashiels 132kV substation was to replace the substation in-situ in RIIO-T3 using SF_6 free AIS circuit-breakers. However, during RIIO-T2, an urgent, end-of-life issue emerged with the existing 132kV oil circuit breakers that meant their replacement had to be accelerated. We therefore now have new 132kV circuit breakers installed but the remaining non-lead assets are at, or near, end of life. Our plan for Galashiels 132kV substation is to retain the new circuit breakers and carry out an in-situ replacement of the substation's non-lead and civil assets.

SF6 Retrofill

8.39. In RIIO-T2, we made a commitment to install SF_6 free equipment where technically viable. At the beginning of RIIO-T2, this meant that all switchgear at 132kV could be SF_6 free, unless a special duty was required, and at 275kV and 400kV Gas Insulated Busbars (GIB) would be SF_6 free. As RIIO-T2 has progressed, SF_6 free technology has continued to develop and more products have started to become available. SPT will have one of the first installations of fully SF_6 free 400kV GIS. Although this won't be delivered until after RIIO-T2, we have evaluated the ongoing technological changes, incorporated them into our strategy and placed orders for the latest SF_6 free technologies. We have also embarked on a project to develop a retrofill gas for 400kV GIB with a leading manufacturer. The first GIB sections are planned to be installed in 2025 and complete in 2026.

8.40. In RIIO-T3, we will have completed our innovation project to develop and install a GIB retrofill. One of the constraints of a retrofill gas is they tend to be model specific and therefore, one retrofill gas does not fit all. We believe that, if possible, we should remove

SF_6 from GIB and replace with a retrofill gas because GIB sections tend to be very long and so contain a lot of SF_6. They are also typically outdoor and therefore subject to harsher environmental conditions, which along with their geometries, means that leaks are more likely on GIB. We have a programme of work to try and mitigate GIB leakage, however, we plan to retrofill all our 400kV GIB in RIIO-T3 where a solution exists, removing the environmental risk of future SF_6 leaks. The GWP of the retrofill gas we will use is around 96% lower than SF_6.

Substation Civils & Buildings

8.41. Our RIIO-T2 programme identified, through our condition assessment programmes, a significant volume of civil assets and buildings that required intervention and we developed a refurbishment plan to allow life extension to be realised on these assets. This includes the refurbishment of concrete and steel structures within substations, refurbishment of substation buildings including taking steps to make the buildings more energy efficient. This included the replacement of heating, installation of insulation and photovoltaic panels. We also established a refurbishment programme of oil filled assets' bunds based on condition and environmental sensitivity.

8.42. The RIIO-T2 works will deliver significant improvements in the condition of substation structures and buildings. These have remediated the condition issues with the population of these asset types and therefore have no refurbishment plans in RIIO-T3, except for elements of the project rolling over from RIIO-T2 into RIIO-T3.

8.43. We are continuing our programme of improving the energy efficiency of our buildings. We have identified 31 substation buildings which we plan to make more energy efficient. We will either remove or replace windows and doors, install draught proofing and more energy efficient lighting and heating. We will install photovoltaic panels on buildings, where we can, supplying the heating and lighting loads and contributing to the other energy demands of the substation, for example to power battery chargers.

8.44. The RIIO-T2 bund refurbishment plan was designed as the first phase of a multiple price control programme, which will continue in RIIO-T3, and intervention on 28 bunds is planned. This programme includes bunds that are in poor condition and refurbishing the bunds of transformers in the transformer refurbishment programme.

8.45. In 2023, the threat of collapse of Reinforced Autoclaved Aerated Concrete (RAAC) became apparent in many sectors of society. SPT owns hundreds of buildings and we identified over one hundred substation buildings that had been constructed during the period when RAAC was commonly used. If RAAC was installed in a substation, it would have been used in the construction of the substation's roof. RAAC is readily identifiable visually and by a simple test, however, access has to be available to the underside of the RAAC roof to make this assessment. Unfortunately, in most SPT substations there is typically plasterboard or another type of suspended ceiling between the floor of the substation building and the underside of the roof. These suspended ceilings were typically installed when it was still common practice to have asbestos as part of the material that made up these ceilings. We have therefore had to carry out an extensive asbestos testing regime to ensure we are not putting our staff at any risk, when removing sections of ceiling to inspect and test the underside of the roof. We then carry out a structural assessment of the RAAC found to understand the risk and the appropriate mitigation measures. We have identified RAAC in a number of substations, but our investigations are ongoing. The solution to this problem also requires to be considered carefully; it is without question that we will have to remove RAAC from buildings, however, how this is executed needs to consider a number of factors, which we are still working through. It may be that the solution is to replace a building rather than to just replace the roof, depending on the assets it contains and any potential space constraint for a new building. We need to carefully evaluate the solutions on an individual basis, which is why we believe a non-load Uncertainty Mechanism is required for this and other projects.

HVDC

8.46. We constructed the Western HVDC link in RIIO-T1. In RIIO-T2, we have gone from the construction phase to the in-service phase and due to the equipment being relatively new, costs were confined to operations and maintenance type activities.

8.47. In RIIO-T3, however, we need to make some small capital investments on the ancillary equipment associated with Western HVDC link, due to the equipment having a short service life. The substation is housed within multiple buildings and employs air conditioning units. The building management systems' control and communication components require to be replaced alongside the site air conditioning units and heat pumps. We need to refurbish elements of the substation's Uninterruptible Power Supply along with other elements of the substation, including control schemes.

Protection and Control

8.48. In RIIO-T2, we continued to prioritise the removal and replacement of the remaining population of first-generation electronic relays on all feeder main protection identified as health index 5 and, therefore, end of life. Circuit breaker failure and busbar protection schemes not captured within major switchgear replacement programmes in RIIO-T2 also contributed to the investment plan. A small number of legacy auto-transformer schemes have been brought up to industry-wide good practice of having two independent forms of protection, as well as investing in full replacement of schemes where relays were classified as health index 4 & 5. Another workstream delivered in the RIIIO-T2 price control was the removal of problematic equipment which failed regularly and required manual intervention to remedy, as well as finding new innovative solutions to replace the failing devices of mesh substation auto-reclose.

8.49. In RIIO-T3, we will prioritise our investments to replace those assets that have health indices 4 & 5 across several protection schemes to ensure we are providing a safe and reliable network to avoid widespread disruption. The extent of generation connected to the distribution system has an adverse effect on transformer LV Directional Overcurrent (LV DOC) at Grid Supply Points (GSPs). We have developed an efficient programme to combine the removal of LV DOC relays with a programme to commence the removal of legacy Voice Frequency (VF) based intertripping relays from the network. These analogue devices have poor performance histories when digital telecoms networks are deployed and as the technology is obsolescent or obsolete, spares and testing equipment are difficult to procure. Another integrated programme is to replace AVC relays and transformer protections assigned health indices 4 & 5. Some AVC models are unable to accommodate the significant levels of embedded generation now common at GSPs and the transformer protection will be replaced due to suffering from an irresolvable type defect.

8.50. We have reviewed the effect on protection operation of the increasing proportion of fault current sources being from inverter systems. In response, we have amended our protection application and settings policies and we will continue to review our approach as system changes require.

8.51. [redacted]

8.52. Our network utilises fault recorders for multiple applications including post-fault analysis, oscillation (stability) monitoring and power quality monitoring. Legacy fault recorders and locators remain on our network, these devices are categorised as Health Index 5, therefore, will be upgraded or replaced in RIIO-T3.

8.53. In RIIO-T3, we will replace outdated Programmable Logic Controllers and Building Management Systems at Dewar Place substation with newer, supported components as well as the replacement and upgrade of part of the protection and control schemes for the Series Compensation Equipment (SCE) installed at sites of Moffat, Eccles and Gretna 400kV substations.

Table 10 Protection & Control Project Costs

Work Programme	Activity	Delivery Year	Total Cost
Series Compensation Control	Replacement	2031	£5.42m
SICAM & MK2 Ferranti Modernisation Programme	Replacement	2031	£1.37m
Dewar Place Control Schemes.	Refurbishment	2031	£2.19m
System Monitoring Modernisation	Refurbishment	2031	£2.81m
Mesh Corner Protection and Mesh Corner Delayed Auto Reclose Devices	Replacement	2031	£1.67m
P&C Modernisation Programme	Replacement	2031	£9.93m
AVC Modernisation	Replacement	2031	£10.30m
VF Intertrips & Signalling Equipment Replacement	Replacement	2031	£11.99m
LV Directional Overcurrent Removal	Replacement	2031	£1.75m
GIC Monitoring	Addition	2031	£1.41m

9. Network Operations

9.1. Our Network Operations teams are key to ensuring our network provides the exceptional reliability required by our customers. They carry out or co-ordinate, the inspection, condition assessment and maintenance activities that allow us to understand the condition of our assets and ensure our network is reliable. They also, when required, remove defects from our network, for example repair a broken anti-climber on an overhead line tower, and repair any faulted assets. These activities not only ensure our network is reliable but ensure we extract the maximum economic life from our assets.

9.2. As we go through the RIIO-T2 period into RIIO-T3, our network will go through a period of significant change. The size and complexity of the network is growing year on year to facilitate net zero. Making sure that we adapt our ways of working as the network grows and changes, while keeping the costs of our operations as low as possible, are key to delivering the levels of reliability required and best value for the consumer.

Substations

9.3. We have a comprehensive inspection, condition assessment and maintenance regime based on the needs of the particular asset, we have discussed this is in section 5 of this document. The changes and growth in our network have led to a change in our operational costs in RIIO-T3. For example, we will have more substations therefore we need to employ additional staff to carry out inspections.

9.4. Our processes are under constant review and as such we have identified the need to enhance our condition assessment regime for our civil assets. This has led to an increase in our costs against civil assets in RIIO-T3. This will ensure we have dedicated resource available to execute our five-year condition assessment programme for civil assets ensuring we are making the right investments at the right time.

9.5. The route to net zero and the change in the generation portfolio in terms of types and location, means we have to install assets on the network whose duty would previously have been undertaken by large thermal power stations. We have installed, or have plans to install, equipment not previously connected to our network, for example we are connecting synchronous compensation at our substation at Eccles in the Scottish Borders. These new technologies are not within the experience of our own operational teams and, therefore, we are putting in place service level agreements with expert external parties. We feel this approach works best, as we are always likely to only have a few examples of these new technologies and therefore the ability for our operational teams to build experience and knowledge will be limited.

9.6. The migration to SF_6 alternatives requires us to obtain specialist skills in their handling and storage. We have built this requirement into our network operating costs in RIIO-T3.

Overhead Lines

Inspection and Condition Assessment

9.7. We have a comprehensive inspection and condition assessment regime for our overhead line assets, this is discussed extensively in section 5 of this document. It Is our plan to increase the condition assessment regime to twenty percent of our network every year for the current ten percent. This change is reflected in our network operating costs. Aerial ground clearance surveys are conducted every 5 years. These surveys allow a digital model of the overhead line network to be built. This model can be used to ensure that all statutory clearances are met in all instances including maximum conductor sag and swing conditions. These digital models also allow for initial design work to be carried out for project work and for tower verticality to be checked. These costs are included in our RIIO-T3 plan.

Vegetation Management

9.8. We manage vegetation near our overhead lines in a three-year cycle, therefore roughly inspecting and cutting around thirty three percent of our network annually. When we cut vegetation, the amount we remove is species dependant, for example, willow will grow more quickly than a silver birch. Our plan is to ensure vegetation is cut to levels where it would take five years of growth before the vegetation infringes statutory clearances to the overhead line. This approach ensures if we have one or two years of above-average growth within the three-year cycle, we maintain safety clearances.

9.9. There is however a clear link between climate change and accelerated vegetation growth and therefore in RIIO-T3 we expect to have to increase our vegetation management activities. We have updated our costs to reflect this increase level of activity.

Cables

9.10. Our cable network is made up of Fluid Filled and XLPE cables at 132kV and above. Each cable type has its own inspection, maintenance and condition assessment regime as discussed in section 5 of this document. In RIIO-T1, we experienced a number of XLPE cable termination failures, and this pattern has continued in RIIO-T2. We have introduced routine testing of XLPE cable termination for partial discharge to try and identify these problems before a failure occurs, which we will continue in RIIO-T3.