SP Energy Networks 2015–2023 Business Plan

Updated March 2014

Annex

33kV and 11kV Overhead Line Strategy

SP Energy Networks

March 2014

SP ENERGY NETWORKS

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33kV and 11kV Overhead Line Strategy

March 2014

Issue Date	Issue No.	Document Owner	Amendment Details
17th March 2014	1.0	Iain Divers	First Issue

1. Scope

This annex summarises SP EnergyNetwork's Non-Load Related Expenditure (NLRE) capital investment plans for our EHV & HV wood pole overhead line networks during RIIO-ED1.

There are two principal work programmes covered in this annex:

- *Rebuild of targeted main lines to a storm resilient, 'fit for purpose' specification; and*
- *Refurbishment of lines to improve performance and asset condition.*

Additional work activity covered in this annex includes ESQCR (ensuring legally required clearance distances to conductors).

Steel tower supported EHV overhead lines are not included in the scope of this annex. Similarly, pole mounted HV apparatus (such as transformers and switchgear) are not included in this annex.

2. Table of Linkages

This strategy supports our ED1 Business Plan. For ease of navigation, the following table links this strategy to other relevant parts of our plan.

Document	Chapter / Section
SP Energy Networks Business Plan 2015-2023	Chapter C6 – Expenditure
SP Energy Networks Business Plan 2015-2023 Annexes	Annex B3 – Stakeholder Engagement – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex B3 – Stakeholder Engagement Further Detail – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – Cost Benefit Analysis – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – LV Overhead Line Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – Asset Health and Criticality Strategy – SPEN
SP Energy Networks Business Plan 2015-2023 Annexes	Annex C6 – Long Term Strategy – SPEN

3. Introduction

3.1. Executive Summary

Our EHV and HV wood pole infrastructure supplies electricity to domestic, commercial and industrial customers in our SPD and SPM licence areas allowing power flow and interconnection for security of supply.

Our investment plan for the EHV and HV wood poles overhead line network during RIIO-ED1 covers the replacement and refurbishment of assets which are at an end of life or in poor condition. This is through an optimum level of investment, delivered through the continuation of a prioritised and targeted project specific approach.

- *Rebuild of targeted main lines to a storm resilient, 'fit for purpose' specification; and*
- *Refurbishment of lines to improve performance and manage condition*

They are essential to delivering a number of our primary outputs, particularly public and employee safety, reliable network performance for our customers and reduced environmental impact. We will also manage the overall Health Index and risk profiles of our assets, a key secondary deliverable. We have invested significantly during DR5 and plan to continue these strategies through ED1.

We plan to continue our long-term programme of renewing our assets over several price control periods to minimise the impact on customer bills.

Asset Replacement and Refurbishment – RIIO-ED1		SPD		SPM	
		Volume	Expenditure (£m)	Volume	Expenditure (£m)
33kV	Conductor (km)	216	5.5	152	3.9
	Pole Replacement (#)	5,072	8.6	3,395	5.7
	Pole refurbishment (#)	8,808	3.4	5,893	2.3
11kV	Conductor (km)	1,521	29.6	1,414	27.4
	Pole Replacement (#)	28,238	43.8	26,136	40.4
	Pole refurbishment (#)	51,208	20.2	46,268	19.1
	Total expenditure	**-**	**111.1**	**-**	**98.8**

Figure 3-1: ED1 forecast volumes and expenditure for asset replacement and refurbishment

HV ESQCR - RIIO-ED1					
Asset	Unit	SPD		SPM	
		Volume	Expenditure (£m)	Volume	Expenditure (£m)
HV ESQCR clearance hazards	#	4,000	6.4	6,000	13.7

Table 3-1: ED1 forecast volumes and expenditure for ESQCR

3.2. Overview

Our plans for the EHV and HV wood pole overhead line distribution network in ED1 aim to address the current volume of end of life assets through an optimum level of investment, delivered through the continuation of a prioritised and targeted project specific approach.

We have over 30,000km of EHV and HV wood pole overhead lines that supply electricity to domestic, commercial and industrial customers in our SPD and SPM licence areas allowing power flow and interconnection for security of supply.

Our overhead lines are potentially exposed to severe weather events. In the late 1990s and early 2000s several storms made a significant impact on our networks. In response, we established leading programmes for managing trees within falling distance of our lines and approved new, resilient construction standards to withstand the most severe weather conditions.

In DR5 we began our long term strategy to ensure the future storm resilience of our overhead line network for our customers. In tandem with this, we also established a cyclic refurbishment programme to manage the performance and condition of our lines, covering the whole network. We have invested significantly in these areas in DR5 and plan to continue this throughout ED1, as part of our long term strategy.

We have developed our detailed plans using inspection data, condition surveys and technical reports. In ED1 we plan to coordinate with other asset replacement and network reinforcement works to maximise efficiency across our programmes.

In this document we discuss our plan development:

- *our risk management and process methodology;*
- *the overall development of our strategies*
- *the use of condition information;*
- *the outputs delivered by the programme; and*
- *the process for delivering risk based, prioritised asset interventions*

Delivery of our overhead line programme is key to a number of our primary outputs, particularly public and employee safety, increased resilience, a reliable network performance for our customers and a reduced environmental impact. The programme also allows us to manage the overall health Index and risk profiles of our assets, a key secondary deliverable.

3.3. ED1 Strategy

Our plan for 33kV and 11kV overhead lines is based on a strategy to improve the resilience to these events, improve the reliability (fault rate) of our network and to rectify all associated ESQCR hazards.

Our long-term plan is that by 2034 over 40% of all interconnected 11kV and 33kV OHL networks will be rebuilt to a storm resilient standard, such that a severe weather event should not affect any connected customer for more than 36 hours.

To achieve this we plan to:

- *Rebuild or modernise EHV and HV interconnected main lines to a fit for purpose specification taking into account the land topography and prevailing severe and normal weather patterns.*
- *We plan to continue a 12-year rolling cycle of refurbishment from DR5 throughout ED1 in order to increase performance, manage asset degradation and meet ESQCR and other relevant standards.*
- *Manage trees within falling distance concurrently with both programmes of works based on the methodology detailed in ENA ETR 132.*

Leading from our DR5 outputs, we plan that over 25% of our main line network at EHV and HV main lines will be resilient to severe weather by the end of ED1.

Additional outputs as a result of these programmes are:

- *We plan to reduce the average number of times our customers lose their power supply by 7% by the end of ED1.*
- *We plan to reduce the average length of time our customers lose their power supply by 16% by the end of ED1.*

	Pole Replacement (#)	Conductor Replacement (km)	Pole Refurbishment (#)
33kV OHL (SPD)	5,072	216	8,808
11kV OHL (SPD)	28,238	1521	51,208
33kV OHL (SPM)	3,395	152	5,893
11kV OHL (SPM)	26,136	1414	46,268

Table 3-2: ED1 volumes for EHV/HV asset replacement and refurbishment

Our Cost Benefit Assessments 50 and 61 in **Annex C6 – Cost Benefit Analysis – SPEN** justify our investment proposals – specifically, ensuring storm resilience on EHV and HV lines using rebuild with ETR132 tree cutting.

3.4. Policy

Our strategy and delivery methodologies are supported by our internal Asset Management practices.

SPEN manages all physical assets utilising an Integrated Management System which combines the requirements of the Asset Management System specification (PAS55, now superseded by ISO55001), the Quality Management System international standard (ISO9001), the Occupational Health & Safety Management System international standard (ISO18001) and the Environmental Management System international standard (ISO14001).

Specifically for our LV network, we utilise the following key internal documents (all policy documents are available on request):

Document Title	Internal Reference
Asset Health Methodology	ASSET-01-019
Hazard & Defect Management Policy	EPS-01-002
Hazard & Defect Management Policy for 33kV, 11kV and LV Overhead Lines	EPS-01-009
Asset Inspection and Condition Assessment Policy	ASSET-01-021
LV Overhead Line Modernisation Policy	ASSET-04-062

4. Network Analysis

4.1. Overview

The EHV (33kV) overhead line network is a strategic asset, connecting our grid and primary substations in rural areas. In the vast majority of cases these are interconnected or have additional feeders to primary substations, which provides redundancy and a higher security of supply. Due to this, EHV lines were historically constructed to more onerous standards than at lower Voltages.

HV overhead lines are most commonly found in rural areas where the installation costs were lower and loading and safety risks more acceptable, as opposed to urban areas where underground cables predominate.

Wood pole overhead lines are composed of two key reportable assets: conductor and wood poles.

Asset	Unit	SPD	SPM
EHV Conductor	km	2,567	1,717
EHV Poles	#	38,397	20,550
HV Conductor	km	13,711	12,370
HV Poles	#	179,586	166,012

Table 4-1: Overhead line asset population

The vast majority of our EHV and HV overhead line networks are constructed with uninsulated conductors. There are small sections of insulated conductors on the HV network that were installed at various periods in the past (these are accounted for separately to uninsulated conductors for Ofgem reporting purposes). A variety of conductors have been installed historically on our networks, and this is most evident on our HV network.

Typically, our conductors are either made from Copper or ACSR (Aluminium Conductor Steel Reinforced). There are, however, some legacy conductors which, due to their construction, are now at end of life (e.g. No.4 steel, Silmalec). We have now standardised on AAAC (All Aluminium Alloy Conductor) for new and modernised EHV and HV overhead line installations.

Bare conductors can present a potential public safety risk via inadvertent contact. The distances from bare conductors are specified in the Electricity Safety, Quality and Continuity Regulations (2002). This risk can be heightened in some circumstances as these lines are commonly located in close proximity to domestic, public and industrial premises. We have focused on quantifying this risk during our inspection process (this is discussed in more detail in our LV overhead line section in **Annex C6 – LV Overhead Line Strategy – SPEN**).

The majority of our EHV and HV overhead line conductors on our network are supported by wood poles. These decay over time but are impregnated with Creosote to slow down this process. Eventually these reach an irreparable state, at which point they cannot safely be climbed or used for operational purposes, such as supporting additional tension for replacing conductors.

Fittings and other non-operational apparatus (e.g. stays, anti-climber devices) are not reportable to Ofgem. However, these form part of our condition assessments prior to work, and are replaced as required.

4.2. Pole Age Profiles

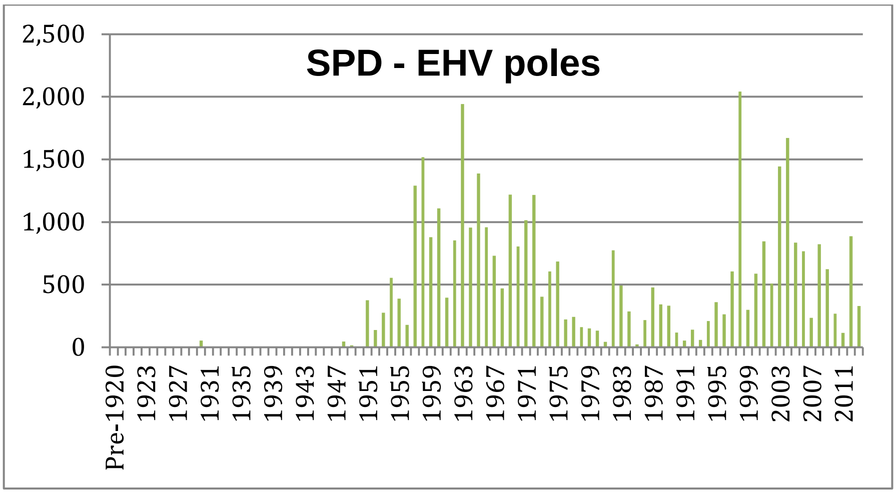


Figure 4-1 SPD EHV Pole age profile at 2013

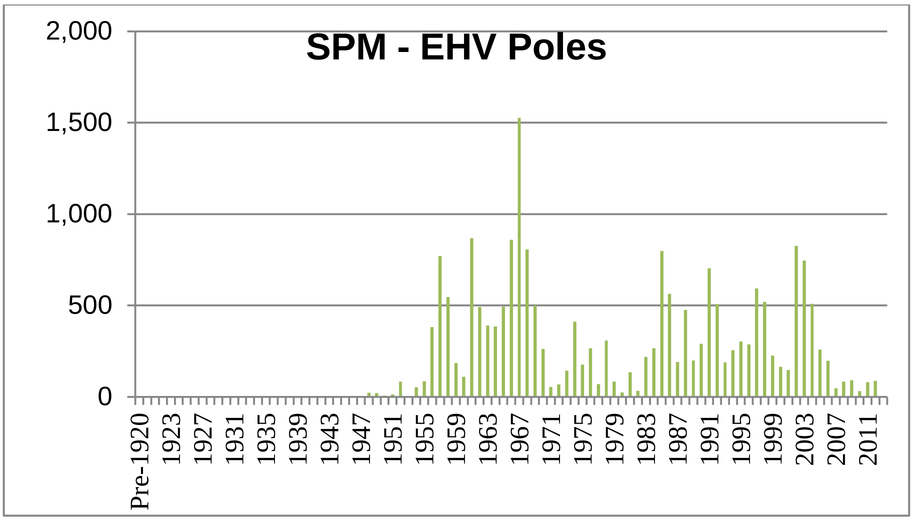


Figure 4-2: SPM EHV pole age profile at 2013

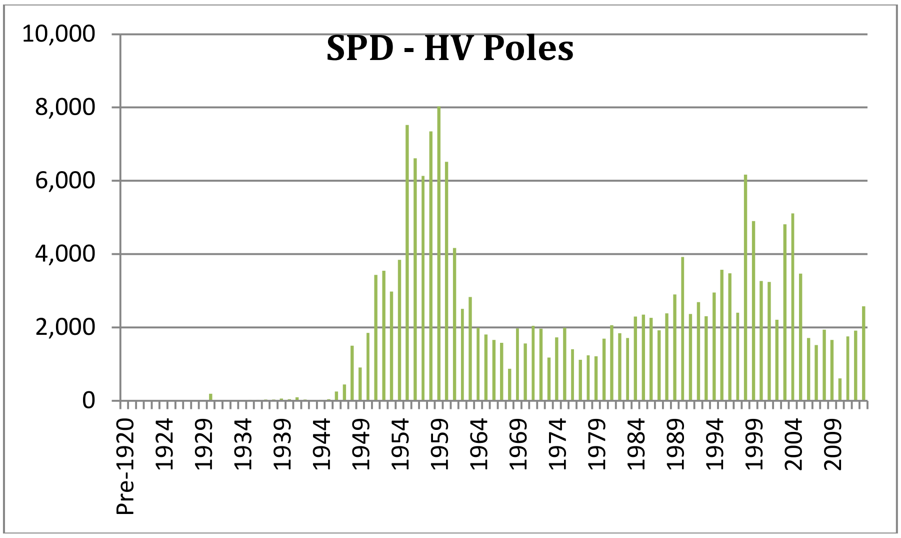


Figure 4-3: SPD HV pole age profile at 2013

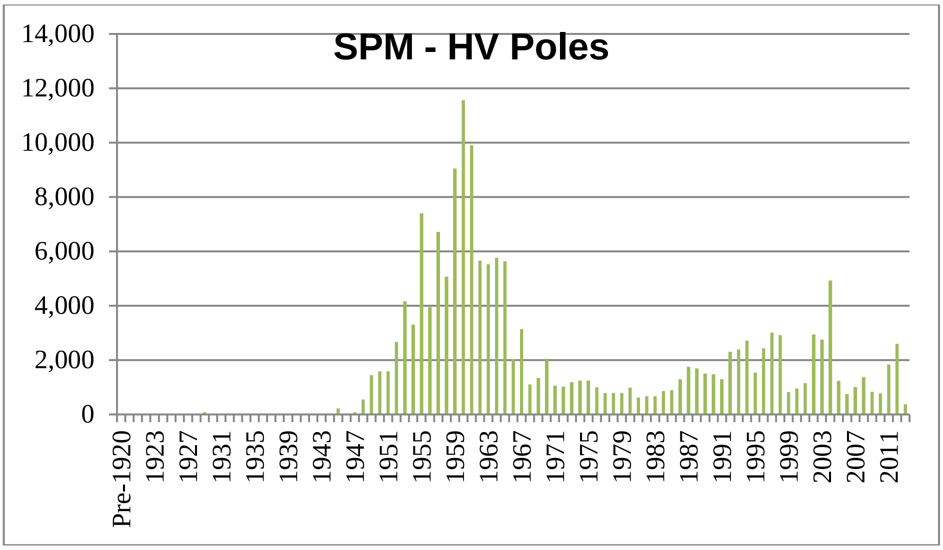


Figure 4-4: SPM HV pole age profile at 2013

5. Investment Drivers

5.1. Storm Resilience

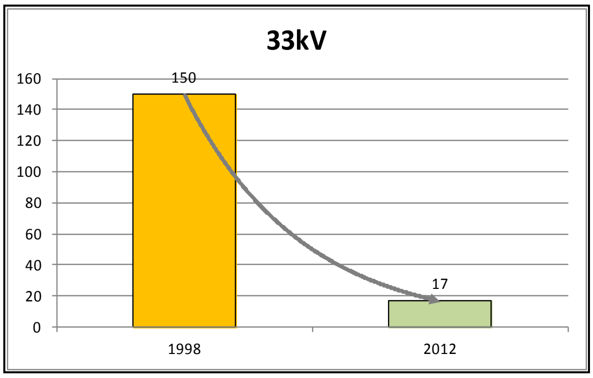
Following the 1998 wind storm and the February 2001 ice storm we established a programme to refurbish the HV network and create a storm resilient network in areas identified as subject to severe weather. This included an enhanced tree clearance programme, an auto-recloser policy (using pole-mounted circuit breakers) to reduce faults due to transients and the widespread introduction of network control points.

An assessment of this work was undertaken by KEMA[1] which confirmed a '10' fold reduction in fault rate during storms on circuits which have been engineered to be storm resilient.

The effectiveness of our storm resilience programme was borne out in the early hours of Tuesday 3 January 2012 when a severe wind storm struck much of the UK, with significant winds across Scotland's Central Belt. With gusts recorded at over 100 mph, the storm was very similar to the 1998 Boxing Day storm in terms of direction, magnitude and intensity. Fallen trees and overturned lorries blocked many roads and structural damage to properties was widespread. This 3 January 2012 storm was followed by a further extremely windy spell from 4 to 5 January 2012.

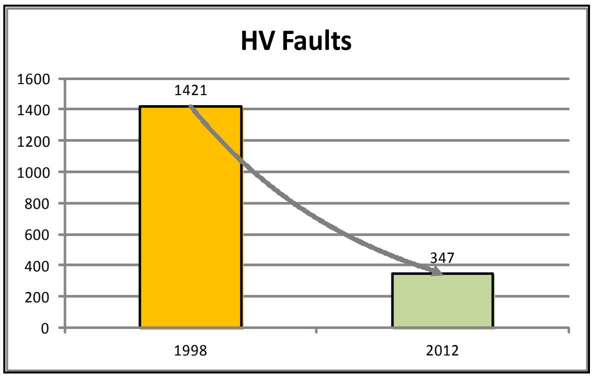
While it is difficult to compare storms, an internal storm review undertaken by ScottishPower[2], in contrast to the 1998 Boxing Day storm, the network withstood the storm extremely well. In 1998 there were 150 faults at EHV and 1,421 faults at HV. In comparison, the 3 January 2012 storm had 17 faults at EHV and 437 faults at HV. Approximately 60% of EHV and HV faults were due to trees and windborne material. The programme to rebuild and refurbish the HV network and create a storm resilient network in severe weather areas resulted in only four faults on lines that were rebuilt or refurbished, with only 20% of HV damage faults in the severe weather areas. There were no damage faults on HV lines where the enhanced tree clearance programme was carried out demonstrating the effectiveness of these policies.

Comparison of faults during storms:



33kV Circuits

- *January 2012 Storm: 17 33kV faults*
- *Boxing Day 1998 Storm: 150 33kV faults*
- ***89% reduction in faults***



11kV Circuits

- *January 2012 Storm: 347 HV damage faults*
- *Boxing Day 1998: 1421 HV damage faults*
- ***76% reduction in faults***

1 KEMA Report G07-1652 February 2007, Iain Wallace: An Assessment of HV Overhead Storm Resilience.

2 ScottishPower Report February 2012, David Kilday: 3 January 2012 Storm Distribution Network Integrity Report.

We plan to modernise our 33kV and 11kV overhead lines to resilient, fit for purpose specifications taking into account the land topography and prevailing severe and normal weather patterns. In addition, we will include a tree clearance programme based on the methodology detailed in ENA ETR 132[3] (clearance to falling distance, depending on tree species and root foundations) and clear all ESQCR hazards in order to comply with UK legislation by 2020.

5.2. Regulatory / DECC

Following storms that afflicted much of the UK in the early 2000s, the UK government began to investigate the changing of legislation that would oblige DNOs to improve the storm resilience of their networks. The most significant benefits were assessed to be from reducing interruptions due to trees near overhead lines.

In response, the electricity industry coordinated to approve the standard ENA ETR132, which outlines a risk based methodology for managing vegetation/trees within falling distance of overhead lines.

Following severe storms on the SPD network in the late 1990s, we had already established an industry leading programme (‘Rural Care’) to provide extensive cuts to trees within falling distance (as shown in our images in Appendix 10.1, figure 10-4). As a result, we were heavily involved in the development of ENA ETR 132.

The full regulatory impact assessment of changes to the Electricity Safety, Quality and Continuity Regulations (2002) set by DECC (Department for Energy and Climate Change) outlines progressive targets for ensuring the resilience of our overhead line networks from trees, at 0.8% per annum. This would result in 20% of the network being resilient within 25 years.

We have assessed that the most effective method of achieving full storm resilience is by delivering ETR132 concurrently with rebuilding the line to a fit for purpose specification.

Our strategy will exceed DECC requirements by making 40% of our EHV and HV interconnected main lines (20% of the total HV network) resilient to severe weather events by 2034.

5.3. Wood Pole Condition

5.3.1. Inspections

Our wood pole distribution overhead lines are routinely inspected every 6 years as per our Asset Inspection and Condition Assessment Policy document ASSET-01-021.

These inspections verify asset data and record condition, hazard and defect data and identify any change in land use that may alter our obligations under ESQCR. Any hazards or defects that require immediate remedial maintenance, is undertaken at the same time by the foot patrol, otherwise it is reported and programmed for completion in accordance with policy.

The condition of wood poles is carried out during inspection by means of a visual inspection and a hammer test and the asset health is categorised using the 1-5 Health Index methodology. For poles assessed as HI4, a further evaluation using a pole ultrasonic rot locator (PURL), a pole auger or a resistograph which can determine the residual strength of a pole allowing for a reassessment of the asset health.

3 ENA ETR 132 : Improving Network Performance under Abnormal weather Conditions by use of a Risk Based Approach to Vegetation Management near Electric Overhead Lines

In accordance with ESQCR and our Hazard and Defect Management Policy (EPS-01-002), all hazards are identified and recorded at the time of inspection, including:

- *the height of overhead lines above the ground,*
- *the proximity of overhead lines to climbable structures & trees,*
- *that all stays are insulated, and*
- *that all signage and anti-climbing guards are installed and adequate.*
- *We have recently introduced an improved overhead line inspection process which enables hazards & defects to be identified & remedial work prioritised on the basis of risk (using a "nature of equipment" & "nature of land use" test prescribed by the ESQCR).*

Records of Inspection are recorded electronically and retained on our corporate systems until next updated.

5.3.2. Health Index Assessment for Wood Poles

Our approach to Health Indices for all of our reportable assets is detailed in our 'Asset Health, Criticality and Outputs Methodology' policy document (ASSET-01-019). The excerpt on wood pole assets is included in this document in appendix 10.2.

5.3.3. Pole Age and Condition

The HSE[4], has developed a deterioration curve for decayed wood poles in GB, shown in figure 5-1 below. The HSE report found the deterioration to be exponential with many poles becoming classified as 'D' ('Defective', i.e. HI.5) after 50 years and all poles with an asset age of >75 years at Health Index 5.

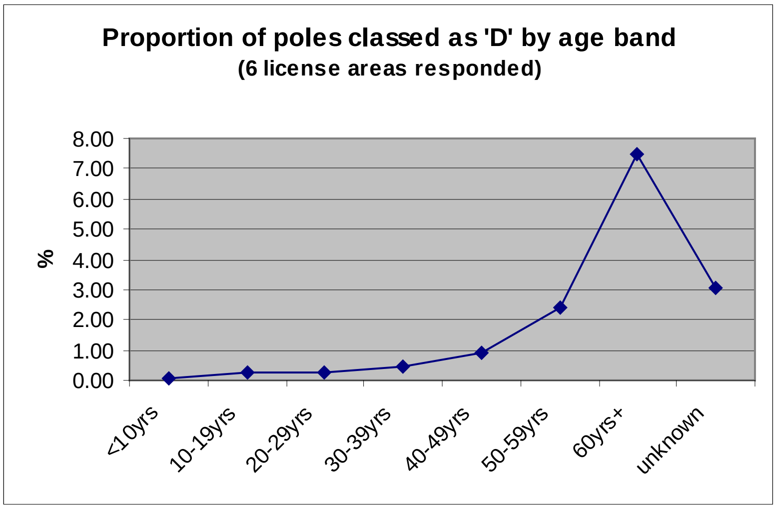


Figure 5-1: Survey of UK DNO 'Defective' poles by age (HSE, 2008)

A large proportion of our EHV and HV network was constructed between 1950 and 1970 with further investment in the 1990s and as a consequence, many poles are at or approaching HI5.

To mitigate the fact that a significant proportion of our poles were installed prior to the 1960s, we assess all wood poles in lines that are being considered for either modernisation or refurbishment.

4 HSE Report 1 February 2008: Condition Assessment Survey of Wood Pole Lines on Distribution Networks in Great Britain.

A cost benefit analysis (**Annex C6 – Cost Benefit Analysis – SPEN**) has shown that it is cost effective to treat many of our poles that have limited amounts of decay with Boron rods. As boron treatment does not increase the strength of a pole, it is not suitable for use on poles that are subject to high stress (e.g. terminal poles or poles with plant attached to them) or where there is a large amount of decay. Where HI4 decayed poles are suitable, they will be boron treated and where this is not technically feasible, the HI4 pole will be reclassified as HI5 and replaced.

All HI5 poles will be replaced. Replacement achieves a movement from HI5 to HI1 and boron treatment will achieve an additional 10+ years of life.

5.4. Weather Areas

In both of our SPD and SPM licence areas we have designated those locations which we consider to be significantly exposed to poor weather and isolated storm events as "severe weather areas".

These designated areas correlate with the weather co-ordinate maps contained within the annexes of ENA "Technical Specification 43-40 Issue 2 (2004) Specification for Single Circuit Overhead Lines on Wood Poles for use at High Voltage up to and Including 33kV" (ENA TS 43-40), on which all UK, EHV and HV overhead line specifications are based.

Our severe weather areas are based upon co-ordinate 4D, where 4 refers to the Wind (pressure) co-ordinate and D refers to the Ice co-ordinate and covers much of our exposed areas up to a height of 500m above sea level.

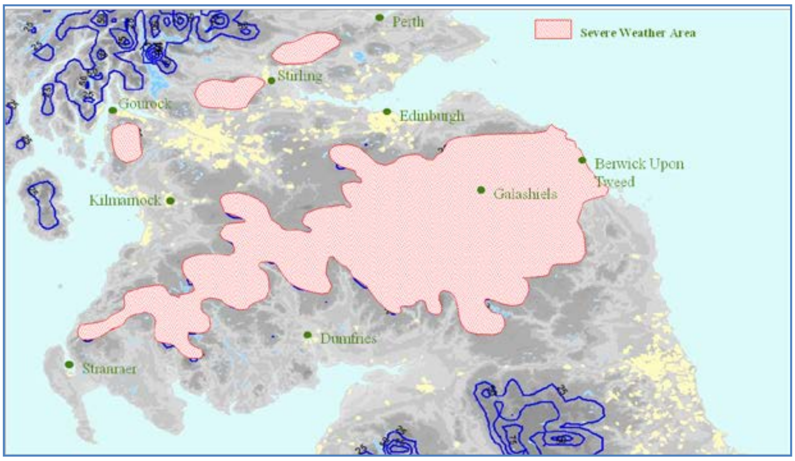


Figure 5-2: Severe weather area map for SPD

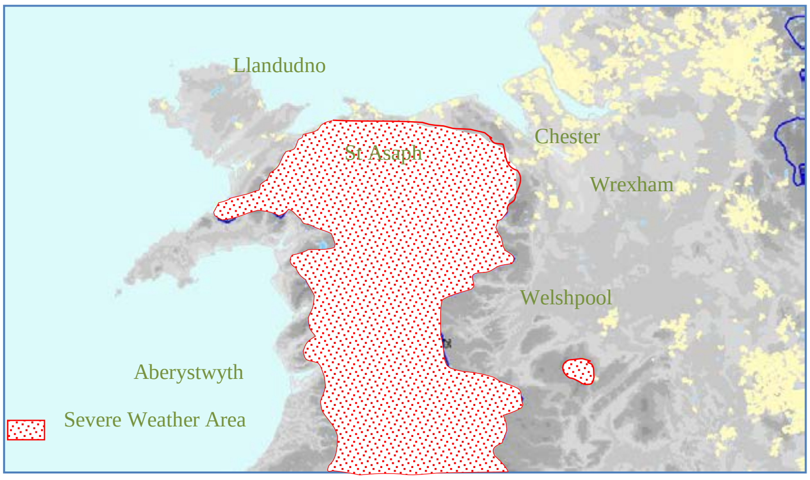


Figure 5-3: Severe weather area map for SPD

5.5. Overhead Line Specification

Table 5-4 below lists the most common overhead line specifications found on our networks and measures them against the suitability for the weather area it is located as per the weather co-ordinate maps contained within the annexes of ENA TS 43-40.

In this table we consider Weather Zones 2D and 4D to be our basic “non-severe” and “severe” weather zones respectively and formulate our plans for overhead line programmes accordingly.

5.5.1. OHL specifications vs. Normal weather (blue) & High weather (yellow)

Line Specification	Weather Zone Conductor	Weather Zone - ENA “Technical Specification 43-40 Issue 2 (2004) Appendix 8									
		1B	1C	2B	2C	3B	2D	3C	3D	4C	4D
BS 1320	0.025 Cu 3/0.104 in	✓	✓	✓	X	X	X	X	X	X	X
BS 1320	0.05 Cu 3/0.147 in	✓	✓	✓	X	X	X	X	X	X	X
L10	50mm^2 ACSR Rabbit	✓	✓	✓	✓	✓	✓	✓	X	X	X
L15	32 mm^2 Cu 3/3.75mm	✓	✓	✓	✓	✓	X	X	X	X	X
L20	150 mm^2 ACSR Dingo	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L25	100 mm^2 Cu 7/4.30mm	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
L27	100 mm^2 AAAC Oak	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L27	150 mm^2 AAAC Ash	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L33	200 mm^2 AAAC Poplar	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L35	300 mm^2 AAAC Upas	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Berwick Ring	75 mm^2 ACSR Racoon	✓	✓	✓	✓	✓	✓	✓	X	X	X
MNW11L	32 mm^2 Cu 3/3.75mm	✓	✓	✓	✓	✓	X	X	X	X	X
MNW11L	50 mm^2 ACSR Rabbit	✓	✓	✓	✓	✓	X	X	X	X	X
MNW11L	25 mm^2 ACSR Caton	✓	✓	✓	✓	✓	X	X	X	X	X
MNW11L*	25 mm^2 ACSR Caton	✓	✓	✓	✓	✓	✓	✓	X	X	X
72/0850/16	150 mm^2 ACSR Wolf	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
72/0850/16	100 mm^2 Cu 7/4.30mm	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GenU 3	150 mm^2 ACSR Wolf	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 5-4: OHL specifications matrix of suitability for weather area category (normal weather highlighted blue; severe weather highlighted yellow)

5.6. Network Performance & Worst Served Customers

Network performance will be assessed for each circuit utilising a number of primary key indicators including the line condition, the number of defects and hazards, the number of customer on the circuit and the historic fault performance (including all tree related faults). Customer interruptions and customer minutes lost are also monitored for each circuit and reported via our business processes.

We plan to utilise our ED1 allowance to improve sections of overhead lines that supply our worst served customers, for example the rebuilding of specific ‘spur’ lines. This will be delivered in tandem with our wider modernisation programmes to achieve efficient delivery.

6. ED1 Strategy

6.1. Rebuild

Our long term strategy for network resilience specifies that, by 2034, 40% of the interconnected 11kV and 33kV OHL networks will be storm resilient in accordance with ETR 132 such that a severe weather event should not affect any connected customer for more than 36 hours.

To support this strategy, in the ED1 period we plan to modernise our 33kV and 11kV overhead lines based on a strategy to rebuild or modernise lines to resilient “fit for purpose” specifications. The resilience of our EHV & HV overhead networks is further enhanced through a coordinated approach of vegetation management in parallel with construction works to ensure the resultant line will remain “fit for purpose” in the long-term, taking into account prevailing weather and circuit topography.

We plan to:

- *Rebuild 2.0% of the EHV network annually to a fit for purpose specification taking into account the land topography and prevailing severe and normal weather patterns.*
- *Rebuild or modernise 0.8% of the 11kV network (2.0% of main lines) annually to a fit for purpose specification taking into account the land topography and prevailing severe and normal weather patterns.*
- *Rebuild a further 0.02% of the 11kV network annually to a resilient, fit for purpose specification to deliver a better quality of supply to our worst served customers.*
- *Where the line is not fit for purpose, we will construct a new fit for purpose overhead line adjacent to the existing circuit.*
- *Where the line is not fit for purpose and the condition of the conductor is good we will modernise the existing line, replacing all HI5 poles and removing all defects and hazards.*
- *A tree clearance programme will run concurrently with both programmes of works based on the methodology detailed in ENA ETR 132.*

6.2. Refurbishment

We plan to improve our performance, condition and reliability on our rural overhead line networks, by carrying out refurbishment to our EHV and HV overhead lines where the construction specification is deemed fit for purpose, taking into account the land topography and prevailing severe and normal weather patterns.

Our plan aims to:

- *Refurbish 6% of the 33kV network annually to improve condition & reliability.*
- *Refurbish 7.2% of the 11kV network annually to improve condition & reliability.*
- *Assess all wood poles in overhead lines that are being refurbished. Boron treat HI4 decayed poles where technically feasible and replace HI5 poles and HI4 poles that are not suitable for boron treatment. Replacement achieves a movement from HI5 to HI1 and boron treatment will achieve an additional 10+ years of life.*

These plans continue the 12-year rolling cycle of refurbishment that began in the DPCR5 period, targeting existing overhead lines to optimise life extension and network performance. This refurbishment programme is now fully mobilised, with sufficient resources in place, and the asset volumes proposed for the RIIO-ED1 period are aligned with current delivery rates.

We have developed our programme of refurbishment of overhead lines in order to achieve an improvement in network reliability that will:

- *reduce the average number of times our customers lose their power supply by 7% by the end of ED1.*
- *reduce the average length of time our customers lose their power supply by 16% by the end of ED1.*

Our plans to improve fault rates / network reliability recognise that there is an underlying degradation of the overhead line network, assuming no intervention. This deterioration in fault rates would be expected to double within circa 50 years at an annual trend rate of 1.5% degradation. A base level of refurbishment is required to address this deterioration prior to actually improving fault rates.

6.3. Stakeholder Engagement & Worst Served Customers

Following stakeholder engagement, we plan to rebuild an additional 48km of HV overhead line in both the SPD and SPM severe weather areas.

More detail on our stakeholder engagement process and results in detailed in **Annex B3 – Stakeholder Engagement – SPEN** and **Annex B3 – Stakeholder Engagement Further Detail – SPEN**.

We recognise that a very small number of our customers receive a service which is much worse than others. We will continue to improve service to our poorly served customers throughout the RIIO ED1 period, specifically targeting a further 80km of overhead lines with known performance issues.

6.4. Pole Replacement Programme

Poles are a crucial aspect of our network and a large proportion of these will be at or approaching end of life in the RIIO-ED1 period. Whilst end of life poles will be replaced in circuits that are being modernised as part of our storm resilience programme, we will also replace approximately 13,000 end of life poles across both licence areas to further manage the ageing wood pole asset population.

Our cost benefit assessments have shown that there are customer performance and financial benefits that can be achieved by utilising live line techniques to replace these poles. Further details are discussed **Annex C6 – Cost Benefit Analysis – SPEN**.

6.5. Vegetation Management

We have planned to include tree clearance as part of our refurbishment programme, targeting those overhead lines identified as having a poor, tree related, fault performance. This will be based on the methodology detailed in ENA ETR 132 (clearance to falling distance, depending on tree species and root foundations).

We plan to continue our rolling programme of vegetation management to maintain an adequate safety clearance from our overhead lines. This programme is consistent with the UK standard ENA TS 43-8.

6.6. Construction Standards

New lines will be built according to our current construction standard OHL-03-099. In a severe weather area, this specification requires the installation of 100mm² AAAC 119-AL3 conductor, code name "Oak" as a minimum and where it is being installed in a normal weather area the requirement is to install 50mm² AAAC 60-AL3 conductor, code name "Hazel".

Our cost benefit assessment in **Annex C6 – Cost Benefit Analysis – SPEN** has shown that employing "Oak" conductor for all main line rebuilds is the most cost effective solution. In addition to the lower lifetime costs, the upgraded lines will benefit from greater storm resilience, providing our customers in these areas with enhanced reliability. The enhanced current carrying capacity also reduces network losses and can support any future load increases due to the uptake of low carbon technology.

6.7. ED1 Wood Pole Risk Profiles

A matrix of HI and CI interventions, indicating the movement in HI and CI volumes between the start and end of ED1, are shown in the tables below for our EHV and HV wood pole assets in both licences. The relative risk measures for each asset category with and without investment are also profiled in the graphs below.

Our HI and CI methodology is detailed in **Annex C6 – Asset Health and Criticality Strategy – SPEN**.

6.7.1. SPD HV Poles

	HI1	HI2	HI3	HI4	HI5	Total CI
CI1	2134	-689	-620	-381	-444	**0**
CI2	25562	-7071	-7111	-6772	-4608	**0**
CI3	2590	-653	-689	-709	-539	**0**
CI4	191	-59	-52	-45	-35	**0**
Total HI	**30477**	**-8472**	**-8472**	**-7907**	**-5626**	**0**

Table 6-1: SPD HV wood pole risk movement matrix, between start and end of ED1 with intervention.

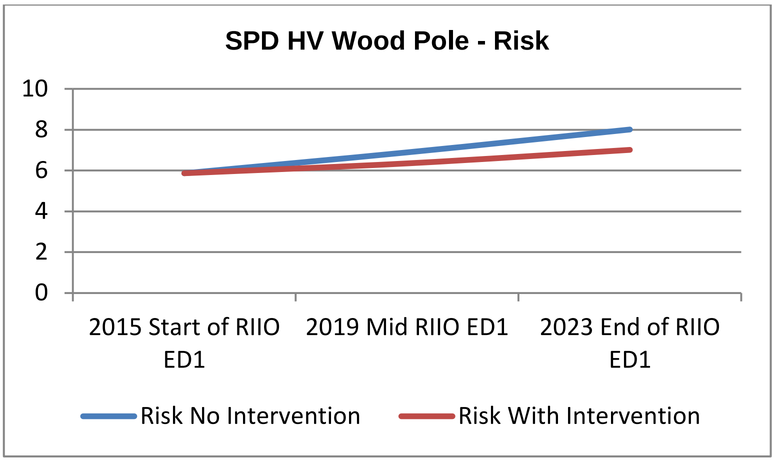


Figure 4-1: SPD risk profile for HV wood poles during ED1 with/without intervention

6.7.2. SPM HV Poles

	HI1	HI2	HI3	HI4	HI5	Total CI
CI1	0	0	0	0	0	**0**
CI2	27889	-7318	-7355	-6863	-6353	**0**
CI3	1842	-503	-469	-430	-440	**0**
CI4	83	-20	-17	-25	-21	**0**
Total HI	**29814**	**-7841**	**-7841**	**-7318**	**-6814**	**0**

Table 6-2: SPM HV wood pole risk movement matrix, between start and end of ED1 with intervention

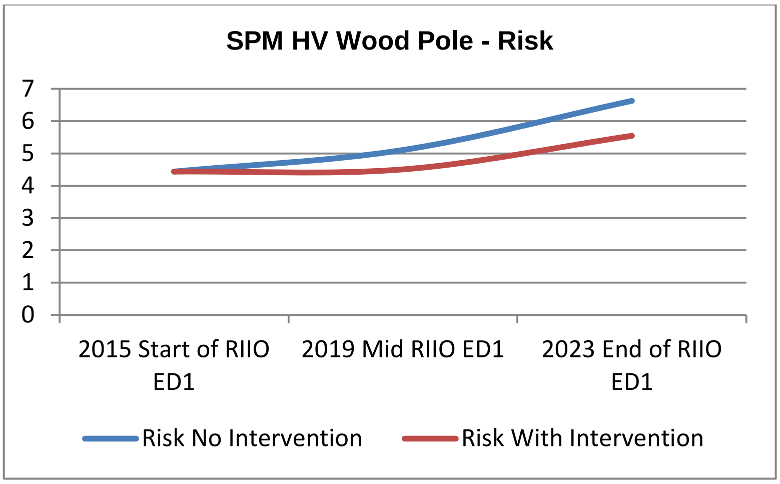


Figure 4-2: SPM risk profile for HV wood poles during ED1 with/without intervention

6.7.3. SPD EHV Poles

	HI1	HI2	HI3	HI4	HI5	Total CI
CI1	1324	-460	-434	-285	-145	0
CI2	2743	-808	-833	-895	-207	0
CI3	852	-254	-243	-203	-152	0
CI4	52	0	-12	-37	-3	0
Total HI	4971	-1522	-1522	-1420	-507	0

Table 6-3: SPD EHV wood pole risk movement matrix, between start and end of ED1 with intervention

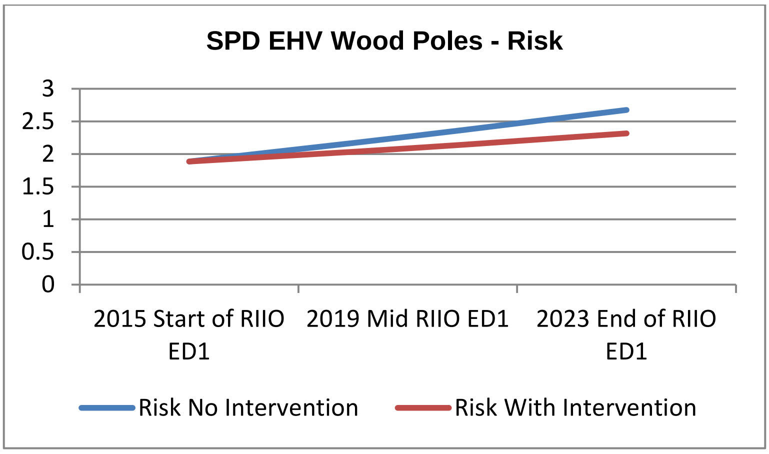


Figure 4-3: SPD risk profile for EHV wood poles during ED1 with/without intervention

6.7.4. SPM EHV Poles

	HI1	HI2	HI3	HI4	HI5	Total CI
CI1	675	-189	-194	-218	-74	0
CI2	2103	-641	-650	-590	-222	0
CI3	531	-188	-171	-130	-42	0
CI4	20	-1	-4	-13	-2	0
Total HI	3329	-1019	-1019	-951	-340	0

Table 6-4: SPM EHV wood pole risk movement matrix, between start and end of ED1 with intervention

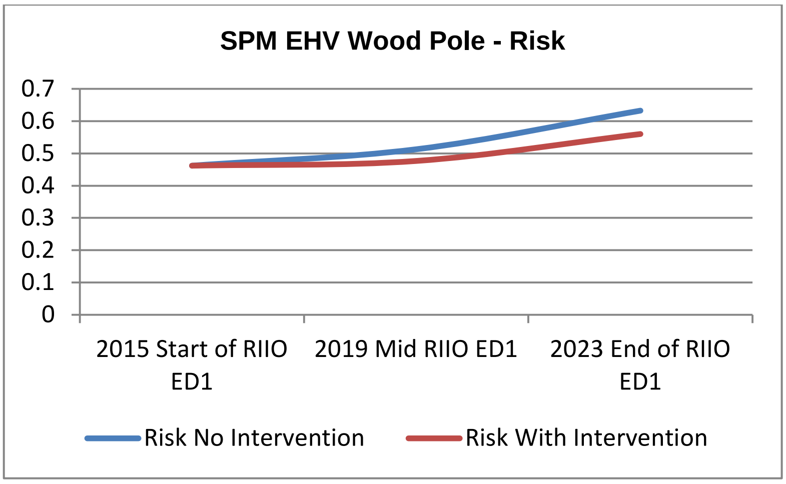


Figure 4-4: SPM risk profile for EHV wood poles during ED1 with/without intervention

7. Volumes & Expenditure

7.1. Conductor Replacement

Asset Replacement		SPD		SPM	
		Volume	Expenditure (£m)	Volume	Expenditure (£m)
33kV	Conductor (km)	216	5.5	152	3.9
11kV	Conductor (km)	1,521	29.6	1,414	27.4

Figure 7-1: ED1 conductor replacement volumes and costs

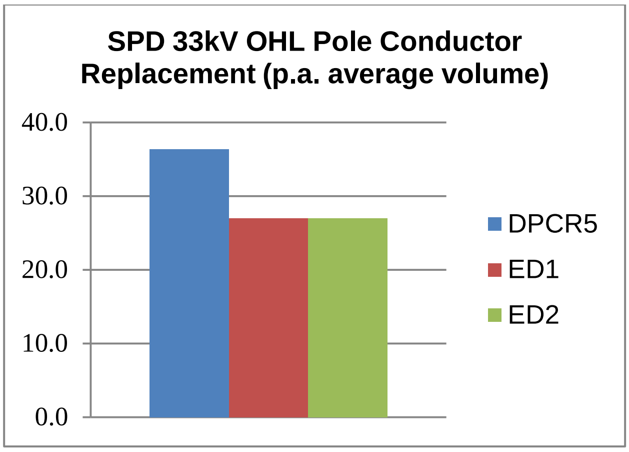


Figure 7-2: SPD EHV conductor replacement, per annum averages

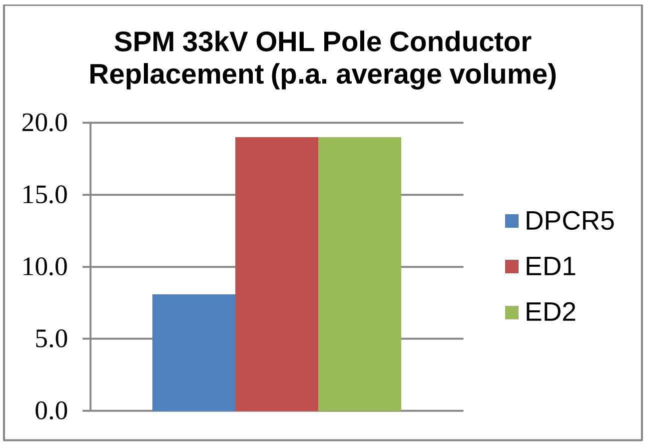


Figure 7-3: SPM EHV conductor replacement, per annum averages

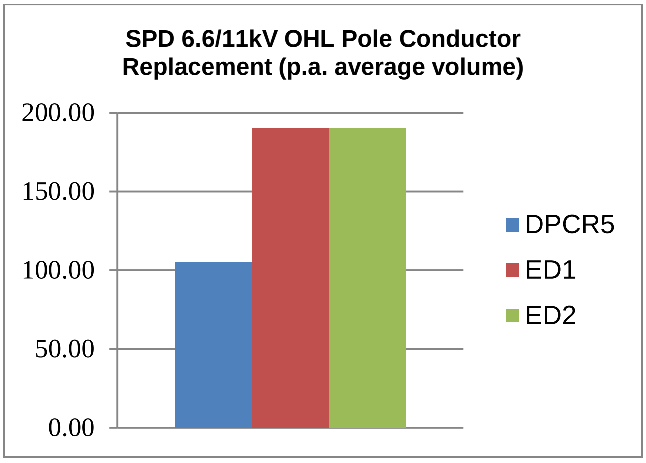


Figure 7-4: SPD HV conductor replacement, DPCR5 to ED1

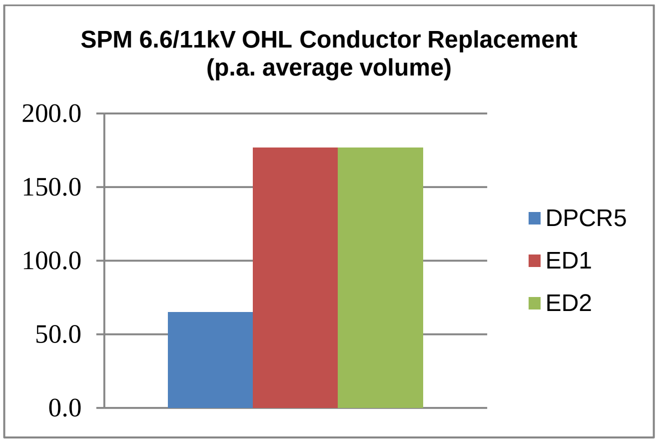


Figure 7-5: SPM HV conductor replacement, DPCR5 to ED1

7.2. Pole Replacement & Refurbishment

Asset Replacement & Refurbishment		SPD		SPM	
		Volume	Expenditure (£m)	Volume	Expenditure (£m)
33kV	Pole Replacement (#)	5,072	8.6	3,395	5.7
	Pole refurbishment (#)	8,808	3.4	5,893	2.3
11kV	Pole Replacement (#)	28,238	43.8	26,136	40.4
	Pole refurbishment (#)	51,208	20.2	46,268	19.1

Figure 7-6: Pole replacement and refurbishment ED1 volumes and costs

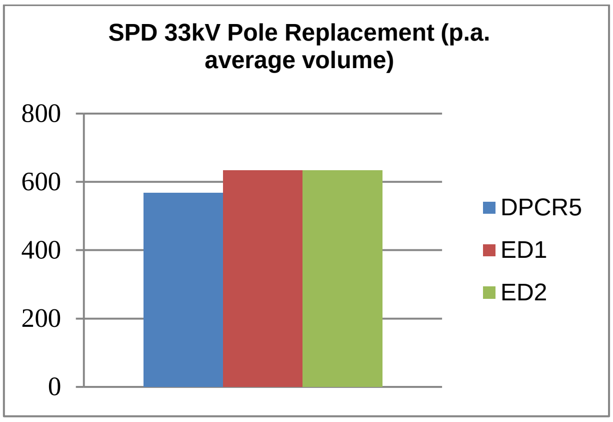


Figure 7-7: SPD 33kV pole replacement average volumes per annum

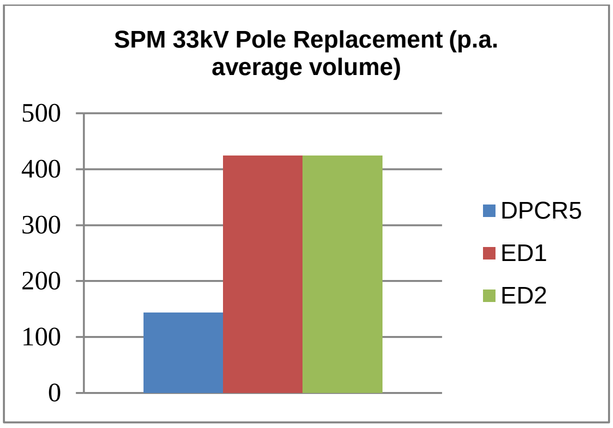


Figure 7-8: SPM 33kV pole replacement average volumes per annum

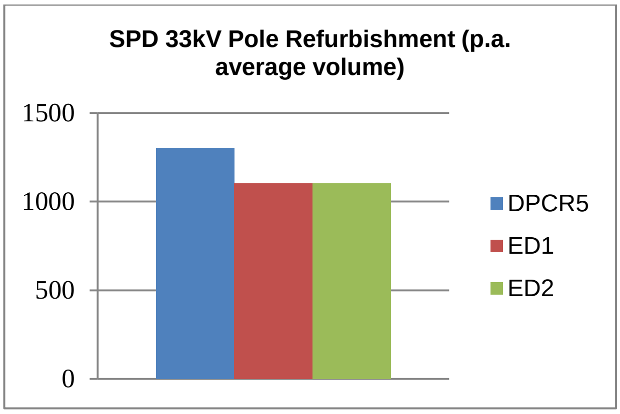


Figure 7-9: SPD 33kV pole refurbishment average volume per annum

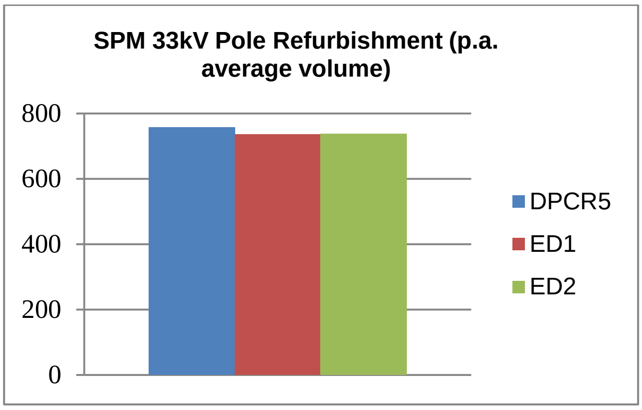


Figure 7-10: SPM 33kV pole refurbishment average volume per annum

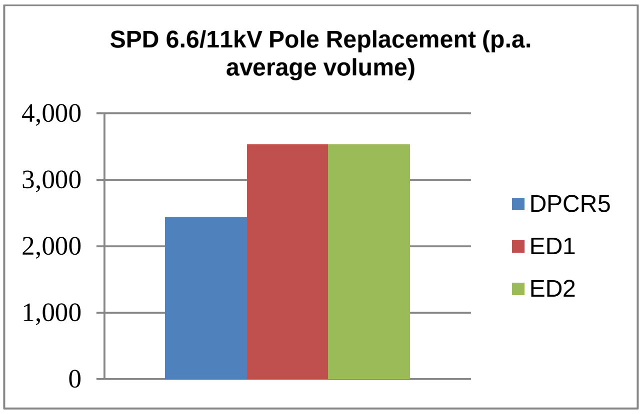


Figure 7-11: SPD 6.6/11kV pole refurbishment average volume per annum

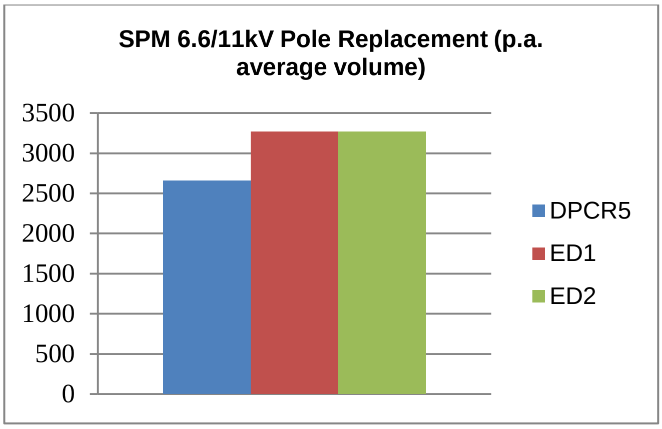


Figure 7-12: SPM 11kV pole refurbishment average volume per annum

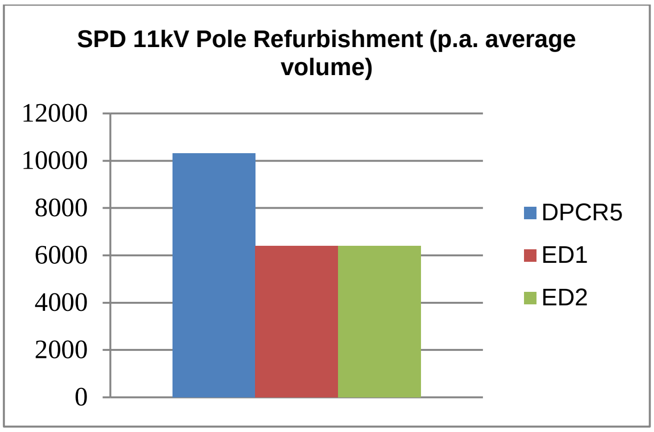


Figure 7-13: SPD 11kV pole refurbishment average volume per annum

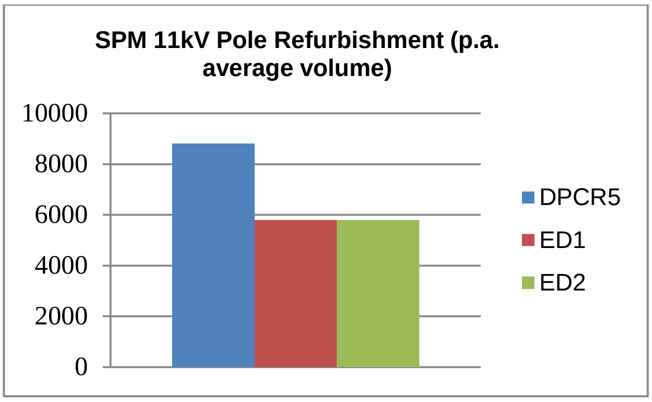


Figure 7-14: SPM 11kV pole refurbishment average volume per annum

7.3. HV ESQCR Clearance Hazards

In 2014 we are due to complete our accelerated 2-year inspection of the EHV and HV wood pole overhead line networks. This was established to provide detailed condition, hazard and defect data on our assets.

The Electricity Safety, Quality and Continuity Regulations (2002) – specifically regulations 17 and 18 - detail the minimum clearances for uninsulated overhead line conductors to the ground, buildings and objects.

We classify all clearance distances issues into two main categories (as per ESQCR regulation 17 and 18)

- *Low ground clearance – the distance from ground level to the conductor at the lowest point*
- *Proximity – the clearance distance to buildings, objects and climbable structures*

Our inspectors electronically measure every span of overhead line at the lowest point, and log this through tailored IT software to our corporate systems. This is the same process as for the LV ESQCR inspections (discussed in **Annex C6 – LV Overhead Line Strategy – SPEN**).

We have already established an industry leading programme to resolve all non-conformances to these clearance distances on our LV overhead line network by 2020, as agreed with the HSE in 2008.

As we have progressed through our EHV and HV inspections we have discovered a very small proportion of non-conformances on the HV network, on approximately 1% of the total inspected.

In ED1 we plan to resolve all ESQCR hazards by 2020 (as with our existing LV agreement with the HSE):

HV ESQCR - RIIO-ED1					
Asset	Unit	SPD		SPM	
		Volume	Expenditure (£m)	Volume	Expenditure (£m)
HV ESQCR clearance hazards	#	4,000	6.4	6,000	13.7

Table 7-1: HV ESQCR hazard removal forecast for ED1

More information on our ESQCR programme is discussed in **Annex C6 – LV Overhead Line Strategy – SPEN.**

7.3.1. ESQCR Risk Matrices

During inspections, our ESQCR hazards are categorised by total, inherent risk using two indicators:

- *Hazard risk – the extent of clearance/distance infringement (e.g. how low the conductors are). This is based on assessment of 1 (low risk) to 5 (very high risk).*

- *Location risk – land use, proximity to the public (e.g. what is likelihood of inadvertent contact). This is categorised via 'Lower than Normal', 'Normal' and 'Higher than Normal'.*

This level of granularity has allowed us to quantify the risk via a matrix approach for internal reporting and planning purposes. The matrices below demonstrate the split between hazard and location risk.

For clarity, the hazard risk in these matrices is on the vertical axis, on the 1 to 5 scale described above. The location risk is simplified to 'High', 'Medium' and 'Low' on the horizontal axis.

7.3.2. SPD

HV total combined hazards (low ground clearances and proximity)

Hazard Risk	Location Risk			Total
	High	Medium	Low	
5	49	0	0	*49*
4	83	1,122	57	*1,261*
3	20	1,831	377	*2,227*
2	3	131	329	*463*
1	0	0	0	*0*
Total	*154*	*3,083*	*762*	*4,000*

HV low ground clearances hazards only

Hazard Risk	Location Risk			Total
	High	Medium	Low	
5	0	0	0	*0*
4	9	432	57	*497*
3	18	522	145	*685*
2	0	49	271	*321*
1	0	0	0	*0*
Total	*27*	*1,004*	*473*	*1,503*

HV Proximity hazards only

Hazard Risk	Location Risk			Total
	High	Medium	Low	
5	49	0	0	*49*
4	74	690	0	*764*
3	2	1,308	232	*1,542*
2	3	82	58	*142*
1	0	0	0	*0*
Total	*128*	*2,080*	*290*	*2,497*

7.3.3. SPM

HV total combined hazards (low ground clearances and proximity)

Hazard Risk	Location Risk			Total
	High	Medium	Low	
5	83	0	0	*83*
4	90	1,035	135	*1,260*
3	10	1,039	3,001	*4,050*
2	0	50	557	*608*
1	0	0	0	*0*
Total	*183*	*2,124*	*3,693*	*6,000*

HV low ground clearances hazards only

Hazard Risk	Location Risk			Total
	High	Medium	Low	
5	0	0	0	0
4	5	67	135	207
3	10	123	367	500
2	0	44	479	523
1	0	0	0	0
Total	15	234	980	1,230

HV Proximity hazards only

Hazard Risk	Location Risk			Total
	High	Medium	Low	
5	83	0	0	*83*
4	85	967	0	*1,053*
3	0	916	2,634	*3,550*
2	0	7	78	*85*
1	0	0	0	*0*
Total	*168*	*1,890*	*2,713*	*4,770*

8. Delivery

8.1. Investment Programme

The EHV and HV wood pole overhead line investment programmes are developed utilising our PAS55 (now ISO55001:2014) asset management methodology and are informed by our 'Asset Health, Criticality and Outputs Methodology' policy document (ASSET-01-019).

Appendix10.3 shows our investment decision making process. We provide a high level identification of circuits that may be suitable for intervention, based on an assessment of detailed data sets produced from our corporate systems (condition, defects, customer performance, etc.). Thereafter, a detailed condition based assessment provides a more nuanced consideration of the circuit's overall condition. A toolbox approach to asset interventions is then adopted to deliver the desired output.

8.2. Pre-Delivery

A sample of our prioritised work programme is shown in appendix 10.4.

This then feeds into the rebuild / refurbishment workstreams, split by Voltage and weather area.

Our delivery service partners are geographically split. They conduct a pre-delivery Condition Based Assessment prior to any works. This is a detailed survey and provides the contractor and our project managers with a full understanding of the circuit requirements. A sample is shown in figure 8-1 below.

This enables us to make an informed decision about the best solution for the circuit – for example, it may be prioritised for refurbishment, but the condition of the line makes it more cost-effective to rebuild.

Strategic priorities from other parts of the networks business, such as the replacement of strategic telecoms/fibre-optic infrastructure, can also provide an input into delivery decision

	Sub-station: CAERGEILIOG - MONA			Circuit No:	MW807846	
	Voltage: 33KV			Location:	CAERGEILIOG - MONA	
	Report: 10			No of Poles:	89	
		Totals				
Pole Data	Pole Number		180L	180R	208L	208R
	Map		230508378168	230508378168	230548378175	230548378175
	Classification		A	A	A	A
	Minimum Residual I Value		1	1	1	1
	Factor of Safety		12.2	11.5	5.9	6.8
	Pole Year		1952	1952	1981	1981
	Pole Length		12	12	14	14
	Pole Diameter/Size		S	S	S	S
	Measurement Basis		Imperial	Imperial	Metric	Metric
	New Pole Size					
	Health Index		HI2	HI2	HI2	HI2
	Type of Pole		H Pole	H Pole	H Pole	H Pole
	Construction of Pole		Terminal	Terminal	Section Angle	Section Angle
	Cross Arm		Delta - Tension Discs	Delta - Tension Discs	Delta - Tension Discs	Delta - Tension Discs
	Second Cross Arm					
	Land Use		Industrial	Industrial	Common	Common
	Total Risk Level		M	M	M	M
	Number of Images		3	1	2	
Conductors	Size of Conductor				ACSR150	
	Number of Conductors				4	
	Span length m (Total in km)	13.212			44	
	Mid-span Height m				8.3	
	Road Crossing Height m					
	Temperature °C		7	7	7	7
Remarks	Remarks		9x GLASS TENSION DISCS. 1x PORCELAIN PILOT. 1x HAND BOUND. 2x UNINSULATED STAYS. REPLACE BINDER ON PILOT AS JUMPER GOES THROUGH MIDDLE OF PILOT AND NOT ATTACHED AT THE SIDE.	2x UNINSULATED STAYS.	18x GLASS TENSION DISCS. 2x PORCELAIN PILOTS. 2x HAND BOUND. 2x PERMALLI STAYS. POLE NUMBER 208 ON SITE.	
Pole Defects	Replacement Pole	9				
	Dual Voltage					
	Pole Leaning	4				
	Pole Leaning In-Lne					
	De-Earth Pole	3			1	
	Safety Sign	150			1	1
	Number Plate	17	1	1	1	1
	Anti-climb Defective					
	Cross Arm	8				
	Ground Level	1				
	Existing "S" Label	1				
	Existing "D" label	1				

Figure 8-1: Example of circuit condition based assessment data

8.3. Local Engagement

Our investment programme, particularly at HV, can make a significant impact to our customers in rural communities. We take a proactive approach to engage with our key stakeholders before we commence work that may affect their day to day activities, and understand the impact on the local area. This also promotes our investment in their network and allows our customers to better understand scale of the activities we undertake and which they fund.

Due to our prioritised delivery process, we sometimes deal with communities that have suffered from poor performance in the past, and we make concerted efforts to address their concerns and demonstrate our commitment to improving their service in the future.

Prior to any work we have an established process of communication, contacting MPs and other governing representatives, local government councils, community bodies and other relevant institutions. We also use local press and social media to reinforce our message.

We first establish the scope and range of works we will be undertaking, which is crucial to minimise disruption if other utilities or works are planned in the area.

Direct engagement with the local communities are generally initiated through meetings held in local halls, where our delivery engineers and managers can inform the public, respond to any requests and resolve potential issues. For example, potential issues with the position of our apparatus, or confirming what identification our staff will be using when on site (to avoid 'bogus callers').

As we will be coordinating outages in many instances for changeover of supplies, and renewing conductors/poles that may be in or near their properties, we also conduct door-to-door discussions with those residents who will be directly affected.

Our project managers will also engage with our local Network Operations 'zone' staff to assess any anecdotal evidence or requirements for the particular circuit, for example, anyscope for additional investment or re-positioning of apparatus to provide faster restoration of customers in the event of a fault.

8.4. Deliverability

Key delivery issues that we have considered in developing our plan include:

- *Our linesman resources with our servce partners are now established at consistent level as our programme continues in DR5 and in preparation for ED1.*
- *We have established linesman training courses at local colleges in both SPD and SPM with the aim of adding to our contractor linesman base.*
- *Long term strategies, work programme stability and contract terms provide security to our service partners to invest.*
- *We are due to complete full inspections of the EHV and HV overhead line networks in 2014, which provides us with a much more granular level of detail and understanding about our network condition. This will feed into future prioritisation processes.*
- *Internal and contractor volume/HI reporting processes reviewed and improved.*
- *As our HV overhead line refurbishment rolling cycle progresses in ED1, there is scope for driving further efficiencies in delivery volume, cost and customer service.*

9. Risks and Mitigation

Potential Risk	Mitigation Actions
Forecast is based on currently available OHL resources. This is limited across the UK and is subject to change dependant on other DNO needs and priorities	SPEN has established industry leading programme. Stable continuation of work programmes through DR5 and into ED1 will provide long term stability for service partners.
EU legislation has led to a review of Creosote as a preservative for wood. Electricity industry exemption could be removed during the ED1 period. This would result in shorter wood pole asset lives with higher turnover rates required in the future. Potentially higher capital costs as alternative techniques are explored for pole preservation and/or alternatives used (undergrounding).	EU legislation changes would impact UK electricity industry as a whole. SPEN will proactively engage with Ofgem and industry bodies and working groups to establish collaborative mitigation efforts.
HV ESQCR forecast is based on current data available from corporate systems. Potential risk of further increase from forecast, or for potential solutions to deviate work from programme.	Further ESQCR hazard reconciliation between SAP and ESRI corporate systems during 2014 to minimise potential errors. Forecast based on 80% completion of inspections. 2020 end date for full ESQCR clearance compliance to be managed as part of prioritised programme of works, which will identify possible synergies with capital programmes. Programme governance to identify any potential deviations from targets at earliest opportunity.
Increase in activity during ED1 may result in more linespersons requiring SPEN Authorisations and hence more strain on our training centres.	DR5 activity has established adequate resource base in SPD and SPM licence areas. Long term stability of work programme to assist service partners in recruitment and SPEN in resource availability at training centres. SPEN programmes with local colleges already established for streamlining linesmen into contractor positions. SPEN authorisations

10. Appendix

10.1. Images

Figure 10-1: 33kV overhead line resilient rebuild of 'A' pole line (in background), SPD

Figure 10-2: Repairing damage caused by falling trees, January 2012 storm, SPD

Figure 10-3: Mature tree fallen onto line, Jan 2012 storm, SPD

Figure 10-4: 33kV overhead line following tree clearance as part of our Rural Care programme, a precursor to ETR132

Figure 10-5: Example of pole top rot

Figure 10-6: Example of pole damage following severe weather

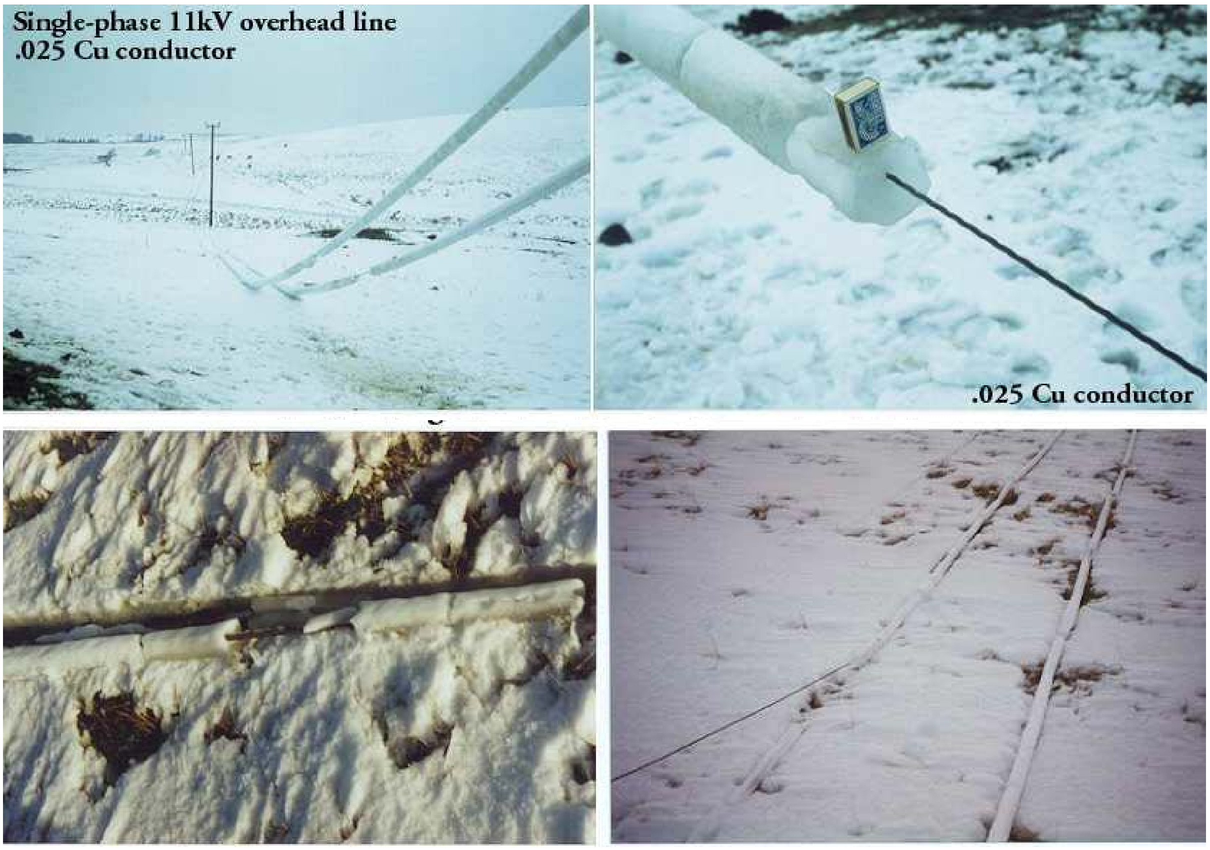
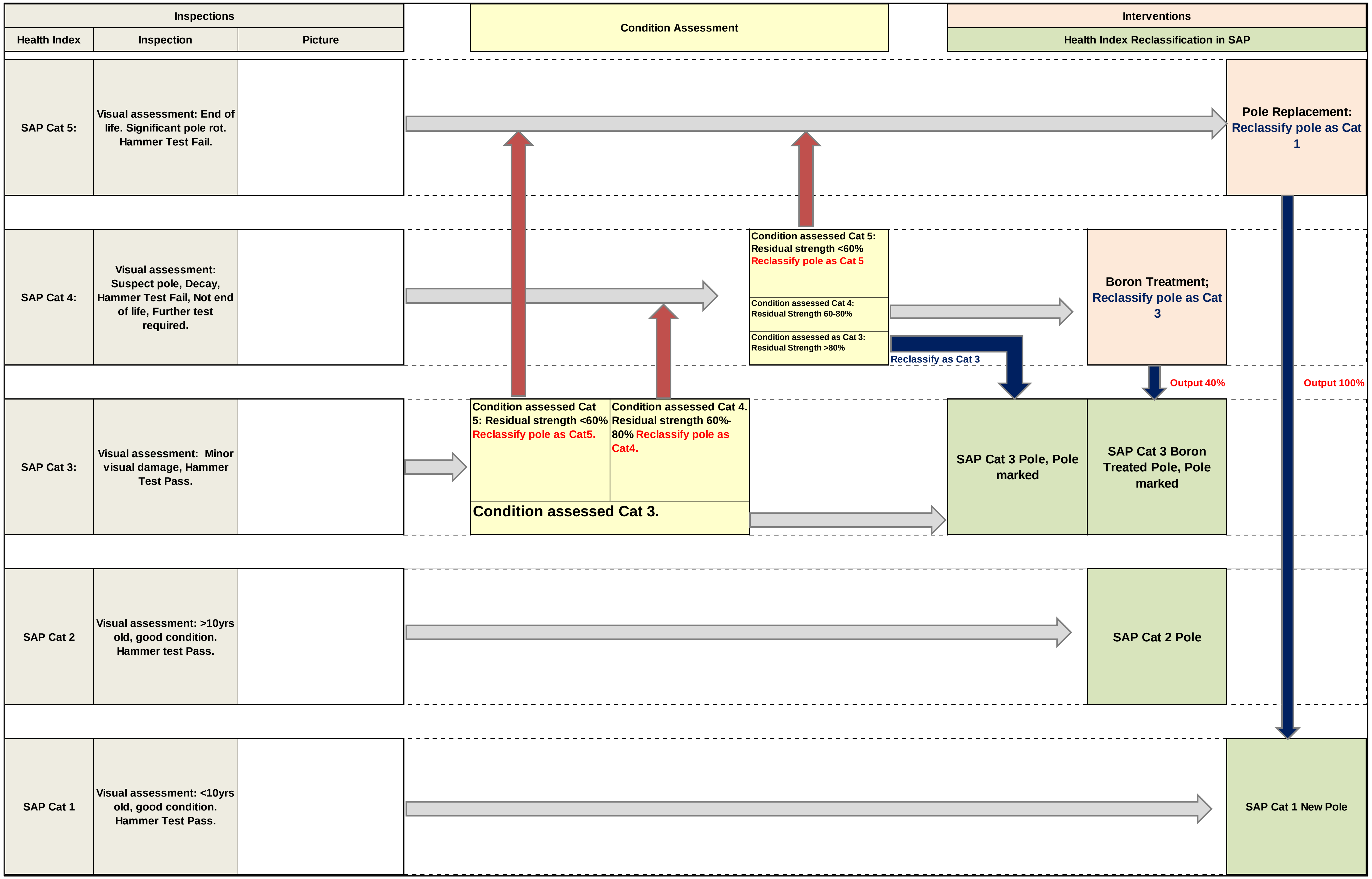


Figure 10-7: Examples of faults due to ice accretion on overhead line conductors during storm events on non-resilient lines, SPD

10.2. Wood Pole Health Index Methodology

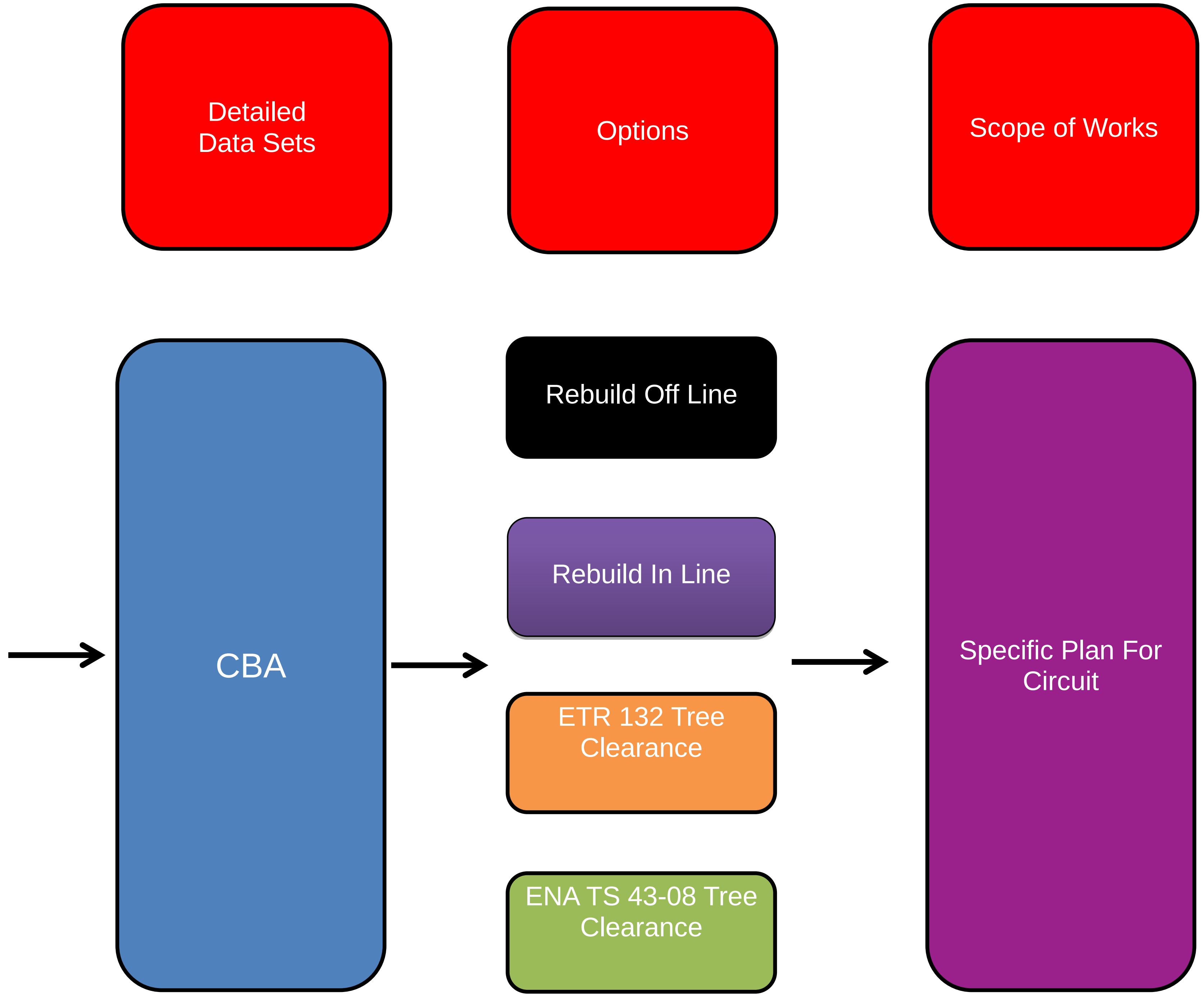


10.3. Circuit Prioiritisation Methodology

Risk/Performance Based Priority List

Rebuild/Refurbishment

Asset category	Asset Sub-category	Activity Description	Asset Category2	Price Control	TPCR Project	Scheme Information	IP 1	IP 2	Stage Gate
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Kaimes Series Reactors				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	PF - Reinforcement Balance Entry: SWS (Moyle TEC450MW)				STAGE 0 PF Balance Entry - Projects to be identified
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Devol Moor-Erskine Dbl cct ohl Braehead Group Reinforcement				STAGE 2 - Authorised / Consents still to be cleared
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East Coast Upgrade ALTERNATIVE LCS (Construction)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East - West Upgrade (Construction)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	SPT - NGT Interconnection (Construction)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	Western HVDC Link (NGET/SPTL) (Construction)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	Western HVDC Link (Onshore) (Construction)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	Hunterston - Kintyre Link (SHETL/SPTL)				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Berwick Ring Voltage Support				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Bonnybridge GSP Reinforcement				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Cupar GSP Reinforcement				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Currie Group Reinforcement				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Devonside GSP Reinforcement				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Galashiels GSP Reinforcement				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Newton Stewart GSP Reinforcement				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Sighthill GSP Reinforcement				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Stirling GSP Reinforcement				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Strathleven GSP Reinforcement				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East Coast (Constr) A1 - Harburn 400kV Substation				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East Coast (Constr) A2 - Grangemouth-Harburn 400kV OHL Upgrade				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East Coast (Constr) A3 - Grangemouth 400kV Substation (GIS)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East Coast (Constr) A4 - Grangemouth - Kincardine 400kV OHL Upgrade				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East Coast (Constr) A5 - Kincardine 400kV Substation				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East Coast (Constr) A6 - Kincardine - SHETL 400kV OHL & U/g cable Upgrade				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East Coast (Constr) A7 - Longannet - Westfield 275kV U/g cables				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East-West (Constr) C1 - Strathaven 400kV Upgrade				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East-West (Constr) C2 - Strathaven-Wishaw (XH) 400kV OHL Upgrade				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East-West (Constr) C3 - Wishaw 400kV Substation (GIS)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East-West (Constr) C4 - Wishaw- Kaimes (XH) 400kV OHL Upgrade				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East-West (Constr) C5 - Kaimes 275kV Substation Reconfiguration				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East-West (Constr) C6 - Kaimes-Smeaton (XJ) 400kV OHL Upgrade				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East-West (Constr) C7 - Smeaton 400kV OHL Works				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	East-West (Constr) C8 - Torness-Eccles (Branxton) 400kV U/g Cables (2nd Core/ph)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	SPT-NGT I/c (Constr) B1 - Strathaven-Coalburn 1 100MVAr SC (Strathaven)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	SPT-NGT I/c (Constr) B2 - Strathaven-Coalburn 2 100MVAr SC (Coalburn)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	SPT-NGT I/c (Constr) B3 - Elvanfoot-Gretna 255MVAr SC (TBC)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	SPT-NGT I/c (Constr) B4 - Moffat-Harker 255MVAr SC (Moffat)				STAGE 1 - Design / Pre Engineering
LRE	Infra - ENSG	31165 Reinforcement 132kv & Above	Load	Main	SPT-NGT I/c (Constr) B5 - Eccles-Stella West 1&2 2x255MVAr SC (Eccles)				STAGE 1 - Design / Pre Engineering
LRE	Infra - General Non-reactive (Excl TIRG)	31165 Reinforcement 132kv & Above	Load	Main	Finnieston GSP (Glasgow City Centre) - Distribution				STAGE 1 - Design / Pre Engineering



10.4. Circuit Ranking Process (Excerpt)

Circuit Ref Number	Circuit Name	Voltage (kV)	OHL cct Length (km)	UGC cct Length (km)	% split of OH vs. UG	Main Line Length (km)	Spur Line Length (km)	Total Poles	Total Poles	AONB or National Park?	Weather Area (% of cct i	# Rotten Poles	# Rotten Poles / Total Po	# Stay rod defects	# Stay wire defects	Stay Defects / Total Leng	# Insulator defects	Insulator Defects / Total	# Conductor defects	Conductor Defects / Tota	Trees Within Falling Distance	Trees (ETR-132) / Total L	Avg Tree Related Faults	Avg Total Tree Related F	Customer Numbers	Single 33kV Primary Sup	Avg # Incidents p.a. (wei	Avg # Incidents p.a. per	Avg Total CI p.a. (weight	Avg Total CML p.a. (weig	PRIORITISED CONDITIO
A61004	CASTLE BEESTON ST:-The Pippins	11	1	10	0	1	1	31	31			0	0	0	0	0	0	0	0	0	28	20	0	0.00	1719	Y	1.80	1.29	1306	93419	13.473
A92806	MMB ELLESMERE:-Exps Dairy/Oswry Gr. L10440 (CM 286)	11	32	3	1	20	11	382	382			45	0	4	5	0	3	0	11	0	502	16	0.14	0.00	365	Y	5.00	0.16	245	22007	12.755
A72403	PONTERWYL:-Moel Gron	11	1	7	0	1	0	18	18			0	0	0	0	0	0	0	0	0	10	11	0	0.00	1634	Y	1.80	1.90	414	27345	12.452
A61301	HOLMES CHAPEL:-Brookfield Crescent	11	18	4	1	6	12	220	220			16	0	1	3	0	0	0	11	1	497	28	0.08	0.00	835	Y	3.20	0.18	796	117245	13.209
A52003	SPITAL:-Parnell Road	11	1	5	0	0	0	8	8			0	0	0	1	2	1	2	0	0	7	12	0	0.00	1573	Y	0.20	0.33	3	192	12.244
A80602	LLANDYFRYDOG:-DULAS/MOELFRE	11	39	3	1	10	29	526	526	29		25	0	1	11	0	2	0	25	1	1343	35	0.08	0.00	1102	Y	5.00	0.13	728	73301	13.393
A40804	RUABON:-L72 IDWAL	11	1	6	0	1	0	11	11			0	0	0	0	0	0	0	0	0	40	61	0	0.00	1511	Y	1.00	1.52	1250	96446	13.621
A14501	MAGHULL:-Liverpool Rd, South	11	7	5	1	5	3	92	92			0	0	1	2	0	1	0	3	0	81	11	0.04	0.01	1705	N	3.00	0.42	714	72191	13.304
A80401	LLANDDEUSANT:-L5876/5861 Llanfaethlu / Llanddeusant	11	51	1	1	11	40	675	675	16		57	0	20	11	1	5	0	30	1	228	4	0	0.00	734	Y	11.40	0.22	1183	142213	12.237
A35205	LYMM:-Highfield Road	11	5	5	1	3	2	67	67			8	0	0	1	0	1	0	1	0	59	12	0.02	0.00	221	Y	2.60	0.52	362	31682	11.638
A81301	HIRAEL:-Ambrose St	11	13	16	0	8	6	6	6			0	0	0	0	0	0	0	0	0	52	4	0.15	0.01	1132	N	6.20	0.46	2510	321913	8.968
A71410	FLINT:-Hillcourt Avenue / Greenfield Distribu	11	2	3	0	1	1	37	37			3	0	0	1	0	0	0	3	1	25	11	0	0.00	820	N	0.20	0.09	4	272	12.916
A81006	PENTRAETH:-Tynygongol / Benllech CM106	11	6	7	0	6	1	94	94	0		2	0	0	0	0	0	0	2	0	242	38	0	0.00	1309	Y	2.40	0.38	997	74751	12.881
A83602	BOTWNNOG:-Mynytho / Abersoch / Llanbedrog	11	17	1	1	5	12	228	228	8		27	0	0	5	0	3	0	9	1	288	17	0.06	0.00	245	Y	2.20	0.13	43	8589	11.935
A70701	PRESTATYN:-Glan Y Gor	11	0	4	0	0	0	7	7			0	0	0	1	2	0	0	0	0	2	4	0	0.00	1508	Y	0.00	0.00	0	0	11.326
A73005	GRAIG FAWR:-Maes Hendre / Roundwood Avenue	11	2	5	0	1	1	22	22			0	0	0	0	0	1	1	0	0	17	10	0	0.00	1615	Y	0.60	0.37	22	10005	12.357
A8A101	ABERSOCH:-ABERSOCH TOWN	11	4	3	1	2	2	52	52	1		3	0	0	0	0	0	0	4	1	16	4	0	0.00	893	Y	1.40	0.35	350	43523	11.297
A40801	RUABON:-PLAS BENNION/AFONEITHA COUNCIL HOUSE	11	3	3	1	2	1	54	54			1	0	0	0	0	0	0	0	0	108	35	0.02	0.01	1394	Y	2.00	0.65	874	58462	13.431
A63801	STAPELEY:-Newcastle Rd / L1068 (Shavington)	11	5	3	1	5	0	64	64			1	0	0	1	0	1	0	2	0	147	29	0.06	0.01	1211	Y	0.40	0.08	142	7537	11.907
A41004	METAL BOX CO:-SAXON ROAD	11	2	4	0	1	1	55	55			3	0	0	0	0	0	0	3	2	4	3	0	0.00	920	N	1.20	0.75	29	3649	11.248
A32204	N C B SUTTON MANOR:-Pendlebury Street	11	2	7	0	0	2	22	22			0	0	0	4	2	1	1	0	0	27	16	0	0.00	1425	N	1.00	0.58	437	52311	11.253
A72402	PONTERWYL:-Chester Road	11	0	2	0	0	0	9	9			0	0	0	0	0	0	0	3	6	36	74	0	0.00	384	Y	0.20	0.41	71	6772	6.282
A32205	N C B SUTTON MANOR:-Wilmere Rd / Warrington Rd	11	1	2	0	0	1	17	17			0	0	0	0	0	0	0	1	1	4	5	0	0.00	106	Y	0.80	0.92	45	6569	1.044
A41404	BERSHAM COLLIERY:-ERDDIG	11	24	5	1	6	18	258	258			28	0	1	1	0	10	0	3	0	231	10	0.09	0.00	246	N	4.00	0.17	343	42849	10.891
A80705	CAERGEILIOG:-Treaddur Bay / Holyhead	11	32	3	1	7	24	430	430	29		9	0	3	4	0	3	0	10	0	121	4	0	0.00	1231	Y	9.80	0.31	2572	248250	10.879
A83704	HARLECH:-HARLECH TOWN	11	13	2	1	4	9	173	173	13		9	0	1	3	0	1	0	12	1	75	6	0.04	0.00	551	Y	3.20	0.25	260	35833	8.565
A63902	WRENBURY FRITH:-Sandfield Estate / L76A	11	38	3	1	9	29	441	441			25	0	1	2	0	2	0	3	0	727	19	0.04	0.00	703	Y	3.80	0.10	793	60813	10.433
A80302	CEMAES BAY:-Stad Castellor / Burwen / Amlwch	11	16	1	1	5	11	225	225	5		20	0	0	11	1	0	0	20	1	91	6	0	0.00	304	Y	1.60	0.10	90	9814	9.513
A91802	LLANDRINIO:-Crew Green L138 (CM182)	11	30	2	1	3	27	339	339			27	0	4	2	0	0	0	5	0	402	13	0.12	0.00	433	Y	4.40	0.15	319	40886	10.139
A90202	OVERTON:-Bangor Is-y-Coed L1101 (CM022)	11	60	2	1	21	40	188	188			6	0	0	1	0	1	0	12	0	452	7	0	0.00	942	Y	7.80	0.13	756	62006	9.740
A00103	BARMOUTH:-North Avenue L6759	11	16	3	1	6	11	259	259	15		2	0	0	3	0	0	0	8	0	1538	94	0.21	0.01	1091	Y	2.60	0.16	550	90018	13.081
A83603	BOTWNNOG:-Hells Mouth / Abersoch	11	44	1	1	15	29	599	599	30		43	0	1	7	0	5	0	31	1	164	4	0.08	0.00	426	Y	10.20	0.23	780	112095	9.026
A63701	WESTON:-CALMIC / L2646 (HASLINGTON)	11	10	4	1	7	3	147	147			2	0	0	0	0	2	0	8	1	240	25	0	0.00	818	Y	1.40	0.14	152	36575	8.164
A83203	LLANFROTHEN:-Cookes	11	16	2	1	5	11	248	248	14		20	0	0	4	0	0	0	28	2	321	20	0.05	0.00	290	Y	2.00	0.12	57	18132	9.484
A90106	IFTON:-MOORS BANK	11	10	5	1	6	4	42	42			0	0	0	0	0	0	0	0	0	254	26	0.11	0.01	1207	Y	1.60	0.16	727	69417	10.443
A63703	WESTON:-WESTON VILLAGE / L12109 (WESTON)	11	15	6	1	7	8	184	184			4	0	0	0	0	9	1	5	0	334	22	0.08	0.01	1115	Y	2.20	0.15	69	8853	11.123
A63602	DUCKINGTON:-L5084 Larkton House (Malpas)	11	18	3	1	10	8	253	253			10	0	3	1	0	8	0	9	1	261	15	0	0.00	731	Y	0.60	0.03	27	2667	9.153
A84601	MONA:-MONA BOOSTER STATION	11	21	2	1	8	13	280	280			11	0	1	0	0	1	0	21	1	210	10	0	0.00	638	Y	3.40	0.16	463	87236	8.243
A80603	LLANDYFRYDOG:-LLWYDIARTH ESGOB/LLANERCHYMED	11	40	1	1	12	28	526	526			33	0	0	8	0	2	0	43	1	838	21	0	0.00	435	Y	4.20	0.10	363	44079	9.038
A72305	LLANFWROG:-Pwll Glas	11	31	1	1	9	22	1296	1296	22		88	0	3	12	0	15	0	53	2	455	15	0.13	0.00	348	Y	4.40	0.14	401	57440	8.807
A91602	PREES:-PREES SALOPIAN L14199 (CM162)	11	38	3	1	4	34	460	460			25	0	15	2	0	3	0	4	0	581	15	0.12	0.00	434	Y	2.60	0.07	385	29479	8.218
A81203	LLANGAFFO:-Gaerwen	11	24	1	1	8	16	319	319			6	0	1	2	0	2	0	13	1	438	18	0.17	0.01	452	Y	2.60	0.11	694	54090	5.903
A90504	YOCKINGS GATE:-Whitchurch /Untd Dairies L5994 (CM054)	11	46	3	1	19	27	557	557			15	0	5	8	0	5	0	4	0	951	21	0.26	0.01	715	Y	6.20	0.14	579	78162	8.483
A90902	LLYNCLYS:-Lloyds Animal Foods L512 (CM092)	11	25	1	1	8	17	282	282			18	0	0	6	0	9	0	6	0	473	19	0.03	0.00	410	Y	6.40	0.26	532	33655	8.889