Document 14
Asset Category – I&M and Faults
LPN

Asset Stewardship report 2014

Chino Atako

Approved by

Approved date

Document History

Version	Date	Details	Originator	Revision Class	Section Update
1.0	21/01/2013	Initial Draft	Colin Bush	N/A	N/A
1.1	17/02/2014	New Preface added Costs Summary Table updated to reflect 13th February 2014 Namp figures Updated references to align to latest Namp and RIGs Addition of appendices 8, 9 and 10 Section 13.0 removed (Trees)	Asha Kiribalasingham	Minor Minor Minor Minor Minor	N/A Section 1.4 – Page 12
1.2	27.02.2014	Updated as per Chino's Review comment	Manjula Singh	Minor	Throughout the document
1.3	28.02.2014	Updated the Appendix 10 and table references	Manjula Singh	Minor	Throughout the document, Appendix 10.
1.4	03.03.2014	Updated Appendix 10	Asha Kiribalasingham	Minor	Appendix 8
1.5	04.03.2014	Modified Appendix 8	Ade Olatunji	Minor	Appendix 8
1.6	05.03.2014	Updated Appendix 10	Asha Kiribalasingham	Minor	Appendix 10
1.7	05.03.2014	Tables 48 & 49 removed	Asha Kiribalasingham	Minor	Appendix 10
1.8	07.03.2014	Updated ED1 summary table and Faults Graph	Ade Olatunji	Minor	Section 1.4 and Appendices 5 & 9
1.9	07.02.2014	Final Update	Chino Atako	NA	NA
2.0	27.03.2014	Final for publication	Regulation	Minor	All

Preface

UK Power Networks uses Asset Stewardship Reports ('ASR') to describe the optimum asset management strategy and proposals for different groups of assets. This optimised asset management strategy and plan details the levels of investment required and the targeted interventions and outputs needed. Separate ASRs define the most efficient maintenance and inspection regimes needed and all documents detail the new forms of innovation which are required to maximise value, service and safety for all customers and staff throughout the ED1 regulatory period. Outline proposals for the ED2 period are also included.

Each DNO has a suite of approximately 20 ASR's. Although asset policy and strategy is similar for the same assets in each DNO the detailed plans and investment proposals are different for each DNO. There are also local issues which must be taken into account. Accordingly each DNO has its own complete set of ASR documents.

A complete list of titles of the ASR's, a summary of capex and opex investment is included in '**Document 20: Asset Stewardship Report: CAPEX/OPEX Overview'**. This document also defines how costs and outputs in the various ASR's build up UK Power Networks 'NAMP' (Network Asset Management Plan) and how the NAMP aligns with Ofgem's ED1 RIGs tables and row numbers.

Where 'HI' or asset 'Health Index' information is included please note predicted ED1 profiles are before any benefits from 'Load driven investment.'

This ASR has also been updated to reflect the feedback from Ofgem on our July 2013 ED1 business plan submission. Accordingly to aid the reader three additional appendices have been added. They are;

1. **Appendix 8 - Output NAMP/ED1 RIGS reconciliation:** This section explains the 'line of sight' between the UKPN Network Asset Management Plan (NAMP) replacement volumes contained in the Ofgem RIGS tables. The NAMP is the UKPN ten year rolling asset management investment plan. It is used as the overarching plan to drive both direct and indirect CAPEX and OPEX interventions volumes and costs. The volume and cost data used in this ASR to explain our investment plan is taken from the UK Power Networks NAMP. Appendix 8 explains how the NAMP outputs are translated into the Ofgem RIGS tables. The translation of costs from the NAMP to the ED1 RIGS tables is more complex and it is not possible to explain this in a simple table. This is because the costs of a project in the 'NAMP' are allocated to a wide variety of tables and rows in the RIGS. For example the costs of a typical switchgear replacement project will be allocated to a range of different Ofgem ED1 RIGs tables and rows such as CV3 (Replacement), CV5 (Refurbishment) CV6 (Civil works) and CV105 (Operational IT Technology and Telecoms). However guidance notes of the destination RIGs tables for NAMP expenditure are included in the table in the Section 1.1 of the Executive Summary of each ASR.

2. **Appendix 9 – Material changes since the June 2013 ED1 submission:** This section shows the differences between the ASR submitted in July 2013 and the ASR submitted for the re-submission in March 2014. It aims to inform the reader the changes made to volumes and costs as a result of reviewing the plans submitted in July 2013. Generally the number of changes made is very small, as we believe the original plan submitted in July 2013 meets the requirements of a well justified plan. However there are areas where we have identified further efficiencies and improvements or recent events have driven us to amend our plans to protect customer safety and service.

We have sought to avoid duplication in other ED1 documents, such as 'Scheme Justification Papers', by referring the reader to key issues of asset policy and asset engineering which are included in the appropriate ASR documents.

Contents

1.0 Executive Summary I&M and Faults

1.1 Scope

This document describes the inspection and maintenance (I&M) of overhead lines, underground cables, switchgear and transformers at all voltages in the LPN region of UK Power Networks. It also examines fault rates on these asset types (excluding third party damages). Exceptional events have not been excluded from the analysis.

This document also includes increased volumes for inspection and maintenance in the Central London Zone. These are explained in the LPN Central London document.

The inspection and maintenance of civils and protection and control assets are dealt with in separate documents.

This document covers the volumes for DPCR5 and the forecast for the remainder of DPCR5 and ED1 periods. It is expected that ED2 volumes will continue at a similar level to that for ED1.

The inspection and maintenance costs in LPN in ED1 is £123m and is equivalent to 0.11% of the MEAV per annum.

The faults costs in LPN in ED1 is £183m and is equivalent to 0.17% of the MEAV per annum.

1.2 Strategy

The strategy for inspection and maintenance is to continue to maintain, monitor and review the performance of the assets to achieve maximum life, while keeping the risks to the network and the general public, as well as whole-life costs, as low as reasonably practical.

The approach to maintenance and inspection is described in UK Power Networks policy EMS 10-0001 – Maintenance and Inspection Overview. Inspection and maintenance frequencies are provided in EMS 10-0002 – Inspection and Maintenance Frequency Schedule.

The overall strategy for ED1 is to manage a steady state position for the majority of the asset types, with Health Indices remaining consistent across the period. This approach is based on known condition data from historic inspection and maintenance reporting and operating performance of the assets, combined with local knowledge and experience. The proposed plan manages any change in risk due to an ageing asset population or from the deployment of increasing volumes of lower maintenance equipment such as vacuum and SF_6 switchgear.

An increase in the inspection period has been recently instigated for substation sites, driven by an opportunity to create efficiency improvements that will optimise expenditure in this area during ED1.

The forecast figures for inspection and maintenance volumes have been derived from Table "O" (Volumes) from the 19th February 2014 NAMP covering from 2013/14 to 2022/23.

Asset volumes and network statistics have been taken from the RIGS V5 return (2012) unless specified otherwise.

Fault volumes for the graphs have been derived from fault data contained in the RIGS (Regulatory Instructions and Guidance) return CV15 (2009/10 – 2011/12) and IIS (Information Incentive System) (2007/8 – 2008/9). These sources provide total fault volumes but the graphs show net faults, i.e. with third party damages excluded. Disaggregated information, such as fault cause data, e.g. Third Party Damages, Condition etc are not available from these sources and have therefore been derived from the UKPN Fault Cube in line with the other (capex) documents. Differences in the data shown between these two sources may be apparent in some graphs. This is due to differences in processing the raw data and presenting it in the appropriate format – for example see graphs in 8.2.

Fault repair volumes for 2010/11 and 2011/12 have been derived from the RIGS returns. In forecasting the volumes for fault rates from 2013/14 and throughout ED1, the average over the past five years (2007/8 through to 2011/12) has been used to establish a reference point from which the volumes from 2013/14 onwards were extrapolated. During the preparation of this document, figures for 2012/13 volumes were not fully available. For fault volumes, these have therefore been set equal to the 2013/14 figures.

1.3 ED1 Proposals

The rationale to developing the I&M ED1 plan for each major asset category is outlined below;

Cables: For LV cables, excluding underground services, fault volumes are expected to increase over the next few years. This is due to the continued extension of the asset base, the large proportion of existing assets increasing in age and degrading, and the replacement plans being limited to faulted cable sections and reactive replacement based on condition as found during other work. As can be seen from the capex interventions available, the majority of work applicable to this asset group is reactive, as it is very difficult to inspect or condition-assess buried or concealed cables.

Plant: To reflect capex interventions proposed for ED1, maintenance of oil CBs has been reduced by a total of 11% from 2016/2017 pro-rata across the period.

In summary the UKPN ED1 proposals for the LPN region are based on continued alignment with existing policies in conjunction with the following plan revisions:

- Inspection periods for Grid and Primary substation sites have been increased from four monthly to six monthly, and secondary from two to three years
- LV underground cable fault volumes are anticipated to increase by 1% per annum due to an increasing and ageing population.

1.4 Summary Table of ED1 investment

The proposed inspection, maintenance and faults expenditure for LPN in ED1 is £305.6m. This comprises of £33.4m of Civils and £11.4m of Protection Costs. Tables 1 and 2 show the expenditure profiles with and without Civil and Protection expenditure. This document describes all the inspection the inspection and maintenance (I&M) of overhead lines, underground cables, switchgear and transformers at all voltages in the LPN region of UK Power Networks. It also examines fault rates on these asset types (excluding third party damages. Exceptional events have not been excluded from the analysis.

The inspection and maintenance of civils and protection and control assets are dealt with in the Protection Assets Stewardship Reports and Civils Asset Stewardship reports respectively.

Activity	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Sum of DPCR5	Sum of RIIO-ED1
Faults	31.9	29.4	30.3	33.4	24.1	23.7	23.3	22.9	22.6	22.4	22.3	22.5	22.8	149.0	182.6
Inspection (I)	2.0	2.5	3.1	4.5	4.2	4.7	4.8	4.8	4.8	4.8	4.8	4.2	4.0	16.3	36.7
Maintenance (M)	11.9	10.4	11.4	9.9	9.6	10.7	10.9	11.0	11.3	11.2	11.2	10.0	9.8	53.3	86.2
I&M	13.8	13.0	14.5	14.4	13.8	15.4	15.7	15.7	16.0	16.0	16.0	14.2	13.9	69.6	123.0
Total	45.7	42.3	44.8	47.8	37.9	39.2	39.0	38.7	38.7	38.4	38.3	36.7	36.7	218.5	305.6

Table 1- LPN I & M Expenditure (Data Source: NAMP of 19/02/2014 from Table J Less Indirect)

Activity	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Sum of DPCR5	Sum of RIIO-ED1
Faults	31.9	29.4	30.3	33.4	24.1	23.7	23.3	22.9	22.6	22.4	22.3	22.5	22.8	149.0	182.6
Inspection (I)	1.8	2.2	2.6	4.0	3.7	4.3	4.4	4.4	4.4	4.4	4.4	3.8	3.7	14.4	33.8
Maintenance (M)	7.5	7.0	7.8	5.0	4.7	5.6	5.7	5.8	6.0	6.0	6.0	4.7	4.6	32.0	44.4
I&M	9.3	9.3	10.4	9.0	8.4	9.9	10.1	10.2	10.4	10.4	10.4	8.6	8.3	46.5	78.2
Total	41.2	38.6	40.7	42.4	32.5	33.6	33.4	33.1	33.1	32.8	32.7	31.1	31.0	195.4	260.8

Table 2 - LPN Summary Table (Excluding Civils and Protection) (Data Source: 19th February 2014 NAMP Table J Less Indirect)

1.5 Innovation

UK Power Networks use of Reliability Centred Maintenance (RCM) assessments is a prime source of opportunity to optimise I&M activities and has been used to justify policy changes. This has recently driven changes to substation inspections and overhead plant maintenance, as well as utilising inspection techniques to change the requirement for other maintenance.

New technology also provides the chance to reconsider how we carry out activities not only more efficiently, but in a safer manner.

Innovations intended to assist in the management of faults include:

- The use of high resolution photography and locally controlled drones to identify the condition of overhead lines and fittings (2.8);
- The use of PFT to assist in fault location of fluid filled cables (4.8).

Inspection and Maintenance innovations include:

- Increased use of (remote) change of state operations to check mechanism operations and hence reduce routine inspections (5.8, 6.8, 7.8);
- Continuous (fixed) partial discharge monitoring (4.8);
- Tailoring post fault maintenance to the cumulative fault current rather than number of operations (7.8);
- Tailoring diverter maintenance to the specific transformer and tap changer types (10.8).

1.6 Risks and Opportunities

Table 3 provides a summary of the risks and opportunities of the investment proposals described in this document

	Description of similarly likely opportunities or risks arising in ED1 period	**Uncertainties**
Opportunity	Introduce condition based maintenance for tap changers	-£50k per annum
Opportunity	Introduce condition based post fault maintenance for feeder circuit breakers	-£35k per annum
Opportunity	Collate service termination condition reports (i.e. cut-out age and condition) by using supply company/meter operator/contractor installing new smart meters	+£2.3m per annum (estimate) over 5 year Smart Metering project period
Risk	Type failures of plant leading to modification programmes	+£750k per occasion
Risk	Increasing number of stuck or slow circuit breakers requiring increased maintenance	+£1.5k per annum

Table 3 - Risk and Opportunities

2.0 Towers (Broad Based) and Conductors

2.1 Asset Information

There are 46 towers operating at 132kV and 66kV as detailed in Table 4 below.

Voltage	No of Towers	Conductor Length (km)
132kV	18	7
EHV (66kV)	28	15

Table 4 – Towers (Broad-based) and Conductors Asset Information

(Source : RIGS Table 2013 V1)

2.2 Summary of Fault Trends, Failure Modes, and Fault Rates

All Voltages - There have been no recorded faults for this very small population of assets in the reporting period, and hence no data or graph is shown.

2.3 Faults Plan

As no faults have been recorded it is not possible to forecast future faults based on historical data. As the asset population is very small it has been assumed that the volumes in this category will remain at zero.

At 132kV, fault patrols are carried out on an adhoc basis where a circuit has tripped with an unknown cause. At 66kV this is required after 3 successful auto-reclose sequences within a 31 day period.

Volumes for EHV (66kV) OHL tower fault repairs are included in the data for 132kV OHL fault repairs.

There is no specific faults budget in this category, but any costs would be covered under “EHV Plant and Other Faults” in section 5.3.

2.4 I&M Drivers

Operator, public and network safety are the leading drivers for an optimised inspection and maintenance regime, with ongoing monitoring of compliance to Electricity, Safety, Quality and Continuity Regulations (ESQCR), and continuing clearance of defects. Public safety is particularly pertinent to this class of asset as it is mainly to be found on private property or highways.

The condition of an asset, which determines its Health Index, is also of paramount importance in identifying the most appropriate maintenance interventions and investment strategies that provide the best value for money.

Consideration of the whole-life asset cost, through the identification of complementary investment and maintenance strategies to maximise asset life, is an important aspect of managing these assets utilised by UK Power Networks. Trade-off between Opex and Capex is examined and whole life cost assessment examples are provided in the Capex related narrative documents.

2.5 I&M Interventions

Towers and conductors at all voltages are inspected every year, alternating between a safety and full inspection. Where the site is determined to be high risk, this will be more frequent as required. Associated equipment is also inspected during tower line inspections. A high risk site is determined by applying the criteria in EOS 09-0061 – Assessing the Risk to the Public from Distribution Network Assets – Section 4, and may typically be a tower with cable terminations (high risk equipment) situated on arable land or a golf course (low or medium risk location), or medium risk equipment (e.g. a 132/66kV tower) at a high risk location (e.g. Recreational areas or camping areas).

A random sample of tower footings are inspected once they are 40 years old, and then at 40-year intervals.

Thermal inspections of 132kV towers and conductors are carried out every two years.

CORMON testing of a 132kV or 66kV steel cored conductor starts once it is 40 years old, and then every 10 years, as outlined in table 3A of EMS 10-0002 – Inspection and Maintenance Frequency Schedule. At 132kV and 66kV, a physical inspection of fittings and supports is undertaken after 20 years of conductor life.

Tower painting is carried out on a reactive basis to maintain asset life and remove the need for larger scale capex interventions.

2.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the timescales for interventions. EDS 01-0003 – Refurbishment and Replacement Standard for Broad Based Towers outlines refurbishment aspects of broad-based towers, with EMS 10-0500 – Maintenance Painting for Overhead Line Steel Structures detailing the maintenance painting of these structures. Inspection of overhead lines at all voltages follows EMS 10-6001 – Inspection of Overhead Line at all Voltages, and maintenance EMS 10-0501 – Maintenance of Overhead Lines at All Voltages.

2.7 I&M Plan

Fault rates and failure modes have not highlighted any particular changes that may be required to the above regime. The plan reflects consistent I&M interventions in line with the above policies. Tables 5 and 6 provides a summary of the I&M volumes in ED1 and ED2 respectively.

Description of Activity	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020/ 2021	2021/ 2022	2022 /2023
132kV Full Patrol Broad Based Tower	11	10	11	10	11	10	11	10	11	10
132KV Safety Patrols Broad Based Towers	10	9	9	8	9	8	9	8	9	9
Climbing Inspection Broad Based Tower	7	20	20	20	20	20	20	20	20	20
132kV Inspection Total	**28**	**39**	**40**	**38**	**40**	**38**	**40**	**38**	**40**	**39**
132kV CORMON Testing	1	0	0	1	0	0	1	0	0	1
132kV Maintenance Total	**1**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**1**
66KV Full Patrol Broad Based Tower	20	19	16	17	16	17	16	17	16	17
66KV Safety Patrols Broad Based Towers	19	19	18	19	18	18	19	19	19	19
66kV Inspection Total	**39**	**38**	**34**	**36**	**34**	**35**	**35**	**36**	**35**	**36**
66KV CORMON Testing	1	0	1	1	1	0	1	1	1	0
66kV Maintenance Total	**1**	**0**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**0**
Includes RIGs Lines: CV13 Lines 39, 40, 41, 53, 54, 55, 67, 68, 69										

Table 5 - DPCR5& ED1 Forecast Volumes – I&M Towers and Conductors (Source: 19th February NAMP, Table O)

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
132kV Inspection	**39**	**39**	**39**	**39**	**39**	**39**	**39**	**39**
132kV Maintenance	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
66kv Inspection	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**
66kv Maintenance	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Table 6 - ED2 I&M Towers and Conductors (Source : 19th February 2014 NAMP Table O)

Figure 1 shows the investment profile for I&M in the three price control review periods DPCR5, ED1 and ED2 trends.

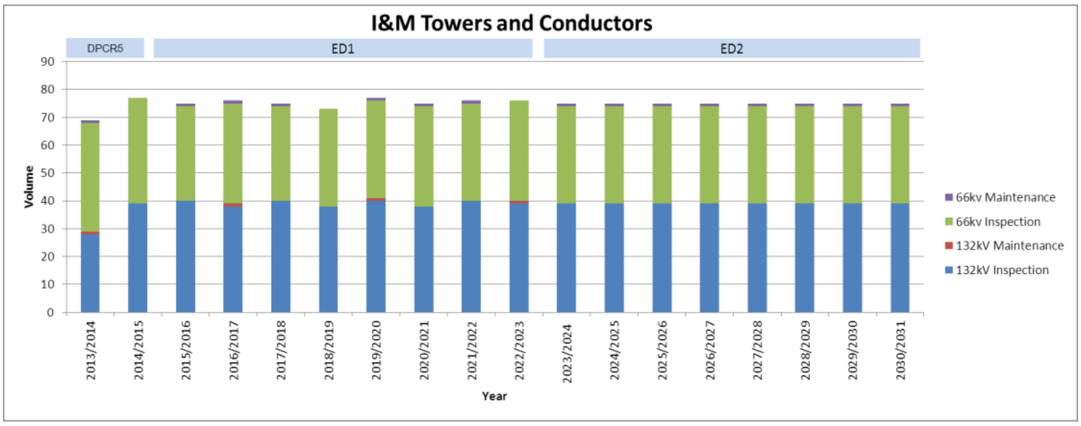

Figure 1 - DPCR5, ED1, & ED2 Historical and Forecast Volumes

2.8 Innovation

All aspects of the I&M programme are subject to continuous improvement. Improved methods of identifying tower and fitting condition (e.g. Figure 2 below), through high-resolution photography, are being investigated with the use of locally controlled drones (Figure 3). These offer the ability to carry out detailed visual condition analysis without the need for outages, or the risks from working at height, by replacing the need for climbing tower inspections. This will not only remove network and employee risk, but improve productivity in this activity.

Figure 2 – Condition of conductor and fitting

Figure 3– Example of locally controlled drone

3.0 Wood Poles and Conductors

This section is not applicable as there are no wood pole lines in this DNO.

4.0 Cables

4.1 Asset Information

The main types of underground cable on the network are shown in table 7.

Voltage	Cable Type	Length (km)
132kV	Fluid / Gas	214 / 65.50
132kV	Solid	206.45
EHV (66kV)	Fluid / Gas	291 / 16
EHV (33kV)	Fluid / Gas	304.24 / 17
EHV (66kV)	Solid	121
EHV (33kV)	Solid	536.79
HV (20kV)	Solid	2
HV (6.6/11kV)	Solid	12,211.92
LV	Solid	22,724.30
All (exc Services)	**All**	**36,694.36**

Table 7 - Cable Asset Information (Source: RIGS 2013)

Breakdown of LV and HV Cables

6.6/11kV – The length 12,211.92km made up of various types: Mainly Paper Insulated Lead Covered (PILC), XLPE (Single Cores), and latterly XLPE (Triplex)

LV – The length 22,724.30km made up of various types: Mainly Paper Insulated Lead Covered (PILC)(20,483.03), Waveconal (Aluminium cores and neutral), Hybrid (Aluminium cores and copper neutral)(All XLPE 2,240.27), CONSAC (Concentric Neutral Solid Aluminium Conductor)(1).

4.2 Summary of Fault Trends, Failure Modes, and Fault Rates

Fault data applies only to solid insulated cable, because loss of oil or gas pressure in other cables rarely leads to electrical failure due to protection systems to detect this.

Fault rates, based on the average of the past five years (2007/8 through to 2011/12) are shown in table 8.

Voltage	Faults per annum	Faults per 100 km
132kV	6	2.95
EHV	23	3.58
HV	351	2.90
LV	1262	5.56
LV Services		N/A

Table 8- Fault Rates (Data Source: IIS and UKPN Fault Cube)

132kV – The small number of these faults makes it difficult to reliably identify long-term trends and fault rates (see figure 4). The trend over the past five-year period shows decreasing volumes. The forecast, starting from 2013/14, at which point volumes have been set using the average over the past five years (2007/8 through to

2011/12), shows no change in the rate of faults predicted across the period for the reasons described below in the Faults Plan.

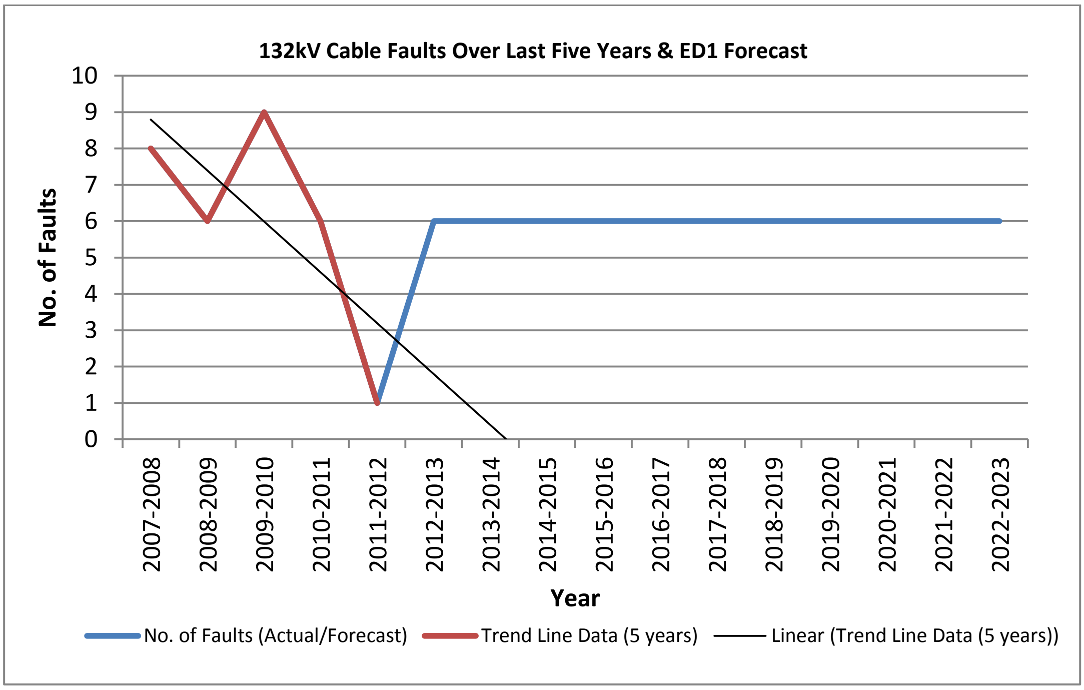

Figure 4 - Data Source: IIS and UKPN Fault Cube

EHV – The trend over the past five years shows decreasing volumes. However, the forecast, starting from 2013/14, at which point volumes have been set using the average over the past five years (2007/8 through to 2011/12), shows volumes remaining constant across the period in line with the Faults Plan as illustrated in figure 5 below.

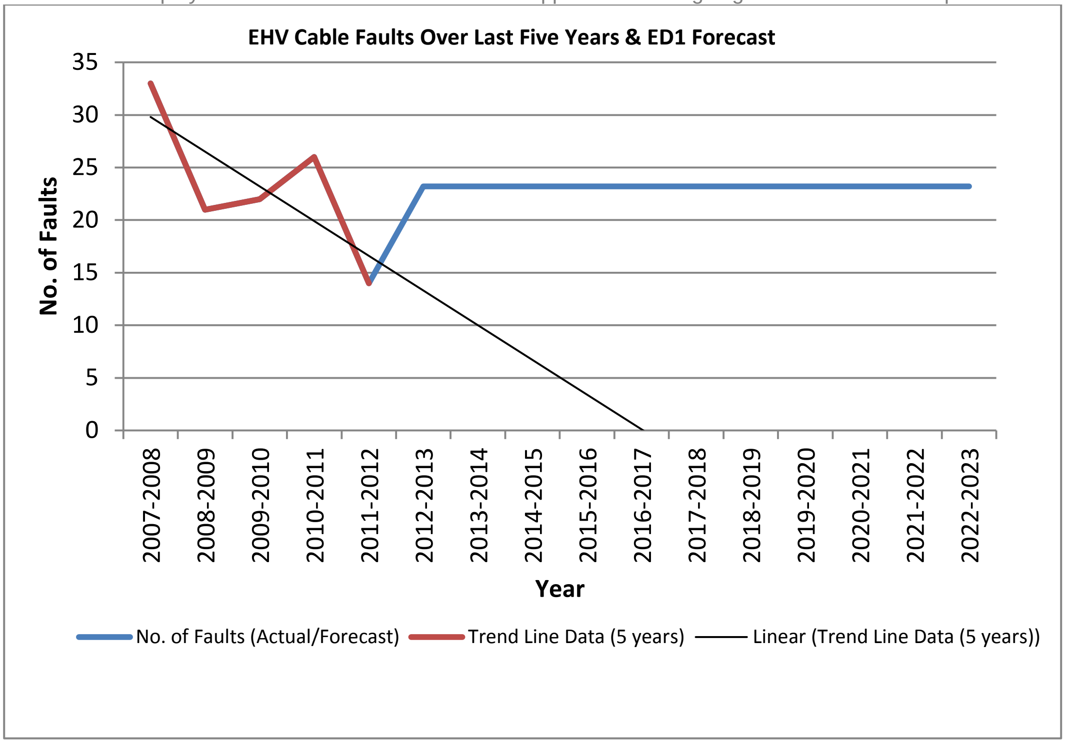

Figure 5 - Data Source: IIS and UKPN Fault Cube

HV (6.6/11kV) - The fault trend shows a slight drop in volumes over the past five years as shown in figure 6 . The forecast, starting from 2013/14, at which point volumes have been set using the average over the past five years (2007/8 through to 2011/12), shows volumes remaining constant across the period.

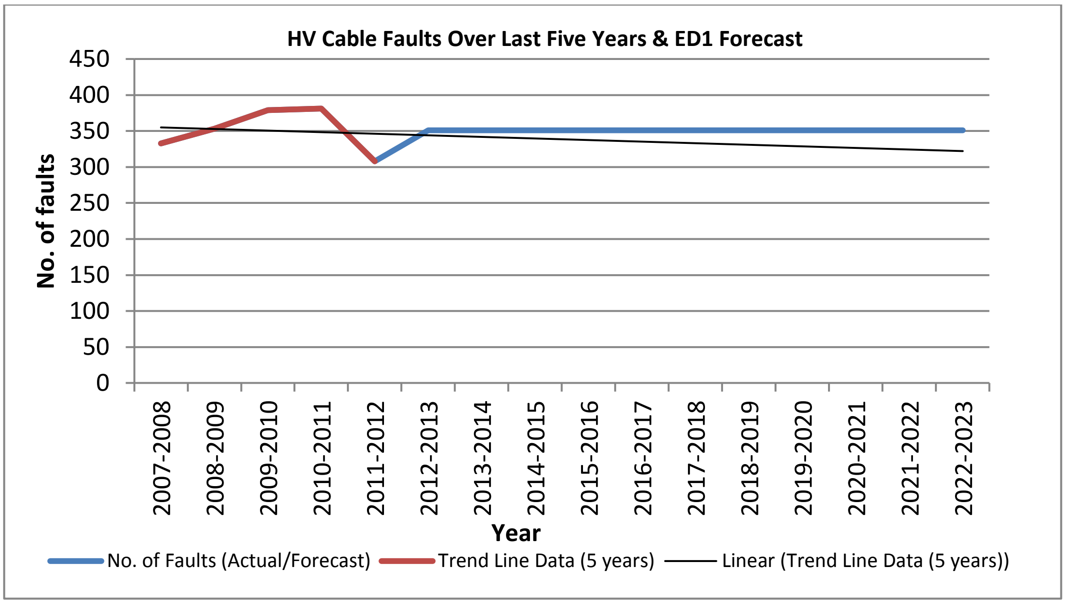

Figure 6 - Data Source: IIS and UKPN Fault Cube

LV – The fault trend in figure 7 shows an increase over the past five years. The forecast, starting from 2013/14, at which point volumes have been set using the average over the past five years (2007/8 through to 2011/12), shows volumes rising by 1% per year across the period in line with the trend.

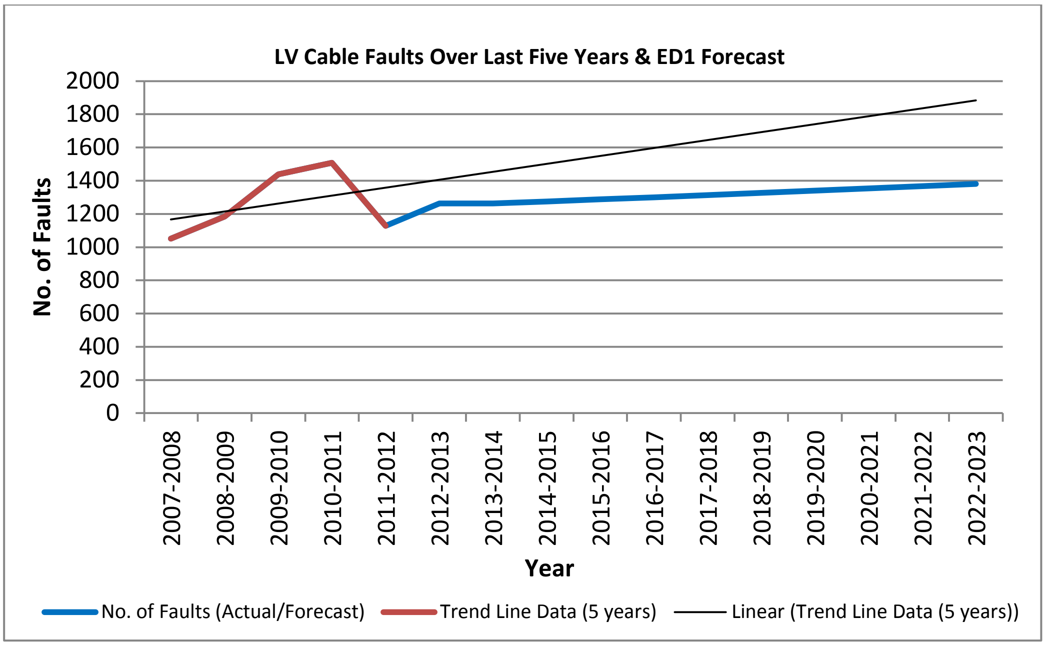

Figure 7 - Data Source: IIS and UKPN Fault Cube

Services – A decreasing trend can be seen for the five-year period 2007 to 2012. The forecast, starting from 2013/14, at which point volumes have been set using the average over the past five years (2007/8 through to 2011/12), shows volumes remaining constant across the period.

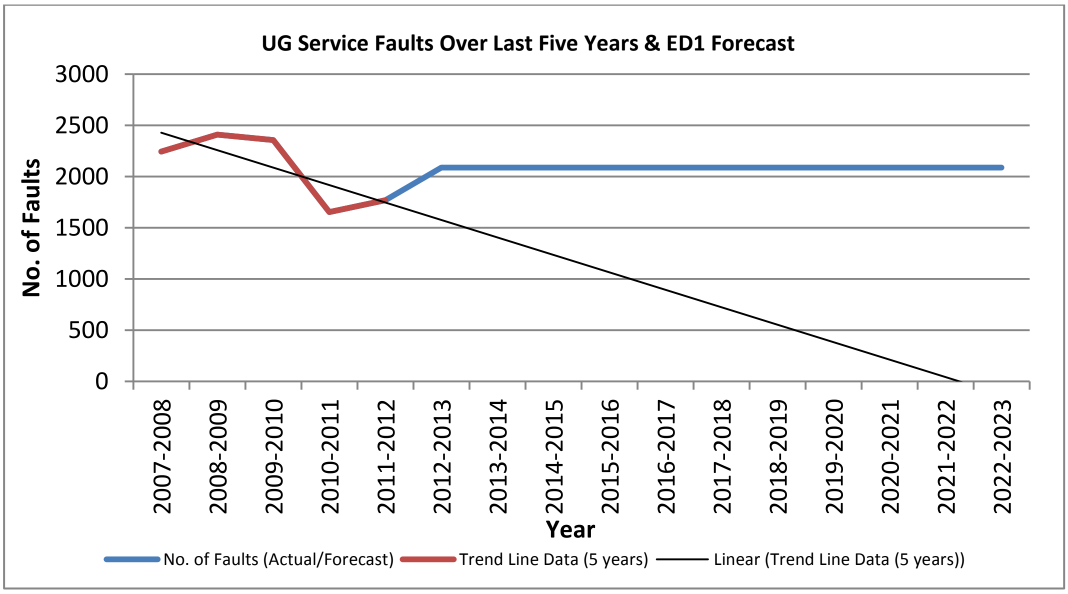

Figure 8 - Data Source: IIS and UKPN Fault Cube

4.3 Faults Plan

At 132kV it is proposed to maintain volumes at a steady state from 2013/14 across ED1 in line with other cable types. The volumes from 2009/10 through to 2011/12 show a continuing drop, but it is expected that there will be a slight upturn in 2012/13. Due to the small volumes it is most likely that the trend will continue as shown at an average rate over the period.

The five-year fault rate of EHV cables show a decreasing trend which is in contrast to the forecast. 2011/12 showed an uncharacteristic fall in fault volumes, which has distorted the trend over the past five years and may be due to a change in reporting systems. This could be exacerbated by an abnormally high peak in 2010/11 which could be attributed to changing weather patterns where we are seeing more extreme dry and wet periods causing damage to underground joints in particular. The relatively stable network lengths will not increase volumes, but the ageing asset base will gradually deteriorate further over the period leading to a higher number of faults. As this activity is almost entirely reactive, identification of cables for replacement can only be made once it has been determined as poorly performing. It is therefore proposed to set the forecast fault volumes at a steady state over the period.

The fault rate of HV cables shows a slightly decreasing trend over the past five years. The network lengths are increasing each year, which will increase volumes over a period, but the greater effect is the ageing asset base. Cables will deteriorate further over the period leading to a higher number of faults, and as this activity is almost entirely reactive, identification of cables for replacement can only be made once it has been determined as poorly performing. It is therefore proposed to maintain the forecast fault volumes at a constant rate.

The fault rate of LV cables shows an increasing trend over the past five years which aligns with the forecast. 2011/12 showed an uncharacteristic fall in fault volumes, which has distorted the trend over the past five years and may be due to a change in reporting systems. This could be exacerbated by an abnormally high peak in 2010/11 which could be attributed to changing weather patterns where we are seeing more extreme dry and wet periods causing damage to underground joints in particular. The network lengths are increasing each year, which will increase volumes over a period, but the greater effect is the ageing asset base. Cables will deteriorate further over the period leading to a higher number of faults, and as this activity is almost entirely reactive, identification of cables for replacement can only be made once it has been determined as poorly performing. It is therefore proposed to increase the forecast fault volumes by 1% per year.

The fault rate of service cables shows a decreasing trend over the past five years. The numbers of services are increasing each year, which will increase fault volumes over a period, but the greater effect is the ageing asset base. Services will deteriorate further over the period leading to a higher number of faults, and as this activity is almost entirely reactive, identification of services for replacement can only be made once it has been determined as poorly performing. It is therefore proposed to maintain the forecast fault volumes at a constant value.

Validated data is not available for Street Lighting Faults (unmetered services) so no graph has been produced. Street Lighting faults would tend to follow the trend of LV mains cable faults as they are in similar locations and have been estimated on this basis. On occasions these are the result of previous third party damages which cannot be recovered as those responsible cannot be identified so long after the event. The number of unmetered services is rising each year, which in turn will increase fault volumes over a period, but the greater effect is the ageing asset base. It is therefore proposed to increase the forecast fault volumes by 1% per year.

Where restoration of supply is achieved solely by replacement of a blown fuse it is not possible to identify the cause of the incident. There is a robust process for identifying repeat fuse operations which may then be categorised as fleeting faults or loading issues and dealt with accordingly. This category reflects the rising volumes of LV cable faults.

EHV and HV supply restoration directly relates to the total number of faults in these categories and therefore the volumes reflect the various trends shown above.

Tables 9 and 10 provide a summary of the volume forecasts for ED1.

Description of Activity	RIGs Reference	2009/ 2010	2010/ 2011	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
132kV Cable Fault Non Pressurised	CV15a Line 35	9	6	1	3	3	3	3	3	3	3	3	3	3	3
132kV Cable Fault Pressurised	CV15a Line 34	Separate data not available for this year	3	1	2	2	2	2	2	2	2	2	2	2	2
132kV Fault Restoration by Switching Only (UG)	CV15a Line 9	0	1	3	4	3	3	3	3	3	3	3	3	3	3
Total 132kV UG Cable Faults		**9**	**10**	**5**	**9**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**
33kV U/G Fault Pressurised	CV15a Line 29	3	6	6	4	4	4	4	4	4	4	4	4	4	4
EHV U/G Fault Non Pressurised	CV15a Line 30	19	25	7	16	16	16	16	16	16	16	16	16	16	16
EHV Fault Restoration by Switching Only (UG)	CV15a Lines 8	6	1	4	8	3	3	3	3	3	3	3	3	3	3
Total EHV UG Cable Faults		**28**	**32**	**17**	**28**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**
11kV cable fault repairs	CV15a Line 22	423	435	339	312	312	311	311	311	311	311	311	311	310	310
HV Fault Restoration by Switching Only (UG)	CV15a Line 7	54	59	91	121	112	112	112	112	112	112	112	112	112	112
Total HV UG Cable Faults		**477**	**494**	**430**	**433**	**424**	**423**	**423**	**423**	**423**	**423**	**423**	**423**	**423**	**423**
LV Underground Cable Fault (Consac)	CV15a Lines 18	10	6	14	14	14	14	14	14	14	14	14	14	14	14
LV U/G Cable Fault Repairs	CV15a Line 17	1,674	1,810	1,428	1,248	1,248	1,261	1,274	1,286	1,300	1,312	1,326	1,340	1,353	1,366
Service Fault Repairs Underground	CV15a Line 15	2,853	2,056	2,144	2,087	2,087	2,087	2,087	2,087	2,087	2,087	2,087	2,087	2,087	2,087
Street Lighting Fault Replacement - Underground	CV15b Line 7	3,972	3,172	3,112	2,152	2,152	2,159	2,165	2,173	2,179	2,184	2,184	2,184	2,184	2,184
Blown LV Fuses at Substations	CV15a Lines All 6 (Includes OH), 17, 18, 19, 20	2,907	2,893	2,556	2,746	2,746	2,773	2,801	2,829	2,857	2,886	2,915	2,944	2,973	3,004
Flickering supplies	CV15b Line 10	213	187	406	3,617	3,617	3,617	1,809	1,809	1,809	1,809	1,809	1,809	1,809	1,809

Description of Activity	RIGs Reference	2009/ 2010	2010/ 2011	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
Network Sweeps	CV15a Line 27	104	129	187	406	406	406	1,248	1,248	1,248	1,248	1,248	1,248	1,248	1,248
High Earth Loop Impedance	CV15b Line 10	1,695	1,485	3,224	413	413	417	197	197	197	197	197	197	197	197
Alarms	CV15b Line 16	168	263	375	712	712	688	688	684	684	684	684	684	686	720
Cut Out Fuses (Formerly CFS Costs)	CV15b Line 9	1,869	1,672	1,544	1,595	1,595	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516
Responding to Critical Safety Calls	CV15b Line 16	741	1,161	1,654	3,132	3,132	3,884	3,884	3,884	3,884	3,880	3,880	3,880	3,880	3,880
Abortive Call (previously Powercare Emergency Rechargeable)	CV15b Line 14	1,166	1,148	11,303	7,793	7,793	7,793	6,234	4,676	3,117	1,559	390	390	390	390
Metering Fault	CV15b Line 15	1,461	1,414	554	296	269	269	216	172	138	110	110	110	110	110
Pilot Wire Failures	CV15b Line 17	All volumes included in UG Services				104	106	102	102	102	102	102	102	102	102
Total LV UG Cable Faults		**18,833**	**17,397**	**28,502**	**26,184**	**26,288**	**26,990**	**26,263**	**24,705**	**23,160**	**21,616**	**20,491**	**20,534**	**20,572**	**20,630**

Table 9 – DPCR4, DPCR5 & ED1 History/Forecast - Cables Faults

Data Source: RIGS Returns (up to and including 2012/13) & NAMP of 19/02/2014 - 2013/14 onwards
RIGs data includes third party damage to UKPN plant, whereas NAMP data excludes such incidents
Note1 – Volumes have been calculated using expenditure and current UCI.

Supply restoration, blown fuses and miscellaneous faults are also applicable to other categories, e.g. switchgear, but the majority of incidents are in this cable category. Service fault repairs also include faults on risers and laterals.

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Total 132kV UG Cable Faults	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**
Total EHV UG Cable Faults	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**
Total HV UG Cable Faults	**423**	**423**	**423**	**423**	**423**	**423**	**423**	**423**

Table 10 - ED2 Forecast – Cable Faults(Source : NAMP of 19/02/2014 Table O)

Figure 9 shows the investment profile for cable faults in the three price control review periods DPCR5, ED1 and ED2 trends.

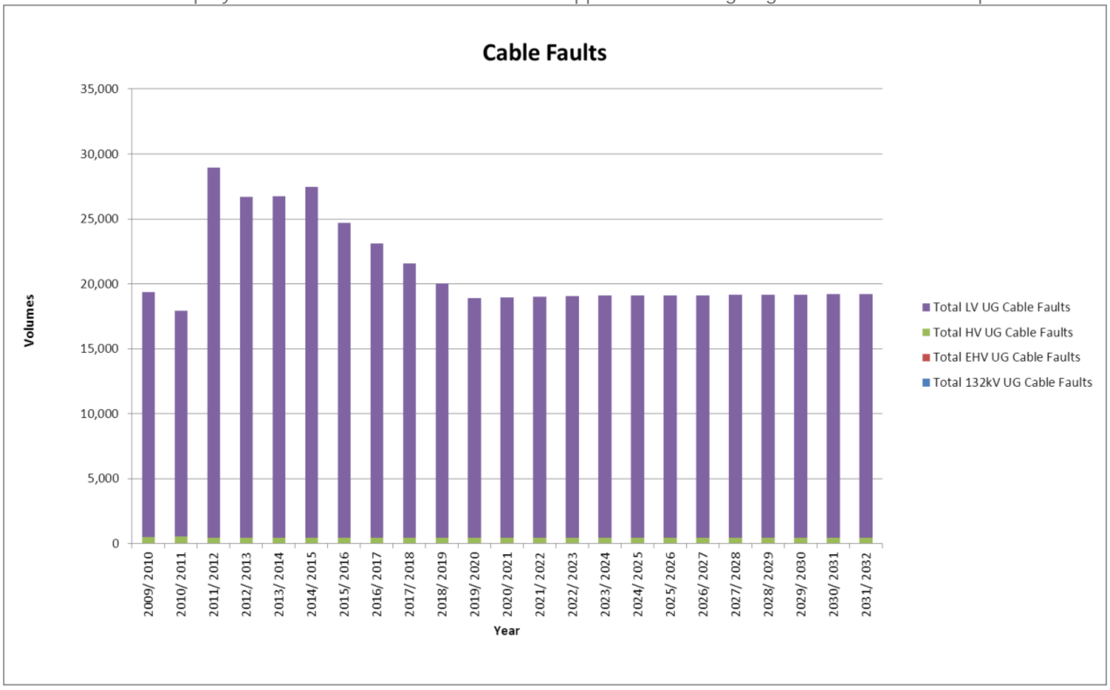

Figure 9 - DPCR4, DPCR5, ED1, & ED2 Historical and Forecast Value

4.4 I&M Drivers

Operator, public and network safety are the leading drivers for an optimised inspection and maintenance regime, with ongoing monitoring of compliance to Electricity, Safety, Quality and Continuity Regulations (ESQCR), and continuing clearance of defects. Public safety is particularly pertinent to this class of asset as it is mainly to be found on private property or highways.

Identification and clearance of defects revolves mainly around fluid/gas-filled cables, ensuring the monitoring equipment is recording effectively and, where leakage is observed, the correct actions are put in place. Environmental considerations will determine when leaks are to be repaired.

Defects on other cable types may be identified due to leaking of compound or oil from cable termination boxes, or damage to overhead line terminations.

The condition of an asset, which determines its Health Index, is also of paramount importance in identifying the most appropriate maintenance interventions and investment strategies that provide the best value for money.

Consideration of the whole-life asset cost, through the identification of complementary investment and maintenance strategies to maximise asset life, is an important aspect of managing these assets utilised by UK Power Networks. Trade-off between Opex and Capex is examined and whole life cost assessment examples are provided in the Capex related narrative documents.

4.5 I&M Interventions

Fluid pressure gauges, with or without remote alarms, and pressure transducers, require gauge readings to be taken and checked for correct operation, accuracy and hydraulic operation. Readings vary between monthly and four years; operation between two and four years; accuracy between two and eight years; and hydraulic operation every two or eight years.

Where cables run with an insulated sheath, and it is known to be intact, a full test will be carried out every two years. Where cables run with lengths of uninsulated sheaths it is not possible to test them. Sheath voltage limiters will have a full test every two years, while cable residual gas pressure checks and dissolved gas analysis will be carried out every eight years.

While carrying out tower inspections, ancillary equipment such as cable terminations will be checked. Inspections of grid/primary sites and secondary substations include inspections of cable terminations.

4.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the timescales for interventions. EMS 10-7001 outlines the inspection and maintenance of underground cables.

4.7 I&M Plan

Fault rates and failure modes have not highlighted any particular changes that may be required to the above regime. The plan reflects consistent I&M interventions in line with the above policy.

Inspection of idle services and unmetered services is increasing the LV expenditure into ED1 having re-assessed processes to comply with ESQCR obligations, and this is reflected in the total spend in this category. The I&M forecast volumes are given in tables 11 and 12.

Description of Activity	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020/ 2021	2021/ 2022	2022 /2023
Gauges-132/33kV inspect and alarm test	282	230	230	230	230	230	230	230	230	230
Gas cable - cylinder change	785	1,068	1,068	1,068	1,068	1,068	1,068	1,068	1,068	1,068
Tank inspection (above ground)	20	36	36	36	36	36	36	36	36	36
Gas Cable - Dewar top up	210	240	240	240	240	240	240	240	240	240
Gauge mal function investigation	0	2	2	2	2	2	2	2	2	2
Check Pressure (Oil/Gas)	48	48	48	48	48	48	48	48	48	48
Test Cable Serving / Oversheath	1	5	5	5	5	5	5	5	5	5
Test Sheath Voltage Limiters (SVLs)	5	5	5	5	5	5	5	5	5	5
132/33kV Inspection Total	**1,351**	**1,634**	**1,634**	**1,634**	**1,634**	**1,634**	**1,634**	**1,634**	**1,634**	**1,634**
Oil top up; Pumping & Testing - 132-33kV	174	240	240	240	240	240	240	240	240	240
Repair Oil Leak	36	39	41	41	41	41	41	41	41	41
Defect repair gas	11	9	9	9	9	9	9	9	9	9
Replace minor oil plant + sheath testing	2	9	9	9	9	9	9	9	9	9
Defect repair of 33/22kv solid cable - locate and repair	5	5	5	5	5	5	5	5	5	5
Defect repair of 132/66kv solid cable - locate and repair	2	2	2	2	2	2	2	2	2	2
Pilot Cable Repairs	31	33	29	29	29	29	29	29	29	29
132/33kV Maintenance Total	**261**	**337**	**335**	**335**	**335**	**335**	**335**	**335**	**335**	**335**
Includes RIGs Lines: CV13 Lines 42, 43, 56, 57, 70, 71										
Partial Discharge mapping – HV	174	174	174	174	174	174	174	174	174	174
Online Partial Discharge Field Investigations	8	8	8	8	8	8	8	8	8	8
HV Inspection Total	**182**	**182**	**182**	**182**	**182**	**182**	**182**	**182**	**182**	**182**
Abandoned/unidentified cable location	25	25	25	25	25	25	25	25	25	25
Online Partial Discharge Monitoring Equipment Maintenance	415	415	415	415	415	415	415	415	415	415
HV Maintenance Total	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**	**440**
Includes RIGs Lines: CV13 Lines 21, 22										
Idle Service Inspection	7,236	9,538	9,538	9,538	9,538	9,538	9,538	9,538	9,538	9,538
LV Inspection Total	**7,236**	**9,538**	**9,538**	**9,538**	**9,538**	**9,538**	**9,538**	**9,538**	**9,538**	**9,538**
UMS Services Inspected	6,690	14,930	27,330	36,000	36,000	36,000	36,000	36,000	36,000	36,000
LV Maintenance Total	**6,690**	**14,930**	**27,330**	**36,000**	**36,000**	**36,000**	**36,000**	**36,000**	**36,000**	**36,000**
Includes RIGs Lines: CV13 Lines 13, 15, 16, 17										
General Network Enquiries										
EMF enquiries	24	24	24	24	24	24	24	24	24	24
Voltage/load investigations	81	112	143	143	143	143	143	143	143	133
Cross Voltage Total	**105**	136	167	167	167	167	167	167	167	157
Included in other RIGs Lines										

Table 11 - DPCR5 & ED1 Forecast – I&M Cables

(Source : 19th February 2014 NAMP Table O)

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
132kV/EHV Inspection	1,634	1,634	1,634	1,634	1,634	1,634	1,634	1,634
132kV/EHV Maintenance	335	335	335	335	335	335	335	335
HV Inspection	182	182	182	182	182	182	182	182
HV Maintenance	440	440	440	440	440	440	440	440
LV Inspection	9,538	9,538	9,538	9,538	9,538	9,538	9,538	9,538
LV Maintenance	34,916	35,865	35,848	35,829	35,807	35,783	35,756	35,725
Cross Voltage	126	126	126	126	126	126	126	126

Table 12 – ED2 Forecast – I&M Cables

(Source : 19th February 2014 NAMP Table O)

Figure 10 shows the investment profile for I&M in the three price control review periods DPCR5, ED1 and ED2 trends.

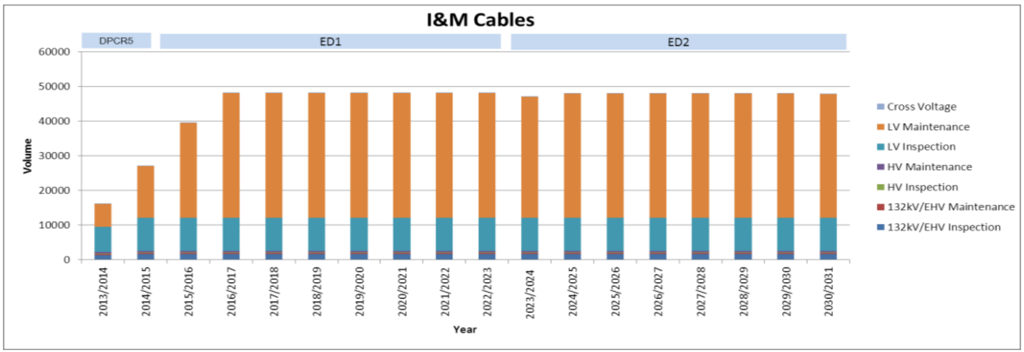

Figure 10 - DPCR5, ED1, & ED2 Historical and Forecast Values

4.8 Innovation

Online partial discharge monitoring has been introduced through an Innovation Funding Initiative (IFI) project, and has recently been adopted into "business as usual". These comprise fixed installations to monitor earth leakage current levels from source circuit breakers at a primary substations. The equipment "looks" into the network as far as the first substation out on a feeder or to a maximum length of around one kilometre. Increasing levels of earth leakage current indicate a potential fault on the cable, and work is ongoing to validate the change in current levels leading to potential faults. Portable online units can be fitted further down the network to identify issues in other cable sections. Offline monitoring is also carried out where reliability of circuits may be in question and where fixed units have not been installed. This technology is still being evaluated, but its benefits are expected to be twofold:

1) better information feeding into the cable replacement capex programme(s)

2) quicker location of faulty feeders,

albeit realisation of any savings may only be achievable once the relationship between partial discharge and cable failures has been established. Consequently no cost benefit has been shown during ED1.

Introduction of Perfluorocarbon tracers (PFT) into fluid-filled cables with leaks is intended to reduce the number of excavations required to find the leakage point. The injection of PFT into the cable allows its detection around the leak site permitting a more accurate location than was previously the case where multiple excavations were often required to establish the site of the leak. Further analysis will be required before any savings can be shown.

5.0 132kV Switchgear

5.1 Asset Information

The total volume in this category is 212 items of plant, split into 3 main types of circuit breakers (CBs), air blast, bulk oil, and SF_6 with associated isolators and busbars.

5.2 Summary of Fault Trends, Failure Modes, and Fault Rates

All CB types (including isolators and busbars) – The small number of these faults makes it difficult to reliably identify long-term trends and fault rates. The forecast, starting from 2013/14, at which point volumes have been set using the average over the past five years (2007/8 through to 2011/12), shows no change in volumes over the period. See Figure 11.

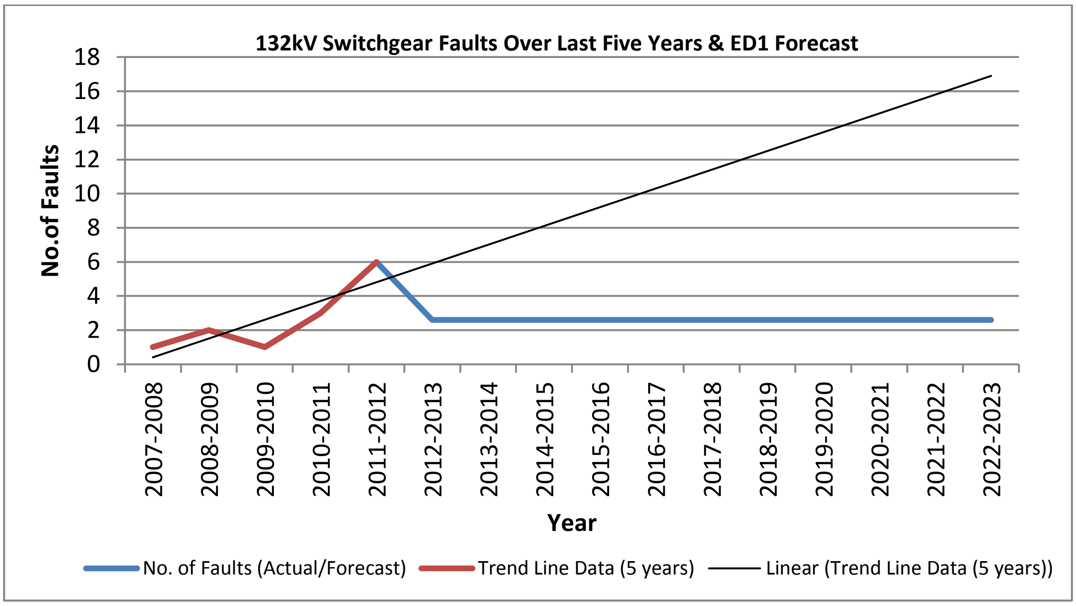

Figure 11 - Data Source: IIS and UKPN Fault Cube

5.3 Faults Plan

The above graph shows an increasing trend, although due to the small numbers of these faults (0.014 per asset), it is difficult to reliably forecast volumes. With the volume in 2013/14 set at the average of the past five years (2007/8 through to 2011/12), it is proposed to keep the volumes constant from then across ED1. The volumes are small, leading to volatility year on year, but generally an upward trend is shown, which, historically, varies greatly.

Volumes in Table 13 are combined with Grid & Primary 132kV transformers (Section 10.3) in order to provide a more predictable forecast. Table 14 provides the ED2 volume forecasts.

Plant faults requiring repair are at a very low level which is reflected in the forecast.

Description of Activity	RIGs Ref	2009 / 2010	2010 / 2011	2011 / 2012	2012 / 2013	2013 / 2014	2014 / 2015	2015 / 2016	2016 / 2017	2017 / 2018	2018 / 2019	2019 / 2020	2020 / 2021	2021 / 2022	2022 / 2023
132kV Plant Fault	CV15 a Line 37	9	21	21	11	11	11	11	11	11	11	11	11	11	11
Total 132kV Plant Faults		**9**	**21**	**21**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**

Table 13 - DPCR4, DPCR5 & ED1 History/Forecast – 132kV Plant Faults

Data Source: RIGS Returns (up to and including 2012/13) & NAMP of 19/02/2014 - 2013/14 onwards
RIGs data includes third party damage to UKPN plant, whereas NAMP data excludes such incidents.
Figures for 2013/14 onwards include both switchgear and transformers. Figures prior to that are switchgear only.

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Total 132kV Plant Faults	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**

Table 14- ED2 Forecast -132KV Plant Faults

Figure 12 shows the volume profile for faults in the three price control review periods DPCR5, ED1 and ED2 trends.

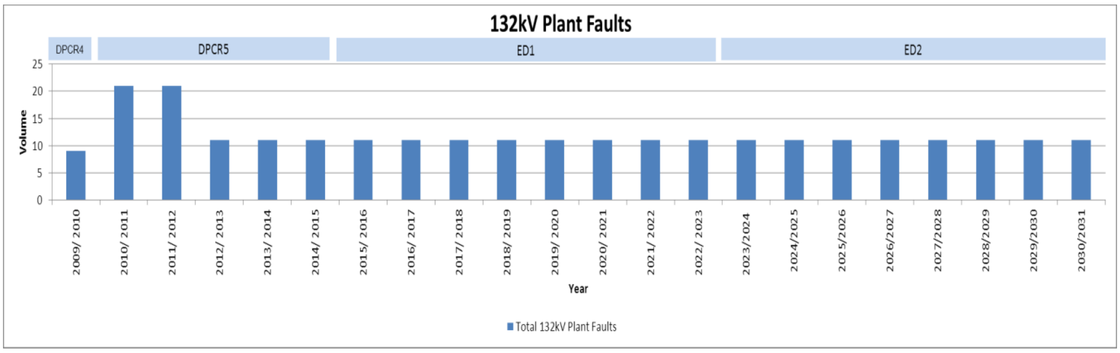

Figure 12 - DPCR4, DPCR5, ED1, & ED2 Historical and Forecast Value

5.4 I&M Drivers

Safety is the top priority, with ongoing monitoring of identification and clearance of defects. Information from the National Defect Reporting Scheme provides an insight into other operators' experiences and an opportunity for UK Power Networks to review its I&M regime against issues found.

Functional performance of this equipment in terms of both its protection and control, as well as the operation of the CB itself, is important for limiting the numbers of customers affected by faults.

The requirement for post-fault maintenance on oil circuit breakers must be met to maintain the operational capability.

Pressurised items of equipment are inspected and maintained in line with statutory requirements.

The condition of an asset, which determines its Health Index, is of paramount importance for identifying interventions and investment strategies that provide the best value for money.

Consideration of the whole-life asset cost, through the identification of complementary investment and maintenance strategies to maximise asset life, is always a factor in managing these assets.

5.5 I&M Interventions

Inspections of all plant were completed every four months until the beginning of 2013 when this was amended to every six months. Alternate inspections are minor and major. Exceptions to this are detailed in the innovation section.

Air Blast CBs are operated every two years and have minor maintenance every four years and full maintenance every 12 years. Statutory inspection of the associated pressurised equipment is carried out in accordance with the individual Written Scheme of Examination. A "Written Scheme of Examination" relates to statutory inspection of pressurised vessels such as air compressors etc associated with air blast circuit breakers. This document outlines the requirements for a particular item of equipment including the frequency of inspections.

The periodic operations of the CBs are timed to identify any slow opening units.

Bulk Oil CBs are operated once a year, with maintenance every six years alternating between mechanism maintenance and full maintenance.

SF_6 CBs are operated every two years, with full maintenance every 12 years, with statutory inspections where required in line with the individual Written Scheme of Examination. Gas quality, including gas zones in GIS boards, is checked every 12 years.

Isolator operation is every six years for manual units, and every two years for motorised types. Time-based maintenance has recently been withdrawn, as explained in the innovation section, and replaced with a reactive regime.

Post-fault maintenance on 132kV oil circuit breakers is carried out after six fault trips, and is recorded as a full maintenance.

Specific makes and types may require enhanced inspection and maintenance from the norm, and these are identified in the appendices of EMS 10-0002 which sets the frequencies for I&M interventions.

5.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the timescales for interventions. EI 10-1501 details maintenance requirements for 132kV to 22kV switchgear, while EMS 10-0005 details the requirements for batteries and chargers.

5.7 I&M Plan

Fault rates and failure modes have not highlighted any particular changes that may be required to the above regime. The plan reflects consistent I&M interventions in line with the above policy, but incorporates a reduction in inspection activity to reflect the change in frequency of minor site inspections which is detailed in section 12. Variances in volumes year on year are significantly affected by circuit breaker maintenance schedules. Tables 15 and 16 show the volumes for each of the I&M activities in ED1.

Description of Activity	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020/ 2021	2021/ 2022	2022 /2023
Inspect Air Compressor	133	145	145	145	145	145	145	145	145	145
Inspect Main Air Receiver	12	12	12	12	12	12	12	12	12	12
Insurance Insp. Air/Gas Receiver	57	17	17	17	17	17	17	17	17	17
Insurance Insp. ABCB Complete Unit	18	31	31	31	31	31	31	31	31	31
132/66kV plant painting	0	2	2	2	2	2	2	2	2	2
Maintenance of Bulk Oil Systems	2	2	2	2	2	2	2	2	2	2
Defect Repair - 132/66 kV Switchgear	57	57	58	58	58	60	60	61	61	62
Inspect Flexible Earths & Rods Note 1	1,164	356	356	356	356	356	356	356	356	356
Infra-Red Inspection Aerial Sets/Busbars Note 2	40	27	27	27	27	27	27	27	27	27
Insurance Insp Switchgear Accumulator	12	12	12	12	12	12	12	12	12	12
Maintain Full 132/66kV Air Blast CB	5	9	0	3	3	10	28	5	1	1
Maint Full 132/66kV Oil CB	3	0	0	4	1	7	32	5	1	3
Maint FULL 132/66kV SF6 O/D CB	2	2	6	16	5	6	2	6	21	8
Maintain Mechanism 132/66kV Oil CB	1	1	1	1	1	2	2	3	3	5
Maint MECH 132/66kV SF6 O/D CB	1	0	2	0	0	0	1	1	1	4
Trip Test 132/66kV CB & op of ext isol.	232	202	191	206	191	206	191	206	181	173
Maintain Isolator (Manual)	16	2	0	0	0	0	0	0	0	0
Maint. Isolator (Motorised)	4	0	0	0	0	0	0	0	0	0
Maintain Earth Switch	8	8	8	8	8	8	8	8	8	8
Maintain LV AC Board	0	0	1	1	1	1	1	0	0	0
Maintain Air Compressor	21	21	21	21	21	21	21	21	21	21
Maintain Metalclad Busbars 132/66kV	0	0	2	0	0	0	0	0	0	0
Maintain Mech 132/66kV Air Blast CB	1	1	1	1	1	1	1	1	1	1
Maint FULL 132/66kV SF6 GIS CB	5	4	4	3	4	16	27	7	16	11
Maint MECH 132/66kV SF6 GIS CB	1	0	0	0	0	1	0	0	0	1
Inspect Earth Switch	1	1	1	1	1	1	1	1	1	0
Maintenance Total	**1,796**	**912**	**900**	**927**	**899**	**944**	**979**	**929**	**920**	**902**
Includes RIGs Lines: CV13 Lines 60, 74										

Table 15 - DPCR5 & ED1 Forecast – I&M 132kV Switchgear

Note 1 - Inspection of flexible earths and rods is for all voltages.

Note - Infra-Red inspections includes those carried out on EHV and Primary switchgear.

Data Source: NAMP of 19/02/2014

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
132kV Switchgear Maintenance	925	925	925	925	925	925	925	925

Table 16 – ED2 Forecast – I & M 132KV Switchgear

Figure 13 shows the volume profile for I&M in the three price control review periods DPCR5, ED1 and ED2 trends.

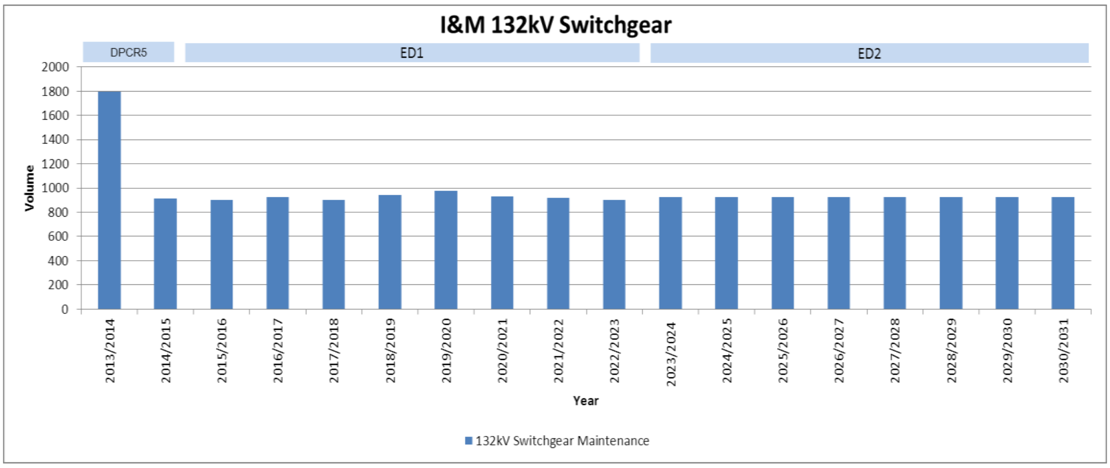

Figure 13 – DPCR 5, ED1, & ED2 Historical and Forecast Values

5.8 Innovation

As part of ongoing Reliability Centred Maintenance (RCM) assessments to optimise I&M activities the following have been changed to tailor the maintenance closer individual requirements:

The number of routine site inspections has been reduced to two per year, one minor and one major, with exceptions based on the site requirements, primarily batteries. A frequency of four months between minor inspections has been retained for sites where wet cells are installed, due to the higher level of intervention required. While on site for this, it is advantageous to carry out an extra minor inspection of plant for very little extra cost.

To evaluate this opportunity further we looked at how we gather condition data at grid sites. The assessment showed that apart from specific visits to formerly gather this information, many other visits are made for other reasons, such as vegetation management, switching etc. It is proposed to introduce methods to record such visits where it is a requirement to report any overt defects that may affect site security or present a safety or environmental hazard.

Mechanism maintenance for vacuum and SF_6 CBs has been withdrawn, as the correct operation of the units is checked every year by remotely opening and closing them, with a full service every 12 years. Often, manufacturers' of these units designate them as being lubricated for life, reducing what could be achieved from this type of action. Oil CBs were not aligned as there are generally of older designs requiring a higher level of intervention to maintain functionality.

Inspection and maintenance of busbars is fairly limited without large outages that introduce heightened network risk and customer outages. For air-insulated busbars, the annual thermal inspection will identify potential failure points; and for metal-clad busbars, monitoring of discharge on inspections will again identify issues. Time-based busbar maintenance has been withdrawn on this basis.

Isolator maintenance was set at every 12 years, which often involved large-scale outages creating increased network risk. The RCM assessment judged that the combination of thermal and visual inspections, along with the revised operation regime, will allow detection of problems with units before it would impact their functional capabilities.

6.0 EHV Switchgear

6.1 Asset Information

The total volume in this category is 408 which is split into 3 main types of circuit breakers (CBs): oil, SF_6 and vacuum – with associated isolators and busbars. This includes 33kV and 66kV switchgear.

6.2 Summary of Fault Trends, Failure Modes, and Fault Rates

All CB Types (Including Isolators and Busbars) – The small number of these faults makes it difficult to reliably identify long-term trends and fault rates. The forecast, starting from 2013/14, at which point volumes have been set using the average over the past five years (2007/8 through to 2011/12) shows no change in anticipated volumes over the period. See figure 14.

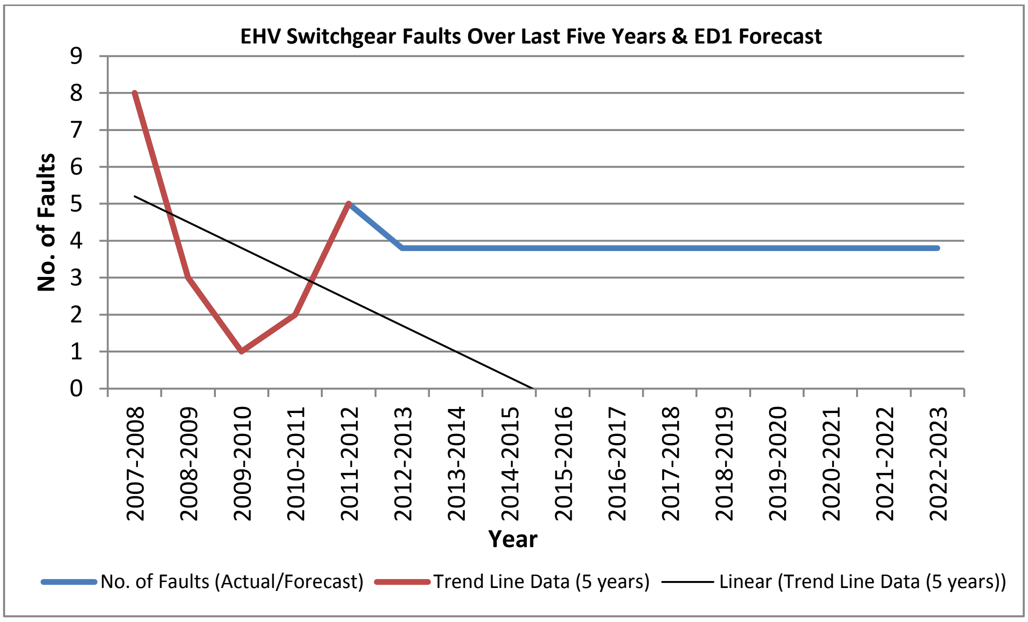

Figure 14 - *Data Source: IIS and UKPN Fault Cube*

6.3 Faults Plan

The above graph shows a decreasing trend over the past five-year period. However due to the small numbers of these faults (0.0078 per asset), it is difficult to reliably forecast volumes. With the volume in 2013/14 set at the average over the past five years (2007/8 through to 2011/12), it is proposed to keep it constant from then across ED1. The volumes are small, leading to volatility year on year, with the historic trend shown varying greatly. In Table 17, EHV switchgear volumes and costs are combined with Grid & Primary EHV Transformers (10.3) in order to provide a more predictable 132kV Plant forecast. Tables 17 and 18 provide the volume forecasts in ED1 and ED2.

Description of Activity	RIGs Ref	2009 / 2010	2010 / 2011	2011 / 2012	2012 / 2013	2013 / 2014	2014 / 2015	2015 / 2016	2016 / 2017	2017 / 2018	2018 / 2019	2019 / 2020	2020 / 2021	2021 / 2022	2022 / 2023
EHV Plant Fault	CV15a Line 32	15	17	15	8	8	8	8	8	8	8	8	8	8	8
Total EHV Plant Faults		**15**	**17**	**15**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**

Table 17 – DPCR4,DPCR5 & ED1 History /Forecast –EHV Plant Faults

Data Source: RIGS Returns (pre 2012/13) & NAMP of 19/02/2014 - 2013/14 onwards

RIGs data includes third party damage to UKPN plant, whereas NAMP data excludes such incidents.

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Total EHV Plant Faults	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**

Table 18 – ED2 Forecast –EHV Plant Faults

Figure 15 shows the volume profile for fauvist in the three price control review periods DPCR5, ED1 and ED2.

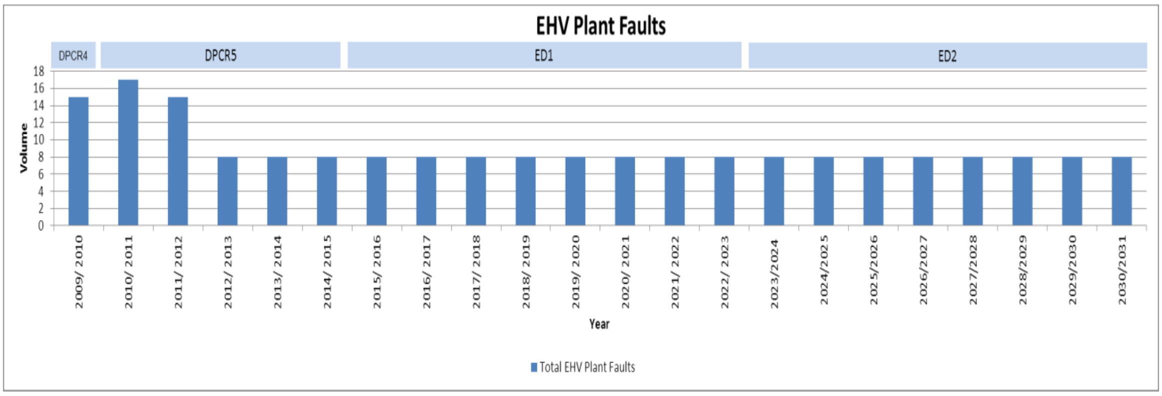

Figure 15 - DPCR4, DPCR5, ED1, & ED2 Historical and Forecast Value

6.4 I&M Drivers

Safety is the top priority, with ongoing monitoring of identification and clearance of defects. Information from the National Defect Reporting Scheme provides an insight into other operators' experiences and an opportunity for UK Power Networks to review its I&M regime against issues found.

Functional performance of this equipment in terms of both its protection and control, as well as the operation of the CB itself, is important to limit the numbers of customers affected by faults.

The requirement for post-fault maintenance on oil circuit breakers must be met to maintain the operational capability.

Pressurised items of equipment are inspected and maintained in line with statutory requirements.

The condition of assets, which determines their Health Indices, is of paramount importance for identifying interventions and investment strategies that provide the best value for money.

Consideration of the whole-life asset cost, through the identification of complementary investment and maintenance strategies to maximise asset life, is always a factor in managing these assets.

6.5 I&M Interventions

Inspections of all plant were completed every four months until the beginning of 2013, when this was amended to every six months. Alternate inspections are minor and major. Exceptions to this are detailed in the innovation section.

Transformer and bus-section/coupler CBs are operated every year, and feeder CBs every two years. The CBs are timed to identify any slow opening units.

Oil CBs are maintained every six years alternating between mechanism maintenance and full maintenance (Figure 16).

Post-fault maintenance on EHV oil circuit breakers is carried out after three fault trips on underground circuits and six fault trips on overhead ones, and is recorded as a full maintenance.

Specific makes and types may require enhanced inspection and maintenance from the norm, and these are identified in the appendices of EMS 10-0002 which sets the frequencies for I&M interventions.

Statutory inspections of pressurised equipment are scheduled in line with the individual Written Scheme of Examination.

Figure 16- Insulation Testing of switchgear is important to understand its condition

6.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the timescales for interventions. EI 10-1501 details maintenance requirements for 132kV to 22kV switchgear, while EMS 10-0005 details the requirements for batteries and chargers.

6.7 I&M Plan

Fault rates and failure modes have not highlighted any particular changes that may be required to the above regime. The plan reflects consistent I&M interventions in line with the above policy, but incorporates a reduction in inspection activity to reflect the change in frequency of minor site inspections which is detailed in section 12. The fluctuating volumes reflect the variance in activity levels associated with the periodic operation and maintenance of circuit breakers. Table 19, Table 20 and figure 17 show the volume profiles in ED1 and ED2.

Description of Activity	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020/ 2021	2021/ 2022	2022 /2023
33kV OCB Painting	0	1	1	1	1	1	1	1	1	1
Defect Repair - 33/22 kV Switchgear	37	37	37	37	38	39	38	40	39	40
Maintain Batteries and Charger	36	36	36	36	36	36	36	36	36	36
Strategic Spares Provision	44	48	51	51	50	50	50	50	50	50
Maintain 33/22kV Oil CB	22	26	16	22	32	28	32	8	7	8
Maint FULL 33/22kV Vac/SF6 F/P & GIS CB	0	1	0	1	3	2	9	13	40	4
Maintain Mechanism 33/22kV Oil CB	28	22	7	10	15	20	27	24	16	14
Maint MECH 33/22kV Vac/SF6 F/P & GIS CB	28	11	2	0	0	0	0	0	0	0
Trip Test 33/22kV CB inc op of Isolators	313	242	250	246	250	246	250	246	234	179
Oil busbar level check	0	0	3	0	0	0	0	0	0	0
Record EPR & Identification of Hot Sites	16	16	16	16	16	16	16	16	16	16
Inspect Grid & Primary Earths & T/Plugs	183	183	183	183	183	183	183	183	183	183
Maintain Air Insulated Busbars 33/22kV	0	0	0	0	0	0	0	1	1	4
Maintain Metalclad Busbars 33/22kV	0	0	0	0	3	6	0	0	1	0
Maint FULL 33/22kV Vac/SF6 W/D CB	0	0	0	0	0	2	9	1	0	0
Maint MECH 33/22kV Vac/SF6 W/D CB	2	10	9	2	9	3	2	2	2	10
Repairs Grid & Primary Earths & T/Plugs	8	33	33	33	33	33	33	33	33	33
Maintenance Total	**717**	**666**	**644**	**638**	**669**	**665**	**686**	**654**	**659**	**578**
Includes RIGs Lines: CV13 Lines 46, 49, 63, 77										

Table 19 - DPCR5 & ED1 Forecast – I&M EHV Switchgear

Note 1: Strategic spares provision applies to all switchgear, transformer, and cables, but is most applicable to EHV switchgear.
Data Source: NAMP of 19/02/2014

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
EHV Switchgear Maintenance	**649**	**649**	**649**	**649**	**649**	**649**	**649**	**649**

Table 20 - ED2 Forecast – I & M EHV Switchgear

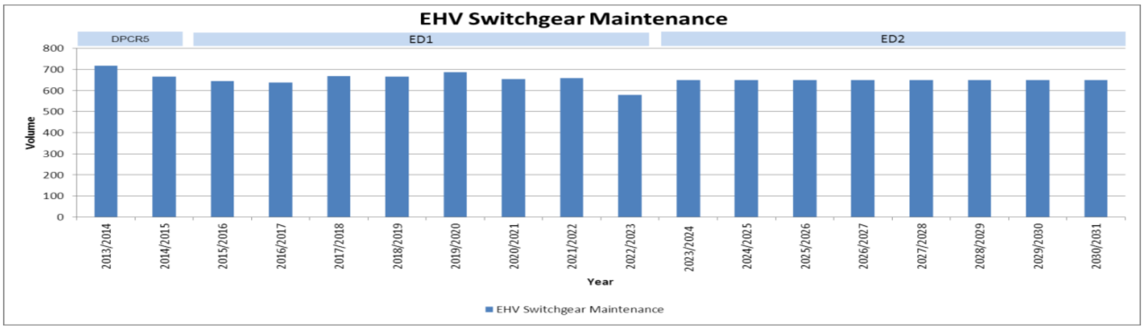

Figure 17 - DPCR5, ED1, & ED2 Historical and Forecast Value

6.8 Innovation

As part of ongoing Reliability Centred Maintenance (RCM) assessments to optimise I&M activities the following have been changed to tailor the requirements closer to individual site and plant needs:

The number of routine site inspections have been reduced to two per year, one minor and one major, with exceptions based on the site requirements, primarily batteries. A frequency of four months between minor inspections has been retained for sites where wet cells are installed, due to the higher level of intervention required. While on site for this, it is advantageous to carry out an extra minor inspection of plant for very little extra cost.

To evaluate this opportunity further we looked at how we gather condition data at grid sites. The assessment showed that apart from specific visits to formerly gather this information, many other visits are made for other reasons, such as vegetation management, switching etc. It is proposed to introduce methods to record such visits where it is a requirement to report any overt defects that may affect site security or present a safety or environmental hazard.

Mechanism maintenance for vacuum and SF_6 CBs has been withdrawn, as the correct operation of the units is checked every year by remotely opening and closing them, with a full service every 12 years. Often, manufacturers' of these units designate them as being lubricated for life, reducing what could be achieved from this type of action. Oil CBs were not aligned as there are generally of older designs requiring a higher level of intervention to maintain functionality.

Inspection and maintenance of busbars is fairly limited without large outages that introduce heightened network risk and customer outages. For air-insulated busbars, the annual thermal inspection will identify potential failure points; and for metal-clad busbars, the monitoring of discharge on inspections will also identify issues. Time-based busbar maintenance has been withdrawn on this basis.

Isolator maintenance was set at every 12 years, which often involved large-scale outages creating increased network risk. It is considered that the combination of thermal and visual inspections, along with the current operation regime, will allow units to be maintained when they show initial signs of problems.

7.0 Primary Switchgear

7.1 Asset Information

The total volume of switchgear in this category is 3,503, located specifically at primary substations. There are three main types of circuit breakers (CBs) – oil, SF_6 and vacuum – with associated isolators and busbars. These units operate at 11/6.6kV and control the downstream side of transformers and outgoing feeders at primary sites.

7.2 Summary of Fault Trends, Failure Modes, and Fault Rates

All CB types (including isolators and busbars) – The volumes for faults in this category are included under HV switchgear in section 8.3, as primary switchgear represents only a small proportion of the total volumes at this voltage. Table 21 shows mechanism performance for all CBs and instances where CBs have failed to trip correctly for a fault over the past nine years. It is included in this section as it is mainly primary feeder CBs that suffer from stiction problems.

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
No of stuck CBs	1	1	0	1	1	5	1	1	1	4

Table 21 -Stuck CBs Data Source: Major network investigation reports

Figure 18 – Circuit breaker timing tests are important to ensure continued operability

7.3 Faults Plan

There is no separate analysis of this category due to the small number of faults, making it difficult to reliably forecast volumes. Fault data for this activity are included in the HV switchgear section 8.0, as it covers the larger population of switchgear operating at 11/6.6kV.

7.4 I&M Drivers

Safety is the top priority, with ongoing monitoring of identification and clearance of defects. Information from the National Defect Reporting Scheme provides an insight into other operators' experiences and an opportunity for UK Power Networks to review its I&M regime against issues found.

The requirement for post-fault maintenance on oil circuit breakers must be met to maintain the operating capability.

For this class of switchgear, specific attention is paid to functionality performance and, in particular, instances where CBs have failed to trip for a fault, as this can significantly increase the number of customers affected.

The condition of assets, which is used to determine their Health Indices, is of paramount importance for identifying interventions and investment strategies that provide the best value for money.

Consideration of the whole-life asset cost, through the identification of complementary investment and maintenance strategies to maximise asset life, is always a factor in managing these assets.

7.5 I&M Interventions

Inspections of all plant were completed every four months until the beginning of 2013, when this was amended to every six months. Alternate inspections are minor and major. Exceptions to this are detailed in the innovation section.

Transformer and automatic bus-section/coupler CBs are operated every year; and feeder, plus all non-remote control CBs, every two years. They are timed to identify any slow opening units. Figure 19 *shows mechanism maintenance on an oil circuit breaker.*

Oil CBs are maintained every six years alternating between mechanism maintenance and full maintenance. This is kept under continual review in relation to instances of CBs failing to trip for a fault.

Post-fault maintenance on primary oil circuit breakers is carried out after three fault trips where the primary fault level is 150MVA or greater, and six fault trips where it is less than 150MVA, and is recorded as full maintenance.

Specific makes and types may require enhanced inspection and maintenance from the norm, and these are identified in the appendices of EMS 10-0002 which sets the frequencies for I&M interventions.

Figure 19– Carrying out mechanism maintenance on an oil circuit breaker

7.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the time scales for interventions, whilst EMS 10-0005 details the requirements for batteries and chargers.

7.7 I&M Plan

Fault rates and failure modes have not highlighted any particular changes that may be required to the above regime. Generally, the plan reflects consistent I&M interventions in line with the above policy, but incorporates a reduction in inspection activity to reflect the change in frequency of minor site inspections which is detailed in section 12.0. To reflect capex interventions proposed for ED1 (where oil CBs are replaced by vacuum or SF_6 CBs), maintenance of oil CBs has been reduced by a total of 11% from 2016/2017 pro-rata across the period. Fluctuating volumes in the forecast are due to variations associated with the periodic operation and maintenance of circuit breakers.

Table 22, Table 23 and figure 20 show the volume profiles in ED1 and ED2.

Description of Activity	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023
Partial Discharge test of switchboard	1	8	0	0	0	0	0	0	0	0
Lifting equipment repairs at main substations	9	9	9	9	9	9	9	9	9	9
Inspection and testing of lifting equipment	2	3	3	3	3	3	3	3	3	3
Defect Repair - 11kV Circuit Breakers	239	240	243	245	247	249	253	255	256	258
Maint FULL 11/6.6kV SF6/Vac CB W/B Feed	76	62	64	57	100	115	277	88	60	95
Maint FULL 11/6.6kV SF6/Vac CB F/B Feed	23	7	6	2	1	0	8	37	55	14
Maint MECH 11/6.6kV OCB Feeder	145	236	85	23	11	2	15	34	46	48
Maint MECH 11/6.6kV SF6/Vac CB W/B Feed	31	3	3	3	3	3	3	3	3	3
Maint MECH 11/6.6kV SF6/Vac CB F/B Feed	0	14	41	0	0	0	0	0	0	0
Trip Test 11/6.6KV CB Feeder	2,150	2,482	3,771	3,735	3,771	3,735	3,771	3,735	3,771	3,722
Maint FULL 11/6.6kV OCB Feeder	9	25	34	58	97	115	167	206	100	51
Maint FULL 11/6.6kV OCB TSC	43	28	20	31	31	42	81	32	12	14
Maint FULL 11/6.6kV SF6/Vac CB W/B TSC	46	34	34	6	16	49	79	29	35	60
Maint FULL 11/6.6kV SF6/Vac CB F/B TSC	8	4	3	2	2	0	0	4	13	1
Maint MECH 11/6.6kV OCB TSC	84	66	14	21	43	43	25	26	22	32
Maint MECH 11/6.6kV SF6/Vac CB W/B TSC	2	9	9	9	9	9	9	9	9	9
Maint MECH 11/6.6kV SF6/Vac CB F/B TSC	0	4	13	13	35	0	0	0	0	2
Trip Test 11/6.6KV CB TSC	1,011	947	973	973	973	973	973	973	969	956
Maintenance Total	**3,879**	**4,181**	**5,325**	**5,190**	**5,351**	**5,347**	**5,673**	**5,443**	**5,363**	**5,277**
Includes RIGs Lines: CV13 Line 27										

Table 22- DPCR5 & ED1 Forecast – I&M Primary Switchgear

Note 1 - Inspection of lifting equipment and partial discharge covers all Grid and Primary sites although mainly used at primaries. Data Source: NAMP of 19/02/2014

ED2 Volumes	2023/2024	2024/2025	2025/2026	2026/2027	2027/2028	2028/2029	2029/2030	2030/2031
Primary Switchgear Maintenance	**5,371**	**5,371**	**5,371**	**5,371**	**5,371**	**5,371**	**5,371**	**5,371**

Table 23 – ED2 Forecast – I&M Primary Switchgear

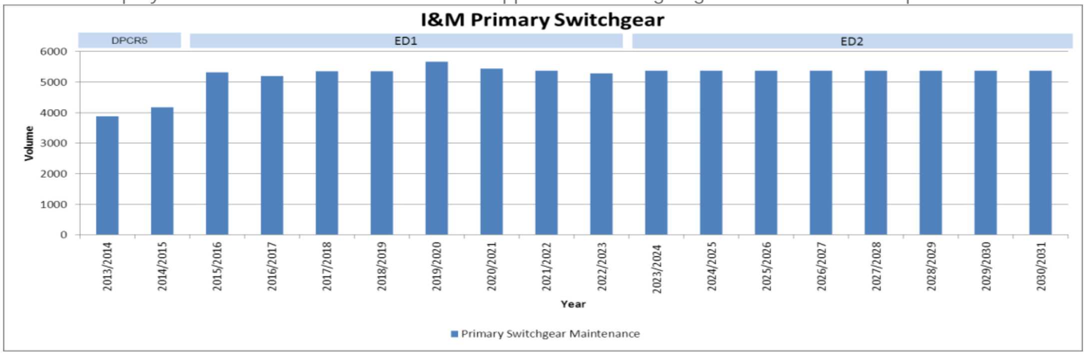

Figure 20 - DPCR5, ED1, & ED2 Historical and Forecast Values

7.8 Innovation

As part of ongoing Reliability Centred Maintenance (RCM) assessments to optimise I&M activities the following have been changed to tailor the requirements closer to individual site and plant needs: The number of routine site inspections have been reduced to two per year, one minor and one major, with exceptions based on the site requirements, primarily batteries. A frequency of four months between minor inspections has been retained for sites where wet cells are installed, due to the higher level of intervention required. While on site for this, it is advantageous to carry out an extra minor inspection of plant for very little extra cost.

To evaluate this opportunity further we looked at how we gather condition data at primary sites. The assessment showed that apart from specific visits to formerly gather this information, many other visits are made for other reasons, such as vegetation management, switching etc. It is proposed to introduce methods to record such visits where it is a requirement to report any overt defects that may affect site security or present a safety or environmental hazard.

In response to the continuous review of CBs failing to trip, the frequency of operation for Siemens Retvac CBs has been amended to every six months. This affects 1,819 units out of a circuit breaker population at all locations of 6,657.

Mechanism maintenance for vacuum and SF_6 CBs has been withdrawn, as the correct operation of the units is checked every one/two years by remotely opening and closing them, with a full service every 12 years. Often, manufacturers' of these units designate them as being lubricated for life, reducing what could be achieved from this type of action. Oil CBs were not aligned as there are generally of older designs requiring a higher level of intervention to maintain functionality.

Inspection and maintenance of busbars is fairly limited without large outages that introduce heightened network risk and customer outages. For air-insulated busbars, the annual thermal inspection will identify potential failure points; and for metal-clad busbars, monitoring of discharge on inspections will also identify issues. Time-based busbar maintenance has been withdrawn on this basis.

Techniques are being investigated to tailor post-fault maintenance to the cumulative value of fault current broken on a particular unit rather than linking it to the number of fault operations. At present CBs are maintained following operation due to a fault (post fault) on the basis of a fixed number of operations dependant on the site fault level. Wear on the CB and carbonisation of the oil is a function of the magnitude of fault current it has broken, which can be measured on each occasion. If this is aggregated it provides a profile of the condition of the CB and once correlation has been established between the cumulative current and CB condition, the maintenance intervals can be driven more accurately leading to better timed interventions, often of a reduced frequency. This will be the subject of an IFI project that will be required to investigate the methodology for collecting the data and the profiles for different types of CB for values of current broken.

8.0 HV Switchgear and LV Plant

8.1 Asset Information

There are three main types of HV switchgear – oil, SF_6 and vacuum – which can be found as extensible switchgear (EXT), ring main units (RMU), and circuit breakers (CBs). The total volume in this category is 20,417 items of plant split as follows:

EXT – 933 Units
RMU – 16,243 units
CB – 3,241 units

There are five main types of LV Plant, Substation Pillars, Indoor Boards, Fuse Cabinets, Circuit Breakers, and Link Boxes. The total volume in this category is 73,971 items of plant split as follows:

Substation Pillars/Fuse Cabinets/Boards – 19,637
Circuit Breaker – 7,062
Link Boxes – 47,272

Data Source: RIGS Return (2013)

8.2 Summary of Fault Trends, Failure Modes, and Fault Rates

Based on the average faults over the past five years (2007/8 though to 2011/12), the fault rates for switchgear are as shown in table 24.

Voltage	Faults per Annum	Fault Rate per Asset
HV Switchgear	65	0.0033
LV Plant	26	0.0036

Table 24 - Fault Rates (Data Source: IIS and UKPN Fault Cube)

HV Switchgear All Types – The fault trend has been increasing over the past five years. The forecast, starting from 2013/14, at which point volumes have been set using the average over the past five years (2007/8 through to 2011/12), shows no change in volumes over the period. It is anticipated that the fault rate will remain the same as the number of assets approaching their life expectancy continues to increase, but is counter-acted by asset replacement. The uncharacteristic increase shown in 2011/12 is due to changes in the reporting system increasing reported electrical open/closing faults for that year only. If this is replaced with the previous five year average the five-year trend aligns better with the forecast. See figure 21.

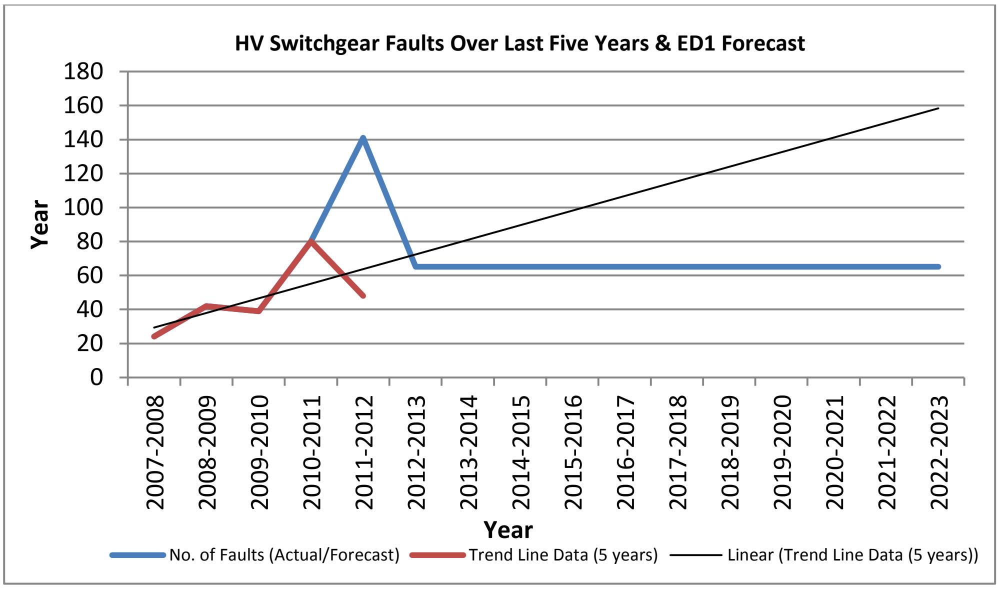

Figure 21 - Data Source: IIS and UKPN Fault Cube

LV Plant All Types – The fault trend in Figure 22 is shown as increasing over this period. The forecast, starting from 2013/14, at which point volumes have been set using the average over the past five years (2007/8 through to 2011/12), shows no change in volumes over the period. This equates to a fault rate of 0.0036 per asset.

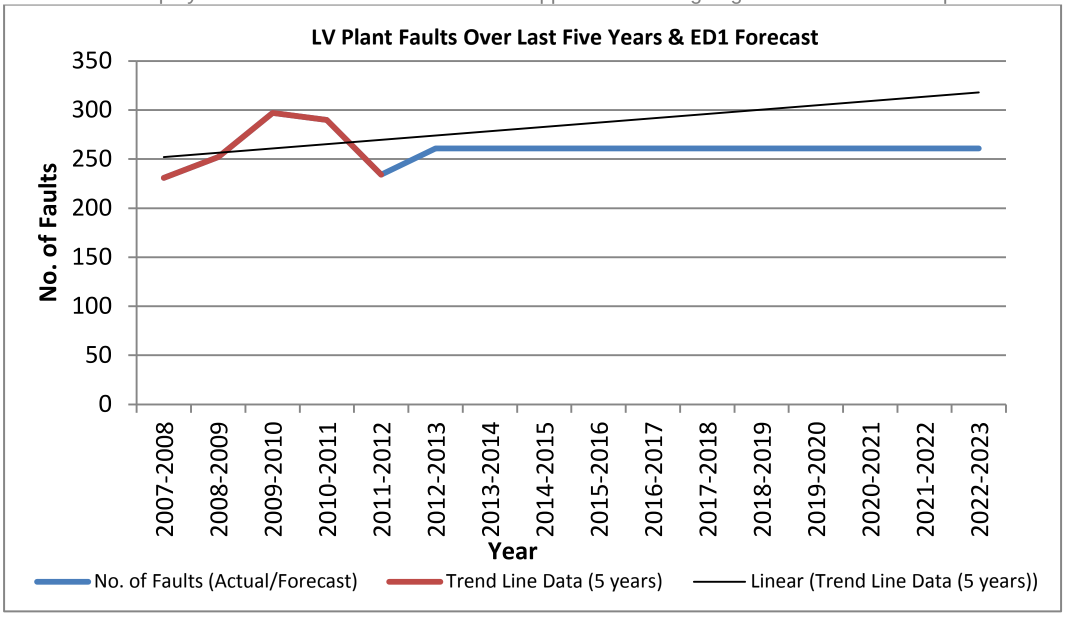

Figure 22 - Data Source: IIS and UKPN Fault Cube

8.3 Faults Plan

Generally, failure of this equipment leads to wholesale replacement as the most cost-effective solution, although repair is always considered as an initial option, especially where a component within the unit is involved. This decision process is also affected by the availability of spares, which can be a problem with older equipment.

HV - The above graph shows an increasing trend. With the volume in 2013/14 set at the average over the past five years (2007/8 through to 2011/12) it is proposed to keep the volumes constant from then across ED1. It is anticipated that the fault rate will remain the same (0.0033 per asset) as the underlying failure rate due to condition is not increasing.

In Table 25 and 26, volumes for HV switchgear are aggregated with HV transformers (section 11.3) as the volumes for both are relatively low, and the numbers of each can vary year to year giving a broader statistical base on which to forecast.

LV – Figure 23 shows a gradually increasing trend. With the volume in 2013/14 set at the average over the past five years (2007/8 through to 2011/12), it is proposed to keep the volumes constant from then across ED1. This aligns with a programme to inspect and replace link boxes to reduce the number of faults.

Description of Activity	RIGs Ref	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
HV Other Plant Faults (volume)	CV15a Line 27	60	97	160	82	83	83	83	83	83	83	83	83	83	83
Total HV Plant Faults		**60**	**97**	**160**	**83**	**83**	**83**	**83**	**83**	**83**	**83**	**83**	**83**	**83**	**83**
Other plant (LV etc)	CV15a Line 20	300	298	241	261	261	261	261	261	261	261	261	261	261	261
Flooding Burst Water Main	CV15b Line 16	Included in "Responding to Safety Critical Calls"				238	243	243	244	244	244	244	244	238	220
Total LV Plant Faults		**300**	**298**	**241**	**261**	**499**	**504**	**504**	**505**	**505**	**505**	**505**	**505**	**499**	**481**

Table 25 - DPCR4, DPCR5 & ED1 History/Forecast – HV Switchgear and LV Plant Faults

Data Source: UKPN Faults Cube (pre 2012/13) & NAMP of 19/02/2014 - 2013/14 onwards
RIGs data includes third party damage to UKPN plant, whereas NAMP data excludes such incidents.

ED2 Volumes	2023/2024	2024/2025	2025/2026	2026/2027	2027/2028	2028/2029	2029/2030	2030/2031
Total HV Plant Faults	**83**	**83**	**83**	**83**	**83**	**83**	**83**	**83**
Total LV Plant Faults	**481**	**481**	**481**	**481**	**481**	**481**	**481**	**481**

Table 26- ED2 Forecast –HV Switchgear and LV Plant Faults

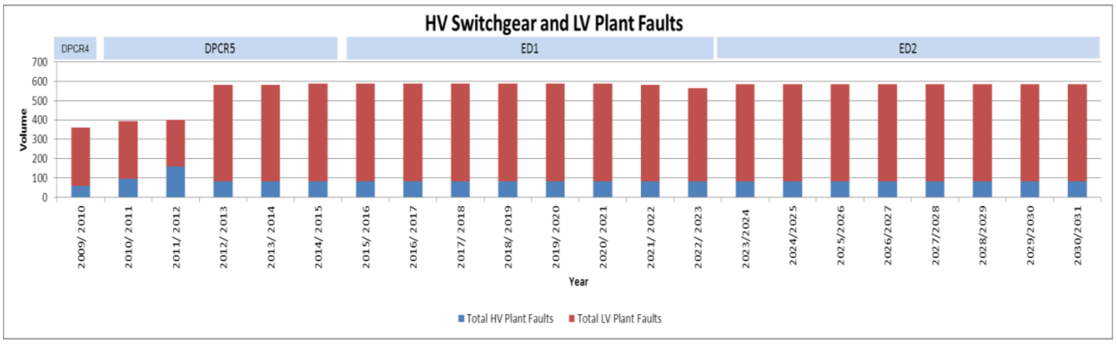

Figure 23 – DPCR4, DPCR5, ED1, & ED2 Historical and Forecast Value

8.4 I&M Drivers

Safety is the top priority, with ongoing monitoring of identification and clearance of defects. Information from the National Defect Reporting Scheme provides an insight into other operators' experiences and an opportunity for UK Power Networks to review its I&M regime against issues found.

The requirement for post-fault maintenance on oil circuit breakers must be met to maintain operating capability.

Due to the large volumes of this type of plant, and the large numbers of manual operations carried out on them with the operator close to the equipment, inspection and maintenance regimes need to quickly reflect issues that could affect operator safety.

Public safety is particularly pertinent to this category of plant, as often it is situated close to domestic properties or in public thoroughfares, in some areas with high numbers of passing pedestrians.

Maintenance of functionality is a prime consideration for this class of equipment, as this often directly affects the ability to restore customers' supplies following an unplanned outage.

The condition of assets, which determine their Health Indices, is of paramount importance for identifying interventions and investment strategies that provide the best value for money.

Consideration of the whole-life asset cost, through the identification of complementary investment and maintenance strategies to maximise asset life, is always a factor in managing these assets.

8.5 I&M Interventions

Plant at secondary substations was inspected every two years up to the end of 2012, with a more targeted approach starting in 2013, as outlined in the innovation section below.

Inspection of network pillars and link boxes takes place every four or eight years depending on their site risk rating.

All HV switchgear has a full maintenance at 18 years, with mechanism maintenance performed every nine years on all oil-insulated equipment that has relay protection and other specific types (Figure 19).

Post-fault maintenance on oil circuit breakers is carried out after three fault trips where the primary fault level is 150MVA or greater, and six fault trips where it is less than 150MVA, and is recorded as full maintenance.

Specific makes and types may require enhanced inspection and maintenance from the norm, and these are identified in the appendices of EMS 10-0002 which sets the frequencies for I&M interventions.

8.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the time scales for interventions. EI 10-1502 details the requirements for secondary substation maintenance.

8.7 I&M Plan

Fault rates and failure modes have not highlighted any particular changes that may be required to the above regime. The plan reflects consistent I&M interventions in line with the above policy, but incorporates a reduction in inspection activity to reflect the change in frequency of minor site inspections which is detailed in section 12.

The variations in volumes across the ED1 period are linked to variations in HV switchgear maintenance which are driven by fixed time periods for maintenance.

Table 27, table 28 and figure 24 show the volume profiles in ED1 and ED2.

Description of Activity	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020/ 2021	2021/ 2022	2022 /2023
VMX Discharge Testing	425	426	426	426	426	426	426	426	426	426
Special Access Checks	2,942	2,918	2,918	2,918	2,918	2,918	2,918	2,918	2,918	2,918
Difficult access checks at TCs (allocation of keys)	1,762	1,768	1,768	1,768	1,768	1,768	1,768	1,768	1,768	1,768
Oil - Bulk delivery - 132-33-11kV	1361	1205	1205	1205	1205	1205	1205	1205	1205	1205
Oil Filtering - 132-33-11kV	1,529	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333
Plant Forensic testing and failure investigation Note 1	17	17	17	17	17	17	17	17	17	17
Maintain Non-Isolatable Oil Switch	13	11	9	7	11	8	9	16	11	7
Maintain Non-Isolatable RMU (Oil)	0	0	0	0	1	0	0	0	0	0
Maintain Non-Isolatable RMU (Gas/Vacuum)	109	132	121	135	48	21	28	21	50	91
Maintain Isolatable Oil Switch	9	1	0	0	3	5	14	16	18	19
Maintain Isolatable Gas/Vacuum Switch	4	12	8	0	0	0	0	0	0	0
Maintain Isolatable RMU (Oil)	69	17	30	39	112	118	127	122	104	66
Maintain HV Metering Unit	46	37	0	0	0	2	0	0	0	0
Maint FULL 11/6.6kV OCB at S/SUB	12	14	15	8	18	23	37	44	67	82
Maint FULL 11/6.6kV SF6/Vac CB F/P S/SUB	26	50	37	64	85	53	144	222	142	61
Maint FULL 11/6.6kV SF6/Vac CB W/D S/SUB	22	37	65	124	175	9	22	69	33	37
Maint MECH 11/6.6kV OCB at S/SUB	80	81	77	72	101	106	32	25	26	29
Maint MECH 11/6.6kV SF6/Vac CB F/P S/SUB	1	2	2	2	3	6	2	2	2	2
Maint MECH 11/6.6kV SF6/Vac CB W/D S/SUB	8	26	13	19	18	56	59	16	8	19
Maint Busbars (inc VT"s) at S/SUB	1	1	1	1	1	1	1	1	1	0
Repairs Secondary Earths & T/Plugs	8	34	34	34	34	34	33	33	33	33
Defect Repair - 11kV Secondary G/M S/S Equipment	327	330	332	336	339	343	346	350	354	356
HV Maintenance Total	**8,771**	**8,452**	**8,411**	**8,508**	**8,616**	**8,452**	**8,521**	**8,604**	**8,516**	**8,469**
Inspect Secondary Earths & T/Plugs	680	680	680	680	680	680	680	680	680	680
HV Inspection Total	**680**	**680**	**680**	**680**	**680**	**680**	**680**	**680**	**680**	**680**
Includes RIGs Lines: CV13 Lines 28, 29, 30, 33										
Trip Test LV ACB	1,840	1,390	1,738	1,390	1,738	1,390	1,738	1,390	1,738	1,390
Maintain LV Dist.Board (Pillar/TOC)	640	856	1059	1059	1059	1059	1059	1059	1059	1059
Maintain LV ACB	174	174	174	174	174	174	174	174	174	174
Defect Repair - LV G/M S/S Equipment	26	26	27	28	28	28	28	28	28	29
LV Maintenance Total	**2,680**	**2,446**	**2,998**	**2,651**	**2,999**	**2,651**	**2,999**	**2,651**	**2,999**	**2,652**
Inspect LV Link Box	20,883	7,728	7,728	7,728	7,728	7,728	7,728	7,728	7,728	7,728
LV Inspection Total	**20,883**	**7,728**	**7,728**	**7,728**	**7,728**	**7,728**	**7,728**	**7,728**	**7,728**	**7,728**
Includes RIGs Lines: CV13 Lines 10, 11										

Table 27 - DPCR5 & ED1 Forecast – I&M HV Switchgear & LV Plant

Note 1 - Plant forensic testing is used at all voltages although mainly at secondary distribution level
Data Source: NAMP of 19/02/2014

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
HV Switchgear Maintenance	8,512	8,512	8,512	8,512	8,512	8,512	8,512	8,512
HV Switchgear Inspection	680	680	680	680	680	680	680	680
LV Plant Maintenance	2,825	2,825	2,825	2,825	2,825	2,825	2,825	2,825
LV Plant Inspection	7,728	7,728	7,728	7,728	7,728	7,728	7,728	7,728

Table 28 – ED2 Forecast – I&M HV Switchgear & LV Plant

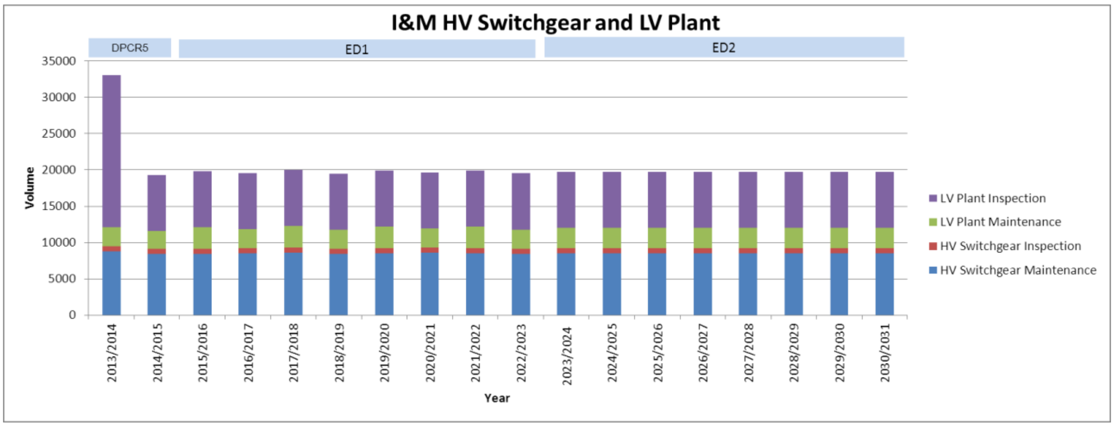

Figure 24 – DPCR5, ED1, & ED2 Historical and Forecast Value

8.8 Innovation

Plant inspections were reviewed in 2012 and a more targeted approach is being used from 2013. As part of ongoing Reliability Centred Maintenance (RCM) assessments to optimise I&M activities the following have been changed to provide a more targeted approach:

For plant at secondary substations, the general inspection frequency has been decreased from two to three years. Exceptions are where protection schemes and batteries are on site.

To evaluate this opportunity further we looked at how we gather condition data at secondary sites. The assessment showed that apart from specific visits to formerly gather this information, many other visits are made for other reasons, such as vegetation management, switching etc. It is proposed to introduce methods to record such visits where it is a requirement to report any overt defects that may affect site security or present a safety or environmental hazard.

9.0 Service Terminations, Cut-outs, and Risers and Laterals

9.1 Asset Information

This equipment covers many different types, depending on the customer's individual requirements, and required capacity.

In the main, services up to 300kVA are supplied through a cut-out, and those larger either into the customer's own switchgear or a termination cubicle.

Multi-occupancy buildings may have one central intake distributed by the owner to individual properties, or have the DNO's network installed through risers and laterals within the building.

Engineering Recommendation G87, issued by the Energy Networks Association (ENA), provides a structure for installation and inspection and maintenance for new riser and lateral installations that has been implemented within UK Power Networks through document EDS 08-0118. This is effective from 1st June 2013. This document also gives some guidance on existing installations.

9.2 Summary of Fault Trends, Failure Modes, and Fault Rates

Currently there is no validated fault data available for this category, but potential improvements into the reporting and extraction of data in this area will be investigated.

9.3 Faults Plan

Generally, wholesale replacement is the most cost-effective solution to failure of this equipment, although repair is always considered as an initial option, especially where a component within a larger unit is involved. This decision process is also affected by the availability of spares, which can be a problem with older or bespoke equipment. It is proposed to keep the volumes relatively constant from 2013/14 and across ED1 based on an estimate of the expected volumes which are likely to reduce during the smart meter roll out. Fault volumes for risers and laterals are included under (service) cables – section 4.3.

Table 29, Table 30 and figure 25 show the volume profiles in ED1 and ED2.

Description of Activity	RIGs Ref	2009 / 2010	2010 / 2011	2011 / 2012	2012 / 2013	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
Service Terminations, Cut-outs	CV15b Line 8	0	1,832	1,721	2,478	2,478	2,478	1,859	1,239	1,239	1,239	1,239	1,239	1,891	1,906
Emergency Disconnections	CV15b Line 6	Included in "Responding to Safety Critical Calls"				699	699	699	699	699	699	699	699	699	699
Total Service Termination Faults		**0**	**1,832**	**1,721**	**2,478**	**3,177**	**3,177**	**2,558**	**1,938**	**1,938**	**1,938**	**1,938**	**1,938**	**2,590**	**2,605**

Table 29 ***- DPCR4, DPCR5 & History/ED1 Forecast – Service Termination Faults***

Data Source: RIGS Returns (pre 2012/13) & NAMP of 19/02/2014 - 2013/14 onwards
RIGs data includes third party damage to UKPN plant, whereas NAMP data excludes such incidents.

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Total Service Termination Faults	**2,180**	**2,180**	**2,180**	**2,180**	**2,180**	**2,180**	**2,180**	**2,180**

Table 30- ED2 Forecast – Service Termination Faults

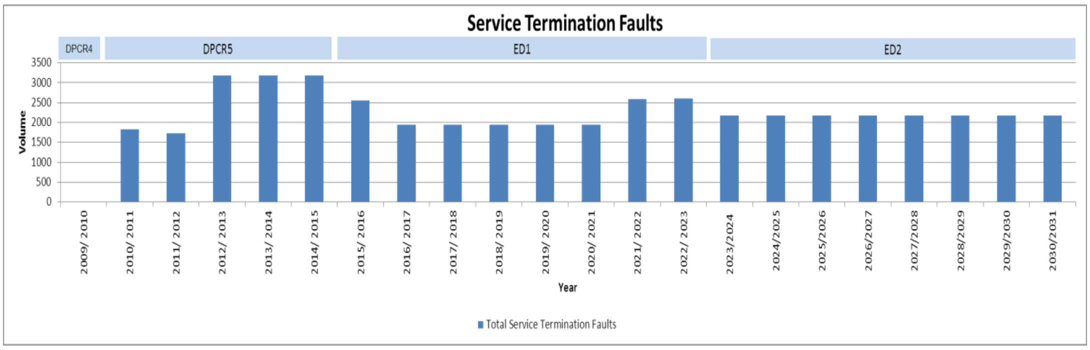

Figure 25 – DPCR4, DPCR5, ED1, & ED2 Historical and Forecast Value

9.4 I&M Drivers

Safety is the top priority, with ongoing monitoring of identification and clearance of reported defects. Where applicable, information from the National Defect Reporting Scheme provides an insight into other operators' experiences and an opportunity for UK Power Networks to review its I&M regime against issues found.

The large volumes of this equipment and the location within private residences and premises present particular challenges in assuring safe operation.

Maintenance of operational and safety integrity is a prime consideration for this class of equipment as customers and meter operators may come in very close proximity.

Where this equipment is housed in vacant properties, with the supply de-energised, the ongoing hazard it represents needs to be monitored and action taken where required to minimise the risk to the public.

The condition of assets is of paramount importance for identifying interventions and investment strategies that provide the best value for money.

9.5 I&M Interventions

The inspection of cut-outs is carried out by suppliers when meter readings are taken.

Where the service terminates in a customer's switchgear, the customer monitors the overall condition and reports exceptions that may affect our incoming supply.

Following a review of the inspection process for risers and laterals, a new process was put in place in 2012 to identify, record and condition-assess this equipment over a 10 year period.

The inspection of idle and unmetered services is required either as identified or on a specified basis.

Maintenance is reactive following the reporting of an issue through the various channels stated above.

9.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the timescales for interventions. EMP 10-0100 covers Idle Services Inspections, and EMP 10-0012 Unmetered Services, whilst the recently introduced policy EMS 10-7005 describes the inspection of Risers and Laterals (R&Ls) in Multi-Occupancy Premises.

9.7 I&M Plan

No changes from the above regime have been highlighted. The plan reflects consistent I&M interventions in line with the above policies.

Table 31 and table 32 show the volume profiles in ED1 and ED2.

Description of Activity	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
Inspection of R&Ls	6,720	6,667	6,667	6,667	6,667	6,667	6,667	6,667	6,667	6,667
Inspection Total	**6,720**	**6,667**	**6,667**	**6,667**	**6,667**	**6,667**	**6,667**	**6,667**	**6,667**	**6,667**
Includes RIGs Lines: CV13 Line 12, 14										

Table 31 - DPCR5 & ED1 Forecast – I&M Service Terminations(Source:19th February NAMP 2014 Table O)

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Service Terminations, Cut-outs, and Risers and Laterals Inspection	**6,667**	**6,667**	**6,667**	**6,667**	**6,667**	**6,667**	**6,667**	**6,667**

Table 32 - ED2 Forecast – I&M Service Terminations(Source: 19th February 2014 NAMP Table O)

9.8 Innovation

No particular innovation initiatives have been identified, although the introduction of smart metering will provide a platform to re-evaluate our processes.

An opportunity may arise through the smart metering initiative for the supplier/meter operator/contractor to carry out service termination/cut-out inspections at the same time as the new meters are installed.

10.0 Grid and Primary Transformers

10.1 Asset Information

There are 171 transformers with a primary winding voltage of 132kV and ratings between 7.5MVA and 90MVA. There are 286 EHV transformers with ratings between 3MVA and 30MVA.

There are various tap-changer types, including: high-speed or slow-speed diverters in separate tanks to the selector; diverter/selector in a combined tank; Jansen/Reinhaussen; and Vacutap.

Any ancillary equipment, such as auxiliary/earthing transformers, neutral earthing resistors/reactors, voltage transformers and surge diverters, are included in this section.

10.2 Summary of Fault Trends, Failure Modes, and Fault Rates

Fault rates based on the average of the past five years (2007/8 through to 2011/12) are shown in table 33.

Transformer Primary	Faults Per Annum	Fault Rate per Asset
132kV	8	0.041
EHV	4	0.013

Table 33 – Fault Rates (Data Source: IIS and UKPN Fault Cube)

All Types (132kV & EHV) – The small numbers of these faults make it difficult to reliably identify long-term trends and fault rates. The forecast, starting from 2013/14, at which point volumes have been set using the average over the past five years (2007/8 through to 2011/12), shows no change in volumes over the period. See figure 26.

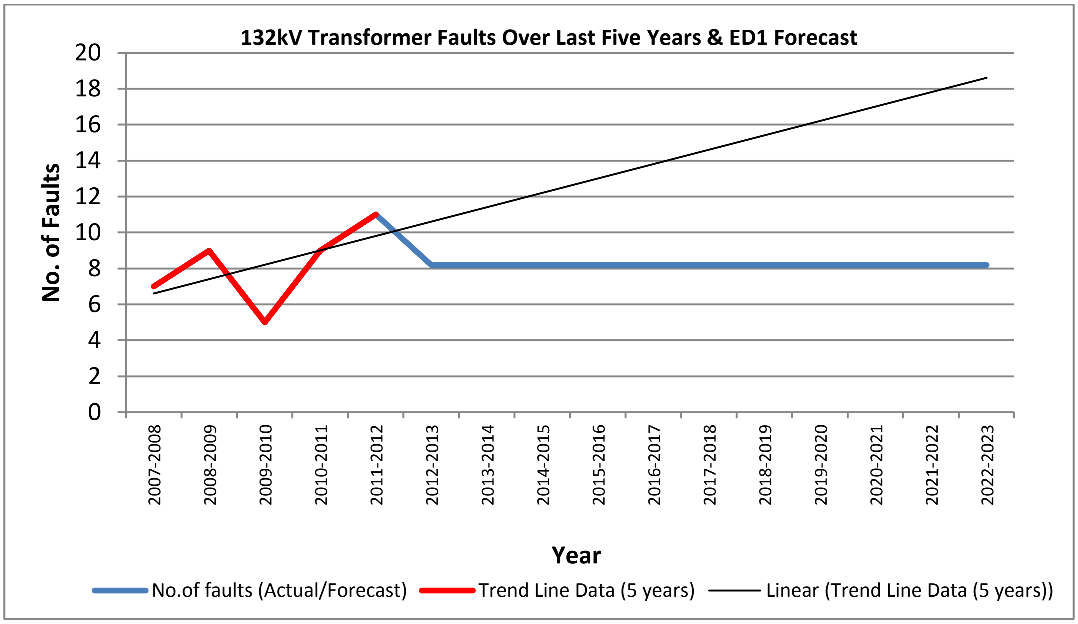

Figure 26 – 132kV transformer faults (Data Source: IIS and UKPN Fault Cube)

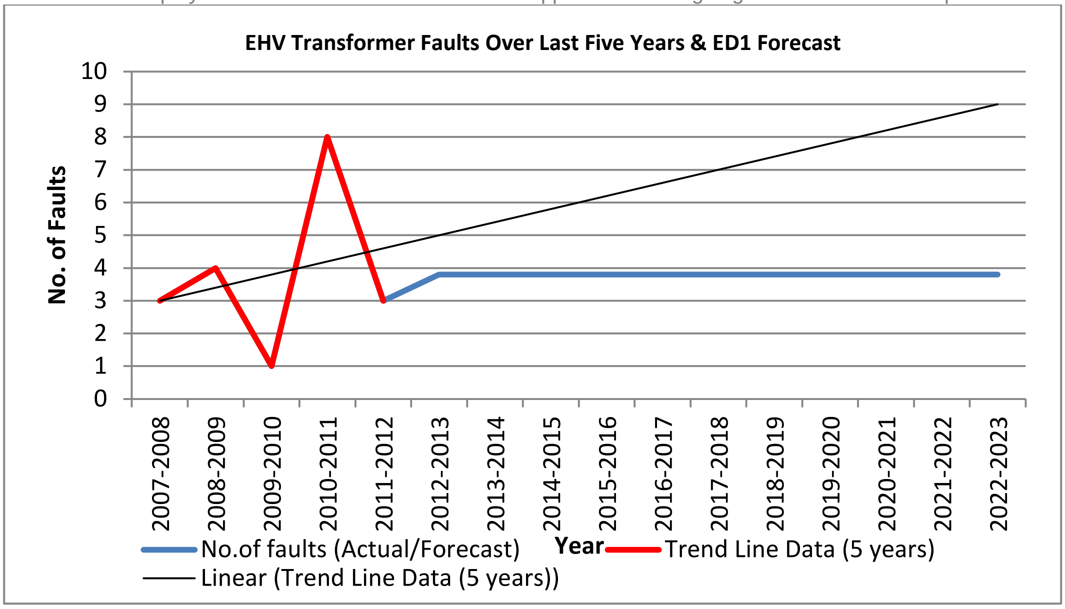

Figure 27 – EHV transformer Faults (Data Source: IIS and UKPN Fault Cube)

10.3 Faults Plan

Figures 26 and 27 show similar trends over a five year period, although, due to the small numbers of these faults, it is difficult to reliably forecast volumes. With both volumes in 2013/14 set at the average over the past five years (2007/8 through to 2011/12), it is proposed to keep the volumes constant from then across ED1.

Overall volumes for 132kV Grid Transformers and Switchgear, and EHV Primary Transformers and Switchgear are shown in Figure 26 and 27 respectively, in order to provide a more predictable forecast.

10.4 I&M Drivers

Mitigation of any safety and environmental factors are the leading priorities for this asset class, with ongoing monitoring of identification and clearance of defects. Information from the National Defect Reporting Scheme provides an insight into other operators' experiences and an opportunity for UK Power Networks to review its I&M regime against issues found.

Issues, such as whether PCBs are present in the oil, are important to understand and redress to ensure a safe working environment.

Functional performance of the tap-changers is a prime consideration to ensure voltage is maintained within statutory limits.

The condition of assets, used to determine their Health Indices, is of paramount importance for identifying interventions and investment strategies that provide the best value for money. Due to the value and criticality of these assets, a more definitive view than visual and thermal inspection is required.

Consideration of the whole-life asset cost, through the identification of complementary investment and maintenance strategies to maximise asset life, is an important aspect of managing these assets utilised by UK Power Networks. Trade-off between Opex and Capex is examined and whole life cost assessment examples are provided in the Capex related narrative documents.

10.5 I&M Interventions.

Inspections of plant were completed every four months until the beginning of 2013, when this was amended to every six months. Alternate inspections are minor and major. Exceptions to this are detailed in the innovation section. Inspections include thermal imaging and discharge monitoring.

Transformers regularly have oil samples analysed for moisture, acidity, electric strength and dissolved gases. At 132kV, this is carried out every year with the lower primary voltages every four years. Every four years, additional tests for FFA (furfuraldehyde) are run on all transformers, and PCB checks are made on 132kV units only.

Generally, slow-speed tap-changers are maintained every four years and high-speed tap-changers are maintained every eight years. There are exceptions to both where the particular make and type need a higher frequency. The maintenance frequencies of transformers, where the general frequency has been found to be too long due to loading and frequency of tap changes, are modified on an individual basis.

Maintenance of combined diverter/selector units have a frequency of two or eight years according to make and type. Figure 28 shows a picture of damaged diverter braids identified during maintenance.

Jansen/Reinhausen units are maintained every four or eight years, depending on the primary winding configuration, and require specialist training. Although the maintenance unit cost is higher than for other units the frequency is generally lower than other types. The latest types of tapchanger being installed require less maintenance, but there is no replacement programme planned for these units based on the cost of maintenance.

Vacutap units require little maintenance, only an oil sample and mechanism check every eight years.

The maintenance of selectors in separate tanks is scheduled every 16 years.

Specific makes and types may require enhanced inspection and maintenance from the norm, and these are identified in the appendices of EMS 10-0002 which sets the frequencies for I&M interventions.

Figure 28 – Recording the condition of diverter braids in tap changers improves how we understand wear and maintenance requirements

10.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the timescales for interventions. EMS 10-1001, Maintenance of Power Transformers details maintenance requirements for power transformers.

10.7 I&M Plan

Fault rates and failure modes have not highlighted any particular changes that may be required to the above regime. The plan reflects consistent I&M interventions in line with the above policy, but incorporates a reduction in inspection activity to reflect the change in frequency of minor site inspections which is detailed in section 12.0.

Table 34, Table 35 and figure 29 show the volume profiles in ED1 and ED2.

Description of Activity	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020/ 2021	2021/ 2022	2022 /2023
Transformer Dryer - inspect & oil sample	107	30	30	30	30	30	30	30	30	30
Transformer 132 & 33kV Oil Sample Retest	1	3	3	3	3	3	3	3	3	13
Defect Repair - Grid Transformers/Tapchangers	182	184	184	188	188	192	192	196	196	200
Defect Repair - Primary Transformers/Tapchangers	96	97	98	99	100	101	102	103	104	105
Maintain Power TX	63	40	37	52	60	87	60	64	60	50
Oil Sample Power TX	325	334	321	325	321	334	320	322	321	334
Maintain Auxiliary/Earthing Tx	11	8	7	13	14	28	27	22	14	14
Maintain Neutral Earthing Reactor	17	7	3	10	5	11	15	11	11	11
Maintain Neutral Earthing Resistor	3	3	5	6	4	6	8	5	3	2
Maintain VT Isolatable	36	0	0	0	0	0	0	0	0	0
Maintain VT Non-Isolatable	0	2	0	0	0	0	0	0	0	0
Maintain CT	0	11	45	45	45	45	45	45	45	45
Maintain CVT (Volume)	0	14	44	44	44	44	44	44	44	44
Oil Sample Selector	244	246	240	239	248	259	240	239	246	260
Oil Sample NEX	16	19	20	21	15	19	20	21	15	18
Maintain Tapchanger single tank	14	11	3	4	7	13	9	5	10	11
Maintain Tapchanger Diverter	58	40	40	56	52	82	57	72	55	54
Maintain Tapchanger Selector	24	14	19	25	13	26	24	26	29	25
Maintain Tapchanger Vacutap	0	0	1	5	5	4	0	0	0	0
Oil Sample Vacutap	0	0	4	7	6	4	4	5	3	3
Oil Sample VT	5	5	5	5	5	5	5	5	5	5
Oil Sample CT	9	8	8	8	8	8	8	8	8	8
Oil Sample F/Breathing Barrier Bushings	5	5	5	5	5	5	5	5	5	5
Maintain Series / Shunt Reactor	4	0	0	1	1	3	6	10	0	0
Maintain Capacitors	0	1	1	1	1	1	1	1	1	1
Maintenance Total	**1,220**	**1,082**	**1,123**	**1,192**	**1,180**	**1,310**	**1,225**	**1,242**	**1,208**	**1,238**
Includes RIGs Lines: CV13 Lines 48, 62, 76										

Table 34 - DPCR5 & ED1 Forecast – I&M Grid & Primary Transformers

Data Source: NAMP of 19/02/2014

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Grid and Primary Transformers Maintenance	**1,215**	**1,215**	**1,215**	**1,215**	**1,215**	**1,215**	**1,215**	**1,215**

Table 35 - ED2 Forecast – I&M Grid & Primary Transformers

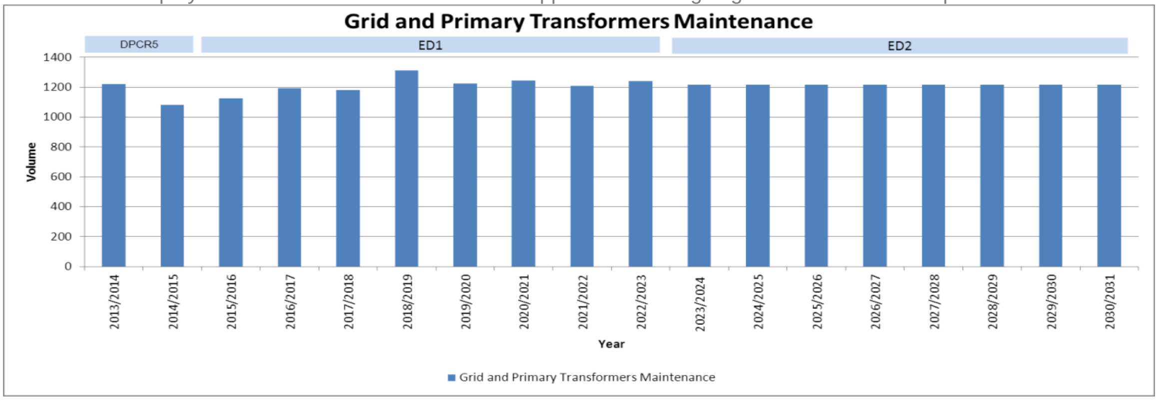

Figure 29 – DPCR5, ED1, & ED2 Historical and Forecast Value

10.8 Innovation

As part of ongoing Reliability Centred Maintenance (RCM) assessments to optimise I&M activities the following have been changed to tailor the requirements closer to individual site needs:

Inspections have been amended to every six months, alternating between minor and major, based on the site requirements, primarily for batteries. A frequency of four months has been retained for sites with wet cells, due to a higher level of intervention being required. While on site for this, it is advantageous to carry out an extra minor inspection of plant for very little extra cost.

To evaluate this opportunity further we looked at how we gather condition data at grid and primary sites. The assessment showed that apart from specific visits to formerly gather this information, many other visits are made for other reasons, such as vegetation management, switching etc. It is proposed to introduce methods to record such visits where it is a requirement to report any overt defects that may affect site security or present a safety or environmental hazard.

To improve the reliability of tap-changers, maintenance kits have been supplied by the manufacturers for high-volume units. Although marginally increasing the unit cost, this ensures the quality and availability of replacement parts ensuring good performance from the units throughout the maintenance period.

Potential avenues are being pursued to tailor diverter maintenance regimes more closely to the requirements of a particular transformer and to record its load and tap-changer operations, so as to set an individual limit on the number of operations, given the type installed. Reliability of SCADA information and an understanding of the limitations and needs of different types of tap-changers are a part of this. This has been suggested as being the subject of an IFI project to initiate the research required.

11.0 Distribution Transformers

11.1 Asset Information

There are 14,995 ground mounted distribution transformers with the majority complying to a “T1” specification (HV RMU and LV Pillar/Board connected via cable to HV and LV cable boxes on different sides of the transformer), or of a unit substation design (HV RMU and LV Fuse cabinet directly coupled to the transformer). Most are oil filled, and all have offload tap changers with a primary voltage of 20/6.6/11kV. Low voltage output is standard nominal 230/400volts.

11.2 Summary of Fault Trends, Failure Modes, and Fault Rates

The fault rate shows an increasing trend over the past five years. The forecast, starting from 2013/14, at which point volumes have been set using the average over the past five years (2007/8 through to 2011/12), shows no change in volumes over the period. See figure 30.

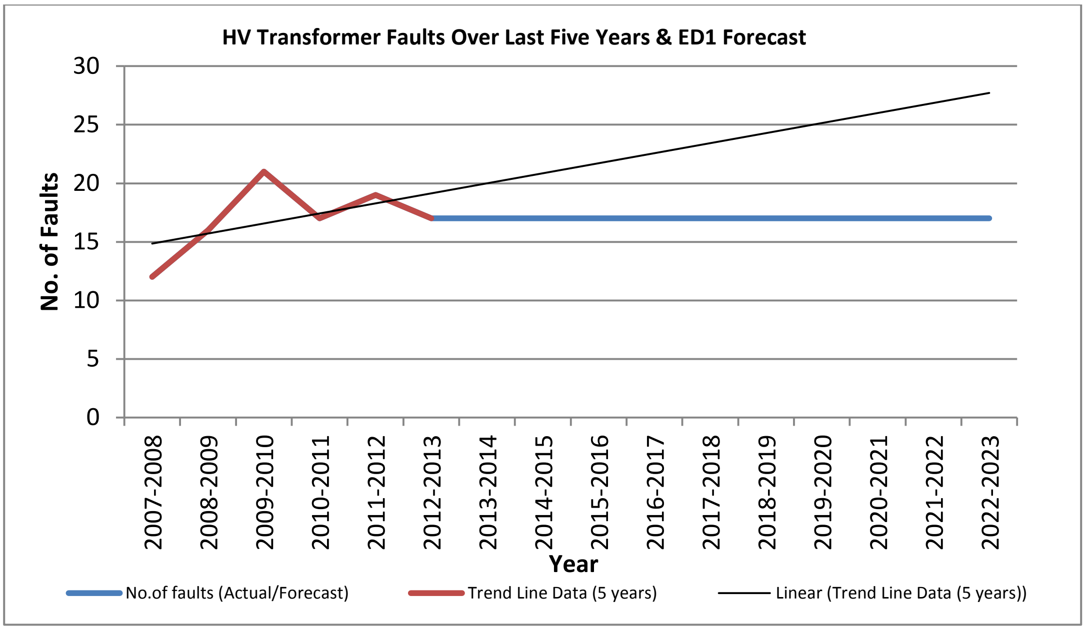

Figure 30 - Data Source: IIS and UKPN Fault Cube

11.3 Faults Plan

Generally, failure of this equipment leads to wholesale replacement as the most cost-effective solution, although repair is always considered as an initial option, especially where a component within the unit is involved. This decision process is also affected by the availability of spares, which can be a problem with older equipment.

The above graph shows a rising trend, but due to the relatively small numbers, it is difficult to predict failure rates in the future. With the volume in 2013/14 set at the average over the past five years (2007/8 through to 2011/12), it is proposed to keep the volumes constant from then across ED1 as it is not anticipated that the volumes will continue to rise to the previous levels due to asset replacement programmes in place.

Volumes for HV transformers are aggregated with HV switchgear (section 8.3) as the volumes for both are relatively low, and the numbers of each can vary year to year giving a broader statistical base on which to forecast. The volume profile is shown in figure 30.

11.4 I&M Drivers

Safety is the top priority, with ongoing monitoring of identification and clearance of defects. Information from the National Defect Reporting Scheme provides an insight into other operators' experiences and an opportunity for UK Power Networks to review its I&M regime against issues found.

Issues, such as whether PCBs are present in the oil, are important to understand and redress to ensure a safe working environment.

Public safety is particularly pertinent to this category of plant, as it is often sited close to domestic properties or in public thoroughfares – in some areas with high numbers of passing pedestrians.

The condition of assets, which determines their Health Indices, is of paramount importance for identifying interventions and investment strategies that provide the best value for money.

11.5 I&M Interventions

Plant at secondary substations was inspected every two years up to the end of 2012, with a more targeted approach starting in 2013 as outlined in the innovation section below.

All distribution transformers have a full maintenance at 18 years, in line with the HV switchgear frequency.

Specific makes and types may require enhanced inspection and maintenance from the norm, and these are identified in the appendices of EMS 10-0002 which sets the frequencies for I&M interventions.

11.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the timescales for interventions. EI 10-1502 details the requirements for secondary substation maintenance.

11.7 I&M Plan

Fault rates and failure modes have not highlighted any particular changes that may be required to the above regime. The plan reflects consistent I&M interventions in line with the above policies, with a reduction starting in 2013/14, compared to previous years, to reflect the change in frequency of site inspections which is included in section 12.

Table 36, Table 37 and figure 31 show the volume profiles in ED1 and ED2.

Description of Activity	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020/ 2021	2021/ 2022	2022 /2023
Maintain Distribution Tx (Volume)	614	724	513	681	1027	694	636	678	716	774
Oil Sample Dist Tx (Volume)	186	515	824	824	824	824	824	824	824	824
Noise complaint investigations by Operations (Volume) Note 1	12	12	12	12	12	12	12	12	12	12
Maintenance Total	**812**	**1,251**	**1,349**	**1,517**	**1,863**	**1,530**	**1,472**	**1,514**	**1,552**	**1,610**
Includes RIGs Lines: CV13 Lines 32										

Table 36- DPCR5 & ED1 Forecast – I&M Distribution Transformers

Data Source: NAMP of 19/02/2014

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Distribution transformer Maintenance	**1,551**	**1,551**	**1,551**	**1,551**	**1,551**	**1,551**	**1,551**	**1,551**

Table 37 – ED2 Forecast – I&M Distribution Transformers

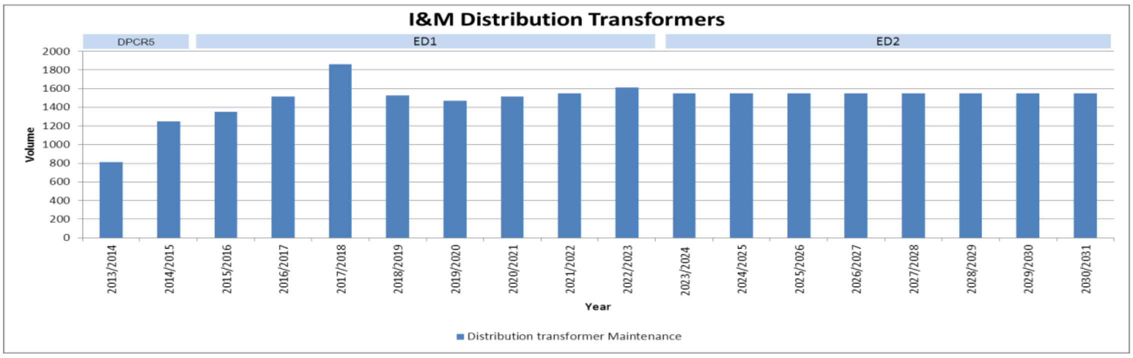

Figure 31 – DPCR5, ED1, & ED2 Historical and Forecast Value

11.8 Innovation

As part of ongoing Reliability Centred Maintenance (RCM) assessments to optimise I&M activities the following have been changed to provide a more targeted approach:

For plant at secondary substations, the general inspection frequency has been decreased from two to three years. Exceptions are where protection schemes and batteries are on site.

To evaluate this opportunity further we looked at how we gather condition data at secondary sites. The assessment showed that apart from specific visits to formerly gather this information, many other visits are made for other reasons, such as vegetation management, switching etc. It is proposed to introduce methods to record such visits where it is a requirement to report any overt defects that may affect site security or present a safety or environmental hazard.

12.0 Sites Housing Electrical Equipment

12.1 Asset Information

This section deals with periodic inspection of sites with ground mounted plant and the factors that are taken into account in their frequency. Remedial action is dealt with in the Civils document.

There are 17,439 substation sites split into 188 grids and primaries, and 17,251 secondary sites. There are also 961 reserved substation sites

Electricity Safety Quality Continuity Regulations (ESQCR) ratings are established using EOS 09-0061. A summary of the ESQCR ratings is shown in Table 38.

ESQCR Risk Rating	Grids & Primaries	Secondary
Very High	9	41
High	50	415
Medium	43	8,032
Low	86	8,763

Table 38- ESQCR Ratings (Data Source: UKPN Asset Register)

12.2 ESQCR Issues

Sites where trespassing has been identified as an issue automatically rise to a high-risk category. For secondary sites, this instigates four additional inspections at a 90-day frequency. For grids and primaries, this instigates four additional inspections: two at a 15-day frequency, followed by two at a 30-day frequency. If after this inspection cycle there are no further signs of trespassing, the frequency returns to normal. If evidence persists, the cycle is repeated.

Theft of metal, either earthing or decommissioned plant left on site, is an ongoing problem. A new standard for above-ground earthing to be aluminium has been issued to discourage theft, and an ongoing project to fully identify decommissioned plant is under way to better manage and provide security for such items.

Breaches of ESQCR for sites with ground mounted equipment generally relate to site security and housekeeping, and signage.

12.3 Security Regimes

Apart from routine and trespass inspections, security patrols may be used to provide random checking for unauthorised entry.

A capex programme is due to be completed in 2014 to change operational locks at grid and primary sites. This change will remove boundary and building door locks, which have keys that have found their way into general circulation, and replace them with an intelligent locking system. The keys require regular re-authorisation to be kept active, and any lost or stolen keys will only remain authorised for a limited time. The keys also download information from locks into the central database system to provide details of entry into sites.
The security of sites that are particularly vulnerable to trespassing have been reviewed and extra security measures taken where appropriate. This aspect of capex work is covered by the Civils document.

12.4 I&M Drivers

Safety is the dominant priority, with ongoing monitoring of identification and clearance of security defects.

Public safety is particularly pertinent, as these sites can often be close to domestic properties.

In particular, where a substation or supply is no longer required, a risk assessment needs to be completed to identify if it is safe to leave energised.

The consideration of the whole-life asset cost, through the identification of complementary investment and maintenance strategies to maximise asset life, is always a factor in managing security of sites.

12.5 I&M Interventions

As part of ongoing Reliability Centred Maintenance (RCM) assessments to optimise I&M activities the following have been changed to provide a more targeted approach:

For secondary substation sites, the general inspection frequency has been decreased from two to three years (Figure 32). Exceptions are where protection schemes and batteries are on site.

Grid & Primary site inspections have been amended to every six months, alternating between minor and major, based on the site requirements, primarily for batteries. A frequency of four months has been retained for sites with wet cells, due to a higher level of intervention being required. While on site for this, it is advantageous to carry out an extra minor inspection of plant for very little extra cost.

Other visits are undertaken for vegetation management and water testing at some grids and primaries, while some operational visits are made to carry out switching or perform maintenance. On each occasion, any security issues can be raised.

Figure 32 – Recording equipment condition on a portable device for automatic updating of the asset register

12.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the timescales for interventions. EMP 10-0100 covers Idle Service Inspections and EMP 10-0012 Idle Site Inspections. EMS 10-5001 details grid and primary substation inspections, while EMS 10-5501 is for secondary sites.

12.7 I&M Plan

The overall plan of grid and primary site inspections and ad hoc visits provides a pro-active regime to identify sites where trespassing may have occurred. Due to the number of secondary sites, there would always be a significant time lapse between trespass and identification, unless by chance it had just happened, so it is not envisaged that a change to increase frequencies would be cost effective. Taking into account measures being put in place to reduce metal theft in particular, the plan reflects consistent I&M interventions in line with the above policies throughout the period, with a reduction starting in 2013/14, compared to previous years, to reflect the change in frequency of grid and primary minor, and secondary site inspections.

Higher volumes in 2011/12 and 2012/13 reflect increased work to catch up with a backlog from previous years, with the forecast showing reductions in line with policy changes in ED1 moving forward.

Table 39, Table 40 and figure 33 show the volume profiles in ED1 and ED2.

Description of Activity	2013 /2014	2014 /2015	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020/ 2021	2021/ 2022	2022 /2023
Inspect Grid/Primary Site (Minor)	394	337	337	337	337	337	337	337	337	337
Inspect Grid/Primary Site (Major)	211	215	215	215	215	215	215	215	215	215
Inspect ESQC Grid/Primary Site High Risk	23	23	23	23	23	23	23	23	23	23
Inspect Secondary Substation	3,699	6,368	6,328	5,846	6,364	6,331	5,843	6,368	6,309	5,771
Inspect ESQC Secondary Substation High Risk	1,499	1,485	1,487	1,485	1,487	1,485	1,487	1,485	1,487	1,486
Inspection Total	**5,826**	**8,428**	**8,390**	**7,906**	**8,426**	**8,391**	**7,905**	**8,428**	**8,371**	**7,832**
Includes RIGs Lines: CV13 Line 23, 24, 44, 58, 72										

Table 39- DPCR5 & ED1 Forecast – I&M Distribution Sites(Source : 19th February 2014 NAMP Table O)

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Sites Housing Electrical Equipment Inspection	**8,206**	**8,206**	**8,206**	**8,206**	**8,206**	**8,206**	**8,206**	**8,206**

Table 40 – ED2 Forecast – I&M Distribution Sites(Source: 19th February 2014 NAMP Table O)

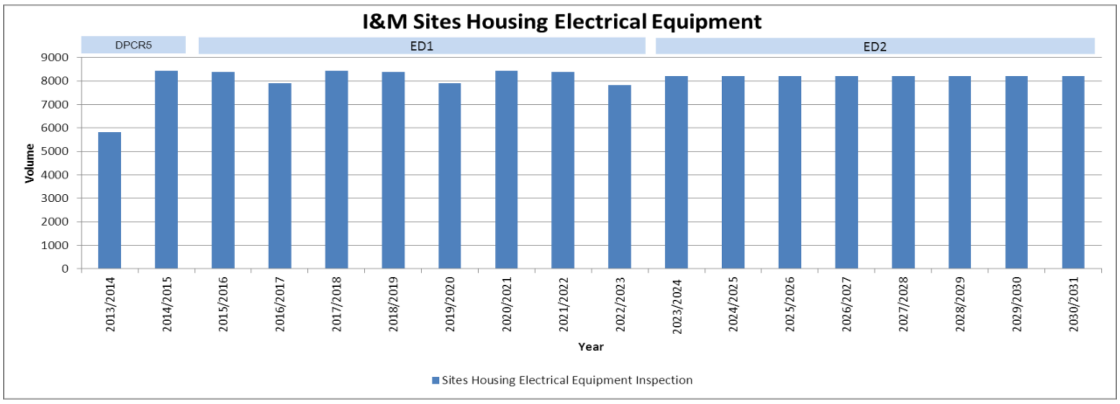

Figure 33 – DPCR5, ED1, & ED2 Historical and Forecast Value

12.8 Innovation

One of the biggest problems currently faced by UK Power Networks is metal theft, often in the form of copper earthing straps or cables, and on occasions batteries. Although the government are proposing to tackle the issue by removing the opportunity for cash transactions, there will always be a market for such items. In order to address this, security measures, such as reducing the attractiveness of theft by using aluminium earthing conductor above ground, or building earthing into structures, have been introduced to reduce the draw to such activity in the long term.

As part of ongoing Reliability Centred Maintenance (RCM) assessments to optimise I&M activities the following have been changed to provide a more targeted approach:

For plant at secondary substations, the general frequency has been decreased from two to three years. Exceptions are where protection schemes and batteries are on site.

The frequency of inspections at Grid and Primary sites has been generally decreased to two per year (one minor and one major inspection) except where other plant on site requires a higher level such as wet cell batteries.

To evaluate this opportunity further we looked at how we gather condition data at all sites. The assessment showed that apart from specific visits to formerly gather this information, many other visits are made for other reasons, such as vegetation management, switching etc. It is proposed to introduce methods to record such visits where it is a requirement to report any overt defects that may affect site security or present a safety or environmental hazard.

13.0 Third Party Damage

This category of work has been excluded from the fault volumes included in the asset sections above as the costs are recoverable from third parties.

Table 41, Table 42 and figure 34 show the volume profiles in ED1 and ED2.

Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
LV Cable Damages	333	336	339	343	346	350	353	356	360	364
LV Cable Damage (Consac)	1	1	1	1	1	1	1	1	1	1
11kV Cable Damage	51	51	51	51	51	51	51	51	51	51
Services - LV Cable Damage	451	451	451	451	451	451	451	451	451	451

Table 41– DPCR5 & ED1 Third Party Damage Forecast Information

(Source: 19th February 2014 NAMP Table O)

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
LV Cable Damages	351	351	351	351	351	351	351	351
LV Cable Damage (Consac)	1	1	1	1	1	1	1	1
11kV Cable Damage	51	51	51	51	51	51	51	51
Services - LV Cable Damage	451	451	451	451	451	451	451	451

Table 42 – ED2 Third Party Damage Forecast Information

(Source: 19th February 2014 NAMP Table O)

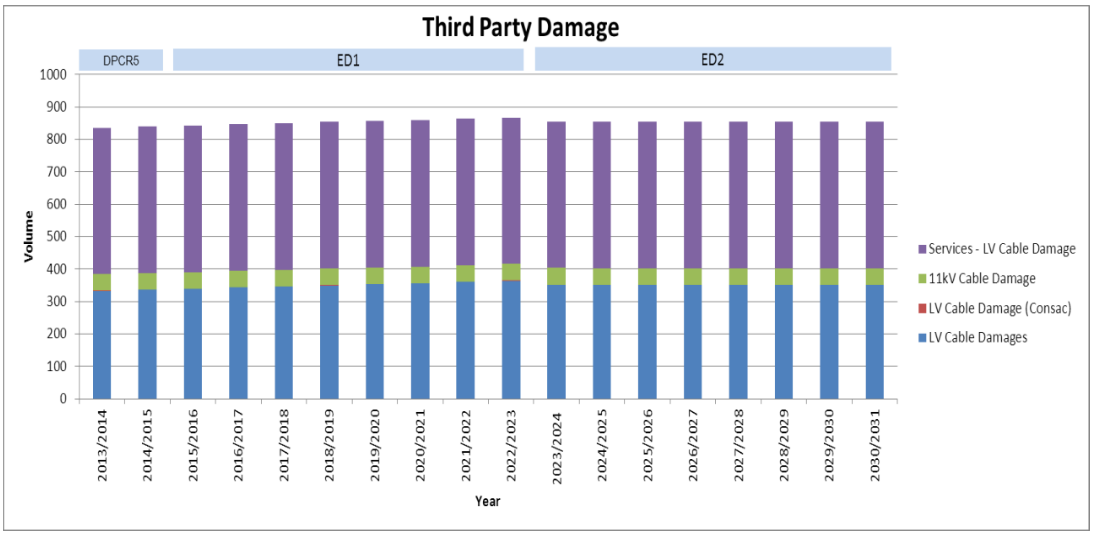

Figure 34 – DPCR5, ED1, & ED2 Historical and Forecast Value

14.0 Trees

Please refer to document 22 for tree related faults data

15.0 Appendices

Appendix 1 Age Profiles – Not relevant: Intentionally left blank

Appendix 2 HI Profiles – Not relevant: Intentionally left blank

Appendix 3 Fault Data

Cable Fault Data

Figure 35 – Cable Fault Data (Data Source: IIS and UKPN Fault Cube)

Switchgear Fault Data

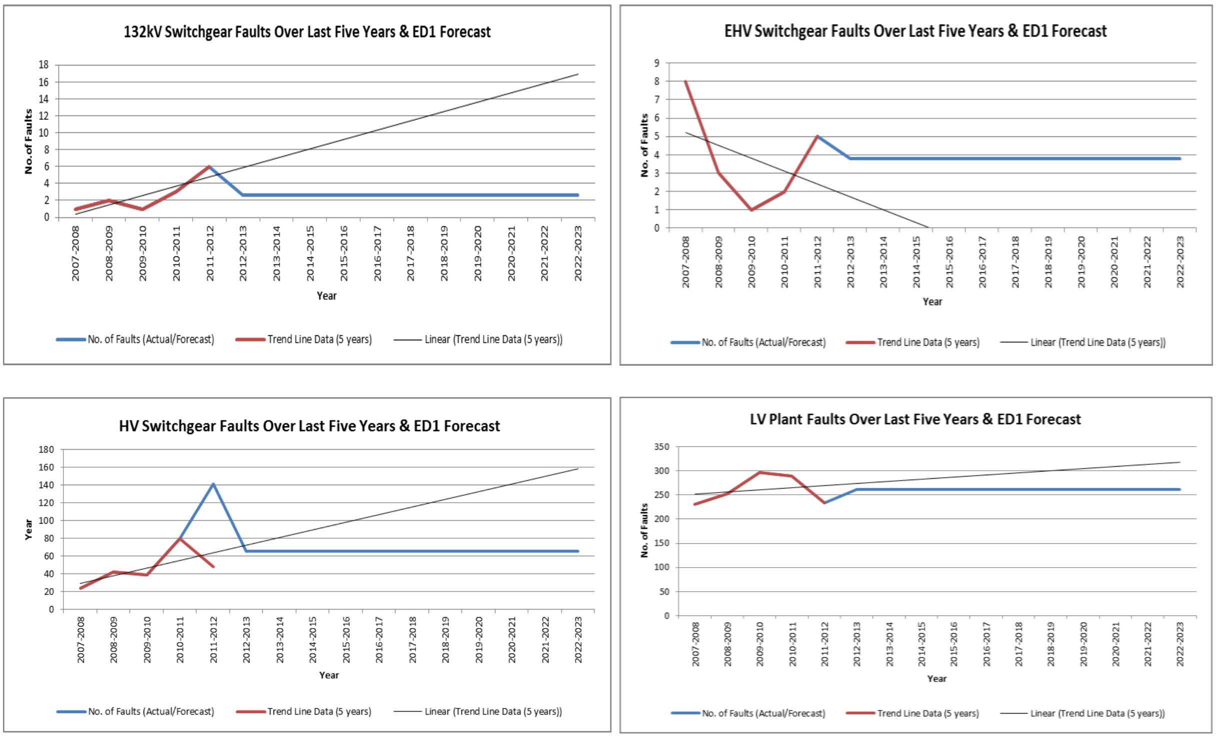

Figure 36 Switchgear Fault Data(Source: IIS and UKPN Fault Cube)

Transformer Fault Data

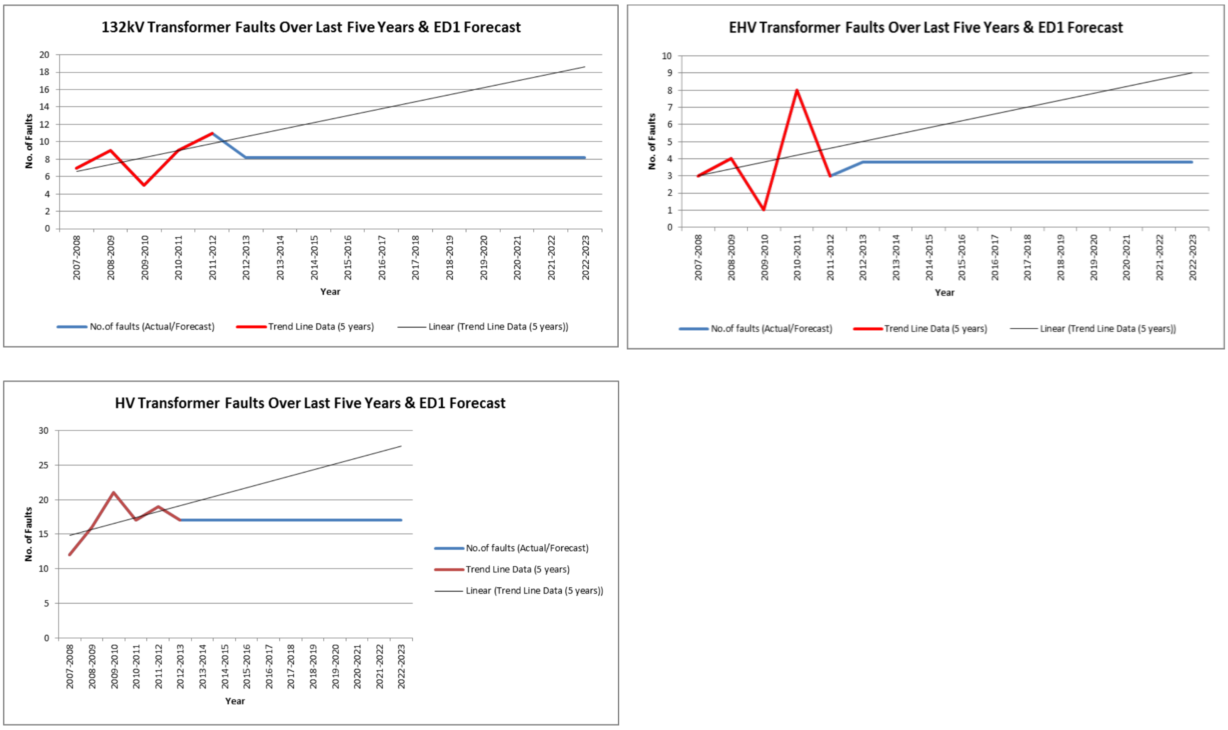

Figure 37 Transformer Fault Data (Source: IIS and UKPN Fault Cube)

Appendix 4 WLC Case Studies – risk, cost, performance, condition profiles for various options – Not relevant: Intentionally left blank

Appendix 5 NLRE plan included in document

Activity	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Sum of DPCR5	Sum of RIIO-ED1
Faults	31.9	29.4	30.3	33.4	24.1	23.7	23.3	22.9	22.6	22.4	22.3	22.5	22.8	149.0	182.6
Inspection (I)	2.0	2.5	3.1	4.5	4.2	4.7	4.8	4.8	4.8	4.8	4.8	4.2	4.0	16.3	36.7
Maintenance (M)	11.9	10.4	11.4	9.9	9.6	10.7	10.9	11.0	11.3	11.2	11.2	10.0	9.8	53.3	86.2
I&M	13.8	13.0	14.5	14.4	13.8	15.4	15.7	15.7	16.0	16.0	16.0	14.2	13.9	69.6	123.0
Total	45.7	42.3	44.8	47.8	37.9	39.2	39.0	38.7	38.7	38.4	38.3	36.7	36.7	218.5	305.6

Table 43- LPN I & M Expenditure (Data Source: NAMP of 19/02/2014 from Table J Less Indirect)

Activity	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Sum of DPCR5	Sum of RIIO-ED1
Faults	31.9	29.4	30.3	33.4	24.1	23.7	23.3	22.9	22.6	22.4	22.3	22.5	22.8	149.0	182.6
Inspection (I)	1.8	2.2	2.6	4.0	3.7	4.3	4.4	4.4	4.4	4.4	4.4	3.8	3.7	14.4	33.8
Maintenance (M)	7.5	7.0	7.8	5.0	4.7	5.6	5.7	5.8	6.0	6.0	6.0	4.7	4.6	32.0	44.4
I&M	9.3	9.3	10.4	9.0	8.4	9.9	10.1	10.2	10.4	10.4	10.4	8.6	8.3	46.5	78.2
Total	41.2	38.6	40.7	42.4	32.5	33.6	33.4	33.1	33.1	32.8	32.7	31.1	31.0	195.4	260.8

Table 44 - LPN Summary Table (Excluding Civils and Protection) (Data Source: 19th February 2014 NAMP Table J Less Indirect)

Appendix 6 Sensitivity Analysis- Not relevant: Intentionally left blank

Appendix 7 Named Schemes – Not relevant: Intentionally left blank

Appendix 8 Output NAMP/ED1 Business Plan Data Tables

I&M – CV13

MappedRigsVolumeTable	MappedRigsVolumeRow	CurrentNampReference	ProjectID	ProjectName	2016	2017	2018	2019	2020	2021	2022	2023
CV13	**10**	4.07.02	**7367**	Inspect LV Link Box	13,474	13,474	13,474	13,474	13,474	13,474	13,474	12,758
CV13	**11**	1.44.07	**9409**	Replace Covers & Frames	570	570	570	570	570	570	570	540
CV13	**11**	1.44.11	**9689**	Replace LB Covers & Frames - Roadway	69	69	69	69	69	69	69	66
CV13	**11**	2.23.02	**6410**	Defect Repair - LV G/M S/S Equipment	36	36	36	36	36	36	36	34
CV13	**11**	4.04.27	**7268**	Maintain LV AC Board	1	1	1	1	1	1	1	1
CV13	**11**	4.08.18	**7405**	Maintain LV Dist.Board (Pillar/TOC)	1,342	1,342	1,342	1,342	1,342	1,342	1,342	1,272
CV13	**11**	4.08.19	**7408**	Maintain LV ACB	220	220	220	220	220	220	220	208
CV13	**11**	4.08.24	**7418**	Trip Test LV ACB	2,424	2,424	2,424	2,424	2,424	2,424	2,424	2,297
					4,662	**4,662**	**4,662**	**4,662**	**4,662**	**4,662**	**4,662**	**4,418**
CV13	**16**	2.35.01	**8348**	UMS Services Inspected	49,200	49,200	49,200	49,200	49,200	49,200	49,200	45,900
CV13	**16**	2.36.03	**8256**	Idle Service Inspection	13,035	13,035	13,035	13,035	13,035	13,035	13,035	12,161
					62,235	**62,235**	**62,235**	**62,235**	**62,235**	**62,235**	**62,235**	**58,061**
CV13	**21**	2.07.11	**9680**	Partial Discharge Mapping - HV	244	244	244	244	244	244	244	226
CV13	**21**	2.07.12	**7020**	Online Partial Discharge Field Investigations	11	11	11	11	11	11	11	11
CV13	**21**	2.08.12	**7019**	Installation and Maintenance of Online PD Monitoring	581	581	581	581	581	581	581	540
CV13	**21**	2.27.13	**9577**	Circuit Routing - Because of Faults and Diversions	36	36	36	36	35	35	34	33
CV13	**21**	2.30.15	**8993**	Cable Pit inspection (HV)	1,981	2,632	2,632	2,632	2,632	2,632	1,111	1,111
					2,853	**3,504**	**3,504**	**3,504**	**3,503**	**3,503**	**1,981**	**1,921**
CV13	**23**	2.21.08	**9562**	Difficult Access Checks at TCs (Allocation of Keys)	2,473	2,473	2,473	2,473	2,473	2,473	2,473	2,297
CV13	**23**	2.21.12	**9928**	VMX Discharge Testing	596	596	596	596	596	596	596	553
CV13	**23**	2.34.04	**9599**	Voltage/Load Investigations	143	143	143	143	143	143	143	133
CV13	**23**	2.41.18	**9964**	Investigation of Other Technical Issues	34	34	34	34	34	34	34	32
CV13	**23**	4.07.01	**7364**	Inspect Secondary Substation	10,462	10,462	10,731	10,462	10,462	10,462	10,462	10,017
CV13	**23**	4.07.06	**7374**	Inspect ESQC Secondary Substation High Risk	2,082	2,082	2,082	2,082	2,082	2,082	2,082	1,933
CV13	**23**	4.07.08	**6991**	Inspect Secondary Earths & T/Plugs	951	951	951	951	951	951	951	884
					16,741	**16,741**	**17,010**	**16,741**	**16,741**	**16,741**	**16,741**	**15,849**
CV13	**25**	2.22.02	**9983**	Maintain TC Forced Ventilation	844	844	844	844	844	844	844	844
CV13	**25**	2.23.01	**6431**	Defect Repair - 11kV Distribution substation	0	311	310	310	310	310	310	310
CV13	**25**	2.32.05	**6453**	Maintain Distribution Sites & Building - 11kV	590	590	590	590	590	590	590	590
CV13	**25**	2.32.08	**6392**	Vegetation Clearance - 11kV	5,040	5,040	5,040	5,040	5,040	5,040	5,040	5,040
CV13	**25**	2.32.11	**9929**	Luxcrete Flap Maintenance	84	150	150	150	150	150	150	150
CV13	**25**	2.32.15	**8273**	Tree Trimming (Distribution Sites)	14	14	14	14	14	14	14	14
CV13	**25**	2.33.02	**9591**	Defect Repair - Secondary Substation Civils	11,652	11,772	11,888	12,008	12,128	12,248	12,372	12,496

CV13	**25**	2.33.24	**7085**	Electrical Wiring - Defect Repair at Secondary Substations	18	18	18	18	19	20	19	19
CV13	**25**	4.08.34	**6992**	Repairs Secondary Earths & T/Plugs	34	34	34	34	33	33	33	33
					18,276	**18,773**	**18,888**	**19,008**	**19,128**	**19,249**	**19,372**	**19,496**
CV13	**27**	2.20.01	**6427**	Defect Repair - 11kV Circuit Breakers at grid/primary substation	243	245	247	249	253	255	256	258
CV13	**27**	4.06.01	**7340**	Maint FULL 11/6.6kV SF6/Vac CB W/B Feed	64	57	100	115	277	88	60	95
CV13	**27**	4.06.02	**7343**	Maint FULL 11/6.6kV SF6/Vac CB F/B Feed	6	2	1	0	8	37	55	14
CV13	**27**	4.06.06	**7349**	Maint MECH 11/6.6kV OCB Feeder	85	23	11	2	15	34	46	48
CV13	**27**	4.06.07	**7352**	Maint MECH 11/6.6kV SF6/Vac CB W/B Feed	3	3	3	3	3	3	3	3
CV13	**27**	4.06.08	**7355**	Maint MECH 11/6.6kV SF6/Vac CB F/B Feed	41							
CV13	**27**	4.06.09	**7358**	Trip Test 11/6.6KV CB Feeder	3,771	3,735	3,771	3,735	3,771	3,735	3,771	3,722
CV13	**27**	4.06.10	**7361**	Maint FULL 11/6.6kV OCB Feeder	34	58	97	115	167	206	100	51
CV13	**27**	4.08.25	**7420**	Maint FULL 11/6.6kV SF6/Vac CB F/P S/S	37	64	85	53	144	222	142	61
CV13	**27**	4.08.26	**7423**	Maint FULL 11/6.6kV SF6/Vac CB W/D S/S	65	124	175	9	22	69	33	37
CV13	**27**	4.08.29	**7432**	Maint MECH 11/6.6kV SF6/Vac CB F/P S/S	2	2	3	6	2	2	2	2
CV13	**27**	4.08.30	**7435**	Maint MECH 11/6.6kV SF6/Vac CB W/D S/S	13	19	18	56	59	16	8	19
CV13	**27**	4.24.01	**7483**	Maint FULL 11/6.6kV OCB TSC	20	31	31	42	81	32	12	14
CV13	**27**	4.24.02	**7486**	Maint FULL 11/6.6kV SF6/Vac CB W/B TSC	34	6	16	49	79	29	35	60
CV13	**27**	4.24.03	**7489**	Maint FULL 11/6.6kV SF6/Vac CB F/B TSC	3	2	2	0	0	4	13	1
CV13	**27**	4.24.05	**7495**	Maint MECH 11/6.6kV OCB TSC	14	21	43	43	25	26	22	32
CV13	**27**	4.24.06	**7498**	Maint MECH 11/6.6kV SF6/Vac CB W/B TSC	9	9	9	9	9	9	9	9
CV13	**27**	4.24.07	**7501**	Maint MECH 11/6.6kV SF6/Vac CB F/B TSC	13	13	35	0	0	0	0	2
CV13	**27**	4.24.08	**7504**	Trip Test 11/6.6KV CB TSC	973	973	973	973	973	973	969	956
					5,430	**5,387**	**5,620**	**5,459**	**5,888**	**5,740**	**5,536**	**5,384**
CV13	**28**	4.08.21	**7411**	Maint FULL 11/6.6kV OCB at S/S	15	8	18	23	37	44	67	82
CV13	**28**	4.08.28	**7429**	Maint MECH 11/6.6kV OCB at S/S	77	72	101	106	32	25	26	29
CV13	**28**	4.08.32	**7441**	Maint Busbars (Inc VTs) at S/S	1	1	1	1	1	1	1	0
					93	**81**	**120**	**130**	**70**	**70**	**94**	**111**
CV13	**30**	1.19.04	**9408**	Replace EFPI	30	30	30	30	30	30	30	30
CV13	**30**	2.41.15	**9716**	Cyclocontrol I&M	208	208	208	208	208	208	208	193
CV13	**30**	4.08.03	**7379**	Maintain Non-Isolatable Oil Switch	14	14	14	14	14	14	14	12
CV13	**30**	4.08.06	**7383**	Maintain Non-Isolatable RMU (Oil)	1	1	1					
CV13	**30**	4.08.07	**7385**	Maintain Non-Isolatable RMU (Gas/Vacuum)	93	93	93	93	93	93	93	86
CV13	**30**	4.08.08	**7387**	Maintain Isolatable Oil Switch	13	13	13	13	13	13	13	12
CV13	**30**	4.08.09	**7389**	Maintain Isolatable Gas/Vacuum Switch	8							
CV13	**30**	4.08.11	**7392**	Maintain Isolatable RMU (Oil)	124	124	124	124	124	124	124	115
CV13	**30**	4.08.13	**7394**	Maintain HV Metering Unit	0	0	0	2				
					491	**483**	**483**	**484**	**482**	**482**	**482**	**448**
CV13	**31**	2.21.05	**9560**	Special Access Checks	4,082	4,082	4,082	4,082	4,082	4,082	4,082	3,791
CV13	**31**	2.25.06	**9313**	11kV Feeder Protection	246	246	246	246	246	246	246	246
CV13	**31**	2.25.13	**8269**	Trip Testing 11kV Sequence Closing	492	492	492	492	492	492	492	492
CV13	**31**	2.26.03	**6440**	Defect Repair - 11 Protection	4	4	4	4	4	4	4	4
CV13	**31**	2.28.05	**9579**	UKPN Primary Telecontrol Circuit Faults	73	73	73	73	73	73	73	73

CV13	**31**	2.28.07	**9581**	UKPN Primary Telecomms Cable Repairs	39	39	39	39	39	39	39	37
CV13	**31**	2.41.09	**9710**	RTU Fault Investigation	270	270	270	270	270	269	264	258
CV13	**31**	2.41.10	**9711**	Telecontrol Abnormality Investigation	111	111	111	111	111	111	111	111
					5,317	**5,317**	**5,317**	**5,317**	**5,317**	**5,316**	**5,311**	**5,012**
CV13	**32**	4.08.17	**7402**	Maintain Distribution Tx	1,009	1,009	1,009	1,009	1,009	1,009	1,009	985
CV13	**32**	4.08.22	**7414**	Oil Sample Dist Tx	1,145	1,145	1,145	1,145	1,145	1,145	1,145	1,065
					2,154	**2,154**	**2,154**	**2,154**	**2,154**	**2,154**	**2,154**	**2,050**
CV13	**42**	4.25.04	**7516**	Check Pressure (Oil/Gas)	48	48	48	48	48	48	48	48
CV13	**43**	2.08.01	**9522**	Defect Repair of 33/22kV Solid Cable - Locate and Repair	5	5	5	5	5	5	5	5
CV13	**43**	2.28.06	**9580**	Cable Maintenance (Tele) - Gas Cable Routine Attention	90	90	90	90	90	90	90	90
					95	**95**	**95**	**95**	**95**	**95**	**95**	**95**
CV13	**44**	2.15.39	**8539**	Inspect Earth Switch	1	1	1	1	1	1	1	
CV13	**44**	2.28.21	**9081**	Substation Security Weekly Data/COMs Checks	74	74	74	74	74	74	74	74
CV13	**44**	2.30.23	**8986**	Description: Water Quality Testing at Primary Substations	485	485	485	485	485	485	485	485
CV13	**44**	2.33.19	**8280**	Water Testing - Remedial Works	26	26	26	26	26	26	26	26
CV13	**44**	2.33.25	**8457**	Drainage Inspection & Maintenance	4	4	4	4	4	4	4	4
CV13	**44**	4.05.03	**7307**	Inspect Grid/Primary Site (Major)	215	215	215	215	215	215	215	215
CV13	**44**	4.05.49	**7319**	Insurance Insp. ABCB Complete Unit	31	31	31	31	31	31	31	31
CV13	**44**	4.05.57	**7331**	Inspect ESQC Grid/Primary Site High Risk	23	23	23	23	23	23	23	23
CV13	**44**	4.05.60	**6816**	Record EPR & Identification of Hot Sites	16	16	16	16	16	16	16	16
					875	**875**	**875**	**875**	**875**	**875**	**875**	**874**
CV13	**45**	2.28.11	**9891**	NT Security System - Fault Repair	288	288	288	288	288	288	288	288
CV13	**45**	2.28.19	**9892**	Substation Security Maintenance	123	123	123	123	123	123	123	123
CV13	**45**	2.32.04	**6452**	Maintain Primary Sites & Building - 33kV	78	78	78	78	78	78	78	78
CV13	**45**	2.32.12	**6457**	Maintain Fixed Fire Protection Equipment	122	122	122	122	122	122	122	121
CV13	**45**	2.32.15	**8687**	Tree Trimming (Primary Sites)	8	8	8	8	8	8	8	8
CV13	**45**	2.33.03	**8980**	Defect Repair - Primary Substation Civils	56	56	58	58	58	58	59	60
CV13	**45**	2.33.15	**8278**	Main Substation Fire Prot. System Defect Repair	20	20	20	20	20	20	20	20
CV13	**45**	2.33.17	**8279**	Pumping Out Flooded Substations	290	290	290	290	290	290	290	290
CV13	**45**	2.33.20	**8281**	Fire Risk Assessment - Remedial Work	29	29	28	29	29	29	29	29
CV13	**45**	2.33.22	**8983**	Electrical Wiring - Defect Repair at Primaries	315	318	320	324	327	331	334	337
CV13	**45**	4.24.10	**8696**	LPN 33 kV-Substation Repair & Maintenance (Civil Works)	12	12	12	12	12	12	12	12
					1,340	**1,343**	**1,346**	**1,351**	**1,354**	**1,358**	**1,362**	**1,365**
CV13	**46**	2.16.19	**9250**	33kV OCB Painting	1	1	1	1	1	1	1	1
CV13	**46**	2.17.01	**6408**	Defect Repair - 33/22 kV Switchgear	37	37	38	39	38	40	39	40
CV13	**46**	2.23.03	**6411**	Plant Forensic Testing and Failure Investigation	0	2	2	2	2	2	2	2
CV13	**46**	2.45.01	**6377**	Strategic Spares Provision	51	51	50	50	50	50	50	50
CV13	**46**	4.04.03	**7215**	Maintain 33/22kV Oil CB	16	22	32	28	32	8	7	8
CV13	**46**	4.04.05	**7221**	Maint FULL 33/22kV Vac/SF6 F/P & GIS CB	0	1	3	2	9	13	40	4

CV13	**46**	4.04.09	**7227**	Maintain Mechanism 33/22kV Oil CB	7	10	15	20	27	24	16	14
CV13	**46**	4.04.11	**7232**	Maint MECH 33/22kV Vac/SF6 F/P & GIS CB	2	0	0	0	0	0	0	0
CV13	**46**	4.04.12	**7235**	Trip Test 33/22kV CB Inc Op of Isolators	250	246	250	246	250	246	234	179
CV13	**46**	4.04.35	**7292**	Maint FULL 33/22kV Vac/SF6 W/D CB	0	0	0	2	9	1	0	0
CV13	**46**	4.04.36	**7295**	Maint MECH 33/22kV Vac/SF6 W/D CB	9	2	9	3	2	2	2	10
					364	**370**	**391**	**390**	**418**	**385**	**389**	**298**
CV13	**47**	2.25.04	**9309**	33kV Feeder Protection	26	26	26	26	26	26	26	26
CV13	**47**	2.25.05	**9310**	System Transformer Protection	15	15	15	15	15	15	15	15
CV13	**47**	2.25.12	**8268**	Trip Testing 33kV AR	52	52	52	52	52	52	52	52
CV13	**47**	2.26.01	**6412**	Defect Repair - EHV Protection	4	4	4	4	4	4	4	4
CV13	**47**	2.28.09	**9583**	PCM Fault Repair	12	12	11	11	10	9	8	7
CV13	**47**	2.28.10	**9584**	Optical Fibre Maintenance	12	12	12	12	12	12	12	12
					121	**121**	**120**	**120**	**119**	**118**	**117**	**116**
CV13	**48**	2.04.02	**8265**	Defect Repair - Primary Transformers/Tapchangers	98	99	100	101	102	103	104	105
CV13	**54**	4.21.02	**8698**	LPN 66KV Full Patrol Broad Based Tower	16	17	16	17	16	17	16	17
CV13	**54**	4.21.04	**8694**	LPN 66KV Safety Patrols Broad Based Towers	18	19	18	18	19	19	19	19
CV13	**54**	4.21.29	**8674**	LPN 66KV CORMON Testing	1	1	1	0	1	1	1	0
					34	**36**	**34**	**35**	**35**	**36**	**35**	**36**
CV13	**59**	4.24.10	**8711**	LPN 66 kV-Substation Repair & Maintenance (Civil Works)	11	12	11	12	11	12	11	12
CV13	**68**	4.21.02	**7444**	LPN 132KV Full Patrol Broad Based Tower	11	10	11	10	11	10	11	10
CV13	**68**	4.21.04	**7447**	LPN 132KV Safety Patrols Broad Based Towers	9	8	9	8	9	8	9	9
CV13	**68**	4.21.05	**7450**	Climbing Inspection Broad Based Tower	20	20	20	20	20	20	20	20
CV13	**68**	4.21.29	**7467**	LPN 132kV CORMON Testing	0	1	0	0	1	0	0	1
					40	**39**	**40**	**38**	**41**	**38**	**40**	**40**
CV13	**70**	2.05.09	**9516**	Gauges-132/33kV Inspect and Alarm Test	230	230	230	230	230	230	230	230
CV13	**70**	2.05.10	**9701**	Gas Cable - Cylinder Change	1,068	1,068	1,068	1,068	1,068	1,068	1,068	1,068
CV13	**70**	2.05.12	**6421**	Tank Inspection (Above Ground)	36	36	36	36	36	36	36	36
CV13	**70**	2.05.14	**9862**	Gauge Malfunction Investigation	2	2	2	2	2	2	2	2
CV13	**70**	2.30.15	**6447**	Cable Pit Inspection (LV)	7,973	7,973	7,973	7,973	7,973	7,973	3,363	3,363
CV13	**70**	2.34.07	**9601**	Abandoned/Unidentified Cable Location	25	25	25	25	25	25	25	25
CV13	**70**	4.25.05	**7519**	Test Cable Serving / Oversheath	5	5	5	5	5	5	5	5
CV13	**70**	4.25.06	**7522**	Test Sheath Voltage Limiters (SVLs)	5	5	5	5	5	5	5	5
					9,344	**9,344**	**9,344**	**9,344**	**9,344**	**9,344**	**4,734**	**4,734**
CV13	**71**	2.05.08	**9515**	Cable Pit Maintain	948	948	948	948	948	948	144	144
CV13	**71**	2.05.13	**9861**	Gas Cable - Dewar Top Up	240	240	240	240	240	240	240	240
CV13	**71**	2.06.01	**9517**	Oil Top Up; Pumping & Testing - 132-33kV	240	240	240	240	240	240	240	240
CV13	**71**	2.06.02	**9518**	Repair Oil Leak	41	41	41	41	41	41	41	41

CV13	**71**	2.06.03	**9519**	Defect Repair Gas	9	9	9	9	9	9	9	9
CV13	**71**	2.06.09	**8266**	Replace Minor Oil Plant + Sheath Testing	9	9	9	9	9	9	9	9
CV13	**71**	2.08.06	**9702**	Defect Repair of 132/66kV Solid Cable - Locate and Repair	2	2	2	2	2	2	2	2
					1,489	**1,489**	**1,489**	**1,489**	**1,489**	**1,489**	**685**	**685**
CV13	**72**	2.02.02	**9505**	Transformer Dryer - Inspect & Oil Sample	30	30	30	30	30	30	30	30
CV13	**72**	2.15.32	**9890**	Oil Busbar Level Check	3							
CV13	**72**	2.17.04	**6568**	Inspection and Testing of Lifting Equipment	3	3	3	3	3	3	3	3
CV13	**72**	2.25.07	**9314**	AVC checks at Grids & Primaries	38	38	38	38	38	38	38	38
CV13	**72**	2.30.10	**9893**	Mulsifyre Inspection & Testing	13	13	13	13	13	13	13	13
CV13	**72**	2.30.22	**6826**	PAT Testing at Grid & Primary Substations	10	10	10	10	10	10	10	9
CV13	**72**	2.30.23	**8260**	Water Quality Testing at Grid & Primary Substations	160	160	160	160	160	160	160	160
CV13	**72**	2.32.13	**6458**	Mulsifyre Systems Monthly Checks	31	31	31	31	31	31	31	31
CV13	**72**	2.34.03	**9064**	EMF Enquiries	24	24	24	24	24	24	24	24
CV13	**72**	2.34.08	**9693**	Noise Complaint Investigations by Operations	12	12	12	12	12	12	12	12
CV13	**72**	4.05.01	**7304**	Inspect Grid/Primary Site (Minor)	337	337	337	337	337	337	337	337
CV13	**72**	4.05.37	**7310**	Inspect Air Compressor	145	145	145	145	145	145	145	145
CV13	**72**	4.05.38	**7313**	Inspect Main Air Receiver	12	12	12	12	12	12	12	12
CV13	**72**	4.05.48	**7316**	Insurance Insp. Air/Gas Receiver	17	17	17	17	17	17	17	17
CV13	**72**	4.05.53	**7325**	Inspect Flexible Earths & Rods	356	356	356	356	356	356	356	356
CV13	**72**	4.05.54	**6990**	Inspect Grid & Primary Earths & T/Plugs	183	183	183	183	183	183	183	183
CV13	**72**	4.05.56	**7328**	Infra-Red Inspection Aerial Sets/Busbars	27	27	27	27	27	27	27	27
CV13	**72**	4.05.58	**7334**	Insurance Insp Switchgear Accumulator	12	12	12	12	12	12	12	12
					1,401	**1,398**	**1,398**	**1,398**	**1,398**	**1,398**	**1,398**	**1,397**
CV13	**73**	2.17.03	**6426**	Lifting Equipment Repairs at Main Substations	0	1	1	2	1	1	2	1
CV13	**73**	2.32.02	**8270**	Graffitti Removal (was Veg Clearance)	575	575	575	575	575	575	575	575
CV13	**73**	2.32.03	**6451**	Maintain Grid Sites & Building - 132kV	311	311	311	311	311	311	311	311
CV13	**73**	2.32.06	**8271**	Vegetation Clearance - 132kV	134	134	134	134	134	134	134	134
CV13	**73**	2.32.06	**8272**	Vegetation Clearance - 33kV	125	125	125	125	125	125	125	125
CV13	**73**	2.32.15	**8688**	Tree trimming (Grid Sites)	5	5	5	5	5	5	5	5
CV13	**73**	2.32.16	**6927**	Maintain Portable Fire Protection Equipment	960	960	960	960	960	960	960	720
CV13	**73**	2.33.03	**9592**	Defect Repair - Grid Substation Civils	56	56	59	58	58	58	60	60
CV13	**73**	2.33.06	**6459**	132 & 33kV Fly Tipping Site Clearance	6	6	6	6	6	6	6	6
CV13	**73**	2.33.21	**6831**	Portable Appliance Removal	0	0	0	0	0	0	0	0
CV13	**73**	2.33.22	**8282**	Electrical Wiring - Defect Repair at Grids	315	318	320	324	327	331	334	337
CV13	**73**	4.24.10	**6993**	Repairs Grid & Primary Earths & T/Plugs	10	9	10	9	10	9	10	9
					2,487	**2,491**	**2,496**	**2,500**	**2,502**	**2,506**	**2,512**	**2,274**
CV13	**74**	2.16.20	**6373**	132/66kV Plant Painting	2	2	2	2	2	2	2	2
CV13	**74**	2.16.23	**9773**	Maintenance of Bulk Oil Systems	2	2	2	2	2	2	2	2
CV13	**74**	2.17.02	**6409**	Defect Repair - 132/66 kV Switchgear	58	58	58	60	60	61	61	62
CV13	**74**	2.25.02	**9307**	132kV CB Feeder Inc BS	29	29	29	29	29	29	29	29
CV13	**74**	4.02.12	**7176**	Maintain CVT	44	44	44	44	44	44	44	44
CV13	**74**	4.02.21	**7198**	Oil Sample VT	5	5	5	5	5	5	5	5
CV13	**74**	4.02.23	**7201**	Oil Sample CT	8	8	8	8	8	8	8	8

CV13	**74**	4.04.13	**7238**	Maintain Full 132/66kV Air Blast CB	0	3	3	10	28	5	1	1
CV13	**74**	4.04.14	**7241**	Maint Full 132/66kV Oil CB	0	4	1	7	32	5	1	3
CV13	**74**	4.04.16	**7244**	Maint FULL 132/66kV SF6 O/D CB	6	16	5	6	2	6	21	8
CV13	**74**	4.04.20	**7250**	Maintain Mechanism 132/66kV Oil CB	1	1	1	2	2	3	3	5
CV13	**74**	4.04.22	**7253**	Maint MECH 132/66kV SF6 O/D CB	2	0	0	0	1	1	1	4
CV13	**74**	4.04.23	**7256**	Trip Test 132/66kV CB & Op of Ext Isolators	191	206	191	206	191	206	181	173
CV13	**74**	4.04.26	**7265**	Maintain Earth Switch	8	8	8	8	8	8	8	8
CV13	**74**	4.04.28	**7271**	Maintain Air Compressor	21	21	21	21	21	21	21	21
CV13	**74**	4.04.33	**7286**	Maintain Mech 132/66kV Air Blast CB	1	1	1	1	1	1	1	1
CV13	**74**	4.04.34	**7289**	Maintain Capacitors	1	1	1	1	1	1	1	1
CV13	**74**	4.04.37	**7298**	Maint FULL 132/66kV SF6 GIS CB	4	3	4	16	27	7	16	11
CV13	**74**	4.04.38	**7301**	Maint MECH 132/66kV SF6 GIS CB	0	0	0	1	0	0	0	1
					383	**412**	**384**	**429**	**464**	**415**	**406**	**389**
CV13	**75**	2.25.03	**9308**	Grid Transformer Protection	23	23	23	23	23	23	23	23
CV13	**75**	2.25.09	**9315**	Low Frequency - 132kV Injection Test	5	5	5	5	5	5	5	5
CV13	**75**	2.25.10	**9318**	132kV Buz Zone	35	35	35	35	35	35	35	35
CV13	**75**	2.25.11	**8267**	Trip Testing 132kV DAR	47	47	47	47	47	47	47	47
CV13	**75**	2.25.14	**9324**	Single Transformer Auto Changer Scheme Proving	2	2	2	2	2	2	2	2
CV13	**75**	2.25.15	**9736**	Pilots and Multicores Test Insulation and Continuity	107	107	107	107	107	107	107	107
CV13	**75**	4.02.11	**7173**	Maintain CT	45	45	45	45	45	45	45	45
					264	**264**	**264**	**264**	**264**	**264**	**264**	**264**
CV13	**76**	1.51.05	**6984**	Replace Silica Gel Breathers on Grid and System Transformers	85	85	85	85	85	85	85	85
CV13	**76**	2.02.03	**6405**	Transformer 132 & 33kV Oil Sample Retest	3	3	3	3	3	3	3	13
CV13	**76**	2.04.01	**8264**	Defect Repair - Grid Transformers/Tapchangers	184	188	188	192	192	196	196	200
CV13	**76**	4.02.01	**7148**	Maintain Power TX	37	52	60	87	60	64	60	50
CV13	**76**	4.02.02	**7151**	Oil Sample Power TX	321	325	321	334	320	322	321	334
CV13	**76**	4.02.03	**7154**	Maintain Auxiliary/Earthing Tx	7	13	14	28	27	22	14	14
CV13	**76**	4.02.05	**7157**	Maintain Neutral Earthing Reactor	3	10	5	11	15	11	11	11
CV13	**76**	4.02.06	**7160**	Maintain Neutral Earthing Resistor	5	6	4	6	8	5	3	2
CV13	**76**	4.02.13	**7179**	Oil Sample Selector	240	239	248	259	240	239	246	260
CV13	**76**	4.02.14	**7182**	Oil Sample NEX	20	21	15	19	20	21	15	18
CV13	**76**	4.02.17	**7186**	Maintain Tapchanger Single Tank	3	4	7	13	9	5	10	11
CV13	**76**	4.02.18	**7189**	Maintain Tapchanger Diverter	40	56	52	82	57	72	55	54
CV13	**76**	4.02.19	**7192**	Maintain Tapchanger Selector	19	25	13	26	24	26	29	25
CV13	**76**	4.02.20	**7195**	Maintain Tapchanger Vacutap	1	5	5	4	0	0	0	0
CV13	**76**	4.02.20	**8424**	Oil Sample Vacutap	4	7	6	4	4	5	3	3
CV13	**76**	4.02.24	**7204**	Oil Sample F/Breathing Barrier Bushings	5	5	5	5	5	5	5	5
CV13	**76**	4.02.26	**7209**	Maintain Series / Shunt Reactor	0	1	1	3	6	10	0	0
					977	**1,045**	**1,032**	**1,161**	**1,075**	**1,091**	**1,056**	**1,085**
CV13	**77**	4.04.02	**7212**	Maintain Batteries and Charger	36	36	36	36	36	36	36	36
CV13	**78**	2.30.14	**6445**	Cable Tunnel Inspections	13	13	13	13	13	13	13	13

CV13	**78**	2.30.16	**6448**	Council Subway Survey / Inspection	13	13	13	13	13	13	13	13
CV13	**78**	2.30.21	**8259**	Building, Tunnel and Bridge Survey	1	1	1	1	1	1	1	1
					27	**27**	**27**	**27**	**27**	**27**	**27**	**27**
CV13	**79**	2.30.24	**6840**	Cable Tunnel Discharge Consent	17	17	17	17	17	17	17	17
CV13	**79**	2.32.17	**8274**	Cable Tunnel Maintenance	240	240	240	240	240	240	240	240
CV13	**79**	2.33.09	**8277**	Tunnel Non Compliance Rectification Work	47	47	47	47	47	47	47	47
CV13	**79**	2.41.07	**8460**	Distributed Temperature Sensing Mtce	64	67	68	71	72	75	76	79
					368	**371**	**372**	**375**	**376**	**379**	**380**	**383**
CV13	**80**	2.30.13	**6442**	Cable Bridge Inspections - LPN	114	114	114	114	114	114	114	114
CV13	**81**	2.32.18	**8275**	Cable Bridge Maintenance - LPN	57	57	57	57	57	57	57	57
CV13	**81**	2.33.05	**9594**	Cable Bridge Repairs	12	12	12	12	12	12	12	12
					183	**183**	**183**	**183**	**183**	**183**	**183**	**183**

Table 45 – NAMP to ED1 Business Plan Data Table Reconciliation (CV13)
Source: 19th February 2014 Namp Table O/21st February 2014 ED1 Business Plan data Tables

Faults – CV15a

MappedRigsVolumeTable	MappedRigsVolumeRow	CurrentNampReference	ProjectID	ProjectName	2016	2017	2018	2019	2020	2021	2022	2023
CV15a	**6**	2.01.28	**9501**	Blown LV Fuses at Substations	2,801	2,829	2,857	2,886	2,915	2,944	2,973	3,004
CV15a	**7**	2.01.44	**8703**	HV Fault Restoration by Switching Only	335	335	335	335	335	335	335	335
CV15a	**8**	2.01.50	**8705**	EHV Fault Restoration by Switching Only	3	3	3	3	3	3	3	3
CV15a	**9**	2.01.51	**8706**	132kV Fault Restoration by Switching Only	3	3	3	3	3	3	3	3
CV15a	**15**	2.01.07	**9488**	LV Service Fault Repairs Underground	2,087	2,087	2,087	2,087	2,087	2,087	2,087	2,087
CV15a	**15**	3.01.15	**8577**	Services - LV Cable Damage	451	451	451	451	451	451	451	451
					2,538	**2,538**	**2,538**	**2,538**	**2,538**	**2,538**	**2,538**	**2,538**
CV15a	**17**	2.01.27	**9500**	LV U/G Cable Fault Repairs	1,362	1,362	1,362	1,362	1,362	1,362	1,362	1,362
CV15a	**17**	3.01.01	**9656**	LV Cable Damages	339	343	346	350	353	356	360	364
					1,701	**1,705**	**1,708**	**1,712**	**1,715**	**1,718**	**1,722**	**1,726**
CV15a	**18**	2.01.26	**8580**	LV Underground Cable Fault (Consac)	14	14	14	14	14	14	14	14
CV15a	**18**	3.01.03	**8590**	LV Cable Damage (Consac)	1	1	1	1	1	1	1	1
					15	**15**	**15**	**15**	**15**	**15**	**15**	**15**
CV15a	**20**	2.01.19	**9496**	Other Plant (LV Etc)	261	261	261	261	261	261	261	261
CV15a	**22**	2.01.24	**9498**	HV Cable Fault Repairs	311	311	311	311	311	311	310	310
CV15a	**22**	3.01.11	**8609**	HV Cable Damage	51	51	51	51	51	51	51	51
					362	**362**	**362**	**362**	**362**	**362**	**361**	**361**
CV15a	**27**	2.01.15	**6583**	HV Other Plant Faults	83	83	83	83	83	83	83	83
CV15a	**27**	2.01.46	**9997**	Network Sweeps	1,248	1,248	1,248	1,248	1,248	1,248	1,248	1,248
					1,331	**1,331**	**1,331**	**1,331**	**1,331**	**1,331**	**1,331**	**1,331**
CV15a	**29**	2.01.20	**8571**	EHV U/G Fault Pressurised	4	4	4	4	4	4	4	4
CV15a	**30**	2.01.21	**6584**	EHV U/G Fault Non Pressurised	16	16	16	16	16	16	16	16

CV15a	**32**	2.01.12	**9492**	EHV Plant Faults	8	8	8	8	8	8	8	8
CV15a	**34**	2.01.23	**8565**	132kV Cable Fault Pressurised	2	2	2	2	2	2	2	2
CV15a	**35**	2.01.22	**8568**	132kV Cable Fault Non Pressurised	3	3	3	3	3	3	3	3
CV15a	**37**	2.01.13	**8624**	132kV Plant Fault	11	11	11	11	11	11	11	11

Table 46 – NAMP to ED1 Business Plan Data Table Reconciliation (CV15a)
Source: 19th February 2014 Namp Table O/21st February 2014 ED1 Business Plan data Tables

Faults – CV15b

MappedRigsVolumeTable	MappedRigsVolumeRow	CurrentNampReference	ProjectID	ProjectName	2016	2017	2018	2019	2020	2021	2022	2023
CV15b	**6**	2.01.52	**8717**	Emergency Disconnections	699	699	699	699	699	699	699	699
CV15b	**7**	2.01.39	**9490**	Street Lighting Fault Replacement - Underground	2,165	2,173	2,179	2,184	2,184	2,184	2,184	2,184
CV15b	**7**	3.02.01	**9993**	St. Ltg. Discons / Recons / Knockdowns / Transfers	990	982	976	971	971	971	971	972
					3,155	**3,155**	**3,155**	**3,155**	**3,155**	**3,155**	**3,155**	**3,156**
CV15b	**8**	2.50.15	**9651**	Faulted Cut-Out Replacement (Customer-driven)	1,859	1,239	1,239	1,239	1,239	1,239	1,891	1,906
CV15b	**9**	2.01.96	**9034**	Cut Out Fuses Only	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516
					3,375	**2,755**	**2,755**	**2,755**	**2,755**	**2,755**	**3,407**	**3,422**
CV15b	**10**	2.01.29	**9502**	Flickering Supplies	1,809	1,809	1,809	1,809	1,809	1,809	1,809	1,809
CV15b	**10**	2.01.48	**6393**	High Earth Loop Impedance (HELI)	197	197	197	197	197	197	197	197
CV15b	**10**	2.41.14	**9715**	Investigation of Noise Complaints	3	3	3	3	3	3	3	3
					2,009	**2,009**	**2,009**	**2,009**	**2,009**	**2,009**	**2,009**	**2,009**
CV15b	**14**	3.05.01	**8719**	Abortive Call	6,234	4,676	3,117	1,559	390	390	390	390
CV15b	**15**	3.05.02	**8720**	Metering Fault	216	172	138	110	110	110	110	110
CV15b	**16**	2.01.42	**9896**	Responding to Critical Safety Calls	3,884	3,884	3,884	3,880	3,880	3,880	3,880	3,880
CV15b	**16**	2.01.47	**9998**	Alarms	688	684	684	684	684	684	686	720
CV15b	**16**	2.01.49	**8585**	Flooding Burst Water Main	243	244	244	244	244	244	238	220
					4,815	**4,812**	**4,812**	**4,808**	**4,808**	**4,808**	**4,804**	**4,820**

CV15b	**17**	2.01.14	**8961**	Pilot Cable Repairs	29	29	29	29	29	29	29	29

Table 47 – NAMP to ED1 Business Plan Data Table Reconciliation (CV15b)
Source: 19th February 2014 Namp Table O/21st February 2014 ED1 Business Plan data Tables

Appendix 10 Material changes since the July 2013 ED1 submission

Asset type	Change type	2013	2014	Difference (Reduction)
I&M (CV13)	Volume	1,166,765	1,206,322	39,557
	Investment (£m)	141.51	123.0	(18.51)
	UCI (£k)	0.12	0.10	(0.02)
Faults (CV15a)	Volume	75,711	76,058	347
	Investment (£m)	138.31	138.31	0
	UCI (£k)	1.83	1.82	(0.01)
Faults (CV15b)	Volume	144,605	127,825	(16,780)
	Investment (£m)	48.87	44.29	(4.59)
	UCI (£k)	0.34	0.35	0.01

*Table **48 - Material Changes in ED1 Business Plan for LPN** (Source: ED1 Business Plan Data Tables following the Ofgem questions and answer process and the 21st February 2014 ED1 Business Plan Data Tables)*

Table *49* provides the differences between the 2013 and 2014 business plan submission for CV13, CV15a and CV15b. The changes were mostly due to mapping and volume corrections.

Some of the key changes made in the revised plans are:

- Correction of units of measure for cable tunnel inspections (from tunnel lengths to number of tunnels)
- Remapping of some substation inspection activities across different voltages
- Pumping out flooded substations – Volumes and unit costs reduced to reflect actual costs
- Vegetation clearance at HV substations – Unit costs reduced
- Forensic testing at 33kV locations – Volumes reduced