Document 14
Asset Category – I&M and Faults
SPN

Asset Stewardship Report 2014

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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 14.0 removed (Trees)	Asha Kiribalasingham	Minor Minor Minor Minor Minor	
1.2	03/03/2014	Updated Appendix 8	Asha Kiribalasingham	Minor	Appendix 8
1.3	04/03/2014	Update to Appendix 10	Chino Atako	Minor	Appendix 10
1.4	05/03/2014	Update to Appendix 10	Chino Atako	Minor	Appendix 10
1.5	07/03/2014	Updated ED1 summary table and Faults graph	Ade Olatunji	Minor	Section 1.4 and Appendices 5 &9

1.6	08/03/2014	Final Update	Chino Atako	NA	NA

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 1.2 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 SPN region of UK Power Networks. It also examines fault rates on these asset types (excluding third party damages), and the effects of trees on the network. Exceptional events have not been excluded from the analysis.

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 cost in SPN in ED1 is £77m and is equivalent to 0.08% of the MEAV per annum.

The faults cost in SPN in ED1 are £191m and is equivalent to 0.19% 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 Section 7.2.

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;

Overhead Lines: Expenditure on HV and LV overhead line faults and inspection and maintenance activities is expected to reduce during the ED1 period because of planned improvements and efficiencies in the management, control and scope of tree-cutting and surveys, the replacement of small section conductors and the replacement of bare LV overhead conductors with aerial bundled conductors (ABC).

Cables: For LV cables, including 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 12% from 2016/2017 pro-rata across the period.

In summary the UKPN ED1 proposals for the SPN 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
- An enhanced programme of 132kV and 33kV tower painting is proposed,
- HV and LV overhead fault volumes are anticipated to decrease by 1% per annum due to undergrounding, and installation of ABC,
- LV underground cable, service and street lighting 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 SPN in ED1 is £267.7m. This comprises of £26.7m of Civils and £4.5m 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 SPN region of UK Power Networks. It also examines fault rates on these asset types (excluding third party damages), and the effects of trees on the network. 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	37.6	36.0	35.1	37.2	26.5	24.6	24.1	23.9	23.7	23.5	23.4	23.8	24.0	172.5	191.0
Inspection	2.2	2.8	2.9	5.6	4.5	3	3.1	3.1	3.1	3.1	3.1	3.1	3.1	18.1	24.9
Maintenance	7.5	8.5	8	5.6	6.5	6.5	6.5	6.6	6.4	6.3	6.5	6.6	6.4	36.2	51.8
I&M	9.7	11.3	11	11.2	11	9.5	9.6	9.7	9.6	9.5	9.6	9.7	9.5	54.3	76.7
Total	47.3	47.3	46.1	48.4	37.5	34.1	33.7	33.6	33.3	33.0	33.0	33.5	33.5	226.8	267.7

Table 1 - I&M and Faults (All costs)

Sources:
Faults – CV15a and CV15b, 2014 ED1 Business Plan Submission
I&M – CV13 2014 ED1 Business Plan Submission

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	37.6	36.0	35.1	37.2	26.5	24.6	24.1	23.9	23.7	23.5	23.4	23.8	24.0	172.5	191.0
Inspection	2.2	2.8	2.9	5.6	4.4	2.9	3	3	3	3	3	3	3	17.9	24.1
Maintenance	4.4	5.1	5.3	2.2	2.5	2.7	2.7	2.7	2.6	2.5	2.7	2.8	2.8	19.5	21.4
I&M	6.6	7.9	8.2	7.8	6.9	5.6	5.7	5.7	5.6	5.5	5.7	5.8	5.8	37.4	45.5
Total	44.2	43.9	43.3	45.0	33.4	30.2	29.8	29.6	29.3	29.0	29.1	29.6	29.8	209.9	236.5

Table 2 - I&M and Faults (Excluding Civils and Protection)

Sources: I&M – CV13 2014 ED1 Business Plan Submission
Faults – CV15a and CV15b, 2014 ED1 Business Plan Submission

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 (refer to section 2.8);
- The use of PFT to assist in fault location of fluid filled cables (refer to section 4.8).

Inspection and Maintenance innovations include:

- Use of a micro-bore pressure sensing device to assess wood pole strength (refer to section 3.8);
- Increased use of (remote) change of state operations to check mechanism operations and hence reduce routine inspections (refer to sections 3.8, 4.16, 5.8 and 6.8);
- Continuous (fixed) partial discharge monitoring (refer to section 4.8);
- Tailoring post fault maintenance to the cumulative fault current rather than number of operations (refer to section 6.8);
- Tailoring diverter maintenance to the specific transformer and tap changer types (refer to section 9.8).

1.6 Risks and Opportunities

The risks and opportunities associated with the investment proposals presented in this document are shown in table 3

	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 p.a. (estimate) over 5 year Smart Metering project period
Risk	Type failures of plant leading to modification programmes	+£40k per occasion
Risk	Increasing number of exceptional events	+£100k per event

Table 3 – Risk and Opportunities

2.0 Towers (Broad Based) and Conductors

2.1 Asset Information

There are a total of 3,150 towers operating at 132kV and 33kV, as detailed in table 4.

Voltage	No of Towers	Conductor Length (km)
132kV	2,575	1,151
EHV (33kV)	575	83

Table 4 - Tower Asset Information, Data source: Table V1, RIGS 2013

2.2 Summary of Fault Trends, Failure Modes and Fault Rates

132kV – The small number of faults at 132kV makes it difficult to reliably identify long-term trends. Figure 1 covers both steel tower and wood pole lines, although the majority of circuits are on the former. Although the trend over the past five years shows volumes increasing, a steady state position is forecast after 2013/14 for the reasons described below (refer to “Faults Plan”). The 2013/14 volumes baseline has been set using the average over the past five years (2007/8 through to 2011/12).

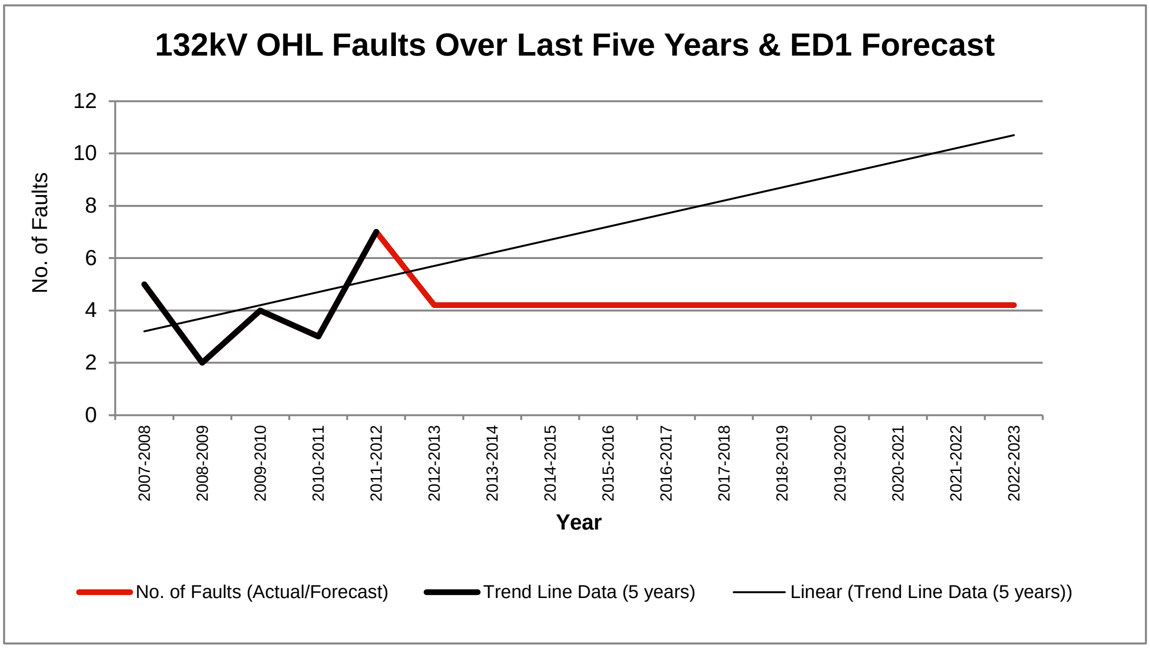


Figure 1 - 132kV overhead Tower Lines Fault Trends (Data Source: IIS and UKPN Fault Cube)

EHV – The small number of faults in this category makes it difficult to reliably identify long-term trends. Figure 2 below covers both steel tower and wood pole lines, although the majority of circuits are on the latter.

It has been assumed that EHV on steel towers follows the same fault profile as 132kV circuits with no change over the ED1 period.

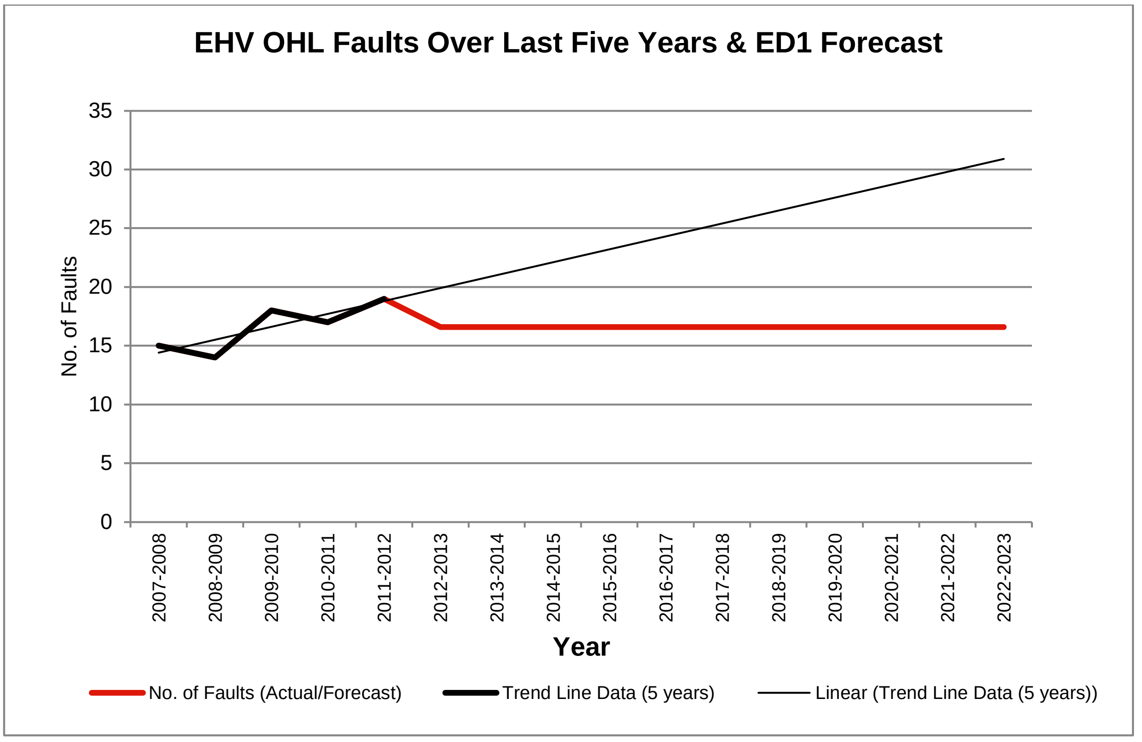


Figure 2 - EHV overhead Tower Lines Fault Trends (Data Source: IIS and UKPN Fault Cube)

2.3 Faults Plan

Due to the low number of faults, it is difficult to predict future fault frequency with a high degree of statistical confidence and trend lines are highly sensitive to minor fluctuations. With the start point from 2013/14 set as the average over the past five years (2007/8 through to 2011/12), the volumes over ED1 are expected to remain fairly steady. This is due to an ongoing conductor condition-assessment programme which informs the conductor replacement programme (capex).

The presence on the network of steel-core conductors, which are known to deteriorate, could affect the small volumes on a year-to-year basis. An example of this occurred in Folkestone (refer to Figure 3) where a single span of 132kV conductor failed unexpectedly on one phase due to corrosion within the aluminium/steel core of the conductor.

Figure 3 – Failed single phase span of 132kV conductor

As outlined in the I&M Interventions section 2.5, cormon testing is undertaken to minimise risk of these types of failures.

EMS 10-0002 – Inspection and Maintenance Frequency Schedule outlines the policies that at 132kV, fault patrols are carried out on an ad hoc basis where a circuit has tripped because of an unknown cause. At EHV (33kV), this is required after three successful auto-reclose sequences within a 31-day period.

Volumes for EHV OHL tower fault repairs are not included in the data for 132kV OHL fault repairs (Table 5) which covers all 132kV OHL faults. All EHV OHL faults (including towers) are covered under the Wood Poles and Conductors section.

Table 5, Table 6 and Figure 4 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
132kV OHL fault repairs	CV15a Line 36	4	3	7	4	4	4	4	4	4	4	4	4	4	4
132kV Fault Restoration by Switching Only (OH)	CV15a Lines 9	5	6	9	6	22	18	4	4	4	4	4	4	4	4
Total 132kV OHL Faults		**9**	**9**	**16**	**10**	**26**	**22**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**

Table 5 - DCPR4, DPCR5 & ED1 History/Forecast – Towers and Conductors 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.

ED2 Volumes	2022 /2023	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2030 /2031
Total 132kV OHL Fault	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**

Table 6 – ED2 Forecast – Towers and Conductors Faults

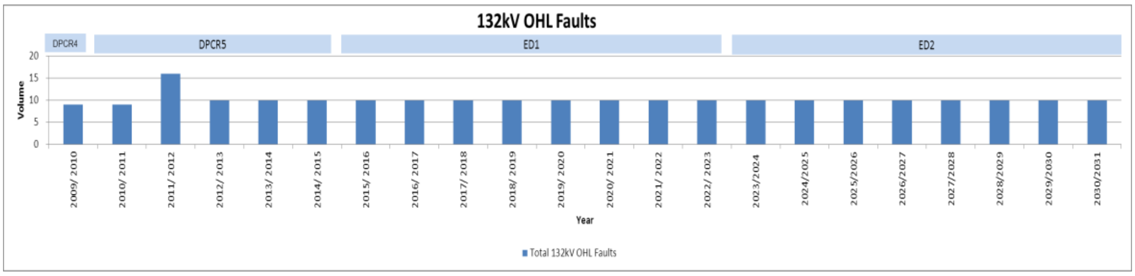


Figure 4 - DPCR4, DPCR5, ED1 & ED2 Historical and Forecast Values

There is an average of four faults at 132kV per year – or approximately 0.35 per 100km.

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 132/33kV 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 33kV steel-core 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 Schedule. At 132kV and 33kV, a physical inspection of fittings and supports is undertaken after 20 years of conductor life.

Tower painting has been carried out on a reactive basis over the last and current review periods to date. A planned, enhanced programme of pro-active tower painting is currently being implemented to maintain asset life and reduce the need for larger scale capex interventions (tower refurbishments) throughout ED1 and ED2.

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 rate and failure mode statistics have not highlighted a need for changes in policy in the ED1 period. Apart from the enhanced tower painting programme the plan reflects consistent I&M interventions in line with the above policies. The increase in steel tower painting is in response to recent condition assessments and is designed to manage the rate of degradation of the equipment where it is identified as an issue.

DPCR5 & ED1 Forecast I&M Towers and Conductors are given in table 7, table 8 and figure 5.

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	1,216	1,248	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288
132kV Safety Patrol Broad Based Tower	1,326	1,224	572	572	572	572	572	572	572	572
132kV Infra Red Patrol Route	340	326	326	326	326	326	326	326	326	326
132kV Cormon Testing	23	23	23	23	23	23	23	23	23	23
Climbing Inspection Broad Based Tower	41	100	100	100	100	100	100	100	100	100
132kV Inspection Total	**2,946**	**2,921**	**2,309**	**2,309**	**2,309**	**2,309**	**2,309**	**2,309**	**2,309**	**2,309**
33kV Full Patrol Broad Based Tower	304	313	288	288	288	288	288	288	288	288
33kV Safety Patrol Broad Based Tower	100	113	42	42	42	42	42	42	42	42
33kV Infra Red Tower Route	28	27	25	25	25	25	25	25	25	25
33kV Cormon Testing	2	2	2	2	2	2	2	2	2	2
Spacer Checks Twin Bundles	1	3	3	3	3	3	3	3	3	3
EHV Inspection Total	**435**	**458**	**360**	**360**	**360**	**360**	**360**	**360**	**360**	**360**
132kV / 66kV Tower Painting	35	65	87	98	130	130	130	130	130	130
Maintenance Total	**35**	**65**	**87**	**98**	**130**	**130**	**130**	**130**	**130**	**130**
Includes RIGs Lines: CV13 Lines 39, 40, 41, 53, 54, 55, 67, 68, 69										

Table 7 - 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 Inspection	**3,299**	**3,299**	**3,299**	**3,299**	**3,299**	**3,299**	**3,299**	**3,299**
EHV Inspection	**474**	**474**	**474**	**474**	**474**	**474**	**474**	**474**
132kV/EHV Maintenance	**121**	**125**	**128**	**128**	**128**	**127**	**127**	**127**

Table 8 – ED2 Forecast – I&M Towers and Conductors

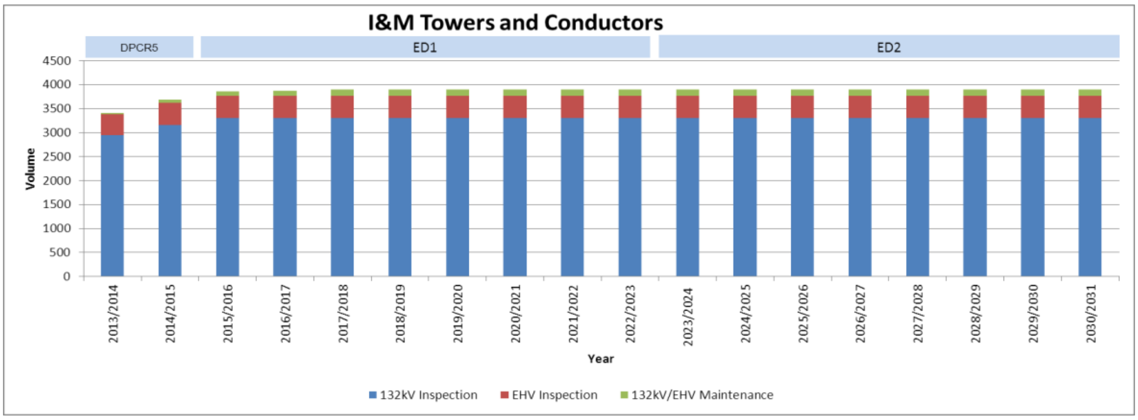


Figure 5 – DPCR5, ED1 & ED2 Historical and Forecast Values

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 6 below), through high-resolution photography, are being investigated with the use of locally controlled drones (Figure 7). 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 6 – Condition of conductor and fitting

Figure 7 – Example of Locally Controlled Drone

3.0 Wood Poles and Conductors

3.1 Asset Information

Although the reference throughout this section is to wood poles, it also includes narrow-based towers, columns and concrete structures.

This section also includes ancillary equipment, such as air break switch disconnectors (ABSD), auto-reclosers, surge arresters, fusegear and pole transformers.

A summary of the asset count is given in table 9 below.

Voltage	No of Poles	Conductor Length (km)
132kV	107	10
EHV (33kV)	11,751	1,134.29
HV (2-11kV)	68,023	5,555.63
LV	126,344	4,551.56

Table 9 - Pole and Conductor Asset Information (Data source: RIGS 2013)

3.2 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 10 below

Voltage	Faults Per Annum	Faults Per 100 Kilometre
132kV	See “Towers”	-*
EHV (33kV)	17	1.5
HV (2-11kV)	642	11.4
LV	844	18.6
Services	813	N/A

Table 10 – Fault Rates Data Source: IIS and UKPN Fault Cube

*132kV – There have been no recorded faults for this very small population of assets (on wood poles) in the reporting period, and hence no data or graph is shown. The majority of OHL faults at 132kV are on tower lines and included in the “Towers” section above.

EHV (33kV) – The relatively low number of these faults makes it difficult to reliably identify long-term trends which are consequently very sensitive to minor variations. The graph below covers both steel tower and wood pole lines, although the majority of circuits are on the latter. The same graph has been included in the “Towers” section for reference.

Although the five-year trend shows volumes increasing, a steady state position is forecast from 2013/14 onwards. The 2013/14 baseline has been calculated using the average over the past five years (2007/8 through to 2011/12). This is illustrated in figure 8.

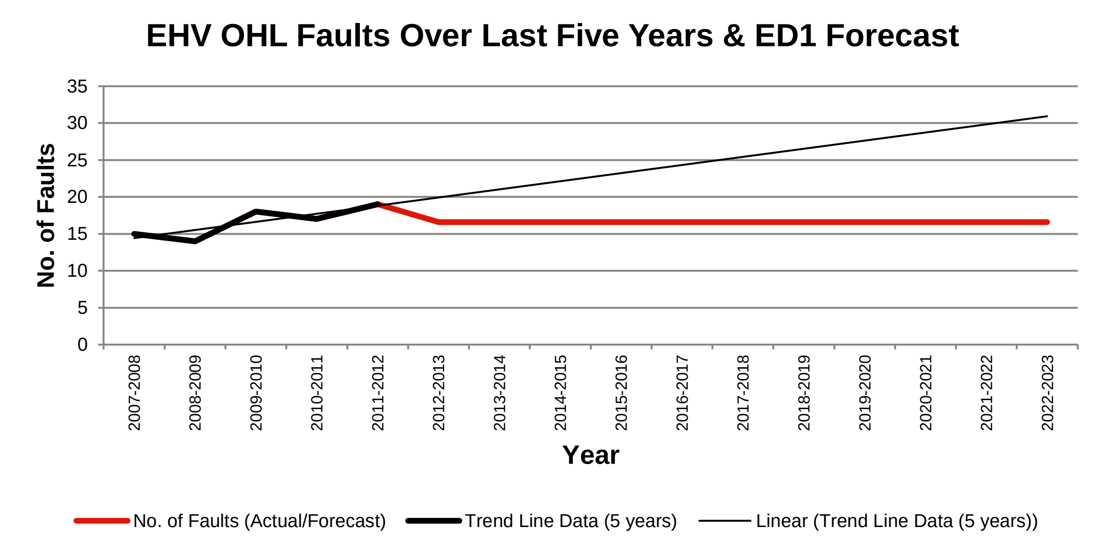


Figure 8 - Data Source: IIS and UKPN Fault Cube

HV (2-11kV) – The fault trend is variable year on year, dependent mainly on weather conditions. The past five years show a downward trend that is consistent with the forecast of a 1% reduction per year, starting from a 2013/14 baseline. This is illustrated in figure 9.

The 2013/14 baseline has been set using the average over the past five years (2007/8 through to 2011/12). This reflects the capex investment in previous years for the replacement of small section conductors and refurbishment of overhead line feeders.

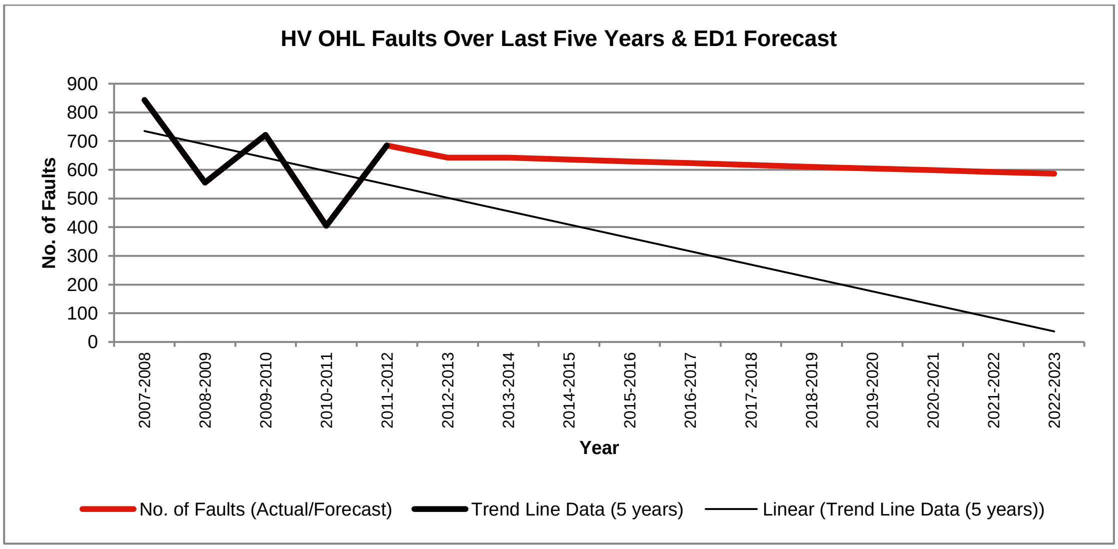


Figure 9 - Data Source: IIS and UKPN Fault Cube

LV – Although the fault trend over the past five years shows that the volumes are decreasing steeply, the underlying long-term trend is expected to stabilise. A reducing trend of 1% per year is forecast from 2013/14, at which volumes have been set using the average over the past five years (2007/8 through to 2011/12). This is illustrated in figure 10. This reflects the change in policy with regard to the targeted investment in and installation of aerial bundled conductors (ABC) in tree-infested spans associated with climbable trees. ABC is effectively insulated LV conductor that removes the risk to the public from inadvertent contact, and improves fault performance due to interference from trees.

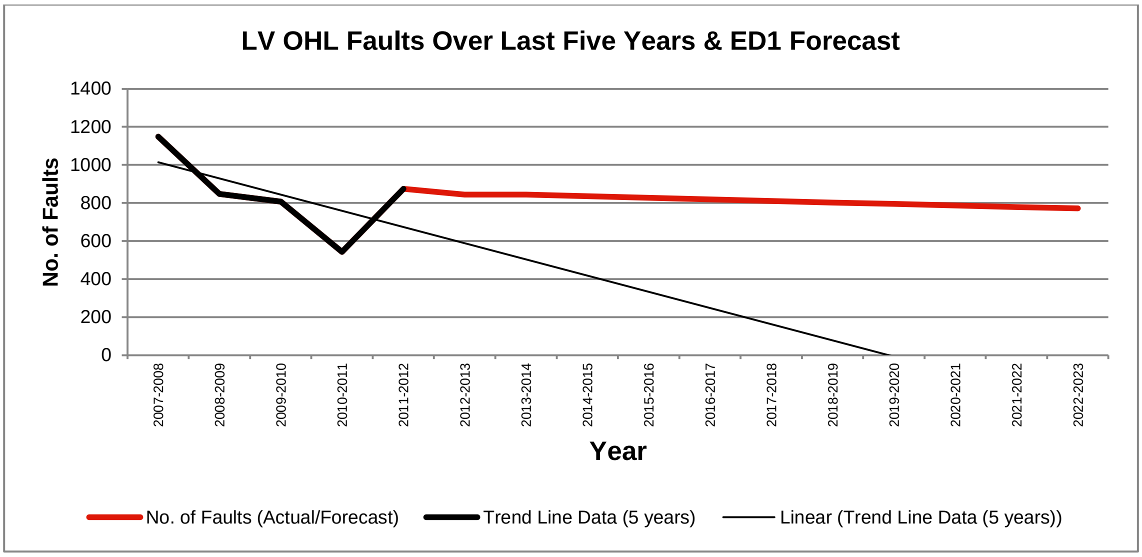


Figure 10 - Data Source: IIS and UKPN Fault Cube

Services – LV overhead service fault rates have increased over the past five years, but the underlying trend is expected to remain constant. 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 across the period. See figure 11.

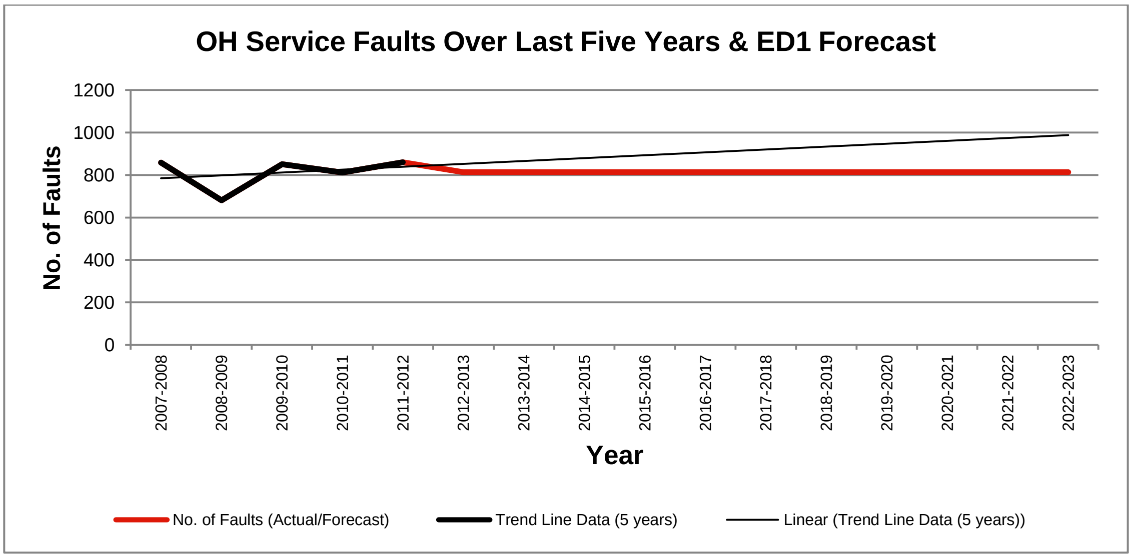


Figure 11 - Data Source: IIS and UKPN Fault Cube

3.3 Faults Plan

In all categories, the volumes in 2013/14 have been set using the average of the past five years (2007/8 through to 2011/12).

For HV and LV mains overhead line faults, the forecast is for the volumes to decrease in line with the effect of associated capex initiatives outlined above, and for a gradually decreasing network length where overhead spans have been replaced by underground cable lengths.

LV services are forecast to be consistent across the period as proposals for the replacement of services are increased where temporary shrouding would have been applied previously, and service replacements associated with ABC installations are completed. The latter is a programme to clear ESQCR clearance defects due to climbable trees, etc, and with these increased (ABC) replacements, the rising trend shown on the graph will be balanced out.

At 132kV, fault patrols are carried out on an ad hoc basis where a circuit has tripped because of an unknown cause. At 2-11kV and 33kV, this is after three successful auto-reclose sequences within a 31-day period.

Table 11, Table 12 and figure 12 show the volume profiles in ED1 and ED2.

Table 11 – DPCR4, DPCR5 & ED1 History/Forecast – Wood Poles and Conductors Faults

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
33kV OHL fault repairs	CV15a Line 31	18	19	23	16	16	17	17	17	17	17	17	17	17	17
EHV supply restoration, including fault location OHL	CV15a Lines 8	32	38	48	38	37	37	13	13	13	13	13	13	13	13
Total EHV OHL Faults		**50**	**57**	**71**	**54**	**53**	**54**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
11kV OHL fault repairs	CV15a Line 23	512	406	663	615	615	610	605	598	591	586	580	574	568	564
HV supply restoration, including fault location OHL	CV15a Lines 7	1,269	758	1,604	768			439	439	439	439	439	439	439	439
Replacement of damaged PMT	CV15a Line 26	87	24	74	125	125	104	40	40	40	40	40	40	40	40
11kV Pole mounted Switchgear (NOT Circuit Breaker) Fault	CV15a Line 25	153	15	1	26	26	26	26	26	26	26	26	26	26	26
11kV Pole Mounted Switchgear (Circuit Breaker) Fault	CV15a Line 24	0	0	0	3	3	3	3	3	3	3	3	3	3	3
Total HV OHL Faults		**2,021**	**1,203**	**2,341**	**1,537**			**1113**	**1106**	**1099**	**1094**	**1088**	**1082**	**1076**	**1072**
LV OHL fault repairs	CV15a Line 19	850	640	770	844	844	836	828	819	811	803	795	787	779	771
Service fault repairs overhead	CV15a Line 14	904	911	943	813	813	813	813	813	813	813	813	813	813	813
Street lighting fault replacement – overhead	CV15b Line 7	All volumes included in UG Services				248	248	248	248	248	248	248	248	248	248
Flickering supplies	CV15b Line 10	1,918	2,011	3,186	3,970	3,970	3,970	3,970	3,970	3,970	3,970	3,970	3,970	3,970	3,970
Total LV OHL Faults		**3,672**	**3,562**	**4,899**	**5,627**	**5,875**	**5,867**	**5,859**	**5,850**	**5,842**	**5,834**	**5,826**	**5,818**	**5,810**	**5,802**

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.
Note 1: Flickering supplies are also applicable to cables, but the majority of activity is in this (Wood Poles and Conductors) category.

Table 12 – ED2 Forecast – Wood Poles and Conductors Faults

ED2 Volumes	2022 /2023	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2030 /2031	2031/20 32
Total EHV OHL Faults	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
Total HV OHL Faults	**1,066**	**1,061**	**1,055**	**1,050**	**1,044**	**1,039**	**1,034**	**1,028**	**1,023**
Total LV OHL Faults	**5,794**	**5,787**	**5,779**	**5,772**	**5,764**	**5,757**	**5,750**	**5,742**	**5,735**

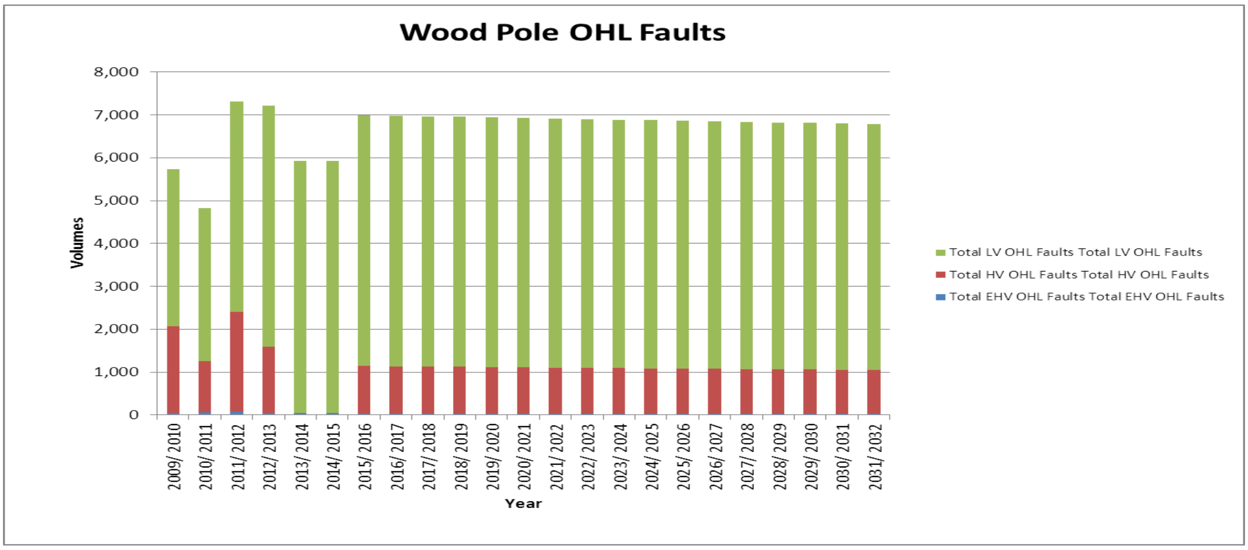


Figure 12 – DPCR4, DPCR5, ED1 & ED2 Historical and Forecast Values

3.4 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.

Functional performance of air-break switched disconnectors (ABSDs) is important for restoring customers' supplies following an unplanned interruption.

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.

3.5 I&M Interventions

In accordance with the I&M policy, 132kV inspections are carried out every year, alternating between a safety and full inspection. 2-11kV and 33kV and LV have a safety inspection every four years, with the third safety inspection being replaced with a full inspection (i.e. every 12 years). Associated equipment is also inspected during inspections. Inspections of high-risk 132kV sites will be more frequent as required. For sites below 132kV, the frequency will be every two years, or more frequent as required. 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 4.0, and may typically be 33kV/HV Plant without an anti-climbing device (ACD) situated on arable land or a golf course (low or medium risk location), or low/medium risk equipment (e.g. LV pole insulated/bare) at a high risk location (e.g. recreational areas or camping areas).

The condition of a wood pole is assessed at the full inspection with a hammer test. Where the pole fails this test, it has traditionally been re-tested using an auger decay, or pole ultrasound rot locator ("PURL") assessment, although a new methodology is being implemented as described in the innovation section. Following this supplementary test, the actual residual strength is assessed and the pole declared suspect ("S") or decayed ("D"). S poles are then monitored at four-year intervals, and D poles entered in the change programme. To improve data quality, a separate re-testing regime has been implemented to provide detailed information on the extent of the decay prior to a pole change.

Tower footings are inspected on a random basis once they are 40 years old, and then at 40-year intervals.

At 132kV, a physical inspection of fittings and supports is undertaken after 20 years of conductor life.

2-11kV and 33kV ABSDs were previously maintained on a 12-year cycle, but a revised operation and reactive maintenance regime, as detailed in the innovation section, is to be implemented over the ED1 period.

All ancillary equipment is inspected as part of the line inspection and is subject to a visual inspection only.

3.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the timescales for interventions. Inspection of overhead line 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.

3.7 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. It should be noted that increased volumes in 2013/14 is due to a backlog in overhead line inspections that is being resourced to be cleared by the end of 2014. The drive to clear defects through a dedicated programme will afford a reduction in these activities through ED1.

Table 13, Table 14 and figure 13 show the volume profiles in ED1 and ED2.

Table 13 - DPCR5 & ED1 Forecast – I&M Wood Poles and Conductors

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 Wood Pole/Lattice	75	116	52	52	52	52	52	52	52	52
132kV Safety Patrol Wood Pole/Lattice	26	23	52	5	5	5	5	5	5	5
132kV Inspection Total	**101**	**139**	**104**	**57**	**57**	**57**	**57**	**57**	**57**	**57**
33kV Full Patrol Wood Pole/Lattice	1,064	1,433	848	848	848	848	848	848	848	848
33kV Safety Patrol Wood Pole/Lattice	2,759	1,991	316	316	316	316	316	316	316	316
EHV Inspection Total	**4,025**	**3,702**	**1,372**	**1,278**	**1,278**	**1,278**	**1,278**	**1,278**	**1,278**	**1,278**
Follow Up - 33kV	43	44	45	45	45	46	46	48	48	48
Maintain ABSD 33kV	31	3	3	3	3	3	3	3	3	3
S poles - 33kV Structural Test after hammer test	45	34	51	51	51	51	51	51	51	51
EHV Maintenance Total	**119**	**81**	**99**	**99**	**99**	**100**	**100**	**102**	**102**	**102**
Includes RIGs Lines: CV13 Lines 36, 37, 38, 50, 51, 52, 64, 65, 66										
Full Patrol Wood Pole/Lattice HV	6,461	8,789	5,490	5,490	5,490	5,490	5,490	5,490	5,490	5,490
Safety Patrol Wood Pole/Lattice HV	15,983	11,359	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
ESQC Inspection Wood Pole/Lattice HV	6457	5,548	5,545	5,545	5,545	5,545	5,545	5,545	5,545	5,545
HV Inspection Total	**28,901**	**25,696**	**12,185**	**12,185**	**12,185**	**12,185**	**12,185**	**12,185**	**12,185**	**12,185**
Follow Up - 11kV	96	96	97	98	100	100	101	102	104	104
Maintain ABSD 11kV	63	28	4	4	4	4	4	4	4	4
S poles - 11kV Structural Test after hammer test	3,367	477	152	152	152	152	152	152	152	152
HV Maintenance Total	**3,526**	**601**	**253**	**254**	**256**	**256**	**257**	**258**	**260**	**260**
Includes RIGs Lines: CV13 Lines 18, 19, 20, 34, 35										
Full Patrol Wood Pole/Lattice LV	11,495	10,133	8,735	8,735	8,735	8,735	8,735	8,735	8,735	8,735
Safety Patrol Wood Pole/Lattice LV	34,619	29,385	22,437	22,437	22,437	22,437	22,437	22,437	22,437	22,437
LV Inspection Total	**46,114**	**39,518**	**31,172**	**31,172**	**31,172**	**31,172**	**31,172**	**31,172**	**31,172**	**31,172**
Follow Up - LV	191	192	195	196	200	200	204	204	208	208
Shrouding for LV mains and Services	935	800	800	800	800	800	800	800	800	800
S poles - LV Structural Test after hammer test	411	419	477	477	477	477	477	477	477	477
LV Maintenance Total	**1,537**	**1,411**	**1,472**	**1,473**	**1,477**	**1,477**	**1,481**	**1,481**	**1,485**	**1,485**
Includes RIGs Lines: CV13 Lines 7, 8, 9										
GS6 enquiries (Volume) Note1	2,372	2,318	2,294	2,294	2,294	2,294	2,294	2,294	2,294	2,294
Included in other RIGs Lines										

Note 1: GS6 enquiries also pertain to steel tower lines, but are mostly received for LV and HV lines.

Data Source: NAMP of 19/02/2014

Table 14 – ED2 Forecast – I&M Wood Poles and Conductors

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
132kV Inspection	**139**	**139**	**139**	**139**	**139**	**139**	**139**	**139**
EHV Inspection	**4,177**	**4,177**	**4,177**	**4,177**	**4,177**	**4,177**	**4,177**	**4,177**

EHV Maintenance	**100**	**101**	**101**	**101**	**101**	**101**	**101**	**101**
HV Inspection	**30,196**	**30,196**	**30,196**	**30,196**	**30,196**	**30,196**	**30,196**	**30,196**
HV Maintenance	**257**	**257**	**258**	**258**	**258**	**258**	**258**	**258**
LV Inspection	**27,936**	**26,636**	**26,659**	**26,685**	**26,714**	**26,748**	**26,785**	**26,827**
LV Maintenance	**1,479**	**1,480**	**1,481**	**1,481**	**1,482**	**1,482**	**1,482**	**1,481**

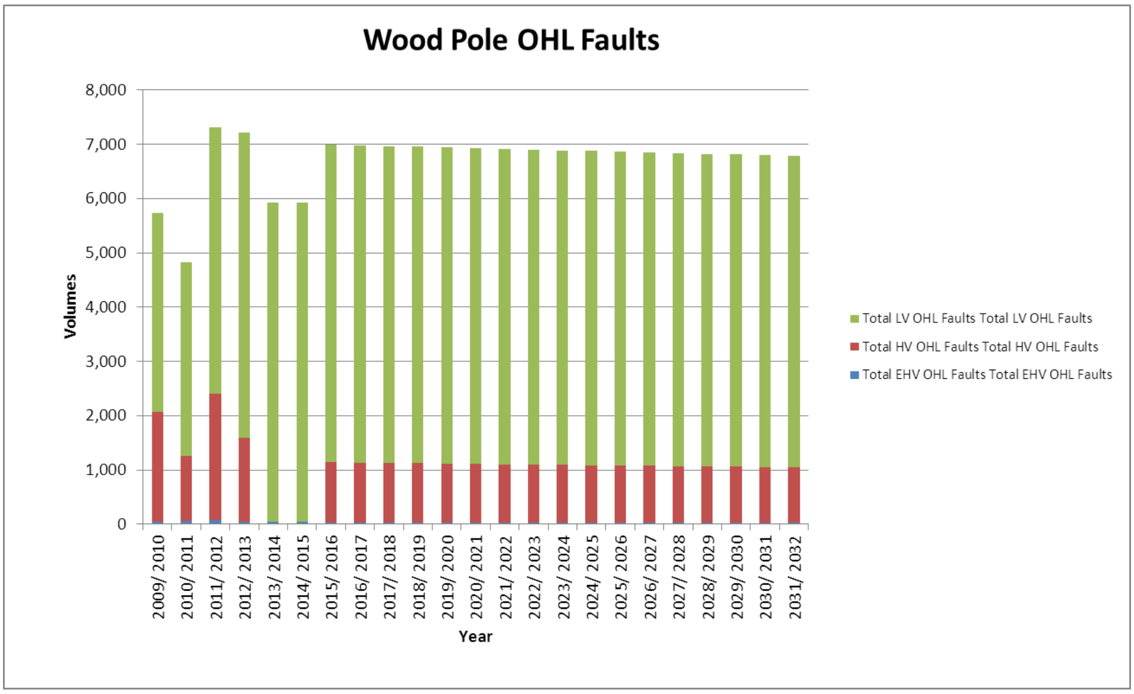


Figure 13 – DPCR5, ED1 & ED2 Historical and Forecast Values

3.8 Innovation

All aspects of the I&M programme are subject to continuous improvement. Safety inspections of 11kV wood poles are currently under review, with the possibility of being combined with tree-cutting inspections. The former are every four years, while the latter are every three years, but despite the increased frequency, cost savings are believed to be achievable. Thus this change would improve the frequency of safety patrols while saving overall costs. This initiative is still at the trial stage. The comparative costs are shown in table 15.

Table 15 – Inspection Costs

	Patrol cost per pole	**No of safety patrols per 12 year cycle**	**Cost per pole per cycle – safety patrols**

Current cycle	£10	2	£20
Proposed cycle	£5	3	£15

The two traditional methods of assessing wood pole residual strength – auger decay measurement assessment and PURL – are being superseded by a new method which adopts a similar principle to the auger method. Use of the new micro-bore pressure sensing drill device (sometimes known as a resistograph) is being implemented from 2013 (refer to Figure 14). It measures the resistance through a pole using a very small bore drill. This is far less invasive than the auger, enabling more tests to be taken of the area, giving a much more accurate picture of decay within the pole and therefore an improved assessment of its residual strength (refer to Figure 15). It can also be used at ground level quite effectively without excavations being required. Coupled with this, UKPN are looking to use a software package to calculate the actual residual strength to give a more accurate picture than the current methodology, comparing areas of decay against a template. At this stage, the revised methodology is being evaluated to provide a better assessment of pole condition over existing methods and to more accurately inform the pole replacement programme (capex). In the future it is expected that the monitoring will assist in reducing or deferring the number of pole changes required.

As part of ongoing Reliability Centred Maintenance (RCM) assessments to optimise I&M activities, 2-11kV and 33kV ABSDs and 33kV line switches will undergo a change of state operation every six years, with reactive maintenance where required (i.e. following a failure to operate); this is a change from undergoing a preventative maintenance programme every 12 years. It is considered that operation of the units will, in most cases, continue to keep the mechanism in a useable state. Any operations that might achieve this during normal network activity will be captured and logged to fulfil this requirement, leaving only a few requiring purposeful operation to achieve a change of state. The numbers of inoperable ABSDs will be monitored to determine if this course of action is successful. Projected savings have been included in the I&M forecast in Table 13 (above).

Figure 14 – Resistograph being used to determine extent of internal decay

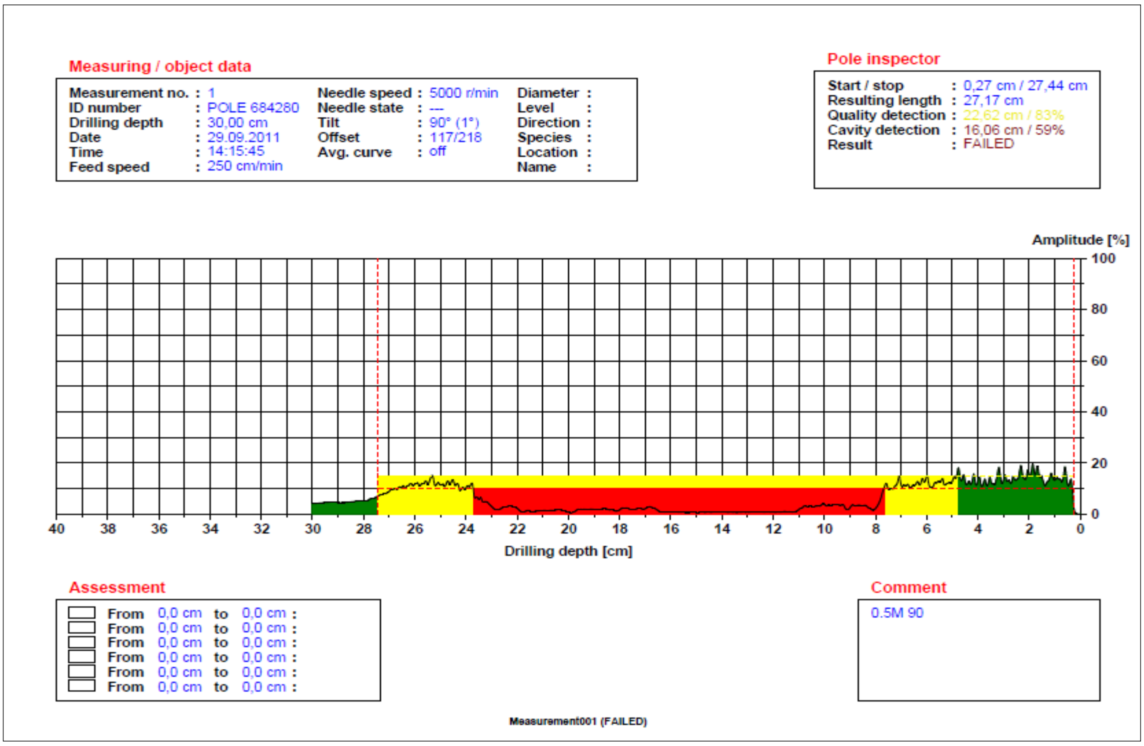


Figure 15 – Sample Output from Resistograph

4.0 Cables

4.1 Asset Information

The main types of underground cable on the network are shown in table16.

Voltage	Cable Type	Length (km)
132kV	Fluid / Gas	239 / 44
132kV	Solid	100.66
EHV	Fluid / Gas	465.40 / 7
EHV	Solid	890.28
HV (2-11kV)	Solid	12,108.76
LV	Solid	26,124.68
All (exc Services)	**All**	**39,979.78**

Table 16 - Cable Asset Information (Data Source: RIGS 2013)

Breakdown of LV and HV Cables

2-11kV – The length 12,108.76km is made up of various types: mainly Paper Insulated Lead Covered (PILC), Screened Corrugated Aluminium Sheath (SCAS) and, latterly, XLPE (Triplex).

LV – The length 26,124.68km is made up of various types: mainly Paper Insulated Lead Covered (PILC) (18,490.31km), Waveconal (aluminium cores and neutral), Hybrid (aluminium cores and copper neutral) (XLPE total 7,674.08km), and CONSAC (Concentric Neutral Solid Aluminium Conductor) (11km).

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 17.

Table 17 – Fault Rates

Voltage	Faults Per Annum	Faults Per 100 Kilometre
132kV	3	2.9
EHV	17	2.0
HV	744	6.2
LV	1,585	6.1
LV Services	1,639	N/A

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. The trend over the past five years shows decreasing volumes (see Figure 16). 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 a steady state position in the rate of faults predicted across the period for the reasons described below in the Faults Plan.

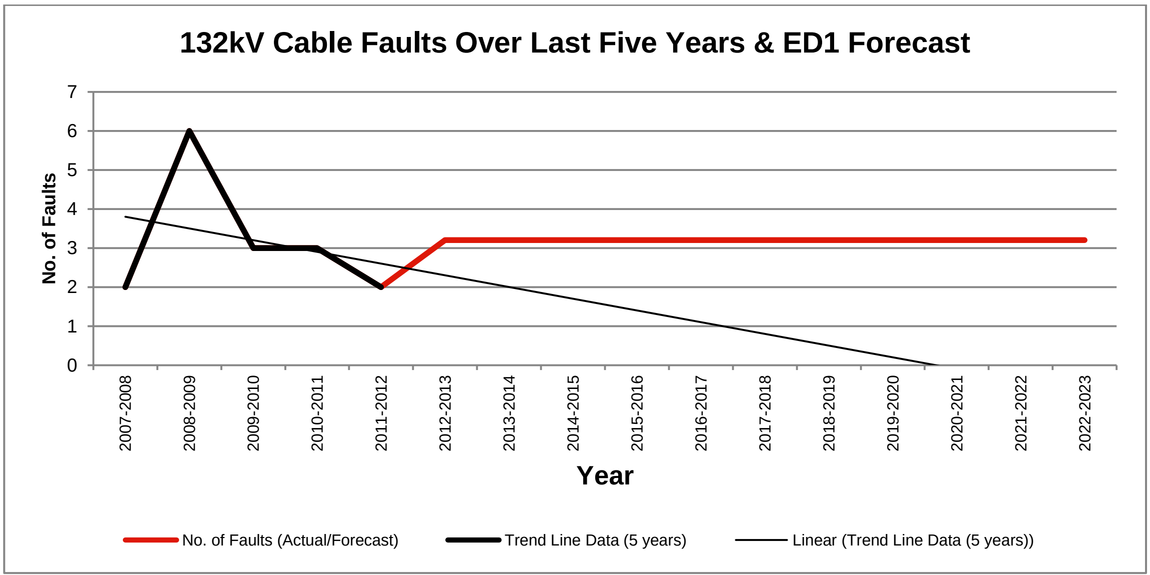


Figure 16- 132kV cable Faults (Data Source: IIS and UKPN Fault Cube)

EHV – The trend over the past five years shows increasing 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 volumes remaining constant across the period in line with the Faults Plan below.

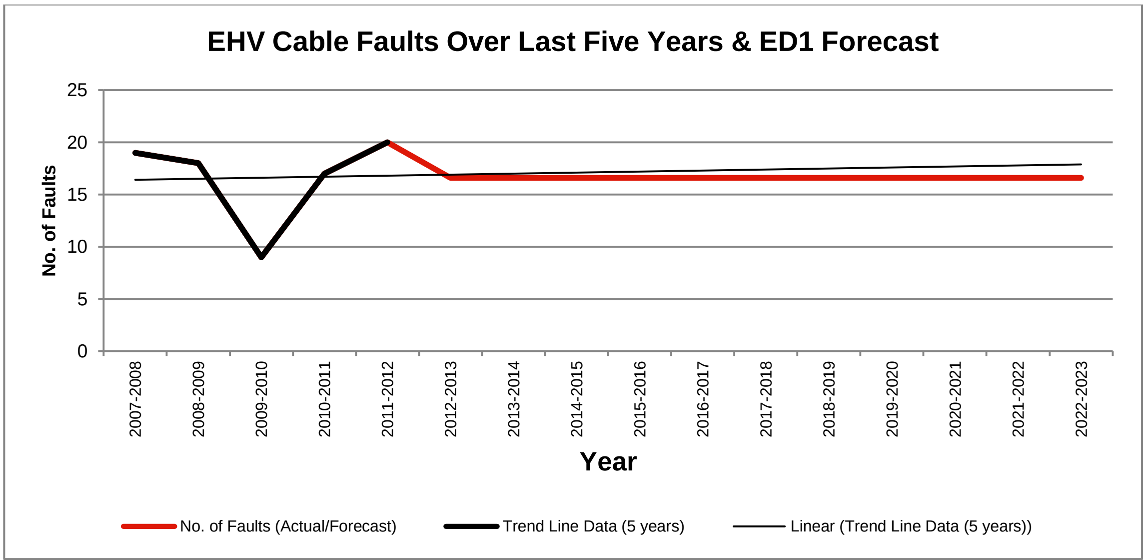


Figure 17 – EHV cable faults (Data Source: IIS and UKPN Fault Cube)

HV (2-11kV) – The fault trend shows a fall in volumes 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 remaining constant across the period for the reasons described below in the Faults Plan.

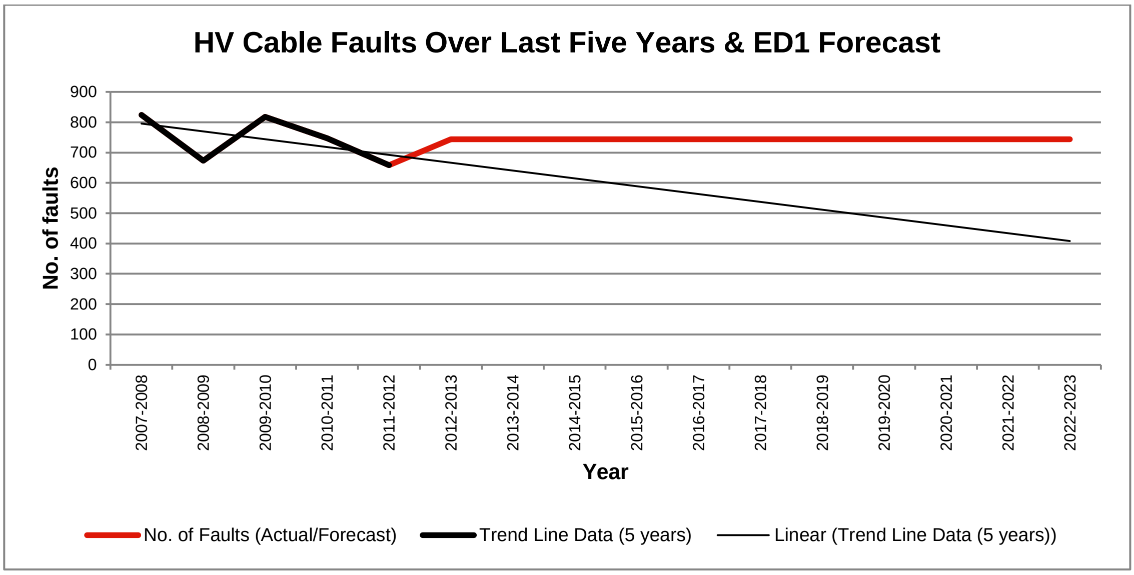


Figure 18 – HV cable faults (Data Source: IIS and UKPN Fault Cube)

LV – The fault trend shows an increase over the past five-years in figure 19. 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.

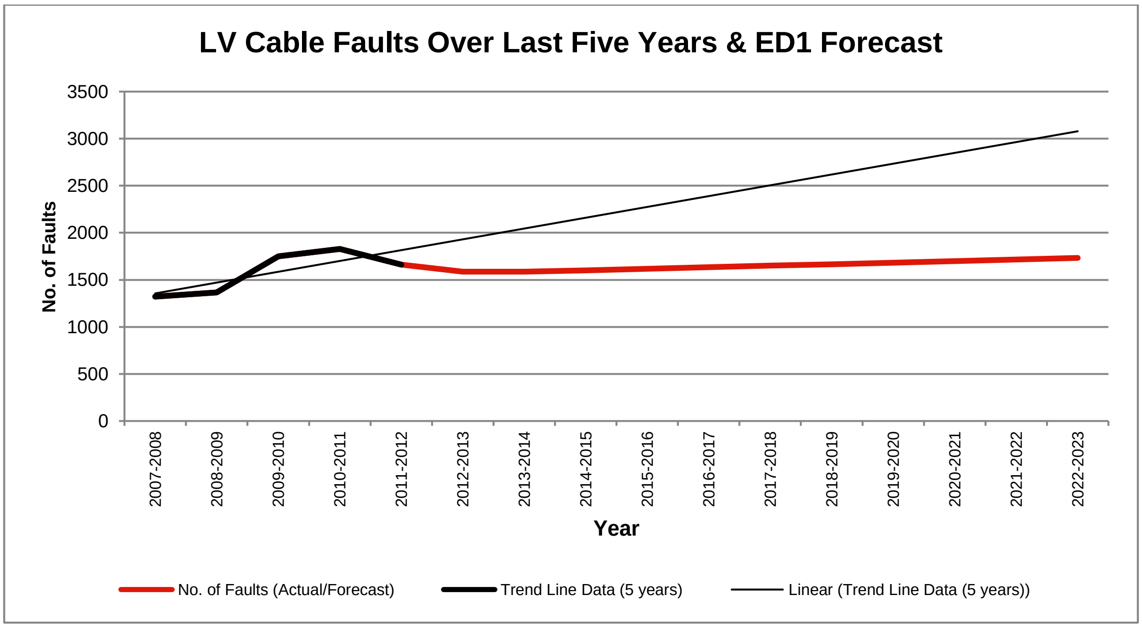


Figure 19 – LV cable faults (Data Source: IIS and UKPN Fault Cube)

Services – An increasing trend can be seen over the past five years in figure 20. 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.

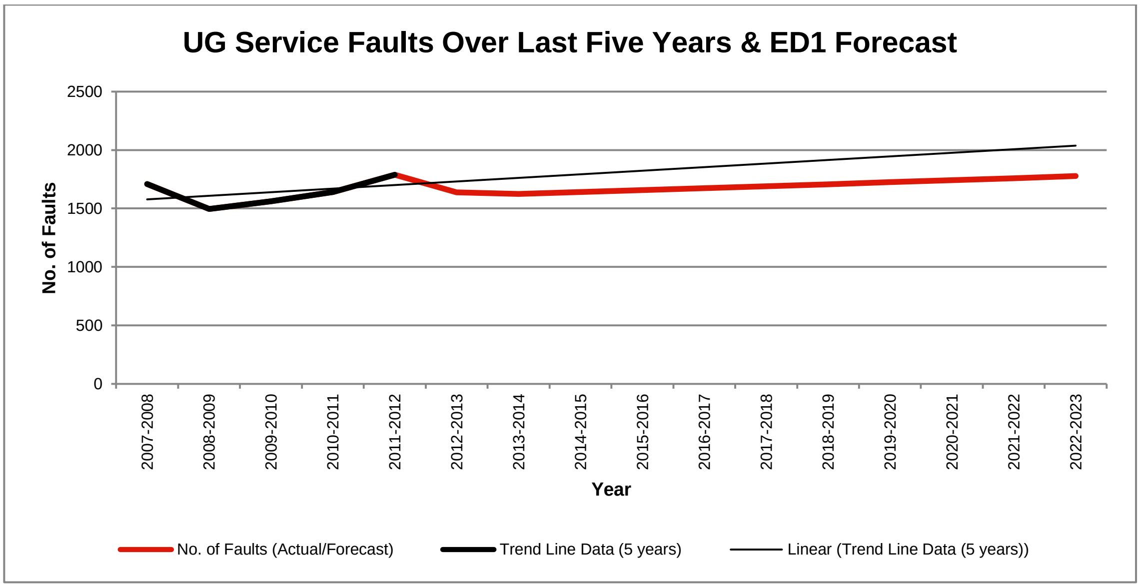


Figure 20 – Services Faults (Data Source: IIS and UKPN Fault Cube)

4.3 Faults Plan

At 132kV, it is proposed to maintain constant volumes from 2013/14 across ED1. Due to the small volumes, and with the figures showing volatility year on year, the historic trend varies greatly and, in this case, cannot be relied on as a sound statistical analysis on which to base the forecast. It is expected that the decreasing fault rate will not continue as the ageing asset base continues to deteriorate over time, but should be maintainable within a steady state threshold.

The five-year fault rate of EHV cables showed an increasing trend but due to the low volumes the trend varies greatly. 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, the identification of cables for replacement can only be made once they have been determined as poorly performing. A capex replacement programme will renew these assets, thus reducing the failure rate, and on this basis, it is proposed to maintain a steady state forecast for fault volumes over the ED1 period.

The fault rate of HV cables shows a decreasing trend over the past five years although it is expected that this trend will not continue due to the aging asset base continuing to deteriorate over time. Fluctuating peaks in fault volumes can be generally attributed to changing weather patterns where we are seeing more extreme dry and wet periods causing damage to underground joints in particular. As this activity is almost entirely reactive, the identification of cables for replacement can only be made once they have been determined as poorly performing. A capex replacement programme will renew these assets, thus reducing the repeat failure rate, and on this basis it is therefore proposed to maintain the forecast fault volumes at a constant level.

The fault rate of LV cables shows an increasing trend over the past five years as does the forecast. The network lengths are increasing each year, which in turn 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. As this activity is almost entirely reactive, the identification of cables for replacement can only be made once they have 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 an increasing trend over the past five years. The number of services is increasing each year, which in turn 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. As this activity is almost entirely reactive, the identification of services for replacement can only be made once they have been determined as poorly performing. It is therefore proposed to increase the forecast fault volumes by 1% per year.

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. 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. It is proposed to maintain a steady state forecast volume for this category based on an historical reducing volume from RIGs which shows a very slight reducing trend.

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 both the rising volumes of LV cable faults, and reducing volumes of overhead faults giving an overall flat profile across ED1.

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 in the previous section.

Table 18, Table 19 and figure 21 show the volume profiles in ED1 and ED2.

Table 18 – DPCR4, DPCR5 & ED1 History/Forecast - Cable Faults

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	4	3	2	2	2	2	2	2	2	2	2	2	2	2
132kV Cable Fault Pressurised	CV15a Line 34	0	2	0	2	2	2	2	2	2	2	2	2	2	2
132kV Fault Restoration by Switching Only (UG)	CV15a Line 9	13	33	20	16	22	18	1	1	1	1	1	1	1	1
Total 132kV UG Cable Faults		**17**	**38**	**22**	**20**	**26**	**22**	**58**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
33kV U/G Fault Pressurised	CV15a Line 29	0	0	0	1	1	1	1	1	1	1	1	1	1	1
EHV U/G Fault Non Pressurised	CV15a Line 30	9	19	20	16	16	16	16	16	16	16	16	16	16	16
EHV Fault Restoration by Switching Only (UG)	CV15a Lines 8	131	103	18	18	18	18	5	5	5	5	5	5	5	5
Total EHV UG Cable Faults		**140**	**122**	**38**	**35**	**35**	**35**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**
11kV cable fault repairs	CV15a Line 22	870	817	711	744	744	744	744	744	744	744	744	744	744	744
HV Fault Restoration by Switching Only (UG)	CV15a Line 7	965	1,559	984	1,265	2,033	1,701	267	267	267	267	267	267	267	267
Total HV UG Cable Faults		**2115**	**2620**	**1771**	**2079**	**2847**	**2515**	**1011**	**1011**	**15201011**	**1011**	**1011**	**1011**	**1011**	**1011**
LV Underground Cable Fault (Consac)	CV15a Lines 18	2	13	2	17	17	17	17	17	17	17	17	17	17	17
LV U/G Cable Fault Repairs	CV15a Line 17	2,066	2,135	1,994	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,686	1,686
Service Fault Repairs Underground	CV15a Line 15	2,453	2,537	2,582	1,625	1,625	1,641	1,658	1,674	1,691	1,708	1,725	1,742	1,760	1,777
Street Lighting Fault Replacement - Underground	CV15b Line 7	3,888	3,591	3,126	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Blown LV Fuses at Substations	CV15a Lines All 6 (Includes OH), 17, 18, 19, 20	4,615	4,671	4,488	1,925	1,925	1,925	1,925	1,925	1,925	1,925	1,925	1,925	1,925	1,925
Cut Out Fuses (Formerly CFS Costs)	CV15b Line 9	2,249	2,011	1,792	1,882	1,882	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788
Responding to Critical Safety Calls	CV15b Line 16	7,107	6,583	9,404	6,564	6,564	6,564	3,182	3,182	3,182	3,182	3,182	3,182	3,182	3,182

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
Abortive Call (previously Powercare Emergency Rechargeable)	CV15b Line 14	491	293	9,106	6,120	6,120	6,120	4,896	3,672	2,448	1,224	308	308	308	308
Metering Fault	CV15b Line 15	424	369	237	240	240	240	192	152	124	124	124	124	124	124
Pilot Wire Failures	CV15b Line 17	All volumes included in UG Services				18	18	9	9	9	9	9	9	9	9
Total LV UG Cable Faults		23,295	22,203	32,731	22,459	22576	22498	17852	16604	15369	14162	13263	13280	13299	13316

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 overhead lines and, to some extent, switchgear, but the majority of incidents are in this cable category. Service fault repairs also include faults on risers and laterals.

Table 19 – ED2 Forecast - Cable Faults

ED2 Volumes	2022 /2023	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2030 /2031
Total 132kV UG Cable Faults	20	20	20	20	20	20	20	20
Total EHV UG Cable Faults	110	110	110	110	110	110	110	110
Total HV UG Cable Faults	2,009	2,009	2,009	2,009	2,009	2,009	2,009	2,009
Total LV UG Cable Faults	18,032	18,032	18,032	18,032	18,032	18,032	18,032	18,032

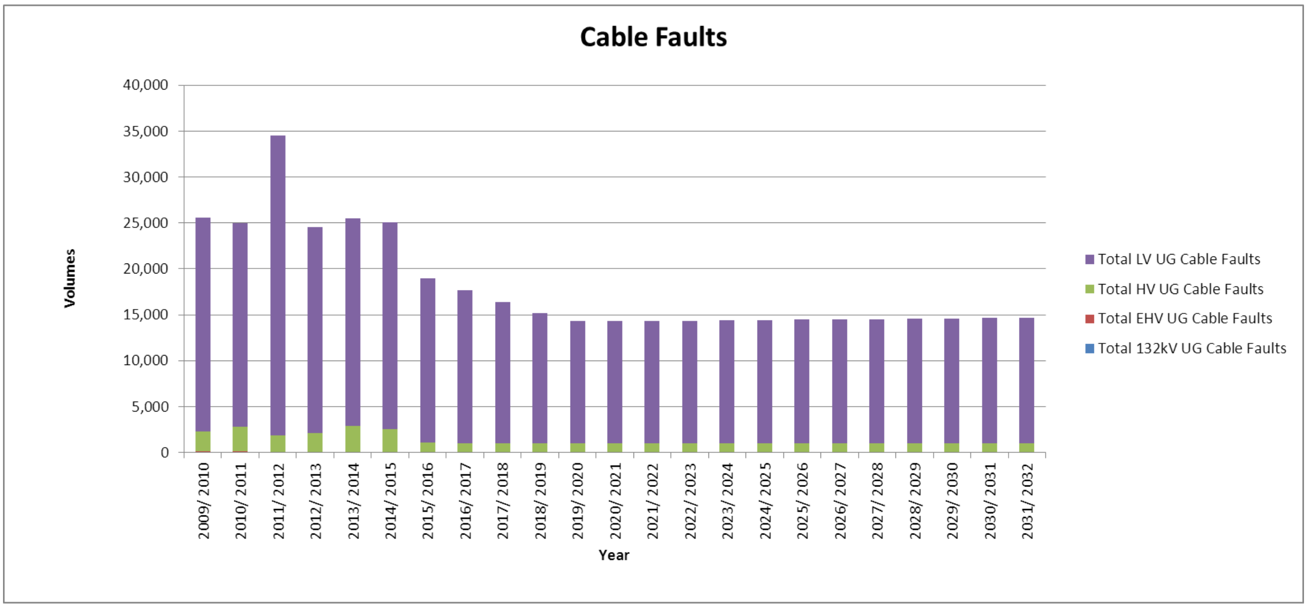


Figure 21 – DPCR4, DPCR5, ED1 & ED2 Historical and Forecast Values

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 and wood pole 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 – Inspection and Maintenance of Underground Cables 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 volumes into ED1 having re-assessed processes to comply with ESQCR obligations, and this is reflected in the total spend in this category.

Table 20, Table 21 and figure 22 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
Gauges-132/33kV inspect and alarm test	213	207	183	184	183	184	183	184	183	184
Gas cable - cylinder change (Volume)	498	488	200	200	200	200	200	200	200	200
Tank inspection (above ground)	7	8	13	13	13	13	13	13	13	13
Gauge mal function investigation	1	2	2	2	2	2	2	2	2	2
Calibrate Pressure Gauge	2	5	5	5	5	5	5	5	5	5
Inspect and Test Pressure Gauge	58	58	58	58	58	58	58	58	58	58
Check Pressure (Oil/Gas)	48	61	93	93	93	93	93	93	93	93
Test Cable Serving / Oversheath	10	11	12	12	12	12	12	12	12	12
Test Sheath Voltage Limiters (SVLs)	5	7	12	12	12	12	12	12	12	12
132/33kV Inspection Total	**842**	**847**	**578**	**579**	**578**	**579**	**578**	**579**	**578**	**579**
Oil top up; Pumping & Testing - 132-33kV	44	46	52	52	52	52	52	52	52	52
Repair Oil Leak	35	35	35	35	35	35	35	35	35	35
Defect repair gas	469	348	4	4	4	4	4	4	4	4
Replace minor oil plant + sheath testing	14	13	14	14	14	14	14	14	14	14
Pilot Cable Repairs	10	10	9	9	9	9	9	9	9	9
132/33kV Maintenance Total	**572**	**452**	**114**	**114**	**114**	**114**	**114**	**114**	**114**	**114**
Includes RIGs Lines: CV13 Lines 42, 43, 56, 57, 70, 71										
Partial Discharge mapping - HV	0	1	4	4	4	4	4	4	4	4
Online Partial Discharge Field Investigations	8	8	8	8	8	8	8	8	8	8
HV Inspection Total	**8**	**9**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
Online Partial discharge monitoring equipment mtce	0	13	54	63	74	82	82	82	82	82
Installation and Maintenance of online PD monitoring	150	150	150	150	150	150	150	150	150	150
Abandoned/unidentified cable location	2	8	8	8	8	8	8	8	8	8
HV Maintenance Total	**152**	**171**	**212**	**221**	**232**	**240**	**240**	**240**	**240**	**240**
Includes RIGs Lines: CV13 Lines 21, 22										
Idle Service Inspection	3,726	4,130	5,720	5,720	5,720	5,720	5,720	5,720	5,720	5,720
Inspect service turret	174	31	31	31	31	31	31	31	31	31
LV Inspection Total	**3,900**	**4,161**	**5,751**	**5,751**	**5,751**	**5,751**	**5,751**	**5,751**	**5,751**	**5,751**
UMS Services Inspected	5,350	7,925	16,525	28,600	28,600	28,600	28,600	28,600	28,600	28,600
LV Maintenance Total	**5,350**	**7,925**	**16,525**	**28,600**	**28,600**	**28,600**	**28,600**	**28,600**	**28,600**	**28,600**
Includes RIGs Lines: CV13 Lines 13, 15, 16, 17										
EMF enquiries	2	7	7	7	7	7	7	7	7	7

Description of Activity	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
Voltage/load investigations	1,053	1,052	1,052	1,052	1,052	1,052	1,052	1,052	1,052	1,052
Cross Voltage Total	**1,055**	**1,059**	**1,059**	**1,059**	**1,059**	**1,059**	**1,059**	**1,059**	**1,059**	**1,059**
Included in other RIGs Lines										

Table 20 - DPCR5 & ED1 Forecast – I&M Cables (Data Source: RIGS Returns (up to and including 2012/13) & NAMP of 19/02/2014 - 2013/14 onwards)

Table 21 – ED2 Forecast – I&M Cables

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
132kV/EHV Inspection	**579**	**579**	**579**	**579**	**579**	**579**	**579**	**579**
132kV/EHV Maintenance	**114**	**114**	**114**	**114**	**114**	**114**	**114**	**114**
HV Inspection	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**
HV Maintenance	**233**	**236**	**238**	**238**	**238**	**238**	**238**	**237**
LV Inspection	**5,751**	**5,751**	**5,751**	**5,751**	**5,751**	**5,751**	**5,751**	**5,751**
LV Maintenance	**27,091**	**28,411**	**28,388**	**28,361**	**28,331**	**28,298**	**28,260**	**28,218**

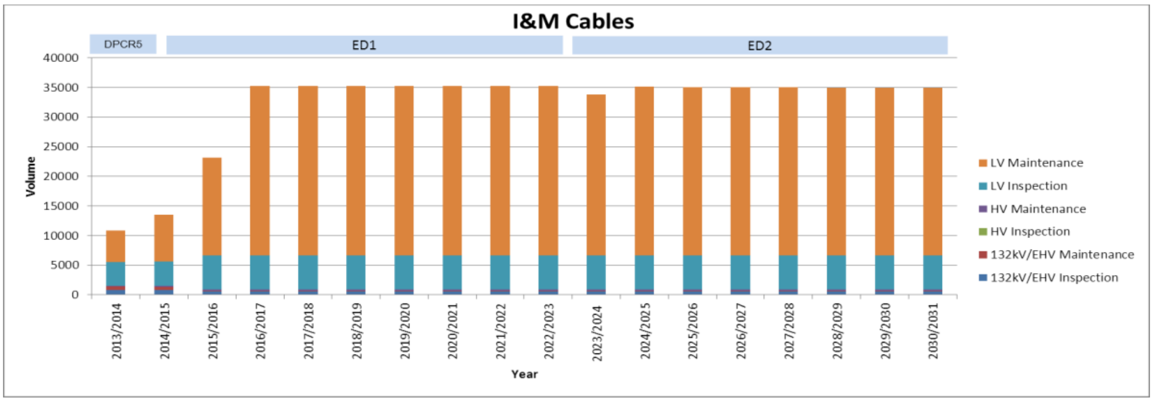


Figure 22 - DPCR5, ED1 & ED2 Historical and Forecast Values

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 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.132kV Switchgear

4.9 Asset Information

The total volume in this category is 215 items of plant, split into three main types of circuit breakers (CBs): air blast, bulk oil and SF_6 with associated isolators and busbars.

4.10 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) (3 p.a.), shows no change in volumes over the period. See figure 23.

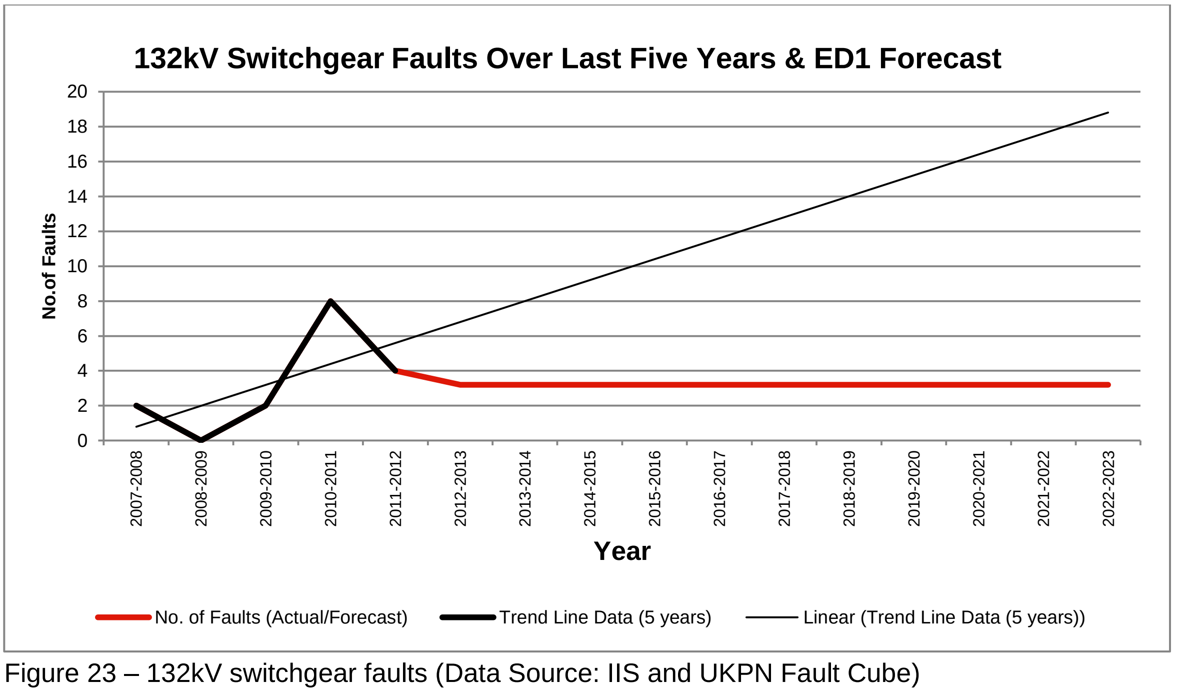


Figure 23 – 132kV switchgear faults (Data Source: IIS and UKPN Fault Cube)

4.11 Faults Plan

Figure 23 shows an increasing trend, although due to the small numbers of these faults (0.015 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 are combined with Grid & Primary 132kV transformers (9.3) in order to provide a more predictable forecast.

Plant faults requiring repair are at a very low level which is reflected in the forecast. Table 22, Table 230 and figure 24 show the volume profiles in ED1 and ED2.

Table 22 – DPCR4, DPCR5 & ED1 History/Forecast – 132kV Plant Faults

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	CV15a Line 37	9	28	18	11	11	11	11	11	11	11	11	11	11	11
Total 132kV Plant Faults		**9**	**28**	**18**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**

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.

Table 23– ED2 Forecast – 132kV Plant Faults

ED2 Volumes	2022 /2023	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2030 /2031
Total 132kV Plant Fault	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**

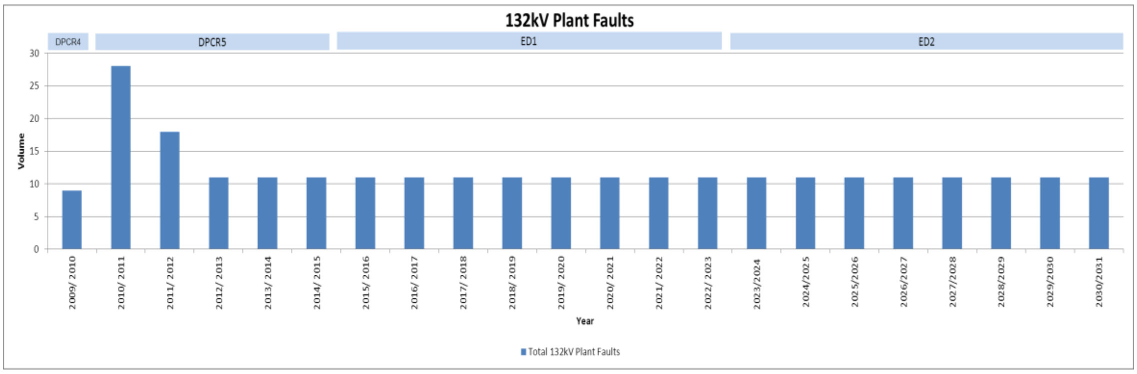


Figure 24 – DPCR4, DPCR5, ED1 & ED2 Historical and Forecast Values

4.12 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.

4.13 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.

4.14 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.

4.15 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 11.0. Variances in volumes year on year are significantly affected by circuit breaker maintenance schedules. Table 24, Table 25 and figure 25 show the volume profiles in ED1 and ED2.

Table 24- DPCR5 & ED1 Forecast – I&M 132kV Switchgear

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	140	61	61	61	61	61	61	61	61	61
Inspect Main Air Receiver	67	67	67	67	67	67	67	67	67	67
Insurance Insp. Air/Gas Receiver	7	7	9	4	4	9	9	4	4	8
Insurance Insp. ABCB Complete Unit	9	22	22	22	22	22	22	22	22	22
Insurance Insp. Air Panel	1	2	2	1	1	2	2	1	1	2
Inspect Flexible Earths & Rods Note 1	101	104	104	104	104	104	104	104	104	104
Infra-Red Inspection Aerial Sets/Busbars Note 2	408	291	291	291	291	291	291	291	291	291
Insurance Insp Switchgear Accumulator	12	12	12	12	12	12	12	12	12	12
Defect Repair - 132/66 kV Switchgear	38	40	40	40	40	41	41	41	42	42
Maintain Full 132/66kV Air Blast CB	4	3	5	5	1	2	1	1	0	1
Maint Full 132/66kV Oil CB	0	1	7	4	10	4	1	0	0	3
Maint FULL 132/66kV SF6 O/D CB	6	5	8	8	7	6	15	12	8	14
Maintain Mechanism 132/66kV Oil CB	2	1	0	0	0	0	1	0	6	6
Maint MECH 132/66kV SF6 O/D CB	1	1	1	1	1	1	1	1	1	1
Trip Test 132/66kV CB & op of ext isol.	142	126	129	130	129	130	129	130	122	94
Maintain Isolator (Manual)	24	4	4	4	4	4	4	4	4	4

Description of Activity	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
Maint. Isolator (Motorised)	0	0	0	4	12	0	0	0	0	1
Maintain Earth Switch	11	4	4	4	4	4	4	4	4	4
Maintain LV AC Board	14	6	4	12	17	32	45	79	13	13
Maintain Air Compressor	12	12	12	12	12	12	12	12	12	12
Maintain Mech 132/66kV Air Blast CB	3	3	3	5	3	4	6	9	6	4
Maint FULL 132/66kV SF6 GIS CB	0	1	2	6	17	4	0	1	2	1
Maintenance Total	**1,002**	**773**	**787**	**797**	**819**	**812**	**828**	**856**	**782**	**767**
Includes RIGs Lines: CV13 Lines 60, 74										

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

Note 2: Infra-Red inspections include those carried out on EHV and Primary switchgear.

Data Source: NAMP of 19/02/2014

Table 25 - ED2 Forecast – I&M 132kV Switchgear

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
132kV Switchgear Maintenance	**806**	**806**	**806**	**806**	**806**	**806**	**806**	**806**

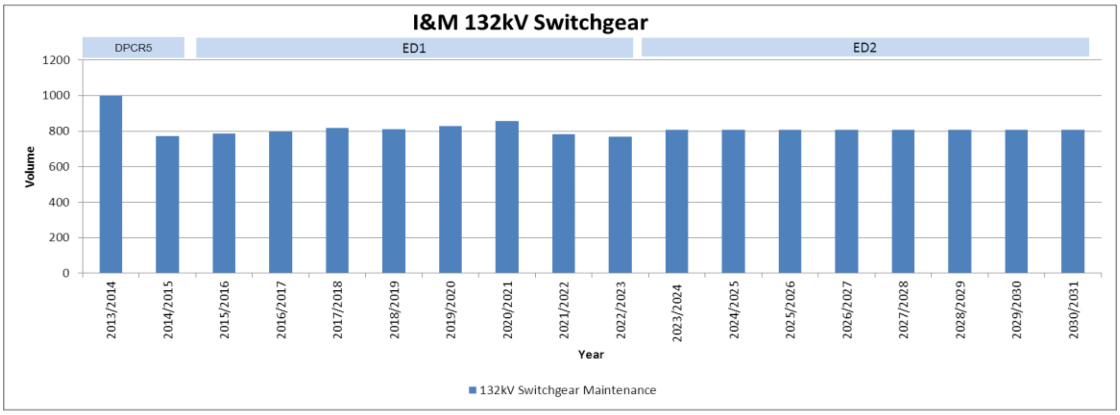


Figure 25 – DPCR5, ED1 & ED2 Historical and Forecast Values

4.16 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.

5.0 EHV Switchgear

5.1 Asset Information

The total volume in this category is 786, split into three main types of circuit breakers (CBs) – oil, SF_6 and vacuum – 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) (8 per annum), shows no change in anticipated volumes over the period. This is illustrated in figure 26.

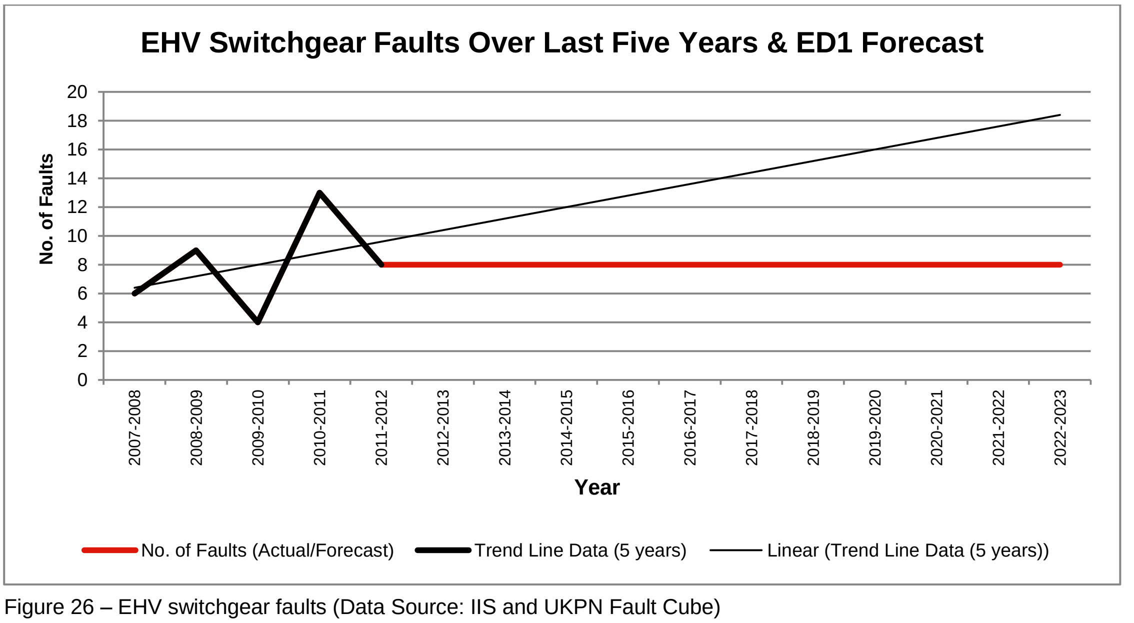


Figure 26 – EHV switchgear faults (Data Source: IIS and UKPN Fault Cube)

5.3 Faults Plan

The above graph shows an increasing trend over the past five-year period. However, due to the small numbers of these faults (0.010 per asset) it is difficult to reliably forecast volumes based on the 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 it constant from then across ED1. The volumes are small, leading to volatility year on year, with the historic trend shown varying greatly. EHV switchgear volumes are combined with Grid & Primary EHV transformers (9.3) in order to provide a more predictable EHV Plant forecast.

Table 25, Table 26 and Figure 27 show the volume profiles in ED1 and ED2.

Table 26 – DPCR4, DPCR5 & ED1 History/Forecast – EHV Plant Faults

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	28	63	78	20	20	20	20	20	20	20	20	20	20	20
Total 132kV Plant Faults		**28**	**63**	**78**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**

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.

Table 27 – ED2 Forecast – EHV Plant Faults

ED2 Volumes	2022 /2023	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2030 /2031
Total EHV Plant Faults	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**

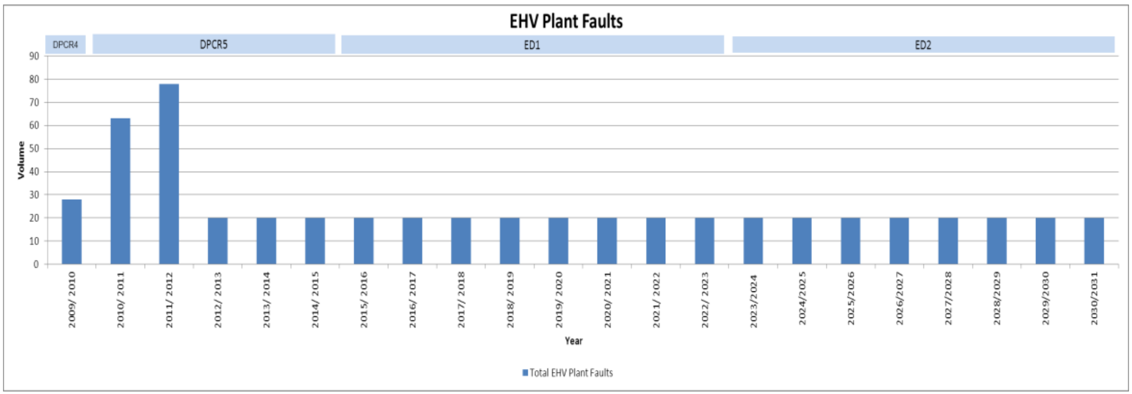


Figure 27 – DPCR5, ED1 & ED2 Historical and Forecast Values

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 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.

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.

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 28).

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 28 – Insulation testing of switchgear is important to understand its condition

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 11.0. The fluctuating volumes shown post 2013/14 reflect the variance in activity levels associated with the periodic operation and maintenance of circuit breakers.

Table 27, Table 28 and Figure 29 show the volume profiles in ED1 and ED2.

Table 28 - DPCR5 & ED1 Forecast – I&M EHV Switchgear

Description of Activity	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
Defect Repair - 33/22 kV Switchgear	19	19	19	19	20	20	20	20	20	20
Strategic Spares Provision Note 1	12	48	51	51	50	50	50	50	50	50
Maintain Batteries and Charger	44	48	48	48	48	48	48	48	48	48
Maintain 33/22kV Oil CB	48	32	16	8	21	37	30	30	48	42
Maint FULL 33/22kV Vac/SF6 O/D CB	3	0	1	0	0	0	0	0	0	0
Maint FULL 33/22kV Vac/SF6 F/P & GIS CB	20	15	12	23	15	18	29	27	29	36
Maintain Mechanism 33/22kV Oil CB	42	44	47	46	39	29	31	24	20	13
Maint MECH 33/22kV Vac/SF6 F/P & GIS CB	1	5	5	5	5	5	5	5	5	5
Trip Test 33/22kV CB inc op of Isolators	119	490	510	485	510	485	510	485	478	247
Maint FULL 33/22kV Vac/SF6 W/D CB	7	0	3	11	9	4	1	2	2	8
Maint MECH 33/22kV Vac/SF6 W/D CB	1	1	1	1	1	1	1	1	1	1
Maintain Air Insulated Busbars 33/22kV	15	0	0	0	0	0	0	0	0	0
Maintain Metalclad Busbars 33/22kV	0	0	2	7	3	3	10	7	10	3
Maintenance Total	**331**	**702**	**715**	**704**	**721**	**700**	**735**	**699**	**711**	**473**
Includes RIGs Lines: CV13 Lines 46, 49, 63, 77										

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

Table 29 – ED2 Forecast – I&M EHV Switchgear

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
EHV Switchgear Maintenance	**682**	**682**	**682**	**682**	**682**	**682**	**682**	**682**

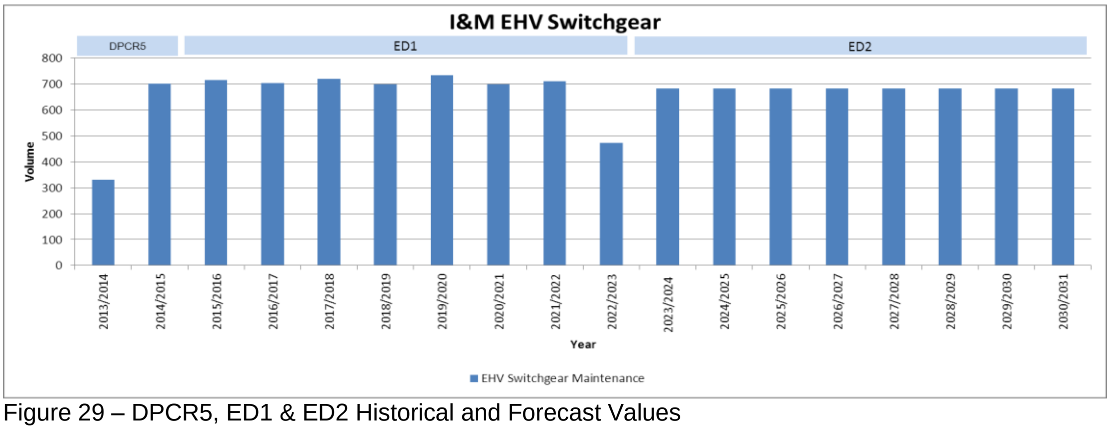


Figure 29 – DPCR5, ED1 & ED2 Historical and Forecast Values

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 requirements closer to individual site and plant needs:

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 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.

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.

6.0 Primary Switchgear

6.1 Asset Information

The total volume of switchgear in this category is 2,906, 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.

6.2 Summary of Fault Trends, Failure Modes and Fault Rates

All CB types (including isolators and busbars) – The volumes for this category are included under HV switchgear in section 7.0, as primary switchgear represents only a small proportion of the total volumes at this voltage. The table below indicates mechanism performance for all CBs and instances where CBs have failed to trip correctly for a fault over the past ten years. It is included in this section as it is mainly primary feeder CBs that suffer from stiction problems. Table 29 provides a summary of stuck breakers over the last few years.

Table 30 - Stuck CBs

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
No of stuck CBs	2	1	3	4	3	1	1	5	2	1

Data Source: Major network investigation reports

Figure 30 – Circuit breaker timing tests are important to ensure continued operability

6.3 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 7.0 as it covers the larger population of switchgear operating at 2-11kV.

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.

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.

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 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 30).

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 31– Carrying out mechanism maintenance on an oil circuit breaker

6.6 I&M Policies

The I&M frequency schedule (EMS 10-0002) details the timescales for interventions, 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. 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 11.0. 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 12% from 2016/2017 pro-rata across the period. Volumes up to 2012/13 reflects resolution of a backlog of maintenance, with fluctuating volumes in the forecast being due to variations associated with the periodic operation and maintenance of circuit breakers. Table 30, Table 31 and Figure 32 show the volume profiles in ED1 and ED2.

Table 31 - DPCR5 & ED1 Forecast – I&M Primary Switchgear

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 Note 1	22	20	16	16	16	16	16	16	16	16
Record EPR & Identification of Hot Sites Note 1	27	27	27	27	27	27	27	27	27	27
Inspection and testing of lifting equipment Note 1	3	3	4	3	4	3	4	3	4	3
Defect Repair - 11kV Circuit Breakers	105	106	108	108	109	110	112	112	113	114
Maint FULL 11/6.6kV SF6/Vac CB W/B Feed	76	55	48	33	72	130	97	71	59	54
Maint FULL 11/6.6kV SF6/Vac CB F/B Feed	24	14	6	25	45	20	18	49	69	77
Maint MECH 11/6.6kV OCB Feeder	140	72	80	48	16	0	0	0	0	27
Maint MECH 11/6.6kV SF6/Vac CB W/B Feed	47	1	1	1	1	1	1	1	1	1
Maint MECH 11/6.6kV SF6/Vac CB F/B Feed	5	17	5	14	17	0	1	1	3	13
Trip Test 11/6.6KV CB Feeder	507	2,057	2,156	2,174	2,156	2,174	2,156	2,174	2,156	2,174
Maint FULL 11/6.6kV OCB Feeder	53	48	72	103	96	77	101	165	130	97
Maint FULL 11/6.6kV OCB TSC	40	20	22	23	44	53	66	69	65	51
Maint FULL 11/6.6kV SF6/Vac CB W/B TSC	34	25	16	10	27	49	40	39	25	23
Maint FULL 11/6.6kV SF6/Vac CB F/B TSC	1	4	1	10	14	8	5	11	7	11
Maint MECH 11/6.6kV OCB TSC	55	65	61	45	42	36	36	15	18	23
Maint MECH 11/6.6kV SF6/Vac CB W/B TSC	2	8	8	8	8	8	8	8	8	8
Maint MECH 11/6.6kV SF6/Vac CB F/B TSC	1	3	3	3	3	3	3	3	3	3
Trip Test 11/6.6kV CB TSC	869	881	960	942	960	942	960	942	960	942
Maint metal clad busbars at Grid/Primary	14	0	0	0	0	0	0	0	0	0
Maintenance Total	**2,025**	**3,426**	**3,594**	**3,593**	**3,657**	**3,657**	**3,651**	**3,706**	**3,664**	**3,664**
Includes RIGs Lines: CV13 Line 27										

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

Table 32 – ED2 Forecast – I&M Primary Switchgear

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Primary Switchgear Maintenance	**3,648**	**3,648**	**3,648**	**3,648**	**3,648**	**3,648**	**3,648**	**3,648**

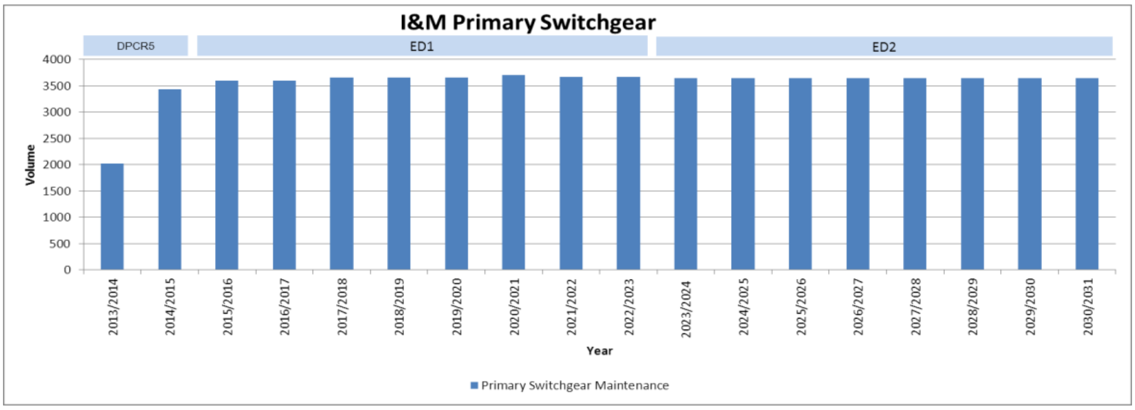


Figure 32 – DPCR5, ED1 & ED2 Historical and Forecast Values

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 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 237 units out of 2,920.

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 dependent 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.

7.0 HV Switchgear and LV Plant

7.1 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 28,6224 items of plant split as follows:

EXT – 13,967 units
RMU – 12,278 units
CB – 2,377 units

There are seven main types of LV Plant, Substation Pillars, Free Standing Pillars, Fuse Cabinets, Indoor Boards, Link Boxes, Regulators and Balancers. The total volume in this category is 50,251 items of plant split as follows:

Substation Pillars/Fuse Cabinets/Boards – 20,800
Link Boxes/Free Standing Pillars – 29,108
Regulators/Balancers – 343

Data Source: RIGS Return (2013)

7.2 Summary of Fault Trends, Failure Modes and Fault Rates

Based on the average faults over the past five years (2007/8 through to 2011/12), the fault rates for switchgear are as follows:

Table 33– Fault Rates

Voltage	Faults Per Annum	Fault Rate Per Asset
132kV	3	0.015
EHV	8	0.005
HV	176	0.0061
LV	432	0.0082

Data Source: IIS and UKPN Fault Cube

HV Switchgear All Types – The fault trend has been falling over the past five years in line with improving techniques, (the latest being ARP modelling,) to identify life-expired plant before it fails in service. 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) (176 p.a.), shows no change in volumes over the period. See figure 33. The forecast is that the fault rate will remain the same (0.0061 per asset), as the number of assets continuing to age and deteriorate will increase in relation to the age profile for this equipment.

This is supported by a further breakdown of fault causes, which shows an increasing trend in condition-based faults (e.g. due to age or wear) representing about 50% of the total number of faults over the past three years (see figure 34). This will be monitored over the period – the probable increase in condition-based faults being offset by the installation of new switchgear.

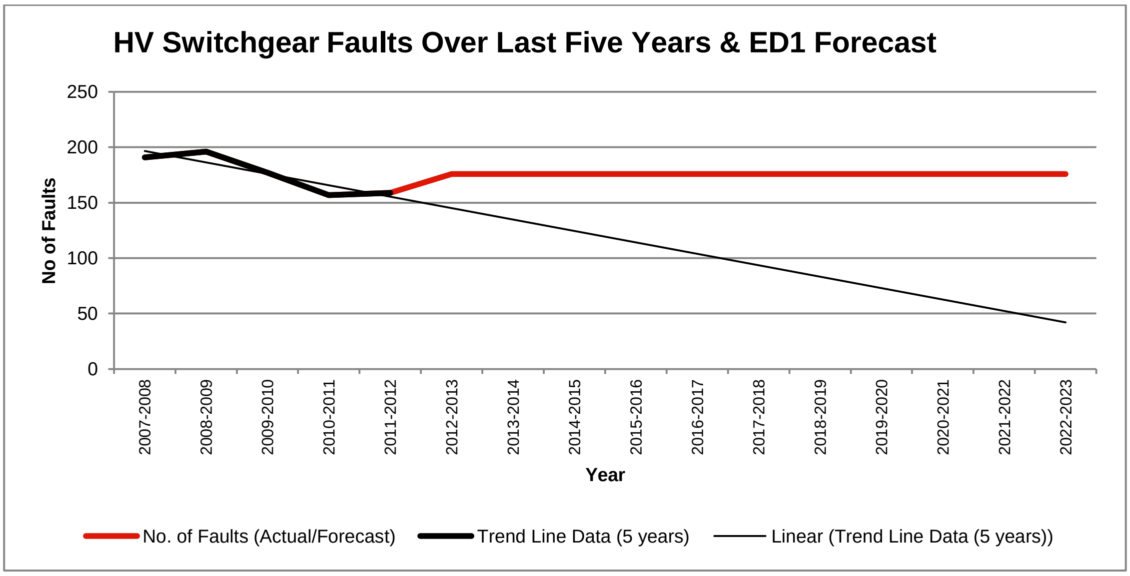


Figure 33 – HV switchgear faults (Data Source: IIS and UKPN Fault Cube)

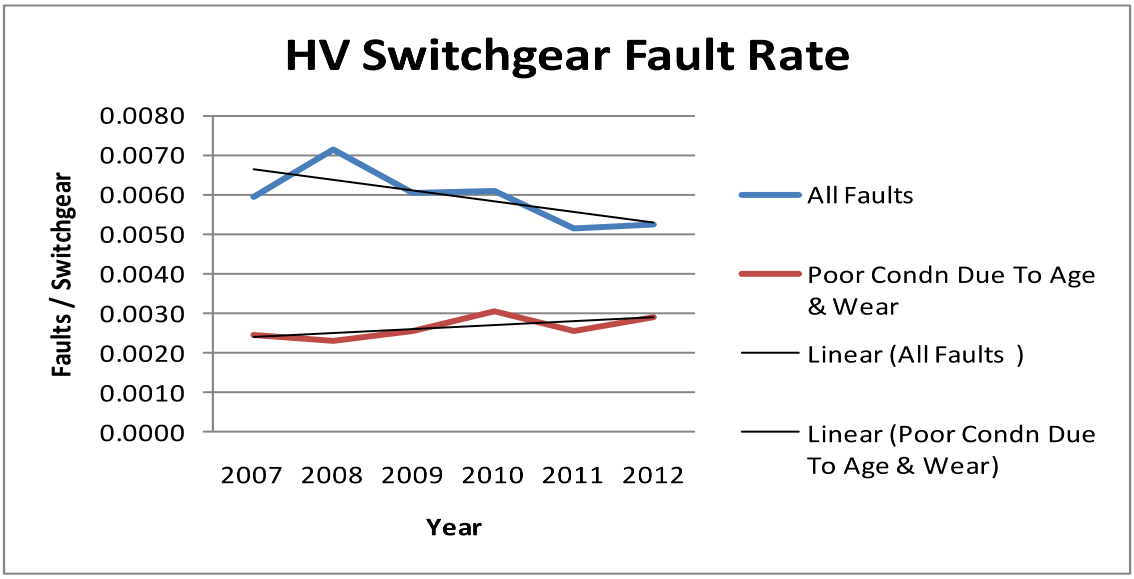


Figure 34 - Data Source: UKPN Fault Cube

LV Switchgear All Types –The fault trend is shown as falling over the past five years (see figure 35), mainly due to the abnormally high volumes in 2009/10. If these are aligned with adjacent years (i.e. smoothed), there is an increasing trend which aligns closer with the forecast. 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) (432 p.a.), shows no change in volumes over the period. This equates to a fault rate of 0.0082 per asset.

From a separate analysis (see figure 36), it is evident that the number of condition-based faults (e.g. due to age and wear) is a consistently high contributor as a percentage of the total number of faults; for LV switchgear, this represents just under 90% of fault causes over the past two years. An enhanced capital investment programme is proposed to offset a proportion of the condition-based faults, resulting in a level forward projection for all LV faults. Further details may be found in the HV Switchgear and LV Plant capex document (No 8).

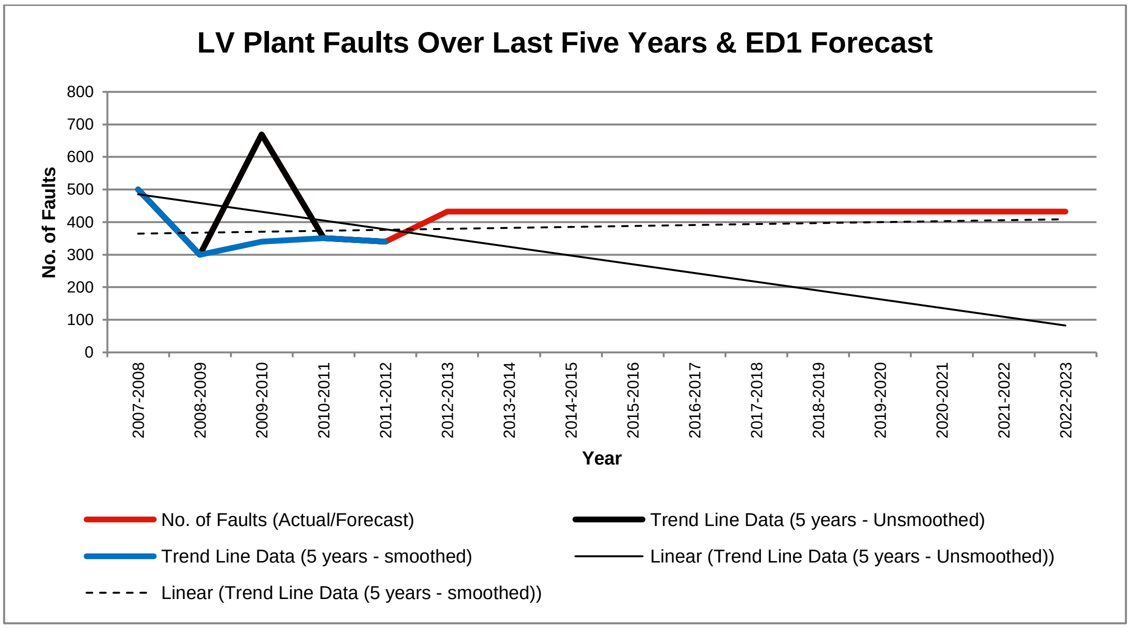


Figure 35 - Data Source: IIS and UKPN Fault Cube

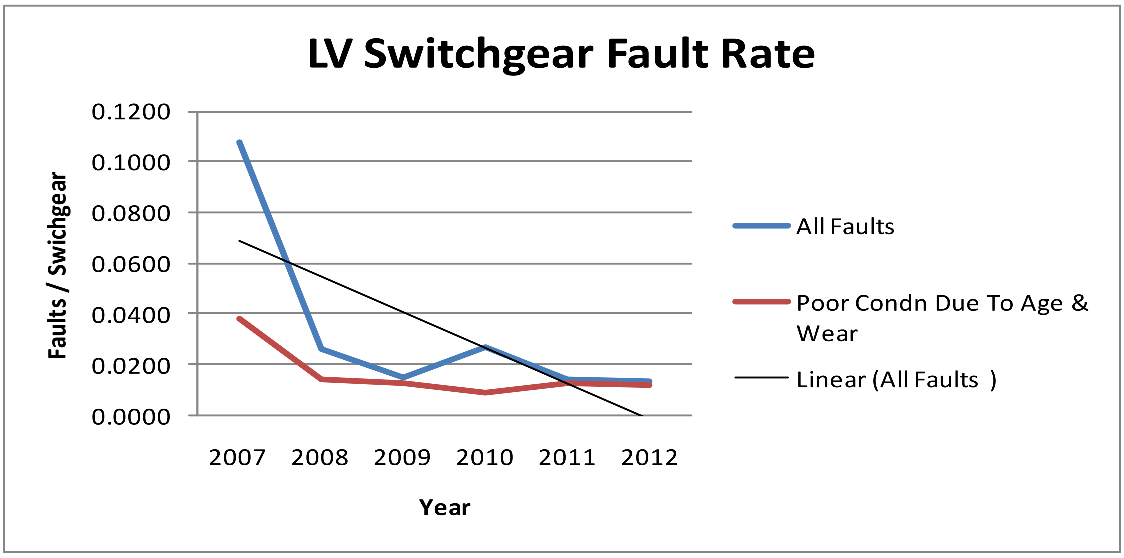


Figure 36 - Data Source: UKPN Fault Cube

7.3 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 – Figures 33 and 34 show a decreasing 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. Opex spend on activities following switchgear faults will continue at a constant level.

Volumes for HV switchgear are aggregated with HV transformers (section 10.3) 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 – Figures 35 and 36 shows a decreasing trend due to abnormally high volumes in 2010/11. The expected underlying trend (smoothed trend), supported by an analysis of condition-based faults at LV, is rising. 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. Table 33, Table 34 and figure 37 show the volume profiles in ED1 and ED2.

Table 34– DPCR4, DPCR5 & ED1 History/Forecast – HV Switchgear and LV Plant Faults

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
HV Other Plant Faults (volume)	CV15a Line 27	315	283	284	309	309	309	309	309	309	309	309	309	309	309
Total HV Plant Faults		**315**	**283**	**284**	**309**	**309**	**309**	**309**	**309**	**309**	**309**	**309**	**309**	**309**	**309**
Other plant (LV etc)	CV15a Line 20	646	340	236	432	432	432	432	432	432	432	432	432	432	432
Flooding Burst Water Main	CV15b Line16	Included in "Responding to Safety Critical Calls"				976	976	976	976	976	976	976	976	976	976
Total LV Plant Faults		**646**	**340**	**236**	**432**	**1,408**	**1,408**	**1,408**	**1,408**	**1,408**	**1,408**	**1,408**	**1,408**	**1,408**	**1,408**

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.

Table 35 – ED2 Forecast – HV Switchgear and LV Plant Faults

ED2 Volumes	2022 /2023	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2030 /2031
Total HV Switchgear and LV Plant Faults	**1,408**	**1,408**	**1,408**	**1,408**	**1,408**	**1,408**	**1,408**	**1,408**

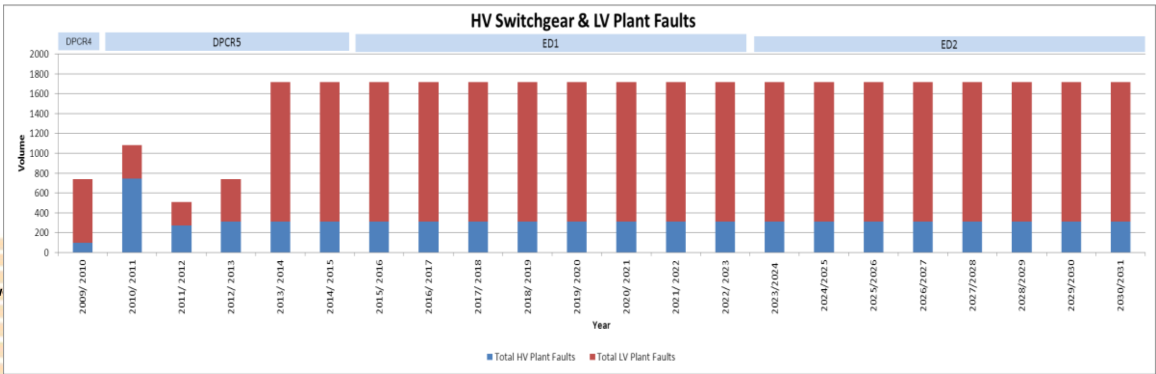


Figure 37 – DPCR4, DPCR5, ED1 & ED2 Historical and Forecast Values

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 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.

7.5 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 38).

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.

Painting provides an opportunity to restore the condition of the external housing of plant where it is seen to be deteriorating quicker than would be expected. This contributes to maintaining the health index of the equipment in line with the predicted rate of degradation within the ARP model, and therefore keeps the forecast replacement date in line.

Figure 38 – Secondary substation maintenance oil-handling facilities

7.6 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.

7.7 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 11.0. A revised programme of preventative maintenance in the form of painting HV switchgear, and LV pillars, has been implemented and will continue over the ED1 period in order to control the rate of degradation of the equipment housing(s) where it is identified as an issue.

Higher volumes in 2011/12 and 2012/13 are due to increased workload to clear a backlog of maintenance. 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. High volumes of link box inspections in 2013/2014 are due to a backlog, and condition data quality improvement.

Table 35, Table 36 and Figure 39 show the volume profiles in ED1 and ED2.

Table 36 - DPCR5 & ED1 Forecast – I&M HV Switchgear & LV Plant

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	12	12	12	12	12	12	12	12	12	12
Inspect 2kV/3.5Kv Pillar	68	70	83	83	83	83	83	83	83	83
Defect Repair - 11kV Secondary G/M S/S Equipment	86	88	88	89	89	90	92	92	93	95
Plant Forensic testing and failure investigation Note 1	17	17	17	17	17	17	17	17	17	17
Maintain Non-Isolatable Oil Switch	467	241	343	289	328	261	143	209	525	277
Maintain Non-Isolatable RMU (Oil)	116	67	62	112	193	189	93	128	292	324
Maintain Non-Isolatable RMU (Gas/Vacuum)	0	2	0	0	3	3	2	1	0	1
Maintain Isolatable Oil Switch	0	8	39	49	38	31	33.4	27.2	42.4	56
Maintain Switch Fuse	465	304	234	305	206	144	144	155	192	189
Maintain HV Metering Unit	17	34	40	40	32	33	27	28	26	27
Maintain Fused End Box	1	24	70	0	0	0	0	0	20	90
Maint FULL 11/6.6kV OCB at S/SUB	36	43	61	54	49	35	49	52	45	39
Maint FULL 11/6.6kV SF6/Vac CB F/P S/SUB	4	28	49	12	73	143	144	159	98	98
Maint FULL 11/6.6kV SF6/Vac CB W/D S/SUB	10	5	3	2	2	4	4	0	4	2
Maint MECH 11/6.6kV OCB at S/SUB	18	17	12	2	8	6	4	18	24	24

Description of Activity	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
Maint MECH 11/6.6kV SF6/Vac CB F/P S/SUB	1	3	0	4	12	0	0	0	0	0
Maint MECH 11/6.6kV SF6/Vac CB W/D S/SUB	1	3	0	0	0	0	1	6	1	7
Maintain Mech Non Isolatable Oil Switch	0	41	127	12	28	18	24	56	187	272
HV Maintenance Sub-Total	**1,319**	**1,007**	**1,240**	**1,082**	**1,173**	**1,069**	**872**	**1,043**	**1,661**	**1,613**
Plant Paint 11kV & below	38	194	389	671	820	820	820	820	820	820
HV Maintenance Total	**1,357**	**1,201**	**1,629**	**1,753**	**1,993**	**1,889**	**1,692**	**1,863**	**2,481**	**2,433**
Includes RIGs Lines: CV13 Lines 28, 29, 30, 33										
Inspect LV Link Box	19,935	3,793	3,793	3,793	3,793	3,793	3,793	3,793	3,793	3,793
Inspect Network LV Pillar	233	231	231	231	231	231	231	231	231	231
Network Pillar inspection	20	0	0	0	0	0	0	0	0	0
LV Inspection Total	**20,188**	**4,024**	**4,024**	**4,024**	**4,024**	**4,024**	**4,024**	**4,024**	**4,024**	**4,024**
Defect Repair - LV G/M S/S Equipment	24	25	25	25	26	26	26	26	26	27
Maintain LV Dist.Board (Pillar/TOC)	718	675	739	739	739	739	739	739	739	739
LV Maintenance Total	**742**	**700**	**764**	**764**	**765**	**765**	**765**	**765**	**765**	**766**
Includes RIGs Lines: CV13 Lines 10, 11										

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

Table 37 – ED2 Forecast – I&M HV Switchgear & LV Plant

ED2 Volumes	2009 /2010	2010 /2011	2011 /2012	2012 /2013	2013 /2014	2014 /2015	2015 /2016	2016 /2017
HV Switchgear Maintenance	**1,967**	**1,967**	**1,967**	**1,967**	**1,967**	**1,967**	**1,967**	**1,967**
LV Plant Inspection	**4,024**	**4,024**	**4,024**	**4,024**	**4,024**	**4,024**	**4,024**	**4,024**
LV Plant Maintenance	**765**	**765**	**765**	**765**	**765**	**765**	**765**	**765**

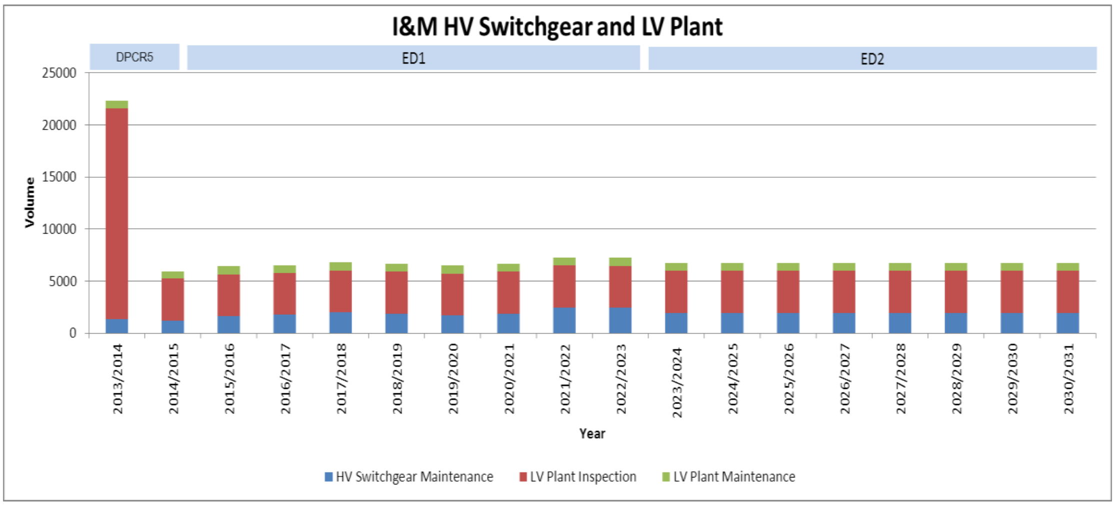


Figure 39 – DPCR5, ED1 & ED2 Historical and Forecast Values

7.8 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.

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

8.1 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.

8.2 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.

8.3 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 constant from 2013/14 and across ED1 based on an estimate of the expected volumes which are likely to reduce with the smart meter roll out. Fault volumes for risers and laterals are included under (service) cables – section 4.3 above. Table 37, Table 38 and Figure 40 show the volume profiles in ED1 and ED2.

Table 38 – DPCR4, DPCR5 & ED1 History/Forecast – Service Termination Faults

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, Risers and Laterals	CV15b Line 8	176	2,429	2,373	4,272	4,272	4,272	3,204	2,136	2,136	2,136	2,136	2,136	3,468	3,468
Emergency Disconnections	CV15b Line 6	Included in "Responding to Safety Critical Calls"				795	795	795	795	795	795	795	795	795	795
Total Service Termination Faults		**176**	**2,429**	**2,373**	**4,272**	**5,067**	**5,067**	**3,999**	**2,931**	**2,931**	**2,931**	**2,931**	**2,931**	**4,263**	**4,263**

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.

Table 39 – ED2 Forecast – Service Termination Faults

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Total Service Termination Faults	3,398	3,398	3,398	3,398	3,398	3,398	3,398	3,398

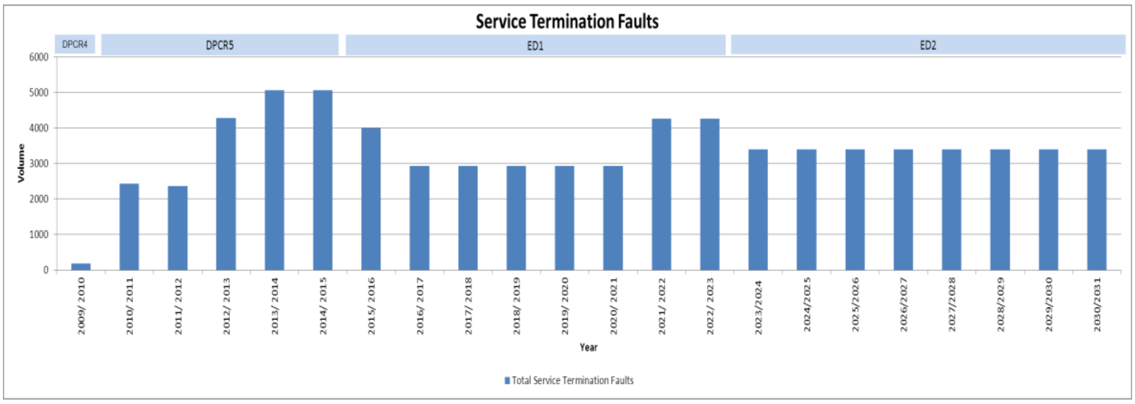


Figure 40 – DPCR5, ED1 & ED2 Historical and Forecast Values

8.4 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.

8.5 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.

8.6 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.

8.7 I&M Plan

No changes from the above policy regimes have been identified and the plan reflects consistent I&M interventions in line with the above policies.

Table 39, Table 40 and Figure 41 show the volume profiles in ED1 and ED2.

Table 40 - DPCR5 & ED1 Forecast – I&M Service Terminations

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	12,625	13,217	15,670	15,670	15,670	15,670	15,670	15,670	15,670	15,670
Inspection Total	**12,625**	**13,217**	**15,670**	**15,670**	**15,670**	**15,670**	**15,670**	**15,670**	**15,670**	**15,670**
Includes RIGs Lines: CV13 Line 12, 14										

Data Source: NAMP of 19/02/2014

Table 41 – ED2 Forecast – I&M Service Terminations

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Service Terminations, Cut-outs, Risers & Laterals Inspections	**15,670**	**15,670**	**15,670**	**15,670**	**15,670**	**15,670**	**15,670**	**15,670**

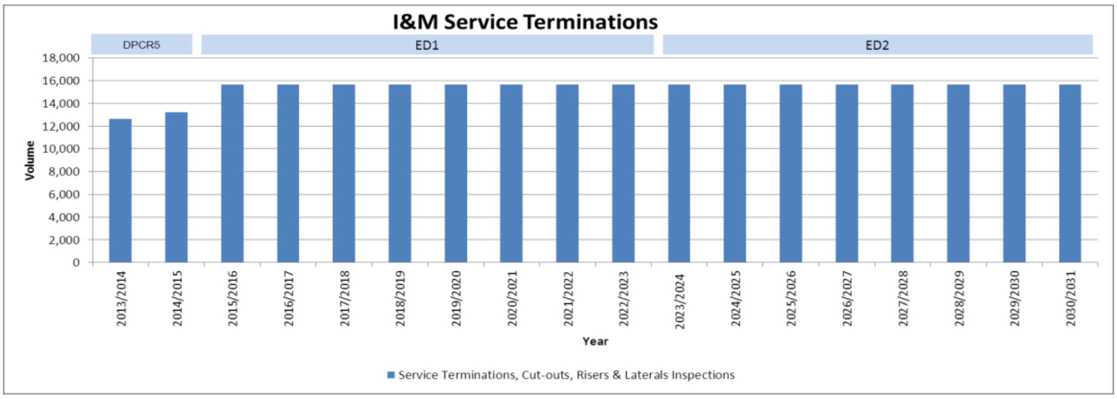


Figure 41– DPCR5, ED1 & ED2 Historical and Forecast Values

8.8 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.

9.0 Grid and Primary Transformers

9.1 Asset Information

There are 164 transformers with a primary winding voltage of 132kV and ratings between 7.5MVA and 90MVA. There are 484 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, arc suppression coils, fault-throwing switches, voltage transformers and surge diverters, are included in this section.

9.2 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 as follows:

Table 42 - Fault Rates

Transformer Primary	Faults Per Annum	Fault Rate per Asset
132kV	8	0.049
EHV	12	0.025
HV (see next section)	138	0.0066

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. This is illustrated in figures 42 and 43.

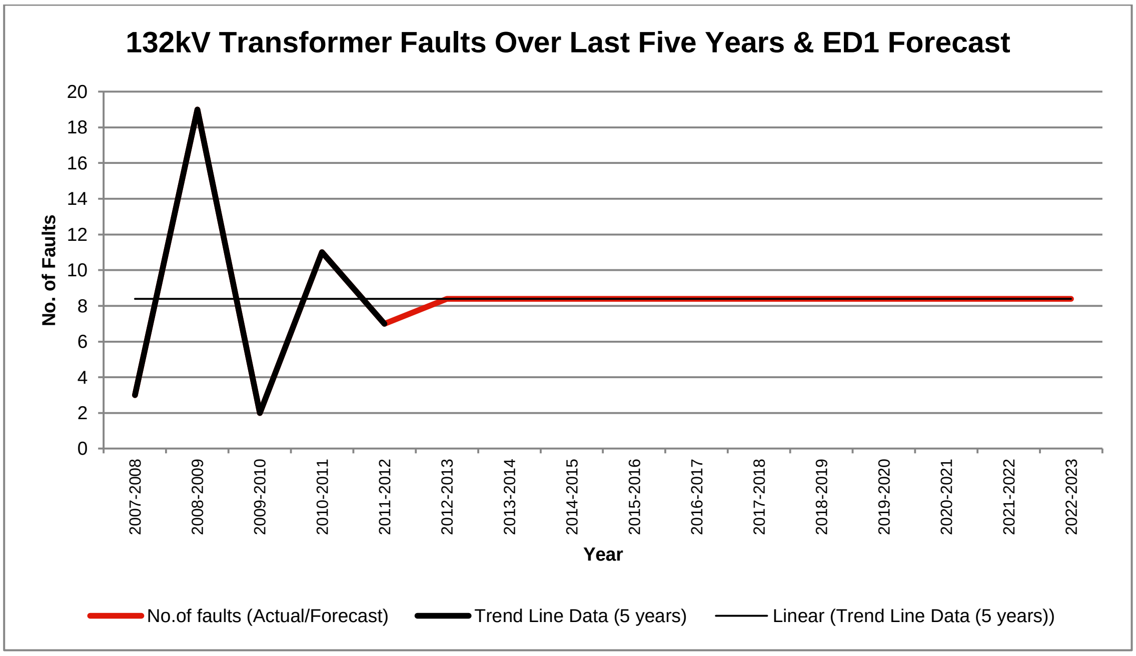


Figure 42 - Data Source: IIS and UKPN Fault Cube

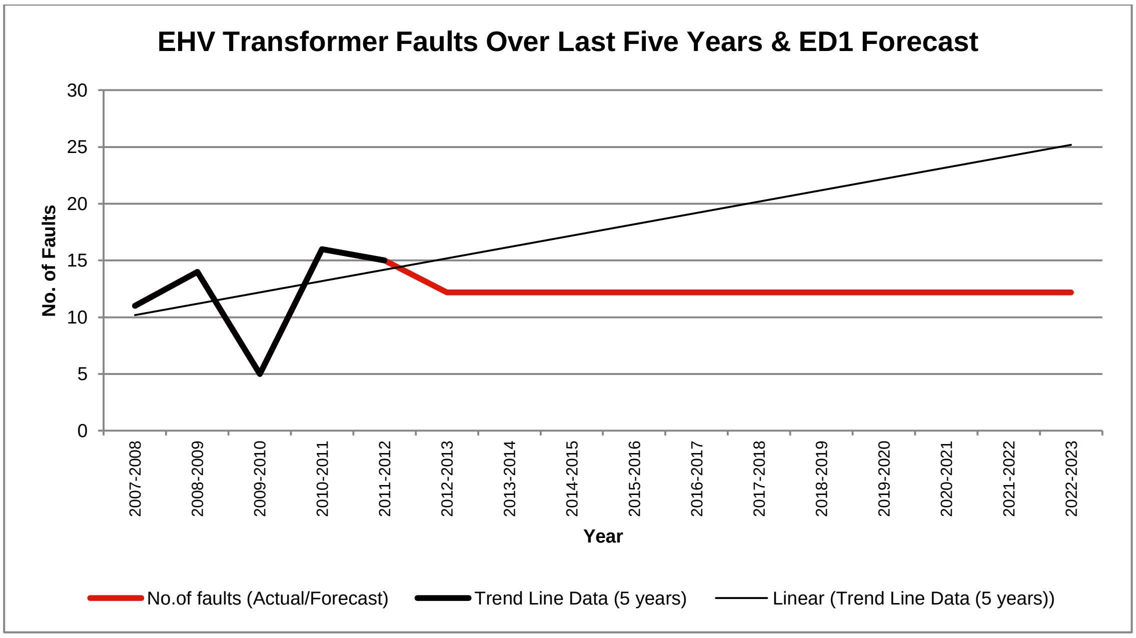


Figure 43 - Data Source: IIS and UKPN Fault Cube

9.3 Faults Plan

Figures 42 and 43 show slightly differing trends over a five year period, although, due to the small numbers of these faults, it is difficult to reliably forecast volumes from the trends. 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.

9.4 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.

9.5 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 has a frequency of two or eight years according to make and type. Figure 44 shows damaged diverter braids.

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 tap changer 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.

Painting provides an opportunity to restore the condition of the external housing of plant where it is seen to be deteriorating quicker than would be expected. This contributes to maintaining the health index of the equipment in line with the predicted rate of degradation within the ARP model, and therefore keeps the forecast replacement date in line.

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 44 – Recording the condition of diverter braids in tap-changers improves our understanding of their wear and maintenance requirements

9.6 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.

9.7 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 11.0.

A revised programme of preventative maintenance in the form of painting transformer radiators/cooling systems has been implemented and will continue over the ED1 period in order to control the rate of degradation of the equipment where it is identified as an issue.

Table 42, Table 43 and Figure 45 show the volume profiles in ED1 and ED2.

Table 43 - DPCR5 & ED1 Forecast – I&M Grid & Primary Transformers

Description of Activity	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
Defect Repair - Grid Transformers/Tapchangers	100	101	102	103	104	104	106	107	108	108
Defect Repair - Primary Transformers/Tapchangers	29	29	29	30	30	30	31	31	31	31
Maintain Power TX	103	75	73	109	122	71	49	45	88	81
Oil Sample Power TX	288	305	325	313	296	305	325	313	296	305
Maintain Auxiliary/Earthing Tx	29	20	13	15	16	13	18	20	35	24
Maintain Neutral Earthing Reactor	1	3	2	0	0	0	0	0	0	0
Maintain Neutral Earthing Resistor	30	23	19	21	20	19	16	22	32	25
Maintain Arc Suppression Coil	0	0	0	0	0	1	1	0	2	0
Maintain Fault Throwing Switches	18	26	23	27	38	26	21	5	19	21
Maintain VT Non-Isolatable	88	9	9	9	9	9	9	9	9	9
Maintain CT	0	0	0	0	0	2	8	2	0	0
Oil Sample Selector	175	186	186	186	186	186	186	186	186	186
Oil Sample NEX	12	3	2	0	0	0	0	0	0	0
Oil Sample ASC	0	0	1	0	1	0	0	0	0	0
Oil Sample Regulator/Balancer	0	0	0	0	1	1	1	2	0	0
Maintain Tapchanger single tank - Contractor	2	2	0	0	0	0	0	0	0	0
Maintain Tapchanger single tank	30	30	55	72	44	30	23	33	30	37
Maintain Tapchanger Diverter	55	45	44	55	64	28	36	36	62	56
Maintain Tapchanger Selector	24	12	10	10	14	4	7	7	14	20
Maintain Tapchanger Vacutap	1	2	2	4	6	6	0	3	0	2
Oil Sample Vacutap	11	16	40	62	73	105	37	51	62	105
Oil Sample VT	7	4	3	0	0	0	0	0	0	0
Oil Sample CT	22	19	15	13	14	18	15	16	19	12
Oil Sample F/Breathing Barrier Bushings	5	7	14	14	14	14	14	14	14	14
Maintain Series / Shunt Reactor	4	0	9	4	14	0	0	16	21	0
Maintain Capacitors	1	0	1	1	1	1	1	1	1	0
Maintenance Sub-Total	**1,035**	**917**	**977**	**1,048**	**1,067**	**973**	**904**	**919**	**1,029**	**1,036**
EHV Transformer / Cooler Painting	13	13	15	19	19	19	19	19	19	19
Maintenance Total	**1,048**	**930**	**992**	**1,067**	**1,086**	**992**	**923**	**938**	**1,048**	**1,055**
Includes RIGs Lines: CV13 Lines 48, 62, 76										

Data Source: NAMP of 19/02/2014

Table 44 – ED2 Forecast – I&M Grid & Primary Transformers

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Grid and Primary Transformers Maintenance	**1,008**	**1,008**	**1,008**	**1,008**	**1,008**	**1,008**	**1,008**	**1,008**

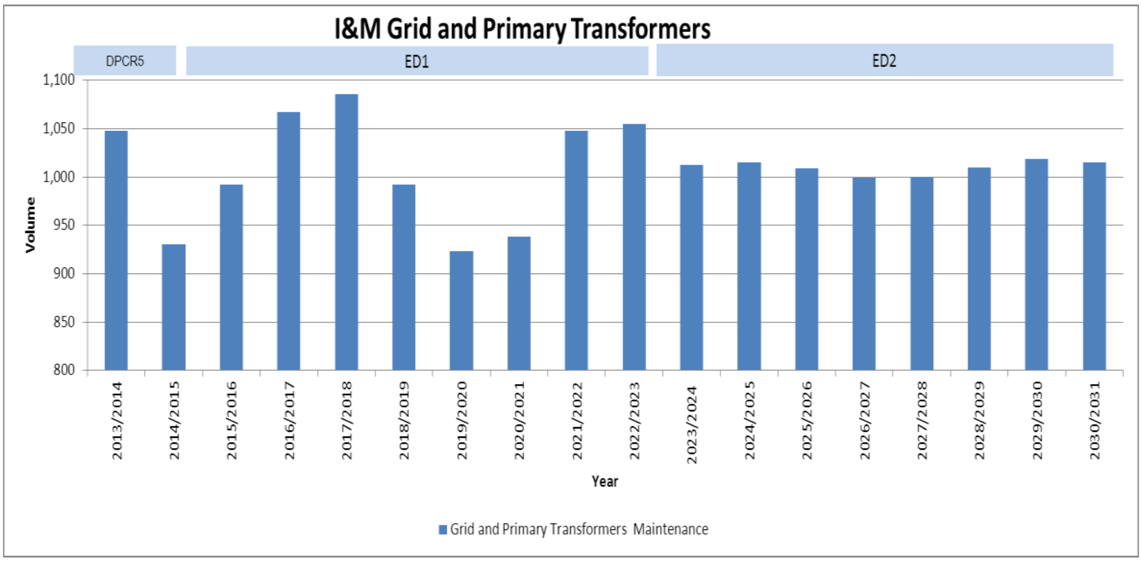


Figure 45 – DPCR5, ED1 & ED2 Historical and Forecast Values

9.8 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.

10.0 Distribution Transformers

10.1 Asset Information

There are 20,857 ground-mounted distribution transformers, with the majority complying with 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 2-11kV. Low voltage output is a standard 230/400 volts, with some single-phase transformers delivering 230/460 volts. Some of the older transformers on the 2kV network are air-cooled. There are some legacy transformer systems, such as the Scott network in Croydon and diametric transformers in Caterham. In particular, the Scott network transformers pose some challenges due to the size of the network, and because they are of an obsolete design, which can pose issues when repairing defects – although often the unit has to be replaced in its entirety. There is a small programme to replace these and the associated network with three-phase distribution transformers and cables which will be funded through capex. Over a period this will generate a source of strategic spares to satisfy the requirements of the remaining network.

10.2 Summary of Fault Trends, Failure Modes and Fault Rates

The fault rate shows a downward trend over a five-year period (see Figure 46). 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) (138 p.a.), and where the fault rate has tended to level out, shows no change in volumes over the period.

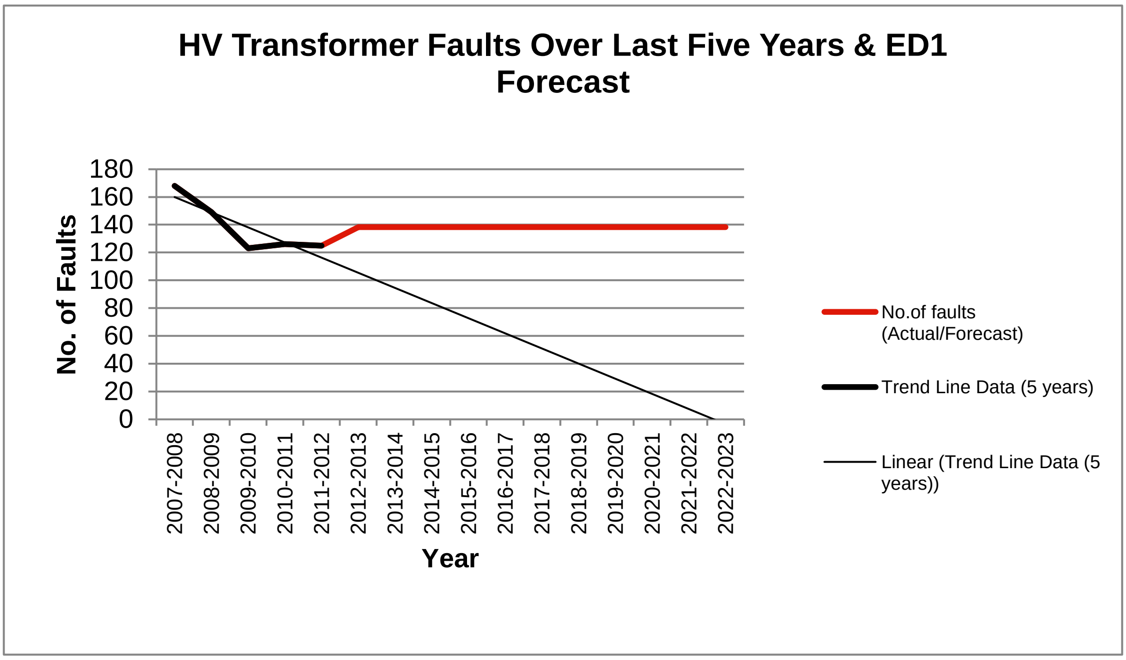


Figure 46- HV transformer faults (Data Source: IIS and UKPN Fault Cube)

10.3 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.

Figure 46 shows a decreasing 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. Opex spend on activities following transformer faults will continue at a constant level.

Volumes for HV transformers are aggregated with HV switchgear (section 7.3) 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. Volumes are shown in section 7.3

10.4 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.

10.5 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.

Painting provides an opportunity to restore the condition of the external housing of plant where it is seen to be deteriorating quicker than would be expected. This contributes to maintaining the health index of the equipment in line with the predicted rate of degradation within the ARP model, and therefore keeps the forecast replacement date in line.

10.6 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.

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 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 11.0.

Also a programme of preventative maintenance in the form of painting transformers has been implemented (volumes are for complete distribution substations and are included in table 35) and will continue over the ED1 period in order to manage the rate of degradation of the equipment where it is identified as an issue.

Table 44, Table 45 and Figure 47 show the volume profiles in ED1 and ED2.

Table 45 - DPCR5 & ED1 Forecast – I&M Distribution Transformers

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	648	643	910	1047	919	701	888	1519	1137	1426
Oil Sample Dist Tx	127	223	280	280	280	280	280	280	280	280
Noise complaint investigations by Operations Note 1	0	2	0	0	0	0	0	0	0	0
Maintenance Total	**775**	**868**	**1190**	**1327**	**1199**	**981**	**1168**	**1799**	**1417**	**1706**
Includes RIGs Lines: CV13 Line 32										

Note 1: Noise complaint investigations cover all transformers, but most are distribution sites.

Data Source: NAMP of 19/02/2014

Table 46 – ED2 Forecast – I&M Distribution Transformers

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Distribution Transformers Maintenance	**1,348**	**1,368**	**1,373**	**1,395**	**1,447**	**1,482**	**1,442**	**1,445**

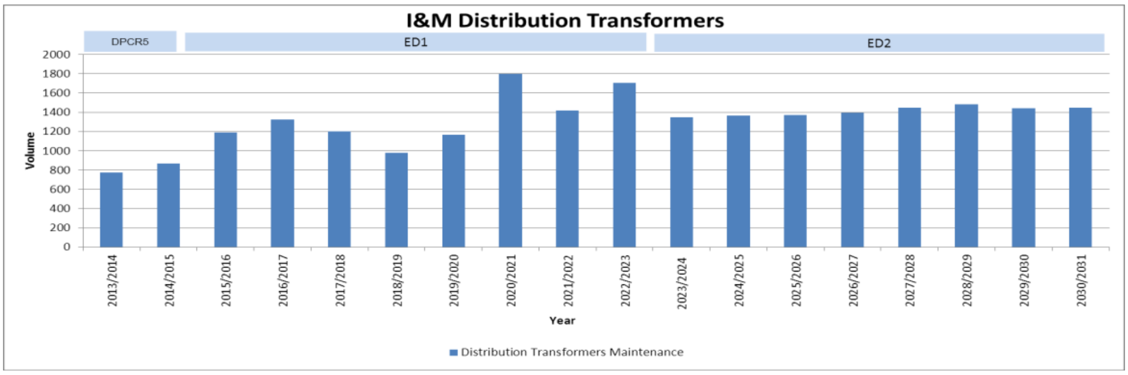


Figure 47 – DPCR5, ED1 & ED2 Historical and Forecast Values

10.8 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 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.

11.0 Sites Housing Electrical Equipment

11.1 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 21,668 substation sites split into 467 grids and primaries, and 21,201 secondary sites. There are also 1,067 reserved substation sites.

Electricity Safety Quality Continuity Regulations (ESQCR) risk ratings are established using EOS 09-0061. A summary of the ESQCR ratings is shown in Table 46.

Table 47 - ESQCR Ratings

ESQCR Risk Rating	Grids & Primaries	Secondary
Very high	22	63
High	88	1,885
Medium	321	12,869
Low	36	6,384

Data Source: UKPN Asset Register

11.2 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.

11.3 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.

11.4 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.

11.5 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. 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 48 shows a portable device used to record condition assessment measurements and to update the asset register.

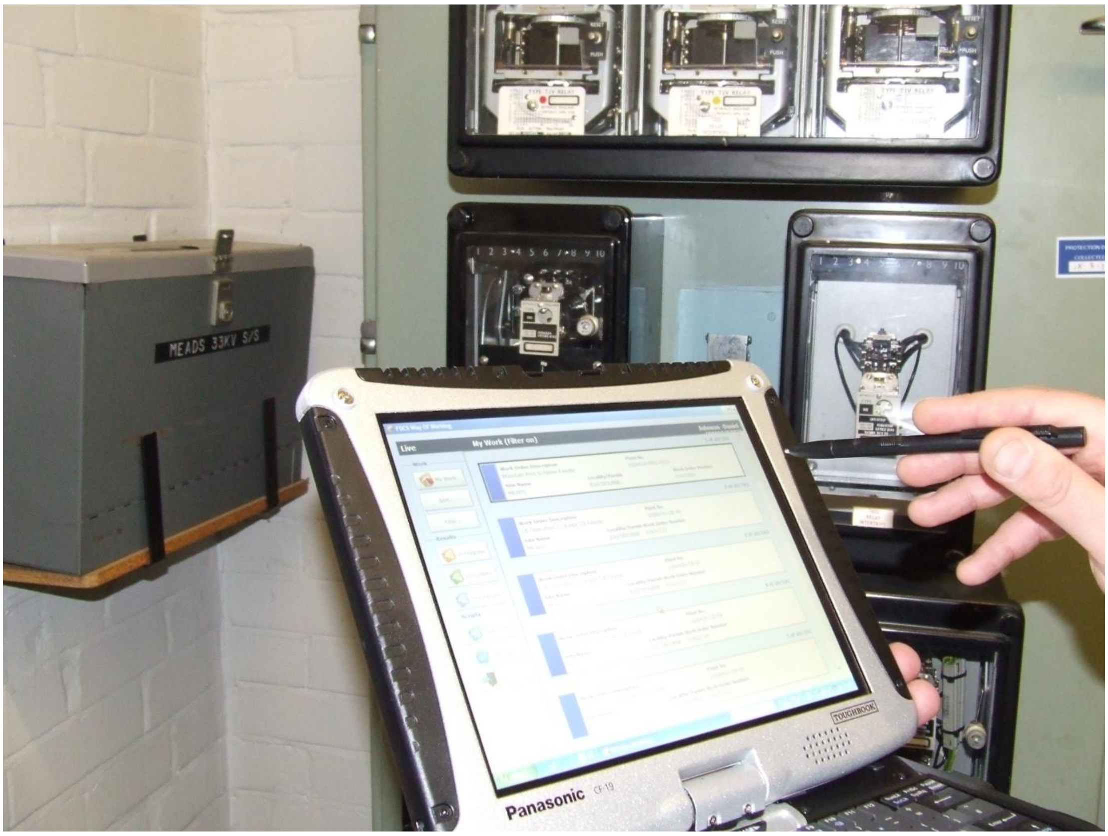


Figure 48 – Recording equipment condition on a portable device for automatic updating of the asset register

11.6 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.

11.7 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 ED1 volumes showing a steady state moving forward.

Security visits are based on 20% of Grid and Primary Sites and 12% of secondary sites requiring attention throughout the year.

Table 47, Table 48 and Figure 49 show the volume profiles in ED1 and ED2.

Table 48 - DPCR5 & ED1 Forecast – I&M Sites Housing Electrical Equipment

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)	465	**534**	**534**	**534**	**534**	**534**	**534**	**534**	**534**	**534**
Inspect Grid/Primary Site (Major)	461	**466**	**466**	**466**	**466**	**466**	**466**	**466**	**466**	**466**
Inspect ESQC Grid/Primary Site High Risk	2,726	**2,722**	**2,722**	**2,722**	**2,722**	**2,722**	**2,722**	**2,722**	**2,722**	**,2722**
Inspect Secondary Substation	6,895	**7,196**	**7,549**	**7,551**	**7,188**	**7,557**	**7,543**	**7,196**	**7,550**	**7,550**
Inspect ESQC Secondary Substation High Risk	6,875	**6,500**	**6,500**	**6,500**	**6,500**	**6,500**	**6,500**	**6,500**	**6,500**	**6,500**
Visit site for security checks (includes redundant sites)	11,686	**11,345**	**11,345**	**11,345**	**11,345**	**11,345**	**11,345**	**11,345**	**11,345**	**11,345**
Inspection Total	**29,108**	**28,763**	**29,116**	**29,118**	**28,755**	**29,124**	**29,110**	**28,763**	**29,117**	**29,117**
Includes RIGs Lines: CV13 Line 23, 24, 44, 58, 72										

Data Source: NAMP of 19/02/2014

Table 49 – ED2 Forecast – I&M Sites Housing Electrical Equipment

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
Sites Housing Electrical Equipment Inspection	**29,028**	**29,016**	**29,004**	**29,035**	**29,024**	**29,013**	**29,044**	**29,035**

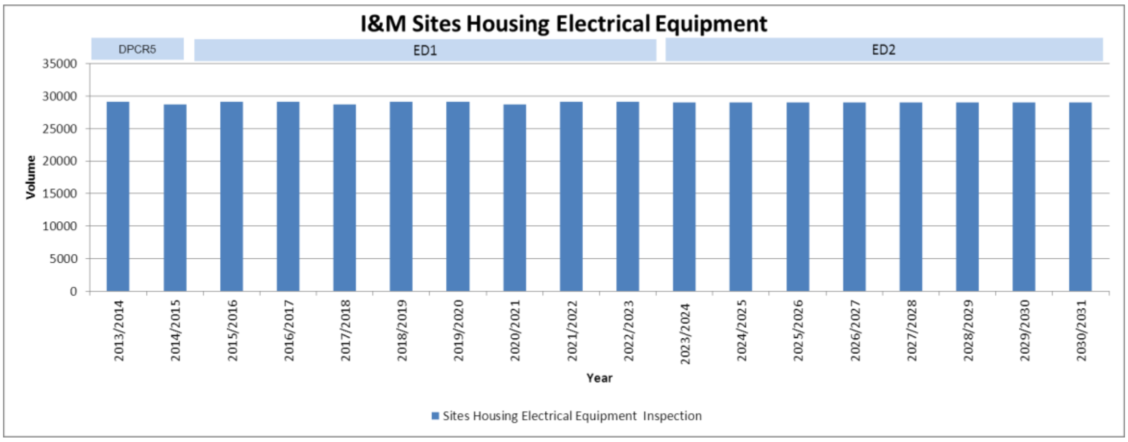


Figure 49 – DPCR5, ED1 & ED2 Historical and Forecast Values

Site inspections cover all plant on the site. At grids and primaries, a minor inspection looks for easily identifiable defects, while major inspections look at items of plant in detail for defects.

11.8 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.

12.0 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 49, Table 50 and Figure 50 show the volume profiles in ED1 and ED2..

Table 50– DPCR5 & ED1 Third Party Damage Forecast Information

Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
LV Cable Damages	310	314	317	320	323	326	330	333	336	340
LV Cable Damage (Consac)	1	1	1	1	1	1	1	1	1	1
LV Overhead Network Damage	118	117	116	115	113	112	111	110	109	108
11kV Overhead Damage	32	32	31	31	30	30	30	30	29	29
11kV Cable Damage	75	75	75	75	75	75	75	75	75	75
33kV Overhead Line Damage	2	2	2	2	2	2	2	2	2	2
Services - LV Cable Damage	891	900	909	918	927	936	946	956	965	974

Data Source: NAMP of 19/02/2014

Table 51– ED2 Third Party Damage Forecast Information

ED2 Volumes	2023 /2024	2024 /2025	2025 /2026	2026 /2027	2027 /2028	2028 /2029	2029 /2030	2030 /2031
LV Cable Damages	328	328	328	328	328	328	328	328
LV Cable Damage (Consac)	1	1	1	1	1	1	1	1
LV Overhead Network Damage	112	112	112	112	112	112	112	112
11kV Overhead Damage	30	30	30	30	30	30	30	30
11kV Cable Damage	75	75	75	75	75	75	75	75
33kV Overhead Line Damage	2	2	2	2	2	2	2	2
Services - LV Cable Damage	941	941	941	941	941	941	941	941

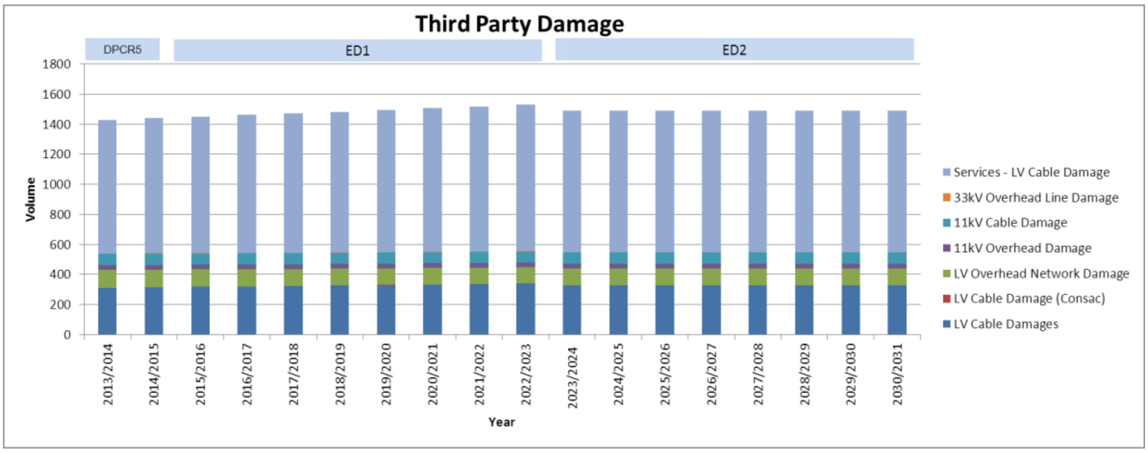


Figure 50 – DPCR5, ED1 & ED2 Historical and Forecast Values

13.0 Trees

Please refer to document 22 for tree related faults data.

14.0 Appendices

Appendix 1 Age Profiles – Not relevant : intentionally left blank

Appendix 2 HI Profiles – Not relevant : intentionally left blank

Appendix 3 Fault Data

OHL Fault Data

Figure 51 Overhead Line Fault Trends (Data Source: Fault Analysis Cube)

Cable Fault Data

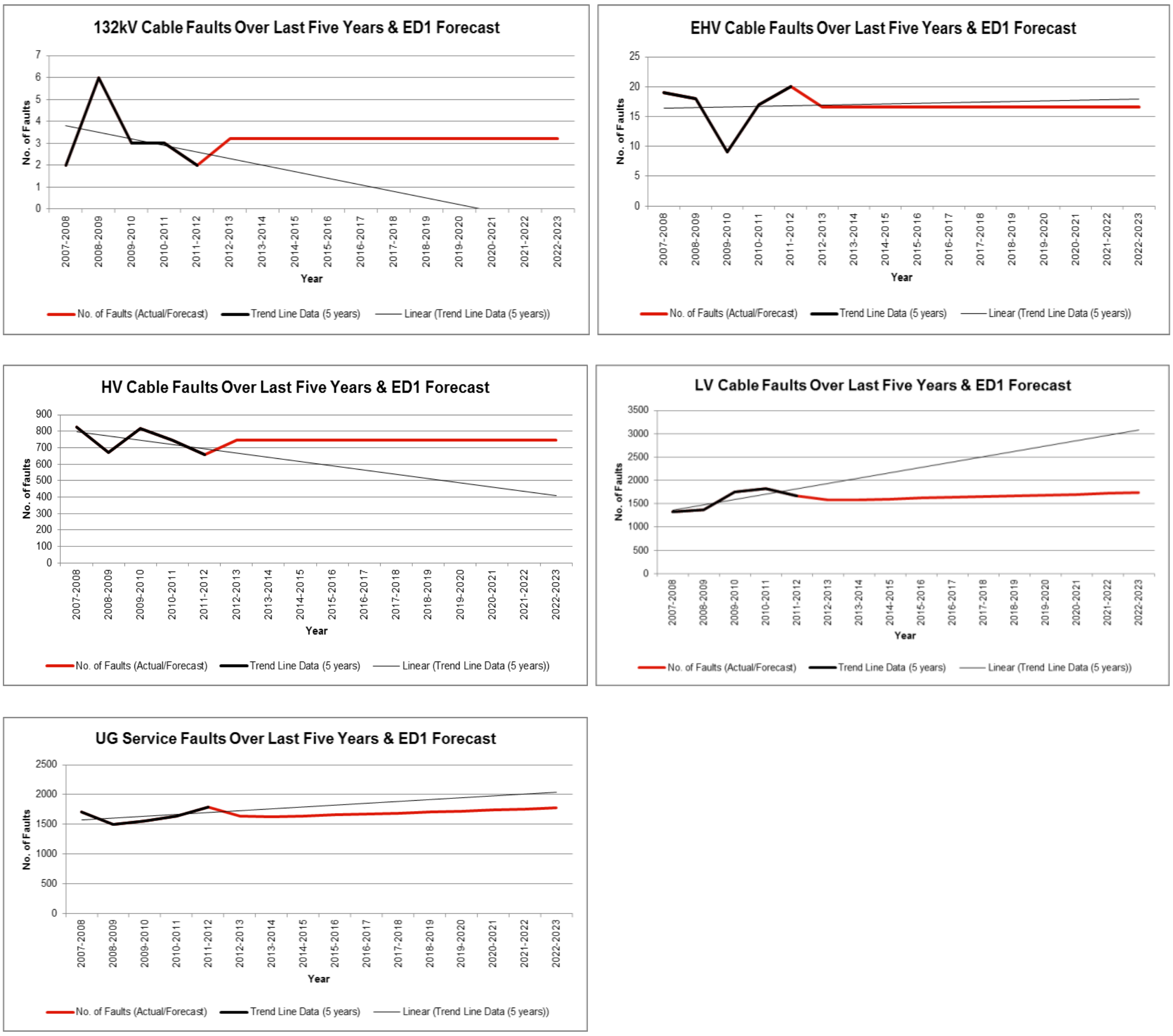


Figure 52 Cable Faults Trends (Data Source: Fault Analysis Cube)

Switchgear Fault Data

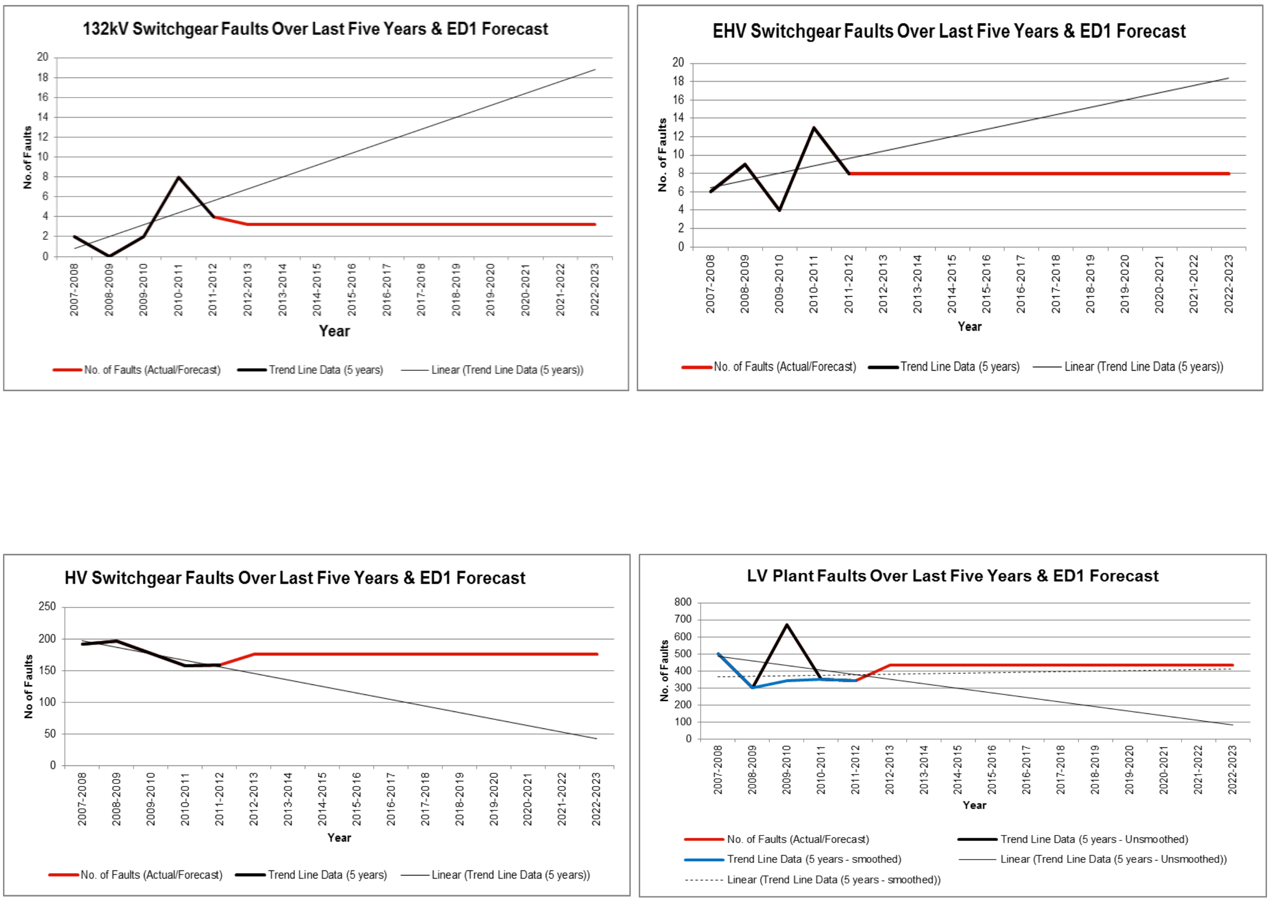
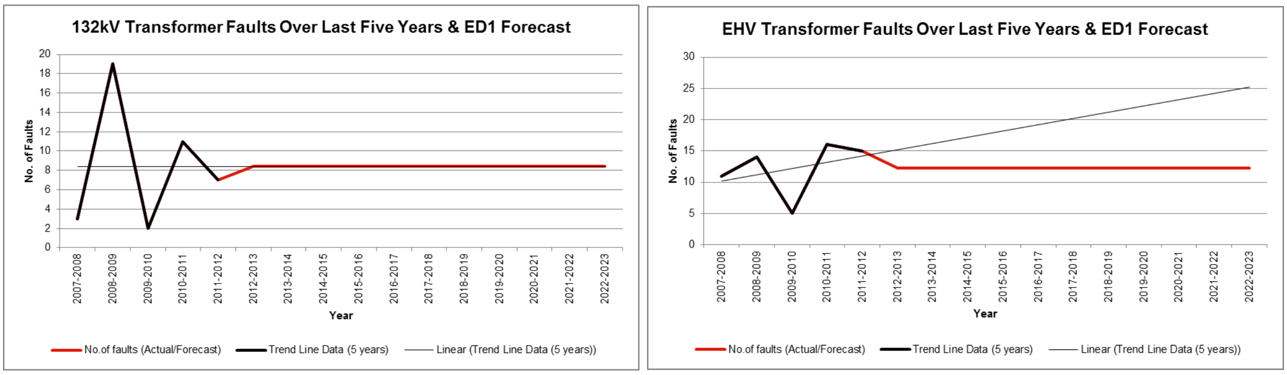


Figure 53 Switchgear Fault Trends (Data Source: Fault Analysis Cube)

Transformer Fault Data



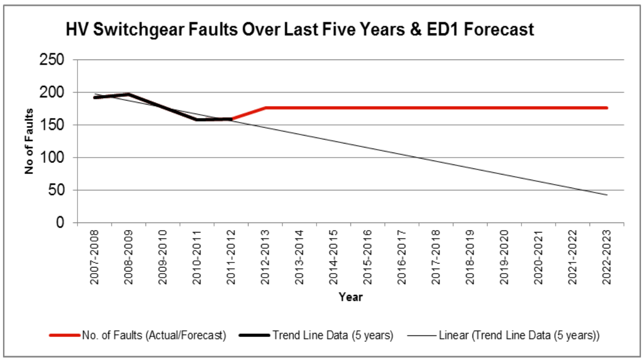


Figure 54 Switchgear Fault Trends (Data Source: Fault Analysis Cube)

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

Appendix 5 NLRE plan All tables included in this document by section

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	37.6	36.0	35.1	37.2	26.5	24.6	24.1	23.9	23.7	23.5	23.4	23.8	24.0	172.5	191.0
Inspection	2.2	2.8	2.9	5.6	4.5	3	3.1	3.1	3.1	3.1	3.1	3.1	3.1	18.1	24.9
Maintenance	7.5	8.5	8	5.6	6.5	6.5	6.5	6.6	6.4	6.3	6.5	6.6	6.4	36.2	51.8
I&M	9.7	11.3	11	11.2	11	9.5	9.6	9.7	9.6	9.5	9.6	9.7	9.5	54.3	76.7
Total	47.3	47.3	46.1	48.4	37.5	34.1	33.7	33.6	33.3	33.0	33.0	33.5	33.5	226.8	267.7

Table 52 - I&M and Faults (All costs)

Sources :
Faults – CV15a and CV15b, 2014 ED1 Business Plan Submission
I&M – CV13 2014 ED1 Business Plan Submission

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	37.6	36.0	35.1	37.2	26.5	24.6	24.1	23.9	23.7	23.5	23.4	23.8	24.0	172.5	191.0
Inspection	2.2	2.8	2.9	5.6	4.4	2.9	3	3	3	3	3	3	3	17.9	24.1
Maintenance	4.4	5.1	5.3	2.2	2.5	2.7	2.7	2.7	2.6	2.5	2.7	2.8	2.8	19.5	21.4
I&M	6.6	7.9	8.2	7.8	6.9	5.6	5.7	5.7	5.6	5.5	5.7	5.8	5.8	37.4	45.5
Total	44.2	43.9	43.3	45.0	33.4	30.2	29.8	29.6	29.3	29.0	29.1	29.6	29.8	209.9	236.5

Table 53 - I&M and Faults (Excluding Civils and Protection)

Sources : I&M – CV13 2014 ED1 Business Plan Submission
Faults – CV15a and CV15b, 2014 ED1 Business Plan Submission

Appendix 6 Sensitivity Analysis – Not relevant: Intentionally left blank

Appendix 7 Named Schemes – Not relevant: Intentionally left blank

Appendix 8 Output NAMP/ED1 RIGS reconciliation

I&M – CV13

Mapped Rigs Volume Row	Current Namp Reference	ProjectID	Project Name	2016	2017	2018	2019	2020	2021	2022	2023	Grand Total
7	4.21.10	**7454**	Full Patrol Wood Pole/Lattice LV	8,735	8,735	8,735	8,735	8,735	8,735	8,735	8,735	69,880
	4.21.13	**7458**	Safety Patrol Wood Pole/Lattice LV	22,437	22,437	22,437	22,437	22,437	22,437	22,437	22,437	179,496
	4.22.04	**7475**	S poles - LV Structural Test After Hammer Test	477	477	477	477	477	477	477	477	3,816
			Subtotal	**31,649**	**31,649**	**31,649**	**31,649**	**31,649**	**31,649**	**31,649**	**31,649**	**253,192**
8	1.13.20	**8976**	Boron Rods SPN (LV poles)	3,126	3,126	3,126	3,126	3,126	3,126	3,126	3,126	25,008
	2.14.03	**6708**	Follow Up - LV	195	196	200	200	204	204	208	208	1,615
			Subtotal	**3,321**	**3,322**	**3,326**	**3,326**	**3,330**	**3,330**	**3,334**	**3,334**	**26,623**
9	2.14.04	**9046**	Shrouding for LV Mains and Services	800	800	800	800	800	800	800	800	6,400
10	4.07.02	**7366**	Inspect LV Link Box	3,793	3,793	3,793	3,793	3,793	3,793	3,793	3,793	30,344
	4.07.03	**7369**	Inspect Network LV Pillar	231	231	231	231	231	231	231	231	1,848
	4.07.07	**7376**	Inspect Service Turret	31	31	31	31	31	31	31	31	248
			Subtotal	**4,055**	**4,055**	**4,055**	**4,055**	**4,055**	**4,055**	**4,055**	**4,055**	**32,440**

11	1.44.07	**6587**	Replace Covers & Frames	300	300	300	300	300	300	300	300	2,400
	2.23.02	**6433**	Defect Repair - LV G/M S/S Equipment	25	25	26	26	26	26	26	27	207
	4.04.27	**7267**	Maintain LV AC Board	4	12	17	32	45	79	13	13	215
	4.08.18	**7404**	Maintain LV Dist.Board (Pillar/TOC)	739	739	739	739	739	739	739	739	5,912
			Subtotal	**1,068**	**1,076**	**1,082**	**1,097**	**1,110**	**1,144**	**1,078**	**1,079**	**8,734**
16	2.30.15	**7122**	Cable Pit Inspection (LV)	286	286	286	286	286	286	111	111	1,938
	2.35.01	**8347**	UMS Services Inspected	16,525	28,600	28,600	28,600	28,600	28,600	28,600	28,600	216,725
	2.36.03	**8418**	Idle Service Inspection	5,720	5,720	5,720	5,720	5,720	5,720	5,720	5,720	45,760
			Subtotal	**22,531**	**34,606**	**34,606**	**34,606**	**34,606**	**34,606**	**34,431**	**34,431**	**264,423**
18	4.21.12	**7456**	Safety Patrol Wood Pole/Lattice HV	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	9,200
19	4.21.08	**8701**	SPN 11KV Full Patrol Wood Pole/Lattice	5,490	5,490	5,490	5,490	5,490	5,490	5,490	5,490	43,920
	4.21.25	**7462**	ESQC Inspection Wood Pole/Lattice HV	5,545	5,545	5,545	5,545	5,545	5,545	5,545	5,545	44,360
	4.22.05	**7477**	S poles - 11kV Structural Test After Hammer Test	152	152	152	152	152	152	152	152	1,216
			Subtotal	**11,187**	**11,187**	**11,187**	**11,187**	**11,187**	**11,187**	**11,187**	**11,187**	**89,496**
20	1.13.20	**8977**	Boron Rods SPN (HV Poles)	1,683	1,683	1,683	1,683	1,683	1,683	1,683	1,683	13,464
	2.14.02	**6707**	Follow Up - 11kV	97	98	100	100	101	102	104	104	806
			Subtotal	**1,780**	**1,781**	**1,783**	**1,783**	**1,784**	**1,785**	**1,787**	**1,787**	**14,270**

21	2.07.12	**7023**	Online Partial Discharge Field Investigations	8	8	8	8	8	8	8	8	64
	2.08.12	**6098**	Online Partial Discharge Monitoring Equipment Maintenance	54	63	74	82	82	82	82	82	601
		7077	Installation and Maintenance of Online PD Monitoring	150	150	150	150	150	150	150	150	1,200
	2.30.15	**8995**	Cable Pit Inspection - HV	192	192	192	192	192	192	72	72	1,296
			Subtotal	**404**	**413**	**424**	**432**	**432**	**432**	**312**	**312**	**3,161**
23	2.21.12	**6311**	VMX Discharge Testing	12	12	12	12	12	12	12	12	96
	2.34.04	**6470**	Voltage/Load Investigations	1,052	1,052	1,052	1,052	1,052	1,052	1,052	1,052	8,416
	4.07.01	**7363**	Inspect Secondary Substation	7,549	7,551	7,188	7,557	7,543	7,196	7,550	7,550	59,684
	4.07.04	**7371**	Inspect 2kV/3.5Kv Pillar	83	83	83	83	83	83	83	83	664
	4.07.06	**7373**	Inspect ESQC Secondary Substation High Risk	6,500	6,500	6,500	6,500	6,500	6,500	6,500	6,500	52,000
			Subtotal	**15,196**	**15,198**	**14,835**	**15,204**	**15,190**	**14,843**	**15,197**	**15,197**	**120,860**
25	1.47.39	**6173**	Dist S/S - Replace Trench Covers	1	0	0	0	0	0	0	1	2
	2.22.02	**8419**	Maintain TC Forced Ventilation	428	628	628	628	628	628	628	628	4,824
	2.23.01	**6432**	11kV Distribution substation	88	89	89	90	92	92	93	95	728
	2.32.05	**6715**	Maintain Distribution Sites & Building - 11kV	333	333	333	333	333	333	332	357	2,687
	2.32.08	**6456**	Vegetation Clearance - 11kV	17,142	17,142	17,142	17,142	17,142	17,142	17,142	14,252	134,246
	2.32.15	**8185**	Tree Trimming (Distribution Sites)	698	698	698	698	698	698	698	698	5,584
	2.33.02	**8188**	Defect Repair - Secondary Substation Civils	1,005	1,100	1,381	1,381	1,381	1,381	1,381	1,381	10,391
	2.33.24	**7090**	Electrical Wiring - Defect Repair at Secondary Substation	78	78	78	78	78	78	78	78	627
	2.34.16	**7012**	Demolish Abandoned/Unsafe Buildings	0	0	0	0	0	0	0	0	3
			Subtotal	**19,77**	**20,06**	**20,35**	**20,35**	**20,35**	**20,35**	**20,35**	**17,49**	**159,09**

				4	**9**	**0**	**1**	**3**	**3**	**3**	**1**	**1**
27	2.20.01	**6711**	11kV Circuit Breakers at grid/primary substation	108	108	109	110	112	112	113	114	886
	4.06.01	**7339**	Maint FULL 11/6.6kV SF6/Vac CB W/B Feed	48	33	72	130	97	71	59	54	564
	4.06.02	**7342**	Maint FULL 11/6.6kV SF6/Vac CB F/B Feed	6	25	45	20	18	49	69	77	309
	4.06.06	**7348**	Maint MECH 11/6.6kV OCB Feeder	80	48	16	0	0	0	0	27	171
	4.06.07	**7351**	Maint MECH 11/6.6kV SF6/Vac CB W/B Feed	1	1	1	1	1	1	1	1	8
	4.06.08	**7354**	Maint MECH 11/6.6kV SF6/Vac CB F/B Feed	5	14	17	0	1	1	3	13	54
	4.06.09	**7357**	Trip Test 11/6.6KV CB Feeder	2,156	2,174	2,156	2,174	2,156	2,174	2,156	2,174	17,320
	4.06.10	**7360**	Maint FULL 11/6.6kV OCB Feeder	72	103	96	77	101	165	130	97	841
	4.08.25	**7419**	Maint FULL 11/6.6kV SF6/Vac CB F/P S/SUB	49	12	73	143	144	159	98	98	776
	4.08.26	**7422**	Maint FULL 11/6.6kV SF6/Vac CB W/D S/SUB	3	2	2	4	4	0	4	2	21
	4.08.29	**7431**	Maint MECH 11/6.6kV SF6/Vac CB F/P S/SUB	0	4	12						16
	4.08.30	**7434**	Maint MECH 11/6.6kV SF6/Vac CB W/D S/SUB	0	0	0	0	1	6	1	7	15
	4.24.01	**7482**	Maint FULL 11/6.6kV OCB TSC	22	23	44	53	66	69	65	51	393
	4.24.02	**7485**	Maint FULL 11/6.6kV SF6/Vac CB W/B TSC	16	10	27	49	40	39	25	23	229
	4.24.03	**7488**	Maint FULL 11/6.6kV SF6/Vac CB F/B TSC	1	10	14	8	5	11	7	11	67
	4.24.05	**7494**	Maint MECH 11/6.6kV OCB TSC	61	45	42	36	36	15	18	23	276
	4.24.06	**7497**	Maint MECH 11/6.6kV SF6/Vac CB W/B TSC	8	8	8	8	8	8	8	8	64
	4.24.07	**7500**	Maint MECH 11/6.6kV SF6/Vac CB F/B TSC	3	3	3	3	3	3	3	3	24
	4.24.08	**7503**	Trip Test 11/6.6KV CB TSC	960	942	960	942	960	942	960	942	7,608
			Subtotal	**3,599**	**3,565**	**3,697**	**3,758**	**3,753**	**3,825**	**3,720**	**3,725**	**29,642**
28	4.08.21	**7410**	Maint FULL 11/6.6kV OCB at S/SUB	61	54	49	35	49	52	45	39	384
	4.08.28	**7428**	Maint MECH 11/6.6kV OCB at S/SUB	12	2	8	6	4	18	24	24	98

			Subtotal	**73**	**56**	**57**	**41**	**53**	**70**	**69**	**63**	**482**
	1.19.04	**6655**	Replace EFPI	270	270	270	270	270	270	270	270	2,160
	2.22.05	**6429**	Plant Paint 11kV & Below	389	671	820	820	820	820	820	820	5,980
	4.02.16	**8203**	Oil Sample Regulator/Balancer		0	1	1	1	2	0	0	5
	4.08.03	**7378**	Maintain Non-Isolatable Oil Switch	343	289	328	261	143	209	525	277	2,375
	4.08.06	**7382**	Maintain Non-Isolatable RMU (Oil)	62	112	193	189	93	128	292	324	1,393
30	4.08.07	**7384**	Maintain Non-Isolatable RMU (Gas/Vacuum)	0	0	3	3	2	1	0	1	10
	4.08.08	**8209**	Maintain Isolatable Oil Switch	39	49	38	31	33	27	42	56	316
	4.08.10	**7390**	Maintain Switch Fuse	234	305	206	144	144	155	192	189	1,569
	4.08.13	**7393**	Maintain HV Metering Unit	40	40	32	33	27	28	26	27	253
	4.08.16	**7399**	Maintain Fused End Box	70	0	0	0	0	0	20	90	180
	4.08.35	**8459**	Maintain Mech Non Isolatable Oil Switch	127	12	28	18	24	56	187	272	724
			Subtotal	**1,574**	**1,748**	**1,919**	**1,770**	**1,557**	**1,696**	**2,374**	**2,326**	**14,965**
	2.25.06	**6437**	11kV Feeder Protection	199	199	199	199	199	199	199	199	1,592
	2.25.13	**8360**	Trip Testing 11kV Sequence Closing	416	416	416	416	416	416	416	416	3,328
	2.26.03	**6468**	Defect Repair - 11 kV Protection	10	10	10	10	10	10	10	10	80
31	2.28.05	**6645**	3rd Party Circuit Faults	8	8	8	8	6	6	6	6	56
	2.28.07	**9470**	UKPN Circuit Faults	5	5	5	6	7	7	7	8	50
	2.28.16	**6646**	SCS Comms/Plant Faults	759	780	800	820	833	820	800	779	6,391
			Subtotal	**1,397**	**1,418**	**1,438**	**1,459**	**1,471**	**1,458**	**1,438**	**1,418**	**11,497**
32	4.08.17	**7401**	Maintain Distribution Tx	910	1,047	919	701	888	1,519	1,137	1,426	8,547
	4.08.22	**7413**	Oil Sample Dist Tx	280	280	280	280	280	280	280	280	2,240

			Subtotal	**1,190**	**1,327**	**1,199**	**981**	**1,168**	**1,799**	**1,417**	**1,706**	**10,787**
35	1.19.09	**6534**	Replace 11kV Surge Divertors	70	70	70	70	70	70	70	70	560
	4.22.02	**7471**	Maintain ABSD 11kV	4	4	4	4	4	4	4	4	32
			Subtotal	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**592**
36	4.21.12	**8691**	Safety Patrol Wood Pole/Lattice EHV	316	316	316	316	316	316	316	316	2,528
37	4.21.08	**8700**	SPN 33KV Full Patrol Wood Pole/Lattice	848	848	848	848	848	848	848	848	6,784
	4.22.03	**7473**	S poles - 33kV Structural Test After Hammer Test	51	51	51	51	51	51	51	51	408
			Subtotal	**899**	**899**	**899**	**899**	**899**	**899**	**899**	**899**	**7,192**
38	1.13.20	**8383**	Boron Rods SPN (EHV)	291	291	291	291	291	291	291	291	2,328
	2.14.01	**6706**	Follow Up - 33kV	45	45	45	46	46	48	48	48	371
			Subtotal	**336**	**336**	**336**	**337**	**337**	**339**	**339**	**339**	**2,699**
39	4.21.04	**8682**	SPN 33KV Safety Patrols Broad Based Towers	42	42	42	42	42	42	42	42	336
	4.21.21	**8677**	SPN 33KV Infra Red Tower Route	25	25	25	25	25	25	25	25	200
			Subtotal	**67**	**67**	**67**	**67**	**67**	**67**	**67**	**67**	**536**
40	4.21.02	**8695**	SPN 33KV Full Patrol Broad Based Tower	288	288	288	288	288	288	288	288	2,304
	4.21.29	**8673**	SPN 33KV Cormon Testing	2	2	2	2	2	2	2	2	16
			Subtotal	**290**	**290**	**290**	**290**	**290**	**290**	**290**	**290**	**2,320**

42	4.25.04	**7515**	Check Pressure (Oil/Gas)	93	93	93	93	93	93	93	93	744
44	2.30.09	**6712**	Visit Site for Security Checks (Includes Redundant Sites) - Primary Sites	7,942	7,942	7,942	7,942	7,942	7,942	7,942	7,942	63,536
	2.30.22	**6842**	PAT Testing at Grid & Primary Substations	25	4	4	4	4	4	4	4	53
	2.30.23	**8985**	Water Quality Testing at Primary Substations	105	105	105	105	105	105	105	105	840
	2.33.25	**8458**	Drainage Inspection & Maintenance	5	4	4	4	4	4	4	4	33
	4.05.01	**7303**	Inspect Grid/Primary Site (Minor)	534	534	534	534	534	534	534	534	4,272
	4.05.03	**7306**	Inspect Grid/Primary Site (Major)	466	466	466	466	466	466	466	466	3,728
	4.05.49	**7318**	Insurance Insp. ABCB Complete Unit	22	22	22	22	22	22	22	22	176
	4.05.53	**7324**	Inspect Flexible Earths & Rods	104	104	104	104	104	104	104	104	832
	4.05.57	**8997**	Inspect ESQC Primary Site High Risk	2,041	2,041	2,041	2,041	2,041	2,041	2,041	2,041	16,328
	4.05.60	**6812**	Record EPR & Identification of Hot Sites	27	27	27	27	27	27	27	27	216
			Subtotal	**11,271**	**11,249**	**11,249**	**11,249**	**11,249**	**11,249**	**11,249**	**11,249**	**90,014**
45	2.28.19	**9489**	Substation Security System Maintenance	206	206	206	206	193	154	154	154	1,479
	2.28.20	**6466**	Substation Security System Repairs/Fault Rectification	99	99	99	99	92	74	74	74	710
	2.32.04	**6714**	Maintain Primary Sites & Building - 33kV	151	151	151	151	151	151	151	151	1,208
	2.32.15	**8685**	Tree Trimming (Primary Sites)	10	10	10	10	10	10	10	10	80
	2.33.03	**8979**	Defect Repair - Primary Substation Civils	118	71	71	71	71	71	71	123	667
	2.33.17	**8420**	Pumping Out Flooded Substations	6	6	6	6	6	6	6	6	48
	2.33.20	**8193**	Fire Risk Assessment - Remedial Work	0	154	154	154	154	154	154	154	1,078
	2.33.22	**8982**	Electrical Wiring - Defect Repair at Primaries	79	79	79	79	79	79	79	68	621
			Subtotal	**669**	**776**	**776**	**776**	**756**	**699**	**699**	**740**	**5,891**

	2.17.01	**6709**	Defect Repair - 33/22 kV Switchgear	19	19	20	20	20	20	20	20	158
	2.23.03	**6434**	Plant Forensic Testing and Failure Investigation	17	17	17	17	17	17	17	17	136
	2.45.01	**6378**	Strategic Spares Provision	51	51	50	50	50	50	50	50	402
	4.02.08	**7164**	Maintain Fault Throwing Switches	23	27	38	26	21	5	19	21	180
	4.04.03	**7214**	Maintain 33/22kV Oil CB	16	8	21	37	30	30	48	42	232
	4.04.04	**7217**	Maint FULL 33/22kV Vac/SF6 O/D CB	1	0							1
46	4.04.05	**7220**	Maint FULL 33/22kV Vac/SF6 F/P & GIS CB	12	23	15	18	29	27	29	36	189
	4.04.09	**7226**	Maintain Mechanism 33/22kV Oil CB	47	46	39	29	31	24	20	13	249
	4.04.11	**7231**	Maint MECH 33/22kV Vac/SF6 F/P & GIS CB	5	5	5	5	5	5	5	5	40
	4.04.12	**7234**	Trip Test 33/22kV CB Inc Op of Isolators	510	485	510	485	510	485	478	247	3,710
	4.04.35	**7291**	Maint FULL 33/22kV Vac/SF6 W/D CB	3	11	9	4	1	2	2	8	40
	4.04.36	**7294**	Maint MECH 33/22kV Vac/SF6 W/D CB	1	1	1	1	1	1	1	1	8
	4.22.01	**7469**	Maintain ABSD 33kV	3	3	3	3	3	3	3	3	24
			Subtotal	**708**	**696**	**728**	**695**	**718**	**669**	**692**	**463**	**5,369**
	2.25.04	**6571**	33kV Feeder Protection	55	55	55	55	55	55	55	55	440
	2.25.05	**6436**	System Transformer Protection	40	40	40	40	40	40	40	40	320
47	2.25.12	**8359**	Trip Testing 33kV AR	113	113	113	113	113	113	113	113	904
	2.26.01	**6467**	Defect Repair - EHV Protection	3	3	3	3	4	4	4	4	28
	2.28.28	**6389**	Satellite Comms Faults	26	26	26	26	26	26	26	26	208
			Subtotal	**237**	**237**	**237**	**237**	**238**	**238**	**238**	**238**	**1,900**
48	2.03.23	**6414**	EHV Transformer / Cooler Painting	15	19	19	19	19	19	19	19	148
	4.02.07	**8195**	Maintain Arc Suppression Coil			0	1	1	0	2		4

	4.02.15	**8196**	Oil Sample ASC	1	0	1						2
			Subtotal	**16**	**19**	**20**	**20**	**20**	**19**	**21**	**19**	**154**
64	4.21.12	**8692**	Safety Patrol Wood Pole/Lattice 132kV	52	5	5	5	5	5	5	5	87
65	4.21.08	**7452**	SPN 132KV Full Patrol Wood Pole/Lattice	52	52	52	52	52	52	52	52	416
67	4.21.04	**7446**	SPN 132KV Safety Patrols Broad based towers	572	572	572	572	572	572	572	572	4,576
	4.21.21	**7460**	SPN 132KV Infra Red Patrol Route	326	326	326	326	326	326	326	326	2,608
			Subtotal	**898**	**898**	**898**	**898**	**898**	**898**	**898**	**898**	**7,184**
68	4.21.02	**7443**	SPN 132KV Full Patrol Broad Based Tower	1,288	1,288	1,288	1,288	1,288	1,288	1,288	1,288	10,304
	4.21.05	**7449**	Climbing Inspection Broad Based Tower	100	100	100	100	100	100	100	100	800
	4.21.28	**7464**	Spacer Checks Twin Bundles	3	3	3	3	3	3	3	3	24
	4.21.29	**7466**	SPN 132KV Cormon Testing	23	23	23	23	23	23	23	23	184
	4.22.07	**7480**	GS6 Enquiries	2,294	2,294	2,294	2,294	2,294	2,294	2,294	2,294	18,352
			Subtotal	**3,708**	**3,708**	**3,708**	**3,708**	**3,708**	**3,708**	**3,708**	**3,708**	**29,664**
69	1.20.03	**6200**	Install Tower Signs, Colour Plates Etc.	129								129
70	2.05.09	**6419**	Gauges-132/33kV Inspect and Alarm Test	183	184	183	184	183	184	183	184	1,468
	2.05.10	**6420**	Gas Cable - Cylinder Change	200	200	200	200	200	200	200	200	1,600

	2.05.12	**6422**	Tank Inspection (Above Ground)	13	13	13	13	13	13	13	13	104
	2.05.14	**6773**	Gauge Mal Function Investigation	2	2	2	2	2	2	2	2	16
	2.07.01	**6175**	Partial Discharge Mapping - HV	4	4	4	4	4	4	4	4	32
	2.34.07	**6471**	Abandoned/Unidentified Cable Location	8	8	8	8	8	8	8	8	64
	4.25.01	**7509**	Calibrate Pressure Gauge	5	5	5	5	5	5	5	5	40
	4.25.02	**7512**	Inspect and Test Pressure Gauge	58	58	58	58	58	58	58	58	464
	4.25.05	**7518**	Test Cable Serving / Oversheath	12	12	12	12	12	12	12	12	96
	4.25.06	**7521**	Test Sheath Voltage Limiters (SVLs)	12	12	12	12	12	12	12	12	96
			Subtotal	**497**	**498**	**497**	**498**	**497**	**498**	**497**	**498**	**3,980**
71	2.05.08	**6418**	Cable Pit Maintain	57	57	57	57	57	57	9	9	360
	2.06.01	**6703**	Oil Top Up; Pumping & Testing - 132-33kV	52	52	52	52	52	52	52	52	416
	2.06.02	**6407**	Repair Oil Leak	35	35	35	35	35	35	35	35	280
	2.06.03	**6768**	Defect Repair Gas	4	4	4	4	4	4	4	4	32
	2.06.09	**6704**	Replace Minor Oil Plant + Sheath Testing	14	14	14	14	14	14	14	14	112
			Subtotal	**162**	**162**	**162**	**162**	**162**	**162**	**114**	**114**	**1,200**
72	2.17.04	**6561**	Inspection and Testing of Lifting Equipment	4	3	4	3	4	3	4	3	28
	2.25.07	**9396**	AVC checks at Grids & Primaries	54	54	54	54	54	54	54	54	432
	2.30.09	**8987**	Visit Site for Security Checks (Includes Redundant Sites) - Grid Sites	3,403	3,403	3,403	3,403	3,403	3,403	3,403	3,403	27,224
	2.30.23	**8182**	Water Quality Testing at Grid Substations	350	350	350	350	350	350	350	350	2,800
	2.33.19	**8192**	Water Testing - Remedial Works	42	42	42	42	42	42	42	42	336
	2.34.03	**6469**	EMF Enquiries	7	7	7	7	7	7	7	7	56
	4.05.03	**7330**	Inspect ESQC Grid Site High Risk	681	681	681	681	681	681	681	681	5,448
	4.05.37	**7309**	Inspect Air Compressor	61	61	61	61	61	61	61	61	488

	4.05.38	**7312**	Inspect Main Air Receiver	67	67	67	67	67	67	67	67	536
	4.05.48	**7315**	Insurance Insp. Air/Gas Receiver	9	4	4	9	9	4	4	8	51
	4.05.52	**7321**	Insurance Insp. Air Panel	2	1	1	2	2	1	1	2	12
	4.05.56	**7327**	Infra-Red Inspection Aerial Sets/Busbars	291	291	291	291	291	291	291	291	2,328
	4.05.58	**7333**	Insurance Insp Switchgear Accumulator	12	12	12	12	12	12	12	12	96
			Subtotal	**4,983**	**4,976**	**4,977**	**4,982**	**4,983**	**4,976**	**4,977**	**4,981**	**39,835**
73	2.32.02	**8184**	Graffitti Removal (was Veg Clearance)	122	122	122	122	122	122	122	122	976
	2.32.03	**6713**	Maintain Grid Sites & Building - 132kV	184	184	184	184	184	184	183	173	1,460
	2.32.06	**6454**	Vegetation Clearance - 132kV	66	66	66	66	66	66	66	66	528
		6455	Vegetation Clearance - 33kV	330	330	330	330	330	330	330	330	2,640
	2.32.15	**8686**	Tree trimming (Grid Sites)	5	5	5	5	5	5	5	5	40
	2.33.03	**8189**	Defect Repair - Grid Substation Civils	118	71	71	71	71	71	71	123	667
	2.33.06	**8190**	132&33kV Fly Tipping Site Clearance	26	26	26	26	26	26	26	26	208
	2.33.22	**8194**	Electrical Wiring - Defect Repair at Grids	79	79	79	79	79	79	79	67	620
			Subtotal	**930**	**883**	**883**	**883**	**883**	**883**	**882**	**912**	**7,139**
74	2.17.02	**6710**	Defect Repair - 132/66 kV Switchgear	40	40	40	41	41	41	42	42	327
	2.25.02	**9395**	132kV CB Feeder Including BS	16	16	16	16	16	16	16	16	128
	4.02.10	**7169**	Maintain VT Non-Isolatable	9	9	9	9	9	9	9	9	72
	4.02.21	**7197**	Oil Sample VT	3								3
	4.02.23	**7200**	Oil Sample CT	15	13	14	18	15	16	19	12	122
	4.04.13	**7237**	Maintain Full 132/66kV Air Blast CB	5	5	1	2	1	1	0	1	16
	4.04.14	**8205**	Maint Full 132/66kV Oil CB	7	4	10	4	1	0	0	3	29
	4.04.16	**7243**	Maint FULL 132/66kV SF6 O/D CB	8	8	7	6	15	12	8	14	78

	4.04.20	**7249**	Maintain Mechanism 132/66kV Oil CB	0	0	0	0	1	0	6	6	13
	4.04.22	**7252**	Maint MECH 132/66kV SF6 O/D CB	1	1	1	1	1	1	1	1	8
	4.04.23	**7255**	Trip Test 132/66kV CB & Op of Ext Isolators	129	130	129	130	129	130	122	94	993
	4.04.24	**7258**	Maintain Isolator (Manual)	4	4	4	4	4	4	4	4	32
	4.04.25	**7261**	Maint. Isolator (Motorised)	0	4	12	0	0	0	0	1	17
	4.04.26	**7264**	Maintain Earth Switch	4	4	4	4	4	4	4	4	32
	4.04.28	**7270**	Maintain Air Compressor	12	12	12	12	12	12	12	12	96
	4.04.33	**7285**	Maintain Mech 132/66kV Air Blast CB	3	5	3	4	6	9	6	4	40
	4.04.34	**7288**	Maintain Capacitors	1	1	1	1	1	1	1		7
	4.04.37	**7297**	Maint FULL 132/66kV SF6 GIS CB	2	6	17	4	0	1	2	1	33
	4.05.59	**7336**	Partial Discharge Test of Switchboard	16	16	16	16	16	16	16	16	128
			Subtotal	**275**	**278**	**296**	**272**	**272**	**273**	**268**	**240**	**2,174**
	2.25.03	**6570**	Grid Transformer Protection	14	14	14	14	14	14	14	14	112
	2.25.09	**8357**	Low Frequency - 132kV Injection Test	4	4	4	4	4	4	4	3	31
	2.25.10	**9397**	132kV Buz Zone	5	5	5	5	5	5	5	5	40
	2.25.11	**8358**	Trip Testing 132kV DAR	30	30	30	30	30	30	30	30	240
75	2.25.15	**6439**	Pilots and Multicores Test Insulation and Continuity	88	88	88	88	88	88	88	88	704
	2.25.16	**9398**	NVD Function Test	20	20	20	20	20	20	20	20	160
	2.28.18	**9471**	Intertripping Faults	18	18	18	18	18	18	18	18	144
	2.28.29	**9472**	SPN SCADA System Management DR5/ED1	240	240	240	240	240	240	240	240	1,920
	4.02.11	**7172**	Maintain CT	0	0	0	2	8	2			12
			Subtotal	**419**	**419**	**419**	**421**	**427**	**421**	**419**	**418**	**3,363**
76	1.51.05	**6983**	Replace Silica Gel Breathers on Grid and System Transformers	83	83	83	83	83	83	83	62	644

	4.02.01	**7147**	Maintain Power Tx	73	109	122	71	49	45	88	81	638
	4.02.02	**7150**	Oil Sample Power Tx	325	313	296	305	325	313	296	305	2,478
	4.02.03	**7153**	Maintain Auxiliary/Earthing Tx	13	15	16	13	18	20	35	24	154
	4.02.05	**7156**	Maintain Neutral Earthing Reactor	2								2
	4.02.06	**7159**	Maintain Neutral Earthing Resistor	19	21	20	19	16	22	32	25	174
	4.02.13	**7178**	Oil Sample Selector	186	186	186	186	186	186	186	186	1,488
	4.02.14	**7181**	Oil Sample NEX	2								2
	4.02.17	**7185**	Maintain Tapchanger Single Tank	55	72	44	30	23	33	30	37	324
	4.02.18	**7188**	Maintain Tapchanger Diverter	44	55	64	28	36	36	62	56	381
	4.02.19	**7191**	Maintain Tapchanger Selector	10	10	14	4	7	7	14	20	86
	4.02.20	**7194**	Maintain Tapchanger Vacutap	2	4	6	6	0	3	0	2	23
		8374	Oil Sample Vacutap	40	62	73	105	37	51	62	105	535
	4.02.24	**7203**	Oil Sample F/Breathing Barrier Bushings	14	14	14	14	14	14	14	14	112
	4.02.26	**7208**	Maintain Series / Shunt Reactor	9	4	14	0	0	16	21	0	64
			Subtotal	**877**	**948**	**952**	**864**	**794**	**829**	**923**	**917**	**7,105**
77	4.04.02	**7211**	Maintain Batteries and Charger	48	48	48	48	48	48	48	48	384
78	2.30.14	**6320**	Cable Tunnel Inspections	840	840	840	840	840	840	840	630	6,510
	2.30.21	**6322**	Building, Tunnel and Bridge Survey	15	15	15	15	15	15	15	15	120
			Subtotal	**855**	**855**	**855**	**855**	**855**	**855**	**855**	**645**	**6,630**
79	2.32.17	**8186**	Cable Tunnel Maintenance	4	4	4	4	3	3	3	5	30

80	2.30.13	**6314**	Cable Bridge Inspections	68	68	68	68	68	68	68	68	544
81	2.32.18	**8187**	Cable Bridge Maintenance - SPN	34	34	34	34	34	34	34	34	272
			Subtotal	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**102**	**816**

Table 54 NAMP to RIGS table mappings (I&M) – CV13

c	MappedRigsVolumeTable	MappedRigsVolume Row	Current NampReference	ProjectID	ProjectName	2016	2017	2018	2019	2020	2021	2022	2023	Grand Total
SPN	**CV5**	50	**2.10.01**	6705	132kV / 66kV Tower Painting	87	98	130	130	130	130	130	130	965

Table 55 NAMP to RIGS table mappings – Tower Painting (CV5)

Faults - CV15a

Mapped Rigs Volume Row	Current Namp Reference	ProjectID	Project Name	2016	2017	2018	2019	2020	2021	2022	2023	Grand Total
6	2.01.28	6688	Blown LV Fuses at Substations	1,925	1,925	1,925	1,925	1,925	1,925	1,925	1,925	15,400

	2.01.44	6690	HV Fault Restoration by Switching Only	706	706	706	706	706	706	706	706	5,648
	2.01.50	8586	EHV Fault Restoration by Switching Only	18	18	18	18	18	18	18	18	144
9	2.01.51	8587	132kV Fault Restoration by Switching Only	4	4	4	4	4	4	4	4	32
14	2.01.10	6684	LV Service Fault Repairs Overhead	813	813	813	813	813	813	813	813	6,504
	2.01.07	6683	LV Service Fault Repairs Underground	1,658	1,674	1,691	1,708	1,725	1,742	1,760	1,777	13,735
	3.01.15	8579	Services - LV Cable Damage	908.999999	918	926.999998	936	945.999999	955.999999	965	973.999998	7530.999992
			Subtotal	**2,567**	**2,592**	**2,618**	**2,644**	**2,671**	**2,698**	**2,725**	**2,751**	**21,266**
	2.01.27	6687	LV U/G Cable Fault Repairs	1,685	1,685	1,685	1,685	1,685	1,685	1,686	1,686	13,482
	3.01.01	6639	LV Cable Damages	317	320	323	326	330	333	336	340	2,625
			Subtotal	**2,002**	**2,005**	**2,008**	**2,011**	**2,015**	**2,018**	**2,022**	**2,026**	**16,107**
18	2.01.26	8582	LV Underground Cable Fault (Consac)	17	17	17	17	17	17	17	17	136
	3.01.03	8588	LV Cable Damage (Consac)	1	1	1	1	1	1	1	1	8

			Subtotal	**18**	**18**	**18**	**18**	**18**	**18**	**18**	**18**	**144**
	2.01.04	6682	LV Overhead Network Fault Repairs	828	819	811	803	795	787	779	771	6,393
19	3.01.04	8603	LV Overhead Network Damage	116	115	113	112	111	110	109	108	894
			Subtotal	**944**	**934**	**924**	**915**	**906**	**897**	**888**	**879**	**7,287**
20	2.01.19	6578	Other Plant (LV Etc)	432	432	432	432	432	432	432	432	3456
	2.01.24	6686	HV Cable Fault Repairs	744	744	744	744	744	744	744	744	5,952
	3.01.11	8607	HV Cable Damage	75	75	75	75	75	75	75	75	600
			Subtotal	**819**	**819**	**819**	**819**	**819**	**819**	**819**	**819**	**6,552**
23	2.01.03	6681	HV OHL Fault Repairs	604.999999	597.999999	590.999999	586	580	573.999999	567.999999	563.999999	4665.999992
	3.01.10	8606	HV Overhead Damage	31	31	30	30	30	30	29	29	240
			Subtotal	**636**	**629**	**621**	**616**	**610**	**604**	**597**	**593**	**4,906**
	2.01.17	8576	HV Pole Mounted Switchgear (Circuit Breaker) Fault	3	3	3	3	3	3	3	3	24
	2.01.18	8671	HV Pole Mounted Switchgear (Not CB) Fault	26	26	26	26	26	26	26	26	208
	2.50.02	9681	Capital Replacement of Damaged PMT	80	80	80	80	80	80	80	80	640

	2.01.15	6700	HV Other Plant Faults	309	309	309	309	309	309	309	309	2,472
	2.01.20	8573	EHV U/G Fault Pressurised	1	1	1	1	1	1	1	1	8
29												
	2.01.21	6685	EHV U/G Fault Non Pressurised	16	16	16	16	16	16	16	16	128
	2.01.02	6680	EHV Overhead Fault Repairs	17	17	17	17	17	17	17	17	136
	3.01.14	8616	EHV Overhead Line Damage	2	2	2	2	2	2	2	2	16
			Subtotal	19	19	19	19	19	19	19	19	152
32	2.01.12	6577	EHV Plant Faults	20	20	20	20	20	20	20	20	160
	2.04.01	8389	Defect Repair - Primary Transformers/Tapchangers	29	30	30	30	31	31	31	31	243
			Subtotal	49	50	50	50	51	51	51	51	403
	2.01.23	8567	132kV Cable Fault Pressurised	2	2	2	2	2	2	2	2	12
35	2.01.22	8570	132kV Cable Fault Non Pressurised	2	2	2	2	2	2	2	2	18

	2.01.01	6679	132kV OHL Fault Repairs	4	4	4	4	4	4	4	4	32
37	2.01.13	8622	132kV Plant Fault	11	11	11	11	11	11	11	11	88
	2.04.01	8388	Defect Repair - Grid Transformers/Tapchangers	102	103	104	104	106	107	108	108	842
			Subtotal	**113**	**114**	**115**	**115**	**117**	**118**	**119**	**119**	**930**

Table 56 NAMP to RIGS mapping – Faults (including Troublecall (CV15a)

Faults – CV15b

Mapped Rigs Volume Row	Current Namp Reference	Project ID	Project Name	2016	2017	2018	2019	2020	2021	2022	2023	Grand Total
6	2.01.52	8718	Emergency Disconnections	795	795	795	795	795	795	795	795	6,360
	2.01.38	6580	Street Lighting Fault Replacement - Overhead	248	248	248	248	248	248	248	248	1,984
	2.01.39	6689	Street Lighting Fault Replacement - Underground	2500	2500	2500	2500	2500	2500	2500	2500	20,000
	3.02.01	6641	St. Ltg. Discons / Recons / Knockdowns / Transfers	700	700	700	700	700	700	700	700	5600
			Subtotal	**3,448**	**3,448**	**3,448**	**3,448**	**3,448**	**3,448**	**3,448**	**3448**	**27,584**
8	2.50.15	6691	Faulted Cut-Out Replacement (Customer-driven)	3204	2136	2136	2136	2136	2136	3468	3468	20,820
9	2.01.96	6736	Cut Out Fuses Only	1788	1788	1788	1788	1788	1788	1788	1788	14,304
	2.01.29	6579	Flickering Supplies	3,970	3,970	3,970	3,970	3,970	3,970	3,970	3970	31,760
14	3.05.01	6640	Abortive Call (Previously Powercare Emergency Rechargeable)	4,896	3,672	2,448	1,224	308	308	308	308	13,472
	3.05.02	8621	Metering Fault	192	152	124	124	124	124	124	124	1,088

16	2.01.42	6581	Responding to Critical Safety Calls	3,182	3,182	3,182	3,182	3,182	3,182	3,182	3182	25,456
	2.01.49	8583	Flooding Burst Water Main	976	976	976	976	976	976	976	976	7,808
			Subtotal	**4,158**	**4,158**	**4,158**	**4,158**	**4,158**	**4,158**	**4,158**	**4158**	**33263.99998**
17	2.01.14	8958	Pilot Cable Repairs	9	9	9	9	9	9	9	9	72

Table 57 NAMP to RIGS mapping – Faults (ONIs) (CV15b)

Appendix 9 Material changes since the July 2013 ED1 submission

Asset type	Change type	2013	2014	Difference (Reduction)
I&M (CV13)	Volume	1,402,439	1,272,839	(129,600)
	Investment (£m)	103.32	76.7	(26.62)
	UCI (£k)	0.07	0.06	(0.01)
Faults (CV15a)	Volume	91,001	92,473	1,472
	Investment (£m)	132.0	150.8	18.8
	UCI (£k)	1.45	1.63	0.18
Faults (CV15b)	Volume	175,836	148,724	(27,112)
	Investment (£m)	49.0	40.15	(8.85)
	UCI (£k)	0.28	0.27	(0.01)

Table 58 - Data Source: October 2013 ED1 RIGS and 21st February 2014 ED1 RIGs

Table 52 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:

- Corrections to units for overhead line patrols via helicopter
- Remapping of boron rods from asset refurbishment (CV5) to inspection of maintenance
- 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
- Defect repair civils at Grid/Primary: Volumes and UCI's were reduced to reflect actuals
- Fire risk assessment remedial works: Volumes and UCI's were reduced to reflect actuals
- Cable oil top up, pumping & testing: the UCI was increased to reflect actual costs