Document 14
Asset Category – I&M and Faults
LPN Central London Area

Asset Stewardship Report 2013

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Approved date: 07/03/2014

Document History

Version	Date	Details	Originator	Revision Class	Section Update
1.0	16/01/2014	Template	Chino Atako	NA	NA
1.1	28/03/2014	Update June 2013 Proposals	Chino Atako	Minor	Entire document
1.2	29/03/2014	Update to section 1.3 and 3.0	Chino Atako	Minor	Section 1.3 and 3.0
1.3	04/03/2014	Update to preface and appendices	Chino Atako	Minor	Preface
2.0	07/03/2014	Final version	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.

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 CLA I&M and Faults

1.1 Scope

This document describes the inspection, maintenance and fault management strategy for low voltage (LV) and high voltage assets (including cable pits, underground cables, switchgear and transformers) in the Central London Area of UK Power Networks.

HV assets EHV and 132kV maintenance will continue to be managed by the existing EHV/132kV maintenance teams in London and is not part of this Central London Strategy.

This document covers the forecast for the RIIO- ED1 period. It is expected that the RIIO-ED2 volumes will continue at a similar level to that for RIIO-ED1.

1.2 Investment Strategy

The strategy is to increase inspection and maintenance frequencies for safety-critical assets and to improve our fault response capability by employing additional resource in the Central London Area. The investment strategy has been set such that we will improve network performance and reliability as well as reduce risks to staff and the general public.

The standard 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 proposed enhanced inspection and maintenance regimes and the fault response approach are outlined in this document.

1.3 ED1 Proposals

The investment proposals for inspection, maintenance and faults in the Central London Area, in RIIO-ED1 are given in Table 1. The investment proposal in ED1 is £48.7m, which is approximately 16% of the LPN budget in ED1. It includes provisions for an enhanced inspection, maintenance and faults management strategy in the central London area. The impact of the enhanced strategy is £1.7m per year.

	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022 /2023	ED1 Total £k
Fault	3,834	3,810	3,795	3,780	3,770	3,772	3,794	3,819	30,373
Inspection	858	858	858	858	858	858	628	624	6,400
Maintenance	1,625	1,629	1,643	1,638	1,645	1,662	1,065	1,039	11,944
Grand Total	6,316	6,297	6,295	6,275	6,272	6,292	5,487	5,481	48,717

Table 1. CLA OPEX Proposals (In £k) (Source: 19th February 2014 NAMP, Table J Less Indirect)

The investment plans have been determined by reviewing network performance and reviewing the risks posed by safety-critical assets including linkboxes and cable pits.

The network performance in the Central London Area is worse than in similar large cities in other parts of the world. To improve network performance we are proposing to carry out routine network sweeps on the network. The network sweeps will allow us to identify “hidden” faults before they result in loss of supplies to customers.

In addition we have observed an increasing trend in linkbox failures in London in the last few years. The larger concentration of linkboxes in densely populated parts of Central London pose a risk to members of the public. To reduce the likelihood of failure we are proposing to increase inspection frequencies for linkboxes. This will enable us to identify linkboxes with water ingress, gas present or signs of electrical distress before they fail. This will minimise the risks to members of the public.

1.4 Innovation

UK Power Networks use of Reliability Centred Maintenance (RCM) has been used to improve the efficiency of inspection and maintenance activities by asset type, and for the vast majority of customers this provides a satisfactory level of service. However in the Central London Area of LPN stakeholder consultation has identified that their expectations are higher.

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

Inspection and Maintenance innovations include:

- Increased use of (remote) change of state operations to check mechanism operations and complement routine inspections;
- Continuous (fixed) partial discharge monitoring
- Tailoring post fault maintenance to the cumulative fault current rather than number of operations

2.0 Description of the Central London Area

2.1 CLA Boundaries

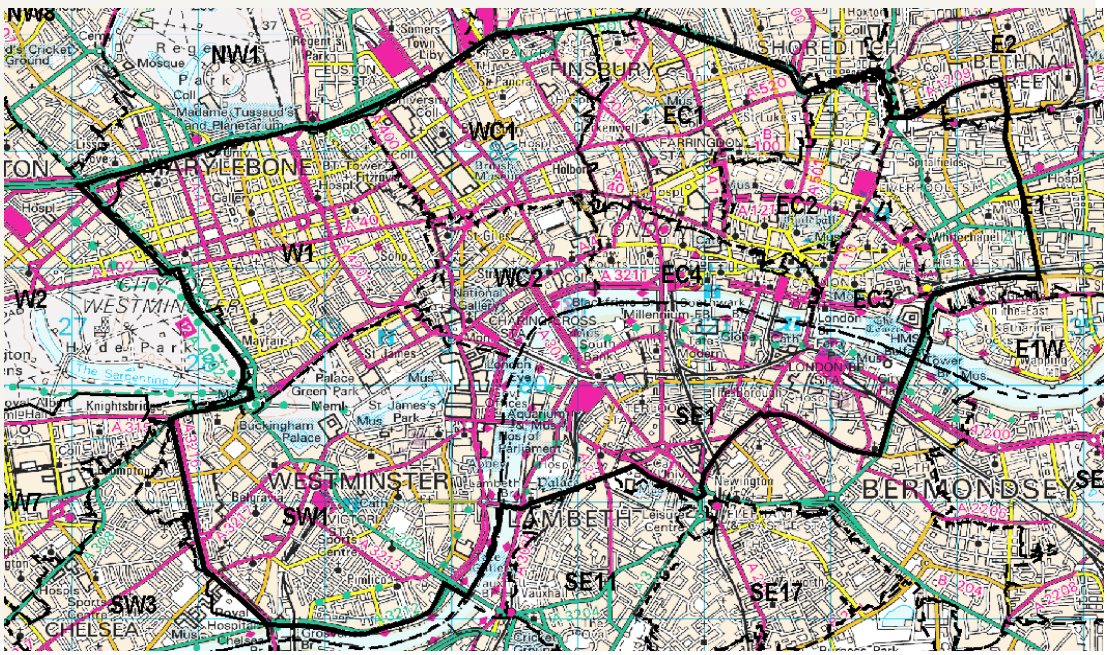

Figure 1 – Central London Area by post code

The Central London Area comprises circa 160,000 customers in the heart of London. Figures 1 and 2 show the geographic area covered by CLN and an overview of the main substations in the LPN network supplying these customers.

The Central London Area comprises of the following:

- Only commissioned assets in substations with a post code of, EC1, EC2, EC3, EC4, E1*, SE1*, SW1, W1, WC1 and WC2
- *Only part of the E1 and SE1 postcodes are part of the Central London Area

The Central London Area is unique in the sense that it is predominantly an interconnected network. In Central London the concept of Interconnected Networks was first developed in the 1930s to deal with increasing demand.

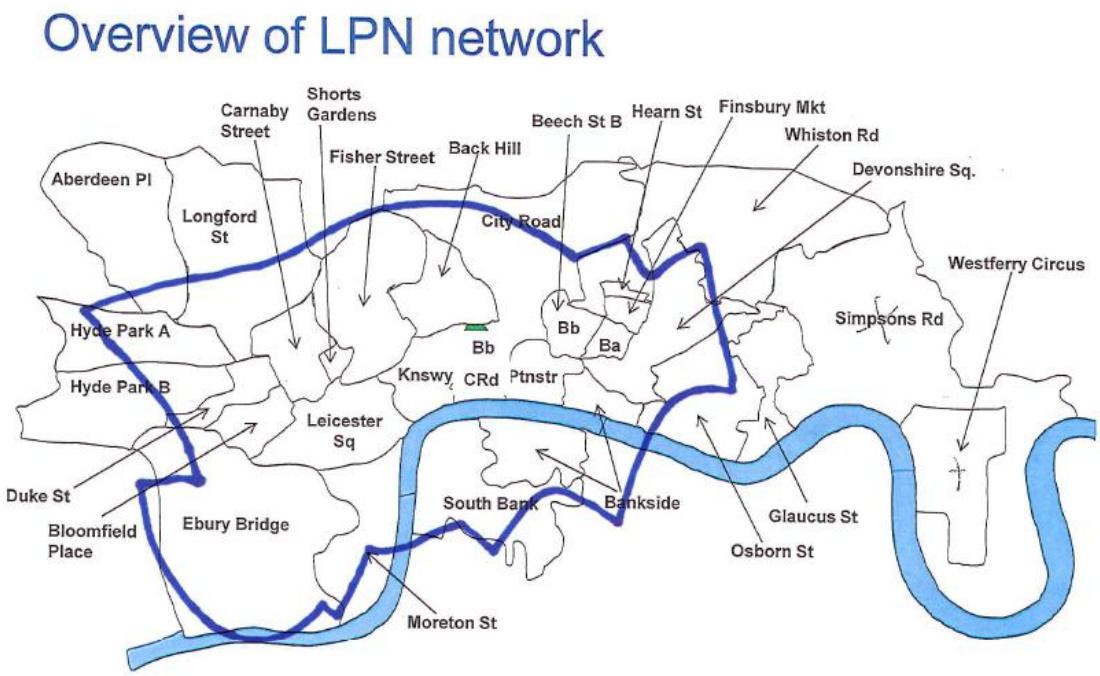

Figure 2 – Central London Area (HV feeders)

The definition of an 'LV Interconnected' network in London is where HV feeders are interconnected via fuses on the LV Network. These networks have evolved over time due to continued load growth and associated 'hold up' issues.

The basic design principles of an LV interconnected network are as follows:

- Ability to maintain supply for HV n-1 fault incidents
- Ability to maintain supply with LV open circuit faults on the system
- Greater utilisation of plant through load share between substations
- Ability to connect larger disturbing loads direct on to the LV network

3.0 Investment drivers (I&M and Faults)

3.1 Safety

We have recorded an increasing number of disruptive linkbox failures in the last few years. Through forensic analyses we have increased our knowledge of the failure mechanisms. The main cause of failure is moisture ingress. We propose to increase the frequency of linkbox inspections from a four-year cycle to an annual cycle to identify linkboxes which are susceptible to failure due to their condition. During inspections, inspectors will check for signs of water ingress, signs of overheating or indications of a flashover due to a fault. We believe this change in strategy will result in fewer linkbox failures in the future. The HSE have also formally requested that we increase the frequency of linkbox inspections following the occurrence of recent incidents.

3.2 Improved Network Performance

Table 3 shows the network performance of the network in the Central London Area compared to other cities. By comparison the network performance is worse. This can be attributed to a number of factors including network age, increased drive times to areas within central London and the location of operational depots serving the Central London Area.

To improve performance we propose to employ dedicated shift teams for 24-hour working. These teams will deliver faster response to network faults reducing customer minutes lost (CMLs).

	Osaka	Hong Kong	Sydney CBD	New York	Central London
HV CI's	2.97	9.83	5.48	0.18	7.36
LV CI's	0.1	4.83	3.07	1.9	12.59
HV CML's	0.91	0.27	8.42	11.85	5.42
LV CML's	0.21	0.1	9.58	6.98	32.15

Table 2. Network performance information ((Source: Central London Plan, 15 July 2013)

Further work is required to model the expected performance improvements generated by this initiative. However, Table 4 shows the indicative CI and CML improvements for 2014, 2015 and 2016.

KPI	(Current)	(Forecast 2014)	(Forecast 2015)	(Forecast 2016)
HV CI's	7.36	6.99	4.60	3.50
LV CI's	12.59	10.07	8.81	8.18
Total CI	**19.95**	**18.32**	**11.21**	**6.59**
HV CML's	5.42	4.88	2.85	1.76
LV CML's	32.15	24.11	17.68	14.47
Total CML	**37.57**	**28.99**	**18.82**	**16.23**
Average Restoration Time (min)				
LV	255	239	201	177

Table 3 – Projected CI/CML improvements in CLA (Source: Central London Plan, 15 July 2013)

3.3 Reliability and resilience of the energy networks

Due to the nature of the interconnected network, we sometimes have “hidden” faults which do not immediately lead to customer disconnections. The network has the ability to sustain load with LV open circuit faults on the system and maintain supply for HV n-1 fault incidents. However if the “hidden” faults are not rectified they could eventual result in loss of supplies to large numbers of customers.

We propose to carry out proactive investigation of network condition and status to identify and rectify these “hidden” faults before they lead to customer disconnection. This will help to improve CI and CML performance in the Central London Area.

3.4 Stakeholders

Central London contains the political, financial and entertainment districts of one of the greatest cities in the world. It is the economic engine of the UK, home to the Royal Family and attracts the headquarters of many blue chip international organisations from around the world. Our network performance has an impact on the economic well-being of London.

4.0 Intervention / Plan

The I&M frequency schedule (EMS 10-0002) details the time scales for interventions. EI 10-1502 details the requirements for secondary substation maintenance. This document proposes enhancements to these for the Central London Area.

The proposed changes to the inspection, maintenance and fault management strategies in CLN are summarised below:

- Enhanced linkbox inspections
- Increased inspections at secondary substations
- Routine proactive investigation of network condition and status
- Additional resources to improve fault response

4.1 Inspection

Key features of the inspection plans are the increases to the linkbox inspections and secondary substations.

There are 3,456 linkboxes in CLA consisting of a mix of cast-iron bitumen-filled and plastic resin-filled construction. In recent years, there has been a rise in link box disruptive failures due to water ingress. Previously we would have inspected linkboxes in the interconnected area on a 4-year cycle (i.e. 864 per year). We now propose an annual inspection cycle. This would mean an additional 2,592 inspections a year and will minimise risks to members of the public. The financial impact of this policy change is an additional £96,000.

The inspection of linkboxes will be part of a broader scope of work– Network sweeps. Network sweeps will be carried out every year on all LV assets on each HV feeder to ensure that linkboxes, wall mounted boards and ACBs are in good condition and are operable. The checks will ensure that the LV network is more resilient and prevent “hidden” faults from resulting in CIs and CMLs.

There are 4,014 secondary substations in the CLN area. These substations will be inspected once a year in ED1. Previously we would have inspected substations on a three-year cycle (i.e. 1,338 per year). The proposed annual inspection cycle will result in an additional 2,676 inspections a year. The financial impact of this policy change is an additional £126,000.

Table 7 shows the planned inspections volumes in the Central London Area in RIIO-ED1.

Namp Reference	Description	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023
2.36.03	Idle Service Inspection	2,133	2,133	2,133	2,133	2,133	2,133	2,133	2,133
2.07.12	Online Partial Discharge Field Investigations	5	5	5	5	5	5	5	5
2.07.11	Partial Discharge Mapping - HV	17	17	17	17	17	17	17	16
2.21.05	Special Access Checks	290	290	290	290	290	290	290	270
2.21.08	Difficult Access Checks at TCs (Allocation of Keys)	176	176	176	176	176	176	176	163
2.21.12	VMX Discharge Testing	42	42	42	42	42	42	42	39
2.34.03	EMF enquiries	2	2	2	2	2	2	2	2
2.34.04	Voltage/Load Investigations	10	10	10	10	10	10	10	9
2.34.07	Abandoned/Unidentified Cable Location	1	1	1	1	1	1	1	1
2.34.08	Noise Complaint Investigations by Operations	3	3	3	3	3	3	3	3
4.05.60	Record EPR & Identification of Hot Sites	2	2	2	2	2	2	2	2
4.07.08	Inspect Secondary Earths & T/Plugs	239	239	239	239	239	239	239	222
4.07.01	Inspect Secondary Substation	4,014	4,014	4,014	4,014	4,014	4,014	4,014	4,014
4.07.02	Routine Network Sweeps (Includes LV Link Box Inspection)	3,456	3,456	3,456	3,456	3,456	3,456	3,456	3,456
4.07.06	Inspect ESQC Secondary Substation High Risk	523	523	523	523	523	523	523	485
2.30.15	Cable Pit Inspection	4,067	4,067	4,067	4,067	4,067	4,067	1,459	1,459

Table 4 – Inspections volumes (Source: 19th February 2014 NAMP, Table O)

4.2 Maintenance

Table 8 shows the maintenance volumes for LV and HV assets, in the Central London Area. EHV and 132kV maintenance will continue to be managed by the existing EHV/132kV maintenance teams in London and is not part of the Central London Strategy.

Namp Reference	Description	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023
2.05.08	Cable Pit Maintain	483	483	483	483	483	483	73	73
2.08.12	Online Partial Discharge Monitoring Equipment Maintenance	246	246	246	246	246	246	246	229
2.20.01	Defect Repair - 11kV Circuit Breakers	61	62	62	63	64	64	64	65
2.22.02	Maintain TC Forced Ventilation	212	212	212	212	212	212	212	212
2.23.02	Defect Repair - LV G/M S/S Equipment	9	9	9	9	9	9	9	9
2.23.03	Plant Forensic Testing and Failure Investigation	4	4	4	4	4	4	4	4
2.23.01	Defect Repair - 11kV Secondary G/M S/S Equipment	83	84	85	86	87	88	89	89
2.25.06	11kV Feeder Protection	85	85	85	85	85	85	85	85
2.26.03	Defect Repair - 11 Protection	1	1	1	1	1	1	1	1
2.32.08	Vegetation Clearance - 11kV	1,265	1,265	1,265	1,265	1,265	1,265	1,265	1,265
2.32.05	Maintain Distribution Sites & Building - 11kV	148	148	148	148	148	148	148	148
2.32.15	Tree Trimming (Distribution Sites)	4	4	4	4	4	4	4	4
2.32.11	Luxcrete Flap Maintenance	84	150	150	150	150	150	150	150
2.33.24	Electrical Wiring - Defect Repair at Secondary Substations	5	5	5	5	5	5	5	5
2.33.17	Pumping Out Flooded Substations	112	112	112	112	112	112	112	112
2.33.02	Defect Repair - Secondary Substation Civils	2,925	2,955	2,984	3,015	3,045	3,075	3,106	3,137
2.35.01	UMS Services Inspected	3,498	3,498	3,498	3,498	3,498	3,498	3,498	3,263
4.06.01	Maint FULL 11/6.6kV SF6/Vac CB W/B Feed	0	0	8	0	0	0	0	0
4.06.06	Maint MECH 11/6.6kV OCB Feeder	4	10	5	5	1	4	8	10
4.06.07	Maint MECH 11/6.6kV SF6/Vac CB W/B Feed	4	17	7	37	38	18	2	5

4.06.08	Maint MECH 11/6.6kV SF6/Vac CB F/B Feed	0	1	0	2	0	0	0	0
4.06.09	Trip Test 11/6.6KV CB Feeder	0	0	0	0	10	15	17	0
4.06.10	Maint FULL 11/6.6kV OCB Feeder	8	9	7	27	40	28	4	10
4.08.03	Maintain Non-Isolatable Oil Switch	0	0	0	0	2	0	0	0
4.08.07	Maintain Non-Isolatable RMU (Gas/Vacuum)	48	53	24	4	13	6	12	10
4.08.08	Maintain Isolatable Oil Switch	0	0	3	0	1	7	2	3
4.08.11	Maintain Isolatable RMU (Oil)	29	13	6	20	29	31	30	28
4.08.13	Maintain HV Metering Unit	25	25	24	21	32	26	13	18
4.08.17	Maintain Distribution Tx	94	102	129	162	172	199	209	202
4.08.19	Maintain LV ACB	78	83	120	130	135	173	168	164
4.08.21	Maint FULL 11/6.6kV OCB at S/S	6	2	9	12	13	14	18	28
4.08.24	Trip Test LV ACB	1,157	1,157	1,157	1,157	1,157	1,157	1,157	1,097
4.08.26	Maint FULL 11/6.6kV SF6/Vac CB W/D S/S	50	57	128	9	2	67	33	13
4.08.28	Maint MECH 11/6.6kV OCB at S/S	11	31	29	82	19	17	15	11
4.08.29	Maint MECH 11/6.6kV SF6/Vac CB F/P S/S	0	1	2	0	0	0	0	0
4.08.30	Maint MECH 11/6.6kV SF6/Vac CB W/D S/S	0	1	0	2	0	0	0	0

Table 5 – Maintenance volumes (Source: 19th February 2014 NAMP, Table O)

4.3 Faults

There are no proposed changes to the overall predicted fault volumes. However it is proposed to improve the response to unplanned interruptions in this area. This will be achieved by providing a 24-hour response from shifted employees, rather than daytime staff and a standby rota. The effect of this will be to attend site promptly with the right skills to immediately start work on the location and repair of the fault. The net financial impact of this strategy is £1.1m per year in the Central London Area.

A number of cost-neutral changes are also proposed to help with the fault management process. These are:

- Post fault LV network sweeps
- Post fault HV network sweeps and
- Unit protection network sweeps

The post-fault network sweeps will ensure that faulted assets are identified and repaired to ensure that the network is returned to its normal operating condition after a fault occurs. Table 9 provides the fault volumes for the Central London Area in ED1.

Namp Reference	Description	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023
2.01.48	High Earth Loop Impedance (HELI)	30	30	30	30	30	30	29	28
2.01.15	HV Other Plant Faults	6	6	6	6	6	6	6	6
2.01.26	LV Underground Cable Fault (Consac)	2	2	2	2	2	2	2	2
2.01.49	Flooding Burst Water Main	36	37	37	37	37	37	36	33
2.01.44	HV Fault Restoration by Switching Only	54	54	54	54	54	54	54	54
2.01.52	Emergency Disconnections	50	50	50	50	50	50	50	50
2.01.96	Cut Out Fuses Only	108	108	108	108	108	108	108	108
2.01.07	Service Fault Repairs Underground	148	148	148	148	148	148	148	148
2.01.39	Street Lighting Fault Replacement - Underground	154	155	155	155	155	155	155	155
2.01.19	Other Plant (LV Etc)	19	19	19	19	19	19	19	19
2.01.24	11kV Cable Fault Repairs	22	22	22	22	22	22	22	22
2.01.27	LV U/G Cable Fault Repairs	204	206	208	210	212	214	216	218
2.01.28	Blown LV Fuses at Substations	1,293	1,293	1,293	1,292	1,292	1,292	1,292	1,292
2.01.29	Flickering Supplies	257	257	257	257	257	257	257	257
2.01.42	Responding to Critical Safety Calls	1,293	1,293	1,293	1,292	1,292	1,292	1,292	1,292
2.01.46	*Post-fault LV Network Sweep*	*612*	*612*	*612*	*612*	*612*	*612*	*612*	*612*
2.01.46	*Post fault HV Network Sweeps*	*175*	*175*	*175*	*175*	*175*	*175*	*175*	*175*
2.01.46	*Unit protection HV network sweeps*	*87*	*87*	*87*	*87*	*87*	*87*	*87*	*87*
2.01.47	Alarms	49	49	49	49	49	49	49	51
2.08.08	Pilot Cable Repairs	2	2	2	2	2	2	2	2
2.50.15	Faulted Cut-Out Replacement	132	88	88	88	88	88	134	136
3.05.01	Abortive Call	443	332	222	111	28	28	28	28
3.05.02	Metering Fault	15	12	10	8	8	8	8	8

Table 6 – Faults volumes (Source: 19th February 2014 NAMP, Table O)

5.0 Commentary

To improve fault management in the Central London area we are proposing to recruit dedicated shift teams for 24-hour working. These teams will deliver faster response to network faults (reducing CML. Overall £3.8m per year will be required for managing faults in the Central London Area. However we already currently manage faults in CLA with existing resources (cost allocation is circa £2.7m per year). Hence we require a net increase in faults provision for CLN of £1.1m per year in CLN.

The proposed enhanced strategy will also result in additional inspections of linkboxes and distribution substations to reduce safety risks to staff and members of the public. We will also carry out proactive investigation of network condition and status to identify and rectify faults that have not yet led to customer disconnection.

The proposed strategy will result in a net increase in operational expenditure of £1.7m per year in the Central London area (£1.1m for faults, £0.1m for linkboxes, £0.1m for distribution substations and £0.4m for Maintenance of Interconnected Networks.

The expected benefits will include:

- Fewer safety incidents from faulted linkboxes
- Improved CI and CMLs in the Central London Area,
- Improved network resilience

6.0 Appendices

Appendix 1 – OPEX expenditure proposals

	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022 /2023	ED1 Total £k
Fault	3,834	3,810	3,795	3,780	3,770	3,772	3,794	3,819	30,373
Inspection	858	858	858	858	858	858	628	624	6,400
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Table 7 CLA OPEX Proposals (In £k) (Source: 19th February 2014 NAMP, Table J Less Indirect)

Appendix 2 – Network Performance Comparisons

	Osaka	Hong Kong	Sydney CBD	New York	Central London
HV CI's	2.97	9.83	5.48	0.18	7.36
LV CI's	0.1	4.83	3.07	1.9	12.59
HV CML's	0.91	0.27	8.42	11.85	5.42
LV CML's	0.21	0.1	9.58	6.98	32.15

Table 8. Network performance information ((Source: Central London Plan, 15 July 2013)