Document 19
Asset Category – RTU – SCADA
SPN

Asset Stewardship Report 2014

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Document History

Version	Date	Details	Originator	Revision Class	Section Update
1.0	18/06/2013	Baselined July 2013 submission'	V Patrick		
1.1	14/02/2014	Document revised and includes NAMP to RiGs mapping	J Ford		
1.2	17/02/2014	Including reviewers comments	J Ford		
1.3	03/03/2014	Date in section 5.1 updated	J Ford		

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1.0 Executive Summary SPN SCADA

1.1 Scope

This document details UK Power Networks' NLRE replacement and inspection and maintenance for Supervisory Control and Data Acquisition (SCADA) equipment and systems in SPN for the RIIO-ED1 period. Indicative proposals for the ED2 period are also included. Although classified under NLRE, this expenditure is not asset replacement as is normally applied to power network equipment. SCADA replacement is based on equipment obsolescence rather than any physical fault and, as such, the fault levels for SCADA equipment are low.

There are 5,947 RTUs (486 primary RTUs and 5,461 secondary RTUs). There are 972 primary SCADA communications circuits (main and stand-by) and 5,461 secondary SCADA communications circuits.

Replacement and refurbishment costs for these assets are held in the Ofgem and UK Power Networks' investment planning documents in the locations outlined below.

Investment type	ED1	RIGs
Replacement	£24.8m	CV105
I&M	£2.5m	CV13

Table 1 – Investment Details

NB, includes RTUs, communications and associated equipment.

1.2 Investment Strategy

The SCADA system underpins any future innovation which would enable the power network and its associated equipment to be run closer to its limits. This is in terms of extracting additional capacity from the network through the use of smart grids and related technologies; by extending the working life of the assets on the network; and by improving asset management and monitoring to ensure intervention takes place before network assets fail.

Much of the SCADA equipment is now so old that it can no longer be supported. The network requires a significant upgrade to enable innovative technologies to be deployed to realise better asset information and enhance its management. This strategy proposes the replacement of a significant amount of SCADA equipment, including RTUs and communications systems.

1.3 ED1 Proposals

It is proposed to replace:

- 150 primary RTUs (£5,800,000).
- 1,100 secondary RTUs (£3,928,000).
- 740 secondary SCADA communications (£722,000).
- 12 primary SCADA communications links. This will be an enhancement of the BT21CN fibre network. (£2,400,000).
- 400 primary SCADA routers (£206,000).

Additional expenditure is also included to enhance the RTU and communication system investment:

- Monitoring of 1,100 secondary SCADA batteries (£331,000).
- Monitoring of weather and general environment (£39,000).
- Replacement of grid/primary substation voice communications at 117 sites (£117,000).

Expenditure is included to upgrade and enhance the NMS platform:

- Replacement and upgrade of IT hardware (£2,312,000).

See Appendix 9 for phased expenditure details.

1.4 Innovation

The upgrade of the SCADA system is the main driver to enable the adoption of innovative solutions for the power network as a whole. The improved level of technology will enable the trial and introduction of technologies such as:

- Improved asset management and monitoring technologies like online transformer DGA, cable partial discharge and circuit breaker health. This will facilitate an enhanced understanding of asset condition; in particular, more accurate trend analysis that will improve the decision processes on asset replacement and refurbishment.
- Smart grids and smart technologies to enable the connection of low-carbon technologies (generation, EVs, etc.) with reduced power network reinforcement.
- Monitoring of LV networks (feeder currents, volts, power flow, etc.).

1.5 Risks and Opportunities

	Description of similarly likely opportunities or risks arising in ED1 period	**Level of (uncertainties)/cost growth(£k)**
Opportunity	Combine work where possible with other planned power network projects or work resulting from faults on the power network to reduce costs and labour requirements.	(£100,000)
Risk	If RTU fault rates were to increase, there is a risk that sites could be left without monitoring or control.	Customer Interruptions (CI) cost: £340,000/100 customers Customer minutes lost (CML) cost: £820,000/customer
Opportunity	Improvement in the resilience of the communications to secondary RTUs will ensure automation schemes operate effectively, thereby improving CIs and CMLs.	CI cost: (£340,000/100) customers CML cost: (£820,000/customer)
Risk	If the proposed ED1 secondary communications replacements are not achieved, there is a risk that, should Vodafone decide to terminate the PAKNET system (which is already old technology), UK Power Networks will not be able to replace the communications to the RTUs (5,465 units) in time. Vodafone need only give UK Power Networks 24 months' notice, so this could result in a loss of communications and SCADA. Assuming it could be achieved, the replacement programme would be accelerated with resulting increased costs.	£900,000

Table 2 – Risks and opportunities

2.0 Description of SCADA

SCADA is the name given to the systems that remotely monitor and control power networks. It provides the mechanism for capturing data about the power network, specifically controls, plant and equipment status, system demands and alarms. This is real-time information regarding the state of the network, which is fed back to the UK Power Networks' control centre. Therefore, SCADA is a critical tool to support UK Power Networks in operating the network in a safe, secure way, to meet and/or exceed Ofgem efficiency frontiers, and to ensure legislative and regulatory compliance, such as P2/6 compliance. SCADA supports P2/6 compliance in the following ways:

- It enables rapid remote switching by control engineers for load transfers between substation groups.

- It enables the use of automatic switching schemes.

A SCADA network can be broken down into three main areas:

- The Network Management System (NMS).
- The Remote Terminal Units (RTUs) in the substations.
- The communications network between the RTUs and the NMS.

SCADA systems use similar technology to IT systems, but they differ in the following ways:

- SCADA systems require very secure and predictable communications.
- IT systems can cope with 'retries'; SCADA systems cannot (for safety reasons).
- IT systems typically have a three to five-year lifespan; SCADA typically has a 10-year-plus lifespan.
- IT systems usually allow delays in processing data; SCADA requires real-time data.
- IT systems can re-route data; SCADA systems cannot.

The interface between the SCADA system and network plant and equipment is via the RTU. RTUs are computer-based equipment installed at remote sites, such as grid/primary substations, secondary substations, and with pole-mounted switches/circuit breakers, etc. The function of the RTU is to manage the control and monitoring of the equipment at the remote site. Traditionally, RTUs are split into two distinct types: primary RTUs and secondary RTUs.

Primary RTUs are installed at all grid and primary substations. The NMS continuously polls the RTUs, typically about every 10 seconds, for any changes, such as alarms, analogues and circuit breaker/switch indications and to facilitate the operation of any equipment on-site, such as circuit breakers/switches etc.

Secondary RTUs are installed at secondary (11kV distribution) substations, where benefit can be gained from the remote control and monitoring functionality. Under normal circumstances, there is no communication between the NMS and the RTU, or vice versa. If a change occurs on-site, such as alarms, analogues or circuit breaker/switch operation, the RTU will dial-up the NMS to communicate.

If an engineer wishes to operate a control at the remote site, or a script running on the NMS needs to operate equipment at the remote site, the NMS will dial-up the RTU. Once the NMS and RTU start to communicate, the NMS will continually poll for any changes in the RTU until the communication is terminated.

2.1 Existing Primary SCADA System

Primary SCADA RTUs are installed at grid (132kV/33kV, 132kV/11kV, 132kV/66kV) and primary (33kV/11kV, 33kV/6.6kV, 66kV/11kV) substations sites, and 33kV and 132kV switching stations.

There are 486 primary SCADA RTUs installed on the SPN network.

There are two types of RTU on the SPN primary SCADA network: Schneider (441) and Converteam (45).

The communications for primary SCADA have been upgraded to use Internet Protocol (IP) during DPCR5. The vast majority of primary and grid substation RTUs use the UK Power Networks' VSAT network for main communications and GPRS for back-up communications.

A small number use rented DSL circuits for main communications and GPRS for back-up communications, but this is not ideal as the rented DSL circuits have very limited availability in the event of a power outage. A small number of RTUs (14) have been or will be replaced in DPCR5 to enable the remaining fleet to be maintained until the ED1 period.

Age profile

One concern about primary RTUs is the age of the technology and the components within the RTU. The Schneider RTUs date from the early 1990s and the Converteam RTUs are a modern design.

NAMP lines and RiGs lines

Primary RTUs	1.57.01.8213
Primary SCADA Comms (links)	1.57.02.8296
Primary SCADA Comms (routers)	1.57.02.8308
SPN SCADA system maintenance	2.28.15.6465
SPN SCADA Satellite System Rental	2.28.15.6814
RTU Fault Rectification	2.28.01.6644
CV105 6	
Environment Monitoring	1.57.04.6208
Emergency Voice Comms	1.57.10.9122
CV105 7	
IT - Control Centre Hardware & Software	1.57.20.8615
CV105 8	
3rd Party Circuit Faults	2.28.05.6645
UKPN circuit faults	2.28.07.9470
CV13 31	

Satellite Comms Faults	2.28.28.6389
CV13 47	
SPN SCADA System management	2.28.29.9472
CV13 75	

2.2 Existing Secondary RTUs/LCUs (Local Control Units)

Secondary RTUs/LCUs are installed at distribution substations (11kV, 6.6kV).

There are 5,465 secondary RTUs/LCUs installed on the SPN network.

There are six types of RTU/LCU on the SPN secondary SCADA network:

- Schneider Sprite II. This is a pole-mounted switchgear used in conjunction with a Whip and Bourn LCU
- Schneider Talus T200E (ground-mounted switchgear LCU)
- Lucy Gemini 2 (ground-mounted switchgear LCU)
- Lucy Gemini 2.5 (ground-mounted switchgear LCU)
- Nu-Lec (Schneider) CAPM (pole-mounted switchgear LCU)
- Schneider T200P (pole-mounted switchgear LCU).

The communications are provided by the Vodafone PAKNET system, which dates from the mid-1990s. This is a low-bandwidth, packet-based commercial radio communications network. UK Power Networks is working with the ENA and Vodafone to monitor the performance of the network and the longevity of the commercial offering. However, this must be considered as a high risk in ED1 and hence mitigation is required.

NAMP lines and RiGs lines

Secondary RTUs	1.57.02.8216
Secondary SCADA Battery Monitoring	1.57.07.8332
CV105 6	
Secondary SCADA Comms	1.57.16.6129
IT - Communications for Switching & Monitoring	1.57.20.8612
CV105 7	
SCS Comms/Plant Faults	2.28.16.6646
CV13 31	

2.3 Existing RTUs Asset Age

The Schneider primary RTUs and Schneider Sprit II and Schneider Talus 200 secondary RTUs date from the mid-1990s, and the Converteam Primary RTUs and Lucy Gemini, Nu-Lec, Schneider 200P and Schneider Talus T200E secondary RTUs are of a modern design. Asset age and volumes are shown in Tables 3 and 4.

SPN primary RTUs	Approximate year	Volume
Schneider	1993	441
Converteam	2000	45

Table 3 – RTU asset age

SPN secondary RTU/LCU				
Control unit	**Switchgear**	**Separate RTU**	**Approximate year**	**Volume**
WBO	PM Recloser	Sprite	1998	393
NUL PTCC	PM Recloser	No	2000	495
SCH T200P Series 3	PM Switch	No	2012	4
Lucy Gemini 2	GM	No	2006	410
Lucy Gemini 2.5	GM	No	2007	540
SCH T200E Series 2	GM	No	1998	3425
SCH T200E Series 3	GM	No	2011	194

Table 4 – RTU volumes

The relevant point with respect to secondary RTUs regarding asset age is the age of the technology and the components within the RTU. The Schneider Sprite II and Schneider Talus 200 RTUs date from the early 1990s and the Lucy Gemini, Nu-Lec, Schneider 200P and Schneider Talus T200E RTUs are a modern design.

The communications used for secondary RTUs (Vodafone PAKNET) dates from the mid-1990s and is supported by Vodafone. While UK Power Networks has not been notified as such, due to the age of the technology it is conceivable that Vodafone may terminate the PAKNET system within the next few years. The current contract allows Vodafone to give UK Power Networks 24 months' notice of a termination. Were this to happen, there is a very high risk that a large number of secondary SCADA RTUs would no longer communicate, as it would be exceptionally challenging to change the communications to all 5,461 secondary SCADA sites within this timeframe.

3.0 Investment Drivers

The government has set stringent targets for the UK to deliver CO_2 emission cuts of 18% on 2008 levels by 2020. To achieve this, it is proposed that 40% of the UK generation needs will be met by low-carbon generation by 2020 and 30% of which will be met by renewable generation. A significant amount will be connected onto UK Power Networks' distribution network at all voltage levels, from 132kV down to LV. To facilitate the connection of this generation at a reasonable cost, much greater use of SCADA and communications will need to be made, and the concept of smart grids will need to be introduced to ensure appropriate monitoring of the power network and to enable additional capacity to be leveraged at minimum cost.

With the anticipated increase in network monitoring and control and the requirement to support new network technologies, a review of SCADA RTU requirements will be carried out, and the traditional voltage split between primary SCADA and secondary SCADA will be removed. Instead, substation sites will be assessed on their own merits and given a classification to identify the minimum RTU requirements, therefore enabling any RTU type to be installed on any voltage level from 132kV down to LV.

UK Power Networks' Future Networks department has produced an Innovation Strategy, which outlines that UK Power Networks is in a position to meet the efficiency challenges it has set by replacing assets reaching the end of their life with equipment that is more cost-efficient or that offers more capabilities for the same price. It also demonstrates that UK Power Networks is taking an innovative approach to support low-carbon transition, and is exploring levers at all stages in the value chain. This includes trialling financial incentives for customers able to suppress or shift their electricity demand, increasing flexibility within the existing network and building smarter or more capable networks when there is no alternative, all with the customer in mind. The policies in this document support the Innovation Strategy by upgrading UK Power Networks' SCADA networks to operate using modern industry-standard protocols such as IP for communications and DNP3 and IEC61850 for applications.

3.1 SCADA Communications Investment Drivers

Significant investment has been made in primary SCADA communications during the DR4/5 period to adapt the application protocols (Wisp+ and DNP3) to operate using IP as the transport protocol. Efforts have also been made to install a private VSAT satellite communications network, and secure access to GPRS networks provided by mobile phone network operators. The satellite network enables primary SCADA to communicate using a network independent of any terrestrial service providers and will guarantee operation during any black-start scenario or widespread power failure.

Figure 1 shows the 7.6m hub antenna at UK Power Networks' Network Control Centre in Ipswich.

Figure 1 – Fore Hamlet antenna

Figure 2 shows a typical VSAT antenna installation at a substation site.

Figure 2 – Substation VSAT

Secondary SCADA uses the Vodafone PAKNET system to provide communications. There are three issues with this system:

1. There are 5,461 units installed on the network. PAKNET is an old technology and it is likely to be ceased during the ED1/ED2 period. Vodafone is required to give UK Power Networks 24 months' notice of termination and this is insufficient time to replace the system.

2. The resilience of the PAKNET system is not sufficient for modern automation schemes due to the lack of battery back-up on the base station sites.

3. Due to the age of the technology, PAKNET is not IP-compliant and is not compatible with modern communications networks and equipment.

To assist in the delivery of the government's carbon reduction targets and to minimise the overall cost to the UK as a whole, the use of smart technologies will become more widespread during ED1. These technologies will leverage greater capacity out of the power network and enable the connection of increased levels of low-carbon generation by providing more accurate data, extracting additional capacity from network elements, such as transformers and circuits, and using fast-acting algorithms to keep a potentially volatile network stable. All of this will require larger volumes of data to be transferred, both between equipment in the field and between that equipment and the control centre site, and at greater speeds than is currently possible. The existing communications networks must also be able to operate during a power outage to swiftly and safely restore supplies.

3.2 Control Centre Hardware & Software Investment Drivers

The Network Management System (NMS) requires continual upgrading to enable reliable operation and to accommodate the ever increasing demands placed upon it. These include:

- Increasing volumes of RTUs installed on the network.
- Increasing volumes of automation.
- Increasing sophistication of automation schemes.
- Obsolescence of IT equipment.
- Increasing functionality required from the NMS.

3.3 Broadband Communications Investment Drivers

Asset management and monitoring techniques will become more widespread over the coming years, which will require a communications system with greater bandwidth to enable substation asset monitoring and management data to be transmitted effectively. This requirement spans the three license areas of UK Power Networks. Examples of asset management and monitoring data that will be required may include:

- Power quality monitoring.
- Partial discharge monitoring.
- CCTV.
- Card access to substations.
- Remote connection to IEDs.

- Access to the corporate IT network (for plans, email, intranet, etc.) from substations.
- Online asset condition monitoring (transformers, circuit breakers, etc.).

These techniques require greater bandwidth, which cannot be provided with the existing SCADA systems. Furthermore, it may not be appropriate to combine SCADA with asset management and monitoring communications channels.

Dial-up modems could be deployed for some of these functions, but with large volumes, this would be difficult to manage, be very inflexible and the communications are slow and unreliable. Also, dial-up modems are old technology and will be difficult to support in the short- to medium-term.

Therefore, the main issues from the above are poor communications speed and circuit capacity.

The provision of broadband communications to substations would satisfy the above functional requirements and provide the additional benefit of broadband being available to provide back-up communications for the primary SCADA system to ensure SCADA communications to substations can be maintained at all times. This would then enable the GPRS connection to be removed, reducing opex costs and further improving the reliability of the SCADA network.

3.4 RTU Investment Drivers

Investment drivers for RTUs can be split into three main categories:

3.4.1 Availability of spares and components

Due to the age of the RTU equipment and the relatively short lifespan of IT equipment, some of the components within the RTU and RTU plant cards are no longer manufactured and/or supported by the manufacturer, and are therefore considered to be obsolete. Table 5 shows the type and volumes of RTUs which cannot be supported.

Control unit/RTU	Approximate year	Volume
WBO	1998	393
SCH T200E Series 2	1998	3,425
Schneider Primary RTU	1998	441

Table 5 – Types and volumes of RTUs

These figures represent 70% of the total population of RTUs on the SPN network.

The stock of spares for these RTU/LCUs is almost exhausted and, due to the fact that they are obsolete, new spares can no longer be obtained.

3.4.2 Suitability of technology

Better technology is required to ensure the network can accommodate higher levels of volatile generation and unpredictable loads. The technology used by the old generation of RTUs is insufficient to cope with the new demands, and a case study demonstrating this is shown in Appendix 13.

Figure 3 shows a typical Schneider primary RTU installed in a substation.

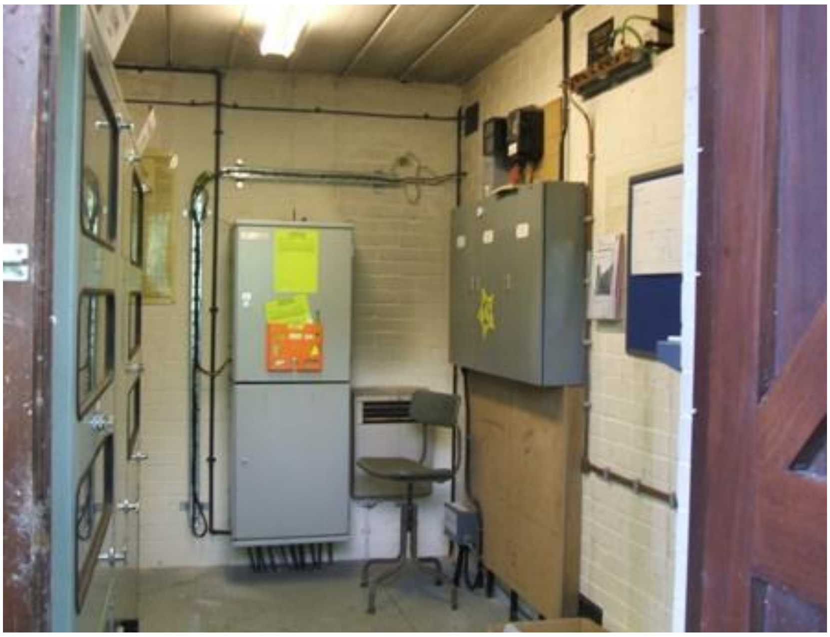


Figure 3 – RTU installation.

3.4.3 RTU availability

The control and monitoring functionality provided by the RTUs is critical to UK Power Networks in the reduction of CIs and CMLs. If an RTU, or some of the functionality provided by an RTU, is unavailable when a fault occurs, the speed of the restoration of supply to customers, and hence the quality of supply, will be significantly reduced, leaving greater numbers of customers without electricity for a longer period of time.

An example of the importance of SCADA is illustrated in Appendix 14, which shows a case study of two faults on the same 11kV feeder: one with the SCADA system functioning correctly and one with the system not operating. The consequence of SCADA not operating was a 100% increase in CIs and a 50% increase in CMLs.

The reasons an RTU will be replaced with a modern RTU with increased functionality are:

- Substation equipment, such as the switchboard, is being replaced with modern equipment. The RTU will be replaced to enable improved facilities, such as serial/IP connection to IEDs and remote connection to equipment, and to reduce the small wiring required to install the switchboard, and therefore reduce installation costs.

- There are insufficient spares in stock to ensure the ongoing maintenance of the remaining RTUs.

- An area of the power network becomes part of a smart network or similar, so improved functionality of the RTUs is required, such as for IEC61850.

3.5 SCADA Condition Measurements

Although classified under NLRE, this expenditure is not asset replacement as is normally applied to power network equipment. SCADA replacement is mainly based on equipment and technology obsolescence, rather than any physical fault with the equipment and, as such, the actual fault levels are low.

3.5.1 Fault volumes

The main source of identification of a SCADA system, component or card becoming unreliable is the volume of reported failures. This can be either equipment failing and recovering which is identified through examination of logs or alarms, or permanent failure which is identified through alarms generated on the Network Management System.

Fault volumes are shown in Appendix 5 and the graphical representation is shown in Figure 4.

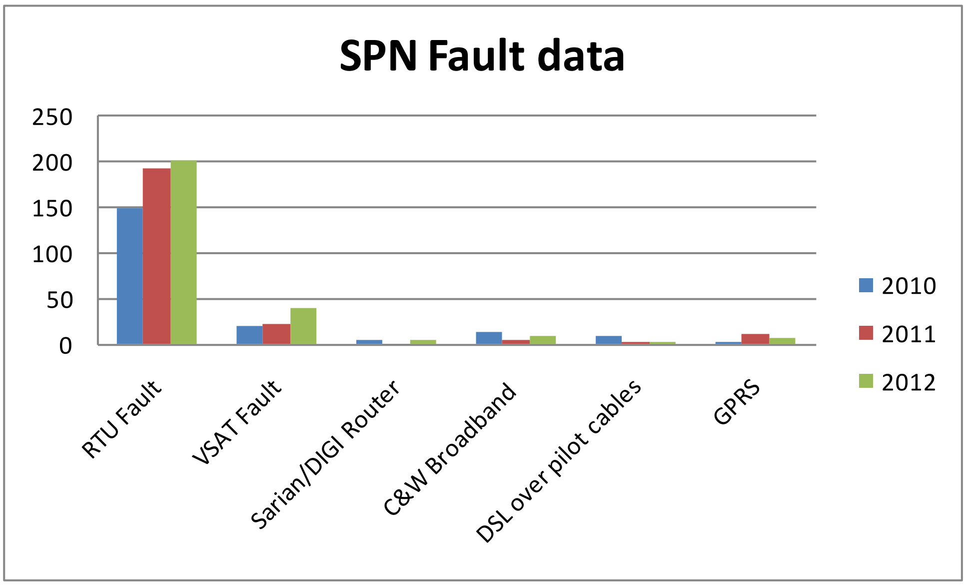


Figure 4 – SPN fault data

This shows a general increase in failure rates over the period, particularly RTU faults. Many of these faults are with RTU components, such as input/output cards, rather than total RTU failure.

The VSAT fault volumes are showing as increasing because the installed volumes are increasing over the period. Many of these faults are associated with installation errors and have been corrected.

3.5.2 Technology level

The replacement of SCADA equipment tends to be based on the level of functionality available, and the obsolescence of the technology and the components used within the equipment rather than the volume of faults.

4.0 Asset Assessment

4.1 Asset Health

Not Applicable. Health indices data does not apply to SCADA equipment as replacement is based on the level of functionality, the technology and the availability of spare components rather than any measurable condition points. As it is the age of technology that is the critical factor, rather than the age of the equipment, the RTUs can be grouped in 'types' based on technology age.

4.2 Asset Criticality

SCADA is a key component in the management and control of the network. While manual intervention is an option under conditions of RTU/SCADA failure, this would be delayed due to staff response times and could result in safety issues for staff and public when emergency intervention is demanded. Therefore, it is important that a very high level of availability is maintained for the SCADA systems.

4.3 Network Risk

The introduction of SCADA onto the SPN primary and secondary networks over recent decades has clearly demonstrated the benefits of network visibility afforded by these systems.

While it can be argued that under system healthy conditions the loss of SCADA may not be an immediate issue, it is the loss of visibility under abnormal or fault conditions that highlights the benefits and criticality of remote network visibility. Under these circumstances the consequences of SCADA loss can result in overloaded networks, delayed restoration post-fault and, most importantly, lack of response to safety risk events.

4.4 SCADA Data Validation

As the age-related issues for SCADA equipment are based on technology (i.e. RTU type, serial communications, etc.) and the information regarding SCADA is extracted from the NMS, the data is considered to be accurate.

4.5 SCADA Data Verification

Sample checking was carried out to verify the quality of the data.

4.6 SCADA Data Completeness

As the volume data is extracted from the NMS the data is complete.

5.0 Intervention Policies

5.1 SCADA Communications Interventions

With the anticipated increase in the requirement for network monitoring and control and the introduction of smart grids, a review of SCADA communications requirements will be carried out. The traditional voltage split between primary (11kV bars and above) and secondary (11kV distribution network) will be removed and instead substation sites will be assessed on their own merits and given a classification to identify their minimum communications requirements. From this classification an appropriate communications medium can be installed. This classification work will be completed in Q4 2014.

Notwithstanding this, a hierarchy of some SCADA sites being continuously polled and some SCADA being reported by exception will be retained.

Additional communications networks will be developed to match the classification criteria and to provide some diversity in available communications. This will involve approaching the market to identify potential communications networks and systems. With the introduction of new communications networks, consideration will be given to separating mission-critical control data and less critical asset management data.

5.1.1 Primary SCADA communications

The communications for SPN primary SCADA have been upgraded to use IP as the transport protocol. As UK Power Networks' fibre/DSL network is installed for the BT21CN project to cater for operational intertripping and inter-site protection systems, and also when a separate fibre link is established into the Network Control Centre at Fore Hamlet, primary and grid substation RTUs should be moved onto the fibre network. This will reduce operating costs by reducing the size of the satellite network and therefore the amount of bandwidth that is required, and improve the speed of communications and bandwidth available to substations. Capacity on the satellite network is rented and the fibre network for the BT21CN project is owned by UK Power Networks, therefore any reduction in the bandwidth on the satellite network will reduce costs.

Before any RTUs can be connected to UK Power Networks' fibre/DSL network, it must be verified that it has sufficient mains independence. Also, some fibre circuits may be required in addition to those installed for BT21CN to provide connectivity to Fore Hamlet.

5.1.2 Secondary SCADA communications

The secondary SCADA network will be upgraded to operate using IP as the transport protocol. DNP3 IP will be introduced when the NMS is upgraded to

V5 (this is planned for March 2014). This will enable the use of any modern communication networks and ensure that all SCADA communications can use a common platform.

During ED1 and ED2, 740 of the PAKNET sites will be replaced with an appropriate communications medium to mitigate the risks associated with the termination of the system. The exact type of communications will be decided on a site-by-site basis using the classification and following procurement of additional IP-compliant communications mediums.

5.1.3 Replace Sarian router interventions

All SPN Grid and Primary substations utilise a GPRS ‘router’ (Sarian routers) to manage the IP connection to the substation and the changeover between main and standby communications, and to facilitate a serial connection to the RTUs (required for old RTUs). These date back to 2007 when the Satellite system was deployed. The technology for this equipment (especially with regards to cyber security and communications network technology such as GPRS and 3G) is currently out of date (they have been superseded for new sites with a new version), and will not be able to be supported by the end of ED1.

The existing routers used at grid and primary substations will be replaced with an appropriate modern equivalent, taking into account future SCADA and substation asset requirements such as smart grids, asset management and monitoring, IEC61850, etc.

5.2 RTU Interventions

5.2.1 Replace some RTUs (recommended option)

The recommended option is to replace 150 of the fleet of Schneider primary RTUs and 1,100 of the combined fleet of Schneider Sprit II and Schneider Talus 200 secondary RTUs. This will provide sufficient spares for the remaining RTUs to remain in service for the ED1 period. These figures have been decided because:

- By the end of ED1 the technology employed in the old RTUs will be around 25-30 years old, and by the end of ED2 it will be around 33-38 years old. It will be impracticable to support the old primary RTUs by the end of ED2 (as described in section 3.4), so UK Power Networks is planning to remove them from the network by the end of ED2. Due to the large number of RTUs on the network, this work must start now to allow a planned and controlled replacement programme to take place. All of the primary RTUs and about half of the secondary RTUs will be replaced by the end of ED2.

- 150 of the primary RTUs and 1,100 of the secondary RTUs is considered to be the maximum number UK Power Networks can realistically replace during ED1, given the resources available.

5.2.2 Replace all RTUs (rejected option)

This option has been rejected because:

- The increased technology level offered by the new generation of RTUs will not be required at all sites.
- The costs of replacing all the RTUs will be very high. It is not necessary to replace all the RTUs and the spares released from those that will be replaced can be used to maintain the remaining RTUs, therefore reducing costs.
- There is insufficient resource to carry out the replacements.

5.2.3 Do nothing (rejected option)

This has been rejected because:

- The technology level of the old generation of RTUs is insufficient to meet the requirements and demands of smart grids and smart networks.
- Some spares for the old generation of RTUs are now unavailable. As units fail they will not be able to be fixed, resulting in network control and monitoring being lost.
- Cost savings associated with the connection of alarms and analogues at new sites through the use of communications bus rather than hard wiring will not be realised.

5.2.4 Intervention strategy

- Intervention strategies for RTUs will be optimised by targeting the replacement of the RTU where possible at sites where other significant work is occurring (such as replacement of the switchboard). This will enable installation costs to be minimised.
- The intervention strategy optimises the expenditure plans by targeting RTU replacements at the sites where the benefits of the improved technology from new RTUs can be used. The spares released by these replacements will then maintain the remaining fleet of RTUs, therefore deferring the need to replace them.

5.3 Environment Monitoring Interventions

As smart grids – associated technologies to extract additional capacity from the existing power network and dynamic plant asset condition data – become more widespread, UK Power Networks will require more detailed information regarding the environment in which its network equipment is installed (such as transformers, switchgear, circuits, etc.). Specifically, for equipment installed outdoors, information such as ambient temperature, wind speed/direction and rainfall rate, which is relevant for communications, is required. For equipment installed indoors, information such as ambient temperature and humidity is required. This information can be used for a 'first level' smart grid by applying environmental data to provide increased equipment ratings based on the actual conditions.

While not a primary driver for SCADA improvements and RTU replacements, facilitating the data recovery from environment monitoring will contribute to a reduction in network costs and capital expenditure. This will be realised through dynamic network operation based on actual environment data, which will enable equipment to be operated closer to its limits (such as conductors, transformers, etc.), thereby extracting additional capacity without the need to replace the asset. Environment monitoring will be installed at 4 substation sites.

5.4 Voice Communications Interventions

All primary and grid substations are equipped with a BT phone line. A fibre/DSL network is planned to be installed for the BT21CN project and, when the fibres connect into the Network Control Centre at Fore Hamlet, this will be used to provide voice communications to substations. The existing BT phones can then be removed, thereby saving the costs of the phone lines. As with 5.3 this is not a primary driver, but a secondary benefit

Substations that do not have UK Power Networks' fibre/DSL connections will keep their existing BT phone line.

5.5 Control Centre Hardware & Software

The Control Centre Hardware and Software will be upgraded or replaced as required to enable continuous and reliable operation for this mission critical system, and enable new features improve the management and reliability of the network to be developed and added as required.

6.0 Innovation

Much of the proposed work in the ED1 period is to upgrade the technology on the SCADA network in both the RTUs and the communications systems. This work will bring the SCADA system into the 21st century and enable the deployment of innovative, intelligent systems to allow the connection of increased levels of low carbon generation and deployments of EVs, heat pumps, etc. This will be at a reduced cost by allowing the power network to be operated closer to its limits, therefore releasing capacity and deferring the need to reinforce the power network.

The upgraded SCADA systems will make allowance for the use of innovative asset management and monitoring technologies. The communications will make allowance of the transfer of large volumes of data such as equipment condition monitoring data (online transformer DGA, cable partial discharge, circuit breaker health, etc.). Where sufficient bandwidth cannot be achieved, innovative technologies will be used to carry out analysis and processing of the data at the substation site to reduce the size of data by only transmitting the processed results. This technology will enable equipment health and remaining life to be more accurately ascertained. Costs will be reduced by allowing equipment to safely remain in service longer and allowing intervention before equipment fails.

SCADA will need to be deployed beyond the 11kV distribution network, down to the LV level. To enable monitoring of the LV network innovative methods of retrofitting monitoring equipment will be developed, such as using Rogowski coils to measure LV feeder currents. This will enable existing LV boards to remain in service and reduce the costs of installing LV monitoring.

7.0 ED1 Expenditure Requirements for SCADA

7.1 Method

During ED1, 150 Schneider primary RTUs and 1,100 of the Schneider Sprit II and Schneider Talus 200 secondary RTUs will be replaced.

Also during this period, 740 of the communications to secondary RTUs will be replaced with IP-compliant communications.

The BT21CN project (Document 17) will provide mitigation for the BT proposals to change the infrastructure of its communications network and the consequent impact on protection systems. This proposal provides the opportunity to independently expand this network to support SCADA communications, asset management data and voice communications. This associated expenditure is dedicated to this activity and is not covered within the proposals for BT21CN mitigation.

Battery monitoring will be installed on all existing secondary SCADA sites. Where batteries are replaced as part of the battery replacement programme, this functionality will be included if not already available. Substation battery replacement is detailed in Document 21.

Environment monitoring equipment will be installed at four substation sites to provide a good level of monitoring across the SPN area.

The inspection and maintenance expenditure for primary SCADA is split into eight categories:

- Third-party circuit faults.
  - Identification and rectification of faults with rented communications circuits. The drop in faults from 2008 to 2009 reflects the replacement of the old SCADA network with the IP/satellite network.
- UK Power Networks circuit faults.

  - Identification and rectification of faults with UK Power Networks-owned communications circuits. The drop in faults from 2008 to 2009 reflects the replacement of the old SCADA network with the IP/satellite network.
- SPN SCADA system maintenance.
  - Maintenance of the primary SCADA system, which includes maintenance of RTUs and communications equipment. No maintenance was carried out on the SPN SCADA network until 2013 because there were insufficient resources due to SPN and EPN satellite installation work.
- SPN SCADA satellite system rental.
  - Rental of capacity on the communications satellite. The equipment was rented immediately after installation, hence the higher costs. System rental costs were reduced following purchase of the equipment.
- SCS communications/plant faults.
  - Identification and rectification of faults associated with secondary SCADA communications and RTUs. It is anticipated that the fault will reduce slightly as equipment and systems are replaced.
- Satellite communications faults.
  - Identification and rectification of faults with the satellite communications system. Although the number of satellite-connected sites will reduce slightly as RTUs are moved onto the fibre network, the fault volumes are expected to remain the same due to age-related failures of the satellite equipment.
- SPN SCADA system management.
  - Management of the SCADA system as a whole.
- RTU fault rectification.
  - Primary SCADA RTU faults. It is anticipated that the fault rate will reduce following replacement of some of the RTUs and communications during ED1/ED2.
- IT - Control Centre Hardware & Software.
  - The NMS will require continual upgrading to ensure reliable and efficient operation and to enable the introduction of additional RTU and RTUs with enhanced features.
- IT - Communications for Switching & Monitoring.

- The costs for switching and monitoring will increase as additional control and monitoring equipment is installed on the network.

7.2 Constructing the Plan

In constructing the plan the following criteria have been taken into account:

- Spares not available due to age of equipment/product obsolescence.
- Risk of no spares and being unable to complete repairs.
- Loss of SCADA functionality.
- Impact on CI/CMLs.
- RTUs selected based on age and obsolescence.
- Increased levels of functionality required for 'smart' networks.
- Improved communications networks resilience.

The main constraints are with regard to qualified personnel to complete the work. A resource plan is being developed for ED1 delivery, which will look at options such as:

- Suppliers carrying out additional build/configuration work prior to delivery.
- Identifying the additional resource requirements and securing the resource (both contractor and employed).

The volumes planned for ED1 are significantly increased when compared to DR4/5, because the technology is becoming unsupportable and requires upgrading.

The additional IP-compliant communications mediums to be used, above those already in use, are yet to be identified, and this process will be carried out during the remainder of DPCR5. The budget for this is based on simply replacing the communications device on-site (PAKNET pad) with a new device (3/4G modem, etc.). The budget unit cost for this is low (£1,000 per site), but the overall cost is high due to the large volume of replacements required.

The replacements will be targeted at sites where other power network equipment is being replaced and sites where additional benefits can be gained from the improved level of technology offered by the new SCADA equipment.

7.2.1 Approach to network risk (providing sufficient spares to maintain the installed fleet)

Replacing 150 of the fleet of Schneider primary RTUs and 1,100 of the combined fleet of Schneider Sprit II and Schneider Talus 200 secondary

RTUs will provide sufficient spares for the remaining RTUs to remain in service during the ED1 period.

7.2.2 SCADA inspection and maintenance

The SCADA inspection and maintenance costs have been derived using a combination of historic fault data to predict the future costs for faults and contract cost data for rented/contracted services.

The historic data dates from 2008, because in 2007 the primary SCADA network was upgraded to use UK Power Networks' new satellite system and IP communications. This is when the project to convert the whole primary SCADA communications system commenced and the method of recording data was changed. Future inspection and maintenance expenditure takes into account the capex expenditure to replace old SCADA equipment and to install additional equipment as the SCADA system expands.

7.2.3 HI profile at end of ED1 with investment

Not relevant: intentionally left blank.

7.2.4 Policy changes, e.g. to asset lives

Not relevant: intentionally left blank.

7.3 Additional Considerations

Not relevant: intentionally left blank.

7.4 Asset Volumes and Expenditure

7.4.1 SCADA investment and volumes.

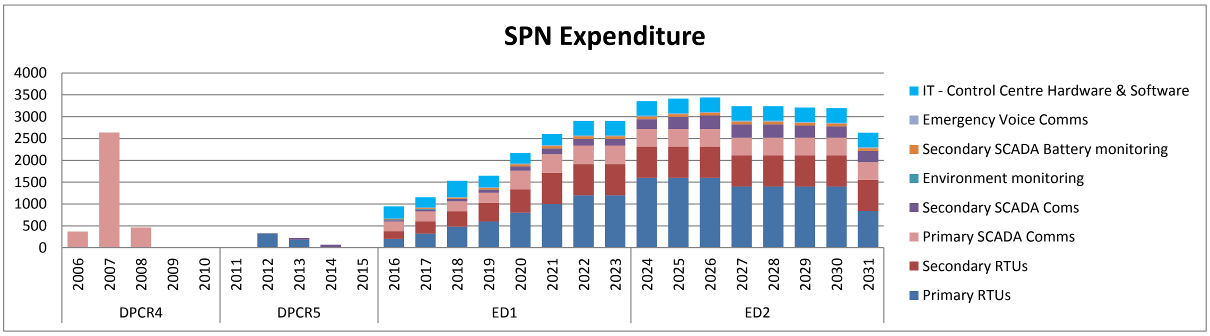


Figure 5 – SCADA expenditure (£k)

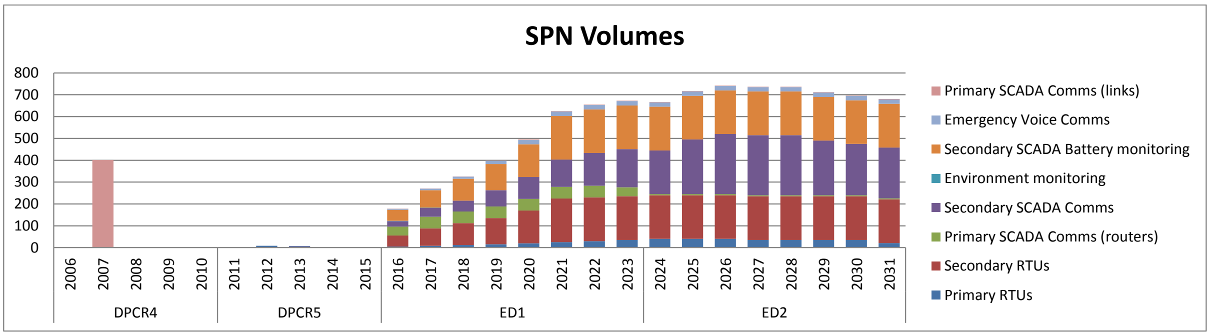
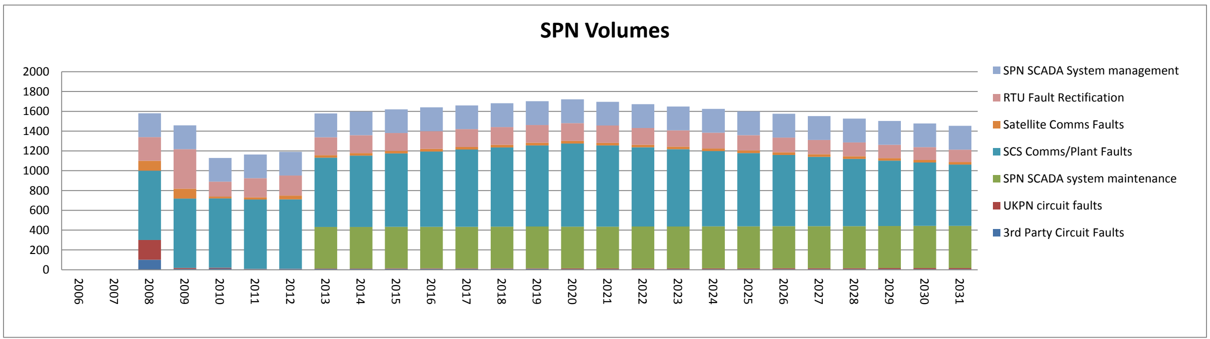


Figure 6 – SCADA replacement volumes and interventions

7.4.2 SCADA inspection and maintenance.

SCADA inspection and maintenance volumes are shown in Figure 7.



Details of the volumes and expenditure for ED1 and ED2 are shown in Appendix 9 NLRE Expenditure Plan.

7.5 Commentary

7.5.1 Explanation of trends and variances from DPCR5

There is a significant increase in the expenditure on replacing SCADA in the ED1 period due to the obsolescence of the technology and the reasons described in this document.

The inspection and maintenance volumes and expenditure decrease during ED1/ED2 due to the replacement of old maintenance-intensive equipment and systems with more modern equipment. This replacement will also reduce the fault rate.

7.6 Sensitivity Analysis and Plan Validation

7.6.1 Average life sensitivity

This is not relevant for SCADA. Replacement is based on the age of the technology and the availability of spares as described within this document.

As such, the age of individual SCADA components is largely irrelevant – the technology age is the critical factor.

7.6.2 Network risk sensitivity

Much of the RTU replacement programme will be linked to the replacement of switchgear due to condition, reinforcement, quality of supply, etc, or other programmes of work where a common resource can be shared. Any delays could have an effect on the delivery of the SCADA replacement programmes.

The SCADA programme will require a significant increase in the number of competent and suitably trained staff. A detailed resource plan will be produced prior to the expenditure programmes, detailing how the resource will be provided.

7.6.3 Asset defect analysis

Delays in the delivery of the SCADA replacement programmes could result in critical spares to support the existing equipment being unavailable. There is sufficient flexibility in the plan to enable replacement sites to be changed at short notice to enable the plan volumes to be delivered.

Availability of spares is reviewed during the quarterly Contract Review Meetings and assessed accordingly.

8.0 Deliverability

8.1.1 Network access and outage availability

For sites where the SCADA equipment is being replaced and does not form part of a project to replace other equipment, the new equipment will be installed and run in parallel with the existing equipment where possible. This will enable the functionality to be cut over in a controlled and planned manner with no loss of functionality to the control engineer.

For sites where SCADA equipment is being replaced as part of a bigger project to replace other network equipment on site (such as switchgear), the SCADA equipment replacement will be subject to the planned outages for that project and the cut-over strategy will be driven by the requirements of that project.

Any additional fibre circuits will be linked in with the BT21CN delivery project.

8.1.2 Consistency of delivery volumes and explanations of how increases will be managed.

This plan proposes a significant increase in work in ED1/2, and one of the biggest risks to delivery is access to sufficient labour to carry out the installation work.

The increase in the volume of SCADA replacements will be managed by targeting the replacements at sites where other significant work is already taking place, and the labour resource on-site can carry out the majority of the installation work. As much work will be done off-site by suppliers prior to delivery of the equipment, much of the work on-site can be completed by fitters and electricians as opposed to specialist SCADA engineers.

The Operational Telecoms department is working on a resource and delivery plan for the ED1 work to identify any additional resources required and ensure the programmes can be delivered.

8.1.3 Explanation of how asset volumes are converted into approved projects

Asset volumes are converted into approved projects in three main ways:

- Replacement of SCADA equipment at sites where other work is planned.
- Replacement of SCADA equipment at sites where additional functionality offered by the new SCADA equipment is required, such as sites which will form part of a smart grid or sites that require broadband communications.
- Replacement of SCADA equipment which contain components which are no longer available.

Appendices

Appendix 1 Age profiles

The technology used in much of the SCADA equipment dates back to the early 1990s and is incompatible with modern equipment. Computers from that date are no longer fit for use and do not have sufficient processing power (286 and 386 processors, for example), and the software (windows 3.1) and systems (serial and modem-connected equipment) cannot be supported. The SCADA equipment is similar.

Primary RTUs: The Schneider RTUs date back to the early 1990s and the Converteam RTUs are a modern design.

Secondary RTUs: The Schneider Sprit II and Schneider Talus 200 RTUs date back to the early 1990s and the Lucy Gemini, Nu-Lec, Schneider 200P and Schneider Talus T200E RTUs are a modern design.

Secondary SCADA communications: The communication used for secondary SCADA is the Vodafone PAKNET system that dates back to the mid-1990s.

Primary SCADA communications: The primary SCADA communications have been upgraded to use IP as the transport protocol. Satellite provides main communications and GPRS is used for back-up communications. Both the satellite and GPRS date from the early 2000s.

Appendix 2 HI Profiles

Not relevant: intentionally left blank.

Appendix 3 Condition Reports

Not relevant: intentionally left blank.

Appendix 4 Risk Assessments

The cost saving in the risk assessment table is based on the following assumption:

- 10% of the RTU replacements will align with other major project work. This will enable 20% cost savings from reduced project management, site set-up costs and reduced cabling/wiring, etc.).

The costs for accelerating the secondary SCADA communications replacement programme are based on the following assumption:

- The project costs will increase by approximately 20% due to the fact that more contract engineers working overtime will be required to meet the timescales.

Appendix 5 Fault Data

Date	Primary RTU fault	VSAT fault	Sarian Router	C&W Broadband	DSL over pilot cables	GPRS	Totals
Jan-10	4	1	0	1	1	0	**7**
Feb-10	10	1	0	0	1	0	**12**
Mar-10	10	1	0	0	1	0	**12**
Apr-10	10	1	0	0	1	0	**12**
May-10	9	6	0	1	1	0	**17**
Jun-10	20	1	0	3	1	0	**25**
Jul-10	16	0	0	1	0	0	**17**
Aug-10	20	0	1	1	1	0	**23**
Sep-10	7	0	0	2	0	0	**9**
Oct-10	26	0	2	0	0	0	**28**
Nov-10	12	4	1	0	0	0	**17**
Dec-10	6	4	1	3	1	2	**17**
	150	**19**	**5**	**12**	**8**	**2**	
Jan-11	14	2	0	0	1	4	**21**
Feb-11	13	1	0	0	0	0	**14**
Mar-11	19	0	0	0	0	0	**19**
Apr-11	19	2	0	0	0	0	**21**
May-11	9	0	0	0	0	1	**10**
Jun-11	22	3	0	2	0	1	**28**
Jul-11	20	1	0	1	0	6	**28**
Aug-11	26	6	0	0	0	0	**32**
Sep-11	13	1	0	1	0	0	**15**
Oct-11	16	3	1	1	0	1	**22**
Nov-11	9	2	0	0	2	0	**13**
Dec-11	13	1	0	1	0	0	**15**
	193	**22**	**1**	**6**	**3**	**13**	
Jan-12	8	0	0	0	0	1	**9**
Feb-12	16	5	1	0	2	0	**24**
Mar-12	15	1	2	1	0	0	**19**
Apr-12	13	2	0	0	0	1	**16**
May-12	9	0	0	1	0	0	**10**
Jun-12	25	1	1	0	0	0	**27**
Jul-12	26	1	0	0	0	0	**27**
Aug-12	17	3	0	2	0	0	**22**
Sep-12	20	3	0	0	0	0	**23**
Oct-12	18	9	0	0	0	0	**27**
Nov-12	15	9	0	2	0	4	**30**
Dec-12	20	5	1	2	0	0	**28**
	202	**39**	**5**	**8**	**2**	**6**	

Table 6 – SCADA fault data

Appendix 6 Maintenance History

Primary SCADA

Maintenance is carried out once a year on primary SCADA sites. This includes:

1. Checking equipment settings.
2. Checking equipment levels.
3. Checking connection leads.
4. Checking earth integrity.
5. Checking fixing bolts.
6. Testing of batteries.
7. Operation of the ‘dummy’ circuit breaker on RTUs.

Secondary SCADA

The only maintenance of secondary SCADA is checking the operation of the ‘dummy’ circuit breaker once a week and replacement of the batteries when required.

Appendix 7 WLC Case Studies
Risk, Cost, Performance and Condition Profiles for Various Options

Not relevant: intentionally left blank.

Appendix 8 Model Validation Test Results

Not relevant: intentionally left blank.

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

Appendix 9 SCADA expenditure by activity

ED1 expenditure

Primary RTUs								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	5	8	12	15	20	25	30	35

Secondary RTUs								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	50	80	100	120	150	200	200	200

Primary SCADA Comms								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes (links)	1	1	1	1	2	2	2	2
Forecast Volumes (routers)	41	53	53	53	53	53	53	41

Secondary SCADA Comms								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	25	40	50	75	100	125	150	175

Environment Monitoring								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	2	2	0	0	0	0	0	0

Secondary SCADA Battery Monitoring								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	50	80	100	120	150	200	200	200

Emergency Voice Comms								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	5	7	10	15	20	20	20	20

IT - Control Centre Hardware & Software								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Forecast Expenditure £k	279	234	376	265	238	254	333	333

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

3rd Party Circuit Faults								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	8	8	8	8	6	6	6	6

UKPN circuit faults								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	5	5	6	6	7	7	7	8

SPN SCADA system maintenance								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	421	421	421	422	422	422	423	423

SPN SCADA Satellite System Rental								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Forecast Expenditure £k	440	439	435	430	425	420	415	415

SCS Comms/Plant Faults								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	760	780	800	820	840	820	800	780

Satellite Comms Faults								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	26	26	26	26	26	26	26	26

SPN SCADA System management								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	240	240	240	240	240	240	240	240

RTU Fault Rectification								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	180	180	180	180	180	175	170	165

IT - Communications for Switching & Monitoring								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Forecast Expenditure £k	532	447	717	507	454	484	637	637

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

ED2 expenditure

Primary RTUs								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	40	40	40	35	35	35	35	21

Secondary RTUs								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	200	200	200	200	200	200	200	200

Primary SCADA Comms								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes (links)	2	2	2	2	2	2	2	2
Forecast Volumes (routers)	5	5	5	5	5	5	5	5

Secondary SCADA Comms								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	200	250	275	275	275	250	235	233

Environment Monitoring								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	0	0	0	0	0	0	0	0

Secondary SCADA Battery Monitoring								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	200	200	200	200	200	200	200	200

Emergency Voice Comms								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	20	20	20	20	20	20	20	20

IT - Control Centre Hardware & Software								
ED1 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Forecast Expenditure £k	333	333	333	333	333	333	333	333

3rd Party Circuit Faults								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	6	6	6	6	6	6	6	6

UKPN circuit faults								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	8	8	9	9	9	10	10	10

SPN SCADA system maintenance								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	424	424	424	425	425	425	426	426

SPN SCADA Satellite System Rental								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Forecast Expenditure £k	405	400	395	390	385	380	375	370

SCS Comms/Plant Faults								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	760	740	720	700	680	660	640	620

Satellite Comms Faults								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	26	26	26	26	26	26	26	26

SPN SCADA System management								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	240	240	240	240	240	240	240	240

RTU Fault Rectification								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	160	155	150	145	140	135	130	125

IT - Communications for Switching & Monitoring								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Forecast Expenditure £k	637	637	637	637	637	637	637	637

Appendix 10 Sensitivity Analyses

Not relevant: intentionally left blank.

Appendix 11 Full Optimised Plan

Individual sites for replacement will be identified between now and ED1 and during ED1. Replacements will be targeted at sites where other work is planned and sites where additional functionality, such as smart grids, is required.

Projects where SCADA equipment replacement can be combined with the work planned for a site will be identified before ED1; however, this approach must remain flexible as other influences can change both the potential projects that may be identified and the drivers behind the replacement of SCADA equipment.

Appendix 12 Audit Trail of Changes

Not relevant: intentionally left blank.

Appendix 13 Named Scheme Case Study 1

Flexible Plug and Play Project (FPP)

As part of the Ofgem Low Carbon Network (LCN) fund, UK Power Networks is carrying out a project to trial new technologies to enable the connection of additional low carbon and renewable generation in an area which based on traditional network technologies cannot accommodate any further generation. Part of this project is to trial the use of smart technologies to enable additional capacity to be safely released from the existing power network infrastructure. This requires integrating and embedding the new technology within the network which involves using modern open standard application protocols and modern communications systems and protocols.

The existing RTUs in the area which were required to form part of the 'smart' system (to provide network data and carry out operations as directed by the smart network controller), were unable to communicate using the modern protocols and systems, and could not be upgraded to the age and obsolesce of the technology used in them . They therefore had to be replaced with new RTUs.

Appendix 14 Named Scheme Case Study 2

Distribution network automation

On 02 April 2012 a fault (FREP-1150683-o) occurred on a Lewes Grid Office 11kV feeder out of Lewes Town Primary. The fault was identified by the SCADA system and an automated restoration script running on the NMS was triggered. The automation script interrogated the RTUs at the defined section points along the feeder to establish which section the fault was located in, and then carried out remote switching operations to restore supply to as many customers as possible. The resulting CIs and CMLs associated with this fault were 1,264 CIs and 70,251 CMLs (total cost £18,000).

On 31 December 2012 a fault (FREP-179497-o) occurred on the Lewes Grid Office 11kV feeder out of Lewes Town Primary. The fault was identified by the SCADA system and an automated restoration script running on the NMS was triggered. The automation scheme was unable to connect to one of the RTUs due to a problem with the communications network, and the automation script therefore failed to run. The control engineer then restored supplies to as many customers as possible using the SCADA network. The resulting CIs and CMLs associated with this fault were 2,409 CIs and 103,733 CMLs (total cost £29,500).

These case studies show that a failure of the automation system, which is dependent on the SCADA system, will incur significantly increased CIs and CMLs. In the case study where the automation system failed, the SCADA system was used to restore supplies by remote switching.

Appendix 15 Asset Stewardship Report – RIGs Table (Volumes)

Document Name	SCADA
Document Author	J Ford
DNO	SPN

This data is taken from Master Tables_SPN_07022014_Unscaled_RV

Outputs – Asset Stewardship reports

Investment destription	NAMP Line	2015/6	2016/7	2017/8	2018/9	2019/20	2020/21	2021/22	2022/23	Total
Primary RTUs	1.57.01.8213	5	8	12	15	20	25	30	35	150
Secondary RTUs	1.57.02.8216	50	80	100	120	150	200	200	200	1,100
Primary SCADA Comms (links)	1.57.02.8296	1	1	1	1	2	2	2	2	12
Primary SCADA Comms (routers)	1.57.02.8308	41	53	53	53	53	53	53	41	400
Secondary SCADA Battery Monitoring	1.57.07.8332	50	80	100	120	150	200	200	200	1,100
SPN SCADA system maintenance	2.28.15.6465	421	421	421	422	422	422	423	423	3,375
SPN SCADA Satellite System Rental	2.28.15.6814	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0
RTU Fault Rectification	2.28.01.6644	180	180	180	180	180	175	170	165	1,410
CV105 6		**748**	**823**	**867**	**911**	**977**	**1,077**	**1,078**	**1,066**	**7,547**
Secondary SCADA Comms	1.57.16.6129	25	40	50	75	100	125	150	175	740
Environment Monitoring	1.57.04.6208	2	2	0	0	0	0	0	0	4
Emergency Voice Comms	1.57.10.9122	5	7	10	15	20	20	20	20	117
IT - Communications for Switching & Monitoring	1.57.20.8612	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0
CV105 7		**32**	**49**	**60**	**90**	**120**	**145**	**170**	**195**	**861**
IT - Control Centre Hardware & Software	1.57.20.8615	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0
CV105 8		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3rd Party Circuit Faults	2.28.05.6645	8	8	8	8	6	6	6	6	56
UKPN circuit faults	2.28.07.9470	5	5	6	6	7	7	7	8	51
SCS Comms/Plant Faults	2.28.16.6646	760	780	800	820	840	820	800	780	6,400
CV13 31		**773**	**793**	**814**	**834**	**853**	**833**	**813**	**794**	**6,507**
Satellite Comms Faults	2.28.28.6389	26	26	26	26	26	26	26	26	208
CV13 47		**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**208**
SPN SCADA System management	2.28.29.9472	240	240	240	240	240	240	240	240	1,920
CV13 75		**240**	**240**	**240**	**240**	**240**	**240**	**240**	**240**	**1,920**
Total		**1,819**	**1,931**	**2,007**	**2,101**	**2,216**	**2,321**	**2,327**	**2,321**	**17,043**

RIG Table

RIG Table	RIG Row	2015/6	2016/7	2017/8	2018/9	2019/20	2020/21	2021/22	2022/23	Total
CV105	6	748	823	867	911	977	1,077	1,078	1,066	**7,547**
CV105	7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**0**
CV105	8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**0**
CV13	31	1,397	1,418	1,438	1,459	1,471	1,458	1,438	1,418	**11,497**
CV13	47	237	237	237	237	238	238	238	238	**1,900**
CV13	75	419	419	419	421	427	421	419	418	**3,363**
		2,801	**2,897**	**2,961**	**3,028**	**3,113**	**3,194**	**3,173**	**3,140**	**24,307**

The volumes in the ASR documents may not match those in the RIGs tables because additional NAMP lines not included within the ASR documents may be mapped in the same RIGs Tables/Lines.

Appendix 16 Asset Stewardship Report – RIGs Table (Costs)

Document Name	**SCADA**
Document Author	**J Ford**
DNO	**SPN**

CV105 data is taken from CV105 - 12 02 2014
CV13 data is taken from Master Tables_SPN_07022014_Unscaled_RV

				Cost in £m									
Asset Type	**Asset Name**	**RIGs Table**	**RIGs Row**	**Total investment by Asset Type**	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**Total**
Primary RTUs		CV105	6		0.200	0.320	0.480	0.600	0.800	1.000	1.200	1.200	5.800
Secondary RTUs		CV105	6		0.179	0.286	0.357	0.429	0.536	0.714	0.714	0.714	3.928
Primary SCADA Comms (links)		CV105	6		0.200	0.200	0.200	0.200	0.400	0.400	0.400	0.400	2.400
Primary SCADA Comms (routers)		CV105	6		0.021	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.206
Secondary SCADA Battery Monitoring		CV105	6		0.015	0.024	0.030	0.036	0.045	0.060	0.060	0.060	0.331
SPN SCADA system maintenance		CV105	6		0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.530
SPN SCADA Satellite System Rental		CV105	6		0.440	0.439	0.435	0.430	0.425	0.420	0.415	0.415	3.419
RTU Fault Rectification		CV105	6		0.079	0.079	0.079	0.079	0.078	0.076	0.074	0.074	0.619
Total		**CV105**	**6**	**29.86**									**17.233**
Secondary SCADA Comms		CV105	7		0.028	0.039	0.053	0.075	0.100	0.126	0.150	0.150	0.722
Environment Monitoring		CV105	7		0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.039
Emergency Voice Comms		CV105	7		0.005	0.007	0.010	0.015	0.020	0.020	0.020	0.020	0.117
IT - Communications for Switching & Monitoring		CV105	7		0.532	0.447	0.717	0.507	0.454	0.484	0.637	0.637	4.414
Total		**CV105**	**7**	**5.30**									**5.292**
IT - Control Centre Hardware & Software		CV105	8		0.279	0.234	0.376	0.265	0.238	0.254	0.333	0.333	2.312
Total		**CV105**	**8**	**2.37**									**2.312**
3rd Party Circuit Faults		CV13	31		0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.022
UKPN circuit faults		CV13	31		0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.013
SCS Comms/Plant Faults		CV13	31		0.134	0.137	0.141	0.144	0.147	0.144	0.141	0.141	1.130
Total		**CV13**	**31**	**2.03**									**1.165**
Satellite Comms Faults		CV13	47		0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.056
Total		**CV13**	**47**	**0.51**									**0.056**
SPN SCADA System management		CV13	75		0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	1.314
Total		**CV13**	**75**	**2.30**									**1.314**
	Total			**42.37**	**2.37**	**2.50**	**3.15**	**3.05**	**3.51**	**3.97**	**4.41**	**4.41**	**27.37**

The costs in the ASR documents may not match those in the RIGs tables because additional NAMP lines not included within the ASR documents may be mapped in the same RIGs Tables/Lines.