RTU/HMI Replacement Programme- OFGEM justification paper	
Name of Scheme/Programme	**RTU/HMI Replacement Programme**
Primary Investment Driver	Asset Health
Scheme reference/ mechanism or category	SPNLT2053 Non-Lead Asset
Output references/type	NLRT2SP2053 / Non-Lead
Cost	£2.3m
Delivery Year	RIIO ET2
Reporting Table	C0.7 / C2.2a
Outputs included in RIIO T1 Business Plan	No

Issue Date	Issue No	Amendment Details
July 2019	Issue 1	First issue of document
December 2019	Issue 2	Cost updated

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1 Introduction

Constant monitoring and control of the SPT Network is essential in the operation of the electrical power network. It is essential to allow the design, connection, control, operation and fault response to enable network management and ensure that there is a secure and reliable electrical supply to all customers.

The Supervisory Control and Data Acquisition (SCADA) system is the means by which every item of plant and the electrical parameters are constantly monitored in real time. It allows remote control of equipment for everyday planned works and gives visibility to network faults as they happen, allowing network management, safety management, risk mitigation and resource response. The particular SCADA systems for electrical network operations are denoted as Electricity Management Systems (EMS).

This SCADA and EMS system requires the constant data communication from the SPT substations. This is done by means of a Remote Terminal Unit (RTU) which takes the signals for all the plant in substations and coverts them to signals to be transmitted to the Operational Control Centre (OCC).

This information is also mirrored locally at the Substation to allow authorised engineers to operate equipment as required and interrogate alarms at the substation. These are referred to as Substation Control and Information systems (SCIS) or Human Machine Interfaces (HMI) and were installed with the main plant installation.

Both plant items use electronics and computer technology that become obsolete and unsupported in short timescales in comparison to the main equipment.

Additionally these equipment types require highly accurate time stamping and synchronisation to ensure that all the information is correct and able to be correlated by the central control system. This is achieved through the use of GPS clocks to ensure a consistent time base. These GPS clocks are now becoming obsolete, unsupported and failing in service.

This justification paper supports the intention for SPT to invest £2.3m over the RIIO T2 period to replace and upgrade the existing population of RTUs, HMIs and GPS clocks.

2 Background Information

This paper supports a proposal to modernise SCIS, RTU and GPS at a number of specific substation sites. Maintaining the integrity of the SCIS/RTU asset base is essential to maintain a continuously monitored network such that network faults can be managed quickly and work on the system can be managed safely and efficiently. The HMI which forms part of the SCIS creates a central point to view the current state of a substation locally, allow switching at the substation to be carried out at the substation and display historical events which have occurred at the substation.

As part of the protection and control asset base, SCIS (including the HMI) and RTUs have been assessed according to the methodology determined by ASSET-01-025. For the RIIO-T1 price control, the SCIS/RTUs based upon the [redacted] processor were rated at Health Index 5 due to the following issues

- Withdrawal of manufacturer support
- Limited ability to support as spares are exhausted
- Increasing failure rate

- Limitations on the means of equipment substitution

Due to the health index rating, a programme of replacement of the [redacted] processors was begun in RIIO-T1. It was intended that this programme would continue and be completed during the RIIO-T2 price control.

The HMIs based on the [redacted] platform have also been assessed as Health Index 5 due to the following issues

- Increasing difficulty of manufacturer support – support may be withdrawn completely
- No ability for SPEN to support
- No means of direct substitution, i.e. each HMI is a bespoke deployment
- Lack of update options means that HMI is not fit for purpose

It is further proposed to replace the older generation of GPS clocks which provide a local time source for the RTU and SCIS. The original [redacted] units are now no longer available or supported by the manufacturer. Using the Asset Health methodology these have been classed as Health Index 5, End of Life and require to be replaced.

This Justification paper splits the investments into the 3 sub topics to evaluate.

3 SCIS/RTU Replacement Programme

3.1 Background Information

The Transmission SCADA system was originally supplied by Ferranti around 1985. The Ferranti SCADA System comprised ARGUS Master Stations together with approximately 120 RTUs. The RTUs were installed in all Transmission substations and large Power Stations. These RTUs utilised the [redacted] communications protocol (modified to meet SP needs) for communication with the ARGUS Master Station.

The Ferranti Group of companies entered receivership in the early 1990s. At this point, manufacture of [redacted] RTUs and related spare parts was ceased. As a result, an initiative was commenced for the supply of alternative RTUs which would emulate the [redacted] protocol. By providing RTUs which could communicate using the [redacted] protocol, any need to change the Ferranti ARGUS Master Station was avoided.

Following a successful pilot project at Neilston substation in the late 1990s, [redacted] developed a new SCIS. Each SCIS comprises both the emulation RTU together with a local HMI. The HMI replaces the Local Control Panel (LCP) and local alarm annunciation panels. The initial SCIS were deployed at Coylton 275kV and Auchencrosh 275kV substations as part of the transmission works associated with the construction of the Moyle Interconnector.

[redacted] also supplied an SCIS for the new 400kV substation built at Eccles as part of the works to upgrade the Scotland/England Interconnector to 2.2GW. [redacted] also demonstrated their SCIS including their emulation RTU, but no RTUs of this type were ever deployed on the Transmission System.

In the early 2000s, the original Ferranti [redacted] RTUs and the components specific to SPT for circuit breaker closing synchronisation and for load reduction were showing increasing failure rates. A solution was developed, based upon the [redacted] SCIS product deployed at Coylton and Auchencrosh, but without an HMI, to allow replacement of the original Ferranti RTU. An engineering process was also developed which allowed the RTU to be replaced in its entirety with only a short duration outage in communications between the SCADA system and a Transmission substation. This solution has subsequently been used to replace the entire population of the original Ferranti RTUs.

During the period up to 2015, the [redacted] SCIS was also deployed at the majority of new Transmission sites. Along with [redacted] Replacement RTUs, those supplied up until 2005 utilised the [redacted] processor. [redacted] (now [redacted]) has now ceased manufacture of the [redacted] processor in favour of the [redacted]. Existing spares holdings of the [redacted] 1 processor are reducing as processor card failures increase. The [redacted] processor cards suffer from the following limitations.

- The processor cards are problematic to reconfigure
- The processor cards are limited due to the lack of an Ethernet interface with connecting with modern substation protection relays and Intelligent Electronic Devices (IEDs) utilising the IEC 61850 standard.
- Development of firmware for the processor card has ceased and therefore any latent defects would be unlikely to be able to be resolved.

3.2 Optioneering

The following is a summary of the options considered for this project.

	Option	Status	Reason for rejection
1	**Do nothing**:	Rejected	This would increase the risk of failure of processors on the RTU. This could lead to either a complete failure of the RTU or a partial failure, where remote visibility of parts of a substation could be affected. This would compromise the ability of the Control Centre to monitor substations on a 24/7 basis. This is an unacceptable risk level.
2	**Replacement of [redacted] processor cards with the [redacted] 1**	Proposed	-
3	**Replacement of RTU**	Rejected	This option was rejected the basis that the component failure of the RTU's are manageable, opposed to the wholesale change of the RTU

3.3 Selected option - Replacement of [redacted] processor cards with the [redacted]

This option proposes a minimal intervention on the older RTUs to replace only the processor cards which are no longer available. All other component parts of the RTU, cubicles, racks, input/output cards, RTU power supply and distribution equipment and plant wiring would be retained. It is proposed that this approach would extend the asset lifetime of the existing RTU by at least another 10 years.

This option will also allow the existing RTUs to be increased in capacity should this be required to accommodate upgrade/refurbishment of Primary Plant.

During the RIIO-T1 Price control, funding was approved to commence a program of this nature. This programme is underway. By the end of the RIIO-T1 Price Control period, it is anticipated that the replacement of the [redacted] processor cards by [redacted] processors will have been completed at 11 sites.

The proposed continuation will replace processors replace at a further 33 sites. These are identified below:

RIIO-T1 Sites	RIIO-T2 Sites
[redacted]	[redacted]

	[redacted]
	[redacted]
	[redacted]

The proposal therefore is a continuation of the programme commenced during RIIO-T1. The result of this programme is that all [redacted] processors will be replaced by the end of RIIO-T2.

3.3.1 Financial Assessment

Costs have been derived using current data which includes the cost of purchasing [redacted] processor cards and engaging the RTU supplier to carry out reconfiguration work for these new processor cards. The costs for this vary from site to site depending on the size of the existing RTU, i.e. number of processor cards currently fitted. Reconfiguration costs will also be greater for larger RTU as a result of the greater number of input/output points to be tested upon deployment.

3.3.2 Risk Reduction

The option would reduce risk as the replacement of existing [redacted] cards with [redacted] cards would result in a system which has full manufacture support and therefore results in a reduction of risk.

In addition, it has been identified that the Substation RTU is a potentially vulnerability to cyber-attack. [redacted] The upgrade works will install a new processor that meets current Cyber security standards. With the new technology there is the ability to ensure that these safe-guards are maintained and improved as threats develop.

3.3.3 Environment & Sustainability

The option would have result in the generation of Waste Electronic and Electrical Equipment. Initial processors liberated would initially be used as spare hardware to support the remaining [redacted] population.

3.3.4 Supply Security and Outage Minimisation

An approach has been proposed which will allow the configuration replacement processor cards to be tested off-line. As such, the replacement of the RTU processor cards will result in an outage on the RTU only of a few hours. No outages on primary plant will be required.

4 HMI Upgrade Programme

4.1 Background Information

As described above, on new substation builds since the mid-2000s the substation has been equipped with an SCIS which includes a HMI to allow local control and alarm annunciation facilities. Up to, and including those installed during 2012, these HMIs were based upon a software platform designed and developed by [redacted]. The HMI platform was integrated into the SCIS by the SCIS supplier [redacted]. For SCIS delivered post-2012 an alternative HMI platform was integrated into these systems.

The HMIs based on the [redacted] platform suffer for the following issues

- Increasing difficulty of manufacturer support – support may be withdrawn completely
- No ability for SPEN to support or update
- Each HMI is a bespoke deployment and therefore there is no means of direct substitution
- [redacted]

4.2 Optioneering

The following is a summary of the options considered for this project.

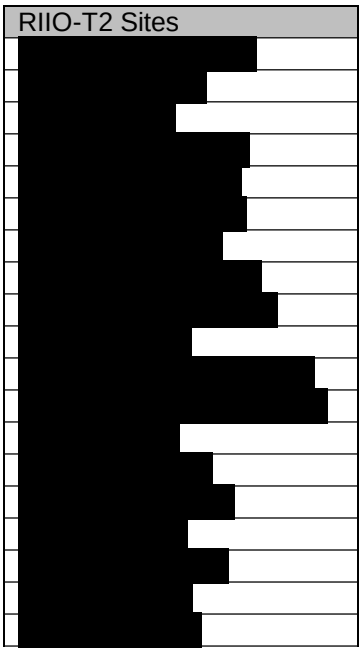
	Option	Status	Reason for rejection
1	**Do nothing**	Rejected	This would increase the risk of failure of the HMI as it is not possible to support the software platform. It will also not be possible to update the HMIs to reflect operational changes at site due to refurbishment programmes or substation extensions. [redacted]
2	**Upgrade of the HMI to a more modern platform**	Proposed	-
3	**Replacement of the entire SCIS**	Rejected	This option would replace the entire SCIS with a new one, built to modern standards. Given the life extension of a replacement is similar to that of the platform upgrade, this option was rejected.

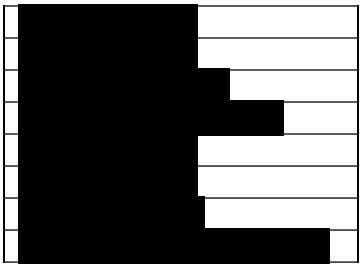
4.3 Selected option - Upgrade of the HMI to a more modern platform

This option would upgrade each [redacted] HMI to a more modern platform, including modern hardware running up to date software operating systems.

To replace the obsolete HMIs with a modern platform which has full manufacturer support and also have the ability to be supported and updated internally by SPEN staff would meet the objective of improving the asset health rating whilst meeting operational safety requirements.

The volumes that require replaced are 27 HMIs to the modern platform. These sites are listed below:





4.3.1 Financial Assessment

The cost for each site is estimated to be the same with the exception of a few sites where additional HMIs are installed to give an additional local control/annunciation location, for example in a power station control room or where there are two differing voltage substations (275kV and 132kV) at the same location.

4.3.2 Risk Reduction

The option to upgrade the HMI platform will eliminate any issues around manufacturer support of the system and ensure that the HMI can be updated to reflect operational changes following substation refurbishment or extension.

4.3.3 Design Safety

Since it will be possible to modify the HMI to reflect changes at the substation site, there will be no potential to compromise the safety of staff attending site.

4.3.4 Environment & Sustainability

The option would lead to the generation of small amounts of Waste Electronic and Electrical Equipment. This will be managed through established SPT procedures for dealing with WEEE waste.

4.3.5 Innovation

It is proposed to investigate whether the existing displays in the e-terra EMS system (or its replacement) could be used by some means at the substation level. It should be realised however that although the displays used in the e-terra EMS do share some common functionality with those on the substation HMI, there are some aspects which the e-terra interface does not perform but the local HMI does (and vice-versa) e.g. local suppression of alarms etc. The approach used in each is also different as the HMI is based around a substation bay view and not the substation as a whole as in e-terra. It is not clear however that the EMS could be scaled down for use at a single substation compared with the whole transmission system.

5 Replacement of SCIS/RTU GPS Clocks

5.1 Background Information

The SCIS/RTU on the SPT System has a requirement to deliver information with an accurate timestamp (1ms) to the OCC and additionally to any connected systems such as Data Historians. These time stamps are critical to allow the analysis of system events to accurately assess the performance of protection systems both in real time and retrospectively.

SCIS and RTUs have two methods of synchronisation. The primary source is a GPS clock located in the substation. The alternative source is a download of time from the SCADA system via the RTU protocol in the event of GPS failure.

Since the first SCIS were installed in 2001 each has been fitted with a GPS clock. This approach has also been taken with all [redacted] Replacement RTUs. The early deliveries of SCIS/RTUs were fitted with a [redacted] GPS clock delivering time to the RTU via a serial interface in [redacted] protocol format. These clocks are now obsolete and are not covered under any support contract with a vendor. There is an increased failure rate of the [redacted] GPS clock and spares are now almost exhausted.

The proposal is to replace these GPS clocks with modern equivalents to ensure that the accuracy of these systems.

5.2 Optioneering

The following is a summary of the options considered for this project.

	Option	Status	Reason for rejection
1	**Do nothing**	Rejected	This is not a viable option as any time stamps applied by the SCIS/RTU would be reliant on the accuracy of the time synchronisation to the SCADA system. As RTU communications with the SCADA system are delivered over TCP/IP network, there is no guarantee in the consistency that protocol messages are delivered and therefore it cannot be guaranteed that all SCIS/RTUs will be running to the same time reference. This in turn means that any post event analysis to determine the performance of protection systems could be inaccurate.
2	**Replacement of Obsolete GPS Clocks**	Proposed	-

5.3 Selected option - Replacement of Obsolete GPS Clocks

This option would replace the GPS clocks with a more modern equivalent. A modern GPS clock can also provide a degree of flexibility in terms of the format and distribution of time on a modern control system and with other IED's. It will be possible to utilise other forms of time management such as IRIG-B, SNTP or PTP if appropriate.

5.3.1 Financial Assessment

The cost for each site is estimated to be the same, SPT have identified 90 [redacted] GPS clocks fitted across the SP Transmission system. These units will be changed within the RIIO-T2 period.

5.3.2 Risk Reduction

This option will ensure that all SPT SCIS/GPS are synchronised to the same time reference and therefore any post event analysis of the performance of protection systems can be guaranteed to be accurate. A reduction in risk to primary plant is therefore achieved.

5.3.3 Innovation

It is proposed to investigate whether any new GPS clock fitted could be used as a single GPS clock source across the substation. This would result in less duplication of assets and lead to modest reduction in investment required at each site in the future.

6 Conclusion

The SCADA system, like the Protection and Control Assets, has a shorter life expectancy than the main plant equipment that it supports. Each asset, RTU, SCIS and GPS Clock has been reviewed independently and a course of action for each proposed.

For all, do nothing is not an option as it leads to a system risk, that would impact the real time operation of the Transmission Network.

For the RTUs, the option proposes a minimal intervention on the older RTUs to replace only the processor cards which are no longer available. All other component parts of the RTU, cubicles, racks, input/output cards, RTU power supply and distribution equipment and plant wiring would be retained. It is proposed that this approach would extend the asset lifetime of the existing RTU by at least another 10 years.

For the SCIS/HMIs, the option would upgrade each HMI to a more modern platform, including modern hardware running up to date software operating systems. To replace the obsolete HMIs with a modern platform which has full manufacturer support and also have the ability to be supported and updated internally by SPEN staff, would meet the objective of improving the asset health rating whilst meeting operational safety requirements

For the GPS Clocks, the option would replace the GPS clocks with a more modern equivalent. A modern GPS clock can also provide a degree of flexibility in terms of the format and distribution of time on a modern control system and with other IEDs. It will be possible to utilise other forms of time management such as IRIG-B, SNTP or PTP if appropriate.

All these actions mitigate the risk of the equipment failing in service.

Costs:	£ 2.3m
Timing of investment:	2022-2026
Declared outputs:	All outputs non-lead asset without category class in business plan data tables 33 RTU upgrades, 27 HMI Platform upgrades, 90 GPS clock changes

7 Future Pathways – Net Zero

We have reviewed this project against the criteria set out within the business plan guidance and have assessed that it does not prevent achievement of our Net Zero plans or lead to stranded assets.

8 Outputs included in RIIO T1 Plans

None.