Engineering Justification Paper

Campbeltown E&I Replacement

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1 Table of Contents

2 Introduction

SGN consider that it is necessary to replace Electrical, Instrumentation, Control and Telemetry assets at SGN's Campbeltown Scottish Independent Undertaking (SIU) to ensure a safe and reliable network and statutory legal compliance.

This will be a continuation to the SIU upgrades which are to be completed as part of GD1. SGN have partially upgraded the Wick & Thurso SIU sites with new Electrical & Instrumentation equipment.

The SIU sites which have been completed and/or are to be completed as part of GD1 are listed in table 1 below.

Table 1: GD1 SIU Upgrade Summary

Site Name	LDZ	Status
Wick	Scotland	Site Construction Stage
Thurso	Scotland	Site Construction Stage
Oban	Scotland	Fire system minor Upgrade complete
Stornoway	Scotland	Telemetry upgrade only
Campbeltown	Scotland	No Upgrade

The SIU sites mentioned above which have not yet had major E&I upgrades need to be upgraded in GD2.

2.1 General Background

This report reviews the upgrades at Campbeltown SIU which is not connected to the mainland transmission network and provides a cost-benefit analysis of various upgrade options.

Based on this analysis recommendations have been made for each site as summarised in Table 3.

2.2 Site Specific Background

There are numerous drivers for upgrading the Campbeltown SIU and various options that can be considered to address these:

- Safety – The existing vessel level gauging systems on the stock storage vessels are expected to need replacing during GD2 due to a forecast decrease in reliability associated with ageing assets, to ensure safe vessel stock level management for SIU COMAH sites.
- Safety-Safety Instrumented Systems require upgrading due to age related decrease in reliability for critical Safety Instrument Functions protecting downstream carbon pipework from low temperatures.
- Safety – Gas Quality instruments need rationalisation to decommission/replace ageing Sigma CV instruments which are obsolete and no longer supported. These are needed to support retention of the HSE GSMR Exemption letter for supplying economically viable High Wobbe gas on the SIU network.
- Safety- Major Electrical and Instrument upgrade is required to ensure compliance with Electricity at Work Regulations 1989 and BS7671 IET wiring requirements for Electrical Installations.
- Safety- To ensure compliance with COMAH regulations 2015 there is an ongoing requirement to update site drawings/plans at regular periods to ensure safe maintenance and operations activities on the site can be realised.

3 Equipment Summary

Table 2: Campbeltown Equipment Summary

Site	Project Details
Campbeltown	Asset Health- E&I Major upgrade of legacy site Electrical and Instrumentation equipment. This will include Low Voltage Electrical distribution system, Yokogowa Main Plant Alarm Annunciator panel and other E&I Control panels, 24Vdc Electrical distribution, all field instrumentation, Uninterruptable Electrical Power Supplies (UPS) and Brightwell DB1 Telemetry system installation to ensure compliance with the Electricity at Work act 1989, IET Wiring regulations for Electrical Installations 18th Edition 2018, Functional Safety standard BSEN 61511 Edition 2 2017 and Management of Health and Safety at Work regulations 1999. Asset Health- Replace legacy Qty 4 LNG vessel ITT Barton 290A stock level gauge/ high level alarm system with a replacement vessel level gauging system providing full vessel stock level and independent high level alarm on site at vessel on the alarm handling panel and via Telemetry to Gas Control to ensure compliance with COMAH regulations 2015, IET Wiring Regulations 18th Edition 2018, Functional Safety standard BSEN 61511 Edition 2 2017 and Management of Health and Safety at Work regulations 1999. Asset Health -Replace aged Safety Instrumented Systems (SIS) Safety Shut Off Valves (SSOV) (Mechanical Asset GD2 budget) and associated valve position proximity switches on the interface with outlet carbon steel pipework to protect against potential low temperature carbon steel pipework embrittlement with potential for catastrophic pipework failure and uncontained gas release. Qty 2 Safety Instrumented Functions (SIFs) are for Hot water vaporisers outlet pipework protection and Qty 1 is for the Ambient vaporiser system outlet pipework protection. These Safety Instrumented Functions (SIF)s are designed to undertake a critical safety gatekeeper role between the cryogenic upstream site pipework which can tolerate low temperatures and the normal carbon steel pipework which leaves the plant into the local area network but is not able to operate safely at cryogenic temperatures. The systems are Safety Integrity Level (SIL) 1 rated and as such must comply with the Functional safety standard BSEN61511 safety lifecycle. The system must be reliable enough to operate when required to bring the process to a safe state in the event of an upstream failure of the process and be fully supportable regarding availability of spares (MTTR) to avoid a prolonged safety risk reduction gap. Statutory Compliance - Replace Obsolete aged Sigma CV Gas Quality analyser to ensure Gas Quality measurement is maintained to comply with GSMR Regulations 1996 and HSE GSMR Exemption reference letter 4545199 dated 27 Mar 2018. Statutory Compliance-Update site E&I drawings to ensure that they continue to provide the necessary up to date information required to ensure compliance with COMAH regulations 2015, Electricity at Work act 1989, IET Wiring Regulations 18th Edition 2018 and Functional Safety standard BSEN 61511 Edition 2 2017. Management of Health and Safety at Work regulations 1999.

4 Problem Statement

Why are we doing this work and what happens if SGN do nothing:
The SIU facilities began life at least 50 years ago as sites to produce Town's gas. The sites were converted to LNG and LPG in the 1970s. The primary driver for investment is compliance with statutory regulations, the mitigation of degradation in asset condition and the reduction in reliability of the assets. The sites are in remote geographical locations which adds considerable Opex costs to any equipment failures that require specialist contractors to attend site to diagnose, this can require repeat visits as spares provision for these aged assets is no longer a viable option as they are no longer supported by the original equipment manufacturers.

If SGN were to do nothing to mitigate degradation of asset condition, then it is expected that we would be subject to increased commercial exposure and be in breach of statutory COMAH legislation leading to potential intervention action by the HSE. There would also be an increased risk of supply to our customers from diminishing reliability of ageing assets that may no longer be supportable in the event of failure.

The HSE GSMR exemption letter requires SGN to manage Gas Quality on the LNG SIUs which requires reliable Gas Quality instruments to provide the Gas Quality performance data for monthly HSE reporting. If the instruments fail, then we would be in breach of the exemption letter requirements to provide Gas Quality data which might lead to revoking the HSE GSMR exemption to supply High Wobbe gas to the Network. This would mean that Nitrogen ballasting might need to be installed/commissioned at all LNG sites which would be considerably costly to install.

What is the outcome SGN are looking to achieve?
Gas enters the local distribution network from the Campbeltown SIU as a single source supply point. The measurement of the Gas Quality data entering the network at each LNG site is a key compliance requirement from the HSE to support the ongoing GSMR exemption to allow the supply of High Wobbe gas from the sites.

Campbeltown SIU is deemed a Local Distribution Zone and Calorific Values are declared on a regular basis for the purposes of calculating customer bills. There is also an OFGEM requirement to confirm the energy content of supplied gas at all SIUs to ensure customers are not overbilled for gas supplied.

SGN wants to achieve SIU COMAH sites which are compliant with both statutory and industry legislation, that deliver the necessary specification of gas safely to the downstream network with the minimum maintenance requirements to achieve a Safe and Reliable network, to satisfy both our customers and our future needs.

How will we understand if the spend has been successful?
The spend will be a success when the SIU COMAH plant asset integrity is mitigated to provide a safe and reliable Supported Independent Undertaking network and accurate billing of gas to customers is realised. This will be successful when faults in relation to asset integrity are minimised to reduce maintenance and operational costs.

4.1 Narrative Real-Life Example of Problem

For Wick SIU both outlet pipework streams A&B from the hot water vaporisers have a SSOV valve fitted that protects the downstream network pipework which is subject to the following:

- Annual proof testing using an approved SGN proof test procedure.
- Process Safety time for SIF operation verified in Safety Requirement Specification.
- SIF SSOV Valve is tested to ensure that it can close within the stipulated time.
- SIF SSOV should not exceed the closure time otherwise proof test is a failure for SIF.

For a SIL 1 Safety Integrity Function (SIF) to comply with Functional Safety standard BSEN 61511 it must be proof tested at appropriate intervals. For Campbeltown SIU this is an annual test.

During annual proof testing of Stream, A at Wick SIU in May 2019, the Stream A SIF SSOV failed the proof test as the valve was too slow to close taking 39 seconds, exceeding the Safety Requirement Specification time of 20 seconds, please see Figure 1 below. The fault was investigated and traced to degradation of the SSOV actuator SOV valve internal components, which controls the gas flow to enable closure of the SSOV valve, necessitating replacement of the SOV valve. If the valve had been required to act in a real situation the reaction time due to degradation would have come close to realising low temperature on the outlet pipework beyond its designed specification. This could lead to catastrophic failure of the downstream pipework if the SSOV valve were to fail to close completely due to further degradation.

SGN consider that replacement of the SSOVs and associated Proximity switches are necessary due to reliability issues (found during proof testing) emerging from ageing of the existing assets which would result in increased unscheduled maintenance costs and may be unsupportable in meeting Mean Time to Repair (MTTR) replacement requirements for the SIFs. To comply with Functional Safety standard BSEN61511 Edition 2 2017 if the SIF becomes unavailable, this requires unspecified compensating measures to be put in place to mitigate the safety risk gap that is not being protected against automatically by the unavailable safety system. This may require the site to be permanently manned 24hrs a day in a worst-case scenario which would incur additional significant Opex costs and may reduce the operational availability of the SIU site personnel to meet their wider SIU distribution network commitments if SIF spares cannot be readily procured due to obsolescence.

Figure 1: Wick proof test Failure

SIF Reference: No1 Heated Vaporiser						
Item	Description			Pass	Fail	Initials
17	**TRIP POINT** Simulate fall in temperature using decade box until trip setpoint is reached (-10 Deg C) within switch point tolerance of +/- 0.5 Deg C as per SGN/WI/MAINT/12.			x		
	DECADE BOX OHMS TRIP SETTING	96.09	OHMS	x		
	DEG C EQUIVALENT	-10	DEG C	x		
	COMMENT	Decade box setting had to be set at 96.00 ohms to trip				
18	Ensure SOV/A3 actuates at setpoint; HMI Alarm confirmed as active and slam shut valve SSVA/3 confirmed closed within 20 secs.			x		
	SSVA/3 TIME TO CLOSE	39	Secs		x	
19	Confirm that slam shut SSVA/3 cannot be reset whilst trip active			x		

4.2 Spend Boundaries

The following is a breakdown of where the spend will be allocated during GD2 works:

Table 3: Allocation of Spend

Site	Spend	Cost (Net)	Justification
Campbeltown	1. Upgrade Electrical, Control & Instrumentation 2. Upgrade Gas Quality instrument 3. Update Drawings/COMAH plans 4. Upgrade SSOV proximity switches 5. Upgrade Level gauging	1. 2. 3. 4. 5. Commercial Confidentiality	Non-conformance with: • COMAH • GSMR • BSEN61511 • BSEN60079-10 • Statutory Electricity at Work Act 1989 regulations; Reduced commercial exposure; Reduction in Opex costs

5 Probability of Failure

Legacy Level gauging of stock vessels for LNG and LPG are aged assets which have been installed in circa 1980. These instruments are not CE approved and cannot be replaced with like for like replacements. There are no spares provision left to support this asset class that are CE approved. Some units are now prone to inconsistent stock level readings and false high-level alarms during tanker filling operations and can suffer from lack of repeatability when re-calibrated during annual maintenance.

The HSE have identified inaccurate vessel stock level systems as being a high-risk factor in accidents involving overfill of the vessel with subsequent uncontained release of product in HSG 176. SGN consider that the existing vessel stock level gauging systems are now beyond their useful life and unsupportable for continued use and therefore need to be replaced with a suitable industry standard level gauging system that is independent of the High-level alarm functionality to avoid common cause failure scenarios, where gauge failure also causes high level alarm failure.

Existing electrical distribution equipment at Campbelltown SIUs has been installed circa 1980s. The equipment is now obsolete and no longer supported. Replacement of the equipment is now necessary to bring the switchgear and UPS systems up to date to comply with IET BS7671: 2018 18th edition, wiring regulations for electrical Installations & Electricity at Work Act 1989. The replacement work will help reduce the site carbon footprint by reducing electricity consumption through use of more efficient up to date equipment. Failure to upgrade could lead to increased reliability, safety and availability issues.

Ageing functional safety assets such as the hot water vaporiser SSOVs are showing reliability issues necessitating replacement due to dormant failures caused by internal degradation of components. During annual proof testing of Stream, A at Wick SIU in May 2019 the Stream A SIF SSOV failed the proof test as it was too slow to close taking 39 seconds and exceeding the safety requirement specification time of 20 seconds. The fault was traced to degradation of the SSOV actuator SOV valve internal components. It is anticipated that more failures due to degradation can be expected as all the

assets were installed at the same time. Replacement of the assets is now required to ensure continuation of uninterrupted gas supply.

Campbeltown Sigma CV gas analyser is obsolete and no longer supportable. This is the only recognised official gas quality instrument on site and is a potential single point of failure. A replacement industry standard analyser is now required to provide supportable gas quality measurement. Campbeltown is also subject to an HSE GSMR Exemption letter to supply High Wobbe gas to the network which requires continuous Gas Quality performance data to be sent to the HSE for monitoring purposes. Any data loss needs to be justified and could lead to intervention action if data is not continuously available due to instrument unreliability.

5.1 Probability of Failure Data Assurance

The data used to generate the Probability of Failure has been collated from routine Annual Maintenance records, Safety Instrumented Function proof tests and related SGN Fault 1 forms for the equipment. The functional safety proof tests are driven by compliance with BSEN61511 Functional Safety -Safety Instrumented Systems for the process industry sector. Annual maintenance is undertaken to ensure compliance with The Electricity at Work Act 1989, PSSR & COMAH regulations 2015. The Lower tier COMAH site is also subject to planned periodic independent intervention inspections by the Health & Safety Executive.

6 Consequence of Failure

Loss of Supply to Customers
Supply to customers may be affected if stock is lost due to an LNG vessel overfill incident occurring which might lead to temporary shutdown of the plant to prevent escalation of the incident. The incident would be reportable to the HSE who may choose to close the plant until improvements are made. Loss of a Safety Instrumented Function could lead to loss of gas supply stream redundancy supplying the downstream network. This would leave the site gas supply vulnerable in the event of a stream being isolated until the safety function could be restored to full functionality. If a second failure on the other stream were to be coincident with the SIF failure, then this could lead to total supply failure from the site. HP storage would supply the town for a limited period in this scenario until it was exhausted.

If the SIF didn't operate when required in the event of a boiler pre-heating failure, then catastrophic failure of the downstream network due to cryogenic low temperature embrittlement of pipework may result in failure of the downstream gas supply to customers.

Loss of mains electrical supply to the site due to equipment failure would be temporarily supplied from the standby generator on site. This is not in itself likely to prevent gas supply to the town due to inherent TD/13 design of the gas supply system, however if the mains failure were prolonged or equipment were damaged by a lightning strike it could cause operational difficulty in maintaining gas supply levels due to significantly reduced capability to monitor process conditions and gas quality performance data correctly to meet the HSE GSMR SIU exemption letter requirements.

Safety Impact of Failure
If an LNG vessel level gauging system were to fail, then it is possible that a tanker may overfill the vessel leading to significant release of gas to the environment. The vessel gauge also incorporates the high-level alarm switches and has been identified as a common cause failure point. For example, if the gauge were to stick then the alarm system would not activate as it relies on the same mechanism within the gauge that drives the indicator which in this scenario is stuck. Current Industry practice for level gauging is to have separation between Level indication and High-level alarms to avoid common

cause failures (where both systems would be failed at the same time due to poor design using shared components which if failed causes double system failure).

In the event of a SIF failure this would leave a gap in the identified risk reduction required to keep the gas process on site safe. Functional Safety standard BSEN61511 Edition 2 2017 requires the site to implement unspecified compensating measures to mitigate the risk from loss of availability of the safety system. This could result in having to permanently monitor the site 24 hours a day by using personnel until telemetry is installed. This might lead to short term capability reduction in the ability of site to respond to downstream Network gas escapes or other emergencies on the network.

Aged electrical & UPS equipment in damp conditions could increase the likely hood of electric shock. Arcing between switchgear beyond its useful life could lead to a fire within the plant with implications for escalation beyond the E&I switch room. The latest BS7671 IET Wiring Regulations 2018 now includes arc protection monitoring within Electrical switchgear as best practice for utilities industries supplying multiple customers.

The UPS system is used to provide temporary emergency backup power for essential supplies in the event of mains power failure scenarios. Aged UPS assets can fail to maintain their design hold up power supply time on demand which could leave essential monitoring systems for the COMAH site at risk if the UPS cannot maintain power for long enough. Aged UPS assets can be susceptible to overheating where additional loads have been added reducing the safety margins on the equipment.

Failure of the Sigma CV gas analyser would leave the site unable to monitor the official CV for the site. This is not likely to have a severe impact on safety unless the Wobbe of the gas supplied is very low but has implications for continuous monitoring of Gas Quality records for the site which are required for visits by the OFGEM Gas Examiner.

Environmental Impact

Loss of containment of large quantities of LNG to the environment would contribute to the amount of methane in the atmosphere which has been documented as being a major contributor to global warming.

If the SIF system were to fail to operate correctly in the event of a boiler pre-heating package failure, then there could be an uncontained failure of the down-stream network pipework due to low temperature embrittlement of the pipework. This would lead to uncontained release of gas to the environment at the point of fracture.

The Sigma CV analyser continuously burns gas to determine what the Calorific value within the gas supplied to the town is. This will have a net effect on total emissions from the site.

Electrical switchgear fires are likely to release toxic fumes, smoke and embers into the local environment. In a worst-case scenario fire spread could lead to an ignition in a Hazardous area resulting in a gas explosion scenario.

7 Options Considered

Replace on failure

As already stated earlier in this paper, the main driver of these works is the uncertainty of stock vessel level measurement and the age of the assets, for this reason, this option has not been considered, however this option has been included in the associated CBA to demonstrate its value to the customer.

Repair on failure

As already stated earlier in this paper, the main driver of these works is the uncertainty of stock vessel level measurement and the age/condition degradation of the assets, for this reason, this option has not been considered. Moreover, most of the electrical distribution equipment and instrumentation cannot be repaired as spare parts and components are no longer available.

Pre-emptively replace

This is the ideal strategy for SGN and the most cost-effective route. Firstly, this will allow SGN to plan works and co-ordinate works across the GD2 term. This will also allow SGN to make cost savings with tendering the work as a package, as well as aligning project work with other projects to reduce operational resource and project management hours.

Below are the costs associated with pre-emptively upgrading the SIU sites:

Table 4: Pre-Emptive Replacement GD2 Costs

LDZ	Sites	Cost	
Scotland	Campbeltown		Upgrade Level Gauging
			Upgrade E&I
	Commercial Confidentiality		Upgrade Gas Quality instrument
			Update COMAH drawings
			Upgrade SSOVs

*Joint project with Mechanical asset.

Pre-emptively repair

This option has not been considered as the proposal does not explore the failure or repair of fault assets and certain assets which fall within scope of this work do not have condition monitoring systems to predict failure and many assets such as telemetry cannot be repaired to due to lack of spare parts/obsolescence.

Do nothing – this is effectively repair on failure

This option could prove costly and inefficient for SGN. If we do nothing the risk of Vessel Stock level measurement inaccuracy leading to a potential tanker overfill is increased. The consequences of product release due to vessel stock overfilling errors could be flash fires (flammable vapour from either vaporising pools or when liquified gas releases are ignited) or vapour cloud explosions if the gas cloud finds an ignition source (Campbeltown SIU site is located within the town with a smokehouse on the site perimeter).

Failure to update E&I COMAH site drawings such as SR25 & EI15 Hazardous Area drawings are a breach of compliance with DSEAR & COMAH regulations 2015. These drawings are key documents which indicate what standard of explosion protective equipment needs to be used in hazardous area zones where flammable liquid or gas may be present. This allows ATEX explosion protection rated equipment to be specified correctly and aids management of change and maintenance activities. If drawings are inaccurate this could lead to the incorrect selection of equipment which may not be rated for a hazardous area leading to a potential explosion if for example flammable gas vapour meets the hot surface of incorrectly specified non-explosion rated equipment.

Failure to upgrade the Gas Quality analyser at Campbeltown SIU could lead to commercial exposure for SGN as this is used to evaluate the energy content of the gas supplied to network customers and the gas composition to ensure compliance with the GSMR regulations and HSE GSMR exemption letter to supply High Wobbe index gas to the downstream network. SGN are obliged under its licence agreement to ensure that gas energy billing is accurate to downstream customers. As the sole Gas quality instrument for the network, the analyser needs to be reliable and supportable to meet these requirements. Increased OPEX costs associated with repair on fault are expensive due to the remote geographical location and lack of spares availability for an unsupported asset.

Failure to upgrade the E&I distribution and Instrumentation equipment at Campbeltown SIU could lead to increased ongoing OPEX and CAPEX costs associated with repair on fault of ageing assets that are no longer supportable. If equipment is no longer available for like for like replacement, then a

management of change design is required which can be disproportionately expensive when compared with using supported equipment which is available for direct replacement without further design being necessary by maintenance personnel. The existing Yokogowa alarm panels use a proprietary software configuration system which is expensive to re-program when changes are required to alarms or modifications need to be added. This can lead to delays in removing obsolete or rectifying defective alarms from the panels which could lead to desensitisation of alarm handling by operators. Failure to manage standing COMAH site alarms would lead to the HSE issuing an Action legal to resolve the issue.

The E&I equipment at Campbeltown SIU is in a legacy building which has been subject to minor dampness in the walls on which the E&I equipment is mounted, this has accelerated degradation of the E&I assets and has required intervention in the past to prevent potential danger to personnel using the equipment. It is expected that this will lead to increased OPEX and CAPEX costs if these assets are not replaced and steps taken to remediate the dampness by replacing E&I equipment and addressing the building integrity to mitigate any further degradation.

Failure to replace Safety Instrumented System SSOVs could lead to failure of the downstream pipework due to low temperature embrittlement. This may lead to a cessation event and major gas escape. The existing SIF SSOV assets are showing signs of internal degradation necessitating intervention to maintain the required functionality and reliability stipulated for this type of system in the Safety Requirements Specification, compiled in accordance with the BSEN61511 Functional Safety Lifecycle. This could lead to operational difficulties maintaining network gas supplies due to loss of redundancy, tie up personnel for monitoring duties if spares cannot be obtained and increase Opex costs.

Risk Costs with doing nothing

The sum of £414,939.38 is the estimated benefit of managing functional safety management system and carrying out the replacement works to the electrical, instrumentation, control and telemetry works at Campbeltown SIU over the recommended lifecycle of the E&I assets. The figures used in this calculation have been obtained from IGEM/SR/15 and the Greenbook methodology.

Table 5: Avoided risk costs from Greenbook methodology

Category	Numbers	Greenbook methodology figures	Maximum Tolerable Individual Risk	PRI pipeline depreciation period in years	Resulting cost
Fatalities	2	£16,170,000	0.000001	25	
Non-fatal incidents	1	£185,000	0.000001	25	
Major offsite incident affecting water, supply, food chain, or housing for a period circa 1 month	1	£5,000,000	0.001	25	
Non-serious "nuisance" / odour incident	1	£50,000	0.01	25	
Total/asset					
E, I, C&T failure					
Gas Quality					
Functional Safety (SSoV/Documentation)		Commercial Confidentiality			
Level Gauges					
Total					£414,939.38

7.1 E, I, C&T Upgrade Cost Details

The technical detail of the option i.e. capacity, system rating, availability etc.
Replace 415Vac 3 phase Low Voltage Electrical Distribution system.
Replace 24Vdc Extra Low Voltage Electrical Distribution system.
Replace Uninterruptable Power Supply (UPS) systems.
Replace Yokogowa Main COMAH Plant Alarm annunciator panel
Replace all site Field instruments and cabling.
Replace E&I Main Plant room control panels.
Install Brightwell DB1 RTU Satellite Telemetry system to introduce remote monitoring by SGN Gas Control.

The basis for the cost estimate/unit cost
£855,000 at 2019 cost levels

The perceived benefits of the option
Reduce ongoing OPEX and CAPEX costs.
Ensure a safe and reliable COMAH plant/ downstream Gas distribution network.
Continued compliance with statutory regulations.
Reduce failure risk from aged Electrical switchgear/Pre-ATEX hazardous area field equipment.
Sustain resilience of sole gas supply SIU COMAH site in remote geographical location.
Avoidance of Commercial exposure, HSE Fines & Reputational damage.
Delivery timescales
Within first 2 years of GD2, 2021/2022
Key assumptions made
Project will be delivered and phased within timescale.
Project will be based on costs prior to Brexit taking place.
ATEX/EC type approved E&I equipment will be available to purchase post Brexit without significant additional tariffs.
BSEN standards remain largely unchanged post Brexit.
Project will be delivered as a tendered rolled up scope to reduce costs.
No provision made for addition of Biomethane site entry to downstream Gas distribution network.
No provision made for future Hydrogen integration to network.
No provision for renewable energy sources being added to local REC Electricity supply network.
No provision made in budget for Installation of Nitrogen ballasting should this be necessary in GD2.

Any other items that differentiate the option from the others considered
Not able to repair the existing assets as most of the equipment is now obsolete and unsupportable.
Existing equipment is not compliant with latest BS7671 2018 IET Wiring Regulations.
Existing Pre-ATEX Hazardous area field equipment is now obsolete and unsupportable for re-use.
No existing Gas Control remote telemetry fitted at this site in GD1.

7.2 Gas Quality Upgrade Cost options

The technical detail of the option i.e. capacity, system rating, availability etc.
Replace Obsolete approved Sigma CV Gas analyser with OFGEM approved Gas Chromatograph.

The basis for the cost estimate/unit cost
Commercial Confident at 2019 cost levels for basic Ofgem approved Gas Chromatograph (GC).

The perceived benefits of the option
Continued compliance with statutory regulations.
Reduce failure risk from obsolete & unsupported /Pre-ATEX hazardous area equipment.
Sustain resilience of COMAH site for GSMR Exemption Letter Gas Quality compliance.
Reduce emissions from Gas quality analysis.

Delivery timescales
Within first 2 years of GD2, 2021/2022

Key assumptions made
Project will be delivered and phased within timescale.
Project will be based on costs prior to Brexit taking place.
ATEX/EC type approved equipment will be available to purchase post Brexit without significant additional custom tariffs being applied.
BSEN standards remain largely unchanged post Brexit.
Project will be delivered as a tendered rolled up scope to reduce costs.
No provision made for addition of Biomethane site entry to downstream network.
No provision made for Hydrogen integration to network.
No provision for renewable energy sources being added to local REC Electricity supply network.
No provision made for GC kiosk. Will need to be installed in existing building in suitable location.
No provision made for initial OFGEM ISO 10723 validation of New Gas Chromatograph.

Any other items that differentiate the option from the others considered
No direct replacement for Sigma CV Gas Quality analyser due to obsolescence.
New GC will improve GSMR compliance monitoring for the site using established technology.
HSE requires close data monitoring of High Wobbe Gas Quality performance for Exemption letter retention purposes.

7.3 Functional Safety (SSOV/Documentation) Cost options

The technical detail of the option i.e. capacity, system rating, availability etc.
Replace aged Safety Instrumented Systems (SIS) Safety Shut Off Valves (SSOV) and associated valve position proximity switches.

Update E&I COMAH site drawings as required.

The basis for the cost estimate/unit cost

Commercial Confident to replace Instrument proximity switches.

The perceived benefits of the option

Continued compliance with BSEN61511 Ed 2 2017 Functional Safety standard Lifecycle.
Maintain reliability of SIF system to control ongoing OPEX & CAPEX costs.
Reduce failure risk and likelihood of a catastrophic gas supply cessation event.
Maintain proof test intervals at Annual frequency for mandatory functional testing/inspection.
Reduce Commercial exposure, HSE fines and reputational damage.

Delivery timescales

Within first 2 years of GD2, 2021/2022

Key assumptions made

Joint Project with Mechanical Asset (replacing SSOVs) will be delivered and phased within timescale.
Project will be based on costs prior to Brexit taking place.
ATEX/EC type approved equipment will be available to purchase post Brexit without significant custom tariffs being applied.
BSEN standards remain largely unchanged post Brexit.
If SIF is not upgraded OPEX costs will go up due to increased Proof Testing requirements driven by SIF system reliability reducing. (E.g. more proof testing, more often)
Existing LOPA risk reduction mitigation provided by the SIF system remains the same.

Any other items that differentiate the option from the others considered

Existing proximity switches are unable to be repaired as they are not maintainable.
Corrosion degradation of the proximity switches and mounting brackets due to exposed locations.

7.4 Level gauges Cost options

The technical detail of the option i.e. capacity, system rating, availability etc.

Replace aged LNG Vessel stock level measuring and alarm systems on all four site LNG stock vessels which are not EC type approval rated.

The basis for the cost estimate/unit cost

Commercial Confident

The perceived benefits of the option

Continued compliance with COMAH 2015 statutory regulations.
Reduce failure risk from non-CE approved & unsupported /Pre-ATEX hazardous area equipment.
Remove common cause failure from combined vessel stock level gauging and high-level alarm systems.
Improve accuracy of vessel stock level measuring system to current industry standards.
Reduce risk from overfill of vessel from Tanker fill operations.
Improve vessel stock level monitoring by Gas Control via telemetry.

Improve level measuring system LNG density compensation for varied LNG supply chain.

Delivery timescales
Within first 2 years of GD2, 2021/2022

Key assumptions made

Project will be delivered and phased within timescale.
Project will be based on costs prior to Brexit taking place.
ATEX/EC type approved equipment will be available to purchase post Brexit without significant custom tariffs being applied.
BSEN standards remain largely unchanged post Brexit.
Appropriate LNG vessel interface connection points are available for new level system without major modification. Modifications to LNG vessel not within GD2 budget scope.
Level gauging system stock measurement values would be included in the new telemetry system project budget.
New Vessel stock level measuring system field cabling would be part of E&I upgrade project.
New Vessel stock level measuring system would be density compensated for changes in LNG supply.
New Vessel stock level measuring system would have independent High- and Low-level alarms separate from stock level indication system to meet Industry best practice.

Any other items that differentiate the option from the others considered

Existing Stock level system is not CE type approved and has limited scope for repair.
Stock level Indicators for the existing system cannot be replaced.
High- & Low-level alarm flameproof switches are contained within the indicator unit and cannot be replaced.
The combined stock level indicator and alarm switch is a common cause failure point and does not meet current industry best practice for stock level system design. Therefore, repair would not facilitate independence of the high-level alarm system.

7.5 Do Nothing Option Summary

The technical detail of the option i.e. capacity, system rating, availability etc.
This option is to effectively ‘do nothing’ that being to not carry out an E, I & C upgrade and to not replace the existing gas quality equipment on site.
As discussed previously, the gas quality and the electrical, instrumentation and control infrastructure to support this is key to maintain the existing gas exemption in place, as the data reporting of gas quality is a vital requirement to the HSE.
The alternative to not carrying out these replacements, would potentially result in SGN rolling out nitrogen ballasting across Campbeltown SIU.

The basis for the cost estimate/unit cost

The estimated for completion of nitrogen ballasting at an SIU sites is £3.9m, and this is the cost which has been applied to the 'do nothing' option as well as the ongoing opex cost of maintenance inspection and testing and carrying the risk costs mentioned earlier in section 7.

The perceived benefits of the option

None

Delivery timescales

N/A

Key assumptions made

Potential for fatalities if downstream Pipeline embrittlement takes place due to failure of the SIF system during a boiler preheating failure scenario.
Nitrogen Ballasting may require to be installed if Gas Quality monitoring is not maintained to the satisfaction of the HSE as required by the HSE GSMR exemption letter.
Potential for a Vessel overfill scenario due to inaccurate level gauging and high-level alarm failure leading to release of gas to the environment.
Potential for loss of GSMR Gas Quality data used for billing and evaluation of gas safety for consumers.
Potential for breach of COMAH 2015 regulations.
Potential for Commercial exposure and fines from HSE executive for non-compliance.
Potential for reputational damage.
Additional OPEX costs for dealing with potential HSE action legal or improvement notices.

Any other items that differentiate the option from the others considered

Not recommended

7.6 Options Technical Summary Table

Table 6: Options Technical Summary

Option	First Year of Spend	Final Year of Spend	Volume of Interventions	Equipment / Investment Design Life	Total Cost
Do Nothing (repair on failure)	2022	2025	0	20	3.96
Pre-emptively Replace	2022	2026	5	20	1.37
Pre-emptively Rebuild	2022	2026	5	20	1.76

7.7 Options Cost Summary

Table 7: Cost Summary

Option	Scope	Cost Breakdown	Total Cost (£m)

Do Nothing	This is to operate as is and not to invest in any infrastructure replacements.	Carried risk cost, ongoing inspection, testing and maintenance with increased frequencies and the installation of a nitrogen ballasting plant.	3.96
Pre-emptively Replace	• E, I, C&T upgrade • Gas Quality upgrade • Functional safety • E&I Documentation upgrade • Level gauge and High-level alarm upgrade	415Vac LV Distribution system.[Commercial Confidentiality] 24Vdc ELV system. UPS Plant Alarm panel Field instruments and cabling E&I Plant room control panels Telemetry system. Gas Chromatograph SSOV proximity switches E&I documentation update LNG Vessel level measurement High level alarm system	1.37
Pre-emptively Rebuild	• Increase scope of pre-emptively replace to include for full E&I rebuild	The costs for pre-emptively replace have been used with a mark up of 30% to include for replacement all essential E&I equipment which is not yet nearing end of life or showing signs of integrity degradation.	1.76

8 Business Case Outline and Discussion

8.1 Key Business Case Drivers Description

Electrical and Instrumentation Upgrade Campbeltown
Installation of new Electrical, Instrumentation and Telemetry system. This includes low voltage Electrical distribution equipment which provides power to key systems on site such as telemetry, Boiler house gas pre-heating and pressure and temperature sensors which are fed back to Gas Control via Telemetry. Key legislative compliance includes COMAH regulations 2015 and SGN licence conditions. SGN need to carry out this work as the equipment at Campbeltown is now obsolete and is showing signs of deterioration and several faults/observations are being found as part of electrical inspection and testing.

Routine Electrical inspection and testing has shown that there are issues with degrading electrical insulation and incorrectly rated electrical distribution equipment which needs corrected. Failure of electrical equipment can result in the risk of SGN colleagues `being exposed to electrical shock or injury which will be in contravention with the Electricity at Work Regulations 1989. To ensure electrical safety, SGN must ensure that their safe systems of work (SSOW's) and their electrical safety rules are followed to ensure compliance with the Electricity at Work Regulations 1989 and HSG8G- Electricity at work-safe working practices.

The main issue with Electrical, Instrumentation and Control equipment is obsolescence, which is usually ultimately driven by spares availability. Older equipment will be analogue, and almost all new equipment is digital.

Other considerations which must be taken into consideration are training, competence and familiarity with the ageing instrumentation and control equipment on site- as this is degrading with the aging workforce also.

SGN have followed guidance presented in the HSE's Research report 823-Plant ageing study Phase 1 report which states: *For Electrical, Control and Instrumentation (EC&I) equipment, lifecycles are often significantly shorter than lifetimes of main plant. This is especially so for modern digital plant for which a lifecycle (start of operation to replacement) duration of 10 to 15 years may be more appropriate.*

Additionally, an extract from MARS (EU Serveso II major accident hazard incidents) database:

In terms of major accidental potential events at major hazard installations, the MARS data provides the most appropriate basis to assess the significance of aging. The study has determined that approximately 60% of incidents are related to technical integrity and, of those, 50% have aging as a contributory factor. It is therefore concluded that aging plant is a significant issue.

Cost - Campbeltown £855,000

SIU site proximity switches -SSOV upgrades- Campbeltown, Oban, Thurso, Wick, Stornoway
This project covers the replacement of safety shut off valves (SSOVs) and associated electrical proximity switches at all SIU locations. The assets are ageing, and the potential risks associated with asset failure are increasing which is exemplified by the lack of readily available spare parts. The safety shut off valves are crucial to isolate LNG/LPG vessels and other key equipment in the event of an abnormal condition, such as gas or fire detection. This is required to comply with the following key legislative documents: COMAH Regulations 2015 and SGN licence conditions. The forecast costs are based on detailed project requirements including material procurement, design, safety assessment and work associated with isolation and re-stocking of plant and equipment. Investment driver: safety critical assets identified within site safety reports and other key regulatory documents identifying SGNs safe operation of the installation (COMAH Safety report & Major Accident Hazard prevention documentation and compliance with PSSR-PS3).

Cost - Campbeltown Commercial Confident

Vessel level gauging upgrade- Campbeltown
Level gauging on all five Scottish Independent Undertakings require upgrading as the existing assets are showing signs of aging. This has been discovered over a sustained programme of inspection and maintenance. Key legislative compliance: COMAH regulations 2015. SGN have estimated £90,000 to fully upgrade the level gauging at the Campbeltown SIU site. It is important to note that similar works of this nature have not been carried out recently, and some of the pressure vessel tanks are cryogenic tanks. SGN will need to carry out a detailed cost feasibility study to obtain more accurate costs for the site before commencement of the work programme. Investment Driver: SGN have pressure vessels at all five of their Scottish Independent Undertakings. Each of these pressure vessels require Electrical, Instrumentation and control equipment to provide safety critical process safeguard systems, such as trips alarms and process ESD to prevent against overfill/over containment or inaccurate/defective level gauging.

SGN are progressing a programme of works in the RIIO GD1 price control period to introduce telemetry to some of the SIU sites. This means that SGN won't have stock levels on telemetry and this will require a manual data input from the site operators (on change over from daytime /manned operation to night time/unmanned telemetry). The existing level gauges are also digital level switches which can be manually adjusted on site by operators, are a single point of failure, and the switches are now obsolete and cannot be procured. This can lead to a multitude of human factors issues, which will be designed/engineered out with this GD2 investment proposal.

The following was taken from the Health & Safety Executives Plant Aging Study phase 1 report (RR823): *Between 1996 and 2008 it is estimated that there have been 173 loss of containment incidents reported*

in RIDDOR that can be attributable to aging plant. This represents 5.5% of all loss of containment events. The limited information provided in RIDDOR about the underlying causes means that it is difficult to identify which events may be aged related: the actual number could be much higher than that quoted here.

Across Europe, between 1980 and 2006, it is estimated that there have been 96 incidents reported in the MARs database relating to major accident potential loss of containment which are estimated to be due to aging plant. This represents 28% of all reported "major accident" loss of containment events in the MARS database and equates to an overall loss of 11 lives, 183 injuries and over 170 Million € of economic loss.

Below are some example incidents taken from the report:

Lessons Learnt	All Safety critical instruments need to be identified and appropriate maintenance and testing must be carried out to ensure that interlocks are available when required.
Data Source	RIDDOR loss of Containment Data

HSE Case ID	4065244
Primary cause of Incident	Aging of safety critical level instrument
Description of Incident	A high-level switch failed resulting in the interlock on the inlet valve failing to close during a tank filling operation. The tank over-filled and approximately 600kg of flammable product was released into the bund. The tank was fitted with a high-level float switch that failed due to a hole in the float caused by corrosion or old age.
Risk Control System	Identification of safety critical instruments. Periodic maintenance and testing of safety critical instruments.

Lessons Learnt	Obsolete plant control systems need to be replaced in a planned and systematic manner.
Data Source	RIDDOR Loss of containment Data
HSE Case ID	1882968
Risk Control System	Release of flammable liquid from overfilled crystallisation vessel. The company had long acknowledged that the Ferranti DDC process computer had problems and were planning to replace it with a Rosemount DCS system. The lessons learned from this incident will be incorporated into the new system i.e. "plain English" text announcing and identifying alarms, tiering of alarms to assess their importance.

Cost - Campbeltown Commercial Confident

Gas Quality - Campbeltown

It is proposed to upgrade the Gas Quality system at Campbeltown as the current equipment is obsolete. Key legislative compliance: COMAH regulations and SGN licence conditions. GSMR regulations.

The Gas Quality analyser at Campbeltown is used to evaluate the energy and at Oban GSMR gas composition of the gas supplied to network customers. SGN are obliged under its licence agreement to ensure that Gas Energy billing is accurate to downstream customers. As the Gas Quality instruments for the network, the analysers need to be reliable and supportable to meet this requirement. Increased OPEX costs associated with repair on fault are expensive due to the remote geological location and lack of spares availability for unsupported assets which are now obsolete.

SGN propose to replace the Campbeltown Sigma CV analyser which is obsolete with an OFGEM approved Gas Chromatograph which can sample the gas quality to ensure gas remains compliant with GSMR regulations. The SIU needs to be able sample at an appropriate rate to ensure compliance with the HSE GSMR exemption letter dated 27 Mar 2018 which requires reporting of Gas Quality excursions that naturally occur based on time limits. To ensure the GC remains fit for purpose for this task, SGN consider the replacement is necessary to achieve the correct frequency of credible data sampling required to achieve this consistently.

Cost - Campbeltown Commercial Confident

COMAH Drawings and Emergency Plans- Campbeltown

The control of Major Accident Hazards regulations 2015 (L111-Regulation 12- Section 8) requires SGN to carry out an internal review of the site emergency plan considering any changes which may have occurred on the site and any material changes which have occurred in relation to the emergency services. Also, any relevant new technical knowledge and any new knowledge relating to the response to major accidents must be considered. The upgrade of drawings at site will consider any on site asset changes and maintain compliance with COMAH regulations 2015. This project falls under the safe Network category and ensures compliance with COMAH regulations 2015. Therefore, no further decision on whether to progress with this project is likely to be required. Key legislative Compliance: COMAH regulations 2015 (L111-regulation 12-Section 8).

Cost - Campbeltown Commercial Confident

Table 8: Summary of Key Value Drivers

Option No.	Desc. of Option	Key Value Driver
1	E, I, C&T upgrade	Reduce ongoing OPEX and CAPEX costs. Ensure a safe and reliable COMAH plant/ downstream Network. Continued compliance with statutory COMAH 2015 and Electricity at Work 1989 regulations. Reduce failure risk from aged Electrical switchgear/Pre-ATEX hazardous area equipment. Sustain resilience of COMAH site in remote geographical location.
2	Gas Quality upgrade	Continued compliance with statutory regulations. Reduce failure risk from obsolete & unsupported /Pre-ATEX hazardous area equipment. Sustain resilience of COMAH site for GSMR Exemption Letter Gas Quality compliance. Reduce emissions from Gas quality analysis.
3	Functional safety	Continued compliance with BSEN61511 Ed 2 2017 Functional Safety standard Lifecycle.

	E&I Documentation upgrade	Maintain reliability of SIF system to control ongoing OPEX & CAPEX costs. Reduce failure risk and likelihood of a gas supply cessation event. Maintain proof test intervals at Annual frequency for mandatory functional testing/inspection. Continued compliance with statutory COMAH 2015, Health and Safety at Work act etc. 1974 and Electricity at Work 1989 regulations.
4	Vessel level gauge /High level alarm upgrade	Compliance with COMAH 2015 statutory regulations. Reduce failure risk from non-CE approved & unsupported /Pre-ATEX hazardous area equipment. Remove common cause failure from combined vessel stock level gauging and high-level alarm system. Improve accuracy of vessel stock level measuring system. Reduce risk from overfill of vessel from Tanker fill operations. Improve vessel stock level monitoring by Gas Control via telemetry. Improve vessel level measuring system LNG density compensation for varied LNG supply chain.

Table 9: Summary of CBA Results

NPVs based on Payback Periods (absolute, £m)								
Option No.	**Desc. of Option**	**Preferred Option (Y/N)**	**Total Forecast Expenditure (£m)**	**Total NPV**	**2030**	**2035**	**2040**	**2050**
Scotland LDZ								
Baseline	Replace on Failure	N	-3.96	-4.93	-3.11	-3.99	-4.34	-4.74
1	Pre-emptively Replace Absolute NPV	Y	-1.37	-1.28	-0.92	-1.05	-1.14	-1.24
1	Pre-emptively Replace NPV Relative to Baseline	Y	-1.37	-1.28	2.19	2.94	3.20	3.50
2	Pre-emptively Rebuild Absolute NPV	N	-1.76	-1.64	-1.64	-1.64	-1.64	-1.64
2	Pre-emptively Rebuild NPV Relative to Baseline	N	-1.76	-1.64	1.47	2.35	2.70	3.10

8.2 Business Case Summary

Table 13 Business Case Matrix

Options	Contributory factors
Pre-emptive replacement	• Scheduled replacement over a period • Reduced operational cost • Avoidance of Legislative fines due to Statutory Non-compliance costs • Achieve fully supportable assets • Safe stock level management system • Cost savings associated with packaged/tendered works • Improved operational monitoring • Improved asset reliability • Accurate energy billing • Safer COMAH Plant • Less risk of a road tanker over filling stock vessel • Less Commercial exposure
Pre-emptive Rebuild	• This option provides the same benefits as the pre-emptive replacement • This option incurs significant additional costs as the scope of works is increased to include the upgrade of additional assets not showing signs of asset condition degradation.
Replace on Failure	• Inaccurate energy billing • Excessive costs associated with Statutory regulation breach/ HSE fines • Reputational damage • Increased operational costs • Unreliable unsupported assets • Increased commercial exposure • Increased periods where Safety Compensation measure costs will be incurred due to lack of maintainability and reliability of Safety Instrumented Systems. • Reduced Operational capability • Potential for Gas flow cessation/escape • Potential for wrong equipment rating to be fitted in Hazardous areas. • Loss of GSMR exemption letter for supply of High Wobbe gas • Requirement to resume Nitrogen Ballasting CAPEX on SIU in the event of GSMR exemption letter retraction by HSE. • Reduced COMAH Plant safety • Increased risk of a tanker vessel overfill incident

Table 10: Business Case Matrix

	Pre-emptively Replacement	Pre-emptively Rebuild
GD2 Capex (£m)	1.37	1.76
Number of Interventions	2.00	2.00
Carbon Savings ktCO2e (GD2)	0.00	0.00
Carbon Savings ktCO2e /yr	0.00	0.00
Carbon Emission Savings (35yr PV, £m)	0.00	0.00
Other Environmental Savings (35yr PV, £m)	0.00	0.00
Safety Benefits (35yr PV, £m)	0.17	0.17
Other Benefits (35yr PV, £m)	0.00	0.00
Direct Costs (35yr PV, £m)	3.41	3.04
NPV (35yr PV, £m)	3.58	3.21
High Carbon Scenario		
Carbon Emission Savings (35yr PV, £m)	0.00	0.00
High Carbon NPV (35yr PV, £m)	3.58	3.21

9 Preferred Option Scope and Project Plan

9.1 Preferred option

The upgrade of the Electrical, Instrumentation, Control and Telemetry at Campbeltown SIU will allow SGN to continuously supply GSMR compliant gas to the network with little to no disruption. Upgrading obsolete legacy E&I equipment and the installation of new vessel level gauging systems and SSOV proximity switches, allows for increased plant safety, availability and increased accuracy of vessel stock levels and installation of new gas quality system will improve gas quality/energy measurement for billing purposes. Maintaining High Wobbe Gas Quality management is important to prevent the GSMR exemption to supply High Wobbe gas from economical global sources being revoked as outlined in HSE exemption letter reference 4545199 dated 27 March 2018 paragraph 8. If the Exemption were revoked then SGN would have to reconsider potentially installing costly Nitrogen ballasting equipment at Campbeltown.

9.2 Asset Health Spend Profile

Table 11: Spend Profile

Asset Health Spend Profile (£m)					
	2021/22	2022/23	2023/24	2024/25	2025/26
Pre-emptively replace	0.28	0.26	0.26	0.28	0.30

9.3 Investment Risk Discussion

Level stock level measurement & Alarm system
A feasibility study will be required to ascertain what new stock level measurement system options can be integrated with the existing LNG vessels. This is not in scope for the GD2 programme budget. The study will need to look at existing vessel interfaces/connection points and determine if these can be utilised to deliver the necessary improvements required without major modification to the LNG stock vessels. There is also a requirement to ensure that the High-level alarm system should be suitably independent from the stock level measurement system to meet current industry good practice for stock level measurement. This is essential to avoid a common cause failure defeating both the primary means of indicating true stock level & providing an alarm if the safe stock level is exceeded to alert an operator in time to prevent an overfill scenario occurring.

The LNG gas stock is supplied from globally available gas supplies which is commercially available and sourced to reduce costs to the consumer. This LNG gas stock has by nature a more variable density than has been the case in the past when LNG gas stock was available from the National Transmission system and wholly GSMR compliant. This variability of Non GSMR compliant LNG stock density will need to be considered within the replacement vessel stock level system which should be able to compensate for changes in stock density. There is a risk that this may add additional expense to the stock level measurement system to compensate appropriately for these density changes. Ideally the system design will compensate inherently for density changes. In the case of the high-level alarm system it should also be designed to be unaffected by density changes to avoid unnecessary false alarms being generated to avoid unnecessary OPEX costs associated with remediation.

The Campbeltown SIU Mechanical asset upgrade programme will undertake repairs/replacement of the LNG vessels and the realisation of the stock level measurement and alarm system should be integrated sufficiently with this work scope to ensure that no duplication of effort is required. If there are any minor modifications required to the vessels to deliver a fully working level measurement and alarm system, then this would be undertaken alongside the vessel upgrade works to save costs.

The feasibility study should aim to review all SIU site vessels and land on a suitable generic design which meets industry best practice and can be integrated with the existing vessels without major modification. As stated earlier in this paper, modification of the pressure vessels is not in GD2 budget scope as it should not be necessary to modify the vessel to achieve what is required. Should major vessel modification be deemed necessary then a budget re-opener would be required to raise the necessary budget to either deliver the modification or facilitate any additional mitigation required.

Functional Safety SSOV proximity switches
The realisation of the SSOV proximity switches replacement programme is not expected to have any major risks associated with the project. The project will require some fabrication work to be undertaken to replace where required proximity switch support brackets. This fabrication work has been included within the GD2 Budget scope. The project will need to be undertaken in stages to ensure continuation of gas supplies, but this would be covered by SGN Safe Control of Operations procedures. The work would be integrated with the Mechanical Upgrade works project where possible to reduce costs.

E&I Documentation
Upgrade of E&I documentation to meet statutory compliance does have some risk associated with work scope boundaries. There have been a limited number of projects undertaken in the GD1 project period for the site which will have modified some smaller elements of the site. A preliminary review of the existing E&I documentation will be required, and an outline scope determined for identified improvements that will be necessary to meet our statutory and regulatory compliance. This may

require additional attention in key compliance areas that is yet to be discovered. It is assumed that recent Project implementation has followed the SGN records policy for capture of records and that the improvements required may be marginal. However legacy projects which may have not followed the rigour of the existing SGN PS6 Management of Change Plant 1 work instruction documentation review process may require more work to remediate wider site drawings which did not fall directly within legacy Project scope. Update to COMAH and BS7671 IET Wiring regulations and BSEN61511 can also impact on the boundaries and assumptions originally made for E&I assets records and drive requirement to hold extra or improved records in some key areas to demonstrate compliance to stakeholders such as the HSE.

E, C&IT Upgrade.
Risks associated with E&I upgrade include the following:

Maintaining Site operations during upgrade necessitating Safe Control of Operations procedures. This may delay the project implementation if operational difficulties occur co-incident with planned works. Careful stakeholder engagement with Gas Control should help mitigate and de-conflict most potential difficulties.

Changes to the BS7671 IET wiring regulations for selection and erection of equipment. Updates to standards typically add more rigour to equipment selection requirements for Utilities companies where multiple customers can be affected by power outages e.g. Surge protection measures for field instruments. This can add to the procurement cost. It is expected that the 18th Edition of BS7671 2018 will still be extant during the earlier years of GD2 and the budget has been based on selection of equipment with these requirements.

The telemetry upgrade will require a backup communication line to be installed which would normally be an ISDN telephone line from BT. These lines are being phased out by BT and an alternative ASDL line will be needed, SGN IT are working on a solution to allow ADSL to be integrated into the SGN SCADA system servers at Gas Control which will need to be in place for GD2 upgrade.

The existing E&I equipment legacy plant room is subject to minor dampness in the building structure walls which can lead to premature degradation of installed E&I equipment. Enough cognisance in the design stage will be required to mitigate this in selection of equipment and mounting arrangements to reduce the risk or stipulate any remediation of the wall structure prior to installation. Additional remediation of the existing building is out of scope for this GD2 budget. Any significant civil work required would require additional funding once a scope was identified. If remediation work is not undertaken, then there is a risk that premature degradation of E&I assets will occur.

The E&I Upgrade is to replace existing aged assets that meet the minimum requirements for the site. No provision has been included for the addition of significant renewable technology onto the external REC Electrical Supply, where this could raise local voltage levels causing difficulty for sensitive instrumentation equipment such as Gas Chromatographs. It is expected that additional voltage stabilisation might be required to establish nominal voltage levels if significant Renewable technology E.G Wind farms are added to the REC Electrical supply grid or cognisance of this requirement was included in for instance UPS supply for these sensitive instruments to stabilise the Voltage supply by design.

The E&I upgrade assumes that the LNG gas Hydrogen levels are not increased above nominal levels. If Hydrogen were introduced above nominally accepted levels to the stock gas, then Hazardous Area Electrical and instrumentation ATEX classification will need to be upgraded as the Gas classification for equipment selection would change. The field instruments will be rated for minimum gas group of 11A as per the existing field instrumentation general specification. No provision has been made within this GD2 budget for upgrade of field instrumentation to hydrogen gas above nominal accepted safe levels. If Hydrogen blend gas were to be introduced in the future a re-opener may be required to upgrade Electrical & Field instrumentation ATEX equipment to the required new standard to maintain

a safe site. A revised SR25 Hazardous Area drawing for the site would be required which has not been included in the current GD2 budget.

Gas Quality Upgrade

If Gas Quality is not managed within acceptable levels there is a risk that SGN may be forced to commission Nitrogen Ballasting equipment at Campbeltown at considerable cost if the HSE were to revoke the 2018 GSMR SIU exemption letter. The exemption letter is conditional on SGN maintaining adequate Gas Monitoring analysis of the gas being supplied by the site. The Gas Chromatograph will provide assurance that consistent Gas Quality analysis can be maintained going forward. No provision has been made in the Gas Chromatograph specification for inclusion of Hydrogen above nominal levels. If Hydrogen needs to be introduced above nominal levels an upgrade will be required for the Gas Chromatograph. It is expected that the new Gas Chromatograph can be installed within existing buildings and a bespoke kiosk will not be required.

No provision has been made within this GD2 budget for addition of Biomethane site entry facilities to the downstream distribution network. If a biomethane site were added to the downstream gas distribution network, then it is expected that the Campbeltown site will become backed off in the summer time for longer periods. This is likely to increase the likelihood of LNG ageing and hold up of gas in in the ambient vaporisers, leading to GSMR excursions on resumption of flow from the site as historically summer time is the worst period in the year for high Wobbe gas excursions. If excursion frequency were intolerable mitigation measures may need to be added which would need a budget re-opener.

The existing meter system may require re-ranging or replacement if site flow rate is adversely affected by the addition of a biomethane site this is not included in GD2 budget scope.

Capex Sensitivity

Table 12: Sensitivity Results

	Campbeltown SIU		
	Low	**Mid**	**High**
GD2 Capex (£m)	1.24	1.37	1.65
Number of Interventions	2	2	2
Carbon Savings ktCO2e (GD2)	-	-	-
Carbon Savings ktCO2e /yr	0	0	0
Carbon Emission Savings (35yr PV, £m)	0.0	0.0	0.0
Other Environmental Savings (35yr PV, £m)	0	0	0
Safety Benefits (35yr PV, £m)	0.2	0.2	0.2
Other Benefits (35yr PV, £m)	0.0	0.0	0.0
Direct Costs (35yr PV, £m)	3.1	3.4	4.1
NPV (35yr PV, £m)	3.2	3.6	4.3

Project payback has not been carried out as part of this analysis due to the effect of the Spackman approach. For a cash-flow traditional project payback period please see scenario 4 of our Capitalisation Sensitivity table.

Network E&I believe the preferred option is pre-emptive replace. For the purpose of sensitivity analysis, the following has been applied to the preferred option of pre-emptive replacement:

Low Case: SGN have applied a reduction of 10% CAPEX costs – this can be applied if SGN achieve greater than expected discounts on material purchase and also if greater efficiencies can be achieved

in projects delivery that haven't already been fed into the costs – this would be process improvements and streamlining working practices to reduce mobilisation time on site.

Mid Case: no changes have been applied, this is the expected output required for the GD2 time period.

High Case: SGN have applied an additional 20% on the CAPEX expenditure, as this is believed to be the potential cost increase if SGN do not go to tender and achieve best possible market prices. This could also be impacted by political changes which may impact on resource availability or material costs. This increase in cost also allows for any issues in obtaining generic designs for the full volume of works or SGN not being able to delivery these projects efficiently due to internal processes which would increase contract labour costs. The other reason for a high case cos is due to the remote location of this site, where contract labour can be difficult to resource or sustain.

Capitalisation Sensitivity

Consumers fund our Totex in two ways – opex is charged immediately though bills (fast money – no capitalisation) and capex / repex is funded by bills over 45 years (slow money – 100% capitalisation). The amount deferred over 45 years represents the capitalisation rate. Traditionally in 'project' CBA's the cashflows are shown as they are incurred (with the investment up front which essentially is a zero capitalisation rate). Therefore, we have developed scenarios that reflect both ways of looking at the investment – from a consumer and a 'project'.

The scenarios are summarised as follows:

- Scenario 1 - we have used the blended average of 65%, used in previous iterations of this analysis.
- Scenario 2 - we have represented the Capex and Opex blend for the two networks, as per guidance.
- Scenario 3 - addresses our concerns on capitalisation rates whereby Repex and Capex spend is deferred (100% capitalisation rate) and Opex is paid for upfront (0% capitalisation rate).
- Scenario 4 - this reflects the payback period in 'project' / cash-flow terms and provides a project payback.

We have taken a view of the NPV in each of the scenarios, with the exception of scenario 4, at the 20, 35 and 45 Year points, to demonstrate the effect of Capitalisation Rate on this value.

Table 13: Capitalisation Rate Sensitivity Results - Scotland

Scenario	1	2 SC	3	4
Capex (%)	65	46	100	0
Opex (%)	65	46	0	0
Repex (%)	100	100	100	0
Output				
NPV (20yr PV, £m)	3.08	3.24	2.77	
NPV (35yr PV, £m)	3.56	3.58	3.51	
NPV (45yr PV, £m)	3.64	3.64	3.63	
Payback	0.00	0.00	0.00	0.00

Appendix A - Acronyms

Acronym	Description
SGN	Scotia Gas Networks
CAPEX	Capital Expenditure
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
LDZ	Local Distribution Zone
PRE's	Public Reported Escapes
OPEX	Operational Expenditure
SSOV	Safety Shut Off Valve
SIU	Supported Independent Undertaking
GSMR	Gas Safety Management Regulations
HSE	Health & Safety Executive
COMAH	Control of Major Accident Hazards
SGN	Scotland Gas Networks
RIDDOR	Reporting of Injuries Diseases and Dangerous Occurrences Regulations
GC	Gas Chromatograph
CV	Calorific Value
E&I	Electrical & Instrumentation
MARs	Major Accident Reporting
RIIO	Revenue=Incentives+Innovation+Outputs
WOBBE	Wobbe Number
CBA	Cost Benefit Analysis
SIF	Safety Instrumented Function
SRS	Safety Requirement Specification
SIS	Safety Instrumented System
SIL	Safety Integrity Level
HSG	Health and Safety Guidance
PSSR	Pressure Systems Safety Regulations
SOV	Solenoid Operated Valve
TRICOCK	Manual Check valve
MTTR	Mean Time To Repair