Engineering Justification Paper

Compliance
Transmission Scotland and Southern Networks

Final Version

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Classification: Highly Confidential

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2 Introduction

The integrity and operational reliability of the company's Transmission assets, namely offtakes, pressure reduction stations and Local Transmission System pipelines, are ensured through the following activities:

Maintenance

Functional checks – the function of equipment, especially safety devices and standby systems, is tested in the manner it would perform in practice, to demonstrate its reliability. An analogy in vehicle maintenance is a test of brakes or lights before the start of a journey.

Maintenance at regular intervals – some equipment, such as control valves, require regular maintenance including check and top-up of oil reservoirs, lubrication etc. Analogies in vehicle maintenance include a check of oil level in the engine or tyre pressures.

Repair – The functional check or an alert via telemetry may identify a failed component within an asset, which may need either repair or replacement. Such components are typically diaphragms or other consumable items, but may include small structural components. Such repairs are anticipated as part of normal operation and are not considered to extend the overall life of an asset or system. An analogy in vehicle maintenance is the replacement of a tyre due to normal wear.

Inspection – An inspection, typically visual, may be required to confirm normal operation of an asset or to identify any deterioration, typically through corrosion. These are routine in nature and would be considered as a low priority task. An analogy in vehicle maintenance is the check for scratches and dents on a hire car before return.

Revalidation and recertification

Revalidation – Some assets, particularly those containing pressure, require a more formal determination of their integrity at defined intervals. Revalidation typically includes the certification of the asset's fitness for purpose for a further defined period of operation. Many revalidations are specified within the Written Scheme of Examination required to comply with the Pressure Systems Safety Regulations 2000. An analogy in vehicle maintenance would be the MOT.

Investment

Refurbishment – Refurbishment covers a range of activities that extend the life of an existing asset. Such activities may include painting of the whole system (thereby reducing deterioration), full overhaul including the replacement of all soft parts and deteriorating components, replacement of housings, replacements of foundations and supports. Typically, the refurbishment of a system will include all of these elements. An analogy in vehicle maintenance would include a new engine, body panels on a classic car.

Replacement – The replacement of major components or a full system. For example, within a pressure reduction system, there are slamshut safety devices and regulators. Replacement will include the replacement of one or more of these assets or indeed all of them. The analogy in vehicle maintenance would be the purchase of a new car.

A number of other steps in the life cycle of an asset have not been included in this schedule as they are not relevant to this discussion. They include: design, construction, commissioning, decommissioning and removal; they also include upgrade, typically to increase the capacity of a component due to increasing downstream demand. Upgrade project are covered in our Capacity Business Plan.

Within SGN, maintenance, repair and inspection is funded from our Opex allowances; refurbishment and replacement is funded from our Capex allowances and the projects we anticipate delivering in GD2 are itemised in our Integrity Business Plan.

This Engineering justification Paper itemises the work we anticipate delivering in GD2 under the heading of Revalidation and Recertification. We anticipate that this work will be funded from Capex allowances, since the recertification element of the plan is necessary to maintain the life expectancy of the asset. We have liaised with other Gas Distribution Networks to confirm that they undertake similar activities, that they agree the common definition of revalidation and that they will request Capex allowances for delivery.

Workloads for RIIO GD2 have been identified in order to deliver a safe and reliable network meeting the following objectives:

- Achieve legislative standards,
- Meet core licence requirements,
- Meet the HSE's directed standards,

Revalidation activities, as covered by this paper, primarily include the major revalidations of pressure vessels identified as examinations under the Written Scheme of Examination as required under PSSR 2000. In addition, the following activities have been included within this plan:

Revalidation of water-bath heaters using a similar specification to that of heat exchangers. Water-bath heaters are not subject to PSSR, but SGN have implemented a similar revalidation process to that of heat exchangers. This is consistent with other distribution networks.

SGN have implemented a formal condition assessment programme, SGN/PM/CM/4 part 1, which includes a detailed inspection of all above ground assets at least every 12 years. Any defects are fully assessed and quantified, prior to the remediation of any critical defects. The HSE are supportive of this programme as a means to recertify aging assets.

The replacement of minor Capital items, such as marker posts, have been included in this paper.

These activities constitute a revalidation of existing assets, that is, the certification of their continued integrity permitting their continued operation for a further defined period. No improvement in life is claimed and therefore no change in Monetised Risk (NARMs) is claimed either.

An extension of life or at least an improvement in health and reliability is claimed for activities that constitute refurbishment or replacement. These projects are therefore justified through a Cost Benefit Assessment. However, since no such benefit is claimed for revalidation activities, no CBA have been applied to the Compliance programme.

The term Compliance is instead used to describe activities that MUST be undertaken to comply with legislation, namely PSSR 2000, or primary activities that allow SGN to demonstrate our obligations for a safe gas network under the Pipeline Safety Regulations 1996.

2.1 General background

Compliance work is the major works required for compliance with both Pressure Systems Safety Regulations 2000 (PSSR) and Pipeline Safety Regulations 1996 (PSR), these are two key pieces of legislation that drive monitoring and inspections, ensuring the gas transportation network is fit for purpose. Two key pieces of legislation are instrumental in ensuring the integrity of the local transmission system: Pressure Systems Safety Regulations 2000 (PSSR) and Pipeline Safety Regulations 1996 (PSR).

Pressure Systems Safety Regulations 2000 (PSSR)

PSSR covers the safe design and operation of pressure systems to reduce the risk of failure of a pressure system that could give rise to a major hazard. PSSR requires that operators document and adhere to a Written Scheme of Examination (WSoE) for all pressure systems including safety devices and key vessels in conjunction with an appointed Competent Person. We meet this requirement through our Management Procedure, SGN/PM/PS/3. The examinations include:

- In-line inspection of pipelines,
- Examination of heat exchangers including NDT and hydrostatic test,
- Examination of filters including NDT.

Each examination categorises an asset according to:

- Category C, a declaration of no faults,
- Category B, a fault that is not judged dangerous or will give rise to danger before the next examination,
- Category A2, a 'significant' fault which does not give rise to immediate danger, but action is required to prevent system failure prior to the next examination, and
- Category A1, is considered to result in immediate danger, with immediate notification to the user and competent person. The competent inspector will not leave the site until the situation is rectified.

Any postponements of examinations must be notified in writing to the Health and Safety Executive (HSE).

Pipeline Safety Regulations 1996 (PSR)

PSR provides an integrated, goal-setting risk-based approach to the management of pipelines and covers design, construction, operation, maintenance and decommissioning activities. SGN demonstrates 'best practice' through the adherence to industry recommendations including those of the Institution of Gas Engineers and Managers (IGEM) as well as the UK Onshore Pipeline Operators Association (UKOPA) and the Engineering Equipment and Materials Users Association (EEMUA). The following recommendations and guidance provide the core structure for our operations:

IGEM/TD/1 – Steel pipelines and associated installations for gas pressure transmission,

IGEM/TD/13 – pressure regulating Installations for Natural Gas, Liquified Petroleum Gas and Liquified Petroleum Gas / Air,

IGEM/SR/25 – Hazardous Area Classification of Natural Gas Installations, and

EEMUA/191 – Alarm Systems – a guide to design, management and procurement.

These recommendations are implemented through our management procedures which have been developed to support compliance, ensure continued fitness for purpose and incorporate best practice.

Condition Inspection Programme

We have implemented a formal condition assessment programme, SGN/PM/CM/4 part 1, which includes a detailed inspection of all above ground assets at least every 12 years, including close inspection of pipework under lagging and pipe supports and through wall transitions. Any defects are fully assessed and quantified, prior to the remediation of any critical defects. With our established CM/4 survey programme, we believe that we are network leaders in the quality of assets assessment which gives us confidence in the quality of the condition assessment used in the investment assessment process.

Activities undertaken to comply with SGN's management procedures which have been developed to support legislative compliance, ensure continued fitness for purpose and incorporate best practice include:

- Revalidation of shell and tube heat exchangers
- Revalidation of high-pressure Filters
- Revalidations of pig traps
- OLI/1s including Feature Investigation
- Revalidation of WBHs

- CM/4 Inspections and Data Base
- CM/4 Remediation
- AC/DC monitoring and mitigation

Site specific background

Offtakes and PRS		
Compliance Activity	**Southern Total Works**	**Scotland Total Works**
Heat Exchanger revalidation	118	74
CM4 revalidations	110	55
Painting	16	20
Water-bath heater Revalidation	40	97

Table 1:Total scope of works Offtakes and PRS

Pipelines		
Compliance Activity	**Southern Total Works**	**Scotland**
OLI	**910 km**	**430km**

Table 2: Total Scope of works Pipelines

3 Equipment Summary

Offtakes including filtration, pre-heating, pressure reduction, volumetric control, cathodic protection and other ancillary systems.

Filters are required to filter the gas to ensure no damaging contamination can harm equipment immediately downstream, namely slamshut safety devices and pressure and volumetric control valves. High pressure filters filter the gas typically to 2µm. Filters are deemed pressure vessels under PSSR 2000. Within the WSoE, filters require full revalidation every 12 years including full visual inspection and inspection of area s of high stress within the filter body by non-destructive inspection techniques.

When the pressure of a gas is reduced, the temperature also reduces according to the Joule-Thomson effect. Typically, the temperature will reduce by 0.50C for every 1bar of pressure drop. Temperature drops of -340C are evident meaning gas can leave the site at -290C. This can lead to mains fractures, ground frost heave and other damaging effects. The phenomenon is avoided by pre-heating the gas by using either heat exchangers or water-bath heaters. Heat exchangers are also deemed pressure vessels under PSSR 2000. Revalidation is undertaken every 10 years and includes visual inspection, cleaning and inspection of heater tubes and a full hydrostatic test.

Water-bath heaters are not covered by PSSR 2000 but are revalidated in a similar fashion to heat exchangers.

Entry points including valves, filtration, pre-heating, pressure reduction, cathodic protection and other ancillary systems, but not including entry point metering systems and electrical and instrumentation assets, for which the Head of E&I is responsible.

Local Transmission System pipelines including pig traps, exposed and buried crossings including any support structures, valves, posts, cathodic protection and other ancillary systems.

The preferred method of revalidating an LTS pipeline is by internal inspection using the magnetic flux leakage ‘pig’. This tool inspects the pipe wall for metal loss, dents, gouges and other damage. An industry algorithm, Intervals 2, is used to identify the periodicity of the revalidation. However, this tool has an inbuilt cap of 15 years and SGN have developed a robust mechanism to review revalidations at the cap to extend the frequency up to a maximum of 20 years. This revalidation, known as OLI/1, is deemed an examination under PSSR 2000.

The Intelligent Pig cannot operate in low pressure or low flow environments or in very small diameter pipelines. The actual deterioration of such pipelines cannot therefore be assessed. Instead, above ground inspections, primarily a Close Interval Polarised Potential Survey, but also a Pearson Survey and a Direct Current Voltage Gradient survey for high risk pipes, are used, which identify the scale of loss of pipe protection (wrap) and the effectiveness of cathodic protection systems. Such revalidations are known as OLI/4 and are also deemed examinations under PSSR 2000.

4 Problem Statement

Condition Management (CM)/4 inspection programmes

SGNs' Management procedure, SGN/PM/CM/4 part 1, specifies the detailed inspection of assets every 12 years. The inspection considers every pipe section and includes removal of pipe supports, lagging and other obstructions, where corrosion could hide. The initial inspections undertaken under this regime have been scheduled based on risk considering our existing knowledge of the condition and configuration of sites.

There are 110 sites in Southern that are due for inspection over the course of GD2 Commercial Confidentiality . In Scotland we have around 175 relevant sites, so over the course of GD2 we expect to survey 55 sites Commercial Confidentiality .

CM/4 inspections generate a number of remedial action**s.** These includes:

- Inspection and Remediation of Pipework Damage through the P11/P20 process
- Replacement of corroded or uncoated bolts (both hot bolting where necessary and cold bolting where possible)
- Replacing plugs through modification of ball valves where required
- Replacement of auxiliary components including inspirator blocks, valve handles and stabbings/branch connections.
- Removal of bypasses
- Renewal of pipework at pipe supports through temporary support, cleaning and painting and reinstating supports.

Once CM/4 inspections have been completed and relevant defects have been remediated, the sites are programmed for painting and civil works completed.

In Southern Network we have been uncovering relatively low volumes of serious faults from the CM/4 inspections that have been undertaken so far Commercial Confidentiality

Key follow-up programmes include the following**:**

- Painting,
- Civil works

In general, the CM4 surveys undertaken in Southern are highlighting the need for remedial painting on sites and fabric or civil works to buildings, pits, paths or in one case a retaining wall. The following are examples of the work being progressed in GD1, although this list is far from exhaustive:

- Newton Longville – Painting for the Wind/Water lines and pig traps – Commercial Confidentiality
- Ipsden – Painting of Pig traps and other pipework – Commercial Confidentiality
- Stanton St John – Pipework painting – Commercial Confidentiality
- Braishfield C – Pipework painting – Commercial Confidentiality

Site painting is an activity which varies significantly in cost depending on the scale of the work to be undertaken and, as such, a unit cost for a site would not be a useful measure.

In Southern, we expect to paint around 25 sites Commercial Confidentiality in total.

This work will include full preparation of existing paintwork including shot-blasting and a new paint coating in accordance with specification SGN/SP/PA/10. over 16 sites. CM/4 surveys commenced in 2016 and remedial works have been progressed from 2017 onwards.

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Online Inspection (OLI) Programmes

Below ground assets of a significant length such as pipelines cannot be inspected visually on an economic basis. The use of intelligent "pigs" has allowed for an economic method of measuring the surface profile of the pipeline wall. Expert analysis is then used to assess this profile data and determine the quantity and nature of the defects. Actual visual inspection can then be targeted to only specific areas of the pipeline as identified by the OLI/1 inspection. It can then be determined whether any remediation is required. Carrying out these inspections on a risk assessed frequency allows otherwise undetectable defects to be located, assessed, remediated and managed as required.

In Southern we will inspect 910km length of pipe Commercial Confidentiality . In Scotland we will inspect 392km length of pipe Commercial Confidentiality

The unit cost for inspections vary based on a number of factors including the following:

- The remote location of some sites in Scotland,
- The presence of permanent pig traps verses the requirement for temporary pig traps installed only for the inspection, which are prevalent in Scotland,
- Some pig trap sites in Scotland remain buried when not required, with excavation and set-up required prior to inspection,
- The cost of inspections has a variable element based on length and also a fixed base cost. Therefore, the unit cost for the inspection of shorter lengths is higher than that for longer lengths.

Revalidations of High-Pressure Water Bath Heaters (WBH)

On various sites within SGN pre-heating is undertaken using Water Bath Heaters. These utilise a large burner to project hot gases down a fire tube and up an exhaust stack. This fire tube is run through the bath to allow heat exchange to the water. By running high pressure gas tubes through the water pre-heating can be carried out to counteract the Joules-Thomson effect from the pressure regulators.

As a part of SGN's revalidation programme, WBHs are inspected under the examination SGN/PR/MAINT/2004 at least every 10 years. These include detailed NDT techniques and pressure testing of the fire tube and high-pressure gas tubes. Specialist techniques are employed including:

Ultrasonic thickness surveys which allow for the remaining wall thickness of a pipe to be measured with a probe.

Magnetic Particle Inspections which are used to detect any evidence of crack-like defects on carbon steel material

Visual inspection combined with knowledge and experience is used in combination with the techniques above to determine if a Water Bath Heater is fit for continued service or requires some form of remediation.

Funding is therefore being sought to carry out each one of these revalidations as scheduled within the GD/2 Price Control.

In Scotland we have 215 WBH, so over the course of GD2 we will inspect 97 of them Commercial Confidentiality

In Southern we have 40 WBH, so over the course of GD2 we will inspect 18 of them Commercial Confidentiality

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Revalidations of High Pressure Heat Exchangers

Where pre-heating is undertaken using Shell and Tube Heat Exchangers SGN carry out an inspection under SGN/PM/PS/3 every 10 yrs. As part of SGN's maintenance programme, detailed inspection on the heat exchangers is carried out.

This involves:

- Pressure Testing and other detailed non-destructive techniques of the High Pressure Gas Tubes
- Pressure Testing and other detailed NDT of the surrounding Water Vessel

In Southern we have 296 high pressure heat exchangers, so over the course of GD2 we will inspect 118 of them Commercial Confidentiality

In Scotland we have 140 high pressure heat exchanges, so over the course of GD2 we will inspect 74 of them Commercial Confidentiality

High Pressure Filters and Pig Traps

Filters and Pig Traps are subject to pressure cycling and environmental exposure. As a result, degradation of apparatus may occur as apparatus that is exposed to the elements may be exposed to thermal expansion due to weathering from sunlight and frost and may suffer from exposure to rain, wind and salt. In addition, apparatus may be exposed to pressure and stress cycling which may grow existing defects. Under the SGN management procedure SGN/PM/PS/3, Filter (ES/94/15 Pt.2) and Pig trap inspections (ES/94/12 Pt.2) and must be carried out under. These inspections involve but are not limited to:

- Visual inspection of the vessels including the closure and venting mechanisms, checking for signs of stress, wear or cracking.
- Magnetic Particle Inspections of welds, the sealing face, load retaining parts and any other areas considered suspect from the visual inspection.

In Southern we have 422 high pressure filters and 74 pig traps, so over the course of GD2 we will inspect 153 of them Commercial Confidentiality . These costs have been derived from equivalent work delivered in RIO GD1 by the SGN Maintenance department considering asset size and complexity. Where necessary, specialist contractors have been procured using competitive tendering processes. Revalidations of High-Pressure Filters and Pig traps

In Scotland we have 25 pig traps, so over the course of GD2 we will inspect 9 of them Commercial Confidentiality

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AC/DC Monitoring and Mitigation

Cathodic Protection (CP) Systems reduce the risk of corrosion on steel pipelines, especially where the coating system is deteriorating. AC and DC interference pose a significant risk to the integrity of CP systems on the LTS. Examples of leakage High Voltage electricity infrastructure causing interference with Cathodic Protection Systems has already been discovered.

AC corrosion occurs where overhead power lines are located parallel to a buried pipeline. AC potentials can be electromagnetically induced into the pipeline and corrosion occurs where the potentials leave the pipeline to return to the source.

AC corrosion has a relatively distinct profile but tends to be very localised. As a result, AC corrosion can quickly lead to through wall corrosion and gas release.

Protection against AC corrosion involves the laying of a zinc ribbon adjacent to the pipeline; the length(s) of the ribbon is proportional to the length of the parallelism between overhead power line and pipeline. The scale and cost of individual protection works can vary significantly. Commercial Confidentiality In GD2, we expect our typical response to AC corrosion to be as follows:

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SGN are currently reviewing all pipelines to identify the presence of AC interference. A nominal sum Commercial Confidentiality has been included to resolve any issues found in Southern and Commercial Confidentiality in Scotland. In both cases, this equates to the mitigation of two instances of AC corrosion.

DC power schemes can create similar problems. DC power systems can be found on transport infrastructure. It is also understood that electricity transmission in DC form is particularly effective.

PO86 AC interference

We have already identified one instance of AC corrosion on pipeline, P086 in Southern – Winkfield to Bramshill, 600mm diameter operating at pressures up to 26.2barg. Modelling is currently being undertaken with a view to installing initial protection measures in GD1. A further sum Commercial Confidential has been included to complete any residual protection measures, including those as a result of increased electrical generation through the overhead lines. This sum has bn derived taking account of existing readings, surveys and modelling by specialist consultants and SGN's own experience in the installation of around 5km of Zinc ribbon, which provides the mitigation against AC interference.

Rail Bonds

Stray currents from the live rail on electrified rail networks can be attracted to metallic pipelines and corrosion occurs where those currents leave the pipeline. Bonds between the pipeline and the live rail allow that current to return to source. SGN are in the process of surveying our rail bonds in Southern network Commercial Confidentiality . SGN utilise an industry expert to advise us on the costs and the extent of the work. Very few rail bonds are present in Scotland due to the nature of the rail network there.

High pressure valve refurbishment – EI/130

Ball valves on the transmission system usually have a vent point to allow blow-down of the valve cavity upon closure, thereby creating a double-block and bleed facility. The valves also have grease points to allow lubrication of the closing faces of the valve.

Engineering Instruction 130 highlighted an issue with the vent and sealant lines, which are piped to the surface and are retained behind clips to the valve actuator stem. Significant corrosion has been noted behind these clips, which can lead to high volume gas release at high pressure.

The programme to remediate vent and sealant lines is ongoing. The cost of excavation, inspection and assessment, shelling of defects as required, recoating and costs of emergency management should severe corrosion be identified have been estimated Commercial Confidentiality . A sum Commercial Confidentiality to remediate 130 valves has been included within the business plan for Southern. The work is co-

ordinated by SGN's Maintenance department using specialist inspectors as appropriate. Specialist support is provided by National Grids Pipeline Maintenance Centre, who have derived low cost techniques both for survey, remediation and response to component failure. The work has been completed in Scotland.

4.1 Narrative real-life example of problem

During GD1 SGN has significantly enhanced our procedures to identify both reliability and condition-based defects in our Transmission assets. Projects are now explicitly derived from an objective review of operational defects and results from the comprehensive survey of asset condition in accordance with the CM/4 procedure. For that reason, the Business Plan for *Transmission Integrity* in GD2 comprises mainly named projects. However, there is still the realistic if unforeseen possibility that new defects impacting asset reliability or condition may be exposed either prior to the start of GD2 or in the early years of the price control period.

In GD1, SGN have had a particular issue with high pressure filters. These assets receive a detailed inspection involving paint removal and non-destructive testing every twelve years. Occasionally cracks are found, which can be of serious concern if they are present in locations where stresses are elevated. Cast bodied filters are especially at risk. Such defects are sentenced by an independent competent body appointed under the Pressure Systems Safety Regulations and, where necessary, filters have had to be replaced due to the risk of failure at a typical cost of around Commercial Confident. SGN has recorded sixteen such defects in six years within GD1.

Also, in GD1, SGN have had numerous problems within condensing boiler systems, particularly with the aluminium heat exchangers within the boiler itself. These faults lead quickly to complete boiler failure and urgent intervention. Issues have been detected on twenty-four sites within GD1 with resolution costing, Commercial Confidentiality , to replace the package boiler system.

Other issues include the rapid deterioration of pressure reduction systems with twenty-four such instances in Scotland linked to aging control systems. In such cases, resolution can cost, on average, around £500,000.

Overall, SGN has been forced to redirect around £30m on investment in six years, an average of £5m per annum.

SGN are confident that the current level of maintenance is sufficient to maintain the safety of the transmission system and to identify these emerging defects promptly and efficiently.

In most cases, these filters have been in service for many years and are not covered by manufacturers' warranties. Nevertheless, manufacturers are contacted for advice and support whenever possible.

Further information on the potential consequences of not completing this work are described in section 6.

4.2 Spend Boundaries

CM/4 Inspections and remediation

The CM/4 procedure ensures that we carry out consistent, periodic assessments of all assets on (> 7 bar) installations to ensure continued asset integrity and fitness for purpose. The process is aimed at ensuring a detailed level of knowledge is obtained for all sites through data capture to identify any defects early for prioritisation in a remediation plan. Investment sought for GD2 will allow for the continuous assessment and remediation of these defects. Costs have been provided on a unit basis for inspections with anticipated remedial work based on historical evidence.

Pigging of high pressure pipelines

Below ground assets of a significant length such as pipelines cannot be inspected visually as it is not economic to do so. The use of intelligent "pigs" has allowed for an economic method of measuring the surface profile of the pipeline wall. Expert analysis is then used to assess this profile data and determine the quantity and nature of the defects. Actual visual inspection can then be targeted to only specific areas of the pipeline as identified by the OLI/1 inspection. It can then be determined whether any remediation is required. To comply with the PSR and PSSR, we will, where possible, inspect all high-pressure pipelines using the magnetic flux leakage in-line inspection tool at frequencies specified by the "Intervals2" software package. We have set out fixed lengths and unit rates for this.

Revalidation of high-pressure filters and pigtraps

PRSs and Offtake on our network feature at least 2 High Pressure Filters. These are typically large pressure vessels with internal filter baskets designed to remove all contaminants larger than 2µm. They must do this while allowing the peak flow at the minimum inlet pressure with minimal differential pressure (≤ 100mbarg). Consequently, these vessels can be large especially on higher flow sites. We also maintain a large number of pig traps on our network to facilitate internal inspections carried out on pipelines within the Local Transmission System. These are high volume pressure vessels that have similar risks to filters. Inspection work is determined at a fixed unit cost.

Revalidation of water-bath heaters

Network pre-heating is undertaken using Water Bath Heaters (WBHs) that utilise a large burner to pre-heat the inlet gas and counteract the Joules-Thomson effect from the pressure regulators. As a part of our revalidation programme, WBHs are inspected under the examination SGN/PR/MAINT/2004 at least every 10 years utilising specialist techniques. We have an ongoing programme of inspection with defined unit costs.

Appendix A - For each of these validation programmes there will be associated costs of remediation. SGN has costed such works based on previous experience and has included efficient costs within the GD2 plan.

5 Probability of Failure

Revalidation is a formal process carried out by a Competent Engineer and any recognised potential causes of failure identified from the revalidation are included in the operational procedures, examinations, maintenance and inspection regimes as appropriate.

Data collected from inspections contributes to the application of the NARMs methodology in Commerci for GD1 and GD2. The probability of failure rate in the model incorporates the attributes form the inspections allowing SGN to achieve a more accurate estimate for the initial likelihood of failure of individual assets.

The sites selected for CM4 inspections are prioritised risk assessed in consultation with the outputs of Commerci utilising the NOMS methodology and the known configuration and duty of the site.

5.1 Probability of Failure Data Assurance

In the methodology the initial PoF is scaled by a number of factors, such as housing condition, kiosk condition, distance to coast and the fault detection rate, to achieve a more accurate estimate for the initial likelihood of failure at individual assets. This is necessary as due to the low numbers of actual failures initial PoF estimates are taken from population level estimates.

SGN links data collected from formal documented inspections and surveys under the governance of established policies and procedures to the NARMs methodology and provides the thinking behind some of the material changes made in for GD2 that calculates Probability of failure rate in the model.

6 Consequence of Failure

The aim of mandatory requirements is to ensure that the plant remains 'fit for purpose' preventing the consequences of failure materialising. Revalidation can be considered a measure preceding or indicating a future event used to drive and measure activities carried out to prevent and control injury.

The consequences of failure vary depending upon the way in which a failure occurs. A matrix of the failure modes and consequences are shown in 5 and the worst-case scenario for each of the main impact areas considered is discussed further.

In the event of not carrying out the revalidation of assets the potential consequences are:

	Failure Consequence		
Failure Mode	**Security of Supply**	**Safety Impact**	**Environmental Impact**
Pressure Containing Component within site (Corrosion)	If gas escape is significant, security of supply could be affected	Safety impact from risk of ignition, proportionate to the volume of the escape	Carbon emissions proportionate to the volume of the escape
Pressure Regulating Equipment (Both Slamshuts Closed)	Security of Supply would be lost for a significant quantity of customers with both slamshuts closed	No direct effect	No direct effect
Pressure Regulating Equipment (Over pressurisation of Outlet)	If over pressurisation causes a significant escape, security of supply could be affected	Safety impact is elevated compared to escape within the site, as this could affect pipework within proximity to the general public	Carbon emissions proportionate to the volume of the escape
Preheating Equipment (Failure at winter, brittle fracture due to cold temperatures)	If brittle fracture causes a significant escape, security of supply could be affected	Safety impact is elevated compared to escape within the site, as this could affect pipework within proximity to the general public (although chilling will be most severe closer to the site).	Carbon emissions proportionate to the volume of the escape
Filter - release of gas	If gas escape is significant, security of supply could be affected	Safety impact from risk of ignition, proportionate to the volume of the escape	Carbon emissions proportionate to the volume of the escape
Pipeline (Corrosion)	If gas escape is significant, security of supply could be affected	Safety impact from risk of ignition, proportionate to the volume of the escape	Carbon emissions proportionate to the volume of the escape
Pipeline 3rd party damage (unreported)	If gas escape is significant, security of supply could be affected	Safety impact from risk of ignition, proportionate to the volume of the escape	Carbon emissions proportionate to the volume of the escape

Table 3: Matrix of Failure Mode against Failure Consequence

Loss of supply to customers

The infrastructure covered by this paper are integral to the gas supply network within SGNs Southern and Scotland Networks. Failure to complete these works could results in significant short- and long-term supply losses.

Safety Impact of failure

The failure of any asset within scope of the inspection have the potential to cause both minor and Catastrophic incidents in the event of failure. Thankfully in the United Kingdom natural gas incidents, resulting in the loss of life are very rare due to compulsory and diligent integrity management. However, the results failure is clearly understood with examples such as the incidents at Flixborough and Ghislenghein that resulted in collectively the loss of 52 lives.

Environmental impact

There are several potential environmental impacts possible if an asset failure were to occur. Firstly, there is the possibility of a release of gas at pressures up to the maximum operating pressure of the Local Transmission System (LTS). This would result in a significant release of methane into the atmosphere until remedial actions could be taken to stop the leak. Secondly there are more localised impacts such as potential pollution to land ground and surface waters should components such as waterbaths and heat exchangers that hold corrosion inhibitors fail.

7 Options Considered

The term Compliance is instead used to describe activities that MUST be undertaken to comply with legislation, namely PSSR 2000, or primary activities that allow SGN to demonstrate our obligations for a safe gas network under the Pipeline Safety Regulations 1996.]

An extension of life or at least an improvement in health and reliability is claimed for activities that constitute refurbishment or replacement. These projects are therefore justified through a Cost Benefit Assessment. However, since no such benefit is claimed for revalidation activities, no CBA have been applied. However, the options are considered below and summarised in table 6.

7.1 Replace on Failure

This option was rejected as failure to complete SGNs Mandatory legislative inspection requirements would result in enforcement action being undertaken by the relevant Enforcement authority.

Not viable – Legislative non-compliance

7.2 Repair on Failure

This option was rejected as failure to complete SGNs Mandatory legislative inspection requirements would result in enforcement action being undertaken by the relevant Enforcement authority.

Not viable – Legislative non-compliance

7.3 Pre-Emptive Replacement of Assets

Rejected as not lowest cost solution to the project. A detailed cost estimate was not prepared as it would cost millions more than the proposed works

Viable – Rejected as not least cost option

7.4 Complete agreed Compliance works program

This is the preferred option as it meets the requirements of legislative standards in accordance with our license to operate.

Viable – Preferred option

To develop the budget estimate, several sources were used to derive aspects of the price. These were:

Indicative estimate of the cost from a supplier of the activity. While this cost estimate was being provided by a service provider or supplier relevant to the activity or item it is being done prior to any tender documentation, specifications or design work having been undertaken. This was the method by with the following were estimated:

a. Based on previous costs incurred during RIIO-GD1. There have been many programs of work delivered during GD1 which provide a selection of similar costs to draw from when estimating future costs. This was the method by which the following were estimated:
b. Cost control, covering tender preparation and evaluation, Quantity surveying and post completion evaluation.
c. Specialist Services such as supervisor, CDM management, Pipeline Inspector, hydrostatic pressure testing.
d. Main Works Contractor (MWC). This is an area which had a significant upward pressure during GD1 due all networks tendering at the same time. These costs are very market dependant, based on how much work the contractors have at the time.

Miscellaneous other costs such as records collection, planning permission, land purchase, direct labour and removal of redundant equipment.

7.5 Do nothing or Defer to GD3

This option was rejected as failure to complete SGNs Mandatory legislative inspection requirements would result in enforcement action being undertaken by the relevant Enforcement authority.

Not viable – Legislative non-compliance

7.6 Options Technical Summary Table

The following options all generate catastrophic consequences and are therefore deemed unacceptable:

- Replace on failure,
- Repair on failure,
- Do nothing.

Therefore, only one practicable option remains – **Undertake compliance works program**.

Other options, such as pre-emptive equipment replacement, have not been considered as they represent unnecessary expenditure to replace functioning, fit for purpose assets.

Commercial Confidentiality

Note 1: Painting and other remedials of Offtakes and PRS may be applicable to NARMs where the intervention is undertaken as part of the full refurbishment of the site / system.

Note 2: LTS Pipelines are included within NARMs. However, Cathodic Protection (including zinc ribbon to prevent AC corrosion) and pipeline markers are treated as a 'Probability of Consequence' rather than an asset sub-group.

8 Business Case Outline and Discussion

The failure of the filters and pre-heat system at Hillside PRS is a 'High Impact Low Probability' event (HILP). Several options to resolve this have been investigated but most have proved to not be viable. This is discussed further in section 7 and summarised in tables 4 & 5. The two viable options are to replace the filters and pre-heat system or to undertake a complete site rebuild. The most cost-effective option is to replace the filters and obsolete singular boiler at Hillside PRS. This option has been assessed through SGN's NARM's model using the software Commercial Investment Decision Optimisation Commercial Confidentiality .

8.1 Key Business Case Drivers Description

The drivers for this work are legislative compliance as described more fully in section 2.1.

8.2 Business Case Summary

The majority of named Transmission Integrity projects will be fully justified by the outputs of the NARMs methodology and are classified as A1, both in terms of CBA and reporting. There are isolated instances of associated assets, such as CP systems for steel pipelines, where the primary asset, the pipeline, is a NARMs related asset, but the sub-system is not separately identified, and no interventions have been identified within NARMs. Such interventions are classified as A2.

The Compliance activities are generally undertaken on NARMs related assets but are driven by legislative requirements and do not improve health or reduce criticality. As such, these interventions are classified as A3.

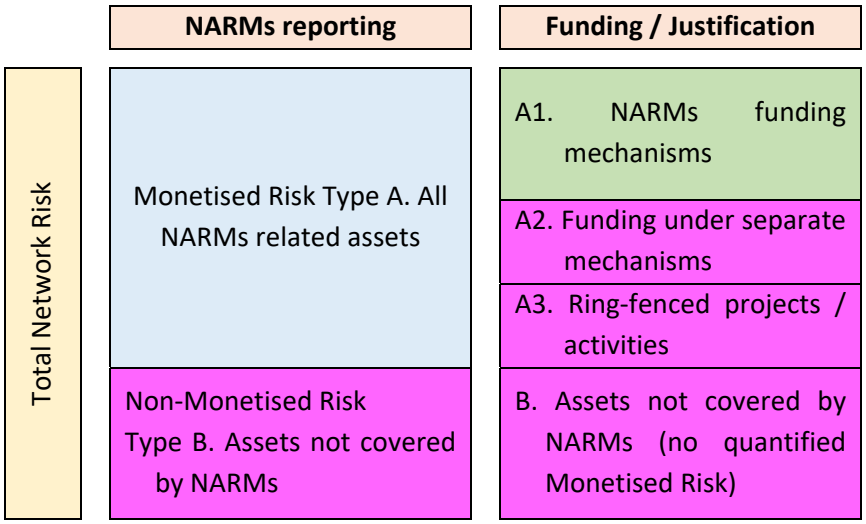

Table 6:Investment Justification methodology

9 Preferred Option Scope and Project Plan

9.1 Preferred option

The delivery of SGNS Compliance work program in GD2 is the only one option is deemed adequate to ensure that SGN meets all legislative and Licence to Operate conditions.

9.2 Asset Spend Profile

Asset Health Spend Profile (£m)						
Intervention	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**Total**
Compliance Program Southern	4.37	5.04	4.11	5.24	5.25	24.02
Compliance Program Scotland	3.94	3.74	3.68	4.04	4.32	19.72

Table 7: Asset Health Spend Profile

9.3 Investment Risk Discussion

Failure to recertify aging assets for continued use and identify life-limiting defects for resolution through the Integrity Plan runs the risk of early failure resulting in loss of supply, catastrophic gas release and associated safety related consequences as defined in more detail in section 6 of this document.

SGN would also be non-compliant with our own GS(M)R Safety Case, legislation, industry recommendations and the HSE's own guidance.

Appendix A - Glossary of Terms

Cost benefit analysis (CBA) – economic assessment of available options to resolve a problem.

CPNI - Centre for the Protection of National Infrastructure.

Engineering Research Station (ERS) - A research and development arm of British Gas that no longer exists.

Electrical and Instrumentation (E&I) – commonly used acronym for all electrical, instrumentation and control systems on operational gas sites.

High Impact Low Probability (HILP) – A term to explain an event which would create a very significant impact if it were to occur but has a very low likelihood of occurring.

Institute of Gas Engineers and Managers (IGEM) – Gas industry technical body who produce the key technical specifications used in the UK gas industry.

Local Distribution Zone (LDZ) – A geographic area used determined based the configuration of the gas network and used for billing. Southern Gas Network consists of South and South East LDZ's.

Liquified Natural Gas (LNG) – Gas that has been cooled sufficiently to cause it to change from a gas into a liquid. Commonly used to transport natural gas by ship around the world.

Local Transmission System (LTS) – A high pressure gas transportation network within a distribution networks control. These are supplied from the NTS and transport gas to town and cities before using PRS to supply lower pressure tiers.

Main Works Contract (MWC) – For large engineering projects a contract with a principal contractor is tendered to construct the project.

Non-Destructive Testing (NDT) – inspection methods used to assess the condition of equipment that doesn't have any impact on the integrity of the equipment being inspected. An example would be using X-Rays to inspect pipeline welds to ensure that they meet the specification.

Network Asset Risk Models (NARM's) – The methodology used to create a common monetised risk for all gas distribution network assets.

National Transmission System (NTS) – The bulk transportation system for gas in the UK from major inputs such as gas terminals and LNG stations to LDZ offtakes and very large users such as power stations.

Pressure Reduction System (PRS) – Installation used to reduce the pressure of gas between pressure systems.

Pressure System Safety Regulations (PSSR) – UK Legislation designed to prevent the release of stored energy.

Water Bath Heater (WBH) – A type of gas pre-heating system that heats a large volume of water through which gas pipes are run in order to exchange heat from the water into the gas. They were used on sites with a high heating requirement.

Appendix B - References

IGEM/TD/1 – Steel pipelines and associated installations for gas pressure transmission,

IGEM/TD/13 – pressure regulating Installations for Natural Gas, Liquified Petroleum Gas and Liquified Petroleum Gas / Air,

SGN/PMPS3 – Management Procedure for Ensuring Compliance with The Pressure Systems Safety Regulations 2000.

SGN/PM/CM/4 part 1- Management Procedure for Condition Assessment and Defect Reporting of Above 7 Bar Assets.