Cathodic Protection

Engineering Justification Paper (SGN-GD3-EJP-G&I-001)

Final Version 1.0

11 December 24

Distribution Asset Management SGN

SGN

Your gas. Our network.

Contents

1 Summary Table

Table 1: Ofgem Project Summary Table

Name of Project	Cathodic Protection		
Scheme Reference	SGN-GD3-EJP-G&I-001		
Primary Investment Driver	Compliance		
Project Initiation Year	2026		
Project Close Out Year	2031		
Total Installed Cost Estimate (£)	£16.18M		
Cost Estimate Accuracy (%)	+/- 20%		
Project Spend to date (£)	£0		
Current Project Stage Gate	Progress in company project process		
Reporting Table Ref	Where in BPDT volumes/costs/outputs are recorded		
Outputs included in RIIO-GT3 and RIIO-GD3 Business Plan	No		
Spend apportionment	GD2	GD3	GD4
	£5.15M	£16.18M	N/A no continued spend into GD4

All expenditure above in 23/24 prices

2 Executive Summary

1 This EJP covers the investment required for SGN to operate an effective Cathodic Protection (CP) system on its steel distribution mains. The Preferred option sees an investment of £16.18M this is to ensure that SGNs cathodic protection systems are operating in accordance with Pipeline Safety regulations 1996 (PSR), IGEM/TD/3 and SGN/PM/ECP/2. Many of SGN's CP systems are at the end of their design life and need repair or replacement. SGN are requesting funding to replace 2,484 Anodes, 22 Transformer Rectifiers and 22 Ground beds. Standard maintenance is no longer sufficient for these systems to continue to operate. This investment will allow these CP systems to continue to function. This work is enforced by the Pipeline Safety Regulation 1996 and specifically, Regulation 13 which defines what is considered a pipeline and requires gas distribution network operators to maintain their gas pipes in good condition (this is for live or dead gas mains).

2 The major drivers for CP are compliance and safety. Without an adequate CP system steel mains will corrode resulting in increased gas leakage. Gas leakage is damaging to the environment as well as posing a risk to life and property. SGN is required to undertake this work to comply with Pipeline Safety regulations 1996 (PSR), IGEM/TD/3 and SGN/PM/ECP/2. Following an HSE intervention, major investment is required to operate and maintain SGN's CP systems to an acceptable level. With a functioning CP system corrosion on SGNs steel mains will be reduced and halted resulting in fewer gas escapes meaning less risk to life and to property, as well as extending the life of steel mains.

3 CP system work is done under compliance and as this is compliance work a CBA is not required. This programme of works will fall under the ex-anti funding mechanism. The mains risks to delivery of this programme are availability of trained personnel and contractors, availability of materials and more coating defects are discovered.

4 Table 2 and Table 3 show the expected expenditure profile and delivery for CP in GD3.

Table 2: GD3 Project Expenditure Profile in 23/24 Prices (for both networks)

Year	26/27	27/28	28/29	29/30	30/31	Total
Forecast Cost (£m)	£5.17	£2.60	£2.51	£2.60	£3.3	£16.18

Table 3: GD3 Forecast Workload.

	GD3 Year 1	GD3 Year 2	GD3 Year 3	GD3 Year 4	GD3 Year 5
	Quantity	Quantity	Quantity	Quantity	Quantity
CIPS	206 Km	206 Km	206 Km	206 Km	206 Km
DCVG	50 Km	50 Km	50 Km	50 Km	50 Km
Current Attenuation Survey	20 Km	20 Km	20 Km	20 Km	20 Km
Scrub Clearance	21 km	21 km	21 km	21 km	21 km
Functionals / Majors / Interims	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys
Bond repair/ Replacement	8	8	8	8	8

Replacement of Anodes	676	452	452	452	452
Groundbed Replacement	6	4	4	4	4
TR Replacement	6	4	4	4	4
TR Kiosk Replacement	3	2	2	2	2
Repair of Insulating Flanges/Joints	1	1	1	1	2
Stray Current Monitoring	12	12	12	12	12
Repair/ Replace Test point	1030	540	510	540	570
Trial Holes	8	4	4	4	4
Coating defect repairs	13	9	10	10	9

5 In GD2 SGN are forecasting to spend the allowance for CP. The funding request in GD3 is not a continuation of this programme as, following the latest interaction with the HSE and an internal review, there is a requirement to increase the scale of work on SGN's CP systems.

Table 4: GD2 FD Allowances and Volumes in 23/24 Prices (for both networks)

Year	21/22	22/23	23/24	24/25	25/26	Total
FD Allowance (£m)	£1.03	£1.03	£1.03	£1.03	£1.03	£5.16

6 Various smaller CP projects were conducted over SGNs 3 networks during GD2 Scotland, South and Southeast.

7 As we look to form our plans and develop our strategy for the next price control GD3, we have engaged with support from our Independent Stakeholder Group (ISG) with a wide range of our customers and stakeholders to better understand what their needs are and what they expect from us. We have responded, challenging ourselves to focus on the projects that prioritise safety and resilience, while delivering most value to our customers. This document should be read in conjunction with our GD3 Business plan, section C2 Customer and Stakeholder priorities. This section provides a greater level of detail of our approach to customer and stakeholder engagement.

3 Introduction

8 This EJP covers a breakdown of the investment required to operate and to maintain SGN's cathodic protection systems on our distribution assets.

9 Cathodic Protection (CP) and pipe coating are the methods used to ensure corrosion is preventable on under-ground assets. Without a functioning CP system and a defect in the mains coating, there is a high likelihood of corrosion occurring.

10 SGN have recently received an intervention from the HSE regarding CP systems. Many of SGN's CP systems require remediation work to operate in accordance with Pipeline Safety regulations 1996 (PSR), IGEM/TD/3 and SGN/PM/ECP/2.

11 Many CP Systems are approaching the end of their lifespan, and some CP systems now require more than basic maintenance, with anodes, TRs and ground beds all needing to be replaced. This is a large increase in workload from GD1 and GD2, however, it is necessary to have functioning CP systems on our distribution assets.

12 Highly trained personnel are essential to operate and maintain CP systems. Recruiting and training competent technicians is a limiting factor for how quickly SGN can maintain and repair our CP systems.

13 SGN has split its CP systems into 3 categories; Fully compliant, Partially Compliant, and Failed. Fully compliant systems operate perfectly and do not require any remediation work at present. Partially compliant systems provide protection to the asset; however, they still require maintenance work. Failed CP systems require major works to bring them up to a compliant standard. A breakdown of SGNs CP systems can be seen in table 5 below.

Table 5: Length (km) of Steel - Fully Compliant, Partially Compliant and Failed by Network

	Pressure Tier	Fully Compliant	Partially Compliant	Failed	Area Totals
Scotland	IP	68.5	683.7	118	870.2
	MP	10	81.2	46.2	137.4
	LP	1.8	6.2	9.9	17.9
	Total	80.3	771.1	174.1	1025.5
	Pressure Tier	**Fully Compliant**	**Partially Compliant**	**Failed**	**Area Totals**
Southern	IP	73.2	1035	0.7	1108.9
	MP	45.5	207.4	24.2	277.1
	LP	7.5	8.1	5.5	21.1
	Total	126.2	1250.5	30.4	1407.1
SGN - Total		206.5	2021.6	204.5	2432.6

14 Steel mains that are not protected by cathodic protection will corrode and have more gas escapes. This leads to a greater chance of Gas in buildings. If a CP system is functioning on a main it will reduce the risk to like and property. It will also make the network more reliable as there is less likely to be an interruption to supply.

15 This programme of work is to extend the life of our steel assets, reduce the potential of unnecessary leakage from our network and reduce the cost of customer's bills.

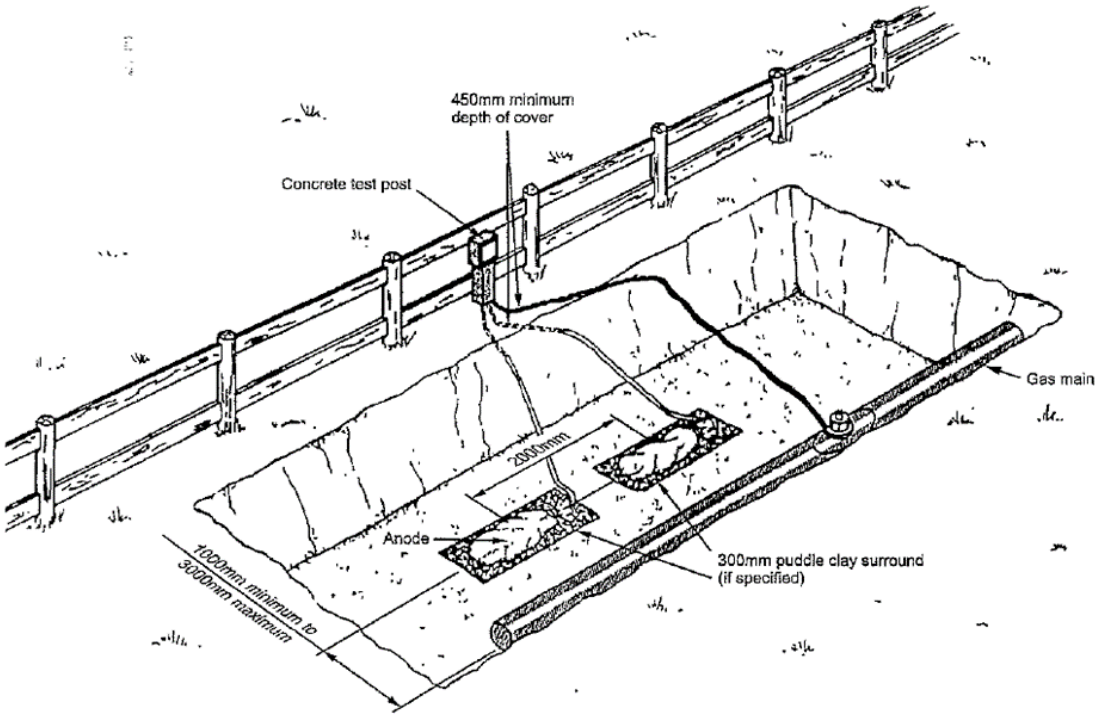
4 Equipment Summary

16 There are two types of Cathodic Protection system, sacrificial and impressed current. For a high-level explanation of both methods please refer to appendix C. SGN use both systems depending on the application. Each systems equipment differs. Please see below a breakdown of the equipment used on SGNs CP systems. Sacrificial Anode System includes:

- Anode bed (usually made from zinc or magnesium)
- Test posts
- Connections (cable)
- Insulating Joints/Flanges

17 Figure 1 shows how these components are laid out in a typical sacrificial system.

Figure 1: Sacrificial Anode System



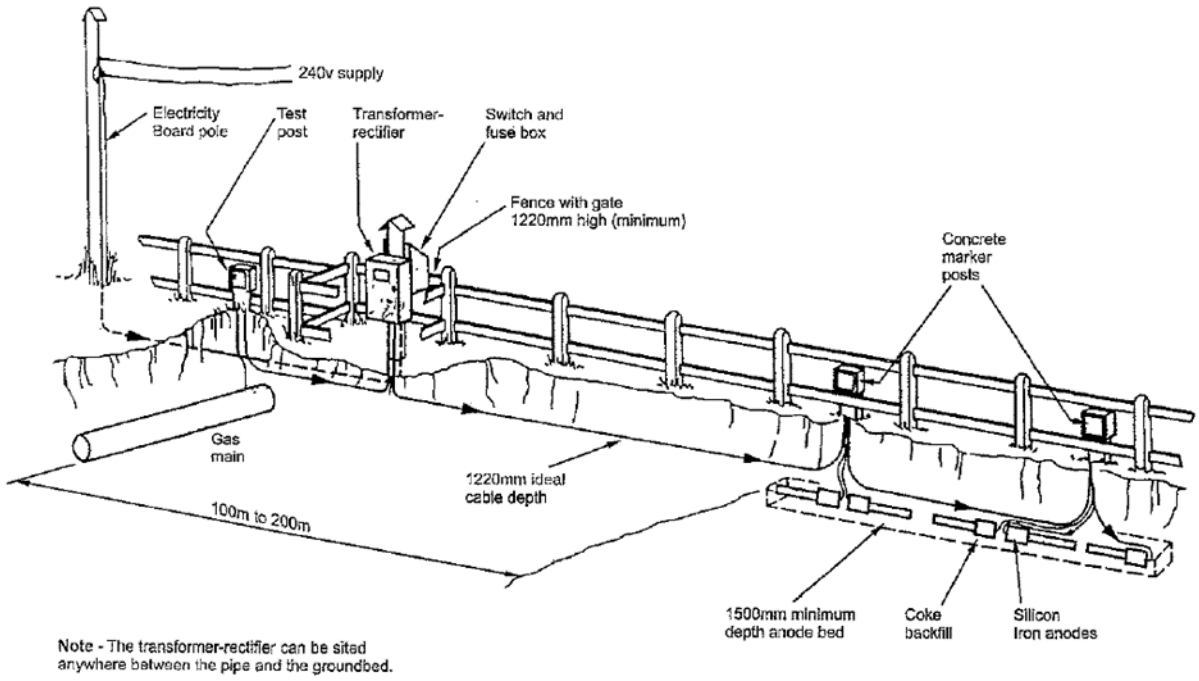
18 Figure 1 shows a typical layout for a sacrificial system. It is relatively simple with no power source required. Instead, it relies on the potential difference between the anodes and the steel pipe. The Anodes need to be situated close to the pipe between 1 and 3 meters. The CP can only protect a short length of steel meaning that anodes need to be installed at frequent intervals. They are best used for urbanised areas or for shorter lengths of pipes.

19 Impressed current system includes:

- Transformer Rectifiers
- Ground bed
- Kiosk
- Connection (cables)
- Electrical Supply
- Test posts
- Insulating Joins/Flanges

20 Figure 2 shows how these components are laid out in a typical Impressed current system.

Figure 2: Impressed Current System



21 Figure 2 shows a typical layout of an impressed current system. Impressed current systems are more complicated requiring an external power source and a transformer rectifier to create a potential difference between the ground bed and the steel main. The major advantage of impressed current systems is that one ground bed can protect kilometres of main. They do not however, work well in urbanised areas where other buried structures can interfere.

5 Problem/Opportunity Statement

Why are we doing this work and what happens if we do nothing?

22 Cathodic Protection is an electrochemical means of corrosion control, applied to supplement the corrosion protection afforded by the mains coating system. The coating system is the primary means of protecting a main from corrosion however, no coating system is perfect. If the coating had a defect or becomes damaged the CP system will prevent corrosion occurring on that asset.

23 SGN has received an improvement notice regarding its Cathodic Protection systems. Many of SGN's CP systems are not compliant with Pipeline Safety regulations 1996 (PSR), IGEM/TD/3 and SGN/PM/ECP/2. CP systems do not last forever and deteriorate over time. The anodes on a sacrificial CP System corrode in favour of the steel main they protect necessitating the replacement of anodes. Impressed current systems exhaust ground beds over time as well as the transformer rectifiers requiring replacement. Many of SGN's CP systems are at the end of their design life and require many of their components to be replaced.

24 Steel mains can carry gas at low, medium, and intermediate pressures. If corrosion is allowed to take place, it will lead to an increased number of leaks and gas escapes on these pipelines meaning that many more repairs will have to be undertaken and could also, in the worst cases, potentially cause a major incident, endangering life and property.

What is the outcome that we want to achieve?

25 By undertaking this major program of repairing and replacing CP systems SGN can continually prevent corrosion occurring on our network. By continually monitoring these CP systems, SGN ensure its continued effectiveness. The combination of a properly applied coating system and CP is the best method of corrosion control on buried steel gas mains.

26 The IGEM/TD/3 document covers the design, construction and maintenance of steel pipelines operating under 16bar. It states, "*the continued effective operation of a CP system is dependent on a satisfactory level of monitoring and maintenance, which should form part of the pipeline management system*."[1] To ensure the compliance with Pipeline Safety regulations 1996 (PSR) to IGEM standard IGEM/TD/3 and SGN's policy SGN/PM/ECP/2, there is a requirement that a combination of cathodic protection and properly applied coating systems be used to provide a comprehensive corrosion protection system to buried steel gas pipelines and fittings.

27 If SGN are unable to install and run a comprehensive corrosion protection system, an increase in corrosion features on steel mains will be seen. A large majority of our distribution networks are in densely populated areas, and this therefore amplifies the consequence of a major incident occurring. CP systems need to be in place to ensure a high level of safety and reliability of operation on our mains.

How will we understand if the spend has been successful?

28 A properly functioning CP system will slow and inhibit corrosion. This will reduce the number of gas escapes, repairs and replacement of mains required. It will also allow SGN to operate a safe and reliable network reducing the likelihood of gas in buildings. A properly functioning CP system protects life and property. Success of the investment will be shown by the low frequency of emergency repair operations on steel pipelines due to corrosion.

[1] IGEM/TD/3 Edition 5 Steel and Polyethylene (PE) Pipeline for Gas Distribution.

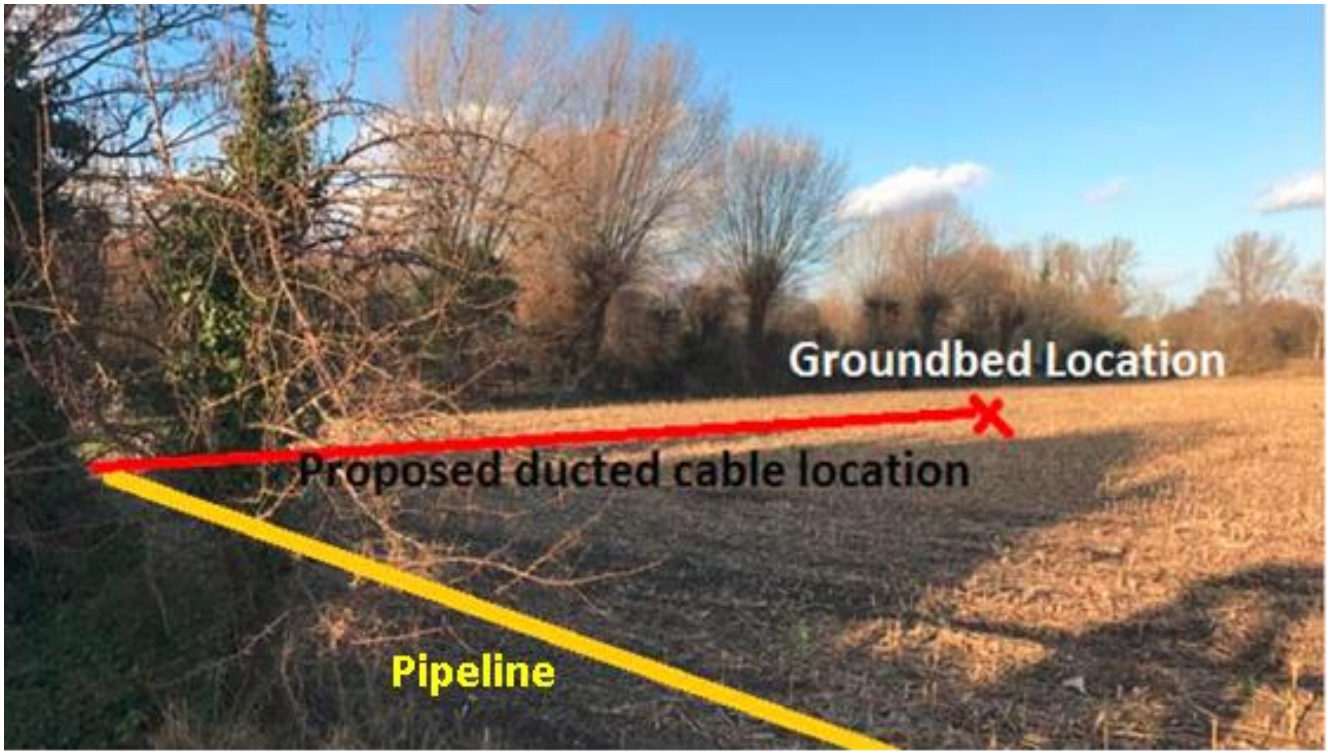
5.1 Narrative Real-Life Example of Problem

Transformer Rectifier Replacement Gillingham, Kent

29 A Transformer Rectifier (TR) was recently replaced in Gillingham, Kent. A fire broke out at Great Grovehurst Farmhouse, which housed the original TR meaning a new location was needed.

30 The new location had to allow an area for the new TR and be 120m away from the pipeline to bury the ground bed, which is a requirement within SGN/PM/ECP/2. This location also required an electrical connection. A location in a farmer's field was identified. SGN are then required to purchase an easement from the landowner for the 120m distance of the ground bed cables and the ground bed itself. The location of the grounded can be seen in figure 3 below.

Figure 3: Proposed location of pipeline and ground bed



31 This section of pipeline was not electrically isolated by an insulation joint. The SGN Land team had managed to legally secure the easement, which took nearly a year to arrange. An electrical and CP design was prepared along with an appraisal for the PS/6 (Internal procedure for New Works, Modification and Repairs). Another consideration required for the CP design was a soil resistivity test.

32 SGN facilitated the excavation of a 120m trench (1m wide) and installed a ground bed and transformer rectifier on to the existing 18" steel pipeline. The TR provides a low current on the pipeline as part of the impressed current CP system, in accordance with SGN/PM/MAINT/5 and SGN/PM/ECP/2.

33 Soil resistivity testing was carried out in accordance with *Appendix D*[2] of SGN/PM/ECP/2 and a single-phase 230V AC supply was provided by UKPN to power the TR. The ground bed compromised of 8 magnesium anodes.

34 Projects like this take mains that are at risk of corroding, this takes a system that is not compliant and to make it compliant with Pipeline Safety regulations 1996 (PSR), IGEM/TD/3 and SGN/PM/ECP/2.

[2] SGN/PM/ECP/2 Management Procedure for Cathodic Protection of buried Steel Systems, 2023.

Figure 4: New TR unit placed in a small kiosk

Figure 5: Newly installed TR

35 Figures 4 and 5 show the newly installed TR and its kiosk.

5.2 Project Boundaries

36 The GD3 allowances will be used as part of an on-going programme to maintain and to replace our CP systems. The work will be conducted by a mixture of SGN direct labour and suitable contractors and includes:

- The monitoring of CP systems
- Scrub clearance to allow access to the main
- Investigation and assessment of corrosion feature where CP has failed.
- Bond repair and replacement

- Anode replacement
- TR and Ground bed replacement
- Repair/Replacement of Insulating Joints and Flanges
- Repair/Replacement of CP test points
- Monitoring of "at risk" mains for stray current form 3rd party activities e.g., uprated high voltage powerlines

37 This work will be to repair/ replace our CP systems and will not include the following:

- Installation of CP schemes on new steel mains
- Expansion of any existing CP system to expand the network
- No Direct repairs to CP schemes on above 7bar (Transmission assets)

6 Probability of Failure

38 To ensure that Cathodic Protection systems are operating correctly, CP schemes undergo a program of monitoring. Any potentials that are recorded are taken with reference to a Copper/Copper Sulphate reference electrode and recorded on a field device. The readings taken from all checks are recorded in *PCS (Pipeline Compliance System)* so that changes can be monitored over time.

39 An impressed current system has a robust series of inspections. These inspections are as follows:

(a) Functional Inspections are conducted monthly. The TRs are checked to be functioning properly, and their setting and outputs recorded. The extremes of the system are also checked to ensure that no bonds on the system are broken. Any AC mitigation measures installed on the scheme are also checked at this time. All readings are recorded and stored in PCS.

(b) Interim Inspections are conducted once a year. These are a more in-depth inspection than the functional checks. In addition, On-readings (readings with the TR switched on) are taken at each test point as well as this all sleeves and insulating joints are checked to make sure they continue to function properly.

(c) Major Inspections are conducted every 5 years. A Major Inspection is more in-depth than Interim Inspections as they also record Off-potentials for the CP Scheme. Off-potentials give a more accurate reading than On-Potentials as they eliminate voltage gradients cost by the flow of current. These readings are obtained by rapidly switching the TR on and off usually in the ratio of 4 seconds on to 1 second off.

(d) CIPS (Close Interval Potential Survey) are carried out every 10 years. A CIPS is done on all schemes that operate at Intermediate Pressure (IP). During a CIPS the entire scheme is walked with both ON and Off Potentials being taken every meter. Theses survey allow for extremely localised faults to be picked up which would be missed by another type of survey. Many of these faults will then require further investigation e.g., coating surveys like DCVG (Direct current voltage gradient) or an excavation to inspect the pipe visually.

40 Sacrificial systems undergo a different system of inspections due to them being simpler; they do not require a power source:

(a) Functional Inspections are conducted every 6 months. On-readings are taken at a selection of test points and all readings recorded.

(b) Major inspections are carried out every 2 years. During Major Inspections a reading is taken at every test post on a scheme. Where a coupon has been installed or the system only has one set of anodes installed an Off-Reading is also taken. Due to the age of SGNs CP systems many do not have coupons so On-Readings are all that can be taken.

41 Common faults on CP systems include:

- Damage to connecting cables due to other works in the area.
- Shielding of the protective current by other structures
- Increased current demand due to failing coatings.
- Depleted anodes
- Transformer Rectifiers (TRs) failing.

6.1 Probability of Failure Data Assurance

42 Predicting failure of CP systems is difficult as failure of systems are not typically recorded, and the failure rate would vary significantly from site to site.

43 The environment in which the system is located can affect the rate of corrosion significantly as the type of soil, the resistivity of the soil, proximity to other steel structures, proximity to power lines and cables, size of the asset etc, will all factor in on the design life of the system. Some sites will inevitably need to be replaced more frequently.

44 SGN currently has several failed and partially compliant systems that require remediation. 8% of SGNs CP schemes require replacement with a further 83% requiring remediation.

7 Consequence of Failure

Loss of supply to customers

45 Cathodic Protection systems, if functioning properly, completely inhibit the corrosion of steel mains. As CP systems fail offering less and less protection to the main the rate of corrosion on the main accelerates until it reaches the same rate as unprotected steel. If allowed to continue, corrosion can cause leaks and degradation of the main eventually resulting in gas leaks. These leaks or the actions required to repair them could cause supply issues as system pressures fall below acceptable minimum levels. The number of customers off gas will vary according to the location of the main, and could include hospitals, prisons, and MOD sites. This could result in loss of supply to customers. The number of customers off gas will vary according to the location of the main.

Safety impact of failure

46 Without a properly functioning CP system there will be an increase in the number of gas escapes. Gas escapes can cause fires and explosions. This is likely to endanger life and property as our distribution assets are usually located in densely populated areas. If the gas does not ignite it will still carry risks associated with asphyxiation.

Environmental impact

47 Gas escapes will affect our shrinkage figure which makes up 98% of SGNs carbon footprint. This is because methane is 28 times more harmful than carbon dioxide as a greenhouse gas.

48 To ensure a high level of safety and longevity it is essential that all buried steel pipework is installed and commissioned to withstand the effects of corrosion. In addition, any corrosion control system installed is monitored and maintained to ensure its continued effectiveness. The degradation of sacrificial CP systems and impressed current ground beds is a gradual but inevitable process, with various remediation techniques utilised to prolong the life of the schemes. However, these partial solutions eventually fail, and more extensive investment is needed.

8 Options Considered

49 SGN has prepared five investment options for consideration. SGNs preferred, do less, do more, do nothing and Do Minimum and Defer to GD4. The options break down the technical details as well as the time scales and any assumptions that have been made.

50 The options below include SGNs preferred option which involves increasing investment to Improve SGNs CP systems following the HSE Intervention. SGN would carry out as much remediation work as possible with the available technicians. (see Investment risk discussion for further detail)

51 Option 2 outlines the investment required to get all SGNs systems functioning in the GD3 period. This is not possible due to the lack of properly qualified technicians available.

52 Option 3 would see SGN having a similar funding level to GD2 this level of funding would not be enough to improve SGNS CP system back to a level acceptable to Pipeline Safety regulations 1996 (PSR), SGN/PM/ECP/2 and IGEM/TD/3.

53 Option 4 outlines what would happen if all CP work were to be differed to GD4. This option has been discounted due to the detrimental effect it would have on SGNs steel mains.

54 Option 5 would see the same level of investment as option 3 with SGNs back log of failed CP systems being deferred into GD4. This option would see the further deterioration of SGNs CP Systems and would mean that SGN was not compliant with Pipeline Safety regulations 1996 (PSR), SGN/PM/ECP/2 and IGEM/TD/3.

55 Failure to comply with regulations and industry standards will lead to increased safety risks which can result in accidents, including explosions and leaks, which can cause serious injuries or fatalities. The consequences of non-compliance to legal standards can result in fines, penalties, and even criminal charges.

8.1 Option 1 – Preferred Option

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

56 This option would see SGN increasing our CP replacement/repair program. SGN would perform remediation on c1,800km of main including all IP mains, this would allow SGN to comply with the improvement notice from the HSE. The CP work required covers a multitude of activates the workloads for each can be seen in table 6.

Table 6: Work Volumes by Year Option 1 – Preferred Option

	GD3 Year 1	GD3 Year 2	GD3 Year 3	GD3 Year 4	GD3 Year 5
	Quantity	Quantity	Quantity	Quantity	Quantity
CIPS	206 km	206 km	206 km	206 km	206 km
DCVG	50 km	50 km	50 km	50 km	50 km
Current Attenuation Survey	20 km	20 km	20 km	20 km	20 km
Scrub Clearance	21 km	21 km	21 km	21 km	21 km
Functionals / Majors / Interims	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys
Bond repair/ Replacement	8	8	8	8	8

Replacement of Anodes	676	452	452	452	452
Ground bed Replacement	6	4	4	4	4
TR Replacement	6	4	4	4	4
TR Kiosk Replacement	3	2	2	2	2
Repair of Insulating Flanges/Joints	1	1	1	1	2
Stray Current Monitoring	12	12	12	12	12
Repair/ Replace Test point	1030	540	510	540	570
Trial Holes	8	4	4	4	4
Coating defect repairs	13	9	10	10	9

The basis for the cost estimate/unit cost

57 The costs have been estimated based on the unit costs of material and labour. Labour is a major constraining factor on this option as obtaining suitably qualified personnel is difficult. The unit costs for each type of work can be seen in table 7 below.

[redacted]

TR Kiosk Replacement	£2,0000/ Kiosk	£2,0000/ Kiosk
Repair of Insulating Flanges/Joints	£370,000 / Joint/ flange repair	£370,000 / Joint/ flange repair
Stray Current Monitoring	£1,000 / Test point location	£1,000 / Test point location
Repair/ Replace Test point	£750 / Test point	£750 / Test point
Trial Holes	£10,000 / Trial hole	£10,000 / Trial hole
Coating defect repairs	£20,000 / Coating Repair	£33,542 / Coating Repair

58 Due to the nature of the networks, we run there are some significant differences in cost between Scotland, South and Southeast. This is due to SGNs southern networks being in more urbanized built-up areas whereas Scotland's assets tend to be located in a greater percentage of open countryside. As a result, South and Southeast experience higher charges when replacing anodes, ground beds and repairing coating defects as it will involve more lane closures and rentals.

The perceived benefits of the option

59 This program of work will allow SGN to maintain and recover CP systems and to move towards complying with Pipeline Safety regulations 1996 (PSR), SGN/PM/ECP/2 and IGEM/TD/3. It is required for SGN to be able to run a safe and reliable network. A properly function CP system will reduce the number of Gas escapes meaning fewer costly repairs and the risk to members of the public.

Delivery timescales

60 All work delivered on time, within year and to the approved level of costs. The work will be spread across GD3 a breakdown of the various aspects of CP that will be addressed can be seen above in table 6.

Key assumptions made

61 Site conditions will be normal with no access issues and stocks of anodes and transformer rectifiers are readily available including having competent resources available.

Any other items that differentiate the option from the others considered

62 This option will allow SGN to improve and recover CP systems and is deliverable with the level of skilled technicians that are available (Please seen section 9 for a further explanation on the availability of CP Technicians). SGNs CP systems require major investment, this option would see the bulk of SGN's CP systems remediated to an acceptable level where they would comply with Pipeline Safety regulations 1996 (PSR), IGEM/TD/3 and SGN/PM/ECP/2. This option also recognises the lack of appropriately trained technicians to carry out CP work, the workload has been set at an achievable level.

8.2 Option 2 – Do More

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

63 This option would see SGN recovering all its failed CP systems over the course of GD3 this would mean remediating 3191.3 km of main. This would require an investment of £33.4M in GD3. The workloads required to achieve this can be seen in table 8 below.

Table 8: Work Volumes by Year Option 2 – Do More Option

	GD3 Year 1	GD3 Year 2	GD3 Year 3	GD3 Year 4	GD3 Year 5
	Quantity	Quantity	Quantity	Quantity	Quantity
CIPS	206 Km	206 Km	206 Km	206 Km	206 Km
DCVG	50 Km	50 Km	50 Km	50 Km	50 Km
Current Attenuation Survey	20 Km	20 Km	20 Km	20 Km	20 Km
Scrub Clearance	21 km	21 km	21 km	21 km	21 km
Functionals / Majors / Interims	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys
Bond repair/ Replacement	19	19	19	19	19
Replacement of Anodes	1600	1069	1069	1069	1069
Ground bed Replacement	14	9	9	9	9
TR Replacement	14	9	9	9	9
TR Kiosk Replacement	7	5	5	5	5
Repair of Insulating Flanges/Joints	2	2	2	2	5
Stray Current Monitoring	28	28	28	28	28
Repair/ Replace Test point	2437	1278	1207	1278	1349
Trial Holes	19	9	9	9	9
Coating defect repairs	13	9	10	10	9

The basis for the cost estimate/unit cost

64 The costs have been estimated based on the unit costs of material and labour. Labour is a major constraining factor on this option as obtaining suitably qualified personnel is difficult. The unit costs for this work remain the same as for the preferred option.

The perceived benefits of the option

65 This option would mean that SGNs CP systems would be fully compliant with Pipeline Safety regulations 1996 (PSR), SGN/PM/ECP/2 and IGEM/TD/3. Fully compliant CP Systems would mean that there would be fewer distribution gas escapes and fewer repairs to steel gas mains. It is not however achievable due to the lack of trained technicians.

Delivery timescales

66 This option is undeliverable as it would be impossible to get enough technicians with the required skills and training to undertake all the work required.

Key assumptions made

67 Site conditions will be normal with no access issues and stocks of anodes and transformer rectifiers are readily available including having competent resources available. That there will be an adequate supply of trained personnel or the capacity to train them.

8.3 Option 3 – Do Less (Do Minimum)

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

68 Continue to repair/replace CP systems at the same rate as in GD2. This would require an investment of £10.3m. The workload can be seen in table 9 below.

Table 9: Work Volumes by Year Option 3 – Do Less

	GD3 Year 1	GD3 Year 2	GD3 Year 3	GD3 Year 4	GD3 Year 5
	Quantity	Quantity	Quantity	Quantity	Quantity
CIPS	206 Km	206 Km	206 Km	206 Km	206 Km
DCVG	50 Km	50 Km	50 Km	50 Km	50 Km
Current Attenuation Survey	20 Km	20 Km	20 Km	20 Km	20 Km
Scrub Clearance	21 km	21 km	21 km	21 km	21 km
Functionals / Majors / Interims	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys
Bond repair/ Replacement	4	4	4	4	4
Replacement of Anodes	366	244	244	244	244
Groundbed Replacement	3	2	2	2	2
TR Replacement	3	2	2	2	2
Repair of Insulating Flanges/Joints	1	1	1	1	1
Stray Current Monitoring	6	6	6	6	6
Repair/ Replace Test point	557	292	276	292	308
Trial Holes	4	2	2	2	2
Coating defect repairs	13	9	10	10	9

The basis for the cost estimate/unit cost

69 The costs associated with this option are based on carrying on replacement and repair at the same rate as in GD2. They are the same unit costs used for option 1 as it is only the volume of work that will change.

The perceived benefits of the option

70 There is limited benefit to carrying on repair/replacement at the same level as in GD2. We have discovered that more schemes are failing than we can repair in this manner. Although some CP schemes would experience an increase in their life span, many would continue to deteriorate.

Delivery timescales

71 There are no specific timescales for this option as it would be an unplanned event. It could take a minimum of couple of days to attend site, assess the CP system, and replace the necessary components.

Key assumptions made

72 Site conditions will be normal with no access issues and stocks of anodes and transformer rectifiers are readily available including having competent resources available.

Any other items that differentiate the option from the others considered

73 The level of repair/replacement conducted in GD2 proved to be insufficient to keep all SGN's CP schemes functioning. This option would result in the following: -

- This option would mean that SGN would not be complying with Pipeline Safety regulations 1996 (PSR), IGEM/TD/3 and SGN/PM/ECP/2.
- There would be an increase in the number of repairs and replacement of mains required.
- An increase in gas escapes could be expected. Raising the risk to life and property.

8.4 Option 4 – Do Nothing

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

74 This option assumes that SGN would perform no remediation work during GD3. This would mean failed CP systems would not be repaired and that more systems would fail. Mains not protected by CP will corrode and pose a greater risk to life and to property. It is not possible to defer this work and to operate a safe and reliable network.

The basis for the cost estimate/unit cost:

75 There would be no cost for CP work however the lack of action would see an increased cost in main repairs and loss of supply.

The perceived benefits of the option:

76 There are no benefits to this option, it will cause our steel mains to deteriorate, putting life and property at risk. It would also mean that there would be a greater number of CP systems to repair in GD4.

Key assumptions made:

77 More of SGN's CP Schemes will continue to fail leaving greater lengths of steel unprotected and corroding.

Any other items that differentiate the option from the others considered:

78 This option has been discounted due to the following reasons:

- This option would mean that SGN would not be complying with Pipeline Safety regulations 1996 (PSR), IGEM/TD/3 and SGN/PM/ECP/2.
- There would be an increase in the number of repairs and replacement of mains required.
- An increase in gas escapes could be expected. Raising the risk to life and property.

8.5 Option 5 – Do Minimum and Defer to GD4

79 This option would be the same as SGNs do less option with the extra work required being pushed back to GD4. SGN would only be able to fix CP schemes on failure. It would not let us tackle the large backlog of outstanding work. This would mean SGN was not complying with Pipeline Safety regulations 1996 (PSR), IGEM/TD/3 and SGN/PM/ECP/2.

8.6 Options Technical Summary Table

Table 10: Option Technical Summary Table

Option Number	Description of Option	Year 1 Spend	Total Spend	Benefits of Option
1	Preferred Option	£5.17M	£16.18M	Facilitates our key business objective of providing a safe, secure, and efficient gas supply network. The proposed work would improve the health of our Cathodic Protection systems. It would also be achievable using appropriately trained personnel and contractors. It will reduce the need to repair defects on our steel distribution mains safeguarding supplies and ensuring safety.
2	Do more	£10.2m	£33.4M	Facilitates our key business objective of providing a safe, secure, and efficient gas supply network. The proposed works being undertaken within GD3 would require to be undertaken by an increased number of in-house technicians and contractors, that are currently not available (Please seen section G for a further explanation on the availability of CP Technicians). This approach offers the opportunity to upgrade SGNs network and avoid the loss of continuity of supply and the risk to customers due to having no heat or hot water, while managing the safety of the site and our employees.
3	Do Less	£3.4M	£10.3M	CP systems would continue to deteriorate with only the worst CP systems being repaired or replaced. This would cause an increase in Gas escapee, repairs, and risk supplies to customers.
4	Do-nothing, defer to GD4	£0	£0	There are no benefits to this option, steel mains will deteriorate and puts the network and customers at risk from gas escapes and loss of supply.
5	Do minimum	£3.4M	£10.3M	CP systems would continue to deteriorate with only the worst CP systems being repaired or replaced. This would cause an increase in Gas escapee, repairs, and risk supplies to customers.

8.7 Options Cost Summary Table

Table 11: Options Cost Summary Table

Option Number	Description of Option	Cost to deliver
1	Preferred option	£16.18M
2	Do more	£33.4M
3	Do less	£10.3M
4	Do nothing	£0
5	Do minimum	£10.3M

9 Business Case Outline and Discussion

9.1 Key Business Case Drivers Description

80 SGN is currently implementing a recovery plan which was instigated after an improvement notice from the HSE. This resulted in an increase in our monitoring of CP schemes and a review of CP in general. SGNs Cathodic Protection systems require investment for them to be effective. CP schemes should comply with Pipeline Safety regulations 1996 (PSR), SGN/PM/ECP/2 and IGEM/TD/3. SGN has many CP systems that to these criteria are currently failed or partially compliant.

81 Failed or partially compliant CP systems allow steel mains to corrode. This means that there is a greater number of repairs required on our distribution mains. Additionally, increasing the chance of gas leaks which pose a risk to both life and property as well as possibly interrupting supplies.

82 To get CP to an acceptable standard, SGN will have to undertake simple repairs to many CP systems including the installation/repair or CP monitoring points, the replacement of bond cables and the replacement of insulating Flanges/Joints. It will also require larger scale projects such as the replacement of transformer rectifiers and ground beds on impressed current systems and the large-scale replacement of anodes on sacrificial systems.

83 Anodes will need to be replaced on sacrificial systems which are often used on smaller lengths of Steel main and in built up areas. Traffic management and lane rental adds to the time and cost of doing work.

84 CP systems require routine monitoring with some test points being monitored up to 12 times a year. Test points often need to be replaced, this is due to them being either test posts that are vulnerable to traffic and farm machinery, or they are surface boxes which are often tarmacked over by local authorities.

85 The role of a CP technician is highly specialised and requires training and experience. SGN puts all its technicians through *ICOR (Institute of Corrosion level 2 on land buried sector)* training, as well as engineers involved with CP to be trained to *ICOR Level 3 (on land buried sector)*. This is to conform to *BS EN ISO 15257* which is *Cathodic protection — Competence levels of cathodic protection persons — Basis for a certification scheme*. Any contractors employed by SGN to undertake CP work would be required to meet the same standard of training. The number of qualified individuals in the U.K. is limited putting a restriction on how many and how quickly we can resolve CP Faults.

86 SGN's preferred option is to take undertake the remediation work required to get CP systems back to an acceptable level. This will prolong the life of the steel mains and allow SGN to operate a safe and reliable network. It considers the availability of suitably trained staff and sets workloads at an achievable level.

9.2 Business Case Summary

Table 12: Business Case Summary Table

Option Number	Description of Option	Benefits of Option	Cost to deliver	Volume of Workload
1	Preferred option	Facilitates our key business objective of providing a safe, secure, and efficient gas supply network. The proposed work would improve the health of our Cathodic Protection systems. It would also be achievable using appropriately trained personnel and contractors. It will reduce the need to repair defects on our steel distribution mains safeguarding supplies and ensuring safety.	£16.18M	All work delivered on time, within year and to the approved level of costs
2	Do more	Facilitates our key business objective of providing a safe, secure, and efficient gas supply network. The proposed works being undertaken within GD3 will be undertaken by an increased number of contractors being supervised by SGN staff who have the knowledge and experience in this type of work. This approach offers the opportunity to upgrade SGNs network and avoid the loss of continuity of supply and the risk to customers due to having no heat or hot water, while managing the safety of the site and our employees.	£33.4M	Undeliverable due to lack of fully qualified technicians
3	Do less	CP systems would continue to deteriorate with only the worst CP systems being repaired or replaced. This would cause an increase in Gas escapee, repairs, and risk supplies to customers.	£10.3M	In line with the current GD2 programme.
4	Do nothing	There are no benefits to this option, steel mains will deteriorate and puts the network and customers at risk from gas escapes and loss of supply.	£0	N/A
5	Do minimum Defer to GD4	This option is the same as option 3 (Do less) and represents a continuation of current Ofgem allowance. CP systems would continue to deteriorate with only the worst CP systems being repaired or replaced. This would cause an increase in Gas escapee, repairs, and risk supplies to customers.	£10.3M	In line with the current GD2 programme.

10 Preferred Option Scope and Project Plan

10.1 Preferred Option

87 Active Repair/Replace - The preferred option is to approve funding of £16.18 million to repair, maintain and replace CP systems across the SGN's network. This would allow us to continue the program of repair/replacement of CP systems after the intervention from the HSE.

88 These works include the replacement of anodes, transformer rectifiers and ground beds of the CP systems that are no longer working and cannot provide Cathodic Protection to the asset. It also Includes ancillary equipment and repairs associated with CP systems, such as CP post replacement, bond repair and repair of Isolation Joints.

89 The current CP systems are surveyed regularly in accordance with SGN/PM/ECP/2 to identify where the CP is no longer effective, and which systems need replacing. This monitoring will allow us to target the CP systems that are in most need of repair/replacement.

90 Volumes of work that fall under this option can be seen in table 13 below.

Table 13: Work volumes by year Option 1 preferred option

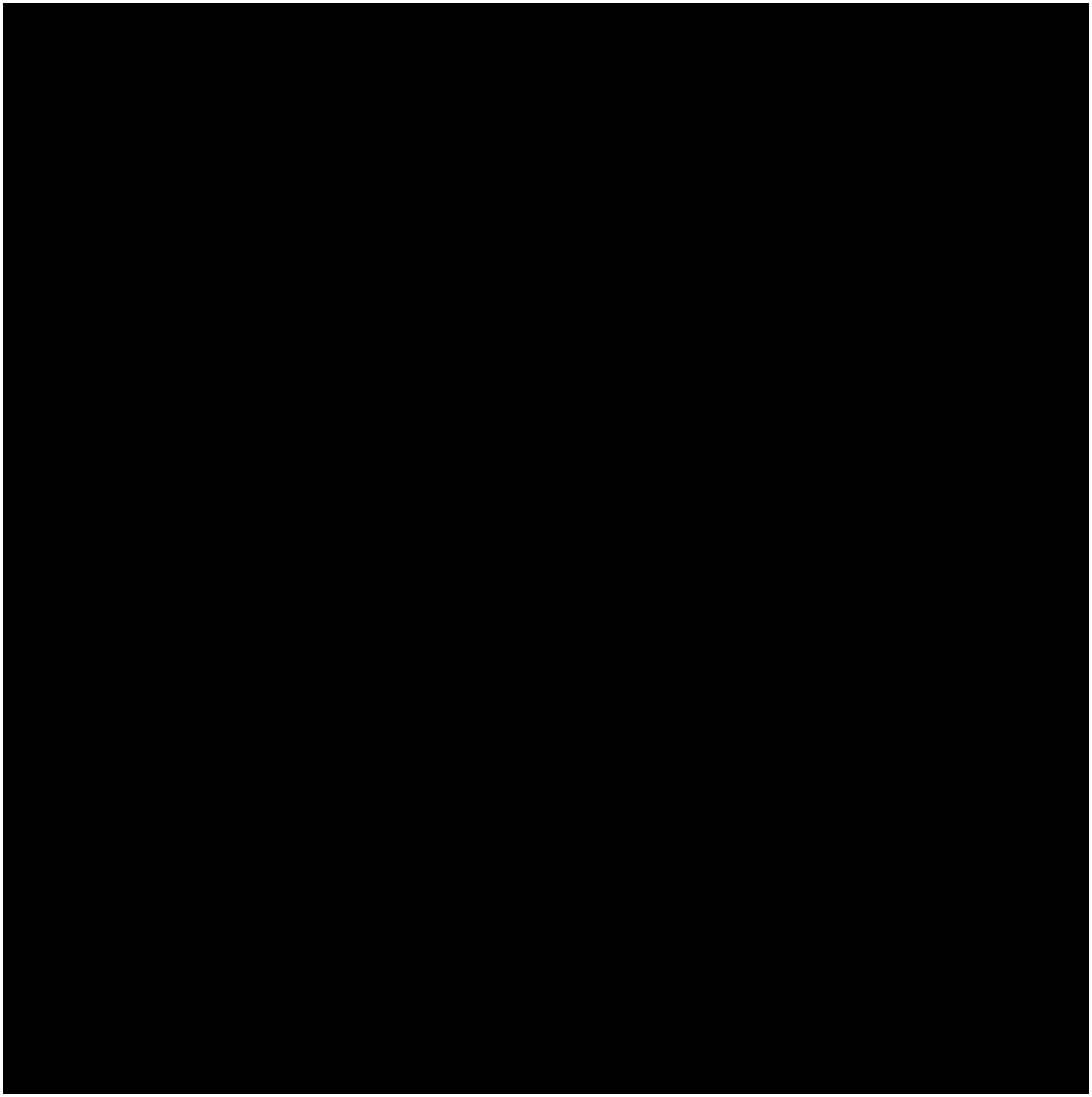
	GD3 Year 1	GD3 Year 2	GD3 Year 3	GD3 Year 4	GD3 Year 5
	Quantity	Quantity	Quantity	Quantity	Quantity
CIPS	206 Km	206 Km	206 Km	206 Km	206 Km
DCVG	50 Km	50 Km	50 Km	50 Km	50 Km
Current Attenuation Survey	20 Km	20 Km	20 Km	20 Km	20 Km
Scrub Clearance	21 km	21 km	21 km	21 km	21 km
Functionals / Majors / Interims	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys
Bond repair/ Replacement	8	8	8	8	8
Replacement of Anodes	676	452	452	452	452
Groundbed Replacement	6	4	4	4	4
TR Replacement	6	4	4	4	4
TR Kiosk Replacement	3	2	2	2	2
Repair of Insulating Flanges/Joints	1	1	1	1	2
Stray Current Monitoring	12	12	12	12	12
Repair/ Replace Test point	1030	540	510	540	570
Trial Holes	8	4	4	4	4
Coating defect repairs	13	9	10	10	9

10.2Asset Health Spend Profile

Table 14: Asset Health Spend Profile Table

Year	26/27	27/28	28/29	29/30	30/31
Spend (£m)	£5.17	£2.60	£2.51	£2.60	£3.30

91 Table 14 above shows the planned spend across GD3. The Spend will be at its highest in the first year of GD3 as we will still be in our recovery plan after the HSE's intervention.



10.3Investment Risk Discussion

Availability of Trained personnel and Contractors

92 The major risk associated with this work is the availability of contractors. This work will be split between SGN and appropriately qualified contractors. SGN trains all its CP Technicians to *ICOR level 2 (on Land buried Sector)* and Engineers working on CP are trained to *ICOR level 3*. All Contractors working for SGN on cathodic protection are required to have the same level of training. Individuals with this level of training are difficult to get and opportunities for training are limited. Following the Improvement notice form the HSE a lack of skilled technicians has been mitigated by SGN training its own personnel and the building of relationships with contractors who could skill up their personnel. With the recruitment and training described SSN will be able to deliver the preferred option.

Availability of Materials

93 The workloads described assume a ready supply of anodes, ground beds, transformer rectifier and other materials. These materials are in good supply but to mitigate this risk SGN has built up relationships with multiple suppliers.

More Coating Defects are Discovered

94 An estimate has been made as to how many coating defects will be discovered as part of SGN's CIPS program. It is possible that some older IP lines will have more defects than we currently expect. This risk has been considered small as the estimates for the number of defects is an average so the numbers should even out over time.

10.4Project Plan

95 Due to the nature of CP a detailed plan of works is difficult to produce. CP work and remediation covers a wide spread of work, form replacing individual CP points, replacing TR's and ground beds. This represents a high volume of low costs jobs. The workloads that we are going to undertake can be seen in Table 16 below.

Table 16: Work volumes by year Option 1 preferred option

	GD3 Year 1	GD3 Year 2	GD3 Year 3	GD3 Year 4	GD3 Year 5
	Quantity	Quantity	Quantity	Quantity	Quantity
CIPS	206 Km	206 Km	206 Km	206 Km	206 Km
DCVG	50 Km	50 Km	50 Km	50 Km	50 Km
Current Attenuation Survey	20 Km	20 Km	20 Km	20 Km	20 Km
Scrub Clearance	21 km	21 km	21 km	21 km	21 km
Functionals / Majors / Interims	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys	10621 Surveys
Bond repair/ Replacement	8	8	8	8	8
Replacement of Anodes	676	452	452	452	452
Groundbed Replacement	6	4	4	4	4
TR Replacement	6	4	4	4	4
TR Kiosk Replacement	3	2	2	2	2
Repair of Insulating Flanges/Joints	1	1	1	1	2
Stray Current Monitoring	12	12	12	12	12
Repair/ Replace Test point	1030	540	510	540	570
Trial Holes	8	4	4	4	4
Coating defect repairs	13	9	10	10	9

10.5 Key Business Risks and Opportunities

96 The major risks associated with this program of CP work and remediation are:

- The availability of appropriately trained technicians to undertake the work.
- The availability of materials and equipment.
- If when inspecting our CP systems, we find they have more coating defects than expected.

97 SGN's preferred option has considered the number of CP technicians that we can train and get from contractors. To be able to work on CP systems a technician must be qualified to *ICOR level 3*.

98 The second risk is that SGN cannot obtain all the materials required. The risk of this is low as SGN has mature relationships with suppliers.

99 The third risk is that we have underestimated the number the number of coating defects we will get from our CIPS and DCVG surveys. The estimate for the number of defects is based on prior experience and should even out.

10.6 Outputs Include in RIIO-GD2 Plans

100 This work represents a new workload with no carry over from GD2. As in GD2 this was part of our integrity work.

Appendix A – Acronyms

Acronym	Meaning
CP	Cathodic Protection
CIPS	Close interval Potential Survey
DCVG	Direct Current Voltage Gradient Survey
FY	Financial Year
GDN	Gas Distribution Network
HSE	Health and safety Executive
ICOR	Institute of Corrosion
IGEM	Institute of Gas Engineers and Managers
IP	Intermediate Pressure (>2bar – ≤7bar)
LP	Low Pressure (≤75mb)
MP	Medium Pressure (>75mb – 2bar)
PCS	Pipeline Compliance System
PSR	Pipeline Safety Regulations
PSSR	Pressure System Management Regulations
TR	Transformer Rectifier

Appendix B – References

Pipeline Safety Regulations (PSR) (1996).

Pressure System Safety Regulations (PSSR) (2000).

Health and Safety at Work Act (HASWA) (1974).

Dangerous Substances & Explosive Atmospheres Regulations (DSEAR) (2002).

IGEM/TD/3 – Steel and PE pipelines for Gas Distribution (2015)

SGN/PM/ECP/2 – Management Procedure for Cathodic Protection of buried Steel Systems (2023)

Appendix C – What is CP

Corrosion is an electrochemical process that converts a refined metal to a more chemically stable form, in the case of steel, an oxide (rust). It occurs when there is water and oxygen present and the metal is in an electrolytic substance such as water, soil or concrete. During this process, an area of the metal surface becomes an anode, and another area becomes a cathode. Electrons are released from the anodic area and travel to the cathode. Corrosion will only occur at the anode.

Cathodic Protection (CP) is a system used to maintain steel pipelines and prevent corrosion of buried assets. CP works, by making the asset (steel pipeline) the cathode in this process. This is either done by using sacrificial anodes or an impressed current system.

A sacrificial anode system works by introducing another metal to the system that will corrode in the place of the asset. This works if the sacrificial anode is made of a metal that has a higher negative potential, then the steel. This is usually zinc or magnesium.

In an impressed current system, anodes are connected to a direct current source which provides a source of electrical flow. Unlike the sacrificial anode system, the impressed current system requires less frequent inspections and provide a much longer life span for its ground bed. The impressed current system covers a much larger area and is the preferred method of CP according to IGEM/TD/3.

Without an adequate CP system in place, there is an increased chance of leakage occurring on our steel pipeline network, which can potentially cause disruption to supply and cause a major incident.

Stray current corrosion is caused by high voltage power lines running in parrel with a steel main inducing a current on the main. This results in rapid corrosion with metal loss rates between 10 and 1000 times greater than normal. The electric grid being upgraded means that SGNs Steel mains are at risk from stray current. SGN needs to monitor areas at risk from stray current corrosion.

SGN have 2,496 CP systems across the two networks (1,080 in Scotland and 1,416 in Southern).

The installation of a CP system would either take the form of a sacrificial anode system or an impressed current system. The choice is dependent on the size of the asset and the environment in which it needs protection e.g., resistivity of the soil, urban or rural area etc.