national gas transmission

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ENGINEERING JUSTIFICATION PAPER (EJP)

OFFICIAL- SENSITIVE

Pipeline Cathodic Protection

Version: 1.0

Issue: Final

December 2024

RIIO-GT3 NGT_EJP20

Contents

1 Summary Table

Table 1: Pipeline Cathodic Protection EJP Executive Summary Table

Name of Project	*Pipeline Cathodic Protection*		
Scheme Reference	NGT_EJP20_Pipeline Cathodic Protection_RIIO-GT3		
Primary Investment Driver	*Asset Health*		
Project Initiation Year	*FY27*		
Project Close Out Year	*FY31*		
Total Installed Cost Estimate (£)	Baseline: £43.4m Volume Driver: £25.6m **Total: £69.01m**		
Cost Estimate Accuracy (%)	+/- 10%		
Project Spend to date (£)	0		
Current Project Stage Gate	ND500 Stage 4.0		
Reporting Table Ref	6.4		
Outputs included in RIIO-T2 Business Plan	Yes		
Spend Apportionment (£m)	**RIIO-T2**	**RIIO-GT3**	**RIIO-GT4**
	0.56	67.74	0.71

2 Executive Summary

2.1.1 This paper proposes £69.01m of total funding (£43.4m baseline and a volume driver with an indicative value of £25.6m) to maintain the performance of our Pipeline Cathodic Protection (CP) assets to ensure the continued protection of National Gas Transmission (NGT) buried pipeline assets from corrosion. This is measured through an Asset Health – NARMS PCD.

2.1.2 This investment is linked with the Pipeline portfolio of works to manage pipeline integrity which are covered in a separate but linked EJP. Table 2 below table summarises the split of funding requested between this EJP and the associated EJP.

Table 2: Funding requested £m (2023/24)

EJP	Funding Request
This EJP (Pipeline- Cathodic Protection) – Baseline Request	43.4
This EJP (Pipeline- Cathodic Protection) –Volume Driver Request	25.6
Associated EJP (Pipeline)	77.7
Total	**146.7**

2.1.3 The primary driver for this investment is asset health to protect pipeline assets from integrity failure. We manage our CP assets with a cyclic regime of examination to identify defects followed by remediation interventions. 1,877 interventions and surveys of 5,324km are required to ensure stable network risk levels are maintained during RIIO-GT3.

2.1.4 The assets in this investment are Cathodic Protection systems. We have considered six types of intervention across the portfolio to address the asset health risk and achieve adequate levels of pipeline protection. In summary we are proposing the following intervention mix:

Table 3: RIIO-GT3 volumes proposed for Pipeline CP

	Replace Insulation Joint	Replace existing Transformer Rectifier	Replace existing CP test post	Close Interval-Potential Survey (CIPS) for Capital Refurbishment	CIPS remediation-New CP system	CIPS remediation-Excavation	Total
RIIO-GT3 volumes	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**1,877 and 5,324km**

2.1.5 In RIIO-T2 we have forecast delivery of 8714 interventions (5041km and 3673 interventions), a decrease from our final determination of 9305. This reduction is caused by a delayed start to the delivery of CIPS remediation activities due to an industry-wide shortage of CP system design resource which we have taken steps to address by training internal resource on CP system design in preparation for RIIO-GT3.

2.1.6 For RIIO-GT3, we are proposing to deliver a reduced volume but are prioritising investment to areas which have over polarisation issues by investing in adding supplementary CP systems. We are intervening on asset population following its cyclic programme. Given our historic delivery performance for CIPS remediation we propose a proportion of this work mix is subject to a volume driver.

Table 4: Comparison of RIIO-T2 vs RIIO-GT3

	RIIO-T2 Business Plan	RIIO-T2 Forecast Delivery	RIIO-GT3 Business Plan
Interventions	4264 and 5041km	2081 and 6633km	1,783 and 5,324km
Investment	[redacted]	[redacted]	[redacted]
Asset population	[redacted]	[redacted]	[redacted]

2.1.7 In delivering the proposed asset health works during RIIO-GT3, we can ensure future network risk levels are not compromised. We have high confidence that this can be delivered following the below profile:

Table 5: RIIO-GT3 funding request for Pipeline CP (£m, 2023/24)

	2026	2027	2028	2029	2030	2031	2032	Total
CIPS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	5.89
CIPS Remediation – CIPS Dig			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	35.27
CIPS Remediation – Install new CP system		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	24.70
Repair/ Replace existing CP test posts	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.53
Replace existing Transformer Rectifier	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	2.62
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**69.01**

3 Introduction

3.1.1 This EJP requests funding to undertake investment to manage our CP systems on the National Transmission System (NTS) for buried transmission pipelines to ensure that they are protecting the pipeline against corrosion.

3.1.2 Performance of Cathodic Protection systems directly correlates to the number of Pipeline Inspections and excavations required with a reduction in CP performance increasing the amount of reactive work required. It is in the interests of the consumer to ensure effective CP systems to reduce costly reactive excavations.

3.1.3 CP is installed along the length of every pipeline on the NTS as a secondary protection measure. The CP system applies a low electrical current to the steel pipeline to corrode a sacrificial element which is more electro-negative in preference to the pipeline. When the CP system is well managed, it prevents corrosion taking place at locations where the pipeline coating has failed.

3.1.4 This paper aims to seek investment so that we can carry out the below:

- Undertake Close Interval Potential Surveys (CIPS) to assess the performance of CP systems and identify defects requiring remediation to restore protection.
- Repair pipeline coating damage via excavation to reduce current loss.
- Install additional components to supplement the existing CP system to optimise pipeline protection.
- Replace existing CP system components as they become defective.

3.1.5 In RIIO-T2, we continued to undertake CIPS investigation following its cyclic programme. This allowed us to assess our CP systems functionality, check electrical current applied to the pipeline is within the acceptable limits and identify defects requiring remediation. We also continued optimising our CP systems by re-balancing the existing current sources where possible.

3.1.6 We commenced physical remediation of defects found during our CIPS investigations which took the form of repairs to damaged coating or the rectification of the CP system itself by applying additional current sources. The aim of both was restoring the correct electrical levels to the pipeline.

3.1.7 For RIIO-GT3, we are proposing a change in practises as to how we manage our CP assets. We propose targeted remediation based on geospatial analysis of protection levels offered by existing CP systems. The worklist in this EJP has been built based on an ongoing programme of inspections, combined with a review of the performance of our existing CP systems and analysis of existing defects. This provides better value to the consumer as we are reducing the number of costly excavations which are less effective in managing the CP system performance than applying additional current. **BAU Innovation**

3.1.8 The scope of this document is aligned with our Asset Management System (AMS) and relates to our *Meeting our critical obligations every hour of every day* and
Delivering a resilient network fit for the future Business Plan Commitments (BPCs). More information on our AMS and a description of our commitments is provided in our NGT_A08_Network Asset Management Strategy_RIIO_GT3 annex and our BPCs are detailed within our NGT_Main_Business_Plan_RIIO_GT3.

3.1.9 This EJP interacts with the NGT_EJP17_Pipeline_RIIO-GT3 submitted by NGT. Poor performing CP systems increases the funding required in the Pipeline EJP by increased volumes of corrosion defects.

4 Equipment Summary

4.1.1 This paper considers Cathodic Protection assets used for the protection of buried pipelines on the National Transmission System (NTS).

4.1.2 The CP system is comprised of the below components (explanation of their function is available in Appendix 1):

- Transformer Rectifier (TR)
- Cathodic Protection Test Post (CP TP)
- Sacrificial Anode
- Insultations Joints (IJ)

4.1.3 We have [redacted] We do not possess centralised data for the number of sacrificial Anodes of IJs and are working to collate records held to our core systems.

4.1.4 A diagram showing the typical arrangement of a CP system is shown in Figure 1.

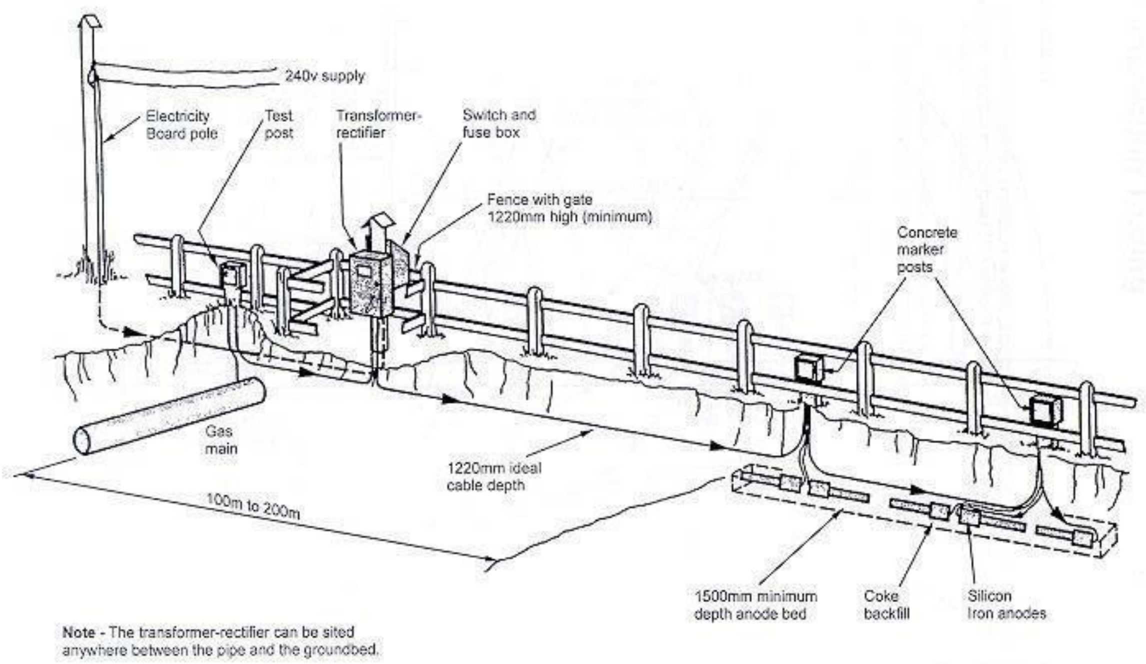


Figure 1: Layout of a typical Cathodic Protection System

4.1.5 Additional information in this equipment group such as the health score at the beginning and end of the price control and monetised risk are provided in the accompanying NGT_IDP06_Portfolio EJP Pipeline CP_RIIO-GT3.

5 Problem/Opportunity Statement

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

5.1.1 Coating systems are the primary protection for pipeline assets against corrosion. They are installed at the time of pipeline installation and naturally degrade over time, with an estimated a useful life of 40 years.

5.1.2 As the coating system degrades, the pipeline becomes un-protected and vulnerable to external corrosion. This causes damage to the pipeline and if left un-managed, results in integrity failure.

[redacted]

[redacted]

5.1.3 Where coating breakdown occurs, the CP system becomes the primary protection system to manage corrosion and maintain integrity of our pipelines. Interventions are required to ensure that CP systems continue to function and are continually optimised to meet with protection levels stated in internal policy T/PM/ECP/2.

5.1.4 Cathodic Protection systems lower the rate of corrosion to buried steel assets, thus prolonging the pipeline asset life. Our policies for managing corrosion set the range of pipe to soil polarised potentials as -1150mV and -850mV for effective Cathodic Protection.

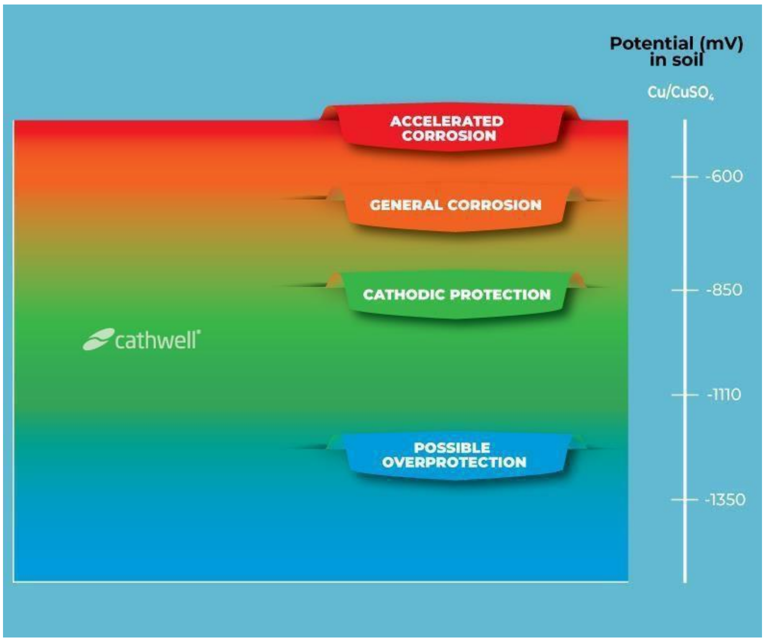


Figure 3: CP systems protection range

5.1.5 Readings outside of the effective range can mean that pipelines are not protected with the following classifications:

- **Under Protection:** Results in the buried steel pipeline being not satisfactorily protected and the development of corrosion and metal loss features.
- **Over Protection:** Results in damage to the coating system causing blistering or disbondment resulting in coating deterioration and an increase in the development of corrosion and metal loss features.

5.1.6 Cathodic Protection performance changes based on the age of the CP system and integrity of the pipeline. As coating breaks down on the pipeline, the system will require increased current density to maintain protection. Over time, current requirements will exceed the amount the CP system can provide so the CP system will reduce in effectiveness. The performance of a CP system is subject to continual change. We must monitor and react to this change to ensure optimal protection of our pipeline assets.

5.1.7 Historically we have aimed to achieve protection levels by re-balancing its systems in the first instance rather than physical intervention. We have increased the current applied to the systems over time which has resulted in a large proportion of our CP systems being over protected.

5.1.8 The drivers for this investment are summarised in Table 6. Further information on legislation can be found in Appendix 2.

Table 6: Categories of Driver for CP

Driver Category	Description
Legislation	Compliance with Pressure System Safety Regulations 2000 (PSSR) and The Pipeline Safety Regulations 1996 (PSR).
Industry Standards	Compliance with IGEM/TD/1 and ISO 15589-1:2015, Key element of demonstrating compliance with legislation noted above.
Risk Management	Cathodic Protection Systems significantly influence the integrity of our pipelines. With the changeable risks associated with managing buried pipeline assets we need to manage our CP assets accordingly. By continuing to collect CIPS data, we can proactively monitor the performance of our CP systems and the impact they have on NTS pipeline assets over time. With our non-internally inspectable pipelines, CIPS is our primary method of establishing asset condition.
Asset Deterioration	The performance of CP systems degrade over time as pipeline condition deteriorates the CP system must work harder to maintain protection levels. Ongoing management of CP systems involves assessment of performance and targeted remediation of coating defects or areas of under/over polarisation in-line with internal policy. Enhanced management of CP systems will result in the reduction of corrosion features.

5.1.9 If we do nothing, our pipelines will be placed under undue risk resulting in integrity issues that would result in loss of containment if left un-treated. A lack of spend on CP systems will require increased reactive spend on corrosion repairs as corrosion growth rates would increase and long term would be requiring unsustainable levels of remediation.

5.1.10 In preparation for RIIO-GT3, We have undertaken analysis with [redacted]. They have analysed our CIPS reports to holistically understand the performance of CP systems on the NTS to develop a series of interventions to remediate CIPS defects. The reports for this analysis are available in Appendix 4 in section 12.4.

5.1.11 Defects are currently classified in the below categories:

[redacted]

Defect Classification	Description
[redacted]	[redacted]

[redacted]	[redacted]

5.1.12 For this review, [redacted] were asked to consider the following elements:

- P1 and P2 defects.
- Locations of Over Protection.
- Locations of Under protection.
- Locations subject to stray current interference.

5.1.13 This piece of work reviewed our existing CIPS data to establish a baseline performance of our CP system and the location of defects. We were then able to simulate changes to electrical potential levels and assess the impact that would have on the protection levels and existing defects. This has enabled us to select the lowest cost remediation options to achieve optimum protection levels on a pipeline. The result of this analysis is available in Appendix 3 under reference 12.3.

5.2 What is the outcome that we want to achieve?

5.2.1 The outcome we are trying to achieve is the protection of our buried steel pipeline assets by the successful management of our cathodic protection systems.

5.3 How will we understand if the spend has been successful?

5.3.1 Successful spend within RIIO-GT3 is defined as identifying areas of under and over protection across our CP systems and remediating the defects identified to achieve CP system protection levels within the protected range. This will be measured in the CIPS report undertaken following CIPS remediation interventions.

5.4 Narrative Real-Life Example of Problem

5.4.1 The work that [redacted] has undertaken has allowed us to review the existing performance of our CP systems.

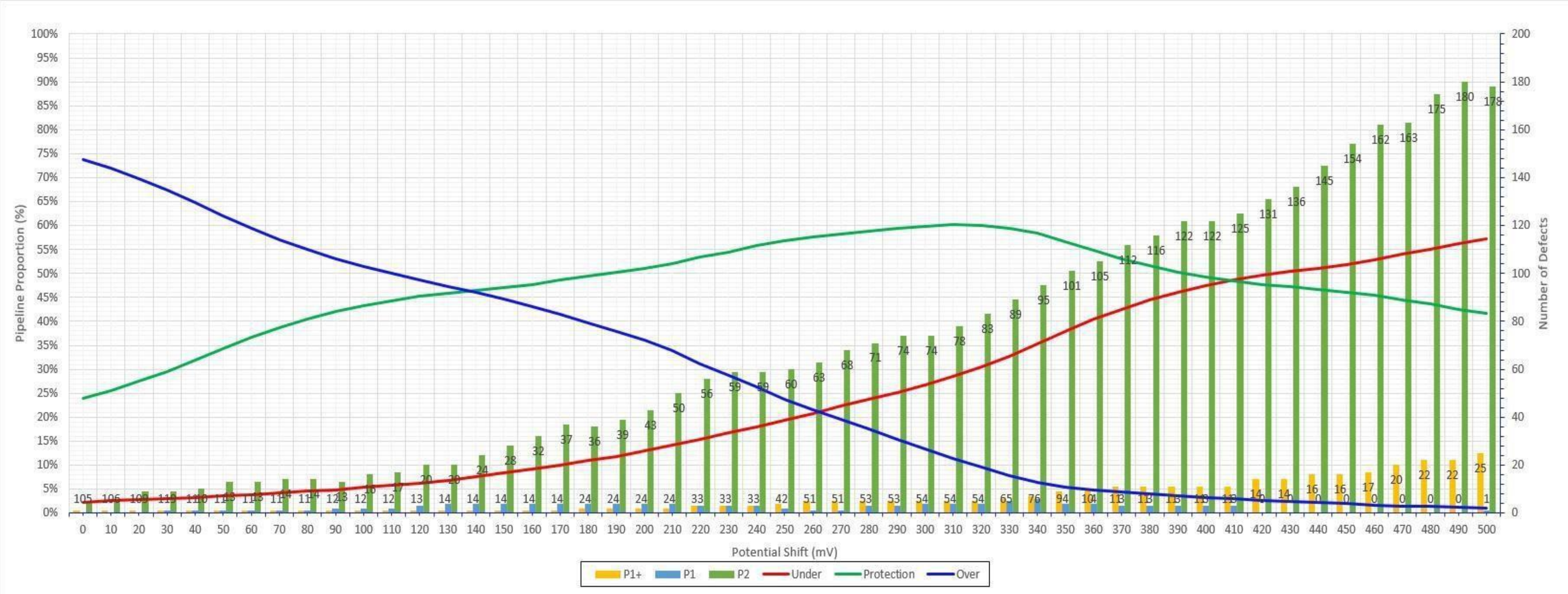
5.4.2 One of the results of this work is shown in Figure 4. This pipeline section is 64.5km in length. Based on the analysis, this results in the below pipeline protection status:

- Under Protected (Vulnerable to corrosion): 18.3km
- Protected within criteria: 38.8km
- Over Protected (Vulnerable to Coating Damage): 7.3km

5.4.3 We have undertaken this analysis to half of the NTS and aim to review the remainder during RIIO-GT3. The results of this show several aspects, including:

- High percentage of pipelines subjected to significant levels of Over Protection.
- Low number of P1 and P2 defects.
- Low percentage of pipeline route subjected to underprotection.

5.4.4 This piece of work has allowed us to understand its holistic CP system performance and target interventions to realise the greatest benefit using balancing and additional current sources to achieve protection levels. This is a shift away from previous assumptions of a CIPS defect being remediated by excavation having a 1:1 defect to intervention relationship. By carrying out this analysis, we will be more efficient in delivery of CIPS remediation activities and target interventions based on risk.



310	5	4	78	18,380 28.48%	38,826 60.16%	7,334 11.36%

Figure 4[redacted]

5.4.5 An example from outside of NGT which demonstrates the importance of manging CP protection is an incident which occurred in the United States. Mariner East 1 Pipeline in the United States had a significant leak in April 2017 due to Sunoco's failure to implement Cathodic Protection effectively.

5.4.6 The Public Utility Commission's Bureau of Investigation and enforcement determined that the cause of the leak was due to poor management of Cathodic Protection systems and the levels of protection on the pipeline did not meet official requirements for minimum protection. [1]

5.5 Project Boundaries

5.5.1 The spend in this EJP will cover assessments of the pipeline focussed on CP performance, repairs of pipeline coating and replacement or upgrade of CP systems or its components.

5.5.2 Not in scope for this investment:

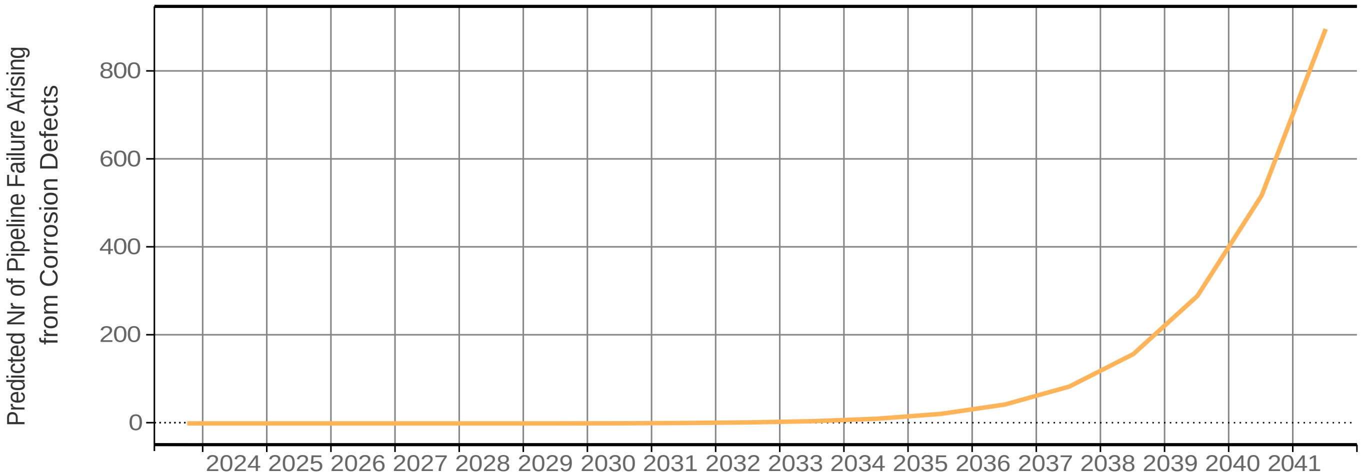
- Pipeline integrity inspections or interventions.
- CP systems located at Above Ground Installations (AGI) sites.

[1] https://stateimpact.npr.org/pennsylvania/2018/12/15/puc-panel-sees-statewide-concern-with-pipeline-corrosion-after-me1-leak/

6 Probability of Failure

6.1.1 Lack of investment in CP systems will result in increased risk for the pipeline assets as they would not be sufficiently protected from the effects of corrosion. This will lead to a growth in the volume of corrosion defects, reaching an eventual point of overwhelm and multiple integrity failures across the NTS.

Figure 5: Predicted number of failures from corrosion defects.



6.1.2 The above chart shows the impact of a lack of investment in CP systems and the pipeline integrity failures expected over time.

6.1.3 Utilising the analysis undertaken by [redacted] we can see that we have significant areas of our NTS pipelines experiencing Over or Under Protection. These areas will be experiencing ongoing damage to the pipeline asset until these levels are within the protection limits.

6.1.4 Table 8 includes a sample of 24 out of 69 of the NTS pipeline sections we have analysed. It shows the distances in which we are currently experiencing areas of under and over protection. The results for the remaining sections are provided in Appendix 4.

Table 8: [redacted]

[redacted]

Probability of Failure Data Assurance

6.1.5 The data from the above sections has been taken from a combination of sources both internally and externally. Internal operational data was used to undertake analysis of the CP sections which has been verified as accurate in accordance with our internal policies.

6.1.6 The model was produced by external supplier [redacted] These works were undertaken utilising our internal policies and industry standard documents shown below:

Table 9: Applicable Standard and Documents

Document	Document Title
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
ISO – 15589 – 1	Petroleum, petrochemical and natural gas industries – Cathodic protection of pipeline systems – Part 1: On-land pipelines
BS EN 12954	Cathodic Protection of Buried or Immersed Metallic Structures. General Principles and Application to Pipelines
BS 50162	Protection against corrosion by stray current from direct current systems

7 Consequence of Failure

7.1.1 The rate of corrosion defect growth, and hence likelihood of a leak or rupture, is strongly related to the condition of the pipeline. Therefore, failure of the CP system directly relates to an increased risk of overall pipeline failure.

7.1.2 In the event of a failure of our pipeline asset, this has a profound impact. The table below indicates the expected impacts due to failure of the pipeline assets.

Table 10: Consequence of Failure Summary

Asset	Impact / Consequence			
	Environment	Financial	Availability	Safety
Pipeline CP	The release of gas arising from a leak or rupture of the pipeline, caused by corrosion, would have a negative impact on the environment with Methane being 28 times more harmful than Carbon dioxide to the contribution of climate change.	There would be a significant financial impact of a large-scale failure or loss of service event. This could include loss of revenue, compensation, cost to repair the asset and fines.	The shut-down of a pipeline to repair a leak or rupture caused by corrosion requires outages which can result in loss of supply to customers. Dependant on the scale of loss of supply, this can have a knock-on impact on the wider economy such as industrial clusters being unable to manufacture and health impacts for people in high-risk groups.	A pipeline leak or rupture caused by corrosion is a significant safety concern. Where the pipeline passes near centres of population risk of ignition of the leak or rupture is relatively large.

8 Interventions Considered

8.1 Interventions

8.1.1 This section summaries the interventions we have considered to manage CP and provides an overview of how costs and scopes have been developed.

8.1.2 These interventions have been developed to comply with our internal policy for managing Cathodic Protection and in accordance with international standards for Cathodic Protection for on land pipelines - ISO 15589-1:2015.

Do Nothing (Counterfactual)

8.1.3 Doing nothing would mean not maintaining the existing CP systems. Without protection from CP the degradation of coating systems would result in increased corrosion events across the NTS. This would result in an increased number of In-Line Inspections and reactive interventions. Eventually this would become impossible to accommodate within pressure reductions/outages without compromising network availability.

8.1.4 This intervention has been ruled out as we would not be compliant with our statutory obligations as a responsible operator. The level of risk is not tolerable and would leave the NTS vulnerable to integrity failure.

CIPS for Capital Refurbishment

8.1.5 The completion of a cyclic programme of CIPS on a 10 year frequency allows us to take proactive measurements along the pipeline section to gather data to support understanding of the performance of the CP systems and resolve areas outside of compliance levels.

8.1.6 The benefit of this intervention is that the measurements allow us to assess whether pipeline sections are protected against corrosion and to identify defects which require remediation.

8.1.7 This can be delivered without impact on customers as no pressure reduction or outage is required.

CIPS Remediation – Excavation

8.1.8 Excavation to undertake repair to a location that has been identified as losing a significant amount of electrical current. Repair of the coating damage involves the application of an appropriate coating.

8.1.9 The benefit of this intervention is reinstatement of protection to the pipeline which reduces corrosion growth.

8.1.10 This intervention generally requires a pressure reduction to deliver.

CIPS Remediation - New CP System/Current source

8.1.11 Application of additional current to the system to protect the coating defects, negating the need to excavate and repair the coating.

8.1.12 This is typically possible on a section which is recorded as under-protected with multiple features within it or at the extremity of a TR's influence. This intervention cannot be used where additional current to meet protection levels would result in over protection as this would damage the coating further.

8.1.13 The benefit of applying additional current sources is an increase in the distributed current reaching the coating defects to meet protection levels. This results in the pipeline being protected from corrosion by resolving multiple defects using only one intervention.

8.1.14 This intervention generally requires a pressure reduction to deliver.

Replace TR

8.1.15 This is the like-for-like replacement of an existing TR. It is not possible to refurbish these assets.

8.1.16 These units fail and result in electricity outputs to be disrupted, such as no current at all or less current than required to meet with protection levels and power the CP system. TRs are identified as failed from measurements taken during CIPS, or during routine maintenance activities as the CP system will not be operational due to the TR not providing necessary power.

8.1.17 The benefit of this intervention is reinstatement of CP system functionality to protect the pipeline from corrosion.

8.1.18 No outage is required to deliver these. If a cable attached to the pipeline requires replacement at the pipeline side, this will require a pressure reduction to deliver.

Replace CP Test Post

8.1.19 This is the like-for-like replacement of an existing CP Test post. It is not possible to refurbish these assets.

8.1.20 Connections between the test post and pipeline deteriorate, or are damaged by third party activities, and become in-operable preventing the completion of CIPs surveys.

8.1.21 The benefit of this intervention is restoration of the ability to carry out CIPs surveys to gather measurements to understand CP system performance.

8.1.22 No outage is required to deliver these. If a cable attached to the pipeline requires replacement at the pipeline side, this will require a pressure reduction to deliver.

Replace Insulation Joint

8.1.23 The replacement of an existing Insulation Joint between two adjacent Pipeline CP sections, ensuring that two separate CP systems remain electrically separate. It is not possible to refurbish these assets.

8.1.24 IJs deteriorate and result in current leakage which negatively impacts the performance of both adjacent CP systems. This can make managing and maintaining compliance within the upper and lower limits more complex to achieve. It also increases the number of current sources which must be synchronously switched.

8.1.25 IJ failure also results in 'importing' interference/interaction from an adjacent scheme including AC onto a pipeline that may otherwise not be at risk.

8.2 Interventions Summary

8.2.1 Table 11 shows a summary of the interventions considered.

Table 11: Interventions Technical Summary Table

Intervention	Investment Design Life	Positive	Negative	Taken Forward	Reasons
Do Nothing	N/A	Low-Cost option in the short term.	Significant increase in corrosion risk and deterioration of the NTS will result in loss of containment failure events.	No	Unacceptable level of risk resulting in lack of compliance with statutory obligations.
CIPS for Capital Refurbishment	10-year	Obtain data on CP system performance to enable decision making on optimisation and remediation.	Requires specialist resource to deliver.	Yes	By undertaking measurements of CP system performance, we can reduce the risk of corrosion to our pipeline assets and optimise existing CP systems to achieve adequate pipeline protection.
CIPS Remediation - Excavation	40 year predicted design life.	Restores primary protection to the pipeline by restoring coating performance and therefore protecting against corrosion.	Repairs to pipeline coating system can often expand in length during excavation compared with the original CIPS defect due to the difference between the current loss feature found and discovery of wider failings of the coating system.	Yes	Protects pipeline from the effects of corrosion by restoring coating system functionality. Restoring performance to the CP system will reduce the number of ILI inspections and associated ILI digs required.

			Hard to predict impact remediation will have on CP system performance.		
CIPS Remediation – New CP System/ Current Source	Typical design life of 40 years.	In certain instances, can protect multiple CIPS defects in one remediation activity. This results in savings by reducing the need for multiple excavations.	Difficult to deliver due to power requirements, the need to install/ extend ground beds. Not always available as dependant on existing protection levels as adding too much current can result in over-protection damage to coating systems. Hard to predict impact remediation will have on CP system performance.	Yes	Where applicable, cost-effective solution for resolving multiple CIPS defects and protecting pipeline from risk of corrosion.
Replace existing TR	Typical design life of 20-25 years.	Restores functionality of the CP system to reinstate protection.	N/A	Yes	Replacement of existing equipment is required when it fails as it is an essential component that powers the CP system.
Replace existing CP Test Post	Typical design life of 40 years. Operational life often less due to third party damage.	Reinstates the ability to take measurements on the pipeline from ground level without requiring direct assessment	N/A	Yes	Replacement of existing equipment is required when it fails as it is an essential component to allow measurements of the pipeline asset to be carried out without excavating and exposing the pipeline.
Replace existing Insulation Joint	Typical design life of 40 years.	Electrical separation of two separate CP systems allows them to operate to intended performance levels. Without a function IJ both CP systems do not adequately protect the pipeline. Without the IJ turning off the CP system current to allow maintenance to be undertaken, safely is impacted.	Difficult to deliver as requires a full pipeline outage and the IJ section to be cut out and re-welded in place.	Yes	Replacement is necessary to maintain separation of CP systems and to ensure electrical safety of operatives working on pipeline assets.

8.3 Volume Derivation

8.3.1 Bottom-up volumes have been developed using a repeatable methodology for managing CP risk using data gathered during RIIO-T2. This has been validated by work undertaken by [redacted].

8.3.2 We have identified locations which are outside of our protection criteria and will resolve them using a combination of excavation and new supplementary CP systems. Interventions will be selected to ensure that we remain compliant with our statutory obligations whilst offering the lowest whole life cost.

8.3.3 The analysis provided different volumes of intervention based on scenarios. The scenarios tested by [redacted] are summarised in table 10 below and are taken from the [redacted] report available in Appendix 3. We have discounted Phase 1 and Phase 2 Level 4a due to the volume of work being undeliverable and the cost associated with the volume of work recommended. We have selected the option highlighted in green in table 10 below for submission as it provides stable risk whilst remaining deliverable.

Table 12: Scenarios tested and impact upon intervention volumes.

Scenario Name	Description of Scenario	Volume of CIPS digs proposed in RIIO-GT3	Volume of New CP systems proposed in RIIO-GT3
Phase 1	Development of a suitable CIPS data screening process to provide us with a detailed list of CP defects attributed to all pipelines within the study.	4894	188
Phase 2 Level 4a	Detailed screening of data, to establish refined list of interventions, via establishing 'assumed' TR influence sections and simulating potential changes in data sets.	848	33
Phase 2 Level 4b	As per Level 4a but including further scrutiny of CIPS data to enable review of pipeline route should additional TR and ground beds be installed. Identifying locations for TR installation and simulation of their influence.	209	66

8.3.4 The below figure shows the approach that we have taken to develop the volumes for CIPS remediation. The triangles on the pipeline represent an identified CIPS defect. Where we have multiple defects or an area of Under-protection on a CP section, we have grouped these together to intervene on multiple defects with one investment as opposed to multiple excavations and the associated expense that brings.

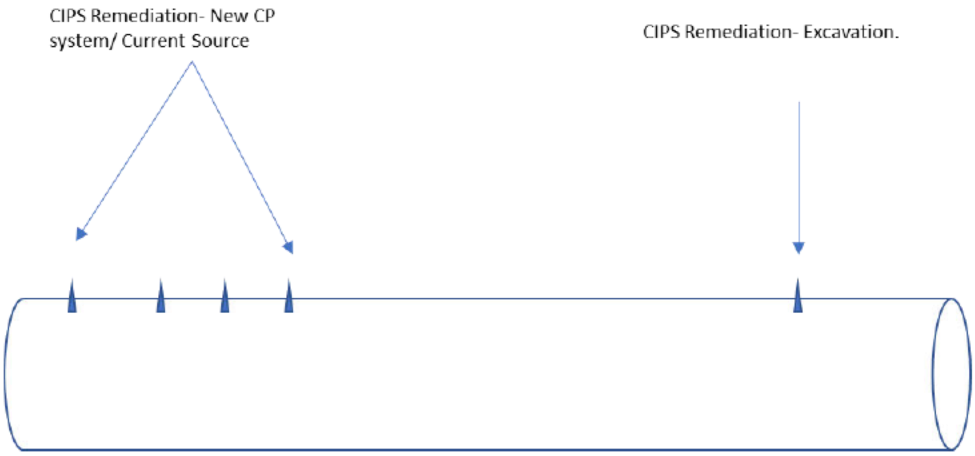


Figure 6: Our approach to CIPS remediation

8.3.5 The analysis used to develop these volumes has allowed us to select a package of works and understand the impact that it will have on the performance of the pipeline CP system. The benefit of the analysis is that we can understand how changes in the levels of electrical potentials can impact on the CP system performance without physically having to carry out works before assessing the impact, saving time and cost.

8.3.6 This will allow us to re-balance our existing CP systems to resolve existing over/under protection levels and then apply supplementary current where required to achieve adequate protection during RIIO-GT3.

8.3.7 Remediating CP systems is an iterative process. The below figure shows how this operates.

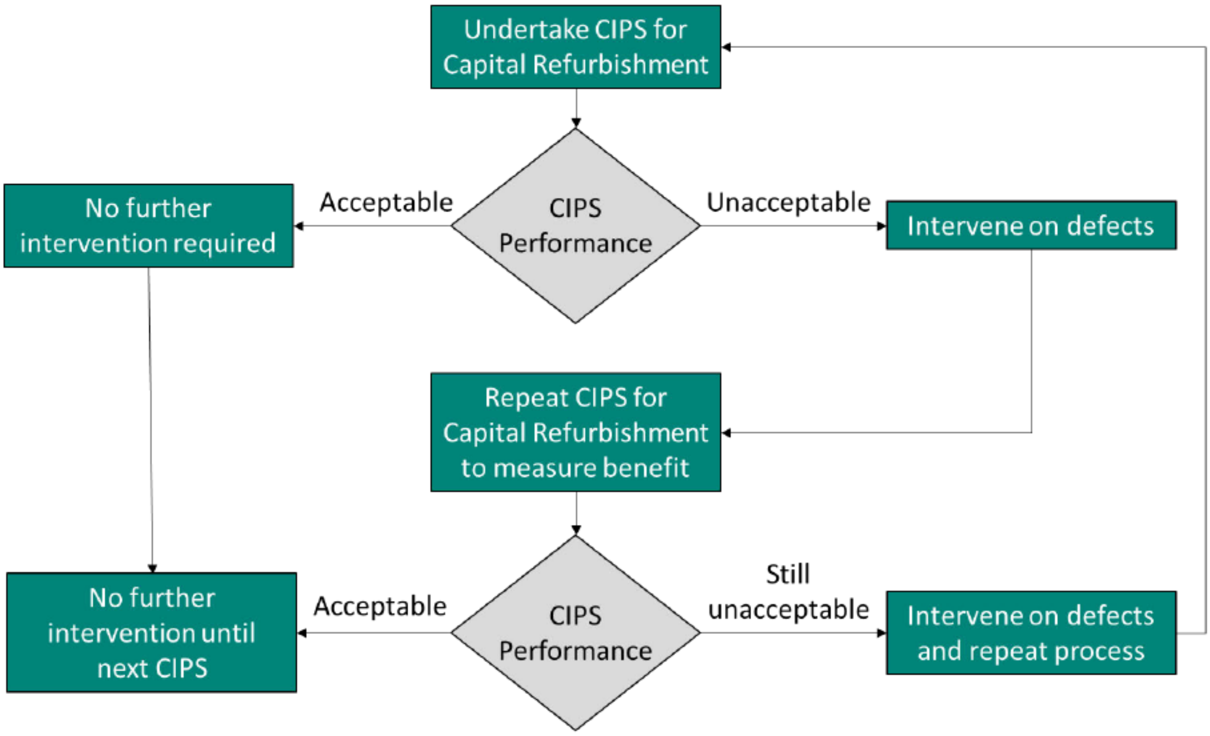


Figure 7: Iterative CP remediation process

Table 13: Development of bottom-up volumes for RIIO-GT3

Investment Name	Volume	Unit of Measure	How this has volume been developed?
CIPS for Capital Refurbishment	5324km	Per km	Interrogate internal records to locate CIPS due within RIIO-GT3. These are undertaken on a 10 year frequency to meet with standards set in ISO 15589-1:2015.
CIPS Remediation - Excavation	209	Per project	Initially we reviewed historic CIPS reports and defects to forecast based on historic events. This was not an appropriate method as CIPS defects do not have a 1:1 defect to remediation relationship and this resulted in a volume of excavations that would be higher than needed. We have worked with [redacted] to analyse our existing CP system performance data and simulate the impact of interventions on CP System performance. This has given us targeted interventions to optimise our CP systems for the minimum level of spend. This work is available in Appendix 4.
CIPS Remediation – New CP System/ Current Source	66	Per project	We have developed these investments with [redacted]. The model that has been produced allows identification of sections in which there are multiple CIPS defects located within an area of under-protection. These instances have been built into investments to apply additional current to the pipeline via installation of a new CP system to protect these defects from growing. This work is available in Appendix 4
Replace existing TR	130	Per asset	Run rate created based on volume of defective TRs using defect data and existing failure rates.
Replace existing CP Test Post	1450	Per asset	Run rate created based on volume of defective CP Test Posts using defect data and existing failure rates.
Replace existing Insulation Joint	22	Per asset	Volume has been created by identifying all pipeline sections which have defective IJs (Pre 1980 pipelines recorded as low resistance) and identified when these are expected to have pipeline outages in RIIO-GT3. The volume for replacement of existing Insulation Joints interventions has been developed with assumptions on age and CP performance classification

8.3.8 The volumes have been selected using a standardised repeatable methodology using data from our centralised core systems.

8.4 Unit Cost Derivation

8.4.1 Costs have been derived using a robust methodology using known data for activities which share the scope with the interventions within this EJP.

Table 14: Intervention Unit Cost Summary Table (£, 2023/24)

Intervention	Unit of Measure	Unit Cost	Cost Accuracy	Number of Data Points	Source Data
CIPS for Capital Refurbishment	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
CIPS Remediation - Excavation	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
CIPS Remediation – New CP System/ Current Source	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Replace existing TR	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Replace existing CP Test Post	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Replace existing Insulation Joint	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Cost derivation example

8.4.2 A specific example of the cost derivation is CIPS Remediation- New CP system. This has been derived using estimate at completion costs received from a supplier. This takes [redacted] for the installation of new CP systems at typical installation locations. Uplifts are then applied for design and landowner costs to obtain access to the land. This intervention has high complexity to cost estimate due to the iterative nature of CIPS remediation and the unknown nature of how many Transformer rectifiers are required to overcome defects, so [redacted] has been applied.

8.4.3 A breakdown of costs for this EJP is provided in Appendix 6.

9 Options Considered

9.1 Portfolio Approach

9.1.1 In developing our plans and making our decision we have been cognisant of the need to develop plans that are value for money and deliverable, whilst achieving a suitable level of risk of our aging assets. In considering the most effective combination of interventions, we have challenged whether our preferred programme of investments is the most cost-beneficial by carrying out a full Cost Benefit Analysis (CBA) utilising our Copperleaf Portfolio Optimisation tool.

9.1.2 In line with HM Treasury Green Book advice and Ofgem guidance we have appraised whether investment in Pipeline Cathodic Protection across the RIIO-GT3 period is value for money by assessing the benefit over a 20-year period in the CBA.

9.1.3 Whilst this EJP has focused on our investment in Pipeline Cathodic Protection, our business case has been assessed across our entire pipeline portfolio. The asset interventions within the Pipeline Cathodic Protection and Pipeline EJPs have been combined to form this Portfolio Approach. This is consistent with the approach we took in RIIO-T2.

9.1.4 We have utilised engineering assessment as described in the previous chapters to derive intervention volumes. Each investment has been assessed using the Ofgem-approved NARMs Methodology, which is embedded within Copperleaf, which calculates both the monetised risk reduction and the Long Term Risk Benefit (LTRB).

9.1.5 By using the NARMs Methodology, we can quantify the impacts of each investment across Service Risk Measures, all of which are reported in the NARMs Business Plan Data Table.

9.1.6 Under the current process for NARMs, only one intervention is assessed per asset. Therefore, a single CBA has been done for pipelines which covers both this EJP and the NGT_EJP17_Pipeline_RIIO-GT3.

9.1.7 Of all the interventions proposed on our pipeline, the benefit of some cannot be modelled (e.g., replacement of Pipeline Insulation Joint). From the interventions where it is possible to model a benefit, a choice had to be made of which to represent in the CBA. This has resulted in the selection of one portfolio option across the pipeline portfolio, to meet the investment drivers defined within the problem statement, business plan commitments and consumer priorities.

9.1.8 This portfolio option presents the minimum work required to achieve compliance with legislation.

9.1.9 Another challenge for the CBA is that although we have ~640k of pipelines assets (each representing a 12m section of pipeline), each carries a relatively small amount of individual risk. In modelling terms, a dig following an ILI would have a small benefit for the section it was carried out upon compared to doing nothing. This benefit is negligible however when compared against the benefit of replacing a CP system which benefits hundreds to thousands of sections. We are only able to model the benefits as a pipeline portfolio of work using CP replacement as the modelled intervention in the CBA for our pipeline asset.

9.1.10 Intervention benefits are valued based on changing the input parameters of these calculations to determine the benefit to individual pipelines of different types of interventions. For instance, a CIPs dig would decrease a metal loss defect size and increase the cathodic protection experienced by a pipeline against the do nothing position.

9.1.11 A table summarising pipeline interventions considered in NGT_EJP17_Pipeline_RIIO-GT3 and Pipeline Cathodic Protection EJP which have parameters in the model that can be varied to correspond to benefits can be found in Appendix 5.

9.2 Options

9.2.1 Due to the process of NARMs methodology used to assess benefits of each intervention on our assets, we are only able to assess the benefits of carrying out CIPS Remediation interventions via CP replacement in our analysis. This approach is documented in section 9.1.

9.2.2 Pipeline assets are modelled in 12 metre sections with a risk value and asset intervention option applied to its respective 12 metre section. A limitation of our pipelines model is that we are unable to assess multiple interventions per section. With ~640k pipeline assets in our decision support software, viewing the results of multiple intervention options at 12 metre sections provides 6.4 million potential solutions. The most cost beneficial interventions to achieve legislative compliance has been chosen at an asset level and the results presented at a portfolio level.

9.2.3 As a result of the above, we are unable to evaluate multiple portfolio options in line with other Asset Health EJPs and have taken the decision to present a portfolio view across Pipelines.

Option 1: Total Monetised Risk Stable to RIIO-T2 Start

9.2.4 In this option we have constrained the overall level of NARMS risk at the end of the RIIO-GT3 period to remain consistent with the levels of risk at the start of the RIIO-T2 period. Individual NARMS service risk measures are not individually constrained, however overall risk outcome is. We have modelled the costs and benefits of carrying out CP replacements proposed in the Pipeline Cathodic Protection EJP as that is the only intervention with variable parameters that are adjustable to reflect benefits.

9.2.5 The total spend of proposed interventions in this option is £146.69m (2023/24) which includes the options presented in this EJP and NGT_EJP17_Pipeline_RIIO-GT3. All investments making up the £146.69m portfolio option are shown in Table 15 which is available in Appendix 6.

9.2.6 This option maintains compliance with legislation and achieves stable risk. No additional investment is proposed through our Predictive analytics model.

9.2.7 The proposed intervention volumes and the associated spend for this option that can be modelled are shown in Table 15 table which the CBA analysis is based on. We are unable to model the other interventions which make up this portfolio of works, so they have not been included within the below table.

Table 15 Option 1 Summary (£m, 2023/24)

Intervention	Volume	RIIO-GT3 Value
CIPS for Capital Refurbishment	[redacted]	[redacted]

9.2.8 Risk scenarios such as + or - 10% risk levels provided in other Asset Health EJPs is not applicable in Pipelines portfolio due to limitations described in section 9.1. This is consistent with how we presented our pipeline portfolio investments in RIIO-T2.

9.3 Options Summary

9.3.1 The below presents the technical summary table for the portfolio option presented.

Option	First Year of Spend	Final Year of Spend	Total Volume of Interventions	Investment Design Life	% of Assets Intervened On	Total Spend Request
Total Monetised Risk Stable to RIIO-T2 Start	FY27	FY31	[redacted]	40 years	[redacted]	146.69

Table 16: Options Technical Summary Table (£m, 2023/24)

9.3.2 The options presented within this portfolio of works are shown in the below table. The highlighted green shows the intervention options which make up this EJP. The CBA is modelled using the spend request which comprises of the below.

Table 17: Portfolio intervention breakdown

Intervention	First Year of Spend	Final Year of Spend	Volume	Investment Design Life	[redacted]
In Line Inspection (Pipeline PSSR Inspection)	FY27	FY31	[redacted]	40 years	[redacted]

Intervention	First Year of Spend	Final Year of Spend	Volume	Investment Design Life	[redacted]
In Line inspection Defect Digs	FY27	FY31	[redacted]	40 years	[redacted]
OLI/4 (Pipeline PSSR Inspection)	FY27	FY31	[redacted]	40 years	[redacted]
OLI/4 Pipeline Defect Remediation	FY27	FY31	[redacted]	40 years	[redacted]
CIPS for Capital Refurbishment	FY27	FY31	[redacted]	10 years	[redacted]
CIPS Remediation - CIPS Dig	FY27	FY31	[redacted]	40 years	[redacted]
Replace Insulation joint- Pipeline to Pipeline	FY27	FY31	[redacted]	40 years	[redacted]
Replace existing Transformer/Rectifier	FY27	FY31	[redacted]	40 years	[redacted]
Repair/replace existing CP Test posts	FY27	FY31	[redacted]	40 years	[redacted]
Easement Reinstatement Campaign (Scrub Clearance)	FY27	FY31	[redacted]	40 years	[redacted]
CIPS Remediation - Install new CP system/system Item	FY27	FY31	[redacted]	40 years	[redacted]
Legacy Flow Stop Device Investigation	FY27	FY31	[redacted]	40 years	[redacted]
Legacy Flow Stop Device Remediation	FY27	FY31	[redacted]	40 years	[redacted]
Easement Reinstatement Campaign (Tree Clearance)	FY27	FY31	[redacted]	40 years	[redacted]
Bacton Road Crossing- Integrity Inspection	FY28	FY30	[redacted]	40 years	[redacted]
Total					**146.69**

10 Business Case Outline and Discussion

10.1 Key Business Case Drivers Description

10.1.1 We have considered how the recommended approach to managing Cathodic Protection aligns with the following drivers for investment:

- Continued compliance with legislation to ensure that we adequately inspect our pipelines and validate their safe continued usage.
- Ensure Cathodic Protection systems are managed in accordance with ISO-15589 standards.
- Protect members of the public and the environment from a loss of containment event.
- Protect long-term integrity of our pipeline assets to ensure a continued supply of service.
- Providing value to consumers by targeting intervention based on bundling of adjacent CIPS defects to maximise risk reduction and provide lowest cost intervention.

10.2 Business Case Summary

10.2.1 We has a duty to comply with Regulation 12 of PSSR legislation. This states we must keep our high-pressure gas pipelines properly maintained in good repair to prevent danger. Our investment proposed in this paper maintains statutory compliance whilst striking an appropriate balance between tolerable risk and value for money for consumers.

10.2.2 By undertaking analysis on our CP systems to geospatially understand performance, we have presented the lowest-cost option whilst adequately protecting our NTS from the threat of corrosion.

10.2.3 We have appraised our suggested investment activity using the NARMs methodology which confirms that the option of surveying and targeted remediation is the lowest cost option to maintain compliance. The CBA results are shown in the below table.

Table 18: Business case metrics of options

Option	Total Volume of Interventions	% of Assets Intervened On	Total Spend Request	PV Costs	PV Benefits	NPV	CB Ratio	Payback Period (from 2031)
Total Monetised Risk Stable to RIIO-T2 Start	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	9 years

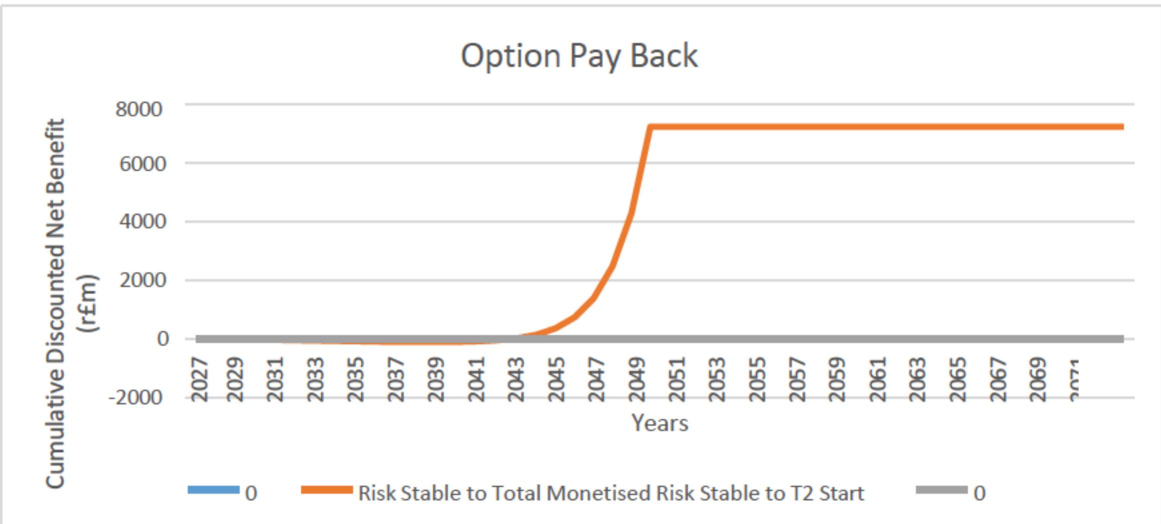


Figure 8: Graph showing Payback of options.

10.2.4 As can be seen above, the options put forward in this EJP offer a positive return for investment and meets with International Standards ISO-15589 for managing CP systems, maintains statutory compliance with PSSR legislation and internal policies for maintaining CP assets.

10.2.5 The investment proposed across this portfolio will pay back in 2044.

10.2.6 We have proposed the investment within this EJP is funded via baseline for £38.5m. We also propose a new volume driver with an indicative value of £36.6m. This is to account for funding that we require to undertake CIPS remediation interventions above the delivery rate we have achieved in RIIO-T2.

Table 19: Business case metrics of options (£, 2023/24)

Option	Total Volume of Interventions	Total Spend Request	Outcome Risk End of RIIO-GT3	% change in comparison to start of RIIO-T2	PV Costs	PV Benefits	NPV	CB Ratio	Payback Period from 2031	% change in service risk measures compared to start of RIIO–T2				
										Financial	Health and safety	Environmental	Availability Reliability	Societal
Option 1A: Risk Stable to RIIO-T2 Start	5,324km	[redacted]	[redacted]	[redacted]	25,403.61	25,341.61	25,341.61	409.69	9 years	101.26%	111.34%	119.68%	133.04%	115.75%

11 Preferred Option Scope and Project Plan

11.1 Preferred Option

11.1.1 The preferred option to manage the CP system performance on the is Total Monetised Risk Stable to RIIO-T2 Start which includes the mixture of interventions listed in the below Table 20.

Table 20: Pipeline Cathodic Protection RIIO-GT3 preferred option summary (£m, 2023/24)

Intervention	Primary Driver	Volume	Unit of Measure	% Assets Intervened Upon	RIIO-GT3 Cost	Funding Mechanism	PCD Measure
CIPS for Capital Refurbishment	Asset Health Legislation	5,324km	Per KM	[redacted]	[redacted]	[redacted]	NARMS
CIPS Remediation - Excavation	Asset Health Legislation	95 Baseline 64 Volume Driver	Per Project	[redacted]	[redacted]	[redacted]	NARMS
CIPS Remediation – New CP System/ Current Source	Asset Health Legislation	26 Baseline 18 Volume Driver	Per Project	[redacted]	[redacted]	[redacted]	NARMS
Replace existing TR	Asset Health Risk Management	77 Baseline 53 Volume Driver	Per Asset	[redacted]	[redacted]	[redacted]	NARMS
Replace existing CP Test Post	Asset Health Risk Management	863 Baseline 587 Volume Driver	Per Asset	[redacted]	[redacted]	[redacted]	NARMS
Replace existing Insulation Joint	Asset Health Risk Management	0	Per Asset	[redacted]	[redacted]	[redacted]	NARMS
Total		**1,783 and 5,324km**		[redacted]	[redacted] [redacted]	[redacted] [redacted]	

11.1.2 The work mix has been identified as being required to maintain stable risk and ensure that CP systems continue to offer required protection. We have elected to submit a proportion of this work mix as volume driver due to the lag in RIIO-T2 between CIPS result analysis and conversion to remedial activities resulting in delivery delays. Whilst we have taken steps to recruit and develop internal resource to mitigate this delay occurring in RIIO-GT3, submitting as a volume driver reduces this risk being borne by the consumer.

11.1.3 For Insulation joint replacements, we have identified a need to replace defective IJs but are unable to identify how many will require replacement in RIIO-GT3. We propose to request a volume driver for this activity to repair these on a fix on failure basis.

11.1.4 It should be noted that the total value in this EJP differs from the value in the CBA. This is due to some investment not able to be modelled as described in section 9.1.

11.1.5 The outputs from this investment will be included in the Asset Health – NARMS PCD reporting mechanism, and cost variance managed through the TIM mechanism.

11.2 Asset Health Spend Profile

11.2.1 The below [redacted] provides an indicative view on when the above interventions are to be carried out. The reason for the significant increase in work from 2029 onwards is due to the remediation interventions from surveys undertaken in 2027 and 2028.

[redacted]

11.3 Investment Risk Discussion

11.3.1 The risk of not being able to deliver the volume of work is small. Within RIIO-T2 we have increased internal resource trained to understand Cathodic Protection management principles to resolve lack of delivery of CIPS remediation interventions in RIIO-T2.

11.3.2 To mitigate against this for RIIO-GT3, we have split our CIPS remediation proposals between baseline funding to the value we have delivered within RIIO-T2 and volume driver for spend above this value.

11.3.3 We have established delivery partners who are effective at remediation of CIPS defects. Replacement of electrical equipment can be undertaken without a pipeline outage meaning it can be carried out year-round.

11.3.4 The long lead time associated with pipeline Insulation joints has been mitigated by carrying common pipeline IJ sizes as part of our strategic spares inventory.

11.3.5 Our costs have been built through unit cost analysis and estimates from the market, however there is a risk that costs of materials may increase due to macro-economic conditions and customer and stakeholder demand. This shall partly be mitigated through the CPI-H inflation and real price effect mechanisms within our RIIO-GT3 regulatory framework.

11.4 Project Plan

Project delivery has been split into three phases which align with our Network Development Process (ND500) as follows. Commissioning dates are not relevant to all intervention types but take place at the end of the delivery phase.

Table 21: Delivery phase alignment with ND500

Delivery Phase	ND500 Stage Gate(s)
Preparation	T0, T1, F1 (Scope establishment), T2, F2 (Option selection), T3, F3 (Conceptual Design Development and Long Lead Items Purchase), T4
Delivery	F4 (Execute Project), T5, Available for Commercial Load (ACL), T6
Close Out	F5 (Reconcile and Close)

11.4.1 The below table shows the summary plan and provisional delivery phases for AC Corrosion Management sanctions within RIIO-GT3. Internal stakeholder engagement has identified when we can obtain network access, where required, to complete these works.

Table 22: Pipeline Portfolio Programme for RIIO-GT3 period

Sanction/Intervention	RIIO-T2		RIIO-GT3					
	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32
T3_Pipelines_CP Remediation								
T3_Pipelines_FY27								
T3_Pipelines_FY28								
T3_Pipelines_FY29								
T3_Pipelines_FY30								
T3_Pipelines_FY31								

11.4.2 The work has been profiled based on a deliverability assessment across the whole RIIO-GT3 plan. We have profiled the investment to ensure the enhanced ILI interventions match with the in-line inspection programme to avoid duplication.

11.1 Key Business Risks and Opportunities

11.1.1 Future changes to the NTS such as repurposing existing pipelines for the introduction of Hydrogen will increase the risk to the remaining methane network. Having effective CP systems will reduce this risk.

11.1.2 Any changes to system operation or supply and demand scenarios will not impact upon the outcome of this justification paper.

11.2 Outputs included in RIIO-T2 Plans

11.2.1 There are no outputs from RIIO-T2 plans to be included within RIIO-GT3. Within RIIO-T2, we will complete all interventions required to remediate CIPS defects.

12 Appendices

12.1 Appendix 1 - Equipment Description

- Transformer Rectifier (TR)- Provides Direct Current (DC) to power the CP system.
- Cathodic Protection Test Post (CP TP)- Connection to the pipeline to enable readings to be taken to ensure that the CP system is functional and operating within defined limits.

Figure 10: CP Test Post (Left) and Transformer Rectifier (Right)

- Sacrificial Anode –A component made from weaker metal than the pipeline. The corrosion reactions are transferred from the pipeline to the sacrificial anode causing it to degrade and protecting the pipeline.
- Insultations Joints (IJ)- Electrically separates two CP Sections at the point in which they meet to allow effective management of them. An example of this could be to electrically separate a river crossing section from a pipeline section or differing coating types. This paper considers Insulation Joints between pipeline CP sections and not where the pipeline meets a NGT Site.

Figure 11: Insulation Joint on a above ground pipeline (Not NGT asset)

12.2 Appendix 2 - Legislation Detail

Title/ Definition	Description
Pressure System Safety Regulations 2000 (PSSR)	Legislation for all pressure vessels and mandates the requirement for a regime of inspection and subsequent remediation of defects to ensure the system is in good repair to prevent danger.
The Pipeline Safety Regulations 1996 (PSR)	Specific legislation for those operating pipelines and places the obligation to manage the safety risks that they present to members of public and NG staff
IGEM/TD/1	The internal/external inspection and subsequent remediation of pipeline defects or "features" to industry standards (IGEM TD/1), supplemented by NG policies and procedures is accepted by the Health and Safety Executive as an appropriate way of operating a safe pipeline network and complying all relevant legislation.
ISO 15589-1:2015	International Standards for the use of Cathodic Protection system for on-land pipelines. These standards have been adopted by operators Worldwide and provide guidance on evaluation, assessment, and remediation methods that NGT has adopted into its management practises.

[redacted]

12.4 Appendix 4 - Parameters changed on Copperleaf for modelling pipeline interventions proposed in Pipeline EJP and Protection Cathodic Pipelines EJP

	Copperleaf Parameter Name					
Intervention	Number of Metal Loss Defects	Maximum Depth of a Metal Loss Defect	Depth of Pipe Burial	Number of Repair Casings	CIPs Off Potential	Number of Impact Protection Slabs
ILI Dig And Shell Installation				Set to 1		Set to 1
CIPS Dig and Repair					Set to -1250	
CP Replacement					Set to -1250	
ILI Dig And Repair	Set to 0	Set to 0				

12.5 Appendix 5 - Bottom Up Intervention Volumes

The below table shows the bottom up intervention volumes included in the CBA options. Those highlighted have been discussed in this EJP.

Table 23: Bottom up intervention volumes and value for pipeline portfolio.

Intervention	First Year of Spend	Final Year of Spend	Volume	Investment Design Life	Total Spend request
In Line Inspection (Pipeline PSSR Inspection)	FY27	FY31	72	40 years	[redacted]
In Line inspection Defect Digs	FY27	FY31	160	40 years	[redacted]
OLI/4 (Pipeline PSSR Inspection)	FY27	FY31	35	40 years	[redacted]
OLI/4 Pipeline Defect Remediation	FY27	FY31	23	40 years	[redacted]
CIPS for Capital Refurbishment	FY27	FY31	5324km	10 years	[redacted]
CIPS Remediation - CIPS Dig	FY27	FY31	159	40 years	[redacted]
Replace Insulation joint- Pipeline to Pipeline	FY27	FY31	0	40 years	[redacted]
Replace existing Transformer/Rectifier	FY27	FY31	130	40 years	[redacted]
Repair/replace existing CP Test posts	FY27	FY31	1450	40 years	[redacted]
Easement Reinstatement Campaign (Scrub Clearance)	FY27	FY31	253	40 years	[redacted]
CIPS Remediation - Install new CP system/system Item	FY27	FY31	44	40 years	[redacted]
Legacy Flow Stop Device Investigation	FY27	FY31	5	40 years	[redacted]
Legacy Flow Stop Device Remediation	FY27	FY31	2	40 years	[redacted]
Easement Reinstatement Campaign (Tree Clearance)	FY27	FY31	185	40 years	[redacted]
Bacton Road Crossing- Integrity Inspection	FY28	FY30	1	40 years	[redacted]
Total					**146.69**

12.6 Appendix 6 - Cost Breakdown

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]