Engineering Justification Paper: EJP12

Pipeline Integrity

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CADENT - CONFIDENTIAL

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1 Summary Table

Pipeline Integrity	HP Pipeline Interventions		
Primary Investment Driver	Asset Health – Safety		
Project Initiation Year	2026		
Project Close Out Year	2031		
Total Installed Cost Estimate (£)	[Cost data redacted]		
Cost Estimate Accuracy (%)	+/-5%		
Project Spend to date (£)	[Cost data redacted]		
Current Project Stage Gate	Strategic plan for rolling asset health programme		
Reporting Table Ref	5.01 LTS Storage & Entry		
Outputs included in RIIO-3 Business Plan	Yes		
Spend apportionment for RIIO-3 plan	RIIO-2	RIIO-3	RIIO-4
	[Cost data redacted]	[Cost data redacted]	[Cost data redacted]
Regulatory Treatment	Other Capex – Base Plan		

Table 1: Summary Table

This investment case does not satisfy the criteria for late competition or early competition and pursuing these activities would not be in the interests of the customer. We recognise the benefits that competition can bring to customers through efficiency and innovation. We continue to challenge ourselves as a business to ensure that we are harnessing competitive forces where they can provide these benefits. For specific detail on how we have assessed competition, please see Chapter 6 of the Workforce and Supply Chain Strategy (Appendix 17).

All costs presented in this paper are pre-efficiency and are in 23/24 price base, unless otherwise stated.

2 Executive Summary

Our approach to pipeline integrity aligns with the overarching goals set out in the Network Asset Management Strategy (NAMS) Appendix 10, which emphasises the importance of a safe, resilient and reliable gas network underpinned by best-in-class asset management practices. This paper provides a foundation for our integrity initiatives by ensuring compliance with safety standards and supporting the long-term sustainability of our network assets in line with RIIO-3 objectives

The primary driver for investment in pipeline interventions is Asset Health (Safety) as defined in our NAMS. We have an obligation within our Transporters Licence to comply with all statutory requirements pertaining to the conveyance of gas, specifically, Pipeline Safety Regulations (PSR, 1996) and Pressure System Safety Regulations (PSSR, 2000).

These legislative drivers enforce need to inspect and maintain c.4900km of high-pressure pipelines to ensure they remain in good serviceable condition. We undertake a combination of internal and external assessments on our pipelines, which include the Pipeline Inspection Gauge (PIG) vessels, using industry guidance (IGEM/TD/1) to appropriately action defects to manage the integrity risk.

We are proposing to continue to proactively intervene on defects identified via mandated inspections to manage the pipeline integrity risks. Successful investment in RIIO-3 will be to hold asset health stable throughout the period with no compliance failures, no unplanned interruptions to supply and continued delivery of performance management via planned inspection. For piggable pipelines, our pipeline data indicates a mean fault rate of 0.25 per km with an average of 3.3 defects per inspection. For non-piggable pipelines, the mean fault rate per km is 0.005 with an average of less than 1 defect per inspection. Through proactive intervention, we expect to keep the fault rate of this asset group stable.

Cost and volumes for this price control and the previous have been included below, as well as a forward look to RIIO-4. The increase in price between RIIO-2 and RIIO-3 is owing to new investments being reported in this group namely, non-piggable interventions moving from Business Plan Data Table (BPDT) 4.02 (Maintenance) and pipeline crossings moving from BPDT 5.06 (other Capex).

[Commercially sensitive information redacted]

Table 2: RIIO-2-GD3 Volume and Spend Profile

3 Introduction

In alignment with NAMS, this paper focuses on interventions designed to sustain high pressure (HP) pipeline integrity and comply with regulatory requirements. The NAMS 10-year investment planning and asset health framework guide our decision-making processes, ensuring that our actions contribute to the broader asset management and risk reduction objectives.

The scope of this paper includes HP major accident pipelines (as defined in PSR, 1996), PIG trap to PIG trap, inclusive of buried and exposed pipeline sections. It excludes pipeline isolation valves and pipeline monitoring and protection equipment; the investment cases for these are contained within EJP13-Pipeline Isolation Valves and EJP14-Pipeline Monitoring and Protection. Routine and non-routine inspections are discussed in this paper for reference only and to support Cost Benefit Analysis (CBA) modelling, otherwise investment associated with these activities are reported on BPDT 4.02 (Maintenance).

Failure of HP pipelines can have significant consequences for safety and interruptions to supply. We have legal duties to maintain the safety and reliability of our pipelines under the PSSR, 2000 and PSR, 1996, specifically.

- PSSR Regulation 8 – for the written scheme of examination – Inspections
- PSSR Regulation 12 – for the maintenance of pressure systems – Repair
- PSR Regulation 13 – for maintenance of pipelines

We have developed an asset deterioration model for our local transmission system (LTS) pipelines founded on the principles of the NARM methodolgy for pipeline defect interventions. For PIG trap vessels and crossing intervetions, we have utilised bottom up engineering volumes to derive a CBA, for our investment strategy and methodology, please see NAMS Appendix 10, sections 4 and 5. Our asset model has been used to help us quantify the risk of programme options presented in Section 8. We have not included a 'do nothing' option; by definition, do nothing is not interventing following maintenance insepctions and is immediately ruled out on the grounds of non-compliance with PSSR (2000) and PSR (1996). We have not used our asset model to optimise the investment programme options because of our need to comply with this legislation.

4 Equipment Summary

4.1 Overview of the Assets

The base data for our pipelines has primarily been sourced from the Pressure System Database (PSDB), a fully audited system to comply with PSSR (2000) and PSR (1996) and used by the Health and Safety Executive (HSE). Our secondary data source is core system inspection data to supplement this investment case where inspections are not reported in PSDB, for example crossing inspections.

Our 4,931 km of HP pipelines can be differentiated into those that are internally inspected using specialist tools (piggable), and those that cannot be internally inspected, due to either mechanical features or unsupportive flow conditions (non-piggable) and are subject to an overland survey regime.

Pipeline assets comprise:

- The pipeline
- Crossing features: pipelines are buried and will run beneath roads, railways, rivers and ditches but they also have above ground-crossings sections that cross a variety of the aforementioned features
- PIG Trap vessels: at either end of the pipeline that enables internal inspection for piggable pipelines

Table 3 summarises our HP pipelines

	Total (km)	Piggable pipelines (km)	Non-Piggable pipelines (km)
East of England	1,327	781	546

East Midlands	1172	1,052	120
North London	635	565	70
North West	911	788	123
West Midlands	887	758	129
Cadent Total	**4,931**	**3,944**	**988**

Table 3. Total population of HP pipelines and their inspection method and population per Network. (Source PSDB and Intervals planning sheet)

For this investment paper, we have reported crossings for all pressure tiers as eligible for intervention.

4.2 Specific Pipeline Features

4.2.1 Above Ground Crossings

Over the course of their length, pipelines run above and below ground. Exposed above ground pipes vary in, diameter, length, and configuration, and can be free standing or supported by a structure such as trestles, column arrangements or attachment to third-party bridges or purpose-built pipe bridges.

Exposed pipes and structures incorporate access deterrent measures to prevent unauthorised third-party access, which traditionally come in the form of fencing, fan guards and rotational spinners.

Purpose built bridges and structures may be Cadent owned or shared with other asset owners and may contain an inspection walkway. Pipe bridges and structural assets carry an additional management requirement and are subject to a principal inspection, these are covered in EJP01-Civil Interventions.

Network	Crossing (Count)	Above Ground Crossings > 7bar	Above Ground Crossings < 7bar	Total Population
Eastern		81	666	747
North London		12	247	259
North West		68	684	752
West Midlands		80	384	464
Cadent Total		241	2,093	2,492

Table 4:Total population of above ground pipeline crossings (Source SAP)

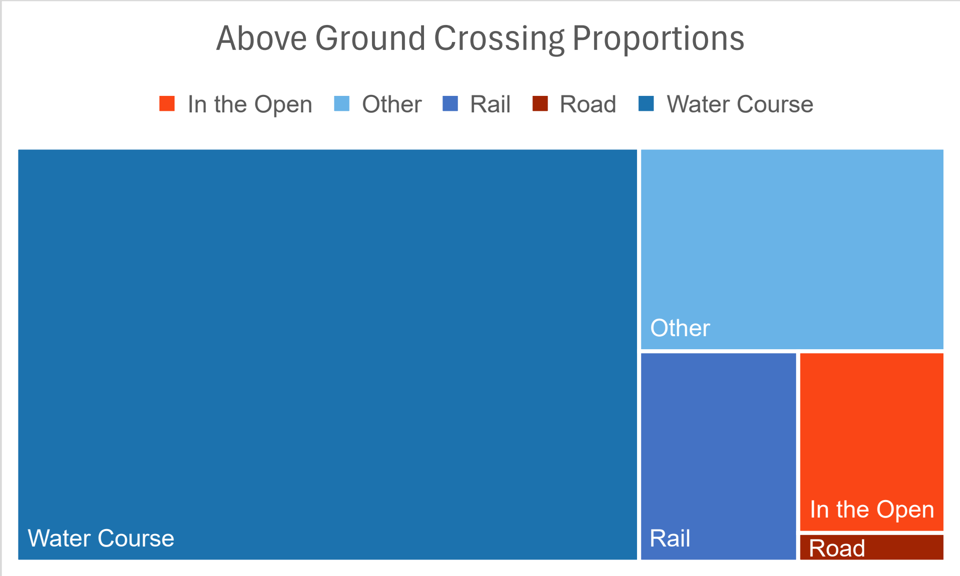

Figure 1: Proportion of features crossed by above ground crossings

Examples of our above ground crossings are depicted in Figure 2 below; watercourse with anti-deterrent guards fitted, and twin pipelines crossing a watercourse affixed to a bridge structure.

[Commercially sensitive information redacted]

Figure 2: Example of above ground crossings

4.2.2 River Crossings

Below ground, underwater pipeline crossings carry an inherent risk due to the nature of the water flow which can cause riverbed and bank erosion. Navigable watercourses also carry further risks of bed and bank erosion caused by turbulence and impact damage (e.g., boat hulls and anchors). Turbulence may be caused by the wake from moving marine vehicles or from other obstacles in the riverbed or bank. Other types of water course the pipeline may encounter are tidal and estuary. Any exposed pipes in the riverbed and banks or those where the cover of the pipeline has significantly reduced are at risk of third-party interference or damage. The watercourse may also be at risk from flooding, which may result in riverbed or bank erosion and exposure of any buried pipelines. Examples of pipeline erosion, third party damage and protection (slabbed) are shown in Figure 3.

	River Crossings (> 7 bar)	River Crossings (< 7 bar)	Total Population
Eastern	348	375	724
North London	117	138	255
North West	119	88	207
West Midlands	83	167	250

Cadent Total	667	768	**1,435**

Table 5.Total population of underwater riverbed/bank crossings (Source: SAP)

[Commercially sensitive information redacted]

Figure 3: Example of river crossing bank and bed defences

4.2.3 PIG Traps

PIG Traps are a pressure vessel that facilitate the means to conduct internal inspections of piggable pipelines. They comprise pipe, valves and auxiliary pipework to balance pressures across an inspection tool, PIG, to launch or receive it from the pipeline. They are subject to the requirements of PSSR (2000) inspection intervals; these inspections occur every 6 years for visual examination and every 12 years the closure mechanism is examined as well as non-destructive testing. Note, only the vessel is presented in this paper and the associated valves are covered in EJP13-Pipeline Isolation Valves.

[Commercially sensitive information redacted]

Figure 4. Example of pig trap inspection

Network	PIG Trap Vessels
Eastern	23
North London	21
North West	37
West Midlands	18
Cadent Total	**99**

Table 6: Total population of PIG Trap vessels (Source: SAP)

We have not presented health scores for the assets within this paper as they do not lend themselves to being modelled in this way.

Investment in the RIIO-2 period is presented below.

[Commercially sensitive information redacted]

Table 7: RIIO-2 expenditure in £m (Source: [sensitive information redacted]23/24)

5 Problem/Opportunity Statement

We consider 'good' asset health to be safe (compliant), secure (supply) and reliable (performance). The primary investment driver for this investment case is asset health, specifically safety, pertaining to compliance with legislative obligations to mitigate the risk caused by asset deterioration. Defects can arise from ground conditions, susceptibility to corrosion or environmental factors and a pose risk to the integrity of our pipelines. Additionally, accessibility to maintain the pipeline or restrict access to unauthorised persons is paramount to ensure both personal safety and pipeline integrity.

5.1 What Happens if we Do Nothing

If we do not act on identified integrity risks (corrosion, third party interference, mechanical damage, access) to our pipelines, the consequence is a breach of legislative and licence obligations. By allowing the potential for loss of containment we risk safety and security of supply which has insupportable legal, reputational and financial impact. Hence, doing nothing to intervene is immediately discounted as a viable option.

Below summarises our obligations and commitments for which our investment must not allow contravention which would otherwise result in penalties, prosecution and enforcement action. For specific consequence of failure, please see Section 7.

Safety – Legislative Compliance: We invest to ensure continued compliance with the PSSR (2000), PSR (1996) and other legislative requirements. Our LTS transports large volumes of gas at very high pressure, failure would have significant safety implications. We have an obligation to prevent serious injury from the hazard of stored energy because of the failure of a pressure system or one of its component parts.

We are also obliged to demonstrate that all hazards that have the potential to cause a major accident are identified, that the risks have been evaluated, that the safety management system is adequate and that it is audited to ensure that associated risks to members of the public and employees are as low as reasonably practicable.

Our proposed investment is in relation to compliance with PSSR (2000) Regulation 8 (Examination in accordance with the written scheme) and PSR (1996) Regulation 13 (maintenance of pipelines), together with interventions required in relation Regulations 12 (PSSR, 2000, Repair) and 15 (PSR, 1996, managing damage to pipelines).

Security of Supply – Regulatory compliance: We have a duty to comply with the terms of our gas transporter licence, specifically Condition 16 (Pipeline System Security Standards) to manage our network to meet the demand of connected customers by supplying to meet the peak aggregate daily demand. Any option that prohibits the meeting of this condition is not favourable.

Environmental: Any leaks will result in a gas-release to the atmosphere, with a resulting impact to carbon emissions. We have a target to materially reduce our network emissions by 2040 and net zero by 2050, any option that undermines our environmental commitments is not favourable.

Providing Value for Money to Our Customers: it is imperative we provide the most efficient and cost-effective long-term solution to minimise customer bills. Reactive repairs have an impact on our customer's bills, due to additional call out costs and the need for temporary repairs. Gas-leaks also result in 'lost gas' which has a commercial impact.

Financial: Any pipeline failure will have resulting costs to respond and mitigate the failure, to re-establish operation, repair and restore supply, this could run into millions of pounds. Options that negatively impact the customer bill or result in penalties through fines is not favourable.

5.2 Key Outcomes and Understanding Success

5.3 Narrative Real-Life Example of Problem

[Commercially sensitive information redacted]

Figure 5. Corrosion example from piggable inspection on Ambergate pipeline (left) with remedial (right)

[Commercially sensitive information redacted]

Figure 6: Minor defect (gouge) identified Catshaw 30" pipeline

[Commercially sensitive information redacted]

Figure 7: Above ground crossing example before intervention

[Commercially sensitive information redacted]

Figure 8: PIG Trap Intervention

5.4 Project boundaries

6 Probability of Failure

6.1 Pipeline Failure Modes

6.2 HP Pipeline failure rates

6.3 Pipelines

[Commercially sensitive information redacted]

Figure 9: Relationship of pipeline commissioned date (age) and prevalence of superficial defects (Source: PRS Database)

[Commercially sensitive information redacted]

Figure 10. Plot showing the number of failures on the LTS system broken down by the age of the pipe (Source: LTS asset model).

6.3.1 Crossings

6.3.2 PIG Traps

[Commercially sensitive information redacted]

Figure 11: Major PIG trap faults per inspection over 10-year period (source: PSSR Database)

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7 Consequence of Failure

[Commercially sensitive information redacted]

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[Commercially sensitive information redacted]

Table 9: Intervention mode summary

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[Commercially sensitive information redacted]

Table 10: Reactive repair intervention mode

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[Commercially sensitive information redacted]

Table 11. Minor replacement intervention

8.2.3 Major replacement

[Commercially sensitive information redacted]

Table 12. Major replacement intervention

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[Commercially sensitive information redacted]

Table 13. Full system replacement

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8.4 Programme Options

[Commercially sensitive information redacted]

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[Commercially sensitive information redacted]

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8.4.2 Programme Option 0: (Baseline) Proactive refurbish or replacement

[Commercially sensitive information redacted]

Table 16. Programme Option 0 justification

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[Commercially sensitive information redacted]

Table 17: Programme Option Summary Table

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[Commercially sensitive information redacted]

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9.2 Business Case Summary

[Commercially sensitive information redacted]

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[Commercially sensitive information redacted]

Figure 12. Monetised risk as a result of capital expenditure for each programme option

9.3.2 Cost Benefit Analysis

9.3.3 Customer Views and Willingness to Pay

9.3.4 Programme Option Discussion

9.3.5 Sensitivity Tests

[Commercially sensitive information redacted]

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10 Preferred Option Scope and Project Plan

10.1 Preferred Option

10.2 Asset Health Spend Profile

[Commercially sensitive information redacted]

Table 21: RIIO-3 Estimated Intervention Volumes for Pipeline Integrity

[Commercially sensitive information redacted]

Table 22: RIIO-3 Estimated Intervention Spend (£m) for Pipeline Integrity

10.3 Investment Risk Discussion

[Commercially sensitive information redacted]

Table 23. Key Business Risks and Opportunities

10.4 Project Plan

[Commercially sensitive information redacted]

Table 24: Indicative project plan

10.5 Key Business Risks and Opportunities

10.6 Outputs included in RIIO-2 Plans

11 Regulatory Treatment

12 Glossary

Term	Definition
ADM	Access Deterrent Measures
BPDT	Business Plan Data Table: Regulatory table in which cost and volume of investment for the regulatory period is reported
CBA	Cost Benefit Analysis: Assessment of the strengths and weaknesses associated with programme options
EJP	Engineering Justification Paper: Paper outlining the scope, costs and benefits of a proposed investment programme
FES	Future Energy Scenarios: Strategic energy futures to support the UKs decarbonisation journey to net-zero
HSE	Health and Safety Executive
LTS	Local Transmission System: Pipeline network than transports gas from the national transmission system to towns, cities and industrial clusters
NAMS	Network Asset Management Strategy: Paper outlining our framework for data-based decision making to optimise our assets and the approach for our RIIO-3 plan
NPV	Net Present Value: A measure of asset value and the difference between the present value of case inflow and the present value of cash outflow over a period of time
PIG	Pipeline Inspection Gauge
PSDB	Pressure System Database
PSR	Pipeline Safety Regulations
PSSR	Pressure System Safety Regulations
UKOPA	United Kingdom Onshore Pipeline Association

Table 25: Glossary Table