Engineering Justification Paper: EJP03

Filters on Offtakes & PRS

Contents

Table of Figures

Table of Tables

1 Summary Table

Name of Programme	Filters: Offtakes & PRS
Programme reference	EJP03
Primary Investment Driver	Asset Health – Compliance
Programme Initiation Year	2027
Programme Close Out Year	2031
Total Installed Cost Estimate (£)	[Cost data redacted]
Cost Estimate Accuracy (%)	+/- 5%
Project Spend to date (£)	RIIO-2 spend to date is [Cost data redacted] RIIO-3 spend to date is [Cost data redacted]
Current Project Stage Gate	Rolling programme of investment
Reporting Table Ref	5.01 LTS storage and entry
Outputs included in RIIO-3 Business Plan	Yes
Spend apportionment (RIIO-3)	[Cost data redacted]
Proposed regulatory treatment for RIIO-3 workplan	Managed via NARMs (network asset risk metric)
Programme reference	EJP03

Table 1: Summary Table

Note: Unless otherwise stated, all prices are pre-efficiency and are in a 23/24 price base throughout this document

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).

2 Executive Summary

Filtration is used to remove dust and debris prior to gas reaching our metering, preheat and pressure reduction systems, to prevent any damage or corrosion affecting asset health, or blockages which could affect security of supply. In RIIO-1 and RIIO-2, we have managed the asset health of our filters through a comprehensive inspection programme, driven by our requirement to comply with the Pressure System Safety Regulations (PSSR 2000), followed by interventions to resolve any defects that are identified. We propose to continue to manage our assets this way in RIIO-3. The primary driver for investing in our filtration systems is asset health-compliance.

We have modelled the performance of our filtration systems including failures, risk to supply and condition, using our standard investment methodology, supported by our model (refer to Network Asset Management Strategy for more information on this approach). This shows we will need to continue to invest in these assets to manage ongoing issues such as: poor performance linked to asset deterioration; specifically, integrity assessment after statutory PSSR inspections; environmental impact; efficiency; compliance with PSSR (2000); and potential interruptions to supply in the event of failures. If we do not invest, the risk of failures and other services impacts (e.g. supply interruptions, leakage, and ignitions) will rise. Please see Section 6 for a more detailed view of how these impacts increase over time. We have used our asset model to derive a range of programme options based on different goals.

Our proposed approach for RIIO-3 is consistent with RIIO-2, in that we will invest in assets that fail compliance-based inspections, with some allowance for proactive investment for filters where deterioration to asset condition has been identified and are outside our planned maintenance regime. Costs and volumes for this price control and the previous are included below, as well as a look forward to RIIO-4.

Our preferred option maximises benefit of investment over the lifecycle of the assets within the bounds of RIIO-2 expenditure. We have capped the spend to have minimal impact on customers' bills, along with what we are able to deliver based on our current workforce competency and expertise to deliver the volumes of work. This option provides a positive NPV and aligns with the expectations of our customers, evidenced by our Willingness to Pay analysis. Most importantly, it removes our lowest scoring assets in the respect of asset health, ensuring we continue to operate a safe, secure and reliable network and maintain PSSR compliance.

	RIIO-2	RIIO-3	RIIO-4
Cost (£m)	[Cost data redacted]		
Volume	[Volume data redacted]		

Table 2: Cost and volumes across regulatory periods

3 Introduction

This document covers the engineering justification for filtration systems at offtakes and pressure reduction system (PRS) sites. Filtration is the facility to prevent and capture any dust or liquids from upstream, to prevent them from going downstream and negatively impacting any equipment before it enters the distribution network. Our investment option is based on the probability and consequence of failure at system level. Operationally the systems are the same, with the same failure modes, however the impact will be different dependant on their classification and the number of customers the site feeds, i.e. if they are on an offtake or PRS.

The investment expenditure and volumes discussed in this paper are derived from our investment methodology (detailed in our Network Asset Management Strategy) through the assignment of health scores per equipment, asset criticality and service risk metrics.

By developing standardised investment programme options, we can demonstrate an optimised programme to manage asset risk and maximise investment benefit. This has been developed using our asset model. This has looked at actual fault rates and has consequence of failure for each fault to derive a monetised risk value.

	Summary Information
Location on the network	Filter systems comprise of two or more gas filters (units) and are installed within an offtake or PRS, typically upstream of the pressure control system. Filters ensure a supply of clean gas to the downstream system and protect the regulators or control valves from damage.
Normal operating modes	For all offtakes and PRS' (pressure reduction systems) the total number of filters selected will be able to maintain the design throughput with one filter out of operation. This means you will commonly find one filter isolated within a filter bank.
Redundancy architecture	We design the network to a N+1, where N = the total number of filters required to maintain designed capacity. This is an industry standard as per IGEM TD/13 Edition 3.
Global equipment count	Across the network we have a total of [volume data redacted] filters that are above 7 Bar. 93% are above 3" in size. 12.34% of all filters can be found on offtakes, and the other 87.65% of filters are on PRIs.
Breakdown of manufacturers / models	We have 18 manufacturers of filters currently in operation at Cadent.

Table 3: Asset Overview – Filters

4 Equipment Summary

Filters are categorised as ‘pressure vessels’ and are therefore covered by the Pressure Systems Safety Regulations (PSSR 2000), which also details the relevant examinations required. This section provides a summary of the number of filters by region and a summary of the current condition of the asset stock.

4.1 Overview of the assets

Filter assets of the same size and type are installed across both offtake and > 7 Bar PRS sites with the same ageing and fault mode mechanisms, therefore have been delivered in one complete investment case. We have however split out the filters for offtakes and PRS’s for this report in line with Ofgem guidance. Filters that are less than 250 litres capacity are not subject to mandatory PSSR inspections. All our filters that are less than 250 litres are below 3” in diameter. The replacement of these filters will now be in line with visual inspections and related to the age of the asset, rather than a more in-depth inspection.

The below figure shows an example of a typical filter system arrangement. These components are the first component that gas passes through on our pressure regulating systems.

[Commercially sensitive information redacted]

Figure 1: Typical Layout of an offtake / Pressure Reduction Station with filters

Our [volume data redacted] high-pressure filters are of various sizes, ranging from 1" diameter up to 47”. These are recorded in the Pressure System Database (PSDB). Approximately 93% of our asset stock is more than 3" in diameter (above 3").

4.2 Global equipment count

	≤3"	>3”	Grand Total
	Offtakes		
Eastern (EE)	[sensitive information]	[sensitive information]	[sensitive information]
North London (NL)	[sensitive information]	[sensitive information]	[sensitive information]
Northwest (NW)	[sensitive information]	[sensitive information]	[sensitive information]
West Midlands (WM)	[sensitive information]	[sensitive information]	[sensitive information]
	PRS		
Eastern (EE)	[sensitive information]	[sensitive information]	[sensitive information]
North London (NL)	[sensitive information]	[sensitive information]	[sensitive information]
Northwest (NW)	[sensitive information]	[sensitive information]	[sensitive information]

	≤3"	>3"	Grand Total
West Midlands (WM)	[sensitive information]	[sensitive information]	[sensitive information]
Grand Total	[sensitive information]	[sensitive information]	[sensitive information]

Table 4: Detailed equipment summary by region (Asset Model – extracted November 2024)

4.2.1 Typical filter arrangement

[Commercially sensitive information redacted]

Figure 2: Example of a Filter

Filter units may be arranged in parallel with common inlet or outlet or both pipework or within individual pressure reduction streams. Valves located on the inlet and outlet of each filter allows the isolation and removal of filter elements for cleaning or replacement. These assets have a rolling maintenance and inspection regime. This provides us insight to asset condition. Our condition data is coupled with fault data which provides an overview on the health of an asset and the metric that is modelled to determine the need for investment. The following table shows todays average health score of these assets split by network and a Cadent average.

This is the overall observed condition of our assets. This condition score is assessed through visual surveys, with clear criteria used to assign an asset to a condition band. Condition 1 assets are in very good condition, typically new or rehabilitated, with little or no evidence of deterioration. Condition 5 assets are in very poor condition, with the asset in unacceptable condition with widespread evidence of deterioration and potential for failure. See Network Asset Management Strategy Document for methodology on how these health scores are derived.

	Offtake	PRS
East Anglia	[sensitive information]	[sensitive information]
North London	[sensitive information]	[sensitive information]
Northwest	[sensitive information]	[sensitive information]
West Midlands	[sensitive information]	[sensitive information]
Cadent Average	[sensitive information]	[sensitive information]

Table 5: Average network condition for filters by end of RIIO-2 (Asset Model – extracted November 2024)

We are forecast to invest in [volume data redacted] in RIIO-2 at a cost of [cost data redacted] to maintain the asset health of our assets. There is an ongoing need to invest in filters to continue to hold asset health stable in RIIO-3. Spend to date for each network is as follows:

	Eastern	North London	Northwest	West Midlands
Cost (£m)	[cost data redacted]	[cost data redacted]	[cost data redacted]	[Cost data redacted]

Table 6: Network RIIO-2 spend to date

5 Problem Statement

Filters are installed upstream of the pressure control, preheating and flow weighted average calorific value systems and prevent failure of this downstream equipment by reducing the risk of debris passing forward into the downstream assets.

A failure of a filter increases the probability of failure of the downstream assets at PRS and offtake sites, which in turn will increase the risk of:

- Supply interruptions
- Emissions / venting
- Explosion risks and associated risks to safety
- Additional operation costs to respond to a failure

To comply with the PSSR (Pressure System Safety Regulations), we have a risk-based approach to physical examination, by a specialist engineer using a magnetic particle inspection (non-destructive testing) to identify any defects. PAUT (Phase array ultrasonic testing) is used if a crack is found and if the filter needs replacing (builds part of DAM 1 report). A DAM/1 is defect assessment management and outlines the next steps if a defect is found.

Our strategy is to hold asset health stable, ensuring security of supply to our customers, whilst remaining compliant as per our PSSR obligations and removing any filters not within our planned maintenance regime that are health score 4-5's, these scores are reflective of the engineering need (condition, faults, and downtime challenges) and criticality (number of customers impacted, and network integration). We consider this our minimum standard for our investment, as remaining compliant with our PSSR obligations is non-negotiable. Those systems that are health score 4-5's outside our maintenance programme pose operational challenges and put us at risk of not complying with our statutory obligations and providing a safe and reliable gas supply to our customers or meeting our 1 in 20 peak demand. Our investment seeks to mitigate the risks posed by poorer performing assets and those that fail inspection.

5.1 What happens if we do nothing?

As our assets age and deteriorate, they are more prone to failures, which in turn affects the ability of these assets to meet safety and reliability requirements.

The following summarises the risks if we do nothing:

- Safety: We must comply with PSSR (2000) Regulation 8 (written scheme of examination for inspections) together with intervention, as required, in relation to Regulation 12 (repair). We have an obligation to prevent serious injury from the hazard of stored energy because of the failure of a filter. We have a robust maintenance regime for our filtration systems and intervene when a defect is found through this maintenance regime. Without this maintenance regime on our filtration systems, this poses a safety risk, due to the fire and explosion risk from a leak, following a failure. The consequences modelled in our AIM model are fatalities and minor injuries following ignition.
- Environmental: Loss of containment will result in an uncontrolled gas release to the atmosphere, with a resulting impact to carbon emissions. We have a target to reduce our emissions, therefore an option that undermines our environmental commitments is not favourable.
- Regulatory compliance: We have a legal obligation to inspect and maintain these assets under the Pressure Systems Safety Regulations 2000 (PSSR). Those systems

that fail to comply within the allowable tolerances, would need intervention to remain compliant and ultimately ensure resilience in the network.

- Security of Supply: 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. Filtration system failures could cause asset or site outage, resulting in customer supply interruptions. Depending on the configuration of the network and the size of the site, this could result in a significant number of customers being impacted. The impact of this would require significant resources to put customer supplies back on and would take a considerable amount of time to do so.
- Financial: Any filtration system failure will have resulting costs to respond and mitigate the failure, to re-establish operation, repair and restore service. Repair costs also increase with the life for all our filtration systems. Options that negatively impact the customer bill or result in penalties through fines is not favourable.
- Customer Interruptions: Safety and resilience are non-negotiable. Customers place a high premium on the safety and resilience of the network. Therefore, any investment must focus on minimising and mitigating risks to prevent customer interruptions, ensuring a continuous, safe and dependable gas supply.

5.2 Key outcomes and understanding success

[Commercially sensitive information – section redacted]

5.3 Narrative real-life example of problem

[Commercially sensitive information redacted]

Figure 3: Typical defects found during PSSR inspections of filters

5.4 Project Boundaries

[Commercially sensitive information redacted]

Figure 4: HP Filter Investment Case Spend Boundaries, the orange filters and differential pressure meters are the only elements of the system included

6 Probability of Failure

[Commercially sensitive information – section redacted]

6.1 The Failure Modes for Filters

[Commercially sensitive information redacted]

Table 7: Failure modes

6.2 Failure rates for each failure mode

[Commercially sensitive information – section redacted]

6.3 Probability of failure data assurance

[Commercially sensitive information redacted]

Table 8: Failure rates over time for baseline programme option "Do-Nothing" (Asset Model – extracted November 2024)

7 Consequence of Failure

[Commercially sensitive information – section redacted]

[Commercially sensitive information redacted]

Table 9: Failure modes and consequence of failure

8 Options Considered

[Commercially sensitive information – section redacted]

8.1 How we have structured this section

[Commercially sensitive information – section redacted]

8.2 Modes of intervention

[Commercially sensitive information redacted]

Table 10: Comparison of intervention modes

8.2.1 Intervention Mode 1: Filter repair

[Commercially sensitive information redacted]

Table 11: Intervention mode 1: filter repair

8.2.2 Intervention mode 2: Filter refurbishment

[Commercially sensitive information redacted]

Table 12: Intervention mode 2: Filter refurbishment

8.2.3 Intervention mode 3: Replacement of filters

[Commercially sensitive information redacted]

Table 13: Intervention mode 3: Replacement of filter

8.3 Timing choices

[Commercially sensitive information – section redacted]

8.4 Option

[Commercially sensitive information – section redacted]

[Commercially sensitive information redacted]

Table 14: Intervention modes against timing choices

8.5 Programme options

[Commercially sensitive information redacted]

Table 15: Programme options

8.6 Technical Summary Table: Programme options

[redacted]

[Commercially sensitive information redacted]

Table 16: Summary of Programme options

.

[Commercially sensitive information redacted]

Figure 5: Condition score of each Programme option by end of RIIO-3

9 Business Case Outline and Discussion

[Commercially sensitive information – section redacted]

9.1 Key Business Case Drivers Description

[Commercially sensitive information – section redacted]

9.2 Business case summary

[Commercially sensitive information – section redacted]

.

[Commercially sensitive information redacted]

Table 17: Programme options comparison

9.3 Discussion of results

9.3.1 Risk removal

[Commercially sensitive information redacted]

Figure 6: Monetised benefit to avoid customer interruptions (relative to baseline option) per programme option (Asset model – extracted November 2024

9.3.2 Cost Benefit Analysis

[Commercially sensitive information redacted]

Table 18: CBA outputs for options 3

[Commercially sensitive information redacted]

Table 19: CBA outputs for options 2, 8 and 9

9.3.3 Customer views

[Commercially sensitive information – section redacted]

9.3.4 Deliverability

[Commercially sensitive information – section redacted]

9.4 Conclusions

[Commercially sensitive information – section redacted]

9.5 Sensitivity analysis

[Commercially sensitive information redacted]

Table 20: Sensitivity testing

10 Preferred Option Scope and Project Plan

[Commercially sensitive information – section redacted]

10.1 Preferred Option

[Commercially sensitive information redacted]

Table 21: RIIO-3 volume of filter replacements

10.2 Asset Health Spend Profile

[Commercially sensitive information redacted]

Table 22: Spend profile for RIIO-3

[Commercially sensitive information redacted]

Table 23: Programme of Filters by PRS/Offtake site

10.3 Investment Risk Discussion

[Commercially sensitive information redacted]

Table 24: Risks

10.4 Project Plan

[Commercially sensitive information – section redacted]

10.5 Key Business Risks and Opportunities

[Commercially sensitive information – section redacted]

10.6 Outputs included in RIIO-2 Plans

[Commercially sensitive information – section redacted]

11 Regulatory Treatment

[Commercially sensitive information – section redacted]

12 Glossary Table

13 Term	Definition
CBA	Cost Benefit Analysis
EJP	Engineering Justification Paper
FES	Future Energy Scenarios
NARM	Network Asset Risk Metric
NPV	Net Present Value
PSSR	Pressure Systems Safety Regulations

Table 25: Glossary Table