national gas transmission

ENGINEERING JUSTIFICATION PAPER (EJP)

OFFICIAL – FOR PUBLIC RELEASE

Pressure Vessels

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RIIO-GT3 NGT_EJP18

Contents

1 Summary Table

Table 1: Summary table for Pressure Vessels EJP

Name of Project	*Pressure Vessels*		
Scheme Reference	NGT_EJP019_Pressure Vessels_RIIO-GT3		
Primary Investment Driver	*Asset Health*		
Project Initiation Year	*FY27*		
Project Close Out Year	*FY31*		
Total Installed Cost Estimate (£, 2023/24)	£13.8m		
Cost Estimate Accuracy (%)	+/- 10%		
Project Spend to date (£m, 2023/24)	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**
	£0.7	£13.0	£0.1

2 Executive Summary

2.1.1 This paper proposes £13.8m of baseline funding to efficiently maintain the health of our Pressure Vessel assets by intervening upon 113 (47%) of our pressure vessel assets in RIIO-GT3. The monetised risk impact of this investment will be calculated using the Network Asset Risk Matrix (NARM) methodology, which will then contribute to our NARMS targets and Price Control Deliverables (PCDs).

2.1.2 The primary driver for this investment is compliance with statutory legislation. NGT manages its pressure vessel assets with a cyclic regime of examinations to validate their continued usage, followed by remediation actions. Major inspections and associated interventions are currently carried out on a 12 yearly cyclical programme whereas minor inspections and associated interventions are carried out every 6 years.

2.1.3 158 interventions are required to ensure NGT comply with legislation and to maintain stable network risk levels during RIIO-GT3. This programme delivers £4.3m of NARMs benefit.

2.1.4 The assets in the scope of this investment are PIG Traps, Scrubbers and Condensate Tanks. We have considered 16 types of intervention across the portfolio to address the asset health risk, to establish an optimal programme that would deliver the desired regulatory outputs. In summary we are proposing the intervention mix summarised in Table 2.

Table 2: RIIO-GT3 volumes proposed in this EJP.

	PIG Trap PSSR Major Inspection	PIG Trap PSSR Defect Resolution-Minor	PIG Trap PSSR Defect Resolution-Major	Scrubber Refurbishment	Replace fixed Condensate Tank with mobile	Total
RIIO-GT3 Volumes	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

2.1.5 In RIIO-T2 we will deliver 111 interventions, a similar level to our final determination of 116. The growth in RIIO-GT3 spend comes from increased inspections and the need to replace the existing Fixed Condensate Tanks therefore an increase in remediation activity. The bulk of the growth in spend request arises from the inclusion of Condensate Tank investments that have moved into this product as shown in Table 3.

Table 3: RIIO-T2 vs RIIO-GT3 (2023/24)

	RIIO-T2 Business Plan	RIIO-T2 Forecast Delivery	RIIO-GT3 Business Plan
Interventions	116	111	158
Investment	£7.4m	£7.7m	£13.8m
Asset population	30%	30%	47%

2.1.6 We need to deliver a stepped increase in asset health works for pressure vessels during RIIO-GT3 to ensure future network risk levels are not compromised.

2.1.7 The deliverability of this work has been assessed and we have high confidence that this can be delivered during RIIO-GT3. The profile of investment for RIIO-GT3 is shown in Table 4.

Table 4: RIIO-GT3 funding request for Pressure Vessels (£m, 2023/24)

Intervention	2026	2027	2028	2029	2030	2031	2032	Total
PIG Trap PSSR Defect Resolution- Major	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3.42
PIG Trap PSSR Defect Resolution – Minor	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	0.64
PIG Trap PSSR Major Inspection	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	4.06
Replace Fixed Condensate Tank with Mobile Condensate Tank	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	4.20
Scrubber refurbishment	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1.43
Total	0.65	3.84	2.60	2.77	2.25	1.56	0.09	13.77

2.1.8 Additional information on 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_IDP07_Portfolio EJP Pressure Vessels_RIIO-GT3.

3 Introduction

3.1.1 We are requesting funding to examine and manage our pressure vessel assets.

3.1.2 This EJP has been structured as shown in the below figure to cover two sub-themes within our Pressure Vessel asset base.

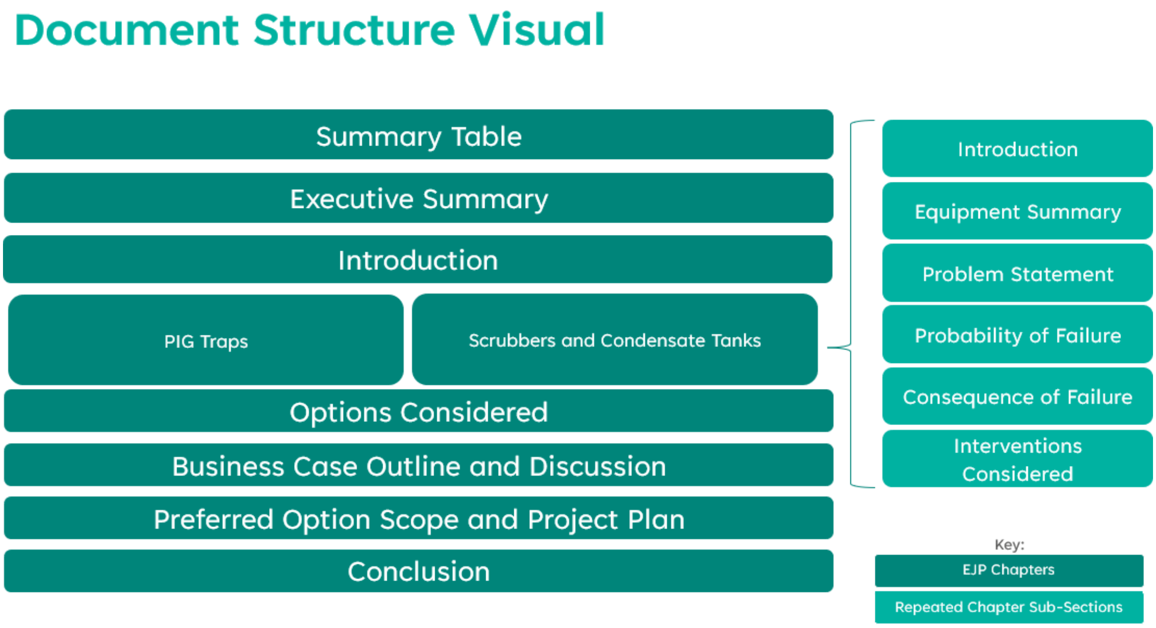

Figure 1: EJP document layout

3.1.3 The scope of this document is aligned with our Asset Management System (AMS) and relates to our Business Plan Commitments (BPCs), "Meeting our critical obligations every hour of every day" and "Delivering a resilient network fit for the future". More information on our AMS and a description of our commitments is provided in our [1]Network Asset Management Strategy annex and our BPCs are detailed within our NGT_Main_Business_Plan_RIIO_GT3.

3.1.4 The decisions made upon assessing the Pressure Vessels Assets investments have interactions with other submission documents: these being [2]Valves-Actuators EJP, [3]Valves-Valves EJP, [4]Pipeline EJP and [5]Gas Quality, Metering and Telemetry EJP.

[1] NGT_A08_Network Asset Management Strategy_RIIO_GT3
[2] NGT_EJP023_Valves: Actuators_RIIO-GT3
[3] NGT_EJP022_Valves: Valves_RIIO-GT3
[4] NGT_EJP017_Pipeline_RIIO-GT3
[5] NGT_EJP06_Gas Quality, Metering and Telemetry_RIIO-GT3

4 PIG Traps - £8.1m (2023/24)

4.1 Introduction

4.1.1 This EJP requests funding to examine and manage our Pipeline Inspection Gauge (PIG) Trap assets on the National Transmission System (NTS) to ensure that they are fit for purpose to allow pipeline inspections to occur.

4.1.2 PIG Traps are pressure vessel assets which are managed in accordance with Pressure Systems Safety Regulations (PSSR) legislation. They are located at either end of the pipeline on the NTS and enable the In-line Inspection (ILI) tool to be launched into the pipeline and retrieved at the end of the section under inspection. PIG Traps need to be kept in an operable condition, to carry out Pipeline inspections and validate their continued usage for transporting gas.

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

- Perform PSSR examinations on PIG Trap assets to validate their continued usage in accordance with their written scheme of examination.
- Minor remedial activities such as replacement of a component to restore functionality to PIG Traps.
- Major remedial activities such as repairing a significant crack to PIG Traps or replacement of PIG Traps with a new permanent PIG Trap or replacement with a pipework arrangement that will accept a portable PIG Trap (where suitable).

4.1.4 In RIIO-T2, we continued with PIG Trap examinations following its cyclic programme to validate their safe usage. Following the examinations, defects identified were remediated to ensure that PIG Trap assets remain operational to enable pipeline inspections to occur.

4.1.5 For RIIO-GT3, we propose to continue the above established practises to manage our PIG Trap assets. The worklist in this EJP has been built based on an ongoing programme of PSSR inspections.

4.2 Equipment Summary

4.2.1 PIG Trap assets which are used to enable inspection of buried pipelines on the NTS without full pipeline outage or excavation. These are located on NGT sites at either end of the pipeline inspection sections.

4.2.2 The PIGs themselves are typically sourced from third party providers.

4.2.3 The PIG Trap allows PIGs to be loaded, launched, and retrieved from high pressure gas pipelines, allowing In Line Inspections of pipelines. Further information is provided in the Appendix 9.1

Figure 2: PIG Trap A on Feeder 7

4.2.4 PIG Traps are classed as pressure vessels and therefore are managed in accordance with the Pressure Systems Safety Regulations (PSSR). NGT does not have any redundant PIG Traps on the NTS, all are currently operational. NGT does not have back up options available for fixed PIG Traps due to the configuration of onsite pipework and public highway access arrangements prohibit the use of temporary PIG Traps.

4.2.5 The 7,641km of pipelines that can be internally inspected comprise of 153 discrete pipeline sections, each with either a permanent PIG Trap or provision for a temporary PIG Trap at each end. NGT currently has 192 permanent PIG Traps which operate at full pressure of 70 to 94 bar.

4.2.6 The most common manufacturers for NGT PIG traps are Robert Jekins, Glapwell, Paul & Loughran and Swinney Engineering.

4.2.7 During RIIO-GT3 we have [redacted] to undertake out of a population of 192 fixed PIG Trap installations. NGT are not responsible for any portable PIG Trap assets. These are hired in from an external supplier when required, with the supplier responsible for PSSR compliance.

4.3 Problem/Opportunity Statement

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

4.3.1 PIG traps are ageing assets that suffer from corrosion and wear related deterioration. This deterioration results in non-compliance with legislation, and potential safety and environmental damage.

Figure 3: Crack defect at [redacted] PIG Trap A

4.3.2 Crack defects occur on the PIG Trap welds and body which left un-resolved will result in a loss of containment.

4.3.3 PIG traps allow a door to be opened onto the live pipeline and their integrity together with that of the PIG Trap isolation valve must be assured to manage the inherent risks to operators.

4.3.4 PIG traps also suffer many more pressure cycles than pipelines and tend to be prone to external and internal corrosion (esp. seal rings). A major release from an open PIG trap would be challenging and take a significant duration of time to contain. The release of gas will cause environmental damage and safety issues for site personnel.

4.3.5 If we do nothing to manage our PIG Trap assets, this will result in a lack of compliance with PSSR legislation. A non-compliant PIG Trap is a risk to operatives' safety and a loss of containment event would be difficult to manage to restore containment. A lack of available PIG Traps would also result in internal Pipeline inspections being unable to take place. If we are unable to validate pipelines for continued usage, NGT would have to depressurise and isolate the pipeline section. This impacts on our ability to operate the NTS resulting in loss of supply incidents.

4.3.6 The drivers for this investment are summarised in Table 5.

Table 5: Categories of Driver for PIG Traps

Driver Category	Description
Legislation	Compliance with Pressure System Safety Regulations 2000 (PSSR) legislation.
Industry Standards	The internal/external inspection and subsequent remediation of pipeline defects or "features" to industry standards (IGEM TD/1), supplemented by NGT 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.
Asset Deterioration	The coating of the PIG traps is subject to deterioration and damage from plant and machinery. Corrosion of the metal of all parts of the asset occurs both externally and internally. The moving parts/components such as door hinges, seals and bleeder block suffer use-based wear. The pressurised elements of the asset can exhibit cracking due to fatigue.

What is the outcome that we want to achieve?

4.3.7 Within RIIO-GT3, the outcome we want to achieve is continued compliance with legislation to enable continued operation of PIG Trap assets.

How will we understand if the spend has been successful?

4.3.8 The spend will have been successful if all PIG Traps remain compliant and are available for use when required for In-line Inspections.

Narrative Real-Life Example of Problem

4.3.9 This EJP seeks investment to resolve the problems such as those experienced in the below examples.

4.3.10 The first example is where PIG Trap doors often become in-operable. Common failure modes are mechanical damage to the door hinges and handles from repeated use. This affects the alignment of the door and its ability to seal. Failure of the door handle results in a PIG Trap that cannot be opened and operated. Seals are located between the door and PIG Trap body to enable containment of gas which degrade or become damaged by door misalignment resulting in a loss of containment.

Damage to the handle on the PT door had been noted. The damage limited the movement of the handle and stopped the door from locking.

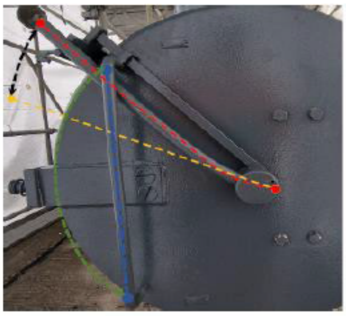

Figure 4: Door fault PIG Trap A at [redacted] *site*

4.3.11 Another example is corrosion/crack features. PIG Traps assets are above ground and subject to time-based deterioration, wear from use, and fatigue from pressure changes. The coating of the PIG trap is subject to deterioration and damage from plant and machinery. Corrosion of the metal of all parts of the asset occurs both externally and internally. The pressurised elements of the asset can exhibit cracking due to fatigue.

Figure 5: Crack features at [redacted] Compressor Station (Left) and corrosion features at [redacted] (Right).

Project Boundaries

4.3.12 The proposed investment includes all permanent PIG Traps on the NTS, including all their subcomponents. The subcomponents that are covered under this plan include the body/door, the PIG alert, and the bridle pipework.

4.3.13 Not included within the scope of this investment:

- In-line Inspections – These are covered within the [6]Pipeline EJP.
- Mobile PIG Traps – NGT do not have any mobile PIG trap assets.
- PIG Traps at St Fergus – These are covered within the [7]St Fergus EJP.

4.4 Probability of Failure

Failure Modes

4.4.1 Probability of failure (PoF) has been assessed both utilising historical defects and utilising the Network Asset Risk Metric (NARM) model. This model is built within our Copperleaf asset management decision support tool to assess the forward-looking probability of failure. This provides an additional lens to consider alongside looking at historically captured defects.

4.4.2 However, there are no failure modes modelled for PIG Trap assets because they don't directly affect our ability to transport gas or the health and safety of our employees. As they are usually depressurised, they also have no environmental impact of failure. The ability to inspect our pipelines, which depends upon functioning PIG traps, is not valued directly by the NARM methodology.

4.4.3 Failures are still modelled but are purely financial. When applied to the asset count with an assumption that no investment is made, a forecast of failures across the RIIO-GT3 period is produced, shown in Table 6.

Table 6: Modelled cumulative failure rates for PIG Traps

Asset Type	No of Assets	Cumulative Average Failure Rate					Expected Failures per Year				
		2027	2028	2029	2030	2031	2027	2028	2029	2030	2031
PIG Traps	192	0.55	0.57	0.59	0.61	0.63	4	4	4	4	4

Defect Analysis

4.4.4 Historical failure rates show that 45% of PSSR inspections have resulted in the identification of defects. Without investment, there will be 44 PIG traps with outstanding PSSR failures or significant defects by the end of the investment period.

4.4.5 There are corrosion/mechanical damage related defects on 18% (or 32) PIG traps. With no investment, the number of defects will rise.

[6] NGT_EJP017_Pipeline_RIIO-GT3
[7] NGT_EJP030_St Fergus: Pressure Vessels_RIIO-GT3

4.4.6 The most common defects associated with PIG Traps are:

- Development of corrosion features
- Cracks on the PIG Trap body and door
- Mechanical failure of the door resulting in in-ability to operate or misalignment
- Failure of the door seal

4.4.7 Between 2009 and 2023, 349 defects have been raised against PIG Traps. Over the 14 years this equates to an average of 25 defects per year. The phasing of these defects over time is shown in Figure 6. The defects are mainly identified during the 12 yearly cyclic inspections.

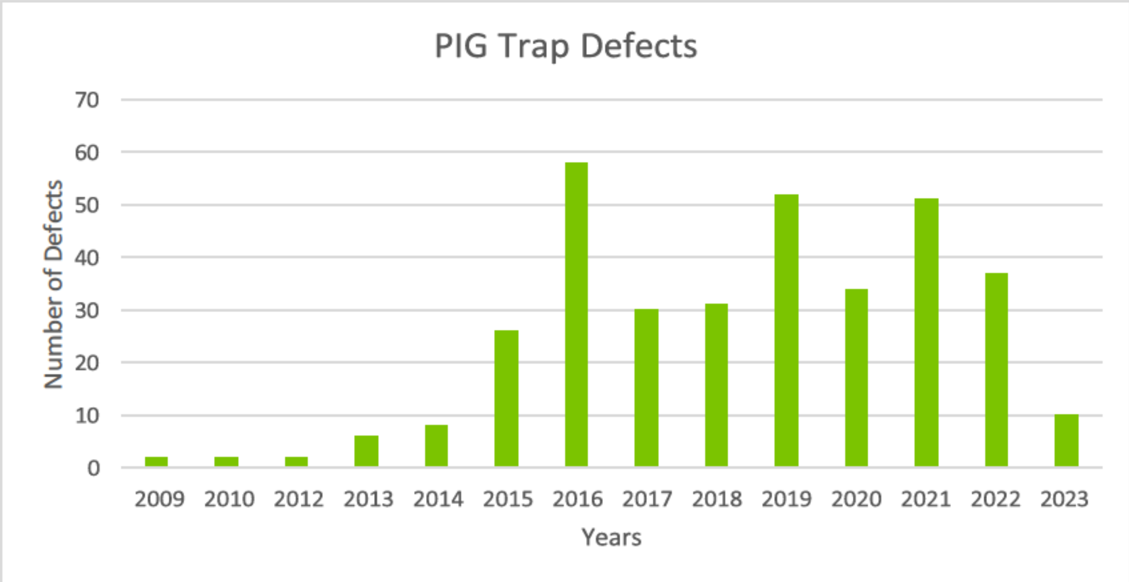

Figure 6: PIG Trap related defects

Probability of Failure Data Assurance

4.4.8 Fault data is obtained from known defects and occurrence / remediation run rates of the PIG Traps on the NTS. Some defects (i.e., surface corrosion) were found during routine inspections and they were repaired using normal techniques. The sample size is deemed to be statistically significant to justify the probability of failure of PIG Traps.

4.4.9 The only defects proposed to be addressed in RIIO-GT3 are those which are proven to have deteriorated sufficiently that they are adversely affecting performance or are in an unsuitable state of deterioration.

4.4.10 These defects have been identified through our rolling asset health plan, including asset condition survey reports, defects registers and inspection schedules.

4.5 Consequence of Failure

4.5.1 In the event of a PIG Trap failure, it has an impact on the ability to inspect buried transmission pipelines due to the inability to launch and receive PIGs. If a PIG Trap is unavailable when an ILI run is due, this could delay the inspection causing additional costs and could result in a breach of PSSR legislation if the pipeline is not examined on time, in accordance with its written scheme of examination. The consequence of this would be a requirement to depressurise and isolate the pipeline section resulting in operational challenges on the NTS with less pipelines available for use.

4.5.2 The table below indicates the expected impacts should any failures occur on PIG traps.

Table 7: Consequence of Failure Summary

Sub Asset	Impact / Consequence			
	Environment	Financial	Availability	Safety
PIG Trap	Associated with the loss of gas arising from leaks from a pressurised system (e.g., loss of seal). A leak to a PIG Trap would result in a large escape of methane to atmosphere which has a negative impact upon climate change.	This is mostly associated with the costs of operating and maintaining the assets at the current level of risk. Significant financial impact of a large-scale failure or loss of service event, due to loss of revenue, impact on reputation, fines, and compensation.	The risk of a loss of supply to customers is low. A PIG Trap incident could result in an outage being required if unable to be contained within the site. Significant proportions of our network are fed via multiple gas pathways. NGT view this risk as low. This risk could increase if we do not remediate the PIG Trap post incident.	This is associated with the possible risk of ignition, fires and explosions following a leak of gas from the PIG Trap impacting on safety of personnel.

4.6 Interventions Considered

Interventions

4.6.1 The interventions in this EJP have been developed to comply with our internal policy requirements for managing PIG Trap assets and associated remediation of defects. The interventions proposed are required to comply with PSSR Legislation, specifically regulations 8, 9 and 12.

Counterfactual (Do Nothing)

4.6.2 The counterfactual intervention considers no specific action to be undertaken in RIIO-GT3 over and above our usual PIG Trap maintenance and repair to meet the minimum level of intervention that would be required to remain complaint with all relevant safety regulations. Any consumables would be replaced through Opex maintenance activities. As the PIG Traps deteriorate, they will not be able to be safely operated for pipeline inspection activities.

4.6.3 This option has been ruled out as we would not be compliant with our statutory obligations as a responsible operator. The level of risk is not a tolerable level of risk for the NTS and exposes the site operatives to an unacceptable level of safety risk.

PIG Trap PSSR Major Inspection

4.6.4 The continuation of a cyclic programme of PIG Trap PSSR inspections allows us to validate that a PIG Trap is safe for continued use and compliant with PSSR legislation. The benefit of this is to achieve compliance with legislation and to allow the in-line inspection of pipeline assets.

4.6.5 This intervention includes a visual inspection of the components, removal of the coating to allow for a detailed examination of the pressure vessel body and welds. This work does not require an outage.

Refurbishment

4.6.6 For identified corrosion or cracking issues this intervention includes minor redressing of the PIG Trap to make good and reinstatement of the coating. The benefit of this is that it enables the PIG Trap to remain operational and compliant with legislation at minimal cost compared to other options.

4.6.7 This is a reactive intervention post PSSR Major Inspection and does not require an outage to deliver it.

Partial Replacement

4.6.8 Replacement of elements of the PIG Trap such as bridle pipework and the door closure mechanism.

4.6.9 This intervention is used when the component part of the PIG trap is the only failing part of the system and is impacting its overall performance. The benefit of this is that it enables the PIG Trap to remain operational and compliant with legislation.

4.6.10 This is a reactive intervention post PSSR Major Inspection and does not require an outage to deliver it.

Full Replacement

4.6.11 The removal of the existing PIG trap when it is uneconomical or unsafe to repair followed by replacement with a new PIG trap.

4.6.12 This intervention will be considered when the ongoing cost of refurbishment and repair is greater than the cost of replacement. This could be caused by an un-repairable crack or significant corrosion to the pressure vessel body.

4.6.13 Full replacement is only used for large PIG Trap vessels above 36" diameter. Below this, we remove the existing PIG Trap and modify the existing pipework to accommodate the use of a portable PIG Trap. Portable PIG Traps are not available for sizes above 36", meaning that replacement is the only viable option.

4.6.14 The benefit of this intervention is that it enables the pipeline asset to remain in-line inspectable and provides a new asset to the location.

4.6.15 This is a reactive intervention post PSSR Major Inspection and does require an outage to deliver it.

Removal

4.6.16 Removal of the existing PIG trap and replace with connections for temporary PIG trap installation and suitable bypass pipework for ongoing valve operations.

4.6.17 This intervention is considered on whole life cost grounds when the ongoing cost of refurbishment and repair is greater than the cost of removal. For logistical reasons, this is used only when the PIG trap is less than 36" diameter and when the site conditions, such as access, mean that the portable PIG Trap can be used. This proposal is a reactive intervention post PSSR Major Inspection and does require an outage to deliver.

4.6.18 The benefit of this intervention is that removing the PIG trap removes the requirement for inspection and maintenance. It also removes the potential hazard of the door closure by replacing it with a blank flange or contiguous pipework which is a more secure point of containment.

4.6.19 When existing PIG traps become uneconomical to repair, they will be replaced with portable options where size and road network allows for the usage of portable PIG Traps.

4.7 Intervention Summary

4.7.1 The below table shows a summary of the interventions considered.

Table 8: PIG Trap Interventions Technical Summary Table

Option	Investment design life	Positives	Negatives	Taken Forward	Reason
Do Nothing	N/A	Low-Cost option in the short term.	Increased risk in loss of containment events and safety of operatives	No	Unacceptable level of risk. Does not meet with statutory legislation.
PIG Trap Major PSSR Inspection	12-year frequency	Re-validates PIG Trap for continued use.	Requires removal of coating system.	Yes	Maintains compliance with PSSR Legislation.
Refurbishment	20 year predicted design life.	Maintains integrity of the pressure vessel body.	PIG Trap is not able to be used until re-validated post work completion could have impact on ILI Programme.	Yes	Low-cost intervention to maintain integrity of asset.
Partial Replacement	Typical design life of component - 20 years.	Keeps existing PIG Trap operational.	Certain components can have long lead times.	Yes	Low-cost intervention to continue operational status of PIG Trap.
Replacement	Typical design life of 40 years.	Retains function at site to launch/receive ILI tools.	Long-lead item as manufactured to requirements.	Yes	For certain pipe sizes and difficult to access sites this is the only option available once un-economical to repair.

Option	Investment design life	Positives	Negatives	Taken Forward	Reason
Removal	Typical design life of 50 years.	Reduced future maintenance as Pressure vessel is removed from site.	Not applicable in all scenarios- dependant on pipe size and road network leading to the site for transportation of the temporary PIG.	Yes	Reduced number of permanent PIG Traps reduces cost to consumer.

4.7.2 The above considered interventions have been organised into 3 intervention options:

- **PIG Trap Major PSSR Inspection**
- **PIG Trap PSSR Defect Resolution – Minor**: Combination of refurbishment and partial replacement. These will be undertaken in response to findings from the Major PSSR inspection.
- **PIG Trap PSSR Defect Resolution – Major**: Combination of replacement and removal. These will be undertaken in response to findings from the Major PSSR inspection. The appropriate remediation will be selected when a PIG trap is deemed to be uneconomical to repair and will depend on PIG trap size and accessibility.

Volume Derivation

4.7.3 These intervention volumes have been built using a repeatable methodology from data held in PSSR records from our centralised systems. The scope is a repeat of RIIO-T2 which is well defined and understood within NGT and has been successfully delivered against.

4.7.4 The below table summarises how the investment volumes have been built for PIG Traps.

Table 9: Development of bottom-up PIG Trap intervention volumes for RIIO-GT3

Investment Name	Volume	Unit of Measure	How this volume has been developed
PIG Trap Major PSSR Inspection	[redacted]	Per asset	Interrogating internal PSSR examination records to identify PIG Trap Major PSSR Inspections due within RIIO-GT3 based on their inspection frequencies. Major inspections, and associated interventions, are carried out every 12 years.
PIG Trap PSSR Defect Resolution – Minor	[redacted]	Per asset	Built from reviewing historical numbers of defects following PSSR examinations which are not recorded as having severe mechanical damage or corrosion. The number of inspections due in RIIO-GT3 are multiplied by the 45% inspection to defect rate. A run-rate based on historical data is then applied identify the number of Minor remediations. Minor inspections, and associated interventions are carried out every six years.
PIG Trap PSSR Defect Resolution – Major	[redacted]	Per asset	Built from reviewing historical numbers of defects following PSSR examinations which are recorded as having severe mechanical damage or corrosion and are therefore not economical to repair requiring complete replacement or conversion to a temporary PIG Trap connection point. The number of inspections due in RIIO-GT3 are multiplied by the 45% inspection to defect rate. A run-rate based on historical data is then applied identify the number of Major remediations.

Unit Cost Derivation

4.7.5 Our unit costs for the above interventions have been based on the costs of delivering the same scopes in RIIO-T2. A summary is provided in Table 10 with a further breakdown of costs provided in Appendix 9.2.

Table 10: PIG Trap Intervention Unit Cost Summary Table (£m, 2023/24)

Option	Unit of Measure	Unit Cost	Cost Accuracy	Number of Data Points	Source Data
PIG Trap Major PSSR Inspection	Per asset	£[redacted]	+/-10%	26	Historical Outturn
PIG Trap PSSR Defect Resolution- Minor	Per asset	[redacted]	+/-10%	5	Historical Outturn
PIG Trap PSSR Defect Resolution- Major	Per asset	[redacted]	**+/-50%**	3	Historical Outturn

4.7.6 The cost for PIG Trap PSSR Defect Resolution- Major has been produced using 3 data points for historically delivered works. These data points have been validated as a correct reflection of the scope. There were no outliers identified in the unit cost schedules provided. The cost produced has been taken as an average of the 3 data points. No uplifts for additional risk have been applied to this figure.

4.7.7 Our cost accuracies are determined based on the type of cost data available, the quantity of this data (i.e., the number of data points) and the similarity of the scope of these historical data points against our RIIO-GT3 investment programme.

4.7.8 Interventions in our pressure vessels investment theme with a +/-50% accuracy are where they have been derived from RIIO-T1 unit costs, acknowledging the time since these interventions were delivered.

5 Scrubbers and Condensate Tanks - £5.6m (2023/24)

5.1 Introduction

5.1.1 This EJP requests funding to manage risk, remain compliant with legislation and address known asset health defects associated with Scrubbers and Condensate Tank Pressure Vessels to ensure that they are fit for purpose to prevent contaminants from damaging downstream assets.

5.1.2 Scrubbers and Condensate Tanks are pressure vessel assets which are managed in accordance with PSSR, like PIG Traps. They are located at our System Entry Points, Compressor Sites and Terminals and are critical in reducing the risk of contaminants damaging pressure reduction, flow control or compression plant assets on the National Transmission System (NTS). Scrubbers remove dust, debris and liquids from the gas flow and Condensate Tanks hold the contaminants removed by the Scrubbers.

5.1.3 This paper aims to seek investment so that NGT can carry out the below:

- **Scrubbers** - The necessary interventions required on Scrubbers, at Compressor Stations, following statutory six and/or twelve yearly inspections.
- **Condensate Tanks** – The necessary interventions required to maintain the Condensate Tank storage facilities at Compressor Stations across the NTS. This includes any refurbishment, repair or replacement of the Condensate Tanks and the associated modifications to ancillary assets. Modifications to Scrubbers to accommodate Condensate Tank interventions are separate from the specific statutory Scrubber interventions.

5.1.4 In RIIO-T2, investment in **Scrubbers** focused on major refurbishment. For RIIO-GT3 the scope of work is largely expected to remain the same with the run rate of expected defects aligned to historical rates.

5.1.5 In RIIO-T2, investment in **Condensate Tanks** has focused on decommissioning of existing Fixed Condensate Tanks (FCTs) in line with NGT's RIIO-T2 funding request and Ofgem's subsequent Final Determination (FD) award. For RIIO-GT3 the investment approach is replacement of the FCTs with Mobile Condensate Tanks (MCTs).

5.1.6 The worklist has been generated through the assessment of known defects and our ongoing asset health management programme as follows:

- Assessment of known defects from the NGT's defect register.
- Assessment of the RIIO-T2 Fixed Condensate Tank strategy.

5.2 Equipment Summary

5.2.1 Scrubbers and Condensate Tanks, schematised in Figure 7, are typically installed at NGT's System Entry Points, Compressor Sites and Terminals.

5.2.2 These two asset types, built between the early 1970s ([redacted] and the late 2000s ([redacted] normally operate in the pressure range of 39 bar to 94 bar with operating temperature between -10˚C and +50˚C.

5.2.3 Condensate Tanks on the NTS vary between 1000ltrs and 46,500ltrs in volumetric capacity. Information available indicates they were manufactured by [redacted] (Danks P. Vessels).

5.2.4 Condensate Tanks hold the contaminants removed from NTS pipework by filters and Scrubbers. These include liquids (for example, oil that has leaked into pipework from compressor shaft seals) along with dust and debris. These tanks are periodically emptied (decanted) into mobile road tankers for safe off-site disposal.

5.2.5 The condensate is highly flammable so there are strict safety rules in place on sites where tanks are present.

[redacted]

Figure 7: Scrubbe[redacted]

5.2.6 There are 15 FCTs installed across 13 sites across the NTS as summarised in Figure 7. [redacted], as part of the ongoing Emissions Reduction 3 (ERP3) programme. Wisbech FCT is planned to be decommissioned along with the site in RIIO-GT3. The St Fergus FCTs are covered in a separate theme. Therefore, this EJP focuses on [redacted]

5.2.7 There are 33 Scrubbers installed across 13 sites across the NTS as summarised in Figure 7. Redundancy is built in by having multiple Scrubbers in parallel at each compressor site. This ensures that loss of a Scrubber on a site does not stop gas flow.

5.2.8 Scrubbers and Condensate Tanks are classed as pressure vessels so require regular safety inspections and maintenance and are governed by PSSR. Any defects identified during these inspection and validation activities need to be remediated appropriately.

5.2.9 In RIIO-T1, Ofgem approved Network Innovation Allowance (NIA) funding for development of the Mobile Condensate Tank (MCT) concept to address significant safety and maintenance concerns with the existing Fixed Condensate Tanks (FCTs) draining Scrubbers at compressor sites across the NTS. We have developed this sole proof-of-concept MCT, tested it refining the design, such that it can be rolled out across the NTS. Further information on this is in Table 11, Section 5.6.32, Section 5.6.38, and Table 26.

5.3 Problem/Opportunity Statement

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

5.3.1 The drivers for investment in Scrubbers and Condensate Tanks are Legislation, Asset Deterioration and Safety.

5.3.2 Scrubbers and Condensate Tanks are installed on the NTS to remove contaminants from the gas flow ensuring gas quality of the right volume and to the right specification thereby providing protection to NTS and customer assets.

Scrubbers

5.3.3 Continued use of Scrubbers without investing in inspections, revalidation and remediation will mean that assets are non-compliant with PSSR legislation. This could lead to serious injury and/or prosecution.

5.3.4 Lack of investment in the remediation of faults found during inspections will render the assets unable to be used to convey gas. Isolation of items of plant and equipment would reduce the resilience of the NTS, ultimately it may lead to the inability of NGT to meet the service requirements of its customers.

5.3.5 Of the 33 Scrubbers on the NTS, [redacted] are scheduled to undergo either minor or major inspection in RIIO-GT3. Out of these and based on the RIIO-T2 run rate it is anticipated that [redacted] of them will require some form of remediation over the RIIO-GT3 period.

Fixed Condensate Tanks

5.3.6 Fixed Condensate Tanks were designed and installed between the early 1970s and late 2000s. The design does not comply with modern standards in terms of protection against breakthrough of high-pressure gas from the Scrubber to the FCT which has a low design pressure. There is a risk of over-pressurisation and possible loss of containment because of equipment or procedural failures during Scrubber draining.

5.3.7 An issue identified in 2016 initiated a chain of events which has concluded in the recognition that FCTs cannot be used as currently configured because it is not possible to demonstrate that the process design is safe under all circumstances and meets modern standards. The systems affected were Gas Scrubbers, Scrubber Dump Line(s), Condensate Vessel, and their Protective Devices. Where FCTs have been refurbished none have been commissioned because of residual safety concerns. This has placed us in a position of significant safety, operational, financial, and reputational risk. The timeline of these events is shown in Table 11.

Table 11: Timeline of events related to the use of FCTs

Date	Development
2016	A scrubber draining issue identified at [redacted] led to the issue of Engineering Bulletin (EB) 471 in 2016 prohibiting use of FCTs until full process safety checks and risk assessments had been completed.
2016	Ofgem approved NIA funding for development of the Mobile Condensate Tank (MCT) concept to address significant safety and maintenance concerns with the existing FCTs draining Scrubbers at compressor sites across the NTS.
2019	HSE Action Legal issued on the [redacted] Scrubber draining system pointing to significant safety problems in the current state of Scrubber draining operations. This resulted in an internal Engineering Bulletin (EB471) update applicable to all NGT Compressor / Terminal sites with Gas Scrubber and Condensate Removal systems. It required that all Condensate Tanks be appropriately isolated with valves locked in place and controlled with appropriate permitry.
2021	Corporate Audit raised concerns over NGT's process safety management of an over-pressurisation risk to its Condensate Tanks at certain Compressor Stations. A subsequent report made a number of strong and wide-ranging recommendations aimed at ensuring that, where required, a workable Scrubber draining system was in place across the NTS.

[redacted]

[redacted]

Investment Drivers

5.3.10 The drivers for investment in Scrubbers and Condensate Tanks include those summarised in Table 12.

Table 12: Categories of Driver for Scrubbers and Condensate Tanks

Driver Category	Description
Legislation	Compliance with Pressure System Safety Regulations 2000 (PSSR).
Risk Management / Safety	Carryover of solids/liquids downstream could result in significant safety consequences, such as damage to compressors machinery trains and customer assets.
Asset Deterioration	The assets deteriorate over time and with use which leads to their inability to perform their required function. This can also result in them no longer complying with direct legislative requirements.

5.3.11 The [redacted] need to be replaced with an appropriate asset set to ensure restoration of the original intent of the Scrubber/Condensate Tank system within the RIIO-GT3 period.

[redacted]

What is the outcome that we want to achieve?

5.3.13 We are seeking funding through this submission to ensure that the following outcomes are achieved:

- Restoration of the original design intent of the Condensate Tank system on the NTS.
- Meet legal requirements and agreed safety standards.
- Ensure ongoing compliance with PSSR.
- Manage deterioration of the assets such that they do not limit availability, performance, or cause damage to other assets on the NTS or those of consumers.
- Providing benefit to consumers through optimised investment to ensure the Scrubber and Condensate Tank assets last as long as compression is needed, balancing cost, risk and performance.

How will we understand if the spend has been successful?

5.3.14 The investment plans will be considered to be successful when the outcomes summarised above and below are met:

- Design gaps in current proof of concept MCT addressed with restoration of the original design intent of the Condensate Tank/Scrubber system across the NTS.
- Ensuring continued compliance with PSSR and PSR and other legislative requirements.
- Ensuring continued integrity of Scrubber assets.

Narrative Real-Life Example of Problem

5.3.15 In early 2021, [redacted] passed significant quantities [redacted] of glycol/water into the NTS over an extended period. This is far beyond the [redacted] capacity of the MCT. The bulk of this liquid was removed from the various low point drains on site, but some settled and accumulated in the Scrubbers at [redacted]

5.3.16 Due to the high gas demand on the NTS, there was a need to drain the Scrubbers at these sites on an emergency basis. This revealed that not having a properly thought through system of Scrubber draining readily available was unacceptable. The process implemented required isolation and venting down of the scrubbers such that the upstream pressure did not exceed the design pressure of the scrubbers. This was successfully implemented although time consuming and did make the compressors unavailable.

5.3.17 In late 2021 [redacted] reported that high levels of condensate in the Scrubbers was being experienced but the site FCT was still out of service, as it had been since 2016. It was judged to be infeasible to bring the FCT back into service quickly and safely and so the site and Safety Engineering jointly developed use of the new proof-of-concept MCT to drain the Scrubber.

5.3.18 At [redacted], condensate draining is required approximately once per year.

5.3.19 The incidents summarised in this section, once each at [redacted], twice at [redacted] and annually at [redacted] highlight the unpredictable frequency and volumes of condensate events, emphasizing the need to have a robust and effective system of scrubber draining readily available at each compressor site.

Project Boundaries

5.3.20 Within scope of spend in this EJP are all Condensate Tanks and their associated Scrubbers, including all relevant ancillary assets. Also included are the Scrubbers anticipated for refurbishment across RIIO-GT3.

5.3.21 Not included within this EJP are:

- Any routine maintenance on any Scrubber and Condensate Tank assets.
- Removal of inlet strainers, which provide a similar protective role, is captured in the Rotating Machinery EJP[1].

[1] NGT_EJP04_Rotating Machinery_RIIO-GT3

5.4 Probability of Failure

5.4.1 Probability of failure (PoF) has been assessed both utilising historical defects and utilising the Network Asset Risk Metric (NARM) model. This model is built within our Copperleaf asset management decision support tool to assess the forward-looking probability of failure. This provides a different lens to consider in addition to looking at historically captured defects.

5.4.2 Not all modelled failures will result in real-world asset failure and this forecast is not a prediction of how many defects will be identified.

5.4.3 The modelled failure impact for Condensate Tank assets is associated with the loss of the system and the impact this has on additional maintenance and remedial activities to protected assets. As the FCTs have already failed and have been isolated/locked-off in readiness for decommissioning in RIIO-T2, failure modes and failure rates are not relevant to our proposed investment.

5.4.4 Likely failure modes for scrubbers, with an average proportion of failures of 0.5 or above, are provided in Table 13: Scrubbers failure modes. The full list of failure modes is available in the NARMs methodology.

Table 13: Scrubbers failure modes

Failure Mode	Average Proportion of Failures
Vessel corrosion	0.7
Vessel failure significant gas release	0.5

5.4.5 When applied to the asset count with an assumption that no investment is made, a forecast of failures across the RIIO-GT3 period is produced, shown in Table 14: Forecast scrubber failures. The average failure rate represents the proportion of that asset type with an unresolved failure. The forecast failures per year shows the quantity of new failures modelled to occur each year.

Table 14: Forecast scrubber failures

Asset Type	No. of Assets	Cumulative Average Failure Rates					Forecast Failures per Year				
		2027	2028	2029	2030	2031	2027	2028	2029	2030	2031
Scrubbers	68	0.96	0.96	0.96	0.96	0.96	1	1	1	1	1

5.4.6 Scrubber failures are most likely faults/defects (e.g. corrosion) found during inspection and not catastrophic. We are predicting they would increase marginally across RIIO-GT3. Our model is predicting our failure rate will go up marginally.

Defect Analysis

5.4.7 Most Scrubber and Condensate Tank assets do not immediately fail but rather deteriorate. This results in poor performance which leads to further deterioration and eventually removal from service to avoid failure. Failures can happen even with regular maintenance due to age and usage frequency.

5.4.8 A review of the defects register, between 2009 and 2023, indicates there have been 15 Scrubber related defects over that time period, with the phasing shown in Figure 8. Over the 14 years this equates to an average of one defect to be resolved per year.

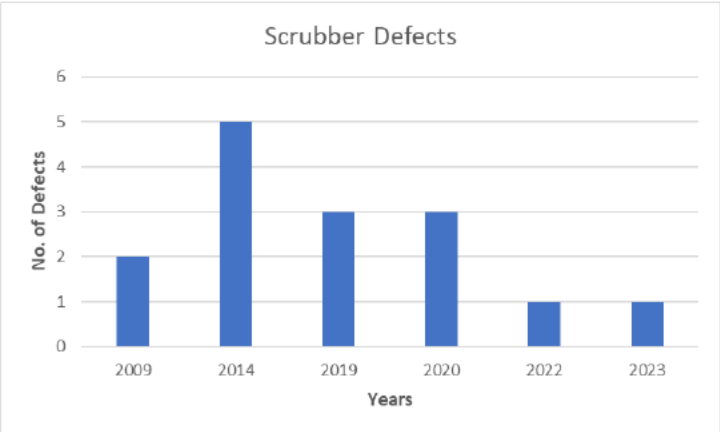

Figure 8: Scrubber related defects

5.4.9 As there has been a prohibition on the use of Fixed Condensate Tanks following an action from the HSE over process safety concerns in 2016, a defect analysis or probability assessment is not required. The risk is driven by the frequency and volume of liquids finding their way onto the NTS.

Probability of Failure Data Assurance

5.4.10 For Scrubbers the fault data is obtained from known defects and occurrence / remediation run rates of the 33 Scrubbers on the NTS. Some defects (i.e., surface corrosion and/or, fouling on the baffles) were found during routine inspections and they were repaired using normal techniques. The sample size, drawn from between 2009 and 2023 is deemed to be sufficient to justify the probability of failure of Scrubbers.

5.4.11 For Condensate Tanks the failure data has been obtained from knowledge of the full sample size of affected FCTs on the NTS and the subsequent faults identified. It is further corroborated by EB471 and the HSE Action Legal.

5.4.12 The only defects proposed to be addressed in RIIO-GT3 are those which are proven to have deteriorated sufficiently that they are adversely affecting performance or are in an unsuitable state of deterioration.

5.4.13 These defects have been identified through our rolling asset health plan, including asset condition survey reports, defects registers and inspection schedules.

5.5 Consequence of Failure

5.5.1 Scrubber and Condensate Tank assets failing and resulting in NTS capability being compromised could lead to network constraints, particularly in low resilience areas of the network. The impact/consequence of failure for Scrubbers and Condensate Tanks, in order of significance, is summarised in Table 15.

5.5.2 Failure or reduction in performance of Scrubbers and Condensate Tanks could lead to contamination and failure of critical downstream equipment which can lead to security of supply issues.

Table 15: Consequence of Failure Summary

Sub Asset	Impact / Consequence			
	Environment	Financial	Availability	Safety
Scrubbers	This is the largest proportion of overall service risk and is associated with the loss of gas from leaks and carbon emissions associated with asset maintenance. For example, leak of gas from a Scrubber. There is also an environmental risk associated with leaks of collected condensate from Scrubbers.	This is mostly associated with the costs of operating and maintaining the assets at the current level of risk. Significant financial impact of a large-scale failure or loss of service event, due to loss of revenue, impact on reputation, fines, and compensation. This could result from downstream assets being contaminated by condensate liquids resulting in damage to the said assets.	There is a risk of damage to us and our customers' downstream equipment because of contaminants/condensate ingress. This would result in failure of NTS assets downstream of Compressor Stations and subsequent isolation of downstream customers. However, the availability impact is negligible due to the ≥ 2 x Scrubber arrangements.	This is associated with the possible risk of ignition, fires and explosions following a leak of gas from the Scrubber impacting on safety of personnel. There is a risk of over-pressurisation and possible loss of containment because of equipment or procedural failures during Scrubber draining.
Condensate Tanks	There is an environmental risk associated with leaks of undrained condensate from the tanks.		Lack of a sufficiently sized Condensate Tank for a Scrubber to drain into causing shutdown of a compressor site. With only 1xMCT tank to service the NTS, availability becomes an issue if it is required to deal with condensate at multiple sites simultaneously.	There is a risk of over-pressurisation and possible loss of containment because of equipment or procedural failures during Scrubber draining. This would impact on safety of personnel.

5.6 Interventions Considered

5.6.1 The interventions in this EJP have been developed to comply with our internal policy requirements for: managing Scrubber and Condensate Tank assets and the associated remediation of defects; and ensuring the process design is safe under all circumstances. The interventions proposed are aimed at complying with PSSR.

Scrubber Interventions

5.6.2 This section summarises the interventions available for Scrubbers to address the drivers identified.

Scrubbers – Counterfactual (Do Nothing)

5.6.3 The counterfactual intervention considers no specific action to be undertaken in RIIO-GT3 over and above our usual Scrubber maintenance and repair to meet the minimum level of intervention that would be required to remain complaint with all relevant safety regulations. Any consumables would be replaced through Opex maintenance activities. As the Scrubbers deteriorate, they will not be able to remove the contaminants effectively and safely from NTS pipework.

5.6.4 This intervention does not address known issues and means we aren't compliant with PSSR and PSR legislation. This is therefore not being progressed.

Scrubbers – Decommission the Scrubbers

5.6.5 This intervention constitutes the disconnection and removal of the Scrubbers with identified defects.

5.6.6 The Scrubber assets are needed to remove and hold dust, debris and liquids removed from the gas flow to prevent downstream asset damage. These assets are still required to perform this function and their removal would compromise efficient operation of the NTS. This intervention does not address known issues and means we are not compliant with PSSR. This is therefore not being progressed.

Scrubbers – Defect repair following inspection

5.6.7 Remediation of faults found during inspection will enable the assets to continue being used to convey gas in a safe and timely manner. The benefit of this intervention is that identified PSSR defects will be dealt with in a timely manner thus mitigating the risk of downstream equipment failure and security of supply issues. Therefore, this intervention is being progressed.

Scrubbers – Delayed defect repair following inspection

5.6.8 In this intervention the assumption is that there would be a delay in remediation of PSSR faults found during inspection. There would be an indeterminate timescale to complete essential remediation.

5.6.9 However, this is fundamentally against legislation and due to the inherent associated risks, this intervention shall not be progressed. The cost of this option would be similar to that of the third option, simply occurring at a later point in time.

Scrubbers – Replace

5.6.10 This intervention would involve replacing defective Scrubber(s). While this is a viable intervention, the 6 and 12 yearly statutory inspections negate the need for replacement, as defects are remediated as soon as they are found.

5.6.11 The assumption is that these assets would be replaced. However, due to legislative, operational and safety considerations the Scrubbers would not be left to deteriorate to such an extent that they needed replacing. This intervention does not provide value for consumers as it is more expensive than addressing defects. Therefore, this intervention is not being progressed.

Condensate Tank Interventions

5.6.12 This section summarises the interventions available for Condensate Tanks to address the drivers identified and provides an overview of the interventions we have considered and how they have been developed.

Condensate Tanks – Counterfactual (Do nothing)

5.6.13 The counterfactual intervention considers no specific action to be undertaken in RIIO-GT3 over and above our usual Condensate Tank maintenance and repair to meet the minimum level of intervention that would be required to remain compliant with all safety regulations. Any consumables would be replaced through Opex maintenance activities.

5.6.14 This intervention does not address the significant safety problems in the current state of Scrubber draining operations highlighted by both the HSE and NGT. It places the business at significant risk surrounding safety, availability, and operability. It is therefore not being progressed.

Condensate Tanks – Repair FCTs and return to service

5.6.15 This intervention assumes the current FCTs are in a state to be repaired and entails assessing the condition of the FCTs to determine the scope for repair/refurbishment. This would be followed by the necessary investments to return them to service.

5.6.16 This approach has been attempted before at [redacted] and [redacted] Neither has been commissioned due to residual safety and operational issues and therefore has limited consumer value.

5.6.17 This intervention is not possible since all FCTs will have been removed by the end of RIIO-T2 in alignment with Ofgem's 2020 Final Determination and they cannot be repaired and returned to service. Therefore, it is not being progressed.

Condensate Tanks – Mix of FCT repair and new MCTs

5.6.18 This intervention would involve identifying which FCTs to retain, and the associated repair/refurbishment costs, based on condition. Assessment would also be made of which FCTs were beyond economical repair and have these replaced with an equivalent number of MCTs to restore the required complement of Condensate Tanks to the NTS.

5.6.19 As this intervention includes the same repair approach as the previous intervention, albeit for a subset of the FCTs, it is not being progressed on the same basis.

Condensate Tanks - Replace FCTs with shared MCTs

5.6.20 This intervention would entail having shared MCTs stationed at central locations from which they could be transported to and from their point of need. The quantity would be based upon the concentration of Compressor Stations in different parts of the NTS.

5.6.21 The design of shared MCTs is such that they are small in volumetric terms [redacted] and would require multiple fill/empty cycles to fully drain a Scrubber in a particularly intense condensate event. They are therefore not suited to handling anticipated large volumes of condensate from Scrubbers such as the [redacted] incident described in Section 5.3.15. The tanks are relatively small, constrained by the requirement to be light enough to be transported by road using a crane equipped lorry.

5.6.22 However, this intervention has inherent risks. The NTS was designed based on having an available Condensate Tank at each Compressor Station, to ensure the Scrubbers can be drained in the event of an emergency incident. If there was a condensate event that filled the Scrubbers and they couldn't be emptied, it would result in a wider condensate event impacting the wider network. A case in point is the example shared in Section 5.3.15 where significant quantities [redacted] of glycol/water was passed into the NTS settling at [redacted] and [redacted]. This is far beyond the [redacted] capacity of the MCT.

5.6.23 There would be a need to invest in a suitable transportation vehicle and operative alongside all the other incidental costs and risk assessments required. There are inherent risks with moving MCTs between sites. In addition, if the driver/operative were unavailable in an emergency it would then not be possible to safely move the MCTs between sites.

5.6.24 Expected ongoing operational (Opex) costs for shared MCTs include:

- Hire and / or maintenance of the crane equipped lorry.
- Fuel associated with the crane equipped lorry.
- Refurbishment associated with the wear and tear of the MCTs and associated ancillary equipment resulting from being transported around.
- Hiring of a crane lorry driver/operative including standby allowance for emergency incidents.
- Management of suitable storage facilities for both the MCTs and the crane equipped lorry.

5.6.25 The operational and management costs associated with shared MCTs is over and above the expected costs for stationary site-specific MCTs. This intervention is therefore not being progressed.

Condensate Tanks – Replace all FCTs with stationary ungrouted MCTs

5.6.26 This intervention is to, following decommissioning of the existing FCTs, replace them all with MCTs. This will include any necessary infrastructure modifications and asset health work to connected Scrubbers and ancillary connected assets. Included in this scope is any hard standing/foundation required to support the fixed MCT. Though the tanks will be stationary they will not be fixed grouted enabling them to be moved/swapped with relative ease compared to the current FCTs giving them the ability to be disconnected and dismantled safely and efficiently if/when the need arises. This intervention restores the original design intent of the Scrubber/Condensate Tank system and does not incur significant resources over and above the other lesser options.

5.6.27 The stationary MCTs will need to have a volumetric capacity larger than the current proof-of-concept MCT [redacted]) to be commensurate with the existing Scrubber liquid capacity which varies between [redacted] and [redacted] The larger capacity becomes possible because we would not be transporting them around the country.

5.6.28 This approach is aligned with NGT's RIIO-T2 business plan and Ofgem's 2020 Final Determination which specify that the existing FCTs should be decommissioned within RIIO-T2.

5.6.29 The benefit of this intervention is that the required Condensate Tank coverage of the NTS is retained and restores the original design intent of the Scrubber/Condensate Tank system. This removes the risk associated with moving MCTs around and management of multiple condensate events happening concurrently. The associated operational expense of this option is lower than that of the shared MCTs.

5.6.30 The design gaps identified in the proof-of-concept MCT are being addressed to enable build and rollout of MCTs across the NTS.

Intervention Summary

5.6.31 Table 16 summarises the interventions considered for our Scrubber and Condensate Tank assets across RIIO-GT3.

Table 16: Scrubber and Condensate Tank Interventions Technical Summary Table

Asset Group	Intervention	Investment design life	Positives	Negatives	Taken Forward	Reason
Scrubbers	Counterfactual	N/A	Lowest cost option	Does not address forecast AH issues that could compromise NTS operation.	No	Unacceptable level of risk. Does not meet with statutory legislation.
	Decommission the Scrubbers	N/A	None	Does not address forecast defects and risks ongoing operation of equipment.	No	Unacceptable level of risk. Does not meet with statutory legislation.
	Timely repair of identified defects	20 years	Addresses forecast defects and ensures ongoing operation of equipment.	Requires immediate investment to remediate found defects.	Yes	Low-cost intervention to maintain integrity of asset.
	Delayed repair of identified defects	20 years	None	Does not immediately address forecast defects and risks ongoing operation of equipment.	No	Unacceptable level of risk. Does not meet with statutory legislation.
	Replace the Scrubbers	N/A	Brand new Scrubbers with full design life.	Costly option which does not need to be implemented as the Scrubbers would not be left to deteriorate to such an extent that they needed replacing. There would need to be extended outages to replace Scrubbers, and must be planned for well in advance to avoid security of supply problems.	No	Costly unnecessary option which does not provide value for consumers.
Condensate Tanks	Counterfactual	N/A	Lowest cost option	Does not address known AH issues that could compromise NTS operation.	No	Unacceptable level of risk. Does not meet with statutory legislation.
	Repair FCTs (x10) and return to service	15 yrs.	None.	Repair/refurbishment of FCTs still leaves residual safety and operational issues.	No	Unacceptable level of risk. Does not meet with statutory legislation. All FCTs are scheduled to be decommissioned in RIIO-T2.
	Mix of repaired FCTs (X4) and new MCTs (x6)	40 yrs.	None.	Does not address known AH issues that could compromise NTS operation.	No	Unacceptable level of risk. Does not meet with statutory legislation.

Asset Group	Intervention	Investment design life	Positives	Negatives	Taken Forward	Reason
						All FCTs are scheduled to be decommissioned in RIIO-T2.
	Replace FCTs with shared MCTs(x7)	40 yrs.	Partially address NTS need. Lower Capex in RIIO-GT3	Does not address NTS needs and increases the risk of not being able to manage condensate events.	No	Does not satisfy the original intent of the Scrubber/Condensate Tank system.
	Replace all FCTs with fixed MCTs (x10)	40 yrs.	Addresses NTS needs. Aligns with NGT Business plan and Ofgem's FD.	It is the highest cost option and needs intervention as every identified site. It is not a solution that can be implemented immediately but has to be rolled out across RIIO-GT3,	Yes	Restoration of the original intent of the Scrubber/Condensate Tank system

5.6.32 The Scrubber scope is a repeat of RIIO-T2 activities which is well defined and understood within NGT and has been successfully delivered against. The FCT refurbishment scope is based on historical works done over RIIO-T1 and RIIO-T2. The FCT replacement scope is based on a RIIO-T1 NIA project.

Volume Derivation

5.6.33 The intervention volumes summarised in the Table 17 have been built using repeatable methodology using data held in Scrubber refurbishment records from our centralised systems; and the need to restore the Condensate Tank systems, on the NTS, to its original design intent.

Table 17: Volume derivation for proposed interventions

Intervention	Volume	Unit of Measure	How this volume has been developed
Timely repair of identified defects - Scrubbers	[redacted]	Per asset	Built from reviewing historical annual rates of refurbishments following scheduled PSSR examinations.
Replace all FCTs with fixed MCTs (x10)	[redacted]	Per site	Built up from the total number of FCTs that need to be replaced. The two at [redacted] are covered in a separate EJP, the ones at [redacted] and [redacted] Compressor Stations are being replaced under a separate Emissions Reduction Project 3 (ERP3) and the one at [redacted] Compressor Station is excluded as the site is planned for decommissioning in RIIO-GT3 – as outlined in Compressor Fleet EJP. We have evaluated our need at [redacted] and determined that one MCT is sufficient to accommodate condensate at the site. Therefore, the 11 original FCTs are to be replaced by 10 MCTs.

Unit Cost Derivation

5.6.34 Unit costs for Scrubbers have been based on the cost of RIIO-T2 work delivered to date for the same scope. For Condensate Tanks, unit costs have been based on outturn cost for work completed at [redacted] and [redacted] or derived using known rates and supplier quotes based on clear scopes.

5.6.35 Our cost accuracies are determined based on the type of cost data available, the quantity of this data (i.e., the number of data points) and the similarity of the scope of these historical data points against our RIIO-GT3 investment programme.

5.6.36 Interventions in our Scrubbers and condensate tank investment theme with a +/-50% accuracy is where they have been derived from RIIO-T2 unit costs, but data points are limited.

5.6.37 A summary is provided in Table 18 with a further breakdown in Appendix 9.2.

Table 18: Scrubber and Condensate Tank Intervention Unit Cost Summary Table (£m, 2023/24)

Intervention	Unit of Measure	Unit Cost (£m)	Cost Accuracy	No. of Data Points	Source Data
Delayed repair of identified defects - Scrubbers	Per asset	[redacted]	+/-50%	1	Historical outturn based on one RIIO-T2 intervention.
Timely repair of identified defects - Scrubbers	Per asset	[redacted]	+/-50%	1	Historical outturn based on one RIIO-T2 intervention.
Repair FCTs (x10) and return to service	Per asset	[redacted]	+/-50%	2	Mix of assumptions and real data.
Mix of repaired FCTs (X4) and new MCTs (x6)	Per asset	[redacted]	+/-50%	2	Mix of assumptions and real data. First principles – derived using known rates/activities and supplier quotes.
Replace FCTs with shared new MCTs(x7)	Per asset	[redacted]	+/-10%	0	First principles – derived using known rates/activities and supplier quotes.

Intervention	Unit of Measure	Unit Cost (£m)	Cost Accuracy	No. of Data Points	Source Data
Replace all FCTs with fixed MCTs (x10)	Per site	[redacted]	+/-10%	0	First principles – derived using known rates/activities and supplier quotes

5.6.38 The costs for replacing the FCTs with MCTs has been derived from first principles, known rates/activities and supplier quotes. The costs have included for a review of the design gaps of the NIA MCT, site specific detailed design studies including allowances for design, site visits, non-routine operation costs, site overheads, main contractor works, infrastructure costs and hard standing and testing and commissioning.

5.6.39 In addition to the historic works, a Construction Estimate has also been generated to validate future works. This estimate has been produced utilising quotations from our key supply chain with additional considerations applied for project management, supervision, and design requirements. The specific scope on this activity was to "Replace Fixed Condensate Tank with Mobile Condensate Tank". In contrast to the existing historical data, a 10% risk and contingency provision has been applied to the estimated figure.

6 Options Considered

6.1 Portfolio Approach

6.1.1 In developing our plans, we focused on value for money and deliverability, while managing the risks of aging assets. We evaluated the cost-effectiveness of our investment program through a full Cost Benefit Analysis (CBA) using the NARMs Methodology within the Copperleaf Decision support tool.

6.1.2 We have assessed the benefit from options across the entire pressure vessel portfolio to meet investment drivers, business plan commitments, and consumer priorities. Therefore, a single CBA covers PIG Traps, Scrubbers and Condensate Tanks.

6.1.3 The options considered combine the interventions discussed previously in varying combinations and volumes to identify the optimal investment for Pressure Vessels.

6.1.4 In Line with HM Treasury Green Book advice and Ofgem guidance, we assessed the value of investing in Pressure Vessels across the RIIO-GT3 period by analysing the cost benefit over a 20-year horizon.

6.1.5 We derived bottom-up intervention volumes using the engineering assessments described in the previous chapters. Each investment was assessed via the Ofgem-approved NARMs Methodology embedded in Copperleaf, quantifying risk reduction and Long-Term Risk Benefit (LTRB). Analysing this performance, Copperleaf Predictive Analytics (PA) is then able to select further NARM driven interventions to create further options to satisfy certain criteria, such as stable risk across the portfolio.

6.1.6 Only interventions assigned to a specific asset have been assessed in the CBA, as benefits cannot be applied to interventions that are assigned to various locations (e.g., based on forecast defects). Interventions which have been discounted (i.e., because they do not meet legislative requirements) have also not been modelled.

6.1.7 Due to the inherent risk associated with pressure vessels we are required to comply with statutory PSSR and PSR legislation. Therefore, it would be remiss of us to allow risk to increase beyond acceptable safety and legislative parameters. Our investments are aimed at reducing negative environmental impacts associated with gas and condensate leaks. Technical optioneering has been undertaken on the AMP pressure vessels investments to select all appropriate interventions for the pressure vessels portfolio as described in sections 4.6 and 5.6. These interventions have then been applied across the portfolio with individual cost benefit analysis performed asset by asset within Copperleaf PA to achieve overarching constraints as outlined in Section 6.2.

6.2 Options

6.2.1 Using the Predictive Analytics Optimisation Module (PA) within Copperleaf, our pressure vessel assets have been optimised against the NARMs Methodology to ensure the portfolio achieves a variety of outcome risk levels, to satisfy stakeholder needs.

6.2.2 All the options described below have been assessed against our Option 0, Counterfactual (Do Nothing) option, which considers no investment over and above maintenance and corrective repairs.

6.2.3 In all options (except the counterfactual) we include investment volumes that have been developed through our bottom-up intervention development, to address know defects and obsolescence issues. A table of these intervention volumes is in Appendix 9.3.

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

6.2.4 In this option we have utilised our Copperleaf Portfolio optimisation tool to constrain 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.

6.2.5 The total spend of proposed interventions in this option is £13.77m (2023/24) which addresses known and forecast defects. No additional investment is proposed through our Predictive analytics model to keep overall NARMs risk stable, therefore this option is purely the bottom-up volumes described in the previous chapters and summarised in Table in Appendix 9.3. The proposed intervention volumes and the associated spend for this option are shown in Table 19.

Table 19: Option 1 Summary (£m, 2023/24)

Intervention	Volumes	RIIO-GT3 Value
Bottom-Up Interventions	158	13.77
Total	**158**	**13.77**

Option 1a: Post Deliverability

6.2.6 In this option, our programme of investments on pressure vessel assets from Option 1 has been taken through a deliverability assessment which factors in network outage, resource, and supply chain constraints. This option delivers the same volume and spend as option 1 (see table 19 above).

Option 2: 10% Additional Risk Reduction

6.2.7 In this option, we applied optimisation to achieve a 10% additional monetised risk reduction by the end of the RIIO-GT3 period. Copperleaf has selected the most cost-effective investments to meet the lower risk constraint.

6.2.8 The total spend of proposed interventions in this option is £16.88m (2023/24). In this option we see greater spend in comparison to Option 1 as the optimisation requires additional interventions to achieve the stricter risk constraint. Given the most cost-effective investments have already been selected in Option 1 further interventions are needed to meet the overall constraint as shown in Table 20.

Table 20: Option 2 Summary (£m, 2023/24)

Intervention	Volumes	RIIO-GT3 Value
Bottom-Up Interventions	158	13.77
PA Interventions	13	3.11
Total	**171**	**16.88**

Option 3: Lowest Whole Life Cost (WLC)

6.2.9 In this option, we applied optimisation to select interventions with the lowest WLC. Copperleaf identifies the most beneficial interventions, and no investment is selected if the cost exceeds the asset's lifetime benefit, as per the NARMS methodology. None of our service risk measures (SRM) (Availability & Reliability, Safety, Environmental, Societal and Transport) have an outcome constraint applied.

6.2.10 The total spend of proposed interventions in this option is £19.27m (23/24). In this option PA has decided to intervene on any asset where the cost is outweighed by the benefit no matter how small the margin. While generally it will reduce risk more over the life of the asset, it may make decisions that are not possible i.e., trying to do too much work.

Table 21: Option 3 Summary (£m, 2023/24)

Intervention	Volumes	RIIO-GT3 Value
Bottom-Up Interventions	158	13.77
PA Interventions	23	5.50
Total	**181**	**19.27**

Option 4: Availability and Reliability Risk Stable

6.2.11 In this option, we applied optimisation to select interventions that not only maintain overall RIIO-T2 monetised risk levels but also maintain the service risk for availability and reliability at RIIO-T2 standards, enhancing asset resilience.

6.2.12 The total spend of proposed interventions in this option is £18.55m (2023/24). This option will undertake more work than option 1 to control the rising risk of availability and reliability. Option 1 is running on overall monetised risk and therefore may make an economical decision to over reduce other SRMs like Financial & H&S due to the associated cost with maintaining supply.

Table 22: Option 4 Summary (£m, 2023/24)

Intervention	Volumes	RIIO-GT3 Value
Bottom-Up Plan	158	13.77
PA Interventions	20	4.78
Total	**178**	**18.55**

6.3 Option Summary

6.3.1 Table 23 presents the technical summary table of all CBA options.

Table 23: Options Technical Summary Table (£m, 2023/24)

Option	First Year of Spend	Final Year of Spend	Total Volume of Interventions	Investment Design Life	% of Assets Intervened On	Total Spend Request
Option 0: Counterfactual (Do Nothing)	2027	2031	0	N/A	0	0
Option 1: Total Monetised Risk Stable to RIIO-T2 Start	2027	2031	158	20 to 40 years	47%	13.77
Option 1a: Post Deliverability	2027	2031	158	20 to 40 years	47%	13.77
Option 2: 10% Additional Risk Reduction	2027	2031	171	20 to 40 years	51%	16.88
Option 3: Lowest Whole Life Cost (WLC)	2027	2031	181	20 to 40 years	53%	19.27
Option 4: Availability and Reliability Risk Stable	2027	2031	178	20 to 40 years	53%	18.55

7 Business Case Outline and Discussion

7.1 Key Business Case Drivers Description

7.1.1 In appraising this investment, we have considered how the recommended approach to managing Pressure vessel assets can impact on availability, safety, and the environment.

7.1.2 The options presented in this paper are driven by safety legislation together and asset health. We have considered the impact of the following drivers for investment:

- Continued compliance with legislation such as PSSR to ensure that we adequately examine our pressure vessel assets and validate their safe continued usage.
- Ensure Pressure vessel assets are managed in accordance with legislative requirements, internal Policy documents and their written scheme of examination.
- Protect site operatives from working near defective equipment.
- Protect members of the public from a loss of containment event.
- PIG Trap assets to enable the In-line Inspections of buried pipelines which protect their long-term integrity.

7.2 Business Case Summary

7.2.1 A variety of technical interventions have been considered and combined to create a range of CBA options, the results of which are presented in Figure 9 below. The graph illustrates the Net Present Value (NPV) of each option over a 20-year period, from 2031 (the end of RIIO-GT3), to 2051. As can be seen from the graph, Option 4 shows the lowest net NPV. Option 1a Post Deliverability and Option 1 deliver identical returns and the NPV is only £0.15m behind option 4. Option 2 has the lowest NPV.

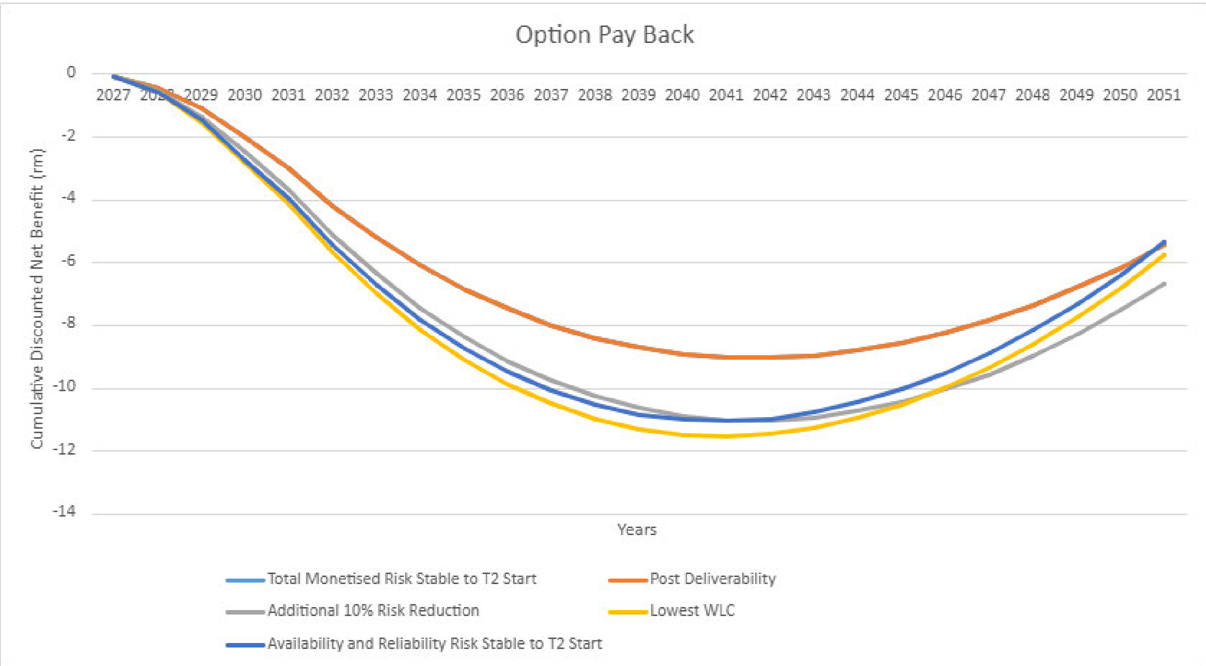

Figure 9: Payback of options

7.2.2 We are proposing to pursue the orange line shown above within RIIO-GT3 (Option 1a Post Deliverability). This is because we have gone through a significant deliverability assessment which factors in network outage, resource, and supply chain constraints and to deliver option 4 (for a marginal increase in NPV) would require a significant additional investment.

7.2.3 Table 24 below shows a summary of these options alongside headline business case metrics.

Table 24: Option summary of headline business case metrics (£, 2023/24)

Option	Total Volume of Interventions	Total Spend Request	Outcome Risk End of RIIO-GT3 (£m)	% change in comparison to start of RIIO-T2	NPV	Payback Period from 2031	% change in service risk measures compared to start of RIIO–T2				
							Financial	Availability Reliability	Environmental	Health and Safety	Societal
Option 0: Counterfactual (Do Nothing)	0	0	1.12	115.58%	0	Does not payback in the period	99.90%	229.61%	106.58%	148.15%	176.61%
Option 1: Total Monetised Risk Stable to RIIO-T2 Start	158	13.77	0.91	94.55%	4.91	Does not payback in the period	91.02%	99.31%	91.70%	101.28%	166.83%
Option 1a: Post Deliverability	158	13.77	0.91	94.55%	4.91	Does not payback in the period	91.02%	99.31%	91.70%	101.28%	166.83%
Option 2: 10% Additional Risk Reduction	171	16.88	0.87	89.82%	6.10	Does not payback in the period	89.63%	31.48%	89.52%	89.82%	165.58%
Option 3: Risk Stable to T2 Start 10% more risk	181	19.27	0.74	76.16%	5.16	Does not payback in the period	85.89%	30.72%	87.45%	48.40%	41.89%
Option 4: Availability and Reliability Risk Stable	178	18.55	0.74	77.01%	4.76	Does not payback in the period	86.10%	97.24%	87.47%	48.71%	41.89%

8 Preferred Option Scope and Project Plan

8.1 Preferred Option

8.1.1 The preferred option to manage our Pressure Vessel assets on the NTS is Option 1: Total Monetised Risk Stable to T2 start. Our programme of investment on Pressure Vessels has been taken through a deliverability assessment which assesses this programme of works against outputs across our entire capital investment plan. This results in a slightly adjusted Option 1A: Post Deliverability which includes the mix of interventions listed in Table 25.

8.1.2 Our proposed investment maintains statutory compliance whilst striking an appropriate balance between tolerable risk and value for money for consumers.

Table 25: Preferred option summary (£m, 2023/24)

Option	Primary Driver	Volume	Unit of Measure	% Assets Intervened upon	Total RIIO-GT3 Request	Funding Mechanism	PCD Measure
PIG Trap Major PSSR Inspection	Asset Health (Legislation and Policy)	[redacted]	Per Inspection	[redacted]	[redacted]	Baseline	A1
PIG Trap PSSR Defect Resolution – Minor	Asset Health (Legislation and Policy)	[redacted]	Per Project	[redacted]	[redacted]	Baseline	A1
PIG Trap PSSR Defect Resolution – Major	Asset Health (Legislation and Policy)	[redacted]	Per Project	[redacted]	[redacted]	Baseline	A1
Scrubber refurbishment	Asset Health (Legislation and Policy)	[redacted]	Per Asset	[redacted]	[redacted]	Baseline	A1
Replace Condensate Tank with mobile Condensate Tank	Asset Health (Legislation and Policy)	[redacted]	Per Project	[redacted]	[redacted]	Baseline	A1
Total		158		47%	£13.77m		

8.2 Asset Health Spend Profile

8.2.1 The spend profile in Figure 10 provides an indicative view on when the above interventions are to be carried out.

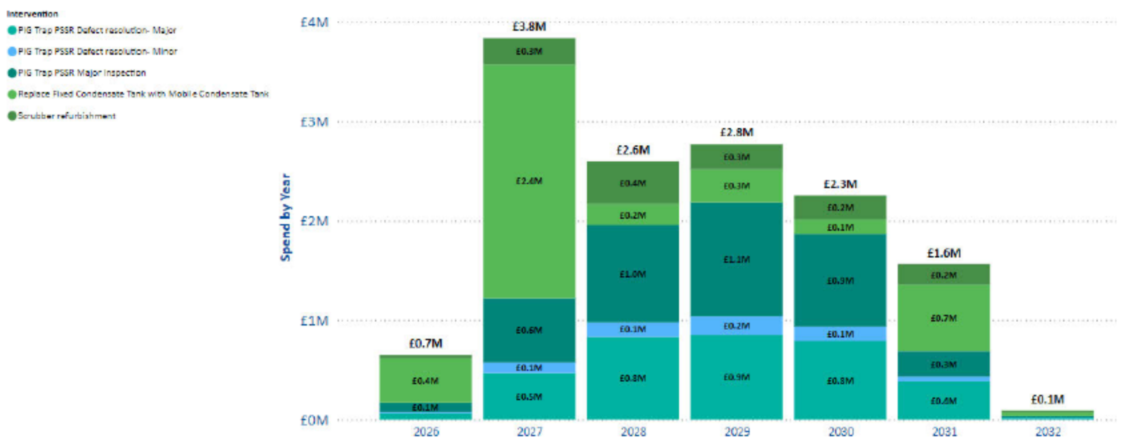

Figure 10: Pressure Vessel Spend Profile RIIO-GT3

8.3 Investment Risk Discussion

8.3.1 There are minimal risks associated with the preferred option. The intervention scopes presented in this EJP are clearly defined and understood. We have a good track record for delivering these scopes in RIIO-T2.

8.3.2 Key risks and currently identified mitigations are summarised in the below table.

Table 26: Pressure Vessels key risks and identified mitigations

No.	Risk	Mitigation (based on current view)
1	PIG Traps are unable to be used when required for internal inspections of pipeline assets resulting in pipeline being unable to be inspected. This could mean the pipeline has to be isolated which might result in a lack of supply to consumers.	PIG Trap records are reviewed cyclically to ensure that defects are resolved in advance of when the PIG trap is required to be used for launching/receiving inspection tools.
2	PIG Trap components become obsolete during RIIO-GT3.	We are continuing engagement with the Original Equipment Manufacturer (OEM) to ensure continuity of supply of components
3	Long lead times associated with PIG Traps, or their components could delay delivery of work.	We carry out interim surveys to monitor condition between examinations. We are unable to keep PIG Traps in strategic spares due to their bespoke nature to cater for different site configurations.
4	The number of Scrubbers suffering from defects is higher than the historical run rate derived volumes.	Proactive engagement with operational teams to identify, forecasts and triage defects to optimise refurbishments.
5	Addressing of proof-of-concept NIA MCT design gaps takes longer than anticipated.	Early-stage engagement with external to ensure the scope, challenges and deliverables are fully understood.
6	During MCT development There is a risk of additional scope requirements (including mechanical, design & civil) leading to scope change / scope creep	Close engagement with contractor and site operations. Detailed surveys to ensure no additional works required
7	There is a risk of increase to materials prices impacting project launch	Project team to work with MWC to make sure that materials are procured in a timely manner and multiple quotes for materials from a number of supplies to ensure value for money

8.4 Project Plan

8.4.1 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 27: 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)

8.4.2 Table 28 shows the summary plan and provisional delivery phases for pressure vessels interventions within RIIO-GT3. Internal stakeholder engagement has identified when we can obtain network access, where required, to complete these works.

Table 28: Pressure Vessels Portfolio Programme for RIIO-GT3 period

Sanctions	RIIO-T2		RIIO-GT3						
	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33
T3_Pipelines_PSSR									
T3_Sites_AGI_Construction_FY27									
T3_Sites_AGI_Construction_FY31									
T3_Pipelines_ILI Dig									
T3_Pipelines_FY28									
T3_Pipelines_FY29									
T3_Pipelines_FY30									
T3_Pipelines_FY27									
T3_Pipelines_FY31									
T3_Sites_AGI_Construction_FY29									

8.4.3 The work has been profiled based on a deliverability assessment across the whole NGT plan and aligns with outages associated with inline inspection programme and major projects.

8.5 Key Business Risks and Opportunities

8.5.1 Changes to system operation or supply and demand scenarios is unlikely to impact upon the proposal in this EJP. Significant changes could mean that particular assets or sites become redundant which would remove the need for some interventions but in general would still require them to be maintained until the point at which decommissioning is completed.

8.5.2 Fast tracking of the transition to hydrogen, within RIIO-GT3 would result in the need to redesign the NTS impacting the materials used to design our assets and this would have an impact on the proposals in this EJP.

8.5.3 The interventions scopes identified within this EJP are clearly identified and understood. We have delivered similar scopes in RIIO-T2 with no change to these scopes proposed in RIIO-GT3 apart from the Mobile Condensate Tank investments.

8.6 Outputs included in RIIO-T2 Plans

8.6.1 There are no outputs from RIIO-T2 plans to be included within RIIO-GT3.

9 Appendices

9.1 PIG Trap Equipment Summary

9.1.1 The PIG is an inspection device that takes measurements of the pipeline to identify and measure corrosion features. These ensure long term integrity of pipeline systems to prevent loss of containment events. There are a few different types of PIG:

- Gauging PIG to check pipeline geometry.
- Cleaning/ Magnetic PIGs to remove deposits and gross blockages in the pipeline.
- Intelligent PIGs are used to collect data on the pipeline integrity, including wall thickness, corrosion, and damage.

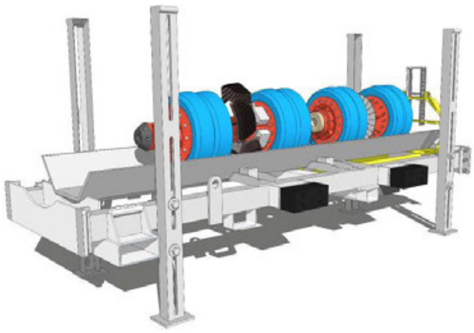

Figure 11: Pipeline Inspection Gauge in cradle

9.1.2 Typically, PIG traps consist of the physical trap enclosure, bridle/bypass pipework to help balance pressures and appropriate supporting structures.

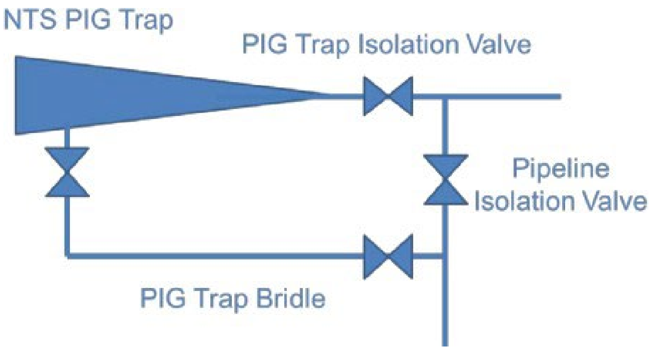

Figure 12: Typical PIG Trap arrangement

9.2 Cost Breakdowns

Table 29: Intervention Cost Breakdown

Intervention Name	External Cost	External %	NG Cost	NG %	Pre build Cost	Pre build %	Materials, Plant & Equipment cost	Materials, Plant & Equipment %	Risk & Contingency cost	Risk & Contingency cost %	Total Cost
PIG Trap PSSR Major Inspection	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
PIG Trap PSSR Defect resolution- Minor	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
PIG Trap PSSR Defect resolution- Major	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Scrubber refurbishment	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Replace Fixed Condensate Tank with Mobile Condensate Tank	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

9.3 Bottom-Up CBA Intervention Volumes

Table 30: CBA Bottom-Up Intervention Volumes for Pressure Vessels (£m, 2023/24)

Intervention	Bottom-Up Volume	Bottom-Up RIIO-GT3 Value
PIG Trap Major PSSR Inspection	[redacted]	[redacted]
PIG Trap PSSR Defect Resolution – Minor	[redacted]	[redacted]
PIG Trap PSSR Defect Resolution – Major	[redacted]	[redacted]
Scrubber refurbishment	[redacted]	[redacted]
Replacing FCTs with MCTs	[redacted]	[redacted]
Total	**158**	**13.77**