

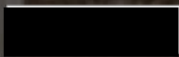


NGT_AH2_12

Bacton Overpressure Protection

Engineering Justification Paper

June 2023



Version: Final

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1. Executive Summary

- 1.1. National Gas Transmission is committed to ensuring gas enters, moves, and exits the network safely and efficiently.
- 1.2. This is achieved by optimally managing the network, complying with all applicable legislation, and driving continual improvement.
- 1.3. A Health & Safety Executive (HSE) inspection at Bacton Terminal found the risk of over pressurisation was not being sufficiently mitigated to make the risk as low as reasonably practicable (ALARP).
- 1.4. Bacton Terminal is a COMAH establishment which necessitates operators to take all measures necessary to prevent major accidents. The current legacy setup is not in line with 'best-practice' guidance (BS EN 61511) and, therefore, represents an elevated level of risk from a dangerous unrevealed failure occurring.
- 1.5. Following independent studies, an option selection process in conjunction with the HSE resulted in this report which recommends proceeding with a project to improve the overpressure protection system at Bacton Terminal.
- 1.6. The total indicative project value is currently forecast at £1.7m, Ofgem is requested to assess the need case and our preferred option.
- 1.7. Our investment is aligned with the Bacton Investment Strategy which ensures certainty on Terminal operation requirements to 2035 including investments required to facilitate this.
- 1.8. This report is submitted in accordance with the National Transmission System Gas Transporter Licence Condition 3.14 Asset Health Re-opener, Price Control Deliverable Reporting Requirements and Methodology Document and RIIO-T2 Re-opener Guidance and Application Requirements Document.
- 1.9. Engagement with Ofgem was held 1st June 2023 to present the high-level summary of Engineering Justification Papers being submitted in the June 2023 Asset Health reopener window. Ofgem are invited to assess and approve the preferred option presented within this EJP.

2. Summary Table

Name of Project	Bacton Overpressure Protection
Scheme reference/ mechanism or category	[REDACTED]
Primary Investment Driver	Legislation
Output references/type	Bacton Overpressure Protection System improvement [REDACTED]
Project Initiation Year	2022
Project Close Out Year	2025
Total Installed Cost Estimate (£m)	£1.7m
Cost Estimated Accuracy (%)	15%
Project Spend to date (£)	[REDACTED]
Price Basis	2018/2019
Current Project Stage Gate	ND500 T5 / F4
Reporting Table	RRP Table 6.2 (Projects) and table 6.1 (CAPEX_Summary)
Outputs included in RIIO T1	No
Outputs included in RIIO T2	No

Table 1: Project Summary Table

3. Project Status and Request Summary

Overview

- 3.1. National Gas Transmission, hereafter referred to as NGT, are requesting funding to undertake investment to reduce the risk of over-pressurisation of Bacton Terminal assets, mitigating the risk to As Low as Reasonably Practicable (ALARP).
- 3.2. Bacton Terminal is one of two designated NGT Control of Major Accident Hazards (COMAH) sites and is of strategic national importance, and thus is subject to regular inspections from the Health & Safety Executive (HSE).
- 3.3. [REDACTED]
- 3.4. [REDACTED] on the incomer overpressure protection system, this project aims to manage the risk of over pressurisation by reducing it to ALARP and make suitable improvements to the system identified following independent inspections and studies.

Project Status

- 3.5. [REDACTED] the project has progressed at funding risk and was last sanctioned at F4 in August 2022 to proceed with detailed design and construction. Detailed design is complete, and construction works are in progress. Commissioning is scheduled to be completed August 2023.
- 3.6. The request is being submitted at this stage in the project due to the previous reopener window (January 2023) being prioritised for addressing the immediate risk of solids/dust at Bacton Terminal by submitting the enhanced filtration engineering justification paper.

Request Summary

- 3.7. This request is for funding to enhance the incomer overpressure protection system at Bacton Terminal by installing new and updating existing sensors, alarms and associated control systems.
- 3.8. The upgrades shall bring the original system up to best practice standard at a total cost of £1.7m.
- 3.9. This request seeks an adjustment to the value of the NARMAHOt license term and has been submitted in accordance with Special Condition 3.14 of NGT license.

4. Problem/Opportunity Statement

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

- 4.1. There are several regulations which relate to preventing over pressurisation of gas assets including Control of Major Accident Hazards (COMAH) Regulations¹ which state:
- Every operator must take all measures necessary to prevent major accidents and to limit their consequences for human health and the environment. Reg 5(1).
 - Every operator must demonstrate to the competent authority that it has taken all measures necessary as specified in these Regulations. Reg 5(2).
- 4.2. Pressure Systems Safety Regulations (PSSR) aim to prevent serious injury from the hazard of stored energy as a result of the failure of a pressure system or one of its component parts.
- 4.3. To ensure compliance with regulations, the Health & Safety Executive (HSE) conduct regular inspections due to Bacton Terminal being a COMAH site. [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
- 4.4. The current legacy arrangement is not in line with best-practice guidance (BS EN 61511²) and, therefore, represents an elevated level of risk from a dangerous unrevealed failure occurring.
- 4.5. [REDACTED]
[REDACTED]
- 4.6. If we do nothing, the risk will remain meaning we will not be able to demonstrate our compliance with HSE COMAH regulations. [REDACTED]
[REDACTED]

Under what circumstances would the need or option change for this project?

- 4.7. Several studies were commissioned to review the current overpressure protection arrangements including a Layers of Protection Analysis (LOPA) risk analysis study and a Safety Integrity Level (SIL) engineering evaluation study.
- 4.8. The reports from all completed studies were provided to the HSE [REDACTED]
[REDACTED]. The studies highlighted a need for improvement to the overpressure protection system in all scenarios.

¹ https://www.legislation.gov.uk/ukxi/2015/483/pdfs/ukxi_20150483_en.pdf

² <https://www.hse.gov.uk/eci/functional.htm>

4.9. Stakeholders support the view of ongoing supply input from UK Continental Shelf (UKCS) to at least 2035 which will require our incomer assets to be fully operational until at least then.

What are we going to do with this project?

4.10. To address the recommendations, this project shall reduce the risk of over pressurisation at Bacton to as low as reasonably practicable (ALARP) [REDACTED]

4.11. The project involves installing suitable protective devices which are defined in PSSR as: “Devices designed to protect the pressure system against system failure and devices designed to give warning that system failure might occur”.

4.12. The engineering solution has been devised following conceptual and detailed design against specific requirements.

What makes this project difficult?

4.13. [REDACTED] required completion date of November 2022. Due to the timescales for detailed design, long lead procurement and construction / commissioning, this was not considered possible. [REDACTED] was to complete by August 2023, which was considered the best achievable timescale. The need to progress the project at pace has required us to commence the project at funding risk.

4.14. The project requires an outage to install new assets, which, although considered manageable, the work must be coordinated to be undertaken during the annual outage window on the Shell SEAL (S4) incomer.

4.15. Close cooperation is also required to enable work to be completed on Perenco A1 and A2 incomers by coordinating flow swaps and using a hot tap approach. This may be challenging due to terminal operations and dynamic network conditions related to demand patterns at Bacton including double filtration.

What are the key milestone dates for project delivery?

4.16. The project needs to be completed as soon as possible [REDACTED] The project aims to have the assets installed and commissioned by the end of August 2023 [REDACTED].

4.17. [REDACTED]

4.18. We have completed stage T5 of the Network Development Process (ND500) - a process aimed at defining and managing the projects lifecycle from inception to closure, ensuring we meet minimum requirement for each project phase.

4.19. Table 2 provides a summary of the programme including scheduled and completed milestones. [REDACTED] the project was sanctioned F4 in August 2022 which included options analysis and conceptual design.

ND500 Milestone	Milestone Description	Month
T1	Acceptance Of Need Case	July 2022
T2	Confirm Preferred Strategic Option	July 2022
T3	Agreement To Proceed to Conceptual Design	July 2022
T4	Scope Freeze	July 2022
F4	Design And Build Sanction	August 2022
T5	Detailed Design Challenge and Review Complete	May 2023
	ACL Available for Commercial Load	August 2023
T6	Hand Back for Closure	September 2024
F5	Closure	December 2024

Table 2: Project Stage Summary

How will we understand if the project has been successful?

4.20. Overall project success will be defined by the installation, commissioning and acceptance of the over pressure protection system enhancements, [REDACTED]

4.21. The design assessment/detailed design was a fundamental phase of this project to ensure the over pressure protection system we are installing meets the Safety Integrity Level (SIL) 2 requirement and addresses the additional improvements recommended by the HSE.

Related Projects

4.22. There are several related projects and investments at Bacton and across the National Transmission System (NTS) detailed as follows.

Bacton Future Operating Strategy

4.23. The Bacton Future Operating Strategy (FOS) (National Transmission System Gas Transporter Licence Condition 3.10 Bacton Site Redevelopment Re-opener) is a key interaction. As part of the strategy, optioneering is currently in progress to consider future strategic direction for the Terminal including redevelopment or asset health options.

4.24. As part of the FOS optioneering, assets are proposed to be retained up to 2035 for incomers and to 2050 for Feeders 2, 3, 4, 5 & 27 in line with Future Energy Scenarios which indicate United Kingdom Continent Shelf (UKCS) supplies will continue until at least 2035. This overpressure protection project is required on the UKCS incomers irrespective of the final FOS option.

Bacton Investment Strategy

4.25. The Bacton Investment Strategy is a two-phase strategy to ensure clarity on short- and medium-term asset health investments (Phase 1) and longer-term future Terminal operating strategies (Phase 2). A summary of the Strategy was previously provided to Ofgem in January 2023, with an updated version included in this June 2023 submission.

4.26. This over pressure protection project is aligned to Phase 1 which aims to deliver accelerated and medium-term investments to provide certainty on Terminal operation requirements to 2026. Accelerated investments have been identified to address short term requirements, whilst medium-term investments have been identified as no regrets based on the options under consideration through the Future Operating Strategy (FOS) workstream. Our Phase 1 investment plan is in development and the list of investments may iterate.

4.27. Phase 2 includes enduring Terminal solutions required beyond 2035 aligned to the development of the Future Operating Strategy to reduce overall Terminal operating risks. Figure 1 provides a summary of the investment areas within the Investment Strategy.

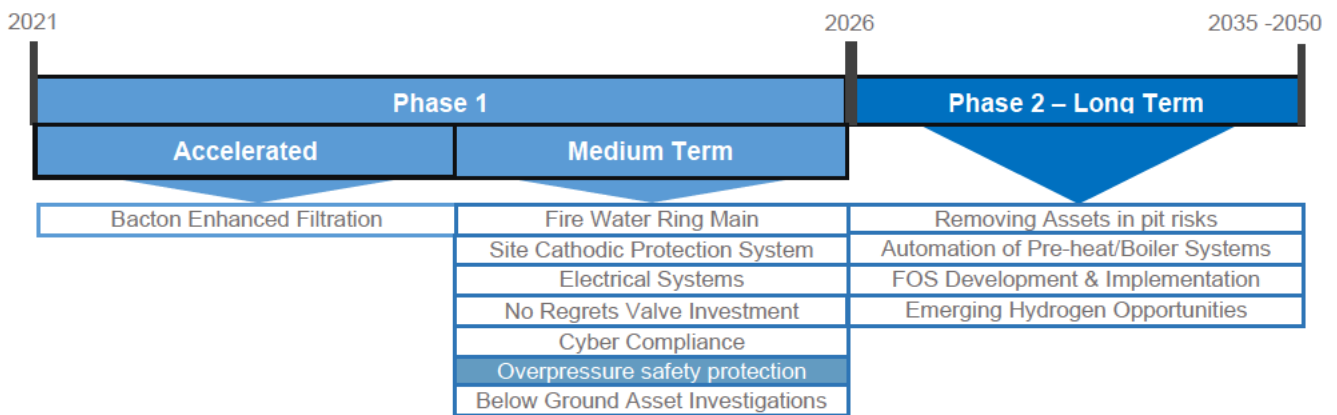


Figure 1: Bacton Investment Strategy Summary

Primary Protection Devices

4.28. [REDACTED] NGT have progressed a project to upgrade [REDACTED] slam shut valves at [REDACTED] sites including Bacton Terminal. These investments are progressing at funding risk and are subject to a separate funding request. [REDACTED]

Project Boundaries

4.29. The boundary of this project is delivery of investments to improve the over pressure protection system on the UKCS incomers at Bacton Terminal to reduce the risk to ALARP and meet Safety Integrity Level requirements.

4.30. The scope of this paper does not include investment on any other asset systems at the Terminal. Separate Engineering Justification Papers (EJPs) will be developed in line with our Investment Strategy as scopes are developed.

5. Project Definition

Supply Demand Scenarios

- 5.1. Our stakeholder engagement supports the view that United Kingdom Continent Shelf (UKCS) supplies will continue until at least 2035 which is aligned to our Bacton Future Operating Strategy. This shall require continued operation and maintenance of incomer assets which are being invested in as part of this overpressure protection project.
- 5.2. The aim of this project is agnostic to supply/demand scenarios and flow patterns [REDACTED]
[REDACTED]
maintain our commitment to always operating a safe and efficient network. The incomers are rated to Maximum Operating Pressures (MOP) as per Network Entry Agreements (NEAs) with upstream parties. Therefore, the Safety Integrity Level (SIL) pressure ratings are in line with these NEAs and any future changes are subject to applicable commercial processes.

Project Scope Summary

- 5.3. The high-level scope of this project is to enhance the overpressure protection system on Perenco A1 & A2 and Shell S4 SEAL incomers. This includes tap-in points, pressure transmitters, site cabling, software, and SCADA modifications.
- 5.4. The general arrangement of the incomers at Bacton Terminal is shown in Figure 2 and comprises of:
 - Primary Protection and Gas Quality Monitoring – Provides monitoring and downstream overpressure protection. Gas Analysers (All in one and Danalysers), temperature, CV, and Dewpoint monitoring.
 - Filtration and Pre-Heating – Incoming gas is filtered to 2 microns and preheated prior to flow control. Several filter vessels are installed on each filter bank.
 - Flow Control and Manifolds – Gas is controlled with Flow Control Valves (FCV) and manifold valves to control blending and pressure.
 - Metering – meter gas flowing onto the manifold through each incomer.



Figure 2: General Arrangement

- 5.5. The incomer pipelines from Shell and Perenco are protected against overpressurisation by motorised valves which operate should the pressure exceed 75 barg (apart from Incomer Shell 4 which is set to 74 barg).
- 5.6. Shell incomers (S1, S2 and S3 have a Safety Integrity Level (SIL) of SILa (low or undefined integrity i.e. a risk reduction factor (RRF) greater than or equal to 1 but less than 10); S4 and Perenco incomers A1 & A2 have a SIL rating of SIL1 (RRF ≥ 10 - < 100). This is currently provided by pressure let-down valves configured in parallel duty/standby mode to control downstream pressure to a maximum of 75 barg.
- 5.7. Upstream Emergency Isolation High Integrity Pressure Protection System (HIPPS) includes two valves in series that close simultaneously (0.9s) at 85 barg aligned to the pressures at which Shell and Perenco operate.
- 5.8. This means the pressure of variable gas supplies from Perenco and Shell could exceed the current safe operating limit of NG Bacton manifold (77 barg).
- 5.9. To address this, the project has used the recommendation the studies commissioned [REDACTED] [REDACTED] to complete detailed design and commence build/modification of the overpressure protection system to meet the required SIL/PFD target to protect against the residual over pressurisation risk identified.
- 5.10. The scope of the project also includes demonstrating that the enhancements meet statutory and industry good practice guidance including the following:
- COMAH Reg 5 - Relevant good practice guidance
 - PUWER Reg 8 - Relevant good practice guidance
 - BS EN 61511 - Functional Safety – Safety Instrumented Systems for the process industry sector
 - BS EN 61508 – Functional Safety of electrical/electronic/programmable electronic safety related systems

- HSE Operational Guidance OG54 - Proof Testing of Safety Instrumented Systems in the Onshore Chemical / Specialist Industry
- HSE Operational Guidance OG46 - 'Management of instrumented systems providing safety functions of low / undefined safety integrity'
- Company policies, technical specifications & standards - IGE/SR/15, T/PM/INS/8

5.11. The enhancements include updating and modifying the existing onsite control system Human Machine Interface (HMI) and Supervisory Control and Data Acquisition (SCADA) with additional alarms and new graphics pages containing high pressure trip systems in line with company requirements.

5.12. Additional pressure stabbings are also being installed to Perenco A2 incoming line which will mirror the revised arrangement on the A1 incomer with the addition of a third pressure sensor as shown in Figure 3.



Figure 3: Perenco A1 Incomer Stabbings and Pressure Switches

5.13. The project also includes ensuring all supporting documentation including, but not limited to, schematics, isometric and arrangement drawings, Engineering Line Diagrams (ELD), Hazardous Area, PSSR, Site Schedule etc. are suitably updated to satisfy G/35, RE/18 and company requirements.

6. Options Considered

6.1. [REDACTED], commercial and asset options were considered. The possibility of using upstream (Perenco & Shell) parties' HIPPS was explored as both Sub-Terminals have overpressure protection systems on gas supplies into our Bacton Terminal, [REDACTED]. As this was discounted, no costs or programme were developed. Significant alterations to the Terminal and brand-new systems were not considered due to there being scope to enhance the existing configuration to meet the requirements more cost effectively.

Option 1 – Improve Over Pressure Protection System

Description

- 6.2. This option fulfils the requirement to reduce the risk of overpressurisation as low as reasonably practicable (ALARP) by introducing dual redundant functionality in both the pressure sensors and the final element isolations for Shell S4 and Perenco A1 & A2 incomers. The improvements shall fulfil the requirements to achieve Safety Integrity Level (SIL) 2 (RRF ≥ 100 - < 1000).
- 6.3. The project involves improving the over pressure protection system by designing, installing, testing, and commissioning the following works:
- Install additional transmitters to determine an overpressurisation event by implementing a 2oo3 on Sensor trip and 1oo2 control on the Final Element (incoming line isolation valves) on Perenco A1, A2 and Shell S4 incomers.
 - Update and modify the existing control system Human Machine Interface (HMI) and Supervisory Control and Data Acquisition (SCADA) with additional alarms, valve position/condition feedback and new graphics pages containing high pressure trip systems.
 - Install additional stabbings (3 of) to Perenco A2 line to mirror the A1 design with the addition of a third pressure sensor (replacing the current pressure switches to SMART transmitters (x3 on A1, A2 and S4 incoming lines).
 - Remove existing and construct new instrument plinth on A2 including constructing a concrete base with cubes to meet T/SP/CE/1 requirements.
 - Update/modify all supporting documentation including, but not limited to, schematics, isometric and arrangement drawings, ELD, Hazardous Area, PSSR, Site Schedule and wider FSM life-cycle files.

- Requires design, procurement, installation, and commissioning

Option 2 – Do Nothing Now

Description

6.8. This option involves continuing with the current operational processes, which relies on a single transmitter to determine if an over-pressurisation event is occurring on A1, A2 and S4 incomers.

6.9. However, continuing with the current procedures would [REDACTED]
 [REDACTED] ongoing risk of over-pressurisation at Bacton Terminal with consequential risk to people, plant and security of supply. [REDACTED]

[REDACTED]
 [REDACTED]
 [REDACTED]
 [REDACTED]

Benefits

- No capital costs
- No outages required which require management and close co-operation with upstream customers

Limitations

- Not acceptable to HSE, likely leading to Improvement or Prohibition notice with potentially uncapped financial penalties and restricted gas flows
- Does not address issue and does not reduce risk of harm to people, plant and equipment to ALARP
- Interruptions to gas flows at Bacton Terminal would be detrimental to the NTS with far reaching consequences in the UK and Europe, leading to consumer impact

Options Summary

Option	Description	Project Start Date	Project Finish Date	Total Cost (18/19 £m)	Cost Accuracy
Option 1	Improvements to overpressure protection system	July 2022	August 2023	1.70	15%
Option 2	Do nothing now	N/A	N/A	N/A	N/A

Table 4: Options Summary

7. Business Case Outline and Discussion

Key Business Case Drivers

Health and Safety Legislation

- 7.1. Health and Safety is the primary driver for this project. Legislation including the Health and Safety at Work Act, PSSR and COMAH are [REDACTED].
- 7.2. Bacton Terminal is one of two designated NGT Control of Major Accident Hazards (COMAH) sites which requires compliance with all COMAH regulations.
- 7.3. The Pressure Systems Safety Regulations 2000 (PSSR) cover the safe design and use of pressure systems. The aim of PSSR is to prevent serious injury from the hazard of stored energy (pressure) as a result of the failure of a pressure system or one of its component parts.
- 7.4. This project aims to address [REDACTED] by reducing the risk to ALARP.

Financial

- 7.5. In addition to any legal enforcement notices with associated uncapped financial penalties, any interruption to the flow of gas at the site would be highly detrimental to the NTS with far reaching consequences in the UK and Europe, leading to consumer impact.
- 7.6. Improving the overpressure protection system also reduces the potential for any overpressure events occurring on downstream pipework which could lead to undue stress on pipelines, resulting in accelerated deterioration and increased prevalence of leaks.

Business Case Summary

- 7.7. [REDACTED]
- 7.8. Ultimately, if the work is not completed, the risk will remain and there will be the potential for an Improvement (or possible Prohibition) notice with uncapped financial penalties which would far outweigh the costs of the project.

8. Preferred Option Scope and Project Plan

Preferred Option

- 8.1. Our preferred option decision is based on qualitative and quantitative engineering assessment. Our preferred option is Option 1 – Improve Overpressure Protection System.
- 8.2. Option 1 is the only option which appropriately meets the requirements to reduce the risk to ALARP by enhancing the existing configuration, rather than undertaking major modifications to the incomers.

Project Spend Profile

- 8.3. The table below shows the project spend profile for our preferred option in 18/19 prices

£m 18/19	FY23	FY24	FY25	FY26	Total
Bacton Overpressure Protection	█	█	█	█	1.704

Table 5: Project Spend Profile

Efficient Cost

- 8.4. Opting to proceed with modifying the existing configuration was the most cost-effective solution available. The single viable option has been executed in alignment with other projects and using lessons learned to ensure efficient cost.
- 8.5. Our direct award methodology to our preferred Main Works Contractor has enabled the project to be progressed at pace whilst minimising procurement effort and timescales, thereby avoiding added costs and delays.
- 8.6. The decision to directly award the contract was made based on the expertise of the Main Works Contractor and their unique position to deliver efficiently alongside the completion of the Bacton Terminal SCADA / HMI system replacement and ongoing technical support (through existing Support Level Agreement) to that project.
- 8.7. Lessons learned from previous projects requiring control system modifications demonstrate that using a single contractor for modifications naturally translates to overall ownership by the Main Works Contractor, which reduces technical and commercial risk to the project.
- 8.8. Gas flows at Bacton Terminal are expected to continue to 2035 which require continued use of the incomers on which this project is upgrading. The investment is therefore no regrets regardless of Future Energy Scenario outcomes.
- 8.9. Upgrading the existing system rather than installing a completely new one ensures the solution meets the requirements without incurring supplementary delays or costs. Similarly, the

preferred solution does not change the amount of maintenance required, thereby avoiding any additional operational burden.

8.10. The project involves undertaking a mix of mechanical and electrical & instrumentation (E&I) works including multiple excavations and running new cabling from the Bacton Control Room to the incomer locations. The enabling works, which make up a large proportion of the projected spend, are fundamental to the upgrades and are required to be completed within the outage window.

Project Plan

8.11. Due to the need to progress the project ahead of receiving a Regulatory Final Determination, we have now completed detailed design and construction is underway, with commissioning scheduled to complete in August 2023.

8.12. The key milestones in the project plan are shown in Table 6.

Milestone	Date
Award Contract for Phase 1 – Scope/Cost Development	Sep 2022
Award Contract for Phase 2 - Detailed Design and Build	Oct 2022
Detailed Design Complete	Mar 2023
Offsite Construction and FATs Complete	Jun 2023
Onsite Mobilisation and Construction Start	Sep 2023
T/PM/RE/18 Commissioning Acceptance Certificate	Dec 2023
T/PM/RE/18 Operational Acceptance	May 2024
T/PM/RE/18 Asset Acceptance Certificate Submitted	Nov 2024

Table 6: Project Milestones

Key Business Risks & Opportunities

8.13. [REDACTED] to complete by August 2023 has required us to progress the project prior to receiving a determination from Ofgem. This proactive approach has ensured we should achieve success on time but has involved capital expenditure in advance of this funding request.

8.14. Our preferred option requires the work to be completed during a single outage on the Shell SEAL (S4) Incomer. Although this is considered manageable, network conditions may present challenges in undertaking the outages as planned leading to changes in planning assumptions.

8.15. Outage availability/duration and operational resource during monitoring/commissioning activities are the main constraint faced by the project. To mitigate this, the current strategy is to perform the upgrade in series which will minimise any possible impacts.

8.16. [REDACTED]
[REDACTED]

Outputs and Allowances in RIIO-T2

8.17. There were no outputs relating to enhancements to over pressure protection systems at Bacton Terminal in RIIO-T1. Costs have been incurred from this project during the RIIO-T2 regulatory period only.

Additional RIIO-2 Outputs

8.18. Costs associated with the preferred option for the project have been assigned against the RIIO-2 Unique Identifiers (UID) in Table 7 below in 2018/19 prices. Full cost breakdown details are included in the associated Cost Book.

UID	Baseline volume of Intervention (By PP)	Output Year	UID funding requested through UM	Unit of measure
	(by unit of measure)			
			£1,704,000	1

Table 7: RIIO-2 Outputs

NARMs Benefit

8.19. It is proposed that all the investments that arise from the UMs are collated and one NARMs update is provided.

8.20. There are no other New Addition UIDs within the current mechanism. For further details and a summary of UIDs, please see the Asset Health UM Overarching Document being submitted concurrently with this EJP.

9. Conclusion

- 9.1. This report has explained the needs case, options considered and the programmatic aspects of the project.
- 9.2. The project has used the outputs [REDACTED] independent studies to develop a design and associated scope of works to optimally meet a range of requirements and specifications.
- 9.3. The preferred option to enhance the existing system to improve risk mitigation without increasing maintenance operations has been presented alongside costs, risks, and delivery timescales.
- 9.4. The work is ongoing at Bacton Terminal, with commissioning forecasted to be complete in August 2023.

10. Appendices

Appendix 1 – 