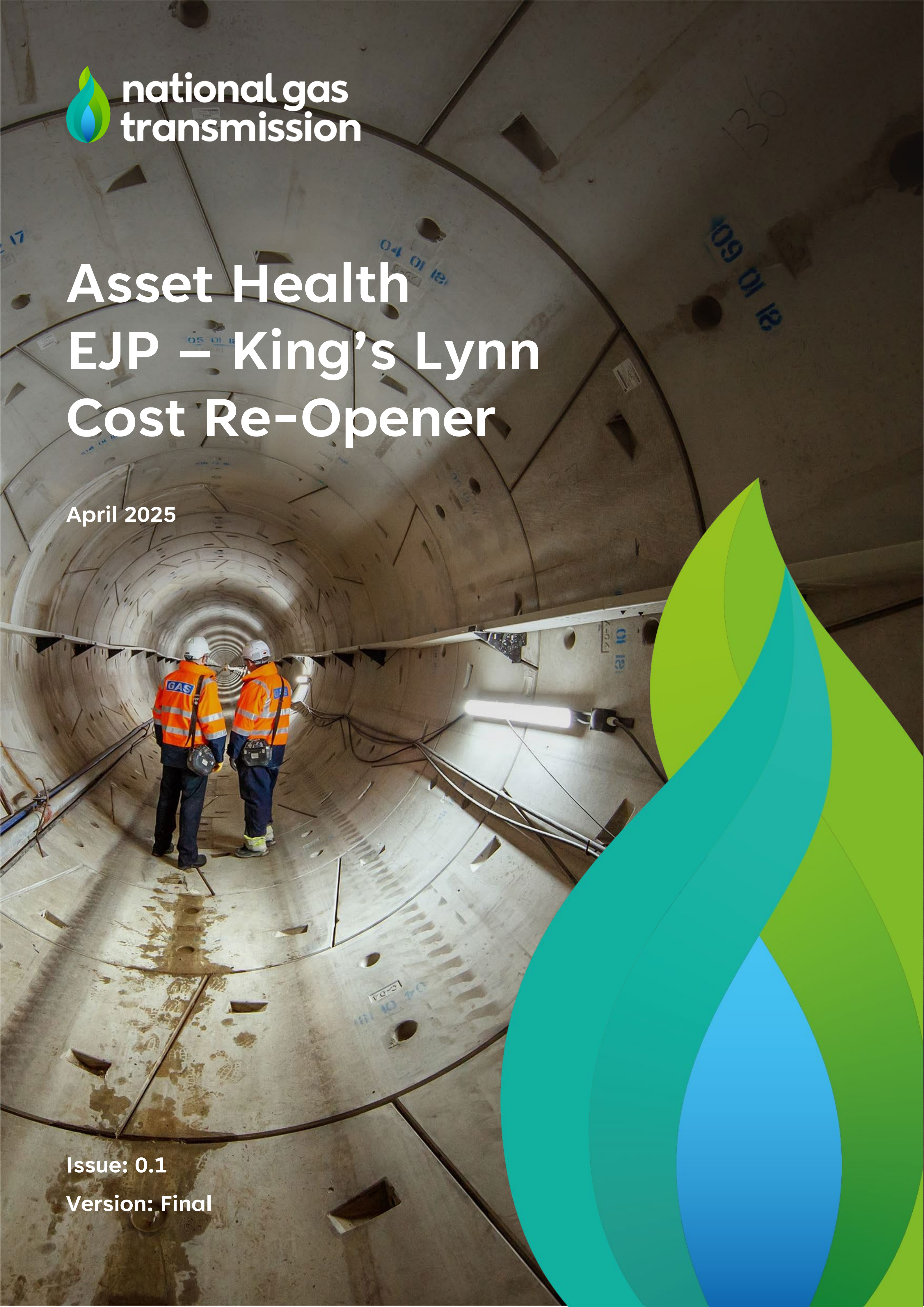

national gas transmission

Asset Health EJP – King's Lynn Cost Re-Opener

April 2025

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Version: Final

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0.1	Nov 2024	First draft
	Feb 2025	NGT Review
	Apr 2025	Ofgem Submission

Contents

1 Executive Summary

1.1.1 This Engineering Justification Paper (EJP) explains the engineering justification, detailed scope, delivery plan, efficient costs and requested regulatory allowances for Asset Heath interventions to King's Lynn unit B. Our objective was to identify the most cost efficient Asset Health interventions to enable unit B to provide efficient service under the 500-hour Emergency Use Derogation allowed for in the Medium Combustion Plant Directive (MCPD) and support the site when units C and D are unavailable.

1.1.2 We gathered information on asset condition from a Remnant Life Study (RLS) and undertook site surveys to identify potential interventions to address the need case and to inform scope definition and cost estimation. Where possible we considered a range of intervention options ranging from do nothing, through to minor refurbishment, major refurbishment or replacement. We used a multi criteria assessment with qualitative and quantitative measures around whole life costs and consumer benefit to assess the relative merit of alternative intervention options. This is further detailed in Section 4.

1.1.3 King's Lynn compressor station has two MCPD compliant Siemens SGT-400s, units C and D, and two SGT-A20 units, A and B, which fall within the (MCPD) legislation, but have a potential to breach the Nitrogen Oxide (NOx) limits imposed and therefore are non-compliant.

1.1.4 SGT-A20 unit A was disconnected in 2017 after becoming life expired and beyond economical to continue investing in for current and future requirements. However, for unit B, Ofgem have approved a final preferred option (option 1) to comply with MCPD by 2030 following NGT's submission of the Final Options Selection Report (FOSR) Appendix G in January 2023, under which NGT can run the unit up to 500-hour under Emergency Use Derogation.

1.1.5 This paper describes costs to implement Asset Health interventions on unit B. The costs to implement the options for units A, C and D are held in separate EJP documents.

1.1.6 [redacted]

1.1.7 High usage of the unit has necessitated in SGT-A20 unit B receiving additional maintenance support to keep it operational during periods of high flow demand. Carrying out the combination of asset life interventions detailed in this Engineering Justification Paper (EJP) will provide the required site resilience and extend its life to 2050.

1.1.8 [redacted].

1.1.9 Delivery of this project by 2030 will ensure that our customers continue receiving gas at volumes and pressures required. Once this project is delivered, unit B will be able to support units C and D when they are not available and therefore provide the necessary level of site resilience.

1.1.10 [redacted].

1.1.11 The project is at Network Development (ND500) project stage 4.4 recently completed surveys to define scope and project boundaries to further support the needs case and puts cost confidence in the range of +/-15.

1.1.12 This document should be read in conjunction with the King's Lynn MCPD Re-opener Submission Overarching document.

2 Introduction

2.1.1 The King's Lynn site ensures high EU import and export can be achieved by moving large volumes of gas towards or away from Bacton.

2.1.2 This Engineering Justification Paper (EJP) emanates from the Ofgem approved FOSR submission for King's Lynn Compressor Station (Appendix G) to comply with the MCPD emissions legislation deadline while ensuring that the network is resilient and able to meet a wide range of future demand patterns. The FOSR provided a summary of all the work performed to date to evaluate, cost, analyse and justify the full suite of feasible options available to maintain current levels of network capability and availability for our customers.

2.1.3 This EJP further supports the proposed Asset Health (AH) interventions on unit B compressor by addressing defects, and safety concerns to support its life extension to 2050.

2.1.4 Figure 1 below shows a site overview with unit B shaded for reference.

[redacted]

Figure 1: King's Lynn Compression Station

2.1.5 To confirm the works required to improve the unit's B operational condition, Electrical and Mechanical Asset Health surveys were completed in December 2024 (Appendix E). The results have been challenged by NGT Subject Matter Experts (SME) in collaboration with external contractors-to achieve the most economic and efficient solution which will extend the asset life by an additional 25 years.

2.1.6 Refurbishing the unit will enhance its availability and reliability which will add to the station's resilience and the need to manage higher demands whilst delivering the gas to customers at the volumes required. Funding to make the necessary interventions is now required to deliver the Asset Health intervention on unit B.

2.1.7 Upon implementation of the proposed investments, the current non-compliance of unit B will be derogated in line with MCPD and enable the station to operate at maximum capacity to support the security of supply.

2.1.8 This EJP interacts with other documents to form the King's Lynn reopener submission pack as illustrated in Figure 2 below.

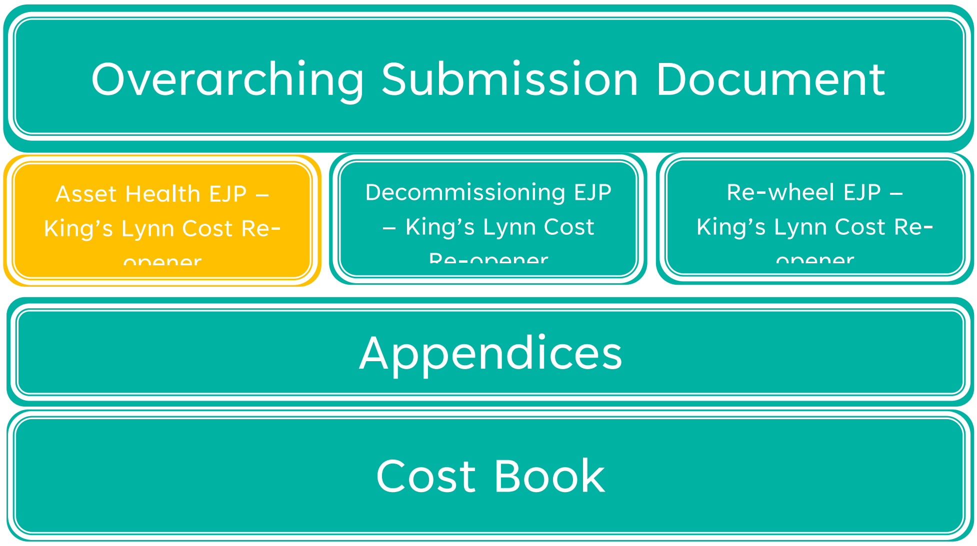

Figure 3: King's Lynn Reopener Submission Pack

Summary Table

2.1.9 Table 1 below sets out key information about the King's Lynn Asset Health Investment project summary Table.

Name of Project	King's Lynn Asset Health
Scheme Reference	PAC1051190
Primary Investment Driver	Compliance with MCPD legislation
Project Initiation Year	FY22
Project Close Out Year	FY30
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
Current Project Stage Gate	ND500 (4.4) Project Execution
Relevant Delivery U.I.Ds	Ref - Table 14 of this document
Outputs PCDs	Ref - Table 5 of Overarching Document

Table 1: Summary table for King's Lynn Compressor Asset Health

2.1.10 Table 2 below sets out the cost summary for delivering the selected final option for this project. This is further detailed in the Cost Book Appendix A and Section 3 of the Overarching Document.

	RIIO-T2					RIIO-GT3				
(2018/19 price base)	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**	**Total**
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 2: King's Lynn Asset Health Cost Summary

3 Equipment Summary

3.1.1 There are a total of three operational units at King's Lynn that can run in multiple configurations to move gas East or West. Unit B is a Siemens (formerly Rolls-Royce Avon) SGT-A20 1533 compressor, and unit C and D are Siemens SGT-400s. Unit C and D are the lead units on site, compliant with MCPD legislation, commissioned in 2003, whilst unit B was installed in 1971 and now over 50 years old.

3.1.2 The SGT-A20 as shown in Figure 3 is a model of the Rolls-Royce (Now siemens) gas turbine engine, specifically designed for industrial applications. It's an aero-derivative gas turbine, meaning it was originally developed from an aircraft engine design but adapted for industrial use. The SGT-A20 is commonly used in power generation and mechanical drive applications, such as driving compressors and pumps in the oil and gas industry.

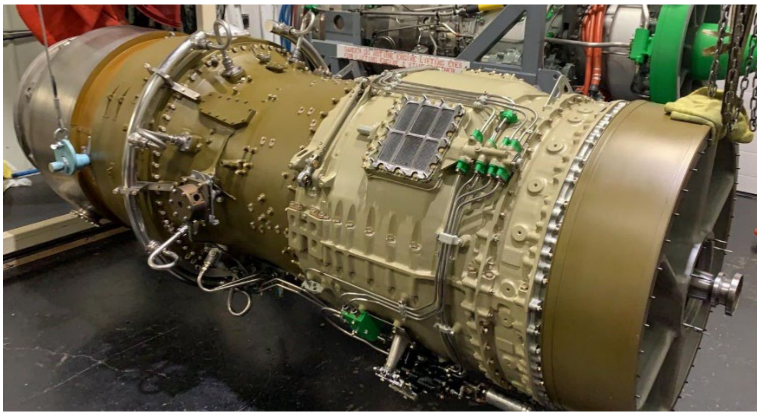

Figure 3: Siemens SGT-A20

3.1.3 The two SGT-400s units C and D can operate in both single and parallel operation according to the flow levels required and have a capacity of up to 42 mscm/d. SGT-A20 unit A, was disconnected in 2017 after becoming life expired and beyond economical to continue maintaining and SGT-A20 unit B, which is still in service, has a capacity of up to 56 mscm/d. Table 3 below shows an overview of the compressors at King's Lynn.

Unit	Engine	Fuel Type	Power Base (MW)	Installation Date	Minimum Operational Flow (mscm/d)	Nominal Capacity (mscm/d)
[redacted]						
***Disconnected in 2017 and partially decommissioned**						

Table 3: King's Lynn Compressor Asset Overview

3.1.4 [redacted]

King's Lynn Historical Running Hours (Hrs)								
Unit	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 4: Compressor Annual Run Hours

3.1.5 As detailed in the approved Needs Case (Appendix O) the forecasted run hours of unit B without re-wheeling unit C and D are noticeably high due to the flow limitations on unit C and D. Re-wheeling unit C and D would improve the performance of these units, enabling their operation at higher flows, subsequently decreasing the reliance (and therefore running hours) on unit B.

3.1.6 The RIIO-GT3 Business Plan Need Case Report indicates that the Future Energy Falling Short Scenario 2023 anticipates a decline in flows in South East to levels below the historical average by the end of RIIO-GT3. However, there remains uncertainty regarding the magnitude and duration of these flows. There are limitations to the FES's data, with no consideration of sudden changes in market trends or geo-political events that result in significant global supply and demand pattern changes. It is therefore important that a full range of scenarios are considered and the appropriate level of capability and resilience for either high levels of entry or exports is maintained.

King's Lynn Unit B Asset Health Mechanical Sub-Asset Summary

3.1.7 Below is a summary description of the sub-assets being addressed as part of the Asset Health interventions on unit B. The findings and recommended solutions are further detailed in Section 7: Options Considered.

3.1.8 **Pipework -** The pipework systems on unit B include suction, discharge, vent, and bypass lines. Suction and discharge lines route gas through the compressor for compression (required increase in gas pressure to discharge onto the NTS). By-pass and venting pipework are critical during emergency shutdowns or routine de-gassing of the compressor for maintenance activities. Figure 4 below shows current condition of pipework

Figure 4: Pipework corrosion and damage

3.1.9 **Valves and Actuators** – Valves are used in either routine valve operations or for isolation of systems for maintenance. Routine valve operations open a flow path to direct gas flow to / via the compressor, by-pass or vent lines. If the unit is to operate effectively and safely, these valves must open and close on demand to either allow gas to flow to / via the compressor or provide an effective seal when closed (gas flow routing and / or flow stopping).

3.1.10 Non-return valves are required to control flow in the desired direction, prevent reverse flow and segregate pressure between systems. Traditionally, remotely operable valves operating on the NTS have been actuated (opened or closed) using high pressure process gas.

3.1.11 Isolation valves are required to provide an effective seal against the flow of gas during maintenance activities. Typically, two isolation valves with a vent to atmosphere (double block and bleed arrangement) are required to prove an isolation has been made and that gas has vented through the vent valve making the downstream gas assets safe to work on.

3.1.12 Gas Driven Valve Actuators – The majority of actuated valves at King's Lynn currently use natural gas as the power source. This requires process gas being used to drive the valve and subsequently being vented when no longer required. The process gas is often passed through a pressure letdown assembly before being utilized on the valve actuator. However, this method releases a charge of natural gas (methane) on each operation. With the increasing awareness of climate change and the need to reduce overall carbon emissions, alternative options, such as electro-hydraulic actuators, are now being installed. Figure 5 below shows a current condition of a valve and actuator for unit B .

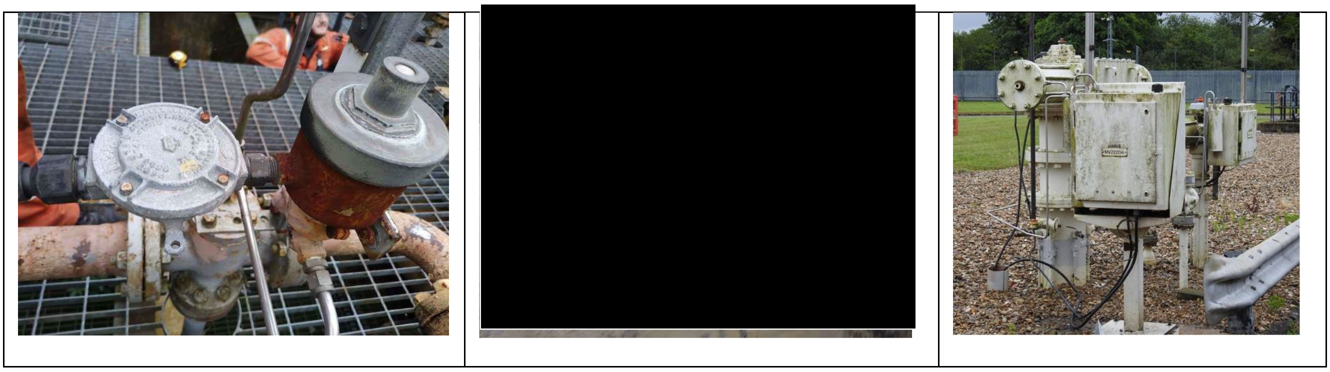

Figure 5: Above ground valve and actuator condition

3.1.13 **Lube Oil System -** The lube oil system, including heat exchangers, filters, pumps and the bulk tank is critical in providing essential lubrication to the Gas Generator, Power Turbine and Compressor. Failure of the Lube Oil System would render the compressor unit inoperable. Lubrication is key to maintaining equipment health over the remnant life, with up to 80% of all bearing failures attributable to improper lubrication. Figure 6 below shows current condition of lube oil system.

Figure 6: Lube Oil System

3.1.14 The Gas Generator uses a synthetic oil whilst mineral oil is used in the Power Turbine and Compressor. The King's Lynn unit B compression package lubrication and seal oil are part of an integrated oil system.

3.1.15 **Fuel Gas Supply Skid** – The Fuel Gas Supply Skid provides a natural gas fuel supply to the Gas Generator for operation. It incorporates pipework, valves and filters required to ensure the gas supply is at the correct flow and pressure for the Gas Generator to run properly, and free of contamination to protect the Gas Generator from damage. Additionally, the Fuel Gas Supply Skid heats the fuel gas to ensure no liquid drop out from the gas which could cause damage to the Gas Generator. Figure 7 below shows the current condition of the asset

[redacted]

Figure 7: Fuel Gas Supply Skid

3.1.16 **Unit B Exhaust Gas Collector –** The Exhaust Gas Collector is a fabricated steel duct connecting the outlet of the Power Turbine to the inlet of the Exhaust Stack, channelling hot exhaust gas from the Gas Generator safely to the atmosphere. The integrity of the Gas Collector is critical so that hot, polluted gas safely exists the compressor unit. Failure of the Gas Collector would result in hot, polluted gas entering the internal compressor Cab enclosure, resulting in shutdown of the unit from high temperature alarms.

3.1.17 **Unit B Exhaust Stack –** unit B's exhaust stack is a fabricated multi-skin layered 'chimney' which connects the outlet of the Exhaust Gas Collector, channelling hot, polluted combustion exhaust gas from the Gas Generator, safely to atmosphere. The stack also has a noise attenuation (reduction) function to meet Environmental Limits under Local Planning Permission. The stack is critical for obtaining emissions sampling mandated under Environmental Legislation. Figure 8 below shows unit B's exhaust stack.

[redacted]

Figure 8: Internal and External Images of unit B's Exhaust Stack

King's Lynn Unit B Asset Health Electrical Sub-Asset Summary

3.1.18 **Low Voltage Switchgear – I**n an electric power system, a switchgear is a combination of electrical disconnect switches, fuses or circuit breakers used to control, protect and isolate electrical equipment. Switchgear is used both to deenergise equipment to allow work to be done and to clear faults downstream. It also provides isolation of circuits from power supplies. Switchgear is in use at virtually every site on the NTS where electrical equipment is installed. Figure 9 below shows the LV switchgears.

[redacted]  [redacted]

Figure 9: Low Voltage Switchgears

3.1.19 **Motor Control Centre (MCC) -** The unit B specific MCC controls all electrical motors on compressor unit B, including motor starters, fuses / circuit breakers and power disconnect. The MCC is critical for operation and Maintenance of all electrical motors on the compressor unit. Failure of the MCC or individual sub-assets would mean loss of critical motive power to motors and pumps required to safely and effectively operate the compressor. Figure 10 below shows the motor control centre.

[redacted] 

Figure 10: Motor Control Centre

3.1.20 **Distribution Boards -** centrally distribute electricity to various circuits for unit B. Circuit breakers or fuses inside these distribution boards help protect and control electrical circuits within the system. As with MCC, failure of the Distribution Boards (DBs) or individual sub-assets would mean loss of critical Safety and Operational systems required to safely operate the compressor. Figure 11 below shows the DBs.

[redacted]

Figure 11: Distribution Boards

3.1.21 **Motors -** all motors provide motive force to drive critical sub-assets of the compressor. These range from small motors for such systems as oil lubrication for the Gas Generator, Power Turbine and compressor, to larger motors such as the main starter motor for the Compressor Power Train (Gas Generator, Power Turbine and Compressor). Figure 12 below shows the current condition of the motors.

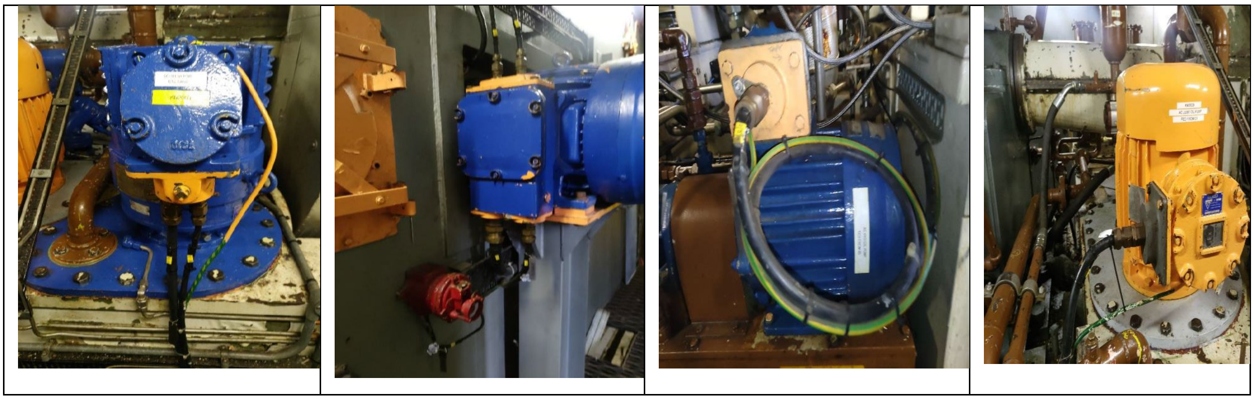

Figure 12: Motors

3.1.22 **Cables –** Cables connect Low Voltage Electrical MCC and Distribution Boards to field devices via local Junction Boxes. The field devices the cables provide power to are critical sub-assets of Operational and Safety Critical Systems essential for the safe operation of the compressor unit as well as the Safety of operational personnel. Degradation or failure of cables results in loss of critical systems to operate the compressor unit and / or compromise the Safety of operational personnel. Figure 13 below shows some cable runs and trays.

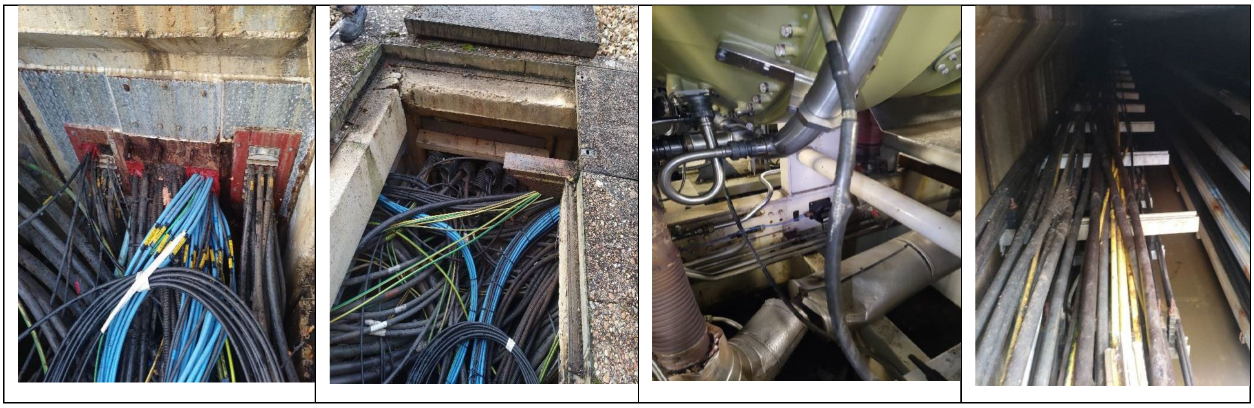

Figure 113: Cables and ducting

3.1.23 **Lighting -** Lighting, internal and/or external, is provided at virtually all operational sites as required to enable safe access and use of internal and external areas for the purpose of operational and maintenance activities. Technology innovations, such as LED systems, present an opportunity to specify more energy efficient lighting options and reduce ongoing operation and maintenance costs. External lighting is generally sensor triggered at rural locations to minimise light pollution. Figure 14 below shows current unit lighting.

Figure 14: Internal CAB lighting

3.1.24 **Arc Flash Assessment -** An arc flash is a release of energy through an electrical arc. This happens when an electrical current passes through air between ungrounded conductors or between ungrounded and grounded conductors. In simpler terms, the effects of an arc flash event mirror that of a bomb.

3.1.25 Energy is released in the form of heat, intense ultraviolet and infrared light, blast pressure waves and intense sound waves. Smoke, toxic fumes, molten metal and flying shrapnel may accompany the electrical event. Any person in proximity to an arc flash blast can suffer injuries as severe as burns, collapsed lungs, loss of vision, ruptured eardrums, soft tissue injuries, broken bones or even death.

3.1.26 Under The Electricity at Work Regulations and The Management of Health and Safety at Work Regulations are specific in these areas), employers are required to undertake an arc flash assessment which involves analysing an organization's electrical systems to determine the incident energy level which quantifies the potential thermal energy exposure from an arc flash event and the required personal protective equipment (PPE) for workers.

3.1.27 It helps to identify arc flash hazards and estimate the likelihood of severe injury. The study determines additional protections needed for electrical safety in the workplace. It is an absolute mandatory requirement in law that arc flash hazards are reduced to the lowest level to protect people from harm. Arc flash assessments have been undertaken on the unit B associated electrical panels including MCC, LV Switchgear and General Services Board to ascertain required interventions to meet this legislative requirement.

4 Problem Statement

4.1.1 Commissioned in 1973, unit B is a Siemens SGT-A20 compressor, now over 50 years old and non-compliant with MCPD directive. In the future the plan for unit B is to support the two MCPD compliant Siemens SGT-400s units C and D at the station following their re-wheel. The following paragraphs explain the key drivers that justify the scope requested to deliver the option selected during previous FOSR submission and review process.

MCPD Legislation

4.1.2 NGT's assets need to comply with all emissions legislation within the Industrial Emissions Directive (IED). The Medium Combustion Plant Directive's (MCPD) compliance deadline is 1st January 2030.

4.1.3 The options available for compliance are as follow:

- Removal of the unit: disconnection or decommissioning
- Limit the usage of the unit under derogation
- Apply emission abatement technology (CSRP/SCR/DLE)
- Build new compliant units

4.1.4 Dry Low Emission (DLE) is not yet available as a technology, however, it might be considered as a solution in future projects. The Control System Restricted Performance (CSRP) has been rejected as a solution by the Environmental Agency and the Selective Catalyst Reduction (SER) technology was found not suitable commercially and technologically to the SGT-A20 compressor. As a result, the emission abatement technology has been excluded as an MCPD compliance option for unit B.

4.1.5 The Final Preferred Option approved by Ofgem in November 2023 to comply with MCPD by 2030 is Option 1, the counterfactual 'do nothing' option, with the existing non-compliant SGT-A20 unit B to be retained under the 500-hour Emergency Use Derogation (EUD) allowed for in the Directive, with significant Asset Health investment to improve unit availability and operational performance until 2050.

4.1.6 Unit B has been used as a 'top up' unit at times depending on flows through the station. When flows exceeded 42mcm (operational envelope of units C and D) in the recent past, unit B has been primarily used to accommodate higher flows of up to 56mcm. In a scenario where flows were higher i.e. 56 – 84mcm, units C and D (or C or D and B if one of those was not available) were in operation. This has had a consequence in unit B being used above the future 500-hour EUD limit, and as such unit B has required significant support to keep it operational with high maintenance costs.

4.1.7 [redacted]

[redacted]

Electrical Standards and Specifications

4.1.9 The following industry standards, specifications, and NGT guidance documents were reviewed to ensure that the Asset Health assessment of the compressor unit B was conducted in alignment with recognised best practices, regulatory requirements, and established technical criteria.

4.1.10 Collectively, they guided the evaluation of equipment integrity, operational functionality, maintenance standards, and overall compliance.

- Electricity at Work Regulations 1989
- Management of Health and Safety at Work Regulations 1999

- T/PM/COMP/20: Compressor Installations for the National Transmission System
- T/SP/COMP/30: Control & Instrumentation Systems on Compressor Installations
- T/SP/EL/50: Gas Transmission Electrical Specifications
- IEC 604391: Low Voltage Switchgear and Control Gear

Mechanical Standards and Specifications

4.1.11 The following industry standards, specifications, and NGT internal guidance documents were referenced and reviewed to ensure that the health assessment of the compressor station was conducted in alignment with recognised best practices, regulatory requirements, and established technical criteria. Collectively, they guided the evaluation of equipment integrity, operational functionality, maintenance standards, and overall compliance.

- API STD 614: Lubrication, Shaft-sealing and Oil-control Systems and Auxiliaries
- T/SP/CM/4: The assessment and reporting of plant coatings, painting & cladding inspections for national transmission system assets
- T/PR/MAINT/5033: Work procedure for the functional check of “ancillary” small bore valves with inlet pressures above 7 bar
- T/PM/PSR/4: Ensuring compliance with the pipeline safety regulations 1996
- T/PM/PS/3: Ensuring compliance with the pressure systems safety regulations 2000
- T/PM/MAINT/6: Maintenance of terminals and compressor installations operating on the national transmission system (excluding PSSR inspections)
- T/PM/SCO/91: Safe Control of Operations at Gas Transmission Sites
- GIS/V6:2019: Steel Valves for the use with natural Gas at normal operating pressure above 7 bar and sizes above DN15
- T/SP/V/6: Specification for steel valves for use with natural gas at normal operating pressure above 7 bar and sizes above DN15
- T/SP/VA/5: Specification for Flow Control Valves
- T/SP/VA/1: Technical specification for fluid powered actuators for two position (OPEN/ CLOSED) quarter turn valves
- T/SP/VA/2: Technical specification for electrically powered actuators for two position (OPEN/ CLOSED) quarter turn valves
- T/SP/VA/4: Electro-Hydraulic Actuators for Two Position (Open/Closed) Quarter Turn Valves

Unit B Defects and Asset Deterioration

4.1.12 The recommended scope to deliver Asset Health interventions covers both electrical and mechanical sub-assets as detailed in the Asset Health survey report (Appendix E). Electrical interventions will include low voltage (LV) distribution boards (DB), LV switchgears, cab lighting, cabling and instrumentation as well as fans, pumps and motors. Mechanical interventions will include exhaust stack, power turbine volute, pipes, valves, actuators, and lube oil systems.

4.1.13 In addition, Table 5 below shows a summary of current defects, examples of faults and associated risks. This is further detailed in the King’s Lynn Unit B Defects List (Appendix I). Without the interventions, it is highly probable that the quantity of defects will escalate and continue to impact the unit’s ability to comply with legislation as well as negatively impacts the flexibility and reliability of the station.

4.1.14 [redacted]

[redacted]	Quantity (Med/High Risk Only)	Example of Defect	Typical Associated Risk
[redacted]			

4.1.15 As described in the Table 5, and further detailed on the defects list, there are significant current defects which will require heavy refurbishment and replacement of sub-assets (where available) as detailed in Section 5 of the Asset Health Electrical and Mechanical Survey.

4.1.16 The assets examined as part of the mechanical and electrical Asset Health surveys scope are summarised below and further detailed are included in Section 7 Options Considered, including the agreed recommendations to resolve them.

4.1.17 The cost to deliver this scope is further detailed in Section 8 of this paper. NGT along with the MWC have carried out a comprehensive review of the survey outcomes and agreed interventions, challenged the costs by benchmarking against similar historical works across the NTS and, where applicable, used existing unit rates as a comparison for the works in the scope.

The Mechanical Sub-Asset Health Survey Report Summary

This is a summary report of the evaluated mechanical sub-assets critical to the operation of unit B at the King's Lynn Gas Compressor Station. The aim of the recommendations was to ensure the operational reliability and safety of these sub-assets over the next 25 years. This is further detailed in the Asset Health Survey Report (Appendix E).

A summary of the survey findings and recommended Asset Health interventions is discussed below.

4.1.18 **Pipework -** The pipework systems, including suction, discharge, vent, and bypass lines, were found to be in generally good condition. Minor issues, such as coating deterioration, surface corrosion, and vegetation growth at some soil-to-air interfaces, were observed. [redacted]

4.1.19 **Valves -** Most valves across unit B have exceeded their design life, with issues such as leakage, corrosion, and coating degradation identified. Operational challenges, including incomplete functional testing records and difficulties with spares due to obsolescence, further complicate their reliability. A major refurbishment programme, including corrosion treatment, sealing upgrades, and the replacement of obsolete valves, is recommended to ensure long term performance.

4.1.20 **Actuators -** Most of the actuators assessed on-site were BIFFI actuators. While these actuators remain operational, they are heavily weathered and aged, showing visible signs of corrosion and deterioration due to prolonged environmental exposure. Limited spare part availability complicates reliability, and emissions from venting impact the environment. Transitioning to modern electric or electro-hydraulic actuators is required to enhance safety, reduce environmental impact, and align with the latest National Gas specifications.

4.1.21 **Lube Oil System -** The lube oil system, including heat exchangers, filters, pumps and the bulk tank, was assessed to be in good overall condition. However, the planned decommissioning of the bulk tank introduces uncertainty regarding alternate oil supply and operational continuity. Minor issues, such as paint deterioration and lack of earthing on some sub-assets, were observed. Additionally, the lube oil coolers have experienced issues with high temperature alarms, which is indicative of deteriorated performance. The overall recommendation is a major refurbishment to blast and recoat pipework and to replace oil coolers to ensure continued operation, integrity and compliance.

4.1.22 **Fuel Gas Supply Skid –** [redacted] However, most sub-assets were constructed in the 1970s, which means they have exceeded their reliable operational life, making them more susceptible to material fatigue, mechanical failure, and performance degradation and face obsolescence risks (as detailed in Section 3 of the Remnant Life Study (Appendix H). A phased replacement programme is recommended, prioritising critical sub-assets such as the governor and filters, while minor refurbishment can address immediate concerns.

4.1.23 **Unit B Exhaust Gas Collector –** Includes a steel fabricated duct to channel the exhaust gas to the main unit B Exhaust Stack. It was found to be very severely corroded, cracked and not feasible to repair. A replacement Gas Collector is required.

4.1.24 **Unit B Exhaust Stack -** The evaluation of the hot gas exhaust system revealed a clear dichotomy between the original components from 1971 and the retrofit equipment from 1996. The original components, except for the support steelwork structure, are in very poor condition, uneconomical to repair, necessitating immediate replacement to ensure the system's safe and reliable operation.

4.1.25 **Mechanical Conclusion -** The proposed recommendations across all systems focused on achieving a balance between immediate cost and long-term performance. Major refurbishment and rationalisation is suitable for addressing issues in the pipework and fuel gas supply systems, while phased replacements are advised for valves and actuators to address environmental issues, obsolescence and ensure safety.

King's Lynn Unit B Electrical Sub-Asset Health Survey Report Summary

4.1.26 This is the summary report of the evaluated the electrical sub-assets critical to the operation of unit B at the King's Lynn Gas Compressor Station, focusing on LV Switchgears and MCCs, Distribution Boards, Motors, Cables, Lighting, Suction and Discharge valve Gas Actuators. The aim was to ensure the operational reliability and safety of these sub-assets over the next 25 years. . This is further detailed in the Asset Health Survey Report (Appendix E).

4.1.27 Several sub-asset concerns were discovered and detailed in the survey report prompting the need to consider the required investment. Of major concern are the systems deterioration due to age, corrosion, and wear. This has resulted in increasing defects or known Issues being recorded and the asset becoming unreliable, unsafe to operate or difficult to maintain.

4.1.28 The assets electrical systems in this scope are no longer suitable from a personnel and equipment safety perspective as they are non-compliant with Arc Flash Protection standards as further detailed in this EJP's Problem Statement (Section 4). The Inspection and Test findings on each system are detailed in the Asset Health Survey Report (Appendix E).

4.1.29 The impact of spares obsolescence, which will worsen over the next 25 years, will also significantly affect the maintenance and reliability. The identified electrical systems spares are no longer supported by the respective manufacturers. Also of concern is the failure of several of these assets to comply with BS EN /IEC 61439, which is a standardised set of safety requirements for power switchgear and control gear assemblies, which came into effect in November 2014.

4.1.30 The purpose of the standard is to harmonise existing general regulations and obligations to achieve uniform expectations and verifications for LV Switchgears and control gear assemblies. Also of importance to National Gas is the compliance of all relevant electrical assets with the Transmission Specification Electrical (T/SP/EL/50). This electrical specification covers the design, manufacture, supply, construction, installation, inspection, testing and commissioning of the main types and aspects of electrical equipment.

A summary of the survey findings and recommended Asset Health interventions is discussed below.

4.1.31 **LV Switchgear -** The switchgear installed on the Kings Lynn site, was commissioned with the original plant installation in the 1980's. The system in place is the old/original switchgear module which is now obsolete with limited OEM support available to maintain them.

4.1.32 **Motor Control Centre (MCC) -** These MCC switchgears were supplied with the original plant and are showing signs of age. Due to the age of equipment, the form of construction does not meet the requirements of present active British and International Electrotechnical Commission (IEC) standards.

4.1.33 For example, there is no mechanical segregation between the outgoing circuits, and forms of separation as defined in BS EN 61439-1:2011. These switchgears appear to have been constructed to Form 3 of the above standard. The present revision of National Grid Electrical Safety Rules SCO 96 requires that each outgoing circuit from a switchgear is fully segregated from adjacent live circuits as part of the isolation procedure.

4.1.34 **Distribution Boards (DB) -** The general services switchgear within the existing switch room and control room building supplies power to site Direct Current (DC) emergency systems via a DC UPS. A defect was identified on DL 5939: the distribution boards (DBs) are obsolete with no spares available. The distribution boards are an integral part of the general services switchgear which presents an operational hazard due to lack of proper mechanical segregation.

4.1.35 The electrical assessment included an obsolescence review, with the board's OEM to look at options for retaining in service (with selected component replacement/upgrade) and procurement and installation of new, current generation distribution boards to replace the existing boards. The obsolescence risk was measured and deemed to be high, particularly component DL 5939 and as a result the mean time to repair would be very long. NGT has taken the decision to replace this equipment for operational availability as well as electrical safety reasons.

4.1.36 **Motors –** The current motors and associated pumps date back to the original year of construction. Motors have experienced failures including winding failure, overheating, insulation breakdown necessitating overhauls.

4.1.37 Given the pump's role in the critical operation of providing lubrication to the Gas Generator, power turbine and compressor, failure presents a serious risk of machine damage / failure, unplanned downtime and safety hazards.

4.1.38 All motors and power supply cables were tested and found to be in good electrical insulation condition. However, factoring the age of both the motors and pumps and criticality to safe and reliable operation for an additional 25 years, the following has been considered:

Assembly Compatibility:

- Motor and pump are integrally coupled. Replacing only the motor introduces misalignment risk and compatibility issues, especially with mounting and shaft alignment.
- New motors only may exceed performance tolerances of existing pump (e.g., torque delivery, rotational speed variances).
- Operational Risks of Partial Replacement
- Increased Downtime: Potential for pump failure shortly after motor replacement, leading to repeat shutdowns and lost operations.
- Reduced System Efficiency: Mismatched components can lead to operational inefficiency, vibration, and premature wear.
- Health & Safety Concerns: Leaking seals and overheating risks create hazards for maintenance personnel and nearby systems.
- Hidden Costs: Partial replacement might require multiple rework interventions and additional alignment labour at increased whole life cost.

4.1.39 **Recommendation -** Based on the age of the motors and pumps, maintenance history, operational risks, and economic analysis, it is recommended that the entire motor and pump assemblies be replaced. This approach ensures compatibility, system integrity, and reliability while minimising the risk of future unplanned failures.

4.1.40 **Cables –** A study of both maintainability records and the Asset Health survey (cable testing and visual inspection) found the cable condition of both internal of the CAB and external of the CAB (visual inspection) to appear in a good condition. However, as the cables are incoming and outgoing of the LV Switchgear and MCC which require replacement, the cables must also be replaced to current technology to support the new switchgear and MCC and must be of the correct length to terminate at new cabinet locations. Replacement also supports the requirement to provide the required 25-year life extension.

4.1.41 **Lighting -** NGT has been progressing a lighting upgrade project for the internal CAB structure of unit B, and pivotal strides have been made to ensure the longevity and efficiency of the system over its anticipated life span of 25 years. The recommended transition from fluorescent-based fixtures, installed during the unit's commissioning in the mid-1980s, to state-of-the-art Light Emitting Diode (LED) technology adheres to the latest British Standards (BS) and NGT technical standards for electrical systems. Fluorescent lighting is no longer supported (tubes no longer manufactured) and spares are dwindling, therefore transition to modern low energy LED lighting is recommended.

4.1.42 **Suction and Discharge Valves -** The present suction and discharge valves are gas activated driven actuators. This type of actuator drive is not compliant with DSEAR, PSSR and COMAH regulations and requires to be replaced for the future operational period of 25 years. The preferred option for the compressor station is to replace the present actuators with electric/hydraulic actuators thereby negating the need for actuating gas pipework and eliminating the release of natural gas to atmosphere.

4.1.43 **Arc Flash Assessment –** Based on the assessment and information collected at site, the Electrical Transit Arc Protection (ETAP) power system analysis software proposed the arc flash incident energy levels at King's Lynn compressor station will vary depending on the incoming utility supply.

4.1.44 When assumed a utility supply of 1.25MVA, there is insufficient fault contributions to trip the main LV relay / breaker. The fault clearing time for the general service board and motor control centre B is capped at 2 seconds.

4.1.45 However, when using utility supply of 6.25MVA – 25MVA, the contribution increases the incident levels considerably and increases until an appropriate level of contribution is reached which operates 3B CB relay reducing the fault clearing time to 1.03 seconds and an incident energy level of 17.53 cal/cm2. In all three utility supply scenarios the Arc Flash study concluded that LV Switchgears, MCC and Distribution Boards require replacement to comply with mandatory Legislation for the protection of personnel.

Electrical Conclusion - The proposed recommendations across all systems focused on compliance with current UK and International safety standards and life extension of the asset for 25 years. The general recommendation for electrical sub-assets across the board is replacement.

What the investment seeks to achieve

4.1.46 This investment aims to secure funding to deliver Asset Health interventions on King's Lynn's unit B compressor to support the agreed derogation to meet MCPD directive by 2030. To achieve this NGT has worked with its MWC contractor to define the optimal scope, volume and cost to deliver this output within the RIIO-T2 and RIIO-GT3 regulatory period and in line with the station's outage windows. The investment, once delivered, will ensure that:

- Unit B will operate and perform their function when required to do so, particularly when the primary compressor units are out of operation.
- The unit is maintainable such that any unexpected defects can be remediated without significant impact on the availability of the station.
- Ensure that we safely remove/or replace sub-assets that are no longer required, to manage overall whole life cost and risk.
- The unit is operationally available and reliable to 2050 ultimately supporting our customers by continuous gas delivery at the volumes and at pressures they require.

4.1.47 Should the proposed interventions not be performed, the increasing defect count means that impacts of failure become more likely and drive an increasing probability of unplanned unit operational stand down potentially negatively effecting UK security of supply.

How will we understand if the project has been successful?

4.1.48 The project will be deemed successful when all asset health works are completed, the unit is returned to service and demonstrates reliable service as a back-up unit to units C and D. Furthermore, once the scope has been delivered, the asset will comply to the relevant technical specifications, safety, and engineering standards.

4.1.49 As mentioned in section 4.1.45, the delivery of this project will ensure the unit continues being available, is maintainable and operational until 2050, ensuring NGT continues delivering gas to customers and end consumers. The life extension and ability to act as a backup unit to units B and C will ultimately support the network resilience and save customer's money by potentially preventing site shut down and potential network constraints when the gas could not be delivered where intended.

4.1.50 Additionally, NGT Management Procedure (T/PM/G/35) incorporates the philosophy and general principles outlined in the Institution of Gas Engineers & Managers (IGEM) standard IGEM/GL/5 Edition 2 'Managing new works, modifications and repairs' and serves to adopt its principles. Adherence to this will be demonstrated prior to the issuing of a commissioning of replacement valves and electrical panels as per NGT Policy (RE/18) and the asset being handed back to the operator.

Spend Boundaries

4.1.51 This paper only covers Asset Health interventions on compressor unit B at King's Lynn Compressor Station and is aligned to the RIIO-GT3 program. The proposed investments only cover agreed defects and improvements following Asset Health survey reviews conducted by NGT and its MWC. The electrical and mechanical interventions covered are further detailed in Section 6 of this paper.

4.1.52 This funding request does not cover decommissioning of unit A or the re-wheel of units C and D as these, as previously mentioned, are covered under separate EJPs.

4.1.53 The scope covered under this re-opener submission has been assessed against the NGT RIIO-GT3 plan to ensure there are no duplication of scope. This is further detailed in the overarching document.

5 Options Considered

5.1.1 [redacted]

[redacted] [redacted]

[redacted] [redacted]

Options Considered Summary

5.1.4 Below in Tables 6 and 7 are the options considered for Asset Health interventions on the sub-assets and the justifications behind the chosen preferred interventions. This is further detailed in the Asset Health Survey Report (Appendix E).

Electrical Assets	Do nothing	Minor Refurbishment	Major Refurbishment	Replacement
LV Switchgears	Not viable as does not satisfy absolute requirements of Legislation (Electricity at Work Regulations) or meet with BS EN 61439-1 2011 Low Voltage Switchgear and Control Gear.	Modifying internal sub-assets does not meet with BS EN 61439-1:2011 Low Voltage Switchgear and Control Gear.	Modifying internal sub-assets does not meet with BS EN 61439-1:2011 Low Voltage Switchgear and Control Gear.	Most viable option providing a guarantee of meeting the absolute requirements of Legislation and the desired reliability for trouble - free operations for 25 years.
Motor Control Centre (MCC)	Not viable to meet with SCO96 safety, NGT standards or Legislation (Electricity at work Regulations).	Modifying internal sub-assets does not meet with BS EN 61439-1:2011 Low Voltage Switchgear and Control Gear.	Modifying internal sub-assets does not meet with BS EN 61439-1:2011 Low Voltage Switchgear and Control Gear.	Most viable option providing a guarantee of meeting the absolute requirement of Legislation and the desired reliability for trouble- free operations for 25 years
Distribution Boards	Not viable as the distribution boards are defective, obsolete with no spare parts available. They are also an integral part of the LV General Services board which must be replaced.	Not viable as LV board to be replaced (same reason as 'Do nothing' option).	Not viable as LV board to be replaced (same reason as 'Do nothing option).	Most viable option providing a guarantee of the desired reliability and trouble - free operations for 25 years. Lighting circuits DB s MCBs to be rated for LED circuits loads.
Motors	Not viable as local control stations are badly corroded presenting a safety and loss of control hazard. This does not support 25-year life extension of pump or vent fan drives.	Not recommended as this will necessitate multiple interventions over the remaining 25-year operational life resulting in increased whole life cost compared with Replacement option.	Not recommended as this will necessitate multiple interventions over the remaining 25-year operational life resulting in increased whole life cost compared with Replacement option.	Viable option, if new pumps and vent fans are recommended providing a guarantee of trouble - free operations for 25 years
Cables	Not Viable as the MCC replacement will necessitate new cables.	Not applicable as cables cannot be repaired.	Not applicable as cables cannot be repaired.	Assuming that the MCC is replaced as per previous recommendation, this will necessitate new cables to the CAB B.

Electrical Assets	Do nothing	Minor Refurbishment	Major Refurbishment	Replacement
Lighting	Not Viable as new LED fittings are recommended by /SP/EL/50 and BS Standards.	Not viable as existing fluorescent tubes are no longer manufactured. New LED lighting would require full system replacement for compatibility	Not viable (same reasons as minor refurbishment)	The Most Viable option to meet with latest Legislation and guarantee lighting performance for 25 years.
Suction Valves & Gas Actuators	Not viable due to the high risk of mechanical failure, leakage, and inefficiencies due to aging valves. Increased emissions and compliance risks.	Not viable due to leaking obsolete valves where some are no longer supported. Does not address environmental and regulatory concerns associated with venting.	Not viable due to leaking obsolete valves where some are no longer supported. Does not address environmental and regulatory concerns associated with venting.	With Electro- Hydraulic actuators: Replacement of the corroded gas pipework would be more costly, operationally inefficient and complex, resulting in significant delays in remediating risk at site, and would not remedy the venting issues. Utilising a more cost-effective electric actuation is recommended. However, where operability and safety criticality require layers of protection beyond single point of failure, including but not limited to a necessity for systems to "fail safe", it is recommended to replace with Electric Hydraulic actuation. This is due to its additional layer of protection should power loss occur and its functionality resulting in valves shutting should actuation completely fail.

Table 6: Electrical Asset Health Options Considered

5.1.5 Mechanical Sub-Asset intervention options are outlined in the Table 13 below.

Mechanical Assets	Do nothing	Minor Refurbishment	Major Refurbishment	Replacement
Pipework	Overlooks corrosion, missing supports and potential vulnerabilities in piping, increasing the likelihood of failure.	Does not ensure long term reliability for infrastructure beyond its design. Would require multiple interventions to assure integrity at increased whole life cost compared with major refurbishment	This is a balanced solution for an aging infrastructure, which ensures the system remains safe, reliable and cost effective.	Excessive expenditure. The cost of full replacement is unwarranted, given current conditions.
Valves	Most valves have exceeded their intended service life, increasing risk of material fatigue, mechanical failure, and inefficiencies.	Does not address age related degradation, obsolescence, or repeated leaks/passing. Gas-actuated systems would still rely on venting process gas, perpetuating emissions and compliance issues.	Does not address age related degradation, obsolescence, or repeated leaks/passing. Gas-actuated systems would still rely on venting process gas, perpetuating emissions and compliance issues.	All valves will be changed to electrohydraulic valves during this project as it minimise the risk of damage due to mix of valve systems. This also supports long term performance, regulatory compliance, and alignment with modern standards.
Actuators	Operation uses vented process gas, leading to operational, environmental and safety concerns. units are aging, beyond design life and showing visible deterioration.	Does not address age related degradation, obsolescence and venting related environmental issues.	Refurbishments or upgrades can address immediate issues but do not resolve inherent design limitations or venting related environmental issues.	Transition to electro-hydraulic actuators. This would eliminate process gas venting, enhance reliability, enhance safety and align with modern industry standards.
Lube Oil System	Not Viable	Does not ensure long term reliability for infrastructure beyond its design.	This is a balanced solution for an aging infrastructure, which ensures the system remains safe, reliable and cost effective.	Excessive expenditure. The cost of full replacement is unwarranted, given current conditions
Fuel Gas	Retaining the 1970s	Addressing only surface	While this approach might	A complete rationalised skid

Mechanical Assets	Do nothing	Minor Refurbishment	Major Refurbishment	Replacement
Supply Skid	skid without intervention ignores the risks associated with ageing infrastructure and component obsolescence. This option leaves the system vulnerable to failures and unplanned downtime due to lack of spare parts.	level issues, such as replacing individual valves or fittings, does not resolve the fundamental challenges of obsolete sub-assets.	extend the skid's life temporarily, integrating modern sub-assets into a 1970s framework creates compatibility risks and fails to eliminate obsolescence. Also, the PRA was designed to supply units A, B and C As units A and C are no longer in service. Major refurb without rationalisation would involve unnecessary cost.	replacement eliminates all concerns of obsolescence, reduces maintainable assets, introduces modern sub-assets with long-term spare-part availability, and provides a robust solution for the next 25+ years.
Unit B Exhaust Gas Collector	Not viable as the existing Collector is too severely corroded,	Not viable as the existing Collector is too severely corroded.	Not viable as the existing Collector is too severely corroded.	Replacement is the most viable solution given it will provide the required operational life extension of 25 years.
Unit B Exhaust Stack	Not viable as critical components of the Exhaust are too badly corroded.	Not viable as critical components of the Exhaust are too badly corroded.	Not viable as the stack must be removed from site for off-site refurbishment which would be both cost and programme prohibitive for the required return to service and not meet the required life extension of 25 years.	Replacement is the most viable solution given it will provide the required operational life extension of 25 years. Off-site fabrication followed by installation during acceptable outages and required return to service is achievable.

Table 7: Mechanical Asset Health Options Considered

6 Preferred Option and Project Plan

6.1.1 As detailed in Tables 12 and 13, the agreed Electrical and Mechanical scope is derived from the Asset Health surveys completed by our MWC and approved by NGT SMEs. The assessments outlined and the associated discounting and costing of options demonstrates that the most viable, cost effective and logical options to take forward is complete replacement of all electrical assets in scope and a mixture of refurbishment and replacement of mechanical assets in scope.

6.1.2 NGT recognises the significant CAPEX investment is required to achieve this scope through the preferred option. However, considering the reliability and safety improvements, the absolute need to comply with current legislation and engineering standards, and the opportunity to modernise various assets, we believe this represents the best investment option to continue to meet customer needs, maintain security of supply and achieve lowest Whole Life Cost.

6.1.3 Focus is therefore on ensuring assets with the most reliable available technology and meeting safety standards are procured, and the investment is delivered at the lowest overall cost.

Project Scope

6.1.4 The project scope as established in the recommended interventions in Section 7 forms the basis of the volumes detailed in this section. The work scope includes:

- Design, Specification, and procurement of appropriate replacement sub-assets in accordance with NGT and International Standards.
- Programming and coordination of works with coinciding site activities.
- Temporary works including civils and groundworks.
- Removal and replacement of life expired and defective sub-assets where replacement is necessary to provide the required life extension.
- Refurbishment of defective assets, where refurbishment provides the required life extension.
- Welding and NDT activities
- Site Acceptance Testing.
- Commissioning works.
- Reinstatement works.
- Collation and archiving of handover spares and records.
- Records and asset data updates.

Asset Health UIDs and Project Timeline

6.1.5 We propose to use the following new UIDs aligned with our Re-opener request to apportion out the cost at delivery stage as shown in Table 8 below. This includes various types, sizes and lengths of power and instrumentation cable required for the re-installation and commissioning of unit B.

New OFGEM UID	Funding Type	Intervention Type	Option Name	Unit of Measure	Delivery Theme
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

New OFGEM UID	Funding Type	Intervention Type	Option Name	Unit of Measure	Delivery Theme
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 8: New unit B Asset Health UIDs

Unit B Sub-Asset Replacement Volumes

6.1.6 Table 9 below is a detail of the key volumes of sub-assets proposed for replacement on unit B. The justification for replacement is detailed in Table 6 and 7 above.

6.1.7 The duplication of volumes between this re-opener and RIIO-GT3 Business Plan are identified in Table 9. The Overarching document, chapter 2.1.9, provides further details on this.

Sub-Asset Description	Quantity to be replaced	UID	T3 Interface
[redacted]			
[redacted]		[redacted]	
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted] [redacted]	[redacted]		
[redacted]		[redacted]	
[redacted]	[redacted]		
[redacted]	[redacted]		

Sub-Asset Description	Quantity to be replaced	UID	T3 Interface
[redacted]		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]

Table 9: Proposed unit B Asset Health Replacement Volumes

Project Timescales

6.1.8 The project was sanctioned at NDP500 Stage 4.2 in April 2022 and detailed Asset Health surveys were completed in November 2024. The project progressed to ND500 Stage 4.4 in April 2025 to ratify the outcome of the Asset Health scoping, cost estimation (+/- 15%) and delivery programme which forms the basis of this cost submission.

6.1.9 [redacted]

6.1.10 Table 10 and 11 below, gives the outline milestones and indicative timeline for delivering the project across RIIO-T2 and RIIO-GT3. An indicative delivery programme is included in Appendix L and the outage plan in Appendix J.

	Activity Name	Indicative Completion Dates
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	
[redacted]	[redacted]	
[redacted]	[redacted]	
[redacted]	[redacted]	

Table 10: King's Lynn Asset Health Scope Indicative Milestones

FY27	FY28	FY29	FY30
[redacted]	[redacted]	[redacted]	[redacted]

Efficient Cost

6.1.11 [redacted]

[redacted]

Final costs from associated Cost Book

6.1.14 To ensure robustness of the EJP costs, NGT employed the use of a Designer / Main Works Contractor (MWC) to validate scope, understand some of the engineering challenges associated, refine details and build up an externally priced estimate showing how the market would cost works of this nature.

6.1.15 [redacted]erarching document.

6.1.16 Table 12 provides a breakdown of the final EAC costs for the project split by several categories.

	Cost Category	Costs (£m) 2024/25 Price Base	Costs (£m) 2018/219 Price Base
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
[redacted]	[redacted]		
	[redacted]		
	[redacted]		
	[redacted]		
	[redacted]		

Table 12: Preferred Option Final Costs

6.1.17 The cost accuracy at this stage of the project is estimated at +15/-10% in accordance with the Infrastructure and Projects Authority (IPA) cost estimating guidance. The investment and works will span across the RIIO-T2 and RIIO-GT3 period.

Key Business Risks and Deliverability Challenges

6.1.18 Due to the complexity of the site, there are significant challenges in delivering this work, a few of which are highlighted below. The risk management process adopted by NGT is described in Appendix F, NGT Cost and Risk Methodology, chapter 3: Risk Methodology. Full descriptions of these risks and their potential impact, including qualitative and quantitative assessments and mitigations, are detailed within the project Risk Register in Appendix A King's Lynn MCPD Costbook.

6.1.19 [redacted].

Risk ID	Scope	Title	Description	Probability Value (%)	P50 Value 2024/25 Price Base	P50 Value 2018/19 Price Base
[redacted]						

Table 13: Top 3 Key Delivery Risks

6.1.20 All associated civils works require additional planning, temporary works, and a complex strategy.

6.1.21 All civils work will be conducted in accordance with relevant safety standards. The dense population of buried services, plant and equipment might lead to above ground complications with heavy machinery.

6.1.22 Emerging scope may lead to additional works required.

6.1.23 Despite the challenges detailed above, NGT has completed a series of deliverability assessments to confirm the scope is deliverable within the planned program. See Table 15 above for outline milestones and Appendix

L for the King's Lynn MCPD Asset Health indicative delivery program for further details.

6.1.24 Deliverability has also been aligned to the RIIO-GT3 plan, and other adjacent work and customer outages.

7 Conclusion

7.1.1 This report has explained the approach NGT has taken to review and conclude the Asset Health interventions required for compressor unit B at King's Lynn compressor station to enable it to operate reliably to 2050, and the implications of not completing these works.

7.1.2 Furthermore, it has detailed the safety, environmental and operational risk concerns NGT has regarding the defective and life expired mechanical and electrical sub-assets and the implications of these on the reliability of unit B. The interventions are necessary to ensure improved reliability and life extension of the unit.

7.1.3 The proposed scope is in line with the Ofgem's approved FOSR option and meets internal SME and external contractor engineering approval.

7.1.4 The project's agreed scope and cost have been assured for efficiency. The scope has been assessed against the current electrical and mechanical standards, while the costs have been assured by benchmarking against similar projects delivered.

7.1.5 Failure to obtain funding will put unit B and at risk of continued failure and operational stand down, potentially leaving King's Lynn compressor station vulnerable and unable to meet its reliability and availability commitments.

7.1.6 The interventions described will provide the best value for money and support the gas delivery at pressures and volumes our customers require.

7.1.7 [redacted]

8 Glossary

Glossary	
CBA	**Cost Benefit Analysis:** A mathematical decision support tool to quantify the relative benefits of each site option.
CDS	Conceptual Design Study
COMAH	Control of Major Accident Hazards (COMAH) Regulations 2015. Bacton Terminal is one of two designated NGT COMAH establishments. The other being St Fergus Terminal
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations 2002
EAC	**Estimated Cost At Completion:** A value expressed in money and/or hours to represent the projected final costs of work when completed.
ECI	Early Contractor Involvement
EJP	Engineering Justification Paper
Entry Capacity	Holdings give NTS users the right to bring gas onto the NTS on any day of the gas year. Capacity rights can be procured in the long term or through shorter term processes, up to the gas day itself. Each NTS Entry point has an allocated Baseline which represents a level of Capacity that NGT is obligated to make available for delivery against on every day of the year
EPC	Engineering Procurement and Construction
Exit Capacity	Holdings give NTS users the right to take gas off the NTS on any day of the gas year. Capacity rights can be procured in the long term or through shorter term processes, up to the gas day itself. Each NTS Exit point has an allocated Baseline which represents a level of Capacity that NGT is obligated to make available for offtake on every day of the year.
FES	**Future Energy Scenarios:** An annual industry-wide consultation process encompassing questionnaires, workshops, meetings and seminars to seek feedback on latest scenarios and shape future scenario work. The Future Energy Scenarios document is produced annually by National Grid ESO and contains their latest scenarios.
FOS	Future Operating Strategy
FOSR	Final Option Selection Report
GS(M)R	**Gas Safety (Management) Regulations:** The Gas Safety (Management) Regulations 1996 (GS(M)R) apply to the conveyance of natural gas (methane) through pipes to domestic and other consumers
HSE	**Health and Safety Executive**
IPA	**Infrastructure and Projects Authority**
LNG	Liquified Natural Gas, Natural gas that has been cooled to a liquid state (around -162°C) and either stored and/or transported in this liquid form.
LAV	Locally Actuated Valves

Glossary	
MWC	Main Works Contractor
(G)NDP	**Network Development Process:** The process by which NGT identifies and implements physical investment on the NTS.
NEA	Network Entry Agreement
NEC	New Engineering Contract
NGT	National Gas Transmission
NTS	**National Transmission System:** The high-pressure system consisting of Terminals, compressor stations, pipeline systems and offtakes. Designed to operate at pressures up to 94 barg. NTS pipelines transport gas from Terminals to NTS offtakes.
OEM	**Original Equipment Manufacturer**
Ofgem	**Office of Gas and Electricity Markets:** The regulatory agency responsible for regulating Great Britain's gas and electricity markets.
PFD	**Process Flow Diagram**
PV	**Process Valves**
PSSR	Pressure Systems Safety Regulations 2000
RAM	**Reliability Availability Maintainability**
Re-opener	Re-openers are a type of RIIO uncertainty mechanism. Depending on their design, they allow Ofgem to adjust a licensee's allowances (in some cases up and in some cases down), outputs and delivery dates in response to changing circumstances during the price control period.
RIIO	**Revenue = Incentives + Innovation + Outputs**: RIIO-T2 is the second transmission price control review to reflect the framework; it sets out what the transmission network companies are expected to deliver and details of the regulatory framework that supports both effective and efficient delivery for energy consumers.
ROV	**Remote Operation Valves**
SOL	**Safe Operating Limit**
Uncertainty Mechanism	Uncertainty mechanisms exist to allow price control arrangements to respond to change. They protect both end consumers and licensees from unforecastable risk or changes in circumstances.
UKCS	**United Kingdom Continental Shelf:** The UK Continental Shelf (UKCS) is the region of waters surrounding the United Kingdom, in which the country has mineral rights. The UK continental shelf includes parts of the North Sea, the North Atlantic, the Irish Sea and the English Channel; the area includes large resources of oil and gas.
UID	Unique Identifier