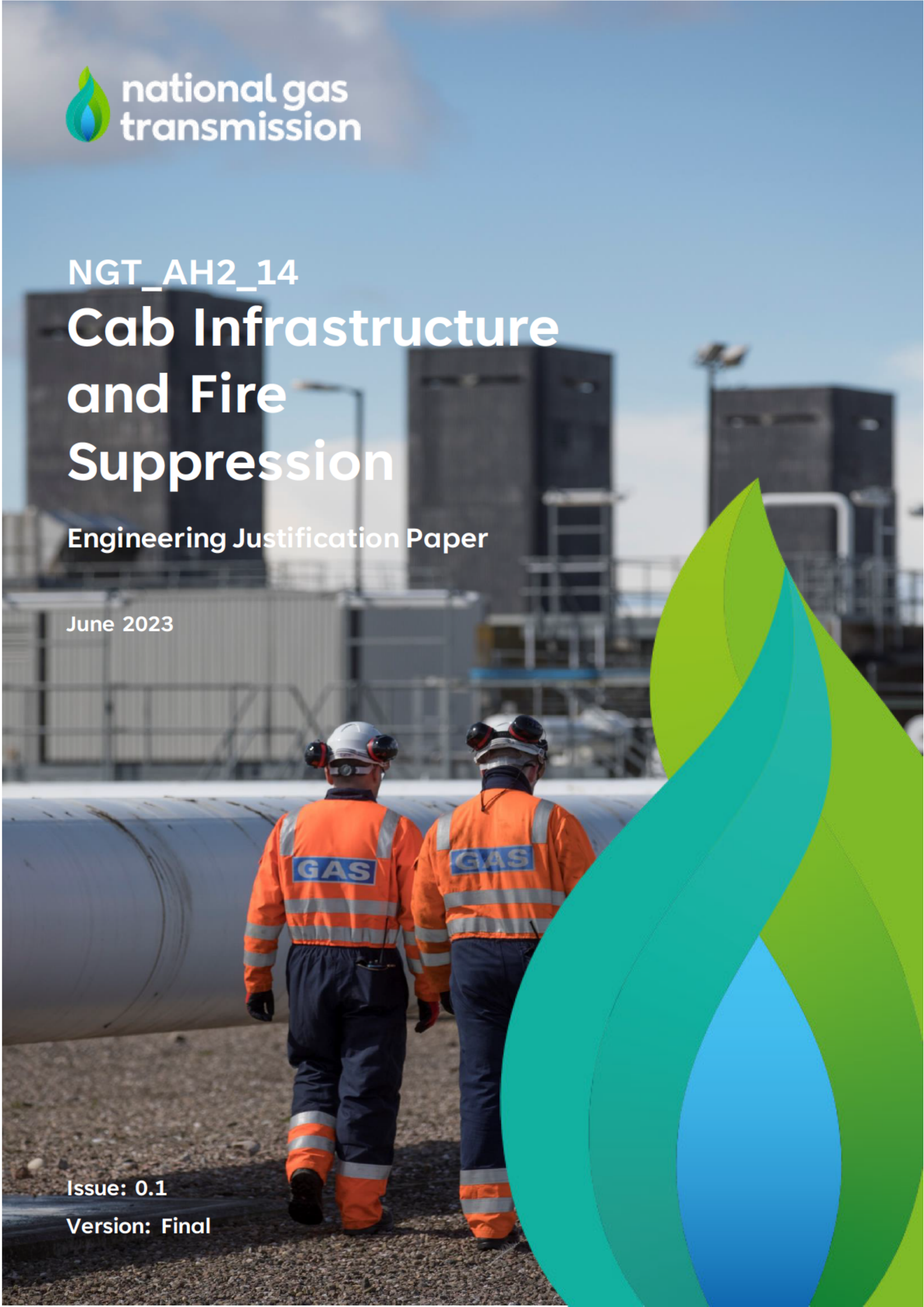
national gas transmission

NGT_AH2_14

# Cab Infrastructure and Fire Suppression

## Engineering Justification Paper

June 2023

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# Executive Summary

This Engineering Justification Paper (EJP) summarises the justification for the planned investment in selected National Gas Transmission's (NGT) Cab Infrastructure Assets in RIIO-2 in line with the agreed Uncertainty Mechanism (UM) approach included in Ofgem's 2020 Final Determination (FD) of NGT's RIIO-2 business plan. It is submitted in accordance with the NTS Gas Transporter Licence Condition 3.14 Asset Health Re-opener, Price Control Deliverable Reporting Requirements and Methodology Document and RIIO-2 Re-opener Guidance and Application Requirements Document.

The total funding request being made through this paper is £42.041m comprising RIIO-2 interventions and RIIO-3 preparatory activities.

The price base used throughout this document is 2018/19 unless otherwise specified.

Compressor cab infrastructure is critical to efficient and safe operation of individual compressor machinery trains whilst meeting environmental permit and legislative requirements. In terms of operational security, essential investment ensures NGT's compressor assets can be operated mindful that in the absence of functioning components (i.e., exhausts, fire suppression, etc) a compressor unit cannot be operated.

There are [redacted] operational compressor units on the National Transmission System (NTS). A typical compressor cab comprises enclosure, air intake, exhaust, ventilation and fire suppression sub asset equipment. [redacted] cabs at [redacted] compressor sites ([redacted]), have been identified for intervention in 2024 and 2025, in line with NGT's need case and future strategy. The compressor cabs across the NTS are aging assets that suffer from corrosion and wear related deterioration. Independent externally conducted condition assessment surveys undertaken of the [redacted] Cabs revealed a number of defects affecting the various compressor cab related sub assets that need resolving to ensure cab and fire suppression infrastructure functions at their required operational levels.

Asset health investments related to cab and fire suppression at St Fergus and Bacton, including the fire water ring mains, are progressed via a separate Uncertainty Mechanism. Investment associated with compressor cabs for new compressor units and decommissioning of redundant units is excluded from this paper, as this is included in the separate compressor and decommissioning themes.

The majority of cabs assets deteriorate, resulting in poor performance which leads to further deterioration and eventually failure. The consequence of failure has varying impacts on availability, the environment, safety and finance. Cab asset failure can result in an inability to operate a compressor.

This investment is required now as no investment in the compressor cab and fire suppression infrastructure assets will lead to their continued and increasing deterioration, limiting their effective operation further leading to failure. If these assets are not operating effectively, they make the compressor units unsafe and inoperable, leading to an increased risk to the availability of the gas supply. This in turn leads to a network unable to meet customer needs.

As of June 2023, circa [redacted] interventions across [redacted] Cabs at nine compressor stations had been completed in the first three years of RIIO-2 (2021-2022). Circa [redacted] has been spent in excess of the baseline allowance to deliver this scope. Variances have been noted between unit costs used to establish the baseline allowance and actual unit costs to complete the works, primarily as a result of higher inflationary pressure and intervention specific scopes/costs. Scopes and costs incurred in completing these interventions has been used to inform and build cab specific unit costs for 2024 and 2025 identified interventions.

Defects, identified through NGT's cab and fire suppression infrastructure rolling asset health plan and bolstered by external cab condition survey reports, were assessed for intervention options. Through Campaign Decision Panels (CDPs) all credible options for each identified defect was assessed to ascertain the most optimum asset management intervention to balance cost risk and performance and deliver on NGT's consumer outcome. A total of [redacted] interventions have been identified to be undertaken across [redacted] cabs in 2024 and 2025 covering seven specific Unique Identifiers (UIDs).

The cost build for 2024/25 and 2025/26 Cabs related interventions has been primarily based on similar identifiable works completed in years one and two (2021/22 and 2022/23) of RIIO-2. All costs are in 2018/19 price base and are based on appropriate cab specific scope and a reasonable comparison to completed and tendered works has been undertaken. Cost confidence and accuracy is based on outturn costs for activities completed with similar scope for years 4 and 5 interventions and rigorous build-up of costs.

Long Term Risk Benefit (LTRB) for the proposed interventions will be reported in FY23's NARMs RRP as part of the forecast position, as the interventions are yet to happen. The target adjustment for NGT is proposed to happen after the submission of the final UM.

Key risks include additional scope requirements (including mechanical, design & civil) leading to scope change / scope creep, outage cancellation post mobilisation, and increase to materials prices impacting project launch. Key opportunities include bundling of works at each site or across sites and long lead procurement efficiencies through early bulk purchasing or utilising spares.

NGT proposes that the volumes and costs within the Cabs Asset Health -Non-Lead Assets PCD Tables are updated to reflect the year 1 to 5 asset health intervention funding request of **£39.446m** within this EJP as summarised in the following table.

| UID | Description / Intervention | RIIO-2 UID Volumes | | | Cost (£m) | In Scope of AH UM |
|---|---|---|---|---|---|---|
| | | Yrs.1-3 | Yrs.4&5 | Total | | |
| [redacted] | | | | | | Yes |
| | | | | | | Yes |
| | | | | | | Yes |
| | | | | | | Yes |
| | | | | | | Yes |
| | | | | | | Yes |
| | | | | | | Yes |
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| | | | | | | Yes |
| | | | | | | Yes |
| | | | | | | Yes |
| | | | | | | Yes |
| | | | | | | Yes |
| | **Totals** | [redacted] | [redacted] | [redacted] | 39.446 | |

To reduce the risk of delayed investment initiation, NGT proposes to undertake asset health condition-based surveys and associated assessments within the RIIO-2 period to identify potential asset health works for the next regulatory period, covering the Cab Infrastructure & Fire Suppression themes. The latest view is that there will be circa [redacted] Cabs to survey. The total cost associated with this cab infrastructure and fires suppression request, for the RIIO-2 period, is [redacted].

The total RIIO-2 spend is **£42.041m** as summarised in the following table. Baseline funding of £12.191m was awarded. Therefore, though the total RIIO-2 spend is £42.041m the total funding request being made through this paper is **£29.850m**.

| **Description** | | | **Totals (£m)** |
|---|---|---|---|
| Baseline Interventions (yrs. 1-3) | ***Baseline Breakdown*** | | [redacted] |
| | *Actual spend* | [redacted] | |
| | *Awarded FD spend* | *12.191* | |
| | *Actual - Awarded* | [redacted] | |
| Years 4&5interventions | | | [redacted] |
| Cab Infrastructure and Fire Suppression RIIO-2 Surveys and FEED activities to identify RIIO-3 cab infrastructure and fire suppression interventions. | | | [redacted] |
| **Total RIIO-2 spend** | | | **42.041** |
| **Awarded baseline spend** | | | **12.191** |
| **Funding request being made through this paper** | | | **29.850** |

# 1 Summary

| | |
|---|---|
| **Name of Scheme/Programme** | Cab Infrastructure and Fire Suppression |
| **Primary Investment Driver** | Asset Health |
| **Scheme reference/ mechanism or category** | [redacted] |
| **Output references/type** | SPc 3.15: Asset Health–non lead assets Re-opener (NLAHOt) |
| **Cost (2018/19 price base)** | Submitted cost of chosen scheme:<br>• Baseline Cabs 2021 to 2023 - [redacted]<br>• UM Cabs 24 and 25 works - [redacted]<br>• RIIO-2 specific Cabs survey and FEED activities for RIIO-3 - [redacted] |
| **Delivery Year** | RIIO-2:<br>• 2021 – 2023: completed and inflight baseline funded interventions.<br>• 2024 – 2025: UM funded interventions. |
| **Reporting Table** | 3.03b |
| **Outputs included in RIIO T2 Business Plan** | Yes |

# 2 Introduction

2.1.1 This paper seeks to agree volumes and unit costs for works completed, and in flight, in years 1 to 3 and proposed for years 4 and 5 following assessment of internal defects data and independently externally conducted condition assessment site surveys.

2.1.2 Cab and fire suppression related asset health investments (including the fire water ring mains) at St Fergus and Bacton are excluded as these are being progressed via a separate Uncertainty Mechanism (UM).

2.1.3 This document summarises the justification for the required investment in National Gas Transmission’s (NGT) Cab Infrastructure assets for works planned for 2024 and 2025 as part of the Uncertainty Mechanism. This programme of works is underpinned by NGT’s completed and ongoing funded works covering the period of 2021 to 2023. The purpose of the compressor cab infrastructure is to enable efficient and safe operation of individual compressor machinery trains whilst meeting environmental permits and legislative requirements. The target is compliance with BS ISO 21789, PSSR, National Fire Protection Association 750 (NFPA750), BS ISO 145202 and internal NGT specifications such as T/SP/COMP/33 T/SP/COMP/35 and T/SP/SFP/3, (for both Cab Infrastructure and Fire and Gas and Fire Suppression). With regards to operational security, essential investment ensures NGT’s compressor assets can be operated mindful that in the absence of functioning components (i.e., exhausts, fire suppression, etc.) a compressor unit cannot be operated.

2.1.4 The worklist for years 1 to 5 has been generated based on specific known issues identified through outputs of proactive surveys, asset management and ongoing asset health intervention programmes. Key drivers, not limited to legislation, safety and environment have also been considered in generating works for RIIO-2.

2.1.5 NGT’s 2019 business plan submission was a request for the full five years of RIIO-2 funding. However, in their Final Determination (FD) of December 2020, Ofgem awarded baseline funding for years 1 to 3 and applied an Uncertainty Mechanism (UM) to years 4 and 5.

2.1.6 It was agreed that intervention volumes for the whole of the RIIO-2 period shall be set at the point of the re-opener, by which time NGT must have a clear understanding of the work required to address the asset health of the compressor cabs requiring intervention in RIIO-2. A 60% baseline allowance, covering activities in years 1, 2 and 3 of RIIO-2, was allowed to enable NGT achieve this. Activities and costs for years 4 and 5 are subject to the UM and dependent on outputs of completed and forecast work, including surveys and prioritisation of works for years 4 and 5.

2.1.7 This report is submitted in accordance with the NTS Gas Transporter Licence Condition 3.14 Asset Health Re-opener, Price Control Deliverable Reporting Requirements and Methodology Document and RIIO-2 Re-opener Guidance and Application Requirements Document.

# 3 Equipment Summary

## 3.1 Overall Equipment Summary

3.1.1 Other than two exceptions, all compressor units on the NTS have one compressor enclosure per compressor train known as a cab. [redacted] The oldest unit, and its associated cab, on the NTS is 52 years old.

3.1.2 Figure 1 summarises the NTS wide equipment count for cabs related infrastructure and the volumes NGT is proposing to intervene on in RIIO-2.

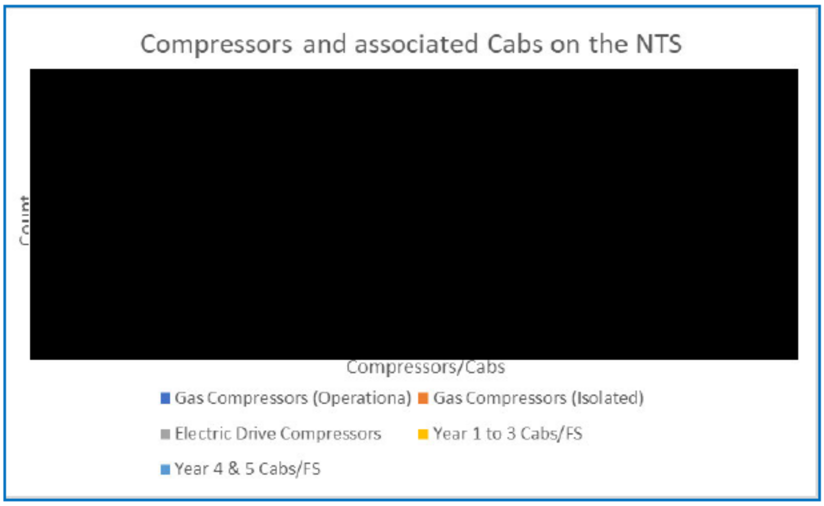


*Figure 1: NTS wide equipment count, and proportion NGT is planning to intervene on in RIIO-2*

3.1.3 Figure 2 shows which decade compressor units were commissioned in. As a general rule, cab infrastructure and fire suppression systems associated with compressor units commissioned before 1990 don't comply to modern standards and require significant upgrades to operate safely and efficiently. Units commissioned after the late 1990's are mostly compliant with modern standards and will require fewer design changes but will still have defects that need to be solved due to deterioration over time.

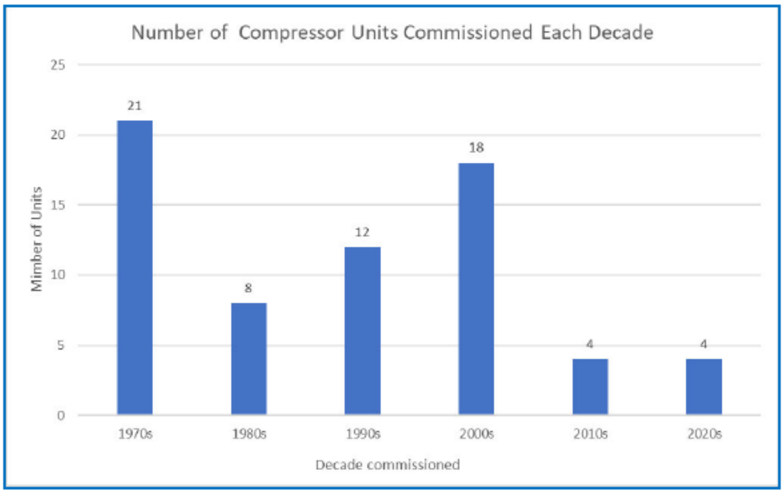


*Figure 2: Number of compressor units and associated cab infrastructure & fires suppression commissioned in each decade*

## 3.2 Cab Infrastructure – Equipment Summary

3.2.1 Cab infrastructure is essential in enabling safe and efficient operation of the compressor machinery trains whilst maximising their life and minimising maintenance costs. They are an essential element of NG legal compliance with PM84 HSE / ISO21789 Control of Risk around Gas Turbine Enclosures. They are also instrumental in maintaining NGT compliance with environmental legislation and permits regarding noise and exhaust emissions. By supporting the optimal performance of the gas turbines, the Cab also supports our compliance with the Emissions Regulations.

3.2.2 The investment case for Cab Infrastructure investment is organised into two groups of assets, Compressor Cab and Fire Suppression. The groups enable assets with similar drivers, purpose and impacts to be discussed and assessed collectively.

3.2.3 Each individual Compressor Cab housing comprises four main elements which work together providing the environment to allow safe, efficient and legally compliant operation of the compressor train and associated components.

- **Cab Enclosure** – applicable to both gas and electric driven compressors protects all compressor train assets in a weatherproof, sound attenuating and sealed enclosure enabling safety systems to operate and any gas/fire risk to be contained. Compressor machinery is housed within a building, the primary function being to attenuate noise emissions from the gas generator in line with the permitted noise levels. The enclosure also serves to protect from weathering effects and the subsequent damage to vulnerable plant and equipment. The integrity of the Cab is critical for ensuring ventilation operates effectively to avoid heat or gas build up and to minimise the risk of explosion to manage the safety risk. Cab designs vary by age and compressor technology, either taking the form of a space-efficient, close- fitting enclosure around the compressor train, or a much larger building providing easier access. All the following elements are integral to the Cab enclosure. There are 66 cab enclosure assets ([redacted] which house operational compressors, on the NTS. *Figure **3*** depicts images of typical cab enclosures on the NTS.

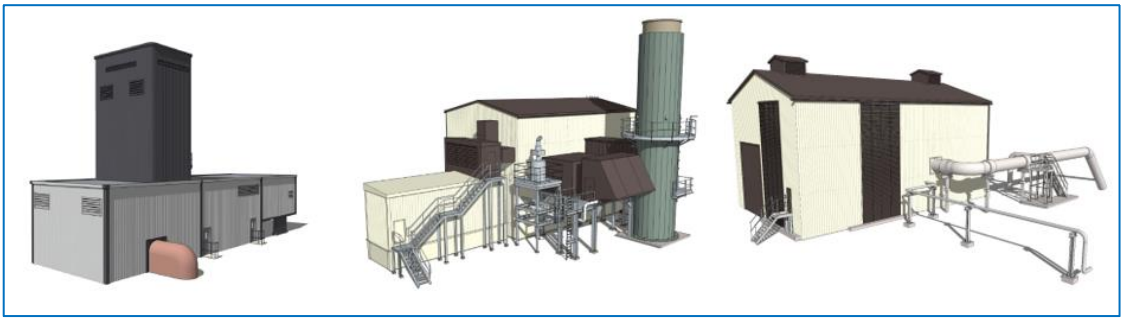

*Figure 3: Cab Enclosures (1970s gas-driven, modern gas-driven, electric driven)*

- **Air Intake –** applicable only to gas driven compressors and provides clean air to the gas generator. The air intake uses filtration to provide clean air for combustion in the gas generator to allow it to operate efficiently whilst seeking to minimise the risk of damage by reducing moisture and removing foreign objects. The air intake ensures air drawn into the gas generator for compression and combustion is contaminant-free and non- turbulent. The air intake inlet filtration system provides protection from dust, oils, salts, liquids and aerosols which otherwise could lead to fouling, erosion and corrosion of the gas generator. The assembly may also house anti-icing (heating) systems, blow in (bypass) doors and weather (snow) hoods, and incorporates design features to reduce noise emissions from the gas generator. The structural integrity must be maintained, or the intake will become a source of contamination and damage for the gas generator. There are [redacted] Air Intake assets on the NTS. *Figure **4*** depicts a typical gas generator air intake on the NTS.

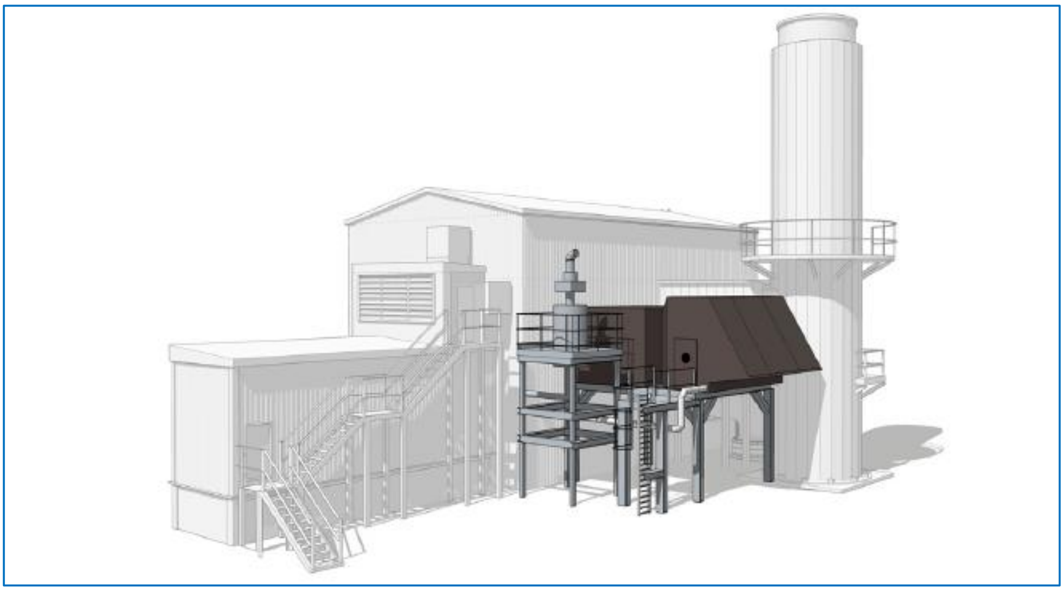

*Figure 4: Air intake for gas compressor unit (the position and configuration can differ)*

- **Exhaust –** applicable only to gas driven compressors enables effective dispersal of exhaust gases and attenuation of exhaust noise. The exhaust is vital in allowing exhaust gases (typically 400°C – 500°C) to disperse into the atmosphere away from ground level while limiting heat emitted into the Cab. The exhaust also ensures the attenuation of any exhaust noise to ensure it remains within the limits of the environmental permits. The exhaust asset comprises the exhaust itself as well as external cladding, noise attenuation features (typically 'bullets baffles' to smooth airflow) and exhaust gas sampling, monitoring and inspection points. The exhaust is a large steel structure, the height of which is integral in ensuring the effective dispersion of exhaust gases; exhausts vary in height from 5m to 15m with diameters of 4m+. As with a car exhaust system, the nature of the operating cycle is such that corrosion of the carbon steel ductwork is a significant issue and the exhaust ducts have a finite life. There are [redacted] cab exhaust Assets on the NTS. *Figure **5*** depicts a typical gas generator exhaust on the NTS.

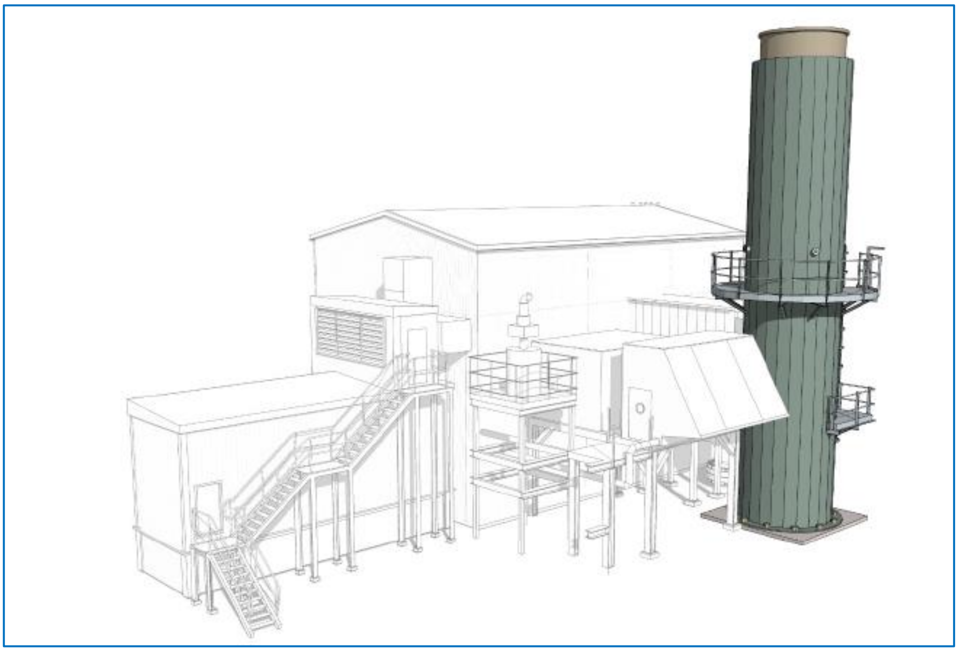

*Figure 5: Typical exhaust on a gas generator*

- **Ventilation System –** applicable to both gas and electric driven compressors cools and prevents build-up of an explosive atmosphere within the cab. Gas generator cabs require ventilation systems to provide suitable airflow through the enclosure to remove the heat lost from the gas generator and power turbine, to prevent overheating and associated trips and equipment deterioration. On gas generator cabs these are complex forced ventilation systems with emergency backup fans. They ensure that a safe (Zone 2) atmosphere is always maintained and that any small gas leaks are effectively diluted to below the lower flammable limit to avoid any risk of a build-up of gas reaching flammable or explosive limits (the latter as defined by HSE Guidance Document PM84 which is now incorporated into ISO21789). Cab ventilation assets include primary and emergency back-up ventilation fans, fan motors (usually ac for primary fans and dc for the emergency back-up fans), motor control and protection systems, cabling, ducting, filters and louvres. There are [redacted] cab ventilation assets on the NTS. *Figure **6*** depicts a typical gas generator exhaust on the NTS.

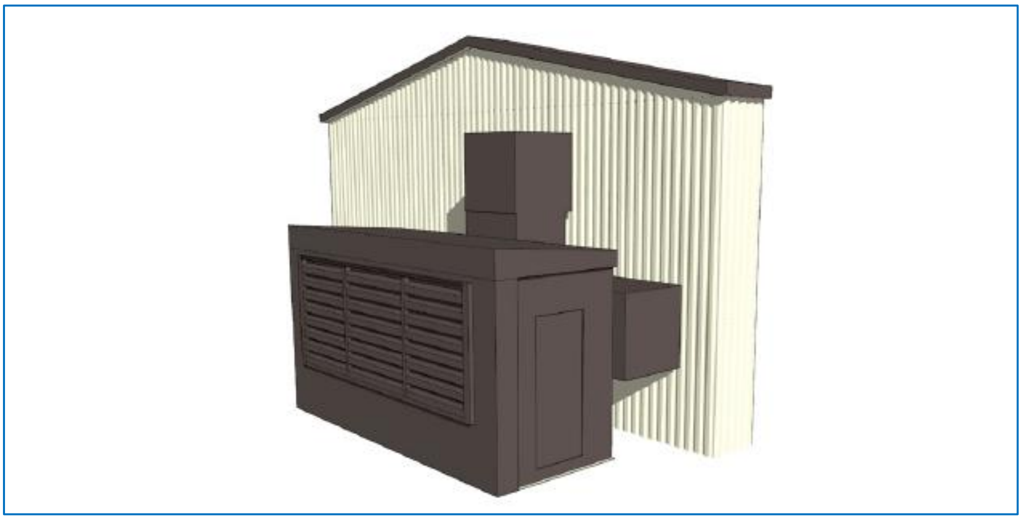

*Figure 6: Compressor Cab Ventilation*

### Compressor Cab Infrastructure – Pressure Ratings

3.2.4 The compressor cabs are designed to operate either very slightly above or below atmospheric pressure according to the design of the ventilation system (forced or induced draft). The design pressures involved are of the order of millibar gauge above or below atmospheric pressure. However, the forces involved can be very significant even with these low design pressures, due to the large surface areas involved.

### Compressor Cab Infrastructure – Redundancy

3.2.5 There is only one site on the NTS ([redacted]) where multiple compressor trains share a single compressor cab, all other compressor trains have their own cab, therefore the availability of any compressor train is dependent on its cab being in good working condition.

## 3.3 Fire Suppression – Equipment Summary

3.3.1 The Fire Suppression Systems –extinguish any fires within the enclosure preventing escalation and minimising safety and environmental risk and plant and associated plant damage. The condition of these assets is critical. There are three main types of fire suppression:

- **200 bar nitrogen bottles** directly pressurise water bottles, forcing the water through spray heads into the enclosure – for smaller older enclosures with four to 15 spray heads.
- **200 bar nitrogen bottles drive a gas driven pump** that takes water from a large water tank and forces it through spray heads into the enclosure; these can protect large volumes but require approximately 30 nitrogen bottles for each fire that must then be replaced.
- **Electric motor driven pumps** take water from a larger water tank. These remove issues with nitrogen but require electric supply infrastructure to be installed which would include any necessary power generation backups.

3.3.2 A fire suppression system typically includes:

- A temperature-controlled enclosure including thermostat and electric heater to maintain bottles at suitable temperature to avoid a pressure drop and to stop water from freezing.
- 200bar Nitrogen or a nitrogen/electric driven pump.
- Water cylinders or a bulk water storage tank.
- Discharge manifold, distribution piping and spray heads (stainless steel).
- Electrical solenoid actuator valves.
- Pneumatically actuated slave valves.
- Pressure switches (to monitor nitrogen cylinder pressure and confirm system operation).
- High pressure flexible hoses.
- System isolation valve and limit switch.
- A changeover switch from main to reserve system.
- Some utilise a pump unit and water storage tank rather than water cylinders.

### Fire Suppression – Location and Volume

3.3.3 Fire suppression systems are permanently installed on every gas generator enclosure on sites across the NTS. Where the fire suppression is not available the compressor cannot be operated. Figure 7 depicts typical fire suppression systems on the NTS.

*Figure 7: Cabs Fire Suppression (Fire point and Pressurised nitrogen bottles for HI-FOG® system)*

### Fire Suppression – Pressure Ratings

3.3.4 The nitrogen bottles and all fittings in use within the fire suppression system are operated at 200 bar.

### Fire Suppression – Redundancy

3.3.5 There are typically two banks of nitrogen bottles, primary and reserve for each compressor cab with a manual changeover to allow for maintenance, repair and refurbishment and availability following a discharge of the primary bank. No automated change-over exists so any failure of the primary systems impact the availability of the whole compressor unit.

## 3.4 Asset Location and Volume

3.4.1 NGT's investment programme for years 4 & 5 of RIIO-2, subject of this funding request, contains interventions on [redacted] Cabs and their fire suppression infrastructure across [redacted] compressor stations on the NTS. Ofgem allowed baseline funding, 60% of NGT's funding request for RIIO-2. NGT identified [redacted] cabs for intervention in the first three years of RIIO-2 and Ofgem invited NGT to use the 2023 reopener process to request funding for interventions on the remaining [redacted] Cabs years in 4 and 5 of RIIO-2. Table 1 summarises the RIIO-2 Cabs infrastructure investment plan. These cabs were selected through NGT's cab infrastructure and fire suppression asset health plan which proposes a rolling campaign to bring the cabs into compliance and remediates deterioration where there is an enduring operational need.

*Table 1: RIIO-2 Planned Interventions*

| Cabs 2021/22, Cabs 2022/23, Cabs 2023/24 RIIO-2 Baseline Funded | | | | Cabs 2024/25 RIIO-2 UM | Cabs 2025/26 RIIO-2 UM |
|---|---|---|---|---|---|
| [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] |

3.4.2 In developing NGT's years 4 and 5 asset health plan and intervention selection NGT considered all cabs and their enduring requirement including how works would be delivered over the five-year RIIO-2 period. Similar to the approach used for years 1 to 3, an opinion was made on the future need for each of the years 4 and 5 cabs targeted for intervention. The current fleet strategy assumptions, included within Compressor Emissions Asset Management Plan 2023 (CE-AMP 2023) documentation is summarised in Table 2 in relation to Cabs 2024 and Cabs 2025. All cabs identified for intervention are in line with NGT's need case and future strategy.

*Table 2: Compressor Fleet Strategy for Cabs 2024 and Cabs 2025 Targeted Interventions*

| Compressor Fleet Strategy | | | | |
|---|---|---|---|---|
| **Intervention Year** | **Compressor Unit** | **Type / Technology** | **Current Plan** | **Notes** |
| Cabs 2024 | [redacted] | [redacted] | Future utilisation | IED compliant unit |
| Cabs 2024 | [redacted] | [redacted] | Operation required to at least 2032 (subject to ongoing reopeners) | Cab and fire suppression related Investment keeps these compressor machinery trains (units) operating safely, irrespective of the UM, to at least 20232 and potentially beyond if new units are not the final decision. |
| Cabs 2024 | [redacted] | [redacted] | | |
| Cabs 2024 | [redacted] | [redacted] | | |
| Cabs 2024 | [redacted] | [redacted] | Future utilisation | 500hrs derogation. |
| Cabs 2024 | [redacted] | [redacted] | Future utilisation | This investment is based on survey condition and future need. |
| Cabs 2025 | [redacted] | [redacted] | Future utilisation | IED compliant unit. |
| Cabs 2025 | [redacted] | [redacted] | Future utilisation | IED compliant unit. |
| Cabs 2025 | [redacted] | [redacted] | Future utilisation | IED compliant unit. |
| Cabs 2025 | [redacted] | [redacted] | Future utilisation | IED compliant unit. |
| Cabs 2025 | [redacted] | [redacted] | Future utilisation | IED compliant unit. |

# 4 Problem Statement

## 4.1 Problem Statement Overview

4.1.1 The compressor cabs across the NTS are aging assets that suffer from corrosion and wear related deterioration. Ongoing defects on these assets reduce their effectiveness and cause them not to operate when required. Compressor availability and performance is reliant on the performance of the Compressor Cab. Reduced performance of these assets leads to increased compressor unit trips and the potential to reduce capacity or increase risks and unavailability of the compressor, often with a long lead time to resolve. Defects that remain unresolved and allowed to deteriorate will ultimately lead to unavailability/unreliability of the compressor unit the cab supports, non-compliance with legislation and potential asset, safety and environmental damage.

## 4.2 Asset Management Issues

4.2.1 **Cab Enclosures** require ongoing inspections and maintenance e.g., to roofs and walls due to age-related wear. Failure of the building fabric can result in faster deterioration of equipment inside the cab and can render the important ventilation systems ineffective. Corrosion in corrugated sheet plates leads to weak points in the structure, resulting in a reduction in noise attenuation and ventilation capability, leading to compressor trips. Cab enclosures that comprise flat roof segments are prone to leaks. Door seal failures deteriorate ventilation performance and the ability to maintain pressure within the enclosures.

4.2.2 **Air Intake** design life is 20 to 30 years, but the filter media requires periodic replacement. Replacement components, or the full air intake assembly if required, are refabricated at the end of their useful life. Failure and wear of internal components can create foreign bodies (such as zinc and rusting steel particles) which are drawn into the gas generator engine causing damage. Some air intakes in colder months suffer from icing on the entry point, leading to temporary bypass (where bypass doors are installed) of the filtration, and manual intervention to dislodge any ice.

4.2.3 **Ventilation fans**, motors, and controls typically last 10-15 years and can become obsolete; when ventilation starts to fail, other enclosure assets can be damaged by heat build-up and safety controls become less effective. Other cab ventilation assets (e.g., air ducting, louvres, dampers) typically last 20 years after which replacement components can be re-fabricated. Some units are unable to operate in the warmer months ($+23^\circ$ C) as design temperatures mandate the unit to trip on safety grounds. Older units do not have filtration installed, which could lead to increased deterioration of assets in the cabs.

4.2.4 Noise attenuation and thermal insulation, of **exhausts**, can degrade over time reducing performance. At the end of its lifetime components will need replacing, or a new exhaust assembly is required. Annual inspections are undertaken with more intrusive inspections undertaken every five years for detailed inspection. When performing inspections, there is no entry point to the stack other than through the top. This presents a safety risk and costly mitigation measures are required to perform the task A point of failure is known to be the expansion joint – pooling of water at the base of the exhaust leads to increased corrosion.

4.2.5 Existing compressor cab **fire suppression systems** on older units have a number of design or asset health issues affecting compliance, maintainability and operational availability to differing degrees.

4.2.6 **Fire suppression deterioration:** Elements of the assets are deteriorating due to age, corrosion, and wear. Increasing defect numbers are being recorded and the assets are becoming unreliable and fail to work when called upon. As systems age, deposits in pipework, bottles and hoses repeatedly block spray heads which reduce effectiveness.

4.2.7 **Fire suppression legislation:** Pressure Systems Safety Regulations (PSSR) require five-year and 10-year inspections and revalidation of high-pressure elements of the fire suppression systems.

4.2.8 Without a fully functioning **fire suppression system** the associated gas compressor cannot be used. This limits the availability of the compressor unit and can impact the overall resilience of the NTS.

## 4.3 The different drivers for intervention

4.3.1 The key drivers for investment in the compressor cab assets are:

- **Legislation - HSE Guidance PM84 and BS ISO 21789:** Control of Safety Risk at Gas Turbine Enclosures. Examples of requirements include maintaining a fully functional ventilation system and suitably sealed building inner enclosure with building integrity as a fire break and suitable fire protection to mitigate process safety risks.
- **The Dangerous Substances and Explosive Atmosphere Regulations (DSEAR)** which require employers to review all potential risks to people (employees and other) whose safety may be at risk of fires and explosions caused by dangerous substances in the workplace.
- **Customers:** Customer behaviour and customer needs to have energy as and when they need it.
- **Asset Deterioration:** Corrosion, mechanical wear, and component failure are primary drivers for investment in the exhaust stack, air intakes and buildings.
- **Environment:** Planning and environmental permits govern exhaust stack design, and they must continue to perform in line with noise and environmental requirements.

4.3.2 The key drivers for investment in the fire suppression assets are:

- **Legislation – PSSR:** requires 5 year and 10-year inspections and revalidation of high-pressure elements of the fire suppression system. PSSR, NFPA750, BS ISO 145202 and internal T/SP/SFP/3 policy are also key drivers.
- **HSE Guidance Document PM84 / ISO21789:** Control of Safety Risk at Gas Turbine Enclosures. - PM84 was first introduced in 2000, following a number of fatal explosions involving gas turbines in acoustic enclosures. Examples of requirements include maintaining a fully functional ventilation system and suitably sealed building inner enclosure with building integrity as a fire break and suitable fire protection to mitigate process safety risks.
- **Suitability (capability to extinguish in the event of a fire):** The fire suppression system relies on specially designed heads that ensure a fine mist of water droplets of certain diameters is produced, this relies on a working system that is within the design limits of the system to provide the pressure and volume of water for these droplets to form consistently to cool and smother a fire. Currently, there are large differences between the size of cab and number of spray heads that the type of system is certified for and the actual cab size and installed spray heads. This results in non-certified and tested systems, insufficient fire time, and inferior capability to extinguish a fire compared to the required certification standard.
- **Asset Deterioration:** Elements of the assets are deteriorating due to age, corrosion and wear. Increasing defect numbers are being recorded and the assets are becoming unreliable and fail to work when called upon. As systems age, deposits in pipework, bottles and hoses repeatedly block spray heads which reduce effectiveness.
- **Safety:** The location and design of the cabinets that contain the nitrogen and water cylinders gives rise to both safety and manual handling issues. The design of the cabinets is also not ideal for maintenance and mitigation activities are required for each maintenance activity. When considering the investment in replacing systems the removal of the risk of injury will be a priority.
- **Policy:** updated policy requires an independent review of all safety studies and confined space mitigation works.

### Cab Infrastructure - Why are we doing this work and what happens if we do nothing?

4.3.3 In principle, no investment in the compressor cab assets will lead to their continued and increasing deterioration, limiting their effective operation. If these assets are not operating effectively, they make the compressor units unsafe and inoperable, driving a decision to isolate the compressor unit and an increased risk to the availability of the gas supply. This in turn leads to a network unable to meet customer needs.

4.3.4 No investment in the air intake and its components will lead to increased corrosion, wear and failure causing inefficient running, increased wear and high-cost damage to the multi-million-pound gas generators. The air intake system is key to ensuring the gas generator operates effectively as it holds the filters that clean the air. With age, the integrity of the intake housing fails, and fragments of metal and coating can enter the gas generator. The air intake systems are also typically at height and where corrosion is present, and sections are not replaced they become a safety risk. During peak conditions air intake anti-icing systems have not always maintained compressor availability, teams of staff had to be deployed around the clock to keep the air intakes clear of snow to keep the compressors operational. In addition to the hazards involved with this task, having to deploy staff to keep the air intakes clear prevented them from being deployed elsewhere on the network.

4.3.5 Without investment the ventilation systems will continue to corrode, and individual components will fail and not provide the adequate flow of air to cool the gas generators and their associated safety and control equipment leading to their increased wear and potential failure to operate. Any gas escape may not be effectively routed through the Cab and dispersed leading to a potential build-up of an explosive atmosphere that is unable to be detected.

4.3.6 Exhausts have layers of material that fail and can lead to the stack becoming unsafe and material falling and damaging the power turbine with potential costs in excess of £1m to replace. The exhaust and volutes have lagging that deteriorates over time and this leads to increased heat in the cab. The failure of integrity of an inner cab will lead to the positive pressure forcing the hot air into the outer cab where this heated air (and any gas) is recirculated back into the inner cab further increasing temperatures and reduced noise attenuation capability which may result in complaints that noise permits are being breached with improvement notices or in extreme cases prosecution if proven. Further failure of outer cab integrity also leads to water ingress causing corrosion and potential failure of safety devices and electrical equipment. In addition, the fire suppression system must perform to ensure the system is able to put out electrical or oil fires that can escalate and lead to significant asset damage and operational downtime.

### Fire Suppression- Why are we doing this work and what happens if we do nothing?

4.3.7 If due to continued asset deterioration or other factors the fire suppression system is not fully functional then the associated gas turbine machinery train cannot be operated. This impacts on the availability of the compressor units and increases availability risk on the NTS.

4.3.8 With no investment, the assets would continue to deteriorate which will increasingly result in their inability to perform their duty when required to do so.

4.3.9 If the fire suppression system fails to operate correctly on demand, a cab fire could fail to be extinguished and escalate. The system primarily provides asset protection but depending on the fire scenario there is also a risk to personnel safety and the environment.

4.3.10 The current gas turbine enclosure fire suppression systems have a number of design flaws which exhibit differing levels of personnel safety, maintainability and operational availability issues. These issues have led to increasing the probability that the system will fail to operate effectively on demand.

### Cab Infrastructure - What is the outcome that we want to achieve?

4.3.11 Ensuring the health of these assets (enclosure, air intake, ventilation, exhaust) is key to their continued delivery of required capability. All proposed investments in compressor cab assets will ensure NGT has the required assets to meet the needs of its customers. The outcome NGT needs to achieve, through this investment, is summarised as:

- Meet legal requirements and agreed safety standards.
- Ensure ongoing compliance with PM84 HSE / ISO21789 Control of Risk around Gas Turbine Enclosures.
- Manage deterioration of the assets such that they do not limit availability, performance or cause damage to the gas turbines or safety systems.
- Providing benefit to consumers through optimised investment to ensure the cabs last as long as compression is needed, balancing cost, risk and performance.

### Fire Suppression- What is the outcome that we want to achieve?

4.3.12 The key outcome affected by the failure of the fire suppression systems is the reliability risk to the compressor units that cannot be operated without a fully functioning fire suppression system.

4.3.13 Maintaining the health of these assets is important in ensuring they continue to deliver the required capability. Specific outcomes associated with this investment are:

- Manage deterioration of the assets such that they are fully functional and of suitable design so as to not limit availability of the compressor units or cause damage to the compressor trains that they are designed to protect.
- Meet legal requirements and agreed safety standards that define how long these systems should fire for to ensure fires are extinguished and what systems are suitable for gas turbine enclosures with the high temperature metal surfaces and complex machinery filled spaces.
- Ensure ongoing compliance with PM84 HSE / ISO21789 Control of Risk around Gas Turbine Enclosures
- Improve the safety of working on the fire suppression systems through the removal of the manual handling issues associated with heavy nitrogen bottles installed at height, removing risk of injury through replacement of high-pressure hoses and pipework and limiting nitrogen asphyxiation risk.
- Providing benefit to consumers through optimised investment to ensure the fire suppression systems last as long as compression is needed balancing cost, risk and performance.

4.3.14 NGT’s proposed investment in the fire suppression systems will ensure the required assets meet the needs of its customers.

### Cab Infrastructure and Fire Suppression Infrastructure Assets - How will we understand if the project has been successful?

4.3.15 NGT will understand if the project has been successful when the identified interventions are complete allowing the Cab infrastructure and Fire Suppression Infrastructure to function at required operational levels. Service risk would have been reduced to an acceptable level where compressor operability is not impacted by any cab infrastructure constraints and all components are compliant with all legislative requirements

# 5 Narrative Real-Life Example of Problem

## 5.1 Data Collection

5.1.1 NGT's cab and fire suppression rolling asset health plan sets out to keep cab and fire suppression infrastructure compliant and remediate deterioration where there is an enduring operational need. The RIIO-2 plan has been developed utilising maintenance and defect data supplemented through the completion of individual independent externally conducted condition assessment surveys.

5.1.2 This section lists out, per cab, the component to be attended to, summary nature of its issue and consequences of not addressing the issue. This information was used in informing NGT's cabs asset health funding request for years 4 and 5 of RIIO-2.

## 5.2 Year 4 and 5 Identified Problems

5.2.1 The following sections summarise the identified cab specific defects present on the [redacted] individual compressor cabs identified for interventions in years 4 and 5 of RIIO-2. A summary of each cab is presented with accompanying narrative. Appendix 1 provides more detail, of the defects identified.

5.2.2 Each of the compressor machinery trains housed by the cabs in this section have an enduring operational need to meet demand and utilisation requirements on the NTS.

### [redacted] Compressor Station Cab

5.2.3 The Cab enclosing [redacted]r compressor [redacted] was surveyed and the following defects, summarised in Table 3 were identified.

*Table 3: [redacted] Cab Specific Defects*

| Defect Area | Defect description summary | Consequence of no action |
|---|---|---|
| Firefighting equipment | • Fire suppression system does not comply with BS ISO 21789. It is undersized for the cab it protects and no longer meets OEM recommended capacity requirements, i.e., an inadequate number of nozzles are installed in the cab, hindering the ability to provide the required volume of suppression within a timeframe to satisfy industry best practices. | • The inability of the fire suppression to provide sufficient suppression in the timeframe required will result in non-containment with the potential to cause fatal explosions involving the gas turbines in its acoustic enclosure. |
| Ventilation | • Three unsealed probe holes were found on the combustion intake ducting on the clean side of the filter. These holes will allow unfiltered air and debris to be ingested into the gas turbine during operation<br>• Smoke test indicated there are many leaks and some noted stagnant areas. In addition, recirculation of enclosure air into the ventilation system affects dilution of flammable gasses in the enclosure.<br>• The ventilation system is non-compliant with the ventilation dilution and/or the gas turbine cooling requirements outlined in BS ISO 21789. | • Unfiltered air bypassing the filter introduces dust, oils, salts, liquids and aerosols which could lead to fouling, erosion and corrosion of the turbine blades. This would make them less efficient, and potential to cause damage to the blades which could result in an expensive failure.<br>• Stagnant areas and recirculation of ventilation air can allow an explosive atmosphere to build up in the enclosure potentially resulting in an explosion.<br>• Small gas leaks may not be effectively diluted to below the lower flammable limit to avoid any risk of a build-up of gas reaching flammable or explosive limits.<br>• Undetected and undiluted gas pockets suitable for ventilation requirements will remain as defects in the case of the ventilation system not being upgraded. |

### [redacted] Compressor Station Cab

5.2.4 The Cab enclosing [redacted] compressor [redacted] were surveyed and the following defects, summarised in Table 4 were identified.

*Table 4: [redacted] Identified Cab Specific Defects*

| Defect Area | Defect description summary | Consequence of no action |
|---|---|---|
| Firefighting equipment | • Fire suppression system does not comply with BS ISO 21789. It is undersized for the cab it protects and no longer meets OEM recommended capacity requirements, i.e., an inadequate number of nozzles are installed in the cab, hindering the ability to provide the required volume of suppression within a timeframe to satisfy industry best practices. | • The inability of the fire suppression to provide sufficient suppression in the timeframe required will result in non-containment with the potential to cause fatal explosions involving the gas turbines in its acoustic enclosure. |
| Ventilation System | • Ventilation System has failed the BS ISO21789 standard - there are currently no gas detectors fitted within the ventilation outlet.<br>• The ventilation system is non-compliant with the ventilation dilution and/or the gas turbine cooling requirements outlined in BS ISO 21789. | • ISO 21789 asks for gas detectors in the ventilation outlet to ensure that a representative sample of the whole cab is taken. Without a detector in the outlet, it is possible that an explosive atmosphere is building up away from the location of a detector.<br>• Undetected and undiluted gas pockets suitable for ventilation requirements will remain as defects in the case of the ventilation system not being upgraded. |

### [redacted] Compressor Station Cab

5.2.5 The Cabs enclosing [redacted] compressor [redacted] were surveyed and the following defects, summarised in Table 5 were identified.

*Table 5: [redacted] Identified Cab Specific Defects*

| Defect Area | Defect description summary | Consequence of no action |
|---|---|---|
| Firefighting equipment | • Fire suppression system does not comply with BS ISO 21789. It is undersized for the cab it protects and no longer meets OEM recommended capacity requirements, i.e., an inadequate number of nozzles are installed in the cab, hindering the ability to provide the required volume of suppression within a timeframe to satisfy industry best practices. | • The inability of the fire suppression to provide sufficient suppression in the timeframe required will result in non-containment with the potential to cause fatal explosions involving the gas turbines in its acoustic enclosure. |
| Combustion (Exhaust) stack | • The current combustion exhaust system is past its 25-year design life. The unit is being retained as backup to the two new Solar Titan 130 units and therefore requires intervention to ensure the unit remains operational. | • Reduction in performance emanating from degradation of noise attenuation and thermal insulation components resulting in breach of environmental permits.<br>• This could result in isolation of the compressor unit if the exhaust fails, and the unit cannot be operated. |
| Air Intake / Filtration | • Corrosion inside combustion intake plenum<br>• Degradation of filter-house roof. | • Reduced efficiency of the turbine due to increased pressure drop across the filters. |
| Ventilation | • The ventilation system is performing poorly, due to a compromise of the cab enclosure integrity (inability to hold a positive pressure). It therefore, does not meet the requirements of BS ISO21789.<br>• Areas of stagnation were noted inside the enclosure.<br>• Re-circulation of gas through ineffective enclosure sealing was evident. | • Stagnant areas and recirculation of ventilation air can allow an explosive atmosphere to build up in the enclosure potentially resulting in an explosion. |

| Defect Area | Defect description summary | Consequence of no action |
|---|---|---|
| Cab integrity | • Ineffective enclosure sealing causing leaks, air circulation, etc.<br>• Defective door seals and gaps in compressor doors.<br>• Defective door latches / Doors unable to be fully closed.<br>• Gaps between inner skin wall panels. | • Poor cab integrity reduces the effectiveness of the ventilation system because the ventilation airflow is not as designed, so ultimately may result in cab overheating or build-up of an explosive atmosphere.<br>• It could also reduce the effectiveness of the fire suppression system which relies on the cab being sealed to prevent more oxygen getting in to feed the fire. |

### [redacted] Compressor Station Cab

5.2.6 The Cab enclosing [redacted] compressor [redacted] was surveyed and the following defects, summarised in Table 6 were identified.

*Table 6: [redacted] Identified Cab Specific Defects*

| Defect Area | Defect description summary | Consequence of no action |
|---|---|---|
| Firefighting equipment | • Fire suppression system does not comply with BS ISO 21789. It is undersized for the cab it protects and no longer meets OEM recommended capacity requirements, i.e., an inadequate number of nozzles are installed in the cab, hindering the ability to provide the required volume of suppression within a timeframe to satisfy industry best practices. | • The inability of the fire suppression to provide sufficient suppression in the timeframe required will result in non-containment with the potential to cause fatal explosions involving the gas turbines in its acoustic enclosure. |
| Combustion stack | • The current combustion exhaust system is past its 25-year design life. The unit is being retained as backup to the two new Solar Titan 130 units and therefore requires intervention to ensure the unit remains operational. | • Reduction in performance emanating from degradation of noise attenuation and thermal insulation components resulting in breach of environmental permits. |
| Air Intake / Filtration | • Combustion intake Filter elements in poor condition. | • Reduced efficiency of the turbine due to increased pressure drop across the filters.<br>• Unfiltered air or turbulent air entering the enclosure. |
| Ventilation | • The ventilation system is performing poorly, due to a compromise of the cab enclosure integrity (inability to hold a positive pressure). It therefore, does not meet the requirements of BS ISO21789.<br>• Smoke recirculation - smoke from the exhaust apertures was observed being recirculated into the void via the intake louvres, this could cause hazardous gas concentration levels to build up within the void or inner cab.<br>• Evidence of corrosion at many points within the void. This suggests that the roof has lost its weather seal or excess moisture is being drawn in. | • Stagnant areas and recirculation of ventilation air can allow an explosive atmosphere to build up in the enclosure potentially resulting in an explosion. |
| Cab integrity | • Ineffective enclosure sealing causing leaks, air circulation, etc.<br>• Defective door seals and gaps in compressor doors.<br>• Defective door latches / Doors unable to be fully closed.<br>• Gaps between inner skin wall panels<br>• Ineffective Sealing Around Suction Pipes - This creates gaps resulting in less flow in the rear half of the void.<br>• The inner skin to suction pipe seal has begun to crack.<br>• Evidence of corrosion at many points within the void. This suggests that the roof has lost its weather seal or excess moisture is being drawn in | • Poor cab integrity reduces the effectiveness of the ventilation system because the ventilation airflow is not as designed, so ultimately may result in cab overheating or build-up of an explosive atmosphere.<br>• It could also reduce the effectiveness of the fire suppression system which relies on the cab being sealed to prevent more oxygen getting in to feed the fire. |

### [redacted] Compressor Station Cabs

5.2.7 Cabs enclosing [redacted] compressor [redacted] were surveyed and the following defects, summarised in Table 7, were identified.

*Table 7: [redacted] Identified Cab Specific Defects*

| Defect Area | Defect description summary | Consequence of no action |
|---|---|---|
| Firefighting equipment | • Fire suppression system does not comply with BS ISO 21789. It is undersized for the cab it protects and no longer meets OEM recommended capacity requirements, i.e., an inadequate number of nozzles are installed in the cab, hindering the ability to provide the required volume of suppression within a timeframe to satisfy industry best practices. | • The inability of the fire suppression to provide sufficient suppression in the timeframe required will result in non-containment with the potential to cause fatal explosions involving the gas turbines in its acoustic enclosure. |

### [redacted] Compressor Station Cabs

5.2.8 Cabs enclosing [redacted] compressor [redacted] were surveyed and the following defects, summarised in Table 8 were identified.

*Table 8: [redacted] Identified Cab Specific Defects*

| Defect Area | Defect description summary | Consequence of no action |
|---|---|---|
| Fire extinguishing system<br><br>(Fire Fighting Equipment) | • The existing system has a number of components deteriorating and approaching their end of life. | • Without a fully functioning fire suppression system the associated gas compressor cannot be used. |
| Ventilation | • The ventilation system is performing poorly, due to a compromise of the cab enclosure integrity as evidenced by identified stagnant regions.<br>• Ventilation system has failed and does not conform to BS ISO21789 standards. | • Stagnant areas can allow an explosive atmosphere to build up in the enclosure potentially resulting in an explosion. |
| Cab integrity Enclosure - Ineffective Enclosure Sealing | • The main contributing leaks in the enclosure were the door seals and the partition between the main enclosure and combustion intake weather hood.<br>• Degraded door latches/hinges.<br>• Water ingress through roof.<br>• Steady stream of water observed leaking through a pipe pass-through in the ceiling of Unit B when it was raining suggesting loss of weather seal integrity of pipe pass through.<br>• The reduced effectiveness of the enclosure seal has a direct impact on the designed pressurisation of the enclosure and the retention of fire suppression media. | • Poor cab integrity reduces the effectiveness of the ventilation system because the ventilation airflow is not as designed, so ultimately may result in cab overheating or build-up of an explosive atmosphere.<br>• It could also reduce the effectiveness of the fire suppression system which relies on the cab being sealed to prevent more oxygen getting in to feed the fire. |

### [redacted] Compressor Station Cabs

5.2.9 The Cabs enclosing [redacted] compressor [redacted] were surveyed and the following defects, summarised in Table 9 were identified.

*Table 9: [redacted] Identified Cab Specific Defects*

| Defect Area | Defect description summary | Consequence of no action |
|---|---|---|
| Fire extinguishing system | • The existing system has a number of components deteriorating and approaching their end of life. | • Without a fully functioning fire suppression system the associated gas compressor cannot be used. |

| Defect Area | Defect description summary | Consequence of no action |
|---|---|---|
| (Fire Fighting Equipment) | | |
| Exhaust | • Expansion joint is cracking (Unit A only). This will lead to deterioration of the condition of the expansion joint leading to leaks within the Cab. | • Hot air leaks from the exhaust will increase the overall cab temperature potentially resulting in some safety equipment becoming unreliable and potentially causing the unit to trip due to cab temperature exceeding the limit. |
| Ventilation | • Ventilation system is performing poorly, due to a compromise of the cab enclosure integrity as evidenced by identified stagnant regions and a low percentage of inlet air in comparison to the outlet volume.<br>• The ventilation system is non-compliant with the ventilation dilution and/or the gas turbine cooling requirements outlined in BS ISO 21789 | • Stagnant areas and recirculation of ventilation air can allow an explosive atmosphere to build up in the enclosure potentially resulting in an explosion. |
| Cab integrity Enclosure - Ineffective Enclosure Sealing | • Ineffective Enclosure Sealing.<br>• Roof is leaking water into cab in multiple locations. | • Poor cab integrity reduces the effectiveness of the ventilation system because the ventilation airflow isn't as designed, so ultimately may result in cab overheating or build-up of an explosive atmosphere.<br>• It could also reduce the effectiveness of the fire suppression system which relies on the cab being sealed to prevent more oxygen getting in to feed the fire. |

5.2.10 The Cabs enclosing Wisbech compressor Unit B were surveyed and the following defects, summarised in Table 10 were identified.

*Table 10: [redacted] Identified Cab Specific Defects*

| Defect Area | Defect description summary | Consequence of no action |
|---|---|---|
| Fire extinguishing system<br><br>(Fire Fighting Equipment) | • The existing system has a number of components deteriorating and approaching their end of life. | • Without a fully functioning fire suppression system the associated gas compressor cannot be used. |
| Ventilation | • Ventilation system is performing poorly, due to identified stagnant regions and a low percentage of inlet air in comparison to the outlet volume.<br>• The ventilation system is non-compliant with the ventilation dilution and/or the gas turbine cooling requirements outlined in BS ISO 21789 | • Stagnant areas and recirculation of ventilation air can allow an explosive atmosphere to build up in the enclosure potentially resulting in an explosion. |
| Cab integrity Enclosure - Ineffective Enclosure Sealing | • Ineffective Enclosure Sealing<br>• Missing door seals<br>• Gaps between inner skin wall panels<br>• Evidence of water ingress through the ceiling at many locations within the enclosure. | • Poor cab integrity reduces the effectiveness of the ventilation system because the ventilation airflow is not as designed, so ultimately may result in cab overheating or build-up of an explosive atmosphere.<br>• It could also reduce the effectiveness of the fire suppression system which relies on the cab being sealed to prevent more oxygen getting in to feed the fire. |

## [redacted] Compressor Station Cab

5.2.11 The Cab enclosing [redacted] compressor [redacted] was surveyed and the following defects, summarised in ***Table 11*** were identified.

*Table 11:* [redacted] *Identified Cab Specific Defects*

| Defect Area | Defect description summary | Consequence of no action |
|---|---|---|
| Exhaust | • The exhaust compensator has multiple cracks on the joints, beyond repair. | • Hot air leaks from the exhaust will increase the overall cab temperature potentially resulting in some safety equipment becoming unreliable and potentially causing the unit to trip due to cab temperature exceeding the limit. |

# 6 Spend Boundaries

## 6.1 Description of spend boundary – in scope

6.1.1 The spend boundaries of this EJP covers baseline funded works (years 1 to 3) and proposed investments (years 4 and 5).

6.1.2 The investments are being undertaken across [redacted] compressor cabs, and associated fire suppression infrastructure.

6.1.3 Any foundation and civil works associated with interventions on the cab enclosure are included within the scope.

6.1.4 Funding to complete condition surveys to inform RIIO-3 cab and fire suppression interventions.

## 6.2 Out of scope

6.2.1 Cab and fire suppression related asset health investments (including the fire water ring mains) at St Fergus and Bacton. These are progressed via a separate Uncertainty Mechanism.

6.2.2 Investment associated with compressor cabs for new compressor units is excluded as this is included in the separate compressor investment business plan. Investment associated with demolishing compressor cabs that have been funded for decommissioning in RIIO-2 are excluded as this is included in the separate redundant asset mechanism.

# 7 Probability of Failure

## 7.1 Probability of Failure Overview

7.1.1 NGT's ongoing asset health assessment programme and the surveys conducted on the [redacted] cabs identified a range of defects, some of which (i.e., on the air intake, exhaust stack, etc.) if not addressed would result in loss of cab infrastructure capability. Our intervention programme on Cab Infrastructure and Fire Suppression assets seeks to intervene prior to the failure of the asset, following identification of asset deterioration, due to the consequence that this failure has on our Compressor operation.

7.1.2 Most cabs assets do not immediately fail but rather deteriorate resulting in poor performance which leads to further deterioration and eventually failure. Many of the Cabs are 30 to 40 years old with some being over 50 years old. The age and frequency of the usage of the cabs and the associated Cab Infrastructure assets has implications on the rate of deterioration. Failures can happen even with regular maintenance due to age and usage frequency drivers.

7.1.3 Corrosion is the main failure mode, and this is applicable to sub assets such as the cab enclosure, duct work and exhausts. Other failure modes include fan motors failing within the ventilation system. Drivers to ventilation deterioration are largely as a result of fluctuating weather conditions. The majority of cabs were designed to run in the winter but are now being used increasingly in the summer. The consequence of deterioration of ventilation systems is cab overheating causing compressor trips resulting in unreliability and unavailability.

7.1.4 As part of the UM all the cabs for which funding is being requested have been assessed and surveyed, defects identified, and known issues affecting performance are being addressed. An engineering assessment has been undertaken by SMEs on the ongoing risk that not rectifying the defects would have on the operation of the Cabs.

7.1.5 Other defects have been identified that, either do not require immediate remediation or can be resolved by operational staff and so are not included in this funding request.

## 7.2 Cabs – Probability of Failure

7.2.1 Cab infrastructure assets failing and resulting in NTS compressor units becoming unavailable could lead to network constraints, particularly in low resilience areas of the network.

7.2.2 All cab infrastructure interventions are defined as consequential interventions as their prime function is to protect assets comprising the compressor train and ensure noise is within permitted levels. Consequential intervention is defined as "any intervention on a network asset or other infrastructure asset that modifies the probability of failure or consequence of failure of another network asset".

7.2.3 For compressor cabs, the failure modes that contribute mostly to the probability of failure are:

- Loss of operation of unit/gas drive, from failure of cab enclosure assets leading to a trip.
- Fault leading to loss of monitoring/control.

## 7.3 Fire Suppression – Probability of Failure

7.3.1 The predominant failure model is a compressor trip and vent, caused by the failure of the fire suppression system itself. The probability of the failure of a unit due to a fire and subsequent failure of the fire suppression system is very low.

7.3.2 Not unlike Cab infrastructure, fire suppression infrastructure interventions are defined as consequential interventions as their prime function is to protect assets comprising the compressor train.

7.3.3 For compressor cab fire suppression assets, the failure modes that contribute most to the probability of failure are:

- Loss of unit leading to trip, resulting from:
    - Fault leading to loss of fire protection
    - Fault leading to trip

## 7.4 Probability of Failure Data Assurance

7.4.1 Only defects, proven to have deteriorated sufficiently that they are adversely affecting performance or are in an unsuitable state of deterioration, identified through NGT's cab and fire suppression rolling asset health plan, and bolstered by external cab condition survey reports, are proposed to be addressed in this UM reopener submission.

# 8 Consequence of Failure

## 8.1 Overview

8.1.1 Though none of the assets being intervened on have failed, following is a summary of what the consequences would be if the assets did fail. This would lead to inefficient network operation, utilisation of sub-optimum compressors to meet NGT pressure requirements which could lead to financial, environmental and reputational impacts and potential emergency repairs costing more.

8.1.2 The consequence of failure has varying impacts on availability, the environment, finance, and safety. This is summarised in Table 12. Failure of the cab enclosure can impact the availability of the associated compressor.

*Table 12: Consequence of Failure Summary*

| Sub Asset | Impact / Consequence | | | |
|---|---|---|---|---|
| | **Availability** | **Environment** | **Financial** | **Safety** |
| Air Intake | Failure and wear of internal components can create foreign bodies (such as zinc particles) which are drawn into the gas generator engine causing damage resulting in loss of operation.<br><br>Reduced efficiency of the turbine due to increased pressure drop across the filters.<br><br>Unfiltered air will result in the turbine blades getting dirty and therefore less efficient, and potential to cause damage to the blades which could result in an expensive failure. | Associated with the **loss of gas** through trips and vents of the compressor unit | Mostly associated with the **OPEX costs** of operating and maintaining the network at the current level of risk. | Exposure to excessive noise above acceptable levels. |
| Cab Enclosure | Associated with the potential **unplanned outages** associated with the loss of compressor trains because of failure of the cab enclosure. This is an indirect effect and only a small proportion of enclosure failures will generate a unit trip and associated outage. | Associated with the **loss of gas** through trips and vents of the compressor unit, caused by the failure of a fire suppression system. This is an indirect effect and only a small proportion of system failures (Enclosure, Ventilation, Exhaust, Fire Suppression) will generate a unit trip and associated vent of gas.<br><br>Potential noise excursions result in non-compliance with | Mostly associated with the **OPEX costs** of operating and maintaining the network at the current level of risk.<br><br>Financial penalties for noncompliance with safety and environmental legislation.<br><br>Potential financial penalties for being unable to supply gas as and when it is needed and associated entry constraints. | Exposure of operatives to excessive noise above acceptable levels.<br><br>Reduced effectiveness of the fire suppression system which relies on the cab being sealed to prevent more oxygen getting in to feed the fire. |
| Cab Ventilation | When ventilation starts to fail, other enclosure assets can be damaged by heat build-up and safety controls become less effective. | | | Potential for overheating of cab enclosure and asphyxiation<br><br>Stagnant areas and recirculation of ventilation air can allow an explosive atmosphere to build up in the enclosure potentially resulting in an explosion. |

| Sub Asset | Impact / Consequence | | | |
|---|---|---|---|---|
| | Availability | Environment | Financial | Safety |
| Cab Exhaust | Ineffective dispersion of combustion gasses.<br><br>Potential for larger sections dropping and leading to turbine damage.<br><br>Hot gases would enter the enclosure, causing overheating and a trip | environmental permits. | | Exposure to excessive noise above acceptable levels.<br><br>Potential for sections of debris to be fired from the stack posing a risk to personnel. |
| Fire Suppression | Without a fully functioning fire suppression system the associated gas compressor cannot be used. This limits the availability of the compressor unit and can impact the overall resilience of the NTS. | | | Asphyxiation, fatalities and damage to equipment.<br><br>Potential to cause fatal explosions involving the gas turbines in its acoustic enclosure. |

# 9 RIIO-2 Baseline Interventions (yrs. 1-3)

## 9.1 Summary of Interventions

9.1.1 At the time of completing this paper (June 2023), circa [redacted] interventions on [redacted] compressor cabs had been completed. Works are still in progress at Chelmsford A and B and at Kirriemuir E. Outage complications at Wormington B have resulted in some ventilation works on this cab being pushed out to year 4 of RIIO-2. [redacted] summarises the interventions on the [redacted] Cabs.

*Table 13: Summary of works completed so far in RIIO-2*

| RIIO-2 Intervention Year | Cab Name | Comments |
|---|---|---|
| Cabs 2021 (Implementation in 2021/2022) | [redacted] | Interventions completed included those on the exhaust, inlet louvres, ductwork, splitters pipework penetrations, acoustic pipe covers, wall cladding and gutter system. |
| | [redacted] | [redacted] |
| | [redacted] | Interventions completed included those on the air intake filter house and ductwork, door seals, ventilation system, dampers, exhaust and the fire suppression system. |
| | [redacted] | [redacted] |
| | [redacted] | Refurbishment of the fire suppression system, including new spray heads, revalidation of pressure containing bottles, and new flexible hoses. |
| | [redacted] | Interventions completed included those on the Local Equipment Room (LER) access doors and floors, AER machinery doors and frame, ventilation fan housing, roof, acoustic louvres, guard rails, filter house door, airlock louvres, door viewing windows, machinery double doors, personnel access door, exhaust, filter stages and fire suppression system. |
| Cabs 2022 (Implementation in 2022/2023) | [redacted] | Interventions completed included those on the cab door seals, guttering, fire suppression system and filter house. |
| | [redacted] | [redacted] |
| | [redacted] | Interventions completed included those on the exhaust and fire suppression system. |
| | [redacted] | Interventions completed included those on the exhaust system, doors, ladder platform, louvres, air intake filter house, ventilation fan, motors, dampers and fire suppression system. |
| | [redacted] | Interventions completed included those on the ventilation, ductwork, cab holes and doors. |
| | [redacted] | Remedial works have been implemented on existing Exhaust Stack to address cracks within Flanges and implement corrosion treatment to enhance the asset life. |
| | [redacted] | Remedial works have been implemented on existing Exhaust Stack to address cracks within Flanges and implement corrosion treatment to enhance the asset life. |
| | [redacted] | Interventions completed include those on compressor cab holes and roof. |
| | [redacted] | Interventions completed include those on compressor cab holes, roof and exhaust. |
| | [redacted] | [redacted] |
| Cabs 2023 (Implementation in 2023/2024) | [redacted] | Interventions in progress include those on compressor cab holes, roof, fire suppression system and air intake filtration. |
| | [redacted] | [redacted] |
| | [redacted] | Interventions in progress include those on the cab roof. |
| Cabs 2024 (Implementation in 2024/2025) | [redacted] | [redacted] Outage complications have resulted in some work on this cab being shifted to year four of RIIO-2. |

9.1.2 Table 14 summarises the interventions on the [redacted] Cabs.

*Table 14: Summary of RIIO-2 baseline (Yrs. 1-3) interventions targeted per Cab*

[redacted]

| Key: | Completed | Partially completed | Inflight |
|---|---|---|---|

9.1.3 For the current inflight works the risks and opportunities are summarised in *Table 15.*

*Table 15: Risks and Opportunities for inflight, baseline funded (RIIO-2 yrs. 1 -3) Cabs interventions*

| Cabs | [redacted] | [redacted] | [redacted] |
|---|---|---|---|
| Delivery | • Outages confirmed, contractor engaged, project is on site undertaking destruct work, materials procured.<br>• Potential for moving delivery to future years is very low. | • Outage scheduled for July 23 but other projects running on site are requiring more time which might move the outage to August/October 2023. Outage available to September 2023. Risk is if the other projects slip this could go into year 4 (2024/25). | • Outage complications have resulted in ventilation works being pushed to year 4 of RIIO-2. |
| Cost | • Fixed price contract, project is running as expected.<br>• Risks are being managed well.<br>• Cost fluctuation is unexpected. | • Cost fluctuation is expected if project moves out to 2024 as a result of delays in other inflight projects.<br>• Some cost has been expended in 2022 for delivery in 2023. | • Costs for undertaking this delayed intervention are expected to remain in line with projections. |

## 9.2 Baseline Funded Costs

9.2.1 Actual costs for completed works and estimated/contracted costs for interventions in flight are summarised in *Table 16*.

*Table 16: Baseline funded (yrs. 1-3) spend*

| UID | Description | Completed UID Cost | Inflight UID Costs | UID Cost Totals |
|---|---|---|---|---|
| [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] | [redacted] | [redacted] | [redacted] |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Totals | | [redacted] | [redacted] | [redacted] |

9.2.2 Unit costs based on Ofgem's Final Determination were used as target costs for years 1-3 works. Through delivery, a range of tendered and outturn costs have been collected. Costs variances between unit costs used to establish the baseline allowance and actual unit costs to complete the works have been found and reasons for these variances are summarised as:

- **Scope specificity:** Intervention specific scopes for each cab as opposed to generic scopes used to generic unit costs establish used to establish baseline allowances.
- **Scope increase:** Increase in scope for works on the Cabs (e.g., for fire suppression the number of cylinders and nozzles increased following cab specific condition assessment). Additional testing, resulting from cab specific condition assessment, requiring to be done (i.e., for nozzles).
- **Workforce:** a number of issues including workforce constraints, material delays and cost increases.
- **Covid 19:** Due to the pandemic the construction industry has had to catchup for lost time and in doing so the demand for materials has increased leading to both shortages and increased cost.
- **Cost to Employ:** National Insurance costs increased since the beginning of RIIO-2. Costs to purchase vehicles have also increased due to microchip shortages.
- **Energy costs:** gas and electricity costs have increased since the beginning of RIIO-2.
- **Fuel costs:** Petrol and diesel costs have increased significantly since the beginning of RIIO-2.

- **Red diesel:** This cheaper diesel is no longer allowed to be used on construction sites. White diesel, which is now being used on construction sites, is considerably more expensive resulting in an increase in site mobilisation and plant fuel costs by an estimated factor of 0.71.
- **Overall Inflation:** Comparison between 2018 and 2022 has shown that GBP has lost approximately 13.85% in value. Therefore, what cost £100 in 2018 cost £113.85 in 2022. Inflation from 2018 to 2023 is approximately 19.38%.

9.2.3 [redacted] provides a summary of awarded baseline spend against actual spend. The table also contains the volumes associated with this spend. Completed and inflight baseline interventions have been used to provide the necessary evidence in relation to unit costs across RIIO-2.

*Table 17: Awarded baseline spend vs actual spend*

| **Category** | **Volumes (no.)** | **Spend (£m)** |
|---|---|---|
| Actual base line spend (yrs. 1 -3) | [redacted] | [redacted] |
| Awarded baseline spend (yrs. 1 -3) | N/A | 12.191 |
| (Actual – Awarded) | | [redacted] |

# 10 Options Considered for Years 2024 and 2025

## 10.1 Options Overview

10.1.1 Defects, identified through NGT's cab and fire suppression infrastructure rolling asset health plan, and bolstered by external cab condition survey reports, were assessed for intervention options. This assessment was completed through a series of Campaign Decision Panels (CDPs), comprising Subject Matter Experts (SMEs) and other identified stakeholders to assess all credible options for each identified defect and ascertain the optimum asset management intervention to balance cost risk and performance and deliver on our consumer outcome. This was to ensure the level of investment to progress and complete the interventions was appropriate for the predicted life of the asset. The CDPs comprised Subject Matter Experts (SME's) and other selected stakeholders.

10.1.2 Table 18 summarises the various interventions considered following defect assessment and surveys, and maps these to the RIIO-2 baseline interventions of 'minor refurbishment', 'major refurbishment' and 'replacement'. This approach provides further granularity and explains the intervention proposed to be completed whilst aligning these to the baseline UIDs, as shown within the non-lead PCD annex. Please note that this is not an exhaustive list – it merely provides an example of the typical types of interventions associated with each sub asset.

*Table 18: Options considered and examples of interventions*

<table>
<tr><th colspan="2">Business Plan</th><th colspan="4">Real Intervention Example</th></tr>
<tr><td colspan="2">Do nothing<br>(all sub assets in the table)</td><td colspan="4">• The impact of no investment in Cab infrastructure generates a compounding increase in service risk every year, across all service risk categories.<br>• The impact of no investment in Fire Suppression assets increases service risk over a 10-year period, the most significant being a three-fold increase in the volume of gas released to atmosphere every year generated through trips and vents of the Compressor unit resulting from failure of a fire suppression system. In the short term, and specifically related to compressor units, if the fire suppression system is non-operational then the compressor unit cannot be operated thus impacting availability and increasing service risk.<br>• This option includes the reactive only investment across all Cab Infrastructure including Fire Suppression and is the option against which all the other options are compared.<br>• This option is largely discounted as it does not result in in any tangible benefit to the asset and increases the risk of failure and safety related incidents.</td></tr>
<tr><td colspan="2">Decommission<br>(all sub asses in the table)</td><td colspan="4">This is the option of permanently removing, through dismantling and disposal, of assets from service. This option is discounted as the assets identified for intervention are still required on the NTS. All cabs identified for intervention are in line with NGT's Needs Case and future strategy of keeping gas flowing in the interests of consumers. Hence the requirement for cab and fire suppression investment to ensure continued and safe operation of the compressor units they support.</td></tr>
<tr><td>Air Intake</td><td>Refurbishment (component relife)</td><td>Filter replacement, OR</td><td>Clean corrosion, OR</td><td>Replace blow in door seal OR</td><td>Additional stage of filtration</td></tr>
</table>

| Business Plan | | Real Intervention Example | | | |
|---|---|---|---|---|---|
| | Replace | New filter house, dehumidifier, replace silencer and plenum walls | | | |
| Exhaust | Refurbishment (component relife) | Repair cracks, OR | Replace gaskets, OR | Replace expansion joint OR | Replace internal lining, OR |
| | | Replace bellows and expansion joint | | | |
| | Replace | New exhaust stack | | | |
| Cab Structure | Minor refurbishment (component relife) | Replace door seals, OR | Replace 1 set of large doors or 2x small doors, OR | Replace corroded perforated sheets, OR | Improve cab sealing |
| | | Re-line roof, OR | Replace multiple doors | Install removable roof panels OR | Crane upgrade |
| | | Re-line roof and install guttering system, OR | Replace roof ladders and platforms, OR | | |
| | Replace | New cab structure | | | |
| Ventilation | Refurbishment (component relife) | Overhaul dampers, OR | Overhaul vent fans and motors, OR | Install additional ducting or fans | |
| | Replace | New ventilation | | | |
| Fire suppression | Refurbishment (component relife) | Revalidate bottles, OR | Revalidate hoses, OR | Revalidate spray heads | |
| | Replace | New electric pump system | | | |

## 10.2 Options Summary

10.2.1 The following section, an expansion of Table 18, provides a description of the options assessed for each defect type sub asset. **Do nothing** and **Decommission**, which apply to all sub assets, are discounted as all of the assets identified for intervention are still required on the NTS.

10.2.2 The majority of cabs assets do not fail but deteriorate resulting in poor performance which leads to further deterioration. Outputs of NGT's cab and fire suppression infrastructure rolling asset health plan, and bolstered by external cab condition survey reports, show that assets haven't failed but are in various states of deterioration and should be intervened upon before adversely affecting performance. Therefore, options explored are on deteriorating assets and those that do not meet the requirements of the key drivers.

10.2.3 In light of the above the two main options being taken forward are planned activities identified as ***Pre-emptive Refurbishment*** and ***Pre-emptive Replacement*** (Replacement)**,** summarised in Table 19. This avoids unplanned availability that impacts on operational resilience and manage the range of prevailing supply and demand and pressure conditions. This approach also avoids potential higher costs from a reactive project over one that can be managed.

*Table 19: Option Summary Conclusion*

| Option | Narrative |
|---|---|
| *Pre-emptive Refurbishment* | This is **an option being taken forward** as the outputs of the survey highlight deterioration that would result in failure. As a prudent Asset Management Company NGT should be planning interventions that prevent asset failure. |
| *Refurbishment on Failure* | This is **not an option being taken forward** as the assets should not be allowed to fail and such an option is an **unplanned activity**. As a prudent Asset Management Company NGT should be planning interventions that prevent asset failure. However, if something did fail in year 4 or 5 NGT would look to intervene. |
| *Pre-emptive Replacement* | This is **an option being taken forward** as the outputs of the survey highlight deterioration that would result in failure and/or assets that need replacement as they do not meet current design standards. As a prudent Asset Management Company NGT should be planning interventions that prevent asset failure. |
| *Replacement on Failure* | This is **not an option being taken forward** as the assets should not be allowed to fail and such an option is an **unplanned activity**. As a prudent Asset Management Company NGT should be planning interventions that prevent asset failure. However, if something did fail in year 4 or 5 NGT would look to intervene. |

## 10.3 Years 4 and 5 Options Details and Selection Summary

10.3.1 Options and identified interventions are based on condition-based assessments reviewed as part of NGT's cab and fire suppression infrastructure rolling asset health plan and bolstered by external cab condition survey reports. The options selected provide the most optimum asset management intervention to balance cost risk and performance and deliver on our consumer outcome.

10.3.2 Each cab is being treated as a separate project but aligned to respective UIDs to provide a holistic view of identified interventions.

### [redacted] Option Summary

10.3.3 Options considered for [redacted] identified defects are discussed and summarised in Table 20 and Table 21.

*Table 20* [redacted] *Firefighting Equipment Outline and Discussion*

| [redacted] **Firefighting Equipment** | |
|---|---|
| **Option** | **Narrative** |
| ***Pre-emptive Refurbishment*** | This option would result in residual risks being carried through due to some components being reused. Manual handling and asphyxiation risks are not removed with this option. The current system is not designed to suit full cab volume and it is unknown if the refurbished system would work effectively. |
| ***Pre-emptive Replacement*** | The current firefighting equipment is not compliant with BS ISO21789. Therefore, replacement with an up-to-date electric pump system is a more reliable and compliant solution. To comply with NGT requirements most of the older nitrogen bottle systems do not have enough volume. They typically supply water mist for around 5 minutes. New electric pump system will supply water mist for an extended period around 30 minutes as per requirement required in T/SP/SFP/3. This option also removes manual handling risks and reliance on manual review of $N_2$ levels. |
| ***Selected Option*** | Funding request through [redacted] |

*Table 21* [redacted] *Ventilation Equipment Outline and Discussion*

| [redacted] **Ventilation Equipment** | |
|---|---|
| **Option** | **Narrative** |
| ***Pre-emptive Refurbishment*** | Refurbishing will result in residual risks being carried through due to some components being reused. |
| ***Pre-emptive Replacement*** | The nature of the defects entails replacing the existing ventilation system with one that is compliant with BS EN ISO21789 standard (gas turbine applications). This removes enclosure overheating issues, provides enhanced gas detection, and reduces the risk of explosion. |
| ***Selected Option*** | Funding request through [redacted] |

### [redacted] Option Summary

10.3.4 Options considered for [redacted] identified defects are discussed and summarised in Table 22 and Table 23.

*Table 22* [redacted] *Firefighting Equipment Outline and Discussion*

| [redacted] Firefighting Equipment | |
|---|---|
| Option | Narrative |
| ***Pre-emptive Refurbishment*** | This option would result in residual risks being carried through due to some components being reused. Manual handling and asphyxiation risks are not removed with this option. The current system is not designed to suit full cab volume and it is unknown if the refurbished system would work effectively. |
| ***Pre-emptive Replacement*** | The current firefighting equipment is not compliant with BS ISO21789. Therefore, replacement with an up-to-date electric pump system is a more reliable and compliant solution. To comply with NGT requirements most of the older nitrogen bottle systems do not have enough volume. They typically supply water mist for around 5 minutes. New electric pump system will supply water mist for an extended period around 30 minutes as per requirement required in T/SP/SFP/3. This option also removes manual handling risks and reliance on manual review of $N_2$ levels. |
| ***Selected Option*** | Funding request through [redacted] |

*Table 23* [redacted] *Ventilation Equipment Outline and Discussion*

| [redacted] Ventilation Equipment | |
|---|---|
| Option | Narrative |
| ***Pre-emptive Refurbishment*** | Refurbishing will result in residual risks being carried through due to some components being reused. |
| ***Pre-emptive Replacement*** | The nature of the defects entails replacing the existing ventilation system with one that is compliant with BS EN ISO21789 standard (gas turbine applications). This removes enclosure overheating issues, provides enhanced gas detection, and reduces the risk of explosion. |
| ***Selected Option*** | Funding request through [redacted] |

## [redacted] Option Summary

10.3.5 Options considered for [redacted] identified defects are summarised in Table 24, Table 25, Table 26, and Table 27.

*Table 24: [redacted] Firefighting Equipment Outline and Discussion*

| [redacted] Firefighting Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | This option would result in residual risks being carried through due to some components being reused. Manual handling and asphyxiation risks are not removed with this option. The current system is not designed to suit full cab volume and it is unknown if the refurbished system would work effectively. |
| *Pre-emptive Replacement* | The current firefighting equipment is not compliant with BS ISO21789. Therefore, replacement with an up-to-date electric pump system is a more reliable and compliant solution. To comply with NGT requirements most of the older nitrogen bottle systems do not have enough volume. They typically supply water mist for around 5 minutes. New electric pump system will supply water mist for an extended period around 30 minutes as per requirement required in T/SP/SFP/3. This option also removes manual handling risks and reliance on manual review of $N_2$ levels. |
| *Selected Option* | Funding request through [redacted] |

*Table 25: [redacted] Exhaust Stack Equipment Outline and Discussion*

| [redacted] Exhaust Stack Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | The stack is past its design life and needs replacement to enable the compressor unit to operate for the next 30 years alongside the new Solar Titan 130 machinery trains. Experience has shown that for assets such as exhausts stacks it is prudent to replace rather than refurbish due to the very high likelihood of finding multiple deteriorations within the stacks. |
| *Pre-emptive Replacement* | This option entails proactive complete replacement of the exhaust stack. The unit is being retained as backup to the two new Solar Titan 130 units and therefore requires intervention to provide it a further 30 years of operational life. Therefore, it is not appropriate to wait for it to fail. |
| *Selected Option* | Replacement utilising [redacted] |

*Table 26: [redacted] Air Intake / Filtration Equipment Outline and Discussion*

| [redacted] Air Intake / Filtration Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | Refurbishing will result in residual risks being carried through due to some components being reused. |
| *Pre-emptive Replacement* | The nature of the defects entails replacing the existing air intake system with one that is compliant with BS EN ISO21789 standard (gas turbine applications). This results in efficient operation of the engine and reduced future overhaul costs through improved filtration and implements dehumidification for protection of the gas turbine when not in operation. |
| *Selected Option* | Funding request through [redacted] |

*Table 27: [redacted] Ventilation outline and discussion*

| [redacted] Ventilation Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | Refurbishing will result in residual risks being carried through due to some components being reused. |
| *Pre-emptive Replacement* | The nature of the defects entails replacing the existing ventilation system with one that is compliant with BS EN ISO21789 standard (gas turbine applications). This removes enclosure overheating issues, provides enhanced gas detection, and reduces the risk of explosion. |
| *Selected Option* | Funding request through [redacted] |

*Table 28: [redacted] Cab Integrity Equipment Outline and Discussion*

| [redacted] Cab Structure | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | This option entails remediating ineffective enclosure sealing, defective door seals and latches and gaps between wall panels. The nature of defects is such that Cab integrity repair is sufficient. |
| *Pre-emptive Replacement* | This is not a suitable option as the cab integrity has not yet failed and should not be allowed to fail. It requires refurbishment to reinstitute its integrity. The nature of defects does not warrant the more expensive option of replacement. |
| *Selected Option* | Funding request through [redacted] |

### [redacted] Option Summary

10.3.6 Options considered for [redacted] identified defects are summarised in Table 29, Table 30, Table 31, Table 32 and Table 33.

*Table 29: [redacted] Firefighting Equipment Outline and Discussion*

| [redacted] Firefighting Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | This option would result in residual risks being carried through due to some components being reused. Manual handling and asphyxiation risks are not removed with this option. The current system is not designed to suit full cab volume and it is unknown if the refurbished system would work effectively. |
| *Pre-emptive Replacement* | The current firefighting equipment is not compliant with BS ISO21789. Therefore, replacement with an up-to-date electric pump system is a more reliable and compliant solution. To comply with NGT requirements most of the older nitrogen bottle systems do not have enough volume. They typically supply water mist for around 5 minutes. New electric pump system will supply water mist for an extended period around 30 minutes as per requirement required in T/SP/SFP/3. This option also removes manual handling risks and reliance on manual review of $N_2$ levels. |
| *Selected Option* | Funding request through [redacted] |

*Table 30: [redacted] Exhaust Stack Equipment Outline and Discussion*

| [redacted] Exhaust Stack Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | The stack is past its design life and needs replacement to enable the compressor unit to operate for the next 30 years alongside the new Solar Titan 130 machinery trains. Experience has shown that for assets such as exhausts stacks it is prudent to replace rather than refurbish due to the very high likelihood of finding multiple deteriorations within the stacks. |
| *Pre-emptive Replacement* | This option entails proactive complete replacement of the exhaust stack. The unit is being retained as backup to the two new Solar Titan 130 units and therefore requires intervention to provide it a further 30 years of operational life. Therefore, it is not appropriate to wait for it to fail. |
| *Selected Option* | Funding request through [redacted] |

*Table 31: [redacted] Air Intake / Filtration Equipment Outline and Discussion*

| [redacted] Air Intake / Filtration Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | Refurbishing will result in residual risks being carried through due to some components being reused. |
| *Pre-emptive Replacement* | The nature of the defects entails replacing the existing air intake system with one that is compliant with BS EN ISO21789 standard (gas turbine applications). This results in efficient operation of the engine and reduced future overhaul costs through improved filtration and implements dehumidification for protection of the gas turbine when not in operation. |
| *Selected Option* | Funding request through [redacted] |

*Table 32: [redacted] Ventilation Equipment outline and discussion*

| [redacted] Ventilation Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | Refurbishing will result in residual risks being carried through due to some components being reused. |
| *Pre-emptive Replacement* | The nature of the defects entails replacing the existing ventilation system with one that is compliant with BS EN ISO21789 standard (gas turbine applications). This removes enclosure overheating issues, provides enhanced gas detection, and reduces the risk of explosion. |
| *Selected Option* | Funding request through [redacted]. |

*Table 33: [redacted] Cab Integrity Equipment Outline and Discussion*

| [redacted] Cab Structure | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | This option entails remediating ineffective enclosure sealing, defective door seals and latches and gaps between wall panels. The nature of defects is such that Cab integrity repair is sufficient. |
| *Pre-emptive Replacement* | This is not a suitable option as the cab integrity has not yet failed and should not be allowed to fail. It requires refurbishment to reinstitute its integrity. The nature of defects does not warrant the more expensive option of replacement. |
| *Selected Option* | Funding request through UID refurbishment using [redacted] |

## [redacted] Option Summary

10.3.7 Options considered for [redacted] identified defects are summarised in Table 34.

*Table 34: [redacted] Firefighting Equipment Outline and Discussion*

| [redacted] Firefighting Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | This option would result in residual risks being carried through due to some components being reused. Manual handling and asphyxiation risks are not removed with this option. The current system is not designed to suit full cab volume and it is unknown if the refurbished system would work effectively. |
| *Pre-emptive Replacement* | The current firefighting equipment is not compliant with BS ISO21789. Therefore, replacement with an up-to-date electric pump system is a more reliable and compliant solution. To comply with NGT requirements most of the older nitrogen bottle systems do not have enough volume. They typically supply water mist for around 5 minutes. New electric pump system will supply water mist for an extended period around 30 minutes as per requirement required in T/SP/SFP/3. This option also removes manual handling risks and reliance on manual review of $N_2$ levels. |
| *Selected Option* | Funding request through [redacted] |

## [redacted] Option Summary

10.3.8 Options considered for [redacted] identified defects are summarised in Table 35, Table 36 and Table 37.

*Table 35: [redacted] Firefighting Equipment Outline and Discussion*

| [redacted] Firefighting Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | The fire suppression system is showing signs of deterioration and requires refurbishment to reinstate its integrity. The nature of defects warrants refurbishment rather than replacement. |
| *Pre-emptive Replacement* | This option would entail complete replacement of the fire-fighting equipment. However, the nature of defects does not warrant the more expensive option of replacement. |
| *Selected Option* | Funding request through [redacted] |

*Table 36: [redacted] Ventilation Equipment Outline and Discussion*

| [redacted] Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | This is not a suitable option as the ventilation system is showing signs of deterioration which would lead to failure and needs replacing. Refurbishing will result in residual risks being carried through due to some components being reused. |
| *Pre-emptive Replacement* | This option entails replacing the existing ventilation system with one that is compliant with BS EN ISO21789 standard (gas turbine applications). This results in efficient operation of the engine, it removes overheating issues, provides enhanced gas detection, and reduces the risk of explosion. |
| *Selected Option* | Funding request through [redacted] |

*Table 37: [redacted] Cab Integrity Equipment Outline and Discussion*

| [redacted] Cab Structure | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | This option entails remediating ineffective enclosure sealing, defective roof, defective door seals and latches and gaps between wall panels. The nature of defects is such that Cab integrity repair is sufficient. |
| *Pre-emptive Replacement* | is not a suitable option as the Cab integrity is showing signs of deterioration and the nature of the defects requires refurbishment to reinstitute its integrity. |
| *Selected Option* | Funding request through [redacted] |

### [redacted] Option Summary

10.3.9 Options considered for [redacted] identified defects are summarised in Table 38, Table 39, Table 40 and Table 41.

*Table 38: [redacted] Firefighting Equipment Outline and Discussion*

| [redacted] Firefighting Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | The fire suppression system is showing signs of deterioration and requires refurbishment to reinstate its integrity. The nature of defects warrants refurbishment rather than replacement. |
| *Pre-emptive Replacement* | This option would entail complete replacement of the fire-fighting equipment. However, the nature of defects does not warrant the more expensive option of replacement. |
| *Selected Option* | Funding request through [redacted] |

*Table 39: [redacted] Exhaust Equipment Outline and Discussion*

| [redacted] Exhaust Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | This option entails replacement of the existing cracked expansion joint component, of the exhaust, to prevent any further deterioration of the condition of the asset which would lead to leaks within the Cab. |
| *Pre-emptive Replacement* | This is not an option as the expansion joint, for the exhaust, is already showing signs of deterioration leading to failure and needs intervention. Refurbishment entails introduction of more welding points with increased risk of repeated cracking. Refurbishment will result in residual risks being carried through due to some components being reused |
| *Selected Option* | Funding request through [redacted] |

*Table 40: [redacted] Ventilation Equipment Outline and Discussion*

| [redacted] Ventilation Equipment | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | This is not a suitable option as the ventilation system is showing signs of deterioration which would lead to failure and needs replacing. Refurbishing will result in residual risks being carried through due to some components being reused. |
| *Pre-emptive Replacement* | This option entails replacing the existing ventilation system with one that is compliant with BS EN ISO21789 standard (gas turbine applications). This results in efficient operation of the engine, |

| [redacted] Ventilation Equipment | |
|---|---|
| Option | Narrative |
| | it removes overheating issues, provides enhanced gas detection, and reduces the risk of explosion. |
| *Selected Option* | Funding request through [redacted] |

*Table 41: [redacted] Cab Integrity Equipment Outline and Discussion*

| [redacted] Cab Structure | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | This option entails remediating ineffective enclosure sealing, defective roof, defective door seals and latches and gaps between wall panels. The nature of defects is such that Cab integrity repair is sufficient. |
| *Pre-emptive Replacement* | This is not a suitable option as the Cab integrity is showing signs of deterioration and the nature of the defects requires refurbishment to reinstitute its integrity. |
| *Selected Option* | Funding request through [redacted] |

## [redacted] Option Summary

10.3.10 Options considered for [redacted] identified defects are summarised in Table 42.

*Table 42: [redacted] Cab Exhaust Equipment Outline and Discussion*

| [redacted] Cab Structure | |
|---|---|
| Option | Narrative |
| *Pre-emptive Refurbishment* | This option entails replacement of the existing cracked expansion joint component, of the exhaust, to prevent any further deterioration of the condition of the asset which would lead to leaks within the Cab. |
| *Pre-emptive Replacement* | This is not an option as the expansion joint, for the exhaust, is already showing signs of deterioration leading to failure and needs intervention. Refurbishment entails introduction of more welding points with increased risk of repeated cracking. Refurbishment will result in residual risks being carried through due to some components being reused |
| *Selected Option* | Funding request through [redacted] |

## 10.4 Options Summary

10.4.1 Selected options for all Cabs identified for 2024 and 2025 interventions are summarised in Table 43.

*Table 43: 2024 and 2025 summary of selected options and their respective UIDs*

| **All Cabs Selected Options and UIDs** | | |
|---|---|---|
| **[redacted] Selected Options and UIDs** | | |
| Defect Area | Option | Associated UID |
| Firefighting equipment | Pre-emptive Replacement | [redacted] |
| Ventilation | Pre-emptive Replacement | [redacted] |
| | | |
| **[redacted] Selected Options and UIDs** | | |
| Defect Area | Option | Associated UID |
| Firefighting equipment | Pre-emptive Replacement | [redacted] |
| Ventilation | Pre-emptive Replacement | [redacted] |
| | | |
| **[redacted] Selected Options and UIDs** | | |
| Defect Area | Option | Associated UID |
| Firefighting equipment | Pre-emptive Replacement | [redacted] |
| Exhaust stack | Pre-emptive Replacement | [redacted] |
| Air Intake / Filtration | Pre-emptive Replacement | [redacted] |
| Ventilation | Pre-emptive Replacement | [redacted] |
| Cab structure | Pre-emptive Refurbishment | [redacted]*t* |
| | | |
| **[redacted] Selected Options and UIDs** | | |
| Defect Area | Option | Associated UID |
| Firefighting equipment | Pre-emptive Replacement | [redacted] |
| Exhaust stack | Pre-emptive Replacement | [redacted] |
| Air Intake / Filtration | Pre-emptive Replacement | [redacted] |
| Ventilation | Pre-emptive Replacement | [redacted] |
| Cab structure | Pre-emptive Refurbishment | [redacted] |
| | | |
| **[redacted] Selected Options and UIDs** | | |
| Defect Area | Option | Associated UID |
| Firefighting equipment | Pre-emptive Replacement | [redacted] |
| | | |
| **[redacted] Selected Options and UIDs** | | |
| Defect Area | Option | Associated UID |
| Firefighting equipment | Pre-emptive Refurbishment | [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] |
| Ventilation | Pre-emptive Replacement | [redacted] |
| Cab structure | Pre-emptive Refurbishment | [redacted] |
| | | |
| **[redacted] Selected Options and UIDs** | | |
| Defect Area | Option | Associated UID |
| Firefighting equipment | Pre-emptive Refurbishment | [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] |
| Exhaust (Unit A only) | Pre-emptive Refurbishment | [redacted] |
| Ventilation | Pre-emptive Replacement | [redacted] |
| Cab structure | Pre-emptive Refurbishment | [redacted] |
| | | |
| ***[redacted] Selected Options and UIDs*** | | |
| Defect Area | Option | Associated UID |
| Exhaust | Pre-emptive Refurbishment | [redacted] |

10.4.2 Table 44 summarises the preferred options for each cab identified for works in 2024 and 2025. It highlights the individual and combined range of interventions per Cab related to specific and unique UIDs. There are a total of [redacted] interventions identified to be undertaken across [redacted] Cabs on seven sites in 2024 and 2025.

*Table 44: Years 4 and 5 Option Summary*

[redacted]

# 11 Years 4 and 5 Options Cost Estimate Details

## 11.1 Cost Estimation Approach

11.1.1 NGT's aim in estimating the asset health UM activities, is to provide cost estimates with the appropriate level of confidence and consistency, based on the available data. The preferred estimating methodology is where possible, use the out-turn actual costs data for works completed in RIIO-2 so far. To ensure the accuracy of the cost estimate, only the out-turn costs for activities completed with similar scope to the years 4 and 5 interventions were used to derive the cost estimates.

11.1.2 The scope and complexities of years 1 to 3 interventions and years 4&5 interventions were compared and normalised, by considering the costs associated with factors such as volume/size, engineering difficulties, location, access and asset condition. Variations in scope were estimated and then added to, or deducted from, the out-turn cost or to reflect future works accurately.

11.1.3 If relevant historical out-turn cost data was not available, tendered prices were used where appropriate and available. The same level of rigour with regards to scope variation and other factors were followed to ensure consistency and accuracy.

11.1.4 If neither historical out-turn cost data nor relevant tendered prices were available, the cost estimates would be developed by internal bottomup estimating methodology, using NGT's unit cost library (for the rates components labour, plant and materials) combined with some price elements extracted from supplier prices of other works. NGT's internal unit cost library is a compilation of labour, plant and materials unit costs collated from frameworks, tenders and contracts.

11.1.5 Since the start of RIIO-2, new ways of working have been implemented and refined, which facilitated this structured approach to estimating years 4&5 costs. One of the benefits of this way of working is the ability to capture actual cost to the appropriate level of granularity at asset and intervention levels. For this purpose, the Unit Cost Schedule (UCS) was introduced in all our contracts and became a contractual requirement for all NGT suppliers to populate the UCS. The UCS is an excel template embedded in the supplier activity schedule, enabling the mapping of actual cost from how they are collated on site into asset intervenable units with associated cost differentiators. This allows the interrogation of cost and understanding the differences in cost for similar UIDs on different sites or assets.

11.1.6 The UCS is kept up to date during the execution of the works, ensuring alignment with NGT's core financial system (SAP) and the Work Breakdown Structure (WBS), to ensure the correct split between direct and indirect costs.

11.1.7 All elements of the cost estimate, whether from historical out turn costs and current prices are in the same base-year and then converted to 18/19.

## 11.2 General Estimating Approach Process

11.2.1 The general estimating methodology is shown as a visual process map in Figure 8 and UID specific costing commentary is summarised in Table 45. Appendix 2 contains more detail on the cost estimating methodology.

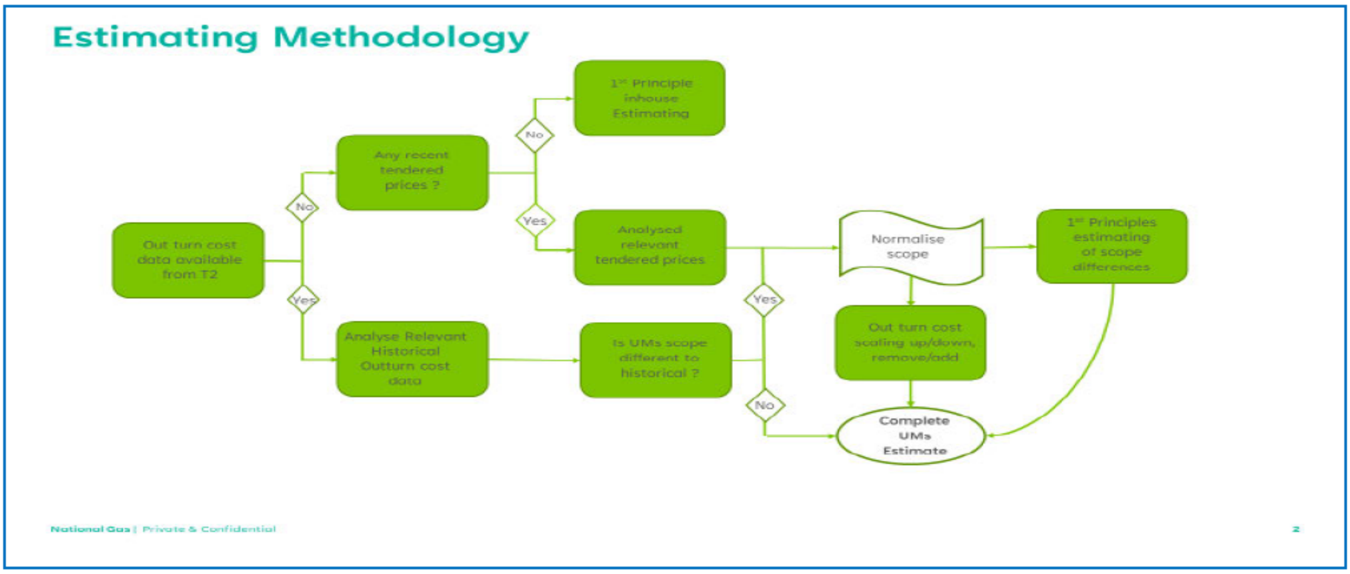


*Figure 8: Estimating Methodology*

*Table 45: UID Specific commentary*

| UID | Description | Interventions in UMs | Estimating Narrative |
|---|---|---|---|
| [redacted] | Air Intake Replacement | Air Intake Replacement | Only one intervention of air intake full replacement has been completed so far in RIIO-2 (2021/2022) on [redacted]. Condition assessment, surveys and subsequent Campaign Decision Panels (CDPs) at [redacted] resulted in the same scope of works as previously completed on [redacted]. The historical Direct and Indirect actual costs for [redacted] were used to estimate the UMs. |
| [redacted] | Ventilation replacement | Ventilation system Replacement | The surveys and subsequent CDPs for [redacted] units, these being [redacted] will require ventilation system replacement, for which the only relevant similar works were completed at [redacted]. Historical Direct and Indirect costs for Wormington used to estimate year 4&5 costs under [redacted]. Reduction in civils cost and cross site cabling factored in for the four units at [redacted] as the fans are replaced in the same location. These costs are obtained from suppliers. |

| UID | Description | Interventions in UMs | Estimating Narrative |
|---|---|---|---|
| [redacted] | Cab Infrastructure Refurbishment | Roof repairs and doors seals replacement and door corrosion repairs. | In RIIO-2 so far, Cab Infrastructure Minor Refurbishment interventions were completed on [redacted] cabs at [redacted]. The interventions on [redacted] cabs included door seals, corrosion repairs and roof repairs and on Alrewas and [redacted] included door seals and corrosion repairs. The surveys and subsequent CDPs for [redacted] and [redacted] will require door refurbishment, hence the average direct and indirect door refurbishment cost per cab from [redacted] were to estimate year 4&5 costs. [redacted] will require roof refurbishment, therefore, the average direct and indirect costs from [redacted] were used to estimate the year 4&5 costs. [redacted] cab roofs are larger than [redacted] hence, additional costs were included by prorating the variable element of the cost. Also, additional cost was included for Fuel Gas Shield on all the cabs. These prices obtained from our current specialist supplier [redacted] |
| [redacted] | Exhaust Stack Refurbishment | Expansion joint replacement Expansion Joint fabric replaced | In RIIO-2 so far, [redacted] Cab Infrastructure minor Refurbishment interventions on [redacted] have been completed. At [redacted] the whole cracked exhaust expansion joint was replaced. This unit had multiple (4) welds done so far and should not be welded any more since welds are weak points. At [redacted], only the expansion joint fabric, within the exhaust was repaired. Condition assessments, surveys and subsequent CDPs for [redacted], where the expansion joint deterioration is worse than [redacted], hence refurbishment is required and only the intervention on [redacted] is relevant. The historical Direct and Indirect actual out turn costs for [redacted] were used to estimate the year 4&5 costs. At this stage, no difference in scope to be considered. |
| [redacted] | Exhaust Replacement | Exhaust stack replacement, | In RIIO-2 so far, [redacted] exhaust minor Refurbishment interventions on [redacted] cabs on [redacted] have been completed. The interventions completed on all the cabs except [redacted] included one of the following, exhaust compensator replacement or flexible connection replacement or cleaning and painting, [redacted] had the exhaust stack replaced. Condition assessment, surveys and subsequent CDPs for [redacted] will require exhaust stack replacement, for which the only similar works completed were at [redacted]. Historical Direct and Direct costs for [redacted] used to estimate year 4&5 costs under [redacted]. |
| [redacted] | Fire Suppression Refurb | Replacement of Gas equipment cylinders and Nozzles | In RIIO-2 so far, [redacted] Fire suppression minor refurbishment interventions on [redacted] cabs on [redacted] have been completed. The intervention involves gas equipment replacement, cylinders and nozzles replacement. Condition assessment, surveys and subsequent CDPs for [redacted] units on [redacted]B determined that the scope of works will be the same historical, however, there are a larger number of cylinders and Nozzles on [redacted] cabs |

| UID | Description | Interventions in UMs | Estimating Narrative |
|---|---|---|---|
| | | | than [redacted]. Therefore, the historical out turn costs were used with the appropriate scaling up to account for the increased works. |
| [redacted] | Fire Suppression Replacement of Electric Water Pump System | Fire Suppression Replacement of Electric Water Pump System | In RIIO-2 so far, [redacted] fire suppression replacement interventions on [redacted] cabs on [redacted] have been completed. Condition assessments, surveys and subsequent CDPs defined the works on [redacted] cabs [redacted].<br>The works completed on [redacted] were not totally inclusive of the work scope for year 4&5. Electric Pump System at [redacted] was the first implementation at NGT network. Whist the implementation was functionally successful, there were some areas of improvement identified and some additional works identified on future sites. All sites are different and have different design and installation requirements associated with:<br>• **Buildability:** Removal and re-instatement of stairs and platform to facilitate placement of the new fire suppression kiosk in its position; Confined space mitigation; New cross-site cabling due to lack of sufficient power and signal interfaces.<br>• **Hazardous Area:** Declassification of the hazardous areas to meet design requirements.<br>• **Policy Changes:** change in policy dictating independent chair and development of all safety studies to ensure reduction and removal of biased engineering design related safety requirements.<br>• **Software:** software modification by Siemens (different PLCs are installed at different sites), Software modifications are dictated by the requirements of those OEMs).<br>Hence only the historical out turn costs of [redacted] were used to estimate years 4&5 works. Also, additional scope/works were identified in the CDPs (Replacement of stairs and platform to facilitate replacement of the fire suppression kiosk, New cross-site cabling, Declassification of the hazardous area to meet design requirements, Software modification by [redacted], change in policy which required independent review of all safety studies, confined space mitigation works required on some or all of UM cabs). The associated costs for the additional works are included for each cab where appropriate. |

## 11.3 Individual Cabs Cost Estimates

11.3.1 Cost estimate details for each individual Cab identified for interventions in 2024 and 2025 are summarised in the following tables.

### [redacted] Option Costs

11.3.2 [redacted] Intervention options costs are summarised in Table 46.

*Table 46: [redacted] Option Costs*

| Cost Category | | [redacted] | | Total Costs(£m) |
|---|---|---|---|---|
| | OEM costs | [redacted] | | |
| Direct | EPC Estimate | | | |
| Indirect | EPC PM | | | |
| Direct | EPC Site Establishment | | | |
| Direct | NGT Direct Company Costs | | | |
| Indirect | NGT Indirect Company Costs | | | |
| | Contractor Risk | | | |
| Direct | NG Project Risk (Direct) | | | |
| | FEED | | | |
| | Development / Optioneering | | | |
| | Land / Easements | | | |
| | **TOTAL COST** | | | |
| | | | | |
| | Direct | | | |
| | Indirect | | | |

### [redacted] Option Costs

11.3.3 [redacted] Intervention options costs are summarised in Table 47.

*Table 47: [redacted] Option Costs*

| Cost Category | | [redacted] | | Total Costs(£m) |
|---|---|---|---|---|
| | OEM costs | [redacted] | | |
| Direct | EPC Estimate | | | |
| Indirect | EPC PM | | | |
| Direct | EPC Site Establishment | | | |
| Direct | NGT Direct Company Costs | | | |
| Indirect | NGT Indirect Company Costs | | | |
| | Contractor Risk | | | |
| Direct | NG Project Risk (Direct) | | | |
| | FEED | | | |
| | Development / Optioneering | | | |
| | Land / Easements | | | |
| | **TOTAL COST** | | | |
| | | | | |
| | Direct | | | |
| | Indirect | | | |

### [redacted] Option Costs

11.3.4 [redacted] Intervention options costs are summarised in Table 48.

*Table 48: [redacted] Option Costs*

| Cost Category | | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Total Costs (£m) |
|---|---|---|---|---|---|---|---|
| | OEM costs | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | EPC Estimate | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Indirect | EPC PM | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | EPC Site Establishment | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | NGT Direct Company Costs | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Indirect | NGT Indirect Company Costs | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Contractor Risk | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | NG Project Risk (Direct) | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | FEED | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Development / Optioneering | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Land / Easements | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | **TOTAL COST** | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Direct | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Indirect | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |

### [redacted] Option Costs

11.3.5 [redacted] intervention options costs are summarised in Table 49.

*Table 49: [redacted] Fire Suppression Option Costs*

| Cost Category | | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Total Costs (£m) |
|---|---|---|---|---|---|---|---|
| | OEM costs | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | EPC Estimate | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Indirect | EPC PM | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | EPC Site Establishment | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | NGT Direct Company Costs | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Indirect | NGT Indirect Company Costs | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Contractor Risk | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | NG Project Risk (Direct) | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | FEED | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Development / Optioneering | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Land / Easements | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | **TOTAL COST** | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Direct | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Indirect | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |

## [redacted] Option Costs

11.3.6 [redacted] intervention options costs are summarised in Table 50.

*Table 50:* [redacted] *Option Costs*

| Cost Category | | [redacted] | [redacted] | [redacted] | Total Costs(£m) |
|---|---|---|---|---|---|
| | OEM costs | [redacted] | | | |
| Direct | EPC Estimate | | | | |
| Indirect | EPC PM | | | | |
| Direct | EPC Site Establishment | | | | |
| Direct | NGT Direct Company Costs | | | | |
| Indirect | NGT Indirect Company Costs | | | | |
| | Contractor Risk | | | | |
| Direct | NG Project Risk (Direct) | | | | |
| | FEED | | | | |
| | Development / Optioneering | | | | |
| | Land / Easements | | | | |
| | **TOTAL COST** | | | | |
| | | | | | |
| | Direct | | | | |
| | Indirect | | | | |

## [redacted] Option Costs

11.3.7 [redacted] intervention options costs are summarised in Table 51 and Table 52.

*Table 51:* [redacted] *Option Costs*

| Cost Category | | [redacted] | [redacted] | [redacted] | Total Costs(£m) |
|---|---|---|---|---|---|
| | OEM costs | [redacted] | | | |
| Direct | EPC Estimate | | | | |
| Indirect | EPC PM | | | | |
| Direct | EPC Site Establishment | | | | |
| Direct | NGT Direct Company Costs | | | | |
| Indirect | NGT Indirect Company Costs | | | | |
| | Contractor Risk | | | | |
| Direct | NG Project Risk (Direct) | | | | |
| | FEED | | | | |
| | Development / Optioneering | | | | |
| | Land / Easements | | | | |
| | **TOTAL COST** | | | | |
| | | | | | |
| | Direct | | | | |
| | Indirect | | | | |

*Table 52:* [redacted] *Option Costs*

| Cost Category | | [redacted] | [redacted] | [redacted] | Total Costs(£m) |
|---|---|---|---|---|---|
| | OEM costs | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | EPC Estimate | [redacted] | [redacted] | [redacted] | [redacted] |
| Indirect | EPC PM | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | EPC Site Establishment | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | NGT Direct Company Costs | [redacted] | [redacted] | [redacted] | [redacted] |
| Indirect | NGT Indirect Company Costs | [redacted] | [redacted] | [redacted] | [redacted] |
| | Contractor Risk | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | NG Project Risk (Direct) | [redacted] | [redacted] | [redacted] | [redacted] |
| | FEED | [redacted] | [redacted] | [redacted] | [redacted] |
| | Development / Optioneering | [redacted] | [redacted] | [redacted] | [redacted] |
| | Land / Easements | [redacted] | [redacted] | [redacted] | [redacted] |
| | **TOTAL COST** | [redacted] | [redacted] | [redacted] | [redacted] |
| | | [redacted] | [redacted] | [redacted] | [redacted] |
| | Direct | [redacted] | [redacted] | [redacted] | [redacted] |
| | Indirect | [redacted] | [redacted] | [redacted] | [redacted] |

### [redacted] Option Costs

11.3.8 [redacted] intervention options costs are summarised in Table 53 and Table 54.

*Table 53:* [redacted] *Option Costs*

| Cost Category | | [redacted] | [redacted] | [redacted] | [redacted] | Total Costs (£m) |
|---|---|---|---|---|---|---|
| | OEM costs | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | EPC Estimate | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Indirect | EPC PM | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | EPC Site Establishment | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | NGT Direct Company Costs | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Indirect | NGT Indirect Company Costs | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Contractor Risk | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | NG Project Risk (Direct) | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | FEED | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Development / Optioneering | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Land / Easements | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | **TOTAL COST** | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Direct | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | Indirect | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |

*Table 54: [redacted] Option Costs*

| Cost Category | | [redacted] | [redacted] | [redacted] | Total Costs(£m) |
|---|---|---|---|---|---|
| | OEM costs | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | EPC Estimate | [redacted] | [redacted] | [redacted] | [redacted] |
| Indirect | EPC PM | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | EPC Site Establishment | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | NGT Direct Company Costs | [redacted] | [redacted] | [redacted] | [redacted] |
| Indirect | NGT Indirect Company Costs | [redacted] | [redacted] | [redacted] | [redacted] |
| | Contractor Risk | [redacted] | [redacted] | [redacted] | [redacted] |
| Direct | NG Project Risk (Direct) | [redacted] | [redacted] | [redacted] | [redacted] |
| | FEED | [redacted] | [redacted] | [redacted] | [redacted] |
| | Development / Optioneering | [redacted] | [redacted] | [redacted] | [redacted] |
| | Land / Easements | [redacted] | [redacted] | [redacted] | [redacted] |
| | **TOTAL COST** | [redacted] | [redacted] | [redacted] | [redacted] |
| | | [redacted] | [redacted] | [redacted] | [redacted] |
| | Direct | [redacted] | [redacted] | [redacted] | [redacted] |
| | Indirect | [redacted] | [redacted] | [redacted] | [redacted] |

## [redacted] Option Costs

11.3.1 [redacted] intervention options costs are summarised in Table 55.

*Table 55: [redacted] Option Costs*

| Cost Category | | [redacted] | Total Costs(£m) |
|---|---|---|---|
| | OEM costs | [redacted] | [redacted] |
| Direct | EPC Estimate | [redacted] | [redacted] |
| Indirect | EPC PM | [redacted] | [redacted] |
| Direct | EPC Site Establishment | [redacted] | [redacted] |
| Direct | NGT Direct Company Costs | [redacted] | [redacted] |
| Indirect | NGT Indirect Company Costs | [redacted] | [redacted] |
| | Contractor Risk | [redacted] | [redacted] |
| Direct | NG Project Risk (Direct) | [redacted] | [redacted] |
| | FEED | [redacted] | [redacted] |
| | Development / Optioneering | [redacted] | [redacted] |
| | Land / Easements | [redacted] | [redacted] |
| | **TOTAL COST** | [redacted] | [redacted] |
| | | [redacted] | [redacted] |
| | Direct | [redacted] | [redacted] |
| | Indirect | [redacted] | [redacted] |

11.3.2 The cost estimates, individually tabled in this section are totalled and summarised in Table 56. Further cost detail in the form of year-by-year split is summarised in Table 57.

*Table 56: Year 4 and 5 cost estimate summary*

| UID | Description | Cost Category | Total Costs (£m) |
|---|---|---|---|
| [redacted] | [redacted] | Direct | [redacted] |
| | | Indirect | |
| [redacted] | [redacted] | Direct | |
| | | Indirect | |
| [redacted] | [redacted] | Direct | |
| | | Indirect | |
| [redacted] | [redacted] | Direct | |
| | | Indirect | |
| [redacted] | [redacted] | Direct | |
| | | Indirect | |
| [redacted] | [redacted] | Direct | |
| | | Indirect | |
| [redacted] | [redacted] | Direct | |
| | | Indirect | |
| [redacted] | [redacted] | Direct | |
| | | Indirect | |
| | | | |
| Total Direct | | | |
| Total Indirect | | | |
| **Grand Total** | | | |

*Table 57: 2024 and 2025 year by year cost split(£m)*

| | Delivery 2024 | Delivery 2025 |
|---|---|---|
| [redacted] | [redacted] | |
| Totals | | |
| Year Split | | |
| **Grand Total** | [redacted] | |

# 12 Business Case Outline and Discussion

## 12.1 Business Case Outline Overview

12.1.1 This section sets out the proposed investment plan for compressor cabs for the latter years of RIIO-2 (2024 and 2025). It demonstrates why the proposed investment levels and options for the identified compressor cabs are at the right level to ensure the health and reliability of these assets for the investment period and beyond.

12.1.2 Compressor cab assets deteriorate over time. This in turn prevents them from performing their required functions and can also result in them no longer complying with current and future legislative requirements. The requirements to comply with the requirements of PM84 / ISO21789, the requirements of DSEAR as well as environmental permits, the arduous operating conditions means that these assets deteriorate with time and use which leads to their inability to perform their required function.

12.1.3 Any failure or significant deterioration causes the associated compression to be unavailable and hence does directly affect the availability of the network and compression assets There is potential for inefficient operation of the NTS, increased operational cost and accelerated asset degradation due to compressor operating in sub-optimal conditions.

## 12.2 Key Business Case Drivers Description

12.2.1 The key drivers for investment in the compressor cab assets, as stated in Section 4.3, are:

- Legislation - HSE Guidance PM84.
- Asset Deterioration.
- Environment.
- Customers.

12.2.2 The key drivers for investment in the fire suppression assets, as stated in Section 4.3, are:

- Legislation – PSSR.
- HSE Guidance Document PM84 / ISO21789.
- Asset Deterioration.
- Safety.
- Policy.

## 12.3 Business Case Summary

12.3.1 Options and identified interventions are based on condition-based assessments reviewed as part of NGT's cab and fire suppression infrastructure rolling asset health plan, and bolstered by external cab condition survey reports, and CDPs. The specific interventions selected are driven by the specific defect/level of deterioration and specific identified means of resolving that defect/level of intervention. The costed option is therefore the one that has been selected to provide the most optimum asset management intervention to balance cost risk and performance and deliver on our consumer outcome.

12.3.2 In appraising asset health investment, NGT has considered how the cabs related assets can impact on a number of outcomes:

- Reliability risk
- Environmental risk
- Safety risk

12.3.3 On failure, the compressor cab elements have an environmental or financial impact, this is shown in the consequences of failure in sections 7 and 8. However, failure of the enclosure can particularly impact the availability of the associated compressor.

12.3.4 Maintaining the health of these assets is important in ensuring they continue to deliver the required capability. Specific outcomes associated with this investment are:

- Meet legal requirements and agreed safety standards.
- Ensure ongoing compliance with PM84 HSE / ISO21789 Control of Risk around Gas Turbine Enclosures.
- Manage deterioration of the assets such that they do not limit availability, performance or cause damage to the gas turbines or safety systems.

12.3.5 NGT's proposed investment in the compressor cab assets will ensure that the required assets meet the needs of its customers.

12.3.6 In order to deliver the outcomes for the investment period the Compressor Cab assets require a mixture of the intervention types defined in Section 10. The decision on the volume of each of the interventions required has been determined using the following methodology:

- Where a compressor is required, there is a need for cab and fire suppression infrastructure to house and facilitate the safe running of that compressor.
- The chosen approach is to be proactive in resolving issues ahead of further deterioration and failure while developing asset strategy based on learning from ongoing condition analysis. There needs to be a minimum level of pro-active asset intervention planned ahead of significant asset condition and risk. Risks and mitigations reviewed through the RIIO-2 period around gas turbine enclosures in line with HSE guidance and this approach will be continued through the investment period as these assets deteriorate with age and use.
- To manage asset obsolescence in a planned manner.
- A forecast of the number of repairs based on the historical information combined with the knowledge of the proposed replacement and refurbishment work.

12.3.7 A risk-based approach has been used to develop an asset-by-asset list of the appropriate type of intervention to be undertaken. This risk-based approach included:

- Deliverability in terms of internal and external cost and resource
- Issues and defects currently identified, through surveys, and those forecast to arise through the period.
- Asset age, condition and impacts of deterioration and no investment.
- Future need of the Compressor Unit.
- Remaining Life of the Compressor Unit.
- Compressor Unit Outages where staggering of work on and across sites is required to ensure local compression is available to meet demand scenarios

12.3.8 The investment proposed is to maintain, and where possible reduce, the current risk profile across the network by remediating the highest risk currently identified defects together with those which are forecast to be identified during scheduled routine inspection and maintenance activities.

12.3.9 The proposed mix of interventions and programme of work will have been set to maximise delivery efficiency. The intervention programme will be continually reassessed and reprioritised to mitigate the risk of not being able to deliver all the work planned for years 4 and 5 of RIIO-2.

12.3.10 There are currently [redacted] separate interventions across [redacted] different cabs on [redacted] compressor sites identified for intervention, in years 4 and 5 of RIIO-2, across the NTS.

12.3.11 In developing interventions and plans and making decisions NGT has been fully cognisant of the need to develop plans that are value for money, acceptable, affordable and deliverable.

12.3.12 No Cost benefit analysis has been completed as the technical option based on engineering judgement has been utilised. Investment in compressor cabs is essential to the safe and efficient running of NGT's fleet of compressors. The investment is fully integrated with CE-AMP and provides life extensions for those cab infrastructures in line with the compressor Fleet Strategy. It is vital for the supply of gas to our customers that NGT compressors remain available and resilient to the demands and changes on the NTS as a whole and investment in our compressor cab infrastructure is essential to ensuring this availability is not compromised.

12.3.13 The level of investment outlined in this paper will ensure NGT successfully manages asset deterioration and obsolescence, whilst meeting legal obligations and expected customer outcomes.

## 12.4 Network Risk Analysis Based on Proposed Work

12.4.1 The Cab infrastructure theme is unique in that the vast majority of UIDs are in the A3 NARMs category [1]as the assets have a monetised risk but are not directly consequential for the movement of Gas across the network. They are instead supporting assets whose primary purpose is to move Gas around the network. All the UIDs proposed in this submission are in either in the A3 pot or are Non-NARM (i.e., [redacted]). All UIDs in the A3 pot deliver Long Term Risk Benefit (LTRB), but this is the not the primary driver for intervention and the structure of the A3 is such that LTRB is not the method of performance assessment.

12.4.2 LTRB for the proposed interventions will be reported in FY23's NARMs RRP as part of the forecast position, as the interventions are yet to happen. As expressed in the UM overarching document, the target adjustment for NGT is proposed to happen after the submission of the final UM.

12.4.3 For the Asset Health reopener Ofgem have proposed a single NARM update at the end of the reopener process.

[1] A3 – Ring-fenced Project/Activity: this is work that will deliver Network Risk Outputs, but which is not within the scope of the NARM Funding Adjustment and Penalty Mechanism. The Network Risk Output associated with this work will not contribute to a company's final ONRO

# 13 Preferred Option Scope and Project Plan

## 13.1 Preferred option

13.1.1 The preferred options for each of the Cabs, covering the RIIO-2 period, is presented in Table 58. The key benefit of all the selected interventions is that the customer is at lower risk of not receiving energy as and when they need it. The interventions are balanced between refurbishment and replacement resulting from robust condition-based assessment. Forty-nine UID interventions are in scope (completed and inflight) for years 1 to 3 and [redacted] UID interventions have been identified for years 4 and 5.

*Table 58: Preferred Options for each Cab across RIIO-2*

| Funding | [redacted] |
|---|---|
| Baseline Funded (yr.1 to 3) | [redacted] |
| Uncertainty Mechanism Funded (Yrs. | [redacted] |
| | [redacted] |
| | [redacted] |

## 13.2 Cabs Asset Health Spend Profile

13.2.1 For Cabs related interventions detailed Design and Build (DD&B) are completed in the same year. *Table 59* summarises the spend profile detailing when the selected interventions for each selected set of options, has been completed or is expected to take place. This cost includes the survey and options assessment activities conducted in determining interventions and costs. There are some preparatory activities, such as survey and feasibility leading up to actual interventions that have resulted in costs incurred to date and this is summarised in Table 59.

13.2.2 Included in Table 59 are the costs incurred and forecast for activities completed and forecast to be complete in years 1 to 3.

*Table 59: Overall Cabs Estimated Spend Profile for RIIO-2 (£m) - 18/19 price base*

| Description | 2021/22 Yr 1 | 2022/23 Yr2 | 2023/24 Yr 3 | 2024/25 Yr 4 | 2025/26 Yr 5 | Totals |
|---|---|---|---|---|---|---|
| Baseline Interventions (yrs. 1-3) | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Years 4&5 prep works (surveys, CDPs assessments) | [redacted] | [redacted] | [redacted] | | [redacted] | [redacted] |
| Years 4&5interventions | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| **Totals** | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | **39.446** |

## 13.3 Efficient Cost

13.3.1 NGT costs are based on current assumptions made as a result of its experience of completing similar asset health interventions in the first two years of RIIO-2. The identified asset health interventions will adopt learning from ongoing intervention projects covering items such as contracting strategy, surveys, bundling etc.

13.3.2 The following key points have guided NGT's cost efficiency:

- Defect data, surveys outputs and CDPs driving a very detailed set of cab specific scopes that reduce scope creep resulting in a reduction in compensation events and enable efficient procurement and cost control during delivery
- Option selection being guided by relevant specific drivers such as legislation, environment, HSE guidance, safety, asset condition, etc.
- A consistent cost estimation approach following a strict hierarchy cascading in order of confidence from outturn costs, through competitive tendered prices to in-house 1s principles cost estimation. This approach ensures consistency and enables the team to focus efforts on high-cost activities, during procurement and negotiation stages.
- Efficiencies due to bundling and contracting strategies, have already been realised and are embedded in the out-turn cost data of completed activities in RIIO 2 used to estimate the activities within the UMs.
- Structured approach to estimating costs by capturing actual cost to the appropriate level of granularity at asset and intervention levels through contractual Unit Cost Schedules populated by all external contractors.
- Use of external contractors to provide independent scopes and costs for validation by NGT.

- Negotiating volume discounts and additional 'value add' services, such as free training or call-out support.
- Bundling works into different packages of work therefore creating lessons learned and best practise for how to maximise efficiencies at tender and what to include in a package contract to aid smooth delivery.
- Consideration of in-house delivery of works where appropriate.
- Utilising innovation to reduce cost e.g., remote monitoring and air filtration.

## 13.4 Project Plan

13.4.1 The milestones are based on NGT's current view of when each cab will be intervened on. NGT has also considered wider works planned across the NTS. Internal stakeholder engagement has identified the best time to undertake these interventions, so the milestones are based on this timescale. Table 60 is NGT's summary plan and provisional internal sanction milestones identified to deliver the cab infrastructure and fires suppression interventions within RIIO-2.

13.4.2 The project plan has been aligned to currently planned system outages.

*Table 60: Summary Project Plan and Provisional Sanction Dates*

| Network Development Stage Gates | Original Sanction Dates | Latest Sanction Forecast Dates | Actual Completion Date |
|---|---|---|---|
| T0 | Completed | Completed | Completed |
| T1 | Completed | Completed | Completed |
| F1 (Scope Establishment) | Completed | Completed | Completed |
| T2 | Completed | Completed | Completed |
| F2 (Option Selection) | Completed | Completed | Completed |
| T3 | June 2023 | June 2023 | April 2023 |
| F3 (Conceptual Design Dev/Long Lead Items) | May 2023 | May 2023 | May 2023 |
| T4 | December 2023 | December 2023 | TBC |
| F4 (Execute Project) | December 2023 | December 2023 | TBC |
| T5 | May 2024 | May 2024 | TBC |
| ACL (Available for Commercial Load) | October 2025 | October 2025 | TBC |
| T6 | September 2026 | September 2026 | TBC |
| F5 (Reconcile and Closure) | February 2027 | February 2027 | TBC |

## 13.5 Key Business Risks and Opportunities

13.5.1 All cabs identified for intervention are in line with NGT's Needs Case and future strategy of keeping gas flowing in the interests of consumers. Key risks and currently identified mitigations are summarised in Table 61. These risks have been extracted from the costed risk register in the cost book contained in Appendix 2.

*Table 61: Cabs and Fire Suppression key risks and identified mitigations (extracted from costed risk register)*

| No. | Risk | Mitigation (based on current view) |
|---|---|---|
| 1 | There is a risk of additional software requirements and associated verification / validation for integrating the F&G system with the new electric pump system and site engineering workstation | Early intervention with Schneider/Siemens/ ITI to confirm PLC Logic Requirements for electric pump system Interface |
| 2 | There is a risk of diluted operational resource support due to a number of concurrent projects running on site | Close engagement with Operations and frequent meetings to ascertain resource requirements. |
| 3 | There is a risk of buried services being identified during excavation | Check data banks and internal desktop review but ensure GPR & underground surveys are completed in areas of the works as assurance to de-risk |
| 4 | There is a risk of additional scope requirements (including mechanical, design & civil) leading to scope change / scope creep | Close engagement with contractor and site operations. Detailed surveys to ensure no additional works required |
| 5 | There is a risk of outage cancellation (prior, during or post mobilisation) | Communication with Portfolio Planning team to understand projects scheduled during this period. |
| 6 | There is a risk of weekend working / additional resource required | Regular Programme Reviews required with Operations and Contractor. |
| 7 | There is a risk of increase to materials prices impacting project launch | Project team to work with MWC to make sure that materials are procured in a timely manner and multiple quotes for materials from a number of supplies to ensure value for money |
| 8 | Cost impacts in RIIO-2 such as cost variances between Final Determination unit costs and actual project unit costs. | Development of detailed site-specific scopes and associated unit costs for 2024 and 2025 interventions to inform<br>Tendering projects early (i.e., ahead of UM submissin and final outcome of UM submission) to gain increased confidence in NGT likely intervention costs. |
| 9 | Specialist asbestos contractor being required | Intrusive surveys required where necessary. |
| 10 | Other projects on intervention sites overrunning their schedule. | Close liaison with the other projects to identify potential programme slippages and flex outage arrangements. |

13.5.2 In developing unit costs to progress and complete identified interventions, NGT has considered the following, as key opportunities, to ensure efficiencies:

- Detailed scoping of works to ensure intervention specific works are costed and completed.
- Aligning intervention activities with NTS outage programmes.
- Resource scheduling to ensure efficient and timely delivery.
- Bundling works together on each site where multiple cab interventions are required.
- Bundling of works with other Cabs Asset Health impacted sites, bringing contracting efficiencies.
- Assessed procurement efficiencies through early bulk purchasing.

# 14 RIIO-3 Lookahead

## 14.1 Learning from RIIO-2

14.1.1 To reduce the risk of delayed investment initiation, NGT proposes to undertake, within the RIIO-2 period, surveys, Front-End Engineering Design (FEED) and Campaign Decision Panels (CDPs) to identify potential Asset Health works (excluding St Fergus and Bacton) for the next regulatory period covering the Cab Infrastructure & Fire Suppression themes. This covers cabs/fire suppression and associated infrastructure that were either not surveyed or intervened on in RIIO-2 and ones that are included as part of NGT's rolling asset health programme in RIIO-3. The latest view is that there will be circa [redacted] Cabs to survey.

14.1.2 Through this submission NGT is requesting funding to complete these proposed surveys and associated assessments. The key driver for this is to be prepared for the start of RIIO-3 with the added benefit of efficient use of resource.

## 14.2 Cab Infrastructure and Fire Suppression Current View

14.2.1 NGT's current view of identified Compressor Stations and associated cab infrastructure and fire suppression assets targeted for survey within RIIO-2, to inform the initial RIIO-3 years of work is summarised in Table 62 and Table 63. The survey and FEED cost for the [redacted] RIIO-3 cabs and associated fire suppression assets are consistent with the costs associated with the [redacted] RIIO-2 years 4 and 5 cab infrastructure and fire suppression assets. Though the activities and costs span RIIO-2 and RIIO-3 the costs presented in this paper are for the RIIO-2 only element of these activities. Cost phasing is indicative and any rephasing will be assessed as the survey and FEED programme progresses.

*Table 62: Cabs identified for survey and FEED*

| RIIO-3 (2026 – 2031) Cabs Planned for Interventions<br>To survey in RIIO-2<br>Cab names are in no particular order | |
|---|---|
| [redacted] | |
| Costs include those for Survey, CDP and FEED | |

*Table 63: Current view of funding request for RIIO-3 focused surveys*

| Sub Activity | Total Request (£m) |
|---|---|
| Surveys and FEED to identify RIIO-3 cab infrastructure and fire suppression interventions. Note that this is only for those activities in RIIO-2. RIIO-3 survey, and FEED activities/costs have not been included in this table. | [redacted] |
| **Total (Survey and FEED for the RIIO-2 period to inform RIIO-3 interventions)** | [redacted] |

# 15 Conclusion

15.1.1 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-2 Re-opener Guidance and Application Requirements Document.

15.1.2 This paper has explained the Needs Case, options considered and presented NGT's preferred options and associated requested funding to ensure NGT's cab infrastructure and fire suppression assets operate to meet customer requirements. Ofgem are invited to assess and approve this funding request.

15.1.3 NGT proposes that the volumes and costs within the Asset Health Non-Lead Assets PCD Tables are updated to reflect the year 1 to 5 funding request of £39.446m, within this EJP as shown in Table 64.

*Table 64: Cab Infrastructure and Fire Suppression RIIO-2 Asset Health -Non-Lead Assets PCD Tables*

| UID | Description / Intervention | RIIO-2 UID Volumes | | | Cost (£m) | | | In Scope of AH UM |
|---|---|---|---|---|---|---|---|---|
| | | Yrs.1-3 | Yrs.4& 5 | Total | Yrs.1-3 | Yrs.4& 5 | Total | |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | Yes |
| | **Totals** | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | 39.446 | |

15.1.4 The total RIIO-2 spend is £42.041m as summarised in Table 65. Baseline funding of £12.191m was awarded. Therefore, though the total RIIO-2 spend is £42.041m the total funding request being made through this paper is **£29.850m**.

*Table 65: Summary funding request*

| **Description** | | | **Totals (£m)** |
|---|---|---|---|
| Baseline Interventions (yrs. 1-3) | ***Baseline Breakdown*** | | [redacted] |
| | *Actual spend* | [redacted] | |
| | *Awarded FD spend* | *12.191* | |
| | *Actual - Awarded* | [redacted] | |
| Years 4&5interventions | | | [redacted] |
| Cab Infrastructure and Fire Suppression RIIO-2 Surveys and FEED activities to identify RIIO-3 cab infrastructure and fire suppression interventions. | | | [redacted] |
| **Total RIIO-2 spend** | | | **42.041** |
| **Awarded baseline spend** | | | **12.191** |
| **Funding request being made through this paper** | | | **29.850** |

# Appendices

# Appendix 1: Cabs Survey Reports and Supporting Information

## Appendix 2: Cost Books

Appendix 2-1: Overarching Summary (Cabs & P&E)

Appendix 2-2: Cabs UM Costbook Final

Appendix 2-3: RIIO-3 Cabs - Surveys and FEED Cost Book FINAL