nationalgrid

King's Lynn MCPD Compressor Emissions

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ABBREVIATIONS & GLOSSARY

Unless otherwise stated in this document, capitalised terms that appear in this document have the meaning given to them in the following table.

AC	Alternating Current
BAT	Best Available Technology
BBL	Balgzand Bacton Line
CAB	Compressor Acoustic Building
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CSRP	Control System Restricted Performance
DC	Direct Current
DLE	Dry Low Emissions
ESD	Emergency Shutdown
EU	European Union
EUD	Emergency Use Derogation
FEED	Front End Engineering Design
GG	Gas Generator
IUK	Interconnector UK
LNG	Liquified Natural Gas
LV	Low Voltage
MCPD	Medium Combustion Plant Directive
NRV	Non-Return Valve
NTS	National Transmission System
OEM	Original Equipment Manufacturer
PRA	Pressure Reduction Area
PT	Power Turbine
RIIO	Revenue = Incentives + Innovation + Outputs
RIIO-T2	Second RIIO Transmission Price Control Period – From 2021 to 2026
SCR	Selective Catalytic Reduction

Executive Summary

As part of the option selection process for the King's Lynn MCPD project, eight (8) emissions compliance options are under review. These options involve various combinations of the following solutions:

- Installation of one or two new emissions compliant gas turbine driven compressors and ceasing operation of the non-compliant Avon gas turbines from 1 January 2030
- Retaining one Avon driven compressor under limited 500 hour per year emergency use derogation
- Retaining one Avon driven compressor with the power restricted such that emissions cannot exceed emissions limit values stipulated in MCPD (referred to as Control System Restricted Performance – CSRP)
- Retaining one Avon driven compressor with upgraded Dry Low Emission (DLE) combustion system.
- Retaining one Avon driven compressor with emissions abatement provided via selective catalytic reduction (SCR)
- Decommission the Avon driven compressor

Each of the above options will require different levels of initial asset health investment to ensure reliable ongoing operation as summarised in Table 1. A conservative approach has been taken to define the minimum required initial investment taking into consideration works already funded in RIIO-T2 under separate investment themes. This report provides an overview of each scope item with detail on how the scope has been determined.

CAPEX estimates for initial and ongoing asset health scope are based on the RIIO-T2 unit cost schedule where applicable per the unit cost ID references in Table 1. The RIIO-T2 plan assumed two new units would be installed for MCPD compliance and the Avon decommissioned by 2030. Therefore, for this option no additional spend above approved RIIO-T2 funding has been included for MCPD as shown in Table 1. There is no planned investment in RIIO-T2 that can be de-scoped under any MCPD compliance option.

In addition to the CAPEX investment proposed for Avon, further CAPEX investment is proposed to re-wheel King's Lynn SGT400 units (C & D). This modification resolves inefficient compressor wheeling for units C & D, this will result in reduced reliance on parallel operation. This upgrade is proposed for all options under consideration.

Asset health interventions beyond 2030 have been determined based on existing maintenance philosophies and approximate forecast run-hours for each option. A similar approach has been applied for new units included in the various new build options. Due to the age of the Avon compressor machinery trains and associated equipment, much of which is beyond its original design life, an increased failure rate should be expected. This is reflected in the intervention frequency for Avons compared with new units.

Table 1 - Initial Asset Health Scope

	Unit Cost ID	Pre-2030 Investment					Intervention Frequency (Post 2030)	
		500 hour	CSRP	1533 DLE	1533 SCR	2030 Decom	Avon	New Unit
Control								
Unit control system	N/A[1]	✓	✓	✓	✓	×	15 years	
Fire and Gas Detection	N/A[1]	✓	✓	✓	✓	×	15 years	
Anti-Surge System	N/A[1]	✓	✓	✓	✓	×	15 years	
Electrical								
Distribution Boards	[redacted]	✓	✓	✓	✓	×	15 years	
Auxiliary Equipment	[redacted]	✓	✓	✓	✓	×	15 years	
LV Switchboards	[redacted]	✓	✓	✓	✓	×	15 years	
Rotating Equipment								
Gas Generator - overhaul	[redacted]	×	×	×	×	×	10 years[3]	15 years
Power turbine	[redacted]	×	×	×	×	×	10 years[3]	15 years
Compressor Impeller Refurb	[redacted]	×	×	×	×	×	30 years	40 years
Compressor – gas seal	[redacted]	×	×	×	×	×	10 years	
Upgrade dry gas seal	N/A	×	✓	✓	✓	×	N/A	
Cab								
Building - CAB (Major)	[redacted]	×	×	×	×	×	40 years	
Building - CAB (Minor)	[redacted]	×	×	×	×	×	10 years	
CAB Ventilation (Major)	[redacted]	✓	✓	✓	✓	×	10 years	40 years
CAB ventilation (Minor)	[redacted]	×	×	×	×	×	5 years	20 years
Air intake (Major)	[redacted]	✓	✓	✓	✓	×	15 years	25 years
Air intake (Minor)	[redacted]	×	×	×	×	×	10 years	
Exhausts (Major/Replace)	[redacted]	✓	✓	✓	×	×	25 years	
Exhausts (Minor)	[redacted]	×	×	×	×	×	5 years	20 years
Piping & Valves								
Unit Isolation Valves	[redacted]	✓	✓	✓	✓	×	40 years	
Non-Return Valves	[redacted]	✓	✓	✓	✓	×	40 years	
Other Ancillary Systems								
Fuel Gas Skid	[redacted]	✓	✓	✓	✓	×	10 years	20 years
Oil System (GG, PT, Comp)	[redacted]	✓	✓	✓	✓	×	10 years	40 years
Fire Suppression	[redacted]	✓	✓	✓	✓	×	25 years	30 years

Note 1) Cost based on RIIO-T2 Plan Annex 15.07 – Cyber Resilience Plan

Note 2) Approved RIIO-T2 funded scope excluded

Note 3) Intervention frequency of 20 years for 500-hour EUD

As shown in Table 1, there is minimal investment planned for existing Avon driven compressor trains in options where they will be decommissioned and replaced with new units prior to 2030. This is consistent with the RIIO-T2 asset health plan which was based on installation of two new units and decommissioning of Unit A & B in the King's Lynn MCPD T2 investment plan (Reference 5).

1. Introduction

1.1. Site Background

King's Lynn Compressor Station performs a critical role on the National Transmission System (NTS), it is used to resolve supply-demand imbalances in the South-East. This is a unique area on the network, including the bi-directional interconnectors (IUK and BBL) at Bacton and the Liquified Natural Gas (LNG) importation facility at Isle of Grain.

In its current configuration King's Lynn is a bi-directional compressor station that comprises two (2) Rolls Royce (now Siemens) Avon MK1533 gas turbine driven compressor units (referred to as Units A and B) and two (2) Siemens SGT400 gas turbine driven compressor units (referred to as Units C and D). Units C and D are the lead units which may be operated in single or parallel operation according to the flow levels required. Unit B provides resilience to Units C and D. Unit A was disconnected in 2017 after becoming life expired, it was no longer economical to continue investing in for current and future requirements. The operating Avon unit is not compliant with the MCPD and therefore, a solution to the future operating restrictions is required prior to the compliance date of 1 January 2030.

1.2. King's Lynn MCPD Shortlisted Options

Eight (8) options have been shortlisted for preliminary review via Cost Benefit Analysis (CBA) and Best Available Technology (BAT) assessment as summarised in Table 2~~Table 2~~. CAPEX estimates at ±30% certainty have been developed for each of the shortlisted options which will be used in CBA and BAT assessments to support the selection of a single preferred option.

Table 2 - Shortlisted Options

Option	Description	Unit B	Unit E (Future)	Unit F (Future)
1	Counterfactual	500Hr EUD	/	/
2	1 x CSRP	CSRP Retrofit	/	/
3	1 x SCR	Avon 1533 SCR Retrofit	/	/
4	1 x 1533 DLE	1533 DLE Retrofit	/	/
5	New GT	Decommission	New GT (Brownfield)	/
6	2 x New GT	Decommission	New GT (Brownfield)	New GT (Brownfield)
7	1 x New GT + 500 Hr EUD	500Hr EUD	New GT (Brownfield)	/
8	Decommission	Decommission	/	/

Note 1) Unit A to be decommissioned for all options
Note 2) All options include re-wheel of units C&D

Option 6 involves installation of two new units and ceasing operation of the Avon unit by 1 January 2030 prior to decommissioning. Option 6 was identified as the preferred MCPD emissions compliance option in the 2019 RIIO-T2 business plan and therefore forms the basis of the RIIO-T2 asset health plans developed at the time. The asset health expenditure included in the CBA for this option is

consistent with funding allowances confirmed in the final determinations of the 2019 RIIO-T2 asset health plan. This similarly also applies to option 5 .

Options 1 to 4 and 7 involve the retention of the Avon unit (Unit B) which will require asset health spend beyond 2030. In these options additional asset health expenditure for Unit B which is not covered by RIIO-T2 asset health funding has been identified as summarised in this document and is included in the King's Lynn MCPD CAPEX estimates and CBA.

1.3. Document Purpose

The purpose of this document is to define the scope of asset health investment required on Unit B and associated assets to be retained in each of the shortlisted MCPD investment options. Asset Health works that are already funded in RIIO-T2 will be identified and excluded from MCPD cost estimates, CBA, and BAT assessment.

Funding mechanisms for various elements of scope are not discussed in this document but it is acknowledged that not all scope described herein will be included in the subsequent MCPD cost re-opener. Funding mechanisms will be confirmed once the MCPD option has been selected.

2. Control & Instrumentation

The control, protection and fire and gas systems at King's Lynn are obsolete. The control systems for the Station, Unit C and Unit D are being replaced under RIIO-T2 Control System Cyber and Asset Health funding. FEED is due to start in 2024, with detailed design in 2025 and site works in 2026. Detailed design and execution phases for Unit B is currently not included in the current control system replacement at King's Lynn.

Control system scope including the following has been included in the initial CAPEX for options that involve retaining Unit B beyond 2030:

- Replacement unit control system including all field instruments and cabling between instruments and unit control panel and all cabling between unit control panel and station control system
- Replacement anti-surge system including control system interface, valves and actuators (excludes piping)
- Replacement fire and gas system including all sensors/detectors and cabling

New units will be installed with new control systems which will tie into the new station control system installed as part of the control system cyber and asset health project. Similar scope to the above is included for all options every 15 years which is the typical design life of control systems and aligned with National Grid procedure T/PM/COMP/20.

3. Piping and Valves

The compressor suction and discharge piping between the compressor nozzle and the common header runs below grade in pits. The existing compressor header pipework was modified in 2020 to mechanically disconnect two decommissioned Avon units, this involved removal of unit isolation and non-return valves and installation of pipe spools to pipe-through the compressor header pipework. Other works included capping off the actuating gas supply lines, vent lines and lube oil lines for decommissioned Avon units.

Unit B isolation is provided by a 750NB remotely operated ESD valve and a 750NB manually operated ball valve on the suction and discharge lines. There is also a 750NB non-return valve on the discharge side of each unit downstream of the ESD and manual isolation valves. Anti-surge protection is provided by a 250NB control valve.

These valves and associated pipework have not received any recent refurbishment and are observed to be in poor condition. It has been assumed that replacement of the isolation, non-return and anti-surge valves are required prior to 2030. Replacement is assumed for any option that retains Unit B, this is included in the CAPEX estimate and are based on RIIO-T2 unit costs.

Future overhauls beyond 2030 have been included based on an intervention frequency of 40 years for isolation valves and 15 years for anti-surge systems. Future interventions of non-return valves have not been included due to the long 40-year intervention period, which extends beyond the expected extended life of the Avon Unit B.

4. Compressor Power Train

A summary of the Unit B gas generator power train assets currently installed at King's Lynn compressor station is shown in the table below.

Table 3 – King's Lynn Avon Compressor Train Assets

Asset	Unit	B
Gas Generator	Manufacturer	Siemens (Formerly Rolls Royce)
	Model	Avon 1533-75G
	Year	1973
	Rated Power	12.34 MW
Power Turbine	Manufacturer	Siemens (Formerly GEC)
	Model	EAS-I33
Compressor	Manufacturer	Siemens (Formerly De Laval)
	Model	PV30/30
Gas Seal	Manufacturer	Kaydon
	Model	101748 face seal
	Type	Seal Oil System
Starter	Type	Electric

The compressor train assets are maintained and overhauled according to the duty they have undertaken (run hours and number of starts and stops). The levels of duty are set by the manufacturers and are accepted best practice across the EU. These overhauls ensure that compression assets remain supported by the manufacturer and continue to operate safely and at an acceptable level of reliability and availability.

The overhaul of a gas generator, power turbine or compressor typically takes 13 to 26 weeks and involves isolation and removal of the equipment from site before inspection and refurbishment can be undertaken in the factory. National Grid has framework agreements with licensed and independent service providers to undertake these rotating machinery overhauls. Due to the age of the equipment, the availability of spare parts and ongoing OEM support has been identified as a risk for retrofit options which retain the Avon power train until 2050.

4.1. Gas Generator

Unit B gas generator and power turbine are due to be overhauled in 2022 / 2023 as part of the RIIO-T2 business plan. There are no planned upgrades as part of these works. No overhauls have been included in the CAPEX estimate. Options which involve replacement of the existing combustion system with a Dry Low Emission (DLE) system will utilise a spare gas generator, therefore a gas generator overhaul has not been included for Avon 1533 DLE options.

Future overhauls beyond 2030 have been included based on an intervention frequency of 10 years for Avons with unlimited run hours and 15 years for new units. For Avon options involving 500-hour emergency use derogation an increased intervention period of 20 years has been assumed to account for the reduced run hours per annum.

Due to the age of the existing equipment, it is likely that the scope and cost of refurbishment and repairs will increase in the future due to ongoing degradation and limited spares availability. This has not been accounted for in CAPEX estimates which are based on RIIO-T2 unit costs.

4.2. Power Turbine

Power turbines are standard items of equipment designed for individual gas generator models and applications. Although not operating at conditions that are as arduous as those in the gas generator, still require regular overhaul to maintain their integrity.

Power turbines are bespoke items of equipment tailored to the individual gas generator and compressor application. The EAS-133 power turbines at King's Lynn are no longer supported by the original OEM and spare parts can take up to 52 weeks to source as they often need to be manufactured to order.

Unit B power turbine is due to be overhauled summer 2022 and it is anticipated that, based on projected run hours, the next overhaul will be required in 2033. For options where the existing Avons will be replaced with new units this cost is excluded.

Based on forecast run hours, subsequent refurbishment is forecast for 2033 and then again in 2043. For options where the Avon will be retained under a 500 hour per year emergency use derogation the time between overhauls will be increased due to fewer run hours per annum and the overhaul in 2038 is not anticipated to be required. The CAPEX estimate for these overhauls is based on the RIIO-T2 unit cost schedule.

4.3. Compressor

Overhaul of the compressor impeller for the existing Avon has been included for in the CAPEX estimate for MCPD in 2043 based on a 30-year intervention frequency.

For new units an intervention frequency of 40 years has been assumed meaning no overhaul will be required prior to 2050.

Due to inefficient compressor wheeling for Units C & D, it is proposed (Ref. 6) to include re-wheel the SGT400 units to match the compressor envelope to the site process duty points. The CAPEX estimate includes the costs for this upgrade for all options. Subsequent intervention would not be required until after 2050, therefore no further costs are assumed in the cost estimate.

4.4. Seals

The Avon unit is currently configured with a mechanical seal oil system. This system is prone to leaks and ancillary equipment is beyond its design life. Components are obsolete and replacements are no longer available. The initial CAPEX estimate includes upgrades to a 'zero loss' dry gas seal for all options that retain the Avon unit except for the 500-hour EUD.

Future overhauls beyond 2030 have been included based on an intervention frequency of 10 years for dry gas seals and for original seal oil systems.

4.5. Starter Motor

Electric and hydraulic starter motors do not have a service interval and aren't expected to fail within the lifetime of a compressor unit. Starter motor costs are currently included within the Fleet Management costs for Gas Generator Assets and no costs have been included in the MCPD cost estimate for these assets.

5. Fuel Gas System

Process gas is taken from either in-station supply to the PRA (Pressure Reduction Area), Unit B has a standalone PRA and Unit C and D use a common skid. The fuel gas for all units passes through filtration before passing through a common fuel gas heater skid which consists of an electric heater and lube oil heat exchanger that utilises waste heat from Unit C and D lubricating oil. The flow is then piped from the PRA through a flowmeter to the dedicated fuel gas packages at the unit where flow to the gas generator is governed by the control system. A fuel gas analyser for each unit is also located on the unit fuel gas package.

The current configuration on Unit B's PRA does not comply with National Grid's current specification. To remain compliant a further pressure control valve is required in-series with the existing valve on each stream of the PRA. This has been included in the CAPEX costs for options that retain the Avon unit to comply with National Grid's safety requirements.

National Grid has an internal process safety action to ensure compliance with OEM service bulletins which state that fuel gas should be filtered to 5 microns and heated to 20°C above the dew point of the gas. The current set up at King's Lynn doesn't achieve this, so dedicated unit fuel gas conditioning skids are included in this CAPEX estimate for options that retain the Avon beyond 2030.

6. Oil System

Lube oil is supplied to Unit B compressor and power turbine from a common tank via three (3). pumps, one (1) primary pump driven by the power turbine and two (2) standby pumps (one (1) AC driven and one (1) DC driven) These pumps and associated electric motors are obsolete and spare parts are no longer available. Replacement has therefore been included in the scope for options involving the retention of the Avon beyond 2030.

There are also leaks within the oil system and inspection and repair of associated pipework is therefore included in the CAPEX estimate for the options retaining the Avon.

7. Compressor CAB

The Compressor Acoustic Building (CAB) Infrastructure assets are secondary assets but fundamental to ensure safe operation of the compressor train and compliance with environmental permits and safety legislation. Faults and degradation on these secondary assets will impact upon the availability of the compressor train due to inherent process safety risks. The CABs must therefore be maintained to ensure compressor train availability, preventing atmospheric conditions that could escalate to an explosion.

Compressor CABs are an essential element of our legal compliance with PM84 HSE / ISO21789 Control of Risk around Compressor Train Enclosures. They are also instrumental in maintaining our compliance with environmental legislation and permits regarding noise and exhaust emissions.

7.1. Building Structure

A major structural overhaul is expected to be carried out every 40 years on average. The last major overhaul on the compressor CAB was carried out in 2014 and due to the good condition of the King's Lynn units the CAPEX estimate assumes the major overhaul is not required until 2048. Major overhaul typically includes; relaying the roof membrane; replacing corroded acoustic and aesthetic panels; replacing and repairing ladders and platforms, and replacing or repairing doors.

After 2030 similar minor CAB structure overhauls have been assumed every 10 years. These overhauls will include; replacing some corroded acoustic panels; repairing some door seals that have failed; and sealing some holes that are affecting the performance of the ventilation system.

7.2. Fire Suppression

Fire suppression in Unit B CAB is provided by a HI-FOG water mist system utilising bottled nitrogen. Options which retain the existing Avon include replacement of fire suppression with an electric pump driven system which will remove the need for manual handling of nitrogen bottles which need to be replaced every time the fire suppression system is activated, thus reducing risk to personnel.

7.3. Gas Generator Air Intake

Air intake minor overhaul typically consists of replacing air filters, repairing corrosion, or replacing blow in door seals. Minor overhauls every 10 years have been included for new and existing assets.

Air intake major overhaul typically consists of a combination of the items listed in the minor overhaul and could also include an anti-icing system upgrade or installation of a second stage of filtration if the unit only has one stage. For existing assets, major overhaul has been included every 15 years. and for a new unit every 25 years. A major overhaul of the gas generator air intake has been included for all options that seek to retain Unit B beyond 2030.

7.4. Gas Generator Exhaust

No exhaust investment is included in RIIO-T2 because the latest condition survey identified no deterioration that is likely to require investment in the next 5 years. Exhausts are surveyed every 5 years to check external and internal corrosion, structure, joints and fasteners, and insulation.

A minor exhaust overhaul would typically consist of repairing cracks, replacing the expansion joint or bellows, or replacing failed gaskets. For existing assets, a minor overhaul is required every 5 years and for new units every 20 years.

A major exhaust overhaul would typically consist of replacing the internal lining and insulation in an exhaust, or a combination of the interventions listed in the minor overhaul section. A major exhaust overhaul will be required every 25 years for new and existing units. A major overhaul of the gas generator exhaust has been included for all options that seek to retain unit B beyond 2030.

Options that modify unit B with a SCR retrofit does not require overhaul to the Gas Generator Exhaust since the entire exhaust is replaced with the SCR unit.

7.5. CAB Ventilation

CAB ventilation systems to provide suitable airflow through the enclosure to remove the heat lost from the gas generator and compressor, 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 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.

Minor overhaul of the ventilation system typically consists for localised repair of corrosion, cracking and failing seals, replacement individual elements and components. For existing assets, a minor overhaul is required every 5 years and for new units every 20 years.

A major overhaul includes repairs described in a minor overhaul and also typically involves replacing failing components and iterative improvements to air flow to resolve stagnant areas through limited redesign of the system. A major ventilation overhaul will be required every 40 years for new and 10 years for existing units. A major overhaul of the gas generator ventilation has been included for all options that seek to retain unit B beyond 2030.

8. Electrical

LV Switchboards are the first stage of power distribution following the main site supply transformer. Usually for a compressor station or large terminal there will be a main LV switchboard, a general services switchboard and unit switchboards/motor control centres. The quantity per site will vary depending on the number of compressors installed.

They are of metal clad construction with a fault rated busbar system and individual incoming and outgoing circuit breakers and/or fuse-switches plus control and instrumentation equipment as required. The boards can be either AC or DC – where the DC are fed from battery chargers for standby power/emergency back-up use. The switchboards form the first part of the LV distribution system which then feeds via electrical cables to various types of equipment and smaller distribution boards.

Switchboards, distribution boards and auxiliary equipment degrades over time and causes faults and trips. For options where the Avon units are to be retained the related LV electrical equipment will be replaced as part of the initial asset health modifications. Replacement of this equipment is included in the CBA every 15 years for new and retrofit options.

9. Decommissioning

Unit A has not been used since 2017 and has been isolated from gas and electrical supplies. Decommissioning costs for Unit A has been included the CAPEX estimate for all options. In addition, options 5, 6 and 8 include decommissioning costs for Unit B in the CAPEX estimate.

10. Other Station Assets

Assets which support the operation of the compressor station as a whole and are not dedicated to Unit B have not been reviewed as part of the MCPD project. These assets will be reviewed as part of the relevant asset health investment projects. Assets which have been excluded from assessment as part of the MCPD project include but are not limited to the following:

- Station inlet/outlet piping
- Above Ground Installation (AGI) / Multijunction Piping and equipment
- Compressed air
- Power actuating gas
- Nitrogen generation
- Towns water
- Site Drainage System
- Standby Power
- Uninterruptable Power Supply (UPS)
- Site Lighting
- Unit and station vent system
- Integrated Site Security
- Firewater ring main
- Cathodic Protection
- Scrubbers
- Pressure reduction area

11. Conclusions and Recommendations

For the new unit options (Options 5, 6 and 7) no initial asset health spend is required as any works required prior to decommissioning of the Avons in 2030 is already funded in the RIIO-T2 asset health plan. This RIIO-T2 funded work on Unit B includes:

- Overhaul of Unit B Gas Generator and Power Turbine
- Fuel gas metering and gas quality upgrades

Options in which the unit B Avon is retained beyond 2030 include some additional initial CAPEX for asset health works required prior to 2030 but not currently funded in the RIIO-T2 plan. This scope is listed in Table 4~~Table 4~~. Cost for this work is based on either RIIO-T2 unit costs, where available, or supplier quotations. A detailed breakdown of the cost estimates and associated estimating methodology is described in the FOSR.

For all options post-2030, CAPEX has been included to cover estimated asset health works required to ensure the safe and reliable asset operation to 2050 for existing assets to be retained and new assets to be installed as part of the MCPD project. This ongoing CAPEX is estimated using the same basis as initial spend (i.e. RIIO-T2 Unit Costs and supplier quotations). Intervention frequencies for new and existing assets are based on; legislative and industry standards; OEM guidance; National Grid policies, procedures and specifications, and previous inspection and survey results from similar NTS assets. To account for the age of existing assets, many of which are beyond their original design life, shorter intervention frequencies have been assumed than for new equipment in some instances.

Table 4 - Summary of Asset Health CAPEX

	Unit Cost ID	Pre-2030 Investment					Intervention Frequency (Post 2030)	
		500 hour	CSRP	1533 DLE	1533 SCR	2030 Decom	Avon	New Unit
Control								
Unit control system	N/A[1]	✓	✓	✓	✓	×	15 years	
Fire and Gas Detection	N/A[1]	✓	✓	✓	✓	×	15 years	
Anti-Surge System	N/A[1]	✓	✓	✓	✓	×	15 years	
Electrical								
Distribution Boards	[redacted]	✓	✓	✓	✓	×	15 years	
Auxiliary Equipment	[redacted]	✓	✓	✓	✓	×	15 years	
LV Switchboards	[redacted]	✓	✓	✓	✓	×	15 years	
Rotating Equipment								
Gas Generator - overhaul	[redacted]	×	×	×	×	×	10 years[3]	15 years
Power turbine	[redacted]	×	×	×	×	×	10 years[3]	15 years
Compressor Impeller Refurb	[redacted]	×	×	×	×	×	30 years	40 years
Compressor – gas seal	[redacted]	×	×	×	×	×	10 years	
Upgrade dry gas seal	N/A	×	✓	✓	✓	×	N/A	
Cab								
Building - CAB (Major)	[redacted]	×	×	×	×	×	40 years	
Building - CAB (Minor)	[redacted]	×	×	×	×	×	10 years	
CAB Ventilation (Major)	[redacted]	✓	✓	✓	✓	×	10 years	40 years
CAB ventilation (Minor)	[redacted]	×	×	×	×	×	5 years	20 years
Air intake (Major)	[redacted]	✓	✓	✓	✓	×	15 years	25 years
Air intake (Minor)	[redacted]	×	×	×	×	×	10 years	
Exhausts (Major/Replace)	[redacted]	✓	✓	✓	×	×	25 years	
Exhausts (Minor)	[redacted]	×	×	×	×	×	5 years	20 years
Piping & Valves								
Unit Isolation Valves	[redacted]	✓	✓	✓	✓	×	40 years	
Non-Return Valves	[redacted]	✓	✓	✓	✓	×	40 years	
Other Ancillary Systems								
Fuel Gas Skid	[redacted]	✓	✓	✓	✓	×	10 years	20 years
Oil System (GG, PT, Comp)	[redacted]	✓	✓	✓	✓	×	10 years	40 years
Fire Suppression	[redacted]	✓	✓	✓	✓	×	25 years	30 years

Note 1) Cost based on RIIO-T2 Plan Annex 15.07 – Cyber Resilience Plan

Note 2) Approved RIIO-T2 funded scope excluded

Note 3) Intervention frequency of 20 years for 500-hour EUD

12. References

1. RIIO-T2 Business Plan, Annex A14.08 – CAB Infrastructure Engineering Justification Paper, December 2019
2. RIIO-T2 Business Plan, Annex A14.10 – Compressor Train Engineering Justification Paper, December 2019
3. RIIO-T2 Business Plan, Annex A14.14 – Valves Engineering Justification Paper, December 2019
4. RIIO-T2 Business Plan, Annex A16.08 – Redundant Assets Engineering Justification Paper, December 2019
5. RIIO-T2 Business Plan, Annex A16.14 – King's Lynn Compressor Engineering Justification Paper, December 2020
6. PAC1051190-PSDQ-006, Project Scope Document Query 'Kings Lynn Unit C & D Rewheel', October 2022