nationalgrid

Wormington 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
CAB	Compressor Acoustic Building
CAPEX	Capital Expenditure
CSRP	Control System Restricted Performance
DC	Direct Current
DLE	Dry Low Emissions
ESD	Emergency Shutdown
EUD	Emergency Use Derogation
FEED	Front End Engineering Design
LV	Low Voltage
MCPD	Medium Combustion Plant Directive
NTS	National Transmission System
OEM	Original Equipment Manufacturer
PRA	Pressure Reduction Area
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 Wormington MCPD project ten 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 or both Avon driven compressors under limited 500 hour per year emergency use derogation
- Retaining one or both Avon driven compressors with the power derated such that emissions cannot exceed emissions limit values stipulated in MCPD (referred to as Control System Restricted Performance – CSRP)
- Retaining one or both Avon driven compressors with upgraded Dry Low Emission (DLE) combustion system. Two variants of this option with different power outputs are under consideration (Avon 1535-DLE and Avon 1533-DLE)
- Retaining one or both Avon driven compressors with emissions abatement provided via selective catalytic reduction (SCR)

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 Avons 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.

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. For new units the first interventions are based on operational acceptance in 2028 and for existing assets the first intervention is based on the elapsed time and run-hours since the previous intervention.

Table 1 - Initial Unit A and/or B Asset Health Scope

	Unit Cost ID	Pre-2030 Investment						Intervention Frequency (Post 2030)	
		500 hour	CSRP	1533 DLE	1535 DLE	1535 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	A22.22.4.17	✓	✓	✓	✓	✓	×	15 years	
Auxiliary Equipment	A22.22.4.30	✓	✓	✓	✓	✓	×	15 years	
LV Switchboards	A22.22.4.20	✓	✓	✓	✓	✓	×	15 years	
Rotating Equipment									
Gas Generator - overhaul	A22.10.2.4			✓	✓	✓	×	10 years[3]	15 years
Power turbine	A22.10.2.14	✓	✓	✓	✓	✓	×	10 years[3]	15 years
Compressor Impeller Refurb	A22.10.2.1	×	×	×	×	×	×	30 years	40 years
Compressor - dry gas seal	A22.10.1.3	×	×	×	✓	✓	×	10 years	
Cab									
Building - CAB (Major)	A22.08.1.8	×	×	×	×	×	×	40 years	
Building - CAB (Minor)	A22.08.1.7	×	×	×	×	×	×	10 years	
CAB Ventilation (Major)	A22.08.1.4	×	×	×	×	×	×	10 years	40 years
CAB ventilation (Minor)	A22.08.1.5	×	×	×	×	×	×	5 years	20 years
Air intake (Major)	A22.08.1.3	×	×	×	×	×	×	15 years	25 years
Air intake (Minor)	A22.08.1.2	×	×	×	×	×	×	10 years	
Exhausts (Major/Replace)	A22.08.1.11	×	×	×	×	×	×	25 years	
Exhausts (Minor)	A22.08.1.10	×	×	×	×	×	×	5 years	20 years
Piping & Valves									
Unit Isolation Valves	A22.14.1.22	×	×	×	×	×	×	40 years	
Non-Return Valves	A22.22.6.4	×	×	×	×	×	×	40 years	
Other Ancillary Systems									
Fuel Gas Skid	A22.10.2.1	✓	✓	✓	✓	✓	×	10 years	20 years
Oil System (GG, PT, Comp)	A22.10.1.4	✓	✓	✓	✓	✓	×	10 years	40 years
Fire Suppression	A22.08.2.3	✓	✓	✓	✓	✓	×	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 no 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 Units A and B in the Wormington MCPD T2 investment plan.

1. Introduction

1.1. Site Background

Wormington Compressor Station was originally commissioned in 1990, but since then has been subject to various modifications and upgrades. Notably in 2009 the station underwent modifications as part of the South West Expansion Project to support flows onto the NTS from the Aggregated System Entry Point (ASEP) at Milford Haven Terminal which includes South Hook and Dragon LNG import and storage facilities.

In its current configuration the site can support bi-directional flow and compression is provided by two (2) Rolls Royce (now Siemens) Avon MK1533 gas turbine driven compressor units (referred to as Units A and B) and a Siemens variable speed drive electrically driven compressor unit (Referred to as Unit C). Units A and B were commissioned in 1990/91 and, due to their age, obsolescence issues and reliability are becoming a significant challenge. The VSD (unit C) was commissioned in 2009 as part of the South West Expansion Project and is the lead unit on site. Units A and B are utilised either when Unit C is unavailable due to planned or unplanned outages or when the flow through the site exceeds the capacity of Unit C, typically when flow from Milford Haven ASEP is high and demand in South Wales is low.

1.2. Wormington MCPD Shortlisted Options

Ten options have been shortlisted for review via CBA and BAT assessment as summarised in 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 A	Unit B	Unit C	Unit D (Future)	Unit E (Future)
1	Counterfactual	500Hr EUD	500Hr EUD	No Change	/	/
2	2 x CSRP	CSRP Retrofit	CSRP Retrofit	No Change	/	/
3	2 x SCR	Avon 1535 SCR Retrofit	Avon 1535 SCR Retrofit	Compressor Re-wheel	/	/
4	DLE + 500	1533 DLE Retrofit	500Hr EUD	No Change	/	/
5	2 x 1533 DLE	1533 DLE Retrofit	1533 DLE Retrofit	No Change	/	/
6	2 x 1535 DLE	1535 DLE Retrofit	1535 DLE Retrofit	Compressor Re-wheel	/	/
7	New GT + 500	500Hr EUD	Decommission	Compressor Re-wheel	New GT (Greenfield)	/
8	New GT + CSRP	CSRP Retrofit	Decommission	Compressor Re-wheel	New GT (Greenfield)	/
9	New GT + DLE	1533 DLE Retrofit	Decommission	Compressor Re-wheel	New GT (Greenfield)	/
10	2 x New GT	Decommission	Decommission	Compressor Re-wheel	New GT (Greenfield)	New GT (Greenfield)

Option 10 involves installation of two new units and ceasing operation of both Avons by 1 January 2030 prior to decommissioning. Option 10 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.

Options 1 to 6 inclusive involve the retention of both Avons (Unit A and B) which will require asset health spend beyond 2030. In these options additional asset health expenditure for Units A and B which is not covered by RIIO-T2 asset health funding has been identified as summarised in this document and is included in the Wormington MCPD CAPEX estimates and CBA.

Options 7 to 9 inclusive involve the retention of one of the two Avons beyond 2030 and ceasing operation of the second unit by 1 January 2030 prior to decommissioning. In these options additional asset health expenditure for Units A or B which is not covered by RIIO-T2 asset health funding has been identified as summarised in this document and is included in the 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 A and B and associated assets to be retained in each of the shortlisted MCPD investment options. Scope which is 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 Wormington are based on a Siemens S7 platform with PCS7 software. This system is obsolete, and the station and unit C systems are being replaced under RIIO-T2 Control System Cyber and Asset Health funding with FEED starting in 2023, detailed design in 2024 and site works in 2025.

Unit A and B control systems will be reviewed as part of the Unit C and Station Control System FEED to determine any upgrade requirements based on the selected MCPD investment option. Any potential interface issues between new and existing control systems will also be reviewed as part of the FEED. Detailed design and execution phases for Unit A and B are not currently included in the Unit C and Station control system replacement project.

Control system scope including the following has been included in the initial CAPEX for options that involve retaining the Avon(s) 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

No investment has been included in Avon units A or B in options where they are to be decommissioned before 2030. The risk of continued operation of these unit control systems till at least 2028 will be assessed as part of the control system cyber and asset health project.

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. This piping underwent refurbishment in 2022 to rectify corrosion issues identified during a survey as part of routine maintenance.

Unit isolation is provided for each unit by a 750 mm remotely operated ESD valve and a 750 mm manually operated ball valve on the suction and discharge lines. There is also a 750 mm non-return valve on the discharge side of each unit downstream of the ESD and manual isolation valves. These valves were overhauled in 2017 and no defects have been logged, so no investment is required prior to 2030. It has been assumed that replacement will be required in 2038. New units will include installation of new suction and discharge piping and valves, and no CAPEX has been included for subsequent refurbishments in this instance.

4. Compressor Power Train

A summary of the gas generator power train assets currently installed at Wormington compressor station is shown in the table below.

Table 3 – Wormington Avon Compressor Train Assets

Asset	Unit	A	B
Gas Generator	Manufacturer	Siemens (Formerly Rolls Royce)	
	Model	Avon 1533-75G	
	Year	1989	1990
	Rated Power	12.34 MW	
Power Turbine	Manufacturer	Siemens (Formerly GEC)	
	Model	EAS-133	
Compressor	Manufacturer	Siemens (Formerly De Laval)	
	Model	PV30/30	
Gas Seal	Manufacturer	John Crane	
	Model	28AT	
	Type	Dry	
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 one or both Avon power trains until 2050.

4.1. Gas Generator

The Avon gas generators were last overhauled in 2017 and no further overhauls are required in RIIO-T2. However, options which involve either: upgrade of the gas generator power (OEM modification 5020 to upgrade from 1533 to 1535 engine derivative), or replacement of the existing combustion system with a dry low emission (DLE) system will require a gas generator overhaul to be conducted at the same time. Therefore, a gas generator overhaul has been included for SCR 1535; Avon 1533 DLE and Avon 1535 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 specialist items of equipment and 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 Wormington 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.

Units A and B power turbines were last overhauled in 2007 and 2011 respectively and it is anticipated that, based on projected run hours, the next overhaul will be required in 2027. This overhaul has been included in the initial investment CAPEX for MCPD options where the existing assets will be retained beyond 2030. 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 2038 and then again in 2048. 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.

For options where the Avon gas generator will be upgraded to the more powerful 1535 derivative a power turbine replacement will be required as part of the initial investment. Subsequent interventions for the power turbine in these options are based on operational acceptance of new power turbine(s) in 2028.

4.3. Compressor

For options that involve upgrading the gas generator to the 1535 derivative (via OEM modification 5020) a compressor re-wheel has been included in the initial CAPEX cost to match the compressor envelope to the upgraded gas generator power. Subsequent intervention would not be required until after 2050 so has not been included in the cost estimate.

Overhaul of the compressor impeller for the existing units 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.

4.4. Seals

An intervention frequency of 10 years has been assumed for dry gas seals for new and existing units. Options involving upgrade of the gas generator to the Avon 1535 derivative (via OEM modification 5020) will require replacement of the dry gas seals as part of the initial investment.

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 instation or outstation supply to the PRA (Pressure Reduction Area) where the gas passes through a water bath heater and then filtration. Pressure is reduced to 39 barg by governor streams before the flow splits into dedicated unit A and unit B streams which each have a flowmeter. The flow is then piped from the PRA to the dedicated fuel gas packages at each 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.

National Grid Gas Transmission 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 Wormington doesn't achieve that so dedicated unit fuel gas conditioning skids are included in this uncertainty mechanism for options which retain the Avons beyond 2030.

6. Oil System

Lube oil is supplied to Unit A and B compressors and power turbines from a common tank via submerged pumps (arranged as 1no. primary + 1no. standby). 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 Avons beyond 2030.

There are also leaks within the oil system and inspection and repair of associated pipework is therefore included in the capital costs for Avons.

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, but due to the good condition of the Wormington units the MCPD CAPEX estimate assumes the major overhaul to be in 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 and inner cab seals.

Unit A and B CAB infrastructure was surveyed by [redacted] in January 2021 with a focus on CAB overheating and poor airflow reported by [redacted] in a previous CAB integrity survey, and CAB condition focusing on water ingress, damaged equipment and corrosion issues noted by National Grid Operations. The survey was conducted based on a minimum residual life of 7 years (based on the recommended MCPD compliance option of replacing these units with new units). Minor structural overhaul scope recommended in the 2021 survey will be carried out on Unit A and B in 2022/23. This work is funded under RIIO-T2 asset health and has therefore not been included in the MCPD cost estimate.

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 the Unit A and Unit B cabs is provided by a HI-FOG water mist system utilising bottled nitrogen which does not comply with current standards. Options which retain the existing Avons 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 and improving compressor availability. This also improved effectiveness sand compliance with latest standards for fire suppression in gas turbine enclosures.

7.3. Gas Generator Air Intake

No air intake investment is included as part of the initial MCPD investment because urgent issues on these assets are being resolved by the 2022/2023 overhaul described in section 7.1.

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.

7.4. Gas Generator Exhaust

No exhaust investment is included in the uncertainty mechanism 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.

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

Decommissioning costs have been included for Unit A and B for options where these units will cease operation prior to 1 January 2030.

The aftercooler at Wormington has not been used since 2012 and is currently electrically isolated and operating in bypass mode. The decommissioning of this asset is funded under RIIO-T2 and will be complete prior to MCPD construction works allowing this area to be potentially utilised for permanent or temporary works as part of the MCPD project.

10. Other Station Assets

Assets which support the operation of the compressor station as a whole and are not dedicated to Unit A and/or 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 preferred option (option 10 – install 2 new GTs by 2028 and decommission existing Avons) 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 A and B includes:

- Unit A and B minor CAB refurbishment including CAB ventilation system and gas generator air intake
- Replacement of Unit A and B manual and remotely operated isolation valves
- Unit A and B suction and discharge piping corrosion repairs

Options in which Avons are to be 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. 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 Cost Estimate Report in Section 10.08 of 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 (IE. 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	1535 DLE	1535 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	A22.22.4.17	✓	✓	✓	✓	✓	×	15 years	
Auxiliary Equipment	A22.22.4.30	✓	✓	✓	✓	✓	×	15 years	
LV Switchboards	A22.22.4.20	✓	✓	✓	✓	✓	×	15 years	
Rotating Equipment									
Gas Generator - overhaul	A22.10.2.4			✓	✓	✓	×	10 years[3]	15 years
Power turbine	A22.10.2.14	✓	✓	✓	✓	✓	×	10 years[3]	15 years
Compressor Impeller Refurb	A22.10.2.1	×	×	×	×	×	×	30 years	40 years
Compressor - dry gas seal	A22.10.1.3	×	×	×	✓	✓	×	10 years	
Cab									
Building - CAB (Major)	A22.08.1.8	×	×	×	×	×	×	40 years	
Building - CAB (Minor)	A22.08.1.7	×	×	×	×	×	×	10 years	
CAB Ventilation (Major)	A22.08.1.4	×	×	×	×	×	×	10 years	40 years
CAB ventilation (Minor)	A22.08.1.5	×	×	×	×	×	×	5 years	20 years
Air intake (Major)	A22.08.1.3	×	×	×	×	×	×	15 years	25 years
Air intake (Minor)	A22.08.1.2	×	×	×	×	×	×	10 years	
Exhausts (Major/Replace)	A22.08.1.11	×	×	×	×	×	×	25 years	
Exhausts (Minor)	A22.08.1.10	×	×	×	×	×	×	5 years	20 years
Piping & Valves									
Unit Isolation Valves	A22.14.1.22	×	×	×	×	×	×	40 years	
Non-Return Valves	A22.22.6.4	×	×	×	×	×	×	40 years	
Other Ancillary Systems									
Fuel Gas Skid	A22.10.2.1	✓	✓	✓	✓	✓	×	10 years	20 years
Oil System (GG, PT, Comp)	A22.10.1.4	✓	✓	✓	✓	✓	×	10 years	40 years
Fire Suppression	A22.08.2.3	✓	✓	✓	✓	✓	×	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 A16.10 – Wormington Compressor Engineering Justification Paper, December 2019