



# **Wormington Compressor Station MCPD FEED Feasibility Project**

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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.

<b>ASEP</b>	Aggregated System Entry Point
<b>BAT</b>	Best Available Techniques
<b>CBA</b>	Cost Benefit Analysis
<b>CSRP</b>	Control System Restricted Performance
<b>DLE</b>	Dry Low Emissions
<b>EPC</b>	Engineering Procurement Construction
<b>FAT</b>	Factory Acceptance Test
<b>FEED</b>	Front End Engineering Design
<b>GT</b>	Gas Turbine
<b>LNG</b>	Liquified Natural Gas
<b>MCPD</b>	Medium Combustion Plant Directive
<b>NTS</b>	National Transmission System
<b>RIIO</b>	Revenue = Incentives + Innovation + Outputs
<b>SCR</b>	Selective Catalytic Reduction
<b>SIMOPS</b>	Simultaneous Operations
<b>VSD</b>	Variable Speed Drive

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- Replacement of non-compliant units with new low emissions compressors;
- Taking non-compliant units out of service;
- Restrict the performance of non-compliant units through control system restriction such that operational emissions are limited to within legislative limits;
- Limit the use of non-compliant units to a maximum of 500 hours per year under an emergency use derogation as defined in the MCPD legislation.

National Grid submitted a compressor emissions compliance strategy paper to Ofgem in 2019 within which compliance options for each site impacted by the incoming MCPD legislation were presented. Due to the uncertainty around the optimum solution for Wormington Compressor Station it was agreed that further review of options would be conducted with the optimum solution presented to Ofgem in a Final Options Selection Report. Agreement on the optimum solution would then allow the project to progress to the next phase of development prior to final funding allowances being agreed via an uncertainty mechanism under the RIIO regulatory framework.

### 1.3 Document Purpose

This document includes Level 2 programmes for all shortlisted MCPD compliance options considered within the Final Option Selection Report. These schedules have been developed to demonstrate the feasibility of delivering each option before the MCPD legislative deadline of 1 January 2030 and to highlight any schedule related risks. The schedules have also been used to develop CAPEX investment profiles for each option which are included in the Cost Estimate Report in section 10.08 of the Final Option Selection Report.

Following selection of the final preferred option further refinement of the schedule will be required alongside development of the delivery strategy. At this stage alignment with other investments and potential bundling opportunities will be considered.

## 2 Investment Options

MCPD compliance solutions include the following retrofit and new build options applied to one or both of the existing Avon driven compressor trains:

- Retain Avon with operation limited to <500 hours per year as a rolling average over a 5-year period under an Emergency Use Derogation as specified in the MCPD legislation
- CSRP Avon whereby the control system is used to restrict performance of the Avon such that it cannot exceed emissions limit values set out in MCPD
- Selective Catalytic Reduction (SCR) system installed on the Avon to remove emissions from the exhaust gases after combustion
- Retrofit of a Dry Low Emissions (DLE) combustion system to an existing Avon
- Replace Avon with new, emissions compliant gas turbine driven compressor machinery train

Various combination of the above options have been considered as well as potential power upgrades to the existing Avons and compressor re-wheels to align compressor capability with forecast requirements. Options involving deferral of investment decisions have also been included.

Asset health interventions must be delivered as part of the MCPD project for any existing assets to be retained beyond 2030. Details of this asset health scope is included in the Asset Health Report in section 10.11 of the Final Option Selection Report. For retrofit options this asset health scope makes up a significant part of the overall MCPD scope and is included in the delivery schedules discussed in this report.

The options described in Table 1 have been shortlisted for assessment via Cost Benefit Analysis (CBA) and Best Available Techniques (BAT) assessment. Level 2 programmes for each option are described in this report.

Further detail on the full range of options considered including all discounted options is included in the Engineering Report within section 10.13 of the Final Option Selection Report. The Engineering Report also contains details of the various layout options considered for new build options and the selection process used to define the preferred layout.

**Table 1 - Option Shortlist**

<i>Option</i>	<i>Description</i>	<i>Unit A</i>	<i>Unit B</i>	<i>Unit C</i>	<i>Unit D (Future)</i>	<i>Unit E (Future)</i>
1	Counterfactual	500Hr EUD	500Hr EUD	No Change	/	/
2	2 x CSR	CSR Retrofit	CSR Retrofit	No Change	/	/
3	2 x SCR	SCR Retrofit	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 + CSR	CSR 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)

*Note 1)* Option 10+ involves initial investment per Option 7 with a second new unit installation and decommissioning of second Avon in 2035 should the forecast capability requirements at the time justify the second new unit

### 3 Basis of Schedules

#### 3.1 General

The basis and the main assumptions used to develop the Level 1 schedules are outlined below. Further details for specific schedule options are provided in the subsequent subsections of this report.

- **Design and Layout**

- Retrofit options will utilise the existing Avon compressor trains in their existing berths. Although not compliant with safety separation distances set out in T/SP/G/37 it is assumed that no significant mitigations will be required
- New units will be installed on an area of National Grid Owned land to the south of Feeder 23 which is routed parallel to the southern boundary of the site.



- For full layout details see Engineering Report and supporting Layout Report is section 10.13 of the Final Option Selection Report
- **Regulation**
  - The Wormington Ofgem Re-Opener period is 31/08/2022 to 31/01/2023.
  - A second Ofgem Re-Opener period of 2 months is required to agree funding allowances. This period will be after Execute (i.e. EPC) tenders have been received.
  - At the conclusion of the Re-Opener period, an option will be selected for the Wormington MCPD project.
- **Project Governance**
  - The following National Grid internal approvals / governance periods are required:
  - 2 months between pre-FEED and FEED (F3 Sanction). This can occur in parallel to the FEED ITT period.
  - 2-month governance cycle (F4 sanction) immediately before the second Ofgem re-opener to confirm remaining funding allowances. This sanction process commences post receipt of Execute bids.
  - 2 months governance cycle at the end of construction/commissioning (T6 Sanction).
- **Delivery Strategy**
  - Pre-FEED ITT and award activities are kicked off immediately following option selection being finalised, i.e. conclusion of Re-opener period.
  - New compressor machinery trains will be procured from the existing compressor framework with an assumed delivery period of 16 months (ex. Works) including FAT.
  - For the retrofit options, the project execution activities for the MCPD facilities and 're-life' facilities will be done in parallel and managed by a single design and installation contractor
  - Required permits and planning permission activities will be performed in parallel to the engineering activities and will be managed such that they will not be on the critical path and thus will not impact the overall schedule.
- **Construction / Outages**
  - Main activities that involve total shutdown of the compressor station can only occur during the period April – October.
  - On site construction activities not requiring a total shutdown of the compressor station can occur all year round, i.e. constructions and operations SIMOPS is allowed.
  - Adequate manpower is available to support the construction activities

The schedules are used to demonstrate the feasibility of delivering each option before the 1 January 2030 legislative deadline. They are also used to highlight schedule related risk and to support the production of estimated CAPEX spend profiles as detailed in the Cost Estimate Report in section 10.08 of the Final Option Selection Report. The schedules have not been used to derive any elements of the CAPEX estimates.

### 3.2 New Build Options

New build options are based on a standard EPC delivery approach. In this approach, a pre-FEED stage will be initiated immediately following confirmation/approval of the final preferred option via the re-

opener planned for September 2022 to February 2023. During this stage the delivery strategy will be confirmed and tender documentation for the FEED stage produced.

During the subsequent FEED phase the selected investment option will be defined to an appropriate level of detail to support the re-opener to confirm remaining project costs and to allow the EPC phase to be contracted on a lump sum or target price basis.

The EPC phase will include development of tender package for the compressor machinery train equipment which will be purchased by National Grid and free issued to the EPC contractor. Site works will commence once detailed design has been sufficiently progressed which allows for a maximum of three years for all site works up to operational acceptance. The selected greenfield location will allow a significant amount of site works to be conducted in a separate CDM area separate from the operational site thus reducing the impact on operations. However, a summer station outage will be required to allow tie-in and commissioning of the new unit(s). Tie-in and commissioning of both units will be conducted in the same outage window. Due to the criticality of Wormington compressor station to support gas supply from Milford Haven ASEP, attaining appropriate outages has been identified as a schedule risk. For this reason an extended window for construction works has been allowed for. Potential optimisation will be reviewed in the FEED stage once the scope has been refined and delivery approach confirmed.

After operational acceptance a winter running period has been allowed to operationally prove the new unit prior to the 2030 legislative deadline when any non-compliant units will be removed from service.

Options that include the installation of a single new unit alongside modifications to one of the existing Avons is described below. In these cases, outages for tie-in and commissioning of the new unit will be separate to outages for retrofit works.

### 3.2.1 Deferral of Second New Unit

An additional option (Option 10+) has been assessed in the CBA where a single new unit is installed with one of the Avon's retained on 500 hour per year emergency use derogation (i.e., Option 7) with an option to install a second new unit to be commissioned and operationally accepted by 31 December 2034.

In this option it has been assumed that the same schedule for Option 7 would apply with no pre-investment for the second unit accounted for other than allocation of sufficient plot area. The delivery of the second new unit would be completely independent from the initial investment from a contracting perspective.

Prior to commencing pre-FEED a period of 16 months has been allocated for development and approval of the needs case, and internal investment governance sanctioning. These activities will be highly dependent on the funding mechanism which will need to be defined in advance.

A similar EPC delivery strategy to other investment options has been assumed. The delivery of the second unit will be independent to the initial investment with new contracts required. Although the only pre-investment for the second unit assumed is allocation of plot space shorter durations have been assumed. Design, permitting and consenting activities will be shorter due to application of lessons learnt and use of preliminary designs from the initial investment. Construction activities will also be quicker due to reduced scope (e.g., site preparation and civil works, tie-ins etc). It has been assumed that the installation and commissioning of the second new unit can be conducted efficiently without additional unit or station outages other than for tie-in and commissioning. This will need to be confirmed as part of the pre-investment philosophy.

## 3.3 Retrofit Options

Retrofit options include a significant amount of asset health works in addition to any emissions compliance scope as outlined in section 10.11 of the Final Option Selection Report. For the purpose of schedule development, it has been assumed that the complete scope required as part of the initial

investment, including asset health works, emissions compliance retrofit modifications and new build activities will be executed under the same EPC delivery strategy. This approach is similar to the new build options.

However, the contract strategy will be reviewed following confirmation of the selected option and some, or all, of the retrofit scope may be delivered under separate contracts. Where appropriate retrofit scope will be delivered under existing asset health related framework agreements. Potential bundling of scope with other asset health investments will also be considered where delivery and/or procurement efficiencies can be leveraged.

Construction for options involving the retention of Unit A and/or Unit B beyond 2030 (retrofit options) was based around a number of summer outages as shown in Table 2. The outages defined assumed both Units A and B will be taken on unit outage in the same season. Full station outages will be minimised through use of unit outages and bundling of appropriate scope.

**Table 2 - Construction Outages for Retrofit Options**

Scope	Outage A	Outage B	Outage C	Outage D
Ancillary Systems	✓			
Control System		✓		
Rotating Equipment Overhaul / Upgrade			✓	
Major Cab Works (SCR)				✓ (Option 3 only)
New Unit Tie-in and Commissioning				✓ (Options 7-9 only)

### 3.4 Control System

Control system scope includes replacement of the unit control panel, anti-surge and fire and gas detection systems. Low voltage electrical works including replacement of switchboards, distribution boards and auxiliary equipment will be conducted in the same outage.

The Unit C (VSD) and Station Control Systems are planned for replacement in 2025 as part of a separate project which has confirmed RIIO-T2 funding under our Control System -Cyber and Asset Health Investment Plan. Engineering for this Control System Project is split into FEED and Detailed Design. FEED will commence next year, and Unit A and B will be included within the scope so that an holistic review of the control requirements can be undertaken. It is anticipated that any control system scope for Unit A and/or B will be incorporated into the separate Control System Project but for the purpose of scheduling it has been included within the MCPD scope.

Unit A and B will be taken on outage together (for options 1-6) with Unit C remaining operational to provide limited compression capability.

### 3.5 Ancillary Systems

This scope includes:

- fire suppression: replacement of the existing bottled nitrogen system to an electric pump based system
- Oil system: replacement of obsolete oil pump
- fuel gas system: Fuel gas conditioning system installation

To avoid excessive scope in each outage and multiple contractors working in the same area this scope will be delivered in a separate outage to the other works. The majority of this work would be done under a unit outage. As these systems are unit specific each unit will be taken on outage consecutively where possible rather than taking both on outage at the same time.

### 3.5.1 Rotating Equipment Overhaul / Upgrade

The rotating equipment scope includes gas generator; power turbine; compressor and compressor dry gas seals. For DLE options the unit will be taken on outage and isolated before the gas generator and (if required) power turbine are removed and shipped to the factory where upgrades will be undertaken before the unit is returned to site, installed and commissioned. The schedules assume both units will be taken on outage for upgrades at the same time but, if possible, this will be split over two consecutive outage seasons.

### 3.5.2 Major Cab Works (SCR)

The SCR option for Wormington consists of a vertical catalyst solution where the existing exhaust stack will be removed and replaced by a larger exhaust stack including the catalyst and emissions sampling points. A significant amount of structural steel work will need to be erected to support the exhaust stack and provide suitable access for maintenance and emissions sampling. The design proposed by [REDACTED] includes a common platform across Units A and B.

Units A and B will be taken on outage during the same summer period to allow removal of the existing exhaust structure and construction and commissioning of the new structure. To minimise the site works and reduce schedule risk offsite fabrication will be maximised through a modular design approach. However, there is still a significant amount of work to be completed in a summer outage period which will need to be carefully managed to ensure the compressors can be brought back into service prior to winter.

The SCR option also involves installation of reagent (ammonia) storage and loading facility, but no significant outages will be required for construction, tie-in and commissioning of this equipment and it will not impact the critical path for construction work.

### 3.5.3 New Unit Tie-in and Commissioning

For investment options 7, 8 and 9 a new unit will be installed as well as retrofit modifications to one of the Avons (units A or B). In these options an outage for tie-in and commissioning of the new unit will be required. To reduce SIMOPS and schedule risk the new unit tie-in and commissioning outage will be conducted under a separate outage and will not be conducted in the same season as retrofit works on unit A or B.

## 4 Risk & Opportunities

A semi-quantitative risk assessment has been conducted on all options. An overview of the risk assessment methodology and summary of key risks and opportunities is described in section 8.4 of the Final Option Selection Report. The project Risk Register can be found in section 10.06 of the Final Option Selection Report. These documents include schedule related risks which have been summarised below.

### 4.1 Schedule Risks

There is a critical risk (the highest category) relating to outage scheduling and coordination. This has been identified as more significant for new unit options due to the scope of work required during outage, but similar risk applies for all options. Delivery strategy development and associated outage plans should be commenced early in the pre-FEED stage to mitigate this risk. This should be done with cognisance of other planned works at Wormington and other compressor sites, AGIs and pipelines which influence capability in the south-west area of the NTS and may impact availability of outages.

A significant risk has also been identified associated with land use/ extension for new build options that involve the use of land outside the existing site footprint. Issues with permitting and consents and potential additional land acquisition may result in significant schedule delays. Permitting and consents for the SCR option has also been identified as a significant risk due to the additional stack height and visual impact. Early engagement with local planning authorities should be undertaken to mitigate this risk.

## 4.2 Schedule Opportunities

Opportunities for schedule optimisation will be conducted after confirmation/approval of the preferred investment option. This schedule optimisation will consider potential bundling of scope with other investments to leverage potential procurement and delivery efficiencies and alignment of construction activities (notably those requiring outage) with other planned investments.

The deferral option (Option 10+) assumes that the only pre-investment for the deferred second unit installation will be allocation of sufficient plot space. A pre-investment philosophy would be developed during pre-FEED alongside the development of the delivery strategy for this option.

## 5 Conclusions and Recommendations

Level 2 schedules for all shortlisted MCPD investment options have been developed which have confirmed the feasibility of delivery prior to the 1 January 2030 MCPD legislative deadline. These programmes have not been used to derive any elements of the CAPEX estimates, but they have been used to determine basic spend profiles.

The most significant schedule related risks are outage scheduling and coordination and permits and consents and this will be an area of focus immediately following confirmation of the preferred investment option. Schedule optimisation will be undertaken following confirmation of the preferred investment option.

## 6 Appendices A - Schedules

Level 2 schedules for the shortlisted options listed in Table 1 are included in the attached Microsoft Excel file.