

REPORT



King's Lynn Compressor Station Level 2 Schedules (Phase 2)

Prepared for:	National Grid PLC
Prepared by:	

Project Title: King's Lynn & Peterborough Compressor Station MCPD FEED Project

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Date: June 2022

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ABBREVIATIONS

CSRP Control System Restricted Performance

DLE **Dry Low Emissions**

EPC Engineering, Procurement and Construction

ERP3 **Emissions Reduction Phase 3**

Front End Engineering Design **FEED**

ITT Invitation To Tender

LER Local Equipment Room

MCPD Medium Combustion Plant Directive

NTS National Transmission System

PDS Process Duty Specification

SCR Selective Catalytic Reduction

SIMOPS Simultaneous Operations

UCP Unit Control Panel

UK Power Networks UKPN

VSD Variable Speed Drive

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HOLDS LIST

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1.0 INTRODUCTION

1.1 General Background

The Medium Combustion Plant Directive (MCPD) requires that existing plant between 1 MW and 50 MW net thermal input must not exceed specified operational emission limit values or be taken out of service before 1 January 2030. This legislation impacts the Rolls Royce Avon driven compressor units on the gas National Transmission System (NTS) including units at King's Lynn and Peterborough Compressor Stations. Investment is required to ensure the capability, that the network requires, can be maintained beyond 1 January 2030. Investment may include various combinations of the following options and the investment must be assessed against network capability requirements predicted under various future energy scenarios to ensure the most cost-effective solution for end consumers.

- Upgrading non-compliant units to bring emissions within acceptable legislative limits;
- 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 King's Lynn and Peterborough Compressor Stations it was agreed that further review of options would be conducted with the optimum solution for each site presented to Ofgem in two separate Final Options Selection Reports. Agreement on the optimum solution would then allow the project(s) to progress to the next phase of development prior to final funding allowances being agreed via an uncertainty mechanism under the RIIO regulatory framework.

1.2 Site Background

Peterborough and King's Lynn Compressor Stations are located in the East of England and their location on the NTS is shown on the schematic below. A brief outline of each site is provided in the section below to put the project scope into context.

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Figure 1-1 Peterborough & King's Lynn Compressor Stations

Peterborough

Unit A, B, C RR Avon

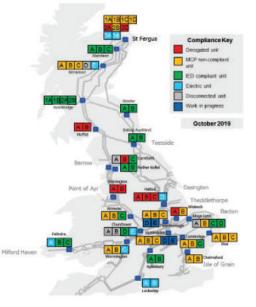
Unit D, E Solar Titan 130

King's Lynn

Unit A Decommissioned Avon

Unit B - RR Avon

Unit C. D Siemens SGT400



1.2.1 Peterborough Compressor Station

The Peterborough Compression Station is used primarily for bulk transmission of gas to support demand and currently has:

- 3 off Rolls-Royce Avon gas driven compressors (A, B, C) existing that do not meet emissions limits:
- 2 off Solar Titan gas driven compressors (D, E) in process of being installed to become lead units as part of ERP3 project due for commissioning Q4 2022.
- Installation of 3rd Solar Titan was originally planned: Limited Construction has been done:

A, B and C compressors do not comply with MCPD (Medium Combustion Plant Directive). They will be used to provide resilience after commissioning of Units D, and E but need to be replaced/modified by 2030.

1.2.2 King's Lynn Compressor Station

The King's Lynn is a bi-directional compression station which is used to resolve supply/demand imbalance for SE England and currently has:

- 2 off Siemens SGT400 driven compressors (C, D) which operate as lead units;
- 1 off Rolls-Royce Avon Gas driven compressor (B) which operates as partial backup to C and D
- 1 off Rolls-Royce Avon Gas driven compressor (A) which is disconnected and partially dismantled

Unit B compressor does not comply with MCPD and does not provide sufficient back-up capacity. Design capacity cannot be achieved with C and D unavailable.

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1.3 MCPD Legislation Compliance Options

The technical options being considered to meet MCPD legislation at the existing compression stations are as follows:

RR Avon Retrofit Options

- a) Change out of Avon engine to a Dry Low Emissions (DLE) unit;
- b) Use of Control System Restricted Performance (CSRP);
- c) Installation of a Selective Catalytic Reduction (SCR) unit.

New Build (Replacement of RR Avon) Options

- a) New Gas Turbine Driven Compressor;
- b) New Electric Variable Speed Drive (VSD) Compressor.

1.4 **Document Objectives**

Several potential alternative locations for siting of the new build compression units at King's Lynn have been considered and a preferred location has been selected (Ref. 4). In order to allow evaluation and screening of the preferred new build options and retrofit options, Level 2 project execution schedules have been developed for both sets of options.

The intention of the Level 2 schedules is to highlight any differences in overall project execution duration for the alternative options for use in the cost benefit analysis of the options and thus allow selection of a preferred MCPD option.

15 **Document Structure**

This document is structured as follows:

Section 2.0 presents and summarises options being considered.

Section 3.0 summarises the main assumptions and basis used for development of the schedules.

Section 4.0 presents the overall estimated project execution duration for each option.

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DEVELOPMENT OPTIONS 2.0

2.1 New Build Options

For King's Lynn installation of one or two new units is being considered.

Beyond 2030, there may be an increase in the requirement for parallel running of compressors and National Grid would be exposed to considerable network constraint costs without a very high availability at King's Lynn. The installation of two new units allows the high compression availability to be achieved.

2.1.1 Single Unit Options

The preferred location of the single new build unit is the Redundant Plant Area 1 Plinths, Option B (Ref. 4). Option B requires extension of the site boundary, but the site security fence extension is well within the current National Grid land ownership boundary.

For Option B, two alternative compressor designs are being considered:

- a) New Gas Turbine Driven Compressor (Option B1);
- b) New Electric Variable Speed Drive (VSD) Compressor (Option B2);

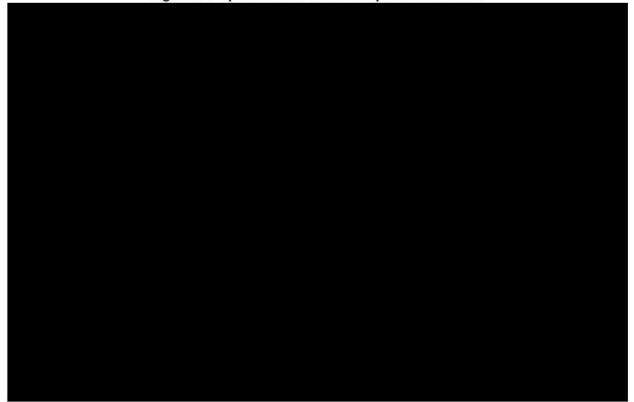


Figure 2-1 Option B New Build Compressor Location

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2.1.2 Two Units Options

The combinations being considered for two unit options locations are as follows:

- Option 4: Two units Located on Redundant Plant Area 1 Plinths (Option B).
- Option 5: Hybrid option, i.e. one new build unit located Redundant Plant Area 1 Plinths (as per Option B) and Upgrade of Avon B (i.e. retrofit option).

As per the single unit options, two alternative compressor designs are being considered:

- New Gas Turbine Driven Compressors (Option 4A);
- New Electric Variable Speed Drive (VSD) Compressors (Option 4B); b)

Option 4 requires use of plot space plus construction outside of the current site security but it is within the current land ownership boundary.



Figure 2-2 Option 4 Two New Build Compressors

2.2 Retrofit Options

For the retrofit options, the existing Avon Unit B is upgraded as follows:

- Change out of Avon engine to a DLE unit (Option D);
- Use of CSRP (Option E);
- Installation of a SCR unit (Option F).

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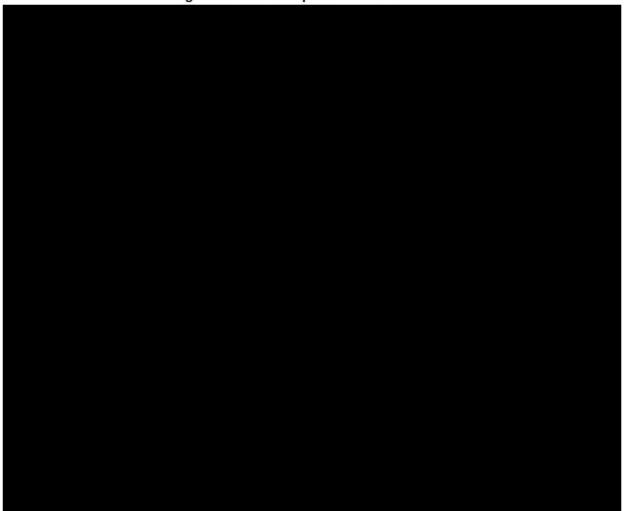
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Figure 2-3 shows the location of Avon Unit B, plus the plot space required by the SCR facilities. For the DLE and CSRP options, no additional equipment is installed outside of the Avon B Compressor Building.

Figure 2-3 Retrofit Options Location



For the retrofit options, as well as the upgrades required to meet the MCPD requirements, additional 're-life' modifications / upgrades also need to be undertaken on the Avon B unit to ensure the requisite design life is achieved. These additional modifications include (Ref. 2):

- Overhaul of the Avon B Gas Compressor Section incl. installation of dry gas seals;
- Overhaul of the Lube Oil System (Electric Motors / Pumps);
- Replacement of Avon B Cab Lighting (ExD Rated LED);
- New Gas Turbine (Governor) & Compressor (UCP) Control System if not being performed as part of the MCPD option retrofit;
- Replacement of recycle valve and piping;
- Replacement of the inlet and outlet valve actuators.

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BASIS FOR SCHEDULES 3.0

Refer to Reference 3 for a summary of the technical scope associated with each option.

The basis and the main assumptions used to develop the Level 1 schedules were as follows:

- The Kings Lynn Ofgem Re-Opener period is 31/12/2022 to 30/06/2023.
- 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 King's Lynn MCPD project.
- The project will be executed in the following project phases:
 - Pre-FEED;
 - > FEED;
 - Detailed Design;
 - Construction.
- The Pre-FEED can start before option approval / selection, i.e. before Ofgem Re-Opener period closure, if it is required in order to achieve project completion before the MCPD target date of 2030.
- 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).
- The tendering periods required plus durations of these project phases for the new build options will be longer than the retrofit options given the significantly greater scope.
- Pre-FEED ITT and award activities are kicked off immediately following option selection being finalised, i.e. conclusion of Re-opener period.
- Activities that involve total shutdown of the compressor station can only occur during the period April - September. For the retrofit options, it is assumed that Unit B is also taken offline for upgrade / refurbishment only in this period too, to ensure that it is available during winter months etc,
- 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.
- The delivery time for GT and EM VSD driven compression is 16 months (ex. Works) and this includes string test. The delivery time for the equipment and bulks required for the retrofit options will be significantly shorter. A duration of 6 months is assumed based on information provided by Reference 6 and previous project experience.

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Purchasing of equipment etc. will occur post FEED, i.e. no early investment. However, in order to reduce the overall procurement cycle for the new compression unit, it is assumed that the procurement specs / documents and compressor unit ITT technical bid evaluations will be performed during FEED. A period for vendor engagement will occur during FEED. Therefore, the purchase order can be placed soon after the Execute activities commence.

- For the retrofit options, the project execution activities for the MCPD facilities and 'relife' facilities will be done in parallel and managed by a single design and installation contractor.
- Adequate manpower is available to support the construction activities, i.e. there are no manpower restrictions. A 7 day working week / 12 hours a day is assumed for the preliminary schedules, This provides opportunity to increase site working hours if delays are experienced.
- Required permits and planning permissions are not on the critical path. It is assumed
 these 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.
- For Electric Driven VSD Compression options, the duration required for connection agreement with UKPN plus time required for a new supply from the 132 kV overhead lines is assumed to be 4 years (HOLD 1), based on preliminary indication received previously for the Peterborough site. It is assumed that UKPN installation activities will be undertaken in parallel to the onsite construction activities.
- Discussions with UKPN and design of the required new supply from the 132 kV overhead lines can occur prior to F4 Sanction. However, the formal agreement with UKPN cannot be concluded plus construction and installation of the new supply cannot commence prior to F4 sanction in order to minimise cost commitments prior to approval of funding allowance by Ofgem and F4 Sanction.
- National Grid's T2 Cyber delivery strategy does not permit compressor engine overhauls and cab refurbishments to be conducted at the same time as control system replacements due to overlap of working areas.

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4.0 LEVEL 2 SCHEDULES

Representative Level 2 schedules are provided in Appendix A and Table 4-1 provides a summary of the estimated project completion dates. The schedules indicate that the project completion by 2030 can be achieved and that there is also some schedule float, except for Options B2. Retrofit options have more float and thus less schedule risk.

Table 4-1: Overall Execution Durations

Option	Project Completion Date	Comments
Single Unit Options		
B1	1Q2029	Note 1
B2	1Q2030	Note 2
D	4Q2027	Note 3
Е	4Q2027	Note 4
F	4Q2027	Note 5
Two Unit Options		
4A	1Q2029	Note 6
4B	1Q2030	Note 7
5	1Q2029	Note 8

Notes

- Two total site shutdowns are required, which can both be scheduled for April September period. The
 first for cable trench extensions, which could occur during the period for new compressor civils works or
 during the period of new compressor installation. The second for hook-up of the new compressor.
- 2. The installation of the new 132 kV incomer to site by the UKPN is on the critical path and pushes the project completion date out by one year compared to Option B1. Thus, potentially not meeting the MCPD target date. This represents a significant schedule risk, and the UKPN construction activities may need to be started earlier, if possible, (e.g. at the same time as the onsite FEED activities) to minimise this risk. For the preliminary level 2 schedule, it has been currently assumed that UKPN construction activities would not commence until funding is approved. Additionally, the schedule assumed that the pre-FEED activities commence before closure of the first Ofgem Re-Opener (i.e. option is approved) but this still does not allow the MCPD target date to be met.
- Two site shutdowns are required, one for the compressor overhaul and refurbishment activities and one
 for the DLE facilities installation and associated control system upgrades. It is assumed DLE technology
 will be tested / proven and commercially available by Q3 2023, before the commencement of pre-FEED /
 FEED project stages.
- Two site shutdowns are required, one for the compressor overhaul and refurbishment activities and one for the CSRP facilities installation and associated control system upgrades.
- 5. Two site shutdowns are required, one for the compressor overhaul and refurbishment activities and one for the SCR facilities installation and associated control system upgrades. The project completion date is the same as Options E and F, even though this option requires on site civils works to be undertaken prior to the SCR facilities installation. This is because all options are reliant on the April September window for the total site shutdown.

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6. Construction activities will take longer than Option B1 but the completion dates are very similar.

- Completion date is the similar to Option B2 as it is driven by the installation of the new 132 kV incomer to site by the UKPN.
- 8. The overall completion date for hybrid option, i.e. one new build unit and upgrade of Avon B unit is the same as the single new build options as it is driven by the installation of the new build unit. This option is based on a new build GT driven unit plus DLE retrofit to the Avon B unit but it would be the same if the other retrofit options were considered instead.

Currently the schedule assumes that new build and retrofit scopes are treated as a single project. The upgrade of the Avon B unit is done in two phases / site shutdowns. During the first phase, the compressor overhaul and refurbishment activities are completed. During the second phase, the DLE facilities installation and associated control system upgrades are completed. The site shutdown required for the second phase coincides with that required for the new build compressor.

If an electric driven new build compressor is selected with a retrofit option, the overall completion date would be the same as Option B2.

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5.0 REFERENCES

REFERENCES		
Ref 1	King's Lynn Compressor Station Study Basis of Design, doc. no. 203513C-001-RT-0008-0002.	
Ref 2	King's Lynn Compressor Station Site Visit Report, doc. no. 203513C-001-RT-0500.	
Ref 3	King's Lynn Compressor Station Cost Estimates (Phase 1 +/-30%), doc. no. 203513C-001-RT-0301.	
Ref 4	King's Lynn Compressor Station Option Review Report (Phase 1), doc. no. 203513C-001-RT-0503.	
Ref 5	King's Lynn Compressor Station Level 1 Schedules (Phase 1), doc/ no. 203513C-001-PLG-0300.	
Ref 6	Avon DLE and Avon Control Systems Restricted Performance (CSRP) Provisional Innovation Study Outputs by National Grid, dated June 2021	

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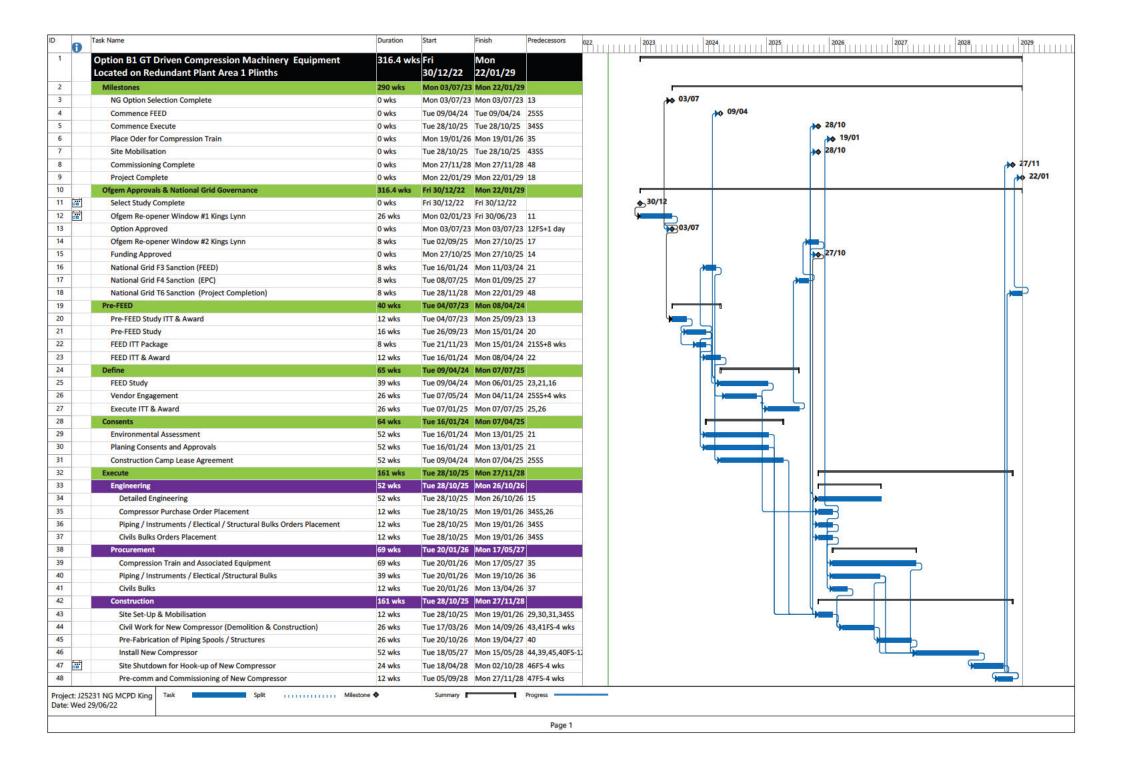
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6.0 APPENDIX A

6.1 Option B1 Level 2 Schedule



J25231 NG MCPD King's Option B1 Exe



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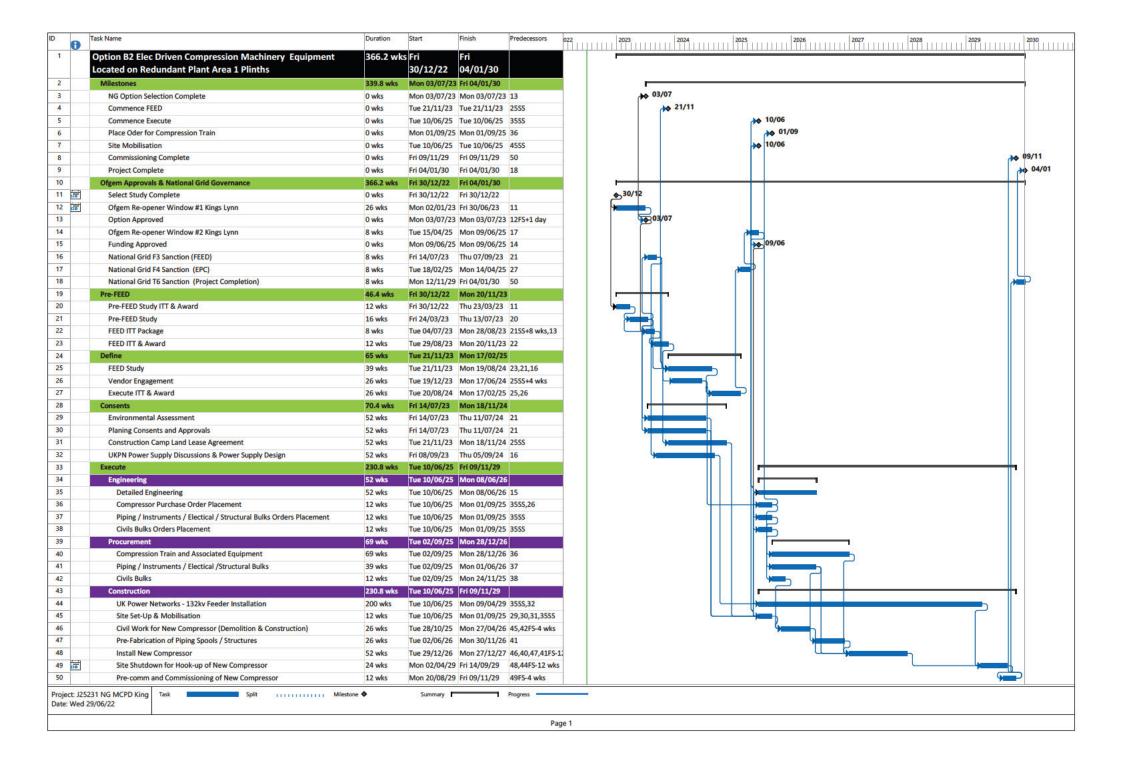
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6.2 Option B2 Level 2 Schedule



J25231 NG MCPD King's Option B2 Exe



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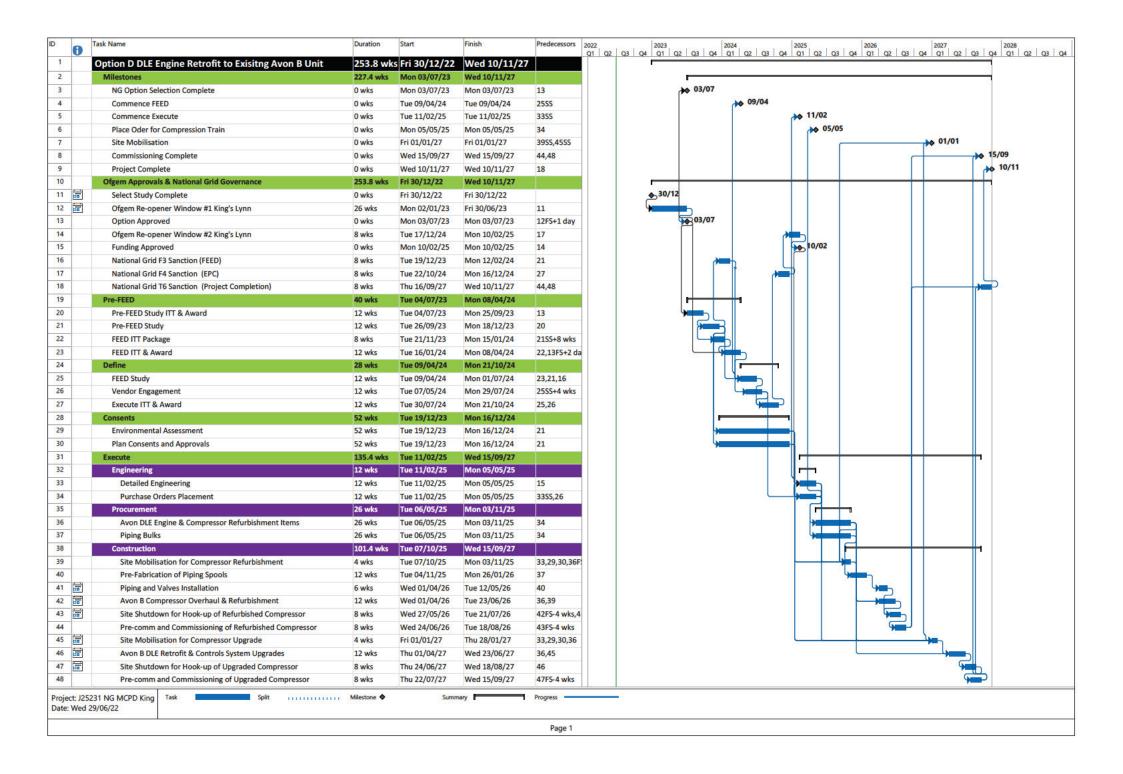
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6.3 Option D Level 2 Schedule



J25231 NG MCPD King's Option D Exe



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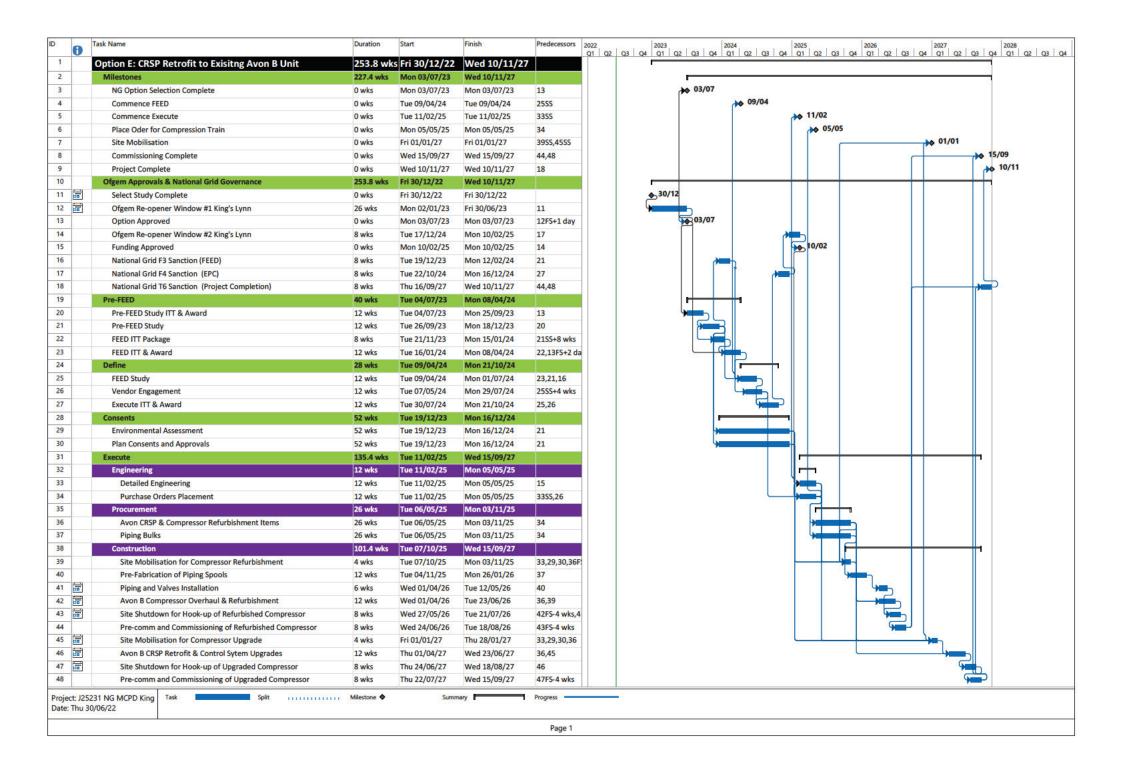
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6.4 Option E Level 2 Schedule



J25231 NG MCPD King's Option E Exec



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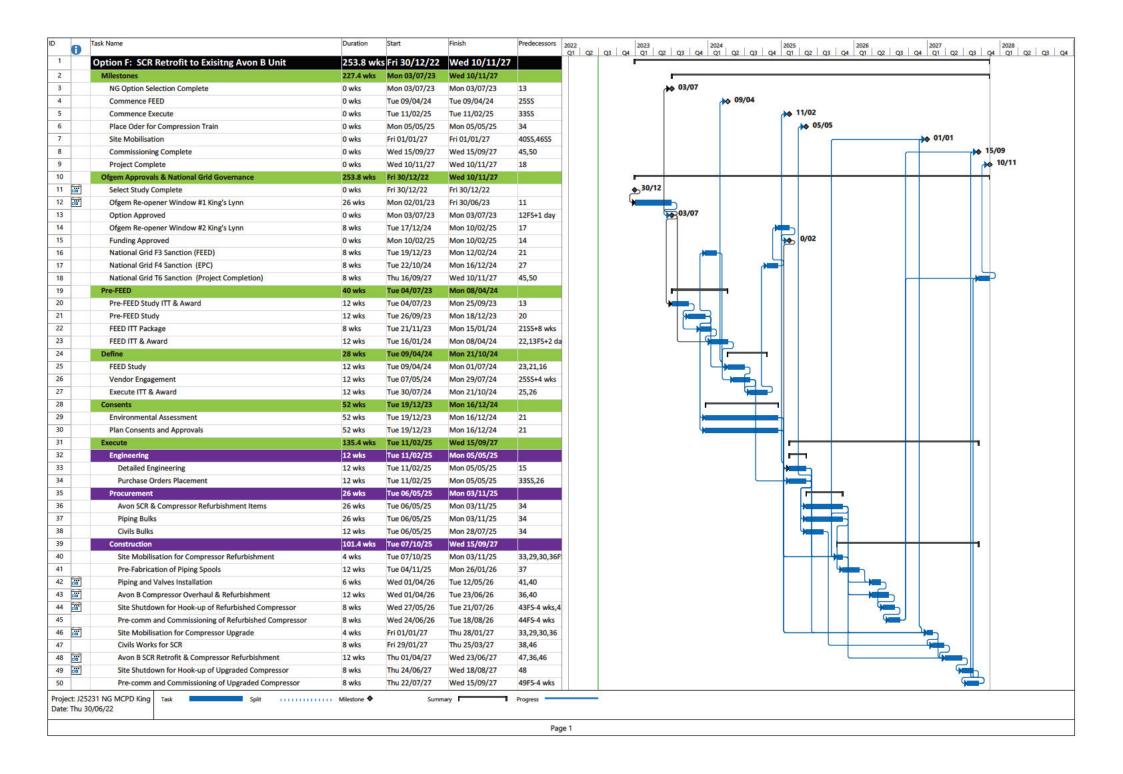
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6.5 Option F Level 2 Schedule



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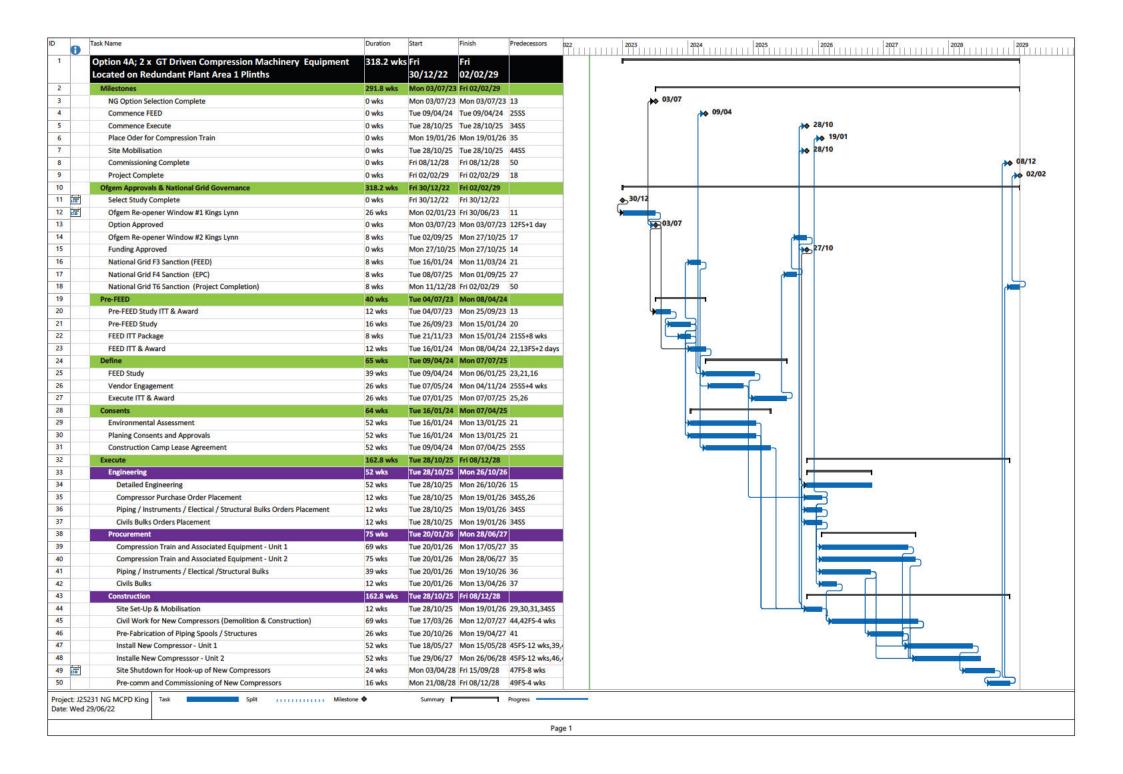
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6.6 Option 4A Level 2 Schedule



J25231 NG MCPD King's Option 4A Ex



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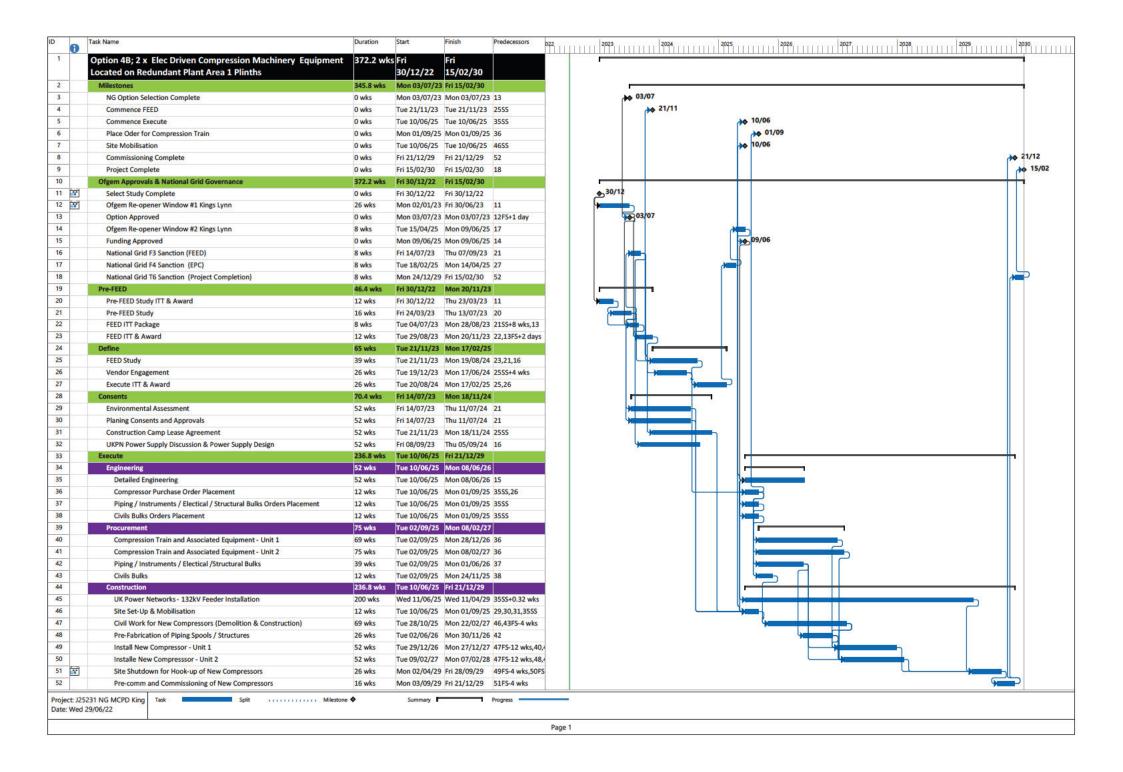
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6.7 Option 4B Level 2 Schedule



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6.8 Option 5 Level 2 Schedule



J25231 NG MCPD King's Option 5 Exec

