national gas transmission

NGT_AH2_09 St Fergus LV Switchboards and MCCs

Engineering Justification Paper

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Table of contents

1. Executive Summary

1. National Gas Transmission (hereafter referred to as 'NGT'), are submitting this needs case in accordance with the RIIO-T2 Engineering Justification Paper Guidance v2 document. The purpose of this stage of the process is to justify the project need, set out the different options considered along with the preferred strategic options, and request funding for the preferred option justified within this paper. This Engineering Justification Paper (EJP) details the investment for a number of works associated with Low Voltage (LV) Switchboards and Motor Control Centres (MCCs) at the St Fergus Gas Terminal.

2. This is part of a suite of documents, shown in Figure 1, and should particularly be read in conjunction with the St Fergus Site Strategy and its appendices. The St Fergus Site Strategy describes the Gas Terminal's function, its criticality to the network and the proposed investments.

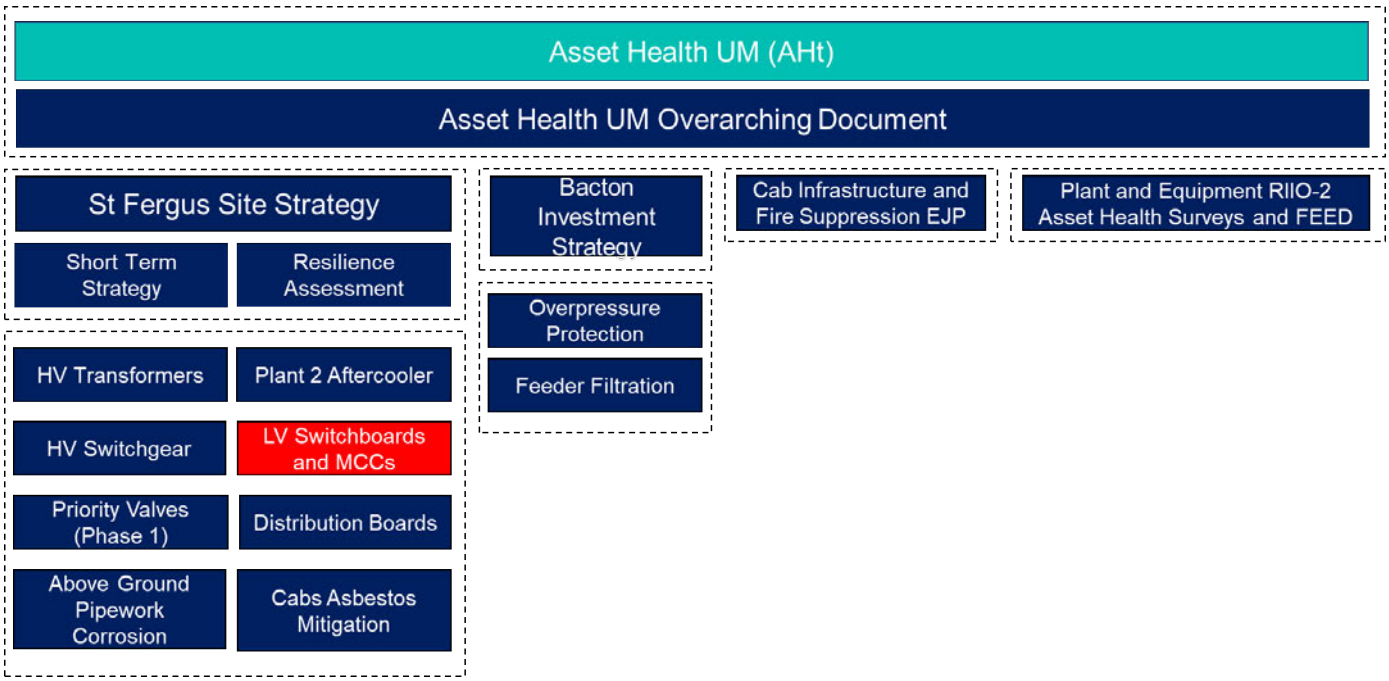

Figure 1: St Fergus Submission Documents Structure

3. The St Fergus Gas Terminal handles between 25% and 50% of the UK's gas supplies, dependent on supply and demand patterns. The site has been in continuous operation for over 45 years and is now moving beyond the design life of the critical original assets. The site is one of two upper tier COMAH sites on our network and as such is a major accident hazard site, subject to regular HSE and SEPA inspections and significant health, safety, and environmental legislation.

4. The St Fergus Site Strategy confirms the requirement for investing in LV Switchboards and MCCs associated with compressor units required until 2030. This is because the assets in this scope have been found to have asset health issues posing failure risks. Failure of these assets would result in the unavailability of essential compressor units and prolonged downtime depending on the nature of failure.

5. The RIIO-T2 business plan included all work associated with Plant 1 and Plant 2 under the Emissions Uncertainty Mechanism as the uncertainty about the future solution affected all those

assets. With a clear understanding of the required plants and units until 2050, it is now pertinent to invest in the associated LV Switchboards and MCCs to enable continued compressor unit operation with sufficient availability and reliability.

6. Cognisant of the age, obsolescence and risks associated with LV Switchboards and MCCs at St Fergus, surveys have been done to ascertain their condition and compliance to current electrical regulations and standards. The surveys were done by a contractor as guided by a detailed project scope document, covering mainly the electrical, instrumentation and control aspects of these assets.

7. Several asset health concerns were discovered and highlighted in survey reports prompting the need to consider the required investment. Of major concern is the assets' deterioration due to age, corrosion, and wear. This has resulted in increasing defects being recorded and the assets becoming unreliable, unsafe to operate or difficult to work on. The assets in scope are no longer suitable from a personnel and equipment safety perspective as they are not compliant with Arc Flash Protection standards as further detailed in the problem statement section. The findings on each asset are detailed in the contractor's report in Appendix B.

8. The impact of spares obsolescence has also significantly affected the maintenance function as LV Switchboards spares are no longer supported by the respective manufacturers.

9. Also of concern is the failure of several of these assets to comply to BS EN /IEC 61439, which is a standardised set of safety requirements for power switchgear and control gear assemblies. The purpose of the standard is to harmonise existing general regulations and obligations to achieve uniform expectations and verifications for LV Switchboards and control gear assemblies.

10. Also, of importance to NGT is the compliance of all relevant electrical assets to the Transmission Specification Electrical (T/SP/EL/50). This electrical specification covers the design, manufacture, supply, construction, installation, inspection, testing and commissioning of the main types and aspects of electrical equipment including LV Switchgears and MCCs.

11. NGT is submitting this investment proposal in the June asset health submission window as funding is needed immediately to ensure safe and continued operation of the site in the short-term out to 2030. A project summary, included in Appendix A, provides key information on this project.

12. The options considered for the LV Switchgears and MCCs are:

    - Do nothing
    - Refurbishment
    - Replacement

13. The recommended option is to replace the 11 identified out of the 18 LV Switchboards and MCCs to require replacement, with the primary benefit of this investment being to eliminate all known safety issues and defects. This will also eliminate the current spares' obsolescence risk and at the same time capitalises on the latest technologies developed for LV Switchgears and MCCs. The remaining seven will not require replacement because they are associated with compressor units which are redundant or only required for the short-term i.e. to around 2030.

14. The indicative cost of this investment is [redacted] (18/19 price base). The estimated RIIO-T2 cost profile is shown in the Table 1. This project is at Stage 4.2 in the ND500 process: Option Selection. Therefore, the cost accuracy is estimated at +30/-15% in accordance with the Infrastructure and Projects Authority (IPA) cost estimating guidance.

Table 1 Current estimated RIIO-T2 spend profile

£m 18/19	FY2023	FY2024	FY2025	FY2026	Total	Comments
LV Switchboards and MCCs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

15. NGT are making this funding application for the LV Switchgears and MCCs replacement Programme RIIO-T2 investment costs through the Asset Health Re-opener, in line with Special Condition 3.14, requesting an adjustment to the value of the NARMAHOt term for costs incurred in RIIO-T2.

16. This is summarised, along with other investments, within in the Asset Health Overarching Document provided as Product 1 of the June 2023 Asset Health Re-opener Submission.

2. Introduction

17. All the assets in this scope have been operating for more than 45 years old, against the Gas Transmission Electrical Specifications (T/SP/EL/50) which states that, all electrical systems and equipment should be designed for an operating life of at least 25 years unless otherwise stated. The prolonged operation time has caused numerous operational defects owing to aged components which are no longer adequately supported by the Original Equipment Manufacturer (OEM) as they are obsolete.

18. In developing our investment programmes at the St Fergus Gas Terminal since the RIIO-T2 Final Determinations, we have adopted a two-phase strategy to ensure clarity between short-term asset health and long-term site operating strategy.

19. Our St Fergus Short-Term Strategy provides certainty on the terminal operation requirements, including minimum compression across Plant 1 and 2, for operation out to 2030. The long-term strategy will deliver the enduring terminal solution, including compression, required for operation beyond 2030.

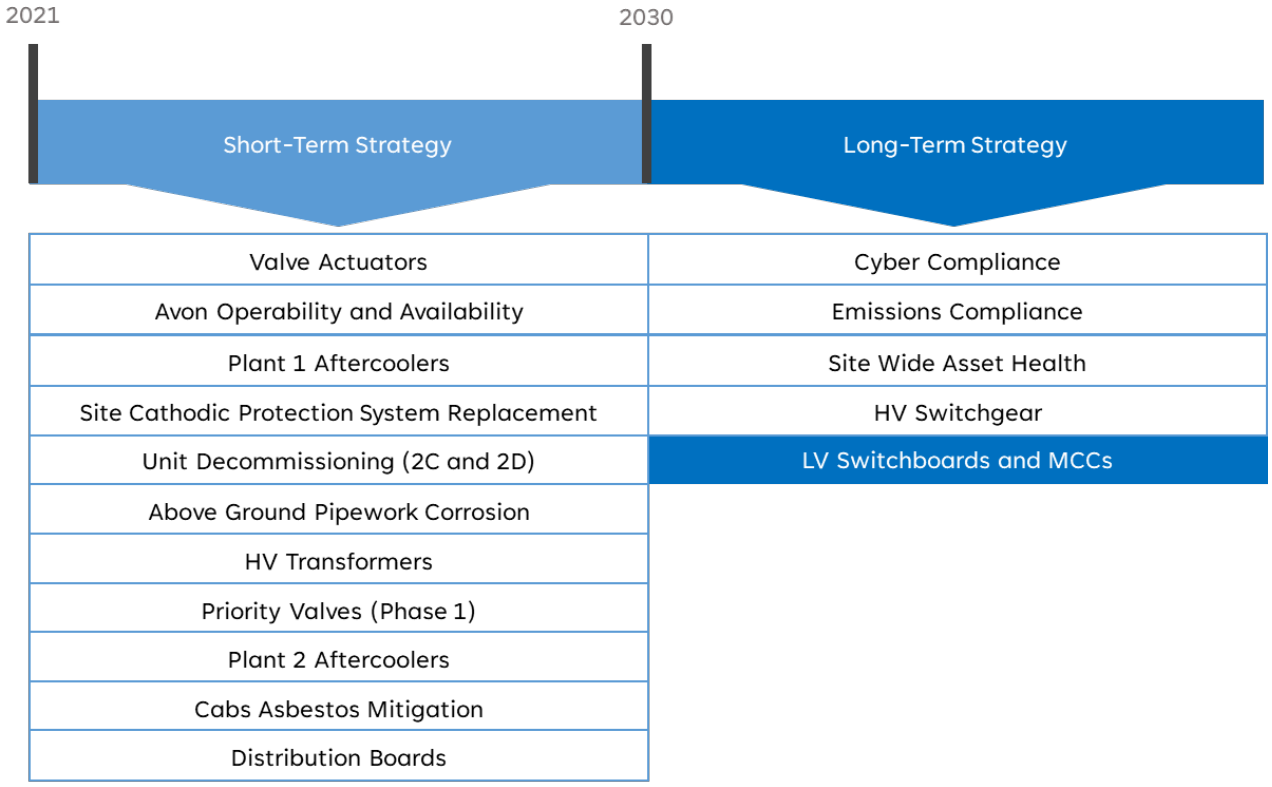

Figure 2: St Fergus Site Strategies Summary

20. The St Fergus Site Strategy outlines which compressor units are required for short-term operation and the proposed solution for the long-term. That information is fundamental to the proposals in this paper, therefore, it is important that these two documents are considered in parallel.

21. Due to the critical nature of the electrical supplies, without a managed programme of investment, the LV Switchboards and MCCs could rapidly become a major risk to the continued safe and efficient operation of St Fergus Site.

22. Recent independent inspection findings and the resultant recommendations by the contractor have also assisted to unearth the risks with a need for immediate investment action.

23. This paper provides the justification for the most cost-effective investment to ensure a balance between cost, risk, and performance of the LV Switchgears and MCCs.

24. Upon implementation of the proposed investment, the envisaged risk of failure and associated safety risks will be reduced to As Low As Reasonably Practicable (ALARP). This is a requirement aligned with the Health and Safety Executive (HSE) guidance which states the need to make sure risks are reduced to ALARP through weighing the risk against the sacrifice needed to further reduce it.

25. Without investment on the LV Switchboards and MCCs the existing safety risk to site personnel will continue to increase. It also significantly impacts the site's resilience and increases the risk on security of supply as there is an increased risk of long plant outages should there be a major failure resulting in loss of compression capacity.

3. Equipment Summary

26. LV Switchboards are the first stage of power distribution following the main site supply transformer. They are used for the connection of incoming LV Distribution Network Operator (DNO) supplies and providing distribution to downstream LV loads, distribution boards and MCCs.

27. At St Fergus, LV Switchboards cover rated voltages not exceeding 1000 Volts Alternating Current (AC) and rated currents greater than 250 Amperes.

28. There are AC and Direct Current (DC) LV switchboards, where the DC switchboards 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. Figure 3 shows the general arrangement of one of the switchboards in scope and the configuration of all the downstream MCCs.

Figure 3: Main LV Switchboard 'D2' and MCCs Schematic Diagram

29. Low Voltage MCCs are used for downstream distribution to LV loads which are principally electric motors. They are of metal-clad construction with a fault rated busbar system and individual incoming and outgoing circuit breakers and motor starters.

30. In this context, of the 19 LV Switchboards and MCCs on site, 18 were surveyed. Of these 18, 11 have been identified as being in poor condition and are associated with assets which are required for operation to 2050. These are therefore included in the investment scope for reasons

further explained in the problem definition section. The LV Switchboards and MCCs are in three subsites which are:

- Main Terminal Building (MTB).
- Plant 1 Area
- Plant 2 Area

31. All the 11 assets in this scope are summarised in Table 2.

Table 2: List of LV Switchboards and MCCs in scope

#	Subsite	Equipment ID	Manufacture
1	MTB	Main LV Switchboard 'C'	Reyrolle Belmos
2	MTB	Building Services Switchboard 'L'	MEM
3	MTB	General Services Switchboard 'M'	Wallacetown
4	MTB	Electrical Distribution Building Switchboard 'N'	GEC
5	MTB	Main LV Switchboard 'B'	Sepkam Ltd assembly with GEC
6	Plant 1	Main LV Switchboard 'D1'	Reyrolle Belmos
7	Plant 1	General Services Switchboard 'J1'	Wallacetown
8	Plant 1	After Cooler MCC Panel 'K1'	Wallacetown
9	Plant 2	Main LV Switchboard 'D2'	Reyrolle Belmos
10	Plant 2	General Services Switchboard 'J2'	Wallacetown
11	Plant 2	After Cooler MCC Panel 'K2'	Wallacetown

32. For this investment proposal, all the LV Switchboards and MCCs were surveyed with particular focus on:

- Asset condition and performance
- Personnel Safety
- Obsolescence of spares
- Compliance with relevant standards such as BS EN 61439, IEC 60255 and IEC 60269
- Interlocks and earthing integrity

33. Figure 4 and Figure 5 shows representative pictures of some of the boards surveyed. Comprehensive images of all the other surveyed assets are presented in Appendix B. All the boards are old models characterised by mechanical handles and old relay logic. Figure 5 is a photograph of Unit 1C MCC which is isolated due to the condition of the Compressor Cab, the removal of this unit is included in the demolition paper along with Units 2C and 2D.

Figure 4: Building Services Switchboard 'L'

Figure 5: Compressor C1201C Switchboard G1

34. Figure 6 shows a typical desired state of a safe switchboard compliant to latest safety and construction standards.

Figure 6: Typical compliant to best-practice standards switchboard

4. Problem Statement

35. The 11 identified LV Switchboards and MCCs assets to be addressed in this scope are now a safety risk with the potential to cause fatal personnel injuries and reduced site capacity.

36. Inspections and testing are finding an increasing number of defects. Some of the assets are also obsolete and therefore spares are difficult to obtain leading to increased mean time to repair.

37. The key drivers for investment on LV Switchboards and MCCs assets are:

    - **Asset Deterioration –** Elements of the assets are deteriorating due to age, corrosion, and wear. The safety of personnel is now compromised as they are exposed to Arc Flash accidents.
    - **Obsolescence –** Spares supply is no longer being supported by manufacturers.
    - **Legislation –** The inspections on the assets have shown the need to upgrade them to maintain compliance with the Electricity at Work Regulations (EAWR). EAWR came into force in 1990 and revoked a number of other earlier specific regulations which were in effect at the time of installation of many switchboards at St Fergus. With these regulations, employers are given duties and responsibilities to make sure that all work activity that uses or may be affected by electricity is done safely, and that all foreseeable risks are assessed and minimised as much as possible. EAWR aim to prevent death or injury to any person from electrical causes while working or in a work environment. This can include electric shocks or burns, electric arching and fires or explosions started or caused by electricity.

38. Table 3 and Table 4 summarise recent survey findings on the General Services Board 'M' and Plant 1 Main Switchboard 'D1' respectively. Detailed findings of all the LV Switchboards and MCCs are presented in Appendix B. The instrument transformers highlighted in these tables have a lower design life as compared to the design life of the overall switchboards.

Table 3: General Services Board 'M' Survey findings

Topic	Observations	Comment
Obsolescence	Wallacetown Company is now part of Allen West Company Instrument transformers have a life expectancy of 20 years Board consists of Fuse Switches TP and N	Minimal OEM support No retrofit replacement The CTs and VTs are past their LE date and will no longer be accurate
Compliance	Does not comply with BS EN 61439-2009 and T/SP/EL50 Arc Flash Protection. Testing, Measurement and Design rules updated many times since 1975 61439-2 ensures compliance with the Low Voltage Directive	Non -compliance
Protection and Control	Does not comply with IEC 60255 and IEC 60269 Relays and Fuses	No fast-acting safety fuses
Interlocks	Interlocks preventing access are basic mechanical type	Improve on safety interlocking with safe circuit controls monitoring

Table 4: Plant 1 Main Switchboard 'D1' Survey findings

Topic	Observations	Comment
Obsolescence	Reyrolle-Belmos became part of the Reyrolle Parsons Group in 1973 then became part of NEI in 1977 M-PAC Circuit breakers and DBF 3 Circuit breakers are obsolete Instrument transformers have a life expectancy of 20 years	No original OEM support No retrofit replacement with intelligent monitoring The CTs and VTs are past their LE date and will no longer be accurate
Compliance	Does not comply with BS EN 61439-2009 and T/SP/EL50 Arc Flash Protection Testing, Measurement and Design rules updated many times since 1975 61439-2 ensures compliance with the Low Voltage Directive	Noncompliance
Protection and Control	Does not comply with IEC 60255 and IEC 60269 Relays and Fuses Standby generator cannot synchronise with this board which means manual return to mains supply	No intelligent digital fast acting relays and safety fuses Remote control and monitoring of generator circuit breakers and synchronisation is a preferred option
Interlocks	Interlocks preventing access and cross switching of the 3 incomers are electrical and castell key type	Improve on safety interlocking with solid state safe circuit controls

39. Of major concern is the fact that the assets in scope are no longer suitable from a personnel and equipment safety perspective as they are not compliant with Arc Flash Protection standards. An arc flash accident in a switchboard occurs when a large electrical current passes through ionised air and gasses. Such arc flash accidents can be triggered in many ways, but examples are when a metallic tool is dropped across live busbars during maintenance or when a circuit breaker fails during a switching operation.

40. Any person in the vicinity of an arc flash accident is at high risk of being injured or killed if not wearing adequate arc flash clothing and protective equipment. It is clear, therefore, that every effort must be made to eliminate these accidents or at least to minimise their effects.

41. The best solution is to use switchboards and MCCs designed to avoid the occurrence of arc flash accidents, by incorporating features such as insulated arc-free busbar assemblies, which is being sought in this justification paper.

42. The continued use of LV Switchboard and MCC assets without investment will result in continued deterioration which will result in an increasing number of defects and increased safety risk to personnel. Depending upon the severity of a failure, the affected assets may require immediate isolation rather than planned repairs.

43. The desired outcome of this investment is to:

    - Maintain the safe operational availability of St Fergus Site.
    - Eliminate the impact of spares obsolescence to the maintenance function.
    - Ensure compliance with all legal obligations and required standards.

44. All the asset health and safety issues highlighted above for these electrical assets can be attributed to their age, with most installed at the time the site was constructed. They are also of varied designs from several manufacturers as this was dependent on the available designs and costs at the time of procurement and installation of each asset. As a result, the switchboards in scope have widely differing standards of design and construction.

5. Probability of Failure

45. The LV switchgear and MCCs in this scope have operated for more than 45 years, thereby significantly increasing their probability of failure. According to the NGT Gas Transmission Electrical Specification (T/SP/EL/50), all electrical systems and equipment should be designed for an operating life of at least 25 years unless otherwise stated.

46. Inspection findings by the contractor have already revealed a lot of asset safety and compliance shortcomings on these assets. For instance, the Current Transformers (CTs) are past their estimated 20 years design life and will no longer be accurate. CTs are used for metering and protection purposes as an integral part of the switchboards.

47. It was found that there were Earth Leakage Amperes indicated on the Earth Leakage ammeters on the Main Terminal Building (MTB), Plant 1 and Plant 2 Incomers Air Circuit Breaker sections. Readings were between 5 and 25 amps which is a safety hazard. This has since been mitigated through defects maintenance. However, there is still a risk of similar findings recurring and requiring constant investigations which is not a safe operational practice

48. Figure 7 shows the equipment failure mode frequency for LV switchboard and distribution board assets representing the probability of failure predicted for a no investment scenario.

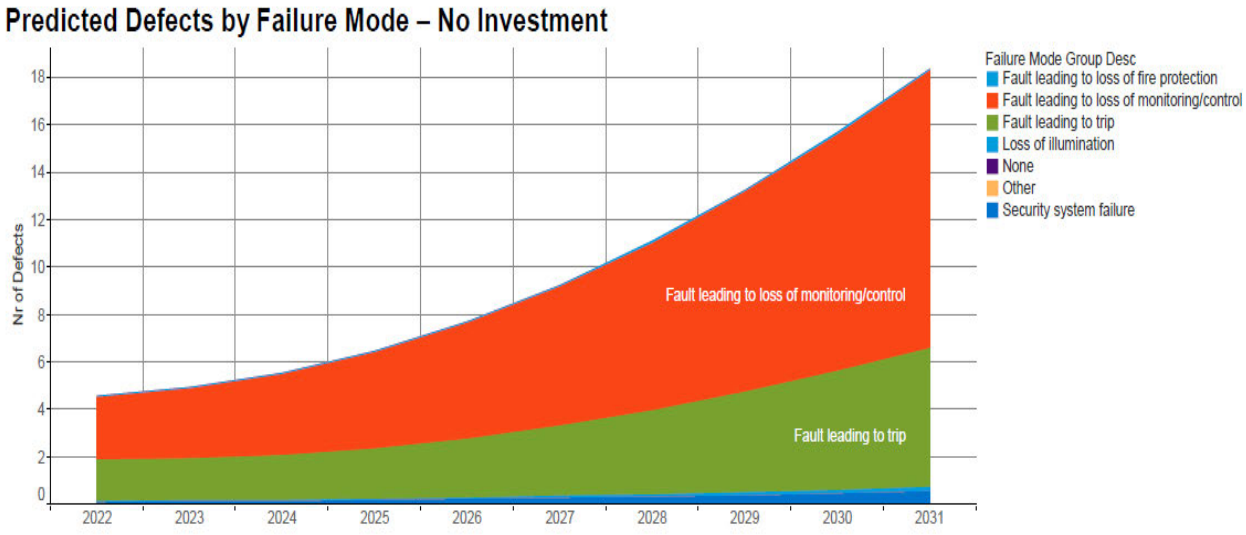

Figure 7: Predicted defects by failure modes

49. The failure modes that contribute most to failures of these types of assets are:

    - Fault leading to loss of monitoring and control.
    - Fault leading to equipment trips.

50. Figure 8 shows the age profiles of Distribution Boards together with LV Switchboards for the network, further giving evidence of a significant number of aged DBs with high probability of failure.

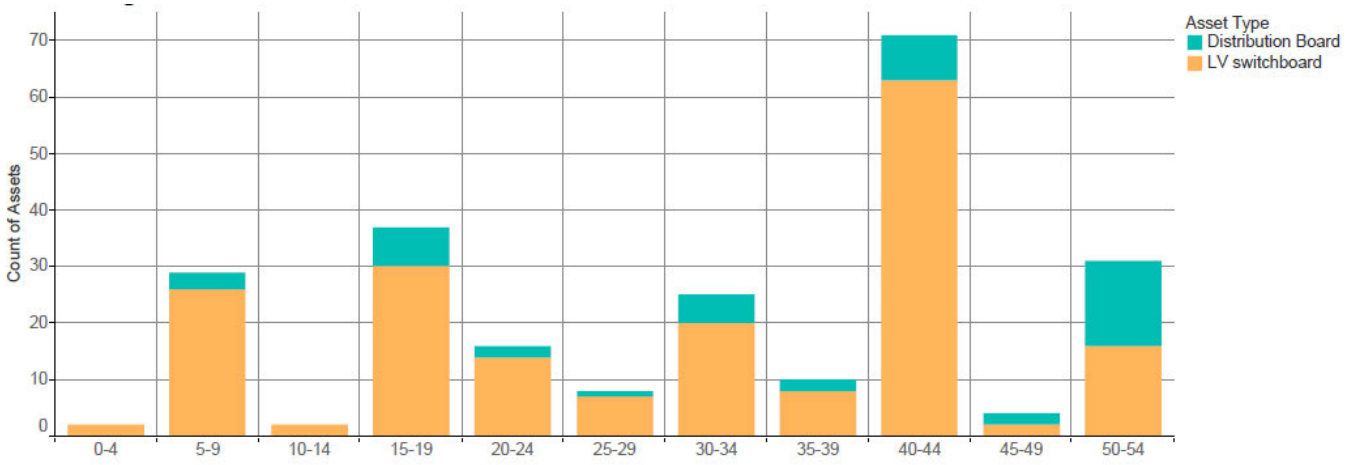

Figure 8: Distribution Boards and LV Switchboards age profile

6. Consequence of Failure

51. The worst-case scenario failure for an LV Switchboard is its inability to supply electrical power to all its outgoing circuits. The impact to loss of supplies due to breakdown failures on the assets in this scope will depend on the corresponding assets being supplied power.

52. In worst case scenarios, this has the potential to result in compressor unit trips and the unavailability of safety, quality, and metering systems.

53. In addition, if certain switchboards listed under the equipment summary section are to fail, this will result in loss of power supplies to the MTB. The ultimate impact of the unavailability of power supplies to the MTB will be failure to operate Plant 4 (Shell), Plant 6 (Ancala) or the whole Terminal which is highly undesirable operationally and could limit the amount of gas being processed through the terminal.

54. Switchboards C, L and M feed the critical supplies to the UPS and Battery Chargers within the MTB which powers the Terminal and Plant 3 Control Systems (Siemens PCS7 and TDC3000). Loss of the entire switchboard would put these systems onto battery backup which are designed for a maximum period of 6 hours. This means the terminal would have to be shut-down into a safe state within this time unless the power supplies to these critical systems could be restored. It is therefore pertinent that failure risks on such switchboards are mitigated to ALARP.

55. Switchboard C is the Main LV switchboard, shown in Appendix C, and by design has 3 independent electrical supply sources BGC/T1 through Incomer 1 Air Circuit Breaker (ACB) C1, BGC/T2 through Incomer 2 Air Circuit Breaker D1 and Petbow Standby Generator through Generator Air Circuit Breaker F1. These are electrically and mechanically interlocked so only one of these ACBs can be closed at a time. Incomer 1 (or Incomer 2) feed the Left-Hand Side (LHS) of Switchboard C which is the normal supply for this switchboard which has protection relays built into it. An electrical fault on the incoming supply would trip ACB C1 and send a start signal to the Standby Generator which would start up and when it is generating the correct voltage and frequency 415V and 50Hz would close ACB F1 restoring supplies to the switchboard. Following investigation into the electrical fault and the incoming supply from SSE being available the power would be restored manually through ACB C1 and the Standby Generator shut down.

56. Switchboard C also has a bus section ACB which is used to connect or separate the LHS and RHS of the switchboard. This is normally closed so the switchboard operates as a single entity but can be opened for maintenance. The outgoing circuits from this switchboard are again duplicated and mechanically interlocked to prevent both supplies being energised simultaneously, these can be swapped over again for faults or maintenance.

57. Provided the supplies to Switchboard ‘C’ are as per the design, the risk of a complete loss of power to the outgoing circuits is extremely unlikely and would be limited to common modes of failure such as loss of tripping or closing supplies, major switchboard failure, building damage/fire. In the event this is realised, supplies to the critical loads would have to be established by site personnel which may not be possible within the 6 hour-period hence the reason shut down of the Terminal has to be considered.

58. Switchboard ‘M’, shown in Appendix D, has a similar design to the Main Switchboard C described in detail above with 2 incoming supplies (both from Switchboard C) and a Bus Section to split the switchboard into a LHS and RHS. As this is a sub-switchboard the outgoing circuits are not duplicated. Critical loads on Switchboard M, are on the LHS with a portable generator connection through B3 if the incoming supplies through B1 and C1 were unavailable. This generator is not permanently connected and would have to be moved to this location and be connected with the bus-section opened to supply only the critical loads.

59. Switchboard ‘L’, shown on a single line diagram in Appendix E, is the only one of these 3 which does not have a bus section so a major fault on this switchboard could lead to an extended outage. It also does not have a generator connection to allow temporary supplies to be connected to the critical UPS and Battery chargers fed from this switchboard.

60. There are numerous other switchboards at St Fergus the failure of which may lead to the outage of a compressor unit or plant until the issue is resolved. This will impact NGT’s ability to handle gas inflows into the site. There will also be the need to vent gas in the event of a trip which impacts on the environment.

61. For instance, if the failure affects a compressor unit which was ordinarily envisaged to be available at the time of failure, then it impacts the site operational strategy. Compensation costs to Shippers would run into millions per day, upstream oil production would likely cease leading to significant flaring.

62. Electrical faults due to switchboard failures can seriously expose operations personnel to electrical burns or electrocution in worst case scenarios. For instance, faulty switchboard may result in an Arc Flash when being operated which poses a safety risk to personnel resulting in injuries or loss of life.

7. Options Considered

63. In total, three options have been considered for management of the condition issues and associated risks outlined in the problem statement. Of these options, two are discounted as they will not address the key investment drivers. Asset deterioration and spares obsolescence, which are the major investment driver for these assets, leaves minimum flexibility in determining viable options.

64. As a result, there is only one logical option which is to replace these electrical assets to make them compliant.

Options Discounted

Option 1: Do nothing

65. This option entails retaining the existing LV Switchgears and MCCs, thus continuing in the current operation and maintenance mode irrespective of the asset health risks and compliance issues identified.

66. Doing nothing is not viable as it does not address safety risks and asset deterioration concerns due to asset deterioration. It is difficult to determine the operating life left in each asset before a fatal failure occurs. Continuing to postpone investment does not eliminate the associated risks but increases the assets' probability of failure and elevates the consequence of failure.

67. There is a need to operate safe plant in compliance with COMAH regulations as well as meeting the expectations set out by the HSE.

68. Given that the site will continue operating to at least 2050, this option will not sustain the St Fergus Operational Strategy. It is therefore necessary that this investment proposal is synchronised with all the other electrical investments as detailed in the Site Strategy document.

69. This option is not viable due to requirements to operate all the electrical assets in scope in compliance with BN EN/IEC 61439 standard and T/SP/EL/50.

Option 2: Major Refurbishment

70. An LV switchgear refurbishment entails completely removing worn or defective components from the enclosure and replacing them with either brand new or recycled functional components. The aim of retrofitting is to extend the useful life of the affected components by restoring system efficiency, safety, and reliability to the current system.

71. However, this option is not viable because upgrading known subcomponents of switchboard does not address impending age and deterioration related failures. Although the life of individual components may be improved, this option is not beneficial from a whole-life cost perspective. Refurbishing is a short-term fix which will inevitably require further intervention as further components eventually fail resulting in downtime. Investing in this option now will not re-life these assets to enable them to operate until 2050 and will still need to be replaced, hence reducing the consumer value for money.

72. The option of partial replacement of components will still be impacted by obsolescence issues where replacement spares compatible with the available switchboards are no longer supported by manufacturers.

73. In addition, retrofitting has the potential to introduce compatibility challenges which will require modifying existing equipment to enable replacement parts to be incorporated. The operating life of such modified electrical assets would be difficult to estimate posing another operational risk.

74. From a compliance perspective, standards such as BN EN/IEC 61439 (which focuses on the integrity, design and construction of the whole switchgear) will not be complied to. As a result, compliance shortcomings will remain unaddressed.

75. As detailed under each option, do nothing and major refurbishment options were discounted and could not be costed as they do not address the major investment drivers and would not deliver the required service of life for the assets to 2050. In summary, these options will not address:

- Elevated risk of a fatal incident occurring due to inferior pre-dated design of present assets (Arc-flash and protection from live components).
- Elevated risk of an occupational health related occurrence due to elevated levels of asbestos fibres and degraded asbestos containing components.
- Obsolescence impacting the safe and continued operational activities and ongoing reliability, availability and maintainability of Terminal assets.
- ALARP requirement for NGT to illustrate it has taken all measures necessary, which as a minimum mandate the use of 'best-practice' standards.
- The Whole-life Cost benefit.

Option Progressed

Option 3: Replacement

76. This option involves completely replacing the existing LV switchboards and MCCs with new equipment. All cables are disconnected from the current system which is then moved off-site before the new switchgear is integrated into the overall power system. Carefully planned outages of a bus-section of each board can be arranged to facilitate installation of a replacement board bus section one at a time. Otherwise, a temporary board can be provided to ensure key supplies to critical loads are maintained during the upgrade. Temporary emergency power can also facilitate maintaining critical power supplies during any upgrade.

77. Design and safety standards for LV switchboards and MCCs have improved and have been updated with most compliant Health and Safety Standards over the past 45 years and it is of paramount importance to upgrade these electrical assets at St Fergus.

78. As a best practice standard, LV switchboards should become controlled and monitored as part of an overall modern digital scheme to enhance the issues listed below. In implementing this replacement option, the project shall adopt these best practices to deliver these benefits.

- Safety and Control – the assets shall be designed with the best safety features such as arc proof.
- Protection.
- Predictable maintenance monitoring.
- Fast reaction to emergency power changeover and secure interlocking.
- Fast changeover to mains supply after an outage.
- Control of cooling fans and performance of fan motors.
- Monitoring and control of UPS and DC power supplies.
- Remote control and operations.
- ATS transfer controls should be implemented.

Advantages

79. The summarised main advantages are:

- Significantly reduces operational risks such as arc flashes to ALARP and enables compliance with latest safety and quality standards.
- Enables NGT to upgrade LV Switchboards and MCCs to newer and more efficient technologies that are compliant with modern switchgear standards.
- Offers a longer life expectancy and in turn providing longer term cost savings.
- Restores switchboards and MCCs efficiency and reliability there by reducing OPEX costs.

Disadvantages

80. The disadvantages are:

- This is the option with the highest immediate cost.
- The replacement process typically involves much longer lead times and a more complex installation process than a switchgear retrofit.

Options Cost Details

Option	Unit cost (£m 18/19)	Volume	Investment value (£m 18/19 prices)
Do Nothing			
Major Refurbishment			
Replacement	[redacted]	[redacted]	[redacted]

Table 5: Option Cost Details

8. Option analysis and selection

81. Table 6 provides a summary of the options considered for the LV Switchgears and MCCs. The table also highlights the recommended option.

Table 6: Summary of considered options

Solution considerations		Option 1 Do Nothing	Option 2 Major Refurbishment	Option 3 Replacement
Cost		Not costed	Not costed	High in short term, but ow from the who e- ife cost perspective and addresses a cost drivers
Compliance	COMAH	Non-comp iant because of the risk associated with aged assets	Non-comp iant because of the risk associated with aged assets	Comp iant
	BN EN/IEC 61439	Non-comp iant due to age	Non-comp iant	Comp iant
	EAWR	Non-comp iant	Non-comp iant	Comp iant
	T/SP/EL/50	Non-comp iant	Non-comp iant	Comp iant
Environmental Impact		Medium due to fai ures resu ting in gas purging	Medium due to fai ures resu ting in gas purging	Low
Maintenance	Ongoing maintenance need	High due to continued deterioration and defects requiring interventions	Medium since refurbishment wi address known defects.	Low
	Risk	High - unsafe for personne to work in the vicinity of high y unpredictab e fai ures.	Medium Recurring defects are mitigated.	Low Recurring defects are reso ved through this intervention
Operational Resilience	Single Point of Failure	High since the probabi ity of fai ure is high and these assets have no direct redundancy	Medium since the probabi ity of fai ure ower that Option 1	Comp iant switchgear and MCCs have very ow probabi ity of fai ure
	Security of Supply	Recurring maintenance activities wou d require continuous p ant outages	High risk - recurring fai ures	Low risk - addresses a age-re ated defects and provides maximum avai abi ity
Overall viability		Not viable	Not viable	Viable

9. Preferred Option Scope and Project Plan

82. The assessments outlined in this paper and the associated discounting and costing of options demonstrates that the most viable, cost effective and logical option to take forward is the replacement of the 11 identified LV Switchgears and MCCs with new compliant ones.

83. Focus is therefore on ensuring LV Switchgears and MCCs of the best available technology are procured and the investment is delivered at the lowest overall cost.

Project Scope

84. The high-level scope for this investment which is the basis of the cost estimate is shown below:

- Disconnection, removal and disposal of the following:
    - MTB x 5 Units
    - Plant 1 x 3 Units
    - Plant 2 x 3 Units
- Installation and termination of the following:
    - MTB x 5 Units
    - Plant 1 x 3 Units
    - Plant 2 x 3 Units
- Specialist Removal and disposal of Switch room floor tiles:
    - Plant 1 x 1 Room
    - Plant 2 x 1 Room
- Installation / Replace of switch room floor tiles:
    - b. Plant 1 x 1 Room
    - c. Plant 2 x 1 Room

Final Cost and program

85. Table 7 provides a breakdown of the final costs for the project split by several categories.

Table 7: Preferred Option Final Costs

	Cost Category	Outturn Costs (£m)	Costs (£m) 2018/19 Price Base
	OEM costs	[redacted]	[redacted]
Direct	EPC Estimate		
Indirect	EPC PM		
Direct	EPC Site Establishment		
Direct	NGT Direct Company Costs		
Indirect	NGT Indirect Company Costs		
	Contractor Risk		
Direct	NGT Project Risk		
	FEED		
	Development / Optioneering		
	Land / Easements		
	TOTAL	[redacted]	[redacted]
	Direct	[redacted]	[redacted]
	Indirect	[redacted]	[redacted]

Asset Health Spend Profile

86. Table 8 shows the spend profile for our preferred option in 2018/19 pricing.

Table 8: Preferred Option Spend Profile

£m 18/19	FY2023	FY2024	FY2025	FY2026	Total	Comments
LV Switchgear and MCCs replacement	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

RIIO-T2 Volume UIDS

87. Table 9 below provides a summary of the UIDs and associated funding for the scope of works proposed in this paper.

Table 9: Summary of UIDs

UID	Baseline volume of Intervention (By PP) (by unit of measure)	Baseline total funding available (£ 18/19)	Current volume of intervention (by unit of measure)	ECC total funding required (£m 18/19)	Output Year	UID funding requested through UM (£m)
[redacted] ST FERGUS TERMINAL – LV Switchboards Replacement	[redacted]	[redacted]	[redacted]	[redacted]	2026	[redacted]
Totals						

88. The cost accuracy at this stage of the project is estimated at +30/-15% in accordance with the Infrastructure and Projects Authority (IPA) cost estimating guidance.

89. This report has explained the safety concerns NGT has regarding the defected transformers and the implications of these on terminal operations. The intervention is necessary to ensure the safety of site personnel and ongoing 24/7/365 operation of the terminal facility.

90. Removal and the subsequent replacement of transformers at the St Fergus gas terminal totals [redacted] (18/19 Prices).

NARMS Benefit

91. Following discussions with Ofgem in the NARM Development Monthly Meetings, it is proposed that for simplicity all the investments that arise from the UMs are collated and one NARMs update is provided after the Plant & Equipment submission.

92. For further details and a summary of UIDs please see the Asset Health UM Overarching document.

Conclusion

93. This report has explained the asset health and compliance shortcomings of the LV Switchboards and MCCs at St Fergus and their implications to the safe and reliable operation of the terminal. As detailed in this justification paper, it is of paramount importance to secure the necessary investment to address the highlighted investment drivers.

94. An estimated cost of [redacted] (18/19) is therefore being requested to replace the identified 11 LV switchboards and MCCs.

10. Appendices

Appendix A – Project Summary

Table 10 summarises the key information on the project.

Table 10: Project Summary

Name of project	T2_St Fergus_2021_St Fergus RIIO-2 Asset Health Programme		
Scheme reference	[redacted]		
Primary investment driver	Asset deterioration and Obsolescence		
Project initiation year	2023		
Project close out year	2026		
Total installed cost estimate	[redacted]		
Cost Estimate accuracy (%)	+30/-15		
Project spend to date	[redacted] (all St Fergus T2 AH UM development)		
Current project stage gate	F2		
Reporting table ref	RRP Table 6.3 (Asset Health) and Table 6.4 (Asset Health Projects)		
Outputs included in RIIO-T1 business plan	No		
Spend apportionment 18/19	T1	T2	T3
	[redacted]	[redacted]	[redacted]

Appendix B – [redacted] Report

File: 5210385-001-EL-REP-013, 13 – LV Switchboards & MCCs, [redacted] Rev 3.0, 2023

Appendix C –Switchboard 'C' Single Line Diagram

File: Single line diagram Switchboard 'C', 6011-03-01-03-0036

Appendix D –Switchboard 'M' Single Line Diagram

File: Single line diagram Switchboard 'M', 6011-03-01-03-0061

Appendix E –Switchboard 'L' Single Line Diagram

File: Single line diagram Switchboard 'L', 6011-03-01-03-0002