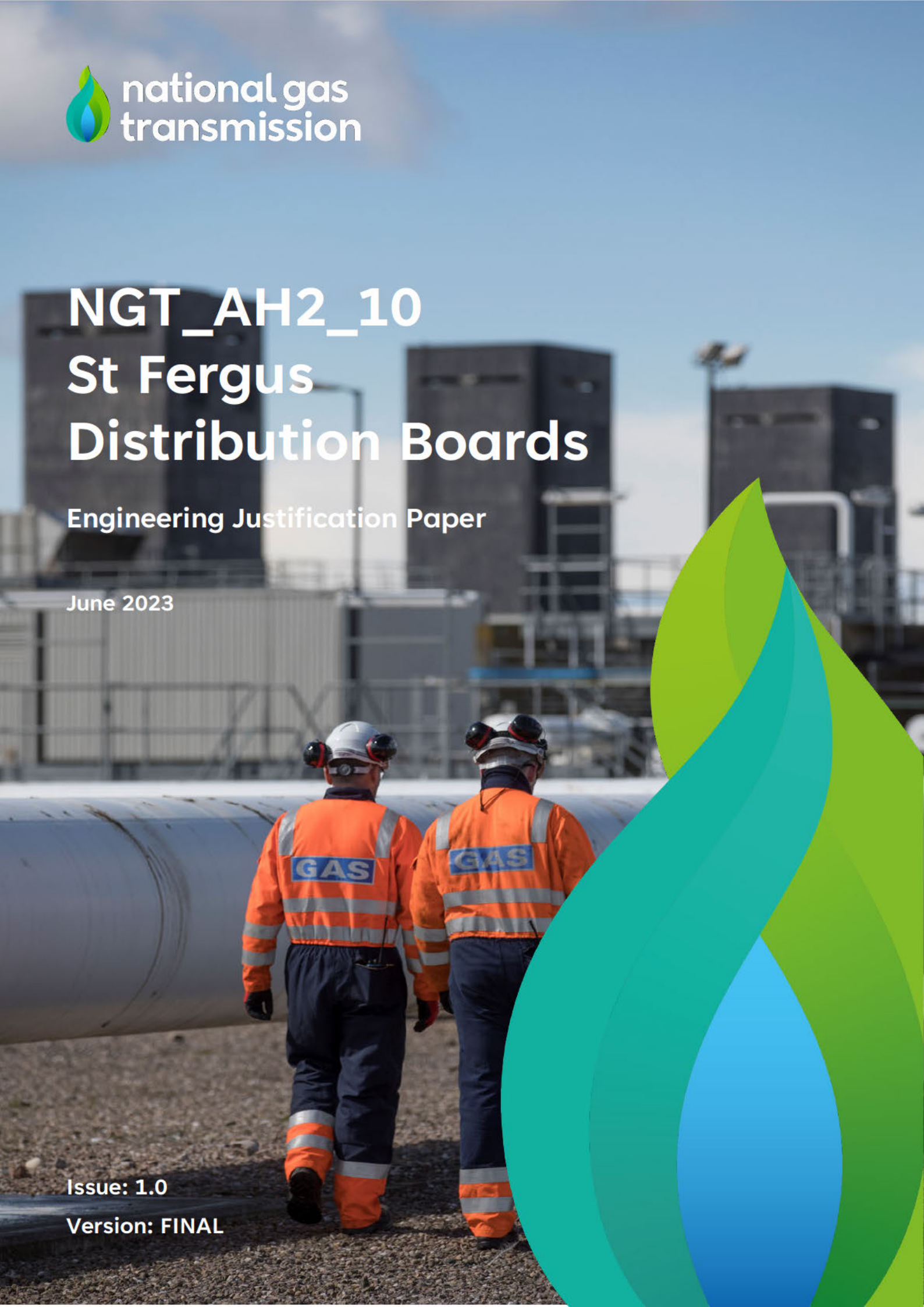
national gas transmission

NGT_AH2_10 St Fergus Distribution Boards

Engineering Justification Paper

June 2023



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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 Distribution Boards (DBs) 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.

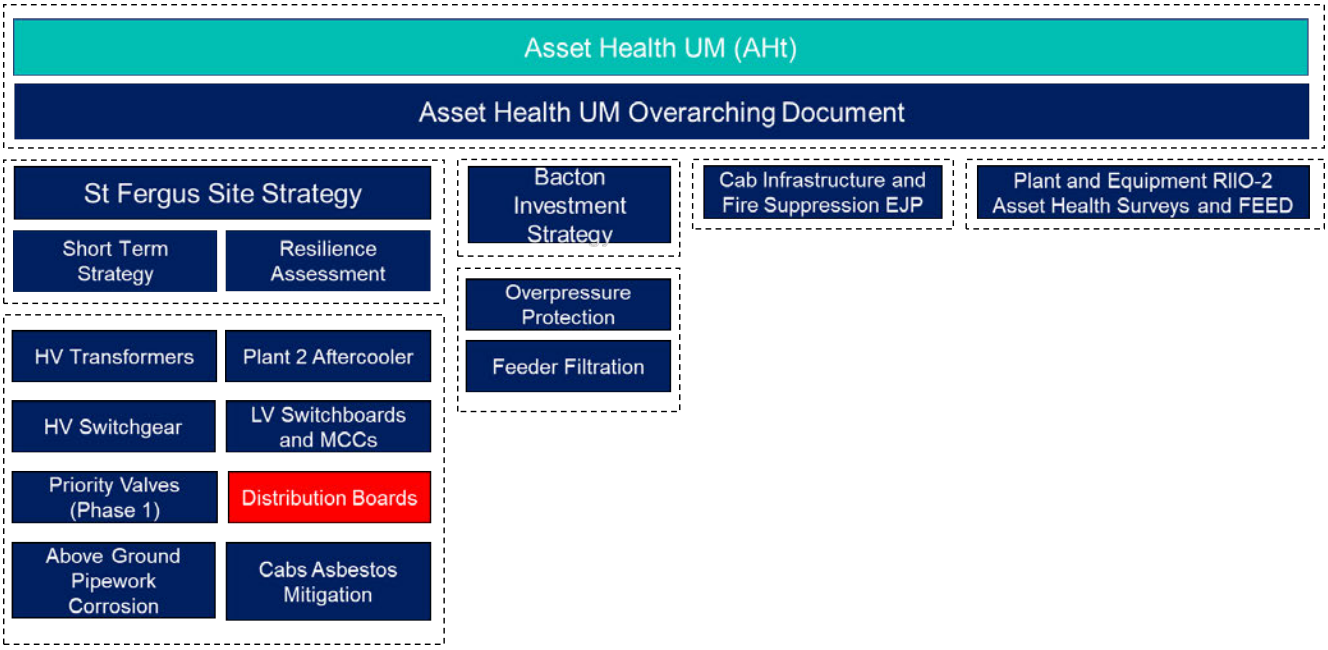

Figure 1: St Fergus Submission Documents Structure

3. The St. Fergus 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 Short-Term Strategy confirms the requirement for investing in Distribution Boards 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 site equipment and ultimately compressor units causing 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 units until 2030, it is now pertinent to invest

in the associated DBs to enable continued compressor units' operation with sufficient availability and reliability.

6. Cognisant of the age, obsolescence and other risks associated with Distribution Boards 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 and 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.

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

9. 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 DBs.

10. 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.

11. The options considered for the DBs are:

    - Do nothing
    - Major Refurbishment
    - Replacement

12. The recommended option is to replace [redacted] out of the 109 DBs in this survey scope. The primary benefit of this investment is the mitigation of all asset health issues exacerbated by obsolescence and unreliable assets. The elevated risk of fatal incidents occurring due to inferior and outdated designs is a cause for concern. Occupational health related occurrences due to degraded asbestos containing components need to be reduced to As Low As Reasonably Practicable (ALARP).

13. In addition, the investment also eliminates the current spares' obsolescence risk and would allow us to capitalise on the latest technologies developed for Distribution Boards.

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
Distribution Boards	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

15. NGT are making this funding application for the Distribution Boards 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 over 45 years resulting in the increased volume of defects as well as spares obsolescence and lack of Original Equipment Manufacturer (OEM) support. This has in turn elevated the risk of fatal incidents occurring due to inferior pre-dated design of present assets which are expose maintenance and operations personnel to arc-flashes and live components.

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.

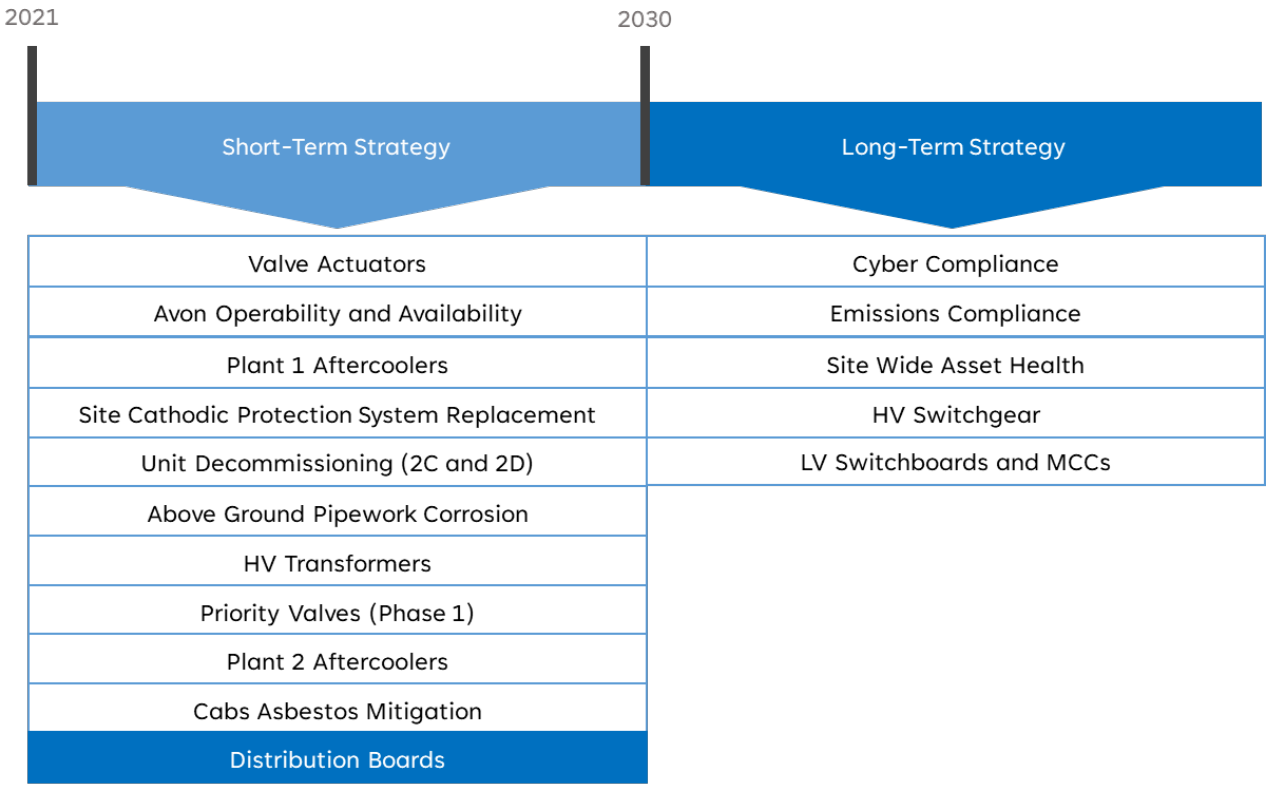

Figure 2: St Fergus Site Strategies Summary

20. The St Fergus Short-Term Strategy supports the decision to rationalise the compression units across Plant 1 and 2 to four Avon units (1A, 1B, 1D and 2B) and maintain these in operation to at least 2030. That recommendation is fundamental to the proposals in this justification paper, therefore, it is important that these two documents are considered in parallel. The now confirmed long-term plan to keep both Plants 1 and 2 makes it pertinent to invest in distribution boards related to both.

21. The Project Scope Documents (Appendix) covered a total of 109 Distribution Boards which were in turn surveyed by the contractor. A total of [redacted] DBs which form the scope of this justification paper were found to have asset heath issues. This is evidenced by the numerous operational defects owing to aged components, some of which are no longer adequately supported by the Original Equipment Manufacturer (OEM) as they are obsolete.

22. Due to the critical nature of the electrical supplies, without a managed programme of investment the DBs could rapidly become a major risk to the continued safe and efficient operation of the St Fergus site. The elevated risk of an occupational health related occurrence due to elevated levels of asbestos fibres and degraded asbestos containing components.

23. Recent independent survey findings and the resultant recommendations by the contractor have significantly contributed to this investment scope as detailed in Appendix B. Surveys were conducted on all the site DBs resulting in specific risk determinations and mitigatory scope definitions.

24. This paper provides the justification for the cost-effective investment to ensure a balance between cost, risk, and performance of the DBs. 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 ALARP through weighing the risk against the sacrifice needed to further reduce it.

25. Not investing in the Distribution Boards gradually increases the safety risk to site personnel. 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. Distribution boards are an important part of an electricity supply system which splits incoming electrical power feed into multiple secondary or subsidiary circuits. All the fuses, breakers and other circuit protection devices for these secondary circuits will be held within the same single enclosure.

27. For illustrative purposes, Figure 3 shows a typical line diagram of Analyser House 1 Raw Power Distribution Boards 2 at St Fergus. This demonstrates the configuration of outgoing circuits to heaters and sample cooling cabinets from a common bus bar rail.

Figure 3: Analyser House 1 RAW DB2

28. The distributed power from the DBs enables more precise and granular control of the supply to different areas, including the ability to isolate and shut down parts of the circuit without completely isolating incoming power.

29. A Distribution Board also provides additional safety features (typically fuses, breakers, Residual Current Devices (RCD) and Miniature Circuit Breakers (MCB)) that allow for safer use of mains power. As each branch circuit has an individual safety cut-off, the entire electrical system is better protected against overloads, short circuits, and other hazards.

4. Problem Statement

30. The St Fergus Distribution Boards in this scope have now been in service for over 45 years with most installed at the time the site was constructed. They are of many varied designs from several manufacturers and therefore have widely differing standards of design and construction.

31. Inspections and testing are finding an increasing number of defects being raised against a range of issues such as:

    - Fuse boards containing asbestos.
    - Lack of protection from live parts posing a personnel safety concern.
    - Arc Flash challenges - 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.
    - Components not functioning or operating correctly there by impacting the performance of downstream equipment such as cabs lighting in Figure 7.
    - Lack of compliance with latest standards such as BS7671 and T/SP/EL/50

32. Figure 3 and Figure 4 shows typical examples of boards which have been identified to contain asbestos in fuse holders. Fuses are consumables on DBs as they periodically blow requiring replacement. As a result, maintenance personnel are frequently exposed to asbestos fibre as they carryout routine maintenance and there is an unacceptable risk as per the Control of Asbestos Regulation 2012.

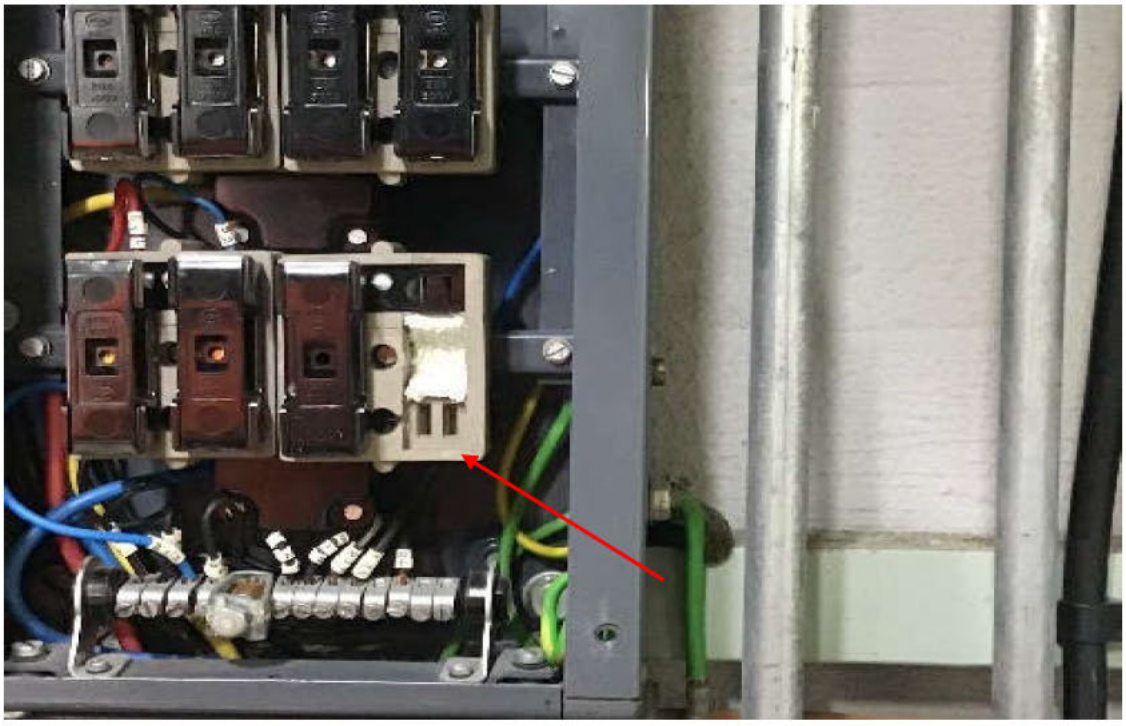

Figure 3: Distribution Board DB(L)

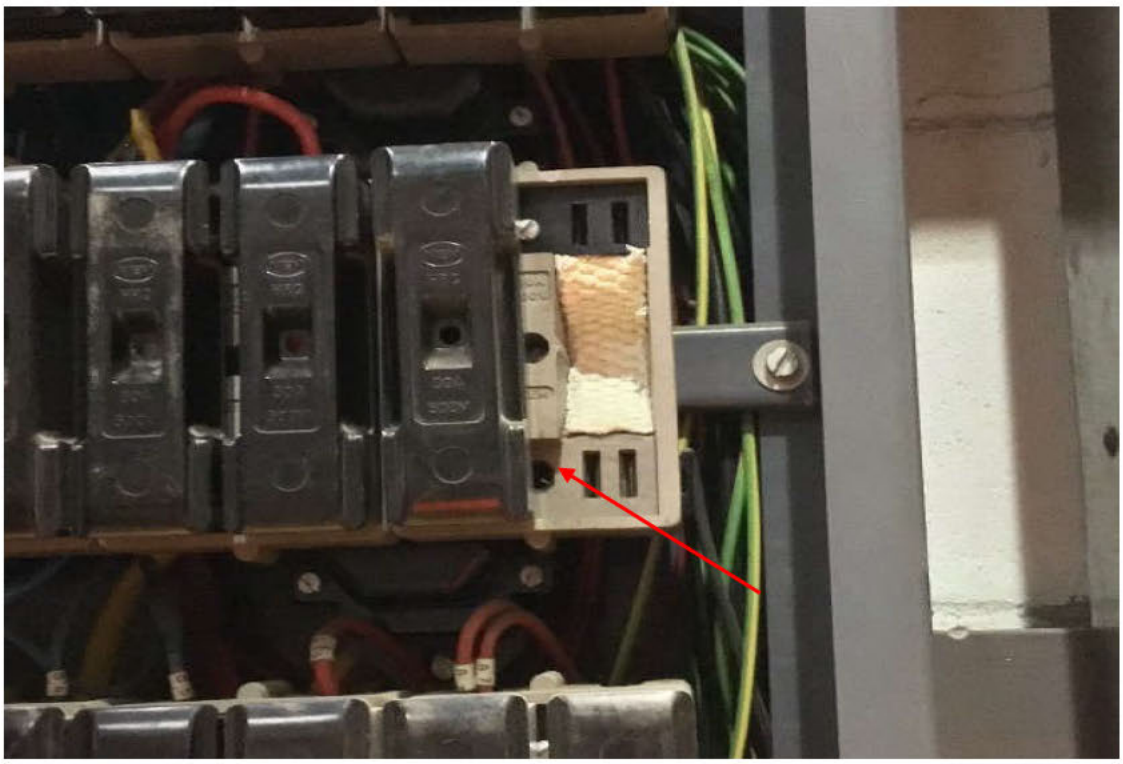

Figure 4: Fuse board 'G' SB/3-E 415V 1

33. The exposed fuse holder sections (indicated by arrows) of the above DBs contain asbestos material which poses a major occupational health risk mainly to maintenance personnel.

34. The bulk of the other DBs in scope were found to have the following issues:

    - Component reliability - there have been failures of fuse holders e.g. GEC Red-Spot sprung contact failure which is a fire risk.
    - Non availability of spares for older DBs and replacement circuit protective devices e.g. Federal Electric; Crabtree Polestar, obsolete for over 10 years as they are no longer being manufactured.
    - Lack of segregation and appropriate covers (Arc Flash risk). Modern distribution boards are fully shrouded internally and allow the safe replacement of Main Circuit Breakers without the requirement to isolate the whole Distribution Board.
    - Many circuit requirements have changed over the years without any associated rationalisation leaving redundant and oversized units in place which still require maintenance and inefficient spending.

35. 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.

36. The best solution is to use Distribution Boards 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.

37. The continued use of Distribution Boards without investment and remediation of the above key issues will result in continued deterioration which will result in an increasing number of defects. Depending upon the severity of the defects, the affected assets may require immediate isolation rather than planned repair which further increases the impact.

38. 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. In worst case scenarios, this has the potential to result in:

    - Compressor unit trips thereby disrupting gas flow though the site.
    - The unavailability of safety, quality, and metering systems.

39. This investment will be beneficial as it will resolve elevated safety and occupational risks highlighted above. The investment will also reduce maintenance activities and defects thereby reducing operating expenditure and in turn increase the reliability of the compressor sites, ensuring the continued safe and efficient operation of the NTS.

5. Probability of Failure

40. The distribution boards in scope have exceeded their estimated design life of 40 years thereby increasing their probability of failure.

41. Figure 5 shows the equipment failure mode frequency for Distribution Boards and LV Switchboard representing the probability of failure predicted for a no investment scenario using our Network Output Measures (NOMs) methodology.

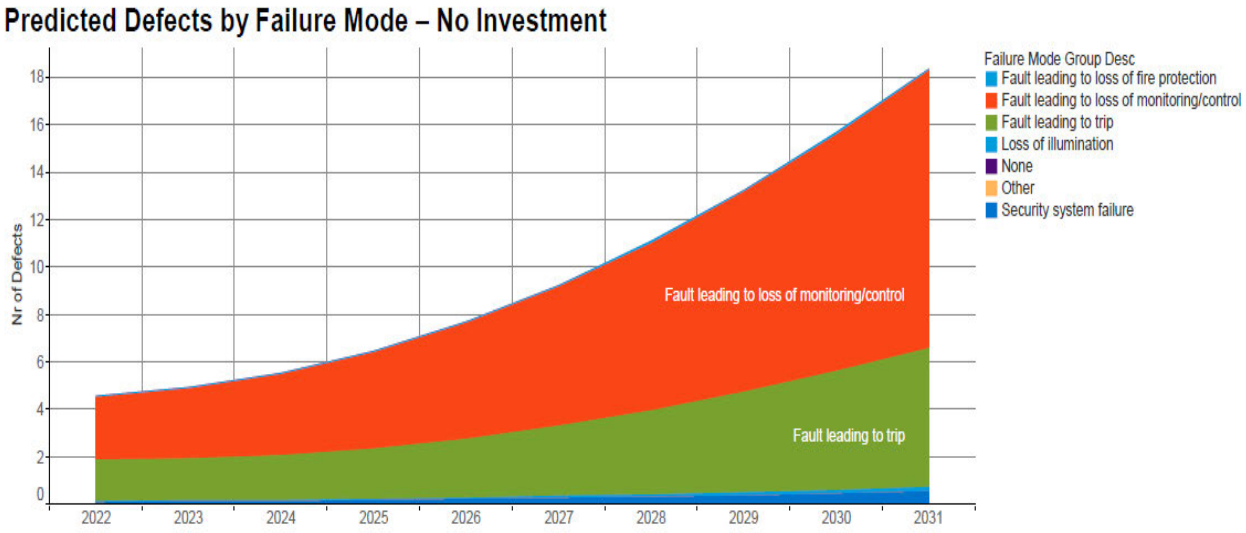

Figure 5: Predicted defects by failure modes

42. 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.

43. Figure 6 shows the age profiles of Distribution Boards together with Low Voltage (LV) Switchboards, further giving evidence of a significant number of aged DBs with high probability of failure as presented in the 2019 Electrical Justification Paper.

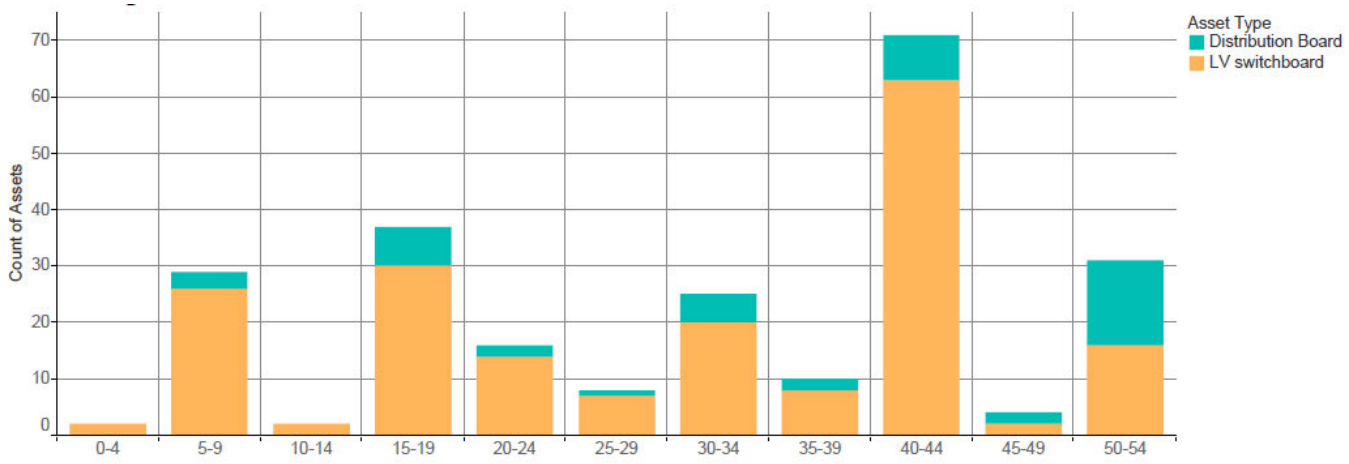

Figure 6: Distribution Boards and LV Switchboards

Figure 6: Distribution Boards and LV Switchgear Age profile

44. As shown above, most assets are predominantly above 40years old and inspection findings by the contractor revealed asset health and compliance shortcomings on these assets.

45. As highlighted in section 5, several DBs were found to contain asbestos in fuse holders with about 51 failing to meet compliance requirements.

6. Consequence of Failure

46. The worst-case scenario failure for a Distribution Board failure is its inability to supply electrical power to all its outgoing circuits. This will then render all the downstream equipment unavailable. A failure can also be localised to a particular outgoing circuit and its severity will result in the affected equipment being unavailable. These scenarios may result in the failure to compress gas to fulfil suppliers and customers' contractual obligations which in turn results excessive financial penalties.

47. A failure of a Distribution Board can lead to the outage of a compressor unit, plant or the entire terminal until the issue is resolved. This will impact NGT's ability to meet its licence obligations to secure compression for customers. 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.

48. Figure 7 shows a single line diagram with number of critical DBs whose failure affects the availability of Unit 2B, as an example.

Figure 7: Unit 2B Single Line Diagram

49. Electrical faults due to Distribution Boards failures can 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.

50. There is also an environmental risk associated with the failure of DBs as we depend upon the electrical system to operate reliably on demand, which may cause a subsequent loss of gas through trips, vents, and leaks. The carbon emissions associated with the maintenance of assets will contribute to environmental risk. As there are many electrical assets within our asset maintenance systems, the proportional share of maintenance emissions attributed to electrical assets will be significant.

7. Options Considered

51. In total, three options have been considered for management of the condition issues and associated risks outlined under the problem statement section. Two options 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.

52. It is also important to note that other options such as minor refurbishment of sections of individual DBs are not considered as health and safety measures and current legislation will not be met.

Options Discounted

Option 1: Do nothing

53. This option entails retaining the existing Distribution Boards, thus continuing in the current operation and maintenance mode irrespective of the asset health risks and compliance issues highlighted in this paper.

54. Doing nothing is not viable as it does not address safety risks and asset deterioration concerns due to asset deterioration.

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

56. St Fergus has a future to at least 2050, hence with this option the assets would not support the site without investment.

57. This option is not viable due to requirements to operate all the electrical assets in scope in compliance with BS7671 standard and T/SP/EL/50.

Option 2: Major Refurbishment

58. Distribution Boards 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.

59. However, this option is not viable because upgrading known subcomponents of a DB does not address impending age and deterioration related failures. Although the life of individual components may be improved, the other components not changed will also 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 customer value for money.

60. On the other hand, 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.

61. From a compliance perspective, standards such as BN EN/IEC 61439 which focusses on the integrity, design and construction of the whole switchgear will not be complied to. As a result, compliance shortcomings will remain unaddressed. In addition, retrofitting has the potential to introduce new compatibility failure modes.

62. DBs are relatively low-cost items which are tested and certified by the OEM utilising specific components. Retrofitting another OEM's equipment with a different manufacturer will not give the required compliance.

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.

Progressed Option
Option 3: Replacement

63. This option involves completely replacing the existing Distribution Boards with new equipment. All cables are disconnected from the current system which is then moved off-site before the new DB is integrated into the overall power system.

64. Carefully planned outages of each board can be arranged to facilitate installation of a replacement board. 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.

Advantages

65. The main advantages are:
    - Significantly reduces safety risks such as arc flashes to personnel because of recurring defects.
    - Restores DBs efficiency and reliability therefore reducing OPEX costs.
    - Offers a longer life expectancy and in turn providing long term cost savings.
    - Changing the DBs now rather than later will provide better investment value to customers.
    - Enables NGT to upgrade Distribution Boards to newer and more efficient technologies that are compliant with modern standards and avoids spending money to overhaul now and spending more money in a few years to replace.
    - Equipment will be supported by the OEM so any spares such as circuit breakers will be readily available.

Disadvantages

66. The disadvantages are:
    - This is the option with the highest immediate cost.

Options Cost Details

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

8. Option analysis and selection

67. The following table provides a summary of the options considered for the Distribution Boards. The table also highlights the recommended option.

Table 2: Summary of considered options

Solution considerations		Option 1 Do Nothing	Option 2 Major Refurbishment	Option 3 Replacement
Cost		Lowest	Medium	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
	BS7671	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 venting	Medium due to fai ures resu ting in gas venting	Low
Maintenance	Ongoing OPEX	High due to continued deterioration and defects requiring OPEX interventions	High since refurbishment wi address known defects, but new ones wi materia ise since parts wi fundamenta y sti be deteriorated.	Low
	Risk	High - unsafe for personne to work in the vicinity of high y unpredictab e fai ures.	High due to recurring defects.	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 DBs have very ow probabi ity of fai ure
	Security of Supply	Recurring maintenance activities wou d require continuous p ant outages	Recurring maintenance activities wou d require continuous p ant outages	Low - addresses a age-re ated defects and provides maximum avai abi ity
Overall viability		Not viable	Not Viable	Viab e

9. Preferred Option Scope and Project Plan

68. 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 all the defective DBs. The presence of asbestos which needs to be eliminated buttressed the need completely replace the affected DBs.

69. Focus is therefore on ensuring Distribution Boards of the best available technology are procured and the investment is delivered at the lowest overall cost.

Project Scope

70. The scope for this investment, which is the basis of the cost estimate, is shown below:
    - Disconnection, removal and disposal of [redacted] Distribution Boards.
    - Replacement of [redacted] Distribution Boards as per specification in T/SP/EL/50 & BS7671.

Final Cost and program

71. Table 3 provides a breakdown of the final costs (to be finalised) for the project split by several categories.

Table 3: *Preferred Option Final Costs*

	Cost Category	Outturn Costs (£m)	Costs (£m) 2018/19 Price Base
	OEM costs		
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]

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Asset Health Spend Profile

72. Table 4 shows the spend profile for our preferred option in 2018/19 pricing.

Table 4: *Preferred Option spend profile*

£m 18/19	FY2023	FY2024	FY2025	FY2026	Total	Comments
Distribution Boards	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

RIIO-T2 Volume UIDS

73. The table below provides a summary of the UIDs and associated funding for the scope of works proposed in this paper.

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 – Distribution Boards Replacement	[redacted]	[redacted]	[redacted]	[redacted]	2026	[redacted]
Totals						

74. 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.

75. 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.

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

NARMS Benefit

77. 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.

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

Conclusion

79. This report has explained the asset health and compliance shortcomings of the Distribution Boards 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 funding to address the highlighted investment drivers.

80. An estimated amount of [redacted] (18/19 Prices) is therefore being requested to replace the [redacted] identified Distribution Boards.

10. Appendices

Appendix A – Project Summary

Name of project	T2_St Fergus_2021_St Fergus RIIO-2 Asset Health Programme		
Scheme reference	[redacted]		
Primary investment driver	Asset Deterioration/Obsolescence		
Project initiation year	2023		
Project close out year	2026		
Total installed cost estimate 18/19	[redacted]		
Cost Estimate accuracy (%)	+30/-15		
Project spend to date Outturn	[redacted] (all St Fergus T2 AH UM development)		
Current project stage gate	F2		
Reporting table ref	RRP Table 6.3 (Asset Health) and 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-010 Rev 02, 10 – Distribution Boards, [redacted] Rev 2.0, 2023

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