NGT_AH3_03 Primary Protective Device

Engineering Justification Paper

January 2024

[redacted]

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1. Executive Summary

1. In January 2019 a vibration-related failure at [redacted] which discovered slamshut valves able to be bypassed at site. A bypass stream allows a direct flow passage from upstream to downstream pipework without passing through the regulating system. [redacted] deemed unacceptable in terms of National Gas procedural control. Furthermore, section 8.7 of IGEM/TD/13- which was introduced after these assets were built- states that regulator streams shall not be provided with a bypass unless another means of pressure control is incorporated in the system.

2. As a result of [redacted], [redacted] identify all similar bypassed slamshut valves across the NTS, generate a plan for risk controls and implement them to address the issue. [redacted]

3. NGT identified [redacted] sites that contain uncontrolled bypasses around slamshuts and categorised them into three different scenarios based on their site configurations. Site surveys of the current gas pipework arrangement were also undertaken by NGT and a third-party contractor at [redacted] complex sites to identify the type of modification required to comply with the requirement of the applicable regulations (TD/13)/HSE requirements and evaluate a range of possible mitigation options.

4. Solutions at all sites in scope apart from the [redacted] complex sites have been delivered. NGT has ongoing dialogue with HSE and as part of the current project status, [redacted]

5. The total indicative project value for resolving this legacy issue at all [redacted] sites is currently forecast at £3.302m, Ofgem is requested to assess the need case, our preferred option and associated funding request.

2. Summary Table

Name of Project	Primary Protection Device Bypass Systems
Scheme reference/ mechanism or category	[redacted]
Primary Investment Driver	Safety
Output references/type	PAC1065070
Project Initiation Year	2022
Project Close Out Year	2026
Total Installed Cost Estimate (£m)	3.302
Cost Estimated Accuracy (%)	15%
Project Spend to date (£m)	[redacted]
Price Basis	2018/2019
Current Project Stage Gate	ND500 T5 / F4
Reporting Table	RRP Table 6.2 (Projects) and table 6.1 (CAPEX_Summary)
Outputs included in RIIO T1	No
Outputs included in RIIO T2	No

Table 1 Project Summary Table

3. Project Status and Request Summary

Overview

6. National Gas Transmission, hereafter referred to as NGT, are requesting funding to undertake investments to upgrade the primary protection systems on several sites across the NTS. A number of uncontrolled bypasses around protection devices have been identified with the project resolving this issue to bring them to an acceptable level of risk, as low as reasonably practicable (ALARP) as per the guidelines of Health and Safety Executive (HSE).

7. In January 2019, a vibration-related failure at [redacted] Above Ground Installation (AGI) [redacted] discovered bypassed slamshut valves onsite. Two slamshut valves on the pressure reduction streams were identified to have rigid pipework and 1" manual plug valves on them providing a potential route for high pressure gas to bypass the respective slamshut valves. Such bypassing, with no equivalent means to ensure closure of the bypass valves, makes the protective devices (i.e. the slamshut valves) ineffective.

8. Installation of a bypass around slamshut device was a common practice throughout the transmission and distribution networks at the time of these installations, to facilitate balancing of pressure over a closed slamshut to facilitate re-opening it once it has been fired. This design was acceptable before TD/13 was introduced as Communication 1672 in 2001.

9. As a result of these findings, [redacted] to identify all similar bypassed slamshut valves across the National Transmission System (NTS), generate a plan for risk controls and [redacted].

10. From September 2019 to March 2020, NGT carried out an initial desktop assessment of bypass routes around primary protection device (PPD) on the NTS and identified [redacted] slamshut valves with uncontrolled bypasses across [redacted] sites. [redacted]

11. Site surveys have been undertaken to evaluate mitigation options, including assessing the suitability of operational solutions in addition to asset investments. This report provides a detailed view of the project, its associated timings, different options considered and the final preferred options[redacted].

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[1] [redacted]

12. Solutions at all sites in scope apart from [redacted] have been delivered. [redacted]

Project Status

13. [redacted] the project has progressed at funding risk. For all sites apart from [redacted], the project is currently at F2 stage (March 2023), and is due for F4 sanction in February 2024 to facilitate the completion of site investment. Commissioning of systems is happening in a phased manner with the final site scheduled to be completed in May 2024.

14. Optioneering and detailed design is ongoing at [redacted]. Due to complexity of the site configurations and project scopes, works at [redacted] have a forecast completion date of end of T2. [redacted]

Request Summary

15. Total project costs for this request is £3.302m (18/19 price base). This comprises [redacted] (18/19 price base) spent at risk and [redacted] (18/19 price base) estimates for works yet to be completed.

16. The investment within this EJP relates to assets captured within the Plant & Equipment Asset Health Investment Theme. As documented through our Plant & Equipment EJP funding was awarded through our RIIO-2 determination for three years of RIIO-2. Our Plant & Equipment EJP has also documented the additional funding required to remediate additional sites surveyed, and therefore there was no opportunity to risk trade funding from other UIDs to fund the work detailed within this paper, requiring the submission of this additional funding request.

17. Ofgem are invited to assess and approve our preferred options presented within this EJP in line with Special Condition 3.14, which we are requesting an adjustment to the value of the NARMAHOt term.

4. Problem/Opportunity Statement

Why are we doing the work and what happens if we do nothing?

18. In January 2019 a vibration-related failure at [redacted] discovering bypassed slamshut valves onsite. A bypass stream allows a direct flow passage from upstream to downstream pipework without passing through the regulating system. [redacted] deemed unacceptable in terms of National Gas procedural control. Furthermore, section 8.7 of IGEM/TD/13 states that regulator streams shall not be provided with a bypass unless another means of pressure control is incorporated in the system.

19. Installation of a bypass around slamshut device was a common practice throughout the transmission and distribution networks at the time of these installations, to facilitate balancing of pressure over a closed slamshut to facilitate re-opening it once it has been fired. This design was acceptable before TD/13 was introduced as Communication 1672 in 2001.

20. [redacted], [redacted] identify all similar bypassed slamshut valves across the NTS, generate a plan for risk controls and implement them to address the issue. [redacted]

21. A list of protective device with bypass was collected from NGT's asset data repository and verified. Further creep relief calculations were undertaken on those assets. Through these exercises, NGT identified [redacted] slamshut valves with uncontrolled bypasses across [redacted] sites. It has been determined that the slam-shut valves on those pressure reduction streams have rigid pipework and manual plug valves that may allow high-pressure gas to bypass the valves, rendering the protective devices ineffective. This poses a significant risk to the system and NGT, and action is required to address it.

22. To mitigate this risk and bring it to an acceptable level of risk, As Low As Reasonably Practicable (ALARP) as per the guidelines of Health and Safety Executive (HSE), assessment of the controls to the primary protection systems could be adopted has been undertaken, considering the existing assets on site, operational controls and the investment of installing additional protective devices. Assessment is undertaken on an asset by asset basis due to the site specific slamshut configurations.

23. If we do nothing, the risk will remain meaning we will not be able to demonstrate our compliance with IGEM standard and HSE's guidelines. This would result in escalation by the HSE in the form of an Improvement Notice, highlighting doing nothing is not a valid option.

Under what circumstances would the need or option change for this project?

24. Through our optioneering we have considered asset and operational solutions which has helped us determine the correct option on a site by site basis. This holistic approach ensures the preferred option provides the optimum approach to reducing risk to ALARP in the most cost-effective manner.

25. The option papers from sites surveys and options evaluations attached in the Appendix highlight the need for improvement to the primary protection system in all scenarios. In addition, [redacted]

What are we going to do with this project?

26. The project involves identifying the locations of the primary protective devices with the aforementioned safety concern in the NTS, conducting initial surveys at those sites to analyse current site pipework arrangements and modifications required to comply with applicable regulations, then undertaking further creep relief calculations and engineering assessments and implementing preferred operation or asset investments on sites.

27. The engineering solutions at all the sites in scope apart from [redacted] have been implemented following conceptual and detailed design against specific requirements. Works at [redacted] are scheduled to be delivered by May 2024 and solutions at [redacted] are anticipated to be implemented by end of T2 due to complexity of the project and long-lead items.

What makes this project difficult?

28. [redacted] The need to progress the project at pace has required us to commence the project at funding risk. [redacted]

29. Furthermore, the [redacted] identified sites are geographically spread across the country making it more complex to plan and deliver this project across a large geographical region.

30. Additionally, sites have specific asset configurations and designs meaning each site need individual optioneering and design conducted rather than applying a common approach across all of the sites in scope, therefore require bespoke solutions at each site.

31. Further delivery and operational difficulties include availability of the certain contractors that can supply the asset components along with the challenge of long lead items from manufacturers.

32. For [redacted], there will be the need for outages to enable solutions to be implemented. Aligning our works to these outages given other priority work on the NTS poses delivery constraints.

33. All of the aforementioned constraints cause delay in delivering the works on sites.

What are the key milestone dates for project delivery?

34. [redacted] The project aims to have the solutions installed at all the sites in scope apart from the more complex sites- [redacted] - by June 2024. [redacted]

35. We are currently at stage F4 of the Network Development Process (ND500) - a process aimed at defining and managing the projects lifecycle from inception to closure, ensuring we meet minimum requirement for each project phase.

36. Table 2 provides a summary of the programme including scheduled and completed milestones for all sites in scope except [redacted].

ND500 Milestone	Milestone Description	Month
T2		Jan 2023
F2	Feasibility Sanction	March 2023
T3	Agreement to proceed to conceptual design	July 2023
F3	Long Lead Item sanction	November 2023
T4	Scope Freeze	Jan 2024
F4	Detailed Design & Build sanction	Feb 2024
T6	Hand back for closure	May 2024
F5	Closure	June 2024

Table 2 Project Stage Summary for all sites in scope except [redacted]

37. Table 3 provides a summary of the programme at [redacted].

ND500 Milestone	Milestone Description	Month
T4	Scope Freeze	Apr 2024
F4	Detailed Design & Build sanction	Feb 2025
T6	Hand back for closure	Mar 2026
F5	Closure	Aug 2026

Table 3 Project Stage Summary for [redacted]

How will we understand if the project has been successful?

38. Overall project success will be defined by the installation and acceptance of the bypassed PPD system modifications.

39. The design assessment/detailed design was a fundamental phase of this project to ensure the pressure protection system modifications we are installing meet the SIL2 requirement and address the [redacted]

40. [redacted]

Related Projects

41. There are a few related projects at [redacted] sites in scope as follows:

Bacton Over Pressurisation Systems

42. [redacted] NGT have progressed a project to install additional assets to meet this requirement. This investment is progressing at funding risk and is subject to a separate funding request.

Flow Control Valve Stream/ Pressure Reduction Stream Replacement

43. [redacted] – PRS streams A and B are scheduled to be replaced in 25/26, including removing the FCV. Streams C, D and E in this project's scope are not being intervened upon, therefore, no interaction.

Project Boundaries

44. The boundary of this project is delivery of investments to mitigate the uncontrolled bypass risk at identified sites. This involves undertaking assessments to understand the current layouts of the bypassed primary protective devices, assessing all possible options to resolve the issue, delivery of the selected options, updating of drawings and records.

5. Project Definition

Assets in Scope

45. The purpose of flow or pressure regulation is to allow control of gas pressure/flow characteristics from the NTS pressure to that required for use by customers, actuation of valves or to provide fuel gas to compressors.

46. Flow Control Valves (FCVs) allow the remote control of the flow of gas and pressure between two or more sections of pipeline. They are sometimes used in conjunction with Pressure Regulators and other devices such as Slamshuts to make up a flow control stream. They may be configured as single streams or be configured with two or more streams in parallel. The stream may contain additional components such as valves, pilot valves, filters and impulse pipework.

47. Pressure reduction streams control the pressure between two different pressure tiers. Their prime purpose is to control and regulate the pressure into the downstream pipeline or pipework. Typically, a Pressure Reduction Installation (PRI) consists of a pair of streams in working / standby configuration. The main components of stream consist of a Slamshut, two Regulators and a relief valve. Additional components include valves, pilot valves, filters and impulse pipework.

48. Pressure Systems Regulations require, in some instances, the use of “Protective Devices”. These devices are designed to protect the pressure system against system failure, and give warning that failure may occur. Some devices are classified as “Primary Protective Devices”, they act as the final or ultimate devices to prevent safe operating limits being exceeded.

49. Downstream over pressurisation must be avoided to protect pipework and equipment from being exposed to pressures for which they are not designed. In extreme cases of over pressurisation, loss of containment can be experienced as a result of, for example, leakage from pipe joints, or rupture of pipework.

50. Slamshuts or relief valves installed on a Pressure/ Flow control streams typically act as Primary Protective devices which automatically operate if the downstream pressure increases above the maximum operating pressure, to protect the downstream pipe work from over pressure failure.

51. Slamshuts are designed to operate at a level that does not exceed the designated 'Safe Operating Limit' (SOL) of the pipework. The SOL is set such that a margin of safety exists between the SOL and the point at which overpressurisation might cause damage. The pressures at which slamshuts are triggered on equipment that makes up the NTS ranges

from approximately 10 mbar up to the full NTS pressure of 94 bar. All slamshuts operating in above 7 bar systems are covered by PSSR legislation.

52. Similarly, a creep relief valve relieves excess pressure by having a lower set-point than the related slamshut to prevent ‘nuisance’ operation of slamshut. Increases in downstream pressure, for example, caused by slight weeping of gas through a pressure regulator during a period of no flow or rising in downstream surrounding temperature are managed via a creep relief valve.

[redacted]

Slamshut valve

Pipework bypassing the slamshut valve

Figure 1 An annotated photo to show a slamshut with a bypass pipework around it at [redacted]

53. When a slamshut operates it closes off the supply to downstream connected systems. This can result in a pressure differential building across the closed slamshut. In order to re-open the slamshut it is necessary to reduce or balance the pressure across the device. It is common to install fixed bypass pipework around a slamshut to facilitate this activity as shown in Figure 1. However this should be avoided if no adequate protection is available. The bypass pipework will have manually operable isolation valves installed that in normal operating conditions are maintained in the closed position. These valves are operated on an as-needs basis to facilitate resetting of a tripped slamshut.

54. Through conducting data gathering of protective devices with bypasses in the network and creep relief calculations, bypassed slamshuts were identified on [redacted] sites. They are [redacted].

55. The table below summarises existing slamshuts on these sites.

Site Name	Description	Slamshut Setting (Barg)	Above ground or below ground
Scenario 1- Double-stream flow regulating system with a bypass stream			
[redacted]	Slamshut valve Stream 1 93/Stream 2 92	76	Above ground
[redacted]	Slamshut valve 23/27	76	Below ground
Scenario 2- A bypass around the slamshut valve to a downstream asset such as compressor unit and boiler house			
[redacted]	Fuel gas slamshut to Unit D	34	Above ground
[redacted]	Fuel gas slamshut to Unit C	34	Above ground
[redacted]	Slamshuts on Boiler House Supply Stream A & B	10.1/10.3	Above ground
[redacted]	Slamshut on Power Station Supply	36.1/28.6	Above ground
[redacted]	Slamshut Stream F SS3	8.9	Above ground
[redacted]	Slamshut stream D SS1/ Stream E SS2	10.1/9.6	Above ground
[redacted]	Slamshut on heating supply Stream C & D	14.4/11.5	Above ground
[redacted]	Slamshut on heating supply Stream E	13	Above ground
[redacted]	Slamshut on heating supply Stream C & D	10	Above ground
[redacted]	Slamshut on heating supply Stream E	9	Above ground
[redacted]	Slamshuts on Power Station Supply	37.6/39	Above ground
[redacted]	Slamshut valve SS3	9	Above ground
[redacted]	Slamshuts to Feeders 2 & 23	79.25	Above ground
[redacted]	Slamshuts to Feeders	79.25	Above ground
[redacted]	Slamshut Valve STM1 27/STM 2 31	75.8/74.8	Above ground
[redacted]	Slamshuts on Boiler House Supply Stream 1 & 2	9/9.8	Above ground
[redacted]	Slamshut Valve SS3 Stream E	6.5	Above ground
[redacted]	1st slamshut	4.5 approx	Above ground
[redacted]	Slamshut valves streams 1 & 2	20/23	Above ground
[redacted]	Slamshut on Streams A & B boiler house supply	9/10	Above ground
[redacted]	Slamshut on supply to water bath heater PZV5037	7.5	Above ground

[redacted]	Main fuel gas supply slamshuts PCV5119/PCV5106	35	Above ground
[redacted]	Slamshuts on supply to standby generator PCV5419/PCV5406	10/10.3	Above ground
Scenario 3 A bypass around slamshut incomer valve			
[redacted]	Incomer Valve	70 approx	Above ground
[redacted]	Incomer Valve	70 approx	Above ground
[redacted]	Incomer valves (V11003)	60 approx	Above ground
[redacted]	Incomer valve (V41001)	77 approx	Above ground
[redacted]	Incomer Valve (PZV6003/PZV6040)	77 approx	Above ground

Table 4 Assets summary in scope

Real Life Examples of Problem

56. Amongst the [redacted] sites, some sites which have similar asset arrangements and existing assets in the systems present the same/ a similar problem, therefore have been grouped together. There is a total of 3 scenarios:

- **Scenario 1-** Double-stream flow regulating system with an uncontrolled bypass stream.
- **Scenario 2-** A bypass around the slamshut valve to a downstream asset such as compressor unit and boiler house.
- **Scenario 3-** A bypass on slamshut incomer valve.

Scenario 1- Double-stream flow regulating system with an uncontrolled bypass stream

57. At both [redacted], there is a double-stream flow and pressure regulating system controlled by a pair of flow control valves (FCVs) and two independently controlled pressure control valves (PCVs) configured in a parallel stream arrangement. Pressure regulating systems are installed to act as boundary control between feeders rated at 85 bar and 70 bar at Bathgate, and 84 bar and 70 bar at Wooler.

Bathgate

58. [redacted] and is equipped with gas compressors for necessary system pressure up-rating. The gas flows through the site is determined by a series of valves remotely operated by GNCC to achieve the required transmission path. There are no operational interlocks built into the Remote Terminal Unit (RTU) valve logic.

59. The gas passes through a double-stream volumetric flow control system for flow and pressure regulation. The flow rate of gas through the system is controlled by a pair of flow control valves (FCV1 – 605597 and FCV2 – 605536) configured in a parallel stream arrangement. Pressure protection is provided by two independently controlled pressure control valves (PCV1 – 605595 and PCV2 - 605594). Further pressure protection is provided by an independent pressure operated slam-shut system which operates the slam-shut valves SS1 (605593) and SS2 (605592).

60. There is a bypass stream on site equipped with an isolation valve 605515 (V15). The isolation valve is normally locked shut and can be opened if necessary to allow a gas path independent of the existing regulator system for gas supply to Glenmavis area. There are stabbings on the [redacted] bypass pipeline above ground section, which could be utilised for protection devices in any future development. The bypass route is highlighted in figure 2 below.

[redacted]

Figure 2 Bypass route through [redacted]

61. Bypass valve V15 is predominantly used for annual routine valve operations (RVOs). However, it is also used to provide a secondary path to ensure gas meets downstream supply when the primary path is isolated (e.g., it was used during lighting strike in 2015). It is currently isolated and locked closed locally. Remote operation is currently disabled but can be enabled if needed.

62. Volumetric control system allows bi-directional gas flow (and gas-feed from other [redacted]). However, backflow is not available currently as some downstream [redacted] are out of service.

[redacted]

Figure 3 Bypass valve V15 at [redacted]

Figure 4 V15 Surrounding pipework arrangement

[redacted]

63. [redacted] is fed by Feeders [redacted] and consists of the same double-stream flow regulating system as that present at the [redacted]. After passing through the regulator

the gas is then supplied to [redacted]. The desired gas transmission path can be selected manually by operating a number of block valves.

64. There is a bypass stream on site equipped with an isolation valve 635716 (V16). The isolation valve is normally locked shut and can be opened if necessary to allow a gas path independent of the existing regulator system for gas supply to downstream areas. The bypass at [redacted] is entirely buried, and as such any stabbings that may be required as part of the solution will need excavation, and possible hot tap, to avoid outage. The bypass is highlighted in Figure 5 below.

[redacted]

Figure 5 Bypass route through [redacted] (highlighted)

65. [redacted] has an intelligent slamshut system on both streams which can be vulnerable to both slamshuts operating at the same time (which is thought to have occurred at [redacted] following the lightning strike). This is currently an issue as, anecdotally, the slamshuts operate when there is a power dip, although they can be brought back into service rapidly. Similarly, when working on one stream, the other stream can trip.

Scenario 2- A bypass around the slamshut valve to a downstream asset such as compressor unit and boiler house

66. Amongst the [redacted] sites in scope, [redacted] sites have uncontrolled bypassed slamshut valves connected to a downstream asset, including fuel gas at the compressor unit, heating supply, power station supply and boiler house supply. They are [redacted].

67. For example, at both [redacted], there is a bypass around the slamshut valve to fuel gas at the compressor unit. Another example is [redacted] where there are slamshuts in the heating supply stream which have bypass lines. Similarly, at [redacted], there are slamshuts on Power Station Supply which have bypass lines whilst at [redacted] there are slamshuts on Boiler House Supply which have bypass lines. Figures 6 and 7 show the bypassed slamshuts to streams A and B at [redacted].

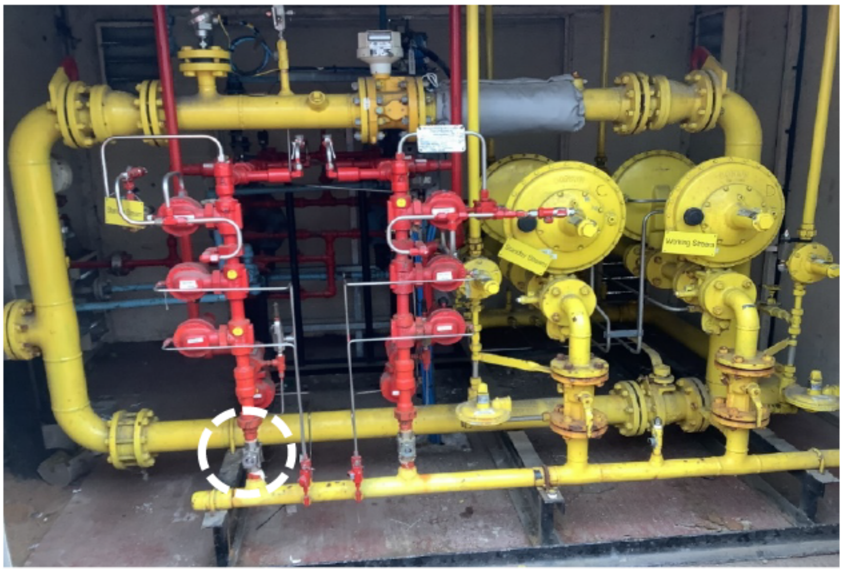

Figure 6 Stream A and B slamshuts (circled) with the bypass lines at [redacted]

Figure 7 Bypass lines (green arrows) for Stream A and B at [redacted]

Scenario 3- A bypass around slamshut incomer valve

68. At both [redacted], a number of incomer valves are found to have uncontrolled bypasses around them, they are slamshuts PZV6040, V21003, V41001, V11003 and PZV600 at [redacted] and slamshuts A/1 and S1/1 at [redacted].

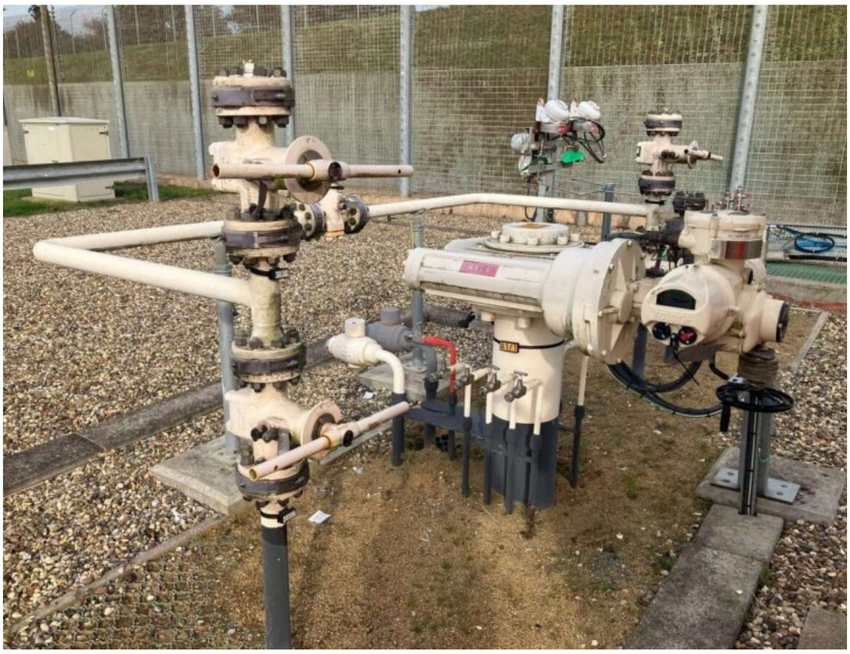

Figure 8 Example of safety valve with bypass installed ([redacted])

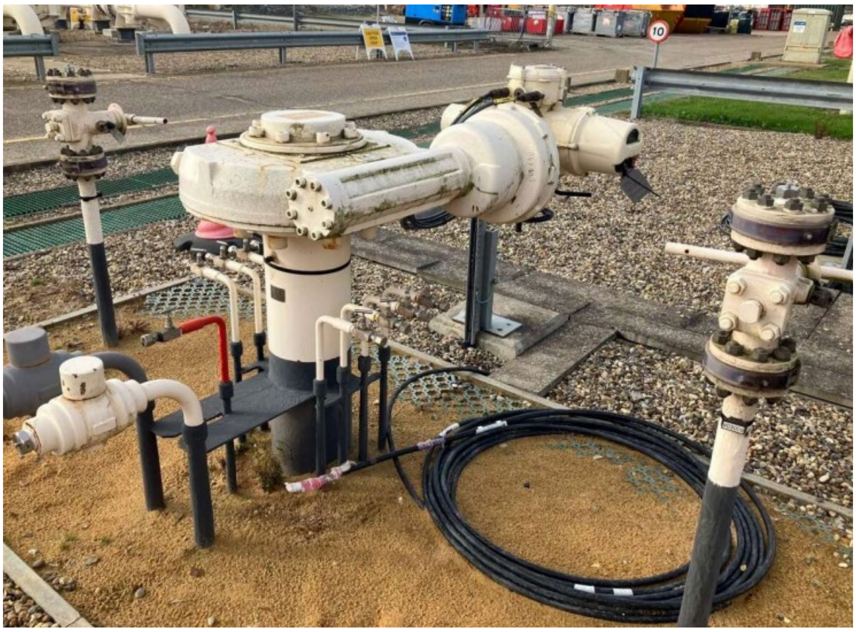

Figure 9 Example of safety valve without bypass installed ([redacted])

6. Options Considered

Option Selection Process

69. A range of operation and asset options were considered against a list of evaluation criteria to shortlist the potential options to be considered further.

70. Additionally, due to the complexity of the site layout at [redacted], surveys of the current gas pipework arrangement were also undertaken by NGT and a third-party contractor at those sites to identify the type of modification required to comply with the requirement of the applicable regulations (TD/13)/HSE requirements and a range of possible options to address the bypass safety concerns.

71. The evaluation criteria being considered when assessing the options are (in approximate order of higher to lower importance):

    - Technical feasibility
    - HSE compliance, Schedule
    - CAPEX
    - OPEX
    - Operational flexibility after modification
    - Project complexity
    - Necessary procedures for carrying out the option

72. A key consideration is compliance to NGT and HSE requirements. The most suitable options should enhance the level of gas safety operationally to satisfy the HSE requirement without impacting the current security of supply.

73. After the high-level assessment based on the evaluation criteria was undertaken, a risk assessment was conducted to assess the selected options qualitatively against various risks based on perspectives of operability, maintenance, network security and other identified categories. The risks/categories are scored for each option based on a simple high (red), medium (amber) and low (green) system. Remedial measures to mitigate the risks were also discussed and presented in the individual site options report attached in the appendix where relevant.

74. The following list of categories for risk assessment were chosen for evaluation:

    - **Operational risk**: This is with respect to the reliability of the new equipment, the OPEX necessary, procedures required, etc.
    - **Maintenance flexibility**: The maintenance demand on the solution, as well as for routine maintenance on other aspects of the AGI (e.g., RVOs)
    - **Network supply security**: Does the solution provide security of supply should the existing regulator streams fail?
    - **Construction complexity**: The CAPEX required, and the time and site disturbance necessary to implement the solution

- **Speed of reinstatement**: This is the time needed to reinstate the bypass gas flow, if the option relates to the elimination or temporary isolation of the bypass route

75. Details of option selections at each site can be found in the Option Papers attached in the Appendix.

Options for 'Scenario 1'- Double-stream flow regulating system with an uncontrolled bypass stream

76. As discussed in section 5, at [redacted], both sites have a double-stream flow and pressure regulating system controlled by a pair of FCVs and two independently controlled PCVs configured in a parallel stream arrangement. A bypass around these regulator streams is present, which poses a potential safety concern should an event of over pressurisation arise.

77. To address this bypass concern, the existing bypass arrangements at both sites need to be modified to comply with the requirement of the applicable regulations. 10 common options were considered, they are:

Option 1A- 'Do Nothing' Keep existing arrangement and de-rate the upstream pipework (where the slamshut valve is located) from 85 bar to 70 bar

78. Option 1A involves derating the pipework upstream of the slamshut to 70 bar from 85 bar. Whilst this would remove the need for the slamshut it is not feasible because of the impact on network operability and capability.

Option 1B- Uprating the pressure rating of downstream feeder to 85 bar

79. Option 1B involves uprating the downstream pipework to match the upstream section. Uprating the downstream system also has implications on downstream assets that may only be rated to 70 bar and therefore need investment to ensure they operate at 85 bar. This would include NGT assets and 3rd party assets, for example, at Distribution network offtakes. Commercial contracts with customers would also need updating.

Option 2- Remove slam shut valve from the bypass stream and restore with pipe spools (and NRV for [redacted])

80. Option 2 involves removing the slamshut from the bypass stream and replacing with a non-return valve and pipe spools. This will remove the physical separation between the upstream and downstream pipework and allow a direct gas passage from the high-pressure system to the low-pressure system, which could over-pressurize the downstream pipework if the upstream supply pressure is higher than the normal operation pressure of

70 bar. As such, it is unlikely to be accepted without additional safety protection due to the potential operational safety risk.

Option 3- Air-gap the bypass stream with inlet and outlet isolation valves

81. Option 3 involves removing the slamshut completely with an ‘air-gap’ in between a pair of isolation valves and blank flanges, physically separating the upstream and downstream systems. Subsequently, the bypass function would be lost until it was deemed necessary to be used for gas supply by operating the isolation valves.

Option 4- Replace slam shut valve with a paddle and isolation valve for maintenance purpose

82. Option 4 involves removing the entire bypass stream from the existing system, including the slamshut and some portion of pipework followed by the capping of the inlet and outlet bypass pipework, resulting in a permanent elimination of the bypass line.

Option 5- Remove the entire bypass stream from the existing system

83. Option 5 involves removing the slamshut and replacing it with a pair of isolation valves with a spectacle blind in-between. The addition of the isolation valves provides an intact separation of upstream and downstream pipework. However, it is uncertain whether the HSE would accept this solution as it involves manual procedural control which has an inherent risk of human error, and from a safety perspective, the spectacle blind would be operated behind only a single isolation.

Option 6- Remove remote control function of the slam shut valve, but keeping local manual control

84. Option 6 involves disabling the remote-control function of the slamshut permanently but keeping the local manual control capability.

Option 7- Add a PRS stream in addition to the existing regulator system for a 2oo3 operation mode

85. Option 7 involves installing a pressure reduction system (PRS) equipped with slam-shut, monitor and active control valves, creep relief and inlet and outlet isolation valves in parallel to the existing two volumetric-control regulator streams, maintaining any two streams to be normally operational for pressure and flow control. To minimize the risk of overpressure, a High Integrity Pressure Protection System could be introduced to shut down the streams from any high-pressure upstream pipework.

Option 8- Add an independent Pressure Reduction System (PRS) stream in addition to the existing regulator system

86. Option 8 involves installing a complete PRS stream which is independent of the existing regulator streams to provide an additional gas supply route.

87. A variant of this option (Option 8b) is to install the PRS equipment onto the bypass line itself, making the bypass a fully regulated stream. This provides the maximum operational safety as the integrity of the stream has now been guaranteed with the protection provided by the PRS. It would also comply with IGEM/TD/13 as there is no alternative gas route bypassing the regulator streams.

Option 9- Adding inlet and outlet isolation valves with creep relief in-between to the bypass route on top of slam shut valve

88. Option 9 involves adding inlet and outlet isolation valves with creep relief in-between to the bypass stream of the slamshut. The creep relief is equipped with inlet isolation valve to prevent gas venting when the bypass is in use.

Option 10- Add pressure interlock (+pressure transmitter) with feedback to slam shut valve

89. Option 10 involves adding a pressure transmitter and interlock with feedback to the slamshut. This allows remote monitoring of the slamshut gas pressure by the operators for immediate reaction on events like over-pressurization.

90. For further details on the options presented above, the full option report has been included in Appendix 2.

91. Below is a summary table of all options considered at [redacted] assessed utilising the assessment criteria.

No.	Operation			Cost		Project Resources		HSE Compliance	Shortlist
	Flexibility after Modification	Complexity	Technical Feasibility	CAPEX	OPEX	Duration	Necessary Procedures and Equipment		
1a 1b	To be assessed	Very ow	Un ike y- subject to network ana ysis	N/A	Low	N/A	Operationa consideration required around procedures, no equipment needed.	TBC	Yes
2	Low due to ack of iso ation va ve between upstream and downstream system	Medium to High- removing arge-diameter ba va ve in vicinity of ive gas pipework	Un ike y- differnet upstream and downstream pressures	Medium to High	Low	1-2 weeks	Gas iso ation and depressurisation of re ated pipework. Co d cutting of concerned va ve and remova of va ve from site. New pipe spoo to be we ded to existing pipework and NDT and pressure test. Equipment needed inc ude Pipe spoo s and NRV	Un ike y as it direct y bypasses a the existing pressure regu ators	No
3	Low due to physica separation between upstream and downstream gas system	Medium insta ing additiona va ves	TBC A considerab e outage window wou d be necessary	Medium to High	N/A	1~2 weeks for modification. 2~3 days for restoring the bypass stream if needed.	Gas iso ation and depressurisation of re ated pipework. Cut pipework. Tie-in new va ves. NDT and pressure test. Equipment needed inc ude Iso ation. va ves (and Pipe spoo s at [redacted])	Acceptab e	Yes
4	Low due to absence of bypass	Medium to High removing buried gas pipework from site and capping the bypass route	TBC A considerab e outage window wou d be necessary. Confirmation needed that bypass wou d not be needed in future.	Medium to High	N/A	A few weeks	Gas iso ation and depressurisation of re ated pipework. Co d cutting of concerned. Pipework and remova of pipework from site. Capping the remaining pipework. NDT and pressure test	Acceptab e	No
5	Low due to physica separation between upstream and downstream gas system	Medium to High removing buried gas pipework from site and capping the bypass route	TBC A considerab e outage window wou d be necessary	Medium to High	N/A	1-2 weeks	Gas iso ation and depressurisation of re ated pipework. Co d cutting of concerned va ve and remova of va ve from site. Tie-in of new pipework and insta ation of spectac e b ind. NDT and pressure test. Spectac e b ind and va ves needed	Like y. TBC	Yes

6	Medium, due to physica separation between upstream and downstream gas system Current V15 sea ing condition to be assessed	Very ow	Adopted as the current operation mode for [redacted] station	N/A	N/A	N/A	N/A	Unacceptab e	No
7	High due to additiona redundancy in option of fai ures of current regu ator streams	Very high exposing the existing buried pipework, cutting, and modifying existing pipework to tie-in with the new stream	TBC a considerab e outage window wou d be necessary	Very High	Additiona OPEX for maintaining the new PRS stream	1~2 months inc uding commissioning time	Gas iso ation and depressurisation of re ated pipework. Co d cutting of concerned pipework and removing them from site. New pipework and regu ators tie-in to existing pipework. NDT and pressure test T&C of the new regu ator stream. Equipment required inc ude S am-shut va ve. Monitor contro va ve, Active contro va ve, Creep re ief va ve, In et and out et and iso ation ba va ves	Like y	Yes
8	High due to additiona redundancy in option of fai ures of current regu ator streams	Very high exposing the existing buried pipework, cutting, and modifying existing pipework to tie-in with the new stream	TBC a considerab e outage window wou d be necessary	Very High Purchasing additiona equipment and p anning site manpower & resources	Additiona OPEX for maintaining the new PRS stream	At [redacted]:1~2 months inc uding commissioning time At [redacted]: Around 1 week	Gas iso ation and depressurisation of re ated pipework. Co d cutting of concerned pipework and removing them from site. New pipework and regu ators tie-in to existing pipework. NDT and pressure test T&C of the new regu ator stream. Equipment needed inc ude S am-shut va ve, Monitor contro va ve, Active contro va ve, Creep re ief va ve, In et and out et iso ation ba va ves	Like y	Yes
9	High enhancement of genera operationa safety of the entire system due to the new devices	High removing part of the existing pipework and tie-in of new devices with the bypass stream	TBC a considerab e outage window wou d be necessary	High Purchasing additiona equipment and p anning site manpower & resources	Additiona OPEX for maintaining the new safety devices/equipment	At [redacted]: Around 1 week At [redacted]: A few days	Gas iso ation and depressurisation of re ated pipework Co d cutting of concerned pipework and removing them from site New pipework and safety devices tie-in to existing pipework NDT and pressure test T&C of the new devices.	To be assessed depending on the type of safety devices added. Further review on IGEM/TD/13 wou d be necessary	No

10	TBA	Medium A tering the va ve contro and new cab ing work anticipated	TBC a considerab e outage window wou d be necessary	TBA	TBA	At [redacted]: A few days At [redacted]: TBA	TBC This wi invo ve excavations, stabbings, site ca cu ation	TBA	Yes

Table 5 Options summary table at Bathgate AGI and Wooler AGI

92. The qualitative assessment of each of the shortlisted options at [redacted] against the risk criteria is summarised in the table below:

Option No.	Operational risk	Maintenance Flexibility	Network Supply Security	Construction Complexity	Speed of Reinstatement
1a & 1b					N/A
3					
4 [redacted] on y)					
5					
7					N/A
8a					N/A
8b					N/A
9					N/A
10					

Table 6 Shortlisted options summary table at [redacted]

Options for 'Scenario 2'- A bypass around the slamshut valve to a downstream asset such as compressor unit and boiler house

93. As discussed in section 5, there are [redacted] sites where uncontrolled bypasses are found around slamshut valves connected to a downstream asset.

94. To address this bypass concern, the existing bypass arrangements at both sites need to be modified to comply with the requirement of the applicable regulations. 4 common options were considered, they are:

Option 1- 'Do Nothing' Keep existing arrangement

95. Option 1 does not involve any modification done to the arrangement meaning we would be non-compliant [redacted].

Option 2- Install valve interlocks for valves bypassing the specified slamshut valves

96. Option 2 involves installing an interlock on the valve in the bypass stream to lock it in 'closed' position and interlocks on the valves in a series arrangement with the slamshut to lock them in 'open' positions such that both valves cannot be in open position simultaneously.

Option 3- Remove the entire bypass stream from the existing system

97. Option 3 involves removing the slamshut and replacing it with a pair of isolation valves with a spectacle blind in-between. The addition of the isolation valves provides an intact separation of upstream and downstream pipework.

Option 4- Replace entire PRS systems with self-resetting slamshut

98. Option 4 involves replacing the entire PRS systems equipped with a slamshut that would self-reset once the condition that triggered it had dissipated.

99. Below is a summary table of all options considered at the [redacted] sites in scenario 2:

No.	Operation			Cost		Project Resources	HSE Compliance	Shortlist
	Flexibility after Modification	Complexity	Technical Feasibility	CAPEX	OPEX	Necessary Procedures and Equipment		
1	No change, as per current maintenance procedure	Very ow	Un ike y	None	None	No additiona procedures apart from current practice	Unacceptab e in terms of HSE procedura contro and its non-comp iance with TD/13	No
2	A physica separation of upstream and downstream system with on y one va ve operab e at any one time	Very ow	Feasib e given the spacing and the size of the va ves to be inter ocked.	Medium	None	More on operationa consideration rather than actua site work.	Enhancement of genera operationa safety of the entire system due to the new devices Acceptab e and satisfies HSE requirements	Yes
3	Low due to absence of bypass.	Medium due to removing existing bypass pipework from stream and capping the bypass route	Confirmation needed that bypass wou d not be needed in future.	Medium to High	None	Loca gas iso ation and depressurisation of re ated pipework - remova of bypass ines and capping the remaining pipework. Reset of the bypass can be done using f exib e hose to equa ize the pressure either side.	Unacceptab e in terms of HSE procedura contro and non-comp iance with IGEM/TD/13	No
4	High due to enhancement of genera operationa safety of the entire system due to the new devices	Very ow	A considerab e outage window wou d be necessary	Very High	Additiona for maintaining the new PRS stream	Gas iso ation and depressurisation of re ated pipework Co d cutting of concerned pipework and removing them from site New pipework and safety devices tie-in to existing pipework NDT and pressure test T&C of the new devices	To be assessed depending on the type of safety devices added. Further review to ensure new system comp iance with IGEM/TD/13 wou d be necessary	No

Table 7 Options summary table for scenario [redacted]

100. The qualitative assessment of each of the shortlisted options at the [redacted] sites in scenario 2 against the risk criteria is summarised in the table below:

Option No.	Operational risk	Maintenance Flexibility	Network Supply Security	Construction Complexity	Speed of Reinstatement
1					N/a
2					
3					
4					

Table 8 Shortlisted options summary table for scenario [redacted]

Options for 'Scenario 3'- A bypass on incomer slamshut valve

101. [redacted] both have bypass pipeworks around their incomer valves.

102. To address this bypass concern, the existing bypass arrangements at both sites need to be modified to comply with the requirement of the applicable regulations. 6 common options were considered, they are:

Option 1- 'Do Nothing' Keep existing arrangement

103. Option 1 does not involve any modification done to the arrangement- a bypass locally locked shut and isolated- meaning we would be non-compliant with [redacted]

Option 2- Blank off rider pipework above ground

104. Option 2 involves removing the bypass pipework - spool and isolation valves on the rider pipework ends- and installing blank flanges.

Option 3- Blank off rider pipework below ground

105. Option 3 involves removing the bypass pipework and valves and cap the remaining pipework underground, requiring excavation to access the pipework to blank off.

Option 4- Simple pipe spool bypass

106. Option 4 is similar to option 1- do-nothing- but without any controls.

Option 5- Bypass with spectacle blind

107. Option 5 involves retaining the bypass and replacing the throtting valve on the bypass spool with a spectacle blind for maintenance purposes.

Option 6- Bypass with slamshut arrangement

108. Option 6 involves adding a slamshut system to the bypass spool to provide increased safety and control.

109. For further details on the options presented, the full option report has been included in Appendix 3.

	Operation			Cost		Project Resources			
No.	Flexibility after Modification	Complexity	Technical Feasibility	CAPEX	OPEX	Duration	Necessary Procedures and Equipment	HSE Compliance	Shortlist
1	No change Bypass can be uti ised if/when necessary	N/A	Current operation	N/A	No change	N/A	Operationa considerations rather than site work. No equipment required.	Deemed unacceptab e as human error / misunderstanding may ead to operation of the bypass va ves	No
2	LOW The bypass cannot be reinstated easi y.	Low	Medium. Outage required to remove the va ves and insta b ank f anges. Leaves pipework accessib e for future use.	Low (Exc udes impact of outage)	No change	~1 week	Gas iso ation and depressurisation of re ated pipework. Remova of va ves. Insta ation of b ank f anges. Pressure test. B ank f anges required.	Acceptab e as no va ve avai ab e to operate to insta bypass hose.	Yes
3	Low. Due to absence of bypass.	High	Low Due to absence of bypass	Medium to high. Site manpower and resources to be p anned.	No change	A few weeks	Gas iso ation and depressurisation of re ated pipework Excavating around key assets. Cutting of pipework and removing the pipework from site. Capping the remaining pipework. NDT and pressure test. B ank f anges Pipe cutting too s Excavation equipment	Acceptab e as the process safety is improved without the presence of bypass	No
4	No change. Bypass can be uti ised if/when necessary	N/A	Current operation	N/A	No change	N/A	Operationa considerations rather than site work. No Equipment required	Deemed unacceptab e as human error / misunderstanding may ead to operation of the bypass va ves	No
5	Medium to high. Physica separation between upstream and downstream pipework for maintenance and f exibi ity to restore the bypass with the thrott ing va ve again.	Medium	High. A considerab e outage window wou d be necessary	Medium to high. Cost of spectac e b ind, spoo and insta ation. Site manpower and resources to be p anned.	Low. Minima maintenance on spectac e b ind.	1~2 weeks	Gas iso ation and depressurisation of re ated pipework. De-f anging the concerned va ve from the bypass pipework (cutting excessive piping from bypass if necessary). Tie-in of pup piece and insta ation of spectac e b ind. NDT and pressure test. Spectac e b ind and pup piece required	Possib e. A physica separation of upstream and downstream system with ow risk of gas eakage. Spectac e b ind can sti be operated in error.	No

6	High. Presence of additiona stream for f exibi ity in maintenance.	High	Medium. A considerab e outage window wou d be necessary. Technica y superior so ution which has been adopted in other insta ations.	High. Cost of spoo , s amshuts and contro system. Site manpower and resources to be p anned.	Medium. Some maintenance necessary on s amshut system.	1 month	Gas iso ation and depressurisation of re ated pipework. Tie-in of new SSV system and re ated tubing connection. Insta ation of pressure gauge downstream of the SSV system in accordance with IGEM/TD/13. NDT and pressure test of new pipework. Commissioning of new SSV system. SSV pipework and tubing connection required.	Acceptab e. Additiona security of s amshut prevents inadvertent gas bypass around safety va ve. Comp iant with IGEM/TD/13.	Yes

Table 9 Options Summary Table at [redacted]

7. Business Case Outline and Discussion

Key Business Case Drivers

Health and Safety Legislation

110. Health and Safety is the primary driver for this project. Legislation including the Health and Safety at Work. Act, PSSR and COMAH (only applicable to [redacted]) [redacted]

111. The Pressure Systems Safety Regulations 2000 (PSSR) cover the safe design and use of pressure systems. The aim of PSSR is to prevent serious injury from the hazard of stored energy (pressure) as a result of the failure of a pressure system or one of its component parts.

112. This project aims to address the findings and subsequent [redacted] reducing the risk to ALARP.

Financial

113. In addition to any legal enforcement notices with associated uncapped financial penalties, any interruption to the flow of gas at the site would be highly detrimental to the NTS with far reaching consequences in the UK and Europe, leading to consumer impact.

114. Improving the overpressure protection system also reduces the potential for any overpressure events occurring on downstream pipework which could lead to undue stress on pipelines, resulting in accelerated deterioration and increased prevalence of leaks.

Business Case Summary

115. The need to address legislative findings by developing and agreeing an action plan [redacted] resulted in the progression of our preferred option.

116. Ultimately, if the work is not completed, the risk will remain and there will be the potential for an Improvement (or possible Prohibition) notice with uncapped financial penalties which would far outweigh the costs of the project.

8. Preferred Option Scope and Project Plan

Options Summary and Preferred Options

Scenario 1- Double-stream flow regulating system with an uncontrolled bypass stream

117. After reviewing the ten potential options proposed by [redacted] [redacted] and [redacted], all options bar 8 and 10 were eliminated for the following reasons:

- Option 2 – Installation of a non-return valve to replace the valve on the bypass- this option does not provide any overpressure protection.

- Option 6 – Carry out no modifications and retain manual control of the bypass- this option is not acceptable to the HSE.

- Option 4 - removal of the bypass stream - was eliminated quickly for [redacted] due to the criticality of the supply to [redacted]. Further discussions with the System Operator on this option concluded that the removal of the bypass at [redacted] was not viable due to the need to retain to avoid a constraint on [redacted] when flowing South to North impacting exit pressures at [redacted].

- Option 1 – Do nothing. The current installation is not acceptable to the HSE.

- Option 3 – Remove the bypass valve leaving an air gap that a pipe spool could be inserted if there was a need to operate the bypass- This would not have provided any overpressure protection and the time taken to install the spool would be too long to avoid operational difficulties and potential loss of supply.

- Option 5 – Replacing the bypass valve with a spectacle blind- This was eliminated for the same reasons as Option 3.

- Option 7 – Installing a PRS adjacent to the existing regulating streams, but retaining the bypass- This option was eliminated, as it did not address the bypass issue itself.

- Option 9 – Installation of isolation valves with a creep relief- This option only increased the integrity of the isolation, but does not itself provide overpressure protection

118. Option 10 was the lowest cost option and could be delivered earliest to meet the requirements of the HSE. However, after being subjected to a Hazard & Operability (HAZOP) Study, further discussions prior to performing a Layers of Protection Analysis (LOPA) to establish the integrity requirements of the safety instrumented system identified that this option would not achieve the integrity target required to prevent the potential consequences of the overpressure scenario.

119. Option 8 is therefore the only viable option [redacted] despite it would involve a high degree of invasive work and subsequently being a much higher cost option and take longer.

Option	Description	Project Start Date	Project Finish Date	Total Cost (18/19 £m)	Cost Accuracy
8	Add an independent PRS stream in addition to the existing regulator system	January 2024	August 2026	[redacted]	15%

Table 10 Final option and high-level project plan at [redacted]

Scenario 2- A bypass around the slamshut valve to a downstream asset such as compressor unit and boiler house

120. After reviewing the potential four options explained in section 6, option 2- *Install valve interlocks for valves bypassing the specified slamshut valves*- was selected as the solution for [redacted] sites- [redacted].

Option	Description	Project Start Date	Project Finish Date	Total Cost (18/19 £m)	Cost Accuracy
2	Install valve interlocks for valves bypassing the specified slamshut valves	April 2023	February 2024	[redacted]	5%

Table 11 Final option summary and high-level project plan at [redacted]

121. For the remaining [redacted] sites in this scenario – [redacted] - Option 3 - *Remove the entire bypass stream from the existing system*- was selected because the slamshuts can be reset without the need for a bypass so the least cost option to address the issue was to remove the bypasses and avoid the need to install any protection on them.

Option	Description	Project Start Date	Project Finish Date	Total Cost (18/19 £m)	Cost Accuracy
3	Remove the entire bypass stream from the existing system	April 2023	February 2024	[redacted]	5%

Table 12 Final option summary and high-level project plan at [redacted]

Scenario 3- A bypass around slamshut incomer valves

122. After reviewing the potential six options proposed by [redacted], all options bar 2 and 6 were eliminated for the following reasons:

- Options 1 and 4 would not meet the safety requirements and HSE would not be satisfied, therefore not shortlisted.
- Option 3 would require excavation to access the pipework to blank off so was not shortlisted as option 2 does the same, therefore not shortlisted.
- Option 5 would involve removing the blanking plates by breaking containment and this would incur added risk in the associated works, therefore not shortlisted.
- Option 6 involves installing a new slamshut on the bypass which is more costly than option 2. As the bypasses were installed purely for equalising the pressure across the incomer valves to allow them to be reset if they had closed. NGT is confident pressure equalisation across the valves can be achieved by using existing process pipework hence negates the need to use a bypass.

123. As a result, option 2- Blank-off rider pipework above ground; Remove the bypass spool and isolation valves on the rider pipework ends and install blank flanges- was selected as the final option at those sites.

Option	Description	Project Start Date	Project Finish Date	Total Cost (18/19 £m)	Cost Accuracy
2	Blank - off rider pipework above ground; Remove the bypass spool and isolation valves on the rider pipework ends and install blank flanges	January 2024	May 2024	[redacted]	5%

Table 13 Final option summary and high-level project plan at [redacted]

Project Spend Profile

124. The table below shows the project spend profile for our preferred option in 18/19 prices:

Sites	FY22 (£)	FY23 (£)	FY24 (£)	FY25 (£)	FY26 (£)	Total Cost (£)
[redacted]						
Total Cost (£)	-	[redacted]	[redacted]	[redacted]	[redacted]	3,301,605

Table 14 Project Spend Profile

Key Business Risks & Opportunities

125. [redacted]l deadline of December 2023 has required us to progress the project prior to receiving a determination from Ofgem. This proactive approach has ensured we should achieve success on time but has involved capital expenditure in advance of this funding request.

126. Outage availability/duration and operational resource to deliver the solutions across the multiple sites without impacting our network operation are the main constraints faced by the project.

127. As this technology has never been implemented on our operational sites within NGT before, the complexity of such a technical challenge requires a longer period of time for NGT to consider potential options at the sites, select a preferred options thoroughly and delivery of the solution on site.

Outputs and Allowances in RIIO-T2

128. There were no outputs relating to enhancements to over pressure protection systems NTS AGIs in RIIO-T2. Costs have been incurred from this project during the RIIO-T2 regulatory period only.

Additional RIIO-2 Outputs

129. Costs associated with the preferred option for the project have been assigned against the RIIO-2 Unique Identifiers in the table below:

UID	Baseline volume of Intervention (By PP)	Baseline total funding available (18/19)	Baseline total funding available (18/19)	ECC unit cost (18/19)	Current volume of intervention	ECC total funding required (18/19)	Output Year	UID funding requested through UM
	(by unit of measure)				(by unit of measure)	(£)		
[redacted]								

Table 15 RIIO-2 Outputs

NARMs Benefit

130. Following discussions with Ofgem in the NARM Development Monthly Meetings, the initial view, while not finalised, is that any work proposed against pre-existing RIIO-T2 baseline funded UIDs in the NARMs A1 category will lead to a restatement of the target (as of SpC 3.1, Part C). Any new UIDs created for investment will automatically fall into the NARMs categories A2/A3 and could result in an update of the Asset Health Non-lead assets PCD Annex (as per SpC 3.14.4).

131. It is proposed that all the investments arising from the re-openers shall result in one update to the Network Asset Risk Workbook (NARW) following the process described in Special Condition 3.1, Part C: Rebasing of Baseline Network Risk Outputs. This is to be

conducted following Ofgem's licence direction following the January 2023 Asset health Reopener determination.

9. Conclusion

132. This report has explained the needs case, options considered and the programmatic aspects of the project.

133. [redacted] to develop a series of designs and associated scope of works to optimally meet a range of operational requirements and specifications.

134. The works at [redacted] have been completed. Solution delivery at [redacted] is forecasted to be complete in March 2024. Optioneering and detailed design is ongoing at [redacted], with commissioning forecasted to be complete by end of T2.

10. Appendices

Appendix 1 – [redacted]

Appendix 2 - [redacted]

Appendix 3 - [redacted]