GAS INNOVATION FUND (GIF) PROJECT

4 bar Service Alteration Tool

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EXECUTIVE SUMMARY

Gas Networks Ireland (GNI) has identified a 4-bar service isolation tool developed by Synthotech Limited in partnership with ALH Systems Limited. This tool is designed to isolate GNI's 4-bar gas service, allowing for gas flow stopping without excavation and squeeze-off methods during exchange of customer isolation valves, one-piece copper risers and Meter Box Adaptors (MBAs). The tool employs a sealing mechanism that can be deployed directly onto the gas service to isolate gas flow. The tool can be used with two different types of seal (a mechanical rubber seal and an inflatable rubber seal).

A Gas Innovation Fund (GIF) funded trial of the 4-bar service isolation tool was conducted in July 2022. The project is co-funded by Synthotech Limited, with a co-funding contribution of €18,472 (44% of the cost). The funding also supported the development of the tool for GNI 4-bar gas service.

The objective of the trial was to assess the reliability of the Synthotech & ALH flow stopper on GNI 4-bar gas services for each sealing method. The trial was successful for both sealing methods for isolation valves. To date, the trial has only been completed on only two (2No.) GNI 4-bar gas services. However, similar trials have been successfully completed on several 2-bar gas services in the UK.

The successful delivery criteria and main outcomes of the evaluation following the field trial are summarised in tabular form below.

No.	Successful Delivery Criteria	Status[1] (Score)	Comments
1	**Reliability –** The solution should allow for effective isolation of the service pipe valve and facilitate the exchange of meter box adaptors (MBAs), isolation valves and one-piece copper risers. Use of the solution should reduce the time for 4-bar service isolation operation.	Partially meets requirement. (3)	• A more extensive field trial is required before reliability can be assessed as to date only a two (2No.) of ball valve exchanges have taken place using the Synthotech & ALH MCEX pressure isolation tool. • The mechanical stopper and inflatable stopper kits were able to effectively exchange isolation gas service isolation valves. • The MCEX tool has not been trialled on meter box adaptor (MBA) and one-piece copper risers yet. Further development of the tool for MBA is required. • It was observed during the field trials that both the mechanical and inflatable stopper operations took less than 18 minutes to isolate the gas service and install an isolation ball valve. It is understood that this significantly faster than using excavation and conventional squeeze-off method.
2	**Viable Alternative** – The solution should offer a practical, safe and effective alternative to traditional methods of pipe squeeze-off of service isolation for 4 - bar gas service.	Partially meets requirement. (3)	• The MCEX tool provides a safe and practical alternative to the conventional excavation and squeeze-off method for isolation of 4-bar gas service. • GNI has determined that service laying crews will be the primary operators of this equipment. This approach also maintains the option of conventional squeeze-off and excavation as a contingency, should any issues arise with the 4-bar stopper. • The MCEX tool has not yet been trialled for MBA exchange therefore cannot be considered a fully viable alternative to the current method of excavation and squeeze-off.

[1] *Evaluation scheme scoring as follows: 0 – Does not satisfy requirement; 1 – Theoretically meets requirement (desk-top study stage); 2 – Potentially meets requirement (field trials not scoped or insufficient data from field trials); 3 – Partially meets requirement (Initial field trials successful, but further trials or design improvement(s) needed); 4 – Mostly meets requirement (mostly satisfies requirement but requires some further testing and / or design refinement); 5 – Fully satisfies requirement (Demonstrably satisfies requirement and is ready for deployment).*

1 INTRODUCTION

1.1 Background

Gas Networks Ireland (GNI) has identified a 4-bar service isolation tool developed by Synthotech Limited in partnership with ALH Systems Limited. This tool is designed to isolate GNI's 4-bar gas service, allowing for gas flow stopping without excavation and squeeze-off methods during exchange of customer isolation valves and Meter Box Adaptors (MBAs). The tool employs a sealing mechanism that can be deployed directly onto the gas service to isolate gas flow. The tool can be used with two different types of seal (a mechanical rubber seal and an inflatable rubber seal).

A Gas Innovation Fund (GIF) funded trial of the 4-bar service isolation tool was conducted in July 2022. The project is co-funded by Synthotech Limited, with a co-funding contribution of €18,472 (44% of the total trial cost). The funding also supported the development of the tool for GNI 4-bar gas service.

The objective of the trial was to assess the reliability of the Synthotech & ALH flow stopper on GNI 4-bar gas services for each sealing method. By deploying this tool, GNI aims to enhance customer service levels, reducing the likelihood of complaints related to service interruptions and disputes that may occur in relation to reinstatements. Additionally, the use of this flow stopper tool offers potential cost savings for GNI.

This document serves as the Technical Report submission for the PC4 Gas Innovation Fund Governance Process.

1.2 Problem Statement

Gas Networks Ireland (GNI) faces challenges in isolating 4-bar gas service during maintenance/alterations activities, particularly when exchanging customer isolation valves, MBAs and one-piece copper risers. Traditional methods such as excavation and squeeze-off are time-consuming, costly and disruptive, often leading to extended customer service interruptions. These methods not only inconvenience customers but also result in higher operational costs due to labour and reinstatement cost.

See Figure 1-1 for a customer isolation valves and Meter Box Adaptors (MBAs).

Figure 1-1:Typical Customer Meter Box.

1.3 Description of Proposed Solution

The Meter Control Exchange (M-CEX) tool, developed by Synthotech Limited and ALH Systems Limited, is a tool designed for isolating medium pressure live gas services without requiring excavation, hot tapping, or squeeze-off methods.

This solution uses a sealing mechanism that is securely placed onto the service pipe, effectively stopping gas flow while preserving the integrity of the supporting infrastructure. When deployed, the isolation tool is positioned on the service pipe and activated to create a secure seal, enabling safe maintenance or replacement of customer isolation valves, one-piece copper risers and Meter Box Adaptors (MBAs).

There are two sealing kits in the M-CEX toolbox for the 4-bar service isolation as follows:

1. Mechanical Stopper: A rubber bung on a shaft that expands via a handle mechanism inside the pipe. It requires no pump, though regular lubrication is required. The mechanical stopper can be used for the replacement of isolation valves and MBAs. It is not suitable for the replacement of one-piece copper risers.
2. Inflatable Stopper: A reinforced rubber bag inserted through a gland that is inflated to seal the gas flow. A pump is required to inflate the bag. A key distinguishing feature from the mechanical stopper is its ability to extend much further down the service line. The inflatable stopper can be used for the replacement of isolation valves, MBAs and one-piece copper risers.

The Synthotech & ALH 4-bar stopper tool is compatible with copper and polyethylene (PE) piping. It supports pipe sizes ranging from 25mm to 32mm PE and 22mm to 28mm copper, operating at pressures from 100mbar to 4-bar. The M-CEX tool measures 400mm x 300mm x 100mm and weighs approximately 3.5kg, making it compact and portable.

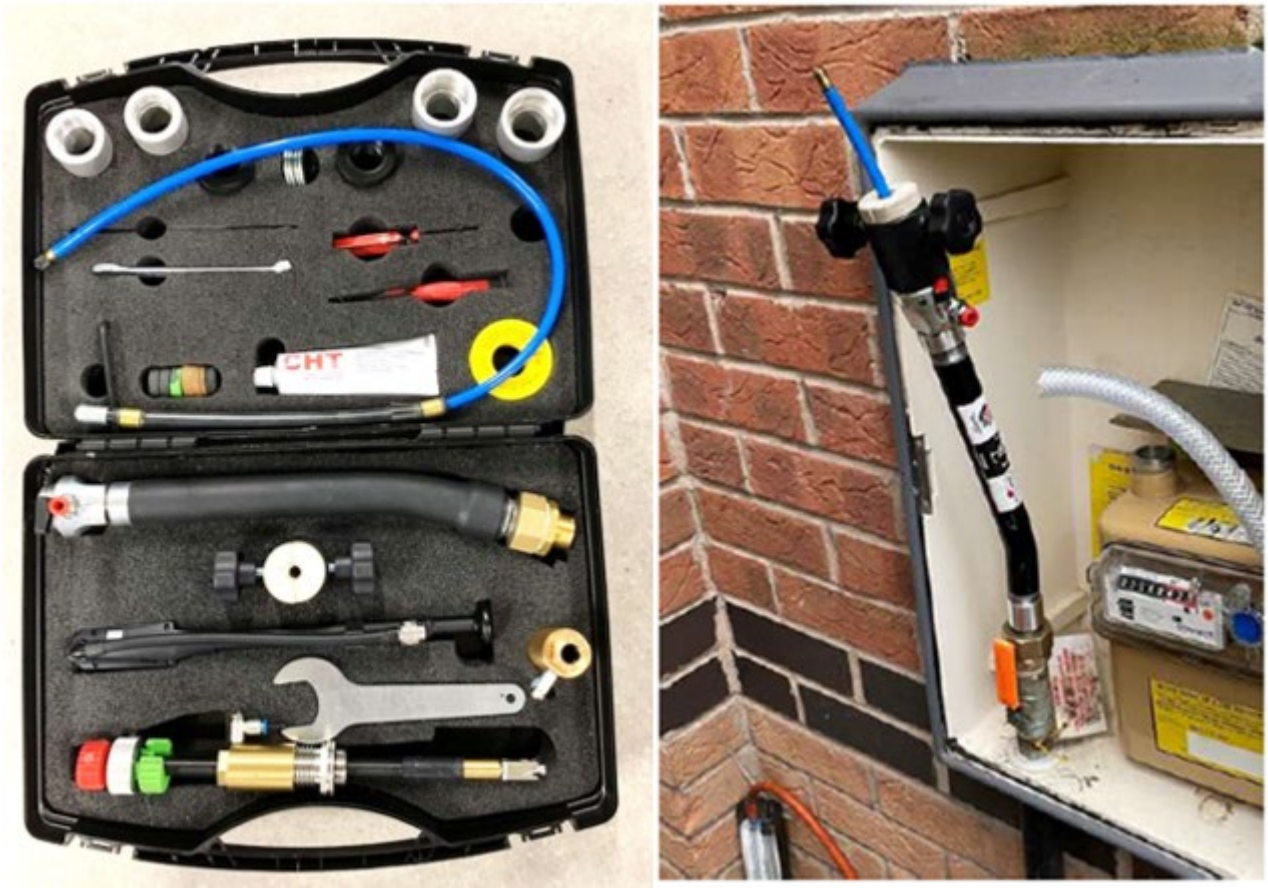

Figure 1-2: Service Connection showing the M-CEX pressure Isolation Tool.

Source: Synthotech Limited.

1.4 Gas Innovation Fund (GIF) Application

A Gas Innovation Fund (GIF) application was submitted in 2019 to develop the tool and carry out trials of the 4-bar service isolation tool.

1.4.1 Timeline

GNI's application included an overall timeline for the project of 5 months.

Funding for the project was granted in November 2019. The target completion date for the project was April 2020.

1.4.2 Success Delivery Criteria

The objective of the field trials was to assess the Synthotech Limited and ALH Systems Limited meter control exchange (M-CEX) tool against the following criteria:

1. **Reliability** - The solution should allow for effective isolation of the service pipe valve and facilitate the exchange of meter box adaptors (MBAs), isolation valves and one-piece copper risers. Use of the solution should reduce the time for 4-bar service isolation operation.
2. **Viable Alternative** - The solution should offer a practical, safe, and effective alternative to traditional methods of pipe squeeze-off of service isolation for 4- bar gas service.

1.5 Evaluation Scheme

A simple scheme has been developed for evaluating innovation projects against the successful delivery criteria. This is indicated on Table 1-1 below.

Table 1-1: Evaluation Scheme used for Innovation Projects

Score	Status	Comments
0	Does not satisfy requirement.	Demonstrably does not satisfy requirement through desk study and / or field trial.
1	Theoretically meets requirement.	Desk-top study stage. Available documentation provides evidence that proposal has potential and can be brought forward to field trials.
2	Potentially meets requirement.	Field trials not scoped or insufficient data available from field trials to determine if innovation will satisfy requirement having regard to the full scope indicated at desk-top study stage.
3	Partially meets requirement.	Initially scoped field trials have been completed and are successful. Likely to satisfy requirement but will require further field testing in specific areas or for longer duration. Scope of additional field trials to be designed to close gaps identified. Requires design improvement(s) in order to be considered suitable for deployment.
4	Mostly meets requirement.	Satisfies most aspects of requirement but will require some further testing and / or design refinement(s) to optimise performance prior to deployment.
5	Fully meets requirement.	Demonstrably satisfies requirement. Ready for deployment without further field testing or design refinement.

2 FIELD TRIALS

As part of the tool development, Initial field trials were conducted in the UK at various locations between October 2021 and November 2021 to evaluate the tool performance under different operational conditions. Subsequently, field trials were conducted on 12th July, 2022 at the GNI Training Centre in Dublin, on a 4-bar service pipe.

Figure 2-1 shows the use of the inflatable stopper to isolate a 4-bar gas service. Figure 2-2 shows a demonstration using the mechanical stopper to isolate a 4-bar service and installing a ball valve.

Figure 2-1:Field Trial Demonstration of Inflatable Stopper at GNI Training Centre, Dublin.

Figure 2-2: Field **Trial Demonstration of Mechanical Stopper at GNI Training Centre, Dublin.**

During the field trials, the inflatable stopper was operated using a hand pump. While the inflatable stopper requires a hand pump to inflate the sealing bag, it was observed to be more flexible and better suited for use in tight or confined spaces compared to the mechanical stopper.

The Synthotech & ALH M-CEX tool has not yet been trialled on exchanges of meter box adaptors (MBAs) or one-piece copper risers yet. Further development of the tool and procedures is required to allow for use for these scenarios. See Figure 2-3 for a typical GNI meter box showing the MBA (Item 3).

Key observations from the field trials include:

- The Synthotech Limited and ALH Systems Limited meter control exchange (M-CEX) tool was tested in the workshop prior to field deployment.
- Two separate trials were conducted: one using the mechanical stopper and the other using the inflatable stopper.

4-bar Service Isolation

- Both trials demonstrated the tool effectiveness in isolating service lines without causing uncontrolled gas release.
- The operation was completed in less than 18 minutes with each stopper.

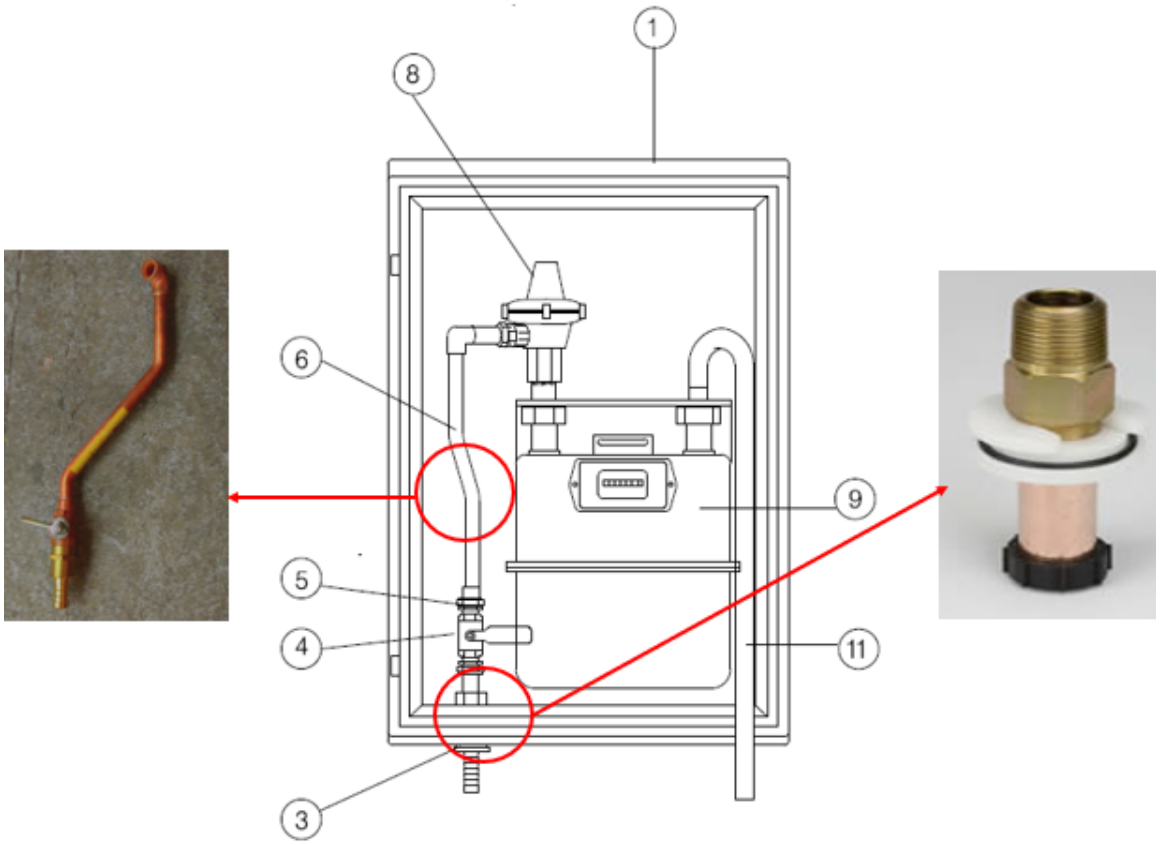

Figure 2-3: GNI Recessed Meter Box showing the MBA and Copper Riser.

Item	Description
1	G.R.P. Recess / Free Standing Meter Box (BGE /D /1/01)
2	G.R.P. Surface Mounted Meter Box (BGE /D /1/002A)
3	25 / 32mm Meter Box Adaptor (MBA)
4	3/4" Ball Valve to BS21 with Tapered Thread
5	Transition Fitting from 3/4" BS21 Tapered Thread to 18mm Sphero-Conic Connection
6	18mm Dia. Inlet Copper Pipe to Regulator with Sphero-Conic Connection (for item 1)
7	18mm Dia. Inlet Copper Pipe to Regulator with Sphero-Conic Connection (for item 2). Copper to BS 2871 Part 1, or Equivalent
8	Low / Medium Pressure (Max. 4 Bar) Regulator (DN /ST /110)
9	G4 Diaphragm Meter
11	3/4" Dia. Copper Outlet Pipe to ISEN 1057 Complete with BS 746 Female Adaptor at one End (DN /ST /21/A)

To date, the trial has only been completed on only two (2No.) of GNI 4-bar gas services, though other trials were carried out in the UK on 2-bar gas services. GNI is now in the process of purchasing a number of kits to enable a more substantial field trial to be carried out.

3 EVALUATION

On the basis of the field trial, RPS's evaluation of the performance of the 4-bar service isolation tool is summarised on Table 3-1 below.

Table 3-1: Field Trial Assessment.

No.	Successful Delivery Criteria	Status[2] (Score)	Comments
1	**Reliability –** The solution should allow for effective isolation of the service pipe valve and facilitate the exchange of meter box adaptors (MBAs), isolation valves and one-piece copper risers. Use of the solution should reduce the time for 4-bar service isolation operation.	Partially meets requirement. (3)	• A more extensive field trial is required before reliability can be assessed as to date only two (2No.) of ball valve exchanges have taken place using the Synthotech & ALH MCEX pressure isolation tool. • The mechanical stopper and inflatable stopper kits were able to effectively exchange isolation gas service isolation valves. • The MCEX tool has not been trialled on meter box adaptor (MBA) and one-piece copper risers yet. Further development of the tool for MBA is required. • It was observed during the field trials that both the mechanical and inflatable stopper operations took less than 18 minutes to isolate the gas service and install an isolation ball valve. It is understood that this significantly faster than using excavation and conventional squeeze-off method.
2	**Viable Alternative** – The solution should offer a practical, safe and effective alternative to traditional methods of pipe squeeze-off of service isolation for 4 - bar gas service.	Partially meets requirement. (3)	• The MCEX tool provides a safe and practical alternative to the conventional excavation and squeeze-off method for isolation of 4-bar gas service. • GNI has determined that service laying crews will be the primary operators of this equipment. This approach also maintains the option of conventional squeeze-off and excavation as a contingency, should any issues arise with the 4-bar stopper. • The MCEX tool has not yet been trialled for MBA exchange therefore cannot be considered a fully viable alternative to the current method of excavation and squeeze-off.

[2] *Evaluation scheme scoring as follows: 0 – Does not satisfy requirement; 1 – Theoretically meets requirement (desk-top study stage); 2 – Potentially meets requirement (field trials not scoped or insufficient data from field trials); 3 – Partially meets requirement (Initial field trials successful, but further trials or design improvement(s) needed); 4 – Mostly meets requirement (mostly satisfies requirement but requires some further testing and / or design refinement); 5 – Fully satisfies requirement (Demonstrably satisfies requirement and is ready for deployment).*

3.1 Technology Readiness Levels (TRLs)

Based on the GNI trials, it appears that the Synthotech 4-bar isolation tool appears to have achieved a Technology Readiness Level (TRL) of 7. The trials demonstrated that the tool has been successfully trialled in an operational environment.

Table 3-2: Technology Readiness Levels (TRLs)

TRL	Description	Explanation
9	Actual system commercially proven through successful deployment.	Fully integrated with operational hardware/software systems. Actual system has been thoroughly demonstrated and tested in its operational environment. All documentation completed. Successful operational experience. Sustaining engineering support in place.
8	Actual system complete and commercially ready through test and demonstration in an operational environment (ground or space)	End of system development. Fully integrated with operational hardware and software systems. Most user, training and maintenance documentations completed. All functionality tested in simulated and operational scenarios. Verification and Validation (V&V) completed.
7	System prototyping demonstration in an operational environment.	System is at or near scale of the operational system, with most functions available for demonstration and test. Well, integrated with collateral and ancillary systems. Limited documentation available.
6	System/subsystem model or prototyping demonstration in a relevant end to end environment.	Prototyping implementations on full-scale realistic problems. Partially integrated with existing systems. Limited documentation available. Engineering feasibility demonstrated in actual system application.
5	System/subsystem/component validation in relevant environment.	Through testing of prototyping in representative environment. Basic technology elements integrated with reasonably realistic supporting elements. Prototyping implementations conform to target environment and interfaces.
4	Component/subsystem validation in laboratory environment.	Standalone prototyping implementation and test. Integration with technology elements. Experiments with full scale problems or data sets.
3	Analytical and experimental critical function and/or characteristic proof-of concept	Proof of concept validation. Active research and development (R&D) is initiated with analytical and laboratory studies. Basic demonstration of technical feasibility using representative data.
2	Technology concept and/or application formulated	Applied research. Theory and scientific principles are focused on specific application area to define the concept. Characteristics of the application are described. Analytical tools are developed for simulation or analysis of the application.
1	Basic principles observed and reported	Transition from scientific to applied research. Essential characteristics and behaviours of systems and architectures. Descriptive tools are mathematical formulations and algorithms.

3.2 Business Case

RPS has reviewed GNI's high-level Cost-Benefit Analysis (CBA) for the project. The analysis indicates that implementing the 4-bar service isolation has the potential to improve business continuity by enabling more efficient and reliable 4-bar service isolation operation.

4 CONCLUSIONS

The key conclusions from the field trials of the Synthotech & ALH MCEX 4-bar isolation tool are listed below:

- The field trial was successfully conducted at the GNI Training Centre during July 2022 using Synthotech & ALH MCEX 4-bar isolation tool, providing valuable insights into the capabilities and limitations of the tool. Both seal types (mechanical and inflatable) were tested during the trial.
- The trial partially met the reliability delivery criteria for isolating a 4-bar service lines and enabling the safe removal and replacement of isolation valves. However, further trials are required to fully access the MCEX tool reliability.
- The tool provides a practical alternative to conventional methods such as excavation and squeeze-off to isolate gas service for isolation valves exchanges. Significantly reducing 4 -bar service isolation time required for isolation valves exchanges.
- The field trials using both the mechanical and inflatable stopper were able to isolate service lines without causing uncontrolled gas release.
- The tool has achieved a Technology Readiness Level (TRL) of 7, indicating it is functional and suitable for extended field trials across the GNI service lines. Further trials are required to advance the prototype toward commercialisation.
- In its current format, field crews considered the tool to be easy to use once it is set up for 4-bar isolation valve exchange.

  To date, the trial has been completed on only two (2) GNI 4-bar gas services, although other trials were conducted in the UK on 2-bar gas services. GNI is currently procuring several kits to facilitate a more extensive field trial.

5 RECOMMENDATIONS

s available information and GNI field trial of the Synthotech & ALH MCEX 4-bar isolation tool, RPS recommends the following next steps for the project:

- Proceed with the deployment of the MCEX service isolation tool in field trials across GNI 4-bar network sites. This approach allows for gradual integration and assessment of the tool effectiveness on different 4-bar service lines.
- Develop operator training programs to ensure safe and effective use of the tool.
- Conduct trials on Meter Box Adaptors (MBAs) and copper risers. As the tool has not yet been assessed on MBA and copper risers, additional trials are also required to validate its reliability for isolation valves exchanges before deployment to the wider GNI network.

Appendix A
GIF innovation Proposal

Appendix B
Vendor &Technical Information

4-bar Service Isolation