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Date: 17 January 2018

Dear Company Secretary,

Project Direction ref: Southern Gas Networks plc (SGN) / Robotic Roadworks and Excavation System (RRES) / 17 January 2018

SGN submitted the project RRES (the Project) in August 2017 to be considered for funding through the Gas Network Innovation Competition (NIC). In this year's decision¹, we selected the Project² for funding.

This Project Direction contains the terms to be complied with by SGN as a condition of the Project receiving funding through the Gas NIC. It must comply with these terms, which can be found in the Schedule to this Project Direction.

Project direction

Chapter 5 of the Gas NIC Governance Document³ states that a Project Direction will:

- set out the Project-specific conditions that the Network Licensee (which for this project is SGN) is committing to in accepting funding;
- require the Network Licensee to undertake the Project in accordance with the commitments it has made in the Full Submission. Where appropriate, the Project Direction may therefore include extracts from the Full Submission or refer to specific sections of the Full Submission;
- set out the Approved Amount for the Project, that will form part of the calculation contained in the Funding Direction issued by the Authority under Chapter 7 of the Governance Document;

¹ <https://www.ofgem.gov.uk/publications-and-updates/network-innovation-competition-2017-funding-decisions>

² Unless otherwise specified, defined terms in this Project Direction have the meaning given to them in Appendix 1 of the Gas NIC Governance Document.

³ <https://www.ofgem.gov.uk/publications-and-updates/version-30-network-innovation-competition-governance-documents>

- set out the Project budget that the Network Licensee must report against and how variances against the Project budget will be reported and approved; and
- set out the mechanism for the Network Licensee receiving the Approved Amount as set out in section 4 of the Funding Direction.

These are described for the Project in the Schedule to this Project Direction.

Decision

Provided SGN complies with the Gas NIC Governance Document and with the Schedule to this Project Direction, the Project is deemed to be an Eligible NIC Project.⁴

This Project Direction constitutes notice pursuant to section 38A (Reasons for decisions) of the Gas Act 1986.



Pete Wightman
Head of RIIO Gas Networks
For and on behalf of the Authority

⁴ Eligible NIC Project has the meaning given in definitions of the Gas Transporter licence.

Schedule to Project Direction

1. TITLE

Project Direction ref: Southern Gas Networks plc (SGN) / RRES / 17 January 2018.

2. PREAMBLE

This Project Direction is issued by the Gas and Electricity Markets Authority (the "Authority") to SGN (the "Funding Licensee") pursuant to the Gas NIC Governance Document issued pursuant to Special Condition 1I (Network Innovation Competition) of the Gas Transporter Licence (the "Licence"). It sets out the terms to be complied with in relation to the 'Robotic Roadworks and Excavation System (RRES)' project (the "Project") as a condition of it being funded under the NIC and the Funding Return Mechanisms.⁵

Unless otherwise specified, defined terms in this Project Direction have the meaning given to them in Appendix 1 of the Gas NIC Governance Document.

References to specific sections of the Funding Licensee's Full Submission in this Project Direction are, for ease of reference, made by referring to the section number in the Funding Licensee's Full Submission pro-forma.

3. CONDITION PRECEDENT

The Funding Licensee will not access any funds from the Project Bank Account until it has signed contracts with the Project Partners named in Table 1.

Table 1. Project Partners

ULC Robotics

4. COMPLIANCE

The Funding Licensee must comply with Special Condition 1I of the Licence and with the Gas NIC Governance Document (as may be modified from time to time in accordance with Special Condition 1I and as modified and/or augmented in respect of the Project by this Project Direction) and with this Project Direction.

Any part of the Approved Amounts that the Authority determines not to have been spent in accordance with this Project Direction (or in accordance with the Gas NIC Governance Document) is deemed to be Disallowed Expenditure.

Pursuant to Special Condition 1I, Disallowed Expenditure is revenue received (whether by the Funding Licensee or by another Licensee) under the NIC and Funding Return Mechanisms that the Authority determines not to have been spent in accordance with the provisions of the Gas NIC Governance Document or with those of the relevant Project Direction.

Pursuant to Chapter 8 of the Gas NIC Governance Document, Disallowed Expenditure includes any funds that must be returned if the Project is halted without Ofgem's permission, any funds that have not been spent in accordance with the approved Project Budget contained within the Project Direction, and any unspent funds on the completion of the Project.

⁵ The Funding Return Mechanism is defined in Special Condition 1I (Network Innovation Competition).

5. APPROVED AMOUNT FOR THE PROJECT

The Approved Amount is **£6,325,674**

6. PROJECT BUDGET

The Project Budget is set out in Annex 1 of this Project Direction.

The Funding Licensee will report on expenditure against each line under the category total in the Project Budget, and explain any projected variance against each line total in excess of 5% as part of its detailed report which will be provided by the Licensee, in accordance with Chapter 8 of the Gas NIC Governance Document. Ofgem will use the reported expenditure and explanation to assess whether the funding has been spent in accordance with the Gas NIC Governance Document and with this Project Direction.

For the avoidance of doubt this reporting requirement does not change or remove any obligations on the Funding Licensee with respect to reporting that are set out in the Gas NIC Governance Document.

7. PROJECT IMPLEMENTATION

The Funding Licensee must undertake the Project in accordance with the commitments it has made in the Full Submission approved by the Authority pursuant to the Gas NIC Governance Document and with the terms of this Project Direction. These include (but are not limited to) the following:

- (i) undertake the Project in accordance with the description set out in Section 2 (Project Description) of the Full Submission;
- (ii) provide a Network Licensee Compulsory Contribution of £710,400;
- (iii) complete the Project on or before the Project completion date of 26 March 2021; and
- (iv) disseminate the learning from the Project at least to the level described in Section 5 (Knowledge Dissemination).

8. REPORTING

Ofgem may issue guidance (as amended from time to time) about the structure and content of the Project Progress Report required by Chapter 8 of the Gas NIC Governance Document. The Funding Licensee must follow this guidance in preparing the reports.

As required by Chapter 8 of the Gas NIC Governance Document, the Funding Licensee must inform the Authority promptly in writing of any material event or circumstance likely to affect its ability to deliver the Project as set out in its Full Submission.

9. INTELLECTUAL PROPERTY RIGHTS (“IPR”)

In Section 5 of its Full Submission (Knowledge Dissemination) the Funding Licensee has stated that the Project conforms to the default IPR arrangements set out in Chapter 9 of the Gas NIC Governance Document. The Funding Licensee must therefore undertake the Project in accordance with the default IPR arrangements.

10. PROJECT DELIVERABLES

At the end of a Project, the Funding Licensee must commission a report from an independent third party that verifies whether the Project Deliverables set out in Table 2 below (which comply with Chapter 5 of the Gas NIC Governance Document) have been achieved.

After it has received the report the Funding Licensee must send it to the Authority. Where a Project Deliverable has not been achieved we will consider whether funding should be returned to customers using the Funding Return Mechanism. If the Network Licensee is deemed by Ofgem to be at fault for the non-delivery of the Project Deliverable, it is the proportion of funding assigned to it within Table 2 below, which may be returned to customers.

Table 2. Project Deliverables

Ref:	Project Deliverable	Deadline	Evidence	NIC Funding Request (%)
1	Review System Specifications	15/05/2018	<ul style="list-style-type: none"> Review has been conducted with stakeholders at SGN and ULC. Specifications document has been generated describing capabilities (in order of priority) to be developed under the project, as mutually agreed upon by SGN and ULC. <p>Project learning:</p> <ul style="list-style-type: none"> To generate the specifications for the project, substantial research, evaluation and engineering will be performed to determine the performance parameters for the system that will be targeted during the development process. Learning related to process automation, sensor and future system capabilities and applications will be generated and finalised. These learnings will guide the whole of the project. <p>Ongoing Project progress:</p> <ul style="list-style-type: none"> Reallocation of resources to project and hiring/onboarding of new staff to support project Project Kickoff and mobilisation System Specification Development and engineering analysis Initial review of high potential sensors identified during Phase 2 Engagement with third-party manufacturers and MTC on project work scope 	12%
2	Source Vendor for Robotic Arm	05/09/2018	<ul style="list-style-type: none"> Robotic arm specification development and technology evaluation have been completed. Suitable vendor has been selected through a competitive procurement process and a purchase order has been submitted. <p>Project learning:</p> <ul style="list-style-type: none"> The robotic arm will serve a pivotal role in the execution of all RRES operations; the level of resources dedicated to performing research, analysis and process development for candidate robotic arms is 	11%

			<p>commensurate with the important role it plays in the project. This process will result in learnings specific to the performance parameters for the robotic arm and the resultant implications for integrating the robotic arm with sensors and tooling. The selection of a robotic arm vendor, technology and in committing to the purchase of this key component holds substantial weight in achieving success in the overall project goals.</p> <p>Ongoing Project progress:</p> <ul style="list-style-type: none"> • Engagement with MTC on Study relative to Sensors and Robotic Arm Technology • Design and Fabrication of testing environment • Development of sensor specifications • Research, evaluation and selection of sensor technology for below ground sensing • Software development for sensors and vision processing • Development and planning of test plan for individual/sensor camera shop testing • Develop specification for excavation tooling • Perform mechanical and electrical design for excavation tooling 	
3	Source vendor for mobile platform	14/11/2018	<ul style="list-style-type: none"> • Mobile platform specification development and technology evaluation have been completed. Suitable vendor has been selected through a competitive procurement process and a purchase order has been submitted. <p>Project learning:</p> <ul style="list-style-type: none"> • Selecting a vendor for the mobile platform will involve developing subsystem specifications and researching and evaluating a wide range of potential platforms to determine which will best meet the specifications. The platform itself will need to be capable of relocating the mobile portion of the RRES system (sensors, end effectors, robotic arm, etc.) to the work site, supporting its weight and the resultant forces of the operation and in maintaining stability through the process. This portion of the project will generate learnings specific to the mechanical and electrical layout of robotic components while taking into consideration factors 	7%

			<p>such as robot weight, size and power requirements.</p> <p>Ongoing Project progress:</p> <ul style="list-style-type: none"> • Begin procurement of select sensors and visions system • Ongoing software development for sensors and vision processing • Perform mechanical and electrical design for excavation tooling • Begin development of Graphical User Interface • Installation of robotic arm in test environment • Ongoing sourcing for support equipment 	
4	Order commercially available and custom electronic components for RRES onboard computing and communication	28/12/2018	<ul style="list-style-type: none"> • Computing system specification development has been completed. Electrical schematics and PCB designs have been documented. Purchase order has been submitted. <p>Project learning:</p> <ul style="list-style-type: none"> • As illustrated in the project plan, the scope of the computing system development is smaller in scale than other project deliverables, and the funding contribution has been updated accordingly. Fewer learnings will be generated by the completion of this specific deliverable since the technology is better understood and the development risk is lower than for other subsystems. <p>Ongoing Project progress:</p> <ul style="list-style-type: none"> • Ongoing programming and testing of robotic arm in test environment • Ongoing sensor testing and software development for data acquisition and visualisation • Complete mechanical and electrical design of excavation tooling • Ongoing sourcing for support equipment 	3%
5	Complete shop testing of prototype excavation tooling	28/05/2019	<ul style="list-style-type: none"> • Shop testing has been conducted to evaluate the capability of excavation tooling employed by the robotic arm. A test report has been submitted. <p>Project learning:</p> <ul style="list-style-type: none"> • Testing of prototype excavation tooling represents an essential portion of the RRES project. Successful completion of this deliverable will yield learnings that directly benefit the GB gas customer - as the technology developed and demonstrated could be utilized as a 	15%

			<p>part of the RRES or as a standalone system. To achieve this Deliverable, substantial mechanical, electrical and software development will be performed and a working prototype excavation tool will be tested. Because of its importance to the project, significant resources have been allocated to developing and optimising this capability.</p> <p>Ongoing Project progress:</p> <ul style="list-style-type: none"> • Ongoing programming and testing of robotic arm in test environment • Ongoing sensor testing and software development for data acquisition and visualisation • Ongoing software development for sensor and vision processing • Electrical and mechanical design of sensor module • Fabrication and assembly of sensor module • Receipt and testing of mobile platform • Ongoing sourcing for support equipment 	
6	Complete shop testing of sensors and vision systems	06/08/2019	<ul style="list-style-type: none"> • Sensors and vision systems have been evaluated, and procured through a competitive procurement process. Testing is underway and a test report has been submitted documenting the capabilities of each component relative to specifications. <p>Project learning:</p> <ul style="list-style-type: none"> • Evaluation, selection and validation of sensors and vision systems for the automation of RRES operations is expected to be an ongoing effort throughout the duration of the project. This Deliverable Milestone will occur at approximately the half way point in the project and will provide substantial learning. This process will provide valuable insights regarding which technologies are accurate, consistent, rugged, and ultimately suitable for the RRES operating environment. <p>Ongoing Project progress:</p> <ul style="list-style-type: none"> • Shop testing of sensor module along with modifications discovered during testing • Ongoing mobile platform testing • Software development for closed loop feedback between sensors/cameras and control systems • Software development for robot end effector control 	8%

			<ul style="list-style-type: none"> • Integration of support equipment along with design of interfacing hardware and electronics • Begin full system assembly and integration • Development of specifications for mobile operations • Begin software development for mobile operations 	
7	Complete off-site testing of below-ground sensing capability	04/02/2020	<ul style="list-style-type: none"> • Sensor module has been developed and fabricated. Sensor module has been tested in an offsite environment in conjunction with the robotic arm. A test report has been submitted, documenting the detection and visualisation capabilities of the system. <p>Project learning:</p> <ul style="list-style-type: none"> • This deliverable represents the second focused specifically on the development of below ground sensing capability and in integrating the most promising sensor and vision technologies; both in hardware and in software. Testing of the integrated sensor module will result in learning regarding coordination of RRES tooling, articulation of the robotic arm, and detection of buried infrastructure using sensors and will mark a ground-breaking achievement for the project. <p>Ongoing Project progress:</p> <ul style="list-style-type: none"> • Ongoing sensor module testing and software development • Complete system integration with support equipment • Offsite testing along with ongoing software and hardware development to enable sensor integration, data acquisition and closed loop feedback/control • Modifications and improvements determined during off site testing in preparation for offsite testing • Planning for interim field test along with preparations for shipping integrated system UK • Mechanical and electrical design for automated tool changing • Updates to sensor processing software for use in mobile operations 	10%
8	Perform interim field test of prototype RRES (Element 2)	26/05/2020	<ul style="list-style-type: none"> • The RRES system has been deployed in the UK in a non-live gas environment to evaluate the capabilities of the system. A final report has been submitted outlining system capabilities and recommended 	9%

			<p>next steps.</p> <p>Project learning:</p> <ul style="list-style-type: none"> • Several months of the project are devoted to integration and shop testing leading up to interim field testing. This deliverable encompasses sourcing of materials, fabrication of hardware, assembly, testing, and hardware and software <p>Ongoing Project progress:</p> <ul style="list-style-type: none"> • Ongoing offsite testing and preparations for interim field testing • Design and fabrication of spare parts to support interim field testing • Training of ULC staff in preparation of field deployment • Development of documentation to obtain approval for field deployment • Relocation of system and ULC team from US to UK for interim field testing • Ongoing updates to sensor processing software for use in mobile operations • Mechanical and electrical design related to UAF • Begin tether design and sourcing 	
9	Fabricate and test universal access fitting	18/08/2020	<ul style="list-style-type: none"> • Prototype universal access fittings have been developed and manufactured for specified pipe material and size. Testing has been conducted to evaluate the fitting design/fitness for purpose and the reliability of the process. A test report has been submitted highlighting results. <p>Project learning:</p> <ul style="list-style-type: none"> • Development and testing of the universal access fitting will focus on performance goals related to robotic installation and open-source tooling. Learnings generated in these areas will enable the widespread use and uptake of the RRES, and the deliverable reflects investment of project resources and importance of its outputs. <p>Ongoing Project progress:</p> <ul style="list-style-type: none"> • Plan and execute the return of the system to US • Design, selection and sourcing of vehicle chassis for second field trial • Evaluate and source vendor for tether • Design and fabricate tether reel and operator console • Ongoing software development and modifications identified during interim 	9%

			<p>field testing</p> <ul style="list-style-type: none"> • Begin full system integration 	
10	Perform field test of full RRES	26/03/2021	<ul style="list-style-type: none"> • The RRES system has been deployed in the UK in a live gas environment to evaluate the capabilities of the system. A final report has been submitted outlining system capabilities and recommended next steps. <p>Project learning:</p> <ul style="list-style-type: none"> • Testing and demonstration of the complete RRES is planned on a live gas environment which represents the culmination of all the development work contained within preceding project deliverables. Preparation for field testing will entail the selection, development and procurement of support equipment as well as fabrication, assembly, integration, testing and debugging of the complete robotic system. Additionally, operational planning and the methodology for system use will be created and learnings will be captured regarding the overall system effectiveness and its path to commercialisation. <p>Ongoing Project progress:</p> <ul style="list-style-type: none"> • Ongoing sensor, hardware and software development and modifications identified during interim field testing • Complete full system integration • Integration of RRES with UK vehicle chassis • Ongoing offsite testing and preparations for interim field testing • Generate documentation and obtain approvals to perform field trial • Design and acquire spare parts for field trial • Training of ULC staff in preparation of field deployment • Relocation of system and ULC team from US to UK for interim field testing 	16%
11	Comply with knowledge transfer requirements of the governance document	End of Project	<ol style="list-style-type: none"> 1. Annual Project progress reports which comply with the governance document. 2. Completed close down report which complies with the requirements of the governance document. 3. Evidence of attendance and participation in the annual conference as described in the governance document. 	N/A

12. USE OF LOGO

The Funding Licensee and Project Partners, External Funders and Project Supporters⁶ may use the NIC logo for purposes associated with the Project but not use the Ofgem logo in any circumstances.

13. AMENDMENT OR REVOCATION

As set out in Chapter 8 of the Gas NIC Governance Document and this Project Direction, this Project Direction may be amended or revoked under the following circumstances:

- (i) if the Funding Licensee considers that there has been a material change in circumstance that requires a change to the Project Direction, and the Authority agrees; or
- (ii) to reflect amendments made to the Licence.

14. HALTING OF PROJECTS

This Project Direction is subject to the provisions contained in paragraphs Chapter 8 of the Gas NIC Governance Document relating to the halting of projects. By extension, this Project Direction is subject to any decision by the Authority to halt the Project to which this Project Direction relates and to any subsequent relevant Funding Direction issued by the Authority pursuant to Special Condition 1I of the Licence.

In the event of the Authority deciding to halt the Project to which this Project Direction relates, the Authority may issue a statement to the Funding Licensee clarifying the effect of that halting decision as regards the status and legal force of the conditions contained in this Project Direction.

NOW THEREFORE:

In accordance with the powers contained in the Gas NIC Governance Document issued pursuant to Special Condition 1I of the Licence the Authority hereby issues this Project Direction to the Funding Licensee in relation to the Project.

This constitutes notice of reasons for the Authority's decision pursuant to section 38A (Reasons for decisions) of the Gas Act 1986.

⁶ As listed in Box 1.6 in Section 1 of the Full Submission pro-forma.

ANNEX 1: PROJECT BUDGET

Cost Category	Cost (£k)
Labour	
Design/Build/Test	3,393.479
Administration	-
Equipment	
Design/Build/Test	2,036.433
Administration	-
Contractors	
Design/Build/Test	183.459
Administration	400.000
IT	
Design/Build/Test	78.745
Administration	-
IPR Costs	
Design/Build/Test	116.187
Administration	-
Travel & Expenses	
Design/Build/Test	191.486
Administration	-
Payments to users	
Design/Build/Test	-
Administration	-
Contingency	
Design/Build/Test	-
Administration	-
Decommissioning	
Design/Build/Test	-
Administration	-
Other	
Design/Build/Test	-
Administration	703.980
Total	7,103.77