

**SOW for the Manufacture  
& Supply of Super Insulated Vacuum lines  
(SIVL) and SIVL/PS Interface pipework**

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## Statement of Work

# For the Manufacture & Supply of Super Insulated Vacuum Lines (SIVL) and SIVL/Phase Separator Interface Pipework For RAL Space

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## Acronyms & Abbreviations

CDR	Critical Design Review
KO	Kick-Off
LN2	Liquid Nitrogen
N2	Nitrogen
OGSE	Optical Ground Support Equipment
PDR	Preliminary Design Review
PRV	Pressure Release Valve
PS	Phase Separator
RAL	Rutherford Appleton Laboratory
SHE	Safety, Health & Environment
SIVL	Super Insulated Vacuum Line
SoW	Statement of Work
STC-2/3	Space Test Chamber 2/3
STFC	Science & Technology Facilities Council

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### 1 INTRODUCTION

The Rutherford Appleton Laboratory (RAL) is the largest of the Science and Technology Facilities Council's laboratories. RAL, whose main function is to support the advancement of science, is situated 15 miles south of Oxford, in the UK. The RAL Space Department is seeking to procure Super Insulated Vacuum Lines (SIVL) and vacuum-insulated valve assemblies for the supply of Liquid Nitrogen (LN2) to its third large Space Test Chamber (STC-3).

STC-3 is a thermally-controlled vacuum vessel, 5m internal diameter and 6m long, which will be used for testing space instruments. Vacuum-insulated valve assemblies and SIVL are required to deliver LN2 from the phase separator to the valve boxes mounted to the outside of STC-3. These valve boxes contain manifolds to distribute the LN2 inside STC-3.

The phase separator has 18 bayonet connections underneath its main body. The PS/SIVL valve assemblies will interface with twelve of these bayonets. These valve assemblies will be located underneath the phase separator and will include pressure release valves and pneumatic isolation valves to control LN2 distribution to the supply SIVLs, and hence the valve boxes. Each supply SIVL connects a vacuum-insulated valve to a valve box.

There are also four exhaust SIVL to carry cold nitrogen gas from the four door-mounted valve boxes out of the clean-room. These are included in Table 3.

STC-3 has two doors, which open to 90 degrees and each has two valve boxes mounted on them. The SIVLs to and from these four valve boxes require rotating bayonets and flexible lines to allow the doors to open and close. It is the responsibility of the Contractor to determine the best scheme based on the dimensions given in AD1.

This tender covers the provision of both the vacuum-insulated valve assemblies and the SIVL lines for the supply of LN2 and the exhaust of cold nitrogen gas from the doors.

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## 2 SCOPE

This document describes the activities to be executed and the deliverables required by STFC-RAL in relation to the manufacture, testing and installation of the SIVL and SIVL interface pipework with the phase separator.

### 2.1 Applicable Documents

The documents listed in Table 1 - Applicable Documents are applicable to this document.

**Table 1 - Applicable Documents**

Item Number	Document Title	Document Number
AD1	Super Insulated Vacuum Line Configuration Drawing-DRAFT	KE-0288-108

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### 3 WORK TO BE PERFORMED

The Contractor shall be fully responsible for:

- The manufacture, assembly, testing, shipping and installation of the Pipework Assembly.
- The manufacture, assembly, testing, shipping and installation of the SIVL.
- The preparation and provision of the documentation necessary for the work.
- Provision of all tools, test equipment, etc., necessary for the work.

Lack of mention of any task or activity within this SOW does, in no way, absolve the Contractor from the responsibility for identification and performance of the tasks and activities where these are necessary to meet the requirements of the Contract.

It is strongly recommended that potential bidders attend a visit to the Rutherford Appleton Laboratory prior to submitting a tender response as seeing the install location may be of benefit when preparing a quotation. RAL will offer a shared site visit to all interested bidders on a nominated day.

Following registration of interest within the Emptoris e-sourcing tool, bidders must further confirm (via Emptoris RFx message) their wish to attend the site visit. Further details will then be provided.

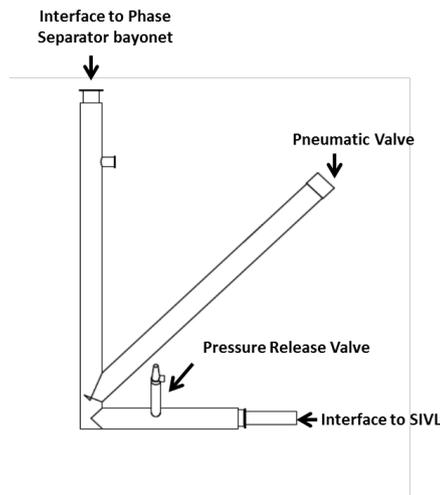
#### 3.1 SIVL/Phase separator Interface pipework assembly

Fig 3.1 below shows a possible scheme for a module of the SIVL/Phase separator interface vacuum-insulated isolation valve assembly. Location and orientation of pneumatic valves and pressure release valves will be agreed with RAL and needs to take into consideration the phase separator male/female bayonet connection location, installation constraints, and the SIVL that each module interfaces with. See AD 1 section B-B for Phase separator bayonet location.

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**Figure 3-1 A possible scheme for one of the twelve modules for the interface pipework assembly**



**Table 2 - SIVL/Phase Separator Interface pipework assembly parts and quantities**

Quantity	Assembly Part
<b>12</b>	DN 20 Pneumatic Valves (1 for each module)
<b>12</b>	Pressure release valves max operating pressure as per requirement R8, (1 for each module)
<b>12</b>	KF 40 Pump out ports (1 for each module)

### 3.2 SIVL

All SIVL parts will require different lengths, number of bends, flexible sections and connections. AD1 is a suggested scheme only; it provides information on the length required for each line. Any alterations to the routes will require approval from STFC prior to commencement of work.

One of each part is required for STC-3. The "Position From/To" are shown in AD1. Please note the lengths below are for information only as lengths will need to be adjusted by the Contractor to fit the phase separator interface pipework referred to in AD1. Dimensioned drawings of the body and door valve boxes will be provided at the Kick-off meeting.

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Table 3 - SIVL list below identifies the parts required for the SIVL. One of each part is required for STC-3. The "Position From/To" are shown in AD1. Please note the lengths below are for information only as lengths will need to be adjusted by the Contractor to fit the phase separator interface pipework referred to in AD1. Dimensioned drawings of the body and door valve boxes will be provided at the Kick-off meeting.

**Table 3 - SIVL list**

<b>Part Number</b>	<b>Position From</b>	<b>Position To</b>	<b>Approximate total length (m)</b>
KE-0288-608	SIVL/PS Interface	Vessel (lower)	9.5
KE-0288-609	SIVL/PS Interface	Vessel (lower)	9.5
KE-0288-610	SIVL/PS Interface	Rotating bayonet (Clean Room)	7.5
KE-0288-640	SIVL/PS Interface	Rotating bayonet (OGSE)	7.5
KE-0288-641	SIVL/PS Interface	Rotating bayonet (OGSE)	7.5
KE-0288-642	SIVL/PS Interface	Vessel (lower)	9.5
KE-0288-643	SIVL/PS Interface	Vessel (lower)	9.5
KE-0288-644	SIVL/PS Interface	Vessel (upper)	4
KE-0288-645	SIVL/PS Interface	Vessel (upper)	4
KE-0288-646	SIVL/PS Interface	Vessel (upper)	4
KE-0288-647	SIVL/PS Interface	Vessel (upper)	4
KE-0288-649	SIVL/PS Interface	Rotating bayonet (Clean Room)	7.5
KE-0288-656	Exhaust (TBC)	Rotating bayonet (OGSE)	5.5
KE-0288-658	Exhaust (TBC)	Rotating bayonet (OGSE)	5.5
KE-0288-659	Exhaust (TBC)	Rotating bayonet (Clean Room)	5.5
KE-0288-660	Exhaust (TBC)	Rotating bayonet (Clean Room)	5.5
<b>Flexibles to Door:</b>			
KE-0288-653	Rotating bayonet	Door (OGSE)	3.5
KE-0288-654	Rotating bayonet	Door (OGSE)	3.5
KE-0288-655	Rotating bayonet	Door (OGSE)	3.5
KE-0288-657	Rotating bayonet	Door (OGSE)	3.5
KE-0288-661	Rotating bayonet	Door (Clean Room)	3.5
KE-0288-662	Rotating bayonet	Door (Clean Room)	3.5
KE-0288-663	Rotating bayonet	Door (Clean Room)	3.5
KE-0288-664	Rotating bayonet	Door (Clean Room)	3.5

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The Contractor shall supply any components which are required for the installation and operation of the pipework and SIVL. This shall include any support structure i.e. for mounting to wall/ceiling and operation parts including (but not limited to) bayonets, rotating bayonets, vacuum ports, and at least two pump-out port adapters with KF40 flanges.

### 3.3 Option 1: Modification of existing STC-2 SIVL

The Contractor is also requested to provide RAL with a pricing option, to be awarded at RAL's discretion, in addition to and after the award of the main contract for the supply and installation of the SIVL & Pipework for STC-3, to modify the existing SIVL on STC-2 to be functionally identical to the STC-3 version.

Under the scope of work associated with this option, the contractor shall be responsible for the manufacture and installation of 12 valve-assembly modules, and the associated modification of the existing SIVL currently installed as part of the STC-2 system.

The modification work shall require the current bayonet-type connections to the existing STC-2 door valve boxes to be modified to the same standard and type as required for STC-3, and for the SIVL to be modified to accommodate the valve-modules under the phase separator.

The option price for STC-2 should be valid for a minimum of 6 months from the date of submission.

## 4 TECHNICAL REQUIREMENTS

The requirements for the SIVL and pipework assembly are detailed below. Each requirement is given a requirement number followed by all of the verification method(s) applicable to that requirement, as follows:-

- R Review of Design
- A Analysis
- I Inspection
- T Test
- S Similarity

The text for each requirement is formatted in italic font. Any additional explanatory text is formatted in normal font.

*R1 [R, T] The helium-gas leak rate for the SIVL and SIVL/PS interface pipework assembly shall be < 1e-9 mbar.l / s. The leak rate is to be validated after installation for both the vacuum jacket and the fluid pipe.*

*R2 [R, T] For a 28x1mm fluid pipe containing liquid nitrogen (LN2) at <90K, the thermal heat leak rate shall be less than*

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*0.3W per metre of length, less than 2.3W for a bayonet joint, and less than 2.8W for a welded coupling.*

- R3 [R, I] The outside diameter of the SIVL should be 75 ± 5 mm to interface with existing LN2 valve boxes.*
- R4 [R, I] Each SIVL/PS interface pipework assembly shall include a pressure release valve (PRV) on the LN2 pipe, a pump-out port incorporating over-pressure release on the vacuum jacket, and a pneumatic valve to allow/stop LN2 flow*
- R5 [R, I] PRVs shall have a suitable operating pressure which is above the operating pressure of the PRV on the phase separator, and with adequate flow rate.*
- R6 [R, I] PRVs shall be installed at an appropriate angle so that all vented flows are directed safely away from areas where an operator might be situated.*
- R7 [R, I] Each SIVL/PS interface pipework assembly shall have a burst disc in case the PRV fails to open*
- R8 [R, T] The SIVL and interface pipework shall be designed, manufactured, and tested to withstand pressures up to 1.5 x PRV.*
- R9 [R, I] Pneumatic valves shall be DN20*
- R10 [R, I] Pneumatic valves shall operate with compressed air at a supply pressure of 70-90 psig*
- R11 [R, I, A] The SIVL/PS interface pipework and SIVL shall be designed and manufactured to withstand a useful working lifetime of 20 years.*
- R12 [R, I] Pump out ports shall be easily accessible for regular maintenance and with minimum maintenance specialist equipment.*
- R13 [R, I] A suitable pump cart shall be supplied to be used for future maintenance of the vacuum jacket of the SIVL*
- R14 [R, I] The weight of the SIVL shall be supported by appropriate bracketry supplied by the Contractor and not impart any load onto the valves when connected*

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### 5 MANUFACTURING PHASE

The contractor shall demonstrate the quality of the work prior to manufacture with examples of, at least; SIVL, flexible SIVL, bayonet fitting. These example items should be shipped to RAL, or RAL will visit the manufacturer's premises, to approve the quality of the item in order for the work to begin. Preliminary and Critical Design Reviews, and Manufacturing Readiness Review meetings shall also be used for RAL to approve pipework assembly design, routes of SIVLs and positions of vacuum ports. Only when approval is given can the contractor proceed with the manufacture of the remaining items.

Note: All SIVL and pipework modules shall be removable without causing damage to the lines or surrounding equipment, for maintenance/repair in the future.

#### 5.1.1 Acceptance Tests

Prior to acceptance tests the inside of the fluid pipe shall be thoroughly cleaned by the Contractor to remove debris from the manufacturing process and to degrease it. Cleaning shall be completed with a final flush-through with Isopropyl Alcohol (IPA).

The Contractor shall be responsible for providing all the equipment needed to perform the quality assurance tests on the lines:

- A helium-gas leak test shall be carried out on all pipes in pipework assembly and all SIVL (both the fluid volume and the vacuum line) after shock cooling the liquid-carrying pipes with liquid nitrogen to  $T < 90\text{K}$  twice. The leak rate should be less than  $1\text{e-}9$  mbar.l / s
- A pressure test shall also be carried out on all lines in accordance with requirement R8.

Note: the contractor is responsible for supplying all equipment required for testing, including gaskets and male bayonet fittings as appropriate.

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## **6 SHIPPING**

The Contractor shall be responsible for delivering the items to STFC-RAL. The Contractor is responsible for ensuring that the items are adequately protected during shipping so that no damage occurs.

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### 7 FREE ISSUE ITEMS

The phase separator (as shown in AD1) has a number of bayonet fittings. The Contractors shall be able to access the bayonet fittings to facilitate the creation of the interface between the phase separator and the pipework.

### 8 INSTALLATION

The contractor is responsible for installing the PS/SIVL interface pipework assembly and SIVL; this includes providing all tools and identifying all assumptions and dependencies on RAL Space lifting equipment.

### 9 DELIVERABLES

The following items are deliverable to STFC RAL:

- Installation of the interface pipework assemblies at RAL
- Installation of all 24 SIVL at RAL
- Certificates of Conformance for all materials and tests
- Test reports which state the results of the leak and pressure tests
- 2 complete sets of any tools required for maintenance
- Pump cart for maintenance testing

### 10 PRODUCT ASSURANCE & QUALITY MANAGEMENT

The Contractor shall have a quality management system certified to ISO 9001 or equivalent internationally recognised quality management system certification and a dedicated Quality Assurance representative shall be assigned to the project. The contractor shall provide a Product Assurance plan as a deliverable.

### 11 MANAGEMENT, REPORTING, MEETINGS AND REVIEWS

#### 11.1 Management

The contractor's nominated Project Manager shall be the point of contact between the contractor and the customer. STFC RAL Space shall be notified in writing at the earliest opportunity if the nominated Project Manager changes during the course of the project.

#### 11.2 Reporting

The contractor shall report progress every week, in the form of electronic progress reports. These reports shall contain at least the following information:-

- Progress made in the reporting period
- Identification of any problems encountered and the anticipated effect on the

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schedule

- Proposed methods to recover schedule
- List and status summary of non-conformances
- Updated schedule
- Action list and status summary

### 11.3 Meetings

Regular face-to-face meetings are not anticipated. Meetings shall be arranged as required to discuss technical issues and any concerns regarding progress.

### 11.4 Design Reviews

The following reviews shall be held at RAL Space's premises. Review dates are to be agreed at KO meeting.

***PDR – Preliminary Design Review***

***CDR/MRR – Critical Design Review /Manufacturing Readiness Review***

## 12 WARRANTY

The Contractor shall provide a minimum 24 month warranty on all hardware and workmanship supplied under the contract.

## 13 SCHEDULE

Delivery and Installation of the interface pipework work assemblies and SIVL within 16 weeks of contract award is preferred but installation by 20 weeks of contract award is required.

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## 14 APPENDIX

### 14.1.1 RAL Space Liquid Nitrogen Supply information (Outside storage tank)

Liquid Nitrogen Supply (Outside storage tank)		
Capacity	40000	litres
Normal working pressure	3.3	bar G
Relief Valve set pressure	3.5	bar G
Maximum delivery rate	2	tonnes per hour
Maximum delivery rate - STC2	1	tonnes per hour
Maximum delivery rate - STC3	1	tonnes per hour

### 14.1.2 RAL Space Liquid Nitrogen Supply information Phase Separator STC2 &STC3

A phase separator is mounted above each chamber to deliver liquid nitrogen to that chamber. The delivery pressure of liquid nitrogen should consider the hydrostatic head generated.

Phase Separator STC2 &STC3		
Capacity	500	litres
Normal working pressure	1-2	bar G
Relief Valve set pressure	3.5	bar G
Supply Pipe vacuum insulated length	82	m(estimated)
Supply Pipe vertical rise	11	m(estimated)
Inlet valve trim Kv	2.6	(m <sup>3</sup> /hr)
Maximum Delivery Rate	959	Kg/hr (by analysis)
Valve opening	100	%