

TS1 Project - Technical Specification for the Cryogenic Methane Transfer Line

Sign Off

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Revision History

Issue	Date	Author	Revision Comments
1	28/02/2018	Abi Basham	Initial Specification
2	21/01/2019	Sean Higgins	Primary Tender Release

Document Location

For STFC internal information the source of the document will be found on the project SharePoint:

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<small>ISIS Design Division Science and Technology Facilities Council (STFC) Rutherford Appleton Laboratory, Harwell Campus, Didcot, OX11 0QX</small>					

1 Purpose

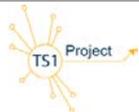
This document provides General Requirements to suppliers for the provision of a cryogenic liquid methane transfer line (and spares) for the TS1 Project.

Specific Technical Requirements are given in the Scope of Supply section.

Information the Supplier is expected to provide, guidance on expected behaviour during the contract period, as well as what documents are required as part of the tender submission are covered in the General Requirements section.

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2 Summary

This tender is for the design, manufacture and supply of a cryogenic, vacuum-insulated-transfer line (approx. 14m total length), which is suitable to supply liquid methane* at 110 K.

The transfer line is to be installed into existing infrastructure and is a replacement for an existing transfer line, which has been functioning successfully for over 30 years. Because of the existing infrastructure space and access constraints, we believe there are limited possible solutions in the new transfer line design. Although this tender document shows a concept solution, which we believe is suitable, STFC are happy to hear new suggestions, however, they must meet the requirements and integrate with existing constraints. It is of utmost importance that the dimensions and designs of a number of interface points, are retained in the replacement equipment in order to mate with existing hardware (e.g. bayonet nose dimensions).

The required date for delivery of the completed transfer line and all associated items is:

Thursday 14th November 2019.

The tender submission must include the documents requested in the 'Request for Proposal' document (PR19004) and Emptoris (the eSourcing tool to which bids will be submitted).

*Potential future development work at the facility may include using ethane or propane as the process fluid. In this event, the system may operate at different pressure and temperature. These shall not exceed the stated design limits shown in this specification.

Also periodic cleaning (approx. every 2 years) of the transfer line is carried out by STFC staff using Methyl Ethyl Ketone (MEK).

In addition, it is known due to radiation chemistry/processes hydrogen gas is formed in normal operation when using liquid methane. Industry standard to reduce likelihood of hydrogen embrittlement is to use 316 / 316L stainless steel.

Therefore, the materials used in the delivered transfer line solution must be suitable for these fluids/gasses. Note: this only applies to wetted surfaces. For example, the outer jackets that just contain vacuum could be 304 / 304L stainless steel.



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3 Introduction

3.1 ISIS Facility

The ISIS pulsed neutron and muon source at the Rutherford Appleton Laboratory (RAL) in Oxfordshire, UK is a world-leading centre for research in the physical and life sciences. It is owned and operated by the Science and Technology Facilities Council (STFC) for UK Research and Innovation.

ISIS produces beams of neutrons and muons that allow scientists to study materials at the atomic level using a suite of instruments, often described as ‘super-microscopes’. It supports a national and international community of more than 2000 scientists who use neutrons and muons for research in physics, chemistry, materials science, geology, engineering and biology. It is the most productive research centre of its type in the world.

From the original vision over 30 years ago, ISIS has become one of the UK’s major scientific achievements. As the world’s leading pulsed neutron and muon source, ISIS has changed the way the world views neutron scattering.



Figure 1 - The ISIS Facility, Rutherford Appleton Laboratory, Harwell Oxford, UK

Neutrons are produced when a tungsten target is bombarded with pulses of high energy protons, driving neutrons from the nuclei of the target atoms in a process called spallation. This gives an extremely intense neutron pulse, and the neutrons then need to be slowed to speeds useful for condensed matter research. This is achieved using an array of hydrogenous moderator vessels.

As part of a major sustainability project (TS1 Project), a replacement transfer line is required to carry cryogenic liquid methane between the refrigeration unit (Coldbox) and the item to be cooled (Moderator Vessel) located adjacent to the neutron source.

There is another transfer line providing cryogenic liquid hydrogen to another Moderator Vessel, but this has been replaced in the past and is not subject to this tender.

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3.2 TS1 Project

During its 30+ years of operation, no significant upgrade or development work has been carried out on the inside of TS1. The TS1 Project will develop and upgrade key elements of TS1 to enable it to run for many more years. The project involves a complete refurbishment of the internals of the target station, including:

- Design of the target & target cooling systems
- Moderators and reflector, and all their cooling systems and services which sit behind the target station

The TS1 project is a sustainability project and the main driver behind the purchase of a new cryogenic methane transfer line. To summarise, the purpose of the TS1 project is;

- To secure the future of TS1 and enable it to operate for many more years
- To provide improved flexibility for future target or moderator changes
- To make operation of the target station easier, e.g. improving the time for methane moderator changes
- To provide a neutron performance increase, of up to a factor of 2, on some instruments
- To provide confidence in the ongoing operation of TS1 to enable future instrument upgrades
- To further improve our knowledge of target station design for future projects and further develop our staff in this area

3.3 Equipment Location

The transfer lines are located between the Cryogenic Coldboxes and the Moderator Vessels at the front of the ISIS Services Trolley (*Figure 2*), located within the Target Station 1 - Target Services Area (TSA).

Transfer lines are routed through two sets of shielding: near the Moderator Vessel the bulk shielding is constructed of solid steel blocks, and the second shield block near the Coldboxes is made of concrete. The route through the shielding has 90-degree bends to provide protection from direct radiation shine.

The TSA is located within a building and within a radiation shielded area. This area has restricted personnel access, and entry is not permitted during operation of the facility.

The Services Trolley is mounted on rails and can be moved forwards and backwards to allow access to different sections during maintenance. However, the area around the Target and Moderator Vessels (left of the steel shielding) is only accessible with remote manipulator arms due to high radiation levels.

The cryogenic cooling equipment (Coldboxes and additional equipment) is to be installed on the Services Trolley within a specially built structure (ATEX enclosure) in order to provide separation for ATEX Zoning requirements.

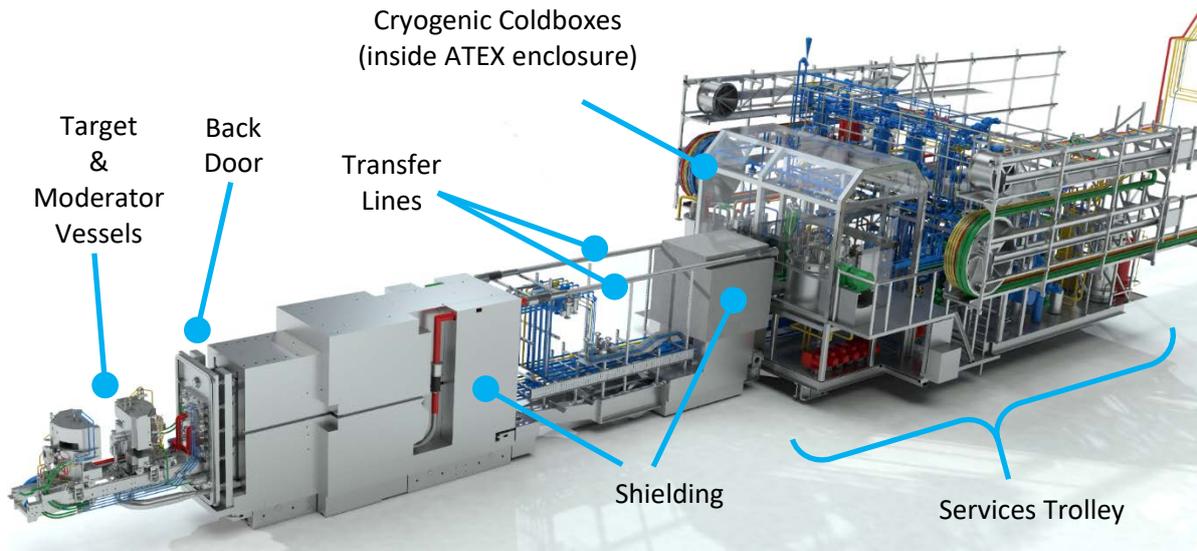


Figure 2 – ISIS Services Trolley Layout (NOTE building/walls not shown)

3.4 The current cryogenic methane transfer line

This transfer line was installed in around 1985 at the beginning of the ISIS facilities' construction. The majority of the transfer line is flexible with a hard section at the right-angle joint.

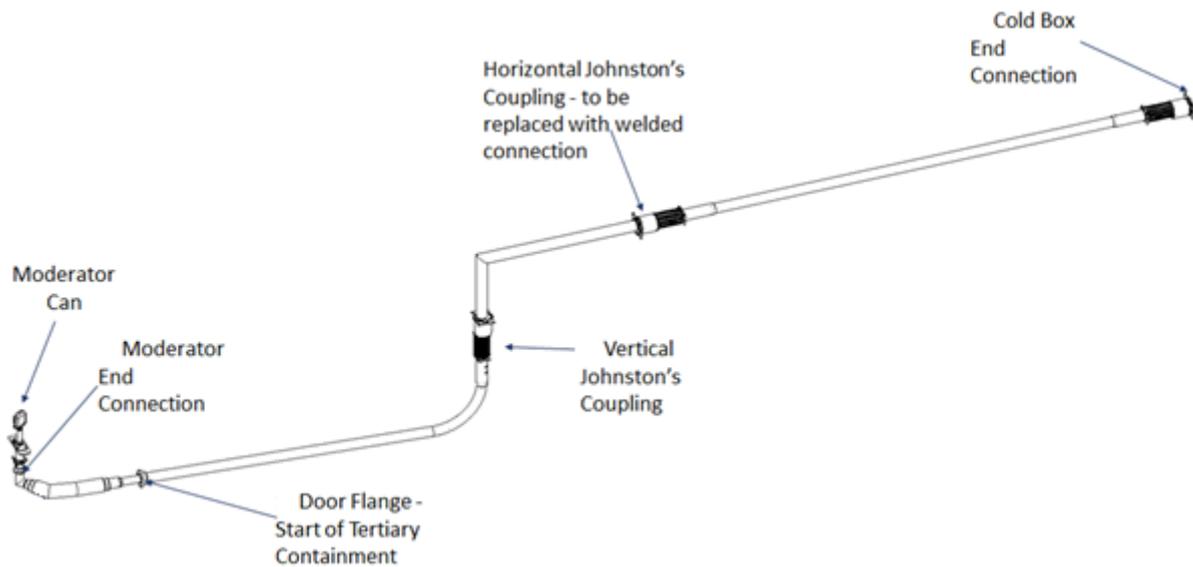


Figure 3 - A view of the current methane transfer line assembly in isolation (other components and shielding not shown). The item to be cooled (Moderator Can) is shown but not part of this tender.

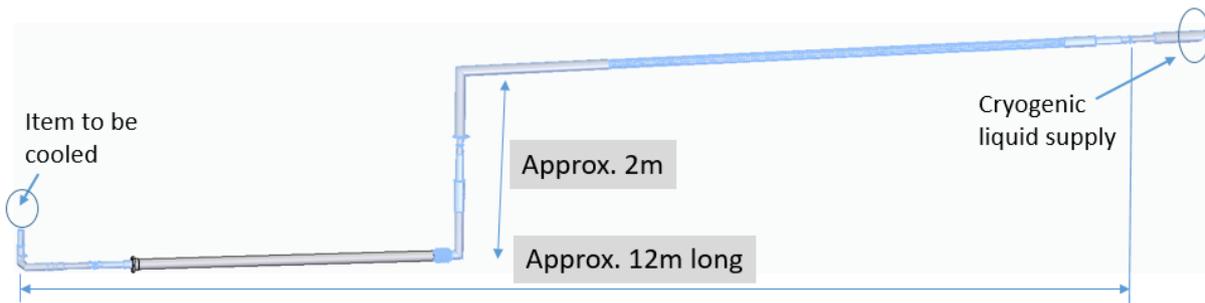


Figure 4 – Transfer Line Length

As previously stated the methane transfer line sits between (connects) the cryogenic plant (methane coldbox) to the Moderator Vessel (item to be cooled) and is approx. 14m long.

The current line consists of concentric flow and return lines, each separated by a vacuum layer as shown in Figure 5. Further details and dimensions of the current line are shown in drawings: SI-7042-400, SI-7042-401, SI-7042-402, and SI-7042-403. These are included within the tender specification pack. The transfer line is constructed mostly from stainless steel.

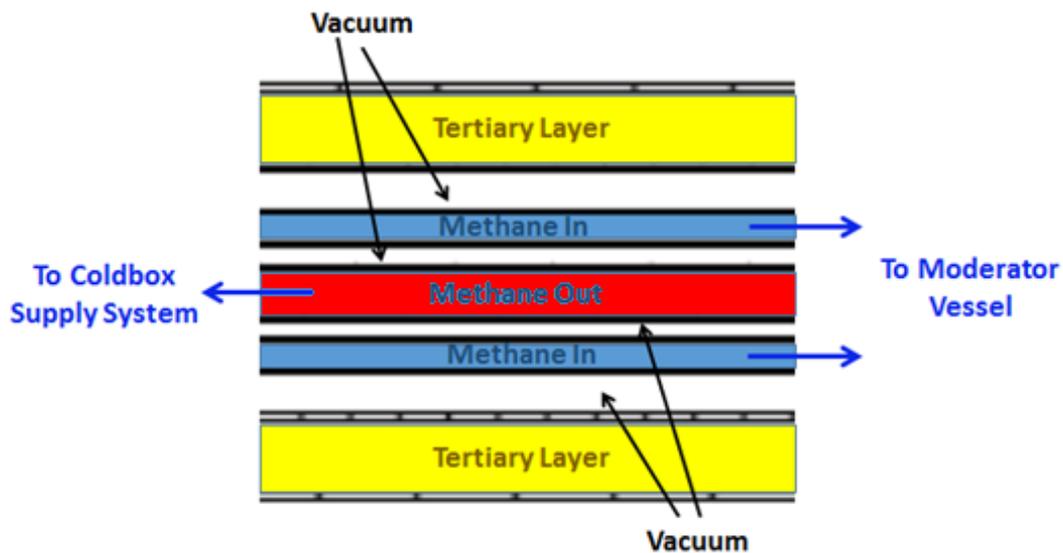


Figure 5 - Construction of current transfer line

Note that the return (hotter) gas flows in the innermost pipe and the flow (colder) goes outside the return (although separated by a vacuum jacket). This might be against normal convention, but this configuration is required to give the desired flow within the Moderator Vessel, and this has been the configuration for around the past 10 years.

Surrounding these process and vacuum lines is the 'tertiary layer', which is designed to contain any leaks. Currently the tertiary layer is segregated into two volumes. The helium gas environment (a few mbar above atmospheric pressure) from the Void Vessel enters the Tertiary Sleeve at the Back Door connection and terminates at the vertical bayonet connection. Then from the vertical bayonet to the ATEX room is the other volume. This just volume contains air from the ATEX room.



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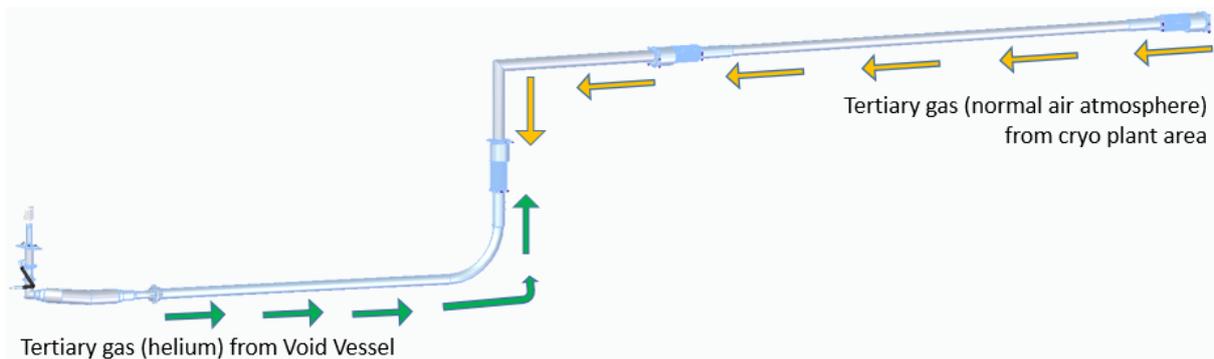


Figure 6 – Separation of tertiary volumes

At the Transfer Line coupling joints (apart from joint located in the void vessel) there are bellows units covering both the main inner joint and vacuum links. The bellows are pulled back to access these inner joints. These bellows assemblies are dismantlable to enable replacement in the event of damage, and in the original design to allow the transfer line to pass through holes within the steel shielding. This is because the bellows diameter is larger than the hole in the shielding.

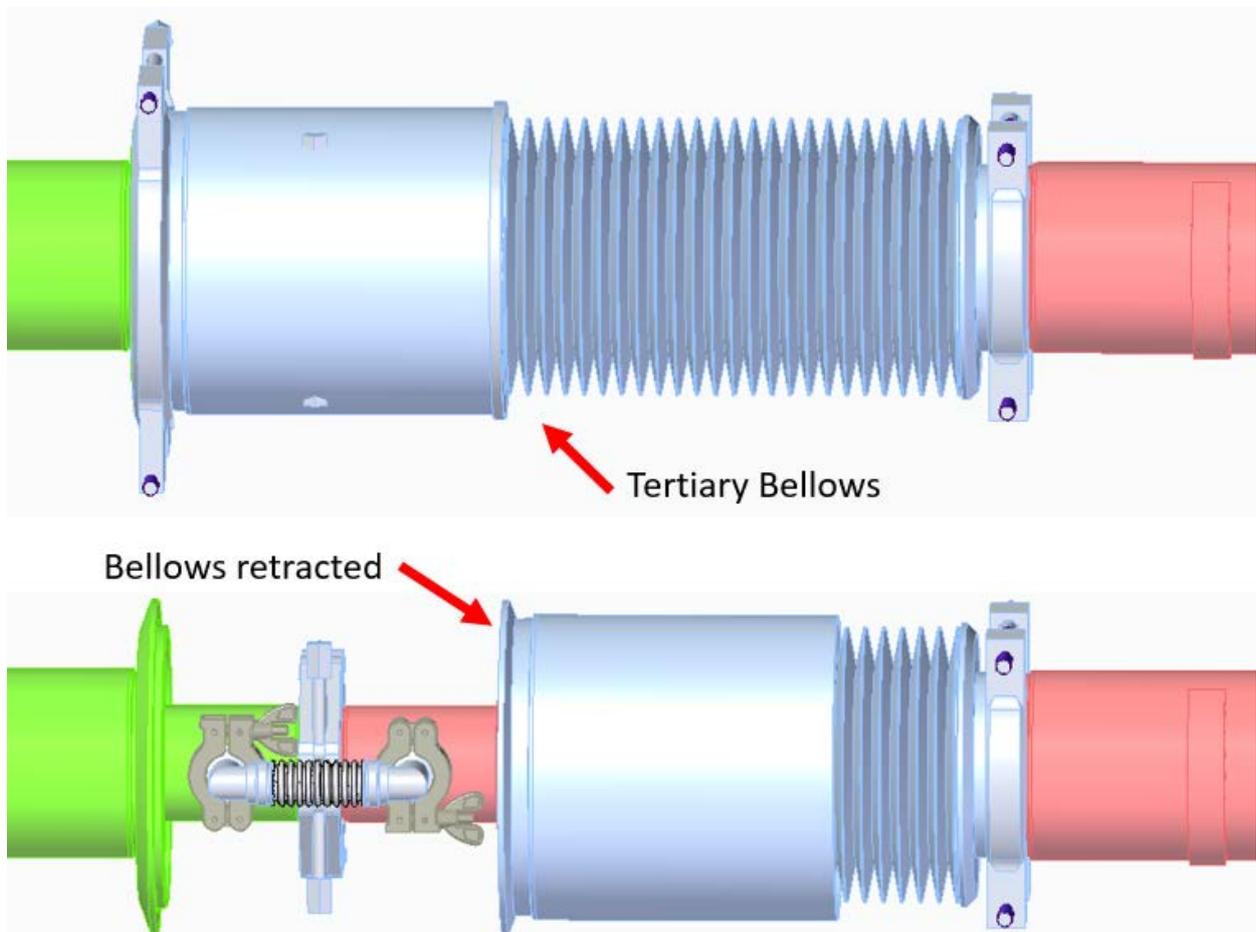


Figure 7 – Bellows covering inner transfer line and vacuum joints



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The current Transfer Lines uses a bayonet connection, which has given reliable operation over the last 30 years. It features tightly toleranced components comprising of a male nose made from Invar, which fits into a female socket made from bronze. The passing of cryogen causes the bronze socket to shrink onto the Invar nose creating a gas tight joint (see *Figure 8*).

From operating experience, it is known that this type of joint performs best in a vertical orientation. Icing has been seen on joints in a horizontal orientation and

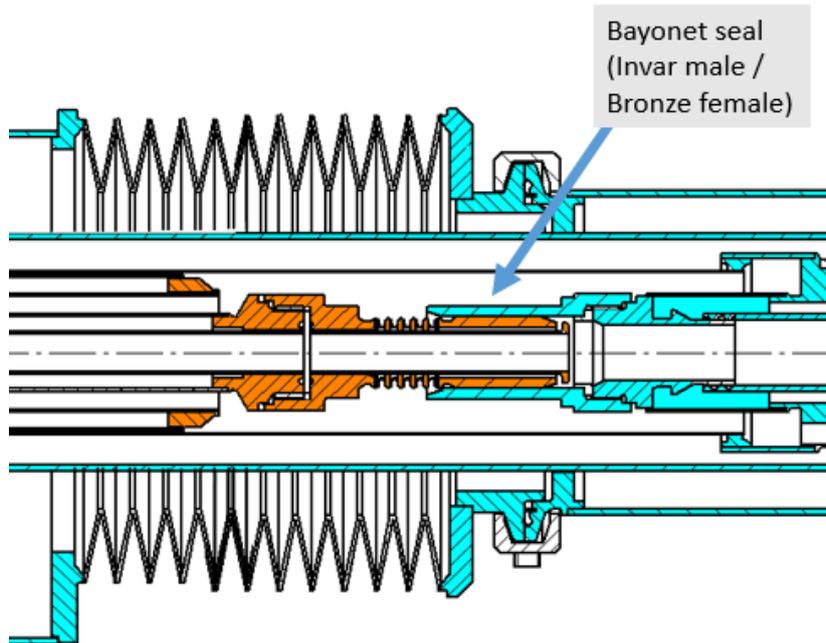
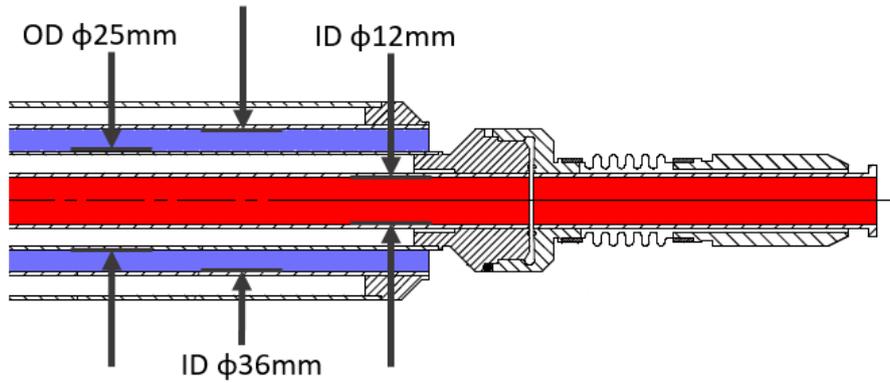


Figure 8 – Current bayonet connection used



Solid tubes at bayonet



Solid tubes after bayonet

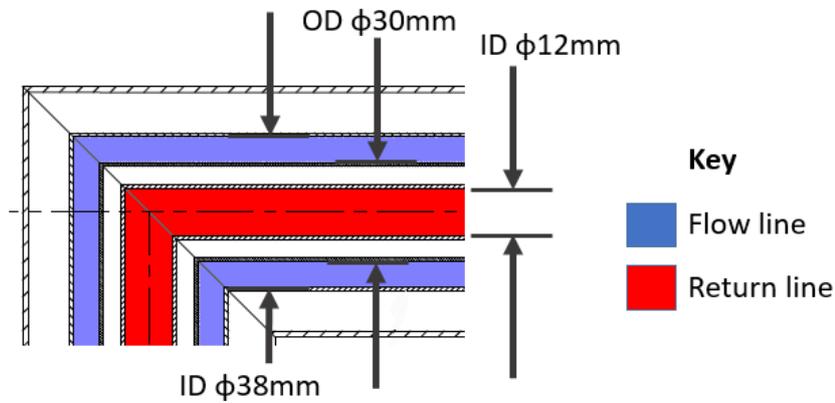


Figure 9 – Tube sizes used in current transfer line

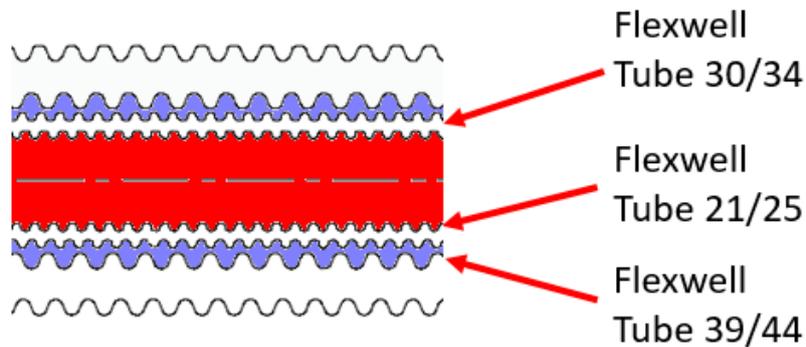


Figure 10 – Sizes used in flexible sections of Transfer Line

A number of PDF's of original drawings are included within the tender specification pack, these show the layout of the area (SI-5404-170) and the original transfer line installation sequence (SI-5404-177).



3.5 New Transfer Line Design Principles & Constraints

Manufacturing an exact copy of the transfer line currently in use will not be suitable for installation reasons. The original method/route used to install the transfer line is no longer an option and existing steel shielding and radiation levels limit options.

However, in 2006 the majority of the other transfer line (liquid hydrogen) in operation was changed, the design and installation was successful and it is this design which the concept presented in this specification is based on.

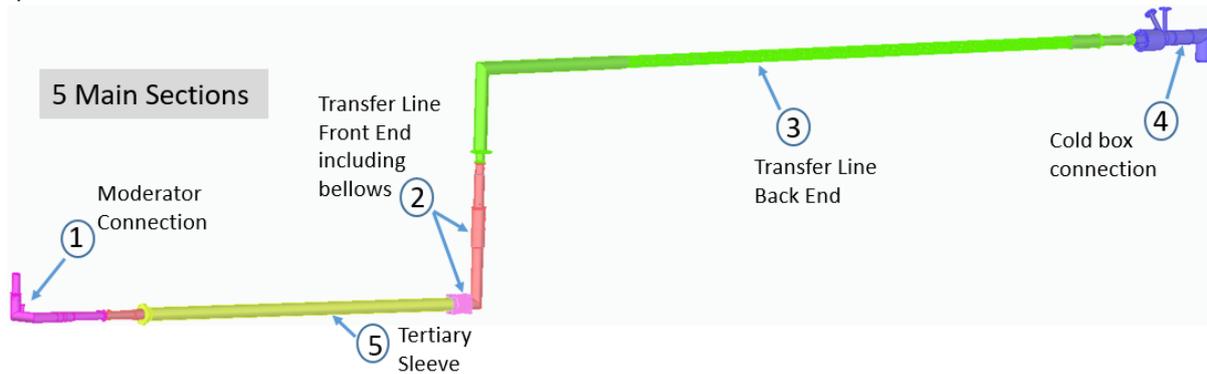


Figure 11 - A view of the replacement methane transfer line assembly (concept) containing 5 main parts or sections.

Sections 1 & 5 have to be installed via remote manipulator arms due to high radiation levels restricting personnel entry into the area. Section 2 can be accessed 'hands-on', and is slid through shielding and inside the Tertiary Sleeve into position. Likewise Section 3 & 4 can be worked hands-on.

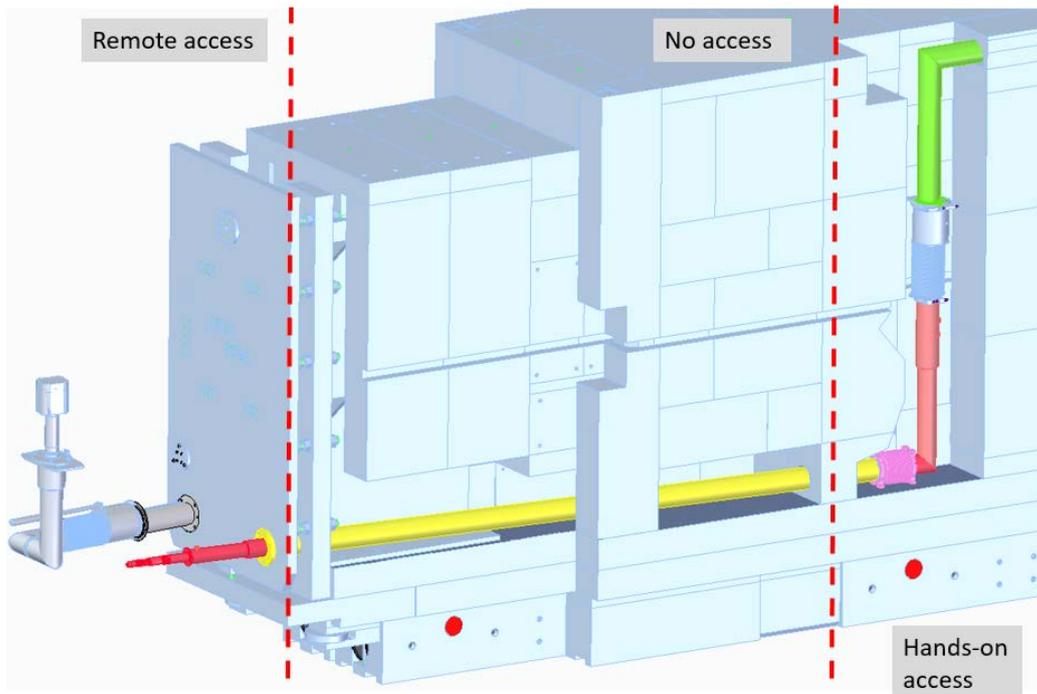


Figure 12 – Steel shielding and how the concept transfer line is located (some steel shielding has been hidden in order to see the Tertiary Sleeve).

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STFC welcomes different ideas and engineering solutions for the replacement transfer line, however it is difficult to convey all the detail, restrictions & environment within this document of the current facility. Once a contract has commenced, it is recommended to liaise with STFC before too much work has been carried out to avoid working on an incompatible solution.

New measurements of the existing area, which the transfer line is located in, cannot be fully made due to access restrictions and radiation levels. The original 1980's pencil drawings of both the building/shielding and transfer lines have been used to obtain the most accurate representations possible. STFC can provide a 3D model of the concept Transfer Line fitted within the existing infrastructure. The dimensions are to the best of our knowledge.

The design philosophy around the two main connections points, which the transfer line must connect to (moderator vessel & cryogenic coldbox), is of adaptability during final installation. As detailed in Section 3.5.2, a small bellows section provides some fore-aft movement in the positioning of the Moderator Vessel connection. The bayonet connection at the Coldbox end will be made and tested, but the mating pipe/tube work supplied loose. Then during installation at RAL, STFC will make-off and weld these pipes/tubes to their correct length and origination. This is shown in more detail within Section 3.7.4 and the included document 'Information on Transfer Line Concept – Coldbox connection'.

There are no hard points or fixings shown on the concept design, but these can be mounted to a number of places to counteract reaction forces and it is the responsibility of the supplier to ensure that these have been accounted for to ensure the transfer line does not distort during operation.

Due to existing interfaces that the transfer line has to interact with, there are a number of dimensions which the replacement transfer line must match.

Important dimensions are:

- Flexibility of Transfer Line Front End (Section 2) where it passes through Tertiary Sleeve, in order to provide adjustment in placing the Moderator Connection (Section 1)
- Position of holes on tertiary sleeve to match existing holes in the back door
- Diameter of the flange at the intermediate vertical Johnston's coupling

Critical dimensions are:

- Largest diameter on tertiary sleeve that passes through steel shielding – Dia. 121mm (As the line will run through the existing shielding (Figure 20) – hole in shielding is Dia. 131, the tube liner inside the hole probably has 3mm wall thickness, so internal dia. of 125mm).
- Bayonet connection and sealing flanges on Moderator Connection to match current design.
- The solution has to sit within the existing space envelope on the rear concrete shield block – 215 x 160mm (see Figure 25).

The table below details the tolerances for the positions of different connections in the line relative to each other. Positions referenced are shown in Figure 13.

Position Dimension	Tolerance (mm)
Tertiary sleeve door flange to moderator end connection (A-B) - Horizontal	+/- 0.5
Tertiary sleeve door flange to vertical section centre line (B-C) - Horizontal	+/- 5
Height between positions D-E - Vertical	+/- 5
Vertical section centre line to cold box end connection (C-F) - Horizontal	+ 20 -10

Table 1 – Tolerance of Transfer Line sections

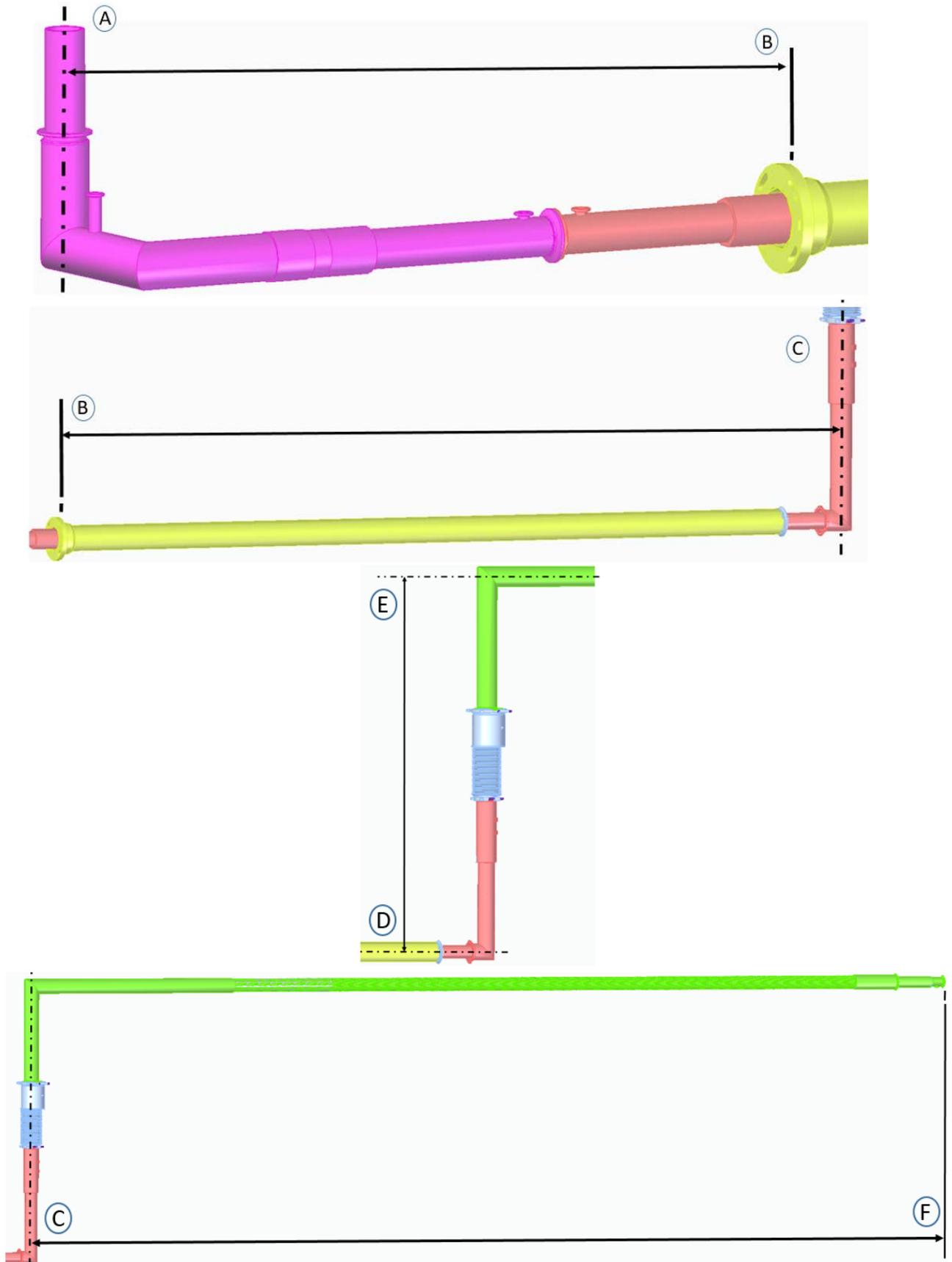


Figure 13 – Positions referenced in Table 1

3.5.1 Moderator End:

Ensuring the Moderator Vessel is in the correct position is of upmost importance. Elsewhere the transfer line has a reasonable amount of clearance to pass through shielding etc. The Moderator Vessel will be situated within the Reflector with only minimal clearance on all sides. Because of the distance from the Transfer Line to the Moderator Vessel, a small difference in angle at the right-angled joint causes a big change in the Moderator's position.

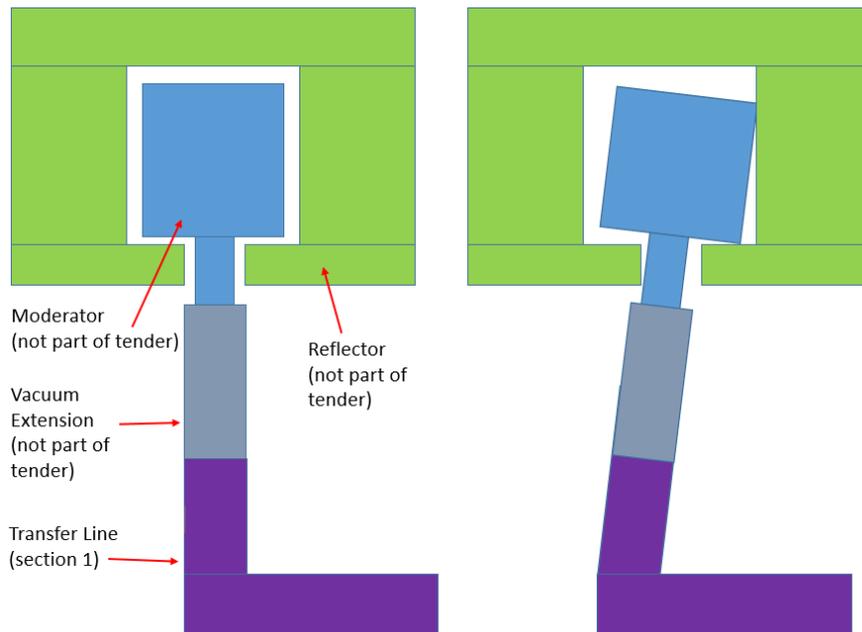


Figure 14 – Sketch showing the effect of Section 1 being out of tolerance

A method around this issue would be to have the front-end section flexible. The original design had the horizontal section flexible but during operation (under vacuum and flowing cold liquid methane) the line distorted.

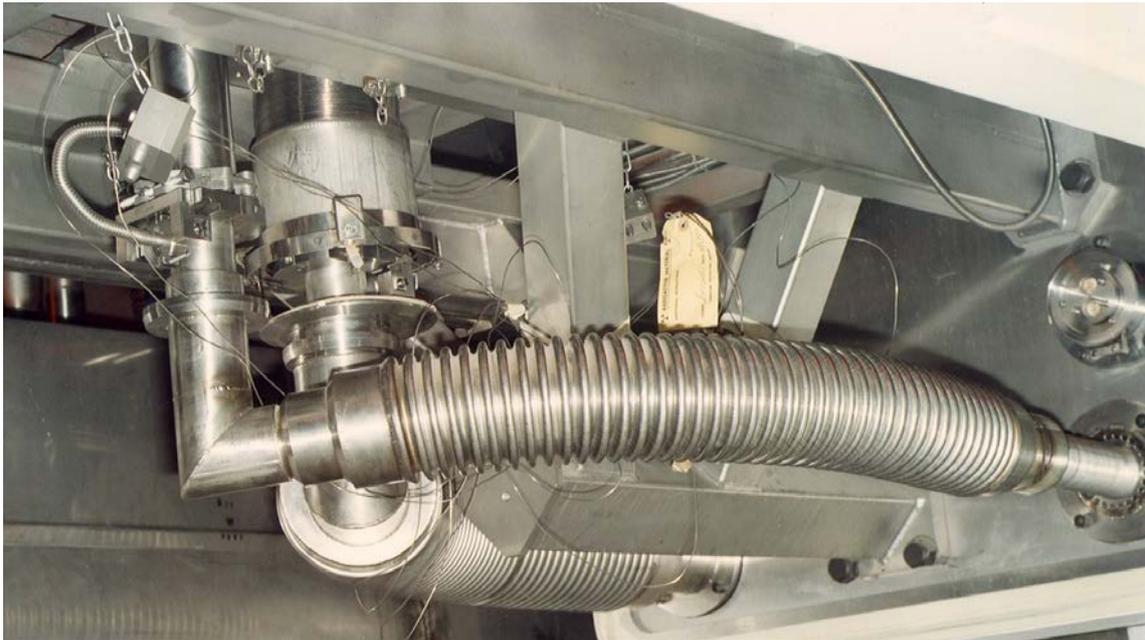


Figure 15 – Original transfer line installation

This was rectified by welding three external sleeves over the outer flexible and the fitment of threaded studding to stop the transfer line contracting towards the back door (shown inside highlighted circle).

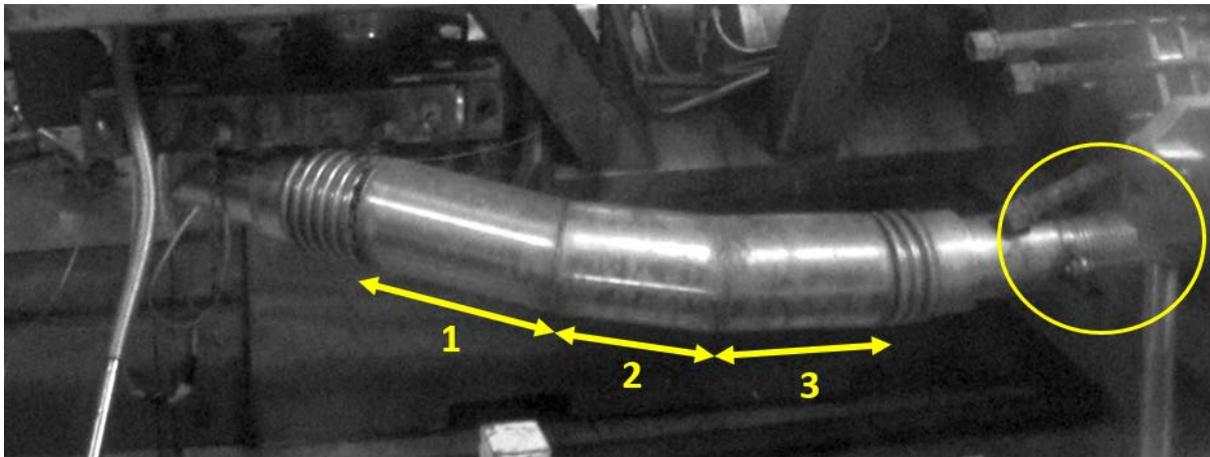


Figure 16 – Original transfer line installation

This arrangement of a flexible line, which once positioned is locked rigid could be suitable as long as the locking mechanism/proposal has been determined by STFC as able to be carried out remotely. It is no longer possible to enter the area and weld on tubes as the original solution shows.

This section of the transfer line is where STFC are expecting the experience and expertise of the Supplier to propose viable solutions.

As mentioned earlier in this specification document, the concept design is based on a solution, which was adopted on the other transfer line that supplies liquid hydrogen. Two individual sub-assemblies (of Section 1) were made and tested, then using a positional jig and overlapping tubes the two

connection assemblies were welded into their correct position. This construction can be seen in the included document ‘Hydrogen Moderator Connection’.

Figure 17 shows a concept for Section 1. The Supplier would manufacture and test the two individual sub-assemblies and it would be STFC’s responsibility to weld them together during installation. Tubes are slid in/out to make the sealing welds, working from the inner tubes out.

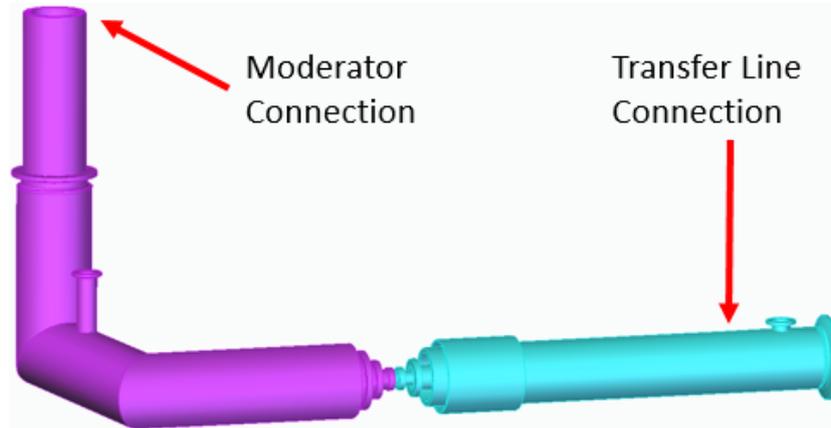


Figure 17 – Concept for Transfer Line – Section 1

3.5.2 Tertiary Sleeve

Figure 18 shows there is a clearance of 10mm between the inner transfer line and the tertiary sleeve (if the same pipe sizes are used). This should provide enough movement (up/down/left/right) to account for minor discrepancies, as long as the inner line has some flexibility.

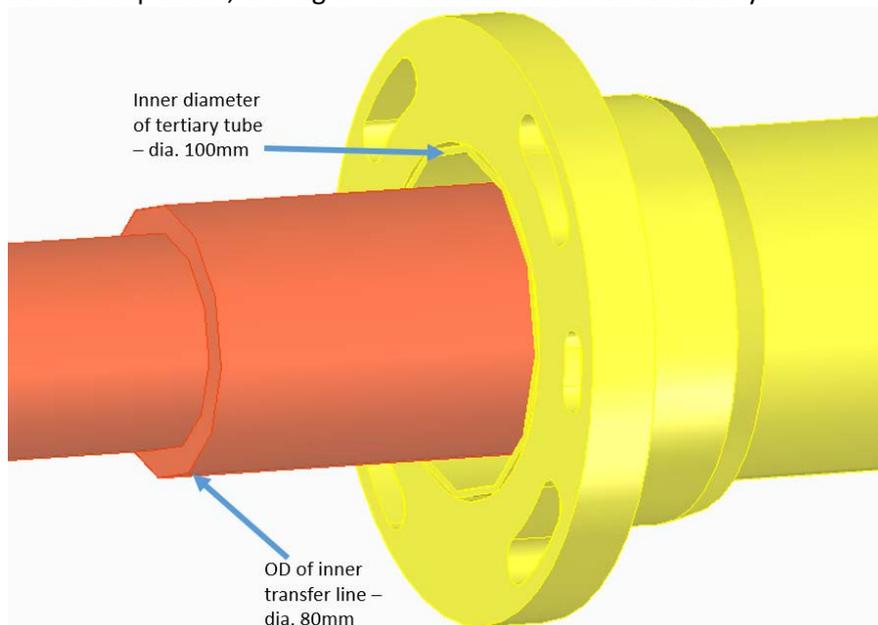


Figure 18 – Clearance around tertiary pipe on concept design

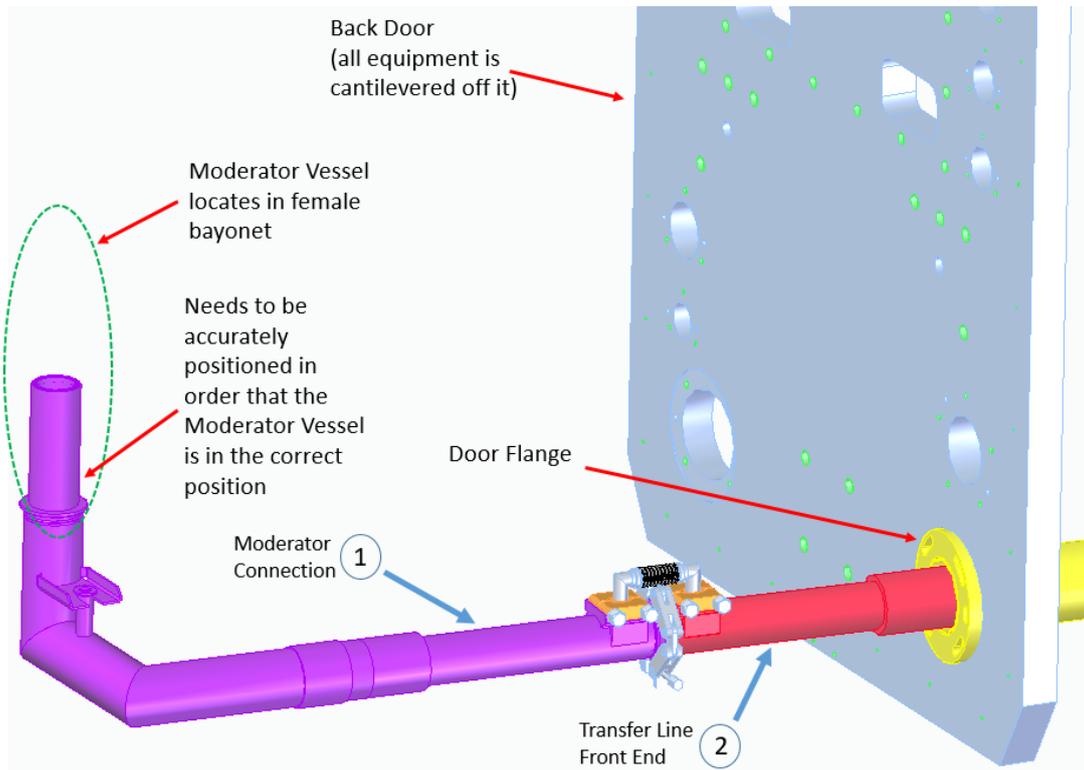


Figure 19 – Concept arrangement at moderator end

The concept design incorporates a bellows section (purple) so that the inner transfer line can move fore-aft within the fixed tertiary sleeve (yellow tube). This is to compensate for the actual dimensions faced during final assembly. As previously stated due to radiation this area cannot be fully surveyed, thus it is prudent to have some adjustability.

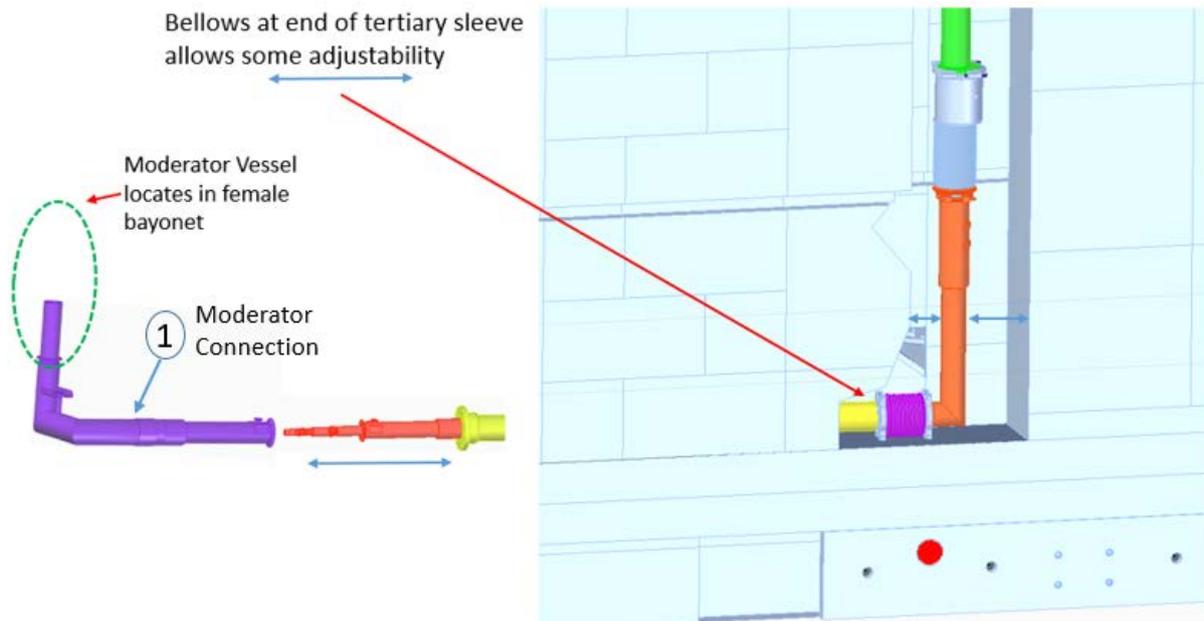


Figure 20 – Tertiary bellows to allow fore-aft movement

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The Moderator Vessel must be located in its correct position and then the transfer line connected. The transfer line shall not dictate the position of the Moderator Vessel.

3.5.3 Front Steel Shielding

The Transfer Line has to fit within the existing front steel shielding. There are a number of constraints. A hard constraint is the size of the hole in the lower shielding (see *Figure 21*). The machined hole in the steel shielding is dia. 131mm and within the hole is a guide tube of which there are no details. Assuming a wall thickness of 3mm this give an internal hole of dia. 125mm.



Figure 21 – Lower hole in steel shielding ~dia. 125mm

The OD of the flange fixed onto the current Transfer Line (largest diameter that has passed through shielding hole) is dia. 121mm. Therefore to ensure fitment any part of the new Transfer Line which needs to pass through this hole must not be greater than 121mm in diameter.

Around the middle of the steel shielding is a chimney or channel section within the steel shielding. The width is 440mm wide x 300mm deep. The new Transfer Line should be located centrally within this channel, this gives maximum adjustment (if required) of moving the line forwards/backwards using the small bellows to maintain gas sealing of the tertiary helium atmosphere.



Regarding the overall height of the vertical section, the concept design (which matches the current Transfer Line height) has a lower clearance of $\sim 10\text{mm}$ and an upper of $\sim 45\text{mm}$. Nothing can protrude higher than the top of the steel shielding because during operation the trolley, which this equipment is mounted on, moves into an enclosure within the building structure.

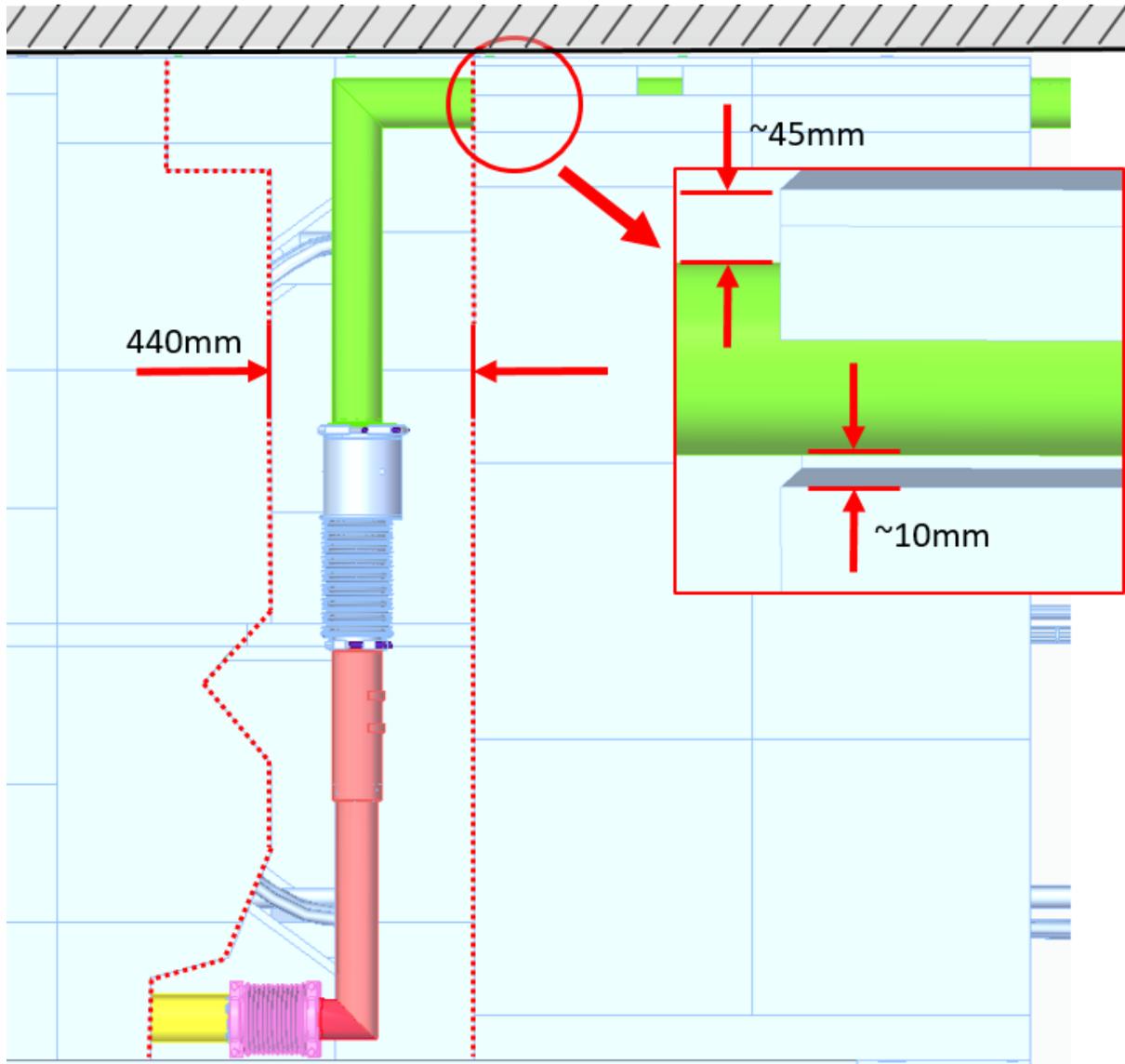


Figure 22 – Clearance in ‘chimney’ within steel shielding

Included in the tender specification pack is the original front steel shielding drawing (SI-5409-837, Primary Shield Carriage Main Assembly).

3.5.4 Rear Concrete Shielding Block

Between the steel shielding and concrete shielding is a relatively open space, which the Transfer Line spans. This is shown in Figure 23.

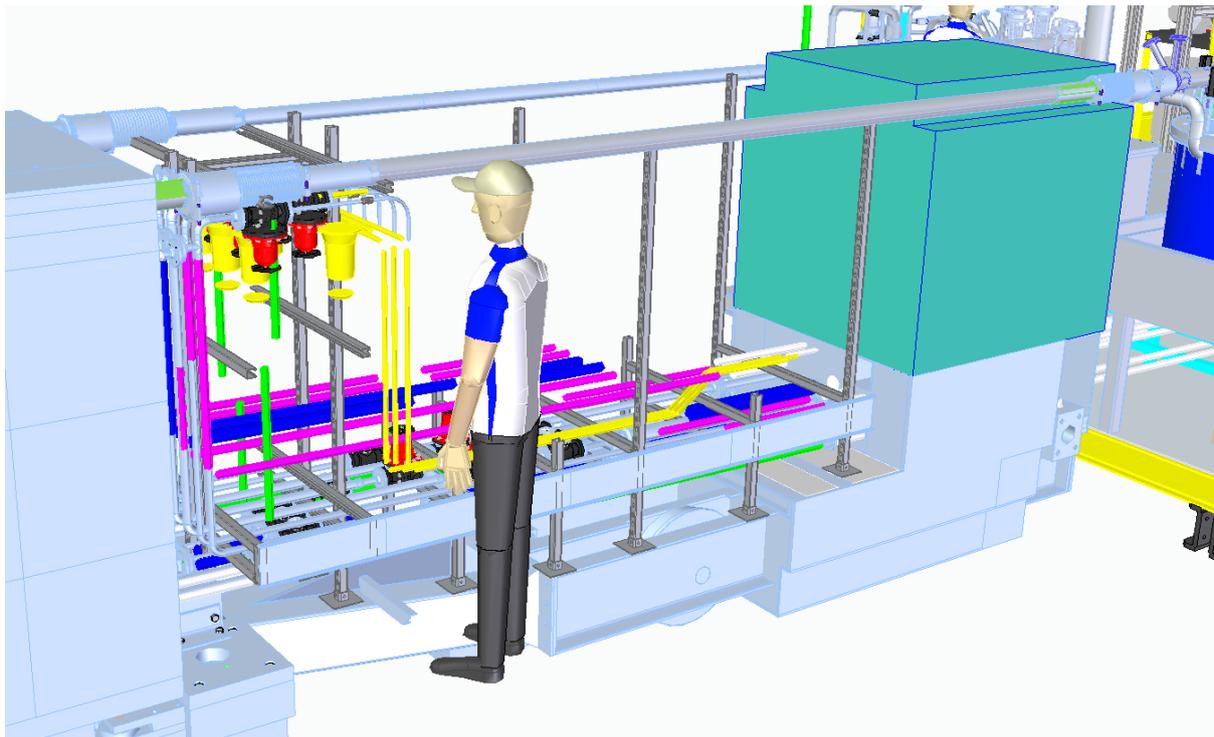
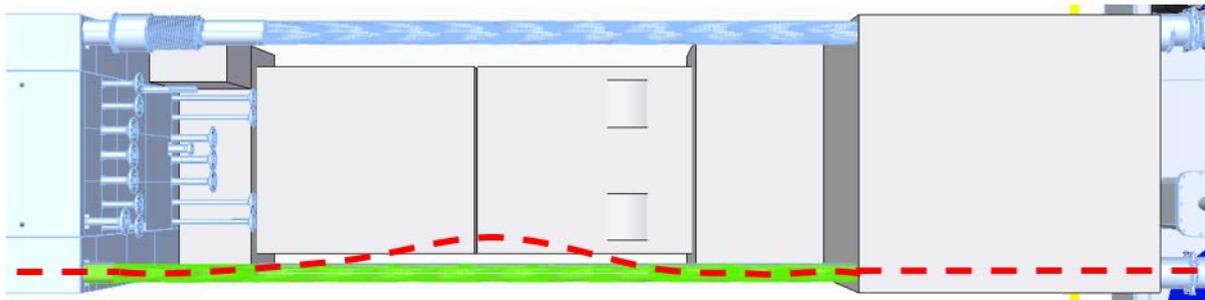


Figure 23 – Space between steel and concrete shielding

It might be advantageous to manufacture this section of the Transfer Line longer than required, then use the space available to 'lose' the additional length in order to ensure the female bayonet for the Coldbox is in the correct position. As indicated in the *Figure 24* below:



*Figure 24 – Bending transfer line into available space to lose length
(indicated by dashed red line)*

The rear concrete shielding block is existing and is not being replaced. Unlike the steel shielding, which is constructed from blocks, the concrete block is one piece and as such difficult to modify. There is a channel cast into the side for the Transfer Line to pass through. As the following figure shows it has a height of 215mm and width of 160mm. The concept Transfer Line uses the existing tertiary bellows design and clamps, which is known to fit within this constraint. If the Supplier has different ideas then it must fit within the channel.

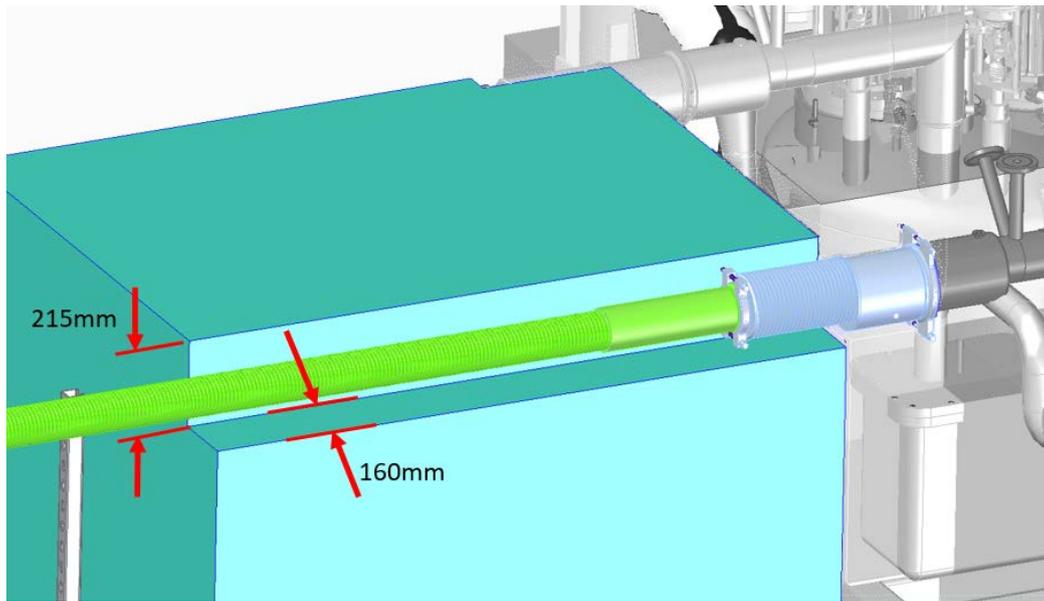


Figure 25 – Dimensions of channel on rear concrete shielding block

3.5.5 ATEX Room

The ATEX room houses the cryogenic plant, it is designed to contain any release of explosive gasses and as such, there should not be any large holes within the room. The Transfer Line passes through the wall of the ATEX room and therefore must be sealed. The concept Transfer Line connection to the coldbox (see *Figure 30*) has provision to alter tube lengths to ensure that the clamp which seals Transfer Line Sections 3 to 4 (see *Figure 11*) does not straddle the wall and therefore present a difficult shape to seal against.

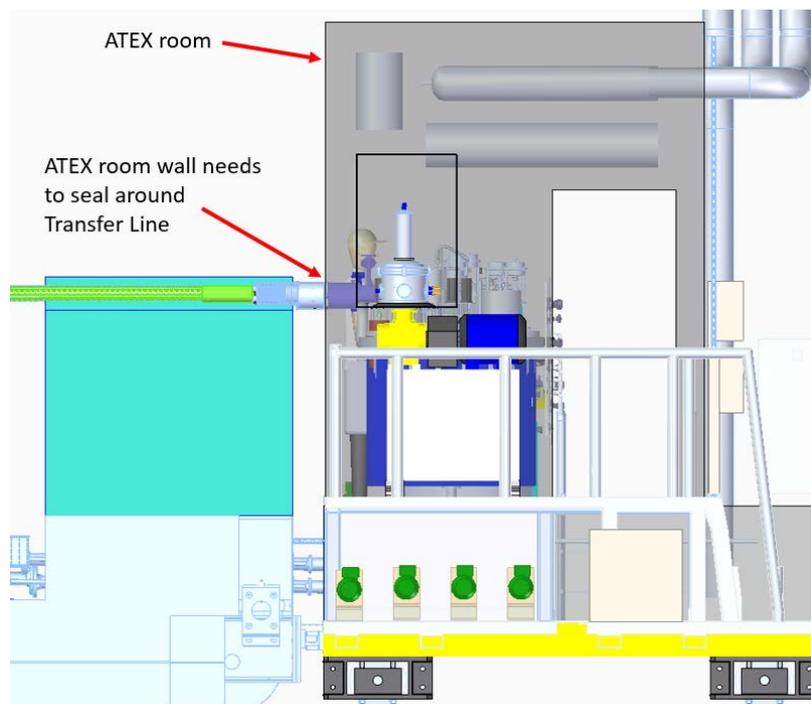


Figure 26 – Transfer Line entering ATEX Room

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3.6 Surrounding Environment and Radiation

Radiation levels in the TSA will be in the region of 100 mGy/hr during system operation. Section 1 – Moderation Connection of the Transfer Line is located in the Void Vessel, during running this area is subjected to much higher levels of radiation, several Gy/hr.

Any parts which cannot be changed as part of a preventative maintenance plan shall have a radiation life of at least 20 years at this level, based on continuous operation 24 hours per day, 200 days per year, representing an anticipated cumulative radiation dose of approximately 10,000 Gy.

STFC has significant experience of equipment and materials operating in this environment and the Supplier shall consult with STFC as to the suitability of different materials being used in the solution. Written approval shall be obtained before any works are carried out.

The following information is based on the construction materials of the existing equipment, which has successfully operated for more than 30 years in this environment:

- Metals for major components: stainless steel and aluminium can generally be used with no issues. S.Steel 304, 304L, 316 & 316L typically used. 316 / 316L to be used on surfaces which will come into contact with methane.
- Typically metal seals are used in place of rubber o-rings in high radiation environments.
- Multi-Layer Insulation if used must be carefully selected due to the radiation levels. No organic materials to be used: STFC to be consulted before selection.

3.7 Connections

The Transfer Line has to connect with a number of existing components, so certain parts must conform to existing designs (STFC has engineering drawings of these areas). These will be listed below starting from the Moderator Vessel end leading back to the Cryogenic Coldbox. The document 'Information on Transfer Line Concept – Overview' included in the tender specification pack details each section of the concept in further detail.

3.7.1 Moderator Connection

The importance of the moderator end connection positioning has been detailed previously. *Figure 8* shows the inner sealing connection.

The connection is a short style Johnston coupling. The design of the male bayonet which fits into the Transfer Line has already been determined, and it is the same connection which has been used from the start of the ISIS facility. It has a male bayonet with an Invar nose, which mates into a female bronze coupling on the Transfer Line. These components are finely toleranced and flowing cryogenics cause the bronze to shrink onto the invar nose causing a gas tight seal.

The Moderator Vessel fitting in this connection is currently changed approx. every 6 months. The Supplier must show that the Transfer Line can accept a bayonet of the existing design and that the

Transfer Line seals and performs its function (a bayonet is required for testing, so this could be used for the fitment test).

3.7.2 Door Flange of Tertiary Sleeve

This has two tasks; allows the Transfer Line to penetrate through the Back Door while providing a gas tight seal to the Void Vessel (a metallic seal is used and is STFC supply) & it fixes the transfer line in position.

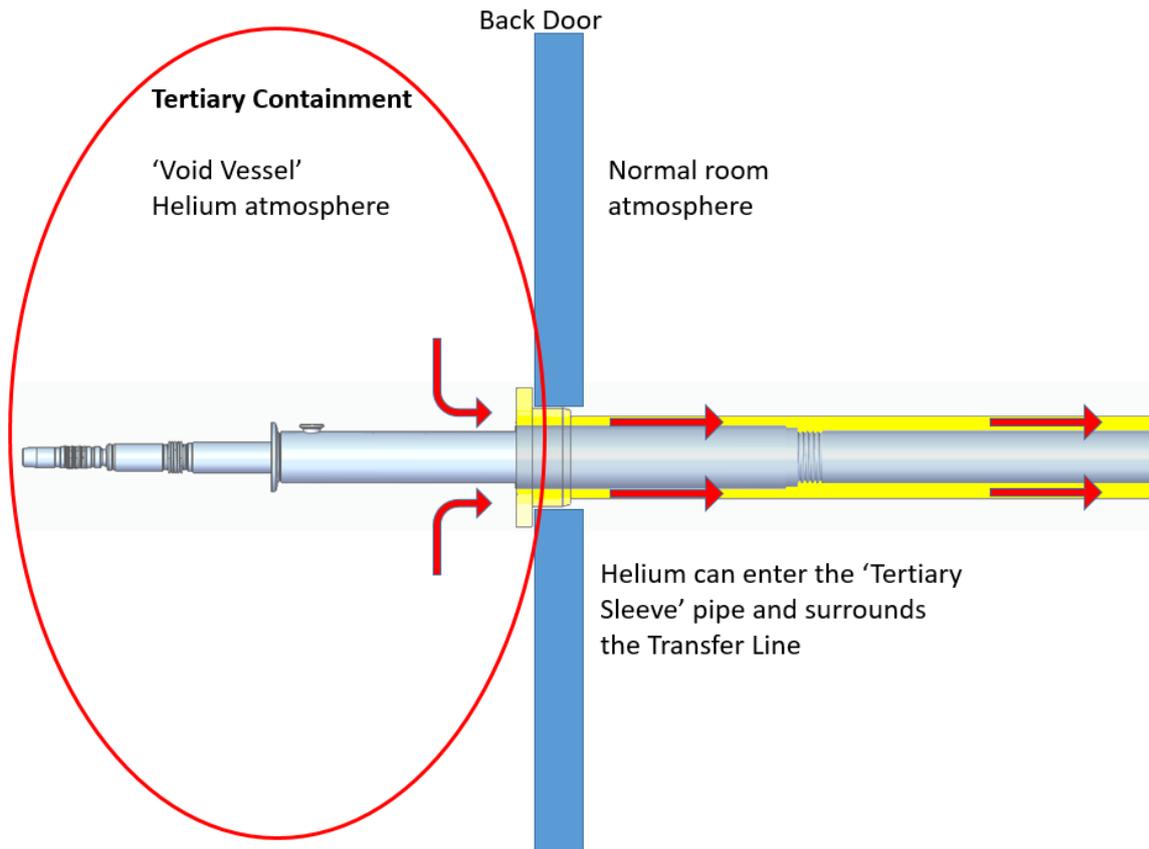


Figure 27 – Void vessel atmosphere passing into tertiary sleeve

The main details of the tertiary sleeve's bolted flange cannot change because it fixes to the Back Door and this item is not being replaced. However, it would be sensible to open up the holes on the flange as this item will need to be installed remotely. Spare sections of the original Transfer Line seem to have followed this idea as the following figure shows.



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Figure 28 – Back Door flange on current Transfer Line spare section showing slotted holes to assist in remote installation

3.7.3 Intermediate Connections

As shown in drawing SI-7042-400 and in the figure below, on the existing transfer line there are three connections joining the sections of the current line together (discounting the Moderator Vessel connection). A desire of the replacement methane transfer line was to reduce the number of horizontal bayonet connections, as there is currently some icing on one of the connections. This was achieved on an early concept design, but then it was found that it could not be installed, as there is not enough space to install a continuous section of the required length. The subsequent concept design then reintroduced a horizontal bayonet connection, to allow for section lengths, which could be installed.

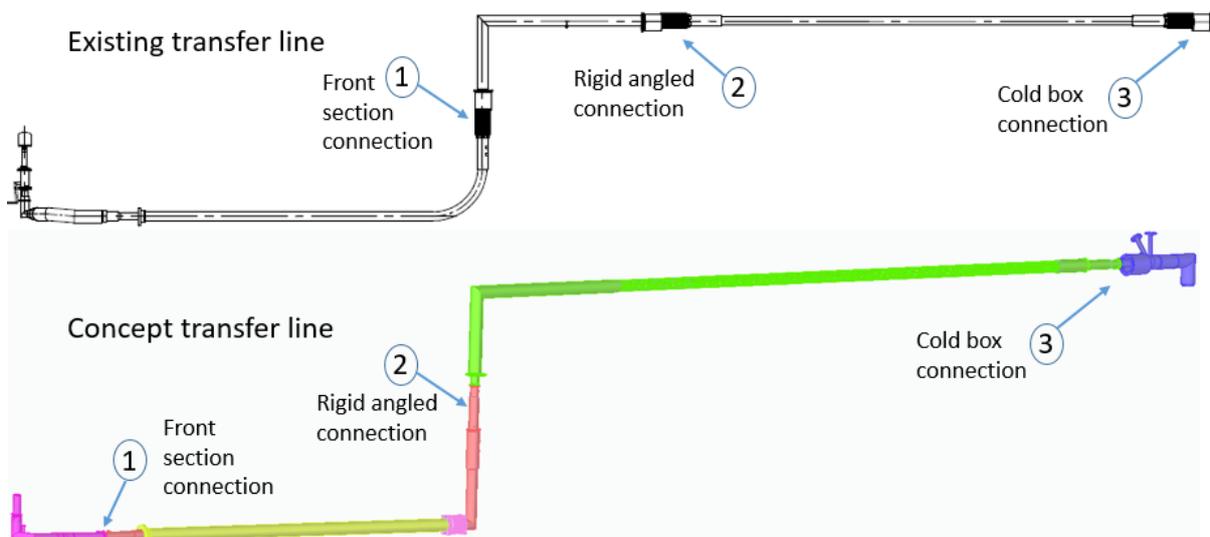


Figure 29 – Transfer line section connections

3.7.4 Coldbox Connection

Currently a horizontal Johnston's coupling is used to connect the transfer line to the coldbox connection - detailed in drawing SI-7042-403 (existing transfer line) & SI-7042-204 (existing coldbox). There needs to be a transition from a parallel pipe arrangement (coldbox) to a coaxial pipe arrangement (transfer line).

The coldbox is currently being redesigned and remanufactured. It will be delivered with a couple of stub pipes featuring weld sockets to accept OD 14mm x 1mm wall tubes and a vacuum jacket of OD 101.6mm. The coldbox connection on the concept transfer line features the current existing male/female bayonet connection design, along with simple tubular connections that can be cut and welded to suit the final dimensions.

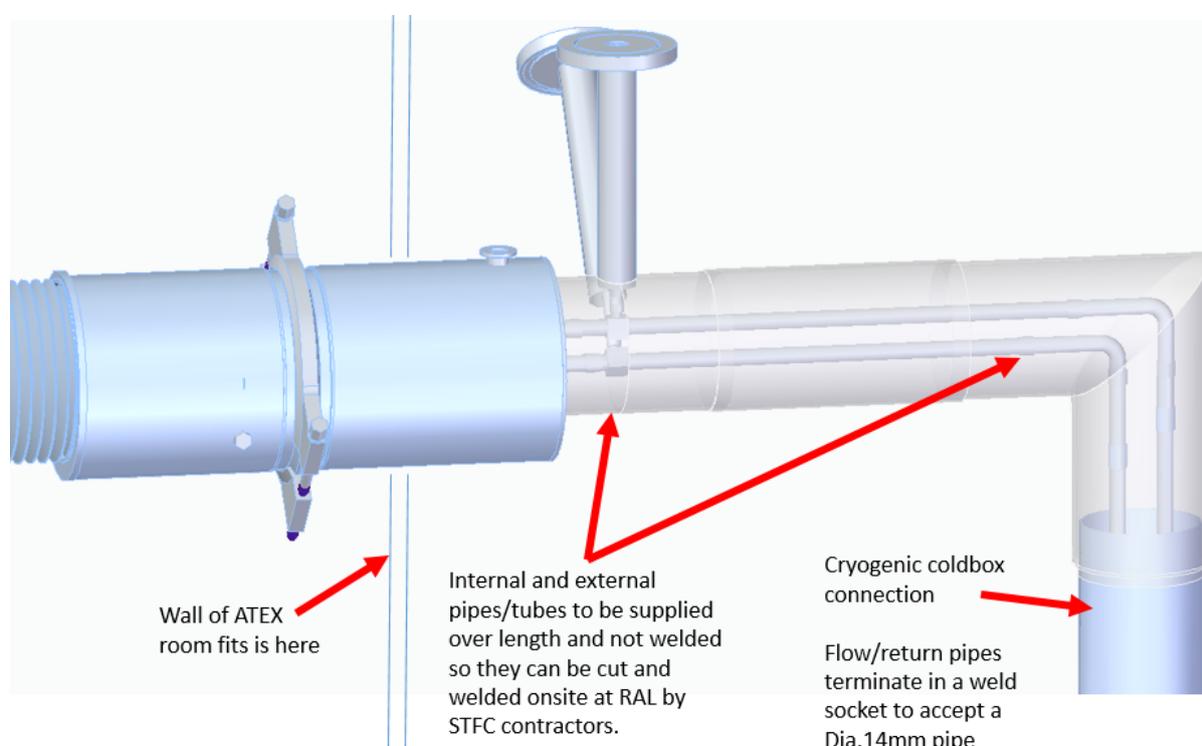


Figure 30 – Concept arrangement at cryogenic coldbox

The final location of the cryogenic coldbox and the ATEX room wall are not currently known, so this concept has been developed to give flexibility to ensure the transfer line connection can be adjusted to the final required position.

To achieve this a number of parts of this connection are to be supplied non-welded and in an overlong length. They will be cut and welded by STFC contractors during the final installation process.

3.7.5 Vacuum Connections

These connections link the vacuum space between the different Transfer Line sections. The vacuum space is pumped via the Coldbox's vacuum space. There is a vacuum connection at the Moderator



connection end (no tertiary bellows) and one at each corresponding female and male bayonet connection (featuring tertiary bellows).

The concept design uses the current vacuum link and pressure clamp, as it is tried and tested and fits within the bellows units mentioned in Sections 3.7.3 and 3.7.6. The vacuum flanges are KF16 flanges and they protrude a certain distance from the centre of the transfer line tube (40.75mm) to ensure that 'Vacuum Link' fits within the retractable bellows units.

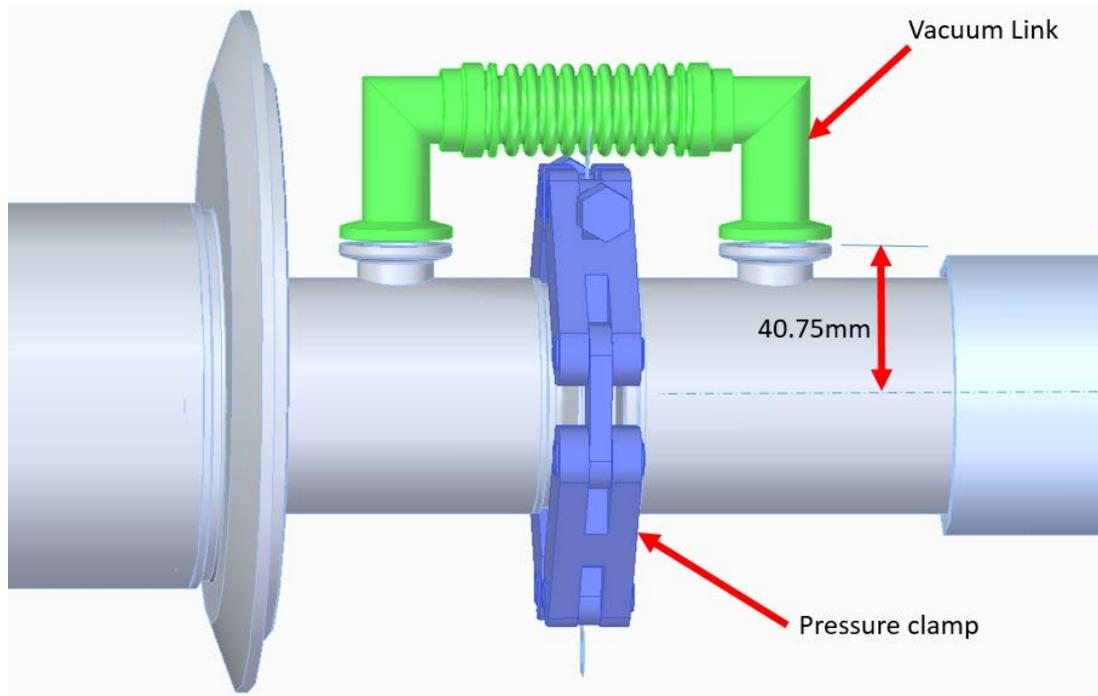


Figure 31 – Transfer line vacuum connections

The Supplier only needs to use standard metal hinge clamps on the vacuum fittings for testing and delivery, along with standard o-rings and carriers. At the Moderator Vessel end of the Transfer Line, which will be located within a high radiation environment STFC will fit clamp carriers and a remotely operable clamps. At the Moderator Vessel connection, the distance from the KF16 flange face to the centre line of the Transfer Line is 99.1mm.



Figure 32 – Typical vacuum clamp to be used for testing and delivery

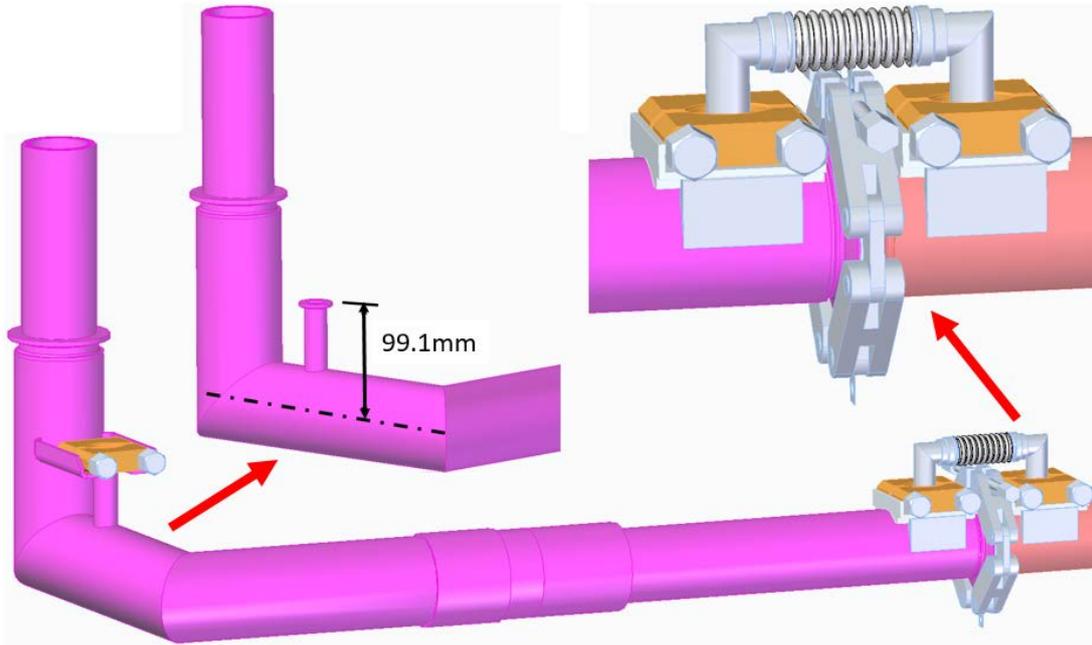


Figure 33 – Vacuum clamps located in high radiation environment, which will be fitted during final installation by STFC

3.7.6 Tertiary Connections

The concept uses the same design which is in current operation (see Figure 7). The drawings for these bellows units are included within the tender pack. The largest diameter of the bellows units and clamps utilised, fit within the areas of limited space (concrete shield block). The sealing of the bellows units to the Transfer Line is made with aluminium seals featuring a machined diamond profile which deforms and seals against the stainless steel flanges. This is a tried and tested method of sealing long term within a radiation environment.

3.7.7 Pressure Relief

The coldbox connection features two vacuum insulated flanged pipes for the connection of pressure relief devices. These pipes connect to the flow and return lines. It is STFC's responsibility for the purchase and fitment of pressure relief devices to the flanged connections.

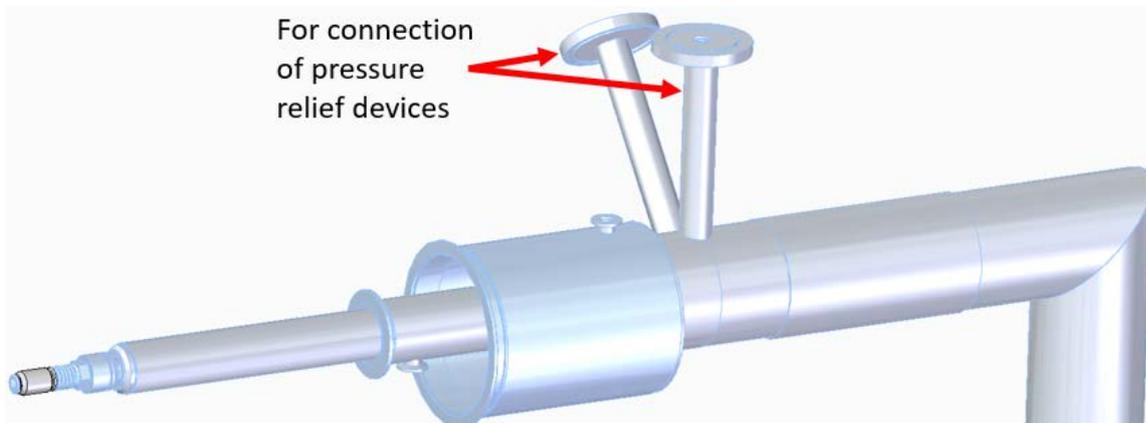


Figure 34 – Provision for pressure relief devices

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4 Scope of Supply

The Supplier is responsible for the design, manufacture, testing and delivery of one complete cryogenic transfer line totalling approximately 14 m long split into at least two sections (for installation reasons), and a spares package comprising of a number of individual sections.

Scope comprises:

- The project plan, project coordination and liaison with STFC to meet the final delivery date (stated in Section 2 of this document)
- Detailed drawings, and any appropriate design calculations
- Manufacture and supply of all materials, seals, jigs and fixtures necessary to complete the assembly and tests excluding those listed in 'STFC free-issue supply items'
- All testing except final SAT & installation at RAL

4.1 Design Parameters*

Design Pressure – Process Pipework	:	Full Vacuum (0 barA) - 6 barG
Design Pressure – Vacuum Insulation	:	Full Vacuum (0 barA)
Design Temperature	:	77 – 310 K
Process Fluid	:	Methane**
Operating Pressure	:	2-3 barA
Operating Temperature	:	110 K
Fluid Flow Rate	:	96.6 g/s
Max ΔP across Transfer Line at Operating Conditions	:	0.6 Bar
Max heat load from transfer line	:	60 W

*Parameters taken from Methane Specific Requirements, TS1 Project, Cryogenic System Replacement

For STFC internal information the source of the parameters will be found on the project SharePoint:

<http://www.facilities.rl.ac.uk/isis/projects/ts1/TS1UpgradeImplementation/UPG16%20%20Services/11%20-%20Cryogenics/02%20-%20Procurement/01%20-%20Technical%20Specification%20and%20Docs/Methane%20Specific%20Requirements%20Specification.docx>

**Potential future development work at the facility may include using ethane or propane as the process fluid. In this event, the system may operate at different pressure and temperature. These shall not exceed the stated design limits shown in this specification.

Note that periodic cleaning (approx. every 2 years) of the transfer line is carried out by STFC staff using Methyl Ethyl Ketone (MEK). In addition, it is known that due to radiation chemistry/processes we know hydrogen gas is formed in normal operation when using liquid methane. Industry standard to reduce likelihood of hydrogen embrittlement is to use 316 / 316L stainless steel.

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Therefore, the materials used in the delivered transfer line solution must be suitable for these fluids/gasses.

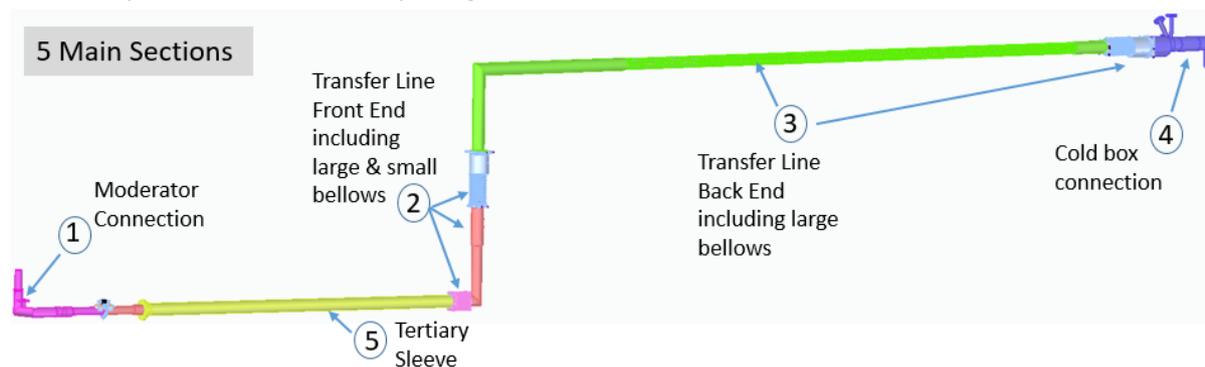
Note: this only applies to wetted surfaces. For example the outer jackets that just contain vacuum could be 304 / 304L stainless steel.

4.2 Supplier Deliverables

This is based on the concept transfer line shown in this specification document. If the supplier produces a different design then some transfer line sections may change in design or the number of individual sections may change. In addition, the concept uses flange designs common in use at STFC's ISIS facility and as a result a number of specialist clamps & seals are in STFC stock and are available for free-issue. If the supplier chooses (and agreed by STFC) to use different flanges across the transfer line then the supplier must supply clamps & seals for installation and a number for spares (quantity which will be agreed once the design is complete).

Using the concept shown in this document this is the requirement:

1-off complete transfer line comprising of 5 main sections as shown in the sketch below:-



*Figure 35 – Complete transfer line requirement
(based up concept presented within this specification)*

(Section 8.6 details the individual sections of the transfer line).

Spares package comprising of:

1-off Section 2 (Transfer Line Front End including large & small bellows)

1-off Section 3 (Transfer Line Back End including large bellows)

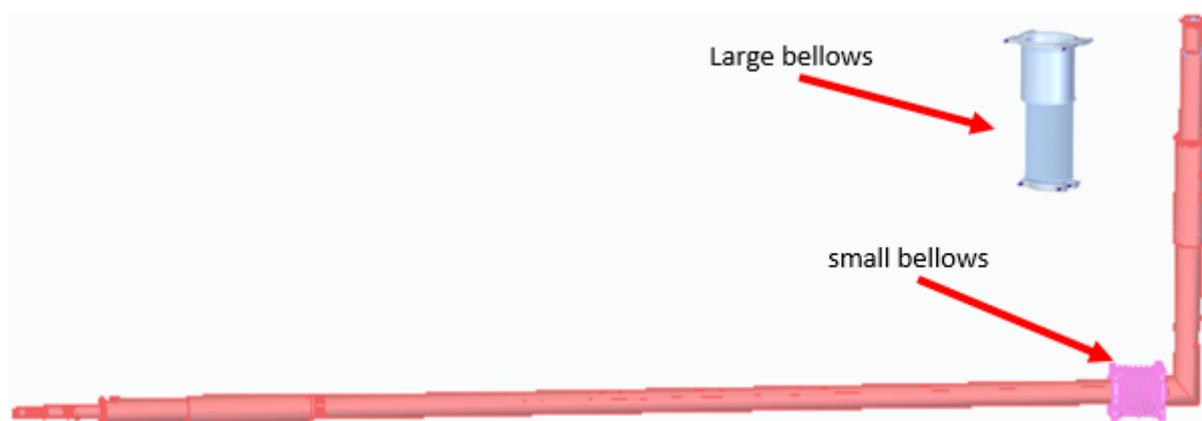


Figure 36 – Spares package – Section 2



Figure 37 – Spares package – Section 3

4.3 Equipment Design Life

The equipment shall not have a defined maximum lifetime but shall be, as a minimum, designed for continuous operation, 24 hours per day for 200 days per annum for 20 years.

The radioactive operating environment needs to be considered to ensure suitable materials are used, so degradation does not occur before the end of the design life. See Section 3.6 for further detail.

4.4 Testing

The transfer lines shall be inspected by the STFC engineering team at the suppliers premises once the manufacturing is complete and prior to shipping. Inspection by STFC shall not relieve the Supplier of the responsibility for meeting the specification and delivery date of the completed transfer lines.

4.4.1 Pressure testing, cold testing, tertiary space testing & vacuum tightness testing

The Supplier shall perform a number of tests on the transfer lines with STFC's attendance. See separate 'Testing Procedure for the Methane Transfer Line' document for further details. The general procedure is to:

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1. Pressure test the methane flow/return lines
2. Check leak tightness of vacuum insulating space (pass rate $<1 \times 10^{-6}$ mbar l/s)
3. Pressure test tertiary space
4. Cold test the line with LN2, check for cold touches and leaks

4.4.2 Dimensional Checks

Dimensional reports should be carried out by the Supplier and supplied or where appropriate witnessed by STFC. See the separate 'Testing Procedure for the Methane Transfer Line' document for further details.

4.5 Delivery

The delivery of the transfer line and spares package to STFC is the responsibility of the Supplier. The Supplier shall take every practicable step to ensure safe delivery, using appropriate packaging. Any customs and delivery charges are the responsibility of the Supplier.

4.5.1 Delivery date

The required date for delivery of the completed transfer line assembly and all associated items is **Thursday 14th November 2019**.

4.5.2 Cleaning

All components delivered are to be cleaned prior to delivery to STFC. The cleaning process must ensure that all internal and external surfaces are clean, dried and rendered free from contamination including dust, cutting fluid, grease, swarf and any other substance that may impair the vacuum level, future handling, maintenance and longevity (via corrosion or embrittlement, etc.) of the component. STFC should be told of the cleaning process to be used and the process is to be agreed by STFC.

4.5.3 Packaging

The purpose of the packaging is to protect the components from damage (especially sealing surfaces) during transportation and to prevent contamination of internal surfaces. The Supplier shall present to STFC their proposal for how to achieve these aims a minimum of 2 months prior to the scheduled date for delivery.

It is expected that the transfer line is delivered in sections and not as one complete assembly. Where possible process lines should be filled and capped with dry nitrogen gas and the vacuum spaces held under vacuum in order to retain their cleanliness.

4.5.4 Warranty

Given the very specialist nature of the requested product and the application it is intended for, STFC expects that a full manufacturer's warranty covering replacement or repair of any items will be provided to STFC as part of the contract, for a period of at least 24 months. The warranty will be

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counted as beginning on the date of delivery to the ISIS facility and completion of SATS (expectation is that SATS will be performed within 2 months of delivery).

4.5.5 Delivery location

All equipment is to be delivered to STFC. The address is as follows.

UK Research and Innovation
 ISIS Facility
 Science and Technology Facilities Council
 Rutherford Appleton Laboratory
 Harwell Oxford
 OX11 0QX
 UK

The delivery must be notified to the STFC contact in sufficient time such that acceptance of the delivery can be organised. This shall be a minimum of 2 weeks' notice.

4.6 STFC Supply

See Section 8.4 for the following items, which can be supplied by STFC to assist in manufacture /testing.

5 General Requirements

5.1 Project Management

The Supplier will be expected to apply appropriate project management controls in order to assist them in delivering the package of work. It also allows for suitable monitoring and reporting of the project status. The following sections layout STFC's expectations and provide detail of key areas.

5.1.1 Communication

Good communication between STFC and the Supplier will be an important part of ensuring the contract runs as smoothly as possible. All communication shall be conducted in (British) English.

A communications plan shall be provided as part of the tender submission (question AW6.10). This document will contain as a minimum:

- The name and contact details of:
 - the project manager – responsible for the schedule
 - the lead engineer – responsible for technical decisions and day to day technical contact
 - the procurement supervisor – responsible for legal and financial decisions
 - the quality control supervisor – responsible for adherence to the quality assurance system

NB/ one person may hold one or more of these roles. If this is the case this shall also be clearly stated.

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- The preferred/expected methods of communication outside of reporting (covered [below](#)) i.e. email, video-conference, etc.
- Expected response period to any questions asked by the supplier to STFC or vice versa, asked by STFC to the Supplier
- Any specific language considerations
- Information expected to be supplied by STFC and the expected frequency

Previous experience has shown that having a clear, defined and agreed chain of communication with defined single contacts for specific aspects is the most efficient and lowest risk approach.

5.1.1.1 Facility visits and meetings

5.1.1.1.1 Kick-off meeting

Upon placement of the contract, STFC would expect to arrange a kick-off meeting, at the Supplier's facilities, within the first month of the contract placement date. This will allow teams from the Supplier and STFC to meet and discuss any outstanding technical points. It will also allow the STFC engineering team to have a tour of the production facilities. A draft version of manufacturing plan is expected to be provided at or prior to the meeting, for discussion.

5.1.1.1.2 Progress review meeting

STFC hold the right at some appropriate and agreed point during the production of the items covered by the contract (typically no less than 2 months prior to the scheduled dates of the FATs), to visit the supplier's facilities again, to inspect progress to date. During this visit it is expected that the STFC engineering team will be able to see and physically inspect completed or in production components.

5.1.1.1.3 Factory Acceptance Testing

It is expected that STFC will send members of the engineering team out to the Supplier's facilities to witness the inspection/factory acceptance tests (FATs) of the final assembled transfer line and spare sections.

5.1.1.1.4 ISIS facility tour

STFC will extend an invitation to the Supplier to visit the ISIS facility during the period covered by the contract. At least two weeks' notice is required to organise such a visit.

5.1.1.1.5 General Meetings

All meetings shall be held at STFC, Rutherford Appleton Laboratory, during normal RAL working hours (09:00 – 16:00 GMT) unless agreed otherwise.

5.1.1.1.6 Telephone / Video Conference

Communication by telephone or video conference shall be conducted during normal RAL working hours (09:00 – 16:00 GMT) unless otherwise agreed.

5.1.1.1.7 Writing and agreeing minutes of meetings

It is understood that both parties (STFC and the Supplier) may choose to take minutes and meeting notes for any of the meetings, reviews or conversations during the period covered by the contract. It is expected that both parties will send a copy of these to the other party for one round of

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consolidated comments and subsequent agreement before these are formally recorded or published somewhere public. In the rare event of a dispute STFC will only recognise testimony from minutes that have been formally agreed by STFC.

5.1.1.2 Documentation Format

All documentation shall be supplied in English.

All documentation shall be supplied in PDF format, except where described differently or otherwise agreed with STFC.

5.1.2 Progress Reporting

The Supplier shall provide regular monthly project progress update reports to STFC throughout the contract period. Reports shall be sent via e-mail.

5.1.2.1 Contents of progress reports

The selected Supplier is expected to provide regular updates throughout the contract period. The minimum requirements for this are:

- Monthly email detailing:
 - activities carried out in the preceding month
 - activities to begin in the coming month
 - commentary on progress compared to the project schedule and any update to timescales, dates and durations
 - where appropriate or when requested, visual evidence of activities, for example, photographs of completed components or material testing data
 - any problems encountered, regardless of perceived impact
 - any risks that have changed (increased or decreased) and commentary on why
 - any developing risks or issues

5.1.2.2 Additional reporting

In addition to the regular updates, in the event that an issue is identified or realised that will result in, but not limited to, the following:

- The final product not meeting the technical specification
- More than a two week delay on agreed delivery date

Under these circumstances, the Supplier shall immediately contact STFC to notify of the issue. This will allow a dialogue to be opened on how to best manage the issue.

5.1.3 Quality control & assurance

The quality of the final product is of paramount importance. To ensure that the quality expectations of STFC are met, a quality management system will need to be in place. Details of this management system, quality controls and quality assurance procedures shall be detailed in a quality assurance plan provided as part of the tender submission. This document will contain as a minimum:

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- Material Certifications
- Conformity report(s)
- Inspection report(s)
- Quality assurance policy
- Health, safety and environment policy
- List of applicable and relevant standards that the Supplier adheres to
- How material traceability, certificate of supply, composition data, mechanical property data are assessed, managed and controlled.

The Supplier must plan, establish, implement and adhere to a documented quality assurance program that fulfils all STFC's requirements. It is expected that the Supplier will demonstrate project-specific considerations in their quality plan submission and not simply provide a generic document.

5.1.3.1 Applicable standards

The selected Supplier will be expected to comply with relevant standards. The system is subject to CE Marking and shall comply with all applicable standards. This list includes, but is not limited to:

- Pressure Equipment Directive
- DSEAR / ATEX (BS EN 60079)*
- PD5500 / alternative Design Code (to be agreed with STFC)

However, Nuclear Industry Regulations are not applicable.

* Certification by Notified Body required.

5.1.3.2 Safety

It is the Supplier's sole responsibility and liability to ensure that there are appropriate health, safety and environmental procedures in place while the transfer line is being manufactured and tested during the contract.

5.1.4 Testing

The Supplier shall perform all necessary testing (includes inspection and material conformity checks) in order to comply with all applicable legal requirements, standards and quality assurance measures.

The Supplier shall provide evidence of all testing carried out.

5.1.4.1 Factory Acceptance Tests

There should be the facility to perform an inspection of the completed assembly and any functional tests for any equipment provided as part of the contract.

The FATs shall be undertaken at the Suppliers premises (or suitable alternative) before delivery to STFC and shall be witnessed by members of the STFC Engineering team.

5.1.4.2 Site Acceptance Tests

The equipment shall be subject to a similar series of testing upon receipt by STFC, prior to installation. These SATs will be completed within 2 months of delivery before the final payment is made to the Supplier.

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5.1.5 Risks and issues

Regular monitoring of identified risks and the effectiveness of their mitigation strategies is a key part of the project management expected by STFC of the Supplier.

For the purposes of this tender an issue is defined as:

- A risk (threat - negative risk) that has been realised (this may be one which has changed probability or a previously unidentified risk that has occurred)
- A risk (threat/opportunity) that is outside of the project manager's control and ability to manage, so it needs to be escalated

Outside of the regular monthly update, STFC expects that if an issue occurs that affects the scope of supply in terms of the final product not meeting the technical specification, more than a two week delay on the promised delivery date or significant cost increase, then the Supplier will immediately contact the appropriate STFC contact and make them aware of the issue. This will allow a dialogue to be opened on how to best manage the issue.

5.1.6 Potential delays

STFC understands that even with effective project management, issues can occur outside of the direct control of a supplier, that might impact on task duration and thus potentially on the final delivery date. Early identification and clear communication of these potential delays to STFC is essential. In most circumstances, delays are more tolerable/manageable if known about well in advance, as it allows for possible adjustments to STFC's project schedules. It is of fundamental importance for the Supplier to be open and honest regards to potential delays.

5.1.7 Project planning

As part of the project management controls it is expected the Supplier will have in place an appropriate project planning and schedule system. This is likely to be a formal project planning and scheduling software package, but this is not a direct requirement. The Supplier will however have to demonstrate that whatever system they have in place and techniques that they apply, these are deemed sufficient and suitable for controlling such a project.

5.1.7.1 Project planning software

STFC uses Microsoft Project (2010) as its project planning and schedule tool and thus it is preferable to receive any schedules and Gantt Charts in a compatible format. If the Supplier uses another software package or does not have a specialised planning software tool, then a PDF file will be sufficient. Schedules must show (as a minimum): logical links, task durations, start and finish dates for tasks.

5.1.8 Drawings and CAD data handling

5.1.8.1 Drawing package and CAD data format

STFC currently uses Solid Edge (ST10) computer-aided design (CAD) software. The controlled technical documents produced from this are 2D drawings, either in an electrical format such as a PDF file or in a physical form. CAD models can also be provided to assist a supplier with the

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environment that the transfer line has to interact with, for example, although it remains the Suppliers responsibility to ensure the final component meets the technical specification (dimensional tolerances, geometric tolerances, etc.) laid out in the drawing for that component. CAD model data can be provided either directly as Solid Edge files or in an intermediary format such as STEP.

5.1.8.2 STFC technical drawing procedure

STFC have a clearly defined and controlled procedure covering changes to technical drawings. Drawings can have one status out of three; *work in progress (WIP)*, *Checked* and *Issued*. Work shall only ever be carried out from Issued drawings. Each drawing also has a revision level denoted by a letter, starting at 'A'.

5.1.8.3 Drawing revisions, approval and change control

The final decision of if, when and how a technical drawing needs to be changed rests with the lead engineer at STFC. If the Supplier identifies what they believe to be a drawing or modelling error, this shall be clearly and quickly raised with the STFC lead engineer. There may be other circumstances where by a drawing change is required. In circumstances where a drawing change is identified, any changes must be discussed with the STFC technical team (including the lead engineer) and be formally recorded (in writing) as part of an agreed change control process. The contract between the Supplier and STFC may also need to be amended in some circumstances. The Supplier must wait for an updated drawing to be issued by STFC before commencing any work on the updated drawing, unless give clear written instruction to proceed by both the STFC lead engineer and the STFC project manager.

5.1.8.4 Working Revisions

As previously mentioned, work can only can be carried out from drawing at the 'Issued' status. If a drawing has a revision change made and approved, it will be re-sent to the Supplier at the new revision level. All previous versions and copies of the drawing at the previous revision must be destroyed, to ensure only the latest revision of the drawing is used.

5.2 Intellectual Property (IP)

5.2.1 Background IP

STFC has no commercial interest in designing or producing cryogenic transfer lines outside of those required for the operation of its various facilities. Therefore, STFC will not place any claim on the background IP of the Supplier. STFC does however, expect that the Supplier will make use of its own background IP and incorporate all appropriate knowledge and experience to ensure the successful completion of the project. It would be expected that if a certain method, technique or approach is employed based on the Suppliers background IP that it would still openly discuss these with the STFC engineering team, as part of technical discussions.

5.2.2 Foreground IP

STFC expects that the engineering team shall be able to openly discuss and develop detailed understanding of any methods, techniques or approaches developed directly for the production of the items covered by the contract. This knowledge is only to allow the better understanding for

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possible modifications (to the items covered by the contract) and as an input to planned post-irradiation examination (PIE) on components at the end of the operational life. Results from these investigations are generally published in scientific journals and therefore provide STFC with no commercial gain.

5.3 Documentation & timing requirements

5.3.1 At tender stage

- Detail of how requirements of this technical specification will be met (Question AW6.2)
 - Proposed manufacturing methods
 - Demonstration of how the challenging areas of the specification will be met, for example how the tolerances will be achieved.
- Approach to transfer line flexibility/adjustment (Question AW6.3)
- Project management plan (Question AW6.8)
 - Project schedule and Gantt chart, clearly indicating key milestones such as; material delivery, machining completion, assembly completion, on-site inspection by STFC team & delivery to STFC site.
 - Risk management plan
- Communications plan (Question AW6.10)
- Quality control and assurance plan (Question AW6.4)
- Provisional testing plan (Question AW6.5)
- Delivery and packaging plan (Question AW6.6)
- Pricing schedule (using template provided, question AW5.2)

5.3.2 Kick-off meeting

- Draft manufacturing plan outlining the processes and procedures that the Supplier intends to follow in order to manufacture the final product¹

5.3.3 2 months prior to factory acceptance stage

- STFC Approved testing & inspection plan

5.3.4 At equipment delivery stage

- Any documents such as a user manual / maintenance manual for all equipment items supplied
- Complete and STFC approved quality control and assurance documentation
- Warranty documentation

5.4 Required Documentation

Bidders will be expected to provide information that will comprise their tender submission. This will be submitted via the Emptoris eSourcing tool.

¹ A finalised and STFC approved version of this document may form part of an early staged payment

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5.4.1 Executive Summary

The Supplier shall provide an executive summary as part of their tender submission (Emptoris question number AW2.1).

5.4.2 Project Management Plan

The Supplier shall be responsible for the scheduling of all activities in order to meet the agreed delivery date.

The Supplier shall include a Project Management Plan as part of the tender submission (question AW6.8), containing, as a minimum:

- Project Schedule / Gantt Chart, highlighting key milestone dates / deliverables (such as):
 - Material supply completion
 - Individual component manufacture complete
 - Sub-assembly completion
 - Full assembly completion
 - Inspection completion
 - Dispatch from supplier's facilities
 - Expected delivery date to STFC site
- Risk management plan:
 - How risks and issues are managed
 - Risk list
 - Risk assessment (likelihood and impact)
 - Mitigation strategies
- Project organisation and structure

Supplier shall update and report to STFC on this document throughout the contract period.

5.4.3 Testing plans

5.4.3.1 Testing plan – tender submission stage

As part of the documentation provided for the tender submission, the Supplier will present an outline of a testing plan including their testing capabilities (question AW6.5). This document shall additionally outline the envisioned testing procedures and estimated timescales for the tests to be carried out as part of the FATs (factory acceptance tests). This document must also state the expected location for these tests to be carried out. It is anticipated that this document will be at a high level and only provide a general overview, rather than any specific detail.

5.4.3.2 Testing plan – 2 months prior to FATs

The testing plan provided by the Supplier during the tender process shall be updated and refined, and then re-submitted to STFC a minimum of 2 months prior to the scheduled date of the FATs. This document will contain more detail of the testing procedures and how these will demonstrate compliance of the product with the technical specification laid out in the contract.

STFC reserves the right to reject the testing plan at this point and request that it is rewritten. If this is the case, STFC will provide clear guidance on the expected changes.

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5.4.4 Delivery and packaging plan

The Supplier shall include a delivery and packaging plan as part of the tender submission, containing, as a minimum:

- Delivery method and estimated timescales
- How the assembly will be cleaned and packaged prior to shipping

Suppliers are encouraged to provide CAD images or photographs in support of their documentation.

5.4.5 Pricing schedule

A template will be provided in order that suppliers can fill in the cost breakdown of their price submission (question AW5.2).

6 Contacts

6.1 During the tender period

During the tender period all contact between potential suppliers and STFC must be made through the procurement system. Any technical or contractual questions will then be noted, made anonymous and their answer posted for all other suppliers to see, so that no one supplier gains any advantage before the bids are submitted. Any attempts at direct contact of STFC employees during this period will not be answered. This includes phone calls, emails and personal visits.

6.2 During the contract period

Once a supplier has been selected and a contract has been signed then direct communication between the Supplier and STFC can begin. At this point a list of relevant STFC contacts will be provided to the selected Supplier.

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7 Glossary of Terms

STFC	Science and technology facilities council
RAL	Rutherford Appleton Laboratory
ISIS	The ISIS pulsed neutron and muon source, a world-leading centre for research
TS1	Target station 1; the building in which the transfer line is installed
Target	System that converts incoming proton beam into neutrons
Moderator	Component that contains a moderating medium that reduces the energy of the neutrons produced in the target so they are appropriate energies for experiments
Back Door	This door is the last section on the services trolley and it seals against the Void Vessel. All the equipment (Target, Moderator, Transfer Lines & electrical sensors) are effectively either mounted on or pass through the back door
Void Vessel	Within this vessel neutrons are generated. The services trolley slides forward positioning the target and moderators into this fixed stainless steel vessel. The back door seals against the void vessel to allow a sealed helium atmosphere
CAD	Computer-aided design (software)
PDF	Portable document format
STEP	Standard for the exchange of product data
FAT	Factory acceptance test
SAT	Site (RAL) acceptance test
TRAM	Target, reflector and moderators (assembly)
IP	Intellectual property
Background IP	Intellectual property that is pre-existing prior to the commencement of the contract and not directly generated as part of it
Foreground IP	Intellectual property that is directly generated as part of the contract to supply
STP	Standard conditions for temperature and pressure – defined as a temperature of 273.15 K (0 °C, 32 °F) and an absolute pressure of exactly 105 Pa (100 kPa, 1 bar)
Pre-payment(s)	Payments made in advance before equivalent value has been received in return
OD	Outside diameter
ID	Inside diameter
PIE	Post irradiation examination carried out after items operational life

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8 Appendices

8.1 Reference Drawings & Documents

Included within the document package there are a number of drawings. They are as follows:

SI-7042-204 REV A	-	Current Transfer Line to Coldbox Bayonet Connection
SI-7042-400 REV A	-	Current Methane Transfer Line Assembly
SI-7042-401 REV A	-	Front section (No. 1)
SI-7042-402 REV A	-	Middle section (No. 2)
SI-7042-403 REV A	-	Coldbox section (No.3)
SI-7042-297 REV A	-	Tertiary Bellows Assembly
SI-7042-252 REV A	-	Flange
SI-7042-253 REV A	-	Bellows endplate assembly
SI-7042-296 REV A	-	Flange
SI-7403-409 REV A	-	Bayonet Nose Assembly
SI-7403-500 REV A	-	Bayonet Nose Inner
SI-7403-501 REV A	-	Bayonet Threaded Bush
SI-7403-502 REV A	-	Bayonet Flexible Bellows
SI-7403-503 REV A	-	Bayonet Nose
SI-5404-170	-	Liquid Gas Transfer Line Replacement Scheme (original dwg.)
SI-5404-177	-	Transfer Line Assembly Sequence (original installation)
SI-5409-837	-	Primary Shield Carriage Main Assembly

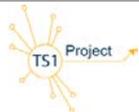
Hydrogen Moderator Connection
Installation of replacement Hydrogen Transfer Line
Information on Transfer Line Concept – Coldbox connection
Information on Transfer Line Concept – Connections
Information on Transfer Line Concept – Overview
Testing Procedure for the Methane Transfer Line

8.2 Payment Schedule

This is the payment schedule proposed by STFC:

- 15% of contract total – Final Design Review
- 60% of contract total – Delivery of transfer line
- 25% of contract total – Site Acceptance Test + completion of paperwork

In the event of a frustrated contract or non-delivered/non-compliant goods, STFC reserves the right to reclaim previous payments made under this contract.

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8.3 STFC's position on pre-payments

As a UK governmental body, STFC is subject to strict codes of conduct and as such is prohibited from making pre-payments in all but truly exceptional circumstances and these would require approval from the Treasury department of the UK Government. Here pre-payment(s) are defined as *payments made in advance before equivalent value has been received in return*. This need to demonstrate equivalent value to the organisation strongly influences the payment schedules STFC are able to accept.

It should be noted that STFC does endeavour to make prompt payment once the correct criteria have been met to release a payment or staged payment. For example, a staged payment for a device that fits into a larger assembly could be released once, STFC have received (or physically seen) evidence that it has been marked the property of STFC and that the device is in an acceptable state/condition.

It is common that STFC is able to make a payment/staged-payment quickly enough that the Supplier can receive STFC's payment before they need to pay their sub-contractor(s) for the goods or services, thus meaning the Supplier does not enter a state of negative cash flow. It is expected that the Supplier will negotiate the most favourable terms they can with all of their sub-contractors.

8.4 STFC free-issue supply items

STFC have a number of items, which are available for free-issue if the supplier wishes. Some items will not be suitable if the supplier changes the design.

3-off vacuum link connection:

STFC ISIS R40 Stores No. (6909) STFC ISIS DWG No. SI-5621-249

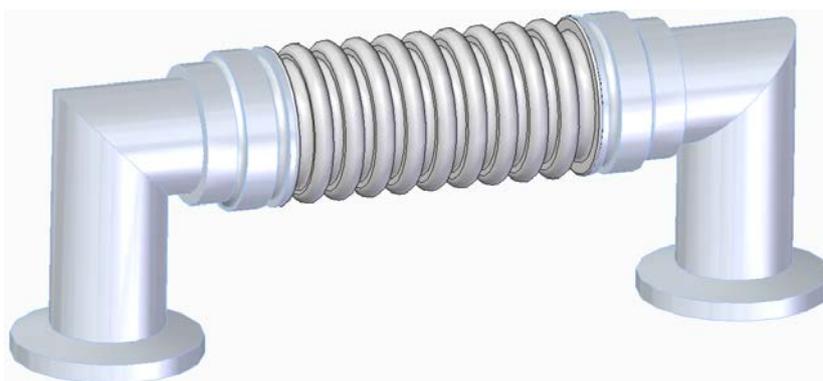


Figure 38 – Vacuum link for Transfer Line

Used to connect the vacuum spaces of the Transfer Line sections together. These will be the actual links used in the final installation.

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4-off main pressure seal clamp:

STFC ISIS R40 Stores No. (6803) Supplier: Technetics Supplier Part No. :

Quick Disconnect Collar 300 RH87SP + special bracket Technetics DWG No. 154.510.00

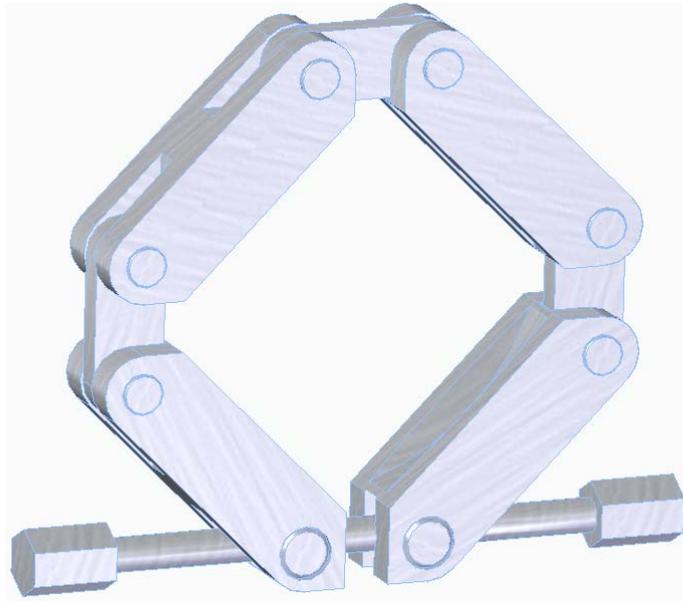


Figure 39 – GARLOCK clamp – main pressure seal clamp

3 to link the transfer line sections together and an additional clamp to connect onto the moderator connection in order to carry out testing.

4-off main pressure seal:

STFC ISIS R40 Stores No. (5104) Supplier: Technetics Supplier Part No. : HELICOFLEX SEAL TYPE HN208 ABK WITH 2 OFF RETAINING LEGS 180 APART Technetics DWG No. 111.4048.0

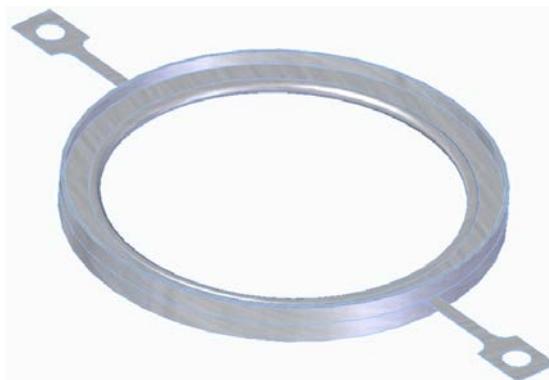


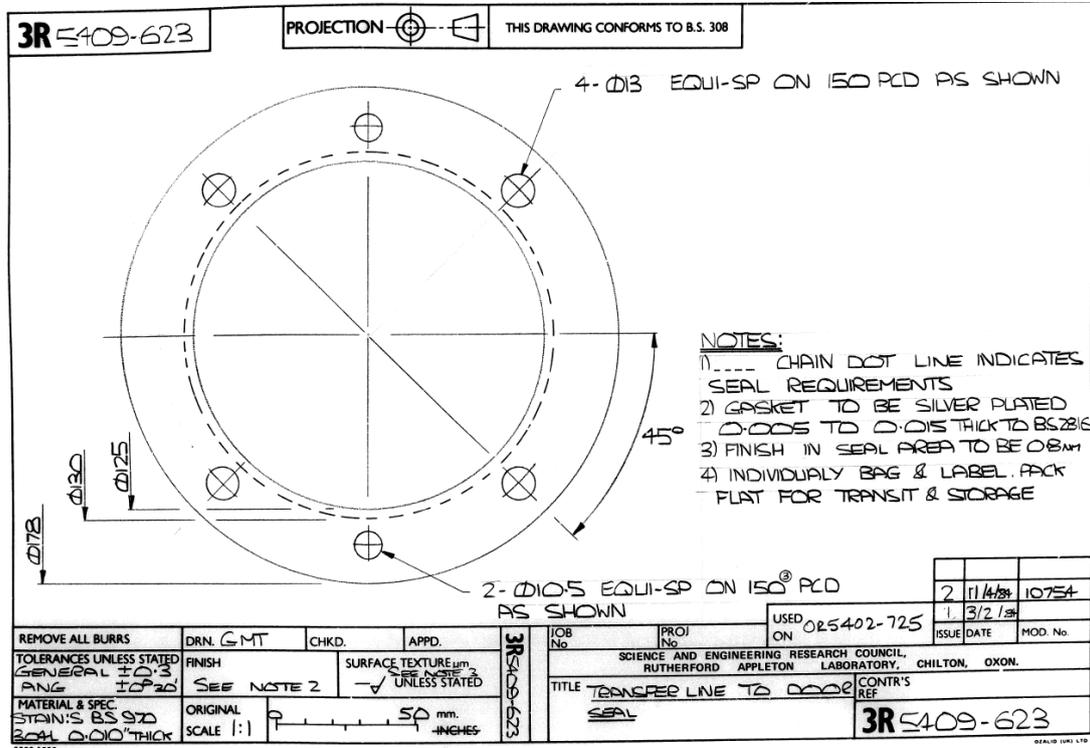
Figure 40 – Main pressure seal

These are used at the Transfer Line bayonet joints. They can be used multiple times.



Tertiary Sleeve – Back Door seal

STFC ISIS DWG No. SI-5409-623 Supplier: Nicholsons



We believe this is only required for fin: *Figure 41 – Back door seal* supplier for manufacturing or testing. One seal can be supplied if required. This is a one-use seal.

2-off Large Tertiary Bellows Clamp

STFC ISIS R40 Stores No. (6878) STFC ISIS DWG No. SI-7042-322



Figure 42 – Large tertiary bellows clamp

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Note: Only suitable for current tertiary bellows design, if the supplier changes the tertiary bellows then they will need to design & supply new clamps.

4-off Small Tertiary Bellows Clamp

STFC ISIS R40 Stores No. (6879) STFC ISIS DWG No. SI-7042-326

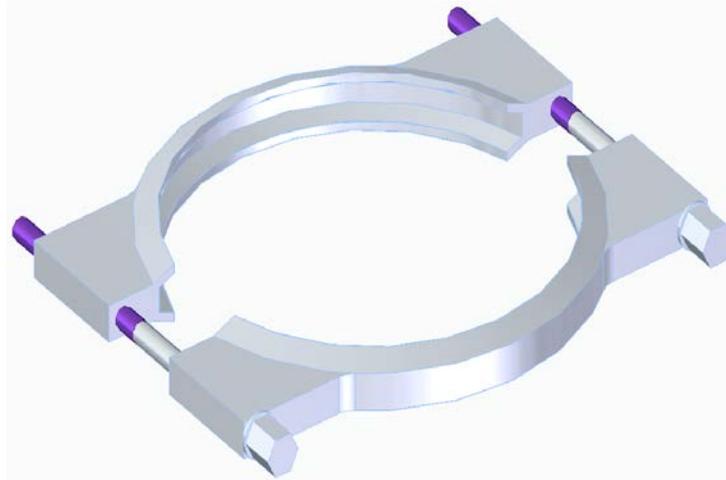
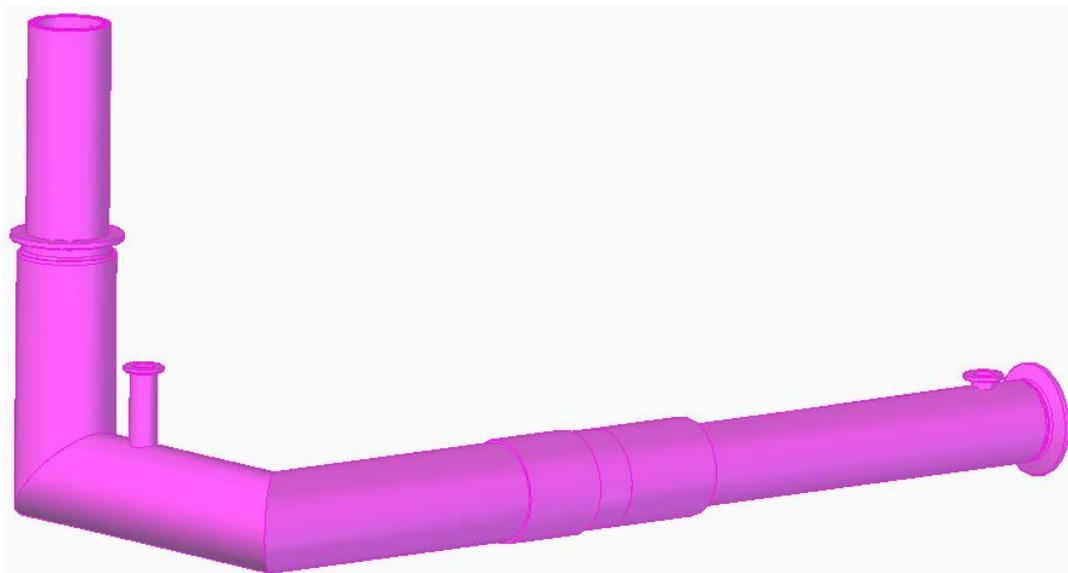


Figure 43 – Small tertiary bellows clamp

Note: Only suitable for current tertiary bellows design, if the supplier changes the tertiary bellows then they will need to design & supply new clamps.

8.5 Transfer Line Section Details

8.5.1 Section 1





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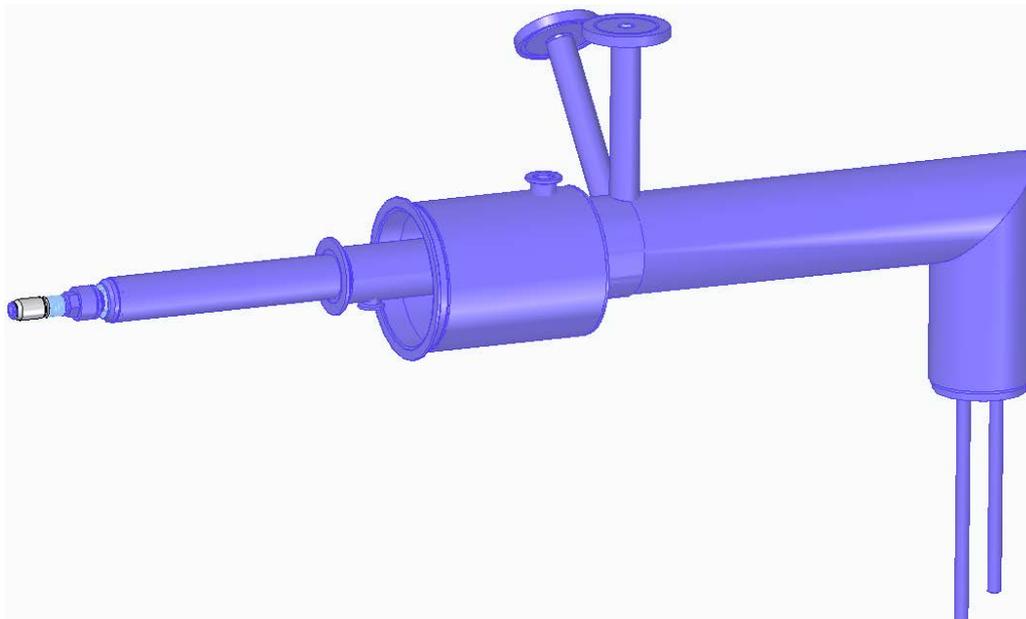
8.5.2 Section 2



8.5.3 Section 3



8.5.4 Section 4



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8.5.5 Section 5

