TS1 Project Technical Specification for the TS1 Project Reflector

Sign Off

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Revision History

Issue	Date	Author	Revision Comments
1	24/11/2017	S Gallimore	Primary Issue
2	10/01/2018	S Gallimore	Updates regarding cost breakdown, payment schedule and 2 new appendices (8.2 & 8.3)
3	26/01/2018	S Gallimore	Modifications made to various parts of section 5. Additional appendix added
4	**01/03/2018**	**S Gallimore**	**Additional clause in 8.2**

Document Location

The source of the document will be found on the project SharePoint:

http://www.facilities.rl.ac.uk/isis/projects/ts1/TS1UpgradeImplementation/UPG11/07%20-%20Documentation/OJEU%20related%20docs/Specification%20for%20the%20TS1%20Project%20Reflector.docx

1 Purpose

This document provides General Requirements to suppliers for the provision of the beryllium the reflector assembly 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 the documents are required as part of the tender submission are covered in the General Requirements section.

Contents

2 Summary

This tender is for the supply of a modular solid beryllium reflector assembly with the following indicative dimensions and approximate mass:

- Height – 700 mm
- Width – 700 mm
- Length – 780 mm
- Mass – 460 kg

As well as a materials test specimen of minimum dimensions: 100 x 50 x 20 mm

Supply is for the production of the finished beryllium components only. Interfacing equipment (including cooling pads), titanium fasteners and diagnostics (including thermocouples) shall be provided by STFC.

The required date for delivery of the completed beryllium reflector assembly, all associated items and all documentation is **Monday 30th September 2019**.

As a minimum, the tender submission is expected to comprise the following documentation:

- One page bid summary including;
  - Proposed delivery date
  - Total price
  - Key information the Supplier would like to highlight
- Project management plan
  - Project schedule and Gantt chart, clearly indicating key milestones
  - Risk management plan
  - Resource plan
- Communications plan
- Quality control and assurance plan
- Provisional testing plan
- Delivery and packaging plan
- Payment schedule (reference Appendices 8.2 & 8.3)
- Pricing schedule (using template provided)

Further details of what these documents shall contain can be found in the General Requirements section of this document. There is also a documentation checklist provide to assist Suppliers in successfully completing their tender submission (see Appendix 8.4)

3 Introduction

3.1 ISIS Facility

ISIS is a world-leading centre for research in the physical and life sciences at the STFC Rutherford Appleton Laboratory (RAL) near Oxford in the United Kingdom. The suite of neutron and muon instruments gives unique insights into the properties of materials on the atomic scale. The facility supports a national and international community of more than 3000 scientists for research into subjects ranging from clean energy and the environment, pharmaceuticals and health care, through to nanotechnology and materials engineering, catalysis and polymers, and on to fundamental studies of materials. A plan view of the facility can be seen in Figure 1.

ISIS produces beams of neutrons and muons (sub-atomic particles) that allow scientists to study materials at the atomic level using a suite of instruments, often described as 'super-microscopes'. The neutrons and muons are produced through the interaction of high energy protons (approximately 84% of the speed of light) with various heavy metal target systems. The protons collide with the atoms in the target sending a shower of neutrons out from the target in every direction. However, in order for the neutrons to be useful, they must lose some energy by passing through the moderators. A beryllium reflector completely surrounds the target and moderators during operation, reflecting any neutrons which have escaped back towards the moderators. The beryllium also has the useful effect of multiplying the number of neutrons by two; for every neutron which reflects off the beryllium, two come back, a so called n-2n reaction[1].

3.2 Equipment Location

The systems shall be installed in place of existing reflector assembly in Target Station 1 (see Figure 1). When in operation it is house inside a helium-filled (void) vessel that is surrounded by metres of biological shielding (concrete and steel primarily).

[1] This is energy dependant there are a wide range of reactions that can occur, but this is normally the dominant one in the range 3-20Mev

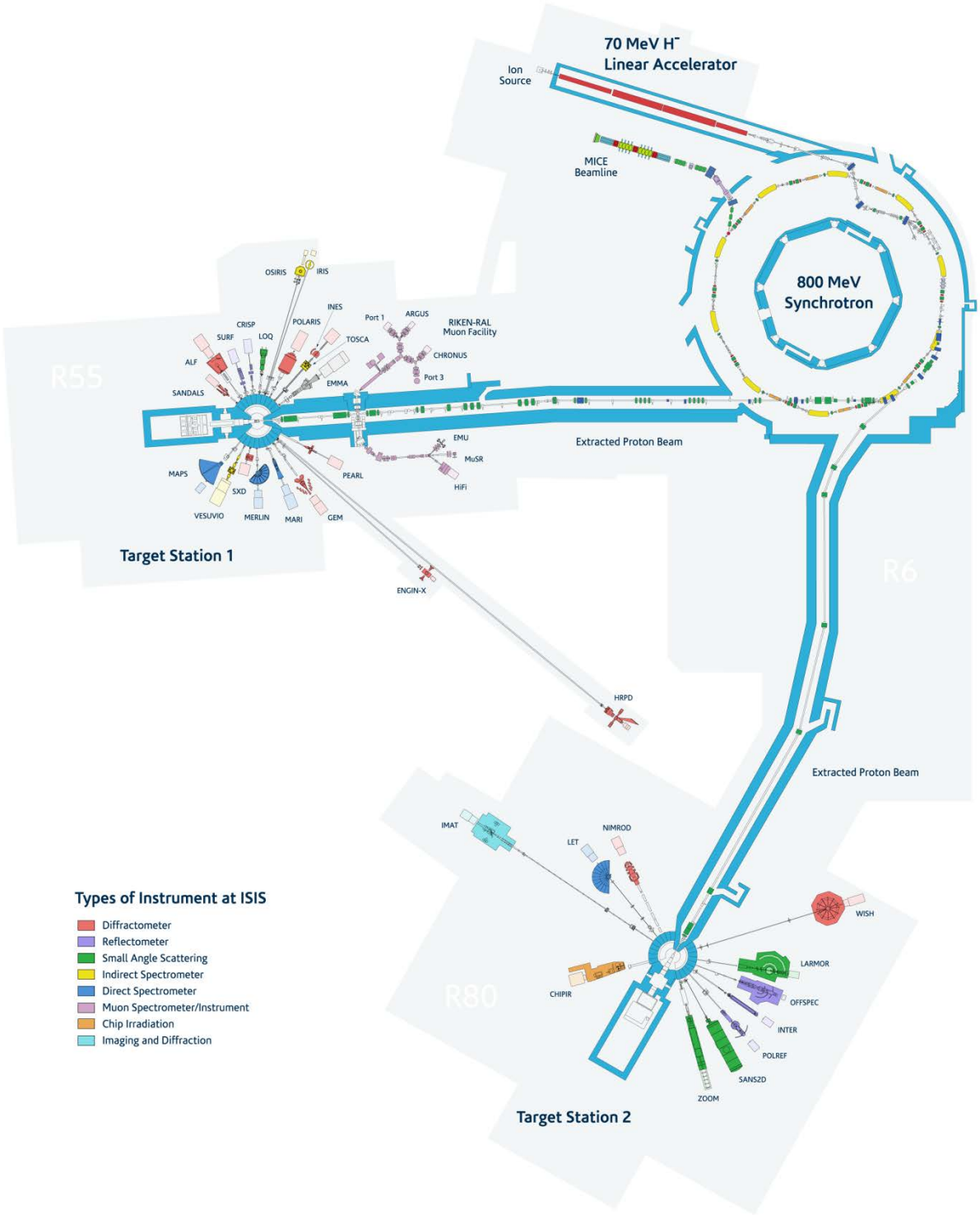


Figure 1 - Plan view of the ISIS facility, RAL, including the outline of the buildings and description of the instruments

3.3 The reflector assembly

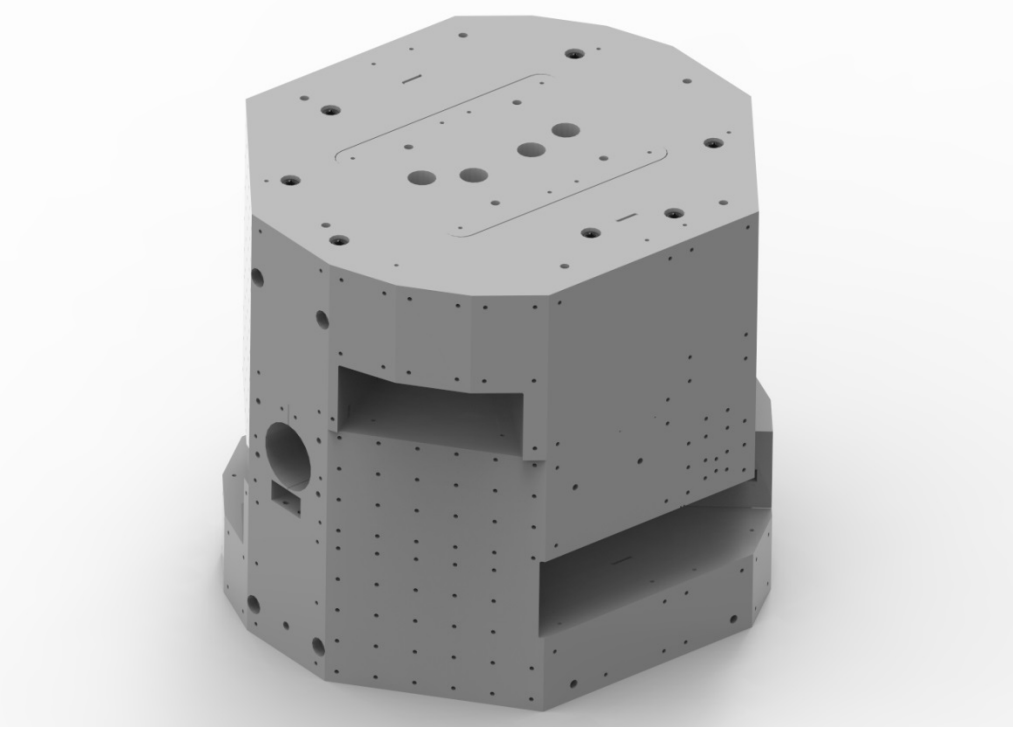


Figure 2 - A view of the reflector assembly in isolation (other components and pipework not shown). The circular hole at the front is where the proton beam enters and the cut-aways are the 'flight lines' down to the instruments

As previous stated the Reflector assembly completely surrounds the target and moderators during operation. As shown in, Figure 2, there is a circular hole in the reflector which allows the proton beam to hit the target unimpeded. There are also four ports cut into the reflector to allow moderated neutrons to leave the Reflector and pass outwards towards a series of instruments. The reflector is cooled by external aluminium cooling pads (can be seen in Figure 3) and the other surfaces are covered in a neutron-absorbing material to prevent stray neutrons 'leaking' out in unwanted directions.

The target, reflector and moderators (TRAM) assembly and its associated pipework and services are all supported by a support frame that is cantilevered from a stainless steel plate, referred to as 'the back door', as this and the seal attached to it completes the (void) vessel that surrounds the TRAM assembly in operation and maintains the helium atmosphere. These features are shown in Figure 3, below. The target assembly is mounted into the lower section of the rear half of the reflector. The upper water moderators are held in position within their own dedicated blocks in the upper sections of the reflector (one in the front half and one in the back half). The cryogenic moderators (the two below the target level) are located and fixed separately to the reflector, with the beryllium sitting closely around them when in operation. There are components called pre-moderators that sit between the target and each of the cryogenic moderators. These are housed and attached to their respective half of the reflector assembly. More details are provided on this later in the document.

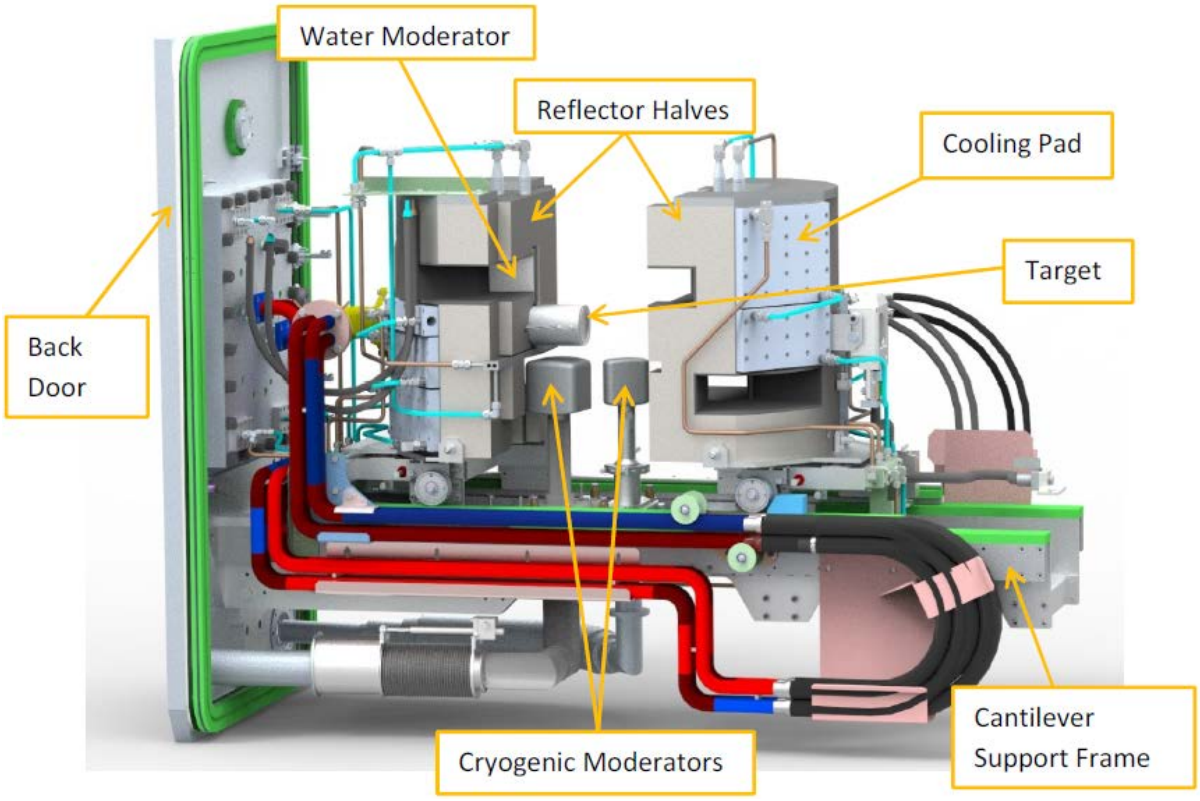


Figure 3 - A labelled view of the TRAM assembly with the reflector in its split position, to allow the view of the target and moderators housed within it. For this image the proton beam would be entering from the right hand side

3.4 TS1 Project

During its 30+ years of operation, no significant maintenance 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 reflector assembly. 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

3.5 Design Principle

The basis of the reflector design is a series of machined blocks of solid beryllium (Be) which, when assembled, will have approximate dimension 700 X 700 x 780mm (general shape can be seen in Figure 2). The overall assembly is made up of 13 'modular' blocks (6 for each half and 1 stationary 'infill' piece). These modular blocks form two halves that can be separated to allow access for maintenance, to the components located inside, as shown by Figure 4. The design of these blocks balances several factors; thermal conductance efficiency, machinability considerations, scientific performance and structural robustness. Where possible the different machined blocks are bolted and dowelled for accuracy and thermal conductivity. Careful consideration has been put into the selection of compatible and appropriate materials for use as bolts, dowel pins and where required thread inserts. More details are provided later in this document.

The modular design provides flexibility for future updates reducing the requirement to replace the entire reflector, should there be changes (in terms of size, shape, volume or position) made to the moderators or target. This effectively means moderator development can continue without incurring the additional cost and downtime associated with having to replace the whole reflector in future. The design allows the reflector to be separated to allow access to the pre-moderators, shown in Figure 5 & Figure 6.

The outside of the reflector assembly is faceted so that the external faces of the reflector can be covered by either aluminium cooling pads or neutron absorbing material; these items are not part of the specification.

As the process of reflecting the neutrons heats the beryllium, the reflector must be cooled. Sets of aluminium cooling pads containing flowing water will be bolted to the outside of the reflector to remove the heat. Some of these can be seen in Figure 3, above. As previously mentioned, the manufacture of the cooling pads is not part of this specification.

There is a general clearance of 4mm around internally housed components, such as the target and the moderators. There are significantly tighter tolerances (both dimensional and geometric) applied to surfaces that are bolted together, including those to which the cooling pads are bolted. The main driver behind these tighter tolerances is to increase the thermal conductance paths.

3.6 Surrounding Environment and Radiation

When in operation the reflector assembly is surrounded by a helium gas atmosphere. During maintenance the whole TRAM assembly is withdrawn into the remote handling cell where it is exposure to air. In certain circumstances, the air to which the reflector is exposed could have relatively high levels of humidity, when compared to normal ambient atmospheric conditions. With the reflector surrounding the neutron production target it is exposed to high levels of ionising radiation. Based on our previous experience, it is expected that the reflector assembly will have an operational life in excess of 20 years.

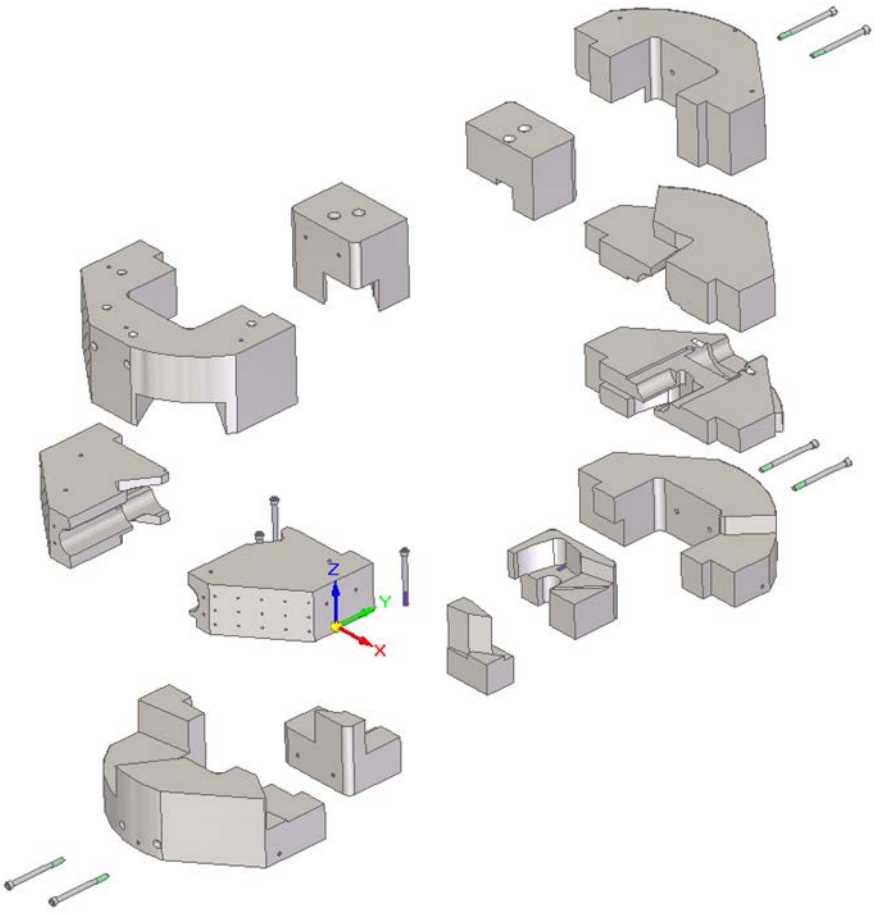


Figure 4 - Exploded view of the modular reflector blocks

3.7 Requirements Overview

The basis of the contract is for the supplier to produce and deliver the assembly described in SI-5630-100 along with all the associated documentation requested (detailed later in this document), while complying with the terms laid out in this technical specification and other contractual documentation. Further details of the drawings are provided here. The contract will also include any costs that the selected supplier will incur due to travel to and from Rutherford Appleton Laboratory, hosting meetings and any video conferencing used to communicate with sub-suppliers or STFC.

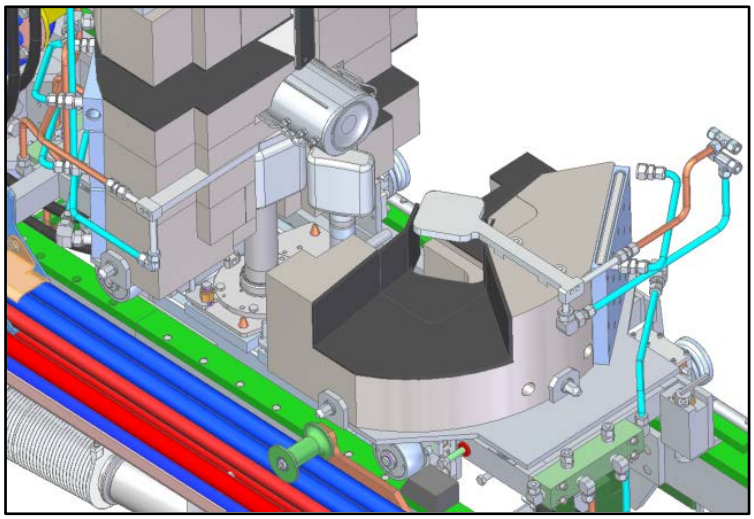


Figure 5 - A view showing how the methane pre-moderator is positioned in the lower section of the front half of the reflector assembly

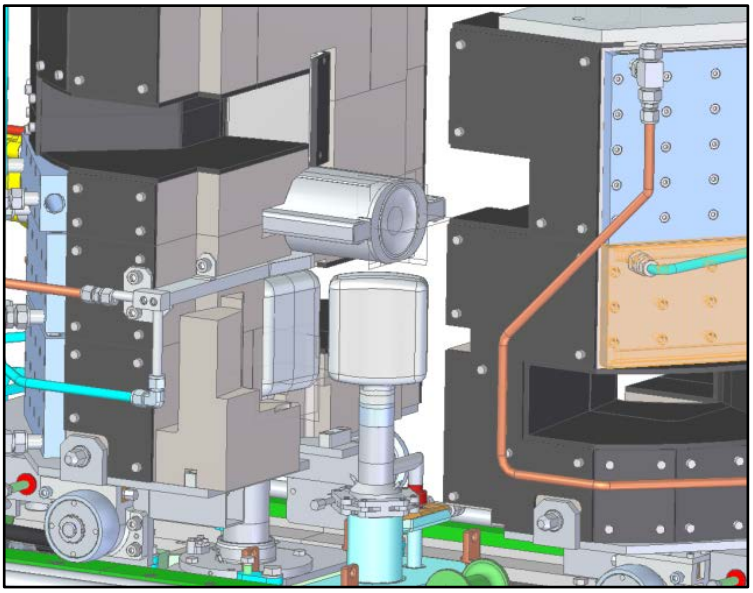


Figure 6 - A view of how the hydrogen pre-moderator is attached to the lower section of the rear half of the reflector assembly

4 Scope of Supply

4.1 Beryllium Blocks

It is anticipated that the blocks will be produced through the consolidation of beryllium powder by an appropriate technique. The parts will then be machined from these near-nett shape materials. The supplier must provide evidence that their proposed manufacturing methods can meet the requirement laid out below.

All materials shall be supplied with a suitable conformity certificate, providing full traceability, composition and mechanical property data.

4.1.1 Material density

It would be ideal to have 100% dense beryllium blocks, it is understood that being produced via powder metallurgy, this is in practice unachievable for the entire thickness of the size of blocks that make up the reflector. Thus the minimum density constraint on all blocks shall be 97.5% of the theoretical density. A higher density if it can be achieved is preferable. The theoretical density of beryllium shall be calculated using the following formula:

$$\text{Theoretical Density} = \frac{100}{\frac{100-BeO(\%)}{1.8477} + \frac{BeO(\%)}{3.009}}$$

4.1.2 Material impurities

Impurities in the beryllium reduce it neutronic performance and increase the complexity and possible cost of its disposal at the end of its operational life, thus a general aim is keep impurities down to a minimum. There are some specific impurities (listed below) that are of particular concern.

The chemical composition of the beryllium shall conform to the following:

Beryllium wt% minimum	98.2
Beryllium Oxide wt% maximum	1.75
Total other impurities, wt% maximum	0.50
Including;	
Gadolinium wt% maximum	0.001
Iron wt% maximum	0.15
Carbon wt% maximum	0.15
Aluminium wt% maximum	0.10
Uranium wt% maximum	0.015
Other Metallic Impurities wt% maximum	0.05

Table 1 - Material Impurity values

A material analysis detailing the chemical composition of the material shall also be supplied.

A nickel plated (to same specification) specimen piece for future materials testing of the size 100x50x20mm must also be supplied (from each separate batch of material used).

4.1.3 Material Defects

A penetrant inspection of all parts shall be performed using an appropriate technique. This inspection method shall be detailed in the testing plan provided to STFC. The penetrant manufacturer's instructions shall be followed throughout the inspection process.

The following acceptance criteria shall be met:

- Cracks are not permissible
- Pores shall not exceed 1.25mm (0.049 inches) in diameter
- There shall not be in excess of 3 pores per 600 mm^2 (approx. square inch). Where there is an edge then this area continues over the edge and down the face.

4.1.4 Grain size

Beryllium grain size has a strong influence on the mechanical properties of the bulk material as well as its susceptibility to radiation damage effects. The following acceptance criterion for grain size shall be met:

- 12µm maximum grain size – to be verified by microstructures images (having 100 µm distance bars as reference in the images).

The supplier must also provide a series of (at least 5 different) microstructure images for each billet of bulk material used, to STFC for STFC verification. These images must have visible reference distance bars in them.

The supplier is responsible for confirmation that the material used on the final assembly is compliant with this acceptance criterion. The STFC check is an independent verification only.

4.1.5 Mechanical properties

The design of the reflector has been carried out in such a way as to remove and minimise, wherever possible the need for the beryllium to play a structural role in the TRAM assembly, however some of the moderators and the target are mounted in the reflector and due to its size there will be forces applied by self-weight. Bolts and inserts will also impart stress to the material as will the proton beam (thermal loads). For these reasons there are the following success criteria that must be met as a minimum (at STP):

- Ultimate Tensile Strength (longitudinal): 325 MPa
- Yield Strength (0.2% offset): 240 MPa
- Young's modulus, E: 280 – 310 GPa
- Elongation (% minimum): 1.5
- Poisson's ratio: 0.03 ± 0.015
- Fracture toughness (K_{IC}): 10-13 $MPa.m^{-1/2}$

4.2 Machining

The reflector assembly was purposefully designed in such a way as to allow the majority of the smaller blocks to be cut out of the larger ones, thus minimising the wasted material and as an

impact, the cost to STFC. Experience from the design and manufacturing of previous reflectors has been incorporated to simplify any machining as much as possible, whilst also preventing any 'shine paths' down which neutrons can escape and thus reduce the neutronic performance of the assembly. It is anticipated that the required features will be manufacturable from the solid blocks of beryllium by using a combination of milling, drilling and wire / plunge electro-discharge machining.

Tolerances and surface finishes shall be adhered to as per the supplied drawings. When finishing, all edges shall be 'broken' to a radius of 1.0 – 1.5mm, unless otherwise stated on the drawings. Changes to this criterion would need to be discussed with STFC and specific written approval would be required.

The Supplier must comply with all legal requirements (in the country in which they are based) for machining beryllium.

For the tender submission each supplier is required to submit a manufacturing plan to show how they intend to meet these requirements.

4.3 Additional Items

The supplier shall list any other items or services that may be required, such as bespoke lifting or handling equipment, or specialist tooling in the tender document. If these additional items require designing and manufacturing in their own right, STFC will expect to accept but not approve any designs, prior to their manufacture. The items and their design would then also form part of the scope of supply for this contract and thus be the full legal property of STFC. The estimated costs for such items shall be separated out in the cost breakdown, so that a fair comparison can be made between all bids.

4.4 Nickel Plating

After machining and/or any surface preparation work, each block must be plated with Nickel. The thickness of the plating shall be between 0.050mm (50µm) and 0.075mm (75µm). The plating must be uniform, continuous and effectively 'bonded' in place. Electroless Nickel Plate as per specification AMS 2404H & ASTM B733-15, or equivalent shall be used. If an equivalent specification is to be used the Supplier must clearly state this in their tender return.

The dimensions stated on the supplied drawings are to be the final dimensions, i.e. they shall include the thickness of any Nickel plating.

Nickel is the only acceptable plating material.

Bolts, screw studs and tapped holes are not to be plated with Nickel.

4.5 Fasteners and fixings

4.5.1 Bolts, screws and thread-inserts

The reflector assembly is held together in certain places with a combination of titanium alloy (Grade 5 - Ti6al4v) bolts, screw studs and stainless steel thread inserts[2]. These materials have been selected as a trade-off between mechanical properties, material compatibility, neutronic performance and waste management considerations. These components do not make up part of the scope of supply and shall be provided by STFC upon the request of the selected Supplier. The supplier must give at least 2 months' notice to STFC prior to the need to have these items. Drawings SI-5630-123, SI-5630-124, SI-5630-125 & SI-5630-305, are all provided only as a reference.

4.5.2 Nuts and washers.

Various stainless steel nuts and washers have been specified to facilitate the construction of the assemblies. These components make up part of the scope of supply.

4.5.3 Dowels

Dowel pins are used in several positions to accurately locate blocks relative to each other and to ensure repeatability of position. There are two types of dowel pins used in the assembly; long pins (SI-5630-108) for location of the assembled halves and short pins used for individual component location (SI-5630-401). These components do not make up part of the scope of supply and shall be provided by STFC upon the request of the selected Supplier. The supplier must give at least 2 months' notice to STFC prior to the need to have these items. The stated drawings are provided only for reference.

4.6 Assembly

The reflector shall be fully assembled by the manufacturer as per general assembly drawing SI-5630-100 & its sub-assembly drawings SI-5630-101 and SI-5630-104 to ensure that the components fit as anticipated. It is strongly encouraged by STFC that assembly trials are carried out periodically throughout the manufacturing process (where appropriate) to reduce the likelihood of an issue on final assembly. STFC would expect to be invited to witness the final assembly.

4.7 Inspection

The reflector shall be inspected by the STFC engineering team once the manufacturing is complete and the reflector is assembled prior to shipping. Inspection by STFC shall not relieve the supplier of the responsibility for meeting the specification and delivery date of the reflector assembly.

4.8 Delivery

The delivery of the reflector assembly to STFC is the responsibility of the supplier. The supplier will take every practicable step to ensure safe delivery, using appropriate packaging. Any customs and delivery charges are the responsibility of the supplier.
The required date for delivery of the completed beryllium reflector assembly, all associated items and all documentation is **Monday 30th September 2019**.

[2] Drawing specification: M12 thread, helicoil thread insert x 2D, 18-8 stainless steel. Free running type

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. 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.
- 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

At some appropriate and agreed point during the production of the items covered by the contract (no less than 6 months prior to the scheduled dates of the FATs), STFC expects 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 (given appropriate protective measures) beryllium either completed or in production.

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 assembly reflector.

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 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 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

- Every 3 months:
  - Provide an updated project schedule and Gantt chart featuring key deliverables and the delivery milestone

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:

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

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:

- 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 covering, the handling, testing, machining and specification of beryllium components. At the tender submission stage, the supplier shall list and demonstrate what beryllium related standards they work to.

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 covering the use, handling and machining of beryllium. The tender submission must provide details of the safety precautions which are in place within their manufacturing facilities and how these comply with the relevant legislation and regulations within the country of operation.

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

The facility to perform an inspection of the completed assembly and any functional tests for any equipment provided as part of the contract. These tests will be undertaken at the Suppliers premises (or suitable alternative) before delivery to STFC.

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 before the final payment is made to the Supplier.

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 that 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 a supplier will have in place is 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 provide to assist a supplier with the creation of tooling paths, 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), *checking* 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 changes 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 made and approved, it will be re-sent to the supplier and 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 beryllium components outside of those required for the operation of the 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 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
  - Proposed manufacturing methods
  - Examples of previous work, showing tolerances achieved for example
- Project management plan
  - Project schedule and Gantt chart, clearly indicating key milestones such as; material delivery, machining completion, Plating completion, metrological testing complete, on-site inspection by STFC team & delivery to STFC site.
  - Risk management plan
  - Resource plan
- Communications plan

- Quality control and assurance plan
- Provisional testing plan
- Delivery and packaging plan
- Payment schedule (reference Appendices 8.2 & 8.3)
- Pricing schedule (using template provided)

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 product[3]

5.3.3 3 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

5.4.1 One Page Bid Summary

The Supplier shall provide a bid summary as part of the tender submission that covers, in no more than a single A4 page, the key points of their bid. This should as a minimum include; the proposed delivery date and a total price. It may also be used by the Supplier to highlight any other key information or aspects of the bid, which they feel are important.

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, containing, as a minimum:

- Project Schedule / Gantt Chart, highlighting key milestone dates / deliverables (such as):
  - Material supply complete
  - Individual component manufacture complete
  - Plating completion
  - Sub-assembly completion
  - Full assembly completion
  - Inspection completion
  - Dispatch from supplier's facilities

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

- Expected delivery date to STFC site

- Risk management plan:
  - How risks and issues are managed
  - Risk list
  - Risk assessment (likelihood and impact)
  - Mitigation strategies
- Resource Plan
  - List of equipment required to complete the work
  - Quantities of labour required in order to complete work
- Project organisation and structure
- Outline of project governance

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. 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 – 3 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 3 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.

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 clean and packaged prior to shipping

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

5.4.5 Payment schedule

It is required for Suppliers to include a proposed payment schedule with their tender submission. Prior to doing so, it is recommended that all Suppliers read Appendices 8.2 and 8.3 covering the constraints on STFC with regards to pre-payments and an example payment schedule. Although the

payment schedule example provided is a guide, there is limited flexibility available to STFC in terms of what it is able to accept.

5.4.6 Pricing schedule

A template will be provided in order that Suppliers can fill in the cost breakdown of their price submission.

5.5 Delivery

The delivery of the reflector assembly 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.

5.5.1 Delivery date

The required date for delivery of the completed reflector assembly, all associated items and all documentation is **Monday 30th September 2019**.

5.5.2 Cleaning

All beryllium 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 future handling, maintenance and longevity (via corrosion or embrittlement, etc.) of the component.

5.5.3 Packaging

The purpose of the packaging is to protect the components from damage during transportation and to prevent the potential spread of beryllium dust. 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.

5.5.4 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 up to and including the date at which point the final product is installed by STFC at which point, STFC accepts full responsibility.

The warranty will be counted as beginning on the date of delivery to the ISIS facility and acceptance by STFC staff.

5.5.5 Delivery location

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

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.

6 Contacts

6.1 During the tender period

During the tender period all contact between potential suppliers and STFC has to 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.

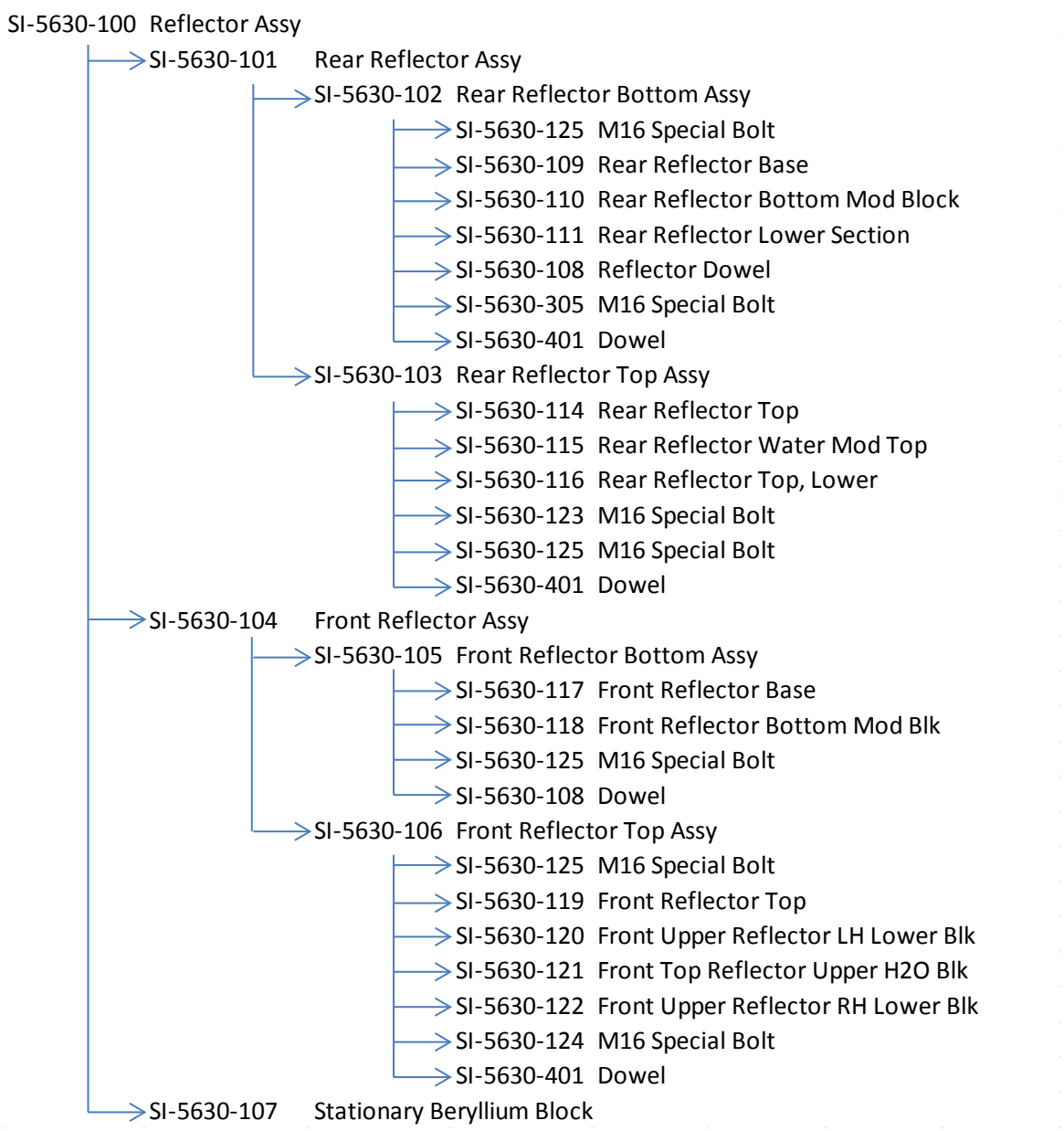
7 Glossary of Terms

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 reflector is used
Target	System that converts incoming proton beam into neutrons
Moderator	Component that contains a moderator media that reduces the energy of the neutrons produced in the target so they are appropriate energies for experiments
Pre-moderator	Aluminium vessel containing water that is positioned between the target and a cryogenic moderator
CAD	Computer-aided design (software)
PDF	Portable document format
STEP	Standard for the exchange of product data
FAT	Factory acceptance test
TRAM	Target, reflector and moderators (assembly)
IP	Intellectual property
Background IP	Intellectual property (IP) that is pre-existing prior to the commencement of the contract and not directly generated as part of it.
Foreground IP	Intellectual property (IP) that is directly generated as part of the contract to supply.
PIE	Post irradiation examination is a term used to cover a wide range of material property investigation and testing techniques carried out after a component has been in service within a radiation environment, to try to better understand the effects of the radiation exposure and operational conditions.
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

8 Appendices

8.1 Reference Drawings

Bill of Materials for SI-5630-100.asm (Top-level General Assembly)



8.2 Payment Schedule Example

The project management plan requires the Supplier to provide STFC with a payment schedule proposal or to accept that proposed by STFC (not necessarily the example one provided below).

Making some assumptions on the delivery and manufacture of the final assembly, we have generated an example of possible payment schedules for the Reflector Assembly contract. This is issued as a guide:

- 10% of contract total - Near net shape material delivered ready for blocks 1 – 4 – Jul 2018
- 10% of contract total - Near net shape material delivered ready for blocks 5 – 8 – Aug 2018
- 20% of contract total - Near net shape material delivered ready for blocks 9 – 13 – Sep 2018
- 5% of contract total – Machining operations for blocks 1 - 4 – Nov 2018
- 5% of contract total – Machining operations for blocks 5 - 8 – Jan 2019
- 5% of contract total – Machining operations for blocks 9 - 13 – Mar 2019
- 5% of total – Completion of Plating – June 2019
- 5% of total - FAT completion – July 2019
- Remaining balance (35%) of total – delivery & acceptance by STFC – Sep 2019

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.

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 Documentation checklist

In order to assist the Supplier in successfully completing their tender submission, a checklist table is provided below, covering which documents are needed for the **price and award/quality questionnaire** and to which question they should be attached.

Document Title	Question Reference	Check once successfully completed
One page bid summary	AW2.1 Executive Summary	
Project management plan	AW6.5 Project management	
Communications plan	AW6.10 Communication Plan	
Quality control and assurance plan	AW6.3 Quality Assurance	
Provisional/outline testing plan	AW6.9 Provisional/Outline Testing Plan	
Delivery and Packaging plan	AW6.7 Packaging and Transportation	
Payment schedule	AW6.11 Payment Schedule	
Pricing schedule	AW5.2 Pricing Schedule	
Technical Documentation	AW6.2 Specification - Documentation	