Science & Technology Facilities Council ISIS	Technical Specification

ISIS Design Division | Science and Technology Facilities Council | Rutherford Appleton Laboratory | Harwell Campus | Didcot | OX11 0QX

Document Title:	Specification for TS1 Cryogenic Methane Moderator		
Used On:	TS1 Project TRAM assembly		
Document No:	ISIS-TS1-UPG-MOD-Sp-0001	**Issue No:**	1

Issue	Date	Change Description	Auth	Check	App
1		Initial Issue	-	-	-

1 Introduction

1.1 Purpose

This document details the requirements for the provision of the cryogenic methane moderator assembly that is used on the Target Station 1 (TS1) project Target, Reflector and Moderators (TRAM) assembly.

1.2 ISIS Neutron & Muon Source

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

Figure 1 - An aerial photograph of the ISIS Facility

1.3 Equipment Location

The cryogenic methane moderator as shown in figures 2 and 3 is situated within the reflector assembly at the core of ISIS TS1. The purpose of moderators is to reduce the energy of the neutrons being released from the target to a suitable level for the receiving scientific instruments conducting various studies. The cryogenic methane moderator operates with a flow of liquid methane at 3.4bar and with a temperature of 110K.

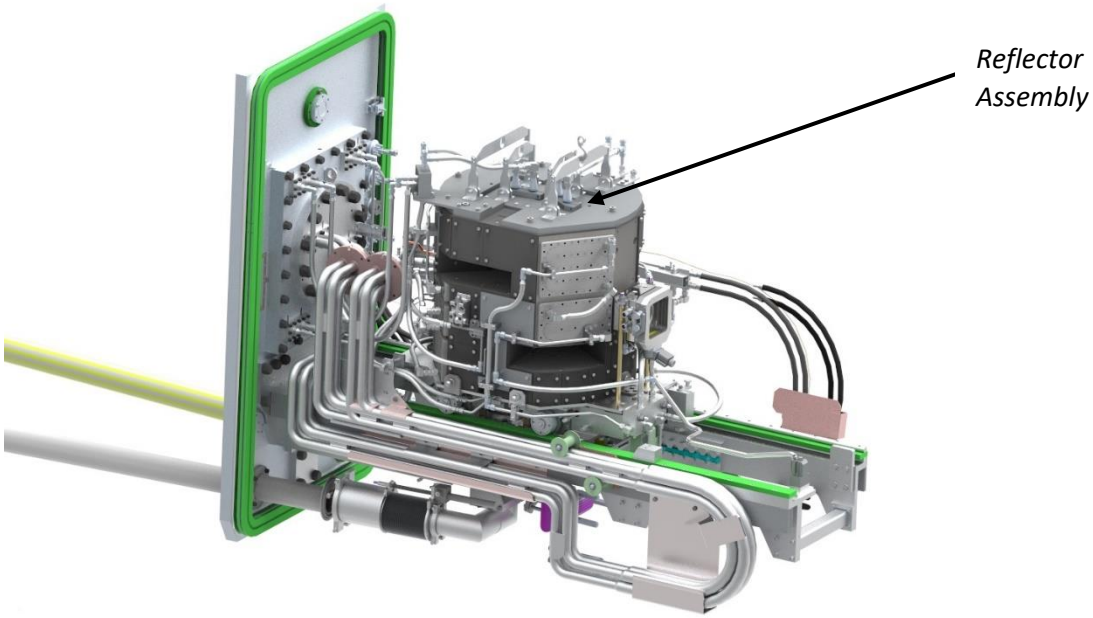

Figure 2 – UKRI STFC, ISIS, TS1 Project, Target\ Reflector \ Moderator assembly (TRAM).

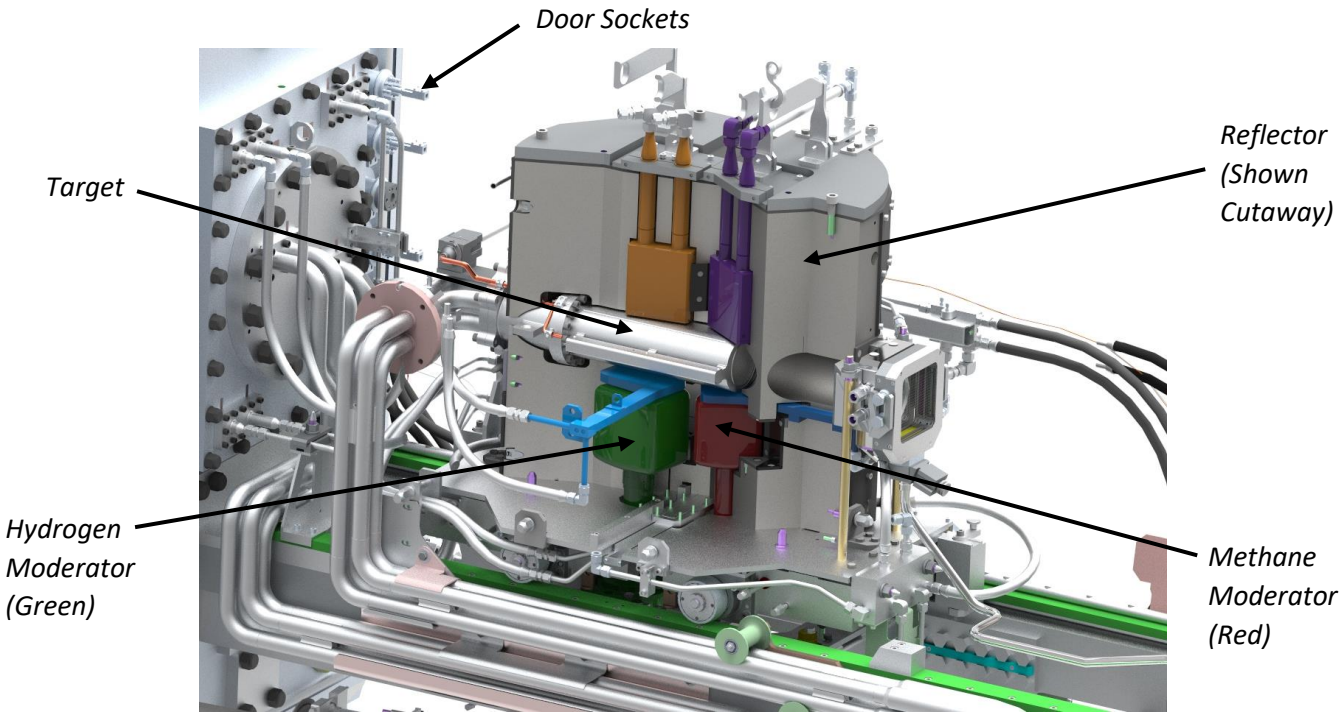

Figure 3 – Sectional view of the Reflector assembly to illustrate the positioning of the Cryogenic Methane moderator

1.4 Mountings & Connections

The methane moderator are assembled on the TRAM support frame by remote handling equipment within an active cell. It is located to the TRAM assembly by the methane pressure flange. The

pressure connections are made by using quick connect remote chain clamps using all metal seals. The temperature sensing thermocouples are connected to the door socket via a remote handling plug.

2 Scope of Supply

The requirement is for the supply of cryogenic methane moderator to the detailed component drawings provided along with the requirement, to the dimensions, tolerances and specifications laid out in the technical drawings, as specified in Appendix 1. The specification of the moderator is detailed in section 5, below. The supplier shall also provide a sample token of each type of material used in the production of the moderator assemblies. This may be in a variety of forms (to be discussed and agreed upon contract placement) including for example material off-cuts.

The Supplier will also provide a summary report and quality documentation pack as detailed in section 6.1.1.

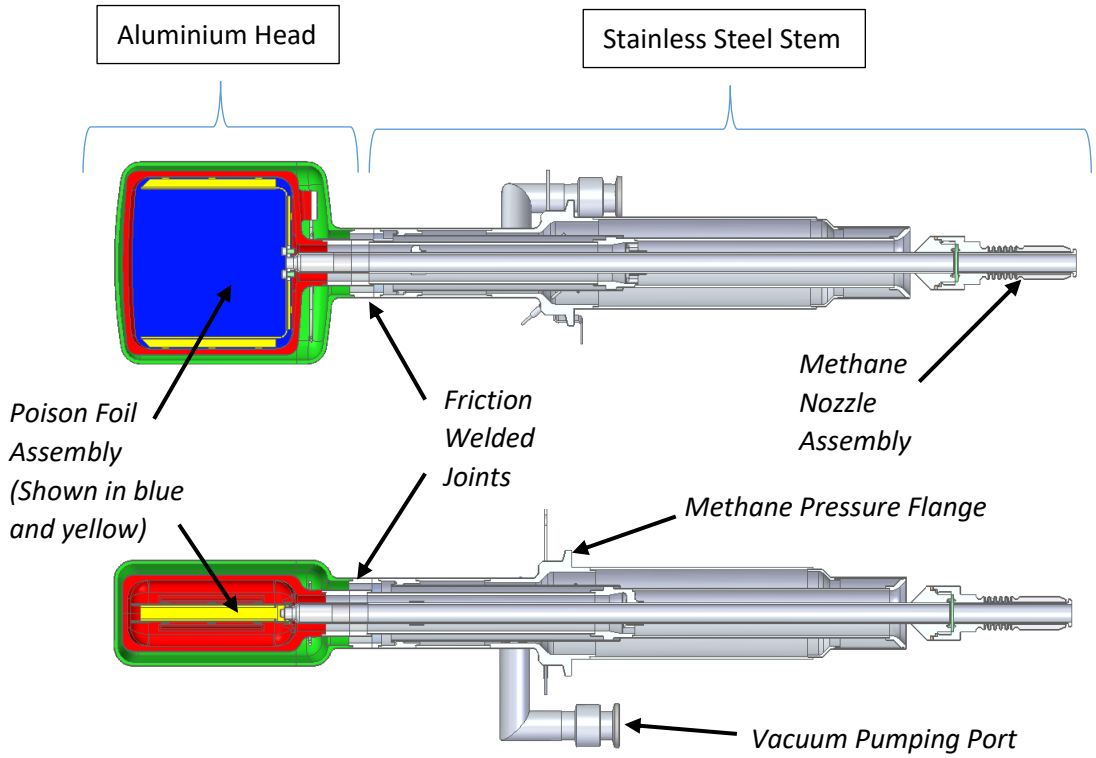

Figure 4 – Sectional views of the Dual Poison Foil Methane Moderator. It consists of a dual vessel assembly, the inner shown in red contains liquid methane and the outer shell is the vacuum containment vessel.

3 Deliverables

- One liquid methane moderator as shown in figure 4, to drawing SI-5620-100.
- Summary report and quality documentation pack (as detailed in 6.1.1).
- All associated tooling.

3.1 Additional Deliverables

Following successful installation of one liquid methane moderator, UKRI – STFC may wish to purchase one additional liquid methane moderator. Bidders are requested to provide a price for this additional liquid methane moderator, to be awarded at UKRI - STFC's discretion.

4 Items to be provided by UKRI - STFC

- Two poison foil assemblies to drawing SI-5620-131.
- One friction welded joint blank to drawing SI-5620-011 (Methane return).
- One friction welded Joint blank to drawing SI-5620-128 (Methane flow).
- One friction welded joint blank to drawing SI-5620-047 (Vacuum blank).
- Two E type thermocouples as per stated on drawing SI-5620-121.

5 Material Parameters

The moderators head shells are to be manufactured using Aluminium AW – 5083-0/H111 grade material for the vessel shells. The stems are to be constructed in Stainless steel with 316L the preferred grade. However, should 316L stock be unavailable, then 304L would be acceptable. A substitution of the type must be made with the full knowledge and prior agreement of UKRI – STFC. The aluminium vessels are joined to the stainless vessels by using friction welded joints. As mentioned in section 4, UKRI - STFC will free issue the 3 types required for the methane moderator. The material grades for the friction joints are stated on the drawings, should the supplier suggest an alternative grade, UKRI - STFC should be notified at the tender stage in order to check suitability and provide written formal approval.

The methane moderator contains a poison foil assembly which is made up of a gadolinium foil sandwiched between two thin sheets of aluminium, caution must be taken with this not to chemically, mechanically or thermally damage it during any part of manufacture, assembly or transport of the moderator assembly.

6 General Requirements

6.1 Documentation

6.1.1 Documentation Requirements

Upon delivery, a quality documentation pack will need to be provided, covering;

- Certification of conformity for materials used in the construction
- Inspection reports for each item confirming compliance with dimensions, tolerances and notes specified on the detailed drawings;
- Material data sheets providing mechanical property data such as tensile strength, density, yield stress and hardness
- Thermal, Pressure and Vacuum testing results

6.2 Quality Control

Due to the nature of the environment where these items will operate, the constraints on their performance and the planned length of service, it is imperative that UKRI – STFC receives components of appropriate quality. It is therefore expected that any quality management plans and systems detailed in documentation provided, will be followed and that the Supplier takes their responsibility for quality seriously.

6.3 Dimensions

The dimensions of each plate are provided in the technical drawings, listed in the Associated Documents section.

The items have been designed and detailed for TIG welding process in mind to fabricate the assemblies allowances can be added in order for additional machining processes to achieve specific features or tighter tolerances.

6.4 Cleaning

All surfaces are to be free from dents, scratches, marks and discolouration. The moderators are vacuum insulted cryogenic vessels and should be cleaned with a suitable and compatible cleaning agent to remove surface oils, greases and cutting-fluids.

All stainless welds are to be cleaned, pickled with a suitable pickling paste, passivated, rinsed and dried.

6.5 Testing

There are three testing methods that are required to be undertaken at various stages during moderator construction. These are as follows.

- **Thermal shock testing** – To check the integrity of welds and friction welded joints by submersion of joints in liquid nitrogen and checking the joints with a vacuum leak test.
- **Vacuum Leak testing** – To check welds and material porosity by evacuating the internal space and purging external joints and surface with helium gas. Leak rate should normally be no greater than 10-6 mbar litres per second.
- **Pressure Testing** – Internal volumes that are subjected to internal pressure are to be tested to test pressure with gas as stated on the drawing.

On completion of moderator manufacture, the moderator is required to be tested with the presence of a UKRI - STFC witness to the steps stated in the TS1 Moderator Pressure and Leak Test Document, a template will be supplied by UKRI - STFC. All test results to be recorded in this document and to be provided to UKRI - STFC on moderator delivery.

7 Delivery

The delivery of the moderators to UKRI - STFC is the responsibility of the Supplier. The Supplier shall take every practicable step to ensure safe and damage-free delivery, using appropriate packaging.

Delivery date

The required date for delivery of the completed moderators, any associated items and all documentation is no later than 31st March 2020.

7.1 Delivery location

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

8 Appendix 1 – List of provided drawings

8.1 Associated Documents

This technical specification shall be read in conjunction with the following technical drawings.

Drawings beginning SI-5620-XXX in the list below are designated as Methane moderator drawings

#	Level	Drawing Number	Revision	Drawing Title	Quantity
1	1 - ASSEMBLY DRW	SI-5620-100	A	DOUBLE FOIL CH4 MODERATOR ASSY	1
2	1	SI-5606-002	A	DUAL FOIL CH4 MOD	1
3	1	SI-5620-026	B	2.5" VAC JACKET TUBE	1
4	1	SI-5620-032	A	BAYONET THREAD UNION	1
5	1	SI-5620-033	A	THERMOCOUPLE CLAMP	1
6	1	SI-5620-040	A	BAYONET NOSE ASSEMBLY	1
7	2	SI-5620-042	A	BAYONET NOSE INNER	1
8	2	SI-5620-043	A	BAYONET THREADED BUSH	1
9	2	SI-5620-044	A	BAYONET FLEXIBLE BELLOWS	1
10	2	SI-5620-045	A	BAYONET NOSE	1
11	1	SI-5620-114	A	DUAL FOIL METHANE VACUUM VESSEL, UPPER	1
12	1 - ASSEMBLY DRW	SI-5620-120	A	CH4 SUB ASSY 1	1
13	2	SI-5620-020	A	DUAL FOIL METHANE VESSEL CAN B	1
14	2	SI-5620-021	A	DUAL FOIL METHANE VESSEL CAN A	1
15	2	SI-5620-027	A	METHANE RETURN TUBE UPPER	1
16	2	SI-5620-031	A	METHANE FLOW ADAPTOR	1
17	2 - ASSEMBLY DRW	SI-5620-130	A	EXTENDED DUAL POISON FOIL	1
18	3	SI-5620-129	A	FOIL FLOW TUBE	1
19	3	SI-5620-131	A	GADOLINIUM FOIL FABRICATION	1
20	4	SI-5620-133	A	GADOLINIUM POISON FOIL	1
21	3	SI-5620-134	A	MACHINED FOIL DIVIDER	1
22	3	SI-5620-135	A	GADOLINIUM FOIL SUPPORT	1
23	3	SI-5620-136	A	THERMAL SPACER	1
24	3	SI-5620-151	A	FRICTION WELDED JOINT - METHANE FLOW	1
25	4	SI-5620-128	A	FRICTION WELDED BLANK - METHANE FLOW	1
26	2	SI-5620-149	A	FRICTION WELDED JOINT - METHANE RETURN	1
27	3	SI-5620-011	A	FRICTION WELDED JOINT BLANK	1
28	1 - ASSEMBLY DRW	SI-5620-121	A	CH4 SUB ASSY 2	1
29	2	SI-5620-022	A	THERMOCOUPLE FEEDTHROUGH	2
30	2	SI-5620-024	A	VACUUM TUBE - INNER	1

31	2	SI-5620-025	A	TRANSFERLINE FLANGE	1
32	2	SI-5620-029	A	VACUUM TUBE OUTER	1
33	2	SI-5620-035	A	FRICTION WELDED JOINT - VACUUM	1
34	3	SI-5620-047	A	FRICTION JOINT - VACUUM BLANK	1
35	2	SI-5620-036	B	VACUUM PORT TUBE	1
36	2	SI-5620-037	A	SPACER	1
37	2	SI-5620-070	B	VACUUM TUBE	1
38	2	SI-5620-074	B	FLEX METAL BELLOWS	1
39	2	SI-5620-113	A	DUAL FOIL METHANE VACUUM VESSEL, LOWER	1
40	2	SI-5620-115	B	GARLOCK CLAMP TAB	2
41	2	SI-5620-116	B	GARLOCK CLAMP SUPPORT	1
42	1 - ASSEMBLY DRW	SI-5620-122	A	CH4 SUB ASSY 3	1
43	2	SI-5620-034	A	METHANE RETURN TUBE	1
44	2	SI-5620-041	A	TUBE DIA 50	1
45	2	SI-5620-051	A	ADAPTOR	1
46	2	SI-5620-112	A	ADAPTOR	1
47	1	SI-5620-206	A	SEAL RING - COPPER	1