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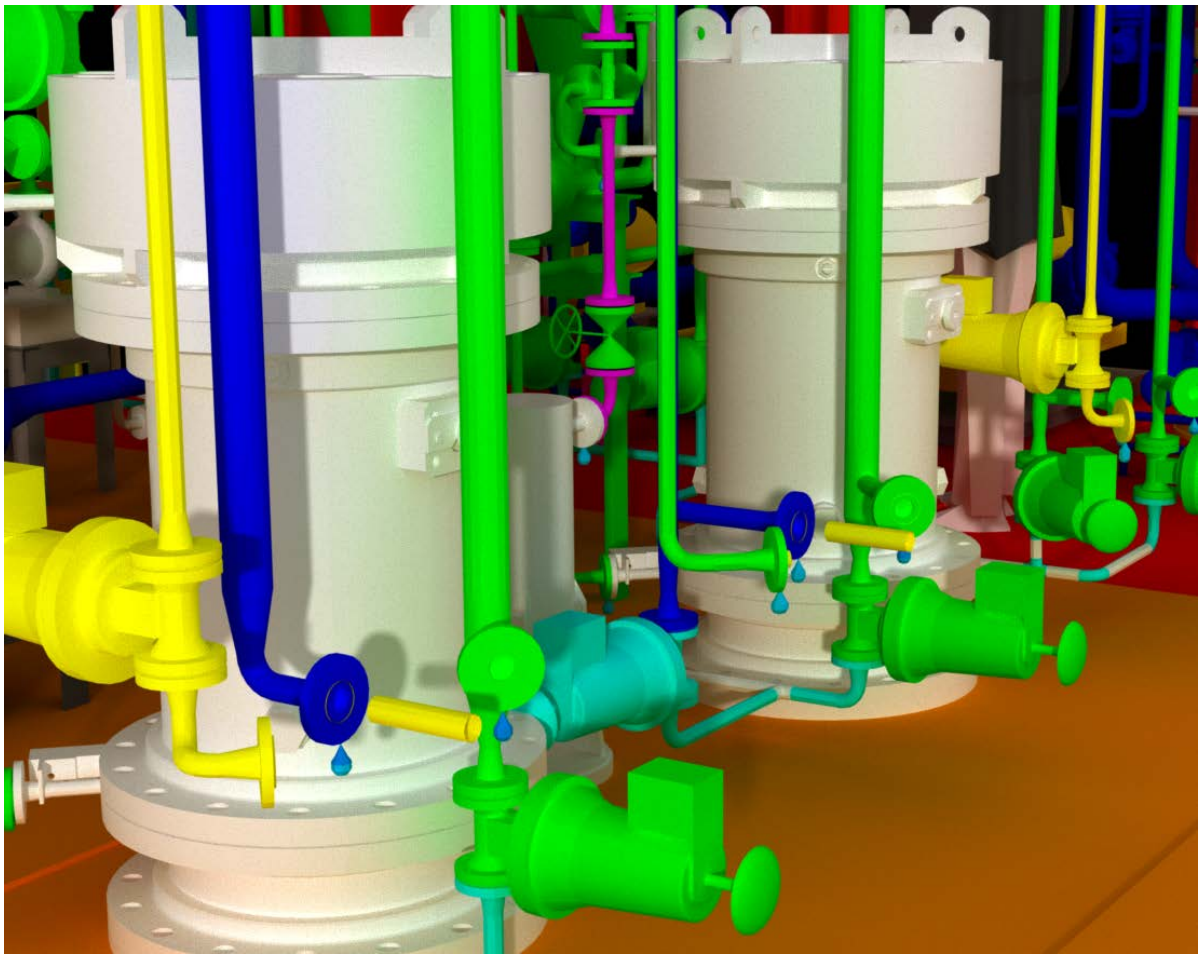
Technical Specification
Ion Exchange Columns

ISIS-TS1-UPG-SRV-RP-0006
TS1 Project WP1.8 – Water Services



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O	First Issue	J.H.	V.M.	21/02/18
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1. Introduction

The ISIS Neutron and Muon source is a world leading centre for civil research in the fields of engineering, physics and material science. The source has been operational since 1984 and was expected to have an operational life of 20 years, however its continuing success and importance to the international neutron scattering community has secured further investment in the operation of the facility.

The TS1 Project is a programme of works aimed at extending the operational life of ISIS's first target station. As part of the project, the cooling water plant that supplies the target, reflector and moderator (TRAM) assembly is being replaced.

This cooling water plant is comprised of 4 separate, closed loop recirculating circuits:

- Target Circuit
- Reflector Circuit
- Moderators Circuit
- Secondary Circuit

Each cooling water circuit is comprised of one or more sealless centrifugal pumps, heat exchangers, a filter, an ion exchange column, a header tank, and associated valves and process instrumentation. This plant equipment is mounted on a movable trolley, located within the Target Services Area (TSA).

In addition to the above, three under-ground drain tanks and their associated pumps, valves and instrumentation are being refurbished. General arrangement drawings of the proposed plant equipment layout and Target Services Area are provided for context.

This document details the technical requirements of the ion exchange columns that will be used to condition the circuits described above:

Section 1 – Scope of Supply lists the materials and quantities to be supplied.

Section 2 – Process Design describes the design process conditions of the fluids that will be handled and the flowrates, temperatures and pressures the ion exchange columns will be subjected to.

Section 3 – Mechanical Design details the mechanical requirements. Please take note of the atypical flange facing requirements and restrictions on the materials of construction that may be used.

Section 4 – Testing & Inspection details our testing and inspection requirements.

Section 5 – Packing & Carriage describes the packing and delivery requirements.

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2. Nomenclature and Definitions

Symbol	Description	Units (typical)
d	Inside diameter of pipe	mm
m	Mass flowrate	kg s^{-1}
P	Pressure	kPa
ΔP	Pressure drop	kPa
Q	Volumetric flowrate	m^3 s^{-1}
T	Temperature	°C
v	Fluid flow velocity	m s^{-1}
σ	Conductivity	µs m^{-1}
ρ	Density	kg m^{-3}
µ	Dynamic viscosity	Pa s

Abbreviation	Definition
ABS	acrylonitrile butadiene styrene plastic
DO	Dissolved oxygen
EPDM	ethylene propylene diene monomer rubber
NB	Nominal bore
OEM	Original equipment manufacturer
SS316	EN 1.4435 / BS 316S13 austentic stainless steel
FAT	Factory Acceptance Test

3. Scope of Supply

Materials

- 4 off ion exchange columns to suit the capacities, flowrates and temperatures stated in section 4.
- 4 sets of 2 year operating spare parts/service kits, if applicable.
- All special OEM tools required for maintenance, if applicable.
- Packaging of the above in wooden crates suitable for indoor warehouse storage.

Services

- Delivery duty paid (DDP) Oxfordshire (Incoterms 2010) of the above to our site in Oxfordshire, UK.
- 12 months warranty.

Documentation

On Tender, for each item:

- Datasheet.
- Dimensioned General arrangement drawing in pdf or DWG format.
- 3D Model (in STEP or DWG format).

On Delivery:

- Operating & Maintenance Manual.
- PD5500 Form X with supporting mechanical design calculations.
- PED Certificate of Conformity
- Hydrostatic test certificate/report.

4. Process Design

4.1. Application

Ion exchange columns I101, I201, I301 and I401 are installed on the target, reflector, moderators and secondary circuits respectively. They maintain circuit conductivities below 3 μS cm^{-1} to reduce corrosion rates and remove actives species (e.g. ^{7}Be) from the target circuit.

A bypass loop installed across the pump of each circuit diverts a small portion of the flow (approximately 2-5%) through the circuit's ion exchange column. Included in each bypass loop is a pneumatically actuated isolation valve, a hand operated commissioning valve used to set the flow rate, and a flap-type non-return valve to prevent reverse flow (all by others). A turbine-type flow transmitter (also by others) is included in the outlet line for flow monitoring and setting of the hand-op commissioning valve.

The columns will utilize proprietary nuclear-grade gel type polystyrene strong acid cation exchange resins.

4.2. Pressure, temperature and particulate solid limits

Operating temperature:	30°C
Operating Pressure:	7 bar g
Maximum Design Temperature:	60°C
Maximum Design Pressure:	14 bar g

The circuits are closed loop, clean water circuits feeding stainless steel equipment and cooling pads, and a 100 μm filter-strainer is installed upstream of each pump. No particulate solids issues are anticipated.

All ion exchange columns shall be designed manufactured and hydrostatically tested to the requirements of PD5500, and the Pressure Equipment (Safety) Regulations 2015 which implement the harmonised EU Pressure Equipment Directive (PED). A copy of form X to PD5500 and a Certificate of conformity to the PED must accompany the items on delivery.

4.3. Radiation

To generate neutrons, the target is bombarded with a beam of protons from a series of particle accelerators. This induces activity in the TRAM assembly materials and its cooling water.

The ion exchange columns must be suitable for handling active fluids.

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4.4. Process Parameters

IE Tag No.	Nominal Flowrate	Nominal Capacity	Process Material	Fluid Density	Fluid Abs. Viscosity	Fluid Nominal Temp. Range	Design Pressure	Fluid Solids Content	pH
	L min^{-1}	**L**	**-**	**g ml^{-1}**	**x10^{-3} Pa s**	**°C**	**Bar g**	**ppm**	**-**
I101	5	216	Deuterium Oxide	1.107	1.2503	30 – 35	14.0	<1,000	7.0
1201	1	57	Demineralised Water	1.000	1.0050	30 – 35	14.0	<1,000	7.0
I301	1	57	Demineralised Water	1.000	1.0050	30 - 35	14.0	<1,000	7.0
I401	2.5	216	Demineralised Water	1.000	1.0050	30 – 40	14.0	<1,000	7.0

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5. Mechanical Design

5.1. Nominal Dimensions

The body of each ion exchange column shall be fabricated out of schedule 10S pipe to the following dimensions:

Column	Body Dia. NPS, inches	Body Height mm
I101	18"	1110
I201	12"	800
I301	12"	800
I401	18"	1100

Please see the attached preliminary general arrangement drawings for details.

5.2. Materials of Construction

The low conductivity, high purity D^2O and demineralised water is highly corrosive. All wetted parts shall be in stainless steel grade EN 1.4401/1.4404 (316/316L) or equivalent.

The ion exchange columns shall be subject to a radiation environment for prolonged periods of time, during which the embrittlement and hardening of elastomers and thermoplastics may occur (radiation damage). Suitably radiation resistant elastomers such as EPDM and thermoplastics such as PEEK shall be used where materials cannot be substituted for metals.

The cooling circuits contain aluminium components. To reduce the risk of galvanic corrosion, the use of copper or copper containing materials is prohibited.

5.3. Surface Finish & Coatings

All external stainless steel surfaces shall be left uncoated with a bright cold rolled mill finish to ASTM A840 2B or equivalent.

5.4. Flanges

All flanges shall be ASME/ANSI Class 150 with **raised faces machined to a surface finish of <0.8 microns**. This is an important requirement, as the metallic crush-type gaskets that are used throughout the target services area will not work with rougher surfaces.

The following inlet and outlet sizes are required:

Column	Inlet Flange Size NPS, ins	Outlet Flange Size NPS, ins
I101	¾	¾
I201	¾	¾
I301	¾	¾
I401	¾	¾

5.5. Fasteners

All fasteners shall be metric standard, coarse-threaded in bright zinc-plated (BZP) mild steel. Flat washers shall be used. Minimum nut thicknesses shall be equal to or greater than one times the nominal bolt diameter, and nuts shall have full engagement (minimum 1-2 exposed threads) on their bolts or studs.

Flange fasteners shall be tightened in a staggered criss-cross pattern to preserve gasket position and alignment. Fasteners are to be tightened to the torque specified by the gasket OEM.

5.6. Gasket

The lids of each ion exchange column are to be supplied without gasket, finished to the surface finish specified in section 5.4.

5.7. Filter Nozzles

Each inlet and outlet internal to the column is to be covered by filter nozzles to prevent the escape of ion exchange resin into the circuit. The fineness of these filter nozzles is to be determined by the ion exchange column manufacturer, based on the following resin particle sizes:

Resin	Particle Size Range mm
Amberlite IRN77	0.60 – 0.70
Amberlite IRN78	0.58 – 0.68

To ensure compatibility with the biological shielding, these nozzles must be located in the positions shown on the accompanying nozzle orientation drawings.

5.8. Lifting

The ion exchange column shall include either fixed lifting lugs or a fixed lifting bar, located on the top vertical centreline to facilitate overhead installation and removal of the column via crane.

5.9. Corrosion Allowance

No corrosion allowance is required.

5.10. Nozzle Locations

An equipment nozzle orientation drawing has been produced showing the positions of each nozzle. Please ensure that the nozzles on your quoted columns match these locations.

5.11.Nameplates

Each ion exchange column shall have mounted on its lid or body a permanently etched thin stainless steel nameplate, complete with the following information as a minimum:

- Tag Number
- Design Code
- Design Pressure (Bar)
- Design Temperature (°C)
- Test Pressure (Bar)
- Dry Weight (kg)
- Fluid Group

Plastic or adhesive label type nameplates are not permitted.

6. Testing & Inspection

An inspecting engineer from The Science and Technology Facilities Council (or an appointed representative) shall be invited to inspect the equipment against this specification and attached drawings, and witness a factory acceptance test (FAT) prior to shipping.

As part of the FAT all ion exchange columns are to be hydrostatically tested to 1.6 times design pressure, with no pressure loss over a 24 hour period (commencing after isolation from supply) being a condition of acceptance. Should this test fail, the supplier is to remedy all faults and re-test to the satisfaction of the inspecting engineer.

- The surface finish of each flange mating face shall be tested using a stylus profiler. A surface roughness of less than 0.8 microns is a condition of acceptance.

A test report/certificate produced by the supplier is to accompany the ion exchange columns on delivery.

7. Packing and Carriage

Prior to transit the equipment shall be shall be fully drained and all nozzles sealed using pipe caps or wooden blanks attached with chloride-free tape. Equipment must be supplied palletized and crated, suitably prepared with adequate strapping and wrapping.

Any spare items or special tools shall be packed separately.

If shipping from overseas terms shall be DDP (delivery duty paid) as per ICC INCOTERMS 2010.

Please include a price in your tender for packing and carriage to the following address:

R106 Stores
Science & Technology Facilities Council
Rutherford Appleton Laboratory
Harwell Science & Innovation Campus
Didcot
OX11 0QX
United Kingdom

8. Delivery

Delivery is required before 28th Feb 2019.