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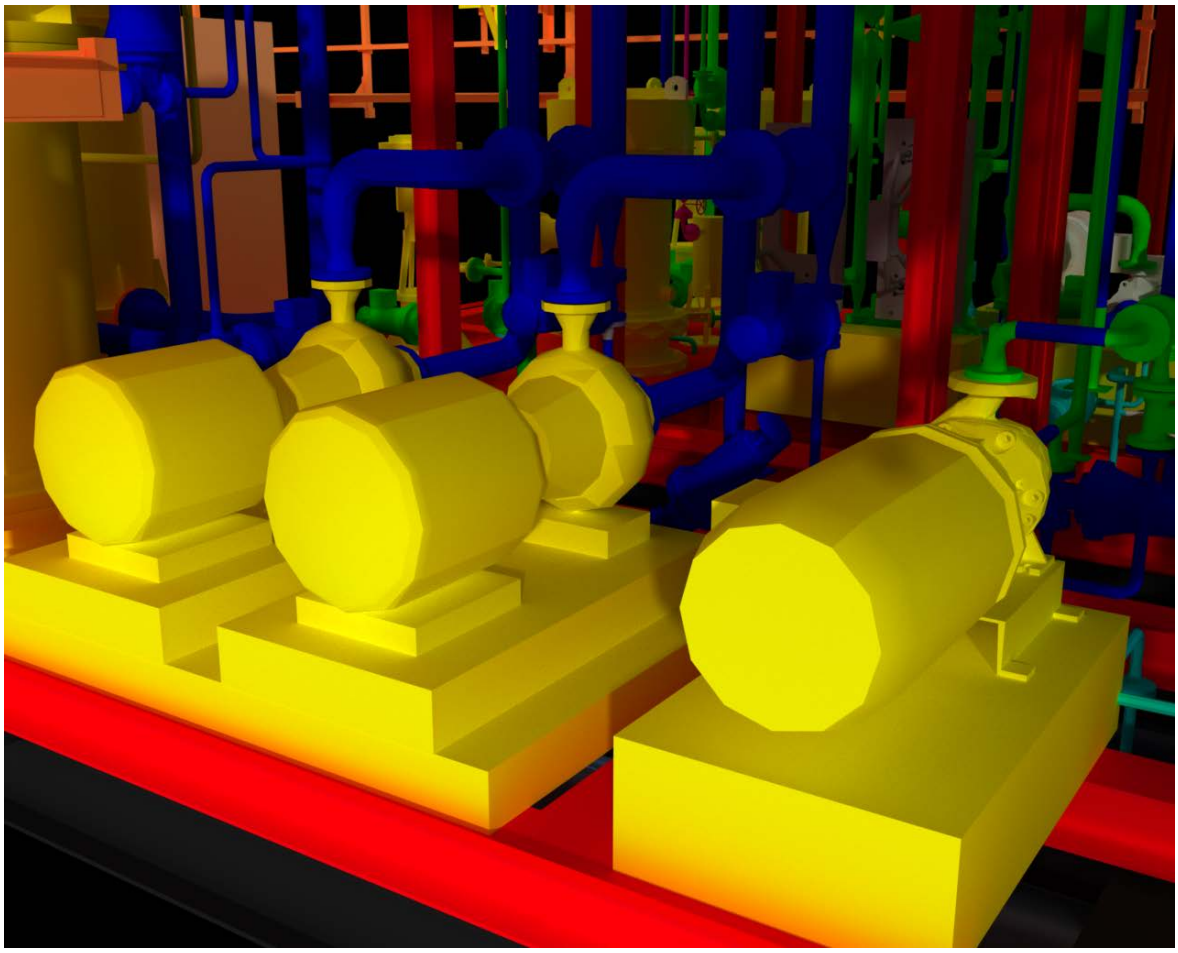
Technical Specification
Sealless Centrifugal Pumps

ISIS-TS1-UPG-SRV-RP-0005
TS1 Project WP1.8 – Water Services



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A	UKSBS advisory amendments	J.H	V.M	18/05/18
B	Revised delivery date	J.H.	V.M	04/06/18
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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 sealless centrifugal pumps that will be used throughout the new cooling water plant:

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

Section 2 – Process Design describes the process conditions of the fluids that will be handled and the flowrates and total developed head that the pumps will be required to deliver.

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 – Electrical Design describes the specification of the electrical drivers, IP ratings of terminal boxes and the condition monitoring instrumentation required.

Section 5 – Testing & Inspection details our testing and inspection requirements.

Section 6 – Packing & Carriage describes the packing and delivery requirements.

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Nomenclature and Definitions

Symbol	Description	Unit (typical)
d	Inside diameter of pipe	mm
C_p	Specific heat capacity	kJ kg^{-1} K^{-1}
f_D	Darcy friction factor	[dimensionless]
K	Resistance coefficient	[dimensionless]
L	Pipe length	m
m	Mass flowrate	kg s^{-1}
P	Pressure	kPa
ΔP	Pressure drop	kPa
P_{hyd}	Hydraulic power	kW
P_{abs}	Absorbed power	kW
$P_{installed}$	Installed power	kW
R_e	Reynolds number	[dimensionless]
Q	Volumetric flowrate	m^3 s^{-1}
T	Temperature	°C
ΔT_{LM}	Log Mean Temperature Difference	°C
v	Fluid flow velocity	m s^{-1}
ε	Relative roughness	mm
σ	Conductivity	μs m^{-1}
ρ	Density	kg m^{-3}
μ	Dynamic viscosity	Pa s

Abbreviation	Definition
AAV	Automatic air vent
ABS	acrylonitrile butadiene styrene plastic
DO	Dissolved oxygen
EPDM	ethylene propylene diene monomer rubber
HMI	Human machine interface
NB	Nominal bore
NPSHa	Net positive suction head available
NPSHr	Net positive suction head required
OEM	Original equipment manufacturer
PLC	Programmable logic controller
SS316	EN 1.4435 / BS 316S13 austentic stainless steel
VSD	Variable speed drive

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1. Scope of Supply

Materials

- 6 off sealless magnetically driven, single volute, centrifugal pumps complete with casing, impeller, bearings and shaft.
- 6 off totally enclosed, fan cooled (TEFC) IE3 Premium or IE4 super premium efficiency pump drivers to IEC/EN 60034-30-1:2014 suitable for use with ABB variable frequency drives and with metal fans.
- 6 off mild steel baseplates to suit the above (common baseplate for each pump and its corresponding driver), complete with all necessary anchor bolts/nuts, washers and alignment shim plates, to be supplied installed.
- 6 sets horizontal alignment jackscrews, if required.
- 6 Stainless steel nameplates, supplied installed.
- 6 sets commissioning spares, if applicable.
- 6 sets 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.
- In-situ laser alignment to be completed post-installation at our site in Oxfordshire, UK.
- A minimum of 12 months warranty, to commence once laser alignment has been completed.

Documentation

On Tender, for each pump model:

- Datasheet
- Performance curve (head vs flowrate)
- Efficiency curve and NPSH curve, or stated $NPSH_R$ value at design conditions.
- Dimensioned General arrangement drawing in pdf or DWG format, to include baseplate.
- If possible, a 3D Model (in STEP or DWG format)

On Delivery:

- Operating & Maintenance Manual
- Hydrostatic test certificate/report

2. Process Design

2.1. Application

P101 and P102 will be used to supply deuterium oxide (D^2O) at 490 L min^{-1} and 7.1 bar g to a tantalum-clad tungsten spallation target. It returns from the target at 2.3 bar g. 70.0 m of total developed head is required.

P103 is a jockey pump used with a uninterruptible power supply (UPS) to remove decay heat from the spallation target in the event of a loss of power or emergency shutdown. It supplies the target with a trickle flow of 50 L min^{-1} at ~3.5 bar g. 35.0 m of total developed head is required.

P201 and P301 are identical pumps used to supply aluminium reflector cooling pads and aluminium ambient water moderators with demineralised cooling water. They are each sized to supply 42 L min^{-1} at 2 bar g. 26.0 m of total developed head is required.

P401 pressurises the secondary circuit, which removes heat from the three circuits described above from a series of fusion bonded stainless steel heat exchangers. P401 supplies the secondary circuit with 900 L min^{-1} at 7.1 bar g. 54 m of total developed head is required.

Each pump must be sized to supply the nominal flowrate required in section 4.5, while operating at the most efficient point on its performance curve (typically 40 Hz). This gives each pump 20% extra capacity.

2.2. Pressure, temperature and particulate limits

All of the circuits are relatively low temperature and pressure (<100°C, 10.0 bar g) - there are no onerous pressure or temperature limits. Pump casings shall have a design pressure of at least 1.6 times the maximum pump delivery pressure.

The circuits are closed loop, clean water circuits with a 100 μm filter-strainers installed upstream of each pump. No particulate solids issues are anticipated.

2.3. Explosive Atmosphere

A DSEAR risk assessment has been completed for the plant area. The pumps will be installed in a safe area and are not subject to any special ATEX requirements.

2.4. Radiation

To generate neutrons, the target is bombarded with a beam of protons from a series of particle accelerators. This results in the TRAM assembly and its cooling water becoming radioactive whilst the source is operating. The pumps must be suitable for handling active fluids.

The use of thermoplastics or elastomers must be avoided. Where possible these materials can be optionally swapped out for radiation-hard materials such as PEEK or EPDM.

2.5. Process Parameters

Pump Tag No.	Nominal Flowrate	TDH[1]	Process Material	Density	Dyn. Viscosity	Operating Temp. Range	Solids Content	pH	NPSHa[2]
	L min^{-1}	**m**	**-**	**g ml^{-1}**	**x10^{-3} Pa s**	**°C**	**ppm**	**-**	**m**
P101	490	70	Deuterium Oxide	1.107	1.2503	30 – 35	<1,000	7.0	3.2
P102	490	70	Deuterium Oxide	1.107	1.2503	30 – 35	<1,000	7.0	3.0
P103	50	35	Deuterium Oxide	1.107	1.2503	30 - 35	<1,000	7.0	3.2
P201	42	26	Demineralised Water	1.000	1.0050	30 – 40	<1,000	7.0	1.5
P301	42	26	Demineralised Water	1.000	1.0050	30 - 35	<1,000	7.0	3.2
P401	900	54	Demineralised Water	1.000	1.0050	25 - 30	<1,000	7.0	3.2

1. Total developed head
2. Net positive suction head available (m)

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3. Mechanical Design

3.1. Materials of Construction

Due to the corrosive nature of the process media all wetted parts to be in stainless steel grade EN 1.4401/1.4404 (316/316L) or equivalent.

Shafts shall be in medium strength steel, EN8 or equivalent material of similar grade and tensile strength. Mild steel shafts are prohibited.

Due to the presence of aluminium components in the cooling circuit downstream of the pumps, the use of copper or copper containing materials is prohibited.

The pumps shall be subject to a radiation environment for prolonged periods of time, during which the embrittlement of elastomers and thermoplastics may occur (radiation damage). Suitably radiation-hard elastomers such as EPDM and thermoplastics (e.g. PEEK) shall be used throughout.

Motor fans to be in suitable metal - plastic fans are prohibited.

3.2. Surface Preparation & Coating

All external surfaces shall be prepared and painted as below.

To ensure coating adherence the prepared surface must be smooth, free of rust, mill scale and organic contaminants such as cutting oils, greases, marking inks etc. Prior to coating application the surfaces shall be:

- Degreased using a suitable organic solvent or emulsion degreasing agent
- Abrasively blast cleaned to at least SA2½ (very thorough blast-cleaning), as per ISO 8501-1: 1998
- All sharp edges filed down and deburred
- Wiped down with a mineral spirit immediately prior to coating application

The paint finish shall consist of 3 separate coats:

- Zinc rich epoxy primer to 80 µm DFT
- Two pack high build epoxy MIO, 2 coats to 200µm DFT

The colour of the final two coats shall be Signal Yellow RAL 1003

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3.3. Casing & Flanges

Casing to be single stage centrifugal volute casing, horizontal back-pullout close coupled magnetic drive type with end suction and vertical centreline discharge in stainless steel SS316/SS316L grade EN 1.4401/1.4404 or equivalent.

All flanges shall be ASME/ANSI Class 150 with raised faces machined to a surface finish of 0.8 microns.

Casing drain and vent with a flanged termination shall be included and the pump casing shall be fully self-draining.

3.4. Impeller

Impeller to be a closed construction, radial vane impeller in stainless steel grade EN 1.4401/1.4404 (316/316L) or equivalent.

3.5. Bearings

Bearings to be sealed for life type with rolling elements in silicon carbide or equivalent suitable material.

3.6. Auxiliary Piping

The wet side of the pump shall be completely self-draining with a casing drain takeoff located at the lowest point of the casing. The casing drain shall be piped in schedule 10S stainless steel, terminating in a flanged connection as per section 3.2.

3.7. Nameplates

Each pump shall have mounted on its casing a permanently etched thin stainless steel nameplate, complete with the following information as a minimum:

- Pump Tag Number
- Manufacturer's Model Number
- Total Developed Head (TDH, m)
- Maximum Safe Working Pressure (Bar)
- Maximum flow rate ($m^3\ h^{-1}$)
- Fluid Temperature (°C)
- Motor Speed (RPM)
- Motor Power (kW)

Plastic or adhesive label type nameplates are not permitted.

3.8. Baseplate

The baseplate of pumps P101, P102 & P401 is restricted to a maximum of 1010 mm in length due to layout considerations. Please ensure that the supplied baseplates are longer than this. The electrical motor is permitted to overhang the edge of the baseplate, within reason.

Baseplate to come with removable lifting eyes or holes for bolt-on lifting eyes to be attached on all four corners to aid with installation. These shall be no smaller than M12.

Pumps to be mounted on anti-vibration mounts to prevent the transmission of vibrations to the steel skid.

3.9. Noise

Noise levels not to exceed 90 dBa at 1 m during normal operation.

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4. Electrical Design

4.1. Condition Monitoring

Pumps to be supplied with 24V DC suitable motor thermistors.

Motor anti-condensation heaters are not required.

4.2. Electric Driver

3 phase 50 Hz asynchronous motors with IE4 super premium efficiency to IEC/EN 60034-30-1:2014 and suitable for control by an ABB inverter/variable frequency drive.

Motors shall be for a totally enclosed, fan cooled (TEFC) design with an IP55 minimum IP rating and a vertical centreline lifting eye/lug to facilitate removal of the motor from the plant area via overhead crane.

Motor fans to be in stainless steel to avoid embrittlement issues.

4.3. Environmental Conditions

The motors will be installed in a heated and well-ventillated building, protected from wind and rain. Ambient temperature range: 15 - 27°C.

4.4. Terminal Boxes

Terminal boxes and cable glands rated to a minimum of IP55.

5. Testing & Inspection

An inspecting engineer from The Science and Technology Facilities Council (or an appointed representative) shall be invited to witness final testing and inspection (factory acceptance test) prior to shipping. The following tests are required:

- All pump casings are to be hydrostatically tested to 1.5 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.

- The hydraulic performance of pumps shall not be tested.

A hydrostatic test report/certificate is to accompany the pumps on delivery.

6. Packing and Carriage

Prior to transit the equipment shall be palletized or crated and suitably prepared with adequate strapping and wrapping.

If shipping from overseas, transit terms shall be DDP to 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

7. Delivery Date

Delivery is required before 21st December 2018.