High Vacuum Pumping Equipment Technical Specification

8.8.33.1 – Rev. 1

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1.0 INTRODUCTION

1.1 PURPOSE

This document describes the Canadian Light Source (CLS) specifications for ion pumps, Titanium sublimation pumps (TSP), controllers and associated high voltage cabling. This specification and any specifications, standards or procedures referenced herein are binding in full unless otherwise specified in writing by CLS staff.

1.2 SCOPE

This specification covers physical and functional requirements for all ion pumps, Titanium sublimation pumps (TSP), controllers, and high-voltage cables used at Canadian Light Source.

1.3 DEFINITIONS AND ABBREVIATIONS

All references in this document or any referenced documents to cleaning or clean components indicate Ultra-High Vacuum (UHV) cleaning.

2.0 FUNCTIONAL REQUIREMENTS

2.1 COMPATIBILITY REQUIREMENTS:

- All ion pumps currently installed at CLS are manufactured by Varian Inc. Hence, the proposed ion pumps shall be compatible and interchangeable with those manufactured by Varian.
- Overall size and weight of ion pumps shall not exceed that of Varian equivalents
- Bolt hole patterns and locations on the pump outer body for supporting the pump must be identical to Varian equivalents
- Controllers must be compatible with Varian pumps
- Pumps must be compatible with Varian controllers
- Connectors shall be identical to that of Varian Ion Pumps

2.2 GENERAL REQUIREMENTS

- All ion pumps shall be designed, fabricated, cleaned, packaged and shipped according to UHV practices described in Canadian Light Source vacuum Design Specification, 8.4.33.1 and Canadian Light Source Vacuum Component Fabrication Technical Specification, 8.8.33.4
- All materials and designs must be UHV compatible and shall be able to operate in ionizing radiation fields up to 10^6 Gy.
- Each pump shall be constructed with diode, “noble” diode or triode configuration.
- All pumps with stated nominal pumping speeds as shown below shall be provided with the following sizes:

Nominal Pumping Speed (liter/sec)	Required Conflat® Flange	L (mm)	W (mm)	H (mm) Incl. Flange
20	2.75" (NW35)	152	121	224
40	2.75" (NW35)	310	137	218
55	4.5"(NW63)	310	137	232
75	6"(NW100)	310	137	242
150	6"(NW100)	273	245	363
300	8"(NW150)	450	245	345
500	8"NW150)	450	305	525

Table 1: List of ion pumps – Nominal Speeds, Conflat® flange sizes, and maximum physical dimensions

- The proponent shall provide drawings with dimensions for all the pumps listed in Table 1.
- All measurements of ion pump pumping speeds shall be in accordance with ISO 3556-1-1992.
- The pump shall be robust enough to withstand the typical physical rigors associated with shipping, storing, placement, attachment and general operation. In addition, the connecting flange on pumps with a pumping speed less than 150 l/s shall be able to support the weight of the entire pump and attachments in any orientation.
- All pump inlet flanges shall be non-rotatable Conflat® type with clearance holes.
- There shall be four mounting holes at bottom of the pump body identical to Varian equivalents

2.3 BAKEOUT EQUIPMENT (WHEN APPLICABLE)

- The bakeout facility heater shall be suitable for a single phase, 60 Hz, 120 V supply. The power of the heater at this voltage shall be clearly stated.
- The heater shall be capable of raising the pump temperature to 300°C in 3 hours. The heater must maintain this temperature at ±50°C without a regulator.
- The design shall be such that the HV connector stays connected to the pump without damage during bakeout.
- The heater systems shall be tested for power and electrical insulation.

2.4 HIGH-VOLTAGE FEEDTHROUGH AND CABLE CONNECTION

- The high voltage feedthrough shall be mounted on a suitably sized Conflat flange.
- The feedthrough assembly shall be designed in such a way that any force placed on the connector is not transmitted to the ceramic/metal seals.

2.5 ION PUMP CONTROLLERS AND POWER SUPPLIES

- The controllers shall be capable of operating diode or triode configured pumps.
- The controllers shall be rack mountable in a standard rack 19" wide by 31.5" deep.
- The AC mains connection shall be 60 Hz, 120 V AC.
- The high voltage connections shall be on the rear panel of the controller. The open circuit voltage per output shall be 7 kV and the prospective current of a circuit per output shall be 400 mA at 7 kV.
- If required, exhausts with dust collectors shall be located at the rear of the device and the design of such system shall be the responsibility of the proponent. It shall be guaranteed that the controller will not be destroyed if the exhaust fails during operation.
- Pump controller shall be equipped with at least 2 programmable process control set point relays per pump connection. Each relay contact shall be capable of switching 3A at 24V.
- Pump controller shall have RS232 serial communications interface.
- Pump controller shall have analog outputs for each pump connection providing controller output high voltage and pump current.
- Pump controller shall have local indication capable of display pump process parameters such as output voltage, and pump current.
- The cable shall be bakeable to 250°C and have appropriate fittings at each end to facilitate connection to the pump and to the power supply.
- The cable pump connection shall be constructed in such a way that it can be securely fixed to the pump feedthrough thus preventing unintentional disconnection.
- The type of connections on both ends of the cable and the standard lengths of cable available shall be stated. The proponent shall state if the end connections can be purchased separate from the cable thus allowing the CLS to make cables.
- The power cable shall be flexible enough to be bent through small radii and pulled through conduit and cable racks where tight directional changes are required.
- CSA (SPE-1000) requirement for the controllers, line cords, HV cable, connectors, and bakeout heaters

3.0 PERFORMANCE REQUIREMENTS

- Each pump shall have a nominal pumping speed as denoted in the request for quotation where the nominal pumping speed is that for nitrogen.
- The proponent shall guarantee the pump speed versus pressure according to the following:
    1. Nominal speed
    2. From 10^{-3} Pa to 10^{-6} Pa,
    3. 50% of the nominal speed at 10^{-7} Pa,
    4. 25% of the nominal speed at 10^{-8} Pa.
- Each pump shall be guaranteed to pump nitrogen at the specified nominal pumping speed for ≥50 000 hours at a pressure of 10^{-4} Pa. During this period, no malfunction that

negatively affects pump performance shall occur and the pump speed shall not see a reduction of more than 20%.

- Each pump shall have a pumping speed for Argon that is greater than 20% of the speed for Nitrogen.
- Each pump shall be capable of starting and pumping at a maximum pressure of $5x10^{-4}$ Pa.
- Each pump shall have a guaranteed ultimate total pressure limit of $<10^{-8}$ Pa.
- The pumps should be capable of withstanding bakeout at a temperature of 300°C for 24 hours without removing magnets. No reduction in pump performance shall be observed to a maximum of 50 bakeout cycles of this magnitude. Each pump shall be baked once prior to delivery and shall have an outgassing rate of $<10^{-10}$ $Pa\cdot L\cdot s^{-1}\cdot cm^{-2}$ after subsequent cooling to 20°C.
- All pump housings shall have an ultimate leakage rate at ambient temperature after bakeout of $<10^{-8}$ $Pa\cdot l\cdot s^{-1}$.
- After bakeout, the magnetic field shall recover to within 0.1% of its initial value without mechanical damage.
- After bakeout, the pump shall be powered and the current shall decrease to <1 μA within four hours.
- The polarity and position of the magnet poles shall be clearly inscribed and visible with the bakeout system fitted to the pump. The polarity of the poles shall be the same on each size of pump.
- The fringe magnetic field of each pump shall have field integrals along the three axes and within the limits defined below, of $<2x10^{-4}$ Tesla·m for i) and $<10^{-4}$ Tesla·m for ii) and iii):
    1. In plane of flange face, along two orthogonal axes (one of which has the highest field in that plane), plus and minus 1000 mm from flange centre,
    2. as but in plane 100 mm above flange face,
    3. In direction perpendicular from flange face up to 1000 mm from flange center.

4.0 SAFETY AND ENVIRONMENTAL

All equipment shall be designed and manufactured with safety and ease of operation, handling and use as paramount concerns.

The components shall be able to withstand a relative humidity range of 0 % to 95%. The expected relative humidity limits under operation are from 25% during the winter months and a maximum of 50% during the summer months. The expected relative humidity range for components under storage will be the same as previously mentioned.

In the tunnel environment, there will be a small amount of production of radioactive air and noxious gasses. These are estimated to be:

1. For N-13,O-15, and C-11: 0.0002 Bq/cc.
2. For ozone: 5.6x108 mol/cc.
3. Nitrogen dioxide: 2.7x108 mol/cc.
4. Nitric acid: 0.8x108 mol/cc.

5.0 APPLICABLE CODES, STANDARDS AND PROCEDURES

The work shall meet the following standards. The issue of any standard shall be the issue in effect as of the tender date. Any conflicts between this specification and the referenced documents shall be brought to the attention of CLS in writing for resolution before any related action is to be taken by the proponent.

1. American Welding Society (AWS)
2. American Society for Testing and Material (ASTM)
3. American Society of Mechanical Engineers, Boiler and Pressure Vessel Code
4. American National Standards Institute (ANSI)
5. International Standards Organization (ISO)
6. CSA Canadian Electrical Code, Safety Standards for Electrical Installations, C22.1-09, 2009.

6.0 QUALITY ASSURANCE

The proponent shall implement and maintain a quality assurance program compliant with ISO9001.

The proponent shall cover all pumps, controllers and other related components by a warranty against material and manufacturing faults. The details of the warranty shall be specified to the CLS in writing for acceptance prior to the production of any pumps. The warranty shall be for a period of 2 years or more.

Proponent shall provide test and inspection procedures to the CLS for review and acceptance.

The proponent's quality assurance program shall ensure the following measurements are made and recorded:

Dimensions, tolerances and finish of all completed components

1. RGA spectra of the ion pump
2. Results of all tests and inspections

7.0 DOCUMENTATION

Each pump shall be accompanied by a test certificate that shall contain, but not be limited to the following:

1. The magnetic field shall be measured for each pump and recorded,
2. After bakeout, the final current and time to reach it shall be recorded,
3. The heater system test results for power and electrical insulation if applicable,
4. The final outgassing rate.
5. The final leakage rate.

Alternative tests may be provided by the proponent for CLS review and acceptance.

Upon receipt, the CLS shall visually inspect components, test components for mechanical accuracy and leak test some or all components to ensure compliance and that no damage has occurred during shipping. The CLS may conduct any test to ensure compliance with this specification and any referenced herein. Failure during any of the aforementioned tests shall require rectification by the proponent as part of the contract conditions. Successful completion of these inspections and tests shall be the basis for final acceptance.

The proponents shall identify any quality control procedures or tests over and above the aforementioned that would be of interest to the CLS.

7.1 RELIABILITY AND MAINTAINABILITY

The reliability and ease of maintenance of chambers and components shall be integral to any design. In addition, Pump elements shall be removable from the pump body through the use of conventional tools without cutting.

7.2 SERVICES

The power supply main connection shall be 120 V AC, 60 Hz.

The bakeout heater requires single phase, 120 V AC, 60 Hz.

In addition to any other documents or certificates referenced herein, the proponent shall provide to the CLS an operations manual. The contents of the manual shall include but are not limited to the following:

i. operating characteristics including current versus pressure specifications,
ii. installation instructions,
iii. operating instructions,
iv. maintenance instructions,
v. disassembly instructions,
vi. instructions for cleaning,
vii. instructions for part replacement,
viii. warranty statement.

8.0 REFERENCES

[1] “Technical Specification for the Supply of Ion Pumps for the ESRF”, European Synchrotron Radiation Facility high vacuum staff, (ESRF, BP 220, 38043 Grenoble Cedex, France, 1989).

[2] “Spezifikation Ionengetterpumpen und Netzgerate fur Ionenengetterpumpen fur das SLS Vakuumsystem”, Schulz, L., (Swiss Light Source, Paul Scherrer Institut, CH-5232 Villigen PSI, 1999).

[3] “Preliminary Specification for SNS Vacuum Systems Large Sputter-Ions Pumps”, Todd, R., (Brookhaven National Laboratory, Upton, New York, 2001).

[4] “ISO 404: Steel and steel products -- General technical delivery requirements”, International Standards Organization, (ISO, 1992).

[5] “ASTM E45-97e2: Standard Test Methods for Determining the Inclusion Content of Steel”, American Society For Testing and Materials, (ASTM West Conshohocken, PA, USA, 2001).