Canadian Light Source Inc.
Vacuum Component Leak Test
Technical Procedure

CLSI Document 8.7.33.2 Rev. 2

Date: 2006-03-08

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Revision History

Revision	*Date*	*Description*	*Author*
A	2000-Apr-25	Original Draft	Jason Fielden
0	2000-Aug-2	Detailed Design Review	Jason Fielden
1	2000-Sept-13	Issued for use	Jason Fielden
1A	2005-Nov-09	Detailed Design Review	Alex Sitnikov
1B	2006-Feb-23	Incorporated comments	Alex Sitnikov
2	2006-March-8	Issued for use	Alex Sitnikov

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1.0 INTRODUCTION

1.1 DOCUMENT PURPOSE

This procedure will outline preparation, precautionary measures, equipment and procedural concerns and requirements for the CLSI leak detection standard. The document applies to both the vendor and CLSI site works.

1.2 RATIONALE

A successfully completed leak test will demonstrate that the tested components comply with requirements of the Section 4.7 of this procedure. This statement shall be a basis for acceptance of the tested components after manufacturing and/or assembly for the following its application in the high or ultra-high vacuum environment.

2.0 PREPARATION

2.1 All test items shall be cleaned according to the CLSI Cleaning Technical Procedure 8.7.33.1 before undergoing any of the following procedures.

NOTE: Preliminary leak test may be performed without baking of the components.

2.2 The leak test procedure must be conducted in a designated "clean area". In this area the air shall be Class 10000 of purity or better and low humidity (<60%). That area must be remote from other operations so as to limit the potential for airborne contaminants.

2.3 Personnel shall be dressed so as to prevent dust or hair shedding and air contamination of any sort, see Handling Requirements in Section 9 of the CLSI Vacuum Component Fabrication Specification 8.8.33.4.

3.0 EQUIPMENT REQUIREMENTS

3.1 CLSI reserves the right to approve the leak detection system and the rough pumping system including all sub components in writing prior to use.

3.2 Only dry ("clean"), hydrocarbon-free (oil-free) **roughing pumps** shall be used in the pumping system. The roughing pump shall be capable of achieving an operating pressure range of 4 Pa (~ 3.0×10^{-2} Torr) or lower.

3.3 In combination with the roughing pump mentioned in the previous Section 3.2 there are three system configurations outlined below as permissible systems in order of **increasing** preference in sections 3.3.1, 3.3.2 and 3.3.3 respectively. In all cases, sensitivity of the leak detector shall be tested using a suitable calibrated leak source prior to each leak test. The leak detector unit must have a **minimum sensitivity** of 2.0 x 10^{-10} standard atm.·cc/sec of Helium (~1.5 x 10^{-10} Torr·l/s or ~2.0 x 10^{-8} Pa·l/s) per leak.

3.3.1 The item under test will be evacuated by a turbomolecular pump of suitable speed. An all metal isolation valve shall be provided between the turbomolecular pump and the item under test. This valve should preferably be connected to the rotor speed interlock of the turbomolecular pump, so that the valve closes automatically in the event of a pump failure. The total pressure as measured between the pump throat and the installed isolation valve shall be less than 6.5 x 10^{-5} Pa (~ 5.0 x 10^{-7} Torr) before the isolation valve may be opened. If the isolation valve is manual and/or not connected to the rotor speed interlock, an additional valve must be installed between the turbomolecular pump and the roughing pump for the same purpose: in case of failure of the turbomolecular pump this valve must close automatically. A conventional mass spectrometer leak detector shall be connected to the fore-vacuum region of the turbomolecular pumping set, i.e. between turbomolecular pump and backing (roughing) pump, using a suitable isolation valve. An auto vent valve fitted on most leak detectors must not be used, and shall be disabled.

3.3.2 Better accuracy will be achieved when the item under test is evacuated by a turbomolecular pump with the same configuration as in Section 3.3.1 above, but instead of a conventional leak detector a residual gas analyzer (RGA) of adequate sensitivity for the probe gas shall be used as the leak monitor. Such residual gas analyzer may be connected either directly to the item under test or to the pumping system.

NOTE: The RGA shall be certified not later then one year prior to testing with mixture of gasses Helium, Argon, Krypton and Xenon to comply with requirements in Section 3.4 below. The RGA must have a minimum sensitivity of 6.0x10 $^{-11}$ standard atm.·cc/sec any of those gasses. If the RGA is certified with an alternative mixture of gasses, this shall be submitted to CLSI for consideration. The vendor will not proceed until written approval from CLSI.

3.3.3 Great accuracy would be achieved when the item under test will be evacuated by a sputter ion pump of suitable speed connected to the system by stainless steel tubing of suitable dimensions and baked to a temperature as high as permitted, but not less then 140^{o} of Celsius for a period of at least 24 consecutive hours. The ion pump may be of diode or triode configuration and may include a titanium sublimation pump or non-evaporable getter pump. A residual gas analyzer (RGA) of adequate sensitivity for the probe gas (see Note in 3.3.2

above) shall be used as the leak monitor. It shall be connected between the item under test and the pumping system.

3.4 Residual gas analysis shall be used as a general monitor of final system cleanliness and shall be able to record over the Residual Gas Mass Spectrum range **1-200 amu**.

3.5 Stainless steel piping and/or stainless steel flexible tubing shall be used for all connections between the test item and any test equipment. Demountable joints shall use metal and/or Viton@ gaskets only. All such equipment shall have been cleaned and baked as per CLSI Cleaning Technical Procedure 8.7.33.1 to at least 250^{O}C (except joints with Viton@ gaskets) in a vacuum environment of 1.3 x10^{-4} Pa (~1.0 x 10^{-6} Torr) or less before use.

3.6 A portable valve with a fine adjustable blow nozzle, connected to a clean, dry 99,99% pure Helium supply using a long enough flexible hose shall be installed close to the tested item.

NOTE: Helium is the gas of preference for the leak detection procedure. However, other gases detectable by the leak detector may be used with prior written consent by CLSI.

3.7 An all-metal vent valve, connected to a clean, dry, 99.99% pure Nitrogen supply (Dew point < -70^{O}C), shall be installed, either on the item under test or on the pipe connecting the pumping station to the item under test.

4.0 LEAK TEST PROCEDURE AND REQUIREMENTS

4.1 Personnel conducting the test must be trained and has experience with leak detection at least one month of operating.

4.2 It is strongly recommended that the pumping system used during bake out evacuation, also be utilized for this leak test procedure.

4.3 If Section 4.2 is not applicable, the test item shall be evacuated to a pressure of 6.5 x 10^{-6} Pa (~ 5.0 x 10^{-8} Torr) or less using one of the pumping systems outlined in section 3.3.1, 3.3.2 or 3.3.3 above.

4.4 The test will not proceed until the leak detection system demonstrates the required sensitivity/accuracy, see Section 3.3 above.

4.5 Tests shall be carried out by spraying all joints, welds and surfaces with the probe gas specified in Section 3.6 above, ensuring sufficient dwell time of the gas around the surface for porosity to be detected.

Rationale: This is best achieved by enclosing the item under test in a polythene bag or tent which is pressurized with the probe gas. For larger items, areas with welds may be bagged individually.

4.6 An alternative test method like Helium "sniffing" may be used to determine the exact location of the leak if this test fails.

4.7 The HV or UHV vessel shall have a leak rate less than 1.0 $x10^{-7}$ Pa·l/s (~7.5 $x10^{-10}$ Torr·l/s). *The leak test will be declared successful if a deflection of 2% or less is observed within the first minute of the test monitor.* If any leaks are detected, CLSI will be contacted prior to any remedial work being done, with the exception of simple tightening or remaking without rework of demountable joints.

4.8 Following a successful leak test shall be repeated with the same results, to ensure that the equipment is still functioning properly.

4.9 The RGA monitoring shall meet the following:

4.9.1 The hydrocarbon contamination (Oil), defined as the sum total of all mass peaks 39, 41, 43, 55 and 57 [3], shall be less than 1% of the total pressure in the system.

4.9.2 The residual chlorinated solvent contamination, defined as the sum total of the mass peaks at mass numbers 35 and 37 [3], shall be less than 0.1% of the total pressure in the system.

4.9.3 The sum total of all masses above mass 45 shall be less 0.5% of the total pressure in the system.

4.10 The item or system after test, if necessary, shall be vented as per Section 3.7 above, upon completing of the test.

4.11 A test certificate shall indicate the completion of all of the aforementioned steps and be signed by the responsible technician. This certificate shall be sent to CLSI depending on conditions stipulated in Sections 4.9 and 4.10 of the CLSI Vacuum Component Fabrication Technical Specification 8.8.33.4.

5.0 APPLICABLE STANDARD AND PROCEDURE

The leak test of vacuum components shall meet the following specification and procedure below. The issue of any document below shall be the issue in effect as of the date of request for tender. Any conflicts between those documents shall be brought to the attention of CLSI in writing for resolution before any related action is to be taken by the vendor.

Canadian Light Source Inc. Vacuum Component Fabrication Technical Specification 8.8.33.4 Rev.1

Canadian Light Source Inc. Vacuum Component Cleaning Technical Procedure 8.7.33.1 Rev.2

6.0 REFERENCES

1. “LT/02/88/A: Vacuum Leak Test (Clean Items)”, R.J. Reid (Central Laboratory of the Research Councils Synchrotron Radiation Source at Daresbury Laboratory, Warrington, Cheshire, U.K., 1989).

2. ”Technical Specification for Vacuum Systems”, J. Khaw, editor (Stanford Linear Accelerator Center, Stanford University, Stanford California, USA, 1987.

3. “Vacuum Diagnosis with an RGA” Application Note #7, http://www.thinksrs.com/downloads/PDFs/ApplicationNotes/Vac_diag_RGA.pdf