CBI

| TITLE | IDENTIFICATION | | | |
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| | HMST1N<br>LIGO-E950066-02-B | | | |
| HELIUM MASS SPECTROMETER HOOD TEST OF BEAM TUBE CAN SECTIONS | REFERENCE NO.<br>930212 | | SHT _1_ OF _6 | |
| | OFFICE<br>RSE | | REVISION<br>2 | |
| PRODUCT<br>LIGO BEAM TUBE MODULES<br>CALIFORNIA INSTITUTE OF TECHNOLOGY | MADE BY<br>CNS | CHKD BY<br>EEB | MADE BY<br>WAC | CHKD BY<br>MLT |
| | DATE<br>3/15/94 | DATE<br>5/1/94 | DATE<br>11/7/95 | DATE<br>11/9/95 |

1.0 SCOPE:

1.1 This procedure covers the helium mass spectrometer hood leak test of each completed beam tube can section. Perform this procedure in conjunction with the current revision of procedure LIGOTP.

1.2 Perform the leak testing outlined in this procedure after the:

1.2.1 Stiffeners, bellows assembly and, when applicable, the pump port nozzle have been welded to the beam tube can section.

1.2.2 Beam tube can section has been visually inspected and any weld repairs have been made to correct excess undercut, lack of penetration and pinholes in either the can spiral welds or the stiffeners to can welds.

1.2.3 Preliminary solvent cleaning has been satisfactorily completed.

2.0 LEAK TESTING EQUIPMENT TO BE USED IN THIS PROCEDURE:

All purchased equipment used in the performance of this procedure shall be specified to be helium mass spectrometer (HMS) leak tested to $1 \times 10^{-10}$ atm. cc/sec. of helium. CBI will HMS leak test all purchased items during the initial leak test of the end seal assemblies. If a manufacturer only has the capability to HMS leak test to a lesser test sensitivity, then the manufacturer must accept the return of that item without charge if it should fail this initial leak test by CBI at this sensitivity level.

2.1 The helium mass spectrometers used to perform the leak testing outlined in this procedure shall be the Leybold Model UL400 with the optional high sensitivity of $2 \times 10^{-11}$ atm. cc/sec. of helium ($8 \times 10^{-12}$ atm. cc/sec. of air) or instrument of comparable capability.

2.2 Hood test enclosure stands. Each enclosure as shown in ER-50 shall consist of a gasketed support cradle and cover and shall be able to structurally withstand being fully evacuated. Each test enclosure stand shall contain the following:

2.2.1 A 40 KF (1 1/2"Ø) long flange installed in the middle on the top of the cover with a valve and piping to an exhaust hood for venting helium gas from the hood.

2.2.2 A 4 1/2" or 6"Ø vacuum dial gauge with a 1/4" NPT connection threaded into a 1/4"Ø NPT coupling welded into the test enclosure cover.

2.2.3 A 40 KF (1 1/2"Ø) long flange installed in the bottom portion of the test enclosure to which is connected a vacuum valve and a Leybold D65B rotary vane pump or unit of comparable or greater capacity. Use this pump for evacuating the test enclosure to about 10 torr (0.394" Hg absolute or 29.5" Hg negative gauge) before backfilling the enclosure with helium.

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2.2.4 A 40 KF (1 1/2"∅) long flange installed in the bottom portion of the test enclosure with a vacuum valve for backfilling with helium into that evacuated enclosure.

2.3 One end double seal assembly includes the following test equipment as shown on the test set-up sketch and described below.

2.3.1 A 160 K (6") ∅ nozzle with a 6"∅ ASA flanged vacuum valve to which is connected a mechanical vacuum pump unit such as a Leybold WAU2001 Roots booster backed by a DK200 rotary piston pump or unit of comparable capacity with a 6"∅ cold trap at the inlet of the booster. The pump unit connection line shall contain a valved 100 mm (4"∅) crossover line to a diffusion pump foreline. It shall also contain a tee with a 40 KF (1 1/2"∅) long flange valved for connecting the helium mass spectrometer.

2.3.2 A 500 K (20"∅) flanged port with a 20"∅ ASA flanged vacuum valve to which is mounted a flanged 20"∅ Balzer Model DIF 500A or equivalent diffusion pump. The 100 K (4"∅) foreline to this pump shall be connected through the valved crossover line to the mechanical vacuum pump unit in item 2.3.1.

**NOTE: The diffusion pumps used in this procedure shall be few units and shall never have been operated with silicone oil. Diffusion pumps will be filled with Santovac 5 pump oil. DO NOT USE SILICONE OIL FOR THIS PROCEDURE.**

2.3.3 A 40 CF-F (1 1/2"∅) long flange connection with a 40 CF-F blind for possible future use with a Residual Gas Analyzer (RGA).

2.3.4 A 40 KF (1 1/2"∅) long flange connection for an ionization gauge tube connected to a control unit. Examples are a Varian Multi-Gauge, an HPS Model 937 or equivalent unit.

2.3.5 A 25 KF (1"∅) UHV valve and a 25 KF (1"∅) long flange connection with an adapter for a thermal conductivity gauge tube connected to the control unit listed in item 2.3.4. An example is a Varian Model 531.

2.3.6 A 16 KF (5/8"∅) short flange valved connection leading from the interspace between the end assembly double seals to a mechanical vacuum pump.

2.3.7 Leybold Trivac D4B or equivalent mechanical vacuum pump for item 2.3.6.

2.4 Second end double seal assembly includes the following test equipment as shown on the test set-up sketch and described below.

2.4.1 A 500 K (20"∅) flanged port with a 20"∅ ASA flanged vacuum valve to which is mounted a 20"∅ flanged housing containing an $LN_2$ cryogenic panel with an $LN_2$ inlet and a $N_2$ outlet.

2.4.2 A 25 KF (1"∅) vacuum gate valve and a 25 KF (1"∅) long flange connection for the mechanical vacuum pump inlet line.

2.4.3 Leybold Model D25B or equivalent mechanical vacuum pump connected to item 2.4.2 with a flexible metal hose with 25 KF (1"∅) connectors for evacuating the $LN_2$ cryogenic panel housing.

2.4.4 16 KF (5/8"∅) long flange connection 1 to 5 $x10^{-10}$ atm cc/sec helium standard leak.

2.4.5 16 KF (5/8"∅) short flange valved connection leading from the interspace between the end assembly double seals to a mechanical vacuum pump.

2.4.6 Leybold Trivac D4B or equivalent mechanical vacuum pump for item 2.4.5.

2.5 All vacuum valves 2" (50mm)∅ and smaller shall be bellows stem sealed and have KF style flange connections. Any such valves facing the evacuated space of the can section shall be stainless steel.

2.6 All valves larger than 2" (50mm)∅ shall be stainless steel UHV gate valves.

2.7 All "O" rings in test equipment shall be elastomers.

3.0 PROCEDURE:

3.1 Install the beam tube can section in the test enclosure stand. Do not close top cover of the enclosure at this time. Confirm expansion joint (if present) is restrained by an installed leak test fixture.

3.2 Engage the end double seal assemblies at each end of the beam tube can section. Energize the Leybold Trivac D4B or equivalent mechanical pump at each end double seal assembly. When the pump blank-off pressure reaches about 10 millitorr or less, open the valve to the space between the double seals.

3.3 Energize the Leybold WAU2001/DK200 or equivalent vacuum pump unit with the 6"∅ gate valve at the pump inlet closed. With that system operating and blanking at an adequate absolute pressure in the very low millitorr range, open the 6"∅ gate valve between the pump unit and the beam tube can section and start evacuating the can section. Also open the 4"∅ crossover line valve to the Balzer Model DIF 500A or equivalent diffusion pump. When the absolute pressure in the beam tube can section reaches about 1000 millitorr, begin cooling the 6"∅ cold trap in front of the inlet to the mechanical vacuum pump unit.

3.4 Evacuate the 20"∅ $LN_2$ cryogenic panel housing with its mechanical backing vacuum pump. As soon as it has been evacuated to the low millitorr absolute pressure level, begin cooling the panel with $LN_2$ in preparation for operation.

3.5 When the absolute pressure in the beam tube can section reaches approximately 500 millitorr, energize the diffusion pump.

3.6 When the absolute pressure reaches approximately 75 to 50 millitorr, close the 6"∅ roughing line gate valve at the 6"∅ flanged nozzle in the end seal assembly and then open the 20"∅ gate valve in front of the diffusion pump.

3.7 When the absolute pressure in the beam tube can section reaches about $5 \times 10^{-4}$ torr and with the $LN_2$ cryogenic panel operating, open the 20"∅ gate valve to the $LN_2$ cryogenic panel mounted to the end seal assembly on the opposite end of the can section from the mechanical pump/diffusion pump systems.

3.8 Put the Leybold UL400 helium mass spectrometer or equivalent instrument into operation and calibrate (peak tune) the instrument to ensure that it meets the optimum leak testing sensitivity requirements.

3.9 When the absolute pressure in the can section reaches approximately $5 \times 10^{-6}$ torr, open the valve to the helium mass spectrometer (HMS). While monitoring the HMS sensing element absolute pressure and the can section absolute pressure, slowly close the valve to the mechanical vacuum pump unit backing the 20"∅ diffusion pump. With the HMS solely backing the diffusion pump, monitor the can section absolute pressure to ensure that it continues to drop. Should the can section absolute pressure start to increase, indicating the throughput is too large for the HMS effective pump speed and diffusion pump foreline absolute pressure, reverse the valve arrangement and continue pumping the can section with the mechanical vacuum pump unit backing the diffusion pump. When the absolute pressure in the can section has reached a lower level, try again to solely back the diffusion pump with the HMS. When this is accomplished, proceed to step 3.11.

3.10 Should the can section absolute pressure fail to reach a level where the HMS can solely handle the diffusion pump throughout and leakage is suspected , helium tracer probe the end assembly seals for leaks.

3.10.1 If either one or both of these seals indicate inleakage, isolate and vent the test system and visually inspect the seal or seals to determine the cause of the leak or leaks. Replace, repair or modify the seal or seals as necessary and repeat steps 3.2 through 3.10 as necessary until the HMS is solely backing the diffusion pump.

3.10.2 If neither of the end seals indicate inleakage, close the top cover of the test enclosure. Evacuate the enclosure to approximately 10 torr. Monitor can section absolute pressure. A significant drop in can section absolute pressure during enclosure evacuation would indicate inleakage. To verify the existence of inleakage, vent the enclosure with helium to atmospheric pressure by closing the valve to the enclosure vacuum pump and opening the valve to the helium gas supply.

3.10.3 When unacceptable leakage in the can section has been verified, evacuate the helium from the test enclosure and backfill it with air. If the verified leakage is larger than $1 \times 10^{-5}$ atm. cc/sec., open the test enclosure lid and attempt to pinpoint the location of the leak or leaks within a reasonable time by the conventional helium probe technique.

3.11 After the can section absolute pressure has gone below about $5 \times 10^{-6}$ torr and the HMS is solely backing the diffusion pump and the can section absolute pressure stabilizes or reaches a very slow rate of decrease, calibrate the test system as follows:

3.11.1 Record the HMS background signal in divisions. A division shall be based on the smallest increment on the most sensitive scale of the leak indicator meter.

3.11.2 Record the helium signal level then open the valve to the helium permeation standard leak on the seal end assembly opposite from the pump end seal assembly and allow the helium signal to stablilze. While monitoring with a stop watch, close the standard leak valve and record the clean up time and the background signal after it has stabilized. The clean up time is the response time of the system.

3.11.3 Subtract the post calibration background signal from the standard leak signal. Divide the helium leakage rate of the standard leak by the net leak indicator signal received in the test system from that system standard leak to obtain the test system sensitivity in atm. cc/sec/ division of helium.

3.11.4 The goal is to attain a test system sensitivity that will enable an operator to detect a total helium leakage rate of $2 \times 10^{-11}$ atm. cc/second. If this desired test system sensitivity cannot be attained, then the test system sensitivity that must be attained is that which will enable an operator to detect a total helium leakage rate of $1 \times 10^{-10}$ atm. cc/second. If the test system sensitivity is inadequate, the can section must either be evacuated to a lower absolute pressure that will enable it to be achieved and/or be allowed to accumulate for a sufficient length of time to achieve this required test sensitivity. This system calibration shall be repeated as necessary to establish the required absolute pressure and/or the accumulation time needed to achieve this specified system sensitivity.

3.12 After successful completion of the system calibration in step 3.11, perform the hood test of that can section as follows.

3.12.1 Evacuate the test enclosure to approximately 10 torr.

3.12.2 Close the valve to the test enclosure vacuum pump.

3.12.3 Record the test system background leak indicator signal in divisions.

3.12.4 Vent the test enclosure to atmospheric pressure with helium gas by opening the valve to the helium gas supply. Record the oxygen level in the test enclosure to demonstrate that the helium content in the test enclosure is at least 80% throughout the test period referenced in paragraph 3.12.5.

3.12.5 Wait three (3) times the measured response time from 3.11.2 established during system calibration and watch for a helium signal rise. Record the helium signal level periodically during the test and determine the leakage rate (if any) from the calibration procedure.

3.12.6 If the signal received indicates an unacceptable total leakage rate in a can section, then that leakage must be pinpointed either by repeating steps 3.10.3 and 3.10.4 or by using other more conventional HMS leak location techniques. (See Decision Tree.)

3.13 If the signal received in the established elapsed test time indicates a total helium leakage rate smaller than $1 \times 10^{-10}$ atm. cc/sec. or if no signal is received in the established elapsed test time, then the can section is acceptable.

3.14 Vent with air and seal both ends of the tube section.

4.0 <u>DOCUMENTATION</u>

See procedure LIGOTP for documentation requirements.