CBI	APPROVED $\underline{\hspace{1cm}}$ 4/7/97 CBI DATE LIGO DATE 2/25/97	IDENTIFICATION HMST3N LIGO-E950068-06-B			
TITLE HELIUM MASS SPECTROMETER HOOD TEST OF PUMP PORTS WITH VALVE		REFERENCE NO. 953570 (930212)		SHT _1_ OF _10_	
		OFFICE RSE		REVISION 6_	
PRODUCT LIGO BEAM TUBE MODULES CALIFORNIA INSTITUTE OF TECHNOLOGY		MADE BY CNS	CHKD BY EEB	MADE BY PBS	CHKD BY WAC
		DATE 3/15/94	DATE 5/1/94	DATE 4/4/97	DATE 4/7/97

1.0 SCOPE:

1.1 This procedure covers the final helium mass spectrometer hood test of each pump port flange to 10"Ø valve flange seal, the valve disk seal, the valve to type "H" pump port hardware seal and the seals in the type "H" hardware.

1.2 Perform the leak testing outlined in this procedure on the beam tube sections with pump ports after each of these applicable tube sections has:

1.2.1 Been successfully HMS leak tested in accordance with procedure HMST1N

1.2.2 Been final cleaned in accordance with procedure CL1N.

1.2.3 Had the 10"Ø UHV gate valve installed on the 10"Ø pump port.

1.2.4 Optionally, had the type "H" hardware installed on the 10"Ø UHV gate valve.

2.0 LEAK TESTING EQUIPMENT TO BE USED IN THIS PROCEDURE:

2.1 The helium mass spectrometer used to perform the leak testing outlined in this procedure shall be a Varian Model 960 T or equivalent with an optimum high sensitivity in the range of 10^{-11} atm. cc/sec of helium. All leak detectors shall be turbo pumped. Diffusion pumped units are not acceptable. See figure 1.

2.2 A disk shaped, pump port leak test plug. The pump port leak test plug shall have 1/2" NPT fittings for attachment of a helium supply line and helium vent and sampling connection. The plug is inserted into the pump port from inside of the beam tube. The plug is inserted into the port as far as possible with the tabs at 45° angle. The bolting is then tightened to compress the o-ring seal. The HMS is attached to the 40 mm valve on the type "H" hardware using a conflat to small ISO (KF or NW fitting) adapter and stainless steel flex hose. If the type "H" hardware is not going to be installed prior to the leak test, a test blind flange must be installed to the 10" valve. See drawings ER- 605 and ER-606.

2.3 A test blind flange to be installed to the 10" valve if the type "H" hardware has not been installed. See drawing ER- 605.

2.4 A standard helium calibrated leak in the range of 1 to 5 X 10^{-10} atm. cc/sec of helium

2.5 A plastic sheeting and duct tape helium hood bag. The hood is installed to cover all seals of the valve and pump port hardware.

2.6 An oxygen analyzer capable of detecting oxygen levels down to below 2.0%.

2.7 An optional external cold trap in the test line.

2.8 An optional Leybold Toss 50 or similar turbomolecular pumping station.

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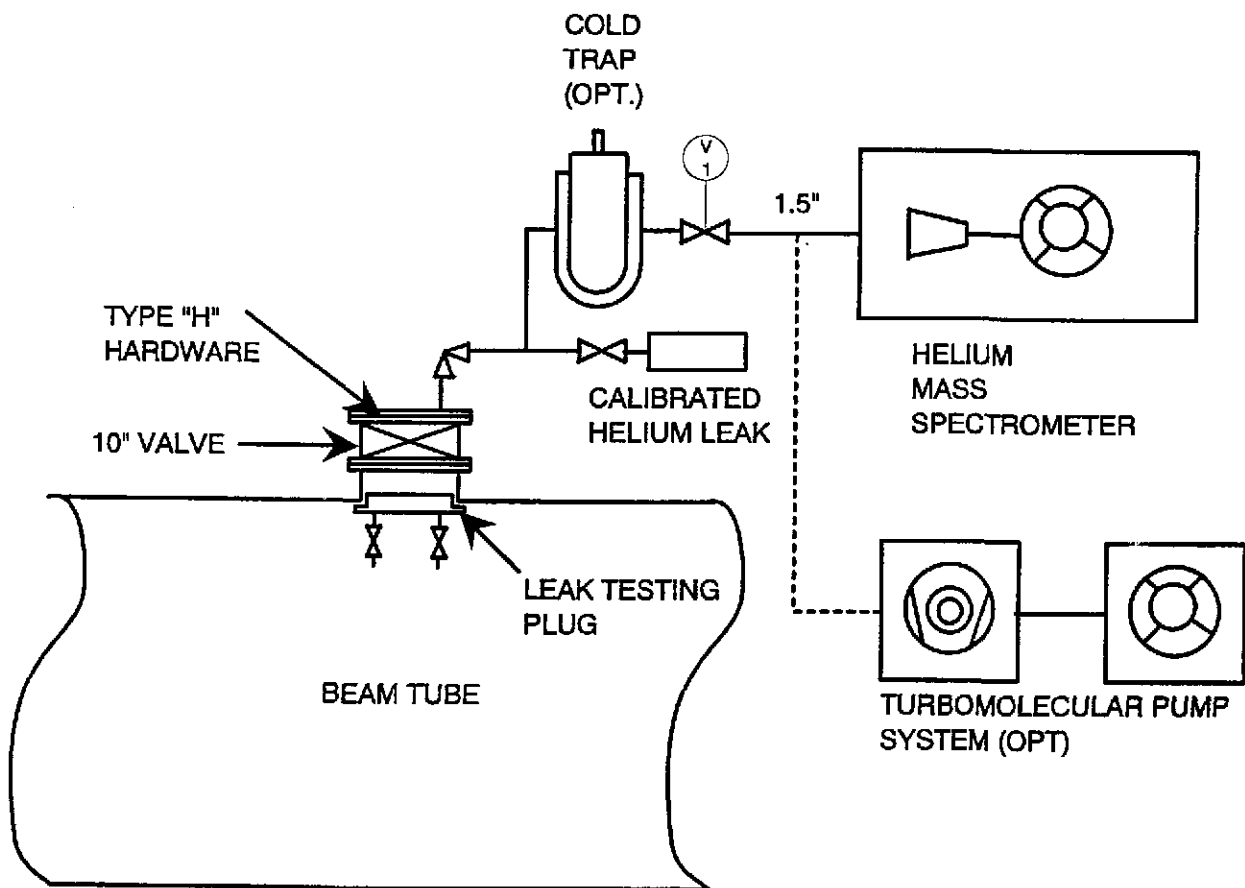| TITLE	REFERENCE NO. 953570 (930212)	SHT _2_ OF _10_	
HELIUM MASS SPECTROMETER HOOD TEST OF PUMP PORTS WITH VALVE	OFFICE RSE	REVISION 6	
	MADE BY CNS	CHKD BY EEB	MADE BY PBS	CHKD BY WAC
PRODUCT LIGO BEAM TUBE MODULES CALIFORNIA INSTITUTE OF TECHNOLOGY	DATE 3/15/94	DATE 5/1/94	DATE 4/4/97	DATE 4/7/97

Figure 1

3.0   PROCEDURE:

3.1   Clean the interior of the port nozzle, the valve, and the type "H hardware. Install the valve and the pump port hardware (if the "H" hardware is being installed at this time).

3.2   Install the pump port leak test plug, the helium mass spectrometer and the calibrated leak as shown in figure 1.

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PRODUCT LIGO BEAM TUBE MODULES CALIFORNIA INSTITUTE OF TECHNOLOGY	MADE BY CNS	CHKD BY EEB	MADE BY PBS	CHKD BY WAC
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3.3 Open the 10" $\varnothing$ valve (if it is not already in the open position).

3.4 Close the two valves in the pump port plug.

3.5 Start the HMS and calibrate as specified in the manufacturers instructions.

3.6 Vent the HMS and open the isolation valve (V1), the external calibrated leak valve, and the type "H" valve.

3.7 Evacuate the test volume with the HMS. Should the vacuum in the HMS test port stabilize at a high pressure indicating potential leakage, helium tracer probe test the port assembly to locate the leak . Repair any leaks found and repeat this procedure beginning at 3.1 above.

3.7(Alt.) Evacuate the test volume with the optional turbomolecular pumping system (TMP) and LN2 filled cold trap in lieu of the HMS described in 3.7 above. Having evacuated the system with the TMP, remove the TMP from the system, place the HMS on the system, and proceed with the test as described below.

3.8 Calibrate the test system against the 1 to 5 X 10^{-10} atm. cc/sec of helium calibrated leak:

3.8.1 Close the calibrated leak valve, and wait for at least 90 seconds before proceeding with the following steps.

3.8.2 Use the HMS zero function to "zero out" the system background.

3.8.3 Open the valve to the helium standard leak, and allow the helium signal to stabilize. Record the time required for the helium leak rate indication to reach a peak (not saturated) which is the response time.

3.8.4 Record the helium signal value (M_1) as a number of divisions on the instrument. A division shall be based on the smallest increment on the most sensitive scale of the leak rate indicator meter.

3.8.5 Close the standard leak valve and record the clean up time required for the helium leak signal to diminish to less than 33% of the M_1 signal value.

3.8.6 Record the background signal (M_2) as a number of divisions on the instrument after the background signal has stabilized. A division shall be based on the smallest increment on the most sensitive scale of the leak rate indicator meter.

3.8.7 Calculate the preliminary system sensitivity (S_1) in atm. cc/sec /div.
S_1 = (Std helium calibrated leak value) ÷ (M_1 - M_2)

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PRODUCT	MADE BY	CHKD BY	MADE BY	CHKD BY
LIGO BEAM TUBE MODULES	CNS	EEB	PBS	WAC
CALIFORNIA INSTITUTE OF TECHNOLOGY	DATE 3/15/94	DATE 5/1/94	DATE 4/4/97	DATE 4/7/97

3.8.8 If $S_1 \leq 1 \times 10^{-10}$ atm. cc/sec/div, proceed with the test. If $S_1 > 1 \times 10^{-10}$ atm. cc/sec/div, perform the necessary maintenance and corrective action to bring the system to the required sensitivity, and begin the test sequence again at step 3.8.1 above.

3.9   Leak Test Of The Port Flange To Valve CF Seal, Valve Bonnet, and (if installed) The "H" Hardware To Gate Valve CF Seal and type "H" hardware Seals

3.9.1 Install the helium hood (bag) if it is not already in place. This bag (or bags) must enclose the port to valve connection, valve body including bonnet, the valve to "H" hardware connection, and the "H" hardware seals.

3.9.2 Deflate the hood bag by hand or with a shop vacuum.

3.9.3 Backfill the hood bag with helium.

3.9.4 Sample the helium concentration in the hood bag.

3.9.5 Calculate the helium concentration sensitivity correction factor $(C_{hc}) = 100 \div \%$ Helium in hood.

3.9.6 Observe the HMS leak rate indicator meter for the larger of one (1) minute or three times the measured response time from section 3.8 above.

3.9.7 Upon completion of the observation time, record the test leak rate indicator signal (M_3) as a number of divisions on the instruments most sensitive scale.

3.9.8   If the test leak rate indicator signal (M_3), less the background signal (M_2), multiplied by the system sensitivity (S_1), corrected for helium concentration is equal to or greater than 4.9×10^{-10} atm cc/sec, go directly to section 5.0 Signal Verification and Leak Location.

If: $(M_3 - M_2) \times S_1 \times C_{hc} \geq 4.9 \times 10^{-10}$ atm cc/sec, go to section 5.0 Signal Verification and Leak Location, below.

3.9.9 If the test leak rate indicator signal (M_3), less the background signal (M_2), multiplied by the system sensitivity (S_1), corrected for helium concentration is less than 4.9×10^{-10} atm cc/sec, proceed with steps 3.12 and following.

If: $(M_3 - M_2) \times S_1 \times C_{hc} < 4.9 \times 10^{-10}$ atm cc/sec, proceed with steps 3.12 and following.

3.10   Leak Test of the 10" Gate Valve Seal

3.10.1 Close the 10" valve.

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PUMP PORTS WITH VALVE	OFFICE	REVISION	
	RSE	6_	
PRODUCT	MADE BY	CHKD BY	MADE BY	CHKD BY
LIGO BEAM TUBE MODULES	CNS	EEB	PBS	WAC
CALIFORNIA INSTITUTE OF TECHNOLOGY	DATE	DATE	DATE	DATE
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3.10.2 Using the valved inlet through the pump port test plug, fill the volume between the pump port test plug and the 10" gate valve with helium.

3.10.3 Sample the helium concentration in the volume between the plug and the valve through the vent valve in the pump port test plug and calculate the helium concentration sensitivity correction factor $(C_{hc}) = 100 \div \%$ Helium in port.

3.10.4 Observe the HMS leak rate indicator meter for at least three times the measured response time from section 3.8 above (but not less than 30 seconds).

3.10.5 Upon completion of the observation time, record the test leak rate indicator signal (M_3) as a number of divisions on the instruments most sensitive scale.

3.10.6 If the test leak rate indicator signal (M_3), less the background signal (M_2), multiplied by the system sensitivity (S_1), corrected for helium concentration is equal to or greater than 1×10^{-9} atm cc/sec, go directly to section 5.0 Signal Verification and Leak Location.

> If: $(M_3 - M_2) \times S_1 \times C_{hc} \geq 1 \times 10^{-9}$ atm cc/sec, go to section 5.0 Signal Verification and Leak Location, below.

3.10.7 If the test leak rate indicator signal (M_3), less the background signal (M_2), multiplied by the system sensitivity (S_1), corrected for helium concentration is less than 1×10^{-9} atm cc/sec, proceed with steps 3.12 and following.

> If: $(M_3 - M_2) \times S_1 \times C_{hc} < 1 \times 10^{-9}$ atm cc/sec, proceed with steps 3.12 and following.

3.11 Leak Test of The "H" Hardware To Gate Valve CF Seal and "H" Ass'y CF Seals ONLY.

3.11.1 Delete steps 3.1 through 3.4 above.

3.11.2 Close the 10" valve if it is not already closed.

3.11.3 Perform steps 3.5 through 3.8.8 above.

3.11.4 Install the helium hood (bag) if it is not already in place. This bag (or bags) must enclose the valve to "H" hardware connection, and the "H" hardware seals.

3.11.5 Deflate the hood bag by hand or with a shop vacuum.

3.11.6 Backfill the hood bag with helium.

3.11.7 Sample the helium concentration in the hood bag.

3.11.8 Calculate the helium concentration sensitivity correction factor $(C_{hc}) = 100 \div \%$ Helium in hood.

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PRODUCT LIGO BEAM TUBE MODULES CALIFORNIA INSTITUTE OF TECHNOLOGY	MADE BY CNS	CHKD BY EEB	MADE BY PBS	CHKD BY WAC
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3.11.9 Observe the HMS leak rate indicator meter for the larger of one (1) minute or three times the measured response time.

3.11.10 Upon completion of the observation time, record the test leak rate indicator signal (M_3) as a number of divisions on the instruments most sensitive scale.

3.11.11 If the test leak rate indicator signal (M_3), less the background signal (M_2), multiplied by the system sensitivity (S_1), corrected for helium concentration is equal to or greater than 1×10^{-10} atm cc/sec, go directly to section 5.0 Signal Verification and Leak Location.

If: $(M_3 - M_2) \times S_1 \times C_{hc} \geq 1 \times 10^{-10}$ atm cc/sec, go to section 5.0 Signal Verification and Leak Location, below.

3.11.12 If the test leak rate indicator signal (M_3), less the background signal (M_2), multiplied by the system sensitivity (S_1), corrected for helium concentration is less than 1×10^{-10} atm cc/sec, proceed with steps 3.12 and following.

If: $(M_3 - M_2) \times S_1 \times C_{hc} < 4.9 \times 10^{-10}$ atm cc/sec, proceed with steps 3.12 and following.

3.12   HMS Calibration Confirmation

3.12.1 Open the valve to the helium standard leak. Wait until the leak rate indication has stabilized, and record the leak rate indication signal (M_4) as a number of divisions on the instruments most sensitive scale.

3.12.2 Calculate the final system sensitivity (S_2) in atm cc/sec/div.

$$S_2 = \text{(Std helium calibrated leak value)} \div (M_4 - M_3)$$

3.12.3 There must be an agreement of 65% or more between S_1 and S_2. If there is not 65% or greater agreement, , perform the necessary maintenance and corrective action to bring the test system to the required sensitivity and begin the test sequence again at step 3.7 above. Percent agreement is equal to the lesser of S_1 or S_2 divided by the greater of S1 or S2.

% Agreement = (Lesser of S1, S2 $\div$ Greater of S1, S2) x 100

3.12.4   If, during calibration confirmation for a leak test of the GATE SEAL(ONLY), the HMS indicates a response to the system calibrated leak but a rising permeation signal prevents a valid M_4 reading (M_4 high by virtue of rising permeation signal): Isolate the HMS, and check HMS calibration against the internal standard leak in the HMS.

3.12.4.1 If the HMS response is NOT within one division of the specified value of the internal standard leak, the test of the gate seal is not valid. Perform necessary repairs, recalibrations, and retest the gate seal.

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PRODUCT LIGO BEAM TUBE MODULES CALIFORNIA INSTITUTE OF TECHNOLOGY	MADE BY CNS	CHKD BY EEB	MADE BY PBS	CHKD BY WAC
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3.12.4.2 If the HMS response is within one division of the specified value of the internal standard leak:

3.12.4.2.1 Document the observed M_4 (including permeation).

3.12.4.2.2 Place and asterisk in the report entry for S_2

3.12.4.2.3 Calculate S_F, and Q_f (paragraphs 3.13 and 3.15 below) using value S_1 instead of S_2. Document by a strike through and entry on the report equation to indicate that S_1 is used to calculate S_F.

3.12.4.2.4 Place a note in the comments section of the report to indicate the use of this alternative test calibration.

3.13   Calculate the final test sensitivity (S_F) corrected for tracer gas concentration .

$$S_F = S_2 \times C_{hc}$$

3.14   If $S_F \geq 1 \times 10^{-10}$ atm cc /sec /div, perform the necessary maintenance and corrective action to bring the system to the required sensitivity, remove the helium from the hood and begin the test sequence again at step 3.9 above.

3.15   Calculate the final observed leak rate (Q_F) corrected for helium concentration.

$$Q_F = (M_3 - M_2) \times S_F = \quad \text{atm cc/sec}$$

3.16   Assemblies which meet the following criteria for Q_F are acceptable:

Valve gate seal; $Q_f < 1 \times 10^{-9}$ atm cc/sec helium

Valve body and bonnet seal; $Q_f < 5 \times 10^{-10}$ atm cc/sec helium

Valve to port, valve to H hardware, and H hardware assembly; $Q_f < 1 \times 10^{-10}$ atm cc/sec.

Assemblies which do not meet the above listed acceptance criteria shall be repaired or replaced, and retested to this procedure.

3.17   With the 10" pump port valve remaining in the closed position, remove the pump port plug and clean the pump port and accessible areas of the valve with isopropyl alcohol and lint free cleaning towels.

3.18   Remove the HMS from the pump port hardware. Clean and replace the blank flange from the 40 mm valve outlet.

5.2.2 If the signal diminishes substantially after removal of the helium from the hood, a leak through the boundary under test is indicated. Proceed with leak location techniques.

5.3 Leak location by tracer probe technique. Perform the following while maintaining the vacuum in the port leak test box, and while monitoring the leak rate indicator of the HMS:

5.3.1 Remove the helium hood.

5.3.2 Helium tracer probe the exterior surface of the port, the valve to flange connection, the valve body, and the pump port hardware flange seals.

5.3.4 The tracer probing should proceed from the highest location (12 o'clock) downward.

5.3.5 When the leak is located, make the repairs necessary to attain the specified leak tightness

5.3.6 Document the location and repair of the leak

5.3.7 Leak test the entire port area again in accordance with this Procedure.

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	OFFICE RSE	REVISION 6

	MADE BY	CHKD BY	MADE BY	CHKD BY
PRODUCT	CNS	EEB	PBS	WAC
LIGO BEAM TUBE MODULES	DATE	DATE	DATE	DATE
CALIFORNIA INSTITUTE OF TECHNOLOGY	3/15/94	5/1/94	4/4/97	4/7/97

CBI LIGO PUMP PORT TO VALVE TEST REPORT

			_953571_	Hanford/Livingston
MODULE One)	PUMP PORT I.D.	VALVE TAG NO.	CONTRACT	LOCATION (Circle

Procedure and Rev. HMST3N Rev. _____	HMS Leak Detector (Mfg., Model and Serial Number)
System Standard Helium Leak ID	System Standard Leak Helium Leakage Rate _____ x 10^{-10} atm. cc/sec.
Basis for HMS Leak Indicator Division Unit of 2 on 10^{-11} Scale (50 divisions to a scale)	HMS Element Pressure During Test Torr

Test of (Check one)

☐ Port to valve only.   ☐ Port to valve, valve to "H", and "H" seals.   ☐ Valve gate seal

☐ Valve to "H", and "H" seals

Observed Response time: _____

M_1 (Initial Helium Signal) [_____ div on 10^{-10} scale, x 10] = _____ divisions on 10^{-11} scale

M_2 (Background Signal) [_____ div on 10^{-10} scale, x 10] = _____ divisions on 10^{-11} scale

Preliminalry system sensitivity $(S_1) = \dfrac{\text{Leakage Rate of Std. Leak}}{M_1 - M_2}$ = _____ x 10^- —— atm cc / sec / division

Helium concentration = _____ %

Helium concentration correction factor $(C_{he}) = \dfrac{100}{\% \text{ Helium}}$ = _____

M_3 (Test Helium Signal) [_____ div on 10^{-10} scale, x 10] = _____ divisions on 10^{-11} scale

M_4 (Final Calibration Signal) [_____ div on 10^{-10} scale, x 10] = _____ divisions on 10^{-11} scale

Final system sensitivity $(S_2) = \dfrac{\text{Leakage Rate of Std. Leak}}{M_4 - M_3}$ = _____ x 10^- —— atm cc / sec / division

Final Test Sensitivity (S_F)

$S_F = S_2 \times C_{he}$ = _____ x 10^- —— atm cc / sec / division

Final Observed Leakage Rate $(Q_F) = (M_3 - M_2) \times S_F$ = _____ x 10—— atm cc / sec.

Check Applicable Box(es):
☐   Weld repairs were made during leak testing and have been visually inspected and re-tested and found acceptable. See VT Report No. .
☐   No welded repairs made during leak testing.

Tests were performed and all leakage was evaluated in accordance with the referenced procedure.
Defects not repaired and retested during testing are recorded above as to location and disposition.
All other tested areas included in this report were found acceptable.

COMMENTS:_____
_____
_____

_____   _____
OPERATOR/EVALUATOR   DATE
Results reviewed by:_____ _____
                                                    DATE