CBI	IDENTIFICATION HMST5N LIGO-E950070-02-B			
TITLE HELIUM MASS SPECTROMETER HOOD TEST OF BEAM TUBE MODULES	REFERENCE NO. 930212		SHT _1_ OF _4_	
	OFFICE RSE		REVISION 2	
PRODUCT LIGO BEAM TUBE MODULES CALIFORNIA INSTITUTE OF TECHNOLOGY	MADE BY CNS	CHKD BY EEB	MADE BY WAC	CHKD BY MLT
	DATE 3/15/94	DATE 5/1/94	DATE 11/9/95	DATE 11/9/95

1.0 SCOPE:

1.1 This procedure covers the helium mass spectrometer hood test which will be performed on any beam module when the results at step 3.14 of procedure RGAPT for that beam tube module indicate it is necessary. Use this procedure in conjunction with the current revision of procedure LIGOTP.

1.2 Perform the leak testing outlined in this procedure on the applicable beam tube module after:

1.2.1 All beam tube can sections in that module have been successfully HMS leak tested in accordance with procedure HMST1N, final cleaned and erected.

1.2.2 All closing weld joints in that module have been successfully HMS leak tested in accordance with procedure HMST2N and locally cleaned.

1.2.3 All pump port assemblies with isolation valve, LN_2 pump and RGA head, cold cathode gauge head and potential HMS test connection have been successfully HMS leak tested in accordance with procedure HMST3N and locally cleaned. After this test is complete, the isolation valves are to remain in the open position.

1.2.4 The mechanical and turbomolecular vacuum pump sets for the applicable beam tube module have been installed at each end of the module.

1.2.5 The helium mass spectrometer/performance test of the applicable beam tube module has been performed in accordance with procedure RGAPT and the results indicate that this HMS hood test is necessary to meet the specification requirements of no inleakage two times the smallest detectable leak which must be smaller than $1x10^{-5}$ atm. cc/sec. but no smaller than $2x10^{-8}$ atm. cc/sec

2.0 LEAK TESTING EQUIPMENT TO BE USED IN THIS PROCEDURE:

2.1 A turbo pumped helium mass spectrometer leak detector with a sensitivity of 2×10^{-11} atm. cc/sec. of helium (8×10^{-12} atm. cc/sec. of air).

2.2 Helium standard leaks in the ranges from 10^{-6} to 10^{-8} atm. cc/sec.

2.3 Flexible stainless steel hose for connecting the helium mass spectrometer to the test system.

2.4 CBI supplied pump port hardware at each pump port.

2.6 Caltech supplied pump sets at each end of the beam tube module. The pump sets shall be provided with valves to accommodate the helium mass spectrometer(s) for the beam tube module leak test.

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2.7 6 to 10 mil polyethylene for making local hoods (bags).

2.8 2" to 4" wide duct tape for sealing local hoods (bags).

3.0 PROCEDURE:

3.1 The beam tube module is already evacuated to some very low absolute pressure from procedure RGAPT.

3.2 Record all manhours spent preparing for and executing this procedure.

3.3 Start a high volume fan blowing at 250 meters from the beam tube end toward the closest end inside the enclosure. As an alternate locate the fan in a position to preclude helium migration to untested portions of the tube. The air flow shall be sufficient to prevent excessive helium migration. Smoke or powder generators should not be used to study air flow direction and currents.

3.4 Begin HMS tracer probe testing at the end of the beam tube module at the end farthest downwind away from the fan.

3.5 Install a 10^{-8} atm. cc/sec. range permeation helium standard leak on pump port hardware assembly in the 250 meter (820 foot) segment of beam tube module to be helium tracer probe tested.

3.6 Connect the HMS behind the pump set turbomolecular pump at the end of the beam tube module farthest from the high volume fan. With the HMS backing as much of the turbomolecular pump throughput as possible, calibrate the test system as follows:

3.6.1 Record the HMS stabilized background signal in divisions. Then open the valve to the standard leak. Record both the response time and HMS leak indicator signal in divisions.

3.6.2 Close the valve to the standard leak. Record the HMS clean-up time and background signal in divisions.

3.6.3 Divide the helium leakage rate of the standard leak by the standard leak indicator HMS signal minus the background signal after clean-up. This is the sensitivity of the test system *in atm cc/sec.* of helium per division.

3.6.4 If a readable signal is not detected on the HMS leak indicator within a reasonable time, close the valve to the permeation standard leak. Replace that standard leak with the

adjustable standard leak set to a leakage rate in the 10^{-6} to 10^{-7} atm. cc/sec. range and repeat steps 3.6.1 through 3.6.3.

3.7 With the doors in the enclosure at the pump port open in the segment, tracer probe all welds and suspect areas with helium starting at the end of the 250 meter (820 foot) long section of beam tube module farthest from the fan.

3.8 Continuously monitor the oxygen level in the tunnel between the beam tube module and the weather cover to ensure safe levels of oxygen in this space.

3.9 Monitor the HMS leak indicator for a period of time equal to the response time unless that is extremely long. If that is the case, wait for a period of time equal to the time when the standard leak signal just started to increase steadily plus five (5) minutes.

3.10 If no leak indicator signal above the background signal is received within the time established in step 3.6.1, that 250 meter (820 foot) section of beam tube shall be considered satisfactory.

3.11 If a leak indicator signal above background is received, then unacceptable leakage has been detected. Purge the 250 meter (820 foot) long space in the weather cover with air until approximately three (3) volumes or more have passed through that space and the HMS leak indicator signal has started to clean-up. If the clean-up is going to take an excessively long time, partially vent the beam tube with nitrogen gas and re-evacuate that system. Repeat this process as necessary to reduce the HMS leak indicator background signal to a level on the most sensitive scale of the instrument. System vent piping shall be cleaned and dried and inspected to prevent particulate and condensation contamination.

3.12 If leakage is indicated, visually inspect all welds in that 250 meter (820 foot) section of beam tube. Revisit all testing and welding logs to try and find a clue as to the approximate location of the leak(s).

3.13 If any suspect area or areas are found in step 3.12, HMS tracer probe test those area or areas first. If none are found, methodically HMS tracer probe test all welds and suspicious areas detected visually in that section of beam tube. Start at the end farthest from the fan and work toward the opposite end of that segment.

3.14 Mark and record any leak (s) detected. Temporarily seal these leaks by covering them with a piece of polyethylene and sealing the polyethylene to the beam tube with sealing compound such as electrical putty.

3.15 If the RGA signature analysis still indicates unacceptable leakage, two times the smallest detectable leak which must be smaller than 1×10^{-5} atm. cc/sec. but no smaller than 2×10^{-8} atm. cc/sec., prepare to leak test the next 250M and move the fan 250 meters further away from the initial end. As an alternate locate the fan in a position to preclude helium migration to untested

portions of the tube. The air flow shall be sufficient to prevent excessive helium migration. Smoke or powder generators should not be used to study air flow direction and currents.

3.16 Then repeat steps 3.3 through 3.14.

3.17 Repeat this cycle until enough detected leaks have been temporarily sealed to reduce the leakage rate of the beam tube module to an acceptable level of two times the smallest detectable leak which must be smaller than $1x10^{-5}$ atm. cc/sec. but no smaller than $2x10^{-8}$ atm. cc/sec.

3.18 When sufficient leakage has been detected and pinpointed or the entire beam tube module has been HMS tracer probe tested per steps 3.3 through 3.14, evaluate the available repair procedures and repair the tube under vacuum or vent the beam tube module with dry nitrogen gas and repair all detected leaks. System vent piping shall be cleaned and dried and inspected to prevent particulate and condensation contamination.

3.19 Re-evacuate the beam tube module and retest all repaired areas. If any unacceptable leaks still exist after being repaired, repair those leaks and re-evacuate and retest those repairs. Repeat this process as necessary. System vent piping shall be cleaned and dried and inspected to prevent particulate and condensation contamination.

3.20 If steps 3.3 through 3.19 do not produce a total leakage rate of less than two times the smallest detectable leak which must be smaller than $1x10^{-5}$ atm. cc/sec. but no smaller than $2x10^{-8}$ atm. cc/sec., as indicated by the RGA signature analysis, in lieu of repeating the helium tracer probe test, enclose each 250 meter (82 foot) segment of the beam tube module in a polyethylene hood (bag) and repeat steps 3.3 through 3.19 using the helium hood technique.

4.0 DOCUMENTATION:

Document in accordance with item 5.0 of procedure LIGOTP.