IDENTIFICATION			
HMST5N			

TITLE	REFERENCE NO.			
HELIUM MASS SPECTROMETER HOOD TEST OF BEAM TUBE MODULES	930212		SHT _1_ OF _6_	
	OFFICE		REVISION	
	RSE		1	
PRODUCT	MADE BY	CHKD BY	MADE BY	CHKD BY
LIGO BEAM TUBE MODULES	CNS	EEB	EEB	MLT
CALIFORNIA INSTITUTE OF TECHNOLOGY	DATE	DATE	DATE	DATE
	3/15/94	5/1/94	5/22/94	7/1/94

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 3.20 of procedure HMST4N 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 HMST4N and the results, either before and/or after the beam tube module bake out, indicate that this HMS hood test is necessary to meet the specification requirements of no inleakage equal to or larger than 1×10^{-9} 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^{-12} atm. cc/sec. of helium (8×10^{-13} atm. cc/sec. of air).

2.2 Adjustable helium standard leak that will span the leakage rate ranges from 10^{-5} to 10^{-7} atm. cc/sec.

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

2.4 Caltech supplied LN_2 pump at each module pump port.

2.5 Caltech supplied RGA instrument at each module pump port with a minimum amu mass range of 1 - 100.

2.6 Caltech supplied pump sets at each end of the beam tube module. They shall consist of a 100 l/s mechanical pump backing a 2200 l/s turbomolecular pump. The pump sets shall be provided with valves at each end of the beam tube module to accommodate the helium mass spectrometer(s) for the beam tube module leak test.

2.7 IBM compatible 486 PC with a DAS 1402 high speed board, STC-37 DAS 1400 terminal interface and Labtech notebook 7.2 software data acquisition program with printer.

2.8 Seven (7) HPS or equivalent cold cathode gauge heads.

2.9 Three (3) HPS Model 937 or equivalent gauge tube controllers.

2.10 6 to 10 mil polyethylene for making local hoods (bags).

2.11 2" to 4" wide duct tape for sealing local hoods (bags).

3.0 <u>PROCEDURE</u>:

3.1 The beam tube module is already evacuated to some very low absolute pressure from procedure HMST4N.

3.2 Connect the high speed data acquisition system to the HPS model 937 or equivalent gauge tube controllers.

3.3 Close the isolation valves between the pump sets and the beam tube module. Conduct a blank-off of the 100 l/s mechanical vacuum pump and 2200 l/s turbomolecular pump set. When they are satisfactory, re-continue evacuating the beam tube module.

3.4 Should the absolute pressure in the beam tube module stop decreasing (plateau) in the 10^{-5} to 10^{-6} torr range:

3.4.1 Isolate the vacuum pump sets at both ends of the beam tube module. At the same instant, energize the high speed data acquisition system. The timing of these three events must be closely coordinated due to the limited memory space of the PC. These high speed pressure change plots should reveal the location of the leak within a few meters.

3.4.2 After sufficient data has been recorded (less than a minute), open the valve(s) to the beam tube module pump sets.

3.4.3 Analyze the high speed acquired pressure rise data for an indication of the approximate location(s) of the leakage problem(s) along the axis of the beam tube module.

3.4.4 Re-calibrate (peak tune) the helium mass spectrometer (HMS).

3.4.5 If this procedure is being performed after the module bake-out, remove the insulation in the area or areas indicated in step 3.4.3.

3.4.6 Throttle the HMS into the roughing line behind the turbomolecular pump nearest the indicated leak area or areas. Isolate the mechanical unit of that pump set from the system. Isolate the other pump set from the module.

3.4.7 Hood test the area or areas revealed in step 3.4.3. Continue to reduce the area of the hood until the leak(s) have been pinpointed. Mark all area or areas of pinpointed leakage.

3.4.8 Isolate the HMS and pump sets from the system, vent the system and repair all pinpointed leakage areas and re-evacuate the beam tube module.

3.4.9 Repeat all steps of item 3.4 until this problem is resolved.

3.5 While continuing to evacuate the beam tube module, monitor with the RGA the following Caltech suggested system atomic mass numbers to obtain a signature analysis of the system gases. These amu values are 2, 12, 14, 15, 17, 18, 28, 32, 39, 40, 41, 42, 43, 44, 51, 52, 55 and 57.

3.6 As long as the system absolute pressure continues to decrease, continue to pump and monitor with the RGA to determine if the signature analysis indicates any significant inleakage.

3.7 When the beam tube module absolute pressure reaches a plateau at a higher absolute pressure level than is desired either before or after the bake-out and the RGA signature analysis indicate unacceptable inleakage of 1×10^{-9} atm. cc/sec. or larger, continue with the remaining steps of this procedure.

3.8 Start a high volume fan blowing from one end of the beam tube module toward the other end inside the weather cover.

3.9 Begin HMS tracer probe testing at the end of the beam tube module at the end farthest downwind away from the fan. If this step is after bake-out, remove the insulation from this first 250 meter (820 foot) section to be HMS tracer probe tested.

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

3.11 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:

3.11.1 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.

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

3.11.3 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 with a division being a unit on the most sensitive scale of the HMS.

3.11.4 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 3.11.1 through 3.11.3.

3.12 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.

3.13 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.

3.14 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.

3.15 If no leak indicator signal above the background signal is received within the time established in step 3.11.1, that 250 meter (820 foot) section of beam tube shall be considered satisfactory.

3.16 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 venting shall be controlled from the standpoint of particulate and condensation concerns.

3.17 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).

3.18 If any suspect area or areas are found in step 3.17, 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.

3.19 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.

3.20 If the RGA signature analysis still indicates unaccep-table leakage in excess of 1×10^{-9} atm. cc/sec., remove the insulation from the next 250 meter (820 feet) segment of beam tube closer to the fan.

3.21 Then repeat steps 3.8 through 3.19.

3.22 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 less than 1×10^{-9} atm. cc/sec.

3.23 When sufficient leakage has been detected and pinpointed or the entire beam tube module has been HMS tracer probe tested per steps 3.8 through 3.19, vent the beam tube module and repair all detected leaks.* System venting shall be controlled from the standpoint of particulate and condensation concerns.

*Guidelines for venting and the repair of leaks is as follows.

a. Venting shall be done immediately if the cause of the leak appears to compromise the structural stability of the tube (cracks, etc.).
b. System venting shall be controlled from the standpoint of particulate and condensation concerns.
c. The tube must be vented if welidng is to be done on the tube wall.

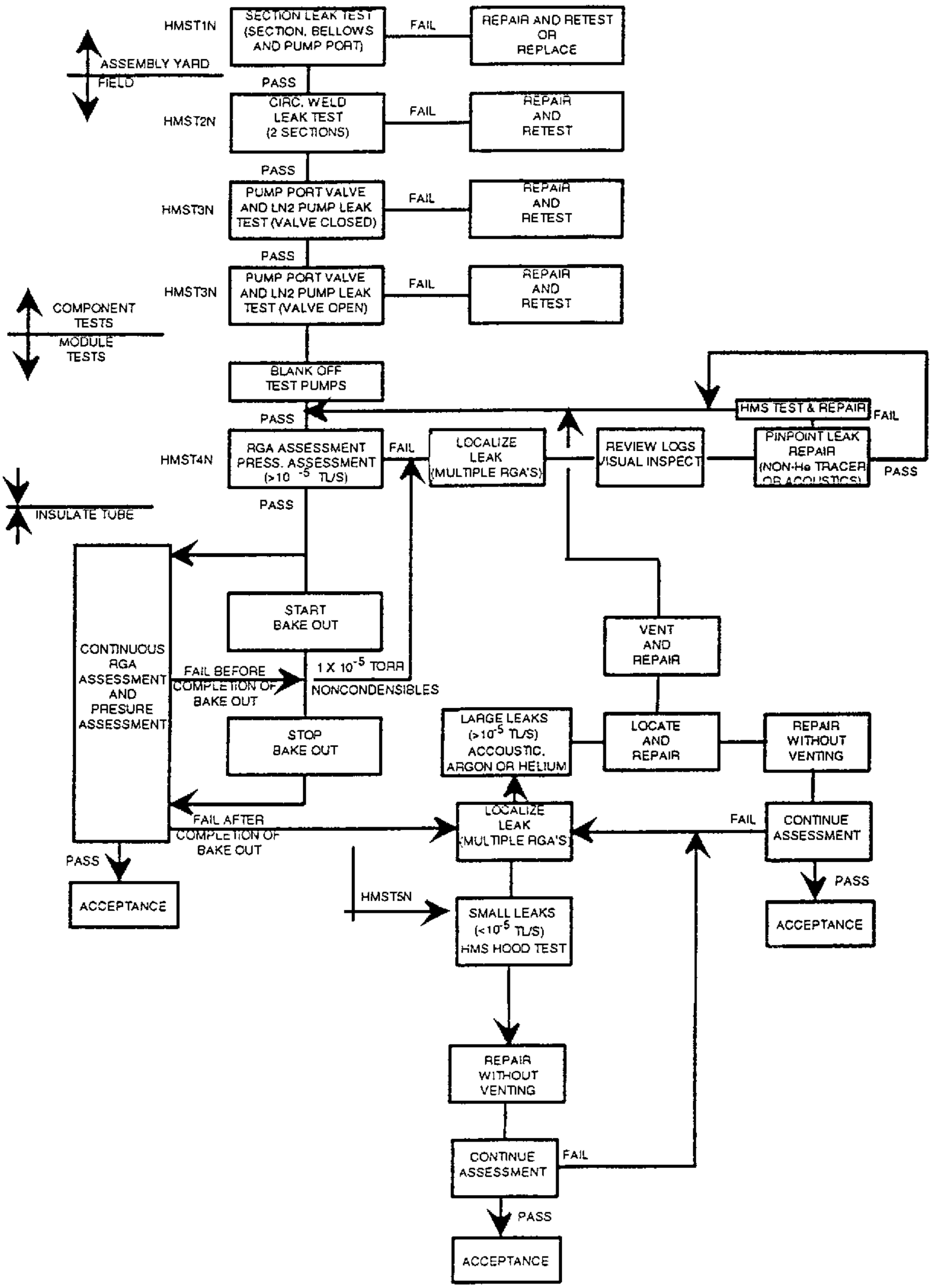
3.24 Re-evacuate the beam tube module and retest all repaired areas. If any unacceptable leaks still exist after being repaired, vent the system, repair those leaks and re-evacuate and retest those repairs. Repeat this process as necessary. System venting shall be controlled from the standpoint of particulate and condensation concerns.

3.25 If steps 3.8 through 3.24 do not produce a total leakage rate of less than 1×10^{-9} 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 3.8 through 3.24 using the helium hood technique.

4.0 <u>DOCUMENTATION</u>:

Document in accordance with item 5.0 of procedure LIGOTP.

LEAK DETECTION DECISION TREE



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