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TITLE RGA PERFORMANCE TEST OF BEAM TUBE MODULES PRODUCT LIGO BEAM TUBE MODULES CALIFORNIA INSTITUTE OF TECHNOLOGY	IDENTIFICATION RGAPT LIGO-E950069-01-B			
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1.0 SCOPE:

1.1 This procedure covers the residual gas analyzer/helium mass spectrometer/performance test of each of the beam modules. Use this procedure in conjunction with the current revision of procedure LIGOTP.

1.2 Perform the sequence 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 have been successfully HMS leak tested in accordance with procedure HMST3N and locally cleaned

1.2.4 The vacuum pump sets for the applicable beam tube module have been installed.

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^{-13} atm. cc/sec. of air).

2.2 Flexible stainless steel hose with 40 KF (1 1/2"∅) fittings for connecting the helium mass spectrometer to the test system.

2.3 Nine sets of pump port hardware.

2.4 Caltech supplied vacuum pump sets at both ends of each beam tube module.

2.5 Ultrasonic leak detector such as a model UF60 by Ultrasonics of Florida.

2.6 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.

3.0 PROCEDURE:

3.1 All 10"∅ pump port isolation valves shall be in the open position.

3.2 Visually inspect the length of the beam tube module to be final tested.

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3.0 PROCEDURE:

3.1 All 10"Ø pump port isolation valves shall be in the open position.

3.2 Visually inspect the length of the beam tube module to be final tested.

3.3 Check-off each item on the checklist as it is inspected and found satisfactory during the walkdown.

3.4 Start and calibrate (peak tune) the helium mass spectrometer (HMS).

3.5 Conduct a blank-off and a HMS tracer probe test of the 100 l/s mechanical vacuum pump and 2200 l/s turbomolecular pump sets located at each end of each beam tube module. When both the blank-off and HMS tracer probe test results are satisfactory, begin evacuating the beam tube module with both roughing pump sets.

3.6 Compare the system absolute pressure during pump down against a prepared theoretical pump down curve. Any time the actual pump down curve starts to vary significantly from the theoretical pump down curve, check all mechanical pump oil levels and condition of the oil for excess moisture and the blank-off pressures for the entire pump set systems. Continue to plot absolute pressure versus time on semi-log paper during the entire pump down and test.

3.7 When the absolute pressure in the beam tube module reaches approximately 100 millitorr, energize the two Caltech supplied turbomolecular pump skids and all nine LN2 traps supplied with the pump port hardware.

3.8 Should the absolute pressure in the beam tube module stop decreasing before it reaches the level of 100 millitorr, indicating either gross leakage or overlooked internal contamination, repeat steps 3.2 and 3.3.

3.8.1 If any obvious problem item such as physical damage is discovered during the repeat walkdown checklist inspection of 3.2 and 3.3, scan the area with an ultrasonic leak detector. If leakage is indicated and pinpointed, isolate the vacuum pump sets, vent the system with nitrogen, repair and/or correct the problem and start over at step 3.5. System vent piping shall be cleaned and dried and inspected to prevent particulate and condensation contamination.

3.8.2 If no leakage is detected, review all can section final test reports/logs/PC entries and all closing weld joint test reports/logs and PC entries for statements or data that reveals potential leakage problem areas or internal contamination previously overlooked. List all potential problem areas revealed by these logs or reports.

3.8.3 Walk the beam tube module in all these potential problem areas with an ultrasonic leak detector to attempt to detect and pinpoint the location of the gross leak. If leakage is detected and pinpointed, record the location. When all areas are ultrasonically leak tested, isolate the vacuum pumps, vent the system, repair and/or correct the problem(s) and start over at step 3.5. System venting shall be controlled from the standpoint of particulate and condensation concerns.

3.8.4 If gross leakage still exists, repeat all steps of item 3.8 using acetone while monitoring for rapid momentary pressure changes on the absolute pressure gauges.

3.8.5 Repeat these item 3.8 steps until gross leakage has been eliminated.

3.9 Calibrate one RGA and demonstrate sensitivity to an intentional air leak.

3.10 While continuing to evacuate the beam tube module, monitor with an 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. The beam tube contractor shall calculate the indicated air leakage rate for air signature analysis results.

3.11 If at this step of the procedure the RGA signature analysis indicates unacceptable leakage 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., proceed as follows:

3.11.1 Calibrate each of the RGA's and conduct a pressure assessment of the beam tube module using the RGA readouts at each of the pump ports to attempt to localize the area of the leakage. This technique assumes a single dominant leak, and must be repeated after location and sealing to find the next smaller leak. The average tube temperature must not change more than 10°C during the course of the leak localization procedures.

3.11.1.1 With both pump sets pumping on the beam tube module, allow three hours for stabilization and then simultaneously readout the nitrogen partial pressure at each RGA..

3.11.1.2 Isolate the pump set on one end of the module. Allow three hours for stabilization and then simultaneously readout the nitrogen partial pressure at each RGA. Repeat this with end pumping conditions reversed.

3.11.1.3 Use the 27 sets of RGA data (three tests for each of the nine RGA's) and input this data into the leak localization software. The software may require a number of iterations before the location of the leak(s) can be accurately predicted.

3.11.1.4 If steps 3.11.1.1 through 3.11.1.4 reveals the approximate location of the leak, proceed to step 3.12.

3.12 Review the log history of beam tube sections in the suspect area (100 ft on either side of the locations (s) indicated by the leak localization software) for prior problems. Visually inspect the area of the approximate leak location and use helium bagging techniques to detect and pinpoint the exact source of the leakage within the 200 ft area.

3.12.1 If the leak is in a mechanical connection such as a flange seal which cannot be temporarily isolated from the system but may be repaired without entry into the beam tube module, vent the system with nitrogen gas, repair or replace the cause of the leak and re-evacuate the system. System venting shall be controlled from the standpoint of particulate and condensation concerns.

3.12.2 If the leak is a hole or crack in a weld which is not jeopardizing structural integrity, cover the leak area with a piece of plastic or aluminum foil and apply sealing compound around the edge of the plastic or foil to isolate the leak from the system.

3.12.3 If the leak is the result of a crack or damage which could be jeopardizing the structural integrity of the beam tube module and the beam tube would have to be entered to either make the repair or to locally test the repair, vent the system with air. After the cause of the leak has been repaired, re-evacuate the system. System venting shall be controlled from the standpoint of particulate and condensation concerns.

3.13 When the beam tube module RGA air signature analysis indicates leakage of 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, the leakage rate of the leak testing would now be complete and the module would now be ready for bake out by Caltech..

3.14 If all procedure steps have been performed and the system will not evacuate to a sufficiently low absolute pressure level and the RGA signature analysis still indicates unacceptable inleakage of 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, perform a HMS hood test of the beam tube module in accordance with procedure HMST5N. Notify the LIGO team that the leak testing is proceeding beyond the ± 100 ft area.

4.0 <u>DOCUMENTATION</u>:

Document in accordance with item 5.0 of procedure LIGOTP.