



IDENTIFICATION			
EQT			
LIGO-E950102-01-B			
REFERENCE NO.		SHT 1 OF 6	
OFFICE		REVISION	
PSE		1	
MADE BY	CHKD BY	MADE BY	CHKD BY
VFG	MLT	VFG	MLT
DATE	DATE	DATE	DATE
8/29/95	8/30/95	11/8/95	11/8/95

TITLE	EQUIPMENT QUALIFICATION TEST
PRODUCT	LIGO BEAM TUBE MODULES CALIFORNIA INSTITUTE OF TECHNOLOGY

**1.0 PURPOSE:**

This procedure covers the steps required to demonstrate that the fabrication and installation equipment functions in the manner it was intended.

**2.0 EQUIPMENT COVERED:**

2.1 Fabrication:

- Tube mill and associated welding equipment.
- Tube end preparation equipment.
- Tube section nitrogen purge equipment.
- Stiffener attachment welding equipment.
- Pump port purge equipment.
- Circumferential seam purge and welding equipment.
- Leak testing equipment.
- Cleaning equipment.

2.2 Installation:

- Clean/Dry air supply system (BDF System)
- End clean room.
- Seam welding clean room.
- Circumferential seam purge and welding equipment.
- Circumferential seam leak testing equipment.
- Pump port valve leak testing equipment.

**APPROVED**

*Marty Bellini* 11/30/95  
CBI DATE

*Sam K. Jones* 12/4/95  
CALTECH DATE

**3.0 FABRICATION EQUIPMENT:**

3.1 In order to demonstrate that the equipment involved with the tube manufacturing, assembly, leak checking, and cleaning processes function as intended, produce a prototype tube approximately 65 feet long final length and take it through each of the processes for the equipment listed in Section 2.1 above. The prototype tube section shall contain a circumferential seam and a coil splice.



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**3.2 Tube Section Manufacturing:**

**3.2.1 Tube Section Manufacturing at the Mill Vendor Facility:** Produce a total length of approximately 100 feet of spiral welded tube section. During the spiral forming and welding, observe the following items, verifying they were accomplished in accordance with C-BT-CO as applicable:

- Seam alignment and fit prior to welding.
- Welding appearance, including weld penetration by checking the cut cross section.
- Tube outside circumference.

**3.2.2 Tube Section Manufacturing at the Site:** Produce approximately 20 feet of spiral welded tube section, observing the following items, verifying they were accomplished in accordance with C-BT-CO as applicable:

- Seam alignment and fit prior to welding.
- Welding appearance, including weld penetration by checking the cut cross section.
- Tube outside circumference.

**3.2.3** Using sections of the spiral welded tube produced in sections 3.2.1 and 3.2.2 above, make two lengths of tube totaling 65 feet to be used for the balance of the equipment qualification testing.

**3.3 Tube End Preparation:** Prepare the ends of both tube sections, observing the following items, verifying they were accomplished in accordance with C-BT-CO as applicable:

- Final end finish.
- End plane flatness and perpendicularity.
- Expanded end circumference.

**3.4 Stiffener Attachment:** Install and connect the nitrogen purge equipment. Fit and weld vacuum stiffeners to the prototype tube sections to allow the prototype



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tube section to be evacuated, observing the following items, verifying they were accomplished in accordance with FP STIFFENER as applicable:

- Performance of the nitrogen purge equipment.
- Fitup of the stiffener to tube.
- Appearance and positioning of the weld of the stiffeners to tube.

3.5 Pump Port Purge: Position the purge box against the inner surface of the prototype tube and initiate a purge, observing the following items, verifying they were achieved in accordance with FP PUMPPORT as applicable:

- Seal of the purge box to the tube.
- That a purge is obtained.

3.6 Circumferential Seams: In order to demonstrate the welding of the expansion joints to the tube, fit and weld the two sections of tube together creating a circumferential seam in the prototype tube, observing the following items, verifying they were accomplished in accordance with FP CIRCUMFERENTIAL as applicable:

- Seam alignment and fit prior to welding.
- Performance of the purge equipment.
- Appearance of the final weld.

3.7 Leak Testing: Place the prototype tube section into the leak testing equipment and draw a vacuum to the same level as required during actual leak testing, observing the following items, verifying they were achieved in accordance with HMST1N as applicable:

- Fit and performance of the end sealing caps.
- Operation of the leak test hoods.
- Operation of the vacuum equipment.
- Leak tightness of the pumping system.
- Leak rate sensitivity.



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The leak tightness of this prototype tube section will be noted, and leaks identified, if possible with reasonable efforts. As it is not a production tube section, additional time to repair any leaks are not necessary.

3.8 Cleaning: Conduct a pass of the cleaning equipment inside the tube, observing the following items, verifying they were accomplished in accordance with CL4 as applicable:

- Coverage of entire circumference of tube.
- Continuous operation of the cleaning apparatus.
- Volume of cleaning solution applied.
- Temperature of tube wall during cleaning.

The effectiveness of the cleaning will be checked by an FTIR analysis on the prototype tube.

#### 4.0 INSTALLATION EQUIPMENT

4.1 In order to demonstrate that the equipment involved with the tube installation functions as intended, place the prototype tube section produced during the fabrication equipment check-out, on temporary supports at the mid-station in the approximate location as the actual beam tube. Then perform the following steps to demonstrate that the equipment referenced in Section 2.2 above functions as intended.

4.2 BDF System: Connect the BDF system to a temporary nozzle in the prototype tube section and run the system, observing the following items, verifying they were achieved in accordance with BDF-1 as applicable:

- Quantity of air entering the tube section is sufficient.
- That the air is clean and dry.

4.3 End Clean Room: Verify the end clean rooms are in accordance with CRSPEC. Position an end clean room over each end of the prototype tube section. Put the seals in place, observing the following items, verifying they were achieved in accordance with CCP-1 and CRSPEC as applicable:



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- The integrity of the clean room isolation from outside atmosphere.
  - Positive air flow from the BDF system and out of the clean room, including during entry into the clean room.
  - Proper balancing from the clean room make up air and the BDF system.
- 4.4 Portable Weld Enclosure: Place one of the portable weld enclosures over the prototype tube section. Put all items in position to seal the weld area as it will be during the actual installation process, observing the following items, verifying they were achieved in accordance with CCP-1 as applicable:
- The integrity of the weld area isolation from outside atmosphere.
  - A positive air flow from out of the weld enclosure, including during entry or exit of the weld enclosure.
- 4.5 Circumferential Seam Purge and Welding Equipment: The operation of the circumferential seam purge and welding equipment was demonstrated during the fabrication equipment test, and this type of equipment and process will have been in use for some time in actual fabrication, therefore no further demonstration is necessary.
- 4.6 Circumferential Seam Leak Testing: Place the leak testing equipment over the prototype tube section. Connect the vacuum equipment and draw a vacuum to the same level as required during the actual testing, observing the following items, verifying they were achieved in accordance with HMST2N as applicable:
- Fit and seal of the test ring to the tube.
  - Operation of the vacuum equipment.
  - Leak rate sensitivity.
- 4.7 Pump Port Valve Leak Testing: Position the leak test box against the outer surface of the prototype tube. Connect the vacuum equipment and draw a vacuum to the same level as required during the actual leak testing, observing the following items, verifying they were achieved in accordance with HMST3N as applicable:



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- Fit and seal of the leak test box to the tube.
- Operation of the vacuum equipment.
- Leak rate sensitivity.