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TITLE CONTAMINATION CONTROL FOR CONSTRUCTION ACTIVITIES DURING BEAM TUBE INSTALLATION PRODUCT LIGO BEAM TUBE MODULES CALIFORNIA INSTITUTE OF TECHNOLOGY	IDENTIFICATION			
	CCP-1			
	LIGO-E950063-04-B			
	REFERENCE NO.		SHT 1 OF 6	
	953570			
OFFICE		REVISION		
LIGO		4		
MADE BY	CHKD BY	MADE BY	CHKD BY	
SDH	KHF	RER	VFG	
DATE	DATE	DATE	DATE	
7/25/94	8/4/94	5/7/98	5/8/98	

1.0 SCOPE:

This procedure outlines and defines the plan to limit contamination of the Beam Tube Module inner surfaces during construction. The contamination of the Beam Tube inner surfaces is considered to be of three major sources:

- 1) **Particle**, ie:, dust, sand, process emissions (grinding dust, etc.)
- 2) **Moisture**, ie:, rain, snow, hydrocarbons, process emissions (spray, solvent excess, etc.)
- 3) **Biologic**, ie, insects, birds, varmints, etc.

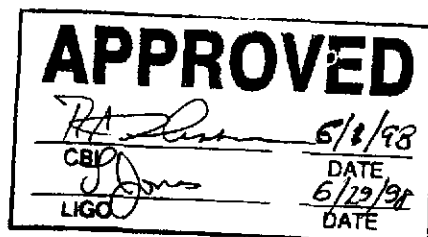
The two possible means of contamination for the above items are considered *resident* (existing on component surfaces), and *air-borne* (contaminants blown or flying onto component surfaces). This procedure provides steps to limit exposure to each of these sources during site construction and installation activities.

2.0 PERSONNEL:

- 2.1 Experienced personnel shall perform, or supervise, the cleaning activities addressed in this procedure.
- 2.2 Personnel entering the Clean Room and/or the controlled area of the beam tube access penetration and interior during final assembly operations shall meet the conditions and clothing requirements of LIGO Procedure, CRWA-1.
- 2.3 This procedure shall be reviewed, with all personnel whose duties could affect the cleanliness of the beam tube inner surface, at the start of beam tube installation and with new personnel as they are added to the workforce.

3.0 REFERENCES:

The cleaning methods and parameters are based on the data contained in the following references:





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- 1) Summary of concepts and Reference Design for a Laser Gravitational-Wave Observatory, California Institute of Technology (Caltech); Feb-92.
- 2) Project Safety Manual, LIGPSM.
- 3) LIGO Procedure, CL3N "Final Cleaning and Inspection of LIGO Beam Tube Module Inner Surfaces"
- 4) LIGO Procedure, CRTSM; "Clean Room Transporting, Storage and Maintenance Procedure"
- 5) LIGO Procedure, BDF1; "Positive Blower/Dryer/Filtration System (BDF) Installation and Maintenance"
- 6) LIGO Cleaning Procedure, CL4; "Cleaning of Beam Tube Can Sections"
- 7) LIGO Procedure, CRWA-1; "Clean Room Wearing Apparel for Beam Tube Access During Construction and Inspection Activities"
- 8) LIGO Procedure, HMST3N; "Helium Mass Spectrometer Hood Test of Pump Ports with Valve, LN₂ Pump and Blind Flange with RGA Assembly"
- 9) LIGO Procedure, INSTALLSEQ; "Beam Tube Can Section Installation Sequence"
- 10) LIGO Weld Shelter Specification WSSPEC.
- 11) LIGO Clean Room Specification CRSPEC.

4.0 GENERAL:

Contamination control shall be achieved by a series of techniques described in this procedure. These are performed to assure that the exposure of the Beam Tube inner surfaces is limited to defined, controlled environments. The Beam Tube interior is susceptible to contamination by exposure from:

- 1) The atmosphere inside the Weld Shelters and Clean Rooms, and the cleanliness of the interior surfaces of these enclosures.
- 2) Access end of Beam Tube after Clean Room connection and during removal and re-installation of the end cap.
- 3) Fit-up end of new beam section during connection to existing/installed beam tube section.
- 4) Fit-up end of existing installed beam tube section during connection to the new beam tube section.
- 5) Tools and equipment used in the Weld Shelters, Clean Rooms, and inside the Beam Tube..
- 6) BDF connection at vacuum pump port connection near the Mid Station, and vacuum pump port cover maintenance and pump installation.



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5.1.3 Protect any previously cleaned areas or items which could be exposed to the weather, such as the beam tube end when the Clean Room is moved away, by covering with a clean protective bag. Remove any contamination and the protective bag before introducing back into a controlled area.

5.1.4 Interior walls of the Weld Shelters and Clean Rooms shall be wiped clean of contaminants with an approved cleaning agent (A Mirachem/water solution or isopropyl alcohol) and wiped dry with clean, lint free towel prior to initial use. The walls shall be visually inspected during installation activities, and if any contamination is noted, the walls shall be cleaned as needed in the same manner.

5.1.5 All tools and materials taken into the Weld Shelters or Clean Rooms shall be cleaned with an approved cleaning agent prior to taking them into the controlled area.

5.2 Air-borne Particle, Moisture, and Biologic Control:

The following steps are used for air-borne contamination control prior to and during inner beam tube surface exposure. The facilities discussed below are areas where the beam tube inner surfaces are exposed to outside air or provide outside make-up air to the inner beam tube chambers.

5.2.1 The interior of the beam tube is supplied with conditioned air which consists of a flow of 750 cfm of dry, filtered air at constant temperature. This air is supplied by a Blower/Dryer/Filter unit (BDF System). It is located at the mid station and provides air to both modules. The system has a redundant back up unit. The system operates continuously, with the air being directed into the beam tube at all times the tube end is open. The air flow is directed to a by-pass when the tube end is closed during setting of the next beam tube section. The flow of air into the beam tube is monitored and balanced to maintain positive pressure from the construction end of the beam tube as additional tube sections are installed.

5.2.2 The Weld Shelter fit-up room is conditioned using a HVAC unit with heating and cooling capabilities. Air is filtered using disposable pre-filters, disposable bag type filters and .3 micron HEPA 100 filters. The fit-up room shall be pressurized above the ante rooms and



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the outside ambient to provide positive air flow from the critical fit-up room. The gaps around the beam tubes, at the beam tube penetrations into the Weld Shelter fit-up room, shall be sealed using a series of fabric covers fastened to the tubes and the Weld Shelter by means of straps and/or Velcro® fasteners. The interior of the Weld Shelter fit-up room shall be inspected for insects, birds, etc., and all sightings eliminated before exposing the beam tube inner surface.

5.2.2.1 Ante rooms are attached to each end of the Weld Shelter. These rooms provide protection when entering the Weld Shelter, and when removing the protective bags, and for preparation of the beam tube ends for entry into the fit-up room.

5.2.2.2 An outer room is attached to the ante room on the leading edge of the Weld Shelter. This room provides additional weather protection. During inclement weather (snow, rain, or dusty conditions) the first protective bag is removed in this outer room prior to continuing to move the beam tube end into the ante room.

Note: the protective bags are never removed when the beam tube end is outside the outer room.

5.2.3 The Clean Room is conditioned using a HVAC unit with heating and cooling capabilities. Air is filtered using disposable bag type filters and .3 micron HEPA 100 filters. The working clean area shall be pressurized above the ante room, the change room and the outside ambient to provide positive air flow from the critical clean area. The Clean Room is sealed to the beam tube end using an inflatable seal.

5.2.3.1 An exterior ante room is attached to the beam tube opening end of the Clean Room. This room provides protection when removing the protective bags, and for preparation of the beam tube end for entry into the Clean Room.

5.2.3.2 An outer room is attached to the exterior ante room of the Clean Room. This room provides additional weather protection. During inclement weather (snow, rain, or dusty conditions) the first protective bag is removed in this outer room prior to continuing to move the Clean Room so the beam tube end is in the ante room.



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Note: the protective bags are never removed when the beam tube end is outside the outer room.

- 5.2.4 The Beam Tube openings in the Clean Room and the Weld Shelter Fit-up Room shall be covered during times when installation activities are not in progress to minimize contamination and decrease the amount of work involved in maintaining the rooms at the desired level of cleanliness.
- 5.2.5 When the Weld Shelter cannot directly cover the termination welds of the beam tube section to the beam tube module valves located in the mid stations, corner station and end stations, temporary weld shelters shall be erected to provide a controlled atmosphere around these termination seams during fit-up.
- 5.2.6 When the Clean Room cannot be used directly on the end of the termination tube or on the module valve because of interference with the building, a temporary clean room shall be constructed to provide a controlled atmosphere for entry into the beam tube.
 - 5.2.6.1 The temporary clean room shall consist of two sections, the working clean area and an ante room for preparation for entry into the clean area.
 - 5.2.6.2 The temporary clean room shall be *pressurized above the surrounding ambient* to provide positive air flow from the temporary clean room. This positive pressure will be achieved with the BDF system air from the tube, supplemented as necessary with outside air passed through a HEPA filter.
- 5.2.7 Control insect contamination by using high impact measures only (fly swatters).

DO NOT APPLY INSECTICIDES
