

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO -
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**LIGO Hanford Observatory
Contamination Control Plan**

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1 ABSTRACT

The LIGO interferometers are extremely sensitive to optical scattering or absorption losses induced by both particulate and hydrocarbon contamination. In order to minimize the likelihood of contamination of optical surfaces, numerous operational practices have been implemented at the LIGO Hanford Observatory. The purpose of this document is to describe the operational practices that have been implemented so that it can serve as a reference for observatory staff and visitors. It is expected that this document will be continuously updated as practices evolve as we gain experience with the interferometer hardware.

2 KEYWORDS

Contamination-sensitive Area, CLASS A hardware, CLASS B hardware, contamination control supplies, ultra high vacuum (UHV), portable clean rooms, vacuum preparation.

3 GENERAL WORKING GUIDELINES

To the maximum extent practicable, persons working in the vicinity of contamination-sensitive hardware should strive to reduce the possibility of particulate or hydrocarbon contamination introduced by themselves, their clothes, or items that they transport into the contamination-sensitive areas. Items transported into the areas should be unpacked outside the area and particulates should be removed by vacuuming (either with a HEPA filtered vacuum cleaner or one that exhausts to the outside of the building) or other suitable method.

Concerning hydrocarbon contamination, the basic operating guideline is “**if you can smell it, it’s bad.**”

Specifically, persons working in the vicinity of contamination-sensitive hardware should:

- not wear articles of clothing that obviously shed particles (e.g., wool sweaters)
- not use overly fragrant detergents for laundering clothing
- not use particularly fragrant body soap or shampoo
- not wear make-up such as mascara, eye shadow, powder, etc.
- not wear cologne or perfume
- not smoke cigarettes or other forms of tobacco on days that they will be working in the vicinity of contamination-sensitive hardware
- not undergo strenuous physical exercise (significant perspiration) without showering prior to working in the vicinity of contamination-sensitive hardware
- not eat particularly fragrant foods (e.g., lots of garlic)

In general, clean room garb should not be worn outside the contamination-sensitive areas. Hanging racks for clean room garb are provided in the Change Rooms and in Portable Change Rooms. Lockers are provided in the Change Rooms. Change clean room garb regularly to ensure cleanliness. Place soiled garments in designated receptacles in the Change Rooms.

Any modifications to the interferometer vacuum hardware, including the vacuum chambers and the beam tubes, must be coordinated with and approved by John Worden, the LHO Vacuum Engi-

neer (509-372-8136, worden_j@ligo.caltech.edu). This includes tasks such as door removal or replacement and installation of hardware such as viewports.

The procurement, stocking, and distribution of the items listed in Appendix 1 are strictly controlled by LHO staff. The items are available to all workers at the LHO. NONE of the items should be brought onto the site except by the designated LHO staff member (Kyle Ryan).

BEFORE bringing any chemicals to the site, authorization must be obtained from Otto Matherny, the LHO Safety Officer (matherny_o@ligo.caltech.edu, 509-372-8118).

4 PROCUREMENT AND DISTRIBUTION OF CONTAMINATION-CONTROL SUPPLIES

Numerous specific items related to contamination control are procured, stocked, and distributed by LIGO Hanford Observatory (LHO) staff as a service to observatory and visiting staff in order to ensure availability and consistency. Reasonable quantities of each item will be on hand at all times. Anyone expecting to require a significant quantity of a stocked item should contact Kyle Ryan (ryan_k@ligo.caltech.edu, 509-372-8129) in advance to ensure availability.

The specific items stocked are described in detail in Appendix 1.

The following rules apply to their procurement, receiving, stocking, and distribution:

- Only the designated LHO staff member (Kyle Ryan) or his designee may procure, approve and introduce controlled supplies into the on-site inventory. Only wrapped, unopened packages of contamination control supplies are stocked.
- Supplies which have been delivered but have not yet been unboxed, examined, and approved are to be stored in the Long-term Storage room.
- Upon examination and approval, supplies are added to the available inventory and are stored in labeled cabinets in the Active Storage Area. Solvents are stored in the outside Chemical Storage Area located between the Operations Support Building (OSB) and the water tank.
- Site and visiting staff may remove required contamination control supplies from the Active Storage Area or the Chemical Storage Area. Please notify LHO staff (Kyle Ryan) when stock of any item is running low or when one has advance knowledge of an unusually large demand for specific items.
DO NOT return opened, partially-used packages of supplies to the cabinets.
- Upon removal from the Active Storage Area or the Chemical Storage Area, it is the user's responsibility to ensure that supplies are handled in a manner that does not compromise their cleanliness. Contaminated items are to be immediately discarded or placed in garment cleaning receptacles located in the Change Room.

When a stocked contamination control item is specifically referred to in the text of this document, *italics* are used, e.g. *Bouffant Cap*.

5 CONTAMINATION-SENSITIVE HARDWARE

CLASS A hardware is defined as any item that will be temporarily or permanently mounted inside of or on the surfaces of the interferometer vacuum equipment and will be exposed to vacuum.

CLASS B hardware is defined as any item that will come into contact with **CLASS A** hardware or the surfaces of the interferometer vacuum equipment that will be exposed to vacuum.

5.1. CLASS A Hardware

Included in this category are the interferometer optics and suspensions and all in-vacuo interferometer hardware that has been prepared for installation. All **CLASS A** hardware is to be manufactured, cleaned, baked, and packaged in accordance with the specifications detailed in LIGO-E960022-04-E *LIGO Vacuum Compatibility, Cleaning Methods, and Qualification Procedures*. Typically, **CLASS A** hardware is wrapped with *Clean Aluminum Foil* then sealed in a bag made of *Ameristat*.

5.2. CLASS B Hardware

Included in this category are tools and fixtures that will come into contact with **CLASS A** hardware or be used inside the interferometer vacuum equipment. As a minimum they must be ultrasonically cleaned, for example with *Acetone* and/or *Isopropanol*, then baked in air at a minimum of 120 deg. C for a minimum of 24 hours (refer to LIGO-E960022-04-E). If tools with rubber or plastic parts cannot be avoided, the rubber or plastic parts must be cleaned with detergent then wrapped in *UHV Aluminum Foil*.

5.3. Handling

CLASS A and **CLASS B** hardware should never come into contact with anything other than other **CLASS A** or **CLASS B** hardware, *UHV Gloves*, *UHV Aluminum Foil*, *Lint-free Wipes*, or the in-vacuo surfaces of the interferometer vacuum equipment.

CLASS A and **CLASS B** hardware are to be unwrapped, and handled only in a contamination-sensitive area (see Section 6). All persons handling or working in the vicinity of **CLASS A** and **CLASS B** hardware shall wear at all times, *Overshoe Covers* or *Boots*, *Frock* or *Coverall*, *Bouffant Cap* or *Hood*, *Mask*, and *UHV Gloves*. While working with **CLASS A** and **CLASS B** hard-

ware, *UHV Gloves* should contact only **CLASS A** or **CLASS B** hardware; they must be changed immediately after contacting any other surfaces.

6 CONTAMINATION-SENSITIVE AREAS AND ACCESS PROTOCOL

Contamination sensitive areas are locations where personnel will be working in the vicinity of exposed Class A or Class B hardware. The contamination-sensitive areas in the corner station are the Optics Laboratory, the Vacuum Prep. and Assembly Area, the Bake Oven Area, the Cleaning Area, the Active Storage Area, the Laser and Vacuum Equipment Area (LVEA), and the Portable Clean Room Enclosures in the LVEA. The contamination-sensitive areas in the mid and end stations are the Cleaning Areas, the Vacuum Equipment Areas (VEA), and the Portable Clean Room Enclosures in the VEAs. All of these areas have HEPA-filtered air supplies. Access to all of these areas is restricted. Each person entering any of these areas must wear the required clean-area clothing (described below) and follow the required procedures for handling and working in the vicinity of contamination-sensitive hardware as described in Section 5.

6.1. Optics Laboratory and Vacuum Prep and Assembly Area and Bake Oven Area

Frock, Bouffant Cap, and Overshoe Covers required at all times. *Mask* required when in the vicinity of any **CLASS A** or **CLASS B** hardware, especially optics. *UHV Gloves* required when handling contamination-sensitive components.

Whenever, **CLASS A** or **CLASS B** hardware such as optics will be left exposed and unattended (e.g., under a laminar flow bench), the area will be clearly marked by, for instance, a yellow plastic chain with an attached warning sign.

Access to the Bake Oven Area is further restricted when an oven is being loaded or unloaded. This condition will be clearly marked by, for instance, a yellow plastic chain with attached warning sign strung across the entrance doors.

6.2. Cleaning Areas, Active Storage Area, Laser and Vacuum Equipment Area, and Vacuum Equipment Areas

Overshoe Covers required at all times. Dedicated clean-area shoes can be worn instead of the *Overshoe Covers*. It is the responsibility of the wearer to ensure that the dedicated clean-area shoes are kept clean.

6.3. Portable Clean Room Enclosures

The fans for the HEPA filters in the Portable Clean Room Enclosures are to be running whenever practicable.

When positioned in any location, including over a vacuum chamber port covered by a temporary aluminum or fabric cover, *Frock, Bouffant Cap, and Overshoe Covers* required at all times. *Mask*

required when in the vicinity of any **CLASS A** or **CLASS B** hardware, especially optics. *UHV Gloves* required when handling contamination-sensitive components.

When positioned over an open vacuum chamber port, *Coverall, Hood, Boots, and Mask* required at all times. *UHV Gloves* required when handling contamination-sensitive components.

6.4. Standing Inside Interferometer Vacuum Chambers

Inside-chamber Overshoe Covers, Coverall, Hood, Mask, and UHV Gloves required at all times. *Inside-chamber Overshoe Covers* must not contact any surface outside the vacuum chambers.

7 HANDLING AND DISPOSAL OF CHEMICALS

Copies of Material Safety Data Sheets (MSDS) for all chemicals on site are available in a yellow notebook labeled “MSDS” that is kept on a shelf in the LHO conference room.

Small quantities (one to two gallons) of chemicals either in their original bottles or in clearly labeled “squirt bottles” are stored inside the flow hoods in the Optics Lab and the Bake Oven Room, in yellow, Flammable Chemical Storage cabinets in the Electronics Lab, Optics Lab, Cleaning Area, and LVEA.

Waste chemicals are to be poured into red, five-gallon waste containers labeled for the particular waste chemical. Chemical waste containers are stored in the Optics Laboratory and in the Bake Oven Room near or under the flow hoods. LHO staff (Kyle Ryan) takes responsibility for recycling the chemicals in the red waste containers.

Empty brown glass chemical bottles are to be placed under the flow hoods with the caps removed until all chemical inside has evaporated. The dry, empty, brown glass bottles are then to be discarded in any trash receptacle.

APPENDIX 1 CONTAMINATION-CONTROL SUPPLIES AND CLOTHING

Item	Description	Vendor
<i>Acetone</i>	VWR brand, reagent grade Part # VW0330-3 4 L bottles	VWR Scientific Account # 05-117460
<i>Ameristat</i>	Clean room sheeting Class 100 stratogrey, single wound, rollstock	Bay Stat 3575 Haven Avenue Menlo Park, CA 94025-1009 (650)364-3205 Voice (650)363-8079 Fax
<i>Clean Room Boots</i>	White C3, knee-high, poly- ester clean-room overshoe boots with 939 sole Sizes M, L, XL	Overall Laundry Services, Inc. P.O. Box 9040 Everett, WA 98206-9040 (800)926-6996 ext. 261 Bud Granger
<i>Bouffant Cap</i>	Tyvek bouffant cap, 21" Part # 1060-802	Cintas-Eastwater Scientific 23161 Antonio Parkway Rancho Santa Margarita, CA 92688 (800)786-6027 Voice (949)549-9579 Fax
<i>UHV Aluminum Foil</i>	Part # ASTM B 479 0.015" x 24" x 500' and 0.015" x 48" x 500' UHV Certified Aluminum Foil	All Foil 4597 Van Epps Road Brooklyn Heights, Ohio 44131 (216)661-0211 Voice (216)398-4161 Fax
<i>Coverall</i>	White C3 polyester clean- room coverall Sizes S, M, L, XL, XXL	Overall Laundry Services, Inc. (see above)
<i>Ethanol</i>	Pending identification of suitable reagent grade sup- plier, <i>Methanol</i> is substi- tuted	
<i>Fast Sorb Towels</i>	Berkshire Fast Sorb #820 Class 100 wipers, 9" x 9" Part # 21914-208	VWR Scientific (see above)
<i>Frock</i>	White C3 polyester clean- room frock (knee-length coat) Sizes M, L, XL	Overall Laundry Services, Inc. (see above)

Item	Description	Vendor
<i>UHV Gloves</i>	Ansell Edmont LP latex gloves Sizes 61/2, 7, 8, 9 Part# 1009-395763,764, 766, 768	Cintas-Eastwater Scientific 23161 Antonio Parkway Rancho Santa Margarita, CA 92688 (800)786-6027 Voice (949)549-9579 Fax
<i>Hood</i>	White C3 polyester clean-room hood Sizes S, M, L, XL	Overall Laundry Services, Inc. (see above)
<i>Inside-chamber Overshoe Cover</i>	Non-marking shoe covers for standing inside the vacuum chambers (worn over the <i>Clean Room Boots</i>) Sizes M, L, XL Terra Universal Part #9309-45, -46, -47	VWR Scientific (see above) Laundered by Overall Laundry Services
<i>Isopropanol</i>	VWR brand, reagent grade Part # VW5520-3 4 liter bottles	VWR Scientific (see above)
<i>Lens 90 Tissue</i>	Berkshire Lens 90 9" x 9" lens tissue Part # 52847-149	VWR Scientific (see above)
<i>Lint-free Wipe</i>	Multi-knit polyester wipe, 9" x 9" Part # 1022-00699	Cintas-Eastwater Scientific (see above)
<i>Mask</i>		VWR Scientific (see above)
<i>Methanol</i>	Reagent grade Part #VW4300-3 4ea. 4 liter brown glass bottles	VWR Scientific (see above)
<i>Overshoe Covers</i>	C3 white polyester slip on overshoe covers with rubber soles Sizes S, M, L, XL	Overall Laundry Services, Inc. (see above)