

Procedures, Safe-Guards and Cautions for Safe and Proper Use, and Diagnosis, of LIGO Equipment

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1 Purpose

The purpose of this document is to provide operators, trouble-shooters and commissioners general guidance and links to procedures/protocols for how to properly and safely operate and diagnose LIGO equipment, such as (but not limited to) the following:

- remove and replace electronics safely
- remove and replace an electrical cable safely
- vent and pump down
- properly boot up the CDS system

2 General References

 Operations Manuals (user's manuals), which are written for specific LIGO equipment, take precedence over the following general guidance:

[M1400128](#), "LIGO Safety Guidelines for Working On Energized Equipment"

[M1300464](#), "Procedure for Preparing the aLIGO Interferometer for Pumpdown or Vent, and Input Power Limits"

[T1300359](#), "How to Handle Small Optics"

<https://awiki.ligo-wa.caltech.edu/aLIGO/How%20To>: how to properly boot up the CDS system, and other guides for diagnostics

3 General Guidance

3.1 Work Permits Required

Any work on installed observatory equipment, including electronics and software, requires an approved work permit.

3.2 Engineering Change Requests Required

Any changes to installed observatory equipment, including electronics and software (other than software 'bug' corrections), requires an approved Engineering Change Request (ECR).

3.3 Report Discrepancies

Any deviations or discrepancies from the intended (and documented) design should be reported to Systems Engineering so that either the physical system is changed to comply with the design, or the design record is updated to reflect the as-built. (We can't fix what we don't know.)



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3.4 Connecting and Disconnecting Cables

The connecting and/or disconnecting of cables should only be performed by knowledgeable and trained personnel¹.

Don't disconnect or connect any cables without first removing power from the related electronics², unless otherwise instructed by the applicable electrical engineer.

3.5 Don't hot swap electronics

Don't hot swap electronics (this includes cards in a chassis) when the power can reasonably be turned off. If it is mandatory to hot swap, then you should consult the system experts (designer, cognizant engineer, etc.) prior to taking such a risk³.

3.6 Caution regarding vacuum electrical feedthrough disconnection

Be aware that the majority of our 25 pin vacuum feedthrough connectors are not labeled. If you need to re-connect cables to a vacuum feedthrough, great care must be taken to ensure you don't plug things in wrong or it's quite possible that you will damage in-vacuum devices. Label the connectors prior to disconnection.

3.7 Seating Boards in Backplanes

Boards can sometimes be improperly seated into backplanes. Because of the mechanical assistance afforded by the board guides and chassis construction, issues are mostly limited to two conditions:

- 1) There is damage to the chassis or backplane or board that causes improper seating. Conditions such as bent or broken pins, loose board guides, damaged receptacles, etc. can cause improper connections. The best practice is to inspect all of these areas before inserting the board.
- 2) The board is insufficiently inserted onto the backplane. Overcoming this is sometimes a "feel" thing that comes with experience, but other times a good solid push is in order. The final check before powering up should include a visual check that the new board appears to line up with the other boards, and that any included mounting screws are tightened appropriately, etc.

3.8 Electro-Static Discharge

Electro-Static Discharge (ESD) causes cumulative damage to electronics. Where provided, personnel should use grounding straps and mats when working on electronics in racks or on benches in the electronics lab.

3.9 Strain Relief

All electrical connections should have proper strain relief by design; If not report this as an issue to Systems Engineering.

Insure that all electrical connections have their strain relief properly in place.

¹ As determined and qualified by Observatory management.

² Energized cables of any appreciable length can give a voltage spike at insertion due to cable inductance and chassis capacitance that is many times the voltage on the cable, and this can sometimes damage chassis electronics.

³ Experience indicates that while it can sometimes be done without harm, hot swapping boards and cards often increases the likelihood of a failure and can lead to shortened lifetime.



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3.10 Proper Grounding

Care must be taken when temporary or auxilliary instrumentation is attached to the interferometer systems, since inadvertent grounding can cause ground loops and injection of noise from 'dirty' power sources. These temporary instrumentation configurations must be approved by a work permit and clearly marked as temporary.

3.11 Overheating Racks or Modules

Keep paper and other blockages out of the racks. Any blockage or constriction of the airflow (forced or natural convection) can result in overheating of electronics modules, failures and reduced lifetimes.