



LIGO Laboratory / LIGO Scientific Collaboration

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Hazard Analysis and FMEA for the Lightwave 10-W
Laser in the Caltech PSL Lab

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of the LIGO Project.

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Summary

This hazard analysis finds a number of hazards that require a decision from the Directorate. These involve:

- Electric shock from high voltage.
- Accidental exposure to direct 1064 nm laser radiation.
- Exposure to strong magnetic fields.
- Flood hazards due to broken pipes.
- Asphyxiation.

These tasks have a risk assessment value printed in either red or orange.

1 Foreword

This hazard analysis and failure modes and effects analysis is the accompanying documentation in support of “Standard Operating Procedure for the Lightwave 10-W Laser in the Caltech PSL Lab” LIGO-M070063-01-D.

2 Blast Hazards

There are no known blast hazards specific to the PSL Lab.

3 Chemical Hazards

Hazard	Fire
Cause	Exposure of cleaning solvents to high temperature or open flame.
Effect	Injury and/or damage to personnel and equipment.
Severity	critical (2)
Level	improbable (E)
Risk Assessment	2E

All flammable chemicals in the PSL Lab are stored in the chemical storage cabinet located under the HEPA workbench. The chemicals are used for cleaning of optics and electronics components and are typically not exposed to any heat sources.

4 Electrical Hazards

Hazard	Electric shock from high voltage.
Cause	Removal or opening of the ion pump power supply housing.
Effect	Injury and/or damage to personnel and equipment.
Severity	critical (2)
Level	improbable (E)
Risk Assessment	2E

Exposure to this hazard requires the deliberate action of removing or opening the ion pump power supply housing.

Hazard	Electric shock from high voltage.
Cause	Removal of the protective cover and exposing the high voltage connections of the pre-modecleaner piezo-electric transducer.
Effect	Injury and/or damage to personnel and equipment.
Severity	critical (2)
Level	remote (D)
Risk Assessment	2D

Exposure to this hazard may occur even if the high voltage power supplies for the pre-modecleaner piezo-transducer have been switched off. When switching off the high voltage power supplies, ample time for the piezo-transducer should be left for it to discharge. Typically this occurs within 1–2 minutes.

Hazard	Electric shock.
Cause	Poor grounding of instrumentation equipment caused by corrosion.
Effect	Injury and/or damage to personnel and equipment.
Severity	critical (2)
Level	improbable (E)
Risk Assessment	2E

For the most part this hazard only arises after a water leak has occurred in the lab. After a water leak, equipment installed in the instrumentation rack shall be carefully dried out and the ground connections shall be checked.

5 Ergonomic Hazards

Hazard	Lifting hazard.
Cause	Moving the Lightwave 10-W Laser by oneself.
Effect	Injury and/or damage to personnel and equipment.
Severity	negligible (4)
Level	remote (D)
Risk Assessment	4D

This hazard is quite unlikely but cannot be totally ruled out. The Lightwave 10-W Laser once installed on the optical table is not likely to be moved around.

Hazard	Lifting hazard.
Cause	Moving the HP6267B power supply laser by oneself.
Effect	Injury and/or damage to personnel and equipment.
Severity	negligible (4)
Level	remote (D)
Risk Assessment	4D

The HP6267B is a low voltage, high current power supply capable of producing 0–40 V, 0–10 A. Caution should be exercised when re-locating this power supply.

Hazard	Low head height.
Cause	Climbing a ladder to access items of equipment.
Effect	Injury and/or damage to personnel and equipment.
Severity	negligible (4)
Level	remote (D)
Risk Assessment	4D

The rather low ceiling for the Caltech PSL Lab may present some problems for taller members of staff. The only mitigation measure available is to be alert of ones surroundings.

Hazard	Mechanical obstruction.
Cause	The prototype laser safety barrier being in place during a power outage.
Effect	Injury and/or damage to personnel and equipment.
Severity	negligible (4)
Level	occasional (C)
Risk Assessment	4C

In the advent of a power outage, the Caltech PSL Lab becomes quite dark making it hard to see the exit. A number of flashlights are in the lab that can be used for short term emergency lighting.

6 Eye Hazards

Hazard	Accidental eye exposure to direct 1064 nm laser radiation.
Cause	The laser safety eyewear is not worn correctly and slips, or falls, off the user.
Effect	Injury and/or damage to personnel and equipment.
Severity	catastrophic (1)
Level	remote (D)
Risk Assessment	1D

The laser safety eyewear should be checked for fit by the wearer before being worn.

7 Fire Hazards

Hazard	The optical table enclosure dust curtains catch fire.
Cause	A stray laser beam hits the dust curtain for a prolonged period of time.
Effect	Injury and/or damage to personnel and equipment.
Severity	negligible (4)
Level	remote (D)
Risk Assessment	4D

The SOP calls for scans of the optical table to be performed with an infrared viewer after adjustments to the optics are made. This should catch any stray beam incident on the dust curtain.

8 Non-ionising Radiation Hazards

Hazard	Exposure to strong magnetic fields.
Cause	Alignment of components inside the laser, near the Faraday isolators.
Effect	Injury and/or damage to personnel and equipment.
Severity	negligible (3)
Level	occasional (C)
Risk Assessment	3C

This hazard only arises when the lid of the laser is removed, which is not all that often. Nevertheless, staff with conditions susceptible to strong magnetic fields should not be present when alignment work is being performed with the insides of the laser.

Hazard	Pinch hazard.
Cause	Losing control of iron-based tools near the Faraday isolators.
Effect	Injury and/or damage to personnel and equipment.
Severity	negligible (3)
Level	occasional (C)
Risk Assessment	3C

Caution should be exercised when using ball drivers or other iron-based tools near the Faraday isolators. The strong localised magnetic fields present can pull the tools towards the magnet housing, which may result in getting one's fingers pinched.

9 Skin Hazards

Hazard	Exposure to alcohols or cleaning fluids.
Cause	Not wearing approved gloves whilst working with chemicals.
Effect	Injury and/or damage to personnel and equipment.
Severity	negligible (4)
Level	remote (D)
Risk Assessment	4D

10 Software Hazards

There are no known software hazards known specific to the Caltech PSL Lab.

11 Facility Hazards

Hazard	Flood hazard.
Cause	One of the many overhead pipes breaks due to wear and tear.
Effect	Injury and/or damage to personnel and equipment.
Severity	critical (2)
Level	occasional (C)
Risk Assessment	2C

Depending on which overhead pipe breaks and the nature of the break, equipment damage can occur.

Hazard	Flood hazard.
Cause	One of the many overhead pipes breaks due to being hit when moving tall items of equipment.
Effect	Injury and/or damage to personnel and equipment.
Severity	critical (2)
Level	improbable (E)
Risk Assessment	2E

Given the cramped confines of the Caltech PSL Lab, this hazard arises only when tall items are moves or when a ladder is in use.

There are a number of pipes sticking out of the walls of the lab, most of which are not labelled. Their origin and contents remain a mystery.

12 Ventilation Hazards

Hazard	Asphyxiation.
Cause	Use of the fire extinguisher.
Effect	Injury and/or damage to personnel and equipment.
Severity	catastrophic (1)
Level	remote (D)
Risk Assessment	1D

If the air handling system is not working, caution should be exercised when using the fire extinguisher.