



LIGO Laboratory / LIGO Scientific Collaboration

LIGO T1000311-v4

aLIGO

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aLIGO TMS Hazards Analysis

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Summary

This mitigated hazard analysis identifies 6 hazards associated with the aLIGO TMS,. The following table categorizes the identified hazards.

Hazard Risk Assessment	Number Of Hazards
1A, 1B, 1C, 2A, 2B, 3A	0
1D, 2C, 2D, 3B, 3C	2
1E, 2E, 3D, 3E, 4A, 4B	4
4C, 4D, 4E	0

1. Foreword

This document, aLIGO TMS Hazards Analysis (LIGO- T1000311-v1)

2. Introduction

The purpose of this document is to identify potential hazards, analyze their consequences, and evaluate proposed methods and systems to manage those hazards in support of the installation, deployment and commissioning of the aLIGO TransMon_SUS (TMS). This is done by developing a description of the intended installation, its support systems and proposed safety systems. Potential hazards are identified and analyzed with the aim of identifying and evaluating safety functions and systems that will be relied upon to manage the hazards. A protocol is established to help ensure that safety functions are realized through the design and operational process.

3. Description of the aLIGO TMS

The TMS consists of the aLIGO three sub assemblies. The suspension frame and top mass with springs and controls. The TRANSMISSION MONITOR SUSPENSION (TMS) is an in-vacuum component that is located behind the ETM (End Test Mass) and is mounted to the BSC ISI platform. The TMS Telescope is a reference for beam location and receives the laser beam transmitted through the ETM This beam can be used for interferometer sensing and control. (FIG 1) The TMS is also used in the opposite direction, for injection of the green laser beam used in the Arm Length Stabilization (ALS) scheme. Finally, the TMS also accommodates probe beams for the Hartmann sensor that monitors the curvature of the ETM.

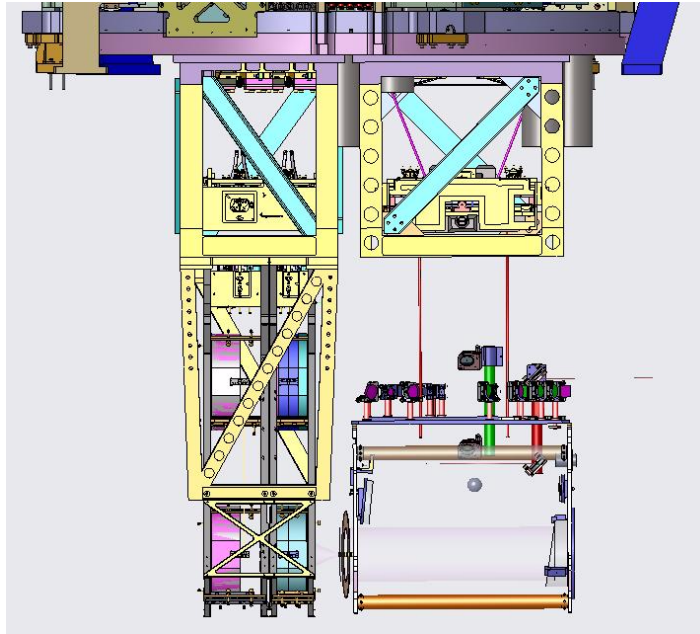


Figure 1. TMS shown at the right

4. Hazard Identification and Assessment

This section identifies those hazards and events that may pose a threat to the workers, equipment or environment. The LIGO Project System Safety Plan (LIGO-M950046) lists the hazard severity descriptions, category values, levels and risk criteria used in accessing the hazards listed in the following sections.

Description	Category	Definition
Catastrophic	1	Death or permanent total disability, system loss, major property damage or severe environmental damage.
Critical	2	Severe injury, severe occupational illness, major system or environmental damage.
Marginal	3	Minor injury, lost work day accident, minor occupational illness, or minor system or environmental damage.
Negligible	4	Less than minor injury, first aid or minor supportive medical treatment type of occupational illness, or less than minor system or environmental damage.

Table 1. Hazard severity categories.

Description	Level	Individual Item
Frequent	A	Likely to occur frequently or continuously experienced.
Probable	B	Will occur several times in the life of an item.
Occasional	C	Likely to occur some time in the life of an item.
Remote	D	Unlikely but possible to occur in the life of an item.
Improbable	E	So unlikely, it can be assumed occurrence may not be experienced.

Table 2. Hazard levels.

Category	Catastrophic	Critical	Marginal	Negligible
Level	1	2	3	4
Frequent (A)	1A	2A	3A	4A
Probable (B)	1B	2B	3B	4B
Occasional (C)	1C	2C	3C	4C
Remote (D)	1D	2D	3D	4D
Improbable (E)	1E	2E	3E	4E

Table 3. The hazard risk assessment matrix.

The risk code criteria are listed in Table 4.

Hazard Risk Assessment	Risk Code Criteria
1A, 1B, 1C, 2A, 2B, 3A	Unacceptable
1D, 2C, 2D, 3B, 3C	Undesirable (Directorate decision required)
1E, 2E, 3D, 3E, 4A, 4B	Acceptable with review by Directorate
4C, 4D, 4E	Acceptable without review

Table 4. The risk code criteria.

5. aLIGO TMS Hazards

Safety toe shoes are required by all involved in a lift.

5.1. Blast Hazards

There are no known blast hazards specific to the aLIGO TMS. The usual blast hazards present in the laboratory environment apply.

5.2. Chemical Hazards

Chemical hazards specific to the aLIGO TMS. In particular Isopropyl alcohol, used occasionally in assembly, in quantities no larger than a 250 to 500 ml, in approved secondary containers. This chemical should be kept away from any ignition source.

5.3. Electrical Hazards

The usual electrical hazards present in the laboratory environment apply to the aLIGO TMS. The specific electrical hazards encountered in the aLIGO TMS are given below. Electrical work on the aLIGO TMS is to be restricted to authorised personnel only.

Hazard	Electric shock.
Cause	Touching live cables (power or signal) that are exposed to water caused either by flooding or a water leak.
Effect	Injury and/or damage to personnel and equipment.
Risk Assessment Level	1D
Mitigation Methods	There are no power or signal cables at the level at which any body of water would pool on the TMS table. All power or signal cables used are insulated and any connector pins are located at a height well above any neighboring water connections
Mitigated Risk Assessment Level	3D

5.4 Material for Handling

Hazard	Lifting hazard.
Cause	Moving a table / telescope assembly (D1002460) (~ 175 lbs.) by oneself.
Effect	Injury and/or damage to personnel and equipment.
Risk Assessment Level	3C
Mitigation Methods	The table / telescope and suspension boxes are labeled as heavy loads and require two or more people to move them. Use Genie lift and and tool attachment D1100908 for Lowering the assembly into the storage box from the table.

	The storage box has casters and is meant to be moved with straps and portable crane. The work permit covering work on the sub assembly boxes would state that work on a heavy load is about to take place. Personnel would be made aware of safe practices for manual lifting as outlined in the OSHA Technical Manual, Section VII, Chapter 1, "Back Disorders And Injuries". . Safety toe shoes required by all involved in lift
Mitigated Risk Assessment Level	4D

The TMS sub-assembly boxes are labeled and identified as heavy loads. However some personnel do not pay attention to signs despite being made aware of the risks.

Hazard	Pinch hazard.
Cause	Insufficient communication results in a member of the installation crew getting some part of their hand under the telescope assembly as it is being positioned on the TMS assembly table.
Effect	Injury and/or damage to personnel and equipment.
Risk Assessment Level	3C
Mitigation Methods	During this part of the installation, the person in charge would act as the watchman to make sure that everyone has their hands out of the way. This would take the form of a visual and verbal check with the co-workers.
Mitigated Risk Assessment Level	4D

5.5 Eye Hazards

Hazard	Accidental eye exposure to direct 532 nm laser radiation.
Cause	The laser safety eyewear is not worn correctly and slips or falls off the user.
Effect	Injury to personnel, corneal or retinal burns (or both). Chronic exposure to excessive levels may cause cataracts or permanent retinal injury.
Risk Assessment Level	1D
Mitigation Methods	Basic laser safety training covers the topic of the integrity of laser safety eyewear and its use. When laser hazard, were laser safety glasses
Mitigated Risk Assessment Level	3D

Hazard	Accidental eye exposure to diffuse 532 nm laser radiation.
Cause	Scatter from an optical component leads to a diffuse beam where one is not expected. The scatter is the result of an optic becoming contaminated or dirty.
Effect	Injury to personnel, corneal or retinal burns (or both). Chronic exposure to excessive levels may cause cataracts or permanent retinal injury.
Risk Assessment Level	3D
Mitigation Methods	The clean room for the aLIGO TMS reduces the risk of dust coming to rest on the optics. Personnel will wear clean room garb which further reduces the chances of contamination. When laser safety hazard, wear safety glasses
Mitigated Risk Assessment Level	4D

5.5 Contamination

Hazard	Staff ignoring the clean room protocols.
Cause	Being lazy to don the full clean room garb.
Effect	Contamination of the TMS optics
Risk Assessment Level	2C
Mitigation Methods	Training given to personnel working on the aLIGO TMS table will emphasize the necessity for wearing clean room garb.
Mitigated Risk Assessment Level	3D

It is hoped that staff will not ignore the signage and protocols for the TMS.