**LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY**

-**LIGO**-

CALIFORNIA INSTITUTE OF TECHNOLOGY

MASACHUSETTS INSTITUTE OF TECHNOLOGY

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| **LIGO-E1200659-v2 5/28/13** |
| AOS SLC BS Elliptical Baffle Install  Hazard Analysis |
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**APPROVAL SIGNATURES**

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Michael Smith, SLC Date

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Lisa Austin, SLC Subsystem Leader Date

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Dennis Coyne, LIGO Chief Engineer Date

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Richard Oram, LLO Operations Manager Date

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John Worden, LHO Operations Manager Date

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Brian O’Reilly, Advanced LIGO LLO Installation Lead Date

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Michael Landry, Advanced LIGO LHO Installation Lead Date

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David Shoemaker, aLIGO Leader Date

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David Nolting, LIGO Lab Safety Officer Date

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Albert Lazzarini, LIGO Directorate Date

**CHANGE LOG**

|  |  |
| --- | --- |
| **Date, version** | **Summary of Changes** |
| 5/28/13  V2 | * Corrected signature page * Added sharp edge cutting hazard * Corrected documentation Sec. 4 * Added damage to BS optic and suspension * Added reference to [E1200660 AOS SLC BS Ellip Baf Installation Doc](https://dcc.ligo.org/LIGO-E1200660-v3/public) |

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# Scope

This document covers safety concerns related to the installation and alignment of the BS Elliptical Baffle on the cartridge or in the BSC chamber of Advanced LIGO. It must be read before beginning the installation, and used in conjunction with [E1200660 AOS SLC BS Ellip Baf Installation Doc](https://dcc.ligo.org/LIGO-E1200660-v3/public).

# Summary of Hazards

## BS Elliptical Baffle

The major hazards to be aware of during installation and alignment of the BS Elliptical Baffles include:

1. Injury to body parts as a result of working in a cramped and confined space (4E)
2. Eye damage from exposure to infrared autocollimator beam (4E)
3. Eye damage from exposure to infrared autocollimator beam (4E)
4. Sharp edges present a cutting hazard (4D)
5. Damage to BS mirror and suspension (4D)

These hazards are described in detail later in the document.

# Overview

## BS Elliptical Baffle

A model of the BS Elliptical Baffle is shown in **Error! Reference source not found.**.



Figure : Model of BS Elliptical Baffles Installed on the BS SUS

The 5 lb BS Elliptical Baffle (both baffles plus hardware) is attached to the BS SUS lower frame, as shown in Figure 1. Installation and alignment may occur either on the cartridge or within the BSC.

1. The Baffles will be attached, using special mounting hardware, after the BS mirror and suspension structure have been installed and aligned on the BSC ISI optical platform.
2. A target will be mounted temporarily to the center of the Baffle, and the Baffle will be moved horizontally and vertically within the mounting clearance holes until the target aligns with an alignment theodolite.
3. After alignment, the Baffle will be secured with its mounting bolts, and the target will be removed.
4. In the event that access is needed for maintenance of the BS mirror, the Baffles will be removed together with the mounting studs. After repair of the BS mirror, the Baffle will be re-installed without the need for subsequent alignment by simply re-inserting and fastening the mounting studs.

During installation of the BS Elliptical Baffle, a task leader will be assigned to supervise all activities.

# Related Documentation

[E1200660 AOS SLC BS Ellip Baf Installation Doc](https://dcc.ligo.org/LIGO-E1200660-v3/public)

Advanced LIGO Safety: Processes and Guidelines (LIGO-M070360)

LIGO Project System Safety Plan (LIGO-M950046)

LIGO Contamination Control Plan (LIGO-E0900047)

aLIGO Chamber Entry/Cleaning/Exit Checklist (LIGO-E1201035)

LLO Safety Procedure documents (<http://www.ligo-la.caltech.edu/contents/internalmain.htm>)

# Hazard Analysis

## Injury to Body Parts

The BS Elliptical Baffle will be installed and aligned *in situ* on the cartridge or within the BSC chamber. Injury to a person’s head or other body parts may occur as a result of working in a cramped and confined space, encumbered with clumsy clean-room garb.

## Eye Damage from Exposure to Infrared Radiation

A visible theodolite or a high power infrared autocollimator beam may be projected onto the surface of the BS Elliptical Baffle during the alignment of the baffle. Directly viewing the light beam could cause permanent damage to the retina.

This hazard can be eliminated by using proper laser eye protection glasses or goggles during the autocollimator alignment procedure.

## Sharp Edges Present a Cutting Hazard

The baffle is fabricated from a thin piece of metal; beam passage holes are intentionally sharp-edged. A potential hazard exists for receiving cuts if parts are handled improperly. Each team member should inspect to their satisfaction the prospective part to be handled to determine if that part has a potentially hazardous sharp edge. In general, avoid grasping the sharp edge of baffle holes; use Teflon a shield if necessary when grasping the sharp baffle edges by hand. Hands may also be pinched when assembling parts to one another, but this can be mitigated with proper attention to handling the parts.

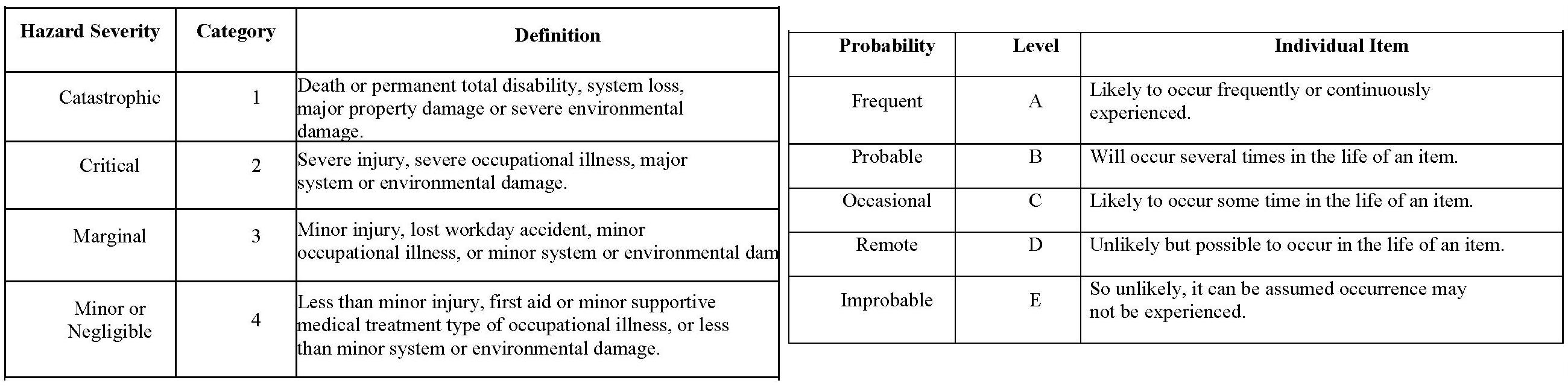
## Damage to BS Suspension

The BS Elliptical Baffle will be attached directly to the BS triple suspension structure. Dropping a tool or object onto the BS suspension structure or touching the BS optical surfaces may cause serious damage to the structure or to the mirror.

Extreme care must be taken to avoid touching the mirror or the delicate suspension parts.

# 6. BS Elliptical Baffle Hazard Analysis Severity Table

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Item # | Hazard | Cause | Effect | Unmitigated  Severity | Unmitigated  Probability  Level | Unmitigated Risk Index | Comment | Mitigation | Mitigation Severity | Mitigated Probability Level | Mitigated Risk Index |
| 1 | Bodily injury | Bumping into rigid structures | Injury to personnel | marginal | occasional | 3C | Head injury is possible | Be observant of hazardous structures | minor | improbable | 4E |
| 2 | Eye Damage | Direct viewing of infrared beam | Injury to personnel | Critical | occasional | 2C | Permanent retinal damage | Use Laser protective eye wear | minor | improbable | 4E |
| 3 | Cutting hazard | Sharp edges present a cutting hazard | Injury to personnel | critical | remote | 2D | Beam passage holes in scraper baffles are intentionally sharp edged | In general, avoid grasping the sharp edge of baffle holes. Use Teflon shield if necessary when grasping the sharp baffle edges by hand. | minor | remote | 4D |
| 4 | Damage to BS and Suspension | Bumping of BS SUS, or impact to BS optic | Misalignment or damage to BS SUS and mirror | critical | occasional | 2C | Use barrier between ITM Ellip Baf and BS SUS; Place BS optic on EQ stops; Cover BS optic with protective cover | marginal | marginal | remote | 3D |



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **PROBABILITY** |  |  |
| **SEVERITY OF** | E | D | C | B | A |
| **CONSEQUENCE** | Improbable | Remote | Occasional | Probable | Frequent |
| 1 |  |  |  |  |  |
| Catastrophic |  |  |  |  |  |
| 2 |  |  |  |  |  |
| Critical |  |  |  |  |  |
| 3 |  |  |  |  |  |
| Marginal |  |  |  |  |  |
| 4 |  |  |  |  |  |
| Negligible |  |  |  |  |  |
|  |  |  |  |  |  |
| **Hazard Risk Index** |  |  | **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** | |  | |