



# LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

ITEM #	Failure Mode	Cause	Effect	Unmitigated Severity	Unmitigated Probability Level	Unmitigated Risk Index	Comment	Mitigation	Mitigation Severity	Mitigated Probability Level	Mitigated Risk Index
1	Failure of power supply or cabling outside vacuum	Electronic breakdown; severing of cable	Shuts down affected ring heater element	Minor	Occasional	Acceptable without review	Failure most likely due to accidental personnel contact (e.g. cables caught in a broom or wheel of cart, cart knocking over power supply)	Ensure cables are neatly routed in trays and labelled, power supplies in racks	Minor	Remote	Acceptable without review
2	Failure of cabling inside the vacuum	Severing of cable	Shuts down affected ring heater element; vent required to repair	Marginal	Remote	Acceptable with review from directorate	Failure most likely due to personnel contact while inside chamber for other work, or 'light saber incident'	Ensure cables are neatly routed through SUS structure elements	Marginal	Improbable	Acceptable with review from directorate
3	Shorting of ring heater element to suspension structure	Breakdown of insulation between heater element and shield	Reduced performance from affected ring heater element; vent and SUS disassembly required to repair	Marginal	Remote	Acceptable with review from directorate	Failure most likely due to thermal cycling of insulation surrounding bare nichrome wire or element mechanical failure	Test integrity of insulation under multiple thermal cycles	Marginal	Remote	Acceptable with review from directorate
4	Shorting of ring heater current leads to each other	Breakdown of insulation between cables	Shuts down affected ring heater element; vent possibly required to repair; could overload power supply	Marginal	Improbable	Acceptable with review from directorate	Failure most likely due to accidental personnel contact (e.g. cables caught in broom or wheel of cart)	Ensure cables are neatly routed in trays	Marginal	Improbable	Acceptable with review from directorate
5	Ring heater element open circuit failure	Severing or burnout of nichrome wire in element	Shuts down affected ring heater element; vent and SUS disassembly required to repair	Marginal	Remote	Acceptable with review from directorate	Failure most likely due to connector to nichrome wire working loose or burnout of nichrome wire	Use Accu-Glass connectors on nichrome rather than crimp leads; ensure ring heater never operates while chamber is vented	Marginal	Remote	Acceptable with review from directorate
6	Ring heater element mechanical failure	Thermal fatigue; mechanical shock (earthquake)	Reduced or no performance from affected ring heater element; vent and SUS disassembly required to repair; possible contamination of test mass or compensation plate	Critical	Remote	Undesirable (directorate decision required)	Most likely mechanical failure is evolution of particulate contamination under thermal cycling	Perform accelerated aging tests on assembled ring heaters	Critical	Remote	Undesirable (directorate decision required)

Hazard Severity	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 workday accident, minor occupational illness, or minor system or environmental damage.
Minor or 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.

Probability	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.

SEVERITY OF CONSEQUENCE	PROBABILITY				
	E Improbable	D Remote	C Occasional	B Probable	A Frequent
1 Catastrophic					
2 Critical					
3 Marginal					
4 Negligible					

Hazard Risk Index
<b>1A, 1B, 1C, 2A, 2B, 3A</b>

Risk Code Criteria
<b>Unacceptable</b>

<b>1D, 2C, 2D, 3B, 3C</b>
<b>1E, 2E, 3D, 3E, 4A, 4B</b>
<b>4C, 4D, 4E</b>

<b>Undesirable (Directorate decision required)</b>
<b>Acceptable with review by Directorate</b>
<b>Acceptable without review</b>