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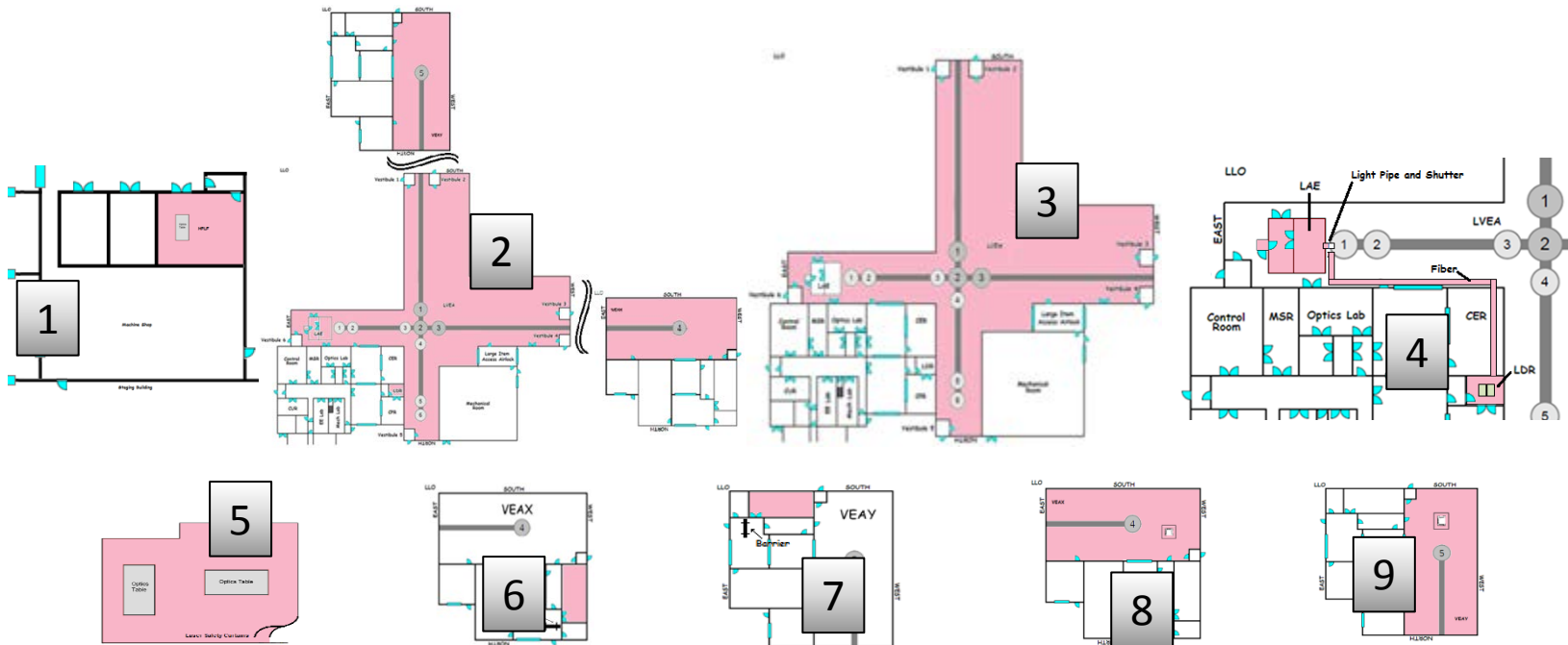
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There are 9 Nominal Hazard Zones (NHZs) that are semi-permanent features of the LLO facility.

These include:

1. HPLF – The High Power Laser Facility run by the University of Florida
2. THE DETECTOR – The LVEA, VEAX, VEAY, LDR, and LAE (PSL)
3. LVEA – The Laser and Vacuum Equipment Area
4. LDR and LAE (PSL) – The Laser Diode Room and the Laser Area Enclosure
5. Optics Lab – Corner Station
6. Optics Lab – X-End Station
7. Optics Lab – Y-End Station
8. VEAX – The Vacuum Equipment Area at the X-End Station
9. VEAY – The Vacuum Equipment Area at the Y-End Station



Both of the following conditions must be met.

- 1) The PSL laser must be off ([M1100038](#)).
- 2) NO OTHER LASER located in the NHZ may be ON.

NOTE: It is possible for this NHZ to be laser safe when the LVEA is laser hazard.

ALL THREE (3) of the following conditions must be met.

1) The PSL INJECTION into the BEAM TUBE must be laser safe.

The PSL laser must be off ([M1100038](#))

Or the light pipe between the PSL Enclosure and HAM1 must be locked closed ([M1100038](#))

2) The LVEA TABLES must be laser safe.

TCSBT1R must be laser safe ([M1300206](#))

(TCSY Laser locked OFF with key removed and in KEYBOX)

And TCSBT3L must be laser safe ([M1300206](#))

(TCSX Laser locked OFF with key removed and in KEYBOX)

And TCSHT4R must be laser safe ([M1300458](#))

(HARTMANN SLEDs locked OFF with key removed and in KEYBOX)

3) NO OTHER LASER located in the LVEA may be ON.

NOTE: ONLY when the LVEA is laser safe can VEAX or VEAY be transitioned to laser safe.

NOTE: It is possible for the LVEA to be laser safe while VEAX or VEAY or both are laser hazard.

ALL THREE (3) of the following conditions must be met.

1) The LVEA must be laser safe.

2) The VEAX lasers must be laser safe.

Both PCALX ([M1300574](#))

(PCALX Laser locked OFF with key removed and in KEYBOX)

And ISCBT4L (ISCTEX) ([M1300551](#))

(ALS-X Laser locked OFF with key removed and in KEYBOX)

3) NO OTHER LASER located in the VEAX may be ON.

NOTE: It is possible for VEAX to be laser hazard when the LVEA is laser safe.

ALL THREE (3) of the following conditions must be met.

1) The LVEA must be laser safe.

2) The VEAY lasers must be laser safe.

Both PCALY ([M1300574](#))

(PCALY Laser locked OFF with key removed and in KEYBOX)

And ISCBT5R (ISCTEY) ([M1300551](#))

(ALS-Y Laser locked OFF with key removed and in KEYBOX)

3) NO OTHER LASER located in the VEAY may be ON.

NOTE: It is possible for VEAX to be laser hazard when the LVEA is laser safe.

The following conditions must be met before laser light is introduced into the NHZ.

- 1) The LDR Entrance Door LASER HAZARD LIGHT must be switched to HAZARD.
- 2) Personnel in the LDR and the LAE (PSL) must be made aware of the transition and must be equipped with the appropriate eyewear.

NOTE: It is possible for the LAE (PSL) and LDR to be laser hazard when the LVEA is laser safe.

ALL Four (4) of the following conditions must be met before laser light is introduced into the beam tube.

- 1) The LVEA Entrance Door LASER HAZARD LIGHT must be switched to HAZARD.
- 2) The VEAX Entrance Door LASER HAZARD LIGHT must be switched to HAZARD.
- 3) The VEAY Entrance Door LASER HAZARD LIGHT must be switched to HAZARD.
- 4) Personnel in all of these NHZs must be made aware of the transition and must be equipped with the appropriate eyewear.

NOTE: Normally, the LVEA cannot be made HAZARD unless the VEAX and the VEAY are made HAZARD as well. There are possible exceptions that require a work permit and permission of the LSO.

The following conditions must be met before laser light is introduced into the NHZ.

- 1) The VEAX Entrance Door LASER HAZARD LIGHT must be switched to HAZARD.
- 2) Personnel in the VEAX must be made aware of the transition and must be equipped with the appropriate eyewear.

NOTE: The VEAX must be HAZARD before the LVEA is.

NOTE: It is possible for VEAX to be laser hazard when the LVEA is laser safe.

NOTE: ONLY the designated GREEN-LIGHT-SAFE eyewear is allowed in the VEAX.

The following conditions must be met before laser light is introduced into the NHZ.

- 1) The VEAY Entrance Door LASER HAZARD LIGHT must be switched to HAZARD.
- 2) Personnel in the VEAY must be made aware of the transition and must be equipped with the appropriate eyewear.

NOTE: The VEAY must be HAZARD before the LVEA is.

NOTE: It is possible for VEAY to be laser hazard when the LVEA is laser safe.

NOTE: ONLY the designated GREEN-LIGHT-SAFE eyewear is allowed in the VEAY.

- LIGO-M960001: [LIGO Laser Safety Program](#)
- LIGO-M080368: [LLO NHZ Transition Procedures](#)

- LIGO-M1000236: [LLO 8W TCS SOP](#)
- LIGO-M1000230: [LLO 35W TCS SOP](#)
- LIGO-M1000233: [LLO CrystaLaser SOP](#)
- LIGO-M1000232: [LLO Photon Calibrator SOP](#)
- LIGO-M1000295: [LLO 40mW Fermionics Diode Laser SOP](#)
- LIGO-M1000229: [LLO 35W PSL SOP](#)
- LIGO-M1000235: [LLO 200mW JDSU NPRO SOP](#)
- LIGO-M1100305: [LLO Silica Fiber Welding Machine SOP](#)
- LIGO-M1100038: [LLO 200 W PSL Installation SOP](#)
- LIGO-M1000231: [LLO 100W HPLF SOP](#)
- LIGO-M1000234: [LLO 700mW Lightwave NPRO SOP](#)
- LIGO-M1200103: [LLO 50 W TCS Laser SOP for use in the HPLF](#)
- LIGO-G1101139: [Wave Plate Lockout-Tagout](#)
- LIGO-G1100150: [LLO Safety Document Emphasis](#)
- LIGO-M1200126: [LLO TMS 130mW Alignment Laser SOP](#)
- LIGO-M1200327: [LLO 5W Autocollimator SOP](#)
- LIGO-G1001060: [aLIGO Laser Safety Eyewear Requirements](#)
- LIGO-M1200279: [LLO Input Mode Cleaner Commissioning SOP](#)
- LIGO-M040112: [LIGO Livingston Observatory Laser Safety Plan \(Obsolete\)](#)
- LIGO-M1300458: [Standard Operating Procedure for aLIGO TCS HWS SLED](#)
- LIGO-M1300551: [SOP for operating the Arm Length Stabilization at LLO](#)
- LIGO-M1300574: [LLO PCAL SOP \(Temporary\)](#)
- LIGO-M1400006: [LLO PRC Probe Laser SOP](#)
- LIGO-E1200231: [Advanced LIGO TCS CO2 Laser Projection System Hazard Analysis](#)
- LIGO-M1200041: [IO Laser Power Control - Standard Operating Procedure](#)
- LIGO-E1000205: [aLIGO TCS HWS Hazard Analysis](#)
- LIGO-M1300206: [Standard Operating Procedure for aLIGO TCS 50W CO2 Lasers](#)

Laser Hazard Lights

TYPE 1: ENTRANCES:

1. LVEA Entrance
2. AIRLOCK Entrance
3. LDR Entrance
4. LAE Entrance
5. OPTICS LAB Entrance
6. VEAX Entrance
7. X-END OPTICS LAB Entrance
8. VEAY Entrance
9. Y-END OPTICS LAB Entrance
10. HPLF Entrance

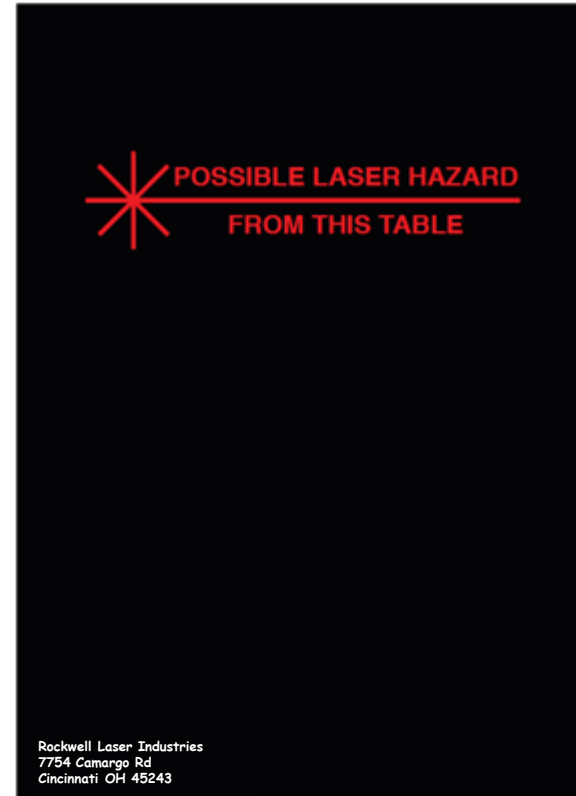
TYPE 2: TABLES:

1. ISCHT1L (IMC)
2. IOHT2L
3. IOHT2R
4. ISCHT6R (OMC)
5. TCSHT4R (Hartmann)
6. TCSBT1R (TCS-Y)
7. TCSBT3L (TCS-X)
8. ISCBT5R (VEAY)
9. ISCBT4L (VEAX)
10. PCALX
11. PCALY

Entrances

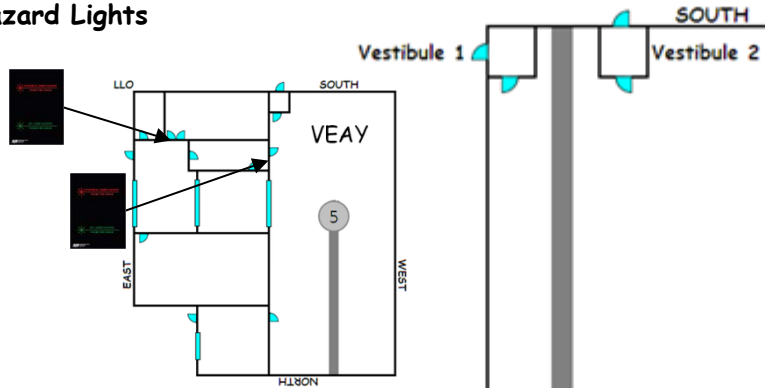


Enclosures



Rockwell Laser Industries
7754 Camargo Rd
Cincinnati OH 45243

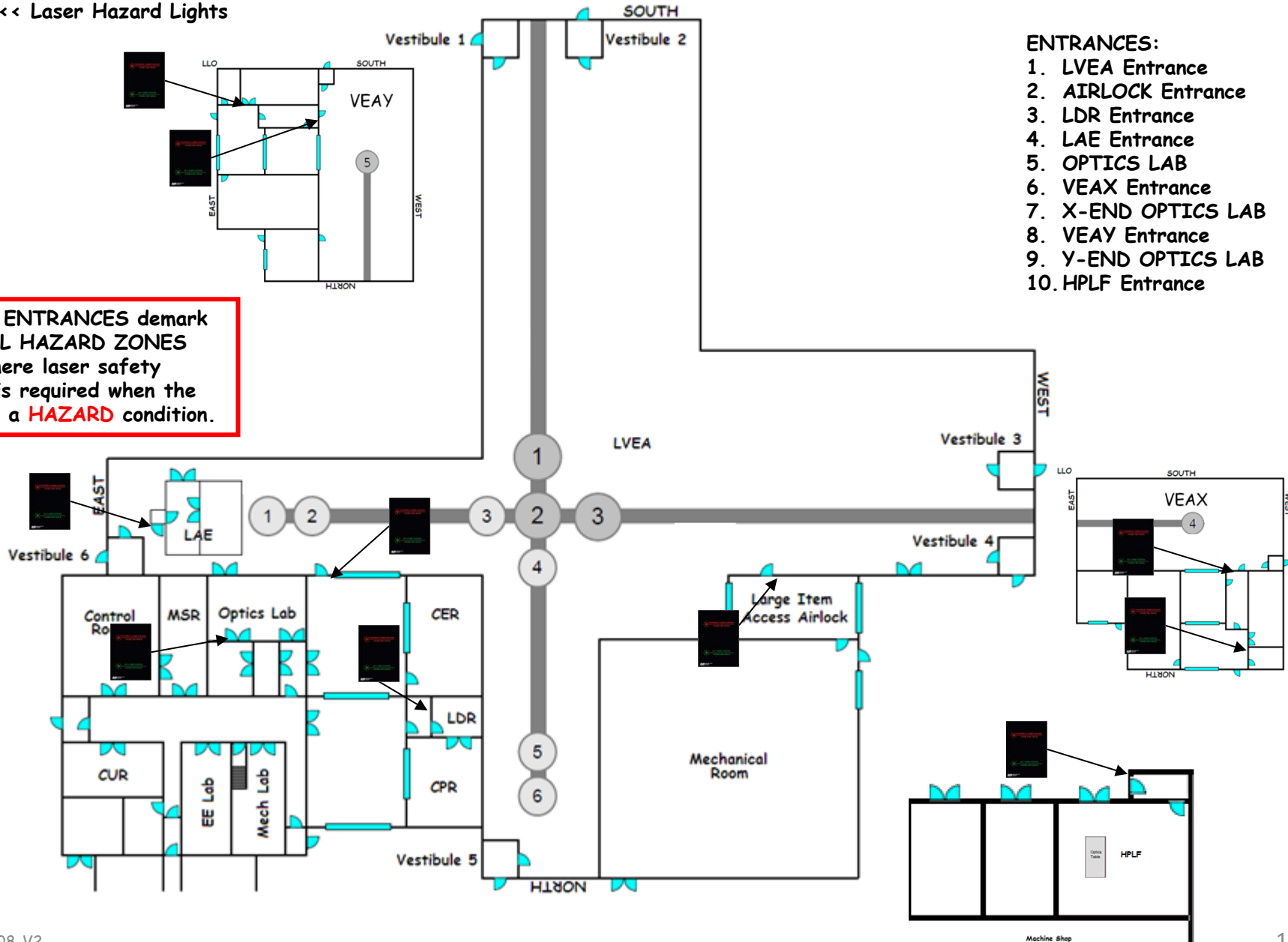
<< Laser Hazard Lights



ENTRANCES:

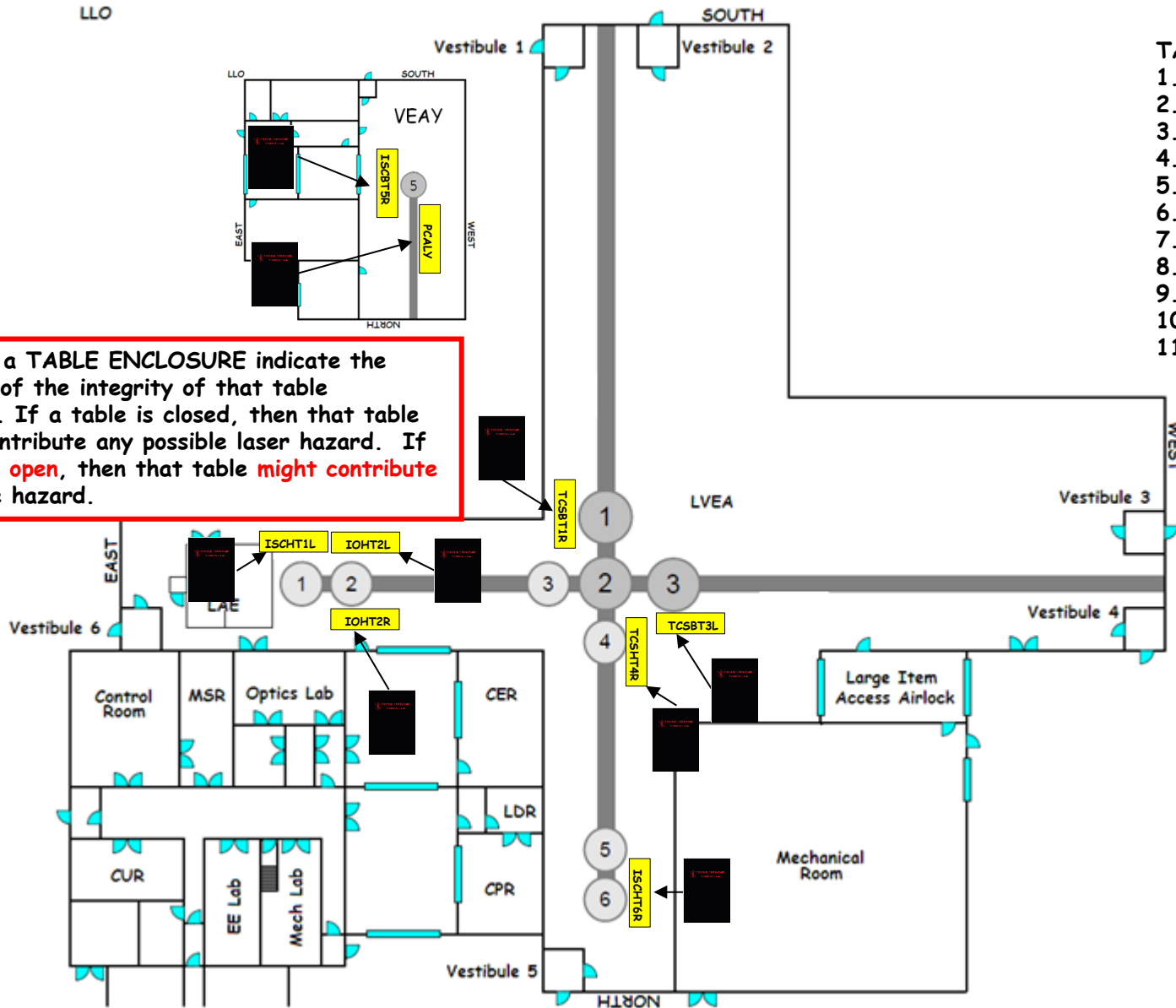
1. LVEA Entrance
2. AIRLOCK Entrance
3. LDR Entrance
4. LAE Entrance
5. OPTICS LAB
6. VEAX Entrance
7. X-END OPTICS LAB
8. VEAY Entrance
9. Y-END OPTICS LAB
10. HPLF Entrance

Lights at ENTRANCES demark NOMINAL HAZARD ZONES (NHZ) where laser safety eyewear is required when the zone is in a HAZARD condition.



LVEA Laser Hazard Light on Tables

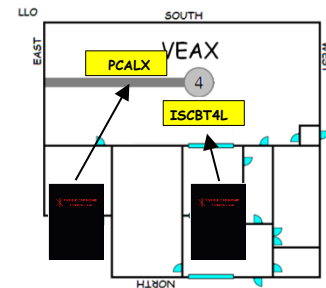
LLO



TABLES:

1. ISCHT1L (IMC)
2. IOHT2L
3. IOHT2R
4. ISCHT6R (OMC)
5. TCSHT4R (Hartmann)
6. TCSBT1R (TCS-Y)
7. TCSBT3L (TCS-X)
8. ISCBT5R (VEAY)
9. ISCBT4L (VEAX)
10. PCALX
11. PCALY

Lights on a TABLE ENCLOSURE indicate the condition of the integrity of that table enclosure. If a table is closed, then that table cannot contribute any possible laser hazard. If a table is **open**, then that table **might contribute** a possible hazard.



Suppose there is a problem that demands that
all the lasers be shut off ...

right *now*.

"Push one of these buttons and the lasers are off."
- Joe Giaime



**EMERGENCY
LASER
ESTOP**

ESTOP buttons are RED mushroom buttons marked **EMERGENCY STOP**. They are located in a variety of places.

If *any* ESTOP is pressed, *all* detector lasers lose their interlocks and cease lasing. These lasers are the PSL, TCS-X CO₂, TCS-Y CO₂, and the Hartmann SLEDs.

In addition, when a Corner Station ESTOP is pressed, the LVEA entrance door, the LVEA AIRLOCK door, and the LDR door will be unsecured allowing them to be opened from the outside without using access cards.

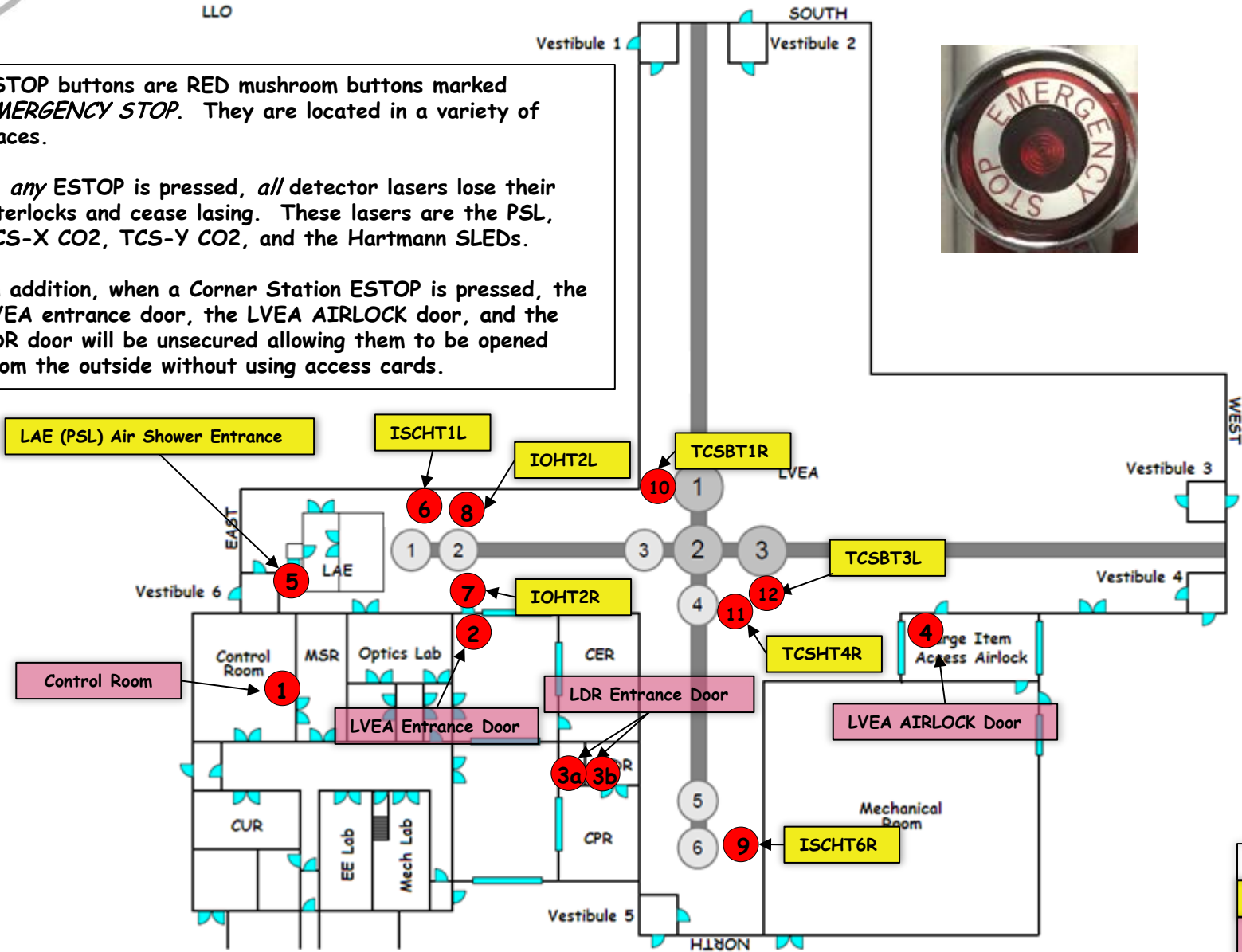


Table Button Type (Standard Access Box)

There is a Standard Access Boxes on each table enclosure, plus one at the entrance to the LAE (PSL) Air Shower.

An ESTOP Button is provided on each Standard Access Box.



Entrance Button Type

There is an ESTOP Button in the control room beside the key box.



Entrance Button Type

There are also ESTOP Buttons strategically located at entrance doors.
There is an ESTOP Button at the LVEA entrance door.
There is an ESTOP Button at the LARGE AIRLOCK entrance door.
There is an ESTOP Button at the LDR entrance door.
There is an ESTOP Button inside the LDR.



If an ESTOP is pressed:

The ESTOP that was pressed causes the latching circuit to unlatch, causing all of the interlocks to be disengaged, causing the various lasers to cease lasing. The ESTOP that was pressed must itself be reset before the ESTOP Control Box is capable of being reset.

An ESTOP Event *must* be thoroughly investigated by the LSO before any further work can proceed. It is a mandatory 'STOP WORK'.

If there is a POWER FAILURE:

The ESTOP Control Box will lose power, causing the latching circuit to unlatch, causing all of the interlocks to be disengaged, causing the various lasers to cease lasing.

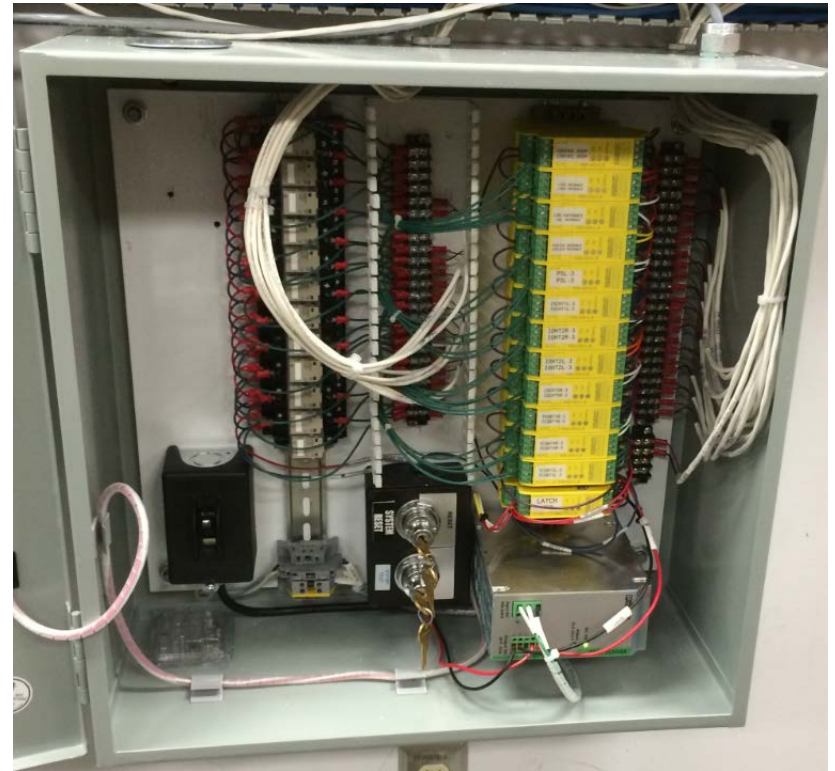
As part of the recovery from a power failure, the ESTOP Control Box must be reset before any laser can be recovered.

Corner Station ESTOP Control Box - OFF

The Corner Station ESTOP Control Box is located in the MSR.

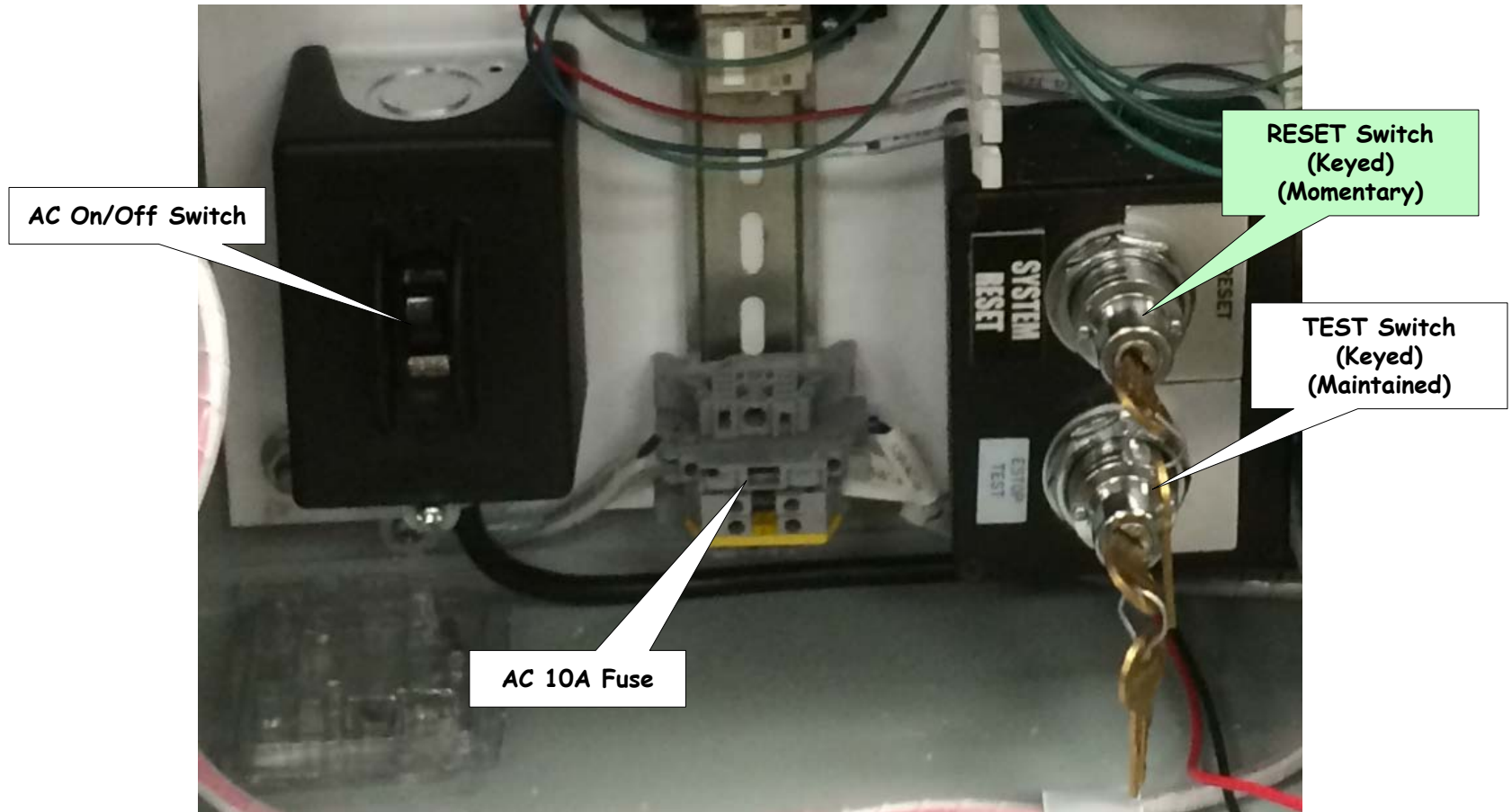


When the Laser Enabled LED (Yellow) is OFF, lasers are prevented from lasing.



Corner Station ESTOP Control Box - Controls

To enable the lasers, the ESTOP Control Box must be reset.



Note: If the Power On LED (Green) is not lit, consider:

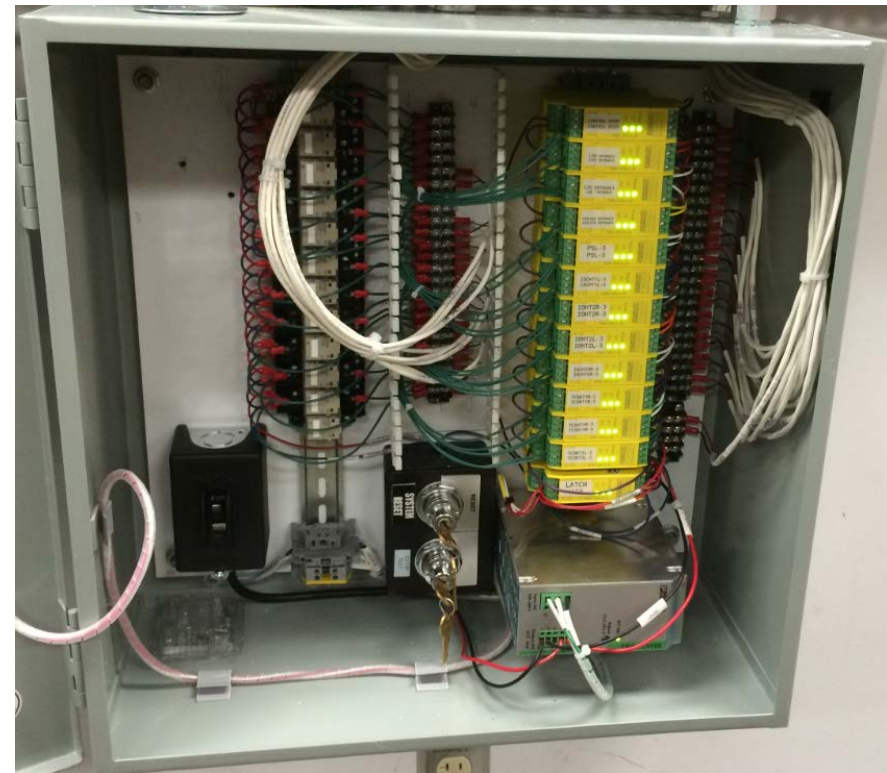
- 1) the On/Off Switch
- 2) the Fuse
- 3) The Circuit Breaker

Corner Station ESTOP Control Box



When the Laser Enabled LED is ON, lasers are not prevented from lasing.

Note: This does NOT mean any laser is on.



Laser Hazard Lights indicate the status of a Nominal Hazard Zone (NHZ). When an NHZ is **HAZARD**, [laser safety eyewear](#) is required.

The status of an NHZ is not based on the actual presence of a laser hazard. Instead, the status is defined by a transition and is signaled by the zone's Laser Hazard Lights.

Although an ESTOP Event causes all controlled lasers to cease lasing, it *will not change the status* of the NHZ, that is, it will not change the state of any Laser Hazard Light.

During an ESTOP Event, one of the first things that must be decided is whether or not to transition the NHZ. This is a manual procedure precisely because there may be mitigating circumstances, and because other actions to insure a safe NHZ cannot be automated.



Laser Safety Eyewear is the Personal Protection Equipment required to be worn by any person who enters a Nominal Hazard Zone (NHZ) NHZ is **HAZARD**.

There are three categories of Laser Safety Eyewear that correspond to the hazardous frequencies that are present in various NHZs.

ALL Laser Safety Eyewear is marked according to Category.

[Category J](#) is for all frequencies in the LVEA.

[Category K](#) is for all frequencies in the PSL and LDR.

[Category M](#) is for all frequencies in the VEAX and VEAY.

Some helpful suggestions:

- Be sure the eyewear you use is correct for the area you are entering.
- Compare the OD written on the eyewear with the OD requirements on the laser hazard signs.
- Clean the eyewear from time to time.
- Inspect the eyewear for structural and optical integrity.
- Return the eyewear to where you got it.



<< [Laser Safety Eyewear](#)

Category J is for all frequencies in the LVEA ONLY.

These are:

- 150 mW @ 900 nm (Hartman) (OD2.2)
- 150 mW @ 950 nm (Hartman) (OD2.1)
- 200 W @ 1064 nm (PSL) (OD5.1)
- 80 W @ 10,600 nm (TCS) (OD4.0)



Category K is for all frequencies in the PSL and LDR.

These are:

- 315 W @ 808 nm (PSL Pump Diodes) (OD5.7)
- 200 W @ 1064 nm (PSL) (OD5.1)
- (NOTE: One must walk through the LVEA to get to the PSL, so for convenience, Category K eyewear also cover the LVEA frequencies.)



Category M is for all frequencies in the VEAX and VEAY.

These are:

- 50 mW @ 532 nm (ALS) (OD2.2)
- 500 mW @ 1047 nm (Photon Calibrators) (OD2.5)
- 200 W @ 1064 nm (PSL, ALS is only 1.5 W) (OD5.1)
- (NOTE: Category M will also cover ALL frequencies in ALL NHZs, but they are harder to see through.)

