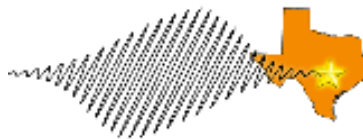


Operational Safety Procedure (OSP)
For The
High Voltage Pulsed Power System
At the
Texas Center for High Intensity Laser Science



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Document Number TPW-D-0012-B

1. Introduction/Purpose

This document establishes policy and procedure to control access to areas of this facility where electrical hazards exist from exposed electrical conductors or high voltage capacitors used with pulsed power. This Operational Safety Procedure (OSP) document also defines specific access procedures and actions required by personnel, students, experimenters and visitors in order to access the pulsed power capacitor room and or catwalks.

The Facility Manager, Mikael Martinez (471-5648) maintains the master copy of this document which is kept on file for reference.

2. Scope

This Safety Procedure shall be used by everyone; all Laser System operators, RI's, and Experimental Personnel must read and sign this document before access to the pulsed power room or catwalks can be granted. Signature and document revision management can be found on the last page of this document.

3. System Overview

The High Voltage Pulsed Power for Texas Petawatt Laser Facility is a system that delivers the voltage needed to fire the flashlamps in the main laser amplifiers. The HV system components are housed in a concrete room (Cave) on the second floor of the High Bay area. A high voltage hazard exists in the Cave room and the associated cable trays that carry the high voltage transmission cables from the Cave down to laser bay. Hazardous liquid mercury is also present in large Ignitron switches which are used in this system. The figure below shows the general layout of the Cave with the capacitor banks, ignitron racks and entry door.

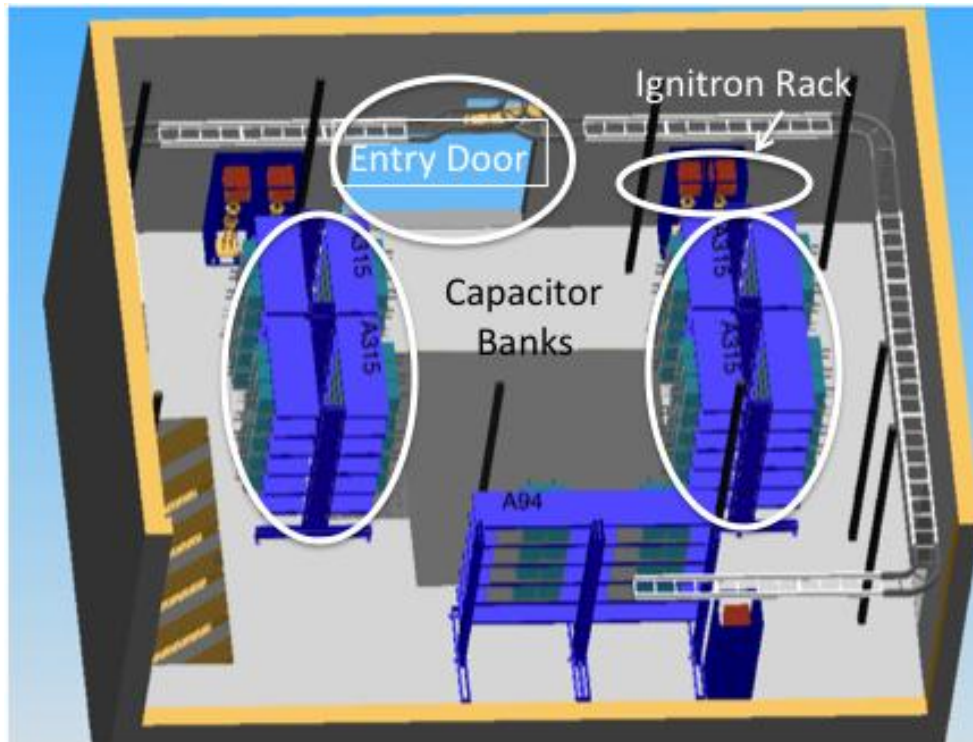


Figure 1. Overview of Cave which houses HV pulsed power components.

4. Descriptions of Pulsed Power Room Hazards

- **Eye Hazard:** The laser system is a Class IV laser and can cause severe eye damage, skin burns and ignite flammable materials. This hazard is present when accessing the Cave when laser light is present in the Target Area.
- **High Voltage Hazard:** All of the electrical apparatus used in the Cave presents a lethal electric shock hazard.
- **Hazardous Materials:** Ignitron switches contain liquid mercury. The large capacitors contain transformer oil. Under normal conditions the mercury and the transformer oil is safely sealed inside their respective housings, but can pose a hazard if leaked.

5. Duties of the Responsible Individuals (PRI) and (RI)

The Pulsed Power system is maintained by the primary responsible individual (PRI) who oversees the normal operation of the high voltage equipment and apparatus used in the pulsed power Cave. The RI is a backup individual who is authorized to change the status of the Cave to SAFE mode for general access (i.e. tours and limited work). The RI is also authorized to change the status to ENERGIZED mode for full system laser operation. An RI can also issue stop work orders or deny access to anyone if it is determined that safety is or will be compromised. Only the PRI can perform repair work, adjustments, testing, and or modifications to the high voltage apparatus in the Cave.

6. Technical Description:

The Pulsed Power system is composed of 20 Pulse Forming Networks (PFN), 40 large 52uF 24KV oil filled capacitors, a HV charging power supply and a liquid mercury Ignitron switch pair. The HV power supply charges all of the capacitors (at the same time) up to a maximum of 22 kV and when a remote fire command is sent, the Ignitrons deliver the stored electrical energy through transmission cables down to the main amplifier flash lamps in the Laser Bay. The charge and fire sequences are initiated by remote system controls in the Facility Control Room. The shot rate of this system can be up to three shots per hour. Below are three photos showing the main components that make up the High Voltage Pulsed Power system.

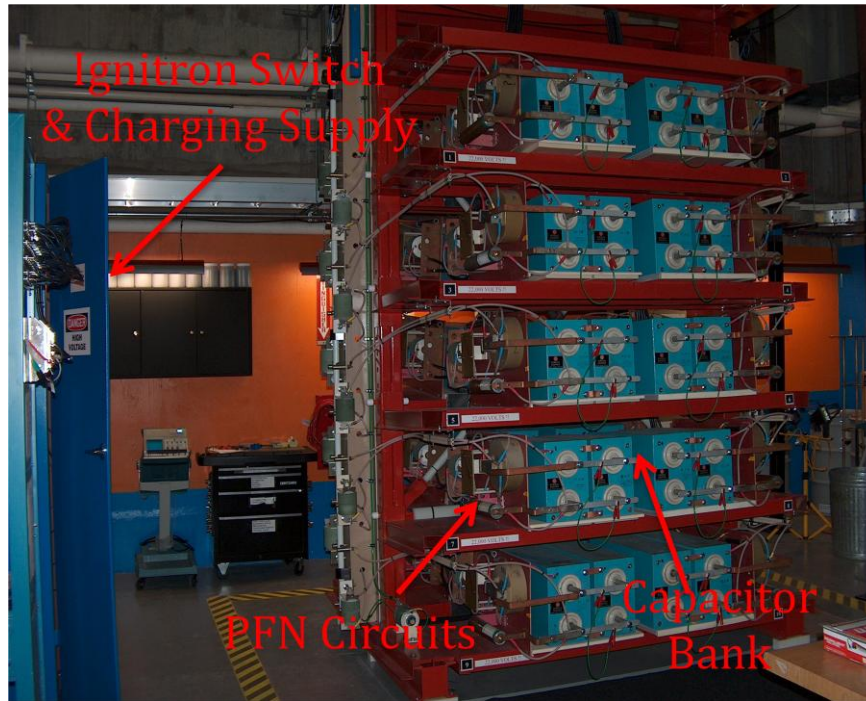


Figure 2: Major components of the Pulsed Power system in the Cave.

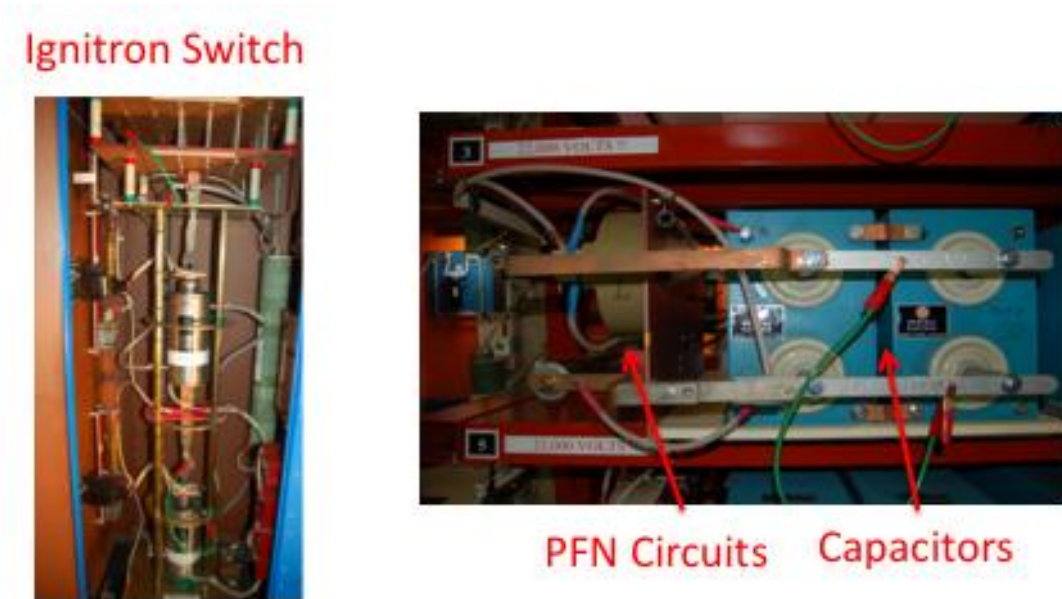


Figure 3: Two Ignitron switches in cab, PFN circuit boards connected to oil filled capacit

7. Modes of Operation:

The Pulsed Power System will be set into one of the three states below.

- **SAFE: (ALL CLEAR):** This mode means that the HV system (ignitrons, capacitors & transmission cables) are discharged and shorted out, primary power is locked out at the mains circuit breaker and room access is safe. In this state, authorized visitors and technical staff are allowed access to the cave. The RI will authorize access or escort at his discretion.
- **RESTRICTED ACCESS:** This is an intermediate state or mode where the high voltage charging power supply circuit breaker is shut off and locked out, however, the capacitors and ignitrons are not shorted out. Although the charge sequence cannot be initiated, a high voltage hazard still exists. In this case, the Cave doors will be padlocked and LCD interlock status panel screens "ISP" will display "Restricted Access" The scrolling message display directly above the Cave entry doors will read "NOT SAFE AUTHORIZED PERSONNEL ONLY".
- **NO ACCESS:** This is the state or mode where all system components are live and charge & fire sequences can be initiated. The Cave doors will be padlocked. The LCD interlock status panels will display "NO ENTRY" and the scrolling message display will read "PP ENERGIZED NO ENTRY!!" When all facility interlocks are activated and the control point has Pulsed Power enabled, red light beacons in the facility will flash indicating the charge and fire cycle can start at any moment. Triggering any of the interlocks will abort the charge cycle discharge the stored energy in the capacitors into the dump-rods resistors network. This WILL NOT lead to a safe mode. Remaining charges on cables and other components can still pose a lethal hazard. Do not access the catwalk over the roof of the Laser Bay.

8. Hazard Indication

There are several LCD Interlock Status Panels (ISP) distributed throughout the facility. Observing these is the best way to identify the current status of the Pulsed Power System. Below are examples of what you will find on the ISP's for the three different status modes of operation.

“**ALL CLEAR**”. Notice the Cave status is shown in **GREEN** indicating all clear, but the Laser Bay and Target Bay status is **RED** “**Wavelengths of 1057 & 532**”. Because the Target Area indicator is **RED**, in order to walk through the Catwalk door, proper laser safety glasses must be worn. There is also a standalone scrolling message sign located above the Cave entry doors which also indicates the Cave status.

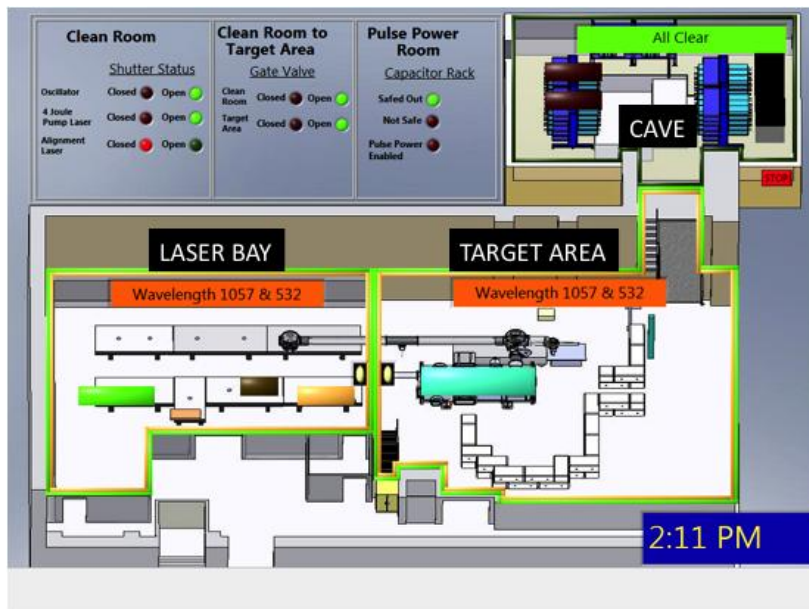


Figure 4. Screen shot of ISP indicating the Cave is all clear but laser hazard is present.

“RESTRICTED ACCESS”.

Notice that the CAVE status on the ISP is now showing **RED**, indicating Restricted Access. The Cave doors are padlocked. The scrolling message sign above the Cave doors will read “NOT SAFE, Authorized Personnel Only!” In this status/mode, the transmission cables are also considered a high voltage hazard, thus an RI escort is required to access the catwalks as well as the Cave.

Also notice on this ISP screen shot where there’s three indicators for “**INTERLOCK ON**”. This means that the interlocks for each respective area have been activated, but in order to fire the entire laser system, the pulsed power will have to be energized and enabled at the control point, which brings us to the next status/mode.

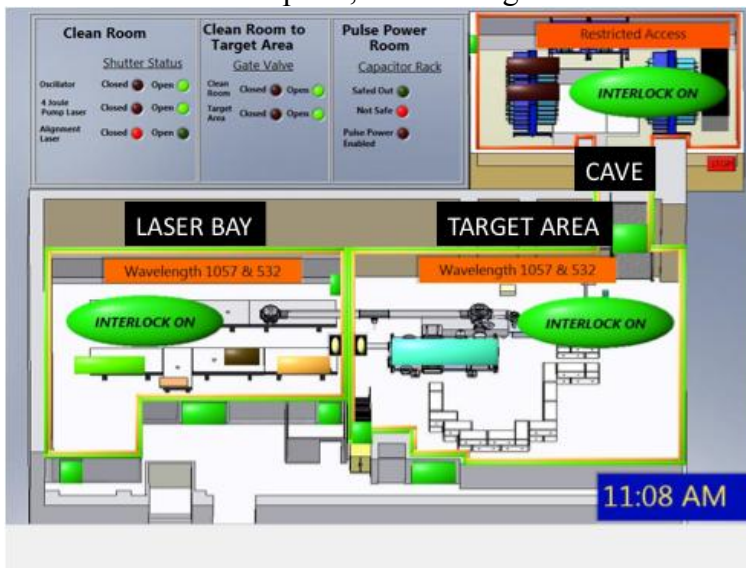


Figure 5. Screen shot of ISP indicating the Cave access is restricted and interlocks are set.

“ENERGIZED”.

In this status/mode you will find the ISP’s showing “NO ENTRY” in **RED**. The Cave doors are padlocked. The scrolling message sign above the Cave entry doors will read “PP ENERGIZED NO ENTRY!” In this mode with all interlocks set and pulsed power energized, the system is now ready to be “enabled” to charge and fire full laser shots. When the pulsed power is enabled at the control point, red rotating warning light beacons in the High Bay, Cat Walk and Cave entry areas will become active.

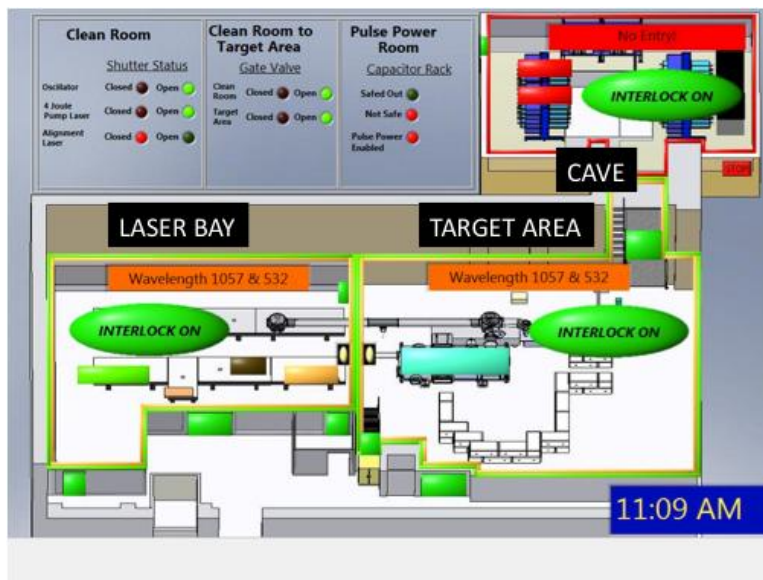


Figure 6. Screen shot of ISP indicating the Cave is in NO ENTRY/ mode with interlocks set.

9. Access to the Pulsed Power Cave/Catwalk:

PRI/RI escort or authorization is required for all access including tours and limited low voltage equipment work. Requests for authorization to access the Pulsed Power Cave or Catwalk must be submitted to the PRI/RI in charge. A list with the PRI and alternate RI’s can be found on the last page of this document as well as posted at the Catwalk entry door and Cave entry doors. The PRI/RI can set the state of the Cave to either SAFE or RESTRICTED ACCESS status depending on the scope of work to be performed by authorized personnel only. The room must in “SAFE” status for tours. If the PRI or RI determines that safety is compromised at any time, they have the authority to stop work or deny access.

Figure 7 below is a photograph of the catwalk entry door with ISP and other warning indicators. Proper authorization is needed to get past this point when laser light is present in the Target Area, or if the pulsed power room is not in “All Clear” status. When the ISP indicates that laser light is present you must wear proper laser safety glasses beyond this point. Note that in this photo, the standalone “DANGER” laser warning sign is lit, which means that a PA warning announcement and or walk through sweep to clear all personnel from the Target area and Cave may happen at any time. If all of the ISP indicators switch to RED and the Pulsed Power enabled rotating beacons become active, the laser system is operational and system shots may be in progress.

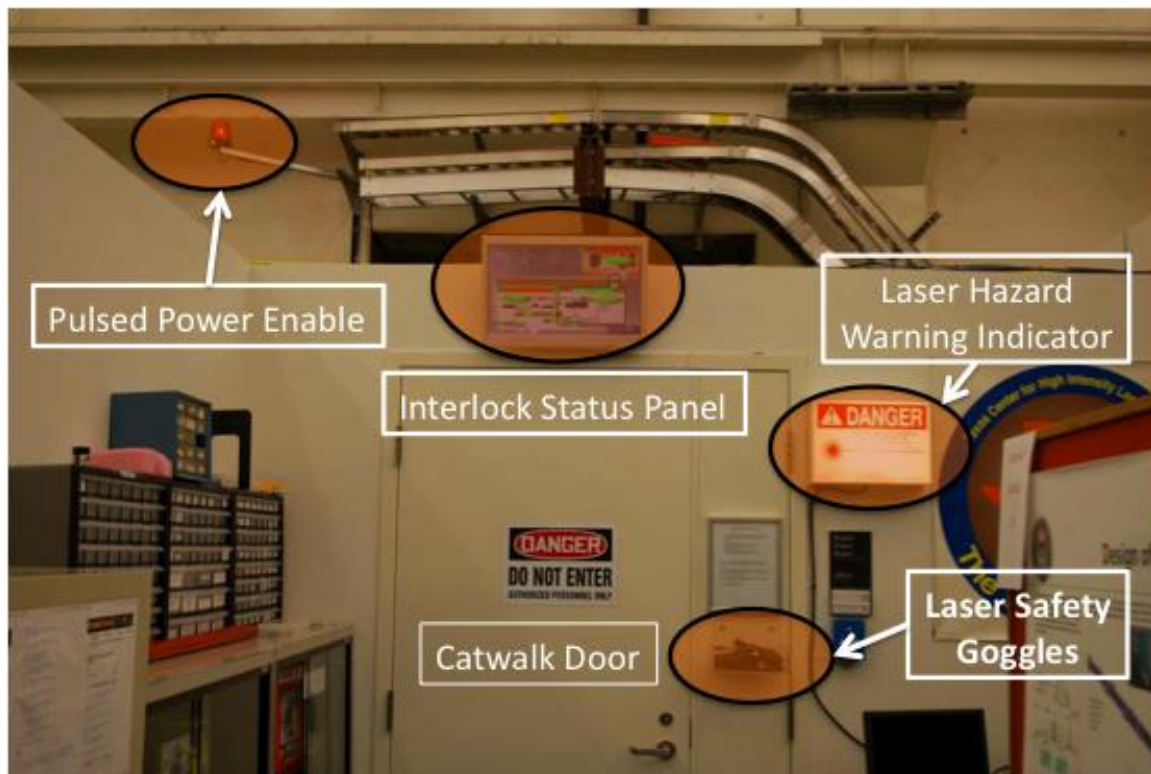


Figure 7. Photograph of Catwalk entry door with hazard indicators.

After entering the Catwalk door, you will see the scrolling message sign above the Cave entry doors which also indicates the current state of the pulsed power system. Located diagonally overhead of the Cave doors and along the left side wall there are cable trays (white) that carry the high voltage transmission cables down to the Laser Bay. These cables are considered a high voltage hazard when the system is in **Restricted Access** mode as well as in **NO ACCESS / ENERGIZED** mode. There is also a yellow safety chain across the stairs blocking access to the upper catwalk where the high voltage transmission cables tray runs along the length of the wall.

This photograph shows the view just inside and beyond the catwalk door.

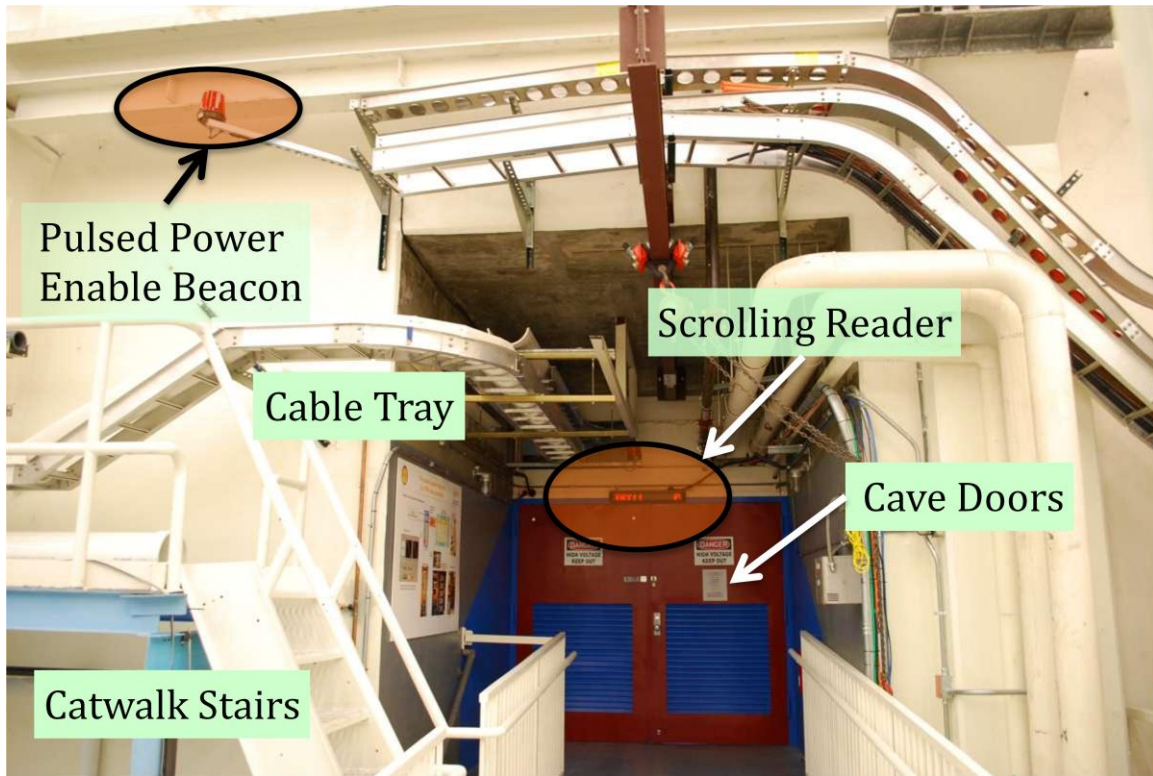
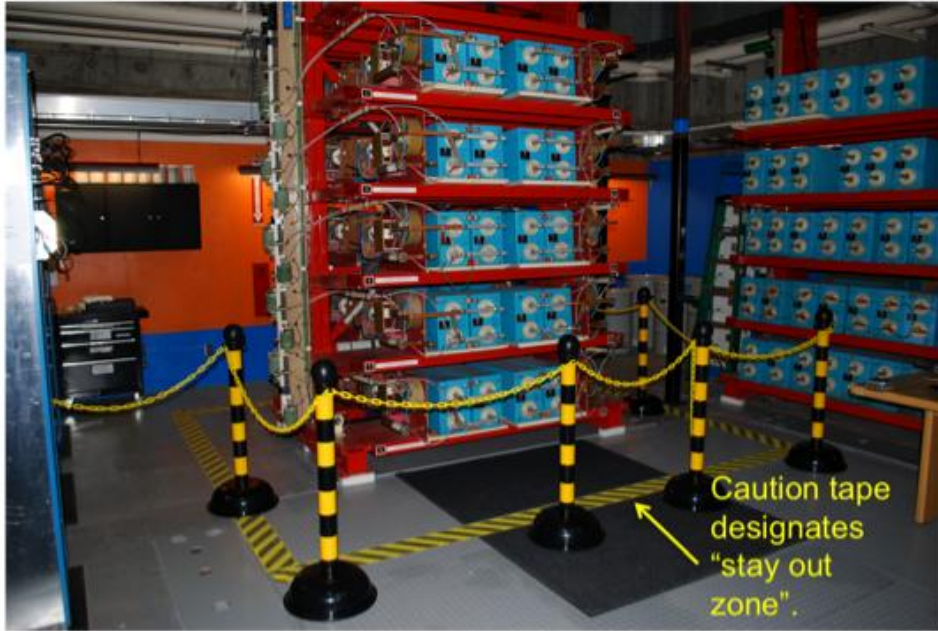


Figure 8. Photograph just inside Catwalk door.

In the Cave, the stay out zone is clearly marked by yellow caution tape on the floor as well as yellow barricade chain. All visitors must stay behind this stay out zone.

Figure 9. Photograph of pulsed power room “Cave”.



ADDENDUM 1

An emergency push-button stop switch has been installed in the Pulsed Power Capacitor Room (cave). This switch is located to the right of the entry doors on the INSIDE of the capacitor room.

The switch is designed to immediately stop the HV charging cycle and drop the energy-dump-rods. This switch is a latching type and will latch in the stop position when pushed. To un-latch, turn the push button ¼ turn to the right, it will then pop out, returning to its “normal” position and status.

The purpose for this switch is to provide an immediate means for the PRI to stop the HV charging cycle from inside the room, such as when performing diagnostics, troubleshooting, and or testing the HV apparatus. This switch may also be used by properly trained emergency personnel. It must be understood however, that pressing this stop switch does not make the room & apparatus electrically “safe”



If the emergency stop switch has been activated (switch pressed) the Shot Director and the Pulsed Power RI must be located immediately and informed of this change in system status.

10. Responsible Individual Contact List

Below is a list of RI's as well as other important contacts:

Primary Responsible Individual (PRI)	Phone Number
Marty Ringuette	232-2880
Alternate Responsible Individual (RI)	
Ted Borger	232-2174
Mikael Martinez	471-5648
Erhard Gaul	471-1803

Emergency Contacts	Phone Number
UTPD Emergency including fire or medical	471-4441
Mikael Martinez Cell	512-554-1309
Ted Borger Cell	925-518-6833
Erhard Gaul Cell	784-4583

12. OSP Revision History

Revision History					
Rev	Description	Author	Reviewed By	Approved By	Date
A	Initial Release	X. XXXXX	X. XXXXX	X. XXXXX	March 2009
B	Modified with the addition of addendum #1 (Emergency Stop Switch)	Marty Ringuette			