Upgraded Injector Test Facility (UITF) Personnel Safety Systems

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Introduction

- The UITF is a new test facility
- Operation of 450KV 3mA photoemission electron gun
- performs electron beam studies and support of other experiments including physics targets, etc.
- It is located in the former Injector Test Stand (ITS) area at the east wall of the Test Lab building.

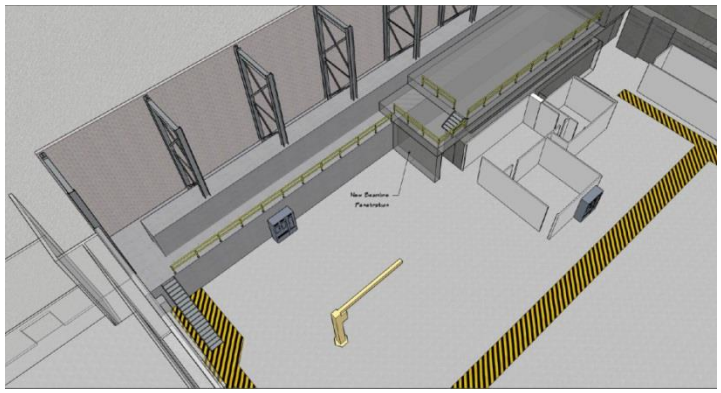
Scope

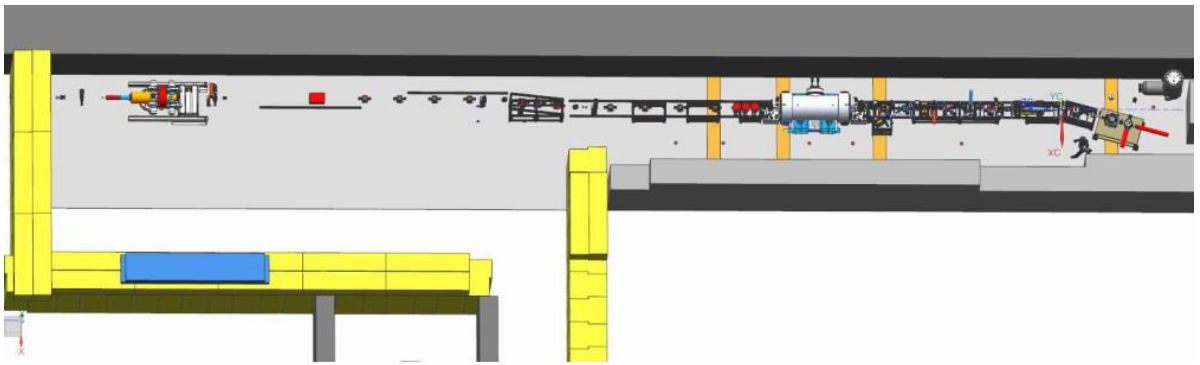
The scope of this presentation is to describe the intended facility and its hazards, and show how each hazard, not already minimized by other methods, will be mitigated by the Personnel Safety System (PSS) or the Oxygen Monitoring System (ODH).

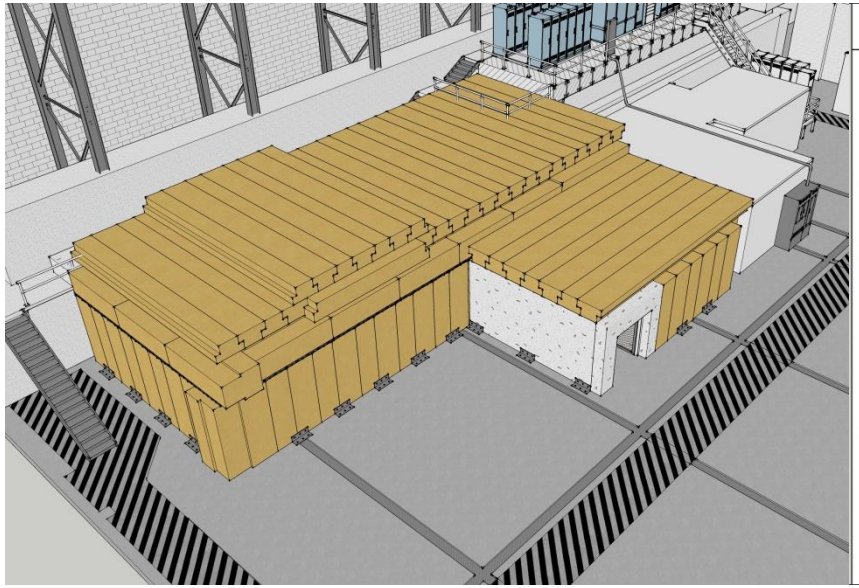
Site Description

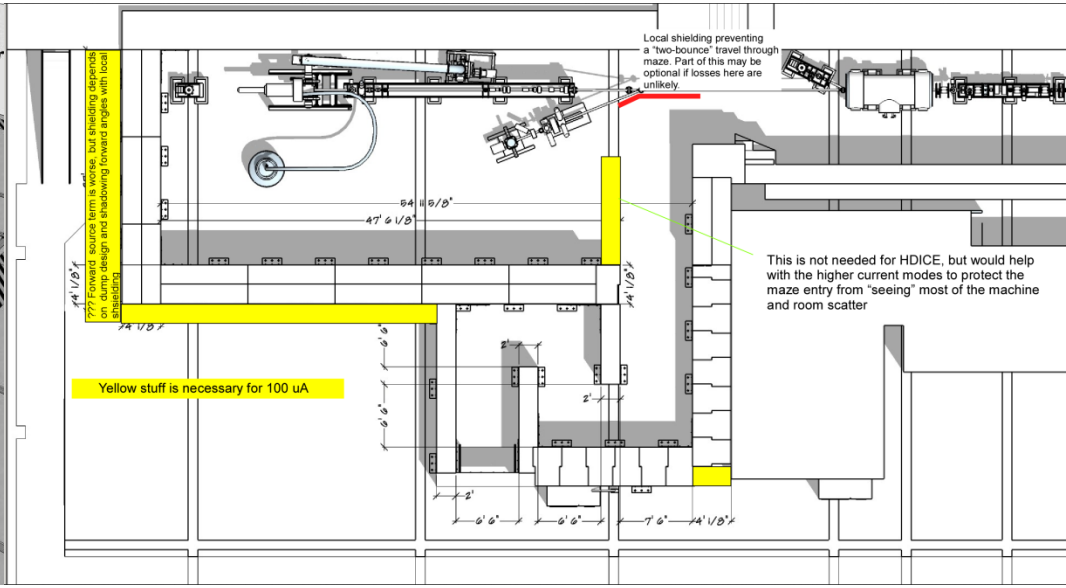
- Environment:
  - 1 entry door, 2 egress points
    - Sliding steel cage door – west wall of vault 2
    - Standard hinged rear door – south wall of vault 1
  - Removable roof sections
  - Permanent passive roof vent
  - Continuous air flow through the original venting system and wire mesh entrance gate

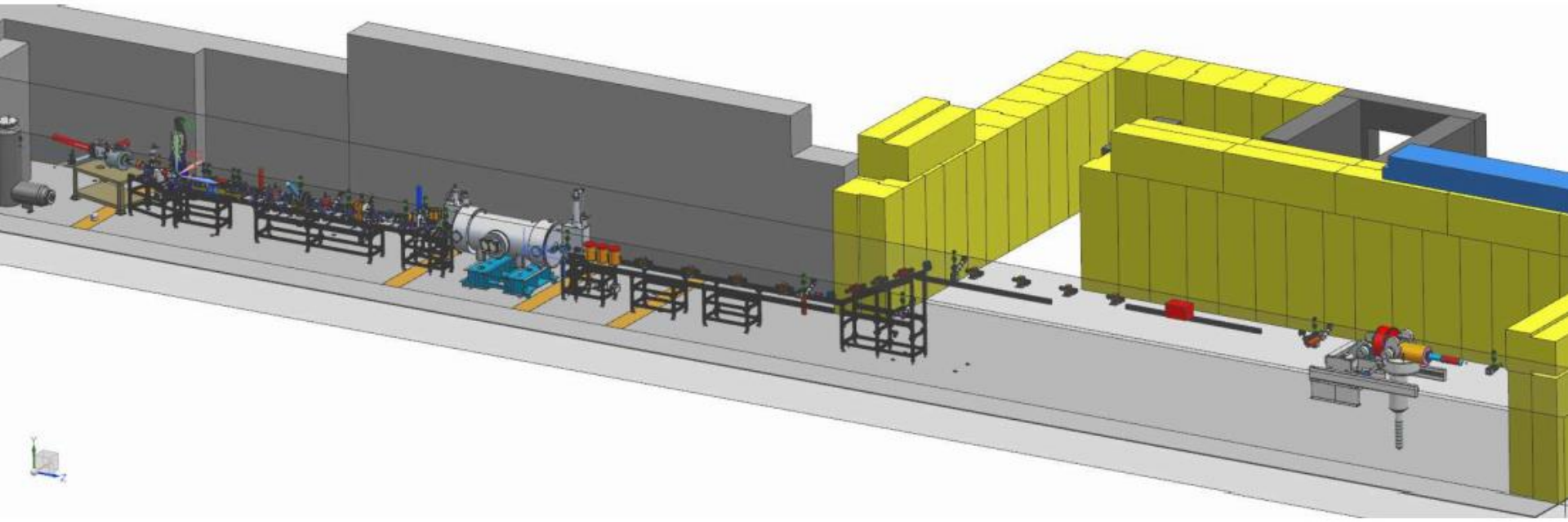
Upgraded Injector Test Facility - UITF











Mandated Requirements

Requirements stemming from DOE orders and JLab EH&S Policy.

SAD1	The PSS shall be designed and operated in a manner consistent with the approved Operations and Safety envelopes.
SAD2	Other PSS systems shall be designed and operated to meet the applicable sections of the JLab EH&S manual.
SAD3	PSS systems shall be certified and tested at an interval consistent to meet regulatory requirements. In the event of a conflict the more conservative test interval shall be used.
SAD4	Personnel performing administrative PSS procedures shall be trained and certified as competent to perform the procedures.
SAD5	Personnel Safety Systems supervising secured PSS areas shall be under the control of trained and certified personnel at all times.
SAD6	The PSS shall meet or exceed the fail-safe requirements.
SAD7	Personnel Safety Systems shall be able to carry out the intended safety functions with a full functional failure of one leg of a redundant (1oo2) system.
SAD8	PSS design and implementations shall be robust against common mode failures.
SAD9	Operations shall be suspended in any area where a PSS function or device is suspected of being defective or compromised. Operations shall not recommence until the problem is fixed and recertified or it is determined that the PSS is performing as designed.

General Requirements

GR1	The PSS shall provide access control, interlock, and alarm devices, which when coupled with other safety layers, reduce the risk of a defined accident to risk code 0 or 1.
GR2	Critical devices shall be used to prohibit beam transport from an operational area to an occupied area.
GR3	A PSS access control system (ACS) shall be used to establish and maintain barriers between personnel and operational hazards.
GR4	A PSS Safety Interlock System (SIS) shall be used to mitigate personnel exposure to hazardous energy from devices interlocked through the PSS.
GR5	The determination of the inclusion or exclusion of devices interlocked through the PSS shall be made during the hazard assessment for each facility.
GR6	Primary Safety Systems shall fail to a safe state or condition.
GR7	The fail-safe state for each PSS device and interface shall be defined.
GR8	Unless otherwise justified in writing, the fail-safe state of PSS controls shall be zero volts.
GR9	The status of any hazardous device which is interlocked through the PSS shall be sensed by the PSS.

General Requirements

GR10	If the indicated status of a hazardous device does not agree with the permitted PSS state, the PSS shall default to the fail-safe state.
GR11	PSS systems for a PSS operational segment (areas) shall have control over all devices which could present a hazard to the segment or control over critical devices that protect the segment.
GR12	The PSS shall provide a means for human initiated emergency shutdown of all hazardous equipment that can affect an access control area (e.g. E-STOP).
GR13	The PSS shall be robust against common failure modes including loss of power, short or open circuits, communication errors, and mechanical damage.
GR14	The PSS mean time to repair shall be consistent with the specified safety availability.

Access Control Requirements

AC1	The PSS shall facilitate establishing and maintaining secure access and exclusion areas.
AC2	The PSS shall monitor the status of all doors that allow access to secure areas.
AC3	No access to a radiation enclosure shall be permitted in an “exclusion” state. If any interlocked door is opened while the PSS is in an “exclusion” state, the PSS system will drop.
AC4	The PSS shall logically require establishing an exclusion area in the beam enclosure prior to permitting operation of a hazardous device.
AC5	The PSS shall remove permits to hazardous devices upon detection of an unauthorized entry to a secure area.
AC6	The establishment of an exclusion area shall require a visual search and secure (Sweep) of the beam enclosure.
AC7	The search and secure pattern (Sweep) shall follow a designated pattern designed to ensure all beam enclosure areas are observed.
AC8	The PSS shall provide clearly visible status indicators of the “Safe” or potentially “Unsafe” status within the beam enclosure.
AC9	The PSS shall provide an audible warning before transitioning from a “Safe” state to an “Unsafe” state.
AC10	The PSS shall provide clearly visible status or warning indicators outside of each entrance to the beam enclosure. The status indicators shall be an indication of a potential radiation area.

Access Control Requirements

AC11	The only designated access points to a secure enclosure shall be through dedicated access areas. All other doors shall be considered as “emergency exit only.”
AC12	During a sweep or controlled access only one of the two access doors may be in the open position. Both doors open simultaneously shall be considered a breach of the enclosure, resulting in a drop to the safest state.
AC13	Secure access points shall be equipped with PSS door interlocks, interlocked exchange tokens, communication, and remote monitoring equipment.
AC14	The PSS shall impede entry into an exclusion area by use of electrical or mechanical door locks.
AC15	All electrical locks shall automatically engage when the PSS is in an “Unsafe” state.
AC16	Unless justified in writing, PSS access controls shall not impede life-safety egress from a beam enclosure.
AC17	
AC18	
AC19	
AC20	
AC21	

Interlock Requirements

SIS1	Unless justified in writing, the SIS shall be implemented with 2 independent (redundant) chains with 1 out of 2 (1oo2) shutdown capability.
SIS2	The two SIS divisions (chains) shall extend from the sensor to the final device.
SIS3	Each division shall remain independent of the other from the field sensing device up to the final control element.
SIS4	Control and status signals of any equipment not under the direct configuration control of the PSS group shall be electrically isolated from SIS equipment.
SIS5	SIS equipment and wiring shall be located in dedicated PSS racks, conduit, or cable tray.
SIS6	All SIS interlock functions shall be safe against single chain undetected failures.
SIS7	No single chain failure shall result in the ability to energize a hazardous device while personnel may be exposed to a hazard otherwise mitigated by the SIS.
SIS8	The SIS system shall be designed to reduce the risk of hazards resulting from unauthorized access to an enclosure to a risk level 0 – Little to no consequences/Extremely unlikely.
SIS9	The SIS system shall be designed to reduce the risk of exposure to high power microwave radiation to level 0 – Little to no consequences/Extremely unlikely.
SIS10	The SIS shall not be used to provide the normal on/off control of an interlocked device.
SIS11	The PSS shall not automatically reset once a tripped interlock is restored. A manual reset by a qualified operator is required.

Hazards

Prompt ionizing radiation due to high power beam operations

Mitigation:

- Gun High Voltage Power Supplies (HVPS) permits:
  - AC contactor (direct)
  - HVPS “Enable” circuit (direct)
- Laser permits:
  - MacroPulse (pockels cell) control
  - Shutter control (direct)
- Required conditions:
  - Cave in “Run” state (exclusion mode)
  - All CARM status = OK
  - Beam current within limits

Hazards

Prompt ionizing radiation due to RF cavity field emission

RF radiation (non-ionizing) emitted from waveguide joints or open sections (over 5 mW/cm^2)

Mitigation:

RF High Voltage Power Supplies (HVPS) permits require:

- Cave in “Run” state (exclusion mode)
- All CARM status = OK
- Waveguide pressure status?

Hazards

Eye hazard due to accidental exposure to drive laser light when the vault is in laser alignment mode

Mitigation:

Assumption: CIS staff will develop safety controls for all possible lasing conditions

Gun HVPS ON when the during laser alignment

Mitigation:

Laser Bypass switch will allow laser alignment and disable Gun HVPS in the “Bypass” position

Hazards

ODH - Oxygen deficiency hazard resulting from a gas/liquid release in the vault.

UITF has been evaluated and is designated an ODH 0 area.

Mitigation:

- Fixed monitoring system (3 sensors)
- Audible and visual warnings
  - within the cave
  - at each entrance
  - in the Control Room

Interfaces

The PSS will provide “Run” mode permits to Gun HVPS control chassis, Laser control chassis, and shutters

- The CIS group will provide an interface to the MacroPulse circuits.

The PSS will provide “Run” mode permits to RF HVPSs contactor and clamping circuits

- The RF group will provide connections for contactor control and output status (or the PSS will use its own contactor)

The Radiation Control Group will provide CARMs/probes with PSS interlock connections

Special Requirements

After the UITF is in the Run state there must be a 30 second time delay before the Gun or RF HVPS or the Laser can be enabled

CARM faults drop PSS permits (Gun, RF, Laser), but not the PSS “Run” state

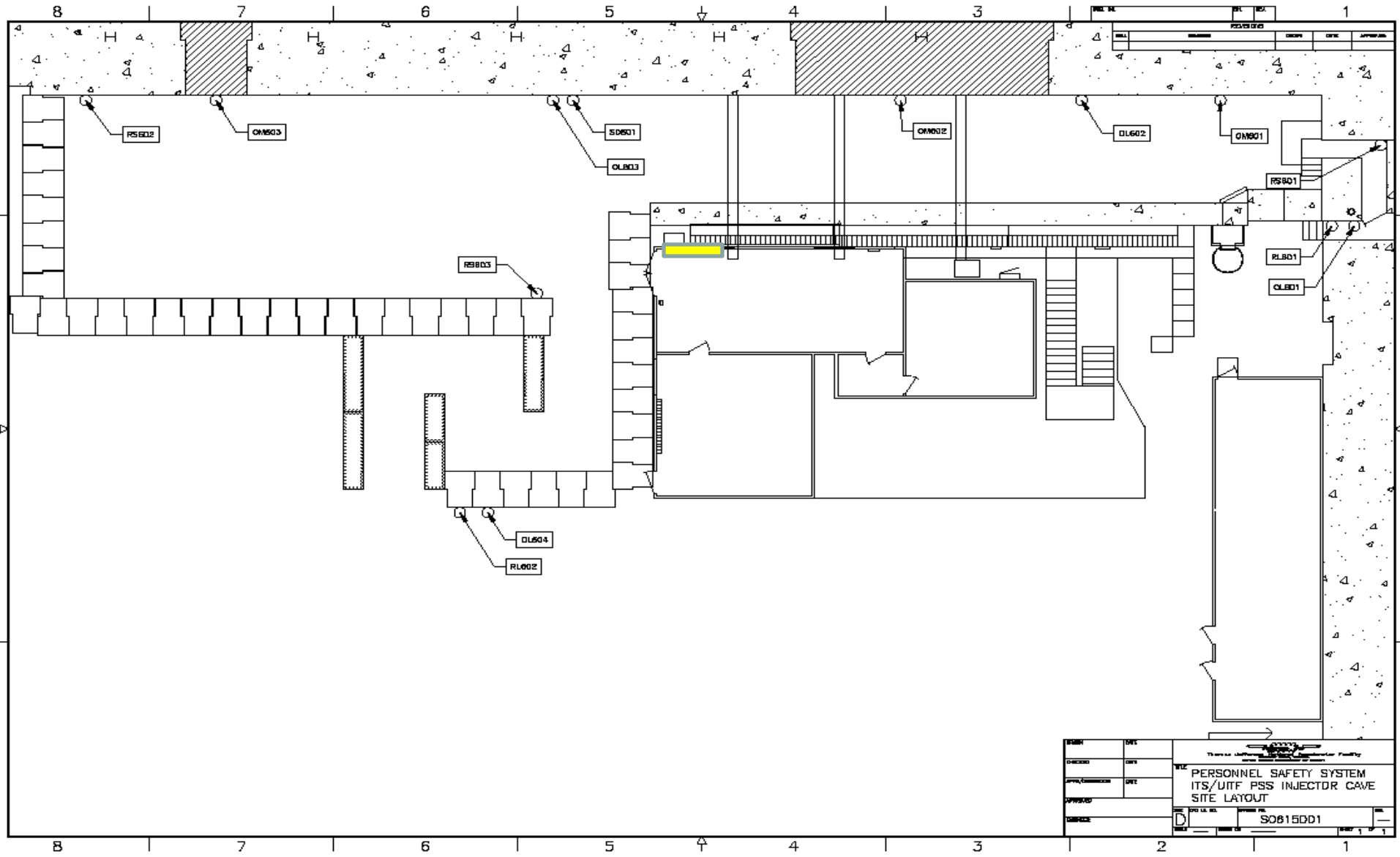
Assumptions

Fixed and removable shielding - i.e. concrete and steel walls, doors, vents and blocks - are adequate to meet all safety requirements that are not protected by functions of the PSS

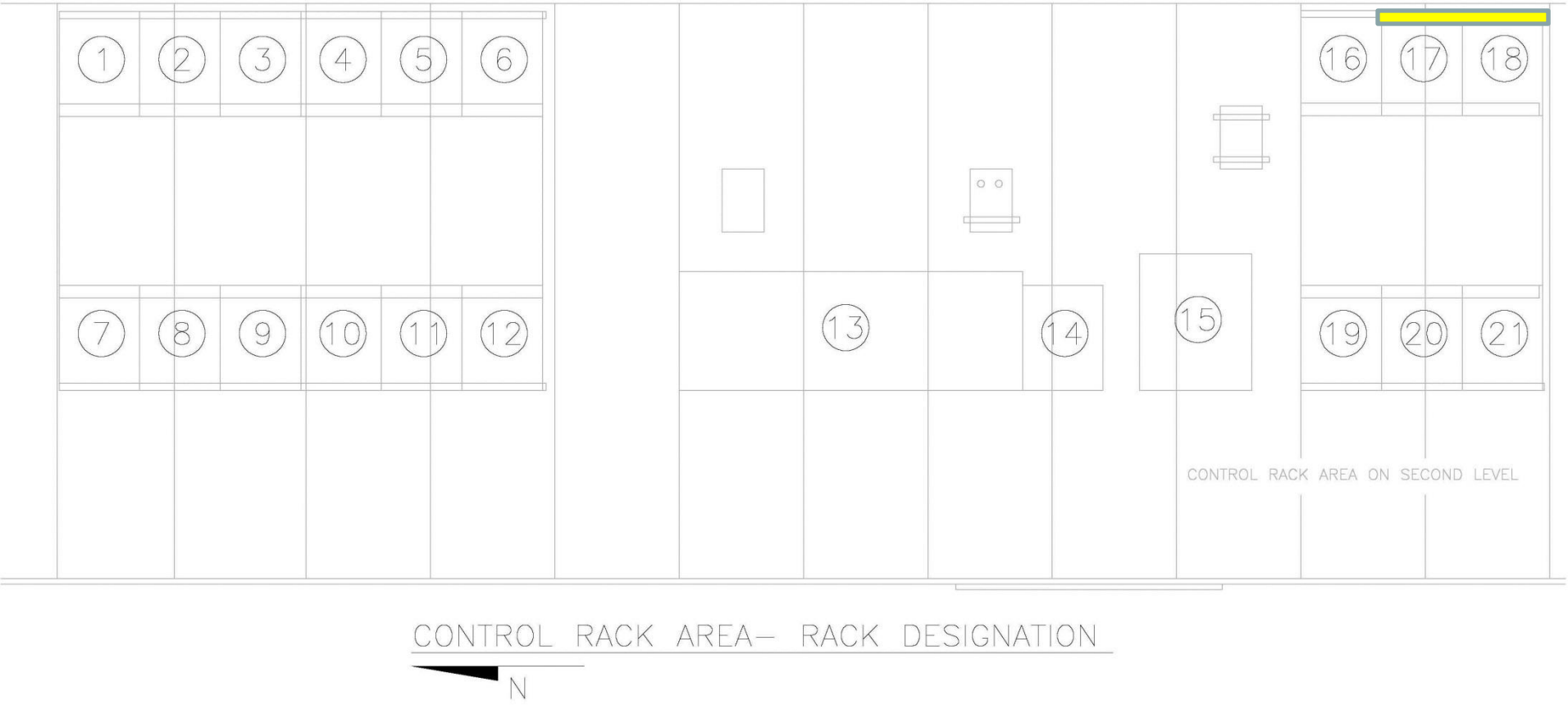
Trip Functions

FAULT	ACTION TAKEN: Drop RUN state	Drop Sweep Complete	Shut off Gun Permits	Shut off RF Permits	Shut off Laser Permits	Insert Shutters
Access Control Fault	✓	✓	✓	✓	✓	✓
ESTOP Crash	✓	✓	✓	✓	✓	✓
Status of Interlocked Device inconsistent with PSS State	✓	✓	✓	✓	✓	✓
RF Waveguide Interlock Fault	✓		✓	✓	✓	✓
Radiation Monitor Alarm			✓	✓	✓	

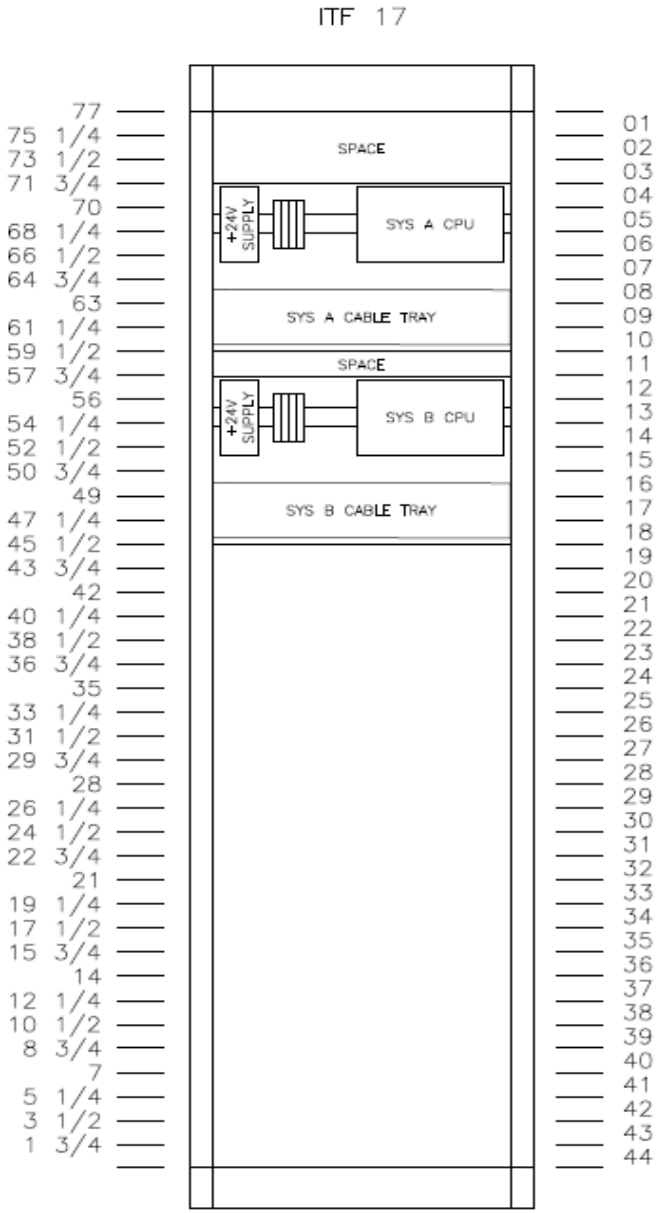
VAULT EQUIPMENT LAYOUT FOR PSS AND ODH



PSS RACKS ON UITF MEZZANINE (17, 18)



PSS Racks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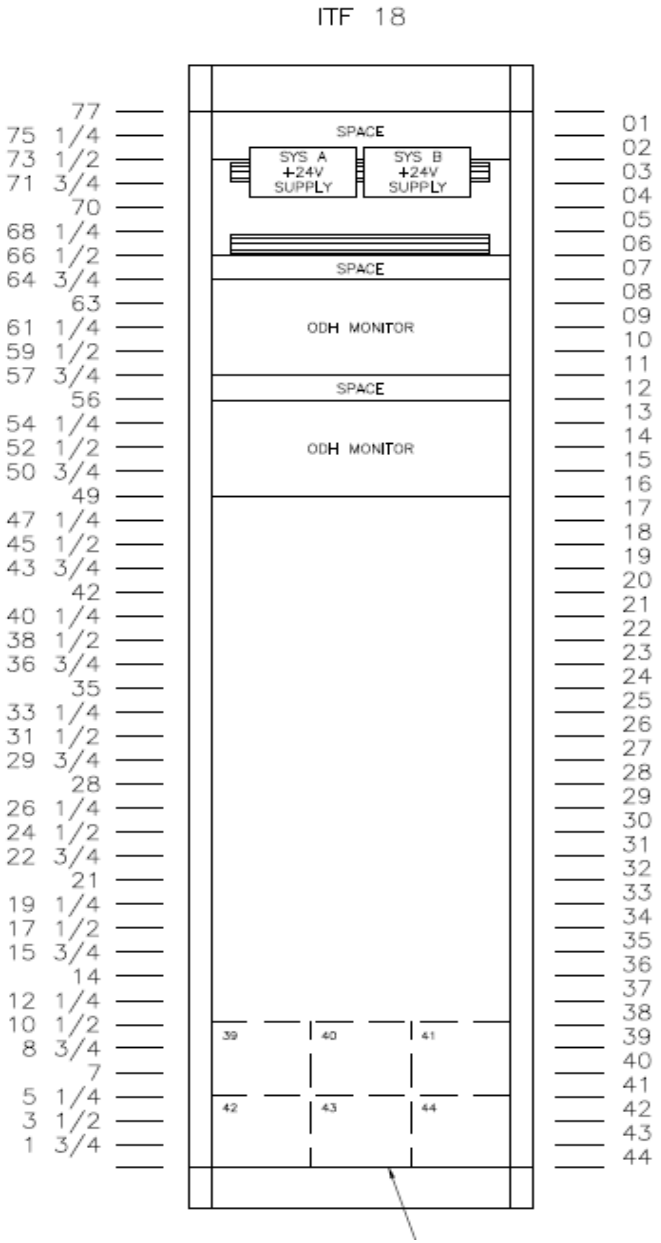
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SYS B +24V SUPPLY
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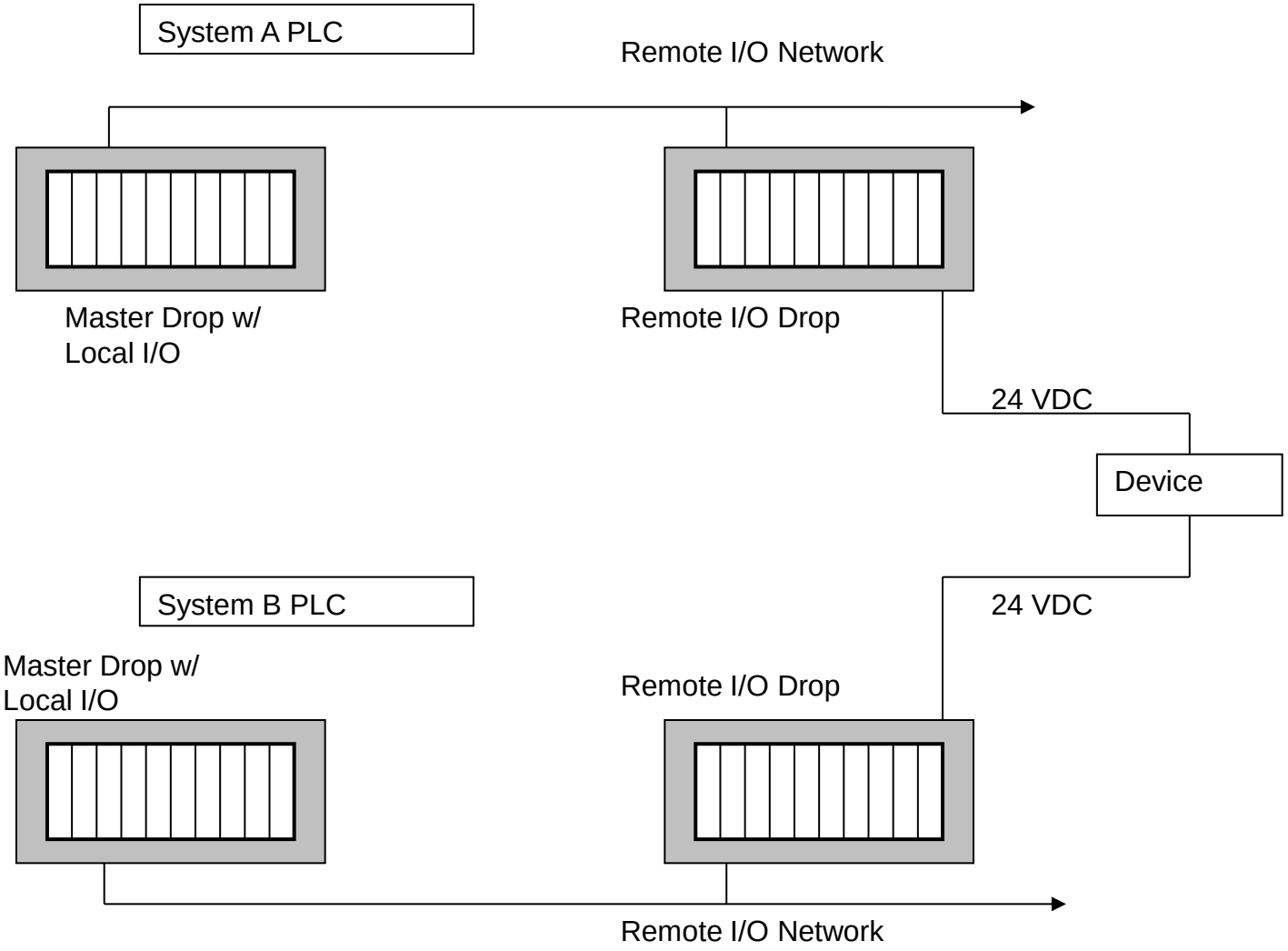
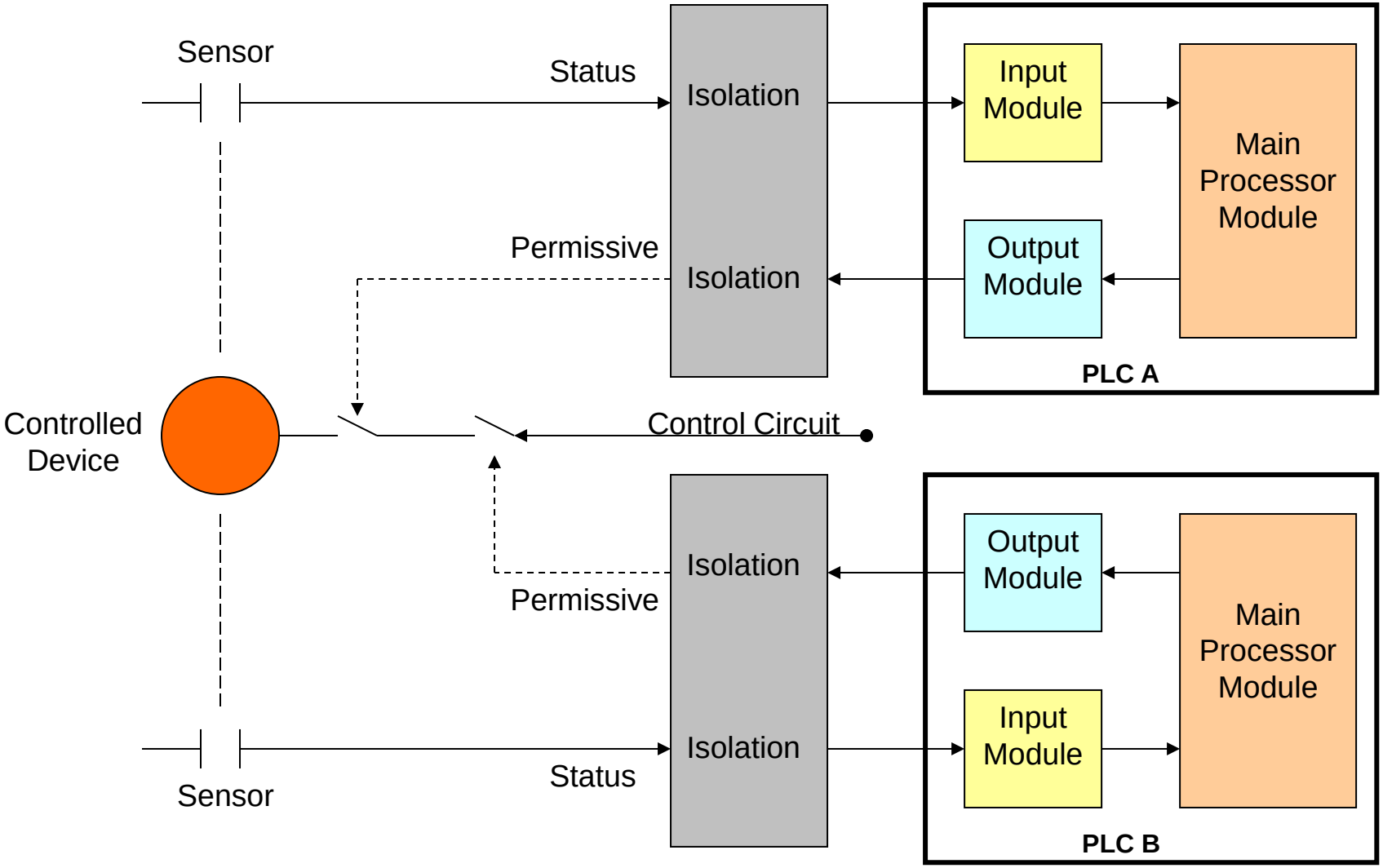
Architecture



Architecture



PSS Equipment Protection / Isolation

- Locked, isolated racks
- Separate conduits / boxduct
- Isolated interfaces to Gun HVPS, Laser, and RF systems

Operational Modes

Open State

- No Gun or RF HVPS permitted
- Laser permitted only in “Bypass” laser alignment mode

Sweep State

- No Gun or RF HVPS permitted
- Sliding steel gate and rear door must be fully closed when sweep complete

Operational Modes

Run State

- Area must be swept and secured
- Gun / RF HVPS permitted (30 second delay)
- Sliding gate closed
- Rear door closed
- Crash buttons active
- Audible warnings (for 30 seconds)
- Visible warnings (continuous)
- CARMs active
- Sweep Key in RUN position

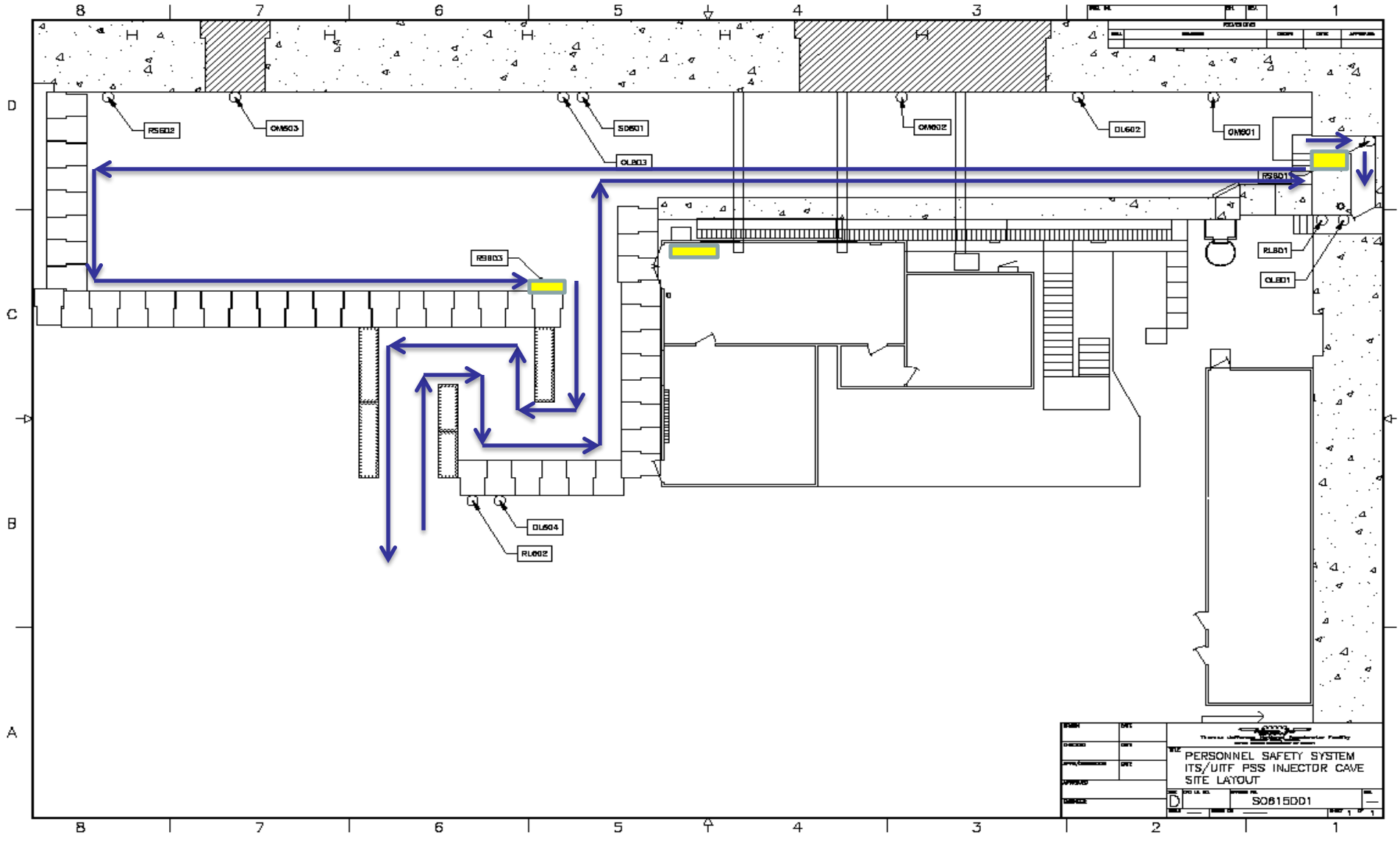
Internal Mode

Ready State = Sweep Complete

- Not Open
- Not Sweep
- Not Run

Sweep/Secure Process

- Two sweepers are required
- Sweep key will be kept in PSS interface panel (UITF control room)
- Sweep Key is switched to “Sweep” mode to start
- Sweep includes Run/Safe Boxes 01 and 02
  - Sequence = RS02, then RS01
- Upon arming RS01, close steel gate and exit (30 seconds)
- Sweep Key is returned to PSS panel and switched to “Run” to begin operations


RS602
OM603
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PERSONNEL SAFETY SYSTEM
ITS/UITF PSS INJECTOR CAVE
SITE LAYOUT
SD615DD1

Any questions?