OAK RIDGE National Laboratory

Safety Documentation Overview

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U.S. DEPARTMENT OF ENERGY

Regulatory Drivers

1. DOE Order 420.2D *Safety Of Accelerator Facilities*
   - Requires Approved Safety Assessment Document (SAD)
   - Requires DOE Approval of Accelerator Safety Envelope (ASE)
   - Requires Unreviewed Safety Issue (USI) Process for the evaluation of accelerator activities that have the potential to significantly impact safety
2. DOE Guide 420.2-1A, *Implementation Guide* for Order 420.2C
   - Provides guidance for complying with DOE Order 420.2C
3. SBMS Subject Area for Accelerator Safety
   - Essentially mirrors order requirements
   - Establishes line mngt responsibility to ensure appropriate FSAD/ASE developed and updated as needed.

SNS Safety Documentation and Location

1. Two Final Safety Assessment Documents (FSADs):
   FSAD-Proton Facilities (FSAD-PF)
   FSAD-Neutron Facilities (FSAD-NF)
2. Single Comprehensive ASE addresses entire complex
3. Unreviewed Safety Issue Evaluations viewed as addendums to safety assessments, material folded into FSAD updates as appropriate.
4. Locating SNS Safety Documentation:
   FSADs and ASE found in OPM 2.B and EDRM
   USI Evaluations found in Safety Documentation section of the SNS ESH webpage and EDRM

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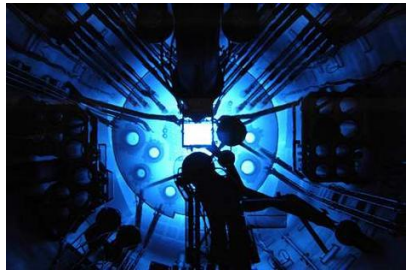
SNS Safety Assessment Documents

FSAD-PF and FSAD-NF Continue as Separate Documents at SNS

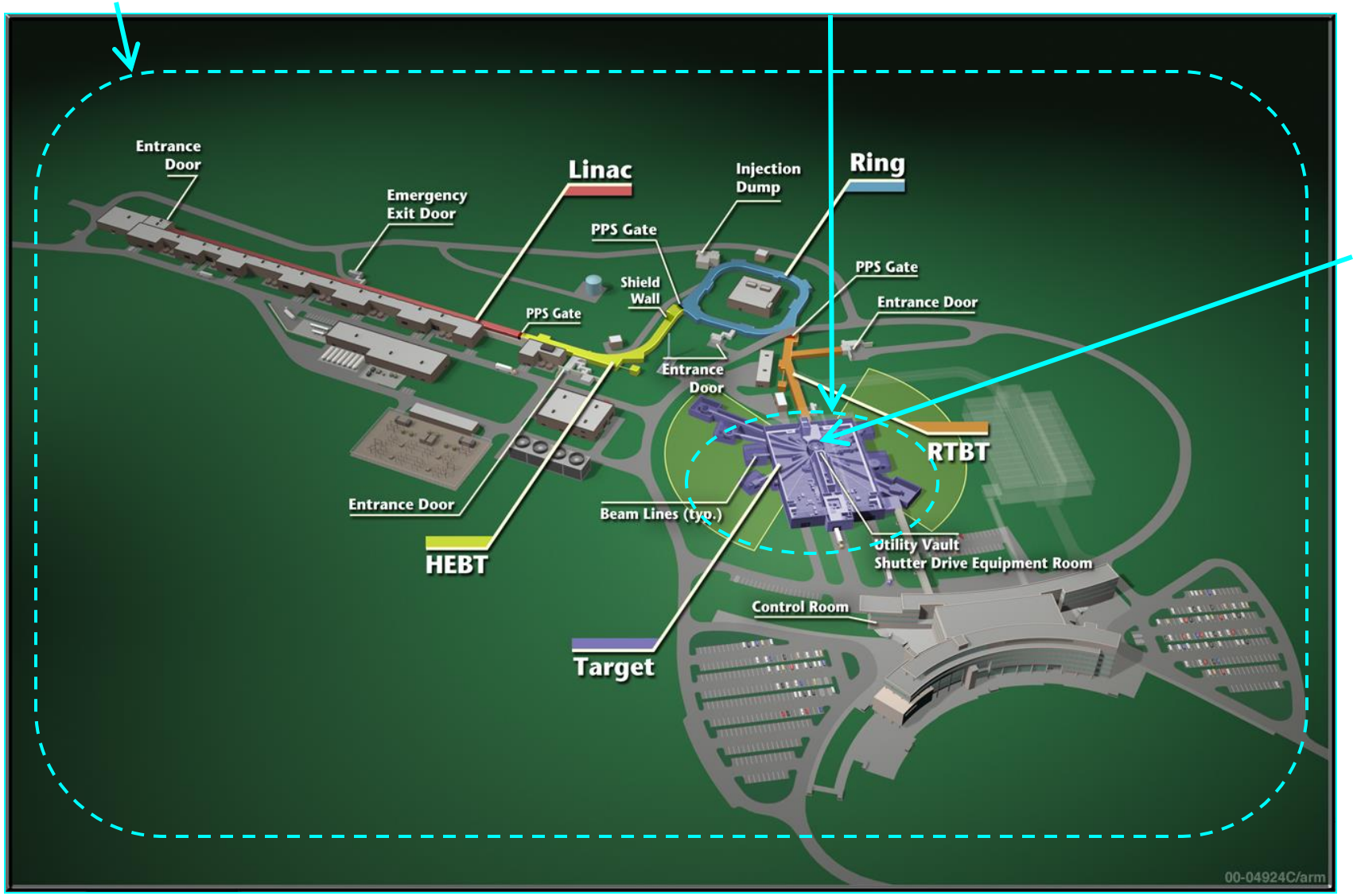
- FSAD-PF – traditional accelerator community approach
  - Address hazards associated w/ proton accelerator
  - Addresses site-wide hazards and issues
  - defers to ORNL Standards Based Management System (SBMS) for standard industrial and laboratory hazards (e.g. hoisting and rigging, electrical safety, etc.)

- FSAD-NF – originally developed using *nuclear facility* approach
  - addresses Neutron Facility hazards (target systems and neutron instruments)
  - defers to the FSAD-PF with regard to common site wide issues
  - defers to ORNL SBMS for standard industrial/lab hazards



2 FSAD Documents - interface at Proton Beam Window

Proton Facilities **Neutron Facilities**



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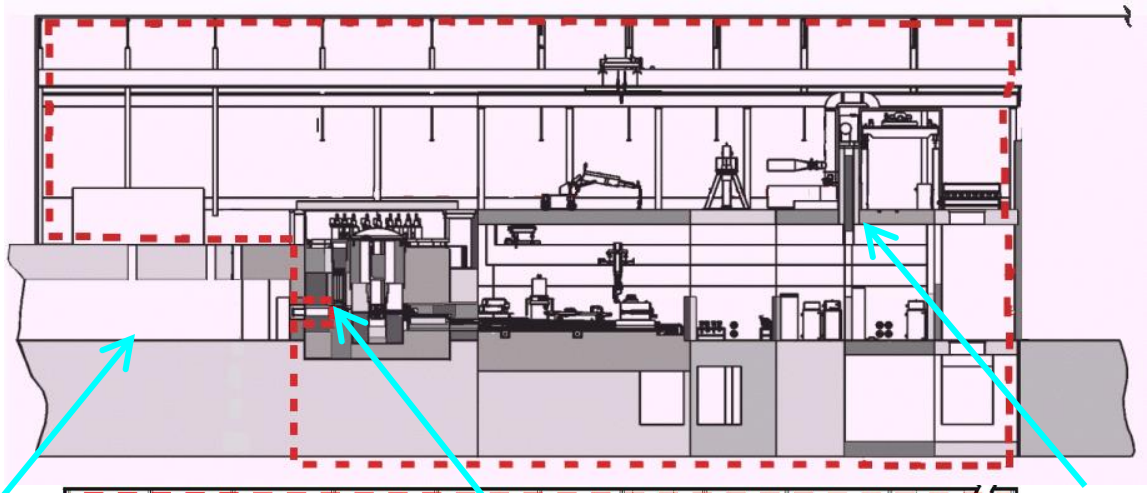
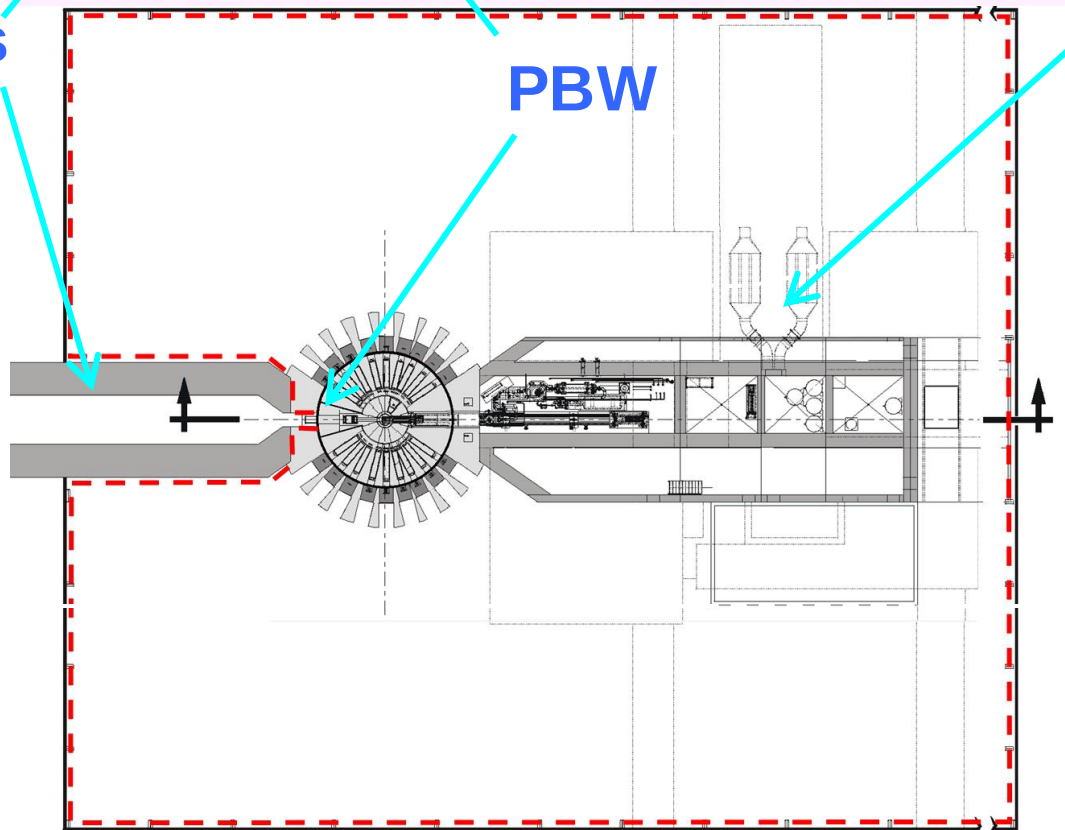
2 FSAD Documents - interface at Proton Beam Window





Proton Facilities

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Neutron Facilities

FSADs – Basic Format and Content

FSADs address basis for safe operations of SNS

- Chapter 1, Introduction
- Chapter 2, Summary and Conclusions
- Chapter 3, Site, Facility, and Operations
- Chapter 4, Hazard and Accident Analysis
- Chapter 5, Credited Controls and Basis for the ASE
- Chapter 6, Interfaces between Proton and Neutron Facility
- Chapter 7, Instrument Systems Hazards[1]
- Chapter 8, QA

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[1]FSAD-NF Only

FSAD Chapter 3 *Site, Facility and Operations*

- Provides site description (FSAD-PF)
- Provides facility description including
  - Processes (i.e. Hg process loop, cryogenic moderator system, accelerator systems, etc.)
  - Support systems
  - Credited controls
- Describes administrative processes supporting operations

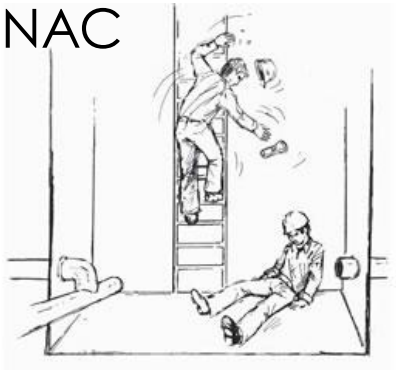
FSAD Chapter 4 *Hazard/Accident Analysis*

- Presents analysis methodology
- Identifies and evaluates hazards to workers and potential accident scenarios
- Identifies controls to protect workers
- Identifies and evaluates hazards to public and potential accident scenarios (FSAD-NF only)
- Identifies need for additional controls to protect public (FSAD-NF only)
- Addresses environmental hazards and protection

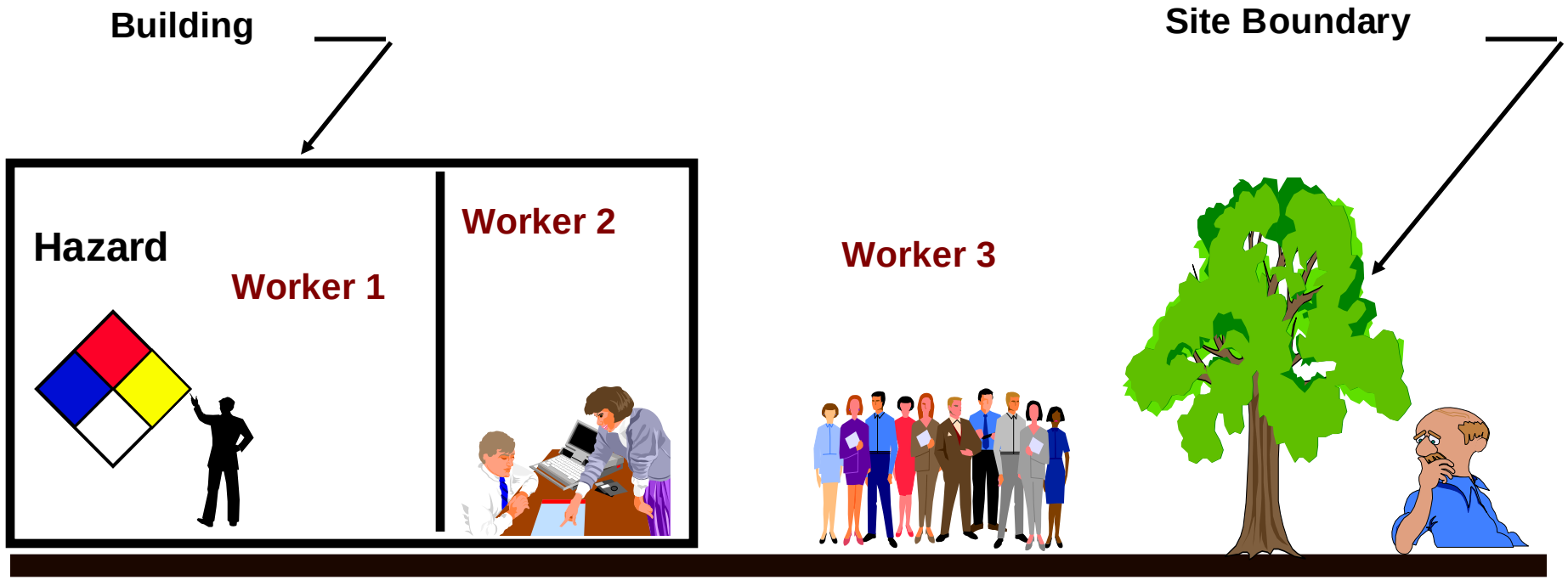
SNS Primary Hazards Summary

- Direct exposure to prompt radiation associated with proton beam
  - Massive passive shielding and Active access control
  - Addressed primarily in FSAD-PF

- Exposure to target mercury (highly radioactive and chemically toxic)
  - Primarily passive design features for confinement of Hg
  - Some Active Controls required
  - Addressed in FSAD-NF
- Oxygen deficiency associated with Helium in CHL and superconducting LINAC
  - Passive and Active Controls
  - See and flee training
  - Addressed in FSAD-PF



FSAD-NF Chapter 4 – Receptor Groups Considered



Facility Worker
Significant Hazards
- direct radiation
- exposure to Hg release

Site Workers
Significant Hazards
- exposure to Hg release

Public – Site Boundary
Hazards
- exposure to Hg release

Ch 4: Credited Control Selection Criteria

Potential Accidents - Unmitigated Worker Impacts:

- Dose > 25 rem or exposure to [Hg] > EPRG-3 (4 mg/m^3)
  - 1 level of credited control required.
- Dose outside building > 25 rem (and f > 10^{-4}/year)
  - 2 levels of control required.
- Unmitigated worker exposure to [O_2] < 12.5 %
  - 1 level of credited control required.

Potential Accidents - Unmitigated Offsite Impacts (FSAD-NF):

- Dose > 25 rem
  - 2 levels of credited control required
- 5 rem < Dose < 25 rem and (f > 10^{-4}/year)
  - 1 level of credited control required.
- [Hg] > ERPG-2 (2 mg/m^3)
  - 1 level of credited control required.

FSAD-NF Appendix A, SNS Controls Matrix

- Accident scenarios requiring credited controls summarized in Appendix A Table (aka "Controls Matrix").
- Credited Controls grouped in columns to represent "levels of control"
  - Note: Multiple Credited Controls may be used to create single level of control.
- Columns map to Selection Criteria for Credited Controls
- Specific Credited Controls identified separately for both radiological and Hg toxicity hazards:
  - Worker 1, 2 and 3
  - Public

Excerpt Example of Controls Matrix

Event	Event Description	Public Evaluation			Worker Evaluation						
		Radiological		Chemical	Radiological				Chemical		
		CEC (1a, 1b) Primary or 2nd level of control*	CEC/CAC level of control (5<C<25 rem) (2)*	CEC/CAC(3)	Worker Group 1	Worker Group 2	Worker Group 3		Worker Group 1	Worker Group 2	Worker Group 3
					CEC/CAC (4 or 5)*	CEC/CAC (4 or 5)*	CEC/CAC (4 or 5)*	CEC/CAC 2nd level of control (5)*	CEC/CAC (4)*	CEC/CAC (4)*	CEC/CAC (4)*
		*NOTE: Numbers in parentheses correspond to criteria for selection of credited controls as outlined in SNS Policy for Selection of Safety Related Credited Controls (Section 4.2.2.4)									
TS3-4 and TS3-6	Release of Hg and activated cooling water into Core Vessel	Not Required	Not Required	Not Required	Not Required (*Physical access within Core Vessel not credible)*	Core vessel and neutron beam windows - Confinement function	Not Required	Not Required	Not Required (*Physical access within Core Vessel not credible)*	Radiological controls for WG 2 are adequate for chemical protection	Not required.

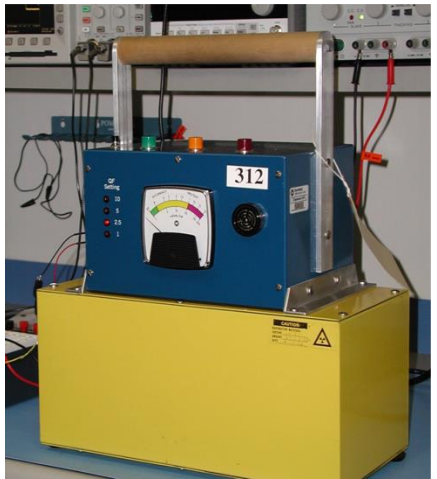
Event identifies the confinement function of Core Vessel and neutron beam windows as Credited Control to protect worker group 2.

FSAD Chapter 5, Credited Controls

- For each CEC, FSAD Chapter 5 addresses:
  - System Description
  - Safety Functions
  - Functional Requirements
  - System Evaluations
  - Requirements to Ensure Continued Operability

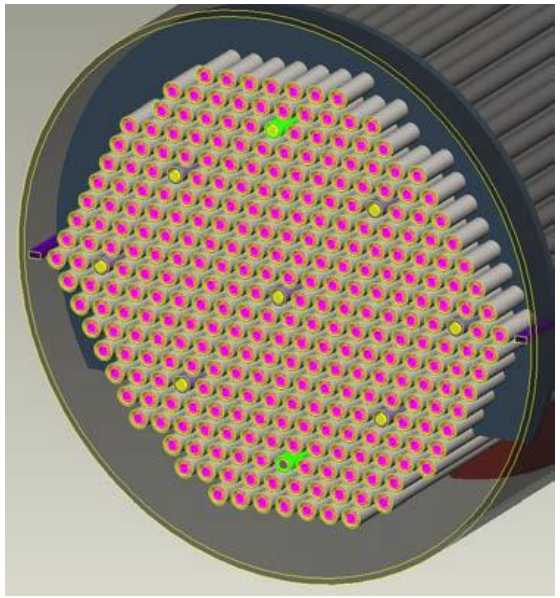
Credited Engineered Controls (CEC)

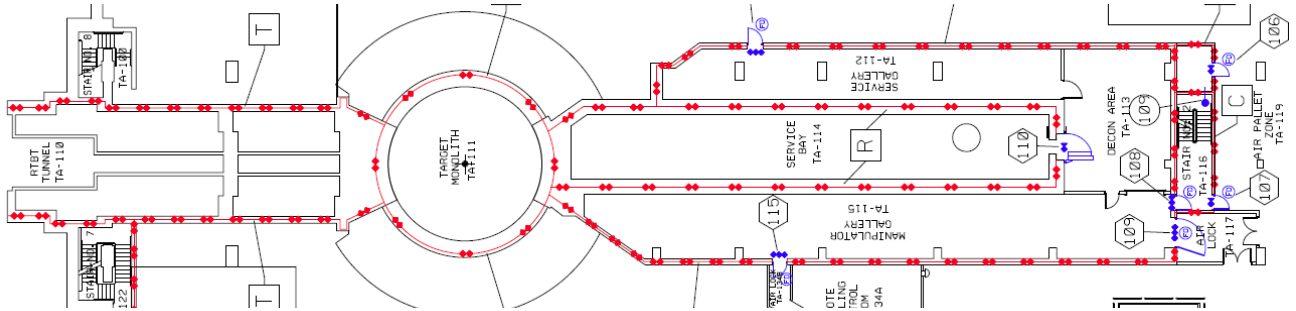
- Active Controls
  - Target Protection System
  - FSS Inside the Service Bay
  - FSS Outside the Service Bay
  - Service Bay Differential Pressure Monitoring System
  - Transfer Bay Access Control System
  - Personnel Protection System
  - Oxygen Deficiency Hazard System
  - Emergency Ventilation System for Accelerator Tunnel



Credited Engineered Controls (CEC)

- Passive Controls
  - CMS Hydrogen and Vacuum Boundaries
  - Target Service Bay and Monolith - Confinement of Hg
  - Service Bay/Core Vessel Fire Barrier
  - Core Vessel - Confinement Function
  - High Bay Crane Design per ASME NOG-1
  - High Bay Floor Design
  - Robust Mercury Heat Exchanger Design
  - Mercury Pump Tank Loop Seal and Orifice
  - Mercury Pump Tank Rupture Disk and Discharge Path
  - Primary Confinement Exhaust System
  - Central Helium Liquefier Bldg- Passive Ventilation Features





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Credited Administrative Controls (CAC)

- Radiological Protection Program
- Chemical Safety Program (no longer required)
- Combustible Materials Control Program
- Ignition Control Program
- Hoisting and Rigging Program
- Procedures and training
- Emergency Response Procedures

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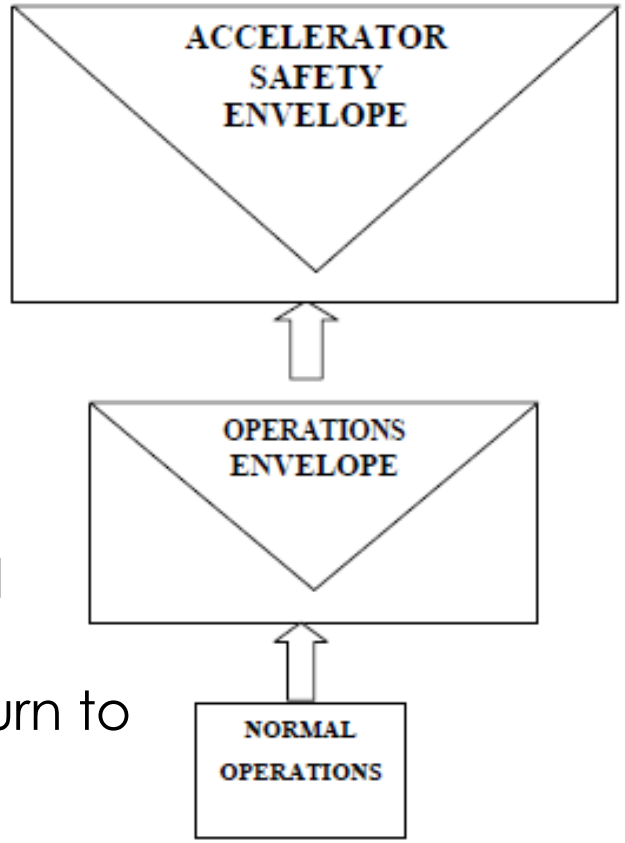
SNS Accelerator Safety Envelope (ASE)

Accelerator Safety Envelope (ASE)

- ASE provides high level requirements
  - 22 page document
- Rigorous compliance is mandatory!
- Order 420.2D Requirements
  - ASE Approved by DOE prior to operations
  - Any activity expected to exceed ASE requires DOE approval
  - Any activity violating ASE must be terminated immediately and placed in a safe configuration
  - If activity shutdown by DOE then DOE approval required to return to operation



SNS ASE Format and Content

- Introduction
- Definitions
- Limitations to Operating Parameters (beam power limits)
- Shielding (broad requirements)
- Active Credited Engineered Controls
  - Safety function requirements for operability
  - Compensatory Measures (if any)
  - Requirements for periodic surveillance to ensure operability
- Credited Administrative Controls
- Modifications and Violations of the ASE
- Staffing
- Appendix 1. Passive CECs

Sample: ASE Requirements for TPS

Target Protection System (TPS): The TPS prohibits proton beam on target based on high mercury temperature or low mercury flow to ensure Hg temperature remains below the Hg boiling point (357° C). The TPS also prevents beam on target when the target cart is not fully inserted.

Operability – The TPS shall be operable whenever beam in excess of 5.6 kWh in any 24-hour period is directed onto the target or when the target cart is retracted.

Compensatory Measures – If the TPS is not operable while the target cart is not fully inserted, beam on target shall be prohibited and controlled in accordance with the appropriate lockout of critical devices.

Surveillance - The TPS system shall undergo annual certification (not to exceed 15 months) as specified in approved SNS procedures.

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Unreviewed Safety Issue (USI) Process

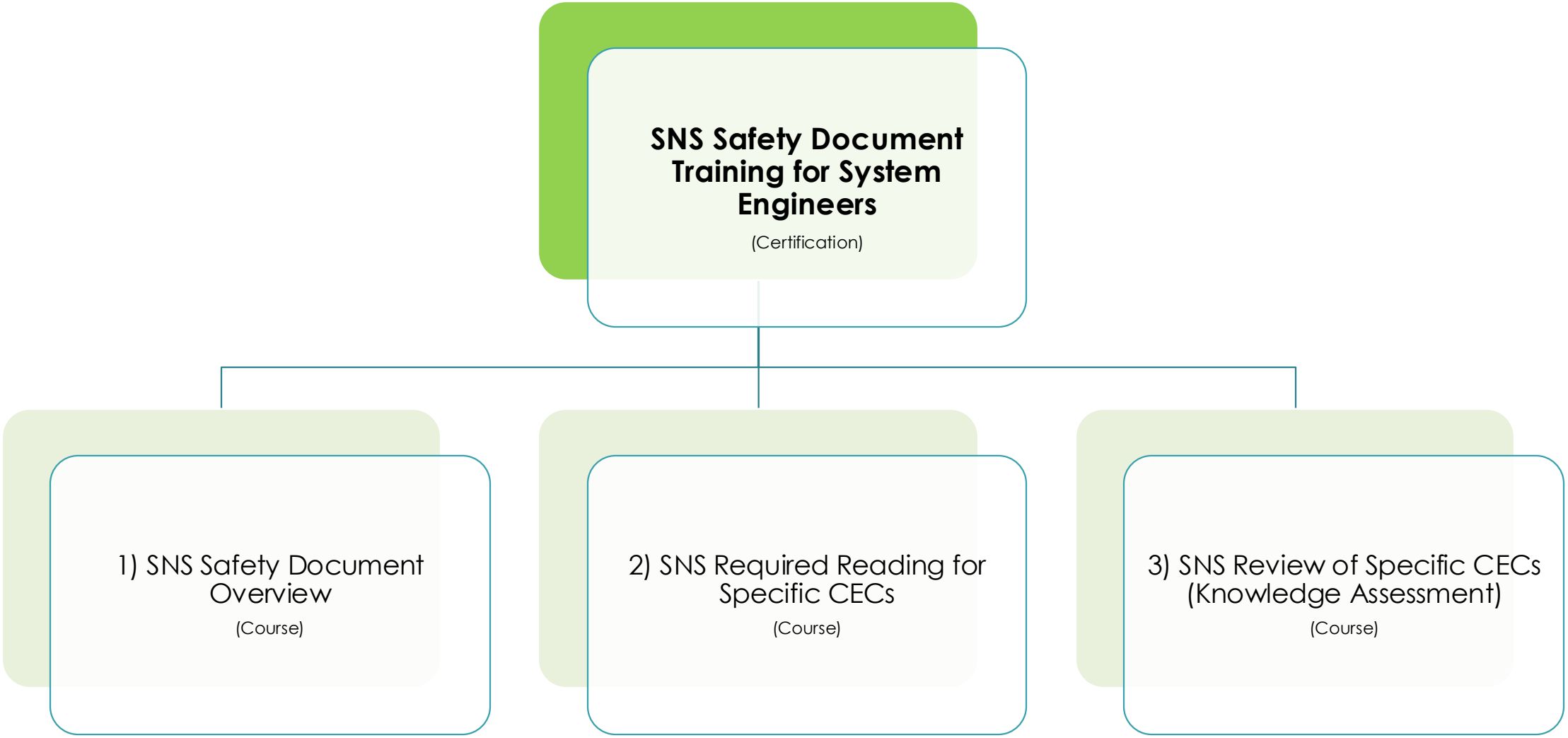
Change Management of Safety Analysis

- USI Process ensures that safety case supporting accelerator operation remains valid and up to date
- USI Process permits the evaluation of changes to systems and activities to determine whether the safety effects require the change to be approved by DOE
  - Implemented during the design phase since a "positive" (DOE approval req'd) would require significant effort prior to operation
  - Some changes clearly "negative" may be screened with limited documentation
  - Otherwise, Six questions are answered to determine if the change could:
    - increase the [**probability or consequences**] of a [**significant accident or malfunction of a CEC**] OR
    - introduce a new [**significant accident or malfunction of a CEC**]
- USI Evaluation forms (OPM 2.B-10.a) are the primary means of documentation for changes that were not able to be screened

Discussion, Questions and Follow-up for System Engineers

- Questions?
- Discussion?

Safety Document Training Concept



Follow-up for System Engineers

- System Engineers will be assigned required reading related to assigned CEC.
- System Engineers self-study assigned material with following objectives:
  - Ensure thorough understanding.
  - Identify any discrepancies between documentation and as built configuration/current practices/processes, etc.
  - Identify any errors and/or needed revisions regarding your CEC.
  - Sign-off completion of assigned reading.
- One-on-one follow-up discussion session w/ Safety Specialist (upon completion of assigned reading).

Safety Basis Roles and Responsibilities

- **First page of Credited Engineered Controls System Engineers List (SNS 102030100-ES0009-R11, February 2024)**
- System Engineer ensures compliance with ASE and SAD
- System Engineer remains knowledgeable of
  - ASE and SAD requirements,
  - the safety role of CEC, and
  - related administrative controls
- The CEC System Engineer assesses CEC periodically as needed to ensure ASE/SAD compliance

Safety Basis Roles and Responsibilities

- Maintains configuration control of assigned CEC
  - Follows SNS change control process for proposed changes
  - Reviews and approves all proposed changes
  - Ensures continued ASE/SAD compliance
  - Implements USI Process for proposed changes and discovered conditions related to assigned CEC
  - Ensures documentation is maintained
  - Ensures system components are labeled and tracked as appropriate
- Provides planning, maintenance, and documentation support for the proper execution of work control and change control for assigned systems
- Maintains awareness of operational status of assigned CEC
- Remains cognizant of system-specific maintenance and operational history
- Provides technical support for operations and maintenance on the assigned CEC