

Nuclear Facility Design

FUNCTIONAL AREA GOAL: Headquarters and Field organizations and their contractors ensure that nuclear facilities are designed to assure adequate protection for the public, workers, and the environment from nuclear hazards.

REQUIREMENTS:

- 10 CFR 830.120
- 10 CFR 830 subpart B
- DOE O 413.3
- DOE O 420.1B
- DOE O 414.1C
- DOE O 226.1
- DOE M 426.1
- DEAR 970-5404-2

Guidance:

- DOE G 420.1-1
- Project Management Practices, Integrated Quality (Rev E, June 2003)
- DOE Implementation Plan for DNSB Recommendation 2004-2

Performance Objective 1: Contractor Program Documentation

Contracts between and the contractors who operate nuclear facilities contain adequate requirements concerning the conduct of nuclear facility safety design for nuclear facility capital projects and major modifications and the contractors have developed comprehensive processes/procedures for performing these requirements.

Criteria:

1. Contractor processes and procedures define roles and responsibilities for engineering duties and tasks such as design changes, standards identification, testing, and formal design reviews for nuclear facility capital projects and major modifications (DOE FRAM, DOE O 414.1C).
2. Contractor processes and procedures ensure that detailed application of nuclear facility structure, systems, and components (SSC) design requirements are guided by the safety analysis that identify and establish safety SSC functional requirements and meet applicable DOE and industry nuclear facility design requirements (DOE P 450.5, DOE O 420.1B section 4.1.1.1).
3. Contractor processes and procedures ensure that nuclear facility SSCs are designed to withstand the effects of natural phenomena hazards (NPH) as necessary to ensure the confinement of hazardous material based on the results of the preliminary documented safety analysis (PDSA) (DOE P 450.5, DOE O 420.1B section 4.4.2).
4. The Contractor Integrated Safety Management (ISM) System Description includes mechanisms for integrating ISM into the project design activities (DOE O 413.3, CRD, #12 and DEAR 970 -5404-2)
5. Contractor processes and procedures incorporate applicable quality assurance requirements for the conduct of engineering design functions (DOE O 413.3 CRD #11, QA criterion 6 -Design)

Suggested Lines of Inquiry

- Is an ISMS description developed that integrates the 5 core functions and 7 guiding principles into project activities and personnel roles and responsibilities?
- Is there evidence through project activities that design decisions and changes are based on or influenced by efforts to eliminate hazards, minimize hazards, mitigate consequences, and preclude accident events that could release hazardous materials?
- Does the Project Execution Plan include a description of ISM implementation for all phases of the project?
- Do project specific performance measures include explicit links to the site/or project ISM system description?
- Do contractor implementing mechanisms and procedures identified in the PEP provide for close coordination between the development of the facility design and the safety analysis documents? (e.g. HAD, FHA, and emergency response evaluations)
- Do contractor implementing mechanisms include procedures for defining the project/design requirements, identifying hazards, performing design, analyzing the hazards and ensuring appropriate controls are built into the design, and obtaining approval of the design by the NNSA Site Office and the NNSA acquisition executive?
- Are contractor implementing mechanisms in place to ensure that ISM requirements are communicated and incorporated into subcontractor or other support organization design/project activities?
- Are feedback and improvement mechanisms in place to identify, evaluate, and correct design/project safety issues?
- Do the project ISM implementing mechanisms provide for a systematic review and approval of all applicable standards for the each of the various stages of design? Are Facility and safety SSC design requirements are traceable to applicable Federal, DOE, State, Site and Local laws and regulations?

Performance Objective 2: Contractor Program Implementation

Contractors responsible for operation of nuclear facilities have effectively implemented processes/procedures to ensure nuclear facility capital projects and major modifications are designed in accordance with contract requirements in order to provide adequate protection for the public, workers, and the environment from nuclear hazards.

Criteria:

1. The following nuclear safety design criteria have been explicitly addressed during the various phases of the nuclear facility design process (DOE O 420.1 section 4.1):
 - Radioactive and Hazardous Material Inventory
 - Conservative Facility Design
 - Defense in Depth concepts and principles have been considered in the design, such as including minimization of material, conservative design margins, quality assurance, and multiple barriers to release
 - Confinement ventilation has been incorporated into the design with preference on use of active confinement (DNFSB 2004-2)
 - Preventative Features
 - Mitigating Features
 - Siting Criteria
 - Facility Siting criteria have been evaluated to determine minimize potential impact to public and adjacent facilities
 - Site planning considered the consequences of all NPH type events
 - NPH
 - Design process considers potential damage and failure of SSCs from both direct and indirect NPH, including damage from failure of other SSCs

- Seismic requirements of executive order 12699 have been identified in the design
 - Access Control
 - Facility design ensures occupational exposure is maintained within limits of 10CFR 835 and includes provisions for maintaining exposure ALARA and to facilitate decontamination during operation
 - Accessibility and Maintainability
 - Reliability, Availability, and Maintainability objectives have been identified for designated SSCs
 - Human Factors Engineering
 - Design to Facilitate Deactivation, Decontamination, and Decommissioning
 - Design processes/procedures ensure that SSC functional requirements are identified early in the design process.
 - Applicable SSC functional design criteria such as single failure, equipment qualification, etc, from section 4 of DOE G 420.1A have been incorporated into the system level functional design.
- 2. Contractor processes and procedures for implementing ISM through each of the project design phases have been effectively implemented. (DOE O 413.3, CRD, #12 and DEAR 970 -5404-2)
 - The engineering and safety analysis processes are integrated to ensure that the design includes a complete set of SSCs required to protect the workers and the public from potential uncontrolled releases
 - Contractor implementing design processes procedures establish the expectations for the required safety, environment, quality, engineering documentation at the various stages of the design process and provide for integration of these various technical disciplines and documents
 - The contractor implementing processes/procedures ensure that appropriate standards are identified and evaluated for the design of safety SSCs based on the relative importance to safety as determined by the hazard analysis and required consensus codes. (ISMS Guiding Principle #XX)
 - Contractor design processes/procedures ensure that ES&H requirements, as delineated in Federal, DOE, State, Site and Local laws and regulations are explicitly included in the design process
- 3. Quality assurance requirements are implemented during the conduct of engineering design functions and activities (DOE O 413.3 CRD #11, QA criterion 6 -Design)
 - Facility processes and procedures ensure that inputs to design engineering activities are clearly identified and approved by appropriate facility management prior to the start of design activities and that changes to those inputs are controlled with appropriate rigor (10CFR830 Subpart A, Criterion 6, 48CFR970.5203(a), DOE O 414.1C 4(b)(6))
 - Facility processes and procedures ensure that management oversight of the design process is adequate to ensure that design deliverables fulfill requirements, including physical installation of the design (10CFR830 Subpart A, Criterion 6, DOE O 414.1C 4(b)(6), DOE O 433.1 4(a))
 - Facility processes and procedures clearly define expected design deliverables sufficient to maintain configuration management, and to maintain and verify compliance with facility requirements (10CFR830 Subpart A, Criterion 6, DOE O 420.1A 4.5.1.2, DOE O 433.1 4(a))
 - Facility processes and procedures ensure that post-design changes are tracked and analyzed to identify problems with the design process, with appropriate corrective actions assigned and tracked to closure (48CFR970.5203 (b), DOE O 414.1C, 4(b)(3))
 - Facility processes and procedures provide for the identification and control of design interfaces (NQA-1, Requirement 3, Design Control, section 700 Interface Control)
 - Facility processes and procedures describe requirements for performing design analysis (NQA-1, Requirement 3, Design Control, section 400 Design Analysis)
 - Facility processes and procedures describe requirements for performing design verification, including conduct of design reviews (NQA-1, Requirement 3, Design Control, section 500 Design Verification)
 - Facility processes and procedures ensure that compliance with the facility's safety basis is adequately considered throughout the design process, from inception through acceptance (10CFR830, Subpart A, Criterion 5, DOE O 420.1A 4.5.1.2, DOE O 433.1 4(a))

- Facility processes and procedures ensure that design output contains proper Quality Assurance classifications for any needed components, total system classification, and resultant drawing changes (10CFR830 Subpart A, Criterion 7, 48CFR970.5203(b), DOE O 414.1C 4(b)(7))
 - Contractor processes and procedures include appropriate software quality assurance requirements for design analysis software tools (DOE O 414.1C section XXX)
 - Contractor processes and procedures require the designation of a Design Authority responsible for the final approval of design requirements (DOE STD 1073 section XXX)
4. The technical baseline for identified safety SSCs has been established and is being controlled per the contractors Configuration management program (DOE O 413.3 CRD #9)
 5. Contractor personnel have been assigned system engineering duties and responsibilities for identifying and integrating nuclear safety requirements and establishing and maintaining the technical baseline for nuclear facility SSCs (DOE O 420.1B section XXX)
 6. Contractor personnel are trained and qualified to perform their assigned duties and responsibilities relative to nuclear facility design and peer review activities (ISM Guiding Principle XX)

Suggested Lines of Inquiry

- Is there a listing of all potentially applicable codes and standards identified in DOE O 420.1A and whether they are applicable and need to be incorporated into the Design efforts for each of the various phases of design?
- Is there an integrated project team that coordinates the development of the following documents during each of the associated project phases?
 - Conceptual Design
 - Define Scope of work
 - Mission Functional and Performance Requirements Established
 - Analyze Hazards
 - Hazard Categorization (HAD)
 - Preliminary Hazards Analysis (PHA)
 - Preliminary FHA
 - Preliminary Accident Analyses
 - Develop/Implement Controls (Develop Design Requirements)
 - Develop Safety Function Definitions
 - Preliminary Identification of Safety SSCs and Administrative Controls
 - Design Requirements Established
 - Identify Design Codes and Standards
 - Perform Work/Design
 - FDD Established
 - SDDs Established
 - PSAR Development Initiated
 - Design Packages
 - Conceptual Design Report
 - Feedback and Improvement (review and validation)
 - PSAR Development Initiated
 - DOE Review/Approval of CDR
 - DOE Review/Approval of HAD
 - Critical Decision-1
 - Preliminary Design
 - Define Scope of work
 - FDD under Change Control
 - SDDs under Change Control
 - CDR establishes Baseline
 - Analyze Hazards

- Detailed Process Hazards Analysis Drafted
 - Design Basis Accidents Identified
 - Some Preliminary Analysis Completed
 - Develop/Implement Controls (Develop Design Requirements)
 - Safety SSC Functional Requirements Established
 - SSC Performance Requirements Established
 - Design Requirements Updated
 - Codes and Standards Updated
 - Perform Work/Design
 - FDD updated
 - SDDs updated
 - Preliminary Design Package
 - Feedback and Improvement (review and validation)
 - PSAR Drafted
 - DOE Review/Accept Preliminary Design
 - Review PSAR Draft
 - Critical Decision-2
 - Final (Detailed) Design
 - Define Scope of work
 - SSC Design Requirements under Change Control
 - FDD and SDD under Change Control
 - Preliminary Establishes a Baseline
 - Analyze Hazards
 - Detailed Process Hazards Analysis Drafted
 - Accident Analysis Completed & DBAs Fully Established
 - Safety SSC Functional Requirements Finalized
 - SSC Performance Requirements Fully Designed
 - Develop/Implement Controls (Develop Design Requirements)
 - Design Requirements Finalized
 - Codes and Standards Finalized
 - Procurement Specifications are Prepared
 - Perform Work/Design
 - FDD Updated
 - SDDs Updated
 - Preliminary Design and Procurement Package
 - Feedback and Improvement (review and validation)
 - PSAR Completed
 - DOE Review/Accept Final Design Package
 - DOE Review/Approval of PSAR (SER)
 - Critical Decision-3
- Are design control procedures and mechanisms are explicitly identified and documented?
- Do design reports demonstrate that requirements and design work and design changes are met?
- Are design control procedures and mechanisms reviewed and approved?
- Is surveillance of design control work completed performed to ensure that procedures and mechanisms are being properly executed?
- Does a design configuration management plan exist that defines the records that need to be developed and maintained?
- Are evaluations of design record periodically conducted?
- Are design calculations and analyses documented and retrievable?
- Are design documents prepared, reviewed, approved, used, and revised in accordance with prescribed processes?
- Does a formal process exist to approve deviations from design requirements?
- Are Integrated Safety Management principles used during design defined and documented?
- Are Documented Safety Analysis requirements planned and scheduled and include appropriate design inputs and outputs?

- Are design interfaces identified, evaluated, and incorporated. Interfaces include national laboratories, design agencies, Architect Engineering firms, etc.?
- Do design calculations and analyses demonstrate that requirements and design bases are met?
- Are contractor mechanisms for completing design reviews explicitly used?
- Are contractor design reviews completed by appropriate personnel who are properly trained?
- Are independent peer reviews completed in accordance with a documented process?
- Are SSC designs validated prior to field implementation in accordance with a defined process?
- Are SSC design criteria linked to the safety function and functional requirements identified in the safety basis documents?
- Do SSC drawings include applicable design requirements derived from safety functions and functional requirements identified in the authorization basis?
- Is SSC design criteria explicitly checked against the set of appropriate standards?
- Is failure analysis, including consideration for single point failures is included in the SSC design process?
- Are specific training and qualification programs for design personnel established?
- Are individual training records for design personnel maintained?
- Do design personnel receive continuing training based on an established process?

Performance Objective 3: DOE Line Management Oversight:

Defined requirements through appropriate contract mechanisms are in place to ensure that nuclear facilities are designed to assure adequate protection for the public, workers, and the environment. HQ and/or Field/Site Offices have assigned personnel and developed processes/procedures for the activities they must conduct in support of contractor nuclear facility safety design activities. HQ and/or Field/Site Offices have assigned personnel and established and implemented effective oversight processes to ensure that the contractor nuclear facility design activities are properly conducted.

Criteria:

1. Field or Site Office has determined the appropriate level of resources and formal expectations for conducting effective oversight of contractor nuclear facility design activities (FRAM, DOE O 226.1)
2. Field or Site Office has assigned technically competent, trained and qualified personnel to perform activities in support of and effective oversight of contractor facility nuclear safety design activities (FRAM; DOE M 426.1).
3. Field or Site Office nuclear facility design/oversight procedures and processes require federal staff involvement in standards identification, hazards analysis, design review, and review of controls (FRAM 9.3.1, 9.4.1, 9.4.2, Draft Program and Project Management Manual/Draft Project Management Practices (10/00).
4. Site Office nuclear facility design oversight procedures and processes include documented feedback and improvement mechanisms through self-assessment, monitoring against performance objectives, occurrence reporting, critiques/management reviews, external reports, routine observation, and activity level feedback. (FRAM 9.6.1, DOE O 226.1)
5. Site Office oversight activities of nuclear facility design activities are being effectively conducted as evidenced by the following:
 - Completion of scheduled formal assessments, operational surveillances, and other oversight activities.
 - Evaluation and communication of assessment results including expected actions for resolution of identified issues.
 - Development, tracking, and closure of corrective actions.

- Evaluation of effectiveness of specific corrective actions.
 - Evaluation of effectiveness of the overall nuclear facility design activities.
- 6. oversight includes an evaluation that the contractor's implementation of the nuclear facility design activities demonstrates effective integration and application of appropriate functions and principles of the Site Integrated Safety Management System

Suggested Lines of Inquiry

- Are Site Office Project personnel qualified and trained to the Project Management System with respect to ES&H/QA requirements integration?
- Do Site Office Project personnel develop plans and schedules, assign resources and assess progress on a day-to-day basis, ensuring safety is integrated into both Federal and Contractor management and work practices at all levels? (DOE 413.3)(Draft Project Management Practices (10/00), Figure 3-9)
- Is there a process to incorporate ES&H/QA lessons learned information into planning and/or training programs (FRAM 9.6.1.1, 9.6.2.1)