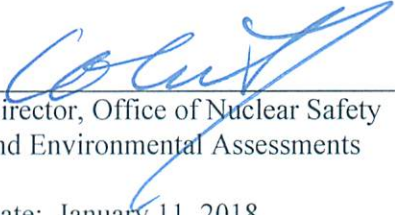


		Number: EA CRAD 31-13 Revision: 1 Effective Date: January 11, 2018
Conduct of Engineering Criteria and Review Approach Document		
Authorization and Approval	 Director, Office of Nuclear Safety and Environmental Assessments Date: January 11, 2018	 Lead, Charles Allen Nuclear Engineer Date: January 11, 2018

1.0 PURPOSE

The mission of the U.S. Department of Energy (DOE) Office of Environment, Safety and Health Assessments (EA-30) is to assess the effectiveness of safety and emergency management systems and practices used by line and contractor organizations and to provide clear, concise, rigorous, and independent evaluation reports of performance in protecting workers, the public, and the environment from the hazards associated with DOE activities.

In addition to the general independent oversight requirements and responsibilities specified in DOE Order 227.1A, *Independent Oversight Program*, this criteria and review approach document (CRAD), in part, fulfills the responsibility assigned to EA in DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*, to conduct independent appraisals of high consequence activities.

The CRADs are available to DOE line and contractor assessment personnel to aid them in developing effective DOE oversight, contractor self-assessment, and corrective action processes. The current revisions of EA's CRADs are available at <http://www.energy.gov/ea/criteria-and-review-approach-documents>.

2.0 APPLICABILITY

The following CRAD is approved for use by the Office of Nuclear Safety and Environmental Assessments (EA-31) for use on DOE Hazard Category 1, 2, and 3 nuclear facilities.

3.0 FEEDBACK

Comments and suggestions for improvements on this CRAD can be directed to the Director, Office of Environment, Safety and Health Assessments.

4.0 CRITERIA AND REVIEW APPROACH

This CRAD focuses on review of the engineering function at nuclear facilities either in operation or under construction. The engineering function may be comprised of various elements as governed by the design/construction or operational stage of the facility. Requirements have been segregated into seven areas as described in the following sections, focused on engineering processes, engineering products, the cognizant system engineering program, configuration management, engineering procurements, issues management within the engineering organization, and field office oversight of the engineering function.

OBJECTIVES

1 – Engineering Processes

Design engineering work is being performed consistent with technical standards, DOE requirements, and safety basis requirements and commitments, using approved procedures and sound engineering/scientific principles in accordance with the requirements of 10 CFR 830.

Criteria:

Requirements pertinent to the engineering function are found in numerous DOE regulations, orders, and technical standards. In aggregate, those requirements and guidance form the review criteria for Objectives 1 and 2. **Applicability to individual facilities must be established based on contractual requirements for those facilities.**

1. Engineering procedures are in place and contain appropriate detail to control development, approval, issuance, and revision of deliverables (engineering products). Key processes essential to the design engineering function are adequately documented and implemented:
 - Preparation, approval, and issuance of design criteria and system design description documents
 - Preparation, approval, and issuance of design drawings
 - Preparation, approval, and issuance of design analyses and calculations
 - Preparation, approval, and issuance of commodity, component, and/or procurement specifications
 - Preparation, approval, and issuance of design change documents
 - Field change request process
 - Design verification (to a level commensurate with importance to safety and design complexity) by individuals other than those who performed the work.

Engineering procedures provide barriers against poor performance, require participation and review by appropriate organizations, and drive communication between distinct groups. Verbatim compliance is required.

2. Documents comprising the facility/project technical baseline are readily identifiable and subject to appropriate control measures. System design documents and supporting documents must be

identified and kept current using formal change control and work control processes. DOE-STD-3024-2011, *Content of System Design Descriptions*, describes an acceptable methodology to achieve this function.

2 – Engineering Products

Engineering design documents and analyses are technically adequate and implement the requirements of the documented safety analysis such that adequate protection of the public, the workers, and the environment from facility hazards is demonstrated. (DOE-STD-3009-2014, 10CFR830.122)

Criteria:

The engineering function for a Hazard Category 1, 2, or 3 nuclear facility is tasked with developing and maintaining the technical baseline for the facility. The technical baseline is comprised of the fundamental design documents (including criteria, drawings, analyses, calculations, specifications, and performance characteristics) pertaining to the systems, structures and components (SSCs) of the facility necessary to demonstrate that the facility meets the requirements and commitments established in the safety basis documents for that facility.

1. Design criteria establish the fundamental requirements pertinent to the design:
 - Applicable codes and standards (including any exemptions and equivalencies)
 - Codes of Record
 - Functional and operational performance requirements
 - Classification of SSCs
 - Natural phenomena hazard design requirements
 - Safety basis compliance
 - Single failure design criteria
2. Analyses and calculations are:
 - Categorized according to safety significance
 - Prepared with design inputs clearly identified, assumptions technically justified, or unverified assumptions clearly identified and tracked to resolution
 - Prepared consistent with the design criteria and safety basis
 - Prepared with sufficient explanation, detail, and clarity of approach (including references) to permit duplication by another similarly qualified individual
 - Conservative in establishing both adequate margin against failure and adequate performance margin
 - Checked by a second party and verified by an independent verifier, as appropriate
3. Specifications for commodities, equipment procurement, and construction adequately reflect:
 - Design criteria and safety basis functional and performance requirements
 - Technical requirements, including reference to applicable drawings and industry codes and standards
 - Safety classification
 - Endurance requirements for natural phenomena hazards
 - Quality requirements
 - Environmental qualification criteria
 - Labeling criteria

- Test, inspection, and acceptance criteria
4. Design drawings are:
 - Categorized per DOE standards
 - Drafted in accordance with DOE HDBK 1016 standards
 - Subject to interdisciplinary review as appropriate prior to issuance
 - Accessible and retrievable in the most current version
 - In accordance with applicable design criteria and industry standards
 5. System and component interfaces are appropriately defined and coordinated to ensure that support functions required from other systems (e.g., cooling water, power supply, control signals) and interfaces with other systems are defined and will support required operability and functionality.

3 – Cognizant System Engineer Program

A cognizant system engineer (CSE) program has been implemented in accordance with the requirements of DOE O 420.1B or 420.1C, as applicable, to ensure continued operational readiness of identified systems to meet their safety functional requirements and performance criteria.

Criteria:

Refer to the applicable revision of DOE O 420.1 for specific requirements based on contract provisions for the facility under review.

1. CSEs have been designated, trained, and qualified (for safety class and safety significant systems, as a minimum) in accordance with DOE requirements:
 - CSEs are fully qualified with up-to-date training records.
 - CSE are responsible for compliance of their system with safety basis requirements and facility design criteria. They are an integral part of the design change process, ensuring that all design documents applicable to their system remain consistent.
 - CSEs have working level knowledge of engineering documents pertaining to their system and provide technical support to operations and maintenance.
 - CSEs initiate actions as necessary to correct problems on their system.
2. CSEs are involved in developing and maintaining System Design Descriptions (SDDs). SDDs identify the requirements associated with the facility's safety SSCs, explain the technical bases for the requirements, and describe the features of the system design provided to meet those requirements. The SDD often serves as the central coordination link among the engineering documents, facility safety basis, and procurement and construction documents:
 - Documentation of system specific requirements necessary to implement the safety basis
 - Safety classification of SSCs
 - Redundancy and single failure criteria
 - Applicability of DOE STD 3024-2011, *Content of System Design Descriptions*
 - Compliance with DOE STD 1189-2008 Appendix A, *Safety System Design Criteria*

CSEs keep system design documents and supporting documents current using formal change control and work control processes. (DOE-STD-3024-2011, *Content of System Design Descriptions*, describes an acceptable methodology to achieve this function.)

3. At operating facilities, system assessments are performed on a periodic basis (recommended quarterly) examining:
 - Operating status of the system; ability to perform design and safety functions
 - System and component performance relative to established criteria
 - Status of maintenance, including equipment out-of-service, other equipment issues, overdue activities, and life cycle issues.
 - Analysis of system reliability, operability, and material condition
 - Identification of outstanding work orders and corrective actions
 - Summary of system risks to operability
4. (Recommended) On operating facilities, system assessments (item 3 above) are used to generate system health reports for management consideration/review and system notebooks are maintained by the CSEs as a source of information on design, operability, maintenance, and on the bases for inspections, tests, and maintenance, such as applicable codes and standards and vendor manuals/records.

4 – Configuration Management

A documented configuration management (CM) program has been established and implemented in accordance with DOE O 420.1 that ensures consistency among system requirements and performance criteria, system documentation, and physical configuration of the systems within the scope of the program. DOE STD 1073-2003 provides an acceptable methodology to accomplish this requirement and may be invoked contractually on the specific facility.

Criteria:

1. Design input and output documents are appropriately established. Requirements from upper tier documents are appropriately incorporated into successor (or lower tier) documents. System design basis documents are kept current using formal change control and work control processes.
2. A design change process is in place which:
 - Ensures that all documents affected by a change, both predecessor and successor, are identified.
 - Ensures that impacts are considered, and all affected documents are revised as part of the change process to ensure that the design remains consistent.
 - Ensures changes are reviewed by all potentially affected disciplines and organizations to ensure that proposed changes are technically acceptable, implementable, and consistent with the design basis.
 - Ensures that extant changes against technical documents are tracked from initial issuance until incorporation in an approved revision.
3. A work control process is in place to ensure that physical changes are installed and tested in accordance with the design output. Change documents are posted against the affected parent documents and incorporated following completion of the change.
4. A field change request process is in place to identify proposed field changes and drive engineering review and approval. Approved field changes result in design changes which adequately identify all affected documents and ensure that revisions occur as appropriate.

5. An unreviewed safety question (USQ) process has been established as required by 10CFR830 and is being appropriately applied within the design change process.
6. A records management system has been implemented which provides:
 - The official electronic record copy for approved records including procedures and vendor manuals.
 - Accessibility to engineering documents using a process that defaults to the most recent (current) revision.
 - Enables the ready identification of predecessor and successor documents for issued records.
 - Tracks unincorporated changes outstanding against issued documents.
 - Limits outstanding changes against engineering documents such as drawings to avoid negative impacts from excessive change paper and difficulties in determining the current design configuration.
 - Ready access to the records system current version of each record as well as archival access to prior versions.

5 – Issues Management Within the Engineering Organization

The facility/site issues management system is adequately implemented within the Engineering Organization. Individual engineers identify and document problems when they occur and are appropriately trained and qualified to develop corrective action plans that will correct the problem identified, addressing both extent of condition and recurrence control where appropriate. Lessons learned are developed and communicated when appropriate. (10 CFR 830.122)

Criteria:

1. Problems associated with the conduct of engineering for the facility are identified/documented and corrective actions are determined and accomplished in a timely manner. Corrective actions for issues assigned to Engineering for resolution are effective in correcting the problem, and in addressing both the extent of condition of the problem identified and in preventing recurrence.
2. A qualification program is in place for engineering personnel establishing minimum qualification and training standards related to the facility issues management process.
3. Internal assessments are performed on a periodic basis to examine performance with regard to procedural and programmatic requirements. Assessors are independent of the area being examined. Lessons learned are identified and communicated to engineering personnel. Problems identified are documented using the issues management system and tracked to completion.

6 –Engineering Procurement

Procure items and services that meet established requirements and perform as specified. (10 CFR 830.122)

Criteria:

1. Specifications developed by Engineering to support the procurement process adequately identify:
 - Required design parameters and performance characteristics,
 - Applicable codes and standards,
 - Component classification,

- Quality assurance requirements,
 - Test requirements, and
 - Receipt inspection requirements.
2. A commercial grade dedication process is in place which will adequately evaluate commercial grade items purchased for safety related applications.

7 –Field Office Oversight of the Engineering Function

Federal oversight programs are established and effective in ensuring that safety systems can reliably perform as intended.

Criteria:

1. The DOE field office has established and implemented an effective safety system oversight process for qualifying staff to apply engineering expertise in its oversight of the assigned safety systems and to monitor performance of the contractor's CSE program.
2. An assessment plan has been implemented to direct and prioritize field office oversight efforts based on risk and importance to safety. (10 CFR 830.122)

REVIEW APPROACH

Record Review:

- Portions of the approved facility safety basis applicable to the engineering SSCs within the review scope to establish safety basis requirements and commitments
- Codes of Record
- Contractor requirements documents (manuals, procedures)
- System design descriptions
- System assessments and periodic system health reports; system notebooks
- Piping & Instrumentation Diagrams
- Physical layout drawings
- Engineering analyses pertinent to establishing and/or implementing the design basis for selected systems
- Calculations used to develop set points used in the Technical Safety Requirements
- Configuration Management Plan and implementing procedures
- Contractor internal assessments
- Engineering procedures for SDDs, drawings, calculations, specifications, design verification, records processing, design changes
- Procurement specifications
- Design change packages, including USQ determinations
- Corrective action documents generated by or assigned to Engineering for resolution
- Training and qualification requirements and records
- Problem reports, root cause analyses, and corrective action documents
- Field Office oversight assessments

Interviews:

- Program owners for CM, system engineering, document control
- Responsible individuals for key procedures

- Cognizant system engineers
- Safety basis, engineering, and training personnel (random sampling)
- Quality assurance and corrective action program personnel
- Field Office engineering oversight group

Observations:

- System walkdown with designated CSE
- Design change review board meeting
- System design coordination meeting