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U.S. Department of Energy
Washington, D.C.

ORDER

DOE O 420.1B

Approved: 12-22-05
Review: 12-22-07

SUBJECT: FACILITY SAFETY

1. OBJECTIVES. To establish facility and programmatic safety requirements for Department of Energy (DOE), including the National Nuclear Security Administration (NNSA), for—

   a. nuclear and explosives safety design criteria,

   b. fire protection,

   c. criticality safety,

   d. natural phenomena hazards (NPH) mitigation, and

   e. the System Engineer Program.

2. CANCELLATION. This Order cancels DOE O 420.1A, *Facility Safety*, dated 05-20-02. Cancellation of an Order does not, by itself, modify or otherwise affect any contractual obligation to comply with such an Order. Contractor requirements documents (CRDs) containing directive requirements already incorporated into, or attached to, a contract remain in effect until the contract is modified to eliminate the existing requirement or substitute a new set of requirements.

3. APPLICABILITY.

   a. DOE Elements. Except for the exclusions in paragraph 3c, this Order applies to all DOE elements with responsibility for DOE-owned or -leased facilities. (See Attachment 1 for a complete list of DOE elements as of the date of this Order. This Order automatically applies to DOE elements created after that date.) Except for the exclusions in paragraph 3c, the requirements in this Order apply to the types of DOE facilities established in the applicability paragraphs of each chapter of this Order.

      The requirements in this Order are applicable to Department employees. Failure to include comparable requirements in contracts does not relieve Department employees of responsibilities in this Order.

      The NNSA Administrator will ensure that NNSA employees and contractors comply with their respective responsibilities under this Order.

   b. DOE Contractors.

      (1) The CRD (Attachment 2) sets forth requirements that are to be applied to contractors with responsibility for the design, construction, management,

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operation, decontamination, decommissioning, or the demolition of DOE sites or facilities.

(2) Once notified, the contracting officer is responsible for incorporating the applicable requirements of the CRD into the laws, regulations, and DOE directives clause of each contract of contractors that perform work at or for any DOE facility affected by the facility safety hazards described in and requirements established by this Order.

(3) Regardless of the performer of the work, the contractor is responsible for compliance with the requirements of the CRD that are incorporated in its contract. The prime contractor is responsible for flowing down the requirements of the CRD to subcontractors at any tier to the extent necessary to ensure the contractor's compliance with the requirements and the safe performance of work.

c. Exclusions.

(1) Requirements in this Order that overlap or duplicate requirements of the Nuclear Regulatory Commission (NRC) related to radiation protection, nuclear safety, (including quality assurance), and safeguards and security of material, do not apply to the design, construction, operations, and decommissioning of DOE facilities. This exclusion does not apply to requirements for which the NRC defers to DOE or does not exercise regulatory authority.

(2) Pursuant to Executive Order (E.O.) 12344, Naval Nuclear Propulsion Program, the Director, Naval Nuclear Propulsion Program, will implement and oversee requirements of this Order for programs under the Director's cognizance as set forth in the Defense Procurement Reform Act of 1984 [Public Law (P.L.) 98-525] and the Military Lands Withdrawal Act of 1999 (P.L. 106-65).

(3) Requirements of this Order that overlap or duplicate requirements of the Department of Transportation (DOT) do not apply. This exclusion does not apply to requirements for which DOT defers to DOE or does not exercise regulatory authority.

(4) Accelerator facilities covered by DOE O 420.2B, *Safety of Accelerator Facilities*, dated 7-23-04, are excluded only from requirements of chapters I, III, and V of this Order.

(5) Fusion facilities are excluded from requirements of chapters I, III, and V of this Order.

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(6) Activities under the Nuclear Explosives and Weapons Safety Program for prevention of accidental or unauthorized nuclear detonation are excluded from a requirement of this Order only if the requirement would compromise the effectiveness or safety of those activities.

(7) Requirements of this Order do not apply to the Bonneville Power Administration.

4. REQUIREMENTS.

a. Each chapter of this document defines specific facility or programmatic safety requirements.

b. In complying with this Order, DOE and contractors must ensure that any work done is consistent with any other safety, design, or other analysis or requirements applicable to the affected facility. In particular, work must be performed in accordance with the integrated safety management requirements of 48 Code of Federal Regulations (CFR) 970.5223-1, *Integration of Environment, Safety, and Health into Work Planning and Execution*, and the quality assurance requirements of either Subpart A of 10 CFR Part 830, *Nuclear Safety Management*, or DOE O 414.1C, *Quality Assurance*, dated 6-17-05 or successor document, as applicable. All new construction, as a minimum, must comply with national consensus industry standards and the model building codes applicable for the state or region, supplemented in a graded manner[1] with additional safety requirements for the associated hazards in the facility that are not addressed by the codes.

c. DOE implementation guidance and technical standards referenced in this Order are not mandatory; however they must be considered in conjunction with the specific requirements. Such guidance, along with both DOE and industry standards referenced therein, represent acceptable methods to satisfy the provisions of this Order. Alternate methods that satisfy the requirements of this Order are also acceptable. Any implementation method selected must be justified to ensure that an adequate level of safety commensurate with the identified hazards is achieved.

5. RESPONSIBILITIES.

a. Assistant Secretary for Environment, Safety and Health.

(1) Develops and maintains policy, requirements, guidance, and technical standards relating to this Order and CRD.

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[1] The depth of detail required and the magnitude of resources expended is commensurate with the relative importance to safety, environmental compliance, safeguards and security, programmatic importance, magnitude of hazard, financial impact, and/or other facility-specific requirements (DOE O 430.1B, *Real Property Asset Management*, dated 9-24-03).

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(2) Provides interpretation of DOE safety policy relating to requirements of this Order.

(3) Provides advice and assistance on policy implementation.

(4) Monitors and reviews field element and contractor implementation of the requirements of this Order and CRD.

(5) Provides comments on requests for exemptions from requirements of this Order.

b. Secretarial Officers (SOs).

(1) Ensure that requirements of this Order and the CRD are implemented for facilities, activities, or programs under their cognizance.

(2) Review and approve requests for exemptions from requirements of this Order after resolving comments, if any, from the Assistant Secretary for Environment, Safety and Health, or in the case of NNSA, following consideration of comments from the Assistant Secretary of Environment, Safety and Health.

(3) Review and approve implementation plans for nuclear and explosives safety design criteria.

(4) Ensure that heads of field elements notify contracting officers when contracts are affected by this Order.

(5) Review and approve implementation methods other than those in referenced implementation guides and standards.

(6) Review and approve any situations that could result in deviations from the double contingency principle in operations involving criticality hazards.

(7) Review and approve the basis for exceptions to including multiple physical barriers to prevent or mitigate the unintended release of radioactive materials to the environment as part of the nuclear facility design in the documented safety analysis (DSA).

c. Director, Office of Security and Safety Performance Assurance.

(1) Acts as an independent authority responsible for environment, safety and health oversight for the Department.

(2) Plans and conducts appraisals to determine compliance with requirements of this Order. (See DOE O 470.2B, *Independent Oversight and Performance Assurance Program*, dated 10-31-02.)

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d. Heads of Field Elements.

(1) Ensure that the facilities, activities, and programs under their purview operate in compliance with the requirements of this Order and the CRD.

(2) Notify contracting officers when contracts are affected by this Order.

(3) Coordinate with contracting officers the revision of contracts to comply with requirements of this Order and require contractors to appropriately flow down requirements to subcontractors.

(4) Ensure that procurement requests include applicable requirements in the CRD for this Order to be applied to awards or sub awards.

(5) If delegated by the SO, review and approve exemption requests after resolving comments, if any, the Assistant Secretary for Environment, Safety and Health for non-NNSA facilities and after considering requests for NNSA facilities. If not delegated, forward requests for exemption to SO.

(6) Conduct comprehensive self assessments and assessments of contractor fire protection programs and criticality safety programs (CSPs).[2]

(7) Specify the frequency of the contractor's periodic facility assessment for fire protection.

(8) Review and approve—

(a) fire department baseline needs assessments, where applicable;

(b) CSP description documents;

(c) plans for upgrades to correct deficiencies in natural phenomena hazards mitigation for existing structures, systems, and components;

(d) recommendations to update NPH assessments;

(e) the qualification program for criticality safety staff;[3]

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[2] See DOE-STD-1156-2002, *Self-Assessment Standard for DOE Contractor Criticality Safety Programs*, for information on assessments of CSPs.

[3] Unless the qualification program complies with DOE-STD-1135-99, *Guidance for Nuclear Criticality Safety Engineering Training and Qualification.*

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(f) shipping containers for off-site shipment that are used to exclude materials from the requirement for a criticality alarm system (CAS) or a criticality detection system (CDS); and

(g) the method for preparing criticality safety evaluations.[4]

(9) Ensure that all procurement requests for work within the scope of this Order, including work requests to be performed through subcontracts, include the appropriate requirements of the attached CRD.

(10) Unless otherwise directed by the Secretarial Officer fulfill the role and responsibilities for the authority having jurisdiction (AHJ) for matters involving fire protection as defined by the National Fire Protection Association (NFPA) codes and standards. Ensure any comments from designated fire protection subject matter experts (SMEs) are appropriately addressed.

e. Contracting Officers.

(1) Incorporate the CRD into affected contracts in a timely manner when notified.

(2) Ensure applicable building code and NFPA codes and standards are incorporated in contracts and other procurement documents.

6. EXEMPTIONS.

a. Exemptions to this Order must follow the process defined for exemptions in DOE M 251.1-1A, *Directives System Manual*, except for the approval authority defined in the responsibilities paragraphs of this Order.

b. Exemptions, exclusions, and equivalencies to standards or other documents referenced in this Order should follow the provisions explicitly set forth in those documents; for example: the equivalency, alternative, and modification provisions in the NFPA Code.

7. REFERENCES. The following documents are expressly referenced in the body of this Order and should be considered when implementing this Order and the associated CRD in the context in which they are referenced in the document.

a. Public Law (P.L.).

(1) P.L. 98-525, Defense Procurement Reform Act of 1984.

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[4] Unless they are conducted in accordance with DOE-STD-3007 and evaluated in accordance with DOE-STD-1134, *Review Guide for Criticality Safety Evaluations.*

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(2) P.L. 106-65, Military Lands Withdrawal Act of 1999.

b. Executive Orders (E.O.).

(1) E.O. 12344, *Naval Nuclear Propulsion Program* (February 1, 1982).

(2) E.O. 12699, Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction (as amended by E.O. 13286, Amendment of Executive Orders, and Other Actions, in Connection with the Transfer of Certain Functions to the Secretary of Homeland Security, January 5, 1990).

(3) E.O. 12941, Seismic Safety of Existing Federally Owned or Leased Buildings (December 1, 1994).

c. Code of Federal Regulations (CFR).

(1) 10 CFR Part 830, Nuclear Safety Management.

(2) 48 CFR 970.5223-1, Integration of Environment, Safety, and Health into Work Planning and Execution.

d. DOE Directives.[5]

(1) DOE O 151.1C, *Comprehensive Emergency Management System*, dated 11-2-05.

(2) DOE M 251.1-1A, *Directives System Manual*, dated 1-30-98.

(3) DOE O 414.1C, *Quality Assurance*, dated 6-17-05.

(4) DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use with DOE O 420.1, Facility Safety*, dated 3-28-00.

(5) DOE G 420.1-2, *Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Nonnuclear Facilities*, dated 3-28-00.

(6) DOE O 420.2B, *Safety of Accelerator Facilities*, dated 7-23-04.

(7) DOE O 430.1B, *Real Property Asset Management*, dated 9-24-03.

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[5]For DOE directives, the contractors should follow the directive specified in the contract or other DOE procurement document instead of the revision cited in this Order. Unless restricted by contract or other requirement, successor documents may be used for DOE directives listed in this Order.

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(8) DOE O 433.1, *Maintenance Management Program for DOE Nuclear Facilities*, dated 6-1-01.

(9) DOE G 440.1-5, *Implementation Guide for Use with DOE Orders 420.1 and 440.1, Fire Safety Program*, dated 9-30-95.

(10) DOE O 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, dated 3-27-98.

(11) DOE M 440.1-1A, *DOE Explosives Safety Manual*, dated 1-9-06.

(12) DOE M 452.4-1A, *Protection of Use Control Vulnerabilities and Designs*, dated 3-11-04.

(13) DOE O 452.4A, *Security and Control of Nuclear Explosives and Nuclear Weapons*, dated 12-17-01.

(14) DOE O 452.2B, *Safety of Nuclear Explosive Operations*, dated 8-7-01.

(15) DOE O 452.1C, *Nuclear Explosive and Weapons Surety Program*, dated 9-20-05.

(16) DOE O 470.2B, *Independent Oversight and Performance Assurance Program*, dated 10-31-02.

(17) DOE O 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, dated 11-15-94.

(18) DOE O 5480.30, *Nuclear Reactor Safety Design Criteria*, dated 1-19-93.

e. DOE Technical Standards (STD).

(1) DOE-STD-1066-99, *Fire Protection Design Criteria*.

(2) DOE-STD-1073-2003, *Configuration Management Program*.

(3) DOE-STD-1134-99, *Review Guide for Criticality Safety Evaluations*.

(4) DOE-STD-1135-99, *Guidance for Nuclear Criticality Safety Engineering Training and Qualification*.

(5) DOE-STD-1156-2002, *Self-Assessment Standard for DOE Contractor Criticality Safety Programs*.

(6) DOE-STD-1186-2004, *Specific Administrative Controls*.

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(7) DOE-STD-3007-93, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities*.

(8) DOE-STD-3024-98, *Content of System Design Descriptions*.

f. Department of Defense (DoD) Documents.

(1) DoD Explosive Safety Board (DDESB) Technical Paper 12, *Fragment and Debris Hazards*, July 1975.

(2) DDESB Technical Paper 13, *Prediction of Building Debris for Quantity-Distance Siting*, April 1991.

(3) DDESB Technical Paper 15 *Approved Protective Construction*, June 2004.

(4) DDESB Technical Paper 16, *Methodologies for Calculating Primary Fragment Characteristics*, dated December 1, 2003.

(5) DDESB Technical Paper 17, DDESB *Blast Effects Computer Version 5.0 User's Manual and Documentation, with accompanying program entitled DDESB Blast Effects Computer (BEC)*, Version 6.1.

(6) DOE/TIC-11268, *Manual for the Prediction of Blast and Fragment Loading for Structures*, (July 1992).

(7) DoD Technical Manual (TM) 5-1300, *Structural Design of Facilities to Resist the Effects of Accidental Explosions*, (1990).

g. Non-Government Standards.

(1) American National Standards Institute (ANSI)/American Nuclear Society (ANS) Subcommittee 8 standards, including, but not limited to—

(a) ANSI/ANS-8.1, *Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors*, and

(b) ANSI/ANS-8.19-1996, *Administrative Practices for Nuclear Criticality Safety*.

(2) National Fire Protection Association (NFPA) Standards.

(3) National Fire Protection Association (NFPA) 5000®, *Building Construction and Safety Code®*, 2003.[6]

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[6] See footnote in Chapter 2 for proper context.

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8. ACRONYMS.

AHJ	authority having jurisdiction
ALARA	as low as reasonably achievable
ANS	American Nuclear Society
ANSI	American National Standards Institute
BEC	blast effects computer
BNA	baseline needs assessment
CAS	criticality alarm system
CDS	criticality detection system
CFR	Code of Federal Regulations
COR	Code of Record
CRD	contractor requirements document
CSE	cognizant system engineer
CSP	criticality safety program
DDESB	Department of Defense Explosive Safety Board
DoD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DSA	documented safety analysis
E.O.	Executive order
FHA	fire hazards analysis
G	Guide (DOE directive)
HPR	highly protected risk
M	Manual (DOE directive)
MPFL	maximum possible fire loss

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NFPA	National Fire Protection Association
NNSA	National Nuclear Security Administration
NPH	natural phenomena hazards
NRC	Nuclear Regulatory Commission
O	Order (DOE directive)
PDSA	preliminary documented safety analysis
P.L.	Public Law
SME	subject matter expert
SSC	structures, systems, and components
SO	Secretarial Officer
STD	standard (DOE directive)
TM	technical manual (DoD)

9. CONTACT. Address inquiries to the Office of Environment, Safety and Health; Office of Nuclear and Facility Safety Policy, 301-903-0078.

BY ORDER OF THE SECRETARY OF ENERGY:

CLAY SELL
Deputy Secretary

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CHAPTER I. NUCLEAR AND EXPLOSIVES SAFETY DESIGN CRITERIA

1. OBJECTIVES.

a. Nuclear Safety.[1]

(1) To ensure that new DOE hazard category 1, 2, and 3 nuclear facilities are designed and constructed in a manner that ensures adequate protection to the public, workers, and the environment from nuclear hazards.

(2) To ensure that major modifications to hazard category 1, 2, and 3 nuclear facilities comply with the design and construction requirements for new hazard category 1, 2, and 3 nuclear facilities.

(3) To ensure that new DOE nuclear reactors comply with the requirements of this Order and the design requirements of DOE O 5480.30, *Nuclear Reactor Safety Design Criteria*.

b. Explosives Safety. To establish mandatory design and construction standards for safety in new DOE explosives facilities and for major modifications to such facilities. Explosives facilities include facilities and locations used for storage or operations with explosives or ammunition.[2]

2. APPLICABILITY.

a. This chapter applies to DOE elements that have responsibility for the design and construction of—

(1) new hazard category 1, 2, and 3 nuclear facilities as defined by 10 CFR Part 830;

(2) new explosives facilities;[3] and

(3) major modifications to such facilities that could substantially change the approved facility safety analysis.[4]

b. This chapter does not impose requirements on existing facilities, except for major modifications to those facilities, but it can be used as a standard for comparison when judging the adequacy of existing facilities.

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[1] The requirements of this chapter complement the requirements for hazard category 1, 2, and 3 nuclear facilities in 10 CFR Part 830, Subpart B, and establish approved design criteria to meet the provisions of 10 CFR 830.206.
[2] Facilities or locations used for storage or operations with explosives or ammunition.
[3] For explosives facilities that also are nuclear facilities, requirements for nuclear safety design also apply.
[4] See 10 CFR Part 830 and associated guidance for additional information on major modifications to hazard category 1, 2, and 3 nuclear facilities.

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c. This chapter does not apply to nuclear deactivation or decontamination and decommissioning activities at end-of-facility-life if the safety analysis demonstrates that adequate protection is provided consistent with the requirements of 10 CFR Part 830 through alternate means and it is not cost beneficial to apply the provisions of this chapter for the limited remaining life of the activity.

3. REQUIREMENTS.

a. Integration of Design with Safety Analyses.

(1) Safety analyses must be used to establish—

(a) the identity and functions of safety class and safety significant structures, systems, and components (SSCs),[5] and

(b) the significance to safety of functions performed by safety class and safety significant SSCs.

(2) Safety analyses must address—

(a) hazards inherent to the facility and its activities,

(b) NPH (See chapter IV for examples of NPH and additional requirements), and

(c) external man-induced hazards, (factors such as proximity to airports, pipelines, hazardous traffic on roads or waterways, and adjacent facilities).

(3) Safety analyses must be performed as early as practical in conceptual or preliminary design processes to ensure that required safety SSCs are specified in the final design.

(4) Safety analyses must be performed in accordance with the requirements for safety analysis defined in DOE directives and technical standards for a DSA.

b. Nuclear Facility Design.

(1) Nuclear facility design objectives must include multiple layers of protection to prevent or mitigate the unintended release of radioactive materials to the environment, otherwise known as defense in depth. These multiple layers must include multiple

[5] See definitions for these and other terms in this chapter in 10 CFR 830.3.

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physical barriers unless the basis for not including multiple physical barriers is documented in the DSA and approved by DOE.

(2) Defense in depth must include all of the following—

(a) choosing an appropriate site;

(b) minimizing the quantity of material at risk;

(c) applying conservative design margins and quality assurance;

(d) using successive physical barriers for protection against radioactive releases;

(e) using multiple means to ensure critical safety functions needed to—

1 control processes,

2 maintain processes in safe status, and

3 confine and mitigate the potential for accidents with radiological releases;

(f) using equipment and administrative controls[6] that—

1 restrict deviation from normal operations,

2 monitor facility conditions during and after an event, and

3 provide for response to accidents to achieve a safe condition;

(g) providing means to monitor accident releases as required for emergency response;[7] and

(h) establishing emergency plans for minimizing the effects of an accident.

(3) Hazard category 1, 2, and 3 nuclear facilities must be sited, designed, and constructed in a manner that ensures adequate protection of the health and safety of the public, workers, and the

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[6] See Appendix A, Section G, of 10 CFR Part 830 Subpart B and DOE STD 1186-2004, *Specific Administrative Controls*, and other associated guidance for additional information on administrative controls for Technical Safety Requirements.

[7] See DOE O 151.1C, *Comprehensive Emergency Management System.*

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environment from the effects of accidents involving radioactive materials release.

(4) Hazard category 1, 2, and 3 nuclear facilities with uncontained radioactive material (as opposed to material determined by safety analysis to be adequately contained within drums, grout, or vitrified materials) must have the means to confine the uncontained radioactive materials to minimize their potential release in facility effluents during normal operations and during and following accidents. Confinement design considerations must include:

(a) for a specific nuclear facility, the number, arrangement, and characteristics of confinement barriers as determined on a case-by-case basis;

(b) consideration of the type, quantity, form, and conditions for dispersing the radioactive material in the confinement system design;

(c) use of engineering evaluations, tradeoffs, and experience to develop practical designs that achieve confinement system objectives; and

(d) the adequacy of confinement systems to perform required functions as documented and accepted through the preliminary DSA (PDSA) and DSA.

(5) Hazard Category 1, 2, and 3 nuclear facilities must be designed to—

(a) facilitate safe deactivation, decommissioning, and decontamination at the end of facility life, including incorporation of design considerations during the operational period that facilitate future decontamination and decommissioning;

(b) facilitate inspections, testing, maintenance, repair, and replacement of safety SSCs as part of a reliability, availability, and maintainability program with the objective that the facility is maintained in a safe state; and

(c) keep occupational radiation exposures within statutory limits and as low as reasonably achievable (ALARA).

(6) Facility process systems must be designed to minimize waste production and mixing of radioactive and non-radioactive wastes.

(7) Safety SSCs and safety software must be designed, commensurate with the importance of the safety functions performed, to perform their safety functions when called upon and to meet the quality

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assurance program requirements of either 10 CFR 830, Subpart A, or DOE O 414.1C, *Quality Assurance*, as applicable.

(8) Safety class electrical systems must be designed to preclude single point failure.[8]

(9) New DOE nuclear reactors must comply with the requirements of this Order, as well as the design requirements of DOE O 5480.30, *Nuclear Reactor Safety Design Criteria*.

c. Explosives Safety Design.

(1) New DOE explosives facilities and all modifications to existing explosives facilities must be designed consistent with the DOE explosives safety requirements established in DOE M 440.1-1A, *DOE Explosives Safety Manual*, dated 1-9-06 and technical standards referenced in that manual. In particular, they must be designed in accordance with—

(a) DoD TM5-1300, Structural Design of Facilities to Resist the Effects of Accidental Explosions (1990);

(b) DOE/TIC-11268, *Manual for the Prediction of Blast and Fragment Loading for Structures* (July 1992); and

(c) the following DoD Explosives Safety Board (DDESB) technical papers:

1 DDESB Technical Paper 12, *Fragment and Debris Hazards*, July 1975.

2 DDESB Technical Paper 13, Prediction of Building Debris for Quantity-Distance Siting, April 1991.

3 DDESB Technical Paper 15, *Approved Protective Construction*, June 2004.

4 DDESB Technical Paper 16, Methodologies for Calculating Primary Fragment Characteristics, dated December 1, 2003.

5 DDESB Technical Paper 17, DDESB Blast Effects Computer Version 5.0 User's Manual and Documentation,

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[8] See the basic approach in section 5.2.3 (Electrical) of DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use with DOE O 420.1, Facility Safety*, dated 3-28-00, with appropriate consideration and application of the national codes and standards referenced therein.

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with accompanying program entitled DDESB Blast Effects Computer (BEC), Version 6.1.

(2) Blast-resistant design to protect personnel and facilities must be based on the TNT equivalency of the maximum quantity of explosives and propellants permitted, increased by 20 percent in accordance with DoD TM5-1300.

d. Implementation.

(1) For new facilities, an implementation plan must be submitted to the responsible SO or designee describing the process for ensuring that facility design and construction will be in compliance with the nuclear facility safety requirements of this Order.

(2) Deviations/exemptions from requirements must be appropriately documented, justified, and approved by DOE in accordance with the provisions stated in this Order.

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CHAPTER II. FIRE PROTECTION

1. OBJECTIVES. To establish this Order[1] as the primary requirement for a comprehensive fire protection program for DOE sites, facilities, and emergency service organizations to minimize the potential for—

   a. Occurrence of a fire or related event;

   b. Fires that cause an unacceptable onsite or offsite release of hazardous or radiological material that could impact the health and safety of employees, the public, or the environment;

   c. Unacceptable interruption of vital DOE programs as a result of fire and related hazards;

   d. Property loss from fire exceeding limits established by DOE; and

   e. Fire damage to critical process controls and safety class systems structures and components (as documented by appropriate safety analysis).

2. APPLICABILITY. This chapter applies to both fire protection programs and facility safety design for all DOE elements that have responsibility for DOE nuclear, non-nuclear, and weapons facilities.[2]

3. REQUIREMENTS.

   a. General. Fire protection for DOE facilities, sites, activities, design, and construction must—

      (1) provide a level of safety sufficient to fulfill requirements for highly protected risk (HPR);[3]

      (2) prevent loss of safety functions and safety systems as determined by safety analysis and provide defense-in-depth; and

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[1] See also worker fire protection requirements in DOE O 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*, dated 3-27-98, and guidance in DOE G 440.1-5, *Implementation Guide for Use with DOE Orders 420.1 and 440.1, Fire Safety Program*.

[2] Activities within weapons facilities relating to accidental or unauthorized nuclear detonation are subject also to requirements of the 452 series of DOE Directives (see references).

[3] The facility as characterized by a level of fire protection design, systems, and management controls to fulfill requirements for the best-protected class of industrial risks. The term “risk” as it is used in this Order is consistent with the use in the insurance industry as the “property” that qualifies for preferred insurance premium status.

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(3) meet or exceed applicable building codes for the region and NFPA codes and standards as follows.[4]

(a) Facilities or modifications thereto must be constructed to meet codes and standards in effect, when design criteria are approved, otherwise known as the Code of Record (COR).

(b) Provisions of subsequent editions of codes or standards (promulgated after the COR) must be met to the extent that they are explicitly stated to be applicable to existing facilities. Other provisions of updated codes and standards must be applied to existing facilities when a construction modification takes place or when a potential for immediate risk to life safety or health has been identified through either the facility assessment or fire hazards analysis (FHA) review process, or during the construction review or permitting process.

b. Fire Protection Program. Acceptable, documented fire protection programs must be developed, implemented, and maintained that include the following elements and requirements.

(1) A policy statement that—

(a) incorporates fire protection requirements from this Order; related DOE directives; and other applicable Federal, state, and local requirements; and

(b) affirms DOE's commitment to fire protection and fire suppression capabilities sufficient to minimize losses from fire and related hazards consistent with highly protected risk status in private industry.

(2) Comprehensive, written fire protection criteria or procedures that include—

(a) site-specific requirements;

(b) staff organization, training, and responsibilities;

(c) administrative responsibilities;

(d) design, installation, operability, inspection, maintenance, and testing requirements;

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[4] The provisions of the applicable state/regional model building codes take precedence over the Building Construction and Safety Code (NFPA 5000®, *Building Construction and Safety Code®*, 2003 Edition).

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(e) use and storage of combustible, flammable, radioactive, and hazardous materials to minimize risk from fire;

(f) fire protection system impairments;

(g) smoking and hot work;

(h) safe operation of process equipment; and

(i) prevention measures that decrease fire risk.

(3) A system to ensure that fire protection program requirements are documented and incorporated in plans and specifications for new facilities and significant modifications to existing facilities.

(4) Documented review of plans, specifications, procedures, and acceptance tests by a qualified fire protection engineer.

(5) Fire hazard analyses (FHAs) using a graded approach conducted for hazard category 1, 2 and 3 nuclear facilities, significant new facilities,[5] and facilities that represent unique fire safety risks. The FHAs must be—

(a) performed under the direction of a qualified fire protection engineer;

(b) reviewed every 3 years; and

(c) revised when—

1 changes to the annual DSA updates impact the contents in the FHA,

2 a modification to an associated facility or process adds a significant new fire safety risk, or

3 the 3 year review identifies the need for changes.

(6) FHA conclusions incorporated into the DSA and integrated into design basis and beyond design basis accident conditions.

(7) Access to qualified, trained fire protection staff that includes fire protection engineers, technicians, and fire fighting personnel to implement the requirements of this Order.

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[5] As determined by the AHJ.

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(8) A baseline needs assessment (BNA) of the fire protection emergency response organization that—

(a) establishes the site fire fighting capabilities to provide—

1 effective response to suppress all fires;

2 emergency medical and hazardous materials response capabilities; and

3 staffing, apparatus, facilities, equipment, training, pre-plans, offsite assistance, and procedures;

(b) reflects applicable NFPA codes and standards; and

(c) is updated at least every 3 years and in accordance with applicable NFPA code provisions and whenever a significant new hazard is introduced that is not covered by the current BNA.

(9) Site emergency plans, FHAs, and DSAs that incorporate BNA information.

(10) Pre-fire strategies, plans, and standard operating procedures to enhance the effectiveness of site fire fighting personnel.

(11) Procedures governing the use of fire fighting water or other neutron moderating materials to suppress fire within or adjacent to moderation controlled areas.

(12) Where no alternative exists to criticality safety restrictions on the use of water for fire suppression, the need for such restrictions is fully documented with written technical justification.

(13) A documented comprehensive fire protection self assessment and an assessment of contractors' programs performed by DOE every 3 years.

(14) Processes to identify, prioritize, and monitor the status of fire protection assessment findings, recommendations, and corrective actions until final resolution.

(15) A process for reviewing and recommending approval of fire safety equivalencies to any fire protection code or standard requirements to the DOE organization AHJ for fire safety.

(16) Procedures governing firefighting techniques to be used during deactivation, decontamination, and demolition phases, when applicable.

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c. Fire Protection Design. A comprehensive fire protection design program for facilities and supporting systems must be developed, implemented, and maintained to include the following elements:

(1) A reliable and adequate supply of water for fire suppression.

(2) Noncombustible construction materials for facilities exceeding the size limits established by DOE (See DOE STD-1066-99, *Fire Protection Design Criteria*, for information on size limitations).

(3) Complete fire-rated construction and barriers, commensurate with the applicable codes and fire hazards, to isolate hazardous areas and minimize fire spread and loss potential consistent with limits as defined by DOE.

(4) Automatic fire extinguishing systems throughout all significant facilities and in all facilities and areas with potential for loss of safety class systems (other then fire protection systems), significant life safety hazards, unacceptable program interruption, or fire loss potential in excess of limits defined by DOE.

(5) Redundant fire protection systems in areas where—

(a) safety class systems are vulnerable to fire damage, and no redundant safety capability exists outside of the fire area of interest, or

(b) the maximum possible fire loss (MPFL) exceeds limits established by DOE.

(6) In new facilities, redundant safety class systems (other than fire protection systems) located in separate fire areas.

(7) A means to notify emergency responders and building occupants of a fire (e.g., fire alarm or signaling system).

(8) Emergency egress and illumination for safe facility evacuation in the event of fire as required by applicable codes or fire hazard analysis.

(9) Physical access and appropriate equipment that is accessible for effective fire department intervention (e.g., interior standpipe systems in multi-story or large, complex facilities).

(10) A means to prevent the accidental release of significant quantities of contaminated products of combustion and fire fighting water to the environment, such as ventilation control and filter systems and curbs and dikes. Such features would only be necessary if required by the

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FHA or DSA in conjunction with other facility or site environmental protection measures.

(11) A means to address fire and related hazards that are unique to DOE and not addressed by industry codes and standards. Mitigation features may consist of isolation, segregation or the use of special fire control systems (water mist, clean agent, or other special suppression systems) as determined by the FHA

(12) Fire protection systems designed such that their inadvertent operation, inactivation, or failure of structural stability will not result in the loss of vital safety functions or inoperability of safety class systems as determined by the DSA.

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CHAPTER III. NUCLEAR CRITICALITY SAFETY

1. OBJECTIVES. To establish requirements for a criticality safety program (CSP) applicable to DOE nuclear facilities and activities, including transportation activities, with potential for criticality hazards so that adequate protection is provided to the public, workers, and the environment.

2. APPLICABILITY. This chapter is applicable to DOE elements with responsibility for nuclear facilities and activities that involve, or potentially involve, nuclides in quantities that are equal to or greater than the single parameter limits for fissionable materials listed in ANSI/ANS-8.1 and 8.15.[1] Any facility or activity involving or potentially involving, amounts of fissionable material in excess of these limits has, by definition, a fissionable material operation.

3. REQUIREMENTS.

   a. General.

      (1) CSPs must be implemented to ensure that fissionable material operations will be evaluated and documented to demonstrate that operations will be sub-critical under both normal and credible abnormal conditions.

      (2) No single credible event or failure can result in a criticality.

      (3) The CSP description document must describe how the contractor will implement the requirements in the CRD including the standards invoked by this Chapter. The CSP description document must be approved by DOE and implemented as approved.

      (4) CSPs must include the following:

         (a) Criticality safety evaluations for fissionable materials operations that document parameters, limits, and controls required to maintain sub-criticality for all normal and credible abnormal conditions;

         (b) The preferred order of controls must be passive engineered controls, active engineered controls, followed by administrative controls.

         (c) Provisions for implementation of limits and controls identified by the criticality safety evaluations;

         (d) Periodic reviews of operations and conditions to ensure that—

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[1] See paragraph 3b(2) of this chapter for applicable revision.

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1 limits and controls are effectively implemented and

2 process conditions have not been altered resulting in compromise of safety limits and controls; and

(e) Assessment of the need for and installation of criticality accident alarm and detection systems where appropriate to conform with paragraphs 3b(2) and 3b(3) of this chapter.

(5) Nuclear criticality safety staff[2] responsible for implementing the CSP must be trained and qualified in accordance with a qualification program approved by DOE, unless the qualification program is compliant with DOE-STD-1135-99, *Guidance for Nuclear Criticality Safety Engineering Training and Qualification*.

b. Specific Requirements.

(1) CSPs must apply to facilities and activities with fissionable materials operations as defined in the paragraph 2 of this chapter.

(2) CSPs must satisfy the requirements of the revisions to consensus nuclear criticality safety standards of American National Standards Institute (ANSI)/American Nuclear Society (ANS) 8 in effect as of the date of this Order, unless otherwise modified or approved by DOE.

(3) All recommendations in applicable ANSI/ANS standards must be considered, and an explanation provided to DOE through the CSP description document whenever a recommendation is not implemented.

(4) The double contingency principle defined in ANSI/ANS 8.1, *Nuclear Criticality Safety in Operations with Fissionable Material outside Reactors*, is a requirement that must be implemented for all processes, operations and facility designs within the scope of this chapter unless the deviation is documented, justified, and approved by DOE.

(5) The methodology for preparing criticality safety evaluations must be approved by DOE unless the evaluations are conducted in accordance with DOE-STD-3007-1993, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities*, or successor document and evaluated in

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[2] See ANSI-8.19-1996, *Administrative Practices for Nuclear Criticality Safety*, for specifics on nuclear criticality safety staff.

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accordance with DOE-STD-1134-1999, *Review Guide for Criticality Safety Evaluations*, or successor document.

(6) Facilities that conduct operations using fissionable material in a form that could inadvertently accumulate in significant quantities must include a program and procedures for detecting and characterizing accumulations.

(7) Guidelines for fire fighting must be established for areas within or adjacent to moderator-controlled areas. The criteria and process for developing the guidelines must be documented in the CSP description document.

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CHAPTER IV. NATURAL PHENOMENA HAZARDS MITIGATION

1. OBJECTIVES. To establish requirements for DOE facility design, construction, and operations that protect the public, workers, and the environment from the impact of all NPH events (e.g., earthquake, wind, flood, and lightning).

2. APPLICABILITY. Requirements in this chapter apply to all DOE facilities and sites.[1] To the extent that design, construction, operation, or decommissioning responsibilities for DOE facilities and sites are assigned to DOE contractors, the cognizant DOE elements must ensure that the requirements for this chapter are implemented.

3. REQUIREMENTS. DOE facilities and operations must be analyzed to ensure that SSCs and personnel will be able to perform their intended safety functions effectively under the effects of NPH. Where no specific requirements are identified, model building codes or national consensus industry standards must be used consistent with the intended SSC functions.[2]

   a. Natural Phenomena Mitigation Design.

      (1) Facility SSCs must be designed, constructed, and operated to withstand NPH and ensure—

         (a) confinement of hazardous materials;

         (b) protection of occupants of the facility, as well as members of the public;

         (c) continued operation of essential facilities; and

         (d) protection of government property.

      (2) The design and construction of new facilities and major modifications[3] to existing facilities and SSCs must address—

         (a) potential damage to and failure of SSCs resulting from both direct and indirect NPH events;

         (b) common cause/effect and interactions resulting from failures of other SSCs; and

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[1] Activities within weapons facilities relating to accidental or unauthorized nuclear detonation are subject to requirements of the 452 series of DOE Directives (see references).

[2] DOE G 420.1-2, *Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Nonnuclear Facilities*, provides guidance on implementing NPH requirements.

[3] Major modifications are those which could substantially change the safety basis. See 10 CFR Part 830 and associated guidance fore additional information on major modifications to hazard category 1, 2, and 3 nuclear facilities.

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(c) compliance with seismic requirements of E.O. 12699, Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction (as amended by E.O. 13286, Amendment of Executive Orders, and Other Actions, in Connection With the Transfer of Certain Functions to the Secretary of Homeland Security, January 5, 1990).

(3) Additions and modifications to existing DOE facilities must not degrade SSC performance during an NPH occurrence.

b. Evaluation and Upgrade Requirements for Existing DOE Facilities.

(1) SSCs in existing DOE facilities must be evaluated when there is a significant degradation[4] in the facility safety basis. Evaluations must address the safety significance of the SSCs and the seismic requirements of E.O. 12941, Seismic Safety of Existing Federally Owned or Leased Buildings.

(2) If the evaluation of existing SSCs identifies NPH mitigation deficiencies, an upgrade plan must be implemented on a prioritized schedule based on the safety significance of the upgrades, time or funding constraints, and mission requirements.

c. NPH Assessment.

(1) Both facility design and evaluation criteria must address the potential types of NPH occurrences. The NPH assessment must use a graded approach commensurate with the potential hazard of the facility.

(2) NPH assessment for new facilities must use a graded approach that considers the consequences of all types of NPHs. Site-wide information may be considered when appropriate.

(3) NPH assessments must be reviewed and upgraded as necessary for existing sites/facilities following significant changes in NPH assessment methodology or site-specific information.

(4) An NPH assessment review must be conducted at least every 10 years and must include recommendations to DOE for updating the existing assessments based on significant changes found in methods or data. If no change is warranted from the earlier assessment, then this only needs to be documented.

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[4] See DOE G 420.1-2 for additional guidance on significant degradation.

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d. Seismic Detection. Facilities or sites with hazardous materials must have instrumentation or other means to detect and record the occurrence and severity of seismic events.

e. Post-Natural Phenomena Procedure. Facilities or sites with hazardous materials must have procedures for inspecting facilities for damage from severe NPH events and placing a facility into a safe configuration when damage has occurred.

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CHAPTER V. SYSTEM ENGINEER PROGRAM

1. OBJECTIVES. To establish requirements for a System Engineer Program for hazard category 1, 2, and 3 nuclear facilities and to ensure continued operational readiness of the systems within its scope.

2. APPLICABILITY.

   a. Requirements of this chapter apply to all hazard category 1, 2, and 3 nuclear facilities.

   b. The System Engineer Program must be applied to active safety class and safety significant SSCs as defined in the facility's DOE-approved safety basis, as well as to other active systems that perform important defense-in-depth functions, as designated by facility line management.

3. REQUIREMENTS.

   a. General.

      (1) Hazard category 1, 2, and 3 nuclear facilities must have a System Engineer Program, as well as a qualified cognizant system engineer (CSE) assigned to each system within the scope of the Program.

      (2) System Engineer Programs must be incorporated into the Integrated Safety Management System (ISMS)[1] must flow down from site and facility implementing procedures and must define CSE functions, responsibilities, and authorities.

      (3) A graded approach must be used in applying the requirements of the System Engineer Program.

   b. Program Elements. The program elements must include and integrate the identification of systems within its scope, configuration management, and CSE support for operations and maintenance.

   c. Configuration Management.[2] An objective of the System Engineer Program is to ensure operational readiness of the systems within its scope. To achieve this, the principles of configuration management must be applied to these systems. Consequently, the following requirements are considered integral parts of the Systems Engineer Program.

      (1) Configuration management must be used to develop and maintain consistency among system requirements and performance criteria,

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[1] See 48 CFR 970.5223-1.
[2] See DOE-STD-1073-2003, *Configuration Management*, for guidance on implementing configuration management.

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documentation, and physical configuration for the SSCs within the scope of the process.

(2) Configuration management must integrate the elements of system requirements and performance criteria, system assessments, change control, work control, and documentation control.

(3) System design basis documentation and supporting documents must be compiled and kept current using formal change control and work control processes or, when design basis information is not available, documentation must include—

(a) system requirements and performance criteria essential to performance of the system's safety functions,

(b) the basis for system requirements, and

(c) a description of how the current system configuration satisfies the requirements and performance criteria.

(4) Key design documents must be identified and consolidated to support facility safety basis development and documentation.[3]

(5) System assessments must include periodic review of system operability, reliability, and material condition.[4] Reviews must assess the system for—

(a) ability to perform design and safety functions,

(b) physical configuration as compared to system documentation, and

(c) system and component performance in comparison to established performance criteria.

(6) System maintenance and repair must be controlled through a formal change control process to ensure that changes are not inadvertently introduced and that required system performance is not compromised.

(7) Systems must be tested after modification to ensure continued capability to fulfill system requirements.

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[3] See DOE-STD-3024-98, *Content of System Design Descriptions*, for guidance on key design documents.
[4] Periodic system assessments are also required by as required by DOE O 433.1, *Maintenance Management Program for DOE Nuclear Facilities.*

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d. System Engineer Support for Operations and Maintenance.

(1) The functions of a System Engineer Program are required to maintain the integrity of a facility's safety basis. System Engineer Program functions are typically accomplished by various parts of a program's operating organization. This organization must designate one person as the CSE for each system to which the System Engineer Program applies (See paragraph 2 of this chapter). The CSE must maintain overall cognizance of the system and be responsible for system engineering support for operations and maintenance. The CSE must provide technical assistance in support of line management safety responsibilities and ensure continued system operational readiness.

(2) The CSE must—

(a) ensure that system configuration is being managed effectively (See paragraph 3c of this chapter);

(b) remain apprised of operational status and ongoing modification activities;

(c) assist operations review of key system parameters and evaluate system performance;

(d) initiate actions to correct problems;

(e) remain cognizant of system-specific maintenance and operations history and industry operating experience, as well as manufacturer and vendor recommendations and any product warnings regarding safety SSCs in their assigned systems;

(f) identify trends from operations;

(g) provide assistance in determining operability, correcting out-of-specification conditions, and evaluating questionable data;

(h) provide or support analysis when the system is suspected of inoperability or degradation;

(i) review and concur with design changes; and

(j) provide input to development of special operating/test procedures.

(3) Qualification requirements for CSEs must be consistent with those defined for technical positions described in DOE O 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, dated 11-15-94, chapter II, paragraph 2c,

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"Technical Staff for Reactor Facilities," and chapter IV, paragraph 2f, "Technical Staff for Non-Reactor Nuclear Facilities."

(4) The requirements of this chapter must be incorporated into contractor training programs also required by DOE O 5480.20A.

(5) Development plans for CSEs should be part of overall training and development programs.

(6) Qualification and training requirements must include knowledge of—

(a) related facility safety basis including any relationship to specific administrative controls;

(b) system functional classification and basis

(c) applicable codes and standards;

(d) system design, procurement, replacement, and related quality assurance requirements;

(e) the existing condition of the system;

(f) a working knowledge of the facility's operation; and

(g) vendor recommendations, manuals, and any product warnings.

(7) Evaluation of a CSE's qualifications should include formal education, prior training, and work experience as described in chapter I, paragraph 13 of DOE O 5480.20A.

(8) Consistent with the graded approach, large, complex, or very important systems may require assignment of more than one technical level CSE while small, simple, less important systems may only require assignment of a technician. Conversely, a single individual may be assigned to be the CSE for more than one system.

e. Graded Approach. Implementation of System Engineer Program requirements should be tailored to facility hazards and the systems relied upon to prevent or mitigate those hazards. This should be done by using a graded approach that considers the following factors.

(1) Remaining Facility Lifetime and the Safety Significance of Remaining Operations. Facilities undergoing deactivation, decontamination and/or decommissioning, may be undergoing frequent changes, modifications, and in some cases, removal of systems no longer needed to support the safety basis of those operations. System Engineer Programs may require

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more attention in these operations than when the facility was in normal operations. After deactivation or when a facility is in long-term surveillance and maintenance, there may be less need for attention.

(2) Safety Importance of the System. Not all systems are equal as measured by the likelihood and consequences of the hazard and the accidents that they prevent or mitigate. The level of system documentation detail in configuration management should be tailored to the importance of the system.

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DOE ELEMENTS TO WHICH
DOE O 420.1B, *FACILITY SAFETY*, IS APPLICABLE

Office of the Secretary
National Nuclear Security Administration
Office of Civilian Radioactive Waste Management
Office of Energy Efficiency and Renewable Energy
Office of Environment, Safety and Health
Office of Environmental Management
Office of Fossil Energy
Office of Legacy Management
Office of Nuclear Energy, Science and Technology
Office of Science
Office of Security and Safety Performance Assurance
Southeastern Power Administration
Southwestern Power Administration
Western Area Power Administration

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CONTRACTOR REQUIREMENTS DOCUMENT
DOE O 420.1B, *FACILITY SAFETY*

Regardless of the performer of the work, the contractor is responsible for complying with requirements of this Contractor Requirements Document (CRD). The contractor is responsible for flowing down the requirements to subcontractors at any tier to the extent necessary to ensure the contractor's compliance with the requirements and the safe performance of work. In doing so, the contractor must not flow down requirements to subcontractors unnecessarily or imprudently.

1. REQUIREMENTS.

a. This CRD establishes facility safety requirements for Department of Energy (DOE) and National Nuclear Security Administration (NNSA) contractors responsible for design, construction, operation, management, decontamination or decommissioning of DOE sites or facilities. Contractors must comply with the CRD requirements to the extent set forth in their contracts. Contractors should refer to corresponding requirements in DOE O 420.1B, *Facility Safety*, dated 12-22-05, and all referenced rules, guidance, and standards when implementing the requirements of this CRD.

b. Chapters of the CRD may have general and specific requirements. In complying with the CRD, contractors must determine acceptability of design and operations based on a comparison with available safety basis information.

c. In complying with this CRD, contractors must ensure that any work done is consistent with any other safety, design, or other analysis or requirements applicable to the affected facility. In particular, work must be performed in accordance with the integrated safety management requirements of Title 48 Code of Federal Regulations (CFR) 970.5223-1, *Integration of Environment, Safety, and Health into Work Planning and Execution*, and the quality assurance requirements of either Subpart A of 10 CFR Part 830, *Nuclear Safety Management*, or DOE O 414.1C, *Quality Assurance*, dated 6-17-05, or successor document, as applicable. All new construction, as a minimum, must comply with national consensus industry standards and the model building codes applicable for the state or region supplemented in a graded manner[1] with additional safety requirements for the associated hazards in the facility that are not addressed by the codes.

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[1] The depth of detail required and the magnitude of resources expended is commensurate with the relative importance to safety, environmental compliance, safeguards and security, programmatic importance, magnitude of hazard, financial impact, and/or other facility-specific requirements (DOE O 430.1B, *Real Property Asset Management*, dated 9-24-03).

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d. DOE implementation guidance and technical standards referenced in this CRD are not mandatory; however they must be considered in conjunction with the specific requirements. Such guidance, along with both DOE and industry standards referenced therein, represent acceptable methods to satisfy the provisions of this CRD. Alternate methods that satisfy the requirements of this CRD are also acceptable. Any implementation method selected must be justified to ensure that an adequate level of safety commensurate with the identified hazards is achieved.

2. EXEMPTIONS.

a. Exemptions to this CRD must follow the process defined for exemptions in DOE O 420.1B, *Facility Safety*.

b. DOE M 251.1-1A, *Directives System Manual*, provides information on the process for requesting and justifying a request for exemption to the requirements of DOE directives, including CRDs.

c. Specific DOE exemption responsibilities and authorities are defined in the Order.

d. Exemptions, exclusions, and equivalencies to standards or other documents referenced in this CRD should follow the provisions explicitly set forth in those documents; for example: the equivalency, alternative, and modification provisions in the NFPA Code.

3. REFERENCES. The following documents are expressly referenced in the body of this contractor requirements document (CRD) and should be considered when implementing this CRD in the context in which they are referenced.

a. Executive Orders (E.O.).

(1) E.O. 12699, Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction (January 5, 1990).

(2) E.O. 12941, Seismic Safety of Existing Federally Owned or Leased Buildings (December 1, 1994).

b. Code of Federal Regulations (CFR).

(1) 10 CFR Part 830, Nuclear Safety Management.

(2) 48 CFR 970.5223-1, Integration of Environment, Safety, and Health into Work Planning and Execution.

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c. DOE Directives.[2]

(1) DOE O 151.1C, *Comprehensive Emergency Management System*, dated 11-2-05.

(2) DOE M 251.1-1A, *Directives System Manual*, dated 1-30-98.

(3) DOE O 414.1C, *Quality Assurance*, dated 6-17-05.

(4) DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use with DOE O 420.1, Facility Safety*, dated 3-28-00.

(5) DOE G 420.1-2, *Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Nonnuclear Facilities*, dated 3-28-00.

(6) DOE O 433.1, *Maintenance Management Program for DOE Nuclear Facilities*, dated 6-1-01.

(7) DOE G 440.1-5, *Implementation Guide for Use with DOE Orders 420.1 and 440.1, Fire Safety Program*, 9-30-95.

(8) DOE O 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, dated 3-27-98.

(9) DOE M 440.1-1A, *DOE Explosives Safety Manual*, dated 1-9-066.

(10) DOE M 452.4-1A, *Protection of Use Control Vulnerabilities and Designs*, dated 3-11-04.

(11) DOE O 452.4A, *Security and Control of Nuclear Explosives and Nuclear Weapons*, dated 12-17-01.

(12) DOE O 452.2B, *Safety of Nuclear Explosive Operations*, dated 8-7-01.

(13) DOE O 452.1C, *Nuclear Explosive and Weapons Surety Program*, dated 9-20-05.

(14) DOE O 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, dated 11-15-94.

(15) DOE O 5480.30, *Nuclear Reactor Safety Design Criteria*, dated 1-19-93.

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[2] For DOE directives, the revision of the directive specified in the contract or other DOE procurement document should be used instead of the revision cited in this CRD. In addition, unless restricted by contract or other requirement, successor documents may be used for DOE directives listed in this CRD.

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d. DOE Technical Standards (STD).

(1) DOE STD-1066-99, *Fire Protection Design Criteria*.

(2) DOE-STD-1073-2003, *Configuration Management*.

(3) DOE-STD-1134-99, *Review Guide for Criticality Safety Evaluations*.

(4) DOE-STD-1135-99, *Guidance for Nuclear Criticality Safety Engineering Training and Qualification*.

(5) DOE-STD-3007-93, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities*.

(6) DOE-STD-3024-98, *Content of System Design Descriptions*.

e. Department of Defense (DoD) Documents.

(1) DoD Explosive Safety Board (DDESB) Technical Paper 12, *Fragment and Debris Hazards*, July 1975.

(2) DDESB Technical Paper 13, *Prediction of Building Debris for Quantity-Distance Siting*, April 1991.

(3) DDESB Technical Paper 15, *Approved Protective Construction*, June 2004.

(4) DDESB Technical Paper 16, *Methodologies for Calculating Primary Fragment Characteristics*, dated December 1, 2003.

(5) DDESB Technical Paper 17, D*DESB Blast Effects Computer Version 5.0 User's Manual and Documentation*, with accompanying program entitled *DDESB Blast Effects Computer (BEC)*, Version 6.1.

(6) DOE/TIC-11268, *Manual for the Prediction of Blast and Fragment Loading for Structures*, (July 1992).

(7) DoD Technical Manual (TM) 5-1300, *Structural Design of Facilities to Resist the Effects of Accidental Explosions* (1990).

f. Non-Government Standards.

(1) American National Standards Institute (ANSI)/American Nuclear Society (ANS) Subcommittee 8 standards, including but not limited to—

(a) ANSI/ANS-8.1, *Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors*, and

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(b) ANSI/ANS-8.19-1996, *Administrative Practices for Nuclear Criticality Safety*.

(2) National Fire Protection Association (NFPA) Standards.

(3) National Fire Protection Association (NFPA) 5000®, *Building Construction and Safety Code®*, 2003.[1]

[1] See footnote 1 in chapter II for proper context.

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CHAPTER I. NUCLEAR AND EXPLOSIVES SAFETY DESIGN CRITERIA

1. OBJECTIVES.

a. Nuclear Safety.[1]

(1) To ensure that new DOE hazard category 1, 2, and 3 nuclear facilities are designed and constructed in a manner that ensures adequate protection to the public, workers, and the environment from nuclear hazards.

(2) To ensure that major modifications to DOE hazard category 1, 2, and 3 nuclear facilities comply with design and construction requirements for new hazard category 1, 2, and 3 nuclear facilities.

(3) To ensure that new DOE nuclear reactors comply with the requirements of this CRD and the design requirements of DOE O 5480.30, *Nuclear Reactor Safety Design Criteria*.

b. Explosives Safety. To establish mandatory design and construction standards for safety in new DOE explosives facilities and for major modifications to such facilities. Explosives facilities include facilities and locations used for storage or operations with explosives or ammunition.[2]

2. APPLICABILITY.

a. This chapter applies to DOE contractors that are responsible for the design and construction of:

(1) new hazard category 1, 2, and 3 nuclear facilities as defined by 10 CFR Part 830;

(2) new explosives facilities;[3] and

(3) major modifications to such facilities that could substantially change the approved facility safety analysis.[4]

b. This chapter does not impose requirements on existing facilities, except for major modifications to those facilities, but it can be used as a standard for comparison when judging the adequacy of existing facilities.

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[1] The requirements of this chapter complement the requirements for hazard category 1, 2, and 3 nuclear facilities in 10 CFR Part 830, Subpart B, and establish approved design criteria to meet the provisions of 10 CFR 830.206.

[2] Facilities or locations used for storage or operations with explosives or ammunition.

[3] For explosives facilities that are also nuclear facilities, requirements for nuclear safety design also apply.

[4] See 10 CFR Part 830 and associated guidance for additional information on major modifications to hazard category 1, 2, and 3 nuclear facilities.

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c. This chapter does not apply to nuclear deactivation or decontamination and decommissioning activities at end-of-facility-life if the safety analysis demonstrates that adequate protection is provided consistent with the requirements of 10 CFR Part 830 through alternate means and it is not cost beneficial to apply the provisions of this chapter for the limited remaining life of the activity.

3. REQUIREMENTS.

a. Integration of Design with Safety Analyses.

(1) Safety analyses must be used to establish—

(a) the identity and functions of safety class and safety significant structures, systems, and components (SSCs)[5] and

(b) the significance to safety of functions performed by safety class and safety significant SSCs.

(2) Safety analyses must address—

(a) hazards inherent to the facility and its activities,

(b) Natural phenomena hazards (NPH),[6] and

(c) external man-induced hazards (factors such as proximity to airports, pipelines, hazardous traffic on roads or waterways, and adjacent facilities).

(3) Safety analysis must be performed as early as practical in conceptual or preliminary design processes to ensure that required safety SSCs are specified in the final design.

(4) Safety analyses must be performed in accordance with the requirements for safety analysis defined in DOE directives and technical standards for a documented safety analysis (DSA).

b. Nuclear Facility Design.

(1) Nuclear facility design objectives must include multiple layers of protection to prevent or mitigate the unintended release of radioactive materials to the environment, otherwise known as defense in depth. These multiple layers must include multiple physical barriers unless the basis for

[5] See definitions for these and other terms in this chapter in 10 CFR 830.3.
[6] See chapter IV and associated guidance for additional information on NPH.

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not including multiple physical barriers is documented in the DSA and approved by DOE.

(2) Defense in depth must include all of the following —

(a) choosing an appropriate site;

(b) minimizing the quantity of material at risk;

(c) applying conservative design margins and quality assurance;

(d) using successive physical barriers for protection against radioactive releases;

(e) using multiple means to ensure critical safety functions needed to—

1 control processes,

2 maintain processes in safe status, and

3 confine and mitigate the potential for accidents with radiological releases;

(f) using equipment and administrative controls[7] that—

1 restrict deviation from normal operations,

2 monitor facility conditions during and after an event, and

3 provide for response to accidents to achieve a safe condition;

(g) providing means to monitor accident releases as required for emergency response;[8] and

(h) establishing emergency plans for minimizing the effects of an accident.

(3) Hazard category 1, 2, and 3 nuclear facilities must be sited, designed, and constructed in a manner that ensures adequate protection of the health and

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[7] See Appendix A Section G of 10 CFR Part 830 Subpart B and associated guidance for additional information on administrative controls for Technical Safety Requirements.
[8] See DOE O 151.1C, *Comprehensive Emergency Management System.*

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safety of the public, workers, and the environment from the effects of accidents involving radioactive materials release.

(4) Hazard category 1, 2, and 3 nuclear facilities with uncontained radioactive materials (as opposed to material determined by safety analysis to be adequately contained within drums, grout, or vitrified materials) must have the means to confine the uncontained radioactive materials to minimize their potential release in facility effluents during normal operations and during and following accidents. Confinement design considerations must include:

(a) for a specific nuclear facility, the number, arrangement, and characteristics of confinement barriers as determined on a case-by-case basis;

(b) the type, quantity, form, and conditions for dispersing the radioactive material in the confinement system design;

(c) use of engineering evaluation, tradeoff, and experience to develop practical designs that achieve confinement system objectives; and

(d) the adequacy of confinement systems to perform required functions as documented and accepted through the preliminary DSA (PDSA) and DSA.

(5) Hazard category 1, 2, and 3 nuclear facilities must be designed to—

(a) facilitate safe deactivation, decommissioning, and decontamination at the end of facility life, including incorporation of design considerations during the operational period that facilitate future decontamination and decommissioning;

(b) facilitate inspections, testing, maintenance, repair, and replacement of safety SSCs as part of a reliability, availability, and maintainability program with the objective that the facility is maintained in a safe state; and

(c) keep occupational radiation exposures within statutory limits, and as low as reasonably achievable (ALARA).

(6) Facility process systems must be designed to minimize waste production and mixing of radioactive and non-radioactive wastes.

(7) Safety SSCs and safety software must be designed, commensurate with the importance of the safety functions performed, to perform their safety functions when called upon, and to meet the quality assurance program

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requirements of either 10 CFR 830, Subpart A, or DOE O 414.1C, *Quality Assurance*, as applicable.

(8) Safety class electrical systems must be designed to preclude single point failure.[9]

(9) New DOE nuclear reactors must comply with the requirements of this CRD, as well as the design requirements of DOE O 5480.30, *Nuclear Reactor Safety Design Criteria*.

c. Explosives Safety Design.

(1) New DOE explosives facilities and all modifications to existing explosives facilities must be designed consistent with the DOE explosives safety requirements established in DOE M 440.1-1A, *DOE Explosives Safety Manual*, dated 1-9-06, and technical standards referenced in that manual. In particular, they must be designed in accordance with—

(a) DoD TM5-1300, *Structural Design of Facilities to Resist the Effects of Accidental Explosions* (1990);

(b) DOE/TIC-11268, *Manual for the Prediction of Blast and Fragment Loading for Structures* (July 1992); and

(c) the following DoD Explosives Safety Board (DDESB) technical papers:

1 DDESB Technical Paper 12, *Fragment and Debris Hazards*, July 1975.

2 DDESB Technical Paper 13, *Prediction of Building Debris for Quantity-Distance Siting*, April 1991.

3 DDESB Technical Paper 15, *Approved Protective Construction*, June 2004.

4 DDESB Technical Paper 16, *Methodologies for Calculating Primary Fragment Characteristics*, dated December 1, 2003.

5 DDESB Technical Paper 17, *DDESB Blast Effects Computer Version 5.0 User's Manual and Documentation*,

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[9] See the basic approach in section 5.2.3 (Electrical) of DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use with DOE O 420.1, Facility Safety*, dated 3-28-00, with appropriate consideration and application of the national electrical codes and standards.

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with accompanying program entitled *DDESB Blast Effects Computer (BEC)*, Version 6.1.

(2) Blast-resistant design to protect personnel and facilities must be based on the TNT equivalency of the maximum quantity of explosives and propellants permitted, increased by 20 percent in accordance with DoD TM5-1300.

d. Implementation.

(1) For new facilities, an implementation plan must be submitted to the responsible Secretarial Officer or designee describing the process for ensuring that facility design and construction will be in compliance with nuclear facility safety requirements of this CRD.

(2) Deviations/exemptions from requirements must be appropriately documented, justified, and approved by DOE in accordance with the provisions stated in this CRD.

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CHAPTER II. FIRE PROTECTION

1. OBJECTIVES. To establish requirements[1] for a comprehensive fire protection program for DOE sites, facilities, and emergency service organizations to minimize the potential for—

   a. Occurrence of a fire or related event;

   b. Fires that cause an unacceptable onsite or offsite release of hazardous or radiological material that could impact the health and safety of employees, the public, or the environment;

   c. Unacceptable interruption of vital DOE programs as a result of fire and related hazards;

   d. Property loss from fire exceeding limits established by DOE; and

   e. Fire damage to critical process controls and safety class SSCs (as documented by appropriate safety analysis).

2. APPLICABILITY. This chapter applies to both fire protection programs and facility safety design for DOE nuclear, non-nuclear, and weapons facilities.[2]

3. REQUIREMENTS.

   a. General. Fire protection for DOE facilities, sites, activities, design, and construction must—

      (1) provide a level of safety sufficient to fulfill requirements for highly protected risk (HPR),[3]

      (2) prevent loss of safety functions and safety systems as determined by safety analysis and provide defense-in-depth, and

      (3) meet or exceed applicable building codes for the region and NFPA codes and standards as follows:[4]

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[1] See also worker fire protection requirements in DOE O 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*, and guidance in DOE G 440.1-5, *Implementation Guide for Use with DOE Orders 420.1 and 440.1, Fire Safety Program*.

[2] Activities within weapons facilities relating to accidental or unauthorized nuclear detonation are subject also to requirements of the 452 series of DOE Directives (see references).

[3] The facility as characterized by a level of fire protection design, systems, and management controls to fulfill requirements for the best-protected class of industrial risks. The term "risk" as it is used in this Order is consistent with the use in the insurance industry as the "property" that qualifies for preferred insurance premium status.

[4] The provisions of the applicable state/regional model building codes take precedence over the Building Construction and Safety Code (NFPA 5000®: *Building Construction and Safety Code®*, 2003 Edition).

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(a) Facilities or modifications thereto must be constructed to meet codes and standards in effect, when design criteria are approved, otherwise known as the Code of Record (COR).

(b) Provisions of subsequent editions of codes or standards (promulgated after the COR) must be met to the extent that they are explicitly stated to be applicable to existing facilities. Other provisions of updated codes and standards must be applied to existing facilities when a construction modification takes place or when a potential for immediate risk to life safety or health has been identified through either the facility assessment or fire hazards analysis (FHA) review process, or during the construction review or permitting process.

b. Fire Protection Program. An acceptable fire protection program must be developed, implemented, and maintained by the contractor, which includes the following elements and requirements.

(1) A policy statement that—

(a) incorporates fire protection requirements of this CRD, related DOE directives, and other applicable Federal, state, and local requirements; and

(b) affirms contractor's commitment to fire protection and fire suppression capabilities sufficient to minimize losses from fire and related hazards consistent with highly protected risk status in private industry.

(2) Comprehensive, written fire protection criteria or procedures that include—

(a) site-specific requirements;

(b) staff organization, training, and responsibilities;

(c) administrative responsibilities;

(d) design, installation, operability, inspection, maintenance, and testing requirements;

(e) use and storage of combustible, flammable, radioactive, and hazardous materials to minimize risk from fire;

(f) fire protection system impairments;

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(g) smoking and hot work;

(h) safe operation of process equipment; and

(i) prevention measures that decrease fire risk.

(3) A system to ensure that fire protection program requirements are documented and incorporated in plans and specifications for new facilities and significant modifications to existing facilities.

(4) Documented review of plans, specifications, procedures, and acceptance tests by a qualified fire protection engineer.

(5) Fire hazard analyses (FHAs) using a graded approach for all hazard category 1, 2, and 3 nuclear facilities, significant new facilities,[5] and facilities that represent unique fire safety risks. The FHAs must be—

(a) performed under the direction of a qualified fire protection engineer;

(b) reviewed every 3 years; and

(c) revised when —

1 changes to the annual DSA updates impact the contents in the FHA,

2 a modification to an associated facility poses a significant new fire safety risk, or

3 the 3 year review identifies the need for changes.

(6) FHA conclusions incorporated into the DSA and integrated into design basis and beyond design basis accident conditions.

(7) Access to qualified, trained fire protection staff that includes fire protection engineers, technicians, and fire fighting personnel to implement the requirements of this CRD.

(8) A baseline needs assessment (BNA) of the fire protection emergency response organization that—

(a) establishes the site fire fighting capabilities to provide—

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[5] As determined by the AHJ.

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1 effective response to suppress all fires;

2 emergency medical and hazardous materials response capabilities; and

3 staffing, apparatus, facilities, equipment, training, pre-plans, offsite assistance, and procedures;

(b) reflects applicable NFPA codes and standards; and

(c) is updated at least every 3 years and in accordance with applicable NFPA code provisions and whenever a significant new hazard is introduced that is not covered by the current BNA.

(9) Site emergency plans, FHAs, and DSAs that incorporate BNA information.

(10) Pre-fire strategies, plans, and standard operating procedures to enhance the effectiveness of site fire fighting personnel.

(11) Procedures governing the use of fire fighting water or other neutron moderating materials to suppress fire within or adjacent to moderation controlled areas.

(12) Where no alternative exists to criticality safety restrictions on the use of water for fire suppression, the need for such restriction is fully documented and with written technical justification.

(13) A documented comprehensive fire protection self assessment program performed every 3 years.

(14) Periodic facility assessments on a schedule as directed by DOE.

(15) Processes to prioritize and monitor the status of fire protection assessment findings, recommendations, and corrective actions until final resolution.

(16) A process for reviewing and recommending approval of fire safety equivalencies to any fire protection code or standard requirements to the DOE.

(17) Procedures governing fire fighting techniques to be used during deactivation, decontamination, and demolition phases, when applicable.

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c. Fire Protection Design. A comprehensive fire protection design program for facilities and supporting systems must be developed, implemented, and maintained to include the following elements.

(1) A reliable and adequate supply of water for fire suppression.

(2) Noncombustible construction materials for facilities exceeding the size limitations established by DOE (See DOE-STD-1066-99, *Fire Protection Design Criteria*, for information on size limitations).

(3) Complete fire-rated construction and barriers, commensurate with the applicable codes and fire hazards, to isolate hazardous areas and minimize fire spread and loss potential consistent with limits as defined by DOE (See DOE-STD-1066-99).

(4) Automatic fire extinguishing systems throughout all significant facilities and in all facilities and areas with potential for loss of safety class systems (other than fire protection systems), significant life safety hazards, unacceptable program interruption, or fire loss potential in excess of limits defined by DOE (See DOE-STD-1066-99).

(5) Redundant fire protection systems in areas where—

(a) safety class systems are vulnerable to fire damage, and no redundant safety capability exists outside of the fire area of interest or

(b) the maximum possible fire loss (MPFL) exceeds limits established by DOE.

(6) In new facilities, redundant safety class systems (other than fire protection systems) must be located in separate fire areas.

(7) A means (e.g., fire alarm or signaling system) to notify emergency responders and building occupants of a fire.

(8) Emergency egress and illumination for safe facility evacuation in the event of fire as required by applicable codes or fire hazards analysis.

(9) Physical access and appropriate equipment that is accessible for effective fire department intervention (e.g., interior standpipe systems in multi-story or large, complex facilities).

(10) A means to prevent the accidental release of significant quantities of contaminated products of combustion and fire fighting water to the environment, such as ventilation control and filter systems, and curbs and dikes. Such features would only be necessary if required by the FHA or

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DSA in conjunction with other facility or site environmental protection measures.

(11) A means to address fire and related hazards that are unique to DOE and not addressed by industry codes and standards. Mitigation features may consist of isolation, segregation, or use of special fire control systems (water mist, clean agent, or other special suppression systems) as determined by the FHA.

(12) Fire protection systems designed such that their inadvertent operation, inactivation, or failure of structural stability will not result in the loss of vital safety functions or inoperability of safety class systems as determined by the DSA.

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CHAPTER III. NUCLEAR CRITICALITY SAFETY

1. OBJECTIVES.

   a. To establish requirements for developing and implementing nuclear criticality safety programs (CSPs) for hazard category 1 and 2 nuclear facilities and activities, including materials transportation activities.

   b. To provide adequate protection to the public, workers, and the environment.

2. APPLICABILITY. This chapter is applicable to nuclear facilities and activities that involve or will potentially involve nuclides in such quantities that are equal to or greater than the single parameter limits for fissionable materials listed in the ANSI/ANS-8.1 and 8.15.[1]

3. REQUIREMENTS.

   a. General.

      (1) CSPs must be implemented to ensure that fissionable material operations will be evaluated and documented to demonstrate that operations will be sub-critical under both normal and credible abnormal conditions.

      (2) No single credible event or failure can result in a criticality.

      (3) The CSP description document must describe how the contractor will implement the requirements in the CRD including the standards invoked by this Chapter. The program description must be approved by DOE and implemented as approved.

      (4) CSPs must include the following:

         (a) Criticality safety evaluations for fissionable materials operations that document parameters, limits, and controls required to maintain sub-criticality for all normal and credible abnormal conditions;

         (b) The preferred order of controls must be passive engineered controls, active engineered controls, followed by administrative controls.

         (c) Provisions for implementation of limits and controls identified by the criticality safety evaluations;

         (d) Periodic reviews of operations and conditions to ensure that—

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[1] See paragraph 3b(2) of this chapter for applicable revision.

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1 limits and controls are effectively implemented, and

2 process conditions have not been altered resulting in compromise of safety limits and controls; and

(e) Assessment of the need for installation of criticality accident alarm and detection systems where appropriate to conform with paragraphs 3b(2) and 3b(3) of this chapter.

(5) Nuclear criticality safety staff[2] responsible for implementing the CSP must be trained and qualified in accordance with a qualification program approved by DOE, unless the qualification program is consistent with DOE-STD-1135-99, *Guidance for Nuclear Criticality Safety Engineering Training and Qualification*.

b. Specific Requirements.

(1) CSPs must apply to facilities and activities with fissionable materials operations as defined in section 2 of the chapter and conditions that have potential for criticality accidents.

(2) CSPs must satisfy the requirements of the revisions to consensus nuclear criticality safety standards of the American National Standards Institute (ANSI)/American Nuclear Society (ANS) 8 in effect as of the date of the Order, unless otherwise modified or approved by DOE.

(3) All recommendations in applicable ANSI/ANS standards must be considered and a explanation provided to DOE through the CSP description document whenever a recommendation is not implemented.

(4) The double contingency principle defined in ANSI/ANS 8.1, *Nuclear Criticality Safety in Operations with Fissionable Material outside Reactors*, is a requirement that must be implemented for all fissionable material processes, operations, and facility designs within the scope of this chapter unless the deviation is documented, justified, and approved by DOE.

(5) The methodology for conducting criticality safety evaluations must be approved by DOE, unless the evaluations are conducted in accordance with the DOE-STD-3007-1993, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities*, or successor document and evaluated in accordance with DOE-STD-1134-1999, *Review Guide for Criticality Safety Evaluations*, or successor document.

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[2] See ANSI 8.19, *Administrative Practices for Nuclear Criticality Safety*, for specifics on nuclear criticality safety staff.

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(6) Facilities that conduct operations using fissionable material in a form that could inadvertently accumulate in significant quantities must include a program and procedures for detecting and characterizing accumulations.

(7) Guidelines for fire fighting must be established for areas within or adjacent to moderator-controlled areas. The criteria and process for developing the guidelines must be documented in the CSP description document.

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CHAPTER IV. NATURAL PHENOMENA HAZARDS MITIGATION

1. OBJECTIVES. To establish requirements for DOE facility design, construction, and operations to protect the public, workers, and the environment from the impact of all NPH event (e.g., earthquake, wind, flood, and lightning).

2. APPLICABILITY. Requirements in this chapter apply to all DOE facilities and sites.[1]

3. REQUIREMENTS. DOE facilities and operations must be analyzed to ensure that structures, systems, and components (SSCs) and personnel will be able to perform their intended safety functions effectively under the effects of NPH. Where no specific requirements are identified, model building codes or national consensus industry standards must be used consistent with intended SSC functions.[2]

   a. Natural Phenomena Mitigation Design.

      (1) Facility SSCs must be designed, constructed, and operated by the contractors to withstand NPH and ensure—

         (a) confinement of hazardous materials,

         (b) protection of occupants of the facility, as well as members of the public areas,

         (c) continued operation of essential facilities,

         (d) protection of government property.

      (2) The design and construction of new facilities and major modifications[3] to existing facilities and SSCs must address—

         (a) potential damage to and failure of SSCs resulting from both direct and indirect NPH events;

         (b) common cause/effect and interactions resulting from failures of other SSCs; and

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[1] Activities within weapons facilities relating to accidental or unauthorized nuclear detonation are subject to requirements of the 452 series of DOE Directives (see references).

[2] See DOE G 420.1-2, *Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Nonnuclear Facilities*, for guidance on implementing NPH requirements.

[3] Major modifications are those which could substantially change the safety basis. See 10 CFR Part 830 and associated guidance for additional information on major modifications to hazard category 1, 2, and 3 nuclear facilities.

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(c) compliance with seismic requirements of E.O. 12699, Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction (as amended by E.O. 13286, Amendment of Executive Orders, and Other Actions, in Connection With the Transfer of Certain Functions to the Secretary of Homeland Security, January 5, 1990).

(3) Additions and modifications to existing DOE facilities must not degrade SSC performance during an NPH occurrence.

b. Evaluation and Upgrade Requirements for Existing DOE Facilities.

(4) SSCs in existing DOE facilities must be evaluated when there is a significant degradation[4] in the facility safety basis. Evaluations must address the safety significance of the SSCs and the seismic requirements delineated in E.O. 12941, Seismic Safety of Existing Federally Owned or Leased Buildings (December 1, 1994).

(5) If the evaluation of existing SSCs identifies NPH mitigation deficiencies, an upgrade plan must be implemented on a prioritized schedule based on the safety significance of the upgrades, time or funding constraints, and mission requirements.

c. NPH Assessment.

(1) Both facility design and evaluation criteria must address the potential types of NPH occurrences. The NPH assessment must use a graded approach commensurate with the potential hazard of the facility.

(2) NPH assessment for new facilities must use a graded approach that considers the consequences of all types of NPHs. Site-wide information may be considered when appropriate.

(3) NPH assessments must be reviewed and upgraded as necessary for existing sites/facilities following significant changes in NPH assessment methodology or site-specific information.

(4) An NPH assessment review must be conducted at least every 10 years and must include recommendations to DOE for updating the existing assessments based on significant changes found in methods or data. If no change is warranted from the earlier assessment, then this only needs to be documented.

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[4] See DOE G 420.1-2 for additional guidance on significant degradation.

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d. Seismic Detection. Facilities or sites with hazardous materials must have instrumentation or other means to detect and record the occurrence and severity of seismic events.

e. Post-Natural Phenomena Procedures. Facilities or sites with hazardous materials must have procedures for inspecting facilities for damage from severe NPH events and placing a facility into a safe configuration when damage has occurred.

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CHAPTER V. SYSTEM ENGINEER PROGRAM

1. OBJECTIVES. To establish requirements for a System Engineer Program for hazard category 1, 2, and 3 nuclear facilities and to ensure continued operational readiness of the systems within its scope.

2. APPLICABILITY.

   a. Requirements of this chapter apply to all hazard category 1, 2, and 3 nuclear facilities.

   b. The System Engineer Program must be applied to active safety class and safety significant SSCs as defined in the facility's DOE-approved safety basis, as well as to other active systems that perform important defense-in-depth functions, as designated by facility line management.

3. REQUIREMENTS.

   a. General.

      (1) Hazard category 1, 2, and 3 nuclear facilities must have a System Engineer Program, as well as a qualified cognizant system engineer (CSE) assigned to each system within the scope of the Program.

      (2) System Engineer Program must be incorporated into the Integrated Safety Management System (ISMS),[1] must flow down from site and facility implementing procedures, and must define CSE functions, responsibilities, and authorities.

      (3) A graded approach must be used in applying the requirements of the System Engineer Program.

   b. Program Elements. The program elements must include and integrate the identification of systems within its scope, configuration management, and CSE support for operations and maintenance.

   c. Configuration Management.[2] An objective of the System Engineer Program is to ensure operational readiness of the systems within its scope. To achieve this, the principles of configuration management must be applied to these systems. Consequently, the following requirements are considered an integral part of the Systems Engineer Program.

      (1) Configuration management must be used to develop and maintain consistency among system requirements and performance criteria,

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[1] See 48 CFR 970.5223-1, Integration of environment, safety and health into work planning and execution.
[2] See DOE-STD-1073-2003, *Configuration Management*, for guidance on implementing configuration management.

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documentation, and physical configuration for the SSCs within the scope of the Program.

(2) Configuration management must integrate the elements of system requirements and performance criteria, system assessments, change control, work control, and documentation control.

(3) System design basis documentation and supporting documents must be compiled and kept current using formal change control and work control processes, or when design basis information is not available, documentation must include—

(a) system requirements and performance criteria essential to performance of the system's safety functions,

(b) the basis for the system requirements, and

(c) a description of how the current system configuration satisfies the requirements and performance criteria.

(4) Key design documents must be identified and consolidated to support facility safety basis development and documentation.[3]

(5) System assessments must include periodic review of system operability, reliability, and material condition.[4] Reviews must assess the system for—

(a) ability to perform design and safety functions,

(b) physical configuration as compared to system documentation, and

(c) system and component performance in comparison to established performance criteria.

(6) System maintenance and repair must be controlled through a formal change control process to ensure that changes are not inadvertently introduced and that required system performance is not compromised.

(7) Systems must be tested after modification to ensure continued capability to fulfill system requirements.

d. System Engineer Support for Operations and Maintenance.

(1) The functions of a System Engineer Program are required to maintain the integrity of a facility's safety basis. System Engineer

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[3] See DOE-STD-3024-98, *Content of System Design Descriptions*, for guidance on key design documents.
[4] Periodic system assessments are also required by as required by DOE O 433.1, *Maintenance Management Program for DOE Nuclear Facilities.*

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Program functions are typically accomplished by various parts of a program's operating organization. This organization must designate one person as the CSE for each system to which the System Engineer Program applies (See paragraph 2 of this chapter). The CSE must maintain overall cognizance of the system and be responsible for system engineering support for operations and maintenance. The CSE must provide technical assistance in support of line management safety responsibilities and ensure continued system operational readiness.

(2) The CSE must—

(a) ensure that system configuration is being managed effectively (See paragraph 3c of this chapter);

(b) remain apprised of operational status and ongoing modification activities;

(c) assist operations review of key system parameters and evaluate system performance;

(d) initiate actions to correct problems;

(e) remain cognizant of system-specific maintenance and operations history and industry operating experience, as well as manufacturer and vendor recommendations and any product warnings regarding safety SSCs in their assigned systems;

(f) identify trends from operations;

(g) provide assistance in determining operability, correcting out-of-specification conditions, and evaluating questionable data;

(h) provide or support analysis when the system is suspected of inoperability or degradation;

(i) review and concur with design changes; and

(j) provide input to development of special operating/test procedures.

(3) Qualification requirements for CSEs must be consistent with those defined for technical positions described in DOE O 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, dated 11-15-94, chapter II, paragraph 2c,

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"Technical Staff for Reactor Facilities," and chapter IV, paragraph 2f, "Technical Staff for Non-Reactor Nuclear Facilities."

(4) The requirements of this chapter must be incorporated into the contractor training programs also required by DOE O 5480.20A.

(5) Development plans for CSEs should be part of the overall training and development program.

(6) Qualification and training requirements must include knowledge of—

(a) related facility safety basis including any relationship to administrative controls;

(b) system functional classification and basis;

(c) applicable codes and standards;

(d) system design, procurement, replacement, and related quality assurance requirements;

(e) the existing condition of the system;

(f) a working knowledge of the facility's operation; and

(g) vendor recommendations, manuals, and any product warnings.

(7) Evaluation of a CSE's qualifications should include formal education, prior training, and work experience as described in chapter I, paragraph 13 of DOE O 5480.20A.

Consistent with the graded approach, large, complex, or very important systems may require assignment of more than one technical level CSE while small, simple, less important systems may only require assignment of a technician. Conversely, a single individual may be assigned to be the CSE for more than one system.

e. Graded Approach. Implementation of System Engineer Program requirements should be tailored to facility hazards and the systems relied upon to prevent or mitigate those hazards. This should be done by using a graded approach that considers the following factors.

(1) Remaining Facility Lifetime and the Safety Significance of Remaining Operations. Facilities undergoing deactivation, and decontamination and decommissioning, may be undergoing frequent changes, modifications, and in some cases, removal of systems no

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(2) longer needed to support the safety basis of those operations. System Engineer Programs may require more attention in these operations than when the facility was in normal operations. After deactivation or when a facility is in long-term surveillance and maintenance, there may be less need for attention.

(3) Safety Importance of the System. Not all systems are equal as measured by the likelihood and consequences of the hazard and the accidents that they prevent or mitigate. The level of system documentation detail in configuration management should be tailored to the importance of the system.