U.S. Department of Energy

Washington, D.C.

ORDER

DOE O 420.1D

Approved: 08-05-2026

SUBJECT: FACILITY SAFETY

1. PURPOSE. To establish facility and programmatic safety requirements for nuclear facilities authorized by the Department of Energy (DOE) for:

   a. Nuclear safety design criteria.

   b. Fire protection.

   c. Criticality safety.

   d. Natural phenomena hazards (NPH) mitigation.

   e. Configuration management program.

   f. Configuration Management Facility safety requirements for explosive, chemical, and industrial hazards are contained in other DOE rules and directives.

2. CANCELS/SUPERSEDES. DOE Order (O) 420.1C, *Facility Safety,* dated December 4, 2012, with respect to the facilities and activities covered by Section 3, below. Cancellation of a directive does not, by itself, modify or otherwise affect any contractual or regulatory obligation to comply with the directive. Contractor Requirements Documents (CRDs) that have been incorporated into a contract remain in effect throughout the term of the contract unless and until the contract or regulatory commitment is modified to either eliminate requirements that are no longer applicable or substitute a new set of requirements

3. APPLICABILITY.

   a. Departmental Elements. This Order applies to all Departmental Elements, including the National Nuclear Security Administration (NNSA) and their associated Field Element(s),[1] to the extent they are involved with facilities and activities described in paragraph 3.b.

[1] Operations offices, service centers, site offices, area offices, field offices, government-owned government-operated facilities, and regional offices of federally-staffed laboratories that report directly to a DOE Headquarters office.

b. Nuclear Facilities. Except as stated in paragraph 3.d., this Order applies to all Hazard Category 1, 2, and 3 nuclear facilities authorized by DOE. Such nuclear activities include the design, construction, management, operation, decontamination, decommissioning, or demolition of nuclear facilities.

c. DOE Contractors. Except as stated in paragraph 3.d., this Order sets forth conditions to be applied to contractors performing work that involves facilities described in paragraph 3.b. The CRD must be included in contracts under which the contractor is involved with such facilities and activities.

d. Equivalencies and Exemptions.

(1) Exemption. In accordance with the responsibilities and authorities assigned by Executive Order 12344, Naval Nuclear Propulsion Program, codified at 50 United States Code §§ 2406, Deputy Administrator for Naval Reactors, and 2511, and to ensure consistency throughout the joint Navy/DOE Naval Nuclear Propulsion Program, the Deputy Administrator for Naval Reactors (Director) implements and oversees requirements and practices pertaining to this directive for activities under the Director's cognizance, as deemed appropriate.

(2) Exemption. This Order does not apply to activities regulated by either the Nuclear Regulatory Commission (NRC) or the authorities of a State under an agreement with the NRC per the *Atomic Energy Act of 1954*, as amended (AEA).

(3) Other Equivalencies/Exemptions. Any other equivalency or exemption to this Order requires the approval of Safety Basis Approval Authority (SBAA). Requests for equivalencies/exemptions will be adjudicated by the SBAA within 14 calendar days of receipt of a substantially complete request.

4. REQUIREMENTS. DOE elements must:

a. Approve and oversee contractor programs, as specified in Section 5 of this Order.

b. Implement the requirements in Attachment 1 of this Order for government-owned government-operated facilities.

c. Review and approve safety basis and safety design basis documents in accordance with DOE-STD-1104-2016, Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents.

5. RESPONSIBILITIES.

a. Secretarial Officers.

(1) Ensure that the requirements of this Order and the CRD are implemented for facilities or programs under their cognizance. Review and, where justified, approve requests for equivalencies and exemptions to the requirements of this Order, processed in accordance with DOE O 251.1D, *Departmental Directives Program*.

(2) Review and approve safety basis and safety design basis documents in accordance with DOE-STD-1104-2016.

b. Safety Basis Approval Authority.

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

(2) Identify contracts to which the CRD applies and notify contracting officers when contracts are affected by this Order.

(3) Review and, where justified, approve equivalencies to DOE technical standards. Approve contractor emergency services organization baseline needs assessments (BNAs) that meet the requirements in Attachment 2, Chapter II, Section 3.e.(1) of this Order.

(4) Approve periodic NPH assessment evaluations.

(5) Consistent with DOE Policy 226.2, *Policy for Federal Oversight and Contractor Assurance Systems*, establish and implement an appropriate self-assessment and oversight program for the elements of this Order.

(6) Review and approve safety basis and safety design basis documents in accordance with DOE-STD-1104-2016.

c. Contracting Officers. Incorporate the CRD, or its requirements, into affected contracts and procurement requests in a timely manner when notified.

6. INVOKED STANDARDS.

7. REFERENCED STANDARDS. The following DOE technical standards and industry standards are required for this Order in accordance with the applicability and conditions described within this Order. Alternatives to these standards may be utilized with the approval of the SBAA.

a. DOE Standard (STD)-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*. This DOE technical standard is required to be used for specified new non-reactor Hazard Category 1, 2, and 3 nuclear facilities.

b. DOE-STD-1104-2016, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*. This DOE technical standard is required to be used by DOE personnel for review and approval of safety basis and safety design basis documents. See Section 4 for specific requirements.

c. DOE-STD-NE-1020, *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities*. This DOE technical standard should be used for developing the NPH design of new facilities and major modifications. See Attachment 2, Chapter IV of this Order for additional allowances and guidance for using DOE-STD-NE-1020.

d. American National Standards Institute (ANSI)/American Nuclear Society (ANS)-8, Nuclear Criticality Safety Standards, and DOE STD-3007-2017, Preparing Criticality Safety Evaluations at DOE Nonreactor Nuclear Facilities (or subsequent as approved per contract). This set of industry standards and this Order is required to satisfy or alternatives are required to be approved by the SBAA by Criticality Safety Programs for facilities and activities with the potential for inadvertent criticalities. See Attachment 2, Chapter III for specific requirements.

e. Institute of Electrical and Electronics Engineers (IEEE) 379-2014, *IEEE* Standard *for Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*. This industry standard should be applied to the design of safety-class structures, systems, and components (SSCs) for new nuclear facilities and major modifications, unless another applicable standard is approved by DOE. See Attachment 3 for specific requirements.

f. IEEE 323-2003 (R2008), *IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*. This industry standard should be used to ensure environmental qualifications of safety-class SSCs for new nuclear facilities and major modifications, unless another applicable standard is approved by DOE. See Attachment 3 for specific requirements.

g. IEEE 384-2008, *IEEE Standard Criteria for Independence of Class IE Equipment and Circuits*. This industry standard should be used for new nuclear facilities and major modifications for physical and electrical separation methods, including the use of separation distance, barriers, electrical isolation devices, or any combination thereof, unless another applicable standard is approved by DOE. See Attachment 3 for specific requirements.

8. APPLICABLE STANDARDS. An applicable DOE technical standard or industry code or standard is one for which it has been determined by the contractor that it will be used or will be applied for a specific facility/site to meet the design, construction, and operational requirements described in this Order. This Order provides an acceptable method for determining which standards will be applicable (as described in the Attachments to this Order). DOE approves the contractor's list of applicable DOE technical standards or industry codes or standards via different means, including approval of safety design documents, the fire protection program, and inclusion of the DOE technical standards or industry codes or standards in the contract.

   Once a standard is identified as applicable, this Order requires that the applicable requirements of the applicable standards be followed unless relief is obtained.

   Together, the applicable standards, and any other applicable DOE requirement documents, along with any exemptions and equivalencies, make up the "Code of Record" for a given project or design, and reflect DOE's commitment to standard-based safety management.

9. ACRONYMS. See Attachment 4.

10. REFERENCES. See Attachment 5

11. CONTACT. Questions concerning this Order should be addressed to the Office of the Deputy Secretary of Energy.

12. Safety and Health Policy.

BY ORDER OF THE SECRETARY OF ENERGY:

JAMES P. DANLY
Deputy Secretary

ATTACHMENT 1
CONTRACTOR REQUIREMENTS DOCUMENT
DOE ORDER 420.1D, *FACILITY SAFETY*

This Contractor Requirements Document (CRD) includes requirements outlined in Attachments 2 and 3 of Department of Energy (DOE) Order (O) 420.1, *Facility Safety*, referenced in and made a part of this CRD, and which provide program requirements and/or information applicable to contracts in which this CRD is inserted.

1. GENERAL REQUIREMENTS.

   a. This CRD establishes facility safety requirements for design, construction, operation, management, decontamination, decommissioning, and demolition of DOE authorized Hazard Category 1, 2, and 3 nuclear facilities. Regardless of the performer of the work, the contractors are responsible for complying with the requirements of this CRD. The contractors are responsible for flowing down the requirements of this CRD to subcontractors at any tier, to the extent necessary, to ensure the contractors' compliance with the requirements.

   b. Contractors must satisfy the requirements set forth in Attachments 2 and 3 of DOE O 420.1.

   c. For design and construction activities, contractors must identify the applicable industry codes and standards, and the applicable DOE requirements and technical standards. Additionally, projects shall establish and maintain a Code of Record (COR) early in project design for identifying applicable industry codes and standards. The COR shall also identify proposed exemptions from and equivalencies to applicable industry codes and standards.

   d. Contractors should satisfy the requirements in DOE technical standards and recommended industry codes and standards that are identified as applicable in accordance with Section 1.c. above, unless relief is approved in accordance with Section 2, below.

   e. Fulfill the roles and responsibilities for the Building Code Official and the Authority Having Jurisdiction for matters involving fire protection, as defined by the National Fire Protection Association (NFPA), including documentation of any delegation or assignment of related responsibilities.

   f. Perform responsibilities of "owner," or other equivalent term in the application of DOE technical standards or industry codes and standards, including documentation of any delegation or assignment of related responsibilities.

2. RELIEF FROM REQUIREMENTS, CODES AND STANDARDS.

   a. Requests for equivalencies and exemptions to the requirements of DOE Orders and invoked DOE technical standards in this attachment are processed and approved by the DOE Safety Basis Approval Authority.

b. Requests for equivalencies and exemptions to the requirements of applicable industry codes and standards in this attachment are processed and approved by the contractor. Equivalencies to industry codes and standards determined to be applicable to the facility design or operations must demonstrate an equivalent level of safety (i.e., meets or exceeds the level of protection).

3. ACRONYMS. See Attachment 9.

4. REFERENCES. See Attachment 5

ATTACHMENT 2
FACILITY SAFETY REQUIREMENTS

This attachment provides information and/or requirements associated with Order (O) 420.1, *Facility Safety*, as well as information and/or requirements applicable to contracts into which the associated Contractor Requirements Document (CRD), (see Attachment 1 of O 420.1) is inserted.

CHAPTER I
NUCLEAR SAFETY DESIGN CRITERIA

1. OBJECTIVE. To establish requirements for safety design of DOE Hazard Category 1, 2, and 3 nuclear facilities to support implementation of DOE Policy (P) 420.1.

   The requirements of this chapter (and the criteria in Attachment 3 of O 420.1) support implementation of the requirements for Hazard Category 1, 2, and 3 nuclear facilities in 10 CFR § 830, Nuclear Safety Management, Subpart B, Safety Basis Requirements.

2. APPLICABILITY.

   a. This chapter applies to the design and construction of:

      (1) New Hazard Category 1, 2, and 3 nuclear facilities, as defined by 10 CFR § 830; and

      (2) Major modifications to Hazard Category 1, 2, and 3 nuclear facilities, as defined in 10 CFR § 830, that could substantially change the facility safety basis.

   b. This chapter does not impose requirements on existing facilities, except for major modifications to those facilities. Major modification design requirements are addressed through strategy documents and preliminary documented safety analysis.

   c. Except for the requirements of Section 3.b.(3), 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 § 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 Safety with Design.

      (1) Safety analyses must be used to:

         (a) Identify safety class and safety significant functions needed to prevent and/or mitigate design-basis accidents (DBAs), including natural and man-induced hazards and events;

         (b) Identify specific and appropriate controls to fulfill those functions.

         (c) Identify specific administrative controls needed to fulfill safety functions. (Note: See DOE-STD-1186, Specific Administrative Controls, as per site contract).

b. Nuclear Facility Design.

(1) The nuclear facility design must include multiple layers of protection (as part of the design defense in depth) to prevent or mitigate the unintended release of radioactive materials into the environment.

(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;

(d) Applying quality assurance;

(e) Using successive/multiple controls for protection against radioactive releases (Note: If an exemption to having multiple controls is required, it is the responsibility of the Safety Basis Approval Authority to approve, or disapprove, the exemption for not including multiple controls);

(f) Using multiple means to ensure safety functions are met by:

1 Controlling processes;

2 Maintaining processes in safe status;

3 Providing preventive and/or mitigative controls for accidents with the potential for radiological releases;

4 Providing the ability to monitor facility conditions to support recovery from upset or accident conditions;

(g) Hazard Category 1, 2, and 3 nuclear facilities with uncontained radioactive materials (as opposed to materials determined by safety analyses to be adequately contained within qualified 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, up to and including DBAs. For a specific nuclear facility, the number, arrangement, and characteristics of confinement barriers as determined on a case-by case basis.

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

(a) Facilitate safe deactivation, decommissioning, decontamination, and demolition at the end of facility life,

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

(c) Keep occupational radiation exposures within regulatory limits; and

(d) Provide hazard controls for prevention and mitigation of hazardous material releases and for defense in depth.

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

(5) Safety SSCs and safety software must be designed to perform their safety functions when called upon.

(6) Active safety class systems must be designed to meet single failure criterion.[2]

(7) Facility design must also be integrated with other design requirements, as applicable, including applicable building codes and proposed standards.

[2] IEEE 379-2014, *IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*, provides a definition of the single failure criterion, and ANS 58.9-2002 (R2009), *Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems*, provides additional guidance for single failure criteria for mechanical systems.

CHAPTER II
FIRE PROTECTION

1. OBJECTIVE. To establish requirements for comprehensive fire protection programs for DOE facilities and emergency response organizations to:

   a. Minimize the likelihood of occurrence of a fire-related event;

   b. Minimize the consequences of a fire-related event affecting the public, workers, environment, property, and missions.

2. APPLICABILITY. This chapter applies to organizations that have responsibility for the design, construction, maintenance, or operation of Hazard Category 1, 2, or 3 nuclear facilities used for DOE mission purposes and associated facilities authorized by the Department of Energy (DOE).

3. REQUIREMENTS.

   a. General Fire Protection Program Requirements.

      (1) Codes and Standards. The codes and standards adopted by the contractor, including DOE technical standards, the building code, the fire code (e.g., International Fire Code), National Fire Protection Association (NFPA) codes and standards, and other industry codes and standards must be identified in the fire protection and emergency response programs.

         (a) New Hazard Category 1, 2, and 3 nuclear facilities, and major modifications thereto must be constructed to meet applicable codes and standards that have been designated within design documentation and are in effect when design criteria are approved (otherwise known as the Code of Record, or COR).

         (b) Provisions of subsequent editions of codes or standards (promulgated after the COR is established) are mandatory only to the extent that they are explicitly stated to be applicable to existing facilities.

         (c) Conflicts between DOE Order (O) 420.1, NFPA codes and standards, and the applicable building code must be resolved as follows:

            1 Requirements of DOE O 420.1 take precedence over all NFPA codes and standards and building code requirements and are subject to the relief requirements of DOE O 420.1.

b. Conflicts between NFPA requirements and the applicable building code requirements are resolved by the contractor Authority Having Jurisdiction (AHJ) Fire Protection Program Administration.

(1) Documentation. A documented fire protection program that includes the elements and requirements identified in this chapter for design; operations; emergency response; fire analysis and assessments; wildland fire; and specific fire protection program criteria must be developed, implemented, and maintained by the contractor.

(2) Fire Protection Methods. Fire Protection Programs must describe the methods used to implement the requirements of this chapter.

(3) DOE-STD-1066-2023 is an acceptable method.

c. Design.

(1) Design Process. The facility design process shall ensure that fire protection program requirements are documented and incorporated into plans and specifications for design activities.

(2) Protection Thresholds.[3]

(a) New facilities housing safety SSCs must be of Type I or Type II construction, as defined in the applicable building codes.

(b) Automatic fire suppression systems must be provided as required by the adopted building code, and throughout facilities in which any of the following conditions exist:

1 Where required by safety basis document or;

2 Where determined by the fire hazards analysis (FHA);

(c) For property protection, multiple fire protection approaches, such as a fire suppression system and a fire detection and alarm system, must be provided in areas where the maximum possible fire loss (MPFL) to a DOE-owned or leased facility exceeds $300 million (in 2025 dollars) at the time of design finalization.

(d) For property protection, fire areas must be established such that the MPFL to a DOE owned or leased facility for each fire area does not exceed $412 million (in 2025 dollars) at the time of design finalization. Fire walls or other separation approaches may be used to meet this requirement.

[3] Some of the requirements in this section on protection thresholds may not apply to portions of subterranean facilities that otherwise meet the requirements in Appendix D of DOE-STD-1066-2023.

(3) Fire Protection and Life Safety Systems.

(a) Fire Suppression. The inadvertent operation or failure of fire suppression systems must not result in the loss of function of safety class or safety significant systems. (Note: This requirement addresses proper design of the fire suppression system to ensure it does not impact safety systems and is not intended to drive need for redundancy in safety significant system design.)

(b) Fire Barriers. Fire barrier locations and construction must be documented.

(c) Life Safety. Requirements for life safety and means of egress are provided in the adopted codes and standards, such as the International Building Code, or NFPA 101, Life Safety Code.

(d) Water Supply and Distribution. A reliable and adequate water supply and distribution system must be provided as documented through appropriate analysis.

(4) Special Hazards. Fire protection systems or features, and appropriate procedures to address fire and related hazards that are special or unique to DOE and not addressed by industry codes and standards, must be established.

d. Operations.

(1) Criteria and Procedures. Comprehensive, written fire protection criteria and procedures must be established to implement the fire protection program requirements that include:

(a) Site-specific requirements;

(b) Staff organization, resources, training, and roles and responsibilities;

(c) Inspection, testing, and maintenance of fire protection systems;

(d) Use and storage of combustible, flammable, radioactive, and hazardous materials;

(e) A “hot-work” control program;

(f) Identification and tracking of fire protection system impairments;

(g) Fire prevention measures (e.g., reduced combustible loading, hot-work procedures, ignition source controls);

(h) Facility and FHA assessment programs;

(i) Design and construction oversight; and

(j) Equivalencies, exemptions, modifications, and variances processes.

(2) Implementation. To ensure effective implementation of these requirements, the following elements must be addressed.

(a) Staffing. The contractor must ensure it has access to qualified, trained fire protection staff (that includes fire protection engineers [FPEs], technicians, and firefighting personnel) needed to implement the requirements of this chapter.

(b) Design Review. Documented review of plans, specifications, procedures, and acceptance tests must be conducted by an FPE. A process must be established to oversee fire protection-related activities from the initiation of design to final acceptance.

(c) Equivalencies and Exemptions. A process must be established for developing and requesting AHJ approval of fire protection equivalencies and exemptions to fire protection requirements. Records of technical justification must be maintained and reevaluated for appropriateness as activities or operations change.

e. Emergency Response. Provide emergency response capabilities, as necessary, to meet site needs as established by the BNA, safety basis requirements, and applicable regulations, codes and standards.

(1) Baseline Needs Assessment. A BNA of the fire protection and emergency response organization must be conducted, and the BNA must:

(a) Establish capabilities to provide:

1 Effective response to extinguish fires;

2 Emergency medical, rescue and hazardous materials response; and

3 Staffing, apparatus, facilities, equipment, training, pre-incident plans, mutual aid, and procedures.

(b) Reflect applicable requirements of NFPA codes and standards, and DOE direction;

(c) Be reviewed at least every 3 years, or whenever a significant new hazard that is not covered by the current BNA is introduced, and be updated as appropriate; and,

(d) Be incorporated into site emergency plans, FHAs, and safety basis documentation.

(2) Pre-Incident Plans. Pre-incident strategies, plans, and standard operating procedures must be established to enhance the effectiveness of manual fire suppression activities, including areas within or adjacent to, moderator-controlled areas. The criticality safety staff must review pre-incident plans and procedures related to moderator-controlled areas.

(3) Manual Fire Suppression Activities.

(a) Physical access and appropriate equipment that is accessible for effective manual firefighting intervention must be provided.

(b) Procedures governing the use of fire-fighting water or other neutron moderating materials to suppress fire within, or adjacent to, moderation-controlled areas must be established and reviewed by a criticality subject matter expert prior to release.

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

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

f. Fire Hazard Analyses and Facility Assessments.

(1) Fire Hazards Analyses. FHAs, using a graded approach, must be conducted for all Hazard Category 1, 2, and 3 nuclear facilities and major modifications thereto;

(a) The FHAs must be:

1 Performed under the direction of an FPE;

2 Reviewed every 3 years by an FPE and revised as appropriate (Note: If no revision is necessary, this result must be documented following the review);

3 Revised when

a A modification to a facility or process adds a significant new fire safety risk as determined by the contractor AHJ;

b Integrated into safety basis documentation.

(2) Facility Assessments. Fire protection assessments must be conducted for Hazard Category 1, 2, and 3 facilities at least every 3 years, or at a frequency with appropriate justification approved by the DOE Head of Field Element.

CHAPTER III
NUCLEAR CRITICALITY SAFETY

1. OBJECTIVE. To establish requirements for developing and implementing nuclear criticality safety programs (CSPs) for nuclear facilities and activities, including materials transportation activities, which provides reasonable expectation of adequate protection to the public, workers, and the environment.

2. APPLICABILITY. This chapter is applicable to Department of Energy (DOE) elements and DOE contractors with responsibility for Hazard Category 1, 2, and 3 nuclear facilities that involve or will potentially involve radionuclides in such quantities that are equal to or greater than the single parameter limits for fissionable materials listed in American National Standards Institute (ANSI)/American Nuclear Society (ANS) S-8.1-2014, Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, and ANSI/ANS-8.15-2014, Nuclear Criticality Safety Control of Selected Actinide Nuclides. These limits must be adjusted where process conditions could credibly involve moderators or reflectors that are more effective than light water.

3. REQUIREMENTS.

   a. A CSP document must be developed and maintained that describes how the contractor will implement the requirements and standards in this chapter.

   b. A reactor facility CSP, documented safety analysis, or safety design study must describe nonreactor nuclear facility activities (e.g., fissile material storage and handling) within the scope of the CSP, and reactor activities excluded from the CSP, as applicable.

   c. The CSP document must describe how the contractor will satisfy the requirements of the American National Standards Institute/American Nuclear Society-8 series of nuclear criticality safety standards that are in effect as of the date this Order, unless otherwise modified and approved by the Safety Basis Approval Authority.

   d. Criticality safety evaluations must be conducted in accordance with DOE-STD-3007-2017, Preparing Criticality Safety Evaluations at DOE Nonreactor Nuclear Facilities, or by other documented methods approved by the DOE Safety Basis Approval Authority.

   e. Fissile Material Accumulation Control. Facilities that conduct operations using fissionable material in a form that could inadvertently accumulate in significant quantities must include procedures for detecting and characterizing accumulations.

f. Criticality safety evaluations must show that entire processes involving fissionable materials will remain subcritical under normal and credible abnormal conditions.

g. The criteria and process for developing the guidelines for firefighting in areas within or adjacent to moderator-controlled areas must be coordinated with firefighting pre-incident plans and procedures.

CHAPTER IV
NATURAL PHENOMENA HAZARDS MITIGATION

1. OBJECTIVE. To establish requirements for facility design, construction, and operations to protect the public, workers, and the environment from the impact of natural phenomena hazards (NPH) events (e.g., earthquake, wind, flood, lightning, snow, and volcanic eruption).

2. APPLICABILITY. Requirements in this chapter apply to nuclear facilities. Design requirements (Sections 3.a, 3.b, and 3.c, below) apply to new Hazard Category 1, 2, and 3 nuclear facilities, major modifications, and modifications that may be warranted to comply with a change in hazard from a periodic NPH assessment.

3. REQUIREMENTS.

   a. General. Facilities must be designed, constructed, maintained, and operated to ensure that structures, systems, and components (SSCs) will be able to perform their intended safety functions effectively under the combined effects of NPH and normal loads defined in the applicable codes contained in facilities' Codes of Records. Nuclear facility safety functions that the SSCs must perform during and after an NPH event must be defined in the facility's safety basis documentation.

   b. NPH Design Criteria. The design and hazard assessment of new nuclear facilities and their major modifications must be developed in accordance with the applicable requirements and criteria contained in DOE-Standard (STD)-1020, Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities.

      Seismic Design Category (SDC)-3 SSCs may be designed, including site characterization and probabilistic seismic hazard analysis, per the DOE-STD-1020 rules for SDC-2 SSCs, but with use of an importance factor I = 2.0. Alternatively, SDC-3 SSCs will be designed per DOE-STD-1020.

   c. NPH Accident Analysis. The NPH analysis supporting design and construction of facilities and safety SSCs must be documented and include evaluation of:

      (1) Potential damage to and failure of safety SSCs resulting from both direct and indirect NPH events and

      (2) Common cause/effect and interactions resulting from failures of other nearby facilities or other SSCs in the same facility caused by or induced by an NPH event.

d. Review and Upgrade Requirements for Existing DOE Nuclear Facilities (Hazard Category 1, 2, and 3).

(1) Existing facility or site NPH assessments must be reviewed at least once every 20 years and whenever significant changes in NPH data, criteria, and assessment methods warrant updating the assessments. Section 9.2 of DOE-STD-1020 contains criteria and guidance for performing these reviews. The review results, along with any recommended updated actions, must be submitted to the DOE Head of Field Element for approval. If no update is necessary, this result must be documented following the review.

(2) As a modification to the procedure in DOE-STD-1020, if the mean hazard of an updated NPH assessment is within one standard deviation of the mean hazard of the NPH assessment of record, then no further evaluation is required.

(3) If a new assessment of NPH indicates deficiencies in existing SSC design, a plan for upgrades must be developed and implemented on a prioritized schedule, based on the safety significance of the upgrades, time or funding constraints, and mission requirements. The upgrade plans must also be submitted to the Safety Basis Approval Authority for approval.

Sections 9.3 and 9.4 of DOE-STD-1020 contain guidance on performing upgrade evaluations.

e. Seismic Detection. Sites with Hazard Category 1 or 2 nuclear facilities must have instrumentation or other means to detect and record the occurrence and severity of seismic events.

f. Post-Natural Phenomena Procedures. Hazard Category 1 or 2 nuclear facilities must have procedures for responding to damage from severe NPH events and placing a facility into a safe configuration when damage has occurred.

CHAPTER V
CONFIGURATION MANAGEMENT PROGRAM

1. OBJECTIVE. To establish requirements for a configuration management program for Hazard Category 1, 2, and 3 nuclear facilities.

2. APPLICABILITY. Requirements of this chapter apply to all Hazard Category 1, 2, and 3 nuclear facilities:

3. REQUIREMENTS.

   a. A documented configuration management program must be established and implemented that ensures consistency among credited system requirements and performance criteria, system documentation, and physical configuration of the systems within the scope of the program. Department of Energy (DOE)-Standard (STD)-1073-2016, Configuration Management, describes one acceptable methodology for establishing configuration management programs. The configuration management program must address the following objectives:

      (1) Design control;

      (2) Work control (including maintenance control);

      (3) Change control;

      (4) Document control; and

      (5) Assessments.

   b. Credited system design documents and supporting documents must be identified and kept current using formal change control and work control processes. DOE-STD-3024-2011, Content of System Design Descriptions, describes one acceptable methodology to achieve this function. Design documentation must include:

      (1) System requirements and performance criteria essential to performance of the system's safety functions;

      (2) The basis for system requirements; and

      (3) A description of how the current system configuration satisfies the requirements and performance criteria.

   c. System assessments must include risk- and performance-based reviews of system operability, reliability, and material condition. Exemptions from periodic reviews may be approved where performance indicators demonstrate stable, low-risk conditions. Reviews must assess the system for:

      (1) The ability to perform design and safety functions;

(2) Physical configuration as compared to system documentation; and

(3) System and component performance in comparison to established performance criteria.

d. System maintenance and repair and modification that could affect credited safety functions 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.

ATTACHMENT 3
DESIGN CRITERIA FOR SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

This attachment provides requirements for the design and construction of safety structures, systems, and components (SSCs).

1. OBJECTIVE. Safety class and safety significant SSCs shall be designed and constructed using an identified and documented set of applicable industry codes and standards, together with relevant Department of Energy (DOE) design criteria, standards, and directives. This approach provides a structured basis for achieving reliable performance of credited safety functions under the conditions and events for which the SSCs are intended.

2. APPLICABILITY.

   a. This attachment applies to the design and construction of:

      (1) New Hazard Category 1, 2, and 3 nuclear facilities as defined by 10 Code of Federal Regulations (CFR) § 830, *Nuclear Safety Management*; and

      (2) Major modifications to Hazard Category 1, 2, and 3 nuclear facilities, as defined in 10 CFR 830.

   b. This attachment does not impose requirements on existing facilities, except for major modifications to those facilities.

   c. This attachment 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 § 830 through alternate means and that it is not cost-beneficial to apply the provisions of this attachment for the limited remaining life of the activity.

3. REQUIREMENTS. Safety SSCs must be designed, commensurate with the importance of the safety functions performed, to perform their safety functions when called upon, as determined by the safety analysis.

   a. General Design Criteria.

      (1) Conservative Design Margin. Safety SSCs must be designed with appropriate margins of safety, as defined in applicable DOE or industry codes and standards.

(2) System Reliability.

(a) The single failure criterion, requirements, and design analysis identified in Institute of Electrical and Electronics Engineers (IEEE) 379-2014, *IEEE Standard for Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*, must be applied to active safety class SSCs during the design process as the primary method of achieving reliability, unless another risk informed methodology is approved in accordance with Section 2 of this Order, by the contractor. American National Standards Institute (ANSI)/American Nuclear Society (ANS) 58.9-2002 (R2015), "Single Failure Criteria for LWR Safety-Related Fluid Systems," may be used in defining the scope of active safety class mechanical SSCs.

(b) Safety significant SSCs must be designed to reliably perform all their safety functions. This can be achieved through a number of means, including use of redundant systems/components, increased testing frequency, high reliability components, and diagnostic coverage (e.g., online testing; monitoring of component and system performance; and monitoring of various failure modes). DOE-STD-1195-2011, Design of Safety Significant Safety Instrumented Systems Used at DOE Nonreactor Nuclear Facilities, provides an acceptable method for achieving high reliability of safety significant safety instrumented systems.

(3) Environmental Qualification.

(a) Safety class SSCs must be designed to perform all safety functions with no failure mechanism that could lead to common cause failures under postulated service conditions. The requirements of IEEE 323-2003 (R2008), *IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations,* must be used to ensure environmental qualifications of safety class SSCs, unless another applicable standard is approved by the Safety Basis Approval Authority.

(b) Safety significant SSCs located in a harsh environment *must* be evaluated to establish qualified life. This may be accomplished using manufacturers' recommendations or other appropriate methods.

(4) Safe Failure Modes. The facility design must provide reliable safe conditions and sufficient confinement of hazardous material during and after all DBAs. At both the facility- and SSC-level, the design must ensure that most probable modes of failure (e.g., failure to open versus failure to close) will increase the likelihood of a safe condition.

(5) Support System and Interface Design.

(a) Support SSCs must be designed as safety class or safety significant SSCs if their failures prevent safety SSCs or specific administrative controls from performing their safety functions.

(b) Interfaces—such as pressure retention boundaries, electrical supply, instrumentation, cooling water, and other support systems—may exist between safety SSCs and non-safety SSCs. These interfaces must be evaluated to identify non-safety SSC failures that would prevent safety SSCs from performing their intended safety function. IEEE 384-2008, *IEEE Standard Criteria for Independence of Class IE Equipment and Circuits*, must be used for physical and electrical separation methods, including the use of separation distance, barriers, electrical isolation devices, or any combination thereof, unless another applicable standard is approved by DOE. This application includes a design to ensure that both direct and indirect impacts of DBAs (e.g., fire, seismic) will not cause failure of safety functions.

(6) Protection Against Fire. Safety class systems must be designed such that safety function is maintained for any postulated fire events that credit the safety class systems.

(7) Quality Assurance. A quality assurance program must be established that satisfies 10 CFR § 830, Subpart A, "Quality Assurance Requirements," early in the project, such that safety SSCs and their associated support systems are designed, procured, fabricated, erected, and tested to standards and quality requirements commensurate with their importance to safety.

b. Specific Design Criteria and Use of National Codes and Standards. The selection and use of an appropriate set of applicable codes and standards establishes design criteria to provide assurance that the SSCs are designed to reliably perform their intended functions. The DOE technical standards and the identified industry codes and standards, which are widely used for nuclear facility design and construction, must be evaluated for applicability. Alternative standards may be selected, provided they are evaluated to achieve an equivalent level of safety.

DOE technical standards and applicable codes and standards are considered necessary when they provide relevant design requirements for the safety SSCs that are being designed and are agreed upon in the Code of Record (COR) (i.e., they provide design requirements that are needed to ensure that desired SSC functions are achieved, and these requirements are appropriate for the design materials, configuration, and service conditions).

Further, the use of specific codes and standards may be directed by the DOE Safety Basis Approval Authority. (Note: The stated applicability of industry codes and standards (e.g., for nuclear reactors) should not be used to narrowly interpret relevancy for SSC design.)

Before using these codes and standards, their application to specific DOE design(s) must be reviewed. Once a code or standard is identified as applicable, the applicable requirements (i.e., mandatory statements) must be applied in the design unless an equivalent approach is documented in the COR.

The Nuclear Safety Design Agreement or the Preliminary Documented Safety Analysis may be used to specify provisions for relief (exemptions and equivalencies) from identified, applicable design and construction codes and standards. The set of codes and standards identified below is not meant to be all-inclusive. It is expected that design of SSCs will require selection of additional codes and standards beyond those identified below. For example, unique design features, detailed design considerations, and release of advancements may drive selection of additional codes and standards. Facility designers must identify the complete set of codes and standards necessary to meet the general design criteria identified above (see also Attachment 4 of O 420.1 for additional codes and standards).

(1) Structural. Table 1 provides relevant codes and standards. Attachment 2, Chapter IV of O 420.1 provides additional natural phenomena hazard design requirements.

Table 1: Codes for Safety Significant and Safety Class Structures

Structures	Safety Significant	Safety Class
Concrete	American Concrete Institute (ACI)-318; ACI-349	ACI-349
Steel	ANSI/ American Institute of Steel Construction (AISC) 360; AISC 325; ANSI/AISC N690	ANSI/AISC N690

Note: See DOE-STD-1020-2016, Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities, for further discussion on selection and use of codes for structural design of SSCs.

(2) Mechanical and Process Equipment. Table 2 provides relevant codes and standards.

Table 2: Codes for Safety Significant and Safety Class Process Equipment

Process Equipment	Safety Significant	Safety Class
Reactor Vessel and Internal Support Structures	American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC), Section III	ASME BPVC, Section III
Pressure vessels	ASME BPVC, Section VIII,	ASME BPVC, Section VIII,

Process Equipment	Safety Significant	Safety Class
Tanks (0-15 psig)	American Petroleum Institute (API)-620; ASME BPVC Section VIII, Division 1 or 2	API-620; ASME BPVC, Section VIII, Division 1 or 2
Tanks (containing flammable liquids)	API-620; API-650; Applicable National Fire Protection Association (NFPA) codes and standards	API-620; API-650; Applicable NFPA codes and standards
Tanks (atmospheric pressure)	API-650; American Water Works Association (AWWA) D100	API-650; AWWA D100
Pumps	ASME B73.1, B73.2; ASME BPVC, Section VIII; AWWA D100; Hydraulic Institute Standards, as applicable	ASME B73.1, B73.2; ASME BPVC, Section VIII; AWWA D100; Hydraulic Institute Standards, as applicable
Piping	ASME B31.3	ASME B31.3
Valves	ASME B31.3; ANSI N278.1	ASME B31.3; ANSI N278.1
Heat Exchangers	American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook; ASME BPVC, Section VIII, Division 1; TEMA B, C, or R	ASHRAE Handbook; ASME BPVC, Section VIII, Division 1; Tank Equipment Manufacturers Association (TEMA) B, C, or R
Gloveboxes	ASTM C852; American Glovebox Society (AGS)-G006	ASTM C852; AGS-G006

(3) Ventilation. Table 3 provides relevant codes and standards.

Appendix A of DOE Guide (G) 420.1-1A, *Nonreactor Nuclear Safety Design Criteria for use with DOE O 420.1, Facility Safety*, and DOE-HDBK-1169-2003, *Nuclear Air Cleaning Handbook*, provide guidance for confinement ventilation systems design and performance criteria. Alternate methods must be approved by DOE Heads of Field Element.

Table 3: Codes for Safety Significant and Safety Class Ventilation System Components

Ventilation	Safety Significant	Safety Class
Ducts	ASME AG-1	ASME AG-1
Fans	ASHRAE Handbook; ASME AG-1	ASHRAE Handbook; ASME AG-1
Filtration	ASME AG-1; DOE-STD-3020-2015	ASME AG-1; DOE-STD-3020-2015
Balance of system for confinement ventilation	ASME AG-1	ASME AG-1
Off-gas treatment	ASME AG-1	ASME AG-1

(4) Mechanical Handling Equipment. Table 4 provides relevant codes and standards.

Table 4: Codes for Safety Significant and Safety Class Handling Equipment

Handling Equipment	Safety Significant	Safety Class
Cranes	Applicable Crane Manufacturing Association of America (CMAA) standards; ASME NOG-1; ASME NUM-1; ASME B30.2; DOE-STD-1090-2011	Applicable CMAA standards; ASME NOG-1; ASME NUM-1; ASME B30.2; DOE-STD-1090-2011
Other equipment	ASME B30 Series: DOE-STD-1090-2011	ASME B30 Series; DOE-STD-1090-2011

(5) Electrical. Tables 5 and 6 provide relevant codes and standards.

Note: ANSI/IEEE standards, below, define requirements for the manufacturing, installation, and testing of commercial reactor Safety-Class 1E electrical systems and components. While these requirements may not be directly applicable to nonreactor nuclear facilities, these standards contain useful and significant information that should be considered.

Table 5: Codes for Safety Significant and Safety Class Electrical Systems

Electrical	Safety Significant	Safety Class
Hardware	Applicable NFPA codes and standards; Illuminating Engineering Society (IES) Handbook (HB)-10; IEEE C2, C37	Applicable NFPA codes and standards; IES HB-10; IEEE C2, C37
	IEEE-80, 141, 142, 242, 399, 446, 493, 577	IEEE-80, 141, 142, 242, 308, 338, 379, 384, 399, 493, 577

Table 6: IEEE Standards used for Both Safety Significant and Safety Class Electrical Systems, as appropriate

Electrical	Safety Significant and Safety Class
Guidance standards for use as applicable for specific hardware	IEEE-323, 334, 336, 344, 352, 379, 382, 383, 387, 420, 450, 484, 493, 535, 603, 627, 628, 649, 650, 833, 946

(6) Instrumentation, Control, and Alarm Systems. The design of safety class instrumentation and control systems must incorporate sufficient independence, redundancy, diversity, and separation to ensure that all safety-related functions associated with such equipment can be performed. Safety significant components must be evaluated as to the need for redundancy on a case-by-case basis. DOE-STD-1195-2011 provides an acceptable method for achieving high reliability of safety significant safety instrumented systems.

Table 7 provides relevant codes and standards. The codes and standards for electrical systems (in Tables 5 and 6) may also be applicable to design of instrumentation and control systems and need to be evaluated in this context.

Table 7: Codes for Safety Significant and Safety Class Instrumentation, Control, and Alarm Components

Instruments, Controls, and Alarms	Safety Significant	Safety Class
Hardware	Applicable NFPA codes and standards; ANSI/ANS-8.3, 58.8, N13.1, N323D; ANSI/ International Society of Automation (ISA)-series including ISA 67.04.01 and ISA TR 84.00.06; IEEE-C2, N42.18, 1023, 1050; 7-4.3.2; and DOE-STD-1195-2011	Applicable NFPA codes and standards; ANSI/ANS-8.3, 58.8, N13.1, ANSI-N323D; ANSI/ISA-series including ISA 67.04.01 and ISA TR 84.00.06; IEEE-C2, N42.18, 603, 1023, 1050, 7-4.3.2

c. Nuclear Reactor Safety Design Criteria. Nuclear reactors are an important class of DOE facilities that require special attention to design criteria and standards to ensure safe design and operations.

(1) The COR for existing DOE nuclear reactors has been established by their designs. When a major modification is made to an existing reactor, the existing COR is the starting point for the design of the major modification.

(2) For any new DOE nuclear reactor, a set of reactor design codes and standards must be established in accordance with the Nuclear Safety Design Agreement required by DOE-STD-1271, existing industry codes and standards should be used to the extent possible.

ATTACHMENT 9
ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
AEA	Atomic Energy Act
AGS	American Glovebox Society AHJAuthority Having Jurisdiction
AISC	American Institute of Steel Construction
ANS	American Nuclear Society
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
BNA	Baseline Needs Assessment
BPVC	Boiler and Pressure Vessel Code
CD	Critical Decision
CFR	Code of Federal Regulations
CMAA	Crane Manufacturing Association of America
COR	Code of Record
CRD	Contractor Requirements Document
CSE	Cognizant System Engineer
CSP	Criticality Safety Program
DBA	Design Basis Accident
DOE	Department of Energy
DNFSB	Defense Nuclear Facilities Safety Board
DSA	Documented Safety Analysis
E.O.	Executive Order
FHA	Fire Hazards Analysis
FPE	Fire Protection Engineer

G	Guide
HDBK	Handbook
HEPA	High efficiency particulate air
ICC	International Code Council
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
ISA	International Society of Automation
M	Manual
MPFL	Maximum Possible Fire Loss
NCRP	National Council on Radiation Protection and Measurements
NFPA	National Fire Protection Association
NNSA	National Nuclear Security Administration
NPH	Natural Phenomena Hazards
NRC	Nuclear Regulatory Commission
O	Order
P	Policy
SBAA	Safety Basis Approval Authority
SSC	Structures, systems, and components
STD	Standard
TEMA	Tank Equipment Manufacturers Association

ATTACHMENT 5
REFERENCES

The following reference documents and information sources are cited to assist in implementing this Order. This attachment does not provide a complete listing of industry codes and standards that may be needed.

1. Public Law (P. L.).

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   b. P. L. 94-580, *Resource Conservation and Recovery Act of 1976 (RCRA)*, as amended.

   c. P. L. 106-65, *National Defense Authorization Act for Fiscal Year 2000*, as amended.

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   a. E.O. 12344, "Naval Nuclear Propulsion Program," February 1, 1982.

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   b. 10 CFR § 835, *Occupational Radiation Protection*.

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   d. 29 CFR § 1910, *Occupational Safety and Health Standards*.

   e. 29 CFR § 1926, *Safety and Health Regulations for Construction*.

   f. 48 CFR § 970, Section 970.5223-1, "Integration of Environment, Safety, and Health into Work Planning and Execution."

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   b. DOE Order (O) 227.1A, *Independent Oversight Program*, December 21, 2015.

   c. DOE O 420.2C, *Safety of Accelerator Facilities*, July 21, 2011.

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e. DOE G 414.1-4, *Safety Software Guide for use with 10 CFR 830 Subpart A, Quality Assurance Requirements,* and DOE O 414.1C, *Quality Assurance*, November 3, 2010.

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f. DOE-STD-1098-2008, *Radiological Control*.

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h. DOE-STD-1128-2013, *Guide of Good Practices for Occupational Radiological Protection in Plutonium Facilities*.

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j. DOE-STD-1186-2016, *Specific Administrative Controls.*

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m. DOE-STD-1271-2025 *Authorization Pathway for Nuclear Facilities*

n. DOE-STD-1628-2013, *Development of Probabilistic Risk Assessments for Nuclear Safety Applications*.

o. DOE-STD-3007-2017, *Preparing Criticality Safety Evaluations at DOE Nonreactor Nuclear Facilities*.

p. DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, Chg. Notice 3, March 2006.

q. DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*.

r. DOE-STD-3020-2015, *Specifications for HEPA Filters Used by DOE Contractors.*

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6. DOE Handbooks (HDBKs).

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