

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

ORDER

DOE O 420.2E

Approved: 08-05-2026

SUBJECT: SAFETY OF ACCELERATORS

1. PURPOSE. To establish accelerator-specific safety requirements for the United States Department of Energy (DOE), including National Nuclear Security Administration (NNSA), accelerators and their operations¹ that, when supplemented by other applicable safety and health requirements, promote safe operations to ensure adequate protection of workers, the public, and the environment.
2. CANCELS/SUPERSEDES. DOE Order (O) 420.2D, *Safety of Accelerators*, dated September 9, 2022.

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contract unless and until the contract or regulatory commitment is modified to either eliminate requirements that are no longer applicable or substitute a new set of requirements.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 Applicability. Except for the exemptions/equivalencies in Section 3.c, this Order applies to any DOE Element with programs involving accelerators, and their operations. The Administrator of the NNSA must assure that NNSA employees comply with their responsibilities under this directive. Nothing in this directive will be construed to interfere with the NNSA Administrator's authority under Section 3212(d) of Public Law (P.L.) 106-65 to establish Administration-specific policies, unless disapproved by the Secretary.
 - b. DOE Contractors. Except for the equivalencies/exemptions in Section 3.c the CRD, Attachment 1, sets forth requirements of this Order that apply to contracts that include the CRD. The CRD, Attachment 1, must be included in site/facility management contracts that involve the management and operation of accelerators and accelerator facilities unless superseded by an alternative standard authorized through an exemption or equivalency process.
 - c. Exemptions/Equivalencies for DOE O 420.2E. Requests for exemptions and equivalencies to the requirements of this Order which are not addressed in this section must be processed in accordance with DOE O 251.1, *Departmental Directives Program*, current version.

¹ See definition of Accelerator Operations in Attachment 2, *Definition*.

A periodic onsite validation process must be established to ensure accelerators and devices granted exemptions or equivalencies through DOE O 251.1 continue to be operated under the conditions of the approved exemption or equivalency.

Exemptions are also subject to requirements in Section 4.d if an accelerator and its operations have the potential for inadvertent criticality.

- (1) Exemption. Devices operated in accordance with 10 Code of Federal Regulations (CFR) § 34, *Licenses for Industrial Radiography and Radiation Safety Requirements for Industrial Radiographic Operations*, are exempt from requirements in Section 4 of this Order.
- (2) Exemption. NNSA nuclear weapons designed neutron generators are exempt from requirements in Section 4.b of this Order.
- (3) Exemption. Accelerators with operating energy of less than or equal to 10 MeV or Accelerators whose hazards can be safely managed under the provisions of 10 CFR § 835 and § 851 that are non-complex and that produce only local work area impacts are exempt from requirements in Section 4.a through 4.c of this Order. Examples of such facilities include:
 - (a) Commercially available equipment including, but not limited to, electron microscopes, ion implant devices, and x-ray generators.
 - (b) Neutron generators (accelerating potential below 600 keV).
 - (c) A room-sized accelerator with an active safety system and limited entry into the hazardous area.

4. REQUIREMENTS.

- a. DOE Elements are required to have oversight, consistent with current DOE oversight policy, over contractors who design, build, and manage accelerators and their operations to be consistent with the DOE mission and operational objectives and to comply with accelerator safety program provisions as described in the CRD.
 - (1) This includes oversight of all accelerators and their operations and all facilities that transition into operating accelerators.
 - (2) Also included is oversight of modifications to an accelerator and/or its equipment or program elements that have the potential to impact the risk, complexity, visibility, safety, and security of operating or maintaining the accelerator and their operation.
- b. Accelerators under this Order must establish the following program elements prior to commissioning and routine operations:
 - (1) A Safety Assessment Document (SAD);

- (2) A DOE-approved Accelerator Safety Envelope (ASE);
 - (3) An Unreviewed Safety Issue (USI) process; and
 - (4) An Accelerator Readiness Review (ARR) process.
- c. Accelerators under this Order must establish a current listing/inventory of accelerators managed under this Order.
- d. Accelerators and their operations with the potential for inadvertent criticality must implement a DOE-approved criticality safety program in accordance with DOE O 420.1, *Facility Safety*, current version, in addition to the requirements of this Order. This requirement cannot be exempted under the provisions of Section 3.c of this Order.

5. RESPONSIBILITIES.

- a. DOE Program Secretarial Officer (PSO)/NNSA Cognizant Secretarial Officer (CSO) for Safety,² or Designee.
 - (1) Oversee the safe operation of accelerators and their operations through the implementation of this Order to ensure adequate protection of workers, the public, and the environment and to meet regulatory requirements.
 - (2) Approve or disapprove the ASE for accelerators and their operations where site boundary mitigated consequences for credible postulated accident scenarios potentially exceed 1 rem (0.01 Sv) and/or values established under the Emergency Response Planning Guide-2 (ERPG-2).
- b. DOE Field Element Managers. For sites under their purview:³
 - (1) Ensure the safe operation of accelerators and their operations through the implementation of this Order.
 - (2) Ensure accelerators and devices granted exemptions or equivalencies through DOE O 251.1 continue to be operated under the conditions of the approved exemption or equivalency.
 - (3) Ensure a process exists that periodically reviews and updates contractor accelerator safety program elements.

² The NNSA Cognizant Secretarial Officer (CSO) for Safety related matter functions and responsibilities are described in NNSA Supplemental Directive (SD) 450.2B, *Functions, Responsibilities, and Authorities (FRA) for Safety Management* (or successor document).

³ The responsibilities in Section 5.b cannot be delegated.

- (4) Notify contracting officers of the applicability of the CRD and any alternate safety standards, requirements, regulations, or DOE directives made applicable pursuant to Sections 3.c and/or 4.d of this Order.
 - (5) Review the listing/inventory of accelerators managed under this Order for appropriateness.
 - (6) Recommend to the DOE PSO (or NNSA CSO for Safety) approval or disapproval of the ASE for accelerators and their operations where site boundary mitigated consequences for credible postulated accident scenarios potentially exceed 1 rem (0.01 Sv) and/or values established under the ERPG-2.
 - (7) Subject to the provisions of Section 5.a.(2), approve or disapprove the following prior to their initiation/use, as applicable in Section 4.b:
 - (a) The ASE and any updates or amendments to the approved ASE.
 - (b) The restart of an accelerator, accelerator facility or activity after a DOE-mandated shutdown because of an ASE violation.
 - (c) Implementation or start of activities associated with a Reviewed Safety Issue that introduces accelerator-specific hazards that are not adequately addressed by the approved ASE.
 - (8) Notify the contractor of any approved or denied requests for exemptions or equivalencies and any conditions of approval.
 - c. Cognizant Contracting Officer. Upon notification of applicability by the DOE Field Element Manager, the contracting officer is responsible for incorporating the CRD, and any alternate safety standards, requirements, regulations, or DOE directives made applicable pursuant to Sections 3.c and/or 4.d of this Order, into the contracts of affected contractors.
- 6. INVOKED STANDARDS. This Order does not invoke any DOE technical standards or industry standards as required methods. Any technical standard or industry standard that is mentioned in or referenced by this Order is not invoked by this Order. Note: DOE O 251.1E, Appendix D, provides a definition for “invoked technical standard.”

Accelerators with the potential for inadvertent criticality must implement a DOE-approved criticality safety program in accordance with DOE O 420.1, current version, and any applicable invoked standards.
- 7. REFERENCES.
 - a. P.L. 106-65, National Defense Authorization Act for Fiscal Year 2000, as amended.

- b. 10 CFR § 34, Licenses for Industrial Radiography and Radiation Safety Requirements for Industrial Radiographic Operations.
 - c. 10 CFR § 835, Occupational Radiation Protection.
 - d. American Industrial Hygiene Association (AIHA) 2020 Emergency Response Planning Guidelines (ERPG) and Workplace Environmental Exposure Levels (WEELs) Handbook.
 - e. DOE O 251.1, *Departmental Directives Program*, current version.
 - f. DOE O 420.1, *Facility Safety*, current version.
 - g. DOE O 450.2, *Integrated Safety Management*, current version
8. DEFINITIONS. See Attachment 2.
9. CONTACT. Questions concerning this Order should be addressed to the Office of Science, Office of the Deputy Director for Field Operations, at (202) 586-5434.

BY ORDER OF THE SECRETARY OF ENERGY:



JAMES P. DANLY
Deputy Secretary

ATTACHMENT 1

CONTRACTOR REQUIREMENTS DOCUMENT DOE O 420.2E, *SAFETY OF ACCELERATORS*

This Contractor Requirements Document (CRD) sets forth requirements that apply to contractors whose contracts include this CRD. Regardless of who performs the work, the contractor is responsible for complying with the requirements of this CRD. The contractor is responsible for flowing down the requirements of this 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.

In addition to the requirements set forth in this CRD, Attachment 2, Definitions, to DOE O 420.2E, *Safety of Accelerators*, is referenced in and made a part of this CRD and provides definitions and information applicable to contracts in which this CRD is inserted. The requirements in this CRD apply to all accelerators and their operations¹ and all facilities that transition into operating accelerators.

1. EXEMPTIONS/EQUIVALENCIES. Requests for exemptions and equivalencies not listed below must be processed in accordance with DOE O 251.1, *Departmental Directives Program*, current version. The contractor must establish a periodic onsite validation process to ensure accelerators and devices granted exemptions or equivalencies through DOE O 251.1 continue to be operated under the conditions of the approved exemption or equivalency.
 - a. Exemption. Devices operated in accordance with 10 CFR § 34, *Licenses for Industrial Radiography and Radiation Safety Requirements for Industrial Radiographic Operations*, are exempt from requirements in Section 2 of this CRD.
 - b. Exemption. NNSA nuclear weapons designed neutron generators are exempt from requirements in Section 2.a of this CRD.
 - c. Exemption. Accelerators with operating energy of less than or equal to 10 MeV or accelerators whose hazards can be safely managed under the provisions of 10 CFR § 835 and § 851 that are non-complex and that produce only local work area impacts are exempt from requirements in Section 2 of this CRD. Examples of such facilities include:
 - (1) Commercially available equipment including, but not limited to, electron microscopes, ion implant devices, and x-ray generators.
 - (2) Neutron generators (accelerating potential below 600 keV).
 - (3) A room-sized accelerator with an active safety system and limited entry into the hazardous area.

¹ See definition of Accelerator Operations in Attachment 2, *Definitions*.

- d. Contractors who manage accelerators and their operations with the potential for inadvertent criticality must implement a DOE-approved criticality safety program in accordance with DOE O 420.1, *Facility Safety*, current version, in addition to the requirements of this CRD. This requirement cannot be exempted under the provisions of Section 3.c of DOE O 420.2E, *Safety of Accelerators*, or this CRD.

2. PROGRAM ELEMENTS.

- a. Contractors that manage accelerators under this Order must establish the following program elements prior to commissioning and routine operations:
 - (1) A Safety Assessment Document (SAD);
 - (2) A DOE-approved Accelerator Safety Envelope (ASE);
 - (3) An Unreviewed Safety Issue (USI) process; and
 - (4) An Accelerator Readiness Review (ARR) process.
- b. Contractors that manage accelerators under this Order must:
 - (1) Establish a current listing/inventory of accelerators managed under this Order.
 - (2) Establish process(es) to periodically review program elements and update them as appropriate.
- c. Accelerator Safety Envelope. The ASE is a documented set of verifiable physical and administrative requirements, bounding conditions, and credited controls that ensure safe operation and address accelerator-specific hazards and risks.
 - (1) The ASE, and any updates or amendment to the approved ASE, must be submitted to the DOE Field Element Manager for approval.
 - (2) Any activity violating the ASE must be terminated immediately and be put in a safe and stable configuration. Affected operations must be terminated immediately and put in a safe and stable configuration for discovered conditions that create or reveal an ASE violation. The DOE Field Element Manager must approve the restart of any activity or affected operations after a DOE-mandated shutdown because of an ASE violation.
- d. Safety Assessment Document. The purpose of the SAD is to provide a description of the facility, an analysis of accelerator-specific safety hazards, and necessary controls to eliminate or mitigate those hazards such that associated risks are clearly understood. All hazards at an accelerator fall within two categories: (1) hazards that are safely managed by other applicable safety and health programs and/or processes; or (2) accelerator-specific hazards that are analyzed and safely managed by the SAD and provisions of the ASE. The amount of detail provided and the depth of analysis must be tailored to be commensurate with the

magnitude and types of hazards present and the complexity of the facility. The SAD, which represents the technical basis for the bounding conditions and controls in the ASE, must be maintained so it reflects current hazards and controls. The contractor must notify the DOE Field Element Manager, or designee, when the SAD is revised and approved. The SAD must:

- (1) Identify hazards at the accelerator facility and determine if each hazard requires analysis as an accelerator-specific hazard. Non-accelerator-specific hazards must be evaluated to determine if they could serve as initiators or contributors to accelerator-specific hazards.
 - (a) Hazards from radiation and residual radioactivity associated with beam operations must be evaluated for onsite and offsite impacts from routine operations and credible accidents as appropriate.
 - (b) Evaluation of radioactive material to determine if it is an accelerator-specific hazard must consider direct radiation, contamination, and airborne dispersion as appropriate.
- (2) Analyze accelerator-specific hazards, including initiators or contributors determined by Section 2.d.(1), and identify necessary controls to eliminate or mitigate hazards to workers, the public, and the environment. Provide a description of uncontrolled risk (i.e., without mitigation) and risk with controls in place associated with accelerators and their operations.
- (3) Provide a description of controls used to mitigate accelerator-specific hazards. This must include:
 - (a) Detailed descriptions of credited controls (e.g., interlocks and physical barriers) that are stated in the ASE.
 - (b) Descriptions, as necessary, of administrative requirements (e.g., training, procedures), and bounding conditions that are stated in the ASE.
 - (c) Descriptions of additional controls taken to eliminate or mitigate hazards to workers, the public, and the environment, as appropriate.
- (4) Include or reference a description of the accelerator and accelerator facility function, location, and management organization in addition to details of major accelerator and accelerator facility components and their operation.

- e. Unreviewed Safety Issue Process. The USI process evaluates proposed activities or discovered conditions that introduce new or previously unreviewed accelerator-specific hazards to ensure controls are in place to prevent or mitigate hazards as described in the current SAD and approved ASE. The term “activities” includes modifications, temporary changes, permanent changes, and new activities. The contractor must document how the USI process is implemented, identify how the requirements listed below are addressed, and notify the DOE Field Element Manager, or designee, when the USI process is revised.
 - (1) The USI process must:
 - (a) Evaluate whether adequate controls are in place to prevent or mitigate accelerator-specific hazards.
 - (b) Identify activities expected to exceed ASE bounding conditions and ensure such activities are evaluated through the USI process prior to implementation.
 - (c) Once an USI has been appropriately reviewed, the issue becomes a Reviewed Safety Issue and may be considered as an addendum to the SAD.
 - (2) For a proposed activity, DOE approval is required if the USI process determines that:
 - (a) It involves accelerator-specific hazards that are not adequately addressed by the approved ASE prior to implementation of the proposed activity; or
 - (b) It is expected to exceed the bounding conditions of the ASE.
 - (3) If conditions are discovered that introduce accelerator-specific hazards that are not adequately addressed by the approved ASE:
 - (a) Impacted/affected operations must be suspended immediately and put in a safe and stable configuration.
 - (b) DOE must approve activities that are not adequately addressed by the approved ASE.
- f. Accelerator Readiness Reviews. ARR must be performed before commissioning and/or routine operation. A single ARR may be conducted prior to commissioning that addresses both commissioning and routine operations. As part of the ARR process, the contractor must ensure an appropriately comprehensive and independent ARR has been conducted, identified pre-start issues have been resolved, commissioning activities required for safe operations have been completed as appropriate, and the following are in place:

- (1) Hardware, personnel, and procedures adequate to support the proposed accelerator activities safely, consistent with the SAD and approved ASE.
 - (2) A Configuration Management Program that addresses accelerator safety; and
 - (3) Appropriate administrative processes related to accelerator safety (training, USI process, etc.).
- g. The contractor must inform the DOE Field Element Manager prior to:
 - (1) The start of commissioning activities; and
 - (2) The start of routine operations.
- h. Decommissioning Activities. Contractors who manage accelerators and their operations under this CRD must inform the DOE Field Element Manager prior to the start of accelerator decommissioning activities.

ATTACHMENT 2 DEFINITIONS

This Attachment provides definitions of terms used in the United States Department of Energy (DOE) Order (O)420.2E, *Safety of Accelerators*, as well as information applicable to contracts in which the associated Contractor Requirements Document (CRD) (Attachment 1 to DOE O 420.2E, *Safety of Accelerators*) is inserted.

1. Accelerator. A device and its components employing electrostatic or electromagnetic fields to impart kinetic energy to molecular, atomic, or subatomic particles to intentionally produce an accelerated particle beam and capable of creating a radiological area as defined by 10 CFR § 835, Occupational Radiation Protection. Accelerator components include injectors, targets, beam dumps, detectors, experimental enclosures, accelerator enclosures, experimental areas, and experimental apparatus utilizing the accelerator. The accelerator also includes associated support and test facilities, equipment, systems, and utilities necessary to operate the accelerator or utilize the accelerated beam.
2. Accelerator Facility. The accelerator, plant, buildings, structures, and equipment supporting the accelerator and its operations that are under the direct control of the contractor.
3. Accelerator Operations. Activities within the accelerator facility that, over the life cycle of the facility, support (1) production or utilization of accelerator beams; (2) research and experimental activities utilizing accelerator beams; (3) handling, storage and analysis of accelerator induced radioactive components and materials within the accelerator facility boundary; (4) receipt, preparation, assembly, inspection, and installation of samples into the accelerator beam; or (5) removal, disassembly, handling, analysis, and storage for radioactive dose minimization to meet the definition of as low as reasonably achievable (ALARA) in 10 CFR § 835, Occupational Radiation Protection, or transportation requirements, and packaging of samples after use in the accelerator beam. Accelerator Operations excludes radioisotope processing activities that are not required to operate or maintain the accelerator.
4. Accelerator Readiness Review. A structured method for verifying that hardware, personnel, and procedures associated with commissioning or routine operations are ready to permit the activity to be undertaken safely.
5. Accelerator Safety Envelope. A documented set of verifiable physical and administrative requirements, bounding conditions, and credited controls that ensure safe operation and address accelerator-specific hazards and risks.
6. Commissioning. A phase of an accelerator facility operation that is typically used to conduct initial beam testing and/or verify design specifications. Commissioning periods may be tailored to the needs of each facility, and there may be great variations in their duration, breadth, and formality, but in all cases, the activities will be bound by an ASE.

7. Credited Controls. Controls determined through a Safety Analysis to be essential for safe operation directly related to the protection of workers, the public, and the environment.
8. DOE Element. First-tier organizations at DOE/NNSA HQ and in the field as listed in the Correspondence Style Guide, Office of the Executive Secretariat.
9. DOE Field Element Manager. The manager having overall responsibility for a DOE field element, including execution of oversight policy implementation. The Field Element Manager directs activities of DOE/NNSA field or site offices and has line accountability for all site program and project execution and contract management.
10. DOE Program Secretarial Officer. An Assistant Secretary, Office Director, Head of Program Element, or NNSA Deputy Administrator to whom designated field offices directly report and who has overall landlord responsibilities for the assigned direct reporting elements.
11. Operating Energy. The operating energy of an accelerator is the nominal energy of the accelerated particle beam that the accelerator is being used to produce. It does not include the theoretical accelerating potential of a device and does not include the energy of secondary particles that may be produced through interactions of the accelerated particle beam.
12. Radiation. Ionizing radiation, including the accelerated particle beam and the radiation produced when the beam interacts with matter or changes direction. Radiation includes alpha particles, beta particles, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions.
13. Radioisotope Processing. Chemical, thermal, or physical actions taken to separate, isolate, refine, or enrich specific isotopes of a chemical element.
14. Residual Radioactivity. Radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from the accelerator or accelerator operations.
15. Reviewed Safety Issue. The outcome of the evaluation and determination phase of the USI process.
16. Risk. A quantitative or qualitative expression of possible harm, which considers both the probability that a hazard will cause harm and the amount of harm; or, alternatively, an estimate of the probability of occurrence of a hazard-related incident and the severity of the consequence associated with the incident.
17. Safety Analysis. A documented process to systematically identify the hazards of a given operation, including a description and analyses of the adequacy of measures taken to eliminate, control, or mitigate the hazards and risks of normal operation and identification and analyses of potential accidents and their associated risks.

18. Safety Assessment Document. A document containing the results of a Safety Analysis for an accelerator or accelerator facility pertinent to understanding the risks to workers, the public, and the environment of operating the accelerator.
19. Unreviewed Safety Issue. An activity or discovered condition with accelerator-specific hazards that have yet to be evaluated to determine if the activity or discovered condition introduces accelerator-specific hazards that are not adequately addressed by the current SAD and approved ASE.
20. USI Process. The process or methodology used to evaluate/review USIs to determine if the activity or discovered condition is adequately addressed by the current SAD and approved ASE.