

**SUBJECT: NUCLEAR EXPLOSIVE AND WEAPON SURETY PROGRAM**

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1. **PURPOSE.** All nuclear explosives and nuclear explosive operations (NEOs) require special safety, security, and use control consideration because of the potentially unacceptable consequences of an accident or unauthorized act; therefore, a Nuclear Explosive and Weapon Surety (NEWS) Program is established to prevent unintended/unauthorized detonation and deliberate unauthorized use of nuclear explosives.
  - a. The NEWS Program is implemented through this Department of Energy (DOE) Order (DOE O) and the following Directives:
    - (1) DOE O 452.2, *Nuclear Explosive Safety*, current version;
    - (2) DOE O 452.4, *Security and Use Control of Nuclear Explosives and Nuclear Weapons*, current version;
    - (3) DOE O 452.6, *Nuclear Weapon Surety Interface with the Department of Defense*, current version;
    - (4) National Nuclear Security Administration (NNSA) Supplemental Directive (SD) 452.2, *Nuclear Explosive Safety Evaluation Processes*, current version.
  - b. The objectives of the NEWS Program are:
    - (1) To prevent accidents involving U.S. nuclear weapons and nuclear explosives.
    - (2) To prevent inadvertent or unauthorized use of U.S. nuclear weapons and nuclear explosives.
    - (3) In conjunction with the Department of Defense (DoD), to protect public health and safety by providing dual-Agency judgment and responsibility for surety (the safety, security, and use control) of nuclear weapons.
    - (4) To establish Nuclear Explosive Surety Standards and nuclear weapon design surety requirements.
    - (5) To address surety vulnerabilities during all phases of the nuclear weapon lifecycle and to upgrade surety during weapon stockpile refurbishments and/or new weapon development.
    - (6) To establish requirements and responsibilities for preplanned and scheduled NEOs such as assembly, disassembly, rebuild, repair,

refurbishment, recodes, limited life component exchanges, dismantlement, transport, and staging. [Responses to emergency events (e.g., Accident Response Group activities) are addressed in DOE O 151.1, *Comprehensive Emergency Management System*, current version.]

- (7) To establish assurance requirements for enhanced resiliency of nuclear weapons (NWs) and NW enabling capabilities against subversion attempts.
2. CANCELLATION. DOE O 452.1E, *Nuclear Explosive and Weapon Surety Program*, dated 01-26-15. 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 either to eliminate requirements that are no longer applicable or substitute a new set of requirements.
  3. APPLICABILITY.
    - a. Departmental Elements.
      - (1) This Order applies to the National Nuclear Security Administration (NNSA) which is the Departmental element that is responsible for maintaining and enhancing the safety, security, reliability, and performance of the United States nuclear weapons stockpile, including the nuclear explosive and weapon surety program and associated activities.
      - (2) The NNSA Administrator 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. Nuclear Security Enterprise Management and Operating (M&O) Contractors.
      - (1) The CRD, Attachment 1, sets forth requirements of this Order that will apply to contracts that include the CRD.
      - (2) This CRD must be included in all contracts that involve performing, managing, overseeing, or directly supporting NEOs or associated activities.
      - (3) Field Element Managers are responsible for notifying Contracting Officers of which contracts are affected. Once notified, Contracting Officers are responsible for incorporating the CRD into each affected contract.

- c. Equivalencies/Exemptions for DOE O 452.1F. Exemptions must be requested when release is sought from a requirement in this Order. The exemption process is outlined in DOE O 251.1, *Departmental Directives Program*, current version. The approval authority is the Deputy Administrator for Defense Programs with concurrence from the Central Technical Authority (CTA).
- (1) Exemptions. As per the requirements of DOE O 420.1, *Facility Safety*, current version, activities involving criticality safety or the safety of critical assembly operations are covered under the applicable ANSI/ANS standards. As such, these activities are not included in the scope of this Order. However, if critical assembly operations have the potential to affect NEOs (i.e., are in close proximity to one another), then those operations are within the scope of this Order.
  - (2) Equivalency. In accordance with the responsibilities and authorities assigned by Executive Order 12344, codified at 50 U.S.C. sections 2406 and 2511, and to ensure consistency throughout the joint Navy/DOE Naval Nuclear Propulsion Program, the Deputy Administrator for Naval Reactors (Director) will implement and oversee requirements and practices pertaining to this Order for activities under the Director's cognizance, as deemed appropriate.

#### 4. REQUIREMENTS.

- a. Nuclear Explosive Surety Standards.
- (1) For all NEOs, there must be a positive measure that will effectively interrupt each credible scenario that leads to an unintended nuclear explosive detonation or main charge High Explosive Violent Reaction (HEVR).
  - (2) For all NEOs, there must be a second independent positive measure that will effectively interrupt each credible scenario that leads to an unintended nuclear explosive detonation or main charge HEVR given the first measure fails.
  - (3) There must be positive measures to prevent unauthorized access, intentional physical damage, misuse, and theft of nuclear explosives.
  - (4) There must be positive measures (a combination of site, facility, or NEO-specific, as appropriate) to prevent malevolent acts that could lead to deliberate unauthorized use.
  - (5) New and refurbished nuclear weapons must have design attributes to prevent nuclear explosive detonation and main charge HEVR, given an adverse environment or unauthorized act.

- (6) New and refurbished nuclear weapons should have design attributes to prevent deliberate unauthorized use, given a malevolent act, consistent with requirements in Attachment 2 of this Order (classified).
- b. Application and Intent of the Surety Standards. The Surety Standards of paragraph 4.a. are qualitative Standards. Organizations involved with NEWS management must use the following guidance in interpreting and applying the Surety Standards of paragraph 4.a.
- (1) The term *prevent* implies an absolute assurance, which cannot be guaranteed and is rarely achievable. Nonetheless, prevention of unintended/unauthorized nuclear explosive detonation and unintended main charge HEVR is a primary goal in the design and performance of NEOs.
  - (2) A primary target of nuclear explosive surety positive measures is to protect nuclear explosive main charge high explosive (HE) from environments capable of initiating it, including those environments to which main charge detonator cable assemblies are exposed. Adequacy of positive measures must be established through application of the concept of defense-in-depth and demonstrated through their effectiveness and independence from other positive measures in all stages of NEOs.
  - (3) *Environment* means the aggregate of surrounding conditions, circumstances, objects, and influences. An *adverse environment* is one that is capable of producing an unwanted response. The adverse environments of interest for the Surety Standards are those that, if unmitigated, might lead to nuclear explosive detonation or main charge HEVR. Examples include anything that introduces unintended or unauthorized energy hazardous to a nuclear explosive such as human error; deliberate acts; equipment malfunction; other accident initiators, precursors, or sequences; and the conditions those events create.
- c. Nuclear Explosive Safety (NES). The NES Standards in paragraphs 4.a.(1) and (2) above must be met for all NEOs conducted by the Department and its contractors to ensure adequate nuclear explosive safety, subject to the provision of this paragraph. When the NES Standards are met, the Authorizing Official may approve proposed operations (or allow ongoing operations to continue). If 4.a.(2) above is not met, and adequate NES is achieved by other means, approval of the Under Secretary for Nuclear Security is required prior to initiating or continuing the affected operations.
- (1) It is desirable for the first positive measure to be as early in the scenario sequence of events as practical, and the second as late in the sequence as possible. It is also desirable to interrupt the scenario with positive measures as often as practical, and as reliably as reasonable to raise confidence in the overall effectiveness of the positive measures.

Continuous improvement of NES is a goal for any NEO to ensure the likelihood of unintended nuclear explosive detonation and HEVR are as low as reasonably practical. In that context, the NES Standards [4.a.(1) and 4.a.(2)] should be viewed as a minimum requirement and efforts should be made to identify additional positive measures as defense-in-depth when practical. However, satisfaction of the NES Standards is achieved by having at least two independent positive measures to effectively interrupt each credible scenario that could lead to nuclear explosive detonation or main charge HEVR.

- (2) The term *positive measure* as used in paragraphs 4.a.(1) and (2) above may refer to a single positive measure or a suite of positive measures. A single positive measure meets the requirement of 4.a.(1) or (2) above if that positive measure can by itself effectively interrupt the scenario. A suite of positive measures (two or more) is necessary if the positive measures are dependent on each other to effectively interrupt the scenario.
- (3) Nuclear Explosive Safety Study Groups (NESSGs) are convened to evaluate NEOs to determine if positive measures are adequate to meet these Standards. These NESSG evaluations are performed as specified in DOE O 452.2, *Nuclear Explosive Safety*, current version; and NNSA SD 452.2, *Nuclear Explosive Safety Evaluation Processes*, current version.
- (4) Hierarchy of Positive Measures.
  - (a) Elimination of the Hazard. Unless impossible or impractical, the hazard will be eliminated.
  - (b) Engineered Positive Measures. If the hazard cannot be eliminated, engineered positive measures, such as design features, should be implemented. Passive engineered positive measures are preferential to active ones. Unless impossible or impractical, engineered positive measures will be in place to prevent NES consequences.
  - (c) Administrative Positive Measures. Administrative positive measures should be incorporated when engineered positives measures cannot.
- (5) *Effectively interrupt* means that each sequence of credible causes and effects that begins with an initiating event and eventually leads to the NES consequence, is prevented or stopped at some point, so that the NES consequence does not occur. Similar to 4.b.(1) above, prevention of unintended/unauthorized nuclear explosive detonation and unintended main charge HEVR is a primary goal in the design and performance of NEOs. As used in this paragraph, the term *initiating event* means an initial event or unauthorized (non-malevolent) act that potentially leads to a NES consequence.

- (6) *Failure of a positive measure* means that during the scenario sequence of events, a positive measure meant to prevent the initiating event or prevent the scenario from progressing toward a NES consequence has failed to perform that function.
- d. Nuclear Explosive Security. NNSA implements Departmental requirements in accordance with the 470-series of Directives. Safeguards and security measures must be documented in the site safeguards and security plan. The Security Standard, paragraph 4.a.(3), above, must be met to ensure adequate nuclear explosive security for all NEOs conducted by the Department and its contractors. The NESSG must evaluate security operations for potential adverse NES impact.
- e. Nuclear Explosive Use Control. The Use Control Standard, paragraph 4.a.(4) above, must be met for all NEOs conducted by the Department and its contractors to ensure adequate use control measures. Additional use control requirements are specified in DOE O 452.4, *Security and Use Control of Nuclear Explosives and Nuclear Weapons*, current version. Use control measures must be evaluated in accordance with the provisions of DOE O 452.4, current version, to ensure all objectives are achieved. The NESSG must evaluate use control measures for potential adverse NES impact.
- f. Nuclear Enterprise Assurance. Nuclear Enterprise Assurance (NEA) supports NSE programs, to assure that NW components/systems are not subverted or compromised, in support of preventing deliberate unauthorized acts (DUA) that may lead to denial of authorized use (DAU), or degradation of weapon reliability or performance. NEA increases system assurance for NWs and enabling capabilities, including digital assurance, throughout the nuclear weapon lifecycle. The execution of the NEA requirements specified in DOE O 452.4, *Security and Use Control of Nuclear Explosives and Nuclear Weapons*, current version, and NNSA SD 452.4-1, *Nuclear Enterprise Assurance (NEA)*, current version, must augment the NEWS program.
- g. Nuclear Weapon Design Surety. Surety must be an integral part of the design and development of new weapons and the refurbishment of existing weapons. The NNSA processes that govern the design and development of new weapons, and the refurbishment of existing weapons are contained in NNSA SD 452.3-1, *Defense Programs Business Process System (DPBPS)*, current version, and NNSA SD 452.3-2, *Phase 6.X Process*, current version. The Nuclear Weapon Design Surety Standards, paragraphs 4.a.(5) and (6) above must be met to support safe and secure response to adverse environments and unauthorized acts. This is evaluated throughout the technology maturation, weapon development, and refurbishment processes by the Office of Defense Programs.
- (1) Documented consideration of surety (safety, security, and use control) must begin at the conception phase and continue throughout all weapon program phases.

- (2) Beginning at the conception phase and continuing throughout Phase X/6.X process design review and design down-selects, the Office of Defense Programs must conduct safety, security, and use control evaluations as necessary to ensure weapon design architecture meets threshold requirements and considers objective requirements.
- (3) Surety-related surveillance program information must be explicitly considered in nuclear weapon design and development activities.
- (4) The following are the NNSA positions for Military Characteristic negotiations for new or refurbished nuclear weapon designs.
  - (a) Nuclear Detonation Safety. Nuclear weapons must incorporate design features that minimize the possibility of accidental and/or unintended nuclear explosive detonation. The following are design requirements for nuclear weapons.
    - 1 Normal Environment. Prior to receipt of the enabling input stimuli, the probability of a premature nuclear explosive detonation must not exceed one in a billion (1E-09) per nuclear weapon lifetime.
    - 2 Abnormal Environment. Prior to receipt of the enabling input stimuli, the probability of a premature nuclear explosive detonation must not exceed one in a million (1E-06) per credible nuclear weapon accident or exposure to abnormal environments.
    - 3 One-Point Safety. Nuclear explosives must be one-point safe without the use of a safing device (i.e., inherently one-point safe). The probability of achieving a nuclear yield greater than four (4) pounds of trinitrotoluene (TNT) equivalent in the event of a one-point initiation of the high explosive must not exceed one in a million (1E-06).
  - (b) Fissile Material Dispersal Safety. Nuclear weapons must incorporate design features for reducing fissile material dispersal from the pit under credible abnormal environments.
  - (c) Use Control. Nuclear weapons must incorporate use control design features that allow timely authorized use of a nuclear weapon while precluding or delaying unauthorized nuclear explosive detonation. The following are requirements for nuclear weapons delivered to DoD.
    - 1 The protection of nuclear weapons must include a combination of administrative (e.g., personnel security) and technical measures (e.g., physical security and use control) designed to prevent deliberate unauthorized

nuclear explosive detonation. These measures must be consistent with DoD operational requirements and must continually be assessed against existing and emerging threats as well as technological opportunities for improvement.

2 Use control capabilities should be upgraded during significant weapon refurbishments consistent with requirements in Attachment 2 of this Order (classified).

(d) Inadvertent Criticality. Nuclear weapons designs must preclude inadvertent criticality in both normal and credible abnormal environments as verified by the Design Agency.

h. Surety Research and Development (R&D).

(1) R&D on a broad range of safety and control methods and devices must be conducted to improve the surety of nuclear weapons and nuclear weapon systems significantly by accomplishing the following:

(a) Identify and characterize physical and digital-based processes that can lead to unacceptable response.

(b) Identify and address surety issues.

(2) Identify and pursue improvements to surety architecture beyond one-point safety (e.g., multi-point safety) and Enhanced Nuclear Detonation Safety (ENDS). R&D must provide use control options with delay or denial capability that, at a minimum, are equivalent to that associated with current non-violent disablement systems.

(3) R&D must pursue technologies that render the unauthorized use of U.S. nuclear weapons impossible without their remanufacture.

i. Nuclear Weapon Surveillance Program. The nuclear weapon surveillance program involves routine periodic examination, evaluation, and testing of stockpile weapons and weapon components to ensure they meet design requirements and are performing effectively. Surveillance must include NEA considerations and safety and use control components.

j. Training and Qualification of Personnel. Each organization responsible for and/or involved in NEOs and activities that may affect the safety and use control of a nuclear explosive or nuclear weapon must implement training and qualification programs for personnel.

(1) Training and qualification requirements must be commensurate with the particular responsibilities assigned.

- (2) NEWS training must include specific training on the specific nuclear explosive and weapon hazards and positive measures for the responsibilities assigned.
        - (3) Training and qualification programs, at a minimum, must be based on the following.
          - (a) 10 CFR Part 712, *Human Reliability Program*, final rule.
          - (b) DOE O 360.1, *Federal Employee Training*, current version.
          - (c) DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*, current version.
          - (d) DOE O 426.1, *Federal Technical Capability*, current version.
      - k. Records. Records must be maintained in accordance with National Archives and Records Administration-approved DOE or site-specific records retention and disposition schedules per DOE O 243.1, *Records Management Program*, current version.
      - l. Implementation Requirements.
        - (1) This revision involves substantive administrative and programmatic changes from the previous directive and an implementation plan is required.
        - (2) This revision is effective upon issue.
5. RESPONSIBILITIES.
  - a. NNSA Administrator. Responsible for the design surety of all nuclear weapons delivered to the DoD and the surety of all NEOs conducted by NNSA and its contractors.
  - b. Deputy Administrator for Defense Programs.
    - (1) Implements DOE/NNSA NEWS Program except independent Federal oversight.
    - (2) Ensures transition from emergency response for nuclear weapons in a damaged or abnormal state (or improvised nuclear device) under DOE 150-series Directives to the requirements for planned NEOs under the DOE 452-series Directives.
  - c. Assistant Deputy Administrator Stockpile Management.
    - (1) Ensures conduct of an active and continuous review of the nuclear stockpile to identify surety concerns and ensures a program exists to

provide for stockpile improvement or controls to address identified concerns.

- (2) Oversees the management and integration of all aspects of nuclear explosives and weapon security, use control, and NEA programs or activities.
- (3) Supports the NNSA Chief of Defense Nuclear Safety in development of NEWS Program Directives under their purview.
- (4) Develops and maintains this Order in coordination with the NNSA Chief of Defense Nuclear Safety.
- (5) Ensures NNSA Chief of Defense Nuclear Safety concurrence is obtained for development and maintenance of requirements associated with NES in this Order.

d. Assistant Deputy Administrator, Office of Research, Development, Test and Evaluation (as delegated).

- (1) Sponsors R&D on a broad range of safety and control methods and devices for nuclear weapons and weapon systems, including use control, and delay and denial capabilities.
  - (a) Identifies and characterizes physical processes that can lead to unacceptable nuclear explosive response.
  - (b) Identifies and addresses surety issues.
  - (c) Identifies areas to improve surety.
  - (d) Ensures that the requirements specified in section 4.h. of this Order are met.
- (2) Sponsors technologies that render the unauthorized use of nuclear weapons impossible without their remanufacture.

e. NNSA Field Element Managers with NEWS Responsibilities.

- (1) Ensure (based on competent, independent reviews) that each NEO authorized meets the Nuclear Explosive Surety Standards applicable to NEOs [paragraphs 4.a.(1) to 4.a.(4) above] and retains documentation of these reviews, their conclusions, and resolution of findings.
- (2) Develop and publish office directives to implement this Order and related Directives, as appropriate.

- (3) Notify contracting officers to incorporate the CRD into each affected contract.
- f. Assistant Deputy Administrator for Secure Transportation. Ensures (based on competent, independent reviews) that each NEO authorized meets the Nuclear Explosive Surety Standards applicable to NEOs [paragraphs 4.a.(1) to 4.a.(4) above] and retains documentation of these reviews, their conclusions, and resolutions of findings.
- g. Chief of Defense Nuclear Safety.
  - (1) Concurs with all developments and maintenance of NES requirements within this Order and directly develops and maintains the other NES Directives.
  - (2) Collaborates with the NNSA Assistant Deputy Administrator for Stockpile Management in development and maintenance of NES requirements in this Order.
  - (3) Performs competent, independent oversight of the NES evaluation process.
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 251.1D, Appendix J, provides a definition for *invoked technical standard*.
7. DEFINITIONS. See Attachment 3.
8. REFERENCES. See Attachment 4.
9. CONTACT. Questions concerning this Order should be addressed to the Assistant Deputy Administrator for Stockpile Management, 202-586-4879. Questions concerning this Order related to nuclear explosive safety should be coordinated with the Chief of Defense Nuclear Safety.

BY ORDER OF THE SECRETARY OF ENERGY:



DAVID M. TURK  
Deputy Secretary of Energy



**ATTACHMENT 1**  
**CONTRACTOR REQUIREMENTS DOCUMENT**  
**DOE O 452.1F, *NUCLEAR EXPLOSIVE AND WEAPON SURETY PROGRAM***

Nuclear Security Enterprise (NSE) contractors, including National Nuclear Security Administration (NNSA) contractors who conduct Department of Energy (DOE) Nuclear Explosive and Weapon Surety (NEWS) Program activities must comply with the requirements in this Contractor Requirements Document (CRD) and Attachment 2. In addition to the requirements set forth in this CRD and Attachment 2, contractors are responsible for complying with Attachments 3 and 4 to DOE O 452.1F, referenced in and made a part of this CRD, which provide information applicable to contracts in which this CRD is inserted.

Regardless of the performer of the work, contractors are responsible for compliance with the requirements of this CRD and Attachment 2. Contractors are responsible for flowing down the requirements of this CRD and Attachment 2 to subcontracts at any tier to the extent necessary to ensure the contractors' compliance with the requirements.

All contractors with this CRD incorporated in their contracts must comply with the following requirements.

1. All nuclear explosives and nuclear explosive operations (NEOs) require special safety, security, and use control consideration because of the potentially unacceptable consequences of an accident or unauthorized act; therefore, contractors must support the NNSA NEWS Program established to prevent unintended/unauthorized detonation and deliberate unauthorized use of nuclear explosives.
2. Ensure adequate nuclear explosive surety for all nuclear explosives and nuclear explosive operations under their purview based on evaluation against the following qualitative DOE Surety Standards.
  - a. For all NEOs, there must be a positive measure that will effectively interrupt each credible scenario that leads to an unintended nuclear explosive detonation or main charge High Explosive Violent Reaction (HEVR).
  - b. For all NEOs, there must be a second independent positive measure that will effectively interrupt each credible scenario that leads to an unintended nuclear explosive detonation or main charge HEVR given the first measure fails.
  - c. There must be positive measures to prevent unauthorized access, intentional physical damage, misuse, and theft of nuclear explosives.
  - d. There must be positive measures (a combination of site, facility, or nuclear explosive operation-specific as appropriate) to prevent malevolent acts that could lead to deliberate unauthorized use.
  - e. New and refurbished nuclear weapons must have design attributes to prevent nuclear explosive detonation and main charge HEVR, given an adverse environment or unauthorized act.

- f. New and refurbished nuclear weapons should have design attributes to prevent deliberate unauthorized use, given a malevolent act, consistent with requirements in Attachment 2 of this Order (classified).
3. Application and Intent of the Surety Standards. Contractors must use the following guidance in interpreting and applying the Surety Standards of paragraph 2.
    - a. The term *prevent* implies an absolute assurance, which cannot be guaranteed and is rarely achievable. Nonetheless, prevention of unintended/unauthorized nuclear explosive detonation and unintended main charge HEVR is a primary goal in the design and performance of NEOs.
    - b. A primary target of nuclear explosive surety positive measures is to protect nuclear explosive main charge high explosive from environments capable of initiating it, including those environments to which main charge detonator cable assemblies are exposed. Adequacy of positive measures must be established through application of the concept of defense-in-depth and demonstrated through their effectiveness and independence from other positive measures in all stages of NEOs.
    - c. *Environment* means the aggregate of surrounding conditions, circumstances, objects, and influences. An *adverse environment* is one that is capable of producing an unwanted response. The adverse environments of interest for the Surety Standards are those that, if unmitigated, might lead to nuclear explosive detonation or main charge HEVR. Examples include anything that introduces unintended or unauthorized energy hazardous to a nuclear explosive such as human error; deliberate acts; equipment malfunction; other accident initiators, precursors, or sequences; and the conditions those events create.
  4. Nuclear Explosive Safety (NES). All NEOs conducted by contractors must have adequate nuclear explosive safety based on evaluation against the NES Standards in paragraphs 2.a. and 2.b. above and NNSA approval as specified in this Order (DOE O 452.1F directive paragraph 4.c. above). Contractors conducting NEOs have the authority and responsibility to disallow NEOs that in the contractor's judgment lack adequate nuclear explosive safety.
    - a. It is desirable for the first positive measure to be as early in the scenario sequence of events as practical, and the second as late in the sequence as possible. It is also desirable to interrupt the scenario with positive measures as often as practical, and as reliably as reasonable to raise confidence in the overall effectiveness of the positive measures. Continuous improvement of NES is a goal for any NEO to ensure the likelihood of unintended nuclear explosive detonation and HEVR are as low as reasonably practical. In that context, the NES Standards (2.a. and 2.b., above) should be viewed as a minimum requirement and efforts should be made to identify additional positive measures as defense-in-depth when practical. However, satisfaction of the NES Standards is achieved by having at least two independent positive measures to effectively interrupt each credible scenario that could lead to nuclear explosive detonation or main charge HEVR.

- b. The term *positive measure* as used in paragraphs 2.a. and b. above may refer to a single positive measure or a suite of positive measures. A single positive measure meets the requirement of 2.a. or b. above if that positive measure can by itself effectively interrupt the scenario. A suite of positive measures (two or more) is necessary if the positive measures are dependent on each other to interrupt the scenario.
  - c. Nuclear Explosive Safety Study Groups (NESSGs) are convened to evaluate NEOs to determine if positive measures are adequate to meet these Standards as specified in DOE O 452.2, *Nuclear Explosive Safety*, current version; and NNSA SD 452.2, *Nuclear Explosive Safety Evaluation Processes*, current version.
  - d. Hierarchy of Positive Measures.
    - (1) Elimination of the Hazard. Unless impossible or impractical, the hazard will be eliminated.
    - (2) Engineered Positive Measures. If the hazard cannot be eliminated, engineered positive measures, such as design features, should be implemented. Passive engineered positive measures are preferential to active ones. Unless impossible or impractical, engineered positive measures will be in place to prevent NES consequences.
    - (3) Administrative Positive Measures. Administrative positive measures should be incorporated when engineered positive measures cannot.
  - e. *Effectively interrupt* means that each sequence of credible causes and effects that begins with an initiating event and eventually leads to the NES consequence, is prevented or stopped at some point, so that the NES consequence does not occur. Similar to 3.a. above, prevention of unintended/unauthorized nuclear explosive detonation and unintended main charge HEVR is a primary goal in the design and performance of NEOs. As used in this paragraph, the term *initiating event* means an initial event or unauthorized (non-malevolent) act that potentially leads to a NES consequence.
  - f. *Failure of a positive measure* means that during the scenario sequence of events, a positive measure meant to prevent the initiating event or prevent the scenario from progressing toward a NES consequence has failed to perform that function.
- 5. Nuclear Explosive Security. The Security Standard, paragraph 2.c., above, must be met to ensure adequate nuclear explosive security for all NEOs conducted by contractors.
  - 6. Nuclear Explosive Use Control. The Use Control Standard, paragraph 2.d. above, must be met for all NEOs conducted by contractors to ensure adequate use control measures.
  - 7. Nuclear Weapon Design Surety. Surety must be an integral part of the design and development of new weapons and the refurbishment of existing weapons. Contractors operating national laboratories with nuclear weapon design responsibilities must do the

following to support meeting the Nuclear Weapon Design Surety Standards, paragraphs 2.e. and 2.f. above.

- a. Document consideration of surety (safety, security, and use control) beginning at the conception phase and continuing throughout all weapon program phases.
- b. Support surety (safety, security, and use control) evaluations conducted by the Office of Defense Programs beginning at the conception phase and continuing throughout the appropriate Phase X/6.X process design review and design down-select to ensure nuclear weapon design architecture meets threshold requirements and considers objective requirements.
- c. Explicitly consider surety-related surveillance program information in nuclear weapon design and development activities.
- d. Support NNSA Military Characteristic negotiations by developing the following design features for new or refurbished nuclear weapons.
  - (1) Nuclear Detonation Safety. Nuclear weapons must incorporate design features that minimize the possibility of accidental and/or unintended nuclear explosive detonation. The following are design requirements for nuclear weapons.
    - (a) Normal Environment. Prior to receipt of the enabling input stimuli, the probability of a premature nuclear explosive detonation must not exceed one in a billion (1E-09) per nuclear weapon lifetime.
    - (b) Abnormal Environment. Prior to receipt of the enabling input stimuli, the probability of a premature nuclear explosive detonation must not exceed one in a million (1E-06) per credible nuclear weapon accident or exposure to abnormal environments.
    - (c) One-Point Safety. Nuclear explosives must be one-point safe without the use of a safing device (i.e. inherently one-point safe). The probability of achieving a nuclear yield greater than four (4) pounds of TNT equivalent in the event of a one-point initiation of the high explosive must not exceed one in a million (1E-06).
  - (2) Fissile Material Dispersal Safety. Incorporate design features in nuclear weapons for reducing fissile material dispersal from the pit under credible abnormal environments.
  - (3) Use Control. Incorporate use control design features in nuclear weapons that allow timely authorized use of a nuclear weapon while precluding or delaying unauthorized nuclear explosive detonation. The following are requirements for nuclear weapons delivered to DoD.

- (a) The protection of nuclear weapons must include a combination of administrative (e.g., personnel security) and technical measures (e.g., physical security and use control) designed to prevent deliberate unauthorized nuclear explosive detonation. These measures must be consistent with DoD operational requirements and must continually be assessed against existing and emerging threats as well as technological opportunities for improvement.
    - (b) Use control capabilities should be upgraded during weapon refurbishment consistent with requirements in Attachment 2 (classified) of this Order.
  - (4) Inadvertent Criticality. Design nuclear weapons to preclude inadvertent criticality in both normal and credible abnormal environments.
- e. Surety Research and Development (R&D).
  - (1) R&D on a broad range of safety and control methods and devices must be conducted to improve the surety of nuclear weapons and nuclear weapon systems significantly by accomplishing the following:
    - (a) Identify and characterize physical and digital-based processes that can lead to unacceptable nuclear explosive response.
    - (b) Identify and address surety issues.
    - (c) Identify and pursue improvements to surety architecture beyond one-point safety (e.g., multi-point safety) and Enhanced Nuclear Detonation Safety (ENDS).
  - (2) R&D must provide use control options with delay or denial capability that, at a minimum, are equivalent to that associated with current non-violent disablement systems.
  - (3) R&D must pursue technologies that render the unauthorized use of U.S. nuclear weapons impossible without their remanufacture.
- 8. Nuclear Weapon Surveillance Program. Each organization responsible for and/or involved in surveillance must establish a program to evaluate the stockpile continually to ensure that safety, use control, and digital components meet specified requirements and are performing effectively.
- 9. Nuclear Enterprise Assurance. Contractor NEA activities must augment the NEWS program, including providing assurance that components/systems are not subverted or compromised, in support of preventing deliberate unauthorized acts (DUA) that may lead to denial of authorized use (DAU), or degradation of weapon reliability and/or performance. NEA requirements (throughout the nuclear weapon lifecycle) for Nuclear Weapons (NWs) and NW-enabling capabilities, including digital assurance, are specified

in DOE O 452.4, *Security and Use Control of Nuclear Explosives and Nuclear Weapons*, current version, and NNSA SD 452.4-1, *Nuclear Enterprise Assurance*, current version.

10. Training and Qualification of Personnel. Each organization responsible for and/or involved in NEOs and activities that may affect the safety and use control of a nuclear explosive or nuclear weapon must implement training and qualification programs for personnel.
  - a. Training and qualification requirements must be commensurate with the particular responsibilities assigned.
  - b. NEWS training must include specific training on the specific nuclear explosive and weapon hazards and controls for the responsibilities assigned.
  - c. Training and qualification programs, as a minimum, must be based on the following.
    - (1) 10 CFR Part 712, *Human Reliability Program*, final rule.
    - (2) DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*, current version, as applicable.
11. Nuclear Security Enterprise Support. Provide NEWS subject matter experts to participate in readiness activities; military Nuclear Weapon System Surety Groups; nuclear weapon surveillance program; NES evaluation activities; and provide other specialized nuclear explosive technical support and assistance.
12. Records. Maintain NEWS records in accordance with National Archives and Records Administration-approved DOE or site-specific records retention and disposition schedules per DOE O 243.1, *Records Management Program*, current version, as applicable.

**ATTACHMENT 2**  
**USE CONTROL REQUIREMENTS (CLASSIFIED)**

This Attachment provides information and requirements associated with DOE O 452.1F as well as information and requirements applicable to contracts in which the associated CRD (Attachment 1 to DOE O 452.1F) is inserted.

Specific delay times for use control equipment is classified information. The classified attachment provides specific delays times for threshold and objective nuclear weapon design surety requirements pertaining to use control. The requirements apply to both Federal and contractor employees.

Questions concerning this attachment and the classified use control requirements should be addressed to the Director, Weapon Security and Control Division, 505-845-4803.



### **ATTACHMENT 3 DEFINITIONS**

This Attachment provides information associated with DOE O 452.1F as well as information applicable to contracts in which the associated CRD (Attachment 1 to DOE O 452.1F) is inserted.

1. Abnormal Environment.
  - a. In DOE operations, an environment that is not expected to occur during nuclear explosive operations and associated activities.
  - b. In DoD operations, as defined in a weapon's stockpile-to-target sequence and military characteristics, those environments in which the weapon is not expected to retain full operational reliability.
2. Adverse Environment. An environment that is capable of producing an unwanted response. Examples include anything that introduces unintended or unauthorized energy hazardous to a nuclear explosive such as human error; deliberate acts; equipment malfunction; other accident initiators, precursors, or sequences; and the conditions those events create.
3. Authorizing Official. For the purposes of this Order, the NNSA field element line manager responsible for authorizing NEOs at any site for which that line manager is responsible.
4. Deliberate Unauthorized Act (DUA). Any intentional action that has not been authorized and approved by proper authority. In the context of the Nuclear Explosive Surety Standards, a DUA is one that is not sanctioned as part of an approved NEO or associated activity, but which could affect a nuclear explosive or main charge high explosive part collocated with a pit. In the context of this Order, a DUA is of interest if it is performed with a malevolent intent to prevent authorized use (see DAU) of a nuclear weapon; create a nuclear detonation or other Deliberate Unauthorized Use (DUU); or to gain unauthorized control of a nuclear explosive.
5. Deliberate Unauthorized Use (DUU). Any of the following consequences resulting from deliberate malevolent acts:
  - a. A nuclear explosive detonation that is not authorized by the National Command Authorities.
  - b. An HEVR that could result in an unauthorized nuclear explosive detonation.
  - c. Theft of nuclear explosives.
6. Denial of Authorized Use (DAU). Any unauthorized act, including DUAs, that would prevent the authorized use or intended functionality of a nuclear weapon. The resulting potential effects on the nuclear weapon include but are not limited to:

- a. Actual alteration of system or critical component functionality.
  - b. Perception that system or critical components are not functioning properly.
7. Digital Assurance. A term for practices, measures and/or controls applied to digital technologies that implement functions within a nuclear weapon (NW), or NW design, production, or test capability, in order to ensure functional, performance and security-related requirements are met while protecting against potential compromise or subversion of these same systems from internal or external sources. Examples of digital technologies include software/firmware, processors, memory devices, application-specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), digital systems on a chip, communication interfaces, communication buses and transmission systems, etc.
  8. Documents. Recorded information that describes, specifies, reports, certifies, requires, or provides data or results. A document is not considered a record until it is a completed document that provides objective evidence of an item, service, or process.
  9. Enabling Input Stimuli. Safety critical inputs that include unique signals, unique environments, and other stimuli that operate (or will be used to operate) safety devices in nuclear weapons. Enabling input stimuli and the time of application to the weapon (e.g., the time/place in the trajectory to the target) are selected during weapon development as appropriate for the abnormal and/or normal safety requirements and are approved by the DoD/DOE project officers.
  10. Enhanced Nuclear Detonation Safety (ENDS). An electrical isolation design for a nuclear weapon that provides assured safety using the Nuclear Safety Design Principles of isolation, inoperability, and incompatibility that is implemented using multiple, passive safety subsystems and independence of safety features.
  11. Environment. The aggregate of surrounding conditions, circumstances, objects, and influences.
  12. Fissile Material Dispersal. The aerosolization and transport of fissile material by a driving force, such as fire, or HEVR.
  13. High Explosive Deflagration. A rapid chemical reaction in which the output of heat is sufficient to enable the reaction to proceed and accelerate without input of heat from another source. Deflagration is a surface phenomenon, with the reaction products flowing away from the unreacted material along the surface at subsonic velocity. Confinement of the reaction increases pressure, rate of reaction, and temperature and may cause transition into a detonation.
  14. High Explosive Detonation. A violent chemical reaction within a chemical compound or mechanical mixture evolving heat and pressure. A detonation is a reaction that proceeds through the reacted material toward the unreacted material at a supersonic velocity. The result of the chemical reaction is exertion of extremely high pressure on the surrounding medium, forming a propagation shock wave that is originally of supersonic velocity.

15. High Explosive Violent Reaction (HEVR). For the purposes of the NEWS Directives, an HEVR includes reactions ranging from a fast deflagration of the high explosive up to and including a detonation of the high explosive. The explosive wave may be subsonic or supersonic.
16. Inadvertent Criticality. The release of energy as a result of accidental production of a self-sustaining or divergent neutron chain reaction.
17. Multipoint Safety. The application of positive measures to prevent or mitigate the possibility of nuclear yield resulting from accidental or deliberate unauthorized initiation of the main-charge explosive at multiple points within the main charge.
18. Normal Environment.
  - a. In DOE operations, the environment in which NEOs and associated activities are expected to be performed.
  - b. In DoD operations, the expected logistical and operational environments, as defined in a weapon's stockpile-to-target sequence and military characteristics, that the weapon is required to survive without degradation in operational reliability.
19. Nuclear Enterprise Assurance (NEA). A Nuclear Security Enterprise (NSE) countersubversion program established to prevent, detect and/or mitigate potential consequences of subversion of nuclear weapons (NWs) or the enabling capabilities throughout the NW lifecycle, including deliberate unauthorized acts (DUA) that may lead to denial of authorized use (DAU) or degradation of nuclear weapon reliability or performance.
20. Nuclear Explosive. An assembly containing fissionable and/or fusionable materials and main charge high-explosive parts or propellants capable of producing a nuclear explosive detonation (e.g., a nuclear weapon or test device).
21. Nuclear Explosive Area. An area that contains a nuclear explosive or collocated pit and main charge high-explosive parts.
22. Nuclear Explosive Detonation. An energy release in a nuclear explosive (as defined in this Order) through a nuclear process, during a period of time on the order of one (1) microsecond, in an amount equivalent to the energy released by detonating four (4) or more pounds of trinitrotoluene (TNT).
23. Nuclear Explosive Operation (NEO). Any activity involving a nuclear explosive including activities in which main charge high-explosive parts and pit are collocated.
24. Nuclear Explosive Safety (NES). The application of positive measures to prevent or mitigate the possibility of unintended or unauthorized nuclear explosive detonation or HEVRs in a nuclear explosive area.

25. Nuclear Explosive Safety (NES) Consequence. An unintended nuclear explosive detonation or a main charge HEVR. NES Consequences are the consequences of concern for nuclear explosive safety evaluations.
26. Nuclear Explosive Safety (NES) Evaluation. A formal evaluation of NEOs to determine if the DOE Nuclear Explosive Safety Standards and other NES criteria are met.
27. Nuclear Explosive Safety Study Group (NESSG). The group established to evaluate NEOs using the formal processes and certified personnel specified in NNSA SD 452.2B, *Nuclear Explosive Safety Evaluation Processes*.
28. Nuclear Security Enterprise (NSE). The collection of DOE laboratories, Nevada National Security Site, production plants, and processing facilities involved in the design, production, and testing of nuclear weapons.
29. Nuclear Weapon. A nuclear explosive configured for Department of Defense use.
30. Nuclear Weapon (NW) Enabling Capabilities. The infrastructure (facilities, utilities, and workforce), processes, equipment, materials, and tools that provide the NSE the ability to ensure reliability and performance of the NW stockpile throughout its lifecycle, including those needed to support procurement, management, research and development (R&D), design, production, testing, surveillance, maintenance, transport, dismantlement, and disposition of NWs or NW components.
31. Nuclear Yield. The nuclear energy released in the detonation of a nuclear explosive measured in terms of the weight of TNT required to produce the same amount of energy release.
32. One-Point Safety. The nuclear safety design principle that states that the probability of achieving a nuclear yield greater than 4 pounds of TNT equivalent in the event of a one-point initiation of the main charge high explosive must not exceed one in a million (1E-06).
33. Pit. A fissile component or set of fissile components designed to fit in the central cavity of an implosion system.
34. Positive Measures. Process or facility design features, safety rules, procedures, or other controls used individually or collectively to provide nuclear explosive surety. Positive measures are intended to ensure a safe response in applicable operations. Some examples of positive measures are verification of strong-link switches; verification of other safety devices; administrative procedures and controls; general and specific nuclear explosive safety rules; design control of electrical equipment and mechanical tooling; and physical, electrical, and mechanical restraints incorporated in facilities and transport equipment.
35. Records. Books, papers, photographs, machine-readable materials, maps, or other documentary materials, regardless of physical form or characteristics, which have documentary or evidential value. Such materials, created or received in connection with

- the transaction of official business, are preserved because of their informational value as evidence of the organization, functions, policies, decisions, operations, or other activities.
36. Refurbishment. Any nuclear weapon alterations or modifications including life extension, modernization, and revised military requirements. Refurbishments are assigned a new alteration (Alt) or modification (MOD) number for stockpile management purposes.
  37. Site. A geographical area consisting of a DOE-controlled land area including DOE-owned facilities.
  38. Surety. Safety, security, and use control of nuclear explosives and nuclear weapons.
  39. System Assurance: The justified confidence that the system functions as intended and is free of exploitable vulnerabilities, either intentionally or unintentionally designed or inserted as part of the system at any time during the lifecycle. (Source: NATO. 2010. Engineering for system assurance in NATO programs. DoD 5220.22M-NISPOM-NATO-AEP-67. February 2010.)
  40. Technical Safety Requirements (TSRs). The limits, controls, and related actions that establish the specific parameters and requisite actions for the safe operation of a nuclear facility and include (as appropriate for the work and the hazards identified in the documented safety analysis for the facility): Safety limits, operating limits, surveillance requirements, administrative and management controls, use and application provisions, and design features, as well as a bases appendix.
  41. Unauthorized Act. Any action that has not been authorized and approved by proper authority. In the context of the Nuclear Explosive Surety Standards, an Unauthorized Act is one that is not sanctioned as part of an approved NEO or associated activity, but which could affect a nuclear explosive or main charge high explosive part in a Nuclear Explosive Area. Unauthorized Acts may be characterized as deliberate or unintended, and as either malevolent or non-malevolent.
    - a. From a NES perspective, an Unauthorized Act is of interest if performed without intent to compromise nuclear explosive surety (i.e., non-malevolent). This includes cognitive errors (errors of omission or commission) and accidental or inadvertent acts.
    - b. From a use control perspective, an Unauthorized Act is of interest if it is both deliberate and malevolent. More specifically, an act performed with intent to create an unauthorized nuclear explosive detonation or to gain unauthorized control of a nuclear explosive.
  42. Use Control. The application of systems, devices, or procedures that allow timely authorized use of a nuclear explosive while precluding or delaying unauthorized nuclear explosive detonation.



## ATTACHMENT 4 REFERENCES

This Attachment provides information associated with DOE O 452.1F as well as information applicable to contracts in which the associated CRD (Attachment 1 to DOE O 452.1F) is inserted.

1. Title XXXII of P.L. 106-65, *National Nuclear Security Administration Act*, as amended, establishes the National Nuclear Security Administration.
2. 10 U.S.C. Sec. 179, *Nuclear Weapons Council*.
3. 10 CFR Part 712, *Human Reliability Program*.
4. 10 CFR Part 820, *Procedural Rules for DOE Nuclear Activities*.
5. 10 CFR Part 830, *Nuclear Safety Management*.
6. 10 CFR Part 1017, *Identification and Protection of Unclassified Controlled Nuclear Information*.
7. Presidential Policy Decision (PPD) – 35, *United States Nuclear Command Control, Safety and Security*, dated 12/08/15.
8. DOE P 450.4, *Integrated Safety Management Policy*, current version, describes DOE's commitment that safety management systems be used to integrate safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment.
9. DOE O 151.1, *Comprehensive Emergency Management System*, current version, provides the framework for development, coordination, control, and direction of all emergency planning, preparedness, readiness assurance, response, and recovery actions.
10. DOE O 227.1, *Independent Oversight Program*, current version, establishes requirements and responsibilities for DOE Independent Oversight that provides DOE and contractor managers, Congress, and other stakeholders with an independent evaluation of the adequacy of DOE policy and the effectiveness of line management performance in safeguards and security and other critical functions.
11. DOE O 243.1, *Records Management Program*, current version, provides a framework for managing information and National Archives and Records Administration approved DOE or site-specific records schedules.
12. DOE O 410.1, *Central Technical Authority Responsibilities Regarding Nuclear Safety Requirements*, current version, establishes Central Technical Authority and Chief of Nuclear Safety/Chief of Defense Nuclear Safety responsibilities and requirements directed by the Secretary of Energy in the development and issuance of Department of Energy regulations and directives that affect nuclear safety.

13. DOE O 420.1, *Facility Safety*, current version, establishes facility and programmatic safety requirements for the DOE, including NNSA.
14. DOE O 425.1, *Verification of Readiness to Startup or Restart Nuclear Facilities*, current version, establishes the requirements for startup of new nuclear facilities and for the restart of existing nuclear facilities that have been shut down.
15. DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*, current version, established selection, training, qualification, and certification requirements for contractor personnel who can impact the safety basis through their involvement in the operation maintenance, and technical support of Hazard Category 1,2, and 3 nuclear facilities.
16. DOE O 452.2, *Nuclear Explosive Safety*, current version, establishes requirements and responsibilities for ensuring the nuclear explosive safety of routine and planned DOE NEOs.
17. DOE O 452.4, *Security and Use Control of Nuclear Explosives and Nuclear Weapons*, current version, establishes DOE requirements and responsibilities to prevent the deliberate unauthorized use of U.S. nuclear explosives and weapons.
18. DOE O 452.6, *Nuclear Weapon Surety Interface With the Department of Defense*, current version, establishes DOE/NNSA requirements and responsibilities for addressing joint nuclear weapon and nuclear weapon system surety activities in conjunction with the DoD.
19. DOE O 461.1, *Packaging and Transportation for Offsite Shipment of Materials of National Security Interest*, current version, establishes DOE requirements and responsibilities for the Transportation Safeguards System Program.
20. DOE O 470.4, *Safeguards and Security Program*, current version, establishes roles and responsibilities for the Department of Energy Safeguards and Security Program.
21. DOE O 471.1, *Identification and Protection of Unclassified Controlled Nuclear Information*, current version.
22. DOE O 471.7, *Controlled Unclassified Information*, current version.
23. DOE O 475.2, *Identifying Classified Information*, current version.
24. NNSA SD 452.2, *Nuclear Explosive Safety Evaluation Processes*, current version, detailing administrative and procedural requirements for nuclear explosive safety evaluations of nuclear explosive operations conducted by the DOE/NNSA, and its respective contractors.
25. NNSA SD 452.3-1, *Defense Programs Business Process System (DPBPS)*, current version, establishes the DPBPS Portal as the mechanism for implementing DOE Order 452.3, Management of the DOE Nuclear Weapons Complex.

26. NNSA SD 452.3-2, *Phase 6.X Process*, current version, establishes the policy for implementing the NNSA roles and responsibilities pertaining to the Nuclear Weapons Council's (NWC) Procedural Guideline for the Phase 6.X Process and describes the sequence of activities and interactions with the DoD during the Phase 6.X process.
27. NNSA SD 452.4-1, *Nuclear Enterprise Assurance (NEA)*, current version, establishes NEA as a NSE countersubversion program to prevent, detect, and/or mitigate potential consequences of subversion of nuclear weapons (NWs) and NW-enabling capabilities, in support of implementing DOE O 452.1, Nuclear Explosive and Weapon Surety (NEWS) Program, and DOE O 452.4, Security and Use Control of Nuclear Explosives and Nuclear Weapons, requirements.