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

ORDER

DOE O 452.2F

Approved: 7-27-2020

SUBJECT: NUCLEAR EXPLOSIVE SAFETY

1 PURPOSE. This Department of Energy (DOE) Order (O) establishes requirements to implement the nuclear explosive safety (NES) elements of DOE O 452.1, *Nuclear Explosive and Weapon Surety Program*, current version, for routine and planned nuclear explosive operations (NEOs) and nuclear explosive-like assemblies (NELAs).

2 CANCELS/SUPERSEDES. DOE O 452.2E, *Nuclear Explosive Safety*, dated 1-26-15. Cancellation of a directive does not, by itself, modify or otherwise affect any contractual obligation to comply with the directive. Contractor Requirements Documents (CRDs) that have been incorporated into or attached to a contract remain in effect until the contract is modified to either eliminate requirements that are no longer applicable or substitute a new set of requirements.

3 APPLICABILITY.

a. Departmental Elements.

(1) This Order applies to NNSA, which is the only Departmental Element that is involved in performing, managing, overseeing, and directly supporting NEOs, NELAs, and NEO-associated activities.

(2) The NNSA Administrator will ensure that NNSA employees comply with their respective responsibilities under this directive. Nothing in this Order 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.

(1) Except for the exclusions in paragraph 3.c., the Contractor Requirements Document (CRD), Attachment 1, sets forth requirements of this Order that will apply to contracts that include the CRD.

(2) The CRD must be included in all contracts that involve performing, managing, overseeing, or directly supporting NEOs or NEO-associated activities.

(3) Attachments 2 through 6 also apply to contractors. These attachments must be included along with the CRD in all contracts that involve performing, managing, overseeing, or directly supporting NEOs, NELAs, or NEO-associated activities. NNSA Field Element managers are responsible for informing Contracting Officers which contracts are affected. Once notified,

Contracting Officers are responsible for incorporating the CRD and Attachments 2 through 6 into each affected contract.

c. Equivalencies/Exemptions for DOE O 452.2F. Exemptions must be requested when release is sought from a requirement in this directive or successor directives. 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.

(1) 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 Directive for activities under the Director's cognizance, as deemed appropriate.

(2) Exemption. This Order does not apply to emergencies requiring Accident Response Group action. DOE O 151.1, *Comprehensive Emergency Management*, current version, addresses emergencies involving nuclear explosives. The Deputy Administrator for Defense Programs is authorized to ensure transition from emergency management directives to this Order once the emergency is terminated.

(3) Exemption. Subcritical Experiments performed at the Nevada National Security Site and conducted under the authority of the Nevada Field Office are exempt from this Order based on their inherently subcritical design features as defined by NFO O 450.X5, *Subcritical Experiment Program*. NFO O 450.X5, or successor document, addresses performing, managing, overseeing, and directly supporting Subcritical Experiments and associated activities.

4 REQUIREMENTS.

a. Nuclear Explosive Safety Program. NEOs require special consideration because of the consequences of an accident or unauthorized act. The NES program outlined in this section supports the requirement that NEOs must be designed and conducted in a manner that meets the NES Standards of DOE O 452.1, current version. It includes the following: Nuclear Explosive Safety Rules (NESRs), general and supplemental; formal NES evaluations; fundamental NEO process requirements (procedures, facilities, equipment, and people); requirements for onsite and offsite transportation (mobile NEOs); sustaining requirements (positive verification, change control, and configuration management); requirements for nuclear explosive-like assemblies (NELAs); and permanent marking of nuclear explosives and NELAs.

(1) General NESRs. The general NESRs set forth in this paragraph are mandatory for all NEOs.

(a) Nuclear Explosive Safety Evaluation. NEOs must not be performed until a NES evaluation has been completed and findings indicating a NES standard has not been met have been closed.

(b) Nuclear Explosive Operating Procedures. NEOs must be performed in accordance with approved, written procedures.

(c) One-Point Safety.

1 Tooling and equipment must be evaluated to ensure that their intended use on an NE certified to be one-point safe does not cause an NE or equipment configuration that is not one-point safe.

2 If it is determined that a nuclear explosive no longer meets the one-point safety criteria, all production plant operations (including assembly, disassembly, and onsite transportation) and offsite transportation with that nuclear explosive must be discontinued in a safe manner. Before operations with that nuclear explosive can be resumed, a path forward must be developed, a NES evaluation must be completed, and findings indicating a NES standard has not been met must be closed.

(d) Nuclear Explosive Areas (NEAs).

1 Energy sources in NEAs must be identified and documented. Unauthorized energy sources must not be available during NEOs.

2 Ignition sources in NEAs must be identified and either (1) eliminated or (2) minimized and controlled to prevent adverse interaction with combustible or flammable materials and the nuclear explosive.

3 Combustible and flammable materials in NEAs must be identified and either (1) eliminated or (2) minimized and controlled to prevent adverse interaction with the nuclear explosive.

(e) Electrical Testing. Except as authorized in paragraph 4.a.(1)(f), Anomalous Units, nuclear explosives must not be subjected to:

1 redundant electrical tests, or

2 electrical troubleshooting (i.e., to confirm the existence of a fault, or aid in fault isolation) except with authorized test equipment and procedures that have been subjected to a NES evaluation and found to be acceptable for the specific application.

Note: Repeat electrical tests performed in conformance with approved Nuclear Explosive Operating Procedures and separated by other actions that might alter test results are not considered redundant.

(f) Anomalous Units.

1 If it is determined that a nuclear explosive is no longer in a condition covered by an approved written procedure, all operations with that nuclear explosive and in the associated facility must be discontinued in a safe manner, resulting in a safe and stable nuclear explosive configuration.

2 Restart of operations on an anomalous unit and other activities in the affected facility must be in accordance with paragraph 4.a.(15) below.

(2) Supplemental Nuclear Explosive Safety Rules. Supplemental NESRs may be developed as needed to support specific tests, operations, or characteristics of a nuclear explosive.

(3) Nuclear Explosive Safety Evaluations. NES evaluations are required before a NEO is authorized; periodically for ongoing NEOs; and when proposed changes or emerging information affect an approved NEO. NES evaluations must be performed in accordance with NNSA SD 452.2, *Nuclear Explosive Safety Evaluation Processes*, current version.

(4) Human Factors.

(a) Elements of NEOs such as new procedures, processes, facilities or facility layouts, new tooling and equipment must incorporate human factors principles during the NEO design and development phase and be maintained throughout the lifecycle of the NEO. Existing NEOs should strive to meet human factors principles to the extent reasonably achievable.

(b) Organizations developing NEOs must consider the application of established research in human factors and ergonomics, including human-system interface design, human cognition and perception, stress and workload, anthropometry and workspace design, environmental factors, training, and human error.

(5) Procedures. Written procedures (paper or electronic) that control the interactions between the nuclear explosive, the operating facility, equipment, and personnel must meet the following requirements:

(a) Design agencies must review and concur with original issues of procedures for NEOs and NEO-associated activities.

(b) All written procedures for NEOs must place proper emphasis on preventing accidents and detecting abnormal conditions by accomplishing the following:

1 Comply with design specifications and technical requirements.

2 Clearly state cautions and warnings.

3 Identify appropriate points to interrupt work safely.

4 Include generic contingency procedures that are directed toward quickly achieving a safe and stable nuclear explosive configuration to be applied in response to all unexpected situations not covered by other written procedures.

(6) Two-Person Concept. Organizations responsible for NEOs and NEO-associated activities and facilities (to include NELA verifications as specified in Attachments 4 and 5 of this Order) must establish and implement the two-person concept as specified in Attachment 2 of this Order.

(7) Facilities. Facilities used for NEOs must be characterized, evaluated, and specifically approved for that use, based (in part) on an independent NES evaluation in accordance with NNSA SD 452.2, *Nuclear Explosive Safety Evaluation Processes*, current version.

During NES evaluations of facilities, safety structures, systems, and components (SSCs) can be considered to credibly control natural phenomenon hazards (NPH) if they meet the appropriate NPH design categories found in DOE-STD-1020, current version, as invoked by DOE O 420.1, *Facility Safety*, current version.

(8) Equipment. Organizations responsible for NEOs and NEO-associated activities and facilities must verify that all equipment used in NEAs (including tooling, testers, and other mechanical and electrical equipment) meet the following requirements.

(a) Design specifications and technical requirements must be documented.

(b) Designs must ensure nuclear explosives will remain in a safe condition should a system or component of the tool or equipment fail.

(c) Each item used in a NEO must be specifically approved for that operation. Unapproved, movable items must be excluded from the NEA. Positive measures must be used to prevent the use of facility equipment that is not approved for the NEO, but is impracticable to remove.

(d) Equipment intended to apply energy to a nuclear explosive must incorporate features that limit application of energy to a known, safe level.

(e) Energy sources associated with equipment used in NEAs must be identified, analyzed, characterized, and documented. Engineered controls relied upon to protect NEs from these energy sources must be validated through analysis and testing.

(f) Energetic equipment intended for use in NEAs by emergency responders (e.g., fire department personnel, security force, and radiological protection) must be evaluated and characterized with respect to potential hazards. Training of expected responders and NEA workers must address emergency situations to help ensure safety of responders and associated equipment.

(g) Attachment 3 of this Order specifies additional requirements for electrical equipment used in NEAs.

(9) Maintenance of Facilities, Tooling, and Other Equipment. Organizations responsible for NEOs and NEO-associated activities and facilities must review maintenance programs and activities for impact on NES. Maintenance implementation plans must include a detailed description of maintenance activity control and approval, including limitations on equipment and materials that are allowed in NEAs.

(10) Personnel. Each organization responsible for or involved in NEOs and NEO-associated activities must implement training, qualification, and certification programs for personnel that manage, oversee, perform, or directly support these operations and activities.

In addition to the applicable requirements in 10 CFR Part 712, *Human Reliability Program*, and DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*, current version, annual training will be conducted for personnel assigned to nuclear explosive duty that includes the following NES-specific topics:

(a) Responsibilities associated with custody of nuclear explosives.

(b) Use of general and supplemental NESRs and Immediate Action Procedures.

(c) Site-, facility-, program-, and operation-specific safety requirements.

(d) The purpose, objective, and responsibilities of the two-person concept for operations.

(e) Explosive safety appropriate for assigned responsibilities.

For site-, facility-, program-, and operation-specific safety requirements, the annual training requirements under paragraph 4.a.(10)(c) above may be met with training provided during an initial certification or qualification program and through a continued recertification or requalification process, provided that the process requires no less than an annual review or demonstration of knowledge of the safety requirements.

(11) Transportation of Nuclear Explosives. Nuclear explosive transportation is a mobile NEO and involves a mobile NEA. Requirements specified for NEOs and NEAs elsewhere in this directive apply.

(a) Organizations responsible for NEOs and NEO-associated activities and facilities must establish requirements and procedures to ensure safe onsite transportation of nuclear explosives.

(b) Offsite transportation of nuclear explosives is performed by the Office of Secure Transportation (OST) and begins when the loaded conveyance is closed and ends with the opening of the conveyance at its destination.

(c) Transportation operations and shipping configurations, including all items in the conveyance, are subject to the NES evaluation requirements of paragraph 4.a.(1)(a) and 4.a.(3).

1 Nuclear explosives must be transported in conveyances specifically reviewed through the NES evaluation process.

2 Criteria must be established for protecting nuclear explosives during transportation. The criteria and restraint designs for specific nuclear explosive configurations must be reviewed through the NES evaluation process.

(12) Mixed Venues. Nuclear explosives must not be transported or staged with any other assembly that could be mistaken for a nuclear explosive.

If operational constraints require nuclear explosives and nuclear explosive-like assemblies (NELAs) to be collocated, the operations must

comply with the NELA standards in paragraph 4.a.(17) of this directive and must be evaluated by a Nuclear Explosive Safety Study Group (NESSG). The operational justification for collocation of the nuclear explosives and NELAs will be provided to the NESSG during the evaluation.

(13) Positive Verification.

(a) Organizations responsible for NEOs and NEO-associated activities and facilities must develop and implement a verification process to ensure use of qualified personnel who are fit for duty, operationally ready facilities, correct equipment that is current in any required calibration and preventive maintenance, and current approved procedures.

(b) The configuration and condition of a nuclear explosive and its safety features must be determined as early as practicable during any planned NEO. For operations occurring prior to this determination, or in the event a determination cannot be made, incompatibility with or isolation from external energy that may lead to credible NES consequences must be demonstrated.

(14) Change Control. Organizations responsible for NEOs and NEO-associated activities and facilities must establish and implement a NES change evaluation process in accordance with NNSA SD 452.2, *Nuclear Explosive Safety Evaluation Processes*, current version. This NES evaluation is separate and independent from the unreviewed safety question process required by 10 CFR Part 830, *Nuclear Safety Management*, and must be completed before approval and implementation of the change.

All proposed changes to authorized NEOs, including the following, are subject to the NEO change control process.

(a) Proposals that may have direct NES implications (e.g., procedural, equipment, or facility changes to an approved NEO).

(b) Proposals that may have indirect NES implications (e.g., changes or new activities that could impact the foundation established by previous NES Master Studies).

(c) Changes in knowledge affecting an approved NEO (e.g., new understanding of a potential threat to NES or new data regarding the response of a nuclear explosive to a stimulus).

(15) Anomalous Unit Processing. An anomalous unit might be created or discovered in the course of NEOs performed by NNSA or its contractors, or might be received from the Department of Defense (DOD) in a known anomalous condition.

The OST NEO change control process must ensure anomalous units accepted for transport are safe to ship and that any special handling, receiving, or staging requirements are known and accepted in advance by the receiving organization.

The following apply to anomalous units at the production agency.

(a) The production agency Process Engineer, production agency NES representative, and design agency System Engineer collectively have the authority to declare a unit anomalous. If the three cannot agree that the unit in question is not anomalous, then the unit will be treated as anomalous. The design agency System Engineer should solicit input from their respective design agency NESSG member(s) prior to making an anomalous unit determination.

(b) Before operations with the anomalous unit can be resumed, the NEO change control process must be completed in accordance with paragraph 4.a.(14). A design agency engineering release must be developed as input to the change control process.

1 The responsible design agencies, to include a NESSG-certified member from the design agency, must specifically review the engineering release for impact on NES. This review must be documented in the engineering release.

2 Transportation operations, if applicable, must be specifically addressed in the engineering release. Offsite transportation operations are subject to the Office of Secure Transportation NEO change control process.

(c) A decision to resume other activities in the facility must include consideration of possible interactions with the anomalous unit.

(d) If additional information is obtained after a unit has been declared anomalous (e.g., from a radiograph), the new information must be evaluated to determine if the unit should remain anomalous.

(16) Configuration Management.

(a) Organizations responsible for NEOs and NEO-associated activities and facilities must develop and implement a configuration management program incorporating elements applicable to NEOs and NEO-associated activities and facilities.

(b) To ensure consistency with design requirements and the safety basis, the configuration management program must include the following:

1 the physical configuration of a nuclear explosive and its components; the tooling, equipment, and procedures used in NEOs and NEO-associated activities; and the interface with the facilities in which these operations and activities are conducted;

2 unique identification of special tooling and equipment used in NEOs;

3 positive identification of tooling and equipment requiring calibration or testing within a calibration or testing control program; and

4 incorporation of approved changes into all affected documents (including design documents, drawings, procedures, and safety basis documents) and programs (including maintenance and training).

(17) Nuclear Explosive-Like Assemblies (NELAs).

(a) Nuclear Explosive-Like Assembly Standards. All NELA operations must meet the following qualitative NELA standards.

1 There must be positive measures to prevent inadvertent or unauthorized assembly of a nuclear explosive in place of a NELA configuration.

2 There must be positive measures to prevent inadvertent or unauthorized transfer of a nuclear explosive in place of a NELA configuration.

In the context of these NELA Standards, the term *prevent* is applied as described for the Nuclear Explosive Surety Standards in DOE O 452.1, current version.

(b) Nuclear Explosive-Like Assembly Requirements. Attachment 4 provides the criteria that must be used to make NELA determinations. If a NELA has been determined to exist, this determination must be documented and retained by the determining authority. Organizations with a NEO mission that are responsible for NELA operations must implement the NELA requirements in Attachment 4 of this directive. Organizations without a NEO mission that are responsible for NELA operations must implement the NELA requirements in Attachment 5 of this directive.

(18) Marking Instructions. Nuclear explosives and NELAs must be marked to distinguish configurations capable of a nuclear explosive detonation from

those that are not. Organizations responsible for NEOs or NELA operations must implement the marking requirements in Attachment 6 of this directive.

b. Independent Oversight. The Associate Administrator for Safety, Infrastructure and Operations executes independent oversight through the Office of the Chief of Defense Nuclear Safety of this directive's implementation and associated NNSA Supplemental Directives by NNSA personnel. This oversight may be carried out through observation of NNSA NES evaluations, independent assessments, shadowing of field element assessments, or other appropriate mechanisms. On an annual basis, the Office of the Associate Administrator for Safety, Infrastructure and Operations will summarize its oversight activities, along with any recommendations for changes in the NES program in a report to the NNSA Deputy Administrator for Defense Programs, the Assistant Deputy Administrator for Stockpile Management, and the Assistant Deputy Administrator for Secure Transportation. The Assistant Deputy Administrator for Stockpile Management and/or Assistant Deputy Administrator for Secure Transportation will respond within 90 days to the recommendations with a proposed corrective action plan, or justification for no action.

c. Records. Records (documentation) must be maintained in accordance with National Archives and Records Administration-approved DOE or site-specific records retention and disposition schedules in accordance with DOE O 243.1, *Records Management Program*, current version.

d. Implementation. This revision does involve substantive administrative or programmatic changes from the previous directive, DOE O 452.2E. An implementation plan is required.

5 RESPONSIBILITIES.

a. Deputy Administrator for Defense Programs.

(1) Ensures implementation of NES Programs.

(2) Approves exemptions to this Order.

b. Assistant Deputy Administrator for Stockpile Management. Responds within 90 days to NA-50 independent oversight recommendations with a proposed corrective action plan, or justification for no action.

c. Assistant Deputy Administrator for Secure Transportation. Supports NA-12 by providing a proposed corrective action plan or justification for no action for oversight recommendations directed toward an NA-15 area of responsibility.

d. NNSA Field Element Managers responsible for NES Program Implementation.

(1) Provide oversight of NNSA management and operating (M&O) contractors.

(2) Provide direction to the Contracting Officers to ensure that the CRD and Attachments 2 through 6 of this directive are included in the appropriate contracts.

e. Chief of Defense Nuclear Safety. Provides independent oversight of the implementation of this Order and associated Supplemental Directives by NNSA personnel.

f. Director, Office of Stockpile Sustainment.

(1) Provides federal leadership for project teams formed to develop nuclear explosive operations at NNSA production agencies.

(2) Ensures that NNSA nuclear explosive operations are designed in a manner that satisfies the NES Program requirements.

g. Director, Office of Stockpile Modernization.

(1) Provides federal leadership for project teams formed to develop nuclear explosive operations at NNSA production agencies.

(2) Ensures that NNSA nuclear explosive operations are designed in a manner that satisfies the NES Program requirements.

h. Director, Office of Stockpile Production Integration.

(1) Manages the NNSA NES evaluation processes.

(2) Provides support to NNSA field element offices as needed for NES oversight of the NNSA M&O Contractors.

i. Chair, Nuclear Explosive Safety Study Group.

(1) Implements the NNSA NES evaluation processes.

(2) Provides the official interpretation of the NES Standards and other NES criteria for use by the Nuclear Explosive Safety Study Group during the performance of NES evaluations per 4.a.(3).

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. Definitions from DOE O 452.1, current version, are not repeated here.

a. Access. The proximity to a nuclear explosive that allows the opportunity to divert, steal, tamper with, or damage the nuclear explosive in spite of any controls that have been established to prevent such unauthorized actions.

b. Anomalous Unit. A configuration in a nuclear explosive operation that has any of the following:

(1) Damage or other condition not identified as a credible deviation or otherwise explicitly addressed in an approved technical operating procedure.

(2) Damage or other condition that results in an unanalyzed configuration or a configuration not covered by a NES evaluation.

(3) Other damage or condition potentially adverse to nuclear explosive safety.

Minor damage or other non-conformances, such as units with scratches, bent connector pins, chipped insulators, stripped screws, etc., need not be considered as an anomalous unit unless the condition is potentially adverse to nuclear explosive safety.

c. Custody of Nuclear Explosives. Responsibility for access to, and control of, nuclear explosives.

d. Dummy Pit. A component or set of components designed to simulate a live pit, but that does not contain fissile material and cannot create a nuclear explosive if placed in the central cavity of an implosion system. A “high-fidelity” dummy pit is one that also has dimensions representative of a live pit.

e. Electrical Equipment. Includes items that contain or use an electrical energy source and the interface (if any) with the nuclear explosive (NE). For Category 1 electrical equipment (as defined in Attachment 3 of this Order), this includes associated adapters, test cables, switch boxes, etc. For some Category 2 electrical equipment (as defined in Attachment 3 of this Order), this includes a mechanical connection to the NE and associated electrical isolation features. Category 3 electrical equipment does not interface with the nuclear explosive.

f. Facility. Any equipment, structure, system, process, or activity that fulfills a specific purpose.

g. Human Factors. A scientific discipline that applies knowledge about human abilities, characteristics, and limitations to design of tasks, equipment, and environments.

h. Human Reliability Program (HRP). A program established by 10 CFR Part 712 to ensure that individuals who occupy positions affording access to certain materials,

nuclear explosive devices, facilities, and programs meet the highest standards of reliability and physical and mental suitability.

i. Main Charge. The high explosive that implodes the pit.

j. Mock High Explosive. A material that is designed to simulate the main charge high explosive, but which is non-detonable and clear or colored pink.

k. Mock Primary. A surrogate nuclear explosive in its basic configuration (e.g., consisting of mock high explosive and dummy pit designed to simulate the geometry of a primary).

l. Nuclear Explosive Assembly. An assembly made up of a nuclear explosive subassembly and a higher level of assembly up to a fully assembled weapon configuration.

m. Nuclear Explosive Subassembly. A subassembly made up of a main charge high explosive and a pit.

n. Nuclear Explosive Duty. Work assignments that allow custody of a nuclear explosive or access to a nuclear explosive device or area.

o. Nuclear Explosive-Like Assembly (NELA). An assembly that resembles a nuclear explosive in the U.S. nuclear weapons stockpile (past, present, or planned), and represents a nuclear explosive in its basic configuration (main charge high explosive (HE) and pit) or any higher level of assembly up to a fully assembled weapon configuration (e.g., mock primary, trainer, Joint Test Assembly, etc.). A NELA is not capable of producing a nuclear explosive detonation and does not contain both main charge HE and a live pit.

p. Nuclear Explosive Operation Associated Activities. Activities directly associated with a specific nuclear explosive operation, such as work on a bomb nose or tail subassembly, even when physically separated from the bomb's nuclear explosive subassembly.

q. Nuclear Explosive Safety Rules (NESRs). Requirements that significantly contribute to minimizing the possibility of nuclear explosive detonation or high explosive violent reaction in nuclear explosive operations.

r. One-Point Safe Nuclear Explosive. A nuclear explosive that, in the event a detonation is initiated at any one point in the high explosive system, presents no greater probability than one in a million of producing a nuclear explosive yield of greater than 4 pounds of TNT equivalent.

s. Permanent Marking. A durable method, normally by metal deformation or engraving, indicating on an external area of an assembly, whether it is a nuclear explosive or a nuclear explosive-like assembly.

t. Safe and Stable. Stabilization of a nuclear explosive intended to ensure it is placed in a configuration that precludes potential hazards from affecting the unit, using the minimum actions necessary.

u. Safety Basis. A safety basis means the documented safety analysis and hazard controls that provide reasonable assurance that a DOE nuclear facility can be operated safely in a manner that adequately protects workers, the public, and the environment.

v. Two-Person Concept (TPC). A concept of operations implemented to ensure no lone individual has unrestricted access to a nuclear explosive or other crucial asset as specified by this Order.

8 REFERENCES. The following list contains references that are relevant to this Order.

a. Title 32 of P.L. 106-65, the National Nuclear Security Administration Act, dated October 5, 1999, as amended, which established a separately organized agency within the Department of Energy.

b. 10 CFR Part 712, *Human Reliability Program*, which establishes the policies and procedures for the DOE, including NNSA, human reliability program (HRP). The HRP is a security and safety reliability program designed to ensure that individuals who occupy positions affording access to certain materials, nuclear explosive devices, facilities, and programs meet the highest standards of reliability and physical and mental suitability.

c. 10 CFR Part 820, *Procedural Rules for DOE Nuclear Activities*, which sets forth procedures to govern the conduct of persons involved in DOE nuclear activities and, in particular, to achieve compliance with the DOE Nuclear Safety Requirements by all persons subject to those requirements.

d. 10 CFR Part 830, *Nuclear Safety Management*, which governs the conduct of DOE contractors, DOE personnel, and other persons conducting activities (including providing items and services) that affect, or may affect, the safety of DOE nuclear facilities.

e. Joint Department of Energy/Department of Defense (DOE/DOD) Technical Publication 20-7, Chg 6, *Nuclear Safety Criteria*, dated 07-20-16.

f. Joint DOE/DOD Technical Publication 35-51 Chg. 4, *General Instructions Applicable to Nuclear Weapons*, dated 12-21-16.

g. Joint DOE/DOD Technical Publication 45-51 Chg. 8, Transportation of Nuclear Weapons Materiel, General Shipping and Limited Life Component Data (LLC), dated 11-17-17.

h. Joint DOE/DOD Technical Publication 45-51A Chg. 3, Transportation of Nuclear Weapons Materiel (Supplement), Shipping and Identification Data for Stockpile Major Assemblies, dated 09-13-16.

i. DOE O 151.1, *Comprehensive Emergency Management System*, current version, which addresses responses to unplanned events.

j. DOE O 226.1, *Implementation of Department of Energy Oversight Policy*, current version, which provides direction for implementing DOE P 226.2, *Policy for Federal Oversight and Contractor Assurance Systems*, current version, which establishes DOE policy for assurance systems and processes established by DOE contractors and oversight programs performed by DOE line management and independent oversight organizations.

k. DOE O 231.1, *Environment, Safety, and Health Reporting*, current version, defines a minimum set of occurrence reporting requirements for DOE (including NNSA) elements and contractors and includes categorizing occurrences related to safety, environment, health, or operations; notifying DOE; and developing follow-up reports.

l. DOE O 232.2, *Occurrence Reporting and Processing of Operations Information*, current version, which provides requirements for categorizing and reporting non-emergency NES occurrences.

m. DOE O 243.1, *Records Management Program*, current version, which provides a framework for managing information in accordance with Department policy and National Archives and Records Administration-approved DOE record schedules.

n. DOE O 251.1, *Departmental Directives Program*, current version, which details the process for requesting exemptions from directives requirements.

o. DOE O 360.1, *Federal Employee Training*, current version, which establishes requirements and assigns responsibilities for DOE federal employee training, education, and development under the Government Employees Training Act of 1958, as amended.

p. DOE O 414.1, *Quality Assurance*, current version, which ensures that the quality of DOE (including NNSA) products and services meets or exceeds the customers' expectations.

q. DOE O 420.1, *Facility Safety*, current version, which establishes the DOE (including NNSA) facility safety for nuclear safety design, criticality safety, fire protection, and natural phenomena hazards mitigation, and includes the configuration management requirements for Safety SSCs.

r. DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*, current version, which establishes selection, qualification, and training requirements for management and operating

contractor personnel involved in the operation, maintenance, and technical support of DOE (including NNSA) Category A and B reactors and nonreactor nuclear facilities.

s. DOE O 433.1, *Maintenance Management Program for DOE Nuclear Facilities,* current version, which defines the safety management program required for maintenance and the reliable performance of structures, systems, and components that are part of the safety basis.

t. DOE O 452.1, *Nuclear Explosive and Weapon Surety Program*, current version, which establishes requirements and responsibilities for the DOE Nuclear Explosive and Weapon Surety Program.

u. DOE O 461.1, *Packaging and Transportation for Offsite Shipment of Materials of National Security Interest*, current version, which establishes requirements and responsibilities for the packaging and transportation of all DOE offsite shipments of Materials of National Security Interest.

v. NNSA SD 452.2, *Nuclear Explosive Safety Evaluation Processes,* current version, which provides requirements and guidance for nuclear explosive safety studies, operational safety reviews, and nuclear explosive safety change evaluations.

w. DOE-STD-1020-2016, *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities*, dated 12-04-16, provides criteria and guidance for the analysis and design of facility structures, systems, and components (SSCs) that are necessary to implement the requirements of DOE O 420.1C, *Facility Safety*, and to ensure that the SSCs will be able to effectively perform their intended safety functions under the effects of natural phenomena hazards (NPHs).

x. DOE-STD-1073-2016, *Configuration Management*, dated 12-23-16, which defines the objectives of a configuration management process for DOE nuclear facilities (including activities and operations) and provides detailed examples and supplementary guidance on methods to achieve those objectives.

y. DOE-STD-1104-2016, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, dated 12-21-16, which describes DOE review and approval of documented safety analyses and Technical Safety Requirements for existing Hazard Category 1, 2, and 3 nuclear facilities that document their safety basis in accordance with 10 CFR Part 830.

z. DOE-STD-1212-2019, *Explosives Safety*, dated 11-27-19, which describes DOE's explosives safety requirements applicable to operations involving the development, testing, handling, and processing of explosives or assemblies containing explosives.

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

which describes a Safety Analysis Report preparation method that satisfies 10 CFR Part 830 requirements.

bb. DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analyses* [DSA], dated 11-12-14, which provides an acceptable methodology for meeting the 10 CFR Part 830 requirements for the preparation of DSAs for both new and existing nonreactor nuclear facilities.

cc. DOE-NA-STD-3016-2018, *Hazard Analysis Reports for Nuclear Explosive Operations*, dated 10-16-18, which clarifies the requirements and provides guidance for conducting hazard analyses and preparing Hazard Analysis Reports for nuclear explosive operations and associated activities.

9 CONTACT. Questions concerning this Order should be addressed to the Chief of Defense Nuclear Safety, 505-845-4404.

DAN BROUILLETTE
Secretary of Energy

ATTACHMENT 1
CONTRACTOR REQUIREMENTS DOCUMENT
DOE O 452.2F, *NUCLEAR EXPLOSIVE SAFETY*

This Contractor Requirements Document (CRD) establishes the requirements for Department of Energy (DOE) contractors, including National Nuclear Security Administration (NNSA) contractors, whose contracts involve the performance, management, oversight, or direct support of DOE (including NNSA) nuclear explosive operations (NEOs), nuclear explosive-like assemblies (NELAs), or NEO-associated activities.

Regardless of the performer of 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.

Attachments 2 through 6 of this directive must be included along with the CRD in all contracts that involve performing, managing, overseeing, or directly supporting NEOs, NELAs or NEO-associated activities.

NEOs require special consideration because of the consequences of an accident or unauthorized act. The Nuclear Explosive Safety (NES) program outlined in this CRD and in Attachments 2 through 6 supports the requirement that NEOs must be designed and conducted in a manner that meets the NES Standards of DOE O 452.1, current version.

All contractors with this CRD incorporated in their contracts must comply with the following requirements to support the NES Program.

1. General Nuclear Explosive Safety Rules (NESRs). Contractors must ensure that NEOs under their purview are designed and performed in a manner that satisfies the following General NESRs.

    a. Nuclear Explosive Safety Evaluation. NEOs must not be performed until a NES evaluation has been completed and findings indicating that a NES standard had not been met have been closed.

    b. Nuclear Explosive Operating Procedures. NEOs must be performed in accordance with approved, written procedures.

    c. One-Point Safety.

        (1) Tooling and equipment must be evaluated to ensure that their intended use on an NE certified to be one-point safe does not cause an NE or equipment configuration that is not one-point safe.

        (2) If it is determined that a nuclear explosive no longer meets the one-point safety criteria, all production plant operations (including assembly, disassembly, and onsite transportation) and offsite transportation with that nuclear explosive must be discontinued in a safe manner. Before

operations with that nuclear explosive can be resumed, a path forward must be developed, a NES evaluation must be completed, and findings indicating a NES standard has not been met must be closed.

d. Nuclear Explosive Areas (NEAs).

(1) Energy sources in NEAs must be identified and documented. Unauthorized energy sources must not be available in an NEA during NEOs.

(2) Ignition sources in NEAs must be identified and (1) eliminated or (2) minimized and controlled to prevent adverse interaction with combustible or flammable materials and the nuclear explosive.

(3) Combustible and flammable materials in NEAs must be identified and (1) eliminated or (2) minimized and controlled to prevent adverse interaction with the nuclear explosive.

e. Electrical Testing. Except as authorized in accordance with paragraph 1.f., Anomalous Units, nuclear explosives must not be subjected to:

(1) redundant electrical tests, or

(2) electrical troubleshooting (i.e., to confirm the existence of a fault or aid in fault isolation) except with authorized test equipment and procedures that have been subjected to a NES evaluation and found to be acceptable for the specific application.

Note: Repeat electrical tests performed in conformance with approved Nuclear Explosive Operating Procedures and separated by other actions that might alter test results are not considered redundant.

f. Anomalous Units.

(1) If it is determined that a nuclear explosive is no longer in a condition covered by an approved written procedure, all operations with that nuclear explosive and in the associated facility must be discontinued in a safe manner, resulting in a safe and stable nuclear explosive configuration.

(2) Restart of operations on an anomalous unit and other activities in the affected facility must be in accordance with paragraph 15. below.

2. Supplemental Nuclear Explosive Safety Rules. Contractors may propose supplemental NESRs to support specific tests, operations, or characteristics of a nuclear explosive.

3. Nuclear Explosive Safety Evaluations. Contractors must ensure that all NEOs under their purview are covered by an approved NES evaluation and request and support NES

evaluations as needed. NES evaluation requirements are specified in NNSA SD 452.2, *Nuclear Explosive Safety Evaluation Processes*, current version.

4. Human Factors.

   a. Elements of NEOs such as new procedures, processes, facility layouts, new tooling and equipment, must incorporate human factors principles during the NEO design and development phase and maintained throughout the lifecycle of the NEO. Existing NEOs should strive to meet human factors principles to the extent possible.

   b. When developing NEOs, the contractor must consider the application of established research in human factors and ergonomics, including human-system interface design, human cognition and perception, stress and workload, anthropometry and workspace design, environmental factors, training, and human error.

5. Procedures.

   a. Contractors responsible for NEOs and NEO-associated activities and facilities must follow approved written procedures (paper or electronic) for all NEOs to control interactions among the nuclear explosive, the operating facility, equipment, and personnel.

   b. Contractors must ensure design agency concurrence with original issues of procedures for NEOs and NEO-associated activities.

   c. Contractors must ensure NEO procedures place the proper emphasis on preventing accidents and detecting abnormal conditions by accomplishing the following:

      (1) comply with design specifications and technical requirements,

      (2) clearly state cautions and warnings,

      (3) identify appropriate points to safely interrupt work, and

      (4) include generic contingency procedures directed toward quickly achieving a safe and stable nuclear explosive configuration to be applied in response to all unexpected situations not covered by other written procedures.

6. Two-Person Concept. Contractors responsible for NEOs and NEO-associated activities and facilities (including NELA verifications as specified in Attachments 4 and 5 of this Order) must establish and implement the two-person concept in accordance with Attachment 2 of this Order.

7. Facilities. Contractors must ensure that facilities used for NEOs are characterized, evaluated, and specifically approved for that use, based (in part) on an independent NES

evaluation in accordance with NNSA SD 452.2, *Nuclear Explosive Safety Evaluation Processes*, current version.

During NES evaluations of facilities, safety structures, systems, and components (SSCs) can be considered to credibly control natural phenomenon hazards (NPH) if they meet the appropriate NPH design categories found in DOE-STD-1020, current version, as invoked by DOE O 420.1, *Facility Safety*, current version.

8. Equipment. Contractors responsible for NEOs and NEO-associated activities and facilities must ensure that all equipment used in NEAs (including tooling, testers, and other mechanical and electrical equipment) meet the following requirements.

   a. Design specifications and technical requirements must be documented.

   b. Designs must ensure that the nuclear explosive remains in a safe condition should a system or component of the equipment fail.

   c. Each item used in a NEO must be specifically approved for that operation. Unapproved movable items must be excluded from the NEA. Positive measures must be used to prevent use of facility equipment that is not approved for the NEO and is impracticable to remove.

   d. Equipment intended to apply energy to a nuclear explosive must incorporate features that limit application of energy to a known safe level.

   e. Energy sources associated with equipment used in NEAs must be identified, analyzed, characterized, and documented. Engineered controls relied upon to protect NEs from these energy sources must be validated through analysis and testing.

   f. Energetic equipment intended for use in NEAs by emergency responders (e.g., fire department personnel, security force, and radiological protection) must be evaluated and characterized with respect to potential hazards. Training of expected responders and NEA workers must address emergency situations to help ensure safety of responders and associated equipment.

   g. Attachment 3 of this Order specifies additional requirements for electrical equipment used in NEAs.

9. Maintenance of Facilities, Tooling, and Other Equipment. Contractors responsible for NEOs and NEO-associated activities and facilities must review maintenance programs and activities for impact on NES. Maintenance implementation plans must include a detailed description of maintenance activity control and approval, including limitations on equipment and materials that are allowed in NEAs.

10. Personnel. Contractors responsible for, or involved in, NEOs and NEO-associated activities must implement training, qualification, and certification programs for personnel that manage, oversee, perform, or directly support these operations and activities.

In addition to the applicable requirements in 10 CFR Part 712, *Human Reliability Program*, and DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*, current version, contractors must provide annual training for personnel assigned to nuclear explosive duty that includes the following NES-specific topics:

a. Responsibilities associated with custody of nuclear explosives.

b. Use of general and supplemental NESRs and Immediate Action Procedures.

c. Site-, facility-, program- and operation-specific safety requirements.

d. The purpose, objective, and responsibilities of the two-person concept for operations.

e. Explosive safety appropriate for assigned responsibilities.

For site-, facility-, program-, and operation-specific safety requirements, the annual training requirements under paragraph 10.c. above may be met with training provided during an initial certification or qualification program and through a continued recertification or requalification process, provided that the process requires no less than an annual review or demonstration of the knowledge of the safety requirements.

11. Transportation of Nuclear Explosives. Nuclear explosive transportation is a mobile NEO and involves a mobile NEA. Requirements specified for NEOs and NEAs elsewhere in this CRD apply.

a. Contractors responsible for NEOs and NEO-associated activities and facilities must establish requirements and procedures to ensure safe onsite transportation of nuclear explosives.

b. Transportation operations and shipping configurations, including all items in a conveyance, are subject to the NES evaluation requirements of paragraphs 1.a. and 3. of this CRD.

(1) Contractors must ensure nuclear explosives are transported in conveyances specifically reviewed and approved through the NES evaluation process.

(2) Contractors must ensure appropriate criteria are established for protecting nuclear explosives during transportation. Contractors must ensure the criteria and restraint designs for specific nuclear explosive configurations are reviewed and approved through the NES evaluation process.

12. Mixed Venues. Contractors responsible for NEOs must not transport or stage nuclear explosives with any other assembly that could be mistaken for a nuclear explosive.

If operational constraints require nuclear explosives and nuclear explosive-like assemblies (NELAs) to be collocated, the operations must comply with the NELA

standards in paragraph 17 of this attachment and must be evaluated by a Nuclear Explosive Safety Study Group (NESSG). The operational justification for collocation of the nuclear explosives and NELAs will be provided to the NESSG during the evaluation.

13. Positive Verification.

a. Contractors responsible for NEOs and NEO-associated activities and facilities must develop and implement a verification process to ensure use of qualified personnel who are fit for duty, operationally ready facilities, correct equipment that is current in any required calibration and preventive maintenance, and current approved procedures.

b. Contractors must ensure the configuration and condition of a nuclear explosive and its safety features are determined as early as practicable during any planned NEO. For operations occurring prior to this determination, or in the event a determination cannot be made, incompatibility with or isolation from external energy that may lead to credible NES consequences must be demonstrated.

14. Change Control. Contractors responsible for NEOs and NEO-associated activities and facilities must establish and implement a NES change evaluation process in accordance with NNSA SD 452.2, current version. This NES evaluation is separate and independent from the unreviewed safety question (USQ) process required by 10 CFR Part 830, *Nuclear Safety Management*, and must be completed before approval and implementation of the change.

Contractors must ensure that their change control process captures all proposed changes to approved NEOs, including the following:

a. Proposals that may have direct NES implications (e.g., procedural, equipment, or facility changes to an approved NEO).

b. Proposals that may have indirect NES implications (e.g., changes or new activities that could impact the foundation established by previous NES Master Studies).

c. Changes in knowledge affecting an approved NEO (e.g., new understanding of a potential threat to NES or new data regarding the response of a nuclear explosive to a stimulus).

15. Anomalous Unit Processing. An anomalous unit might be created or discovered in the course of NEOs performed by NNSA or its contractors, or might be received from the Department of Defense (DOD) in a known anomalous condition.

Contractors must support the Office of Secure Transportation (OST) NEO change control process to ensure anomalous units accepted for transport are safe to ship and that any special handling, receiving, or staging requirements are known and accepted in advance by the receiving organization.

The following apply to anomalous units at the production agency:

a. The production agency Process Engineer, production agency NES representative, and design agency System Engineer collectively have the authority to declare a unit anomalous. If the three cannot agree that the unit in question is not anomalous, then the unit will be treated as anomalous. The design agency System Engineer should solicit input from their respective design agency NESSG member(s) prior to making an anomalous unit determination.

b. Before operations with the anomalous unit can be resumed, the NEO change control process must be completed in accordance with paragraph 14. A design agency engineering release must be developed as input to the change control process.

(1) The responsible design agencies, to include a NESSG-certified member from the design agency, must specifically review the engineering release for impact on NES. This review must be documented in the engineering release.

(2) Transportation operations, if applicable, must be specifically addressed in the engineering release. Offsite transportation operations are subject to the Office of Secure Transportation NEO change control process.

c. A decision to resume other activities in the facility must include consideration of possible interactions with the anomalous unit.

d. If additional information is obtained after a unit has been declared anomalous (e.g., from a radiograph), the new information shall be evaluated to determine if the unit should remain anomalous.

16. Configuration Management. Contractors responsible for NEOs and NEO-associated activities and facilities must develop and implement a configuration management program incorporating elements applicable to NEOs and NEO-associated activities and facilities. To ensure consistency with design requirements and the safety basis, the configuration management program must include the following:

a. the physical configuration of a nuclear explosive and its components; the tooling, equipment, and procedures used in NEOs and NEO-associated activities; and the interface with the facilities in which these operations and activities are conducted;

b. unique identification of special tooling and equipment used in NEOs;

c. positive identification of tooling and equipment requiring calibration or testing within a calibration or testing control program; and

d. incorporation of approved changes into all affected documents (including design documents, drawings, procedures, and safety basis documents) and programs (including maintenance and training).

17. Nuclear Explosive-Like Assemblies (NELAs).

a. Nuclear Explosive-Like Assembly Standards. Contractors responsible for NELA operations must ensure those operations meet the following qualitative NELA standards.

(1) There must be positive measures to prevent inadvertent or unauthorized assembly of a nuclear explosive in place of a NELA configuration.

(2) There must be positive measures to prevent inadvertent or unauthorized transfer of a nuclear explosive in place of a NELA configuration.

In the context of these NELA Standards, the term *prevent* is applied as described for the Nuclear Explosive Surety Standards in DOE O 452.1, current version.

b. Contractors responsible for NELA operations must make NELA determinations in accordance with the criteria in Attachment 4 of this directive. If a NELA has been determined to exist based on the requirements in Attachment 4, this determination must be documented and retained by the determining authority. Organizations with a NEO mission that are responsible for NELA operations must implement the NELA requirements in Attachment 4 of this directive. Organizations without a NEO mission that are responsible for NELA operations must implement the NELA requirements in Attachment 5 of this directive.

18. Marking Instructions. Nuclear explosives and NELAs must be marked to distinguish configurations capable of a nuclear explosive detonation from those that are not. Contractors responsible for NEOs or NELA operations must permanently mark nuclear explosives and NELAs in accordance with the instructions in Attachment 6 of this directive.

19. Records. Contractors must maintain records (documentation) in accordance with National Archives and Records Administration-approved DOE or site-specific records retention and disposition schedules (See CRD to DOE O 243.1, *Records Management Program*, current version).

ATTACHMENT 2:
TWO-PERSON CONCEPT REQUIREMENTS

Note: This Attachment applies to both Federal and contractor organizations.

1. BASIC REQUIREMENTS. The two-person concept (TPC) is implemented to ensure no lone individual has unrestricted access to a nuclear explosive. A TPC team must be in the nuclear explosive area (NEA) when a nuclear explosive is not protected by a dual-lock system or other Nuclear Explosive Safety Study Group (NESSG)-evaluated security system. The TPC is also required for Category 1 electrical equipment as specified in Attachment 3, paragraph 2.c., of this Order and for certain nuclear explosive-like assembly (NELA) verification and assembly steps as specified in Attachment 4, paragraph 4., of this Order. National Nuclear Security Administration (NNSA) field element offices may also require TPC protection for other operations or equipment.

   Each person on a two-person concept team must:

   a. be certified in the Human Reliability Program,

   b. have authorized access to the NEA,

   c. have technical knowledge of the task being performed,

   d. be knowledgeable of pertinent safety and security requirements, and

   e. be in a position to detect incorrect or unauthorized acts and take appropriate action.

2. IMPLEMENTATION OPTIONS. The two-person concept may be implemented using either zone coverage or person-to-person coverage.

   a. Zone Coverage. Zone coverage is a term used to identify two-person concept implementation that meets the basic requirements of paragraph 1. without the additional requirements specified to protect configurations that require person-to-person coverage.

   b. Person-to-Person Coverage. Person-to-person coverage is the more stringent form of the two-person concept. Person-to-person coverage is designed to protect configurations that are particularly vulnerable to inadvertent acts (errors of omission or commission) or deliberate unauthorized acts.

      (1) Configurations requiring person-to-person coverage include the following:

         (a) Exposed conventional high explosive (CHE) main charge in an NEA.

(b) Main charge high explosives (HEs), both CHE and insensitive high explosive (IHE), with accessible detonator cable assemblies in an NEA.

(c) Nuclear explosives connected to Category 1 electrical equipment. (Category 1 electrical equipment is described in Attachment 3, paragraph 2., of this Order.)

(2) In addition, configurations requiring person-to-person coverage may be determined based on specific system characteristics. The application of person-to-person coverage allows recognition of the protection provided by design features (such as IHE, coded-signal-controlled detonators, and unique-signal-operated strong-link devices) and physical protection (such as closed shipping and storage containers and specially designed covers).

3. WHEN TO APPLY PERSON-TO-PERSON COVERAGE.

a. Assembly and Disassembly Operations Involving CHE Main Charge.

(1) For assembly operations involving CHE main charge, person-to-person coverage of the CHE components must begin when the CHE container is opened in an NEA.

(2) Coverage continues until the nuclear explosive is in a configuration in which the application of design-specific environmental stimuli or unique or coded signals is necessary for nuclear explosive detonation or detonation of the main charge HE.

(3) For disassembly operations, this requirement applies in reverse.

b. Assembly and Disassembly Operations Involving IHE Main Charge.

(1) For assembly operations involving IHE main charge, person-to-person coverage must be provided for main charge components located in an NEA, and assemblies containing these components that have accessible detonator cables attached.

(2) Coverage must continue until the nuclear explosive is in a configuration in which the application of design-specified environmental stimuli or unique or coded signals is necessary for nuclear explosive detonation or detonation of the main charge HE.

(3) For disassembly operations this requirement applies in reverse.

c. For purposes of person-to-person coverage, systems with installed and unactuated (safe or reset) mechanical safe and arm detonators are not considered to have accessible detonator cables. Configurations with physical protection that precludes immediate and unrestricted access to the configuration by a lone

individual are not considered to be exposed. When such physical protection is in place, zone coverage provides adequate protection for configurations that would otherwise require person-to-person coverage.

4. HOW TO APPLY PERSON-TO-PERSON COVERAGE. When a configuration requires person-to-person coverage, a qualified two-person concept team must be either working on or controlling access to the configuration. Specific person-to-person coverage requirements are as follows.

   a. Lone individuals must not be allowed within the immediate vicinity (approximately six feet) of a configuration that requires person-to-person coverage.

   b. The two people providing person-to-person coverage must each be responsible for the safe conduct of the operations.

   c. During the performance of operations on a configuration requiring person-to-person coverage:

      (1) the two-person concept team must be in the immediate vicinity of the configuration;

      (2) each person on the two-person concept team must observe all operations, ensure that only authorized operations are performed, and ensure that operations are performed correctly; and

      (3) a reader-worker process that includes the following must be incorporated.

         (a) The procedure must be read aloud, the operation must be performed, and the completion of the operation must be documented in the stated sequence.

         (b) One of the two people performing the operation may read the procedure aloud provided that both people can move away from the immediate vicinity of the configuration while the reading is accomplished.

         (c) If both people cannot move away from the immediate vicinity of the configuration while the reading is accomplished, then a third person must read the procedure aloud.

      (4) Based on an approved NES evaluation, other means to achieve the person-to-person coverage objective may be authorized.

   d. When operations are not being performed on a configuration requiring person-to-person coverage:

(1) the two-person concept team must be in the immediate vicinity of the configuration when another individual is in the immediate vicinity of the configuration.

(2) the two-person concept team is not required to be in the immediate vicinity of the configuration when other individuals are not in the immediate vicinity of the configuration. However, team members must remain in a position to directly observe the approach of any individual to the configuration.

e. Only one configuration requiring person-to-person coverage is allowed in a vacated bay or cell. This requirement does not apply to emergency evacuations.

ATTACHMENT 3
ELECTRICAL EQUIPMENT REQUIREMENTS

Note: This Attachment applies to both Federal and contractor organizations.

1. BASIC REQUIREMENTS. For purposes of defining electrical equipment requirements, this Order categorizes electrical equipment used in nuclear explosive areas (NEAs) as Category 1, Category 2, or Category 3. Electrical equipment categorization is intended to ensure that controls are implemented commensurate with the various levels of potential electrical threat.

   As used in this Attachment, a high explosive (HE) subassembly is defined to be a main charge HE component with at least one detonator attached.

2. CATEGORY 1 ELECTRICAL EQUIPMENT. Electrical equipment intended for connection to an electrical circuit of a nuclear explosive or main charge HE subassembly is referred to as Category 1 electrical equipment. Category 1 electrical equipment must be clearly identified and meet the following minimum requirements.

   a. General Requirements.

      (1) Each item of Category 1 electrical equipment must have safety features independent of the nuclear explosive's safety features.

      (2) Category 1 electrical equipment must have a safety requirements document that identifies the safety features.

      (3) Category 1 electrical equipment must use the lowest values of internal and output currents and voltages required to perform the function(s) and be documented and justified.

      (4) Category 1 electrical equipment must not apply unacceptable stimuli or electrical energy in excess of its design limits as the result of a single-point failure.

      (5) Each item of Category 1 electrical equipment and its interface with a nuclear explosive require the performance and documentation of a comprehensive safety analysis, including consideration of relevant abnormal environments.

      (6) NES evaluations:

         (a) A NES evaluation of Category 1 electrical equipment and its interface with a nuclear explosive is required prior to its implementation in a nuclear explosive operation.

         (b) A NES evaluation is required prior to changing approved Category 1 electrical equipment.

Note: Approved Category 1 electrical equipment is under formal NES change control and authorized for use in an NEO.

(7) Procedures must be established to operate, control, calibrate, maintain, and store Category 1 electrical equipment.

(8) A record of approved Category 1 electrical equipment must be established and maintained. The record must identify each item of Category 1 electrical equipment by its unique designation or part number and associate it with the nuclear explosives for which it is authorized and the NES evaluations that examined its specific applications.

(9) Category 1 electrical equipment shall incorporate engineered tamper indication features. These features shall be inspected prior to each use, to include calibration and maintenance.

b. Computer-Controlled Electrical Equipment.

(1) When software is used to achieve the safe state of the unit under test, a separate (non-software) means of verification must also be employed to verify the safe state of the unit. Verification must be done before relying on the safe state of tested components.

(2) If software is used to evaluate the safe state of a unit, a separate independent means of verification must also be employed to verify the safe state of the unit. If a separate means of verification is not feasible, other Nuclear Explosive Safety Study Group (NESSG)-evaluated positive measures must be incorporated to ensure the electrical equipment is performing as intended immediately before and after a test.

(3) Category 1 electrical equipment must be designed such that software is incapable of causing bypass of any safety feature of the electrical equipment.

(4) Software failure must not compromise the safety attributes of the equipment or unit under test.

(5) A formal software safety analysis is required to document compliance with the requirements in paragraphs 2.b.(3) and 2.b.(4).

(6) Software and firmware shall be developed, tested, installed, and updated using secure processes to guarantee functionality and minimize the risk of alteration.

(7) Software and firmware attributes shall be verified prior to each use.

c. Two-Person Concept (TPC). Category 1 electrical equipment requires two-person concept protection. (The TPC is delineated in Attachment 2 of this Order.)

(1) Person-to-person coverage is required during calibration and all operations that afford internal access to Category 1 electrical equipment and associated cables and adapters, and while Category 1 electrical equipment is connected to a nuclear explosive.

(2) Zone coverage is required for fully assembled Category 1 electrical equipment and associated cables and adapters when that equipment is not protected by a dual-lock system or other NESSG-evaluated security system.

3. CATEGORY 2 ELECTRICAL EQUIPMENT. Electrical equipment that is not intended for connection to an electrical circuit of a nuclear explosive or HE subassembly, but makes mechanical connection to, or could come in contact with, a nuclear explosive or HE subassembly, is referred to as Category 2 electrical equipment. Category 2 electrical equipment must be clearly identified and meet the following minimum requirements.

a. General Requirements.

(1) Category 2 electrical equipment must not be intentionally connected to the electrical circuitry of a nuclear explosive or HE subassembly.

(2) Category 2 electrical equipment must be positioned in a manner to preclude contact with a nuclear explosive or HE subassembly except when a mechanical connection is required to perform its intended and authorized function.

(3) The potential for inadvertent connection between the Category 2 electrical equipment and the nuclear explosive circuitry must be minimized.

b. Positive Electrical Isolation. Positive electrical isolation must be established and demonstrated for Category 2 electrical equipment that makes a mechanical connection to a nuclear explosive or main charge HE subassembly. Electrical isolation must account for both normal and credible abnormal conditions (such as equipment faults or lightning strikes). The electrical isolation scheme used must be clearly identified and documented (including the technical basis for the "defined safe value" used in 3.b.(1) and 3.b.(2) below) using one of the following subcategories, listed in priority order.

(1) Path-on isolation reducing leakage or fault current from electrical energy sources associated with the equipment to a defined safe value. This must be verified annually.

(2) Path-off isolation reducing leakage or fault current from electrical energy sources associated with the equipment to a defined safe value. This must be verified annually.

(3) An electrical isolation scheme requiring at least two independent failures before exposing the nuclear explosive to unacceptable leakage or fault current from electrical energy sources associated with the equipment. Each failure mechanism must be identified.

c. Records. A record of approved Category 2 electrical equipment must be established and maintained. The record must identify each item of Category 2 electrical equipment by its unique designation or part number and associate it with the nuclear explosive operations for which it is authorized.

4. CATEGORY 3 ELECTRICAL EQUIPMENT. Moveable and facility electrical equipment used in an NEA that is not intended for connection to an electrical circuit of a nuclear explosive or HE subassembly and does not make mechanical connection to, and cannot come in contact with, a nuclear explosive or HE subassembly is referred to as Category 3 electrical equipment.

5. NES EVALUATIONS AND CHANGE CONTROL. Electrical equipment used in NEAs and proposed changes to electrical equipment, procedures, and interfaces with a nuclear explosive are subject to the NES evaluation and NEO change control processes required by this Order and detailed in NNSA SD 452.2, *Nuclear Explosive Safety Evaluation Processes,* current version.

Design agency documents which specify general design and process requirements for Category 1 electrical equipment used on nuclear explosives (e.g., DG10001 and EP401075) are subject to NES evaluation (i.e., during applicable evaluations such as the Approved Equipment Program Master Study). Changes to these documents must be concurred on by each design agency NES organization. This concurrence must be documented in an engineering authorization. However, each change does not require formal NESSG review.

ATTACHMENT 4
NUCLEAR EXPLOSIVE-LIKE ASSEMBLY (NELA) REQUIREMENTS FOR SITES WITH A NUCLEAR EXPLOSIVE OPERATION (NEO) MISSION

Note: This Attachment applies to both Federal and contractor organizations. The following requirements support the NELA standards defined in paragraph 4.a.(17)(a) of this Order and paragraph 17.a. of the CRD (Attachment 1 of this Order).

1. NUCLEAR EXPLOSIVE-LIKE ASSEMBLY DETERMINATIONS.

   a. All new NELA determinations must be documented, justified, and auditable.

   b. Where practicable, determinations should be made as early in the project planning stages as possible (e.g., design).

2. NUCLEAR EXPLOSIVE-LIKE ASSEMBLY DESCRIPTION. A NELA may exist at any level of assembly from one representing a basic nuclear explosive configuration (HE and pit) up to and including one representing a fully assembled weapon configuration (e.g., mock primary, trainer, Joint Test Assembly, etc.).

   All NELAs have the following two attributes:

   a. A NELA resembles a nuclear explosive in the U.S. nuclear weapons stockpile (past, present, or planned) to the degree that it can be mistaken for a nuclear explosive without any disassembly.

   b. A NELA lacks main charge high explosive (HE) (or propellant), primary fissile material, or both.

3. NUCLEAR EXPLOSIVE-LIKE ASSEMBLY TYPES. There are three types of NELAs:

   a. A High Explosive NELA contains live HE main charge and dummy pit, void, or other non-nuclear items in place of the live pit.

   b. An Inert-with-Live-Pit NELA contains a live pit and mock HE, void, or substitute non-explosive material in place of the main charge.

   c. An Inert NELA contains mock HE, void, or substitute non-explosive material in place of the main charge and a dummy pit, void, or other non-nuclear items in place of the live pit.

4. VERIFICATION OF NUCLEAR EXPLOSIVE-LIKE ASSEMBLY COMPONENTS BEFORE ASSEMBLY.

   a. High Explosive NELAs. Verification requirements of this section are not necessary for NELA configurations for which physical dimensions preclude substitution of a live pit.

(1) High-Fidelity Dummy Pit Verification Requirements.

(a) Before assembly into a high explosive NELA, the high-fidelity dummy pit must be examined by radiation detection means to verify the absence of radioactive material. If radiation is detected, the pit must be assayed using gamma spectrometry to verify the absence of fissile material. This verification must be either performed or observed by a two-person concept team.

(b) After dummy pit verification, the pit must be controlled until the pit is assembled into the basic NELA configuration. This control must be achieved by a two-person concept team, a dual-lock, or other Nuclear Explosive Safety Study Group (NESSG)-evaluated security system.

(c) An auditable record of radiation detection verification of the high-fidelity dummy pit must be available.

(2) Main Charge High Explosive Introduction Sequence. The high-fidelity dummy pit verification must be accomplished before introduction of the main charge HE and dummy pit into the same immediate assembly area of the high explosive NELA.

b. Inert-with-Live-Pit NELAs. A two-person concept team is required to perform all assembly and disassembly operations on Inert-with-Live-Pit NELAs.

(1) Mock High Explosive Verification Requirements.

(a) All mock HE used in place of live main charge HE must be non-detonable and must be clear or colored pink. Clear mock HE refers to LEXAN or a similar inert substance and does not require chemical verification. Where possible, preference must be given to noncombustible formulations. Live main charge HE must not be colored pink.

(b) Each pink mock HE main charge used in place of live main charge HE must be chemically verified before assembling the NELA.

(c) An auditable record of chemical verification of the mock HE must be available.

(2) Mock High Explosive Two-Person Concept Verification Requirements.

(a) In addition to the mock HE verification requirements, another chemical verification of each pink mock HE main charge used in place of live main charge HE must be accomplished before

assembly into an Inert-with-Live-Pit NELA. This verification must be either performed or observed by a two-person concept team.

(b) After the mock HE two-person concept verification, the mock HE must be controlled until the mock HE is assembled into the basic NELA configuration. This control must be achieved by a two-person concept team, a dual-lock, or other NESSG-evaluated security system.

(c) An auditable record of two-person concept chemical verification of the mock HE must be available.

(3) Live Pit Introduction Sequence. The mock HE verifications required by paragraphs 3.b.(1) and 3.b.(2) must be accomplished before introduction of the live pit and mock HE into the same immediate assembly area of the Inert-with-Live-Pit NELA.

c. Inert NELAs. Repetition of verification requirements of this section is not necessary for repeated disassembly and reassembly training operations provided the mock HE and high-fidelity dummy pit remain in a training area where main charge HE and live pits are not authorized.

Verification requirements of this section are not necessary for NELA configurations for which physical dimensions preclude substitution of live main charge and pit components.

(1) Mock High Explosive Verification Requirements.

(a) All mock HE used in place of live main charge HE must be non-detonable and must be clear or colored pink. Clear mock HE refers to LEXAN or similar inert substances and does not require chemical verification. Where possible, preference must be given to noncombustible formulations. Live main charge HE must not be colored pink.

(b) Each pink mock HE main charge used in place of live main charge HE must be chemically verified before assembling the NELA.

(c) An auditable record of chemical verification of the pink mock HE must be available.

(2) High-Fidelity Dummy Pit Verification Requirements.

(a) Before assembly into an Inert NELA, the high-fidelity dummy pit must be examined by radiation detection means to verify the absence of radioactive material. If radiation is detected, the pit must be assayed by using gamma spectrometry to verify the

absence of fissile material. This verification must be either performed or observed by a two-person concept team.

(b) After dummy pit verification, the pit must be controlled until the pit is assembled into the basic NELA configuration or until the pit is delivered into an assembly area where live pits are not authorized. This control must be achieved by a two-person concept team, a dual-lock, or other NESSG-evaluated security system.

(c) An auditable record of radiation detection verification of the high-fidelity dummy pit must be available.

5. ASSEMBLY AND DISASSEMBLY OF NELAs. NELAs must not be assembled or disassembled in close proximity (i.e., the same immediate assembly or disassembly area) to other activities where components (e.g., main charge HE hemispheres or pits) could be interchanged. This prohibition includes collocated assembly/disassembly of the following:

a. Any NELA type and a nuclear explosive.

b. Any NELA type and a different NELA type.

6. OFFSITE TRANSPORTATION OF NUCLEAR EXPLOSIVE-LIKE ASSEMBLIES. NELAs considered materials of national security interest must follow the packaging and transportation requirements of Department of Energy (DOE) Order (O) 461.1C, *Packaging and Transportation for Offsite Shipment of Materials of National Security Interest*. Additional requirements apply in Sections 6.a. through 6.e. of this Attachment.

a. Inert-with-Live-Pit NELA Transfer Restriction. A configuration assembled as an Inert-with-Live-Pit NELA must not be transferred to the custody of the Department of Defense.

b. Identification Requirements. NELAs that are shipped between DOE sites must be identified externally (e.g., stencil or tag) with the following information.

(1) NELA contents identified as one of the following:

(a) High Explosive NELA.

(b) Inert-with-Live-Pit NELA.

(c) Inert NELA.

(2) Name and agency of responsible person at the shipping location.

(3) Name and agency of person who authorized the shipment at the receiving location.

c. Permission to Ship Between NNSA Sites. The shipping agency must obtain permission to ship from the receiving agency before shipment of a NELA.

d. NELA Survey Before Offsite Transport.

(1) Before offsite transfer of a NELA, the NELA must be surveyed in its shipping configuration by radiation detection means to verify the absence or presence of fissile material. Anomalies or ambiguities found by radiation detection means must be resolved before shipment.

(2) An auditable record of this survey must be available.

e. NELA Survey Upon Receipt.

(1) Upon receipt of a NELA, the NELA must be surveyed in its shipping configuration by radiation detection means to verify the absence or presence of fissile material. Anomalies or ambiguities found by radiation detection means must be resolved before release.

(2) An auditable record of this survey must be available.

ATTACHMENT 5
NUCLEAR EXPLOSIVE-LIKE ASSEMBLY (NELA) REQUIREMENTS FOR SITES WITHOUT A NUCLEAR EXPLOSIVE OPERATION (NEO) MISSION

Note: This Attachment applies to both Federal and contractor organizations at sites without a NEO mission. The following requirements support the NELA standards defined in paragraph 4.a.(17)(a) of this Order and paragraph 17.a. of the CRD (Attachment 1 of this Order). When a mock primary, comprised of mock HE and/or high fidelity dummy pit, is not considered a NELA but will be assembled into a higher-level assembly that is treated as a NELA, the agency responsible for assembling the mock primary must provide the mock component verification record(s) to the agency responsible for assembling the higher-level NELA. If the mock primary lacks mock components, justification for a lack of verification record(s) must be provided from the originating agency in the form of auditable documentation.

1. NUCLEAR EXPLOSIVE-LIKE ASSEMBLY DETERMINATIONS.

   Attachment 4, Paragraph 1. applies.

2. NUCLEAR EXPLOSIVE-LIKE ASSEMBLY DESCRIPTION.

   Attachment 4, Paragraph 2. applies.

3. NUCLEAR EXPLOSIVE-LIKE ASSEMBLY TYPES.

   Attachment 4, Paragraph 3. applies.

4. VERIFICATION OF NUCLEAR EXPLOSIVE-LIKE ASSEMBLY COMPONENTS BEFORE ASSEMBLY. Verification requirements of this section are not necessary for NELA configurations for which physical dimensions preclude substitution of a live pit.

   a. High Explosive NELAs.

      (1) Assembly in a Facility NOT Authorized to Receive or Handle Live Pits. The high-fidelity dummy pit must be examined by radiation detection means to verify the absence of radioactive material before assembly into a High Explosive NELA. If radiation is detected, the pit must be assayed by using gamma spectrometry to verify the absence of fissile material.

      (2) Assembly in a Facility Authorized to Receive or Handle Live Pits.

         (a) The HE NELA verification requirements in Attachment 4, paragraph 4.a.(1) apply.

         (b) At non-NEO sites where the security system has not been evaluated by a Nuclear Explosive Safety Study Group (NESSG), the dual-lock program or other security system required for control of the dummy pit after verification must be reviewed by HQ

National Nuclear Security Administration (NNSA)/Nuclear Explosive Safety Division.

(3) Main Charge High Explosive Introduction Sequence. The high-fidelity dummy pit verifications required by paragraphs 4.a.(1) or 4.a.(2) (if required) must be accomplished before introduction of the main charge HE and dummy pit into the same immediate assembly area of the high explosive NELA.

b. Inert with Live Pit NELAs.

(1) Assembly in a Facility NOT Authorized to Receive or Handle Main Charge HE.

(a) All mock HE used in place of live main charge HE must be non-detonable and must be clear or colored pink. Clear mock HE refers to LEXAN or a similar inert substance and does not require chemical verification. Where possible, preference must be given to noncombustible formulations. Live main charge HE must not be colored pink.

(b) Each pink mock HE main charge used in place of live main charge HE must be chemically verified before assembling the NELA.

(c) An auditable record of chemical verification of the mock HE must be available.

(2) Assembly in a Facility Authorized to Receive or Handle Main Charge HE.

(a) The verification requirements in Attachment 4, Paragraphs 4.b.(1) and 4.b.(2) apply.

(b) A two-person concept team is required to perform all assembly and disassembly operations on Inert-with-Live-Pit NELAs.

(c) At non-NEO sites where the security system has not been evaluated by a NESSG, the dual-lock program or other security system required for control of the mock HE after verification must be reviewed by HQ NNSA/Nuclear Explosive Safety Division.

(3) Live Pit Introduction Sequence. The mock HE verifications required by paragraphs 4.b.(1) or 4.b.(2) (if required) must be accomplished before introduction of the live pit and mock HE into the same immediate assembly area of the Inert-with-Live-Pit NELA.

c. Inert NELAs. Repetition of verification requirements of this section is not necessary for repeated disassembly and reassembly operations provided the mock

HE and high-fidelity dummy pit remain in a controlled area where main charge HE and live pits are not authorized.

Verification requirements of this section are not necessary for NELA configurations for which physical dimensions preclude substitution of live main charge and pit components.

(1) Assembly in a Facility NOT Authorized to Receive or Handle Main Charge HE AND/OR Live Pits.

(a) All mock HE used in place of live main charge HE must be non-detonable and must be clear or colored pink. Clear mock HE refers to LEXAN or similar inert substances and does not require chemical verification. Where possible, preference must be given to noncombustible formulations. Live main charge HE must not be colored pink.

(b) Each pink mock HE main charge used in place of live main charge HE must be chemically verified before assembling the NELA.

(c) An auditable record of chemical verification of the pink mock HE must be available.

(d) The high-fidelity dummy pit must be examined by radiation detection means to verify the absence of radioactive material. If radiation is detected, the pit must be assayed by using gamma spectrometry to verify the absence of fissile material.

(2) Assembly in a Facility Authorized to Receive or Handle Main Charge HE AND/OR Live Pits.

(a) The verification requirements in Attachment 4, Paragraph 4,c, apply.

(b) At non-NEO sites where the security system has not been evaluated by a NESSG, the dual-lock program or other security system required for control of the dummy pit and mock HE after verification must be reviewed by HQ NNSA/Nuclear Explosive Safety Division.

5. ASSEMBLY AND DISASSEMBLY OF NELAs. For sites designated as meeting the protection requirements for Category III SNM, the assembly and disassembly restrictions in this paragraph do not apply.

NELAs must not be assembled or disassembled in close proximity (i.e., the same immediate assembly or disassembly area) to other activities where components (e.g.,

main charge HE hemispheres or pits) could be interchanged. This prohibition includes collocated assembly/disassembly of any NELA type and a different NELA type.

If operational constraints require an INERT and a LIVE PIT NELA to be collocated during assembly or disassembly, the operational justification must be provided for review and approval by HQ NNSA/Nuclear Explosive Safety Division.

6. OFFSITE TRANSPORTATION OF NUCLEAR EXPLOSIVE-LIKE ASSEMBLIES.

The requirements of Attachment 4, Paragraph 6. apply.

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ATTACHMENT 6
MARKING REQUIREMENTS

Note: This Attachment applies to both Federal and contractor organizations. Nuclear explosives and nuclear explosive-like assemblies (NELAs) must be permanently marked in accordance with the following requirements. Additional markings such as serial numbers and configuration identification may also be required by design agencies.

1. PERMANENT MARKING REQUIREMENTS FOR NELAs AT SITES WITHOUT A NUCLEAR EXPLOSIVE OPERATION (NEO) MISSION. NELAs at sites not authorized to conduct nuclear explosive operations (NEOs) that are staged or stored in a facility not authorized to introduce the missing component that would form a nuclear explosive (live main charge high explosive (HE), live pits, or both), and designated for irreversible destruction within 6 months of assembly, are not required to be permanently marked. Where practicable, temporary markings or identification such as tagging or stenciling should be applied to the configuration or container.

2. SITES ONLY REQUIRED TO MEET PROTECTION REQUIREMENTS FOR CATEGORY III SPECIAL NUCLEAR MATERIAL (SNM). NELAs at sites meeting the protection requirements for Category III SNM are not required to be permanently marked until the NELA is transferred offsite. Where practicable, temporary markings or identification such as tagging or stenciling should be applied to the configuration or container. Prior to offsite transfer, the permanent marking requirements of this Attachment, Paragraphs 3., 4., 5., and 6. apply.

3. PERMANENT MARKING LEGENDS.

   a. Nuclear Explosives. A "NUCLEAR" permanent marking legend must be applied to nuclear explosives (i.e., units containing a live pit and an HE main charge).

   b. Nuclear Explosive-Like Assemblies.

      (1) High Explosive NELAs. The "HIGH EXPLOSIVE" permanent marking is applied to a NELA containing live main charge HE and a dummy pit, void, or other non-nuclear items in place of the live pit.

      (2) Inert-with-Live-Pit NELAs. The "INERT-WITH-LIVE-PIT" permanent marking is applied to a NELA containing a live pit and mock HE, void, or substitute non-explosive material in place of the live main charge HE.

      (3) Inert NELAs. The "INERT" permanent marking is applied to a NELA containing mock HE, void, or substitute non-explosive material in place of the live main charge HE and a dummy pit, void, or other non-nuclear items in place of the live pit.

      Note: Using the permanent marking "INERT" or "INERT WITH LIVE PIT" does not preclude the presence of materials that may present a hazard to personnel.

4. PERMANENT MARKING LOCATION. Nuclear explosives and NELAs must be permanently marked on an external surface.

   a. The permanent marking must be on a part that encloses the live main charge or mock HE.

   b. The marking location must be specified by the applicable design agency.

5. PERMANENT MARKINGS. Nuclear explosives and NELAs must be marked in accordance with the following requirements. The particular marking method must be specified by the applicable design agency.

   a. The permanent marking method must produce the most durable mark possible, consistent with acceptable deleterious effect on the material to which the marking is applied.

      (1) The preferred marking methods are mechanical engraving (with or without fill) and impression-die stamping.

      (2) Other acceptable methods are impression freehand, impression sandblast, and surface conversion.

   b. The preferred marking size is ¼-inch characters with ¼-inch spacing between lines, if space permits.

6. PERMANENT MARKING OBLITERATION. When a nuclear explosive or NELA is altered or disassembled to the point that its permanent marking is no longer valid, the permanent marking must be obliterated in accordance with the following requirements.

   a. Methodology.

      (1) The preferred method of obliteration is overprinting the letter "X" on each letter of the permanent marking legend using the same permanent marking method as that used to apply the original marking.

      (2) If obliteration by overprinting is not feasible for technical reasons, the permanent marking must be removed using a method specified by the applicable design agency.

   b. Components That Will Be Reassembled. Permanent marking need not be obliterated on marked components that will be reassembled into the same configuration in accordance with the following requirements.

      (1) After the marked component is removed, the disassembled components must be controlled until the disassembled components and marked component are reassembled into the same configuration.

(2) Prior to final assembly of a nuclear explosive or NELA, verification of the permanent marking(s) shall be performed and documented by two human reliability program (HRP)-certified personnel. Dual (or concurrent) verification is acceptable.

Positive measures must be in place to ensure that NELA permanently marked components are not inadvertently introduced into areas where nuclear explosive assembly or disassembly operations are ongoing.