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DOE STANDARD

Safety Functions and Other Features of Lethal Activated Denial Systems

U.S. Department of Energy
Washington, D.C. 20585

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TABLE OF CONTENTS

U.S. Government agencies and their contractors may obtain the complete OUO standard from:

- The Security Technology Information Archive by contacting Jason Morrow at 865-241-6616 or morrowj@ornl.gov; or
- The Security Technology Program, DOE Office of Health, Safety and Security by contacting Lynne Preston at 301-903-2627 or lynne.preston@hq.doe.gov.

FOREWORD

This Department of Energy (DOE) Standard is for use by all DOE elements.

Beneficial comments (recommendations, additions, and deletions) and any pertinent data that may improve this document should be mailed to the U.S. Department of Energy; Office of Health, Safety and Security; Office of Technology, GTN/HS-82; 1000 Independence Ave., SW; Washington, DC 20585-1290 or e-mailed to lynne.preston@hq.doe.gov. Please use the Document Improvement Proposal form (DOE F 1300.3) appearing at the end of this document.

DOE technical standards do not establish requirements. However, all or part of the provisions in this standard can become requirements under the following circumstances:

(1) They are explicitly stated to be requirements in a DOE requirements document (e.g., a purchase requisition); or

(2) The organization makes a commitment to meet a standard in a contract, implementation plan, or program plan.

Throughout this standard, the word "shall" is used to denote actions that are required if the objectives of this standard are to be met. If the provisions in this standard are made requirements through one of the two ways discussed above, then the "shall" statements would become requirements. Goals or intended functionality are indicated by "will," "may," or "should." It is not appropriate to consider that "should" statements would automatically be converted to "shall" statements as this action would violate the consensus process used to approve this standard.

This standard was prepared following requirements for due process, consensus, and approval as required by the DOE Standards Program. Consensus is established when substantial agreement has been reached by all members of the writing team and the standard has been approved through the DOE directives approval process (REVCOM). Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

When the writing team reached substantial agreement that this document should be submitted for approval as a DOE standard, it included the following members:

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1 SCOPE AND PURPOSE

This standard establishes the minimum safety functions and features of lethal activated denial systems necessary for authorized deployment at U.S. Department of Energy sites, including the National Nuclear Security Administration facilities. These requirements are intended to improve the safety, reliability, and ease of use of these systems; they may also improve the performance of these systems. The intent is to communicate common requirements to vendors and users of these systems, so as to ease safety review.

This standard applies to lethal activated denial systems employed to incapacitate or neutralize all persons entering a protected space. The intent is to prevent adversary access to critical systems or assets, or to quickly defeat an adversary who has gained access, while minimizing damage to property and the environment. These systems may be activated to protect a space upon determination that an adversary attack is probable.

The overall philosophy for safety of a lethal activated denial system is:

- No single action, person, or event can cause inadvertent release of lethal energies, agents, or projectiles (e.g., poisonous gases, electricity, air overpressure).
- Systems shall be designed so that system safety analysis shows that probability of inadvertent exposure per year to lethal energies, agents, or projectiles is less than 10^{-6}.
- 10 CFR 1047.7 authorizes DOE protective force officers to employ deadly force only when all lesser means have failed or cannot reasonably be employed. Lethal denial systems shall not be used as standalone protection elements, but shall only be used to supplement other protection systems.
- Lethal denial systems shall not be employed except by the deliberate act of a person authorized to employ deadly force. (DOE M 470.4-3A, Attachment 1, Appendix A “Guidelines for Legal Authority, Fresh Pursuit, and Rules of Engagement,” provides guidance regarding the use of deadly force.)
- A minimum of three separate operator actions shall be required for release of lethal energies, agents, or projectiles.

2 APPLICABILITY

It is recommended that DOE sites use this standard as one of the required elements of a purchase requisition.

The use of this standard is voluntary; its existence does not in any respect preclude anyone from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard. Should a manufacturer or vendor of a lethal activated denial system state to a user that a system meets this standard, the system shall meet all specifications and acceptance tests in the standard.

The use of this standard does not exempt contractors of the United States government from regulatory requirements as required by contract.

3 NORMATIVE REFERENCES

Lethal activated denial systems that meet the requirements of this standard shall meet the requirements of the following national standards and regulations, incorporated by reference.

3.1 ASME Y 14.100, "Engineering Drawing Practices," American Society of Mechanical Engineers.

3.2 NFPA 70, "National Electrical Code," National Fire Protection Association.

3.2.1 NFPA 70E, "Standard for Electrical Safety in the Workplace," National Fire Protection Association.

3.3 NFPA 79, "Electrical Standard for Industrial Machinery," National Fire Protection Association.

3.4 Applicable standards, 29 CFR Part 1910 (U.S. Department of Labor, Occupational Safety & Health Administration), including:

3.4.1 OSHA Standard 29 CFR Part 1910.212, "General Requirements for All Machines."

3.4.2 OSHA Standard 29 CFR Part 1910.147, "The Control of Hazardous Energy (Lockout/Tagout)."

3.5 ANSI Z535.4, "Product Safety Signs and Labels," National Electrical Manufacturers Association.

3.6 10 CFR 1047.7, "Use of Deadly Force," U.S. Department of Energy.

3.7 DOE M 470.4-3A, "Protective Force," Attachment 1, Appendix A, "Guidelines for Legal Authority, Fresh Pursuit, and Rules of Engagement," U.S. Department of Energy.

3.8 DOE O 414.1C, "Quality Assurance," U.S. Department of Energy.

4 DEFINITIONS

4.1 **ALARMS AND INDICATORS.** Any device capable of providing audible, visible, or olfactory indication.

4.2 **ARMED.** The system state after receipt of the first activation signal.

4.3 **CENTRAL ALARM STATION (CAS).** The continuously staffed location that monitors the site intrusion detection sensors and other alarm systems, and provides command, control, and other support to response forces.

4.4 **LETHAL ACTIVATED DENIAL SYSTEM (LADS).** A system which releases, fires, or produces lethal energies, agents, or projectiles and is used to deny human access to a protected space. Lethal systems shall be under human control and are activated from outside the protected space.

4.4.1 A LADS which continuously releases lethal agents or continuously produces lethal energies for an extended period may be activated upon determination that an attack is imminent to automatically disable any adversary entering the protected space.

4.4.2 A LADS which fires projectiles or produces air overpressure may be placed as a "trap" within a protected space.

4.5 **LOCKOUT.** A system feature that can be physically locked out to prevent the release of lethal energies, agents, or projectiles.

4.6 **LOCKOUT/TAGOUT.** A workplace safety procedure by which the machine controls or safety feature are secured with a lock and key and tagged to prevent the release of lethal energies, agents, or projectiles.

4.7 **SAFETY SOFTWARE.** As used in this standard, control software which initiates or prevents the release of lethal energies, agents, or projectiles.

4.8 **SAFETY SWITCH.** A device which prevents the transmission of activation signals to the delivery system(s).

5 VENDOR SPECIFICATIONS

5.1 CONTROL SYSTEM REQUIREMENTS.

5.1.1 Release of lethal energies, agents, or projectiles shall require a minimum of three separate operator actions. The use of three separate and independent activation signals which command separate and independent control devices is intended to reduce the probability per year of inadvertent activation to less than 10^{-6}.

5.1.1.1 System activation signals shall be designed so that no single system fault or unsafe condition can initiate or simulate two of the required three operator actions.

5.1.1.2 At least one of the activation signals shall be communicated by a separate and distinct means not under software control (e.g., closure of a hard-wired electrical

or optical signal). This signal shall be effected as close as practicable to the source of the lethal energies, agents, or projectiles.

5.1.1.3 Activation signals may be transmitted from operator to destination by electrical, optical, pneumatic, or wireless communication as permitted by Departmental policies.

5.1.1.4 For the activation controls, each switch/button/lever at the operator control station shall have a single function. (It is permissible for switches/buttons associated only with monitoring system status to have multiple functions.)

5.1.2 One or more safety switches shall be incorporated to prevent accidental communication of activation signals to the delivery system(s).

5.1.3 At the user's discretion, the vendor shall provide a control system that implements a two-person requirement for arming (e.g., by physically separate switches in series).

5.1.4 Activation controls shall be configured to prevent inadvertent activation (e.g., by use of switch covers).

5.1.5 The system control station shall include indicators to show the status of the activation controls.

5.1.6 The system shall include provision for a programmed delay between arming and release of lethal energies, agents, or projectiles (for the protection of employees), with evacuation alarms in the protected space(s) upon arming (receipt of the first activation signal). (See section 6.1.) System shall be designed to provide less than a 10^{-3} probability of failure of the specified delay as demonstrated through safety analysis. Note: This delay is not intended to restrict the communication of activation signals.

5.1.7 A single set of activation signals may activate multiple lethal activated denial systems of the same type.

5.1.8 If the activation sequence is not completed within a period of time determined by the user, the control system shall time-out and return to a safe state.

5.1.9 At the user's discretion, the system may include one or more control(s) to place an activated system in a safe state.

5.1.10 System designers shall select components which have been certified by a Nationally Recognized Testing Laboratory (N_RTL) or components shall be equivalently tested.

5.1.11 Control system components shall be rated for the expected operational environments (temperature and humidity), as specified by the user.

5.1.12 The system control station shall be clearly labeled for each protected space.

5.1.13 The operator's control station shall employ locks, passwords, or other means to prevent the issuance of unauthorized system commands.

5.1.14 Setup and maintenance screens shall be password protected to allow access by maintenance personnel only.

5.1.15 The control system and subsystems shall be assembled and tested by shops which have been certified as conforming to the requirements of ISO 9000, DOE O 414.1C, or equivalent.

5.2 DELIVERY SYSTEM REQUIREMENTS.

5.2.1 Delivery system components shall be rated for the expected operational environments (temperature, humidity, acidic vapors), as specified by the user.

5.2.2 Delivery hardware and controller shall be protected from tampering.

5.3 ELECTRICAL SUBSYSTEMS.

5.3.1 Design features shall prevent actuation by external energy sources.

5.3.2 Actuation lines shall be monitored for tamper. Tamper shall be alarmed to a continuously manned location.

5.3.3 Design features shall be incorporated to prevent inadvertent actuation due to power supply fluctuations, including low voltage surges, high voltage surges, and fluctuations caused by lightning strike.

5.3.4 The input supply voltage to critical subsystems (e.g., logic controllers) shall be monitored to ensure operation within manufacturer and system design specifications.

5.3.5 Design features, such as shielding, shall be incorporated to prevent inadvertent actuation due to electrical noise and surges.

5.3.6 Upon failure of system power sources (facility, power supplies, backup) resulting in the system being unpowered, the system shall fail such that lethal energies, agents, or projectiles are not released. Upon restoration of power, an inactive system shall come up with the safety switch and mechanical safety barrier(s) in "safe" position. Upon loss of primary power to the denial system, a signal

indicating that power has been lost shall be transmitted to a continuously attended location, such as a central alarm station.

5.3.7 The system shall have a backup power source to maintain operability (including safety subsystems) for a length of time to be determined by the user.

5.4 MECHANICAL SUBSYSTEMS

5.4.1 All lethal denial systems shall incorporate a mechanical safety barrier to stop or mitigate the effects of accidental release of lethal energies, agents, or projectiles. The safety barrier shall fail in the safe position. The vendor shall include the capability to remotely confirm the placement of the barrier in the "safe" position.

5.4.2 System design shall consider the potential for abnormal events (e.g., fire earthquake, tornado) to adversely affect the safety of mechanical subsystems (e.g., safety switch, safety barrier, chemical containers).

5.5 MAINTENANCE FUNCTIONS AND FEATURES.

5.5.1 The system shall include a lockout method (e.g., lockable on/off switch or valve) near or on each delivery system to prevent the release of lethal energies, agents, or projectiles during maintenance (e.g., lockout/tagout).

5.5.2 Components that have a potential safety impact shall be labeled where appropriate with safety warnings in accordance with ANSI Z535.4.

5.5.3 Cables, pipes, hoses, and their connectors should be marked with unique permanent identifiers and clearly visible when accessed for maintenance. Where there is the possibility of mismating cables, pipes, or hoses such that safety would be compromised, there shall be design features to preclude this from occurring.

5.6 TESTING FUNCTIONS AND FEATURES.

5.6.1 The system shall have a self-test capability that, when exercised, provides assurance that alarms, safety switches, mechanical safety barriers, signal transmission subsystems and backup power supply are operating correctly.

5.6.2 The system shall support routine function tests to determine proper operation of the control and delivery systems.

5.7 SAFETY SOFTWARE (if any).

5.7.1 The vendor is responsible for quality assurance review and validation of software written for the control of a lethal activated denial system, and shall make application software available for independent review. Software quality assurance shall meet applicable requirements of DOE O 414.1C, IEEE Std 730, ISO/IEC 9126, or equivalent.

5.7.2 The vendor shall understand the consequence of failure of commercial off-the-shelf software used in system subcomponents. The vendor shall provide to the user any known hazards associated with the failure of commercial off-the-shelf hardware and software.

5.7.3 Safety software shall include only required and intended functionality.

5.7.4 Power surges (e.g., low or high power levels) shall not corrupt safety software.

5.7.5 The vendor shall maintain version control of safety software and shall inform users of upgrades to safety software.

5.8 SYSTEM DOCUMENTATION.

5.8.1 System design documentation shall include system safety analysis including credible failure modes. The analysis shall use quantitative analysis models and conservative assumptions or data.

5.8.2 System documentation shall include full software documentation and full system engineering drawings (as built) with a full set of electrical schematics including connector types and identifiers; piping, hoses, and other agent storage and release mechanisms; and vendor's safety planning documents, analyses, certifications, and acceptance test report(s).

5.8.3 The vendor shall maintain a log of reported safety-related hardware and software failures and shall alert the users to failures, changes, or upgrades.

5.8.4 System design shall consider the expected lifetime of the system and the reliability of system components.

5.8.5 The vendor shall provide a recommended spare parts list, including specialty or long-lead items (e.g., which meet safety specifications). Vendor shall specify critical components, their maintenance needs, and recommended testing and maintenance frequency.

5.8.6 System documentation shall have clear and concise operating and maintenance procedures. These procedures, and the safety system interface with personnel, should be designed to be user and maintenance friendly.

5.9 TRAINING.

5.9.1 The vendor shall provide training materials and qualification information for maintenance personnel.

5.9.2 The vendor shall provide training materials for system operators.

5.10 SYSTEM CONSTRUCTION.

5.10.1 Designer shall ensure that system is built in accordance with applicable industry standards (see paragraph 6.3.6).

6 USER REQUIREMENTS

6.1 SAFETY IN DEPTH.

6.1.1 LADS shall be placed in a safe state, with the safety switch and mechanical safety barrier(s) in the "safe" positions, except when being tested or upon determination that an attack is imminent.

6.1.2 Protected spaces shall be under video surveillance, with display at both the operator's console and the command and control center (e.g., central alarm station). Surveillance shall be capable of confirming the presence of an adversary and the absence of friendly forces within the protected space.

6.1.3 At least one safe evacuation point shall be provided. The user shall consider location capacity, travel distance and travel time, ventilation requirements, and access control when establishing the evacuation point.

6.1.4 The user shall develop a procedure to initiate employee evacuation of a protected space when the hostile intent of an adversary attacker is determined.

6.1.5 For interior systems, upon receipt of the first activation signal, the system shall trigger visible and audible alarms within the protected space(s) informing employee occupants (if any) to evacuate to the evacuation point. Alarm system notification devices (horns and strobes) shall meet requirements of NFPA 72 "National Fire Alarm Code." Alarms shall be configured so that they are not turned off until the lethal activated denial system has been returned to a safe state.

6.1.6 The user shall conduct an evacuation analysis. The analysis shall identify and eliminate, as far as practicable, congestion which may develop during an evacuation. The analysis shall consider the movements of the protective force and the potential for casualties along escape routes.

6.1.7 The user shall determine the time delay between evacuation alarms and release of the lethal energies, agents, or projectiles which permits employees to exit each protected space, and shall ensure that the system is configured accordingly (see section 5.1.6).

6.1.8 Personnel entering a protected space shall work in multi-person teams, and be able to assist other members of the team to the exit upon notice to evacuate.

6.2 SAFETY-CRITICAL SOFTWARE (if any).

6.2.1 The user shall review application software to ensure that code is not retained that could cause malfunction (e.g., dead code, virus code, malicious code, ghosting, spoofing).

6.3 INSPECTION, TESTING, AND MAINTENANCE.

6.3.1 Nonessential personnel shall be evacuated from the protected space(s) prior to conducting any testing, service, or maintenance on the lethal activated denial system.

6.3.2 Lockout/Tagout procedures shall be used where appropriate while performing maintenance on the system.

6.3.3 The user should consider the vendor reliability and the future availability of spare parts (e.g., specialty items) during procurement.

6.3.4 The user shall ensure the development and documentation of an inspection, testing, and maintenance program based on vendor's recommended testing and maintenance frequency which supports the site security plan.

6.3.5 Post-modification or post-maintenance testing shall be performed prior to returning the system to service.

6.3.6 The user shall specify applicable industry standards or an independent testing laboratory to develop a standard by which certification could be performed on system components and subsystems.

6.3.7 The user shall ensure that system components and subsystems meet defined certification requirements.

6.4 SYSTEM DOCUMENTATION.

6.4.1 The user shall ensure that system safety analysis has been performed to demonstrate that the probability of inadvertent exposure per year to lethal energies, agents, or projectiles is less than 10^{-6}.

6.4.2 Hardware and software for activated denial systems shall be placed in the user's configuration control program.

6.4.3 The vendor's quality assurance documents (e.g., system requirements, project planning and development documentation, software quality assurance, test results, assessments and analyses) shall be examined and approved by the user.

6.4.4 Upon request, DOE users shall provide other DOE contractors with approved documentation confirming compliance with the requirements of this standard in accordance with 15 CFR Part 287, "Guidance on Federal Conformity Assessment."

6.4.5 A manuscript or electronic logbook shall be maintained to document system maintenance and system performance tests.

6.5 TRAINING.

6.5.1 Personnel who routinely access a protected space shall be trained annually and when first assigned to the facility on system hazards, recognition of system alarms, evacuation procedures, evacuation routes, and evacuation points. Personnel who do not routinely access the space shall be escorted by a person knowledgeable in system hazards, system alarms, and evacuation procedures.

6.5.2 Protective force and other response personnel shall receive training regarding access procedures following the release of lethal energies, agents, or projectiles.

6.5.3 Only trained personnel shall be permitted to operate, maintain, or test the system.

7 SAFETY ACCEPTANCE TESTS

7.1 VENDOR REQUIREMENTS.

7.1.1 There will be a specified, agreed-upon review process between the vendor and the user, to show that system documentation is complete and correct.

7.1.2 The vendor shall create an acceptance test to prove that the system meets the requirements of section 5, which shall be agreed to by the user.

7.1.2.1 Tests shall verify that all modes of operation perform as designed, and that there is no exception to the prescribed activation sequence. Tests shall include system power interruption and individual component failure simulations.

7.1.3 When vendor installed, acceptance testing shall be conducted by the vendor and witnessed by the user.

7.1.4 The vendor shall certify that safety reviews have been completed and documented.

7.2 USER REQUIREMENTS.

7.2.1 During the user readiness review, the user shall show that the installed system and facility meets the requirements of section 6.

7.2.2 For all modifications and changes to an installed system, the user shall: maintain responsibility for documentation revision control, document reason for design changes, perform a performance and safety impact analysis, and retest the affected hardware and/or software.

APPENDIX A
ACRONYMS AND ABBREVIATIONS

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
DOE	U.S. Department of Energy
CFR	Code of Federal Regulations
IEC	International Electrotechnical Commission
LADS	Lethal Activated Denial System
OSHA	U.S. Department of Labor, Occupational Safety & Health Administration
NFPA	National Fire Protection Association
REVCOM	U.S. Department of Energy Directives Review and Comment System

APPENDIX B
INFORMATIVE REFERENCES

B.1 DOE-HDBK-1140-2001, “Human Factors/Ergonomics Handbook for the Design for Ease of Maintenance,” U.S. Department of Energy.

B.2. IEC61508, “Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems,” International Electrotechnical Commission.

B.3 NFPA 780, “Standard for the Installation of Lightning Protection Systems,” National Fire Protection Association.

B.4 NFPA 72, “National Fire Alarm Code,” National Fire Protection Association.

B.5 DOE O 414.1C, “Quality Assurance,” U.S. Department of Energy. Note: This order is mandatory for DOE users.

B.6 10 CFR 830, Subpart A, “Quality Assurance Requirements,” U.S. Department of Energy. Note: This regulation is mandatory for DOE users.

B.7 DOE G 414.1-4, “Safety Software Guide for Use with 10 CFR 830, Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance,” U.S. Department of Energy.

B.8 ANSI/ANS 10.4, “Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry,” American Nuclear Society.

B.9 IEC 61508:2000, Parts 1-7, “Functional Safety of Electrical / Electronic / Programmable Electronic Safety Related Systems,” International Electrotechnical Commission.

B.10 NISTIR 4909, “Software Quality Assurance: Documentation and Reviews,” U.S. Department of Commerce, National Institute of Standards and Technology.

B.11 10 CFR 851, “Department of Energy Worker Safety and Health Program,” U.S. Department of Energy. Note: This regulation is mandatory for DOE users.

B.12 “Systems Safety Analysis Handbook,” System Safety Society.

B.13 MIL-STD-882D, “Standard Practice for System Safety,” U.S. Department of Defense.

B.14 FAA Advisory Circular No. 25.1309-1A, “System Design and Analysis,” U.S. Department of Transportation, Federal Aviation Administration.

B.15 "Guidelines for Hazard Evaluation Procedures, 3rd Edition" Center for Chemical Process Safety, American Institute of Chemical Engineers.

B.16 IEEE Std 730, "Software Quality Assurance Plans," IEEE.

B.17 ISO/IEC 9126, "Software Engineering – Product Quality," International Organization for Standardization and the International Electrotechnical Commission.

B.18 ISO 9001:2008, "Quality Management Systems: Requirements."

B.19 UL 864, "Standard for Control Units and Accessories for Fire Alarm Systems," Underwriters Laboratories Inc., Sections 5-29, 30-43, and 50-219.

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1. The submitter of this form must complete blocks 1 through 8.
2. The Technical Standards Program Office (TSPO) will forward this form to the Preparing Activity. The Preparing Activity will reply to the submitter within 30 calendar days of receipt from the TSPO.

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CONCLUDING MATERIAL

Review Activities:

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