

Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

February, 2026 ¹

Contents

1	Introduction	1-1
1.1	Background	1-1
1.2	Purpose	1-2
1.3	Scope	1-2
1.4	Applicability	1-2
2	Radiation Safety Organization and Responsibilities	2-1
2.1	US Army Installation Management Command Commander	2-1
2.1.1	Duties	2-1
2.1.2	Change of the IMCOM commander	2-1
2.2	US Army Garrison Commander	2-1
2.3	License Radiation Safety Officer	2-1
2.3.1	Qualifications	2-2
2.3.1.2	Health physics experience	2-2
2.3.1.3	Specialized knowledge	2-2
2.3.2	Duties	2-2
2.3.3	Authority	2-3
2.3.4	Change of the License RSO	2-4
2.4	Garrison RSO	2-4
2.4.1	Qualifications	2-4
2.4.2	Duties	2-5
2.4.3	Authority	2-5
2.4.4	Change of the Garrison RSO	2-5
2.5	Personnel in the RCA	2-6
2.5.1	Training	2-6
2.5.2	Responsibilities	2-6
2.5.3	Authority	2-6
2.6	Authorized visitors	2-7
3	Radiation Control Areas	3-1
3.1	Identification	3-1
3.2	Changes to RCAs	3-1
3.3	DU removal	3-1

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Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

4	Range Activities Authorized in RCAs	4-1
4.1	Unexploded ordnance in RCAs	4-1
4.2	Unauthorized range activities	4-1
4.3	Authorized range activities	4-1
4.4	Training in the Schofield Barracks Battle Area Complex	4-2
4.4.1	Training events	4-3
4.4.2	Training controls	4-3
4.5	Training in Fort Hunter Liggett Range C8 Target Zone/Impact Area	4-3
4.5.1	Training events	4-4
4.5.2	Road Maintenance.....	4-4
4.5.3	Training controls	4-5
4.6	Vehicle Passage through the Fort Jackson Range 62	4-5
4.6.1	Road Maintenance.....	4-5
4.6.2	Controls	4-6
4.7	Soldier Training in RCAs at Fort Moore.....	4-6
4.7.1	Routine maintenance	4-6
4.7.2	Duke Range, Facility M6852 (formerly Burma Hill Demolition Area).....	4-7
4.7.3	Cactus Range, Facility M6530 (formerly Cactus Observation Post)	4-7
4.7.4	Lae Field and Molnar Military Operations in Urban Terrain (MOUT).....	4-7
5	Radiation Safety Principles	5-1
5.1	Justification	5-1
5.2	Optimization	5-1
5.3	Individual dose and risk limits.....	5-1
6	Radiation Safety Standards.....	6-1
6.1	Individuals entering the RCA.....	6-1
6.2	Surface contamination.....	6-1
6.3	Declared pregnant worker	6-1
6.4	Dose to individual members of the public.....	6-2
7	Dosimetry	7-1
8	Bioassay.....	8-1
9	Personnel Protective Equipment	9-1
10	Respiratory Protection.....	10-1
11	Contamination Surveys	11-1
11.1	Instrument scanning.....	11-1
11.1.1	Personnel.....	11-1
11.1.2	Equipment and vehicles.....	11-1
11.2	Documentation	11-1
11.3	Swipe tests.....	11-2
11.4	Reporting results to workers.....	11-2
12	Environmental Monitoring.....	12-1
12.1	Environmental radiation monitoring.....	12-1
12.2	Drinking water	12-1
12.3	Notification to the NRC.....	12-1
13	Inventory	13-1
14	Posting Requirements.....	14-1
14.1	“CAUTION, RADIOACTIVE MATERIAL” signs	14-1

Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

14.2 Radiation area	14-1
14.3 NRC-required postings	14-1
14.3.1 NRC Form 3, "Notice to Employees"	14-2
14.3.2 Other notices to workers	14-2
14.3.3 Notices of violation	14-2
15 Access Control	15-1
15.1 RCA access	15-1
15.2 Installation training area access	15-1
16 Markings on Containers and Equipment	16-1
17 Instrumentation	17-1
17.1 Essential instruments	17-1
17.2 Instrument calibration and maintenance	17-1
17.3 Minimum detectable concentrations	17-1
17.3.1 Static minimum detectable concentration	17-1
17.3.2 Scan minimum detectable concentration	17-2
18 Radioactive Waste	18-1
19 Program Audits	19-1
19.1 Purpose of annual audit	19-1
19.2 Guide for annual audit	19-1
19.3 Sample checklist	19-3
20 Training	20-1
20.1 Frequency of Training	20-1
20.2 Training Topics	20-1
20.2.1 General Radiation Safety Topics	20-1
20.2.2 RCA-Specific Radiation Safety Topics	20-2
20.3 Training Documentation	20-2
21 Recordkeeping	21-1
21.1 Garrison Documentation	21-1
21.2 Radioactive Material License Documentation	21-1
22 Emergency Planning	22-1
22.1 General	22-1
22.2 Radiological Emergencies	22-1
22.3 Non-Radiological Emergencies	22-1
23 Standard Operating Procedures	23-1

Tables

Table 6-1 Acceptable surface contamination levels	6-1
Table 6-2 Comparison of regulatory standards to corresponding calculated maximum value using RESRAD 7.0 and RESRAD-OFFSITE 3.1	6-2

Figures

Figure 1-1 Davy Crockett M101 spotting round	1-2
Figure 4-1 IED Defeat Lane (shown by arrows) in Range C8 RCA at Fort Hunter Liggett.	4-4

Figure 4-2 North Tower Road (shown by arrow) in Fort Jackson RCA..... 4-5
Figure 14-1 "CAUTION, RADIOACTIVE MATERIAL" sign..... 14-3

Abbreviations and Acronyms

²³⁴ U	uranium-234
²³⁵ U	uranium-235
²³⁸ U	uranium-238
AEC	US Army Environmental Command
ALARA	as low as reasonably achievable
BAX	battle area complex
BFTA	Battalion Field Training Area/Target Zone/Impact Area
CFR	Code of Federal Regulations
cm	centimeter
dpm	disintegration per minute
DPW	declared pregnant worker
DU	depleted uranium
EOD	explosive ordnance disposal
EPA	US Environmental Protection Agency
h	hour
HE	high explosive
IMCOM	US Army Installation Management Command
m	meter
MDC	minimum detectable concentration
mL	milliliter
mm	millimeter
mrem	millirem
NRC	US Nuclear Regulatory Commission
PPE	personal protective equipment
RCA	Radiation Controlled Area
RSO	Radiation Safety Officer
RSP	Radiation Safety Plan
SOP	standard operating procedures
TEDE	total effective dose equivalent
USAG	US Army Garrison
UXO	unexploded ordnance
μCi	microcurie

1 Introduction

This Radiation Safety Plan (RSP) is for use when personnel enter, work in, and leave areas on IMCOM ranges that Davy Crockett M101 spotting rounds (Figure 1-1) may have affected. This RSP provides guidance and instructions to help assure compliance with US Nuclear Regulatory Commission (NRC) regulations and license conditions.

The M101 spotting round contains depleted uranium (DU). The License Radiation Safety Officer (RSO) controls the affected areas as radiation control areas (RCAs)² for radiation safety purposes. See Section 3.

The License RSO can make changes to this RSP only with prior NRC approval, except that the License RSO may correct minor typographical and grammatical errors.

1.1 Background

Depleted uranium is a byproduct of uranium enrichment, part of the process of manufacturing fuel for nuclear power plants. When uranium is *enriched* in the fissile³ uranium-235 (²³⁵U) isotope, the leftover uranium is *depleted* in ²³⁵U.⁴ DU is useful in certain commercial and military applications because of its high density. It is slightly radioactive, but it also poses some chemical toxicity danger to the kidneys if ingested in sufficient quantities, for example, by inhaling DU-laden dust or drinking DU-contaminated water.

The M101 spotting round was a 20-millimeter low-speed projectile, weighing approximately one pound⁵ that the Army used as part of the M28 Davy Crockett weapon system from 1960 to 1968.

In 2005, the Army discovered tail assemblies from the M101 spotting round during range clearance before construction of a battle area complex (BAX) at the Schofield Barracks training range in Hawaii. The Army then began investigating various sites where it may have used the M101 spotting round. These studies determined that NRC-licensable quantities of DU in the form of M101 fragments likely are present at several IMCOM sites.⁶

² The Army's intends that an RCA is the same as what the NRC calls a "restricted area." Title 10 CFR Part 20, §20.1003 defines "restricted area" as an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

³ A *fissile* nuclide is a nuclide that is capable of undergoing fission after capturing low-energy thermal (slow) neutrons. This definition excludes natural uranium and DU that have not been irradiated or have only been irradiated in thermal reactors.

⁴ Like ²³⁵U, uranium-234 (²³⁴U) also is enriched or depleted in enriched uranium and DU, respectively, but it is not fissile.

⁵ The DU content in a single M101 spotting round was 0.190 kilogram.

⁶ These sites are on ranges at Schofield Barracks/Pohakuloa Training Area HI, Fort Knox KY, Joint Base Lewis-McChord/Yakima Training Center WA, Joint Base McGuire-Dix-Lakehurst NJ, Fort Riley KS, Fort Polk (formerly named Fort Johnson) LA, Fort Benning (formerly named Fort Moore) GA, Fort Campbell KY, Fort Bragg (formerly named Fort Liberty) NC, Fort Carson CO, Fort Gordon (formerly named Fort Eisenhower) GA, Fort Hood (formerly named Fort Cavazos) TX, Fort Hunter Liggett CA, Fort Jackson SC, Fort Sill OK, and Donnelly Training Area, Fort Wainwright AK.

1.2 Purpose

NRC regulations required the US Army Installation Management Command (IMCOM) to submit a license application for the possession of DU. The NRC has stated, "Routine Army activities that would occur within the radiation control area of any of the Davy Crockett DU sites ... require the operation of a radiation safety program approved by the NRC via a license."⁷ This RSP meets that requirement for an NRC-approved radiation safety program.

The purpose of this RSP is to address radiation safety during performance of routine range activities in RCAs and other activities involving M101 DU on IMCOM ranges. The goals are to protect the health and safety of Army personnel and the public; protect the site environment; and meet all applicable Federal, Department of Defense, and Army regulations.

1.3 Scope

This RSP describes the RCA, defines the roles and responsibilities of supporting radiation safety personnel, and explains the radiation safety controls for use during performance of routine range activities in RCAs and performance of any other activities involving M101 DU on IMCOM ranges.

1.4 Applicability

The requirements of this plan are applicable to all personnel, including members of the public, who enter an RCA.

Requirements of this plan are in addition to, not in lieu of, all other safety requirements, especially those related to unexploded ordnance (UXO) in or around RCAs.



Figure 1-1 Davy Crockett M101 spotting round

⁷ "Meeting Report, November 16, 2010." Rockville, Maryland, US Nuclear Regulatory Commission, 2010 (ADAMS accession number ML103360437).

2 Radiation Safety Organization and Responsibilities

2.1 US Army Installation Management Command Commander

2.1.1 Duties

As the NRC M101 DU license holder, the IMCOM Commander is responsible for:

- Radiation safety for, security of, and control of M101 spotting round DU
- Completeness and accuracy of the radiation safety records and of all information provided to the NRC
- Knowledge about the contents of the license and application
- Compliance with current NRC regulations and the licensee's operating and emergency procedures
- Commitment to provide adequate resources (including space, equipment, personnel, time, and, if needed, contractors) to the radiation safety program to ensure that the public and personnel that enter an RCA are protected from radiation hazards and meticulous compliance with regulations is maintained
- Selection and assignment of a qualified individual to serve as the License RSO with responsibility for the overall radiation safety program
- Prohibition against discrimination of employees engaged in protected activities
- Commitment to provide information to employees regarding the NRC's employee protection and deliberate misconduct provisions
- Obtaining NRC's prior written consent before transferring control of the license

2.1.2 Change of the IMCOM commander

The License RSO will inform the NRC whenever a change of the IMCOM commander (that is, the "certifying officer" in item 13 of NRC Form 313, "Application for Material License") occurs by email and a subsequent letter.

2.2 US Army Garrison Commander

The Garrison Commander is responsible to the IMCOM Commander for assuring compliance with requirements of NRC regulations and license conditions on local ranges.

The Garrison Commander will select and assign a qualified individual to serve as the Garrison RSO with responsibility to both the Garrison Commander and the License RSO for garrison compliance with NRC regulations and license conditions regarding M101 DU on local ranges.

2.3 License Radiation Safety Officer

The License RSO is responsible to the IMCOM Commander for the development, implementation, and overall administration of this RSP. He is also responsible to both the IMCOM Commander and the NRC for assuring and monitoring compliance with NRC regulations and license conditions for M101 DU on Army ranges.

2.3.1 Qualifications

The License RSO will have the following education, training, and experience:

2.3.1.1. Education

A Bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in radiological protection. Usually, two years of relevant experience are equivalent to one year of academic study.

2.3.1.2. Health physics experience

At least one year of work experience in applied health physics, industrial hygiene, or similar work relevant to radiological hazards associated with site remediation. This experience should involve actually working with radiation detection and measurement equipment, not strictly administrative or "desk" work.

2.3.1.3. Specialized knowledge

A thorough knowledge of the proper application and use of all health physics equipment used for detecting and monitoring DU and its progeny, of the chemical and analytical procedures used for DU radiological sampling and monitoring, of methodologies used to calculate personnel exposure to DU and its progeny, of how M101 DU was used at Army ranges, how M101 DU hazards are generated and controlled, and of NRC decommissioning requirements.

2.3.2 Duties

The License RSO will:

- Coordinate with appropriate personnel as necessary to assure that routine range activities in RCAs comply with the requirements of this RSP
- Provide periodic program updates to the IMCOM Commander
- Provide recommendations to the Garrison RSO and other appropriate personnel for the control and, if possible, elimination of existing and potential radiological hazards
- Maintain documentation that demonstrates that the dose to individual members of the public does not exceed the limit specified in 10 CFR Part 20, § 20.1301
- Ensure security of radioactive material
- Ensure proper posting of documents required by 10 CFR Part 19, § 19.11 and by 10 CFR Part 21, § 21.6
- Ensure that radiation exposures are as low as reasonably achievable (ALARA)
- Oversee all activities involving DU, including monitoring and surveys
- Function as liaison with NRC and other regulatory authorities
- Provide necessary information on all aspects of radiation safety to personnel at all levels of responsibility, pursuant to 10 CFR Parts 19 and 20, and any other applicable regulations
- Conduct training and otherwise instruct personnel in the proper procedures
- Supervise and coordinate the radioactive waste disposal program, including recordkeeping on waste storage and disposal records.

Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

- Oversee the storage and disposition of radioactive waste
- Maintain an inventory of all radioisotopes possessed under the license⁸
- Immediately terminate any unsafe condition or activity that is found to be a threat to public health and safety or property
- Maintain other records not specifically designated above, for example, records of receipts, transfers, and surveys as required by 10 CFR Part 20, Subpart L, "Records"
- Perform comprehensive annual audit with periodic on-site and remote audits of garrison radiation safety programs⁹ to ensure that the licensee is complying with all applicable NRC regulations and the terms and conditions of the license, the content and implementation of the radiation safety program to achieve occupational doses¹⁰ and doses to members of the public that are ALARA in accordance with 10 CFR Part 20, § 20.1101, and required records are maintained
- Ensure that the results of audits, identification of deficiencies, and recommendations for change are documented, maintained for at least 3 years, and provided to management for review; ensure that prompt action is taken to correct deficiencies
- Ensure that the audit results and corrective actions are communicated to all affected personnel
- Ensure that all incidents, accidents, and personnel exposure to radiation more than ALARA or Part 20 limits are investigated and reported to NRC and other appropriate authorities, if required, within the required time limits
- Maintain understanding of and up-to-date copies of NRC regulations, the license, revised licensee procedures, and ensure that the license is amended whenever there are changes in licensed activities, responsible individuals, or information or commitments provided to NRC during the licensing process

2.3.3 The License RSO has authority to:

- Directly contact personnel of IMCOM Headquarters, IMCOM Regions, IMCOM garrisons, and the Army Environmental Command (AEC) in the performance of the License RSO duties
- Task personnel of IMCOM Headquarters, IMCOM Regions, IMCOM garrisons, and the AEC within their capabilities and resources to maintain compliance with NRC regulations and license conditions

⁸ The precise amount of DU in any RCA is not known. The Army provided conservative estimates to the NRC in its license application documents.

⁹ Provides clarified programmatic audit compliance according to NRC Inspection Report No. 040-09083/2024-001 (ADAMS accession number ML24162A304). Periodic RSP inspections by the Army are performed every three years according to Army Regulation 385-10 (Army Safety and Occupational Health Program); when budget and mission allow every two years.

¹⁰ From 10 CFR Part 20, § 20.1003, occupational dose means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released under 10 CFR Part 35, § 35.75, from voluntary participation in medical research programs, or as a member of the public.

- Immediately stop any operation involving the use of M101 DU in which health and safety may be compromised or may result in non-compliance with NRC requirements
- Temporarily suspend individuals from field activities for infractions against the RSP pending consideration by the Garrison Commander

2.3.4 Change of the License RSO

The IMCOM Commander will notify the NRC within 30 days by sending NRC Form 313, "Application for Material License," when he or she appoints a new License RSO. The appointment is subject to the approval of the NRC.

2.4 Garrison RSO

The Garrison RSO represents both the Garrison Commander and the License RSO in the day-to-day radiation safety operations and oversight at his or her garrison. The Garrison RSO will maintain records of radiation safety activities in the RCAs for review by the License RSO and by NRC inspectors.

2.4.1 Qualifications¹¹

The Garrison RSO shall have completed a formal course of instruction addressing the following topics:

- Basic radiation interactions
- Radioactivity
- Terms and units
- Biological effects
- Radiation detection and measurement
- Radiation and contamination control
- Radiation dosimetry

The U.S. Army and commercial radiation safety courses can be taken to meet the above requirements. The License RSO may provide this training (and document it) if time or resources do not allow a Garrison RSO to attend one of the formal courses on a timely basis. In addition, the Garrison RSO shall receive specific training from the License RSO on his or her duties and responsibilities related to M101 spotting rounds on his or her installation. This training will be documented and will include:

- Viewing of the Army's DU awareness training video for soldiers, TVT 3-120 Tier I Depleted Uranium (DU) General Awareness Training, a copy of which the License RSO will provide
- How to use and maintain radiation safety instruments specific to the license

¹¹ The Garrison Commander and License RSO cannot allow any activities within any garrison RCA when a Garrison RSO is not designated or is not fully trained (see Section 2.4.1). This includes furlough periods.

- How to perform Garrison RSO duties described in this RSP
- How to perform procedures in RSP-supporting SOPs (see Section 23)

2.4.2 Duties

The Garrison RSO, as necessary, will:

- On behalf of the Garrison Commander and License RSO, assure implementation of and compliance with this RSP, applicable NRC regulations and license conditions
- Provide periodic program updates to the Garrison Commander, with updates to the the Safety and Occupational Health Advisory Council (SOHAC).
- Discuss deviations from routine range activities that affect radiation safety with appropriate personnel and the License RSO
- Perform annual audit with license RSO review and as necessary to verify compliance with provisions of this RSP and of NRC regulations and license conditions
- Advise personnel as they carry out their radiation safety responsibilities
- Stop work if conditions indicate that a potential exists for an unanticipated or excessive radiation exposure to range personnel or the general public, or if an individual violates the radiation safety rules, regulations, or procedures in a manner that may adversely affect personnel at the RCA or the general public
- Train personnel in the proper use of radiological instruments for monitoring personnel and equipment leaving the RCA
- Implement, audit, and validate instrument calibrations and the appropriateness of calibration sources, methods, records, and procedures
- Ensure that radiation exposures are maintained ALARA
- Implement and maintain records of radiological surveys and evaluations
- Ensure appropriate radiation safety training is provided to all personnel who enter an RCA and maintain documentation of this training
- Arrange maintenance and calibration service and maintain associated records for radiation survey instruments
- Review planned RCA activities and implement radiation safety procedures to ensure safe performance and completion of work
- Perform any other activities as directed by the License RSO in order to maintain compliance with NRC regulations and license conditions

2.4.3 Authority

The Garrison RSO has authority to:

- Immediately stop any operation involving the use of M101 DU in which health and safety may be compromised or may result in non-compliance with NRC requirements (the License RSO will be notified as soon as possible if this occurs)
- Temporarily suspend individuals from field activities for infractions against this RSP pending consideration by the Garrison Commander and License RSO

2.4.4 Change of the Garrison RSO

The Garrison Commander (directly or through the garrison safety manager) will notify the License RSO as soon as possible when the current Garrison RSO departs and

when he or she appoints a new Garrison RSO. The appointment is subject to the concurrence of the License RSO, who will verify that Garrison RSO candidate meets the qualifications in Section 2.4.1.

The License RSO will notify the NRC, by telephone or email within 30 days of a change in the Garrison RSO. The notification will include the name and contact information of the new Garrison RSO. The License RSO will follow up the rapid notification with formal notification by letter.

The License RSO and the Garrison RSO will maintain documentation that demonstrates Garrison RSO compliance with training qualifications and make this documentation available to NRC inspectors upon request.

2.5 Personnel in the RCA

2.5.1 Training

Personnel entering the RCA are not occupationally exposed to ionizing radiation. However, they will receive radiation safety and DU awareness training (essentially on provisions of this RSP applicable to them) from the Garrison RSO at a level commensurate with their activities in the RCA as the Garrison RSO determines and documents.

2.5.2 Responsibilities

Each person who enters the RCA is responsible for demonstrating familiarity with the provisions of this RSP applicable to them, for strict adherence to radiation safety rules and regulations, and for minimizing radiation exposure to a level ALARA.

Responsibilities of personnel who enter the RCA include:

- Understanding and abiding by the policies and procedures specified in this RSP and in other applicable safety policies, and clarifying those areas where understanding is incomplete
- Providing feedback to health and safety management relating to errors, deficiencies or omissions and modifications in the RSP or in other safety policies

2.5.3 Authority

The health and safety authority of each person assigned to the RCA includes the following:

- The right to refuse to work and/or stop work authority when the person feels that the work conditions are unsafe (including subcontractors or team contractors), or where specified safety precautions are not adequate or fully understood
- The right to refuse to work on any task or operation where the safety procedures specified in this RSP or in other safety policies are not being followed
- The right to contact the Garrison Commander, the Garrison RSO, the License RSO, or the NRC at any time to discuss potential concerns

2.6 Authorized visitors

All visitors to the RCA will comply with the requirements of this RSP. Depending on the areas to be accessed and the nature of the visit, the Garrison RSO, as necessary, will escort visitors in order to assure safe radiation safety practices.

The Garrison RSO will brief authorized visitors requiring entry to the RCA on the presence of DU in the RCA. Visitors will be escorted at all times in the RCA and will be responsible for compliance with health and safety policies. The Garrison RSO will maintain records of the briefings and the visits for later License RSO and NRC review.

Unauthorized visitors, and visitors not meeting the specified qualifications, may not enter the RCA.

3 Radiation Control Areas

3.1 Identification

Figures that show the location of all IMCOM M101 DU RCAs are included in the required NRC license documentation that the Garrison RSO maintains, with the assistance of the License RSO.

3.2 Changes to RCAs

The Garrison RSO and License RSO will be notified if M101 spotting round debris (or any other heretofore-unknown radioactive material) is discovered on any IMCOM range outside of known RCAs.

The License RSO will establish a new or extended RCA to address this discovery. The License RSO will notify the NRC about the new or extended RCA within 30 days and arrange for the preparation of revisions that add the new RCA to the existing set of M101 DU impact area figures and documents.

Only the NRC can authorize area reduction of an RCA once the RCA is established in the license.

3.3 DU removal

Deliberate searches for and removal of M101 DU are not authorized within an RCA except for explosive ordnance disposal (EOD) UXO blow-in-place activities (see Section 4.1). However, unintended discovery of M101 DU debris in an RCA and its location will be reported immediately to the Garrison RSO. The Garrison RSO, in consultation with the EOD personnel and the License RSO, will determine whether it is more reasonable to pick up the DU and hold it for appropriate disposal (see Section 18) than it is to leave it in place.

4 Range Activities Authorized in RCAs

The NRC license to IMCOM allows for possession only of M101 DU on IMCOM ranges. Therefore, the NRC has limited the types of activities in RCAs that the Army may perform.

4.1 Unexploded ordnance in RCAs

If UXO requires disposition in an RCA, EOD personnel will determine the appropriate methods to follow in accordance with EOD policies and procedures.

If EOD personnel decide to remove the UXO, then, if it safe to do so, the UXO will be scanned for DU contamination before it leaves the RCA.

If EOD personnel decide to blow the UXO in place, then:

- Prior knowledge and approval of the Garrison RSO and the License RSO is required.
- Before the detonation, the immediate area (blast zone) will be checked for and cleared (to the maximum reasonable extent possible) of DU using appropriate radiological instrumentation under the joint supervision of the Garrison RSO and EOD personnel.

4.2 Unauthorized range activities

Entry into an RCA only will be for one or more of the purposes listed in Section 4.3 (also see Sections 4.4, 4.5, and 4.6).

Eating, drinking, smoking, and applying of cosmetics are not allowed in an RCA. Drinking water to maintain hydration and health is allowable, but water bottles, cups, and glasses must be clean of any apparent dirt or soil.

Excavations and building construction within an RCA are not allowed.¹²

Cleanup of DU within an RCA is not allowed unless the Army has applied for and received an NRC license amendment for decommissioning for that specific RCA, in accordance with 10 CFR 20, Subpart E.

4.3 Authorized range activities

The NRC allows only those range activities in RCAs listed below in this section (except see Section 4.4). Range personnel will keep records of these activities in appropriate range logs that will be accessible to NRC inspectors.

- HE fires
- Standard marksmanship and weapons familiarization training

¹² Upon request, the License RSO will ask the NRC for case-by-case exemptions to allow construction of new targets, access roads, and other projects related to the normal use of the RCA for training.

- Installation, programming, operation, preventive maintenance, and repairs on Army Standard Integrated Target Systems
- Diagnosis and inspection of all electronics and computerized integrated target systems
- Installation and wiring of range equipment
- Installation and replacement of targets and target mechanisms
- Testing of target systems after the completion of repairs
- Control of vegetation by mowing and use of weed eaters
- Maintenance and repair of support facilities, range towers and buildings
- Inspection and monitoring of training
- Monitoring of threatened and endangered species
- Controlled burning
- Cleaning of solar panels and adjustment of charge controllers
- Maintenance of batteries
- Maintenance of signage (for example, painting, alignment, and replacement)
- Maintenance of berms
- Maintenance of trail roads
- Removal and disposal of items that cannot be repaired (for example, batteries, solar panels, signage, targets, and targetry)
- Range Division and Officer-in-Charge Range-Walk to ensure range is ready for training activity
- On-site repair and recovery of vehicles
- Removal of brass and litter
- Walk/drive-through for range clearance at end of training activities
- Cultural resources activities to include survey and archaeological site recordation, archaeological site testing, archaeological site treatment, maintenance of site protection measures, monitoring of training activities and access for cultural practitioners for purposes of the Native American Graves Protection and Repatriation Act, Section 106 consultation, and cultural access
- Environmental radiation monitoring (see Section 12)
- Radiological surveys and quality assurance, quality control, and audits to support the other listed activities

Upon request, the License RSO will ask the NRC for approval of new activities not listed above.

4.4 Training in the Schofield Barracks Battle Area Complex

All personnel directly involved in BAX training events at Schofield Barracks are exempt from the radiation safety requirements of this RSP. This exemption does not apply to routine activities (see Section 4.3) that occur at other times in the BAX, such as target maintenance. This exemption is permissible because:

- A contractor working under authority of its NRC license cleared that portion of the BAX that overlaps the RCA of DU contamination, and

- No exit monitoring has detected any DU contamination on people, equipment, and vehicles.

4.4.1 Training events

Training events in the BAX may involve a platoon-sized element consisting of approximately fifty soldiers or may focus on a company-sized element of approximately 150 soldiers. Operations may include training on the following types of tactical operations:

- Conduct attack
- Conduct security
- Integration of enablers
- Company intelligence support team
- Re-supply
- Movement techniques
- React to contact
- Fire support planning
- Clearance of fires
- Dismounted counter improvised explosive device
- Conduct care under fire
- Evacuate casualties

4.4.2 Training controls

Restrict vehicles to course roads. Units will maneuver on foot and in wheeled vehicles (including Strykers) through designated training lanes on the BAX. They will establish secure positions, engage targets, and conduct re-supply operations that consist of driving convoys of vehicles to specified locations to support operations and evacuate casualties.

4.5 Training in Fort Hunter Liggett Range C8 Target Zone/Impact Area

All personnel directly involved in Improvised Explosive Device (IED) Defeat Lane training events in the Fort Hunter Liggett Range C8 RCA (see Figure 4-1) are exempt from the radiation safety requirements of this RSP. This exemption does not apply to routine activities (see Section 4.3) that may occur in this RCA, such as target maintenance. This exemption is permissible because:

- Less than 30 kilograms of DU (estimated 135 M101 DU spotting rounds) are in three RCAs with a total area of 3 square kilometers (about 740 acres) at Fort Hunter Liggett. Encountering a random M101 round is unlikely.
- Routine road grading that has occurred since the 1960s before the establishment of the RCA likely moved any M101 DU spotting rounds that may have been in the roadway to the sides of the road.
- All personnel entering a training range receive instructions to leave undisturbed any ordnance, which includes M101 DU spotting rounds, they may encounter.

- Exit monitoring (over 10,000 individual checks, mostly at Hawaii ranges) has never detected any DU contamination on people, equipment, and vehicles any time anywhere.
- Avoiding the 0.7-mile portion of the IED Defeat Lane that is within the Range C8 Target Zone/Impact Area RCA adds no less than 2.7 miles and up to 3.9 miles of unproductive travel around the RCA.

4.5.1 Training events

Training events in the Range C8 may involve a platoon-sized element consisting of approximately fifty soldiers or may focus on a company-sized element of approximately 150 soldiers.

Operations may include training on the following types of tactical operations:

- Dismounted counter IED
- Conduct attack
- Conduct security
- Integration of enablers
- Company intelligence support team
- Re-supply
- Movement techniques
- React to contact
- Fire support planning
- Clearance of fires
- Conduct care under fire
- Evacuate casualties

4.5.2 Road Maintenance

Road maintenance is included in this exemption if workers remain in their vehicles. Workers will inform the Garrison RSO before maintenance begins, so that the Garrison RSO is aware and can provide brief instructions to the workers.

If workers perform road maintenance dismounted from their vehicles, the Garrison RSO will perform contamination surveys in accordance with section 11 and relevant SOPs.

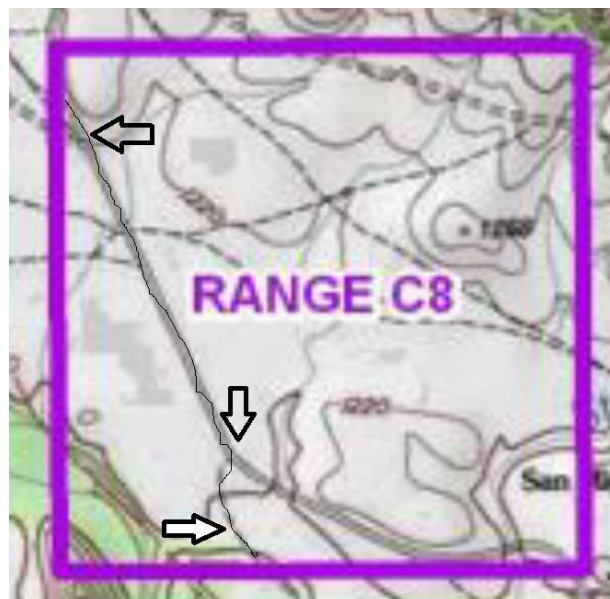


Figure 4-1 IED Defeat Lane (shown by arrows) in Range C8 RCA at Fort Hunter Liggett.

4.5.3 Training controls

Vehicles are restricted to the IED Defeat Lane Road within the Range C8 RCA (see Figure 4-1). Units will maneuver on foot only within 200 yards of the IED Defeat Lane Road within the Range C8 RCA.

4.6 Vehicle Passage through the Fort Jackson Range 62

All personnel and equipment riding in vehicles passing through the Fort Jackson Range 62 RCA on the North Tower Road (see Figure 4-2) and the vehicles themselves (including road maintenance vehicles on the main road) are exempt from the radiation safety requirements of this RSP. This exemption does not apply to routine activities (see Section 4.3) that may occur at other times in the RCA. This exemption is permissible because:

- Less than 30 kilograms of DU (estimated 135 M101 DU spotting rounds) are in the RCA with a total area of 1 square kilometer (about 247 acres) at Fort Jackson. Encountering a random M101 round is unlikely.
- Routine road grading that has occurred since the 1960s before the establishment of the RCA likely moved any M101 DU spotting rounds that may have been in the roadway to the sides of the road.
- All personnel entering a training range receive instructions to leave undisturbed any ordnance, which includes M101 DU spotting rounds, they may encounter.
- Exit monitoring (over 10,000 individual checks, mostly at Hawaii ranges) has never detected any DU contamination on people, equipment, and vehicles any time anywhere.
- No one will exit the vehicle while it is in the RCA except for emergencies (see section 22.3) or vehicle breakdowns.
- Avoiding the RCA to reach areas east of the RCA adds more than two miles of unproductive travel. The alternate roads themselves are often unusable because of harsh weather.

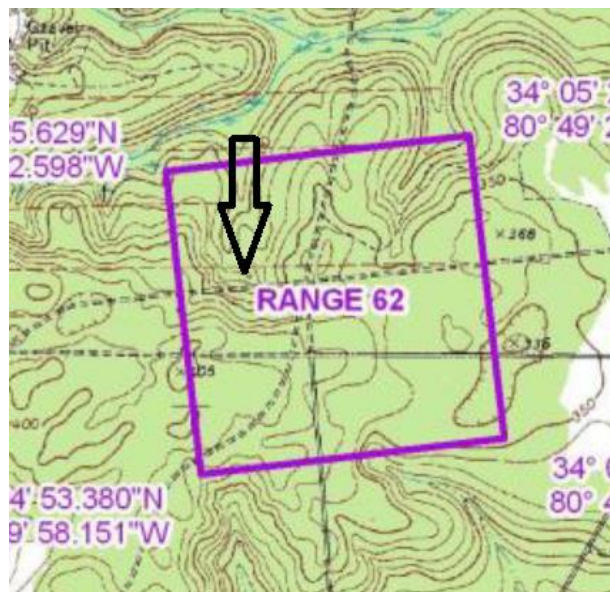


Figure 4-2 North Tower Road (shown by arrow) in Fort Jackson RCA.

4.6.1 Road Maintenance

Road maintenance is included in this exemption as long as workers remain in their vehicles. Workers will inform the Garrison RSO before maintenance begins, so that the Garrison RSO is aware and can provide brief instructions to the workers.

If workers perform road maintenance dismounted from their vehicles, the Garrison RSO will perform contamination surveys in accordance with section 11 and relevant SOPs.

4.6.2 Controls

Vehicles and personnel are restricted to the main east-west road (North Tower Road, see Figure 4-2) while in the RCA. Departures of more than ten feet from the roadway require implementation of all pertinent RSP requirements.

4.7 Soldier Training in RCAs at Fort Moore

All personnel and equipment directly involved in Soldier training and in ground and road maintenance associated with Soldier training as described in the subsections below are exempt from the radiation safety requirements of this RSP. This exemption does not apply to routine activities (see Section 4.3) that may occur at other times in the RCA except as noted. This exemption is permissible because:

- The Army used these training areas for more than forty years before the NRC issued its current license without incident involving or discovery of any M101 DU spotting rounds or associated items that may be in these areas.
- Compliance with this RSP during Soldier training requires increased personnel (hotline monitors) and equipment (pancake Geiger counters) resources and adds to training time (DU awareness training and exit monitoring), although no risk is apparent.
- Routine road grading that occurred since the 1960s before the establishment of the RCA likely moved any M101 DU spotting rounds that may have been in roadways to the sides of the road.
- All personnel entering a training range receive instructions to leave undisturbed any ordnance, which includes M101 DU spotting rounds, they may encounter.
- Exit monitoring (over 10,000 individual checks, mostly at Hawaii ranges) has never detected any DU contamination on people, equipment, and vehicles any time anywhere.

4.7.1 Routine maintenance

Maintenance workers will inform the Garrison RSO before maintenance begins, so that the Garrison RSO is aware and can provide brief instructions to the workers.

Maintenance workers should minimize their time outside of their vehicles while in RCAs.

Seasonal grass cutting and ground maintenance required to keep range footprints (including portions within the RCA) cleared of tall grass requires the use of agricultural tractors with brush cutters. This maintenance does not disturb the soil. However, as tree saplings grow, occasionally some brush and small tree cutting is necessary on the range footprint within the RCA to maintain target locations and visibility of targets.

Unimproved course roads on ranges (including those within the RCA) require grading and regular maintenance to ensure they remain trafficable, which until the RCA was established, was done annually over the last 30 years.

4.7.2 Duke Range, Facility M6852 (formerly Burma Hill Demolition Area)

Duke Range is currently a Light Antiarmor Weapons (LAW/AT-4) Live Fire Range that also supports stationary small arms (rifle and pistol) live firing training. Soldiers shoot from firing positions along a firing line to target locations 100 meters within the RCA. The target locations are along an existing berm and outside the impact area. The training requires Soldiers to walk down range from the firing line into the RCA to a berm to service targets and to gather downrange marksmanship feedback.

4.7.3 Cactus Range, Facility M6530 (formerly Cactus Observation Post)

Cactus Range is a Multipurpose Range Complex – Heavy (MPRC-H) on which the Army trains Infantry and Armor crews, teams, sections, and platoons on the skills necessary to detect, identify, engage, and defeat stationary and moving infantry and armor targets in a tactical live fire scenario. Cactus Range also supports dismounted Infantry tactical live fire operations independently of or simultaneously with supporting vehicles.

Outside of the RCA, the training scenario allows both mounted (track and wheeled tactical vehicles) and dismounted maneuver (firing and movement). However, within the RCA, vehicles (both track and wheeled) will only move along designated routes (existing dedicated unimproved course roads) to ensure they do not disturb soil elsewhere. Additionally, Soldiers on foot (dismounted) will walk through the RCA as they continue down the range Northeast towards the next target engagement past the RCA.

4.7.4 Lae Field and Molnar Military Operations in Urban Terrain (MOUT)

Lae Field and Molnar MOUT (also known as Molnar Range) consists of a helicopter landing pad on Lae Field, and a drop zone¹² on both Lae Field and a portion of the RCA, and Molnar MOUT facility within the RCA. Training in these non-live fire facilities within the RCA allow the ability to conduct Airborne operations and collective training across the entire drop zone including the southeast portion of Lae Field and within Molnar MOUT.

With access to the RCA, expanded training opportunities allow Airborne operations (airfield seizures) with Soldiers parachuting onto and conducting tactical dismounted (on foot) movement within Lae Field/Molnar MOUT. Training includes dry fire rehearsals and blank-fire force-on-force engagements with Soldiers replicating opposing forces on the ground. These types of operations include truck movement along existing unimproved roads, movement of Soldiers on foot throughout the RCA, and movement of medical vehicles within the RCA.

¹³ A drop zone is a place where parachutists or parachuted supplies land. It can be an area targeted for landing by paratroopers and airborne forces.

5 Radiation Safety Principles

The following are general radiation safety principles that guide radiation safety policies in the RCA.

5.1 Justification

No one will be exposed to ionizing radiation needlessly. This means that only essential personnel will be in the RCA at any time.

5.2 Optimization

All personnel radiation exposure will be ALARA, considering technological and socioeconomic factors.

Implement "ALARA" using the following:

- Training of personnel in appropriate radiation safety practices and work procedures
- Good housekeeping practices
- Engineering controls
- Use of personal protective equipment (PPE) as necessary

5.3 Individual dose and risk limits

No one will exceed regulatory dose limits. This will be achieved through the implementation of the ALARA program and contamination control within NRC limits (Table 6-1).

6 Radiation Safety Standards

Title 10 CFR, Part 20, Subpart C contains the NRC occupational and public dose limits, which we will not exceed under any circumstances.

6.1 Individuals entering the RCA

All reasonable conservative estimates of the maximum annual total effective dose (TEDE) equivalent due to Davy Crockett DU in impact areas on IMCOM ranges show that no one will exceed ten percent of the NRC annual public dose limit of 0.100 rem.

6.2 Surface contamination

Table 1 in NRC Regulatory Guide 1.86 provides NRC acceptable surface contamination levels. Table 6-1 is an extract relevant for DU from that table. Decontamination will always be to surface contamination levels that are below those in Table 6-1 and that are ALARA.

Table 6-1 Acceptable surface contamination levels

NUCLIDE ^a	AVERAGE ^{b,c,f}	MAXIMUM ^{b,d,f}	REMOVABLE ^{b,c,e,f}
U-natural, ²³⁵ U, ²³⁸ U, and associated decay products	5,000 dpm alpha/100 cm ²	15,000 dpm alpha/100 cm ²	1,000 dpm alpha/100 cm ²

- ^a Where surface contamination by both alpha- and beta-gamma emitting nuclides exists, the limits established for alpha and beta-gamma emitting nuclides should apply independently.
- ^b As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
- ^c Measurements of average contamination level should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each object.
- ^d The maximum contamination level applies to an area of not more than 100 square centimeters (cm²).
- ^e The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally, and the entire surface should be wiped.
- ^f The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 millirad per hour at 1 centimeter and 1.0 millirad per hour at 1 centimeter, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

6.3 Declared pregnant worker

Because of the radio-sensitivity of the embryo/fetus, the NRC sets the dose limit to the embryo/fetus of a declared pregnant worker (DPW) at 0.5 rem TEDE for the period of gestation. The NRC determined that this limit provides an adequate margin of safety for the embryo/fetus. However, no one can exceed even a small percentage of this limit for all reasonable scenarios (see paragraph 6.1).

Nevertheless, in the event a worker informs the Garrison RSO that she is a DPW, the Garrison RSO will take the following actions:

- Acknowledge receipt of the declaration and maintain a record of it

Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

- Provide the worker with a copy of NRC Regulatory Guide 8.13, “Instruction Concerning Prenatal Radiation Exposure,” for her information
- Consult with the License RSO

6.4 Dose to individual members of the public

Documents provided to the NRC during the license amendment application demonstrate that the dose to individual members of the public does not exceed the limit specified in 10 CFR Part 20, § 20.1301(a)(1), which is 100 mrem in a year. These documents incorporate calculations using RESRAD 7.0 and RESRAD-OFFSITE 3.1 and show that the maximum possible annual dose to anyone in an RCA is less than about 0.3 mrem and to anyone outside the training range complex is less than about 0.04 mrem. The following table summarizes the results of the RESRAD calculations.

Table 6-2 Comparison of regulatory standards to corresponding calculated maximum value using RESRAD 7.0 and RESRAD-OFFSITE 3.1

Situation	Maximum Value			
	Average Annual Dose (mrem)	Water Concentration		Air Concentration (pCi/m ³ ²³⁸ U)
		Effluent (pCi/L ²³⁸ U)	Drinking water (µg/L total U)	
Regulatory standard (NRC; EPA for drinking water)	100	300	30	0.06
Typical: 1000 rounds, 1 km ² , default parameters	0.029	0.13	0.37	0.0000065
Maximum reasonable: 9700 rounds, 1 km ² , default parameters	0.28	1.3	3.7	0.000065
Maximum bounded: 9700 rounds, 1 km ² , several changed defaults	0.33	0.63	1.8	0.00013
Maximum reasonable 1 km offsite: 9700 rounds, 1 km ² , default parameters	0.035	0.23	0.66	0.000000088

7 Dosimetry

Entry into the RCA does not require dosimetry. See Section 6.1 and Section 6.4.

8 Bioassay

Bioassay is not required for anyone who enters the RCA. See Section 6.1 and Section 6.4. The Garrison RSO will consult with the License RSO if an uptake of DU may have occurred (see Section 22.1).

9 Personnel Protective Equipment

Normal work clothing provides adequate protection for radiation safety purposes from M101 DU on IMCOM ranges for authorized routine range activities (see Section 4.2).

Wear disposable gloves always when handling DU.

10 Respiratory Protection

Entry into the RCA does not require respiratory protection. See Section 6.1 and Section 6.4.

11 Contamination Surveys

11.1 Instrument scanning

When necessary, the Garrison RSO will establish access control points (“hotlines”) for entry and exit to the RCA. The Garrison RSO will assure that appropriate instruments and supplies (for example, soap and water for decontamination) are available at the hotlines.

The Garrison RSO will assure that instrument scanning on all personnel, vehicles, and equipment occurs at the hotline as they exit the RCA. The Garrison RSO will notify the License RSO as soon as possible if contamination is present.

Normally, the Garrison RSO will perform these measurements. However, when the Garrison RSO cannot be present and work must proceed, the Garrison RSO may designate a worker to perform the hotline functions once the Garrison RSO has trained and verified that the worker is able to do so accurately, correctly, and in accordance with this RSP. The Garrison RSO will train that worker and verify his or her ability to comply with this RSP in accordance with an SOP that the License RSO has provided (see Section 23). The Garrison RSO will maintain records of all such designations, training, and verifications.

11.1.1 Personnel

All personnel exiting an RCA will be monitored for contamination as they leave the RCA. If DU contamination is detected, they will be completely decontaminated if possible. The Garrison RSO will contact the License RSO for instructions if decontamination measures are ever necessary. (Usually, washing with soap and water will achieve complete DU decontamination.)

See Section 17 for instrumentation requirements.

11.1.2 Equipment and vehicles

All equipment and vehicles will be monitored for contamination as they leave the RCA. If DU contamination is detected, the equipment item or vehicle will be decontaminated to meet the requirements in Table 6-1 (which includes the requirement to decontaminate to levels ALARA). The Garrison RSO will contact the License RSO for instructions if decontamination measures are ever necessary. (Usually, washing with soap and water will achieve complete DU decontamination.)

11.2 Documentation

The Garrison RSO will document all contamination surveys of personnel, equipment, and vehicles¹⁴ to include:

- Reason for or purpose of RCA entry

¹⁴ The Exit Monitoring SOP includes a form, “Exit Monitoring Record,” the use of which is mandatory.

- Description of instrument used, along with its calibration date and calibration due date
- Identification of person, equipment item, or vehicle
- Location of contamination or a notation that no contamination was detected
- Initial contamination found, if any, in units of dpm/100 cm² or dpm over smaller area
- Decontamination method(s) used, if necessary
- If initial decontamination efforts are not fully successful, interim contamination in units of dpm/100 cm² or dpm over smaller area
- Final contamination status
- Name and signature of person performing monitoring

See Section 17 for instrumentation requirements.

11.3 Swipe tests

Swipe tests generally are not necessary. However, if instrument scanning detects contamination, the Garrison RSO will take swipe tests to verify that subsequent decontamination efforts were adequate. The License RSO will provide instructions on how to analyze the swipes.

11.4 Reporting results to workers

The Garrison RSO will provide results of swipe tests and scanning to any RCA personnel who ask for them, as it is a right of workers to know the potential hazards to which they are exposed.

12 Environmental Monitoring

12.1 Environmental radiation monitoring

Each site-specific ERMP annex will be in accordance with the guidance in the “Programmatic Approach for Preparation of Site-Specific Environmental Radiation Monitoring Plans.”

The License RSO and Garrison RSOs will assure that performance of environmental radiation sampling and measurements will be in accordance with the site-specific ERMP for each RCA.

12.2 Drinking water

The Garrison RSO will coordinate, as necessary, with Garrison Department of Public Works personnel who perform these tests to obtain copies of drinking water records pertaining to uranium. Results are normally located on the Garrison Department of Public Works (DPW) Environmental public website. The Garrison RSO will make available for NRC review records of routine analysis for uranium to meet requirements of US Environmental Protection Agency (EPA) drinking water regulations (40 CFR Part 141).

12.3 Notification to the NRC

When analytical sampling results from locations outside of an RCA indicate that the $^{238}\text{U}/^{234}\text{U}$ activity ratio exceeds three, the License RSO shall notify NRC within 30 days and collect additional environmental samples within 30 days of the notification of NRC, unless prohibited by the absence of sampling media.

The License will estimate the dose to the public following the instructions in the SOP, “Calculation of Public Dose” and include that estimated dose in the notification to the NRC.

13 Inventory

The Garrison RSO will inventory and control all check sources associated with instrumentation used at the RCA. No other radioactive sources, other than M101 DU itself, are expected to be in the RCA. (Also, see Section 18.)

The Garrison RSO will maintain a log of all M101 DU found on the installation. The log will show the location of each find, an estimate of the amount of DU (for example, two mostly intact rounds, three fragments, evidence of soil contamination, and so on) and whether the DU was left in place or removed for proper disposal.

14 Posting Requirements

A radiation control area (RCA) is an area controlled for the purpose of radiation safety (see Section 3). The Garrison RSO, in coordination with range personnel, will establish each M101 DU impact area on the installation as an RCA.

The Garrison RSO will assure that all range operations and training personnel are aware of the RCAs.

14.1 “CAUTION, RADIOACTIVE MATERIAL” signs

Title 10 CFR Part 20, Subpart J, § 20.1902(e) says:

Posting of areas or rooms in which licensed material is used or stored.

The licensee shall post each area or room in which there is used or stored an amount of licensed material exceeding 10 times the quantity of such material specified in appendix C to part 20 with a conspicuous sign or signs bearing the radiation symbol and the words “CAUTION, RADIOACTIVE MATERIAL(S)” or “DANGER, RADIOACTIVE MATERIAL(S).”

The Garrison RSO, in coordination with range operations and training personnel and, as required, EOD personnel, will conspicuously post these signs (see Figure 14-1) at a sufficient number of locations around the RCA to ensure that individuals entering the RCA are aware of the presence of DU. The signs may be placed at the perimeter of the range impact areas if posting them at the Radiation Control Area boundary is unsafe.

Signs will be made of weather-resistant material. Additional guidance regarding sign letter size may be obtained from ANSI Z35.1.¹⁵

14.2 Radiation area

A radiation area is an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

M101 DU on IMCOM ranges cannot produce a radiation area.

14.3 NRC-required postings

Documents, notices, or forms posted under this section shall appear in a sufficient number of places to permit individuals engaged in NRC-licensed or regulated activities to observe them on the way to or from any particular licensed or regulated activity location to which the document applies, shall be conspicuous, and shall be replaced if defaced or altered.¹⁶

¹⁵ Incorporation by reference 29 CFR 1910.6(e)(59).

¹⁶ See Section 21 for all recordkeeping requirements.

At a minimum, the Garrison RSO will post these documents, notices, and forms in control towers for DU-affected ranges, in his or her office, and with documents that are required reading for range personnel.

14.3.1 NRC Form 3, “Notice to Employees”

Current copies of NRC Forms 3 will appear in a sufficient number of places to permit personnel to observe them on the way to or from any particular work location to which the document applies, will be conspicuous, and will be replaced if defaced or altered.

14.3.2 Other notices to workers

The Garrison RSO shall post or make available current copies of

- Title 10 CFR, Part 19, “Notices, Instructions and Reports To Workers: Inspection And Investigations”
- Title 10 CFR, Part 20, “Standards for Protection against Radiation”
- Title 10 CFR, Part 21, “Reporting of Defects and Noncompliance”
- The license, license conditions, and documents incorporated into the license by reference, and amendments thereto
- The operating procedures applicable to licensed activities (specifically, this RSP)

If posting of any of these documents specified in this sub-section is not practicable, the Garrison RSO instead may post a notice that describes the document and states where it may be examined.

14.3.3 Notices of violation

The Garrison RSO shall post or make available current copies of any notice of violation involving radiological working conditions, proposed imposition of civil penalty, or order from the NRC and any IMCOM response.



Figure 14-1 "CAUTION, RADIOACTIVE MATERIAL" sign

15 Access Control

15.1 RCA access

Personnel access to an RCA is not authorized except with the knowledge and approval of the Garrison RSO. This is because the Garrison RSO must make appropriate arrangements to assure compliance with NRC regulations and license conditions as implemented in this RSP. The Garrison RSO will assure that all appropriate range operators and trainers are aware of this requirement. This requirement is in addition to and not in lieu of any other approvals for access that may be required.

Whenever personnel access to the RCA is required, the Garrison RSO will establish access control points on the RCA's perimeter for entry and exit (except in an emergency).

Other than official visitors, no one may enter the RCA unless he or she meets all radiation safety training requirements (see Section 20). The Garrison RSO will maintain documentation to show that these requirements have been met.

Personnel qualified to enter the RCA will escort official visitors.

15.2 Installation training area access

Restrictions on RCA access (see Section 15.1) are in addition to, not in place of, any other access restrictions.

16 Markings on Containers and Equipment

Garrison RSOs and the License RSO will ensure compliance with Title 10 CFR Part 20, § 20.1904, which requires that all containers that contain more than 100 microcuries of ^{238}U or natural uranium¹⁷ be properly labeled with a “CAUTION—RADIOACTIVE MATERIALS” sign or label. The label will also provide information, such as the radionuclides present (DU), an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, and kinds of materials, to permit individuals handling or using the containers, or working in the vicinity of the containers, to take precautions to avoid or minimize exposures.

The specific activity of DU is about 0.4 μCi per gram, so 100 μCi of DU has a mass of about 250 grams. A single, intact M101 spotting round contains about 190 grams of DU.

The only containers of M101 DU on the installations, if any, shall be containers awaiting disposal as radioactive waste (see Section 18).

¹⁷ The activity in DU is mostly due to ^{238}U . The activity in natural uranium is mostly due to ^{234}U and ^{238}U in equilibrium with each other. Table C in Appendix C to 10 CFR Part 20 does not list DU specifically, but the inference is that the labeling requirement for an activity of more than 100 microcuries should also apply for DU.

17 Instrumentation

17.1 Essential instruments

The Garrison RSO will assure that appropriate calibrated instruments are available for use by appropriately trained personnel before allowing personnel access to the RCA.

The Garrison RSO will possess at least two Geiger-Mueller pancake detectors for alpha-beta-gamma surveys for contamination and frisking [for example, a Ludlum Model 26 Integrated Frisker, a Ludlum Model 44-9 Pancake G-M Detector with appropriate meter, or an AN/PDR-77 RADIAC¹⁸ set that includes a pancake probe].

17.2 Instrument calibration and maintenance

A qualified calibration/repair facility will calibrate all instruments at least annually in accordance with manufacturers' instructions. The Garrison RSO will retain calibration records for each instrument for at least three years.

Each instrument shall be checked before first use each day with check sources to verify that its response is within ± 20 percent of the value established by the calibration laboratory (or the Garrison RSO immediately upon receipt of a newly calibrated instrument) for that instrument/check source/geometry combination.

Each item of survey equipment shall meet function response requirements before, during, and at the end of the workday. If survey equipment requires routine maintenance (such as battery replacement, spot painting of Mylar® window, etc.) during a workday, its proper function will be verified before it is returned to use.

Instruments that require other than routine maintenance will be re-calibrated after repair before being returned to use.

17.3 Minimum detectable concentrations

The following sections describe how minimum detectable concentrations (MDCs) will be determined for field equipment. The MDC will be calculated and documented for each field instrument put into use. The Garrison RSO will maintain this documentation and make it available to the License RSO and NRC personnel upon request.

After completing background measurements outside of but nearby the RCA, MDCs will be calculated using RCA-specific variables (reference activity/instrument efficiencies) to verify that all MDCs are significantly below the regulatory limits that correspond to the instruments' uses.

17.3.1 Static minimum detectable concentration

According to *MARSSIM*, the *critical level* (L_C) is the level, in counts, at which there is a 5 percent statistical probability of incorrectly identifying a measurement-system

¹⁸ RADIAC is a military acronym for "radioactivity, detection, indication, and computation."

background value as greater than background. Any response above this level is considered greater than background. The *detection limit* (L_D) is the *a priori* estimate of the detection capability of a measurement system and is reported in units of counts. The MDC is the detection limit (counts) multiplied by an appropriate conversion factor to give units consistent with a site guideline, such as dpm/100 cm². In other words, the MDC is the *a priori* net activity level above the critical level that an instrument can be expected to detect 95 percent of the time,

MARSSIM explains how to calculate L_C , L_D , and MDC and arrives at the following result (*MARSSIM* Equation 6-7) for the static MDC:

$$\text{Static MDC} = C(3 + 4.65\sqrt{B}).$$

C represents total detection and efficiency and other constants or factors needed to put the static MDC into appropriate units and B is the number of background counts that are expected to occur while performing an actual measurement. The equation assumes that static counts are taken in 1 minute. If a different time is necessary,¹⁹ the License RSO will adjust the calculations accordingly.

For the present purposes,

$$C = \frac{1}{A\varepsilon_1\varepsilon_2} \times \frac{100 \text{ cm}^2}{100 \text{ cm}^2}.$$

A is the effective area of the probe, ε_i is the instrument or detector efficiency, ε_s is the efficiency of the contamination source (surface efficiency),²⁰ and the final factor, which equals 1, helps put the units of scan MDC into dpm/100 cm².

17.3.2 Scan minimum detectable concentration

The minimum detectable concentration of a scan survey (scan MDC) depends on the intrinsic characteristics of the detector (such as efficiency and physical probe area), the nature (type, abundance, and energy) of emissions, the relative distribution of the potential contamination (point versus distributed source and depth of contamination), scan rate, and personal characteristics of the surveyor. *MARSSIM* Section 6.7.2.1 discusses the basis for estimating scanning MDCs and arrives at the following equation for scan MDC:

¹⁹ For example, Fort Carson has background count rates so great that increased count times are necessary to achieve adequate MDCs.

²⁰ The ISO-7503-1 standard on the evaluation of surface contamination for beta-emitters and alpha emitters recommends an ε_s value of 0.5 for betas (maximum beta energy greater than 0.4 megaelectron volt (MeV)) and an ε_s value of 0.25 for alpha and betas (maximum beta energy between 0.15 MeV and 0.4 MeV).

Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

$$\text{Scan MDC} = \frac{\text{MDCR}}{\sqrt{\rho A \epsilon_i \epsilon_s}} \times \frac{100 \text{ cm}^2}{100 \text{ cm}^2}.$$

MDCR is the minimum detectable count rate (interpolated from MARSSIM Table 6.6), ρ is surveyor efficiency (assumed to be 0.5), and other parameters are shown above. The final factor, which equals one, helps put the units of scan MDC into dpm/100 cm².

18 Radioactive Waste

The Garrison RSO, in coordination as necessary with EOD personnel, will double-bag in plastic bags all M101 DU that is picked up and removed from the RCA (see Section 3.2). Anyone handling DU will use tools or gloved hands to handle it. The bagged DU will be stored in sturdy containers with appropriate markings (see Section 16).

The Garrison RSO will secure these containers in a locked storage facility with access limited to personnel appropriately trained in radiation safety and security.

The Garrison RSO, in coordination with the License RSO, will contact Chief, Army Low-Level Radioactive Waste Disposal Division, US Army Joint Munitions Command, ATTN: AMSJM-SF, Rock Island Arsenal, Rock Island, IL 61299-6500, who will arrange for appropriate disposal of the DU.

19 Program Audits

The Garrison RSO will continuously monitor activities in an RCA when personnel are in the RCA and maintain appropriate documentation of those activities. Garrison RSOs will perform an annual audit with license RSO review. The License RSO will review comprehensive radiation safety program content and implementation and will document the results of this review at least annually to ensure the following:

- Compliance with NRC and the terms and conditions of the license
- Occupational doses and doses to members of the public are ALARA (10 CFR Part 20, § 20.1101)
- Records of audits and other reviews of program content are maintained for 3 years

19.1 Purpose of annual audit

An audit is conducted, in part, to fulfill the requirements of 10 CFR Part 20.1101 for an annual review of the content and implementation of the radiation safety program. It should identify program weaknesses and allow licensees to take early corrective actions (before an NRC inspection). During an audit, the auditor needs to keep in mind not only the requirements of NRC's regulations, but also the licensee's commitments in its applications and other correspondence with NRC. The auditor should also evaluate whether the licensee is maintaining exposures to workers and the general public ALARA and, if not, make suggestions for improvement.

19.2 Guide for annual audit

The form in this section is for documentation of the annual audit of the radiation safety program. Guidance follows on completing each section of the form. In the "remarks" portions of the form, note any identified deficiencies, and the corrective actions taken (or to be taken). The following guidance is based on sample checklist from NUREG-1556, volume 7, appendix L:

- Section 1, Audit History. Enter the date of the last audit, whether any deficiencies were identified, and whether actions were taken to correct the deficiencies.
- Section 2, Organization and Scope of Program. Give a brief description of the organizational structure, noting any changes in personnel. Describe the scope of licensed activities at the audited location. Check whether the RSO is the person identified in the license and fulfills the duties specified in the license.
- Section 3, Training, Retraining, and Instructions to Workers. Ensure that workers have received the training required by 10 CFR Part 19, § 19.12. Be sure that, before being permitted to enter an RCA, the worker has received training. Note whether refresher training is conducted annually. Ensure by interview and/or observation of selected workers that they can implement the licensee's procedures.
- Section 4, Audits. Verify that audits fulfill the requirements of 10 CFR Part 20, § 20.1101, are conducted in accordance with licensee commitments, and are properly documented.

Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

- Section 5, Facilities. Verify that the licensee's facilities are as described in its license documents.
- Section 6, Radiation Surveys.
 - Verify that the licensee has appropriate, operable, and calibrated survey instruments available, that the instruments are calibrated (at the required frequency) in accordance with license conditions and in accordance with 10 CFR Part 20, § 20.2103. Calibration records must be retained for 3 years after the record is made.
 - Check that radiation levels in areas adjacent to use are within regulatory limits and in accordance with 10 CFR Part 20, § 20.2103.
 - Verify compliance with 10 CFR Part 20, § 20.1301. Records of surveys must be retained for 3 years after the record is made.
- Section 7, Transfer of Radioactive Material for Waste Disposal. Ensure that transfers are performed in accordance with 10 CFR Part 40, § 40.51. Records of surveys, receipt, and transfer must be maintained in accordance with 10 CFR Part 20, § 20.2103 and Part 40, § 40.51.
- Section 8, Personnel Radiation Safety. Evaluate the licensee's determination that unmonitored personnel are not likely to receive more than 10 percent of the allowable limits. If any worker declared her pregnancy in writing, evaluate the licensee's compliance with 10 CFR Part 20, § 20.1208. Check whether records are maintained as required by 10 CFR Part 20, §§ 20.2101, 2102, 2103, 2104 and 2106.
- Section 9, Auditor's Independent Measurements (If Made). The auditor should make independent survey measurements and compare the results with those made or used by the licensee.
- Section 10, Notification and Reports. Check on the licensee's compliance with the notification and reporting requirements in 10 CFR Parts 19, 20, and 30. Ensure that the licensee is aware of the telephone number for NRC's Emergency Operations Center: (301) 816-5100.
- Section 11, Posting and Labeling. Check for compliance with the posting and labeling requirements of 10 CFR Part 19, § 19.11; Part 20, §§ 20.1902 and 20.1904; and Part 21, § 21.6.
- Section 12, Recordkeeping for Decommissioning. Check to determine compliance with 10 CFR Part 40, § 40.36(f).
- Section 13, Bulletins and Information Notices. Check to determine if the licensee is receiving bulletins, information notices, NMSS Newsletters, and so on from the NRC. Check whether the licensee took appropriate action in response to NRC mailings.
- Section 14, Special License Conditions or Issues. Verify compliance with any special conditions on the licensee's license. If the licensee has any unusual aspect of its work, review and evaluate compliance with regulatory requirements.
- Section 15, Continuation of Report Items. This section is self-explanatory.
- Section 16, Problems or Deficiencies Noted; Recommendations. This section is self-explanatory.

- Section 17, Evaluation of Other Factors. Evaluate licensee management's involvement with the radiation safety program, whether the RSO has sufficient time to perform his/her duties, and whether the licensee has sufficient staff to manage the workload and maintain compliance with regulatory requirements.

19.3 Sample checklist

The following pages provide a sample checklist based on NUREG-1556, volume 7, appendix H.

The Garrison Annual Audit Questionnaire may be used when performing Garrison audit.

Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

Audit Report No. _____ License No. _____

Licensee's Name and Mailing Address:

Audit of Activities at (Address):

Contact at Audit Location: _____ Telephone No. _____ Date
of this Audit: _____

Summary of Findings and Action:

No deficiencies

Deficiencies

Action on previous deficiencies

Recommendations:

Auditor: _____ Date: _____
(Signature)

Garrison RSO²¹: _____ Date: _____
(Signature)

Reviewed by
License RSO: _____ Date: _____

(Signature)

²¹ The Garrison RSO's signature indicates participating in the annual audit and consequentially receiving annual license radiation safety refresher training from the License RSO.

Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

1. AUDIT HISTORY N/A (N/A means "Not applicable" – Initial Audit

A. Last audit of this location conducted _____

B. Problems/deficiencies identified during last two audits or two years, whichever is longer Y N

C. Open problems/deficiencies from previous audits:

Status Requirement	Prob/Def	Corrective Action Taken (Y/N)	Open/Closed
--------------------	----------	-------------------------------	-------------

D. Any previous problem/deficiency not corrected or repeated

Y N N/A

2. ORGANIZATION AND SCOPE OF PROGRAM

A. Briefly describe organizational structure

- 1. Structure is as described in license documents Y N
- 2. Multiple authorized locations of use Y N
- 3. Briefly describe scope of activities involving M101 DU, frequency of use, staff size, etc. Y N

B. Radiation Safety Officer Y N

- 1. Authorized on license Y N
- 2. Fulfills duties as RSO Y N

C. Use only by authorized individuals Y N

Remarks:

Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

3. TRAINING, RETRAINING, AND INSTRUCTIONS TO WORKERS

- A. Instructions to workers per [10 CFR Part 19.12] Y N
- B. Training program required Y N
- C. Training records maintained Y N
- D. Evaluation of individuals' understanding of procedures and regulations based on interviews, observation of selected workers Y N
- Adequate understanding of:
- Current safe use procedures Y N
- Emergency procedures Y N
- E. Part 20
- Workers cognizant of requirements for:
1. Radiation Safety Program [20.1101] Y N
2. Annual dose limits [20.1301, 20.1302] Y N
3. 10 percent monitoring threshold [20.502] Y N
4. Dose limits to embryo/fetus and declared pregnant women [20.1208] Y N

Remarks:

4. INTERNAL AUDITS, REVIEWS, OR INSPECTIONS

- A. Audits are conducted Y N
1. Audits conducted by _____
2. Frequency _____
- B. Content and implementation of the radiation safety program reviewed annually [20.1101(c)] Y N
- C. Records maintained [20.2102] Y N

5. FACILITIES

- Facilities as described in license application Y N

Remarks:

6. RADIATION SURVEYS

- A. Instruments and Equipment: Y N
- 1. Appropriate operable survey instrumentation possessed or readily available Y N
 - 2. Calibrated as required [20.1501] Y N
 - 3. Calibration records maintained [20.2103(a)] Y N
- B. Briefly describe survey requirements [20.1501(a)]:
- C. Performed as required [20.1501(a)] Y N
- 1. Radiation levels within regulatory limits Y N
 - 2. Corrective action taken and documented Y N
- D. Records maintained [20.2103] Y N
- E. Protection of members of the public
- 1. Adequate surveys made to demonstrate either (a) that the TEDE to the individual likely to receive the highest dose does not exceed 100 mrem in a year, or (b) that if an individual were continuously present in an unrestricted area, the external dose would not exceed 2 mrem in any hour and 50 mrem in a year [20.1301(a)(1), 20.1302(b)] Y N
 - 2. Unrestricted area radiation levels do not exceed 2 mrem in any one hour [20.1301(a)(2)] Y N
 - 3. Records maintained [20.2103, 20.2107] Y N

Remarks:

7. TRANSFER OF RADIOACTIVE MATERIAL FOR WASTE DISPOSAL

- A. Transfer(s) for "disposal" performed per [40.51] Y N N/A
- B. Records of transfer maintained [20.2103(a), 40.51] Y N

Remarks:

8. PERSONNEL RADIATION SAFETY

- A. ALARA considerations are incorporated into the Radiation Safety Program [20.1101(b)] Y N
- B. Adequate documentation of determination that unmonitored individuals are not likely to receive more than 10 percent of allowable limit [20.1502(a)] Y N N/A
- C. Worker declared her pregnancy in writing during inspection period (review records) Y N N/A
- If yes, determine compliance with [20.1208] Y N
- Check for records per [20.2106(e)] Y N
- F. Records of exposures, surveys, monitoring, and evaluations maintained [20.2102, 20.2103, 20.2106, L/C] Y N

Remarks:

9. AUDITOR'S INDEPENDENT MEASUREMENTS (IF MADE)

- A. Survey instrument Serial No. _____ Last calibration

- B. Auditor's measurements compared to licensee's Y N
- C. Describe the type, location, and results of measurements:

10. NOTIFICATION AND REPORTS N/A

- A. Licensee in compliance with [19.13, 30.50] (reports to individuals, public and occupational, monitored to show compliance with Part 20) Y N N/A
- B. Licensee in compliance with [20.2201, 40.60] (theft or loss) Y N None
- C. Licensee in compliance with [20.2202, 40.60] (incidents) Y N None
- D. Licensee in compliance with [20.2203, 40.60] (overexposures and high radiation levels) Y N None
- E. Licensee aware of telephone number for NRC Emergency Operations Center [(301) 816-5100] Y N

Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

11. POSTING AND LABELING

- A. NRC-Form 3 "Notice to Workers" is posted [19.11] Y N
- B. Parts 19, 20, 21, Section 206 of Energy Reorganization Act, procedures adopted pursuant to Part 21, and license documents are posted, or a notice indicating where documents can be examined is posted [19.11, 21.6] Y N
- C. Other posting and labeling per [20.1902, 1904] and the license is not exempted by [20.1903, 1905] Y N

Remarks:

12. RECORD KEEPING FOR DECOMMISSIONING (if needed) N/A

- A. Records of information important to the safe and effective decommissioning of the facility maintained in an independent and identifiable location until license termination Y N
- B. Records include all information outlined in [40.36(f)] Y N

Remarks:

13. BULLETINS AND INFORMATION NOTICES

- A. Receipt of NRC Bulletins, NRC Information Notices, NMSS Newsletters, and so on Y N
- B. Appropriate action taken in response to Bulletins, Information Notices, etc. Y N

Remarks:

14. SPECIAL LICENSE CONDITIONS OR ISSUES N/A

- A. Review special license conditions or other issues, and describe findings:
- B. Problems/deficiencies identified at licensee facilities other than at audit location:
- C. Evaluation of compliance:

15. CONTINUATION OF REPORT ITEMS N/A

(If more space is needed, use separate sheets, and attach to report.)

Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium

16. PROBLEMS OR DEFICIENCIES NOTED; RECOMMENDATIONS N/A

Note: Briefly state (1) the requirement and (2) how and when violated. Provide recommendations for improvement.

17. EVALUATION OF OTHER FACTORS

- A. Senior licensee management is appropriately involved with the radiation safety program and/or RSO oversight Y N
- B. RSO has sufficient time to perform his/her radiation safety duties and is not too busy with other assignments Y N
- C. Licensee has sufficient staff Y N

Remarks/recommendations:

Garrison Annual Audit Questionnaire of Davy Crockett Depleted Uranium NRC License

Please supply your answers within the document. Provide date completed, Garrison RSO information and signature (electronic or hard copy). Each “no” answer requires an explanation. Include documents or photos you wish to help document items in the annual audit.

Date performed: _____

1. Do you have a copy of the NRC license with NRC Operations Center phone number 301-816-5100 for emergencies (listed in license condition 20), 10 CFR 19, 20, 21, Section 206 of Energy Reorganization Act, and operating procedures? State which license amendment is on file.
2. Do you have a copy of every required document listed in license condition #11? Each is available on the NRC ADAMS website (<https://adams-search.nrc.gov/home>) with ML accession number.
3. Are procedures and controls in place, to extent practical, to ensure occupational doses and doses to members of the public that are as low as reasonably achievable (ALARA)?
4. Are “CAUTION — RADIOACTIVE MATERIAL” signs posted at a sufficient number of locations around each RCA to ensure that individuals entering the RCA are aware of the presence of DU?
5. Do you have a copy of each of the following to document qualifications, training, and appointment in support of the license?
 - a. Certificates of training for basic radiation safety and license-specific training?
 - b. A letter or memo from the garrison commander appointing the garrison RSO?
 - c. Workers, including range control, appropriately trained and aware of requirements?
6. Do you have at least two Geiger-Mueller pancake detectors, calibrated at least annual by a qualified calibration/repair facility, for alpha-beta-gamma surveys for contamination and frisking?
7. Is it correct that no worker informed you that she is a “declared pregnant worker”?
8. Was periodic environmental radiation monitoring performed?
9. Is it correct that no massive soil erosion (>25m²) occurred from within the RCA to areas outside? Massive soil erosion to areas outside RCA requires soil sampling (following UXO risk assessment).

10. The following questions are about all entries to an RCA at your location since the last audit. Were there no entries into the RCA?
- a. Were you aware of the entry before it happened?
 - b. Did these personnel receive pre-entry training? (Please supply a copy of documentation)
 - c. Did you check them and their vehicles and equipment for DU contamination with a calibrated pancake detector and meter when they exited the RCA? (Provide copy)
11. Are the following NRC-required postings at “a sufficient number of places” (usually in Garrison safety office and at Range Control)?
- a. The NRC Form 3, “Notice to Employees” (latest version)
 - b. NRC Notice of Violation (as applicable)
 - c. A notice where other required documents may be seen (usually in Garrison RSO office)
12. Is it true that no M101 DU spotting rounds or fragments were incidentally found? If no, answer the following and provide documentation.
- a. Was the DU found inside the RCA and documented?
 - b. Was the DU left in place and documented?
 - c. If picked up, was the DU double-bag in plastic bag, stored in sturdy container with marking, and coordination for appropriate disposal performed?
13. Is management appropriately involved, with SOHAC updates, and RSO has sufficient resources?
14. Have you corrected all problems or deficiencies noted during the last annual audit at your location?
15. Notes (as applicable):

Thank you for your support of the NRC license issued to CG IMCOM.

Auditor: _____
(Signature)

Date: _____

Garrison RSO²²: _____
(Signature)

Date: _____

License RSO: _____
(Signature)

Date: _____

²²The Garrison RSO's signature indicates participating in the annual audit and consequentially receiving annual license radiation safety refresher training from the License RSO.

20 Training

Before RCA entry, all personnel, except one-time visitors (see Section 2.6), will receive and acknowledge training on the requirements of this RSP. The Garrison RSO will conduct this training.

20.1 Frequency of Training

Personnel who enter an RCA will receive radiation safety training:

- Before assuming duties that involve entry into an RCA
- Whenever meaningful changes in duties, regulations, or license conditions occur
- Annually (refresher training)

20.2 Training Topics

The Garrison RSO will tailor training for personnel wanting to enter an RCA to be commensurate with the type of work they will perform. These personnel are not occupationally exposed to radiation and, so, only require a minimum of awareness and familiarization training that will assure compliance with this RSP.

20.2.1 General Radiation Safety Topics

General RCA worker radiation safety training may include the following topics at the discretion of the Garrison RSO:

- Fundamentals of radiation safety
- Characteristics of radiation
- Units of radiation dose (rem) and radioactivity (curie)
- Significance of radiation dose
- Radiation safety standards
- Biological effects of radiation
- Levels of radiation from sources of radiation
- Methods of controlling radiation dose
 - Time
 - Distance
 - Shielding
- Radiation safety practices, including prevention of contamination and methods of decontamination
- Discussion of internal exposure pathways
- Radiation detection instrumentation to be used
- Radiation survey instruments
 - Operation
 - Calibration
 - Maintenance
 - Limitations
- Survey techniques
- Individual monitoring devices

- Equipment to be used
- Handling equipment and remote handling tools
- Sources of radiation
- Storage, control, disposal, and transport of equipment and sources of radiation
- Requirements of pertinent federal and state regulations
- Written operating, safety, and emergency procedures
- Recordkeeping procedures

20.2.2 RCA-Specific Radiation Safety Topics

RCA-specific radiation safety training will include the following topics:

- Provisions of this RSP
- Radiological characteristics of DU and its biological effects
- Estimates of expected total effective dose equivalents
- Contamination control
- Decontamination, techniques, methods, procedures, and management practices
- Worker rights and responsibilities
- Emergency procedures for events such as personnel injury, fire, RCA evacuation, lightning, and so on
- Reporting of incidents
- Stop work procedures
- Special training and rights of declared pregnant workers

20.3 Training Documentation

The Garrison RSO will establish and maintain the following training documentation:

- Attendance rosters that include each attendee's name, signature, and organization for each class
- The time, date, and location of the training for each class
- The name of the instructor for each class
- The lesson plans for the RCA-specific radiation safety training

21 Recordkeeping

21.1 Garrison Documentation

The Garrison RSO will maintain the following garrison-specific documentation, which, upon request, will be provided to the License RSO in electronic form and, upon request, made available to the NRC:

- Minutes of Radiation Safety Committee or SOHAC²³ meetings
- Records of radioactive waste disposal of M101 DU
- RCA-specific radiation safety training records
- Instrument inventory and calibration records
- RCA exit monitoring forms, which will include purpose for entry into the RCA
- Notification of incidents
- Program audits
- Reports of overexposure and excessive levels and concentrations
- Notification and reports to individuals
- Any other records generated for the purposes of radiation safety during licensed activities

21.2 Radioactive Material License Documentation

The License RSO will maintain generally applicable license files and provide copies to all Garrison RSOs. For example, such files include:

- The current amendment of the license itself
- License-required documents
- NRC-required postings
- Standard Operating Procedures (see Section 23)
- Reports of annual audits
- Garrison RSO training records
- Environmental radiation monitoring results
- Reports of NRC inspections

²³In reference to IMCOM Reply to a Notice of Violation Report No. 04009083 (ADAMS Accession No. ML25239A662) and 29 CFR 1960.36 and 37, IMCOM HQ and Garrison may use the Safety and Occupational Health Advisory Council (SOHAC), to maintain open communication channels with management to monitor and assist the program.

22 Emergency Planning

The Garrison RSO will provide radiation safety support to supporting emergency medical personnel as necessary and upon request. The Garrison RSO will notify the License RSO as soon as possible when an emergency occurs within an RCA.

22.1 General

Range control maintains emergency response standard operating procedures (SOP). Information in that SOP includes:

- DIAL “911” for all emergencies.
- Contact information for local emergency care (emergency room, ambulances, etc.)

Army Medics are always present during training. Army air ambulances are available when needed.

22.2 Radiological Emergencies

Although unlikely, significant acute ingestion or inhalation of DU-contaminated dust could occur and is the only credible radiological emergency at the RCA. In such an event, the worker will be evacuated to the local supporting military medical facility for evaluation.

22.3 Non-Radiological Emergencies

Lifesaving and limb-saving emergency treatments always take priority over all radiation safety concerns, including decontamination. (Note that removal of outer clothing will remove most surface contamination.)

23 Standard Operating Procedures

The License RSO will produce and maintain the following SOPs for implementing this RSP.

Section(s)	Topic
2.4.1	License-specific training of the Garrison RSO
2.5.1 and 20	DU awareness and license requirement training for personnel who enter an RCA
9, 11, and 15	Exit monitoring ²⁴
11.1	Training and verification of workers to perform instrument scanning
12.1	Description and general list of requirements necessary to ensure adequate application of site-specific ERMPs
12.3	Calculation of Public Dose
17	Instrument use, maintenance, and calibration

²⁴This SOP includes and requires the use of an exit monitoring form. The purpose of entry into the RCA will be written on this form.