

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

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## Abbreviations and Acronyms

<sup>234</sup> U	uranium-234
<sup>235</sup> U	uranium-235
<sup>238</sup> U	uranium-238
AEC	Army Environmental Command
ALARA	as low as reasonably achievable
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
IMCOM	US Army Installation Management Command
m	meter
MDC	minimum detectable concentration
MEDCOM	US Army Medical Command
mL	milliliter
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

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TEDE      total effective dose equivalent  
USAG      US Army Garrison  
UXO      unexploded ordnance  
 $\mu$ Ci      Microcurie

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# 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 may have affected (Figure 1-1). 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)<sup>1</sup> 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 fissile<sup>2</sup> uranium-235 (<sup>235</sup>U) isotope, the leftover uranium is *depleted* in <sup>235</sup>U.<sup>3</sup> DU is useful in certain commercial and military applications because of its high density, which is about twice the density of lead. It is slightly radioactive, but it 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 pound that the Army used as part of the M28 Davy Crockett weapon system from 1960 to 1968. The M28 Davy Crockett weapon system was classified to some extent in the 1960s, and records of its use were guarded.

In 2005, the Army discovered tail assemblies from the M101 spotting round during range clearance before construction of a Battle Area Complex at the Schofield Barracks target impact area in Hawaii. The Army then began investigating various sites where the M101 spotting round may have been used. Characterization studies have

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<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> Uranium-234 (<sup>234</sup>U) is enriched or depleted as well in enriched uranium and DU, respectively, but it is not fissile.

determined that NRC-licensable quantities of DU in the form of M101 fragments exist at several IMCOM sites.<sup>4</sup>

## **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."<sup>5</sup> This RSP meets that requirement for an NRC-approved radiation safety program.

The purpose of this RSP is to address radiation safety issues that one may encounter 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 staff, 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, any and all other safety requirements, especially those related to unexploded ordnance in or around RCAs.

## **1.5 The unexpected and the unanticipated**

While all radiation safety contingencies are intended to be addressed by this plan, something unexpected or unanticipated may arise. If this occurs, the Garrison RSO will promptly establish appropriate procedures and then inform the License RSO.

The License RSO will inform the NRC as Title 10, Code of Federal Regulations (CFR), Part 20, Subpart M, requires.

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<sup>4</sup> These sites are Schofield Barracks/Pohakuloa Training Area HI, Fort Knox KY, Joint Base Lewis-McChord/Yakima Training Center WA, Fort Riley KS, Fort Polk LA, Fort Benning GA, Fort Campbell KY, Fort Bragg NC, Fort Carson CO, Fort Gordon GA, Fort Hood TX, Fort Hunter Liggett CA, Fort Jackson SC, and Fort Sill OK.

<sup>5</sup> "Meeting Report, November 16, 2010." Rockville, Maryland, US Nuclear Regulatory Commission, 2010 (ADAMS accession number ML103360437).



Figure 1-1 Davy Crockett M101 spotting round

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## ***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 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 submitting a new NRC Form 313.

### ***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 (including this RSP) in RCAs on the garrison.

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 installation 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 IMCOM ranges.

### **2.3.1 Qualifications**

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

#### **2.3.1.1. Education**

A Bachelors 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. Two years of relevant experience are generally considered 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 depleted uranium and its progeny, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to depleted uranium and its progeny, and a thorough understanding of how DU was used at the location and how the hazards are generated and controlled.

### **2.3.2 Duties**

The License RSO will:

- Coordinate with appropriate personnel as necessary to assure that routine range activities in RCAs comply the requirements of this RSP
- Provide recommendations to the Garrison RSO and other appropriate personnel for the control and, if possible, elimination of existing and potential radiological hazards
- Review and interpret analytical results for radiological samples
- 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
- Act 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
- Determine the need for personnel monitoring
- As necessary, evaluate bioassays, monitor personnel radiation exposure and bioassay records for trends and high exposures, notify individuals and their

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supervisors of radiation exposures approaching the limits, and recommend appropriate remedial action

- Conduct training programs and otherwise instruct personnel in the proper procedures
- Supervise and coordinate the radioactive waste disposal program, including recordkeeping on waste storage and disposal records.
- Oversee the storage of radioactive waste
- Maintain an inventory of all radioisotopes possessed under the license
- 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"
- Hold periodic meetings with, and provide reports to, licensee management
- Perform periodic audits of the radiation safety program 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 doses<sup>6</sup> 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 in excess of 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

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<sup>6</sup> 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.

### **2.3.3 Authority**

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<sup>7</sup>
- Task personnel of IMCOM Headquarters, IMCOM Regions, IMCOM garrisons, and the Army Environmental Command (AEC) within their capabilities and resources in order to maintain compliance with NRC regulations and license conditions<sup>7</sup>
- Immediately stop any operation involving the use of source material 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 during routine range activities. 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 Qualifications<sup>8</sup>**

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

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<sup>7</sup> HQ IMCOM Operations Order 11-302, Delegation of Authority to Nuclear Regulatory Commission (NRC) License Radiation Safety Officer (RSO) (U), 132138Z Apr 11

<sup>8</sup> The License RSO cannot allow any activities within any garrison RCA until he has determined that the Garrison RSO meets the training qualifications in Section 2.4.1.

The US Army Chemical School, US Army Medical Command, the National Guard Bureau, and US Army Materiel Command offer acceptable formal courses for garrison RSOs. 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, which is available at the website of the US Army Combat Readiness/Safety Center<sup>9</sup>
- How to use and maintain radiation safety instruments
- 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 and applicable NRC regulations and license conditions
- Discuss deviations from routine range activities that affect radiation safety with appropriate personnel and the License RSO
- Maintain a log of routine range activities in RCAs as they occur<sup>10</sup>
- Routinely report on radiation safety activities in RCAs at Garrison Radiation Safety Committee meetings (with appropriate documentation in the minutes of these meetings)
- Perform audits 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

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<sup>9</sup> The License RSO will make this available to the Garrison RSO.

<sup>10</sup> This log may be in the form of check boxes on the access control log. Each check box will correspond to a routine authorized range activity as shown in Chapter 4.

- 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 used at the RCA
- Ensure that all required radiation monitoring is performed at the RCA
- 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 source material 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 (or 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 approval of the License RSO.

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 the maximum extent practical.

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 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 in the NRC license amendment application. The License RSO will provide the figures pertinent to each installation to that installation's Garrison RSO, who will attach those figures to this RSP.

### **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, including this RSP.

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

### **3.3 DU removal**

A condition of the NRC license says that the Army shall not perform any decommissioning or ground disturbing activities to collect or remove depleted uranium fragments or contaminated soil that is identified during routine range activities in the RCAs without prior authorization from the NRC.

"Ground disturbing activities" for the purpose of this RSP include:

- excavations for construction, road-building and decommissioning
- tracked vehicle movement
- heavy wheeled vehicle (for example, Stryker) movement

Consequently, deliberate searches for and removal of DU are not authorized within an RCA except for explosive ordnance disposal (EOD) unexploded ordnance (UXO) blow-in-place activities (see Section 4.2). 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 Routine 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 that the Army may perform in the RCAs. Whenever any of the authorized range activities are performed in an RCA, the provisions of this RSP apply to those activities within the RCA in addition to any other safety or environmental requirements.

Casual visits within an RCA are not authorized.

Eating, drinking, smoking, and applying of cosmetics are not allowed in an RCA.

### **4.1 High-explosive fire in RCAs**

#### **4.1.1 Prohibition**

The NRC prohibits firing of HE rounds into any RCA.<sup>11</sup> The NRC may lift restrictions on HE fire into a specific RCA on a case-by-case basis as follows.

- Upon request of a garrison commander or garrison RSO, the License RSO will submit a plan to the NRC for air sampling during HE fire.
- After NRC approval of the air sampling plan, the License RSO will inform the NRC when the HE fire will occur.
- After NRC approval of the HE fire, the License RSO and garrison will implement the air sampling plan during the HE fire.
- The License RSO will submit a report of the results of the air sampling to the NRC along with a request to permit HE fire in the future with no air sampling.
- If the NRC approves the request, then HE fire is allowable subject to the notification requirement in the following sections.

#### **4.1.2 Notification requirement**

High explosive (HE) munitions will not be fired into an RCA until the License RSO has informed the NRC.<sup>12</sup> The Garrison RSO will assure that range operators, trainers, and planners are well aware of this requirement.

#### **4.1.3 Notification procedures**

Notification procedures follow.

- Range operators, trainers, and planners will notify the Garrison RSO as soon as they become aware of a training need to fire HE munitions into an RCA. They will provide the following information:

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<sup>11</sup> This prohibition for firing HE munitions into RCAs does not apply for other types of non-HE munitions, such as small-arms fire and inert training rounds.

<sup>12</sup> Sudden unexpected mission requirements may make it unfeasible to meet this notification requirement. In such situations, the License RSO will notify the NRC as soon as possible.

- Dates and times of HE fire
- Types and estimated numbers of HE munitions to be fired
- The Garrison RSO will forward this information to the License RSO.<sup>13</sup>
- The License RSO will provide the information to the NRC

#### **4.2 Unexploded ordnance in RCAs**

If UXO is encountered in an RCA, EOD personnel will determine the appropriate disposition in accordance with EOD policies and procedures.

If EOD personnel decide to remove the UXO, then it will be checked 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.

#### **4.3 Authorized range activities**

Range activities in RCAs not listed below in this section are not authorized and may not be performed unless and until authorization is received from the License RSO. Upon request, the License RSO will forward requests for additional range activities to the NRC for approval. Upon NRC approval, the License RSO will add those NRC-approved activities to the list.

The following routine range activities in RCAs are authorized. Records of these activities will be recorded in appropriate range logs that will be accessible to NRC inspectors as necessary. Range personnel shall provide copies of these records to the Garrison RSO to facilitate NRC inspections.

- HE fire under circumstances permitted by the NRC (see Section 4.1 for notification requirements)
- Standard marksmanship and weapons familiarization 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

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<sup>13</sup> If the Garrison RSO cannot contact the License RSO (who may be, for example, on leave or official travel), the Garrison RSO will contact the NRC directly.

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- 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 OIC Range-Walk to ensure range is ready for training activity
- On-site repair and recovery of vehicles, as necessary
- Police calls (for example, for 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 Native American organizations and 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

## **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.

“ALARA” will be implemented 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 will not be exceeded 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 <sup>a</sup>	AVERAGE <sup>b,c,f</sup>	MAXIMUM <sup>b,d,f</sup>	REMOVABLE <sup>b,c,e,f</sup>
U-natural, <sup>235</sup> U, <sup>238</sup> U, and associated decay products	5,000 dpm alpha/100 cm <sup>2</sup>	15,000 dpm alpha/100 cm <sup>2</sup>	1,000 dpm alpha/100 cm <sup>2</sup>

<sup>a</sup> 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.

<sup>b</sup> 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.

<sup>c</sup> 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.

<sup>d</sup> The maximum contamination level applies to an area of not more than 100 square centimeters (cm<sup>2</sup>).

<sup>e</sup> The amount of removable radioactive material per 100 cm<sup>2</sup> 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.

<sup>f</sup> 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 radiosensitivity 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). Therefore, a written declaration of pregnancy and required subsequent actions are not expected to be necessary.

However, 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

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- 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

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## ***7 Dosimetry***

Dosimetry is not required for entry into the RCA. See Section 6.1.

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## **8 Bioassay**

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

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## ***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 4.3).

Wear disposable gloves at all times when handling DU.

If RCA exit monitoring detects DU contamination, the Garrison RSO shall notify the License RSO for reconsideration of this policy.

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## ***10 Respiratory Protection***

Respiratory protection is not required for entry into the RCA. See Section 6.1.

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# **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, if necessary) are available at the hotlines.

The Garrison RSO will assure<sup>14</sup> 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 discovered.

### **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 vehicles to include:

- 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 cm<sup>2</sup> or dpm over smaller area

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<sup>14</sup> 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 is confident the worker is able to do so accurately, correctly, and in accordance with this RSP. The Garrison RSO will maintain records of such designations and the means by which the Garrison RSO confirmed the designated worker’s ability.

- Decontamination method(s) used, if necessary
- If initial decontamination efforts are not fully successful, interim contamination in units of dpm/100 cm<sup>2</sup> 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.

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## **12 Environmental Monitoring**

The License RSO will provide the NRC with details and results of any environmental monitoring, sampling, or testing for depleted uranium that may be relevant for an RCA.

### **12.1 Dose from external sources**

Each time someone enters an RCA, the garrison RSO will measure dose rates at each hotline and at worksites inside the RCA for the purpose of demonstrating compliance with 10 CFR Part 20, § 20.2130(b)(1).<sup>15</sup>

### **12.2 Environmental radiation monitoring**

The License RSO and garrison RSOs will assure that environmental radiation sampling and measurements are performed in accordance with the site-specific Environmental Radiation Monitoring Plan for each installation.

### **12.3 Drinking water**

Records of routine analysis for uranium to meet requirements of US Environmental Protection Agency (EPA) drinking water regulations (40 CFR Part 141) will be maintained for NRC review. The Garrison RSO will coordinate with the Garrison Department of Public Works, who performs these tests, to obtain and maintain copies of the records pertaining to uranium.

If the EPA drinking water maximum contaminant level for uranium (30 micrograms per liter) is exceeded, the Garrison RSO will notify the License RSO, who then will notify NRC.

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<sup>15</sup> 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 is confident the worker is able to do so accurately, correctly, and in accordance with this RSP. The Garrison RSO will maintain records of such designations and the means by which the Garrison RSO confirmed the designated worker's ability.

### **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 at 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.

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## 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.

**Error! Reference source not found.** and **Error! Reference source not found.** show the M101 DU RCAs on installation ranges. 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).”

Ten times the value for natural uranium<sup>16</sup> in Appendix C to 10 CFR Part 20 is 1000 µCi. A single intact M101 spotting round contains about 0.8 microcurie (µCi) of <sup>234</sup>U, 8.3 µCi of <sup>235</sup>U, and 63 µCi of <sup>238</sup>U, for a total uranium activity per M101 round of about 72 µCi. Fourteen intact M101 rounds contain more than 1000 µCi of DU. The Army believes it likely fired more than 14 M101 rounds on each of the M101 DU-affected ranges. Therefore, the Garrison RSO will post RCAs with “CAUTION, RADIOACTIVE MATERIAL” signs (see Figure 14-1).

The Garrison RSO, in coordination with range operations and training personnel and, as required, EOD personnel, will conspicuously post these signs 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 RCA boundary is unsafe or not feasible.

Signs will be made of weather-resistant material.

### 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.

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<sup>16</sup> Appendix C to 10 CFR Part 20 does not list DU. We assume the natural uranium value applies to DU.

### **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.

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

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## **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), known as the "hotline."

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.

The Garrison RSO will control access to the RCA in accordance with the above instructions and with the "Physical Security Plan for US Army Installation Management Command Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds," which is a part the license. The Garrison RSO will refer to the License RSO for additional guidance as necessary.

### **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**

Title 10 CFR Part 20, § 20.1904 requires that all containers that contain more than 100 microcuries of  $^{238}\text{U}$  or natural uranium<sup>17</sup> 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  $\mu\text{Ci}$  per gram, so 100  $\mu\text{Ci}$  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).

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<sup>17</sup> The activity in DU is mostly due to  $^{238}\text{U}$ . The activity in natural uranium is mostly due to  $^{234}\text{U}$  and  $^{238}\text{U}$  in equilibrium with each other. Table C in Appendix C to 10 CFR Part 20 does not list DU, but the inference is taken 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.

#### **17.1.1 Alpha-beta-gamma surveys**

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 44-9 Pancake G-M Detector (see Figure 17-1) with appropriate meter or an AN/PDR-77 with a pancake probe].

#### **17.1.2 Dose rate surveys**

The Garrison RSO will possess at least two dose rate meters for dose rate surveys to meet the requirements of 10 CFR Part 20, §20.2103(b)(1) [for example, a Ludlum Model 19 MicroR/Ratemeter (see Figure 17-2) or an AN/PDR-77 with a microR probe].

### **17.2 Instrument calibration and maintenance**

All instruments will be calibrated by a qualified calibration/repair facility 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  $\pm 20$  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 concentrations

According to the *Multi-Agency Radiation Survey and Site Investigation Manual (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 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 minimum detectable concentration (MDC) is the detection limit (counts) multiplied by an appropriate conversion factor to give units consistent with a site guideline, such as dpm/100 cm<sup>2</sup>. 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 different times are used, the License RSO will adjust the calculations accordingly.

For the present purposes,

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

$A$  is the effective area of the probe,  $\varepsilon_i$  is the instrument or detector efficiency,  $\varepsilon_s$  is the efficiency of the contamination source (surface efficiency),<sup>18</sup> and the final factor, which equals 1, helps put the units of scan MDC into dpm/100 cm<sup>2</sup>.

### 17.3.2 Scan minimum detectable concentrations

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

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<sup>18</sup> The ISO-7503-1 standard on the evaluation of surface contamination for beta-emitters and alpha emitters recommends an  $\varepsilon_s$  value of 0.5 for betas (maximum beta energy greater than 0.4 megaelectron volts (MeV)) and an  $\varepsilon_s$  value of 0.25 for alpha and betas (maximum beta energy between 0.15 MeV and 0.4 MeV).

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discusses the basis for estimating scanning MDCs and arrives at the following equation for scan MDC:

$$\text{Scan MDC} = \frac{\text{MDCR}}{\sqrt{pA\varepsilon_i\varepsilon_s}} \times \frac{100 \text{ cm}^2}{100 \text{ cm}^2}.$$

MDCR is the minimum detectable count rate (interpolated from MARSSIM Table 6.6),  $p$  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 cm<sup>2</sup>.



INDICATED USE: Alpha beta gamma survey; Frisking  
DETECTOR: Pancake type halogen quenched G-M  
WINDOW:  $1.7 \pm 0.3 \text{ mg cm}^{-2}$  mica  
WINDOW AREA: Active – 15 cm<sup>2</sup>; Open – 12 cm<sup>2</sup>  
EFFICIENCY (4 $\pi$  geometry): Typically 5 percent – <sup>14</sup>C; 22 percent – <sup>90</sup>Sr/<sup>90</sup>Y; 19 percent – <sup>99</sup>Tc; 32 percent – <sup>32</sup>P; 15 percent – <sup>239</sup>Pu  
SENSITIVITY: Typically 3300 cpm (mR h<sup>-1</sup>)<sup>-1</sup> (<sup>137</sup>Cs gamma)  
ENERGY RESPONSE: Energy dependent  
DEAD TIME: Typically 80 microseconds  
COMPATIBLE INSTRUMENTS: General purpose survey meters, ratemeters, and scalers  
OPERATING VOLTAGE: 900 volts  
CONNECTOR: Series C (*others available*)  
CONSTRUCTION: Aluminum housing with beige polyurethane enamel paint  
TEMPERATURE: –4 °F (–20 °C) to 122 °F (50 °C)  
SIZE: 1.8 inches (4.6 cm) height × 2.7 inches (6.9 cm) width × 10.7 inches (27.2 cm) length  
WEIGHT: 1 pound (0.5 kg)

Source: [www.ludlums.com](http://www.ludlums.com)

**Figure 17-1 Ludlum Model 44-9 Pancake G-M Detector**

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POWER: 2 each "D" cell batteries (housed in sealed compartment that is externally accessible)  
BATTERY LIFE: typically 2000 hours with alkaline batteries (battery condition can be checked on meter)  
CONSTRUCTION: cast and drawn aluminum with beige powder coat finish  
SIZE: 15.2 x 8.9 x 21.6 cm (6.0 x 3.5 x 8.5 in.) (H x W x L), without handle  
WEIGHT: 2.04 kg (4.5 lb), including batteries INDICATED USE: low-level ( $\mu$ R) gamma survey  
MEASUREMENT RANGE: 0–50  $\mu$ Sv/h (0–5000  $\mu$ R/hr)  
DETECTOR: 2.5 x 2.5 cm (1 x 1 in.) NaI (TI) scintillator  
SENSITIVITY: approximately 17,500 cpm/ $\mu$ Sv/h (175 cpm/ $\mu$ R/hr) ( $^{137}$ Cs gamma)  
ENERGY RESPONSE: energy dependent  
LINEARITY: reading  $\pm$ 10% of true value  
METER: 6.4 cm (2.5 in.) arc, 1 mA analog type  
METER DIAL: 0–25  $\mu$ R/hr, 0–50  $\mu$ R/hr, BAT TEST, High Voltage Test

### CONTROLS

ROTARY KNOB SELECTOR: 0–25, 0–50, 0–250, 0–500, 0–5000  $\mu$ R/hr, Instrument Off  
RESPONSE: toggle switch for FAST (4 seconds) or SLOW (22 seconds) from 10% to 90% of final reading  
AUDIO: built-in unimorph speaker with ON/OFF switch (greater than 60 dB at 0.6 meters [2 ft])  
HIGH VOLTAGE: pushbutton to display HV setting on meter  
BATTERY: pushbutton checks battery voltage  
RESET: pushbutton to zero meter  
LAMP: pushbutton to activate meter light  
CALIBRATION CONTROLS: accessible from front of instrument (protective cover provided)  
WORKING ENVIRONMENT: splashproof shields for outdoor use  
TEMPERATURE RANGE: -20 to 50 °C (-4 to 122 °F), may be certified for operation from -40 to 65 °C (-40 to 150 °F)

Source: [www.ludlums.com](http://www.ludlums.com)

Figure 17-2 Ludlum Model 19 MicroR/Ratemeter

## **18 Radioactive Waste**

The Garrison RSO, in coordination 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.

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## **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.

The License RSO will review 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, § 20.1101 for an annual review of the content and implementation of the radiation safety program. It should also 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 as low as is reasonably achievable (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 deficiencies that were identified and the corrective actions taken (or to be taken).

- 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 Radiation Safety Officer (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.

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- 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.
- 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 handle 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 L.

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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)

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

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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 a described in license documents  Y  N
  2. Multiple authorized locations of use  Y  N
  3. Briefly describe scope of activities involving source material, 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  Y
- C. Use only by authorized individuals  Y  N

Remarks:

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



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.)

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:

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## **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 there is a significant change in duties, regulations, or the terms of the license
- 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
- Hotline procedures
- 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 documentation, which will be provided to the License RSO in electronic form and, upon request, made available to the NRC:

- Minutes of Garrison Radiation Safety Committee meetings
- Records of radiation surveys, monitoring and disposal
- RCA-specific radiation safety training records
- Instrument inventory and calibration records
- RCA personnel entry logs to include reason for entry
- 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 a copy of each of the documents listed in Section 21.1 in license files.

## **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**

Life-saving 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.

<b>Section</b>	<b>Topic</b>
2.4.1	License-specific training of the Garrison RSO
2.5.1, 20	DU awareness and license requirement training for personnel who enter an RCA
17	Instrument use, maintenance, and calibration
9, 11, 15	Exit monitoring

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