

Radiation Safety Plan for US Army Garrison Hawaii Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds

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Abbreviations and Acronyms

²³⁴ U	uranium-234
²³⁵ U	uranium-235
²³⁸ U	uranium-238
ALARA	as low as reasonably achievable
ASR	Archive Search Report
CFR	Code of Federal Regulations
cm	centimeter
dpm	disintegration per minute
DPW	declared pregnant worker
DU	depleted uranium
EOD	explosive ordnance disposal
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
OTSG	Office of the Surgeon General
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
UXO	unexploded ordnance
μCi	microcurie

1 Introduction

The US Nuclear Regulatory Commission (NRC) has approved this Radiation Safety Plan (RSP). Among other things, it is intended for use when personnel enter, work in, and leave areas on US Army Garrison Hawaii ranges that may have been affected by Davy Crockett M101 spotting rounds (see figure in Section 23). The M101 spotting round contains depleted uranium (DU). The affected areas are controlled for radiation safety purposes and are radiation controlled areas (RCAs).

Changes to this RSP will be made only with NRC approval.

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 uranium-235 (^{235}U) isotope, the leftover uranium is depleted in ^{235}U . 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, either through inhaling dust or drinking contaminated water, for example.

A number of Army installations across the United States have residual DU contamination resulting from the testing of the M101 spotting round. The M101 spotting round was a 20-millimeter low-speed projectile, weighing approximately a pound that the Army used with the Davy Crockett recoilless rifle system from 1960 to 1968.

The Davy Crockett weapons system, including the M101 spotting round, 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 a range clearance exercise at the Army's Schofield Barracks target impact area in Hawaii. The Army then began investigating various sites where the M101 Spotting Round may have been used, and characterization studies have determined that NRC-licensable quantities of DU in the form of M101 fragments exist at several sites.

As required by NRC regulations, the US Army Installation Management Command submitted a license application for the possession of DU to the NRC. The NRC has stated, "Routine Army activities that would occur within the radiation control area of any of the Davey [*sic*] Crockett DU sites ... require the operation of a radiation safety program approved by the NRC via a license." This RSP is intended to meet that requirement for an NRC-approved radiation safety program.

1.2 Purpose

The purpose of this RSP is to address radiation safety issues that may be encountered during performance of routine range activities in RCAs and of any other activities involving M101 spotting round DU on US Army Garrison Hawaii ranges. The goals are to protect the health and safety of Army personnel and the general 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 to be used during performance of routine range activities in RCAs and of any other activities involving M101 spotting round DU on US Army Garrison Hawaii ranges.

1.4 Applicability

The requirements of this plan are applicable to all personnel, including the general 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 US Army Garrison Hawaii RSO (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.

2 Radiation Safety Organization and Responsibilities

2.1 US Army Installation Management Command (IMCOM) Commander

Regarding M101 spotting round DU on all IMCOM ranges, the Commanding General, IMCOM 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

2.2 US Army Garrison Hawaii Commander

Regarding M101 spotting round DU on installation ranges, the US Army Garrison Hawaii Commander is responsible to the IMCOM Commander for assuring compliance with requirements of NRC regulations and license conditions (including this RSP) in RCAs on his or her installation.

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

The NRC allows no activities within any RCAs until the License RSO has determined that the Garrison RSO meets the training qualifications in Section 2.4.1. The License RSO will maintain documentation that demonstrates Garrison RSO compliance with these training qualifications.

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 spotting round DU on US Army Garrison Hawaii ranges.

2.3.1 Qualifications

The License RSO will meet the NRC's education, training, and experience requirements. The IMCOM Commander will notify the NRC when the current License RSO departs and when he or she appoints a new License RSO. The appointment is subject to the approval of the NRC.

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 20.13011
- 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, evaluate bioassays, monitor personnel radiation exposure¹ and bioassay records for trends and high exposures, notify individuals and their supervisors of radiation exposures approaching the limits, and recommend appropriate remedial action
- Conduct training programs and otherwise instruct personnel in the proper procedures

¹ Under the direction of the License RSO, the Garrison RSO will monitor and record general personnel exposure by exposure rate measurements using appropriate handheld calibrated instruments during routine surveys in work areas and access control points. The License RSO may also use appropriate integrating area monitors or dosimeters to document estimates of personnel exposure.

- 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 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 and doses to members of the public that are ALARA in accordance with 10 CFR 20.1101 and required records are maintained.
- Ensure that the results of audits, identification of deficiencies, and recommendations for change are documented (and 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.

2.3.3 Authority

The License RSO has authority to:

- Directly contact personnel of IMCOM Headquarters, Regions, and garrisons in the performance of the above License RSO duties
- Task IMCOM Region and garrison personnel within their capabilities and resources in order to maintain compliance with NRC regulations and license conditions
- 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

2.4 US Army Garrison Hawaii 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

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 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, which will be documented, 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 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
- How to use and maintain radiation safety instruments and air samplers
- How to perform Garrison RSO duties 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 occur²
- 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
- 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 the RSP pending consideration by the Garrison Commander and License RSO

² This log may be in the form of check-boxes on the access control log. Each check-box will correspond to the a routine authorized range activity as shown in Chapter 4.

2.5 Personnel in the RCA

2.5.1 Training

Generally, personnel entering the RCA are not considered to be 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 employee assigned to the RCA includes the following:

- The right to refuse to work and/or stop work authority when the employee 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 are required to comply with the requirements of this RSP. Depending on the areas to be accessed and the nature of the visit, the Garrison will escort visitors in order to assure safe radiation safety practices as necessary.

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.

Unauthorized visitors, and visitors not meeting the specified qualifications, are not permitted within the RCA.

3 Radiation Controlled Areas

3.1 Identification

The St. Louis District of the US Army Corps of Engineers performed the Archive Search Report (ASR) Project from 2006 to 2011. The result was a report with annexes for specific installations that described Army efforts to identify Army ranges where the Army fired M101 Davy Crockett spotting rounds. The typical Davy Crockett range impact area is a rectangle, 1000 meters (m) × 1000 m = 1,000,000 m² ≈ 247 acres.

For the purposes of this plan and as a starting point, RCAs are M101 spotting round impact areas (and any similarly affected areas) identified in ASR annexes. The License RSO may add to ASR-identified areas in coordination with the Garrison RSO using information that was not available to or used by the ASR authors.

Figures in Section 23 show a typical Davy Crockett range impact area and the locations of actual M101 spotting round impact areas as determined by the ASR Project.

3.2 Changes to RCAs

The Garrison RSO and License RSO will be notified when M101 spotting round debris (or any other heretofore unknown radioactive material) is discovered on US Army Garrison Hawaii ranges outside of known RCAs. The Garrison RSO will establish a new or extended RCA to address this discovery. The Garrison RSO will forward information about the discovery and the location of the new or extended RCA to the License RSO. 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 spotting round DU impact area figures and documents, including this RSP.

Deliberate searches for and removal of DU are not authorized within an RCA except for EOD UXO blow-in-place activities (see Section 4.2). However, unintended discovery of M101 spotting round 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.

Only the NRC can authorize reduction to an RCA area once it is established.

4 Routine Range Activities Authorized in RCAs

The IMCOM license application to the NRC is for possession only of the DU from the M101 spotting rounds on US Army Garrison Hawaii ranges. Therefore, the NRC has strictly limited the types of activities that may be performed 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 explosives in RCAs

High-explosive munitions will not be fired into an RCA. The Garrison RSO will assure that this prohibition is well-known to range operators and trainers.

Department of Defense Directive Number 4715.11 (certified current as of 24 April 2007), paragraph 5.4.9.2 states, "... high-explosive munitions shall not be fired into the same area as DU." The NRC has reinforced this rule in some of its formal communications to IMCOM.

This ban on firing high-explosive munitions into RCAs does not apply for other types of non-high-explosive munitions such as small-arms fire.

4.2 Unexploded ordnance (UXO) in RCAs

If unexploded ordnance (UXO) is encountered in an RCA, explosive ordnance disposal (EOD) personnel will determine the appropriate disposition in accordance with EOD policies and procedures.

If EOD personnel decide to remove the UXO (if safe), 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.
- The Garrison RSO will perform air sampling beginning shortly before the detonation and continuing for at least 15 minutes after the detonation or until the dust settles, whichever is later. As a minimum, two air samplers will be placed downwind of the blast area.

In coordination with the License RSO, the Garrison RSO will collect and send the air sampling filters along with pertinent information (such as sampling time) to a radiological laboratory for analysis. The License RSO will retain results of the laboratory analyses.

If results for at least three EOD blow-in-place detonations show concentrations of DU in air that do not exceed the action level, the License RSO may ask the NRC to relax the requirement for future air sampling during EOD detonations. The action level is 5×10^{-15} microcurie per milliliter ($\mu\text{Ci}/\text{mL}$) of air, which is 10 percent of the air effluent limit for ^{234}U (5×10^{-14} $\mu\text{Ci}/\text{mL}$) in Table 2, 10 CFR 20.

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 should provide copies of these records to the Garrison RSO to facilitate NRC inspections.

- Standard marksmanship and weapons familiarization training
- Down-range movement throughout the expanse of the range by mounted and dismounted personnel
- 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 OIC Range-Walk to ensure range is ready for training activity

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- 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 Hawaiian organizations and cultural practitioners for purposes of the Native American Graves Protection and Repatriation Act, Section 106 consultation, and cultural access
- Environmental Radiation Monitoring Plan (see Section 12) and range reclamation activities
- Radiological surveys and quality assurance, quality control, and audits to support the other listed activities

Of the activities listed above, controlled range burns are the most likely to produce airborne DU, although this is still unlikely. Air sampling during range burns will be performed in order to produce data for comparison with the action level of 5×10^{-15} $\mu\text{Ci/mL}$ of air. If results for at least three controlled range burns show concentrations of DU in air that do not exceed the action level, the License RSO may ask the NRC to relax the requirement for future air sampling during controlled range burns.

The License RSO will evaluate other activities expected to produce large dust clouds and may require air sampling during those activities.

The Garrison RSO will be present and operate access control points whenever personnel enter an RCA (see Section 11.1).

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 occupationally 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 kept ALARA, taking technological and socioeconomic factors into account.

The ALARA program will be implemented through the use of 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 be allowed to 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 to a worker or member of the public due to Davy Crockett DU in impact areas on IMCOM ranges show that the NRC annual public dose limit of 0.100 rem will not be exceeded.

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 also ALARA.

Table 6-1 Acceptable surface contamination levels

<i>NUCLIDE</i> ^a	<i>AVERAGE</i> ^{b,c,f}	<i>MAXIMUM</i> ^{b,d,f}	<i>REMOVABLE</i> ^{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 radiosensitivity of the embryo/fetus, the NRC has set the dose limit to the embryo/fetus of a declared pregnant worker (DPW) at 500 mrem TEDE for the period of gestation. It has determined that this limit provides an adequate margin of safety for the embryo/fetus. Upon a written declaration of pregnancy by a DPW (see sample declaration below), the Garrison RSO will:

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- Perform a retrospective review of the dose received by the DPW to date during the period of gestation.³ Exposure limits for the remaining balance of the dose will be set at that time if necessary.
- Counsel the DPW regarding the fetal risks for radiation exposure and the options to limit the radiation dose to the fetus for the balance of the pregnancy period as described in NRC Regulatory Guide 8.13. The Garrison RSO will provide a copy of NRC Regulatory Guide 8.13 to the DPW. A fetal dosimeter is not required.
- Provide increased radiation safety surveillance of the DPW (for example, take exposure rate measurements more often and at the DPW's worksite) to ensure that radiation exposure is maintained ALARA.

Sample DPW Declaration:

To: (Name of the Garrison RSO, your supervisor or other employer representative)

I am declaring that I am pregnant. I believe I became pregnant in _____, (you need only provide the month and year).

I understand that regulations do not allow my occupational radiation dose during my entire pregnancy to exceed 0.5 rem (unless that dose has already been exceeded between the time of conception and submitting this letter). I also understand that meeting the lower dose limit may require a change in job or job responsibilities during my pregnancy.

If I find out that I am not pregnant, or if my pregnancy is terminated, I will promptly inform you in writing that my pregnancy has ended. (This promise to inform your employer in writing when your pregnancy has ended is optional. You may cross out the sentence if you wish.)

(Your signature)

(Your name printed)

(Date)

³ The Garrison RSO will review records of all environmental exposure rates measured in RCAs that the DPW visited during the period of gestation for indications of exposure rates above background. He will document this review along with the DPW's occupancy time in RCAs. He will forward a copy of this documentation to the License RSO for final review and entry into license records.

7 Dosimetry

Dosimetry is not required for entry into the RCA.

8 Bioassay

Bioassay is not normally required for entry into or following exit from the RCA. The Garrison RSO will consult with the License RSO if it is believed 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 spotting round DU on US Army Garrison Hawaii 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 on personnel or equipment, the Garrison RSO shall notify the License RSO for reconsideration of this policy.

10 Respiratory Protection

Respiratory protection is not required for entry into the RCA.

If air sampling detects DU in air above the action level (see Section 4.2 and Section 4.3), the License RSO will reconsider of this policy.

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 perform instrument scanning on personnel, vehicles and equipment at the hotline as they exit the RCA.

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. Usually, washing with soap and water will achieve complete DU decontamination. The Garrison RSO will consult with the License RSO if other decontamination measures become necessary.

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). Usually, washing with soap and water will achieve complete DU decontamination. The Garrison RSO will consult with the License RSO if other decontamination measures become necessary.

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 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.

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

A separate Environmental Radiation Monitoring Plan provides environmental monitoring requirements.

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 spotting round DU itself, are expected to be at the RCA. (Also, see Section 18.)

The Garrison RSO will maintain a log of all M101 spotting round 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 controlled 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 spotting round DU impact area on the installation as an RCA.

Plates in Section 23 show the M101 spotting round DU impact areas on the installation. 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 (^{234}U , ^{235}U , and ^{238}U) values for DU in Appendix C are 0.01 μCi , 0.01 μCi and 1000 μCi for ^{234}U , ^{235}U , and ^{238}U , respectively. A single M101 spotting round contains about 0.8 μCi , 8.3 μCi , and 63 μCi of ^{234}U , ^{235}U , and ^{238}U , respectively. Therefore, the RCA will be posted with “CAUTION, RADIOACTIVE MATERIAL” signs.

As a minimum, the Garrison RSO, in coordination with range operations and training personnel and, as required, EOD personnel, will conspicuously post these signs as a minimum:

- At each corner of the RCA
- At 200-m intervals on the perimeter of the RCA

The signs will be made of weather-resistant material.

14.2 Radiation area

A radiation area is an area, accessible to personnel, in which radiation levels could result in which an individual could be exposed to five milliroentgens in one hour at thirty centimeters from the source or from any surface through which the radiation penetrates.

M101 spotting round DU on US Army Garrison Hawaii ranges is not in sufficient quantity or form to 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.

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 [IMCOM has applied for the license; the NRC has not yet issued it]
- The operating procedures applicable to licensed activities (specifically, this RSP and the environmental radiation monitoring plan)

If posting of any of these documents specified in this sub-section is not practicable, the Garrison RSO instead may post a notice which 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.

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 a minimum number of 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.

Official visitors will be escorted by personnel otherwise qualified to enter the RCA.

The Garrison RSO will control access to the RCA in accordance with the above instructions and with the "Physical Security Plan for US Army Garrison Hawaii Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds." He or she 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. The following extract from DA PAM 385-63, Range Safety, 4 August 2009, is provided for information purposes:

2-1. Restricting access to impact areas

- a. Unauthorized persons are prohibited from entering the installation training complex. ...
- b. Unauthorized persons are prohibited from entering impact areas and other areas known or suspected to contain UXO by use of positive controls, to include fencing and posting of UXO hazard warning signs. ...
- ...
- e. Access into temporary and/or dedicated impact areas will be strictly controlled. ...
- f. Personnel access to high hazard impact areas is limited to qualified EOD personnel, range control, range maintenance, and safety personnel designated by the installation range control officer. The installation commander may approve entry into impact areas by non-[Department of Defense] personnel on a case-by-case basis.

...

h. Digging entrenchments, foxholes, slit trenches, or any other activities that disturbs earth within an impact area is not permitted unless authorized by the installation range control officer. Maneuvers within a temporary impact area that include bivouac must prevent disturbing earth by driving poles, pegs, and so forth, into the ground, trenching around tents, or any activity that could disturb a dud located just beneath the ground surface. Open fires will not be permitted.

i. Unauthorized personnel are prohibited from handling UXO and munitions or removing them from the training complex. Procedures (for example, amnesty boxes) will be established for turn in of ammunition and explosives items by unauthorized personnel.

j. All normal vehicular and foot traffic approaches to ranges and impact areas will be guarded by range guards, properly instructed in their duties, or closed off by appropriate barriers, as determined by the installation range control officer. When barriers are used, appropriate signs will be posted.

...

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}U or of natural uranium⁴ 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 microcurie per gram, so 100 microcuries of DU has a mass of about 250 grams or 9 ounces. A single, intact M101 spotting round contains about 190 grams of DU.

The only containers of M101 spotting round DU on the installations should be containers of DU being held for disposal as radioactive waste (see Section 18).

⁴ 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 explicitly, but the inference is taken that the labeling requirement for an activity of more than 100 microcuries should also apply for DU.

17 Instrumentation

Section 25 shows examples of commercial instruments. Instruments such as these, including those in RADIAC Set AN/PDR-77, are suitable for use in support of this RSP.

17.1 Essential instruments

The Garrison RSO, in consultation with the License RSO, as necessary, will assure that appropriate calibrated instruments are available for use by appropriately trained personnel before allowing personnel access to the RCA. This generally means that the Garrison RSO will possess at least two (in case one is turned in for calibration) of each of the following types of detectors with appropriate ratemeters:

- A pancake Geiger-Mueller detector for alpha-beta-gamma surveys for surface contamination and frisking (examples: Ludlum Model 44-9 Pancake G-M Detector; AN/PDR-77 with a pancake probe)
- A thin window scintillator instrument for alpha-beta contamination surveys (examples: Ludlum Model 43-89 Alpha/Beta Scintillator; AN/PDR-77 with an alpha probe)
- A detector for measuring exposure rates at background levels (examples: Ludlum Model 19A MicroR Meter; AN/PDR-77 with a Gamma Micro "R" probe)

As necessary, the Garrison RSO will use a specialized detector for *in situ* scanning of soil in EOD "blow in place" blast zones (see Section 4.2) (example: Ludlum Model 44-10 Gamma Scintillator).

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.

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 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 to be greater than background. The *detection limit* (L_D) is an *a priori* estimate of the detection capability of a measurement system and is also 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 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 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, ε_i is the instrument or detector efficiency, ε_s is the efficiency of the contamination source,⁵ and the final factor, which equals 1, helps put the units of scan MDC into dpm/100 cm².

⁵ 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 volts (MeV)) and an ε_s value of 0.25 for alpha and betas (maximum beta energy between 0.15 MeV and 0.4 MeV).

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 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 1, helps put the units of scan MDC into dpm/100 cm².

18 Radioactive Waste

The Garrison RSO, in coordination with EOD personnel, will double-bag in plastic bags all M101 spotting round 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 bags then 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. This documentation will be provided periodically to the License RSO for his or her license files.

The License RSO will review the radiation safety program content and implementation and 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 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 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 will be used to document 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 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 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 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 20.2103. Verify compliance with 10 CFR 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 40.51. Records of surveys, receipt, and transfer must be maintained in accordance with 10 CFR 20.2103 and 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 20.1208. Check whether records are maintained as required by 10 CFR 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 19.11, 20.1902, 20.1904, and 21.6.
- Section 12, Recordkeeping for Decommissioning. Check to determine compliance with 10 CFR 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)

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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 cy 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 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:

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 to personnel wanting to enter an RCA to be commensurate with the type of work to be performed. Generally, 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 Radiation RCA worker training may include the following topics:

- 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 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 an emergency response SOP. Information in that SOP includes:

- DIAL "911" for all emergencies.
- The Army Urgent Care Clinic provides primary emergency medical care.

Phone number: (808) 433-8850
Building 683
Schofield Barracks, Hawaii 96857

- The Queen's Medical Center Emergency Department provides catastrophic emergency medical care.

Phone number: (808) 547-4311
1301 Punchbowl Street
Honolulu, Hawaii 96813

- Tripler Army Medical Center Emergency Department provides catastrophic emergency medical care.

Phone number: (808) 433-6629/3710
1 Jarrett White Road
Honolulu, Hawaii 96859

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

22.2 Radiological Emergencies

Although unlikely if personnel follow normal precautions and personal hygiene measures, 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.

As information for supporting medical personnel, current US Army Medical Command guidance is in OTSG/MEDCOM Policy Memo 09-038, 18 June 2009 (expires 18 June 2011), subject: Medical Management of Army Personnel Exposed to Depleted Uranium (DU).

22.3 Non-Radiological Emergencies

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

23 Standard Operating Procedures

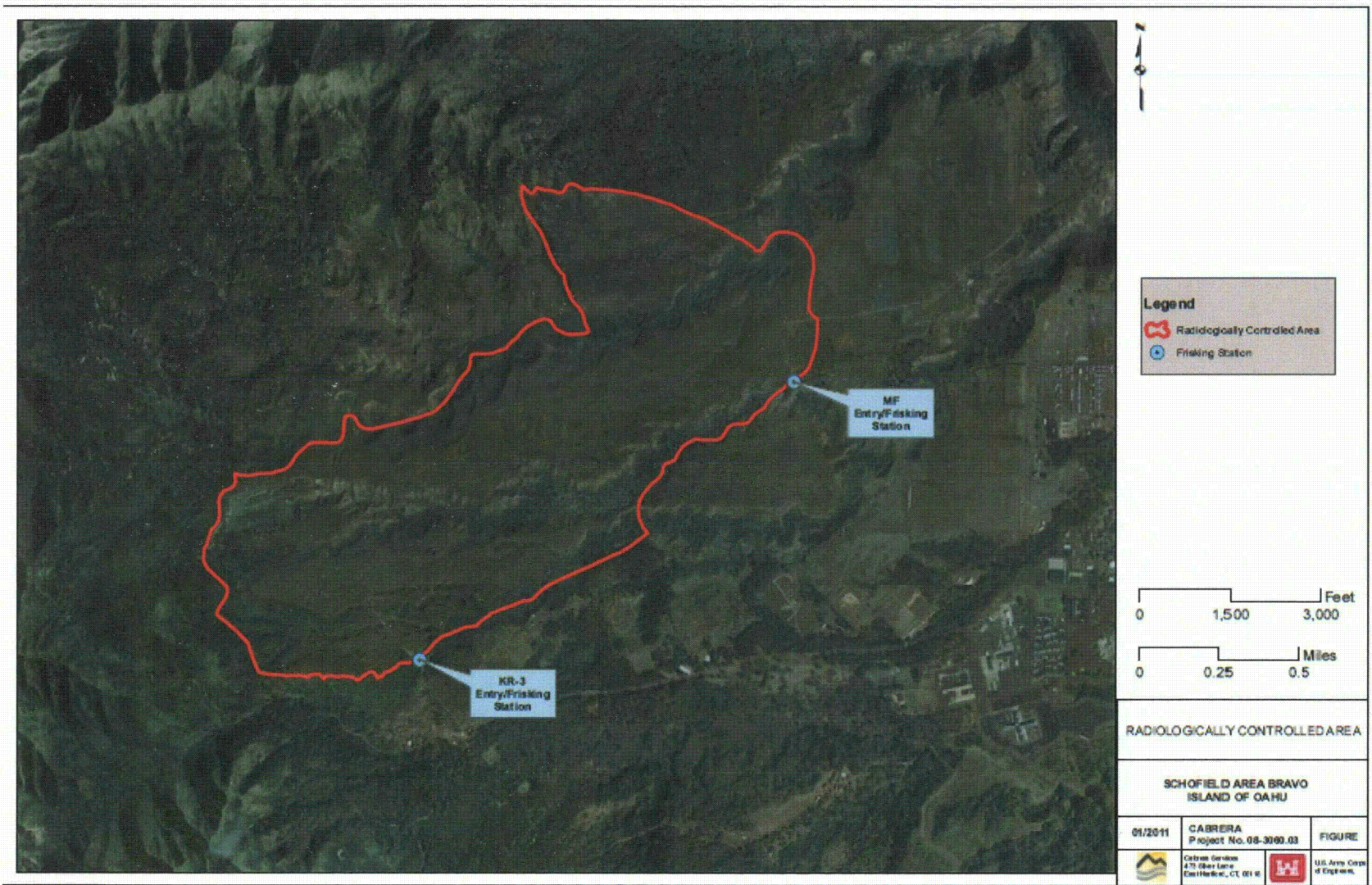
The License RSO will produce and maintain the following SOPs for implementing this RSP.

Section	Topic
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
4.2, 4.3	Air sampling
5.3	ALARA program
6.2, 11, 15	Contamination surveys, decontamination techniques, and hotline operations
13, 18	Radioactive material inventory control
17	Instrument use, maintenance, and calibration

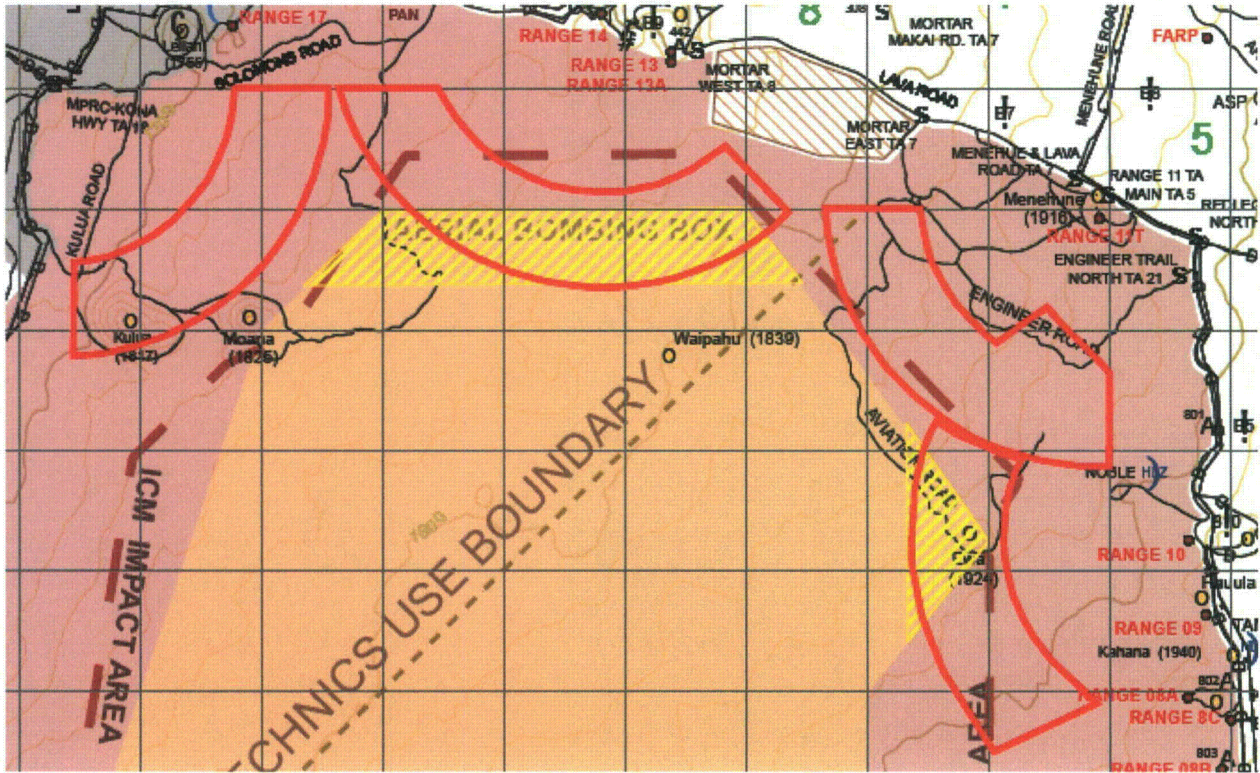
24 Figures



M101 spotting round



Radiation Safety Plan for US Army Garrison Hawaii Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds



RCAs at Pohakuloa Training Area, Island of Hawaii

25 Example Instrumentation

Ludlum Model 12 Ratemeter

COMPATIBLE DETECTORS: G-M, proportional, scintillation
METER DIAL: 0 - 500 cpm, 0 - 2.5 kV, BAT TEST (*others available*)

MULTIPLIERS: $\times 1$, $\times 10$, $\times 100$, $\times 1000$

LINEARITY: Reading within plus or minus 10 percent of true value with detector connected

CONNECTOR: Series "C" (*others available*)

AUDIO: Built in unimorph speaker with ON/OFF switch
(*greater than 60 dB at 2 feet*)

CALIBRATION CONTROLS: Accessible from front of instrument (*protective cover provided*)

HIGH VOLTAGE: Adjustable from 200 – 2500 volts (*can be read on meter*)

DISCRIMINATOR: Adjustable from 2 – 60 mV

RESPONSE: Toggle switch for FAST (4 s) or SLOW (22 s) from 10 percent to 90 percent of final reading

RESET: Push-button to zero meter

POWER: 2 each D cell batteries (*housed in sealed compartment that is externally accessible*)

BATTERY LIFE: Typically 600 hours with alkaline batteries (*battery condition can be checked on meter*)

METER: 2.5" (6.4 cm) arc, 1 mA analog type

CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint

TEMPERATURE RANGE: -4° F (-20° C) to 122° F (50° C)

SIZE: 6.5 inches (16.5 cm) height \times 3.5 inches (8.9 cm) width \times 8.5 inches (21.6 cm) length

WEIGHT: 3.5 lbs (1.6 kg) including batteries



Radiation Safety Plan for US Army Garrison Hawaii Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds

Ludlum Model 19A MicroR Meter

WORKING ENVIRONMENT: Splash proof shields for outdoor use

INDICATED USE: Low level gamma survey

DETECTOR: 1-inch × 1-inch sodium iodide NaI(Tl) scintillator

SENSITIVITY: Typically 175 cpm ($\mu\text{R h}^{-1}$)⁻¹ (¹³⁷Cs gamma)

ENERGY RESPONSE: Energy dependent

METER DIAL: 0 – 500 $\mu\text{R h}^{-1}$ dual colored logarithmic scale,

BAT TEST

ALARM: Indicated by red lamp and audible tone (Alarm audio overrides the audio ON/OFF switch)

LIGHT: Push-button to activate

LINEARITY: Reading within ± 10 percent of true value

AUDIO: Built in unimorph speaker with ON/OFF switch (greater than 60 dB at 2 feet)

CALIBRATION CONTROLS: All calibration controls are internal

RESPONSE: Dependent on number of counts present (typically not greater than 7 seconds from 10 percent to 90 percent of final reading)

RESET: Push-button to zero meter

POWER: 2 each "D" cell batteries (housed in sealed compartment that is externally accessible)

BATTERY LIFE: Typically 600 h with alkaline batteries (battery condition can be checked on meter)

METER: 2.5 inches (6.4 cm) arc, 1 mA analog type

CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint

TEMPERATURE RANGE: -4°F (-20°C) to 122°F (50°C)

SIZE: 7.8 inches (19.8 cm) height × 3.5 inches (8.9 cm) width × 8.5 inches (21.6 cm) length

WEIGHT: 4.5 pounds (2.1 kg) including batteries



Radiation Safety Plan for US Army Garrison Hawaii Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds

Ludlum Model 43-89 Alpha/Beta Scintillator

INDICATED USE: Alpha-beta survey

SCINTILLATOR: ZnS(Ag) adhered to 0.010-inch thick plastic scintillation material

WINDOW: Typically 1.2 mg cm^{-2} aluminized Mylar

WINDOW AREA: Active – 125 cm^2 ; Open – 100 cm^2

EFFICIENCY (4π geometry): Typically 16 percent – ^{239}Pu ; 5 percent – ^{99}Tc ; 16 percent – $^{90}\text{Sr}/^{90}\text{Y}$

BACKGROUND: Alpha - Less than 3 cpm; Beta - Typically 300 cpm or less ($10 \mu\text{R h}^{-1}$ field)

NON-UNIFORMITY: Less than 10 percent

CROSS TALK: Alpha to Beta - Less than 10 percent; Beta to Alpha - Less than 1 percent

COMPATIBLE INSTRUMENTS: Model 2224, 2360, 2929

TUBE: 1.5 inches (3.8cm) diameter magnetically shielded photomultiplier

OPERATING VOLTAGE: Typically 500 - 1200 volts

DYNODE STRING RESISTANCE: 100 megohms

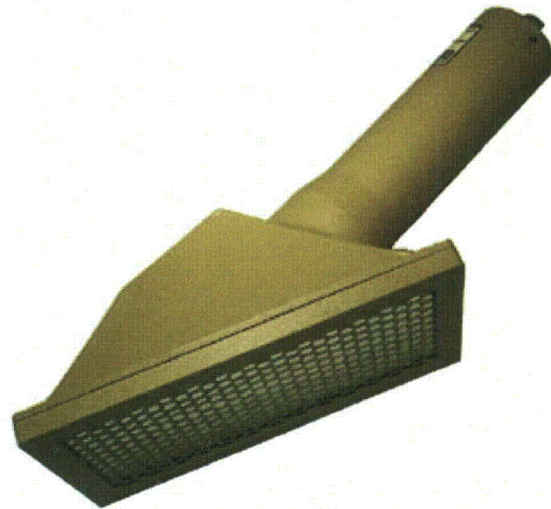
CONNECTOR: Series C (others available)

CONSTRUCTION: Aluminum housing with beige polyurethane enamel paint

TEMPERATURE RANGE: $-4^\circ \text{ F} (-20^\circ \text{ C})$ to $122^\circ \text{ F} (50^\circ \text{ C})$

SIZE: 5.5 inches (13.9 cm) height \times 4 inches (10.2 cm) width \times 12.3 inches (33 cm) length

WEIGHT: 1.5 lb (0.7kg)



Radiation Safety Plan for US Army Garrison Hawaii Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds

Ludlum Model 44-9 Pancake G-M Detector

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^2 ; Open – 12 cm^2

EFFICIENCY (4π geometry): Typically 5 percent – ^{14}C ; 22 percent – $^{90}\text{Sr}/^{90}\text{Y}$; 19 percent – ^{99}Tc ; 32 percent – ^{32}P ; 15 percent – ^{239}Pu

SENSITIVITY: Typically $3300 \text{ cpm (mR h}^{-1}\text{)}^{-1}$ (^{137}Cs gamma)

ENERGY RESPONSE: Energy dependent

DEAD TIME: Typically $80 \mu\text{s}$

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 RANGE: -4° F (-20° C) to 122° F (50° C)

SIZE: 1.8 inches (4.6 cm) height \times 2.7 inches (6.9 cm) width \times 10.7 inches (27.2 cm) length

WEIGHT: 1 lb (0.5kg)



Radiation Safety Plan for US Army Garrison Hawaii Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds

Ludlum Model 44-10 Gamma Scintillator

INDICATED USE: High energy gamma detection

SCINTILLATOR: 2-inch (5.1-cm) diameter × 2-inch (5.1-cm) thick NaI(Tl) scintillator

SENSITIVITY: Typically 900 cpm ($\mu\text{R h}^{-1}$)⁻¹ (¹³⁷Cs)

ENERGY RESPONSE: Energy dependent

COMPATIBLE INSTRUMENTS: General purpose survey meters, ratemeters, and scalers

TUBE: 2-inch (5.1cm) diameter magnetically shielded photomultiplier

OPERATING VOLTAGE: Typically 500 – 1200 volts

DYNODE STRING RESISTANCE: 60 megohms

CONNECTOR: Series C (others available)

CONSTRUCTION: Aluminum housing with beige polyurethane enamel paint

TEMPERATURE RANGE: -4° F (-20° C) to 122° F (50° C)

SIZE: 2.6 inches (6.6 cm) diameter × 11 inches (27.9 cm) length

WEIGHT: 2.3 pounds (1.1kg)



Radiation Safety Plan for US Army Garrison Hawaii Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds

Ludlum Model 2221, Scaler/Ratemeter Single Channel Analyzer

INDICATED USE: Field analysis

COMPATIBLE DETECTORS: G-M, proportional, scintillation

CONNECTOR: Series "C" (others available)

AUDIO: Built in unimorph speaker with volume control (greater than 60 dB at 2 feet, full volume)

AUDIO DIVIDE: Thumb switch for 1, 10, or 100 events-per-click

AUDIO JACK: For optional headset

METER DIAL: 0 - 500 cpm; 50 - 500k cpm logarithmic scale (others available)

MULTIPLIERS: $\times 1$, $\times 10$, $\times 100$, $\times 1k$, and LOG for logarithmic scale

LINEARITY: Reading within $\pm 10\%$ of true value with detector connected

DIGITAL DISPLAY: 6-digit LCD display with 0.5" (1.3 cm) digits

LCD BACKLIGHT: Activated by LAMP switch

DIGITAL RATEMETER: Provides a digital display of count rate when selector switch is in Dig. Rate position

SCALER: Used in conjunction with timer to allow for gross counting with range from 0 - 999999 counts when

selector switch is in Scaler position (controlled by COUNT and HOLD buttons)

TIMER: Switch selectable divisions of 0.1, 0.5, 1, 2, 5, 10 minutes or CONT (continuous) for manual timing

CALIBRATION CONTROLS: Accessible from front of instrument (protective cover provided)

HIGH VOLTAGE: Adjustable from 200 - 2400 volts (can be checked on display)

THRESHOLD: Adjustable from 100 - 1000 (can be checked on display)

WINDOW: Adjustable from 0 - 1000 above threshold setting (can be turned on or off)

GAIN: Adjustable from 1.5 - 100 mV at threshold setting of 100

OVERLOAD: Senses detector saturation. Indicated by "-----" on LCD display and meter going to full scale (adjustable depending on detector selected)

RESPONSE: Toggle switch for FAST (4 seconds) or SLOW (22 seconds) from 10% to 90% of final reading

RESET: Push-button to zero meter

POWER: 4 each "D" cell batteries (housed in sealed compartment that is externally accessible)

BATTERY LIFE: Typically 250 hours with alkaline batteries (battery condition can be checked on digital display)

METER: 2.5" (6.4 cm) arc, 1 mA analog type

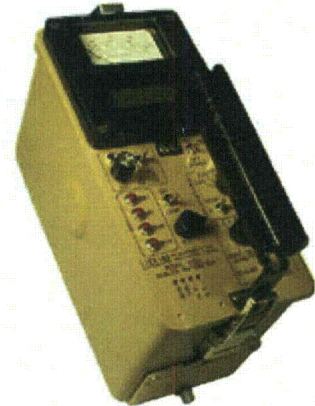
CONSTRUCTION: Milled and drawn aluminum with beige polyurethane enamel paint

TEMPERATURE RANGE: -4° F (-20° C) to 122° F (50° C)

May be certified for operation from -40° F (-40° C) to 150° F (65° C)

SIZE: 9" (22.9 cm) height \times 4.3" (10.9 cm) width \times 10" (25cm) length including handle

WEIGHT: 5.5 lbs (2.5kg) including batteries



Radiation Safety Plan for US Army Garrison Hawaii Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds

Ludlum Model 2224 Alpha/Beta Scaler/Ratemeter

INDICATED USE: Simultaneous alpha, beta counting and discrimination

COMPATIBLE DETECTORS: Proportional and dual phosphor scintillation detectors

CONNECTOR: Series C (others available)

AUDIO: Built in unimorph speaker with volume control (greater than 60 dB at 2 feet, full volume)

AUDIO DIVIDE: Selectable dual or individual click-per-event for alpha and beta counts and divisions of 1, 10, 100, or 1000 events-per-click (beta counts only)

METER: 2.5 inches (6.4 cm) arc, 1 mA analog type

METER DIAL: 0 – 500 cpm, 0 – 2 kV, BAT OK, OL(overload)

MULTIPLIERS: $\times 1$, $\times 10$, $\times 100$, $\times 1000$

LINEARITY: Reading within ± 10 percent of true value with detector connected

SCALER: 6 digit LCD display with 0.25-inch (0.64-cm) digits, overflow arrow, and colons to indicate when a count is in process

COUNT: Push-button to initiate scaler count

COUNT TIME: Internally selected times of 0.1, 0.5, 1, or 2 minutes

SELECTOR SWITCH: Toggle switch to select alpha and beta, alpha only, or beta only

HIGH VOLTAGE: Adjustable from 200 – 2000 volts (can be read on meter)

HIGH VOLTAGE ADJUST: Accessible from front of instrument (protective cover provided)

THRESHOLD: Internal control allows adjustment from 2 mV – 15 mV for beta, and 40 mV – 700 mV for alpha

WINDOW (Beta only): Internal control allows adjustment from beta threshold up to the alpha threshold setting

OVERLOAD: Senses detector saturation. Indicated by red lamp on meter and meter going to full scale (adjustable depending on detector selected)

RESPONSE: Will vary according to number of counts present. Typically 2 s – 11 s from 10 percent to 90 percent of final reading

POWER: 2 each D cell batteries (housed in sealed compartment that is externally accessible)

BATTERY LIFE: Greater than 350 hours with alkaline batteries (battery condition can be checked on meter)

CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint

TEMPERATURE RANGE: -4° F (-20° C) to 122° F (50° C)

SIZE: 6.5 inches (16.5 cm) height \times 3.5 inches (8.9 cm) width \times 8.5 inches (21.6 cm) length

WEIGHT: 3.5 lbs(1.6 kg) including batteries



Radiation Safety Plan for US Army Garrison Hawaii Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds

Ludlum Model 2241 Digital Survey Meter

INDICATED USE: General purpose survey, gross counting

COMPATIBLE DETECTORS: G-M, proportional, scintillation

CONNECTOR: Series C (others available on request)

AUDIO: Built in unimorph speaker with ON/OFF switch (greater than 60 dB at 2 feet)

ALERT/ALARM: Indicated by enunciator on display and audible tone

DISPLAY: 4 digit LCD display with 0.5-inch (1.3-cm) high digits, separate enunciators for display units, alert, alarm, low battery, detector overload, counting overflow, and scaler counting

BACKLIGHT: Push-button to activate

RATEMETER: Can display in R/hr, Sv/hr, cpm, or cps when control switch is in RATEMETER position

DISPLAY RANGE: Auto ranging from $0.0 \mu\text{R h}^{-1}$ – 9999 R h^{-1} ; $0.000 \mu\text{Sv h}^{-1}$ – 9999 Sv t^{-1} ; 0 cpm – 999k cpm ;
or 0 cps – 100 kcps

LINEARITY: Reading within ± 10 percent of true value with detector connected

SCALER: Activated by push-button in handle (count time adjustable from 1 to 9999 s in 1-s intervals)

CALIBRATION CONTROLS: Accessible from front of instrument (protective cover provided)

HIGH VOLTAGE: Adjustable from 200 volts – 2500 volts

DISCRIMINATOR: Adjustable from 2 mV – 100 mV

OVERLOAD: Indicated by OVERLOAD on display (adjustable depending on detector selected)

RESET: Push-button to zero display, acknowledge and/or reset alarm

POWER: 2 each D cell batteries (housed in sealed compartment that is externally accessible)

BATTERY LIFE: Typically 200 h with alkaline batteries (low battery indicated on display)

CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint

TEMPERATURE RANGE: -4° F (-20° C) to 122° F (50° C)

SIZE: 6.5 inches (16.5cm) height \times 3.5 inches (8.9cm) width \times 8.5 inches (21.6cm) length

WEIGHT: 3.5 lbs (1.6kg) including batteries

