
SAFETY EVALUATION REPORT

**For the U.S. Army's Possession
License for Depleted Uranium from
Davy Crockett M101 Spotting
Rounds – Amendment to Address
License Conditions Nos. 18 and 19**

Docket No. 040-09083

U.S. Army Installation Management Command

U.S. Nuclear Regulatory Commission

Office of Nuclear Material Safety and Safeguards

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Introduction

License SUC-1593 (Agencywide Document Access and Management System (ADAMS) Accession [ADAMS] No. ML16039A234) applies to the 16 United States Army Installation Management Command (Army) installations¹ with sites that have depleted uranium (DU) from Davy Crockett M101 spotting rounds. These sites are located at: Donnelly Training Area, Fort Wainwright, AK; Fort Benning, GA; Fort Bragg, NC; Fort Campbell, KY; Fort Carson, CO; Fort Gordon, GA; Fort Hood, TX; Fort Hunter Liggett, CA; Fort Jackson, SC; Fort Knox, KY; Fort Polk, LA; Fort Riley, KS; Fort Sill, OK; Joint Base Lewis-McChord/Yakima Training Center, WA; Joint Base McGuire-Dix-Lakehurst, NJ; and Schofield Barracks/Pohakuloa Training Area, HI.

With the issuance of SUC-1593, Amendment 1, the NRC approved a programmatic radiation safety plan (RSP), programmatic physical security plan (PSP), and programmatic environmental radiation monitoring plan (ERMP) that applies to all 16 installations. Included in the amended license are License Conditions (LC) 18 and 19, which require the Army to submit site-specific information to the NRC in a timely manner. In accordance with LC 18 of the license, the Army is required to:

“Within 6 months of the effective date of the license amendment, the licensee shall provide to the NRC for approval, site-specific environmental radiation monitoring plans for each installation listed in License Condition 10 that address all (radiation control areas) RCAs at the installations. The licensee shall fully implement each installation’s site-specific environmental radiation monitoring plan within 6 months of NRC approval.”

In accordance with LC 19, the Army is required to:

“Within 6 months of the effective date of this license amendment, the licensee shall provide to the NRC for verification, documentation, including site-specific dose modeling parameters, showing that the approved dose modeling methodology was applied and that the calculated site-specific all-pathway dose for each Radiation Control Area at each installation listed in License Condition 10 does not exceed 1.0E-2 mSv/yr (1.0 mrem/yr) TEDE [total effective dose equivalent].”

In a letter, dated September 15, 2016 (ADAMS Accession No. ML16265A221 (Pkg)), the Army submitted documents as required by LCs 18 and 19 of Source Materials License No. SUC-1593, Amendment 1 (ADAMS Accession No. ML16039A234) to the U.S. Nuclear Regulatory Commission (NRC or the Commission).

Also, through a clarification email from the Army, dated May 24, 2015 (ADAMS Accession No. ML16341C807), the NRC staff became aware that it mislabeled the number and name of the sites located at Fort Riley, KS in Table 1 of the SER for License Amendment 1. In this SER, the NRC staff clarifies this information. However, no change to the license was needed because

¹ In the application for Amendment 1, the Army identified 16 Army installations with sites where DU from Davy Crockett M101 spotting rounds are located, as opposed to 17 Army installations with sites where DU from the Davy Crockett M101 spotting rounds are located. The Army considers the Schofield Barracks/Pohakuloa Training Area HI, as one Army installation, similar to a joint base (ML16011A373) for this license. Therefore, in this SER, the NRC staff refers to 16 Army installations; however, the NRC considers them as two separate installation-facilities for dose assessment purposes. Refer to footnotes 8 and 11 and information in Section 3.4 of this SER for Amendment 1 for more detailed information.

the maps in the application did not need to be modified.

The regulatory requirements that are applicable to this review are summarized below, followed by a summary of the NRC staff's findings.

Regulatory Requirements and Guidance

This SER summarizes the NRC staff's review of the submittal for LC 18 against the approved programmatic ERMP in SUC-1593, Amendment 1 and the submittal for LC 19 against the approved technical basis dose methodology and RCA bounding dose constraint for each RCA in the Army's application.

The NRC staff conducted its review in accordance with the applicable requirements of 10 CFR Part 40, "Domestic Licensing of Source Material," and the applicable guidance in NUREG-1556, Vol. 7, "Consolidated Guidance About Materials Licenses: Program-Specific Guidance About Academic, Research and Development, and Other Licenses of Limited Scope Including Gas Chromatographs and X-Ray Fluorescence Analyzers" [NRC 1999]. This guidance document was used by the NRC staff for licensing these types of sites because no other guidance document was applicable for the DU in the form of an unsealed source in the environment. NUREG-1556, Vol. 7 was determined to be acceptable for the Davy Crockett DU that is present on active Army ranges because this guidance document addresses Part 20 radiological protection requirements for Part 30 materials licensees. Although this guidance explicitly states that it does not apply to source material (Part 40) licensees, in the absence of guidance for licensing actions such as these Davy Crockett DU licensing actions, the NRC staff determined that this guidance is appropriate for determining whether the applicant meets Part 20 requirements that are germane to Part 30 and Part 40 licensing actions. This evaluation assesses the applicant's compliance with the requirements of 10 CFR Part 40, "Domestic Licensing of Source Material," as well as the applicable requirements of 10 CFR Part 20, "Standards for Protection Against Radiation."

Summary of NRC Staff's Findings

The NRC staff reviewed the submittals to verify the following:

- 1) To satisfy the requirements of LC 18, each site-specific ERMP is consistent with the previously approved programmatic approach for preparation of site-specific ERMPs and conditions in license SUC-1593, Amendment 1.
- 2) To satisfy the requirements of LC 19, the U.S. Army provided site-specific dose assessments for each RCA demonstrating that doses from each RCA did not exceed 1.0×10^{-2} mSv/yr (1.0 mrem/yr) TEDE.

The NRC staff finds that the Army's submittals for the Davy Crockett M101 spotting rounds at the Donnelly Training Area, Fort Wainwright, AK; Fort Benning, GA; Fort Bragg, NC; Fort Campbell, KY; Fort Carson, CO; Fort Gordon, GA; Fort Hood, TX; Fort Hunter Liggett, CA; Fort Jackson, SC; Fort Knox, KY; Fort Polk, LA; Fort Riley, KS; Fort Sill, OK; Joint Base Lewis-McChord/Yakima Training Center, WA; Joint Base McGuire-Dix-Lakehurst, NJ; and the Schofield Barracks/Pohakuloa Training Area, HI, satisfy the requirements of LC 18 and 19.

Specifically, based on the NRC staff's review of the Army's submittal for LC 18, the NRC staff concludes that the Army has developed adequate site-specific ERMPs consistent with the approved programmatic ERMP for each Army installation with sites or RCAs where Davy Crockett M101 spotting rounds are present. Therefore, the NRC staff finds that the site-specific ERMPs are appropriate and should be incorporated into the license by reference.

Based on the NRC staff's review of the Army's submittal for LC 19, the NRC verified that the Army's site-specific dose assessments for each RCA is acceptable. The NRC staff reviewed the submittal and found the Residual Radiation (RESRAD)², Version 7.2 (Yu et al., 2016a) parameter values to be acceptable and confirmed that the dose associated with each RCA was below the required TEDE. Although the Army's submittal included offsite doses calculated with RESRAD-OFFSITE³, Version 3.2 (Yu et al., 2016b), NRC staff ultimately concluded that this information was not needed to satisfy the requirements of LC 19.

The NRC staff concludes that the findings described in the succeeding sections of this SER support the issuance of a license amendment requiring the use of the site-specific ERMPs and the associated Quality Assurance Plan applicable to the following areas:

ADAMS Accession No.	Site-Specific ERMP
ML16265A234	Final Site-Specific Environmental Radiation Monitoring Plan, Donnelly Training Area, Fort Wainwright, Alaska, Annex 1
ML16265A235	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Benning, Georgia, Annex 2
ML16265A237	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Bragg, North Carolina, Annex 3
ML16265A238	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Campbell, Kentucky, Annex 4
ML16265A239	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Carson, Colorado, Annex 5
ML16265A240	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Gordon, Georgia, Annex 6
ML16265A241	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Hood, Texas, Annex 7
ML16265A242	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Hunter Liggett, California, Annex 8
ML16265A243	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Jackson, South Carolina, Annex 9
ML16265A224	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Knox, Kentucky, Annex 10

² RESRAD is a computer model code designed to estimate radiation doses and risks from RESidual RADioactive materials developed by Argonne National Laboratory (ANL). The U.S. Department of Energy (DOE) through ANL currently maintains code and version control.

³ RESRAD-OFFSITE is an extension of the RESRAD (onsite) computer code that was developed to estimate the radiological consequences to a receptor located onsite or outside the area of primary contamination. It calculates radiological dose and excess lifetime cancer risk with the predicted radionuclide concentrations in the environment, and derives soil cleanup guidelines corresponding to a specified dose limit.

ADAMS Accession No.	Site-Specific ERMP
ML16265A225	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Polk, Louisiana, Annex 11
ML16265A226	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Riley, Kansas, Annex 12
ML16265A227	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Sill, Oklahoma, Annex 13
ML16265A228	Final Site-Specific Environmental Radiation Monitoring Plan, Joint Base Lewis-McChord, Tacoma, Washington, Annex 14
ML16265A229	Final Site-Specific Environmental Radiation Monitoring Plan, Yakima Training Center, Washington, Annex 15
ML16265A230	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Dix, Joint Base McGuire-Dix-Lakehurst, New Jersey, Annex 16
ML16265A231	Final Site-Specific Environmental Radiation Monitoring Plan, Pohakuloa Training Area, Hawaii, Annex 17
ML16265A232	Final Site-Specific Environmental Radiation Monitoring Plan, Schofield Barracks Military Reservation, Oahu, Hawaii, Annex 18
ML16265A233	Final Environmental Radiation Monitoring Program, Programmatic Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP), Annex 19

Background

Background information on the Davy Crockett DU M101 spotting rounds can be found in the SER for License Amendment 1 (ADAMS Accession No. ML16039A230).

In the course of its review of the Army's submittal for LC 18 and 19, the NRC staff also identified labelling errors associated with the NRC staff's SER for Amendment 1. Corrections for these labeling errors are explained below. These corrections do not impact the license because the Army's submittals, which are referenced in the license, are correct. The corrections are provided here for completeness.

According to the SER for SUC-1593, License Amendment 1:

"Based on the Army's amendment application, there are a total of 41 sites (RCAs) that contain Davy Crockett M101 spotting rounds over 15 different States in the U.S and 16 different Army Installations, as summarized in Table 1, "Location of Army Installations and Ranges with Depleted Uranium (DU) from Davy Crockett M101 Spotting Rounds."

The NRC staff incorrectly identified the number of RCAs at Fort Riley, KS, in Table 1 of the SER for Amendment 1 as: "3 (RANGES 27A & 27B, RANGE 18 A, B, & C, and RANGE 19A & 19B)."

In an email from the Army, dated May 24, 2016 (ADAMS Accession No. ML16341C807), the Army clarified that the number of ranges or RCAs at Fort Riley, KS, as reflected in its amendment application are RCAs 27A/27B and 29. The NRC staff reviewed the maps in amendment application for Fort Riley and confirmed that there are two RCAs at Fort Riley, KS,

27A/27B and 29.

In an email from the Army, dated December 7, 2016 (ADAMS Accession No. ML16351A092), the Army confirmed that the number of ranges or RCAs at Fort Knox, KY is 2, the Arms Knob Range and the O'Brien Range. The Arms Knob Range is one range, not two ranges as the NRC staff incorrectly identified in its SER for Amendment 1. Also, the Army confirmed that there is only one range at Fort Polk, LA, identified as "Range 33 and 34A."

The NRC then confirmed by checking the maps that were submitted during Amendment 1 that the NRC incorrectly labelled the following ranges in Table 1 of the SER for Amendment 1. The total number of Davy Crockett RCAs is 38, not 41.

Following these corrections it was determined that there are a total of 38 RCAs as reflected in Table 1, below. There is no change to License SUC-1593. However, the NRC makes this statement for the purpose of clarification of the SER documentation.

Table 1. Location of Army Installations and Ranges⁴ with Depleted Uranium (DU) from Davy Crockett M101 Spotting Rounds

Installation	Nearest City	Individual Range(s)
Donnelly Training Area ⁵	Fairbanks, AK	Georgia Range
		Brann Range
		Buchanon Range
		Burma Hill Range
		Coolidge Range
Fort Benning	Columbus, GA	Hook Range
		K15 Range
		K18 Range
		LAE Field Z4 Range
		Patton Range
Fort Bragg	Fayetteville, NC	OP5
Fort Campbell ⁶	Clarksville, KY	Range OP2 and OP3
Fort Carson ⁷	Colorado Springs, CO	Battalion Range 141
Fort Gordon	Augusta, GA	Range E
Fort Hood	Killeen, TX	Davy Crockett Range
Fort Hunter	Monterey, CA	Liggett B11
		Liggett B13
		Liggett C8
Fort Jackson	Columbia, SC	Range 62
	Fort Knox, KY	Arms Knob

⁴ In its application, the Army refers to the sites that have DU from Davy Crockett M101 spotting rounds as M101 impact areas, RCAs, M101 Target areas, M101 Target zone/impact areas, active ranges, or sites.

⁵ This RCA was formerly part of Fort Greely, AK, but now this area is under administrative control of Fort Wainwright, AK.

⁶ The M101 target zone/impact area (site or RCA) is located in TN, not KY.

⁷ The Army requested that the 3 sites at Titus and Sergeants Roads (not listed in Table 1, above) be licensed under a General License. Refer to Section 9.0 of this SER for information regarding these 3 sites.

Fort Knox ⁸		O'Brien Range
Fort Polk	Leesburg, LA	Ranges 33 and 34A
Fort Riley	Junction City, KS	Range 29 Ranges 27A and 27B
Fort Sill	Lawton, OK	West Range
JBLM	Tacoma, WA	Range 52 OP-8 OP-9
JBMDL	Trenton, NJ	Frankford Arsenal
Pohakuloa ⁹	Hilo, HI	Training Area 1 Training Area 2 Training Area 3 Training Area 4
Schofield Barracks	Honolulu, HI	M101 Impact Area
Yakima	Selah, WA	Range 14 Range 17 Range 20

The documents that were evaluated by the NRC staff for this SER are contained in the Army's submittal ADAMS Accession No. ML16265A221 (Pkg), dated September 15, 2016.

Safety Evaluation

1.0 License Condition 18, Submittal of Site-Specific Environmental Monitoring Plans

1.1 Regulations and Guidance

Title 10 of the Code of Federal Regulations (CFR), Part 20, Subpart F – Surveys and Monitoring, section 20.1501(a) states that each licensee shall make, or cause to be made, surveys of areas that are reasonable under the circumstances to evaluate the magnitude and extent of radiation levels, concentrations or quantities of residual radioactivity, and the potential radiological hazards. The regulation at 10 CFR 20.1301 establishes public dose limits which are applicable in this instance.

The NRC staff used NUREG-1301, "Off-site Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors," to review the Army's the proposed methods of sample collection and the frequency of collection. Although this guidance

⁸ M101 firing was on the O'Brien (aka O'Brein) Range; Also, Arms Knob range is depicted as two overlapping ranges of the same name. Lawley and Garvin Ranges shown on the M101 Impact Maps, submitted on January 8, 2016 (ML16022A161), do not contain DU, per the ASR report (ML16041A107).

⁹ The Army considers the Pohakuloa Training Center and the Schofield Barracks to be one Army facility located in the State of Hawaii in its amendment application, even though one facility is located on the island of Oahu and the other is located on the island of Hawaii. The NRC considers each as an installation-facility for dose assessment purpose. For additional information, refer to Footnote 11 in Section 3.4 of the SER for License Amendment 1.

is specific to Pressurized Water Reactors, the NRC staff found that it was appropriate to apply this guidance to a possession only license for DU in the absence of specific guidance for DU spent rounds present in the environment.

With respect to the residual DU present on various Army ranges as a result of expended Davy Crockett munitions (specifically, the M101 spotting rounds), the NRC has approved a “programmatic” ERMP (see ADAMS Accession No. ML16039A230 for the NRC’s SER and ADAMS Accession No. ML16004A369 for the programmatic ERMP). This programmatic ERMP was to be used to guide the development of site-specific ERMPs to address all RCAs licensed in SUC-1593.

1.2 Submittal

On September 15, 2016, the Army submitted a compilation of the Programmatic ERMP, dated September 15, 2016 (ADAMS Accession No. ML16265A218) and 18 site-specific ERMPs that address 38 RCAs on 16 Army bases (ADAMS Accession No. ML16265A221). The September 15, 2016 ERMP was identical to the December 31, 2015 ERMP (ADAMS Accession No. ML16004A369) except it was updated to remove the RESRAD environmental default parameters. The programmatic approach recognized any environmental monitoring within an active range poses undue risk caused by unexploded ordinance. As such, the site-specific ERMPs primarily focuses on surface water bodies and sediments which may contain or accumulate residual DU due to runoff and transport outside of the active range areas/RCAs. If significant discernable soil¹⁰ is transported out of the RCAs, then that soil will be sampled. Also, any existing wells which may be impacted by DU in ground water will be sampled for uranium. If evaluations of environmental sampling data indicate that DU is present (as determined by an isotopic activity ratio for U-238/U-234 of 3 or greater), then the Army would notify the NRC within 30 days and collect additional environmental samples within an additional 30 days of the notification.

Each site-specific ERMP included figures showing the RCAs, predominant direction of surface water flow, and any wells in the vicinity as well as the proposed surface water and sediment sampling locations. Most site-specific ERMPs identified 1 or 2 sampling locations for surface water and/or sediment which were to be sampled quarterly except when conditions warranted not sampling (i.e., dry streams, freezing, or flooding conditions may limit sample collection). There were 2 site-specific ERMPs at which 3 sample locations were identified. Each ERMP also contained the contingent commitment for soil sampling if the Army discovers significant discernable soil erosion/transport/deposition. Finally, each ERMP contained prescribed general methods for sample collection and sample analysis.

Also included in the Army’s submittal as Annex 19 is the “Programmatic Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP).” Included in this plan are worksheets stating the Army’s action levels for sample evaluation and what actions it will take should the sample data exceed these action levels.

1.3 NRC Staff Evaluation

¹⁰ The Army proposes sampling of deposition areas of soil outside the RCA if a localized erosion rate in an RCA area greater than 25 m² exceeds a volume of 3.75 m³ per year or if the general erosion rate for the RCA is greater than 2 tons per acre per year.

The NRC staff reviewed the figures in each ERMP showing the topography of the base, the RCAs, direction of surface water runoff, and proposed sampling location(s). The NRC staff found the sampling locations to be downgradient from the various RCAs and therefore adequate for tracking and trending purposes to discern if there is any significant transport of DU from the RCAs through the actions of surface water runoff. The proposed methods of sample collection are reasonable and the frequency of collection is not inconsistent with frequencies for environmental monitoring established in NUREG-1301, "Off-site Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors." The NRC considers it most likely that only sediment sampling (as opposed to soil sampling) will be needed because it is unlikely that significant soil transport will occur. Regardless, the NRC staff acknowledge the commitment made to sample any significant soil depositions discovered. The methods for sample analysis are commonly utilized methods and the action levels are consistent with those imposed by the NRC in license SUC-1593, LC 17.

1.4 Findings/Conclusions

The NRC finds the site-specific ERMPs compiled by the Army to be consistent with the previously approved programmatic approach for preparation of site-specific environmental monitoring plans and conditions in License SUC-1593, Amendment 1. Therefore, the NRC finds the site-specific ERMPs to be adequate for monitoring for transport of DU from the RCAs.

Based on this finding, staff recommends modification of existing LC 18 solely to impose a time frame for implementation of the ERMPs and modification of LC 11 to incorporate the site-specific ERMPs by reference as part of the licensing basis for License SUC-1593.

Existing License Condition 18 (to be modified):

"Within 6 months of the effective date of the license amendment, the licensee shall provide to the NRC for approval, site-specific environmental radiation monitoring plans for each installation listed in LC 10 that address all RCAs at the installations. The licensee shall fully implement each installation's site-specific environmental radiation monitoring plan within 6 months of NRC approval."

Existing License Condition 18 should be replaced with the following:

"Within 6 months of the effective date of the license amendment, the licensee shall fully implement each installation's site-specific environmental radiation monitoring plans."

Existing License Condition 11 (to be modified):

11. Except as specifically provided otherwise, the licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the license amendment application:

- Programmatic RSP, "Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium," dated December 31, 2015 (ML16004A369);

- Programmatic PSP; “Physical Security Plan for US Army Installation Management Command Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds,” dated December 31, 2015 (ML16004A369);
- Army’s Form 313, “Application for Materials License,” items 1-7, dated June 1, 2015 (Pkg. ML15161A454);
- Attachment 3, “Calculation of TEDE to Individual Likely to Receive Highest Dose,” dated June 1, 2015 (Pkg. ML15161A454);
- Attachment 4, “Attachment 4. How the Army Determined the M101DU RCAs,” dated June 1, 2015 (Pkg. ML15161A454);
- Attachment 5, “Bounding Calculations Using RESRAD 7.0 and RESRAD-OFFSITE 3.1,” dated June 1, 2015 (Pkg. ML15161A454);
- Attachment 8, “Arguments against Air Sampling During HE [High Explosive] Fire into RCAs [Radiation Control Areas],” dated June 1, 2015 (Pkg. ML15161A454);
- Email clarifying RCAs at Fort Knox, KY, dated January 29, 2016 (ML16041A107);
- Attachment 8, “Estimating Public Exposure to Airborne Depleted Uranium Outside the U.S. Army Pohakuloa Training Area, Hawaii,” September 30, 2015, (ML15294A276);
- Attachment 9, “Examples of Army Range fires,” September 30, 2015, (ML15294A276);
- Attachment 10, “Arguments against Air Sampling During HE Fire into RCAs, rev. 1,” September 30, 2015, (ML15294A276);
- Attachment 11, “Calculation of Public Dose SOP,” September 30, 2015, (ML15294A276);
- Programmatic ERMP, “Programmatic Approach for Preparation of Installation-specific Environmental Radiation Monitoring Plans,” dated December 31, 2015 (ML16004A369);
- “US Army Decommissioning Funding Plan (DFP) for License Number SUC-1598,” dated February 9, 2016 (ML16042A232);
- Maps of the locations of the RCAs, “M101 Impact Areas,” dated December 31, 2015 (but, sent February 12, 2016, (ML16048A358);
- Army’s email clarifying M101 Target Areas (Radiation Control Areas), dated February 12, 2016 (ML16048A347); and
- Army’s Statement of Intent, dated June 1, 2015 (ML15161A458).

Proposed License Condition 11:

Except as specifically provided otherwise, the licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the license amendment application and related submissions:

- Programmatic RSP, "Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium," dated December 31, 2015 (ML16004A369);
- Programmatic PSP; "Physical Security Plan for US Army Installation Management Command Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds," dated December 31, 2015 (ML16004A369);
- Army's Form 313, "Application for Materials License," items 1-7, dated June 1, 2015 (Pkg. ML15161A454);
- Attachment 3, "Calculation of TEDE to Individual Likely to Receive Highest Dose," dated June 1, 2015 (Pkg. ML15161A454);
- Attachment 4, "Attachment 4. How the Army Determined the M101DU RCAs," dated June 1, 2015 (Pkg. ML15161A454);
- Attachment 5, "Bounding Calculations Using RESRAD 7.0 and RESRAD-OFFSITE 3.1," dated June 1, 2015 (Pkg. ML15161A454);
- Attachment 8, "Arguments against Air Sampling During HE [High Explosive] Fire into RCAs [Radiation Control Areas]," dated June 1, 2015 (Pkg. ML15161A454);
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- Attachment 8, "Estimating Public Exposure to Airborne Depleted Uranium Outside the U.S. Army Pohakuloa Training Area, Hawaii," September 30, 2015, (ML15294A276);
- Attachment 9, "Examples of Army Range fires," September 30, 2015, (ML15294A276);
- Attachment 10, "Arguments against Air Sampling During HE Fire into RCAs, rev. 1," September 30, 2015, (ML15294A276);
- Attachment 11, "Calculation of Public Dose SOP," September 30, 2015, (ML15294A276);
- Programmatic ERMP, "Programmatic Approach for Preparation of Installation-specific Environmental Radiation Monitoring Plans," dated September 15, 2016 (ML16265A218);
- "US Army Decommissioning Funding Plan (DFP) for License Number SUC-1598," dated February 9, 2016 (ML16042A232);
- Maps of the locations of the RCAs, "M101 Impact Areas," dated December 31, 2015 (but, sent February 12, 2016 (ML16048A358);
- Army's emails clarifying M101 Target Areas (Radiation Control Areas), dated February 12, 2016 (ML16048A347), May 24, 2016 (ML16341C807), and December 7, 2016 (ML16351A092)
- Army's Statement of Intent, dated June 1, 2015 (ML15161A458);
- Site-Specific Environmental Radiation Monitoring Plans and Associated Quality Assurance Plan, dated September 15, 2016 (Pkg ML16265A221)

2.0 License Condition 19, Verify Dose

2.1 Regulations and Guidance

The regulation at 10 CFR 20.1301 establishes public dose limits which are applicable in this instance.

2.2 Submittal and Staff Evaluation

In support of LC 19 of SML SUC-1593, each Army installation listed on the license is responsible for submitting a dose assessment to the NRC demonstrating that the previously approved dose modeling methodology was applied and that the calculated site-specific dose for each RCA at each installation listed in LC 10 does not exceed 1.0×10^{-2} mSv/yr (1.0 mrem/yr) TEDE. This information was submitted to the NRC on September 15, 2016 (ML16265A221 (Pkg)) as part of each installation's proposed site-specific ERMP. Each dose assessment considered a residential farmer scenario in which the individual receptor was located on the RCA as well as at the nearest normally occupied area outside of the RCA. The onsite doses were calculated using the RESRAD, Version 7.2, computer code (Yu et al., 2016a) and the offsite doses were calculated using RESRAD-OFFSITE, Version 3.2 (Yu et al., 2016b). The analyses considered a combination of default and site-specific parameter values. NRC staff reviewed the dose assessments for each site and included the findings in this section of the SER.

2.2.1 Submittal – Source Material

The Army calculated radionuclide-specific soil concentrations for U-234, U-235, and U-238 for each RCA using the mass of DU listed on the license for each installation, the radionuclide-specific specific activity and mass abundance values calculated by the Army and provided as Attachment 1 to each ERMP, and appropriate conversion factors related to the volume of soil on each RCA. Table 2, adapted from the corresponding table that the Army provided with each dose assessment, includes the radionuclide-specific mass abundance and specific activity values used in these calculations. The Army assumed that the total activity of each isotope is homogeneously distributed in the top 15 centimeters (cm) (6 inches (in.)) of soil on the individual RCAs. Distribution of the radioactivity over the RCA soil might represent a case in the future after munitions have degraded sufficiently to allow the radioactivity to be dispersed in the environment. In cases where multiple RCAs exist at a single installation, the Army used the entire mass of DU listed for the installation to calculate specific soil concentrations for a single RCA (i.e., the Army assumes that the total mass for an entire site/installation is present in each and every RCA). The Army stated that this assumption is valid for all RCAs except for the Burma Hill Range, a demonstration area located at Fort Benning, where it is assumed that 9 DU rounds or about 2 kg of DU were deposited on the range (instead of 1850 kg of DU estimated for the entire Fort Benning site).

Table 2. Specific Activity and Mass Abundance Values

Radionuclide	Specific Activity pCi/g	Mass Abundance
U-234	6.22×10^9	3.56×10^{-6}
U-235	2.16×10^6	9.38×10^{-4}
U-238	3.36×10^5	9.99×10^{-1}

Using the values included in Table 2 along with the total mass of DU (Table 3) and parameter values specific to each contaminant zone (i.e., RCA), which are included in Table 6, the Army calculated RCA-specific radionuclide concentrations for use in the RESRAD and RESRAD-OFFSITE analyses. Table 4 summarizes the radionuclide concentrations used in the dose assessment calculations.

Table 3. Total mass of DU associated with each installation

Installation	Number of Ranges	Total Mass of DU (kg)
Donnelly Training Area	1	20
Fort Benning	9	1850
Fort Bragg	1	810
Fort Campbell	1	130
Fort Carson	2	270
Fort Gordon	1	30
Fort Hood	1	770
Fort Hunter	3	30
Fort Jackson	1	30
Fort Knox	2	760
Fort Polk	1	370
Fort Riley	2	20
Fort Sill	1	120
JBLM & Yakima	6	340
JBMDL	1	10
Pohakuloa & Schofield Barracks	5	140
Total DU	38	5700

Table 4. RCA-Specific Radionuclide Concentrations

Installation	Range	Soil Concentration Input Values (pCi/g)		
		U-234	U-235	U-238
Fort Benning	Georgia Range	1.97×10^{-3}	1.80×10^{-4}	2.98×10^{-2}
	Brann Range	1.82×10^{-1}	1.67×10^{-2}	2.76
	Buchanan Range	1.82×10^{-1}	1.67×10^{-2}	2.76
	Burma Hill Range ¹¹	2.34×10^{-3}	2.1×10^{-4}	4.00×10^{-2}
	Coolidge Range	1.82×10^{-1}	1.67×10^{-2}	2.76
	Hook Range	1.82×10^{-1}	1.67×10^{-2}	2.76
	K15 Range	1.82×10^{-1}	1.67×10^{-2}	2.76
	K18 Range	1.82×10^{-1}	1.67×10^{-2}	2.76
	LAE Field Z4 Range	1.82×10^{-1}	1.67×10^{-2}	2.76
	Patton Range	1.82×10^{-1}	1.67×10^{-2}	2.76
Fort Bragg	OP5	7.97×10^{-2}	7.29×10^{-3}	1.21
Fort Campbell	Range OP2 and OP3	1.28×10^{-2}	1.17×10^{-3}	1.94×10^{-1}
Fort Carson	Battalion	2.66×10^{-2}	2.43×10^{-3}	4.03×10^{-1}
	Range 141	2.66×10^{-2}	2.43×10^{-3}	4.03×10^{-1}

¹¹ Calculations submitted for the Burma Hill Range, a demonstration area at Fort Benning, were based on the assumption that only 9 DU rounds or about 2 kg of DU were deposited on the smaller range (instead of 1850 kg of DU used in the calculations for the other RCAs at Fort Benning)

Fort Gordon	Range E	2.95×10^{-3}	2.70×10^{-4}	4.48×10^{-2}
Fort Hood	Davy Crockett Range	7.58×10^{-2}	6.93×10^{-3}	1.15
Fort Hunter	Liggett B11	2.95×10^{-3}	2.70×10^{-4}	4.48×10^{-2}
	Liggett B13	2.95×10^{-3}	2.70×10^{-4}	4.48×10^{-2}
	Liggett C8	2.95×10^{-3}	2.70×10^{-4}	4.48×10^{-2}
Fort Jackson	Range 62	2.95×10^{-3}	2.70×10^{-4}	4.48×10^{-2}
Fort Knox	Arms Knob	4.37×10^{-2}	4.00×10^{-3}	6.63×10^{-1}
	O'Brien Range	7.48×10^{-2}	6.84×10^{-3}	1.13
Fort Polk	Ranges 33 and 34A	3.64×10^{-2}	3.33×10^{-3}	5.52×10^{-1}
Fort Riley	Range 29	1.97×10^{-3}	1.80×10^{-4}	2.98×10^{-2}
	Ranges 27A and 27B	1.97×10^{-3}	1.80×10^{-4}	2.98×10^{-2}
Fort Sill	West Range	1.18×10^{-2}	1.08×10^{-3}	1.79×10^{-1}
JBLM	Range 52	3.35×10^{-2}	3.06×10^{-3}	5.07×10^{-1}
	OP-8	3.35×10^{-2}	3.06×10^{-3}	5.07×10^{-1}
	OP-9	3.35×10^{-2}	3.06×10^{-3}	5.07×10^{-1}
JBMDL	Frankford Arsenal	9.84×10^{-4}	9.00×10^{-5}	1.49×10^{-2}
Pohakuloa	Training Area 1	1.38×10^{-2}	1.26×10^{-3}	2.09×10^{-1}
	Training Area 2	1.38×10^{-2}	1.26×10^{-3}	2.09×10^{-1}
	Training Area 3	1.38×10^{-2}	1.26×10^{-3}	2.09×10^{-1}
	Training Area 4	9.19×10^{-3}	8.40×10^{-4}	1.39×10^{-1}
Schofield Barracks	M101 Impact Area	5.01×10^{-3}	4.58×10^{-4}	7.59×10^{-2}
Yakima	Range 14	3.35×10^{-2}	3.06×10^{-3}	5.07×10^{-1}
	Range 17	3.35×10^{-2}	3.06×10^{-3}	5.07×10^{-1}
	Range 20	3.35×10^{-2}	3.06×10^{-3}	5.07×10^{-1}

2.2.1.1 Staff Evaluation – Source Material

In most cases, the calculated radionuclide concentrations (above) match the values that the Army used to calculate the RCA-specific doses provided in the submittal. In some cases the Army used rounded values in the RESRAD calculations but this rounding did not impact the calculated dose. To be consistent, the Army calculated radionuclide concentrations assuming a contaminated zone area of 1 km²; however, during its review NRC staff found that other contaminated zone area values were used for five of the RCAs. For one case, the Burma Hill Range at Fort Benning, historical information suggested that smaller amounts of DU were used on this small demonstration range compared to the other RCAs at Fort Benning. For the other four RCAs the NRC determined that different values were used for the “Area of Contaminated Zone” parameter. NRC staff recalculated the soil concentration values for these four RCAs using a contaminated zone parameter value of 1 km² and found minimal changes (Table 5). As discussed below, NRC staff used the updated soil concentration values to calculate new RCA-specific doses.

Table 5. Updated RCA-Specific Radionuclide Soil Concentrations

Installation	Range	Updated Soil Concentration Values (pCi/g)		
		U-234	U-235	U-238
Fort Knox	Arms Knob	7.48E-02	6.84E-03	1.13E+00
	O'Brien Range	7.48E-02	6.84E-03	1.13E+00
Pohakuloa	Training Area 4	1.38E-02	1.26E-03	2.09E-01
Schofield Barracks	M101 Impact Area	1.38E-02	1.26E-03	2.09E-01

The underlying assumption in the concentration calculations is that the DU rounds are completely degraded and isotopes of uranium are homogeneously mixed within the top 15 cm of soil within each RCA. Depending on such factors as the actual areal density of munitions in each of the RCAs, the rate of degradation of the munitions, and the dispersal of DU isotopes in the environment, this approach may significantly over or underestimate concentrations over time. For example, the soil concentrations are expected to be overestimated at early times prior to significant degradation of the DU rounds, but soil concentration may have been underestimated at later times in certain “hot spot” locations in relatively close proximity to degraded DU rounds. But the assumption that all of the DU mass for an installation is located in each and every RCA in that installation tends to lead to overestimation of the concentrations and helps mitigate the concern with underestimating concentrations, especially for Fort Benning, which has 9 RCAs.¹² While the Army provided some information on the expected degradation rates and distribution of DU munitions in the range areas based on analog sites, significant uncertainty in the distribution of DU isotopes over time exists. Finally, while it might be representative of a less likely but plausible scenario in the event that knowledge of the site and controls over the site are lost over long periods of time, the use of a conservative exposure scenario like the resident farmer for a controlled area where unexploded ordnances are present is not a reasonably foreseeable land use scenario.

2.2.2 Submittal – Site-Specific Dose Assessments

LC 19 requires a site-specific dose assessment for each RCA be submitted to the NRC documenting that the site-specific, all-pathway dose for each RCA does not exceed 1.0×10^{-2} mSv/yr (1.0 mrem/yr) TEDE. These dose assessments were provided as part of the site-specific ERMPs required by LC 18.

Each of the Army’s submittals included dose calculations for a hypothetical resident farmer located on each RCA as well as at the nearest normally occupied area using RESRAD, Version 7.2 (Yu et al., 2016a), and RESRAD-OFFSITE, Version 3.2 (Yu et al., 2016b), respectively. Each analysis included a combination of site-specific and default parameter values. The Army’s site-specific considerations include the areas of the contaminated zone, the soil types associated with the saturated and unsaturated zones, and weather-related parameters. Each dose calculation also assumes that the depth of the contaminated zone equals 0.15 m. Tables 4.2 and 4.3 of the site-specific ERMPs list the site-specific parameter values used for each RCA for both RESRAD and RESRAD-OFFSITE. The non-default site-specific values that the Army used in both RESRAD and RESRAD-OFFSITE are summarized in Table 6 of this SER. The Army used default values for the parameters not included in the table.

¹² This is true for all RCAs at Fort Benning with the exception of Burma Hill. Only 2 kg of a total of 1850 kg of DU present at Fort Benning are assumed to be present in the Burma Hill RCA.

Table 6. Site-specific RESRAD and RESRAD-OFFSITE Input Parameter Values

Site		Donnelly	Ft. Benning		Ft. Bragg	Ft. Campbell	Ft. Carson	Ft. Gordon
Range(s)		Georgia Range	Z-4, Brann, Hook, Coolidge, Patton, Buchanan, K-15, and K-18 Ranges	Burma Hill Range	OP-5 Range	OP2/OP3 Impact Area	Range 141 and Battalion Field Training Range	Range E
Parameter	Default Value							
Contaminated Zone								
Area of contaminated zone (m2)	10,000	1,000,000	1,000,000	84,000	1,000,000	1,000,000	1,000,000	1,000,000
Depth of contaminated zone (m)	2	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Fraction of contamination submerged	0	0	0	0	0	0	0	0
Length parallel to aquifer flow (m)	100	1,000	1,000	330	1,000	1,000	1,000	1,000
Contaminated zone total porosity	0.4	0.39	0.39	0.39	0.39	0.45	0.39	0.39
Contam. zone hydraulic cond. (m/y)	10	5,550	5,550	5,550	4,930	227	1090	5,550
Contaminated zone b parameter	5.3	4.05	4.05	4.05	4.38	5.3	4.9	4.05
Average annual wind speed (m/s)	2.0	8.1	7.4	7.4	0.5	8.2	9.2	7.4
Precipitation rate (m/y)	1.0	0.35	1.1	1.1	1.2	1.3	0.49	1.14
Saturated Zone								
Density of saturated zone (g/cm3)							1.5	
Saturated zone total porosity	0.4	0.39	0.39	0.39	0.39	0.45	0.39	0.39
Saturated zone effective porosity	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.3
Saturated zone hydraulic cond. (m/y)	100	5,550	5,550	5,550	1,090	227	1090	5,550
Saturated zone b parameter	5.3	4.05	4.05	4.05	4.9	5.3	4.9	4.05
Unsaturated Zone								
Unsat. zone 1, thickness (m)	4.0	54	1.5	1.5		5.2		
Unsat. zone 1, total porosity	0.4	0.39	0.39	0.39	0.39	0.45	0.39	0.39
Unsat. zone 1, effective porosity	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.3
Unsat. zone 1, b parameter	5.3	4.05	4.9	4.9	4.05	5.3	4.9	4.05
Unsat. zone 1, hydraulic cond. (m/y)	10	5,550	1,090	1,090	5,550	227	1090	5,550

Table 6 (cont.). Site-specific RESRAD and RESRAD-OFFSITE Input Parameter Values

Site		Ft. Hood	Ft. Hunter			Ft. Jackson	Ft. Knox	
Range(s)		Davy Crockett Range	Range C8	Range B11	Range B13	Range 62	O'Brien Range	Arms Knob Range
Parameter	Default Value							
Contaminated Zone								
Area of contaminated zone (m2)	10,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,910,000	1,710,000
Depth of contaminated zone (m)	2	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Fraction of contamination submerged	0	0	0	0	0	0	0	0
Length parallel to aquifer flow (m)	100	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Contaminated zone total porosity	0.4	0.45	0.45	0.45	0.45	0.39	0.42	0.42
Contam. zone hydraulic conductivity (m/y)	10	53.6	219	227	32.6	4,930	32.6	32.6
Contaminated zone b parameter	5.3	7.75	5.39	5.3	10.4	4.38	10.4	10.4
Average annual wind speed (m/s)	2.0	7.4	7.4	7.4	7.4	6.9	7.4	7.4
Precipitation rate (m/y)	1.0	0.83	0.54	0.54	0.54	1.2	1.3	1.3
Saturated Zone								
Density of saturated zone (g/cm3)								
Saturated zone total porosity	0.4	0.45	0.45	0.45	0.45	0.39	0.42	0.42
Saturated zone effective porosity	0.2	0.2	0.20	0.20	0.20	0.3	0.06	0.06
Saturated zone hydraulic conductivity (m/y)	100	53.6	219	227	32.6	4,930	32.6	32.6
Saturated zone b parameter	5.3	7.75	5.39	5.3	10.4	4.38	10.4	10.4
Unsaturated Zone								
Unsat. zone 1, thickness (m)	4.0							
Unsat. Zone 1, total porosity	0.4	0.45	0.45	0.45	0.45	0.39	0.42	0.42
Unsat. zone 1, effective porosity	0.2	0.2	0.20	0.20	0.20	0.3	0.06	0.06
Unsat. zone 1, b parameter	5.3	7.75	5.39	5.3	10.4	4.38	10.4	10.4
Unsat. zone 1, hydraulic conductivity (m/y)	10	53.6	219	227	32.6	4,930	32.6	32.6

Table 6 (cont.). Site-specific RESRAD and RESRAD-OFFSITE Input Parameter Values

Site		Ft. Polk	Ft. Riley		Ft. Sill	JBLM			JBMDL
Range(s)		Ranges 33 and 34A	Ranges 27A and 27B	Range 29	FP 182/West Range	Range 52	OP-8	OP-9	Frankford Arsenal Range
Parameter	Default Value								
Contaminated Zone									
Area of contaminated zone (m2)	10,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Depth of contaminated zone (m)	2	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Fraction of contamination. submerged	0	0	0	0	0	0	0	0	0
Length parallel to aquifer flow (m)	100	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Contaminated zone total porosity	0.4	0.43	0.45	0.45	0.45	0.45	0.45	0.45	0.39
Contam. zone hydraulic conductivity (m/y)	10	4,930	227	53.6	1,090	227	227	227	4,930
Contaminated zone b parameter	5.3	4.38	5.3	7.75	4.9	5.3	5.3	5.3	4.38
Average annual wind speed (m/s)	2.0	6.5	7.7	7.7	7.3	10.1	10.1	10.1	8.9
Precipitation rate (m/y)	1.0	1.5	0.8	0.8	0.89	1.27	1.27	1.27	1.2
Saturated Zone									
Density of saturated zone (g/cm3)						1.5	1.5	1.5	
Saturated zone total porosity	0.4	0.43	0.45	0.45	0.42	0.45	0.45	0.45	0.39
Saturated zone effective porosity	0.2	0.33	0.20	0.20	0.06	0.20	0.20	0.20	0.3
Saturated zone hydraulic conductivity (m/y)	100	4,930	227	53.6	32.6	227	227	227	4,930
Saturated zone b parameter	5.3	4.38	5.3	7.75	10.4	5.3	5.3	5.3	4.38
Unsaturated Zone									
Unsat. zone 1, thickness (m)	4.0								1.5
Unsat. zone 1, total porosity	0.4	0.43	0.45	0.45	0.42	0.45	0.45	0.45	0.39
Unsat. zone 1, effective porosity	0.2	0.33	0.20	0.20	0.06	0.20	0.20	0.20	0.3
Unsat. zone 1, b parameter	5.3	4.38	5.3	7.75	10.4	5.3	5.3	5.3	4.38
Unsat. zone 1, hydraulic conductivity (m/y)	10	4,930	227	53.6	32.6	227	227	227	4,930

Table 6 (cont.). Site-specific RESRAD and RESRAD-OFFSITE Input Parameter Values

Site		Yakima			Pohakuloa				Schofield
Range(s)		Range 14	Range 17	Range 20	Area 1	Area 2	Area 3	Area 4	Davy Crockett Range
Parameter	Default Value								
Contaminated Zone									
Area of contaminated zone (m2)	10,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,500,000	2,750,000
Depth of contaminated zone (m)	2	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Fraction of contamination submerged	0	0	0	0	0	0	0	0	0
Length parallel to aquifer flow (m)	100	1,000	1,000	1,000	1,000	1,000	1,000	1,500	1000
Contaminated zone total porosity	0.4	0.34	0.34	0.34	0.43	0.43	0.43	0.43	0.45
Contam. zone hydraulic conductivity (m/y)	10	5,550	5,550	5,550	4,930	4,930	4,930	4,930	32.6
Contaminated zone b parameter	5.3	4.05	4.05	4.05	4.38	4.38	4.38	4.38	10.4
Average annual wind speed (m/s)	2.0	7.4	7.4	7.4	5.3	5.3	5.3	5.3	5.0
Precipitation rate (m/y)	1.0	0.45	0.45	0.45	0.51	0.51	0.51	0.51	0.9
Saturated Zone									
Density of saturated zone (g/cm3)									
Saturated zone total porosity	0.4	0.34	0.34	0.34	0.43	0.43	0.43	0.43	0.45
Saturated zone effective porosity	0.2	0.28	0.28	0.28	0.33	0.33	0.33	0.33	0.2
Saturated zone hydraulic conductivity (m/y)	100	5,550	5,550	5,550	4,930	4,930	4,930	4,930	32.6
Saturated zone b parameter	5.3	4.05	4.05	4.05	4.38	4.38	4.38	4.38	10.4
Unsaturated Zone									
Unsat. zone 1, thickness (m)	4.0								180
Unsat. zone 1, total porosity	0.4	0.34	0.34	0.34	0.43	0.43	0.43	0.43	0.45
Unsat. zone 1, effective porosity	0.2	0.28	0.28	0.28	0.33	0.33	0.33	0.33	0.2
Unsat. zone 1, b parameter	5.3	4.05	4.05	4.05	4.38	4.38	4.38	4.38	10.4
Unsat. zone 1, hydraulic conductivity (m/y)	10	5,550	5,550	5,550	4,930	4,930	4,930	4,930	32.6

Table 7. RESRAD and RESRAD-OFFSITE-Calculated Maximum Annual Doses for Resident Farmer Scenario¹

Installation	RCA	RESRAD mrem/yr ²	RESRAD-OFFSITE mrem/yr
Donnelly TA	Georgia Range	3.5×10^{-3}	1.6×10^{-3}
Fort Benning	Hook Range	3.2×10^{-1}	3.1×10^{-1}
	Buchanan Range	3.2×10^{-1}	3.1×10^{-1}
	Coolidge Range	3.2×10^{-1}	3.2×10^{-1}
	Brann Range	3.2×10^{-1}	3.3×10^{-1}
	Patton Range	3.2×10^{-1}	3.2×10^{-1}
	Z-4 (Lae Range)	3.2×10^{-1}	2.9×10^{-1}
	K-18 (Cactus OP)	3.2×10^{-1}	3.3×10^{-1}
	K-15	3.2×10^{-1}	3.5×10^{-1}
	Burma Hill	4.5×10^{-3}	3.8×10^{-3}
Fort Bragg	OP-5 Range	1.8×10^{-1}	7.3×10^{-2}
Fort Campbell	OP2/OP3	2.2×10^{-2}	7.2×10^{-3}
Fort Carson	Range 141	4.6×10^{-2}	3.0×10^{-2}
	Battalion Field	4.6×10^{-2}	3.7×10^{-2}
Fort Gordon	Range E	4.6×10^{-3}	3.7×10^{-3}
Fort Hood	Davy Crockett Range	1.3×10^{-1}	3.8×10^{-4}
Fort Hunter	B11	4.7×10^{-3}	2.2×10^{-3}
	B13	4.7×10^{-3}	1.9×10^{-5}
	C8	4.7×10^{-3}	1.9×10^{-3}
Fort Jackson	Range 62	4.7×10^{-3}	4.1×10^{-3}
Fort Knox	O'Brien Range	3.6×10^{-1}	6.0×10^{-2}
	Arms Knob Range	2.2×10^{-1}	3.6×10^{-2}
Fort Polk	Ranges 33 and 34A	6.4×10^{-2}	4.2×10^{-2}
Fort Riley	Ranges 27A and 27B	3.5×10^{-3}	1.2×10^{-3}
	Range 29	3.5×10^{-3}	1.3×10^{-3}
Fort Sill	FP 182/West Range	2.1×10^{-2}	1.3×10^{-2}
JBLM	Range 52	6.0×10^{-2}	1.9×10^{-2}
	OP-8	6.0×10^{-2}	2.1×10^{-2}
	OP-9	6.0×10^{-2}	2.0×10^{-2}
Yakima	Range 14	6.0×10^{-2}	2.0×10^{-2}
	Range 17	6.0×10^{-2}	2.2×10^{-2}
	Range 20	6.0×10^{-2}	2.6×10^{-2}
JBMDL	Frankford Arsenal Range	1.2×10^{-3}	9.6×10^{-4}
Pohakuloa	Area 1	2.5×10^{-2}	1.2×10^{-2}
	Area 2	2.5×10^{-2}	1.3×10^{-2}
	Area 3	2.5×10^{-2}	1.2×10^{-2}
	Area 4	1.7×10^{-2}	7.4×10^{-3}
Schofield Barracks	Davy Crockett Range	9.4×10^{-3}	2.6×10^{-3}

¹To calculate the dose in mSv/yr, multiply mrem/yr by 0.01

² This is the dose that the NRC calculated using RESRAD, Version 6.5, and the site-specific RESRAD parameter values provided in Table 4-2 of the submitted report (and included in Table 6, above). Minimal differences between this dose and the dose provided with the submittal can be attributed to differences in the RESRAD versions used in the submittal (RESRAD, Version 7.2).

2.2.2.1 Evaluation – Site-Specific Dose Assessments

The NRC staff reviewed the site-specific RESRAD input parameters for each RCA and found them to be conservative and acceptable for the resident farmer scenario being considered. In all cases the calculated dose to the resident farmer located on the RCA was below 1.0×10^{-2} mSv/yr (1.0 mrem/yr) TEDE with the peak dose occurring at time zero for all of the sites. Table 7 summarizes the calculated doses.

As discussed above, during its review of the source material NRC staff recalculated the radionuclide concentrations for four of the RCAs. NRC staff used the recalculated radionuclide concentrations (Table 5) to calculate RCA-specific doses (Table 8). There were minimal differences between the updated doses that the NRC calculated and the doses that the Army provided in its submittal. In all cases RCA-specific doses were at levels that were less than 1.0×10^{-2} mSv/yr (1.0 mrem/yr) TEDE.

Table 8. RESRAD-Calculated Maximum Annual Doses Using the Updated Radionuclide Concentrations

Installation	Range	Submitted Dose (mrem/yr)	Recalculated Dose (mrem/yr)
Fort Knox	Arms Knob	2.37E-01	3.77E-01
	O'Brien Range	2.13E-01	4.05E-01
Pohakuloa	Training Area 4	1.17E-02	2.46E-02
Schofield Barracks	M101 Impact Area	8.93E-03	2.45E-02

In its review in support of Amendment 1, NRC staff concurred with the Army's position that doses associated with acute events, such as high explosive (HE) activities, were not likely to result in significant risks or necessitate air monitoring. As discussed in the SER for Amendment 1 to the Army's DU possession license (NRC, 2016), calculations and experiences documented by the Army show that it is highly unlikely that any significant airborne transport of DU has occurred via aerosolization of the DU rounds from HE ordinance strikes in RCAs. Because the materials being licensed have been present for greater than 50 years, a logical case is made that, if aerosolization occurs due to range activities at levels approaching regulatory limits or monitoring limits, there would be little DU expected in the RCAs at this time. The Army also cited past documentation that contamination from DU munitions is typically localized in the immediate vicinity (within 10-100 meters) of the impact area and that airborne particulate sampling conducted during recent live fire events in Hawaii did not find any evidence of DU airborne contamination.

As part of the submittal, the Army also provided individual dose calculations for a resident farmer located at the nearest normally occupied area outside each RCA. Based on the doses provided, only RCA doses associated with the Fort Benning installation, when summed together, approach the 1.0×10^{-2} mSv/yr (1.0 mrem/yr) TEDE limit in the license condition. However, the entire DU mass at Fort Benning is assumed to be present in 8 of the RCAs¹³ at the same time, making it inappropriate to sum the RESRAD-OFFSITE calculated doses to estimate the cumulative impact of multiple RCAs at Fort Benning. Nevertheless, the NRC staff

¹³ A smaller mass of DU is associated with the Burma Hill Range at Fort Benning

determined that a review of the reported RESRAD-OFFSITE doses (Table 7) was not necessary because the results are not needed to demonstrate that the Army has met the requirements of LC 19. In all cases the RCA-specific RESRAD-OFFSITE doses were less than the conservatively-calculated onsite doses, which were below the dose requirement of 1.0×10^{-2} mSv/yr (1.0 mrem/yr) TEDE listed in LC 19.

2.3 Findings/Conclusions

In support of LC 19, the Army provided site-specific dose assessments for each RCA demonstrating that doses from each RCA did not exceed 1.0×10^{-2} mSv/yr (1.0 mrem/yr) TEDE. Each analysis considered a resident farmer scenario and a combination of RESRAD site-specific and default parameter values. NRC staff reviewed the submittal and found the RESRAD parameter values to be acceptable and confirmed that the dose associated with each RCA was below the required 1.0×10^{-2} mSv/yr (1.0 mrem/yr) TEDE. It is important to note that an onsite resident farmer is unlikely given the presence of unexploded ordnances at the site. Therefore, the dose calculations to onsite members of the public, which are well within the dose limits for individual members of the public per 20.1301, are provided primarily to bound the expected dose to members of the public far into the future.

Existing License Condition 19 (to be modified):

Within 6 months of the effective date of this license amendment, the licensee shall provide to the NRC for verification, documentation, including site-specific dose modeling parameters, showing that the approved dose modeling methodology was applied and that the calculated site-specific all pathway dose for each Radiation Control Area at each installation listed in License Condition 10 does not exceed 1.0×10^{-2} mSv/yr (1.0 mrem/yr) TEDE.

Existing License Condition 19 should be replaced with the following:

19. Deleted.

3.0 Consultations with Other Agencies

The NRC determined that consultation with other agencies is not required regarding this proposed amendment to ensure that the requirements of Section 7 of the Endangered Species Act of 1973 (ESA), and Section 106 of the National Historic Preservation Act of 1966 (NHPA),¹⁴ are met. Neither is consultation with State liaison agencies to provide them with the opportunity to comment on the proposed action required because this action will not impact endangered species or critical habitats or impact any historic properties or cultural resources.

National Historic Preservation Act of 1966

3.1 Regulations

Section 106 of NHPA requires Federal agencies to take into account the effects of their undertakings on historic properties and allow the Advisory Council on Historic Preservation

¹⁴ 16 USC 470 et seq.

(ACHP) an opportunity to review and comment on the undertaking. The NHPA implementing regulations at 36 CFR Part 800, "Protection of Historic Properties," define an undertaking as "a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; and those requiring a Federal permit, license or approval." Therefore, the NRC's approval of the Army's site-specific ERMPs for each RCA is an undertaking.

The NRC has determined that issuing the license amendment 2 to the Army has no potential to affect historic properties, if present, for the following reasons: (i) the license is for possession only; (ii) no new construction will occur from the proposed action; and (iii) no areas will be significantly disturbed from the proposed action. Therefore, in accordance with 36 CFR 800.3(a)(1), the undertaking is not the type of activity that has the potential to affect historic properties, and NRC has no further obligations under Section 106 of NHPA.

Endangered Species Consultations

3.3. Regulations

The following regulations apply to the environmental consultations with the U.S. Fish and Wildlife Service (FWS) Regional Offices:

- Section 7 of the Endangered Species Act of 1973 and
- 50 CFR 402, "Interagency Cooperation – Endangered Species," which require the NRC to meet certain requirements in the protection of endangered and threatened species and critical habitat.

The NRC staff has determined that Section 7 consultation is not required, because the proposed action would not affect listed species or critical habitat. Specifically, the NRC staff is approving site-specific ERMPs that conform to the programmatic ERMP that is already in place and the license amendment would incorporate the site-specific ERMPs into the license by reference.

Based on the NRC's assessment, the NRC staff has determined that no consultation is necessary for this project because the proposed action would not affect listed species or critical habitat.

3.4. Conclusions/Findings

NRC staff has determined that the proposed action would not affect listed species or critical habitat. Therefore, no further consultation is required under Section 7 of the Endangered Species Act.

4.0 National Environmental Policy Act

4.1 Regulatory Requirements and Guidance

The National Environmental Policy Act (NEPA) mandates that Federal agencies carefully consider the environmental impacts of their actions prior to making decisions that affect the environment. The NRC's NEPA implementing regulations are found at 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

Pursuant to 10 CFR 51.22(a), categorical exclusions are categories of actions that the NRC, by rule or regulation, has declared to be a categorical exclusion, after first finding that the category of actions does not individually or cumulatively have a significant effect on the human environment. Criteria for identifying a categorical exclusion and a list of actions eligible for categorical exclusions are found in 10 CFR 51.22(c).

The regulation at 10 CFR 51.22(c)(14)(xv) establishes "...amendment...of materials licenses issued pursuant to 10 CFR Part...40...authorizing...[p]ossession, manufacturing, processing, shipment, testing, or other use of depleted uranium military munitions" as a categorical exclusion.

NUREG-1748 "Environmental Review Guidance for Licensing Actions Associated with Nuclear Materials Safety and Safeguards Programs" contains the NRC staff's guidance for environmental reviews and includes a process for determining the type of NEPA action the NRC staff must undertake to comply with NEPA.

Appendix B to NUREG-1748 is a checklist and series of questions that must be answered by the NRC staff to determine if the proposed action falls under a categorical exclusion in 10 CFR 51.22. The NRC staff's responses to the questions in NUREG-1748 for this proposed action are summarized below.

4.2 Regulations and Guidance

The NRC staff evaluated the proposed licensing action in accordance with 10 CFR 51.22 and the guidance in NUREG-1748.

4.3 NRC Staff Review and Analysis

The discussion below presents the NRC staff's analysis of the proposed action with respect to the CATX checklist questions found in NUREG-1748, Appendix B.

- A. Is the action consistent with the Statements of Consideration (SOC) for the CATX chosen?
YES

The SOC for CATX 51.22(c)(14)(xv) states:

Possession, manufacturing, processing, shipment, testing or other use of depleted uranium munitions, e.g., bullets and other projectiles, includes about 10 licenses held by U.S. military organizations and less than 10 licensees involved

with the manufacturing process. The military tests involve the use of low specific activity depleted uranium (3.6×10^7 curies/gram) as metal alloy penetrators (rods) which vary in weight from a few grams to less than 10 kilograms. These rods are propelled at high velocities against metal targets such as armor plate. Testing of these munitions is carried out at remote desert locations on military reservations, in constructed enclosures, or over deep ocean waters. Any materials released to the environment are of low radioactive content, are highly dispersed, and are of chemical and physical form which is not readily incorporated into flora or fauna. Thus, radioactive releases to the environment which could affect human, animal or plant life from testing at any of the locations are negligible and occupational exposures from handling depleted uranium are so low that personnel monitoring is not required. Additionally, since the penetrators tested do not explode, cratering or other defacing of the environment is not experienced. The military also transports and stores depleted uranium munitions for war-readiness posture. Because the munitions are transported and stored in sealed containers as solid metal in nondispersible form, there is negligible environmental impact associated with such transportation and storage.

Manufacturers of depleted uranium munitions are also included here for the sake of completeness, although manufacturers are excluded in section (xiii) of Category 14.

49 FR 9379 March 12, 1984

The SOC includes “possession.... of depleted uranium munitions including e.g., bullets and other projectiles.” In a letter (ADAMS Accession No. ML16265A221 (Pkg)), dated September 15, 2016, the United States Army Installation Management Command (Army) submitted documents as required by LCs 18 and 19 of Source Materials License No. SUC-1593, Amendment 1 (ADAMS Accession No. ML16039A234) to the U.S. Nuclear Regulatory Commission (NRC or the Commission). The NRC reviewed the Army’s submittal in support of LC 18, and found that each site-specific ERMP is consistent with the previously approved programmatic approach for preparation of site-specific ERMPs (ADAMS Accession No. ML16004A369), as reproduced in Programmatic ERMP, dated September 15, 2016 (ADAMS Accession No. ML16265A218, and conditions in license SUC-1593, Amendment 1. Therefore, these site-specific ERMPs were acceptable to the NRC and should be incorporated into the license by reference.

Also, in support of LC 19, the NRC verified that the U.S. Army provided site-specific dose assessments for each RCA demonstrating that doses from each RCA did not exceed 1.0×10^{-2} mSv/yr (1.0 mrem/yr) TEDE. As a result, the NRC LC 19 was removed from the license because the licensee fulfilled the license condition and the LC 19 is no longer applicable.

LC 18 should be modified to remove the requirement to submit the site-specific ERMPs if they are to be added to the license. Also, LC 19 should be removed from the license since it is no longer applicable.

The Davy Crockett M101 spotting round is a military munition and is a projectile. The DU portion of the Davy Crockett projectile is about 190 grams of DU per M101 spotting round.

Thus, the “possession” of a “projectile” discussed in the SOC is consistent with the Army’s request to possess the DU portion of the spotting round.

The SOC refers to the testing of the DU munition and describes the locations of the testing as remote areas such as deserts on military reservations, oceans and enclosures. In the Army’s license application, the intended “use” by the Army of the DU from Davy Crockett M101 spotting rounds are not for testing. Rather, it already has obtained authorization to possess material that is already in the environment, and has been in the environment for many years. Therefore, the discussion of testing of the round is not germane to the proposed action by the NRC staff (i.e., authorization to possess the DU). However, it is important to note that the areas that do contain the spent M101 spotting rounds and fragments are controlled by the Army for unexploded ordnance and other materials and are not occupied without specific authorization from the Army (i.e., they are not open to the public). Thus, while the discussion of the locations of testing is not germane to the intended use by the Army, it is relevant to the concept that the material is not readily accessible to unauthorized individuals or the public and therefore radioactive releases to the environment which could affect human life are negligible.

The SOC discusses the chemical/physical form of the DU and states that the radioactive content is low, highly dispersed (i.e., the locations of the rounds are widely separated) and the DU is not readily incorporated into flora or fauna. This is the rationale for concluding that releases to the environment are negligible and that possible exposures to the DU are so low that personnel monitoring is not necessary. Because the DU from the spent M101 spotting rounds is of a small quantity (less than ½ lb) and will be widely dispersed on the ranges, it is consistent with the SOC. Site-specific ERMPs themselves do not cause dispersion of the material on the ranges, rather they are used as a surveillance mechanism to track and monitor that migration of the material is not in unexpected locations and at levels that are not anticipated.

Finally, the M101 spotting round did not explode on contact and was not fired into a hard target. Rather, the round was fired at a distant target and, while the M101 spotting round did contain a small marking charge in the projectile nose which could fracture the DU portion of the round, cratering or defacing of the environment of the environment was minimal and the dispersal of the round in the environment was not as extensive as one fired into an armored target (not done at these Army ranges in question).

B. Is the action likely to significantly affect any aspect of the natural environment? NO

Issuance of the license amendment will not change or affect the environment because the DU is already present and was deposited in the environment nearly 60 years ago. Thus, the proposed action will have negligible effects on the environment approving site-specific ERMPs that conform to the programmatic ERMP that is already in place. The license amendment would incorporate the site-specific ERMPs into the license by reference.

C. Is the action likely to significantly affect any aspect of the cultural environment including those that might be related to environmental justice? NO

The NRC staff verified that it was consistent with a plan already approved by License Amendment 1 and therefore the site-specific ERMPs should be added to the license. Thus, the proposed action will have no effect on the cultural environment. Additionally, because negligible

effects to the environment are expected from DU possession, there are no disproportionately high or adverse impacts to minority or low-income populations.

D. Is the action likely to generate a great deal of public interest about any environmental issue?
NO

There is some public interest in the DU at the Schofield Barracks/Pohakuloa Training Area, HI, which was originally licensed in 2013 and then again with the issuance of Amendment 1 in 2016, based on the public's concern about the human health effects of the DU. However, the NRC is not aware of any substantial public interest in the other installations, as identified in LC 10 of Source Materials License No. SUC-1593. Two individuals provided unsolicited comments on the submittal for the Pohakuloa RCAs (ADAMS Accession No. ML17010A188). The NRC staff reviewed the comments and considered them in its review for this licensing action.

E. Is there a high level of uncertainty about the action's environmental effects? NO

Authorizing addition of the site-specific ERMPs that are consistent with the already approved programmatic ERMP is not expected to have an effect on the cultural or physical environment. Migration of the DU in the environment is not controlled by the approval or addition of these site-specific plans to the license. Consequently, there is not a high level of uncertainty about the action's environmental effects.

4.4 Evaluation Findings

An environmental assessment for this action is not required, because this action is categorically excluded under 10 CFR 51.22(c)(14)(xv).

5.0 License Conditions

Based on the conclusions discussed above, the NRC staff determined that the changes to the following conditions are necessary to ensure that the site-specific ERMPs are tied to the license and their implementation becomes subject to inspection.

Proposed License Condition Changes are provided below in **bold** text:

11. Except as specifically provided otherwise, the licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the license amendment application:
 - Programmatic RSP, "Radiation Safety Plan for IMCOM Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium," dated December 31, 2015 (ML16004A369);
 - Programmatic PSP; "Physical Security Plan for US Army Installation Management Command Ranges Affected by Depleted Uranium in M101 Davy Crockett Spotting Rounds," dated December 31, 2015 (ML16004A369);
 - Army's Form 313, "Application for Materials License," items 1-7, dated June 1, 2015 (Pkg. ML15161A454);

- Attachment 3, “Calculation of TEDE to Individual Likely to Receive Highest Dose,” dated June 1, 2015 (Pkg. ML15161A454);
 - Attachment 4, “Attachment 4. How the Army Determined the M101 DU RCAs,” dated June 1, 2015 (Pkg. ML15161A454);
 - Attachment 5, “Bounding Calculations Using RESRAD 7.0 and RESRAD-OFFSITE 3.1,” dated June 1, 2015 (Pkg. ML15161A454);
 - Attachment 8, “Arguments against Air Sampling During HE [High Explosive] Fire into RCAs [Radiation Control Areas],” dated June 1, 2015 (Pkg. ML15161A454);
 - Email clarifying RCAs at Fort Knox, KY, dated January 29, 2016 (ML16041A107);
 - Attachment 8, “Estimating Public Exposure to Airborne Depleted Uranium Outside the U.S. Army Pohakuloa Training Area, Hawaii,” dated September 30, 2015, (ML15294A276);
 - Attachment 9, “Examples of Army Range fires,” dated September 30, 2015, (ML15294A276);
 - Attachment 10, “Arguments against Air Sampling During HE Fire into RCAs, rev. 1,” dated September 30, 2015, (ML15294A276);
 - Attachment 11, “Calculation of Public Dose SOP,” dated September 30, 2015, (ML15294A276);
 - Programmatic ERMP, “Programmatic Approach for Preparation of Installation-specific Environmental Radiation Monitoring Plans,” **dated September 15, 2016 (ML16265A218)**;
 - “US Army Decommissioning Funding Plan (DFP) for License Number SUC-1598,” dated February 9, 2016 (ML16042A232);
 - Maps of the locations of the RCAs, “M101 Impact Areas,” dated December 31, 2015 (but, sent February 12, 2016 (ML16048A358);
 - Army’s emails clarifying M101 Target Areas (Radiation Control Areas), dated February 12, 2016 (ML16048A347), **May 24, 2016 (ML16341C807), and December 7, 2016 (ML16351A092)**
 - Army’s Statement of Intent, dated June 1, 2015 (ML15161A458);
 - **Site-Specific Environmental Radiation Monitoring Plans and Associated Quality Assurance Plan, dated September 15, 2016 (Pkg ML16265A221)**
18. Within 6 months of the effective date of the **License Amendment 2**, the licensee shall fully implement each installation’s site-specific environmental radiation monitoring plan.
19. **Deleted.**

6.0 Acronyms and Initialisms

AEA	Atomic Energy Act of 1954, as amended
CATEX	Categorical Exclusion
CFR	<i>Code of Federal Regulations</i>
DU	Depleted Uranium
ERMP	Environmental Radiation Monitoring Plan
FR	<i>Federal Register</i>
FWS	U.S. Fish and Wildlife Service
IMCOM	U.S. Army Installation Management Command
NHPA	National Historic Preservation Act of 1980
NEPA	National Environmental Policy Act
NUREG	NRC technical report designation (<u>N</u> uclear <u>R</u> egulatory Commission)
PSP	Physical Security Plan
RCA	Radiation Control Area
REM	roentgen equivalent man
RESRAD	dose assessment code for RESidual RADioactive materials
RSP	Radiation Safety Plan
SOC	Statements of Consideration
SER	Safety Evaluation Report
SOI	Statement of Intent
SOP	Standard Operating Procedures
SRM	Staff Requirement Memorandum
TEDE	Total Effective Dose Equivalent

7.0 References

[AEA] Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2011 et seq., Pub. L. 83-703.

[DOE, 2008] *RESRAD Home Page*. [Online] Available at:
<http://web.ead.anl.gov/resrad/home2/index.cfm> [Accessed 19 November 2012].

[NRC 1998b] "NRC Collection of Abbreviations, Rev. 4," July 1998.

[NRC 1999] NUREG-1556, Vol. 7, "Consolidated Guidance About Materials Licenses: Program-Specific Guidance About Academic, Research and Development, and Other Licenses of Limited Scope Including Gas Chromatographs and X-Ray Fluorescence Analyzers," 1999.

[NRC 2000] NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Rev. 1," August 2000 (ML003761445).

[NRC 2003a] NUREG-1757, Vol. 3, "Consolidated NMSS Decommissioning Guidance: Financial Assurance, Recordkeeping and Timeliness, Rev. 1," September 2003 (ML12048A683).

[NRC 2003b] NUREG-1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs" July 2003 (ML032450279).

[NRC 2006] NUREG-1757, Vol. 2, "Characterization, Survey, and Determination of Radiological Criteria, Revision 1," September 2006 (ML063000252).

[NRC 2013b] Safety Evaluation Report for the U.S. Army's Possession License for Depleted Uranium from the M101 Spotting Round, October 23, 2013 (ML13259A081).

[NRC 2015] *Davy Crockett - Depleted Uranium – Possession Only License Source Materials License No. SUC- 1593 Additional Guidance*, February 27, 2015 (ML15061A177).

[NRC 2016] Safety Evaluation Report for the U.S. Army's Possession License for Depleted Uranium from the M101 Spotting Round- Addition of 15 Sites, Amendment No. 1, March 21, 2016 (ML16039A230).

[U.S. Army, 2016] Site-Specific Environmental Radiation Monitoring Plans and Associated Quality Assurance Plan, dated September 15, 2016 (Pkg ML16265A221)

ML16265A218	Programmatic Environmental Radiation Monitoring Plan
ML16265A234	Final Site-Specific Environmental Radiation Monitoring Plan, Donnelly Training Area, Fort Wainwright, Alaska, Annex 1
ML16265A23	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Benning, Georgia, Annex 2
ML16265A237	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Bragg, North Carolina, Annex 3
ML16265A238	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Campbell, Kentucky, Annex 4

ML16265A239	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Carson, Colorado, Annex 5
ML16265A240	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Gordon, Georgia, Annex 6
ML16265A241	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Hood, Texas, Annex 7
ML16265A242	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Hunter Liggett, California, Annex 8
ML16265A243	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Jackson, South Carolina, Annex 9
ML16265A224	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Knox, Kentucky, Annex 10
ML16265A225	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Polk, Louisiana, Annex 11
ML16265A226	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Riley, Kansas, Annex 12
ML16265A227	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Sill, Oklahoma, Annex 13
ML16265A228	Final Site-Specific Environmental Radiation Monitoring Plan, Joint Base Lewis-McChord, Tacoma, Washington, Annex 14
ML16265A22	Final Site-Specific Environmental Radiation Monitoring Plan, Yakima Training Center, Washington, Annex 15
ML16265A230	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Dix, Joint Base McGuire-Dix-Lakehurst, New Jersey, Annex 16
ML16265A231	Final Site-Specific Environmental Radiation Monitoring Plan, Pohakuloa Training Area, Hawaii, Annex 17
ML16265A232	Final Site-Specific Environmental Radiation Monitoring Plan, Schofield Barracks Military Reservation, Oahu, Hawaii, Annex 18
ML16265A233	Final Environmental Radiation Monitoring Program, Programmatic Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP), Annex 19
ML16265A234	Final Site-Specific Environmental Radiation Monitoring Plan, Donnelly Training Area, Fort Wainwright, Alaska, Annex 1
ML16265A235	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Benning, Georgia, Annex 2
ML16265A237	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Bragg, North Carolina, Annex 3
ML16265A238	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Campbell, Kentucky, Annex 4
ML16265A239	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Carson, Colorado, Annex 5
ML16265A240	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Gordon, Georgia, Annex 6
ML16265A241	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Hood, Texas, Annex 7
ML16265A242	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Hunter Liggett, California, Annex 8

ML16265A243	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Jackson, South Carolina, Annex 9
ML16265A224	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Knox, Kentucky, Annex 10
ML16265A225	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Polk, Louisiana, Annex 11
ML16265A226	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Riley, Kansas, Annex 12
ML16265A227	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Sill, Oklahoma, Annex 13
ML16265A228	Final Site-Specific Environmental Radiation Monitoring Plan, Joint Base Lewis-McChord, Tacoma, Washington, Annex 14
ML16265A229	Final Site-Specific Environmental Radiation Monitoring Plan, Yakima Training Center, Washington, Annex 15
ML16265A230	Final Site-Specific Environmental Radiation Monitoring Plan, Fort Dix, Joint Base McGuire-Dix-Lakehurst, New Jersey, Annex 16
ML16265A231	Final Site-Specific Environmental Radiation Monitoring Plan, Pohakuloa Training Area, Hawaii, Annex 17
ML16265A232	Final Site-Specific Environmental Radiation Monitoring Plan, Schofield Barracks Military Reservation, Oahu, Hawaii, Annex 18
ML16265A233	Final Environmental Radiation Monitoring Program, Programmatic Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP), Annex 19

[Yu, C., et al., 2001] *User's Manual for RESRAD Version 6*. Argonne, Illinois: Department of Energy Argonne National Laboratory, 2001.