DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
2405 GUN SHED ROAD
FORT SAM HOUSTON, TEXAS 78234-1223

November 7, 2014

ATTN: Document Control Desk
Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate
Division of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Management Programs
Mailstop T8 F5
US Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Deputy Director:

Relating to license conditions 11 and 17 of source material license number SUC-1593 (docket number 040-9083), I am submitting our report of the air sampling performed during a training exercise at Schofield Barracks last February. The exercise included firing of high explosive munitions. I also am providing my evaluation of that report.

The Army recommends and requests that the NRC concur with the Army's analysis and evaluation of the enclosed "Effluent Sampling Report" and lift its prohibition of firing HE rounds into the RCA at Schofield Barracks. If the NRC concurs, we will delete the NOTE in section 4.1.1 of the Radiation Safety Plan for Hawaii ranges.

You may reach me by telephone at (210) 466-0368 or by email at robert.cherry@us.army.mil.

Sincerely,

Robert N. Cherry, Jr.
License Radiation Safety Officer

NMSS20

Army Evaluation of "Effluent Sampling Report for Air Monitoring of Depleted Uranium During a Training Exercise Using High Explosive Rounds within an Existing Radiation Controlled Area"

November 2014

Introduction

On October 23, 2013, the U.S. Nuclear Regulatory Commission (NRC) issued source material license SUC-1593 to the U.S. Army Installation Management Command (Army) to allow the possession of depleted uranium (DU) from the Davy Crockett M101 spotting round (NRC 2013). License Condition 22 of source material license SUC-1593 reads, "The licensee shall provide an air sampling plan to the NRC within 90 days of [effective date of this license] for review and approval. Until the air sampling results are approved by NRC, the licensee will conduct activities on the ranges in accordance with previously approved restrictions and provisions."

On December 16, 2013, the Army submitted an air sampling plan (Cabrera Services 2013) in accordance with License Condition 22. The letter transmitting that plan said, "The 25th Infantry Division will conduct a scheduled training exercise at the Battle Area Complex (BAX) at Schofield Barracks on February 4-11, 2014. This presents the best opportunity to implement this air sampling plan for high explosive (HE) fire into impact area that overlaps the radiation controlled area (RCA)."

On January 23, 2014, Mr. Norato of the NRC wrote in an email (Norato 2014) to Colonel Baldwin of Headquarters, US Army Installation Management Command (IMCOM):

> In the Army's December 16, 2013, cover letter submitting the air sampling plan, the Army requested NRC's expedited approval of the plan in order to perform air sampling during an actual live-fire training exercise scheduled for early February 2014. NRC staff has not yet completed its review of the air sampling plan. However, we do not object to the Army conducting the training and air sampling as discussed in the December 16, 2013, letter and air sampling plan, because we do not believe that it represents a threat to public health and safety; and the Army will be monitoring the air as it leaves the high-explosive impact area. However, please be advised that, if the NRC review determines that the sampling done in accordance with the submitted plan will not provide adequate information necessary for the NRC staff to reach a conclusion regarding the need for air continued air sampling at the Hawaiian installations, NRC will not approve the plan; and the Army may be required to do additional air sampling at a later date.

On January 28, 2014, Dr. Cherry of IMCOM wrote in an email (Cherry 2014) to Mr. Orlando and Mr. Evans of the NRC:

> As required by ... license condition [17], I am informing the NRC that the Army plans to fire high explosive (HE) munitions into an impact area that is in the radiation controlled area (RCA) at the Schofield Barracks Battle Area Complex (BAX). This will occur as part of a training exercise scheduled for February 4 through February 11.
>
> We plan to follow the air sampling plan that is currently under your review. We will perform background air sampling on February 3 (even though depleted uranium is not normally present in background).
>
> ... [If] we have to cancel the air sampling, we will shift the HE impact area to an impact area outside of the RCA and let you know about as soon as we can.

From February 3 to February 12, 2014, the Army conducted a training exercise using high explosive (HE) rounds within an existing Radiation Controlled Area (RCA) in the BAX at Schofield Barracks. The Army's contractor performed air sampling during this time and, with a few exceptions discussed below, followed the December 16, 2013 air sampling plan.

On March 11, 2014, a Technical Evaluation Report (TER) (NRC 2014) summarized the NRC staff's review of the Army's air sampling plan and assessed the Army's compliance with the applicable requirements of 10 CFR Part 40 "Domestic Licensing of Source Material" and 10 CFR Part 20, "Standards for Protection Against Radiation."

On October 3, 2014, the Army's contractor provided its final report (Cabrera Services 2014) for the effluent sampling during the training exercise held in February 2014.

Report Summary

The final report (Cabrera Services 2014) indicates that the air sampling efforts were unable to detect uranium-238 (^{238}U) in air concentrations greater than minimum detectable concentrations (MDCs) that ranged from 8.9×10^{-17} microcurie per milliliter (µCi/mL) to 2.1×10^{-15} µCi/mL for any single sample. We were also unable to detect depleted uranium in the samples.

Report Evaluation and Analysis

The radiochemistry laboratory reported results for each sample for volume sampled and for concentrations of uranium in air. From this information it is possible to back-calculate the uranium activity for each sample. This was done, and the uranium activities were summed in an effort to improve relative uncertainties. Table 1 summarizes the results.[1]

[1] All uncertainties are two standard deviations.

Table 1 – Uranium isotope concentrations and activities on air sample filters determined by alpha spectroscopy, summed over all filters

Sample	Concentration (10^{-16} × μCi/mL)[a]		Activity (pCi)[a]		Ratio
	^{234}U [b]	^{238}U	^{234}U [b]	^{238}U	$^{238}U/^{234}U$
Before HE fire	7.7 ± 1.4	2.1 ± 0.7	1.6 ± 0.3	0.42 ± 0.15	0.27 ± 0.11
During HE fire	5.2 ± 0.7	1.3 ± 0.5	1.8 ± 0.3	0.5 ± 0.2	0.26 ± 0.10
After HE fire	5.4 ± 0.9	0.5 ± 0.7	1.9 ± 0.3	0.2 ± 0.3	0.09 ± 0.13
Total	5.8 ± 0.5	1.2 ± 0.4	5.3 ± 0.5	1.1 ± 0.3	0.20 ± 0.07

[a] All lab-reported regular sample results were corrected by a factor of 0.9 to account for the filter collection efficiency. See Section 3.3.2 of the final report (Cabrera Services 2014).

[b] The laboratory spiked the samples with ^{232}U. According to the report (Cabrera Services 2014), "The ^{232}U peaks tend to exhibit tailing into the ^{234}U [region of interest], resulting in higher detectable counts for ^{234}U." This results in an indeterminate systematic error that that produces an apparent ^{234}U activity higher than the true value.

μCi = microcurie = 10^{-6} curie; mL = milliliter = 10^{-3} liter; pCi = picocurie = 10^{-12} curie

The ratio column in Table 1 clearly shows that the values for ^{234}U are incorrect. The ratios should be close to one for natural uranium only and must be greater than three before we would conclude a sample contains both DU and natural uranium. However, the ratios are all much less than one. The report explains:

> The higher detectable activity for ^{234}U was likely due to the manner in which the samples were prepared and measured at the offsite laboratory. Each sample collected, including the blanks, was spiked with a ^{232}U tracer in order to monitor radiochemical recoveries throughout the preparation process. The ^{234}U activity reported for samples and blanks are biased slightly high due to counts resulting from mass attenuation of the ^{232}U tracer peak, which occurs just up field from the ^{234}U Region of Interest (ROI). The ^{232}U peaks tend to exhibit tailing into the ^{234}U ROI, resulting in higher detectable counts for ^{234}U. However, it should be noted that it is not possible to perform a post-analysis correction to the ^{234}U ROI counts for the tailing effect.

Since the results for ^{234}U are essentially useless, the results for ^{238}U can be converted to results for natural uranium for discussion purposes, as follows.

The maximum permissible effluent concentration for natural uranium in air is 9×10^{-14} μCi/mL (NRC 2012). The ^{238}U isotope contributes 48.9 percent of the total activity in natural uranium. Assuming the uranium in the samples was natural uranium, the MDCs for any single sample for natural uranium can be calculated from the MDCs for ^{238}U by dividing by 0.489.[2] Therefore, the MDCs for natural uranium ranged from 1.8×10^{-16} μCi/mL to 4.3×10^{-15} μCi/mL, which are well below the maximum permissible effluent concentration for natural uranium.[3]

[2] The ^{238}U isotope contributes about 85 percent of the total uranium activity in DU. Assuming natural uranium instead of DU in the samples is conservative.

[3] The NRC allows licensees to average effluent concentrations over the entire calendar year (NRC 2012). This training exercise lasted about eight days, so applicable concentrations, averaged over a year, would be about 8/365 ≈ 2 percent of these results for a single exercise in a year.

Table 2 shows that the estimated concentration of natural uranium in air for the entire exercise was 2.4×10^{-16} μCi/mL (about 95 percent confidence), which is slightly more than 0.2 percent of the effluent standard. However, the results from before HE fire, when no DU was in the air, imply that DU also was not in the air during and after the HE fire. That is, it appears that virtually all the uranium detected was of natural origin. Hence, the effluent standard does not even apply to these results.[4]

Table 2 – Uranium isotope concentrations and activities on air sample filters assuming samples are 100 percent natural uranium

Sample	Concentration (10^{-16} × μCi/mL)		Activity (pCi)	
	^{238}U [a]	Natural uranium [b]	^{238}U [a]	Natural uranium [b]
Before HE fire	2.1 ± 0.7	4.3 ± 1.5	0.42 ± 1.5	0.9 ± 0.3
During HE fire	1.3 ± 0.5	2.7 ± 0.9	0.5 ± 0.2	1.0 ± 0.3
After HE fire	0.5 ± 0.7	1.0 ± 1.4	0.2 ± 0.3	0.3 ± 0.5
Total	1.2 ± 0.4	2.4 ± 0.7	1.1 ± 0.3	2.2 ± 0.7

[a] All lab-reported regular sample results were corrected by a factor of 0.9 to account for the reduced filter collection efficiency.

[b] Results assume that the samples are natural uranium with 48.9 percent of the total uranium activity due to ^{238}U.

μCi = microcurie = 10^{-6} curie; mL = milliliter = 10^{-3} liter; pCi = picocurie = 10^{-12} curie

Discussion of Sampling Plan

Time constraints, which the deputy commanding general of the 25th Infantry Division set, forced performance of air sampling during HE fire before the NRC approved the sampling plan. The NRC provided its critique of the sampling plan and did not approve the plan before sampling began. Had the Army been able to perform the sampling in accordance with an approved plan that implemented the NRC recommendations, the results likely would be different from the above, but not different enough to change the general conclusions.

Although the Army's air sampling during HE fire was not in full compliance with the NRC's recommendations, the results the Army obtained unequivocally show that uranium, no matter what form, appears in air concentrations orders of magnitude below applicable effluent standards.

Not enough uranium was available to demonstrate a measurable fraction of DU in the uranium, especially in concert with the flawed measurement of ^{234}U activity using alpha spectroscopy.[5]

To summarize, although the air sampling during HE fire was flawed, the results are sufficient to show that DU leaves the RCA during HE fire in no more than miniscule, unimportant quantities, if at all. These miniscule quantities produce, at the most, air concentrations that are likely much less than 0.1 percent of applicable effluent standards.

[4] 10 CFR 20, § 20.1002 says, "The limits in this part do not apply to doses due to background radiation ... ."

[5] In the future, the Army will use inductively coupled plasma–mass spectroscopy (ICP-MS) in its attempts to detect DU in samples.

Recommendation

Section 4.1.1 of the Radiation Safety Plan (RSP) for the Schofield Barracks radiation controlled area (US Army IMCOM 2013) says:

> High explosive (HE) munitions will not be fired into an RCA until the License RSO has informed the NRC. The Garrison RSO will assure that range operators, trainers, and planners are well aware of this requirement.
>
> > NOTE: Until the NRC has reviewed and concurred on the results of the air sampling plan that a license condition requires, firing of HE rounds into the RCA is prohibited, in accordance with current restrictions the NRC has placed on firing HE. (This note will be removed from this RSP when the NRC lifts these restrictions.)
>
> This notification requirement for firing HE munitions into RCAs does not apply for other types of non-high-explosive munitions, such as small-arms fire and inert training rounds.

The number of HE rounds fired during this training exercise did not suspend a large amount of dust. The dust that was suspended did not appear to move off-post. The Schofield Barracks Training Support System Director provided the attached certificate attesting that the Army fired a typical amount of HE rounds during this exercise.

The Army recommends and requests that the NRC concur with the Army's analysis and evaluation of the "Effluent Sampling Report" and lift its prohibition of firing HE rounds into the RCA at Schofield Barracks.

Condition 11 of License Number SUC-1593 incorporates the RSP by reference. The RSP allows the Army to delete the NOTE mentioned above when the NRC lifts HE fire restrictions. Therefore, it appears that a license amendment is not necessary if the NRC accepts the Army recommendation and request. The Army will merely delete the NOTE from the RSP.

Bibliography

Cabrera Services, Inc. *Effluent Sampling Plan for Air Monitoring of Depleted Uranium During High Explosive Fire.* Final, North Highlands, California: Cabrera Services, Inc., 2013.

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Cherry, Robert. *NRC License No. SUC-1593, Condition 17.* Email to Mr. Norato and Mr. Evans of the NRC. Fort Sam Houston, Texas, Janaury 28, 2014.

Norato, Michael. *NRC Approval for Air Sampling During Live HE Fire in Hawaii.* Email to Colonel Baldwin of IMCOM. Rockville, Maryland, January 23, 2014.

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—. "10 CFR Part 20 Standards for Protection Against Radiation." August 23, 2012. http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/full-text.html (accessed August 31, 2012).

NRC. *Technical Evaluation Report: U.S. NRC Staff Evaluation of the U.S. Army's Air Sampling Plan for Depleted Uranium from the M101 Spotting Round.* Rockville, Maryland: NRC, 2014.

US Army IMCOM. *Radiation Safety Plan for US Army Garrison Hawaii Ranges Affected by M101 Davy Crockett Spotting Round Depleted Uranium.* Fort Sam Houston, Texas: US Army IMCOM, 2013.

High Explosive Inventory for Firing Exercise

Thursday February 6, 2014

CA45	CTG MORTAR, 120MM HE XM1101 EFSS	**8**

Friday February 7, 2014

CA04	CTG MORTAR, 120MM HE M934A1	**12**

Saturday February 8, 2014

CA45	CTG MORTAR, 120MM HE XM1101 EFSS	**13**

Sunday February 9, 2014

CA04	CTG MORTAR, 120MM HE M934A1	**1**
CA45	CTG MORTAR, 120MM HE XM1101 EFSS	**14**

Monday February 10, 2014

CA45	CTG MORTAR, 120MM HE XM1101 EFSS	**11**

total	**59**

The amount fired into the impact area is typical for an exercise conducted into this impact area. ~~The~~ The training value for artillery is somewhat limited due to the short range and the increased precision of modern munitions result in a decreased ammunition count for this area as compared to years past.

(808) 655-4353 Tom Haywood, Training Support System Director