UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 8, 2017

Mr. Scott Schierman, Manager
Health, Safety, and Environment
Uranium One USA, Inc.
907 N. Poplar Street, Suite 260
Casper, WY 82601-1310

SUBJECT: URANIUM ONE, USA, INC., WILLOW CREEK PROJECT, REQUEST FOR ADDITIONAL INFORMATION ON SUBMITTALS IN RESPONSE TO LICENSE CONDITION 11.9, MATERIALS LICENSE SUA-1341 (CAC J00711)

Dear Mr. Schierman:

By letters dated May 30, 2014, and April 17, 2017, Uranium One USA, Inc. (Uranium One) submitted its responses to License Condition 11.9 (NRC's Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML14153A103 and ML17111A945). The NRC staff has reviewed the submittals and is unable to verify Uranium One's responses meet License Condition 11.9. The enclosed requests for additional information and written evaluation explain the NRC staff's open items. Upon receipt of Uranium One's reply, the NRC staff will continue its evaluation and notify Uranium One in writing of its results.

In accordance with 10 CFR 2.390 of the NRC's "Agency Rules of Practice and Procedure," a copy of this letter will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of NRC's ADAMS. ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

If you have any questions, contact me at 301-415-7777, or by e-mail at ron.linton@nrc.gov.

Sincerely,

/RA/

Ron Linton
Uranium Recovery Licensing Branch
Division of Decommissioning, Uranium Recovery, and Waste Programs
Office of Nuclear Material Safety and Safeguards

Docket No.: 040-08502
License No.: SUA-1341
Enclosures:
1. NRC Staff Review
2. Request for Additional Information

cc: Luke McMahan, PG. (WDEQ)
Ryan Schierman (WDEQ)

SUBJECT: URANIUM ONE, USA, INC., WILLOW CREEK PROJECT, REQUEST FOR ADDITIONAL INFORMATION ON SUBMITTALS IN RESPONSE TO LICENSE CONDITION 11.9, MATERIALS LICENSE SUA-1341 (CAC J00711)
DATE: JUNE 8, 2017

DISTRIBUTION:
RKellar/RIV BBaca/RIV SAchten

ML17143A330(Ltr.)

OFC	URLB	URLB	URLB	URLB	URLB
NAME	D. Brown	R. Linton	S. Achten	B. VonTill	R. Linton
DATE	06/05/17	06/05/17	05/24/17	06/08/17	06/08/17

OFFICIAL RECORD COPY

NRC Staff Review of Uranium One USA, Inc. Submittals dated May 30, 2014 and April 17, 2017, Regarding License Condition 11.9, Materials License SUA-1341; Docket No. 040-08502

Background

In the NRC staff's Safety Evaluation Report for License Renewal of the Willow Creek Uranium In Situ Recovery Project (NRC 2013), NRC staff found that Uranium One USA, Inc. (Uranium One) had not specified the scan minimum detectable concentration (MDC) or survey capability for instrumentation the licensee described in its License Renewal Application.

As a result of the issue described above, license condition 11.9 of Uranium One's renewed Byproduct and Materials License SUA-1341, Amendment 5, states (NRC 2016c):

11.9 The licensee shall provide for NRC review the surface contamination detection capability (minimum detectable concentration (MDC)) for radiation survey instruments, including scan MDC for portable instruments, used for contamination surveys to release equipment and materials for unrestricted use and for personnel contamination surveys. The detection capability in the scanning mode for the alpha and beta radiation expected shall be provided in terms of dpm per 100 cm^2.

The licensee shall revise the applicable radiation safety training program to specify when alpha and beta contamination surveys are required to be conducted for personnel, equipment, and materials leaving a restricted area.

By letter dated May 30, 2014, Uranium One provided a description of the detection capability of its radiation survey instruments (Uranium One 2014). The NRC staff requested additional information on the licensee's submittal by letter dated July 25, 2016 (NRC 2016b). By letter dated April 17, 2017, Uranium One responded with the additional information (Uranium One 2017). As stated in license condition 11.9, the NRC staff's review of information contained in these submittals is limited to the surface contamination detection capability (MDC) for radiation survey instruments. Other aspects of the licensee's contamination control program (e.g., release procedures) will be assessed during NRC staff inspections of the licensee's facility.

In this evaluation, the NRC staff identified deficiencies in the licensee's approach to estimate scan MDCs for beta-emitting radionuclides. Therefore, the NRC staff can not verify that the licensee's calculations presented in submittals dated May 30, 2014 (Uranium One 2014) and April 17, 2017 (Uranium One 2017) meet the requirements of license condition 11.9 of Source Material License SUA-1341. The specific deficiencies are identified in this evaluation in *underlined italics*.

Evaluation of alpha survey instrument for personnel exit surveys

In its April 17, 2017, submittal, the licensee described use of a Ludlum Model 43-5 alpha detector for personnel exit surveys. The use of alpha detectors for personnel exit surveys is described in Section 5.7.6 the licensee's License Renewal Application (Cogema 2008) and was approved by NRC staff in Section 5.7.6.3.2 of its 2013 Safety Evaluation Report for License Renewal of the Willow Creek Uranium In Situ Recovery Project (NRC 2013). The NRC staff also notes that license condition 10.11 of the licensee's Materials License SUA-1341 requires, "If employees do not shower prior to leaving the restricted area, they shall monitor themselves with an alpha survey instrument prior to exiting in conformance with Regulatory Guide 8.30, as revised" (NRC 2016b). Therefore, the NRC staff has previously approved the use of only alpha detectors for personnel exit surveys.

The licensee also provided an analysis of why it believed alpha surveys are an appropriate surrogate for beta surveys. However, as stated above, the NRC staff previously accepted use of alpha detectors for personnel exit surveys at this facility, and no further justification for this survey approach was requested or required. Therefore, the staff did not evaluate this information.

With regard to the MDCs for the proposed Ludlum Model 43-5 alpha detector, the licensee described formulas for both static and scan MDCs. Personnel exit surveys using the Ludlum Model 43-5 are generally performed holding the detector fixed over shoe bottoms and open palms. Therefore, the NRC staff determined that only the static survey MDC is relevant for personnel exit surveys at the licensee's facility. The NRC staff's evaluation of the use of the Ludlum Model 43-5 for release of equipment and materials is provided in a separate section below, "Evaluation of survey instruments for equipment and materials release."

To calculate the static MDC, the licensee used an equation from Strom and Stansbury (1992), which is also described in NRC guidance contained in NUREG-1507, "Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions" (NRC 1998). This formula is as follows:

$$MDC = \frac{3 + 3.29\sqrt{\mathrm{R}_b t_g (1 + t_g/t_b)}}{(\text{counting efficiency})(t_g)\,\dfrac{probe\ area, cm^2}{100\ cm^2}}$$

where R_b is the background counting rate; t_g is the gross counting time; t_b is the background counting time; and probe area is the active area of the detector. The NRC staff previously found this MDC formula acceptable for calculating static survey MDCs for alpha-emitting radionuclides (NRC 2015, 2016a).

Using the equation above, the NRC staff independently calculated the static MDC to evaluate the licensee's methodology and results. For background count rate, the NRC staff used the licensee's value of 1 count per minute (cpm). The NRC staff determined this is a reasonable value because it is consistent with the manufacturer's estimates that the background count rate is 3 cpm or less.

For counting efficiency, the licensee stated the 2π instrument efficiency (ε_i) of the Ludlum Model 43-5 is 0.35 using a thorium-230 calibration source, which when multiplied by a recommended source efficiency (ε_s) of 0.25 from ISO 7503-1 (ISO 1988), results in a counting efficiency ($\varepsilon = \varepsilon_i \times \varepsilon_s$) of 0.09 counts per minute per disintegration per minute (cpm/dpm). The alpha particle energy from the decay of thorium-230 (4.6 MeV) is similar to the alpha particle energies from the decay of uranium isotopes in natural uranium (4.2 to 4.8 MeV). Therefore, the NRC staff determined that the licensee's proposal to calibrate the Ludlum Model 43-5 with a thorium-230 source is acceptable for determining counting efficiency. To evaluate the counting efficiency stated by the licensee, the NRC staff examined information provided by the manufacturer on its website. The Ludlum Model 43-5 manufacturer states the nominal 4π instrument efficiency is 0.13 cpm/dpm for plutonium-239, an alpha-emitting radionuclide. Therefore, the NRC staff assumed in its independent evaluation a lower 2π instrument efficiency of 0.26, or twice the manufacturer's estimate of 4π instrument efficiency for plutonium-239, which results in an overall counting efficiency of 0.065 cpm/dpm, as compared to the licensee's value of 0.09 cpm/dpm.

For counting time, the NRC staff assumed a person will scan each foot and hand for about 15 seconds (a more conservative assumption that the licensee's assumed value of 1 minute). The NRC staff also verified from information on the manufacturer's website that the active area of the Ludlum Model 43-5 is 76 cm^2. Using the parameter values described above, the NRC staff estimated a static survey MDC of about 400 disintegrations per minute (dpm) alpha per 100 square centimeter (cm^2) (dpm α per 100 cm^2). Using its assumptions, the licensee estimated the MDC would be 112 dpm α per 100 cm^2. Both the licensee's and NRC staff's MDC values are less than the recommended lower limit of detection of 500 dpm α per 100 cm^2 presented in Table 3, Regulatory Guide 8.30, for skin and personal clothing (NRC 2002). Therefore, the NRC staff finds that the survey instruments proposed by the licensee is sufficiently sensitive for personnel exit surveys.

<u>Evaluation of survey instruments for equipment and materials release</u>

The licensee will use both alpha and beta survey instruments to release equipment and materials for unrestricted use. The instruments evaluated by the licensee include the Ludlum Model 43-5 for detection of total (i.e., fixed and removable) alpha-emitting radionuclides; the Ludlum Model 44-9 for detection of total (i.e., fixed and removable) beta-emitting radionuclides; and the Ludlum Model 3030 for assessment of wipe samples for removable alpha-emitting and beta-emitting radionuclides. The NRC staff evaluated the sensitivity each instrument separately below.

MDCs for total (i.e., fixed and removable) alpha-emitting radionuclides

For surveys of total alpha-emitting radionuclides, the licensee will use the same Ludlum Model 43-5 alpha detector for equipment and materials release that it uses for personnel exit surveys described above. The licensee described a static MDC using the Ludlum Model 43-5 of 112 dpm α per 100cm^2, and the NRC staff independently assessed a value of about 400 dpm α per 100 cm^2. Both values are less than the recommended lower limit of detection of 500 dpm α per 100 cm^2 presented in Table 3, Regulatory Guide 8.30, for release of equipment (NRC 2002). Therefore, the NRC staff determined the Ludlum Model 43-5 alpha detector is sufficiently sensitive for static surveys of total alpha-emitting radionuclides for purposes of release of equipment and materials.

To calculate scan sensitivity for alpha-emitting radionuclides using the Ludlum Model 43-5, the licensee used Equation 6-12 of MARSSIM (NRC 2000). Equation 6-12 of MARSSIM describes the probability of observing a single count (i.e., $P(n\geq1)$) while passing the detector over a contaminated area. The licensee estimated $P(n\geq1)$ values greater than 0.9 for scanning speeds of 1 and 2 centimeters per second (cm/s). In its May 30, 2014, submittal, the licensee stated scan speeds are stipulated by procedure to be no greater than 1 cm/s. The NRC staff evaluated the licensee's approach by independently calculating the Ludlum Model 43-5 alpha scan MDC using the method proposed by Abelquist (2014). Abelquist defined the minimum alpha activity that can be detected by solving Equation 6-12 of MARSSIM for "G." After also correcting for the active detector area, this results in:

$$Alpha\ scan\ MDC = \frac{\left[-\ln\left(1 - P(n \geq 1)\right)\right] * 60}{\varepsilon_i \varepsilon_s t \frac{probe\ area, cm^2}{100\ cm^2}}$$

Where P(n≥1) is the probability of detecting a single count; ε_i is the instrument efficiency; ε_s is the surface efficiency; t is the scan time (also referred to as residence time) in seconds; and the probe area is the active area of the detector. Using the licensee's estimates for these parameter values, the NRC staff estimated an alpha scan MDC of about 500 dpm α per 100 cm^2. Using the slightly lower counting efficiency of 0.065 cpm/dpm estimated by the NRC staff for the Ludlum Model 43-5, the NRC staff estimated an alpha scan MDC of about 700 dpm α per 100 cm^2. These scan MDC values are close to the recommended lower limit of detection of 500 dpm α per 100 cm^2 presented in Table 3, Regulatory Guide 8.30, for release of equipment. Therefore, the NRC staff finds that the survey equipment proposed by the licensee is sufficiently sensitive for scanning equipment and materials for release.

MDCs for total (i.e., fixed and removable) beta-emitting radionuclides

For surveys of total beta-emitting radionuclides, the licensee uses a Ludlum Model 44-9 Geiger-Müller (GM) pancake type detector. As with the alpha scan and static MDCs, the static and scan formulas used by the licensee to calculate beta scan and static MDCs were previously approved the NRC staff for use at other uranium recovery facilities (NRC 2015, 2016a).

For static MDCs for beta-emitting radionuclides, the licensee used the same formula described above for static MDCs for alpha-emitting radionuclides. The licensee described a background counting rate (R_b) of 60 cpm; a gross counting time (t_g) of 2 minutes; a background counting time (t_b) of 1 minute; and an active area of the detector of 15 cm^2. The licensee used a counting efficiency for the Ludlum Model 44-9 of 0.05 cpm/dpm for detection of technetium-99, which has a maximum beta decay energy (β_{max}) of 294 kiloelectronvolts (keV). Using these values, the licensee estimated a static MDC of 4,361 dpm βγ per 100 cm^2 for fixed plus removable beta contamination.

The NRC staff observes that the licensee committed in its April 17, 2017, submittal, to acquire a carbon-14 or technetium-99 calibration source to allow calibration of the Ludlum Model 44-9 to detect low energy beta-emitting radionuclides in the uranium decay series. In previous evaluations, the NRC staff noted that the radiation emission energy of strontium-90 calibration sources are sufficiently close to the emission energies of proactinium-234m to calibrate detectors for use at an ISR facility to detect proactinium-234m (NRC 2015, 2016a). This means that strontium-90 calibration sources, which include yttrium-90, a short-lived progeny of strontium-90, emit beta particles with maximum beta particle energies of up to 2,280 keV (i.e., β_{max} = 2,280 keV), are acceptable for use in calibrating instrument responses to proactinium-234m (i.e., β_{max} = 2,269 keV). However, the NRC staff also stated that a strontium-90 source is not appropriate for calibrating detectors to detect and quantify beta-emitting radionuclides with much lower maximum emission energies than that of protactinium-234m, such as thorium-234 (β_{max} = 199 keV) and thorium-231 (β_{max} = 307 keV), which are also present in the natural uranium decay series. Therefore, the NRC staff stated that unless licensees use either an alternative source or an appropriate additional source (e.g., carbon-14, β_{max} = 156 keV) to calibrate detectors at those lower energies, it should not credit the instrument's response to those energies when estimating minimum detectable concentrations and surface contamination levels. In cases where calibration with either an alternative source or an appropriate additional source has not been performed, it is appropriate to rely on a strontium-90 calibration source to quantify proactinium-234m, and an appropriate weighting factor to account for the presence of lower energy beta-emitting radionuclides thorium-234 and thorium-231.

The NRC staff observed the counting efficiency assumed by the licensee is conservatively low. For this reason, the NRC re-evaluated the likely MDC of the Ludlum Model 44-9 under the same conditions, except that it assumed the predominant beta-emitter present at an ISR facility is protactinium-234m, as described above. Protactinium-234m would be present along with beta-emitting radionuclides thorium-234 and thorium-231 and, for reasons explained above, would nominally account for a fraction of 0.489 of all beta-emitting activity present in natural uranium. Because protactinium-234m decays by emission of a beta particle with higher energy than that of technetium-99, the instrument efficiency (ε_i) and the ISO 7503-1 source efficiency (ε_s) would be higher than assumed by the licensee, resulting in a higher counting efficiency ($\varepsilon = \varepsilon_i \times \varepsilon_s$). Therefore, in its independent evaluation, NRC staff assumed an instrument efficiency (ε_i) of up to 0.5, a source efficiency (ε_s) of 0.5, and a weighted counting efficiency of 0.489 x 0.5 x 0.5 = 0.12 cpm/dpm. Using its assumptions, the NRC staff estimated a static MDC of about 1,800 dpm βγ per 100 cm^2. NRC guidance (e.g., Regulatory Guide 8.30) does not specify an acceptable MDC for beta-emitting contamination. However, the values estimated by the licensee and NRC staff are both below the regulatory limit for fixed and removable beta contamination of 5,000 dpm βγ per 100 cm^2. Therefore, the licensee's instrument for static surveys for beta-emitting radionuclides has an acceptably low static MDC for fixed and removable beta contamination.

To determine scan MDCs for beta-emitting radionuclides, the licensee stated it used the methodology for calculating MDC for beta scan surveys outlined in NUREG-1575 (NRC 2000) and Abelquist (2014). Equation 6-10 of NUREG-1575 provides a formula for estimating the scan MDC for beta-gamma-emitting radionuclides on structure surfaces:

$$Beta - Gamma\ Scan\ MDC = \frac{MDCR}{\sqrt{p}\varepsilon_i \varepsilon_s \frac{probe\ area, cm^2}{100\ cm^2}}$$

Where MDCR (minimum detectable count rate) is determined using equations 6-8 and 6-9 of NUREG-1575 (NRC 2000); p is the surveyor efficiency; ε_i is the instrument efficiency; ε_s is the source efficiency; and the probe area is characteristic of the instrument.

In its determination of the MDCR, the licensee assumed a background count rate for the Ludlum Model 44-9 of 300 cpm, about 5 times higher than the manufacturer's estimate of the nominal instrument background count rate of 60 cpm. The licensee also assumed a false positive rate of 0.60 (60%) and a true positive proportion of 0.95 (95%), resulting in an index of sensitivity (d') of 1.38; and a 1 second residence time. *The NRC staff observes that the licensee's assumed 1 second residence time corresponds to about a 4 cm/s scan speed using a 15 cm^2 detector, which is four times higher scan speed than specified in the licensee's procedures.* The licensee's assumptions result in an MDCR of 185cpm above background.

The licensee assumed a surveyor efficiency of 0.5 and counting efficiency ($\varepsilon_i \times \varepsilon_s$) of 0.05 cpm/dpm. Using these values, the licensee estimated a beta scan MDC of about 5,233 dpm βγ per 100 cm^2. *However, the licensee did not consider the active probe area of the Ludlum Model 44-9 in its calculation. All other assumptions being the same, had the licensee correctly considered the Ludlum Model 44-9 active probe area of 15 cm^2 in its calculation, it would have estimated an MDC of about 35,000 dpm βγ per 100 cm^2.*

In its evaluation, the NRC staff used a nominal background count rate for the Ludlum Model 44-9 of 60 cpm, as stated by the manufacturer. The NRC staff also used a higher weighted counting efficiency of 0.12 cpm/dpm, as described above. In its calculation, the NRC staff also reduced the scan speed to about 1 cm/s, as specified in the licensee's procedures. Though the licensee did not consider the active area of the detector in its assessment, the NRC staff calculated the MDC using the active area of the Ludlum Model 43-5 detector of 15 cm^2. Using these values, the NRC staff calculated a beta scan MDC of about 3,200 dpm βγ per 100 cm^2.

NRC guidance (e.g., Regulatory Guide 8.30) does not specify an acceptable MDC for beta-emitting contamination. However, while the scan MDC estimated by the NRC staff is below the regulatory limit for fixed and removable beta contamination of 5,000 dpm βγ per 100 cm^2, *the licensee did not adequately demonstrate acceptably low values. Therefore, the licensee's instrument and methodology for scan surveys for beta-emitting radionuclides does not have an acceptably low MDC for fixed and removable beta contamination.*

MDCs for removable alpha-emitting and beta-emitting radionuclides

The licensee provided an assessment of the MDC for the Ludlum Model 3030 used to detect removable contamination. The licensee used the formula for calculating MDC by Strom and Stansbury (1992), as presented in Table 3.1 of NUREG-1507 (NRC 1998). This formula is as follows:

$$MDC = \frac{3 + 3.29\sqrt{\mathrm{R}_b t_g (1 + t_g/t_b)}}{(\text{counting efficiency})(t_g)}$$

where R_b is the background counting rate; t_g is the gross counting time; t_b is the background counting time; and the counting efficiency is determined in the same manner as described above for other detectors using the method described in ISO 7503-1 (ISO 1988). For alpha-emitting radionuclides, the licensee assumed a Ludlum Model 3030 alpha background count rate of 3 cpm, an alpha counting efficiency of 0.09, and a background and survey count time of 1 minute to estimate an MDC of 158 dpm per 100 cm^2. Using the licensee's assumptions, the NRC staff calculated an MDC of 123 dpm per 100 cm^2. For beta-emitting radionuclides, the licensee assumed a beta background count rate of 50 cpm, a beta counting efficiency of 0.06 for technetium-99, and a background and survey count time of 1 minute to estimate an MDC of 598 dpm per 100 cm^2.

To evaluate the licensee's stated MDCs, the NRC staff examined information available on the manufacturer's website. The licensee's estimates of nominal alpha and beta background count rates for the Ludlum Model 3030 are consistent with the manufacturer's information. The licensee's estimates of alpha counting efficiency is reasonable because the manufacturer states the 4π instrument efficiency for thorium-230 is about 32%. This means the 2 π instrument efficiency (ε_i) is about 0.64, which, when combined with the ISO 7503-1 suggested value for surface efficiency (ε_s) of 0.25, yields a counting efficiency of 0.16 cpm/dpm (as compared to the licensee's estimate of 0.09 cpm/dpm). The manufacturer states the 4π instrument efficiency for the energetic beta-emitting radionuclide strontium-90/yttrium-90 is about 26%. This means the 2π instrument efficiency (ε_i) for protactium-234m, which decays with about the same energy beta particle as strontium-90/yttrium-90, is at least 0.52, which, when multiplied with the ISO 7503-1 suggested value for surface efficiency (ε_i) of 0.5 and an activity fraction of 0.489, yields a weighted counting efficiency of about 0.13 cpm/dpm (as compared to the licensee's value of 0.06 cpm/dpm). The NRC staff calculated nominal MDC values of less than 100 dpm α per 100 cm^2 and about 300 dpm βγ per 100 cm^2. The MDC value estimated by the licensee, and verified by the NRC staff, for alpha-emitting radionuclides is below the recommended lower limit of detection of 500 dpm α per 100 cm^2 presented in Table 3, Regulatory Guide 8.30, for release of equipment. Therefore, the licensee's instrument for surveys of removable alpha-emitting radionuclides has an acceptably low MDC. NRC guidance (e.g., Regulatory Guide 8.30) does not specify an acceptable MDC for beta-emitting contamination. However, the licensee's estimate of the MDC for beta-emitting radionuclides, and verified by the NRC staff, is below the regulatory limit for removable beta contamination of 1,000 dpm βγ per 100 cm^2. Therefore, the licensee's instrument also has an acceptably low MDC for assessing removable beta-emitting radionuclides.

Conclusion

As described above, the NRC staff identified deficiencies in the licensee's approach to estimate scan MDCs for beta-emitting radionuclides. Therefore, the NRC staff can not verify that the licensee's calculations presented in submittals dated May 30, 2014 (Uranium One 2014) and April 17, 2017 (Uranium One 2017) meet the requirements of license condition 11.9 of Source Material License SUA-1341.

References

Abelquist, E.W. 2014. Decommissioning Health Physics A Handbook for MARSSIM Users, Second Edition, CRC Press, 2014.

Cogema (Cogema Mining, Inc.) 2008. Letter from T. Hargrove, Cogema, to B. Von Till, NRC, dated May 30, 2008, Re: Docket 40-8502, License SUA-1341 (Renewal Application). ADAMS Accession No. ML081850689 (pkg). Updated October 31, 2008 (ML083110405), July 17, 2009 (ML092110700), November 19, 2010 (ML103280266), March 7, 2012 (ML120820095), and July 10, 2012 (ML12206A436).

ISO (International Organization for Standardization). 1988. ISO–7503–1, "Evaluation of Surface Contamination – Part 1: Beta Emitters and Alpha Emitters (first edition)." ISO: Geneva, Switzerland. 1988.

NRC (U.S. Nuclear Regulatory Commission). 1993. "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, April 1993, ADAMS accession No. ML003745526.

NRC (U.S. Nuclear Regulatory Commission). 1998. NUREG-1507, "Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," June 1998.

NRC (U.S. Nuclear Regulatory Commission). 2000. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). NUREG-1575, Washington, DC: NRC, Office of Nuclear Regulatory Research. Accession No. ML003761476

NRC (U.S. Nuclear Regulatory Commission). 2002. Regulatory Guide 8.30, Revision 1, "Health Physics Surveys in Uranium Recovery Facilities." Washington, DC., ADAMS Accession No. ML021260524.

NRC (U.S. Nuclear Regulatory Commission). 2013. Letter from A. Persinko, NRC to D. Wichers, Uranium One USA Inc., dated March 7, 2013, Re: Materials License SUA-1341, License Renewal, Uranium One USA, Inc., Willow Creek Uranium In Situ Recovery Project, Campbell and Johnson Counties, Wyoming (TACX J00564). ADAMS Accession No. ML13015A179 (pkg).

NRC (U.S. Nuclear Regulatory Commission). 2015. Letter from A. Persinko, NRC, to M. Griffin, Strata Energy, Inc., dated October 28, 2015, Re: Amendment 4, Source and Byproduct Materials License SUA-1601, Ross In-Situ Recovery (ISR) Project, Crook County, Wyoming, Removal of License Condition 12.8, Docket No. 040-09091, TAC J00735. ADAMS Accession No. ML15295A045.

NRC (U.S. Nuclear Regulatory Commission). 2016a. Letter from A. Kock, NRC, to S. Hatten, Lost Creek ISR, LLC, dated March 18, 2016, Re: Amendment 4, Source and Byproduct Materials License SUA-1598, Lost Creek In Situ Recovery Project, Sweetwater County, WY, Removal of License Conditions 12.10, 12.11, and 12.12 (TAC J00717). ADAMS Accession No. ML15279A572.

NRC (U.S. Nuclear Regulatory Commission). 2016b. Letter from R. Linton, NRC to Mr. S. Schierman, Uranium One USA Inc., dated July 25, 2016, Re: Uranium One, USA, Inc., Willow Creek Project, Campbell and Johnson Counties, Wyoming, Source Materials License SUA-1341, NRC Staff Request for Additional Information on Submittal in Response to License Condition 11.9 (TAC No. J00711). ADAMS Accession No. ML14295A555.

NRC (U.S. Nuclear Regulatory Commission). 2016c. Letter from A. Kock, NRC to Mr. S. Schierman, Uranium One USA Inc., dated September 29, 2016, Re: Uranium One, USA, Inc., Willow Creek Project, Campbell and Johnson Counties, Wyoming, Source Materials License SUA-1341, Annual Financial Assurance (Surety) Estimate Adjustment (TAC No. L00793). ADAMS Accession No. ML16173A142 (pkg)

Strom and Stansbury, 1992. Strom, D.J., Stansbury, P.S. Minimum Detectable Activity When Background is Counted Longer than the Sample, Health Physics 63(3):360-1. September 1992.

Uranium One (Uranium One USA, Inc.). 2014. Letter from S. Schierman, Uranium One, to R. Linton, NRC, dated May 30, 2014, Re: License Condition 11.9, SUA-1341, Electronic Submission Only. ADAMS Accession No. ML14153A103.

Uranium One (Uranium One USA, Inc.). 2017. Letter from S. Schierman, Uranium One, to R. Linton, NRC, dated April 17, 2017, Re: Response to RAIs, License Condition 11.9 (TAC No. J00711) Materials License SUA-1341, July 25, 2016. ADAMS Accession No. ML17111A945.

NRC Staff Request for Additional Information on Uranium One USA, Inc. Submittals dated May 30, 2014, and April 17, 2017, Regarding License Condition 11.9, Materials License SUA-1341; Docket No. 040-08502

Background

Uranium One's responses to LC 11.9 are provided in letters dated May 30, 2014 and April 17, 2017 (Uranium One 2014, 2017). The NRC staff has continued its technical review of these letters, and requires additional information to complete its review.

Request for Additional Information

Regulatory Basis. The individual items in this request for information (RAI) have a common regulatory basis. The regulations in Title 10, *Code of Federal Regulations* (10 CFR) 20.1101(b) states a licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational dose and doses to members of the public that are as low as is reasonably achievable (ALARA). The regulations in 10 CFR 20.1501(a) states each licensees shall make or cause to be made, surveys of areas, including the subsurface, that (1) may be necessary for the licensee to comply with the regulations in this part; and (2) are reasonable under the circumstances to evaluate -- (i) the magnitude and extent of radiation levels; and (ii) concentrations or quantities of residual radioactivity; and (iii) the potential radiological hazards of the radiation levels and residual radioactivity detected. Acceptance criteria for In Situ Recovery licensing are contained in Section 5.7.6.3 of NUREG-1569 (NRC 2002).

No. 1. Ludlum Model 44-9 background count rate used to calculate Scan MDC

Request: Please justify or revise, as appropriate, the background count rate used to calculate scan minimum detectable concentrations (MDCs) for the Ludlum Model 44-9.

Description: On page 8 of its April 17, 2017, submittal (Uranium One 2017), in the equation for "b_i," the number of background counts in the counting interval, Uranium One assumed a nominal background count rate of 300 counts per minute (cpm) for the Ludlum Model 44-9 detector. The manufacturer specifies a nominal background count rate of 60 cpm, which Uranium One used at the top of page 9 to estimate the static MDC for this same Ludlum Model 44-9 detector.

No. 2. Ludlum Model 44-9 scan rate used to calculate Scan MDC

Request: Please justify or revise, as appropriate, the scan rate used to calculate scan minimum detectable concentrations (MDCs) for the Ludlum Model 44-9.

Description: On page 8 of its April 17, 2017, submittal (Uranium One 2017), in the equation for "b_i," the number of background counts in the counting interval, Uranium One assumed a sample interval of 1 second during scans using the Ludlum Model 44-9 detector. In its May 30, 2014, submittal, the licensee stated on page 2 of its enclosure that licensee procedures stipulate a scan rate of 1 centimeter per second (cm/s) (Uranium One 2014). Given that the Ludlum Model 44-9 detector face is about 4 cm across, a sample interval of 1 second corresponds to a scan rate of 4 cm in 1 second, or 4 cm/s, and not the scan rate of 1 cm/s stipulated in licensee procedures.

No. 3. Ludlum Model 44-9 active area used to calculate Scan MDC

Request: Please justify or revise, as appropriate, the equation used to calculate scan minimum detectable concentrations (MDCs) for the Ludlum Model 44-9.

Description: On page 8 of its April 17, 2017, submittal, in the equation for "scan MDA," the licensee did not use the complete version of Equation 6-10 of NUREG-1575 (NRC 2000). The equation in the licensee's April 17, 2017, submittal, is missing a term in the denominator that accounts for the active area of the detector. The manufacturer states the active area of the Ludlum Model 44-9 detector is about 15 cm^2.

References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation." Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission). 2000. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). NUREG-1575, Washington, DC: NRC, Office of Nuclear Regulatory Research. Accession No. ML003761476

NRC (U.S. Nuclear Regulatory Commission). 2003. *Standard Review Plan for In Situ Leach Uranium Extraction License Applications*. NUREG-1569, Washington, D.C. ADAMS Accession No. ML032250177.

Uranium One (Uranium One USA, Inc.). 2014. Letter from S. Schierman, Uranium One, to R. Linton, NRC, dated May 30, 2014, Re: License Condition 11.9, SUA-1341, Electronic Submission Only. ADAMS Accession No. ML14153A103.

Uranium One (Uranium One USA, Inc.). 2017. Letter from S. Schierman, Uranium One, to R. Linton, NRC, dated April 17, 2017, Re: Response to RAIs, License Condition 11.9 (TAC No. J00711) Materials License SUA-1341, July 25, 2016. ADAMS Accession No. ML17111A945.