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

March 14, 2018

Mr. Walter Nelson
Coordinator, Safety, Health,
Environment & Quality
Cameco Resources
Crow Butte Operation
86 Crow Butte Road
Post Office Box 169
Crawford, NE 69339-0169

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION VERIFICATION REGARDING LICENSE CONDITION 11.10, CROW BUTTE RESOURCES, INC., CRAWFORD, NEBRASKA

Dear Mr. Nelson:

By letter dated December 19, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14364A196), Cameco Resources Crow Butte Operation (Cameco) submitted to the U.S. Nuclear Regulatory Commission (NRC) staff a response to license condition (LC) 11.10 of license SUA-1534 providing information on its proposed contamination survey program for its operations for NRC written verification. The NRC staff provided comments on Cameco's submittal by letter dated February 24, 2016 (ADAMS Accession No. ML16050A513). By letter dated August 8, 2017, Cameco submitted responses to these comments (ADAMS Accession No. ML17230A043). Cameco revised the August 8, 2017, responses in their entirety in a letter dated October 31, 2017 (ADAMS Accession No. ML17313A803). The responses in the October 31, 2017, letter are considered the submittal in regards to this verification.

The NRC staff has completed its technical review of Cameco's submittal. This letter transmits the NRC staff's review and verification that the requirements of LC 11.10 have been met.

The NRC staff's review of Cameco's response to LC 11.10 is documented in the enclosed evaluation. The evaluation documents the NRC staff's conclusion that Cameco's proposed contamination survey program for its licensed operations meets the requirements of 10 CFR 20.1101(b), and 20.1501(a) and (c), and is protective of public health, safety and the environment. The commitments in the October 31, 2017, letter will be incorporated into LC 9.2 of license SUA-1534 as an administrative change during a future license amendment.

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 ADAMS. ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

If you have any questions, please contact me at 301-415-6443, or by e-mail at Ronald.Burrows@nrc.gov.

Sincerely,

/RA/

Ronald A. Burrows, Project Manager
Uranium Recovery Licensing Branch
Division of Decommissioning, Uranium Recovery,
and Waste Programs
Office of Nuclear Material Safety
and Safeguards

Docket No.: 40-8943
License No.: SUA-1534

Enclosure:
Verification of Contamination

cc: D. Miesbach, NDEQ
D. Pavlick, CBR

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION VERIFICATION REGARDING LICENSE CONDITION 11.10, CROW BUTTE RESOURCES, INC., CRAWFORD, NEBRASKA DATE March 14, 2018

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NAME	R. Burrows	B. VonTill	R. Burrows
DATE	3/14/18	3/14/18	3/14/18

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U.S. Nuclear Regulatory Commission
Staff Verification of Contamination Survey Program
Cameco Resources Crow Butte Operation
License Condition 11.10
Source Material License SUA-1534

BACKGROUND

By letter dated November 5, 2014 (NRC, 2014a), the U.S. Nuclear Regulatory Commission (NRC) staff renewed Crow Butte Resources, Inc.'s (CBR's or the licensee's) Source and Byproduct Materials License SUA-1534 (license) for the extraction and recovery of uranium source material at its Crow Butte In Situ Recovery (ISR) Project. License Condition (LC) 11.10 of the renewed license requires CBR to submit a contamination survey program, including information on its survey equipment, for NRC staff's written verification. Specifically, LC 11.10 requires the licensee to submit the following information for its licensed operations:

> The licensee shall develop a survey program for beta/gamma contamination for personnel exiting from restricted areas, and beta/gamma contamination in unrestricted and restricted areas that will meet the requirements of 10 CFR Part 20, Subpart F and submit the program to NRC for review and written verification.
>
> The licensee shall provide for NRC review and written verification the surface contamination detection capability (minimum detection 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.

By letter dated August 8, 2017 (Cameco, 2017a), and as revised by letter dated October 31, 2017 (Cameco, 2017b), the licensee submitted to the NRC staff a response to LC 11.10, and addressed the NRC staff's comments (NRC, 2016), providing information on its contamination survey program for its licensed operations.

The purpose of this evaluation is limited to the NRC staff reviewing the proposed contamination survey program addressing the requirements of LC 11.10 as stated above. The NRC staff previously evaluated other aspects of the licensee's contamination survey program as documented in the Safety Evaluation Report (SER) for the renewed license (refer to Section 5.7.7 of NRC, 2014b).

REGULATORY REQUIREMENTS

The requirements related to a contamination survey program are found in 10 CFR 20.1101(b), and 20.1501(a) and (c). The NRC staff evaluated CBR's submittal (Cameco, 2017b) against Acceptance Criteria (4) and (8) in Section 5.7.6.3 of NUREG-1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications (NRC, 2003).

TECHNICAL EVALUATION

Designation of Controlled Area

NRC staff guidance pertaining to the control of radioactive contamination (referred to as simply "contamination" hereinafter) from uranium recovery operations is provided in Regulatory Guide 8.30, Health Physics Surveys in Uranium Recovery Facilities (NRC, 2002). This guidance is intended to prevent the spread of contamination from the licensee's operations to unrestricted areas.

With this submittal (Cameco, 2017b), the licensee proposed changing the designation of all areas outside of its restricted areas (refer to Figure 1.7-2 of Cameco, 2015) from an unrestricted area to a controlled area. NRC staff reviewed the proposed designated controlled area along with the information submitted in Appendix A to the Enclosure of the licensee's submittal (Cameco, 2017b). This information consisted of land ownership information and an affidavit signed by a representative of the licensee (see General Manager of U.S. Operations in Figure 5.1-1, Crow Butte Resources Organizational Chart, of Cameco, 2018). The NRC staff reviewed this information and determined that the licensee's designation of the controlled area meets the regulatory definition of a controlled area, including demonstrating that it can limit access to that area (refer to definition of controlled area in 10 CFR 20.1003). This includes the ability to require a member of the public to exit the controlled area at any time (refer to questions 29 and 417, and NRC's responses, from NRC, 1994).

Minimum Detectable Concentrations

The licensee described how it will determine the detection capability of the instruments it uses for the detection of contamination as a result of its operations (Cameco, 2017b). This detection capability is referred to as the minimum detectable concentration, or MDC. The MDC is the activity concentration on a surface expected to be detected with 95 percent confidence (NRC, 1998).

The licensee provided the methodologies that it would use to calculate both static (i.e., holding the probe still over a potentially contaminated area) and scan (i.e., moving the probe slowly over a potentially contaminated area) MDC for alpha and beta contamination (Cameco, 2017b). These methodologies included fundamental concepts found in NUREG-1507 (NRC, 1998) and NUREG-1575 (NRC, 2000) and were applied to the types of instruments expected to be used at its facility.

The NRC staff finds that the methodologies proposed by the licensee for determining the MDC of the instruments it uses for the detection of contamination meets Acceptance Criterion (8) in Section 5.7.6.3 of NUREG-1569 (NRC, 2003).

Radionuclide Mixtures

In response to NRC staff comment 11 on the licensee's proposed contamination survey program (refer to Issue 11 of NRC, 2016), CBR evaluated the radionuclide-weighted alpha and beta counting efficiencies and MDC values for the radionuclide mixtures of aged yellowcake and

pregnant lixiviant. For aged yellowcake, the licensee based the mixture on constituents previously described by NRC staff (NRC, 2015a) as natural uranium along with short-lived daughters, and approved for use at another licensee using a similar uranium recovery process (NRC, 2015b). The uranium in situ recovery (ISR) process produces a yellowcake that is initially essentially all uranium compounds (Metzger, et al, 1997; Uranium One, 2014). Therefore, the NRC staff finds it reasonable for the licensee to use this same assumption. CBR determined the alpha instrument efficiency using a National Institute of Standards and Technology (NIST) traceable natural uranium source. CBR used this efficiency to derive the MDC for alpha for aged yellowcake in a manner consistent with NUREG-1575, Supplement 1 (refer to Table 3.1 of NRC, 2009a).

The licensee did not have sample results of pregnant lixiviant to use for this purpose. Instead, it based its assumed pregnant lixiviant composition on data presented by another ISR licensee (Strata, 2015) that uses similar methods of uranium production. The NRC staff evaluated this assumption to determine if it was a reasonable approach. Specifically, the NRC staff evaluated the licensee's approach to determine if it was likely to produce a beta counting efficiency that was overly optimistic. This would occur if the Protactinium-234m (Pa-234m) activity fraction (as a percentage of all beta-emitting radionuclides) was estimated to be significantly higher than what could be expected to be found at the licensee's facility. The reason for this is that the higher energy beta particle of Pa-234m results in a higher instrument and surface efficiency and thus a higher overall weighted efficiency for this radionuclide. This effect does not occur with alpha particles because the typical alpha-emitting radionuclides in pregnant lixiviant have similar energies and thus the individual instrument and surface efficiencies are the same for each.

In its renewal application (Cameco, 2007), CBR stated that the Crow Butte ore body ranges in grade from less than 0.05 to greater than 0.5 percent U_3O_8, with an average grade of 0.2 percent U_3O_8. This indicates that a pregnant lixiviant sample result, at least for uranium, is dependent on which section of the ore body the uranium is being recovered. Moreover, it has been reported (Hunter, 1996) that uranium concentrations from new well patterns can climb to peak levels of 200 to 400 mg/l. The highest peak uranium levels at the Highland Uranium Project reported by Hunter (1996) exceeded 1000 mg/l. As the ore is progressively depleted, the grade of uranium in the ore body gradually declines. Hunter (1996) reported that 25 to 30 percent of in-place reserves are depleted in the first three months of a new production pattern. Therefore, a pregnant lixiviant sample result is not only dependent on where in the ore body it was taken from, but at what time during the production cycle it was taken. This would suggest that multiple samples be taken from different production units over the course of time until such time, if ever, the beta activity fractions were shown to stabilize.

The licensee assumed a uranium concentration in lixiviant of 40 mg/l. This value is within the ranges evaluated in NUREG-1910, Vol.1 (NRC, 2009b) and NUREG-/CR-6733 (NRC, 2001). This value determined the licensee's activity fraction of uranium-235 (U-235) and thus thorium-231(Th-231) as equilibrium was assumed. CBR assumed a Th-234 concentration in lixiviant of 2,290 pCi/l as this was what was measured by another ISR licensee (LCI, 2016). This value, in turn, determined the concentration of Pa-234m as equilibrium was assumed.

As discussed in the previous section, the NRC staff found the licensee's approach for determining the MDC of the instruments it uses for the detection of contamination consistent with current NRC guidance. This includes the use of calibration sources to approximate the

particle being measured and accounting for source efficiencies. The NRC staff considers the effort to determine a true beta activity fraction across an ISR site to be unduly burdensome. Considering the variables above that can affect the calculation of activity fractions for beta emitting radionuclides, the NRC staff finds the assumptions made by the licensee reasonable to derive a weighted beta counting efficiency.

Therefore, the NRC staff finds that the methodologies proposed by the licensee for determining the counting efficiencies of expected mixtures meets Acceptance Criterion (4) in Section 5.7.6.3 of NUREG-1569 (NRC, 2003).

Survey Program for Beta/Gamma Contamination

The licensee provided details on how it will conduct surveys for potential beta/gamma contamination on personnel and material and equipment (Cameco, 2017). Using the radionuclide weighted counting efficiencies discussed above, CBR calculated MDC values for assumed background levels. The licensee described the actions it would take if the background levels caused the MDC values to exceed the contamination limit of 1000 disintegrations per minute (dpm) per 100 cm^2. If the beta/gamma background levels are too high, the licensee will perform an alpha survey in the restricted area and complete the beta/gamma survey in a lower background area within the controlled area (see discussion of controlled area above). Cameco, 2017

In addition to the licensee's proposed survey program for beta/gamma contamination, LC 9.6 (NRC, 2017) requires CBR to release items for unrestricted use in accordance with the NRC guidance document "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," (the Guidelines) (NRC, 1993). In addition to specific release limits, the Guidelines provide recommendations for minimizing contamination levels on equipment and scrap. Furthermore, LC 9.7 (NRC, 2017) requires the licensee to follow the guidance in RG 8.30 (NRC, 2002). RG 8.30 provides recommendations on surveys for surface contamination for areas, items, and personnel as well as the calibration of survey instruments.

The NRC staff finds that the survey program for beta/gamma contamination proposed by the licensee meets Acceptance Criterion (4) in Section 5.7.6.3 of NUREG-1569 (NRC, 2003).

CONCLUSION

The NRC staff concludes that the licensee has established an acceptable contamination survey program, including establishing the detection capability of its survey equipment. Therefore, the NRC staff has reasonable assurance that the licensee's program, as described in its submittal (Cameco, 2017b), will comply with 10 CFR 20.1101(b), and 20.1501(a) and (c) and that public health, safety and the environment will be protected.

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