U. S. Nuclear Regulatory Commission Staff DRAFT Verification of Uranium One USA, Inc. Submittals dated September 25, 2013, July 3, 2014, January 20, 2015, and June 5, 2015, Regarding License Condition 11.3, Materials License SUA-1341; Docket No. 040-08502

Background

In the U.S. Nuclear Regulatory Commission (NRC) staff's Safety Evaluation Report for License Renewal of the Willow Creek Uranium In Situ Recovery Project (LR SER) (NRC 2013), NRC staff found that Uranium One USA, Inc. (Uranium One) had not demonstrated that in-plant concentrations of gross alpha activity used in determining occupational dose was entirely attributable to natural uranium. For this reason, NRC staff proposed a license condition, described below, which required Uranium One to determine whether radium-226 or other alpha-emitting radionuclides are present in plant air samples.

NRC staff also found the following deficiencies with regard to Uranium One's airborne effluent and environmental monitoring program:

1. Uranium One had not provided sufficient justification for not performing environmental sampling for airborne particulate matter in the vicinity of the Christensen Ranch satellite building;

2. Uranium One had not provided a description of how quantities of radionuclides in air effluent would be determined in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40.65, "Effluent monitoring reporting requirements";

3. Uranium One had not provided an acceptable methodology by which it would annually evaluate the highest public doses in accordance with 10 CFR 20.1302;

4. Uranium One had not explained how radon progeny would be considered in annual assessments of public dose; and

5. Uranium One had not explained how it will account for occupational dose received outside the Irigaray central processing facility and Christensen Ranch satellite building and throughout the licensed area.

As a result of the issues described above, license condition 11.3 of Uranium One's renewed Byproduct and Materials License SUA-1341, Amendment 4, states (NRC 2015b):

11.3 The licensee shall conduct effluent, personnel, and environmental monitoring programs in accordance with Sections 5.7 and 5.8 of the approved license application.

The licensee shall conduct airborne samples for natural uranium, Ra-226, Po-210, Th-230 and Pb-210 at each in-plant air particulate sampling location at a frequency of once every 6 months for 2 years, and annually thereafter, to ensure compliance with 10 CFR 20.1204. The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required

to demonstrate compliance with 10 CFR 20.1204. The licensee may demonstrate compliance or provide alternative procedures specific to in-plant air particulate sampling to show compliance with 10 CFR 20.1204 to the NRC for review and verification within 6 months of license renewal.

The licensee shall conduct airborne samples for natural uranium, Ra-226, Po-210, and Pb-210 at each Christensen Ranch environmental monitoring location at a frequency of once every 6 months for 2 years, and annually thereafter, to ensure compliance with 10 CFR 20.1301. The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required to demonstrate compliance with 10 CFR Part 20.1301. The licensee may demonstrate compliance or provide alternative procedures specific to environmental monitoring for natural uranium, Ra-226, Po-210, and Pb-210 to show compliance with 10 CFR 20.1301 to the NRC for review and verification within 6 months of license renewal.

The licensee shall describe how the environmental monitoring program demonstrates that 10 CFR Part 20 public dose limits in controlled and unrestricted areas are met. The documentation of the areas designated as restricted, controlled and unrestricted areas and the environmental monitoring station locations shall be updated periodically, as needed.

The licensee shall provide the following information for the airborne effluent and environmental monitoring program in which it shall develop written procedures, that shall be submitted to NRC for verification prior to implementation, to:

a. Discuss, in accordance with 10 CFR 40.65, how the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring.

b. Evaluate, consistent with 10 CFR 20.1301 and 10 CFR 20.1302, the highest exposures likely for member(s) of the public from licensee operations.

c. Discuss how radon progeny (radon-222) will be factored into the determination of potential public dose from the licensee's operations consistent with 10 CFR Part 20, Appendix B, Table 2.

d. Discuss, in accordance with 10 CFR Part 20.1501, how the occupational dose (gaseous and particulate) received throughout the entire license area from licensee operations will be accounted for, and verified by surveys and/or monitoring.

By letter dated September 25, 2013, Uranium One responded to the requirements in LC 11.3 by providing a description of its in-plant air particulate sampling program and its proposed alternative to collecting airborne samples for natural uranium, Ra-226, Po-210, and Pb-210 at each Christensen Ranch environmental monitoring location (Uranium One 2013). By letter dated May 6, 2014, NRC staff informed Uranium One that its September 25, 2013, letter was incomplete because it did not address the latter parts of LC 11.3, including the requirements in

LC 11.3, parts a. through d. (NRC 2014a). NRC staff and Uranium One met on May 27, 2014, to discuss licensing issues, including the issues addressed in LC 11.3 (NRC 2014b). By letter dated July 3, 2014, Uranium One provided additional information in response to LC 11.3, parts a. through d. (Uranium One 2014).

By letter dated November 12, 2014, NRC staff informed Uranium One that information provided by Uranium One in its letters dated September 25, 2013, and July 3, 2014, had not been accepted for detailed technical review because the submittals did not contain sufficient information (NRC 2014c). NRC staff provided an 11-page enclosure to its November 12, 2014, letter, which provided examples of information that Uranium One had not provided. By letter dated December 15, 2014, NRC staff requested a response to the staff's November 12, 2014, letter within 30 days of receipt of its December 15, 2014, letter (NRC 2014d).

By letter dated January 20, 2015, Uranium One provided a revision to its July 3, 2014, submittal that addressed LC 11.3, parts a. through d. (Uranium One 2015a). By letter dated May 4, 2015, NRC staff informed Uranium One that its January 20, 2015, submittal had been accepted for detailed technical review (NRC 2015a). In its May 4, 2015, letter, the NRC staff also enclosed requests for additional information required for the staff to complete its review. By letter dated June 5, 2015, Uranium One responded to the NRC staff's requests for additional information (Uranium One 2015b).

It follows from the discussion above that the scope of the NRC staff's ongoing verification review includes the following Uranium One submittals:

1. Letter dated September 25, 2013, addressing the first three paragraphs of LC 11.3 (Uranium One 2013);

2. Letter dated July 3, 2014, addressing the last two paragraphs of LC 11.3 (Uranium One 2014);

3. Letter dated January 20, 2015, revising the July 3, 2014, submittal addressing the last two paragraphs of LC 11.3 (Uranium One 2015a); and

4. Letter dated June 5, 2015, responding to NRC staff requests for additional information (Uranium One 2015b).

In its comments below, the NRC staff organized its verification review into the following LC 11.3 topics:

1. In-plant air sample compliance with 10 CFR 20.1204

2. Environmental particulate air samples at Christensen Ranch

3. Accounting for air effluent quantities in accordance with 10 CFR 40.65

4. Evaluating the highest public dose in accordance with 10 CFR 20.1302

5. Accounting for radon progeny in public dose assessments

6. Accounting for occupational dose in all licensed areas

Evaluation

1. In-plant air sample compliance with 10 CFR 20.1204

As stated in Section 5.7.3.3.1, "Airborne Particulate Uranium Monitoring," of the NRC staff's LR SER (NRC 2013), NRC staff did not agree with Uranium One's approach to in-plant air sampling as described in Section 5.7.3.1 of its License Renewal Application (LRA). Specifically, NRC staff stated that Uranium One should not assume that all gross alpha activity collected on air samples is attributable to natural uranium. Rather, Uranium One should conduct surveys in accordance with 10 CFR 20.1501 to assess whether other radionuclides, including radium-226 and thorium-230, are also present. Uranium One may then apply the requirements in 10 CFR 20.1204 for mixtures of radionuclides in order to determine occupational internal exposures. This is why the second paragraph of LC 11.3 of the renewed license requires Uranium One to periodically assess mixtures of radionuclides and then provide to the NRC for review and verification within 6 months of license renewal either: (1) a demonstration that 10 CFR 20.1204 is met, or; (2) provide procedures to show compliance with 10 CFR 20.1204.

By letter dated September 25, 2013, Uranium One responded to LC 11.3 and described its procedures for compliance with 10 CFR 20.1204 (Uranium 2013). Uranium One described different approaches for the Christensen Ranch satellite building and the Irigaray central processing facility. For the Christensen Ranch satellite building, Uranium One explained that it would measure radionuclide concentration in incoming pregnant lixiviant to determine the mixture of radionuclides present in process solutions. Uranium One proposed to perform this sampling semi-annually. Using this information, Uranium One would assume that alpha-emitting radionuclides detected in plant air samples are present in the same proportions as detected in samples of process solutions. Airborne concentrations of each alpha-emitting radionuclide would then be compared to its respective derived air concentration (DAC) from Appendix B to Part 20. Uranium One stated that if the sum of the fractions is less than 10 percent, or the total concentration is less than 10 percent of the most restrictive DAC, then it would not be required, under 10 CFR 20.1502(b), to monitor occupational intake, and compliance with 10 CFR 20.1204 is not required.

For areas inside the Irigaray central processing facility that are outside the yellowcake drypack area, Uranium One proposed the same approach as described above for the Christensen Ranch satellite building. Inside the yellowcake drypack area at the Irigaray facility, Uranium One will measure only gross alpha concentrations in air and compare these results to the appropriate uranium DAC. As noted in Section 5.7.3.3.1 of the NRC staff's LR SER for Willow Creek (NRC 2013), the staff agrees that radioactivity in air samples in the dryer/packaging area is natural uranium.

The NRC staff agrees that if Uranium One continues to perform surveys of airborne contamination in accordance with its commitments in Section 5.7.3 of its LRA and the requirements of 10 CFR 20.1501, Uranium One may demonstrate that occupational intakes remain well below the limits in 10 CFR 20.1502(b), and the requirements of 10 CFR 20.1204 would not apply. This approach also complies with LC 11.7, which requires Uranium One to monitor for internal exposure in accordance with 10 CFR 20.1502(b)(1) and Section 5.7.3 of the approved license application. NRC staff evaluated this approach using data from the LRA, Table 5.3, "Inplant Airborne Uranium Monitoring Summary" (Cogema Mining, Inc. (Cogema)

2008[1]). For the year 2007, Uranium One stated that maximum gross alpha concentration in the Christensen Ranch satellite facility was 1.6×10^{-11} µCi/mL. Using a Class D DAC for natural uranium of 5×10^{-10} µCi/mL, Uranium One calculated a DAC fraction of 0.032 (i.e., 3.2 percent).

The NRC staff evaluated the Uranium One methodology by considering an example. In this example, NRC staff assumed Uranium One measured gross alpha concentrations in the Christensen Ranch facility at a level equivalent to its historical maximum of 1.6×10^{-11} µCi/mL. If the activity fractions in pregnant lixiviant were measured by Uranium One to be 79 percent natural uranium, 20 percent radium-226, and 1 percent thorium-230, then Uranium One would apportion its measured gross alpha concentration of 1.6×10^{-11} µCi/mL as follows:

Radionuclide	Fraction	Radionuclide concentration in air, µCi/mL	DAC, µCi/mL	DAC fraction
Natural-U	0.79	1.26×10^{-11}	5×10^{-10}	0.025
Ra-226	0.20	3.20×10^{-12}	3×10^{-10}	0.011
Th-230	0.01	1.60×10^{-13}	3×10^{-12}	0.053
			Total	0.089

A worker exposed to this airborne mixture of radionuclides for 2,000 hours would receive an exposure of 2,000 hours x 0.089 DAC = 179 DAC-hours, which is less than an exposure of 200 DAC-hours over 2,000 hours that corresponds to the limit in 20.1502(b)(1) (i.e., less than 10 percent of the applicable ALI(s) in table 1, columns 1 and 2, of appendix B to §§20.1001-20.2402). As a result, the licensee would have demonstrated that occupational intakes remain below the limits in 10 CFR 20.1502(b), and the requirements of 10 CFR 20.1204 would not apply.

The NRC staff reviewed the licensee's proposed methods for conducting surveys for airborne contamination at the Willow Creek project and determined that it meets the acceptance criterion 5.7.3.3(2) of NUREG-1569 regarding monitoring equipment that accurately measures concentrations of airborne radioactive species. Therefore, the NRC staff finds that Uranium One's survey procedures of airborne contamination at the Willow Creek project meet the survey requirements of 10 CFR 20.1501.

2. Environmental particulate air samples at Christensen Ranch

As stated in Section 5.7.3.3.2, "Airborne Effluent and Environmental Air Particulate Monitoring," of the NRC staff's LR SER (NRC 2013), NRC staff did not agree with Uranium One's approach to airborne effluent and environmental air particulate monitoring at the Christensen Ranch satellite building, as described in Section 5.8.1 of its LRA. This is why the third paragraph of LC 11.3 states that Uranium One should either: (1) collect airborne samples for natural uranium, Ra-226, Po-210, and Pb-210 at each Christensen Ranch environmental monitoring location at a frequency of once every 6 months for 2 years, and annually thereafter, to ensure compliance with 10 CFR 20.1301, or (2) provide to the NRC for review and verification within 6 months of license renewal alternative procedures specific to environmental monitoring for natural uranium, Ra-226, Po-210, and Pb-210 to show compliance with 10 CFR 20.1301.

[1] Cogema was the prior licensee of the Willow Creek license SUA-1341. License SUA-1341 was transferred to Uranium One in 2010.

By letter dated September 25, 2013, Uranium One provided alternative procedures for environmental monitoring in which it repeated its previous position that environmental air particulate monitoring at Christensen Ranch should not be required and that the results of environmental air particulate monitoring around the Irigaray central processing facility should be considered bounding and representative of values that would be measured at Christensen Ranch. In its January 20, 2015, letter, Uranium One committed to comparing effluent quantities of particulate radionuclides from the Christensen Ranch satellite building (described further in Section 3. below) with effluent quantities from the Irigaray central processing plant stack. Uranium One explained that the effluent quantities from the dryer stack will be higher than those from the satellite building, which doesn't have a dryer or any other significant source of particulate matter emissions. This comparison will demonstrate environmental air sample concentrations downwind of the Irigaray stack are bounding and representative of environmental air concentrations that would be measured downwind of Christensen Ranch satellite building. As described below in Section 4., particulate radionuclide measurements from the Irigaray central processing plant environmental monitoring stations would be used to calculate public dose regardless of where individuals likely to receive the highest dose are located.

The NRC staff finds Uranium One's approach acceptable because Uranium One has described a method to demonstrate that radionuclides in air downwind of the Christensen Ranch satellite building would not be higher than concentrations of radionuclides in air around the Irigaray central processing facility.

3. Accounting for air effluent quantities in accordance with 10 CFR 40.65

As described above, Uranium One's revised response to LC 11.3.a. is provided in a letter dated June 5, 2015 (Uranium One 2015b). The NRC staff has summarized Uranium One's proposal in Table 1 below. Upon organizing Uranium One's proposed survey methodology in Table 1 to more clearly summarize sample types, locations, and frequencies, the NRC staff observed the following deficiencies:

1. With regard to Uranium One's proposed Method 1 and Method 2 estimates of air effluent quantities of radon and radon progeny using the ASTM D 5072-92 approach, which would apply to Christensen Ranch satellite facility, wellfields, and deep disposal well houses, Uranium One did not state how it would estimate quantities of radon progeny released. For purposes of estimating effluent quantities of both radon and its short-lived progeny, when radon is measured, Uranium One may conservatively assume that short-lived radon progeny are in equilibrium with radon.

2. With regard to Method 2 for both the Christensen Ranch de-gas column radon-in-water measurements and the deep disposal well house radon-in-water measurements using the ASTM D 5072-92 approach, Uranium One did not specify sample frequencies.

3. With regard to Method 2 (and Method 1 for bag filter changes in modular buildings), as observed by NRC staff in comments on a similar plan (NRC 2015c), the methodology proposed by Uranium One to estimate quantities of radon and radon progeny in air effluent for the Christensen Ranch satellite building, Irigaray central processing facility, resin truck, modular buildings, and well fields (production wells) is not correct. The modified Kusnetz method measures only radon progeny (i.e., working levels), not radon. In locations where only radon gas escapes from the ISR process in well-ventilated spaces, short-lived radon progeny concentrations in air will not be in equilibrium with

concentrations of radon. This means that radon gas concentrations would be higher than would be estimated by measuring short-lived radon progeny alone and assuming that radon and its short-lived progeny are in equilibrium. A direct measurement of radon by track-etch detectors would be an acceptable approach in these areas. For purposes of estimating effluent quantities of both radon and its short-lived progeny, when radon is measured, Uranium One may conservatively assume that short-lived radon progeny are in equilibrium with radon. Uranium One may choose to adjust the frequency of track-etch measurements to meet target detection limits.

Table 1. NRC staff summary of effluent monitoring proposal at Willow Creek Project

Effluent Location	Particulate Matter	Radon	Radon Progeny
Christensen Ranch Satellite Plant	Semi-annual isotopic of monthly filters x building ventilation flow[1]	Method 1: Semi-annual radon-in-water loss ***Method 2: Assumes equilibrium – not valid***	***Method 1: Assumes equilibrium [?]*** Method 2: Monthly M.K.[2] samples x building ventilation flow rate
Christensen Ranch Process Vents	Not measured[3]	Method 1: Semi-annual radon-in-water loss Method 2: ***[Frequency?]*** de-gas column radon-in-water x column flow rate	***Method 1: Assumes equilibrium [?]*** ***Method 2: Assumes equilibrium [?]***
Irigaray Stack	Stack sampling[4]	Not measured[5]	Not measured[5]
Irigaray Plant	Semi-annual isotopic of monthly filters x building ventilation flow[1]	Method 1: Accounted for at Christensen Ranch Satellite ***Method 2: Assumes equilibrium – not valid*** ***Method 2: Assumes equilibrium – not valid***	Method 1: Accounted for at Christensen Ranch Satellite Method 2: Monthly M.K.[2] samples x building ventilation flow rate ***Method 2: Quarterly resin truck M.K.[2] sample x yellowcake precipitation tank exhaust flow rate– not practicable***
Modular Buildings	Not measured[6]	***Method 1 and 2: Assumes equilibrium – not valid***	Method 1 and 2: Monthly and semiannual M.K.[2] samples[7] x vent. flow rate
Wellfields	Not measured[6]	Method 1: Semi-annual radon-in-water loss ***Method 2: Assumes equilibrium – not valid***	***Method 1: Assumes equilibrium [?]*** Method 2: Semiannual M.K. of 3-5% of wells in each mine unit x 3 LPM flow rate per well
Spills	Not measured[6]	***Method 2: Assumes equilibrium – not valid***	***Method 2: M.K. sample – not valid***
DDW Houses	Not measured[6]	Method 2: ***[Frequency?]*** radon-in-water; 100% of radon released to air	***Method 2: Assumes equilibrium [?]***
Ponds	Not measured[6,8]	Not measured[8]	Not measured[8]

[1]Isotopic analysis includes natural uranium, thorium-230, radium-226, lead-210, and polonium-210.
[2]M.K. = modified Kusnetz method. For measurement of working levels (i.e., radon progeny only)
[3]Process vents for wet processes at this ISR would not contain significant particulate matter.
[4]Already part of approved sampling program
[5]The dryer is not a significant source of radon emissions
[6]Operating wellfields, modular buildings, deep disposal buildings, lixiviant spills, and ponds are not sources of significant diffuse emissions of particulate matter.
[7]Semiannual samples will be collected during bag filter changes. If semiannual samples exceed 2 standard deviations of monthly samples, then semiannual samples will be used to determine effluent quantities.
[8]Emissions from ponds are considered to be negligible (see EPA 40 CFR Part 61, Subpart W proposed rule)

4. With regard to Method 2 measurements of radon and radon progeny released from resin trucks at the Iragaray facility, NRC staff determined that attempting to account for this effluent quantity by direct measurements of either radon progeny (modified Kusnetz method) or radon (track-etch device) is not practicable. As stated in Regulatory Position C.3.3, "Unmonitored Effluents," of Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities," where monitoring is not practicable, the license should estimate the magnitude of the unmonitored effluents. For resin truck releases, an approach under Method 2 that would be acceptable to NRC staff would be to estimate radon effluent quantities by assuming that the concentration of radon in transfer water used to mobilize and transfer resin from the resin truck is no greater than the concentration of radon in the incoming lixiviant from the wellfields, and that 100 percent of the radon is released during each transfer. For purposes of estimating effluent quantities of both radon and its short-lived progeny, when radon is measured, Uranium One could assume that radon is in equilibrium with its short-lived progeny.

5. With regard to Method 2 measurements of radon and radon progeny released from spills, Uranium One proposed in its June 5, 2015, letter (p. 8) that the modified Kusnetz method would be used to estimate radon emissions from spills. NRC staff finds that attempting to account for releases of radon and radon progeny from spills by direct monitoring of radon progeny in air (i.e., the modified Kusnetz method) after the spill has occurred is not reasonable or practicable. For spills, an acceptable approach under Method 2 for estimating radon effluent quantities would be to assume that the concentration of radon in water in the spill is no greater than the concentration of radon in the incoming lixiviant from the wellfields, and that 100% of the radon in the spill volume is released. For purposes of estimating effluent quantities of both radon and its short-lived progeny, when radon is measured, Uranium One could assume that radon is in equilibrium with its short-lived progeny.

As a result of the deficiencies described above, the NRC staff is not able to verify Uranium One's proposed procedures for accounting for air effluent quantities in accordance with 10 CFR 40.65.

4. Evaluating the highest public dose in accordance with 10 CFR 20.1302

As described above, Uranium One's revised response to LC 11.3.b. is provided in its letters dated January 20, 2015 (Uranium One 2015a) and June 5, 2015 (Uranium One 2015b). Uranium One stated that it used the MILDOS-AREA computer code to initially identify the individual likely to receive the highest dose from licensed operations, in accordance with 10 CFR 20.1302(b)(1). As described below, the methodology used by Uranium One will be used each year to reassess whether the individual likely to receive the highest dose should be updated as a result of changes in land use.

The use of the MILDOS-AREA code to assess the individual likely to receive the highest dose requires information about: (1) the radionuclide air effluent locations and annual quantities of radionuclides released to the atmosphere; (2) representative on-site meteorological data; (3) potential exposure pathways; and (4) locations of individuals likely to receive the highest dose.

In its initial assessment of the individual likely to receive the highest dose, which was included as Attachment 2 to its January 20, 2015, letter, Uranium One evaluated four individual sources of effluent release in its MILDOS-AREA model: the Irigaray central processing facility stack; the

Christensen Ranch satellite building; Mine Unit 7 wellfield; and wellfields in Mine Units 10 and 12. Uranium One used the methodology in Regulatory Guide 3.59 to estimate effluent quantities of radon-222. It also used measured monthly effluent quantities of natural uranium, thorium-230, radium-226, and lead-210, from the Irigaray dryer. For meteorological data, Uranium One used its on-site meteorological data collected at Irigaray central processing facility in 1980 and 1981. The potential exposure pathways considered by Uranium One include inhalation and ingestion pathways. To evaluate individuals likely to receive the highest dose, Uranium One first evaluated the total effective dose equivalent rate (i.e., mrem/yr) that would be received assuming 100 percent occupancy at each of 1,050 locations on a square grid centered on the Christensen Ranch satellite building. Uranium One used a grid spacing of 500 meters in its assessment. Uranium One calculated that the highest overall total effective dose equivalent (TEDE) rate would be 12.1 mrem/yr at a distance of about 4,000 meters east of the Christensen Ranch satellite building. This location corresponds to the location of the Mine Unit 7 wellfield source. As described below, Uranium One applied the maximum calculated TEDE rate to hunters, CBM workers and oil company workers. Uranium One similarly calculated a maximum TEDE rate of 6.6 mrem/yr for members of the public likely to remain within 250 meters of the Christensen Ranch satellite building, which were assumed to be couriers, vendors, and Uranium One employees that stay overnight in on-site housing. The two maximum TEDE rates (i.e., 12.1 mrem/yr and 6.6 mrem/yr), which are based on 100 percent occupancy, were then reduced to account for expected occupancy for each type of public receptor. Using this methodology, Uranium One estimated that the individual likely to receive the highest dose from licensed operations is a CBM well worker receiving an annual TEDE of up to 3.75 mrem/yr. Uranium One also estimated that its employees in on-site workforce housing would receive a public dose of up to 1.39 mrem TEDE per year.

As a result of the assessment described above, Uranium One committed to initially place passive radon detectors and gamma radiation monitoring devices (e.g, optically-stimulated luminescent dosimeters) at each of the following locations shown on Figure 2 of Attachment 2 to its January 20, 2015 letter (Uranium One 2015a): (1) well number 4447-2-21 for Mine Unit 10; (2) well number 34-4-4476 in Mine Unit 7; well numbers 4577-25-41 and 4577-25-32 in Mine Unit 8; each man camp; the electrical substation near Mine Unit 8; and the Anadarko compressor and water station located about 2.5 miles SE of the Irigaray central processing facility.

As stated above, Uranium One committed to re-evaluate its estimates of individuals likely to receive the highest dose from licensed operations each year as part of the land use survey.

To demonstrate compliance with the dose limits for individual members of the public, Uranium One committed to calculate dose in accordance with 10 CFR 20.1302(b)(1). The dose calculations will be based on concentrations of particulate radionuclides in air at the Irigaray central processing facility environmental air sample stations; environmental dosimeters; and radon-222 concentrations at each of the locations described above where individuals are likely to receive the highest dose. Uranium One will use occupancy times for each receptor based on site-specific estimates, which will be justified when the annual public dose is reported.

The NRC staff reviewed the licensee's proposed methods for evaluating the member(s) of the public likely to receive the highest exposures from radon and its progeny and particulates from licensed operations at the Willow Creek project and determined that it meets the requirements of 10 CFR 20.1302 and is therefore acceptable.

5. Accounting for radon progeny in public dose assessments

To account for radon progeny, Uranium One stated it would a dose conversion factor derived from the effluent concentrations in Appendix B to 10 CFR Part 20 for radon-222 with daughters present.

The NRC staff reviewed the licensee's proposed methods for incorporating the progeny from radon-222 into its estimates of public dose resulting from licensed operations at the Willow Creek project and determined that it meets the requirements of 10 CFR 20.1302 and is therefore acceptable.

6. Accounting for occupational dose in all licensed areas

License condition 11.3.d. requires Uranium One to discuss how it will account for occupational dose received by monitored employees throughout the license area. In other words, Uranium One had explained in its LRA how it would conduct surveys in the Irigaray central processing facility and Christensen Ranch satellite building, but it had not discussed surveys in other license areas where occupational doses may be received. In its January 20, 2015, letter, Uranium One stated in addition to the measurements in the Irigaray central processing facility and Christensen Ranch satellite building, as specified in Sections 5.7 and 5.8 of the NRC–approved LRA, Uranium One will commit to making measurements of radon progeny in the wellfield modular buildings at the same frequencies as specified in Section 5.7 of the LRA. Uranium One will also assign occupational dose to workers in the wellfields by assuming 2,000 hours per year occupational exposures at the concentrations measured in the Irigaray central processing facility and Christensen Ranch satellite building.

Uranium One also explained that external dose is assigned to all monitored employees based on work groups. In this case, individuals not assigned dosimeters will be assigned a dose based on the dose received by a representative member of their group. The groups include plant operators, wellfield operators, maintenance workers, and laboratory workers.

The NRC staff reviewed the licensee's proposed methods for accounting for occupational dose received throughout the Willow Creek project from radon and its progeny and particulates and determined that it meets the requirements of 10 CFR 20.1501 and is therefore acceptable.

References

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

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

Cogema 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 (Uranium One) (ML103280266), March 7, 2012 (Uranium One) (ML120820095), and July 10, 2012 (Uranium One) (ML12206A436).

NRC 1987. Regulatory Guide 3.59, “Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations,” Washington, DC: NRC, Office of Nuclear Regulatory Research. Accession No. ML003739503.

NRC 1993. Regulatory Guide 8.37, “ALARA Levels for Effluents from Materials Facilities,” Washington, DC: NRC, Office of Nuclear Regulatory Research. Accession No. ML003739553.

NRC 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 2014a. Letter from R. Linton, NRC to S. Schierman, Uranium One, dated May 6, 2014, Re: Review of Submittal of Requested Standard Operating Procedures Required by License Condition 11.3 dated September 25, 2014, Uranium One USA, Inc., Materials License SUA-1341, Willow Creek In Situ Recovery Project, Campbell and Johnson Counties, Wyoming (TAC J00711). ADAMS Accession No. ML14125A008.

NRC 2014b. Memorandum from R. Linton, NRC to B. Von Till, NRC, dated July 7, 2014, Re: Summary of May 27, 2014, Meeting with Uranium One USA, Inc., Willow Creek Licensing Issues. ADAMS Accession No. ML14156A141.

NRC 2014c. Letter from R. Linton, NRC to S. Schierman, Uranium One, dated November 12, 2014, Re: Denial of Acceptance for Review, Information Required by License Condition 11.3, Uranium One, USA, Inc., Willow Creek Project, Campbell and Johnson Counties, Wyoming, Materials License SUA-1341 (TAC No. J00711). ADAMS Accession No. ML14295A668.

NRC 2014d. Letter from R. Linton, NRC to S. Schierman, Uranium One, dated December 15, 2014, Re: Denial of Acceptance for Review, Information Required by License Condition 11.3, Response Requested by January 23, 2015, Uranium One, USA, Inc., Willow Creek Project, Campbell and Johnson Counties, Wyoming, Materials License SUA-1341 (TAC No. J00711). ADAMS Accession No. ML14345A214.

NRC 2015a. Letter from R. Linton, NRC to S. Schierman, dated May 4, 2015, Re: Uranium One, USA, Inc., Willow Creek Project, Campbell and Johnson Counties, Wyoming, License SUA-1341, Acceptance for Review and Request for Additional Information, License Condition 11.3, Part A-D, (TAC J00711). ADAMS Accession No. ML15113A634.

NRC 2015b. Letter from NRC to Mr. S. Schierman, Uranium One, dated August 20, 2015, 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. J00743), ADAMS Accession No. ML15202A122 (pkg).

NRC 2015c. Letter from J. Saxton, NRC, to M. Griffin, Strata Energy, Inc., dated November 19, 2015, Re: U.S. Nuclear Regulatory Commission Verification of Strata’s Response to License Condition 12.7, Ross In-Situ Recovery (ISR) Project, Crook County, WY, Source Material License SUA-1601, Docket No. 040-09091, TAC J00735. ADAMS Accession No. ML15278A110.

Uranium One 2013. Letter from S. Schierman, Uranium One, to R. Linton, NRC, dated September 25, 2013, Re: License SUA-1341, Docket No. 40-8502 Willow Creek Project Submittal of Requested SOP's. ADAMS Accession No. ML13273A017.

Uranium One 2014. Letter from S. Schierman, Uranium One, to R. Linton, NRC, dated July 3, 2014, Re: License Condition 11.3, Parts a-d, Materials License SUA-1341. ADAMS Accession No. ML14195A361.

Uranium One 2015a. Letter from S. Schierman, Uranium One, to R. Linton, NRC, dated January 20, 2015, Re: License Condition 11.3, Parts a-d, Materials License SUA-1341. ADAMS Accession No. ML15040A077 (pkg).

Uranium One 2015b. Letter from S. Schierman, Uranium One, to R. Linton, NRC, dated June 5, 2015, Re: Request for Additional Information, License Condition 11.1, Part (a-d) Materials License SUA-1341, May 4, 2015. ADAMS Accession No. ML15181A357.