uraniumone
investing in our energy

June 5, 2015

Mr. Ron Linton, Project Manager
Decommissioning & Uranium Recovery Licensing Directorate
Division of Waste Management & Environmental Protection
Office of Federal & State Materials & Environmental Management Programs
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Mail Stop T7-E18
Rockville, Maryland 20852-2738

Re: Request for Additional Information, License Condition 11.3, Part (a-d)
Materials License SUA-1341, May 4, 2015

Dear Mr. Linton:

In response to your letter of May 4, 2015, request for additional information (RAI's) for the January 20, 2015, Uranium One submittal (ML15040A077) please find the requested information as they pertain to License Condition 11.3, parts a-d, for Material license SUA-1341.

Uranium One as part of this submittal to address NRC RAI's is providing replacement text for pages 1-12 of the January 20, 2015 submittal. Attachments submitted with the January 20, 2015, have not been modified and are not being replaced or provided as part of this response package submittal.

If you have any questions or need additional clarification on any information provided, please do not hesitate to contact me at 307-233-6330.

Sincerely,

Scott Schierman
HSE Manager
Uranium One Americas

cc: Greg Kruse – Manager, U.S. Operations
Rick Kukura – Mine Manager
Ryan Schierman – Uranium One USA, Inc. w/attachment

Uranium One USA, Inc.
A Member of the Uranium One Inc. Group of Companies
tel +1 307-234-8235 • **fax** +1 307-237-8235
907 N. Poplar Street, Suite 260
Casper, Wyoming 82601
www.uranium1.com

Response to Request for Additional Information (RAI)
Dated May 4, 2015
License Condition (LC) 11.3 (a-d)

The following RAI's are focused on LC 11.3 (a)

1) **Licensee Statement of Position**
Uranium One (licensee) identifies two methods for determining the amount of radon emanating from the Willow Creek facilities. Uranium One indicated that the first methodology involves sampling the incoming lixiviant for radon using the American Society for Testing and Materials (ASTM) test method ASTM D 5072-09. Uranium One implies that this approach overestimates the amount of true effluent released from these sources.

RAI LC 11.3 (a) # 1
NRC staff cannot determine of the intended purpose of measurement devices and criteria for monitoring (sampling the incoming lixiviant) are being used at both the Christensen Satellite Plant and Irigaray Plant or just the Christensen Satellite Plant. The licensee needs to clarify the position.

Uranium One Response RAI LC 11.3 (a) # 1
The lixiviant will only be sampled at the Christensen Ranch Satellite facility. Originally Uranium One was trying to characterize radon that would be emitted from Irigaray. However, with the position that the ore bodies are the only source of radon loses of radon at Irigaray will be accounted for in loses seen at Christensen Ranch. The response has been changed, more specifically page 3 of the response.

2) **Licensee Statement of Position**
The licensee indicates (Pg.1) that they will use ASTM-D 5072-09 for sampling the lixiviant. ASTM D 5072-09 is a standard for drinking water. This method is designed on the premise that a faucet is available to extract water.

RAI LC 11.3 (a) #2
NRC staff cannot determine if the monitoring is appropriate for the types of effluent generated. More specifically, NRC staff cannot determine if the sampling locations are representative of the effluent. The licensee needs to address the following:

a) Provide the location where Uranium One plans to extract the water from the lixiviant to perform the ASTM 5072-09 method
b) Demonstrate how Uranium One will control the pressure and prevent spill using the ASTM D 5072-09 method since the incoming lixiviant will likely be under pressure greater than a typical residential drinking water system
c) Demonstrate how does Uranium One plans to extract the liquid and prevent potential spills

d) Please provide a piping diagram and sketch of the sampling station.
e) Please provide a technical basis or demonstrate that the radon sample collected using the ASTM 5072-09 method is representative of the radon (Rn-222) concentration in the incoming lixiviant.

Uranium One Response RAI LC 11.3 (a) #2

a) Sampling locations will be located at the plant header house on the incoming recovery trunk line and injection trunk line. These lines represent all the solutions that are incoming to the plant and all the solutions that are going for injection to the wellfield. Sample ports on the incoming solutions to the old and expansion plants at the satellite are also available to sample. Uranium One will sample both of these lines and sum the results to determine radon concentrations for the incoming lixiviant measurement. Additionally there are sample ports for the injection solutions f at the Christensen Satellite that can also be collected and summed to confirm the sample taken on the injection solution headed to the wellfield. Lastly the sample port for solutions to be injected into the DDW will be taken before the RO unit. Further clarification on sampling locations is included in the discussion provided for License Condition 11.3, Par A-D.

b) Uranium One trunk lines will be under greater pressure than typical residential lines; however the flow coming out of the sample ports is typical of residential flows from a faucet (see Figure 1). Please note Figure 1 shows typical flows from a sample port on the incoming lixiviant line, and no spraying or misting that would cause the radon to volatize was encountered.

c) Spills from collecting the samples is anticipated to be less than 1 gallon and all captured solutions will be returned to the plant sump for further processing. Dialogue explaining how Uranium One will collect samples has been added to the response.

d) Uranium One does not see any benefit in providing a piping diagram or sketch of the sampling port as part of this submittal. NRC has a copy of the process flow diagrams provided with the license renewal application that can illustrate the lixiviant lines proposed for sampling.

e) Liquid scintillation counting (LSC) is an accepted method of detecting Rn-222 in water. The methodology has been described as far back as 1977 when it was described by Prichard and Gesell 1977. The technical application of this proposed methodology may potentially vary from ASTM method only in regards to collection of the sample and the potential for a positive bias in analytical results. When lines are under pressure the potential to cause more radon to go into solution exists. As the pressurized solution drops in pressure (sample port) radon could come out of solution in the form of visible de-gassing or bubbling. Uranium One has collected samples of the incoming lixiviant and de-gassing was not observed.

The potential for a positive bias should be minimal and would only be present at the surface of the interchange between the water and the oil cocktail. The radon will move to the oil and leave the uranium in the water. To demonstrate this Uranium One sent a filter press sample in for analysis utilizing ASTM D method 5072-09 that

contained primarily Uranium with little radon present. The sample resulted in a small interference when compared to other samples taken from the wellfield. Samples taken from the incoming lixiviant had a concentration of 136,000 pCi/L. The sample taken from the filter press resulted in 36,000 pCi/L. The sample with no radon did not have well defined peaks as described in the ASTM methodology and resulted in what appeared to be background noise. Additionally the filter press resulted in a large hump right before the radon channels of interests. When looking at the wellfield sample it was void of this interference. On a worst case basis the interference would result in 26% positive bias. It is important to note that the uranium content coming from the wellfield would never come close to the uranium concentrations in the filter press solution. To put this in perspective the filter press sample is roughly 240 times higher in uranium concentration than what we would expect to see for the incoming wellfield lixiviant at the Christensen Satellite. The interference from uranium in the samples will result in an insignificant amount of positive bias.

3) **Licensee Statement or Position**
Uranium One states (Pg.2) that "The measurement will be made at the top hatch."

RAI LC 11.3 (a) #3
NRC staff cannot determine if the monitoring is appropriate for the types of effluent generated. The licensee needs to address the following:

a) Specify what top hatch is referenced (hatch of a truck, tank, etc.)
b) Specify if this top hatch will be open or closed.
c) Specify what type of measurement is being taken
d) Provide a technical basis indicating why sampling will be performed at the hatch and provide a discussion if this is this representative of the effluent.

Uranium One Response RAI LC 11.3 (a) #3
Uranium One has changed the response to reflect the concerns addressed by the NRC. Uranium One will not make measurements at Irigaray using methodology number one since the loss of radon will be accounted for at the Christensen Satellite facility. This is based on the position that all radon at our facilities originate from the ore body in which we are mining.

In alternative methodology 2 the top hatch is referenced to as the resin truck tank utilized to haul loaded resin from the Christensen Satellite to the Irigaray facility. The discussion talks about the hatch being closed and utilizing a valve that can be opened to collect a radon sample which will be counted using the Modified Kusnetz method.

4) **Licensee Statement or Position**
Uranium One states (Pg.2) that "The second method involves characterizing each potential source of radon and cumulating the total of the sources for a total effluent release."

RAI LC 11.3 (a) #4

NRC staff cannot determine if the monitoring and method(s) is appropriate for the types of effluent generated. NRC staff cannot determine if Uranium One will combine the sum of the quantity from multiple methods or a single method. Please provide clarification if Uranium One will combine the sum of the quantity from multiple methods or a single method. If a single method is used, please provide a description of the method used.

Uranium One Response RAI LC 11.3 (a) #4

Uranium One anticipates using methodology one to estimate the quantity of radon emitted from our facility. However we will also perform methodology number two to compare results and determine which methodology is most appropriate in determining effluent release from the operations.

5) **Licensee Statement or Position**

Uranium One states (Pg2) that "Sampling of elution tanks will be performed initially on a quarterly basis and then a semi-annual basis.

RAI LC 11.3 (a) #5

NRC staff cannot determine if the monitoring methodology and frequency is appropriate for the types of effluent generated. The licensee needs to address the following

a) Explain the method Uranium One will use to sample the elution tanks. For example identify if the sample is an air sample or a liquid sample, how will the sample be collected, and at what frequency the sample be collected.
b) Provide an explanation and demonstrate that the samples from the elution tanks are representative of the effluent release

Uranium One Response RAI LC 11.3 (a) #5

Under the position that all radon originates from the ore bodies being mined, any radon introduced at Irigaray will have already been accounted for as lost as discussed in methodology number one.

6) **Licensee Statement or Position**

Uranium One states (Pg. 3) that "Routine sampling will be used to determine the effluent leaving the Christensen facility. Radon effluent from the Christensen plant is estimated using average monthly radon concentration the activity (0.33 WL([working levels] is equal to 3.0 E-8 µCi/ml) released can be calculated using the equation below.

RAI 11.3 (a) #6

The licensee states (Pg 3) that "Routine sampling will be used to determine the effluent leaving the Christensen Satellite Facility. The licensee also states (Pg 3) "Radon effluent from the Christensen plant is estimated using average monthly radon concentrations. These two statements are confusing and need clarification. It is not clear if the licensee is attempting to measure the concentration based on routine sampling or estimating the activity being released using an occupational concentration limit from 10 CFR Part 20

Table 1. This method is also referenced on page 4 and page 5 of Uranium One's responses. It is not clear how the results from the routine sampling will be integrated into the estimated concentration. Please clarify the method used to determine the effluent leaving Christensen Ranch.

Uranium One Response RAI 11.3 (a) #6
Uranium One made revisions to the response to clarify the language.

7) **Licensee Statement or Position**
The licensee states (Pg 4) that if the high elution tank after sampling shows concentration below 0.03 WL it will be assumed to be negligible and will not be included in the effluent released from the facility.

RAI LC 11.3 (a) #7
The negligible value identified by the licensee is above the public concentration value of 1.0E-10 µCi/ml (0.1 pCi/L). This value represents 10 % of the occupational concentration limit from 10 CFR Part 20 Appendix B Table 1. The public concentration limit is 1E-10 µCi/ml. The licensee needs to explain why 0.03 (i.e., 3.0E -9 µCi/ml) WL is assumed to be negligible.

Uranium One Response RAI LC 11.3 (a) #7
Uranium One has updated the response such that it will no longer take measurements at the elution tanks. Originally the 0.03 WL was chosen based on the fact that the LLD for the Modified Kusnetz methods is roughly 0.03 WL.

8) **Licensee Statement or Position**
The licensee states (Pg5) the following, "Therefore Uranium One will consider the radon coming off the dryer stack to be minimal and will not be included in required reporting requirements for effluent releases.

RAI LC 11.3 (a) #8
Please explain why radon coming off the dryer stack is considered minimal. Please provide data or calculation to support his statement.

Uranium One Response RAI LC 11.3 (a) #8
Using methodology number one Uranium One's position is that any radon introduced into the elution circuit at Irigaray Processing Plant has already been considered released to the environment at the Christensen Satellite facility.
Using methodology number two Uranium One will assume any radon coming into the Irigaray from the loaded resin will be emitted to the atmosphere at the rate of the exhaust on the precipitation exhaust fan. Uranium One will not attempt to determine the amount of radon that moves through the elution circuit and is emitted as part of the dryer stack emission.

9) Licensee Statement or Position

The licensee states (page 5) that "Modular buildings are sampled on a monthly basis for radon progeny using the Kusnetz methodology.

RAI LC 11.3 (a) #9

The licensee needs to provide more detailed technical information as follows:

a) Please explain in detail how the modular building will be sampled. For example explain what method will be used to sample the modular building, how long the sample will be collected, and how the concentration and quantity released will be determined.

b) Explain if the Kusnetz methodology used is the original method, modified method, or bot. If original Kusnetz method is used, please explain why this method was chosen over the modified version

Uranium One Response RAI LC 11.3 (a) #9

The methodology is explained in the written response to License Condition 11.3, Par A-D. Uranium One will use the modified Kusnetz method to determine the radon being emitted from the header houses. Uranium One will take average concentrations of each mine unit and apply the exhaust rates to determine the total amount of activity emitted. As part of the modified Kusnetz procedure a five minute sample will be taken.

10) Licensee Statement or Position

Uranium One (Pg 5 Second Equation)

$$quantity\ emmited\ \frac{\mu Ci}{ml} = \frac{Average\ Concentration \frac{\mu Ci}{ml} X\ Sample\ Volume\ (ml) X\ Time\ (min)}{Sample\ Time\ (\text{min})}$$

RAI 11.3 (a) #10

NRC staff has determined that this equation is not correct. The equation results in a concentration and not a quantity. In addition the equation does not take into consideration the well head vent rate of three liters per minute and the equation does not take into consideration the conversion from liters to milliliters. Please correct this equation.

Uranium One Response RAI 11.3 (a) #10

The equation has been changed.

11) Licensee Statement or Position

The licensee state (Pg. 7) that "Analysis of filters will be for RA-226 Po-210, Th-230 and Pb-210 as per LC 11.3

RAI LC 11.3 (a) #11

The licensee did not identify natural uranium (Unat) as an analyte. Provide an explanation as to why U-Nat will not be analyzed or include U-Nat into the suite of analytes.

Uranium One Response RAI LC 11.3 (a) #11
Uranium One has added natural uranium as a parameter.

The following RAIs are focused on LC 11.3 (b)

1) **Licensee Statement or Position**
The licensee states (Pg. 7) that, "10 CFR Part 20.1301 list another option to demonstrate compliance; however Uranium One will use the first method in demonstrating public dose.

RAI LC 11.3 (b) #1
NRC staff determined that this statement "10 CFR Part 20.1301 list another option to demonstrate compliance..." is not correct. 10 CFR Part 20.1302 not CFR Part 20.1301 provides another option to demonstrate compliance. Please correct this statement.

Uranium One Response RAI LC 11.3 (b) #1
The reference has been corrected.

2) ***Licensee Statement or Position***
The licensee states (Pg.7) that "10 CFR Part 20 .1301 list another option to demonstrate compliance, however Uranium One will use the first method in demonstrating public does

RAI LC 11.3 (b) #2
a) Please explain the statement "Uranium One will use the first method in demonstrating public dose." NRC cannot determine if Uranium One is referring to the first method on the first page or a different method
b) If Uranium One is using measurement(s) method, please clarify what type of measurements Uranium One plans on using
c) NRC staff is not clear as to how the licensee will use the measurements taken in field and its application with the software program MILDOS. Provide an explanation how the software tool MILDOS and the effluent measurements will be used.

Uranium One Response RAI LC 11.3 (b) #2
a) Uranium One will use the method described in 10 CFR 20. 1302(b)(1).
b) Uranium One will use as stated in the response individual Radtrak detectors, OSL dosimeters, and particulates from Irigaray will be applied to each maximally exposed individual. Uranium One has identified multiple maximally exposed individuals as outlined in Appendix 2 Identification of Maximally Exposed Individual. Monitors will be placed at locations that could be potentially the highest exposed individual. Uranium One treats the wellfields, Irigaray, and Christensen Satellite as separate systems and each system has a maximally exposed individual. Whatever system results in the highest dose will be reported to the NRC as part of the 10 CFR 40.65 report.
c) Uranium One will use measurements to determine dose for receptors. MILDOS is a tool to help identify the receptors that are likely to receive the highest dose from our

operations. Yearly Uranium One will look at land use to determine if the receptors being monitored are the receptors likely to receive the highest doses. Uranium One will take recent land use developments or activities and compare them to the isodose curves provided in the MILDOS run. If those receptors fall within a higher isodose curve indicating a potential for a higher dose Uranium One will change the monitoring location for the potential maximum exposed individual. If a new receptor, due to changes in land activity has more potential than existing receptors monitoring will begin at that receptor site.

3) **Licensee Statement or Position**

The licensee states (Pg. 8) that "The emissions or source term from Irigaray should be higher."

RAI LC 11.3 (b) #3

NRC staff cannot determine if this statement is correct. Please provide a technical basis explaining why the emission or source terms from Irigaray should be higher.

Uranium One Response RAI LC 11.3 (b) #3

In the Safety Evaluation Report for SUA 1341 Section 5.7.7.3.2 NRC makes the comment "based on the staff's experience and knowledge the air particulate releases, air particulate impacts at Christensen Ranch should be lower than Irigaray operations." At some point NRC was able to make this discussion. This position is justified in the fact that the only potential sources of particulate release for the Christensen Satellite would be spills. Spills that would occur in the plant are washed promptly to remove the potential of buildup of material and particulate release. Additionally this is substantiated by the routine particulate airborne sampling conducted at Christensen Satellite. If the potential for particulates did exist in the Christensen Satellite plant the isotopic analysis of the filters would demonstrate the particulates. Those could then be compared to Irigaray source term for particulates (isotopic analysis of filters and dryer emissions) and the results will be lower. Therefore using the air particulate environmental monitoring stations at Irigaray would overestimate particulate effluent releases for the operations at Christensen Satellite.

4) **Licensee Statement or Position**

The Licensee states (Pg. 8) that "Historically, the environmental stations located at Irigaray have been applied to Christensen under the assumption that it would overestimate the true particulate emission from Christensen Ranch. Uranium One will verify this assumption by comparing the isotopic analysis and the dryer stack test emissions from Irigaray to the isotopic analysis of the Christensen plant air particulates.

RAI LC 11.3 (b) #4

NRC staff cannot determine if the assumption is correct that data from Irigaray can be applied to Christensen. Please provide actual data or calculations and technical basis for these assumptions.

For example, if Uranium One is planning on measuring the radon in pregnant lixiviant from the wellfields to the Christensen plant, using the ASTM methods as discussed on page 1, and assuming that all radon in the pregnant lixiviant is released to the atmosphere then the release of radon from the Christensen Ranch facility may be higher than the concentrations from Irigaray due to the larger amount of radon in the pregnant lixiviant. When considering the response, the licensee should take into consideration the above statement

Uranium One Response RAI LC 11.3 (b) #4
As stated in the response Uranium One only plans to apply air particulate sampling from Irigaray to Christensen Satellite monitoring locations. Each monitoring location at the Christensen Satellite will have radon detectors and OSL badges for gamma. We are separating the radon and radon progeny from air particulates.

5) Licensee Statement or Position
The licensee states on (Pg 9 and 10) that "Dose conversion factors are established by taking the 10 CFR Part 20 Appendix B, Table 2 value for radon with progeny present in air (2E-10µCi/ml or 0.2 pCi/L).

RAI 11.3 (b) #5
The discussion on pages 9 and 10 are not consistent with current regulatory standards. Please revise the dose conversion factors and revise any calculations that were derived using the incorrect conversion factors.

The dose conversion factor used should be 500mrem/yr per pCi/L. This is based on the 10 CFR Part 20 Appendix B Table 2 limit of 1E-10 µCi/ml or 0.1 pCi/L. 10 CFR Part 20 Appendix B Table 2 states that "The concentration values given in columns 1 and 2 of table 2 are equivalent to the radionuclide concentration which, if inhaled or ingested continuously over the course of a rear would produce a total effective dose equivalent of 0.05 rem (50 mrem or 0.5 millisieverts)." Thus 50 mrem/yr/0.1pCi/L=500 mrem/yr per pCi/L.

10 CFR Part 20.1301 assigns a total effective dose equivalent (TEDE) limit of 100 mrem per year. This is not to be confused with the dose limit in 10 CFR Part 20 Appendix B, Table B is the dose limit from breathing or drinking that concentration over a year. This would represent a TEDE or a committed effective dose equivalent of 50 mrem/yr. The TEDE from 10 CFR Part 20.1301 allows the licensee to apply an additional 50 mrem per year to the member of the public from an external dose or some combination thereof.

In addition, if the licensee was to apply an equilibrium ration of 0.5 as suggested in the interim draft radon guidance to the 10 CFR Part 20 Appendix B, Table 2 limit for Rn-222 with daughters, then the licensee could use the 0.2 pCi/L value (0.1 pCi/L/0.5=0.2pCi/L). This would still be equivalent to the 50 mrem/yr. If uranium One assumes an equilibrium ratio of 100% then the Rn-222 with progeny concentration value would be 0.1 pCi/L

***Uranium One Response* RAI 11.3 (b) #5**

*Uranium One does not agree with the NRC interpretation of the 10 CFR Appendix B Table 2 limits in regards to only being allowed 50 mrem per year for radon. Uranium One is not aware of anywhere in the regulations where it stipulates that only so much of the 100 mrem per year total can be attributed to radon. The regulations do prohibit other items such as 10 CFR 20.1101 (d) which states " to implement the ALARA requirement of 10 CFR 20.1101(b) and notwithstanding the requirements in 10 CFR 20.1301 of this part, a constraint on air emissions of radioactive material to the environment , **excluding Radon-222 and its daughters,** shall be established but the licensees other than those subject to §50.34a such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 10 mrem (0.1mSv) per year from these emissions." As can be seen it does not give a constraint on radon or its daughters. That being said Uranium One has changed the response to be in agreement with the requested information. Uranium One will use as discussed in the RAI the 50% equilibrium factor as suggested in the interim radon draft guidance lowering the dose conversion factor from 500 to 250 mrem/yr per pCiRn/l. Uranium One has made the requested changes to the document.*

The following RAI are focused on LC 11.3 (c)

1) **Licensee Statement or Position**

The licensee states (Pg. 11) that "Annually an assessment will be performed to determine if methodologies are still conservative and maximally exposed individual receptors location still represent the individual most potentially affected by Uranium One operations. The licensee plans to use MILDOS to make assessment.

RAI LC 11.3 (c) #1

Provide additional details and discussion how actual field measurements will be incorporated into MILDOS during annual assessment

Uranium One Response RAI LC 11.3 (c) #1

Uranium One will not enter in the field parameters into the MILDOS calculation. Uranium One will take recent land use developments or activities and compare them to the isodose curves provided in the MILDOS run. If those receptors fall within a higher isodose curve indicating a potential for a higher dose Uranium One will change the monitoring location for the potential maximum exposed individual. The major component on these estimations is occupancy time.

For an example of a change that may occur consider the following; a CBM well is installed closer to our Mine Unit 10. When comparing the location to the CBM well already being monitored to the Isodose curves in MILDOS it is predicted that the new CBM well would receive higher concentrations. Uranium One at that point would move the monitoring to the highest predicted location.

Replacement Text for January 20, 2015 Submittal

Uranium One Willow Creek ISR Project

License Condition 11.3

Uranium One will re-evaluate information contained in the following responses on an as needed basis to verify measurements and methodologies are adequately describing the current situations.

LC 11.3(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.

Uranium One will characterize all point and diffuse sources with the assumption that the measurements taken in the process areas will be released to the environment completely or be emitted at the rate of the ventilation exhaust for fans located throughout the facilities. Emissions will refer to particulates, radon and radon progeny. This approach overestimates the amount of effluent released from these sources. Quantities of effluent released from the Willow Creek facilities will be reported on a semi-annual basis as is required by 10 CFR 40.65 and per License Condition (LC) 12.1. Methodologies in determining effluent releases will be analyzed on an annual basis to determine if they are adequate in estimating effluent.

Emissions from the Willow Creek facilities will be determined based on the following assumptions and measurements.

Radon

The amount of radon emanating from the Willow Creek facilities will be determined initially by two different methodologies. It is the intent of Uranium One to use methodology number one, but will perform methodology two as a comparison. The quantity of radon emitted will be reported to the NRC in agreement with 10 CFR 40.65 and as per LC12.1.

Methodology Number 1

The first methodology involves sampling the incoming lixiviant for radon using the American Society for Testing and Materials test method ASTM D 5072-92 or other equivalent methodologies. At some point Uranium One may purchase a Durridge Rad 7 or equivalent that allows for radon measurements in water. The ASTM test method allows for measurement of radon in water in concentrations above 2 Bq/L. The ASTM test method is based on the scintillation of Rn-222 and its progeny. The un-aerated water is placed in a vial with as little head space as possible allowing the radon to remain in solution. An aliquot of the sample is taken and placed into vial below a mineral oil cocktail that has already been added. The sample is shaken or disturbed causing the radon to diffuse from the sample into the mineral oil due to radons affinity to the oil over the water. The sample is than counted on a Liquid Scintillation Counter to obtain the amount of radon in the sample. Other constituents such as Uranium should remain in the water and not diffuse into the mineral oil. There may be a slight positive bias at the surface of the two layers.

In order for the test methodology to be effective care has to be taken on collecting the sample. It is important that the source of the water is coming through an un-aerated source. This

minimizes the volatilization of radon before the sample can be counted. Additionally the flow should be steady and consistent and not under pressure such that it mists causing radon to volatilize. Uranium One ensures this by collecting samples at sample ports. The sample ports allow for Uranium One to collect solutions from pressurized lines with minimal volatilization radon. An example of a typical sample port is shown in Figure 1. As can be seen the flow from the port is less or equal to that of a household faucet. The pressure on the line at the time of sampling was 100 psi.

When sampling the water for radon Uranium One will use a glass 1 L beaker to catch the solution. A hose will be attached to the sample port and placed below the water surface to prevent loss of radon. Additionally the glass beaker is placed in a 5 gallon bucket to collect any spillage that may occur. All excess solution will be returned to the plant sump for further processing. At the time of sampling Uranium One places the sample vial under the water and caps it under water to create minimal head space in the vial. The sample is then taken to a third party laboratory for analysis.

Figure 1

The incoming lixiviant can be sampled at three different locations. It can be sampled in the plant modular building which represents all the incoming wellfield solutions, a sample port at the old CR Plant, and a sample port at the expansion part of the CR Plant. Between the three sample ports an appropriate concentration can be derived. The lixiviant will be tested on a semi-annual basis by a third party laboratory. Once the concentration of the incoming lixiviant is known a

source term quantity for radon can be calculated by taking the total amount of solution that came into the plant and the concentration provided by laboratory analysis as is shown in the following equation.

$$Incoming\ Lixiviant\ Radon\ Activity\ (pCi) = \frac{pCi}{L} * \frac{L}{0.264 Gallons} * \frac{Gallons}{Minute} * Minutes$$

This methodology accounts for all point and diffuse sources of radon based on the position that the overall source of radon is coming from the ore bodies that are being mined at the time of sampling. The solution from the ore bodies to the Christensen plant is a closed system and no radon should be lost in its transition from the modular buildings to the plant.

To determine where the incoming source term of radon is lost in the system other areas of the satellite stream will be sampled. The returning solution in the injection line, solutions before the RO unit that will eventually go to deep well for disposal or is recycled into the process stream, and each individual modular building during filter changes give an overall estimate of where radon is lost in the system. To characterize these loses each of these locations would need to be sampled.

The injection trunk line in the plant modular building carries all solution that is to be injected back into the wellfield. A sample port can be installed on this line and the sampled solution can be analyzed using the ASTM D 5072-92 or equivalent methodologies to obtain a radon concentration. The solution that are disposed of at the deep disposal well or ponds can be sampled at a sample port right before the reverse osmosis unit. This sample will be analyzed using ASTM D 5072-92 methodology. Using the amount of solution going back to the wellfield or for deep disposal well injection Uranium One can put a quantity to the radon in these solutions using the same equation used for the recovery line as follows.

$$Disposal\ solutions\ radon\ activity\ (pCi) = \frac{pCi}{L} * \frac{L}{0.264 Gallons} * \frac{Gallons}{Minute} * Minutes$$

There is also loss of radon in the modular buildings due to filter change outs and leaks. Uranium One currently samples each operating modular building on a monthly basis. On a semiannually basis the sampling event will coincide with the bag filter change outs. If the samples collected during the bag filter change out are more than two standard deviations greater than the monthly samples the semiannual resulting concentrations will be applied instead of those collected on a monthly basis. These radon concentrations are determined using the Modified Kusnetz method. Using the concentration of the modular buildings an average radon value for each mine unit can be calculated using the conversion of 0.33WL is equal to 3E-8 µCi/ml. The quantity of material released can be estimated using the average concentrations and the exhaust rates for each modular building. Exhaust rates are determined based on manufacturer specifications or through the use of an anemometer. The following equation shows how quantities are obtained:

$$Activity_i(\mu Ci) = B * (Average\ Concentration\left(\mu\frac{Ci}{ml}\right) * Emission\ rate\left(\frac{ml}{min}\right) * Time\ (\text{min}))$$

Where Activity$_i$ is the activity of each mine unit;

B is the number of modular buildings in the mine unit

Average Concentration is the average for each mine unit;

Emission Rate is the exhaust rate of modular building fans; and

Time is the monitoring period of interest

This sum of all the mine units will represent the loss of radon due to the filtration at the modular buildings.

For the Irigaray facility the only source term of radon would be residual radon being transferred from Christensen IX resin during resin transfer. Uranium One will consider this source to have been accounted for at the Christensen facility and will not be accounted for again at the Irigaray facility.

To clarify there will be a loss of radon when comparing the incoming lixiviant and subtracting the radon disposed of through injection in the deep disposal wells and injection into the wellfield. Additionally the radon loss due to bag filter change or major spills will be added to the overall loss. The following equation demonstrates the overall emission or loss of radon

$$Emission\ of\ radon\ (\mu Ci) = \left(L_1 - (S_1 + S_2)\right) + BF + SP$$

Where L_1 is the incoming lixiviant or recovery solution (µCi);

S_1 is the returning injection solution (µCi);

S_2 is the solution going to deep well injection (µCi);

BF is radon loss due to bag filter change out (µCi); and

SP is radon loss due to major spills (µCi)

Alternative Methodology Number 2

The second methodology involves characterizing each potential source of radon and cumulating the total of the sources for a total effluent release. To accomplish this Uranium One has separated the discussion into three categories Christensen Plant, Irigaray Plant, and the wellfields.

Christensen Ranch Satellite Plant

The amount of radon emanating from the Christensen Plant will be determined first by characterizing the radon concentrations within the plant. HP-7 Radon Daughter Survey outlines the methodology on how radon samples are collected and analyzed. Locations and frequency of radon samples are dictated by license condition 10.10 which states "The licensee shall sample particulates and radon progeny on a monthly frequency at the Irigaray and Christensen Ranch Satellite locations shown in Figure 5.2 and 5.3 of the approved license application. Additional sample locations can be added by the licensee through the SERP" and guidance supplied in Regulatory Guide 8.30. The exhaust from the fans located in the Christensen Ranch facility will be determined by one of the following methods; manufacturer specifications, air balance studies performed by Tetra Tech, or through direct measurement using an anemometer. There are two (2) exhaust fans located in the plant one in the old plant and one in the satellite expansion plant. As these fans are changed or replaced the new exhaust rates will be updated accordingly. Uranium One will utilize the fan exhaust rate to estimate the quantities of effluent released from the satellite plant. Uranium One will assume both fans are in operation at all times. During

routine operations one fan is always running so assuming both fans are operating continuously will overestimate the overall effluent released.

To increase air flow through the building and increase the ventilation bay doors at times will be left open. When the bay doors are open the fans are operational and they create a negative draw on the building pulling the air from the bay doors through the plant. This has been demonstrated by air flow studies performed by TetraTech. The release of effluent from doors being opened is minimal and is accounted for by assuming that both exhaust fans are continuously operational.

Radon effluent from the Christensen plant is estimated using average monthly radon concentrations, the activity (0.33WL is equal to 3E-8 µCi/ml) released can be calculated using the equation below. Volumes are calculated using flow rates from the exhaust fans and the amount of time for the monitoring period. A total of the effluent released from the plant can then be calculated and compared to the release values reported in methodology one discussed above. Based on the comparison Uranium One will determine which effluent release methodology is most appropriate for our operations.

$$Activity(\mu Ci) = Concentration\left(\mu\frac{Ci}{ml}\right) * Emission\ rate\left(\frac{ml}{min}\right) * Time\ (\text{min})$$

At the Christensen Ranch there is only one tank that is vented to the atmosphere that could be considered a radon source. The other tanks, such as the IX columns are all vented to the backwash line. The backwash line feeds into the backwash pond, and therefore the IX columns themselves are not venting to the atmosphere. Releases of radon from ponds will be discussed in sources from the wellfield. The de-gas column in the plant however is vented to the atmosphere. The purpose of the degas column is to remove carbon dioxide and dioxide from the solution coming from the reverse osmosis unit (RO). Radon is also released from the solution as a consequence of the process in removing the other gases. The degas column works as the incoming solution is sprayed into the tank from the top. As the water is sprayed it releases the gas. The solution then collects and precipitates through diffusers which agitate the solution enough to release any residual gases in the solution. The column has a layer of these diffusers. Additionally a fan is constantly pulling outside air into the tank which by displacement causes gas to vent through the top of the tank and to the outside. The flow diagram shows the de-gas column and how it relates to the process (Attachment 1 Figure 3.13).

Uranium One tracks the amount of solution that goes to the degas column on a continuous basis utilizing the operations PLC computer system. . Estimation of the amount of radon released from the degas column can be made using the amount of solution entering the de-gas column over a given period of time and the concentration of the incoming solution. The concentration can be measured for radon using the American Society for Testing and Materials test method ASTM D 5072-92. The concentration would be reported in pCi/L with a sensitivity of 100 pCi/L, and would be performed by a third party laboratory. If the results are below the sensitivity of the analysis the 100 pCi/L will be used for the calculation. It would be Uranium One position that all the radon in the incoming solution is released to the atmosphere through the passive vent in the tank. The quantity of radon released will be calculated with the below equation and used to compare with methodology number one.

$$Activity\ (pCi) = \frac{pCi}{L} * \frac{L}{0.264Gallons} * \frac{Gallons}{Minute} * Minutes$$

Irigaray Plant

Emissions from the Irigaray Ranch facility will be determined based on the following assumptions and measurements. The amount of radon emanating from the plant will be determined first by characterizing the radon concentration within the plant. HP-7 Radon Daughter Survey outlines the methodology on how radon samples are collected and analyzed. Locations and frequency of radon samples are dictated by license condition 10.10 which states" The licensee shall sample particulates and radon progeny on a monthly frequency at the Irigaray and Christensen Ranch Satellite locations shown in Figure 5.2 and 5.3 of the approved license application. Additional sample locations can be added by the licensee through the SERP" and guidance supplied in Regulatory Guide 8.30. The exhaust from the fans located in the Christensen Ranch facility will be determined by one of the following methods; manufacturer specifications, air balance studies performed by Tetra Tech, or through direct measurement using an anemometer. There are 2 exhaust fans located in the plant. Using monthly radon concentrations, the activity (0.33WL is equal to 3E-8 µCi/ml) released can be calculated using the equation below. Exhaust fans are operating continuously and volumes can be determined by taking flow rates and the time period of interest. Total effluent released from the plant will be calculated and a total effluent released will added to the Christensen effluent release total and comparted to the effluent release totals derived from methodology one.

$$Irigaray\ Plant\ activity\ (\mu Ci) = Concentration\left(\mu\frac{Ci}{ml}\right) * Emission\ rate\left(\frac{ml}{min}\right) * Time\ (\min)$$

Additionally under the premise that the only source of radon entering the Irigaray Plant is residual radon that has bound to the IX resin, Uranium One will also sample the radon concentrations in the resin truck tank before entering the elution system. During transport from Christensen to Irigaray the residual solution in the tank is sloshed and agitated causing radon to preferentially be volatilized into the air inside the tank. Uranium One will sample the air by taking using the Modified Kusnetz method and sampling at the top hatch of the resin truck. The hatch will remain closed but there is a valve that can be opened such that a filter head connected to a air pump can be lowered into the air space inside the tank. The resin truck will be sampled on a quarterly basis. The concentration obtained should be an indicator of the radon entering the elution circuit.

The percent of the radon form the original source term that is carried through the elution circuit should be minimal. As part of the elution circuit the resin is stripped with a brine solution, agitated as it passes through multiple tanks, filtered, and pressed before it eventually is dried. It is unlikely that much of the radon would make it through the elution process to the dryer or even the filter press. Radon would have been released to the plant, other tanks, and presumably the atmosphere. Many of the tanks at Irigaray are vented to the atmosphere to prevent pressurization (Attachment 1 Figure 3.11). These all present possible release points for radon. The flow out of these tanks is passive and should be minimal. The practice of trying to characterize each of the sources is complex therefore Uranium One will simplify the characterization by making the assumption that all the radon measured in the IX resin truck is emitted at the exhaust rate of the exhaust fan on the yellowcake precipitation tank.

The ventilation in the yellowcake precipitation tank is necessary since acid is added to the slurry. The exhaust fan helps remove gas that has developed from the acid addition. Additionally it is the only location that radon could be actively emitted into the surrounding

environment. The quantity of radon is calculated similar to other source terms as is shown in the following equation:

$$elution\ circuit\ \ activity\ released\ \ (\mu Ci) = Concentration\left(\mu\frac{Ci}{ml}\right) * Emission\ rate\left(\frac{ml}{min}\right) * Time\ (\text{min})$$

Where The Concentration is from the resin truck;

Emission Rate is the exhaust rate of the yellowcake precipitation fan;

And the time is the monitoring period of interest.

By assuming the radon is emitted from the IX resin truck at the exhaust rate of this fan Uranium One is overestimating the release of radon since the likelihood of the radon reaching the yellowcake precipitation tank is unlikely and Uranium One will be accounting for any radon emitted to the plant twice. Twice meaning we already account for plant radon emitted through monthly radon measurements and then we account for all the radon in the resin trucks even though some is emitted to the plant and is already accounted for as part of monthly sampling.

Wellfield

Potential for Radon emissions include modular buildings, wellheads, process spills, ponds, and deep disposal well tanks houses. Radon being emitted by modular buildings will be determined by the following method. Modular buildings are sampled on a monthly basis for radon progeny using the Modified Kusnetz methodology. The average concentration of radon measured in each well field will be used in conjunction with the exhaust fans that are located in each modular building. The same exhaust fans are installed in each building. This assumes that all radon in the modular buildings will be released into the environment at a rate of the exhaust fan. Exhaust fans are operating on a continuous basis and activity of radon released is calculated by the following equation.

$$Mine\ Unit\ Activity\ Released(\mu Ci) = \#Buildings * Concentration\left(\mu\frac{Ci}{ml}\right) * Emission\ rate\left(\frac{ml}{min}\right) * Time\ (\text{min})$$

Potential emission of radon in the wellfield is limited to recovery wells. Injection wells have sealed well heads and the potential of radon release is minimal. The release of radon from recovery wells is considered to be negligible, since the hydraulic head is approximately 200 to 500 feet below surface. These down hole pumps are extracting production solutions and radon from the formation, and transferring the solutions to the nearest modular building through closed polylines. The stagnant water in the well is raised or lowered within the column by atmospheric conditions or changes in pump flow rates. This change in the well water level will either force air into the column or force air out of the column. To quantify the potential release from the well 3 to 5 percent wells in each mine unit will be sampled for radon using the Modified Kusnetz method. For tracking and trending purposes the same wells will be used for sampling. Wells will be chosen randomly but will be representative of the licensed area. Samples will be taken at the source of ambient ventilation at the well head. Using the relationship of 0.33 WL is equal to 3E-8 µCi/ml (Table 1 of 10CFR 20 Appendix B) a concentration can be calculated. The average concentration over all recovery well heads sampled will be converted to a quantity of activity emitted from each well by using the following equation below. Multiplying the result by the number of recovery wells estimates the radon emitted from the wellfield. The measurements are based on the assumption that the wellhead is venting at the rate of 3 LPM which is the flow rate

that our air monitors pull. Samples will be taken on a semiannual basis or upon changes to operating parameters. Results will be added to the other point and diffuse sources outlined in methodology two.

$$quantity\ emmited\ from\ wellfield\ \mu Ci = \frac{Average\ Concentration \frac{\mu Ci}{ml} X\ Sample\ Volume\ (ml) X\ Time\ (min)}{Sample\ Time\ (\text{min})}$$

Where Average Concentration represent an average of 3-5 wells per mine unit;

Sample Volume is the amount of volume pulled up through the well column (3LPM) needs to be converted to ml;

Time is the monitoring period of interest; and

Sample time is 5 minutes as is required for the Modified Kusnetz method

Another potential source of radon is unplanned releases of process fluids in the wellfield. At the time of an unplanned release, the radon emitting from the source will be minimal. To ensure that the radon contribution is minimal, samples may be taken using the Modified Kusnetz method. Any activity resulting from the spill will be included in the total emissions from the facility.

Ponds also need to be analyzed as a potential radon sources. Recently the EPA has sent out a proposed rule change in regards to NESHAPS subpart w (40 CFR part 61) regarding storing ponds at ISR mining operations. In the document they reiterate the position taken in 1986 from the EPAs Final Rule for Radon-222 Emissions from Licensed Uranium Mill Tailings which state

> "Recent technical assessments of radon emission rates from tailings indicate that radon emission rates from tailing indicate that radon emissions from tailings covered with less than one meter of water, or merely saturated with water, are about 2% of emissions from dry tailings. Tailings covered with more than one meter of water are estimated to have zero emissions rate. The agency believes this calculated difference between 0% and 2 % is negligible. The agency used an emission rate of zero for all tailings covered with water or saturated with water in estimating radon emissions."

In the proposed rule change they state as long as one meter of liquid is maintained in the pond, radon emissions from the pond are so low that it is difficult to determine whether there is any contribution above background radon levels. They also propose in the document that no monitoring be required for the type of impoundments we have at our facility. The EPA's reasoning is that they have received information and collected data that show there is no acceptable radon flux test method for evaporation or water storage ponds holding a large amount of liquid. (Method 115 does not work because solid surface is needed to place large area activation canisters used in the method). Further, even if there was an acceptable method, we recognize that radon emissions from the pond would be expected to be very low because the liquid acts as an effective barrier to radon emissions; given that radon -222 has a very short half-life (3.8 days), there simply is not enough time for most of the radon produced by the solids or from solution to migrate to the water surface and cross the water/air interface before decaying. Uranium One will maintain sufficient solution to maintain coverage of the sediments in each pond. In doing so Uranium One will also use the assumption that emissions from ponds will be negligible.

Deep disposal well tank houses also provide a potential for radon release. After the RO unit brine solution is brought inside the tank house to two holding tanks. The overflow of the tanks flows into the evaporation ponds. The tanks are vented to the atmosphere by three forced exhaust fans. Quantifying the release of radon will occur by sampling the incoming stream. The stream will be tested for radon using the American Society for Testing and Materials test method ASTM D 5072-92. The concentration is reported in pCi/l with a sensitivity of 100 pCi/L. If concentrations are below the sensitivity limit the 100 pCi/L value will be assumed to be the concentration. The analysis would be performed using a third party laboratory.

Using the concentration Uranium One can use the total flow into the tank houses to determine the total effluent released. Uranium One tracks the flow to the tank houses using the operations PLC computer system. This information can then be used to calculate the amount of radon. It will be Uranium One's position that all incoming radon will be released to the environment.

Particulates

Christensen Ranch

Emissions of particulates will be estimated based upon semi-annual isotopic analysis of filters from monthly sample locations shown in Figure 5.2 and 5.3 of the approved license application. The analysis will be for U-Nat, Ra-226, Po-210, Th-230 and Pb-210. The concentrations reported by an outside accredited laboratory, will be used to calculate the effluent by factoring in the exhaust rate and the time of the monitoring period (6 months). Total effluents for each radionuclide will be reported on a semi-annual basis in agreement with 10 CFR 40.65 and as per LC 12.1.

Irigaray

Emission of particulates will be estimated based on stack sampling and isotopic analysis of filter from monthly sample locations shown in Figure 5.2 and 5.3 of the approved license application. Additionally air particulate samples are taken continuously within the dryer enclosure. The dryer enclosure particulates should remain within the dryer enclosure and exhaust with the stack that comes off the building. The stack is sampled semiannually during normal operating conditions by a third party. Those results will be included in the effluent report.

Emissions of particulates in the plant will be estimated based upon semi-annual isotopic analysis of filters from the sample locations shown in Figure 5.2 and 5.3 of the approved license application. Sampling locations in the dryer enclosure will not be included in the isotopic analysis since they are already represented by the required stack testing. Analysis of filters will be for U-Nat, Ra-226, Po-210, Th-230 and Pb-210 as per LC 11.3. The concentrations reported by an outside accredited laboratory will be used to calculate the effluent by factoring in the exhaust rate and the time of the monitoring period (6 months). Total effluents for each radionuclide will be reported on a semi-annual basis in agreement with 10 CFR 40.65 and as per LC 12.1.

Summary

All point and diffuse sources have been identified and will be sampled accordingly. Annually in the Land Use report the point and diffuse sources will be examined to determine if all potential sources are identified. The overall effluent will be reported semiannually according to 10 CFR 40.65 and as per LC 12.1.

LC 11.3(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.

10 CFR 20.1301 sets forth the public dose limits that industry must abide by and 10 CFR 20.1302 details how licensee may demonstrate compliance with these dose limits. As part of 10 CFR 20.1302 it states that a licensee shall show compliance with annual dose limits in 10CFR 20.1301 by (1) Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operations does not exceed the annual dose limit. 10 CFR 20.1302 list another option to demonstrate compliance, however Uranium One will use the method described in 10 CFR 20.1302(b)(1) to demonstrate public dose. In order to comply with this requirement Uranium One first identified the maximally exposed individuals through predictive modeling software MILDOS (Attachment 2 Identification of Maximally Exposed Individual). As depicted in the report in Attachment 2 the wellfields and the plants will be treated as separate systems and maximally exposed individuals will correlate with each system. Annually during the land use survey Uranium One will reevaluate the maximally exposed individual predictions to verify if they adequately represent the land use around the licensed boundary.

Environmental monitoring for radon and gamma will occur at each maximally exposed individual location. Radon will occur through the use of passive air monitoring using RADTRAK trak etch detectors. The gamma will be monitored using Optically Stimulated Luminescence dosimeters. The dose from particulates will be based on environmental monitoring stations placed at Irigaray. Historically the environmental stations placed at Irigaray have been applied to Christensen under the assumption that it would overestimate the true particulate emission from Christensen Ranch Satellite. Christensen Ranch Satellite process is an entirely wet process and because uranium (yellowcake) is not concentrated onsite, there are no uranium particulate effluent released from the plant. Spills inside the plant are immediately washed down to reduce the potential for buildup. In the Safety Evaluation Report for SUA 1341 Section 5.7.7.3.2 NRC made the comment "based on the staff's experience and knowledge the air particulate releases, air particulate impacts at Christensen Ranch Satellite facility should be lower than Irigaray operations". Uranium One will verify this assumption by comparing the isotopic analysis and drier stack test emissions from Irigaray to the isotopic analysis of the Christensen Plant air particulate samples. The emissions or source term from Irigaray should be higher. During times that Irigaray is not in operations the historical average of the stack emissions and isotopic analysis will be compared to Christensen to demonstrate the source term is greater at Irigaray. The average for each particulate measured at the Irigaray environmental stations will be applied to each maximally exposed individual. The dose assessment will be evaluated using the following equation:

Doses from

$$D = DCF \sum_i C_i T_i$$

Where:
D = annual dose (TEDE) (mrem/yr);
DCF =dose conversion factor
C_i = annual average concentration of particulate at the receptor location i;
Ti = occupancy time factor (fraction of year) for receptor location i

The receptor (i) represents the different locations at which an individual is exposed. Thus if a person is exposed indoors and outdoors two values would be used.

Dose conversion factors are established by taking effluent concentration limits in 10 CFR 20 Appendix B, Table 2, and using the annual dose limit of 100mrem/yr. Taking the annual dose limit and dividing by the effluent concentration limit will provide the dose conversion factor.

External gamma radiation will be determined through the use of Landauer environmental dosimeters. A dosimeter will be placed at each maximally exposed individual location. Dose will be assigned to each receptor.

Dose from radon and radon progeny will be based at radon monitoring based at each maximally exposed individual location. RADTRAK dosimeters will be placed at each location. Using the concentration measured at the location the following dose assessment can be made

$$D = DCF \sum_{i} C_i F_i T_i$$

Where:

D = annual dose (TEDE) (mrem/yr);

DCF =dose conversion factor for Rn-222 with 100% equilibrium with Rn-222 progeny (mrem/yr per pCi Rn/L);

C_i = annual average concentration of Rn-222 in air (pCi/L) at the receptor location i;

F_i = radon progeny equilibrium factors (fraction) for receptor location i; and

Ti = occupancy time factor (fraction of year) for receptor location i

The receptor (i) represents the different locations at which an individual is exposed. Thus if a person is exposed indoors and outdoors two values would be used.

Dose conversion factors are established by taking the 10 CFR 10 Appendix B, Table 2, value for radon with progeny present in air, (1 × 10-10 µCi/ml or 0.1 pCi/L). The annual dose is 50 mrem/yr (0.5 mSv/yr). Uranium One could than apply the 0.5 equilibrium factor suggested in the interim draft radon guidance to the 10 CFR Appendix B Table 2 Limit for Rn-22 with daughters (1E-10 *0.5) to get 0.2 pCi/L Therefore, the dose conversion factor for radon-222 with progeny at 50% equilibrium is determined as 50 mrem/yr (0.5 mSv/yr) divided by 0.2 pCi/L, or 250 mrem/yr per pCi Rn/L.

Annual concentration of Rn-222 in air is determined by taking measurements at individual receptor locations. Equilibrium between radon and radon progeny is assumed to be 50% as suggested by the NRC interim radon guidance. Uranium One will assume this equilibrium factor until site specific equilibrium factors are established and are approved by NRC or general equilibrium factor for industry are approved by NRC.. Dose conversion factors other than what is listed above will be approved by NRC before implementation.

The combination of particulate, gamma, radon, and radon progeny will be used to demonstrate public dose requirements. The use of dose assessments to show compliance with 10 CFR 1302 is based on an individual receptor likely to receive the maximum dose. Occupancy times will be established for these receptors based on real life scenarios. Justification will be provided on occupancy times when public dose is reported using this method.

LC 11.3(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

In 10 CFR 20.1302 (2) (i), the regulation states that it is acceptable to show compliance to public dose limits by demonstrating measurements or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit. To demonstrate compliance with 10 CFR 20.1302 for radon and radon progeny Uranium One will measure annual average concentrations of radioactive material released in gaseous effluents at individual receptor sites with potential to be the maximally exposed individual. These locations will be based on MILDOS modeling and will be re-evaluated annually during the land use survey.

Uranium One has outlined areas that will be considered restricted, controlled, and unrestricted consistent with definition provided within 10 CFR 20. Controlled areas reside within fenced boundaries, such as production areas, with access points are conspicuously posted and are within the site boundaries and access can be limited by the licensee. Restricted areas at the site include buildings with locks that limit access, such as modular buildings within wellfields. Currently, site restricted areas include but are not necessarily limited to the Christensen Satellite Plant, Irigaray Plant, modular buildings, deep disposal well houses, tank houses, ponds, byproduct storage bins and contaminated storage areas around Irigaray and Christensen. Wellfields are considered controlled since the areas are fenced, and postings are placed at all entrances. With the designated controlled and restricted areas any other area is considered to be an unrestricted use area. The boundaries for unrestricted areas are at the fence line common with the controlled area.

Measurements of radon around the Irigaray and Christensen Ranch facilities will be done using Radtrak trak etch dosimeters by Landauer. Dosimeters will be placed at individual receptors locations predicted as most affected by Uranium One's activities. Wellfields, Irigaray Plant, and Christensen Satellite will all be treated as separate systems that expose different individuals. Those individuals that will be most affected by activities for each system will be identified and monitored. Irigaray individuals that will be monitored will be the workforce housing and the Anadarko compressor and water station. For the Christensen facility the workforce housing will be monitored. Additionally within the permit boundaries there are numerous coal bed methane (CBM) wells and oil wells. Wellfields activities potentially may create additional dose to these workers. Using MILDOS, well locations that have the highest predicted dose will be monitored for each active wellfield (Attachment 2). The concentration at these locations will be averaged and assumed to be at all well locations. All of the above mentioned locations are discussed in Section 3.2.4 and displayed in Figure 2 of Attachment 2.

Compliance to 10 CFR 20.1302 will be demonstrated by treating wellfields, Irigaray, and Christensen plants as separate systems. Assessment of individuals likely to receive the highest dose will be performed annually during the land use survey. Dose Assessments will be performed using the following equation:

$$D = DCF \sum_{i} C_i F_i T_i$$

Where:
D = annual dose (TEDE) (mrem/yr);

DCF =dose conversion factor for Rn-222 with 100% equilibrium with Rn-222 progeny (mrem/yr per pCi Rn/L);
C_i = annual average concentration of Rn-222 in air (pCi/L) at the receptor location i;
F_i = radon progeny equilibrium factors (fraction) for receptor location i; and
Ti = occupancy time factor (fraction of year) for receptor location i

The receptor (i) represents the different locations at which an individual is exposed. Thus if a person is exposed indoors and outdoors two values would be used.

Dose conversion factors are established by taking the 10 CFR 10 Appendix B, Table 2, value for radon with progeny present in air, (2 × 10-10 µCi/ml or 0.2 pCi/L). The annual dose is 100mrem/yr (1 mSv/yr). Therefore, the dose conversion factor for radon-222 with progeny at 100% equilibrium is determined as 100 mrem/yr (1 mSv/yr) divided by 0.2 pCi/L, or 500 mrem/yr per pCi Rn/L.

Annual concentration of Rn-222 in air is determined by taking measurements at individual receptor locations. Equilibrium between radon and radon progeny is assumed to be 100%. This is a conservative approach, but will be used until accurate equilibrium factors can be developed and new dose conversion factors calculated. Dose conversion factors other than what is listed above will be approved by NRC before implementation.

The use of dose assessments to show compliance with 10 CFR 1302 is based on an individual receptor likely to receive the maximum dose. Occupancy times will be established for these receptors based on real life scenarios. Justification will be provided on occupancy times when public dose is reported using this method.

Annually an assessment will be performed to determine if methodologies are still conservative and maximally exposed individual receptor locations still represent the individuals most potentially affected by Uranium One operations.

LC 11.3(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.

In accordance with 10 CFR 20.1501 occupational doses will be calculated through monitoring of exposures from radon and its progeny, particulate radiation, and external radiation. Occupational concentration characterization occurs through various collection methods.

Radon and its progeny are surveyed using the modified Kusnetz method. The modified Kusnetz method samples are taken as required by NRC Regulatory Guide 8.30. Sampling locations for Irigaray and Christensen are outlined in the license renewal application sections 5.7 and 5.8. Additionally modular buildings will be sampled at the frequency specified in Section 5.7 of the approved License Renewal Application.

Uranium One will assign workplace concentrations for radon in the wellfield, satellite and processing facilities for use in calculating occupational dose. Workers that spend most of their time in the plant will be subjected to the average plant concentrations. Those that work around the wellfields will be subjected to the average radon concentrations over the modular buildings. It will be assumed that workers spend 2,000 hours a year within one of these two concentrations. Dose to individuals will be performed by comparing the applying concentration

to the values in 10 CFR Appendix B Table 1 with the corresponding radionuclide. A percent DAC will be calculated using the assumption that the worker will spend 2,000 hours a year within this concentration.

Particulate radiation concentrations will be calculated based on routine sampling of the processing plant and the satellite plant as specified in NRC Regulatory Guide 8.30. Isotopic analysis collected at the air sampling locations shown in Figure 5.2 and 5.3 of the approved license application will be performed on a semi-annual basis. Results of the semi-annual isotopic analysis will serve as the basis for determining the mixed DAC ratio as specified in 10 CFR 20.1204.It will be Uranium One position that taking the concentrations from Christensen and from Irigaray and applying it to the wellfield workers and other non plant workers will overestimate the true dose from particulates. Dose to individuals will be performed consistent with 10 CFR 20 by comparing the concentration to the values in 10 CFR Appendix B Table 1. A percent DAC will be calculated using the assumption that the worker will spend 2,000 hours a year within this concentration.

External radiation exposure will be assigned by personal dosimetry. Individuals that have the greatest potential for exposure will have personnel dosimeters assigned them. These individuals include plant operators, wellfield operators, maintenance workers, and laboratory workers. Those individuals not assigned dosimeters will be assigned dose based on work groups.

Total occupational dose or Total Effective Dose Equivalent (TEDE) will be applied to individuals summing the three sources of exposure. Work performed under Radiation Work Permits and during yellow cake enclosure activities will be monitored and additionally included in the TEDE calculation.

References

EPA. Risk Assessment Revision for 40 CFR Part 61 Subpart W Radon Emissions from Operating Mill Tailings, Task 5 Radon Emission from Evaporation Ponds EPA-HQ-OAR-2008-0218-0080.

USNRC "Health Physics Surveys in Uranium Recovery Facilities," Regulatory Guide 8.30, Revision 1, May 2002.

USNRC "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations, "Regulatory Guide 3.59, March 1987

NRC. NUREG/CR-1736 " Consolidated Guidance: 10CFR Part 20- Standards for Protection Against Radiation." Washington, DC:NRC, 2001.

From: (307) 234-8235
Scott Schierman
Uranium One Americas, Inc.
907 North Poplar Street
Suite 260
Casper, WY 82601

Origin ID: CPRA

FedEx Express

J15121502303uv

Ship Date: 05JUN15
ActWgt: 0.5 LB
CAD: 1044753/INET3610

Delivery Address Bar Code

Ref #
Invoice #
PO #
Dept #

SHIP TO: (301) 415-7295 BILL SENDER
Ron Linton-Project Manager
U.S. NRC
11545 Rockville Pike
Mail Stop T8F5
Rockville, MD 20852

MON - 08 JUN AA
STANDARD OVERNIGHT

TRK# 0201 7737 7304 5510

SA NSFA

20852
MD-US
IAD

537J1/9A0E/EE4B