From:	Linton, Ron
To:	Mike Thomas (mthomas@uranerz.com); Dawn Kolkman (dkolkman@uranerz.com)
Cc:	VonTill, Bill; Burrows, Ronald; Persinko, Andrew; Webb, James
Subject:	Nichols Ranch, SUA-1597, License Condition 12.8, NRC draft evaluation
Date:	Friday, February 14, 2014 5:18:00 PM
Attachments:	NRC evaluation of Uranerz LC 12 8 - final 2-14-14.pdf

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Mike Thomas
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RE: Uranerz Energy Corporation, Nichols Ranch Project, Source Materials License SUA-1597, Docket No. 40-9067, License Condition 12.8 (ML13288A156)

Dear Mr. Thomas:

The NRC staff is providing you with its draft evaluation of the above referenced submission so that Uranerz can begin its review and dialogue with staff on License Condition 12.8. The NRC staff evaluation has not undergone legal review, therefore we are sending it in draft form until we can obtain legal review. If you have any questions, please contact me.

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

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Uranerz Energy Corporation, Nichols Ranch Project, Materials License SUA-1597, Draft Evaluation, Pre-operational License Condition 12.8
February 14, 2014

By letter dated October 8, 2013 (UEC, 2013a), Uranerz Energy Corporation (UEC, or the licensee) submitted a response to Condition 12.8 of its Materials License SUA-1597 (NRC, 2011a). License Condition (LC) 12.8 states the following:

> Prior to the preoperational inspection, the licensee shall provide the following information for the airborne effluent and environmental monitoring program in which it shall develop written procedures to:
>
> A. Discuss how, in accordance with 10 CFR 40.65, 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 the member(s) of the public likely to receive the highest exposures from licensed operations consistent with 10 CFR 20.1302.
>
> C. Discuss and identify how radon (radon-222) progeny will be factored into analyzing potential public dose from operations consistent with 10 CFR Part 20, Appendix B, Table 2.
>
> D. Discuss how, in accordance with 10 CFR 20.1501, the occupational dose (gaseous and particulate) received throughout the entire license area from licensed operations will be accounted for, and verified by, surveys and/or monitoring.

U.S. Nuclear Regulatory Commission (NRC, or the Commission) staff evaluated the licensee's response to LC 12.8 for compliance with applicable regulations and consistency with Commission guidance. The results of staff's evaluation are as follows.

<u>LC 12.8(A)</u>

In its response to LC 12.8(A) (UEC, 2013a), the licensee proposed relying on the use of predictive models such as Regulatory Guide 3.59 (NRC, 1987) and the MILDOS-AREA (Yuan, et al., 1989) computer code to estimate the quantity of principal radionuclides released to unrestricted areas during operations. The licensee stated (UEC, 2013a) that it will report these estimated releases during operations in accordance with 10 CFR 40.65(a)(1).

Staff observes that the licensee previously provided the same approach and rationale for estimating these releases during operations in its February 24, 2010 letter (UEC, 2010a) responding to NRC staff open issues and subsequently incorporated in the licensee's revised Technical Report (UEC, 2010b). NRC staff previously evaluated (refer to Safety Evaluation Report (SER) Sections 4.1 and 5.7.7 of NRC, 2011a) the licensee's proposed approach for complying with 10 CFR 40.65(a)(1) and found it to be inadequate. Staff has found nothing in

the licensee's current submittal (UEC, 2013a) to invalidate these previous findings; therefore, the original findings stand and previous staff conclusions remain valid.

Staff observes that the licensee's main argument for relying solely on predictive models to satisfy the reporting requirements of 10 CFR 40.65(a)(1) is the wording of the regulation itself. As observed by the licensee, 10 CFR 40.65(a)(1) does not explicitly require measurements for the information to be reported. Staff agrees with this observation. However, reporting quantities of radioactive materials released to unrestricted areas is only one part of the requirements of 10 CFR 40.65(a)(1). A licensee is also required to address in its 10 CFR 40.65(a)(1) report any instances where quantities of radioactive materials released during the reporting period are significantly above its design objectives previously reviewed as part of the licensing action.

Staff reviewed (refer to SER Section 5.7.7 of NRC, 2011a) the licensee's use of the predictive model MILDOS-AREA (Yuan, et al., 1989) computer code to evaluate potential doses to receptors as a result of the licensee's proposed operations and found it to be acceptable, thus forming the safety basis for compliance with public exposure limits. In other words, the results of the licensee's use of the predictive model MILDOS-AREA (Yuan, et al., 1989) computer code is the design objective that NRC staff relied upon for its licensing action to which the licensee should compare quantities of radioactive materials released as a result of operations during future reporting periods. Staff has determined that comparing the results of multiple future calculations using the same, or similar, predictive models as used in the original design objective yields no meaningful data for evaluation of quantities of radioactive materials released in the licensee's effluents as a result of its licensed operations. Specifically, the licensee has not demonstrated that it can determine when quantities of radioactive materials released during the reporting period are significantly above its design objectives previously reviewed as part of the licensing action. Therefore, the licensee's proposed method does not provide NRC staff with reasonable assurance that it can fully comply with the reporting requirements of 10 CFR 40.65(a)(1).

Staff also observes that 10 CFR 40, Appendix A, Criterion 7, requires that an operational monitoring program must be conducted to, among other things, measure or evaluate compliance with applicable standards and regulations and to evaluate the performance of control systems and procedures. Staff has determined that the alternative proposed by the licensee, relying solely on the use of predictive models such as Regulatory Guide 3.59 (NRC, 1987) and the MILDOS-AREA (Yuan, et al., 1989) computer code to estimate the quantity of principal radionuclides released to unrestricted areas during operations, is not equivalent to, nor more stringent than, the requirements of 10 CFR 40, Appendix A, Criterion 7. Specifically, the licensee has not demonstrated that its current operational monitoring program provides sufficient monitoring results that can be used to measure or evaluate compliance with public exposure limits. In addition, the licensee has not demonstrated that its current operational monitoring program provides sufficient information to evaluate the performance of its radon control systems and procedures. Therefore, the requirements as specified in 10 CFR 40, Appendix A, Criterion 7 are relevant to the licensee and no exceptions are approved as a result of this submittal (UEC, 2013a).

In any case, 10 CFR 40.65(a)(1) also requires the licensee to include in its effluent report other information that the Commission may require to estimate maximum potential annual radiation doses to the public resulting from effluent releases. As described above, NRC staff has determined that the licensee's proposed method for accounting for effluent releases from operations, and subsequent reporting in accordance with 10 CFR 40.65(a)(1), is insufficient for staff to perform these estimates. Staff requires monitoring data to such an extent that the licensee's design basis can be verified and reasonably accurate maximum potential annual radiation doses to the public can be estimated.

Lastly, the licensee asserts (UEC, 2013a) that historical use of the MILDOS code and the results of the environmental monitoring program to verify compliance with 10 CFR 20, Appendix B, Table 2 values by two current operating in situ recovery (ISR) facilities indicates that this method can be used to satisfy the reporting requirements of 10 CFR 40.65. On the contrary, staff has completed its review of the license renewal application of one of these facilities and has determined that this practice does not provide the information required by 10 CFR 40.65 (refer to Section 5.7.8 of NRC, 2012).

LC 12.8(B)

In its response to LC 12.8(B) (UEC, 2013a), the licensee presented the process that it used to identify the dose to the member of the public likely to receive the highest dose from its operations. The licensee evaluated categories of members of the public that were likely to spend at least 50 hours per year in the vicinity of the site. In addition, the licensee evaluated input parameters for its MILDOS-AREA (Yuan, et al., 1989) calculations used to provide an initial estimate of potential doses to members of the public.

The results of the evaluation of categories of members of the public are presented in Table 1 of the licensee's response (UEC, 2013a). Time spent during a year in the vicinity of the site by members of the public ranged from an estimated 90 hours (courier) to 260 hours (equipment delivery/maintenance). Other postulated members of the public included a hunter (240 hours) and oil field workers (175 hours). Staff requires additional information on how the total projected number of hours for an oil field worker is derived. In addition, staff requires clarification as to whether or not the projected hours for coal bed methane workers is represented by the hours projected for oil field workers and how these hours were derived.

In order to bound the highest predicted public dose, the licensee- chose to run the MILDOS model using a generic worker with access across all areas of the licensed area. It is a bounding calculation because the generic worker is postulated to spend 2000 hours per year at any location in the vicinity of the licensed area. This time is significantly more than that projected for members of the public presented in Table 1 (UEC, 2013a). Figure 1 of the licensee's submittal (UEC, 2013a) presents the results of these calculations.

The licensee presented its analysis of the potential source terms at the Nichols Ranch Project (UEC, 2013a). After rejecting uranium particulates as a potential source of exposure, the licensee modeled the radon source term in MILDOS. Table 2 of the licensee's response (UEC, 2013a) presents the MILDOS input values for the Nichols Ranch and Hank Units.

In rejecting uranium particulates as a potential dose contributor, the licensee cited (UEC, 2013a) measurement data demonstrating that the emissions at the dryer exhaust are "essentially zero". Staff is unaware of these measurements and will require the licensee to supply this data for staff to be able to verify the licensee's technical basis.

In any case, staff observes that the licensee previously provided the same approach and rationale for rejecting uranium particulates as a potential dose contributor in its March 11, 2009 letter (refer to Section 4.1 of UEC, 2009) responding to NRC staff's request for additional information and subsequently incorporated in the licensee's revised Technical Report (UEC, 2010b). NRC staff previously evaluated (refer to SER Sections 4.1 and 5.7.7 of NRC, 2011a) the licensee's proposed approach for rejecting uranium particulates and found it to be inadequate. Staff has found nothing in the licensee's current submittal (UEC, 2013a) to invalidate these previous findings; therefore, the original findings stand and previous staff conclusions remain valid.

The licensee reported (UEC, 2013a) that the results of the MILDOS evaluation predict a maximum dose to the generic worker (i.e., 2000 hrs/yr) from radon is 2.02 mrem/yr. However, staff observes that a dose of 119.54 mrem/yr is calculated for the location with the following coordinates (in units of kilometers (km)): X = 7, Y = 4.5. See the last entry on Table 1 below, reproduced, in part, from Attachment 1 of the licensee's response (UEC, 2013a). This calculated dose is above the public dose limit of 100 mrem/yr and is not addressed by the licensee.

Table 1 – Doses from the Time Step of Highest Predicted Exposures (Step 5) (Adapted from Attachment 1 of UEC, 2013a)

Location			
X (km) (East of CPP)	Y (km) (North of CPP)	Maximum Dose (mrem) (Time Step 5)	Corrected for 40 Hour Work Week
6.75	2.5	0.282	0.064578
6.75	2.75	0.394	0.090226
6.75	3	0.622	0.142438
6.75	3.25	1.16	0.26564
6.75	3.5	1.67	0.38243
6.75	3.75	1.3	0.2977
6.75	4	0.87	0.19923
6.75	4.25	0.662	0.151598
6.75	4.5	0.531	0.121599
6.75	4.75	0.403	0.092287
6.75	5	0.321	0.073509
6.75	5.25	0.292	0.066868
6.75	5.5	0.263	0.060227
6.75	5.75	0.236	0.054044
6.75	6	0.212	0.048548
7	2	0.145	0.033205
7	2.25	0.155	0.035495
7	2.5	0.244	0.055876
7	2.75	0.398	0.091142
7	3	0.589	0.134881
7	3.25	1.33	0.30457
7	3.5	2.12	0.48548
7	3.75	1.53	0.35037
7	4	0.938	0.214802
7	4.25	0.716	0.163964
7	4.5	522	119.538

Staff observes that the calculations presented by the licensee (UEC, 2013a) represent only an initial identification of a potential maximally exposed member of the public as a result of the licensee's operations. 10 CFR 20.1302 requires the licensee to demonstrate compliance with the annual public dose limit. To satisfy LC 12.8(B) (NRC, 2011a), the licensee must address how it will evaluate the member(s) of the public likely to receive the highest exposures from licensed operations on an ongoing basis throughout its operational lifetime.

Staff observes that the results of MILDOS are dependent on site-specific meteorological conditions at the Nichols Ranch and Hank Units. LC 12.7 of Materials License SUA-1597 (NRC, 2011a) requires the collection of this information. Staff is aware that the licensee has submitted data (UEC, 2013b) in accordance with LC 12.7 (NRC, 2011a). However, this information has not yet been evaluated by staff. Any changes to the meteorological data resulting from this evaluation could impact the licensee's calculations addressing LC 12.8(B) (NRC, 2011a).

LC 12.8(C)

In its response to LC 12.8(C) (UEC, 2013a), the licensee presented a variety of methods that could potentially be used to asses public dose from radon progeny but did not specifically address how radon progeny are incorporated into public dose assessment at its facility. For example, the licensee did not discuss specific types of measurements for radon daughters that will be used at its facility, how these measurements will be used for assessing public dose, or which value in 10 CFR Part 20, Appendix B, Table 2 will be used for comparison with measured radon concentrations. Regarding the use of measurements for analyzing potential public dose from operations due to radon progeny, the licensee previously stated (UEC, 2010a, 2010b) that it would manage the area between the process area and the site boundary as a controlled area pursuant to 10 CFR 20.1003. In addition, the licensee did not propose (UEC, 2013a) any additional monitoring locations for assessing public dose than what was previously proposed (refer to Section 5.7.7 of UEC, 2010b) for its airborne effluent and environmental monitoring program.

Staff observes that in order to be classified as a controlled area, the licensee must be able to demonstrate that it can limit access to that area (refer to definition of controlled area in 10 CFR 20.1003). This includes the ability to require a member of the public to exit the controlled area at any time (refer to questions 29 and 417, and NRC's responses, from NRC, 1994). This requirement is the same for all licensees subject to 10 CFR 20 (see, for example, Silverman, 2003). The licensee's Nichols Ranch and Hank Units include a total of approximately 3,370.53 acres (refer to Appendix D2 of UEC, 2007). Surface ownership is mostly private, with the exception of approximately 280 acres of Bureau of Land Management (BLM) land in the Hank Unit (refer to Appendix D2 of UEC, 2007). Land use within these units includes oil and gas wells (Hank Unit) and coal bed methane wells (both units) (refer to Section 2.2.5 of UEC, 2007). These wells are operated by numerous corporations (refer to Addendum 2A of UEC, 2007) whose workers are members of the public for the licensee's dose assessment purposes. In addition, staff observes that the licensee stated that it "...does not anticipate that in situ recovery operations will interfere with ongoing coal bed methane operations." (refer to Appendix D1 of UEC, 2007). Given the expanse of UEC's licensed area, the amount of identified commercial activity, and potential BLM activity (also members of the public for the licensee's dose assessment purposes), on the Hank and Nichols Ranch Units, NRC staff does not have reasonable assurance that the licensee can limit access to its proposed controlled area, including the ability to require all corporate entities and BLM personnel to exit these areas at any time.

Because of the lack of any specificity related to the licensee's dose assessment of radon progeny during operations, and the lack of detail regarding how the licensee can restrict access to the proposed controlled area, NRC staff does not have reasonable assurance that the licensee will correctly factor in radon progeny to assess public dose and therefore finds this response unacceptable. In addition, until such time as the licensee can demonstrate with reasonable assurance (e.g., written agreements from all necessary parties, etc.) that it can limit

access to its proposed controlled area, the areas outside of restricted areas should be treated as unrestricted areas for public dose assessment purposes.

NRC staff observes that the licensee proposed (UEC, 2013a) that calculations with no supporting monitoring results can be used to demonstrate that the plant design will comply with the public dose limits specified in 10 CFR 20.1301 during actual operations. The licensee refers to Regulatory Guide 3.59 (NRC, 1987) and the MILDOS-AREA computer code (Yuan, et al., 1989) as methods approved by NRC for use at in ISR facilities (UEC, 2013a). Staff agrees with the licensee insofar as these two documents are approved for use by the NRC. The value of the predictive nature of the MILDOS code is discussed in several places (NRC, 1981, Chen, et al., 1998). As discussed in staff's response to LC 12.8(A) in this document, staff reviewed the licensee's use of the predictive model MILDOS-AREA (Yuan, et al., 1989) computer code to evaluate potential doses to receptors as a result of the licensee's proposed operations and found it to be acceptable, thus forming the safety basis for compliance with public exposure limits.

However, staff observes that the use of predictive modeling, such as Regulatory Guide 3.59 (NRC, 1987) and the MILDOS-AREA computer code (Yuan, et al., 1989), has never been explicitly approved for demonstrating compliance with radiation protection standards during operations (see, for example, the discussion on predictive evaluations of 10 CFR 20 compliance in NRC, 1981). On the contrary, Regulatory Guide 3.59 (NRC, 1987) is for use when environmental monitoring data is not yet available and it directs applicants and licensees where to look for separate guidance on compliance with radiation protection standards. This separate guidance is provided in NUREG-0859 (NRC, 1982). Staff recognizes that NUREG-0859 (NRC, 1982) was written to specifically address compliance issues with 40 CFR Part 190. However, as Regulatory Guide 3.59 (NRC, 1987) addresses compliance issues with 10 CFR Part 20, 10 CFR Part 40, and 40 CFR Part 190 and refers to the guidance in NUREG-0859 (NRC, 1982), and as the technical shortcomings related to predictive modeling are generic in nature, staff has determined that the guidance regarding the use of predictive modeling in NUREG-0859 (NRC, 1982) is relevant to ISR facilities for compliance with 10 CFR Part 20 and 10 CFR Part 40.

NUREG-0859 (NRC, 1982) provides guidance to NRC's Uranium Recovery Licensing Branch (URLB) and addresses the use of predictive modeling and environmental monitoring. The specific guidance in NUREG-0859 (NRC, 1982) to URLB staff relevant to this review regarding the assessment of radioactivity concentrations to which individuals may be exposed is "...the primary means of compliance <u>must be</u> by measurements made at the point of an actual individual receptor..." and that "...actual compliance determination during operation will be based on environmental monitoring data." Staff observes that Regulatory Guide 3.59 (NRC, 1987) and NUREG-0859 (NRC, 1982) is Commission-approved guidance and, as discussed above, is relevant to this review. Consistent with a request by the National Mining Association (refer to the first discussion point of NMA, 2010), staff is not modifying this Commission-approved guidance. Staff presented this approach to the ISR industry during the 2011 Uranium Recovery Workshop (NRC, 2011b).

By providing the guidance discussed above, NUREG-0859 (NRC, 1982) also addresses how the licensee should demonstrate compliance with 10 CFR 20.1501(a). Specifically, by stating that the primary means of compliance must be by measurements made at the point of an actual individual receptor, the Commission has specified what surveys (i.e., monitoring) are necessary for compliance with 10 CFR 20.1501(a)(1), and has defined what surveys are reasonable (i.e., monitoring) under the circumstances experienced at ISR facilities (refer to 10 CFR 20.1501(a)(2)). Therefore, as discussed in staff's evaluation of the licensee's response to LC 12.8(A) above, staff requires monitoring data to such an extent that the licensee's design basis can be verified and reasonably accurate maximum potential annual radiation doses to the public can be estimated.

Staff observes that the guidance in NUREG-0859 (NRC, 1982) is consistent with other Commission-approved guidance as well as the requirements in 10 CFR 20.1302(b)(1). For example, Regulatory Guide 8.37 (NRC, 1993) provides guidance on a licensee's as low as reasonably achievable (ALARA) program for demonstrating compliance with 10 CFR 20.1101(b). Regulatory Position C.3 states that "Licensees must perform surveys and monitoring sufficient to demonstrate compliance with the requirements of 10 CFR 20.1302." In addition, NUREG-1736 (NRC, 2001) provides similar guidance for demonstrating compliance with 10 CFR 20.1101(b). NUREG-1736 (NRC, 2001) states that "...the licensee should be able to demonstrate that periodic reviews of performance have been made and that efforts have been made to achieve ALARA." Staff observes that performance, as generally defined (Urdang and Flexner, 1973) by "the manner of performing or functioning", can't be determined with predictive modeling. Similar to staff's evaluation of the licensee's response to LC 12.8(A) above for demonstrating compliance with 10 CFR 40.65(a)(1), the licensee's current environmental monitoring program and proposed use of predictive modeling fails to provide staff with reasonable assurance that the licensee can demonstrate that doses to members of the public are ALARA.

Lastly, in its response to LC 12.8(A) (UEC, 2013a), UEC quotes the requirements of 10 CFR 20.1302(b)(1): "A licensee shall show compliance with the annual dose limit in § 20.1301 by demonstrating by measurement **or calculation** (emphasis added) 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.". As discussed in Commission guidance addressing 10 CFR 20.1302 (NUREG-1736 (NRC, 2001)), there is a distinction between the dose received by a member of the public and the exposure of that member of the public. These terms are separately defined in 10 CFR 20.1003. Staff observes that the definition of "monitoring" also distinguishes between exposure and dose. Clearly, these terms have specific meanings and are not used interchangeably. Basically, exposure means being exposed to radioactive material and dose, or committed effective dose equivalent in the case of internal dose from radon and its progeny, is the dose received by each of the body organs or tissues that are irradiated. NUREG-1736 (NRC, 2001) goes on to say that public dose may result from any combination of external and internal exposure. Staff observes that when a member of the public is exposed to radon and its progeny, it is generally the exposure of that individual to the progeny of radon that contributes the majority of the dose to that member of the public. The other requirements (e.g.,

10 CFR 40, Appendix A, Criterion 7) and guidance discussed above relating to monitoring will provide the necessary information on the exposure of a member of the public to radon and its progeny. This exposure information can then be used by the licensee to calculate the dose to the member of the public receiving the highest exposure. Therefore, in proposing that only calculations be used for demonstrating compliance with public dose limits, it is staff's determination, based on the wording of 10 CFR 20.1302(b)(1) and the provisions in Commission-approved guidance, that the licensee's proposed methodology does not provide staff with reasonable assurance that it can derive relevant exposure information, and therefore dose, for members of the public without supporting monitoring results. After the licensee has determined the exposure of a member of the public, it can then calculate or measure the dose to members of the public, consistent with the provisions of 10 CFR Part 20.

However, even if this were not the case, the licensee's proposed method of using only calculations appears to be inconsistent with LC 9.2 of Materials License SUA-1597 (NRC, 2011a). Specifically, LC 9.2 (NRC, 2011a) requires the licensee to conduct its operations in accordance with the commitments, etc., in the license application and subsequent amending submissions as specified in the condition. Two specific amending submissions include licensee documents dated February 24, 2010 (UEC, 2010a) and September 15, 2010 (UEC, 2010b). In these documents, the licensee committed itself "...to show compliance with the annual dose limit in 10 CFR 20.1301 by using results from routine monitoring supplemented by calculation pursuant to 10 CFR Part 20.1301(b)(1)." Staff observes that there appears to be an error in the licensee's submittals as there is no 10 CFR 20.1301(b)(1) codified in the regulations. In any case, the licensee clearly committed to using monitoring as the primary means by which it will demonstrate compliance with the annual dose limit in 10 CFR 20.1301. As defined in 10 CFR 20.1003, "monitoring" is defined as measurements of radiation levels, concentrations, surface area concentrations or quantities of radioactive materials and the use of the results of these measurements to evaluate potential exposures and doses. Therefore, the licensee is not authorized to demonstrate compliance with public dose limits using calculations only, as proposed in this submittal (UEC, 2013a).

LC 12.8(D)

In its response to LC 12.8(D), the licensee described its approach for determining occupational dose received throughout the licensed area. In its license application (refer to Section 2.9.3 and Figures 2-25 and 2-26 of UEC, 2010b), the licensee established baseline environmental monitoring stations in the Nichols Ranch and Hank Units. The locations of these baseline environmental monitoring stations were based upon the wind data from regional meteorological stations (refer to Section 2.5 of UEC, 2010b). Based upon onsite meteorological data (refer to Figure 1 of UEC, 2013a), the licensee proposed adding three additional radon Track-etch detectors in the Nichols Ranch Unit (two in the downwind direction, one in the wellfield) and two additional radon Track-etch detectors (radon detectors) in the Hank Unit (two in the downwind direction) (refer to Figure 2 of UEC, 2013a). The licensee stated that it would use radon

monitoring station HR-2, already established at the Hank Unit, to determine radon emanation from the wellheads there. (UEC, 2013a)

The location of the additional radon detectors was based on the licensee's reasoning that placing them in the downwind direction will result in measuring the highest radon concentrations (UEC, 2013a). However, the license did not explain why the radon detectors were placed in the specified locations within the downwind direction. If the purpose was to determine an average radon concentration within the licensed area outside of the plant, staff does not have reasonable assurance that using the additional five radon detectors will provide a reasonable average radon concentration over an area of approximately 3,370.53 acres (Nichols Ranch and Hank Units combined, refer to Appendix D2 of UEC, 2007).

For the following reasons, staff also does not have reasonable assurance that the additional five radon detectors can be used to determine the maximum radon concentrations. Firstly, the licensee characterizes the source of radon as "nearly pure radon gas" (UEC, 2013a). In its response to LC 12.8(D) (UEC, 2013a), the licensee stated that radon and its progeny originate primarily from the central processing plant (CPP). Staff observes that the licensee's characterization of radon gas does not take into account radon within the plant that has already undergone radioactive decay, thus having some fraction of radioactive progeny present prior to exposure. Occupational exposure from radon progeny is well documented during normal operations within the plant areas at ISR facilities (see, for example, Section 5.8.3.2 of CBR, 2007 and Section 5.8.2.2 of Cameco, 2012) and radon levels can increase during changes in a licensee's operations (See Section 3 of NRC, 2011c and Section 2 of NRC, 2013). In the licensee's application (refer to Section 4 of UEC, 2010b), it described its method for controlling radon buildup within buildings. This includes open doorways during favorable weather. Staff does not find it reasonable to assume that occupational exposure (and public exposure) from radon progeny inside plant areas, such as that received at other operating ISR facilities, stops at the door or other exit point from the building. On the contrary, radon progeny will continue to build up over time (Evans, 1969). For these reasons, the radon exiting the buildings can't be characterized as "nearly pure radon gas". Therefore, although the licensee stated that "..."closer to the source" does not necessarily mean "greater dose"...", proximity to the CPP does not rule out that this location could be the site of highest exposure.

Secondly, the licensee used results of its onsite baseline year wind data to determine placement of the five additional radon detectors (refer to Figure 1 of UEC, 2013a). The results of these radon detectors will then be used to calculate occupational dose, which is done on an annual basis (refer to 10 CFR 20.1201). Staff observes that the licensee also submitted a second year wind rose from the Nichols Ranch meteorological station in response to another license condition (see UEC, 2013b). In this second year wind rose, two of the three primary wind directions (east and south-southwest) remained the same, while the north-northwest wind sector replaced the southwest wind sector. Staff observes that the MILDOS code uses a Gaussian diffusion equation to estimate atmospheric concentrations of radionuclides and uses the joint wind speed and direction frequency distribution provide by the licensee to normalize the average atmospheric concentration of the radionuclides (Momeni, et al., 1979). Variations in

dominant wind sectors are to be expected for any given year, especially for such short collection times as one year. However, assuming the wind rose was established in a year representative of the long term meteorological conditions, this does not present a problem for using the MILDOS code to evaluate placement of environmental monitoring stations. The reasons are that the major purposes of the environmental monitoring stations are to evaluate the performance of effluent controls and the environmental impact of milling operations over the operational life of the facility (NCRP, 1993; NRC, 1980). For these purposes, long term trending is more important than instantaneous values. However, for calculating annual occupational dose, short term variations (i.e., year to year, or within a year) can have a more profound impact if, for example, a dominant sector is missed in any given year. Without longer-term wind data, staff does not have reasonable assurance that placing the radon detectors in the baseline year downwind direction will be representative of maximum radioactivity concentrations on a yearly basis for purposes of calculating annual occupational dose.

Thirdly, the licensee does not appear to take into account work inside the header houses where radon progeny could potentially build up to levels higher than found in the general outdoors.

Fourthly, staff observes that in its response to LC 12.8(B) the licensee provided isodose curves for the Nichols Ranch and Hank Units (refer to Figure 1 of UEC, 2013a). Comparing Figure 2 of the licensee's response to LC 12.8(D), describing the placement of the additional radon detectors, to these isodose curves, staff observes that they do not appear to correlate. In other words, it does not appear that additional radon detectors are placed within the licensed area where the maximum dose was calculated to occur.

Based on staff's evaluation above, additional information is necessary to justify the number and locations of the radon detectors used for calculating occupational dose in the license area.

While the licensee discussed its proposed methodology for monitoring radon and presented calculational aspects of deriving a dose from exposure to radon progeny, it did not commit to accounting for occupational exposure to employees throughout the licensed area, including header houses and wellfields. Staff requires information on how the dose received by employees working throughout the entire license area, including header houses and wellfields, will be assigned to those employees. This information should include how exposure times and exposure concentrations will be assigned to individual employees working throughout the entire license area, including header houses and wellfields and entered into exposure records.

In rejecting uranium particulates as a potential dose contributor, the licensee cited (UEC, 2013a) measurement data demonstrating that the emissions at the dryer exhaust are "essentially zero". Staff is unaware of these measurements and will require the licensee to supply this data for staff to be able to verify the licensee's technical basis.

As discussed above in staff's evaluation of the licensee's response (UEC, 2013a) to LC 12.8(B), the licensee previously provided the same approach and rationale for rejecting uranium particulates as a potential dose contributor in its March 11, 2009 letter (refer to Section 4.1 of

UEC, 2009) responding to NRC staff's request for additional information and subsequently incorporated in the licensee's revised Technical Report (UEC, 2010b). NRC staff previously evaluated (refer to SER Sections 4.1 and 5.7.7 of NRC, 2011a) the licensee's proposed approach for rejecting uranium particulates and found it to be inadequate. Staff has found nothing in the licensee's current submittal (UEC, 2013a) to invalidate these previous findings; therefore, the original findings stand and previous staff conclusions remain valid.

Also discussed above in staff's evaluation of the licensee's response (UEC, 2013a) to LC 12.8(B), the results of MILDOS are dependent on site-specific meteorological conditions at the Nichols Ranch and Hank Units. LC 12.7 of Materials License SUA-1597 (NRC, 2011a) requires the collection of this information. Staff is aware that the licensee has submitted data (UEC, 2013b) in accordance with LC 12.7 (NRC, 2011a). However, this information has not yet been evaluated by staff. Any changes to the meteorological data resulting from this evaluation could impact the licensee's proposed methodology for addressing LC 12.8(D) (NRC, 2011a).

In addition, based on data submitted by the licensee (UEC, 2010b), NRC staff concluded (refer to SER Section 2.6.3.1 of NRC, 2011a) that there was insufficient information to determine that the baseline environmental radon monitors were located in sectors with the highest predicted airborne radioactivity. LC 11.9 (NRC, 2011a) requires the licensee to establish radon air samplers in the three sectors with the highest predicted radioactivity concentrations resulting from operations. NRC staff is not evaluating the adequacy of the location of the licensee's baseline environmental monitoring stations during this review. If the licensee submits revised locations for its baseline environmental monitoring stations, staff will review the information at that time.

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