The following information presented is the Uranerz Energy Corporation responses to the open issues for the Safety Evaluation Report for the Nichols Ranch ISR Project.

2.2 – Meteorology

2.2.1 Uranerz has not provided sufficient information regarding the atmospheric stability of the site for the staff to evaluate its use of the Antelope station in lieu of site-specific data. A summary of the MILDOS methodology used to determine the atmospheric stability and the results contained in Addendum 7C should have been provided. **This is an open issue.**

URZ Response:

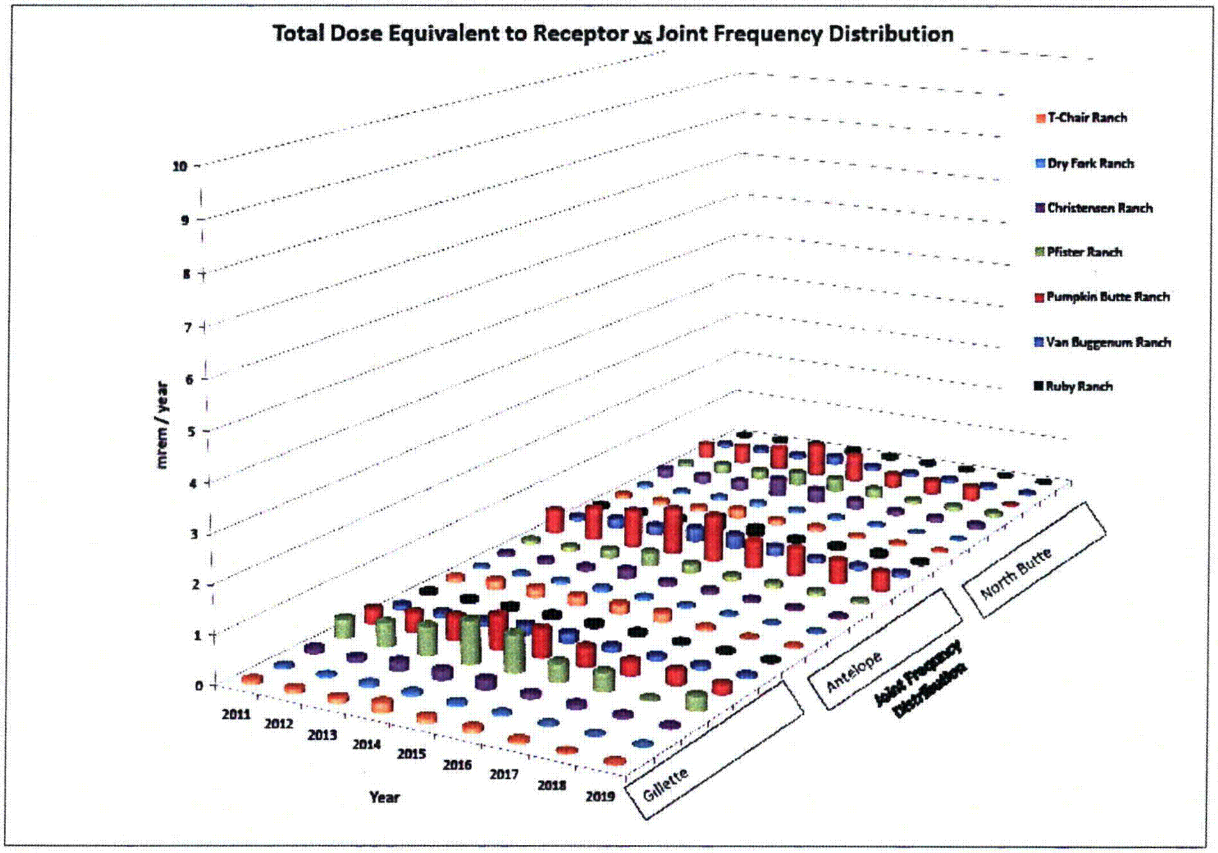
Prior to this response, Uranerz had run the MILDOS model using two different atmospheric stability arrays: the first run utilized a long-term data set (1996-2005) from the National Weather Service (NWS) station at Gillette, which was obtained from the National Oceanic and Atmospheric Administration (NOAA); and the second data set was developed from a private meteorological station associated with the Antelope Coal Company. Additional details on the Antelope meteorological station (years of operation, data recovery, etc.) are provided in response item 2.5.1.

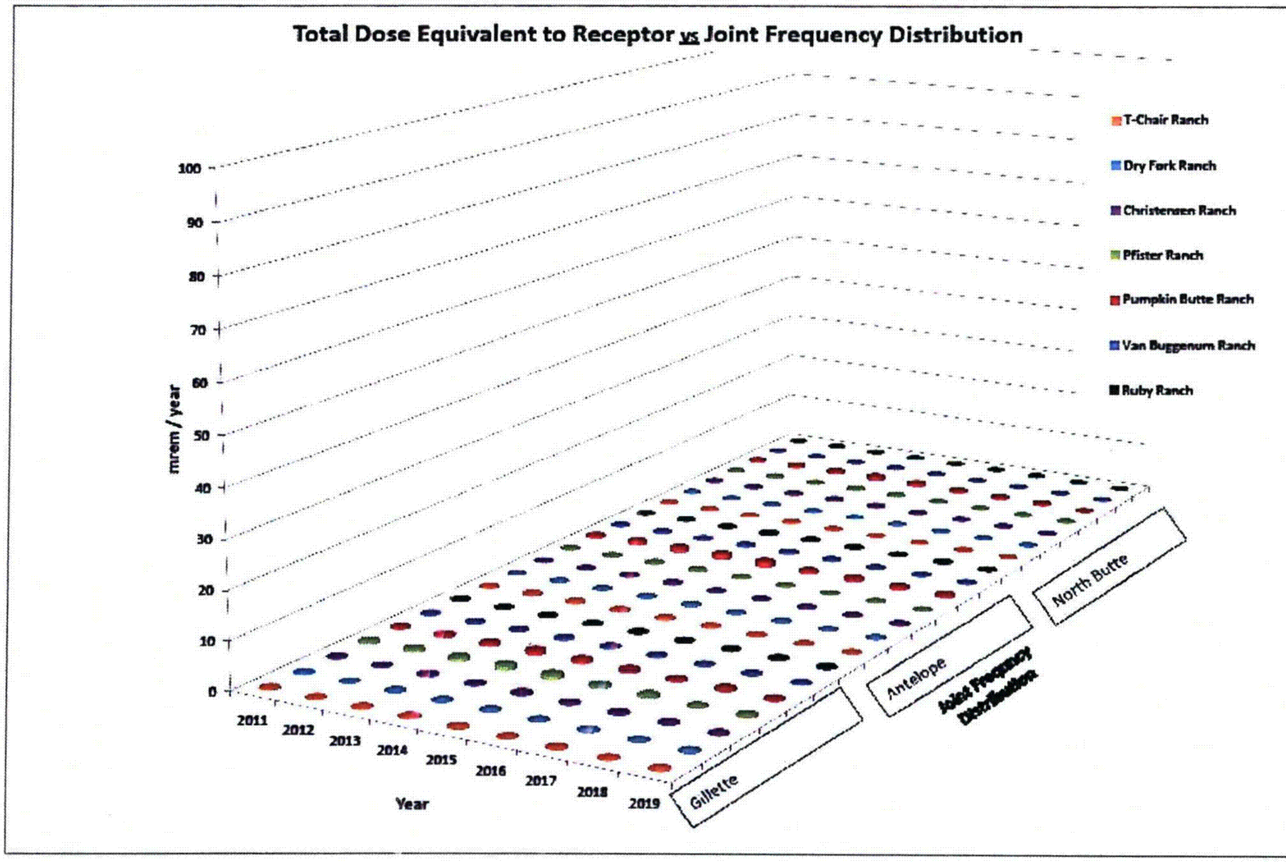
A review of the MILDOS results from the two previous submissions (see Chapter 7), shows that the use of the above-noted stability arrays did not cause a significant change in the predicted doses to the public. Because of the climatic similarities between Antelope and the Hank/Nichols Ranch project site, the similar results in the two MILDOS runs came as no surprise. Although this was the case, Uranerz decided to make a third MILDOS run to further demonstrate that the dose projections generated by the MILDOS model are not significantly different when using generally applicable stability data.

The atmospheric stability data that was used in the third MILDOS run, which is presented in this response, was established from an on-site meteorological station that was located very near the Hank/Nichols project area. The station was established to develop on-site stability data in support of the "old Uranerz," now Cameco, North Butte NRC license application, which was approved and licensed by NRC. The distance between the former North Butte project site and the Hank site is approximately one to two miles, and the distance to the Nichols Ranch site is approximately 5 miles. Because of the very short distance involved, atmospheric stability data from this station is certainly appropriate to use for MILDOS modeling at the Hank and Nichols Ranch project sites.

The meteorological station at North Butte was operated for a full year (October 1978 through September 1979). The data set included hourly average wind speed, wind direction and sigma theta values. The instruments were set at an elevation of 10 meters above the ground surface. Following EPA Guidance on Air Quality Modeling (1986), the data were processed to produce hourly stability classifications.

As can be seen from the new MILDOS results (attached to these responses) and the two graphs below, predicted dose values are in tight agreement with the previous estimates. All three runs demonstrate that any of the three sets of stability data are appropriate for use for the Nichols Ranch ISR project with all predicted does values being very small and very much under regulatory dose values. Therefore the Antelope data is appropriate for use.





2.2.2 Uranerz did not provide a summary of the MILDOS calculations and their effect on atmospheric dispersion of effluents and the resulting dose to the public, nor propose a source of mixing height data that is representative of the Nichols Ranch ISR Project site. **This is an open issue.**

URZ Response:

The calculations and algorithms imbedded within the MILDOS code cannot be accessed or altered during the modeling effort. However, the input parameters necessary to execute the model such as average mixing height, fractional frequency occurrence of wind speed, wind direction and atmospheric stability for the Pasquill stability classes can be inputted. In addition to the meteorological parameters, details were provided for fluid volume, time steps, radiological constituents and their concentrations, release elevations, operating parameters, etc into the MILDOS model. A review of the 2009 Technical Report response shows that an average mixing height of 100 meters was used in conjunction with the Brigg's height cutoff dispersion coefficient (see Section 7.3.1.2.6 Meteorological Parameters). Section 7.3.1.2.7 of the same report references Tables 7-6 and 7-7, which provide all of the remaining details on input parameters. Lastly, as described above in Section 2.2.1, a third MILDOS assessment was performed using meteorological data from a very near-by station (North Butte Project); data established from this site is certainly representative of the Hank and Nichols sites.

2.2.3 Although the Antelope station and the proposed central processing plant at the Nichols Ranch Unit are located at similar elevations, Uranerz has not provided enough information describing the terrain of the Antelope station for the staff to evaluate if the terrain of the Antelope station is representative of the Nichols Ranch ISR Project terrain. **This is an open issue.**

URZ Response:

To address this comment, Uranerz will provide additional discussion to Section 2.5.1 of the Technical Report. This section has been revised to describe the similarities of terrain between the Antelope met station and the Nichols Ranch ISR project area. Section 2.5.1 of the Technical Report has been revised and reads as follows:

2.5.1 Introduction

The Nichols Ranch ISR Project area is located in northeastern Wyoming, where the climate is generally classified as having relatively low annual precipitation (10-20 inches per year) but it is sufficient for the growth of short sparse grass. This climate is due in part to the effective barrier to moisture from the Pacific Ocean offered by numerous mountain ranges that run primarily north and south throughout the state, perpendicular to the prevailing west winds. The topography in this portion of Wyoming tends to restrict the passage of storms and thereby restricts precipitation in eastern Wyoming (Curtis and Grimes 2004).

There are no current meteorological (met) stations within or immediately adjacent (within 20 mi) of the Nichols Ranch ISR Project area. However, meteorological data has been collected from the seven meteorological stations that surround the project area (between 25 and 62 mi)(Table 2-7 and Figure 2-7). These seven met stations encompass all existing met stations within 62 mi of the Nichols Ranch ISR Project area. Six of the stations are operated by the National Weather Service (NWS) and one station is operated by a private firm (Intermountain Laboratory (IML). The Antelope Coal Company Mine (Antelope) met station is operated and maintained in accordance with an air quality permit issued by the Wyoming Department of Environmental Quality/Air Quality Division and has been in operation since 1987. Data recovery for the Antelope met station is greater than 90% for all parameters. The NWS stations were selected because they are the closest meteorological stations to the Nichols Ranch ISR Project area and will be used to provide regional and local weather information that is relevant to the Nichols Ranch ISR Project area.

All of the selected meteorological weather stations provide temperature and precipitation data. Only the Casper, Antelope, Gillette, and Buffalo met stations provide wind data and only the Casper met station reports relative humidity and evaporation data.

The Antelope met station was chosen as a surrogate met station for the Nichols Ranch ISR Project area based on the meteorological parameters measured (e.g., wind speed and direction, temperature and precipitation), its relatively close proximity to the Nichols Ranch ISR Project area and most importantly its similarity of topography and vegetation to the Nichols Ranch ISR Project area. Specifically, the Nichols Ranch ISR Project area is characterized by rolling hills and it is located in a semi-arid or steppe climate and vegetation types are mainly native grasses with some sagebrush and sparse woody coverage. As documented in Table 2-7 and Figure 2-7, the Antelope met station is located approximately 48.5 mi east-southeast from the Nichols Ranch ISR Project area. The Antelope met station is located on gently rolling hills with native grasses and shrub plant communities (Knight 1994). There are no major topographic or vegetation differences between the meteorological conditions at the Nichols Ranch ISR and the Antelope met station site except for minor differences related to microclimates associated with each location.

The Casper, Gillette, or Buffalo met stations could also be used as the surrogate met station for the Nichols Ranch ISR Project area. However, a review of the physical location of these sites and the data collected from these sites indicated that these met stations would not be the most appropriate surrogate sites as discussed below.

The Casper met station is located approximately 60 miles southwest of the Nichols Ranch ISR project area. The Casper met station is also located approximately 5 miles north of Casper Mountain which is the north extend of the Laramie Mountain Range (Knight 1994). Casper Mountain rises about 2,700 ft above the city of Casper and about 2,500 ft above the elevation of the Casper met station. While winds at the Casper met station are predominately from the southwest the local weather patterns are likely affected to some degree by Casper Mountain which is a major local topographic feature and would likely result in more microclimate affects compared to those that would be expected at the Nichols Ranch ISR Project area. Therefore, based on the increased distance of the Casper met station to the Nichols Ranch ISR Project area and the microclimatic affects of Casper Mountain it is reasonable to hypothesize that the Antelope met station is a better surrogate met station.

The Gillette and Buffalo met stations are located approximately 46.5 miles north-northwest and 58 miles northwest of the Nichols Ranch ISR Project area, respectively. The wind pattern for these stations generally show a westerly pattern with a relatively strong component from the north that appears to be reflective of a stronger northern influence of Canadian weather systems that push down directly from northern latitudes or from pacific weather systems that move around the Big Horn Mountain Range and then south. Therefore, based on the microclimatic affects of Big Horn Mountain Range on these two met stations it is reasonable to postulate that the Antelope met station would be a better surrogate met station.

The Antelope station offers the most representative data for the generation of the monthly wind roses and seasonal diurnal temperature norms required by the NRC. The NRC also approved use of the Antelope met station for Energy Metals

Corporation's Moore Ranch Uranium Project License Application that is located approximately 10 mi south of the Nichols Ranch ISR Project area. The other meteorological stations presented in Table 2-7 will be used in the discussion of regional climatology and meteorology.

2.2.4 The quantitative or qualitative criteria Uranerz used to conclude that the Pumpkin Buttes have little effect to the topography and the climate is not specified. Without specific information that supports these conclusions, the staff cannot determine if the meteorological data from Antelope is representative of the Nichols Ranch ISR Project site and cannot determine if the use of the Antelope station data is acceptable. **This is an open issue.**

URZ Response:

A qualitative discussion on the climatic effects of the Pumpkin Buttes is presented in Section 2.5.3.4 and should be adequate for the NRC staff to determine if the meteorological data from Antelope met station is representative of the Nichols Ranch ISR Project site. No additional response is required.

2.2.5 Uranerz analyzed 20 years of wind data collected from the Antelope station (1987-2006), but did not compare the 20 years of data from Antelope to the longer term data collected from the Antelope station. Uranerz should demonstrate that the period of data used is representative of long-term meteorological conditions in the site vicinity. **This is an open issue.**

URZ Response:

The period of record for the Antelope met station is 1987 – 2006; however, regional data presented in Section 2.5.2 and 2.5.3 clearly demonstrates that data from the Antelope met station is representative of long-term meteorological conditions in the region. No additional response is required.

2.2.6 Uranerz did not provide any information on the maintenance, inspection, or service of the Antelope meteorological station. Meteorological calibration records are required to be maintained as part of the radiation safety records. The staff cannot determine the validity of the meteorological data collected by Uranerz during the time period from 1987 to 2006. Uranerz should provide records for the Antelope Station to establish the validity of the data. **This is an open issue.**

URZ Response:

It is important to remember that Uranerz did not collect data, operate, or maintain the Antelope met station. As noted in Section 2.5.1, the Antelope met station is operated and maintained by Intermountain Laboratories in accordance with an air quality permit issued by the Wyoming Department of Environmental Quality/Air Quality Division and has been in operation since 1987. Since this station is mandated by the Wyoming Department of Environmental Quality/Air Quality Division the Antelope met station is operated and maintained in accordance with the EPAs regulatory modeling application criteria and adheres within a strict set of operating and maintenance guidelines. These system/equipment accuracies and resolutions are generally more stringent than those of National Weather Service systems. In accordance with EPA guidelines, the Antelope met station is audited once every six months and calibrations and repairs are performed on an "as found" basis. It should also be noted that the Wyoming Department of Environmental Quality/Air Quality Division typically has not identified issues or concerns with the collection of data from this station. Had there been any problems with data collection from this met station the Wyoming Department of Environmental Quality/Air Quality Division would have required appropriate corrective action. All calibrations and repairs at this station are performed immediately after they are identified as the EPA minimum data recovery criteria is 75%. As stated in Section 2.5.1 above, data recovery from this site is greater than 90% for all parameters. No additional response is required.

2. 3 - Geology and Seismology

2.3.1 Uranerz provided the isopach of the B shale and the C shale which together act as the underlying confining layers to the ore zone at the Hank Unit in Exhibit D5-21. The vast majority of the borings were not deep enough to penetrate these shales, so the isopachs were defined by very few points along the ore body. NRC staff cannot interpret and determine the continuity and thickness of these underlying confining unit shales with so many non-detect points. **This is an open issue.**

URZ Response:

Although many drill holes were completed in the license area of the Hank Unit, the B and C sands were not targets of this drilling. The data set has been reviewed and new B and C sand isopachs have been constructed providing further understanding of these sands. Isopachs were projected into areas so that the entire permit area is now covered.

New isopach maps for the C and B Sands at the Hank Unit along with a new B-C Shale isopach have been developed and are enclosed as Exhibits D5-22, D5-23, and D5-24.

2.3.2 At the Hank Unit, the C and B Sands are the underlying sands to the ore zone. These units were only shown on cross sections C-C', F-F', H-H' and J-J', which had borings deep enough to identify their presence. The "C sand" is thin and discontinuous, whereas the "B sand" appears thick and continuous. The majority of the borings were not deep enough to reach this sand on the isopach, so it was defined using very few points. Both of these sand units underlie the ore zone and one of these sands may be defined as the underlying aquifer for excursion monitoring purposes. NRC staff needs more thorough isopach maps for the C and B Sands (Exhibit D5-22) to assess the presence or absence of these sands across the license area to properly assess the ore zone underlying aquifer. **This is an open issue.**

URZ Response:

New isopach maps for the C and B Sands at the Hank Unit along with a new B-C Shale isopach have been developed and are enclosed as Exhibits D5-22, D5-23, and D5-24.

2.4 – Hydrology

2.4.1 Uranerz recognized that the magnitude of the peak flows and velocities for the tributaries that cross the wellfields in the Nichols Ranch Unit license area may present an erosion risk to the site and damage wellfield infrastructure. Uranerz proposed to minimize damage from erosion and to wellfield infrastructure from peak flow events by avoiding well installation in the ephemeral drainages. Uranerz stated that if it is necessary to install such wells, appropriate erosion protection controls will be applied to minimize damage to the drainage. If wells are to be placed near a stream, appropriate well and well head protection will be utilized. Embankments, culverts, and drainage crossings will be protected using best management practices in accordance with Chapter 3 of Wyoming Department of Environmental Quality (WDEQ) Land Quality Division (LQD) Rules and Regulations. Uranerz should confirm that these practices will also be applied to any wells or infrastructure to be located in the 25-year flood plain of Cottonwood Creek shown in Figure 2-15a. The use of these practices should also be confirmed for Dry Willow Creek and for Willow Creek at the Hank Unit. **This is a confirmatory item.**

URZ Response:

Uranerz will use the erosion practices presented for the Nichols Ranch Unit within areas of the 25-year flood for Cottonwood Creek and for the Hank Unit within the areas of the 25-year flood for Dry Willow Creek. The wellfield does not extend to the Willow Creek 25-year flood plain.

2.4.2 Uranerz estimated the peak velocities for the Hank Unit license area based on the 25-year peak flow rate and reported these values in Table D6-1 in Appendix D6 for all of the drainages except HDA7 and HDA8. Peak velocities for HDA7 and HDA8 should be determined. **This is an open issue.**

URZ Response:

The peak flow rates will be added for drainages HDA7 and HDA8 in Table 2-14. (see attached updated Table D6-1 that shows the peak velocities of HDA7 and HDA8).

2.4.3 The satellite facility at the Hank Unit is located in the middle of the license area and is not shown to be flooded by any drainage area. However, this facility could be subjected to sheet flow. Uranerz should identify engineering measures to protect this facility from sheet flow flooding. **This is a confirmatory item.**

URZ Response:

The Hank Unit satellite facilities will be protected from sheet flow in the same manner as proposed for the Nichols Ranch Unit facilities. A ditch and berm will be constructed on the upslope side of this facility for sheet flow to drain around this facility. Page TR-61 of the Technical Report will be updated with this commitment.

2.4.4 Uranerz stated in a request for additional information (RAI) response that the Coal Bed Methane (CBM) operator at Hank Unit will not discharge any CBM water in the near future in the license area. The operator will pump it off site for reinjection into the Madison formation at a site 35 miles distant. Uranerz did not include this statement in the application or provide assurance that this or any additional CBM operator will continue this practice for the lifetime of the Hank Unit. Currently, the CBM operator possesses permits for CBM water basins within the Hank Unit. NRC staff requests a commitment in the application that Uranerz will notify NRC if CBM ponds or basins are installed in or within ¼ mile of the Hank Unit. **This is a confirmatory item.**

URZ Response:

A sentence will be added to Section 2.7.2.4.1 Coal Bed Methane Groundwater Quality of the Technical Report that states the NRC will be notified if any new CBM ponds or basins are installed in or within ¼ mile of the Hank Unit.

2.4.5 The "A sand" aquifer is the ore zone in the Nichols Ranch Unit license area. Uranerz used seven wells, MN-1, MN-2, MN-3, MN-4, MN-5, MN-6 and Nichols 1 to measure water levels in the "A sand." The reported water levels in MN-2 average approximately 4,592 feet, which is approximately 70 feet less than surrounding wells. Uranerz did not comment on the difference in water level between MN-2 and the other wells. In addition, Uranerz provided the potentiometric surface for the "A sand" in the license area using a water level of 4662 feet for well MN-2, which is not a value reported for this well. The potentiometric surface shows contours which do not reflect the measured potentiometric low at MN-2. NRC staff notes that these contours and the associated groundwater flow direction and gradient magnitude of 0.0033 ft/ft derived from these contours appears to be in error. **This is an open issue.**

URZ Response:

An error in the measuring point for well MN-2 resulted in incorrect water-level elevation in the tables. This error has been corrected and the water-level elevations for well MN-2 fit the piezometric map. (see attached updated Table D6D.1-1)

2.4.6 Uranerz did not provide a description of any underlying aquifers to the "1 sand" at the Nichols Ranch Unit. Uranerz did provide a deeper cross section in Exhibit D6-5 to show the relationship of the CBM production zone to the ore zone at the Nichols Ranch Unit. This figure shows that the next underlying aquifer would be located in the Fort Union sand, which appear to be separated from the "1 sand" by a significant shale layer. Because the "1 sand" appears to lack continuity, it is unclear if it is the only underlying aquifer for the Nichols Ranch Unit license area. **This is an open issue.**

URZ Response:

The 1 Sand is the underlying aquifer for the Nichols Ranch Unit. This sand is thin in some areas and may require adjustments in the underlying aquifer monitoring well in areas where the sand is too thin.

2.4.7 Uranerz investigated the potential for the presence of artificial hydraulic connections between the deep coal seams that are producing methane and the ore zone in and around the Nichols Ranch Unit. It identified several exploratory borings and permitted wells that extended to depths sufficient to penetrate the coal seams. One exploratory boring, RAM-5, with a depth of 903 feet, was located in the permit area. Uranerz did not indicate it would investigate the condition of this boring at the Nichols Ranch Unit to assess if it could act as a conduit. **This is an open issue.**

URZ Response:

Uranerz has conducted visual inspections of both the Nichols Ranch and Hank permit area while conducting exploration drilling and drilling reclamation activities in these areas over the past three years. No open historic drill holes have been found. Additionally there has not been any evidence of historic drill holes causing cross contamination between aquifers when conducting pump tests or when reviewing historic versus current water levels in monitor wells that are present in the permit areas. Furthermore, since the historic drill holes have been released by the WDEQ, an assumption can be made that the holes were properly abandoned according to the rules and regulations in place at the time the drill holes were abandoned.

Section 2.7.5 of the Technical Report will be revised to include this information.

2.4.8 Uranerz reported the surficial aquifer in the Hank Unit license area is located in the "H sand." Uranerz provided a map of the depth to water to the "H sand" surficial aquifer. The water levels range from 50 -200 feet below ground surface (bgs) based on one well and hydrologic interpretation in Figure 2-21b of the application. Uranerz reported that alluvial wells in the Willow Creek drainage in the south of the license area are monitored by the Bureau of Land Management (BLM) and have been dry recently. NRC staff could not ascertain if a hydrologic connection exists between the "H sand" and the alluvium in the Dry Willow Creek drainage in the south and with the Willow Creek alluvium in the north of the license area. **This is an open issue.**

URZ Response:

Figure 2-21B presents the depth to water in the H Sand. This depth to water level map is defined by the three H Sand wells within the permit area. The depth to water in the Dry Willow Creek area is likely shallow enough west of the Hank Unit that the H Sand could discharge to the Dry Willow Creek alluvium. The two BLM monitoring alluvial wells west of the Hank Unit in Dry Willow Creek do not show any saturation in the alluvium in this area. The H Sand depth to water north of the Hank Unit in the Willow Creek area is less than 50 feet and therefore the H Sand may discharge to Willow Creek alluvium north of the permit area. The small quantity of water flowing in the low permeability H Sand is not likely to create saturation in the Willow Creek alluvium. (see attached Figure D6-7b for current H Sand water levels. Figure 2-21B will be revised to reflect the information in Figure D6-7b.)

2.4.9 Uranerz conducted three multi-well pumping tests at URZHF-5, URZHF-1 and SS1-F in the Hank Unit license area. The first test was conducted at pumping well URZHF-5 for four days and nineteen hours with two "F sand" observation wells and one underlying "B sand" and one overlying "G sand" monitoring well (MW). The transmissivity in the "F sand" could only be determined from the pumping well as 470 gpd/ft. The observation wells, which were located 500 and 1000 feet away, respectively, showed no response. Uranerz did not address the lack of response. NRC staff notes the aquifer is unconfined, so the drawdown from the well would have limited areal extent. **This is an open issue.**

URZ Response:

Uranerz will conduct two additional multi-well pump tests in the F Sand at the Hank Unit. These two pump test will have observation wells which are close enough to cause adequate drawdown to produce specific yield results for the unconfined F Sand aquifer. One of these tests will have an observation well spaced 500 feet outward from the ore body on each side of the pumping well to define drawdown in the monitoring ring area. The second test will be a partially penetrating pumping well to define the drawdown vertically within the F Sand.

2.4.10 NRC staff finds there is substantial dewatering from low pumping rates in the Hank Unit "F Sand" unconfined aquifer. Uranerz should determine the limiting extraction rate which can be maintained in the "F sand" unconfined aquifer without causing excessive dewatering. **This is an open issue.**

URZ Response:

Uranerz has developed a MODFLOW numerical model of the F Sand. The results of this numerical modeling are presented in the attached WDEQ Addendum MPH. This model will also be incorporated into the Technical Report once the open issues are finalized.

Section 2.5 – Background Surface and Groundwater Quality

2.5.1 Uranerz reported surface water quality for Ra-226 as zero for the Cottonwood Creek upstream measurements in 2008 and the Cottonwood Creek at Brown Ranch and Brown Water Pond in 1979. Uranerz reported values of zero for selenium in the overlying and ore zone sands at the Nichols Ranch Unit. Uranerz reported a value of zero for arsenic, cadmium, mercury and selenium in the ore zone sands. Uranerz reported a value of zero for selenium in the underlying sand at the Hank Unit. Zero values should be reported as non-detect, if appropriate. **This is an open issue.**

URZ Response:

Reporting radium values of zero is correct when a radium error value is presented with the zero radium value. Therefore, the zero radium values were not removed. Zero values were changed to detection levels for all of the other parameters except for carbonate. Carbonate can be zero below the value of a pH of 8.3. Therefore the zero values for carbonate were kept. (see attached updated water quality Tables D6E.1-1 and D6E.2-1.)

2.5.2 Uranerz reported that CBM produced water will be discharged into impoundments that are designed to infiltrate this discharge into the surficial aquifer near the Nichols Ranch Unit license area. The possibility exists that groundwater quality in the surficial aquifer will be impacted by CBM water during the life of the Nichols Ranch Unit. Uranerz did not provide any discussion of this issue in the technical report. The ability to distinguish between CBM produced water infiltration to the surficial aquifer and impacts from surface spills, well/pipeline leaks, or excursions from ISR operations to the surficial aquifer has not been demonstrated. **This is an open issue.**

URZ Response:

The coal bed methane water contains a high sodium and bicarbonate concentration while the sulfate concentration is very low. The G Sand water quality near the CBM wells has relatively low sodium and bicarbonate and higher sulfate concentrations. These three parameters should enable the effects of the CBM water on the surficial aquifer to be easily determined.

Section 2.6 – Background Radiological Characteristics

2.6.1 Uranerz did not collect air particulate samples as recommended in Regulatory Guide 4.14 because no uranium particles are expected to be generated in an ISR. Uranerz did not address the radon progeny particulates that are generated as radon decays. Emanation of radon and progeny undergoes diurnal and seasonal variations. Collecting the air particulate samples at the same location as the radon samples allows for evaluating the correlation between radon and its progeny. Therefore, pre-operational air particulate results may not accurately reflect site-specific conditions. **This is an open issue.**

URZ Response:

Four air particulate samplers were installed at each of the two project sites. The locations of the samplers are shown on the enclosed Figures 2-25 and 2-26. Since the time of installation, three full quarters of measurements have been documented and the results are provided in the attached tables. Monitoring has begun for the fourth quarter. Uranerz will provide the data from this quarter as soon as it becomes available.

As can be seen from the attached tables, measured concentrations expressed as µCi/ml are compared to the effluent concentrations provided in 10 CFR Part 20, Appendix B – Table 2. A review of the attachment shows extremely low concentrations for all of the monitored parameters, which include U, Th-230, Ra-226 and Pb-210. Data from the lab reports also show consistency among the monitoring locations over time and over the two project sites (see Summary Comparison of Radiological Concentrations for Two Quarters 2009).

2.6.2 Uranerz did not describe the analytical methodology and the lower limit of detection used to quantify concentrations of radionuclides in soil and sediment samples. **This is an open issue.**

URZ Response:

The laboratory reports include a column identifying approved methods of analysis for each of the radionuclides; and a column is also included which lists the analyte reporting limit (RL). In the year 2007, the laboratory was using analyte Practical Quantitation Limits (PQL) derived in part from 40 CFR Part 136 Method

Detection Limits (MDL) studies and on counting precision for full volume routine count time analyses. The soils and sediments had preparation factor(s) applied to determine the reportable soil PQLs.

The methods used to quantify the concentrations of radionuclides in the soil and sediment samples are as follows:

Radionuclide	Method
Radium-226	E903.0
Uranium	SW6020
Lead-210	NERHL-65-4
Thorium-230	E907.0

A footnote will be added to the radionuclides in soils and sediment tables in Section 2.9 of the Technical Report that includes the methods list above.

2.6.3 Baseline surface water samples were not collected and analyzed for U, Ra-226, Pb-210, Th-230. **This is an open issue.**

URZ Response:

Surface water samples that were collected in surface samplers or when any surface water was present were analyzed for Uranium and Ra-226, but were not analyzed for Pb-210 or Th-230. This is an oversight by Uranerz. Any future surface water samples that are collected will be analyzed for U, Ra-226, Pb-210, and Th-230.

Section 3.1 – ISR Leaching Process and Equipment

3.1.1 NRC staff notes that screw and glue joints have experienced many failures in ISR operations. Uranerz did not describe how the casing would be joined in the well completions. **This is an open issue.**

URZ Response:

The casing for the well completions will be joined using an O-ring and spline locking system. Screw and glue joints will not be used for well completions. Products that typically are used include CERTA-LOK and SureFIT.

3.1.2 Uranerz stated that during wellfield operations, injection pressures at the wellheads would not exceed 90 percent of the mechanical integrity test (MIT) pressure. Uranerz, however, did not provide the MIT pressure value or a fracture gradient for the Nichols Ranch Unit or the Hank Unit. NRC staff cannot evaluate if the fracture gradient will be exceeded. **This is an open issue.**

URZ Response:

The injection pressures for the Class III wells for the Nichols Ranch Unit and the Hank Unit will be calculated to assure the pressure in the production zones do not generate new fractures or spread existing fractures. Uranerz Energy Corporation will operate the Class III wells in a manner that the injection pressure will be lower than the calculated pressure that could fracture the confining zone, or cause the injection fluid to migrate to unauthorized zones. The injection pressure for the Nichols Ranch Unit and Hank Unit will be no greater than 60% (range – 38% to 60%) of the formation fracture pressure and will not exceed the pressure rating of the casing.

Search of published fracture gradient information resulted in selecting a conservative fracture gradient of 0.80 psi/ foot of depth, for reservoir rock formations of 2000 feet in depth or less. The following range for maximum injection pressures are: average depth for Nichols Ranch (600 ft X 0.80 psi/foot = 480 psi) and average depth for Hank (375 ft X 0.80 psi/foot = 300 psi). The range of 480 psi to 300 psi is greater than the maximum injection pressure ratings for PVC casing that Uranerz intends to use. The maximum operating pressure rating for SDR 17 casing is 180 psi and for SDR 21 casing (if used would only be at Hank) is 130 psi. MIT testing will be conducted at the maximum operating pressure of the installed casing. The casing pressure rating therefore will be the limiting factor and maximum injection pressure would be 180 psi if SDR 17 is in use and 130 psi if SDR 21 is in use. At Nichols Ranch 180 psi is 38% of the formation fracture pressure and for Hank is 60% of the formation fracture pressure.

3.1.3 Uranerz stated that injection wells may be equipped with downhole spargers with oxygen being metered through individual rotometers or an oxygen manifold will be installed. Uranerz did not describe downhole spargers to enable NRC staff to evaluate their operation. **This is an open issue.**

URZ Response:

A down hole sparger is typically constructed of approximately two feet of three quarter inch diameter weighted PVC pipe caped on the lower end. One sixteenth inch diameter holes are drilled throughout the two feet of pipe. The perforated pipe acts as a sparger and diffuses the oxygen for dissolution into the injection fluid.

3.1.4 Uranerz provided a plant material balance in Figure 3-6 and a typical plant water balance in Figure 3-7. The figures show that all liquid waste will be sent to two deep disposal wells during production and restoration operations. No storage or evaporation ponds will be constructed for disposal. Uranerz also provided predictions of waste volumes to be sent to each disposal well for each unit for the production, production and restoration, and restoration only phases. These calculations showed that with a capacity of 100 gpm for each disposal well, restoration and production operations would bring each unit close to the maximum with little extra capacity (e.g. 1 gpm available). In RAIs to Uranerz, NRC staff questioned this lack of sufficient extra capacity in each disposal well, especially if a disposal well became inoperable. Uranerz stated that if either disposal well becomes inoperable, each unit will have a surge capacity to maintain the water balance. At Nichols Ranch Unit this surge capacity will come from four large tanks with a capacity of 17,000 gallons each. At a rate of 42 gpm this will provide 24 hours of capacity. At Hank Unit, there will be six large tanks with a capacity of 17,000 gallons each. At a fill rate of 77 gpm, this will allow for 22 hours of capacity. To manage surge capacity, Uranerz stated it could rent large capacity bladder tanks for more capacity; it could haul solution over to the other unit; or it could reduce production flow rates to minimize waste tank fill rate. Uranerz has not demonstrated an adequate plan or methodology to maintain wellfield bleed rates, given the possibility that either or both disposal wells may become inoperable or have reduced capacity for more than 22 or 24 hours. **This is an open issue.**

URZ Response:

Uranerz has a four part answer to this question.

a.) Uranerz commits to having 2 deep disposal wells drilled prior to staring up Nichols Ranch. Uranerz also commits to having the critical spare parts for the deep disposal injection system on site.

b.) Uranerz provides the following information on timing for deep disposal well emergency maintenance. The work over is estimated to be an average of 5 days.

Prairie Well Service

P.O. Box 94

Evansville, Wyoming 82636

Phone Number
(307) 237-7854

Fax Number
(307) 237-7268

July 9, 2009

Uranerz Energy Corporation
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming 82605-0850

Attention: Mr. Bruce Larson
Exploration Manager

Dear Mr. Larson,

Sorry for not getting back with sooner, but to answer some of your questions, rig availability is very good right now due to decline in oil and gas prices. A workover rig should easily be able to get to your project within a week.

A good crew should be able to move to location and rig up and start pulling tubing in 1 day. The next day they should be able to get the tubing and packer out of the hole. If you want to scrap the perforations with a mill that should be able to done in a day to 2 days depending on what they find. If you want to do an acid job after scraping the perorations, then they should be able to run in with the tubing and set the packer and then do the acid job.

If this is the procedure you choose, I believe that rig would be there between 4 to 6 days.

Of course if you think an acid job will cure your problem, you don't even need a rig. You could start pumping some acid when the injectivity of the well falls off and then decide if you need a rig.

I hope this answer some of your questions, if not please contact me and we can discuss further.

Sincerely,

Wayne Neumiller

c.) Uranerz investigated Frac tank availability and rental information. Frac tanks are readily available in Wyoming from the petroleum industry, and can be mobilized quickly. They are capable of holding 16,800 gallons (400 barrels) of water each.

d.) Uranerz conducted an analysis regarding shutting in the wellfield and not having a bleed during the time the deep disposal well is down. A cone of depression is in place, and Uranerz wanted to determine the amount of time the groundwater would migrate without a bleed.

A depression in the piezometric surface will exist during operation of the wellfields. If the wellfield operation had to be shut-in for a short period of time the water levels would gradually recover with flow inward to the wellfield on the down gradient side initially, then becoming a very flat gradient with very little flow and finally recovery to a outward gradient that is flatter than the natural gradient for the aquifer. The use of the natural gradient to estimate the movement of the ground water outward during a shut-in period is therefore very conservative. The use of the natural gradient in the ground-water movement rate should account for the variability in the ground-water velocity due to variability in aquifer properties.

The natural ground-water velocity for the A Sand aquifer at Nichols Ranch Unit is 12 ft/yr. This ground-water velocity was used to estimate the movement of ground-water at Nichols Ranch Unit for 45 days of non-operation which indicates that the ground water would move less than two feet from it position prior to the shut-off period. This analysis demonstrates adequate containment of the ISR solution during a significant shut-in period of 45 days at Nichols Ranch Unit.

The natural ground-water velocity for the F Sand aquifer at Hank Unit is 8 ft/yr. The use of this ground-water velocity to estimate the travel distance of the ISR solution during a 45 day shut-in period indicates that the solution would move roughly one foot during the non-operation period. This indicates that the Hank Unit solution should adequately be contained during a significant shut-in period of 45 days.

3.1.5 NRC staff reviewed the “reversal of gradient analysis" for the “F sand” unconfined aquifer for the Hank Unit. The simulations only use extraction wells at low bleed rates to represent consumptive use. The simulations do not account for the fact that during operation the extraction wells will create dewatered cones and the injection wells will create groundwater mounds that will affect the gradient reversals calculated by Uranerz. NRC staff suggests Uranerz could revise the simulations and include extraction and injection wells operating at true rates to show that the gradient reversal will still be adequate. **This is an open issue**.

URZ Response:

The numerical modeling mentioned in the response for item 2.4.10 that was conducted on the F Sand in the Hank Unit uses the injection and recovery wells (see WDEQ Addendum MPH that is attached for results).

3.1.6 The gradient reversal simulations at the Hank Unit “F sand” only report the difference in head between two nodes and not the actual drawdown in the aquifer. It is possible that when true extraction rates (3% bleed) are applied over the unconfined aquifer in this area it may create excessive dewatering at the extraction wells. Consequently, this dewatering may become prohibitive if the entire side of a well field is converted to extraction only to capture an excursion. Uranerz has not demonstrated that these rates can be maintained. **This is an open issue**.

URZ Response:

The USGS WTAQ program for partially penetrating wells in an unconfined aquifer was used to calculate the drawdown adjacent to the pumping well in the unconfined aquifer at the Hank site for a bleed rate of 3%. A typical recovery well will have a pumping rate of 8 gpm based on the results from this evaluation. This partially penetrating well was assumed to be completed 66 to 81 feet from the top of the aquifer. An injection 50 feet from this well was assumed to be 3% less at 7.76 gpm. The aquifer properties from the observation well HF-8 from the Hank 1 multi-well pump test were used in the WTAQ program with these rates. An aquifer thickness of 84 feet, specific yield of 0.144, specific storage of 1.37E-5 per foot, horizontal hydraulic conductivity of 1.06 ft/day and vertical hydraulic conductivity of 0.085 ft/day were used. Drawdown at 1 ft from the pumping well and 50 ft from the injection were summed together to obtain the predicted drawdown at the recovery well with the operation of the injection. Additionally the bleed rate of 0.24 gpm for each recovery well was used for stresses with distances of the following: 4 wells at 100 feet, 10 wells at 200 feet, 8 wells at 300 feet and 5 wells at 500 feet. Recovery wells beyond this distance will not create a significant drawdown. Drawdowns were computed for 0.01, 0.1 and 1 years and these drawdowns varied from 52.6 to 54.3 feet. This analysis demonstrates that the F Sand will be able to maintain adequate heads in the extraction wells with a bleed rate of 3%.

This analysis indicates the average yield of the Hank F Sand wells will likely be 8 gpm with wells with shallower completion yielding less and wells with deeper completion typically yielding more. This analysis indicates MU1 at Hank will likely be operated at a level less than the peak design of 2500 gpm due to the maximum recovery rate of the F Sand wells. Areas of higher transmissivity than those observed at the Hank 1 well in the F Sand would allow the rates to be higher.

3.1.7 Uranerz concluded the simulations provide evidence that Uranerz can maintain a cone of depression for expected production and restoration operations in the unconfined "F sand" aquifer. However, as noted above, substantial dewatering can occur at extraction wells in an unconfined aquifer as the water is produced by actual dewatering of the sediments. In the results from Uranerz' multi-well pumping test at URHZF-5, Uranerz reported a drawdown of about 40 feet after a 5 day pumping test at 4 gpm. If the saturated thickness above the ore zone averages 50 feet as reported by Uranerz, this drawdown would reduce the available drawdown to 10 feet of head at the extraction well. If more wells are operating, such as in the case of capturing an excursion, the dewatering will be even more severe. Lowering the water level near the well can also impact submersible pump performance, as such pumps require a certain head to operate efficiently. NRC staff, therefore, notes dewatering of wells in the unconfined aquifer will limit the flexibility in the extraction rates which can be used at Hank Unit. These limits may pose a problem if an excursion of lixiviant from a wellfield occurs. Uranerz needs to demonstrate an excursion capture stategy at the Hank Unit which will not cause excessive dewatering. **This is an open issue.**

URZ Response:

The numerical modeling that has been conducted for the Hank Unit has been used to demonstrate the adequate excursion capture strategy for the Hank Unit. The modeling results in the attached WDEQ Addendum MPH show that small increases to a few wells will adequately retrieve an excursion without creating excessive drawdowns.

3.1.8 Uranerz stated that the groundwater simulation showed that the gradient reversal would reach the monitoring well ring which is located 500 feet away with wells 500 feet apart in the Hank Unit. NRC staff notes that this simulation only demonstrates that the gradient would reach the monitoring well ring. It does not demonstrate that the monitoring wells would detect an excursion. In addition, in an unconfined aquifer like the "F sand" a monitoring well sample only intercepts a small amount of water near the well because it is delivered to the well by draining the sediments. It is, therefore, possible that an excursion could slip in between the monitoring wells. Uranerz needs to demonstrate how the monitoring well ring will intercept an excursion to support the 500 foot spacing. **This is an open issue.**

URZ Response:

The numerical modeling is being used to justify the 500 foot spacing for the F Sand aquifer at Hank Unit. WDEQ Addendum MPH (attached) presents results that justify the 500 foot spacing.

3.1.9 NRC staff notes that the steep drawdown and limited areal extent of drawdown created by pumping in the unconfined "F sand" aquifer will require an unique pumping test strategy to ensure the wellfield is in communication with the monitoring well ring. Therefore it may take many pumping tests perhaps operating simultaneously to demonstrate hydraulic communication between the monitor ring and production zone in each of the wellfields. These tests will need to be conducted when the wellfields are installed as part of the hydrologic data collection for each wellfield. In a response to an NRC RAI, Uranerz indicated that it would take at least three pumping tests to establish communication with observation wells 1000 feet distant. NRC staff notes that an almost five day multi-well pumping test conducted by Uranerz at URZHF-5 at 4 gpm in the Hank Unit did not create a response at observation wells located 500 and 1000 feet distant. Therefore, it is likely that pumping wells and observation wells will probably need to be much closer in the "F sand" to demonstrate communication. Uranerz has not provided a pumping test strategy which will show this communication. **This is an open issue**.

URZ Response:

Uranerz will develop a pump test strategy for the initial F Sand wellfield. This strategy will be presented to the NRC and WDEQ for approval prior to conducting the wellfield pump test as is stated in Section 5.7.8.4 of the Technical Report.

3.1.10 Based on the unconfined nature of the "F sand," NRC is concerned that dissolved oxygen or hydrogen peroxide in lixiviant at Hank Unit could lead to a free gas phase which can create "gas lock." This could reduce conductivity and affect the flow system in the "F sand" aquifer such that excursions would increase and contact within the ore zone during restoration could be impacted. The presence of a free oxygen gas phase could also damage wells, piping and pumps and interfere with instrumentation such as flow and pressure measurements. Uranerz did not address the potential for the "gas lock" problem at the Hank Unit and how it would identify, monitor, and correct this problem. Uranerz needs to address this issue with respect to dissolved oxygen use. **This is an open issue.**

URZ Response:

Due to the possibility of gas locking problems that occur in the wellfield in the ore bearing formation, Uranerz commits to not using hydrogen peroxide in the wellfield at the Hank Unit. In addition, Uranerz will monitor the recovery solution to insure excess oxygen does not become evident so no possibility of gas locking can occur. Periodic testing of the oxygen levels will be performed on the recovery solution to insure the solubility limit is not exceeded. Special care will also be taken to control the amount of oxygen added to the injection solution in areas of low hydrostatic pressure to insure off gassing of oxygen does not present a problem. An additional corrective action that may be taken is to cycle wells from injection to extraction duty during the mining sequence. Pressure gauges and oxygen flow meters on the injection solution will be used during oxygen addition to insure no excess of oxidant occurs. If necessary, a limited number of ore body wells will be installed with completion of the wells being just below the upper aquitard to relieve any build up of gas in that area.

3.1.11 Uranerz did not explain the duration of restoration for the production areas, which ranged from one year to five years. In particular, if restoration is going to take longer than 2 years, an explanation and alternate schedule should be provided. **This an open issue**.

URZ Response:

The amount of time for restoration shown in Figure 3-12 is based on the current estimate of deep disposal well capacity and the restoration methods outlined in Chapter 6 of the Technical Report. As stated in Chapter 6, Section 6.1, Uranerz will adhere to 10 CFR 40.42. When decommissioning and/or restoration begin, the NRC will be notified and a plan submitted for review or approval. If, at that time, groundwater restoration is estimated to take longer than 24 months based on items such as deep disposal well capacity, Uranerz will request for an alternate schedule as allowed under 10 CFR 40.42(i).

Section 3.2 - Recovery Plant, Satellite Facility, and Well Fields

3.2.1 Uranerz has included a list of chemicals that may be used in the uranium recovery process. These include hydrochloric acid, hydrogen, peroxide, sodium chloride, sodium hydroxide, sodium hypochlorite, ammonia, oxygen, carbon dioxide, sodium carbonate, and sodium bicarbonate. Hazardous chemicals that have the potential to impact radiological safety, are ammonia, hydrogen peroxide, and hydrochloric acid, and would be stored outside and segregated from areas where licensed materials are processed and stored. Uranerz indicates that for these hazardous chemicals, it will comply with the Environmental Protection Agency's risk management program regulations. The chemicals proposed for use are similar to those discussed in NUREG-6733, Chapter 4, Consequence Analyses. NUREG-6733, Table 1, presents a list of chemicals and pertinent regulation for the chemical used at ISR facilities (NRC, 2001). Uranerz has not listed the specific regulations that would apply to chemicals used. (NUREG – 3.2.3 (6). **This is a confirmatory item.**

URZ Response:

Uranerz conducted detailed design work for chemical usage and chemical storage areas. The detailed design calculations were based upon using sodium hydroxide and not ammonia, and then hydrochloric acid and not sulfuric acid. Uranerz confirms compliance with NUREG-6733, Chapter 4 for Chemical Hazard Consequence Analysis. The following list summarizes the specific regulations for the proposed chemicals.

Chemical	Name	Regulation	Minimum Reporting
NH_3	Ammonia	Threshold Quantity(TQ) from Clean Air Act for 40 CFR part 68 RMP	10,000 lb
		TQ for OHSA 29 CFR part 1910.119 Process Safety Management	10,000 lb
		TPQ (planning) for 40 CFR part 355 Emergency Response (ERP)	500 lb
		Reportable for CERCLA from 40 CFR 302.4	100 lb
H_2SO_4	Sulfuric Acid	TPQ for 40 CFR 355 ERP	1,000 lb
H_2O_2	Hydrogen Peroxide	TPQ for 40 CFR 355 ERP (conc > 52%)	1,000 lb
		TQ for OSHA 29 CFR 1910.119 PSM (conc > 52%)	7,500 lb
O_2	Oxygen	Not listed in any of the 4 regulations	NA
CO_2	Carbon Dioxide	Not listed in any of the 4 regulations	NA
Na_2CO_3	Sodium Carbonate	Not listed in any of the 4 regulations	NA
NaCl	Sodium Chloride	Not listed in any of the 4 regulations	NA
HCl	Hydrochloric Acid	TQ from CAA for 40 CFR Part 68 RMP (conc >37%)	15,000 lb
		TQ from OSHA for 29 CFR 1910.119 PSM (anhydrous HCl)	5,000 lb
		RQ for CERCLA from 40 CRF 302.4	5,000 lb
NaOH	Sodium Hydroxide	RQ for CERCLA from 40 CRF 302.4	1,000 lb

Section 3.3 - Instrumentation and Control

3.3.1 Uranerz has provided information in the application on proposed instrumentation, but at this point has not provided specific details of the final selected equipment. NRC staff notes that final selected control equipment may have to be reviewed and inspected prior to facility operation to ensure compliance with 10 CFR 40.32(c). **This is a confirmatory item.**

URZ Response:

The NRC will have the opportunity to review and inspect control equipment prior to facility operation to ensure compliance with 10 CFR 40.32(c). This commitment will be added to Section 3.5 of the Technical Report.

Section 4.1 – Gaseous and Airborne Particulates

4.1.1 Uranerz has not provided information regarding how it plans to meet the requirement in 10 CFR 40.65 for reporting the quantity of each of the principal radionuclides released to unrestricted areas in gaseous effluents. 10 CFR 40, Appendix A, Criterion 8 states that milling operations must be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable (ALARA). The primary means of accomplishing this is by emission controls. Uranerz stated that the ventilation system will exhaust air from within the plant to outside the building but has not demonstrated how the gaseous effluents will be monitored and meet 10 CFR 40, Appendix A, Criterion 8. **This is an open issue.**

URZ Response:

As stated in NUREG 1910, *Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities*, Section 4.2.11.2.1, " ...radon gas is emitted from ISL well fields and processing facilities during operations and is the only radiological airborne effluent for those facilities that use vacuum dryer technology". The off gas treatment system and associated emission controls for the vacuum dryer system are described in Section 4.1 of the Technical Report and are ALARA by design. NRC recognizes that the emission of radionuclide particulates from this technology is essentially zero.

Regarding radon emissions, calculations performed in accordance with existing NRC guidance will be used to estimate source terms and calculate off site dose to the public. For example, Regulatory Guide 3.59, section 2.6 provides methods acceptable to NRC for estimating the radon source term during ISR operations. Additionally, NUREG 1569, Appendix D, provides the MILDOS – AREA methodology acceptable to the NRC, which includes expressions for calculating the annual radon 222 source terms from various aspects of ISR operations.

We believe the requirements for providing a semi annual report to NRC @ 10 CFR 40.65 of the quantity of each of the principal radionuclides released to unrestricted areas can be met through these methods since 40.65 does not specifically require "measurement". Furthermore, the disperse and diffuse nature of potential radon releases from multiple locations at ISRs makes empirical source term measurements impractical. However, the operational environmental monitoring program for Nichols ranch will provide for continuous radon monitoring at site boundary locations as described in section 5.7.7.2 of the Technical Report.

Throughout the 30 years of ISR operational experience in the US there is no evidence of public exposure from radon releases in excess of public exposure criteria. For example, NUREG 1910, Table 4.2-2 presents 9 dose estimates to offsite receptors solely from radon releases from ISR facilities, all of which are ≤ 40 mrem / yr. Further, section 4.2.11.2.1 states " all doses reported are well within the 10 CFR 20 annual radiation dose limit for the public of 1 mSv (100 mrem / yr)"

Accordingly, the methods proposed above are considered compliant, technically defensible and sufficiently protective.

4.1.2 Uranerz stated that the principal particulate radiological effluent is uranium and daughters released from the drying and packaging of yellowcake. Uranerz did not discuss radon progeny in potential effluent discharges containing particulates. While radon is a gas, its progeny are particulates that have not been discussed by Uranerz in the application. Uranerz should discuss particulates derived from radon progeny and how they will be sampled or accounted for in its effluent discharges. **This is an open issue.**

URZ Response:

Concentrations of both radon and progeny will be measured during operations at site boundary locations. As described in section 5.7.7.2 of the Technical Report, radon 222 gas will be measured using "alpha track" detectors (e.g., Radtrak detectors available from Landauer, Inc.) for the measurement of radon. Alpha track detectors will be exchanged and analyzed on a quarterly basis.

Radionuclide air particulates are measured at site boundary locations via filter paper collection and subsequent radiochemical analysis. Although no radionuclide particulates are expected to be released from modern ISRs (see NUREG 1910, *Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities*, Section 4.2.11.2.1 and response to Open Issue 4.1.1), particulate radon daughters are produced from the decay of their Radon 222 parent. The air particulate filters are analyzed on a quarterly basis for radionuclides including Pb 210, the representative long lived radon progeny that will survive during the time period from point of radon 222 release to point of potential exposure, filter collection and analysis.

4.1.3 Uranerz stated that during routine operations, the air pressure differential gauges for other emission control equipment is observed and documented at least once per shift during dryer operations. 10 CFR 40, Appendix A, Criterion 8 states that checks must be made and logged hourly of all parameters (e.g., differential pressures and scrubber water flow rates) that determine the efficiency of yellowcake stack emission control equipment operations. The Uranerz procedure does not appear to meet 10 CFR 40, Appendix A, Criterion 8. **This is an open issue.**

URZ Response:

Uranerz will implement procedures to satisfy requirements of 10 CFR 40, Appendix A, Criterion 8. Section 4.1.2 of the technical report is revised as follows

Instrumentation provides an audible and/or visual alarm if the vacuum level is how it intends to demonstrate compliance with 10 CFR 20.1101(d), 10 CFR 20.1301, and 10 CFR 20.1302. **This is an open issue.**

URZ Response:

Regarding determination of buildup of radon in buildings, air sampling will be routinely performed to assess concentration of radon progeny using the modified Kusnetz method. Measurements will be made throughout plant areas on a monthly basis. If concentrations exceed 10 % of the DAC in 10 CFR 20 Appendix B (> 0.03 Working Levels), sampling will be increased to weekly and working level (WL) – hrs of exposure will be calculated and assigned to worker exposure records. At concentrations > 25 % of the DAC (> 0.08 WL), the RSO will investigate potential causes and institute necessary correction actions. (See also response to Open Issue 5.7.1.1)

As described in response to open issue 4.1.1, release of airborne particulate emissions from ISRs with modern vacuum dryer technology is expected to be essentially zero and therefore compliance with the particulate dose limits @ 10 CFR 20.1101(d) is assured. The only source of exposure of the public from radiological emissions is from Radon. Regarding compliance to general public dose limits and related requirements at 10 CFR 20.1301 and .1302, only radon needs to be considered. Compliance is achieved by (1) radon monitoring at site boundary locations as described in response to Issue 4.1.2 and (2) Use of an approved dispersion and dosimetry code (e.g. MILDOS – Area , Argonne National Laboratory) to demonstrate compliance to 10 CFR 40.65 reporting requirements and the public exposure limits at 10 CFR 20.1301 and 20.1302.

Operational experience as previously documented by NRC in e.g., NUREG 1910, section 4.2.11.2.1 supports the above approach. Throughout the 30 + years of ISR operational experience in the US there is no evidence of public exposure from radon releases in excess of public exposure criteria. See response to Open Issue 4.1.1.

Section 4.2 – Liquids and Solids

4.2.1 Uranerz has not demonstrated that the deep well liquid waste disposal method and facilities proposed are adequate to handle production and restoration efforts. See earlier discussion. **This is an open issue.**

URZ Response:

Uranerz answered this question as part of 3.1.4

4.2.2 Uranerz will need to demonstrate UIC approval from WDEQ of the deep well injection wells and plans prior to operations. **This is an open issue.**

URZ Response:

Uranerz will demonstrate UIC approval from WDEQ for the deep disposal wells prior to injection. Uranerz will have permits from the WDEQ for deep well injection.

4.2.3 The plants at both units will have a concrete foundation with concrete curbed side walls. The height of the concrete sides would be such that the curbed foundation would contain the volume of the largest tank in the unit. Based on a recent accident at another ISR facility, the plans to contain only the volume of the largest tank may not be sufficient. **This is an open issue.**

URZ Response:

Sufficiently curbed concrete pads containing sump collection systems and supplemental fluid storage can definitely retain the volume of the largest vessel. The curbed concrete pad can hold 4.9 volumes of the largest tank or 490% for the Nichols Ranch Unit and 2.9 volumes of the largest tank or 290% for the Hank Unit. Although a catastrophic tank failure is not likely, it is reasonable to have a secondary containment system that will capture the fluids if this event were to occur. In addition to the fixed retention capacity of the pad, sumps and storage tanks, two other mechanisms come into play to assure adequate containment: (1) constant removal of fluid via sump pumps and (2) disposal well rate. To illustrate, fluid can be removed from the pad at Nichols Ranch at a rate of 150 gpm, and at Hank at a rate of 30 gpm and the disposal well rate is estimated to be 100 gpm.

A major leak in a vessel is one scenario that could produce a significant volume of fluid spilling onto the process pad but it is also possible that a pipeline could rupture and produce a significant release of fluid onto the pad. Assuming the largest diameter pipeline carrying uranium-bearing fluid from the wellfield was to rupture at its connection point on the process pad, approximately 3,500 gallons per minute of fluid could be contained for 29 minutes at Nichols Ranch and 2,500 gallons per minute could be contained for 23 minutes at Hank. This would be released before the fluid in the pipeline would be secured by the automated pressure fall off switches/shutdown valves. It should also be noted that the safety shutdown system will not be entirely dependent on automation, operators will be present 24 hours a day and they would take immediate action to control the situation. The 29 minutes for Nichols Ranch and 23 minutes for Hank should be adequate for operator or automatic shutdown.

Given the fluid retention/removal capacity described above, the pipeline spill would be safely captured. Instead of being routed to the disposal well, however, the uranium-bearing fluid would be pumped to the process circuit to recover the uranium. The sump pumps would be rerouted to the sand filters and then continue through the process. Immediately following the transfer of the lixiviant to the process circuit, the pad and sumps will be washed with clean water to remove any residual contaminants. Water from the cleaning operation will be pumped to the waste disposal well.

When viewed as an entire control system, it is clear that the proposed design will have a surplus of fluid retention capacity during routine operations and during two types of scenarios involving significant spills. A scenario resulting in a significantly larger spill would involve an extremely remote chain of events such as simultaneous tank failures or multiple tank failures coupled with pipelines breaking at the same time. Because the likelihood of such an event is extremely remote, it cannot be reasonably argued that such an occurrence should be considered to be a worst case scenario. Uranerz believes that the two types of significant spills provided herein are reasonable worst case scenarios.

4.2.4 Uranerz has committed to notifying NRC within 7 days if any disposal agreement is terminated, and submitting within 90 days of agreement termination, a new agreement for NRC approval. Prior to operation, Uranerz will need to provide the details of a waste disposal agreement for 11e.(2) byproduct material disposal at an NRC or Agreement State licensed facility. **This is a confirmatory item.**

URZ Response:

Prior to operation, Uranerz will provide the NRC the details of a waste disposal agreement for 11e.(2) byproduct disposal at an NRC or Agreement State licensed facility. Uranerz also commits to notify the NRC within 7 days if any disposal agreement is terminated, and submitting within 90 days of agreement termination, a new agreement for NRC approval. This commitment will be added to Section 4.2.2.2 of the Technical Report.

4.2.5 In the application, it was unclear if Uranerz will temporarily store contaminated 11e.(2) solid waste. If there are temporary waste sites, Uranerz needs to discuss what controls will be required. **This is a confirmatory item.**

URZ Response:

The storage of contaminated equipment, including wastes, will be in the fenced-plant boundary for the Nichols Ranch Unit and the Hank Unit. The amount of 11e(2) byproduct material stored at the Nichols Ranch Unit and Hank Unit will be kept to a minimum. The byproduct material from the plants will be placed into 55-gallon drums with drum liners. The drums will be located in designated signed areas inside the plants. After a drum is full it will be moved to the plant's 11e(2) byproduct storage area, and the contents placed in a strong tight roll-off container. If material such a pipe is too large to fit in the drum, the large material will be placed in the specific plant's byproduct storage area. The storage areas are shown on the revised diagrams: Figure 3-1 Site Facility Diagram Nichols Ranch Unit and Figure 3-2 Site Facility Diagram Hank Unit. The areas will have concrete pads and appropriate signage. The strong tight containers will follow DOT regulations, and typically be covered roll-off containers with an estimated capacity of 20 cubic yards. After a roll-off container is filled, it will be transported to an approved 11e(2) byproduct storage facility.

In the wellfields outside the plant areas there will be some temporary storage of equipment and supplies that are needed for wellfield construction. Equipment and materials that are not releasable for unrestricted use and are not amenable to placement in a container will be stored to prevent dispersion and migration of contamination; e.g. decontamination of removable or covering to prevent weathering. The wellfield sites will be minimized, have appropriate signage, and will be within the wellfield fenced boundary.

Section 5.7.1 - Effluent Control Techniques

5.7.1.1 The staff cannot determine if the ventilation process is adequate to ensure that radon daughter concentrations in the facility are maintained below 25% of the derived air concentration (DAC) from 10 CFR 20, and if controls will ensure all airborne releases are ALARA consistent with 10 CFR 40, Appendix A, Criterion 8. **This is an open issue.**

URZ Response:

A. Ensuring radon daughter concentrations in the facility are maintained ≤ 25% of the DAC: Section 4.1.1 of the Technical report describes both the general plant ventilation system and local ventilation systems that will be used to maintain concentrations of radon and progeny below 25% of the DAC. Systems independent of general area ventilation will provide local ventilation for process vessels where significant quantities of radon could reasonably be expected to be released. These systems will consist of ducting or piping near the expected point of release for the respective process vessel. Fans will collect gases through the ducting or piping and exhaust outdoors. Airflow through openings in the vessels will be from the process area into the vessel and into the ventilation system, thus controlling any releases that occur inside the vessel. Local (tank/vessel) ventilation systems of this kind have demonstrated effectiveness over many years to control employee exposure to radon and progeny to ALARA levels. (See e.g., Brown S, 2007, *Radiological Aspects of In Situ Uranium Recovery*. American Society of Mechanical Engineers, Proceedings of 11th International Conference on Environmental Management, Bruges, Belgium, September; ASME Press, New York, NY, ISBN 0-7918-3818-8 and Brown S, 2009, *Design Improvements and ALARA at U.S. Uranium In Situ Recovery Facilities*, American Society of Mechanical Engineers, Proceedings of the Twelfth International Conference on Environmental Management (ICEM 09), Liverpool, UK, October, ASME Press, New York, ISBN to be assigned)

Routine air sampling will be conducted in plant areas where workers are potentially exposed to radon and progeny (primarily front end areas associated with IX and elution). Radon gas monitoring will be performed via use of passive alpha track-etch type detectors. Radon progeny monitoring will be conducted via the modified Kusnetz method of air particulate filter collection and analysis. (see also response to Open Issue 4.1.4)

Quarterly sampling for radon daughters will be made where previous measurements have shown the daughters are not generally present in concentrations exceeding 0.03 working levels (≤10% of the limit). Monthly measurements of radon daughter concentrations will be made where radon daughters routinely exceed 10% of the limit or 0.03 working levels above background and exposures (e.g., "WL hrs") will be assigned to workers as part of their permanent exposure records. If radon daughter concentrations are normally greater than 0.08 working levels or radon concentrations are above 7.5 x 10-9 µCi/ml (> 25% of either limit), the sampling frequency will be increased to weekly.

Sampling will continue to be performed weekly until four consecutive weekly samples indicate concentrations of radon daughters below 0.08 working level.

B. Ensuring all airborne releases are ALARA and consistent with 10 CFR 40, Appendix A, Criterion 8.

B.1 Air Particulate Radiological Effluents: NUREG-6733, "A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees" (NRC, 2001) discusses the available technologies for drying and packaging yellowcake:
"Two kinds of yellowcake dryer are used: multihearth dryers and vacuum dryers. Older plants use gas-fired multihearth dryers. These dryers typically dry the yellowcake at about 400 to 620 degrees C (750 to 1,150 degrees F)...The offgas discharge from the dryer is scrubbed with a high intensity venturi scrubber that has a 95 to 99 percent efficiency for removal of uranium particulates prior to release to the atmosphere. Solutions from the scrubber are normally returned to the precipitation circuit and are processed to recover any uranium particulates. As a result, the stack discharge normally contains only water vapor and quantities of uranium fines that are well below regulatory limits".

NUREG-6733 then describes the off gas emission control systems for vacuum dryers: *First, vapor passes through a bag filter to remove yellowcake particulates with an efficiency exceeding 99 percent. Any captured particulates are returned to the drying chamber. Then, any water vapor exiting the drying chamber is cooled and condensed. This process is designed to capture virtually all escaping particles.*

The impact analysis contained in NUREG-1910, "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities" as it relates to impacts from airborne radioactive effluents was based on the analysis in NUREG-6733. NUREG-1910 determined that air quality impacts due to the release of radiological effluents would be SMALL.

10 CFR Part 40, Appendix A, Criterion 8 states: *Milling operations must be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable. The primary means of accomplishing this must be by means of emission controls.*

Uranerz has proposed the use of vacuum drying technology for the Nichols Ranch project. As noted in NUREG-6733, vacuum dryer technology provides an emission control approach to ALARA at the source that exceeds 99% (relative to the 95 to 99 percent efficiency of multihearth dryers) and "*is designed to capture virtually all escaping particles*". Furthermore, it is also of importance to note that NUREG 1910, section 4.2.11.2.1 explains " radon gas is emitted from ISL well fields and processing facilities during operations and is the only radiological airborne effluent for those facilities that use vacuum dryer technology". Therefore, the use of a vacuum dryer as an emission control method by definition is "as low as reasonably achievable" and complies with the requirements of 10 CFR Part 40, Appendix A, Criterion 8.

B.2 Radon Effluents:

The Nichols Ranch design includes the use of pressurized down flow ion exchange columns. NUREG-1910 in section 2.7.1 notes:

Pressurized processing systems may contain most of the radon in solution; however, radon may escape from the processing circuit in the central uranium processing facility through vents or leaks, during well field operations, or during resin transfer when remote ion exchange is used. For open air activities, the gas quickly disperses into the air. In closed processing areas, the building ventilation systems are designed to limit indoor radon concentrations.

As noted, pressurized ion exchange systems contain most of the radon gas present in the lixiviant. In these systems, radon gas may be released during venting and resin transfer operations. These releases of radon gas are collected in vessel venting systems and directed outside the plant through blowers and discharge stacks to maintain radon and progeny concentrations within the plant to levels that are ALARA relative to potential worker exposure. Plant buildings are ventilated through the use of general area ventilation to remove any radon and progeny present from leaks in an effort to further reduce worker exposure.

The alternative to pressurized down flow ion exchange columns typically employed for ISL mining is up flow atmospheric ion exchange columns. These columns release virtually all of the radon gas present in the lixiviant. The radon gas is usually collected at the ion exchange columns and exhausted outside the plant through ventilation systems and stacks.

Accordingly, the use of pressurized down flow ion exchange columns at Nichols Ranch is an "ALARA design approach" since it will reduce the radon gas emissions relative to other ion exchange technologies and represents an emission control method that reduces emissions to levels that are as low as reasonably achievable and complies with the requirements of 10 CFR Part 40, Appendix A, Criterion 8. Further, the use of these ion exchange systems coupled with tank and area ventilation systems ensures that worker exposure to radon and its progeny is maintained ALARA through the use of engineering control. See also responses to Open Issues 4.1.1, 5.7.1.1 and Brown, 2009 previously cited.

Accordingly, the process design and emission control methods described above are considered technically prudent, sufficiently protective and fully compliant with ALARA requirements of 10 CFR 40, Appendix A, Criterion 8.

5.7.1.2 The staff cannot determine if the operational monitoring program required in 10 CFR 40, Appendix A, Criterion 7 includes sampling that effectively evaluates the performance of control systems, procedures and environmental impacts of operations. In addition, Uranerz must identify if the areas affected by effluent controls are restricted or unrestricted areas to ensure compliance with 10 CFR 20.1101. **This is an open issue.**

URZ Response:

The operational monitoring program for construction and operation of the Nichols Ranch ISR is described in the Technical Report at Section 5.7.7. The sampling and analysis requirements of the program are developed from NRC Regulatory Guide 4.14 "Radiological Effluent and Environmental Monitoring at Uranium Mills," Revision 1, 1980. The results of the program will be provided to NRC pursuant to 10 CFR 40.65.

The Technical Report will be revised as follows at Section 5.7.7.2 to include collection of air samples for particulate.

5.7.7.2.1 Air Particulate

Air particulate samples will be collected continuously at the same locations as the pre-operational air particulate sampling. The air particulate samples will be collected continuously. The filters will be changed weekly or more often as required by dust loading. The filters will be composited quarterly per location. The composite samples will be analyzed for total uranium, Th-230, Ra-226, and Pb-210.

The existing text of Section 5.7.7.2 will be moved to new Section 5.7.7.2.2 Radon.

The response to open issue 5.7.7.2 addresses the restricted/unrestricted issue.

Section 5.7.2 - External Radiation Exposure Monitoring Program

5.7.2.1 Uranerz stated that survey instrumentation will cover a range of 0.010 mrem/hr to 5 mrem/hr. However, Uranerz has not discussed whether it will have sufficient instrumentation to measure gamma dose rates in excess of 5 mrem per hour. 10 CFR 20.1501(a)(2)(i) states that the licensee shall make or cause to be made surveys that are reasonable under the circumstances to evaluate the magnitude and extent of radiation levels. Uranerz has not shown that it will have sufficient instrumentation to evaluate the magnitude and extent of radiation levels. **This is an open issue.**

URZ Response:

Section <u>5.7.2.2 Exposure Rate Surveys</u> included a typographical error; five mrem has been revised to read five rem. Instruments used to conduct exposure rate surveys are described in a response to Request for Additional Information 5.7.2 d of 11 March 2009.

5.7.2.2 Regulatory Guide 8.30 recommends that, in addition to gamma surveys, beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake be performed to ensure that extremity and skin exposures are not unduly high. Uranerz did not discuss beta surveys nor provide information on the lower limits of detection on the beta and gamma radiation survey instruments. Uranerz did not indicate in the application that beta surveys will be performed and if the monitoring equipment has a lower limit of detection that allows measurement of 10% of the applicable limits. **This is an open issue.**

URZ Response:

Beta exposure rate surveys will be performed at the specific operations that involve direct handling of large quantities of aged yellowcake. This would include in plant areas associated with precipitation, dewatering (filter press) and drying/packaging. These surveys will be performed near the surface of the material (e.g., within 10 cm) so as to be representative of beta exposure rates to workers' hands and skin during the handling of the material. Surveys will be performed at initiation of operations and subsequent surveys and/or beta evaluations will be performed whenever procedural and/or equipment changes could affect the beta levels to which employees may be exposed. Any beta exposure rate evaluations for these operations that are performed in lieu of instrument surveys will use the information provided in Regulatory Guide 8.30 Figures 1 and 2. Should evaluations and/or measurements indicate workers could be exposed to levels > 10% of the limits for shallow-dose equivalent to the skin of the whole body or to the skin of any extremity specified @ 10 CFR 20.1201(a)(2)(ii), finger and/or wrist TLD badges will be used in addition to "whole body" TLDs.

Beta contamination surveys will similarly be performed in these same plant areas initially and whenever procedural and/or equipment change may increase risk of beta contamination. These surveys will be performed with a Ludlum 43-1-1 alpha – beta phoswich scintillation probe or equivalent. This probe has an active window area of 83 cm^2, rated efficiencies of 30% alpha (Pu ^{239}) and 30% beta (Sr ^{90} / Y ^{90}) and typical backgrounds of 3 cpm alpha and < 300 cpm beta. However, it should be recognized that there are no process mechanisms by which the beta emitters Th 234 or Pa 234 can be separated from their alpha emitting uranium parents and therefore there cannot be "beta contamination" in the absence of detectable alpha. (Maximum beta possible would when Th 234 / Pa 234 are at equilibrium with the uranium at approximately 4 months post mining)

5.7.2.3 Uranerz has not discussed records and reporting requirements associated with the external radiation exposure monitoring program. Uranerz should provide a description of how its external radiation exposure monitoring program will meet the requirements of 10 CFR 20, Subpart L, which specifies record keeping requirements and 10 CFR 20, Subpart M, which defines reporting requirements. **This is an open issue.**

URZ Response:

The Technical Report at Section 5.2.1.3 Record Keeping will be revised to include the statement "Records of surveys and monitoring will be maintained in accordance with 10 CFR 20 Subpart L." Records of surveys include documentation of the results of exposure rate and dose rate surveys, and respective instrument calibrations. Records of monitoring include documentation of the results of personnel monitoring described in the Technical Report at Section 5.7.2.1 Personnel Monitoring the results of exposure rate and dose rate surveys used to supplement results of personnel monitoring.

The Technical Report at Section 5.2.1.4 Reporting includes a commitment to report results of personnel monitoring in accordance with 10 CFR 20 Subpart M.

5.7.2.4 Uranerz described the ALARA policy and management's commitment to ALARA in Section 5.1.1. However, Uranerz does not describe how emission controls will be implemented on ventilation systems to ensure airborne effluent releases of radon and radon progeny from the liquid phases of the ISR processes will be reduced to ALARA.

URZ Response:

See responses to items 4.1.1 and 5.7.1.1 above.

5.7.2.5 Uranerz does not describe how the operational effluent and environmental monitoring programs will include sampling that will detect possible long-term effects and evaluate performance of control systems, procedures, and environmental impacts of operations as required by 10 CFR 40, Appendix A, Criterion 7 and 8.

URZ Response:

See responses to items 4.1.1 and 5.7.1.1 above.

Section 5.7.3 - Airborne Radiation Monitoring Program

5.7.3.1 Uranerz indicated that measurement of airborne uranium will be performed by gross alpha counting of the air filters for uranium air particulates. Uranerz has not provided justification that the air filters will contain only uranium or explained how it will evaluate a mixture of radionuclides including uranium and its progeny, Th-234 and Pa-234. Gross alpha counting of the air filters will not be able to differentiate specific radionuclides. Thus, Uranerz may not be able to accurately determine if the action level for uranium or its progeny has been reached by relying on gross alpha counting of the air filters. **This is an open issue.**

URZ Response:

Specifically regarding the potential for radionuclide mixtures in air containing the short-lived beta emitters Th -234 and Pa -234, it must be recognized that in growth from the freshly extracted uranium product takes approximately 4 months to reach equilibrium. Accordingly, very little, if any Th -234 or Pa-234 would be expected to be present in the active processing areas of an ISR. Additionally, the DACs for these two nuclides are several orders of magnitude higher than for Unatural. Controlling to the DAC for U nat (even using D or W solubility class), ensures any contribution in the mixture from these two beta emitters will meet the exclusion allowance in 10 CFR §20.1204(g). See the more general discussion that follows.

In general terms, regarding any potential combination of nuclides in air at ISRs (e.g., long lived alpha emitting progeny of uranium), it is important and fundamental to recognize the radiological environment of a modern ISR as related to the potential radionuclides of concern that could become airborne. Studies performed in the late 1970s and early 1980s of radionuclide mobilization from several ISRs and subsequent measurements at operating ISRs indicate a relatively small portion of the uranium daughter products in the ore body are actually mobilized by the lixiviant. (See e.g., Brown, S. 1982, *Radiological Aspects of Uranium Solution Mining*, In: Uranium, 1, 1982, p. 37-52, Elsevier and Brown, S, 2007, *Radiological Aspects of In Situ Uranium Recovery.* American Society of Mechanical Engineers, Proceedings of 11th International Conference on Environmental Management, Bruges, Belgium, September; ASME Press, New York, NY, ISBN 0-7918-3818-8)

The vast majority of secular equilibrium radionuclides remain in the host formation. This is one of the recognized public health and safety benefits of ISR mining when compared with conventional milling. In these studies, thorium-230 appeared to equilibrate and very little was actually removed by the process. The majority of the mobilized radium-226 (80—90 percent), which was estimated to be approximately 5 to 15 percent of the calculated equilibrium radium in the host formation, followed the calcium chemistry in the process and resulted in radium carbonates/sulfates in the calcite byproduct waste streams. Little, if any, lead-210 was mobilized, as the lead carbonate complexes formed in situ are virtually insoluble in the lixiviant processes studied.

In addition to the fact that very little of these uranium daughter products are mobilized in situ, the ion exchange (IX) resin used in ISR facilities is specific for removal of uranium. Thorium compounds are not removed by the IX resin and are therefore not present in the process downstream of the IX columns (e.g., elution, precipitation, and drying circuits). Accordingly, the "nuclide mix" that can potentially become airborne in the precipitation, drying and packaging areas of a modern ISR is expected to be almost exclusively Unat. Ingrowth of the first few short lived daughter products (Thorium 234, Protactinium 234) takes 4+ months to reach equilibrium and therefore is not expected to be associated with relatively fresh product.

Additionally, it should be noted that in accordance with 10 CFR §20.1204(g), nuclides can be ignored in a mixture in air if the total activity in the mixture is used to determine compliance with §20.1201 and §20.1502(b) and any nuclides ignored are < 10% of the mixture and the sum of all nuclides ignored are < 30% of the mixture. For modern ISRs, these conditions are expected to me met.

In order to establish that natural uranium isotopes are the exclusive alpha emitting radionuclides of concern in airborne particulate samples at Nichols Ranch, Uranerz will prepare composite samples from each of the air particulate monitoring locations noted in Figures 2-25 and 2-26 of the Technical Report. These sample locations will adequately characterize various points in the process (e.g., lixiviant, precipitation, and drying/packaging areas). These samples will be submitted to a laboratory for radioisotopic analysis. Samples will be analyzed for U nat (total uranium) Th-230, and Ra-226. Uranerz will compare the results of these samples with mixture requirements in 10 CFR §20.1204(g) to ensure that the appropriate DAC from 10 CFR 20 Appendix B Table 1 is used. If necessary, a "sum of fractions rule" will be applied to establish the appropriate DAC. Time studies of job functions will be performed (or actual time workers are in process areas) and DAC – hrs of exposure estimated on weekly basis whenever air monitoring indicates workers were exposed to airborne concentrations > 10% of the DAC (which may be an "effective DAC" using sum of fractions as described above). Dose assignment will be based on the ratio of DAC-hrs of exposure to 2000 DAC –hrs /yr X 5 Rem.

Section 5.7.4 - Exposure Calculations

5.7.4.1 The staff commented in the RAI that it could not determine how Uranerz derived the basis for the "D" solubility class for natural uranium. In the response to the RAI, Uranerz cites a journal article by Metzger et al. (1997) to support its use of "D" solubility class and states the revised Chapter 5 cites Regulatory Guide 8.30 as a reference for the basis. Uranerz' response and revision does not demonstrate that calculations will comply with 10 CFR 20.

Regulatory Guide 8.30 does not provide specific guidance on which inhalation class should be applied to uranium recovery operations, other than to consider yellowcake "soluble" if dried at low temperatures. This terminology does not comport with the current regulatory basis of 10 CFR 20, Appendix B, which uses a three-tiered system of inhalation classes; D, W, and Y. Furthermore, the regulations do not specifically address the carbonate and peroxide forms of uranium that are relevant to the ISR operations. Additionally, Metzger et al. concludes that the airborne concentrations of uranium in the wet process and drum loading area where uranyl peroxide is the primary chemical form of uranium will be considered 97% class D and 3% Class W.

10 CFR 20.1204c(3) states that when specific information on the physical and biochemical properties of the radionuclides is known, the licensee may assess the contribution of fractional intakes of Class D, W, or Y compounds from 10 CFR 20, Appendix B to the committed effective dose equivalent. 10 CFR 20.1204(e) states that if the concentration of each radionuclide in a mixture are known, the fraction of the DAC used in calculating DAC-hours must be either: (1) the sum of the ratios of the concentration to the appropriate DAC value, or (2) the ratio of the total concentration to the most restrictive DAC value for any radionuclide in the mixture. However, Uranerz does not know the concentration or the chemical components of the uranium compounds in the ISR process. Uranerz has not demonstrated how exposures will be calculated. **This is an open issue.**

URZ Response:

Uranium will be present at the facility exclusively in relatively soluble forms i.e., uranyl carbonates, (various forms) uranyl trioxide (UO_3), uranyl peroxide (UO_4) and their hydrates. The lixiviant uses oxygen and carbonate to dissolve and mobilize the uranium minerals in situ. Accordingly, the uranium goes into solution as a carbonate. If the uranyl carbonates formed were not very soluble, the in situ mining process could not work.

However, when acid is added to the precipitation cell the carbonate complexes are destroyed and disassociate to form uranyl ions. When hydrogen peroxide is added to the precipitation vessel, the uranium is oxidized further to form uranyl peroxide (UO_4*nH_2O). When dried by the vacuum drier at relatively low temperature, a combination of UO_4, UO_3 and their hydrates will result.

Although specific studies and references on solubility (e.g., in vitro solubility studies in simulated lung fluids, historical animal studies, etc.) for UO_4 are sparse (a few specific references are provided below), numerous references appear in the literature over 30 + years regarding general solubility characteristics of industrial uranium compounds (representative list also provided below). The UO_4 and UO_3 products should be ICRP 19 class D or W (most or moderately soluble), which is equivalent to ICRP 66 class F or M (fast or medium dissolution). See ICRP 19, Task Group on Lung Dynamics *Metabolism of the Compounds of Plutonium and Other Actinides* (1974) and ICRP 66 *Human Respiratory Tract Model for Radiological Protection (1994).* It is also of note that ICRP 54, *Individual Monitoring for Intakes of Radionuclides by Workers*, which assigns Class W to UO_3 indicates " ...there is evidence from animal studies that industrial uranium trioxide may behave more like a class D material ". (Note: Uranerz recognizes that the current approved version of 10 CFR 20 is ICRP26/30 based. References above to subsequent revisions of ICRP dosimetric models are provided for illustrative purposes only). The issue of assumed solubility class is critical in establishing the appropriate DAC for defining air-monitoring parameters for worker airborne exposure control and dose assessment.

The following provides support for a Class D or W designation for UO_4:

- RG 8.30 calls out UO_4 specifically: "Yellowcake dried at low temperature, which is predominantly composed of ammonium diuranate, or in the new processes uranyl peroxide, both are more soluble in body fluids than yellowcake dried at higher temperature and a relatively large fraction is rapidly transferred to kidney tissues"

- Reference: *Proposed Standards for Acute Exposure to Low Enriched Uranium for Compliance with 10 CFR 70.61*, Kathren R.L and Burklin R.K., Operational Radiation Safety, V. 95.2. August 2008 Page S123 – "...the more soluble compounds of uranium such as.... and UO4 are more quickly absorbed into the blood and therefore exhibit toxic effects in moderate doses"

- Reference: *Solubility Characteristics of Airborne Uranium From an In Situ Uranium Processing Plant.* Metzger R, Wichers D. et al. Health Physics 72.3, March 1997 p 418. Results indicated airborne U in wet process area = 97% with dissolution $T_{1/2}$ = 0.3 days; airborne U in drum load out area = 97% with dissolution $T_{1/2}$ = 0.25 days. NRC staff makes reference to this study in context of a "split DAC". However, the results of this study indicated airborne U in both the wet process and drum load out areas of 97% dissolution with half times <0.5 day. These results are clearly indicative of a TGLD Class D or ICRP 66 Class F compound. Several of the published studies referenced below do in fact present results suggesting "di" (2) or "tri" (3) phased dissolution patterns indicative of mixtures of uranium compounds of differing solubility classes (U_3O_8 plus UO_3, e.g.). However, based on reported results, the study referenced here is clearly a single-phase dissolution pattern, i.e. single solubility class, single DAC and it is Class D. (Since the secondary "W" component is reported at only 3%, use of the < 10% exclusion rule similar to that allowable for mixtures of radionculides in air @10 CFR 20.1204(g) would seem to be appropriate)

Examples of some additional references that specifically address solubility and solubility class of uranium mill and related uranium fuel cycle uranium compounds are provided below:

1. *Preliminary Study of Uranium Oxide Dissolution in Simulated Lung Fluid.* R.C. Scipsick, et al, Los Alamos National Laboratory report LA – 10268-m, UC-41, Jan, 1985
2. *The Solubility of Some Uranium Compounds in Simulated Lung Fluid*, N. Cook and B Holt, Health Physics 27, 69-77,1974
3. *In Vitro Solubility of Yellow Cake Samples from Four Uranium Mills and Implications for Bioassay Interpretation*", A, Eidson and J. Mewhinney, Health Physics 39, 893-902, 1980
4. *Toxicological profile for uranium (Update).* Prepared by Research Triangle Institute for U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. September 1999.
5. *Biokinetics model for uranium inhalation/excretion of uranium mill workers.* Alexander R.E In: Moore RH, Ed. Biokinetics and analysis of uranium in man. United States Uranium Registry Report USUR-05, HEHF-47, 1984.
6. *Dissolution Fractions and Half Times of Single Source Yellowcake in Simulated Lung Fluids.* M. Blauer, J Kent and N Dennis, Health Physics 42, 469-477, 1982
7. *Characterization of Yellowcake and Implications for Uranium Mill Bioassay.* S Brown and M. Blauer, proceedings of Conference on Analytical Chemistry and Bioassay, Ottawa, October, 1980
8. *Physical and Chemical Parameters Affecting the Dissolution of Yellowcake in Simulated Lung Fluids.* Brown S and Blauer M. Abstracts of the 25th Annual Meeting of Health Physics Society, Seattle, Paper # 177, Pergamon Press, 1980
9. *Biokinetics and Analysis of Uranium in Man.* Proceedings of Colloquium held at Richland, Washington, August, 1984, United States Uranium Registry, R Moore ed., USUR – 05 HEHF-47

Conclusion: Although evidence suggests that both the wet process UO_4 and dried UO_3 products of modern ISRs in general and Nichols Ranch specifically will be ICRP 19 Class D or ICRP 66 Class F compounds, we will assume them to be Class W / Class M for purposes of establishing the initial DAC upon plant startup. Studies on Nichols Ranch products involving dissolution studies in simulated lung fluids may be performed in accordance with the established protocols (well documented in the literature – examples above) to establish if Class D / Class F may be more appropriate. This is appropriate to define not only the relevant DAC, but also to verify assumptions of appropriate sampling frequencies and action levels for the plant uranium bioassay program. See also response to open issue 5.7.3.1 that discusses how we will evaluate potential for mixtures of radionuclides in air, determine the appropriate DAC and calculate resultant dose.

5.7.4.2 Uranerz did not account for the possibility of other radionuclides that may be present in air. According to 10 CFR 20.1204(f), if the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture must be the most restrictive DAC of any radionuclide in the mixture. Uranerz needs to identify all radionuclides and concentrations that may exist in air and determine the dose from this mixture. **This is an open issue.**

URZ Response:

See response to open issue 5.7.3.1

5.7.4.3 10 CFR 20.1201(e) states that in addition to the annual dose limits, the licensee shall limit the soluble uranium intake by an individual to 10 milligrams per week in consideration of chemical toxicity. Uranerz has not described in this section how it will monitor and keep records of this requirement. **This is an open issue.**

URZ Response:

Intake of soluble uranium will be limited to 10 mg per week per 10 CFR 20.1201(e). Accordingly, at an assumed specific activity of 0.67 µCi/gram for Unat (10 CFR 20, Appendix B, footnote 3), the weekly soluble intake limit is 6.7 E-3 µCi. Initially, solubility Class W will be used to establish the appropriate ALI of 0.8 µCi and DAC of 3 E-10 µCi/ml for U natural (10 CFR 20, App B, Table 1). Assuming a 40 hour work week and average breathing rate of 20 liters/min, the average concentration at the soluble weekly intake limit is approximately equal to 50% of the DAC. Compliance to this requirement will be documented by recording of worker airborne exposure in DAC – hrs, whenever long lived particulate concentrations in air are determined to be ≥ 10 % DAC and an action level of 25% DAC will be established requiring RSO investigation and potential corrective actions. Assignments of positive airborne exposure will be reviewed weekly. Accordingly, any exposures to soluble uranium > 20 % of the 10 mg/week limit will in fact be recorded (as DAC –hrs) and controlling exposure to 25% of DAC ensures both that the 10 mg / week limit is not exceeded and ALARA. Worker exposure to soluble uranium will be assessed via standard grab and breathing zone sampling particulate filtration techniques and subsequent analysis of radionuclide content of filter papers. See also response to Open Issue 5.7.3.1.

5.7.4.4 Uranerz states that any employee may request a written report of their exposure history at any time. These reports will be provided within 30 days of the request and will provide the information as discussed in 10 CFR 19.13. Uranerz does not identify any reporting requirements of reports to individuals exceeding dose limits as defined in 10 CFR 20.2005. **This is an open issue.**

URZ Response:

Uranerz will provide reports to individuals in accordance with 10 CFR 19.13 Notifications and reports to individuals and 10 CFR 20 Subpart M – Reports.

Section 5.7.5 - Bioassay Program

5.7.5.1 Uranerz has not demonstrated the technical basis for selecting the "D" solubility class for airborne uranium. NRC staff cannot determine if the proper classification and DAC is being used to show compliance with 10 CFR 20, Subpart C. **This is an open issue.**

URZ Response:

See response to open issue 5.7.3.1 and 5.7.4.1

5.7.5.2 In addition to the dose limit, Uranerz is also required to limit the soluble uranium intake by an individual to 10 milligrams (mg) in a week in consideration of chemical toxicity. This requirement is defined in 10 CFR 20.1201(e). Uranerz did not discuss how it will limit the soluble uranium intake by an individual to 10 mg per week. **This is an open issue.**

URZ Response:

See response to open issue 5.7.4.3

5.7.5.3 Uranerz needs to provide a technical basis for how the uptake will be converted to a dose as assigned to the individual in accordance with 10 CFR 20, Subpart C. **This is an open issue.**

URZ Response:

Dose calculations to workers will be performed in accordance with the guidance contained in Regulatory Guide 8.30 Section 3 – Intake and Exposure Calculations and Regulatory Guide 8.34 Section 3 - Calculation of CEDE from Inhalation. The primary method of assigning occupational dose to workers will be via use of the stochastic inhalation ALIs and/or DACs per methods 1 and 2 respectively as described in Regulatory Guide 8.30, Section 3. (Ratio of calculated intake to ALI X 5 Rem or ratio of DAC-hrs of exposure to 2000 DAC-hrs / yr X 5 Rem). However, confirmed bioassay results may need to be used in cases where the estimated dose could approach or exceed annual limits and/or it is determined by the RSO that the confirmed bioassay results may provide greater accuracy or be more representative of actual intake than relying exclusively on air sampling results and related calculations. The methods and assumptions described in Regulatory Guide 8.9, NUREG 0874, *Internal Dosimetry Models for Application to Bioassay at Uranium Mills* and/or HPS N 13.22 – 1995, *Bioassay Programs for Uranium*, will be used to estimate and assign internal dose using bioassay results

5.7.5.4 Uranerz does not indicate that it will obtain prior dose histories for all employees in accordance with 10 CFR 20.2104(a)(2) and (c). The prior dose history may be an NRC Form 4 (or equivalent) signed by the individual monitored, or a written statement that includes the names of all facilities that monitored the individual for occupational exposure to radiation during the current (or previous) year and an estimate of the dose received. **This is an open issue.**

URZ Response:

Uranerz will obtain prior dose histories of all employees in accordance with 10 CFR 20.2104 Determination of prior occupational dose.

Section 5.7.6 - Contamination Control Program

5.7.6.1 Uranerz does not address conducting surface contamination surveys of unrestricted or clean areas of the facility. Frequent contamination surveys of work areas, restrooms, lunchrooms, hallways, etc., are needed to ensure contamination is controlled properly and that employees are following procedures and not transferring radioactivity in unrestricted areas. The staff cannot determine if surveys of unrestricted areas will be conducted. **This is an open issue.**

URZ Response:

The Technical Report at Section 5.7.6.2 will be revised to include requirements for weekly and monthly surface contamination surveys of unrestricted areas of the facility. The section title change and paragraph will be inserted in the Section 5.7.6.2 of the Technical Report.

<u>5.7.6.2 Surveys for Surface Contamination in Controlled and Unrestricted Areas</u>

A survey for each of total alpha and total beta/gamma contamination will be made weekly within the unrestricted area. The scope of this survey will include break areas, eating areas, change rooms, and offices. The total alpha contamination limit for these surveys is 1000 dpm/100cm^2. The total beta/gamma contamination limit for these surveys is 1000 dpm/100cm^2.

5.7.6.2 Surveys of controlled areas will be conducted monthly. Uranerz stated that the action level for surface contamination in these areas will be 1000 dpm/100 cm^2. This represents the contamination limits for natural uranium and progeny for equipment to be released for unrestricted use as defined in Table 2 of Regulatory Guide 8.30. However, the removable contamination limit for Ra-226 is 20 dpm/100 cm^2 according to Enclosure 2 to Policy and Guidance Directive 83-23. Uranerz has not demonstrated that it can account for and detect Ra-226 as well as other naturally occurring daughter products that may be present as a result of the uranium recovery operations, such as Th-230. The staff cannot determine that Uranerz proposed program will be consistent with Enclosure 2 to Policy and Guidance Directive 83-23 nor that it will meet the requirements in 10 CFR 20 Subpart F. **This is an open issue.**

URZ Response:

We recognize that NRC has indicated that Regulatory Guide 8.30, *Health Physics Surveys at Uranium Recovery Facilities* will be revised and may address this issue. Until such time as this revision is officially promulgated, Uranerz provides the following discussion and approach on how we will meet current NRC requirements in 10 CFR 20 Subpart F, Policy and Guidance Directive 83 - 23 and related guidance.

In response to this issue, it is important and fundamental to recognize the radiological environment of a modern ISR as related to potential radionuclides of concern for which contamination surveys must be performed and unrestricted release limits established. This is discussed in response to Open Issue 5.7.3.1 in the context of air sampling.

Accordingly, the existing, approved NRC guidance for unrestricted release of equipment / clearance limits for "Unat, U-235, U-238 and associated decay products" are applicable and appropriate for ISR plants as described in NRC Regulatory Guide 8.30, *Health Physics Surveys in Uranium Recovery Facilities,* 2002 (RG 8.30). Section B, *Discussion* indicates, " The contents of this guide conform with NRC's current licensing practice". We are unaware of any revisions of RG 8.30, subsequently issued NRC regulatory guides and/or NRC rules and regulations that supersede the continued use of RG 8.30 as issued in 2002. Our understanding of these issues in support for these conclusions follows.

Recommended surface contamination limits are defined in RG 8.30 in its Table 2 entitled *Surface Contamination Levels for Uranium and Daughters on Equipment to be Released for Unrestricted Use, on Clothing and on Non Operating Areas of UR Facilities.* A footnote to RG 8.30 Table 2 indicates the stated contamination levels are taken from Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors* and from *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct Source or Special Nuclear Material,* August 1987. It is also of interest to note that Policy and Guidance Directive FC 83-23, *Termination of Byproduct Source and Special Nuclear Material* (1983), referenced by NRC staff, uses the 1982 version of *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct Source or Special Nuclear Material,* as its ENCLOSURE 2 with the identical radionuclide categories and contamination limits as the 1987 version as well as with RG 1.86.

Accordingly, FC - 83-23 including its Enclosure 2 (both the 1982 and 1987 versions of *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct Source or Special Nuclear Material)* use identical radionuclide categories and quantitative limits although the 1987 document also specifies dose rate guidance (mrad/hr for beta gamma emitters)· Therefore the radionuclide categories, limits and intended application of FC 83-23, of *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct Source or Special Nuclear Material* (1982 and 1987), Regulatory Guide 8.30 and Regulatory Guide 1.86 are all consistent.

Since the title of RG 8.30 Table 2 indicates applicability of the table's values to uranium *and its daughters* (emphasis added), it is reasonable to assume that is was clearly intended to be applied to uranium recovery facilities with expected varying degrees of equilibrium and ratios of natural uranium series radionuclides. Nothing in the historical documents referenced above provide any contradiction to or clarification of this interpretation. The use of the phrase " and associated decay products" in e.g., FC 83-23 Enclosure 2 (and subsequent 1987 revision) is not defined nor clarified in any historical documents we could find nor is there any indication of distinctions made relative to the phrase " and its daughters" as used in RG 8.30.

Additionally, for ISR license applicants, NUREG 1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* provides the current review guidance to NRC staff. We are unaware of any revisions of NUREG 1569 and/or subsequently issued NRC NUREG documents or regulatory guides that supersede NUREG 1569. It states that the applicant must ensure that "appropriate criteria are established to relinquish possession or control of equipment or scrap having surfaces contaminated with material in excess of the limits specified in Table 5.7.6.3" which is taken from Table 1 of Regulatory Guide 1.86. (See page 5-31 of NUREG 1569). Furthermore, NUREG 1569 states (page 5-30) "The contamination control program is acceptable if it meets the following criteria:

- Radiation surveys of workers will be conducted to prevent contaminated employees from entering clean areas or from leaving the site in conformance with guidance in Regulatory Guide 8.30...

- The proposed contamination control program is consistent with the guidance on conducting surveys for contamination of skin and personal clothing provided in Regulatory Guide 8.30....

- Action levels for surface contamination are set in accordance with Regulatory Guide 8.30, Section 4."

NRC staff has also recently cited to uranium recovery applicants SECY 98-155 as containing examples of dose calculations associated with these release limits. Attachment 6 to SECY 98-155 appears to be the portion of interest. However, according to the NRC Public Document Room staff, Attachment 6 is unavailable to the public due to national security concerns. We assume that the data provided in this attachment is similar or identical to the dose calculations NRC presented in NMSS *Handbook for Decommissioning Fuel Cycle and Material Licenses* (also no longer available). In that document the following results were presented for each of the groupings at the average surface activity guidelines of RG 1.86 (See Abelquist 2001. *Decommissioning Health Physics- A Handbook for MARRSSIM Users,* Institute of Physics Publishing, ISBN: 0-7503-076):

U-nat, U-235, and U-238 and daughters	13 mrem/yr
Ra-226, Ra-228, Transuranics	0.2 mrem/yr
Th-nat, Th-232, Sr-90	28 mrem/yr
Beta-gamma emitters	20 mrem /yr

It is interesting to note that three of the groupings are generally consistent with NRC's 25 mrem /yr criteria in 10 CFR 20 Subpart E and NUREG 1757 as used for the risk/dose based approach under the License Termination Rule. The estimated dose of 0.2 mrem /yr for the radium / transuranic grouping indicates that the RG 1.86 guideline of 100 dpm / 100 cm^2 for those radionuclides should be increased by approximately a factor of 100 to yield the same dose! Admittedly, the exposure scenarios and modeling assumptions NRC used are unknown.

Conclusion: To the best of our knowledge and belief, the personnel contamination control guidance and surface contamination criteria for release of equipment and material to unrestricted areas as defined in RG 8.30 (and as referenced therein, the 1987 version of FC 83-23) represents the current, approved NRC staff position. NUREG 1569 similarly represents the currently approved guidance to NRC staff against which an ISR applicant's source material license submittal is to be reviewed. Accordingly, until such time as NRC issues a revision to RG 8.30, the release limits defined in Table 1 of RG 8.30 and historical interpretation of the phrase " and associated decay products" as synonymous with " and its daughters" will be used.

Section 5.7.7 - Airborne Effluent and Environmental Monitoring Program

5.7.7.1 Regulatory Guide 8.37 states, "When practicable, releases of airborne radioactive effluents should be from monitored release points (e.g., monitored stacks, discharges, vents) to ensure that the magnitude of such effluents is known with a sufficient degree of confidence to estimate public exposure." Uranerz has not discussed how the effluent control techniques will ensure that the magnitude of such effluents is known with a sufficient degree of confidence to estimate public exposure. **This is an open issue.**

URZ Response:

See responses to Open Issues 4.1.4 and 5.7.1.1

5.7.7.2 Uranerz has not discussed how it will control the area between the points of release and the radon sampling stations to limit its access to members of the public and has not discussed how it will determine that doses to members of public in that area are in compliance with 10 CFR 20 Subpart D. **This is an open issue.**

URZ Response:

Uranerz will manage the area between the process area and the site boundary as a controlled area pursuant to 10 CFR 20.1003. The types of controls used for this area are described in the Technical Report at Section 5.6. Uranerz will 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). The results of process area and environmental monitoring for direct radiation, air particulates, radon, and surface water will be extrapolated and or used to estimate a dose from licensed operations in the controlled area.

Section 5.7.8 - Ground and Surface Water Monitoring Programs

5.7.8.1 During baseline water quality monitoring, Uranerz stated the wells will be sampled for all of the water quality parameters in WDEQ Guideline 8 including uranium. If certain analytes are not detected in the first two samples, these elements may not be tested in the remaining samples. NRC staff notes there are several separate tables of analytes in WDEQ Guideline 8. Uranerz needs to reference the specific tables in Guideline 8 or provide the table of analytes to be evaluated in the application for NRC staff to determine if they are sufficient. **This is an open issue.**

URZ Response:

The new table, Table D6-6a (located below), details the parameters that will be sampled during the analysis of baseline water quality. The table will be reference in Section 5.7.8.5.1 of the text. The table will also included in Volume VI, Appendix D6 of the Source Material License Application.

Table D6-6a Baseline Water Quality Monitoring Parameters*	
Parameter	*Units*
Carbonate as CO3	mg/L
Bicarbonate as HCO3	mg/L
Calcium	mg/L
Chloride	mg/L
Fluoride	mg/L
Magnesium	mg/L
Nitrogen, Ammonia as N	mg/L
Nitrogen, Nitrate+Nitrate as N	mg/L
Potassium	mg/L
Silica	mg/L
Sodium	mg/L
Sulfate	mg/L
Conductivity	umhos/cm
pH	s.u.
Total Dissolved Solids	mg/L
Dissolved Aluminum	mg/L
Dissolved Arsenic	mg/L
Dissolved Barium	mg/L
Dissolved Boron	mg/L
Dissolved Cadmium	mg/L
Dissolved Chromium	mg/L
Dissolved Copper	mg/L
Dissolved Iron	mg/L
Dissolved Lead	mg/L
Dissolved Manganese	mg/L
Dissolved Mercury	mg/L
Dissolved Molybdenum	mg/L
Dissolved Nickel	mg/L
Dissolved Selenium	mg/L
Dissolved Uranium	mg/L
Dissolved Vanadium	mg/L
Dissolved Zinc	mg/L
Total Iron	mg/L
Total Manganese	mg/L
Gross Alpha	pCi/L
Gross Beta	pCi/L
Radium-226	pCi/L
Radium-228	pCi/L

*Parameters from WDEQ-LQD Guideline No. 8, Hydrology, March 2005

5.7.8.2 Uranerz did not provide the location of the screens in the production zone monitoring wells or the production zone ring monitoring wells that will be used for baseline water quality in either license area. Uranerz did not provide the location of the screens in the overlying and underlying monitoring wells in either license area. NRC staff needs this information to evaluate if the sampling will be representative. **This is an open issue.**

URZ Response:

Production zone ring monitor wells, overlying monitor wells, and underlying monitor wells are completed with the entire aquifer sand exposed to open hole. Screens are installed in these wells and open slots are adjacent to the sand for the entire thickness of the aquifer. Production zone monitor wells do not have screens installed in them. Some of these wells have the entire thickness of the production sand exposed. The remainder of this type of well is under reamed for better contact with the mineralization but collectively cover the full thickness of the production aquifer.

5.7.8.3 NRC staff agrees with the strategy of consulting with regulators concerning placement of monitoring wells in areas where the sands are thin or absent to be acceptable in either license area, but asks that Uranerz provide some mechanism for this approach. **This is a confirmatory item.**

URZ Response:

This issue will be addressed when Uranerz submits the Production Area Pump Test plan document to the WDEQ for approval prior to conducting any wellfield pump tests as outlined in Section 5.7.8.3 of the Technical Report. In addition, Uranerz has previously committed to supply the NRC the first Production Area Pump Test document for review and approval for the first wellfield of the Nichols Ranch ISR Project.

5.7.8.4 Uranerz stated that the overlying and underlying aquifer wells will be sampled four times prior to wellfield operation, with a minimum of two weeks between samples. In the first and second sampling, the wells will be sampled for all of the water quality parameters provided in Table 5-1 of the application. The third and fourth samplings will be tested for parameters of chloride, total alkalinity and conductivity. NUREG-1569 Section 5.7.8.3 (1) states that at least four independent sets of samples should be collected, with adequate time between sets to represet any pre-operational temporal variations. Uranerz did not provide a technical basis for limiting the list of constituents to these three parameters in the third and fourth sampling events. **This is an open issue.**

URZ Response:

Uranerz will analyze the third and fourth rounds of sampling for all parameters listed in Table 5-1 of the Technical Report. The reasoning behind only taking two full sets of samples and then the third and fourth for UCL parameters comes from the WDEQ-LQD Guideline No. 8 recommendations. Section 5.7.8.5.1 of the Technical Report will be updated to reflect the change in sampling.

5.7.8.5 Uranerz did not propose monitoring well locations to establish baseline water quality in the surficial aquifers at either the Nichols Ranch Unit or the Hank Unit. NRC staff notes the surficial aquifer water quality may be impacted by spills, piping and casing leaks that routinely occur at ISR operations and potentially artificial connections between the surficial aquifer and other aquifers. Additionally, CBM produced water is and will continue to be discharged to surface impoundments which are designed to infiltrate into the surficial aquifer near the Nichols Ranch Unit and potentially the Hank Unit. This infiltration may impact the surficial aquifer water quality within the Nichols Ranch permit boundary over the lifetime of the operations and be mistaken as an impact from ISR operations. NRC staff is concerned that the lack of characterization of baseline water quality in the surficial aquifers of each license area before operations will hinder the ability of Uranerz to assess impacts to the surficial aquifer from ISR or CBM operations. **This is an open issue.**

URZ Response:

This issue was first address in the March 2009 responses to RAI 2.7.2 g. and k. Figures 2-21a and 2-21b were included to show the location of the in place surficial monitoring wells along with the locations of the proposed four additional surficial monitoring wells. The four proposed monitoring wells (URZNG-5, URZNG-6, URZHH-9, and URZHH-10) have been drilled, installed, and sampled. Figures D6-7a and D6-7b (Figures 2-21a and 2-21b will be revised) are included to show the exact locations of all surficial monitoring wells. Water quality results for the surficial water wells can be found in the revised and included Volume VI, Appendix D6, Addendum D6E, Tables D6E.1-1 and D6E.2-1.

5.7.8.6 The pumping test strategy to assess communication in the "F sand" unconfined aquifer at the Hank Unit is not sufficient. Uranerz needs to demonstrate that the monitoring well ring can detect an excursion. **This is an open issue.**

URZ Response:

A multi-well pump test is planned to be conducted to define the drawdowns to two monitoring wells spaced 500 feet on each side of the Hank Unit. This multi-well pump test will be used to demonstrate that adequate drawdowns will be able to be developed at the monitoring ring distance of 500 feet.

5.7.8.7 Uranerz indicated it will implement corrective actions once an excursion is verified. Corrective actions may include the suspension of lixiviant injection that will remain suspended until a declining trend in UCLs is established. Uranerz also stated that when a significant declining trend is established, normal injection and extraction operations will resume. The declining trend will be maintained until all excursion indicators are returned to values less than UCLs. NRC staff is unsure what Uranerz means by a "significant declining trend" to indicate an excursion has been corrected. **This is an open issue.**

URZ Response:

Uranerz will maintain excess bleed in an area to correct an excursion. The excess bleed will be maintained until the UCL concentrations have been restored. The numerical modeling (see Attachment Addendum MPH) indicates how the retrieval of an excursion will need to be conducted. Normal injection and extraction operations will resume after concentrations have been restored.

5.7.8.8 NRC staff is concerned that increased pumping of the unconfined aquifer at Hank Unit without injection to capture an excursion could lead to excessive dewatering which may interfere with excursion capture. **This is an open issue.**

URZ Response:

The numerical modeling (see attachment Addendum MPH) of the F Sand at the Hank Unit will be used to demonstrate that an adequate capture of an excursion can be done in the unconfined aquifer at the Hank site.

5.7.8.9 Uranerz did not state that it will update its surety for cleanup of excursions which remain for more than 60 days as discussed in NUREG-1569. **This is an open issue.**

URZ Response:

Uranerz will provide a statement in Section 5.7.8.10.3 of the Technical Report that if injection of lixiviant is not stopped to correct an excursion then the surety amount posted by Uranerz will be increased to an amount that is agreeable to the NRC and will cover the expected full cost of correcting and cleaning up the excursion as stated in NUREG-1569 Section 5.7.8.3 (5). The surety increase will remain in force until the excursion is corrected.

5.7.8.10 In addition to wellfield monitoring, Uranerz stated that any private wells within one kilometer of the Nichols Ranch and Hank Units wellfield area boundaries will be sampled on a quarterly basis for natural uranium and radium-226. Uranerz did not identify these wells in the technical report. **This is an open issue**.

URZ Response:

The private wells that will be sampled are those wells located within one kilometer of the Nichols Ranch and Hank Unit wellfield area boundaries and that are also completed in the same sand as the ore. For Nichols Ranch the wells that will be sampled are: Red Springs #4 Lower (aka DW-4L), Pats Well #1, and Brown 20-9. For Hank the wells are: BR-F, Dry Willow #1, and Means #1.

5.7.8.11 Uranerz did not propose any surface water monitoring for either license area during operations. NRC staff notes that Cottonwood Creek in the license area is the receiving water body for almost all of the ephemeral drainages from the Nichols Ranch Unit. In addition, the surficial alluvial aquifer in the southern portion of the Nichols Ranch Unit discharges to Cottonwood Creek. At the Hank Unit, the Dry Willow Creek in the southern portion of the license area receives almost all the ephemeral drainage from the Hank Unit permit area. In addition, the surficial alluvium near Dry Willow Creek is sometimes saturated and thus hydraulically connected to the creek. There is a possibilty that Cottonwood Creek at Nichols Ranch Unit or Dry Willow Creek at the Hank Unit may, at some point during the life of the ISR, be impacted by ISR operations. Without surface water monitoring during operations, any impacts to these drainages will not be detected. **This is an open issue**

URZ Response:

Surface water samples will continue to be collected in the same locations that were used during the pre-mining baselining for both the Nichols Ranch and Hank Units. Additionally surface water samples will be collected whenever water is present in the locations outlined in Table D6A.1-1 of Appendix D6, Addendum D6A of Volume VI. This information will be added as a new section 5.7.8.11 in Chapter 5 of the Technical Report.

Section 5.7.9 - Quality Assurance

5.7.9.1 Uranerz did not provide a comprehensive plan describing the Quality Assurance/Quality Control (QA/QC) procedures for all radiological, effluent and environmental monitoring which is in accordance with Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills, Revision 1" and Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations)-Effluent Streams and the Environment" as noted in NUREG-1569 Section 5.7.9.3 (1). NRC staff requests that Uranerz provide a comprehensive plan addressing both radiological and non-radiological QA/QC in detail for review in the application or include a statement which commits it to submit this QA Plan to NRC for review and approval before operations will begin. **This is an open issue.**

Uranerz Response: Not totally clear what is needed. There are commitments in Section 5.7.9. of the application.

NRC indicated that Uranerz can provide a QA plan prior to licensing or it could become a condition of the license. Staff stated that Uranerz should ensure laboratory QA/QC procedures are addressed, both onsite and/or offsite laboratories. NRC does not have a standard format and content, but there is guidance in Regulatory Guides 4.14 and 4.15.

URZ Response:

A QA/QC document will be available for the NRC to review prior to starting operations. Uranerz will accept this as a license condition. This commitment will apply to all the following open issues items in this section (Section 5.7.9).

The following items in Section 5.7.9, Quality Assurance, were not discussed in detail during the meeting due to constraints in time. These items are included, as they have been noted as open issues by NRC staff reviewers.

5.7.9.2 Uranerz needs to clarify the QA organization and how these individuals are organizationally integrated with the Radiation Safety Officer. Uranerz needs to identify who has ultimate authority for the QA Program at the site. NRC staff cannot determine if the described QA-related organization and responsibilities are consistent with Regulatory Guide 4.15. **This is an open issue.**

5.7.9.3 Uranerz stated that personnel and training will be consistent with Regulatory Guide 4.15. However, Uranerz did not provide sufficient detail as to how the recommendations in Regulatory Guide 4.15 will be implemented. **This is an open issue.**

5.7.9.4 The measurement system was not described in sufficient detail to allow NRC staff to determine if the measurement system is consistent with Regulatory Guide 4.15. **This is an open issue.**

5.7.9.5 Uranerz did not provide field quality objectives for field and analytical methods that are industry standards and laboratory quality objectives that will include precision, bias, accuracy, representativeness, comparability, and sensitivity. **This is an open issue.**

5.7.9.6 Uranerz did not state that it will use a sampling process design that defines the sample locations and sampling frequency and determine the types of analyses that will be conducted on the samples collected from these locations. **This is an open issue.**

5.7.9.7 Uranerz did not state that it will ensure that field measurements and sample collections will follow procedures attached to nationally recognized consensus standards, such as EPA methods, ASTM, or instrument manufacturer recommended procedures. **This is an open issue.**

5.7.9.8 Uranerz did not state that it will include preparation and decontamination requirements for sampling equipment. **This is an open issue.**

5.7.9.9 Uranerz did not state that it will ensure laboratory requirements for subcontractor and site-owned laboratories will have a QA/QC program. **This is an open issue.**

5.7.9.10 Uranerz has not provided any information or discussed the routine QC checks for acceptable performances, such as background checks, reference checks, and the use of control charts to track trends. **This is an open issue.**

5.7.9.11 NRC staff cannot determine how data acquired through non-direct measurements will be incorporated into the QA/QC program including, for example, record keeping and verification and validation. **This is an open issue.**

5.7.9.12 Uranerz did not discuss verification and validation in the license application. **This is an open issue.**

5.7.9.13 Uranerz did not describe an assessment, audit, and surveillance program that will be implemented at the Nichols Ranch ISR Project facility. Although Uranerz stated that the QA program will be audited by qualified personnel, the application did not describe the qualifications of the auditors and it did not indicate that assessments, audits, and surveillances will be implemented for facility operations. **This is an open issue.**

5.7.9.14 Uranerz has not discussed or demonstrated a corrective action program at the site that integrates components of the QA program. **This is an open issue.**

Section 6.1 – Plans and Schedules for Groundwater Quality Restoration

6.1.2 Restoration Standards

6.1.2.1 Uranerz stated in the application the restored groundwater quality of the production areas will be consistent with the standards presented in NUREG-1569. NRC staff notes that these primary and secondary restoration standards are inconsistent with the restoration standards in 10 CFR Part 40, Appendix A, Criterion 5B(5). NRC has notified licensees and applicants in Regulatory Information Summary, RIS 09-05, dated April 29, 2009, that the restoration standards listed in NUREG-1569, Section 6.1.3 (4) are not consistent with those listed in 10 CFR Part 40, Appendix A. Uranerz must commit to achieve restoration standards in Appendix A, Criterion 5B(5). **This is an open issue.**

URZ Response:

This issue has been debated between potential licensees, the NRC, and the NMA on whether or not the actual 10 CFR Part 40, Appendix A, Criterion 5(B)(5) standards apply to ISR facilities. As a result of discussions held with NRC at a workshop in Denver, the NRC stated the following which was published in the November 17-18, 2009 Uranium Recovery Application Workshop Meeting Summary (ML093510162):

5. *Provide guidance in writing regarding literal compliance with 10 CFR 40, Appendix A, Criterion 5(B)(5).* ***To resolve this issue, licenses will be issued with a condition that states that groundwater in the wellfield (production zone) will be restored to the standards presented in Criterion 5(B)(5). This condition will not use the term "point of compliance" to avoid confusion regarding the literal interpretation of Criterion 5(B)(5). The ISR rulemaking will resolve the "point of compliance" issue regarding ISR facilities. Standards for corrective actions of excursions will also be Criterion 5(B)(5).***

Although Uranerz does not agree with the NRC that 10 CFR 40, Appendix A, Criterion 5(B)(5) applies to groundwater restoration standards at ISR facilities (as previously stated by both NMA and the Wyoming Mining Association). Uranerz will accept the license condition stated above by the NRC unless future ISR groundwater restoration rulemaking results in different standards.

6.1.3 Restoration Methods

6.1.3.1 Uranerz has agreed, in Section 6.1.3.3 of the application, to develop a comprehensive safety plan and implement it prior to using any reductant. In addition, Uranerz has also stated it may consider using a biological reduction method to achieve groundwater restoration. If Uranerz chooses to use a reduction method to achieve groundwater restoration targets, it should submit a detailed plan to NRC. Uranerz should commit to sending this plan to NRC for review and approval prior to reductant use. **This is a confirmatory item.**

URZ Response:

Uranerz will submit a detail plan for review and approval to the NRC prior to using any reductant during groundwater restoration. This commitment will be added to Section 6.1.3.3 of the Technical Report.

6.1.4 Effectiveness of Groundwater Restoration Methods

6.1.4.1 In Section 6.2.8 of the application, Uranerz discusses the Bison Basin commercial facility and restoration. NRC staff is aware that this was a licensed facility but is unfamiliar with the details of this project. Uranerz should consider expanding its discussion of groundwater restoration and approval for this site for use as an analog. **This is a confirmatory item.**

Uranerz Meeting Response: Bison Basin had a pilot project and did restoration. It received a license and operated the first wellfield for approximately one year. When uranium prices dropped, it ceased operations. The project was abandoned and the state cashed in the bond. Duke power stayed involved until decommissioning plan was finished and restored the site. This occurred in the 1982 timeframe. Restoration was completed in approximately 1986. Uranerz did not indicate it would make changes or update the application as many of the files are very old and not readily accessible.

URZ Response:

The Uranerz response to open issue 6.1.4.2 summarizes the ore sand aquifer properties of Bison Basin compared to the Nichols Ranch ISR Project. Further review of the restoration that was conducted at both the R&D and commercial scale operations at Bison Basin found that approximately 6 pore volumes were used to restore the R&D sight and 8 to restore the commercial site (the commercial site was restored with 6 pore volumes, but an agreement was made with the regulators at that time to do 8). The restoration was completed by using a combination of groundwater sweep, groundwater transfer, and reverse osmosis. These are the same techniques that have been applied to all successfully restored ISR facilities in Wyoming and the same techniques that are proposed to be used for the Nichols Ranch ISR Project.

6.1.4.2 Uranerz stated in Section 6.1.3.5 of the application that the restoration methods proposed for the Nichols Ranch Project have been successfully implemented at nearby ISR sites (within 56 km ((35 mi)) with similar hydrological characteristics as the Powder River Basin. The ISR sites identified included the Bison Basin ISR located in the Great Divide Basin of Wyoming, the COGEMA Christensen Ranch and Irigaray ISRs, Smith Ranch/Highlands ISR, Collins Draw Research and Development (R&D) Facility, Ruth R&D Facility, and the Reno Creek R&D Facility. Apart from the "similar formation" argument, Uranerz did not provide any additional details of how these sites are analogs for the proposed Nichols Ranch Project ISR. **This is an open issue.**

URZ Response:

The hydrologic characteristics at the other ISR sites make them good analogs for the Nichols Ranch and Hank sites. The attached table summarizes the variation in ore sand aquifer properties of the different analog sites to the Nichols Ranch and Hank Units. The transmissivities at the NRC licensed North Butte site range from 181 to 1440 gal/day/ft while the hydraulic conductivities range from 0.34 to 5.5 ft/day. The NRC licensed and previous test site Ruth transmissivities and hydraulic conductivities are significantly lower and range from 1.8 to 260 gal/day/ft and 0.17 to 0.62 ft/day for transmissivity and hydraulic conductivity, respectively. Aquifer properties at the NRC licensed Christensen Ranch are similar to the North Butte aquifer properties. The previously licensed and restored Bison Basin ISR aquifer properties were similar to the aquifer properties with values between the Ruth and North Butte sites. Transmissivities at Smith Ranch and Highlands have varied from as low as typical values at the Ruth site;

but significantly higher than typical values observed at the North Butte site. This makes Smith Ranch a good analog site for Nichols and Hank also. Storage values for the other sites are similar to the Nichols Ranch site. The storage value for the Hank Unit is significantly different due to it being an unconfined aquifer. Therefore, some different considerations need to be used for the Hank site but overall these analogs are still very applicable to the Hank site. The aquifer properties from the Reno Creek R&D site are very similar to those observed at the Hank site.

COMPARISON OF ISR ORE SAND AQUIFER PROPERTIES

	TRANSMISSIVITY		HYDRAULIC CONDUCTIVITY	STORAGE COEFFICIENT	SPECIFIC YIELD
	(GAL/DAY/FT)	*(FT²/DAY)*	*(FT/DAY)*		
NICHOLS UNIT	101-460	13-61	0.18-0.7	1.80E-04	-
HANK UNIT	19-6670	2.5-8917	0.14-9.4	6.80E-05	0.14
NORTH BUTTE	181-1440	24-192	0.34-5.5	4.4E-5 - 3.6E-4	-
RUTH	1.8-260	0.24-35	0.17-0.62	4.2E-5 - 1.7E-3	-
CHRISTENSEN RANCH	264-1030	35-138	0.32-0.54	8.7E-5 - 1.5E-3	-
RENO CREEK	11.4-6490	1.5-867	0.03-5.5	1.3E-4 - 2.6E-3	0.024-0.11
BISON BASIN	117-198	16-26	0.77-1.3	3.9E-5 - 1.9E-4	-
SMITH RANCH	90-8650	12-1156	0.5-3.8	5.2E-6 - 5.4E-4	-

6.1.4.3 NRC staff notes there is very little field information available on the success of traditional restoration methods in the unconfined aquifer setting. The Reno Creek facility was operated by Rocky Mountain Energy Corporation in a location approximately 32 km (20 mi) to the east of the Nichols Ranch ISR Project. A portion of the project, known as Pattern 2, was located in an unconfined aquifer. Restoration of Pattern 2 demonstrated that all groundwater constituents, except uranium, were restored to levels below or within baseline ranges at the end of groundwater restoration. NRC staff notes that the Reno Creek operation was a demonstration project, which was subjected to only 10 weeks of injection and only 1 month of groundwater sweep for restoration. The reduced restoration operation may not represent the conditions that will exist at the Hank Unit after production. Apart from the unconfined aquifer similarity, Uranerz did not provide any additional discussion about why the Reno Creek R&D facility should be considered as an appropriate analog for the Hank Unit site. **This is an open issue.**

URZ Response:

The Reno Creek Project is an applicable analog to the Hank site. On a geologic basis, the uranium found at Reno Creek is located in the Wasatch Formation in sandstone lenses as is the uranium found not only at Hank and Nichols Ranch but also in every other uranium deposit in the Pumpkin Buttes Mining District (Ruth, North Butte, Iragaray, Christensen Ranch). The hydrologic properties of the Reno Creek Project are also similar to Hank. See the previous response and table provided for this information.

Furthermore, both the WDEQ-LQD and the NRC both concluded after analyzing the groundwater restoration and stabilization monitoring data that the Reno Creek Project would be suitable to support commercial-scale operations. The letters showing this conclusion can be found under ML081570670. This document also gives an overview of successful groundwater restoration operations at other ISR projects located in Wyoming.

6.1.4.4 Uranerz has not provided any additional information or discussion related to restoration issues that are specific to unconfined aquifers. These include: (i) an examination of dewatering/mounding characteristics of the aquifer through field testing and/or groundwater modeling to ensure operations can be maintained; (ii) the provision of a strategy that will ensure that restoration fluids will contact all parts of the ore zone in the unconfined aquifer; and (iii) evaluation of conductivity impairment in the ore zone due to "gas lock" from the evolution of dissolved oxygen in the lixiviant under low hydrostatic head conditions (see SER Section 3.1). **This is an open issue.**

URZ Response:

Uranerz will use pulsing of the extraction and injection wells to have contact of restoration fluids with all parts of the mine production zone. Moore Ranch did specific numerical modeling for five spot patterns to show how the pulsing will complete a sweep of the mine zone. Switching of extraction and injection wells will be done if necessary to meet the restoration goals.

Adjustments will be made if gas locking is resulting in a reduction in the hydraulic conductivity of the aquifer. Procedures that have been used at the Texas operations will be used to remove the effects from the gas locking.

6.1.5 Pore Volume Estimates

6.1.5.1 Uranerz presented the method used to determine pore volume and the results for pore volume estimates in Section 6.2.8 of the application. Uranerz estimated the pore volume as the product of affected ore zone area, average well completed thickness, flare factor, and porosity. In an unconfined aquifer like the Hank Unit, there is significant dewatering and mounding, which creates vertical flow throughout the ore zone. It is therefore necessary to reconsider the definition of the thickness of the aquifer which should be used to determine the pore volume in an unconfined aquifer. **This is an open issue.**

URZ Response:

Uranerz simulation of the Hank vertical flare produced similar numbers that have been used for the confined aquifers. The much lower vertical hydraulic conductivity restricts the vertical flare in the F Sand aquifer at the Hank Unit. This simulation indicates that the vertical flare of 22% is appropriate for the Hank Unit.

6.1.5.2 Uranerz stated that the estimated number of pore volumes needed to restore the partial operating Production Area 1 in the first year at the site is seven. Uranerz cited several examples of nearby ISR facilities (Cogema, Bison Basin, and Reno Creek), where the pore volumes ranged from 6 to 18.4, as the basis for estimating seven pore volumes. However, Uranerz did not clearly explain (i) the relevancy of the analog sites to the Nichols Ranch Project and (ii) why seven pore volumes was an appropriate estimate for restoring the operating Production Area 1 in the first year of operation. **This is an open issue.**

URZ Response:

The hydrologic conditions of the analogs used by Uranerz are discussed in response 6.1.4.2. Similar aquifer properties make the estimates of observed pore volumes at these other ISR sites to be applicable to the Nichols Ranch project.

6.1.5.3 Using a flare factor of 1.45 was based on Cogema's Irigaray/Christensen Ranch sites that used an overall flare factor of 1.44. Uranerz stated that Irigaray/Christensen Ranch sites are adjacent to the proposed site and operate in very similar formations and deposits. Uranerz provided no technical basis beyond the similar formation argument for the use of this flare factor. The use of this flare value for the unconfined aquifer conditions at the Hank Unit, however, has not been established. **This is an open issue.**

URZ Response:

The simulation of the flare factors for the Nichols Ranch Unit indicates that the flare factor 1.45 is appropriate for the Nichols Ranch Unit. The simulations for the flares at the Hank Unit indicate a total flare of 1.7 is appropriate for the Hank Unit.

6.1.6 Restoration Monitoring

6.1.6.1 Uranerz stated in Section 6.1.3.4 of the application that the monitoring wells (MR-Wells), overlying aquifer wells (MO-Wells), and underlying aquifer wells (MU-Wells) sampling frequencies will be changed from once every 2 weeks to once every 60 days during restoration. Uranerz stated in Section 6.1.3.4 that production wells (MP-wells) will be monitored on a "frequent basis" to assess the progress and efficacy of restoration and to optimize the operation. Uranerz did not clearly state the frequency of monitoring or define "frequent basis" for the production wells (MP-wells). **This is an open issue.**

URZ Response:

During restoration, the solution returning from the wellfield will be sampled on a daily basis to track how restoration is progressing. The MP-wells will be sampled once a month to check how certain areas of the wellfield are progressing versus the solution returning from the wellfield. Section 6.1.3.4 of the Technical Report will be revised to reflect the sampling frequency of the MP-wells from a "frequent basis" to once a month.

6.1.6.2 The NRC staff checked the sufficiency of the 60-day sampling frequency for overlying and underlying monitoring wells. Uranerz estimated that if the groundwater moves at 0.00007 m/s (22 ft/year), the distance traveled in 60 days is 1.1 m (3.6 ft). NRC staff checked the calculation based on information given in Section 2.7.2.3 of the application (hydraulic gradient 0.003 ft/ft, effective porosity of 0.05, average hydraulic conductivity 0.000001 m/s ((0.5 ft/day)) and it appears to be correct. However, the monitoring well ring (MR wells) will be subjected to a different gradient because of operations in the ore zone, therefore Uranerz has not justified the 60-day period for MR wells based on this calculation. **This is an open issue.**

URZ Response:

The ground-water gradient toward the wellfield during operation based on the numerical model simulations is roughly an order of magnitude larger at the monitoring ring wells. This indicates that the ground-water would move at 0.30 ft/day or roughly 18 feet over 60 days at the Nichols Ranch Unit. This small ground-water movement also indicates that the 60 days frequency should be adequate for the monitoring ring wells also.

The operational gradients are flatter at the Hank Unit and therefore the movement in 60 days would be less than the Nichols Unit estimate and therefore 60 days frequency should be appropriate for the MR wells at the Hank Unit also.

6.1.7 Restoration Wastewater Disposal

6.1.7.1 Proposals for disposal of liquid waste from process water by injection in deep wells must meet the regulatory provisions in 10 CFR 20.2002 and demonstrate that doses are ALARA and within the dose limits in 10 CFR 20.1301. Uranerz has not provided a description of the waste, the conditions of waste disposal, the location of potentially affected facilities, and an analysis and procedures to ensure that doses are ALARA and within the dose limits of 10 CFR 20.1301. **This is an open issue.**

URZ Response:

A description of the waste stream that will be sent to the deep disposal wells was include as a response to RAI 4.2.1 a. submitted to the NRC on March 11, 2009. The response was as follows:

An expected chemical and radiological composition of the liquid waste stream to be disposed of in the deep wells that is based on a currently operating ISR operation is described as follows:

Constituent	***mg/l ****
Ammonia as nitrogen	*~ 1*
Sodium	*50 - 100*
Calcium	*400 - 700*
Potassium	*15 - 30*
Bicarbonate as HCO3	*500 - 700*
Carbonate as CO3	*0*
Sulfate	*600 - 800*
Chloride	*150 - 900*
TDS	*1900 - 3200*
Uranium as U3O8	*1 - 10*
Ra-226, pCi/l	*900 - 3200*
pH, standard units	*5 - 7*

** unless otherwise indicated*

Fluids captured on the process pad, reject water from the RO units, bleed, accidental spills, routine cleaning of equipment and the pad, maintenance operations and decommissioning will be injected down Class I disposal wells. The rules governing Class I wells are rigorous and provided a high level of protection to workers, members of the public and the environment. Examples of protection that are in full keeping with the ALARA principle include: requirements covering mechanical integrity testing (prior to using the well, after performing workovers and during the operational life of the well and prior to plugging and abandonment); routine inspections by state personnel; 24 hour monitoring/recording of pressure and fluid volume; corrosion monitoring; reviewing and approving full engineering details on the pre-injection units (i.e., equipment such as by-product storage tanks, pipelines, filters, pumps and emergency cutoff switches); preparation of process flow diagrams (PFDs) and piping and instrumentation diagrams (P&IDs); and preparation of a fluid balance table showing that the facility has sufficient capacity to accommodate all fluids. In addition to the above, the materials used to build waste disposal wells and their associated facilities are well known and have a 30 year plus record of successful performance.

With regard to the location of potentially affected facilities, the project sites are in remote, sparsely populated areas with little to no infrastructure. The pipeline routes to the wellheads will not pass near other non-project related facilities. As discussed in sections covering accidental spills and corrective action, it was demonstrated that potential impacts from a spill would be significantly minimized.

As summarized above, the design, frequent inspections both by company personnel, state and NRC inspectors and the corrective action plans combine to assure that potential impacts (including dose to individual members of the public) are in line with the ALARA principle. It should also be noted that this method of disposal ensures that members of the public are most protected in that the fluid is placed deep underground near the facility. In other words, if fluids were to be transported by tanker trucks to a distant disposal facility over public roads, potential exposure to the environment and the public would be much greater. Piping the fluid over a short distance and then injecting it deep underground affords the best protection. In summary, the potential for causing any dose to an individual member of the public is extremely remote in that they (the public) are completely shielded from the material.

6.1.7.2 In its response to NRC's RAI, Uranerz estimated the waste water flow to be sent to the deep disposal well during restoration will be 50 gpm for the Nichols Ranch Unit and at least 22 gpm for the Hank Unit. These estimates do not match the flow rates given in Section 3.2.6 of the application, which are 90 gpm for both units during restoration. Uranerz needs to confirm which values are correct. **This is a confirmatory item.**

URZ Response:

This question was addressed in question 3.1.11. There are three phases for mine life: Production Only, Production and Restoration, and Restoration Only. The following information summarizes the Nichols Ranch Unit and Hank Unit flow for the three phases.

Nichols Ranch Unit 1% Bleed

Production Only

Deep Disposal Well (DDW) Flow	+100	gpm
Production Flow to DDW	(-)40	gpm
Other	(-)1-2	gpm
Remaining Balance	+58	gpm

Production and Restoration

Deep Disposal Well (DDW) Flow	+100	gpm
Production Flow to DDW	(-)40	gpm
Restoration Flow to DDW	(-)57	gpm
Other	(-)1-2	gpm
Remaining Balance	+1	gpm

Restoration Only

Deep Disposal Well (DDW) Flow	+100	gpm
Restoration Flow to DDW	(-)90	gpm
Other	(-)1-2	gpm
Remaining Balance	+8	gpm

Hank Unit 3% Bleed

Production Only

Deep Disposal Well (DDW) Flow	+100	gpm
Production Flow to DDW	(-)75	gpm
Other	(-)1-2	gpm
Remaining Balance	+23	gpm

Production and Restoration

Deep Disposal Well (DDW) Flow	+100	gpm
Production Flow to DDW	(-)75	gpm
Restoration Flow to DDW	(-)22	gpm
Other	(-)1-2	gpm
Remaining Balance	+1	gpm

Restoration Only

Deep Disposal Well (DDW) Flow	+100 gpm
Restoration Flow to DDW	(-)90 gpm
Other	(-)1-2 gpm
Remaining Balance	+8 gpm

It should be noted that the numbers above are estimates only. Uranerz plans to permit 4 disposal wells at each site. If the flow estimates for one disposal well prove to be inadequate, additional wells will be added to accommodate the disposal requirements.

6.1.7.3 The remaining deep disposal well capacity balance for both units is 8 gpm. If a deep disposal well becomes inoperable or loses capacity, Uranerz has stated it will use four large tanks with a capacity of over 17,000 gallons each at Nichols Ranch, and six large tanks with a capacity of over 17,000 gallons each at Hanks Unit for surge capacity. The surge capacity is only 24 hours for the former and 22 hours for the latter. Uranerz needs to demonstrate a clear contingency plan for restoration fluid disposal and safety margin in case of deep disposal well malfunction so that hydraulic control of the well field can be maintained. **This is an open issue.**

URZ Response:

Uranerz answered this question as part of question 3.1.4

6.1.8 Restoration Stability Monitoring

6.1.8.1 Uranerz proposed, in Section 6.1.4, to use averages of target parameter concentrations to demonstrate restoration is complete. However, Uranerz did not address or provide a methodology how to evaluate areas with higher concentrations (i.e., "hot spots") if they occur in a set of data used to show restoration is complete. These "hot spots" can act as point sources of contamination and may require specific attention if they remain. **This is an open issue.**

URZ Response:

During restoration, the production zone wells will be monitored on a monthly basis to determine the progress of restoration activities. If an area is noticed as having higher concentrations, then appropriate measures such as adjusting the flows in the area or providing additional treatment to the area will be used to aid in reducing the higher concentrations. Additionally the fluid coming from the wellfield being restored will be sampled on a frequent basis that could include daily sampling to check to the progress of restoration.

6.1.8.2 The monitoring duration should be extended to 4 sampling events on a quarter-year basis rather than 3 events spaced two months apart (6 months). **This is an open issue.**

URZ Response:

Uranerz will provide 4 sampling events on a quarter-year basis during restoration stability monitoring. Section 6.1.4 of the Technical Report will be revised to reflect the sampling.

6.1.10 Restoration Schedule

6.1.10.1 A preliminary wellfield restoration schedule was provided in Table 7-5 of the application. Uranerz reported it will take approximately three years to restore Nichols Ranch Area #1, one year to restore Nichols Ranch Area #2, five years to restore Hank Area #1, and one year to restore Hank Area #2. For wellfield restoration schedules expected to take longer than two years, justification is required as per 10 CFR 40.42. **This is an open issue.**

URZ Response:

Uranerz answered this question as part of question 3.1.11

Section 6.2 - Plans and Schedules - Reclaiming Disturbed Lands

6.2.1 Prior to operation, Uranerz will need to provide the details of a waste disposal agreement for 11e.(2) See Section 4.2 for discussion of this open issue. **This is an open issue.**

URZ Response:

Uranerz will have an agreement for disposal of 11e.(2) material for NRC review prior to commencing operations. Uranerz accepts this commitment as a license condition.

Section 6.3 – Process for Removing and Disposing of Structures and Equipment

6.3.1 Prior to operation, Uranerz will need to provide the details of a waste disposal agreement for 11e.(2) See Section 4.2 for discussion of this open issue. **This is an open issue.**

URZ Response:

See response to Open Issue 6.2.1

Section 6.4 - Post Reclamation and Decommissioning Radiation Surveys

Uranerz committed to develop cleanup criteria for uranium in soil based on the radium benchmark dose approach of 10 CFR Part 40, Appendix A, Criterion 6(6). Uranerz also stated that the cleanup criteria for Th-230 in soil will be that concentration which, when combined with the residual concentration of Ra-226, will satisfy the radium cleanup standard. Uranerz has not described the survey methodology to be used in the decommissioning plan nor has provided assurance that the survey method for verification of soil cleanup is designed to provide 95% assurance that the soil units meet the cleanup guidelines. Because the surety agreement requires quantification of the costs of reclamation and decommissioning, a description of the survey methodology is needed to comply with 10 CFR 40, Appendix A, Criterion 9. **This is an open issue.**

URZ Response:

The Technical Report at Section 6.4 will be revised to include reference to survey methodology and a commitment to provide 95-percent confidence that the survey unit meets the cleanup guidelines.

6.2.6.1 Reclaiming Disturbed Lands

{retain original text}

{insert following paragraph at end of section}
The survey designs for verification of soil cleanup will be developed from NUREG-1575 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). Statistical tests for analysis of survey data will be chosen from the MARSSIM. The statistical tests will be applied to provide 95-percent confidence that the survey units meet the cleanup criteria.

Section 6.5 – Financial Assurance

Uranerz has established a financial assurance cost estimate that will need to be updated based on the requirements in 10 CFR Part 40, Appendix A, Criterion 9, prior to operations. Updates will need to incorporate other requirements such as updated pore volumes estimates and flare factors. **This is a confirmatory item.**

URZ Response:

Prior to commencing operations, Uranerz will have a financial assurance in place that has been approved by both the NRC and WDEQ.

Section 7.0 – Accidents

7.0.1 The plants at both units will have a concrete foundation with concrete curbed side walls. The height of the concrete sides would be such that the curbed foundation would contain the volume of the largest tank in the unit. Uranerz has not discussed contingency plans for a failure of a larger spill related to multiple tank failure or an in plant pipe or joint failure releasing a volume larger than the largest tank. **This is an open issue.**

URZ Response:

This issue has been raised in Section 4.2.3. Please refer to the response provided in Section 4.2.3.

7.0.2 The Effects of Accident in Section 7.5 does not mention reporting requirement of accidents. Uranerz accident response program and reporting must be consistent with 20.2202 and 20.2203 and NUREG -1569, 7.5.3 (4). **This is an open issue.**

URZ Response:

In addition to promptly initiating corrective action in response to an accident, as presented in various parts of the Application, Uranerz will notify NRC and file the appropriate reports in accordance with the rules provided in 10 CFR Part 20, §§ 20.2202 Notification of Incidents and 20.2203 Reports of Exposures, Radiation Levels, and Concentrations of Radioactive Material Exceeding the Constraints or Limits.

7.0.3 Uranerz states in Section 7.5 of the application that if the amount and/or concentration of the process fluid lost in a pipeline failure constitutes an environmental concern, the affected area would have the contaminated soil surveyed and removed for disposal according to NRC and State regulations. Uranerz has not defined how large a spill, at what concentration, or combination of both factors, would constitute an environmental concern. **This is an open issue.**

URZ Response:

A single spill incident in an area would not likely raise the background soils to levels that equal or exceed 5pCi/g. As noted previously and in the application, the spill area will be surveyed with a gamma meter and soil samples will be collected throughout the wetted area. A spill record will be made documenting the volume of the spill, the area affected and the corrective action taken (sampling and results of analysis). Areas exceeding twice background gamma will receive additional soil sampling to determine whether radiological concentrations (radium-226, thorium-230, lead-210) have increased significantly above background. Soils will also be analyzed for uranium. If soil sampling results show an increase from baseline, 2.5 – 3 pCi/g, for example, the soil will be removed and placed in approved by-product storage containers prior to shipping to a licensed site.

7.0.4 Section 7.5 in the application discusses the risk of fire and dispersal of yellowcake due to a propane explosion. It is not clear in Section 7.5 of the application where propane will be stored and if it will be away from the dried yellowcake containment building to minimize the risk of yellowcake dispersal. **This is a confirmatory item.**

URZ Response:

The propane tank will be located away from the dried yellowcake building to minimize the risk of yellowcake dispersal. The attached Figure 3-1 Site Facility Diagram Nichols Ranch Unit, shows the location of the propane storage tank and the dried yellowcake storage area.

7.0.5 Uranerz discussed the possibility of fire and explosion from propane and oxygen. Uranerz did not discuss coordination or training of local fire departments and ambulance on responding to a fire or injury at its facility. Uranerz should commit to contacting and training local responders to the hazards at the facility. **This is a confirmatory item.**

URZ Response:

Uranerz will contact local fire departments, medical services, and other local agencies that may respond to emergencies in the area of the Nichols Ranch ISR Project to inform the agencies about the project, training for the agencies when dealing with fire, injury, or other emergencies, and how to contact and locate the Nichols Ranch Project.