Uranerz Energy Corporation Nichols Ranch ISR Project

Response to the NRC Request for Additional Information

Pre-Operation License Condition 12.8 Supplemental Information March 11, 2014

The attached RAD-LOG-39, "Effluent Sampling Plan" (Attachment 1) details the monitoring type, instruments used, frequency, lower limit of detection, and referenced operating procedures and is utilized in conjunction with narrative below. Uranerz will reevaluate information contained in the following responses on an as needed basis to verify measurements are accurate or more conservative.

Attachment 2 contains draft Figure 2-25. The figure depicts the location of the environmental air samples, RADTRAK locations, and gamma dosimeters in the Nichols Ranch Unit license area.

LC 12.8(A): Discuss how, in accordance with 10 CFR 40.65, the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring.

In identifying all point and diffuse sources it is Uranerz's assumption that measurements taken within process areas will be released to the environment at rates of the exhaust ventilation. This is a conservative estimate that likely overestimates the amount of true effluent released to the environment. Effluent releases will be compared to design objectives, specified in Nichols Ranch ISR Project TR Chapter 7, Section 7.3. Results that are significantly above design objectives will be addressed in the semi-annual effluent report.

Plant

Emissions from the plant will be determined based on the following assumptions and measurements. The amount of radon emanating from the plant will be determined first by characterizing the radon concentrations within the plant. As detailed in RAD-LOG-39 Effluent Sampling Plan, the concentration of radon in the plant will be sampled initially on a weekly basis and then according to Regulatory Guide 8.30. The rate of release from two exhaust fans is determined based on an air balance report supplied by West Plains Engineering. Each exhaust fan on average can produce 13,500 CFM. Using the monthly radon concentrations (0.33WL is equal to 3E-8 μCi/ml), the activity released can be calculated using the equation below. Volumes are calculated using flow rates from the exhaust fans and the time that the fans are operating. During times when the fans are not operating an anemometer will be used to verify the flow outside the building. If the anemometer is not able to read the flow the lowest sensitivity of the instrument will be used for the flow coming out the building. A total of the effluent released from the plant will be calculated monthly and reported semiannually in agreement with 10 CFR 40.65.

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

Releases of radon from vented tanks will be calculated by measuring the concentration of radon being emitted from the exhaust vent. Active Scintillation cells, or Lucas cells, will be used to quantify the amount of radon at each vent. Cells are considered active since the user must actively place the gas sample into the cell. Cells are evacuated with a vacuum pump in order to draw the gas sample into the cell. Once inside the cell, radon gas undergoes decay to its daughter products. The decay of radon and its daughter products create alpha particles that strike the sensitive scintillator lining of the interior of the cell. The scintillations, light pulses, pass through a photomultiplier tube which allows the monitoring

device to count light pulses and equate that to a radon concentration. There is a direct relationship between the number of light pulses counted and the concentration (or activity) of the radon gas in the cell. The relationship between the counts recorded and the activity of the sample is referred to as counting efficiency and is determined on an annual basis when the unit is sent off for calibration by a NIST traceable laboratory.

Measurements of **the radon from tank vents will be performed at a minimum of once a quarter. Samples will be taken during highest predicted concentrations and will be used to determine the effluent of radon from vented tanks. Highest predicted concentrations will be assumed to be when all tanks are open for ventilation. To test the assumption of the highest predicted concentration multiple measurements over the quarter will be utilized until Uranerz can demonstrate when the highest concentrations occur. Once the highest predicted concentration is validated it may need to be revaluated with changes to operating parameters that may affect the amount of effluent released.**

Once the concentration is determined from the scintillation cell, assumptions of flow can be made by using a conservative manufacturer estimate of 293 CFM for the forced ventilation fan. Fans will be assumed to be running continuously, and total releases from vented tanks will be calculated and added to total radon released from the plant. Results will be reported semiannually in the agreement with 10 CFR 40.65.

This use of scintillation cells to characterize radon is an approved method, as outlined in Method 115 from 40 CFR 61 Appendix B. While the method describes the use of scintillation cells for underground mining and tailing piles, it can be applied to this application.

Emissions of particulates will be estimated based upon semi-annual isotopic analysis of filters used for monthly gross alpha measurements as outlined in RAD-LOG-39 Effluent Sampling Plan. The concentrations reported from the analysis of an outside accredited lab will be used to calculate the effluent by factoring in the exhaust rate and time of operation for exhaust fans. During times when the fans are not operating an anemometer will be used to verify the flow outside the building. If the anemometer is not able to read the flow, the lowest sensitivity of the instrument will be used for the flow coming out the building. Total effluents for each radionuclide will be reported on a semi-annual basis in agreement with 10 CFR 40.65.

Header Houses

Emissions from Header Houses will be determined based on the following assumptions and measurements. The amount of radon emanating from the header houses will be based on radon measurements taken within the header house as outlined in RAD-LOG-39, Effluent Sampling Plan. Radon concentrations within the header houses will be measured using the modified Kusnetz on a frequency stipulated in Regulatory Guide 8.30. These average monthly concentrations will then be converted to a total activity by factoring in the 1,275 cfm exhaust capabilities of the fan. This assumes that all radon in the header house is released into the environment at a rate of the exhaust fan. The exhaust fans in the header houses are operated on a continual basis.

Emissions of U-Nat, Ra-226, Th-230, and Pb-210 will be estimated based upon semi-annual isotopic analysis of filters used for monthly gross alpha measurements as summarized in RAD-LOG-39, Effluent Sampling Plan. The filters are sent to an accredited outside laboratory for analysis, and reported concentration are converted to total activity by using the designed 1,275 cfm exhaust rates of the fans

within the header houses. Each header house effluent will be added to the accumulative release from all header houses.

As Production Areas are developed and additional header houses are installed, the new Header Houses will be added to the total release from all header houses.

Wellfield

Potential emission of radon in the wellfield is limited to recovery wells. Injection wells have sealed well heads and the potential of radon release is minimal. The release of radon from recovery wells is considered to be negligible, since the hydraulic head is approximately one hundred feet subsurface. The down hole pumps are positioned within the production zone of the wellfield and approximately 450' to 500' below surface. These down hole pumps are extracting production solutions and radon from the formation and transferring the solutions to the nearest header house through a closed poly line. The stagnant water in the well is raised or lowered within the column by atmospheric conditions or changes in pump flow rates. This change in the well water level will force air from the well to surface. This release of air from the well head is a source of a radon release, but the flow rate is too variable to measure. In order to validate this assumption on a quarterly basis, 10 percent of the wells will be sampled for radon using the modified Kusnetz method. Samples will be taken at the source of ambient ventilation at the well head. Using the relationship of 0.33 working levels is equal to 3E-8 μCi/ml (Table 1 of 10 CFR 20 Appendix B) a concentration will be calculated. The average concentration over all well heads sampled will be converted to a quantity of activity emitted from each well by using the equation below. Multiplying the result by the number of recovery wells estimates the radon emitted from the well field. Results will be reported on a quarterly basis in the semiannual effluent report. These measurements are based on the assumption that the wellhead is venting at the rate of 3 LPM which is the flow rate that our air monitors pull. Uranerz has an anemometer which will be used as needed to verify the assumption of 3LPM per well head is a very conservative value which leads to an overestimation of the release of radon for each recovery well heads. Overtime estimating effluent from wellfield will be adjusted to more accurately determine a source term for the wellfield

$$Quantity\ emitted\ per\ quarter\left(\frac{\mu Ci}{well}\right) = \frac{Average\ Concentration(\frac{\mu Ci}{ml}) \times Sample\ Volume\ (ml) \times Quarter\ Time(min.)}{Sample\ Time\ (min.)}$$

The other potential source of radon is the unplanned releases of process fluid in the wellfield. At the time of an unplanned release, the radon emitting from this source will be analyzed using the modified Kusnetz and converted to an activity. These activities will be included in the total emissions from the wellfield calculated monthly.

LC 12.8(B): Evaluate the member(s) of the public likely to receive the highest exposures from licensed operations consistent with 10 CFR 20.1302.

The response for LC 12.8 B is located in Attachment 3. The attachment contains the response submitted in the October 8, 2013 submittal, but with revisions that incorporate information that was discussed in the February 24, 2014 NRC/URZ meeting.

For clarification, as presented in a previous submittal from October 8, 2013 a MILDOS evaluation predicted a dose at location 7 – 4.5 that resulted in a dose of 119 mrem. This value was a typographical error such that the decimal point was accidentally removed when results were transferred to excel for analysis, see the attached memo from Senes explaining the error. The correct dose for location 7 – 4.5 should be 0.522 mrem/year for the maximum dose and 0.119 mrem/year when corrected to the 40 hour work week. See additional attached document for analysis and identification of expected maximally exposed individual. The letter detailing this information from SENES is found in Attachment 4.

LC 12.8(C): Discuss and identify how radon (radon-222) progeny will be factored into analyzing potential public dose from operations consistent with 10 CFR Part 20, Appendix B, Table 2.

In 10 CFR 20.1302 (2) (i), the regulation states that it is acceptable to show compliance to public dose limits by showing the average concentrations of radioactive material released in gaseous and liquid effluent at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B. To demonstrate compliance with10 CFR 20.1302 for radon and radon progeny at unrestricted boundaries, Uranerz will measure the annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area.

In the attached plate "Restricted, Controlled, Unrestricted Areas" (Attachment 5), Uranerz depicts areas that will be considered restricted, controlled, and unrestricted. **Controlled areas reside within fenced boundaries, such as Production Areas, with access points conspicuously posted. Controlled areas also include buildings with locks which limit access, such as header houses.** Currently, the only restricted area is within the CPP where all access doors are locked. Uranerz has the authority through surface use agreements with the landowner and in Wyoming Department of Environmental Quality – Land Quality Division Permit to Mine No. 778 to remove unauthorized individuals present in areas designated as controlled or restricted. These restrictions apply to Nichols Ranch only since construction has not commenced on Hank Unit. With these designated controlled and restricted areas any other area is considered to be an unrestricted use area. The boundaries for unrestricted areas are at the fence lines common with the controlled areas.

Measurements of Radon around the central processing plant will be measured using an array of eight (8) RADTRAK dosimeters along the fence line. It will be assumed that the radon progeny is in equilibrium with Radon in a 1 to 1 ratio. The active region of Nichols Ranch Production Area #1 is also surrounded by an array of five (5) RADTRAK dosimeters positioned at CBM wells and a new non-CBM location on the west end of the wellfield for a total of six (6) receptors. As Production Area #1 development continues, more RADTRAK dosimeters will be placed. The Radon detected at these location will also be assumed to be in 1 to 1 equilibrium with the radon progeny. The annual average concentrations will be compared to 10 CFR Appendix B Table 2 radon progeny effluent concentrations to demonstrate compliance to 10 CFR 20 1302.

In the event of an exceedance of effluent concentration limits, one of two methods will be used to demonstrate compliance to public dose limits. The first method takes into account the point and diffuse sources of effluent associated with operations. A source term is calculated to determine the effluent released from each receptor within the license boundary. In the case of Nichols Ranch, the two controlled areas, Production Area #1 and the fenced area around the plant, will be treated as two different systems. As part of the semiannual effluent report, source terms are measured and calculated for each source identified. Using standard atmospheric dispersion modeling calculations or appropriate code, such as MILDOS-AREA or CAPP-88, verification of measured values at the fence line of unrestricted areas can be accomplished.

The other option is to perform a dose assessment to show compliance with 10 CFR 20.1301 by demonstrating that the dose (TEDE) to the individual likely to receive the highest dose from the licensed operation does not exceed 100 mrem/yr (1 mSv/yr). In order to demonstrate compliance using dose assessments, Production Area #1and the area around the plant will have to be treated as two separate systems. Individuals likely to receive the highest dose would be the resident in workforce housing for the plant and the coal bed methane (CBM) worker for the Production Area as addressed earlier for LC 12.8 B. Monitoring devices for radon, RADTRAK dosimeters, are placed at these individual receptors. The individual likely to receive the highest dose, and/or changes to operations which may impact the maximally exposed individual, will be evaluated annually during the ALARA review.

Dose assessment will be performed using the following equation:

$$D = DCF \sum_i C_i F_i T_i$$

Where:

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

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

Dose conversion factors are established by taking the 10 CFR 10 Appendix B, Table 2, value for radon with daughters present in air, (1 × 10-10 μCi/mL or 0.1 pCi/L). The annual dose is 50 mrem/yr (0.5 mSv/yr). Therefore, the dose conversion factor for radon-222 with progeny at 100% equilibrium is determined as 50 mrem/yr (0.5 mSv/yr) divided by 0.1 pCi/L, or 500 mrem/yr per pCi Rn/L.

The annual concentration of Rn-222 in air is determined by taking measurements at the individual receptor locations. At the Production Area, RADTRAK dosimeters are placed at CBM wells and new west fence line location that can be used to assess the amount of radon in air at that location. For the area around the plant, the workforce housing is located near the fence line. A RADTRAK dosimeter will be placed within the housing to assess radon concentrations in the housing unit. In an article published by Shiager (1974), it was shown that buildings immediately adjacent to tailing piles had indoor radon concentration in equilibrium with those found outdoors. Because of the close vicinity of the plant to the workforce housing, the indoor concentrations should be the same as the outdoor concentrations. To verify this assumption, additional RADTRAK dosimeters are located near the housing at a nearby CBM well, NR-7, and along the plant fence line.

Equilibrium between radon and radon progeny is assumed to be 100%. This is a conservative approach but will be used until accurate equilibrium factors can be developed for the site. Site specific equilibrium factors will be approved by NRC before use.

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

Additionally, the member likely to receive the highest dose will be evaluated annually during the ALARA review. Changes to operations which may impact the maximally exposed individual will be evaluated annually during the ALARA review.

LC 12.8(D): Discuss how, in accordance with 10 CFR 20.1501, the occupational dose (gaseous and particulate) received throughout the entire license area from licensed operations will be accounted for, and verified by, surveys and/or monitoring.

URZ Response:

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

The first is the modified Kusnetz method for radon and its progeny. The modified Kusnetz method samples are taken as required in NRC Regulatory Guide 8.30 and is specified in Attachment 1, Effluent Sampling Plan. Inside the CPP, locations are selected based on highest predicted concentrations. These locations will be refined once operations have stabilized and an air flow study can occur with more finite data for positioning of sampling locations. Additionally, header houses and deep disposal well (DDW) buildings will be sampled at least monthly using the modified Kusnetz method.

The second method is using RADTRAK or track-etch dosimeters for radon and its progeny. For the CPP facility eight RADTRAKs will be placed on the fence line surrounding the CPP in order to characterize the effluents in the outdoor controlled area. In the active portion of Production Area (PA) #1 RADTRAKs will be placed at three surrounding Coal-Bed Methane (CBM) wells and one location on the west end of the wellfield fence line. As development continues in PA #1 additional monitoring locations may be established. These locations are chosen based on review of on-site meteorological data. This data was determined to represent long term conditions as presented in the February 18, 2014 Uranerz SUA-1597 L.C. 12.7 license condition submittal.

Uranerz will assign workplace concentrations for radon in the wellfield as well as the CPP surrounding fenced area for annual occupational dose assessments. Averaged concentrations taken from routine radon sampling (modified Kusnetz) will be analyzed with averaged measurements taken from RADTRAK dosimeters. The analysis will compare the data points and the most conservative concentrations will be applied to workers. Concentrations from header houses and surrounding CBM wells will apply to the wellfield and likewise, CPP concentrations and surrounding fence line dosimeters will apply to facilities inside the CPP fence line. Occupancy times for DDW are predicted to be negligible and data is expected to be used for informational purposes only.

Dose will be applied by taking the concentration measured and comparing it to 10 CFR Appendix B Table 2 values for the DAC with daughters present to get a percent DAC. Unless it can be shown that employees will spend considerable time in the wellfield it will be assumed the worker spends 2,000 hours a year within the plant concentration, with exception of operators that spend 2,400 hours. In the event that a worker spends a majority of the time in the wellfield adjustments to the dose will consider time spent in the wellfield concentration and time spent in the plant concentration. In all dose calculation conservative estimates on time will be used.

Particulate radiation concentrations will be calculated based on routine sampling of header houses, DDW buildings, and CPP as specified in NRC Regulatory Guide 8.30. Isotopic analysis of air sampling

locations within the CPP and the header houses will also be performed on a semiannual basis. That data will be analyzed with environmental air monitoring data and the most conservative values will be assigned as workplace concentrations, as described in the previous paragraph.

Dose assigned to the individual from particulates will be assessed by comparing the applying concentration to the values in 10 CFR Appendix B Table 2 with the corresponding radionuclide. A percent DAC will be calculated and taking a conservative occupancy time a dose is attributed to each worker. It will be assumed the worker spends 2,000 hours a year within the plant concentration, with exception of operators that spend 2,400 hours. In the event that a worker spends a majority of the time in the wellfield adjustments to the dose will consider time spent in the wellfield concentration and time spent in the plant concentration. In all dose calculation conservative estimates on time will be used.

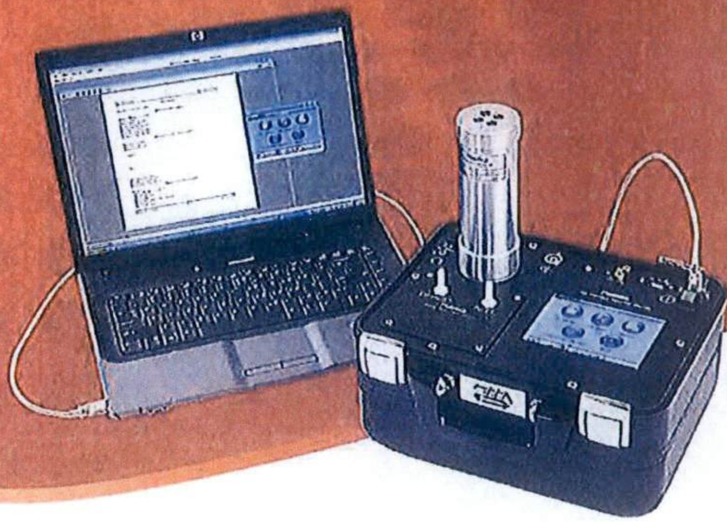
External radiation exposure will be assigned by personal dosimetry or, if not issued, then as work group dose. Each work group will have at least one person assigned external monitoring dosimetry and high risk work groups, such as plant operators, will have all individuals assigned personal dosimetry.

Total occupational dose or Total Effective Dose Equivalent (TEDE) will be applied to individuals summing the three sources of exposure. Occupancy factors for each area will be assigned for each work group (i.e. operators, wellfield workers, radiation safety staff…). Work performed under Radiation Work Permits will be monitored separately from the routine sampling program and the concentrations will be included in the TEDE calculation. Results will be reported to employees on an annual basis as required and summarized in the semi-annual effluent report.

PYLON AB6

Active Cell Detectors

The reliable, versatile, and user-friendly solution for a wide variety of radiation monitoring applications.



We understand that reliable radon detection is not a luxury - it is an absolute necessity.

The Active Cell Detectors are Lucas type cells that are used on our next generation laboratory-grade instrument, the Pylon AB6 Portable Radiation Monitor, for fast, accurate measurement of radon levels.

Every bit as reliable as our previous cells, they have been designed to match the detection specifications of the AB-5 active cell detectors to maintain detection compatibility.

Backed by over 30 years of radon and thoron detection and measurement expertise, superior engineering, and world-class customer service, the Pylon AB6 and active cells provide radon detection you can depend on.

Key Features

High Sensitivity	Can detect low radon levels	Radiation Immunity	Immune to beta and gamma radiation
Versatile	Can be used for both Continuous and Grab sampling measurements	Stable	Insensitive to temperature and humidity changes
Simple Operation	Easy to use & transport		

Applications

When combined with the Pylon AB6 radiation monitor, these active cells can be used for:

- Radon/Thoron Analysis
- Autonomous Continuous Monitoring
- Residential Monitoring
- Industrial Monitoring
- Environmental Monitoring
- Radioactive Site Monitoring
- Mining / Ore Processing
- Mineral Exploration
- Entry Point Testing (Radon Sniffing)
- Meteorological Studies
- Geological Studies
- Education
- Building Materials Research
- Health Protection

... And More

PYLON

Lucas ZnS(Ag) scintillation cells are frequently used to measure radon gas. When radon decays into its daughter products, it gives off an alpha particle. When the alpha particle strikes the ZnS (Ag) scintillator that coats the inside of the cell, the scintillator gives off a photon of light. This photon is detected, converted to an electrical pulse, and amplified by the photomultiplier tube (PMT) in the monitor. The monitor further amplifies the pulse, discriminates out false pulses, and counts the number of pulses in periods of time. With other factors, this provides a measure of the radon that is present in the sample.

Technical Specifications

GENERAL

Radiation Detected:	Alpha
Scintillator:	ZnS(Ag)
Alpha Energy Range:	4.5 to 9 MeV
Accuracy [1]:	± 4%
Background:	< 1 cpm
Calibration [2]:	Upon Request
Maximum Flow Rate [3]:	10 l/min
Connectors:	Quick Connect Fittings
Mating Connectors:	Swagelok B-QC4-S-4HC
Primary Construction Material:	Aluminum

DETECTION SPECIFICATIONS

<u>600A</u>	
Lowest Activity Detectable:	27.4 Bq/m³ (0.74 pCi/l)
Sensitivity:	0.037 cpm/Bq/m³ (1.36 cpm/pCi/l)
Active Volume:	271 ml (9.2 oz [US Liquid])
<u>610A</u>	
LAD:	48.1 Bq/m³ (1.30 pCi/l)
Sensitivity:	0.021 cpm/Bq/m³ (0.76 cpm/pCi/l)
Active Volume:	154 ml (5.2 oz [US Liquid])

ENVIRONMENTAL

Operating Temperature Range:	0 to +50 °C (32 to +122 °F)
Storage Temperature Range:	-20 to +60 °C (-4 to +140 °F)
Relative Humidity Range:	0 to 90 % (Non-Condensing)

DIMENSIONS

<u>600A</u>	
Diameter:	6.1 cm (2.4 in.)
Height:	19.7 cm (7.75 in.)
Weight:	359 g (0.8 lb.)
<u>610A</u>	
Diameter:	6.1 cm (2.4 in.)
Height:	14.5 cm (5.7 in.)
Weight:	324 g (0.7 lb.)

1 At a 1σ Confidence Level.

2 Active cells are tested on a sampling basis. Custom calibrations are available.

3 For Continuous sampling, 0.5 l/min is recommended.

Ordering Information:

Model 600A Large Active Cell: Order part number 7100180.

Model 610A Small Active Cell: Order part number 7100190.

Values are nominal and based on new units.
Specifications subject to change without notice.

Contact a Representative

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Canada

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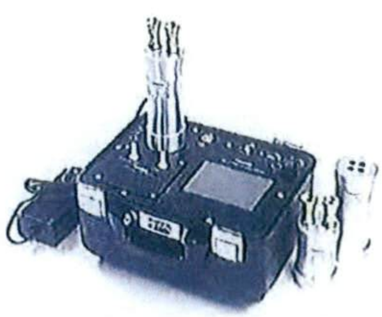


PYLON **AB6**

Portable Radiation Monitor

The reliable, versatile, and user-friendly solution for a wide variety of radiation monitoring applications.

We understand that reliable radon detection is not a luxury — it is an absolute necessity.

The Pylon AB6 Portable Radiation Monitor is our next generation laboratory-grade instrument for fast, accurate measurement of radon levels.

Every bit as reliable as our previous monitors, it incorporates advanced technology and user-friendly features for enhanced performance and versatility.

Backed by over 30 years of radon and thoron detection and measurement expertise, superior engineering, and world-class customer service, the Pylon AB6 provides radon detection you can depend on.

Key Features

Field Readiness	Compact, lightweight unit with rechargeable battery and built in photomultiplier tube (PMT)
Modular Versatility	Multiple detectors interface with internal PMT enabling a variety of measurements
LCD Touch Screen	Intuitive, efficient user interface offers increased visibility and data entry options
USB/Pulse Interfaces	Host and client USB interfaces for fast, efficient data transfers and pulse output port for external data logging
Enhanced Compatibility	Includes PC software for measurement, reporting, and remote monitor set-up and operation
Customizable Solution	Adjustable PMT high voltage and discriminator settings, pre-programmed methods and optional internal pump
Automated Calculations	For some measurements, eliminates need for manual calculations from raw data
User Calibration	Simplified programming and operation saves time and expense of factory calibrations
Safety and Reliability	Compact, rugged sampling cells ideal for environments that require intrinsically safe equipment

Applications

- Continuous Monitoring
- Grab Sampling
- Environmental Studies
- Area Scanning
- Field Surveys
- Uranium Mining/Production/Exploration
- Oil & Gas
- Governments
- Educational Institutions
- Research Facilities

... And More

PYLON

"I have been associated with Pylon and their products for more than 25 years. Not only are their products accurate and reliable, but they have proven to be important tools in the scientific community. I look forward to the next generation of Pylon products."

Dr. Georges Vandrish - Instruscience Ltd.

Technical Specifications

GENERAL

Mode of Operation:	Multiple
Sample & Count Periods:	User programmable
Maximum Counting Rate:	10,000 cps
Electronic Background:	< 0.4 cpm

DETECTOR

Detector:	Active and passive Lucas type scintillation cells (sold separately)
Detection Specifications:	Available in respective detector brochures

POWER

Power Supply Requirements:	12 - 14.7 Vdc 4 A - 110/220 VAC adapter/charger included
Battery:	Integrated 12V gel cell
Battery Operating Time:	22 Hrs backlight off, without pump 5 Hrs backlight on, without pump
Battery Charge Time:	5 Hrs

FEATURES

Display:	14.5 cm (5.7 in.) colour touchscreen LCD
Memory:	1) 1 GB SD memory card 2) 2 GB USB memory stick
Data Ports:	1) USB host port 2) USB client port 3) 5V TTL pulse via SMA connector
Lid:	Removable

PUMP (sold separately and user installable)

Pump Flow Rate:	0 to 2 lpm - User adjustable

ENVIRONMENTAL

Operating Temperature Range:	0 to +40 °C (-32 to +122 °F)
Storage Temperature Range:	-20 to +60 °C (-4 to +140 °F)
Relative Humidity Range:	0 to 90 % - Non-condensing

DIMENSIONS

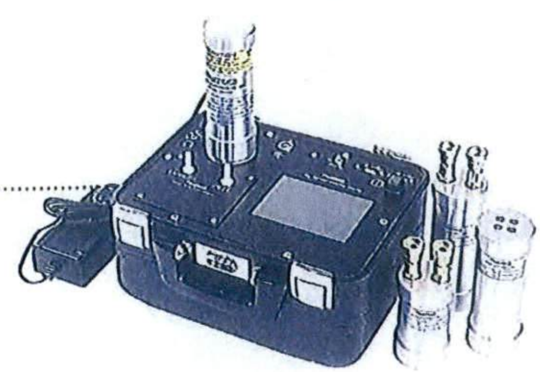
Width:	31 cm (12 in.)
Depth:	23 cm (9 in.)
Height:	20 cm (7.75 in.)
Weight:	6 kg (13 lb.)

• Values are nominal.

Ordering Information:

Model AB6 Monitor: Order part number 7100000.
Model 6100 Optional Pump: Order part number 7100140.

CE10



Contact a Representative

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www.pylonelectronics.com

Datasheet: DS129 Rev 1

Attachment 1

Effluent Sampling Plan

RAD-LOG-39

Effluent Sampling Plan

Type and Location	Radionuclides	Instrumentation	Frequency	LLD/MDC	Procedures
Central Processing Plant Isotopic Analysis (at locations of highest predicted concentrations)	Particulates-U-Nat, Ra-226, Th-230, Pb-210	Radeco HD-66A, H-809VII, and H-809VI. Glass Fiber filter paper	Semiannually for two years	U-Nat= 3E-11, Ra-226= 3E-11, Th-230= 3E-13, Pb-210= 1E-11 µCi/mL	RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls
Central Processing Plant Airborne Particulates (at locations of highest predicted concentrations)	Gross α	Radeco HD-66A, H-809VII, and H-809VI. Glass Fiber filter paper,	Monthly	U-Nat- 3E-12 µCi/ml	RAD-SOP-03 Operational Radiation Safety Program RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls
Central Processing Plant Radon Daughter (at locations of highest predicted concentrations)	Radon Daughters	Lapel Samplers, Buck M-30 with a flow of 3LPM	Weekly Initially, afterwhich frequency is based upon regulatory guidance 8.30.	0.033 WL (Modified Kusnetz)	RAD-SOP-03 Operational Radiation Safety Program RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls
Central Processing Plant (Exterior) (at locations of highest predicted concentrations)	Radon Daughters	8 RADTRAK© dosimeters surrounding the Central Processing Plant	On a six month basis	0.06 pCi/L	RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls RAD-SOP-17 Radiological Effluent and Environmental Monitoring Program
Environmental Monitoring Stations License Boundary NA-2,NA-3, NA-4 (BKG), NA-5 Plant to Licensed Boundary NA-6 (near plant) NA-1 (Nearest Resident) ***Additional stations may be placed at injection and recovery spills that are reportable, since no reportable spills have occurred these are future locations******	Gamma (Located at Each Environemtnal Monitoring Station)	Landauer InLight OSL with aluminum oxide detector	Quarterly for one year	0.1mrem	RAD-SOP-17 Radiological Effluent and Environmental Monitoring Program
	Particulates-U-Nat, Ra-226, Th-230, Pb-210	F&J Specilaty Products DF-40L-AC 1 to 40 LPM, DF-30L-AC 1 to 30 LPM. Glass Fiber filter paper	Quarterly composits of weekly samples for one year	U-Nat= 1E-16, Ra-226= 1E-16, Th-230= 1E-16, Pb-210= 1E-15 µCi/mL	RAD-SOP-17 Radiological Effluent and Environmental Monitoring Program
	Radon Daughters (Located at each Environmental Monitoring Station)	RADTRAK© Type DRNF	Quarterly for one year	0.06 pCi/L	RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls RAD-SOP-17 Radiological Effluent and Environmental Monitoring Program
Header House (Interior) - HH-1, HH-2, HH-3 additional HH as developed	Radon Daughters	Lapel Samplers, Buck M-30 with a flow of 3LPM	Weekly Initially, after which frequency is based upon regulatory guidance 8.30.	0.033 WL (Modified Kusnetz)	RAD-SOP-03 Operational Radiation Safety Program RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls
	Gross α	Radeco HD-66A, H-809VII, and H-809VI. Glass Fiber filter paper,	Initially monthly, based upon data review sampling frequency may be changed	U-Nat- 3E-12 µCi/ml	RAD-SOP-03 Operational Radiation Safety Program RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls

Effluent Sampling Plan

Type and Location	Radionuclides	Instrumentation	Frequency	LLD/MDC	Procedures
Header House Isotopic Analysis (in operating header houses)	Particulates-U-Nat, Ra-226, Th-230, Pb-210	Radeco HD-66A, H-809VII, and H-809VI. Glass Fiber filter paper	Semiannually for two years	U-Nat= 3E-11, Ra-226= 3E-11, Th-230= 3E-13, Pb-210= 1E-11 µCi/mL	RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls
Header House (Exterior) - HH-1, HH-2, HH-3 additional HH's as developed	Gamma	Ludlum Model 19, Thermo Eberline RO-20,	Weekly documented in the RSO weekly report	Verify less than 2 mR/hr	RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls
	Radon Daughters	RADTRAK© Type DRNF	Four stations surrounding well field intitially. Changed every six months	0.06 pCi/L	RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls RAD-SOP-17 Radiological Effluent and Environmental Monitoring Program
Plant (exterior)	Gamma	Ludlum Model 19, Thermo Eberline RO-20.	Weekly documented in the RSO weekly report	Verify less than 2 mR/hr	RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls
Well fields 10% of well heads	Radon Daughters	Lapel Samplers, Buck M-30 with a flow of 3LPM	Quarterly for one year then assess for frequency	0.033 WL (Modified Kusnetz)	RAD-SOP-03 Operational Radiation Safety Program RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls
Deep Disposal Well House (Interior)	Radon Daughters	Lapel Samplers, Buck M-30 with a flow of 3LPM	Weekly Initially, after which frequency is based upon regulatory guidance 8.30.	0.033 WL (Modified Kusnetz)	RAD-SOP-03 Operational Radiation Safety Program RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls
	Gross α	Radeco HD-66A, H-809VII, and H-809VI. Glass Fiber filter paper,	Initially monthly, based upon data review sampling frequency may be changed	U-Nat- 3E-12 µCi/ml	RAD-SOP-03 Operational Radiation Safety Program RAD-SOP-09 Airborne Radioactive Material Monitoring and Controls
Deep Disposal Well House (Exterior)	Gamma	Ludlum Model 19, Thermo Eberline RO-20	Weekly documented in the RSO weekly report	Verify less than 2 mR/hr	ADM-SOP-01 Routine Environemntal, Safety, and Health Inspections RAD-SOP-03 Operational Radiation Safety Program
Radium-226 Concentration in Production Fluid	U-nat, Th-230, Ra-226, Pb-210	Outside Laboratory	Quarterly for one year		RAD-SOP-17 Radiological Effluent and Environmental Monitoring Program

Effluent Sampling Plan

Objective	Group	Purpose	Dose Assessment	Decision Rule	Procedures
Evaluate Dose to the Public	unrestricted area boundary or maximally exposed individual	Validate that dose is less than 100mrem per year	Particulate-NA-4,NA-6 Radon NR-5, NR-7, eight receptors encircling the plant and receptors encircling the wellfield*inside workforce housing Gamma- NR-5, NR-7 *inside workforce housing	If dose is validated at well less than 100mrem per year , no further actions. If potential exists to exceed limit a dose assesment will occur to validate the data	RAD-SOP-14 Radiation Dose Assessment
	unrestricted area boundary or maximally exposed individual	Demonstrate dose constrant rule	Particulate- NA-4, NA-6, eight receptors encircling the plant and receptors encirculing the well field	If dose is validated at less than 10mrem per year, no further action. If potential exists to exceed limit a dose assessment will occur to validate the data.	RAD-SOP-14 Radiation Dose Assessment
Evaluate Occupational Dose	Office Worker	Demonstrate adequacy of existing programs by validating less than 10 percent. (10CFR 20.1502(a)(1)	Airborne Particulate- Semiannually Radon Daughter-consistent with Reg Guid 8.30 Gamma- data from badged office workers	If the current program consistently overestimates dose, no further action. If potential for underestimation of dose evaluate alternative in estimation of methods and or monitoring	RAD-SOP-14 Radiation Dose Assessment
	Lab Worker	Demonstrate that current program adequately assesses or overestimates dose	Airborne Particulate- Quarterly Radon Daughter-consistent with Reg Guid 8.30 Gamma- data from badged lab worker	If the current program consistently overestimates dose, no further action. If potential for underestimation of dose evaluate alternative in estimation of methods and or monitoring	RAD-SOP-14 Radiation Dose Assessment
	Well Field Development	Demonstrate that current program adequately assesses or overestimates dose	Airborne Particulate- Averages of header houses concentrations from routine sampling Radon Daughter-Averages of header concentration and surrounding wellfield RADTRAK dosimeters. Gamma- badges	If the current program consistently overestimates dose, no further action. If potential for underestimation of dose evaluate alternative in estimation of methods and or monitoring	RAD-SOP-14 Radiation Dose Assessment

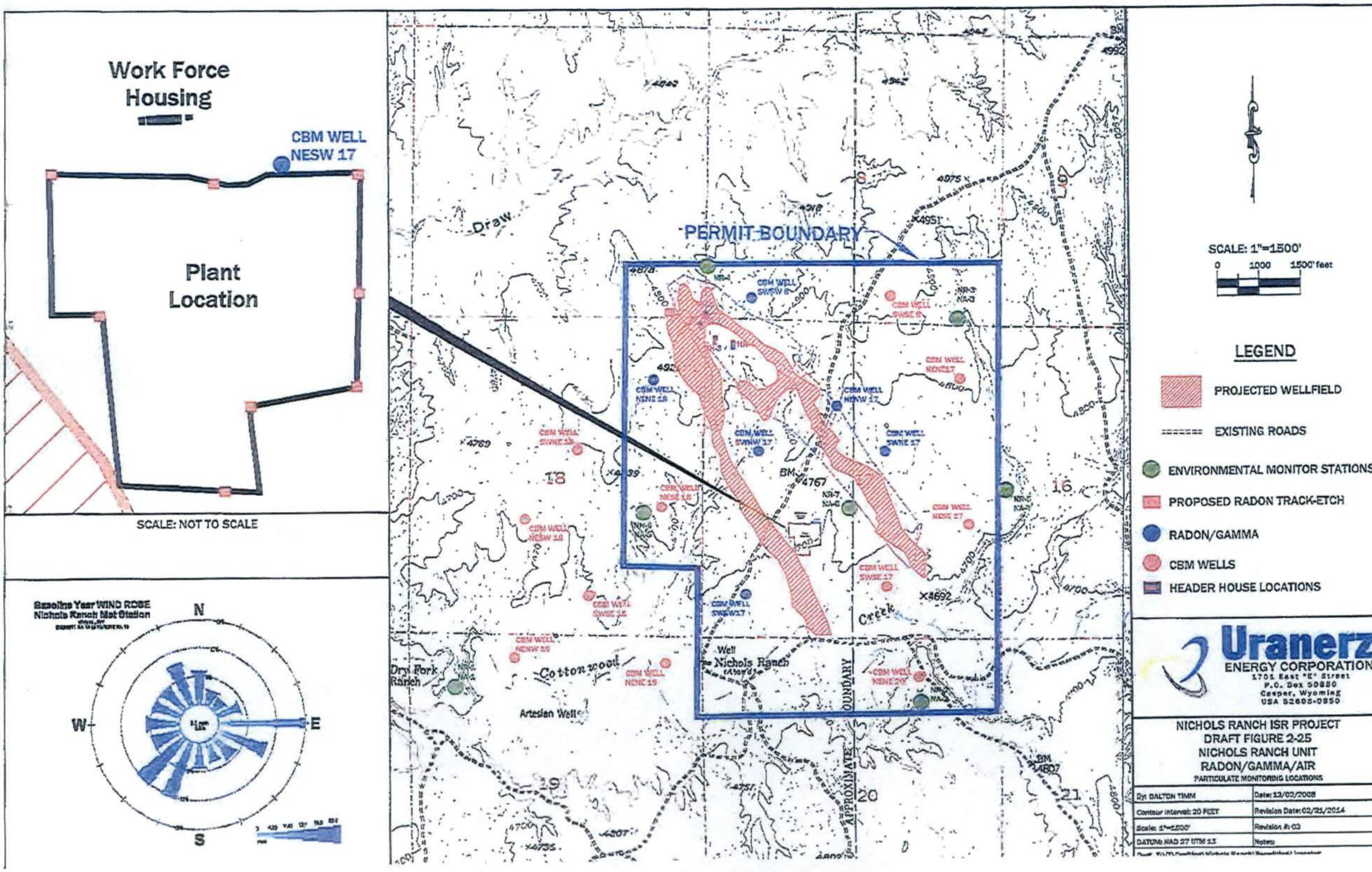
Effluent Sampling Plan

Objective	Group	Purpose	Dose Assessment	Decision Rule	Procedures
Evaluate Occupational Dose	Operations	Demonstrate that current program adequately assesses or overestimates dose	Airborne Particulate- Averages of plant concentrations from routine sampling Radon Daughter-Averages of plant concentration and surrounding RADTRAK dosimeters. Gamma- badges	If the current program consistently overestimates dose, no further action. If potential for underestimation of dose evaluate alternative in estimation of methods and or monitoring	RAD-SOP-14 Radiation Dose Assessment
	ESH staff	Demonstrate that current program adequately assesses or overestimates dose	Airborne Particulate- Combinations based on occupancy times Radon Daughter-Combination based on occupancy times Gamma- badges	If the current program consistently overestimates dose, no further action. If potential for underestimation of dose evaluate alternative in estimation of methods and or monitoring	RAD-SOP-14 Radiation Dose Assessment

Attachment 2

Draft Figure 2-25

Nichols Ranch Unit Radon/Gamma/Air


Work Force Housing
CBM WELL NESW 17
Plant Location
SCALE: NOT TO SCALE
Baseline Year WIND ROSE
Nichols Ranch Met Station
N
W
E
S
PERMIT BOUNDARY
Draw
Cottonwood
Creek
Dry Fork Ranch
Nichols Ranch
Artesian Wells
APPROXIMATE BOUNDARY
BM 4767
18
16
19
20
21
SCALE: 1"=1500'
0 1000 1500' feet
LEGEND
PROJECTED WELLFIELD
EXISTING ROADS
ENVIRONMENTAL MONITOR STATIONS
PROPOSED RADON TRACK-ETCH
RADON/GAMMA
CBM WELLS
HEADER HOUSE LOCATIONS
Uranerz
ENERGY CORPORATION
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850
NICHOLS RANCH ISR PROJECT
DRAFT FIGURE 2-25
NICHOLS RANCH UNIT
RADON/GAMMA/AIR
PARTICULATE MONITORING LOCATIONS
By: DALTON TIMM
Date: 12/02/2008
Contour interval: 20 FEET
Revision Date: 02/21/2014
Scale: 1"=1500'
Revision #: 03
DATUM: NAD 27 UTM 13
Notes:

Attachment 3

License Condition 12.8 B

Response

Identification of the Maximally Exposed Member of the Public At the Nichols Ranch Project

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3 October 2013
Modified by Uranerz 27 February 2014
& March 6, 2014

Introduction and Nature of Problems Solved by MILDOS-AREA

Provided in this document is a supplement to the original MILDOS-AREA model provided in Section 7.3.1.2 (Exposures from Air Pathways) in the Nichols Ranch Technical Report. This document includes expanded dose assessments for determining the maximally exposed member of the public as a result of operations at the Nichol's Ranch site. Dose estimates from air pathways were made using MILDOS-AREA, the Argonne National Laboratory computer code recommended by NRC in NUREG 1569, Section 7.3.1.2.2, for assessing radiological impact to the public from air emissions at ISRs. The estimates were calculated using MILDOS-AREA version 3.1, a version updated in February 2012 to address issues with the dusting algorithm in the previous version.

The MILDOS-AREA computer code calculates the radiological dose commitments received by individuals and the general population within an 80-km radius of an operating uranium recovery facility. In addition, air and ground concentrations of radionuclides are estimated for individual locations. The transport of radiological emissions from point and area sources is predicted with a sector-averaged Gaussian plume dispersion model. Mechanisms such as radioactive decay, plume depletion by deposition, ingrowth of decay products, and resuspension of deposited radionuclides are included in the MILDOS-AREA transport and dosimetry model.

Alterations in operation throughout the facility's lifetime can be accounted for by MILDOS-AREA via selection of inputs. Dose commitments were calculated primarily on the basis of the recommendations of the International Commission on Radiological Protection (ICRP). Only airborne releases of radioactive materials were considered in MILDOS-AREA; releases to surface water and to groundwater are not addressed by the MILDOS-AREA code.

The MILDOS-AREA computer code was designed as a primary licensing and evaluation tool and is used to provide basic input to critical licensing, regulatory, and policy decisions. It is used by the staff of the USNRC to perform routine radiological impact and compliance evaluations for various uranium recovery operations.

Source Description

Radionuclide releases are defined for each emission source. The U-238 decay chain is assumed to be the only significant source of radiation. The contribution from the U-235 chain is less than 5% of that from the U-238 chain. The gaseous releases are defined for Rn-222, with ingrowth of short-lived decay products also considered. For Rn-222, these decay products include Po-218, Pb-214, Bi-214, Pb-210, and Po-210. The dosimetry model accounts for releases and ingrowth of other radionuclides by assuming secular equilibrium.

The time history of release for each source is defined for the life of the facility and post-operational period. Typically, an ISR will operate for a period of years, during which there will be radon and particulate releases from wellfields and from the CPP during construction, operation and aquifer restoration.

Atmospheric Transport and Diffusion

Emissions of radioactive materials from different sources are modeled with a sector-averaged Gaussian plume dispersion model, which utilizes user-provided wind frequency data. Mechanisms such as deposition of particulates, resuspension, radioactive decay, and ingrowth of decay-product radionuclides are included in the transport model. The model computes annual average air concentrations of radionuclides and then uses the results to compute impacts to humans through various pathways. Ground surface concentrations are estimated from deposition buildup and ingrowth of radioactive decay products. Surface concentrations are modified by radioactive decay, weathering, and other environmental processes.

Potential Sources of Radiological Effluent at the Nichols Ranch Project

The Nichols Ranch ISR project has the potential to produce radiological effluent in the form of Rn-222 that is dissolved in the production and restoration fluid and is present as a result of the uranium decay series. It is assumed there will be no particulate emissions during routine operations of this facility as the facility will use modern, low temperature vacuum driers, the particulate release of which is considered to be essentially zero by the USNRC as provided in NUREG 1910 (USNRC 2009). This has been historically verified by measurements taken of dryer exhausts at operating ISRs in Wyoming, Nebraska and Texas. This will be the case for the Nichol's Ranch ISR since the dryer off gas system captures essentially all particulates and exhausts into the dryer room (demonstrated in sections 4.1 and 5.7.1 of the Nichols Ranch ISR Project Technical Report). **To validate this assumption, particulate monitoring stations will be placed to access the emissions of particulates. The concentrations present at receptor locations will be used in establishing doses to the public. Since the dose due to particulates is minor in comparison to radon released, this model only evaluates the radon. The inclusion of particulates would not alter the results of the study in identifying the maximally exposed individual.**

The Rn-222 releases result from the following sources during the lifespan of an ISR project:

- New Wells: The drilling process removes soil/drill cuttings which contain Rn-222. This soil is stored in mud pits until the wells are reclaimed. Rn-222 is released during the mud pit storage.
- Production Wells: Rn-222 may be released via leaks/venting in the well heads or the header houses.
- Central Processing Plant (CPP): The pressurized, closed system for the production fluids is opened at the point of ion-exchange column transfer and during pressure reductions during purging.
- Restoration Wells: Circulating water and discharged water from the restoration process also contains Rn-222 which may be released during the process.

The Nichols Ranch project will have two well field units, the Nichols and Hank Units, and one CPP located at the Nichols unit

Potential Maximally Exposed Members of the Public

In order to fully evaluate the potential exposure to members of the public, a list of potential persons of interest (in addition to the full time resident and theoretical future receptors previously discussed in the Nichols Ranch Technical Report Section 7.3.1.2) was created and only people spending at least 50 hours per year in the vicinity of the site were considered. The individual members of the public who may be at or near the site were defined to be a courier and an equipment vendor that may visit the central processing plant, a hunter who sets up camp directly downwind of the site, CBM workers, workforce housing residents, and oil field workers at the Hank Unit. Estimates of their hours at or near these sites are shown below in Table 1.

Table 1 Potentially Exposed Members of the Public

Member of Public	Activities	Annual Hours	Calculation of Total Hours of Exposure
Courier	Package Delivery	90	20 min/d x 5 d/w x 52 w/y
Vendor	Equipment Delivery/ Maintenance	260	1 h/d x 5 d/w x 52 w/y
Hunter	Recreation	240	24 h/d x 10 d/yr = 240 hrs
Oil Field Worker 1	Operation and Maintenance	175	Op: 0.5 h/d x 5 d/w x 50 w/y Maint: 10 h/d x 5 d/y
Oil Field Worker 2	Operation and Maintenance	175	Op: 0.5 h/d x 5 d/w x 50 w/y Maint: 10 h/d x 5 d/y
Oil Field Worker 3	Operation and Maintenance	175	Op: 0.5 h/d x 5 d/w x 50 w/y Maint: 10 h/d x 5 d/y
CBM Worker	Operation and Maintenance	660	Op: 4 h/m well x 12 wells 12m/yr Maint: 7h/yr well x 12 well
Workforce Housing	Sleeping / Eating	2400	Op 12 h/d x 4 d/wk x 50 wk/yr

The courier and vendor exposure times are based on anticipated delivery needs at the site and conservatively assumes that the same courier and vendor visit the site each time. This is a likely scenario for the courier, however it is less likely that the same vendor will be used for all vendor visits on a daily basis to the site. Oil/Gas wells currently are only located in the Hank Unit. Oil field worker estimates are based on the assumption that daily operational activities at a given oil well take about 30 minutes to complete and are carried out on a daily basis. Additionally, it is assumed that the oil wells require about 10 hours of maintenance activities approximately 5 days per year. At the Nichols Ranch facility there are 12 CBM wells within the licensed boundary. In consultation with WPX a conservative estimate is 4 hours per month per well with 7hours per year of maintenance. Uranerz has made the conservative assumption that workers will not spend more than an average of four nights a week in workforce housing. Assuming 50 weeks worked a year and staying 12 hours each night, this would equal 2400 hours a year.

Because there may be unanticipated occupational activities anywhere across the site, a generic worker was placed in the vicinity of the Nichols and Hank units at multiple locations on a 4 km^2 grid centered at the approximate center of both facilities (grid locations were placed out to 2km North, South, East, and West). The generic worker is a worker assumed to be at that location for 40 hours per week, 50 weeks per year **for a total of 2,000 hours.** In setting locations for a generic worker, it was determined that the locations of the courier, vendor, hunter, and oil field workers are all included at the same locations of the generic worker. **Using occupancy times for individuals a dose was calculated using the exposure predicted at the receptors location.**

The MILDOS code considers constant occupancy by all receptors. The doses calculated for the generic worker were scaled such that the doses reported in this report represent 22.9% of the calculated dose (2,000 hour work year / 8,736 hours assumed by MILDOS). **The doses calculated for individual receptors took into consideration occupancy times and were scaled using the same methodology as the generic worker (hours in location/ 8736 hours assumed by MILDOS.)**

Source Term Calculations

MILDOS calculations for source terms at ISR facilities were applied to the Nichols and Hank Units for construction, production and restoration. Table 2 provides input values that were used in estimating the source terms for each location and Table 3 provides the source terms that were calculated for each phase of the project. The input values used were obtained from the previously submitted Technical Report for the Nichols Ranch ISR Project as supplemented by communications with Uranerz personnel. The center of milling operations (0km, 0km, 0m) was placed in the Nichols unit at the location of the central processing plant with the wellfields placed relative to the CPP at (-0.9km, 0.4km, 6m) and the Hank unit was considered relative to the Nichols unit as well at (8.2km, 3.5km, 142m).

Source terms were calculated using equations provided in NUREG 1569, Appendix D and the ISR specific patch to the MILDOS-AREA code. The primary source of Rn-222 during the construction process is identified as the mud pits. Ore cuttings from the drilling operations have the potential to contain radium which produces radon through radioactive decay. Construction source terms were calculated at the centroid of both well fields using the following equation:

$$Rn_{nw} \equiv 10^{-12} E\, L\, [Ra]\, T\, M\, N$$

where

Rn_{nw}	=Rn-222 release rate from new well field (Ci/yr)
10^{-12}	=unit conversion factor (Ci/pCi)
[Ra]	=concentration of Ra-226 in ore (pCi/g)
E	=emanating power (Assumed 0.2)
L	=decay constant of Rn-222 (0.181/d)
T	=storage time in mud pits (days)
M	=average mass of ore material in mud pits (g)
N	=number of mud pits generated per year

The total source term during operations is the sum of three terms that represent Rn-222 releases as a result of occasional venting and leaking of wellheads and pipes at header houses, purge water release, and unloading of IX columns. The contribution of Rn-222 from unloading IX columns and purge water release were modeled as the CPP source term. The Rn-222 release associated with leaking and venting of wellheads and header houses (well field source term) was calculated with the following equations:

$$Rn_v = 3.65E\text{-}10\ v\ C_{Rn}\ V$$

where

Rn_v = Rn-222 release from venting (Ci/yr)
v = rate of radon venting from piping and valves during circulation(day^{-1})
V = Volume of water in circulation (L)

where

$$C_{Rn} = \frac{10^6 [Ra]\ A\ D\ \rho\ E\ L\ f}{(L+v)\ V + F_p + F_i}$$

where

C_{Rn} = Rn-222 concentration in the process water (pCi/L)
[Ra] = concentration of Ra-226 in the ore (pCi/g)
A = active area of ore zone (m^2)
D = average thickness of the ore zone (m)
ρ = density of ore material (g/cm^3)
E = emanating power (Assumed 0.2)
L = decay constant of Rn-222 (0.181/d)
M = average mass of ore material in mud pits (g)
N = number of mud pits generated per year
F_p = purge rate of treated water (L/d)
F_i= water discharge rate, resin unloading of IX columns (L/d)
V,v = as previously defined

The following equation was used to calculate the contribution to the CPP source term from purge water:

$$Rn_w = 3.65E\text{-}10\ C_{Rn}\ F_p$$

where

Rn_w =Rn-222 release rate from purge water (Ci/yr)
3.65E-10= unit conversion factor (C/pCi)(d/yr)
F_p =purge rate of treated water (L/d)

The following equation was used to calculate the contribution to the CPP source term as a result of IX column unloading:

$$Rn_x = 3.65 \times 10^{-10} F_i \, C_{Rn}$$

where:

Rn_x =annual Rn-222 discharge from unloading IX column contents
F_i =water discharge rate from resin unloading of IX columns (L/d)

During aquifer restoration, radon will continue to be vented through surface well heads and released via purge water release.

Table 2 MILDOS Input for Nichols and Hank Units

	Nichols Unit	
Construction	Area of Active Drilling	228,644 m^2
	Radon Emanation Fraction	0.2
	Ra-226 Concentration in Ore	331 pCi/g
	Storage Time in Mudpits	30 days
	Ore Material into Pit	136,532 g/y
	Number of Mudpits	966
Production	Thickness of Ore Zone	2.2 m
	Density of Ore Zone	1.9 g/cm^3
	Volume of Water in Circulation	149,068,519 L
	Rate of Radon Venting	0.01 / day
	Treated Purge Water Rate	190,779 L/day
	IX Column Volume	14,158 L
	IX Column Unloading Rate	2 /day
	Resin Porosity	0.4
Restoration	Treated Purge Water Rate	310,698 L/day
	Operating Days	360 days/ y
	Hank Unit	
Construction	Area of Active Drilling	313,627 m^2
	Radon Emanation Fraction	0.2
	Ra-226 Concentration in Ore	277 pCi/g
	Storage Time in Mudpits	30 days
	Ore Material into Pit	160949 g/y
	Number of Mudpits	776
Production	Thickness of Ore Zone	2.6 m
	Density of Ore Zone	1.9 g/cm^3
	Volume of Water in Circulation	245,770,913 L
	Rate of Radon Venting	0.01 / day
	Treated Purge Water Rate	408,813 L/day
	IX Column Volume	14,158 L

	IX Column Unloading Rate	2 /day
	Resin Porosity	0.4
Restoration	Treated Purge Water Rate	119,918 L/day
	Operating Days	360 days/ y

Table 3 Source Terms Calculated for Nichols and Hank Units

Nichols Unit		
Construction	Rn-222 Release Rate from Drilling/Mudpits	0.0447 Ci/y
Production	Rn-222 Release from Purge Water	19.7 Ci/y
	Rn-222 Release from Well Venting	153 Ci/y
	Rn-222 Release from Ion Exchange Venting	1.17 Ci/y
Restoration	Rn-222 Release from Purge Water	31 Ci/y
	Rn-222 Release from Well Venting	150 Ci/y
Hank Unit		
Construction	Rn-222 Release Rate from drilling/mudpits	0.0376 Ci/y
Production	Rn-222 Release from Purge Water	36.7 Ci/y
	Rn-222 Release from Well Venting	221 Ci/y
	Rn-222 Release from Ion Exchange Venting	1.02 Ci/yr
Restoration	Rn-222 Release from Purge Water	10.7 Ci/y
	Rn-222 Release from Well Venting	219 Ci/y

In addition, because this analysis was performed for casual, non-resident members of the public, the ingestion pathways were not included. The milk pathway was also not considered (no local dairies providing milk). Data from the onsite meteorological station was used in a STAR file format to compute the model results and this data represented 90% recovery for one full calendar year at the site.

In the Time Parameters menu, 6 time steps were included to represent phases of the project including construction, production, and restoration at both units. The time step option in MILDOS allows the user to determine what source terms are considered for a period of time set by the user. The time steps represent the phases of the Nichols Ranch project where the Nichols and Hank units transition from construction to production to restoration. Source terms for each of these phases are considered in the appropriate time period as defined by the schedule in the Nichols Ranch Technical Report. The time steps 1-6 are listed in Table 4, and the source terms that are considered in each sequential time step are marked with an "x" to indicate their inclusion in the dose estimate during that time period.

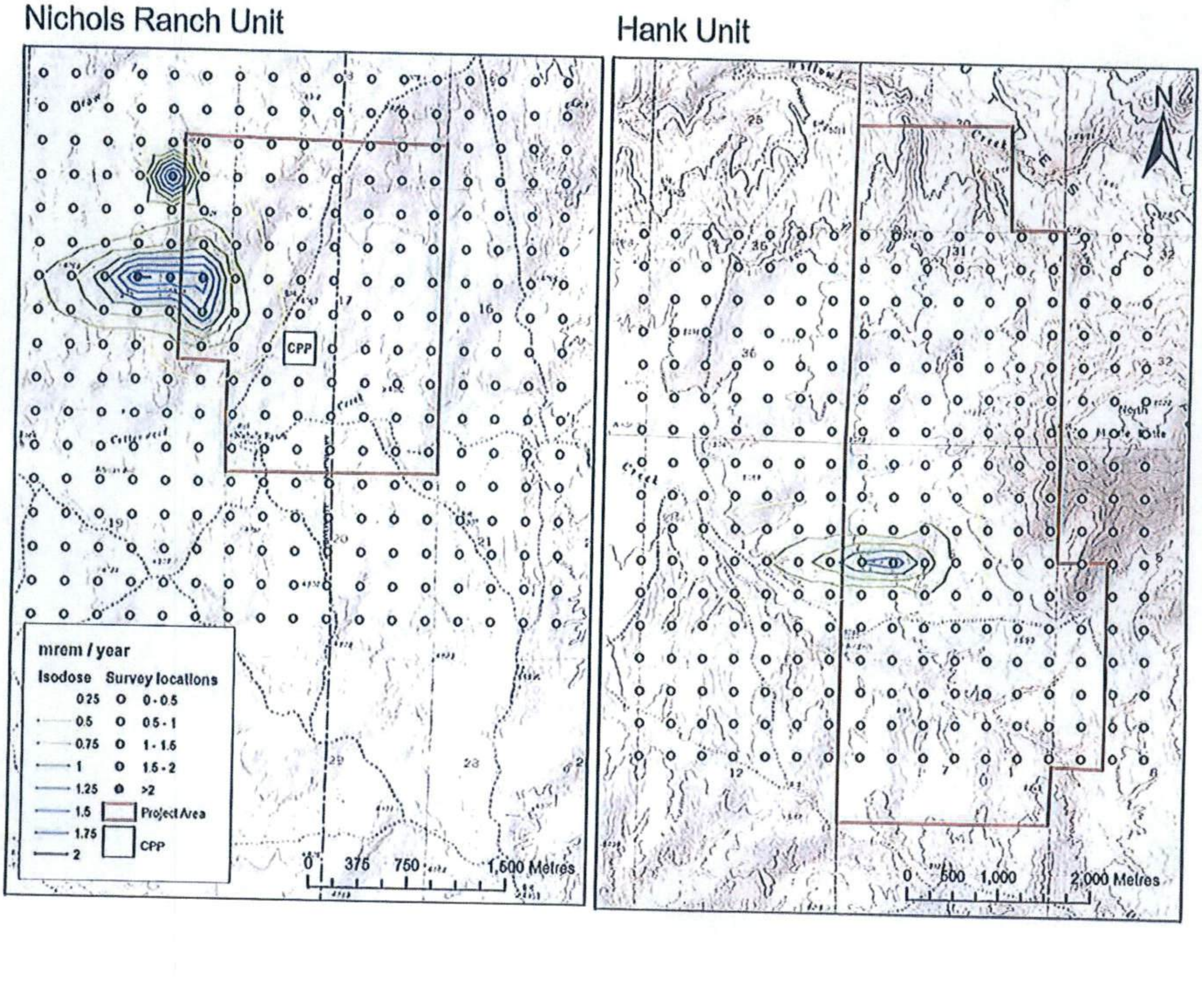
Table 4 **Source Terms Applied in Each Time Step**

Time Step (duration)	**Nichols Construction**	**Hank Construction**	**Nichols Production**	**Hank Production**	**Nichols Restoration**	**Hank Restoration**
1 (6 months)	X					
2 (3 months)	X	X				
3 (6 months)		X	X			
4 (3.25 years)			X	X		
5 (1.25 years)				X	X	
6 (4.25 years)					X	X

Dose Estimates

The MILDOS model was used to calculate doses to the generic worker at 576 locations around the Nichols and Hank units at the Nichols Ranch Project area. MILDOS modeling shows that the highest doses to the generic worker are found in time steps 5 and 6, i.e., during the time period when both the Nichols unit restoration and the Hank unit production is occurring (time step 5) and during both units' restoration phases (time step 6). This is expected as the restoration source term for the Nichols unit was the highest and the production source term and restoration source term for the Hank unit are quite similar. **Using the predicted exposures doses were calculated for individual receptors.** The map depicted in Figure 1 presents the dose estimate results overlaid on the site map, with regions of similar dose connected to produce isodose curves over the property. The isodose lines on these maps represent regions of similar dose. No doses below 0.5 mrem/yr were included as survey locations on this map. A table of all doses from the time step of highest predicted exposures (step 5) is included as Attachment 1 at the end of this document.

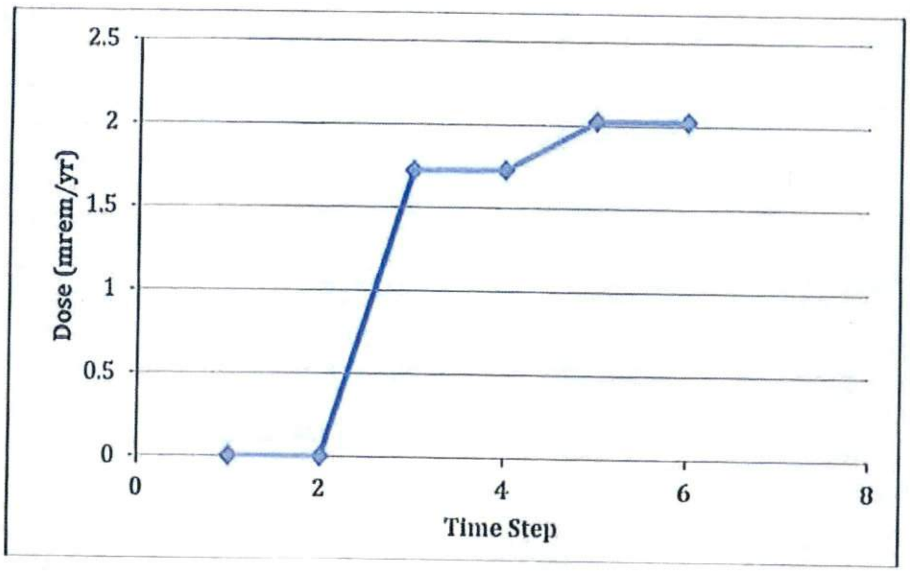
Figure 1 Regions of Similar Projected Exposure (Isodose Curves) at the Nichols Ranch and Hank Project Sites



The maximum dose modeled by this analysis at the Nichols Ranch Project site was located at 1.25 km west and 0.5 km north of the center of operations at the Nichols unit. The maximum dose to a 40-hour a week, generic worker at this location as a result of radon effluents* from the facility was estimated to be 2.02 mrem/yr. The dose to the generic worker at this location over all time steps modeled for construction, production, and restoration phases at the Project is shown in Figure 2. **The dose projected to the generic worker at this location is greater than the dose predicted for an individual with estimated occupancy times.**

* As described previously, MILDOS considers in growth of short-lived decay products. For Rn-222, these decay products include Po-218, Pb-214, Bi-214, Pb-210, and Po-210. However, it must be noted that because nearly pure radon gas is being emitted (progeny equilibrium factor close to zero at time of release), time is required for progeny in growth as the gas is dispersed and travels through the atmosphere. In-growth as a function of time and distance is considered by MILDOS.

Figure 2 Dose to the Maximally Exposed Generic Worker



The dose to the maximally exposed generic worker is slightly more than twice the dose to the maximally exposed resident at the Pfister Ranch (identified in the original Nichols Ranch Technical Report, Table 7-8), with a dose estimate of 0.9 mrem/yr. This result is expected, as the Pfister Ranch is located approximately 10 km from the center of the Nichols Unit operations. However, this dose is lower than the largest public dose (5 mrem/yr) previously predicted at the east-central permit boundary of the Hank Unit from the previous analysis (Section 7.3.1.2.8.1 of the Technical Report), which assumed this receptor to be a full time, resident farmer.

The dose to an individual receptor within the licensed areas was estimated. Predictions of estimated doses for each identified member of the public can be made taking the

easting and the northing from the central point within the plant. For the hunter it will be assumed that the highest exposure predicted in the MILDOS run was the exposure during the hunters occupancy around the area. The courier and the vender will do all their work around the plant and therefore the highest predicted dose within a quarter kilometer of the plant was used to be conservative. Workforce housing will use the highest estimated exposure within a quarter kilometer of the plant. For the CBM worker the exposure is assumed to be the highest CBM well exposure based upon the MILDOS run and the northing and easting from the central processing plant. The highest predicted dose was predicted at 1.25 km west and 0.5 km north which corresponds to one of the CBM wells. Since MILDOS assumes 100 percent occupancy, the predicted dose was corrected based on actual occupancy times.

Table 5 MILDOS Predicted Doses

Member of Public	MILDOS Predicted Dose (mrem)	Predicted Dose Corrected for Occupancy Time (mrem)
Courier	1.14	0.01
Vendor	1.14	0.03
Hunter	8.84	0.24
Oil Field Worker 1	NA / will provide with commissioning of Hank	NA
Oil Field Worker 2	NA / will provide with commissioning of Hank	NA
Oil Field Worker 3	NA / will provide with commissioning of Hank	NA
CBM Worker	8.84	0.67
Workforce Housing	1.14	0.31

All dose estimates **for generic workers and individuals** are below 2.5 mrem/yr, which is a small fraction of the 100 mrem/yr exposure criteria for members of the public (10CFR20.1301) and demonstrates that occupationally exposed workers and any member of the public within and/or proximate to the Project's permit area will receive a dose that is consistent with ALARA principles. The maximum dose to a member of the public from licensed activities remains estimated to be the approximately 5 mrem/yr to the theoretical future resident farmer at the permit boundary as described previously in TR Section 7.3.1.2.8.1. Evaluation of the maximally exposed individuals will occur annually considering factors such as changes to operation conditions, changes to surrounding land use, and data collected over the year.

References

Argonne National Laboratories, "MILDOS-AREA User's Guide (Draft)" September 1998.

NUREG/CR 2011 "MILDOS- A Computer Program for Calculating Environmental Radiation Doses from Uranium Recovery Operations" 1981.

NUREG-1569 "Standard Review Plan for In Situ Leach Uranium Extraction License Applications", NRC, 2002.

NUREG 1910 "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities" NRC, 2009.

Attachment 4

Letter from SENES Regarding Error in 12.8 B MILDOS Report

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To Ryan Schierman, Uranerz Energy Corporation

From Lisa Manglass, SENES Consultants

Subject Nichols Ranch MILDOS Errata

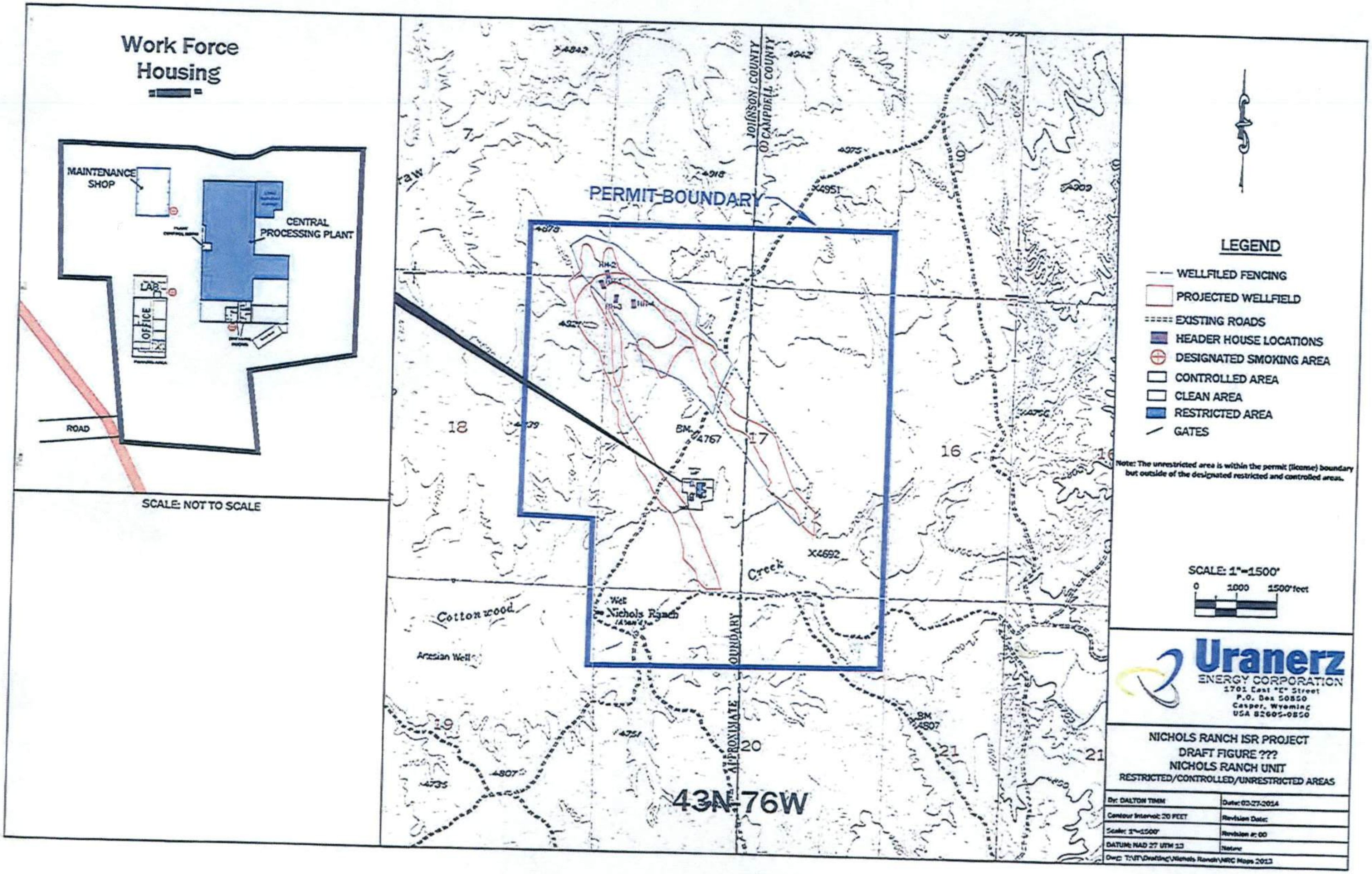
Date 18 February 2014

The document prepared for Uranerz Energy Corporation, "Identification of the Maximally Exposed Member of the Public at the Nichols Ranch Project," on 18 September 2012 by SENES Consultants contains a typographical error on page 4 of Attachment 1. The document erroneously indicated that the dose from "Time Step 5" for the location (7, 4.5) was estimated to be 522 mrem/yr for a full time resident of that location, with a dose of 119 mrem/yr for a corrected 40-hour work week. There is no indication in the result of the MILDOS analysis that this number is a real result of the MILDOS run, as it is inconsistent with all data surrounding it, and is certainly the result of a typographical error such that the decimal point was accidentally removed when the results were manually transferred to Excel for analysis. The correct dose for the location (7, 4.5) should be 0.522 mrem/yr for the Maximum Dose and 0.119538 mrem/yr when corrected to a 40-hour work week. While the original outputs for the entire MILDOS model are not available, a simplified version of the original model was run to provide evidence that 0.522 mrem/yr is the correct value for this location. The model was simplified such that all source terms were entered to MILDOS in the quantities identified in Table 3 of "Identification of the Maximally Exposed Member of the Public at the Nichols Ranch Project" for Nichols Unit restoration and Hank Unit production as point source terms. Source terms for Nichols Unit restoration and Hank Unit production were used to match the time step of the original model. Site specific meteorological data was also applied using the same STAR file as was utilized in the original model. The simplified model produced a very close result of 0.537 mrem/yr, confirming that a dose of 0.522 mrem/yr estimated for a receptor at location (7, 4.5) is accurate (the minor difference in value is a result of the use of a simplified model). The MILDOS output is attached for confirmation. Please accept the proper value of 0.522 mrem/yr for location (7, 4.5) as a correction to the erroneously reported value.

Attachment 5

Draft Figure

Restricted/Controlled/Unrestricted Areas


Work Force Housing
MAINTENANCE SHOP
CENTRAL PROCESSING PLANT
LAB
OFFICE
ROAD
SCALE: NOT TO SCALE
PERMIT BOUNDARY
JOHNSON COUNTY
CAMPBELL COUNTY
7
18
17
16
19
20
21
Cottonwood
Creek
Nichols Ranch
Artesian Well
APPROXIMATE BOUNDARY
43N-76W
LEGEND
WELLFILED FENCING
PROJECTED WELLFIELD
EXISTING ROADS
HEADER HOUSE LOCATIONS
DESIGNATED SMOKING AREA
CONTROLLED AREA
CLEAN AREA
RESTRICTED AREA
GATES
Note: The unrestricted area is within the permit (license) boundary but outside of the designated restricted and controlled areas.
SCALE: 1"=1500'
0 1000 1500'feet
Uranerz
ENERGY CORPORATION
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850
NICHOLS RANCH ISR PROJECT
DRAFT FIGURE ???
NICHOLS RANCH UNIT
RESTRICTED/CONTROLLED/UNRESTRICTED AREAS
Dr: DALTON TIMM
Date: 02-27-2014
Contour Interval: 20 FEET
Revision Date:
Scale: 1"=1500'
Revision #: 00
DATUM: NAD 27 UTM 13
Notes:
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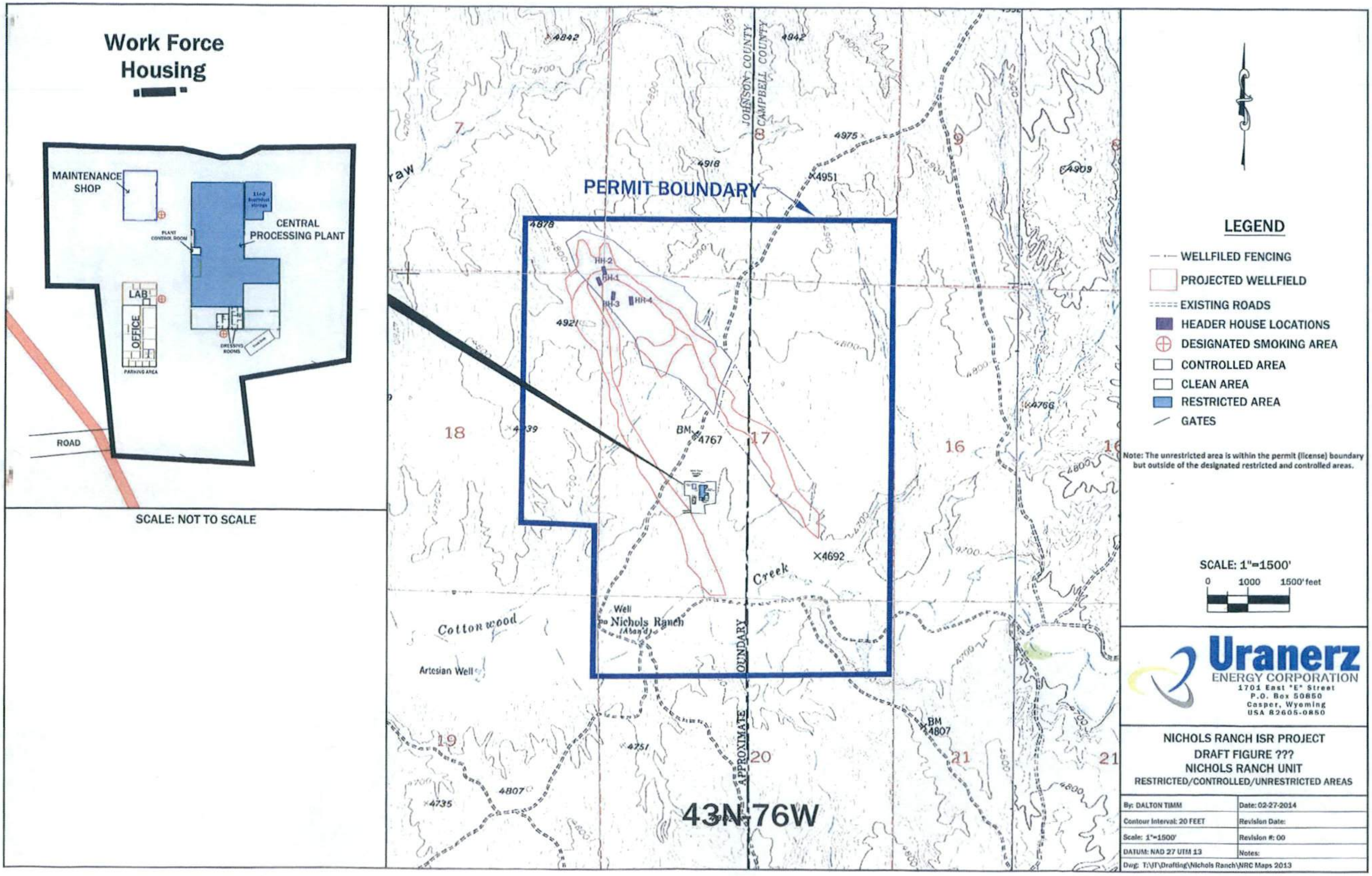

Work Force Housing
MAINTENANCE SHOP
CENTRAL PROCESSING PLANT
PLANT CONTROL ROOM
LAB
OFFICE
PARKING AREA
DRESSING ROOMS
ROAD
SCALE: NOT TO SCALE
PERMIT BOUNDARY
JOHNSON COUNTY
CAMPBELL COUNTY
APPROXIMATE BOUNDARY
HH-1
HH-2
HH-3
HH-4
BM 4767
BM 4807
Creek
Cottonwood
Well
Nichols Ranch (Aban'd)
Artesian Well
43N-76W
7
8
9
16
17
18
19
20
21
4842
4942
4975
4918
4951
4909
4878
4921
4739
4766
4692
4751
4807
4735
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