Cameco Resources
Crow Butte Operation

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October 14, 2022

ELECTRONIC DELIVERY

Attn: Document Control Desk, Director
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

2021 Annual ALARA Report
Source Materials License SUA-1534
Docket Number 40-8943

Dear Director:

Enclosed please find a copy of the Crow Butte Operation 2021 Annual ALARA Report and 2021 Land Use Survey. These reports are required under License Condition 11.1.2 of Source Materials License SUA-1534.

If you have any questions, please feel free to contact me at (308) 665-2215 ext 117.

Sincerely,

Casey Yada
SHEQ Coordinator

Attachments: As Stated

cc: Deputy Director
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ALARA Audit Report for 2021

Crow Butte Operations

Prepared for:

Cameco Crow Butte Operations

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Prepared by:

Kari Toews
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SHEQ Systems
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1.0 INTRODUCTION

The ALARA Audit for 2021 at the Crow Butte Operations (CBO) in situ uranium recovery facility was conducted by Cameco's SHEQ Systems department. Due to the changing COVID-19 situation late in 2021 and early 2022, the audit was planned to be completed remotely. The audit items that could not be performed remotely, as detailed in this report, will be performed once the COVID-19 pandemic has stabilized.

The audit commenced with opening comments and discussion via email and instant messaging, led by the auditors, Kari Toews (Program Manager, Occupational Safety) and David Kennedy (Health Physicist) from Cameco's corporate Safety, Health, Environment and Quality (SHEQ) Systems department. Attendees included in the electronic correspondence:

Auditors:

- Kari Toews, Lead Auditor
- David Kennedy

Smith Ranch – Highland Operation:

- Tami Dyer, Radiation Safety Officer
- Casey Yada, Coordinator SHEQ/HPT

A tour of the facility was not conducted and will be scheduled for a later date.

For purposes of the ALARA audit, numerous records were examined, including those shown in the table below. The site personnel were very helpful and both electronic and paper records, which were scanned and provided electronically, were readily available during the audit. Documents and records were clear, accessible, and produced efficiently by the site upon request.

In summary, 2 recommendations were identified through the course of this audit and are included in Section 6 of this document.

2.0 SITE HISTORY

Commercial operations at the Crow Butte Operations commenced in April 1991. The in-situ recovery process extracts uranium from the Basal Chadron sandstone aquifers at a depth of approximately 400 to 800 feet below the ground surface. The uranium in the formations is leached by a solution pumped through injection wells. The uranium-rich solution is pumped through recovery wells to the Central Processing Plant (CPP) where the uranium is extracted by ion exchange, precipitated, and dried in a "zero emissions" vacuum dryer. The purified uranium product, called yellowcake, is packaged in 55-gallon drums and transported to the Blind River refinery in Port Hope, Ontario for chemical processing. Based on the process used for drying the precipitate and laboratory data, the uranium product is classified as "soluble" for the purpose of radiation protection.

Liquid waste from the plant, primarily "bleed" water is disposed of in the evaporation ponds or through deep well injection. Solid waste (11e2 byproduct) is transported to either Pathfinder or the White Mesa uranium facility in Blanding, Utah under a contract for disposal.

2.1 ALARA Audit Requirements

License Condition 9.7 of Amendment No. 24 to Source Material License No. SUA-1548 requires an annual ALARA audit of the SR-HUP radiation safety program consistent with the recommendations in Nuclear Regulation Commission (NRC) Regulatory Guide 8.31 (NRC, 2002). In accordance with License Condition 9.7 and the guidance in Regulatory Guide 8.31, the records reviewed during the ALARA audit and summarized in this report are as follows:

- Bioassay results
- Records of internal and external exposures
- Safety meeting minutes, attendance records, and training program records
- Routine inspection reports and Monthly RSO reports
- Radiological survey and monitoring data
- Environmental radiological effluent and monitoring data
- Radiation Work Permits (RWPs)
- Reports of overexposures submitted to the URP
- Reviews of operating and monitoring procedures completed during the period
- Results of required leak tests on radioactive sources
- Instrument calibration records
- Worker training and annual refresher training

In addition, the following topics were addressed:

- Trends in occupational radiation doses

2.2 Summary of General Site Activities in 2021

In 2021 no mine units were restored, mine units 3 and 5 remained in stability monitoring, mine units 2, 4, 6, 7, and 8 were in active restoration, and mine units 9, 10, and 11 remained in standby awaiting restoration. The plant was being used to process resin from restoration activities and produced 8,733 pounds of yellowcake.

3.0 OCCUPATIONAL DOSE SUMMARY

The committed effective dose equivalent (CEDE) for each monitored worker is calculated monthly based on average uranium concentration in airborne particulate material and the radon daughter concentration in each area in which the individual worked and the time spent in the area. External radiation doses are measured using Optically Stimulated Luminescence Dosimeters (OSLD) on a quarterly basis. The total effective dose equivalent (TEDE) is calculated quarterly based on the deep dose equivalent measured by the worker's badge and the total CEDE for the three months of the quarter. Monitoring data is stored and managed within the internal CamRad database and dose calculations are also performed within the database. The program is documented in the CamRad Enterprise User's Manual (CAM-SHEQ-RP-05), published within the internal Management Document System database. The document includes a listing of the calculations performed by the database.

3.1.1 Internal Dose Details

The Committed Effective Dose Equivalent (CEDE) to workers is calculated based on the estimated intake of airborne uranium and radon decay products. The dose from airborne uranium is calculated based on the monthly average airborne uranium concentration in the each of the exposure areas and the time each worker spent in that area. Similarly, radon daughter dose is calculated using the monthly average concentration and work time by exposure area. Doses are calculated and monthly by the CamRad database and a summary included in the Monthly Radiation Safety Report. A summary of airborne radiological conditions (airborne uranium and radon daughters) and the maximum monthly intakes for uranium and radon decay products, expressed as a percent of the maximum permissible exposure to workers is also included in the report.

3.1.1.1 Airborne Radionuclide Concentrations and Associated Dose

Uranium concentrations in air are measured in plant areas monthly at set locations area samplers with flow rates in the range of 40 to 50 l/min. Breathing zone samplers are used in the dryer area at flow rates of 5 L/min, when it is in operation. These samples may be used to assign individual dose from dryer operation. Due to limited operation of the dryer, there were only 5 dryer room breathing zone samples collected in 2021. The concentration calculations and formulas used in CamRad were checked and found to be accurate. Corporate CamRad administrators perform an annual quality control of all calculations within the database.

Users can classify samples as either dosimetry or engineering in the database, dosimetry samples are then used as part of dose calculations. Engineering samples are generally related to samples taken to investigate issues and not indicative of routine worker exposures. As part of compilation of the monthly report any apparently outliers are investigated to ensure accurate entry and sample classification.

The dosimetry samples in CamRad are averaged monthly by Exposure Area. There are currently three exposure areas used by the site for dosimetry purposes: the dryer room, CPP, and yellowcake storage. Worker doses (in μCi) are calculated by multiplying the monthly average

airborne uranium concentration (in µCi/ml) in each Exposure Area by the number of hours each worker was exposed in each area, then multiplied by the standard breathing rate ($1.2x10^6$ ml/hr). Currently there is one exposure area at the site, the main plant, and all exposure hours are assigned to that location; this includes time spent in the wellfields, deep disposal well and laboratory.

Table 1 shows the annual average of the monthly airborne uranium dosimetry sample concentrations measured in the Plant Exposure Area from 2019 – 2021. The average concentration dropped in 2021 after an increase in 2020. The increase was speculated to have been caused by a decrease in cleaning activities related to a staff reduction, however no significant changes were made in 2021, therefore the source of the variation is unclear. The average concentration in 2019 was between 2020 and 2021, so it could just be statistical variations.

Table 1: Annual Average Airborne Uranium Concentration (µCi/ml)

	2019	2020	2021
Plant	1.1E-12	1.6E-12	4.0E-13

The monthly average and maximum uranium exposures in µCi, as reported in the Monthly Radiation Safety Summary Reports, are shown in Table 2. Doses dropped in 2021 in alignment with the drop in area concentrations of airborne uranium. If the ALI, 1 µCi, were normalized to a monthly value, all calculated monthly intakes in 2021 were less than 0.55% of that monthly value.

Table 2. Monthly Maximum and Average Uranium Intakes by Workers for 2021.

Month	Average U Intake (µCi)	Maximum U Intake (µCi)
January	6.68E-06	9.44E-06
February	1.19E-05	5.39E-05
March	5.98E-06	1.83E-05
April	6.28E-06	9.61E-06
May	1.36E-05	7.78E-05
June	7.76E-05	1.65E-04
July	3.81E-05	6.07E-05
August	3.72E-05	5.93E-05
September	2.61E-04	3.74E-04
October	2.29E-04	4.47E-04
November	1.39E-05	2.12E-05
December	1.21E-05	1.71E-05

The reports available from CamRad also include an estimate of the soluble uranium intake by individuals for the time frames specified by the report to allow the site to demonstrate compliance to the weekly intake limit of 10 mg. Soluble intake values were reviewed on a

monthly basis for 2021. The maximum intake over an entire month was 0.66 mg, therefore, the weekly intake limit was also not exceeded.

The site also performed annual isotopic monitoring of airborne particulates in the plant. The site has requested and been granted an exemption for the reporting of Th-234, Pb-210 and Bi-210 doses. The exemption was granted provided that these radionuclides be present at concentrations below 1% of their respective DACs. The sampling results for 2021 are shown below for these radionuclides; each radionuclide is well below the required 1% of its DAC.

Table 7. Average Airborne Beta Particulate Concentrations Compared to DAC - 2021.

Radionuclide	Average Concentration (µCi/ml)	DAC (µCi/ml)	Percent of DAC
Th234	8.6E-15	6E-8	0.000014 %
Pb-210	3.9E-14	1E-10	0.039 %
Bi-210	3.9E-14	1E-8	0.0039 %

3.1.1.2 Radon Decay Product Concentrations and Associated Dose

Radon decay product concentrations are measured monthly in 12 locations in the plant using the Modified Kusnetz method to calculate worker doses from these measurements. The samples are entered into CamRad and applicable samples are used in worker dose calculations. The formulas used to calculate sample results and doses are included in the CamRad User's Manual (CAM-SHEQ-RP-05). Similar to airborne uranium samples, users can classify samples as either dosimetry or engineering in the database and dosimetry samples are used in the calculation of worker doses. Sample results are reviewed by the RSO or designate to ensure they are entered and categorized correctly.

Monthly dosimetry samples in CamRad are averaged by Exposure Area to calculate the average concentration. Worker doses are calculated by multiplying the average monthly radon daughter concentration (in Working Levels (WL)) by the number of hours each worker was exposed in the month, then dividing by 170 working level hours per month to obtain a worker exposure in Working Level Months (WLM). Currently there is one exposure area at the site, namely the main plant, and all exposure hours are assigned to this location including time spent in the wellfields, deep disposal well and lab areas. Dosimetry reports are generated on a monthly basis and reviewed by the RSO.

The practice of assigning all time that workers are potentially exposed to radiation sources to the plant area will conservatively estimate doses to workers in these other areas, because the site has demonstrated in their license application that the plant radon daughter average is higher than other areas within the facility.

Table 3 shows the average annual radon decay product concentration (in WL) by Exposure Area from 2019 to 2021. Concentrations in 2021 are within historic ranges. As with airborne uranium, 2020 was slightly higher and reduced again in 2021, however, overall variations were small.

Table 3: Annual Average Radon Decay Product Concentration (WL)

	2019	2020	2021
Plant	0.005	0.008	0.007

The monthly maximum and average radon decay product exposures are shown in Table 4. If the ALI, 4 WLM, were normalized to a monthly value, all calculated monthly intakes in 2021 were less than 4% of that monthly value.

Table 4 Worker Radon Decay Products Exposures during 2021

Month	Average WLM	Maximum WLM
January	0.007	0.010
February	0.007	0.010
March	0.007	0.011
April	0.003	0.005
May	0.003	0.005
June	0.009	0.013
July	0.003	0.005
August	0.006	0.009
September	0.004	0.006
October	0.007	0.014
November	0.005	0.007
December	0.004	0.005

3.1.2 External Doses

Occupational direct gamma and beta radiation doses are measured using Optically Stimulated Luminescent (OSL) dosimeters supplied by Landauer, Inc. All Crow Butte workers are issued dosimeters except for one individual in administration who does not routinely access the restricted areas of the facility. The OSL dosimeters measure deep dose equivalent, shallow (skin) dose and dose to the lens of the eye. The deep and shallow doses are imported into the CamRad database. During a review of a quarterly report from Landauer, it was confirmed that the shallow and eye dose were comparable to the deep dose and no elevated readings were observed. The dosimeters are exchanged quarterly. When not in use, dosimeters are stored on a badge board near the building entry. Workers pick up their dosimeters at the start of the shift and return them to the badge board at the end of the shift. The control badge is stored on the badge board. The vendor subtracts the control badge dose from the worker badge dose to obtain the reported dose to the worker while at work. The maximum annual gamma dose to an individual worker in 2021 was 0.057 rem. The average external dose was 0.013 rem, which is comparable to 2020.

3.1.3 Total Effective Dose Equivalent (TEDE)

The TEDE for each worker is calculated by adding the dose from inhalation of radon decay products and uranium in airborne dust to the deep dose equivalent (DDE) measured using the worker's OSLD badge.

Table 5 presents a comparison of average and maximum dose across the site by year and Table 6 shows the distribution of individual doses, both in comparison to the previous two years. The average and maximum dose decreased from 2020 and remained within the range of the last two years. That drop was driven by the decrease in airborne uranium and radon decay products discussed above. In terms of the dose distribution, the TEDE for all workers was at or below 0.15 rem, with those at the upper end of the range assigned to the plant or restoration tasks.

Table 5: Average and Maximum TEDE

Year	Average Dose (rem)	Maximum Dose (rem)
2019	0.083	0.15
2020	0.135	0.21
2021	0.096	0.15

Table 6: Distribution of Annual TEDE for 2017 to 2021

Dose Range (rem/y)	**2019 (rem/y)**	**2020 (rem/y)**	**2021 (rem/y)**
	Number of workers	**Number of workers**	**Number of workers**
0.000 – 0.050	4	3	3
0.051 - 0.100	7	0	4
0.101 – 0.150	7	6	11
0.151 – 0.200	1	8	0
0.201 – 0.250	0	1	0
0.251 – 0.300	0	0	0
0.301 – 0.350	0	0	0
0.351 – 0.400	0	0	0
0.401 – 0.450	0	0	0
0.451 – 0.500	0	0	0
> 0.500	0	0	0
Total number of monitored workers	19	18	18

The Annual TEDE, including the breakdown by dose component, for individual workers is shown in Figure 1. The doses for nearly all workers are very similar. This is the result of assigning all exposure time to the main plant. As noted, this is a conservative practice and would tend to somewhat overestimate those working in the wellfields, lab or other areas. The three workers with significantly lower doses spent the majority of their time in the offices, with little time in exposure areas. The majority of dose is from radon daughters, with gamma as the second

largest contributor. Gamma makes up a larger portion of dose for those who spend more time in the plant area. All worker doses for 2021 were less than 10 percent of the annual dose limit (0.50 rem), the level that requires additional dose monitoring under 10 CFR 20.1502.

Figure 1 Worker Doses by Component in 2021

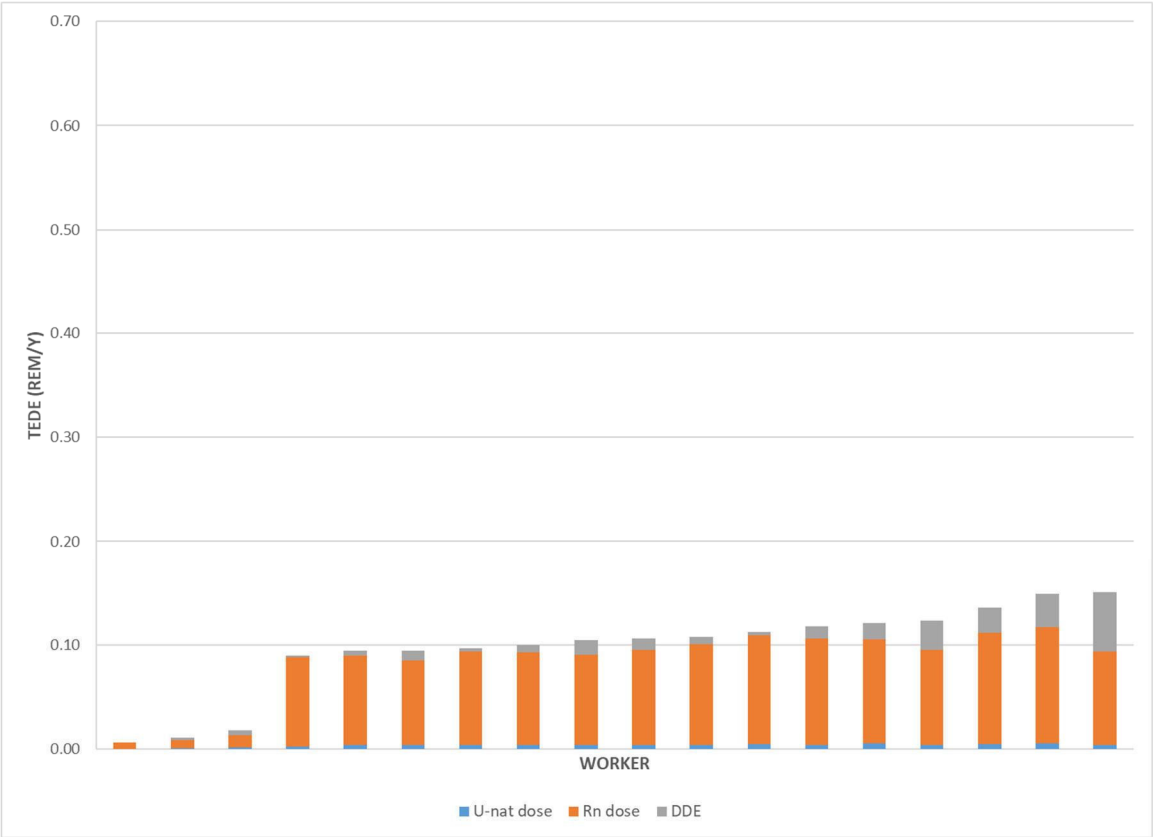
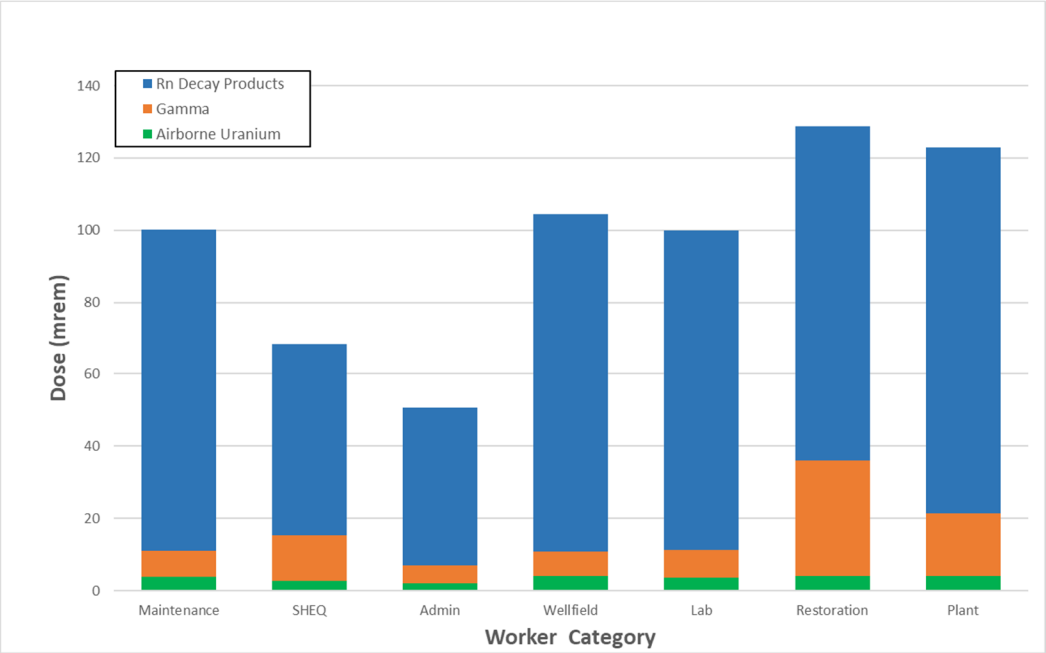


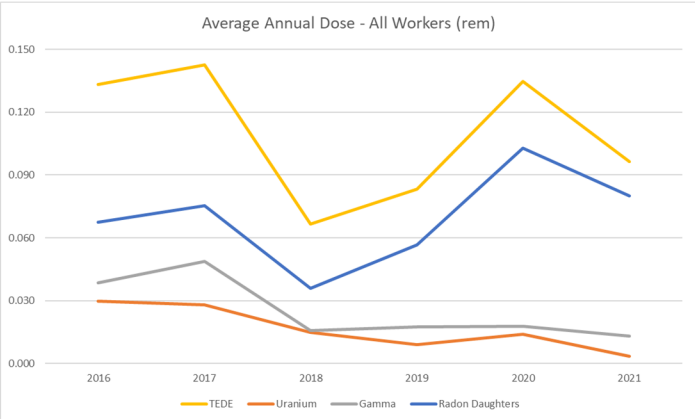
Figure 2 shows the breakdown of the average TEDE by dose component for each worker category (Position in the CamRad database). There was a reduction in doses overall from 2020, however the distribution remained comparable with radon daughters contributing the majority of dose to all position groups. The position with the highest dose shifted from Plant workers to Restoration in 2021, however, there are only a small number of people in each group and with the low number of workers, people can often perform tasks typically associated with other positions.

Figure 2: Breakdown of TEDE by Dose Component for Each Worker Task Category



As per the requirements of Regulatory Guide 8.31, longer term dose trends were reviewed by worker task category, as well as by dose component and by main work task (i.e. CPP/Restoration and Wellfields/Support groups (SHEQ, Lab, Maintenance). Figures 3 -5 contain the average and maximum TEDE dose for all workers and by various Position categories for the years 2016 through 2021. In 2021, positions only included between 1 and 4 workers. With a small number of workers overall, even a small change in one individual's dose will have a significant impact on the overall average. Overall, doses showed a downward trend from a peak in 2020 and remained within historic ranges.

Figure 3: Average and Maximum Annual Dose Trend for All Workers



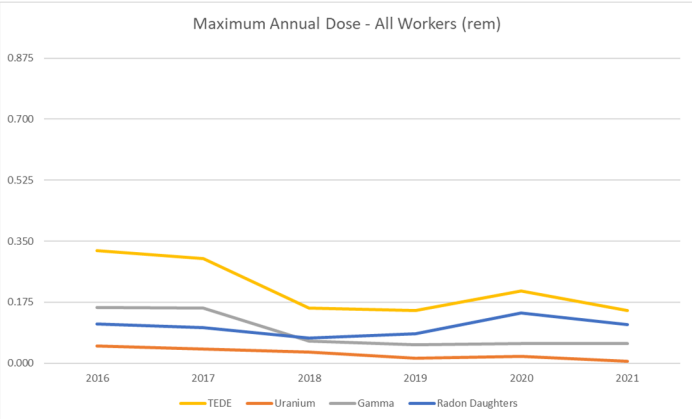
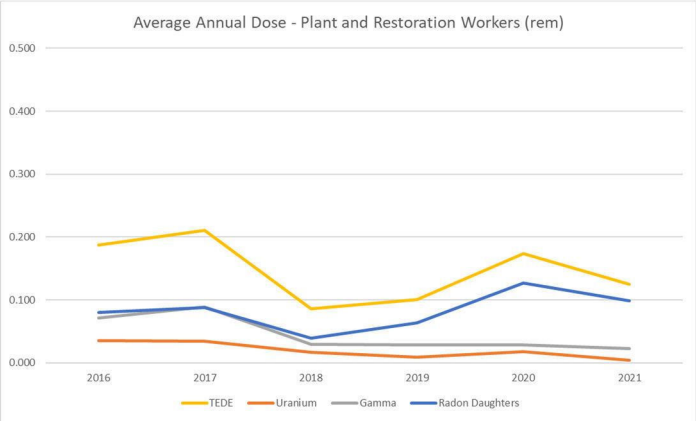


Figure 4: Average and Maximum Annual Dose Trend for Plant and Restoration Workers



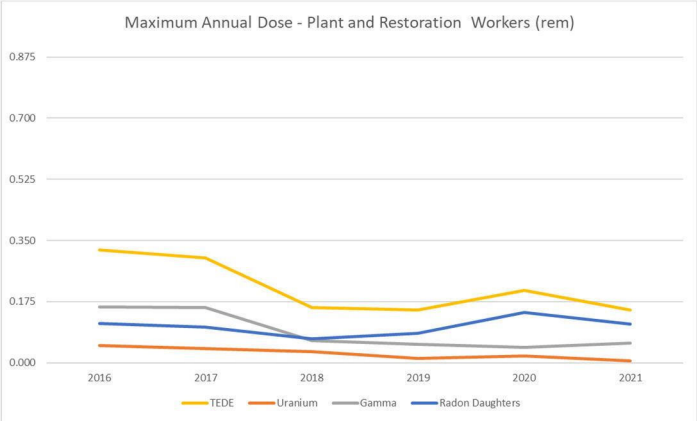
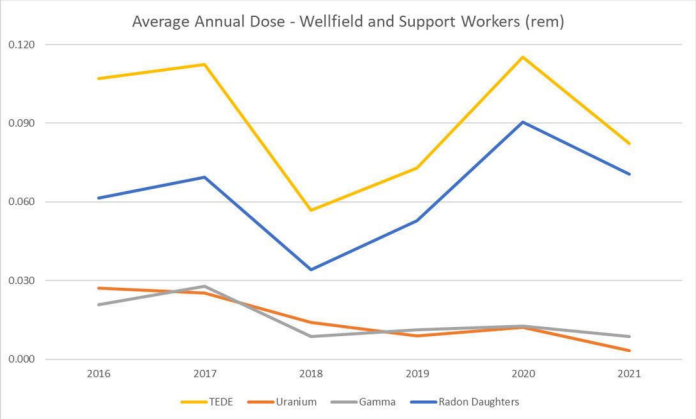
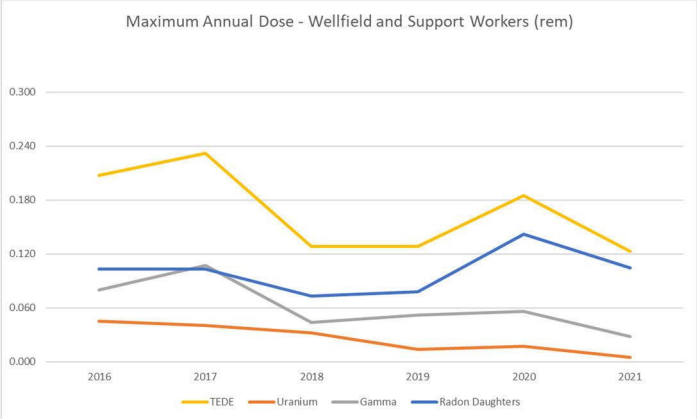


Figure 5: Average and Maximum Annual Dose Trend for Wellfield and Support Workers





Annual doses are reported to each employee in a Cameco-specific format that includes the same information as is provided on the NRC Form 5 Occupational Dose Record for a Monitoring Period. As was noted in the previous ALARA reports, the Cameco form does not report the eye or shallow equivalent doses. The shallow dose is entered into the CamRad database and is available for trending and reporting. The shallow dose was reviewed and was found to be comparable to the deep dose equivalent and well below applicable dose limits.

4.0 PUBLIC DOSE SUMMARY

The potential dose to members of the public is calculated based on the net average measured concentrations of radionuclides in airborne particulate matter, radon concentration, and measured total direct gamma dose for the calendar year. The potential doses at all monitoring stations are calculated and reported in the Semi-Annual Radiological Effluent and Environmental Monitoring Report for the second half of the calendar year. All values were compliant with 10 CFR 20.1301 for radiation dose limits for members of the public, and well below the public dose limit of 100 mrem. More detailed discussion on all environmental monitoring is included below, this section only addresses the resulting public dose calculation.

Monitoring Station AM-9 is located at the nearest residence, where the maximally exposed member of the public resides. Monitoring station AM-6 is the background monitoring station. Table 2 contains the data from AM6 and AM9 and the calculated dose to the maximum receptor.

Table 7: Public Dose Calculation at AM9 for 2021

Location	Analyte	Measured Value	Background Value (AM6)	Net Value	10 CFR 20 App. B, Table 2	Occupancy Factor	Indoor Equilibrium Factor	Dose to Public (mrem/y)
AM9 (nearest resident)	Uranium (µCi/ml)	5.1E-17	5.4E-17	-3.0E-18	9E-14			0.0
	Radium-226 (µCi/ml)	4.9E-17	4.9E-17	5.0E-19	9E-13			0.0
	Lead-210 (µCi/ml)	1.6E-14	2.0E-14	-3.5E-15	6E-13			0.0
	Radon-222 (µCi/ml)	1.6E-10	1.7E-10	-1.2E-11	1E-10	0.75	0.5	0.0
	Gamma (mrem/yr)	57.4	50.9	6.5E+00				6.5
							TEDE (mrem/y)	**6.5**

The average net uranium, radium-226 and lead-210 concentrations at AM-9 were all very low. Dose from inhalation of these radionuclides are calculated by dividing the net average measured concentration for each radionuclide by its respective 10 CFR 20 Appendix B, Table 2 effluent standard (included in Table 3 for each radionuclide), and then multiplying that ratio by 50 mrem/y. The only radionuclide above background was radium-226, however, the resulting dose was to small to account for. The total dose from these radionuclides for 2021 is 0 mrem.

The net annual average radon concentration was below background. As with previous years, this is significantly lower than the 10 CFR 20, Appendix B effluent standard for Rn-222 in equilibrium with its decay products. However, since the measurement location is not at the boundary to the restricted zone, this is not an acceptable criterion for comparison. The radon dose to the maximum receptor, as per commitments references in the Materials License (SUA-1534), is calculated as per equation (1).

$$Dose\ Rn222\ (mrem) = \frac{Average\ Concentration\ above\ Background * 50\ mrem * Occupancy\ Factor * Equilibrium\ Factor}{10\ CFR\ 20\ AppB\ Table\ 2\ value\ in\ \mu Ci/ml} \quad (1)$$

The occupancy factor is based an estimate of the time spend in the residence. This estimate was made as follows:

> Total hours per year (8760) – time spend at work (40 hrs * 49 weeks worked) – time away due to hobbies/vacations/errands/etc. (48 hr * 10 weekends + 2hrs * 180 days) = 5960 hours.

This value represents an occupancy factor of 68%. However, because this is estimated, the site used an occupancy factor of 75% to be conservative and consistent with previous years. The

nearest resident was determined based on a land use survey, reviewed during the audit. The equilibrium factor is assumed to be 0.50 for an indoor receptor as per the recommendations of the NRC draft radon guidance (FSME-ISG-01, NRC 2014) and LC 9.2 of the Materials License. The estimated dose from radon decay products was 0.0 mrem for 2021.

The net gamma dose for the year 2021 was slightly above background, resulting in a dose of 6.5 mrem. The total effective dose equivalent (TEDE) for the member of the public was 6.5 mrem. This is a slight increase over the last few years, where the dose was very near to zero, however, because there is no real mechanism for an increase in gamma dose, this could be the result of uncertainty in the measurements.

5.0 ROUTINE DATA COLLECTION AND INSPECTIONS

While the ALARA report was performed remotely, all digital documents were provided by a remotely accessible file directory and all physical records requested were scanned and digitally provided as well. As was noted in the previous ALARA report, it remains true that all records that were requested were readily available, clear and in good order.

5.1 Bioassay Data

Routine bioassays are conducted quarterly for all CBO personnel with the potential for exposure to uranium and monthly for individuals working in the dryer facility and yellowcake packaging area. The samples are submitted to Pace Analytical (formerly Intermountain Laboratories (IML)) in Sheridan, Wyoming for analysis. Pace Analytical operates under Radioactive Materials License No. 49-29405-01, which expires on 03/31/2036.

As summarized in Table 10, 78 worker samples were submitted to Pace Analytical in 2021. Each batch of samples was accompanied by two spiked and one blank samples. The spiked and blank samples were prepared from urine provided by Radiation or SHEQ staff and submitted as blind samples under fictitious names. As shown in Table 10, the results of all spiked samples were within the quality control limits (±30%). All measured blank sample concentrations were below the reporting limit of 5 micrograms per liter (µg/L). All urine bioassay concentrations were below the reporting limit of 5 micrograms per liter (µg/L).

Table 10: Results of Urine Bioassay Samples Submitted During 2021.

Date collected	No. Workers Samples	% Difference in spike and result		Max Uranium concentrations (µg/L)
		Spike 1	Spike 2	
03/16/2021 – 03/23/2021	19	4.3	2.6	<5.0
06/12/2021 – 06/25/2021	22	6.5	3.7	<5.0
09/16/2021 – 09/21/2021	18	3	1	<5.0
11/01/2021 – 11/04/2021	1	7	0.86	<5.0
11/11/2021 – 11/14/2021	2	2.9	1.7	<5.0
12/16/2021 – 12/21/2021	16	3.8	4	<5.0
Total	78			

5.2 Contamination Surveys

Routine alpha and beta removable contamination surveys are performed weekly in the restricted and unrestricted areas. Locations include offices, the control room, the lunchroom and transition points out of the restricted area to ensure that contamination is not being tracked. There were no elevated samples in the unrestricted zone. Some samples within the restricted zone were elevated, but below the limit. In these cases, standard practice is to notify the area operator to clean the elevated area. Survey records for 2021 were spot checked and no issues were identified. All results were below 1000 DPM/100cm^2.

5.2.1 Personal Contamination Surveys

A sample of the on-site and off-site Surveys of Material Release forms from each quarter of 2021 were reviewed. All forms reviewed were complete and when the measured alpha or beta activity exceeded 750 DPM/100 cm^2, removable contamination surveys were conducted as required. All equipment released met the applicable release requirements.

License Condition 11.1.9, and subsequent amendment, updated the use of controlled zone between the restricted areas and unrestricted zones and changed the requirements for personnel surveys. Surveys are performed prior to entering an unrestricted area rather than leaving a restricted area. Frisker station records were reviewed, no issues were identified. In addition, it was confirmed that the RSO or designate performed a monthly review of the records from the frisker stations, including initialing the survey forms. All employees are surveyed quarterly, and personnel contamination spot checks are done monthly. Interviews with the RSO indicated that employees are retrained on the spot when deficiencies are found. Workers receive initial training on use of the equipment and scanning process. In addition, on a monthly basis the HPT or RSO performs a task observation on a sampling of workers while performing a scan. Personal survey logs CBR-RPP-FORM-011 were reviewed on a sampling basis. No issues were found.

The license condition details were reviewed with workers in the annual refresher training.

5.2.2 Material Release Surveys

Equipment and materials to be released for unrestricted use are surveyed for total contamination and wipe tested for removable contamination. Total contamination surveys for alpha and beta radiation are performed using a Ludlum Model 43-93 alpha/beta probe. The action limit is 750 dpm per 100 cm^2. Removable contamination surveys (wipe tests) are required when the action limit is exceeded. The Reg. Guide 8.30 release criterion for uranium and its decay products is 1000 dpm alpha per 100 cm^2 and 5000 dpm per 100 cm^2 total (fixed plus removable) alpha. The release criteria for beta radiation are the same. A representative sample of release surveys was reviewed and found to be compliant with these requirements. One survey found to be incomplete (Offsite Release\Pickups\#402 MIT-6-21-21.xlsx), however follow-up discussion with the RSO indicated the vehicle was not released from site. It was noted that previous electronic survey forms appear to be used on occasion as a starting point for the next survey. There were occasions where some residual data, commonly the removable contamination tabs on the release surveys, may contain data from a previous survey. It is recommended that either electronic

forms should be inspected to ensure there is no residual data prior to use or consider creating blank templates with standard locations already pre-populated to make data entry simpler.

Recommendation 1: Ensure all previous data is removed from file when using an historic form as a starting point for subsequent surveys or consider creation of templates with standard sample areas pre-populated.

5.3 Instrument Calibration and Efficiency Records

Instrument calibration records were reviewed. Most of the radiation detection instruments are sent to the manufacturer (Ludlum Measurements) for calibration. High voltage verification and reliability factor checks are performed after calibration or repair or if the instrument response is questionable. The reliability factor calculation was checked and found to be accurate. A check on the calibration dates of equipment in the Equipment Calibration Schedule found no deficiencies, but since this was a remote audit, it was not possible to verify calibration dates on the in-service instruments.

The spreadsheet used to calculate equipment efficiency was also reviewed. The check source activity used to calculate efficiency is the decay corrected 2Pi emission rate from the calibration certificate. Source area assumed in the formula is 150 cm^2, which is accurate for the sources used. Energy and branching ratio weighted efficiency calculations are performed as per NRC requirements. It was noted that the cell containing the title or description of the check source activity says "Total Activity (dpm)". It is recommended that be changed to "Decay corrected 2Pi Emission Rate (dpm)" or something similar to avoid confusion or potential error in the future.

Proper operation of the instruments used for personal scanning at the south plant location ("primary bunker") and the RO facility is verified weekly. The verification includes a battery check and instrument alpha and beta efficiency checks. Also, the calculation of the maximum allowable alpha and beta counts for a 0.5 minute count time and the minimum detectable activity in disintegrations per minute per 100 cm^2 are determined. A Ludlum Model 3030 and/or a Ludlum Model 2224-1 is set up in the bunker to count both alpha and beta radiation and integrate the total counts for each 30-sec count. Measurements of alpha and beta on each hand, each foot and clothing are recorded on the log sheet.

Recommendation 2: Change the Total Activity (dpm) term to "Decay Corrected 2Pi Emission Rate (dpm)", or similar, for clarity on the equipment reliability spreadsheets.

5.4 Source Leak Tests

The Crow Butte facility has no radioactive sources that require leak testing.

5.5 Environmental Radiological Effluent and Surveillance Data

As part of the environmental monitoring program, airborne radionuclide concentrations and direct gamma radiation dose rates are measured quarterly at eight air monitoring stations around

the permitted area boundary, including a background location (AM6) and the residence of the maximum receptor (AM9). Radon gas concentration is measured semi-annually at the same locations. The measured concentrations and the gamma exposure rate are used to calculate the potential dose to a member of the public.

5.5.1 Radon Gas

Radon gas concentrations are measured using the Landauer, Inc. RadTrak alpha track detector. The detectors are exchanged semi-annually with a lower limit of detection of 2E-9 µCi/mL. The annual average radon concentrations for 2019 to 2021 are given in Table 11. In 2021, annual average radon concentrations were somewhat higher than the averages in previous years for several stations. The background station did not show a comparable increase, however, with no significant activity occurring within the facility, there is no obvious operational source for an environmental increase. It is worth noting that due to a loss of data in the first half of 2020, 2019 data was used as an estimate for the first semi-annual 2020 results. It's possible that this estimate biased 2020 data somewhat lower making 2021 look like a larger increase than it actually was.

Table 11 Annual Average Environmental Radon Concentration in Air

Station	2019 (µCi/mL)	2020 (µCi/mL)	2021 (µCi/ml)
AM-1 (residence)	2.0E-10	1.7E-10	1.7E-10
AM-2 (permit area boundary)	1.5E-10	1.5E-10	1.9E-10
AM-3 (permit area boundary)	1.0E-10	1.2E-10	1.5E-10
AM-4 (permit area boundary)	1.5E-10	1.6E-10	1.9E-10
AM-5 (residence)	1.5E-10	1.5E-10	2.2E-10
AM-6 (background)	1.5E-10	1.8E-10	1.7E-10
AM-8 (site boundary)	1.5E-10	1.7E-10	1.5E-10
AM-9 (nearest resident – max receptor)	1.5E-10	1.4E-10	1.6E-10

5.5.2 Radionuclides in Airborne Particulate Matter

Radionuclide concentrations in airborne particulate matter are measured at the same locations as the environmental radon samples. Particulates are collected on filters that are exchanged weekly and composited quarterly. The flow rate is approximately 50 liters per minute (L/m). The filters are analyzed for natural uranium (U-Nat), Ra-226, Pb-210 and Th-230.

The radionuclide concentrations in airborne particulate matter are comparable for the last five years at all each location, without background subtraction, shown in Table 12. The concentration of all radionuclides at all stations remain below the effluent limits stated in 10CFR 20 Appendix B. Concentrations of radionuclides remained roughly stable compared with previous years and comparable to the background station (AM6). All results were well below effluent limits.

Table 12: Annual Average Radionuclide Concentrations in Airborne Particulate Matter

Year	Annual Average Ra-226 Conc. (µCi/mL)				
Location	**2017**	**2018**	**2019**	**2020**	**2021**
Effluent Limit	*9E-13*				
AM-1	1E-16	9E-17	3E-17	9E-17	5E-17
AM-2	1E-16	5E-17	4E-17	2E-16	6E-17
AM-3	7E-17	5E-17	2E-17	5E-17	4E-17
AM-4	7E-17	4E-17	4E-17	7E-17	5E-17
AM-5	9E-17	5E-17	4E-17	2E-16	6E-17
AM-6	9E-17	5E-17	4E-17	7E-17	5E-17
AM-8	8E-17	1E-16	2E-17	2E-16	3E-17
AM-9	8E-17	1E-16	3E-17	8E-17	5E-17

Year	Annual Average Pb-210 Conc. (µCi/mL)				
Location	**2017**	**2018**	**2019**	**2020**	**2021**
Effluent Limit	*6E-13*				
AM-1	2E-14	1E-14	1E-14	2E-14	2E-14
AM-2	2E-14	1E-14	1E-14	1E-14	2E-14
AM-3	2E-14	1E-14	3E-14	1E-14	1E-14
AM-4	2E-14	1E-14	1E-14	1E-14	1E-14
AM-5	2E-14	1E-14	1E-14	1E-14	2E-14
AM-6	2E-14	2E-14	1E-14	2E-14	2E-14
AM-8	2E-14	1E-14	2E-14	2E-14	2E-14
AM-9	2E-14	2E-14	1E-14	1E-14	2E-14

Year	Annual Average U-Nat Conc. (µCi/mL)				
Location	**2017**	**2018**	**2019**	**2020**	**2021**
Effluent Limit	*9E-14*				
AM-1	2E-16	2E-16	3E-17	4E-17	6E-17
AM-2	4E-16	1E-16	6E-17	9E-17	6E-17
AM-3	4E-17	1E-16	8E-17	4E-17	6E-17
AM-4	2E-16	1E-16	6E-17	6E-17	6E-17
AM-5	2E-16	1E-16	5E-17	6E-17	5E-17
AM-6	8E-17	2E-16	5E-17	4E-17	5E-17
AM-8	7E-17	2E-16	4E-17	5E-17	6E-17
AM-9	8E-17	1E-16	4E-17	6E-17	5E-17

Year	Annual Average Th-230 Conc. (µCi/mL)				
Location	**2017**	**2018**	**2019**	**2020**	**2021**
Effluent Limit	*3E-14*				
AM-1	3E-17	5E-17	1E-17	0	0
AM-2	4E-17	1E-16	2E-17	2E-17	4E-17
AM-3	2E-17	1E-16	2E-17	1E-17	1E-17
AM-4	1E-17	7E-17	1E-17	1E-17	2E-17
AM-5	3E-16	7E-17	6E-17	2E-17	2E-17
AM-6	2E-15	3E-17	1E-16	3E-17	4E-18
AM-8	2E-16	9E-17	6E-17	2E-17	3E-17
AM-9	1E-15	1E-16	6E-17	3E-17	2E-17

5.5.3 Direct Gamma Radiation

Direct gamma radiation doses at the nine air monitoring stations are measured using Landauer, Inc. dosimeters. The dosimeters are exchanged quarterly. The total annual gamma doses for each monitoring location (without background (AM6) subtraction) are given in Table 13. Most stations remained comparable to their historic ranges. It was noted that doses at AM8 and AM9 were somewhat higher than previous years. When the background station (AM6) dose is subtracted from the other station results, the maximum net dose is 12.5 mrem/yr in 2021 at AM8. The public dose station AM9 had a net gamma dose of 6.5 mrem.

Table 13: Annual Measured Gamma Dose from 2018 to 2021

	Annual Dose (mrem/y)			
Year/Station	**2018**	**2019**	**2020**	**2021**
AM-1	41.9	49.2	52.1	48.9
AM-2	52.5	44.2	47.8	52.5
AM-3	50.6	58.5	60	56
AM-4	39.6	49.3	45.6	49.5
AM-5	61.4	56.4	50.1	58.4
AM-6	51.4	52.6	55	50.9
AM-8	57.8	52	53.2	63.4
AM-9	54	49.3	54.2	57.4

5.5.4 Emissions Calculation

Site emissions are calculated based on the sampling plan shown in Table 14. All samples were collected according to the schedule with the exception of wellheads while venting, which were not collected as there were no wellheads vented in 2021. It was also noted that 8 wellhouses were sampled, with 5 production and 3 restoration wellhouses, rather than 4 and 4. The emissions calculation is based on measured ventilation rates and radon gas and radon daughter measurements at the listed emissions points.

Table 14. Sampling Commitments for the Monitoring Program.

Sample Type	Location	Frequency
Radon Gas	Main Plant - tanks	Specified tank vents – quarterly
	Main Plant - general area	6 specified locations - semi-annually
	Wellfield	Venting well head - quarterly
	Wellhouse	4 production and 4 restoration wellhouses – semi-annually
	Spills	As required
Radon Daughters	Main Plant - tanks	Specified tank vents – quarterly
	Main Plant - general area	Routine sampling as per approved schedule
	Wellhouse	4 production and 4 restoration wellhouses – semi-annually
Particulate	Main Plant	Semi-annually (routine locations) for 2 years, annually after that – now performing annual sampling
	Wellhouse	4 production and 4 restoration wellhouses – semi-annually

Table 15 summarizes the year-end emissions results. The tanks clearly contribute the vast majority of the emissions. It is also apparent that essentially all emissions are from the main plant. This is true for all years that this emissions sampling program has been in effect. There has been a significant drop in overall emissions since 2017 due to reduced production. In 2017, total emissions were 9040 Ci. Reduction in site activities and changes to process beginning in 2017 reduced the rate at which tanks were filled and drained and a shutdown of some stacks and in-plant fans. Emissions began dropping in 2018 and continued to decrease in 2021 to 699 Ci.

Table 15. Emissions in Ci/Yr by Source 2021.

Source	**Radon Progeny (Ci)**	**Radon Gas (Ci)**	**Particulate (Ci)**	**Total by Source**	**% by Source**
Plant Floor Vents	0.46	4.36	7.72E-05	**4.82**	**0.7%**
Wellhouses (64)	0.29	2.73	2.98E-05	**3.02**	**0.4%**
Plant Tanks/vents	47.2	643.7	N/A	**690.8**	**98.9%**
Spills	N/A	5.03E-02	N/A	**5.03E-02**	**0.0%**
Deepwells	N/A	N/A	2.21E-06	**2.21E-06**	**0.0%**
Total by Type	**47.91**	**650.83**	**1.09E-04**		
Total Emissions for Full Year		**698.74 Ci**			

There were a number of recommendations made during the 2018 ALARA audit related to emissions calculations. These recommendations remain open at this time and, while not required, are still applicable to the observations made during this audit. Specifically, it remains reasonable to consider a reduction in the sampling plan to only target the one source (main plant) generating the vast majority of emissions and only during steady state conditions. Consideration should also be given to the impact of fan changes on emission calculations and whether updates are required to the calculations.

5.6 Quarterly Gamma Exposure Rate Surveys

Quarterly gamma exposure surveys are conducted outside the Central Processing Plant (CPP), Reverse Osmosis (RO) facility and the Well Houses. All areas are surveyed quarterly, which meets the criteria that surveys are performed quarterly for all locations considered "Radiation Areas" in Section 1.4.1.3 of Regulatory Guide 8.30.

The maximum exposure rates at various locations inside and outside the plant are recorded and compared to the previous month's data. All Well Houses with exposures rates above 5 mrem/hr are posted as Radiation Areas according to 10 CFR §20.1902. No areas surveyed outside any facility had exposure rates exceeding 2 mrem/hr which would require posting or additional controls according to site procedures.

The maximum exposure rates measured outside the CPP and the RO facility are given in Table 16.

Table 16. 2021 Maximum Gamma Dose Rate Measured Outside (mrem/hr).

	Maximum dose rate measured outside (mrem/hr)	
Quarter	**CPP**	**RO plant**
1	0.1	0.6
2	0.09	0.6
3	0.1	0.6
4	0.1	0.7

5.7 Visitor Records

Visitors to the Cameco Crow Butte facility are not given an access badge or issued personal dosimeters. Passes are issued to site visitors at the time of entry. Visitors are escorted when entering the Restricted Areas of the site.

Contractors and other individuals who may be on the site for an extended period of time must receive documented Hazard Recognition and Safety Orientation. The training, which includes radiation hazards, must be renewed annually and allows the individual unescorted access to specific work areas on the site. Contract workers who will enter the Restricted Area receive additional training from the RSO or HPT. Training and orientation is documented on the Hazard Recognition Recognition/Safety Orientation form. A sampling was reviewed and compared to the Visitor Registration logs and were found to be complete. The requirements of Reg Guide 8.31 are being followed as indicated in the description of the hazard recognition and safety orientation training and visitor log.

5.8 Annual Review of Operating Procedures

Procedures and associated documents (e.g., work instructions, forms) are maintained in the Cameco Management Document System (MDS) database. MDS manages the creation, approval, and review of management documents. Typically, most management documents have been assigned a three-year review cycle in MDS and the site supplements additional reviews with a manual process through ORC/SERP. The fundamental purpose of the review of procedures in Reg Guide 8.31 is to ensure operating procedure remain in alignment with any "newly established radiation protection practices". A review of radiation protection program, procedure and work instructions MDS showed that all of these documents were up to date. No SOPs required a change through the SERP process in 2021.

5.9 Source Leak Tests

The Crow Butte facility has no radioactive sources that require leak testing.

5.10 Radiation Work Permits (RWPs)

RWPs are issued for non-routine activities that involved the potential for significant exposure to radioactive materials and for which there were no standard operating procedures. RWPs describe the activity, personnel involved, radiological data and protective equipment required. All RWPs required for dose tracking are entered into CamRad.

There were 4 Radiation Work Permits (RWPs) issued in 2021. RWPs are issued for non-routine activities that involved the potential for significant exposure to radioactive materials and for which there were no standard operating procedures. RWPs describe the activity, personnel involved, radiological data and protective equipment required

RWPs for which workers are assigned a dose are entered into CamRad. All records were entered into CamRad even if the dose contribution was null or negligible to ensure completeness of records. The RWPs in CamRad were reviewed and no problems were identified.

5.11 Respiratory Protection

The Respiratory Protection Program was reviewed. Full face piece air purifying respirators are used in situations where respiratory protection is required. When the dryer is operating, the dryer room is designated as an Airborne Radioactivity Area and respiratory protection is required. The Respiratory Protection Program includes evaluation of medical fitness for respirator use, fit testing and training. Cameco uses Legends Butte Health Services in Crawford, Nebraska as the medical provider. Respirator training is included in the annual radiation worker training. Respirator training and medical evaluation records were reviewed and are in good condition. Annual refresher was performed for all Crow Butte Employees and Contractors between October 26th – November 2nd, 2021, and respirator fit testing was completed in May of 2021.

5.12 Safety Meeting Records

"All Hands" safety meetings are to be held monthly. Records of the meetings were reviewed. There was no safety meeting recorded for the month of December 2021. The dates and topics discussed at the meetings are given in Table 12.

Table 12. Safety Meeting Date and Topics during 2021.

Date	Subjects	Attendees
01/2021	Snow and Ice	17
02/2021	Corporate Containment Standard	10
03/2021	Safety Tips at Easter	18
04/2021	Dehydration	18
05/2021	IOGP Safety Alert 324	18
06/2021	Site Risk Review	14
07/2021	Canadian Occupational Safety: Worker dies in exploding car tire accident	18
08/2021	Mandatory Vaccine Meeting – COVID 19 Safety Discussion	17
09/2021	CDC COVID19 Protection	19
10/2021	Winter Safety Standard Review	11
11/2021	Fall On Uneven Terrain	10

5.13 Radiation Worker Training

According to site procedure, introductory radiation safety training is conducted for all new employees. Contractor Radiation Safety Training was provided to two new contractors of Country Electric. Due to social distancing requirements, worker radiation safety refresher training was provided in a self-guided format. As part of the refresher training, all participants completed a quiz covering the training material. All employees and contractors received passing scores on the radiation safety training provided. A sample of completed tests was reviewed by auditors and found to be acceptable.

RSO and HPT training was also reviewed during the audit. All records were found to be up to date and meet the requirements of Regulatory Guide 8.31. Both the RSO and HTP held valid certification in 2021 and was recertified in 2022.

5.13.1 Job Task Observation

Crow Butte conducts Job Task Observations (JTOs) to reinforce conformance with procedures, particularly those related to safety and this includes radiation. In 2021 the site conducted 132 JTOs, including those performed on tasks associated or required following of radiation protection procedures. Several JTOs were reviewed including radiation related tasks such as performing fit test, quantification of a spill and yellowcake packaging. No issues were noted with the radiation staff or workers performing these tasks. Radiation protection issues have been successfully included as part of the JTOs and indicate a good level of conformance to the radiation procedures.

5.14 Safety and Environmental Review Panel (SERP)

The SERP is tasked with approving changes in the facility or procedures as described in the license application and conduct tests or experiments not described in the license application as long as conditions specified in License Condition 9.4. (Amendment 1) are met. License Condition 9.4D defines the purpose and makeup of the SERP. There were no actions approved by the SERP in 2021.

5.15 Unusual Events

There were no unusual events reported during 2021 that required reporting.

5.16 Inspection Reports

5.16.1 Routine Inspections

Daily walk-through inspections are conducted in the plant. As per the Materials License (SUA-1534), the site is permitted to identify one or more qualified designees who may perform daily inspections in the absence of the RSO and HPTs. The training program as well as the results of exams and on the job training (proficiency checks) were reviewed and found to be present for all designees. As previously noted, during the review of inspection records, it was found that the requirements for review by the RSO or HPT were met.

The daily walk-through inspection forms for the central processing and RO plants were reviewed during the audit. Each walk-through inspection log form covers a full week. The area owner/operator fills out the checklist and initials the form. The RSO then uses that checklist to perform a walk-through and then signs the form. Checklists from 2021 were spot checked to ensure completion and that the timelines required by the license were met. No issues were identified. Where a problem was identified during the inspection, initials of the RSO verified that the problem was acknowledged, and a follow-up comment noted when and how the problem was addressed.

The RSO or an alternate RSO-qualified individual performs a weekly inspection of the site, accompanied by the Restoration Manager or Plant Supervisor. Representative copies of the form (CBR-RPP-FORM-002) were reviewed. The inspections are compliant with Regulatory Guide 8.31.

5.16.2 NRC Inspections

The last NRC inspection took place July 31st – August 1st, 2019. NRC inspections will now take place on a three-year schedule, with the next inspection occurring in 2022. As reported in the previous 2019 ALARA Report, there were no violations identified in the previous NRC inspection. That inspection covered management organization and controls, ISL facilities, radiation protection, effluent control and environmental protection, transportation, and emergency preparedness and fire protection.

5.17 Review of 2020 ALARA Audit Recommendations

Recommendation #1: Generate and review on a continuous basis radon daughter level trends in the Plant, and in particular Pond Water Treatment, to ensure that radon daughter levels are in the expected range. If the levels remain elevated, additional remedial actions may be necessary.

Response: Complete - These are being reviewed as part of monthly report.

Recommendation #2: Have a digital backup of the information used to track the locations where the alpha track detectors are measuring. Digital backups should be stored on a network drive, as opposed to a personal computer, as there are redundancies built into the system to protect against the loss of important information (i.e. network drive backups).

Response: Complete

6.0 SUMMARY OF 2021 AUDIT FINDINGS AND RECOMMENDATIONS

6.1 Findings

There were no findings identified in this ALARA audit.

6.2 Recommendations

Recommendation 1: Ensure all previous data is removed from file when using an historic form as a starting point for subsequent surveys or consider creation of templates with standard sample areas pre-populated.

Recommendation 2: Change the Total Activity (dpm) term to Decay Corrected 2Pi Emission Rate (dpm) for clarity on the equipment reliability spreadsheets.

7.0 REFERENCES

[NRC] Nuclear Regulatory Commission. 2002. Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable. Regulatory Guide 8.31. Revision 1. May.

[NRC] Nuclear Regulatory Commission. 2014. Bioassay at Uranium Mills. Regulatory Guide 8.22. Revision 2. May.

[NRC] Nuclear Regulatory Commission. 2014. Evaluation of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstration of Compliance with 10 CFR 20.1301. Revised Draft for Comment FSME-ISG-01. March.

[NRC] https://www.nrc.gov/reading-rm/doc-collections/cfr/part020/appb/Radon-222.html (accessed 14.02.2019) Table 2. Effluent Concentrations for Radon-222

APPENDIX A

LIST OF ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
µCi	Micro Curie
µg/L	Microgram per liter
ALARA	As Low As Reasonably Achievable
ALI	Annual Limit of Intake
APR	Air Purifying Respirator
BZ	Breathing Zone
CEDE	Committed Effective Dose Equivalent
Ci	Curie
CPP	Central Processing Plant
DAC	Derived Air Concentration
DDE	Deep dose equivalent
HPT	Health Physics Technician
IML	Intermountain Laboratories
JHA	Job Hazard Analysis
ND	Non detect
NRC	Nuclear Regulatory Commission
pCi/L	Picocuries per liter
QNFT	Quantitative Fit Test
RO	Reverse Osmosis
RSO	Radiation Safety Officer
RWP	Radiation Work Permit
SERP	Safety and Environment Review Panel
SOP	Standard Operating Procedure
SRH	Smith Ranch-Highland Operation
TEDE	Total Effective Dose Equivalent
TLD	Thermoluminescent Dosimeters
URP	(WDEQ) Uranium Recovery Program
WL	Working Level – measure of the concentration of radon decay products
WLM	Working Level Months
WDEQ	Wyoming Department of Environmental Quality

APPENDIX B

Records Reviewed during ALARA Audit

For purposes of the ALARA audit, numerous records were examined prior to and during the audit visit including those shown in the table below.

Radiation Program Documents
Uranium Recovery Program (URP) inspection reports
Previous audit reports
RSO and HPT training Records
Annual radiation worker training records
Bioassay laboratory reports
Worker dosimetry reports
Radon decay product measurements
Air particulate measurement data
Routine inspection logs (daily walk through and weekly RSO inspection)
Monthly RSO reports
SERP records
Monthly Safety Meeting records
Job task observation
Personal surveys
Survey instrument calibration records
On-site survey records
SHEQ Monthly Reports
Radiation Work Permits
Semi-annual environmental monitoring reports
Environmental gamma measurement data
Environment air particulate concentrations

Interoffice Memo

Cameco Resources
Crow Butte Operation

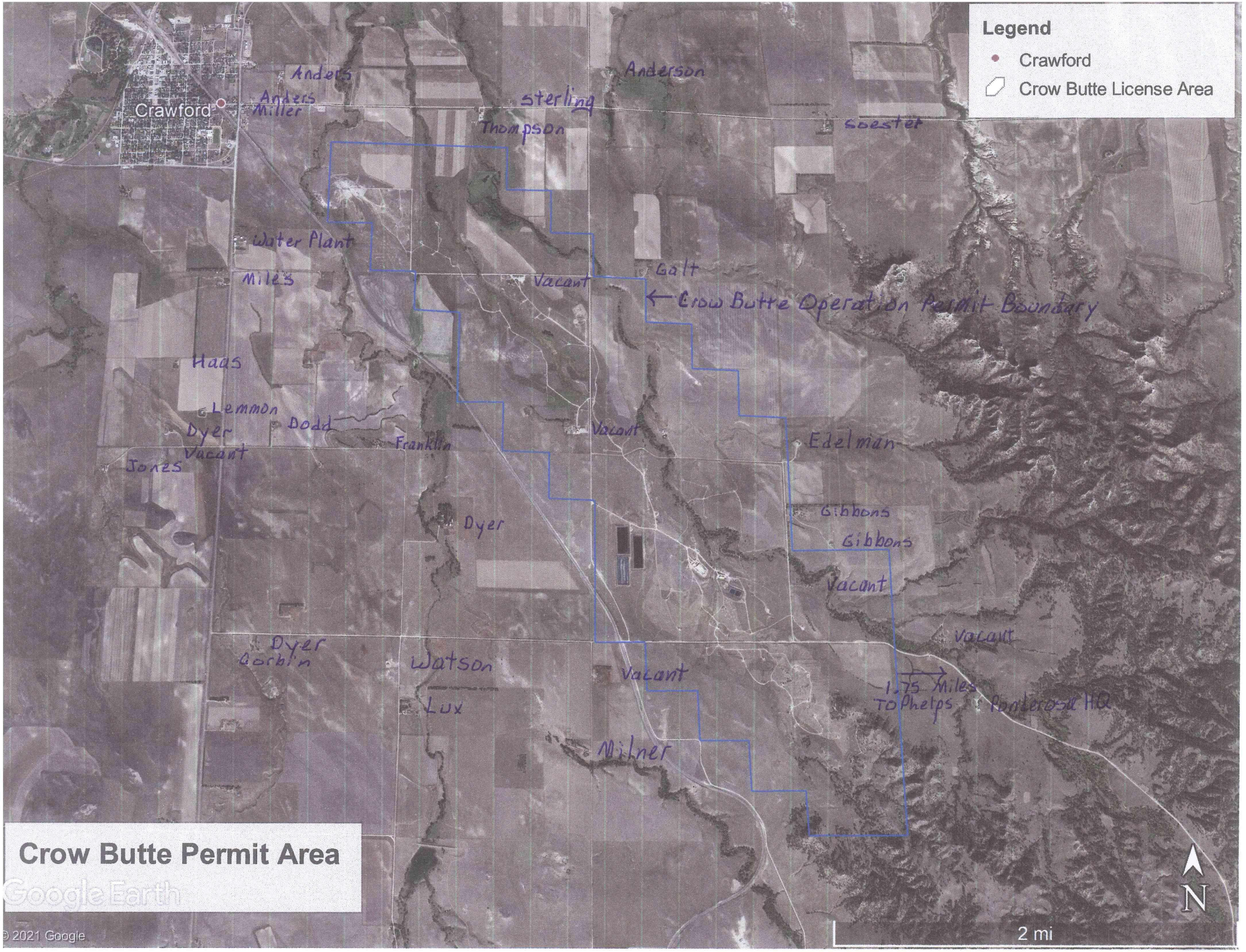
Date: February 2, 2022

To: File

From: Casey Yada, SHEQ Coordinator
Tami Dyer, Radiation Safety Officer

Re: License Renewal (November 2014) License Condition 11.2 , Land Use Survey

Source Material License SUA-1534 (Renewed November 2014) License Condition 11.2 requires the licensee to conduct an annual land use survey. This survey was conducted by the Radiation Safety Officer and SHEQ Coordinator using aerial maps, interviews and ground verification. Attached is an aerial photo of the survey. No changes in ownership were discovered nor new occupied structures identified that would affect dose to the public of the nearest resident or the Crow Butte operation.


Legend
Crawford
Crow Butte License Area
Crawford
Anders
Anders
Miller
Anderson
Sterling
Thompson
Soester
Water Plant
Miles
Vacant
Galt
← Crow Butte Operation Permit Boundary
Haas
Lemmon
Dyer
Vacant
Jones
Dodd
Franklin
Vacant
Edelman
Dyer
Gibbons
Gibbons
Vacant
Vacant
Dyer
Corbin
Watson
Lux
Vacant
1.75 Miles TO Phelps
Ponderosa HQ
Milner
Crow Butte Permit Area
Google Earth
© 2021 Google
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