January 16, 2009

Mr. Stephen P. Collings
President
Crow Butte Resources, Inc.
141 Union Boulevard, Suite 320
Lakewood, CO 80228

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION, LICENSE RENEWAL AMENDMENT REQUEST, CROW BUTTE RESOURCES, INC., CRAWFORD, NEBRASKA, LICENSE SUA-1534 (TAC J00555)

Dear Mr. Collings:

By letter dated November 27, 2007, Crow Butte Resources, Inc., (CBR) submitted to the U.S. Nuclear Regulatory Commission (NRC) staff a request to renew its source material license for its uranium *in situ* recovery (ISR) facility located in Crawford, Nebraska. License No. SUA-1534 authorizes the licensee to operate an ISR uranium recovery facility to produce yellowcake. Specifically, the amendment requests that NRC renew CBR's current license for a standard 10-year period. By letter dated March 28, 2008, NRC staff informed CBR that its application was accepted for further detailed technical review.

NRC staff has completed its technical review of the license renewal application. During our technical review, NRC staff identified certain areas of deficiency for which we are requesting additional information. The staff's request for additional information (RAI) is enclosed, herein. This RAI is organized according to the sections in the application. Please either respond to this RAI or provide a schedule for submitting your responses within 30 days of receipt of this letter. With your RAI responses, please submit all appropriate page changes that incorporate these RAI responses.

If you have any questions, please contact Mr. Ronald Burrows at 301-415-6443 or, by email, at ronald.burrows@nrc.gov.

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

Sincerely,

/RA/

Stephen J. Cohen, Project Manager
Uranium Recovery Licensing Branch
Decommissioning and Uranium Recovery
Licensing Directorate
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

Docket No.: 40-8943
License No.: SUA-1534

Enclosure: Request for Additional Information

cc: D. Miesbach, NDEQ
J. Abrahamson, NDEQ
L. Teahon, CBR

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CROW BUTTE RESOURCES, INC.
CROW BUTTE LICENSE RENEWAL
REQUEST FOR ADDITIONAL INFORMATION

By letter dated November 27, 2007, Crow Butte Resources, Inc., (CBR) submitted to the U.S. Nuclear Regulatory Commission (NRC) staff a request to renew its source material license for its uranium *in situ* recovery (ISR) facility located in Crawford, Nebraska. Specifically, this amendment requests that NRC renew CBR's current license for a standard 10-year period. By letter dated March 28, 2008, NRC staff informed CBR that its application was accepted for further detailed technical review. NRC staff has completed its technical review of the license renewal application. During its technical review, NRC staff identified certain areas of deficiency, for which this request for additional information (RAI) has been prepared.
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Section 2.5 Meteorology

1. Please confirm that precipitation and temperature data from Chadron, Nebraska, are comparable to Crawford, Nebraska. NRC staff notes that spring and summer rain showers often occur as scattered thunderstorm cells; therefore, precipitation at one location may not be representative of another.

2. CBR did not provide local humidity data. Instead, data from Scottsbluff, Nebraska, and Rapid City, South Dakota, were presented for the site. Considering the distance of these locations to the site, please explain how this data is representative of conditions at Crawford, Nebraska.

3. Please provide updated wind data for the main Crawford, Nebraska facility or explain why the previous data is still representative.

2.7 Hydrology

1. In its application, CBR assessed stream flow in the White River, using various data from 1992 through 2005. However, CBR should assess more recent stream flow data that includes Squaw Creek and English Creek, where feasible. The assessment should include whether or not the recent data is comparable to past data. In this manner, a trend in stream flow may be identified.

2. Please provide updated information (based on recent close spaced drilling activities as discussed in the application, p. 2-113) regarding the horizontal and vertical extents of the White River structural feature and the continuity of the upper confining unit of the Basal Chadron sandstone in northern parts of Mining Unit 10. Include up-to-date potentiometric maps for the Basal Chadron and Brule Formations (in addition to water level measurements in 1982, 1983, and 1993).

3. Page 2-140 states that data for existing wells is over 10 years old and that groundwater flow regimes are different north and south of the White River. Therefore, no regional contour maps are presented. Despite these arguments, CBR should develop and present updated regional groundwater contour maps.

4. In Section 2.7.2.3, please define "hydraulic resistance" and "travel time of a water molecule" in the application, and please explain why CBR's values for the hydraulic resistance and travel time of a water molecule in the application are different from the

calculated values shown below. Additionally, the vertical hydraulic conductivity for the overlying confining layer was reported to be 2.8×10^{-10} cm/sec on page 2-159, but it was reported to be 3.49×10^{-11}cm/sec. on page 2-161. Please correct this inconsistency and check all calculations in this section.

<u>Hydraulic Resistance of the Upper Confining Unit (page 2-159)</u>: Given the upper confining unit's vertical hydraulic conductivity (K_v) of 7.8×10^{-7} ft/day, the effective porosity (θ) of the confining layer of 0.02 (page 2-159), and the unit gradient (dh/dl) assumed in calculations (page 2-159), the vertical groundwater velocity of the upper confining unit is:

$$V = K_v / \theta \times dh/dl = 7.8 \times 10^{-7} / 0.02 = 3.9 \times 10^{-5} \text{ ft/day.}$$

Since the average thickness of the upper confining layer is 300 ft (page 2-154), it follows that

$$\text{Hydraulic resistance} = 300/3.9 \times 10^{-5} = 7.7 \times 10^{6} \text{ days or} \sim 21{,}000 \text{ years.}$$

However, the hydraulic resistance in the application was reported to be 53,000 years and the travel time of a water molecule was reported to be 1,050 years.

<u>Hydraulic resistance of the lower confining layer (page 2-159)</u>: Given the lower confining layer's vertical hydraulic conductivity (K_v) of 9.6×10^{-8} ft/day, the effective porosity (θ) of the confining layer is 0.02 (page 2-159), and the unit gradient (dh/dl) assumed in calculations (page 2-159), the vertical groundwater velocity of the lower confining layer is:

$$V = K_v / \theta \times dh/dl = 9.6 \times 10^{-8} / 0.02 = 4.8 \times 10^{-6} \text{ ft/day}$$

Since the average thickness of the lower confining layer is reported to range from 1,200 ft to 1,500 ft (page 2-157), it follows that corresponding hydraulic resistance range from ~ 685,000 ($1200/4.8 \times 10^{-6} = 2.5 \times 10^{8}$ days) to ~ 856,000 ($1500/4.8 \times 10^{-6} = 3.1 \times 10^{8}$ days). However, the hydraulic resistance was reported to be 34,000,000 years and the travel time of a water molecule was reported to be 685,000 years.

<u>Hydraulic resistance of the lower confining layer (page 2-161)</u>: Given the red confining layer's vertical hydraulic conductivity (K_v) is 3.49×10^{-11} cm/sec, the average thickness of the red clay confining layer is= 30ft (page 2-161), Effective porosity (θ) of the confining layer = 0.02 (page 2-161), and the unit gradient (dh/dl) assumed in calculations (p. 2-161), the vertical groundwater velocity of the red clay layer is:

$$V = K_v / \theta \times dh/dl = 3.49 \times 10^{-11}/0.02 = 1.745 \times 10^{-9} \text{ cm/sec} \sim 0.055 \text{ cm/yr}$$

Since the thickness the red clay confining layer is 30 ft (914.4 cm), then if follows the hydraulic resistance is ~ 16,600 years. However, the hydraulic resistance was reported by CBR is 830,200 years and the travel time of a water molecule was reported to be 16,600,000 years.

5. Include groundwater-level distributions (in addition to water level measurements in 1982, 1983, and 1993) for the Brule and Chadron Formations to show both seasonal and historical variations in groundwater levels, flow direction, and gradient.

6. Referring to Table 7.12-2 in the application, please use current operational data to assess any changes to the maximum available drawdown.

7. Include baseline concentrations for other water quality measures (in addition to uranium and radium) for surface waters (see the application, p. 5-118 of for a list of baseline water quality parameters). If only uranium and radium were deemed to be sufficient for setting baseline concentrations, please provide the justification.

2.9 Background Radiological Characteristics

Please update the background concentrations, if necessary, to account for data collected during wellfield development but prior to operations in the main facility wellfields.

4.2.1 Liquid Wastes

1. On page 4-3, CBR states that during the groundwater sweep phase of restoration, extracted water will not be reinjected. However, CBR has stated during multiple site visits and inspections that it reinjects all restoration water except for the bleed to maintain hydraulic control without needlessly wasting water. Please confirm CBR's groundwater sweep procedures.

2. Please provide a discussion of the manner in which liquid waste generated in the laboratory is managed.

5.3 Management Audit and Inspection Programs

Please provide information on your record retention policies for records required under 10 CFR 20 and 10 CFR 40.

5.8.2 External Radiation Monitoring Program

1. Radiation detection equipment - Please update the methods of calibration for survey equipment. For example, CBR does not state whether it has developed its own procedures for instrument calibration or if contractors will calibrate instruments. CBR should discuss the major aspects of instrument calibration identifying whether or not contractors will perform this function. If contractors will perform this function, please identify the standards that will be used and what specific QA/QC requirements apply.

2. Establishing Radiation Areas – Please clarify the use of the definition of a radiation area as defined in 10 CFR 20.1003. CBR has defined an "action level" (i.e., an area that requires posting as a radiation area) as exceeding "5.0 mRem per hour for worker occupied stations." 10 CFR 20 requires the measurement to be made "at 30 centimeters from the radiation source or any surface that the radiation penetrates." Using CBR's definition of a radiation area, a high radiation area could exist without the proper posting.

3. Public Access to Operations –Considering the current operations, please provide an analysis of public doses for compliance with 10 CFR 20.1302. Please comment

specifically on 10 CFR 20.1302(b) and 10 CFR 20.1301(b) and include a discussion of contractors receiving public doses.

5.8.3 Airborne Radiation Monitoring Program

1. Airborne Uranium Particulate Monitoring:

a. CBR states, “Sample volume is adequate to achieve the lower limits of detection (LLD) for uranium in air.” CBR also states in its original application that it would use LLDs specified in Regulatory Guide 4.14. Please provide any updates to the LLDs.

b. CBR states, “After implementation of the new 10 CFR 20 on January 1, 1994, the Derived Air Concentration (DAC) for soluble (D classification) natural uranium of 5 E-10 µCi/ml from Appendix B to 10 CFR §§20.1001 - 20.2401 was used. This is a conservative method because the gross alpha results include Uranium-238 and several of its daughters (notably Ra-226 and Th-230), which are alpha emitters.” The following questions apply to this statement:

   i. Considering that the air sample is a mixture of radionuclides, please justify the use of the DAC value of $5x10^{-10}$ µCi/ml which corresponds to natural uranium with no other radioactive constituents.

   ii. Please justify the comment that analyzing gross alpha counts for airborne uranium and applying the DAC value of $5x10^{-10}$ µCi/ml for natural uranium is “a conservative method.”

   iii. Please justify the use of 100 percent class D for Crow Butte Project yellowcake.

   iv. Please describe specifically what dose is calculated when comparing airborne uranium levels to the DAC value of $5x10^{-10}$ µCi/ml.

   v. Please clarify what the current airborne radiation monitoring program is, not was. Please revise this section as needed to discuss the current practice instead of using the past tense.

c. CBR states, “An action level of 25 percent of the MPC (DAC since 1994) for soluble natural uranium was established at the Crow Butte Project facilities. If an airborne uranium sample exceeded the MPC (DAC), an investigation was performed.” Please clarify the current established action level. The use of maximum permissible concentration (MPC) is an outdated term no longer used for regulatory purposes. This statement also appears to be a typographical error. It is presumed that the 25 percent action level will be used to initiate an investigation and not the full DAC value.

d. CBR’s airborne uranium particulate monitoring program appears to be based on compliance with 10 CFR 20, Appendix B, Table 1 values for the DAC. Please describe how the program also ensures compliance with 10 CFR 20.1201(e) regarding the chemical toxicity of uranium (including exposure to multiple exposures during a time period) and how the “as low as is reasonably achievable” (ALARA) program will be applied to this exposure or indicate where this information is found in the application.

2. In-Plant Radon Daughter Surveys - please propose an LLD for radon measurements.

5.8.4 Exposure Calculations

Prenatal and Fetal Exposure

Please describe the program for the Crow Butte Project for complying with 10 CFR 20.1208, *Dose equivalent to an embryo/fetus*, or indicate where this can be found in the application.

5.8.4.1 Natural Uranium Exposure

1. General – CBR states, "Exposure calculations for airborne natural uranium are carried out using the intake method from USNRC Regulatory Guide 8.30, *Health Physics Surveys in Uranium Recovery Facilities,* Revision 1, Section 2." This appears to be a typographical error in that intake and exposure calculations are discussed in Section 3 of Regulatory Guide 8.30. Please clarify the aforementioned statement.

2. Intake Calculation – The following questions apply to the natural uranium intake equation (duplicated below) provided by CBR in section 5.8.4.1:

$$I_u = b\sum_{i=1}^{n} \frac{X_i \times t_i}{PF}$$

where:

I_u	=	uranium intake, µg or µCi
t_i	=	time the worker is exposed to concentrations X_i (hr)
X_i	=	average concentration of uranium in breathing zone, µg/m^3, µCi/m^3
b	=	breathing rate, 1.2 m^3/hr
PF	=	respirator protection factor, if applicable
n	=	number of exposure periods during the week or quarter

a. Exposure Time (t_i in the above equation) – CBR states, "One hundred percent occupancy time is used to determine routine worker exposures." It is not clear what is meant by this statement in regards to assigning time to a worker in any given uranium airborne concentration. Please provide more detail on how routine workers' time will be calculated for input into this equation. This discussion should include details on how workers working more than the standard work week (e.g., 40 hours) are handled.

b. Average Concentration of Uranium in Breathing Zone (the X_i term in the above equation): The X_i term is given both as mass (µg) and activity (µCi) of uranium per unit volume of air. Please provide a discussion on how the mass of uranium is measured or calculated for this equation.

3. Deriving Dose to Worker:

   CBR states: “Exposures to airborne uranium will be compared to the DAC for the "D" solubility class for natural uranium from appendix B of 10 CFR §§20.1001 - 20.2401 (5 E-10 µCi/ml) for all areas of the plant.”

   a. Same questions as questions 1.b.i through iv under Section 5.8.3 regarding use of the DAC value of $5x10^{-10}$ µCi/ml for all areas of the plant.

   b. The uranium intake, I_u, is calculated in terms of mass or activity and yet for deriving a dose it is compared to the DAC, which is tabulated in terms of activity per unit volume. CBR should provide more detail, including a sample calculation, on how dose is calculated using both mass and activity units for I_u.

4. Mathematical Notations – the term “i” in the above equation is not properly annotated. For example it would appear that X_i refers to the average concentration of uranium in breathing zone *for exposure period “i”*. The same applies to the t_i term. Please clarify the notation.

5.8.4.2 Radon Daughter Exposure

1. See question 1 under Section 5.8.4.1.

2. Intake Calculation – The following questions apply to the intake equation for radon daughters provided by CBR in section 5.8.4.2:

$$I_r = \frac{1}{170} \sum_{i=1}^{n} \frac{Wi \times t_i}{PF}$$

where:

I_r	=	radon daughter intake, working-level months
t_i	=	time that the worker is exposed to concentrations W_i (hr)
W_i	=	average number of working levels in the air near the worker's breathing zone during the time (t_i)
170	=	number of hours in a working month
PF	=	the respirator protection factor, if applicable
n	=	the number of exposure periods during the year

a. See question 2.a in Section 5.8.4.1.

b. Deriving Dose to Worker – CBR states, “Exposures to radon daughters will be compared to the DAC for radon daughters from Appendix B of 10 CFR §§20.1001 - 20.2401 (0.33 WL).” However, the radon daughter intake, I_R, is calculated in terms of working level months, or activity, and yet for deriving a dose it is compared to the DAC. The DAC is tabulated in terms of working levels, or activity per unit volume. Please provide more detail, including a sample calculation, of how dose is calculated.

3. See question 4 in Section 5.8.4.1.

5.8.6 Contamination Control Program

Radiation detection equipment - See question 1 in section 5.8.2 .

Contamination Limits

Please discuss the contamination limits to be used for contamination involving radium that is not in equilibrium with uranium.

5.8.6.3 Surveys of Equipment Prior to Release to an Unrestricted Area

With regard to surveying items from restricted areas CBR states, “The RSO, the radiation safety staff, or properly trained employees perform surveys of all items from the restricted areas with the exception of small, hand-carried items described above.” This statement appears to be inconsistent with what CBR states in Section 5.1.6. In this section, CBR states that the HPT is “responsible for the orderly collection and interpretation of all monitoring data, to include data from radiological safety and environmental programs.”

In addition, this statement appears to be inconsistent with License Condition 9.12 which requires CBR to “…follow the guidance set forth in U.S. Nuclear Regulatory Commission Regulatory Guides…and 8.31 or NRC-approved equivalent.” Regulatory Guide 8.31 states that, “The RSO and radiation safety office staff are responsible for performing all routine and special radiation surveys as required by license conditions and by 10 CFR Part 20.” Please clarify who is allowed to perform surveys for releasing items from restricted areas. If “properly trained employees” are being used for releasing items from restricted areas, please provide the technical qualifications of these individuals and justification for using them.

5.8.7 Airborne Effluent and Environmental Monitoring Program

Similar to what is discussed in section 5.8.2, question 3, it is not clear how CBR is in compliance with 10 CFR 20.1301 and 1302 regarding public dose to members of the public in areas outside of restricted areas. Please demonstrate by surveys and calculations that public dose limits are in compliance.

6.1 Plans and Schedules for Groundwater Quality Restoration

1. License Condition 10.3(C) in Source Materials License SUA-1534 states that CBR will restore groundwater in the production zones to baseline and Nebraska Department of Environmental Quality- (NDEQ-) approved class of use, if restoration to baseline is not

achievable. However, NRC staff must amend this license condition to state that CBR will return the groundwater quality to the standards listed in Criterion 5B(5) of 10 CFR Part 40, Appendix A, as required by the Uranium Mill Tailings Radiation Control Act of 1978, as amended.

2. Please provide the following:

   a. The volume of groundwater solutions to be extracted during groundwater restoration and whether the quantity of water pumped during restoration will adversely affect offsite groundwater uses.

   b. The wellfield pore volume affected by the extraction processes within the ore body water-bearing zone.

   c. An estimate of the horizontal and vertical flare, and the number of pore volumes that will be displaced during groundwater restoration.

   Please note that the restoration pore volume estimate should consider the pore volume quantity required to restore Mine Unit 1 as well as current and projected pore volume quantities required to restore Mine Units 2, 3, 4, and 5. Please show all calculations and discuss any assumptions.

3. Please update the list of reductants used and their associated hazards (e.g., safety hazards associated with the reductants' storage and use).

4. Please provide a justification for the length of the stabilization period. Any justification should include CBR's experience with restoring Mine Unit 1.

5. Please provide further details regarding the well abandonment practices to be used.

6. Page 6-24 of the application is blank. Please provide any missing information.

6.2 Plans for Reclaiming Disturbed Areas

1. As required by 10 CFR 40.36(f) and meets the criteria of 10 CFR 40.42(g)(4) and (5), the reclamation plan must specify the location of records of information important to the decommissioning.

2. CBR plans to treat and discharge evaporation pond water in the later stages of groundwater restoration if the water is treatable within discharge limits. CBR states that this treatment and discharge would be under an appropriate NPDES permit. Please identify the locations of the potential discharge under an NPDES permit.

6.3 Removal and Disposal of Structures, Waste Materials, and Equipment

Please include more detail to the survey and decontamination procedures which include a commitment to determining radioactivity along the interior surfaces of pipes, drain lines, and duct work by taking measurements at traps or other access points. Additionally, please expand your discussion in the CBR technical report to include a commitment to control contamination of structures and equipment.

6.4 Post-Reclamation and Decommissioning Radiological Surveys

1. Regarding the radium-226 criterion in 10 CFR 40, Appendix A, CBR states : “The Benchmark Dose was modeled using the MILDOS.” This appears to be a typographical error. Please clarify which computer code was utilized to model the Benchmark Dose and provide outputs from it.

2. Please provide acceptable cleanup criteria for Th-230 for areas that already meet the radium cleanup criteria, but still contain elevated thorium levels.

3. Please justify in greater detail the use of 17,900 counts per minute (cpm) as an action level.