CAMECO RESOURCES
CROW BUTTE OPERATION

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January 23, 2018

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SIGNATURE CONFIRMATION

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

Annual Report of Changes, Tests, or Experiments
License No. SUA-1534
Docket No. 40-8943

ATTN: Document Control Desk:

Crow Butte Resources, Inc. (CBR) d/b/a Cameco Resources – Crow Butte Operation (CBO) is providing this annual report summarizing the changes, tests or experiments made under License Condition 9.4 of SUA-1534 during calendar year 2017. This report is made in accordance with the reporting requirements contained in License Condition 9.4 (E).

CBR's second renewal of its source material license was received November 5, 2014. The renewed license contained Performance Based License Conditions (PBLC). In a PBLC, CBR is allowed to make changes or conduct tests and experiments under certain conditions. These changes, tests, and experiments must be reviewed and approved by the CBR Safety and Environmental Review Panel (SERP). During 2017, the CBR SERP approved four changes.

The following materials are attached to provide the required summary information and documentation required by License Condition 9.4 (E).

- SERP Evaluation Index, which summarizes each SERP Action and tracks any modifications to an approved action affected by subsequent SERP actions.
- A copy of the text of each approved SERP Evaluation. These evaluations describe the change or test approved and the safety and environmental evaluation performed by the SERP. Supporting documentation is maintained on site for NRC review.

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- Highlighted versions of page changes made to the License Renewal Application (LRA) because of the SERP actions in 2017. These highlighted page changes use a strikethrough to denote deleted text and an underline to indicate new text.

- Page replacement versions of page changes for insertion in the updated NRC copy of the LRA. These pages have a revision date in the footer.

There were two SERP evaluations conducted during calendar 2017 that required a page change to the license renewal issued November 5, 2014. These changes included the approved Security Plan and the Quality Assurance Program. Highlighted versions and replacement copies of these documents are also included in the attachments.

By letter dated October 19, 2009, in the response to violation of 10 CFR 40.42 (h)(1) and 10 CFR 40.42 (i), CBO submitted a request for an alternate decommissioning (groundwater restoration) schedule for mine units 2 through 5. (A request for an alternate decommissioning schedule for mine unit 6 was submitted on December 21, 2010). CBO also indicated in this request that an annual review of the groundwater decommissioning schedule would be added to the Annual Summary of Changes list.

By letter dated June 22, 2016 (received June 27, 2016), the U.S. Nuclear Regulatory Commission (NRC) staff indicated that they had reviewed information previously submitted by CBO in support of an alternate decommissioning (groundwater restoration) schedule for MUs 2-6 by letters dated October 26, 2012 (ML12313A517), and August 8, 2013 (ML13226A353). The NRC staff had no further questions on these submittals.

As a separate matter, NRC staff indicated that CBO's current estimates for groundwater restoration (ML15279A139) were not in compliance with approved schedules (refer to LC 10.6 of ML13324A101). In addition, CBO's groundwater restoration schedule reflected in its 2016 surety estimate indicated that a formal request to remove (MUs) 2 and 3 from restoration was to occur in the fourth quarter of 2015. As this date had passed, the NRC staff found that the groundwater restoration schedule reflected in the 2016 surety estimate was no longer valid and may not provide a sufficient amount of restoration time for the development of an alternate concentration limit (ACL) application or, alternatively, to reach concentration limits under 10 CFR 40, Appendix A Criterion 5B(5).

In accordance with 10 CFR 40.42 and 10 CFR 40.44, the NRC staff requested a license amendment request on NRC Form 313 for an alternate decommissioning (groundwater restoration) schedule for MUs 2-6 to update the schedule reflected in the 2016 surety estimate (ML15279A139) with sufficient amount of restoration time for the development of an ACL application, or alternatively, to reach concentration limits under 10 CFR 40, Appendix A, Criterion 5B(5).

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The following is a summary of the license amendment requesting an alternate decommissioning schedule for MUs 2-6.

Summary of License Amendment Request for Alternate Decommissioning Schedule for Mine Units 2 through 6			
Mine Unit	Current Status of Ground Water Restoration	Requested Alternate Decommissioning Date	**Status**
2	Stability Monitoring	June 1, 2022	Under NRC Review
3	Stability Monitoring	June 1, 2022	Under NRC Review
4	IX / RO Treatment	July 1, 2023	Under NRC Review
5	IX / RO Treatment	October 1, 2025	Under NRC Review
6	IX Treatment	January 1, 2025	Under NRC Review

The request for an alternate decommissioning schedule remains under NRC Review.

While ensuring stability trends in MU3, well P246 (WH7 MU3) exceeded the restoration value for uranium. The value for uranium went from .09 (9/26/14) to 4.04 (3/29/17). Based on a discussion with Nebraska Department of Environmental Quality (NDEQ), MU3 was returned to IX / RO treatment on September 15, 2017 in order to spot treat the well. Spot treatment is currently ongoing in contrast to the requested alternate decommissioning schedule which lists MU3 as in stability monitoring. It is likely that mining solution from MU7 migrated into the area and impacted the water quality in P246. In addition to resuming restoration activities around the well, CBO has implemented a monitoring program around MU2 and MU3 in order to prevent a similar event.

CBO anticipated requesting alternate concentration limits for MU2 and MU3 in the second quarter of 2017 in its request for the alternate decommissioning schedule. However, this submittal has not been made to date, therefore, CBO anticipates that the decommissioning dates for MU2 and MU3 will be June 1, 2023 rather than June 1, 2022 as is listed in the alternate decommissioning schedule.

In MU4, MU5, and MU6, CBO projects that restoration is proceeding on schedule with the requested alternate decommissioning schedule.

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If you have any questions or require further information, please do not hesitate to contact me at (308) 665-2215 ext. 117.

Sincerely,
CAMECO RESOURCES
CROW BUTTE OPERATION

Walter D. Nelson

Walt Nelson
SHEQ Coordinator

Enclosures: As Stated

cc: Deputy Director, Division of Decommissioning
Uranium Recovery and Waste Programs
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Mail Stop T-8F5
11545 Rockville Pike
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CBO – File

ec: CR – Electronic File

2017 SERP Evaluation Index

CAMECO RESOURCES
CROW BUTTE OPERATION

Safety and Environmental Review Panel

2017 SERP Index

SERP Evaluation Number	Date	Action Taken	Modifications to Previous SERP Actions
SERP 17-01	16 March 2017	Rescind SERP 16-02	Closed
SERP 17-02	12 June 2017	Organizational Structure	Closed
SERP 17-03	17 October 2017	New Liner Commercial Evaporation Pond #4	Closed
SERP 17-04	21 November 2017	Revisions to the Approved License Renewal	Closed

CAMECO RESOURCES

SERP 17-01 Evaluation

Crow Butte Resources, Inc.

Safety and Environmental Review Panel

Evaluation Report – SERP #17-01

Figures 1, 2, and 5 in the Evaporation Pond Onsite Inspection Program
Approved December, 1992
Revised February, 1996

March 16, 2017

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met to review SERP 16-02 that made revisions to Figures 1, 2, and 5 in the Evaporation Pond Onsite Inspection Program. Figures 1, 2, and 5 are forms used when conducting the pond inspections.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Mike Thomas	Director SHEQ	Management
Larry Teahon	SHEQ Manager	Regulatory Environment
Bob Tiensvold	Restoration Manager	Wellfield Operations
Tami Dyer	Radiation Safety Officer	Radiation
Tate Hagman	Plant Supervisor	Plant Operations
Sabrina Fox	SHEQ Specialist	Permitting and Document Control

Mr. Thomas is the SERP Chairman. Mr. Teahon was appointed SERP Secretary for this evaluation.

Purpose of SERP Evaluation

The purpose of this evaluation by the CBR SERP was to review SERP 16-02 that made revisions to Figures 1, 2, and 5 in the Evaporation Pond Onsite Inspection Program. Figures 1, 2, and 5 are forms used when conducting the pond inspections.

The Evaporation Pond Onsite Inspection Program was approved by the U.S. Nuclear Regulatory Commission in December 1992. On October 5, 1995, Crow Butte requested an amendment to revise the program which would change the frequency of inspection of the pond underdrain system from daily to weekly. The request was approved and the plan was revised on February 5, 1996.

Figure 1 in the revised program is titled "*Commercial Pond Inspection Form*", and is the form used when conducting the daily, weekly, and monthly inspections requirements for the commercial evaporation ponds. Minor changes were made to this figure making it easier to use when conducting the daily commercial evaporation pond inspections.

Figure 2 in the revised program is titled "*R & D Pond Inspection Form*", and is the form used when conducting the daily, weekly, and monthly inspection requirements for the R & D ponds. Minor changes were made to this figure making it easier to use when conducting the daily R & D evaporation pond inspections.

Figure 5 in the revised program is titled "*Weekly Evaporation Pond Underdrain Analysis*", and is the form used to record the underdrain analysis. Minor changes were made to the figure making it easier to record the freeboard measurements.

Upon further review of the SERP process it has been determined that the panel mistakenly approved changes to License Condition 11.9. Changes to a license condition are outside the scope of the panels' authority and such changes must be made through the amendment process. Therefore it has been determined by the SERP to rescind SERP 16-02.

License Condition 11.9 (November 2014) specifically states that the licensee shall perform and document inspections in accordance with the February 5, 1996, revised Evaporation Pond Onsite Inspection Program. The site will continue to use the figures approved in this program for documentation of the pond inspections.

AUTHORITY OF SERP

License Condition 9.4. *Change, Test and Experiment License Condition*

A) The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in (B) of this condition:

i. Make changes in the facility as described in the license application (as updated);
ii. Make changes in the procedures as described in the license application (as updated); and
iii. Conduct tests of experiments not described in the license application (as updated).

B) The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would:

i. Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);
ii. Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a facility structure, equipment, or monitoring system (SEMS) important to safety previously evaluated in the license application (as updated);
iii. Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application (as updated);
iv. Result in more than a minimal increase in the consequences of a malfunction of an SEMS previously evaluated in the license application (as updated);
v. Create a possibility for an accident of a different type that any previously evaluated in the license application (as updated);
vi. Create a possibility for a malfunction of an SEMS with a different result than previously evaluated in the license application (as updated);
vii. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER), environmental impact statement (EIS), environmental assessment (EA) or the technical evaluation reports (TERs) or other analysis and evaluations for license amendments.
viii. For the purposes of SERP evaluations, SEMS means any SEMS that has been referenced in a staff SER, TER, EA, or EIS and supplements and amendments thereof.

C) Additionally, the licensee must obtain a license amendment unless the change, test, or experiment is consistent with NRC's previous conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or facility SER, TER, and EIS or EA. This would include all supplements and amendments, and TERs, EAs, EISs issued with amendments to this license.

The SERP evaluation was conducted in accordance with the instructions contained in CR-QMP-06, *Managing Change*. The SERP reviewed the supporting documentation and evaluated this information as compared with the requirements of the licensing basis, including the following documents:

- Title 10, Code of Federal Regulations;
- Source Materials License SUA-1534, Renewal dated November 5, 2014;
- *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, Crow Butte Resources, Inc. November 2007;
- *Environmental Assessment for Renewal of Source Materials License No. SUA-1534*, USNRC October 2014;
- *Safety Evaluation Report for Renewal of Source Materials License No. SUA-1534*, USNRC August 2014;
- Technical Evaluation Reports issued in support of Amendments to SUA-1534.

Title 10 Code of Federal Regulations

The proposed change will have no impact on CBR's ability to meet all applicable NRC regulations.

Source Materials License SUA-1534 Requirements (Renewed November 5, 2014)

Amendment 1 to SUA-1534 (November 2014) dated December 5, 2016 was reviewed for changes to the February 5, 1996, revised Evaporation Pond Onsite Inspection Program.

License Condition 11.9 (November 2014) specifically states that the licensee shall perform and document inspections in accordance with the February 5, 1996, revised Evaporation Pond Onsite Inspection Program.

A license amendment request will be made to revise the Evaporation Pond Onsite Inspection Program.

Environmental Assessment

Not applicable to this review.

Financial Surety

Not applicable to this review.

Safety Evaluation Report

Not applicable to this review.

Degradation of Essential Safety or Environmental Commitment

Not applicable to this review.

Based upon this evaluation of the licensing basis, the CBR SERP hereby rescinds SERP 16-02 and the proposed revisions to Figures 1, 2, and 5 in the Evaporation Pond Onsite Inspection Program.

Approved this 16th day of March 2017.

Mike Thomas, Director SHEQ
SERP Chairman

Larry Teahon, SHEQ Manager
SERP Secretary

Bob Tiensvold, Restoration Manager

Tami Dyer, Radiation Safety Officer

Tate Haman, Plant Supervisor

Sabrina Fox, SHEQ Specialist

FIGURE 1

CROW BUTTE MINE COMMERCIAL POND INSPECTION FORM

CHECK ACCORDINGLY: √=OK X=NEEDS ATTENTION OR REPAIRS

FOR THE MONTH OF:		WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5
ENTER DATES ▸						
LOCATION	FREQUENCY					
POND 1-DEPTH	Daily					
EMBANKMENTS	Daily					
N.E. UNDERDRAIN	Weekly					
N.M. UNDERDRAIN	Weekly					
N.W. UNDERDRAIN	Weekly					
S.E. UNDERDRAIN	Weekly					
S.M. UNDERDRAIN	Weekly					
S.W. UNDERDRAIN	Weekly					
POND 3-DEPTH	Daily					
EMBANKMENTS	Daily					
N.E. UNDERDRAIN	Weekly					
N.M. UNDERDRAIN	Weekly					
N.W. UNDERDRAIN	Weekly					
S.E. UNDERDRAIN	Weekly					
S.M. UNDERDRAIN	Weekly					
S.W. UNDERDRAIN	Weekly					
POND 4-DEPTH	Daily					
EMBANKMENTS	Daily					
N.E. UNDERDRAIN	Weekly					
N.M. UNDERDRAIN	Weekly					
N.W. UNDERDRAIN	Weekly					
S.E. UNDERDRAIN	Weekly					
S.M. UNDERDRAIN	Weekly					
S.W. UNDERDRAIN	Weekly					
INSPECTED INLET PIPING	Weekly					
PERIMETER FENCE	Weekly					
OTHER (EXPLAIN ON BACK)						
LEAK DETECTION ANALYSES	Weekly					
INSPECTED LINERS	Weekly					
INSPECTED DIVERSION DITCHES	Monthly					
INSPECTED WASTE PIPELINE	Monthly					
INSPECTOR INITIAL HERE ▸						

- Add 3 inches to the reading of each pond underdrain measurement device to obtain correct water level of the underdrain.

COMMENTS ON BACK

FIGURE 2

CROW BUTTE PROJECT

R & D POND INSPECTION FORM

For The Month of ______________

CHECK ACCORDINGLY: ✓ = OK
X = NEEDS ATTENTION OR REPAIRS

		WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5
ENTER DATE ▶						
LOCATION	FREQUENCY					
CELL 1 (WEST)						
DEPTH	Daily					
EMBANKMENTS	Daily					
UNDERDRAIN (<6")	Weekly					
CELL 2 (EAST)						
DEPTH	Daily					
EMBANKMENTS	Daily					
UNDERDRAIN (<6")	Weekly					
INSPECTED INLET PIPING	Weekly					
PERIMETER FENCE	Weekly					
OTHER (EXPLAIN BELOW)						
INSPECTED LINERS	Weekly					
INSPECTED DIVERSION DITCHES	Monthly					
INSPECTED WASTE PIPELINE	Monthly					
INSPECTOR INITIAL HERE ▶						

OTHER:

FIGURE 5

CROW BUTTE PROJECT

WEEKLY EVAPORATION POND UNDERDRAIN ANALYSIS

COMMERCIAL PONDS		INSTRUMENT READING	TEMPERATURE °C	TEMPERATURE CORRECTION	CONDUCTIVITY umhos/cm	LAB/FIELD MEASUREMENT
NORTH POND 3	POND CONTENTS					
	N.E. UNDERDRAIN					
	N.M. UNDERDRAIN					
	N.W. UNDERDRAIN					
	S.E. UNDERDRAIN					
	S.M. UNDERDRAIN					
	S.W. UNDERDRAIN					
SOUTH POND 4	POND CONTENTS					
	N.E. UNDERDRAIN					
	N.M. UNDERDRAIN					
	N.W. UNDERDRAIN					
	S.E. UNDERDRAIN					
	S.M. UNDERDRAIN					
	S.W. UNDERDRAIN					
POND NUMBER 1	POND CONTENTS					
	N.E. UNDERDRAIN					
	N.M. UNDERDRAIN					
	N.W. UNDERDRAIN					
	S.E. UNDERDRAIN					
	S.M. UNDERDRAIN					
	S.W. UNDERDRAIN					

DATE: ____________________

REMARKS:

ACTION LIMIT EXCEEDED? ____________

SAMPLER/ANALYST: ____________________

FIGURE 5

SERP 17-02 Evaluation

CROW BUTTE RESOURCES, INC.

SAFETY AND ENVIRONMENTAL REVIEW PANEL

Evaluation Report – SERP 17-02

Revisions to the Approved License Renewal (November 2014)

June 14, 2017

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met in accordance with USNRC Source Materials License SUA-1534 to review proposed changes to the approved License Renewal (November 2014). This change reflects a recent organizational change that directly affects the radiation safety department.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Bob Tiensvold	Restoration Manager	Management
Larry Teahon	Manager of SHEQ	Environment and Safety
Tami Dyer	Radiation Safety Officer	Radiation Safety
Tate Hagman	Plant Supervisor	Plant Operations
Sabrina Fox	SHEQ Specialist	Permitting and Document Control

Mr. Tiensvold is the SERP Chairman. Mr. Teahon was appointed SERP Secretary for this evaluation.

PURPOSE OF SERP EVALUATION

The purpose of the SERP evaluation was to review a change made to the Cameco Divisional organizational structure. This evaluation removes the position of Director of Safety, Health, Environment, and Quality (SHEQ). These change affects the direct and indirect reporting requirements for the Radiation Safety Officer.

An organizational change was made that directly and indirectly affected the reporting responsibilities of the radiation safety staff. The direct reporting of the Radiation Safety Officer (RSO) has been changed as shown in the revised Figure 5.1-1 from the approved License Renewal (November 2014). The RSO currently reported to the Director of SHEQ, with the organizational change, the RSO now reports directly to the Restoration Manager. The indirect reporting for the RSO has been changed as shown in the revised Figure 5.1-1 from the approved License Renewal (November 2014). The RSO currently reports indirectly to the President. With the organizational change, the RSO will have an indirect reporting requirement to the General Manager of U.S. Operations.

AUTHORITY OF SERP

License Condition 9.4. <u>Change, Test and Experiment License Condition</u>

A) The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in (B) of this condition:

i. Make changes in the facility as described in the license application (as updated);
ii. Make changes in the procedures as described in the license application (as updated); and
iii. Conduct tests of experiments not described in the license application (as updated).

B) The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would:

i. Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);
ii. Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a facility structure, equipment, or monitoring system (SEMS) important to safety previously evaluated in the license application (as updated);
iii. Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application (as updated);
iv. Result in more than a minimal increase in the consequences of a malfunction of an SEMS previously evaluated in the license application (as updated);
v. Create a possibility for an accident of a different type that any previously evaluated in the license application (as updated);
vi. Create a possibility for a malfunction of an SEMS with a different result than previously evaluated in the license application (as updated);
vii. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER), environmental impact statement (EIS), environmental assessment (EA) or the technical evaluation reports (TERs) or other analysis and evaluations for license amendments.

viii. For the purposes of SERP evaluations, SEMS means any SEMS that has been referenced in a staff SER, TER, EA, or EIS and supplements and amendments thereof.

C) Additionally, the licensee must obtain a license amendment unless the change, test, or experiment is consistent with NRC's previous conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or facility SER, TER, and EIS or EA. This would include all supplements and amendments, and TERs, EAs, EISs issued with amendments to this license.

SERP EVALUATION

The SERP evaluation was conducted in accordance with CR-QMP-06, *Quality Management Manual - Managing Change.* The SERP reviewed the proposed change and evaluated this information as compared with the requirements of the licensing basis, including the following documents:

- Title 10, Code of Federal Regulations;
- Source Materials License SUA-1534, Renewal dated November 5, 2014;
- *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, Crow Butte Resources, Inc. November 2007;
- *Environmental Assessment for Renewal of Source Materials License No. SUA-1534*, USNRC October 2014;
- *Safety Evaluation Report for Renewal of Source Materials License No. SUA-1534*, USNRC August 2014;
- Technical Evaluation Reports issued in support of amendments to SUA-1534.

Title 10 Code of Federal Regulations

The proposed changes to the License Renewal will have no impact on CBR's ability to meet all applicable NRC regulations.

Source Materials License SUA-1534 Requirements

The SERP reviewed the requirements contained in Source Materials License SUA-1534, Amendment 1, dated December 5, 2016. The proposed changes will have no impact on CBR's ability to meet NRC License Conditions.

Environmental Assessment

The SERP reviewed the contents of the Environmental Assessment (EA) prepared by NRC in October 2014 to determine whether the proposed change caused substantive safety or

environmental impacts. The proposed changes to the License Renewal do not conflict with the EA.

Financial Surety

The proposed changes will have no effect on the level of financial surety maintained by CBR.

Safety Evaluation Report

The Safety Evaluation Report (SER) prepared by NRC in August 2014 principally provides the basis for worker safety at Crow Butte. The proposed change applies to the following sections of the SER:

Section 5.1, Corporate Organization and Administrative Procedures, discusses the relationships of the organizational components responsible for operations, radiation safety, and environmental protection at the Crow Butte site. The change did not alter the organizational position of the RSO, in accordance with organizational changes previously approved by the CBR SERP. Therefore, there is no change to the intent of Section 5.1 of the SER.

The SERP determined that the management structure and responsibilities are consistent with recommendations in Regulatory Guide 8.31, Section 2.1, *Health Physics Authorities and Responsibilities.*

Based on this review, the proposed changes to the Renewed License (November 2014) will have no impact on CBR's ability to continue to meet the commitments cited in the SER.

Technical Evaluation Reports

There have been no Technical Evaluation Reports (TERs) prepared by NRC staff since renewal of SUA-1534 on November 5, 2014.

License Renewal Application (LRA) Approved November 5, 2014

The proposed changes revise Section 5.1, Corporate Organization and Administrative Procedures, in the LRA.

Degradation of Essential Safety or Environmental Commitment

SUA-1534 allows CBR to make changes as long as they do not degrade the essential safety or environmental commitments made in the application. The SERP determined that safety

commitments made in the LRA and discussed in the EA and the SER are not affected by this review and will not degrade the safety and environmental commitments.

Conclusion

It was the conclusion of the SERP that the proposed change is allowed by License SUA-1534 and should be approved. The revised pages of the license application required in accordance with License Condition 9.4 were reviewed and approved and are attached to this evaluation.

Approved this 14th day of June 2017:

Bob Tiensvold, Restoration Manager
SERP Chairman

Larry Teahon, Manager of Safety, Health, Environment and Quality
SERP Secretary

Tami Dyer, Radiation Safety Officer

Tate Hagman, Plant Supervisor

Sabrina Fox, SHEQ Specialist

SERP 17-03 Evaluation

CROW BUTTE RESOURCES, INC.

SAFETY AND ENVIRONMENTAL REVIEW PANEL

Evaluation Report – SERP 17-03

New Liner System for Commercial Evaporation Pond #4

October 17, 2017

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met in accordance with USNRC Source Materials License SUA-1534 to review proposed changes to the liner system for Commercial Evaporation Pond #4.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Bob Tiensvold	Restoration Manager	Management
Larry Teahon	Manager of SHEQ	Environment and Safety
Tami Dyer	Radiation Safety Officer	Radiation Safety
Tate Hagman	Plant Supervisor	Plant Operations
Walt Nelson	SHEQ Specialist	Permitting and Document Control

Mr. Tiensvold is the SERP Chairman. Mr. Teahon was appointed SERP Secretary for this evaluation.

PURPOSE OF SERP EVALUATION

The purpose of the SERP evaluation was to review a new liner and leak detection system in Commercial Evaporation Pond #4. The new liner will consist of a 60-mil HDPE geomembrane, over a 200-mil Geonet, over a 60-mil geomembrane. The leak detection system is proposed to be modified to include a single leak detection trench in the middle of the pond floor. The existing liner system will remain in-place and will be removed when final site reclamation commences.

Site History
Commercial Evaporation Pond #4 was constructed in the late summer/fall of 1991. The original pond design and supporting engineering documents were prepared by Western Water Consultant, Inc. (WWC). The existing pond liner system consists of a 60-mil HDPE geomembrane over a 200-mil Geonet, over a 20-mil PVC geomembrane. The pond currently has three leak detection trenches that drain to the north and south ends of the pond. Two leak detection trenches are located along the east and west toes of the pond slopes and one located in the middle of the pond. The leak detection trenches consist of a 4" perforated SDR35 pipe wrapped geotextile and covered with graded sand.

Existing Site Design
Generally, the approximately 15' deep pond is oriented in a north south direction with approximate bottom dimensions of 700'x250'. Interior pond slopes are 2:1 (H;V) and exterior pond slopes are 2.5:1. The floor slopes at a ±2% grade towards the center of the pond. Settlement in the sand drainage layer in the east and west leak detection trenches is visible, with approximately 2-3 inches of standing water present in the settled areas. The leak detection trenches drain from the middle of the pond, to the north and south at 0.50% grade.

Surface Water Control
Stormwater diversion ditches are constructed around the perimeter of the pond in order to intercept runoff from outlying areas. The ditches were sized to convey the six hour Probable Maximum Precipitation (PMP) event of 23 inches. Existing ditches are vegetated with no signs of erosion, thus it has been assumed the ditches, as designed and constructed, are adequate to prevent stormwater from entering the pond.

Hydraulic Capacity
The ponds were originally designed to provide storage and evaporative surface area to evaporate waste water generated by mining and restoration activities. Only 3 of the 5 ponds originally permitted have been constructed. The ponds use several methods to enhance evaporation. Methods have included evaporative misters and dispersion manifolds on the slopes.

Freeboard Capacity
The maximum operating capacity is 5' below the crest of the pond, which provides freeboard to account for reserve operating capacity in the event Pond 1 or 3 need to be pumped for maintenance. Also included in the 5' freeboard is an allowance for wave action as well as direct precipitation from the PMP over the pond area. While Pond 4 is under liner replacement, the maximum operating capacity for Ponds 1 and 3 will be 5' below the crest of the pond.

Slope Protection
Pond 4's geomembrane liner system will provide adequate protection against wave action. The wave run-up from the 2-year wind speed (60 mph) over the longest fetch of the pond

surface results in a wave run-up of 1.1' with an additional freeboard of 1.8' remaining for additional safety.

Geomembrane Liner System
The entire pond, slopes and floor, will be overlain with a double liner system, consisting of a primary (top) liner, leak detection layer, and secondary (bottom) liner. The primary and secondary liners will both be textured (both sides for slope stability and safety) 60-mil HDPE geomembranes. The leak detection layer will consist of a 200-mil bi-planar Geonet. A leak detection trench with washed sand will be located between the primary and secondary liners. A non-woven geotextile will be placed on top of the Geonet within the leak detection trench prior to sand placement to prevent sand migration into the Geonet.

Detailed technical specifications are outlined in the *Engineering Design Report, Pond #4* prepared by Solid Waste Professionals of Wyoming, LLC. This report can be found on file in CBO's library.

AUTHORITY OF SERP

License Condition 9.4. Change, Test and Experiment License Condition

A) The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in (B) of this condition:

i. Make changes in the facility as described in the license application (as updated);
ii. Make changes in the procedures as described in the license application (as updated); and
iii. Conduct tests of experiments not described in the license application (as updated).

B) The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would:

i. Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);
ii. Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a facility structure, equipment, or monitoring system (SEMS) important to safety previously evaluated in the license application (as updated);
iii. Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application (as updated);
iv. Result in more than a minimal increase in the consequences of a malfunction of an SEMS previously evaluated in the license application (as updated);
v. Create a possibility for an accident of a different type that any previously evaluated in the license application (as updated);

vi. Create a possibility for a malfunction of an SEMS with a different result than previously evaluated in the license application (as updated);
vii. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER), environmental impact statement (EIS), environmental assessment (EA) or the technical evaluation reports (TERs) or other analysis and evaluations for license amendments.
viii. For the purposes of SERP evaluations, SEMS means any SEMS that has been referenced in a staff SER, TER, EA, or EIS and supplements and amendments thereof.

C) Additionally, the licensee must obtain a license amendment unless the change, test, or experiment is consistent with NRC's previous conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or facility SER, TER, and EIS or EA. This would include all supplements and amendments, and TERs, EAs, EISs issued with amendments to this license.

SERP EVALUATION

The SERP evaluation was conducted in accordance with CR-QMP-06, *Quality Management Manual - Managing Change.* The SERP reviewed the proposed change and evaluated this information as compared with the requirements of the licensing basis, including the following documents:

- Title 10, Code of Federal Regulations;
- Source Materials License SUA-1534, Renewal dated November 5, 2014;
- *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, Crow Butte Resources, Inc. November 2007;
- *Environmental Assessment for Renewal of Source Materials License No. SUA-1534*, USNRC October 2014;
- *Safety Evaluation Report for Renewal of Source Materials License No. SUA-1534*, USNRC August 2014;
- Technical Evaluation Reports issued in support of amendments to SUA-1534.

<u>Title 10 Code of Federal Regulations</u>

The proposed changes to the License Renewal will have no impact on CBR's ability to meet all applicable NRC regulations.

<u>Source Materials License SUA-1534 Requirements</u>

The SERP reviewed the requirements contained in Source Materials License SUA-1534, Amendment 2, dated October 5, 2017. The proposed changes will have no impact on CBR's ability to meet NRC License Conditions.

Environmental Assessment

The SERP reviewed the contents of the Environmental Assessment (EA) prepared by NRC in October 2014 to determine whether the proposed changes caused substantive safety or environmental impacts. The proposed changes apply to the following section of the EA:

Section 2.2.2.2, Liquid Waste Management – Evaporation Pond. An underdrain system consisting of perforated piping between the primary and secondary liners is installed to monitor for leaks. The underdrains slope gradually to the ends of the ponds where they are connected to a surface monitor pipe.

Based on this review, the proposed changes to the liner in Commercial Evaporation Pond #4 do not conflict with the EA.

Safety Evaluation Report

The Safety Evaluation Report (SER) prepared by NRC in August 2014 principally provides the basis for worker safety at Crow Butte. The proposed change applies to the following section of the SER:

Section 4.2.3.1.1, Disposal Options. CBO has three commercial and two R&D evaporation ponds which comply with the design, installation, and operation criteria specified in NRC Regulatory Guide 3.11.

Section 4.2.3.1.4 Monitoring of the Disposal Options. The three commercial ponds are constructed with dual liners with a leak detection system (underdrain system) in between liners. During the construction of the additional liner and leak detection system, CBO will follow the monitoring requirements outlined in the *"Evaporation Pond Onsite Inspection Program".* (License Amendment #2, October 5, 2017).

Based on this review, the proposed changes to Commercial Evaporation Pond #4 will have no impact on CBR's ability to continue to meet the commitments cited in the SER.

Technical Evaluation Reports

The SERP reviewed the Technical Evaluation Reports (TERs) prepared by NRC staff to support amendments made to SUA-1534 since renewal in November 2014.

CBO staff reviewed the TER dated October 5, 2017 and will follow the commitments made for a liner replacement in the revised *"Evaporation Pond Onsite Inspection Program"*.

License Renewal Application (LRA) Approved November 5, 2014

The proposed changes do not impact commitments made in *Section 4.2.1.3, Liquid Waste Disposal*.

Financial Surety

License Condition 9.5 requires the licensee to submit 90 days prior to the beginning of construction an updated estimate to cover the expansion or change. By letter dated May 31, 2017, CBO submitted an updated surety estimate to include the additional liner and underdrain materials.

Degradation of Essential Safety or Environmental Commitment

SUA-1534 allows CBR to make changes as long as they do not degrade the essential safety or environmental commitments made in the application. The SERP determined that safety commitments made in the LRA and discussed in the EA and the SER are not affected by this review and will not degrade the safety and environmental commitments.

Conclusion

It was the conclusion of the SERP that the proposed change is allowed by License SUA-1534 and should be approved.

Approved this 17th day of October 2017:

Bob Tiensvold

Bob Tiensvold, Restoration Manager
SERP Chairman

Larry Teahon

Larry Teahon, Manager of Safety, Health, Environment and Quality
SERP Secretary

Tami Dyer

Tami Dyer, Radiation Safety Officer

Tate Hagman

Tate Hagman, Plant Supervisor

Walter D. Nelson

Walt Nelson, SHEQ Specialist

SERP 17-04 Evaluation

CROW BUTTE RESOURCES, INC.

SAFETY AND ENVIRONMENTAL REVIEW PANEL

Evaluation Report – SERP 17-04

Revisions to the Approved License Renewal (November 2014)

November 21, 2017

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met in accordance with USNRC Source Materials License SUA-1534 to review proposed organizational changes that impact the approved License Renewal (November 2014), the site Quality Assurance Program approved by License Amendment #2 (October 2017), and the Security Plan approved by NRC Safety Evaluation Report dated May 27, 2015 (ML15131A475).

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Bob Tiensvold	Restoration Manager	Management
Walt Nelson	SHEQ Coordinator	Environment and Safety
Tami Dyer	Radiation Safety Officer	Radiation Safety
Tate Hagman	Plant Supervisor	Plant Operations

Mr. Tiensvold is the SERP Chairman. Mr. Nelson was appointed SERP Secretary for this evaluation.

PURPOSE OF SERP EVALUATION

The purpose of the SERP evaluation was to review changes made to the Crow Butte Resources, Inc. organizational structure. This change removes the positions of Manager, Safety, Health, Environment, and Quality and SHEQ Specialist. The responsibilities of these positions will be assigned to a new position, SHEQ Coordinator. Also, the Safety Technician will report to the Restoration Manager. These changes affect the assignment

of roles and responsibilities as described in the approved License Renewal (November 2014), the Quality Assurance Program (October 2017) and the Security Plan (May 2015).

AUTHORITY OF SERP

License Condition 9.4. Change, Test and Experiment License Condition

A) The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in (B) of this condition:

i. Make changes in the facility as described in the license application (as updated);
ii. Make changes in the procedures as described in the license application (as updated); and
iii. Conduct tests or experiments not described in the license application (as updated).

B) The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would:

i. Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);
ii. Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a facility structure, equipment, or monitoring system (SEMS) important to safety previously evaluated in the license application (as updated);
iii. Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application (as updated);
iv. Result in more than a minimal increase in the consequences of a malfunction of an SEMS previously evaluated in the license application (as updated);
v. Create a possibility for an accident of a different type that any previously evaluated in the license application (as updated);
vi. Create a possibility for a malfunction of an SEMS with a different result than previously evaluated in the license application (as updated);
vii. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER), environmental impact statement (EIS), environmental assessment (EA) or the technical evaluation reports (TERs) or other analysis and evaluations for license amendments.
viii. For the purposes of SERP evaluations, SEMS means any SEMS that has been referenced in a staff SER, TER, EA, or EIS and supplements and amendments thereof.

C) Additionally, the licensee must obtain a license amendment unless the change, test, or experiment is consistent with NRC's previous conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations

analyzed and selected in the site or facility SER, TER, and EIS or EA. This would include all supplements and amendments, and TERs, EAs, EISs issued with amendments to this license.

SERP EVALUATION

The SERP evaluation was conducted in accordance with CR-QMP-06, *Quality Management Manual - Managing Change.* The SERP reviewed the proposed change and evaluated this information as compared with the requirements of the licensing basis, including the following documents:

- Title 10, Code of Federal Regulations;
- Source Materials License SUA-1534, Renewal dated November 5, 2014;
- *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, Crow Butte Resources, Inc. November 2007;
- *Environmental Assessment for Renewal of Source Materials License No. SUA-1534*, USNRC October 2014;
- *Safety Evaluation Report for Renewal of Source Materials License No. SUA-1534*, USNRC August 2014;
- Technical Evaluation Reports issued in support of amendments to SUA-1534.

Title 10 Code of Federal Regulations

The proposed changes to the License Renewal will have no impact on CBR's ability to meet all applicable NRC regulations.

Source Materials License SUA-1534 Requirements

The SERP reviewed the requirements contained in Source Materials License SUA-1534, Amendment 2, dated October 5, 2017. The proposed changes will have no impact on CBR's ability to meet NRC License Conditions.

Environmental Assessment

The SERP reviewed the contents of the Environmental Assessment (EA) prepared by NRC in October 2014 to determine whether the proposed change caused substantive safety or environmental impacts. The proposed changes to the License Renewal do not conflict with the EA.

Financial Surety

The proposed changes will have no effect on the level of financial surety maintained by CBR.

Safety Evaluation Report

The Safety Evaluation Report (SER) prepared by NRC in August 2014 principally provides the basis for worker safety at Crow Butte. The proposed organizational changes do not conflict with the SER.

Technical Evaluation Reports

The SERP reviewed the Technical Evaluation Reports (TERs) prepared by NRC staff to support amendments made to SUA-1534 since renewal in November 2014.

CBO staff reviewed the TER dated October 5, 2017 which in part approves the Quality Assurance Program. This organizational change will cause the roles and responsibilities assigned to the Manager, Safety, Health, Environment, and Quality and the roles and responsibilities assigned to the SHEQ Specialist to shift to the SHEQ Coordinator. The Quality Assurance Program will be revised to reflect the changes. Section 2: Page 1 of the approved Quality Assurance Program states in part that "Organizational changes will be maintained through the Safety Environmental Review Panel (SERP) process".

License Renewal Application (LRA) Approved November 5, 2014

The proposed changes revise Section 3.3, Instrumentation and Control, Section 5.1, Corporate Organization and Administrative Procedures, Section 5.4, Management Audit and Inspection Program, and Section 5.7, Security in the LRA.

Degradation of Essential Safety or Environmental Commitment

SUA-1534 allows CBR to make changes as long as they do not degrade the essential safety or environmental commitments made in the application. The SERP determined that safety commitments made in the LRA and discussed in the EA and the SER are not affected by this change and will not degrade the safety and environmental commitments.

Conclusion

It was the conclusion of the SERP that the proposed change is allowed by License SUA-1534 and should be approved. The revised pages of the license application required in accordance with License Condition 9.4 were reviewed and approved and are attached to this evaluation. For simplicity, the revised Security Plan and the revised Quality Assurance Program have been reprinted in their entirety.

Approved this 21st day of November 2017:

Bob Tiensvold, Restoration Manager
SERP Chairman

Walt Nelson, SHEQ Coordinator
SERP Secretary

Tami Dyer, Radiation Safety Officer

Tate Hagman, Plant Supervisor

CAMECO RESOURCES

License Renewal Application

Affected Pages (highlighted version)

2017 SERP Actions

**Proposed License Renewal Application
Page Changes**

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5 OPERATIONS

CBR operates a commercial-scale in-situ leach uranium mine (the Crow Butte Project) near Crawford, Nebraska. CBR maintains a headquarters in Casper, Wyoming, where site-licensing actions originate. All CBR operations, including the Crow Butte Project operations, are conducted in conformance with applicable laws, regulations, and requirements of the various regulatory agencies. The responsibilities described below have been designed to both ensure compliance and further implement CBR's policy for providing a safe working environment with cost-effective incorporation of the philosophy of maintaining radiation exposures as low as is reasonably achievable (ALARA).

5.1 CORPORATE ORGANIZATION/ADMINISTRATIVE PROCEDURES

CBR will maintain a performance-based approach to the management of the environment and employee health and safety including radiation safety. The Safety, Health, Environment, and Quality Management System (SHEQMS) encompasses licensing, compliance, environmental monitoring, industrial hygiene, and health physics programs under one umbrella, and it includes involvement for all employees from the individual worker to senior management. This SHEQMS will allow CBR to operate efficiently and maintain an effective environment, health, and safety program.

Figure 5.1-1 is a partial organization chart for CBR with respect to the operation of the Crow Butte Uranium Project and associated operations and represents the management levels that play a key part in the SHEQMS Program. The personnel identified are responsible for the development, review, approval, implementation, and adherence to operating procedures, radiation safety programs, environmental and groundwater monitoring programs, as well as routine and non-routine maintenance activities. These individuals may also serve a functional part of the Safety and Environmental Review Panel (SERP) described under **Section 5.3.3**.

Specific responsibilities of the organization are provided below.

5.1.1 Board of Directors

The CBR Board of Directors has the ultimate responsibility and authority for radiation safety and environmental compliance for CBR. The Board of Directors sets corporate policy and provides procedural guidance in these areas. The Board of Directors provides operational direction to the President of CBR.

5.1.2 President

The President is responsible for interpreting and acting upon the Board of Directors' policy and procedural decisions. The President directly supervises the General Manager of US Operations. The President is empowered by the Board of Directors to have the

responsibility and authority for the radiation safety and environmental compliance programs. The President is responsible for ensuring that the operations staff is complying with all applicable regulations and permit/license conditions through direct supervision of the General Manager of US Operations.

5.1.3 General Manager of US Operations

The General Manager of US Operations is responsible for managing all US Operations. The General Manager of US Operations is responsible for ensuring that Crow Butte personnel comply with Industrial Safety, Radiation Safety, Environmental Protection Programs, and all relevant state and federal regulations. The General Manager of US Operations has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The General Manager of US Operations reports directly to the President.

~~5.1.4 Director of Safety, Health, Environment and Quality~~

~~The Director of Safety, Health, Environment and Quality reports directly to the President and is responsible for ensuring the corporate personnel comply with industrial safety, radiation safety, and environmental protection programs as stated in the SHEQ Management System. The Director of Safety, Health, Environment and Quality is also responsible for company compliance with all regulatory license conditions/stipulations, regulations and reporting requirements. The Director of Safety, Health, Environment and Quality has the responsibility and authority to terminate immediately any activity that is determined to be a threat to employees or public health, the environment, or potentially a violation of state or federal regulations as indicated in reports from the Manager of Safety, Health, Environment and Quality or the RSO.~~

~~5.1.5~~5.1.4 Restoration Manager

The Restoration Manager is responsible for all uranium production and restoration activities at the project site. The Restoration Manager is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with operations and restoration. The Restoration Manager is authorized to immediately implement any action to correct or prevent hazards. The Restoration Manager has the responsibility and the authority to suspend, postpone, or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The Restoration Manager cannot unilaterally override a decision for suspension, postponement, or modification if that decision is made by the Manager of Safety, Health, Environment and Quality, or the RSO. The Restoration Manager reports directly to the General Manager of US Operations.

~~5.1.6~~5.1.5 Manager of Safety Health Environment and Quality

The Manager of Safety, Health, Environment and Quality is responsible for all health and safety, and environmental programs as stated in the SHEQMS Program and for ensuring that CBR complies with all applicable regulatory requirements. The Manager of Safety, Health, Environment and Quality reports directly to the ~~Director of SHEQ~~Restoration Manager. This position assists in the development and review of radiological and environmental sampling and analysis procedures and is responsible for routine auditing of the programs. The Manager of Safety, Health, Environment and Quality has no production-related responsibilities. The Manager of Safety, Health, Environment and Quality also has the responsibility and authority to suspend, postpone, or modify any activity that is determined to be a threat to employees, public health, the environment or potentially a violation of state or federal regulations.

~~5.1.7~~5.1.6 Plant Supervisor

The Plant Supervisor supervises plant operations, including the safe and efficient recovery and processing of uranium oxide while staying within regulatory and technical constraints. The Plant Supervisor is responsible for carrying out any procedures or actions implemented by the Restoration Manager, Manager of SHEQ, or the RSO to correct or prevent radiation safety hazards in the plant. The RSO and the Plant Supervisor or the RSO and Restoration Manager are responsible for conducting weekly inspections of all facility areas to observe general radiation control practices and review required changes in procedures and equipment. The Plant Supervisor reports directly to the Restoration Manager.

~~5.1.8~~5.1.7 Radiation Safety Officer

The RSO is responsible for the development, administration, and enforcement of all radiation safety programs. The RSO is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate radiation safety hazards and/or maintain regulatory compliance. The RSO is responsible for the implementation of all on-site environmental programs including emergency procedures. The RSO inspects facilities to verify compliance with all applicable requirements in the areas of radiological health and safety. The RSO works closely with all supervisory personnel to ensure that established programs are maintained. The RSO is also responsible for the collection and interpretation of employee exposure-related monitoring including data from radiological safety. The RSO makes recommendations to improvement any and all radiological safety-related controls. The RSO has no production-related responsibilities. The RSO reports directly to the ~~Director of SHEQ~~Restoration Manager and has a secondary reporting requirement to the ~~President~~General Manager of US Operations.

~~5.1.9~~5.1.8 Health Physics Technician

The Health Physics Technician (HPT) assists the RSO with the implementation of the radiological and industrial safety programs. The HPT is responsible for the orderly collection and interpretation of all monitoring data, to include data from radiological safety and environmental programs. The HPT reports directly to the RSO.

~~5.1.10~~5.1.9 SHEQ Specialist

The SHEQ Specialist assists in the development and submittal of regulatory permits and license applications. Provides analysis and guidance in the areas of Safety, Health, Environment and Quality and is responsible for assisting site management with coordination of the corrective and preventative action process. The SHEQ Specialist maintains and updates documents associated with the activities relating to the SHEQ system. The SHEQ Specialist reports directly to the SHEQ Manager.

~~5.1.11~~5.1.10 Lab Foreman

The Lab Foreman has direct oversight of the on-site analytical laboratory including implementing laboratory quality assurance procedures. The Lab Foreman is responsible for carrying out any procedures or actions implemented by the Restoration Manager, Manager of SHEQ, or the RSO to correct or prevent radiation safety hazards in the laboratory. The Lab Foreman reports directly to the SHEQ Manager.

~~5.1.12~~5.1.11 Safety Supervisor/Technician

The Safety Supervisor/Technician is responsible for the non-radiation-related health and safety programs. The Safety Supervisor/Technician is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate safety hazards and/or maintain regulatory compliance. Responsibilities include the development and implementation of health and safety programs in compliance with Occupational Safety and Health Administration (OSHA) regulations. Responsibilities of the Safety Supervisor/Technician include development of industrial safety and health programs and procedures, coordination with the RSO where industrial and radiological safety concerns are interrelated, safety and health training of new and existing employees, and the maintenance of appropriate records to document compliance with regulations. The Safety Supervisor/Technician may be a qualified HPT and may function in that capacity when needed. The Safety Supervisor/Technician reports directly to the Manager of Safety, Heath, Environment and Quality.

~~5.1.13~~5.1.12 Qualified Designated Operator

The qualified Designated Operator is responsible for performing daily inspection in the occasional absence of the RSO and the HPT. A qualified Designated Operator will meet the minimum qualifications and perform only those duties as outline in Section 5.6.6.

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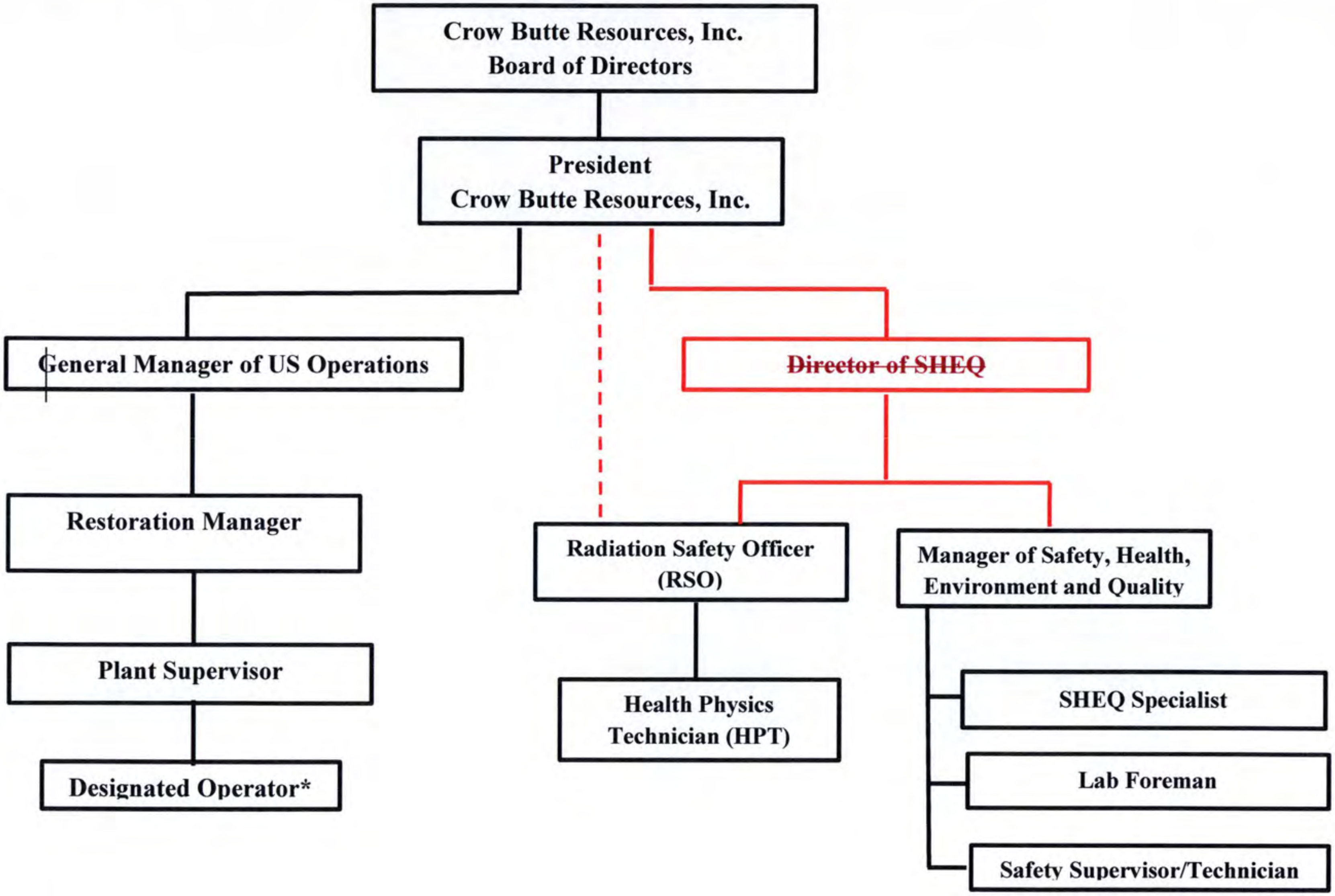
Figure 5.1-1: Crow Butte Resources Organizational Chart



*Qualifications for Designated Operator described in SUA-1534, Section 5.6.6 (Nov. 2014)

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FIGURES

TABLES

APPENDIX

3-33

- Elution/precipitation
- Dewatering/drying

The ion exchange system consists of eight up-flow and six down-flow ion exchange columns. The uranium loading process is continuous but the elution process is operated on a batch process. The loaded up-flow columns are eluted in place; the down-flow loaded resin is moved across a screen deck for washing before being eluted in a separate elution column.

The up-flow injection filtration system consists of backwashable filters, with an option of installing polishing filters downstream. The down-flow system utilizes screens to prevent resin loss, and the resin itself acts as an injection filter, with an option of installing polishing filters downstream.

The up-flow lixiviant injection system consists of the injection surge tanks and the injection pumps. The tanks are fabricated out of FRP, and the injection pumps are centrifugal. The down-flow injection system depends on the down-hole submersible pumps to push through the sealed down-flow system and reinject the lixiviant. There is an option for in-line centrifugal booster pumps as needed to maintain pressures.

The elution/precipitation circuit consists of the barren eluant tanks and the acidizer/precipitator tanks. The barren eluant tanks and the precipitation tanks are constructed of FRP. The eluant is pumped from the barren eluant tanks to the ion exchange column that is in the elution mode. After the resin is eluted, the pregnant eluant is transferred to the acidizer/precipitator where the uranium is precipitated.

The areas in the processing plant where fumes or gases are generated are discussed in **Section 5.8**. Process tanks are vented for radon, O_2 and CO_2 removal. Building ventilation in the process equipment area is accomplished by the use of an exhaust system. This exhaust system draws fresh air in from ventilators and helps sweep radon, which can accumulate near the floor of the building, out to the atmosphere.

3.2.2 Chemical Storage Facilities

Chemical storage facilities at the CBR Facility include both hazardous and non-hazardous material storage areas. Bulk hazardous materials, which have the potential to impact radiological safety, are stored outside and segregated from areas where licensed materials are stored. Other non-hazardous bulk process chemicals (e.g., sodium carbonate) that do not have the potential to impact radiological safety are stored in a designated area.

3.2.2.1 Process Related Chemicals

Process-related chemicals stored in bulk at the CBR Facility include carbon dioxide, hydrogen peroxide, oxygen, sodium hydroxide, hydrochloric acid, sodium carbonate, sodium bicarbonate, sodium chloride and sodium sulfide. Operating procedures, safety precautions and hazards associated with the handling and use of process-related chemicals are discussed in CBR's SHEQMS Volume V Industrial Safety Manual. CBR maintains current material safety data sheets (MSDSs) for each of the process-related chemicals onsite, and these sheets are available upon request.

- **Carbon Dioxide** - Carbon dioxide is stored at the CBR Facility where it is added to the lixiviant. Carbon dioxide serves as a pH buffer to keep oxidized uranium carbonate in solution.

  Carbon dioxide is a suffocating agent and may cause nausea, respiratory problems and asphyxia in a confined area. It is a slightly toxic, nonflammable, colorless and odorless gas, with a slightly pungent taste. It is soluble in water, ethanol and acetone. It is an acidic oxide and reacts with water to form carbonic acid, and it reacts with alkalis to produce carbonates and bicarbonates.

- **Hydrogen Peroxide** – Hydrogen peroxide (50% aqueous solution) is stored at the CBR Facility where it is added to the lixiviant. It serves as an oxidant used during the precipitation phase of uranium and can be used in place of oxygen. This phase of the process is described in Section 3.1.4.3. Hydrogen peroxide is a clear, colorless liquid that is soluble in water. It is a strong oxidizer capable of oxidizing uranium mineralization and killing some forms of well fouling bacteria. It can be corrosive to eyes, nose, throat and lungs, may cause skin irritation, and may cause irreversible tissue damage to the eyes including blindness. Hydrogen peroxide is not a stable compound; and as it decomposes, it generates oxygen and water, which cause an increase in the volume of product present. The storage container is vented to allow gaseous oxygen to escape as the hydrogen peroxide breaks down. The chemical is not allowed to become trapped in a closed vessel, valve or pipe, and this is accomplished through venting.

- **Oxygen** - Oxygen is also typically stored at the plant, or within wellfield areas, where it is centrally located for addition to the injection stream in each wellhouse. Since oxygen readily supports combustion, fire and explosion are the principal hazards that must be controlled. The oxygen storage facility is located a safe distance from the CBR plant and other chemical storage areas for isolation. The storage facility has been designed to meet industry standards in NFPA-50 (NFPA 1996). Oxygen is added to the lixiviant used for extraction of uranium forming UO_3.

  Oxygen service pipelines and components must be clean of oil and grease since gaseous oxygen will cause these substances to burn with explosive violence if

ignited. All components intended for use with the oxygen distribution system are properly cleaned using recommended methods in CGA G-4.1 (CGA 2000). The design and installation of oxygen distribution systems is based on CGA-4.4 (CGA 1993).

The design locations of the carbon dioxide and oxygen storage tanks are shown on **Figure 3.2-1**.

- **Sodium Hydroxide** – Sodium hydroxide is used at the CBR Facility for pH adjustment during the uranium precipitation phase. The sodium hydroxide raises the pH to a level conducive for precipitating pure crystals. This phase of the process is described in Section 3.1.4.3. Sodium hydroxide is in the form of a fine granular, nonflammable, solid or a whitish liquid. It is stable under ordinary conditions of use and storage. It is very hygroscopic, and can slowly pick up moisture from the air and react with carbon dioxide from air to form sodium carbonate. Sodium hydroxide is a strong irritant, with effects from inhalation of dust or mist varying from mild irritation to serious damage of the upper respiratory tract, depending on the severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Severe pneumonitis may also occur.

- **Hydrochloric Acid** – Hydrochloric acid (HCl) is used for pH adjustment during the uranium precipitation phase at the CBR Facility. The HCl acidifies the pregnant eluant in order to destroy the uranyl carbonate complex ion. HCl is highly corrosive, and the inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and can cause pulmonary edema, circulatory failure and death. It is very hazardous in with regard to skin contact (corrosive, irritant and permeator), eye contact (irritant, corrosive) and ingestion. It is a colorless liquid with a pungent odor, and is infinitely soluble.

  As part of the SHEQMS Program, a risk assessment was completed to recognize potential hazards and risks associated with chemical storage facilities (and other processes), and to mitigate those risks to acceptable levels. The risk assessment process identified HCl as the most hazardous chemical with the greatest potential for impacts to chemical and radiological safety. The HCl storage and distribution system at the Central Plant (**Figure 3.2-1**) has a maximum capacity of approximately 6,000 gallons. Strict unloading procedures are utilized to ensure that safety controls are in place during the transfer of HCl. Process safety controls are also in place at the Central Plant where HCl is added to the precipitation circuit. Since precipitation is not performed at CBR satellite facilities, the use and storage of concentrated HCl will not be necessary in these areas.

- **Sodium Carbonate** – Sodium carbonate is stored at the CBR Facility and, when combined with CO_2 to form sodium bicarbonate, keeps oxidized uranium in solution. Sodium carbonate is used with carbon dioxide in oxidizing the uranium. Sodium carbonate is only slightly toxic, but can be very irritating to the eyes and skin, and poses as an inhalation hazard when it is in its salt stage (dust inhalation) or from small leaks in the form of a spray. Symptoms from excessive inhalation of dust may include coughing and difficult breathing. Its appearance is a white powder or granules, and it is stable under ordinary conditions of use and storage. It is hygroscopic and readily absorbs moisture from the air. Solutions are strong bases.
- **Sodium Bicarbonate** – Sodium Bicarbonate is stored at the CBR Facility and is used to keep oxidized uranium in solution. Sodium Bicarbonate is also used in the resin regeneration process. Sodium bicarbonate can be used without carbon dioxide in oxidizing the uranium. CBR maintains the option of using sodium carbonate/carbon dioxide or sodium bicarbonate in the oxidization of uranium. Inhalation of dust may cause irritation to the respiratory tract, and excessive contact is known to cause damage to the nasal septum. Symptoms from excessive inhalation of dust may include coughing and difficulty in breathing. Its appearance is in the form of a white powder or granules, and it is stable under ordinary conditions of use and storage. It is hygroscopic and readily absorbs moisture from the air. Solutions are strong bases.
- **Sodium Chloride** – Sodium chloride is stored at the CBR Facility and is used to regenerate/recycle the resin for further use in uranium extraction. Sodium chloride can be very irritating to the eyes and the skin and may cause mild irritation to the respiratory tract. However, it is not believed to present a significant hazard to health. Its appearance is in the form of crystals or white powder, odorless, and it is stable under ordinary conditions of storage and use. It is hygroscopic.
- **Sodium Sulfide** – Sodium sulfide is currently used at the existing licensed area during groundwater restoration activities as a chemical reductant. The use of sodium sulfide in groundwater restoration decreases the solubility of various heavy metals. To minimize potential impacts to radiological safety, this material is stored outside of process areas.

  The sodium sulfide consists of a dry, flaked product and is typically purchased on pallets of 55-pound bags or super sacks of 1,000 pounds. The bulk inventory is stored outside of process areas in a cool, dry, clean environment to prevent contact with any acid, oxidizer, or other material that may react with the product.

  Both solid and liquid sodium sulfide can be hazardous and toxic. The chemical, which becomes alkaline when moist, is corrosive. Protective clothing and PPE

should be worn to prevent any eye or skin contact, inhalation or ingestion. Contact lenses must not be worn when handling this material. Any contact with water, acids, oxidizers or heat can produce hydrogen sulfide gas, which is both flammable and toxic. Exposure to this gas, which, in low concentrations smells of rotten eggs, can result in loss of the sense of smell when present in concentrations greater than 100 ppm. At higher concentrations, hydrogen sulfide can cause paralysis and death. Fine sodium sulfide dust/air mixtures can also be explosive in confined spaces.

If the correct operating procedures are followed, the risk of generating hydrogen sulfide gas while mixing this reagent is extremely low. The saturation tank at CBR is vented outside the building as a precaution. During normal operating activities, Safety, Health, Environment and Quality (SHEQ) personnel may monitor chemical makeup activities with a portable H_2S monitor, if required. Whenever possible, the chemical is mixed during the day shift, Monday through Friday.

None of the hazardous chemicals used at the Crow Butte Project are covered under the USEPA's Risk Management Program (RMP) regulations. The RMP regulations require certain actions by covered facilities to prevent accidental releases of hazardous chemicals and minimize potential impacts to the public and environment. These actions include measures such as accidental release modeling, documentation of safety information, hazard reviews, operating procedures, safety training, and emergency response preparedness.

3.2.2.2 Non-Process Related Chemicals

Non-process related chemicals that are stored at the CBR Facility include petroleum (gasoline, diesel) and propane. Due to the flammable and/or combustible properties of these materials, all bulk quantities are stored outside of process areas at the satellite plant. All gasoline and diesel storage tanks are located above ground and within secondary containment structures to meet USEPA requirements.

3.3 INSTRUMENTATION AND CONTROL

The basic control system at the Crow Butte site is built around an Allen-Bradley SCADA (Sequential Control and Data Acquisition) System. This system allows for extensive monitoring of all wellfield and recovery plant operations. The system is monitored twenty four hours per day, seven days per week by control room operators. The operators rely on visual and audible alarms from a variety of systems to control mine operations. Examples include but are not limited to power failures, pressure exceedances, flow disruptions and the presence of liquids in the well houses.

The Allen-Bradley system consists of a series of menus which allows the plant operator to monitor and control a variety of systems and parameters. In addition, each wellfield house contains its own processor, which allows it to operate independent of the main computer. All critical equipment is equipped with uninterrupted power supply systems with a 30-minute supply in the event of a power failure.

Through this system, not only can the plant operators monitor and control every aspect of the operation on a real time basis, but management can review historical data to develop trend analysis for production operations. This not only ensures an efficient operation, but allows Crow Butte personnel to anticipate problem areas, and to remain in compliance with appropriate regulatory requirements.

Wellfield instrumentation is provided to measure total production and injection flow. In addition, instrumentation is provided to indicate the pressure that is being applied to the injection wells. Wellfield houses are equipped with wet alarms to detect the presence of liquids in the wellfield house sumps. The deep injection well is also equipped with a variety of sensors to monitor its status.

Instrumentation is provided to monitor the total flow into the plant, the total injection flow leaving the plant, and the total waste flow leaving the plant. Instrumentation is provided on the plant injection manifold to record an alarm in the event of any pressure loss that might indicate a leak or rupture in the injection system. The injection pumps are equipped with pressure reducing valves so that they are incapable of producing pressures high enough to exceed the design pressure of the injection lines or the maximum pressure to be applied to the injection wells. During power failures, overpressuring of wells is not possible as all pump systems are shut down.

In the process areas, tank levels are measured in chemical storage tanks as well as process tanks. A number of different monitors are in place for the dryer system, and drum logging is automated.

Handheld radiation detection instruments and portable samplers are used to monitor radiological conditions at the CBR facility. Specifications for this equipment are included in CBR's SHEQMS P*rogram Volume IV, Health Physics Manual,* and are discussed in further detail in Section 5. The location of monitoring points, monitoring procedures, and monitoring frequencies for in-plant radiation safety is also discussed in Section 5.

The types of health physics instrumentation that are used at the existing CBR facility include the following:

Air Sampling Equipment

- Eberline RAS-1 or Aircon 2 samplers (0-100 liters per minute (lpm) or equivalent

Calibrated semiannually or after repair-on site with a primary standard instrument or a properly calibrated secondary standard instrument

- BDX II or SKC lapel samplers (0-5 lpm) or equivalent

Calibrated daily before each use-on site with a primary standard instrument or a properly calibrated secondary standard instrument

External Radiation Equipment

- Ludlum Model 19 Gamma Meter (μR/hr) or equivalent
- Ludlum Model 3 Gamma Meter with Ludlum Model 44-38 G-M detector (mR/hr) or equivalent
- Ludlum Model 2221 Ratemeter/Scaler with a Ludlum Model 44-10 NaI detector (counts per minute [cpm]) or equivalent

Calibrated annually or after repair-manufacturer or qualified accredited vendor

Surface Contamination Equipment

- Ludlum Model 2241 scaler or a Ludlum Model 12 Ratemeter with a Model 43-65 or Model 43-5 alpha scintillation probe or equivalent (Total Alpha)
- Ludlum Model 177 Ratemeter with a Ludlum Model 43-5 alpha scintillation probe or equivalent (Personnel Contamination)
- Ludlum Model 2000 Scaler or Model 2200 Scaler with an Eberline SAC-R5 or Ludlum Model 43-10 alpha scintillation sample counter or equivalent (Removable Alpha, Radon Daughters, Airborne Radioactivity)

Instruments are calibrated annually or at a frequency recommended by the manufacturer, whichever is more frequent. Repairs are by the manufacturer or by a qualified accredited vendor, and the instrument is calibrated following such repair. The calibration vendor provides the as-found calibration condition of each instrument. If greater than 10% of the instruments are out of calibration when received by the calibration vendor, consideration is given to increasing the calibration frequency.

The manufacturer or a qualified accredited vendor calibrates portable survey instruments, counter/scalers, mass flow meters and/or dry cell calibrators, and calibration sources. Calibration is performed as recommended in ANSI N323 and ANSI N323A. The ANSI standard requires that radiation detection instruments are performance tested on an annual basis to verify that they continue to meet operational and design requirements. Instruments must be tested for range, sensitivity, linearity, detection limit, and response to overload. The specific calibration requirements for various types of instruments are discussed in CBR's SHEQMS Program *Volume IV, Health Physics Manual.*

Regulatory Guide 8.30 specifies requirements for routine maintenance and calibration of radiological survey instruments. Regulatory Guide 8.30 references the standards contained in ANSI N323-1978, *Radiation Protection Instrumentation Test and Calibration*. ANSI is in the process of a major revision of this Standard that will result in three separate Standards that apply to radiological instrumentation. The first revision, ANSI-N323A-1997, *Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments*, was incorporated in this Chapter. When conflicts arise between NRC Regulatory Guide 8.30 and the ANSI Standard, the Regulatory Guide recommendations are followed.

Calibration vendors provide a certificate of calibration for all instruments. These calibration certificates are maintained by the RSO on file for that instrument. Records of repair completed by the calibration vendor are also maintained in the instrument file.

Documentation of calibration of air samplers performed on site are be maintained. This documentation is maintained by the RSO in the sampler file.

Record of instrument checks, including the daily checks and initial checks, will be maintained in a format determined by the RSO. These records will be readily available and provided in a format that will allow the RSO to review the records for the types of potential problems (e.g., background drift in a continuous direction, battery check that does not respond, ratemeter that does not zero and alpha background rates greater than 0.5 cpm).

All records of instrument calibration and checks will be retained until NRC License termination. The RSO will be responsible for record retention.

Details as to calibration, functional tests, procedures and recordkeeping/retention are discussed in CBR's SHEQMS Program *Volume IV, Health Physics Manual*.

Contract Laboratory Quality Control

CBR's radiological quality assurance program is discussed in Section 2.9 of the SHEQMS Program *Volume IV, Health Physics Manual*. Quality control efforts are implemented to ensure that radiological data provided by contract laboratories are accurate and reliable. CBR conducts periodic audits of its QA/QC program as it relates to the health physics program; these audits are reviewed by facility and corporate management.

One purpose of the quality control program is to determine the precision and accuracy of the monitoring processes. Quality control sampling includes replicate samples to determine precision, spiked samples with a known concentration to determine accuracy, and blank samples to detect and measure contamination of analytical samples. NRC

Regulatory Guide 4.15, *Quality Assurance for Radioloigcal Monitoring Programs (Normal Operations) – Effluent Streams and the Environment*, describes requirements for these types of quality control samples. Generally, NRC recommends that 5 to 10% of the analytical load at an environmental laboratory should be quality control samples. The contract laboratory quality assurance program is required to describe the program implemented to meet these requirements. Each qualified laboratory is required to have an acceptable QA/QC program in place. The ~~Manager of Health Safety and Environmental Affairs~~SHEQ Coordinator or designee reviews the vendors QA/QC program and is responsible for approving the use of the vendor. Qualified laboratories are required to submit verification of an appropriate NRC License and certification(s) to meet NRC requirements.

3.3.1 References

Compressed Gas Association (CGA). 1993. CGA G-4.4, *Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems.*

Compressed Gas Association (CGA). 2000. CGA G-4.1, *Cleaning Equipment for Oxygen Service.*

National Fire Protection Association (NFPA). 1996. NFPA-50, *Standard for Bulk Oxygen Systems at Consumer Sites.*

responsibility and authority for the radiation safety and environmental compliance programs. The President is responsible for ensuring that the operations staff is complying with all applicable regulations and permit/license conditions through direct supervision of the General Manager of US Operations.

5.1.3 General Manager of US Operations

The General Manager of US Operations is responsible for managing all US Operations. The General Manager of US Operations is responsible for ensuring that Crow Butte personnel comply with Industrial Safety, Radiation Safety, Environmental Protection Programs, and all relevant state and federal regulations. The General Manager of US Operations has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The General Manager of US Operations reports directly to the President.

5.1.4 Restoration Manager

The Restoration Manager is responsible for all uranium production and restoration activities at the project site. The Restoration Manager is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with operations and restoration. The Restoration Manager is authorized to immediately implement any action to correct or prevent hazards. The Restoration Manager has the responsibility and the authority to suspend, postpone, or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The Restoration Manager cannot unilaterally override a decision for suspension, postponement, or modification if that decision is made by the ~~Manager of Safety, Health, Environment~~SHEQ Coordinator~~ and Quality~~, or the RSO. The Restoration Manager reports directly to the General Manager of US Operations.

5.1.5 ~~Manager of Safety Health Environment and Quality~~SHEQ Coordinator

The ~~Manager of Safety, Health, Environment and Quality~~SHEQ Coordinator is responsible for all health and safety, and environmental programs as stated in the SHEQMS Program and for ensuring that CBR complies with all applicable regulatory requirements. The ~~Manager of Safety, Health, Environment and Quality~~SHEQ Coordinator reports directly to the Restoration Manager. This position assists in the development and review of radiological and environmental sampling and analysis procedures and is responsible for routine auditing of the programs. The ~~Manager of Safety, Health, Environment and Quality~~SHEQ Coordinator has no production-related responsibilities. The ~~Manager of Safety, Health, Environment and Quality~~SHEQ Coordinator also has the responsibility and authority to suspend, postpone, or modify any activity that is determined to be a threat to

employees, public health, the environment or potentially a violation of state or federal regulations.

5.1.6 Plant Supervisor

The Plant Supervisor supervises plant operations, including the safe and efficient recovery and processing of uranium oxide while staying within regulatory and technical constraints. The Plant Supervisor is responsible for carrying out any procedures or actions implemented by the Restoration Manager, ~~Manager of SHEQ~~SHEQ Coordinator, or the RSO to correct or prevent radiation safety hazards in the plant. The RSO and the Plant Supervisor or the RSO and Restoration Manager are responsible for conducting weekly inspections of all facility areas to observe general radiation control practices and review required changes in procedures and equipment. The Plant Supervisor reports directly to the Restoration Manager.

5.1.7 Radiation Safety Officer

The RSO is responsible for the development, administration, and enforcement of all radiation safety programs. The RSO is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate radiation safety hazards and/or maintain regulatory compliance. The RSO is responsible for the implementation of all on-site environmental programs including emergency procedures. The RSO inspects facilities to verify compliance with all applicable requirements in the areas of radiological health and safety. The RSO works closely with all supervisory personnel to ensure that established programs are maintained. The RSO is also responsible for the collection and interpretation of employee exposure-related monitoring including data from radiological safety. The RSO makes recommendations to improvement any and all radiological safety-related controls. The RSO has no production-related responsibilities. The RSO reports directly to the Restoration Manager and has a secondary reporting requirement to theGeneral Manager of US Operations.

5.1.8 Health Physics Technician

The Health Physics Technician (HPT) assists the RSO with the implementation of the radiological and industrial safety programs. The HPT is responsible for the orderly collection and interpretation of all monitoring data, to include data from radiological safety and environmental programs. The HPT reports directly to the RSO.

~~5.1.9 SHEQ Specialist~~

~~The SHEQ Specialist assists in the development and submittal of regulatory permits and license applications. Provides analysis and guidance in the areas of Safety, Health,~~

~~Environment and Quality and is responsible for assisting site management with coordination of the corrective and preventative action process. The SHEQ Specialist maintains and updates documents associated with the activities relating to the SHEQ system. The SHEQ Specialist reports directly to the SHEQ Manager.~~

~~5.1.10~~5.1.9 Lab Foreman

The Lab Foreman has direct oversight of the on-site analytical laboratory including implementing laboratory quality assurance procedures. The Lab Foreman is responsible for carrying out any procedures or actions implemented by the Restoration Manager, Manager of SHEQ, or the RSO to correct or prevent radiation safety hazards in the laboratory. The Lab Foreman reports directly to the SHEQ ~~Manager~~Coordinator.

~~5.1.11~~5.1.10 Safety Supervisor/Technician

The Safety Supervisor/Technician is responsible for the non-radiation-related health and safety programs. The Safety Supervisor/Technician is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate safety hazards and/or maintain regulatory compliance. Responsibilities include the development and implementation of health and safety programs in compliance with Occupational Safety and Health Administration (OSHA) regulations. Responsibilities of the Safety Supervisor/Technician include development of industrial safety and health programs and procedures, coordination with the RSO where industrial and radiological safety concerns are interrelated, safety and health training of new and existing employees, and the maintenance of appropriate records to document compliance with regulations. The Safety Supervisor/Technician may be a qualified HPT and may function in that capacity when needed. The Safety Supervisor/Technician reports directly to the Restoration Manager ~~of Safety, Heath, Environment and Quality~~.

~~5.1.12~~5.1.11 Qualified Designated Operator

The qualified Designated Operator is responsible for performing daily inspection in the occasional absence of the RSO and the HPT. A qualified Designated Operator will meet the minimum qualifications and perform only those duties as outline in Section 5.6.6.

CROW BUTTE RESOURCES, INC.

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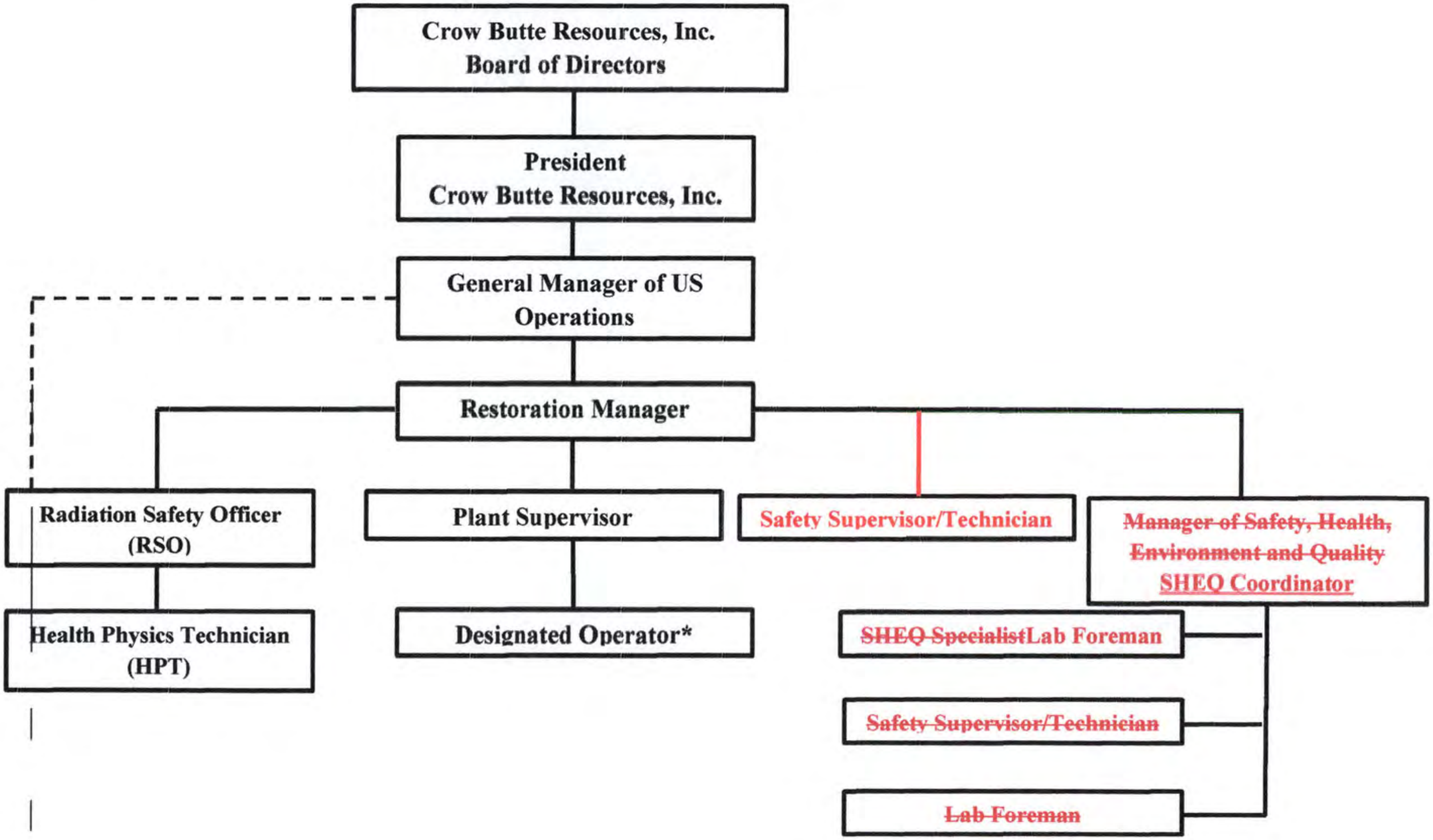
Figure 5.1-1: Crow Butte Resources Organizational Chart

Revised: March 2015, June 2016, October 2016

Figure 5.1-1: Crow Butte Resources Organizational Chart



*Qualifications for Designated Operator described in Marsland Expansion Area Technical Report, Section 5.5.4

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5.4.2.2 Weekly Inspections

- Perimeter Fence - The game-proof perimeter fence is inspected for holes that would allow animals to enter the pond area.
- Inlet Pipes – The pond inlet piping is inspected to verify that it is not clogged with ice, dirt, etc.
- Underdrain Measurements - The underdrains are measured, and the vertical depth of fluid in the standpipe is recorded.
- Pond Sprays - When in use, the enhanced evaporation systems should be checked at regular intervals.
- Pond Liner - The liner is visually inspected weekly for holes or other signs of distress.
- Leak Detection System - The leak detection pipes for all ponds are measured for fluid in the standpipes, and the vertical depth of the fluid shall be recorded on the Pond Inspection Forms.

5.4.2.3 Quarterly Inspections

- Embankment Settlement - The tops of the embankments and downstream toe area are examined for settlement or depressions.
- Embankment Slopes - Embankment slopes are examined for irregularities in alignment and variances from originally constructed slopes (sloughing, toe movement, surface cracking, or erosion).
- Seepage - Evidence of seepage in any areas surrounding the ponds (especially the downstream toes) is investigated and documented.
- Slope Protection - Vegetation on the outslopes of the pond is examined. Any evidence of rills or gullies forming is noted.
- Post-Construction Changes - Any changes to the upstream watershed areas that could affect runoff to the ponds is noted.
- Emergency lines are inspected to ensure that the rope has not deteriorated and the ropes reach to the pond water level.

5.4.2.4 Annual Inspection

A technical evaluation of the pond system which addresses the hydraulic and hydrologic capacities of the ponds and ditches and the structural stability of the embankments will be conducted annually. A survey of the pond embankments will be conducted annually and the survey results documented and incorporated into the annual inspection report. The

survey is reviewed for evidence of embankment settlement, irregularities in embankment alignment, and any changes in the originally constructed slopes.

The technical evaluation will be the result of an annual inspection and a review of the weekly, monthly, and quarterly inspection reports by a professional engineer registered in the State of Nebraska. The pond monitor well sampling data will also be reviewed for signs of seepage in the embankments.

The inspection report will present the results of the technical evaluation and the analysis of inspection data collected since the last report. The report will be kept on file at the site for review by regulatory agencies. A copy is also submitted to the USNRC within 1 month of the annual inspection.

5.4.3 Annual ALARA Audits

CBR will conduct annual audits of the radiation safety and ALARA programs. The ~~Manager of Health, Safety, and Environmental Affair~~SHEQ Coordinators may conduct these audits. Alternatively, CBR may use qualified personnel from other uranium recovery facilities or an outside radiation protection auditing service to conduct these audits. The purpose of the audits is to provide assurance that all radiation health protection procedures and license condition requirements are being conducted properly at the Crow Butte Project facility. Any outside personnel used for this purpose will be qualified in radiation safety procedures as well as environmental aspects of solution mining operations. Whether conducted internally or through the use of an audit service, the auditor will meet the minimum qualifications for education and experience for the RSO as described in **Section 5.5.**

The audit of the radiation protection and ALARA program is conducted in accordance with the recommendations contained in USNRC Regulatory Guide 8.31. A written report of the results is submitted to corporate management. The RSO may accompany the auditor but may not contribute to the conclusions.

The annual ALARA audit report summarizes the following data:

- Employee exposure records;
- Bioassay results,
- Inspection log entries and summary reports of mine and process inspections,
- Documented training program activities,
- Applicable safety meeting reports,
- Radiological survey and sampling data,
- Reports on any overexposure of workers, and
- Operating procedures that were reviewed during this period.

The ALARA audit report specifically discusses the following:

- Trends in personnel exposures;
- Proper use, maintenance, and inspection of equipment used for exposure control; and
- Recommendations on ways to further reduce personnel exposures from uranium and its daughters.

The ALARA audit report is submitted to and reviewed by the CBR President and ~~Mine~~ Restoration Manager. Implementation of the recommendations to further reduce employee exposures, or improvements to the ALARA program, is discussed with the ALARA auditor.

An annual audit of the Quality Assurance/Quality Control (QA/QC) program is also conducted. An individual qualified in analytical and monitoring techniques who does not have direct responsibilities in the areas being audited performs the audit. The results of the QA/QC audit are documented with the ALARA Audit. The RSO has the primary responsibility for the implementation of the radiological QA/QC programs at the Crow Butte Project facilities.

5.4.4 Records Management

Detailed discussions of recordkeeping policies, responsibilities and procedures are maintained in CBR's SHEQMS Program Volume II, Management Procedures Manual. Key components of the recordkeeping retention policies are discussed below.

Determination of Records to be Maintained

Records that are maintained as part of the CBR's records retention policy are identified by utilizing the following sources of information:

- Records and maintenance periods established by regulations (e.g., 10 CFR 20 and 10 CFR 40);
- Records and maintenance periods established by license or permit requirements;
- Records established by industry and international standards (e.g., ISO-14001:2004); and
- Records established by Company policies.

Records that are deemed critical to records retention includes, but is not limited to:

- Decision on communication of significant environmental aspects*;
- Record of changes to documented procedures resulting from corrective action*;
- External communication records*;

- SHEQMS audit records*;
- EMS management review records*;
- Records of calibration and maintenance of monitoring equipment*;
- Training records*;
- Information on applicable laws or other requirements;
- Process monitoring information, where it has a bearing on environmental, health and safety aspects, impacts, or operational controls;
- Monitoring data;
- Change management records;
- Nonconformance and incident reports;
- Information on emergency response situations; and
- Product information, including lists and composition of products (i.e. MSDS's).

* required by the ISO 14001:2004 and OHSAS-18001:1999 standards

Records are classified as permanent and non-permanent for purposes of retention timelines:

- Permanent records are maintained for the life of the project, operation or facility. **All such records must be maintained until the NRC has terminated any license authorizing operations.** These records may be required to meet any of the following criteria:
  1. Records that are required to maintain and decommission a facility (e.g., operating history);
  2. Information which may be of value in determination of an accident, a malfunction, etc., (e.g., test results);
  3. Baseline data;
  4. Personnel medical records, including health physics data;
  5. Facility design documents;
  6. Monitoring data identified in State permits and NRC licenses.
- Non-permanent records are those that do not meet any of the above criteria but are required to provide evidence that an activity was performed according to the requirements. Examples of these types of records are certificates, inspection reports, operator qualifications, purchase orders, personnel qualifications, inspections and test plans, audits, etc.

CBR complies with the record retention requirements stated in 10 CFR 20 and 10 CFR 40. For example, this would include, but not limited to, requirements specified in 10 CFR 20.2102 (Records of radiation protection programs), 20.2103 (Records of surveys), 20.2104 (determination of prior occupational doses), 20.2105 (Any records of planned

special exposures), 20.2106 (Records of individual monitoring results), 20.2107 (Records of dose to individual members of the public) and 20.2108 (Records of waste disposal). In addition records would be retained as specified in 10 CFR 40.61 (Records) for the receipt, transfer, and disposal of source or byproduct material as specified in this regulation. Record retention timelines typically vary from 3 years following the generation of the record or until termination of the license that authorizes the activity and associated record. For example, as per 10 CFR 20.2102, records of CBR's radiation protection program (including provisions of the program) shall be maintained until the NRC terminates the site's radioactive material license requiring the record, and records of audits and other reviews shall be maintained for 3 years after the record is made.

Where possible, site records are identified in the appropriate project implementing procedures. Retention time and personnel responsible for handling of the records are also identified. For instance, record retention times for radiological monitoring records required by the NRC License are identified in CBR's SHEQMS Program Volume IV, Health Physics Manual.

All records are required to be legible and traceable to the applicable activity, product or service. The form of records is maintained as per 10 CFR 20.2110.

Record Storage

Obsolete versions of some documents may be considered a record and will be retained in the SHEQMS Program records. An example would be history copies of previous revisions of implementing procedures and operating manuals.

Records are filed as to allow for prompt retrieval in accordance with the retention time criteria stipulated in CBR's Record Management Matrix.

Records are stored in an environment that minimizes damage or deterioration and/or loss. Backup copies of critical and permanent records are maintained in a separate location. Backup copies may be paper or electronic versions.

Records are retained for a minimum of three years unless otherwise specified in other documents or subject to longer record retention requirements specified in regulations such as 10 CFR 20 and 10 CFR 40.

Review of Recordkeeping Requirements

The format and contents of the records will be reviewed **at least annually** as part of the established review of the site programs and changes initiated will be reflected in the revisions to this procedure.

As additional EMS-related records (including new or revised regulatory requirements) are identified, they will be incorporated into this recordkeeping review procedure as part of continual improvement to this procedure.

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5.5 HEALTH PHYSICS QUALIFICATIONS

CBR project staff is highly experienced in the management of uranium development, mining, and operations. The following are the minimum required personnel specifications and qualifications.

5.5.1 Radiation Safety Officer Qualifications

The minimum qualifications for the RSO are as follows:

- Education - A Bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in UR facility radiation protection. Two years of relevant experience are generally considered equivalent to one year of academic study.
- Health Physics Experience - At least 1 year of work experience relevant to UR operations in applied health physics, radiation protection, industrial hygiene or similar work. This experience should involve actually working with radiation detection and measurement equipment, not strictly administrative or "desk" work.
- Specialized Training – At least 4 weeks of specialized classroom training in health physics specifically applicable to uranium recovery. In addition, the RSO should attend refresher training on UR facility health physics every 2 years.
- Specialized Knowledge - A thorough knowledge of the proper application and use of all health physics equipment used in the UR facility, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposures to uranium and its daughters, and a thorough understanding of the UR process and equipment used in the facility and how hazards are generated and controlled during the UR process.

5.5.2 Health Physics Technician Qualifications

The HPT will have one of the following combinations of education, training, and experience:

- Education - An Associate's degree or 2 years or more of study in the physical sciences, engineering, or a health-related field;

  Training - At least a total of 4 weeks of generalized training (up to 2 weeks may be on-the-job training) in radiation health protection applicable to UR facilities;

Experience - One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a UR facility; or

- Education - A high school diploma is required.

  Training – A total of at least 3 months of specialized training (up to 1 month may be on-the-job training) in radiation health protection relevant to UR facilities;

- Experience - Two years of relevant work experience in applied radiation protection.

5.6 TRAINING

All site employees and contractor personnel at the Crow Butte Project are administered a training program based on the SHEQMS Program covering radiation safety, radioactive material handling, and radiological emergency procedures. This training program is administered in keeping with standard radiological protection guidelines and the guidance provided in USNRC Regulatory Guide 8.29, *Instructions Concerning Risks From Occupational Radiation Exposure* (Revision 1, February 1996); Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002); and Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure* (Revision 3, June 1999). The technical content of the training program is under the direction of the RSO. The RSO or a qualified designee conducts all radiation safety training.

5.6.1 Training Program Content

5.6.1.1 Visitors

Visitors to the Crow Butte Project who have not received training are escorted by on-site personnel who are properly trained and familiar with the hazards of the facility. At a minimum, visitors are instructed specifically on what they should do to avoid possible hazards in the area of the facility that they are visiting.

5.6.1.2 Contractors

Any contractors having work assignments at the facility are given appropriate radiological safety training. Contract workers who will be performing work on heavily contaminated equipment receive the same training normally required of Crow Butte workers as discussed in **Section 5.6.1.3**.

5.6.1.3 Crow Butte Resources Employees

The CBR SHEQMS Program Volume VII, *Training Manual*, incorporates the following topics recommended in USNRC Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002), USNRC's Regulatory Guide 8.29, *Instruction Concerning Risks from Occupational Radiation Exposure (Revision 1, February 1996)*, and USNRC Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure (Revision 3, June 1999)*:

<u>Fundamentals of Health Protection</u>

- The radiological and toxic hazards of exposure to uranium and its daughters.

- How uranium and its daughters enter the body (inhalation, ingestion, and skin penetration), and
- Why exposures to uranium and its daughters should be kept as low as reasonably achievable (ALARA).

Personal Hygiene at Uranium Mines

- Wearing protective clothing;
- Using respirators when appropriate;
- Eating, drinking, and smoking only in designated areas; and
- Using proper methods for decontamination.

Facility-provided Protection

- Cleanliness of working spaces,
- Safety designed features for process equipment,
- Ventilation systems and effluent controls,
- Standard Operating Procedures, and
- Security and access control to designated areas.

Health Protection Measurements

- Measurements of airborne radioactive material,
- Bioassay to detect uranium (urinalysis and in vivo counting),
- Surveys to detect contamination of personnel and equipment, and
- Personnel dosimetry.

Radiation Protection Regulations

- Regulatory authority of USNRC, MSHA, and state;
- Employee rights in 10 CFR Part 19; and
- Radiation protection requirements in 10 CFR Part 20.

Emergency Procedures

All new workers, including supervisors, are given specialized instruction on the health and safety aspects of the specific jobs they will perform. This instruction is performed in the form of individualized on-the-job training. Retraining is conducted annually and documented. Every 2 months, all workers attend a general safety meeting.

Consistent with USNRC Regulatory Guide 8.13, *Instruction Concerning Prenatal*

Radiation Exposure (Revision 3, June 1999), all female workers and those supervisors who will work with them will be given specific instruction about prenatal exposure risks to the developing embryo and fetus.

5.6.2 Testing Requirements

A written test with questions directly relevant to the principals of radiation safety and health protection in the facility covered in the training course is given to each worker. The instructor reviews the test results with each worker and discusses incorrect answers to the questions with the worker until worker understanding is achieved. Workers who fail the exam are retested, and test results remain on file.

5.6.3 On-The-Job Training

5.6.3.1 Health Physics Technician

On-the-job training is provided to HPTs in radiation exposure monitoring and exposure determination programs, instrument calibration, plant inspections, posting requirements, respirator programs, and health physics procedures contained in the SHEQMS Program Volume IV, *Health Physics Manual.*

5.6.4 Refresher Training

Following initial radiation safety training, all permanent employees and long-term contractors receive ongoing radiation safety training as part of the annual refresher training and, if determined necessary by the RSO, during monthly safety meetings. This ongoing training is used to discuss problems and questions that have arisen, any relevant information or regulations that have changed exposure trends, and other pertinent topics.

5.6.5 Training Records

Records of training are kept for 5 years for all employees trained as radiation workers (occupationally exposed employees).

5.6.6 Qualifications and Requirements for Daily Inspections

Cameco conducts daily walk-through inspections of all work and storage areas of the facility to ensure proper implementation of good radiation safety procedures, including good housekeeping and cleanup practices that minimize unnecessary contamination. Normally, these inspections are conducted by the RSO or an HPT. However, on certain occasions, such as weekends or holidays, a qualified operator may be designated to conduct the daily inspection.

Crow Butte Resources will use an alternative approach to qualify designated operators to conduct daily walkthrough inspections of all work and storage areas at the Crow Butte

Plant and satellite facilities (**Appendix D**). One or more qualified designated operators will be identified to perform daily inspections in the occasional absence of the RSO and HPT.

A qualified designated operator will only perform daily inspections on weekends, holidays and times when both the RSO and HPT's must both be absent (e.g. illness or offsite training). With the exceptions of those instances when a Federal holiday falls on a Friday or Monday, the Thanksgiving holiday, or a site closure due to weather or other safety or security related event, qualified designated operators will not conduct the inspections for more than two days per week. When a Federal holiday falls on Friday or Monday, qualified designated operators may perform the daily inspections for a total of three consecutive days. For the Thanksgiving holiday only, the qualified designated operator may perform the daily inspections for four consecutive days. When weather or other safety or security related event causes a site closure, a qualified designated operator, if available, will continue performing the daily inspections until the RSO or HPT can access the site after such an event. The licensee will also have the RSO or HPT available by telephone while a qualified designated operator is performing the daily inspections.

Reports generated by a qualified designated operator will be reviewed by the RSO or an HPT as soon as practicable, but not later than the close of business the next work day following an absence (including site closure due to weather or other safety or security related event), weekend or holiday. The RSO or HPT review shall be annotated with date and time on the report or other document that can be inspected upon request.

Any problems noted by the designated operator during the daily inspection will be recorded on an inspection form, signed and dated, and retained on file. The RSO will review the inspection forms and take appropriate action to correct any noted problems.

A qualified designated operator has no authority for the development and administration of the radiation protection program, other than conducting daily inspections. He may not approve plans for new equipment, process changes, or changes in operating procedures that may affect the radiation protection program. He will not conduct radiation safety audits or make determinations about personnel dosimetry. A qualified designated operator may not authorize non-routine maintenance jobs involving potential for personnel radiation exposure or radioactive contamination for which there are no standard operating procedures nor an existing radiation work permit. The designated operator will not have the authority to release materials for unrestricted use. In the event of an emergency, the on-call RSO or HPT will be responsible for radiation protection decisions.

At the Crow Butte Plant and satellite facilities, the only activity required to be performed by the RSO or HPT on a daily basis is the daily inspection. Instrument calibrations are performed on a weekly basis during the regular workweek by the RSO or HPT. For that

reason, it is not necessary for the designated operator to perform any other HPT function on weekends or holidays.

The designated operator will observe, through visual inspection, radiation safety practices, housekeeping and implementation of the radiation safety program throughout the plant/satellite. Such duties include, but not be limited to, inspecting for compliance with radiation safety postings, contamination control, proper control point ingress and egress, control of airborne radioactivity, worker protection practices in the yellowcake drying and packaging area, and proper storage of byproduct material.

5.6.6.1 Minimum Qualifications for Designated Operators

Before a designated operator may conduct such inspections, he must be qualified by reason of training and experience to observe proper implementation of good radiation safety practices. In addition to the annual radiation worker training required by Regulatory Guide 8.31, Section 2.5, the operator seeking designation must not only complete one-time training specific to daily inspections, but also demonstrate proficiency. The additional training will emphasize how the inspections affect employee safety.

At a minimum, the operator seeking designation must have the following combination of education, training and experience:

Education: a high school diploma or equivalent.

Training: New employee radiation safety training, including guidance pertinent to prenatal radiation exposure (Regulatory Guide 8.13) and instruction concerning risks from occupational radiation exposure (Regulatory Guide 8.29) and additional training specific to conducting daily inspections at Crow Butte ISR facilities. In addition, the designated operator will be required to demonstrate proficiency during daily inspections to the RSO.

Experience: A minimum of three months' work experience in operations or maintenance at a uranium recovery facility, including procedures that involve health physics, industrial safety or industrial hygiene at a uranium recovery facility to demonstrate qualification is required.

5.6.6.2 Additional Training for Designated Operators

The additional radiation safety training afforded to operators seeking designation involves four hours training and a test covering the topics discussed below with an 80 percent passing grade, but does not include the more advanced topics required for the facility RSO or HPT.

The additional training for Designated Operator includes the following topics:

1. Employee PPE usage
2. Personal contamination control (ingress and egress)
3. Radiation area boundaries
4. Signage
5. Labeling
6. Leaks
7. Yellowcake spillage
8. Ventilation
9. General housekeeping
10. Reporting procedures specific to type of finding (e.g., how and when to contact the on-call RSO or HPT)
11. Completion and control of the daily inspection form

5.6.6.3 Demonstration of Proficiency

Upon completion of training and prior to designation, an operator will be required to demonstrate to the RSO an understanding of and proficiency in conducting the daily inspections. Prior to performing inspections, the operator seeking designation will perform a minimum of four (4) daily inspections under the supervision of the RSO or HPT. The supervised inspections will cover the training topics listed above and will be documented with signatures of the RSO and HPT and the operator seeking designation on the daily inspection form. An operator who fails to qualify will be re-evaluated after performing additional supervised inspections until proficiency is demonstrated to the satisfaction of the RSO.

5.6.6.4 Documentation

The designation process will be documented in a file which includes education, training results with a passing test score, and signed supervised daily inspection forms. The designation itself will be co-signed by the Designated Operator and the RSO when the RSO is satisfied that the training and supervised inspections demonstrate proficiency.

5.6.6.5 Maintaining Designated Operator Status

To remain qualified, the Designated Operators must complete an annual refresher training which addresses the same topics covered in the additional training described above. A test will be given with a required passing grade of 80 percent. In addition, the Designated Operator must complete at least two (2) supervised inspections performed semiannually under the direct supervision of the RSO or HPT.

5.7 SECURITY

CBR security measures for the current operation are specified in the Security Plan and Security Threat chapter in Volume VIII, *Emergency Manual*. CBR is committed to:

- Providing employees with a safe, healthy, and secure working environment;
- Maintaining control and security of USNRC licensed material;
- Ensuring the safe and secure handling and transportation of hazardous materials; and
- Managing records and documents that may contain sensitive and confidential information.

The USNRC requires licensees to maintain control over licensed material (i.e., natural uranium ["source material"] and byproduct material defined in 10 CFR §40.4). 10 CFR 20, Subpart I, *Storage and Control of Licensed Material*, requires the following:

§20.1801 Security of Stored Material

The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.

§20.1802 Control of Material not in Storage

The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.

Stored material at the Crow Butte Project would include uranium packaged for shipment from the facility or byproduct materials awaiting disposal. Examples of material not in storage would include yellowcake slurry or loaded ion exchange resin removed from the restricted area for transfer to other areas.

5.7.1 License Area and Plant Facility Security

5.7.1.1 Central Processing Facility Area

All Central Processing Facility areas where source or byproduct material is handled are fenced. The main access road is equipped with a locking gate. Strategically placed surveillance cameras monitor the access road and areas around the Central Processing facility. A 24-hour-per-day, 7-day-per-week staff is on duty in the Central Processing facility.

Central Plant operators perform an inspection to ensure the proper storage and security of licensed material at the beginning of each shift. The inspection determines whether all licensed material is properly stored in a restricted area or, if in controlled or unrestricted areas, is properly secured. In particular, operators ensure that loaded ion exchange resin, slurry, drummed yellowcake, and byproduct material are properly secured. If licensed material is found outside a restricted area, the operator will ensure that it is secured, locked, moved to a restricted area, or kept under constant surveillance by direct observation by site personnel or surveillance cameras. The results of this inspection will be properly documented.

5.7.1.2 Office Building

There is a reception area located at the main entrance into the office building. All other entrances are locked during off-shift hours. There are a limited number of traceable keys to the office, and they are given out to select employees. The main door and the door to the Central Plant Facility entrance are also equipped with an access keypad.

Visitors entering the office are greeted by the receptionist and announced to the receiving person. All visitors are required to sign the access log and indicate the purpose of their visit and the employee to be visited. The person being visited is responsible to supervise the visitors at all times when they are on site. Visitors are only allowed at the facility during regular working hours unless prior approval is obtained from the ~~Mine~~ Restoration Manager or the SHEQ Coordinator~~Manager of Health, Safety, and Environmental Affairs~~.

5.7.2 Transportation Security

CBR routinely receives, stores, uses, and ships hazardous materials as defined by the U.S. Department of Transportation (DOT). In addition to the packaging and shipping requirements contained in the DOT Hazardous Materials Regulations (HMR), 49 CFR 172, Subpart I, *Security Plans* requires that persons who offer for transportation or transport certain hazardous materials develop a Security Plan. Shipments may qualify for this DOT requirement under the following categories:

§172.800(b)(4) A shipment of a quantity of hazardous materials in a bulk package having a capacity equal to or greater than 13,248 L (3,500 gallons) for liquids or gases or more than 13.24 cubic meters (468 cubic feet) for solids;

§172.800(b)(5) A shipment in other than a bulk packaging of 2,268 kg (5,000 pounds) gross weight or more of one class of hazardous material for which placarding of a vehicle, rail car, or freight container is required for that class under the provisions of subpart F of this part;

§172.800(b)(7) A quantity of hazardous material that requires placarding under the provisions of subpart F of this part.

DOT requires that Security Plans assess the possible transportation security risks and evaluate appropriate measures to address those risks. All hazardous materials shippers and transporters subject to these standards must take measures to provide personnel security by screening applicable job applicants, prevent unauthorized access to the hazardous materials or vehicles being prepared for shipment, and provide for en route security. Companies must also train appropriate personnel in the elements of the Security Plan.

Transport of licensed/hazardous material by CBR employees will generally be restricted to transferring contaminated equipment between company facilities. This transport generally occurs over short distances through remote areas. Therefore, the potential for a security threat during transport by CBR vehicle is minimal. The goal of the driver, cargo, and equipment security measures is to ensure the safety of the driver and the security and integrity of the cargo from the point of origin to the final destination by:

- Clearly communicating general point-to-point security procedures and guidelines to all drivers and non-driving personnel;
- Providing the means and methods of protecting the drivers, vehicles, and customer's cargo while on the road; and
- Establishing consistent security guidelines and procedures that shall be observed by all personnel.

For the security of all tractors and trailers, the following procedures will be utilized:

- If material is stored in the vehicle, access must be secured at all openings with locks and/or tamper indicators.
- Off-site tractors will always be secured when left unattended with windows closed, doors locked, the engine shut off, and no keys or spare keys in or on the vehicle.
- The unit is to be kept visible by an employee at all times when left unattended outside a restricted area.

The security guidelines and procedures apply to all transport assignments. All drivers and non-driving personnel are expected to know and adhere to these guidelines and procedures when performing any load-related activity.

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License Renewal Application

Affected Pages (replacement pages)

2017 SERP Actions

CROW BUTTE RESOURCES, INC.

SERP 17-02

Proposed License Renewal Application Page Changes

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5 OPERATIONS

CBR operates a commercial-scale in-situ leach uranium mine (the Crow Butte Project) near Crawford, Nebraska. CBR maintains a headquarters in Casper, Wyoming, where site-licensing actions originate. All CBR operations, including the Crow Butte Project operations, are conducted in conformance with applicable laws, regulations, and requirements of the various regulatory agencies. The responsibilities described below have been designed to both ensure compliance and further implement CBR's policy for providing a safe working environment with cost-effective incorporation of the philosophy of maintaining radiation exposures as low as is reasonably achievable (ALARA).

5.1 CORPORATE ORGANIZATION/ADMINISTRATIVE PROCEDURES

CBR will maintain a performance-based approach to the management of the environment and employee health and safety including radiation safety. The Safety, Health, Environment, and Quality Management System (SHEQMS) encompasses licensing, compliance, environmental monitoring, industrial hygiene, and health physics programs under one umbrella, and it includes involvement for all employees from the individual worker to senior management. This SHEQMS will allow CBR to operate efficiently and maintain an effective environment, health, and safety program.

Figure 5.1-1 is a partial organization chart for CBR with respect to the operation of the Crow Butte Uranium Project and associated operations and represents the management levels that play a key part in the SHEQMS Program. The personnel identified are responsible for the development, review, approval, implementation, and adherence to operating procedures, radiation safety programs, environmental and groundwater monitoring programs, as well as routine and non-routine maintenance activities. These individuals may also serve a functional part of the Safety and Environmental Review Panel (SERP) described under **Section 5.3.3**.

Specific responsibilities of the organization are provided below.

5.1.1 Board of Directors

The CBR Board of Directors has the ultimate responsibility and authority for radiation safety and environmental compliance for CBR. The Board of Directors sets corporate policy and provides procedural guidance in these areas. The Board of Directors provides operational direction to the President of CBR.

5.1.2 President

The President is responsible for interpreting and acting upon the Board of Directors' policy and procedural decisions. The President directly supervises the General Manager of US Operations. The President is empowered by the Board of Directors to have the

responsibility and authority for the radiation safety and environmental compliance programs. The President is responsible for ensuring that the operations staff is complying with all applicable regulations and permit/license conditions through direct supervision of the General Manager of US Operations.

5.1.3 General Manager of US Operations

The General Manager of US Operations is responsible for managing all US Operations. The General Manager of US Operations is responsible for ensuring that Crow Butte personnel comply with Industrial Safety, Radiation Safety, Environmental Protection Programs, and all relevant state and federal regulations. The General Manager of US Operations has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The General Manager of US Operations reports directly to the President.

5.1.4 Restoration Manager

The Restoration Manager is responsible for all uranium production and restoration activities at the project site. The Restoration Manager is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with operations and restoration. The Restoration Manager is authorized to immediately implement any action to correct or prevent hazards. The Restoration Manager has the responsibility and the authority to suspend, postpone, or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The Restoration Manager cannot unilaterally override a decision for suspension, postponement, or modification if that decision is made by the Manager of Safety, Health, Environment and Quality, or the RSO. The Restoration Manager reports directly to the General Manager of US Operations.

5.1.5 Manager of Safety Health Environment and Quality

The Manager of Safety, Health, Environment and Quality is responsible for all health and safety, and environmental programs as stated in the SHEQMS Program and for ensuring that CBR complies with all applicable regulatory requirements. The Manager of Safety, Health, Environment and Quality reports directly to the Restoration Manager. This position assists in the development and review of radiological and environmental sampling and analysis procedures and is responsible for routine auditing of the programs. The Manager of Safety, Health, Environment and Quality has no production-related responsibilities. The Manager of Safety, Health, Environment and Quality also has the responsibility and authority to suspend, postpone, or modify any activity that is determined to be a threat to employees, public health, the environment or potentially a violation of state or federal regulations.

5.1.6 Plant Supervisor

The Plant Supervisor supervises plant operations, including the safe and efficient recovery and processing of uranium oxide while staying within regulatory and technical constraints. The Plant Supervisor is responsible for carrying out any procedures or actions implemented by the Restoration Manager, Manager of SHEQ, or the RSO to correct or prevent radiation safety hazards in the plant. The RSO and the Plant Supervisor or the RSO and Restoration Manager are responsible for conducting weekly inspections of all facility areas to observe general radiation control practices and review required changes in procedures and equipment. The Plant Supervisor reports directly to the Restoration Manager.

5.1.7 Radiation Safety Officer

The RSO is responsible for the development, administration, and enforcement of all radiation safety programs. The RSO is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate radiation safety hazards and/or maintain regulatory compliance. The RSO is responsible for the implementation of all on-site environmental programs including emergency procedures. The RSO inspects facilities to verify compliance with all applicable requirements in the areas of radiological health and safety. The RSO works closely with all supervisory personnel to ensure that established programs are maintained. The RSO is also responsible for the collection and interpretation of employee exposure-related monitoring including data from radiological safety. The RSO makes recommendations to improvement any and all radiological safety-related controls. The RSO has no production-related responsibilities. The RSO reports directly to the Restoration Manager and has a secondary reporting requirement to the General Manager of US Operations.

5.1.8 Health Physics Technician

The Health Physics Technician (HPT) assists the RSO with the implementation of the radiological and industrial safety programs. The HPT is responsible for the orderly collection and interpretation of all monitoring data, to include data from radiological safety and environmental programs. The HPT reports directly to the RSO.

5.1.9 SHEQ Specialist

The SHEQ Specialist assists in the development and submittal of regulatory permits and license applications. Provides analysis and guidance in the areas of Safety, Health, Environment and Quality and is responsible for assisting site management with coordination of the corrective and preventative action process. The SHEQ Specialist maintains and updates documents associated with the activities relating to the SHEQ system. The SHEQ Specialist reports directly to the SHEQ Manager.

5.1.10 Lab Foreman

The Lab Foreman has direct oversight of the on-site analytical laboratory including implementing laboratory quality assurance procedures. The Lab Foreman is responsible for carrying out any procedures or actions implemented by the Restoration Manager, Manager of SHEQ, or the RSO to correct or prevent radiation safety hazards in the laboratory. The Lab Foreman reports directly to the SHEQ Manager.

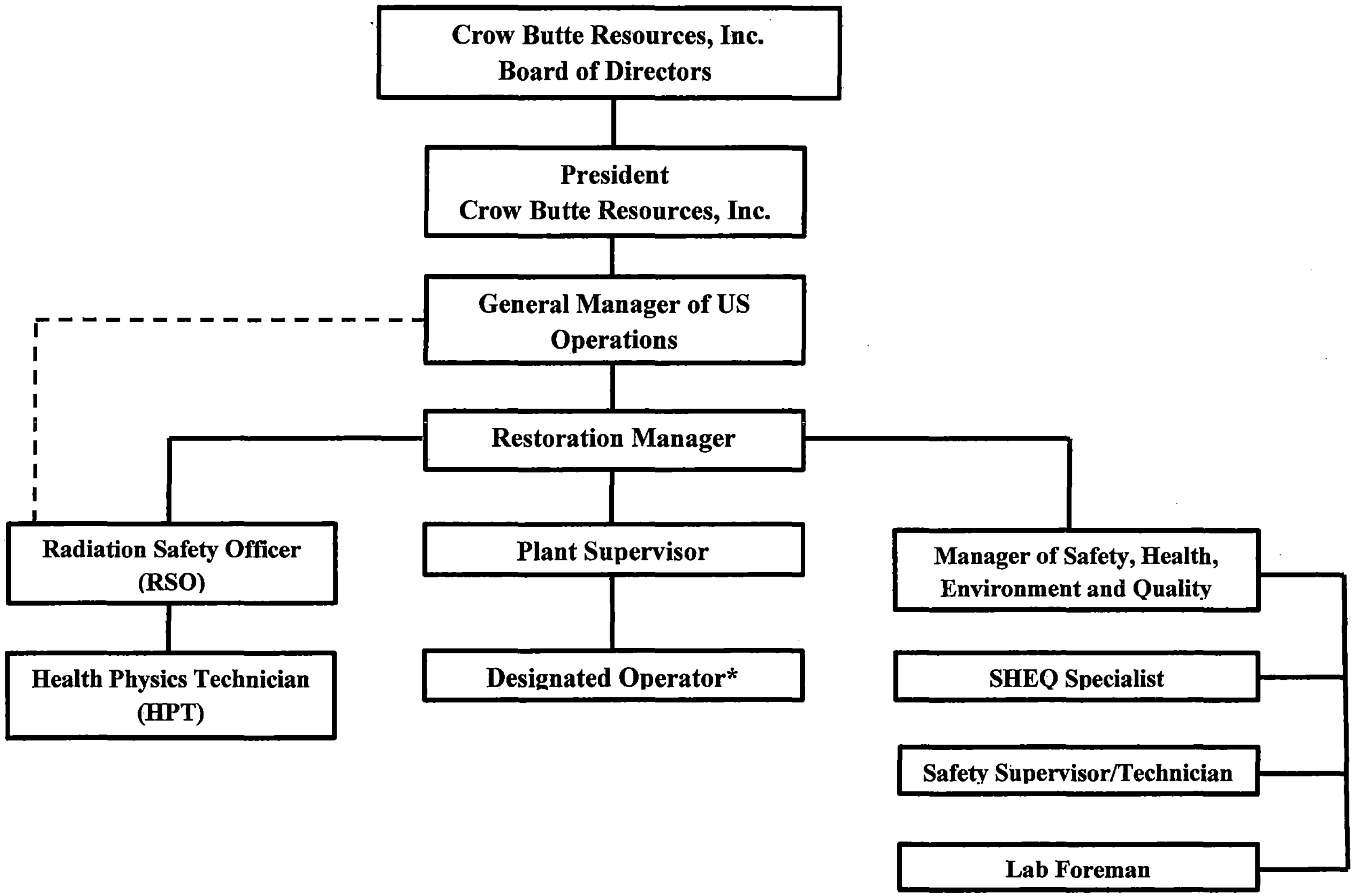
5.1.11 Safety Supervisor/Technician

The Safety Supervisor/Technician is responsible for the non-radiation-related health and safety programs. The Safety Supervisor/Technician is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate safety hazards and/or maintain regulatory compliance. Responsibilities include the development and implementation of health and safety programs in compliance with Occupational Safety and Health Administration (OSHA) regulations. Responsibilities of the Safety Supervisor/Technician include development of industrial safety and health programs and procedures, coordination with the RSO where industrial and radiological safety concerns are interrelated, safety and health training of new and existing employees, and the maintenance of appropriate records to document compliance with regulations. The Safety Supervisor/Technician may be a qualified HPT and may function in that capacity when needed. The Safety Supervisor/Technician reports directly to the Manager of Safety, Heath, Environment and Quality.

5.1.12 Qualified Designated Operator

The qualified Designated Operator is responsible for performing daily inspection in the occasional absence of the RSO and the HPT. A qualified Designated Operator will meet the minimum qualifications and perform only those duties as outline in Section 5.6.6.

Figure 5.1-1: Crow Butte Resources Organizational Chart



*Qualifications for Designated Operator described in SUA-1534, Section 5.6.6 (Nov 2014)

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Page Changes

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FIGURES

TABLES

APPENDIX

- Elution/precipitation
- Dewatering/drying

The ion exchange system consists of eight up-flow and six down-flow ion exchange columns. The uranium loading process is continuous but the elution process is operated on a batch process. The loaded up-flow columns are eluted in place; the down-flow loaded resin is moved across a screen deck for washing before being eluted in a separate elution column.

The up-flow injection filtration system consists of backwashable filters, with an option of installing polishing filters downstream. The down-flow system utilizes screens to prevent resin loss, and the resin itself acts as an injection filter, with an option of installing polishing filters downstream.

The up-flow lixiviant injection system consists of the injection surge tanks and the injection pumps. The tanks are fabricated out of FRP, and the injection pumps are centrifugal. The down-flow injection system depends on the down-hole submersible pumps to push through the sealed down-flow system and reinject the lixiviant. There is an option for in-line centrifugal booster pumps as needed to maintain pressures.

The elution/precipitation circuit consists of the barren eluant tanks and the acidizer/precipitator tanks. The barren eluant tanks and the precipitation tanks are constructed of FRP. The eluant is pumped from the barren eluant tanks to the ion exchange column that is in the elution mode. After the resin is eluted, the pregnant eluant is transferred to the acidizer/precipitator where the uranium is precipitated.

The areas in the processing plant where fumes or gases are generated are discussed in **Section 5.8**. Process tanks are vented for radon, O_2 and CO_2 removal. Building ventilation in the process equipment area is accomplished by the use of an exhaust system. This exhaust system draws fresh air in from ventilators and helps sweep radon, which can accumulate near the floor of the building, out to the atmosphere.

3.2.2 Chemical Storage Facilities

Chemical storage facilities at the CBR Facility include both hazardous and non-hazardous material storage areas. Bulk hazardous materials, which have the potential to impact radiological safety, are stored outside and segregated from areas where licensed materials are stored. Other non-hazardous bulk process chemicals (e.g., sodium carbonate) that do not have the potential to impact radiological safety are stored in a designated area.

3.2.2.1 Process Related Chemicals

Process-related chemicals stored in bulk at the CBR Facility include carbon dioxide, hydrogen peroxide, oxygen, sodium hydroxide, hydrochloric acid, sodium carbonate, sodium bicarbonate, sodium chloride and sodium sulfide. Operating procedures, safety precautions and hazards associated with the handling and use of process-related chemicals are discussed in CBR's SHEQMS Volume V Industrial Safety Manual. CBR maintains current material safety data sheets (MSDSs) for each of the process-related chemicals onsite, and these sheets are available upon request.

- **Carbon Dioxide** - Carbon dioxide is stored at the CBR Facility where it is added to the lixiviant. Carbon dioxide serves as a pH buffer to keep oxidized uranium carbonate in solution.

  Carbon dioxide is a suffocating agent and may cause nausea, respiratory problems and asphyxia in a confined area. It is a slightly toxic, nonflammable, colorless and odorless gas, with a slightly pungent taste. It is soluble in water, ethanol and acetone. It is an acidic oxide and reacts with water to form carbonic acid, and it reacts with alkalis to produce carbonates and bicarbonates.

- **Hydrogen Peroxide** – Hydrogen peroxide (50% aqueous solution) is stored at the CBR Facility where it is added to the lixiviant. It serves as an oxidant used during the precipitation phase of uranium and can be used in place of oxygen. This phase of the process is described in Section 3.1.4.3. Hydrogen peroxide is a clear, colorless liquid that is soluble in water. It is a strong oxidizer capable of oxidizing uranium mineralization and killing some forms of well fouling bacteria. It can be corrosive to eyes, nose, throat and lungs, may cause skin irritation, and may cause irreversible tissue damage to the eyes including blindness. Hydrogen peroxide is not a stable compound; and as it decomposes, it generates oxygen and water, which cause an increase in the volume of product present. The storage container is vented to allow gaseous oxygen to escape as the hydrogen peroxide breaks down. The chemical is not allowed to become trapped in a closed vessel, valve or pipe, and this is accomplished through venting.

- **Oxygen** - Oxygen is also typically stored at the plant, or within wellfield areas, where it is centrally located for addition to the injection stream in each wellhouse. Since oxygen readily supports combustion, fire and explosion are the principal hazards that must be controlled. The oxygen storage facility is located a safe distance from the CBR plant and other chemical storage areas for isolation. The storage facility has been designed to meet industry standards in NFPA-50 (NFPA 1996). Oxygen is added to the lixiviant used for extraction of uranium forming UO_3.

  Oxygen service pipelines and components must be clean of oil and grease since gaseous oxygen will cause these substances to burn with explosive violence if

ignited. All components intended for use with the oxygen distribution system are properly cleaned using recommended methods in CGA G-4.1 (CGA 2000). The design and installation of oxygen distribution systems is based on CGA-4.4 (CGA 1993).

The design locations of the carbon dioxide and oxygen storage tanks are shown on **Figure 3.2-1**.

- **Sodium Hydroxide** – Sodium hydroxide is used at the CBR Facility for pH adjustment during the uranium precipitation phase. The sodium hydroxide raises the pH to a level conducive for precipitating pure crystals. This phase of the process is described in Section 3.1.4.3. Sodium hydroxide is in the form of a fine granular, nonflammable, solid or a whitish liquid. It is stable under ordinary conditions of use and storage. It is very hygroscopic, and can slowly pick up moisture from the air and react with carbon dioxide from air to form sodium carbonate. Sodium hydroxide is a strong irritant, with effects from inhalation of dust or mist varying from mild irritation to serious damage of the upper respiratory tract, depending on the severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Severe pneumonitis may also occur.

- **Hydrochloric Acid** – Hydrochloric acid (HCl) is used for pH adjustment during the uranium precipitation phase at the CBR Facility. The HCl acidifies the pregnant eluant in order to destroy the uranyl carbonate complex ion. HCl is highly corrosive, and the inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and can cause pulmonary edema, circulatory failure and death. It is very hazardous in with regard to skin contact (corrosive, irritant and permeator), eye contact (irritant, corrosive) and ingestion. It is a colorless liquid with a pungent odor, and is infinitely soluble.

  As part of the SHEQMS Program, a risk assessment was completed to recognize potential hazards and risks associated with chemical storage facilities (and other processes), and to mitigate those risks to acceptable levels. The risk assessment process identified HCl as the most hazardous chemical with the greatest potential for impacts to chemical and radiological safety. The HCl storage and distribution system at the Central Plant (**Figure 3.2-1**) has a maximum capacity of approximately 6,000 gallons. Strict unloading procedures are utilized to ensure that safety controls are in place during the transfer of HCl. Process safety controls are also in place at the Central Plant where HCl is added to the precipitation circuit. Since precipitation is not performed at CBR satellite facilities, the use and storage of concentrated HCl will not be necessary in these areas.

- **Sodium Carbonate** – Sodium carbonate is stored at the CBR Facility and, when combined with CO_2 to form sodium bicarbonate, keeps oxidized uranium in solution. Sodium carbonate is used with carbon dioxide in oxidizing the uranium. Sodium carbonate is only slightly toxic, but can be very irritating to the eyes and skin, and poses as an inhalation hazard when it is in its salt stage (dust inhalation) or from small leaks in the form of a spray. Symptoms from excessive inhalation of dust may include coughing and difficult breathing. Its appearance is a white powder or granules, and it is stable under ordinary conditions of use and storage. It is hygroscopic and readily absorbs moisture from the air. Solutions are strong bases.
- **Sodium Bicarbonate** – Sodium Bicarbonate is stored at the CBR Facility and is used to keep oxidized uranium in solution. Sodium Bicarbonate is also used in the resin regeneration process. Sodium bicarbonate can be used without carbon dioxide in oxidizing the uranium. CBR maintains the option of using sodium carbonate/carbon dioxide or sodium bicarbonate in the oxidization of uranium. Inhalation of dust may cause irritation to the respiratory tract, and excessive contact is known to cause damage to the nasal septum. Symptoms from excessive inhalation of dust may include coughing and difficulty in breathing. Its appearance is in the form of a white powder or granules, and it is stable under ordinary conditions of use and storage. It is hygroscopic and readily absorbs moisture from the air. Solutions are strong bases.
- **Sodium Chloride** – Sodium chloride is stored at the CBR Facility and is used to regenerate/recycle the resin for further use in uranium extraction. Sodium chloride can be very irritating to the eyes and the skin and may cause mild irritation to the respiratory tract. However, it is not believed to present a significant hazard to health. Its appearance is in the form of crystals or white powder, odorless, and it is stable under ordinary conditions of storage and use. It is hygroscopic.
- **Sodium Sulfide** – Sodium sulfide is currently used at the existing licensed area during groundwater restoration activities as a chemical reductant. The use of sodium sulfide in groundwater restoration decreases the solubility of various heavy metals. To minimize potential impacts to radiological safety, this material is stored outside of process areas.

  The sodium sulfide consists of a dry, flaked product and is typically purchased on pallets of 55-pound bags or super sacks of 1,000 pounds. The bulk inventory is stored outside of process areas in a cool, dry, clean environment to prevent contact with any acid, oxidizer, or other material that may react with the product.

  Both solid and liquid sodium sulfide can be hazardous and toxic. The chemical, which becomes alkaline when moist, is corrosive. Protective clothing and PPE

should be worn to prevent any eye or skin contact, inhalation or ingestion. Contact lenses must not be worn when handling this material. Any contact with water, acids, oxidizers or heat can produce hydrogen sulfide gas, which is both flammable and toxic. Exposure to this gas, which, in low concentrations smells of rotten eggs, can result in loss of the sense of smell when present in concentrations greater than 100 ppm. At higher concentrations, hydrogen sulfide can cause paralysis and death. Fine sodium sulfide dust/air mixtures can also be explosive in confined spaces.

If the correct operating procedures are followed, the risk of generating hydrogen sulfide gas while mixing this reagent is extremely low. The saturation tank at CBR is vented outside the building as a precaution. During normal operating activities, Safety, Health, Environment and Quality (SHEQ) personnel may monitor chemical makeup activities with a portable H_2S monitor, if required. Whenever possible, the chemical is mixed during the day shift, Monday through Friday.

None of the hazardous chemicals used at the Crow Butte Project are covered under the USEPA's Risk Management Program (RMP) regulations. The RMP regulations require certain actions by covered facilities to prevent accidental releases of hazardous chemicals and minimize potential impacts to the public and environment. These actions include measures such as accidental release modeling, documentation of safety information, hazard reviews, operating procedures, safety training, and emergency response preparedness.

3.2.2.2 Non-Process Related Chemicals

Non-process related chemicals that are stored at the CBR Facility include petroleum (gasoline, diesel) and propane. Due to the flammable and/or combustible properties of these materials, all bulk quantities are stored outside of process areas at the satellite plant. All gasoline and diesel storage tanks are located above ground and within secondary containment structures to meet USEPA requirements.

3.3 INSTRUMENTATION AND CONTROL

The basic control system at the Crow Butte site is built around an Allen-Bradley SCADA (Sequential Control and Data Acquisition) System. This system allows for extensive monitoring of all wellfield and recovery plant operations. The system is monitored twenty four hours per day, seven days per week by control room operators. The operators rely on visual and audible alarms from a variety of systems to control mine operations. Examples include but are not limited to power failures, pressure exceedances, flow disruptions and the presence of liquids in the well houses.

The Allen-Bradley system consists of a series of menus which allows the plant operator to monitor and control a variety of systems and parameters. In addition, each wellfield house contains its own processor, which allows it to operate independent of the main computer. All critical equipment is equipped with uninterrupted power supply systems with a 30-minute supply in the event of a power failure.

Through this system, not only can the plant operators monitor and control every aspect of the operation on a real time basis, but management can review historical data to develop trend analysis for production operations. This not only ensures an efficient operation, but allows Crow Butte personnel to anticipate problem areas, and to remain in compliance with appropriate regulatory requirements.

Wellfield instrumentation is provided to measure total production and injection flow. In addition, instrumentation is provided to indicate the pressure that is being applied to the injection wells. Wellfield houses are equipped with wet alarms to detect the presence of liquids in the wellfield house sumps. The deep injection well is also equipped with a variety of sensors to monitor its status.

Instrumentation is provided to monitor the total flow into the plant, the total injection flow leaving the plant, and the total waste flow leaving the plant. Instrumentation is provided on the plant injection manifold to record an alarm in the event of any pressure loss that might indicate a leak or rupture in the injection system. The injection pumps are equipped with pressure reducing valves so that they are incapable of producing pressures high enough to exceed the design pressure of the injection lines or the maximum pressure to be applied to the injection wells. During power failures, overpressuring of wells is not possible as all pump systems are shut down.

In the process areas, tank levels are measured in chemical storage tanks as well as process tanks. A number of different monitors are in place for the dryer system, and drum logging is automated.

Handheld radiation detection instruments and portable samplers are used to monitor radiological conditions at the CBR facility. Specifications for this equipment are included in CBR's SHEQMS P*rogram Volume IV, Health Physics Manual*, and are discussed in further detail in Section 5. The location of monitoring points, monitoring procedures, and monitoring frequencies for in-plant radiation safety is also discussed in Section 5.

The types of health physics instrumentation that are used at the existing CBR facility include the following:

Air Sampling Equipment

- Eberline RAS-1 or Aircon 2 samplers (0-100 liters per minute (lpm) or equivalent

Calibrated semiannually or after repair-on site with a primary standard instrument or a properly calibrated secondary standard instrument

- BDX II or SKC lapel samplers (0-5 lpm) or equivalent

  Calibrated daily before each use-on site with a primary standard instrument or a properly calibrated secondary standard instrument

External Radiation Equipment

- Ludlum Model 19 Gamma Meter (μR/hr) or equivalent
- Ludlum Model 3 Gamma Meter with Ludlum Model 44-38 G-M detector (mR/hr) or equivalent
- Ludlum Model 2221 Ratemeter/Scaler with a Ludlum Model 44-10 NaI detector (counts per minute [cpm]) or equivalent

  Calibrated annually or after repair-manufacturer or qualified accredited vendor

Surface Contamination Equipment

- Ludlum Model 2241 scaler or a Ludlum Model 12 Ratemeter with a Model 43-65 or Model 43-5 alpha scintillation probe or equivalent (Total Alpha)
- Ludlum Model 177 Ratemeter with a Ludlum Model 43-5 alpha scintillation probe or equivalent (Personnel Contamination)
- Ludlum Model 2000 Scaler or Model 2200 Scaler with an Eberline SAC-R5 or Ludlum Model 43-10 alpha scintillation sample counter or equivalent (Removable Alpha, Radon Daughters, Airborne Radioactivity)

Instruments are calibrated annually or at a frequency recommended by the manufacturer, whichever is more frequent. Repairs are by the manufacturer or by a qualified accredited vendor, and the instrument is calibrated following such repair. The calibration vendor provides the as-found calibration condition of each instrument. If greater than 10% of the instruments are out of calibration when received by the calibration vendor, consideration is given to increasing the calibration frequency.

The manufacturer or a qualified accredited vendor calibrates portable survey instruments, counter/scalers, mass flow meters and/or dry cell calibrators, and calibration sources. Calibration is performed as recommended in ANSI N323 and ANSI N323A. The ANSI standard requires that radiation detection instruments are performance tested on an annual basis to verify that they continue to meet operational and design requirements. Instruments must be tested for range, sensitivity, linearity, detection limit, and response to overload. The specific calibration requirements for various types of instruments are discussed in CBR's SHEQMS Program *Volume IV, Health Physics Manual.*

Regulatory Guide 8.30 specifies requirements for routine maintenance and calibration of radiological survey instruments. Regulatory Guide 8.30 references the standards contained in ANSI N323-1978, *Radiation Protection Instrumentation Test and Calibration.* ANSI is in the process of a major revision of this Standard that will result in three separate Standards that apply to radiological instrumentation. The first revision, ANSI-N323A-1997, *Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments,* was incorporated in this Chapter. When conflicts arise between NRC Regulatory Guide 8.30 and the ANSI Standard, the Regulatory Guide recommendations are followed.

Calibration vendors provide a certificate of calibration for all instruments. These calibration certificates are maintained by the RSO on file for that instrument. Records of repair completed by the calibration vendor are also maintained in the instrument file.

Documentation of calibration of air samplers performed on site are be maintained. This documentation is maintained by the RSO in the sampler file.

Record of instrument checks, including the daily checks and initial checks, will be maintained in a format determined by the RSO. These records will be readily available and provided in a format that will allow the RSO to review the records for the types of potential problems (e.g., background drift in a continuous direction, battery check that does not respond, ratemeter that does not zero and alpha background rates greater than 0.5 cpm).

All records of instrument calibration and checks will be retained until NRC License termination. The RSO will be responsible for record retention.

Details as to calibration, functional tests, procedures and recordkeeping/retention are discussed in CBR's SHEQMS Program *Volume IV, Health Physics Manual.*

Contract Laboratory Quality Control

CBR's radiological quality assurance program is discussed in Section 2.9 of the SHEQMS Program *Volume IV, Health Physics Manual.* Quality control efforts are implemented to ensure that radiological data provided by contract laboratories are accurate and reliable. CBR conducts periodic audits of its QA/QC program as it relates to the health physics program; these audits are reviewed by facility and corporate management.

One purpose of the quality control program is to determine the precision and accuracy of the monitoring processes. Quality control sampling includes replicate samples to determine precision, spiked samples with a known concentration to determine accuracy, and blank samples to detect and measure contamination of analytical samples. NRC

Regulatory Guide 4.15, *Quality Assurance for Radioloigcal Monitoring Programs (Normal Operations) – Effluent Streams and the Environment*, describes requirements for these types of quality control samples. Generally, NRC recommends that 5 to 10% of the analytical load at an environmental laboratory should be quality control samples. The contract laboratory quality assurance program is required to describe the program implemented to meet these requirements. Each qualified laboratory is required to have an acceptable QA/QC program in place. The SHEQ Coordinator or designee reviews the vendors QA/QC program and is responsible for approving the use of the vendor. Qualified laboratories are required to submit verification of an appropriate NRC License and certification(s) to meet NRC requirements.

3.3.1 References

Compressed Gas Association (CGA). 1993. CGA G-4.4, *Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems.*

Compressed Gas Association (CGA). 2000. CGA G-4.1, *Cleaning Equipment for Oxygen Service.*

National Fire Protection Association (NFPA). 1996. NFPA-50, *Standard for Bulk Oxygen Systems at Consumer Sites.*

responsibility and authority for the radiation safety and environmental compliance programs. The President is responsible for ensuring that the operations staff is complying with all applicable regulations and permit/license conditions through direct supervision of the General Manager of US Operations.

5.1.3 General Manager of US Operations

The General Manager of US Operations is responsible for managing all US Operations. The General Manager of US Operations is responsible for ensuring that Crow Butte personnel comply with Industrial Safety, Radiation Safety, Environmental Protection Programs, and all relevant state and federal regulations. The General Manager of US Operations has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The General Manager of US Operations reports directly to the President.

5.1.4 Restoration Manager

The Restoration Manager is responsible for all uranium production and restoration activities at the project site. The Restoration Manager is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with operations and restoration. The Restoration Manager is authorized to immediately implement any action to correct or prevent hazards. The Restoration Manager has the responsibility and the authority to suspend, postpone, or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The Restoration Manager cannot unilaterally override a decision for suspension, postponement, or modification if that decision is made by the SHEQ Coordinator, or the RSO. The Restoration Manager reports directly to the General Manager of US Operations.

5.1.5 SHEQ Coordinator

The SHEQ Coordinator is responsible for all health and safety, and environmental programs as stated in the SHEQMS Program and for ensuring that CBR complies with all applicable regulatory requirements. The SHEQ Coordinator reports directly to the Restoration Manager. This position assists in the development and review of radiological and environmental sampling and analysis procedures and is responsible for routine auditing of the programs. The SHEQ Coordinator has no production-related responsibilities. The SHEQ Coordinator also has the responsibility and authority to suspend, postpone, or modify any activity that is determined to be a threat to employees, public health, the environment or potentially a violation of state or federal regulations.

5.1.6 Plant Supervisor

The Plant Supervisor supervises plant operations, including the safe and efficient recovery and processing of uranium oxide while staying within regulatory and technical constraints. The Plant Supervisor is responsible for carrying out any procedures or actions implemented by the Restoration Manager, SHEQ Coordinator, or the RSO to correct or prevent radiation safety hazards in the plant. The RSO and the Plant Supervisor or the RSO and Restoration Manager are responsible for conducting weekly inspections of all facility areas to observe general radiation control practices and review required changes in procedures and equipment. The Plant Supervisor reports directly to the Restoration Manager.

5.1.7 Radiation Safety Officer

The RSO is responsible for the development, administration, and enforcement of all radiation safety programs. The RSO is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate radiation safety hazards and/or maintain regulatory compliance. The RSO is responsible for the implementation of all on-site environmental programs including emergency procedures. The RSO inspects facilities to verify compliance with all applicable requirements in the areas of radiological health and safety. The RSO works closely with all supervisory personnel to ensure that established programs are maintained. The RSO is also responsible for the collection and interpretation of employee exposure-related monitoring including data from radiological safety. The RSO makes recommendations to improvement any and all radiological safety-related controls. The RSO has no production-related responsibilities. The RSO reports directly to the Restoration Manager and has a secondary reporting requirement to theGeneral Manager of US Operations.

5.1.8 Health Physics Technician

The Health Physics Technician (HPT) assists the RSO with the implementation of the radiological and industrial safety programs. The HPT is responsible for the orderly collection and interpretation of all monitoring data, to include data from radiological safety and environmental programs. The HPT reports directly to the RSO.

5.1.9 Lab Foreman

The Lab Foreman has direct oversight of the on-site analytical laboratory including implementing laboratory quality assurance procedures. The Lab Foreman is responsible for carrying out any procedures or actions implemented by the Restoration Manager,

Manager of SHEQ, or the RSO to correct or prevent radiation safety hazards in the laboratory. The Lab Foreman reports directly to the SHEQ Coordinator.

5.1.10 Safety Supervisor/Technician

The Safety Supervisor/Technician is responsible for the non-radiation-related health and safety programs. The Safety Supervisor/Technician is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate safety hazards and/or maintain regulatory compliance. Responsibilities include the development and implementation of health and safety programs in compliance with Occupational Safety and Health Administration (OSHA) regulations. Responsibilities of the Safety Supervisor/Technician include development of industrial safety and health programs and procedures, coordination with the RSO where industrial and radiological safety concerns are interrelated, safety and health training of new and existing employees, and the maintenance of appropriate records to document compliance with regulations. The Safety Supervisor/Technician may be a qualified HPT and may function in that capacity when needed. The Safety Supervisor/Technician reports directly to the Restoration Manager.

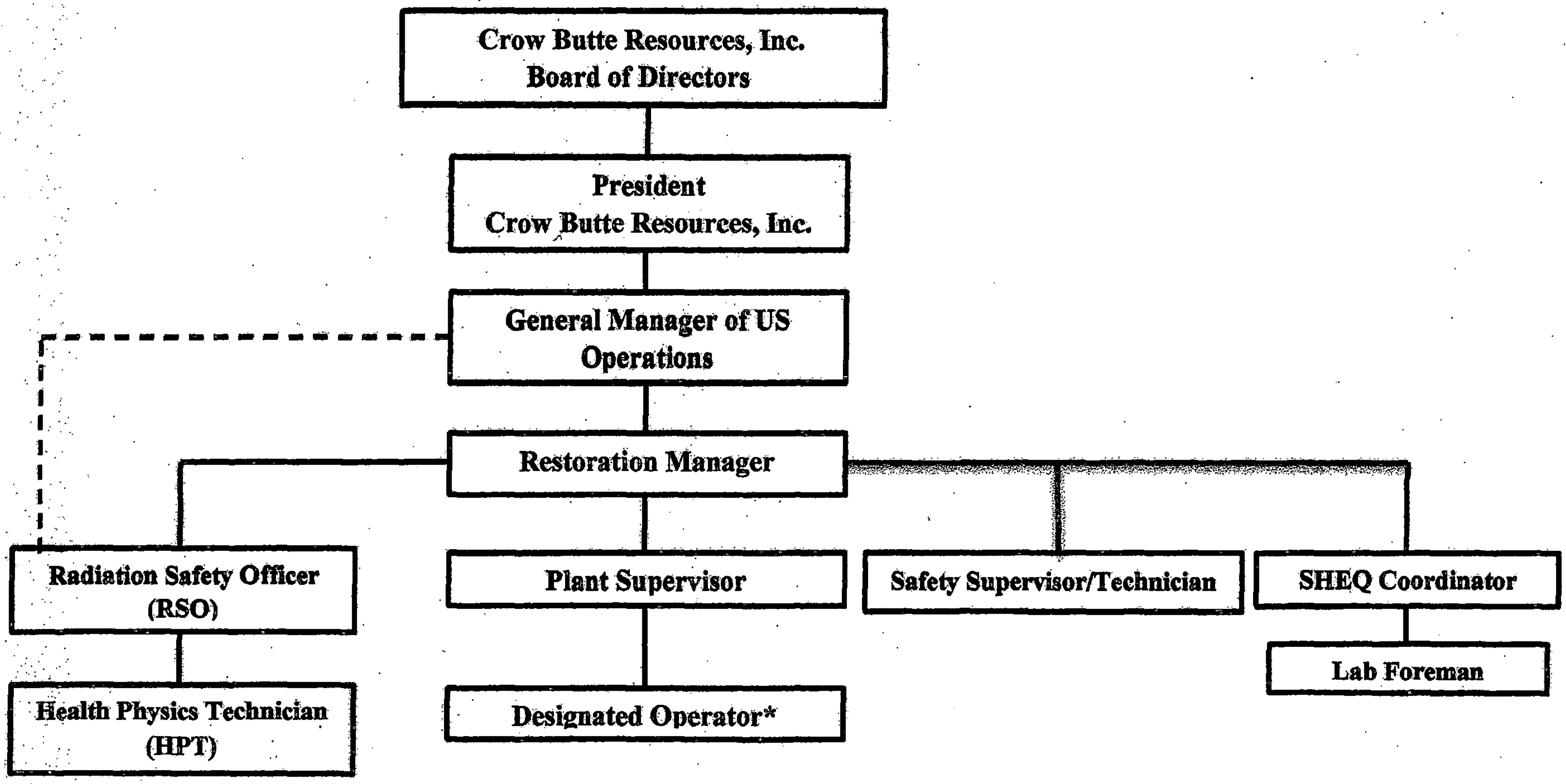
5.1.11 Qualified Designated Operator

The qualified Designated Operator is responsible for performing daily inspection in the occasional absence of the RSO and the HPT. A qualified Designated Operator will meet the minimum qualifications and perform only those duties as outline in Section 5.6.6.

Figure 5.1-1: Crow Butte Resources Organizational Chart

Revised: March 2015, June 2016, October 2016

Figure 5.1-1: Crow Butte Resources Organizational Chart



*Qualifications for Designated Operator described in SUA-1534, Section 5.6.6 (Nov 2014)

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5.4.2.2 Weekly Inspections

- Perimeter Fence - The game-proof perimeter fence is inspected for holes that would allow animals to enter the pond area.
- Inlet Pipes – The pond inlet piping is inspected to verify that it is not clogged with ice, dirt, etc.
- Underdrain Measurements - The underdrains are measured, and the vertical depth of fluid in the standpipe is recorded.
- Pond Sprays - When in use, the enhanced evaporation systems should be checked at regular intervals.
- Pond Liner - The liner is visually inspected weekly for holes or other signs of distress.
- Leak Detection System - The leak detection pipes for all ponds are measured for fluid in the standpipes, and the vertical depth of the fluid shall be recorded on the Pond Inspection Forms.

5.4.2.3 Quarterly Inspections

- Embankment Settlement - The tops of the embankments and downstream toe area are examined for settlement or depressions.
- Embankment Slopes - Embankment slopes are examined for irregularities in alignment and variances from originally constructed slopes (sloughing, toe movement, surface cracking, or erosion).
- Seepage - Evidence of seepage in any areas surrounding the ponds (especially the downstream toes) is investigated and documented.
- Slope Protection - Vegetation on the outslopes of the pond is examined. Any evidence of rills or gullies forming is noted.
- Post-Construction Changes - Any changes to the upstream watershed areas that could affect runoff to the ponds is noted.
- Emergency lines are inspected to ensure that the rope has not deteriorated and the ropes reach to the pond water level.

5.4.2.4 Annual Inspection

A technical evaluation of the pond system which addresses the hydraulic and hydrologic capacities of the ponds and ditches and the structural stability of the embankments will be conducted annually. A survey of the pond embankments will be conducted annually and the survey results documented and incorporated into the annual inspection report. The

survey is reviewed for evidence of embankment settlement, irregularities in embankment alignment, and any changes in the originally constructed slopes.

The technical evaluation will be the result of an annual inspection and a review of the weekly, monthly, and quarterly inspection reports by a professional engineer registered in the State of Nebraska. The pond monitor well sampling data will also be reviewed for signs of seepage in the embankments.

The inspection report will present the results of the technical evaluation and the analysis of inspection data collected since the last report. The report will be kept on file at the site for review by regulatory agencies. A copy is also submitted to the USNRC within 1 month of the annual inspection.

5.4.3 Annual ALARA Audits

CBR will conduct annual audits of the radiation safety and ALARA programs. The SHEQ Coordinator may conduct these audits. Alternatively, CBR may use qualified personnel from other uranium recovery facilities or an outside radiation protection auditing service to conduct these audits. The purpose of the audits is to provide assurance that all radiation health protection procedures and license condition requirements are being conducted properly at the Crow Butte Project facility. Any outside personnel used for this purpose will be qualified in radiation safety procedures as well as environmental aspects of solution mining operations. Whether conducted internally or through the use of an audit service, the auditor will meet the minimum qualifications for education and experience for the RSO as described in **Section 5.5.**

The audit of the radiation protection and ALARA program is conducted in accordance with the recommendations contained in USNRC Regulatory Guide 8.31. A written report of the results is submitted to corporate management. The RSO may accompany the auditor but may not contribute to the conclusions.

The annual ALARA audit report summarizes the following data:

- Employee exposure records;
- Bioassay results,
- Inspection log entries and summary reports of mine and process inspections,
- Documented training program activities,
- Applicable safety meeting reports,
- Radiological survey and sampling data,
- Reports on any overexposure of workers, and
- Operating procedures that were reviewed during this period.

The ALARA audit report specifically discusses the following:

- Trends in personnel exposures;
- Proper use, maintenance, and inspection of equipment used for exposure control; and
- Recommendations on ways to further reduce personnel exposures from uranium and its daughters.

The ALARA audit report is submitted to and reviewed by the CBR President and Restoration Manager. Implementation of the recommendations to further reduce employee exposures, or improvements to the ALARA program, is discussed with the ALARA auditor.

An annual audit of the Quality Assurance/Quality Control (QA/QC) program is also conducted. An individual qualified in analytical and monitoring techniques who does not have direct responsibilities in the areas being audited performs the audit. The results of the QA/QC audit are documented with the ALARA Audit. The RSO has the primary responsibility for the implementation of the radiological QA/QC programs at the Crow Butte Project facilities.

5.4.4 Records Management

Detailed discussions of recordkeeping policies, responsibilities and procedures are maintained in CBR's SHEQMS Program Volume II, Management Procedures Manual. Key components of the recordkeeping retention policies are discussed below.

<u>Determination of Records to be Maintained</u>

Records that are maintained as part of the CBR's records retention policy are identified by utilizing the following sources of information:

- Records and maintenance periods established by regulations (e.g., 10 CFR 20 and 10 CFR 40);
- Records and maintenance periods established by license or permit requirements;
- Records established by industry and international standards (e.g., ISO-14001:2004); and
- Records established by Company policies.

Records that are deemed critical to records retention includes, but is not limited to:

- Decision on communication of significant environmental aspects*;
- Record of changes to documented procedures resulting from corrective action*;
- External communication records*;

- SHEQMS audit records*;
- EMS management review records*;
- Records of calibration and maintenance of monitoring equipment*;
- Training records*;
- Information on applicable laws or other requirements;
- Process monitoring information, where it has a bearing on environmental, health and safety aspects, impacts, or operational controls;
- Monitoring data;
- Change management records;
- Nonconformance and incident reports;
- Information on emergency response situations; and
- Product information, including lists and composition of products (i.e. MSDS's).

* required by the ISO 14001:2004 and OHSAS-18001:1999 standards

Records are classified as permanent and non-permanent for purposes of retention timelines:

- Permanent records are maintained for the life of the project, operation or facility. **All such records must be maintained until the NRC has terminated any license authorizing operations.** These records may be required to meet any of the following criteria:
    1. Records that are required to maintain and decommission a facility (e.g., operating history);
    2. Information which may be of value in determination of an accident, a malfunction, etc., (e.g., test results);
    3. Baseline data;
    4. Personnel medical records, including health physics data;
    5. Facility design documents;
    6. Monitoring data identified in State permits and NRC licenses.
- Non-permanent records are those that do not meet any of the above criteria but are required to provide evidence that an activity was performed according to the requirements. Examples of these types of records are certificates, inspection reports, operator qualifications, purchase orders, personnel qualifications, inspections and test plans, audits, etc.

CBR complies with the record retention requirements stated in 10 CFR 20 and 10 CFR 40. For example, this would include, but not limited to, requirements specified in 10 CFR 20.2102 (Records of radiation protection programs), 20.2103 (Records of surveys), 20.2104 (determination of prior occupational doses), 20.2105 (Any records of planned

special exposures), 20.2106 (Records of individual monitoring results), 20.2107 (Records of dose to individual members of the public) and 20.2108 (Records of waste disposal). In addition records would be retained as specified in 10 CFR 40.61 (Records) for the receipt, transfer, and disposal of source or byproduct material as specified in this regulation. Record retention timelines typically vary from 3 years following the generation of the record or until termination of the license that authorizes the activity and associated record. For example, as per 10 CFR 20.2102, records of CBR's radiation protection program (including provisions of the program) shall be maintained until the NRC terminates the site's radioactive material license requiring the record, and records of audits and other reviews shall be maintained for 3 years after the record is made.

Where possible, site records are identified in the appropriate project implementing procedures. Retention time and personnel responsible for handling of the records are also identified. For instance, record retention times for radiological monitoring records required by the NRC License are identified in CBR's SHEQMS Program Volume IV, Health Physics Manual.

All records are required to be legible and traceable to the applicable activity, product or service. The form of records is maintained as per 10 CFR 20.2110.

Record Storage

Obsolete versions of some documents may be considered a record and will be retained in the SHEQMS Program records. An example would be history copies of previous revisions of implementing procedures and operating manuals.

Records are filed as to allow for prompt retrieval in accordance with the retention time criteria stipulated in CBR's Record Management Matrix.

Records are stored in an environment that minimizes damage or deterioration and/or loss. Backup copies of critical and permanent records are maintained in a separate location. Backup copies may be paper or electronic versions.

Records are retained for a minimum of three years unless otherwise specified in other documents or subject to longer record retention requirements specified in regulations such as 10 CFR 20 and 10 CFR 40.

Review of Recordkeeping Requirements

The format and contents of the records will be reviewed at least annually as part of the established review of the site programs and changes initiated will be reflected in the revisions to this procedure.

As additional EMS-related records (including new or revised regulatory requirements) are identified, they will be incorporated into this recordkeeping review procedure as part of continual improvement to this procedure.

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5.5 HEALTH PHYSICS QUALIFICATIONS

CBR project staff is highly experienced in the management of uranium development, mining, and operations. The following are the minimum required personnel specifications and qualifications.

5.5.1 Radiation Safety Officer Qualifications

The minimum qualifications for the RSO are as follows:

- Education - A Bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in UR facility radiation protection. Two years of relevant experience are generally considered equivalent to one year of academic study.
- Health Physics Experience - At least 1 year of work experience relevant to UR operations in applied health physics, radiation protection, industrial hygiene or similar work. This experience should involve actually working with radiation detection and measurement equipment, not strictly administrative or "desk" work.
- Specialized Training – At least 4 weeks of specialized classroom training in health physics specifically applicable to uranium recovery. In addition, the RSO should attend refresher training on UR facility health physics every 2 years.
- Specialized Knowledge - A thorough knowledge of the proper application and use of all health physics equipment used in the UR facility, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposures to uranium and its daughters, and a thorough understanding of the UR process and equipment used in the facility and how hazards are generated and controlled during the UR process.

5.5.2 Health Physics Technician Qualifications

The HPT will have one of the following combinations of education, training, and experience:

- Education - An Associate's degree or 2 years or more of study in the physical sciences, engineering, or a health-related field;

  Training - At least a total of 4 weeks of generalized training (up to 2 weeks may be on-the-job training) in radiation health protection applicable to UR facilities;

Experience - One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a UR facility; or

- Education - A high school diploma is required.

  Training – A total of at least 3 months of specialized training (up to 1 month may be on-the-job training) in radiation health protection relevant to UR facilities;

- Experience - Two years of relevant work experience in applied radiation protection.

5.6 TRAINING

All site employees and contractor personnel at the Crow Butte Project are administered a training program based on the SHEQMS Program covering radiation safety, radioactive material handling, and radiological emergency procedures. This training program is administered in keeping with standard radiological protection guidelines and the guidance provided in USNRC Regulatory Guide 8.29, *Instructions Concerning Risks From Occupational Radiation Exposure* (Revision 1, February 1996); Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002); and Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure* (Revision 3, June 1999). The technical content of the training program is under the direction of the RSO. The RSO or a qualified designee conducts all radiation safety training.

5.6.1 Training Program Content

5.6.1.1 Visitors

Visitors to the Crow Butte Project who have not received training are escorted by on-site personnel who are properly trained and familiar with the hazards of the facility. At a minimum, visitors are instructed specifically on what they should do to avoid possible hazards in the area of the facility that they are visiting.

5.6.1.2 Contractors

Any contractors having work assignments at the facility are given appropriate radiological safety training. Contract workers who will be performing work on heavily contaminated equipment receive the same training normally required of Crow Butte workers as discussed in **Section 5.6.1.3**.

5.6.1.3 Crow Butte Resources Employees

The CBR SHEQMS Program Volume VII, *Training Manual*, incorporates the following topics recommended in USNRC Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002), USNRC's Regulatory Guide 8.29, *Instruction Concerning Risks from Occupational Radiation Exposure (Revision 1, February 1996)*, and USNRC Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure (Revision 3, June 1999)*:

<u>Fundamentals of Health Protection</u>

- The radiological and toxic hazards of exposure to uranium and its daughters.

- How uranium and its daughters enter the body (inhalation, ingestion, and skin penetration), and
- Why exposures to uranium and its daughters should be kept as low as reasonably achievable (ALARA).

Personal Hygiene at Uranium Mines

- Wearing protective clothing;
- Using respirators when appropriate;
- Eating, drinking, and smoking only in designated areas; and
- Using proper methods for decontamination.

Facility-provided Protection

- Cleanliness of working spaces,
- Safety designed features for process equipment,
- Ventilation systems and effluent controls,
- Standard Operating Procedures, and
- Security and access control to designated areas.

Health Protection Measurements

- Measurements of airborne radioactive material,
- Bioassay to detect uranium (urinalysis and in vivo counting),
- Surveys to detect contamination of personnel and equipment, and
- Personnel dosimetry.

Radiation Protection Regulations

- Regulatory authority of USNRC, MSHA, and state;
- Employee rights in 10 CFR Part 19; and
- Radiation protection requirements in 10 CFR Part 20.

Emergency Procedures

All new workers, including supervisors, are given specialized instruction on the health and safety aspects of the specific jobs they will perform. This instruction is performed in the form of individualized on-the-job training. Retraining is conducted annually and documented. Every 2 months, all workers attend a general safety meeting.

Consistent with USNRC Regulatory Guide 8.13, *Instruction Concerning Prenatal*

Radiation Exposure (Revision 3, June 1999), all female workers and those supervisors who will work with them will be given specific instruction about prenatal exposure risks to the developing embryo and fetus.

5.6.2 Testing Requirements

A written test with questions directly relevant to the principals of radiation safety and health protection in the facility covered in the training course is given to each worker. The instructor reviews the test results with each worker and discusses incorrect answers to the questions with the worker until worker understanding is achieved. Workers who fail the exam are retested, and test results remain on file.

5.6.3 On-The-Job Training

5.6.3.1 Health Physics Technician

On-the-job training is provided to HPTs in radiation exposure monitoring and exposure determination programs, instrument calibration, plant inspections, posting requirements, respirator programs, and health physics procedures contained in the SHEQMS Program Volume IV, *Health Physics Manual.*

5.6.4 Refresher Training

Following initial radiation safety training, all permanent employees and long-term contractors receive ongoing radiation safety training as part of the annual refresher training and, if determined necessary by the RSO, during monthly safety meetings. This ongoing training is used to discuss problems and questions that have arisen, any relevant information or regulations that have changed exposure trends, and other pertinent topics.

5.6.5 Training Records

Records of training are kept for 5 years for all employees trained as radiation workers (occupationally exposed employees).

5.6.6 Qualifications and Requirements for Daily Inspections

Cameco conducts daily walk-through inspections of all work and storage areas of the facility to ensure proper implementation of good radiation safety procedures, including good housekeeping and cleanup practices that minimize unnecessary contamination. Normally, these inspections are conducted by the RSO or an HPT. However, on certain occasions, such as weekends or holidays, a qualified operator may be designated to conduct the daily inspection.

Crow Butte Resources will use an alternative approach to qualify designated operators to conduct daily walkthrough inspections of all work and storage areas at the Crow Butte

Plant and satellite facilities (**Appendix D**). One or more qualified designated operators will be identified to perform daily inspections in the occasional absence of the RSO and HPT.

A qualified designated operator will only perform daily inspections on weekends, holidays and times when both the RSO and HPT's must both be absent (e.g. illness or offsite training). With the exceptions of those instances when a Federal holiday falls on a Friday or Monday, the Thanksgiving holiday, or a site closure due to weather or other safety or security related event, qualified designated operators will not conduct the inspections for more than two days per week. When a Federal holiday falls on Friday or Monday, qualified designated operators may perform the daily inspections for a total of three consecutive days. For the Thanksgiving holiday only, the qualified designated operator may perform the daily inspections for four consecutive days. When weather or other safety or security related event causes a site closure, a qualified designated operator, if available, will continue performing the daily inspections until the RSO or HPT can access the site after such an event. The licensee will also have the RSO or HPT available by telephone while a qualified designated operator is performing the daily inspections.

Reports generated by a qualified designated operator will be reviewed by the RSO or an HPT as soon as practicable, but not later than the close of business the next work day following an absence (including site closure due to weather or other safety or security related event), weekend or holiday. The RSO or HPT review shall be annotated with date and time on the report or other document that can be inspected upon request.

Any problems noted by the designated operator during the daily inspection will be recorded on an inspection form, signed and dated, and retained on file. The RSO will review the inspection forms and take appropriate action to correct any noted problems.

A qualified designated operator has no authority for the development and administration of the radiation protection program, other than conducting daily inspections. He may not approve plans for new equipment, process changes, or changes in operating procedures that may affect the radiation protection program. He will not conduct radiation safety audits or make determinations about personnel dosimetry. A qualified designated operator may not authorize non-routine maintenance jobs involving potential for personnel radiation exposure or radioactive contamination for which there are no standard operating procedures nor an existing radiation work permit. The designated operator will not have the authority to release materials for unrestricted use. In the event of an emergency, the on-call RSO or HPT will be responsible for radiation protection decisions.

At the Crow Butte Plant and satellite facilities, the only activity required to be performed by the RSO or HPT on a daily basis is the daily inspection. Instrument calibrations are performed on a weekly basis during the regular workweek by the RSO or HPT. For that

reason, it is not necessary for the designated operator to perform any other HPT function on weekends or holidays.

The designated operator will observe, through visual inspection, radiation safety practices, housekeeping and implementation of the radiation safety program throughout the plant/satellite. Such duties include, but not be limited to, inspecting for compliance with radiation safety postings, contamination control, proper control point ingress and egress, control of airborne radioactivity, worker protection practices in the yellowcake drying and packaging area, and proper storage of byproduct material.

5.6.6.1 Minimum Qualifications for Designated Operators

Before a designated operator may conduct such inspections, he must be qualified by reason of training and experience to observe proper implementation of good radiation safety practices. In addition to the annual radiation worker training required by Regulatory Guide 8.31, Section 2.5, the operator seeking designation must not only complete one-time training specific to daily inspections, but also demonstrate proficiency. The additional training will emphasize how the inspections affect employee safety.

At a minimum, the operator seeking designation must have the following combination of education, training and experience:

Education: a high school diploma or equivalent.

Training: New employee radiation safety training, including guidance pertinent to prenatal radiation exposure (Regulatory Guide 8.13) and instruction concerning risks from occupational radiation exposure (Regulatory Guide 8.29) and additional training specific to conducting daily inspections at Crow Butte ISR facilities. In addition, the designated operator will be required to demonstrate proficiency during daily inspections to the RSO.

Experience: A minimum of three months' work experience in operations or maintenance at a uranium recovery facility, including procedures that involve health physics, industrial safety or industrial hygiene at a uranium recovery facility to demonstrate qualification is required.

5.6.6.2 Additional Training for Designated Operators

The additional radiation safety training afforded to operators seeking designation involves four hours training and a test covering the topics discussed below with an 80 percent passing grade, but does not include the more advanced topics required for the facility RSO or HPT.

The additional training for Designated Operator includes the following topics:

1. Employee PPE usage
2. Personal contamination control (ingress and egress)
3. Radiation area boundaries
4. Signage
5. Labeling
6. Leaks
7. Yellowcake spillage
8. Ventilation
9. General housekeeping
10. Reporting procedures specific to type of finding (e.g., how and when to contact the on-call RSO or HPT)
11. Completion and control of the daily inspection form

5.6.6.3 Demonstration of Proficiency

Upon completion of training and prior to designation, an operator will be required to demonstrate to the RSO an understanding of and proficiency in conducting the daily inspections. Prior to performing inspections, the operator seeking designation will perform a minimum of four (4) daily inspections under the supervision of the RSO or HPT. The supervised inspections will cover the training topics listed above and will be documented with signatures of the RSO and HPT and the operator seeking designation on the daily inspection form. An operator who fails to qualify will be re-evaluated after performing additional supervised inspections until proficiency is demonstrated to the satisfaction of the RSO.

5.6.6.4 Documentation

The designation process will be documented in a file which includes education, training results with a passing test score, and signed supervised daily inspection forms. The designation itself will be co-signed by the Designated Operator and the RSO when the RSO is satisfied that the training and supervised inspections demonstrate proficiency.

5.6.6.5 Maintaining Designated Operator Status

To remain qualified, the Designated Operators must complete an annual refresher training which addresses the same topics covered in the additional training described above. A test will be given with a required passing grade of 80 percent. In addition, the Designated Operator must complete at least two (2) supervised inspections performed semiannually under the direct supervision of the RSO or HPT.

5.7 SECURITY

CBR security measures for the current operation are specified in the Security Plan and Security Threat chapter in Volume VIII, *Emergency Manual*. CBR is committed to:

- Providing employees with a safe, healthy, and secure working environment;
- Maintaining control and security of USNRC licensed material;
- Ensuring the safe and secure handling and transportation of hazardous materials; and
- Managing records and documents that may contain sensitive and confidential information.

The USNRC requires licensees to maintain control over licensed material (i.e., natural uranium ["source material"] and byproduct material defined in 10 CFR §40.4). 10 CFR 20, Subpart I, *Storage and Control of Licensed Material*, requires the following:

§20.1801 Security of Stored Material

The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.

§20.1802 Control of Material not in Storage

The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.

Stored material at the Crow Butte Project would include uranium packaged for shipment from the facility or byproduct materials awaiting disposal. Examples of material not in storage would include yellowcake slurry or loaded ion exchange resin removed from the restricted area for transfer to other areas.

5.7.1 License Area and Plant Facility Security

5.7.1.1 Central Processing Facility Area

All Central Processing Facility areas where source or byproduct material is handled are fenced. The main access road is equipped with a locking gate. Strategically placed surveillance cameras monitor the access road and areas around the Central Processing facility. A 24-hour-per-day, 7-day-per-week staff is on duty in the Central Processing facility.

Central Plant operators perform an inspection to ensure the proper storage and security of licensed material at the beginning of each shift. The inspection determines whether all licensed material is properly stored in a restricted area or, if in controlled or unrestricted areas, is properly secured. In particular, operators ensure that loaded ion exchange resin, slurry, drummed yellowcake, and byproduct material are properly secured. If licensed material is found outside a restricted area, the operator will ensure that it is secured, locked, moved to a restricted area, or kept under constant surveillance by direct observation by site personnel or surveillance cameras. The results of this inspection will be properly documented.

5.7.1.2 Office Building

There is a reception area located at the main entrance into the office building. All other entrances are locked during off-shift hours. There are a limited number of traceable keys to the office, and they are given out to select employees. The main door and the door to the Central Plant Facility entrance are also equipped with an access keypad.

Visitors entering the office are greeted by the receptionist and announced to the receiving person. All visitors are required to sign the access log and indicate the purpose of their visit and the employee to be visited. The person being visited is responsible to supervise the visitors at all times when they are on site. Visitors are only allowed at the facility during regular working hours unless prior approval is obtained from the Restoration Manager or the SHEQ Coordinator.

5.7.2 Transportation Security

CBR routinely receives, stores, uses, and ships hazardous materials as defined by the U.S. Department of Transportation (DOT). In addition to the packaging and shipping requirements contained in the DOT Hazardous Materials Regulations (HMR), 49 CFR 172, Subpart I, *Security Plans* requires that persons who offer for transportation or transport certain hazardous materials develop a Security Plan. Shipments may qualify for this DOT requirement under the following categories:

§172.800(b)(4) A shipment of a quantity of hazardous materials in a bulk package having a capacity equal to or greater than 13,248 L (3,500 gallons) for liquids or gases or more than 13.24 cubic meters (468 cubic feet) for solids;

§172.800(b)(5) A shipment in other than a bulk packaging of 2,268 kg (5,000 pounds) gross weight or more of one class of hazardous material for which placarding of a vehicle, rail car, or freight container is required for that class under the provisions of subpart F of this part;

§172.800(b)(7) A quantity of hazardous material that requires placarding under the provisions of subpart F of this part.

DOT requires that Security Plans assess the possible transportation security risks and evaluate appropriate measures to address those risks. All hazardous materials shippers and transporters subject to these standards must take measures to provide personnel security by screening applicable job applicants, prevent unauthorized access to the hazardous materials or vehicles being prepared for shipment, and provide for en route security. Companies must also train appropriate personnel in the elements of the Security Plan.

Transport of licensed/hazardous material by CBR employees will generally be restricted to transferring contaminated equipment between company facilities. This transport generally occurs over short distances through remote areas. Therefore, the potential for a security threat during transport by CBR vehicle is minimal. The goal of the driver, cargo, and equipment security measures is to ensure the safety of the driver and the security and integrity of the cargo from the point of origin to the final destination by:

- Clearly communicating general point-to-point security procedures and guidelines to all drivers and non-driving personnel;
- Providing the means and methods of protecting the drivers, vehicles, and customer's cargo while on the road; and
- Establishing consistent security guidelines and procedures that shall be observed by all personnel.

For the security of all tractors and trailers, the following procedures will be utilized:

- If material is stored in the vehicle, access must be secured at all openings with locks and/or tamper indicators.
- Off-site tractors will always be secured when left unattended with windows closed, doors locked, the engine shut off, and no keys or spare keys in or on the vehicle.
- The unit is to be kept visible by an employee at all times when left unattended outside a restricted area.

The security guidelines and procedures apply to all transport assignments. All drivers and non-driving personnel are expected to know and adhere to these guidelines and procedures when performing any load-related activity.

5.4.2.2 Weekly Inspections

- Perimeter Fence - The game-proof perimeter fence is inspected for holes that would allow animals to enter the pond area.
- Inlet Pipes – The pond inlet piping is inspected to verify that it is not clogged with ice, dirt, etc.
- Underdrain Measurements - The underdrains are measured, and the vertical depth of fluid in the standpipe is recorded.
- Pond Sprays - When in use, the enhanced evaporation systems should be checked at regular intervals.
- Pond Liner - The liner is visually inspected weekly for holes or other signs of distress.
- Leak Detection System - The leak detection pipes for all ponds are measured for fluid in the standpipes, and the vertical depth of the fluid shall be recorded on the Pond Inspection Forms.

5.4.2.3 Quarterly Inspections

- Embankment Settlement - The tops of the embankments and downstream toe area are examined for settlement or depressions.
- Embankment Slopes - Embankment slopes are examined for irregularities in alignment and variances from originally constructed slopes (sloughing, toe movement, surface cracking, or erosion).
- Seepage - Evidence of seepage in any areas surrounding the ponds (especially the downstream toes) is investigated and documented.
- Slope Protection - Vegetation on the outslopes of the pond is examined. Any evidence of rills or gullies forming is noted.
- Post-Construction Changes - Any changes to the upstream watershed areas that could affect runoff to the ponds is noted.
- Emergency lines are inspected to ensure that the rope has not deteriorated and the ropes reach to the pond water level.

5.4.2.4 Annual Inspection

A technical evaluation of the pond system which addresses the hydraulic and hydrologic capacities of the ponds and ditches and the structural stability of the embankments will be conducted annually. A survey of the pond embankments will be conducted annually and the survey results documented and incorporated into the annual inspection report. The

survey is reviewed for evidence of embankment settlement, irregularities in embankment alignment, and any changes in the originally constructed slopes.

The technical evaluation will be the result of an annual inspection and a review of the weekly, monthly, and quarterly inspection reports by a professional engineer registered in the State of Nebraska. The pond monitor well sampling data will also be reviewed for signs of seepage in the embankments.

The inspection report will present the results of the technical evaluation and the analysis of inspection data collected since the last report. The report will be kept on file at the site for review by regulatory agencies. A copy is also submitted to the USNRC within 1 month of the annual inspection.

5.4.3 Annual ALARA Audits

CBR will conduct annual audits of the radiation safety and ALARA programs. The SHEQ Coordinator may conduct these audits. Alternatively, CBR may use qualified personnel from other uranium recovery facilities or an outside radiation protection auditing service to conduct these audits. The purpose of the audits is to provide assurance that all radiation health protection procedures and license condition requirements are being conducted properly at the Crow Butte Project facility. Any outside personnel used for this purpose will be qualified in radiation safety procedures as well as environmental aspects of solution mining operations. Whether conducted internally or through the use of an audit service, the auditor will meet the minimum qualifications for education and experience for the RSO as described in **Section 5.5.**

The audit of the radiation protection and ALARA program is conducted in accordance with the recommendations contained in USNRC Regulatory Guide 8.31. A written report of the results is submitted to corporate management. The RSO may accompany the auditor but may not contribute to the conclusions.

The annual ALARA audit report summarizes the following data:

- Employee exposure records;
- Bioassay results,
- Inspection log entries and summary reports of mine and process inspections,
- Documented training program activities,
- Applicable safety meeting reports,
- Radiological survey and sampling data,
- Reports on any overexposure of workers, and
- Operating procedures that were reviewed during this period.

The ALARA audit report specifically discusses the following:

- Trends in personnel exposures;
- Proper use, maintenance, and inspection of equipment used for exposure control; and
- Recommendations on ways to further reduce personnel exposures from uranium and its daughters.

The ALARA audit report is submitted to and reviewed by the CBR President and Restoration Manager. Implementation of the recommendations to further reduce employee exposures, or improvements to the ALARA program, is discussed with the ALARA auditor.

An annual audit of the Quality Assurance/Quality Control (QA/QC) program is also conducted. An individual qualified in analytical and monitoring techniques who does not have direct responsibilities in the areas being audited performs the audit. The results of the QA/QC audit are documented with the ALARA Audit. The RSO has the primary responsibility for the implementation of the radiological QA/QC programs at the Crow Butte Project facilities.

5.4.4 Records Management

Detailed discussions of recordkeeping policies, responsibilities and procedures are maintained in CBR's SHEQMS Program Volume II, Management Procedures Manual. Key components of the recordkeeping retention policies are discussed below.

Determination of Records to be Maintained

Records that are maintained as part of the CBR's records retention policy are identified by utilizing the following sources of information:

- Records and maintenance periods established by regulations (e.g., 10 CFR 20 and 10 CFR 40);
- Records and maintenance periods established by license or permit requirements;
- Records established by industry and international standards (e.g., ISO-14001:2004); and
- Records established by Company policies.

Records that are deemed critical to records retention includes, but is not limited to:

- Decision on communication of significant environmental aspects*;
- Record of changes to documented procedures resulting from corrective action*;
- External communication records*;

- SHEQMS audit records*;
- EMS management review records*;
- Records of calibration and maintenance of monitoring equipment*;
- Training records*;
- Information on applicable laws or other requirements;
- Process monitoring information, where it has a bearing on environmental, health and safety aspects, impacts, or operational controls;
- Monitoring data;
- Change management records;
- Nonconformance and incident reports;
- Information on emergency response situations; and
- Product information, including lists and composition of products (i.e. MSDS's).

* required by the ISO 14001:2004 and OHSAS-18001:1999 standards

Records are classified as permanent and non-permanent for purposes of retention timelines:

- Permanent records are maintained for the life of the project, operation or facility. **All such records must be maintained until the NRC has terminated any license authorizing operations.** These records may be required to meet any of the following criteria:
  1. Records that are required to maintain and decommission a facility (e.g., operating history);
  2. Information which may be of value in determination of an accident, a malfunction, etc., (e.g., test results);
  3. Baseline data;
  4. Personnel medical records, including health physics data;
  5. Facility design documents;
  6. Monitoring data identified in State permits and NRC licenses.
- Non-permanent records are those that do not meet any of the above criteria but are required to provide evidence that an activity was performed according to the requirements. Examples of these types of records are certificates, inspection reports, operator qualifications, purchase orders, personnel qualifications, inspections and test plans, audits, etc.

CBR complies with the record retention requirements stated in 10 CFR 20 and 10 CFR 40. For example, this would include, but not limited to, requirements specified in 10 CFR 20.2102 (Records of radiation protection programs), 20.2103 (Records of surveys), 20.2104 (determination of prior occupational doses), 20.2105 (Any records of planned

special exposures), 20.2106 (Records of individual monitoring results), 20.2107 (Records of dose to individual members of the public) and 20.2108 (Records of waste disposal). In addition records would be retained as specified in 10 CFR 40.61 (Records) for the receipt, transfer, and disposal of source or byproduct material as specified in this regulation. Record retention timelines typically vary from 3 years following the generation of the record or until termination of the license that authorizes the activity and associated record. For example, as per 10 CFR 20.2102, records of CBR's radiation protection program (including provisions of the program) shall be maintained until the NRC terminates the site's radioactive material license requiring the record, and records of audits and other reviews shall be maintained for 3 years after the record is made.

Where possible, site records are identified in the appropriate project implementing procedures. Retention time and personnel responsible for handling of the records are also identified. For instance, record retention times for radiological monitoring records required by the NRC License are identified in CBR's SHEQMS Program Volume IV, Health Physics Manual.

All records are required to be legible and traceable to the applicable activity, product or service. The form of records is maintained as per 10 CFR 20.2110.

Record Storage

Obsolete versions of some documents may be considered a record and will be retained in the SHEQMS Program records. An example would be history copies of previous revisions of implementing procedures and operating manuals.

Records are filed as to allow for prompt retrieval in accordance with the retention time criteria stipulated in CBR's Record Management Matrix.

Records are stored in an environment that minimizes damage or deterioration and/or loss. Backup copies of critical and permanent records are maintained in a separate location. Backup copies may be paper or electronic versions.

Records are retained for a minimum of three years unless otherwise specified in other documents or subject to longer record retention requirements specified in regulations such as 10 CFR 20 and 10 CFR 40.

Review of Recordkeeping Requirements

The format and contents of the records will be reviewed at least annually as part of the established review of the site programs and changes initiated will be reflected in the revisions to this procedure.

As additional EMS-related records (including new or revised regulatory requirements) are identified, they will be incorporated into this recordkeeping review procedure as part of continual improvement to this procedure.

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5.5 HEALTH PHYSICS QUALIFICATIONS

CBR project staff is highly experienced in the management of uranium development, mining, and operations. The following are the minimum required personnel specifications and qualifications.

5.5.1 Radiation Safety Officer Qualifications

The minimum qualifications for the RSO are as follows:

- Education - A Bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in UR facility radiation protection. Two years of relevant experience are generally considered equivalent to one year of academic study.
- Health Physics Experience - At least 1 year of work experience relevant to UR operations in applied health physics, radiation protection, industrial hygiene or similar work. This experience should involve actually working with radiation detection and measurement equipment, not strictly administrative or "desk" work.
- Specialized Training – At least 4 weeks of specialized classroom training in health physics specifically applicable to uranium recovery. In addition, the RSO should attend refresher training on UR facility health physics every 2 years.
- Specialized Knowledge - A thorough knowledge of the proper application and use of all health physics equipment used in the UR facility, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposures to uranium and its daughters, and a thorough understanding of the UR process and equipment used in the facility and how hazards are generated and controlled during the UR process.

5.5.2 Health Physics Technician Qualifications

The HPT will have one of the following combinations of education, training, and experience:

- Education - An Associate's degree or 2 years or more of study in the physical sciences, engineering, or a health-related field;

  Training - At least a total of 4 weeks of generalized training (up to 2 weeks may be on-the-job training) in radiation health protection applicable to UR facilities;

Experience - One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a UR facility; or

- Education - A high school diploma is required.

  Training – A total of at least 3 months of specialized training (up to 1 month may be on-the-job training) in radiation health protection relevant to UR facilities;

- Experience - Two years of relevant work experience in applied radiation protection.

5.6 TRAINING

All site employees and contractor personnel at the Crow Butte Project are administered a training program based on the SHEQMS Program covering radiation safety, radioactive material handling, and radiological emergency procedures. This training program is administered in keeping with standard radiological protection guidelines and the guidance provided in USNRC Regulatory Guide 8.29, *Instructions Concerning Risks From Occupational Radiation Exposure* (Revision 1, February 1996); Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002); and Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure* (Revision 3, June 1999). The technical content of the training program is under the direction of the RSO. The RSO or a qualified designee conducts all radiation safety training.

5.6.1 Training Program Content

5.6.1.1 Visitors

Visitors to the Crow Butte Project who have not received training are escorted by on-site personnel who are properly trained and familiar with the hazards of the facility. At a minimum, visitors are instructed specifically on what they should do to avoid possible hazards in the area of the facility that they are visiting.

5.6.1.2 Contractors

Any contractors having work assignments at the facility are given appropriate radiological safety training. Contract workers who will be performing work on heavily contaminated equipment receive the same training normally required of Crow Butte workers as discussed in **Section 5.6.1.3**.

5.6.1.3 Crow Butte Resources Employees

The CBR SHEQMS Program Volume VII, *Training Manual*, incorporates the following topics recommended in USNRC Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002), USNRC's Regulatory Guide 8.29, *Instruction Concerning Risks from Occupational Radiation Exposure (Revision 1, February 1996)*, and USNRC Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure (Revision 3, June 1999)*:

<u>Fundamentals of Health Protection</u>

- The radiological and toxic hazards of exposure to uranium and its daughters.

- How uranium and its daughters enter the body (inhalation, ingestion, and skin penetration), and
- Why exposures to uranium and its daughters should be kept as low as reasonably achievable (ALARA).

Personal Hygiene at Uranium Mines

- Wearing protective clothing;
- Using respirators when appropriate;
- Eating, drinking, and smoking only in designated areas; and
- Using proper methods for decontamination.

Facility-provided Protection

- Cleanliness of working spaces,
- Safety designed features for process equipment,
- Ventilation systems and effluent controls,
- Standard Operating Procedures, and
- Security and access control to designated areas.

Health Protection Measurements

- Measurements of airborne radioactive material,
- Bioassay to detect uranium (urinalysis and in vivo counting),
- Surveys to detect contamination of personnel and equipment, and
- Personnel dosimetry.

Radiation Protection Regulations

- Regulatory authority of USNRC, MSHA, and state;
- Employee rights in 10 CFR Part 19; and
- Radiation protection requirements in 10 CFR Part 20.

Emergency Procedures

All new workers, including supervisors, are given specialized instruction on the health and safety aspects of the specific jobs they will perform. This instruction is performed in the form of individualized on-the-job training. Retraining is conducted annually and documented. Every 2 months, all workers attend a general safety meeting.

Consistent with USNRC Regulatory Guide 8.13, *Instruction Concerning Prenatal*

Radiation Exposure (Revision 3, June 1999), all female workers and those supervisors who will work with them will be given specific instruction about prenatal exposure risks to the developing embryo and fetus.

5.6.2 Testing Requirements

A written test with questions directly relevant to the principals of radiation safety and health protection in the facility covered in the training course is given to each worker. The instructor reviews the test results with each worker and discusses incorrect answers to the questions with the worker until worker understanding is achieved. Workers who fail the exam are retested, and test results remain on file.

5.6.3 On-The-Job Training

5.6.3.1 Health Physics Technician

On-the-job training is provided to HPTs in radiation exposure monitoring and exposure determination programs, instrument calibration, plant inspections, posting requirements, respirator programs, and health physics procedures contained in the SHEQMS Program Volume IV, *Health Physics Manual*.

5.6.4 Refresher Training

Following initial radiation safety training, all permanent employees and long-term contractors receive ongoing radiation safety training as part of the annual refresher training and, if determined necessary by the RSO, during monthly safety meetings. This ongoing training is used to discuss problems and questions that have arisen, any relevant information or regulations that have changed exposure trends, and other pertinent topics.

5.6.5 Training Records

Records of training are kept for 5 years for all employees trained as radiation workers (occupationally exposed employees).

5.6.6 Qualifications and Requirements for Daily Inspections

Cameco conducts daily walk-through inspections of all work and storage areas of the facility to ensure proper implementation of good radiation safety procedures, including good housekeeping and cleanup practices that minimize unnecessary contamination. Normally, these inspections are conducted by the RSO or an HPT. However, on certain occasions, such as weekends or holidays, a qualified operator may be designated to conduct the daily inspection.

Crow Butte Resources will use an alternative approach to qualify designated operators to conduct daily walkthrough inspections of all work and storage areas at the Crow Butte

Plant and satellite facilities (**Appendix D**). One or more qualified designated operators will be identified to perform daily inspections in the occasional absence of the RSO and HPT.

A qualified designated operator will only perform daily inspections on weekends, holidays and times when both the RSO and HPT's must both be absent (e.g. illness or offsite training). With the exceptions of those instances when a Federal holiday falls on a Friday or Monday, the Thanksgiving holiday, or a site closure due to weather or other safety or security related event, qualified designated operators will not conduct the inspections for more than two days per week. When a Federal holiday falls on Friday or Monday, qualified designated operators may perform the daily inspections for a total of three consecutive days. For the Thanksgiving holiday only, the qualified designated operator may perform the daily inspections for four consecutive days. When weather or other safety or security related event causes a site closure, a qualified designated operator, if available, will continue performing the daily inspections until the RSO or HPT can access the site after such an event. The licensee will also have the RSO or HPT available by telephone while a qualified designated operator is performing the daily inspections.

Reports generated by a qualified designated operator will be reviewed by the RSO or an HPT as soon as practicable, but not later than the close of business the next work day following an absence (including site closure due to weather or other safety or security related event), weekend or holiday. The RSO or HPT review shall be annotated with date and time on the report or other document that can be inspected upon request.

Any problems noted by the designated operator during the daily inspection will be recorded on an inspection form, signed and dated, and retained on file. The RSO will review the inspection forms and take appropriate action to correct any noted problems.

A qualified designated operator has no authority for the development and administration of the radiation protection program, other than conducting daily inspections. He may not approve plans for new equipment, process changes, or changes in operating procedures that may affect the radiation protection program. He will not conduct radiation safety audits or make determinations about personnel dosimetry. A qualified designated operator may not authorize non-routine maintenance jobs involving potential for personnel radiation exposure or radioactive contamination for which there are no standard operating procedures nor an existing radiation work permit. The designated operator will not have the authority to release materials for unrestricted use. In the event of an emergency, the on-call RSO or HPT will be responsible for radiation protection decisions.

At the Crow Butte Plant and satellite facilities, the only activity required to be performed by the RSO or HPT on a daily basis is the daily inspection. Instrument calibrations are performed on a weekly basis during the regular workweek by the RSO or HPT. For that

reason, it is not necessary for the designated operator to perform any other HPT function on weekends or holidays.

The designated operator will observe, through visual inspection, radiation safety practices, housekeeping and implementation of the radiation safety program throughout the plant/satellite. Such duties include, but not be limited to, inspecting for compliance with radiation safety postings, contamination control, proper control point ingress and egress, control of airborne radioactivity, worker protection practices in the yellowcake drying and packaging area, and proper storage of byproduct material.

5.6.6.1 Minimum Qualifications for Designated Operators

Before a designated operator may conduct such inspections, he must be qualified by reason of training and experience to observe proper implementation of good radiation safety practices. In addition to the annual radiation worker training required by Regulatory Guide 8.31, Section 2.5, the operator seeking designation must not only complete one-time training specific to daily inspections, but also demonstrate proficiency. The additional training will emphasize how the inspections affect employee safety.

At a minimum, the operator seeking designation must have the following combination of education, training and experience:

Education: a high school diploma or equivalent.

Training: New employee radiation safety training, including guidance pertinent to prenatal radiation exposure (Regulatory Guide 8.13) and instruction concerning risks from occupational radiation exposure (Regulatory Guide 8.29) and additional training specific to conducting daily inspections at Crow Butte ISR facilities. In addition, the designated operator will be required to demonstrate proficiency during daily inspections to the RSO.

Experience: A minimum of three months' work experience in operations or maintenance at a uranium recovery facility, including procedures that involve health physics, industrial safety or industrial hygiene at a uranium recovery facility to demonstrate qualification is required.

5.6.6.2 Additional Training for Designated Operators

The additional radiation safety training afforded to operators seeking designation involves four hours training and a test covering the topics discussed below with an 80 percent passing grade, but does not include the more advanced topics required for the facility RSO or HPT.

The additional training for Designated Operator includes the following topics:

1. Employee PPE usage
2. Personal contamination control (ingress and egress)
3. Radiation area boundaries
4. Signage
5. Labeling
6. Leaks
7. Yellowcake spillage
8. Ventilation
9. General housekeeping
10. Reporting procedures specific to type of finding (e.g., how and when to contact the on-call RSO or HPT)
11. Completion and control of the daily inspection form

5.6.6.3 Demonstration of Proficiency

Upon completion of training and prior to designation, an operator will be required to demonstrate to the RSO an understanding of and proficiency in conducting the daily inspections. Prior to performing inspections, the operator seeking designation will perform a minimum of four (4) daily inspections under the supervision of the RSO or HPT. The supervised inspections will cover the training topics listed above and will be documented with signatures of the RSO and HPT and the operator seeking designation on the daily inspection form. An operator who fails to qualify will be re-evaluated after performing additional supervised inspections until proficiency is demonstrated to the satisfaction of the RSO.

5.6.6.4 Documentation

The designation process will be documented in a file which includes education, training results with a passing test score, and signed supervised daily inspection forms. The designation itself will be co-signed by the Designated Operator and the RSO when the RSO is satisfied that the training and supervised inspections demonstrate proficiency.

5.6.6.5 Maintaining Designated Operator Status

To remain qualified, the Designated Operators must complete an annual refresher training which addresses the same topics covered in the additional training described above. A test will be given with a required passing grade of 80 percent. In addition, the Designated Operator must complete at least two (2) supervised inspections performed semiannually under the direct supervision of the RSO or HPT.

5.7 SECURITY

CBR security measures for the current operation are specified in the Security Plan and Security Threat chapter in Volume VIII, *Emergency Manual*. CBR is committed to:

- Providing employees with a safe, healthy, and secure working environment;
- Maintaining control and security of USNRC licensed material;
- Ensuring the safe and secure handling and transportation of hazardous materials; and
- Managing records and documents that may contain sensitive and confidential information.

The USNRC requires licensees to maintain control over licensed material (i.e., natural uranium ["source material"] and byproduct material defined in 10 CFR §40.4). 10 CFR 20, Subpart I, *Storage and Control of Licensed Material*, requires the following:

§20.1801 Security of Stored Material

The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.

§20.1802 Control of Material not in Storage

The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.

Stored material at the Crow Butte Project would include uranium packaged for shipment from the facility or byproduct materials awaiting disposal. Examples of material not in storage would include yellowcake slurry or loaded ion exchange resin removed from the restricted area for transfer to other areas.

5.7.1 License Area and Plant Facility Security

5.7.1.1 Central Processing Facility Area

All Central Processing Facility areas where source or byproduct material is handled are fenced. The main access road is equipped with a locking gate. Strategically placed surveillance cameras monitor the access road and areas around the Central Processing facility. A 24-hour-per-day, 7-day-per-week staff is on duty in the Central Processing facility.

Central Plant operators perform an inspection to ensure the proper storage and security of licensed material at the beginning of each shift. The inspection determines whether all licensed material is properly stored in a restricted area or, if in controlled or unrestricted areas, is properly secured. In particular, operators ensure that loaded ion exchange resin, slurry, drummed yellowcake, and byproduct material are properly secured. If licensed material is found outside a restricted area, the operator will ensure that it is secured, locked, moved to a restricted area, or kept under constant surveillance by direct observation by site personnel or surveillance cameras. The results of this inspection will be properly documented.

5.7.1.2 Office Building

There is a reception area located at the main entrance into the office building. All other entrances are locked during off-shift hours. There are a limited number of traceable keys to the office, and they are given out to select employees. The main door and the door to the Central Plant Facility entrance are also equipped with an access keypad.

Visitors entering the office are greeted by the receptionist and announced to the receiving person. All visitors are required to sign the access log and indicate the purpose of their visit and the employee to be visited. The person being visited is responsible to supervise the visitors at all times when they are on site. Visitors are only allowed at the facility during regular working hours unless prior approval is obtained from the Restoration Manager or the SHEQ Coordinator.

5.7.2 Transportation Security

CBR routinely receives, stores, uses, and ships hazardous materials as defined by the U.S. Department of Transportation (DOT). In addition to the packaging and shipping requirements contained in the DOT Hazardous Materials Regulations (HMR), 49 CFR 172, Subpart I, *Security Plans* requires that persons who offer for transportation or transport certain hazardous materials develop a Security Plan. Shipments may qualify for this DOT requirement under the following categories:

§172.800(b)(4) A shipment of a quantity of hazardous materials in a bulk package having a capacity equal to or greater than 13,248 L (3,500 gallons) for liquids or gases or more than 13.24 cubic meters (468 cubic feet) for solids;

§172.800(b)(5) A shipment in other than a bulk packaging of 2,268 kg (5,000 pounds) gross weight or more of one class of hazardous material for which placarding of a vehicle, rail car, or freight container is required for that class under the provisions of subpart F of this part;

§172.800(b)(7) A quantity of hazardous material that requires placarding under the provisions of subpart F of this part.

DOT requires that Security Plans assess the possible transportation security risks and evaluate appropriate measures to address those risks. All hazardous materials shippers and transporters subject to these standards must take measures to provide personnel security by screening applicable job applicants, prevent unauthorized access to the hazardous materials or vehicles being prepared for shipment, and provide for en route security. Companies must also train appropriate personnel in the elements of the Security Plan.

Transport of licensed/hazardous material by CBR employees will generally be restricted to transferring contaminated equipment between company facilities. This transport generally occurs over short distances through remote areas. Therefore, the potential for a security threat during transport by CBR vehicle is minimal. The goal of the driver, cargo, and equipment security measures is to ensure the safety of the driver and the security and integrity of the cargo from the point of origin to the final destination by:

- Clearly communicating general point-to-point security procedures and guidelines to all drivers and non-driving personnel;
- Providing the means and methods of protecting the drivers, vehicles, and customer's cargo while on the road; and
- Establishing consistent security guidelines and procedures that shall be observed by all personnel.

For the security of all tractors and trailers, the following procedures will be utilized:

- If material is stored in the vehicle, access must be secured at all openings with locks and/or tamper indicators.
- Off-site tractors will always be secured when left unattended with windows closed, doors locked, the engine shut off, and no keys or spare keys in or on the vehicle.
- The unit is to be kept visible by an employee at all times when left unattended outside a restricted area.

The security guidelines and procedures apply to all transport assignments. All drivers and non-driving personnel are expected to know and adhere to these guidelines and procedures when performing any load-related activity.

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CAMECO RESOURCES

Security Plan (highlighted version)

2017 SERP Actions

Proposed Security Plan

(Edited Version)

Crow Butte Resources, Inc.
d/b/a Cameco Resources
Crow Butte Operation

SECURITY PLAN

~~June 29, 2016~~November 10, 2017
~~Revision #3~~Revision #4

SECURITY PLAN

Purpose and Scope

Crow Butte Operation (CBO) is committed to:

- Providing employees with a safe, healthful, and secure working environment;
- Maintaining control and security of NRC licensed material;
- Ensuring the safe and secure handling and transporting of hazardous materials;
- Managing records and documents that may contain sensitive and confidential information;

The purpose of this Security Plan is to ensure that CBO operations are conducted in such a manner that these objectives are met.

This plan applies to CBO operations at the Crow Butte Uranium Project and other CBO properties, as appropriate. This plan also applies to the transport of licensed or hazardous materials by CBO employees over public highways.

Regulatory Requirements

Security and Control of NRC Licensed Material

CBO is authorized by a license issued by the U.S. Nuclear Regulatory Commission (NRC) to receive, acquire, possess, and transfer natural uranium ("source material") and byproduct material defined in 10 CFR §40.4 as follows:

Source Material: (1) Uranium in any physical or chemical form or (2) ores that contain by weight greater than one twentieth of one percent (0.05%) uranium. Common examples would include uranium in solution, loaded on ion exchange resins, in slurry form, or as dry product.

Byproduct Material: The tailings or wastes produced by the extraction or concentration of uranium from any ore processed primarily for its source material content, including surface wastes resulting from uranium solution extraction processes. Common examples would include contaminated equipment, materials, and wastes produced during facility operations.

The NRC requires licensees to maintain control over such licensed material. 10 CFR 20, Subpart I, *Storage and Control of Licensed Material*, requires the following:

§20.1801 Security of Stored Material

> The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.

§20.1802 Control of Material not in Storage

> The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.

Stored material would include uranium packaged for shipment from the facility or byproduct materials awaiting disposal. Examples of material not in storage would include yellowcake slurry or loaded ion exchange resin removed from the restricted area for transfer to other areas.

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CBO routinely receives, stores, uses, and ships hazardous materials as defined by the U.S. Department of Transportation (DOT). In addition to the packaging and shipping requirements contained in the DOT Hazardous Materials Regulations (HMR), 49 CFR 172, Subpart I, *Security Plans*, requires that persons that offer for transportation or transport certain hazardous materials develop a Security Plan. Shipments may qualify for this DOT requirement under the following categories:

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§172.800(b)(7) A quantity of hazardous material that requires placarding under the provisions of subpart F of this part.

DOT requires that Security Plans assess the possible transportation security risks and evaluate appropriate measures to address those risks. All hazardous materials shippers and transporters subject to these standards must take measures to provide personnel security by screening applicable job applicants, prevent unauthorized access to the hazardous materials or vehicles being prepared for shipment, and provide for en route security. Companies must also train appropriate personnel in the elements of the Security Plan.

Responsibilities

Responsibilities of personnel have been designed to both ensure compliance and further implement CBR's policy for providing a safe working environment with cost-effective incorporation of the philosophy of maintaining radiation exposures as low and reasonably achievable (ALARA). The specific responsibilities of security plan personnel including managerial and operational personnel are described in Section 5 of the Source Material License Renewal, SUA-1534. The Crow Butte Resources Organizational Chart, is shown in Section 5, Figure 5.1-1 of the Source Material License Renewal, SUA-1534. Organizational changes will be maintained through the Safety Environmental Review Panel (SERP) process.

Restoration Manger

The Restoration Manger will ensure that the individuals responsible for implementing this Security Plan have the appropriate training and resources required.

SHEQ ~~Manager~~Coordinator

The SHEQ ~~Manager~~ Coordinator has overall responsibility for the implementation of the Security Plan. The SHEQ ~~Manager~~ Coordinator will periodically review this plan for improvements. In addition, the SHEQ ~~Manager~~ Coordinator will be responsible for reviewing Security Plans submitted by carriers that are contracted to transport materials covered by this plan.

Individual

Individuals whose job functions involve maintaining control of licensed material or shipping and transporting radioactive materials are responsible for ensuring that the security requirements of this plan are implemented.

Permit Area and Facility Security

CBO provides adequate measures to ensure the safety and security of employees, contractors, visitors and CBO equipment and facilities. This section was developed to explain the general security procedures and guidelines that apply to the physical structures and facilities within the permit area. Following are the guidelines and procedures that apply to security issues related to CBO physical facilities:

Central Processing and Restoration Facility Areas

All Central Processing and Restoration facility areas where source or byproduct material is handled are fenced. The main access road is equipped with a locking gate. The access road and areas around the Central Processing facility are monitored by strategically placed surveillance cameras. A 24-hour per day 7-day per week staff is on duty at these facilities.

Plant Operators perform an inspection to ensure the proper storage and security of licensed material at the beginning of each shift. The inspection determines whether all licensed material is properly stored in a restricted area or, if in controlled or unrestricted areas, is properly secured. In particular, Operators will ensure that loaded ion exchange resin, slurry, drummed yellowcake, and byproduct material is properly secured. If licensed material is found outside a restricted area, the Operator ensures that it is secured, locked, moved to a restricted area, or kept under constant surveillance by direct observation or surveillance cameras. The results of this inspection are documented in the Control Room Log Book.

Mine Units and Wellhouses

Lixiviant is found in injection piping in the wellfields, wellhouses and trunklines to the Central Processing Plant and Restoration Building. All mine units and wellfields are fenced and all entry gates have signs posted restricting public access. Each wellhouse is locked with an electronic keypad. The mine site is staffed 24-hours a day, 7-days per week. During each shift an inspection is performed to ensure each wellhouse is secure, free of leaks, and to verify correct pressures and settings are maintained. During the shift inspection, wellfields (Mine Units) are monitored for trunkline leaks and to monitor for unauthorized access. Inspections are documented on the Shift Wellfield Inspection sheet and the Control Room Log Book. Nonconformities are reported to appropriate supervisors and site management for further evaluation and corrective actions if necessary.

Office Building

There is a reception area located at the main entrance into the office building. All other entrances are locked during off-shift hours. There are a limited number of traceable keys to the office and they are given out to select employees. The main door and the door to the Central Plant facility entrance are also locked with an electronic keypad.

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Driver, Cargo and Equipment Security

Transport of licensed/hazardous material by CBO employees is generally restricted to moving ion exchange resin from a Satellite facility to the Central Processing Plant or transferring contaminated equipment between company facilities. This transport generally occurs over short distances through remote areas. Therefore, the potential for a security threat during transport by CBO vehicle is minimal. The goal of the driver, cargo, and equipment security measures is to ensure the safety of the driver and the security and integrity of the cargo from the point of origin to the final destination by:

- Clearly communicating general point-to-point security procedures and guidelines to all drivers and non-driving personnel;

- Providing the means and methods of protecting the drivers, vehicles, and customer's cargo while on the road; and
- Establishing consistent security guidelines and procedures that shall be observed by all personnel.

Locked and Secured Equipment

For the security of all tractors and trailers, the following must be adhered to:

- If material is stored in the vehicle, access must be secured at all openings with locks and/or tamper indicators;
- Off-site tractors will always be secured when left unattended with windows closed, doors locked, the engine shut off, and no keys or spare keys in or on the vehicle;
- The unit is to be kept visible by an employee at all times when left unattended outside a restricted area.

The security guidelines and procedures apply to all transport assignments. All drivers and non-driving personnel are expected to be knowledgeable of, and adhere to, these guidelines and procedures when performing any load-related activity.

Training

All drivers and employees are required to attend training upon employment in accordance with the training requirements specified in SHEQMS Program Volume VII, *Training Manual*. The training includes (but is not limited to):

- The need for awareness;
- Security requirements in this plan;
- Employee, material, and equipment security;
- Specialized "Hazardous Material" training required under the DOT HMR;
- Workplace violence

Hazardous Material Control and Training

Hazardous materials and specialized radioactive shipments (Class 7) training sessions are conducted for all employees involved in handling, packaging, shipping, and transporting hazardous materials as defined by DOT.

The training includes all regulatory requirements of the following:

Emergency Preparedness procedures prepared for use in the event of an emergency involving a radioactive materials shipment and are contained in SHEQMS Program Volume VIII, *Emergency Manual*, CBR-EPRP-008. These procedures contain the emergency contact and product information necessary to

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All key management personnel are trained in Emergency Response. Periodic meetings are held to review and modify procedures, as required. Key management personnel are available for emergency response through the Emergency Notification procedures in SHEQMS Program Volume VIII, *Emergency Manual*, CBR-EPRP-010.

CAMECO RESOURCES

Security Plan (replacement pages)

2017 SERP Actions

Proposed Security Plan

(Final Version)

Crow Butte Resources, Inc.
d/b/a Cameco Resources
Crow Butte Operation

SECURITY PLAN

November 10, 2017
Revision #4

SECURITY PLAN

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All drivers and employees are required to attend training upon employment in accordance with the training requirements specified in SHEQMS Program Volume VII, *Training Manual*. The training includes (but is not limited to):

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All key management personnel are trained in Emergency Response. Periodic meetings are held to review and modify procedures, as required. Key management personnel are available for emergency response through the Emergency Notification procedures in SHEQMS Program Volume VIII, *Emergency Manual*, CBR-EPRP-010.

CAMECO RESOURCES

Quality Assurance Program (highlighted version)

2017 SERP Actions

CROW BUTTE RESOURCES, INC.

SERP 17-04

Proposed Quality Assurance Program

(Edited Version)

CROW BUTTE RESOURCES, INC.
d/b/a
CAMECO RESOURCES
CROW BUTTE OPERATION

QUALITY ASSURANCE PROGRAM

Approved by License Amendment #2
October 5, 2017

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1 OBJECTIVES AND ELEMENTS OF A QUALITY ASSURANCE PROGRAM

To define the objectives of a Quality Assurance (QA) program, it is important to first define what quality assurance is and its relationship to quality control.

Quality assurance comprises all those planned and systematic actions that are necessary to provide adequate confidence in the results of a monitoring program. Quality control comprises those quality assurance actions that provide a means to control and measure the characteristics of measurement equipment and processes to established requirements. Therefore, quality assurance includes quality control.

The overall objectives of a QA program are:

- To identify deficiencies in the sampling and measurement processes to those responsible for these operations so that corrective action can be taken, and
- To obtain some measure of confidence in the results of the monitoring programs in order to assure the regulatory agencies and the public that the results are valid.

To achieve these objectives, the QA plan contains the following elements:

- Designation of an individual within the organization as the QA Coordinator. The QA Coordinator should undertake activities such as quality planning, audits and programs to insure reliability and should have the responsibility to assure that the QA plan is being properly implemented.
- A systematic policy for selection and use of measurement and sampling methodology. Where available, this methodology should be approved by the appropriate agency.
- Procedures for the documentation and review of operating procedures and instructions.
- QA audits of acceptance criteria for a QA plan to determine on a systematic basis that all planned activities are being done.

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2 ORGANIZATIONAL STRUCTURE AND RESPONSIBILITIES OF MANAGERIAL AND OPERATIONAL PERSONNEL

Responsibilities of personnel have been designed to both ensure compliance and further implement CBR's policy for providing a safe working environment with cost-effective incorporation of the philosophy of maintaining radiation exposures as low and reasonably achievable (ALARA). The specific responsibilities of QA personnel including managerial and operational personnel are described in Section 5 of the Source Material License Renewal, SUA-1534. The Crow Butte Resources Organizational Chart, is shown in Section 5, Figure 5.1-1 of the Source Material License Renewal, SUA-1534. Organizational changes will be maintained through the Safety Environmental Review Panel (SERP) process.

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3 QUALIFICATION AND TRAINING OF PERSONNEL

The minimum qualifications of operational personnel involved in the QA program are as follows:

3.1 PRESIDENT OF CBR

Bachelor's degree in engineering or science field and five (5) years' experience or equivalent in mine operations management or a related field.

3.2 GENERAL MANAGER OF US OPERATIONS

Bachelor's degree in engineering or science field and five (5) years' experience or equivalent in mine operations management or a related field.

3.3 RESTORATION MANAGER

Bachelor's degree in engineering or science field and three (3) years' experience or equivalent in mine operations management or a related field.

3.4 ~~MANAGER OF SAFETY, HEALTH, ENVIRONMENT, AND QUALITY~~SHEQ COORDINATOR

Bachelor's degree in science, industrial hygiene, environmental technology or engineering or an equivalent combination of training and relevant experience in uranium mill/solution mining radiation protection. A minimum of 3 years working in environmental protection or related regulatory experience in a similar field. The ~~Manager of Safety, Health, Environment and Quality~~SHEQ Coordinator will serve as the Quality Assurance Coordinator.

3.5 RADIATION SAFETY OFFICER

3.5.1 Education

A Bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in UR facility

radiation protection. Two years of relevant experience are generally considered equivalent to one year of academic study.

3.5.2 Health Physics Experience

A minimum of one year of work experience relevant to UR operations in applied health physics, radiation protection, industrial hygiene or similar work. This experience should involve actually working with radiation protection and measurement equipment, not strictly administrative or "desk" work.

3.5.3 Specialized Training

At least four weeks of specialized classroom training in health physics specifically applicable to uranium recovery. In addition, the RSO should attend refresher training on UR facility health physics every 2 years.

3.5.4 Specialized Knowledge

A thorough knowledge of the proper application and use of all health physics equipment used in the UR facility, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to uranium and its daughters, and a thorough understanding of the UR process and equipment used in the facility and how the hazards are generated and controlled during the UR process.

3.6 HEALTH PHYSICS TECHNICIAN

3.6.1 Education

An associate degree or two years or more of study in the physical sciences, engineering or a health related field.

3.6.2 Training

At least a total of four weeks of generalized training (up to 2 weeks may be on the job training) in radiation health protection applicable to UR facilities.

3.6.3 Experience

One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a UR facility.

3.6.4 Alternate Qualifications and Training

The HPT may also possess the following alternate qualification and training:

- Education - A high school diploma
- Training - A total of at least three months of specialized training (up to 1 month may be on the job training) in radiation protection relevant to UR facilities.
- Experience - Two years of relevant work experience in applied radiation protection.

3.7 PLANT SUPERVISOR

Bachelor's degree in science or a closely related field. Minimum of 2 years working experience in ISR Plant Operations.

~~3.8 SHEQ SPECIALIST~~

~~Bachelor's degree in science or a closely related field. Minimum of 3 years working in safety, health environment and quality or related regulatory experience in a similar field.~~

~~3.9~~3.8 LAB FOREMAN

The minimum qualifications for a Lab Foreman are two years of post-secondary education in Chemistry or Physical science and two years of inorganic laboratory experience. At least one year of this experience should be at a UR facility.

~~3.10~~3.9 QUALIFIED DESIGNATED OPERATOR

The minimum qualifications and training requirements for a qualified Designated Operator are described in Section 5.6.6 of the Source Material License Renewal (November 2014).

~~3.11~~3.10 TRAINING

Personnel performing quality related activities will be trained in the principals and techniques of the activities performed. An on-the-job training program that will be administered by experienced professionals will achieve training of the field personnel.

~~3.12~~3.11 TRAINING EVALUATION

On an annual basis, the ~~Manager~~ SHEQ Coordinator~~of SHEQ~~ or a designated outside consultant will observe field and plant personnel in the sample collection and analysis process and evaluate the personnel performance on the basis of adherence to written procedures.

4 OPERATING PROCEDURES

4.1 ADMINISTRATIVE AND OPERATION PROCEDURES

The CBR Quality Assurance Program is implemented through the use of written Standard Operating Procedures (SOPs). These SOPs have been developed for all process activities, including those activities involving radioactive materials, for the Crow Butte Uranium Project. Where radioactive material handling is involved, pertinent radiation safety practices are incorporated into the SOP. Additionally, SOPs contain instructions for performing non-process activities including instrument calibration, environmental monitoring, health physics monitoring, and emergency measures.

Quality assurance and control objectives are met by including the requirements for performance of quality control measures in the appropriate SOP. In some instances, separate SOPs are developed to implement quality measures.

Written SOPs are kept electronically and in hard copy in the areas of the plant facility where they are used. This allows for easy access by employees. Employees are trained on the appropriate SOPs for their job description when they are initially hired and when any procedure revisions are made.

4.2 TYPES OF PROCEDURES

The SOPs developed by CBR are a critical step to insuring that quality assurance objectives are met. Current SOPs exist for a variety of areas, including but not limited to:

1. Environmental monitoring procedures.
2. Testing and calibration procedures.
3. Exposure control procedures.
4. Equipment operation and maintenance procedures.
5. Employee radiological health and safety procedures.
6. Incident response procedures.
7. Laboratory procedures.

The CBR Safety, Health, Environment, and Quality Management System (SHEQMS) are organized into eight volumes. The volumes are as follows:

Volume I & II, *Management Procedures (CR-QMP)*
Volume III, *Operations Manual (CBR-SOP)*
Volume IV, *Health Physics Manual (CBR-RPP)*
Volume V, *Industrial Safety Manual (CBR-SHMP)*

Volume VI, *Environmental Manual (CBR-EMP)*
Volume VII, *Training Manual (CBR-TRG)*
Volume VIII, *Emergency Manual (CBR-EPRP)*

Specific SOPs that are used by CBR to implement quality measures are listed throughout this Quality Assurance Program. These SOPs may be revised and/or supplemented with additional SOPs to meet quality requirements as the need arises. The site also has a *Laboratory Procedures Manual* for a quality assurance/quality control program to determine the precision and accuracy of the laboratory analysis performed in the on-site laboratory.

4.3 PROCEDURE REVIEW AND APPROVAL

Written SOPs have been developed, reviewed and approved by the RSO and the responsible managers. The responsible manager ensures that the operational aspects of the SOP are correct and appropriate. All written SOPs are reviewed for radiological protection aspects and approved by the RSO prior to implementation.

SOPs are revised as necessary to meet changing operational and regulatory requirements. Any revisions made to the SOPs are reviewed and approved by the RSO and responsible manager prior to implementation. At a minimum, the SOPs are reviewed and, where necessary, revised, on an annual basis by the RSO. The annual review is documented by the RSO.

The personnel shown in Table 1 are responsible for approvals for each of the SHEQMS volumes.

Table 1
Procedure Approval Responsibility

SHEQMS Volume	**Radiological Protection Approval**	**Final Approval**
Volume I & II, *Quality Manual* (CR-QMP)	*	*
Volume III, *Operations Manual (CBR-SOP)*	RSO	*
Volume IV, *Health Physics Manual (CBR-RPP)*	RSO	RSO
Volume V, *Industrial Safety Manual (CBR-SHMP)*	RSO	*
Volume VI, *Environmental Manual (CBR-EMP)*	RSO	*
Volume VII, *Training Manual (CBR-TRG)*	RSO	*
Volume VIII, *Emergency Manual (CBR-EPRP)*	RSO	*
Laboratory Procedures Manual (CBR-LAB)	RSO	Lab Foreman

* Final procedure approval will be conducted by the responsible manager.

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5 INSTRUMENT CALIBRATION

CBR implements a routine maintenance and calibration program for all radiological survey instruments and samplers. This program is implemented through the use of appropriate SOPs. The CBR instrument maintenance and calibration program is based upon the recommendations contained in USNRC Regulatory Guide 4.15, *"Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) – Effluent Streams and the Environment,"* (Revision 2, 2007) and Regulatory Guide 8.30, *"Health Physics Surveys in Uranium Mills,"* (Revision 1, 2002).

5.1 INSTRUMENT CHECKS

CBR performs checks of radiation survey and counting equipment daily before use. The daily checks consist of a physical check and a response check. CBR also performs checks of counting instruments to determine instrument efficiency and sensitivity.

5.1.1 Vendor Calibration

The physical checks performed on a daily basis include verification that the instrument is properly calibrated, has sustained no physical damage that may interfere with accuracy, and that the instrument battery has adequate power (if appropriate).

The manufacturer or a qualified accredited vendor shall calibrate portable survey instruments, counter/scalers, mass flow meters and/or dry cell calibrators, and calibration sources. Calibration will be performed as recommended in ANSI N323 and ANSI N323A. The ANSI standard requires that radiation detection instruments be performance tested on an annual basis to verify that they continue to meet operational and design requirements. Instruments must be tested for range, sensitivity, linearity, detection limit, and response to overload. The specific calibration requirements for various types of instrument are given in the following sections.

5.1.1.1 Linear and Digital Readout Instruments

Linear readout instruments with a single calibration control for all scales shall be adjusted at the point recommended by the manufacturer. Instruments with calibration controls for each scale must be adjusted on all scales. After adjustment, the instrument must be checked near the end points (approximately 20% and 80% of full scale).

5.1.1.2 Logarithmic Readout Instruments

Logarithmic readout instruments normally have two or more adjustments. The instrument must be adjusted for each scale as recommended by the manufacturer. After adjustment, the instrument must be checked at a minimum of one point on each decade.

5.1.1.3 Surface Contamination Measurement Instruments

Alpha and beta-gamma detection instruments usually consist of a count rate meter and a separate detector. The electronics and the detector may be calibrated together or separately. The detector should be calibrated with the radionuclide to be detected, if possible, or with radionuclides of similar energies. When the instrument is calibrated as an integral unit, a minimum of one point on each scale is calibrated up to approximately 6×10^4 dpm/100 cm^2. When calibrated separately, the count rate meter is calibrated with an electronic pulser. Exchange of detectors is allowed if the response to a calibrated check source is within the range of acceptable counts for the original probe and check source.

5.1.1.4 Radioactive Calibration Sources

Calibration sources, used to determine instrument operating parameters such as high voltage setting and efficiency, must be calibrated annually by the manufacturer or other accredited laboratory. Depending on the half-life of the radionuclide used for the source, decay correction may also be necessary during use to ensure accuracy. All calibration sources are stored in the Radiation Safety Laboratory and are secured after hours by a locked door.

5.1.1.5 Calibration Records

The calibration vendor shall provide a record of all calibration, maintenance, repair, or modification. Calibration records will be filed with all previous records for the same instrument. In addition, each instrument will be labeled with the following information:

- Date of most recent calibration;
- Initials of calibrator;
- Date that primary calibration is again required;
- Special use or limitations (if applicable);
- Serial number of the instrument.

5.1.1.6 Calibration Frequency

Calibration frequency is annual or at the frequency recommended by the manufacturer, whichever is more frequent. Where instruments are subjected to extreme operational conditions, hard usage, multi-shift use, or corrosive environments, the RSO should consider increasing the calibration frequency. The calibration vendor should provide the as-found calibration condition for each instrument. If greater than 10% of the instruments are out of calibration when received by the calibration vendor, consideration should be given to increasing the calibration frequency.

5.1.2 On-Site Calibration

Regulated air samplers (Eberline RAS-1 or equivalent) and high volume air samplers are calibrated semiannually or at the manufacturer's recommended frequency, whichever is more frequent. Breathing zone samplers are calibrated daily during use. With the exception of breathing zone samplers, air samplers should be labeled with the date of calibration, correction factors (if applicable), and initials of the calibrator. This information is recorded on the daily calibration sheet for the breathing zone samplers. All alpha counting systems used for radon daughter measurements are calibrated at least monthly using a known standard alpha source.

5.2 FUNCTIONAL TESTS

Functional tests are performed at the mine site to ensure that an instrument is acceptable for use. The functional tests are checks that are often qualitative and consider the physical condition of the instrument (e.g., battery condition) and response of the instrument to a radioactive source.

5.2.1 Initial Instrument Checks

Initial instrument checks are performed initially after receipt of the instrument from the calibration vendor. The results of these initial instrument checks are recorded and are used to ensure that a system continues to operate in as-received condition until the next scheduled calibration. These functional tests are also performed after any repair or if the response of the instrument to a known source is questioned.

5.2.1.1 Instrument Reliability (Chi-Square Test)

The instrument reliability (Chi Square Test) will indicate whether an instrument is operating properly within the statistical limits of counter reliability. The Chi-Square Test will be performed initially after receiving the appropriate type of instrument from the calibration vendor prior to returning the

instrument to service. The Chi-Square Test will also be performed at the discretion of the RSO or HPT in order to test the operational adequacy of the instrument. This test statistically evaluates the sample counter against a Poisson distribution. The Chi-Square Test should also be performed for an instrument that has not been in service for an extended period or for an instrument that has a daily source check count that falls outside the acceptable range. The Chi-Square value should be between 3.325 and 16.919. The Chi values correlate to p-values of 0.95 and 0.5 respectively. This implies that the instrument is operating reliably. A Chi-Square value outside this range will be investigated by the RSO.

5.2.1.2 Acceptable Range

The acceptable range will allow a quick determination that the daily source count performed for a specific instrument is within satisfactory limits. Note that the daily source count must be performed using the same calibrated source that was used to determine the reliability factor.

5.2.1.3 High Voltage Plateau Verification

The instrument high voltage plateau will indicate whether or not the high voltage applied to the instrument detector is set at the appropriate point for maximum sensitivity with minimal influence from background radiation levels. The high voltage is verified initially after receiving the appropriate type of instrument from the calibration vendor. The purpose of this high voltage plateau verification is to confirm the high voltage matches the calibration vendor's certificate. If the high voltage reading does not match the calibration certificate, the instrument will be taken out of service and returned to the vendor for recalibration.

A secondary purpose is to ensure that the setting was not affected by shipment of the instrument. A high voltage plateau verification should also be performed on an instrument when a new detector is installed or when there is a noticeable degradation in instrument performance as indicated by the daily functional tests. Performance problems would include a decrease in the instrument efficiency over time or erratic results indicated by a daily source check count that falls outside the acceptable range.

5.2.1.4 Lower Limit of Detection (LLD)

The instrument lower limit of detection (LLD) is the smallest concentration of radioactive material that has a 95 percent probability of being detected. The LLD will determine whether the instrument and counting procedures are capable of detecting the presence of radioactive material below the allowable regulatory limits (i.e., allowable air concentrations or removable activity concentrations). The LLD is a determination of sensitivity for a measurement system and is not intended to be calculated for individual samples.

If the LLD is at or above the allowable limit, adjustments will be made to reduce it to an acceptable level. Typically, the counting system LLD should be 10 percent of the allowable limit. In no case should the LLD be above 50% of the allowable limit. Increasing the sample count time, increasing the sample volume, or reducing background levels will lower the LLD.

The LLD is determined initially after receiving the instrument from the calibration vendor. LLD should also be determined for an instrument that has not been in service for an extended period or for an instrument that has required repairs or a high voltage plateau.

5.2.1.5 Minimum Detectable Concentration (MDC)

The LLD is the determination of sensitivity for a measurement system and is not intended to be calculated for individual samples. Minimum detectable concentration (MDC) is a measurement of the detection sensitivity for a single sample based on sampling and counting parameters and should be calculated to ensure adequate sensitivity is achieved for each sample.

5.2.2 Instrument Checks

Regulatory Guide 8.30 specifies requirements for routine maintenance and calibration of radiological surveys instruments. Regulatory Guide 8.30 also references the standards contained in ANSI N323-1978, *Radiation Protection Instrumentation Test and Calibration*. ANSI is in the process of a major revision of this Standard that will result in three separate Standards that apply to radiological instrumentation. The first revision, ANSI-N323A-1997, *Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments*, was incorporated in this Chapter. Where conflicts arise between Regulatory Guide 8.30 and the ANSI Standard, the Regulatory Guide recommendations have been followed.

5.2.2.1 Calibration Verification

Any survey or counting equipment in use shall have a current calibration sticker in place. Calibration stickers shall be checked before use or daily when in use. Calibration date and due date will be recorded on the appropriate form.

Air samplers shall have a current calibration sticker in place. Calibration stickers shall be checked each day before use of these regulated air samplers. Breathing zone samplers do not require calibration stickers if they are calibrated before each use. Calibration results will be recorded on the appropriate form.

5.2.2.2 Physical Check

Before each use, all instruments and samplers shall be inspected for physical condition. The inspection should include determining whether there are any loose or damaged knobs, buttons, cables, or connectors. Meter movements or displays should be inspected for damage. Instrument cases should be inspected for dents or corrosion. Probes should be inspected for damage such as punctured or deformed probes or probe windows.

An instrument that has any physical damage should not be placed in service. Repairs shall be made and documented.

5.2.2.3 Battery/High Voltage Check

The battery check is performed to determine the condition of the instrument's batteries. This check is important to ensure that there is sufficient voltage being supplied to the detector and the instrument circuitry. The battery check will be performed in accordance with the instructions contained in the appropriate instrument technical manual. If the battery check is unsatisfactory, refer to the technical manual for instruction for replacement of batteries and repeat the check. If results are still not satisfactory, remove the instrument from service until repairs can be made. Repairs shall be made and documented.

High voltage checks shall be performed in accordance with the appropriate instrument technical manual. The purpose of the high voltage check is to ensure that the proper voltage is being applied to the detector. The high voltage setting is provided by the instrument calibration vendor on the calibration certificate or is determined by performing a high voltage plateau.

5.2.2.4 Response Source Check

The response source check is made to ensure that the instrument in use will respond to a known source of radiation. The response check does not result in determination of efficiency or the instrument correction factor. The response check is typically performed before each use and indicates that the instrument has not sustained damage that would prevent it from detecting radiation. An example of a response check would be checking an alpha contamination survey meter at a restricted area access point with a check source of Th-230.

5.2.2.5 Constancy Check

Survey instruments should be checked for constancy of operation with a radiation check source prior to each usage or at a minimum checked weekly. If the instrument response to the radiation check source differs from the reference reading by more than 20%, the instrument should be repaired if necessary and recalibrated. The constancy check should be supplemented by calibrations at 12 month intervals or at the manufacturer's suggested interval whichever is shorter.

5.2.2.6 Background Measurement

Background measurements for radiation survey instruments are performed daily or as required. Local background may need to be determined before a particular use, such as performing a gamma radiation survey for characterization of potential contamination.

Background measurements for scaler type instruments are used to evaluate the radiation level in the area where the instrument is located. High background radiation levels will affect the sensitivity of scaler type instruments and will adversely affect the lower limit of detection (LLD).

5.2.2.7 Determination of Efficiency and Correction Factor

Instrument efficiency (E) is determined to check instrument performance when measured with a source of known activity of a particular radioisotope. A correction factor (CF) is determined that allows conversion of instrument cpm to disintegrations per minute (dpm) and is the inverse of the known efficiency (i.e., 1/E).

The instrument dpm Factor may be determined for contamination survey instruments to correct the indicated cpm to dpm per 100 cm^2. This factor is typically determined for instruments that are used for performing total surface contamination surveys since the action levels and regulatory limits are expressed in units of dpm/100 cm^2.

5.2.3 Instrument Check Schedules

Routine checks of radiation survey and counting instruments are made to ensure that the instrument is responding accurately and is in proper condition for field use. The check schedule for each type of instrument based on the guidance contained in Regulatory Guide 8.30. Specific instructions for performing these checks on each instrument are contained in the appropriate instrument technical manual.

5.2.3.1 Radiation Survey Instruments

Radiation survey type instruments include the Ludlum Model 3 Gamma Survey Meter and the Ludlum Model 2224-1with a 43-93 probe or equivalent. These instruments require the following checks at the noted frequency:

- Physical check – Daily when in use;
- Battery Check (if applicable) – Daily when in use;

- Response source check – Daily when in use;
- Calibration verification – Daily when in use;
- Background measurement – Daily when in use, as required.

5.2.3.2 Surface Contamination Instruments

Surface contamination instruments are used to measure alpha and beta-gamma surface contamination levels and include the Ludlum Model 2241 Ratemeter/Scaler Survey Meter or equivalent. These instruments require the following checks at the noted frequency:

- Response source check – Before each use;
- Battery Check (if applicable) – Daily when in use;
- High Voltage Check (if applicable) – Daily when in use;
- Calibration verification check – Daily when in use;
- Background measurement – Daily when in use, as required;
- Determination of efficiency/correction factor – Daily when in use;
- Determination of instrument reliability factor – Initially after calibration.

5.2.3.3 Scaler Type Instruments

Scaler type instruments are used to analyze the alpha contamination on air filters and loose surface contamination ("smear") samples. These instruments consist of a detector and a scaler and include the Ludlum Model 2000 Scaler, Ludlum Model 3030P Scaler or equivalent. These instruments require the following checks at the noted frequency:

- Physical check – Daily when in use;
- Battery Check (if applicable) – Daily when in use;
- High Voltage Check (if applicable) – Daily when in use;
- Calibration verification check – Daily when in use;

- Background measurement – Daily when in use;
- Verification of efficiency/correction factor – Daily when in use;
- Determination of instrument reliability factor – Initially after calibration, after repair or if instrument response is questionable;
- Determination of lower limit of detection – Initially after calibration, after repair or if instrument response is questionable;
- High voltage plateau – Initially after calibration, after repair or if instrument response is questionable.

5.2.3.4 Alpha/Beta Survey Meters

Alpha/Beta survey meters are used to measure alpha/beta surface contamination levels on skin and equipment and include a ratemeter such as the Ludlum model 2224-1 with a 43-93 probe or Ludlum model 3030E with a 43-93 probe or equivalent. These instruments require the following checks at the noted frequency:

- Response source check – Before each use;
- Battery Check (if applicable) – Weekly;
- High Voltage Check (if applicable) – Weekly;
- Calibration verification check – Weekly;
- Background measurement – Weekly;
- Verification of efficiency/correction factor – Weekly;
- Determination of instrument reliability factor – Initially after calibration.

5.2.4 Beta Calibration

Periodic beta detector calibration checks should be performed using aged yellowcake (i.e., at least 4 months old). The calibration should be performed at the surface and at 2 cm (approximately one inch) from the surface of the yellowcake source.

5.3 POTENTIAL DETECTION PROBLEMS

In the course of performing instrument checks and reviewing records, the RSO or HPT will be aware of the following observations that may indicate a detection problem:

- Background drift in a continuous direction, either up or down;
- Alpha background rates greater than 1.0 cpm;
- A calculated LLD that is greater than 50 percent of the appropriate regulatory limit;
- A ratemeter instrument that does not zero;
- A battery check that does not respond;
- Reliability factors greater than 1.40 or less than 0.50;
- A daily response source check that does not fall within ± 20 percent of the calculated mean.

If any of the potential problems listed above are noted, the RSO or HPT will remove the instrument from service and investigate until the source of the problem can be determined and corrected.

5.4 RADIOLOGICAL INSTRUMENT CALIBRATION

CBR calibrates radiation survey and counting instruments after each repair. Routine calibration is performed annually or at the frequency recommended by the manufacturer, whichever is more frequent. A qualified instrument calibration vendor performs all calibration of radiation survey and counting instruments.

5.5 AIR SAMPLER CALIBRATION

Proper calibration of air sampling equipment is important to ensure that the total volume of air sampled is accurate. Air sampling is performed at the Crow Butte project and expansion areas to determine environmental and occupational levels of radioactivity in air.

Calibration of field flow rate measurement instruments (typically rotameters) is performed by comparing the flow rate measured by the field instrument with the flow rate measured by a primary standard instrument or a properly calibrated secondary standard instrument. Primary measurements generally involve a direct measurement of the volume based on the physical dimensions of an

enclosed space, such as a "frictionless" piston meter (i.e., soap film flowmeter or dry cell calibrator). Secondary standards are reference instruments or meters that trace their calibration to a primary standard, such as a mass flow meter.

Calibration should be performed semiannually as recommended in Regulatory Guide 8.30 or at the manufacturer's recommended frequency, whichever is shorter. Calibration should be performed with air filters in place to properly account for the reduction in flow due to solid material deposited on the filter.

5.5.1 Calibration Using the Soap Film Technique

The soap film technique involves using a graduated burette and a soap solution to measure the volume of air drawn through the burette during a measured time. The pump is started and connected to the burette, which is then dipped into a soap solution to form a bubble. The bubble will move along the burette. The time that it takes the bubble to move between volume graduations is measured, resulting in an indicated flow rate that is corrected to liters per minute (LPM). This measurement is then compared to the volume indicated by the air meter on the sampler. The comparison results in a correction between the indicated and the actual flow rate.

5.5.2 Calibration Using a Dry Cell Calibrator

A dry cell calibrator is a primary air flow calibrator that is a variation on the wet cell technique. The calibrator consists of a flow cell using a near-frictionless piston to measure the volume of air pumped. The flow cell is made of dimensionally stable borosilicate glass with a sensing encoder. The cell dimensions and crystal timing device are NIST traceable which allows use of the unit as a primary standard. Depending on the design flow rates, these units may be used for low and high flow samplers.

5.5.3 Calibration Using a Linear Mass Flow Meter

Linear mass flow meters may be used to calibrate sampling pumps. The linear mass flow meter measures the differential temperature of a gas drawn through a heated capillary tube and is considered a secondary standard.

5.5.4 Adjustment for Pressure and Temperature

Many variables affect the accuracy of air sampling measurements. Two of these are temperature and pressure variations. USNRC Regulatory Guide 8.25 states that corrections to the measured flow rate

should be made if there are differences exceeding five percent in either the absolute pressure or absolute temperature between the calibration situation and the sampling situation.

Differences in the absolute pressure are common when calibration is performed at a different altitude (and thus a different air pressure) than that at which the instrument will be used. An example of this would be the calibration of a secondary standard at sea level and then use to calibrate rotameters at a higher elevation. Differences in pressure may be evaluated by comparing the barometric pressure readings at the calibration location with those at the sampling location.

Similarly, differences in temperature between the calibration location and the sample location will adversely affect accuracy of flow meters. Since calibrations are generally made at room temperature (i.e., approximately 72°F), corrections should be made to account for sampling conditions if the ambient temperature is expected to exceed the five percent limit. Based on absolute temperature, five percent of a calibration temperature of 72°F would correspond to an ambient temperature less than 45°F and greater than 98°F.

5.6 SAMPLE ANALYSIS PROCEDURES

5.6.1 Analyzing Area Airborne Uranium Samples

Uranium airborne particulate samples are determined by counting alpha emissions using a scaler ratemeter or equivalent. The scaler is used with an alpha detector such as a Ludlum 43-10, Ludlum 218, Eberline SAC-R5, or equivalent. Some detectors, such as the Eberline SAC-R5, require the use of scintillation paper to detect alpha activity. The analyst should review the specific manufacturer's instruction manual to ensure familiarity with the detector operating requirements.

NOTE: Samples must age for 24 to 48 hours after sampling to allow decay of short-lived radionuclides.

5.6.2 Analyzing Breathing Zone Samples

Because breathing zone samples are typically collected over relatively short durations (i.e., less than a full work shift) it is necessary to utilize longer count times for both background and the sample in order to achieve the desired LLD. It should be noted that Regulatory Guide 8.25 recognizes that breathing zone samples may not be able to detect 10% of the appropriate DAC but that such samples are still acceptable for measuring potential uranium exposure to workers.

5.6.3 Radon Daughter Counting Procedure (Modified Kusnetz)

Radon daughter samples are analyzed using the modified Kusnetz method. Samples are collected on fiberglass or membrane filters using a lapel sampler or equivalent pump pulling a minimum of 2 liters per minute. Samples are collected for exactly five minutes, resulting in a 10 liter sample.

The sample filter is allowed to decay between 40 and 90 minutes after the end of collection before counting. After 40 minutes, only alpha particles from the decay of Po-214 are counted because virtually all of the Po-218 (3.05 minute half-life) has decayed.

The sample is counted with a scaler rate meter and an alpha scintillation detector at a count time determined by the RSO as adequate to meet the LLD requirements of 0.03 WL. The resulting gross counts are divided by the count time to arrive at a count rate (cpm).

Working levels are derived by dividing the count rate, minus background, by the product of the counter efficiency, the volume of air sampled, and the time factor.

The time factor (TF) is dependent on the time elapsed between end of sampling and the beginning of counting. The time factor is based on the assumption that equilibrium existed between Po-218, Pb-214, and Bi-214 at the time of sampling. The time factor relates dpm per liter of air from 40 to 90 minutes after sampling to the decay activity that would be present from an initial concentration of 1 WL.

5.6.4 Analyzing Smear Samples

Smear samples are taken to quantify the amount of removable contamination present on a surface or object. Following sample collection, smears are analyzed using a scaler rate meter and an alpha scintillation detector.

5.6.5 Filter Self Absorption

Regulatory Guide 8.25 requires that counting results be corrected for self-absorption of radiation by the filter collection media that would reduce the count rate by more than 5 percent. Regulatory Guide 8.25, further recommends that filter efficiencies of less than 95% be adjusted to account for airborne radioactive material not collected from the sampled atmosphere.

CBO uses glass fiber filters with an efficiency of 99.97%. If a filter collection efficiency of less than 95% is used, collection efficiency will be calculated as described in NUREG 1400 Section 6.2, Efficiency of Collection Media.

Self-absorption will be assessed according to NUREG 1400 Section 6.2, if self-absorption is > 5% a correction factor will be used.

5.6.6 Regulated Air Samplers (RAS)

Regulated air samplers are used at the Crow Butte project for measurement of airborne concentrations of particulate radioactivity. CBR calibrates regulated air samplers on a semiannual basis. Calibration is performed using a properly calibrated mass flow meter. As a result of this calibration, the correction factor for the air sampler is determined and is used to ensure accurate total flow determinations are available.

5.6.7 Breathing Zone Samplers

Breathing zone samplers are used at the Crow Butte project for area sampling to determine the concentration of radon daughters in air using the Modified Kusnetz Method. Breathing zone samplers are also used for measuring the concentration of airborne particulate radioactivity in the breathing zone of workers. These samplers are calibrated before each use using a bubbler tube and stopwatch to ensure accurate determination of total volume of air sampled.

5.7 RADIONUCLIDE REFERENCE STANDARDS

Crow Butte uses calibrated radionuclide reference standards (sources) to determine the counting efficiency of instrumentation for a given radionuclide. Non-calibrated check sources are also used to check the response of certain instruments.

5.7.1 Calibrated Standards

Calibrated radionuclide standards that have been certified as traceable to National Bureau of Standards (NBS, now known as the National Institute of Standards and Technology, or NIST) measurements are used for determination of instrument efficiency and correction factor. The instrument efficiency is used to convert the instrument indicated count rate to a concentration of radioactivity. These calibrated standards are used to determine counting efficiencies for all radioactivity measurements that require comparison to a specified concentration of radioactivity per unit volume or area, such as air samples and surface contamination level determinations.

5.7.2 Non-calibrated Standards

Certain radionuclide check sources that are not traceable to NBS measurements are used at the Crow Butte project to indicate that an instrument is responding properly. These non-calibrated check sources include sources that are maintained at restricted area boundaries near survey instruments. The sources are used before each use of the instrument to perform a response check. This response check is performed in addition to the daily determination of efficiency and correction factor.

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6 ENVIRONMENTAL AND EFFLUENT SAMPLING

CBR performs environmental and effluent monitoring at the Crow Butte project as required by NRC regulations and CBR's source materials license. Measurements are performed for the following purposes:

- To allow CBR to estimate the maximum annual radiation dose to the public;
- To ensure that the regulatory requirements and license conditions for dose and release limitations and meeting "as low as reasonably achievable" objectives are met;
- To evaluate the performance of effluent controls;
- To evaluate the environmental impact of mining operations; and
- To establish baseline data to aid in decommissioning or remediation efforts.

CBR's environmental and effluent sampling program was prepared in accordance with the guidance contained in Regulatory Guide 4.14, *"Radiological Effluent and Environmental Monitoring at Uranium Mills"*, (Revision 1, 1980). Regulatory Guide 4.14 and 4.15 contain guidance for quality assurance and quality control measures to ensure the accuracy of effluent and environmental sampling and analysis activities. It has been CBR's practice, and will continue to be CBR's practice, to submit all samples collected to meet the requirements described in Regulatory Guide 4.14 to an independent third party accredited laboratory for analysis.

6.1 SAMPLE COLLECTION

The quality assurance program for environmental sampling is implemented in the following areas:

- Procedures are used which define the details of sample location, sample frequency, number of samples, duration of sampling, sample volume, sample collection methods, and equipment to be used for sample collection.
- Procedures have been prepared for calibration and maintenance of equipment used for measurement. These procedures provide details for the standardization, use and maintenance of the instruments.
- Taking duplicate samples and submitting these to a third party accredited analytical laboratory makes random control checks. These checks allow evaluation of the performance of the analytical laboratory and to some extent, the validity of sampling procedures. In the event that the results

of the duplicate samples do not agree within predetermined limits, an audit will be performed to determine whether the problem is in the sampling or analysis.

CBR collects samples of environmental media within the NRC license area. Samples are also obtained from the surrounding area. Specific CBR SOPs are used to provide instructions for obtaining each type of environmental sample.

6.1.1 Air Sampling

The airborne effluent and environmental monitoring program is designed to monitor the release of airborne radioactive effluents from the Crow Butte project. To evaluate the effectiveness of the effluent control systems, the results of the monitoring program are compared with the background levels and with regulatory limits.

The accuracy of monitoring data is critical to ensure that the air monitoring program precisely reflects air quality in each phase of the program. Regulatory Guide 4.14 specifies the following lower limits of detection (LLD):

Radionuclides	LLD (μCi/ml)
Natural Uranium	1×10^{-16}
Thorium-230	1×10^{-16}
Radium-226	1×10^{-16}
Radon-222	2×10^{-10}
Lead-210	2×10^{-15}

6.1.1.1 Radon Gas Sampling

The radon gas effluent released to the environment is monitored using Track-Etch radon cups provided by Landauer Corporation. The cups are exchanged on a semiannual basis. In addition to the manufacturer's quality assurance program, CBR exposes two duplicate radon Track Etch cups during each monitoring period.

Radon-222 is monitored continuously at the environmental monitoring locations. Monitoring is performed using Landauer RadTrak detectors. These detectors are an alpha-track radon gas detector using Landauer's Track-Etch® process and are designed to monitor radon exposure for three months to one year. Landauer service includes the RadTrak detector and a comprehensive analysis.

The RadTrak radon detectors are supplied in aluminum bags to prevent radon exposure before deployment. The detectors should not be stored or deployed in any area in which the temperature may exceed 160°F. There is no low temperature limit.

Note: Landauer does not provide the LLD on the analytical result report. The LLD for Track-Etch® detectors is a function of the exposure time and the area of the cup that is analyzed by Landauer. The LLD should be determined in consultation with Landauer before monitoring is performed. If the LLD is above the NRC requirements from Regulatory Guide 4.14, it may be reduced by either employing a longer sampling time or requesting that Landauer analyze a larger portion of the Track-Etch® cup.

6.1.1.2 Air Particulate Sampling

Airborne particulate sampling is performed at the locations specified in the NRC License. The CBO License requires monitoring for at least 2 weeks of every month that the yellowcake dryer is in operation. However, CBO has instituted continuous monitoring at these sites as a best management practice.

Filters are collected for two weeks and then composited for analysis on a quarterly basis. At the end of the calendar quarter, the composite filter samples are submitted to the contract laboratory for radiometric analysis using standard Chain of Custody Procedures. The filters are composited according to location. The composite samples are analyzed for the concentrations of natural uranium, radium-226, and lead-210. The actual volume of air filtered at each station for the quarter is also forwarded to the contract laboratory with the filters. The flow rate on the RAS-1 pumps is calibrated at six-month intervals in order to ensure the accuracy of the volume of air sampled. The uncertainties in the volume of air sampled should be less than 20% as described in Regulatory Guide 8.25.

6.1.2 Water Sampling

During operations at the Crow Butte project, a detailed water-sampling program is conducted to identify any potential impacts to water resources of the area. CBR's operational water monitoring program includes the evaluation of groundwater on a regional basis, groundwater within the permit or licensed area and surface water on a regional and site specific basis. To evaluate the effectiveness of the effluent control systems, the results of the groundwater and surface water monitoring programs are compared with the background levels and with regulatory limits.

6.1.2.1 Groundwater Monitoring

The groundwater-monitoring program is designed to detect impacts to the local and regional groundwater from mining operations. Potential sources of impacts to the groundwater could be excursion of mining solutions beyond the perimeter of the wellfields or a failure of evaporation pond

lining systems. Monitor wells are installed around the wellfield boundaries and the evaporation ponds to monitor for impacts to the local groundwater. Sampling all private wells within one kilometer of the wellfield area boundary monitors impacts to regional groundwater.

Groundwater samples obtained for preoperational, operational, and restoration purposes are critical to meeting environmental protection goals at solution uranium mines. The results of these samples are used to determine pre-mining conditions, to monitor operational environmental protection efforts, and to determine whether restoration activities are successful. In order to ensure the accuracy of these monitoring efforts, strict compliance with groundwater sampling procedures is necessary.

6.1.2.1.1 Water Level Determination

The accurate determination of the static water level in wells provides important information concerning aquifer conditions. Well static water levels are monitored using an electrical measuring line (an "e-line"). The sampler takes e-line readings of all monitor wells before sampling. Significant changes in the water level in overlying aquifers may indicate a vertical excursion of mining solutions. Similarly, changes in the production zone water levels may provide an early indication of the migration of mining solutions from the active wellfield. Water level measurements are also used to determine groundwater gradients in the mining zone to assist operating personnel in managing wellfield balancing.

6.1.2.1.1 Field pH Measurements

Field measurement of pH is used in conjunction with conductivity as an indication that well purging has successfully removed stagnant water from the well casing and formation water is being sampled.

Degasification (such as loss of carbon dioxide), precipitation (such as calcium carbonate), and other chemical and physical reactions may cause the pH of a water sample to change significantly within several hours after the sample is collected. Therefore, immediate analysis of a sample in the field is required.

pH measurements will be performed in accordance with manufacturer's recommendations. The probe should be swirled in the sample to remove any air bubbles adhering to the surface of the probe. A reading is not valid until the reading on the panel is stable for at least ten (10) seconds or bounces around a point for at least ten (10) seconds.

Standardization will be checked daily during regular use. For the range of water quality encountered in well sampling activities, standardization will be performed using a pH 7.00 buffer and a pH 10.00 buffer.

6.1.2.1.1 Field Conductivity Measurements

Field measurement of conductivity is used to indicate when well purging has successfully removed stagnant water from the well casing and formation water is being sampled. Specific conductance meters used in the field are battery operated, and read directly in micromhos (μmhos) or microsiemens (μS) per cm.

The conductivity cell is checked daily during regular use. A standard solution of known electrical conductance that falls in the range of samples to be measured is used to check the cell. For the range of water quality typically encountered, a standard solution of from 500 to 1500 micromhos/cm at 25°C will be used. Instrument calibration will be performed in accordance with the manufacturer's recommendations.

Measurements are performed in accordance with manufacturer's recommendations. The probe is swirled in the sample to remove any air bubbles adhering to the surface of the probe. Conductivity readings stabilize much more quickly than pH readings. The Sampler will ensure that the reading is stable before recording the results.

6.1.2.1.2 Well Purging

Water that remains in the well casing between samples may not be representative of the formation water quality. The quality of water left in the casing between samples may be changed by sorption or desorption from casing materials, oxidation, or biological activity. Purging is required to remove this stagnant water and allow formation water into the well screen.

Purging should be accomplished at a flowrate that is lower than the well development rate. The purge rate should approximate the natural groundwater flow rate (i.e., little change in the well water level during purging) while satisfying time constraints. Purging at too high of a flow rate can result in redevelopment of the well and increased turbidity. In no case should a well be purged at a flowrate high enough to cause the well to pump dry. Purging is deemed complete only when it is determined through field monitoring of pH and conductivity that the water quality is stable.

6.1.2.1.3 Well Sampling

The sample should be taken as soon as the well is adequately purged. If the well was pumped dry during purging, the sample should be obtained as soon as adequate formation water is present in the casing. Do not touch the sampled water with your hands as this could result in contamination of the sample.

Make sure that the water being sampled is very low in visible solids and any contamination that may show up in the analysis. Fill the sampling container(s) completely, so all air is excluded from the container.

Record the time of sample collection and include any remarks as to unusual conditions of the water quality (e.g., odor, color) on the data sheet.

Keep the sample cool and transport it to the laboratory as soon as possible for analysis or filtering, preservation and/or shipment.

6.1.2.2 Surface Water Monitoring

The surface water-monitoring program is designed to detect impacts to the regional surface water from mining operations. Potential sources of impacts to the surface water could be releases of mining solutions, drainage from potentially contaminated areas, or failure of evaporation pond embankments. Surface waters within one kilometer of the wellfield area boundary are sampled.

Samples are collected in the appropriate container(s) and field measurements for pH and conductivity are performed and documented. The sample bottle must be rinsed with the sample water. The bottle is then filled with the mouth of the sample bottle pointed downstream to prevent collecting debris. If samples involve analysis that requires filtration, collect water in a clean bucket for transfer to the filter apparatus. Treatment of sample containers, preservation techniques, holding times, and shipping techniques are identical to those used for groundwater.

6.1.3 Soil and Sediment Sampling

Samples of soil and sediment are collected at the Crow Butte project to monitor radioactivity concentrations in these media. To evaluate the effectiveness of the effluent control systems, the results of the soil and sediment monitoring program are compared with the background levels and with regulatory limits.

6.1.3.1 Soil Sampling

Preoperational surface soil has been sampled. Surface soil samples will be taken at the air monitoring locations following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Preoperational subsurface soil has been sampled at the plant. Subsurface soil samples will be taken following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Soil samples are obtained with a clean auger, spade, or shovel. At the sampling location, remove the vegetation and collect a grab soil sample of the top 15 cm (6 inches) of soil. Samples may also be collected at successive 15 cm intervals for comparison with the decommissioning criteria contained in 10 CFR Part 40 Appendix A, Criterion 6-(6). Samples are placed in appropriate plastic bags. The amount of sample should be sufficient to provide the laboratory with at least 50 grams of soil. This quantity of sample is necessary to meet the LLD requirements. Any non-soil material such as rocks, sticks, vegetation, and large amounts of roots should be removed from the sample. Remove the air in the bag and seal it.

The plastic bags must be clearly labeled at the time of sampling with a permanent marker, identifying the project location, sample site, the depth interval of the sample (e.g. 0-6"), and the sample date. It is important that the type of soil extraction method to be used for the various chemical analyses be clearly identified on the chain of custody to the independent third party accredited laboratory.

6.1.3.2 Sediment Sampling

Sediment in local surface water features was sampled on a semiannual basis for one year prior to any construction in the area. Operational samples are taken upstream and downstream of the Crow Butte project site to monitor for impacts to the sediments from mining operations.

At the sampling location, collect a grab sample of the stream or impoundment sediment. Remove any vegetation, rocks, or other debris that may be present; place the sample in a plastic bag and seal. After allowing the bag to set, pour off any liquid that has decanted, remove the air, and re-seal the bag. The laboratory requires at least 50 grams of sample to meet the LLD requirements.

The sample bag should be pre-labeled with the sample identification, sample location, sample analysis required, date, and company initials. Prepare a Chain of Custody form and submit the sample to the independent third party accredited laboratory.

6.1.4 Vegetation Sampling

Vegetation samples from Crow Butte project were collected on an annual basis in animal grazing areas in the direction of the prevailing wind through 1997. Sampling was normally performed during the summer months. In 1998, routine vegetation sampling was discontinued with NRC approval due to the determination that exposure from grazing animals was not a potentially significant pathway.

Vegetation sampling may be required at some time in the future. Circumstances that would indicate the necessity for vegetation sampling include land application for waste disposal or characterization of impacted areas.

When obtaining vegetation samples, select mainly grasses or leafy plants that would normally be used as forage by domestic and wild animals as opposed to woody plants such as sagebrush. Samples should be comprised mainly of stems, leaves, and fruit and should be representative of the current year's growth. Cut the plants with a trimmer within a few inches of the ground and place in the sample bag until the bag contains a minimum of 8-10 kilograms (wet weight) of vegetation. Do not include any root material. The sample should be representative of dominant vegetation present at the sample location.

The plastic bags must be weighed and clearly labeled at the time of sampling with a permanent marker, identifying the project location, sample site, and the sample date. It is important that the sample wet weight and type of analytical method to be used for the various analyses be clearly identified on the chain of custody to the contract laboratory. Vegetation samples should be submitted to the independent third party accredited laboratory as quickly as possible.

6.1.5 Direct Radiation Measurement

Environmental gamma radiation levels are monitored continuously at the air quality monitoring stations. Dosimeters that fully meet ANSI N545 performance, testing, and procedural specifications will be used.

The dosimeters are supplied by the vendor before the end of each quarter. Each shipment of dosimeters contains a control dosimeter that measures exposure rates during processing and shipping of the dosimeters and a deployment dosimeter that measures exposure rates while deploying the dosimeters. Before deployment of the dosimeters, the control dosimeter must be placed in a storage area with a low ambient background gamma dose rate. The deployment dosimeter is also placed in the storage area after the dosimeters are deployed.

The dosimeters are deployed at the beginning of each quarter. The dosimeters are clipped onto each survey location with the fastener provided with the dosimeter. Each dosimeter has a tag with an identification number. When exchanging the dosimeters, the dosimeter is replaced with the corresponding dosimeter identification number.

After the dosimeters are collected, care is taken to ensure that they are not exposed to any additional gamma radiation or x-rays. Once the dosimeters are collected, they are returned to the vendor in the original box with the provided shipping label. This label cautions against exposure to radioactive materials or x-rays while in transit.

6.1.6 Uncertainty Limits for Volume and Mass Measurements

Sample volumes are derived for each type of sample based on measurement requirements. For liquid or solid samples consideration is given for the density/composition of the matrix, counting efficiency of the instrumentation, laboratory specific MDLs, applicable analytical chemical recovery, preservation techniques, and homogeneity of the samples. Air particulate volumes are impacted by filter collection efficiency, filter dust loading, and flow rates of sampling equipment. Methods for reporting sample analysis and results are found in; SHEQMS Volume IV, *Health Physics Manual*, SHEQMS Volume VI, *Environmental Manual*, and the SHEQMS *Laboratory Manual*.

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7 OCCUPATIONAL SAMPLE COLLECTION

CBR performs occupational monitoring at the Crow Butte project as required by NRC regulations and CBR's source materials license. Measurements are performed for the following purposes.

- To allow CBR to determine the annual internal and external radiation dose to employees;
- To ensure that the regulatory requirements and license conditions for dose limitations and meeting "as low as reasonably achievable" objectives are met; and
- To evaluate the performance of exposure controls;

CBR's occupational monitoring program was prepared in accordance with the guidance contained in Regulatory Guide 8.30. Regulatory Guide 4.15 was also consulted for guidance for quality assurance and quality control measures to ensure the accuracy of occupational monitoring activities.

7.1 AIRBORNE URANIUM SURVEYS

7.1.1 Area Samples

Area air samples should be collected during the performance of work duties. Area samples may be used to monitor concentrations in work areas or to determine the effectiveness of the confinement of radioactive materials. For work area monitoring, the location of air samples should be as close to the breathing zone as practical without interfering in the performance of duties. To determine confinement, samplers should be placed in the airflow path near the source of contamination.

At a minimum, airborne uranium samples will be collected as approved by NRC in the source materials license. The frequency of the airborne uranium sampling is weekly in Airborne Radioactivity Areas and monthly in areas not designated as Airborne Radioactivity Areas as recommended in Regulatory Guide 8.30, although this frequency may be modified by specific NRC license conditions. More frequent sampling may be advisable when starting new equipment or facilities. During yellowcake packaging operations, sampling in the dryer room is continuous. Spot samples may also be collected to verify the adequacy of the sampling procedures or as determined necessary by the RSO

Measurement of airborne uranium is performed by gross alpha counting of the area air filters using an alpha scaler such as a Ludlum L-2000 or equivalent. The analytical results are compared to 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. Crow Butte has collected isotopic samples from seven locations throughout the Central Processing Plant. As per Regulatory Guide 4.14, airborne particulate

samples from the in-plant sampling stations were analyzed for U^{-Nat}, Th^{230}, Ra^{226}, and Pb^{210}. Sampling indicated that the concentrations of the isotopes analyzed were present in concentrations significantly below 10% of their respective DAC's. In addition, the sum of the DAC percentage from Th^{230}, Ra^{226}, and Pb^{210} combined is significantly less than 1%, meeting the criteria of less than 30%. Therefore, these three radionuclides can be disregarded from the determination of the internal dose under 10 CFR 20.1204(g). Solubility studies performed at the Crow Butte operation demonstrated that the Uranium is of Class D solubility. Uranium compounds that have no assigned inhalation classification, or for which no site-specific data is available, such as uranium carbonates, shall be assigned to inhalation Class W for radiation protection purposes.

Samples should be obtained using the following steps:

- Obtain an Eberline RAS-1 or Hi-Q or Staplex Hi-Vol Sampler or similar equipment and the appropriate glass fiber filters. Ensure that the air sampler has a current calibration as discussed in Section 5.
- Record data concerning sample location, start and end time, total time in minutes, flow rate, as found operating status of the air sampler, air sampler identification, location and calibration data on the sampling form.
- Place a filter in the filter holder taking care not to damage or contaminate the filter.
- Place the air sampler at a location where workers could be exposed to airborne particulates at 4 to 6 feet above the floor and at least 1 foot away from walls, cabinets, etc.
- Ensure that the sampling environment is representative of the conditions encountered by workers while performing assigned duties.
- Start the pump and record the start time and the initial flow rate on the sampling form. Ensure that an adequate volume of air is obtained to meet the lower limit of detection (LLD) for uranium (i.e., 10% of the applicable DAC).
- At the conclusion of sampling, record the flow rate, shut off the sampler and record the sampling stop time on the sampling form. Unless the sample period is extremely long, with resulting dust loading on the filter, there should be no change between the initial and final flow rate.
- Carefully remove the filter from the filter holder and place in the sample holding envelope, taking care not to touch or disrupt the particulate material collected on the filter.

7.1.2 Breathing Zone Air Samples

In the plant, breathing zone air samples may be collected periodically. The samples are representative of the air inhaled by the worker. Breathing zone samples for specific jobs are used to monitor the intakes of individual workers performing tasks that have the potential for high airborne exposures. Breathing zone samples may also be collected for an entire work shift, resulting in a composite sample for an employee performing his normal duties. The breathing zone sample, in the latter case, may be used as a means of judging the adequacy of the area air monitoring program.
The RSO typically determines under which circumstances a breathing zone sample should be obtained.

Samples should be obtained using the following steps:

- Obtain a lapel sampler (Sensidyne BDX or equivalent). Ensure that it is fully charged and properly calibrated.
- Obtain a glass fiber filter(s), or equivalent, of the proper size and an appropriate filter holder. Place filter in holder and attach to sampler hose.
- Secure the pump to belt and the filter holder to the shirt collar or lapel. Make sure the pump is in the upright position at all times. Consolidate the tubing to minimize restriction of motion.
- Turn the pump on (recording the time and flow rate) and continue monitoring until the task is completed. Record the time and flow rate at which the job is completed.
- Lapel samplers are to be analyzed within two working days of sampling, where possible. Ensure that the SHEQ Department obtains the filter and information in a timely manner so analysis can be completed.

7.1.3 Natural Uranium Radiometric Analysis

Natural uranium air sample filter(s) must be aged a minimum of three (3) hours in order to eliminate the short-lived radon daughters. These include Pb-214 (26.8 min), Bi-214 (19.7 min), and Po-214 (164 μsec) in the shorter-lived decay chain. A sample counted immediately after collection will not only contain possible uranium ore dust and a possible static charge, but it may also contain radon daughters. Counting the sample too soon after sample collection will result in an overestimation of airborne uranium.

Samples may also be sent as individual samples or as part of a composite sample, to an approved outside independent third party accredited laboratory for analysis for specific isotopes.

7.2 RADON DAUGHTER MEASUREMENT

Radon daughter samples are taken in various areas of the plant and offices. The sample locations are near areas where workers are most often present to ensure that the samples are representative of worker exposure. Sampling is performed at a monthly frequency, unless concentrations greater than 0.08 WL are discovered. When concentrations greater than 0.08 WL are discovered, the sampling frequency is increased to weekly. Weekly sampling continues until concentrations of less than 0.08 WL occur for four consecutive weekly samples.

Analysis of radon daughter samples is performed on-site using the Modified Kusnetz Method. Measurement of radon daughters on sample filters is performed by gross alpha counting using an alpha scaler such as a Ludlum L-2000 or equivalent.

In addition to the Modified Kusnetz Method, CBR uses the PRISM II continuous radon monitoring system, which allows "real time" analysis of atmospheres for radon daughter concentrations. The PRISM II is used as a diagnostic tool to allow evaluation of work practices and engineering controls and may not be used for routine monitoring or exposure determination purposes.

7.3 EXTERNAL RADIATION EXPOSURE

7.3.1 Personnel Dosimeters

Occupational exposure to external gamma and beta radiation is measured using personnel dosimeters such as Thermoluminescent Dosimeters (TLD) or Optically Stimulated Luminescence (OSL) dosimeters. With two exceptions, dosimeters must meet NRC requirements, which state that a contract vendor must be certified by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The exceptions to this requirement are direct and indirect reading pocket ionization chambers and dosimeters used to measure the dose to extremities. The dosimeters consist of a clip-on badge worn by workers. The badge contains a chip that is constructed of a material that senses total exposure to external radiation. When the chip is properly developed, the radiation dose received by an individual during the period of time that the badge was worn may be determined.

The RSO is responsible for determining the dosimetry requirements based on the facility radiation levels, worker job locations and tasks, and specific licensing requirements. For each category of workers, the RSO must determine whether it is likely that a worker's dose may exceed the criteria from § 20.1502(a). If it is determined that dosimetry is required, the RSO will determine the exchange frequency for the dosimetry (i.e., monthly or quarterly). Contractors, depending upon the task to be performed, may also be issued dosimeters at the discretion of the RSO.

The RSO is responsible for reviewing the dosimetry results and comparing them with past data and regulatory exposure limits. Upon receipt of the dosimetry results from the NVLAP laboratory, the individual exposure records are to be maintained on hard copy and/or a computer system.

The control personnel dosimeters used by the NVLAP processor to subtract background exposure from the personnel badges, are to be stored in areas away from areas where elevated gamma dose rates may be present. It is important that control badges are returned to the NVLAP processor with the personnel dosimeters. In the event that a control badge is damaged, any unused personnel dosimeter may be designated as a control badge as long as it has been stored away from areas where gamma activity is mostly likely to occur.

7.3.2 Gamma Surveys

Gamma surveys are conducted at various locations throughout the facility. Routine gamma surveys are performed as approved by NRC in the source materials license. In areas that meet the criteria for posting as "Radiation Areas", surveys should be performed at least quarterly as recommended in Regulatory Guide 8.30. NRC licensing requirements specific to the facility may require alternate survey frequencies. Gamma surveys are conducted on a semiannual basis at various locations through the plant. These results are used to insure plant areas are properly placarded in accordance with 10 CFR 20. Additional gamma surveys may be performed at the discretion of the RSO or HPT to further characterize gamma dose rates. These surveys can be random, in conjunction with RWPs, to assist in identifying Radiation Areas, or performed before or during routine work, during contaminated waste control, or during upset conditions. Regardless of the purpose of the survey, the same procedure will be utilized to perform gamma surveys.

7.3.2.1 Instruments

- Ludlum Model 3 Gamma Meter with Ludlum Model 44-38 G-M detector or equivalent, calibrated in MilliRoentgen per hour (mR/hr).

7.3.3 Beta Surveys

In addition to gamma surveys, beta surveys should be performed before specific tasks that involve direct handling of large quantities of aged yellowcake (i.e., older than four months) to ensure that extremity and skin exposures for workers performing these operations are not unduly high.

Extremity dosimetry is required by 10 CFR 20.1502 if a worker is likely to receive a dose to any extremity in excess of 1250 mR/qtr or to the eye in excess of 375 mR/qtr.

Beta surveys should be performed before any special maintenance or non-routine operational activity with aged yellowcake to determine protective clothing needs and what portion of the body may be most exposed. If appropriate protective clothing and equipment is used (e.g. heavy rubber gloves, eye

protection, etc.) the beta dose rate may not be a significant factor to overall dose. However, the protective clothing and equipment used must be of sufficient density to ensure that significant beta radiation does not reach the skin or the lens of the eye.

7.3.3.1 Instrument

- Ludlum Model 2224-1 with a 43-93 probe or equivalent equipment.
- The detector must be equipped with a beta shield to perform this survey.

7.3.4 Surface Contamination

The primary sources of potential surface contamination at in situ leach uranium mines are associated with precipitation, slurry transfer, drying and packaging activities, and filter press activities. The remaining recovery and elution portions of the process do not present a significant surface contamination problem except for dried spills or when special equipment maintenance is required. Any visible yellowcake or production fluid spills must be cleaned up as soon as possible to prevent the potential spread by contact or drying and possible suspension into the air that could pose an inhalation hazard. If contamination is detected in a designated clean area above specified limits, the RSO will be promptly notified and the area will be cleaned. An investigation into the source of the contamination will be performed.

Routine surveys in the process areas consist of both a visual inspection for obvious signs of contamination (i.e. visible yellowcake) and instrument surveys to determine total alpha contamination. If the total alpha survey indicates that contamination is greater than 200,000 dpm/100 cm^2, the area shall be cleaned and resurveyed. This level of contamination has been determined to be low enough to ensure little contribution to airborne radioactivity and is readily visible due to the low specific activity of uranium.

In designated clean areas, such as lunchrooms, offices, and respirator cabinets, the target level of contamination is nothing detectable above background. If the total alpha survey indicates contamination exceeds 250 dpm/100 cm^2 (25% of the removable limit) a smear survey must be performed to assess the level of removable alpha activity. If smear test results indicate removable contamination greater than 250 dpm/100 cm^2, the area must be cleaned promptly and resurveyed. The RSO will investigate the cause of the contamination and implement corrective action to minimize the potential for a recurrence.

Direct measurement of total contamination is performed using alpha scintillation detectors. Measurement of loose contamination is performed by gross alpha counting of the smears using an alpha scaler such as an Eberline MS-3 or equivalent.

7.4 BIOASSAY PROGRAM

CBR has implemented a bioassay program to monitor for internal exposure to natural uranium. The bioassay program has been prepared in accordance with the guidance contained in Regulatory Guide 8.22, *"Bioassay at Uranium Mills"*, (Revision 2, 2014). All plant personnel are included in the bioassay program. The program is implemented by the RSO.

CBR routinely performs bioassay by urinalysis for natural uranium. A baseline urinalysis is performed on all employees prior to their initial assignment at the plant. Routine bioassay samples are collected at a frequency that is based upon the employee's work assignment. Diagnostic bioassays may be required by the RSO based upon specific work activities. Upon termination of employment, a final urinalysis will be performed on all employees.

Records of bioassay results are maintained to document the sample collection and analysis dates as well as the individual's record to allow the most recent results to be compared to the employee's previous history.

Analysis of bioassay samples is performed at an independent third party accredited analytical laboratory. CBR submits spike and blank samples with each batch of bioassay samples to monitor the laboratory for accuracy and sample contamination. Analytical results for spiked samples must be within 30 percent of the spiked value. Otherwise, the most recent batch of samples will be re-run. The RSO will conduct an investigation to determine whether the CBR spiking procedure or the analytical laboratory was the cause of the inaccurate results.

Duplicate samples are obtained for submission to a different laboratory to monitor precision. These samples are submitted by CBR on a periodic basis. These duplicate samples are in addition to the duplicate samples analyzed by the analytical laboratory.

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8 SAMPLE MANAGEMENT AND QUALITY CONTROL

Performance indicators are used to determine if the laboratory's processes are in control. The accuracy of the instruments or containers are checked regularly to ensure that sampling performance criteria remain within the limits specified by the QAP. The results of mass, flow rate, or volume calibrations and associated uncertainties are tracked and recorded. Performance indicators are selected to provide a management tool for tracking and trending performance and to identify precursors to nonconforming conditions. Laboratories consider necessary levels of precision, acceptable bias, and applicable detection limits. Definitions are as follows:

- Precision is the closeness of agreement between independent test results and can be assessed using replicate samples. It may be expressed as the standard deviation.
- Bias of a measurement process is a persistent deviation of the mean from the accepted reference value of the quantity being measured. It does not vary if a measurement is repeated.
- Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the analyte of interest. An evaluation of sensitivity is included in the CBO and/or vendor laboratory analytical methods that are used to analyze samples.
- Representativeness is generally ensured through the use of standard sampling protocols.
- Accuracy is the nearness of a measurement or the mean of a set of measurements to the true value and is usually expressed as the relative percent difference.
- Comparability is the confidence with which one data set can be compared to another and is ensured by employing approved sampling plans, standardized field procedures, and experienced personnel using properly maintained and calibrated instruments.

8.1 SAMPLE HANDLING AND DELIVERY

Chain of Custody (COC) forms should accompany every sample sent to off-site laboratories. The chain of custody should contain at a minimum the type of sample, the sample identification number, the preservation techniques (if any), the name of the sampler, the date and time the sample was taken, the name(s) of individuals who handled the sample and when they passed it on to another person, and the required analysis. Once the laboratory is finished with the chain of custody, it is sent back to the SHEQ Department with the analytical package so it can be filed for future reference.

8.2 INDEPENDENT THIRD PARTY ACCREDITED LABORATORY QUALITY CONTROL

CBR has implemented a quality control program to determine the precision and accuracy of the monitoring processes. Quality control sampling includes replicate samples to determine precision, spiked samples with a known concentration to determine accuracy, and blank samples to detect and measure contamination of analytical samples.

Inter-laboratory duplicate samples are analyzed by a second laboratory to determine the precision of the original laboratory. In addition, intra-laboratory duplicate samples may be collected and sent to the primary laboratory to assure internal laboratory precision. The RSO selects the locations, media and number of inter-laboratory and intra-laboratory duplicate samples. A minimum of one duplicate sample is collected per sampling period.

In addition to the quality control samples prepared and submitted by CBR to contract analytical laboratories, each qualified laboratory will have an acceptable QA/QC program in place. The CBR QA Coordinator will review the vendors QA/QC Program and will be responsible for approving the use of the vendor. Qualified laboratories will submit verification of participation in the EPA's Quality Control Program and the laboratory certification programs for environmental waters.

8.3 ANALYTICAL SENSITIVITY

8.3.1 Lower Limits of Detection

The NRC in Regulatory Guide 4.14 recommends the lower limits of detection (LLD) for radiological samples. CBR has adopted these LLD values that are appropriate for the samples obtained at the Crow Butte project. The required LLD values are listed in Table 2.

Table 2
Radiological Lower Limits of Detection

Media	Radionuclide	Lower Limit of Detection
Air	Natural Uranium Thorium-230 Radium-226	1×10^{-16} µCi/ml
	Lead-210	2×10^{-15} µCi/ml
	Radon-222	2×10^{-10} µCi/ml
Water	Natural Uranium Thorium-230 Radium-226	2×10^{-10} µCi/ml
	Polonium-210 Lead-210	1×10^{-9} µCi/ml
Soil and Sediment (dry)	Natural Uranium Thorium-230 Radium-226 Lead-210	2×10^{-7} µCi/g
Vegetation, Food and Fish (wet)	Natural Uranium Thorium-230	2×10^{-7} µCi/kg
	Radium-226	5×10^{-8} µCi/kg
	Polonium-210 Lead-210	1×10^{-6} µCi/kg

8.3.2 Non-radiological Detection Limits

Minimum detection levels are necessary for non-radiological samples obtained at the Crow Butte project. CBR has adopted the detection levels listed in Table 3.

Table 3
Non-radiological Detection Limits

Analyte	Detection Level (mg/l)
COMMON IONS	
Calcium	1.00
Magnesium	1.00
Sodium	1.00
Potassium	1.00
Carbonate	0.10
Bicarbonate	0.10
Sulfate	1.00
Chloride	0.10
Ammonia-N	0.05
Nitrite-N	0.01
Nitrate-N	0.01
Fluoride	0.10
Silica	1.00
Total Dissolved Solids	1.00
Total Alkalinity	0.10
Conductivity	1.00 (μmho)
pH	± 0.02 (standard units)
ACCURACY CHECKS (acceptable range)	
Ion Balance	0.95 to 1.05
TDS Balance	0.90 to 1.10
Conductivity Balance	0.95 to 1.05
MINOR AND TRACE METALS	
Arsenic	0.001
Barium	0.100
Boron	0.100
Cadmium	0.010
Chromium	0.050
Copper	0.010
Iron	0.050
Lead	0.015
MINOR AND TRACE METALS (continued)	
Manganese	0.010
Mercury	0.001

Table 3
Non-radiological Detection Limits

Analyte	Detection Level (mg/l)
Molybdenum	0.100
Nickel	0.050
Selenium	0.001
Vanadium	0.100
Zinc	0.010

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9 ON-SITE LABORATORY QUALITY ASSURANCE

CBR has implemented a quality assurance /quality control program to determine the precision and accuracy of the laboratory analysis performed in the on-site laboratory. Quality control in the on-site laboratory includes the use of appropriate analytical methods, quality control samples and other internal quality control activities including instrument calibration, analyst training, equipment maintenance, and external quality control.

9.1 ANALYTICAL METHODS

The use of approved standard analytical methods ensures that the quality objectives for operation of the laboratory are met. Table 4 lists the assays that are performed in the on-site laboratory and the analytical method that is used. Specific procedures for each method are described in the *Laboratory Manual* maintained in the laboratory for use by the analysts.

Table 4
On-Site Laboratory Analytical Methods

Parameter	Reference/Method
U_3O_8	"Spectrophotometric Determination of Uranium (VI) with Bromo-PADAP", DA Johnson and TM Florence "Standard Methods for Chemical and Atomic Absorption Analysis of Uranium-Ore Concentrate", Titrimetric ASTM C1022-05(2010)e[1]. Uranium by Inductively Coupled Plasma – Optical Emission Spectroscopy
Alkalinity as $CaCO_3$	EPA 310.1 Titrimetric
Chloride	Standard Methods, 17th Ed. 4500-Cl^- B. Argentometric

Table 4
On-Site Laboratory Analytical Methods

Parameter	Reference/Method
Sulfate	EPA 375.4 Turbidimetric EPA 200.7 Inductively Coupled Plasma-Atomic Emission Spectrometry
Total Dissolved Solids	EPA 160.1 Residue – filterable, Gravimetric, 180°C
pH	EPA 150.1 Electrometric
Sodium	EPA 273.1 Atomic Absorption, direct aspiration EPA 200.7 Inductively Coupled Plasma-Atomic Emission Spectrometry
Calcium	EPA 215.1 Atomic Absorption, direct aspiration EPA 200.7 Inductively Coupled Plasma-Atomic Emission Spectrometry
Vanadium	EPA 286.1 Atomic Absorption, direct aspiration EPA 200.7 Inductively Coupled Plasma-Atomic Emission Spectrometry

9.2 QUALITY CONTROL SAMPLES

CBR uses three types of quality control samples at the on-site laboratory. These samples are duplicate samples, spiked samples, and control standards. Although the quality control samples are primarily used to monitor and control systematic and random measurement errors, they are useful in detecting all types of laboratory error.

9.2.1 Duplicate Samples

Duplicates are taken of the original sample and analyzed in the same way as the original sample. These duplicate samples allow the analysts to determine the precision of the assay. The acceptable limit for the duplicate analysis is ± 10% over the range normally encountered in the laboratory. If the assay is very high or very low, criteria for limits will be determined on a case-by-case basis.

9.2.2 Spiked Samples

Standard addition spikes are the addition of a known amount of analyte to a duplicate sample aliquot. These samples are useful in estimating the accuracy of an assay and in identifying potential interferences. The acceptable limit for spikes is 90 to 110 percent recovery.

9.2.3 Control Standards

Control standards are certified standards whose chemical concentration values are known. They are used for spiking and standardizing reagents. For example, a chloride standard that is sodium chloride with a concentration of 1,000 ± 0.0005 moles per liter is used to standardize the $AgNO_3$ solution which is used in the analysis of chloride. The standard is certified traceable to National Institute of Standards and Technology Standard Reference Material. This standard is also used for preparing chloride spiked samples. The acceptable limit for control standards is 90 to 110 percent recovery.

9.2.4 Internal Quality Control Activity Schedule

Analysts will perform a minimum of one duplicate and one spike quality control sample per week per parameter assay.

Reagent blanks will be analyzed whenever new reagents are used and as often as required in specific methods. A reagent blank is the reference base with which the analytical results are compared under the same conditions as the samples to be analyzed, except deionized water is used in place of the sample.

For analysis of metals in water by atomic absorption and inductively coupled plasma-atomic emission spectrometry, calibration standards and blanks are analyzed with each batch of samples. Calibration standards are samples with a known concentration that are used to plot an absorbance versus concentration curve. This curve is used to determine the concentration of the samples being assayed. The standards that are used to prepare the calibration standards are certified and traceable to NIST Standard Reference Material.

9.3 INSTRUMENT CALIBRATION

9.3.1 pH Meter

The pH meter is calibrated daily with pH 7 and pH 4 (or pH 10) buffer solutions. Calibration results are recorded.

9.3.2 Conductivity Meter

The conductivity meter has a set of cell constant and automatic temperature compensation. In order to ensure the accuracy of the instrument, the conductivity of standardized 0.01 molar potassium chloride with a specific conductance of 1413 µmho/cm at 25°C is checked and recorded on a monthly basis.

9.3.3 Turbidimeter

The turbidimeter is calibrated with Formazin, the primary turbidity standard, at least semiannually. All calibration data is recorded.

9.3.4 Balance

The Mettler balance is cleaned and checked annually by a certified technician.

When in use, the balance is checked on a monthly basis with NBS Class S masses calibrated to within 0.025mg or better.
All calibration data is recorded.

9.3.5 Perkin Elmer Atomic Absorption Spectrophotometer Model 3100

The operator can determine whether instrumental parameters are optimized and if the instrument is performing to specifications by using the sensitivity check. The sensitivity check value (in mg/l) is

the concentration of an element that will produce a signal of approximately 0.2 absorbance units under optimum conditions at the wavelength listed. This number can be found in the *Analytical Methods for Atomic Absorption Spectrophotometry.*

If the instrument develops a malfunction that cannot be corrected by operator maintenance, a trained specialist will service it.

9.3.6 Optima 8300DV ICP-OES

For daily operations the instrument is calibrated according to the manufacturer's recommended procedures, using mixed calibration standard solutions and the calibration blank. The calibration line should consist of a minimum of a calibration blank and a high standard. Replicates of the blank and highest standard provide an optimal distribution of calibration standards to minimize the confidence band for a straight-line calibration in a response region with uniform variance. If the instrument develops a malfunction that cannot be corrected by operator maintenance, a trained specialist will service it.

9.3.7 Automatic Pipettes

Based upon equating milligrams with milliliters, automatic pipettes will be checked for accuracy by weighing the contents of the pipette on a precision balance. This will be performed and documented periodically as deemed necessary by the Lab Foreman.

9.3.8 Auto Titration

Two different autotitrators are used for analyzing monitor well samples; Mettler Toledo Autotitrator and a Metrohm Autotitrator. Calibration of the two autotitrators is performed, at a minimum, weekly. The procedures for performing the calibrations are described in CBO-QMP-10-009, *Autotitrator Procedures.*

9.4 CROSS-CONTAMINATION CONTROL

All glassware used in the laboratory is washed in a solution of tap water with the addition of a low phosphate laboratory grade detergent. The glassware is then rinsed with tap water. The glassware is then final rinsed with deionized water.

A deionized water system consisting of one activated carbon unit and two mixed bed deionizers is used to provide quality deionized water for assay work and glassware final rinsing.

9.5 ANALYST TRAINING

9.5.1 Lab Foreman

The minimum qualifications for a Lab Foreman are two years of post-secondary education in science and two years of inorganic laboratory experience. At least one year of this experience should be at an in-situ uranium facility.

9.5.2 Laboratory Technician

The minimum qualifications for a Lab Technician are a High School Diploma or a minimum of two years of directly related work experience. The Lab Foreman will directly supervise the Laboratory Technicians in the performance of their duties.

9.6 EQUIPMENT PREVENTATIVE MAINTENANCE PROCEDURES

Analysts will become thoroughly acquainted with the instrument operation manuals and will use the proper maintenance procedures as specified by the manufacturers.

9.7 EXTERNAL QUALITY CONTROL

Samples from wellfield monitor wells will be split and analyzed for the excursion parameters (alkalinity, chloride, and conductivity) at the on-site laboratory on a quarterly basis. The sample splits will be sent to a contract laboratory for analysis of the same excursion parameters. The on-site laboratory results will be compared with the contract laboratory results for consistency. The Lab Foreman or QA Coordinator will review the results from each laboratory. If the results are not within 10 percent for all parameters that are greater than 50 ppm or within ± 5 ppm for those parameters with a concentration less than 50 ppm, an investigation will be performed and appropriate corrective action will be taken.

9.8 DATA HANDLING

Production zone and shallow monitor well data will be reviewed for accuracy and reported to the Restoration Manager. Results of monitor well analysis for excursion indicators will be checked by the analysts to determine whether they are within the range of the upper control limits (UCLs) for that well. Any discrepancies will be investigated. If the data for a particular well falls out of range, it will be immediately reported to the SHEQ ~~Manager~~ Coordinator or designee.

All process analytical data will be reported to the Plant Supervisor or designee.

The Lab Foreman will maintain all original laboratory worksheets and instrument calibration data on file in the on-site laboratory. Records will be maintained for the appropriate duration as discussed in Section 12.4.

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10 VERIFICATION AND VALIDATION (V & V)

The verification and validation (V&V) of certain aspects and support activities of radiological, environmental and effluent measurement processes or monitoring programs are essential to the QAP. These aspects and activities include data and computer software, spreadsheet V&V, and project method validation.

The analytical data from the CBR radiological counting laboratory will be reviewed by the RSO. The RSO or the QA Coordinator will also review the environmental and effluent monitoring data from the on-site laboratory and contract laboratories. The RSO or the QA Coordinator will be responsible for evaluating the data, entering the data into the corporate data handling system, and distributing the data to the corporate files and specified personnel. Data review will be properly documented.

10.1 Validation and Verification for Accuracy and Completeness

The objective of verification is to ensure that data is collected and reported in a consistent manner with approved procedures and per time requirements. This involves the review of raw data for completeness, transcription errors, accuracy of calculations, and whether proper procedures are followed. The RSO is principally responsible for the validation and verification of activities whose failure could have an impact on the environment, health, or safety. The RSO, HPT, and Lab Foreman are responsible to review and initial logbooks, QC reports, and logs at least monthly for completeness and accuracy.

Technical data is routinely verified and validated to ensure that the data is of sufficient quality and quantity. Computer software and spreadsheets used in the implementation of radiological and environmental monitoring are documented, verified, and validated before initial routine use and after each modification of the software. To ensure records remain consistent and accurate, software testing includes comparing calculations against known data. Critical data migrated from old systems to new systems are also compared to verify accuracy and completeness.

Spreadsheets used for radiological monitoring are cross checked monthly by the RSO. The cross checks include the following:

- Data entry
- Hand calculation of randomly selected radiological surveys
- Hand calculation of formulas used

10.2 TECHNICAL REVIEW

Technical review involves reviewing screened data points to determine if the point is acceptable or

corrective action is needed. This evaluation takes into consideration factors such as number of historical data points, analyte concentrations, magnitude of deviation, variability of historical data, and location of sample point in regards to other potentially interfering activities. If point is not acceptable corrective action is taken.

10.2.1 Detection Limit Review Criteria

The reviewer will determine that the detection limits specified in **Tables 2 and 3** have been met.

10.2.2 Accuracy Check Criteria

- The radionuclide content of the various matrices (soil, vegetation, water, and air) should be evaluated for consistency with published data normally found in government reports.
- The radionuclide content of matrices where one would expect radiological constituents to be in secular equilibrium (such as soil) should be evaluated for internal consistency.
- The gross alpha value (if available) should be compared to the sum of the individual alpha emitting nuclides such as natural uranium, radium 226, and thorium 230.
- The cation-anion balance should be between 0.95 and 1.05.
- The ratio of the measured total dissolved solids (TDS) at 180°C to the calculated TDS corrected for bicarbonate decomposition should be between 0.90 and 1.10.
- The ratio of the measured electrical conductance (dilute) with the calculated electrical conductance should be between 0.95 and 1.05.

If the data on a given sample does not meet the above accuracy checks, the RSO will investigate the laboratory and sampling procedures to determine the cause of the discrepancy.

10.2.3 Data Comparison Criteria

The data on a given sample or set of samples will be compared with the data from previous representative samples from the same population. If an individual result falls within the range obtained on previous samples, the result is considered acceptable. If the result falls outside of the range, the data is evaluated for trends or other unusual distribution. The laboratory will then be notified and asked to check all calculations and quality control checks. If no discrepancies are found a new analysis may be requested on the sample provided that the maximum holding time for the

sample has not been exceeded. If the maximum holding time has been exceeded, the RSO may then request a re-sample.

10.2.4 Anomalous Data

The determination of anomalous data is done through the validation process. Sampling data is screened for values that fall outside of the historical data ranges. The historical data ranges are established by historic sampling events. It involves screening of the data, technical review, and corrective actions to determine if the data point is indeed anomalous.

10.2.5 Corrective Action

Corrective action allows for further investigation into the cause behind anomalous data. Corrective action may include requesting a laboratory check of calculations and dilutions, sample reanalysis, re-sampling, and comparison of data to the next sampling event. Based on the corrective action the RSO or QA Coordinator can then determine if the data point is acceptable or an anomalous point. Anomalous points are considered unusable.

10.2.6 Validation of Field Data

Field data verification ensures that data is collected in accordance with designated procedures and per required schedules. The data should be reviewed for completeness, transcription errors, compliance with procedure, and accuracy of calculations. The individual validating the data, in consultation with the RSO or QA Coordinator, may correct problems that are found or noted in the documentation by lining through the incorrect entry with a single line, correcting the information, then initialing changes made to the document. Care must be made not to obscure the erroneous information. The person validating the data must also ensure that erroneous data is not entered into the database.

10.2.7 Variance of Field Data

Changes from field protocols established in SHEQMS Volume IV, *Health Physics Manual* and SHEQMS Volume VI, *Environmental Manual* must be authorized by the RSO and ~~Manager of~~ SHEQ **Coordinator** and fully documented by the initiator. Field variance will be reported immediately to evaluate the impact the variance has on the data. Examples of variance in the field would be the activity performed or sample collection technique did not follow proper protocols, the monitoring or measurement instrument used was out of calibration, or there is a loss or damage to the record that cannot be duplicated. In events of variance it may be necessary for a corrective action(s). Field variance will be recorded in field notebooks and log sheets.

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11 PREVENTIVE AND CORRECTIVE ACTIONS

The preventive and corrective actions aspect of the QAP ensures continuous improvement processes are implemented, deficiencies and non-conformance on programs are defined and identified, and corrective or preventive actions are taken.

11.1 DEFICIENCIES AND NON-CONFORMANCE

Assessments, audits, inspections, and surveillance form the basis of the continuous improvement program. These methods allow for identification of deficiencies and non-conformance in programs, tasks, or performance as well as providing valuable information on areas of improvement. The information from these methods is reviewed by the Restoration Manager, SHEQ ~~Manager~~ Coordinator and RSO, these personnel have the authority to implement corrective actions to ensure the program, task or performance meets quality or regulatory acceptance criteria. Documentation of the deficiency or non-conformance is taken, tracked, and reported to regulatory agencies as required by the SHEQ ~~Manager~~ Coordinator~~or SHEQ Specialist~~.

11.2 CORRECTIVE ACTIONS

In the event that a program, task, or performance does not meet regulatory or quality acceptance criteria, corrective action is taken to ensure the program or task meets the appropriate criteria. The corrective action process involves the basic elements:

- Identification and documentations;
- Classification;
- Cause analysis;
- Corrections;
- Follow-up; and
- Closure

Findings and corrective actions are documented and tracked, through the Cameco Incident Reporting System (CIRS) and reported to the Restoration Manager, SHEQ ~~Manager~~Coordinator, RSO, and regulatory agencies as required. Follow-up reviews are performed by the Restoration Manager, SHEQ ~~Manager~~ Coordinator and RSO to verify the effectiveness and adequacy of the corrective actions as required in SHEQMS Volume II, *Management Systems, CR-QMP*.

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12 RECORDS

12.1 FIELD RECORDS

Radiological Monitoring Data Sheets and all environmental sampling data sheets will be retained at the plant site. It will be the responsibility of the RSO to assure that all sampling records are kept in an organized and secure manner.

12.2 ENVIRONMENTAL/RADIOLOGICAL ANALYTICAL RECORDS

Analytical data will be retained at the plant site and/or the corporate office. It will be the responsibility of the RSO to assure that all analytical reports are kept in an organized and secure manner.

12.3 ENVIRONMENTAL/RADIOLOGICAL AUDIT REPORTS

All audit reports shall be maintained at the site. The SHEQ ~~Manager~~ Coordinator will be responsible to see that all audit reports are kept in an organized and secure manner.

12.4 RECORD STORAGE DURATION

All regulatory required records of the following activities, operations or actions shall be documented and retained including; sampling analyses, surveys or monitoring, survey/monitoring equipment calibrations, reports on audits and inspections, all meetings and training courses, and any subsequent reviews, investigations or corrective actions.

All required records and documentation will be available for regulatory review and inspection. Upon termination of all regulatory license and permits, the President of CBR will have the final authority to authorize the disposal of records.

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13 AUDITS AND INSPECTIONS

CBR conducts audits of various programs at the Crow Butte project to ensure the quality of the implementation of the programs. In addition, CBR personnel conduct routine inspections of work areas to check for compliance issues and any other problems. These audits and inspections are summarized in this section.

13.1 QUALITY ASSURANCE/QUALITY CONTROL AUDIT

The QA Coordinator will conduct an audit of the radiological monitoring, sampling and analytical QA/QC programs once every three years. The QA Coordinator may designate qualified individuals who do not have direct responsibility in the areas being audited to perform the audits. Audit results will be reviewed by the RSO and corrective action taken where necessary.

An audit of the water sampling and analytical QA/QC programs will be conducted once every three years. The QA Coordinator or a designated qualified consultant, who does not have direct responsibility in the areas being audited, will perform the audits. Audit results will be reviewed by the QA Coordinator and corrective action taken where necessary.

13.2 ALARA AUDIT

Annually a third party will perform a formal audit of the ALARA program and submit a detailed written report to the SHEQ ~~Manager~~ Coordinator and RSO. 10 CFR §20.1101 (c) and CBR's source materials license require this audit of the occupational and effluent control ALARA programs. The audit will be performed in accordance with the guidance contained in USNRC Regulatory Guide 8.31, *"Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Mills Will Be As Low As Reasonably Achievable"*, (Revision 1, 2002) and will include a review of the results of the following operational data:

- Bioassay results, including any actions taken when the results exceeded action levels given in Table 1 of Regulatory Guide 8.22.
- Exposure records, both external and internal, showing the time-weighted calculations.
- Training program activities.
- Safety meeting minutes and attendance records.

- Daily inspection log entries and summary reports of the daily and monthly reviews.
- In-plant radiological survey and sampling data.
- Environmental radiological effluent and monitoring data.
- Surveys required by radiation work permits.
- Reports on overexposures submitted to NRC, and
- Reviews of operating and monitoring procedures completed or revised during this period.

Specific attention will be given to air sampling results as recommended in USNRC Regulatory Guide 8.25, *"Air Sampling in the Workplace"*, (Revision 1, 1992). This review will determine whether air sampling results for the previous year are accurate and whether changes should be made to the air sampling program. The review will include the purposes and amount of air sampling, locations, trends, posting, procedures, correction factors, representativeness, and any indicated changes to the air sampling program.

The written ALARA audit report shall be specific in addressing any noticeable trends in personnel exposures for identifiable categories of workers and types of activities. Recommendations to further reduce personnel exposures will be included. The report should also provide data to show that the equipment for exposure control and effluent control is properly used, maintained and inspected.

In addition to reviewing the results of the occupational ALARA program, the audit will review trends in radiological effluent data as recommended in USNRC Regulatory Guide 8.37, *ALARA Levels for Effluents from Materials Facilities"*, (1993). The audit report will include any recommendations to further reduce environmental releases of radioactive materials.

13.3 OTHER REVIEWS

13.3.1 Standard Operating Procedures

The RSO will perform an annual review of all Standard Operating Procedures for radiation safety and environmental protection issues. This annual review will be properly documented. Appropriate operations supervisory personnel will review process procedures in their area of responsibility to ensure that the instructions reflect current operating conditions.

13.3.2 Inspection Reviews

The RSO will perform a monthly review of the daily and weekly inspections and all monitoring and exposure data. The RSO will prepare a written summary of significant worker protection activities, including exposure data, bioassays, and survey data. A discussion of any trends or deviations from the radiation protection and ALARA programs, implementation of license conditions, and unresolved problems and corrective actions, will be included.

13.3.3 Respiratory Protection Program

The RSO or other similarly qualified individual will conduct an annual review of the implementation of the CBR Respiratory Protection Program. The review will include discussions with workers that use respiratory protection to solicit comments on the effectiveness of the program. The review will ensure that the program procedures reflect the requirements of current applicable regulations and accepted standards and that the program is implemented in accordance with the Standard Operating Procedures.

13.4 INSPECTIONS

13.4.1 Daily Inspections

The RSO, HPT or a qualified Designated Operator will conduct a daily visual walk-through inspection of the plant facility to check for compliance issues and any other problems. These inspections will be properly documented. The results of these inspections will be reviewed by the RSO. The inspections will be properly documented.

13.4.2 Weekly Inspections

The RSO and the Restoration Manager, or the RSO and the Plant Supervisor will conduct a weekly walk-through inspection of the plant operating areas to observe general radiation safety practices and to review required changes in procedures and equipment. The inspections will be properly documented.

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Appendix A

Containers, Preservation Techniques, and Holding Times

APPENDIX A

Parameter	Volume Required (mls)	Preservative	Holding Time	Container
Dissolved Metals	250	Filter (0.45 µm), then add HNO_3 to ph<2	6 months	Plastic or Glass
Total Metals	250	HNO_3 to ph<2	6 months	Plastic or Glass
Alkalinity	100	Cool, 4°C	14 days	Plastic or Glass
Chloride	50	None Required	28 days	Plastic or Glass
Conductance	100	Cool, 4°C	28 days	Plastic or Glass
Fluoride	50	None Required	28 days	Plastic or Glass
Ammonia as N	50	H_2SO_4 to pH<2, Cool, 4°C	28 days	Plastic or Glass
Nitrate + Nitrite	50	H_2SO_4 to pH<2, Cool, 4°C	28 days	Plastic or Glass
Nitrate	50	Cool, 4°C	48 hours	Plastic or Glass
Nitrite	50	Cool, 4°C	48 hours	Plastic or Glass
pH	25	None Required	Analyze immediately	Plastic or Glass
TDS	500	Cool, 4°C	7 days	Plastic or Glass
TSS	500	Cool, 4°C	7 days	Plastic or Glass
Sulfate	100	Cool, 4°C	28 days	Plastic or Glass
Lead-210	1000	HNO_3 to ph<2	6 months	Plastic or Glass
Polonium-210	1000	HNO_3 to ph<2	6 months	Plastic or Glass
Radium-226	1000	HNO_3 to ph<2	6 months	Plastic or Glass
Uranium	1000	HNO_3 to ph<2	6 months	Plastic or Glass
U_3O_8	N/A	N/A	N/A	Glass

Proposed Quality Assurance Program

(Final Version)

CAMECO RESOURCES

Quality Assurance Program (replacement pages)

2017 SERP Actions

CROW BUTTE RESOURCES, INC.
d/b/a
CAMECO RESOURCES
CROW BUTTE OPERATION

QUALITY ASSURANCE PROGRAM

Approved by License Amendment #2
October 5, 2017

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1 OBJECTIVES AND ELEMENTS OF A QUALITY ASSURANCE PROGRAM

To define the objectives of a Quality Assurance (QA) program, it is important to first define what quality assurance is and its relationship to quality control.

Quality assurance comprises all those planned and systematic actions that are necessary to provide adequate confidence in the results of a monitoring program. Quality control comprises those quality assurance actions that provide a means to control and measure the characteristics of measurement equipment and processes to established requirements. Therefore, quality assurance includes quality control.

The overall objectives of a QA program are:

- To identify deficiencies in the sampling and measurement processes to those responsible for these operations so that corrective action can be taken, and
- To obtain some measure of confidence in the results of the monitoring programs in order to assure the regulatory agencies and the public that the results are valid.

To achieve these objectives, the QA plan contains the following elements:

- Designation of an individual within the organization as the QA Coordinator. The QA Coordinator should undertake activities such as quality planning, audits and programs to insure reliability and should have the responsibility to assure that the QA plan is being properly implemented.
- A systematic policy for selection and use of measurement and sampling methodology. Where available, this methodology should be approved by the appropriate agency.
- Procedures for the documentation and review of operating procedures and instructions.
- QA audits of acceptance criteria for a QA plan to determine on a systematic basis that all planned activities are being done.

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2 ORGANIZATIONAL STRUCTURE AND RESPONSIBILITIES OF MANAGERIAL AND OPERATIONAL PERSONNEL

Responsibilities of personnel have been designed to both ensure compliance and further implement CBR's policy for providing a safe working environment with cost-effective incorporation of the philosophy of maintaining radiation exposures as low and reasonably achievable (ALARA). The specific responsibilities of QA personnel including managerial and operational personnel are described in Section 5 of the Source Material License Renewal, SUA-1534. The Crow Butte Resources Organizational Chart, is shown in Section 5, Figure 5.1-1 of the Source Material License Renewal, SUA-1534. Organizational changes will be maintained through the Safety Environmental Review Panel (SERP) process.

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3 QUALIFICATION AND TRAINING OF PERSONNEL

The minimum qualifications of operational personnel involved in the QA program are as follows:

3.1 PRESIDENT OF CBR

Bachelor's degree in engineering or science field and five (5) years' experience or equivalent in mine operations management or a related field.

3.2 GENERAL MANAGER OF US OPERATIONS

Bachelor's degree in engineering or science field and five (5) years' experience or equivalent in mine operations management or a related field.

3.3 RESTORATION MANAGER

Bachelor's degree in engineering or science field and three (3) years' experience or equivalent in mine operations management or a related field.

3.4 SHEQ COORDINATOR

Bachelor's degree in science, industrial hygiene, environmental technology or engineering or an equivalent combination of training and relevant experience in uranium mill/solution mining radiation protection. A minimum of 3 years working in environmental protection or related regulatory experience in a similar field. The SHEQ Coordinator will serve as the Quality Assurance Coordinator.

3.5 RADIATION SAFETY OFFICER

3.5.1 Education

A Bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in UR facility radiation protection. Two years of relevant experience are generally considered equivalent to one year of academic study.

3.5.2 Health Physics Experience

A minimum of one year of work experience relevant to UR operations in applied health physics, radiation protection, industrial hygiene or similar work. This experience should involve actually working with radiation protection and measurement equipment, not strictly administrative or "desk" work.

3.5.3 Specialized Training

At least four weeks of specialized classroom training in health physics specifically applicable to uranium recovery. In addition, the RSO should attend refresher training on UR facility health physics every 2 years.

3.5.4 Specialized Knowledge

A thorough knowledge of the proper application and use of all health physics equipment used in the UR facility, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to uranium and its daughters, and a thorough understanding of the UR process and equipment used in the facility and how the hazards are generated and controlled during the UR process.

3.6 HEALTH PHYSICS TECHNICIAN

3.6.1 Education

An associate degree or two years or more of study in the physical sciences, engineering or a health related field.

3.6.2 Training

At least a total of four weeks of generalized training (up to 2 weeks may be on the job training) in radiation health protection applicable to UR facilities.

3.6.3 Experience

One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a UR facility.

3.6.4 Alternate Qualifications and Training

The HPT may also possess the following alternate qualification and training:

- Education - A high school diploma
- Training - A total of at least three months of specialized training (up to 1 month may be on the job training) in radiation protection relevant to UR facilities.
- Experience - Two years of relevant work experience in applied radiation protection.

3.7 PLANT SUPERVISOR

Bachelor's degree in science or a closely related field. Minimum of 2 years working experience in ISR Plant Operations.

3.8 LAB FOREMAN

The minimum qualifications for a Lab Foreman are two years of post-secondary education in Chemistry or Physical science and two years of inorganic laboratory experience. At least one year of this experience should be at a UR facility.

3.9 QUALIFIED DESIGNATED OPERATOR

The minimum qualifications and training requirements for a qualified Designated Operator are described in Section 5.6.6 of the Source Material License Renewal (November 2014).

3.10 TRAINING

Personnel performing quality related activities will be trained in the principals and techniques of the activities performed. An on-the-job training program that will be administered by experienced professionals will achieve training of the field personnel.

3.11 TRAINING EVALUATION

On an annual basis, the SHEQ Coordinator or a designated outside consultant will observe field and plant personnel in the sample collection and analysis process and evaluate the personnel performance on the basis of adherence to written procedures.

4 OPERATING PROCEDURES

4.1 ADMINISTRATIVE AND OPERATION PROCEDURES

The CBR Quality Assurance Program is implemented through the use of written Standard Operating Procedures (SOPs). These SOPs have been developed for all process activities, including those activities involving radioactive materials, for the Crow Butte Uranium Project. Where radioactive material handling is involved, pertinent radiation safety practices are incorporated into the SOP. Additionally, SOPs contain instructions for performing non-process activities including instrument calibration, environmental monitoring, health physics monitoring, and emergency measures.

Quality assurance and control objectives are met by including the requirements for performance of quality control measures in the appropriate SOP. In some instances, separate SOPs are developed to implement quality measures.

Written SOPs are kept electronically and in hard copy in the areas of the plant facility where they are used. This allows for easy access by employees. Employees are trained on the appropriate SOPs for their job description when they are initially hired and when any procedure revisions are made.

4.2 TYPES OF PROCEDURES

The SOPs developed by CBR are a critical step to insuring that quality assurance objectives are met. Current SOPs exist for a variety of areas, including but not limited to:

1. Environmental monitoring procedures.
2. Testing and calibration procedures.
3. Exposure control procedures.
4. Equipment operation and maintenance procedures.
5. Employee radiological health and safety procedures.
6. Incident response procedures.
7. Laboratory procedures.

The CBR Safety, Health, Environment, and Quality Management System (SHEQMS) are organized into eight volumes. The volumes are as follows:

Volume I & II, *Management Procedures (CR-QMP)*
Volume III, *Operations Manual (CBR-SOP)*
Volume IV, *Health Physics Manual (CBR-RPP)*
Volume V, *Industrial Safety Manual (CBR-SHMP)*

Volume VI, *Environmental Manual (CBR-EMP)*
Volume VII, *Training Manual (CBR-TRG)*
Volume VIII, *Emergency Manual (CBR-EPRP)*

Specific SOPs that are used by CBR to implement quality measures are listed throughout this Quality Assurance Program. These SOPs may be revised and/or supplemented with additional SOPs to meet quality requirements as the need arises. The site also has a *Laboratory Procedures Manual* for a quality assurance/quality control program to determine the precision and accuracy of the laboratory analysis performed in the on-site laboratory.

4.3 PROCEDURE REVIEW AND APPROVAL

Written SOPs have been developed, reviewed and approved by the RSO and the responsible managers. The responsible manager ensures that the operational aspects of the SOP are correct and appropriate. All written SOPs are reviewed for radiological protection aspects and approved by the RSO prior to implementation.

SOPs are revised as necessary to meet changing operational and regulatory requirements. Any revisions made to the SOPs are reviewed and approved by the RSO and responsible manager prior to implementation. At a minimum, the SOPs are reviewed and, where necessary, revised, on an annual basis by the RSO. The annual review is documented by the RSO.

The personnel shown in Table 1 are responsible for approvals for each of the SHEQMS volumes.

Table 1
Procedure Approval Responsibility

SHEQMS Volume	Radiological Protection Approval	Final Approval
Volume I & II, *Quality Manual* (CR-QMP)	*	*
Volume III, *Operations Manual (CBR-SOP)*	RSO	*
Volume IV, *Health Physics Manual (CBR-RPP)*	RSO	RSO
Volume V, *Industrial Safety Manual (CBR-SHMP)*	RSO	*
Volume VI, *Environmental Manual (CBR-EMP)*	RSO	*
Volume VII, *Training Manual (CBR-TRG)*	RSO	*
Volume VIII, *Emergency Manual (CBR-EPRP)*	RSO	*
Laboratory Procedures Manual (CBR-LAB)	RSO	Lab Foreman

* Final procedure approval will be conducted by the responsible manager.

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5 INSTRUMENT CALIBRATION

CBR implements a routine maintenance and calibration program for all radiological survey instruments and samplers. This program is implemented through the use of appropriate SOPs. The CBR instrument maintenance and calibration program is based upon the recommendations contained in USNRC Regulatory Guide 4.15, *"Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) – Effluent Streams and the Environment,"* (Revision 2, 2007) and Regulatory Guide 8.30, *"Health Physics Surveys in Uranium Mills,"* (Revision 1, 2002).

5.1 INSTRUMENT CHECKS

CBR performs checks of radiation survey and counting equipment daily before use. The daily checks consist of a physical check and a response check. CBR also performs checks of counting instruments to determine instrument efficiency and sensitivity.

5.1.1 Vendor Calibration

The physical checks performed on a daily basis include verification that the instrument is properly calibrated, has sustained no physical damage that may interfere with accuracy, and that the instrument battery has adequate power (if appropriate).

The manufacturer or a qualified accredited vendor shall calibrate portable survey instruments, counter/scalers, mass flow meters and/or dry cell calibrators, and calibration sources. Calibration will be performed as recommended in ANSI N323 and ANSI N323A. The ANSI standard requires that radiation detection instruments be performance tested on an annual basis to verify that they continue to meet operational and design requirements. Instruments must be tested for range, sensitivity, linearity, detection limit, and response to overload. The specific calibration requirements for various types of instrument are given in the following sections.

5.1.1.1 Linear and Digital Readout Instruments

Linear readout instruments with a single calibration control for all scales shall be adjusted at the point recommended by the manufacturer. Instruments with calibration controls for each scale must be adjusted on all scales. After adjustment, the instrument must be checked near the end points (approximately 20% and 80% of full scale).

5.1.1.2 Logarithmic Readout Instruments

Logarithmic readout instruments normally have two or more adjustments. The instrument must be adjusted for each scale as recommended by the manufacturer. After adjustment, the instrument must be checked at a minimum of one point on each decade.

5.1.1.3 Surface Contamination Measurement Instruments

Alpha and beta-gamma detection instruments usually consist of a count rate meter and a separate detector. The electronics and the detector may be calibrated together or separately. The detector should be calibrated with the radionuclide to be detected, if possible, or with radionuclides of similar energies. When the instrument is calibrated as an integral unit, a minimum of one point on each scale is calibrated up to approximately 6×10^4 dpm/100 cm^2. When calibrated separately, the count rate meter is calibrated with an electronic pulser. Exchange of detectors is allowed if the response to a calibrated check source is within the range of acceptable counts for the original probe and check source.

5.1.1.4 Radioactive Calibration Sources

Calibration sources, used to determine instrument operating parameters such as high voltage setting and efficiency, must be calibrated annually by the manufacturer or other accredited laboratory. Depending on the half-life of the radionuclide used for the source, decay correction may also be necessary during use to ensure accuracy. All calibration sources are stored in the Radiation Safety Laboratory and are secured after hours by a locked door.

5.1.1.5 Calibration Records

The calibration vendor shall provide a record of all calibration, maintenance, repair, or modification. Calibration records will be filed with all previous records for the same instrument. In addition, each instrument will be labeled with the following information:

- Date of most recent calibration;
- Initials of calibrator;
- Date that primary calibration is again required;
- Special use or limitations (if applicable);
- Serial number of the instrument.

5.1.1.6 Calibration Frequency

Calibration frequency is annual or at the frequency recommended by the manufacturer, whichever is more frequent. Where instruments are subjected to extreme operational conditions, hard usage, multi-shift use, or corrosive environments, the RSO should consider increasing the calibration frequency. The calibration vendor should provide the as-found calibration condition for each instrument. If greater than 10% of the instruments are out of calibration when received by the calibration vendor, consideration should be given to increasing the calibration frequency.

5.1.2 On-Site Calibration

Regulated air samplers (Eberline RAS-1 or equivalent) and high volume air samplers are calibrated semiannually or at the manufacturer's recommended frequency, whichever is more frequent. Breathing zone samplers are calibrated daily during use. With the exception of breathing zone samplers, air samplers should be labeled with the date of calibration, correction factors (if applicable), and initials of the calibrator. This information is recorded on the daily calibration sheet for the breathing zone samplers. All alpha counting systems used for radon daughter measurements are calibrated at least monthly using a known standard alpha source.

5.2 FUNCTIONAL TESTS

Functional tests are performed at the mine site to ensure that an instrument is acceptable for use. The functional tests are checks that are often qualitative and consider the physical condition of the instrument (e.g., battery condition) and response of the instrument to a radioactive source.

5.2.1 Initial Instrument Checks

Initial instrument checks are performed initially after receipt of the instrument from the calibration vendor. The results of these initial instrument checks are recorded and are used to ensure that a system continues to operate in as-received condition until the next scheduled calibration. These functional tests are also performed after any repair or if the response of the instrument to a known source is questioned.

5.2.1.1 Instrument Reliability (Chi-Square Test)

The instrument reliability (Chi Square Test) will indicate whether an instrument is operating properly within the statistical limits of counter reliability. The Chi-Square Test will be performed initially after receiving the appropriate type of instrument from the calibration vendor prior to returning the

instrument to service. The Chi-Square Test will also be performed at the discretion of the RSO or HPT in order to test the operational adequacy of the instrument. This test statistically evaluates the sample counter against a Poisson distribution. The Chi-Square Test should also be performed for an instrument that has not been in service for an extended period or for an instrument that has a daily source check count that falls outside the acceptable range. The Chi-Square value should be between 3.325 and 16.919. The Chi values correlate to p-values of 0.95 and 0.5 respectively. This implies that the instrument is operating reliably. A Chi-Square value outside this range will be investigated by the RSO.

5.2.1.2 Acceptable Range

The acceptable range will allow a quick determination that the daily source count performed for a specific instrument is within satisfactory limits. Note that the daily source count must be performed using the same calibrated source that was used to determine the reliability factor.

5.2.1.3 High Voltage Plateau Verification

The instrument high voltage plateau will indicate whether or not the high voltage applied to the instrument detector is set at the appropriate point for maximum sensitivity with minimal influence from background radiation levels. The high voltage is verified initially after receiving the appropriate type of instrument from the calibration vendor. The purpose of this high voltage plateau verification is to confirm the high voltage matches the calibration vendor's certificate. If the high voltage reading does not match the calibration certificate, the instrument will be taken out of service and returned to the vendor for recalibration.

A secondary purpose is to ensure that the setting was not affected by shipment of the instrument. A high voltage plateau verification should also be performed on an instrument when a new detector is installed or when there is a noticeable degradation in instrument performance as indicated by the daily functional tests. Performance problems would include a decrease in the instrument efficiency over time or erratic results indicated by a daily source check count that falls outside the acceptable range.

5.2.1.4 Lower Limit of Detection (LLD)

The instrument lower limit of detection (LLD) is the smallest concentration of radioactive material that has a 95 percent probability of being detected. The LLD will determine whether the instrument and counting procedures are capable of detecting the presence of radioactive material below the allowable regulatory limits (i.e., allowable air concentrations or removable activity concentrations). The LLD is a determination of sensitivity for a measurement system and is not intended to be calculated for individual samples.

If the LLD is at or above the allowable limit, adjustments will be made to reduce it to an acceptable level. Typically, the counting system LLD should be 10 percent of the allowable limit. In no case should the LLD be above 50% of the allowable limit. Increasing the sample count time, increasing the sample volume, or reducing background levels will lower the LLD.

The LLD is determined initially after receiving the instrument from the calibration vendor. LLD should also be determined for an instrument that has not been in service for an extended period or for an instrument that has required repairs or a high voltage plateau.

5.2.1.5 Minimum Detectable Concentration (MDC)

The LLD is the determination of sensitivity for a measurement system and is not intended to be calculated for individual samples. Minimum detectable concentration (MDC) is a measurement of the detection sensitivity for a single sample based on sampling and counting parameters and should be calculated to ensure adequate sensitivity is achieved for each sample.

5.2.2 Instrument Checks

Regulatory Guide 8.30 specifies requirements for routine maintenance and calibration of radiological surveys instruments. Regulatory Guide 8.30 also references the standards contained in ANSI N323-1978, *Radiation Protection Instrumentation Test and Calibration.* ANSI is in the process of a major revision of this Standard that will result in three separate Standards that apply to radiological instrumentation. The first revision, ANSI-N323A-1997, *Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments,* was incorporated in this Chapter. Where conflicts arise between Regulatory Guide 8.30 and the ANSI Standard, the Regulatory Guide recommendations have been followed.

5.2.2.1 Calibration Verification

Any survey or counting equipment in use shall have a current calibration sticker in place. Calibration stickers shall be checked before use or daily when in use. Calibration date and due date will be recorded on the appropriate form.

Air samplers shall have a current calibration sticker in place. Calibration stickers shall be checked each day before use of these regulated air samplers. Breathing zone samplers do not require calibration stickers if they are calibrated before each use. Calibration results will be recorded on the appropriate form.

5.2.2.2 Physical Check

Before each use, all instruments and samplers shall be inspected for physical condition. The inspection should include determining whether there are any loose or damaged knobs, buttons, cables, or connectors. Meter movements or displays should be inspected for damage. Instrument cases should be inspected for dents or corrosion. Probes should be inspected for damage such as punctured or deformed probes or probe windows.

An instrument that has any physical damage should not be placed in service. Repairs shall be made and documented.

5.2.2.3 Battery/High Voltage Check

The battery check is performed to determine the condition of the instrument's batteries. This check is important to ensure that there is sufficient voltage being supplied to the detector and the instrument circuitry. The battery check will be performed in accordance with the instructions contained in the appropriate instrument technical manual. If the battery check is unsatisfactory, refer to the technical manual for instruction for replacement of batteries and repeat the check. If results are still not satisfactory, remove the instrument from service until repairs can be made. Repairs shall be made and documented.

High voltage checks shall be performed in accordance with the appropriate instrument technical manual. The purpose of the high voltage check is to ensure that the proper voltage is being applied to the detector. The high voltage setting is provided by the instrument calibration vendor on the calibration certificate or is determined by performing a high voltage plateau.

5.2.2.4 Response Source Check

The response source check is made to ensure that the instrument in use will respond to a known source of radiation. The response check does not result in determination of efficiency or the instrument correction factor. The response check is typically performed before each use and indicates that the instrument has not sustained damage that would prevent it from detecting radiation. An example of a response check would be checking an alpha contamination survey meter at a restricted area access point with a check source of Th-230.

5.2.2.5 Constancy Check

Survey instruments should be checked for constancy of operation with a radiation check source prior to each usage or at a minimum checked weekly. If the instrument response to the radiation check source differs from the reference reading by more than 20%, the instrument should be repaired if necessary and recalibrated. The constancy check should be supplemented by calibrations at 12 month intervals or at the manufacturer's suggested interval whichever is shorter.

5.2.2.6 Background Measurement

Background measurements for radiation survey instruments are performed daily or as required. Local background may need to be determined before a particular use, such as performing a gamma radiation survey for characterization of potential contamination.

Background measurements for scaler type instruments are used to evaluate the radiation level in the area where the instrument is located. High background radiation levels will affect the sensitivity of scaler type instruments and will adversely affect the lower limit of detection (LLD).

5.2.2.7 Determination of Efficiency and Correction Factor

Instrument efficiency (E) is determined to check instrument performance when measured with a source of known activity of a particular radioisotope. A correction factor (CF) is determined that allows conversion of instrument cpm to disintegrations per minute (dpm) and is the inverse of the known efficiency (i.e., 1/E).

The instrument dpm Factor may be determined for contamination survey instruments to correct the indicated cpm to dpm per 100 cm^2. This factor is typically determined for instruments that are used for performing total surface contamination surveys since the action levels and regulatory limits are expressed in units of dpm/100 cm^2.

5.2.3 Instrument Check Schedules

Routine checks of radiation survey and counting instruments are made to ensure that the instrument is responding accurately and is in proper condition for field use. The check schedule for each type of instrument based on the guidance contained in Regulatory Guide 8.30. Specific instructions for performing these checks on each instrument are contained in the appropriate instrument technical manual.

5.2.3.1 Radiation Survey Instruments

Radiation survey type instruments include the Ludlum Model 3 Gamma Survey Meter and the Ludlum Model 2224-1with a 43-93 probe or equivalent. These instruments require the following checks at the noted frequency:

- Physical check – Daily when in use;
- Battery Check (if applicable) – Daily when in use;

- Response source check – Daily when in use;
- Calibration verification – Daily when in use;
- Background measurement – Daily when in use, as required.

5.2.3.2 Surface Contamination Instruments

Surface contamination instruments are used to measure alpha and beta-gamma surface contamination levels and include the Ludlum Model 2241 Ratemeter/Scaler Survey Meter or equivalent. These instruments require the following checks at the noted frequency:

- Response source check – Before each use;
- Battery Check (if applicable) – Daily when in use;
- High Voltage Check (if applicable) – Daily when in use;
- Calibration verification check – Daily when in use;
- Background measurement – Daily when in use, as required;
- Determination of efficiency/correction factor – Daily when in use;
- Determination of instrument reliability factor – Initially after calibration.

5.2.3.3 Scaler Type Instruments

Scaler type instruments are used to analyze the alpha contamination on air filters and loose surface contamination ("smear") samples. These instruments consist of a detector and a scaler and include the Ludlum Model 2000 Scaler, Ludlum Model 3030P Scaler or equivalent. These instruments require the following checks at the noted frequency:

- Physical check – Daily when in use;
- Battery Check (if applicable) – Daily when in use;
- High Voltage Check (if applicable) – Daily when in use;
- Calibration verification check – Daily when in use;

- Background measurement – Daily when in use;
- Verification of efficiency/correction factor – Daily when in use;
- Determination of instrument reliability factor – Initially after calibration, after repair or if instrument response is questionable;
- Determination of lower limit of detection – Initially after calibration, after repair or if instrument response is questionable;
- High voltage plateau – Initially after calibration, after repair or if instrument response is questionable.

5.2.3.4 Alpha/Beta Survey Meters

Alpha/Beta survey meters are used to measure alpha/beta surface contamination levels on skin and equipment and include a ratemeter such as the Ludlum model 2224-1 with a 43-93 probe or Ludlum model 3030E with a 43-93 probe or equivalent. These instruments require the following checks at the noted frequency:

- Response source check – Before each use;
- Battery Check (if applicable) – Weekly;
- High Voltage Check (if applicable) – Weekly;
- Calibration verification check – Weekly;
- Background measurement – Weekly;
- Verification of efficiency/correction factor – Weekly;
- Determination of instrument reliability factor – Initially after calibration.

5.2.4 Beta Calibration

Periodic beta detector calibration checks should be performed using aged yellowcake (i.e., at least 4 months old). The calibration should be performed at the surface and at 2 cm (approximately one inch) from the surface of the yellowcake source.

5.3 POTENTIAL DETECTION PROBLEMS

In the course of performing instrument checks and reviewing records, the RSO or HPT will be aware of the following observations that may indicate a detection problem:

- Background drift in a continuous direction, either up or down;
- Alpha background rates greater than 1.0 cpm;
- A calculated LLD that is greater than 50 percent of the appropriate regulatory limit;
- A ratemeter instrument that does not zero;
- A battery check that does not respond;
- Reliability factors greater than 1.40 or less than 0.50;
- A daily response source check that does not fall within ± 20 percent of the calculated mean.

If any of the potential problems listed above are noted, the RSO or HPT will remove the instrument from service and investigate until the source of the problem can be determined and corrected.

5.4 RADIOLOGICAL INSTRUMENT CALIBRATION

CBR calibrates radiation survey and counting instruments after each repair. Routine calibration is performed annually or at the frequency recommended by the manufacturer, whichever is more frequent. A qualified instrument calibration vendor performs all calibration of radiation survey and counting instruments.

5.5 AIR SAMPLER CALIBRATION

Proper calibration of air sampling equipment is important to ensure that the total volume of air sampled is accurate. Air sampling is performed at the Crow Butte project and expansion areas to determine environmental and occupational levels of radioactivity in air.

Calibration of field flow rate measurement instruments (typically rotameters) is performed by comparing the flow rate measured by the field instrument with the flow rate measured by a primary standard instrument or a properly calibrated secondary standard instrument. Primary measurements generally involve a direct measurement of the volume based on the physical dimensions of an

enclosed space, such as a "frictionless" piston meter (i.e., soap film flowmeter or dry cell calibrator). Secondary standards are reference instruments or meters that trace their calibration to a primary standard, such as a mass flow meter.

Calibration should be performed semiannually as recommended in Regulatory Guide 8.30 or at the manufacturer's recommended frequency, whichever is shorter. Calibration should be performed with air filters in place to properly account for the reduction in flow due to solid material deposited on the filter.

5.5.1 Calibration Using the Soap Film Technique

The soap film technique involves using a graduated burette and a soap solution to measure the volume of air drawn through the burette during a measured time. The pump is started and connected to the burette, which is then dipped into a soap solution to form a bubble. The bubble will move along the burette. The time that it takes the bubble to move between volume graduations is measured, resulting in an indicated flow rate that is corrected to liters per minute (LPM). This measurement is then compared to the volume indicated by the air meter on the sampler. The comparison results in a correction between the indicated and the actual flow rate.

5.5.2 Calibration Using a Dry Cell Calibrator

A dry cell calibrator is a primary air flow calibrator that is a variation on the wet cell technique. The calibrator consists of a flow cell using a near-frictionless piston to measure the volume of air pumped. The flow cell is made of dimensionally stable borosilicate glass with a sensing encoder. The cell dimensions and crystal timing device are NIST traceable which allows use of the unit as a primary standard. Depending on the design flow rates, these units may be used for low and high flow samplers.

5.5.3 Calibration Using a Linear Mass Flow Meter

Linear mass flow meters may be used to calibrate sampling pumps. The linear mass flow meter measures the differential temperature of a gas drawn through a heated capillary tube and is considered a secondary standard.

5.5.4 Adjustment for Pressure and Temperature

Many variables affect the accuracy of air sampling measurements. Two of these are temperature and pressure variations. USNRC Regulatory Guide 8.25 states that corrections to the measured flow rate

should be made if there are differences exceeding five percent in either the absolute pressure or absolute temperature between the calibration situation and the sampling situation.

Differences in the absolute pressure are common when calibration is performed at a different altitude (and thus a different air pressure) than that at which the instrument will be used. An example of this would be the calibration of a secondary standard at sea level and then use to calibrate rotameters at a higher elevation. Differences in pressure may be evaluated by comparing the barometric pressure readings at the calibration location with those at the sampling location.

Similarly, differences in temperature between the calibration location and the sample location will adversely affect accuracy of flow meters. Since calibrations are generally made at room temperature (i.e., approximately 72°F), corrections should be made to account for sampling conditions if the ambient temperature is expected to exceed the five percent limit. Based on absolute temperature, five percent of a calibration temperature of 72°F would correspond to an ambient temperature less than 45°F and greater than 98°F.

5.6 SAMPLE ANALYSIS PROCEDURES

5.6.1 Analyzing Area Airborne Uranium Samples

Uranium airborne particulate samples are determined by counting alpha emissions using a scaler ratemeter or equivalent. The scaler is used with an alpha detector such as a Ludlum 43-10, Ludlum 218, Eberline SAC-R5, or equivalent. Some detectors, such as the Eberline SAC-R5, require the use of scintillation paper to detect alpha activity. The analyst should review the specific manufacturer's instruction manual to ensure familiarity with the detector operating requirements.

NOTE: Samples must age for 24 to 48 hours after sampling to allow decay of short-lived radionuclides.

5.6.2 Analyzing Breathing Zone Samples

Because breathing zone samples are typically collected over relatively short durations (i.e., less than a full work shift) it is necessary to utilize longer count times for both background and the sample in order to achieve the desired LLD. It should be noted that Regulatory Guide 8.25 recognizes that breathing zone samples may not be able to detect 10% of the appropriate DAC but that such samples are still acceptable for measuring potential uranium exposure to workers.

5.6.3 Radon Daughter Counting Procedure (Modified Kusnetz)

Radon daughter samples are analyzed using the modified Kusnetz method. Samples are collected on fiberglass or membrane filters using a lapel sampler or equivalent pump pulling a minimum of 2 liters per minute. Samples are collected for exactly five minutes, resulting in a 10 liter sample.

The sample filter is allowed to decay between 40 and 90 minutes after the end of collection before counting. After 40 minutes, only alpha particles from the decay of Po-214 are counted because virtually all of the Po-218 (3.05 minute half-life) has decayed.

The sample is counted with a scaler rate meter and an alpha scintillation detector at a count time determined by the RSO as adequate to meet the LLD requirements of 0.03 WL. The resulting gross counts are divided by the count time to arrive at a count rate (cpm).

Working levels are derived by dividing the count rate, minus background, by the product of the counter efficiency, the volume of air sampled, and the time factor.

The time factor (TF) is dependent on the time elapsed between end of sampling and the beginning of counting. The time factor is based on the assumption that equilibrium existed between Po-218, Pb-214, and Bi-214 at the time of sampling. The time factor relates dpm per liter of air from 40 to 90 minutes after sampling to the decay activity that would be present from an initial concentration of 1 WL.

5.6.4 Analyzing Smear Samples

Smear samples are taken to quantify the amount of removable contamination present on a surface or object. Following sample collection, smears are analyzed using a scaler rate meter and an alpha scintillation detector.

5.6.5 Filter Self Absorption

Regulatory Guide 8.25 requires that counting results be corrected for self-absorption of radiation by the filter collection media that would reduce the count rate by more than 5 percent. Regulatory Guide 8.25, further recommends that filter efficiencies of less than 95% be adjusted to account for airborne radioactive material not collected from the sampled atmosphere.

CBO uses glass fiber filters with an efficiency of 99.97%. If a filter collection efficiency of less than 95% is used, collection efficiency will be calculated as described in NUREG 1400 Section 6.2, Efficiency of Collection Media.

Self-absorption will be assessed according to NUREG 1400 Section 6.2, if self-absorption is > 5% a correction factor will be used.

5.6.6 Regulated Air Samplers (RAS)

Regulated air samplers are used at the Crow Butte project for measurement of airborne concentrations of particulate radioactivity. CBR calibrates regulated air samplers on a semiannual basis. Calibration is performed using a properly calibrated mass flow meter. As a result of this calibration, the correction factor for the air sampler is determined and is used to ensure accurate total flow determinations are available.

5.6.7 Breathing Zone Samplers

Breathing zone samplers are used at the Crow Butte project for area sampling to determine the concentration of radon daughters in air using the Modified Kusnetz Method. Breathing zone samplers are also used for measuring the concentration of airborne particulate radioactivity in the breathing zone of workers. These samplers are calibrated before each use using a bubbler tube and stopwatch to ensure accurate determination of total volume of air sampled.

5.7 RADIONUCLIDE REFERENCE STANDARDS

Crow Butte uses calibrated radionuclide reference standards (sources) to determine the counting efficiency of instrumentation for a given radionuclide. Non-calibrated check sources are also used to check the response of certain instruments.

5.7.1 Calibrated Standards

Calibrated radionuclide standards that have been certified as traceable to National Bureau of Standards (NBS, now known as the National Institute of Standards and Technology, or NIST) measurements are used for determination of instrument efficiency and correction factor. The instrument efficiency is used to convert the instrument indicated count rate to a concentration of radioactivity. These calibrated standards are used to determine counting efficiencies for all radioactivity measurements that require comparison to a specified concentration of radioactivity per unit volume or area, such as air samples and surface contamination level determinations.

5.7.2 Non-calibrated Standards

Certain radionuclide check sources that are not traceable to NBS measurements are used at the Crow Butte project to indicate that an instrument is responding properly. These non-calibrated check sources include sources that are maintained at restricted area boundaries near survey instruments. The sources are used before each use of the instrument to perform a response check. This response check is performed in addition to the daily determination of efficiency and correction factor.

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6 ENVIRONMENTAL AND EFFLUENT SAMPLING

CBR performs environmental and effluent monitoring at the Crow Butte project as required by NRC regulations and CBR's source materials license. Measurements are performed for the following purposes:

- To allow CBR to estimate the maximum annual radiation dose to the public;
- To ensure that the regulatory requirements and license conditions for dose and release limitations and meeting "as low as reasonably achievable" objectives are met;
- To evaluate the performance of effluent controls;
- To evaluate the environmental impact of mining operations; and
- To establish baseline data to aid in decommissioning or remediation efforts.

CBR's environmental and effluent sampling program was prepared in accordance with the guidance contained in Regulatory Guide 4.14, *"Radiological Effluent and Environmental Monitoring at Uranium Mills"*, (Revision 1, 1980). Regulatory Guide 4.14 and 4.15 contain guidance for quality assurance and quality control measures to ensure the accuracy of effluent and environmental sampling and analysis activities. It has been CBR's practice, and will continue to be CBR's practice, to submit all samples collected to meet the requirements described in Regulatory Guide 4.14 to an independent third party accredited laboratory for analysis.

6.1 SAMPLE COLLECTION

The quality assurance program for environmental sampling is implemented in the following areas:

- Procedures are used which define the details of sample location, sample frequency, number of samples, duration of sampling, sample volume, sample collection methods, and equipment to be used for sample collection.
- Procedures have been prepared for calibration and maintenance of equipment used for measurement. These procedures provide details for the standardization, use and maintenance of the instruments.
- Taking duplicate samples and submitting these to a third party accredited analytical laboratory makes random control checks. These checks allow evaluation of the performance of the analytical laboratory and to some extent, the validity of sampling procedures. In the event that the results

of the duplicate samples do not agree within predetermined limits, an audit will be performed to determine whether the problem is in the sampling or analysis.

CBR collects samples of environmental media within the NRC license area. Samples are also obtained from the surrounding area. Specific CBR SOPs are used to provide instructions for obtaining each type of environmental sample.

6.1.1 Air Sampling

The airborne effluent and environmental monitoring program is designed to monitor the release of airborne radioactive effluents from the Crow Butte project. To evaluate the effectiveness of the effluent control systems, the results of the monitoring program are compared with the background levels and with regulatory limits.

The accuracy of monitoring data is critical to ensure that the air monitoring program precisely reflects air quality in each phase of the program. Regulatory Guide 4.14 specifies the following lower limits of detection (LLD):

Radionuclides	LLD (µCi/ml)
Natural Uranium	1×10^{-16}
Thorium-230	1×10^{-16}
Radium-226	1×10^{-16}
Radon-222	2×10^{-10}
Lead-210	2×10^{-15}

6.1.1.1 Radon Gas Sampling

The radon gas effluent released to the environment is monitored using Track-Etch radon cups provided by Landauer Corporation. The cups are exchanged on a semiannual basis. In addition to the manufacturer's quality assurance program, CBR exposes two duplicate radon Track Etch cups during each monitoring period.

Radon-222 is monitored continuously at the environmental monitoring locations. Monitoring is performed using Landauer RadTrak detectors. These detectors are an alpha-track radon gas detector using Landauer's Track-Etch® process and are designed to monitor radon exposure for three months to one year. Landauer service includes the RadTrak detector and a comprehensive analysis.

The RadTrak radon detectors are supplied in aluminum bags to prevent radon exposure before deployment. The detectors should not be stored or deployed in any area in which the temperature may exceed 160°F. There is no low temperature limit.

Note: Landauer does not provide the LLD on the analytical result report. The LLD for Track-Etch® detectors is a function of the exposure time and the area of the cup that is analyzed by Landauer. The LLD should be determined in consultation with Landauer before monitoring is performed. If the LLD is above the NRC requirements from Regulatory Guide 4.14, it may be reduced by either employing a longer sampling time or requesting that Landauer analyze a larger portion of the Track-Etch® cup.

6.1.1.2 Air Particulate Sampling

Airborne particulate sampling is performed at the locations specified in the NRC License. The CBO License requires monitoring for at least 2 weeks of every month that the yellowcake dryer is in operation. However, CBO has instituted continuous monitoring at these sites as a best management practice.

Filters are collected for two weeks and then composited for analysis on a quarterly basis. At the end of the calendar quarter, the composite filter samples are submitted to the contract laboratory for radiometric analysis using standard Chain of Custody Procedures. The filters are composited according to location. The composite samples are analyzed for the concentrations of natural uranium, radium-226, and lead-210. The actual volume of air filtered at each station for the quarter is also forwarded to the contract laboratory with the filters. The flow rate on the RAS-1 pumps is calibrated at six-month intervals in order to ensure the accuracy of the volume of air sampled. The uncertainties in the volume of air sampled should be less than 20% as described in Regulatory Guide 8.25.

6.1.2 Water Sampling

During operations at the Crow Butte project, a detailed water-sampling program is conducted to identify any potential impacts to water resources of the area. CBR's operational water monitoring program includes the evaluation of groundwater on a regional basis, groundwater within the permit or licensed area and surface water on a regional and site specific basis. To evaluate the effectiveness of the effluent control systems, the results of the groundwater and surface water monitoring programs are compared with the background levels and with regulatory limits.

6.1.2.1 Groundwater Monitoring

The groundwater-monitoring program is designed to detect impacts to the local and regional groundwater from mining operations. Potential sources of impacts to the groundwater could be excursion of mining solutions beyond the perimeter of the wellfields or a failure of evaporation pond

lining systems. Monitor wells are installed around the wellfield boundaries and the evaporation ponds to monitor for impacts to the local groundwater. Sampling all private wells within one kilometer of the wellfield area boundary monitors impacts to regional groundwater.

Groundwater samples obtained for preoperational, operational, and restoration purposes are critical to meeting environmental protection goals at solution uranium mines. The results of these samples are used to determine pre-mining conditions, to monitor operational environmental protection efforts, and to determine whether restoration activities are successful. In order to ensure the accuracy of these monitoring efforts, strict compliance with groundwater sampling procedures is necessary.

6.1.2.1.1 Water Level Determination

The accurate determination of the static water level in wells provides important information concerning aquifer conditions. Well static water levels are monitored using an electrical measuring line (an "e-line"). The sampler takes e-line readings of all monitor wells before sampling. Significant changes in the water level in overlying aquifers may indicate a vertical excursion of mining solutions. Similarly, changes in the production zone water levels may provide an early indication of the migration of mining solutions from the active wellfield. Water level measurements are also used to determine groundwater gradients in the mining zone to assist operating personnel in managing wellfield balancing.

6.1.2.1.1 Field pH Measurements

Field measurement of pH is used in conjunction with conductivity as an indication that well purging has successfully removed stagnant water from the well casing and formation water is being sampled.

Degasification (such as loss of carbon dioxide), precipitation (such as calcium carbonate), and other chemical and physical reactions may cause the pH of a water sample to change significantly within several hours after the sample is collected. Therefore, immediate analysis of a sample in the field is required.

pH measurements will be performed in accordance with manufacturer's recommendations. The probe should be swirled in the sample to remove any air bubbles adhering to the surface of the probe. A reading is not valid until the reading on the panel is stable for at least ten (10) seconds or bounces around a point for at least ten (10) seconds.

Standardization will be checked daily during regular use. For the range of water quality encountered in well sampling activities, standardization will be performed using a pH 7.00 buffer and a pH 10.00 buffer.

6.1.2.1.1 Field Conductivity Measurements

Field measurement of conductivity is used to indicate when well purging has successfully removed stagnant water from the well casing and formation water is being sampled. Specific conductance meters used in the field are battery operated, and read directly in micromhos (μmhos) or microsiemens (μS) per cm.

The conductivity cell is checked daily during regular use. A standard solution of known electrical conductance that falls in the range of samples to be measured is used to check the cell. For the range of water quality typically encountered, a standard solution of from 500 to 1500 micromhos/cm at 25°C will be used. Instrument calibration will be performed in accordance with the manufacturer's recommendations.

Measurements are performed in accordance with manufacturer's recommendations. The probe is swirled in the sample to remove any air bubbles adhering to the surface of the probe. Conductivity readings stabilize much more quickly than pH readings. The Sampler will ensure that the reading is stable before recording the results.

6.1.2.1.2 Well Purging

Water that remains in the well casing between samples may not be representative of the formation water quality. The quality of water left in the casing between samples may be changed by sorption or desorption from casing materials, oxidation, or biological activity. Purging is required to remove this stagnant water and allow formation water into the well screen.

Purging should be accomplished at a flowrate that is lower than the well development rate. The purge rate should approximate the natural groundwater flow rate (i.e., little change in the well water level during purging) while satisfying time constraints. Purging at too high of a flow rate can result in redevelopment of the well and increased turbidity. In no case should a well be purged at a flowrate high enough to cause the well to pump dry. Purging is deemed complete only when it is determined through field monitoring of pH and conductivity that the water quality is stable.

6.1.2.1.3 Well Sampling

The sample should be taken as soon as the well is adequately purged. If the well was pumped dry during purging, the sample should be obtained as soon as adequate formation water is present in the casing. Do not touch the sampled water with your hands as this could result in contamination of the sample.

Make sure that the water being sampled is very low in visible solids and any contamination that may show up in the analysis. Fill the sampling container(s) completely, so all air is excluded from the container.

Record the time of sample collection and include any remarks as to unusual conditions of the water quality (e.g., odor, color) on the data sheet.

Keep the sample cool and transport it to the laboratory as soon as possible for analysis or filtering, preservation and/or shipment.

6.1.2.2 Surface Water Monitoring

The surface water-monitoring program is designed to detect impacts to the regional surface water from mining operations. Potential sources of impacts to the surface water could be releases of mining solutions, drainage from potentially contaminated areas, or failure of evaporation pond embankments. Surface waters within one kilometer of the wellfield area boundary are sampled.

Samples are collected in the appropriate container(s) and field measurements for pH and conductivity are performed and documented. The sample bottle must be rinsed with the sample water. The bottle is then filled with the mouth of the sample bottle pointed downstream to prevent collecting debris. If samples involve analysis that requires filtration, collect water in a clean bucket for transfer to the filter apparatus. Treatment of sample containers, preservation techniques, holding times, and shipping techniques are identical to those used for groundwater.

6.1.3 Soil and Sediment Sampling

Samples of soil and sediment are collected at the Crow Butte project to monitor radioactivity concentrations in these media. To evaluate the effectiveness of the effluent control systems, the results of the soil and sediment monitoring program are compared with the background levels and with regulatory limits.

6.1.3.1 Soil Sampling

Preoperational surface soil has been sampled. Surface soil samples will be taken at the air monitoring locations following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Preoperational subsurface soil has been sampled at the plant. Subsurface soil samples will be taken following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Soil samples are obtained with a clean auger, spade, or shovel. At the sampling location, remove the vegetation and collect a grab soil sample of the top 15 cm (6 inches) of soil. Samples may also be collected at successive 15 cm intervals for comparison with the decommissioning criteria contained in 10 CFR Part 40 Appendix A, Criterion 6-(6). Samples are placed in appropriate plastic bags. The amount of sample should be sufficient to provide the laboratory with at least 50 grams of soil. This quantity of sample is necessary to meet the LLD requirements. Any non-soil material such as rocks, sticks, vegetation, and large amounts of roots should be removed from the sample. Remove the air in the bag and seal it.

The plastic bags must be clearly labeled at the time of sampling with a permanent marker, identifying the project location, sample site, the depth interval of the sample (e.g. 0-6"), and the sample date. It is important that the type of soil extraction method to be used for the various chemical analyses be clearly identified on the chain of custody to the independent third party accredited laboratory.

6.1.3.2 Sediment Sampling

Sediment in local surface water features was sampled on a semiannual basis for one year prior to any construction in the area. Operational samples are taken upstream and downstream of the Crow Butte project site to monitor for impacts to the sediments from mining operations.

At the sampling location, collect a grab sample of the stream or impoundment sediment. Remove any vegetation, rocks, or other debris that may be present; place the sample in a plastic bag and seal. After allowing the bag to set, pour off any liquid that has decanted, remove the air, and re-seal the bag. The laboratory requires at least 50 grams of sample to meet the LLD requirements.

The sample bag should be pre-labeled with the sample identification, sample location, sample analysis required, date, and company initials. Prepare a Chain of Custody form and submit the sample to the independent third party accredited laboratory.

6.1.4 Vegetation Sampling

Vegetation samples from Crow Butte project were collected on an annual basis in animal grazing areas in the direction of the prevailing wind through 1997. Sampling was normally performed during the summer months. In 1998, routine vegetation sampling was discontinued with NRC approval due to the determination that exposure from grazing animals was not a potentially significant pathway.

Vegetation sampling may be required at some time in the future. Circumstances that would indicate the necessity for vegetation sampling include land application for waste disposal or characterization of impacted areas.

When obtaining vegetation samples, select mainly grasses or leafy plants that would normally be used as forage by domestic and wild animals as opposed to woody plants such as sagebrush. Samples should be comprised mainly of stems, leaves, and fruit and should be representative of the current year's growth. Cut the plants with a trimmer within a few inches of the ground and place in the sample bag until the bag contains a minimum of 8-10 kilograms (wet weight) of vegetation. Do not include any root material. The sample should be representative of dominant vegetation present at the sample location.

The plastic bags must be weighed and clearly labeled at the time of sampling with a permanent marker, identifying the project location, sample site, and the sample date. It is important that the sample wet weight and type of analytical method to be used for the various analyses be clearly identified on the chain of custody to the contract laboratory. Vegetation samples should be submitted to the independent third party accredited laboratory as quickly as possible.

6.1.5 Direct Radiation Measurement

Environmental gamma radiation levels are monitored continuously at the air quality monitoring stations. Dosimeters that fully meet ANSI N545 performance, testing, and procedural specifications will be used.

The dosimeters are supplied by the vendor before the end of each quarter. Each shipment of dosimeters contains a control dosimeter that measures exposure rates during processing and shipping of the dosimeters and a deployment dosimeter that measures exposure rates while deploying the dosimeters. Before deployment of the dosimeters, the control dosimeter must be placed in a storage area with a low ambient background gamma dose rate. The deployment dosimeter is also placed in the storage area after the dosimeters are deployed.

The dosimeters are deployed at the beginning of each quarter. The dosimeters are clipped onto each survey location with the fastener provided with the dosimeter. Each dosimeter has a tag with an identification number. When exchanging the dosimeters, the dosimeter is replaced with the corresponding dosimeter identification number.

After the dosimeters are collected, care is taken to ensure that they are not exposed to any additional gamma radiation or x-rays. Once the dosimeters are collected, they are returned to the vendor in the original box with the provided shipping label. This label cautions against exposure to radioactive materials or x-rays while in transit.

6.1.6 Uncertainty Limits for Volume and Mass Measurements

Sample volumes are derived for each type of sample based on measurement requirements. For liquid or solid samples consideration is given for the density/composition of the matrix, counting efficiency of the instrumentation, laboratory specific MDLs, applicable analytical chemical recovery, preservation techniques, and homogeneity of the samples. Air particulate volumes are impacted by filter collection efficiency, filter dust loading, and flow rates of sampling equipment. Methods for reporting sample analysis and results are found in; SHEQMS Volume IV, *Health Physics Manual*, SHEQMS Volume VI, *Environmental Manual*, and the SHEQMS *Laboratory Manual*.

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7 OCCUPATIONAL SAMPLE COLLECTION

CBR performs occupational monitoring at the Crow Butte project as required by NRC regulations and CBR's source materials license. Measurements are performed for the following purposes.

- To allow CBR to determine the annual internal and external radiation dose to employees;
- To ensure that the regulatory requirements and license conditions for dose limitations and meeting "as low as reasonably achievable" objectives are met; and
- To evaluate the performance of exposure controls;

CBR's occupational monitoring program was prepared in accordance with the guidance contained in Regulatory Guide 8.30. Regulatory Guide 4.15 was also consulted for guidance for quality assurance and quality control measures to ensure the accuracy of occupational monitoring activities.

7.1 AIRBORNE URANIUM SURVEYS

7.1.1 Area Samples

Area air samples should be collected during the performance of work duties. Area samples may be used to monitor concentrations in work areas or to determine the effectiveness of the confinement of radioactive materials. For work area monitoring, the location of air samples should be as close to the breathing zone as practical without interfering in the performance of duties. To determine confinement, samplers should be placed in the airflow path near the source of contamination.

At a minimum, airborne uranium samples will be collected as approved by NRC in the source materials license. The frequency of the airborne uranium sampling is weekly in Airborne Radioactivity Areas and monthly in areas not designated as Airborne Radioactivity Areas as recommended in Regulatory Guide 8.30, although this frequency may be modified by specific NRC license conditions. More frequent sampling may be advisable when starting new equipment or facilities. During yellowcake packaging operations, sampling in the dryer room is continuous. Spot samples may also be collected to verify the adequacy of the sampling procedures or as determined necessary by the RSO

Measurement of airborne uranium is performed by gross alpha counting of the area air filters using an alpha scaler such as a Ludlum L-2000 or equivalent. The analytical results are compared to 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. Crow Butte has collected isotopic samples from seven locations throughout the Central Processing Plant. As per Regulatory Guide 4.14, airborne particulate

samples from the in-plant sampling stations were analyzed for U^{-Nat}, Th^{230}, Ra^{226}, and Pb^{210}. Sampling indicated that the concentrations of the isotopes analyzed were present in concentrations significantly below 10% of their respective DAC's. In addition, the sum of the DAC percentage from Th^{230}, Ra^{226}, and Pb^{210} combined is significantly less than 1%, meeting the criteria of less than 30%. Therefore, these three radionuclides can be disregarded from the determination of the internal dose under 10 CFR 20.1204(g). Solubility studies performed at the Crow Butte operation demonstrated that the Uranium is of Class D solubility. Uranium compounds that have no assigned inhalation classification, or for which no site-specific data is available, such as uranium carbonates, shall be assigned to inhalation Class W for radiation protection purposes.

Samples should be obtained using the following steps:

- Obtain an Eberline RAS-1 or Hi-Q or Staplex Hi-Vol Sampler or similar equipment and the appropriate glass fiber filters. Ensure that the air sampler has a current calibration as discussed in Section 5.
- Record data concerning sample location, start and end time, total time in minutes, flow rate, as found operating status of the air sampler, air sampler identification, location and calibration data on the sampling form.
- Place a filter in the filter holder taking care not to damage or contaminate the filter.
- Place the air sampler at a location where workers could be exposed to airborne particulates at 4 to 6 feet above the floor and at least 1 foot away from walls, cabinets, etc.
- Ensure that the sampling environment is representative of the conditions encountered by workers while performing assigned duties.
- Start the pump and record the start time and the initial flow rate on the sampling form. Ensure that an adequate volume of air is obtained to meet the lower limit of detection (LLD) for uranium (i.e., 10% of the applicable DAC).
- At the conclusion of sampling, record the flow rate, shut off the sampler and record the sampling stop time on the sampling form. Unless the sample period is extremely long, with resulting dust loading on the filter, there should be no change between the initial and final flow rate.
- Carefully remove the filter from the filter holder and place in the sample holding envelope, taking care not to touch or disrupt the particulate material collected on the filter.

7.1.2 Breathing Zone Air Samples

In the plant, breathing zone air samples may be collected periodically. The samples are representative of the air inhaled by the worker. Breathing zone samples for specific jobs are used to monitor the intakes of individual workers performing tasks that have the potential for high airborne exposures. Breathing zone samples may also be collected for an entire work shift, resulting in a composite sample for an employee performing his normal duties. The breathing zone sample, in the latter case, may be used as a means of judging the adequacy of the area air monitoring program.
The RSO typically determines under which circumstances a breathing zone sample should be obtained.

Samples should be obtained using the following steps:

- Obtain a lapel sampler (Sensidyne BDX or equivalent). Ensure that it is fully charged and properly calibrated.
- Obtain a glass fiber filter(s), or equivalent, of the proper size and an appropriate filter holder. Place filter in holder and attach to sampler hose.
- Secure the pump to belt and the filter holder to the shirt collar or lapel. Make sure the pump is in the upright position at all times. Consolidate the tubing to minimize restriction of motion.
- Turn the pump on (recording the time and flow rate) and continue monitoring until the task is completed. Record the time and flow rate at which the job is completed.
- Lapel samplers are to be analyzed within two working days of sampling, where possible. Ensure that the SHEQ Department obtains the filter and information in a timely manner so analysis can be completed.

7.1.3 Natural Uranium Radiometric Analysis

Natural uranium air sample filter(s) must be aged a minimum of three (3) hours in order to eliminate the short-lived radon daughters. These include Pb-214 (26.8 min), Bi-214 (19.7 min), and Po-214 (164 µsec) in the shorter-lived decay chain. A sample counted immediately after collection will not only contain possible uranium ore dust and a possible static charge, but it may also contain radon daughters. Counting the sample too soon after sample collection will result in an overestimation of airborne uranium.

Samples may also be sent as individual samples or as part of a composite sample, to an approved outside independent third party accredited laboratory for analysis for specific isotopes.

7.2 RADON DAUGHTER MEASUREMENT

Radon daughter samples are taken in various areas of the plant and offices. The sample locations are near areas where workers are most often present to ensure that the samples are representative of worker exposure. Sampling is performed at a monthly frequency, unless concentrations greater than 0.08 WL are discovered. When concentrations greater than 0.08 WL are discovered, the sampling frequency is increased to weekly. Weekly sampling continues until concentrations of less than 0.08 WL occur for four consecutive weekly samples.

Analysis of radon daughter samples is performed on-site using the Modified Kusnetz Method. Measurement of radon daughters on sample filters is performed by gross alpha counting using an alpha scaler such as a Ludlum L-2000 or equivalent.

In addition to the Modified Kusnetz Method, CBR uses the PRISM II continuous radon monitoring system, which allows "real time" analysis of atmospheres for radon daughter concentrations. The PRISM II is used as a diagnostic tool to allow evaluation of work practices and engineering controls and may not be used for routine monitoring or exposure determination purposes.

7.3 EXTERNAL RADIATION EXPOSURE

7.3.1 Personnel Dosimeters

Occupational exposure to external gamma and beta radiation is measured using personnel dosimeters such as Thermoluminescent Dosimeters (TLD) or Optically Stimulated Luminescence (OSL) dosimeters. With two exceptions, dosimeters must meet NRC requirements, which state that a contract vendor must be certified by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The exceptions to this requirement are direct and indirect reading pocket ionization chambers and dosimeters used to measure the dose to extremities. The dosimeters consist of a clip-on badge worn by workers. The badge contains a chip that is constructed of a material that senses total exposure to external radiation. When the chip is properly developed, the radiation dose received by an individual during the period of time that the badge was worn may be determined.

The RSO is responsible for determining the dosimetry requirements based on the facility radiation levels, worker job locations and tasks, and specific licensing requirements. For each category of workers, the RSO must determine whether it is likely that a worker's dose may exceed the criteria from § 20.1502(a). If it is determined that dosimetry is required, the RSO will determine the exchange frequency for the dosimetry (i.e., monthly or quarterly). Contractors, depending upon the task to be performed, may also be issued dosimeters at the discretion of the RSO.

The RSO is responsible for reviewing the dosimetry results and comparing them with past data and regulatory exposure limits. Upon receipt of the dosimetry results from the NVLAP laboratory, the individual exposure records are to be maintained on hard copy and/or a computer system.

The control personnel dosimeters used by the NVLAP processor to subtract background exposure from the personnel badges, are to be stored in areas away from areas where elevated gamma dose rates may be present. It is important that control badges are returned to the NVLAP processor with the personnel dosimeters. In the event that a control badge is damaged, any unused personnel dosimeter may be designated as a control badge as long as it has been stored away from areas where gamma activity is mostly likely to occur.

7.3.2 Gamma Surveys

Gamma surveys are conducted at various locations throughout the facility. Routine gamma surveys are performed as approved by NRC in the source materials license. In areas that meet the criteria for posting as "Radiation Areas", surveys should be performed at least quarterly as recommended in Regulatory Guide 8.30. NRC licensing requirements specific to the facility may require alternate survey frequencies. Gamma surveys are conducted on a semiannual basis at various locations through the plant. These results are used to insure plant areas are properly placarded in accordance with 10 CFR 20. Additional gamma surveys may be performed at the discretion of the RSO or HPT to further characterize gamma dose rates. These surveys can be random, in conjunction with RWPs, to assist in identifying Radiation Areas, or performed before or during routine work, during contaminated waste control, or during upset conditions. Regardless of the purpose of the survey, the same procedure will be utilized to perform gamma surveys.

7.3.2.1 Instruments

- Ludlum Model 3 Gamma Meter with Ludlum Model 44-38 G-M detector or equivalent, calibrated in MilliRoentgen per hour (mR/hr).

7.3.3 Beta Surveys

In addition to gamma surveys, beta surveys should be performed before specific tasks that involve direct handling of large quantities of aged yellowcake (i.e., older than four months) to ensure that extremity and skin exposures for workers performing these operations are not unduly high.

Extremity dosimetry is required by 10 CFR 20.1502 if a worker is likely to receive a dose to any extremity in excess of 1250 mR/qtr or to the eye in excess of 375 mR/qtr.

Beta surveys should be performed before any special maintenance or non-routine operational activity with aged yellowcake to determine protective clothing needs and what portion of the body may be most exposed. If appropriate protective clothing and equipment is used (e.g. heavy rubber gloves, eye

protection, etc.) the beta dose rate may not be a significant factor to overall dose. However, the protective clothing and equipment used must be of sufficient density to ensure that significant beta radiation does not reach the skin or the lens of the eye.

7.3.3.1 Instrument

- Ludlum Model 2224-1 with a 43-93 probe or equivalent equipment.
- The detector must be equipped with a beta shield to perform this survey.

7.3.4 Surface Contamination

The primary sources of potential surface contamination at in situ leach uranium mines are associated with precipitation, slurry transfer, drying and packaging activities, and filter press activities. The remaining recovery and elution portions of the process do not present a significant surface contamination problem except for dried spills or when special equipment maintenance is required. Any visible yellowcake or production fluid spills must be cleaned up as soon as possible to prevent the potential spread by contact or drying and possible suspension into the air that could pose an inhalation hazard. If contamination is detected in a designated clean area above specified limits, the RSO will be promptly notified and the area will be cleaned. An investigation into the source of the contamination will be performed.

Routine surveys in the process areas consist of both a visual inspection for obvious signs of contamination (i.e. visible yellowcake) and instrument surveys to determine total alpha contamination. If the total alpha survey indicates that contamination is greater than 200,000 dpm/100 cm^2, the area shall be cleaned and resurveyed. This level of contamination has been determined to be low enough to ensure little contribution to airborne radioactivity and is readily visible due to the low specific activity of uranium.

In designated clean areas, such as lunchrooms, offices, and respirator cabinets, the target level of contamination is nothing detectable above background. If the total alpha survey indicates contamination exceeds 250 dpm/100 cm^2 (25% of the removable limit) a smear survey must be performed to assess the level of removable alpha activity. If smear test results indicate removable contamination greater than 250 dpm/100 cm^2, the area must be cleaned promptly and resurveyed. The RSO will investigate the cause of the contamination and implement corrective action to minimize the potential for a recurrence.

Direct measurement of total contamination is performed using alpha scintillation detectors. Measurement of loose contamination is performed by gross alpha counting of the smears using an alpha scaler such as an Eberline MS-3 or equivalent.

7.4 BIOASSAY PROGRAM

CBR has implemented a bioassay program to monitor for internal exposure to natural uranium. The bioassay program has been prepared in accordance with the guidance contained in Regulatory Guide 8.22, *"Bioassay at Uranium Mills"*, (Revision 2, 2014). All plant personnel are included in the bioassay program. The program is implemented by the RSO.

CBR routinely performs bioassay by urinalysis for natural uranium. A baseline urinalysis is performed on all employees prior to their initial assignment at the plant. Routine bioassay samples are collected at a frequency that is based upon the employee's work assignment. Diagnostic bioassays may be required by the RSO based upon specific work activities. Upon termination of employment, a final urinalysis will be performed on all employees.

Records of bioassay results are maintained to document the sample collection and analysis dates as well as the individual's record to allow the most recent results to be compared to the employee's previous history.

Analysis of bioassay samples is performed at an independent third party accredited analytical laboratory. CBR submits spike and blank samples with each batch of bioassay samples to monitor the laboratory for accuracy and sample contamination. Analytical results for spiked samples must be within 30 percent of the spiked value. Otherwise, the most recent batch of samples will be re-run. The RSO will conduct an investigation to determine whether the CBR spiking procedure or the analytical laboratory was the cause of the inaccurate results.

Duplicate samples are obtained for submission to a different laboratory to monitor precision. These samples are submitted by CBR on a periodic basis. These duplicate samples are in addition to the duplicate samples analyzed by the analytical laboratory.

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8 SAMPLE MANAGEMENT AND QUALITY CONTROL

Performance indicators are used to determine if the laboratory's processes are in control. The accuracy of the instruments or containers are checked regularly to ensure that sampling performance criteria remain within the limits specified by the QAP. The results of mass, flow rate, or volume calibrations and associated uncertainties are tracked and recorded. Performance indicators are selected to provide a management tool for tracking and trending performance and to identify precursors to nonconforming conditions. Laboratories consider necessary levels of precision, acceptable bias, and applicable detection limits. Definitions are as follows:

- Precision is the closeness of agreement between independent test results and can be assessed using replicate samples. It may be expressed as the standard deviation.
- Bias of a measurement process is a persistent deviation of the mean from the accepted reference value of the quantity being measured. It does not vary if a measurement is repeated.
- Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the analyte of interest. An evaluation of sensitivity is included in the CBO and/or vendor laboratory analytical methods that are used to analyze samples.
- Representativeness is generally ensured through the use of standard sampling protocols.
- Accuracy is the nearness of a measurement or the mean of a set of measurements to the true value and is usually expressed as the relative percent difference.
- Comparability is the confidence with which one data set can be compared to another and is ensured by employing approved sampling plans, standardized field procedures, and experienced personnel using properly maintained and calibrated instruments.

8.1 SAMPLE HANDLING AND DELIVERY

Chain of Custody (COC) forms should accompany every sample sent to off-site laboratories. The chain of custody should contain at a minimum the type of sample, the sample identification number, the preservation techniques (if any), the name of the sampler, the date and time the sample was taken, the name(s) of individuals who handled the sample and when they passed it on to another person, and the required analysis. Once the laboratory is finished with the chain of custody, it is sent back to the SHEQ Department with the analytical package so it can be filed for future reference.

8.2 INDEPENDENT THIRD PARTY ACCREDITED LABORATORY QUALITY CONTROL

CBR has implemented a quality control program to determine the precision and accuracy of the monitoring processes. Quality control sampling includes replicate samples to determine precision, spiked samples with a known concentration to determine accuracy, and blank samples to detect and measure contamination of analytical samples.

Inter-laboratory duplicate samples are analyzed by a second laboratory to determine the precision of the original laboratory. In addition, intra-laboratory duplicate samples may be collected and sent to the primary laboratory to assure internal laboratory precision. The RSO selects the locations, media and number of inter-laboratory and intra-laboratory duplicate samples. A minimum of one duplicate sample is collected per sampling period.

In addition to the quality control samples prepared and submitted by CBR to contract analytical laboratories, each qualified laboratory will have an acceptable QA/QC program in place. The CBR QA Coordinator will review the vendors QA/QC Program and will be responsible for approving the use of the vendor. Qualified laboratories will submit verification of participation in the EPA's Quality Control Program and the laboratory certification programs for environmental waters.

8.3 ANALYTICAL SENSITIVITY

8.3.1 Lower Limits of Detection

The NRC in Regulatory Guide 4.14 recommends the lower limits of detection (LLD) for radiological samples. CBR has adopted these LLD values that are appropriate for the samples obtained at the Crow Butte project. The required LLD values are listed in Table 2.

Table 2
Radiological Lower Limits of Detection

Media	Radionuclide	Lower Limit of Detection
Air	Natural Uranium Thorium-230 Radium-226	1×10^{-16} µCi/ml
	Lead-210	2×10^{-15} µCi/ml
	Radon-222	2×10^{-10} µCi/ml
Water	Natural Uranium Thorium-230 Radium-226	2×10^{-10} µCi/ml
	Polonium-210 Lead-210	1×10^{-9} µCi/ml
Soil and Sediment (dry)	Natural Uranium Thorium-230 Radium-226 Lead-210	2×10^{-7} µCi/g
Vegetation, Food and Fish (wet)	Natural Uranium Thorium-230	2×10^{-7} µCi/kg
	Radium-226	5×10^{-8} µCi/kg
	Polonium-210 Lead-210	1×10^{-6} µCi/kg

8.3.2 Non-radiological Detection Limits

Minimum detection levels are necessary for non-radiological samples obtained at the Crow Butte project. CBR has adopted the detection levels listed in Table 3.

Table 3
Non-radiological Detection Limits

Analyte	Detection Level (mg/l)
COMMON IONS	
Calcium	1.00
Magnesium	1.00
Sodium	1.00
Potassium	1.00
Carbonate	0.10
Bicarbonate	0.10
Sulfate	1.00
Chloride	0.10
Ammonia-N	0.05
Nitrite-N	0.01
Nitrate-N	0.01
Fluoride	0.10
Silica	1.00
Total Dissolved Solids	1.00
Total Alkalinity	0.10
Conductivity	1.00 (µmho)
pH	± 0.02 (standard units)
ACCURACY CHECKS (acceptable range)	
Ion Balance	0.95 to 1.05
TDS Balance	0.90 to 1.10
Conductivity Balance	0.95 to 1.05
MINOR AND TRACE METALS	
Arsenic	0.001
Barium	0.100
Boron	0.100
Cadmium	0.010
Chromium	0.050
Copper	0.010
Iron	0.050
Lead	0.015
MINOR AND TRACE METALS (continued)	
Manganese	0.010
Mercury	0.001

Table 3
Non-radiological Detection Limits

Analyte	Detection Level (mg/l)
Molybdenum	0.100
Nickel	0.050
Selenium	0.001
Vanadium	0.100
Zinc	0.010

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9 ON-SITE LABORATORY QUALITY ASSURANCE

CBR has implemented a quality assurance /quality control program to determine the precision and accuracy of the laboratory analysis performed in the on-site laboratory. Quality control in the on-site laboratory includes the use of appropriate analytical methods, quality control samples and other internal quality control activities including instrument calibration, analyst training, equipment maintenance, and external quality control.

9.1 ANALYTICAL METHODS

The use of approved standard analytical methods ensures that the quality objectives for operation of the laboratory are met. Table 4 lists the assays that are performed in the on-site laboratory and the analytical method that is used. Specific procedures for each method are described in the *Laboratory Manual* maintained in the laboratory for use by the analysts.

Table 4
On-Site Laboratory Analytical Methods

Parameter	Reference/Method
U_3O_8	"Spectrophotometric Determination of Uranium (VI) with Bromo-PADAP", DA Johnson and TM Florence "Standard Methods for Chemical and Atomic Absorption Analysis of Uranium-Ore Concentrate", Titrimetric ASTM C1022-05(2010)e[1]. Uranium by Inductively Coupled Plasma – Optical Emission Spectroscopy
Alkalinity as $CaCO_3$	EPA 310.1 Titrimetric
Chloride	Standard Methods, 17th Ed. 4500-Cl^- B. Argentometric

Table 4
On-Site Laboratory Analytical Methods

Parameter	Reference/Method
Sulfate	EPA 375.4 Turbidimetric EPA 200.7 Inductively Coupled Plasma-Atomic Emission Spectrometry
Total Dissolved Solids	EPA 160.1 Residue – filterable, Gravimetric, 180°C
pH	EPA 150.1 Electrometric
Sodium	EPA 273.1 Atomic Absorption, direct aspiration EPA 200.7 Inductively Coupled Plasma-Atomic Emission Spectrometry
Calcium	EPA 215.1 Atomic Absorption, direct aspiration EPA 200.7 Inductively Coupled Plasma-Atomic Emission Spectrometry
Vanadium	EPA 286.1 Atomic Absorption, direct aspiration EPA 200.7 Inductively Coupled Plasma-Atomic Emission Spectrometry

9.2 QUALITY CONTROL SAMPLES

CBR uses three types of quality control samples at the on-site laboratory. These samples are duplicate samples, spiked samples, and control standards. Although the quality control samples are primarily used to monitor and control systematic and random measurement errors, they are useful in detecting all types of laboratory error.

9.2.1 Duplicate Samples

Duplicates are taken of the original sample and analyzed in the same way as the original sample. These duplicate samples allow the analysts to determine the precision of the assay. The acceptable limit for the duplicate analysis is ± 10% over the range normally encountered in the laboratory. If the assay is very high or very low, criteria for limits will be determined on a case-by-case basis.

9.2.2 Spiked Samples

Standard addition spikes are the addition of a known amount of analyte to a duplicate sample aliquot. These samples are useful in estimating the accuracy of an assay and in identifying potential interferences. The acceptable limit for spikes is 90 to 110 percent recovery.

9.2.3 Control Standards

Control standards are certified standards whose chemical concentration values are known. They are used for spiking and standardizing reagents. For example, a chloride standard that is sodium chloride with a concentration of 1,000 ± 0.0005 moles per liter is used to standardize the $AgNO_3$ solution which is used in the analysis of chloride. The standard is certified traceable to National Institute of Standards and Technology Standard Reference Material. This standard is also used for preparing chloride spiked samples. The acceptable limit for control standards is 90 to 110 percent recovery.

9.2.4 Internal Quality Control Activity Schedule

Analysts will perform a minimum of one duplicate and one spike quality control sample per week per parameter assay.

Reagent blanks will be analyzed whenever new reagents are used and as often as required in specific methods. A reagent blank is the reference base with which the analytical results are compared under the same conditions as the samples to be analyzed, except deionized water is used in place of the sample.

For analysis of metals in water by atomic absorption and inductively coupled plasma-atomic emission spectrometry, calibration standards and blanks are analyzed with each batch of samples. Calibration standards are samples with a known concentration that are used to plot an absorbance versus concentration curve. This curve is used to determine the concentration of the samples being assayed. The standards that are used to prepare the calibration standards are certified and traceable to NIST Standard Reference Material.

9.3 INSTRUMENT CALIBRATION

9.3.1 pH Meter

The pH meter is calibrated daily with pH 7 and pH 4 (or pH 10) buffer solutions. Calibration results are recorded.

9.3.2 Conductivity Meter

The conductivity meter has a set of cell constant and automatic temperature compensation. In order to ensure the accuracy of the instrument, the conductivity of standardized 0.01 molar potassium chloride with a specific conductance of 1413 μmho/cm at 25°C is checked and recorded on a monthly basis.

9.3.3 Turbidimeter

The turbidimeter is calibrated with Formazin, the primary turbidity standard, at least semiannually. All calibration data is recorded.

9.3.4 Balance

The Mettler balance is cleaned and checked annually by a certified technician.

When in use, the balance is checked on a monthly basis with NBS Class S masses calibrated to within 0.025mg or better.
All calibration data is recorded.

9.3.5 Perkin Elmer Atomic Absorption Spectrophotometer Model 3100

The operator can determine whether instrumental parameters are optimized and if the instrument is performing to specifications by using the sensitivity check. The sensitivity check value (in mg/l) is

the concentration of an element that will produce a signal of approximately 0.2 absorbance units under optimum conditions at the wavelength listed. This number can be found in the *Analytical Methods for Atomic Absorption Spectrophotometry.*

If the instrument develops a malfunction that cannot be corrected by operator maintenance, a trained specialist will service it.

9.3.6 Optima 8300DV ICP-OES

For daily operations the instrument is calibrated according to the manufacturer's recommended procedures, using mixed calibration standard solutions and the calibration blank. The calibration line should consist of a minimum of a calibration blank and a high standard. Replicates of the blank and highest standard provide an optimal distribution of calibration standards to minimize the confidence band for a straight-line calibration in a response region with uniform variance. If the instrument develops a malfunction that cannot be corrected by operator maintenance, a trained specialist will service it.

9.3.7 Automatic Pipettes

Based upon equating milligrams with milliliters, automatic pipettes will be checked for accuracy by weighing the contents of the pipette on a precision balance. This will be performed and documented periodically as deemed necessary by the Lab Foreman.

9.3.8 Auto Titration

Two different autotitrators are used for analyzing monitor well samples; Mettler Toledo Autotitrator and a Metrohm Autotitrator. Calibration of the two autotitrators is performed, at a minimum, weekly. The procedures for performing the calibrations are described in CBO-QMP-10-009, *Autotitrator Procedures.*

9.4 CROSS-CONTAMINATION CONTROL

All glassware used in the laboratory is washed in a solution of tap water with the addition of a low phosphate laboratory grade detergent. The glassware is then rinsed with tap water. The glassware is then final rinsed with deionized water.

A deionized water system consisting of one activated carbon unit and two mixed bed deionizers is used to provide quality deionized water for assay work and glassware final rinsing.

9.5 ANALYST TRAINING

9.5.1 Lab Foreman

The minimum qualifications for a Lab Foreman are two years of post-secondary education in science and two years of inorganic laboratory experience. At least one year of this experience should be at an in-situ uranium facility.

9.5.2 Laboratory Technician

The minimum qualifications for a Lab Technician are a High School Diploma or a minimum of two years of directly related work experience. The Lab Foreman will directly supervise the Laboratory Technicians in the performance of their duties.

9.6 EQUIPMENT PREVENTATIVE MAINTENANCE PROCEDURES

Analysts will become thoroughly acquainted with the instrument operation manuals and will use the proper maintenance procedures as specified by the manufacturers.

9.7 EXTERNAL QUALITY CONTROL

Samples from wellfield monitor wells will be split and analyzed for the excursion parameters (alkalinity, chloride, and conductivity) at the on-site laboratory on a quarterly basis. The sample splits will be sent to a contract laboratory for analysis of the same excursion parameters. The on-site laboratory results will be compared with the contract laboratory results for consistency. The Lab Foreman or QA Coordinator will review the results from each laboratory. If the results are not within 10 percent for all parameters that are greater than 50 ppm or within ± 5 ppm for those parameters with a concentration less than 50 ppm, an investigation will be performed and appropriate corrective action will be taken.

9.8 DATA HANDLING

Production zone and shallow monitor well data will be reviewed for accuracy and reported to the Restoration Manager. Results of monitor well analysis for excursion indicators will be checked by the analysts to determine whether they are within the range of the upper control limits (UCLs) for that well. Any discrepancies will be investigated. If the data for a particular well falls out of range, it will be immediately reported to the SHEQ Coordinator or designee.

All process analytical data will be reported to the Plant Supervisor or designee.

The Lab Foreman will maintain all original laboratory worksheets and instrument calibration data on file in the on-site laboratory. Records will be maintained for the appropriate duration as discussed in Section 12.4.

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10 VERIFICATION AND VALIDATION (V & V)

The verification and validation (V&V) of certain aspects and support activities of radiological, environmental and effluent measurement processes or monitoring programs are essential to the QAP. These aspects and activities include data and computer software, spreadsheet V&V, and project method validation.

The analytical data from the CBR radiological counting laboratory will be reviewed by the RSO. The RSO or the QA Coordinator will also review the environmental and effluent monitoring data from the on-site laboratory and contract laboratories. The RSO or the QA Coordinator will be responsible for evaluating the data, entering the data into the corporate data handling system, and distributing the data to the corporate files and specified personnel. Data review will be properly documented.

10.1 Validation and Verification for Accuracy and Completeness

The objective of verification is to ensure that data is collected and reported in a consistent manner with approved procedures and per time requirements. This involves the review of raw data for completeness, transcription errors, accuracy of calculations, and whether proper procedures are followed. The RSO is principally responsible for the validation and verification of activities whose failure could have an impact on the environment, health, or safety. The RSO, HPT, and Lab Foreman are responsible to review and initial logbooks, QC reports, and logs at least monthly for completeness and accuracy.

Technical data is routinely verified and validated to ensure that the data is of sufficient quality and quantity. Computer software and spreadsheets used in the implementation of radiological and environmental monitoring are documented, verified, and validated before initial routine use and after each modification of the software. To ensure records remain consistent and accurate, software testing includes comparing calculations against known data. Critical data migrated from old systems to new systems are also compared to verify accuracy and completeness.

Spreadsheets used for radiological monitoring are cross checked monthly by the RSO. The cross checks include the following:

- Data entry
- Hand calculation of randomly selected radiological surveys
- Hand calculation of formulas used

10.2 TECHNICAL REVIEW

Technical review involves reviewing screened data points to determine if the point is acceptable or

corrective action is needed. This evaluation takes into consideration factors such as number of historical data points, analyte concentrations, magnitude of deviation, variability of historical data, and location of sample point in regards to other potentially interfering activities. If point is not acceptable corrective action is taken.

10.2.1 Detection Limit Review Criteria

The reviewer will determine that the detection limits specified in **Tables 2 and 3** have been met.

10.2.2 Accuracy Check Criteria

- The radionuclide content of the various matrices (soil, vegetation, water, and air) should be evaluated for consistency with published data normally found in government reports.
- The radionuclide content of matrices where one would expect radiological constituents to be in secular equilibrium (such as soil) should be evaluated for internal consistency.
- The gross alpha value (if available) should be compared to the sum of the individual alpha emitting nuclides such as natural uranium, radium 226, and thorium 230.
- The cation-anion balance should be between 0.95 and 1.05.
- The ratio of the measured total dissolved solids (TDS) at 180°C to the calculated TDS corrected for bicarbonate decomposition should be between 0.90 and 1.10.
- The ratio of the measured electrical conductance (dilute) with the calculated electrical conductance should be between 0.95 and 1.05.

If the data on a given sample does not meet the above accuracy checks, the RSO will investigate the laboratory and sampling procedures to determine the cause of the discrepancy.

10.2.3 Data Comparison Criteria

The data on a given sample or set of samples will be compared with the data from previous representative samples from the same population. If an individual result falls within the range obtained on previous samples, the result is considered acceptable. If the result falls outside of the range, the data is evaluated for trends or other unusual distribution. The laboratory will then be notified and asked to check all calculations and quality control checks. If no discrepancies are found a new analysis may be requested on the sample provided that the maximum holding time for the

sample has not been exceeded. If the maximum holding time has been exceeded, the RSO may then request a re-sample.

10.2.4 Anomalous Data

The determination of anomalous data is done through the validation process. Sampling data is screened for values that fall outside of the historical data ranges. The historical data ranges are established by historic sampling events. It involves screening of the data, technical review, and corrective actions to determine if the data point is indeed anomalous.

10.2.5 Corrective Action

Corrective action allows for further investigation into the cause behind anomalous data. Corrective action may include requesting a laboratory check of calculations and dilutions, sample reanalysis, re-sampling, and comparison of data to the next sampling event. Based on the corrective action the RSO or QA Coordinator can then determine if the data point is acceptable or an anomalous point. Anomalous points are considered unusable.

10.2.6 Validation of Field Data

Field data verification ensures that data is collected in accordance with designated procedures and per required schedules. The data should be reviewed for completeness, transcription errors, compliance with procedure, and accuracy of calculations. The individual validating the data, in consultation with the RSO or QA Coordinator, may correct problems that are found or noted in the documentation by lining through the incorrect entry with a single line, correcting the information, then initialing changes made to the document. Care must be made not to obscure the erroneous information. The person validating the data must also ensure that erroneous data is not entered into the database.

10.2.7 Variance of Field Data

Changes from field protocols established in SHEQMS Volume IV, *Health Physics Manual* and SHEQMS Volume VI, *Environmental Manual* must be authorized by the RSO and SHEQ **Coordinator** and fully documented by the initiator. Field variance will be reported immediately to evaluate the impact the variance has on the data. Examples of variance in the field would be the activity performed or sample collection technique did not follow proper protocols, the monitoring or measurement instrument used was out of calibration, or there is a loss or damage to the record that cannot be duplicated. In events of variance it may be necessary for a corrective action(s). Field variance will be recorded in field notebooks and log sheets.

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11 PREVENTIVE AND CORRECTIVE ACTIONS

The preventive and corrective actions aspect of the QAP ensures continuous improvement processes are implemented, deficiencies and non-conformance on programs are defined and identified, and corrective or preventive actions are taken.

11.1 DEFICIENCIES AND NON-CONFORMANCE

Assessments, audits, inspections, and surveillance form the basis of the continuous improvement program. These methods allow for identification of deficiencies and non-conformance in programs, tasks, or performance as well as providing valuable information on areas of improvement. The information from these methods is reviewed by the Restoration Manager, SHEQ Coordinator and RSO, these personnel have the authority to implement corrective actions to ensure the program, task or performance meets quality or regulatory acceptance criteria. Documentation of the deficiency or non-conformance is taken, tracked, and reported to regulatory agencies as required by the SHEQ Coordinator.

11.2 CORRECTIVE ACTIONS

In the event that a program, task, or performance does not meet regulatory or quality acceptance criteria, corrective action is taken to ensure the program or task meets the appropriate criteria. The corrective action process involves the basic elements:

- Identification and documentations;
- Classification;
- Cause analysis;
- Corrections;
- Follow-up; and
- Closure

Findings and corrective actions are documented and tracked, through the Cameco Incident Reporting System (CIRS) and reported to the Restoration Manager, SHEQ Coordinator, RSO, and regulatory agencies as required. Follow-up reviews are performed by the Restoration Manager, SHEQ Coordinator and RSO to verify the effectiveness and adequacy of the corrective actions as required in SHEQMS Volume II, *Management Systems, CR-QMP*.

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12 RECORDS

12.1 FIELD RECORDS

Radiological Monitoring Data Sheets and all environmental sampling data sheets will be retained at the plant site. It will be the responsibility of the RSO to assure that all sampling records are kept in an organized and secure manner.

12.2 ENVIRONMENTAL/RADIOLOGICAL ANALYTICAL RECORDS

Analytical data will be retained at the plant site and/or the corporate office. It will be the responsibility of the RSO to assure that all analytical reports are kept in an organized and secure manner.

12.3 ENVIRONMENTAL/RADIOLOGICAL AUDIT REPORTS

All audit reports shall be maintained at the site. The SHEQ Coordinator will be responsible to see that all audit reports are kept in an organized and secure manner.

12.4 RECORD STORAGE DURATION

All regulatory required records of the following activities, operations or actions shall be documented and retained including; sampling analyses, surveys or monitoring, survey/monitoring equipment calibrations, reports on audits and inspections, all meetings and training courses, and any subsequent reviews, investigations or corrective actions.

All required records and documentation will be available for regulatory review and inspection. Upon termination of all regulatory license and permits, the President of CBR will have the final authority to authorize the disposal of records.

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13 AUDITS AND INSPECTIONS

CBR conducts audits of various programs at the Crow Butte project to ensure the quality of the implementation of the programs. In addition, CBR personnel conduct routine inspections of work areas to check for compliance issues and any other problems. These audits and inspections are summarized in this section.

13.1 QUALITY ASSURANCE/QUALITY CONTROL AUDIT

The QA Coordinator will conduct an audit of the radiological monitoring, sampling and analytical QA/QC programs once every three years. The QA Coordinator may designate qualified individuals who do not have direct responsibility in the areas being audited to perform the audits. Audit results will be reviewed by the RSO and corrective action taken where necessary.

An audit of the water sampling and analytical QA/QC programs will be conducted once every three years. The QA Coordinator or a designated qualified consultant, who does not have direct responsibility in the areas being audited, will perform the audits. Audit results will be reviewed by the QA Coordinator and corrective action taken where necessary.

13.2 ALARA AUDIT

Annually a third party will perform a formal audit of the ALARA program and submit a detailed written report to the SHEQ Coordinator and RSO. 10 CFR §20.1101 (c) and CBR's source materials license require this audit of the occupational and effluent control ALARA programs. The audit will be performed in accordance with the guidance contained in USNRC Regulatory Guide 8.31, *"Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Mills Will Be As Low As Reasonably Achievable"*, (Revision 1, 2002) and will include a review of the results of the following operational data:

- Bioassay results, including any actions taken when the results exceeded action levels given in Table 1 of Regulatory Guide 8.22.
- Exposure records, both external and internal, showing the time-weighted calculations.
- Training program activities.
- Safety meeting minutes and attendance records.

- Daily inspection log entries and summary reports of the daily and monthly reviews.
- In-plant radiological survey and sampling data.
- Environmental radiological effluent and monitoring data.
- Surveys required by radiation work permits.
- Reports on overexposures submitted to NRC, and
- Reviews of operating and monitoring procedures completed or revised during this period.

Specific attention will be given to air sampling results as recommended in USNRC Regulatory Guide 8.25, *"Air Sampling in the Workplace"*, (Revision 1, 1992). This review will determine whether air sampling results for the previous year are accurate and whether changes should be made to the air sampling program. The review will include the purposes and amount of air sampling, locations, trends, posting, procedures, correction factors, representativeness, and any indicated changes to the air sampling program.

The written ALARA audit report shall be specific in addressing any noticeable trends in personnel exposures for identifiable categories of workers and types of activities. Recommendations to further reduce personnel exposures will be included. The report should also provide data to show that the equipment for exposure control and effluent control is properly used, maintained and inspected.

In addition to reviewing the results of the occupational ALARA program, the audit will review trends in radiological effluent data as recommended in USNRC Regulatory Guide 8.37, *ALARA Levels for Effluents from Materials Facilities"*, (1993). The audit report will include any recommendations to further reduce environmental releases of radioactive materials.

13.3 OTHER REVIEWS

13.3.1 Standard Operating Procedures

The RSO will perform an annual review of all Standard Operating Procedures for radiation safety and environmental protection issues. This annual review will be properly documented. Appropriate operations supervisory personnel will review process procedures in their area of responsibility to ensure that the instructions reflect current operating conditions.

13.3.2 Inspection Reviews

The RSO will perform a monthly review of the daily and weekly inspections and all monitoring and exposure data. The RSO will prepare a written summary of significant worker protection activities, including exposure data, bioassays, and survey data. A discussion of any trends or deviations from the radiation protection and ALARA programs, implementation of license conditions, and unresolved problems and corrective actions, will be included.

13.3.3 Respiratory Protection Program

The RSO or other similarly qualified individual will conduct an annual review of the implementation of the CBR Respiratory Protection Program. The review will include discussions with workers that use respiratory protection to solicit comments on the effectiveness of the program. The review will ensure that the program procedures reflect the requirements of current applicable regulations and accepted standards and that the program is implemented in accordance with the Standard Operating Procedures.

13.4 INSPECTIONS

13.4.1 Daily Inspections

The RSO, HPT or a qualified Designated Operator will conduct a daily visual walk-through inspection of the plant facility to check for compliance issues and any other problems. These inspections will be properly documented. The results of these inspections will be reviewed by the RSO. The inspections will be properly documented.

13.4.2 Weekly Inspections

The RSO and the Restoration Manager, or the RSO and the Plant Supervisor will conduct a weekly walk-through inspection of the plant operating areas to observe general radiation safety practices and to review required changes in procedures and equipment. The inspections will be properly documented.

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Appendix A

Containers, Preservation Techniques, and Holding Times

APPENDIX A

Parameter	Volume Required (mls)	Preservative	Holding Time	Container
Dissolved Metals	250	Filter (0.45 µm), then add HNO_3 to ph<2	6 months	Plastic or Glass
Total Metals	250	HNO_3 to ph<2	6 months	Plastic or Glass
Alkalinity	100	Cool, 4°C	14 days	Plastic or Glass
Chloride	50	None Required	28 days	Plastic or Glass
Conductance	100	Cool, 4°C	28 days	Plastic or Glass
Fluoride	50	None Required	28 days	Plastic or Glass
Ammonia as N	50	H_2SO_4 to pH<2, Cool, 4°C	28 days	Plastic or Glass
Nitrate + Nitrite	50	H_2SO_4 to pH<2, Cool, 4°C	28 days	Plastic or Glass
Nitrate	50	Cool, 4°C	48 hours	Plastic or Glass
Nitrite	50	Cool, 4°C	48 hours	Plastic or Glass
pH	25	None Required	Analyze immediately	Plastic or Glass
TDS	500	Cool, 4°C	7 days	Plastic or Glass
TSS	500	Cool, 4°C	7 days	Plastic or Glass
Sulfate	100	Cool, 4°C	28 days	Plastic or Glass
Lead-210	1000	HNO_3 to ph<2	6 months	Plastic or Glass
Polonium-210	1000	HNO_3 to ph<2	6 months	Plastic or Glass
Radium-226	1000	HNO_3 to ph<2	6 months	Plastic or Glass
Uranium	1000	HNO_3 to ph<2	6 months	Plastic or Glass
U_3O_8	N/A	N/A	N/A	Glass