SECTIONS 5.1 TO 5.6
OPERATIONS

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5.0 OPERATIONS

INTRODUCTION

The following sections address the FEN operational plan for the Crow Butte Commercial facility. This operational plan defines the basic management policies and programs to achieve the objective of maintaining radiation exposures to employees "As Low As Reasonably Achievable" (ALARA).

5.1 Corporate Organization and Administrative Procedures

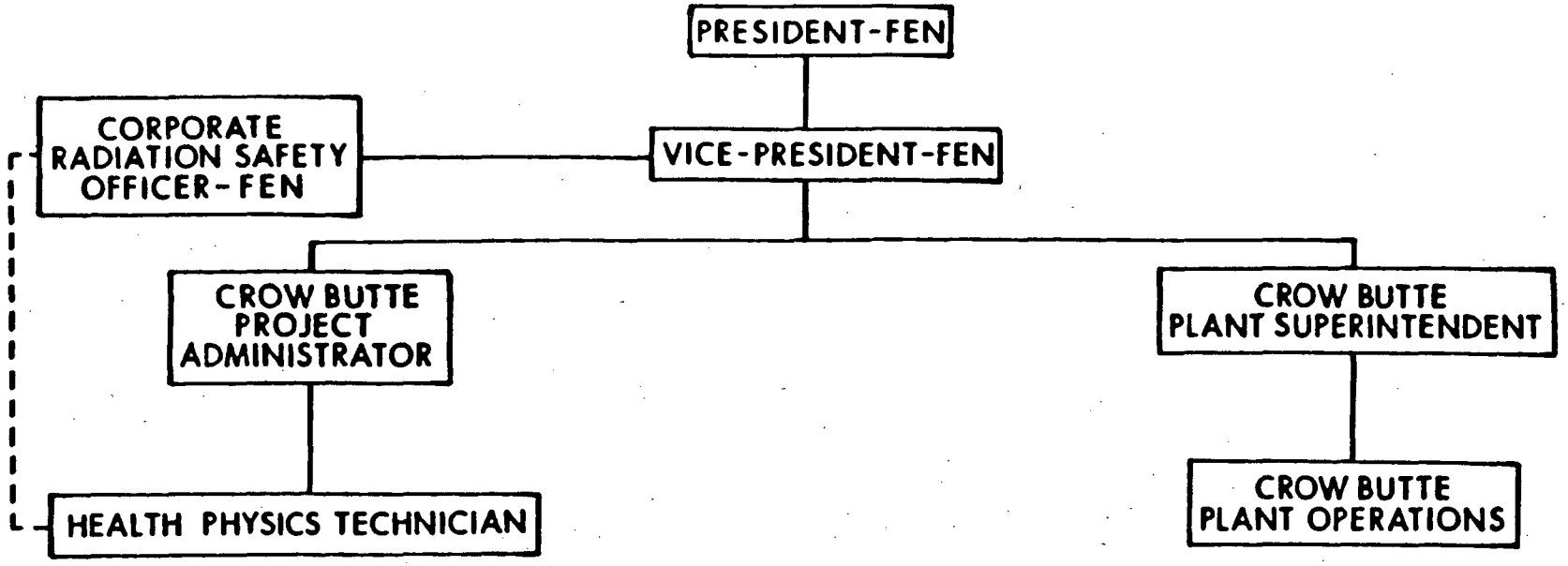
FEN's organization for the Crow Butte Commercial facility is presented on Figure 5.1-1. Levels of management are corporate and production (on site). The corporate level is responsible for monitoring production safety for the purpose of detecting any activity which may result in significant impacts on the environment. The production level is responsible for implementation of all radiation safety and health programs. Responsibilities with regard to development, review, approval implementation, adherence to operating procedures, radiation safety programs, environmental groundwater monitoring programs, quality assurance, routine and non-routine maintenance activities and changes in any of the above are defined through the first supervisory level below.

5.1.1 President, FEN

The President of FEN has overall responsibility for the radiation, environmental. and safety activities of the Crow Butte Commercial facility. The President has direct lines of communication to the Vice President of Ferret-Nebraska.

5.1.2 Vice President, FEN

The Vice President of FEN is responsible for all Crow Butte Commercial production facilities, reporting directly to the President. He is directly responsible for the radiation safety programs and nonradiological programs at the production facility. The Vice President, FEN supervises the Project



REV. DATE	FERRET OF NEBRASKA, INC.		
	CROW BUTTE PROJECT Dawes County, Nebraska		
	ORGANIZATIONAL CHART		
	PREPARED BY: F.E.N.		
	DWN. BY: J.C.	DATE: 8/4/87	FIGURE: 5.1-1

Administrator, the Plant Superintendent, and the Corporate Radiation Safety Officer, and sees that these programs are conducted in a manner consistent with the regulatory requirements. The Vice President, FEN will be responsible for all regulatory agency contacts.

5.1.3 Crow Butte Plant Superintendent

The Crow Butte Plant Superintendent is responsible for all uranium production activity at the site. He is responsible for implementing any safety and/or monitoring programs associated with operations, including yellowcake handling procedures. The Crow Butte Plant Superintendent is authorized to immediately implement any action to correct or prevent radiation safety hazards.

5.1.4 Crow Butte Project Administrator

The Crow Butte Project Administrator is responsible for the implementation of radiological programs and nonradiological environmental programs, public relations, and exploration activities. He is responsible for licensing development, licensing modifications, and license compliance.

5.1.5 Corporate Radiation Safety Officer (CRSO)

The CRSO is responsible for the development, administration and enforcement of all radiation safety programs. The CRSO 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 CRSO reports directly to the Vice President, FEN.

5.1.6 Health Physics Technician (HPT)

The HPT will be responsible for the implementation of all on site environmental and safety programs, including emergency procedures. The HPT will personally inspect facilities to verify compliance with all applicable requirements in the areas of radiological health and safety as well as

industrial health and safety. The HPT will work closely with all supervisory personnel to ensure established programs are maintained. The HPT will be responsible for collection and interpretation of employee exposure related monitoring data, including data from industrial safety and radiological safety. The HPT will recommend as necessary, to improve any and all safety related controls. The HPT will report to the Crow Butte Project Administrator and will also be responsible to the Corporate Radiation Safety Officer for technical guidance.

5.2 Management Control Program

FEN will establish standard operating procedures (SOP's) for all operational activities involving radioactive materials that are handled, processed or stored. Standard operating procedures for operational activities will include pertinent radiation safety practices. Additionally, written procedures will be established for nonoperational activities including health physics and environmental monitoring, sampling analysis and instrument calibration. An up-to-date copy of each written procedure will be kept at the facility where it is used.

Operational and nonoperational procedures will be reviewed and approved by the Corporate Radiation Safety Officer. The CRSO will review written procedures annually and implement necessary changes in procedures to insure no violation of newly established radiation practices have or will occur.

For work on non-routine maintenance jobs, where the potential for exposure to radioactive material exists and for which no standard written operating procedure already exists, a radiation work permit (RWP) will be used (See Figure 5.2-1 for example RWP). At a minimum, RWP will describe the following:

1. The details of the job to be performed,
2. Any precautions necessary to reduce exposure to uranium and its daughters, and
3. The radiological monitoring and sampling necessary during and following completion of the job.

The HPT shall indicate by signature, the review of each RWP prior to initiation or work, and the work will be carried out in strict adherence to the conditions of the RWP. When the HPT is not available, e.g., during off-shifts, the HPT will designate a member of the supervisory staff to review and sign RWP's in the HPT's absence.

During the first year of R&D operations, 31 RWP's (as of July 31, 1987) were issued and only one potential problem was observed. An employee was performing a grinding operation and a breathing zone sample indicated that the employee exceeded the weekly limit for soluble uranium. The employee was wearing a respirator and follow up bioassay indicated no exposure.

5.3 Management Audit and Inspection Program

5.3.1 General

FEN will develop a Management Audit and Inspection of worker health protection practices at the commercial facility. This program will provide management with the information necessary to conduct an appropriate ALARA program.

5.3.2 Daily and Weekly Inspections

The HPT will conduct a daily walk through (visual) inspection of all areas of the plant and working areas to insure proper implementation of good safety practices, including good housekeeping and clean-up practices that will minimize unnecessary contamination and insure adherence to the SOP's. Problems observed will be noted in writing in a daily inspections log book. The HPT will review violations of radiation safety procedures or other potentially hazardous problems with the Plant Superintendent.

A weekly inspection will be made by the HPT of all work and storage areas and a report submitted to the CRSO on any items of noncompliance with SOP's, license requirements or safety practices affecting radiological safety.

FERRET EXPLORATION OF NEBRASKA

RWP No.	Date of Issue:		Date of Expiration:
Requested by:	Date of request:	Estimated number of days to complete:	Work location:
scription of work be performed:			Names of personnel performing work:
Time of Entry:	Time of Departure:		Total Time:

RADIOLOGICAL DATA

adiation levels _____ mr/hr

Radon daughters _____ WL

Surveyed by: _____ Date___/___/___

PROTECTIVE EQUIPMENT REQUIRED

- ☐ TLD Badge
- ☐ Hood
- ☐ Gloves
- ☐ Shoe Covers
- ☐ Plastic Suit
- ☐ Respiratory Protection
- ☐ Face Shield
- ☐ Goggles

SPECIAL INSTRUCTIONS:

Approved by ( ) Signature _____ Date___/___/___

Terminated for:

☐ Completion of Job ☐ Expiration of RWP ☐ Cancellation of RWP ☐ Change in Radiological Condition

Signature _____ Date___/___/___

5.3.3 Monthly Inspection

On a monthly basis, the HPT will conduct an inspection of all work and storage areas and will review all monitoring and exposure data for the month. The HPT will provide to the Plant Superintendent for review, a written summary of the month's significant work protection activities containing at a minimum, (1) a summary of personnel exposure data, including bioassays, if applicable, and time weighted calculations, and (2) a summary of all pertinent radiation safety records. In addition, the monthly inspection will specifically address any trends or deviations from the ALARA program, including an evaluation of the adequacy of the implementation of license conditions regarding the ALARA program. The summary will provide a description of the unresolved problems and will propose corrective measures. A copy of the Monthly Summary Inspection Report, initialled by the Crow Butte Plant Superintendent, will be forwarded to the Vice President, FEN.

5.3.4 ALARA Program Audit

The CRSO and an audit team knowledgeable in uranium processing will perform a formal annual audit of the ALARA program and submit a detailed written report on the audit to the Plant Superintendent. The primary purpose of this audit will be to evaluate the overall effectiveness of the ALARA program. The audit report will summarize the results of the following data:

1. Employee exposure records (external and time weighted calculations),
2. Bioassay results,
3. Inspection log entries and summary reports of daily, weekly and monthly inspections,
4. Documented training program activities,
5. Safety meeting reports,
6. Radiological survey and sampling data,
7. Radioactive effluent and environmental monitoring data,
8. Reports on overexposure of workers submitted to NRC, MSHA or the designated state regulatory authority,
9. Operating procedures that were reviewed during this time period.

The report on the annual ALARA audit will specifically discuss the following:

1. Trends in personnel exposure for identifiable categories of workers and types of operational activities,
2. Trends in effluent releases,
3. Whether equipment for exposure control and effluent control is being properly used, maintained and inspected,
4. Recommendations on ways to further reduce personnel exposures to effluent releases of uranium and its daughters.

A copy of this report will be forwarded to the Vice President, FEN.

5.4 Qualifications

The minimum qualifications of operational personnel are as follows:

5.4.1:

Vice President, Ferret-Nebraska - B.S. in Engineering or Physical Science and five (5) years experience or equivalent.

5.4.2:

Project Administrator - B.S. in Engineering or Physical Science and three (3) years experience or equivalent.

5.4.3:

Plant Superintendent - B.S. in Engineering or Physical Science and three (3) years experience or equivalent.

5.4.4:

Qualifications for the CRSO and the HPT are found in Section 5.7-9.

5.5 Training

5.5.1 General

The on-site HPT will be responsible for implementing the radiation protection training program at the facility. Responsibility will include the implementation of the program, training materials, reviews and documentation. The CRSO will provide health physics assistance in program development and administration and conduct an annual evaluation. The objectives of the radiation protection training program are to:

1. Develop a basic understanding of the biological effects of exposures to radiation so that the potential risk of radiation doses will be understood and can be evaluated.
2. Develop an understanding of the radiation hazards associated with each portion of the plant.
3. Develop the expertise necessary to insure individual effort in maintaining exposures as low as reasonably achievable.

Note: Female workers and those supervisors who work with them will be given specific instruction about prenatal exposure risks to the developing embryo and fetus.

5.5.2 Employee Radiation Protection Training

Basic indoctrination in radiation protection will be given to all plant employees before starting work. The basic indoctrination training will include:

1. Fundamentals of health protection
   a. What are the radiological and toxic hazards of exposure to uranium and its daughters.
   b. How uranium and its daughters enter the body (inhalation and ingestion).
   c. Why exposures to uranium and its daughters should be kept as low as reasonably achievable (ALARA).

2. Personal hygiene at uranium mills
   a. Wearing protective clothing.
   b. Using respirators when appropriate.
   c. Eating, drinking and smoking only in designated areas.
   d. Using proper methods for decontamination.
3. Facility-provided protection
   a. Cleanliness of working space.
   b. Safety designed features for process equipment.
   c. Ventilation systems and effluent controls.
   d. Standard operating procedures.
   e. Security and access control to designated areas.
4. Health protection measurements
   a. Measurement of airborne radioactive material.
   b. Bioassays to detect uranium (urinalysis and invivo counting)
   c. Surveys to detect contamination of personnel and equipment.
   d. Personnel dosimetry.
5. Radiation protection regulations
   a. Regulatory authority of NRC, MSHA and state.
   b. Employee rights in 10 CFR Part 19.
6. Emergency procedures

A written test with questions directly relevant to the principles of radiation safety and health protection in the facility covered in the training course shall be given to each worker. The instructor will review the test results with each worker and will discuss incorrect answers to the questions with the worker until worker understanding is achieved. Workers who fail the exam shall be retested and test results will remain on file. Each permanent worker at the facility will be provided with an abbreviated retraining course annually. The successful completion of the retraining course will also be maintained on file. Retraining shall include relevant information that has become available during the previous year, a review of safety problems that have arisen during the year, and changes in regulations and license conditions, exposure trends and other current topics.

In addition, all new workers, including supervisors, will be given specialized instruction on the health and safety aspects of the specific

jobs they will perform. This instruction will be done in the form of individualized on the job training. Supervisors will be provided with additional specialized training on their supervisory responsibilities in the area of worker radiation protection. Retraining will be done annually and documented. All employees will sign a statement that they received job specific training. Their statement will indicate the dates the training was received and it will be cosigned by the instructor. Every two months, all workers will attend a general safety meeting with at least 30 minutes of meeting devoted to radiation safety matters.

Visitors who have not received training will be escorted by on site personnel properly trained and knowledgeable about the hazards of the facility. As a minimum, visitors will be instructed specifically on what they should do to avoid possible hazards in the area of the facility they will be visiting.

Any contractors having work assignments at the facility will be given appropriate training and safety instruction. Contract workers who will be performing work on heavily contaminated equipment will receive the same training instruction normally required of all permanent workers. In the event contract workers have received full training on prior work assignments at the facility, only job specific safety instruction will be necessary.

5.6 Security

Access to the facility will be limited by a fence around the restricted area or by the walls of a building housing the process area. A gate or door will be placed at the entrance to the restricted area. Access to the restricted area will be limited to authorized personnel only. Appropriate signs will be posted identifying the restricted area.

All visitors (any person not permanently assigned to the project site) will be required to register at the office and will not be permitted inside the plant areas without proper authorization from designated supervisory personnel.

The plant will normally operate 24 hours per day and 7 days per week, so FEN employees will normally be on site except for occassional shutdown. All plant personnel will be instructed to immediately report any unauthorized person or persons to their supervisors. The supervisor will contact the reported unauthorized person or persons and make sure that the person has been authorized for entry. If the person is unauthorized, and has no business on the property, he or she will be escorted to the main entrance for departure.

SECTION 5.7

RADIATION SAFETY CONTROLS & MONITORING

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5.7.1 Effluent Control Techniques

The only radioactive airborne effluent at the Crow Butte Commercial Facility will be radon-222 gas. A vacuum dryer will be used when drying the yellowcake product and there will be no airborne effluent from the system.

The radon-222 will be found in the pregnant lixiviant which comes from the wellfield into the plant. The radon-222 will be released in the recovery surge tanks, in the ion exchange columns, and in the injection surge tanks. All of these vessels will be covered and vented to the atmosphere. The vents from the individual vessels will go into a manifold which will be exhausted to atmosphere outside the plant building via an induced draft fan. Venting the radon-222 to atmosphere outside the plant building will minimize operating personnel exposure. Small amounts of radon-222 may be released via solution spills, filter changes and maintenance activities. To further minimize personnel exposure, the plant building will have an adequate exhaust system. The air in the plant will be sampled for radon daughters to assure that concentration levels of radon and radon daughters is maintained ALARA.

If air samples indicate that the radon control system is not functioning properly, the ventilation in the plant building will be increased by opening doors and windows. The HPT will then investigate to determine the source of the problem and take necessary corrective action.

The radioactive liquid effluents associated with the Crow Butte Commercial Facility can be classified as follows: (1) plant waste water, (2) laboratory waste water, (3) solution bleed, and (4) restoration waste solution. These effluent solutions will be collected and their volumes reduced by evaporation and water treatment.

The contaminated liquids generated in the laboratory will be poured into a special sink which drains to the plant sump. The water used in the plant for equipment wash down and the employee showers will collect in the sump. From the sump, the liquid will be pumped to the waste tank and then to the evaporation ponds.

The evaporation ponds are used to contain the liquid effluents produced during the production phase of the project. During the restoration phase, substantial increases in liquid wastes are anticipated. Volume reduction is accomplished through the use of water treatment and reinjection or land application. Complete restoration is estimated to generate two pore volumes of liquid wastes. The evaporation ponds have been sized to contain the volume required for restoration. Volume reduction in the ponds will be accomplished by evaporation, enhanced evaporation and water treatment followed by authorized land application. The remaining solids or slurry in the pond bottoms will be transported to a USNRC licensed disposal facility or tailings facility in U.S. Department of Transportation approved vehicles and containers.

The effects of spills in both the wellfield and the plant are discussed in Section 7.5. The methods of preventing and controlling the spills were discussed. Briefly, spills in the plant are contained on the curbed concrete pad. The spill material is washed to the collection sumps. From the sumps, the solution may be placed back in the process flow or pumped to waste. Spills in the wellfield will be readily absorbed by the soil. If the results of the soil sampling indicate radioactive contamination above approved limits, the soil will be removed and treated in accordance with USNRC Guidelines.

5.7.2 External Radiation Exposure Monitoring Program

The objective of this Section is to detail the program to monitor employee exposure to external radiation. The methods proposed conform to 20.101 of 10 CFR Part 20 and an action level of 25% of the maximum permissible exposure will be enforced. Employee exposure will be monitored using personnel dosimeters. The personnel dosimeters will be exchanged quarterly. Specifications on the TLD dosimeters are shown in Table 5.7-1. Dosimeters of this type or equivalent will be used at the facility.

Gamma surveys will be conducted at work stations on a monthly basis at specific locations in the plant. The results of the surveys will then be used in conjunction with the predicted employee occupancy times to arrive

TABLE 5.7-1

SPECIFICATIONS FOR THE EBERLINE INSTRUMENTS CORPORATION DOSIMETERS

Detector	LiF TLD chips
Detector Shields	One 10 mg/cm^2 One 285 mg/cm^2
Sensitivity	1 mR
Range	1 mR - 1000R
Exchange Frequency	Quarterly

at an estimate of employee exposure to external radiation. The TLD results will be compared to the results of the gamma survey for consistency.

The results reported from the commercial laboratory are in millirem of penetrating radiation and millirem of nonpenetrating radiation. Each report will include the cumulative exposure for the quarter. An investigation into the cause of any high reading can then be initiated and any abnormal situation corrected.

The results of the personnel dosimeters will be kept on file at the plant. These files will be reviewed by representatives of the radiation safety officer and the management during the annual audits of the entire radiation safety program.

If in any area, the radiation level is sufficiently elevated so that the possibility exists that an employee may receive a dose in excess of five millirem in any hour to a major portion of his body, or a dose in excess of 100 millirem during any five consecutive days, then the area will be designated a "Radiation Area" as defined in 10 CFR Part 20.202 (b)(2). In the event that this situation occurs, it would be considered an action level. Once this level of exposure is determined, the cause for the radiation will be investigated and corrective measures will be taken to reduce the level, if practicable. Should reduction of the radiation levels not be possible, employee work time in the area will be controlled, to insure that exposures will not exceed the action level. During the R&D operations (from July 1986 to July 1987) at Crow Butte, no personnel exceeded 10% of the exposure limit specified in 10 CFR 20.

5.7.3 Airborne Radiation Monitoring Program

The airborne radiation monitoring program at the Crow Butte Commercial Facility is designed to monitor employee exposure to airborne uranium dust and radon daughters. This will be accomplished by taking periodic air samples in specified work areas and analyzing the samples for the concentration of various radionuclides. The employee's exposure may be determined from the employee's occupancy records and the measured airborne concentrations.

During routine operations, specified locations will be sampled monthly for the concentrations of radon daughters and airborne radionuclides. These values will be kept on record and used in conjunction with the employee work records to determine the individual employee's exposure.

If any analysis indicates airborne concentrations above 25% of the Maximum Permissible Concentration (MPC) for a particular radionuclide, a confirming sample will be taken to determine if the occurrence was transient, steady state, or representative of an increasing trend. The 25% MPC level will represent the action level and occurrences above this limit will require an investigation by health physics personnel or their designee. The cause of the increase will be investigated and corrective action taken to prevent future occurrences. Documentation of the employees in the areas at the time of occurrence will be required.

The results of all air monitoring samples will be kept on file at the facility. All sampling and analysis data for radon daughters and airborne particulates will be entered on the forms shown in Table 5.7-2 and Table 5.7-3 or equivalent forms. Periodic audits will be performed by the radiation safety officer or designee to insure proper operation of the program and adequate protection of the employees. Annual audits will be performed by representatives of the radiation safety officer in conjunction with management personnel.

Uranium particulates will be monitored by drawing a specified volume of air through a filter with a properly calibrated vacuum pump. The alpha activity collected on the filter paper will then be measured using a scintillation detector and scaler. The sampling and counting procedures will ensure a minimum detection limit of 0.05 MPC.

Radon daughters will be determined using the modified Kusnetz method. At least 10 liters of air will be drawn through a high efficiency membrane filter with a calibrated vacuum pump. The alpha activity on the filter will be determined after a delay of 40 to 90 minutes. The resulting concentration will be expressed in working levels (WL). One working level is represented by any combination of radon daughters whose total alpha activity is

TABLE 5.7-2

AIRBORNE PARTICULATE SAMPLE FORM

LOCATION: _____

DATE: _____

SURVEYOR: _____

AIR SAMPLING - LONG HALF-LIFE RADIONUCLIDES

SAMPLE LOCATION	COLLECTION						ANALYSIS							
	Time From	To	Total Time Minutes	Flow Rate CFM LPM Initial	Final	Total Volume in ml	Count Time From	To	Ttl. Cnt. Time Minutes	Gross Counts	CPM	BKG	Corrected Counts CPM-BKG	Activity µCi/ml

[ ] ROUTINE [ ] SPECIAL (If special, indicate reason for initiation of survey below) [ ] CORRECTIVE ACTION TAKEN

INITIAL FLOW + FINAL FLOW ÷ 2 = AVERAGE FLOW

AVERAGE FLOW x TOTAL TIME = TOTAL VOLUME

VOLUME ft^3 x 2.83×10^4 = VOLUME in ml

VOLUME L x 10^3 = VOLUME in ml

$$\frac{(CPM-BKG)(4.5 \times 10^{-7}\ \mu Ci/dpm)}{(EFFI)(VOLUME\ in\ ml)} = \mu Ci/ml$$

SAMPLE PUMP ID.NO._____CAL.DATE_____CAL.COR._____

1. AIR SAMPLE COLLECTION MINIMUM OF 3000 LITERS OR 106 CU. FT.
2. SAMPLE COUNT & BKG COUNT MINIMUM OF 50 MINUTES.
3. ANALYSIS MINIMUM OF 24 HOURS AFTER COLLECTION.
4. CALIBRATION CHECK

   THORIUM 230 STANDARD ID.NO._____DPM_____

   GROSS COUNTS (CPM)_____

   $\frac{CPM}{DPM} \times 100 = \%$ EFF. EFFICIENCY = _____%

TABLE 5.7-3

RADON DAUGHTER SAMPLE FORM

Sample #	_____
Sample Location	_____
Sample Date	_____
Time Pump On	_____
Time Pump Off	_____
Air Rate	_____
Air Volume (Rate x Time)	_____
Count Time	_____
Counts per Minute (cpm)	_____
Average Counts per Minute	_____
Elapse Time (From Midpoint of Count)	_____
Time Factor	_____
Counter EF (DPM/CPM)	_____
Working Level Conc. (WL = CPM x EF/Vol x TF)	_____

equal to 1.3 x 10^5 MeV. The sample size and scintillation detector efficiency will ensure a minimum detection limit of 0.03 working levels.

The procedures and techniques described above are to be employed during routine plant operations. Procedures during non-routine operations, such as non-routine maintenance and clean-up activities will be adjusted to accommodate the particular circumstances.

All non-routine operations will require review of the procedure by the health physics technician or designee and issuance of an RWP. If monitoring is deemed necessary, it will be performed before work commences.

In the plant, breathing zone air samples may be collected periodically. These air samples are collected using a low volume, battery powered vacuum pump with a filtered inlet. The filter is then analyzed for uranium by alpha counting. The result of this type of sample more accurately reflects the exposure of the individual than does the area air particulate sample. The breathing zone sample is used as a means of judging the adequacy of the area air monitoring-occupancy time method of estimating exposures.

FEN proposes to initiate a respirator program prior to vacuum dryer operations at the Crow Butte Commercial Facility. The respirator program will be in compliance with USNRC Regulatory Guide 8.15, ***Acceptable Programs for Respiratory Protection***, (1976). FEN will submit the respiratory protection program to the USNRC 90 days prior to initiation of vacuum dryer operations.

5.7.4 Exposure Calculations

There will be only two sources of airborne radioactivity at the Crow Butte Project, yellowcake and radon daughters. As described in previous sections the concentration of yellowcake and radon daughters in the air will be monitored monthly. These values will be used in conjunction with occupancy times to determine employee exposure. The occupancy time for routine operations may be an actual measurement of the time or may be obtained from a time study. The occupancy times for non-routine operations will always be from actual measurement of the time involved in the operation.

The intake of yellowcake and radon daughters by individual employees will be calculated using the equation found in Section 2.0, *Intake and Exposure Calculations* of USNRC Regulatory Guide 8.30, *Health Physics Surveys in Uranium Mills*, June 1983.

Records of exposures will be maintained on all employees whose exposure may exceed 25% of the applicable limits. Also, if the sum of the fraction of the quarterly yellowcake intake limit and the working level months for the past four quarters divided by four exceeds unity, an over exposure will have occurred. Exposure records will be maintained for all employees as per Regulatory Guide 8.30. All over exposures will be reported to the appropriate NRC Regional Office.

The action level at the Crow Butte Project will be 25% of the 40 hour control measure specified in 10 CFR 20.103(b)(2). Once the action level has been exceeded, an investigation into the cause will be performed by health physics personnel or designee. Once the cause has been determined, corrective action will be taken to reduce the possibility of further exposures.

During R&D operations, one employee potentially exceeded the weekly limit specified in 10 CFR 20 for soluble uranium and no other employee exceeded 10% of the 10 CFR 20 limit for either airborne uranium or radon daughters. Subsequent bioassay on the potentially exposed employee did not indicate an exposure had occurred.

Action levels for airborne radioactivity have been described in Section 5.7.3. It is the intention of FEN to maintain exposures and airborne radionuclide concentrations as low as is reasonable achievable.

5.7.5 Bioassay Program

The objective of the bioassay program is to determine actual employee exposure and to assess the adequacy of the air sampling and contamination control programs. The program will be designed to closely follow the

requirements of USNRC Regulatory Guide 8.22 ***Bioassays at Uranium Mills***, (1978).

All employees whose routine work assignments require them to enter areas where the possibility of yellowcake inhalation exists will be sampled on a quarterly basis. All other employees will be sampled on an annual basis. A baseline urinalysis will be performed on all employees prior to their initial assignment at the plant. In the event of a suspected over exposure to yellowcake dust, a sample will be collected after a 48 hour interval and analyzed as soon as possible. Records will be 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. The action levels to be employed are those given in Table I of Regulatory Guide 8.22.

During R&D operations at Crow Butte, no employee exceeded the 15 ug/l uranium action level for urinalysis.

5.7.6 Contamination Control Program

The areas of potential contamination at the Crow Butte Facility will be associated with the precipitation circuit, slurry storage areas and drying/packaging area. The limits for surface contamination in unrestricted areas at the Crow Butte Commercial Facility are those shown in Table 5.7-4 and are adopted from the U.S. Nuclear Regulatory Commission publication entitled ***Health Physics Surveys in Uranium Mills***, (Regulatory Guide 8.30, June 1983). These limits are expressed in terms of total and removable contamination. The limits are for surfaces in unrestricted areas and for equipment that is to be released for unrestricted use.

The surface contamination monitoring program at the Crow Butte Project will consist of two parts. The first part will be weekly surveys throughout the plant in both restricted and unrestricted areas. These surveys will include visual inspection for obvious signs of contamination and instrument surveys to determine total contamination. If the instrument survey indicates total contamination above 1000 dpm/100 cm^2 in the unrestricted

TABLE 5.7-4

SURFACE CONTAMINATION LIMITS FOR NATURAL URANIUM

Total[a]	5000 dpm/100 cm^2 average 15000 dpm/100 cm^2 maximum
Removable	1000 dpm/100 cm^2

(a) The average value may be averaged over an area not to exceed 1 m^2. The maximum is over an area not to exceed 100 cm^2.

area, a smear test will be conducted to measure the removable contamination. If contamination above the limits listed in Table 5.7-4 is found in unrestricted areas, then documentation procedures will begin as soon as feasible. The cause of the contamination will be investigated and procedures to prevent future occurrences will be considered. If any visible yellowcake or surface contamination levels of greater than 10^{-3} uCi/cm^2 are observed in the restricted area, the area will be cleaned up promptly. Both the weekly surveys and the routine monthly smear tests will be documented and the records kept on file at the plant site.

In areas such as lunch rooms, action levels of 25 percent of the values given in Table 5.7-4 will be used. If these action levels are exceeded the area will be closed until it can be properly cleaned. The health physics technician will also try to determine the cause of the contamination. The lunch rooms will be visually inspected on a daily basis and surveyed weekly. If during the alpha survey any areas are suspect, a smear test will be performed to ensure that the removable contamination is below the action level of 250 dpm/100 cm^2. All surveys and smear tests will be documented and the records retained at the plant site.

All shipments of yellowcake from the plant site will have the exterior surfaces of the transport vehicle surveyed to insure that the surface contamination is below the acceptable limits. Smear samples will be taken from areas that have the highest levels of contamination as indicated by the survey. The limits for removable surface contamination for yellowcake packages prepared for shipment will be 2,200 dpm per 100 cm^2 averaged over 300 cm^2. If these limits are not met then the vehicle will be decontaminated until smear tests of the areas of highest contamination result in levels below this limit.

5.7.7 Airborne Effluent and Environmental Monitoring Programs

This Section outlines the operational program FEN proposed to use to monitor the environmental effects of any airborne effluents from the Crow Butte Facility. Particulates and radon gas will be measured at six locations and a control location. At the conclusion of operations, the soil and

vegetation at the air monitoring stations will be sampled and compared to the results of the preoperational sampling program. Sediments in Squaw Creek will be sampled semiannually. The ground and surface waters will also be monitored for the concentration of natural uranium and radium-226 at the locations specified in Table 5.7-5.

The design of the operational radiological monitoring program is based on the preoperational radiological program (see Section 2.10) and on USNRC Regulatory Guide 4.14, ***Radiological Effluent and Environmental Monitoring at Uranium Mills*** (1980b). The operational radiological monitoring program is presented in Table 5.7-5.

Air particulates and radon gas will be monitored at five locations and a control location during the operation of the Facility. Figure 5.7-1 is a topographic map of the area surrounding the restricted area boundary. The air monitoring stations AM-1, AM-2, AM-3, AM-4, AM-5 and AM-8 will be used to assess the radiological impact, if any, on the air quality in the region. These stations are located at the nearest residences and at prevalent downwind directions. Site AM-6 which is near the town of Crawford, is used as a background location. These stations (with the exception of AM-8 at which sampling was initiated in March 1987) have been in intermittent operation since April 1982. It should be noted that air monitoring station AM-7 was used as the control location during R&D operations. Based on wind data from the local meteorlogical station, it was determined that Site AM-6 would be a more appropriate control location and that AM-7 should not be used.

The airborne particulates will be collected on the inlet filter of a regulated vacuum pump. The filter will be changed weekly or more frequently if dust loading is a problem. The pump will be in operation a maximum of two weeks per month with the filters being composited according to location on a quarterly basis. The composite samples will be analyzed for the concentrations of natural uranium, thorium-230, radium-226, and lead-210. The lower limits of detection (LLD) will be those specified in NRC Regulatory Guide 4.14.

TABLE 5.7-5

RADIOLOGICAL OPERATIONAL
MONITORING PROGRAM
CROW BUTTE PROJECT

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
AIR						
Particulates						
	Six	Nearest residences and in the prevalent wind direction	Continuous air sampler with glass fiber filter	Two week per month (maximum)	Quarterly composite of filters according to location	Natural Uranium Thorium-230, Ra-226 Pb-210
	One	Control location near the Town of Crawford	same	same	same	same
Radon						
	Seven	Same as air particulates	Continuous	Monthly	Each sample	Rn-222
WATER						
Groundwater						
	One from each water well	Within 1 km of area wellfield	Grab	Quarterly	Each sample	Natural Uranium, Ra-226

Radiological Operational Monitoring Program (Cont'd)

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
Surface Water						
	Two from Squaw Creek	One upstream, one downstream of restricted area	Grab	Quarterly	Each sample	Natural Uranium, Ra-226
SOIL						
	One each	Air sampling stations	Grab (top 5 cm)	Once	Once	Natural Uranium Ra-226, Pb-210
SEDIMENT						
	Two from Squaw Creek	One upstream, one downstream of restricted area	Grab	Annually	Annually	Natural Uranium Ra-226, Th-230, Pb-210
VEGETATION						
	One	Animal grazing area in direction of prevailing wind	Composite of dominant vegetation present	Three times during grazing season	Each sample	Ra-226 and Pb-210
DIRECT RADIATION						
	One each	Plant site, well field, evaporation ponds, air sampling stations	Dosimeter	Quarterly	Quarterly	Gamma exposure rate uR/hr using a continuous integrating device

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:
FIGURE NO.: 5.7-1, "RADIOLOGICAL OPERATIONAL SAMPLE LOCATIONS"

WITHIN THIS PACKAGE... OR, BY SEARCHING USING THE DOCUMENT/REPORT FIGURE NO.: 5.7-1

D-01

Radon will also be measured at the air monitoring stations. Track etch detectors (radon cups) will be used to measure the radon. Detectors will be changed monthly and sent to the manufacturer for interpretation and measurement of the radon concentration.

Gamma radiation will be measured at the air monitoring stations. Thermoluminescence detectors supplied by Eberline Instrument Corporation will be used to record the gamma radiation. All dosimeters will be exchanged on a quarterly basis.

Upon decommissioning, soil samples will be collected at the six air monitoring stations. These samples will be analyzed for the concentrations of uranium, radium-226 and lead210. Preoperational samples were also collected at these locations and a comparison will be made to assess the effect the operation have had on the concentrations of these radionuclides in the soil.

Vegetation samples will be taken three times per grazing season in the direction of the prevailing winds for the plant site and analyzed for Ra-226 and Pb-210.

During the preoperational monitoring program, vegetation samples were collected at the seven air monitoring stations. These samples were analyzed for natural uranium and radium-226. After decommissioning of the Facility, the vegetation near the air monitoring stations will be sampled again and analyzed for the same radionuclides. The samples are composites of the dominant vegetation types present.

Sediment in Squaw Creek was sampled at two locations on a semiannual basis for one year prior to any construction in the area. The sample locations represent one sample upstream and one downstream of restricted area and are shown in Figure 5.7-1. During the operation of the Commercial Facility, sediments at these sample locations will be collected annually and analyzed for the concentrations of natural uranium, thorium-230, radium-226 and lead-210.

Also detailed in Table 5.7-5 is the radiological monitoring of the surface and groundwater in the area surrounding the restricted area boundary. Water supply wells within 1 km of this boundary will be sampled on a quarterly basis and analyzed for the concentration of natural uranium and radium-226. Two surface water samples will be taken from Squaw Creek, one upstream and one downstream of the restricted area boundary. These samples will be collected quarterly and analyzed for the concentration of natural uranium and radium-226.

5.7.8 Groundwater and Surface Water Monitoring Programs

Three types of unplanned liquid effluents can potentially be released from an in situ uranium Facility: (1) mining solutions which migrate to areas outside the wellfield, (2) waste solutions in the subsoil resulting from loss of evaporation pond liner integrity, and (3) mining solutions released at the surface from leaks or breaks in pipelines and at wellheads.

5.7.8.1 Groundwater Monitoring

The groundwater excursion monitoring system will be designed to detect excursions of lixiviants into the ore zone aquifer outside of the wellfield area being leached and into the overlying water bearing strata. The Pierre Shale below the ore zone is over 1200 feet thick and contains no water bearing strata. Therefore, it is not necessary to monitor any water bearing strata below the ore zone.

Results of two aquifer tests (See Section 2.7) indicate that the ore zone aquifer is essentially isotropic and homogeneous. No faults or other conditions which may require special monitoring locations were noted in the hydrologic data analysis.

FEN proposes that ore zone monitoring wells be located approximately 400 feet from the perimeter of the wellfield and that these wells be 500 to 600 feet apart. These proposed locations are consistent with the USNRC Staff

Technical Position found in WM-8102 ***Groundwater Monitoring at Uranium In Situ Solution Mines.*** FEN also proposes that monitoring wells in the overlying aquifer be installed at a density of one monitoring well per five acres of wellfield.

Upon installation of the monitor wells, baseline samples will be taken from each well. The water level in each well will also be measured. Three samples at two week intervals will be taken from each monitor well and analyzed for the parameters found in Table 5.7-6.

The excursion indicators for the monitor wells will be chloride, conductivity, alkalinity, and sodium. The Upper Control Limit (UCL) for the excursion indicators will be set at 20% above the maximum baseline concentration for the excursion indicators.

The monitor wells will be sampled and analyzed at a frequency of once per two weeks. Water level elevations in these wells will be measured and barometric pressure recorded prior to sampling.

All monitor well data will be reported to the appropriate agencies on a quarterly basis. If two UCL values are exceeded in a well, or if one UCL value is exceeded by 20 percent, another water sample will be taken within twenty-four (24) hours of the first analysis and analyzed for the excursion indicators. If the second sample does not indicate excedence of the UCLs, a third sample shall be taken within forty-eight (48) hours from the first sample. If neither the second or third indicate excedence of the UCLs, the first sample shall be considered in error. If the second or third sample indicates an excedence of the UCLs, the well in question shall be placed on excursion status. An excursion is confirmed if two or more UCL values are exceeded, or if one UCL value is exceeded by 20 percent or more. Corrective action to mitigate the situation shall be initiated by FEN when an excursion is confirmed and the NRC shall be notified by telephone within twenty-four (24) hours and within five (5) days in writing from the time the confirmation sample was taken. Corrective actions shall be continued until the excursion is concluded. In addition to corrective actions, sampling frequency and analysis of excursion status wells shall be

TABLE 5.7-6

BASELINE WATER-QUALITY INDICATORS TO BE DETERMINED DURING PREMINING DATA COLLECTION

Physical Indicators

Specific Conductivity[1]	Alkalinity	Total Dissolved Solids[3]
Temperature[2]		
pH[1]		

Common Constituents

Ammonia	Chloride	Mercury
Bicarbonate	Magnesium	Sodium
Calcium	Nitrate	Sulfate
Carbonate	Nitrite	Potassium

Trace and Minor Elements

Arsenic	Copper	Mercury
Boron	Fluoride	Molybdenum
Barium	Iron	Nickel
Cadmium	Lead	Selenium
Chromium	Manganese	Vanadium
		Zinc

Radionuclides

Radium-226	Uranium

[1] Field and laboratory determination.
[2] Field only.
[3] Laboratory only.

performed once every seven (7) days for the excursion indicators. An excursion is considered concluded when the concentrations of excursion indicators are below the concentration levels defining an excursion for three (3) consecutive one (1) week samples.

In the event of an excursion, corrective actions will be taken by FEN. Corrective actions may include:

- Over-recovery of leach solutions,
- Under-injection of leach solutions,
- Modification of the injection-recovery well patterns.

5.7.8.2 Evaporation Pond Monitoring

Leaks of waste solutions through the pond liners will be monitored by use of an underdrain leak detection system and pond level indicators. The latter will consist of marks at half-foot intervals with which the level of fluid in the ponds can be determined.

Leak detection systems will be installed beneath the liners of each evaporation pond. A french drain situated at the lower end of each pond will culminate in a sump with a vertical standpipe.

Pond Monitoring and Action Procedures. Monitoring of the ponds will be performed daily as a routine operator responsibility and the waste fluid level in each pond will be recorded daily.

The underdrain leak detection system will be monitored daily by checking within the standpipe to ascertain if liquid is present. If the depth of the fluid in the standpipe exceeds six inches, a sample will be taken and analyzed for chloride, sodium, uranium, and conductivity.

If the analyses indicate that the pond is leaking, the USNRC shall be notified by telephone within forty-eight (48) hours of verification and the pond level shall be lowered by transferring the contents into another pond. Water quality samples taken from the standpipe shall be analyzed for

chloride and TDS once every seven (7) days during the leak period and once every seven (7) days for at least two (2) weeks following repairs. Additionally, water samples collected from the standpipe will be analyzed for chloride, sodium, uranium, and conductivity at least once during the leak period.

FEN will submit a written report within thirty (30) days to the USNRC notifying the USNRC that a leak exists and describing the mitigative actions and the results of that action.

5.7.8.3 Wellfield Surface Monitoring

Wellfield piping at the Crow Butte Facility will be buried and pitless adapters will be used at the wellhead. Buried pipelines will be leak tested at operating pressures prior to being covered. The buried trunk lines will have a recording low pressure alarm system which will sound if line pressures drop below the normal operating pressures.

If there is a leak or rupture, immediate action will be taken to correct the problem

FEN will then notify the USNRC by telephone within forty-eight (48) hours and a written report detailing the failure conditions, corrective actions and results achieved will be submitted within seven (7) days.

5.7.9 Quality Assurance

The quality assurance program that will be initiated at the Crow Butte Facility is described in this Section. The objective of this program is to provide confidence in the results obtained from the monitoring programs that will be employed during the plant operation. This program will allow FEN personnel to identify deficiencies in sampling and measurement techniques and to instigate corrective action when necessary.

The quality assurance program to be conducted at the Crow Butte Project is designed to provide confidence in the results of the monitoring programs described in previous sections. The USNRC Regulatory Guide 4.15, ***Quality Assurance for Radiological Monitoring Programs (Normal Operations) Effluent Streams and the Environment*** (1979), was used as a basis for the program. There are eight main sections of the program and each will be discussed in detail.

Organization Structure and Responsibility. In Section 5.1, the corporate organization and administrative procedures are presented. The authority and responsibility of each level of management in regard to the quality assurance programs are discussed. The plant manager and health physics technician will have responsibility for review and evaluation of monitoring data and reports. The data dealing with radiological safety will also be reviewed by the corporate radiation safety officer. The corporate radiation safety officer will have responsibility for review and approval of any written procedures associated with the radiological and nonradiological monitoring programs.

Qualifications of Personnel. The qualifications of the radiation safety officer and the health physics technician are similar to those presented in the NRC Draft Regulatory Guide, ***Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills Will Be As Low As Is Reasonably Achievable*** (1980c).

The minimum qualifications of the radiation safety officer are as follows:

Education: A bachelors degree in physical science or engineering an accredited college or university, or an equivalent combination of relevant experience and training in uranium mill radiation protection.

General Experience: One year supervisory experience and one year in a uranium mill or related experience.

Health Physics Experience: One year work experience in applied health physics, radiation protection, industrial hygiene, or similar work.

Specialized Training: At least four weeks of formalized courses in health physics and radiation protection.

Specialized Knowledge: A thorough knowledge of the proper application and use of all the health physics equipment used at the mine, the procedures for radiological sampling and monitoring, and methods of exposure calculation.

The minimum qualifications for the health physics technician are as follows:

Education: An associates degree in the physical sciences, engineering or a health-related field. Alternately, a high school diploma plus 2 years of relevant work experience in applied radiation protection.

General Experience: One year of work experience in a uranium mill or related industry involving radiation protection.

Health Physics Experience: One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety.

Specialized Training: At least four weeks of specialized training in radiation health protection.

Specialized Knowledge: Knowledge of the proper operation of health physics instruments used for monitoring and surveying at the mine, and personnel dosimetry requirements.

The qualifications of the individuals chosen to assume the responsibilities of the radiation safety officer and health physics technician will be submitted at a later date.

It will be the responsibility of the radiation safety officer to insure that all personnel performing quality related activities are trained and qualified in the activities they must perform. These personnel will be made aware of the nature and goals of the quality assurance program and their proficiency in performing activities affecting quality assurance will be maintained by retraining and reexamination.

Operating Procedures and Instructions. Written procedures will be prepared and approved for all activities involving sample collection, preparation and analysis of samples, calibration of radiation and radioactivity measurement systems, and reduction, evaluation and reporting of data. These procedures and any changes will be reviewed and approved by individuals knowledgeable in the procedures. The Table of Contents from the Crow Butte Operating Procedures Manual used at the R&D site has been included in Appendix 5.7. A similar manual will be prepared and used for the commercial oeration.

Records. Records will be maintained to adequately document radiological and environmental sample collection, analysis, and reporting. Records for sample collection will include a sample description, sample collection location, date, analysis required, the individual collecting the sample, and laboratory performing the analysis if not performed by FEN. Analysis records will include such items as the instrument readings, instrument backgrounds, reagent blanks, and data reduction and verification. The result of calibration checks and date of calibration will also be recorded.

Quality Control in Sampling. Instruments used for continuous measurement or sample collection will be calibrated on a regularly scheduled basis. At the Crow Butte Project, this requirement will generally pertain to the environmental monitoring of radon and airborne radionuclides. The collection efficiency of the air particulate samplers will be documented and their flow rate calibrated at six month intervals.

When grab sampling is used, procedures will be developed to insure that the sample is representative of the material being sampled. Replicate samples will be collected periodically to insure reproducibility. This will facilitate the comparison of grab samples collected at different intervals.

When samples are to be sent to an outside laboratory for analysis, written procedures will be followed to insure proper preservation technique, labeling, packaging, shipping, and storage of the samples. The laboratory will be notified that the samples are being released and will notify FEN upon receipt. A complete listing of the samples and the required analysis will accompany each shipment.

Quality Control in the Laboratory. Radiation instruments used at the Crow Butte Project will be calibrated against standards that are traceable to the National Bureau of Standards (NBS). If the instrument is calibrated on site, the activity of the source used for the calibration will be certified. If the instrument is not calibrated on site, it will be sent to a laboratory whose procedures and standards are certified.

The individual instruments will be subjected to daily performance checks when in use. The background will be determined by an appropriate method and a check source will be used to monitor the count rate or counting efficiency. Investigative and corrective action will be initiated should the instrument fail to produce results within the predetermined control value range.

In order to assess the quality of the analyses in the analytical laboratory replicate samples will be run routinely. This will allow an estimate of the precision that can be expected for the analysis. Spiked samples will be analyzed and evaluated to determine the accuracy of the procedure. Reagent blank samples will be run periodically to insure reagent contamination is not a problem. When using commercial laboratories, random duplicate samples will be sent to different laboratories to aid in evaluation of the quality of the results.

Review and Analysis of Data. Analytical and radiological data will be reviewed as it is received by the health physics technician. The data will be examined to determine any extraordinary results, as well as possible trends resulting from sources such as instrumental drift or gradually changing backgrounds. Finally, all duplicate, spiked, and reagent blank samples will be evaluated. The data will be reviewed on a periodic basis by the radiation safety officer. If abnormalities are found, corrective action will be taken and documented.

Audits. Audits of the quality assurance program will be conducted during the planned, periodic audit of the radiation safety program. This audit will be conducted by representatives of the corporate management, operations management, and representatives of the radiation safety office.

The results of the audit will be documented. If indicated, corrective action and re-audit will be required.

REFERENCES

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United State Nuclear Regulatory Commission, ***Bioassay at Uranium Mills***, Regulatory Guide 8.22, Washington D.C., July 1978.

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United States Nuclear Regulatory Commission, Staff Technical Position Paper, ***Ground Water Monitoring at Uranium In-Situ Solution Mines***, #WM-8102, December 1981.

United States Nuclear Regulatory Commission, ***Standard Format and Content of License Applications, Including Environmental Reports, for In-Situ Uranium Solution Mining***, Regulatory Guide 3.46, Task FP818-4, Washington D.C., June 1982.

APPENDIX 5.7

INSTRUMENT SPECIFICATIONS, SAMPLING AND ANALYTICAL PROCEDURES

5.7 APPENDIX

The approximate number of instruments and types of equipment or equivalent that will be available at the Crow Butte Facility are found in this Appendix.

Detailed procedures for sampling and analysis of radiological samples have not been included in this Appendix. These detailed procedures are found in the Standard Operating Procedures (SOP) Manual which will be prepared for the Crow Butte Facility. The Table of Contents from the SOP manual used at the Crow Butte R & D operation has been included in this Appendix for reference.

RADIATION DETECTION INSTRUMENTS

No. In Service	Manufacturer/ Model No.	Radiation Measured	Use	Calibration Interval
1	Eberline ESP E/120 with HP-270 Probe	gamma	Area Survey	6 months
4	Eberline RM-19 with AC-3 Probe	alpha	Personnel Survey	6 months
1	Eberline SAC-R5 with MS-2 mini-scaler	radon	Bench-Top Area Monitor	6 months
1	Eberline RD-14 with MS-3 mini-scaler	alpha	Bench-Top Alpha	6 months
2	Mt. Sopris Scintillometer with Integral 1x1 NaI Crystal	gamma	Gamma Survey (Micro-R)	6 months
N/A	Eberline TLD Dosimeter	gamma	Area Survey	N/A
4	MSA Model S Personnel Pump	N/A	Air Sampling	6 months
7	Eberline RAS-1 Regulated Air Pump	N/A	Air Sampling	6 months
1	Bendix Model 550 Hi Vol Air Sampler	N/A	Air Sampling	6 months

NOTE: Sensitivities and specifications are found in the following data sheets. Instruments with equivalent specifications may be substituted by FEN during operations.

SPECIFICATIONS AND SENSITIVITY
MT. SOPRIS SCINTILLOMETER
Model SC-132

Power Supply	-	2 ea 1.1 volt batteries
Counting Range	-	0-100 counts per second (cps) with multipliers of 1, 2, 5, 10, 20, 50, 100 (Note: Calibration with Ra-226 source indicates that 10 cps is equal to 1 microroentgen (uR)
Time Constant	-	1, 4, 16 seconds
Detector	-	Photomultiplier coupled to a 1" x 1" NaI (Tl) scintillator
Sensitivity	-	10 cps (equivalent to 1 ,R) above background

SPECIFICATIONS FOR THE EBERLINE INSTRUMENTS CORPORATION DOSIMETERS

Detector	LiF TLD chips
Detector Shields	One 10 mg/cm^2 One 285 mg/cm^2
Sensitivity	1 mR
Range	1 mR - 1000R
Exchange Frequency	Quarterly

SPECIFICATIONS FOR THE RD-14 ALPHA COUNTER WITH AN EBERLINE MS-3 SCALER

General Description - The RD-14/MS-3 system is used in determining alpha activity on filters and smears.

The RD-14 uses a ZnS(Ag) scintillation detector and will accept up to 4" diameter samples. The MS-3 scaler can accurately measure alpha activity over a wide range.

Efficiency - 35 to 40% based on Th-230

MS-3 SCALER SPECIFICATIONS

High Voltage - Regulated, Adjustable from 200 to 2500 volts

Scaler - Six Decade LED readout

Timer - Time base in minutes with settings of 1, 2, and 5 and multiples of x.1, x1 and x10

Timer Accuracy - Better than 0.05%

SPECIFICATIONS FOR THE EBERLINE MODEL SAC-R5 DETECTOR AND SC-6 SCINTILLATION CELL WITH AN MS-2 MINI-SCALER

Photomultiplier Tube	- Nominal 5 inch, 10 stage end window tube
Background	- One cpm maximum when set properly
Connection	- Single coaxial MHV type connector
High Voltage	- To 2500 volts
SC6 Cell Volume	- 1.4 liters
Response Factors	
CPM per pCi	- 4.3
CPM per pCi/l	- 6.0

MS-2 MINI-SCALER SPECIFICATIONS

High Voltage	- Regulated, adjustable from 200 to 1500 volts
Scaler	- Six decade LED readout
Timer	- Preset times from 0.1 minutes to 50 minutes in a 1, 2, 5 sequence; accurate to 0.05%

SPECIFICATIONS FOR THE EBERLINE RM-19 ALPHA SURVEY METER WITH AN EBERLINE AC-3 PROBE

RM-19 SPECIFICATIONS

Range	- Switch controlled x1, x10, x100, x 1000 yielding 500, 5K, 50K or 500 K cpm full scale
Response Time	- Fast - approximately 2 seconds Slow - approximately 20 seconds measured to 90% of final reading
Linearity	- Typically within +/- 2% of full scale

AC-3 SPECIFICATIONS

Scintillator	- ZnS(Ag) powder embedded on tape
Active Area	- 9.1 in^2 within 5.75 in x 2 in sampling area
Window Thickness	- 0.5 mg/cm^2 aluminized mylar
Maximum Voltage	- + 1600 Volts

SPECIFICATIONS FOR THE EBERLINE INSTRUMENT CORPORATION MODEL RAS-1 REGULATED AIR PUMP

Pump Type	Oil-less, carbon vane
Maximum Capacity	4 cfm at 0 pressure drop
Ultimate Vacuum	26 inches Hg at sea level
Typical Operating Capacity	0.5 - 2.0 cfm
Sample Size	47 mm
Flow Meter	0 - 100 liters per minute
Filter	Outlet and by-pass filter/muffler
Power	115 volts, 60 Hz at 5A
Thermal Protector	In motor
Calibration Frequency	6 months
Manufacturer	Eberline Instrument Corp. P.O. Box 2108 Sante Fe N.M. 87501

SPECIFICATIONS FOR THE BENDIX MODEL 550 HIGH VOLUME AIR SAMPLER

Pump Type	High capacity, turbine
Air Flow Gauge	Pressure type, calibrated in CFM with a range of 0 to 70 CFM and readable to 1 CFM
Max. Air Flow	60 CFM
Filter Size	102 mm
Power	115 volt, 60 Hz
Calibration Frequency	6 months

OPERATING PROCEDURE OUTLINE

CROW BUTTE OPERATING PROCEDURES MANUAL

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