NRC FORM 313
9-88
10 CFR 30, 32, 33, 34, 35 and 40

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U.S. NUCLEAR REGULATORY COMMISSION
APPROVED BY OMB 3150-0120
Expires 6-30-90

APPLICATION FOR MATERIAL LICENSE

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

APPLICATIONS FOR DISTRIBUTION OF EXEMPT PRODUCTS FILE APPLICATIONS WITH:

U.S. NUCLEAR REGULATORY COMMISSION
DIVISION OF INDUSTRIAL AND MEDICAL NUCLEAR SAFETY, NMSS
WASHINGTON, DC 20555

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS. IF YOU ARE LOCATED IN:

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U.S. NUCLEAR REGULATORY COMMISSION, REGION I
NUCLEAR MATERIALS SAFETY SECTION B
475 ALLENDALE ROAD
KING OF PRUSSIA, PA 19406

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

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MATERIALS LICENSING SECTION
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH, OR WYOMING, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
MATERIAL RADIATION PROTECTION SECTION
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TX 76011

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO:

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NUCLEAR MATERIALS SAFETY SECTION
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WALNUT CREEK, CA 94596

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1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

- [X] A. NEW LICENSE
- [ ] B. AMENDMENT TO LICENSE NUMBER ____________
- [ ] C. RENEWAL OF LICENSE NUMBER ____________

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include Zip Code)*

Spokane Tribal Mining and Minerals Department, Inc.
P. O. Box 100
Wellpinit, Washington 99040

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED

Sherwood Uranium Mill
Wellpinit, Washington 99040

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION: Robert J. Roberts

TELEPHONE NUMBER: (509) 624-4291

SUBMIT ITEMS 5 THROUGH 11 ON 8½ x 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
a. Element and mass number, b. chemical and/or physical form, and c. maximum amount which will be possessed at any one time.

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.
See Attachment 2

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE. See Attachment 3

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.
See Attachment 4

9. FACILITIES AND EQUIPMENT. See Attachment 5

10. RADIATION SAFETY PROGRAM. See Attachment 6

11. WASTE MANAGEMENT. See Attachment 7

12. LICENSEE FEES *(See 10 CFR 170 and Section 170.31)*
FEE CATEGORY 2.A.
AMOUNT ENCLOSED $ 150.00

13. CERTIFICATION. *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.
THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, AND 40 AND THAT ALL INFORMATION CONTAINED HEREIN, IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.
WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948, 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

SIGNATURE—CERTIFYING OFFICER	TYPED/PRINTED NAME	TITLE	DATE
x Joe V. Flett (signature)	Joe V. Flett	Chairman	4/5/89

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TYPE OF FEE	FEE LOG	FEE CATEGORY	COMMENTS

AMOUNT RECEIVED	CHECK NUMBER

8904270288 890404
PDR ADOCK 040*****
B PDC

APPROVED BY | DATE

NRC FORM 313 (9-88)

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 7.5 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE OFFICE OF INFORMATION AND REGULATORY AFFAIRS, OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

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INDEX

ATTACHEMENT 1

5. Radioactive Material

   a. Element and mass number

      Naturally occurring uranium, approximately 99.3% U_{238}, approximately 0.7% U_{235}

   b. Chemical and/or physical form

      U_3O_8

   c. Maximum amount which will be possessed at any one time

      Unlimited

ATTACHEMENT 2

6. Purpose for which Licensed material will be used.

   Sale to domestic and foreign utilities for use in power generation.

ATTACHEMENT 3

7. Individual(s) responsible for radiation safety program and their training and experience.

RADIATION SAFETY OFFICER QUALIFICATIONS

The Radiation Safety Officer (RSO) will be responsible for all aspects of employee and environmental radiation protection, monitoring and reporting. The RSO qualifications will comply with the requirements of section 2.4.1 in the U.S. Nuclear Regulatory Commission Regulatory Guide 8.31, "Information Relevant To Ensuring That Occupational Radiation Exposures At Uranium Mills Will Be As Low As Is Reasonably Achievable".

ATTACHEMENT 4

8. Training for individuals working in or frequenting restricted areas.

RADIATION PROTECTION TRAINING

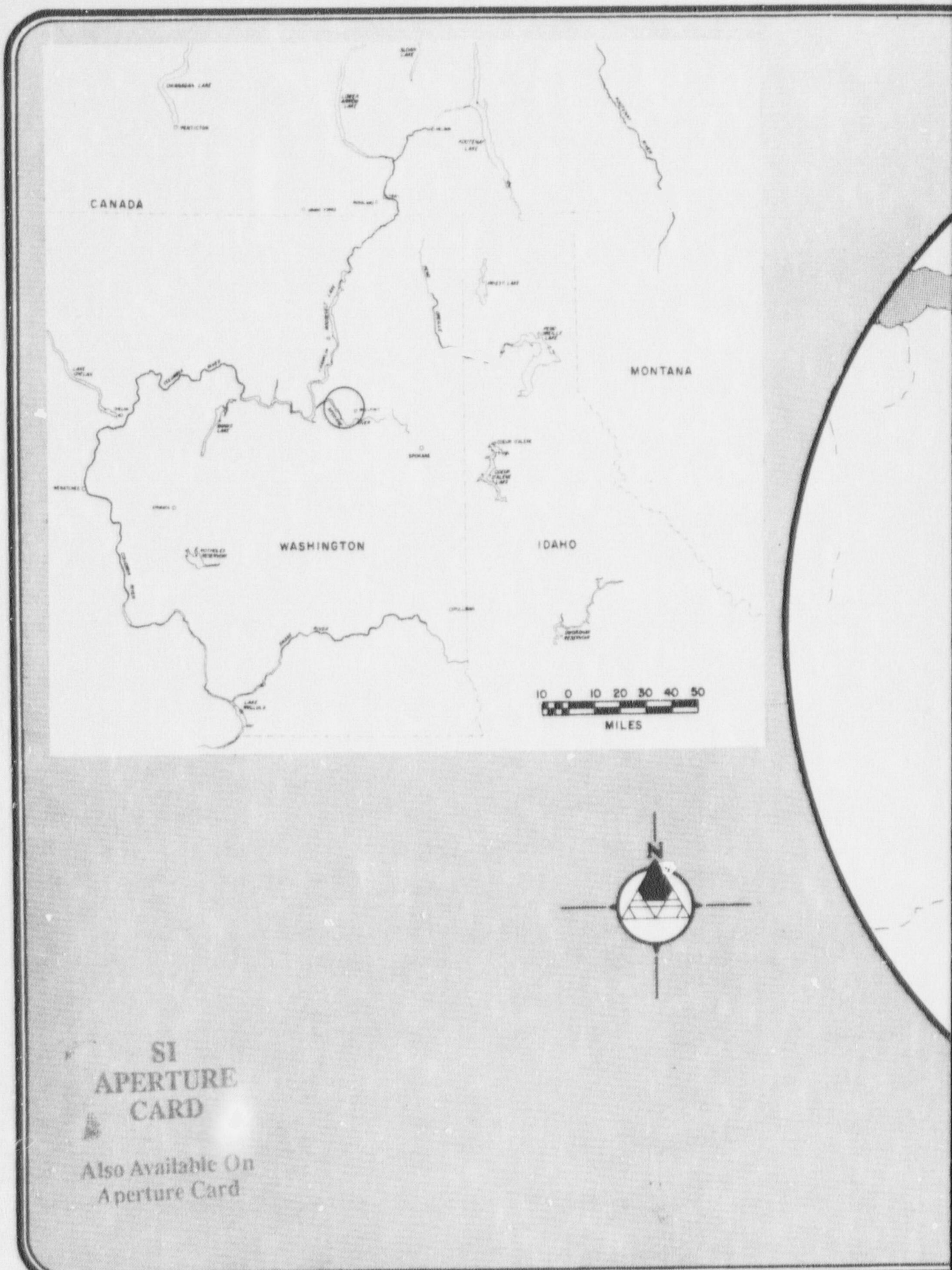
Radiation protection training will be provided for new employees as per section 2.5 of U.S. Nuclear Regulatory Commission Regulatory Guide 8.31, "Information Relevant To Ensuring That Occupational Radiation Exposures At Uranium Mills Will Be As Low As Is Reasonably Achievable".

RESPIRATORY PROTECTION PROGRAM

Respiratory protection programs will be in accordance with U.S. Nuclear Regulatory Commission Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection" and NUREG-0041, "Manual of Respiratory Protection Against Airborne Radioactive Materials".

ATTACHEMENT 5

9. Facilities and equipment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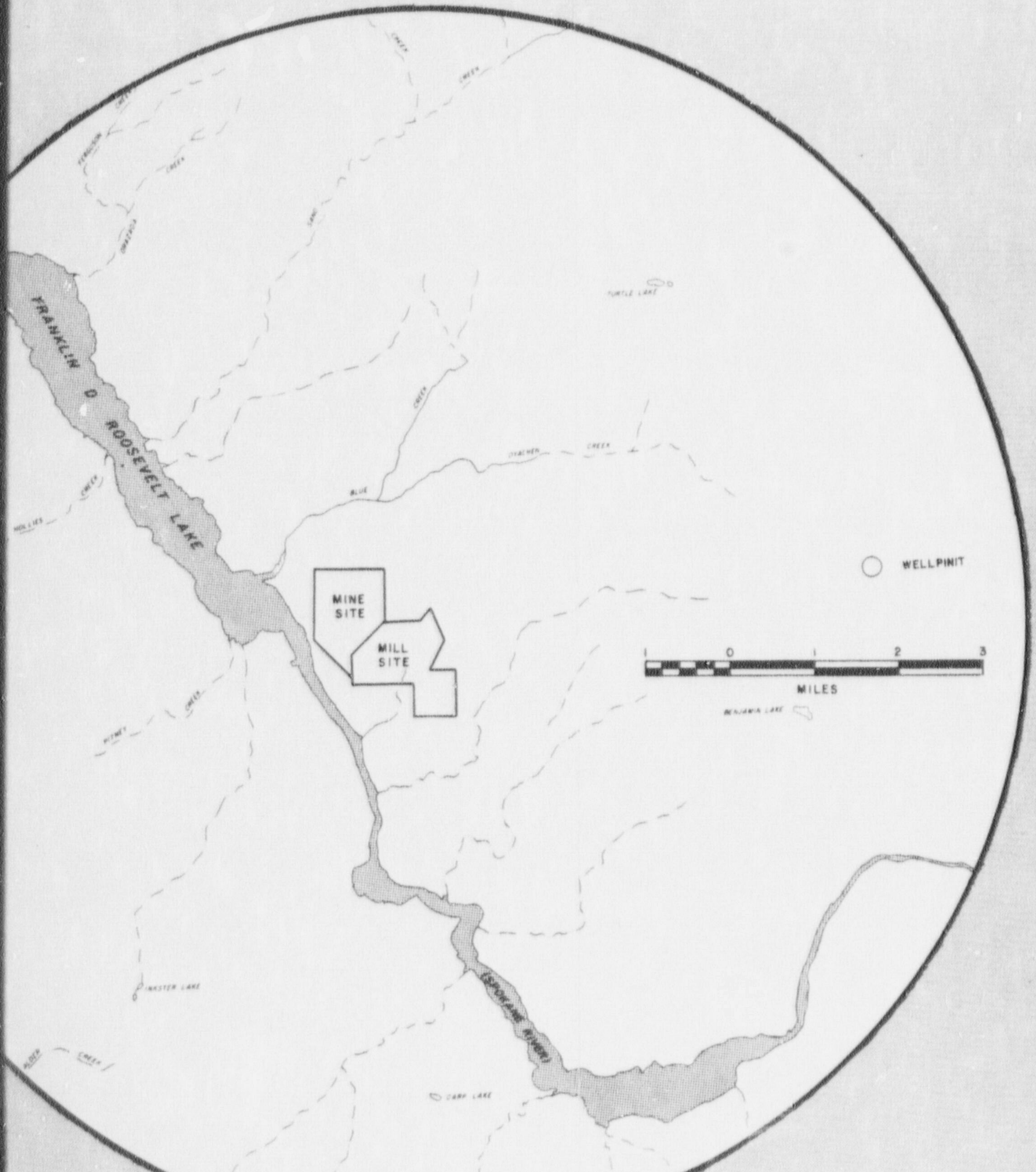

Figure 1-1
Project Location

8904270288-01

GENERAL PROCESS DESCR.PTION

The Sherwood Mill is a conventional acid leach-colvent extraction circuit for the recovery of U3O8 from uranium bearing ores. The mill is designed to process 2000 tons of dry ore per day, and to produce 6000 pounds of uranium concentrate (yellowcake) per day.

The operating areas are: 1) crushing; 2) grinding; 3) leach; 4) countercurrent decantation; 5) clarification; 6) solvent extraction; and 7) precipitation, drying and packaging. The operating areas must be coordinated and function together to provide the optimum operational efficiency. Each area must be aware of the effect it has on the preceding and following area and maintain communications to alert the other operators of changing situations. The crushing circuit and the drying and packaging circuit do not influence the other areas of operation and can be operated independently as long as the the grinding circuit has sufficient feed material at the front end of the milling circuit and there is sufficient surge capacity for yellowcake at the end of the milling circuit.

Each of the operating areas is described in this operating procedures manual. The various aspects of each section are presented on an individual basis to familiarize the operator with the specific section. Each section will make reference to the preceeding and following operating areas and the dependency of one area to another. The relationship of one area to another must be understood to provide a good milling operation.

The general process description describes the overall operation and the sequence of the material flow. A simplified process flow diagram is included and is described as follows:

COARSE ORE PAD

The run-of-mine ore is delivered from the mine by truck. The ore is stockpiled on the coarse ore pad according to the contained uranium values (ore grade). The feed to the crushing circuit can then be blended with a predetermined number of loader bucketfulls from each of the selected piles.

CRUSHING CIRCUIT

Crushing is the first step in reducing the particle size of the ore for the processing operation. A FRONT END LOADER transfers ore from the coarse ore pad to the 325 ton coarse ore bin. Oversize material (plus 24-inch) is prevented from entering the bin by an inclined GRIZZLY. The oversize material is removed and stacked in a separate pile to be broken down and fed, or the oversize may be hauled to the waste dumps. The ore is removed from the bottom of the coarse ore bin by an APRON FEEDER which controls the rate of feed to a second grizzly. The secondary grizzly has 4-inch spacing between the bars. Material going through the 4-inch grizzly is dropped directly onto the No. 1 CONVEYOR. The oversize ore drops into the JAW CRUSHER which has a 4-inch set. The JAW CRUSHER product joins the fine material on the No. 1 CONVEYOR. The ore on the No. 1 CONVEYOR is fed to the No. 2 CONVEYOR which feeds the VIBRATING SCREEN DECK. The VIBRATING SCREEN DECK has two screens, the top screen scalps out the large particles and the lower screen separates the particle sizes at 1-inch. Material passing through the 1-inch screen drops onto the No. 3 CONVEYOR which transports the ore to the FINE ORE BIN. The oversize ore (plus 1-inch) from both screens is fed from the screen deck to the CONE CRUSHER which has a 3/4-inch set. The CONE CRUSHER product is fed to the No. 1 CONVEYOR to be recycled to the VIBRATING SCREEN DECK. Eventually, all the ore is crushed to minus 1-inch and is transported to the FINE ORE BIN. The crushing circuit has the capacity to crush 24-hours of mill feed in an eight (8) hour crushing shift. When full, the FINE ORE BIN can provide about 1-1/2 days of feed to the grinding circuit.

GRINDING CIRCUIT

Fine ore is reclaimed from storage by four (4) variable speed BELT FEEDERS. The feeders regulate ore fed to the No. 5 CONVEYOR which feeds the BALL MILL. A WEIGHTOMETER on the No. 5 CONVEYOR weighs and totalizes the tons of ore fed to the BALL MILL. A sample for ore moisture determination is composited and the moisture determined. The tonnage fed and the moisture content are used to determine the tons of dry ore fed to the milling operation.

The minus 1-inch ore reclaimed from the FINE ORE BIN must be reduced to a finer size to enable leaching solutions to contact and dissolve the uranium from the solids. The grinding circuit provides the size reduction necessary for acceptable recovery.

The fine ore (5 to 7 percent moisture) is fed into the BALL MILL where it is slurried with the CLASSIFIER underflow solids and the NEUTRAL THICKENER overflow solution. The rotation of the mill and the action of the ball charge in the mill grind the ore. The BALL MILL discharges minus 1/2-inch material to the CLASSIFIER. The larger particles settle and are augered out of the CLASSIFIER to be returned to the BALL MILL for further grinding. Sizing of particles in the CLASSIFIER is a function of the slurry density (or percent solids). The denser the slurry in the pool area of the CLASSIFIER, the larger will be the particles overflowing the weir to be pumped to the NEUTRAL THICKENER. The slurry density in the CLASSIFIER is adjusted by water addition to about 35 percent solids to maintain sizing at 5 percent or less 28-mesh particles. As this slurry density is too light for efficient leaching operations, the CLASSIFIER overflow is thickened in the NEUTRAL THICKENER to 55 to 60 percent solids. A flocculant is added at the NEUTRAL THICKENER feed launder to aid in settling of the fine particles. As the solids include very fine particles which settle very slowly, flocculant is added to the feed to the thickener. The flocculant, in effect, gathers many of the fine particles to produce a mass that settles rapidly. The solids settle to the bottom, are raked to the center, and are removed by a diaphragm pump. The slurry density of 55 to 60 percent solids is desirable for the LEACHING circuit and is controlled by the rate of pumping. The solution from the NEUTRAL THICKENER is returned to the GRINDING CIRCUIT.

LEACHING CIRCUIT

The underflow from the NEUTRAL THICKENER is sampled through a four-stage automatic sampling system before it is fed to the first of the seven (7) leach tanks. The sample obtained is prepared and analyzed to determine the feed grade (% uranium) each operating day. The calculated dry tons and the analyses are used in the metallurgical balance to determine the pounds of uranium contained in the tons of ore fed.

Reagents added to the LEACHING CIRCUIT to dissolve the uranium are sulfuric acid and sodium chlorate. Steam is added to heat the slurry and increase reaction speeds. Acid is added to the first tank to about pH 0.8. The amount of acid added is controlled to result in free (unreacted) acid concentration of 7 to 10 grams per liter in the final leach tank. The oxidizing agent, sodium chlorate, is added to the second leach tank to obtain an oxidation potential of approximately minus 420 millivolts in the final leach tank. The oxidizing acidic solution dissolves about 90 percent of the uranium values in the ore, producing uranyl sulfate in aqueous (water based) solution.

Particle size reduction and control of the leaching solution is critical to the overall uranium recovery. Once the solids leave the leaching circuit, further uranium extraction is negligible. The recovery hereafter is based on the uranyl sulfate recovered from the solution.

COUNTERCURRENT DECANTATION (CCD)

COUNTERCURRENT DECANTATION separates the leached solids from the solution and provides the feed solution to the SOLVENT EXTRACTION CIRCUIT where the uranium is concentrated. A CLARIFICATION CIRCUIT is required to remove suspended solids before the solution is fed to SOLVENT EXTRACTION.

COUNTERCURRENT DECANTATION (CCD) is the stagewise washing of the dissolved uranium values from the tailings solids in a series of THICKENERS. The Sherwood Mill utilizes six (6) 100-foot diameter THICKENERS in the CCD circuit. Washing is accomplished by mixing the slurry with solutions of progressively weaker uranium values. The solids settle, are removed, and are mixed with solutions of weaker value, and are pumped to the following THICKENER. The six THICKENERS of the CCD circuit are interconnected by pumps and piping in a manner to progressively move the solids from CCD THICKENER No. 1 towards and out of CCD THICKENER No. 6, and move the solution from CCD THICKENER No. 6 toward and out of CCD THICKENER No. 1.

The flow of solids through the CCD circuit is as follows: As the slurry leaves the final leach tank it is joined with the overflow solution from CCD THICKENER No. 2 and together are pumped to feed CCD THICKENER No. 1. The solids pumped from the bottom of CCD THICKENER No. 1 are joined by the overflow solution of CCD THICKENER No. 3 and together are pumped to feed CCD THICKENER No. 2. The solids mixed with advancing solutions progress in this manner through CCD THICKENER No.s 3, 4, 5, and 6, then to the NEUTRALIZATION TANK where the acid is neutralized before the tailings are pumped to the TAILINGS POND.

The flow of solutions through the CCD circuit is as follows: At the end of the CCD circuit, solution barren of uranium (raffinate) from the SOLVENT EXTRACTION CIRCUIT joins with the underflow solids from CCD THICKENER No. 5 and is fed to CCD THICKENER No. 6. The solution overflowing CCD THICKENER No. 6 proceeds up the circuit through CCD THICKENER No.s 5, 4, 3, 2, and 1. The concentration of uranium in solution is the lowest in the raffinate and becomes higher in uranium values as it progresses stagewise to CCD THICKENER NO. 1. The CLARIFICATION CIRCUIT removes the suspended solids from the solution which is then fed to the SOLVENT EXTRACTION CIRCUIT.

The underflow from each of the CCD thickeners is pumped out at 55 to 60 percent solids. The higher the percent solids, the more efficient is the washing of the dissolved uranium values from the tailings solids.

As the solids include very fine particles which settle very slowly, flocculant is added to the feed of each thickener. The amount of flocculant added to each thickener is controlled to maintain a depth of solution. The nearly clear solution overflows into a launder and then is pumped to the next stage.

The flocculant is purchased as a dry powder. The powder is carefully mixed in water for dissolution. The dissolved flocculant is further diluted and "aged" prior to use in the thickeners. Aging is the time needed for the flocculant to fully hydrate to obtain maximum effectiveness.

CLARIFICATION

The overflow solution from the No. 1 CCD THICKENER has the highest concentration of uranium in the CCD circuit and will be the feed to SOLVENT EXTRACTION. Before being fed to the SOLVENT EXTRACTION CIRCUIT suspended solids remaining in the THICKENER overflow solution must be removed. This solution contains from 100 to 200 ppm of suspended solids. The solution must be clarified to less than 10 ppm suspended solids to minimize problems in SOLVENT EXTRACTION.

Most of the suspended solids are removed by the cone shaped REACTOR CLARIFIER. The REACTOR CLARIFIER has a cylindrical base where the feed is introduced and a conical upper section where solids are removed by the flocculant and a suspended sludge layer. A flocculant is added to the No. 1 CCD THICKENER overflow and the solution is pumped tangentially into the cylindrical base. The solution thus pumped swirls in the clarifier which aids in flocculation of the particles. The swirling motion and the upward rise of solution suspends a moving bed of solids through which the solution is "filtered." The clear solution, generally less than 20 ppm suspended solids, overflows into a launder and out of the unit. If the suspended solids are less than 10 ppm, the overflow solution can flow directly to the clarified feed tank for SOLVENT EXTRACTION feed. When the suspended solids are greater than 10 ppm, the solution can be directed to the filter feed tank (unclarified surge tank) to be further clarified by filtration through the SAND FILTERS.

The suspended blanket of solids within the REACTOR CLARIFIER is collected in an interior cone which is piped for periodic or continuous removal of solids. Heavy solids or agglomerations which cannot be suspended are periodically removed from the cylindrical portion.

Solution from the unclarified surge tank is fed to the pressure filters (SAND FILTERS). The filters contain anthracite coal as the filter media which removes solids from the solution. The four (4) filters are automated to backwash when sufficient solids' loading causes a high differential pressure across the filter media.

The solids from the interior cone of the REACTOR-CLARIFIER and the solids flushed from the FILTERS by the backwash solution are combined with the leach discharge slurry and are returned to the CCD circuit. The solids progress through the CCD circuit and eventually report to tails.

The cone REACTOR-CLARIFIER and the pressure filters clarify solution fed to the SOLVENT EXTRACTON CIRCUIT.

SOLVENT EXTRACTION CIRCUIT

The SOLVENT EXTRACTION CIRCUIT is the portion of the mill designed to purify and concentrate the uranium. SOLVENT EXTRACTION is a two step operation, extraction and stripping. Extraction is done by chemical transfer of uranium from the aqueous feed solution to an amine in an organic solution. The transfer occurs when the aqueous feed solution is mixed with the organic mixture of a tertiary amine and isodecanol dissolved in a kerosene carrier. Extraction through four countercurrent stages removes in excess of 99-percent of the uranyl sulfate from the aqueous solution. The barren aqueous solution is called raffinate and is recycled to the CCD circuit for washing of the leached solids.

The organic from the first stage of extraction has the greatest concentration of uranium in the extraction process and is termed "loaded". The loaded organic is pumped to the water wash mixer-settler to remove entrained acidic solution. The washed loaded organic then progresses to the first of the four stripping stages where uranium is removed from the organic by mixing with an aqueous solution of ammonium sulfate. The pH of the ammonium sulfate solution is controlled to 4.0 to 4.2 by the addition of anhydrous ammonia to the mixer of No.s 1 and 2 strip units. The stripped organic (barren organic) can be pumped to the moly scrub unit or directly to the barren organic tank from which it is recycled to the extraction circuit to be loaded again.

The moly scrub mixer settler is used to remove interfering substances, such as molybdenum and humic acid, by mixing with sodium carbonate. These interferring substances on the organic decrease the loading capacity of the amine extractant. The scrub solution is pumped to CCD and then to tails. The moly scrub mixer-settler is generally by-passed as the interferring substances are not present in the ore to any great extent.

The ammonium sulfate solution from the strip circuit is termed pregnant aqueous when it leaves the No. 1 strip settler. The preg aqueous is pumped from the SOLVENT EXTRACTION area to the PRECIPITATION tanks.

PRECIPITATION, DRYING, AND PACKAGING

Anhydrous ammonia is added in the PRECIPITATION tanks to the pregnant strip solution from the SOLVENT EXTRACTION CIRCUIT. The ammonia is added to pH 5.2 in the first of the two PRECIPITATION tanks and to pH 7.0 in the second tank. The ammonia reacts with the uranyl sulfate in the solution to form ammonium diuranate, or yellowcake. The yellowcake is in the form of a fine solid. This is the first solid form of uranium since the uranium was in the unleached ore.

The yellowcake slurry overflows the No. 2 PRECIPITATION tank to the No. 1 YELLOWCAKE THICKENER. The solids settle to the bottom and the barren solution overflows into the launder then to the BARREN AQUEOUS TANK and is pumped to the stripping circuit of SOLVENT EXTRACTION. Excess Barren Aqueous is pumped to the LEACH CIRCUIT. The solids from the No. 1 YELLOWCAKE THICKENER are pumped to feed the No. 2 YELLOWCAKE THICKENER where they are joined with solution from the CENTRIFUGE (centrate). The solids from the No. 2 YELLOWCAKE THICKENER are pumped to a head tank which feeds the CENTRIFUGE. Water is added to the feed from the head tank to dilute the slurry fed to the CENTRIFUGE. The CENTRIFUGE solids are pumped to the ROASTER for drying and calcining. The countercurrent washing of the yellowcake is to reduce the amount of sulfates fed to the ROASTER.

Drying and calcining are done in a six-hearth ROASTER where the operating temperature is maintained at 1250 degrees F. in the sixth hearth. At this temperature, not only is the water driven off, but the ammonia and some of the sulfates are driven out of the yellowcake. The solids become a uranium oxide product which is almost black, but by historical use is still called YELLOWCAKE. The final concentrate at the Sherwood Mill is in excess of 90-percent U3O8.

The yellowcake from the ROASTER is crushed to powder in a hammer mill and is gravity fed to a surge bin. The yellowcake is fed from the surge bin to fill 55-gallon drums which are weighed, stenciled, and prepared for shipment. The finished drums are stored in a secured product storage yard to await shipment from the Sherwood Project.

NEUTRALIZATION AND TAILINGS

The solids from the underflow of the No. 6 CCD THICKENER contains acid solution. Milk-of-lime slurry is added to the NEUTRALIZATION TANK to neutralize the acid and precipitate most of the heavy metals from solution before the slurry is pumped to the TAILINGS POND. Milk-of-lime slurry addition is controlled to about pH 8 in the NEUTRALIZATION TANK discharge.

Water used in the operation to make up reagents, provide seal water to the pumps, and for washdown join the process flows and are processed through the SOLVENT EXTRACTION CIRCUIT. All the raffinate cannot be recycled to the CCD CIRCUIT and the neutralized tailings are discharged at high density, therefore, the excess raffinate is discharged to tails through a separate line. Milk-of-lime is pumped to neutralize the excess raffinate as it flows into the tailings pond.

The TAILINGS POND is lined with a reinforced Hypalon liner to prevent seepage of solutions into the ground. The main impoundment dam is located on the lower end of the tailings area and a SOLUTION HOLDING POND (also lined with Hypalon) is located on the upper end. Neutralized tailings are pumped at high density to minimize segregation of fine particles from the coarser sands. The slurry is pumped to various locations in the lined area where the solids build up and the solution drains away. The solution is pumped from the main impoundment area to the SOLUTION HOLDING POND. This removal of solution from the main impoundment helps to drain solution from the emplaced solids which assists in densifying the solids. The solution from the SOLUTION HOLDING POND is pumped back to the milling circuit where it is used in the grinding circuit and throughout the mill for pump seal water. Recycle of the tailings solution minimizes the amount of fresh water introduced into the circuit which is ultimately pumped to the tailings pond.

ANCILLARY UNITS

There are units that have a supporting function for the processing of the ore. These units are separate from the actual milling scheme but are essential to the proper operation of the various unit operations. The units and their functions are as follows:

1. BOILERS

The Sherwood Mill has three (3) boilers which supply steam to heat leach slurry, water for receiving sodium chlorate, buildings and offices, tracing for freeze protection, and for miscellaneous uses.

2. PROCESS WATER

The fresh water for the Sherwood Project is pumped in two stages from the Spokane River arm of Lake Roosevelt to the water storage tank. The water is pumped from the storage tank by centrifugal pumps to the process and for other uses throughout the property. A portion of the water is filtered and treated to be used as domestic water and further treated for boiler feed water.

The lower portion of the storage tank is reserved for fire protection. A jockey pump maintains pressure in the fire water system. When any part of the system loses pressure by use or leakage and the jockey pump cannot keep up with the loss of pressure, an electrically driven centrifugal pump will automatically start. This pump is sized to deliver up to 1000 gpm. If more water is needed or if there is a loss of power, a diesel driven pump will start to supply water to the fire water system.

3. COMPRESSORS

Air compressors provide pressurized air for use throughout the mill. Plant air is used to unload acid trucks, mix solutions, drive equipment, unplug ore or slurry stoppages, and for many other uses. The instrument air has the moisture removed so it can be used in instruments for such functions as to open and close valves throughout the mill.

4. AMMONIA VAPORIZER

Ammonia is used in the stripping circuit of solvent extraction and in the precipitation circuit. As the pressure of the ammonia decreases by high use or by cold weather, heat must be supplied to increase the pressure. The liquid ammonia is heated by the electric vaporizer located between the two ammonia storage tanks.

5. STORAGE TANKS

Large volumes of reagents and supplies are stored. The quantities stored allow for continuous operation during periods when supplies cannot be delivered due to road conditions or other supply problems. Bulk storage is provided for:

a) Sulfuric Acid

b) Sodium Chlorate

c) Ammonia

d) Lime

e) Fuel oil

f) Propane

The unit operations of the Sherwood mill are described separately in the following sections. It is intended that each section will be complete of itself to assist the operator in his/her duties and responsibilities in the unit operation. The operator may be required to refer to more than one section if the assigned duties extend into more than one area.

Check with supervision when questions arise, as your safety and the efficient operation of the mill are assured with understanding of the operation and the safety requirements of the job.

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RECORDS AND REPORTS MANAGEMENT BRANCH

ATTACHEMENT 6

10. Radiation safety program

Walk Through Inspections

Walk through inspections by the Radiation Safety Officer to observe general radiation control practices and review of required changes in the equipment, are deferred until milling operations resume. Radiological hazards are addressed by individual Radiation Work Permits issued by the RSO during the interim shutdown period.

QUALITY ASSURANCE PROGRAM

US NRC Regulatory Guide 4.15 "Quality Assurance For Radiological Monitoring Programs (Normal Operations) - Effluent Streams And The Environment".

SCOPE: Environmental Monitoring Program - Sampling, Sample Data

Management Structure

Management Responsibilities

Management of the Sherwood Project is responsible for the proper execution and overall quality of the environmental monitoring program by providing adequate staffing, equipment, training, budget and organizational support to this end. The primary front-line supervisor of the environmental monitoring program will be the Radiation Safety Officer (RSO).

Management will inform the RSO of all changes in licensure regarding all aspects of the environmental monitoring program. This shall include changes in license conditions, regulations, and any other pertinent information that has influence or impact on the environmental monitoring program.

The RSO will be responsible for implementing and conducting all environmental sampling programs. In addition, the RSO will integrate with management on items regarding changes in the environmental monitoring program due to changes in regulations or licensure.

The RSO shall be responsible for the timely collection and reporting of all environmental monitoring program samples. This includes: the timing, scheduling, preparation for and actual sample collection; sample preparation, packaging and shipping; contacting outside laboratories for assay services maintaining records of all samples shipped and assays for proper identification on assay reports; assuring adequate numbers of sample are split for duplicate analysis; reviewing assay reports for anomalous or spurious values; investigating anomalous or spurious values; posting assay data in permanent logbooks; reporting to management any noticeable or significant data or trends that may represent a potential excursion or exposure of radioactive materials outside the restricted area or in excess of previously observed values; propose and/or edit suggested corrective actions; integrate with management on corrective actions to be taken, where necessary, and see that these actions are carried out as planned and in compliance with applicable regualtions; evaluate subsequent data for indications of the efficacy of actions taken; reporting data in regularly scheduled environmental monitoring program reports;provide regulatory agencies with access to all data through audit process or in relation to deficiencies or items of non-compliance noted; continually evaluate the environmental monitoring program to assure compliance with applicable regulations.

Environmental Sample Quality Assurance

Aspects of quality assurance with regard to quality control of environmental sampling are incorprated into specific sampling procedures. Quality assurance of some samples depends on the analytical laboratory providing the service. Specifically, thermoluminescent dosimetry services providing environmental gamma exposure data and passive radon-222 gas detector services each have their own rigorous internal quality assurance programs. However, crosscheck sampling against these suppliers will be initiated should data begin to and consistently appear anomalous with regard to values reported or the error terms associated.

Quality Assurance Program : Environmental Monitoring Program

Quality Control In Sampling

Air Sampling

Radon-222 Gas Concentrations

Passive integrated samplers (track-etch type) are used to determine average quarterly radon-222 gas concentrations at six perimeter, two nearest residence and one control (background) station(s). Shipments of samplers in factory sealed aluminized plastic bags are recieved from the supplier just prior to the end of the quarter. New samplers are exchanged for exposed samplers at all stations on the same day. Exposed samplers are packaged as per manufacturers instructions and shipped the following day.

When data are recieved, the RSO reviews the data for spurious values, calculates the 2 sigma counting error from the provided one sigma error in percent of the average concentration and posts the data in the environmental monitoring logbook.

Direct Gamma Measurement

Thermoluminescent dosimeters (TLD's) with 5 calcium sulphate chips are used at six perimeter, two nearest residence and one control station(s)to determine quarterly direct gamma exposure rates. TLD shipments which include two shield control and two intransit TLD's are recieved prior to the end of the quarter. TLD's are exchanged at all stations on the same day and the exposed TLD's returned to the supplier the following day.

When data are recieved, the RSO calculates average daily exposure from the total quarterly exposure provided, reviews these data for spurious data and posts the data in the environmental monitoring logbook.

Air Particulates

Air particulate samples are collected on glass fiber filters composited quarterly for analysis. Continuous low volume samples are collected at three perimeter, two nearest residence and one control station(s).Eberline RAS-1 or RAP-1 samplers with 47 millimeter filter holders are used. Filters are changed weekly to prevent dust loading. Samplers are calibrated at the initiation and ending of each quarter using a dry test meter for ten minute calibrations. Adjustments are made, where necessary, to maintain flow rates at or just above thirty liters per minute. Quarterly sample volume is calculated from the average flow rate of pre- and post quarter calibrations and the time sampled.

High volume samples are collected twenty four hours per month at three perimeter stations and samples are collected on glass fiber filters composited quarterly for analysis. The high volume sampler is calibrated quarterly.

All air particulate samples are packaged along with sample volumes and an assay request and sent to the analytical laboratory within seven days of the end of the quarter.

When the data are recieved, the RSO reviews the data for spurious values and posts the data in the environmental monitoring logbook.

General Procedures for Air Sampling

For each quarter, all efforts should be made to exchange passive radon-222 samplers and TLD's and to perform calibrations to initiate the next quarter.

Water Sampling

Sample Collection Preparations

Sample collection preparations include arranging to have ground water monitoring wells bailed out twenty four hours prior to sampling, thoroughly washing well bailer, sample collection buckets and sample containers, calibrating (as per manufacturers specifications) the dissolved oxygen meter and the pH meter.

Sample Collection

Samples are to be drawn from each water sample site in an adequate volume for assay purposes including split or replicate samples. As samples are drawn, containers are rinsed with raw sample prior to filling. An aliquot is drawn for temperature, dissolved oxygen content, salinity and conductivity determination immediately after sampling. This aliquot is not saved. Prior to sampling the next site, all sampling equipment is thoroughly rinsed with distilled water; i.e. buckets, funnels, bailer, funnels.

Sample Preparations

Samples are brought to the lab for preparation for assay and pH determination. A small aliquot is drawn (approximately 50 milliliters) for pH determination. The pH probe is thoroughly rinsed between samples. The aliquot is not retained.

Filtering is done with a pressurized drum filter and 0.45 micron pore size filter membranes. All filtering apparatus is washed thoroughly and rinsed with disstilled water prior to filtering and rinsed thoroughly with distilled water between samples. Adequate sample must be filtered for analysis including split or replicate samples. Known sample volumes must be filtered for suspended fraction analyses. All sample containers must be identified by marking the sample location and date on the container. Precautions are taken when marking disguised split or replicate samples by recording separately the identity of the disguised samples.

All samples are filtered within twenty four hours of sampling. Aliquots for radionuclide analyses are acidified with nitric acid (concentrated reagent grade) to a pH less than two to prevent plating on container surfaces.

Samples are boxed along with assay requests and shipped to the analytical laboratory within thirty six hou of sampling.

Split sampling is done for each set of samples collected. At least ten percent is split for duplicate analysis. Represented in aplit samples are lake surface (both suspended and dissolved fractions), seep and both up and down gradient groundwater monitoring well samples.

When analytical reports are recieved, the RSO reviews the data for spurious values and enters the data in the environmental monitoring logbook.

Soil, Sediment, Vegetation and Fauna (fish) Sampling

Soil, sediment, vegetation and fauna (fish) sampling are conducted as per US NRC Regulatory Guide 4.14.

Soil and sediment samples are collected from the top 2 inches of the surface in a twelve by twelve inch area. The labelled samples are dried and screened. An aliquot is weighed out for each sample for analysis.

Vegetation and fish samples are collected, labelled, weighed, dried and reweighed for shipment to analytical laboratories.

Data Review

As data are recieved, the RSO reviews the data for spurious values. Comparisons are made to preoperational data (where available), operational data, control station data and maximum persmissible concentrations. Values that do not fall within error limits of previously observed values (the mean plus 3 standard deviations) or exceed maximum permissible concentrations are considered spurious. In such instances, an investigation is prompted which may include the following: notification of management, review of sampling procedures and preparations, interviewing laboratory personnel with regard to analytical procedures and calculations, resampling, additional split sampling, cross check sampling, notification of regulatory agency.

SHERWOOD MILL

RADIATION SURVEILLANCE

PROGRAM

Table 1

SUMMARY OF CURRENT AND PROPOSED SURVEY FREQUENCIES

Type of Survey	Type of Area[a]	Survey Frequency As Per NRC Regulatory Guide 8.30	Proposed Sampling Frequency
1. Uranium ore dust	Airborne radioactivity areas Other indoor process areas Outdoor areas	Weekly grab samples Monthly grab samples Quarterly grab samples	No routine sampling proposed[b]
2. Yellowcake	Airborne radioactivity areas Other indoor process areas Special maintenance involving high airborne concentrations of yellowcake	Weekly grab samples Monthly grab samples Extra breathing zone grab samples	No routine sampling proposed[b] See footnote (b) below
3. Radon daughters	Areas that exceed 0.08 working level Areas that exceed 0.03 working level Areas below 0.03 working level	Weekly radon daughter grab samples Monthly radon daughter grab samples Quarterly radon daughter grab samples	No routine sampling proposed[b]
4. External radiation: Gamma	Throughout mill Radiation areas	Semiannually Quarterly	Routine annual survey throughout mill[illegible]
Beta	Where workers are in close contact with yellowcake	Survey by operation done once plus whenever procedures change	(1) Survey by operation involving work with yellowcake in accordance with RWP[c] (2) Routine annual sampling propose
5. Surface contamination	Yellowcake areas Eating rooms, change rooms, control rooms, offices	Daily Weekly	No routine sampling proposed[c]
6. Skin and personal clothing	Yellowcake workers who shower Yellowcake workers who do not shower	Quarterly Each day before leaving	Monitoring will be performed only when employees perform work with yellowcake concentrate[b]
7. Equipment to be released	Equipment to be released that may be contaminated	Once before release	Once before release
8. Packages containing yellowcake	Packages	Spot check before release	Spot check before release
9. Ventilation	All areas with airborne radioactivity	Daily	No routine survey proposed[b](d)
10. Respirators	Respirator face pieces and hoods	Before reuse	Respirators will be used in accordance with the provisions of NRC Regulatory Guide 8.15[b]

Footnotes:

(a) Monitoring locations are specified in Section 6 of the June 23, 1976 WNI License Application as revised in December 1977.

(b) When any work activities are to be performed with equipment that routinely contains radioactive materials, a Radiation Work Permit (RWP) will be issued. Additional sampling, including sampling for airborne radioactive materials, external gamma exposure rates, external beta dose rates, and surface contamination will be performed where appropriate. Respirators will be used where appropriate in accordance with NRC Regulatory Guide 8.15.

(c) No routine sampling for surface contamination is proposed since resuspension of airborne radioactive materials has been virtually eliminated by removal of radioactive materials from the mill circuit. Again, surface contamination surveys will be performed when appropriate in accordance with issuance of a RWP.

(d) Active ventilation systems - i.e., scrubbers and baghouses are not operating. The building has been designed to provide several air exchanges per hour by passive mechanisms that cannot be monitored.

SHERWOOD PROJECT

RADIOACTIVE MATERIAL/RADIATION SAFETY AUDIT CHECKLIST

License Condition:

#1-9	----	Not applicable at this time
#10	----	Organizational chart as per 6/23/76
#11	----	Not applicable at this time
#12	----	Compliance with provisions of Chapter 402-24 WAC, 402-10 WAC, 402-12 WAC and 402-48 WAC concerning radiation protection standards, philosophy, general provisions and notices respectively.
#13	----	All entrances to mill property and mill building posted with words "Caution - any area or container within this area may contain radioactive material."
#14	----	Not Applicable at this time
#15	----	Superceded by #52 (amendment #9)
#16	----	Superceded by #52 (amendment #9)
#17	----	Release of mill equipment from restricted area in accordance with "guidelines for decontamination".
#18,#51	----	Respiratory protection program in accordance with Reg. Guide 8.15
	----	Allowance in dose calculations for proper respiratory use
#19	----	Superceded by Criteria 7
	----	Scrubber in drying and packaging area checked 2 times per shift with documentation per shift
	----	Scrubber fan checked and documented once per shift
#20	----	Urinalysis for all mill employees as per Reg. Guide 8.30
#21	----	Training
#22,#40	----	Effluent monitoring program as per Reg. Guide 4.14 (40CFR190)
	----	2 stacks, sampling semi-annually; analyzed for U-nat, Th-230, Ra-226, Pb-210
	----	Crusher, fine ore storage, reclaim tunnel, sampled semi-annually; analyzed for above parameters

#22,#40 continued......

pCi/l ---- 6 low volume locations, quarterly composite for Unat, Ra-226, Th-230, Pb-210

pCi/l ---- 3 high volume locations, quarterly composite for Unat, Ra-226, Th-230, Pb-210

pCi/l ---- Radon gas at nine (9) locations

pCi/l ---- soil annually at 9 locations; Unat,Ra-226, Th-230,Pb-210

pCi/l ---- 5 sediment locations sampled annually for Unat,Ra-226, Th-230, Pb-210

pCi/l ---- 7 groundwater locations supplied quarterly for dissolved Unat, Ra-226, Th-230, Pb-210

pCi/l ---- 4 springs sampled quarterly for above parameters

pCi/l ---- 3 surface water locations sampled quarterly for above parameters

pCi/l ---- 2 seepage water locations sampled monthly, analyzed quarterly for above paramenters, Quarterly Th-230

pCi/l ---- 3 crops sampled annually analyzed for Ra-226, Pb-210

pCi/l ---- 3 livestock sampled annually analyzed for Ra-226, Pb-210

pCi/l ---- fish sampled semi-annually for Ra-226, Pb-210

pCi/l ---- 3 locations for vegetation sampling; three times in growing season analyzed for above parameters

---- gamma 10 locations, quarterly (mrem/day)

---- land use survey conducted annually within 5 km

---- aerial photograph - annually

--- met. data, wind speed, direction continuously

---- tailings stabilization survey weekly

#23,#40 ---- RSO B. K. DeWaard

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#24 ---- deleted as per amendment 5

#25 ---- any unexpected adverse effects of operations; evaluate situation with plan of corrective action

#26 ---- mill tailings will not be transferred from site without approval

#27 ---- minimum of 5 feet of freeboard between top edge of tailings liner and tailings pond liquid throughout project life

---- minimum of 1 foot of freeboard any time

#28 ---- superceded by #50

#29 ---- interim stabilization program with SOP to minimize blowing tailings

---- daily inspection of tailings for blowing

#30 ---- control dusting from ore piles

#31 ---- no alteration in height, design of tailings without prior approval

---- construction, maintenance, operation of tailings system as represented in various documents (BIA, 1976; Dravo Report 1977; renewal, 1980)

#32 ---- tailings impoundment area reclaimed to meet long term physical stability and radon concentration of twice background

#33 ---- surety bond for tailings reclamation and decommissioning

#34 ---- decommissioning mill as per ANNEX A; 1000 dpm removable alpha/ 100 cm^2

---- RWP issued for maintenance and decommissioning of equipment in the mill

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#35 Documentation of:

---- sampling results

---- analyses

---- surveys and monitoring

---- calibrations

---- reports on audits and inspections

---- meetings and training

#36 ---- transportation of radioactive material off site subject to WAC 402-19-500 "Transportation"

#37 ---- annual radiation safety audit

---- review of radiation safety procedures

#38,#40,#22 deleted

#39 ---- use of radioactive material as per license as amended

#40 (22)(38) Radiological Effluent Monitoring

#41 ---- monitoring as per #40 effective as of 4/01/81

#42 ---- QA program as per Reg. Guide 4.15

---- split samples/duplicates

---- calibration of sampling equipment - semi-annual, prior to each use (file)

#43 ---- semi-annual radiological monitoring report by May 1 and November 1 for previous two quarters 7-12 and 1-6

#44 ---- (#22)

#45 ---- report due by May 1 shall include:

---- a) 40CFR190 compliance assessment based on land use survey, 12 month averages of data, dose assessments

---- corrective action taken, if necessary

---- b) results of land use survey with changes noted if appropriate

---- c) initial submittal of 2 copies of aerial photographs of mill site and large topographic maps with stations posted

---- d) trends in radiological monitoring data with graphs, calculations

#46 ---- ongoing data review program

---- comparison with predetermined control levels

---- any exceedance of control levels, not explained by common error, reported within 30 days with statement of corrective action

#47 ---- emergency response procedures for uncontrolled release and transportation

#48 ---- technical evaluations of impoundments as per Reg. Guide 3.11.1 by 2/15/84

#49 ---- submission of "as built construction plans" for PhaseII and Phase III of Sherwood Project tailings system

#50 Embankment Inspection Program

---- piezometer readings - graphic monthly

---- daily inspections

---- monthly inspection

---- quarterly inspection

---- annual technical evaluation

#51 ---- respiratory program

---- fitting, testing documentation

#52 Health Physics Monitoring in Mill

---- issuance of RWP for work that is routinely associated with radioactive material

---- if RWP used, additional sampling of air, surface contamination, gamma/beta dose rates will be conducted, <u>if appropriate</u>

---- annual gamma and beta survey throughout the mill

---- skin and personal clothing monitored if employees work with yellowcake concentrate

---- survey of equipment prior to release

---- spot check packages containing yellowcake prior to release

---- if as per RWP respirators required, respirators will be used as per Reg. Guide 8.15

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SHERWOOD PROJECT

SEALED SOURCE LICENSE CHECKLIST

#4 ---- Expiration date

#6 ---- 2 Cs-137 sources - used for density checks

#9 ---- used in Ohmart Source holders, Model SP-1

#14 ---- leak test every 36 months on surface of storage compartment

---- detection at 0.005 micro curies level

---- records maintained in micro curies

#18 ---- physical inventory every 6 months to account for all sealed sources - records kept 2 years including

---- kind and quantity

---- location

---- date of inventory

RADIATION WORK PERMIT ISSUANCE

Introduction:

A Radiation Work Permit (RWP) is to be issued when any non-routine maintenance or repair activities are performed; whenever a vessel, tank or other enclosed structure which has contained radioactive materials is to be entered; whenever a maintenance activity could result in an individual's exposure based on a time weighted average in excess of 25% of MPC; or for any work or maintenance for which there is no effective operating procedure.

The RWP must contain information pertaining to all precautions taken before, during and after completing the maintenance activity.

Reference shall also be made to all surveys conducted before or during the time the maintenance is in progress.

Please note: All RWP's are issued as a minimum standard toward radiation protection during non-routine maintenance activities. Input regarding all hazards (especially radiation related) is encouraged from maintenance personnel.

RWP's are issued as a method of controlling and maintaining exposures ALARA and are, as the word "Permit" implies, a release to maintenance personnel allowing them to perform an activity. Caution must, therefore, be taken to ensure that a license or safety requirement is not overlooked at the time of issuance. Ascertaining when RWP's are needed is not, in some cases, easily discernable. The policy concerning RWP issuance will be one of requiring the maintenance department to inquire before proceeding with a job unless it is obviously routine, no radiation hazards exist, or written operating procedures exist, (see the operation's manual under "Maintenance").

As RWP's are issued, a list of areas where RWP's are required, accessory equipment and associated safety requirements will be compiled and thus provide some assurance that nothing has been overlooked. A radiation safety technician will observe the proposed work area and conduct any surveys required before and during the maintenance operation.

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RWP REQUIREMENTS

RWP's will be required for all maintenance activity from which an unprotected exposure (to combined dust and radon, soluble uranium dust, or beta, gamma) could reasonable be expected to expose individuals to doses greater than 25% of MPC for dust and 556 mRem for beta or 100 mRem for gamma. In addition, RWP's will be issued without exception for all entries into vessels, tanks or other enclosed structures which have contained ore or uranium bearing solutions and all yellowcake packaging and drying system maintenance.

Precautions must be taken to limit possible skin absorbtion and offsite contamination in addition to respiratory equipment requirements. Therefore, any or all of the following equipment and/or precautions must be used while work is performed under a RWP:

Urine Sample Bottles
Gloves (rubber)
Boots (rubber)
Hard Hat
Safety Glasses
Full Face Respirator
Half Mask Respirator
Air Powered Respirator
Coverall
Impermeable Disposable Coverall
Shower
Impermeable Hood
High Efficiency Vacuum Cleaner
Wilson Air Supplied Full Face or Half Mask Respirator
Taped Clothing
Regular Coveralls
Self-Contained Breathing Apparatus
Lapel Sampler
TLD Badge
Ring or Extremity TLD Badge

Individuals who are involved in the maintenance activity must receive instruction concerning precautions and read and sign the RWP when it is issued. Employees who refuse to sign the permit will not be allowed to work on the project and further, a refusal to sign the permit will constitute a refusal to do the work for which appropriate disciplinary action will be taken. The Radiation Safety Department must also be notified when the work begins and when the work is completed.

Work activities under an RWP will be discontinued if the RWP requirements are not being met and will not be started again until they are met.

The Radiation Safety Officer or his designate will walk through the Mill at least twice daily to ensure that that no activity which would require RWP's is being conducted out of compliance.

All tanks must be ventilated before entry.

Everyone involved in yellowcake circuit maintenance activity must give a urine sample within forty-eight (48) hours.

Types of Hazards and Protection Required:

Radiation hazards requiring special RWP protection can be grouped into three basic types:

1. External Radiation Exposure
2. Internal Radiation Exposure
3. Surface Contamination and Skin Absorption

1. External Radiation Exposure:

External radiation comes from either gamma or beta sources.

Gamma radiation associated with natural uranium comes primarily from Ra-226. Thus all surfaces and filters within the milling circuit where radium gamma exceeds 2.5 mR/hr. must be controlled so an employee will not receive an exposure in excess of 1.2 Rem/per quarter. Radium is selectively absorbed in some elemental carbon products and on to some types of rubbers and is also precipitated with calcium carbonate and calcium sulfate precipitates.

Beta radiation is emitted primarily from protactinium-234 (a short lived uranium daughter). Beta radiation only becomes a problem in areas where concentrated uranium is allowed to build up for long periods of time. Beta dose to the skin is limited to 14 mR/hr. for continuous exposure from the beta emitted by Pa-234. Safety glasses must be worn at all times since the eye is the limiting organ of the body for exposure to beta radiation at 1.25 rem per quarter. Safety glasses effectively shield beta exposure to the eye.

2. Internal Radiation Exposure:

It is quite important that radon daughter and uranium dust levels be estimated before a maintenance task is performed so that the proper type of respiratory protection is chosen. If there is a doubt concerning dust or radon levels to be encountered in the activity the RWP covers, an air powered or air supplied respirator with either a half or full face mask shall be used. An air supplied respirator with a full face mask must be used in areas where there is a high uranium dust and ammonia or acid fume concentration. Keeping work areas wet, if feasible will reduce dust problems significantly.

Urine samples must be taken within forty-eight (48) hours of a RWP maintenance activity performed in a soluble uranium area and forty-eight (48) hours after each day a respirator was checked out for RWP's in soluble uranium areas.

3. Surface Contamination and Skin Absorption:

Uranium (in the oxide or ammonia salt) tends to be very mobile and is freely picked up and transported through smoking, chewing tobacco, eating on contaminated surfaces, through personal hygiene and skin absorption. Precautions should therefore be taken to eliminate all contact with soluble yellowcake on internal and external body surfaces.

When working in a tank which contains or has contained soluble concentrated uranium, individuals must wear rubber gloves and impermeable disposable coveralls. In addition, a full face mask respirator must be worn in order to protect the face from splashing and an impermeable disposable hood to protect the rest of the head and neck areas.

Welding on surfaces which are contaminated with uranium presents a special problem since the uranium could be vaporized and inhaled. Welding operations on contaminated surfaces will require an RWP and an air powered respirator.

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RWP SURVEYS:

Surveys for RWP activities shall be conducted in such a manner as to prrtect the maintenance crew from any type of radiation hazard (internal or external) above 25% of MPC and shall include, but not be limited to lapel samples for dust, gamma and beta measurement and radon daughter measurement (before entry into a vessel, tank, etc.).

In addition to the minimum requirments, both beta and gamma radiation should be measured inside all vessels containing concentrated uranium. Area dust samples may also be required.

SUMMARY:

If in doubt as to the need for a RWP during any maintenance activity, ask a member of the Radiation Safety staff.

All individuals involved in the activity must read and sign the RWP.

All stipulations or precautions listed must be adhered to.

A thorough inspection of the work area must be made prior to starting the RWP activity.

Care must be taken to avoid omission of important protective equipment or precautions when issuing the RWP.

RADIATION WORK PERMIT

00029

Date & Time Started: ____________________

Date & Time Completed ____________________

Work Location: ____________________

Nature of Work To Be Performed: ____________________

____

____

Protective Equipment Issued: ____________________

____

Record of Radiation Surveys Performed Prior To and During Maintenance Activity: ____________________

____

____

____

Precautions To Be Taken During Maintenance Activity: ____________________

____

____

____

Comments: ____________________

____

____

I (We) understand the hazards involved and the precautions to be observed while performing the above operation:

____________ ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

The individuals listed above have been cleared by the Radiation Safety Officer or his designate to perform the maintenance activity at the listed location.

____________________ ____________ ____________

Radiation Safety Officer — Date — Time

NON-ROUTINE MAINTENANCE PERMIT

Location of Maintenance: Date:
Type of Maintenance:
Approximate Length of Time Job Will Take:
Name of Individual(s):

I. Radiological Hazards
   A. Inhalation of airborne particulates
   B. Ingestion of uranium particulates
   C. Exposure of skin to uranium particulates

II. Precautions To Be Taken
   A. Care, use and fitting of respirator
   B. Protective clothing to include coveralls, gloves, hard hat and safety glasses
   C. Respirator and protective clothing must be worn at all times while working in the dusty area. You are advised that you may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions or any other condition that might require such relief (NU-REG-0041, Section 2.2)
   D. Personal Hygiene
      1. Employees must be clean shaven
      2. Employees must wash before eating
      3. Employees must remove coveralls and shower before leaving the Mill area
   E. To keep dust down, area should be sprayed frequently when possible with fine water mist

III. General
   A. Work from top of the equipment to the bottom when cleaning
   B. When cleaning, make every effort to keep dust at a minimum
   C. The Safety Department will monitor your exposure by taking grab samples. Your exposure may also be monitored by placing a constant air flow sampler on you which you will wear until your task is finished. At any time physical (dust) conditions or the results of the grab samples indicate a possible overexposure you may be asked to leave the area until a full exposure evaluation is made. You are not to re-enter the area until authorized by the Safety Department.
   D. When clean up or maintenance is finished, remove coveralls and wash boots before leaving the area and report to the Safety Department for removal of monitoring equipment, return of respirator and verification of time spent in area.
   E. Clean up the area when the job is finished, put away all equipment and tools.
   F. Coveralls will be washed and dryed and returned to the Radiation Safety Office.

IV. Bioassay
   A. When a respirator is used, a urine sample will be submitted 48 hours after completion of the non-routine maintenance.

V. I certify that I have received these instructions and fully undertand them.

   Signature: ______________________________

   The above individual(s) has been instructed as per letter and is cleared through the Safety Department to perform the task so stated.

____
Radiation Safety Officer

Non-Routine Maintenance
Checklist

1) Date: ____________________

2) Personnel performing maintenance: ______________________________

3) Maintenance to be performed: ______________________________

(completed authorized initials)

4) ____________ NRM Instruction Form signed.

5) ____________ Lapel Sampler(s) issued.

6) ____________ Insure proper protective gear being worn.

7) ____________ Dust samples completed

8) ____________ Radon daughter sample collected (optional)

9) ____________ Maintenance completed? ________ yes ________ no

10) ____________ Prepare filters for analysis

11) ____________ Collect urine sample 48 hrs. later.

12) ____________ Prepare time study form.

Filter ID	Time Start	Time Stop	ugm/filter	Dust ugm/ml$\times 10^{-11}$	Urine ugU_3O_8/lit

Repirator Worn: ☐ ½ face
☐ full face
☐ ½ face (air powered)
☐ full face (air powered)

WESTERN NUCLEAR, INC.
Sherwood Project

RESPIRATOR CHECK OUT LOG

I, ______________________ have checked out the following respirator:
(print name)

#_____ Half-Face #_____ Full-Face Cartridge Type: H GMB GMC GMC-S GMD
(Circle one, Other?_____)

Powered Air Purifying: #_______Half-Face #_______Full-Face

In-Plant Air Supplied: #_______Half-Face #_______Full-Face

To assure proper respirator protection:

1.) I have inspected this respirator for possible defects such as missing or broken parts or tears in the rubber facepiece.

2.) I shaved just prior to coming to work.

3.) To the best of my knowledge, I have no medical condition which prevents me from wearing a respirator.

4.) My last respirator training and fitting was not more than one year ago. (Date of last respirator training and fitting:_______________)

5.) I was smoke tested while wearing this respirator to make sure a proper fit could be obtained. (Smoke tested by: Signed_______________)

6.) I will perform the positive and negative pressure tests on this respirator each time I put it on to make sure a good skin to facepiece seal is obtaine and all valves operate correctly.

7.) I will use this respirator for only one shift and return it to the Radiatio Safety Office at the end of this shift.(Return date_______________

8.) I have obtained a non-routine maintenance permit from the Radiation Safety Office. (Only if non-routine maintenance is to be performed.)

I have read the above and understand that these conditions are for my protection.

Signed:______________________ Date:_______________

Type of work performed while wearing the respirator: OPERATIONS_________

MAINTENANCE: PREVENTATIVE_____

NON-ROUTINE_____

Estimate as close as possible, the amount of time spent in respirator usage areas:

M-14 - YC Centrifuge, top floor _______________

M-15 - YC Drier, hammermill level _______________

M-16 - Roaster Scrubber, 2nd from top _______________

M-17 - Packaging Area, bottom floor _______________

Other Areas; describe briefly _______________

____

Radiation Safety Office Checklist: Respirator returned?_____

Exposures calculated?_____

NRM form complete?_____ _______________

RADON DAUGHTERS

Discussion:

The "Maximum Permissible Concentration" (MPC) of Radon-222 and its daughters of air is 0.33 (1/3) working level, where:

One (1) working level is defined as any combination of short lived Rn-222 daughters in one liter of air, without regard to equilibrium, that emits 1.3×10^5 Mev of alpha particle energy. No worker is allowed to work in an environment that contains more than 0.33 working levels of Radon Daughters without respiratory protection equipment.

The "Standards For Protection Against Radiation", (NRC; 10CFR20) state that time weighted exposure records will be kept of all radon daughter exposures that exceed 25% of MPC; thus by law we must keep records of radon daughter concentrations in all areas where a worker could breathe an atmosphere that contains more than 25% of the MPC for radon daughters (0.08 working levels), or a combination of radon daughters and insoluble uranium dust that exceeds 25% of MPC. (To calculate the combined dust and radon exposure, calculate the percent MPC of radon daughters present and the percent MPC of insoluble uranium dust, and add the two percentages.)

Radon daughters are a series of four short-lived decay products, which, upon decay from Radon-222, become radioactive metal particulates (Po-218, Pb-214, Bi-214, and Po-214). Radon daughters are analyzed by drawing a known volume of air through a 2.5cm fiberglass filter. The metal particulates accumulate on the filter which is then analyzed after 40 to 90 minutes for alpha activity. This is known as the modified Kusnetz Technique of radon daughter measurement.

Equipment:

1. Stop Watch
2. MSA Model S Portable Pump
3. Battery Charger
4. Screwdriver
5. Gelman Type AE Fiberglass Filters (2.5cm)
6. Filter holders (2.5cm) with tubing connectors
7. Filter holder caps
8. Certified (National Bureau of Standard Traceable) alpha
9. Eberline PS-2-2 scaler and SPA-1 alpha scintillation detector
10. Bubble tube, one (1) liter
11. Legally bound log book
12. Notepad and data sheet(s)

Procedure:

1. Calibrate sampling pump as outlined in GRAB SAMPLING pump calibration.

2. Check PS-2-2 and SPA-1 detector function with alpha source and record in log book: Instrument ID, check source type and strength, calibration certificate source reading, observed reading, initials, date and battery function indication.

3. Prepare filters and holders. Open empty filter holder and place a 2.5cm glass fiber filter with the smooth "patterned" side towards the support screen. Replace filter cap and tighten. Cover filter cap with a labeled "cap plug".

4. Five minute samples are to be taken. Samples are grouped by location for filter self-absorbancy calculations. Thus, sample a group, and count them.

5. While sampling, indicate on filter "cap plug" label the station ID and on a note pad along with date and initials record the station ID, and sample <u>start</u> and <u>end</u> times. Also, note the state of equipment operation in the vicinity (especially ventilation equipment).

6. To count samples, obtain "RADON WORKING LEVEL CALCULATIONS" data sheet (attached), fill in the appropriate information regarding count instrument date for the area samples taken.

7. Open a filter holder and <u>with tweezer</u>, place the filter into the SPA-1 detector with the side facing the air while sampling, up.

8. Count the sample for two (2) minutes beginning 40 - 90 minutes after sampling. While counting enter the appropriate sample data onto the data sheets: i.e., sample stop time, count time, minutes counted, pump flow volume in (5) minutes, meter factor which is the inverse of the instrument efficiency (1/instrument efficiency).

9. Determine the radon daughter working level calculation time factor from the table, calculating the interval from stop sample time to midpoint of the count time, in minutes.

10. For all sample groups obtain all samples and their identity for filter self absorbtion correction factors (SACF).

11. After counting all group samples and prior to the end of the 90 minute period, for any of the samples, select the highest counting sample and recount the filter as per the top of the data sheet.

12. Enter the appropriate data into the formula and calculate the SACF; enter this factor into the calculation for all samples within that group only.

13. <u>Calculate the radon daughter working levels for each sample.</u>

WESTERN NUCLEAR, INC.
Sherwood Project

Mo.______________ Yr.______

RADON DAUGHTER WORKING LEVEL CALCULATIONS

Fiber filter self-absorption correction factor (SACF).

C_1 = cpm - topside of filter

C_2 = cpm - bottomside of filter

C_3 = cpm - topside of filter covered with unused filter

$$\% \text{ SACF} = \frac{C_2 - C_3}{2C_1 + C_2 - C_3} \times 100$$

---

1. OUTSIDE AREAS - Count Instr. ID______________________ Calib. Date__________

Sampling Date______________ SACF Sample: M-______

$$\text{SACF} = \frac{(\quad) - (\quad)}{2(\quad) + (\quad) - (\quad)} = \_\_\_\_\_\_\_\_$$

M- 1 Pump#____ Count :#________

Sample: Stop Time______ :Min.____ $WL = \frac{CPM}{\frac{\ell}{5 \text{ min}}} \times \frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

: Count Time______ :Int.____

Mill Status: ______________________________

M- 3 Pump#____ Count :#________

Sample: Stop Time______ :Min.____ $WL = \frac{CPM}{\frac{\ell}{5 \text{ min}}} \times \frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

: Count Time______ :Int.____

Mill Status: ______________________________

M- 9 Pump#____ Count :#________

Sample: Stop Time______ :Min.____ $WL = \frac{CPM}{\frac{\ell}{5 \text{ min}}} \times \frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

: Count Time______ :Int.____

Mill Status: ______________________________

M-18 Pump#____ Count :#________

Sample: Stop Time______ :Min.____ $WL = \frac{CPM}{\frac{\ell}{5 \text{ min}}} \times \frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

: Count Time______ :Int.____

Mill Status: ______________________________

M-27 Pump#____ Count :#________

Sample: Stop Time______ :Min.____ $WL = \frac{CPM}{\frac{\ell}{5 \text{ min}}} \times \frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

: Count Time______ :Int.____

Mill Status: ______________________________

M-28 Pump#____ Count :#________

Sample: Stop Time______ :Min______ $WL = \frac{CPM}{\frac{\ell}{5 \text{ min}}} \times \frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

: Count Time______ :Int______

Mill Status: ______________________________

M-40 Pump#____ Count :#________

Sample: Stop Time______ :Min______ $WL = \frac{CPM}{\frac{\ell}{5 \text{ min}}} \times \frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

: Count Time______ :Int______

Mill Status: ______________________________

M-41 Pump#____ Count :#________

Sample: Stop Time______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

: Count Time______ :Int______

Mill Status: ____

M-42 Pump#____ Count :#________

Sample: Stop Time______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

: Count Time______ :Int______

Mill Status: ____

---

2. LAB/ADMIN - Count Instr. ID______________________________ Calib. Date__________

Sampling Date________________ SACF Sample: M-________

$$SACF = \frac{(\quad) - (\quad)}{2(\quad) + (\quad) - (\quad)} = \_\_\_\_\_\_\_\_\_\_$$

M-19 Pump#____ Count :#________

Sample: Stop Time______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

: Count Time______ :Int______

Mill Status: ____

M-20 Pump#____ Count :#________

Sample: Stop Time______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

: Count Time______ :Int______

Mill Status: ____

M-21 Pump#____ Count :#________

Sample: Stop Time______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

: Count Time______ :Int______

Mill Status: ____

M-22 Pump#____ Count :#________

Sample: Stop Time______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

: Count Time______ :Int______

Mill Status: ____

M-23 Pump#____ Count :#________

Sample: Stop Time______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

: Count Time______ :Int______

Mill Status: ____

2. LAB/ADMIN, CONT'D

M-29 Pump#____ Count :#________
Sample: Stop Time________ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{METER\ FACTOR}{GRAPH\ FACTOR}$ X $\frac{1}{1-(\quad)}$ = ________
: Count Time________ :Int______
Mill Status: ________________________________

M-30 Pump#____ Count :#________
Sample: Stop Time________ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{METER\ FACTOR}{GRAPH\ FACTOR}$ X $\frac{1}{1-(\quad)}$ = ________
:Count Time________ :Int______
Mill Status: ________________________________

M-36 Pump#____ Count :#________
Sample: Stop Time________ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{METER\ FACTOR}{GRAPH\ FACTOR}$ X $\frac{1}{1-(\quad)}$ = ________
:Count Time________ :Int______
Mill Status: ________________________________

3. CRUSHER BLDG. - Count Instr. ID____________________ Calib. Date________
Sampling Date______________ SACF Sample: M-______

$$SACF = \frac{(\quad)-(\quad)}{2(\quad)+(\quad)-(\quad)} = \_\_\_\_\_\_$$

M- 2 Pump#____ Count :#________
Sample: Stop Time________ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{METER\ FACTOR}{GRAPH\ FACTOR}$ X $\frac{1}{1-(\quad)}$ = ________
:Count Time________ :Int______
Mill Status: ________________________________

M-31 Pump#____ Count :#________
Sample: Stop Time________ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{METER\ FACTOR}{GRAPH\ FACTOR}$ X $\frac{1}{1-(\quad)}$ = ________
:Count Time________ :Int______
Mill Status: ________________________________

M-44 Pump#____ Count :#________
Sample: Stop Time________ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{METER\ FACTOR}{GRAPH\ FACTOR}$ X $\frac{1}{1-(\quad)}$ = ________
:Count Time________ :Int______
Mill Status: ________________________________

4. GRIND CIRCUIT - Count Instr. ID____________________ Calib. Date________
Sampling Date______________ SACF Sample: M-______

$$SACF = \frac{(\quad)-(\quad)}{2(\quad)+(\quad)-(\quad)} = \_\_\_\_\_\_$$

M- 5 Pump#____ Count :#________
Sample: Stop Time________ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{METER\ FACTOR}{GRAPH\ FACTOR}$ X $\frac{1}{1-(\quad)}$ = ________
:Count Time________ :Int______
Mill Status: ________________________________

M-32 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

:Count Time_______ :Int______

Mill Status: ____

M-33 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

:Count Time_______ :Int______

Mill Status: ____

M-43 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

:Count Time_______ :Int______

Mill Status: ____

---

5. NEUT. THICK., CCD #2 - Count Instr. ID______________________Calib. Date________

Sampling Date______________SACF Sample: M-_______

$$SACF = \frac{(\quad)-(\quad)}{2(\quad)=(\quad)-(\quad)} = \_\_\_\_\_\_\_\_$$

M-38 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

:Count Time_______ :Int______

Mill Status: ____

M-39 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

:Count Time_______ :Int______

Mill Status: ____

---

6. CCD CIRCUIT, CCD #1 - Count Instr. ID______________________Calib. Date________

Sampling Date______________SACF Sample: M-_______

$$SACF = \frac{(\quad)-(\quad)}{2(\quad)+(\quad)-(\quad)} = \_\_\_\_\_\_\_\_$$

M-8 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

:Count Time_______ :Int______

Mill Status: ____

M-10 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min______ WL = $\frac{CPM}{\frac{\ell}{5\ min}}$ X $\frac{\text{METER FACTOR}}{\text{GRAPH FACTOR}}$ X $\frac{1}{1-(\quad)}$ = __________

:Count Time_______ :Int______

Mill Status: ____

---

7. LEACH CIRCUIT - Count Instr. ID__________ __________ Calib. Date________

Sampling Date________ ________ SACF Sample: M-____

$$SACF = \frac{(\quad)-(\quad)}{2(\quad)+(\quad)-(\quad)} = \_\_\_\_\_\_$$

M- 6 Pump#_____ Count :#______

Sample: Stop Time______ :Min______ $WL = \frac{CPM}{\frac{\ell}{5\ min}} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

:Count Time______ :Int______

Mill Status: ____________________

M- 7 Pump#_____ Count :#______

Sample: Stop Time______ :Min______ $WL = \frac{CPM}{\frac{\ell}{5\ min}} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

:Count Time______ :Int______

Mill Status: ____________________

M-34 Pump#_____ Count :#______

Sample: Stop Time______ :Min______ $WL = \frac{CPM}{\frac{\ell}{5\ min}} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

:Count Time______ :Int______

Mill Status: ____________________

M-35 Pump#_____ Count :#______

Sample: Stop Time______ :Min______ $WL = \frac{CPM}{\frac{\ell}{5\ min}} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

:Count Time______ :Int______

Mill Status: ____________________

---

8. SX CIRCUIT - Count Instr. ID____________________ Calib. Date________

Sampling Date____________ SACF Sample: M-____

$$SACF = \frac{(\quad)-(\quad)}{2(\quad)+(\quad)-(\quad)} = \_\_\_\_\_\_$$

M-26 Pump#_____ Count :#______

Sample: Stop Time______ :Min______ $WL = \frac{CPM}{\frac{\ell}{5\ min}} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

:Count Time______ :Int______

Mill Status: ____________________

M-37 Pump#_____ Count :#______

Sample: Stop Time______ :Min______ $WL = \frac{CPM}{\frac{\ell}{5\ min}} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_$

:Count Time______ :Int______

Mill Status: ____________________

---

9. PRECIP. CIRCUIT - Count Instr. ID____________________ Calib. Date________

Sampling Date____________ SACF Sample: M-____

$$SACF = \frac{(\quad)-(\quad)}{2(\quad)+(\quad)-(\quad)} = \_\_\_\_\_\_$$

9. PRECIP. CIRCUIT, CONT'D

M-11 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min_____ $WL = \frac{\frac{CPM}{\ell}}{5\ min} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} =$ _______

:Count Time_______ :Int_____

Mill Status: ________________________________

M-12 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min_____ $WL = \frac{\frac{CPM}{\ell}}{5\ min} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} =$ _______

:Count Time_______ :Int_____

Mill Status: ________________________________

M-13 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min_____ $WL = \frac{\frac{CPM}{\ell}}{5\ min} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} =$ _______

:Count Time_______ :Int_____

Mill Status: ________________________________

---

10. ROASTER/PACKAGING - Count Instr. ID________________ Calib. Date________

Sampling Date________________ SACF Sample: M-__________

$SACF = \frac{(\quad)-(\quad)}{2(\quad)+(\quad)-(\quad)} =$ __________

M-14 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min_____ $WL = \frac{\frac{CPM}{\ell}}{5\ min} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} =$ _______

:Count Time_______ :Int_____

Mill Status: ________________________________

M-15 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min_____ $WL = \frac{\frac{CPM}{\ell}}{5\ min} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} =$ _______

:Count Time_______ :Int_____

Mill Status: ________________________________

M-16 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min_____ $WL = \frac{\frac{CPM}{\ell}}{5\ min} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} =$ _______

:Count Time_______ :Int_____

Mill Status: ________________________________

M-17 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min_____ $WL = \frac{\frac{CPM}{\ell}}{5\ min} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} =$ _______

:Count Time_______ :Int_____

Mill Status: ________________________________

---

11. SHOPS - Count Instr. ID______________________________Calib. Date__________

Sampling Date____________________SACF Sample: M-________

$$SACF = \frac{(\quad)-(\quad)}{2(\quad)+(\quad)-(\quad)} = \_\_\_\_\_\_\_\_\_\_$$

M-24 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min_____

:Count Time_______ :Int_____

$$WL = \frac{CPM}{\frac{\ell}{5\ min}} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_\_\_$$

Mill Status: ____

M-25 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min_____

:Count Time_______ :Int_____

$$WL = \frac{CPM}{\frac{\ell}{5\ min}} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_\_\_$$

Mill Status: ____

---

12. RECLAIM TUNNEL - Count Instr. ID______________________Calib. Date__________

Sampling Date____________________SACF Sample: M-_____

$$SACF = \frac{(\quad)-(\quad)}{2(\quad)+(\quad)-(\quad)} = \_\_\_\_\_\_\_\_\_\_$$

M- 4 Pump#_____ Count :#_______

Sample: Stop Time_______ :Min_____

:Count Time_______ :Int_____

$$WL = \frac{CPM}{\frac{\ell}{5\ min}} \times \frac{METER\ FACTOR}{GRAPH\ FACTOR} \times \frac{1}{1-(\quad)} = \_\_\_\_\_\_\_\_$$

Mill Status: ____

URANIUM DUST GRAB SAMPLING

DISCUSSION:

Natural uranium is a poisonous heavy metal, and a low specific activity (LSA) radiologic hazard. Federal law requires that uranium milling operations maintain strict control over the amount of uranium bearing dust to which workers are exposed.

Various stages of the milling process produce uranium dust of differing chemical composition and solubility. Classification of this dust into soluble or insoluble categories (for the purpose of radiologic control) is based upon the way in which uranium compounds react with body fluids and tissue.

Soluble uranium dust is defined as any airborne uranium mists or particulates which, after ingestion into the body, (primarily into the lungs since uranium compounds are very poorly absorbed by the digestive system) have a biological lung half life of ten (10) days or less. With regard to milling uranium ore, uranium is considered to be in its soluble form from the leach circuit until it is dried at temperatures above four hundred degrees centigrade (400°C).

Insoluble uranium compounds are composed of natural uranium ore dust and "yellow cake" concentrates which, when dried at temperatures above four hundred degrees centigrade (400°C), become relatively insoluble to dissolution by body fluids. The biological lung half life of insoluble uranium is greater than ten (10) days.

The Nuclear Regulatory Commissions', "Standards For Protection Against Radiation", set the limit of exposure from airborne soluble uranium compounds to a "Maximum Permissable (sustained) Concentration" (MPC) of $10uCix10^{-11}$/ml of air during a forty (40) hour work week, or a maximum of 9.6 milli-grams per week ingested into the lungs. While the contribution of soluble uranium dust to the bodies radiation exposure is negligible, the rapid elimination of uranium through body waste which is processed by the kidneys can cause kidney damage. Thus, soluble uranium dust exposure is calculated separately from insoluble uranium dust exposure.

Insoluble uranium ore dust consists of U-238 and certain concentrations of its' daughter products (Th-230, Ra-226 & U-234). Since ore dust is made up of several alpha emitters, when uranium alone is assayed the MPC for a 520 hour work quarter is $5uCix10^{-11}$/ml of air, but when gross alpha is measured the MPC for a 520 hour work quarter is $10uCix10^{-11}$/ml. (The reason the MPC is lower when only uranium is assayed is that a uranium assay doesn't measure the entire concentration of alpha emitters.) The MPC for uranium product dried at temperatures above 400°C is $10uCix10^{-11}$/ml for a 520 hour work quarter.

Respiratory protection is required whenever a chance exists that someone could be exposed to greater than MPC levels of airborne radiation.

When grab samples are taken, a known volume of air is drawn through a fiber glass filter for a predetermined amount of time. The filter is then analyzed for either gross alpha or total uranium.

A1: URANIUM DUST SAMPLING

1. Sampling Pump Calibration

   A. Make sure pump battery pack(s) have been charged at least 24 hours prior to using them.

   B. For RAC pumps, plug pump into battery pack. Staplex pumps have battery packs enclosed.

   C. Connect pump inlet tube to dry test meter (Singer DTM-200) with white nylon hose coupling.

   D. Set dry test meter guages to zero except for the large dial, set this dial between 9.7 and 9.9.

   E. Start pump, then start stop watch as dial passes zero.

   F. Time pump for 5 minutes minimum. When stopwatch is just about to the selected stop time, grasp each half of the nylon hose coupler and with a quick twist and pull disconnect the coupler as the stop time is reached.

   G. Record the following information in the Air Sampler Calibration Logbook.

      1. Pump ID., eg. RAC #4
      2. Air volume indicated on dry test meter in liters (l), eg. 55.5 l.
      3. Number of minutes used to calibrate pump, eg. 5 min.
      4. Divide liters (from #2) by the number of minutes (from #3) to obtain flow rate in liters per minute. Eg. 55.5 l/ 5 min. = 11.1 l/min.
      5. Initial and date all calibrations. Include all units mentioned in steps 1 - 4 above.
      6. An example of a typical log book entry.

         Aug. 30 RAC #4 55.5 l / 5 min. = 11.1 l/min. BKD

   H. Be sure to check all calibrated flow rates. There must be at least 9.40 liters per minute flow rate to get the sample volume needed in a 20 minute sample to reach the currently used LLD (lower limit of detection) on the X-ray machine. If a flow rate is less than 9.40 l/min., divide the calibrated flow rate into 188 liters (the minimum sample vol.) to get the number of minutes the samples must be run to get 188 liters.

      Example: Calibrated flow rate = 7.44 l/min.

      -then 188 liters / 7.44 liters/min. = 25.27 min. or 26 min. to assure adequate sample vol.

11. Dust Filter Preparation (see Figure 1.)

   A. Unscrew the filter holder leaving the red caplug cover on the top half.

   B. Place a Gelman 25 mm glass fiber filter with the patterned side toward the screen on the filter holder.

   C. Screw filter holder back together just so its snug. Too much pressure will cut the filter around the edges and allow air to escape around the sides.

D. Be sure to match filter holder tops and bottoms.

1. Filter holder bottoms with a black "O" ring glued to them match tops that have a flat flange inside the top. These filter holder tops and bottoms have been marked with a black marker.
2. Filter holder bottoms with no "O" ring match tops that have a raised ridge inside the top. These tops and bottoms are not marked.

E. Place an ID label on the top of the red caplug (3/4 inch mail routing stickers, color should sharply contrast blue or black ink). To aid removal of these stickers, fold about 1/8 inch of an edge under prior to attaching to the caplug.

III. Taking Dust Samples

A. Check filter holder to make sure it is screwed together snugly and plug into the air inlet tube of the pump.

B. Remove red caplug and position pump in the breathing zone where respirable dust will be sampled. Don't place filter holder and/or pump under dust producing equipment where no one can reasonably be expected to work.

C. Start pump and note the time.

D. Record the following information on notepad

1. Station ID, eg., M-42
2. Pump ID, eg., RAC #4
3. Sample start time
4. On the top of the notepad write "Dust Samples", the date, and your initials.

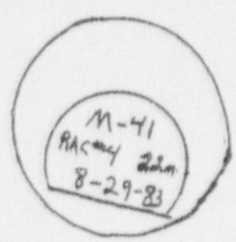
E. Run pump for 20 minutes minimum or longer if needed (see section A1,1.H.)

F. Shut off pump, record time on notepad, replace red caplug and figure the sample time in minutes and record.

G. Note the operational state of process equipment if this may affect results.

H. On the sample ID label (on the caplug) record:

1. Station ID
2. Pump ID
3. Sample time in minutes
4. Date



Label will look like this when finished.

I. When finished with a set of samples, retain the notepad with the sampling data. These are kept and become part of the monthly report.

J. On a desk pad or data sheet, mark off the stations that have been sampled. Keep a list like this for each month, it will help prevent wasted time on repeat samples.

IV. Preparation of Dust Filters for X-ray Analysis.

A. In the X-ray room in the lab, obtain small red caplugs, metal "O" rings, mylar dispenser and dust sample assay sheet. (See Johnnie Pitman for the location of these materials and for any assistance)

B. Place small red caplug open end down on desk, remove the filter ID label and attach to the small red caplug.

C. Record data on the filter ID label onto the data sheet, i.e.; Station #, Pump #, sample time (minutes) and date (see figure 3).

D. Turn caplug over and open filter holder.

E. Get a piece of mylar from the dispenser about twice as long as it is wide.

F. Lay one end of the mylar sheet over the caplug, lay the dust filter on the mylar with the intake side up (patterned side down)(see figure 2).

G. Fold other end of mylar over the filter, center filter in the folded mylar and over the caplugs open end.

H. Center metal "O" ring over caplug and filter with the split side of the ring up. Push the ring down over the caplug to secure the filter between the mylar sheets. If done correctly, the ring will tighten the mylar leaving a smooth surface. Be careful not to leave any finger prints or wrinkles in the mylar as this will have an affect on the assay results.

I. When finished prepping a set of filters, place the prepped filters on the data sheet and next tothe X-ray machine. Cover the filters with tissue paper to prevent dust from settling on them.

V. Calculating Uranium Concentrations in Air From Samples Assayed by the Lab.

A. The lab reports X-ray determined values for air samples in gross μgU/filter. A blank average or tare value is also determined when batches of samples are assayed, this value appears in the upper right corner of the assay sheet.

B. Subtract the blank average or tare from all gross readings to obtain net μgU/filter. This number is then used in the calculator program to convert from μgU/filter to 10^{-11} μCi/ml.

C. Calculations.

1. Program the HP-41C calculator with the DUST (Uranium) program. Insert the card from the right side of the calculator. The calculator will display 0.0000.

2. Push the execute button XEQ and 0 1. The calculator will display UGM/FILTER?

3. Enter the net μgU/filter of a sample, eg. 1.30. Then push the run/stop button R/S. The calculator will display LITERS/MIN?
4. Enter the calibrated flowrate for the pump used to take that sample (This number is in the air sampler calibration log book). Eg. 11.1 l/min., then push R/S again. The calculator will display SAMPLE TIME?
5. Enter the number of minutes that the sample was run (this number is on notepad carried when the sample was taken, on the sample ID label and on the lab assay sheet). Eg. 20 minutes, then push R/S again.
6. The calculator will calculate the answer and display it in units of 10^{-11} μCi/ml. For the above example data the display is 0.34, thus the answer is 0.34×10^{-11} μCi/ml.

A15: INTERNAL RADIATION EXPOSURE CALCULATIONS

Chapter 402-24 of the Washington Administrative Code describes the limits of radiation exposures to workers employed by radioactive materials licensees. WAC 402-24-030 describes the exposure limits of individuals to airborne radionuclides while working in licensees restricted areas.

Internal radiation exposure calculations in the uranium milling industry are done to assess exposure from both soluble and insoluble uranium and insoluble radon daughters (soluble implying a biological lung half-life of 10 days or less).

Calculations can be done in several ways and each of the methods used is adequate since the same basic data can be used for these methods. Currently, inhalation exposures at the Sherwood Mill are calculated as a time weighted exposure which is compared to the maximum allowable and expressed as a decimal fraction of that maximum. Thus, an exposure value of 1.000 represents the maximum allowable exposure. Time weighted exposure implies that the exposure is calculated from the amount of time spent in a given concentration of airborne radioactivity. A given exposure calculation will include several areas with differing amounts of time spent in them and concentrations of airborne radioactivity, thus, the total exposure would equal the sum of all the area specific exposures during the exposure period of concern.

WAC 402-24-030 also describes an action level which is 25% of the maximum allowable or an exposure value of 0.250. When this value is exceeded, there is need for additional precautions or actions to reduce the exposure ALARA and prevent its' reccurrence.

Soluble uranium passes through the body quickly and, thus, exposure calculations are done weekly. Soluble uranium areas at the Sherwood Mill are the Solvent Extraction, Yellowcake (YC) Precipitation, YC Roaster and YC Packaging areas. The maximum allowable exposure is based on a 40 hour week and equals 40 hours at MPC concentrations of soluble uranium or 40 MPC hours.

Insoluble uranium and radon daughter exposures are calculated on a quarterly basis with the maximum allowable equalling 520 hours at MPC concentrations of any combination of insoluble uranium and radon daughters. All areas of the Sherwood Mill not include in the soluble uranium areas are considered insoluble uranium areas. All mill areas are considered insoluble for radon daughters.

The data used to calculate these exposures are: 1) the results of uranium dust and radon daughter sampling, and 2) weekly or monthly time study sheets which document the times employees spend at or near monitoring stations.

The weekly or monthly time study sheets are filled out by the employees each week or month depending on their operating station. On the 20th of each month when the memo is issued listing yet to be received bioassay samples, the time study sheets received are to be checked off the monthly Radiation Safety checklist. Those individuals who have not submitted time study sheets should be liste_ on the bioassay memo.

The use of respirators provides respiratory protection to the wearer from airborne radionuclides and other contaminants. The U.S. NRC in Reg. Guide 8.15 provides the protection factors to be used in exposure calculations and WAC 402-24-030 allows for use of these protection factors to its' licensees. These protection factors essentially reduce the concentration of airborne radionuclides used in the exposure calculations.

The formula used for calculating the internal rediation dose form soluble uranium is presented below.

$$E_{s.m} = \sum_{m=1}^{45} \frac{\left(\frac{(U_m)\times(t_m)}{(MPC_s)\times(RPF)}\right)}{40 \text{ hours}}$$

; where: $E_{s.m}$ = total exposure (E) to soluble uranium (s) in all areas (m).

$\sum_{m=1}^{45}$ = summing over all areas (m) or monitoring stations 1 - 45 which are currently considered as soluble uranium areas.

U_m = concentration of soluble uranium at an area (m).

t_m = time spent at an area (m).

MPC_s = maximum permissible concentration of soluble uranium (s).

RPF = respirator protection factor.

The formula for calculating the internal radiation exposure from both insoluble uranium and radon daughters is an expansion of the above formula and is presented below.

$$E_{i.m} = \sum_{m=1}^{45} \frac{\left(\frac{(U_m)\times(t_m)}{(MPC_i)\times(RPF)} + \frac{(RD_m)\times(t_m)}{(MPC_i)\times(RPF)}\right)}{520 \text{ hours}}$$

; where: $E_{i.m}$ = total exposure (E) to insoluble uranium and radon daughters (i) in all areas (m).

$\sum_{m=1}^{45}$ = summing over all areas (m) or monitoring stations which are currently considered as insoluble uranium and/or radon daughter areas.

U_m = concentration of insoluble uranium at an area (m).

RD_m = concentration of insoluble radon daughters at an area (m).

t_m = time spent at an area (m).

MPC_i = maximum permissible concentration of insoluble uranium (left side of formula) and radon daughters (right side of formula).

RPF = respirator protection factor.

It must be noted that for the latter calculations for insoluble uranium and radon daughters, radon daughter exposures must be done for soluble uranium areas with these exposures added on to the insoluble calculations.

PERSONNEL DOSIMETRY

Gamma radiation is emitted by natural uranium and its' associated daughter products. Thus, assessment of this radiation dose to uranium mill workers is necessary while working in any section of a uranium mill. Personnel dosimetry is the method used to assess the gamma radiation dose to workers in uranium mills. On a periodic schedule, workers are issued either a film badge or a thermoluminescent dosimeter which they wear at all times while at work. Thus, the measurement of radiation dose is continuous as long as the device is being worn.

At the Sherwood mill, all mill operators, maintainence personnel, electricians, lab personnel and representatives from administration and mining departments are issued quarterly thermoluminescent dosimeters (TLD's). All personnel issued a TLD on a regular schedule are to report to the radiation safety office for a replacement or spare badge if their TLD was misplaced or lost. No worker will be allowed to work in the mill without a TLD.

Correct placement of the TLD is necessary to obtain a representative measurement of an individuals' dose. TLD's will be worn between the neck and waist in front of the body. Attachment to hardhats will not be acceptable at any time. TLD's will also be worn outside the clothing.

TLD's are changed quarterly, near the end of the month. Any noteable comments from the supplier,who determines the dose received by each badge,will be addressed via memo. These items will include elevated or increasing doses and notations of contamination. Other items to be addressed will include incorrect placement of TLD's or missing TLD's.

Exposure limits are described in 10-CFR-20 as;

1. 1.25 Rem (1250 millirem) to the whole body per quarter,

2. 7.5 Rem (7500 millirem) to the skin of the whole body per quarter.

3. 18.75 Rem (18,750 millirem) to the hands, feet and ankles per quarter.

When TLD reports are received from the supplier, the report must be reviewed by the RSO for any significant exposures or trends. Any exposure in excess of 25% of the quarterly limits will be noted in a memo and a follow up form will be completed (attached). This form will include an interview of the individual and assessment of areas frequented. Corrective actions will also be initiated where appropriate and may include but not limited to the following; restrictions in work areas frequented, time spent in work areas, retraining and counselling with regard to work habits.

After initial RSO review of TLD reports, the exposure value for each individual will then be entered into their personal exposure file. Annually, the TLD supplier sends out an annual summary of each badges' exposure. One copy is to be filed in each individuals file, one copy to a master file and one copy for permanent storage and microfilming.

HIGH FILM BADGE READING

FOLLOW-UP FORM

EMPLOYEE'S NAME: ______________________________

EXPOSURE PERIOD: ______________________________

INDICATED DOSE: ______________________________

COMMENTS:

CORRECTIVE ACTION:

SIGNED: ______________________ DATE: ______________________

Radiation Safety Officer

GAMMA SU. EYS

I. Introduction

The intent of periodic measurement of gamma exposure rates within mill work areas is to document whether any potential build-up of gamma emitting uranium decay products has occurred. The surveys are conducted monthly or quarterly, (see attached gamma survey data sheets). The information obtained can be helpful in determining the source in the event of high personnel dosimeter readings.

Gamma surveys are also conducted after yellowcake transport trucks are loaded to comply with U.S. Department of Transportation Regulations (See attached Yellowcake Shipment Survey Forms).

II. Equipment:

1. Eberline PRS-1 ("RASCAL") and HP-270 probe
2. Eberline PRM-7 micro-R/hr. meter
3. Ludlum 12S Micro-R-Meter.

III. Procedures for conducting the surveys:

A. Check calibration with the check source;

1. Eberline PRM-7 and Ludlum 12S

   a. check battery and record in log book

   b. consult calibration certificate for proper Cs-137 source and source reading

   c. place source on detector area of instrument and record the value observed in the logbook along with the instrument ID (make,model and serial number), source used and strength, calibrators source reading, date of last calibration and initials.

2. Eberline PRS-1 and HP-270

   a. connect PRS-1 and HP-270

   b. consult calibration certificate for proper internal switchings for LEGEND and MULTIPLICATION, and external adjustments for THRESHOLD and GROSS.

III. Procedures for taking surveys

A2. Continued

c. Select the proper check source, turn selector knob to the proper RATE and place source against probe as indicated in the calibration certificate.

d. Record the calibration check data as per above for PRM-7 and 12S.

3. Consistent readings more than twenty percent (20%) in error from calibration certificate should be noted and the instrument sent out for recalibration.

B. Taking surveys

a. record pertinent instrument information on the data sheets (attached)

b. set response to slow on PRM-7 and 12S meters, an A rate initially on PRS-1.

c. walk slowly through the survey area with instrument at waist height

d. on PRM-7 and 12S meters record the average reading

e. on PRS-1, rate adjustments may be necessary so that a reading is obtained after the area is walked through. Greater accuracy is obtained with an average of more than one reading or on the next rate (i.e., accuracy improves from A to B to C to D rates).

C. Walk through surveys

Periodically, a walk through gamma survey should be conducted in the mill. To do this survey, the instrument should have its calibration checked and recorded as above. The response control should then be set at "Fast Response", and one should walk through the mill watching for any high (+1 mR/hr.) areas. Any high areas located, should be documented on a data sheet, and consideration should be given toward including that location in monthly survey (depending on the amount of work time spent in the area). Any area above 2.5 mR/hr. should be designated as a "Radiation Area" with the appropriate signs. When necessary, work time within a "radiation area" should be controlled so there are no exposures above 100 mR/week, or 1.25 Rem/quarter.

QUARTERLY GAMMA RADIATION SURVEYS

LOCATION NO.	LOCATION	mR/hr.
M-1	COARSE ORE FEED HOPPER	
M-2	CRUSHER BUILDING	
M-3	TRANSFER CHUTE AREA	
M-4	FINE ORE BIN	
M-5	GRINDING AREA	
M-6	LEACH OPERATORS CONTROL AREA	
M-7	LEACH AREA	
M-8	CCD THICKNER AREA	
M-9	TAILINGS DISCHARGE PUMP	
M-10	CCD CONTROL AREA	
M-11	PRECIPITATION AREA	
M-12	YELLOW CAKE THICKNER	
M-13	PRECIPITATION & DRYING CONTROL	
M-14	YELLOW CAKE CENTRIFUGE	
M-15	YELLOW CAKE DRYER	
M-16	YELLOW CAKE DRYER DUST COLLECT.	
M-17	YELLOW CAKE PACKAGING ROOM	
M-18	CLARIFICATION AREA	
M-26	SOLVENT EXTRACTION CONTROL AREA	
M-27	ORE STORAGE PAD	
M-28	YELLOW CAKE STORAGE AREA	
M-31	CRUSHER CONTROL ROOM	
M-32	BALL MILL FEED	
M-33	GRIND CONTROL ROOM	
M-37	SX BUILDING	
M-38	CCD PH#2 ENTRY LEVEL	
M-39	CCD PH#2 BASEMENT SUMP	
M-40	CCD THICKNER #3 CATWALK	
M-41	FINE ORE TUNNEL BAGHOUSE	
M-42	MILL MAINT. SERVICE AREA	
M-43	MILL BUILDING SERVICE AREA	
M-44	TRAMP METAL PICKER BOOTH	

INSTRUMENT ID. S/N CALIB. DATE. OK.

SURVEYS BY: DATE:

RSO FORM #14 (REV. 1-31-85)

GAMMA RADIATION SURVEYS

LOCATION NO.	LOCATION	FREQUENCY		
M-19	Change Room Area Men's	Monthly		
M-20	Flourometric & AA Room	Monthly		
M-21	Balance Room	Monthly		
M-22	Metallurgical Lab	Monthly		
M-23	Laboratory Central Work Area	Monthly		
M-24	Electrical Shop Bench	Monthly		
M-25	Repair Shop General Maintenance	Monthly		
M-29	Sample Prep. Room	Monthly		
M-30	Ladies Change Room	Monthly		
M-34	Mill Office	Monthly		
M-35	Radiation Safety Office	Monthly		
M-36	Lab. Yellow Cake Room	Monthly		

Inst. ID.______________________________ S/N______________

Calibration Date:______________________ Calib. Check OK?__________

Surveys by:____

Date:____

YELLOWCAKE SHIPMENT SURVEY
EXCLUSIVE USE ONLY

I. Date ____________________

Person(s) conducting survey ____________________

Trucking Carrier ____________________

Contract # ____________________ Lot # ____________________

Trailer # ____________________ Tractor # ____________________

II. Removable surface contamination - wipe tests averaged over 300 cm^2.

Note: Complete either Subsection A or B below.

A.

Barrel	Gross Wt.(mg)	Tare Wt.(mg)	Net Wt.(mg)	Allowable Limit
1. ____	____	____	____	45mg/cm^2
2. ____	____	____	____	45mg/cm^2
3. ____	____	____	____	45mg/cm^2
4. ____	____	____	____	45mg/cm^2

B.

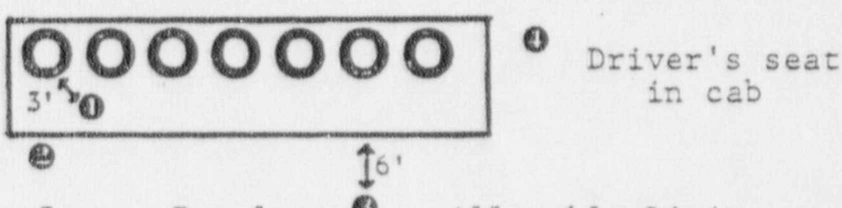
Barrel	Gross Alpha(cpm)	Gross Alpha(dpm)	Allowable Limit(dpm)
1. ____	____	____	220dpm/cm^2
2. ____	____	____	220dpm/cm^2
3. ____	____	____	220dpm/cm^2
4. ____	____	____	220dpm/cm^2

III. External Radiation Levels

Gamma Survey Instrument Identification ____________________

Calibration Date ____________ Check Source i.d./reading ____________

Gamma Survey Locations:



Gamma Survey Location	Survey Results (mrem/hour)	Allowable Limit (mrem/hour)
1. 3' from barrels	____	1000
2. Surface of trailer	____	200
3. 6' from trailer	____	10
4. In driver's seat (in cab)	____	2

IV. All drums were inspected during loading to assure the barrels were tightly sealed, none leaked, and there was no loose material in the vehicle.

Yes ( ) No ( )

BETA SURVEY PROCEDURE

When uranium-239 is allowed to reach secular equilibrium with its two short lived daughter products, thorium-234 and protactinium-234, the resultant isotopic mixture is a strong beta radiation emitter. Surface beta emission after uranium-239 achieves secular equilibrium with these daughters (about 8 or 9 months of decay time) is approximately 150 - 200 mRem/hour. Through the uranium milling process, daughter equilibrium is disrupted. However, their ingrowth is a constant process and beta radiation emissions will begin increasing in yellowcake to a maximum of about 150 mRem/hour at the surface after 100 days of aging. Thus, noteable increases in beta dose rates can be detected where yellowcake has been deposited and not cleaned up via thorough housekeeping.

In order to maintain control of beta radiation exposures, the following precautions should be implemented;

1. Employees who handle yellowcake on a regular basis must wear safety glasses at all times to protect the cornea of the eye.
2. Floors should be sealed to prevent uranium absorbtion into cracks and pores.
3. Tanks requiring entry for maintenance purposes and which routinely contain uranium and/or uranium bearing solutions must be surveyed for beta radiation prior to the entry of personnel performing the maintenance.
4. NRC regulations stipulate only that surveys be "adequate" in frequency to control radiation exposures. Walk through beta surveys will be conducted quarterly through each work area of the mill. These surveys should locate any contaminated areas as indicated by increasing beta exposure rates with time.
5. Quarterly exposure limits for beta radiation exposures are:

:7.5 Rems (7500 millirems) to the whole body.

:18.75 Rems (18,500 millirems) to the hands, forearms, feet and ankles.

Note: A ten percent reduction in exposure is allowed for clothing and individuals wearing rubber boots may receive virtually no exposure to the lower legs, feet and ankles.

6. Areas where beta radiation levels are above 100 millirem/hour must be posted "HIGH RADIATION AREA" and access must be controlled in accordance with 10 CFR 20.203(c). Areas where the beta radiation levels are above 5 millirem/hour must be posted "RADIATION AREA".

Equipment for beta survey.

1. Eberline PRS-1 ratemeter/scaler and Eberline HP-210AL probe
2. NBS Traceable sources: SrY-90 and C-14.
3. Lead Shield
4. Data Sheet (attached) or equivalent.

Procedure for beta survey.

1. Constancy checks - Review calibration certificate for instrument to be used and determine if instrument is within calibration period and the the correct internal/external settings and constancy check values. Set up instrument and probe accordingly. Check battery function and record. Check instrument with Sry-90 and C-14 sources and record. Record instrument identification and probe, calibration certificate values sources used, date and initials.
2. Obtain data sheet (attached) and record pertinent instrument information. Refer to calibration certificate for the conversion factor from cpm readings to mRem/hour exposure values and record on data sheet.
3. Survey each area at waist height. Surfaces on which an operator walks or contaminated surfaces which require handling should be surveyed 6 (six) inches from the surface. Determine a background count for each area using the lead shield to cover the probe face. Record the infor-

mation in the appropriate spaces on the data sheet. If surveys are to be continued on another day, use a new data sheet. If surveys are done for special situations, the same data will be necessary and additional data recorded as necessary.

4. Periodically, the inside surface of work clothing and boots worn by yellowcake workers should be surveyed. Quarterly surveys will determine any beta exposure rate increases. Gloves used in the roaster should be surveyed more frequently as the potential for contamination is much greater in this area.
5. When conducting beta surveys, pay particular attention to unsealed surfaces where yellowcake slurry of solids could potentially occur and accumulate.
6. Calculate the exposures at each survey location by subtracting the background from each sample count yielding a net cpm. Then divide the net cpm count by the conversion factor to obtain an exposure rate value in mRem/hour. This resultant exposure can then be applied to time weighted exposure calculations for employees frequenting the areas.

Care must be taken when conducting the surveys and in making calculations so that the actual circumstances fit the exposure. For example, a worker may be working on contaminated equipment in the precipitation section but his back faces a relatively clean area. Thus, only half of his skin surface was exposed to the contamination. The opposite is also possible while working on clean equipment while the back is exposed to contamination.

BETA RADIATION SURVEYS

Month __________________ 19____

LOCATION/DESCRIPTION	DATE	SAMPLE CPM	BKGD CPM	NET CPM	mR/hr.
M- 1 Coarse Ore Feed Hopper					
M-27 Ore Storage Pad					
M-45 Ore Loader Cab					
M- 2 Crusher Building					
M-31 Crusher Control Room					
M-44 Tramp Metal Picker Booth					
M- 3 Transfer Chute					
M- 4 Fine Ore Tunnel					
M- 5 Grinding Area					
M-32 Ball Mill Feed					
M-33 Grind/Ball Mill Control Room					
M-38 CCD PH #2, Entry Level					
M-39 CCD PH #2, Basement Sump					
M-43 Mill Building Service Oil Storage Area					
M- 6 Leach Control Desk Area					
M- 7 Leach Tank Base Area					
M-40 CCD Thickener #3 Catwalk					
M-10 CCD PH #1 Control Booth					
M- 8 CCD PH #1 Thickener Underflow Area					
M- 9 Tailings Discharge Pump					
M-26 SX Control Room					
M-37--SX-Building					
M-18 Clarification Tank Area					
M-12 Yellowcake Thickener Underflows					
M-11 Yellowcake Precipitation Tanks					
M-13 Precipitation/Roaster Control Room					
M-14 Yellowcake Centrifuge					
M-15 Yellowcake Roaster					
M-16 Yellowcake Dust Collector/Hammermill					
M-17 Yellowcake Packaging					
M-34 Mill Office					
M-35 Radiation Safety Office					
M-24 Electricians Repair Bench					
M-25 Mill Maintenance Repair Shop					
M-42 Mill Maintenance Yard					
M-41 Fine Ore Tunnel Baghouse					
M-28 Yellowcake Storage Area					
M-36 First Aid Room					
M-19 Men's Change Room					
M-30 Women's Change Room					
M-29 Sample Prep. Room					
M-22 Metallurgical Lab - YC Room					
M-23 Central Lab Work Area					
M-21 Balance Room					
M-20 Fluorimetrics and AA Room					

Survey Instr. ID ____________________ Probe ____________ S/N ____________

Calibration Date ________ BY ________ Source Check OK? ________ Source ID ________

Conversion Factor (CPM-net to mR/hr.) = ______________________________

SURFACE CONTAMINATION SURVEYS

I. Introduction:

The purpose of surface contamination surveys is to detect levels of alpha contamination on surfaces such as desks and table tops in designated eating and smoking areas, on filled yellowcake drums prior to shipment, on clothing of off-shift mill employees prior to leaving the restricted area, on mill equipment which is to be shipped off-site for repairs, on the interiors of cleaned respirators and in the laboratory's fluorimeter room prior to urine bio-assay analysis.

The intent of these surveys is to prevent radioactive materials from release to unrestricted areas, ingestion or from contaminating "clean" areas.

There are three (3) types of contamination that surveys can document; total, removeable and residual contamination. Each type has specified limits for one or more types for a given situation. There are two sampling methods which determine all three types; 1) surveys with a hand held probe for total and 2) wipe tests for removeable contamination. Residual contamination can be determined by subtracting removeable from total contamination.

All of the surveys and the appropriate limits are based on the number of alpha radiation emissions (or counts) per minute per unit area. Thus, the basic instrumentation to determine levels of contamination must be able to detect alpha radiation. When limits specified for a given situation are exceeded, the item(s) must be decontaminated, the steps taken to decontaminate documented and steps taken or recommended to prevent recurrence documented.

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II. Survey Methods:

A. Total Surface Contamination Surveys

1. Personnel monitoring: on clothing and skin of of off-shift mill workers who have worked with yellowcake and have not showered and/or changed clothes.

a. Equipment Used:

1) Eberline RM-20-1 and AC-3 alpha scintillation probe.

2) NBS traceable alpha source Thorium-230

3) Data Sheet(s) as (attached)

b. Procedure Used:

1) Check RM-20-1 and AC-3 probe function with alpha source. Record in log book: Instrument ID, source type and strength, calibration certificate date and source reading, and the observed reading.

2) Set Alarm for 1000 DPM/100 cm^2 limit

a) Determine Efficiency, E

$$= \frac{\text{calibration certificate alpha source count(cpm}}{\text{certified alpha source count (dpm)}}$$

b) Account for probe size of AC-3, 59 cm^2

$$\frac{59\ cm^2}{100\ cm^2} = 0.59$$

c) Alarm setting $= \frac{1000\ DPM}{100\ cm^2}(E)(0.59)$

3) Survey clothing at or near (less than 1 cm) at a rate of about 1 meter per 30 seconds.

4) If the Alarm sounds, hold the probe directly on that area for 5-10 seconds.

5) If the Alarm sounds again, the person <u>Must</u> shower <u>and</u> change clothes.

6) Contaminated clothing will be laundered on site and resurveyed prior to returning them to the owner.

SURFACE CONTAMINATION SURVEYS

A. Total Contamination Surveys
b) Procedure Used continued...

7) Initial every survey done and indicate if "OK".

8) Eberline PRS-1 and AC-3 probe can be used as a replacement survey instrument.

2. Designated Eating and Sampling Area Surfaces and Mill Equipment for Offsite Release

a. Equipment Used:

1) Eberline PRS-1 and AC-3 alpha scintillation probe.

2) NBS traceable alpha source, Thorium-230.

3) Data sheets (attached).

b. Procedure Used:

1) Check PRS-1 calibration certificate for correct internal and external settings for link to AC-3 probe.

2) Check PRS-1 and AC-3 probe function with alpha source. Record in log book: Instrument ID, source type and strength, calibration certificate date and source reading, the observed reading and the battery condition indication.

3) Determine cpm reading equivalent to 1000 DPM/100 cm^2 maximum

a) Determine Efficiency,

$$E = \frac{\text{calibration certificate alpha source count in cpm}}{\text{certified alpha source count in DPM}}$$

b) Account for probe face size of AC-3:

$$\frac{59\ cm^2}{100\ cm^2} = 0.59$$

c) 1000 DPM/100 cm^2 limit on PRS-1 with AC-3 probe

$$= \frac{1000\ DPM}{100\ cm^2}\ (E)\ (0.59)$$

4) Survey areas by placing probe face down on flat surface.

5) Set PRS-1 to A or B scale and wait for reading on LCR board.

6) Take several readings from a single surface such as a desk or table. More if a large object for offsite release is involved.

7) If the 1000 DPM/100 cm^2 limit is exceeded, then conduct a wipe test in that area to determine the removeable portion (see below).

8) For regularly scheduled surveys, record (cpm) readings on data sheet and convert to DPM/100 cm^2 values for comparison.

9) Other mill areas, equipment, etc. the limits for total alpha contamination is 5000 DPM/100 cm^2.

B. Removeable Contamination - Swipe Tests

a. Equipment Used:

1) Eberline PS-2-2 and SPA-1 alpha scintillation detector.

2) NBS traceable alpha source Thorium-230

3) Data sheets

4) 2.4 cm filter paper circles

b. Procedure Used:

1) Check PS-2-2 and SPA-1 detector function with alpha source. Record in log book: Instrument ID, source type and strength, calibration certificate date and source reading,observed reading and battery condition indication.

2) Take filter paper circle and wipe over dry surface using considerable pressure in a lazy "S" pattern approximately 20 inches long. Smaller objects or respirator interiors will require some adjustment if a 20 inch pattern cannot be approximated.

3) Gently place wipe circle in a labeled 2x3 manila envelope if counting is to be done later.

4) Place wipe circle in SPA-1 detector, set counter to two (2) minutes and count all samples.

5) Record counts in (cpm), taking into account the count times.

6) Convert results to DPM/100 cm^2 by multiplying by efficiency factor equal to 1/Efficiency, where

$$\text{Efficiency} = \frac{\text{calibrated alpha source reading in cpm}}{\text{certified alpha source reading in DPM}}$$

7) Compare all results to appropriate limits and action levels:

   a) Yellowcake Drums: 22,000 DPM/100 cm^2 and action level 5000 DPM/100 cm^2.

   b) Respirator Interiors after cleaning and prior to reissue and Laboratory Fluorimetric Room prior to Bioassay analysis: 100 DPM/100 cm^2.

   c) Equipment for offsite release, Designated Eating and Smoking Areas; Action Level: 500 DPM/100 cm^2.

C. Residual or Fixed Alpha Contamination

This is determined by subtracting reuseable from total contamination values for surveys done in the Same Specific Area.

SURFACE CONTAMINATION SURVEYS

Mo.________ Yr.______

Gross CPM/DPM per ____ cm^2 (Instr. readings)

AREA DESCRIPTION		DATE	TOTAL CPM	TOTAL DPM	REMOVEABLE CPM	REMOVEABLE DPM	RESIDUAL CPM	RESIDUAL DPM	Init.
M-13 Precip. Control:	1. Table								
	2. Fountain								
	3. Sink								
M-10 CCD Control PH#1:	Desk								
M- 7 Leach Control Area:	Desk								
M-26 SX Control Rm.:	1. Counter								
	2. Sink								
M-31 Crusher Control:	1. Table								
	2. Fountain								
M-34 Mill Office:	1. Desk - TKM								
	2. Desk - LLM								
	3. Desk - ELJ								
	4. Desk - Fmn.								
	5. Desk - Secy.								
	6. Microwave								
	7. Fountain								
M-33 Grind Control Rm:	1. Table								
	2. Counter								
	3. Sink								
M-19 Men's Change Rm:	1. Bench								
	2. Sink								
M-30 Women's Change	1. Bench								
	2. Sink								
M-23 Lab. Area:	1. Sink								
	2. Counter								
	3. Lunch Rm.								
M-20 Fluorometrics	1. Table								
	2. Counter								
	3. Fluorimeter								
M-24 Mill Maint.	1. Table (N)								
	2. Table (S)								
	3. Desk - DLT								
	4. Desk - JWH								
M-35 Rad. Safety Rm:	1. Desk - BKD								
	2. Desk - LS								
	3. Resp. Desk								
	4. Instr. Desk								
Mill Entrance	Bench								

DPM = Instr. reading CPM x 1/Efficiency

S/N ________ CALIB. DATE ________ Efficiency = ________

RSO Form #15 (Rev 8/83)

SURFACE CONTAMINATION SURVEYS

Mo.______ Yr.______

$\frac{\text{(Gross CPM - Bkgd. CPM)}}{\text{(100 / Probe Area)}}$ = NET CPM/DPM per 100 cm^2

DPM = Instr. reading CPM x 1/ Efficiency

AREA DESCRIPTION		DATE	TOTAL CPM	TOTAL DPM	REMOVEABLE CPM	REMOVEABLE DPM	RESIDUAL CPM	RESIDUAL DPM	Init.
M-13 Precip. Control:	1. Table								
	2. Fountain								
	3. Sink								
M-10 CCD Control PH#1:	Desk								
M- 7 Leach Control Area:	Desk								
M-26 SX Control Rm.:	1. Counter								
	2. Sink								
M-31 Crusher Control:	1. Table								
	2. Fountain								
M-34 Mill Office:	1.Desk - TKM								
	2.Desk - LLM								
	3.Desk - ELJ								
	4.Desk - Fmn.								
	5.Desk - Secy.								
	6.Microwave								
	7.Fountain								
M-33 Grind Control Rm:	1. Table								
	2. Counter								
	3. Sink								
M-19 Men's Change Rm:	1. Bench								
	2. Sink								
M-30 Women's Change	1. Bench								
	2. Sink								
M-23 Lab. Area:	1. Sink								
	2. Counter								
	3. Lunch Rm.								
M-20 Fluorometrics	1. Table								
	2. Counter								
	3. Fluorimeter								
M-24 Mill Maint.	1. Table (N)								
	2. Table (S)								
	3. Desk - DLT								
	4. Desk - JWH								
M-35 Rad. Safety Rm:	1. Desk - BKD								
	2. Desk - LS								
	3. Resp. Desk								
	4. Instr. Desk								
Mill Entrance	Bench								

Instr. ID ______ S/N ______ Efficiency = ______ Probe face size ______ cm^2 Bkgd.CPM ______ CPM

MEMORANDUM

DATE: ______________________________

TO: ______________________________

FROM: B. K. DeWaard, Radiation Safety Officer

SUBJECT: Surface Contamination Levels on Equipment to be Released Offsite

Equipment Description: ______________________________

____

Surface Contamination Wipe Test(s) Results

Area Wiped: ______________ Approx. Area Wiped: __________ cm^2

Results: CPM = ________/________ cm^2 DPM = ____________/ 100 cm^2

Area Wiped: ______________ Approx. Area Wiped: __________ cm^2

Results: CPM = ________/________ cm^2 DPM = ____________/ 100 cm^2

Area Wiped: ______________ Approx. Area Wiped: __________ cm^2

Results: CPM = ________/________ cm^2 DPM = ____________/ 100 cm^2

MAXIMUM ALLOWABLE . . . . 1000 DPM / 100 cm^2

Surface contamination levels on this equipment are are not below acceptable limits for release offsite.

COMMENTS:

Wipe tests taken by: ______________________

cc: GTM
TKM
Others:
File

WESTERN NUCLEAR, INC.
SHERWOOD MINE

G.B.F. WNI-108

WESTERN NUCLEAR, INC.
SHERWOOD PROJECT

Date: ____________________

Name: ____________________

Respirator Wipe Test Log

ACTION LEVEL . . . . 100 DPM Alpha/100 cm^2
(From U.S. NRC Reg. Guide 8.15 and NUREG-0041)

Harness #	cpm	DPM	Harness #	cpm	DPM
1.			26.		
2.			27.		
3.			28.		
4.			29.		
5.			30.		
6.			31.		
7.			32.		
8.			33.		
9.			34.		
10.			35.		
11.			36.		
12.			37.		
13.			38.		
14.			39.		
15.			40.		
16.			41.		
17.			42.		
18.			43.		
19.			44.		
20.			45.		
21.			46.		
22.			47.		
23.			48.		
24.			49.		
25.			50.		

Survey Instr. ID ______________________________ Calibration Date ______________

6/83

WESTERN NUCLEAR INC.
SHERWOOD PROJECT
Yellowcake Barrel Wipe Test Log

LOT #: CONSIGNEE:

Barrel #	cpm/dpm	Barrel #	cpm/dpm	Barrel #	cpm/dpm

Wipes Taken By:____________________ Date:____________

(RSO 6, 10/78) Meter Factor: ________

MONTH ____________________

YEAR ____________________

NAME	MONITORED BY:	TIME/DATE	RESULTS	SIGN NAME IF SHOWERED	FOLLOW-UP ACTION

LAB INSTRUCTION & REPORT SHEET

Department: ______________________ Date: ______________

Submitted By: ______________________ Report By: ______________

Sample Identification URINE	Date Taken	Assays Needed									
		µgU/ℓ		Repeat µgU/ℓ			Sample + 15 µgU/ℓ		Sample + 30 µgU/ℓ		

SURFACE CONTAMINATION WIPE TEST RESULTS

(To be completed prior to analysis of urine bioassays)

AREA	CPM	x	1/Eff.	=	DPM
Fluorimeter		x		=	
Burner Counter		x		=	
Prep. Table		x		=	

Instr. ID: ______________ S/N ______

Calibration Date: ______ Calib. Check OK? ______

Surveys by: ______________

Date: ______________

CALIBRATIONS

Health Physics Survey Instrumentation

Instruments used for health physics surveys are calibrated annually by an outside calibration firm, except where noted below. Monthly checks are made of each instrument to assure that instruments are available for surveying. Each month batter function is checked and constancy check made with a radiation source. Instruments that provide readings more than twenty percent (20%) in error of calibration certificate readings are sent out for recalibration and/or repair.

Instrument List:

2 - Eberline PRS-1 (Portable Ratemeters/Scaler, "RASCAL")

Used with:
Eberline AC-3 Alpha Scintillation Probes for surface contamination surveys

Used with:
Eberline HP-270 Gamma Probes for Gamma surveys

Used with:
Eberline HP-210A1 Beta probes for Beta surveys

Note: Calibrations of Eberline PRS-1 instruments and probes are done by an outside calibration firm annually. The Sherwood RSO determines Beta dose conversion factors after calibrations with an aged yellowcake source as per U.S. NRC Regulatory Guide 4.15, Appendix C.

2 - Eberline RM-20-1 (Radiation Monitor)

Used with:
2-Eberline AC-3 probes - for surface contamination surveys on exitting yellowcake workers' (clothing and skin) who have not showered.

1 - Ludlum 12-S Micro-R-Meter (Gamma surveys)

1 - Eberline PRM-7 Micro R/hr. Meter (Gamma surveys)

1 - Eberline MS-3 "Miniscaler"

Used with:
SAC-R5 and Lucas cells (6 ea.) for counting Radon-222 samples (Environmental)

CALIBRATIONS

Instrument List continued.....

2 - Eberline PS-2-2 (Portable Scalers)

Used with:

2 Eberline SPA-1 detectors for counting radon daughter samples and counting wipe test samples for removeable contamination.

Note: Calibration of Eberline PS-2-2 instruments and SPA-1 probes are done by the Sherwood RSO monthly when required and annually by an outside calibration firm as per U.S. NRC Regulatory Guide 8.30, Section C.7.

GRAB SAMPLE PUMP CALIBRATION PROCEDURE

EQUIPMENT:

1. Sampling pump to be calibrated:
   a. Eberline RAS-1
   b. Eberline RAP-1
   c. MSA Model 5 portable pumps
   d. Staplex portable pumps
   e. RAS portable pumps
2. Singer Dry Test Meter, Model DTM-200
3. One liter bubble tube
4. Stop watch with 1/10 second capability

PROCEDURE:

A. RAS-1 and RAP-1 Calibration:

1. Calibration of perimeter environmental dust sampling pumps is performed by placing a 47mm filter head and filter on the dry test meter inlet while in-house uranium dust sampling pumps are calibrated using a 25mm filter head and filter on the dry test meter.
2. Connect the dry test meter to the pump being calibrated by slipping the ¼ inch I.D. tygon tubing from dry test meter on to the ¼ inch pipe nipple to which the filter head is normally attached.
3. Start the pump and measure the volume on the dry test meter after ten (10) minutes for environmental station samplers and for five (5) minutes for in-house uranium dust samplers.
4. Calculate the flow rate and if necessary adjust the flow to obtain the values listed in the discussion.

   Flowrate in liters per minute = Volume in liters/time(min.)
5. Record the calibration of environmental station samplers in the Quarterly Air Particulate log book for each station calibrated. These samplers are to be calibrated at the very beginning and end of each quarter and after any repairs or pump replacements.
6. Pumps used for dust exposure sampling should be each day before use.

PROCEDURE:

B. Pump Calibration for Radon Monitoring:

1. Measure the pressure drop across an in-line 25mm filter and adjust the flow meter for the desired pressure drop.

2. Connect the radon daughter pump to the bubble tube, turn the pump on and move the soap solution up to the bubble tube until bubbles are forming regularly. Fill the bubble tube with bubbles until the entire tube surface is wet.

3. After no more bubbles are present in the bubble tube dip the end of the tube in the soap solution quickly so that one bubble forms and time the bubble from the starting mark to the one liter mark and record. Repeat at least twice and record. Units to record are in seconds per liter.

4. Calculate the flow rate;

Example calculation:

16.2 sec./l
+16.4 sec./l
+16.3 sec./l
+48.9 sec./l   48.9 sec./3liters;
16.3 sec./l average;

$$\frac{300 \text{ sec.}}{5 \text{ min.}} \times \frac{1 \text{ liter}}{16.30 \text{ sec.}} = 18.40 \frac{\text{liter}}{5 \text{ min.}}$$

5. Record the following information in the Air Sampling Pump Calibration log book:

   1. Date
   2. Pump ID, eg. MSA#1
   3. Time, average and calculations from step 4 above including all units.
   4. Initials

BIOASSAY PROGRAM

I. Introduction

The bioassay program at uranium mills is a personnel protective measure for all uranium mill workers against the biological effects of heavy metal poisoning resulting from excessive levels of soluble uranium compounds in the bloodstream (soluble implying a biological lung half-life of 10 days or less).

Deposition of soluble uranium compounds in the body occurs by 3 uptake methods: inhalation, ingestion and absorbtion. Uranium is poorly absorbed through the digestive tract and absorbtion through unbroken skin is poorly documented. Inhalation is regarded as the most commonly occurring source of internal uranium deposition.

Once deposited in the lungs, soluble uranium begins to dissolve immediately into the bloodstream and lymphatic systems. The kidneys function as the body's waste disposal system for the bloodstream and lymphatic systems and, as such, filter and concentrate liquid and dissolved body wastes. Dissolved uranium is also filtered and concentrated as waste product. Since uranium is a heavy metal as well as being radioactive, the kidney becomes the critical organ for heavy metal poisoning.

The Nuclear Regulatory Commission in Regulatory Guide 8.22, "Bioassay at Uranium Mills", establishes the criteria by which the extent of heavy metal poisoning (from uranium) is to be determined and formulates urine concentration levels of uranium at which action will be taken to maintain exposures ALARA.

In Reg. Guide 8.22, initial action is to be taken when the uranium in urine concentration exceeds 15 micrograms of uranium per liter (ugU/l). Additional action is to be taken if samples contain 30 ugU/l and 130 ugU/l concentrations.

When the uranium concentration in the urine reaches 30 ugU/l for four (4) consecutive weeks or exceeds 130 ugU/l in any sample, kidney damage may begin to occur. When kidney damage occurs from heavy metal poisoning, the initial sign is the presence of the protein albuminurea in the urine which is released from the damaged microfiltration structures in the kidney. When samples are assayed and the results exceed either the 30 or 130 ugU/l criteria, checks are made for albuminurea to ascertain whether kidney damage has occurred. Documented actions are then to be taken to reduce exposures ALARA of the affected worker and to prevent recurrence in any worker.

I. Introduction continued..

Urine samples are to be collected monthly from all WNI mill operators and mill maintenance, electrical maintenance and lab personnel. Weekly samples are collected from mill operators who work in areas classified as soluble uranium areas, i.e., Solvent Extraction, Yellowcake Precipitation, Yellocake Drying, and Yellowcake Packaging. Additional samples are collected as needed from Radiation Work Permit personnel in soluble uranium areas and from any individual who submits a sample that exceeds NRC uranium in urine concentrations.

II. Supplies

1. 4 to 6 ounce sample bottles with tight fitting lids.
2. Gum-backed labels.
3. 1% Nitric Acid (HNO_3)

III. Procedures

1. Sample bottles are warehouse stock and when purchased from the warehouse they are to be taken to the laboratory fluorometric room and stored there only.

2. To prepare the sample bottles, put about ¼ inch of 1% nitric acid in the bottom of the bottle and cap tightly.

3. Put names of all individuals on the gum-backed labels and under the name write "Date" with a blank space to the right. For those individuals who submit weekly samples, prepare 5 bottles each per month. Take all bottles out to the Security Guard House so they can be picked up after the shift.

4. Daily, check the Guard House for returned urine samples. Bring the samples to the lab and enter the names and sample dates onto the Urine Bioassay Data Sheet (see attached).

5. Split at least 10% of a month's samples for QA analysis. In split sample sets to be sent out, have the laboratory spike one sample with 15 ugU/l and one sample with 30 ugU/l.

6. Prior to analyses of urine samples, wipe tests are to be taken in the fluorometric room as described in the section SURFACE CONTAMINATION. If any wipe sample exceeds the 10 DPM alpha/100 cm^2, the area must be cleaned and the wipe test repeated.

III. Procedures continued...

7. As the samples are received, check off employees on the monthly Radiation Safety Checklist. On the 20th of each month, issue a memo listing those individuals who have not yet submitted a sample.

8. When any urine sample assay exceeds the 15 ugU/l action level, the information is relayed to the individual and to mill supervisors. The individual is to submit daily samples for the next 7 days and is interviewed to determine the reason for the occurrence.

9. Washington DSHS/U.S. NRC must be notified within 30 days if any sample exceeds 130 ugU/l or remains above 30 ugU/l for four (4) consecutive weeks.

10. All bioassay results are to be filed in each individuals personnel Radiation Exposure File.

11. Should all samples need to be sent out for assaying, split at least ten percent (10%) for QA purposes. Carefully divide a given sample in half and put into another sample bottle for identification, use any employee name and a different date to avoid confusion with actual samples. Provide 15 ugU/l and 30 ugU/l spike samples within any set of split samples.

12. Make certain that all results are received within 20 days of sampling. Special arrangements with outside laboratories are necessary.

IV. Employee Participation

Initial bioassay samples will be submitted by all new hires during pre-employment physicals. This sample should be submitted offsite prior to any site visit.

During employment, the BIOASSAY PROGRAM is a topic for review and discussion at regular Safety Meetings. Employee participation and adherence to the procedures for and the timing of bioassay samples is a matter of policy and is a primary condition of employment. Refer: (Employee Handbook, Plant Rules, page 21, Item No. 9).

WESTERN NUCLEAR, INC

SHERWOOD PROJECT

BIOASSAY RESULTS

NAME: ____________________ JOB : ____________________ DATE: ____________________

DATE:	RESULTS ug U/liter

MEMORANDUM

DATE: ______________________________

TO: B. K. DeWaard, Radiation Safety Officer

FROM: ______________________________ (Supervisor's Name)

SUBJECT: Missed Bioassay Sample From ______________________________

For the week (Sun. - Sat.) of ______________________________

The weekly bioassay(s) from ______________________________ were missed due to the following (Check the appropriate reason).

On vacation __________

Sick __________

On leave __________

Other (fill in reason) ______________________________

____

____

Signed: ______________________________
(Employee)

Signed: ______________________________
(Supervisor)

WESTERN NUCLEAR, INC.
SHERWOOD MINE

G.B.F. WNI-108

BIOASSAY ACTION CHECKLIST

NAME:________________________ DATE:_________________

_____________________ READING

_____________________ RE-TAKE

1. 15 to 30 μg/l

   a. Confirm results (re-take uranalysis) DATE:________________ ( )

   b. Check air samples of the Job/Task area. ( )

   c. Identify cause of reading and initiate additional control measures. ( )

   d. Check other workers in the task area and determine whether or not they could have been exposed, if so re-take their urinary sample. ( )

   e. Consider work limitations.

2. Above 30 μg/l

   a. Same as above and continue operations if it is virtually certain that no other worker will exceed a urinary concentration of 30 μg/l. ( )

   b. Establish work restrictions for affected personnel. ( )

3. 30 μg/l for (4) four consecutive specimens or greater than 130 μg/l for any specimen.

   a. Take above action. ( )

   b. Test for Albuminuria. RESULTS:_____________________________ ( )

4. Where was the sample taken and how? ( )

   Routine specimen's should be collected at least 48 hours after the most recent occupancy of the yellowcake concentrate area. The 48 hour delay is necessary to avoid uranium that is eliminated without uptake in kidney tissues. First thing in the morning or when you wake up. But not more than 96 hours, (this is necessary to permit detection of an exposure before elimination renders it undetectable). The specimen must be taken in a clean environment.

5. Re-train personnel in Radiation Safety if personal hygiene or respirators are a problem. ( )

6. REMARKS: FOR CLOSEOUT ACTION ONLY

LAPEL SAMPLING PROCEDURES

Introduction:

Sampling for uranium dust with a lapel sampler provides an air sample collected directly from the breathing zone of the wearer. Thus, the exposure calculated from lapel samples provides a very accurate estimate of actual exposures. The use of lapel sampling is a requirement for all yellowcake packaging operations at the Sherwood Mill and for all maintenance requiring an RWP in soluble uranium areas and in enclosed tanks where uranium bearing solutions are processed. Lapel sampling is also done to verify exposure calculations and in any area where a worker may receive a significant exposure from airborne uranium, soluble or insoluble.

Set-up and Calibration:

Unplug the DuPont Model P200 or P200A sampler from the charger carefully so the clock starts and is reset to 0.00. Turn the pump to ON and plug the intake into the tubing from the calibrator flowmeter. Wait for the pump to reach the maximum stable flow and adjust flow with a screwdriver through the capped port in the front of the sampler. If the mump fails to start in about one minute, replug it into the charger and take another sampler and repeat the above process. The calibrator flowmeter should read 200-210 ml/min. (or about 0.2 lpm). Once calibrated, turn the pump to OFF. Turning the pump off stops the clock but does not delete any time elapsed. Take a filter holder and connecting tube and connect to the pump. On the filter holder, enter the user's name, the date and the time indicated on the digital clock into the appropriate spaces.

LAPEL SAMPLING PROCEDURES

Set-up and Calibration continued:

The use of lapel samplers is generally in areas where respirators are required at all times, i.e.; Roaster and Packaging areas. In these situations, instruct the user to turn the pump on prior to putting on the respirator and turn the pump off after each time the respirator is removed. In this way, the sample collected is representative of actual airborne concentrations while the respirator is worn. At the end of the shift or need for the lapel sampler, enter the stop time on the filter holder. If the sampler is used during off hours, weekends or at any other time the Radiation Safety staff is absent, instruct the user prior to leaving on how to record the stop time, unplug the sample holder and replug the sampler into the charger. Supervisory personnel in the mill office should be instructed on how to issue these samplers should the need arise in the absence of Radiation Safety staff.

The sample filter is to be prepared for nondestructive assay by the laboratory in the same way as other uranium dust sample filters. On the data sheet in the laboratory, enter the users name under "STATION", LAPEL under "PUMP ID", and total sample time in minutes under "SAMPLE TIME". These samples are counted for one thousand (1000) seconds by the laboratory.

ATTACHEMENT 7

11. Waste management and Environmental Monitoring Program.

OPERATIONAL

Mill Tailing Dam Inspection Checklist

Name of Dam ______________________________

Location of Dam ______________________________

Date Constructed ______________________________

Type of Dam ______________________________

Materials in Construction ______________________________

Owner ______________________________

Address ______________________________

____

____

Type of Tailings ______________________________

Water Level Below Crest ______________________________

Spillway Freeboard ______________________________

Type ______________________________

Width ______________________________

Weather Previously ____________________ Currently __________

Temperature ____________________ °F

Inspection Date ______________________________

Inspection Team ______________________________

____

____

____

Directions: Place an "X" in the YES or NO columns. If an item does not apply to the particular dam, write an "N/A" in the Remarks column. Any other pertinent information may be placed in the Remarks column.

ITEM	YES	NO	REMARKS
I. DAM OPERATION:			
A. Is there a qualified monitoring program?			
B. Is there regular surveillance?			
C. Is dam frequently inspected? How often?			
D. Is there a contingency plan posted?			
E. Is the tailings transport system maintained?			
F. Is the retention system maintained?			
G. Are records available for:			
1. Piezometer readings?			
2. Pond levels? Dates:			
3. Groundwater quality?			
4. Survey monuments?			
a. Structural b. Foundation			
5. Background radioactivity			
6. Seepage			
a. Any observed b. Color c. Estimated d. Measured			

ITEM	YES	NO	REMARKS
II. POND LINER			
A. Type			
B. Any rips, tears, perforations?			
1. Is cause known?			
2. Corrective action taken?			
C. Any unusual bubbles?			
1. Is cause known			
2. Corrective action taken?			
D. Are all repairs adequate?			
E. Slump of dirt cover?			
1. Cause known?			
2. Corrective action taken?			
III. UPSTREAM SLOPE			
A. Any noticable erosion?			
B. Adequate riprap protection?			
C. Deterioration from wave action?			
D. Evidence of stone deterioration?			
E. Is condition of grass cover adequate?			
F. Is type of grass cover adequate?			
G. Are trees growing on slope?			
H. Are trees on slope healthy?			
I. Are any longitudinal cracks evident?			

ITEM	YES	NO	REMARKS
J. Are any transverse cracks evident?			
K. Are any settlements in evidence?			
L. Are there any visible bulges?			
M. Are there any visible depressions?			
IV. CREST			
A. Are there any visual depressions?			
B. Is there any misalignment?			
C. Is there any evidence of cracking?			
D. Is there any signs of migration?			
V. DOWNSTREAM SLOPE			
A. Any noticeable erosion?			
B. Are there any visual depressions?			
C. Are there any visible bulges?			
D. Is there any evidence of settlement?			
E. Are there any longitudinal cracks?			
F. Are there any transverse cracks?			
G. Is there any seepage present?			
H. Are boils present at the toe?			
I. Are relief wells flowing adequately?			

ITEM	YES	NO	REMARKS
J. Is toe drain dry?			
K. Is there adequate grass cover?			
L. Is grass cover healthy?			
M. Are trees growing on slope?			
N. Are trees healthy?			
O. Have there been any changes in cover from toe to crest?			
VI. ABUTMENT CONTACTS			
A. Any evidence of erosion?			
B. Any evidence of differential movement?			
C. Any evidence of cracks?			
D. Is there any seepage present?			
E. Are the abutments competent?			
VII. SEEPAGE			
A. Is seepage present?			
B. Amount of seepage?			
C. Amount of seepage: 1. Estimated 2. Measured			
D.			
E.			
F. Are there any springs forming?			

ITEM	YES	NO	REMARKS
G. Are there wet or boggy areas?			
H. Are underdrain pipes:			
1. Clogged?			
2. Cracked?			
3. Eroded?			
4. Showing deposits at down-stream end?			
VIII. TAILINGS TRANSPORT SYSTEM			
A. Are there unusual bends in pipe?			
B. Are there any adverse slope changes?			
C. Is the pipe worn extensively?			
D. Any evidence of clogging?			
E. Any evidence of corrosion?			
F. Any evidence of cracking?			
G. Are the supports for the piping stable?			
H. Is the character of the water into and out of the system similar?			
I. Are there any open joints?			
J. Any evidence of leakage?			
IX. DIVERSION CHANNELS			
A. Any evidence of bank erosion?			
B. Any obstruction to flow by means of:			
1. Bed aggradation?			
2. Bed degradation?			

ITEM	YES	NO	REMARKS
3. Siltation			
4. Undesirable vegetation?			
5. Other?			
C. Is there any evidence of unusual or inadequate operational behavior?			
D. Are the diversion channels functional?			
X. EMERGENCY DISCHARGE FACILITIES			
A. Is there evidence in the spillway of:			
1. Erosion?			
2. Structural problems?			
3. Backcutting?			
4. Obstructions?			
5. Improper functioning?			
6. Inadequate size?			
B. Are the culverts:			
1. In good operating condition?			
2. Are they functional?			
3. Are they adequate?			
C. Do the retaining walls show evidence of:			
1. Spalling?			
2. Cracking?			
3. Scaling?			
4. Erosion?			
5. Other detriments?			

ITEM	YES	NO	REMARKS
XI. AVAILABLE INSTRUMENTATION			
A. Are there flow monitoring weirs that are:			
1. Functional			
2. Adequate			
3. In good working order?			
B. Are there survey monuments?			
C. Are settlement plates or gauges working properly?			
D. Are piezometers:			
1. Functioning properly?			
2. Protected adequately?			
3. Marked correctly?			
E. Are there other types of instrumentation?			
XII. EROSION EVALUATION			
A. Does erosion occur away from the site boundary?			
B. Is there evidence of tailings material being transported by:			
1. Air?			
2. Water?			
3. Man?			
4. Animal?			
XIII. RADIATION MONITORING			
A. Is there documentation showing monitoring for:			
1. Radon 222?			

ITEM	YES	NO	REMARKS
2. Other radionuclides?			
3. Heavy metals?			
B. Are the following types of samples taken on a regular basis?			
1. Soil?			
2. Air?			
3. Groundwater?			
4. Effluent?			
XIV. CHANGES IN DAM OR POND			
A. Has additional information been placed on data sheet for dam?			
1. Date of last enlargement			
2. Method of enlargement			
B. Has last inspection been documented?			
C. Has pond area been increased?			
D. Have any corrections been made since last inspection?			
XV. CONCLUSIONS			
A. Is the dam in good condition?			
B. Does the dam appear stable?			
C. Does the dam have sufficient freeboard?			
D. Does the dam currently jeopardize the environment?			
1. How much?			
2. In what manner?			

INTERIM STABILIZATION
OF
TAILINGS

WAC 402-52-100 Criterion 7 states in part, "To control dusting from tailings, that portion not covered by standing liquids shall be wetted or chemically stabilized to prevent or minimize blowing and dusting to the maximum extent reasonable achievable. ...operators shall develop written operating procedures specifying the methods of control which will be utilized".

The Sherwood tailings have been neutralized and discharged at the highest density possible. These two elements have allowed natural vegetation to occur on stacked and drained tailings. The combined sand-slime mix maintains moisture to the surface which promotes crust formation as water is evaporated. The moisture retention of the high density discharge, crusting of solids, and natural revegetation have contributed to the lack of blowing tailings. In addition, the elevation of the tailings at its current state (below grade) reduces the chance of blowing tails.

Daily inspection of the tailings area includes notation of dusting. Minor blowing dust has been observed by momentary high gusts in areas. No other problems have been noted to-date.

As stated above, dusting or blowing of tailings has not been a problem at the Sherwood Project. However, should dust or blowing of tailings become evident for any sustained period, the following methods are available to alleviate the problem and to prevent any future blowing of tailings:

1. Pumps and transport lines are set up to deliver water to the affected areas.

2. Tailings discharge lines are set up to deliver wetted or fresh tails to the area.

3. Vegetation growth is promoted on temporarily inactive areas.

4. Other; Includes working the tailings by low-ground-pressure dozing, as conditions dictate.

5. Currently for evaporation as well as the prevention of blowing tails the surface area being wetted is maximized.

WESTERN NUCLEAR, INC.
Sherwood Project

Table 1.

ENVIRONMENTAL MONITORING PROGRAM

Environmental Element	Sampling Location	Sampling Frequency	Type of Measurement
1. Direct Gamma (TLD)	Stations B, C, D, E, F-2, G-2, Rajewski, Hamilton and Tum Tum (control).	Quarterly.	Direct gamma exposure rate.
2. Air Quality	a. Restricted Area Effluent Stacks.		Natural Uranium, Radium-226, Thorium-230, Lead-210 and Stack Flow.
	1) Yellowcake Roaster Scrubber	Quarterly.	
	2) Yellowcake Packaging Baghouse	Quarterly.	
	3) Crusher Scrubber	Semi-annually.	
	4) Fine Ore Reclaim Tunnel Baghouse	Semi-annually.	
	b. Unrestricted Area.		Natural Uranium, Radium-226, Thorium-230 and Lead-210 in particulates from composited filters.
	1) Stations B, C, G-2, Rajewski, Hamilton and Tum Tum.	Quarterly, continuous low volume with weekly filter changes.	
	2) Stations D, E, and F-2.	Quarterly, 24 hours per month high volume.	
	3) Stations B, C, D, E, F-2, G-2, Rajewski, Hamilton and Tum Tum.	Quarterly integrated composite.	Radon-222.
3. Soil	Stations B, C, D, E, F-2, G-2, Rajewski, Hamilton and Tum Tum.	Annually.	Natural Uranium, Radium-226 and Lead-210.
4. Vegetation	Stations B, S-2 (near C), and D.	Three times annually during grazing season.	Radium-226 and Lead-210.
5. Fauna (Fish)	Lake Roosevelt, near site boundary.	Semi-annually.	Radium-226 and Lead-210.
6. Sediment	Surface water sample sites L-1, L-2 and L-3 and Seep water sample sites L-3 Seepage and Pumphouse Seepage.	Annually	Natural Uranium, Radium-226, Thorium-230 and Lead-210
7. Water	a. Surface Water from Lake Roosevelt at L-1, L-2 and L-3.	Quarterly	Dissolved Natural Uranium, Radium-226, Thorium-230, pH, TDS, SO_4, Cl, Na, Ca and Mg. Suspended Natural Uranium, Radium-226 and Thorium-230

Table 1, continued

ENVIRONMENTAL MONITORING PROGRAM

Environmental Element	Sampling Location	Sampling Frequency	Type of Measurement
7. Water, cont'd	b. Groundwater Monitoring Wells MW-1A, MW-2, MW-3, MW-4, MW-5 and MW-6.	Quarterly	Dissolved Natural Uranium, Radium-226 and Thorium-230, pH TDS, SO_4, Cl, Na, Ca and Mg.
		Biweekly	Static Water Level.
	c. Springs S-1, S-2, S-3 and S-4.	Quarterly	Dissolved Natural Uranium, Radium-226 and Thorium-230, pH TDS, SO_4, Cl, Na, C and Mg.
	d. Seeps L-3 Seepage and Pumphouse Seepage.	Monthly	Dissolved Natural Uranium and Radium-226, pH, TDS, SO_4, Cl, Na, Ca and Mg.
		Quarterly	Dissolved Thorium-230.
8. Aerial Photography	Mill Lease Area.	Annually	Color photograph to assess visible changes in vegetati and topography.
9. Foodstuffs; Garden Produce and Livestock	Nearest residences Rajewski Hamilton.	Annually at time of harvest or slaughter.	3 replicates of eac sample for Radium-226 and Lead-210.
10. Land Use	Area within 8 km of millsite.	Annually	Inventory all residences and document land use by each.
11. Meteorological Conditions	Millsite.	Continuous	Wind speed, direct and stability in hourly averages an quarterly composite
12. Interim Tailings Stabilization	Tailings Impoundment Area.	Daily and annual inspections.	Document conditions deficiencies and corrective actions.

February 4, 1987
RE: Sherwood Groundwater Monitoring Wells

Sherwood #	Dravo #	Dravo Depth	Log Info	01/21/87 Total Depth (Ft. MSL)	01/21/87 Total Depth Readings (From Top of Casing)
MW1A	WNI drilled	(83')	Lower 10' perforated Water @ 78' overnight	2046.45	83.65'
MW2	MWU2	94'	5.6 inch O.D. casing Bedrock @ 88' Cased to 78'; lower 10' perforated Water @ 82' 24 hrs after drilling	2012.30	95.80'
MW3	MWU3	65'	2.5 inch O.D. casing (PVC) Bedrock @ 55' Cased to 62'; lower 10' perforated Water @ 7' detected 2 weeks after drilling	2037.05	61.95'
MW4	MWD3E	219'	5.6 inch O.D. casing Bedrock @ 198' Cased to 199'; lower 10' perforated Water @ 218.4' 4 hrs after drilling	1769.30	219.90'
MW5	MWD3C	174'	5.6 inch O.D. casing Bedrock @ 158' Cased to 159'; lower 10' perforated Water @ 174' 5 days after drilling	1816.25	172.85'
MW6	MWD3D	160'	5.6 inch O.D. casing Bedrock @ 135' Cased to 137'; lower 10' perforated Water @ 142' 5 hrs after drilling	1832.80	161.60'
MW7	MWD5	158.5'	5.6 inch O.D. casing Bedrock @ 153' Cased to 148'; lower 10' perforated Water @ 159' 24 hrs after drilling	-	-

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APPENDIX 1

Groundwater Monitoring System