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0	1996			Exploration Safety Group
1	Jan, 1997	All	See Forward	Cameco Exploration Safety Officer
2	Mar, 2004	All	Meet the current Cameco Exploration Health and Safety Policy best practice guidelines	Cameco Exploration Safety Officer
3	Feb, 2008	All	Update and revise deemed to be outdated.	SHEQ Coordinator and Data & Quality Assurance Coordinator
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1.0 PLAN

1.1 Radiation Safety Program

In exploration camps where uranium mineralization has been discovered, members of the workforce may work routinely with core samples containing uranium. Since uranium undergoes a spontaneous radioactive decay, the workforce has a probability of an exposure to radiation as a consequence of coming into close contact with, and handling, uranium mineralization and ores. In addition, there is a risk of a radiation exposure from the radioactive sources incorporated in certain items of equipment used in uranium exploration.

In recognition of the potential for radiation exposure to individuals working with uranium mineralization, this Radiation Safety Manual has been prepared for distribution to the Exploration Department and contractors. The manual details the types of radioactive materials that may be encountered, the relevant regulations, and the work practices to be adopted to minimize exposure.

1.2 Radiation Safety Program Objective

The objective of the Radiation Safety Program is to minimize personal and environmental radiation exposures to levels that are as low as reasonably achievable (ALARA), economic and social factors considered. This is accomplished by the implementation of personal and area monitoring procedures, safe work practices, and, where applicable, the use of personal protective equipment.

Though the level of radiation exposure resulting from exploration activities is generally minimal, Cameco is committed to the ALARA principle.

1.3 Regulator Framework

The first stage of exploration activity is regulated by the province of Saskatchewan and Health Canada. The primary regulatory documents are the Saskatchewan Occupational Health and Safety Act and Regulations, Radiation Protection Guidelines for Uranium Exploration, and the Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM). In addition, the Canadian Nuclear Safety Commission (CNSC) regulates exploration activities related to nuclear gauges and the transport of radioactive substances. Once a project has progressed to the stage of “evaluating” an ore body (as defined in the CNSC Guidance for Uranium Mine Site Licence Preparation) the CNSC becomes the primary regulator.

Under the Canadian Guidelines for the Management of NORM, naturally occurring radioactive materials are radioactive elements found in the environment. This includes uranium, thorium, and potassium, and any of their radioactive decay products. By definition NORM is not part of the nuclear fuel cycle, therefore it is not under the control of the CNSC. It is the principle of the Canadian Guidelines, though, that workers exposed to NORM should by subject to the same radiation exposure standards that apply to workers exposed to CNSC-regulated radioactive materials.

The Guideline recommends that the annual effective dose of persons exposed to NORM as the result of a work practice (occupationally exposed workers) be limited to the values given in Table 1. Occupationally exposed workers are those people who are exposed to NORM as part of the routine duties, and are officially classed as NORM Workers. Incidentally exposed workers and members of the public include employees or visitors whose routine duties do not include exposure to NORM.

Table 1: Radiation Dose Limits

Affected Group	Annual Effective Dose Limit (mSv) [(a)]	Five Year Cumulative Dose Limit (mSv)
Occupationally Exposed Workers [(b)]	20 [(c)]	100
Incidentally Exposed Workers and Members of the Public	1	5

a) These limits are exclusive of natural background and medical exposure
b) For the balance of a known pregnancy, the effective dose to an occupationally exposed worker must be limited to 4 mSv.
c) The five-year dose limit is 100 mSv/y, which translates to an annual dose limit of 20 mSv/y. For occupationally exposed workers, a maximum dose of 50 mSv is allowed in one year, provided the five-year limit is not exceeded.

1.4 Requirements of the NORM Management Program

In order to control doses to member of the public, as well as NORM workers, the Canadian Guidelines recommend a program of dose classifications/thresholds and reviews. These classifications determine the level and type of activities that must take place in order to effectively protect the workers. The classifications and program steps are described below and illustrated in Figure 1. Additional Cameco requirements are also included in the programs, as applicable

Note this program is based on an assessment of the maximum annual effective dose for members of the public and NORM workers, not the average. Additional information and standards for establishing radiation protections programs is contained in the Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials

The underlying theme of all radiation protection programs and decisions, regardless of the classification, is the ALARA principle. This means keeping doses As Low As Reasonably Achievable, social and economic factors taken into account.

1.4.1 NORM Program Classifications

1.4.1.1 Unrestricted Classification

The program classification used when the maximum effective dose to a member of the public is expected to be below 0.3 mSv/y and to a worker is expected to be less than 1.0 mSv/y. No further action is needed to control doses.

1.4.1.2 NORM Management Classification

The program classification when the assessed maximum annual effective dose to a member of the public or incidental worker is expected to exceed 0.3 mSv/y. Public access would need to be restricted, but worker access would be unrestricted. The NORM Management Program for this classification may include:

- Restricting access to incidentally exposed workers.
- Introduction of material management procedures.
- Changes in work practices.

1.4.1.3 Dose Management Classification

The program classification when the assessed maximum annual effective dose to an occupationally exposed worker is expected to exceed 1.0 mSv/y. For this classification, the Dose Management Program should include:

- Worker notification of radiation sources.
- Consideration of work practices and protective clothing to limit worker exposures.
- Application of engineering controls where appropriate.
- Training to control and reduce worker dose.
- Introduction of a worker radiation dose estimation program.
- Reporting of worker doses to the National Dose Registry.

Components of the corporate Radiation Protection Program also need to be incorporated into the Dose Management Program.

1.4.1.4 Radiation Protection Management Classification

The program classification when the assessed maximum annual effective dose to a worker is expected to exceed 5.0 mSv/y. The Radiation Protection Management Program for this classification should include:

- Introduction of a formal radiation protection program.
- Place workers expected to exceed 5 mSv/y in a personal radiation dosimetry program, meeting the requirements of the CNSC.
- Provide protective equipment, clothing, and work procedures to reduce the worker dose and spread of contamination.

When the actual measured dose of a worker is over 5 mSv/y, the following steps should be added to the program:

- Use engineering controls and provide protective equipment designed to reduce worker dose as required.
- Ensure that workers do not exceed the five-year average occupational dose limit of 20 mSv/y.

Further, the entire corporate Radiation Protection Program and all requirements therein must also be incorporated into the Radiation Protection Management Program.

1.4.2 Program Reviews

1.4.2.1 Initial Review

This is an initial assessment to determine if it is suspected that the maximum annual effective dose will exceed 0.3 mSv/y for either the public or workers. A radiation dose assessment is part of this review.

1.4.2.2 Radiation Dose Assessment

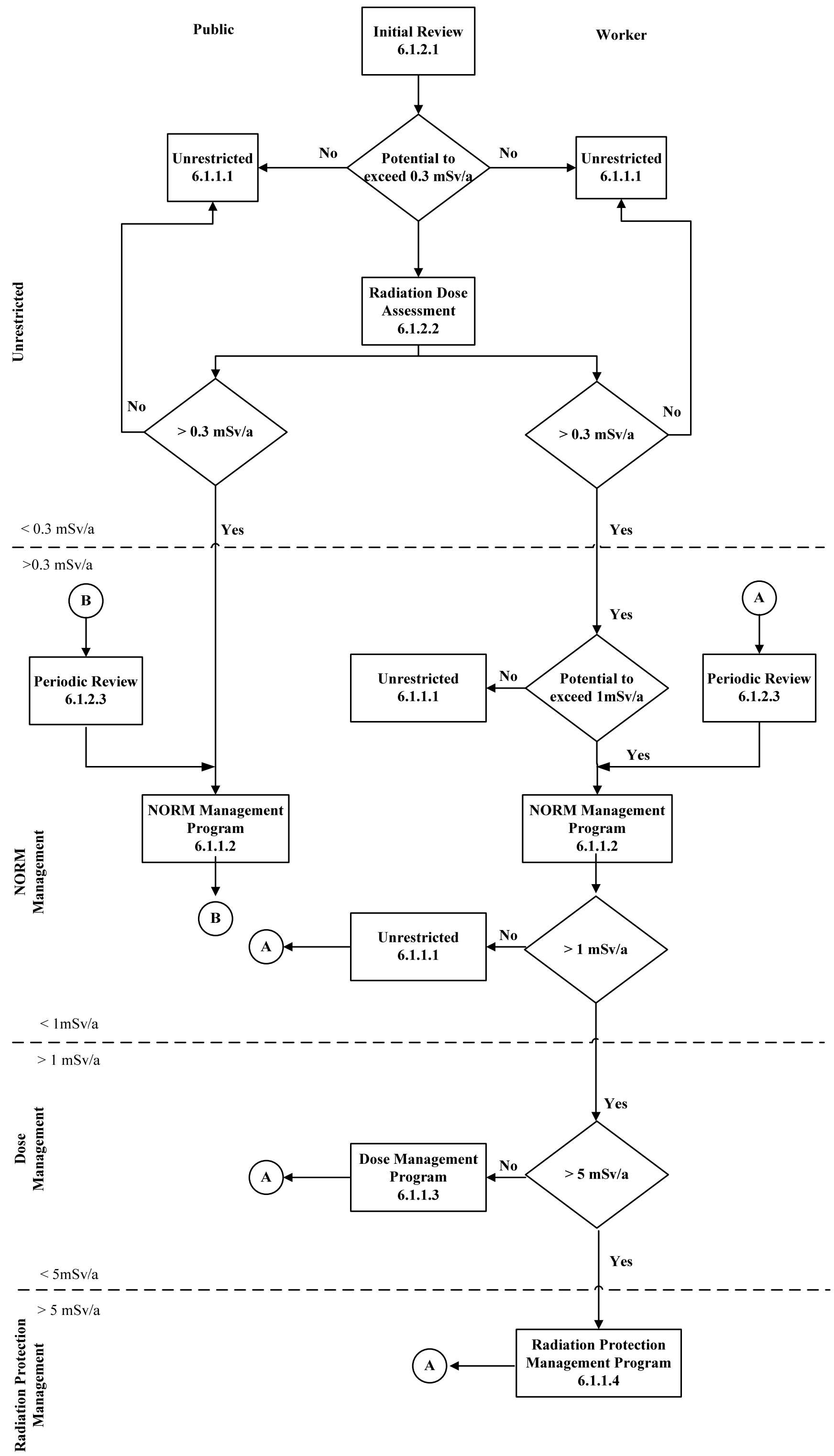
Estimate the doses to workers and members of the public by conducting a radiation survey of the workplace. This survey should include both gamma radiation and airborne radioactivity, as appropriate.

1.4.2.3 Periodic Review

Whenever a NORM Management, Dose Management, or Radiation Protection Management Program has been implemented, a periodic review is needed. The review is to determine if there are any changes to the system that might affect doses, to monitor the effectiveness of the program, and determine if any changes are needed. The frequency of the review depends on the program itself and the likelihood that conditions at the work site will change.

Figure 1: NORM Program Flowchart

Figure 1: NORM Program Flowchart



1.5 The Exploration Dose Management Program

Based on an assessment of doses in June of 2005, the potential currently exists for an occupationally exposed worker to exceed 1.0 mSv in a year. According to the classification scheme outlined in Section 1.4.1, the exploration radiation safety program must meet the requirements of a Dose Management Classification, including components of the corporate Radiation Protection Program. Requirements specific to individuals, e.g. training, apply to occupationally exposed workers only.

Table 2 shows the breakdown of jobs performed at a typical exploration camp by exposure category (occupationally or incidentally exposed workers). This list is based on annual gamma doses measured by TLD badge between the years of 2003 and the first quarter of 2005.

Table 2: Classification of Jobs by Exposure Group

Incidentally Exposed Group	Occupationally Exposed Group
Drilling Crews	Geologists
Labourers	Geological Technicians
Corporate Management	Geoscientists
Economic Geologist	Geophysicists

The first four requirements of the Dose Management program are met via the requirement for radiation training for all occupationally exposed employees, and the requirement that all such employees have read this manual prior to beginning work. The radiation dose estimation program and reporting of doses to National Dose Registry (NDR) is detailed in Section 3.1.

Additional requirements of the corporate Radiation Protection Program are as follows:

- hazard identification and risk assessment (Section 2.2);
- documentation and records (Section 3.4.1);
- management reviews (Section 5.1); and
- auditing.

A review of all monitoring results (engineering and dosimetry) will be conducted annually by the corporate Safety, Health, Environment, and Quality (SHEQ) Department. The corporate Internal Audit SHEQ will also conduct an audit of one exploration field camp every 18-24 months to assess compliance with this program and assess the overall effectiveness of the program.

1.6 Risk Assessment

As per the corporate Radiation Protection Program, a risk assessment must be performed to assess any hazards that, without controls, could reasonably cause a dose limit to be exceeded or a non-compliance with laws or regulations. Though the occupationally exposed worker dose limit is 50 mSv per year and 100 mSv over a five-year dosimetry block, the Dose Management classification is predicated on doses being less than 5 mSv/y. As such, hazards that could reasonably cause a dose in excess of 5 mSv will be assessed. Example of such hazards includes a damaged radiation source, improper storage of large quantities of high-grade uranium, or non-compliance with transportation regulations.

2.0 DO

2.1 Application and Administration of Radiation Safety Program

All applicable radiation safety principles and procedures will be applied at exploration sites where uranium mineralization is present. Once mineralization has been detected it is the responsibility of the project geologist to implement and oversee the radiation protection program at each site. The overall radiation protection program for the exploration division is overseen by the SHEQ Coordinator, Exploration . Oversight duties include record keeping (this includes all radiation monitoring data, dose information, and training records, as detailed in Sections 2.2 and 3.1), communicating any program changes to all department members and contractors, ensuring new hires and contractors receive training, and general program management.

As per the corporate Radiation Protection Program, the corporate Safety, Health and Environment (SH&E) department will conduct an annual management review of elements of this program, including monitoring results, doses, and compliance, as detailed in Section 9. In addition, the Exploration department has been added to the corporate audit program. One exploration site will be audited every 18-24 months to assess compliance with applicable laws and regulation, and overall program effectiveness.

2.2 Training

Workers who are expected to exceed a dose of 0.3 mSv/y are considered occupationally exposed and require additional radiation protection training. To assist in determining which workers require training, Section 1.5 contains a breakdown of the jobs performed by occupationally exposed workers and those performed by incidentally exposed workers (those expected to be less than 0.3 mSv/y). If a job classification is not already included in the list, contact the Exploration SHEQ Coordinator for assistance in performing an initial dose assessment for this worker.

All new occupationally exposed workers, including contractors and students, must receive the corporate office radiation safety presentation or attend the radiation protection training course offered at one of Cameco’s operating sites in northern Saskatchewan prior to starting work. The corporate office course is designed to give a basic knowledge of radiation and radiation protection and provide general information on radiation hazards and safe work practices at an exploration site. A copy of the corporate office presentation is available on Exploration’s intranet site, SHEQ page. The Basic Radiation course at an operating site also provides the basics of radiation protection, spotting radiation hazards, and safe work practices.

Training records, including worker name, course type (corporate or site), course date, employment type (student, new hire, etc.) and employment start date will be maintained by the SHEQ Coordinator, Exploration.

The SHEQ Coordinator, Exploration will also be responsible for communicating changes in this program manual or in any department-wide procedures with a radiation safety component to the field sites. This person will also be responsible for ensuring each new employee is given a copy of this manual and informed of the need to read it before they begin working with uranium.

Each field site will be responsible for presenting any site-specific procedures or work instructions related to radiation safety to new hires.

2.2.1 Introduction to Radiation and Radiation Protection

This section provides a brief overview of the types of radiation, potential exposure routes, and basic radiation protection principles. See the corporate office radiation safety presentation, available on Exploration's intranet site, SHEQ page, for further information on radiation and radiation protection.

2.2.1.1 Types of Radiation

There are three types of ionizing radiation that are emitted by uranium ore, namely, alpha, beta and gamma radiation. Alpha particles are relatively heavy charged particles (helium nuclei) that are readily stopped by materials, such as a sheet of paper or outer layers of dead skin. Beta particles are lighter, charged particles (electrons or positrons) with slightly more penetrating power. They can be stopped by plastic or a thin layer of metal, but can penetrate into the outer layers of the skin. Gamma rays are electromagnetic radiation with high penetrating ability, such as being able to pass through steel pipes and body tissues.

2.2.1.2 Internal and External Exposure

An external exposure to radiation occurs if a person is subjected to radiation originating outside the body. External exposures primarily arise from gamma radiation emitted from a radioactive material outside the body, for example a high-grade core sample. Beta particles also have a limited ability to penetrate into body tissues and can result in external exposures to both skin and eyes. Alpha particles are not an external hazard.

An internal exposure to radiation occurs if a person is subjected to radiation arising from a radioactive material that has entered the body. The internal exposure is caused by alpha and beta particles having direct access to sensitive body tissue, rather than being stopped by less sensitive external tissues. Intake routes for radioactive materials are by inhalation of dusts and particles, ingestion of loose material, or absorption through an open wound.

2.2.1.3 Sources of Radiation

There are three sources of radiation to be concerned with: uranium ore, long lived radioactive dust, and radon progeny. These sources can be thought of as the physical substances (rocks, dusts, etc.) that are giving off the alpha, beta, and gamma radiation.

Uranium ore is found in core samples containing uranium mineralization. It gives off gamma radiation and is also a source of alpha and beta radiation. Gamma is its primary hazard, however.

Long lived radioactive dust (LLRD) is the dust produced when uranium ore samples are dispersed in some way (e.g. cut, ground, crushed, etc). These dust particles give off alpha, beta, and gamma radiation. The primary hazard from LLRD is alpha radiation, because the dust particles are loose (airborne or on surfaces) and can be taken into our bodies by inhalation or ingestion.

Radon progeny are four radioactive particles produced by the decay of radon gas, which is part of the uranium-238 decay series. Radon progeny are airborne and their primary hazard is from alpha radiation, because they can be inhaled into the lungs.

2.2.1.4 Radiation Protection Principles

For routine exploration activities, external radiation (e.g. from core) is the most likely source of radiation. There is potential for internal exposures, but this tends to be much less than the external exposure potential.

Protection from both internal and external exposures is the responsibility of every worker. This can be achieved by adhering to the four principles of Time, Distance, Shielding, and Ventilation:

Time — radiation exposure is reduced by minimizing the time spent close to radioactive material;

Distance — radiation dose rate from a source falls off drastically as the distance between you and the radioactive source is increased;

Shielding — radiation can be absorbed by materials. External exposure is reduced by placing dense materials like steel or concrete between you and the radioactive material. Denser materials are more effective shields, but even water can be a very good shielding material, and

Ventilation — by ensuring good air-flow when working with uranium bearing materials, radioactive dusts and particles are removed from the air that workers are breathing. This significantly reduces the potential for internal exposure caused by inhalation.

Section 2.4 includes specific work practices that incorporate these radiation safety principles and must be followed whenever working with mineralized and other radioactive materials.

2.2.2 Good Housekeeping and Personal Hygiene

Since an internal exposure to radiation occurs from the inhalation or ingestion of radioactive materials, work practices should be adopted that restricts the amount of airborne dusts and contamination of hands, clothing, food utensils, etc. Reducing airborne dusts is best achieved by handling mineralized materials in the wet state whenever cutting or grinding is required. To further limit the potential for ingestion of uranium, always wash hands before eating or smoking, do not chew gum or sunflower seeds when working with ore, and remove all contaminated clothing and wash before entering clean areas (e.g. eating areas or lodgings).

Radiation protection also involves minimizing the external exposures to radiation. To this end it is important that the uranium mineralization is kept in its correct storage locations. Any spillage or accumulation of the materials should be cleaned up immediately. A gamma radiation exposure will arise from small piles of mineralized material while an internal exposure will occur from inhalation of airborne dusts.

2.2.3 Personal Protective Equipment

When working with mineralized drill core samples, workers should wear coveralls and gloves to keep ore dust from their hand and regular clothes. This helps to limit the spread of contamination. Also, safety glasses are mandatory when working with mineralized drill core to protect the eyes from beta radiation. Respiratory protection is also an option for limiting exposure from dust and radon progeny, particularly when working in an enclosed area.

2.3 Facility Radiological Hazards and Safe Work Procedures

2.3.1 Facility Radiological Hazards

This section summarizes the types and sources of radiation that can be present at the various exploration facilities followed by a risk assessment.

2.3.1.1 Field Camps / Core Shack

The primary source of radiation at a field camp or in a core shack is drill core and chips from drilling programs that contain uranium. The main radiation hazards are external exposure from gamma radiation emitted from the uranium mineralization, internal exposure from inhaling or ingestion of the dusts arising from handling the uranium mineralization, and inhalation of radon progeny.

Consequently the components of the radiation dose will be

i) external exposure from gamma radiation;
ii) internal exposure from inhaled airborne dusts;
iii) inhalation of radon and radon progeny; and
iv) ingestion of dust (minor source).

In addition, radiation hazards may exist due to artificial radioactive sources, such as soil density gauges, down-hole logging equipment, spectrometers (with built-in sources) and calibration sources for scintillation detectors. The radiation hazards from these sources are external exposure from gamma radiation.

2.3.1.2 Corporate Office

Cameco Corporate Office does not currently possess a licence to receive or store radioactive materials.

2.3.1.3 Saskatchewan Research Council (SRC)

Radioactive samples to be stored in Saskatoon will be stored at the Saskatchewan Research Council, which is licensed for radioactive materials storage. The project geologist will notify SRC of the impending arrival and departure dates of radioactive material shipments. The project geologist will be responsible for completing the logbook entries and taking spot radiation readings. When working at SRC, follow all of their radiation safety procedures.

2.4 Safe Work Practices

This section provides a summary of safe work procedures when dealing with both external and internal radiological hazards. These work practices address both the hazards identified in Section 2.3 and less significant hazards.

2.4.1 Gamma Radiation (External)

The following general procedures are adopted when working with mineralized core:

- Store mineralized core in a “hot tent” at least 30 metres away from other structures,
- Any area where the gamma field is 25 µSv/h or greater must be posted with a sign indicating elevated radiation fields, for example hot core storage areas,
- Do not loiter or work close to mineralized core samples when it is not required,
- Clean-up any material dispersed or left over after working with mineralized core samples,
- Always wear a TLD monitor badge,
- If available, wear a DRD when working with mineralized core, and
- wear safety glasses to protect eyes from beta radiation and conventional hazards

2.4.2 Radon Progeny Exposure (Internal)

When working with uranium mineralization, it is important to work in a well-ventilated area to minimize exposure to radon progeny. Open tent flaps or use the ventilation fan, if available, to ensure adequate airflow within tents. When working in an enclosed area, respiratory protection may be worn to further reduce any exposure to radon progeny.

2.4.3 Long Lived Radioactive Dust - LLRD (Internal)

Internal exposure from the ingestion or inhalation of contaminated dusts or particles is limited if the work procedure is 'wet'. The core cutting procedure is a 'wet' process, which utilizes water to cool the blade during cutting. Gloves and coveralls are also normally worn when handling the core whether wet or dry to limit contamination of hands and regular clothing and limit the spread of contamination. Respiratory protection may also be used to reduce exposure.

Prevention of ingestion of radioactive bearing material can also be achieved by washing hands prior to smoking and eating, not chewing gum or sunflower seeds where there is the potential for contamination, and removing coveralls and gloves prior to entering clean areas (e.g. eating or lodging areas). Open wounds present a pathway for radioactive contaminants. Personnel must ensure that any such wound is covered by clothing or other means.

2.4.4 Drilling and Core handling

Once mineralization has been intersected the drillers need to be instructed on how to minimize contact with the core and to store mineralized core at some distance from the core shack, prior it being transported into camp.

1. When drilling through mineralized zones, any recycled water should be collected into tanks or drums. Once the cuttings settle out, the water can be recycled. The container should then be sealed and shipped to a Cameco mine or mill for disposal.
2. Any spills of radioactive material should be collected in barrels, sealed and moved to a Cameco mine or mill for disposal.
3. Core is logged into the hot core shack. Date, time and the gamma level at 1 meter are recorded in a logbook. This requires a special meter; one with the lowest scale reading 0 to 1 μSv/h is preferred. The core is only allowed to remain in the core shack for 48 hours. The radiation level is recorded daily, while the hot tent is in use. A sign warning of radiation must be placed on the core shack door while core is inside. The date and time is recorded when the mineralization is removed. Each time the core is brought into the core shack you must record the entry and exit date and time.
4. If you can smell the uranium, then you have a problem with ventilation. Standard practice should be to have two fans set up in separate windows. One should force air into the tent and the other forcing it out. Before entering the core shack, the door should be fanned a few times to help flush the tent.
5. Before entering the hot core shack, a personal dosimeter (DRD) should be obtained and activated. Time in the hot core shack and the dosimeter reading at the end of work is recorded. (Note: Sometimes these DRDs can be obtained from the mine sites).
6. Floor sweepings from the mineralized core tent and contaminated gloves and personal protective gear will be collected in a dedicated, sealed storage container or drum and disposed of at a licensed facility, typically a Cameco mine or mill.

7. Upon completion of drilling, the contractor's equipment must be decontaminated before being released. This may require the equipment being taken to one of our mines or mills. The floorboards may have to be replaced, to reduce the surface activity. The contaminated equipment must be disposed of at the designated radioactive disposal site at one of Cameco's facilities.
8. It is assumed that the projects are using the normal safety equipment when dealing with mineralized drill core. This would include coveralls, gloves, respirator and safety glasses.
9. Safety glasses are mandatory when working with mineralized drill core.
10. After a drill hole is completed, drill mud, cuttings, soils, etc. with a uranium content greater than 0.05 % U_3O_8 must be disposed of down the drill hole. The upper 30 metres of bedrock or the entire depth of the hole, whichever is less, is then grouted. In addition, if mineralization greater than 1.0% U_3O_8 was encountered over a length of greater than one metre and with a metre-percent concentration greater than 5.0, grout the entire length of the mineralized zone and not less than 10 metres above and below the mineralized zone.

After moving off a mineralized drill hole the site must be scanned for contamination. Since the drilling fluid would have been collected during drilling, no contamination should be found. However, core chips and fluid from the tube may cause a problem. Sites must be cleaned to the Saskatchewan Environment clean-up criteria (Guidelines for Northern Mines Decommissioning and Reclamation, Nov 30, 2008), which is 1.0 µSv/h above background averaged over a 100m by 100m area. Readings are to be taken at a height of one meter. The contaminated soil must be removed and disposed of at a licensed facility.

3.0 CHECK

3.1 Exposure Control and Monitoring

The level of radiation exposure of personnel during all facets of the exploration activities can be expected to be low. However, to meet the requirements of a Dose Management program under NORM Guidelines and to assist in implementing the ALARA principle, a certain amount of radiation monitoring is to be conducted. This will range from personal monitoring when working with mineralization to routine swipe surveys of the camp. All radiation monitoring information is to be recorded.

3.1.1 Gamma Radiation

3.1.1.1 Personal Monitoring for Saskatchewan Camps

For official dosimetry purposes, monitoring equipment (e.g. TLD or OSL badges) from a licensed dosimetry service provider are used to measure gamma doses. The corporate Exploration Department rents the dosimeters from the licensed distributor (an example is Landauer) and distributes them to the appropriate personnel on a quarterly basis.

All Cameco or contractor personnel who will be working with or handling the core, working at the drill, or in the hot core shack must have a dosimeter assigned to them. These badges are to be worn whenever working with uranium mineralization. When not in use, the dosimeters should be stored next to the control dosimeter for that location (i.e. camp or corporate office). The dosimeters are sent to the appropriate dosimetry service (e.g., Landauer) for reading when they are changed.

Direct Reading Dosimeters (DRDs), such as the Canary IV units, provide a daily reading of the gamma dose. These units do not replace the dosimeters, which provide the official gamma dose, but can be useful at tracking radiation doses on a daily basis. DRDs should be used whenever working with mineralized core.

3.1.1.2 Personal Monitoring for International Travellers

This section applies specifically to the Global Exploration group, but could include anyone who will be travelling outside of Canada as part of their routine duties. This section has been added to address the problem of dosimeters accumulating exposure due to x-ray scanning at airports. Once scanned, the dosimeter no longer reflects the actual dose received by the worker.

In addition to a personal dosimeter, all routine international travellers will be assigned their own control dosimeter. The personal dosimeter is to be worn as per Section 3.1.1.1 and the control unit kept in a low background area (e.g. office, hotel, etc). When not in use, the personal dosimeter is to be stored in the same location as the control unit. It is <u>very important</u> that while travelling, the routine and control dosimeters be stored together in carry-on baggage. This will help insure that the control unit accurately accounts for additional exposure received from x-rays, while limiting the amount of x-ray exposure (baggage that is stowed gets significantly higher exposure than carry-on baggage does).

The use of individual control badges will have to be communicated properly to the dosimetry provider to ensure accurate results are reported.

3.1.1.3 Area Monitoring

For general occupational and environmental monitoring, the gamma radiation levels at normally occupied locations, excluding areas with mineralized material, (e.g. kitchen, lodgings, and other clean areas) should be measured at least annually. These measurements are typically taken at 1m above the ground, and can be used to assess contamination build-up issues.

Core samples will also be measured as they are logged in or before transport.

It is important when using a gamma radiation meter or scintillometer to become familiar with the units in which the meter is calibrated and the range of each scale. The indicated units can be (i) roentgens (R), (ii) Rad (rad), (iii) rem (rem or r), (iv) grays (Gy), (v) sieverts (Sv), or (vi) counts per second for the scintillometer. When dealing with gamma radiation levels in air, then the relationship between the first four units is:

$$1\ \text{R} = 0.87\ \text{rad} = 0.87\ \text{rem} = 0.0087\ \text{Gy} = 0.0087\ \text{Sv}$$

These units are quite large quantities so it is common to use the metric prefixes for subunits, such as milli- (m) and micro- (μ). Thus the above relationships can be written as

1 mR = 0.87 mrad = 0.87 mrem = 8.7 μGy = 8.7 μSv

While technically 1 R = 0.87 rad, for simplicity the conversion between roentgen and rad is often given as1 R = 1 rad. The other units are simply converted 1 rad = 1 rem = 0.01 Gy = 0.01 Sv. A useful conversion table is:

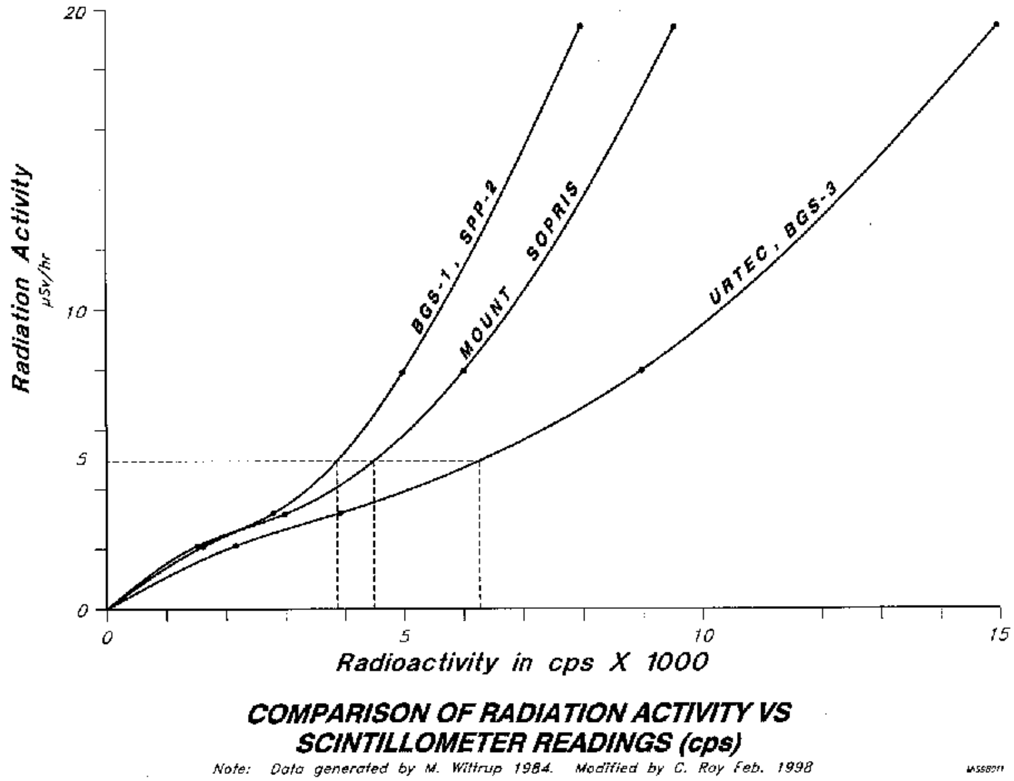
Table 4: Unit Conversion Table

μR	mrem	mSv	μSv
	100	1	1000
	10	0.1	100
1000	1	0.01	10
100	0.1	0.001	1
10	0.01	0.0001	0.1

The relationship between the number of counts per second for three common scintillometers and the unit of microsievert per hour is shown in Figure 2.

For actual operating instructions for any gamma radiation meter or scintillometer to be used refer to the manufacturer's manual. The meters must be calibrated annually by the appropriate authority.

Figure 2: Conversion Graph Between Counts per Second (cps) and Microsieverts per Hour for Common Scintillometers



3.1.2 Radon Progeny

One of the decay products of uranium is radon. Radon is a gas that emanates from materials containing uranium. In an unventilated room, the level of radon in the air in the vicinity of uranium materials can rise substantially and become a health risk from inhalation of the radon and its progeny. A natural breeze or forced ventilation quickly disperses airborne radon concentrations.

At uranium exploration camps potential radon problem areas are enclosed storage sheds or tents. Such work places should be well ventilated prior to commencing work in them. Storage sheds/tents can be ventilated by opening windows and doors to obtain airflow through the area.

Past monitoring has shown only trace background levels of radon progeny in the core tents. Either radon progeny monitors from Radiation Institute of Canada (RSIC) or radon track etch cups will be placed in the core shacks to assess radon progeny concentrations. Results of these monitors have historically been below the threshold for dosimetry monitoring required in the NORM Guidelines, see Appendix C for a detailed assessment.

3.1.3 Long Lived Radioactive Dust (LLRD)

The majority of work carried out on the core, where particulate matter is generated, is a wet process and therefore minimal dust is generated. It is important to ensure that machinery and work areas are cleaned after use. Dirty machinery and work areas can become dust sources when they dry. Personal hygiene is also important in preventing the inadvertent spread or ingestion of radioactive material. Food must not be consumed and no smoking allowed in areas where radioactive core is being stored or handled. When handling mineralized core, coveralls and gloves must be worn, and these must be taken off before entering uncontaminated areas.

LLRD monitors from Radiation Institute of Canada (RSIC) will be placed in the core shacks to assess LLRD concentrations. Results of these monitors have historically been below the threshold for dosimetry monitoring required in the NORM Guidelines, see Appendix C for a detailed assessment.

3.1.4 Contamination Monitoring

Contamination monitoring is performed by assessing the loose contamination using a swipe. Data collection should begin once the camp is laid out to establish background levels in the camp. The results from these checks will be submitted, when an ore extraction permit is applied for.

Before drilling, swipe tests should be completed in your work area and around the camp. A swipe sample is taken by wiping the swipe over an area 100 cm^2. The following locations are recommended for routine swipe samples:

- 2 tests of each core shack floor.
- 2 tests of the core table in each core shack.
- 1 test of each office table in the core shacks.
- 2 tests of the floor in the dry. (If possible a dirty dry should be established for contaminated clothing, laundering of coveralls doesn’t get done regularly in a drill camp.)
- 2 tests of the benches in the dry
- 2 tests of the kitchen floor.(people with dirty coveralls should not be allowed in the kitchen)
- 2 tests of the kitchen benches
- 2 tests of the kitchen tables

If contamination starts showing up in the kitchen, then urine samples may be required. In addition, dust samples could be required if contamination levels are found to be unacceptable. Clean areas are to be maintained at less than or equal to 0.05 Bq/cm^2.

These tests should be completed every 30 days and at the end of the program. The swipes are sent out to the radiation department at one of the Cameco operations for counting.

3.2 Documentation of Monitoring Results

The project geologist is responsible for collecting and maintaining accurate records of all monitoring results. Appendix D contains an example of an Excel spreadsheet that is to be used to record the radon progeny, LLRD, and contamination information for each camp and the TLD doses by year and quarter for all Exploration Department employees and contractors.

3.3 Equipment Calibration

All radiation monitoring equipment (e.g. gamma meters, DRDs) used at the exploration camps must be calibrated by a CNSC approved facility on an annual basis. Each exploration camp is responsible for maintaining a list of all equipment on site and ensuring that each piece is calibrated on-time by an approved facility. The Data & Quality Assurance Coordinator is responsible for maintaining the calibration records for equipment required for radiation protection within the Exploration division. Annually, each camp will provide the Data & Quality Assurance Coordinator with a summary of the number of pieces of equipment calibrated.

3.4 Radioisotope Control

The use and storage of all radioisotopes must follow all applicable regulations of the Canadian Nuclear Safety Commission, the primary regulator of radiation sources and devices. Examples of such sources include instrument check sources and nuclear gauges.

3.5 Transportation of Radioactive Material

The transportation of uranium mineralization and ores that have an average specific activity in excess of 1 kBq/kg U-238 conform to the requirements of the Packaging and Transport of Nuclear Substances Regulations. The procedure for the transport of uranium bearing material is contained in Appendix A. All personnel shipping radioactive materials shall be certified to the standards required by the Transport of Dangerous Goods Regulations

The exploration camps have one exemption to the Transport of Dangerous Goods Regulations. Due to the remoteness of some exploration camps, we are permitted to transport core samples by air, providing they are less than 100 mm in diameter and are packaged in accordance with the Packaging and Transport of Nuclear Substances Regulations (section 12.11 of the TDG Regulations). This packaging requirement includes using IP-2 packaging if the sample averages more than 2% uranium.

3.5.1 Shipping Material Off Exploration Property

Prior to shipping anything off of an Exploration property, it must be cleared for free release to the public or have the proper shipping documents. To ensure that the appropriate measurements are taken and documents are completed correctly it may be necessary to request a radiation technician from one of Cameco's operating sites travel to the Exploration property to take the required radiological measurements. To ensure that a technician is made available, it is important to make this request well in advance of needing the material moved off-site.

Material may not be released to the public (including the owner of the material) unless it is below the contamination limit for free release. This limit is 0.4 Bq/cm^2, as defined by the International Atomic Energy Agency, Regulations for the Safe Transport of Radioactive Materials 2009 Edition. Any material with surface contamination levels above this amount must be cleaned to below the release limit before it can be released to the public.

To properly clean a material, prior to release, it may be transported under applicable regulations to one of Cameco's licensed sites. Prior to shipping any material to (or through) a CNSC licensed Cameco site, that site's Radiation Department must be notified of the shipment, in advance. The Exploration Department is responsible for scheduling and arranging any work that to be performed at a Cameco site (e.g. cleaning, repairs, etc.) with the appropriate site departments (e.g. maintenance, site services, etc.). Typically several weeks notice may be required.

Because the uranium encountered during exploration activities is considered naturally occurring radioactive material (NORM), a CNSC licence is not required to possess this material. Because of this, it is possible to ship materials that are considered contaminated under the transport regulations between Cameco exploration properties with the proper shipping documents. However, before any material leaves Cameco's control, it must be cleaned to the free release limit of 0.4 Bq/cm^2.

3.5.2 Radioactive Sources

Radioactive sources need to be transported as per the Packaging and Transport of Nuclear Substances Regulation. The particular packaging and labelling required depends upon the source to be transported. Transportation of radioactive sources is not likely to be routine so each case needs to be considered separately. Reference to the Packaging and Transport of Nuclear Substances Regulations should be made at the appropriate time.

4.0 ACT

4.1 Management Reviews

The Project Geologist is also responsible for reviewing the monitoring results on a routine basis and assessing compliance. Table 5 shows the control points that have been established for each monitoring type.

The swipe control point is the same as the clean-up criteria used by the mines and mills. The radon/radon progeny and LLRD criteria are set at the upper limit of concentrations for the Unrestricted Class. Above these levels, doses need to be assessed and additional controls may need to be implemented. The gamma dosimeter control point is set somewhat below the annual dose constraint for the Dose Management Classification of 5 mSv, to provide advance warning of possible changes in work practices, exposure conditions, and the need to reassess and/or upgrade the current radiation protection program.

These control points are also listed on the spreadsheets described in Section 7.5. In addition, Appendix E contains an example of the compliance report for each of the monitoring types.

Table 5: Control Points for Each Radiation Monitoring Types

Monitoring Type	Control Point
Swipe	Any reading over 0.05 Bq/cm^2
Radon/Radon Progeny	Average concentration of 150 Bq/m^3 radon or 0.016 WL Radon progeny measured by PAD over one month period
LLRD	0.11 Bq/m^3 average LLRD concentration measured by PADs over one month period
Gamma dosimeter	Individual dose of 1 mSv per quarter or 4 mSv per year

Annually, a report is to be submitted to the Director, Safety and Radiation for review. This report will contain the following information:

- a summary of the monitoring results for each camp (e.g average and maximum for each monitoring type);
- the percent of required/competed samples by monitoring type and site;
- a detailed report of the gamma dosimetry results for each worker;
- the percent of required/competed training; and
- the percent of equipment calibrated on time.

Appendix A

Transportation of Radioactive material

The standard unit of measure of the activity (number of atoms decaying per second) is he becquerel (Bq). Since 1 Bq is a very small quantity, larger multiples are used as follows:

1kBq	=	kilobecquerel	=	1000 Bq	=	1 x 103 Bq
1MBq	=	megabecquerel	=	1,000,000 Bq	=	1 x 106 Bq
1GBq	=	gigabecquerel	=	1,000,000,000 Bq	=	1 x 109 Bq
1TBq	=	terabecquerel	=	1,000,000,000,000 Bq	=	1 x 1012 Bq

Becquerels replace the curie (Ci) as the unit of measure of activity. The radiation dose-equivalent is expressed in units of sieverts (Sv). Smaller fractions are often used as follows:

1 mSv	=	millisievert	=	0.001 Sv	=	1 x 10-3 Sv
1 μSv	=	microsievert	=	0.000001 Sv	=	1 x 10-6 Sv

The sievert replaces the older unit for dose-equivalent, the “rem”.

Following are procedures that can be followed for shipping many types of Class 7 materials and surface contaminated objects from Exploration Sites/Camps. These procedures are designed to help certified shippers of Class 7 radioactive material meet al regulatory and corporate requirements. These procedures do not apply to the air transport of radioactive material.

Other references you may require are:

- Packaging and Transport of Nuclear Substances Regulations, SOR/2000-208, February, 2004.
- IAEA Safety Standards TS-R-1 2005 Edition: Regulations for the Safe Transport of Radioactive Material.
- Transport of Dangerous Goods Clear Language Regulations, SOR/DORS/2001-286.

Radioactive material shipments are shipments of a known mass, grade, and type of radioactive substances, for example core samples, yellowcake, and tailings. Surface contaminate objects (SCOs) are pieces of equipment, scrap, etc. that have uranium embedded into the surface that can not be removed. The proper procedure should be followed for each type of shipment

If you are shipping material from a Cameco Mine or Mill Operation, site procedures must be followed.

Road Transport of Radioactive Materials (Core Samples)

Step 1: Determine the specific activity of the material

The specific activity is the number of Becquerels of activity per unit of mass of material (kBq/kg or Bq/g). Table 1 shows the specific activities of yellowcake, ore, and tailings. To calculate the specific activity for an ore/YC or tailings sample, multiply the appropriate specific activity from Table A1 by either the sample's grade or mill feed grade, respectively. If the grade is not known, it can be estimated using the following formula:

$$\%\ U3O8 = \frac{\text{Contact Gamma Reading } (\mu\text{Sv/h})}{45\,\mu\text{Sv/h}}$$

Table A1: Summary of Specific Activities for Radioactive Material

Material	Specific Activity
Key Lake YC	42,000 kBq/kg
Rabbit Lake YC	35,000 kBq/kg
Uranium Ore	1500 kBq/kg per % U_3O_8
Tailings	1100 kBq/kg per % U_3O_8 of mill feed grade

If the specific activity is greater than 1 Bq/g (1 kBq/kg), the material is considered radioactive and TDG is required.

Step 2: Determine the total activity of the shipment

To calculate the total activity, multiply the specific activity by the mass of the sample, as described below (note: the unit of MBq is used here instead of kBq because the total activity is usually a large value and the unit of MBq is more appropriate (1 MBq = 1000 kBq)).

1) Calculations for Total Activity for Yellowcake:

Total Activity (for **Rabbit Lake**) = (35 MBq/kg) * (mass of sample (kg))

Total Activity (for **Key Lake**) = (42 MBq/kg) * (mass of sample (kg))

2) Calculation for Total Activity for Uranium ore/drill core:

Total Activity = (1.5 MBq/kg per % U_3O_8) * (%U_3O_8) * (mass of sample (kg))

3) Calculation for Total Activity for Uranium Tailings:

Total Activity = (1.1 MBq/kg per % U_3O_8 of mill feed grade) * (%U_3O_8 in mill feed) * (mass of sample (kg)).

Step 3: Package the material

The following instructions describe how to package both liquid and solid samples of radioactive material. As noted below, IP-2 packages (steel drums) are preferred where possible for shipment, but are a requirement if the material being shipped has an average grade of 2% U_3O_8 or greater. Below 2%, the material may be shipped in IP-1 packages (sealed plastic bucket).

Inner Packaging – Solid Samples

1. Place the sample in a bottle or a plastic bag. If the sample is in a bottle, tightly secure the lid using electrical tape.
2. Line the shipping drum using a shipping envelope or a large plastic bag. Ensure the plastic bag extends above the height of the shipping drum.
3. Place the prepared sample bottle/bag in the shipping drum and fill all empty spaces with suitable filler.
4. Secure the shipping envelope.
5. Add more filler if necessary then secure shipping drum lid.

Inner Packaging – Liquid Samples

1. Line the shipping drum using a shipping envelope or a large plastic bag. Ensure the plastic bag extends above the height of the shipping drum.
2. Place the prepared sample bottle in the shipping drum and fill with absorbent.
3. Secure the shipping envelope.
4. Add more absorbent then secure shipping drum lid.

Note: If the liquid volume is equal to or less than 50 ml, the package must contain absorbent (vermiculite) sufficient to absorb twice the volume of the liquid. If the liquid volume is greater than 50 ml the package must contain the absorbent and an inner and outer containment component. A plastic bucket is the best choice for the inner containment component.

Outer Packaging – Solid or Liquid Samples

Industrial packages IP are designed to meet general requirements in relation to mass, volume and shape therefore allowing for easy and safe handling and transport. Cameco is a leader in the uranium industry and strives to surpass the minimum standards therefore, use a steel drum (IP-2) when possible.

Step 4: Take gamma measurements and record Transport Index

Once the material has been packaged, move the package to a low background area, and take gamma measurements on contact and at 1m on as many sides of the package as possible. Record the maximum contact and 1m reading in µSv/h.

If there is more than one package (i.e. pail, drum, etc.), a gamma measurements must be for each package.

The next step is to determine the transport index (TI). The formula for calculating the TI is as follows:

$$TI = \left(\frac{\text{Max Gamma at 1m } (\mu Sv/h)}{10} \right) \times \text{Multiplication Factor}$$

The Multiplication Factors are determined by the size of the package, as shown in Table 2.

This calculated TI should be rounded up to the first decimal place (e.g. 1.13 becomes 1.2). If the TI calculated from the formula above is less than 0.05, the TI is zero.

Table A2: Multiplication factors for use in TI calculation

Size of Load *	Multiplication Factor
Less than 1 m^2	1
More than 1 m^2 but less than 5 m^2	2
More than 5 m^2 but less than 20 m^2	3
More than 20 m^2	10

* Use largest cross-sectional area of load being measured

Step 5: Determine Labeling Requirements and UN Number

Two pieces of information are required to determine the method of shipment: (1) the TI, and (2) the maximum radiation level on the external surface of package. Using these two numbers, first determine the label category from Table A3. Note that both conditions must be met for a category or you will need to choose the next label category. (e.g. If the TI is 0 but the maximum radiation measurement on the external surface is 7 μSv/h the label would be II-YELLOW)

If there is more than one package, each package must be labeled properly.

Table A3: Labeling requirements.

Transportation Index TI	Maximum Radiation Level on External Surface	Label Category
0	Not more than 5 μSv	I-WHITE
More than 0 but not more than 1	More than 5 μSv/h but not more than 500 μSv/h	II-YELLOW
More than 1 but not more than 10	More than 500 μSv/h but not more than 2000 μSv/h	III-YELLOW
More than 10	More than 2000 μSv/h but not more than 10000 μSv/h	III-YELLOW and also under exclusive use

Next, determine the description / shipping name and the product identification number (PIN) from Table A4. The choices for shipping uranium are LSA I UN2912, SCO I and SCO II UN 2913, Excepted Material UN2910. The PIN number UN 2913 is for SCO shipments and should not be used for radioactive material shipments. The following procedure may be helpful in deciding.

Is the label category II-YELLOW or higher?

If YES, then it should be shipped as LSA UN2912.

If NO, then determine whether the amount of uranium in the package is below the limit for an excepted package. An excepted material package must have less than 8.6g of 100% grade natural uranium ore; this is the same as 430g of 2% material (8.6/0.02) or 860g of 1% material (8.6/0.01 = 860), etc. Substitute the grade, as a decimal, into the following formula. If the mass of the package is less than the mass calculated below, it can be shipped as Excepted Material.

$$\frac{8.6\,\text{g}}{\text{Sample Grade (decimal)}} = \underline{\qquad\qquad}$$

Note that the loose contamination on the outside of the package must be less than 0.4 Bq/cm^2.

When there is any doubt, sent the shipment as LSA I UN2912.

Table A4: Classification of Class 7 (Radioactive) Material

Description & Shipping Name	**Product Identification Number (PIN)**	**Definition**
Radioactive material, low specific activity (LSA I) N.O.S.	**UN 2912**	LSA**-** radioactive material which, by its nature has a limited specific activity. Yellowcake, tailings, ore, special waste are categorized as LSA
Radioactive material, excepted package, limited quantity of material	UN 2910	Excepted package – package containing radioactive that is designed to meet the general requirements in IAEA Safety Series No. 6. Limited quantity of material – must meet activity limits in Table IV of IAEA Safety Series No. 6.
Radioactive material, surface contaminated object (SCO I and II)	UN 2913	A solid object which is not itself radioactive but which has radioactive material distributed on its surface.

Step 6: Fill in the TDG paperwork

1. The name of the radioactive material or the symbol of the radionuclide or element and its atomic number; (U-natural)
2. A description of the physical and chemical form of the radioactive material or, where the material is a special form, a statement to that effect. Standard formats for exploration shipments are as follows:

When Shipping	Material Name	Physical Form	Chemical Form
Drill core	U-natural	Solid	U-natural
Tailings	U-natural	Solid or Liquid	Uranium Tailings

For SCO shipments a physical description is low specific activity material embedded on surface

Special form shipments may include "encapsulated instrument", etc.

3. The volume (or mass) of the sample and the number of pieces (drums, barrels, etc.) in the shipment
4. The total activity of the radioactive material in Bq, MBq, GBq, etc.
5. A statement indicating which of the labels is affixed to or printed o the package ("Radioactive White-I", "Radioactive Yellow-II", or "Radioactive Yellow-III")
6. If the package displays a Radioactive Yellow-II or Radioactive Yellow-III label, the transport index of the package.
7. Where no special instructions are required indicate this with the statement "no special handling required".

Refer to Example 1 at the end of this Appendix for an example of the completed paperwork

Step 7: Placard the transport vehicle

Place the appropriate placard for the class of radioactive material on the transport vehicle (Step 5, Table A4).

Transportation of Surface Contaminated Objects

If a beta/gamma meter is not available, equipment may need to be taken to one of the Cameco sites to be scanned for surface contamination. This procedure applies to a contractor's or employee's tools and vehicle after working with mineralization, as well as any other objects that were in contact with mineralization. The assistance of a CNSC licensed site's radiation department staff and equipment will be required for this process.

Step 1: Clean the object

Step 2: Determine objects surface radioactivity (Bq/cm^2)

Using a beta/gamma meter, measure the object's surface radioactivity in Bq/cm^2 to determine if it can be released from regulatory control (free released). The contamination limit for free release is 0.4 Bq/cm^2. This monitoring is to be performed in accordance with the procedures of the site from which the radiation staff has been requested.

If the surface of the object is below 0.4 Bq/cm^2 – this item is not considered radioactive and can be released from site. The remaining steps are not applicable and do not need to be followed.

If the surface of the object is above 0.4 Bq/cm^2:

- Attempt to clean the object again
- If this item cannot be cleaned to below 0.4 Bq/cm^2, it must be shipped with appropriate shipping paperwork (e.g. TDG) and cannot be released to the public. Proceed through the remaining steps below.

Step 3: Estimate the total activity

Shipping documents and labels for SCO-I require the total radioactivity present on the surface of the object to be recorded. Estimate the "Total Activity" on the object with the following calculation:

Bq/cm^2 (from step 1) x surface area of the object (in cm^2) = Bq

The surface area of the object will have to be measured or estimated.

The calculated total activity is used for the completion of the TDG paperwork (SCO-I) and is entered on the category labels for the object or package. The result can be converted to kBq or MBq if this is more convenient.

The following are the contamination limits to qualify as an SCO-I item:

- nonfixed contamination on accessible surfaces must not exceed 4 Bq/cm^2 averaged over 300 cm^2 for all radiation types,
- fixed contamination on accessible surfaces must not exceed 40,000 Bq/cm^2 averaged over 300 cm^2 for all radiation types, and
- non-fixed and fixed contamination on inaccessible surfaces must not exceed 40,000 Bq/cm^2 averaged over 300 cm^2 for all radiation types.

The following are the contamination limits to qualify as an SCO-II item:

- nonfixed contamination on accessible surfaces must not exceed 400 Bq/cm^2 averaged over 300 cm^2 for all radiation types,
- fixed contamination on accessible surfaces must not exceed 8 x 10^8 Bq/cm^2 averaged over 300 cm^2 for all radiation types, and
- non-fixed and fixed contamination on inaccessible surfaces must not exceed 8 x 10^8 Bq/cm^2 averaged over 300 cm^2 for all radiation types.

All SCO II items must be shipped in an IP-2 package.

Step 4: Packaging and Shipment of an SCO

Options for shipping items that meet the SCO-I designation.

1. Unpackaged (ie. an SCO-I item strapped to a pallet):

   i) the objects can not be lost off of the conveyance (ie. the tailgate on the truck must be done up)
   ii) the load shall be exclusive use for the SCO-I shipment, nothing else can be shipped with the unpackaged SCO-I item
   iii) where it is suspected that non-fixed radioactive material exists on the inaccessable surface of the object (ie. inside a pump), measures must be taken to prevent this material from shaking loose and contaminating the truck box (ie. the bottom of the pump may have to be shrink wrapped)
   iv) a transport index and two category labels must be done on each SCO-I item

2. Packaged in an Industrial Package Type 1 (IP-1)

   i) the shipping container must legibly indicate the maximum permissible gross mass allowed
   ii) the container can not be used to ship non-radioactive items due to the potential of contamination on the inside of the container even when empty (exclusive use). It should be noted that the empty shipping container may have to be shipped as an "Excepted package" due to the internal contamination (outside category labels must be removed). The other option is to have the container fully cleaned ($\leq$ 4.0 Bq/cm^2) before being shipped empty.
   iii) the external surfaces of the container can not exceed 4.0 Bq/cm^2 for non-fixed contamination
   iv) only one transport index is needed for the package

To ship items that meet the SCO-II designation an IP-2 package must be used. To be classified as IP-2, the package must meet the requirements of IAEA TS-R-1 paragraph 622.

Step 5: Take the Transport Index

Determine the transport index as per Step 4 of the Transport of Radioactive Material procedure.

Step 6: Determine Labeling Requirements and UN Number

Determine the labeling requirements and UN number as per Step 5 of the Transport of Radioactive Material procedure.

Step 7: Fill in the TDG paperwork

Fill in the TDG paperwork as per Step 6 of the Transport of Radioactive Material procedure. Refer to Example 2, below, for an example of the completed paperwork.

Step 8: Placard the transport vehicle

Place the appropriate placard for the class of radioactive material on the transport vehicle (Step 5, Table 4 of Transport of Radioactive Material procedure)

Appendix C – Historic radon and LLRD concentrations based on air sampling

Between 2000 and 2005, there were 50 samples collected of the ambient radon progeny (RnP) and LLRD concentrations in the core tents and hot core tents at various exploration camps. The results of these samples are shown in Table C1 and summarized in Table C2.

All of the samples were collected using personal alpha dosimeters (PADs) from the Radiation Safety Institute of Canada (RSIC). These are continuous low airflow pumps that are placed in the tents and run for approximately one month before being returned to the distributor for analysis.

Table C1: Raw Radon Progeny and LLRD Results Between 2000 and 2005

Camp	Location	Start Date	End Date	Flow Rate (l/min)	RnP (WL)	LLRD (Bq/m3)	Inferred Annual LLRD Intake (Bq)*
		1/27/2000	2/27/2000	0.48	0.0010		
		1/27/2000	2/27/2000	0.51	0.0016		
	Hot core shack	2/27/2000	3/24/2000	0.45	0.0023		
	Core shack	2/27/2000	3/24/2000	0.65	0.0010		
	Hot core shack	6/11/2000	7/11/2000	0.5	0.0011		
	Core shack	6/11/2000	7/11/2000	0.66	0.0040		
	Hot core shack	7/7/2000	7/23/2000	0.51	0.0070		
	Core shack	7/7/2000	7/23/2000	0.58	0.0010		
	Core shack	2/6/2001	3/3/2001	0.5	0.0013		
	Hot core shack	2/9/2001	3/3/2001	0.57	0.0028		
	Hot core shack	3/3/2001	4/3/2001	0.66	0.0070		
	Core shack	3/3/2001	4/3/2001	0.75	0.0010		
		6/27/2001	7/29/2001	0.57	0.0011		
		6/27/2001	7/29/2001	0.66	0.0005		
		7/29/2001	8/8/2001	0.47	0.0012		
		7/29/2001	8/8/2001	0.69	0.0058		
LaRocque Lake	Hot core shack	6/10/2002	7/10/2002	0.52	0.0004	0.0019	2.28
LaRocque Lake	Core shack	6/10/2002	7/10/2002	0.43	0.0038	0.0001	0.06
Slush Lake	Hot core shack	6/12/2002	7/7/2002	0.5	0.0007	0.0021	2.52
Slush Lake	Core shack	6/15/2002	7/7/2002	0.61	0.0060	0.0008	0.97
Slush Lake	Hot core shack	7/7/2002	7/26/2002	0.46	0.0014	0.0020	2.40
Slush Lake	Core shack	7/7/2002	7/26/2002	0.39	0.0030	0.0003	0.37
Slush Lake	Hot core shack	1/30/2003	2/25/2003	0.56	0.0006	0.0000	0.00
Slush Lake	Core shack	1/30/2003	2/25/2003	0.57	0.0004	0.0010	1.20
Slush Lake	Hot core shack	1/30/2003	2/25/2003	0.58	0.0006	0.0000	0.00
Slush Lake	Core shack	1/30/2003	2/25/2003	0.56	0.0004	0.0010	1.20
LaRocque Lake	Core shack	2/16/2003	3/18/2003	0.43	0.0004	0.0000	0.00
LaRocque Lake	Hot core shack	2/28/2003	3/17/2003	0.72	0.0004	0.0010	1.20
Shamus Lake	Core shack	3/3/2003	3/29/2003	0.82	0.0006	0.0020	2.40
Slush Lake		6/10/2003	7/8/2003	0.61	0.0007	0.0040	4.80
Slush Lake		6/10/2003	7/8/2003	0.58	0.0004	0.0000	0.00
Dawn Lake	Core shack	6/12/2003	7/10/2003	0.43	0.0014	0.0000	0.00

Dawn Lake	Hot core shack	6/21/2003	7/10/2003	0.56	0.0004	0.0000	0.00
Slush Lake	Hot core shack	7/8/2003	7/25/2003	0.88	0.0018	0.0060	7.20
Slush Lake	Core shack	7/8/2003	7/25/2003	0.43	0.0005	0.0000	0.00
Slush Lake	Core shack	1/28/2004	3/1/2004	0.45	0.0004	0.0010	1.20
Slush Lake	Hot core shack	1/28/2004	3/1/2004	0.55	0.0007	0.0030	3.60
Dawn Lake	Core shack	2/10/2004	3/12/2004	0.41	0.0011	0.0010	1.20
Slush Lake	Core shack	3/1/2004	3/18/2004	0.39	0.0006	0.0010	1.20
Slush Lake	Hot core shack	3/1/2004	3/18/2004	0.55	0.0008	0.0020	2.40
Shamus Lake	Core shack	3/19/2004	4/3/2004	0.54	0.0007	0.0010	1.20
LaRocque Lake	Core shack	6/23/2004	7/22/2004	0.55	0.0006	0.0000	0.00
Slush Lake	Core shack	8/26/2004	9/20/2004	0.55	0.0005	0.0010	1.20
Slush Lake	Core shack	8/26/2004	9/20/2004	0.55	0.0006	0.0010	1.20
Slush Lake	Hot core shack	1/23/2005	2/23/2005	0.55	0.0006	0.0011	1.32
Slush Lake	Core shack	1/23/2005	2/23/2005	0.55	0.0005	0.0004	0.48
LaRocque Lake	Core shack	1/23/2005	3/1/2005	0.55	0.0006	0.0003	0.36
Cree Extension	Hot core shack	2/23/2005	4/4/2005	0.55	0.0012	0.0088	10.56
Cree Extension	Core shack	2/23/2005	3/28/2005	0.55	0.0006	0.0001	0.12
Dawn Lake	Core shack	3/19/2005	4/15/2005	0.55	0.0009	0.0000	0.00

* assumes breathing rate of 1.2 m^3/h and 1000 hours per year in the measured ambient concentration – this is a highly conservative estimate for typical exploration activities.

Table C2: Summary of the Detailed Radon Progeny and LLRD Samples

	Radon Progeny (WL)	Radon (Bq/m3)**	Inferred Annual LLRD Intake (Bq)
Average	0.001	13.9	1.55
Maximum	0.007	65.5	10.56

** The radon concentration was calculated from the radon progeny concentration assuming an equilibrium factor of 0.4.

Section 4.2.2 of the NORM Guidelines states that the Unrestricted program classification applies whenever the average radon concentration is less than 150 Bq/m^3. In addition, Section 4.3.1 states that incidentally exposed workers must receive less than 1/20 of the annual limit on intake (ALI) of radioactive material. For uranium ore dust, including all decay products, the ALI is 2800; therefore 1/20 of the ALI is 140 Bq. Further, Section 4.3.3 states that engineering controls are only required if the annual intake by workers exceeds 1/20 of the ALI.

All of the measurements both radon and LLRD, as summarized in Table C2, were below the criteria requiring further actions to calculate and reduce dose. In the case of radon, the average concentration is about 10% of the 150 Bq/m^3 limit for the Unrestricted classification. The average LLRD intake inferred from the LLRD concentrations was about 1% of the limit for incidentally exposed workers.

Based on these readings and the corresponding limits, readings will continue to be collected for control and trending purposes, but no doses will be calculated for these sources.

This analysis should be repeated annually.

Appendix D – An Example of the Data Tracking Spreadsheet

Summary of Swipe Results (in Bq/cm^2) for the ----- Camp - 2005

* If the camp was not operating during a particular month, enter N/A for the date
** All readings above the cleanup criteria of 0.05 Bq/cm^2 will appear in red

	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mandatory Locations	Cold Shack Core Table 1												
	Cold Shack Core Table 2												
	Cold Shack Floor 1												
	Cold Shack Floor 2												
	Cold Shack Office Table 1												
	Cold Shack Office Table 2												
	Dry Bench 1												
	Dry Bench 2												
	Dry Floor 1												
	Dry Floor 2												
	Hot Shack Core Table 1												
	Hot Shack Core Table 2												
	Hot Shack Floor 1												
	Hot Shack Floor 2												
	Hot Shack Office Table 1												
	Hot Shack Office Table 2												
	Kitchen Floor 1												
	Kitchen Floor 2												
	Kitchen Benches 1												
	Kitchen Benches 2												
	Kitchen Table 1												
	Kitchen Table 2												
Additional Locations													

Summary of PAD Results for the ------- Camp - 2005

* If the camp was not operating during a particular month, enter **N/A** for the result
** RnP readings above 16 mWL and LLRD reading above 117 mBq/m^3 will appear in red

Location	Month	Start Date	End Date	Flow Rate (l/min)	RnP (mWL)	LLRD (mBq/m^3)
Hot core shack	January					
Core shack	January					
Hot core shack	February					
Core shack	February					
Hot core shack	March					
Core shack	March					
Hot core shack	April					
Core shack	April					
Hot core shack	May					
Core shack	May					
Hot core shack	June					
Core shack	June					
Hot core shack	July					
Core shack	July					
Hot core shack	August					
Core shack	August					
Hot core shack	September					
Core shack	September					
Hot core shack	October					
Core shack	October					
Hot core shack	November					
Core shack	November					
Hot core shack	December					
Core shack	December					

Appendix E – An Example of the Compliance Spreadsheet

For assistance with this spreadsheet contact corporate SH&E radiation group

Compliance Summary for Swipe and PAD Monitoring for 2005

I = Incomplete
C =Complete
N/A = Not applicable or not required

		Month												
Camp	**Monitoring Type**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Compliance**
Slush Lake	Swipes	C	C	C	C	C	C	C	C	C	C	C	C	100%
	Hot Tent PAD	C	C	C	C	C	C	C	C	C	C	C	C	100%
	Core Tent PAD	C	C	C	C	C	C	C	C	C	C	C	C	100%