# AREVA Resources Canada Inc.

## Kiggavik Project, Nunavut

# RADIATION PROTECTION PLAN

**June 2012, Version 6 Revision 0**

## REQUIRED USERS

Required and other users are responsible for using the current version of the Radiation Protection Plan as posted on Q:\KS_Feasibility. Users may print copies of this plan, but are ultimately responsible for ensuring they are using a current copy as posted. Users are requested to destroy all previously printed copies of the plan when they are informed of revisions.

## HISTORY OF REVISIONS

| Version | Revision | Date | Details of Revision |
|---|---|---|---|
| 01 | 00 | March 2007 | Original submission |
| 02 | 00 | October 2007 | Update to reflect changes in field activities/capabilities and goals of continual improvement |
| 03 | 00 | August 2008 | Update to reflect changes in field activities/capabilities and goals of continual improvement |
| 04 | 00 | January 2009 | Update to reflect changes in field activities/capabilities and goals of continual improvement |
| 05 | 00 | January 2010 | Update to reflect changes in field activities/capabilities and goals of continual improvement |
| 05 | 01 | May 2011 | Updated to reflect changes in personnel position titles. |
| 06 | 00 | June 2012 | Updated to reflect changes in personnel titles and positions. Grammatical corrections. |

**Original Copy of this Manual:**

**Approved and Signed by title:** **Kim Jackson**

**Environment and Radiation Protection Supervisor**

| Approved by: |
| --- |
| Signature and Date |

**Approved and Signed by title:** **Joseph Roux**

**Vice President, Exploration**

| Approved by: |
| --- |
| Signature and Date |

**The original hard copy of this approval page has been signed and is located at the AREVA Resources Canada Inc. corporate office.**

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# 1 INTRODUCTION

This Radiation Protection Plan will be in effect for the duration of the Kiggavik Project located about 80 km west of Baker Lake:

- West Boundary 97° 57' 50.4" W Longitude;
- East Boundary 97° 20' 56.4" W Longitude;
- North Boundary 64° 39' 28.8" N Latitude; and,
- South Boundary 64º 17' 02.4" N Latitude.

## 1.1 Purpose and Scope

The Radiation Protection Program is designed to meet the requirements of the applicable Nunavut Occupational Health and Safety Regulations, Mineral Exploration Guidelines for Saskatchewan, the Canadian Nuclear Safety Commission (CNSC) Regulations (although current activities are not regulated by the CNSC) and the AREVA Resources Canada Inc. (ARC) Integrated Quality System Manual (IQMS). The program elements include:

Administrative Elements

- Program documentation
- Training
- Designation of Occupational Workers
- Dose limits and dose levels
- Obligations of Occupational Workers
- Pregnant Occupational Workers

Program Elements

- ALARA
- Radiological monitoring
- Dosimetry monitoring
- Management of radioactive materials
- Shipping of radioactive materials
- Site abandonment and restoration
- Emergency response

## 1.2 Revision to Manual

The Kiggavik Radiation Protection Plan is reviewed on an annual basis and is updated as required to keep the information current and consistent with regulatory and procedural changes. A History of Revisions can be found at the front of this manual.

## 1.3 Responsibilities

The Senior Project Geologist is responsible to ensure that this plan is implemented. Implementation may be completed by:

- Project Geologist
- Environment and Radiation Protection (ERP) Supervisor
- Or designate

The Vice President, Exploration is ultimately responsible for any activity being carried out by Kiggavik Project personnel.

# 2 ADMINISTRATIVE ELEMENTS

## 2.1 Program Documentation

The Radiation Protection Program is comprised of a series of key documents combined in the Radiation Protection Procedures Manual (RPPM). These include Routine Radiological Monitoring Schedule, and Shipping Radioactive Material.

The Radiation Protection Program includes comprehensive work instructions for worker dosimetry, radiological monitoring and the safe handling of radioactive materials.

To ensure occupational exposures are managed in accordance with the As Low As Reasonable Achievable (ALARA) principle, radiological parameters are monitored against defined Action and Administrative levels. The Action and Administrative levels define values of radiological parameters above which intervention may be required and the corresponding mitigative measures to be followed.

## 2.2 Training

ARC provides necessary training to all its employees and contractors to ensure worker safety and protection of the environment during exploration activities. The training programs provided are designed to meet the requirements of the CNSC *Uranium Mines and Mills Regulations,*, Workers' Safety Compensation Commission (WSCC) *ISO 14001:2004 and OHSAS 18001:2007.*

All new employees, including contractors, receive appropriate radiation protection training prior to beginning work. This includes instruction on the origins of ionizing radiation, the types of radiation, health risks, the principles of radiation safety, protection and regulatory compliance. Training also includes the safe handling, management and disposition of radioactive materials such as drill muds, cuttings, and radioactive core. Training may be in the form of a PowerPoint presentation or interactive display.

All visitors at the Kiggavik site for more than 72 hours, or who will be left without an escort will receive radiation protection training. Visitors who have not received training must be escorted on site at all times.

Personnel supervising the shipment of radioactive materials must possess a valid TDG certificate in accordance with Transport Canada Transportation of Dangerous Goods Regulations. If radioactive materials are to be transported by aircraft, TDG training is to include the necessary aviation components for Class 7 materials. If contractors have their own training program they must submit their documentation. Support personnel providing assistance during

the preparation and shipment of radioactive material do not require TDG training as long as they are working under the direct supervision of trained individuals.

ARC field personnel and contractors establishing temporary work camps and/or handle fuel, lubricants and radioactive material require spill response training. If the contractors have their own training program they must submit evidence of the training program as per *EXP-820, Training, Awareness and Competence*. Training for ARC employees is provided in accordance with the *Spill Contingency Plan*. Contractors are provided a copy of said plan. If the contractors do not have an acceptable training program in place, AREVA will supply the training material and/or provide the training as required.

## 2.3 Designation of Occupational Workers

An Occupational Worker is defined as a person with a reasonable probability of receiving an occupational dose of radiation that is greater than 1 milliSievert per year (1 mSv/y), the prescribed limit for the general public.

An Occupational Worker by definition is equivalent to a Nuclear Energy Worker under the Canadian Nuclear Safety Act.

## 2.4 Dose Limits and Dose Levels

Occupational Workers are informed of the risks associated with radiation to which they may be exposed in the course of their work, and the applicable dose limits, during radiation protection training. Occupational Workers are limited to a maximum annual effective dose of 50 mSv in a one year dosimetry period, however must not exceed 100 mSv in a five year dosimetry period. A pregnant Occupational Worker is limited to 4 mSv for the balance of the pregnancy, once notification has been made to the employer. In the event of an emergency and the consequent immediate and urgent remedial work, the effective dose shall not exceed 500 mSv. The relaxation of normal dose limits in emergency situations does not apply to pregnant workers.

Occupational Workers are informed of their radiation dose levels in writing.

## 2.5 Obligations of Occupational Workers

Occupational Workers are obliged to provide information required to identify them to the National Dose Registry (i.e. given name, surname, previous surname, SIN, sex, date and province and country of birth) and release their dose histories for the current one and five year dosimetry periods. The purpose of this information is described to the Occupational Workers during radiation protection training. Occupational Workers are obliged to provide written

acknowledgement that they have received information regarding the risks associated with exposure to radiation and dose limits.

## 2.6 Pregnant Occupational Workers

Occupational Workers are informed during training of the risks associated with radiation to which the worker may be exposed in the course of their work, including the risks associated with the exposure of embryos and fetuses to radiation. Female Occupational Workers are informed of their obligation to inform their employer, in writing, when they become pregnant and are informed of the applicable effective dose limit of 4 mSv for the balance of the pregnancy.

# 3 PROGRAM ELEMENTS

## 3.1 ALARA

Radiation protection practice has its foundation in the ALARA principle, As Low As Reasonably Achievable. The commitment to maintain worker doses ALARA is established as a policy within ARC's Quality Management System Manual (QMS). This policy is established by senior management and is approved by the President and Chief Executive Officer. This Plan and the Radiation Protection Procedures all follow the ALARA principle.

## 3.2 Radiological Monitoring

Routine radiological monitoring consists of dosimetry monitoring and contamination control.

Dosimetry monitoring is conducted to determine and document worker exposures to radiological components which include gamma radiation, radon progeny (RnP) and long-lived radioactive dusts (LLRD).

Contamination control measures are in place to minimize the spread of radioactive materials into unintended locations.

Radiological monitoring is conducted in accordance with the *EXP-740, Routine Radiological Monitoring Schedule* and associated work instructions.

## 3.3 Management of Radioactive Materials

### *3.3.1 Radioisotopes*

Nuclear materials and radiation devices are used for exploration and instrument calibration. The possession, use, storage, and disposal of nuclear materials and radiation devices are carried out in strict accordance with CNSC *Nuclear Substances and Radiation Devices Regulations* and licence conditions.

### *3.3.2 Core Storage*

Nunavut currently lacks regulations or guidelines for uranium mineral exploration or mineral industry environmental protection. In the absence of territorial regulations, the storage and disposal of radioactive materials arising from project activities are be carried out in accordance with Saskatchewan *Mineral Industry Environmental Protection Regulations, 1996*. ARC's

Saskatchewan uranium drilling activities have been ongoing for the last 35 years and continue to this day.

Permanent and long-term storage areas of radioactive material must be located at least 30 m from the main camp and at least 100 m from the high water mark of all water bodies.

Gamma radiation dose rates at 1 m from the surface of a storage area should be reduced to 1 µSv/h and in no instances exceed 2.5 µSv/h.

Permanent on-site radioactive core storage areas must be appropriately labelled with radiation warning sign and fenced.

### *3.3.3 Disposition of Drill Cuttings*

During drilling activities, drill mud solids or cuttings in non-mineralized zones are deposited on the ground, in a selected natural low-lying depression. This natural depression must be located, at a minimum, 30 m beyond the ordinary high level water mark of any nearby water bodies, and where direct flow into the water body is not possible. A radiological survey is conducted before and after drilling to ensure elevated readings are not occurring. The depression is then backfilled and contoured, as much as possible, back to natural pre-existing conditions.

When mineralized core is intercepted, drill mud and cuttings are collected in appropriate containers and categorized as radioactive through appropriate radiation measurements.

Drill mud or cuttings with uranium content greater than 0.05% will be collected and stored at the radioactive storage compound with an appropriate containment system in place. Down hole disposal of cuttings is not often practical at Kiggavik. Drill holes are sealed by cementing/grouting the upper 30m of bedrock or the entire depth of the hole, depending on the presence of mineralization or otherwise approved of by the appropriate regulatory agencies in writing.

### *3.3.4 Spills*

The uncontrolled or accidental release of any radioactive materials including drill mud solids and cuttings is considered a spill. Spills of radioactive material are appropriately reported and responded to in accordance with the Spill Contingency Plan.

In the event of a spill, radioactive materials are collected and necessary site remediation undertaken to meet the site abandonment criteria of less than 1 µSv/h above background at a height of 1 m. To the greatest extent possible, all spill affected areas will be decontaminated.

Material collected during the clean-up is stored in appropriate containers in the radioactive storage compound, for future handling.

### 3.4 Shipping of Radioactive Materials

Shipping and receiving radioactive material is carried out in accordance with the CNSC *Packaging and Transport of Nuclear Substances Regulations* and the Transport Canada *Transportation of Dangerous Goods Regulations*.

### 3.5 Site Abandonment and Restoration

Site abandonment and restoration is carried out in accordance with the Abandonment and Restoration Plan.

Gamma radiation surveys are conducted at each site prior to drilling and prior to final abandonment. Contaminated soil or cuttings are collected in appropriate containers and stored in the radioactive storage compound for future handling, which may include transfer to an operating mine site. Drill sites are cleaned to ensure that the gamma dose rate at a height of 1 m from surface is less than 1 µSv/h above ambient background.

Materials and equipment leaving the Kiggavik site are monitored for contamination in accordance with the *EXP-740, Routine Radiological Monitoring Schedule.* Materials or equipment that cannot be decontaminated to meet unrestricted release criteria are either stored in the radioactive storage compound or shipped to a licensed facility such as the McClean Lake Operation in accordance with the CNSC *Packaging and Transport of Nuclear Substances Regulations* and the Transport Canada *Transportation of Dangerous Goods Regulations*.

### 3.6 Emergency Response

Emergencies could include such incidents as spills, lost or damaged radioactive sources and transportation incidents.

Emergencies involving radioactive materials are responded to in accordance with the Emergency Response Manual. When responding to an incident involving radioactive material, emphasis is always placed on minimizing exposures.

In the event of an incident involving radioactive material, immediate actions are taken to minimize worker exposures. In the event of any incident involving radioactive material, the Environment and Radiation Protection Supervisor or designate is notified immediately.

In accordance with the Spill Contingency Plan, in the event of a spill involving radioactive material, actions are taken to contain the spill, limit the spread of contamination and to control access to the spill area. Appropriate radiological and dosimetry monitoring is performed to ensure worker doses remain ALARA. Mitigation measures to be followed include recovery of radioactive material and decontamination of affected areas.

In the event a radiation source is damaged, it is removed from service immediately and stored in a secure location. The removal of a damaged source from site is coordinated with the Environment and Radiation Protection Supervisor, Safety and Radiation Coordinator and the McClean Lake Operation Radiation Protection Group.

If at anytime it appears that a radiation source has been lost, misplaced or stolen, the Project Geologist or designate, the Vice President, Exploration, the McClean Lake Radiation Protection Group, and the Safety and Radiation Coordinator are notified immediately.

Emergency response is co-ordinated through the corporate office in Saskatoon. The ARC *Emergency Response Assistance Plan* details the organization, responsibilities, procedures and mitigative measures to be followed in the event of an offsite emergency involving the transport of radioactive material. Environmental emergencies are considered secondary to the safety of personnel.

All incidents involving radioactive materials and devices are reported to the Vice President, Exploration within 24 hours and appropriately investigated.

In the event of any incident involving a radiation source, federal and territorial agencies are notified in accordance with applicable regulations.

# 4 REFERENCES

*EXP-740, Routine Radiological Monitoring Schedule*

AREVA Resources Canada Inc. Integrated Quality System Manual

Spill Contingency Plan

Emergency Response Manual

*ARC Emergency Response Assistance Plan*

Canadian Nuclear Safety Commission (CNSC) *Nuclear Substances and Radiation Devices Regulations*

CNSC Uranium Mines and Mills Regulations

CNSC Packaging and Transport of Nuclear Substances Regulations

Transport Canada *Transportation of Dangerous Goods Regulations*

Saskatchewan *Mineral Industry Environmental Protection Regulations, 1996*

Mineral Exploration Guidelines for Saskatchewan. 2007. Government of Saskatchewan (November 2007)

Canadian Nuclear Safety Act

Nunavut Occupational Health and Safety Regulations