Kiggavik Project

Environmental Impact Statement

Tier 3 Technical Appendix 4C

Air Monitoring Plan

December 2011

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1 INTRODUCTION

The Kiggavik Project Air Monitoring Plan (the Plan) has been prepared by AREVA Resources Canada Inc. (AREVA) for the Kiggavik Project (Project) to ensure compliance with relevant environmental regulations during construction and operation of the Project. This Plan has been prepared in concert with the Air Quality and Climate Change Assessment (Tier 2, Volume 4) and the Air Dispersion Assessment (Technical Appendix 4B) of the Kiggavik Project Environmental Impact Statement (EIS). The Plan applies to the Project located approximately 80 km west of Baker Lake, points located within Baker Lake, and/or at the Project Dock and Storage Facility located southeast of the community of Baker Lake and will be in effect for the duration of the Project.

1.1 PURPOSE AND SCOPE

The purpose of the Air Monitoring Plan for the Project is to monitor and mitigate effects identified within the air quality assessment pursuant to the Nunavut Impact Review Board (NIRB) guidelines. The Plan provides guidance on management of air quality effects from the Project as they relate to human health, the terrestrial environment, and aquatic/marine environments as expressed through ambient air quality criteria and objectives. The Plan includes actions to prevent, control, and mitigate air emissions imposing a potential nuisance to surrounding populations. The Plan intends to conform to applicable standards, guidelines and regulations to minimize and mitigate potential effects.

The implementation of air emissions mitigation measures is derived from the assessment of key emission sources in relation to applicable best practices or standards of practice. The following Plan outlines air emission abatement methods in addition to emission reduction achieved through design and uses continuous improvement and minimization through monitoring programs.

In general terms, the objectives of the Air Monitoring Plan are as follows:

1. To collect data complimentary to existing data;
2. To monitor any potential effects to air quality resulting from the Project;
3. To provide additional baseline data against which potential future effects can be assessed; and,
4. To validate/verify the predictions and confirm that unexpected, greater effects are not occurring.

The Plan will address one of the most prominent issues for uranium mines: the concentration of suspended particulate matter, metals (particularly uranium), radionuclides and radon in the air surrounding the major areas of activity.

The Project footprint consists of three components; Kiggavik and Sissons Mine Sites including the Kiggavik-Sissons Access Road, the Baker Lake-Kiggavik Winter Road, and the Dock and Storage Facility. The Plan will be in effect during construction, operation, and decommissioning of the Project. The Plan will undergo regular review and be updated as indicated by incident investigation, regulatory change, management review, and when otherwise required.

2 EMISSION SOURCES AND MITIGATION

2.1 KEY EMISSION SOURCES OF COPCS

During each Project phase (construction, operation, final closure and post-closure), activities will occur which have the potential to increase ambient air concentrations of Constiuents of Potential Concern (COPCs) within the Local Assessment Area (LAA) and Regional Assessment Area (RAA), including dust (i.e., particulate matter), metals, gaseous compounds and radionuclides. A summary of emission generating Project activities in each phase are as follows:

Construction Activities:

- land clearing, excavating (i.e., earth moving), quarrying, material handling and fuel combustion.

Operation Activities:

- drilling and blasting, ore and mine rock handling, stockpile and road maintenance, wind erosion of stockpiles, vehicle travel, fuel combustion and milling operations.

Final Closure Activities:

- backfilling mine rock into the Tailings Management Facilities (TMFs), closure of TMFs and fuel combustion.

Post-Closure Activities:

- passive radon emissions from permanent mine rock stockpiles and closed TMFs.

2.2 MITIGATION MEASURES

Design aspects, operational measures and other mitigation measures have been incorporated into the current Project plans which will minimize Project-associated emissions and/or the potential effect of Project-related emissions (i.e., increased ambient concentrations of COPCs). Mitigation measures that will be applied to reduce changes to ambient air quality are divided into three categories: Design-Based Mitigation; General Mitigation; and Activity-Specific Mitigation Measures. Each category is outlined below.

Design-Based Mitigation

- Several focussed dispersion modelling studies were conducted during the Project design phase to examine the potential effects of alternate locations of the following Project facilities within the Project Footprint:
    - Acid Plant
    - Power Plant
    - Storage Piles
    - Accommodation Complex
- The locations utilized in the Environmental Impact Statement (EIS) reflect the outcome of these studies where the potential impacts to air quality have been minimized.

General Mitigation Measures

- Employ standard operating procedures for use of equipment and machinery.
- Perform regular maintenance of equipment and machinery in accordance with good engineering practices or as recommended by equipment suppliers such that the equipment is kept in good operating condition (e.g., effective fuel combustion).
- Develop community complaint/response procedure(s) (see Appendix 3C - Community Involvement Plan of the EIS).
- Adhere to all permits, authorizations and/or approvals.

Activity-Specific Mitigation Measures

- Heavy Equipment Operation, Vehicles and Marine Vessels:
    - Where available, use diesel-powered heavy equipment equipped with appropriate exhaust emissions controls like catalytic converters and diesel particulate filters.
    - Optimize the number of heavy equipment movements and minimize travel distances, where possible.
    - Minimize the number of barge shipments and container off-loading activities.
    - Diesel fuel will meet the Canada-wide Diesel Sulphur Content standard of 15 ppm for off-road engines and marine vessels were assumed to have a sulphur fuel content of 1000 ppm.
- Unpaved Road Transportation:
    - Minimize or reduce vehicle speed on unpaved mine site roads (including pit ramps) and the Kiggavik-Sissons Access Road and enforce speed limits, where possible.

    - Apply water or another approved dust suppressant to the surfaces of unpaved mine site roads (including pit ramps) and the Kiggavik-Sissons Access Road, when possible.
    - Maintain all unpaved road surfaces via grading or other maintenance practices to minimize the amount of silt (i.e., fine particles) present in the roadbed material.
- Blasting:
    - Minimize the number of charges per day to reduce NO_x and particulate matter emissions.
    - Optimize/minimize the use of ANFO to reduce emissions of NO_x.
- Milling and Tailings Management:
    - Appropriate air pollution controls will be installed on the exhaust stacks of the mill complex and acid plant (e.g., wet scrubbers, dust collectors).
    - Tailings will be released to the TMFs as a slurry below a water surface to avoid tailings dust emissions.
    - Tailings will be treated to minimize the release of radon.
- Post-closure:
    - Where possible, permanent mine rock stockpiles will be stabilized to minimize the release of long-term dust emissions. For example, piles could be compacted and/or re-vegetated to suppress emissions of dust.
- Waste Management:
    - Installation of incinerator that complies with the Canada-wide Standards.

In addition, AREVA commits to initiating a Dust Management Program in advance of the Final EIS submission. The initial phase of this Program is intended to identify appropriate chemical dust suppressants that may be applied as a control measure, in addition to further developing operational strategies that will assist in dust control.

2.3 SUMMARY OF PREDICTED RESIDUAL EFFECTS

The need for monitoring of a specific contaminant in a specific Project phase is indicated by the prediction of residual effects to air quality. For the purposes of the Project, a residual effect is defined as an exccedance of the selected Air Quality (AQ) Indicator Threshold for each COPC, beyond the Project Footprint. A summary of residual Project effects, as discussed under separate cover, is as follows:

Construction

The emissions from construction activities within the Project Footprint at each site are much lower than those of the operations phases; as such model predicted concentrations were not produced. However, these activities have the potential to generate significant quantities of dust. This Plan therefore includes some initial monitoring during construction to verify that the proposed mitigation and best management practices are being implemented effectively.

Operations

During the operations phase, the AQ Indicator Thresholds were predicted to be exceeded for some COPCs at limited distances beyond the Project Footprint. This includes the following:

- Exceedances of maximum 24-hour concentrations for all three size fractions of dust (TSP, PM_{10}, $PM_{2.5}$) into a limited area of the LAA at both Kiggavik and Sissons.
    - ***Predicted residual effect – monitoring to be considered***
- The maximum predicted 24-hour uranium concentrations are marginally above the AQ Indicator Threshold beyond the Project Footprint, into the LAA. The concentrations of all other metals and radionuclides are predicted to be below their respective AQ Indicator Thresholds
    - ***Predicted residual effect – monitoring to be considered***
- The maximum predicted 1- and 24-hour NO_2 concentrations exceed their AQ Indicator Thresholds both within the Project Footprint, extending into the LAA.
    - ***Predicted residual effect – monitoring to be considered***

At the Baker Lake Dock and Storage Facility:

- Maximum predicted 1- and 24-hour concentrations of NO_2 exceeded AQ Indicator Thresholds, extending to a distance of about 1 km southwest of the dock.
    - ***Predicted residual effect – monitoring to be considered***

Final Closure/Post Closure

No residual effects to air quality were predicted for the Final Closure or Post Closure phases of the Project.

3 AIR MONITORING PROGRAM

Air monitoring is a useful tool that can be used to verify or validate the results of the EIS in addition to providing continuous feedback on the efficacy of the proposed Dust Management Program and other mitigation measures. Two types of monitoring are considered: compliance and follow-up environmental monitoring.

Compliance monitoring is undertaken to confirm that Project design features, mitigation measures and environmental protection measures are being effectively implemented.

In general, these monitoring programs are used to:

- verify predictions of environmental effects;
- determine the effectiveness of mitigation measures, environmental protection measures or benefits agreements in order to modify or implement new measures where required;
- support the implementation of adaptive management measures to address previously unanticipated adverse environmental effects; and,
- support environmental management systems used to manage the environmental effects of projects.

Definition of the program should include:

- parameters to be measured,
- methods and equipment to be used,
- location and timing of surveys, and
- how the results of the monitoring will be applied, including consideration of an adaptive management approach.

3.1 PROPOSED AMBIENT PROGRAM

An ambient air quality monitoring program will be implemented to demonstrate that the environmental effects are equivalent to or lower than those predicted. The proposed monitoring program includes the following:

- Meteorology (wind speed, wind direction, temperature, precipitation, solar radiation)
- Particulate (TSP or PM_{10})
    - Selected metals in particulate, including uranium and radionuclides

    - Dust deposition (particle fallout)
- Sulphur dioxide
- Nitrogen oxides, NOx (particularly nitrogen dioxide – NO_2)
- Radon

Based on the summary of predicted residual effects from the Project, an ambient air monitoring program is proposed for the construction and operations phases of the Project for verification and compliance purposes. In order to further develop the long term record of meteorological data in the vicinity of the Project, a meteorological station with a 10 m tower is proposed to be installed at the current Pointer Lake location or at the Accommodation Complex, whichever is preferred operationally. The proposed station will be equipped to measure wind speed, wind direction, temperature, precipitation and solar radiation.

The proposed air monitoring program for COPCs is to include the following:

Construction

- dust deposition (particle fallout)
    - samples collected monthly
    - at selected locations at the boundary of the Project Footprint at Kiggavik and Sissons (minimum of 3 locations at each)
        - samples to be collected using dustfall jars over 30 day intervals

In addition, short-term local monitoring will be undertaken at Baker Lake for NO_x during one shipping season to confirm the model predictions, using the same instrumentation as that recommended for the operations phase. This will likely be carried out during the shipping season in which construction of the Project Footprints is being done. It is proposed that the instrument be placed in a building or shelter located within the Baker Lake community with data collected continuously for one month prior to and throughout this shipping season.

Operations

- airborne dust (TSP or PM_{10})
    - includes metals, uranium and radionuclides in the dust
    - samples to be collected using high volume air samplers
        - at selected locations at the boundary of the Project Footprint at Kiggavik and Sissons, downwind in principal directions from major sources, where power is available (minimum of 2 locations at each, plus Accomodation Complex)
        - samples to be collected every 6 days
            - quarterly composites for metals, uranium and radionuclides

- dust deposition (particle fallout)
    - samples collected monthly
    - at selected locations at the boundary of the Project Footprint at Kiggavik and Sissons (minimum of 3 locations at each)
        - samples to be collected using dustfall jars over 30 day intervals
- NOx and SO_2
    - Samples to be collected using continuous, automated samplers
    - SO_2 to be collected at a single location downwind of the acid plant stack, based on the prevailing wind direction, housed in a shelter or building
    - NOx to be collected at a single location downwind of the major sources, based on the prevailing wind direction, housed in a shelter or building
- Radon
    - to be collected using a combination of Track-Etch cups and Algade alpha energy dosimeters
        - samples to be collected monthly (Algade) and semi-annually (Track-Etch)
        - at locations downwind in principal directions from major sources at Kiggavik and Sissons (minimum 5 locations around each major source, 1 at Accommodation Complex plus a minimum of 2 reference stations)
- lichen and soil monitoring
    - to be collected at locations downwind in principal directions or the major sources, preferrably co-located with select radon monitoring sites, as appropriate
        - samples to include established native lichens and soils
        - will include analysis for metals, uranium and radionuclides
        - to be collected every three years to ensure an adequate, ongoing supply of lichen at each location
        - will include baseline measurements prior to start-up

Potential effects to air quality from the Baker Lake-Kiggavik Winter Road or other Project elements will be monitored using a complaints/community concerns response procedure since there are no predicted residual effects. Should effects occur (i.e., complaints, excessive visible dust on roadside vegetation), dust control measures will be developed and implemented. If effects still occur, dust deposition (particle fallout) monitoring will be considered.

Final Closure/Post-Closure

Although there are no predicted residual effects from the final closure and post-closure phases of the project, radon monitoring will be continued throughout the final closure phase. In addition, a reduced dust monitoring program (dustfall jars) will continue through the final closure phase to verify that dust emissions are being effectively controlled. The need for continuation of

the radon and dust monitoring programs beyond the final closure phase will be assessed based on monitoring data collected during final closure.

For any Project phases or COPCs where monitoring requirements have not been recommended, monitoring will be considered/implemented on a complaints basis.

3.2 SOURCE MONITORING

Direct measurement of source emission rates is often used in addition to ambient monitoring programs to verify that the emission rates and hence model predictions used in the EIS were conservative, and that expected effects will be less than originally predicted.

The key stack/process sources at the facility are the Acid Plant and the Mill Complex. Several sources at the Mill Complex will undergo periodic source testing to measure and verify the emission rates of key COPCs, and to demonstrate that the facility is operated in a manner such that the emission rates have not increased over time.

The sources for which source emission testing is proposed are as follows:

- Acid plant stack (SO_2)
    - Source emission monitoring at the acid plant stack using a continuous emission monitor (CEM) is proposed given the remote nature of the Kiggavik site and potential logistical challenges in shipping source testing equipment to the site.
- Mill Complex - Yellowcake Plant (particulate, uranium, metals, radionuclides)
    - Proposed source emission monitoring at the Mill Complex entails periodic (every three years) source tests for particulates (TSP, PM_{10} and $PM_{2.5}$), metals, uranium and radionuclides, with annual grab samples collected in intervening years.

It is anticipated that the data from the source monitoring program will be used to update the air quality assessment, if required, to provide a more refined assessment using actual emission rates, actual production, etc, in comparison to the conservative scenarios developed and used in the EIS.

A summary of the proposed monitoring activities is presented in Table 3-1.

Table 3-1 Proposed Air Quality Monitoring Program for the Kiggavik Project

Type / COPC	Location	Method	Frequency	Analysis
Meteorological Data	Pointer Lake or Accommodation Complex	Meteorological station with 10 m tower	Continuously	Wind speed, wind direction, temperature, precipitation, solar radiation
Dust Deposition	Construction/Final Closure Boundary of Project Footprint at Kiggavik and Sissons (minimum 3 locations)	Dustfall jars	Every two months to monthly (30 d)	Total fallout ($g/m^2/30d$)
	Operation Boundary of Project Footprint at Kiggavik and Sissons (minimum 3 locations)	Dustfall jars	Every tow months to monthly (30 d) at minimum 3 locations	Total fallout ($g/m^2/30d$)
Airborne Dust (TSP or PM_{10})	At selected locations at the boundary of the Project Footprint at Kiggavik and Sissons, downwind in principal directions from major sources, where power is available (minimum 2 each at Kiggavik and Sissons, plus one at Accommodation Complex)	High Volume Air Samplers (Hi Vols)	24-hour at 6 day or weekly intervals	Total dust, quarterly composites of weekly samples for metals and uranium, Ra-226, Po-210, Pb-210, Th-230
Ambient SO_2	At a single location, downwind of the acid plant stack, to be determined in consultation with regulators	Continuous, automated SO_2 analyzer	Continuously	SO_2
Ambient NO_x	Construction Within the Baker Lake community	Continuous, automated sampler	Continuously over one shipping season	NO, NO_2 and Total NO_x
	Operation At a single location to be determined in consultation with regulators	Continuous, automated sampler	Continuously	NO, NO_2 and Total NO_x
Radon	At locations around major sources at Kiggavik and Sissons (minimum 5 each at Kiggavik and Sissons, plus minimum of 2 reference stations)	Track-Etch cups and Algade alpha energy dosimeters	Monthly (30 d) Algade dosimeters and semi-annual (Track-Etch)	Alpha energy (Algade) and radon (Track-Etch)

Type / COPC	Location	Method	Frequency	Analysis
Source Monitoring	Yellowcake Plant Stacks	Stack Testing	Every 3 years, with grab samples in intervening years	Particulate, uranium, ICP/MS metals, Ra-226, Po-210, Pb-210, Th-230
	Acid Plant Stack	Continuous emission monitor	Continuously	SO_2, daily emissions
Lichen sampling	At radon monitoring locations	Collection of established, native lichens	Every 3 years	Plants expressed on a dry weight basis: species, % ash, metals, uranium, Pb-210, Po-210, Ra-226, Th-230
Soil sampling	At radon monitoring locations	Collection of soil samples	Every 3 years	Soil expressed on a dry weight basis: Moisture, pH, metals, uranium, Ra-226, Pb-210, Th-230, Po-210

4 CONCLUSIONS

It is anticipated that the proposed mitigation measures will effectively reduce airborne concentrations of COPCs resulting from the Project. The collection of air monitoring data as outlined in this Air Monitoring Plan will assist in verifying that the actual effects are less than those predicted in the EIS, and will provide information to be used as feedback for continuous improvement on the mitigation measures, to ensure that the actual effects are in fact lower than predicted.

As an example, residual effects were predicted for TSP, PM_{10} and $PM_{2.5}$ during the operation of the Project, and can generally be attributed to emissions from unpaved roads at the mine site, including in-pit ramps. Since reasonable mitigation measures such as watering and use of low vehicle speeds have already been considered in the assessment, it is expected that monitoring of TSP or PM_{10} locations proximate to the sites will verify the conservatism of the model predictions. If effects higher than those predicted are observed (i.e. more frequent exceedances of the AQ Indicator Thresholds), enhanced dust controls or increased implementation of the existing controls will be considered at that time.