[Form 2 (to be reported to Committee on Countermeasures for Contaminated Water Treatment and to be disclosed to public)

Technology Information	
Area	5 - Management of Measures to curb underground water into the site
Title	5-3 – Technique for collecting radioactive Sr
Submitted by	Candu Energy Inc., SNC-Lavalin, Atomic Energy of Canada Ltd., Canadian Nuclear Partners

Strontium Removal Technologies

1. Overview of technologies (features, specification, functions, owners, etc.)

We are proposing three potential technologies:

Technology No.1: *Zeolites* – natural and synthetic zeolites are effective adsorbents of isotopes of strontium in effluents from nuclear facilities. However, the selectivity depends on several factors: processing conditions, zeolite composition, pH, isotopes concentrations and ionic strength of treated effluents. Generally synthetic zeolites of are favorable to strontium.

The advantages of this technology are:

a) Could be readily incorporated into subsurface as part of a slurry wall and work passively.
b) Can be easily adapted for above surface treatment of contaminated water.

Technology No.2: *Chemical injection and ion-exchange resin* – injection of organic chelating agents such as EDTA or citrate and subsequent removal via a groundwater recovery well/s and use of a suitable ion-exchange resin.

The advantages of this technology are:

a) Uses well established chemistry principals (very similar to methods for extracting strontium 90 in radionuclide analysis.
b) Can use existing groundwater wells as injection and recovery wells.
c) Ion-exchange materials to be disposed, relatively small volume.

Technology No.3: *Electro-kinetics* – installation of a cathode and anode array in the soils, application of high voltages through the soil and collection of positively charged strontium at the cathode. The strontium is then removed at the surface using a treatment technology such as ion-exchange or an adsorption media.

The advantages of this technology are:

a) Dewatering rates at the cathode can be kept low and not significantly affect the groundwater flow regime at the site.
b) Once installed the only materials requiring disposal are associated with water treatment at the surface.

2. Notes (Please provide following information if possible)

- *Technology readiness level (including cases of application, not limited to nuclear industry, time line for application)*

  The Candu consortium would partner with Burgeap Nudec in the delivery of these technologies. Burgeap Nudec was retained by the CEA (Commissariat a l'Energie Atomique) to provide engineering services with respect to decommissioning of facilities at the Grenoble Nuclear

Power Plant in France. The role of the CEA is equivalent to those of United States Department of Energy and Atomic Energy of Canada Limited. Nudec developed methodologies related to the safe decommissioning and remediation of facilities. The scope included monitoring studies, surveys, and investigations to characterize radiological and non-radiological hazards and pollution areas for the facilties, outdoor areas, and land under the buildings. Burgeap Nudec has undertaken research as to the effectiveness of cesium and strontium removal via adsorption onto synthetic and natural zeolite materials. This work was undertaken on behalf of the IRSN (Institute for Protection and Nuclear Safety). Burgeap Nudec has also undertaken research into understanding of factors influencing the mobility of strontium and cesium in soil, groundwater and soil/groundwater partitioning of these substances at three nuclear power plant sites in France. This work was undertaken on behalf of the EDF (Electricité de France).

Technology No.1: Is a well-established method applied to the nuclear industry. AECL has operated two such facilities for many years at its Chalk River Laboratories: an in-ground wall-and-curtain system and a well-based pump-and-treat system.

Technology No. 2: This technology is used on a laboratory scale for strontium separation and analysis. It has been shown to be affective in pilot trials at several nuclear sites requiring soil remediation. Other specialist contractors beyond Burgeap Nudec may be engaged if this technique was deemed feasible (to be specified at a later date).

Technology No. 3: Electro-kinetic techniques have been used for the remediation of several former nuclear weapon sites in the United States. Other specialist contractors beyond Burgeap Nudec may be engaged if this technique was deemed feasible (to be specified at a later date).

- *Challenges*

For Technology No. 1:

- Requires experimental pilot testing as adsorption performance is affected by the geochemical attributes of the radioactive effluent.
- Zeolite materials will reach saturation and thus may require replacement and disposal.

For Technology No. 2:

- Requires experimental pilot testing as strontium removal effectiveness affected by soil attributes (such as organic content, proportion of adsorbent clays and iron hydroxides) and the forms strontium maybe present (adsorbed / organically bound / salt precipitate).
- May require the installation of groundwater injection / recovery wells.
- May require dewatering at a rate that could significantly affect groundwater flow regime.

For Technology No. 3:

Requires experimental pilot testing as strontium removal effectiveness is influenced by pH gradients, chemical processes at the electrodes and various soils attributes such as organic content, proportion of adsorbent clays and iron hydroxides, soil pore water current density, grain size, ionic mobility, contaminant concentration and salinity.

- *Others (referential information on patent if any)*

No specific patent issues have been identified for Technologies 1 and 2. Several companies have patents regarding electro-kinetic techniques (Technology 3). The Candu consortium would evaluate the implications of these patents as part of the feasibility evaluation.