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# NWMO BACKGROUND PAPERS
# 4. SCIENCE AND ENVIRONMENT

## 4-4 THE CHEMICAL TOXICITY POTENTIAL OF CANDU SPENT FUEL

## EXECUTIVE SUMMARY

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# EXECUTIVE SUMMARY

The purpose of this background paper is to identify elements in CANDU spent fuel that should be included in environmental assessments when demonstrating “safety” with respect to chemical toxicity in long-term storage or disposal of spent fuel. It should be noted that previous assessments have demonstrated the safety of specific storage/disposal concepts with respect to radiotoxicity, and similar demonstrations can probably be made with respect to chemical toxicity. This paper is not intended to be a safety assessment. However, it is useful to develop a rationale by which such assessments can focus on the elements of greatest potential concern. The rationale presented herein involves very conservative assumptions such as rapid chemical release from fuel and unretarded transport to the biosphere. The resulting short list of chemicals of potential environmental concern provides a starting point for subsequent safety assessment, in that the onus is on the proponent to demonstrate why conditions in the long-term management facility and surrounding environment will be such that these chemical elements do not pose unacceptable environmental risk.

The screening process begins by a consideration of the total elemental composition of spent fuel approximately 10 years following its removal from the reactor core. Since most of all known elements are present at very trace quantities in the spent fuel, the first screen applied is a comparison of the concentration of a particular element in spent fuel with the comparable concentration in background rock (granite). Elements found in spent fuel in concentrations lower than that found in granite rock are excluded from further consideration. In addition, certain “elements of life” such as carbon, nitrogen, hydrogen, oxygen, etc., and other non-toxic elements such as noble gases, are excluded from further consideration.

The second step in the screening process is to make some very conservative assumptions concerning the degradation of the spent fuel and the release of the contents to the surrounding environment. Decay and ingrowth of new elements is also considered, as well as a minimal degree of dilution in various environmental media such as water, soil, sediment and air. The result of this process is a set of maximum concentrations of a wide range of the elements that could ever reasonably be expected to be encountered in the vicinity of a spent fuel management facility.

The third step in the screening process is to compare the concentrations of these elements to a number of toxicity-based environmental guidelines. If an element has a guideline concentration and it is exceeded, it is considered as an element of potential concern and recommended for evaluation in any safety assessment. If an element does not have a guideline or other benchmark because it is very rare and has not been studied, but if it is relatively abundant in spent fuel and soluble, it is identified as a candidate for toxicity studies.

The result of this screening process is a short list of elements present in spent fuel, either initially or as a result of radioactive decay and ingrowth through time, that will require consideration in the safety assessment to be carried out for any spent fuel long-term management facility.

The elements identified based on screening-level estimates of concentration in water (groundwater and/or surface water) included lead (Pb), nickel (Ni), uranium (U), molybdenum (Mo), antimony (Sb), cobalt (Co), cadmium (Cd), chromium (Cr) and zirconium (Zr). All of these elements were also identified based on estimates of concentration in soil, as well as sediment or air in some cases. Elements identified based only on estimates of concentration in soil included lanthanum (La), iodine (I), bromine (Br), tungsten (W), technetium (Tc), tin (Sn) and niobium (Nb). The soil and air estimates, by direct partitioning from undiluted groundwater, were considered to be particularly conservative.