Environment Canada Environnement Canada
Health Canada Santé Canada

Canadian Environmental Protection Act, 1999

PRIORITY SUBSTANCES LIST ASSESSMENT REPORT

Releases of Radionuclides from Nuclear Facilities (Impact on Non-human Biota)

Canada

SYNOPSIS

The impact of the release of radionuclides from nuclear facilities on non-human biota was assessed. Nuclear facilities examined included all aspects of the uranium fuel chain, from mining and milling through to power generation and waste management. Although nuclear facilities release non-radioactive substances (e.g., metals, organic chemicals), the effects of such non-radioactive substances were not considered in this assessment.

Because of the variety of industrial activities and processes that result in the release of a large number of radionuclides with different radiological half-lives and chemical, biological and environmental properties, sectorial assessments were conducted. The sectors and numbers of facilities considered were as follows: five operating uranium mines and mills, two uranium refineries and conversion plants, three stand-alone waste management facilities and five nuclear power plants. Heavy water production facilities were not included, because there is no production, use or release of radionuclides from these facilities.

Uranium (U) and thorium (Th) and their decay chain daughter radionuclides are the radionuclides of primary interest released from uranium mines and mills, whereas uranium is the main radionuclide released from uranium refining and conversion facilities. Radionuclides of interest in tailings management facilities at uranium mines and mills are primarily ^{226}Ra and uranium, although other radionuclides (e.g., ^{3}H, ^{14}C, ^{60}Co, ^{90}Sr and ^{137}Cs) may also be important in some waste management facilities. Fission and activation products released from nuclear generating stations include ^{3}H, ^{14}C, ^{51}Cr, ^{54}Mn, ^{59}Fe, ^{60}Co, ^{65}Zn, ^{90}Sr, ^{95}Zr, ^{106}Ru, ^{124}Sb, $^{128–135}$I, ^{137}Cs and ^{144}Ce. Releases of radionuclides from these facilities are primarily to air or to water. Emissions to air will result in the deposition of particle-reactive radionuclides and increased scavenging of radionuclides from the plume with distance from the source. Mobile radionuclides such as the inert gases will disperse quickly and reach background concentrations a short distance (a few kilometres) from the source. Most of the radionuclides released are particle reactive and partition either from water to sediment or from air to soil.

There are two modes of toxic action for the radionuclides assessed: chemical and radiological. Because of its relatively low specific activity, uranium is the only radionuclide examined that has greater potential to cause chemical rather than radiological toxicity. Radiotoxicity can result from exposure to ionizing radiation emitted by radionuclides. Radiotoxicity differs from chemical toxicity in that radiation dose, the measure of radiation exposure, results from radionuclides incorporated in tissues (internal dose) and from external radionuclides (external dose) that emit radiation adjacent to the organism.

For the chemical toxicity of uranium, releases are largely restricted to the front end of the nuclear fuel chain: namely the mining, milling and refining of uranium and the management of mill tailings. Comparison of exposure values with Estimated No-Effects Values (ENEVs) indicates the potential for localized harm to organisms resulting from current releases of uranium and uranium compounds contained in effluents from three older operating uranium mines and mills. However, there was no evidence of environmental harm from exposure to uranium at two new uranium mines and mills with state-of-the-art effluent facilities.

There is relatively little evidence that exposure to ionizing radiation resulting from current releases of radionuclides from nuclear facilities is causing environmental harm. Comparison of exposure values with ENEVs does suggest that there is potential for biota to be

harmed from exposure to radiation at two locations near operating mines and at one stand-alone waste management facility as a consequence of current releases. However, uncertainties and some conservative assumptions associated with risk estimates for ionizing radiation, complicate their interpretation.

Based on available data concerning the effects from exposure to uranium, it has been concluded that (i) releases of uranium and uranium compounds contained in effluent from uranium mines and mills are entering the environment in quantities or concentrations or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity; and (ii) releases of uranium and uranium compounds from uranium refineries and conversion facilities, stand-alone waste management facilities, power reactors and their associated waste management facilities, and research reactors are not entering the environment in quantities or concentrations or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. Based on available data concerning the effects from exposure to ionizing radiation, it has been concluded that ionizing radiation emitted by radionuclides released from uranium mines and mills, uranium refineries and conversion facilities, stand-alone waste management facilities, power reactors and their associated waste management facilities, and research reactors is not entering the environment in quantities or concentrations or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. Therefore, it is concluded that releases of uranium and uranium compounds contained in effluent from uranium mines and mills are "toxic" as defined in Section 64 of the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

Since it is concluded that uranium and uranium compounds contained in effluent from uranium mines and mills are "toxic" as defined in Section 64 of CEPA 1999, it is recommended that investigations of options to reduce exposure to uranium from these sources be considered a high priority. Discussions have been initiated with the Canadian Nuclear Safety Commission (CNSC) to determine whether it will be possible to manage these releases under the *Nuclear Safety and Control Act*. It is proposed that the process for risk management be formalized in an annex to the memorandum of understanding that has been negotiated between Environment Canada and the CNSC.

Risk quotients calculated for ionizing radiation indicate limited potential for harmful effects on the environment. The indicators of risk were fairly low, however, especially considering the uncertainties and somewhat conservative assumptions made when estimating risks for some biota. It is nevertheless believed that an increase in environmental concentrations of radionuclides could significantly increase risks, particularly at uranium mines and mills and stand-alone waste management facilities. It is thus recommended that releases of radionuclides from such facilities be regularly monitored through existing mechanisms to evaluate whether risk management initiatives may be needed for ionizing radiation in the future. It is important that operators of such facilities recognize that if information in their possession, such as monitoring data, shows a significant increase in near-field radionuclide concentrations or loadings, such information may be subject to reporting under Section 70 of CEPA 1999.