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A Model Safeguards Approach for a Geological Repository

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Introduction

The direct underground disposal of spent fuel from commercial nuclear power reactors is an option that is currently being explored by a number of countries. Implementation of this option for the final part of the nuclear fuel cycle requires construction and operation of two new types of facilities:

- conditioning plants for preparation and packaging of the spent fuel in disposal containers; and
- geological repositories (operating and closed) for final emplacement of the filled containers.

The introduction of these new facilities imposes an obligation on the International Atomic Energy Agency (IAEA) in Vienna to develop and effectively implement new safeguards systems that will provide adequate assurance of non-diversion of nuclear material from both conditioning plants and repositories during all phases of operation and following repository closure. The safeguards support programs of Canada and several other Member States have accepted the IAEA task on Safeguards for Final Disposal of Spent Fuel in Geological Repositories (SAGOR) to develop generic safeguards approaches for these facilities.

Canada's Role in the SAGOR Project

Canada has undertaken a lead role in performing studies and preparing the associated technical reports covering the development of a safeguards approach for an operating geological repository. In collaboration with its partners, Canada has also prepared a report that provides a general overview on the application of different geophysical techniques and a brief description of related instruments that have potential for safeguards applications in a geological repository for spent fuel.

The Safeguards Approach for a Reference Repository

As a prerequisite to designing a model safeguards approach for a geological repository, a report was prepared to describe the design and operation of the reference facility and the design of the disposal canister and cask that would be received from the conditioning plant. The reference repository is a generic facility which incorporates aspects of several design concepts; however, actual specifications on characteristics of different fuel types and the conceptual designs of disposal facilities from a number of Member States are also provided as appendices in the report. The reference facility is excavated to a depth of about 500 m in crystalline rock. Disposal canisters filled with spent LWR fuel are lowered into the repository via a single vertical shaft and

emplaced in boreholes that are drilled in the floors of disposal rooms. Each disposal canister has a copper shell for corrosion protection and an internal steel liner for strength, and will contain nine BWR or four PWR fuel assemblies. A reusable outer cask reduces the radiation dose rate from the spent fuel to acceptable levels within the repository from the time of receipt at the surface until final transfer of the canister to the underground emplacement site.

A second study was then undertaken to determine the potential paths for diversion of nuclear material from the repository. It was found that a limited number of locations ("detection points") could be identified for the detection of all attempted diversion strategies. Further examination of these detection points revealed that an even smaller number of locations ("strategic points") - common to multiple diversion scenarios - would cover all of the postulated diversion paths listed in the report.

Based on the findings from these two initial reports, it was then possible to develop a model safeguards approach for the reference repository. The most recent IAEA consultants' group meeting on Safeguards for the Direct Final Disposal of Spent Fuel in Geological Repositories has recommended that the IAEA combine containment and surveillance (C/S) methods with design information verification (DIV) as the basic safeguards approach for an operating repository. The research undertaken by Canada within the framework of the SAGOR Project supports the feasibility of that recommendation to the extent that a reliable and comprehensive C/S system could be employed, mainly at the surface of the site, to verify, inter alia, the flow of full and empty spent fuel casks, and that DIV could be used as the primary safeguards technique below ground level. It is thought that DIV, possibly in combination with environmental monitoring, would be particularly effective in the detection of a clandestine underground reprocessing facility or the existence of any undeclared structures or excavations within the repository.

As with previously established safeguards systems, a major consideration in the design of this model safeguards approach is to employ non-intrusive methods. The ultimate goal is to develop a system that is accepted by the IAEA as a basis for safeguards at all types of geological repositories.