Tritium and Technology Developments for its Management
A Canadian Perspective

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Canada has been a pioneering country in tritium technologies because of its CANDU® Reactors. Tritium is produced in small quantities in the heavy water moderator and heat transport system in these reactors. As a result, a vast amount of experience has been built up in the management of tritium in CANDU stations. One of the main methods of managing tritium emissions and worker dosage has been to reduce tritium concentrations in the heavy water through detritiation. For example, the Darlington Tritium Removal Facility (DTRF) has been successfully maintaining low tritium levels in the Ontario Power Generation's reactors in Ontario for more than two decades. More recently, the Wolsong Tritium Removal Facility (WTRF) has come on-line to reduce tritium levels in the CANDU reactors at Wolsong.

Atomic Energy of Canada Limited (AECL) has been a leader in developing advanced technologies for detritiation applications and tritium handling. These developments have been achieved through the experience gained from tritium handling and engineering in facilities licensed to handle high levels of tritium and prototype hydrogen isotope exchange process plants. AECL's Combined Electrolysis and Catalytic Exchange (CECE) technology for water detritiation relies on electrolysis for deuterium gas return to the Liquid Phase Catalytic Exchange (LPCE) system for hydrogen isotope exchange. Though the technology has been demonstrated, an extensive research program has been ongoing to advance this technology further, particularly in electrolysis cell materials. Components of commercial alkaline cells that come into contact with the tritiated electrolyte have been qualified for the potential irradiation conditions that may prevail in the CECE process for various applications. One class of membranes tested so far have been found to be physically robust after a gamma-radiation dose of 1.3 MGy (equivalent to 14.6 years of exposure to tritiated water at $180 Ci \cdot kg^{-1}$). Polysulfone has been found to be essentially unaffected by a radiation dose of 0.5 MGy (equivalent to 5.3 years of exposure to tritiated water at $180 Ci \cdot kg^{-1}$). Similar results were observed with samples exposed to the beta-radiation of tritiated water. Isotope exchange catalyst samples exposed to the generated hydrogen gas, potentially carrying by-products from the irradiation of cell components, showed no significant permanent performance loss.

This paper discusses the results of the extensive studies carried out on materials used in tritium processing (such as those mentioned above) as well as tritium as a resource or product and some of the latest technologies available for its safe handling.