

Canadian and International Fusion Fuel Cycle Capabilities supporting Global Fusion Energy Developments

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Since the dawn of the CANDU nuclear power technology, its significance as a tritium fuel supply source for fusion developments has been well recognized. The tritium by-product from the capture of neutrons by the heavy water in CANDU reactors is removed for safe operation of the reactors, stored in solid form and supplied for various peaceful applications including fusion energy research developments. For example, the experiments in the JET facility were carried out with tritium purchased from Ontario Power Generation's (OPG) Darlington Tritium Removal Facility (DTRF) and packaged and shipped by Canadian Nuclear Laboratories (CNL). Many fusion developers are potentially reliant on the availability of tritium from continued operation of the CANDU reactors around the world. Recent estimates of the amount of tritium potentially available from CANDU reactors (globally) is about 30 to 40 kg over the next three decades; however, with ITER operation potentially requiring tritium in the 10 kg range in late 2030's, the tritium inventory is expected to dwindle there on. This potential demand for ITER can cause a critical tritium supply limitation for fusion development demonstrations around the world. Canada's ambition to deploy CANDU® MONARK™ 1,000 MWe reactors may partially relieve the tritium supply limitation in the second half of this century.

CNL's Tritium Facility is a one-of-a-kind laboratory licensed to handle up to 1MCi for processing and up to 2.5MCi in storage. This facility, under a contract with OPG, dispenses tritium for OPG customers around the world. And, in conjunction with the Hydrogen Laboratory at CNL where other isotopes of hydrogen are handled, this facility has been the Canadian centre for establishing a range of tritium capabilities. Some examples are: hydrogen-water isotope exchange processes for heavy water production and detritiation of heavy and light water for tritium management/control; air detritiation; materials development for tritium services in high temperature fission and fusion reactor applications; tritium permeation studies in metals and membranes; tritium pumping; tritium analytics, diagnostics and accountancy; tritium storage, packaging and transportation to national and international customers; specialized glove boxes to handle tritium processing operations; and ventilation systems for safe operation in closed spaces. These capabilities have been demonstrated in laboratory operations and in small- and large-scale systems over the last several decades.

The recent boom in new fusion companies has put these capabilities in the spotlight for the benefit of fusion energy across the world. The UNITY-2 facility, currently under detailed design at CNL, encompasses Canada's tritium capabilities and Kyoto Fusioneering's engineering capabilities to deliver a versatile D-T fusion fuel cycle platform with up to 30 g tritium inventory for fusion energy developers to collaborate, witness, study and validate technologies, as well as test out their proprietary equipment and processes. The UNITY-2 facility will consist of all processes and components typically required for the fusion fuel cycle in a power plant, but at prototypical conditions.

This presentation will discuss current status of tritium supply, Canadian fusion capabilities and their applications in UNITY-2 for advancing fusion energy developments.

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