Intelligence MEMOS

From: Esam Hussein

To: Canadian Nuclear Observers

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Re: **Nuclear is Coming Back. What About Canada's Fuel Supply Chain?**

Canada appears on the verge of a nuclear-power renaissance instigated by the need for reliable carbon-free energy, with the provinces and the federal government putting their weight behind a wide range of initiatives.

How did we get here and what could be next for Canada's nuclear fuel structure?

Canada pioneered the CANDU-reactor design that uniquely uses natural uranium and heavy water. Natural uranium is used as a fuel despite the low abundance (0.72 percent) of its fissionable isotope U-235.

Outside Canada, different systems prevail. The 305 pressurized water reactors, and the 41 boiling water reactors, are dominant and use low enriched uranium (LEU) containing 3 to 5 percent U-235, along with ordinary light water.

There are 47 pressurized heavy water reactors currently in operation worldwide, 19 of which are in Canada and first connected to the grid between 1973 and 1993: Six at Pickering, eight at the Bruce site on Lake Huron, four at Darlington near Toronto, and one at Point Lepreau, NB.

Canada's supply chain for the natural uranium used in these reactors is well established. Raw uranium is mined in Saskatchewan. It is domestically refined into a purified form and converted into uranium dioxide, then manufactured into fuel pellets and bundles for CANDU reactors. Canada has the world's largest commercial uranium refinery in Blind River, Ont. Cameco also operates conversion and fuel manufacturing facilities in Port Hope. In Toronto, BWXT Nuclear Energy Canada Inc. has a facility to manufacture CANDU nuclear fuel pellets, assembled into fuel bundles in its other facility in Peterborough. Most of uranium is exported to the US, Europe and Asia with only about 15 percent used in domestic CANDU units.

No new reactors have been constructed in Canada since the 1990s. However, by the end of 2024 Ontario Power Generation is expected to receive a construction permit for a BWRX-300 small reactor at its Darlington site. The same reactor type was selected for potential deployment in Saskatchewan. This brings new challenges to Canada's fuel supply chain. The BWRX-300 reactors use enriched fuel, and Canada has no enrichment facilities, and will need to buy it from facilities in the US, France, Germany. Netherlands, or the UK.

Meanwhile, Ontario has also announced its desire to add a new nuclear generating station at the Bruce Power site that would include a large-scale nuclear plant that may utilize LEU. And Ontario and Saskatchewan are exploring microreactors, which are designed to have years-long fueling cycles, and can stand alone in remote communities to replace diesel fuel, or produce hydrogen for heavy industry. These reactors require high-assay low enriched uranium (HALEU), which is enriched in U-235 from 5 percent to close to 20 percent (the maximum limit inder international rules). HALEU will be also needed in the ARC-100 reactor being developed in Saint John, NB and the X-Energy reactor explored with Cameco. HALEU fuel is not produced in Canada and is not available in Western countries at commercial scale, though the US Department of Energy is exploring options to support testing and demonstration of HALEU-dependant reactors.

There is also the Moltex reactor being developed in New Brunswick, designed to use molten salt fuel of low-purity reactor-grade plutonium; reprocessed from stocks of spent CANDU fuel. The goal is to reduce the nuclear waste of spent fuel by burning long-lived isotopes. Nuclear fuel reprocessing has not been conducted in Canada, though there are no technical obstacles. However, concerns have been raised about the extraction of plutonium, as it can be used in nuclear devices and the federal government has yet to decide if reprocessing will be permitted in Canada.

To date, the only full supply chain available in Canada is for natural uranium that fuels CANDU reactors. There appear to be no explicit policies yet in Canada on enriching uranium. In the meantime, Canadian utilities and fuel manufacturers may consider purchasing domestic natural uranium, send it abroad for enrichment, and have it back for fabrication domestically into reactor fuel. This may complicate the procurement process, but will secure the supply of enriched uranium, while growing the domestic fuel manufacturing capability.

Reactor design is advancing towards reaching the goals of Generation IV reactors of sustainability, better economies and enhanced safety and reliability. Canada should maintain its standing as a leader in nuclear power. As a first step, the federal government should clarify its policies on uranium enrichment and the processing of spent fuel. Governments should also continue to support domestic nuclear-related industries, to add value to our valuable uranium resources.

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