Nuclear Fuel Cycle

Highlights

Canada is the world's largest producer of uranium, supplying about 30% of global demand.

The CANDU reactor uses uranium that is no more readioactive that it is found in nature.

CANDU fuel bundles are highly radioactive only after they have been in the reactor.

The mining and processing of uranium is strictly controlled by federal and provinical at each stage of the process.

CANDU reactors use about 28% less natural uranium that light water designs, producing that much less waste to be disposed of.

The nuclear fuel cycle is the term used to describe the entire progress of nuclear fuel, from uranium as it is mined from the ground, refining and fabrication of uranium into pellets for fuel bundles, through the year or so each bundle spends producing energy in a reactor, to eventual disposal.

URANIUM MINING: Uranium is a naturally-occurring radioactive mineral, i.e. it is radioactive as found in nature. Canada is the world's largest uranium producer, supplying about 30% of the global demand. All of the currently operating Canadian uranium mines are located in the province of Saskatchewan. In 1995, they produced just over 10,000 tonnes, about 80% of which was exported.

Until 1983, most uranium in Canada came from low grade underground mines in northern Ontario. Today, Canadian uranium production comes from high-grade mines discovered in northern Saskatchewan's Athabasca Basin. The region continues to be the focus of significant exploration activity.

Uranium mining in Canada (from the environmental assessment of a mining proposal to the actual mining operation) is governed by federal as well as provincial regulations. Currently, Canadian uranium requirements needs vary between 15-20% of the annual production.

Uranium mining is similar to mining for many other minerals. The uranium-bearing ore is mined and transferred to milling facilities, where it is crushed and treated with chemicals to extract the uranium oxide concentrate.

REFINING & CONVERSION: The concentrate, a yellow powder known as yellowcake, is then shipped for further refining and final conversion. Canada has only one refining and one conversion facility, both owned by Cameco. The refinery is located at Blind River, Ontario. The conversion facility at Port Hope, east of Toronto enhances the chemical composition of the uranium compound to either uranium oxide (which is used to manufacture the ceramic pellets for CANDU fuel) or to uranium hexafluoride (which is used for the manufacture of fuel for other types of reactors).
Uranium fuel for CANDU reactors is unique in that it does not need to be enriched, that is, the proportion of the fissile U235 isotope is not increased. Natural uranium contains about 0.7% U235.

The Canadian Nuclear Workers' Council is comprised of Locals for the following organizations: *Canadian Union of Public Employees*Communications, Energy & Paper Workers Union*International Association of Firefighters*International Association of Machinists & Aerospace Workers*International Brotherhood of Electrical Workers*Office & Professional Employees International Union*Power Workers' Union*Professional Institute of the Public Service*Public Service Alliance of Canada*United Steelworkers of America*

Uranium pellets are roughly the size of a one-inch stack of dime coins. Seven such pellets produce enough electricity to supply the annual electricity requirements of the average Canadian household. The pellets are loaded into virally tubes about 50 cm long and these tubes are in turn held together in bundles by small plates welded to each end. A fuel bundle weighs about 25 kg.

ENERGY PRODUCTION: Fuel bundles are then ready for service in a CANDU reactor. A new CANDU fuel bundle is only mildly radioactive and can be handled safely wearing only protective gloves to protect the fuel bundle from dirt and moisture. The bundles are loaded into a reactor by hand in its initial startup. Once the reactor is operating, bundles are loaded automatically by a fuelling machine. This is another unique aspect of the CANDU design - it can be refuelled while in operation.

The fuelling machine locks on to a pressure tube and inserts a new fuel bundle while a similar machine locks on to the other end of the same pressure tube to receive a spent bundle. Thus a CANDU is constantly being “topped up” with fuel, whereas the more widely-used light water reactors must be shut down in order to replace all of the fuel.

A CANDU fuel bundle spends on average about 12-15 months in the reactor and produces about 20,000 times as much electricity as the same volume of coal, or about 15,000 times as much as the equivalent volume of oil.

CANDU reactors also require on average about 28% less natural uranium to operate than light water reactors, therefore producing that much less waste to be disposed of.