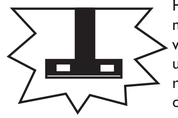
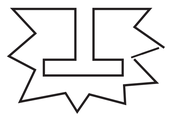
# Nuclear Map of Canada – Glossary of Icons

## Impending Nuclear Projects


PLUTONIUM FUEL, or MOX ("mixed oxide") fuel, refers to a blend of uranium and plutonium oxides fabricated into new reactor fuel. Plutonium for MOX can come from dismantled nuclear warheads or reprocessed spent fuel. Unlike CANDU uranium fuel, plutonium fuel is a strategic material; it can be easily stolen or diverted, and used to make an atomic bomb.



HIGH LEVEL WASTE REPOSITORY. The nuclear industry wants to bury high level waste (spent fuel) in rocky chambers deep underground. It claims this waste will remain safely buried forever; but since the danger lasts millions of years, certainty is not possible. If the repository concept is approved, the industry says it may extract plutonium from the spent fuel before burying the rest of the waste.



A TEST SHAFT has been excavated in Manitoba in the Pre-Cambrian Shield to study the possibility of a geologic repository for high level radioactive waste. $700 million (Canadian) has been spent on this Underground Research Laboratory so far. Japan and the US have also invested in the test facility. However, the Manitoba government has outlawed any import of high level waste for the purpose of burial.

TEST DRILLING. Many communities in Ontario (e.g. Madoc, Massey) have prevented test drilling for high level waste disposal research. They fear that allowing such research may lead to the eventual siting of a high level waste repository nearby, and possibly a reprocessing plant.

FOOD IRRADIATION utilizes powerful gamma rays from cobalt-60 to kill insects and microbes in spices, fruit, poultry, grain and other foodstuffs in order to prolong shelf-life. A similar technology is used to sterilize medical equipment.

DISTRICT HEATING REACTORS produce hot water or steam, but little or no elec-tricity. They are intended to provide heat to a group of buildings and are designed for unattended operation. Like all reactors, they also produce radioactive wastes.

FUSION RESEARCH. Today's nuclear reactors use "fission", whereby energy is released by the splitting of heavy atoms. Energy can also be obtained by combining or "fusing" light atoms; but fusion is very difficult to initiate and to maintain. After decades of research costing billions, it is doubtful whether fusion will ever work on a commercial scale. Fusion reactors would produce large amounts of radioactive tritium and result in radioactive structures.

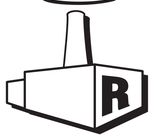
## Front End of the Nuclear Fuel Chain

URANIUM MINE. Uranium is a radio-active metal widely distributed in the earth's crust. It is a blend of two isotopes. The lighter one, uranium-235, is the only naturally occurring element that can sustain a chain reaction, so it can be used as a nuclear explosive or as reactor fuel.


A URANIUM MILL crushes uranium ore, grinds it to a fine powder, then separates out the uranium using solvents. The sandy wastes discarded at the mill are far more radioactive than the uranium itself, since these wastes contain a dozen other radio-active materials also present in the ore.

RADIOACTIVE TAILINGS are the sand-like residues left over from uranium milling. They constitute a perpetual radio-active hazard. Other ores rich in uranium also yield radioactive tailings after milling (e.g. at Calgary, Oka, Varennes, & St. John's).


YELLOWCAKE. Uranium is shipped from the mill packed in drums as a radioactive yellow powder ($U_3O_8$) called "yellowcake".



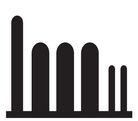

A URANIUM REFINERY chemically transforms yellowcake into other uranium compounds such as dioxide (for reactor fuel) or hexafluoride (for enrichment).

by land

by water

"YELLOWCAKE ROAD" is the path taken by uranium from the mill to the refinery, and then to domestic and foreign buyers.


CANDU REACTOR FUEL is fabricated from pellets of uranium dioxide, which are inserted in thin metallic rods welded together to form fuel bundles for use in CANDU power reactors.

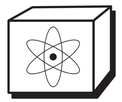


HEAVY WATER is a non-radioactive, naturally occurring variant of normal water. Expensive to produce, it is needed in large quantities for the CANDU reactor.


URANIUM HEXAFLUORIDE or "HEX" is the only known uranium compound that turns easily into a gas: a property that is needed in order to "enrich" the uranium.

URANIUM ENRICHMENT increases the concentration of uranium-235 (it is only 0.7 percent in natural uranium). Highly enriched uranium (over 90 percent) is used for bombs, nuclear submarine fuel, and some research reactors. Low-enriched uranium (3 to 20 percent) fuels most reactors other than CANDU reactors. Enrichment plants are strategic facilities because they can produce bomb materials.

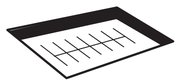
## Back End of the Nuclear Fuel Chain



RESEARCH REACTORS produce heat and neutrons, but no electricity. They are used to study nuclear reactions, to irradiate materials, or to produce isotopes (including plutonium).

CANDU POWER REACTORS boil water, and the resulting steam turns a turbine to generate electricity. Thick containment walls are required to keep radioactive materials out of the environment in the event of an accident. The CANDU is one of the few power reactors that can be fuelled with natural (unenriched) uranium.

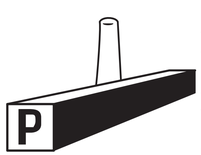

A VACUUM BUILDING is designed to suck up radioactive steam and gas during an accident. In Ontario, each cluster of four CANDU reactors is joined to a single vacuum building. Other CANDU reactors have no vacuum building.



SPENT FUEL POOLS. When irradiated fuel is discharged from a reactor, it is stored under water. Spent fuel is far more radioactive than fresh fuel, due to new radioactive materials created inside the reactor. Water in the pool shields workers from lethal doses of radiation and prevents spent fuel from overheating as a result of radioactive decay.

SPENT FUEL SILOS provide dry storage for spent fuel that has cooled off in a pool for seven years or more. By then, the radioactivity has declined enough that spent fuel can be cooled by air circulating through vents in concrete silos. However, since spent fuel remains hazardous for millions of years, pools and silos are only temporary storage measures.


TRITIUM REMOVAL FACILITY. Tritium is a radioactive form of hydrogen, created from heavy water inside every CANDU reactor. Tritium is a hazard for workers and the environment. Ontario has a one-of-a-kind plant that removes tritium from heavy water and sells it. Tritium is used in luminous dials and emergency exit signs. It is also used as a powerful explosive in modern nuclear bombs

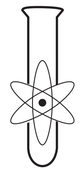



REPROCESSING. Inside all reactors fuelled with uranium, some of that uranium is transmuted into plutonium. A reprocessing plant dissolves the spent fuel in acid, then chemically extracts the plutonium contained within. Plutonium is the primary explosive in most nuclear bombs, and it can also be used as reactor fuel. Reprocessing of spent fuel took place at Chalk River in the 1950s.

HIGH LEVEL LIQUID RADWASTE is the corrosive radioactive liquid left over from reprocessing. It contains almost all of the radioactivity in the spent fuel. Chalk River stores high level liquid radioactive waste in six tanks underground .

## Miscellaneous Nuclear Activities

NUCLEAR RESEARCH includes studies of isotopes, radioecology, effects of radiation, nuclear chemistry, materials science, and radwaste migration, as well as work on fission or fusion reactors, accelerators, and other atomic or subatomic processes.



RADIO-ISOTOPES refer to radioactive materials used since 1900 in medicine (for diagnosis or therapy), and in industry and science (as radiation sources and tracers). Before WW II , only naturally occurring isotopes were used. Since then, artificial isotopes created in cyclotrons and reactors have become available. Canada is the world's largest supplier of artificial isotopes like cobalt-60 and molybdenum-99, both produced in Canadian reactors.


CANDU REACTOR COMPONENTS include zirconium pressure tubes, steel calandrias, robotic refuelling machines, and a wide array of specialized valves, controls and instruments. They are manufactured mainly in Ontario and Quebec.

SOIL/WATER CONTAMINATION results from dumping or leakage of radioactive materials. Areas around Chalk River, Port Hope, Deloro and Pinawa, as well as uranium tailings areas, are among the most radioactively contaminated sites in Canada.

RADWASTE STORAGE. Radioactive wastes from hospitals, universities, industry, and unidentified sources are stored in a variety of forms throughout Canada. Sometimes, radioactive wastes or discarded isotopes surface in scrapyards, sewers and dumps.

RADWASTE BURIAL (other than spent nuclear fuel) Radioactive mops, rags, gloves, shoes, clothing, tools, and contaminated equipment from reactors such as filters and damaged pressure tubes, are temporarily stored in near-surface underground containers at Bruce and elsewhere.

LIQUID RADWASTE DISPERSAL. At Chalk River, millions of gallons of radioactive liquids have been poured into pits and shallow trenches in sandy soil adjacent to the Ottawa River.

A RADWASTE INCINERATOR reduces the volume of combustible radioactive waste materials, yielding atmospheric releases and radioactive filters. Canada has one radwaste incinerator at Bruce.

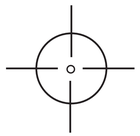
A PARTICLE ACCELERATOR is a machine designed to speed up charged subatomic particles. Often used as research tools, accelerators can also be used to irradiate objects, thereby producing radio-isotopes without any need for a reactor.

## Nuclear Weapons Systems & Components

US NUCLEAR-ARMED CF-101 VOODOO JETS were on alert at Canadian bases from the mid 1960s to the mid 1980s. These planes were equipped with nuclear-tipped air-to-air missiles; they were under orders to use a small nuclear warhead to destroy any attacking Soviet bombers.

US NUCLEAR SUBMARINES are powered by nuclear reactors fuelled with highly enriched uranium, and are designed to carry intercontinental ballistic missiles with nuclear warheads. These subs dock at various Canadian ports, and test their torpedoes at Nanoose Bay near Vancouver.

US CRUISE MISSILES are robot airplanes designed to deliver a conventional or nuclear warhead. For several years they were flight-tested in Northern Alberta; they were not armed during these tests.



US MISSILE GUIDANCE SYSTEMS. The inertial guidance systems for cruise and MX missiles were manufactured near Toronto. Other nuclear-bomb related manufacturing has occurred at various sites in Canada.

US NUCLEAR-ARMED BOMARC MISSILES were deployed at several Canadian army bases during the Pearson administration. They were designed to blow up incoming soviet nuclear-armed bombers using a small nuclear warhead.

NUCLEAR BOMBS all use either highly enriched uranium or plutonium as the primary nuclear explosive. For this reason, the abolition of nuclear weapons would necessitate an end to uranium enrichment and plutonium reprocessing.

## Status Symbols

When another icon is placed over this upwards-pointing triangle, it indicates a PROPOSED facility – one not yet approved or operating when the map was printed.



When another icon is placed over this downwards pointing triangle, it indicates a facility that has been SHUT DOWN or an activity which has been terminated.



When another icon is placed under this one, it indicates a facility or activity which was STOPPED or PREVENTED as a result of citizen opposition.



When another icon is placed over this stop sign, it indicates a government declaration or law which PROHIBITS the facility or activity in question from taking place within