Management of Spent Fuel from Nuclear Power Reactors

Lifecycle of Nuclear Fuel

The fuel that is used in most nuclear power reactors today is based on ceramic uranium oxide. The design of the fuel and its fissile content varies between different reactor types. The fuel in light water reactors, such as pressurized water reactors and boiling water reactors, and in modern gas cooled reactors, uses uranium enriched to increase its fissile uranium-235 content to up to 5 per cent, while CANDU and pressurized heavy water reactors mainly use slightly enriched or natural uranium, with a uranium-235 content of about 0.7 per cent.

A 1000 megawatt electric pressurized water reactor core typically contains between 120 and 200 fuel assemblies. Each fuel assembly contains around 500 kg of uranium oxide and can generate about 200 million kilowatt hours of electricity over its lifetime in the core. A reactor of this size discharges about 40 spent fuel assemblies per year containing about a total of 20 tonnes of uranium oxide.

The nuclear fuel is considered spent when it no longer can sustain the fission reaction. In a pressurized water reactor, this takes about three to seven years, depending on the fuel and its location in the reactor core. When it is removed from the core, spent fuel looks similar to a fresh fuel assembly, but it is highly radioactive and hot and must be cooled and shielded. It is transferred to a storage pool since water is a good cooling and shielding material. After a period of cooling time, it can be transferred to a dry storage facility, if required.

Currently, after an adequate period of storage, spent fuel can either be:

- considered as waste to be conditioned and disposed of in a deep geological repository. This is called open fuel cycle; or
- reprocessed to recover remaining fissile material that can be recycled as new fuel in nuclear reactors, generating high-level waste that will be disposed of in a deep geological repository. This is referred to as closed fuel cycle.