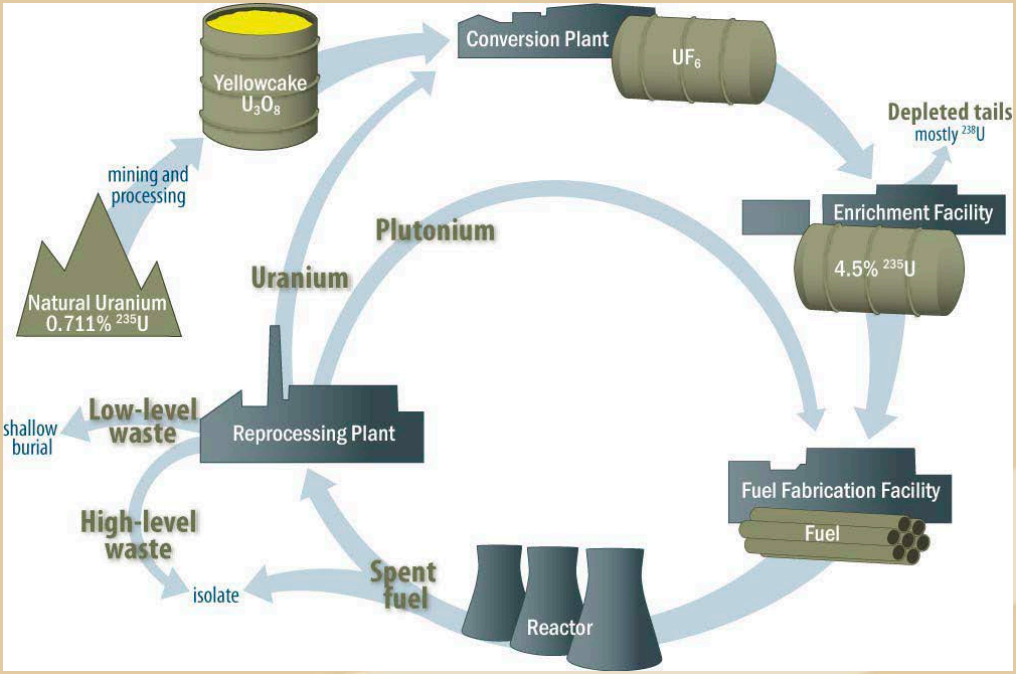
Nuclear Fuel Cycle Overview Training

Course Description

- This training seeks to deepen understanding of the definition and role of the nuclear fuel cycle both historically and in the present day.
- The offering has tailored modules for managers as well as for scientists, technicians, and engineers (STEs) who work in nuclear proliferation-sensitive settings around the globe.
- Components of the nuclear fuel cycle are introduced and discussed in depth.
- Curricula encourages engagement in peer-to-peer discussion.
- Instruction is in the form of interactive classroom lectures.
- Course Duration: 1 day

Nuclear Fuel Cycle General Flow



Nuclear Fuel Cycle

The nuclear fuel cycle is a complex entity, with many stages and possibilities, encompassing natural resources, energy, science, commerce, and security, involving a host of nations around the world.

The nuclear fuel cycle concerns the life of nuclear material:

- extraction from the earth in raw form
- processing and enrichment
- use in reactors or weapons
- reprocessing or disposal

The basic fuel material for the generation of nuclear power is uranium (and to a lesser extent thorium), however, these materials change chemically and at the nuclear level throughout the fuel cycle.

Nuclear Fuel Cycle Overview Training

Topical Areas Addressed

Introduction to the Nuclear Fuel Cycle
- Nuclides, isotopes, special nuclear material (SNM), and weapons
- General flow of the nuclear fuel cycle, and types of fuels cycles
- Examples from countries with nuclear programs

Uranium Mining and Milling
- Natural sources and forms of uranium
- Pros and cons of open-pit, underground, and in-situ leach mining
- Uranium milling: ore to yellowcake

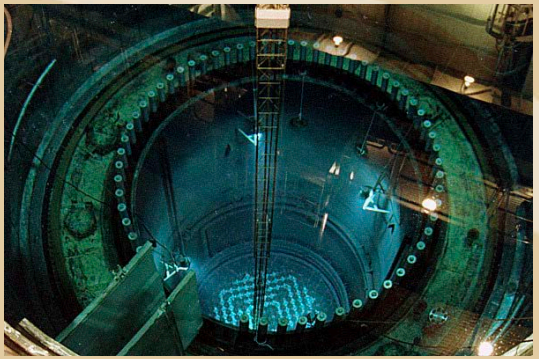
Uranium Conversion and Enrichment
- Basic chemistry and definitions
- Storage and transport of UF6
- Uranium enrichment by gas centrifuge, gaseous diffusion, and laser isotope separation

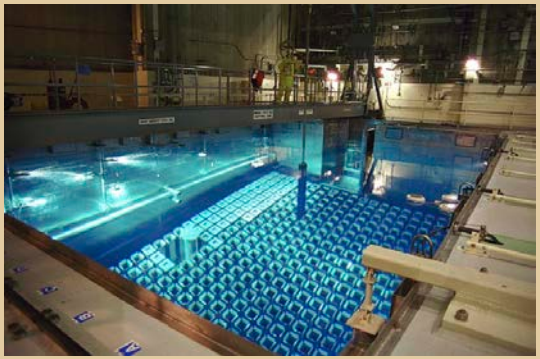
Fuel Fabrication and Reactors
- Fuel bundles and assemblies
- Boiling and pressurized light-water reactors
- Heavy-water reactors, gas-cooled and fast-neutron reactors, and other reactor designs
- Accidents: Three-Mile Island, Chernobyl, and Fukushima

Spent Nuclear Fuel
- Characteristics and management
- The PUREX Process
- Mixed-oxide (MOX) fuel

The Joint Comprehensive Plan of Action (JCPOA)

Radiation Signatures





Radiation Signatures

- Types of Radiation Used in Detection/Verification
- Uranium Ore and Natural Background Radiation
- Secular Equilibrium
- Gamma rays from Yellowcake
- The Effect of Shielding on Data from UF6 Cylinders
- U-232 in Re-cycled Uranium
- Passive Uranium-Enrichment Measurements
- Spent Fuel Gamma Rays
- Plutonium Gamma-Ray Spectra
- Neutrons from Nuclear Material
- Other Data From: MOX, Np-237
- U-233 and the Thorium Fuel Cycle

End Goal of Course

Learn the flow and function of the various types of nuclear fuel cycles, including the many stages and resources involved. Understand uranium mining, milling, conversion, and enrichment processes, and how fuel fabrication and reactors work.

LA-UR-17-24102