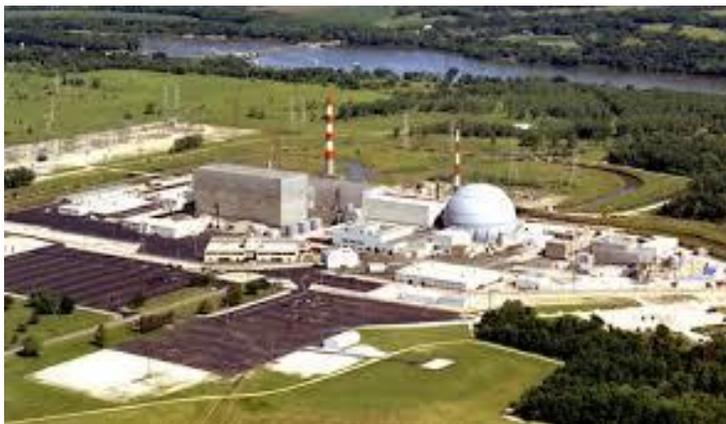


# IEEMA

ILLINOIS EMERGENCY MANAGEMENT AGENCY

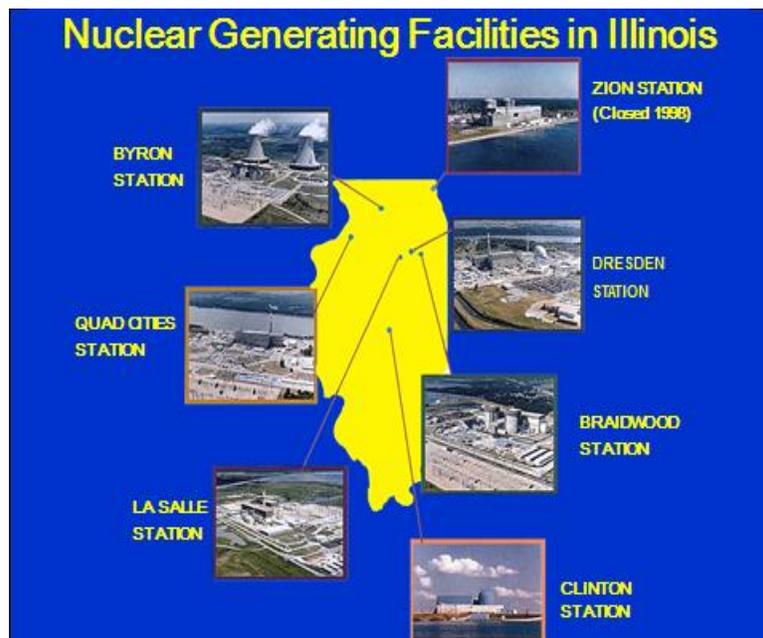


# Nuclear Generating Facilities in Illinois

About one-sixth of the world's electricity is generated by 450 nuclear power reactors (installed capacity of 393,843 megawatts electric (MWe)). The United States' 99 power reactors generate about 20 percent of the nation's electricity (about 805 billion kilowatt-hours). In Illinois there are eleven operating commercial nuclear power reactors at six sites, generating about 50 percent of the state's electricity.

In Illinois electricity is generated by two types of power reactors: Boiling Water Reactors (BWR) and Pressurized Water Reactors (PWR). Boiling Water Reactors (BWR) are located at the Dresden, Clinton, LaSalle, and Quad Cities Stations. Pressurized Water Reactors (PWR) are located at the Braidwood and Byron Stations.

Two commercial nuclear power reactors at Zion were recently decommissioned, and now only the ISFSI (Independent Spent Fuel Storage Installation) pad remains. There is also one commercial nuclear power reactor no longer operating, at the Dresden facility. Several other reactors have previously operated in Illinois but are now shut down or decommissioned. These include the first nuclear reactor at the University of Chicago (CP1) and research reactors at Argonne National Laboratory and the University of Illinois at Champaign. In addition, there is an inactive fuel reprocessing facility near Morris, Illinois.



# How Nuclear Reactors Work

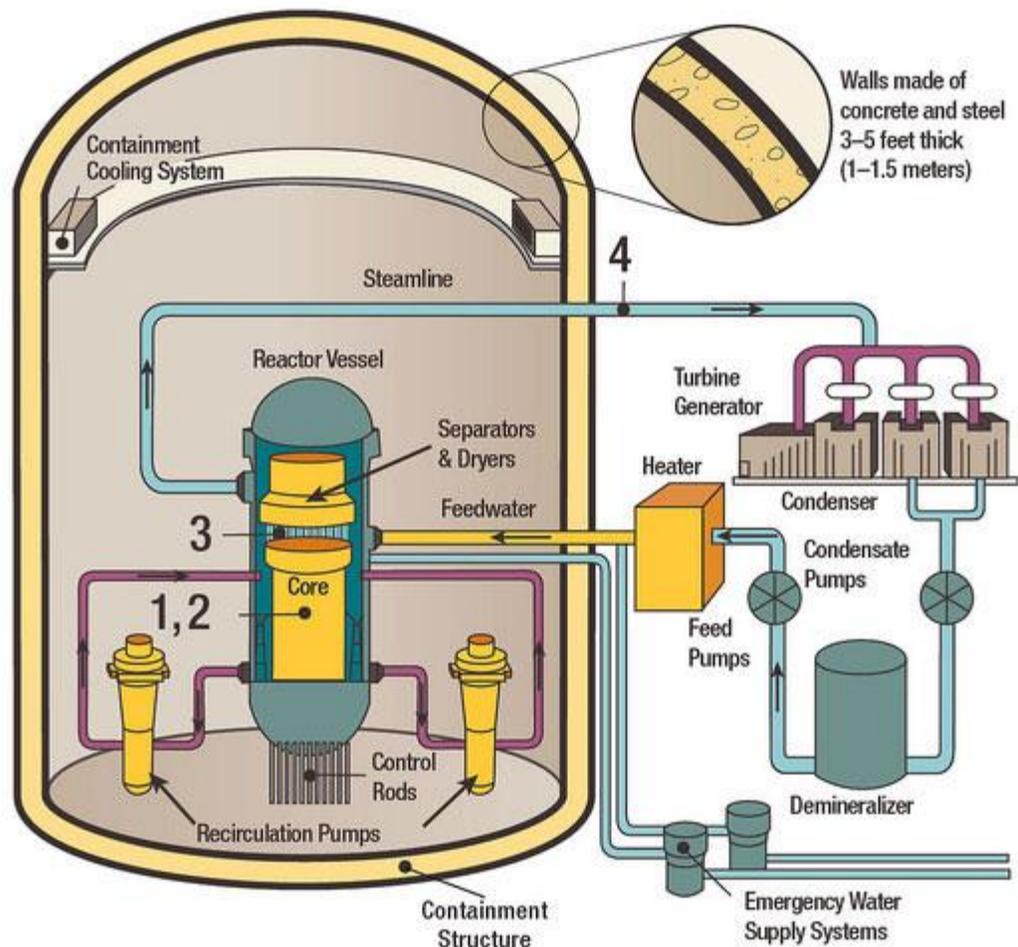
## Typical Boiling-Water Reactor

### How Nuclear Reactors Work

In a typical design concept of a commercial BWR, the following process occurs:

1. The core inside the reactor vessel creates heat.
2. A steam-water mixture is produced when very pure water (reactor coolant) moves upward through the core, absorbing heat.
3. The steam-water mixture leaves the top of the core and enters the two stages of moisture separation where water droplets are removed before the steam is allowed to enter the steamline.
4. The steamline directs the steam to the main turbine, causing it to turn the turbine generator, which produces electricity.

The unused steam is exhausted to the condenser, where it is condensed into water. The resulting water is pumped out of the condenser with a series of pumps, reheated, and pumped back to the reactor vessel. The reactor's core contains fuel assemblies that are cooled by water circulated using electrically powered pumps. These pumps and other operating systems in the plant receive their power from the electrical grid. If offsite power is lost, emergency cooling water is supplied by other pumps, which can be powered by onsite diesel generators. Other safety systems, such as the containment cooling system, also need electric power. BWRs contain between 370-800 fuel assemblies.



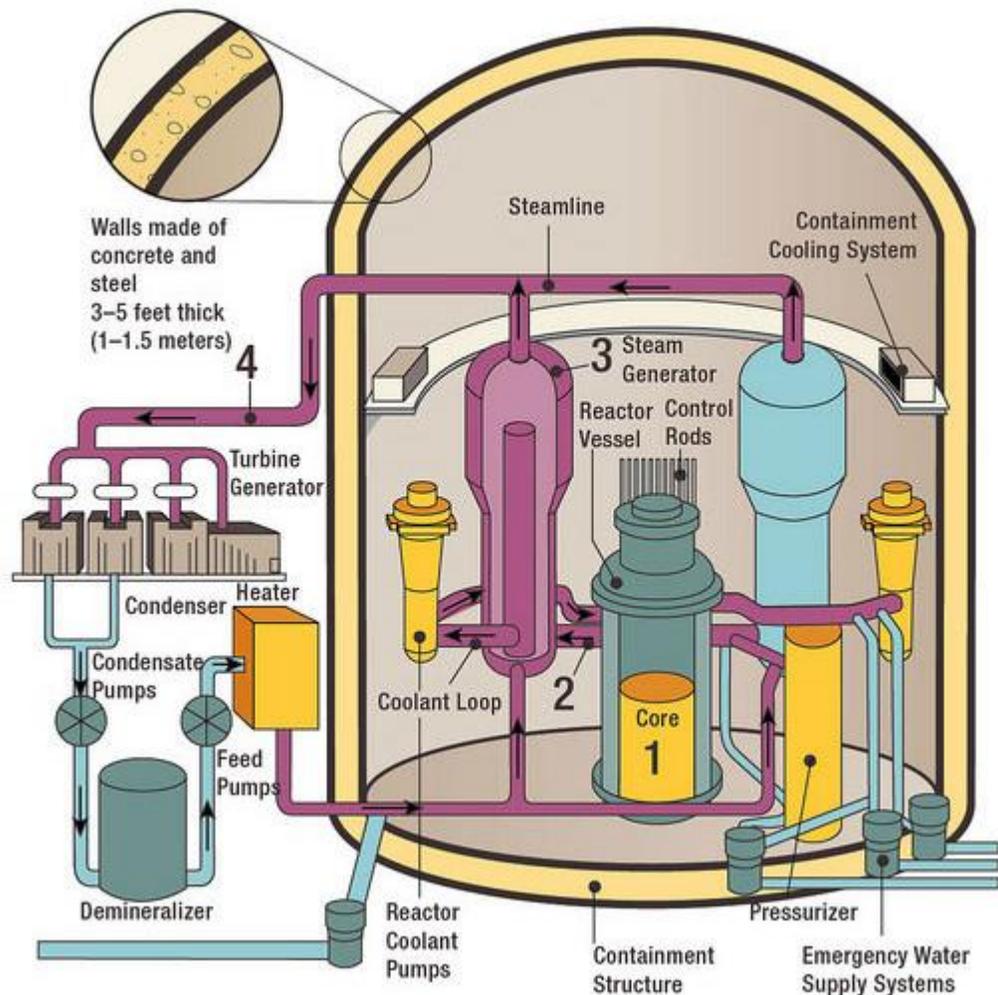
## Typical Pressurized-Water Reactor

### How Nuclear Reactors Work

In a typical design concept of a commercial PWR, the following process occurs:

1. The core inside the reactor vessel creates heat.
2. Pressurized water in the primary coolant loop carries the heat to the steam generator.
3. Inside the steam generator, heat from the primary coolant loop vaporizes the water in a secondary loop, producing steam.
4. The steamline directs the steam to the main turbine, causing it to turn the turbine generator, which produces electricity.

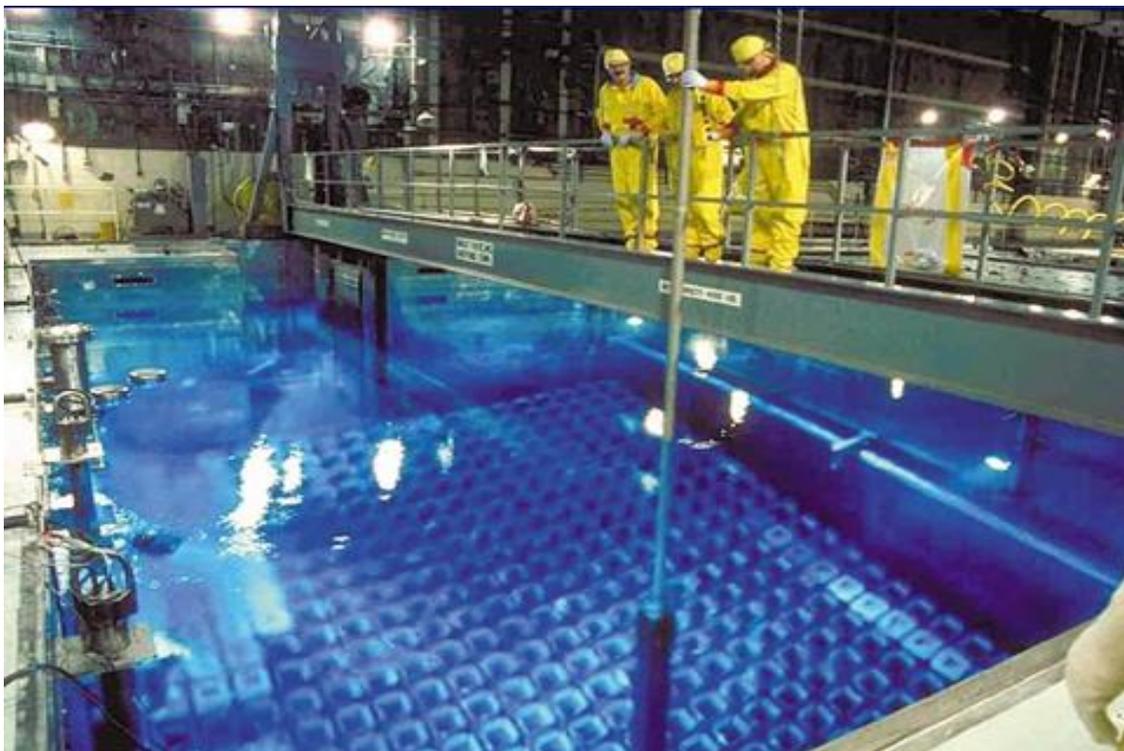
The unused steam is exhausted to the condenser, where it is condensed into water. The resulting water is pumped out of the condenser with a series of pumps, reheated, and pumped back to the steam generator. The reactor's core contains fuel assemblies that are cooled by water circulated using electrically powered pumps. These pumps and other operating systems in the plant receive their power from the electrical grid. If offsite power is lost, emergency cooling water is supplied by other pumps, which can be powered by onsite diesel generators. Other safety systems, such as the containment cooling system, also need electric power. PWRs contain between 150-200 fuel assemblies.



## Spent Nuclear Fuel

Nuclear fuel provides the energy source for a nuclear reactor. The fuel consists of small ceramic pellets, about the size of a pencil eraser. These pellets are arranged in 12 foot long tubes and loaded into the reactor core to provide the reactor's heat source. As electricity is generated, the uranium inside the fuel pellets is gradually depleted and the pellets must be replaced. When the used fuel is removed from the core, it is called spent nuclear fuel. The spent fuel is still capable of producing a significant amount of heat and radiation. It must be stored in such a way as to remove the heat and provide protection from the radiological hazards.

Most spent nuclear fuel in Illinois is stored on-site at each nuclear power plant in specially designed pools of water under at least 20 feet of very pure water. The water provides shielding from the radiation given off from the spent nuclear fuel and also provides cooling from the heat that is created by spent nuclear fuel. Fuel assemblies are always moved under water to provide radiation protection for workers. About one-third to one-fourth of the fuel assemblies are replaced with new fuel every eighteen months to two years during a refueling outage. The spent fuel assemblies are moved to the spent fuel pool and after several years moved to Dry Cask Storage.



In the late 1970's the need for alternative spent fuel storage began to grow when spent fuel pools at many nuclear reactor sites began to fill up with stored spent fuel. Utilities began looking at options, such as Dry Cask Storage, to increase spent fuel storage capacity. Independent Spent Fuel Storage Installations (ISFSI), also known as Dry Cask Storage, allows spent fuel that has already been cooled in a spent fuel pool to be relocated into a steel container called a cask and surrounded by an inert gas (helium). The casks are steel cylinders that are seal welded closed. The steel cylinder provides leak-tight containment of spent fuel. Each steel cylinder is surrounded by additional steel and concrete to provide radiation shielding to workers and members of the public. Selected casks can be used for both storage and transportation. Currently, all Illinois sites are storing some spent fuel on-site in NRC-licensed dry casks.



The Nuclear Waste Policy Act of 1982, amended in 1987, specified that spent nuclear fuel will be disposed of underground in a deep geologic repository and that Yucca Mountain, Nevada, would be the single candidate site for characterization as a potential geologic repository. Spent fuel from nuclear power plants in the US

would be stored, entombed in concrete and metal canisters capable of withstanding any conceivable seismic shock or military strike. As of 2013, the Yucca Mountain storage repository is no longer an option. There is currently no designated repository for High Level Waste in the United States. The Department of Energy is pursuing the creation of interim Dry Cask Storage locations. Until such time as these locations become operational, spent nuclear fuel will continue to be stored on-site at nuclear power stations.

Illinois is ready to deal with the shipping of spent nuclear fuel across Illinois, once the national repository or an interim storage facility is operational. In over thirty years of commercial spent nuclear fuel shipments across the country, there have been no accidents resulting in a release of radioactive materials or radiation. The shipping casks are designed and rigorously tested to withstand extreme accident conditions. In partnership with the Illinois State Police and the Illinois Commerce Commission, the Illinois Emergency Managements Agency's Spent Nuclear Fuel and High-Level Radioactive Waste Inspection and Escort Program inspects and escorts every shipment of spent nuclear fuel, high-level radioactive waste, transuranic waste, and Highway Route Controlled Quantity of radioactive material originating in, destined for, or traversing the state. Since its inception, the program has helped ensure the safe and secure transport of more than 1,200 shipments throughout the state.

