# Types of Nuclear Reactors

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Nuclear reactors serve three general purposes. **Civilian reactors** are used to generate energy for electricity and sometimes also steam for district heating; **military reactors** create materials that can be used in nuclear weapons; and **research reactors** are used to develop weapons or energy production technology, for training purposes, for nuclear physics experimentation, and for producing radio-isotopes for medicine and research. The chemical composition of the fuel, the type of coolant, and other details important to reactor operation depend on reactor design. Most designs have some flexibility as to the type of fuel that can be used. Some reactors are dual-purpose in that they are used for civilian power and military materials production. The two tables below give information about civilian and military reactors.

## Types of Nuclear Reactors – Table 1

| Reactor Type | Light Water Reactor (LWR) | | Heavy Water Reactor (HWR) |
|---|---|---|---|
| | a. Boiling Water Reactor | b. Pressurized Water Reactor (PWR) | |
| Purpose [1] | electricity | electricity; nuclear powered ships (U.S.) | electricity; plutonium production |
| Coolant Type | water ($H_2O$) | water | heavy water (deuterium oxide, $D_2O$) |
| Moderator Type | water | water | heavy water |
| Fuel — Chemical Composition [2] | uranium-dioxide (UO2) | uranium-dioxide | uranium-dioxide or metal |
| Fuel – Enrichment Level [3] | low-enriched | low-enriched | natural uranium (not enriched) |
| Comments | steam generated inside the reactor goes directly to the turbine | steam is generated outside the reactor in a secondary heat transfer loop | used in Canada: called "CANDU" – "Canadian Deuterium Uranium;" Also used in Savannah River Site reactors (metal fuel at SRS) |

## Types of Nuclear Reactors – Table 2

| Reactor Type | Graphite Moderated Reactor | | **Fast Breeder Reactor (FBR)** |
|---|---|---|---|
| | a. Gas Cooled | b. Water Cooled | Liquid Metal (LMFBR) (most common type of breeder) |
| Purpose | electricity; plutonium | electricity; plutonium | electricity; plutonium |

| | | | |
|---|---|---|---|
| | production | production | production |
| Coolant Type | gas (carbon dioxide or helium) | water | molten, liquid sodium |
| Moderator Type | graphite | graphite | not required |
| Fuel — Chemical Composition | uranium dicarbide ($UC_2$) or uranium metal | uranium dioxide (RBMK) or metal (N-reactor) | plutonium dioxide and uranium dioxide in various arrangements |
| Fuel – Enrichment Level | slightly-enriched, natural uranium | slightly-enriched | various mixtures of plutonium-239 and uranium-235 |
| Comments | used in Britain, and France (e.g.: AGR, MAGNOX) | used in former Soviet Union, e.g. Chernobyl (RBMK); N-reactor at Hanford. | breeder reactors are designed to produce more fissile material than they consume. Monju; Phenix |

*Source:* Lamarsh, John, *Introduction to Nuclear Engineering*, (Reading, MA: Addison-Wesley publishing Co., 1983), 120-143.

Notes:

1. The purpose of the reactor does not depend on the choice of coolant or moderator, but rather on reactor size and on how the reactor is operated, and on what ancilliary materials are put into fuel rods besides fuel. The same reactors can, in principle, be used for electricity production, military plutonium production, and production of other radioactive materials such as tritium for military and civilian applications. The purposes listed in this column are the common ones to which such reactors are or have been put. *This note applies to both tables.* ? Return
2. Not all fuel types necessarily included. *This note applies to both tables.* ? Return
3. The enrichment of fuel refers to the percentage of the isotope of uranium-235 compared to uranium-238 present in fuel. It is defined here as follows: slightly enriched uranium = about 0.8 to 3%; low enriched uranium = 3 to 5 %.*This note applies to both tables* ? Return