The Civilian and Military Characteristics of Plutonium

Nuclear weapons require fissile materials, that is certain isotopes of uranium and plutonium, to sustain explosive fission chain reactions. Plutonium for weapons is normally obtained by reprocessing.

Reprocessing is the separation of plutonium from irradiated uranium, often in the spent fuel from a nuclear reactor. The process was originally developed in the United States as part of its nuclear weapons program during World War II, and some of the recovered plutonium was used in the bomb detonated over Nagasaki, Japan on August 9, 1945. Scientists later found civilian applications as electricity-generating nuclear reactors began to spread across the globe when there was an unfounded concern that there would not be enough low-cost uranium in the world to power the world's reactors.

The uranium found in nature contains only 0.7% of the chain-reacting isotope uranium-235 (U-235), which is useful in weapons and for fueling civilian reactors, while 99.3% is U-238, which is not useful, but far more plentiful. So-called plutonium "breeder" reactors can, in theory, convert the far more abundant isotope U-238 into the chain-reacting isotope plutonium-239 (Pu-239). The "breeder" reactor would produce more plutonium than it consumes, but the economics have not been justified and so far, no country has developed one suitable for commercial use.

The countries using reprocessing to recover fuel from their spent fuel are China, France, India, Japan, Russia and the United Kingdom. The United States ended its civilian reprocessing program in 1972 and the five nuclear weapon states (China, France, Russia, the United Kingdom and the United States) ended their military reprocessing activities with the end of the Cold War. However, India used its breeder reactor program as civilian cover and obtained a reprocessing facility that was used in its nuclear weapons program. Iran does not have a reprocessing facility.

For plutonium, the ability to sustain an explosive chain reaction has to do with the concentration of Pu-239 in comparison to other isotopes. However, plutonium is characterized or graded by the percentage of plutonium-240 (Pu-240) it contains. Below are the various grades of plutonium.

Grade of Plutonium	Percentage of Pu-240
Super-grade	2-3%
Weapons-grade	less than 7%
Fuel-grade	7% to less than 19%
Reactor-grade	19% or greater

The International Atomic Energy Agency assumes eight kilograms (kg) is enough plutonium for a first-generation nuclear bomb, but advanced weapons programs can use as little as 3.5 kg. The International Panel on Fissile Materials estimates that as of 2020, the global stockpile of separated plutonium was about 540 tons, of which about 316 tons was civilian plutonium.