Iranian officials this week revealed that the country's nuclear program will break the limit for uranium enrichment, set under the terms of the deal struck in 2015 between Iran and world powers including the United States under former president Barack Obama.

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What is uranium enrichment?

The nucleus of a uranium atom is a very rich source of energy. The splitting of a uranium atomic nucleus – a process called nuclear fission – produces more than 20 million times more energy than a strong chemical reaction such as burning a molecule of natural gas.

Atomic nuclei are made of two types of subatomic particles: protons and neutrons. All uranium atoms contain 92 protons, but can contain varying numbers of neutrons. Each specific combination of neutrons and protons is called an isotope. Isotopes are named according to the total number of protons and neutrons – hence, uranium-238 (U-238) contains 92 protons and 146 neutrons, whereas U-235 contains three fewer neutrons.

U-235 undergoes nuclear fission more readily than U-238, making it more valuable as a source of nuclear energy. What's more, only U-235 can sustain a "nuclear chain reaction", in which enough neutrons are released during nuclear fission to trigger fission in neighbouring atomic nuclei. This process is necessary to efficiently release large amounts of energy – either in a controlled way, such as in a nuclear power station, or in an uncontrolled explosion such as in a nuclear bomb.

Natural uranium, however, contains just 0.7% U-235, and 99.3% U-238. Commercial nuclear reactors designs generally require uranium fuel with U-235 concentrations of between 3.5% and 5%.

Uranium enrichment is the process of artificially increasing the proportion of U-235 in a sample of uranium to meet this requirement.

What does the process involve?

The technical details of uranium enrichment technology are highly classified, but we know the most efficient technique uses a process called centrifuge enrichment.

This involves reacting the uranium with fluorine to form a gas called uranium hexafluoride (UF₆). This is then spun at very high speeds in a series of centrifuges.

UF_6 molecules containing the heavier U-238 isotope are forced to the outside of the centrifuge, where they are removed. The remaining gas is thus richer in U-235, hence the term “enrichment”.

By feeding the mixture through a succession of centrifuges, the uranium becomes successively more enriched. Higher levels of uranium enrichment are therefore more expensive and time-consuming.

A typical 1-gigawatt commercial nuclear reactor contains one reactor and uses around 27 tonnes of enriched uranium fuel per year, although this depends on the quality of the nuclear fuel used. In a commercial market this costs around US$40 million, which is a small fraction of the US$450 million revenue that would be generated if we assume an electricity price of 5 cents per kilowatt-hour.

Does it inevitably lead to weapons?

The technical details of nuclear weapons development are more closely guarded still. But we know that a uranium fission weapon requires tens of kilograms of highly enriched uranium, with U-235 concentrations of around 90%.

While the level of enrichment is much higher, there is no difference in the equipment used to make weapons-grade uranium, as opposed to nuclear fuel.

The same facilities used to produce 27 tonnes of 3.6% U-235 fuel for a commercial reactor could conceivably also be used to make one tonne of U-235 enriched to 90% – roughly enough for 20 nuclear weapons.

However, the post-processing of the UF_6 to make nuclear fuel is considerably different to that required for a weapon. In the case of nuclear fuel, it is formed into uranium oxide pellets and encased in zirconium alloy tubes. Weapons require pure uranium metal.

What limit has Iran breached, and what does it stand to gain?

Under the treaty, Iran agreed to enrich uranium to no more than 3.6%, and to only stockpile enough fuel to run its single commercial nuclear reactor for one year.

It has already breached the stockpiling limit, and has now broken the enrichment limit.

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In theory, these breaches could allow Iran's nuclear reactor to run more economically and for a longer time before the fuel needs to be replaced. However, these higher-enrichment fuels require very specialised processing, and only a handful of companies worldwide have the technology to do this. The waste handling required for the spent fuel is also more sophisticated.

Whatever Iran's ultimate aim, and despite the diplomatic tensions, its uranium enrichment levels are not yet near those required for nuclear weapons.

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