NUCLEAR ENERGY VS. NUCLEAR BOMBS

Nuclear power has a bad reputation, thanks in no small part to a lack of education on the subject. While recent events in Japan have reminded us that the safety of nuclear energy cannot be guaranteed, it is important to realize that not all nuclear material is necessarily explosive. Though some of the same elements are involved in the fission process, nuclear energy is created very differently than nuclear weapons, and the processes should not be confused.

All nuclear power requires fissionable isotopes of radioactive elements. An isotope is a variation of an element with a different number of neutrons. Even for a radioactive element like uranium, not all isotopes can create nuclear energy. Uranium has two naturally occurring isotopes, but only uranium-235 can sustain a fission reaction. However this isotope only makes up 0.7% of all uranium [1]. In its most basic form, when U-235 is bombarded with neutrons, it splits into other elements. This process is known as a fission reaction, in which small particles are emitted, including more neutrons. These neutrons bombard other U-235 atoms, which creates more fission. A chain reaction occurs, and continues until all of the U-235 has been split. This process creates heat, which is used to boil water. The steam rotates a turbine and generates electricity [2][3].

I'm going to focus specifically on the CANDU (CANada Deuterium Uranium) Reactor, which was invented in Canada. Unlike traditional reactors, the CANDU reactor uses "heavy water" as a coolant, containing deuterium instead of hydrogen. Deuterium is heavier than hydrogen because it has both a proton and a neutron, and is quite rare: there is only one naturally occurring deuterium atom for every 6400 hydrogen atoms [4][5].

The heavy water serves as more than just a coolant. Only slow moving neutrons can sustain a fission reaction, and the neutrons which are emitted by the uranium travel too quickly. The heavy water intersects many of the neutrons as they are emitted, and slows them down to fissionable speeds [4][6]. When fission occurs, it heats the heavy water. Because it is highly pressured, the water can be heated to temperatures far higher than its usual boiling point. The heavy water then undergoes a heat transfer and boils regular water, the steam of which then turns a turbine. The then-cooled heavy water returns to the CANDU system and the cycle repeats.

The CANDU reactor provides a trade-off. Heavy water does not absorb as many neutrons, meaning the reaction is more likely to be sustained, and less fissionable uranium is necessary. Though heavy water is rare and expensive to gather, the CANDU reactor is able to use regular (less expensive) uranium. Other reactors use inexpensive normal water, but since that absorbs more neutrons they require enriched uranium, which is uranium with a higher than natural percentage of U-235.

There are multiple safety features in place in these reactors. One is that, in case of an emergency, the heavy water can be drained away. This means that there's nothing to slow down the neutrons, and the reaction will not be sustained. A second safety feature is the presence of cadmium rods. Cadmium is an element which is very good at absorbing neutrons. If necessary, these rods can be lowered into the reaction, absorbing neutrons and stopping the nuclear process. These rods also provide a fail-safe if the power is cut. The rods are held above the reaction using electromagnets. If the power plant loses power, the cadmium rods will automatically drop, and the reaction will stop [7].

Nuclear power plants have many safety features to prevent explosions from occuring. But there is a critical mass of nuclear material which, once surpassed, causes a self-sustaining and exponentially accelerating reaction, releasing huge quantities of energy in a very short period of time. There are two ways in which this critical mass can be achieved. In the first, less sophisticated method, a subcritical mass is "shot" with a bullet of a fissionable isotope. Their combination makes the mass critical. A second way of creating this critical mass is to surround a core with more traditional explosives, inside a pressurized container. When these bombs are detonated, they force the core into a smaller region, increasing its density to the required critical number [8]. These bombs use either highly enriched uranium or, more commonly, plutonium as their fuel.

Though nearly all nuclear power plants use uranium-235 as their primary fuel source, plutonium is created as a by-product of the U-235 fission reactions. This has two potential consequences. If neutrons are absorbed by the non-fissionable isotope of uranium, U-238, they can produce Pu-239, plutonium's primary fissile isotope. If this plutonium remains in the reactor, it too with undergo fission and produce energy. In fact, more than one third of the energy produced in most nuclear power plants comes from this plutonium [9]. But as already stated, plutonium is also the primary fuel used in nuclear bomb. The by-product is known as reactor grade plutonium, and though it is not immediately suitable for nuclear weapons, it can undergo further processing to become 'weapons grade'.

Nuclear power's bad reputation is not entirely undeserved. But nuclear energy is not something that should be feared in the same way as nuclear weapons. A lack of education on nuclear material has led to some confusion about the processes, and therefore some unnecessary worries. This misinformation has real world impacts. Nuclear energy is being demonized, not for reasons which are factual or grounded in reason, but because people are afraid. Politicians are dependent on public opinion, and so when people protest it means that many potential nuclear plants don't get built. But if the general public becomes more knowledgeable about nuclear power, they will be able to demand greater accountability, and more safety features will be created and implemented. Fossil fuels like coal and oil are greatly limited and soon we will need to find a new source of energy. Even though nuclear isn't ideal, it shouldn't be automatically taken off the table due to unjustified fear.

Source : http://www.sassweb.ca/3bb3/nuclear/nuclear-energy-vs-nuclear-bombs