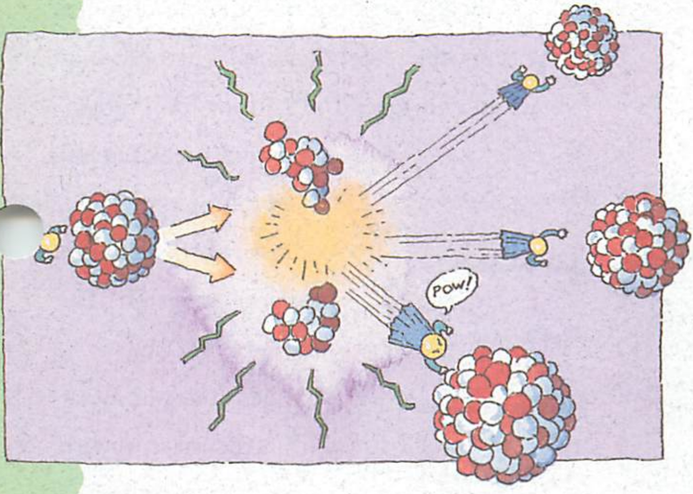
Nuclear Energy:



How nuclear power plants work

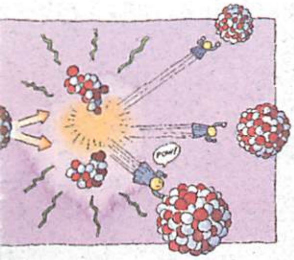
tration of fissionable U-235 is kept very low. And the U-235 is diluted with other, non-fissionable, materials, so the chain reaction tends to slow down as it gets hotter—a natural safety feature.

The arrangement of the fuel in the reactor is another safety feature. The pellets are stacked end-to-end in 12-foot-long tubes made of a special metal, called zirconium. This zirconium resists heat, radiation and corrosion. The tubes are precisely arranged into bundles within the reactor, with spaces between them for the control rods. Water flowing up through the bundles removes the heat of the chain reaction.

Americans get more electricity from nuclear energy than from any other source, except coal.

The water also serves as a "moderator." This means it slows down the neutrons and increases the probability of fission. Just as in a baseball game—where a batter is more likely to hit a slow ball than a fast ball—a slow-moving neutron is more likely to hit a uranium atom and split it.

The "moderating" effect of the water adds another safety feature. Any loss of water would slow down the chain reaction.



The nuclear chain reaction starts when a neutron splits an atom of uranium. When the atom splits, it releases heat and more neutrons, which other atoms.

Nuclear power plants also use multiple back-up systems to protect against equipment failure and severe events like floods, earthquakes and tornadoes and the radioactive fuel is locked away behind multiple barriers of thick steel and concrete, to guard against release of radioactivity.

What Happens To Used-up Fuel?

Most pieces left over after the atoms have split—called "fission fragments"—are radioactive. These fragments collect within the pellets. (Remember, though, that all this is happening at the atomic level. The ceramic fuel pellet still looks the same.) Eventually, these fragments begin to reduce the efficiency of the chain reaction—like ashes smothering a fire. Then it's time to change the fuel. Between one-fourth and one-third of the fuel is replaced every 12-18 months.

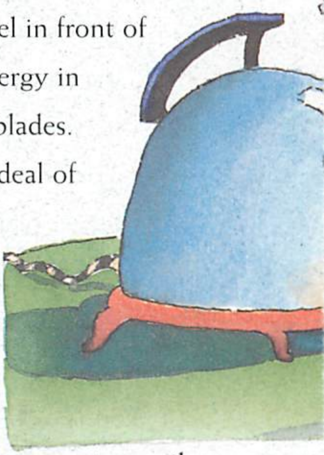
The used fuel is cooled and stored safely under water in large concrete pools lined with stainless steel. At some plants, the pools have filled up, and some of the fuel stored in the pools has been moved to big casks or bunkers. Eventually, it will be sent to a federal government facility for permanent disposal deep underground.

When you flip on your TV or log on to your computer, pop a pizza in the microwave or light up the living room, it's a good bet that some of your electricity comes from a nuclear power plant. Throughout the United States, there are more than 100 nuclear power plants providing electricity to homes and businesses.

How do they work? Well, maybe it takes an engineer to understand the details. But the rest of us can easily understand the basics.

First, Think Of A Tea Kettle

When you hear it whistle, you know that heat from the stove has turned some of its water into steam to blow the whistle. If you were to put a toy pinwheel in front of the blast of steam, the energy in the steam would spin its blades.



Now, picture a great deal of steam inside a power plant "blowing" the propeller-like blades of a giant turbine, which spins the shaft of a huge generator. Inside the generator, coils of wire and magnetic fields interact—and electricity is created.

All steam-electric power plants produce electricity in just this way—whether they are powered by coal, natural gas, oil or nuclear energy.

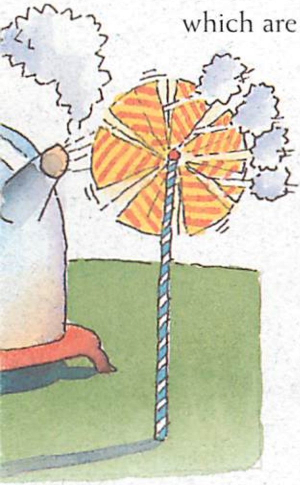
Turning Water Into Steam Without A Tea Kettle

In a fossil-fueled plant, you burn coal, natural gas or oil to heat water in a boiler, turning it into steam to turn the turbine.

In a nuclear plant, you don't burn anything at all. Instead, you split atoms of uranium—which creates the heat that turns the water into steam. Splitting atoms is called fission.

What Does The Uranium Look Like?

It comes in the form of ceramic pellets—about the size of the end of your finger. The pellets are inserted into long, vertical tubes, which are bundled together and placed inside the plant's reactor—where the fission takes place.



Power plants produce steam, which spins a turbine to make electricity. Nuclear power plants produce heat to make steam by splitting uranium atoms.

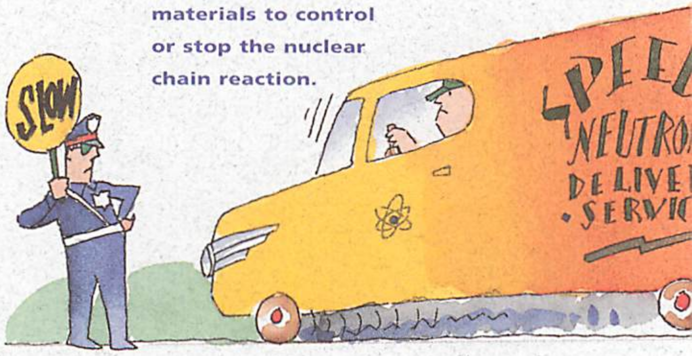
When a plant starts up, atomic particles called neutrons are let loose to strike the uranium atoms. When the neutrons hit some of the uranium atoms in the pellets, the atoms split—or fission—to release neutrons of their own, along with heat. These neutrons strike other atoms, splitting them. One fission triggers others, which trigger still more until you have a chain reaction.

When that happens, the plant is up and running, splitting atoms to create the heat that will turn the water into steam.

How Do You Control A Chain Reaction?

You insert long rods among the tubes holding the fuel. These "control rods" are made of a material that absorbs neutrons—so the neutrons can no longer hit atoms and make them split. To slow down the chain reaction, you insert more control rods. To speed it up, you withdraw more—either partially or fully.

Nuclear power plants use special materials to control or stop the nuclear chain reaction.



U.S. Nuclear Power Plants Come In Two Designs

If there's a nuclear power plant in your area of the United States, you can be sure it's one of two types: a pressurized water reactor or a boiling water reactor. Both types operate on basically the same principles. And both are cooled by ordinary water.

At both types of plants, the steam is used to make electricity just as it is at a power plant that burns fossil fuel—by spinning the turbine that drives an electric generator.

More About The Uranium Fuel

Both reactor types use essentially the same fuel—solid pellets containing two kinds, or isotopes, of uranium atoms. One isotope—U-235—makes up less than 1 percent of natural uranium, but it fissions readily. The other isotope—U-238—makes up the other 99 percent, but sadly, it is practically non-fissionable.

What to do? Enrich the uranium, so the concentration of U-235 is increased to 3 to 4 percent. This is enough fissionable uranium to work nicely in a nuclear power plant. Yet the concentration of U-235 is still so low that a bomb-like nuclear explosion is impossible.

Are Nuclear Power Plants Safe?

Several built-in natural features help make sure they are.

Take the fuel, for instance. The uranium is formed into ceramic pellets, which resist the effects of high temperature and corrosion during the plant's operation. The concen-

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