U of A's own nuclear reactor

by Dragos Ruiu

In the bowels of this campus there are many things most students don't know about. One of the signs around campus that causes many a quizzical look is the one reading "SLOWPOKE Reactor" in the Dentistry-Pharmacy Building.

SLOWPOKE is the U of A's own nuclear reactor. To some people those two words bring trepidation and thoughts of big hemispherical containments to mind, but SLOWPOKE is different. It's a "user-friendly" reactor, according to Pete Ford, the reactor technologist who works with it.

SLOWPOKE stands for Safe Low Power Critical Experiment. It is both safe and low power. Due to its design, it is very difficult to get it to do anything dangerous. The drawback of this design is that it doesn't produce huge amounts of power like other reactors — less than a car, as a matter of fact.

Its low power is not a drawback as far as university applications are concerned. It makes enough power (neutrons) to irradiate objects near its core, which is its primary use.

As you descend the stairs to visit it, you are struck by the simplicity and casual attitude of those who work with it. Here, clip on this dosimeter, sign in, and let's go down the stairs. None of the armed guards, heavy doors, air locks, large steel girders you see in a commercial reactor. It just looks like a large orange concrete block.

The reactor itself is a 20 feet deep, 9 feet wide concrete well covered by the concrete cover (orange!) in a room under the Dentistry Pharmacy courtyard. The well is filled with ordinary water, which is the cooling agent for the reactor. In the center of this pool there is a 24 inch wide cylinder with about 300 pencil-like rods of uranium (enriched to 93% U-235, which is a reactive form of ordinarily boring U-238). Though 300 rods might sound like a lot, the rods only contain 900 grams of U-235. Less than a kilogram of uranium makes this reactor run.

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In the center of this core there is a cadmium rod which controls the nuclear reaction occurring inside the reactor. Cadmium stops (absorbs) neutrons which are radiated by the uranium. When the reactor is running, neutrons would hit other uranium atoms, releasing more neutrons which would continue the reaction, and generate heat in the process.

In large nuclear reactors, the cadmium rods are critical to safe operation, because the rods control the level of the reaction (the same reaction that occurs in an atomic bomb). So if the reaction gets out of hand the rods are inserted to slow it down. The importance of these rods means they must have many fail-safe redundant mechanisms to operate them.

In SLOWPOKE the rod does control the reaction, but it is not crucial to the reactor's safety. This is due to what they call the "negative temperature coefficient." In simple words, this reactor has a tendency to shut itself off because it works less at high temperatures, and it gets hotter the more it works.

The neutrons in the core of a nuclear reactor need to be slowed down for the reaction to take place. A substance called a moderator needs to be in between the rods to do this. A moderator can be many things: paraffin, water, etc...(the substance just has to have lots of hydrogen in it.) In SLOWPOKE, water is used for two reasons: it is easy to work with, and it expands when it gets hotter. The second item is the key to SLOWPOKE's safety.

As the water gets hotter it expands and becomes a less efficient moderator, which in turn reduces the level of the reaction. So if the rod gets pulled out all the way and stays out, the reactor would eventually almost shut itself down, to produce a minimum of reaction. The more the reactor works, the less efficient it is. That's the reason why the reactor can only run a maximum of four hours a day five days a week at maximum flux.

When it is running, it is used for a variety of tasks: Neutron Activation Analysis, radioactive isotope production, and teaching. The reactor is used by a surprisingly large number of departments, for many widely differing tasks.

The key to its use is the sets of pneumatic tubes that enable shooting capsules of material to be irradiated directly in or near the central core of the reactor for specified lengths of time (from seconds to hours). By lowering or raising the control rod, a specific level of activity in the reactor can be set. With the timing of the capsules and the reactor level, material to be studied can be irradiated with precise amounts of radiation.

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Sometimes this irradiation is used to produce radioactive versions of normal chemicals to be used as tracers. These mildly radioactive tracers can be detected and help scientists examine reactions and biology they normally couldn't. Pharmacy, Rheumatology, and Medicine (particularly cancer studies) use these tracers.

Another use of this irradiation is Neutron Activation Analysis, where a small sample is irradiated. By studying the frequency and intensity of the radiation (gamma rays) you can find out the contents of the sample, with the help of a computer.

Activation Analysis has an advantage over other techniques because you can look for more than one element at a time, and test the same sample using other methods afterwards. It is non-destructive. It is used in environmental studies, analysis of biological tissues, digestibility studies, geological studies, studies of commercial processes and more. New uses for this versatile technizque are still being found.

Classes come to visit the reactor and use its products for labs. The facility cost the university around half a million dollars, a relative bargain for the use it is getting.

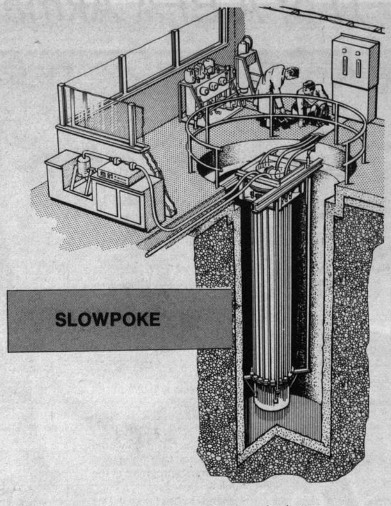
The reactor's fuel lasts ten years running at full efficiency, but at the rate of activity used here it will last twenty. Since it was installed ten years ago, that means that it will probably be ten years before the fuel will have to be replaced.

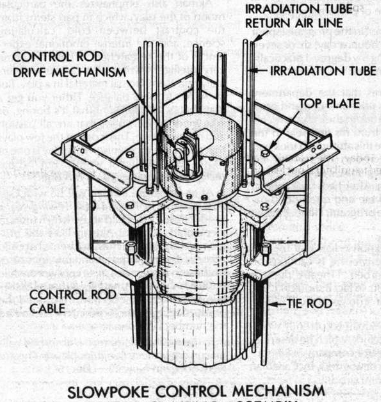
The fuel is replaced by removing the entire core in a large lead box, and replacing it with a new one.

Even when it is removed, the core will be reprocessed because it will only have used up 2 percent of the uranium. It will be replaced because the fission byproducts will have built up — absorbing too many neutrons.

There are eight other SLOWPOKEs in the world, seven in Canada. The original designer of SLOWPOKE, Dr. John Hillborn, is now working on a bigger version that could generate up to 20 megawatts of power. While this is a piddling amount compared to normal nuclear reactors, SLOWPOKE's low maintenance and safety has interested power companies considering them for powering remote locations like the far north.

And there are other uses for it too. In 1985, a local rock video show did a show from the U of A SLOWPOKE...





SLOWPOKE CONTROL MECHANISM AND MOUNTING ASSEMBLY