NUCLEAR INFORMATION AND RESOURCE SERVICE

6930 Carroll Avenue, Suite 340, Takoma Park, MD 20912
301-270-NIRS (301-270-6477); Fax: 301-270-4291
nirsnet@nirs.org; www.nirs.org

Thorium Reactors: Their Backers Overstate the Benefits

Recently there has been a lot of hype about nuclear reactors using thorium as a fuel. Thorium's backers claim the element is inexhaustible, provides nuclear power that is much safer than uranium-fueled reactors, that thorium reactors produce less radioactive waste, and so on.

The reality is quite different, and there is more experience with thorium as a reactor fuel than many people realize. That experience shows that its backers' overstating the benefits of thorium fuels is putting it mildly. Here are some bits of history about the U.S. experience with thorium fuels:

- In the 1960"s,the U.S. spent between $5 billion to $11 billion to produce and separate ~1.55 metric tons of uranium-233 from irradiated thorium fuel at government weapons material and commercial power reactors.
- Research and development of several reactor types was launched with the goal of demonstrating that uranium-233 derived from thorium would be a safe and economical source of electricity. Projects demonstrating the potential viability of slow-neutron "breeder" reactors using uranium-233 were established, most notably the Elk River Reactor in Minnesota, the Molten Salt Reactor at ORNL, and the Light Water Breeder Reactor at Shippingport, Pennsylvania. By 1977, however, pursuit of the thorium fuel cycle was effectively abandoned.
- Because thorium-232 is not fissile it requires significant amounts of fissile materials (ie plutonium-239 or uranium-235) to generate the neutrons necessary for transmute some of the thorium to uranium-233 - a fissile material that has a critical mass comparable to Pu. Unlike Pu, U-233 does not require implosion engineering to set it off, and can more readily be used in an improvised nuclear device. Several U.S. nuclear weapons were successfully tested using U-233.
- The main reasons interest waned in the use of uranium-233 for weapons were its radiological hazards and related costs. Of particular concern is exposure to uranium-232, which is co-produced and is 60 million times more radioactive than uranium-238. The uranium-232 contaminant level, however, is not considered to be an adequate barrier to prevent a terrorist from making an improvised nuclear device. According to researchers at Oak Ridge National Laboratory: *"…if a diverter was motivated by foreign nationalistic purposes, personnel exposure would be of no concerns since exposure even that these levels would not result in immediate death."*

- Another factor that may have influenced the decision to abandon the thorium fuel cycle is that thorium itself is more radioactive than uranium and thus requires additional precautions. The surface dose rate from a 55 gallon drum of thorium oxide is approximately 60 mR/hr--about 13 times higher than from a similar-sized drum of uranium. A worker spending time inside a thorium storage facility could expect to encounter dose rates of 60–100 mR/hr. In a little over six working days, such an employee could reach the maximum annual U.S. occupational exposure limit of 5 rem.
- A molten salt reactor was developed at the Oak Ridge National Laboratory in the late 1960's to demonstrate the potential for "breeding" U-233. It was abandoned and is costing the U.S. taxpayer ~$100 million to clean up the mess from this project.
- After several failed attempts to establish a thorium fuel cycle, the commercial nuclear industry also walked away from thorium fuels. For instance:

The first commercial nuclear plant to utilize thorium was Indian Point Unit I, a pressurized water reactor that began operation in 1962. However, the cost of recovering uranium-233 from this reactor was described as a “financial disaster. Less than one percent of the irradiated thorium was converted to uranium-233.The utility switched to uranium fuel.

The Peach Bottom I Unit, a prototype 40 megawatt high-temperature gas-cooled reactor used thorium fuel. It operated from 1967 to 1974. The reactor was closed after experiencing a high rate of fuel element failures, causing significant down-time.

The Fort St. Vrain plant was a high-temperature-gas-cooled 330 megawatt reactor using thorium and uranium-235 fuels which operated from 1979 to 1989. Hundreds of events involving equipment failure, gas leaks, fuel failures, cracked piping and graphite, and human error led to its closure.

- Despite the claim that the US is pursing development of thorium fuel, in 2005, the U.S. Congress ordered the Energy Department to dispose of its remaining U-233 as waste, and ordered the Defense Department to dispose of its strategic stockpile of thorium. The cost for disposal of the remaining U-233 is ~$500 million. To get around paying this high cost, the DOE is seeking to dump about 101 kg of U-233 mixed with 796 kg of U-235 in a shallow landfill in Nevada in violation of international safeguard standards and norms.

Robert Alvarez, Institute for Policy Studies, February 2014