Nuclear Power Will Become Dominant

By Roy Minet (Rev. 01/08/19)

Clean, safe, inexpensive and abundant energy is crucial to the progress of civilization. Nuclear energy is an important contributor today and will become much more prevalent in the future.

Unfortunately, the nuclear power industry has gotten off to a somewhat rocky start. It has been a half-century learning experience. However, the next generation of nuclear power plants, actively under development, will be so fundamentally improved that mainstay status seems assured.

The first nuclear power plant was shepherded into service (January, 1954) by Admiral Hyman Rickover for use in our atomic submarine fleet. The nuclear power industry quickly scaled this reactor up in various versions for commercial use. Thus, virtually all of the world's nuclear power fleet ended up with the same water-cooled, uranium-fueled design.

It turns out that water is a rather poor choice to cool a nuclear reactor. Reactors need to run at a high temperature to produce electricity efficiently. But as we all know, water boils and turns to vapor at the fairly low temperature of 100 degrees C (212 F). So, to operate even at a moderately high temperature, it is necessary to keep the water under extremely high pressure.

Should pressure be lost, the coolant water would instantly explode into steam. If cooling is lost, the solid fuel reactor core quickly overheats and can melt down, releasing radioactive materials. A reinforced concrete dome large enough and strong enough to contain everything is a necessity in case this happens.

There have been three notable accidents of this sort to-date. A partial meltdown at Three Mile Island in 1979 was indeed scary, but did not turn out to be serious. Chernobyl in 1986 was the most serious because the Russian reactor design did not include an adequate containment dome and other safety features. Three cores melted down in 2011 at Fukushima Daiichi when an historic earthquake followed by a tsunami knocked out backup cooling systems. Though serious, it was determined that the accident was preventable. Lessons learned have resulted in safety upgrades.

With over 400 reactors in operation worldwide plus about a hundred more on ships, the overall safety record for nuclear power is excellent – better than for most other energy sources. Nuclear also is one of the cleanest. However, it is possible to build nuclear power plants which perform even better and for which the design is inherently safer.

Next generation reactors will not use water for cooling. Instead, they will use molten salts, usually a mixture of lithium fluoride and beryllium fluoride. Not only do molten salts cool better than water, but they enable reactors to operate at higher temperatures and thus be significantly more efficient – without having to be pressurized.

A second major change is to mix the fuel right in with the molten salt coolant. There is no separate core to melt down; the normal state *is* melted down. Containment structures can be a lot smaller and

lighter weight. Operation is much more stable and, in the worst possible case, the molten salt with fuel simply drains into an underground tank where nuclear fission automatically stops and everything cools down safely – completely passively.

Molten salt reactors (MSR) can use uranium as a fuel and can even consume other nuclear wastes. Current reactors use only about 2% of their fuel while MSRs utilize substantially 100% of it.

An even more exciting probability is that MSRs will use thorium as fuel. Thorium is much more plentiful and lower cost than uranium. This type of MSR is called a LFTR (Liquid Fluoride Thorium Reactor).

Much less radioactive waste is produced. None of the waste is useful for weapons. And the radioactivity of these wastes decays to safe levels in about 300 years (compared to tens of thousands of years for current reactor waste).

There are more benefits, but no more space to describe them.

MSR development is proceeding in many places. By far, the largest effort is in China where funding is in the $350 million range. They hope to nail down important intellectual property rights. This is a key technology area. The US needs to move faster.

Operating prototypes are planned within five years, with scale up to commercial plants in ten. It's just engineering work; feasibility has already been demonstrated. The US Atomic Energy Commission developed and successfully operated a thorium-fueled MSR for well over a year at Oak Ridge National Laboratories during the 1960s! The MSR program was cancelled because industry had already embarked upon its learning experience scaling up Admiral Rickover's reactor. Also, there was little interest in MSRs as they were not good for breeding plutonium which was in great demand at the time for the nuclear arms race.

We should not rush to shutter our current nuclear plants. They are doing a fine job of safely and cleanly supplying base-load electricity. However, using government force to keep them operating is a bad idea. Instead, all subsidies for any kind of energy should be eliminated so the free market can function properly. Also, the federal government should complete the Yucca Mountain (Nevada) facility for interment of nuclear waste that was promised to the nuclear power industry.