Reactor Safety

Thermal reactors are physically limited in how fast they can ramp power (that is why there are no thermal spectrum nuclear weapons), and of all thermal reactors the MSR has the lowest amount of excess reactivity. It is at or near its most reactive configuration during normal operation. Volatile fission products are removed and stabilized as they are produced, and the remaining fission products are in forms that are stable at very high temperature. I have tried without success to think of how an MSR could be blown up with enough energy to produce a large release of fission products beyond the plant boundary, any suggestions?

I do not think that the regulatory requirements for MSR's have to be as strict as for IFR's, just as the requirements for handling fire crackers is not the same as for dynamite.

Had there been no WWII it would probably have taken several decades to do what was done in 3.5 years, the development of nuclear weapons, at a time when knowledge of nuclear cross sections and fission products was very limited. With that level of effort we could be mass producing simple MSR's in a similar time frame.

But my recommendation is to spend $100 billion per year to push every technology as fast as possible, and use what ever works best. – Bill Hannahan 11/21/2011

> LFTR is a good design for the long run, but it is the wrong design for build out in the next 50 years. The first generation MSR should be the simplest possible uranium fueled reactor. It has several advantages.
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> 1… No continuous online reprocessing. Just replace graphite and clean the salt at 30 year intervals.
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> 2… Uses 1/4 the uranium of conventional reactor. Fuel cost is negligible for the foreseeable future. Next generation reactors do not need to be breeders.
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> 3… Shortest development time and cost in a well funded engineering environment unconstrained by political and emotional constraints. It would be a scaled up version of the technology demonstrated at Oak Ridge in the 60's, using similar materials running a steam cycle at relatively low temperature.
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> 4… Easiest and lowest cost to mass produce due to compact size and lack of complex safety systems.
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> 5… Highest level of safety without complex active safety systems. Volatile fission products are extracted as they are produced and converted to safe chemical forms that can easily be stored and passively cooled without risk of meltdown or criticality.

> With molten salt there is no large bolus of volatile fission products trapped in fuel pellets waiting to be released in an accident with fuel melting; for example, cesium atoms quickly react with fluorine ions to form cesium fluoride, boiling temp 1251 C vs. 671 C for elemental cesium.
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> Machines designed for high temperature operation are easier to passively cool than machines containing low melting temperature materials like solid metal fuel.
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> Liquid fuel can be redistributed into a geometry that is critically safe and easy to passively cool while solid fuel reactors must be protected in their existing geometry - - Bill Hannahan 11/19/2011

Dan, thanks for the response. You may well be right in claiming that it is physically impossible for an IFR to have a high energy criticality accident, but I have yet to see a convincing analysis, can you point me to one or more?

I think it could be shown that a core can be designed such that the initial meltdown will take place without a high energy event; I am more concerned with what happens after the core is melted. For example, could a collapse or low energy criticality in one region force a large mass of plutonium in another region rapidly into a more favorable geometry?

How do you poison a melted core to guarantee there will be no criticalities after a meltdown, and is this part of existing designs?

People can differentiate between a plane crash and a train crash, but they do not differentiate between a PWR, IFR or MSR accident. A large IFR accident would put the industry back another decade or more.

The potential for a big accident is my biggest knock against fast reactors, especially if there are other options that can produce abundant cheap kWh’s without that risk. If big accidents can be shown to be impossible I would be more supportive. - Bill Hannahan 11/22/2011