

Teaching Notes

Operational Reactor Safety Course

Lecture: 24 – Advanced Reactors

Objective:

Students are always interested in new developments in reactor technology. The purpose of this lecture is to summarize key new reactors that are being offered on the market and those of the next generation. The lectures should identify how these new designs meet the challenges faced by existing designs in terms of improvement in safety and cost.

Key Points to Bring Out:

<u>Slide number</u>	<u>Points</u>
2-3	Bring students up to the current situation in terms of changes that have occurred legislatively and from the regulatory perspective to encourage the building of new nuclear plants. Describe the new regulatory process of certification and early site permits including the new Part 52 combined construction and operating licenses (COL).
4-6	Provide an overview of new plant offerings identifying and identify those designs that are certified.
7-8	Review current trends in new reactor designs - more passive systems with lower core damage frequencies for the evolutionary Light water reactors.
9-12	Review the design features of the Economic Safe BWR (ESBWR) focusing on the natural circulation cooling, elimination of recirculation pumps and passive safety systems.
13-19	Review the key features of the AP1000 which is largely based on passive safety systems from core and containment cooling. The key design changes result in a significant reduction in components, piping, cables, etc.
20-22	The European Pressurized Water reactor is the least innovative

design which features more robust safety systems and redundancy including a core catcher for the European market. In all these discussions point out the trend to higher power level reactors which hope to capitalize on economies of scale.

- 23-24 Slide 23 shows the present margins on electricity sales that nuclear utilities can earn with their nuclear plants but challenges to future expansion exist which should be explained - the most significant of which is the capital cost of the new plants.
- 25 Review for the students the basic elements of the Global Nuclear Energy Partnership as a concept for the future. It may not be Realized as aggressively envisioned by DOE.
- 26-33 These slides provide a high level review of current MIT research projects in the area of improved safety, design and economics of future reactors. Each can be described briefly. The message here is that even though LWRs are mature, there are many opportunities for improvement which universities can research.
- 34 Risk informed licensing is a new trend in regulation which will be useful in licensing non-traditional water reactors Explain the notion of technology neutral safety standards using risk as a metric.
- 35-40 Review the objective of the "Next Generation Nuclear Reactor" as a new technology for process heat applications including hydrogen production - emphasis this plant is legislatively mandated by the Energy Policy Act of 2005 to be built at the Idaho National Laboratory.
- 41-50 Provides background information on the development of pebble reactors in South Africa, China and at MIT. Pebble bed reactors are one of two technologies being considered for the NGNP. The other is a more traditional prismatic reactor originally developed by General Atomics in the 1970s.
- 51-65 Review of the novel MIT modular design of the pebble bed reactor using lego style factory made modules for site assembly. The big question for these smaller reactors is can they compete with larger plants and what is their market on a world wide scale. The cost of power chart shown was prepared by Exelon when they were involved in the development of the pebble bed reactor in South Africa. The costs are for the US market which shows competitive results.
- 66 This slide explains why helium gas reactors have certain safety and

Economic advantages over water reactors if developed.

67-68 Possible applications are listed that go beyond electricity due to the higher operating temperatures that are needed for many process heat applications.

69 The last summarizes major strategic directions for new nuclear plants. These are all opportunities for young nuclear engineers.

MIT OpenCourseWare
<http://ocw.mit.edu>

22.091 / 22.903 Nuclear Reactor Safety
Spring 2008

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.