Proceedings of the ASME 2011 Small Modular Reactors Symposium
SMR2011
September 28-30, 2011, Washington, DC, USA

SMR2011-6579

Promoting US Readiness for Developing the SMR Supply Chain

David Crawford
Senior Fellow, U.S. Nuclear Infrastructure Council
Washington, DC, USA

Harrison Akins
Policy Fellow, U.S. Nuclear Infrastructure Council
Washington, DC, USA

ABSTRACT TEXT

The U.S. Nuclear Infrastructure Council (NIC) is undertaking various initiatives to develop strategies and facilitate U.S. manufacturing readiness in the near-term to meet U.S. and global demands for new nuclear builds. Job creation and clean energy benefits arise from new nuclear builds, and the development of the Small Modular Reactor (SMR) supply chain is critical to realizing these positive attributes of nuclear energy. Opportunities exist for the U.S. nuclear industry to build its SMR supply chain capabilities in order to take advantage of expanded nuclear energy utilization.

This presentation will provide, first, a brief overview of the challenges which exist for the development of the domestic SMR supply chain, such as expanding industrial capacity, promoting workforce development, ensuring American competitiveness in the global energy market, resolving licensing issues, and securing financing.

Secondly, the presentation will discuss why the United States and, in particular, the nuclear industry should respond to these challenges. This is important in helping to shape the future political debates and form recommendations that will help promote the SMR supply chain industry and its role in expanding the demand and infrastructure for nuclear energy.

Finally, the presentation will look at NIC recommendations in the supply chain area to support SMRs and other nuclear power plant deployments.

DEVELOPING THE SMR SUPPLY CHAIN

With 104 operating reactors, the United States has the largest installed commercial reactor base and nuclear infrastructure of any country. The US reactor fleet also includes about 75 submarines and a dozen aircraft carriers with propulsion reactors built and installed at US nuclear infrastructure facilities, ostensibly giving the US expertise and experience for the commercialization of small modular reactors. Four decades ago, this country, in the midst of a 100-reactor

construction campaign, was completing an average of four reactors per year. The performance was impressive, but facilities and people needed to build those reactors are in a state of decline. There has not been a new nuclear reactor ordered here since 1977. As the order backlog from the 1970s was completed, the US nuclear industry had no new domestic reactors to build. As a result, the number of companies that make parts for nuclear reactors has shrunk by 80 percent since the 1970's, leaving only about 100 companies with nuclear stamps. The remaining companies have focused on making existing US reactors safer and more efficient instead of new reactor construction, limiting their ability to adapt to new technology and reactor designs.

The limitations of the current nuclear energy supply chain leaves many questions about this nation's ability to support the deployment of a long-term, sustainable supply chain for small modular reactors. A 2005 report prepared for DOE by MPR addressed the adequacy of reactor construction infrastructure in the US.[1] It concluded that enough manufacturing, fabrication, labor, and construction equipment is available, or can be readily developed, to support construction and commissioning of up to eight nuclear units during the first eight-year period after the NRC begins issuing combined operating licenses (COLs). This assessment is, however, confined to existing and proven reactor technology. The ability to adapt this existing infrastructure for SMRs based on light water reactor (LWR) technology is possible, but the deployment of advanced reactor technology and design concepts is a much more precarious situation. The MPR Report also cautioned, even with LWR designs, that there are areas where the infrastructure and resources are limited and that there were open issues related to codes and standards, licensing, and physical infrastructure that will create some schedule delays. Supply chain issues in the United States become further complicated for small modular reactors due to the NRC's lack of experience in licensing these types of reactors. Licensing issues, such as licensing fees, staffing and control room requirements, mandatory evacuation area, and safety redundancies need to be addressed concurrent with supply chain development.

Developers in other countries are competing for business with US reactor developers in the domestic and global markets. The global supply chain will be adequate to meet the initial build plan, but the materials and components for the new reactors will largely come from non-US sources. Other countries, such as China and South Korea, are quickly developing the manufacturing capabilities required for the deployment of small modular reactors. Competition for key reactor components for foreign reactors may adversely affect the cost and schedule of new US reactors relying on vendors who are offering standardized designs with non-US components. There will be some schedule risk as US reactor customers compete with other customers around the world. They include:

- **Digital Plant Control Systems and Plant Simulators**.

  The MPR study noted successful construction of GEN III+ units

[1] *DOE NP2010 Nuclear Power Plant Construction Infrastructure Assessment, 2005,* http://nuclear.energy.gov/np2010/reports/mpr2776Rev0102105.pdf

depends on the design and approval of the digital plant control systems and simulators. Hardware for these systems is available from US and international manufacturers, but at the time of the MPR report, NRC guidance was not adequate to support the efficient design and the NRC review of plant control system software. Digital instrumentation and control system issues contributed to the length of time the NRC has spent on design certification. Final digital design, hardware fabrication, software installation, test and acceptance by vendors may still be a challenge for pursuing licenses for small modular reactors.

- **Reactor Forgings**.

  The US has lost its capacity to manufacture large nuclear grade forgings with limited global forging capacity. Initial US reactor forging orders will have to go into queue with foreign suppliers, forcing reactor vendors and customers to make forging purchase commitments early and arrange deliveries to support construction schedules. Since the MPR Report, the global situation has improved. Japan, China, Russia, France, Britain, South Korea and India are all developing forging capability. A joint venture of Areva and Northrop Grumman (now Huntington Ingalls Industries) is planning a forging facility in Norfolk, VA, but it will not be operating in the near-term. The Fukushima event has placed strains on Japanese forgings capability due to the disruption in their entire manufacturing and supply chain infrastructure, as experienced by US car manufacturers. This may cause delayed delivery of pressure vessels and other forgings for the US market.

- **Fabricated components**.

  Although there is adequate capacity to provide specialty components for new reactors, many fabricators have let their nuclear supplier certifications lapse since the last nuclear build. It is costly and difficult to re-qualify for an NQA-1 certificate. The situation for fabricated components is the opposite from the forgings situation. US fabrication capability and technology has advanced faster than NRC regulations, leaving state-of-the-art welding technology for fabrication of nuclear components un-recognized. NRC standards for welding are out of date. Adoption of new standards would realize reactor cost savings and quality improvements, and give US fabricators an edge in the global market place.

- **Workforce**

  Construction workers. According to the MPR Report, finding and hiring the highly-skilled and highly-valued construction workers needed to

build nuclear units is expected to be a challenge. Qualified boilermakers, pipefitters, electricians, and iron workers are expected to be in short supply in local labor markets, particularly the Southeast, where the first reactors will be built. The use of workers from other communities and states will be required for these construction trades. All other construction trades (i.e., laborers, insulators, equipment operators, teamsters, etc.) should be available in sufficient numbers to support new construction projects. When the NRC issues COLs, the reactor owners and their contractors can be expected to sign national agreements and initiate local training programs to address this need.

Quality Assurance professionals
Quality Assurance professionals need to be identified, trained, and available early in the construction process to be sure that the work gets done right the first time and that additional construction labor and schedule time are not needed to correct deficiencies.

Operating staff
These individuals, such as health and safety professionals, operators, and maintenance technicians need to be recruited, trained and ready to support the start-up, commissioning, and testing of new reactors.

Serving the US market.

According to EIA projections, demand for electricity will rise 49% by 2035.[2] SMRs will be able to supplement US power generation in meeting these demands with a reliable, affordable, and clean power supply. In this time of economic downturn, a major nuclear construction program requiring thousands of construction workers, technicians, professionals, and managers would be a major source of economic development and job creation.

The support of SMR production in the United States will have a positive economic impact across all 50 states. The manufacture and operation of SMRs, a geographically neutral technology, means the creation of thousands of needed jobs for our country and the bolstering of the clean energy sector. Manufacture of a single 100-megawatt SMR is estimated to create 7,000 new jobs and nearly $2.5 billion in financial impact, according to a study published by the Energy Policy Institute at Boise State University.[3] In addition to direct employment, SMRs are an enabling technology in that the electricity and process heat produced by the reactors will help to induce job growth in other economic areas.

This indirect impact is difficult to quantitatively measure, however the importance of a clean, sustainable, affordable and predictable energy source can not be stressed enough. The ripples from the development of SMRs will be

---

[2] *International Energy Outlook-2010*, U.S. Energy Information Administration. May 2010. http://www.eia.doe.gov/oiaf/ieo/highlights.html

[3] *The Economic and Employment Impacts of Small Modular Reactors.* The Energy Policy Institute. Boise State University. June 2010.

felt throughout the US economy, creating hundreds of thousands of jobs.

By commercializing small reactors, utilities, in addition to promoting economic development, will now have increased flexibility to replace dependence on fossil-fuel plants and other carbon-emitting sources of energy. SMRs are a real alternative to providing clean and affordable electricity to American citizens, making nuclear energy financially feasible for both large and small scale utilities and providing energy independence for the future.

For the country to realize these employment benefits, vendors and EPC contractors and their supply chain subcontractors will need a higher degree of probability that there will be a broad market before they will commit resources to large-scale and expensive nuclear facilities and investment in workforce development. They will need to see reactor developers with NRC licenses, financing, and a readiness to place firm reactor orders. In order for that to happen, the government will need to initiate the financial and regulatory reforms that will spur developers to order new US reactors.

Serving the international market.

A US supply chain with facilities and a workforce able to service the growing domestic demand for construction and operation of small modular reactors will also enable US-based nuclear companies to compete for business in the growing international market, making the nuclear industry an engine for further economic growth and long-term manufacturing jobs. Domestic SMR technology offers a means for the US to leap ahead of international nuclear competitors pursuing orders for large LWRs. SMRs offer a means to streamline construction of reactors, lower their cost and serve market niches too small for large LWRs. Development and deployment of small modular technologies is another way the nuclear industry can spur economic and employment growth stemming from international markets.

It is too soon to speculate whether and how the Fukushima event will affect the global nuclear development. The early indications from political leaders in the US, Russia, China, France and the Middle East are that it will not make a large difference in national development plans. One exception may be Germany, where Chancellor Merkel has announced her intention to shut down the country's reactors and replace them with renewable energy sources. Commentators have noted that renewable sources are a poor replacement for base-load nuclear power generation, and if Germany shuts down its nuclear industry, it will get base-load generation from coal, contrary to its clean energy policy, natural gas from Russia, with its cost and security risks, or even nuclear generated power from France, an ironic twist for a country seeking to relinquish its dependence on nuclear energy. On the other hand, Fukushima could actually spur new reactor development if regulators order that older design reactors be shut down and replaced with modern and safer SMR or advanced reactor designs.

A large and well-trained nuclear workforce and expanded manufacturing capacity will help the US compete and succeed in the global nuclear market.

This economic development strategy can work, but the US nuclear industry is behind competitors in countries who have support from their governments, notably China, France, Russia, Canada, and Korea.

CONCLUSIONS AND RECOMMENDATIONS

An integrated nuclear strategy cannot be limited to the US domestic reactor market alone. To assure the commercialization of small modular reactors and the incubation of an SMR supply chain, we need initiatives that support the nuclear infrastructure serving those reactors and government support for marketing US technology in the international market. This will leverage our scientific and industrial expertise to make the US the global leader in new reactor builds. Specific actions include:

- Implement financial and regulatory reforms to assure the licensing and economics of SMRs over the next decade.
- Congress and federal agencies with nuclear export control regulatory responsibility should work with US nuclear companies to eliminate regulations implementing out-dated Cold War era policies that restrict US nuclear trade with peaceful countries.
- Systems and design-related codes and standards for suppliers and new construction of new nuclear power plants need to be updated by the NRC.
- Partnerships between universities specializing in nuclear engineering and related sciences and nuclear companies in the US and in advanced nuclear countries are needed to develop the next generation of nuclear scientists, engineers, and managers.

ACKNOWLEDGEMENTS

The authors would like to thank the U.S. Nuclear Infrastructure Council and C.J. Milmoe, Senior Policy Advisor to U.S. NIC, for their support and contributions to this paper.

While these opinions represent the consensus views of the U.S. Nuclear Infrastructure Council, it does not necessarily reflect the specific views of every individual member.

REFERENCES

DOE NP2010 Nuclear Power Plant Construction Infrastructure Assessment, 2005, http://nuclear.energy.gov/np2010/reports/mpr2776Rev0102105.pdf

The Economic and Employment Impacts of Small Modular Reactors. The Energy Policy Institute. Boise State University. June 2010.

International Energy Outlook-2010, U.S.Energy Information Administration. May 2010. http://www.eia.doe.gov/oiaf/ieo/highlights.html