



November 20, 2013

To: Richard Meserve, NEAC Chair

From: Michael Corradini, NEAC Subcommittee Chair

Re: Nuclear Reactor Technology Subcommittee Meeting on Nuclear Plant Closures

The Nuclear Reactor Technology (NRT) Subcommittee has historically examined the research and development activities within the DOE Office of Nuclear Energy (DOE-NE) as they relate to nuclear reactor technologies; i.e., reactor design, reactor systems and associated applied research programs. Recent LWR plant closures have prompted DOE-NE leadership to consider contributing factors for these shutdowns and what can be appropriately done at national and regional levels. This issue will be discussed at the December NEAC meeting.

In anticipation of this NEAC discussion, the NRT subcommittee was asked to consider what can be done at the national and regional levels in keeping the nuclear power option viable now and into the future as well as provide initial findings and recommendations. The subcommittee considered both currently operating plants and future LWR's under construction or being planned in the U.S.

The NRT subcommittee considered the following issues during its discussion:

- Review and identify the circumstances for each plant shutdown, in order to get a common understanding of the situation.
- While the Light Water Reactor Sustainability (LWRS) program may be working on important issues, what may be missing (e.g., something of major consequence in policy space)?
- Have national and regional policies created market structures, which may recognize value in certain clean energy resources, but not in clean nuclear energy, both existing and new? What has changed in this regard, since the existing fleet of nuclear resources came into operation?
- Are current restructured energy markets not appropriately valuing existing nuclear generation, so that some plants may inappropriately appear uneconomic? If so, how can this problem be addressed?
- Are there actions/incentives for current plants, for advanced large LWRs and for the planned Small Modular Reactor (SMR) program that need to be considered?

On November 6th, 2013, our NRT subcommittee met at the DOE Forrestal Bldg. and had discussions with representatives from specific nuclear plant owner/operators (Dominion and Entergy) and the Nuclear Energy Institute (NEI) about the recent plant closures. The NRT subcommittee also had the benefit of public documents (see References). Our summary findings and recommendation are given below.

Finding: There have been five recent nuclear plant closures (or closure announcements): the two San Onofre reactors, and one reactor each at Crystal River, Kewaunee and Vermont Yankee. All of these closures were business decisions.

Closures of the Crystal River 3 and San Onofre 2 and 3 were primarily due to problems associated with steam generator replacement. San Onofre and Crystal River steam generator replacement projects resulted in extended outages due to technical and regulatory issues. Both units had experienced problems and the owners had determined that substantial additional time and financial investment would be required to return them to normal operation. These reflect unique circumstances that may not likely be repeated.

Kewaunee and Vermont Yankee had each been granted twenty-year license renewals and had each been approved for power uprates. In recent years, both plants had operated with high (90% or higher) capacity factors. Kewaunee and Vermont Yankee are single-unit merchant plants that are older and smaller than many plants in the fleet, and thus do not share operating efficiencies of some larger multi-unit plants. In the judgment of the owners, when taking into consideration operating and maintenance and fuel costs, and cost uncertainties, e.g., due to safety upgrade requirements, these plants did not appear profitable in a wholesale electricity market going forward. Neither plant was able to secure a long-term power purchase agreement, which made the ability to recover investment and production costs problematic. This inability was due in large part because of the current short-term low natural gas prices and the current electricity capacity market structure. Discussions indicate that there may be additional nuclear capacity at risk of closing.

Finding: In the longer-term, except for decadal power purchase agreements, the capacity markets as currently structured (to the extent that they exist at all in some regions) do not provide adequate revenues to assure that positive cash flows will be produced for merchant nuclear plant owner/operators. There is additional evidence that some of these markets as currently structured will not support investment in new generating facilities of any fuel source. When combined with the anticipated closure of fossil fueled plants as the result of proposed Clean Air Act regulations, regional reserve margins may be projected to shrink in an accelerated manner below that generally regarded as prudent.

Recommendation: The NRT subcommittee recommends that the DOE Office of Nuclear Energy work with the DOE Secretary Office to begin high-level discussions to develop a sense of urgency at the federal level within the DOE as well as with other federal agencies (i.e., Environmental Protection Agency [EPA] and Federal Energy Regulatory Commission [FERC]) to ensure that electricity markets take into consideration desirable attributes that are not currently reflected in electricity market prices. Key attributes include:

- **Fuel source diversity:** An appropriate balance of more than one type of energy resource within the electricity supply system. Such diversity protects against short-term energy supply scarcity, price volatility, impacts of severe weather conditions, and single-source influence of any single energy resource.
- **Electric supply reliability:** An electrical power supply that is stable in time and space, and has an adequate capacity margin.
- **Environmental sustainability attributes:** These include low carbon emissions, small environmental footprints, minimal solid waste requirements and water requirements.

Recommendation: The NRT recommends that DOE-NE assess the amount of nuclear power plant capacity that may be at risk as well as the time frame and the key contributing factors. The NRT suggests that DOE-NE work with the Office of Energy Policy and System Analysis on this assessment. This collaboration should also develop a strategy and action plan to address potential near-term loss of generation capacity that otherwise would be retained if restructured electric markets took into account the attributes identified above.

Recommendation: Given the desirability of having an electricity market that takes into account the attributes identified above, the NRT subcommittee also recommends that an interagency task force be formed at the federal level to help promote regional and state policy that would influence Public Utility Commissions and Load Serving Entities to create electricity markets that take these attributes into account.

Action Item: The NRT subcommittee recognizes that new nuclear power generation capacity (advanced LWRs such as the AP1000 or ESBWR or future SMRs) will also be influenced by these findings on economics and market structure. The subcommittee plans to take up this investigation in our future meetings.

References:

Dominion Shuts Down Kewaunee Power Station Permanently, <http://dom.mediaroom.com>

SCE Announces Plans to Retire San Onofre, <http://newsroom.edison.com/releases>

Crystal River Nuclear Plant to be Retired, <http://www.duke-energy.com/news/releases>

Entergy to Close, Decommission Vermont Yankee, http://www.entergy.com/news_room

M.Wald, Nuclear Plants Vexed at Prices That Shift as Demand Does - NYTimes.com 10/28/13

APPENDIX A
Nuclear Energy Advisory Committee
Reactor Technologies Subcommittee Meeting
November 6, 2013
FORS GH-035
Agenda

8:00 Refreshments	
8:15 Introduction and plan for the day	M. Corradini (UW)
8:30 Updates on NE-7 Program	Dr. John Kelly
8:45 Discussion and Clarification of Charge	Corradini/Kelly
9:15 Presentation on Kewaunee	D.Stoddard (Dom.)
9:45 Q&A and discussion period	All
10:30 Break	All
10:45 Presentation on Vermont Yankee	W. Mohl (Entergy)
11:15 Q&A and discussion period	All
12:00 Lunch- Self Serve/Cafeteria	All
12:45 Presentation by NEI	R. Meyers (NEI)
1:15 Q&A and discussion period	All
2:30 General Discussion and Q&A	All
4:00 Closed Session	NEAC NRT