Nuclear Energy Advisory Committee

June 30, 2011

Dr. Steven Chu
Secretary of Energy
U.S. Department of Energy
Washington, D.C. 20855

Dear Secretary Chu:

This letter is provided to you in response to the request of the Assistant Secretary of Nuclear Energy in his August 20th, 2010 letter to the Nuclear Energy Advisory Committee (NEAC) to review the Next Generation Nuclear Plant activities and to advise whether the Project is ready to proceed to its second phase.

Background

The Next Generation Nuclear Plant (NGNP) project was established under the Energy Policy Act in August 2005 (EPACT-2005). EPACT-2005 defined an overall plan and timetable for NGNP research, design, licensing, construction and operation by the end of FY 2021. At the time that EPACT-2005 was passed, it was envisioned that key aspects of the project included:

- NGNP is based on R&D activities supported by the Gen-IV Nuclear Energy initiative;
- NGNP is to be used to generate electricity, to produce hydrogen or (to do) both;
- The Idaho National Laboratory (INL) will be the lead national lab for the project;
- NGNP will be sited at the INL in Idaho;
- INL will organize a consortium of industrial partners for the cost-shared project;
- NGNP project will be conducted in two phases:
    - Phase I (2005 - 2011) is to select and validate hydrogen generation technology; carry out enabling R&D on associated technologies and components (energy conversion, nuclear fuel development, materials selection, reactor and plant); determine if it is appropriate to produce electricity, hydrogen or both; and carry out initial design activities for the prototype nuclear power plant.

- Phase II (2011-2021) is to continue first phase activities and to competitively develop a final detailed design, obtain an NRC license for construction and operation, and construct and start-up operations for the NGNP.

- NGNP project will have technical interchange and technology transfer with other sources of relevant expertise; i.e., nuclear and chemical industries, international Gen-IV partners.

The NGNP project selected the High Temperature Gas Reactor (HTGR), a helium-cooled, thermal spectrum nuclear reactor as the overall reactor technology to be designed, licensed and constructed. The gas-cooled reactor offers the attractive feature of potentially filling a market for a high-temperature source to a range of process heat applications (e.g., chemical processes such as hydrogen production) and for electricity to selected industries, and thereby reducing CO_2 emissions by replacing the use of fossil fuels for such applications. This technology is unique in its ability to expand the role of nuclear reactor systems to a broader range of energy products. The NGNP project did not decide on the reactor core design for the technology.
EPACT-2005 sets a target date to complete the first project phase by the end of FY2011. At that time, EPACT-2005 states that "the Secretary is to either (1) select the technology to be used by the NGNP Project and the initial design parameters for the prototype nuclear plant; or (2) submit to Congress a report establishing an alternative date for making the selection". On a determination by the Secretary that the appropriate activities under the first project phase are nearly complete, the Secretary shall request the NEAC to conduct a comprehensive review of the Project and to report to the Secretary their recommendation concerning whether the Project is ready to proceed to the second project phase.

Approach[1]

This letter report provides our recommendations regarding NGNP readiness to proceed with Phase II. These recommendations were developed from a thorough review conducted by our NEAC Nuclear Reactor Technology (NRT) Subcommittee.

Because this project represents a major investment for the DOE and requires establishment of a public-private partnership, strong and effective project management and oversight are a necessity. As a result, the NEAC NRT Subcommittee held four meetings (on September 30, November 15, 2010, February 22 and April 20, 2011) and reviewed the following NGNP project management topics that were part of the Phase I activities:

- The charge and review criteria provided to the committee by DOE;
- Identification of NGNP project requirements to successfully proceed to Phase II;
- The background and history of the NGNP project since its inception;
- The perspective of potential NGNP customers and their commitment;
- The market case and public-private partnership possibilities for the project;
- The current range of possible design specifications for the NGNP;

[1] *Subcommittee member, Dr. Joy L. Rempe, attended and where appropriate, offered information to assist other Subcommittee members in their meetings on this topic. However, because of her affiliation with INL, Dr. Rempe did not participate in formulating the recommendations on this topic.*

- The program plan, including Phase II activities, decision points, time schedule, cost estimates, and needed NGNP products;
- The NGNP licensing strategy with input from DOE as well as NRC;
- The conceptual design efforts considering two NGNP reactor core concepts;
- The enabling research, development and demonstration activities on needed base technologies and components.

During these meetings, we had the benefit of numerous NGNP reference documents, summary reports, and presentations provided by the DOE and its contractors. Key findings are first reported from the subcommittee efforts, and then, we present our recommendations.

Findings

Hydrogen Production: NGNP Phase I activities were initially focused on selecting and validating the appropriate hydrogen production technology as well as determining if it is appropriate to combine electricity and hydrogen production in a single prototype nuclear reactor and plant. Since the initiation of the project, the role of the NGNP to produce hydrogen, as called for under EPACT-2005, has been expanded. This broadened role seeks to produce process heat for a variety of applications, including hydrogen production as one of many chemical processes that require process heat. These applications are more general in scope; thus, they can significantly expand the market and improve the business case for the NGNP. Furthermore, program efforts indicate that the lower outlet temperature associated with process heat applications optimizes initial plant deployment efforts with respect to plant cost, safety, and investment risk. We agree with the expanded direction of the project and the associated broader impact that the project can provide to chemical process industries.

Research and Development: NGNP Phase I included enabling research, development, and demonstration activities on technologies and components. Specific areas of investigation included: energy conversion systems, nuclear fuel qualification, reactor materials, and analysis methods development. The research and development program conceived by the DOE and its contractors was well designed and properly focused on the necessary key areas. The fuel qualification program is clearly the major task that has the longest lead-time requiring not only reliable and reproducible TRISO fuel manufacturing but also fuel compact irradiation testing and post-irradiation examination. In addition, materials research and development will be needed in key areas. Based on the review of these activities, no impediments were identified from technological barriers to continue the project at this time. As the detailed NGNP design and licensing safety case are developed, additional research and development needs may be identified to address particular issues; e.g., component testing or analysis methods validation to address specific questions.

Reactor System Conceptual Design: Phase I activities also involved the development of NGNP conceptual designs using two HTGR reactor concepts; i.e., a prismatic reactor core design and a pebble-bed core design. A number of design teams carried forward these two concepts and included development of the design as well as safety analytical methods and studies. Most recently, an effort was begun in FY2009 with these two conceptual designs to be completed by January 2011. In the summer of 2010, the pebble-bed conceptual design effort was curtailed because its design team disbanded. The remaining prismatic conceptual design team submitted a conceptual design report to the DOE in December 2010. In addition, the DOE funded a vendor to review the status of a pebble-bed reactor concept and present key findings to the NEAC subcommittee during its February meeting. We reviewed the status of both of these efforts and found that design activities were substantially more complete for the prismatic design. However, the prismatic design concept is still conceptual and needs more detailed design, research, and development efforts to be sufficient for licensing. It should be noted that both teams focused on design concepts with lower reactor outlet temperatures than identified by the Industry Alliance (see Ref. 1); e.g., the 700 °C outlet temperature for the pebble bed concept and the 725 °C outlet temperature for the prismatic concept are both lower than the 750 to 800 °C identified by the Industry Alliance in Reference 1[2].

NGNP Siting: EPACT-2005 designates that the NGNP demonstration plant be built at the INL. However, the business case to optimize its use for process heat applications and electricity indicates that it is more appropriate to select a site near a wide range of industrial uses. A site at INL will not support a partnership agreement with industry as required by EPACT-2005. It is essential that an alternate site be identified to finalize NGNP design details and address key licensing questions associated with the plant design and location.

Licensing Activities: As directed by EPACT-2005, the DOE, in collaboration with the Nuclear Regulatory Commission (NRC), developed an NGNP licensing strategy. The proposed strategy invokes the 10CFR52 process to submit a combined operating license (COL) for the NGNP. Such an approach requires a sufficiently detailed design so that the required analyses can be performed, the safety case developed, and the COL submitted to the NRC. The 10CFR52 approach also requires the designer to be sufficiently confident of the reactor system that the first plant is a detailed representative of the subsequent fleet of plants to be built and licensed as standardized units. The licensing strategy planning has been led by the INL, and several white papers addressing generic licensing issues have been submitted to the NRC. However, given the limited scope and duration of the current conceptual design activities and recent industry experience with 10CFR52 in design certification efforts, it is unlikely that any vendor could complete a sufficiently detailed design to certify or obtain a COL for the NGNP under the

[2] "Next Generation Nuclear Plant Project Implementation Strategy," November 2009, attachment to letter from the NGNP Industry Alliance to Steven Chu, Secretary of Energy, November 30, 2009.

current schedule. Furthermore, prior experience suggests that the first unit is unlikely to be the actual prototype of a subsequent fleet because changes emerge from operation of the first unit.

In contrast, if a 10CFR50 licensing path were pursued with a partnership that included vendor, owner-operator, and end-user members, it may be possible that answers to many of the key licensing issues could be answered with less detailed design information and at a reduced first cost to the DOE and partnership members. That is, a less detailed design is needed to obtain a construction permit; and once the construction permit is granted, the remainder of the design of the plant and its construction would proceed in parallel. The final design and the changes made during construction would then be submitted to the NRC for review to obtain the operating license. After the plant has operated for some time and desirable improvements identified, the designer can proceed with a Design Certification Document for the final design. It is our view that either licensing path should identify a site for the NGNP along with an owner-operator to solidify the partnership and minimize future risk. Once key licensing issues are addressed by the NRC (and the risk associated with the cost of licensing the NGNP is reduced), it may be possible to obtain a stronger financial commitment from partnership members.

Industrial Partnerships and Cost Sharing: EPACT-2005 directed the DOE to have the INL organize a consortium of appropriate industrial partners that will carry out cost-shared research, development, design, and construction activities, and operate facilities, on behalf of the NGNP Project. The activities of industrial partners funded by the Project would be cost-shared in accordance with section 988 of the EPACT-2005; i.e., a 50/50 cost share for the project. Note that EPACT-2005 states that the Secretary can alter the requested amount of cost share and the terms over which the cost share must be provided (e.g., how the cost share is divided over the life of the project or on an annual basis are not specified). Currently, there is no public-private partnership in place to carry this project forward. Also, no potential customer has indicated a willingness to commit to share in the cost of constructing a first-of-a-kind NGNP with a 50/50 cost share on an annual basis. Moreover, the current reluctance of vendors, owner-operator, and customers to commit to substantial up-front cost sharing in the NGNP development is unlikely to change in the near term. In addition, other conditions that work against nuclear process heat projects need to be recognized; e.g., short-term natural gas prices, a failure to internalize the social cost of carbon emissions, and the perceived high initial capital cost of the first few reactor plants deployed.

Project Plan: The DOE developed a project plan for Phase II activities. The plan includes issuing a call in FY2011 for a public-private partnership to be formed by the end of FY2012. This approach would mean that any additional detailed design activities would occur after the partnership is formed, and a cost-share is determined. Given the absence of a partnership and the limited amount of conceptual design work completed, it does not appear that a COL can be submitted by September 2014, or construction completed by 2021 as defined in the project plan.

Recommendations

NEAC concurs with these results and findings. Based on the review of the NGNP Project, NEAC concludes that the project is not ready for a decision to proceed to the complete set of Phase II activities. However, because of the great potential for the NGNP to reduce the carbon footprint associated with process heat for industrial uses, for electricity production in certain applications, and ultimately, for its potential for hydrogen production, we recommend proceeding with a portion of the Phase II activities suggested in EPACT-2005; i.e., continue with Phase I efforts, initiate a partnership and begin the needed design activities required to support NRC licensing.

The NEAC recommends that the federal government continue to support the development of the NGNP at an appropriate level in the next few years to sustain its investment in this technology. However, NEAC does not see a credible path forward within the constraints imposed by EPACT-2005 and the current lack of potential vendors, owner-operators, and customers willing to make substantial up-front funding commitments for the licensing and construction of a first-of-a-kind HTGR design.

Consequently, the NEAC recommends:

1] Accelerate the formation of a public-private partnership as soon as practical to obtain end-user input into design activities and fund additional design activities to support this effort. The private sector of this partnership should, as a minimum, include (i) a vendor, (ii) an owner-operator, and (iii) a process heat end user. Because of the benefits offered by the NGNP with respect to carbon footprint reduction, cost incentives (e.g., loan guarantees, tax credits, licensing delay insurance, etc.), similar to those offered for other options associated with renewable energy, should be offered to partnership members. A phased partnership should be pursued (with cost sharing requirements increased as uncertainties associated with NGNP deployment are reduced). Because site-specific parameters are key for various aspects associated with the NGNP effort, it is emphasized that this partnership must include an organization that will operate the plant at a site of interest for process heat end users.

2] Continue to engage the NRC for necessary licensing activities to ensure that the regulatory framework for this new reactor technology is ready to support commercialization. However, NEAC recommends that a 10CFR50 licensing path be adopted to reduce the investments required to address key licensing issues. In particular, we believe that design information consistent with at least a Preliminary Safety Analysis Report (PSAR) level of detail (such as the acceptance of an appropriate containment concept, multi-module control room staffing, technology-neutral licensing requirements, etc.) is sufficient for early licensing evaluation and decision-making. As noted above, it is expected that DOE would require increased cost sharing from partnership members as these licensing issues are addressed. Further, the reduced initial

funding needed early in the NGNP project prior to regulatory approval might increase the likelihood of forming a successful and effective public-private partnership. However, it is important to note that the use of the 10CFR50 approach may not reduce the overall NGNP cost or schedule.

3] Expedite NGNP deployment efforts by:

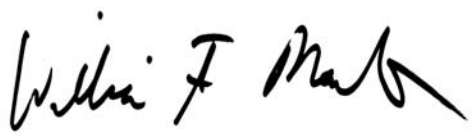
a) Revising the NGNP program plan to reflect the current situation and sustain progress through appropriate funding levels for a single design concept (prismatic or pebble bed) to move forward.

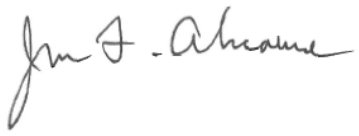
b) Completing additional design activities required to support a PSAR level of detail for this single design concept that is selected by the partnership. The partnership would select this concept based on site-specific information and end-user needs. Hence, it is essential that the partnership be established as soon as possible.

c) Focusing current research and design efforts on this single concept that will accelerate initial deployment efforts. While high reactor outlet temperatures are desirable for ultimate NGNP applications, issues associated with licensing and deployment must first be addressed.

d) Removing the EPACT-2005 requirement that the NGNP first-of-a-kind be located at the INL site. Rather, the NGNP should be sited at an appropriate location defined by the industrial partnership that will be formed by the end of FY2012.

4] If the development of the public-private partnership is not substantially under way by the end of FY12, then the NGNP program should be repurposed for advanced reactor systems R&D.





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