August 27, 2009 CCN 217493

Mr. Trevor L. Cook
NGNP Project Manager
NE-33, Germantown Building
U.S. Department of Energy
19901 Germantown Road
Germantown, MD 20874

SUBJECT: Contract No. DE-AC07-05ID14517 – Completion of Level 2 Milestone – Provide a Progress Report Describing the Status of Nuclear Regulatory Commission White Paper Development in the Area of Fuel Qualification

Dear Mr. Cook:

This letter formally documents completion of the Next Generation Nuclear Plant (NGNP) Licensing Level 2 milestone. The specific milestone is:

> *"Provide a progress report describing the status of Nuclear Regulatory Commission white paper development in the area of fuel qualification,"* due August 31, 2009.

This letter and enclosure satisfy the notification requirement for completion of this milestone.

If you have any questions, please contact me at (208) 526-6063 or Jim Kinsey, Director, NGNP Regulatory Affairs at (208) 526-6882.

Sincerely,

G. A. Gibbs

Greg Gibbs, Project Director
Next Generation Nuclear Plant Project

MH:CN

Enclosure: NGNP Fuel Qualification White Paper Development Status Report, August 2009

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Next Generation Nuclear Plant Licensing

NGNP FUEL QUALIFICATION WHITE PAPER DEVELOPMENT STATUS REPORT

August 2009

Introduction

The Next Generation Nuclear Plant (NGNP) Project is moving toward the Nuclear Regulatory Commission's (NRC) preapplication phase, and it must complete a significant level of licensing bases development work in support of this licensing phase. In conjunction with NGNP Engineering, the Technology Development Office, and other project team members, NGNP Regulatory Affairs is currently addressing a number of high priority preapplication topics and activities related to licensing risk reduction and management in support of this licensing bases development. These activities are consistent with PLN-3202, "NGNP Licensing Plan," dated June 26, 2009.

The TRISO coated fuel particle is common to current high temperature gas-cooled reactor designs. The particle's multiple-coating-layer system has been designed to retain the fission products generated by fissioning of the nuclear material in the fuel kernel during normal and abnormal events over the lifetime of the fuel. Therefore, TRISO coated fuel forms the primary (but not the only) barrier to fission product releases for high temperature gas-cooled reactors such as the NGNP. Qualification of the fuel with respect to stringent fuel performance requirements is essential to NGNP licensing as noted by the NRC in the DOE/NRC NGNP Licensing Strategy Report to Congress.

Purpose

The work discussed in this letter report consists of developing project white papers that address NGNP fuel qualification topics to be submitted to the NRC for their review early in the NGNP preapplication process. Because of the differences in fuel design for the prismatic and pebble bed concepts, a prismatic fuel qualification white paper will be developed by General Atomics (GA) and a pebble bed fuel qualification white paper will be developed by the Westinghouse-PBMR group (WEC).

Discussion of both the prismatic and pebble bed fuel qualification processes with NRC staff is currently planned to commence in December 2009, following submittal of the white papers.

Description of the White Paper Development Work Scope

As previously noted, the use of low-defect, high performance fuel is critical to the NGNP safety case because the TRISO-coated fuel particle provides the primary boundary to the release of fission products under normal, off-normal, and accident conditions. This fuel performance characteristic is expected to result in smaller than typical accident condition fission product releases (as compared to light water reactors), thereby allowing the NGNP to be co-located with

those industrial complexes that would benefit from the process heat provided by the NGNP. An effective fuel qualification program therefore needs to be established for review by the NRC.

The fuel qualification white paper task involves preparation of two white papers (to individually address the prismatic and pebble bed fuel forms) that summarize applicable NRC regulations, policies, and guidance; fuel design and service conditions; the method of fuel fabrication; the existing fuel performance database; and plans for further testing to qualify fuel for use in the NGNP. These fuel qualification white papers are expected to also identify policy and technical issues that should be discussed and resolved with the NRC during the preapplication phase of the NGNP licensing process. In general, the prismatic and pebble bed fuel qualification white papers being developed will:

- Summarize the existing regulatory policy and guidance that may apply to the fabrication and qualification of particle fuel to be used in the NGNP.
- Describe the particle fuel design and service conditions under normal and accident conditions.
- Describe the proposed method and testing for qualification of the NGNP TRISO-coated particle fuel. Include references to any existing databases that may be used, and justify their applicability to the NGNP design, including supporting test data or analyses.
- Describe the quality assurance process and quality control procedures/measures necessary to ensure that the fuel is manufactured in a manner that is consistent with the design and fabrication specifications. Include (1) a description of the process parameters and fuel characteristics that will be monitored, (2) justification for the parameters/characteristics selected, and (3) the associated limits or acceptance criteria that will be applied.
- Identify policy and technical issues that should be discussed and resolved with the NRC during the preapplication phase.

Status of the Prismatic Fuel Qualification White Paper

Initiation of the prismatic fuel qualification white paper development occurred on June 16, 2009, when NGNP Regulatory Affairs personnel held a task kick-off meeting with GA personnel. The purpose for this meeting was to discuss GA's approach for performing the work outlined in the white paper statement of work; development of the annotated white paper outline and plans for future project communications and meetings were also discussed.

On July 2, 2009, GA provided an annotated outline for their fuel qualification white paper (a summary of this outline is provided in Appendix A). Based on the most recent bi-weekly conference call with GA, their prismatic fuel qualification white paper is at the 50% development stage. This means that the annotated outline is developed and reviewed, and the majority of the report content drafted and provided to Battelle Energy Alliance (BEA) for input.

On August 21, 2009, a 50% review was conducted of the prismatic fuel qualification white paper. In general, it was agreed that GA was pursuing the right approach in developing their white paper. GA was asked to consider adding discussion regarding source term derived from analysis that supports fuel behavior during specific accident scenarios (fission product transport, retention characteristics, etc.) to the white paper rather than leaving this discussion to other

preapplication white papers now in progress. Although there are interdependencies and similarities between these documents, it was decided that the fuel qualification white paper should be the driver for this topic.

The following actions are necessary to complete the prismatic white paper task:

1. Submit white paper draft for BEA review
2. Conduct 90% review meeting
3. Incorporate comments and issue the Rev. 0 white paper
4. Attend an initial NRC white paper review meeting discussing the prismatic fuel qualification topic
5. Incorporate any needed revisions based on NRC meeting results and initial requests for additional information.

The Rev. 0 white paper describing the prismatic fuel qualification process is scheduled for December 2009.

Status of the Pebble Bed Fuel Qualification White Paper

Initiation of the pebble bed fuel qualification white paper development occurred on July 27, 2009, when NGNP Regulatory Affairs personnel held a task kick-off meeting with WEC personnel. The purpose for this meeting was to discuss and agree upon the basic deliverables and schedule.

The pebble bed fuel qualification white paper will address the qualification of fuel particles and fuel spheres for the NGNP pebble bed design. A detailed development schedule has been prepared for the white paper and its annotated outline is in the final review stage (a summary of the outline is provided in Appendix B). The starting point for the draft paper will be the similar paper prepared and submitted to NRC as part of the Pebble Bed Modular Reactor U.S. Design Certification program, with revision emphasis placed on making the paper specifically applicable to the NGNP program. New information will be added to address NGNP operating conditions, quality assurance overviews, the Pebble Bed Modular Reactor (PBMR) burnup measurement system, and interactions with the NGNP Fuel Research and Development program. The paper will address questions raised by the NRC staff, in the form of Requests for Additional Information, during the previous PBMR preapplication program review.

The following actions are necessary to complete the pebble bed white paper task:

1. Complete development needed for the white paper (including 50% review meeting)
2. Submit white paper draft for BEA review
3. Conduct 90% review meeting
4. Incorporate comments and issue the final white paper
5. Attend NRC meeting discussing the prismatic fuel qualification topic
6. Incorporate any needed revisions based on NRC meeting results.

The primary deliverables are a draft paper by the end of October and a Rev. 0 white paper is scheduled for November 2009.

APPENDIX A

Prismatic Fuel Qualification White Paper Outline

1. Purpose and Scope
2. Regulatory Bases
   - 2.1. NRC Regulations
   - 2.2. Policy Statements
   - 2.3. NRC Guidance
   - 2.4. Gas Reactor Precedents
3. Background
   - 3.1. NGNP Prismatic Block Reactor Design
   - 3.2. Coated Particle Fuel Design and Service Conditions
     - 3.2.1. Fuel Design Description
       - 3.2.1.1. Coated Particles
       - 3.2.1.2. Fuel Compacts
       - 3.2.1.3. Prismatic Fuel Blocks
     - 3.2.2. Fuel Service Conditions
   - 3.3. Fuel Product Specifications and Basis
   - 3.4. Fuel Manufacturing and Quality Control
     - 3.4.1. Kernel Fabrication
     - 3.4.2. Coated-Particle Fabrication
     - 3.4.3. Compact Fabrication
     - 3.4.4. Statistical Quality Control
   - 3.5. Fuel Performance Experience
     - 3.5.1. Irradiation Test Experience
     - 3.5.2. Simulated Accident Condition Heating Test Experience
4. Proposed Approach
   - 4.1. Evaluation of Irradiation and Heating-Test Data Bases for UCO Fuel
   - 4.2. Fuel Performance Codes and Models
   - 4.3. NGNP/AGR Fuel Development and Qualification Program
     - 4.3.1. Fuel Manufacturing Process and Quality Control Methods Development
     - 4.3.2. Irradiation Test Program
     - 4.3.3. Simulated Accident Heating Tests (Safety Tests)
     - 4.3.4. Fuel Performance Model Development
   - 4.4. Qualification of Production –Scale Fuel Manufacturing Facility for NGNP UCO Fuel
5. Issues for Preapplication Resolution
6. References

APPENDIX B

Pebble Bed Fuel Qualification White Paper

1. Purpose and Scope
   - 1.1. Purpose
   - 1.2. Scope
   - 1.3. Outcome Objectives from Preapplication Engagement
   - 1.4. Summary of Topics for Preapplication Discussion
   - 1.5. Relationship to Other Preapplication Focus Topics/Papers
2. Regulatory Bases
   - 2.1. NRC Regulations
   - 2.2. NRC Policy Statements
   - 2.3. NRC Guidance
   - 2.4. Gas Reactor Precedents
   - 2.5. Other References
3. NGNP Approach
   - 3.1. Background
     - 3.1.1. Fuel Element Design and Manufacturing Description
       - 3.1.1.1. Coated Particle Design and Manufacture Description
       - 3.1.1.2. Fuel Sphere Design and Manufacture Description
   - 3.2. Discussion
     - 3.2.1. Manufacturing Quality Assurance
     - 3.2.2. Spherical Fuel Functional Characteristics and Service Conditions
       - 3.2.2.1. Overview of NGNP Reactor Unit Design
       - 3.2.2.2. NGNP Fuel Service Conditions
       - 3.2.2.3. NGNP Burnup Measurement System
   - 3.3. German Fuel Design and Operating Experience
     - 3.3.1. Design and Manufacturing Experience
       - 3.3.1.1. Normal Operation Irradiation Performance
       - 3.3.1.2. Heating Test Experience
         - 3.3.1.2.1. Heating Test Facilities and Procedures
         - 3.3.1.2.2. Heating Test Results – 85Kr Release
         - 3.3.1.2.3. Heating Test Results – Metallic Fission Product Release
       - 3.3.1.3. Summary of German Fuel Design and Experience
4. NGNP Fuel Qualification Program
   - 4.1. Materials Test Reactors
   - 4.2. Testing of Laboratory-Produced Fuel Spheres
   - 4.3. Testing of Production Plant Fuel Spheres – Overview
     - 4.3.1. Testing Objectives
     - 4.3.2. Pre-irradiation Characterization
   - 4.4. Testing of Production Plant Fuel Spheres – Partial Burn-up
   - 4.5. Testing of Production Plant Fuel Spheres – Full Burn-up Proof Test
   - 4.6. Fuel Spheres from PBMR/NGNP Operation

435.77
12/03/2007
Rev. 03

NEXT GENERATION NUCLEAR PLANT PROJECT
INFORMATION INPUT SHEET

1. Document Information

Document ID:	CCN 217493	Revision ID:	Project Number: 23843
Document Title/Description:	Contract Number DE-AC07-05ID14517 - Completion of Level 2 Milestone - Provide a Progress Report Describing the Status of Nuclear Regulatory Commission White Paper Development in the Area of Fuel Qualification	Sub-Project No.:	08/27/09
		Date of Record:	
Document Author/Creator:	G.A. Gibbs	OR	
Document Owner:	G.A. Gibbs	Date Range:	
Originating Organization:	INL	From:	To:

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Category: ☒ General Record ☐ Quality Assurance ☐ Controlled Document

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Keywords: GG--28-09

Medium: ☒ Hard Copy ☐ CD/Disk (each CD/Disk must have an attached index) ☐ Other:

Total Number of Pages (including transmittal sheet): 10 File Index Code: 0100.1

Folder: Project Management

Type: Communications

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