June 14, 2002

MEMORANDUM TO: Farouk Eltawila, Director
Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research

THRU: John H. Flack, Chief **/RA/ original signed by J. Persensky**
Regulatory Effectiveness Assessment and Human Factors Branch
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FROM: Stuart D. Rubin, Senior Technical Advisor **/RA/**
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SUBJECT: INEEL WORKSHOP ON HIGH-TEMPERATURE GAS-COOLED REACTOR FUEL DEVELOPMENT AND IRRADIATION TESTING

During the period May 21-22, 2002, I participated in a workshop on High Temperature Gas Cooled Reactor (HTGR) fuel development and irradiation testing. The workshop was sponsored by the U.S. Department of Energy (DOE) and was hosted by the Idaho National Engineering and Environmental Laboratory (INEEL) at their offices in Idaho Falls, Idaho. The purpose of the workshop was for the invited participants to discuss: (1) the research and development (R&D) needs for near-term HTGR fuel, and (2) the tentative scope and approach to address these needs. The organizations that participated in the workshop were NRC, DOE, INEEL, OAK Ridge National Laboratory (ORNL), Argonne National Laboratory (ANL), BWXT and General Atomics (GA). The meeting agenda for the workshop is provided as Attachment 1

The workshop was prompted by the Exelon Generation Corporation (Exelon) decision to withdraw from the Pebble Bed Modular Reactor (PBMR) project in South Africa and to terminate PBMR pre-application review activities with the NRC. These decisions significantly impacted the planned DOE/Exelon fuel irradiation testing plans which, from DOE's perspective, were to support HTGR fuel qualification aimed at near-term licensing of an HTGR in the U.S. The workshop brought together DOE, national laboratory and industry representatives to assist in reprogramming DOE's HTGR fuel R&D activities to best support DOE's program to assist industry in HTGR fuel development and qualification. The revised program activities were to be broad-based, generic and technology-driven rather than design-specific and qualification driven.

My participation in the workshop was to provide NRC's views on HTGR fuel irradiation testing needs with emphasis on near-term testing of German archive pebble fuel. I gave a presentation on the first day of the meeting (Attachment 2) on the NRC's research needs related to HTGR fuel. The presentation was based on the NRC's goals, objectives, issues and specific plans for HTGR fuel safety research as described in the March 2002 draft Advanced Reactor Research Plan.

Dr. David Petti (INEEL) gave a presentation (Attachment 3) on a proposed irradiation test plan for six German archive pebbles that can be provided by the Julich Research Center. The proposed test plan can accommodate additional fuel pebbles, in increments of two, up to a total of twelve. This would require additional pebbles to be obtained in a timely manner from INET or another source beyond those that can be provided by Julich. As seen in Attachment 3, the first six pebbles would be focused on "safety margin" testing. These tests would be aimed at key operational (irradiation) parameters that are known to adversely effect fuel performance. The goal of the tests would be to significantly extend the current TRISO particle fuel performance irradiation test database. These operational conditions involve irradiation temperature, burnup, fast fluence and particle power. The proposed irradiation conditions for the six pebbles would significantly exceed PBMR design operating conditions and would thereby be important to establishing margins to failure for TRISO coated particle fuels. The expanded test plan (up to six additional pebbles) would also complement the high burnup irradiation tests on German archive fuel planned by the European Commission.

Dr. Don McEachern (GA) provided an overview of GA's plans for GT-MHR fuel development and qualification (Attachment 4). McEachern indicated that GA plans to also utilize the German reference particle coating process for fabricating GT-MHR fuel particles. However, GT-MHR fuel kernels utilize UCO rather than UO_2 as is used in PBMR fuel. Additionally, the GT-MHR fuel has a different kernel diameter than the German reference fuel and will have different coating layer thicknesses than the PBMR fuel particles. These differences will require adjustments in the German fabrication process variables (e.g., layer coating time). The needed adjustments in process parameters have not yet been worked out nor have the effects been determined. Since the PBMR particle design (e.g., layer thicknesses) is the same as the German reference design, process parameter adjustments are not needed for the PBMR fuel. GA indicated that the irradiation tests proposed by INEEL for the German archive fuel would be beneficial by exploring the operational integrity limits for GT-MHR fuel particles as well as PBMR fuel particles.

General Atomics, INEEL and ORNL believed that the fuel particle fabrication process was critical to in-reactor fuel performance. Considerable discussion and debate focused on the best strategy for DOE to re-establish the German fabrication processk now-how in the U.S. An objective was to understand the relationship between process parameters and fuel particle layer material properties and micro-structure and, fuel irradiation performance and accident condition performance. It was note that the German fuel fabrication process resulted in excellent quality and superior performance but the German fuel fabrication experts did not know the product characteristics that resulted from these processes and which led to superior irradiation and accident condition performance. Correlating process variables to the measurable product characteristics would be needed and would require considerable R&D including a careful examination of the German fuel particle characteristics.

It was clear from McEachern's presentation that GA was just starting to formulate its plans for developing a fabrication capability to make GT-MHR fuel. Laboratory-scale efforts would be undertaken first , then a pilot plant would be built and finally a full scale production plant would be built. Fuel qualification testing would not be conducted until the pilot plant was operational. Proof testing would not occur until the production facility was completed. GA's fuel fabrication development planning activities appeared to behind the PBMR fuel fabrication development

activities. Accordingly, it appeared that GA's pre-application documentation for GT-MHR fuel was less developed than PBMR's documentation for PBMR fuel.

An important issue for GA (and NRC) is the relatively limited experience and data for German LEU UCO TRISO particle fuel compared to LEU UO_2 fuel. Accordingly, German fuel manufacture and irradiation testing performance for UCO fuel appears to involve a greater extrapolation of the "proof of concept" for GT-MHR fuel compared to PBMR fuel.

Following DOE's HTGR fuel development and qualification program re-assessment, DOE will decide how to reapportion their available program funding between fabrication development, model development and irradiation testing activities to best support near-term deployment of an HTGR in the U.S. The workshop was intended to provide input into this decision process. The major areas which are competing for the funds are fuel manufacturing process development and fuel irradiation testing.

It is clear that ORNL (fuel manufacturing capabilities) and INEEL (fuel irradiation testing capabilities) are competing for the limited available DOE funding. Exelon no longer provides a strong impetus for neat term irradiation testing of pebble fuel. At the same time, GA's priority interests lie in fuel fabrication process development as a key to GT-MHR fuel irradiation and accident performance. General Atomics also wants to become a supplier of HTGR TRISO coated particle fuel. Accordingly, INEEL is concerned that DOE may place a lower priority on HTGR fuel irradiation testing activities and a higher priority on HTGR fuel fabrication process development activities.

At the meeting, I reaffirmed NRC's strong interest in safety margin testing on the German archive fuel pebbles. DOE indicated that it would decide by the Summer of 2002, on whether or not it would proceed with near-term irradiation testing of the German archive fuel pebbles.

If you have any questions or require additional information, please contact me.

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