GA-A23811

GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
February 1 through February 28, 2003

by
GT-MHR Staff

Contact: A. S. Shenoy

Prepared under
Oakland Operations Office
Program DE-AC03-01SF22343
for the U.S. Department of Energy

General Atomics Project No. 30103
DATE PUBLISHED: March 2003

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Contract No. DE-AC03-01SF22343
Submitted to: DOE - Oakland Operations Office
By: General Atomics

PART 1 – Technical Progress

Summary

- GA provided Petten authorities with the composition of the particles and the compacts sent in January 2003 for the HFR-EU2 irradiation test. Also, positions were recommended within the test rig for the compacts. The test is now scheduled to start in the fourth quarter of 2003. Planning for the EU 6th Framework Program has been initiated that would support the post-irradiation examination (PIE) of HFR-EU2.

- A draft fuel specification is nearing completion applicable to demonstration test capsule fuel samples that defines the fuel requirements, the process specifications and enhanced characterization methods.

- A development strategy, along with the underlying assumptions, was defined for drafting the Development Plan for Advanced High Temperature Coated-Particle Fuels. The scope of the Plan includes: (1) optimization of conventional TRISO-coated particle, (2) investigation of advanced coating systems (e.g., ZrC coatings, multiple diverse coatings, etc.), (3) investigation of getters (e.g., SiC in kernels, ZrC kernel overcoating, etc.), and (4) optimized fuel element designs (e.g., 11-row block, molded fuel elements, etc.).

Task 1 – Fuel Irradiation

During February 2003, GA provided Petten authorities with the composition of the particles and the compacts sent in January 2003 for the HFR-EU2 irradiation. We also recommended that the six activated compacts be placed in positions 3, 4, 5, 6, 7 and 8 within the test rig. Non-activated compacts were recommended for the 1, 2, 9 and 10 positions. This will permit 6 of the 10 total compacts with initially known Kr-85m release to birth (R/B) ratio to be exposed to the peak neutron flux and will allow the initial R/B from the HFR-EU2 test rig to be compared with this value.

We have learned that the irradiation is set to start in the fourth quarter of 2003.

We are finalizing the preparation of the Pre-irradiation Report for HFR-EU2. Work on this report is approximately 85% complete.

We inquired about the status of the 6th Framework Program that would support the post-irradiation examination (PIE) of HFR-EU2. We were told “A First Call” to support the 6th Framework Program was launched in December 2002. HTR related projects were not included yet, as most of the FP5 activities are actually running until the end of 2003 or even beyond. We expect that the 6th FP will be supported for HTR work by June 2003, and the definition of these projects will then include details on PIE and thermal ramps. Several options and priorities have already been discussed within the HTR-Fuel Project, but a decision was postponed as a function of available budget.

Task 2 – Fuel Manufacturing Process Improvement

This task has been completed.

Task 3 – NRC Interaction

This task is not currently funded.

Task 4 – Plant Cost Evaluation

This task has been completed.

Task 5 – Waste Disposal Assessment

This task has been completed.

Task 6 – Project Management and Project Development

This task covers all of the commercialization study project management and project development activities. During February, routine reviews of project activities were performed and the monthly report for January was prepared.

Task 7 – DOE Fuel Plan

This task has been completed.

Task 8 – MHR-2 Fuel Specification

GT-MHR Fuel Product Specification DOE-GT-MHR-100209A is being revised to include the requirements applicable to demonstration test capsule fuel samples and to define the process specifications and enhanced characterization methods

for the reference fuel and fuel variants. A draft specification is nearing completion.

Task 9 – This task number not currently used

Task 10 – Advanced Fuel Studies

The scope of this task is to prepare a draft plan for the development of advanced coatings to enable core outlet coolant temperatures above 850 ^{o}C in High Temperature Gas-Cooled Reactors (HTGRs) to expand their commercialization potential and to support GEN IV program objectives. The latter objective emphasizes the development of advanced fuel systems for Very High Temperature Reactors (VHTRs) with core outlet temperatures of $\geq$1000 ^{o}C for highly efficient electricity production and for process heat applications, including nuclear hydrogen production.

A development strategy, along with the underlying assumptions, was defined for drafting the Development Plan for Advanced High Temperature Coated-Particle Fuels. Programmatically, a key assumption is that this advanced fuel development program is an incremental program: the DOE Advanced Gas Reactor program will provide the base technology including fission product transport in core graphite and transport ex-core. In order to define the scope of the Plan, a complete list of VHTR Fuel/Fission Product Design Data Needs (DDNs) was identified, using the DDNs for the GT-MHR (850 ^{o}C outlet temperature) as a point of departure. These DDNs were then assigned to one or more of the on-going DOE-sponsored coated-particle fuel development programs: (1) AGR fuel development program, (2) International GT-MHR programs ("RF program"), and (3) this advanced fuels program. With this basis, a detailed annotated outline of the Plan was drafted, and its preparation was initiated.

The scope of the Plan includes: (1) optimization of conventional TRISO-coated particle (e.g., more isotropic PyC, more corrosion resistant SiC, etc.), (2) investigation of advanced coating systems (e.g., ZrC coatings, multiple diverse coatings, etc.), and (3) investigation of getters (e.g., SiC in kernels, ZrC kernel overcoating, etc.), and (4) optimized fuel element designs (e.g., 11-row block, molded fuel elements, etc.). In support of the planning of these tasks, a comprehensive literature review is in progress utilizing the following resources: (1) several NERAC searches (a commercial information search service), (2) the IAEA HTGR data base, and (3) the GA in-house information resources. To date, more than a 1000 abstracts and technical documents have been reviewed.

Of the advanced designs for high temperature applications, various ZrC-coated particle designs have received the most attention as candidate replacements for conventional SiC-coated particles. ZrC coatings are thermodynamically stable to higher temperatures than are SiC coatings, and ZrC coatings appear to be more

resistant to fission product corrosion (including Pd corrosion) than SiC coatings; for these reasons, advanced particle designs utilizing ZrC as both a replacement coating for SiC and as an oxygen getter will be emphasized in the Plan, at least in the initial screening phase. To that end, provisional designs for the three different types of ZrC particles are being developed.

Task 11 – VHTR Materials Survey

This task has been completed.

Part 2 - Cost Management

Item	Total Expenditures, K$	
	February 2002	Inception to Date[1], Totals
Task 1 – MHR-1 Fuel Irradiation	16.0	131.9
Task 2 – Fuel Manufacturing Process Improvement	0.0	204.0
Task 3 – NRC Interaction	0.0	143.8
Task 4 – Plant Cost Evaluation	0.0	87.3
Task 5 – Waste Disposal Assessment	0.0	103.2
Task 6 – Project Management and Development	1.4	138.3
Task 7 – DOE Fuel Plan	0.0	141.3
Task 8 – MHR-2 Fuel Specification	10.1	32.9
Task 10 – Advanced Fuel Plan	26.8	28.3
Task 11 – VHTR Materials Survey	0.0	25.3
Totals	**54.3**	**1,036.3**

Note:
1. Work started June 18, 2001.