GA-A24622

GT-MHR COMMERCIALIZATION STUDY

Final Report
of work performed
from contract beginning, June18, 2001,
to contract end, January 31, 2004

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: February 2004

DISCLAIMER

GA-A24622

GT-MHR COMMERCIALIZATION STUDY

Final Contractual Report
of work performed
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Table of Contents

1. **Introduction**

This is the final report of work performed by General Atomics on a Gas Turbine Modular Helium Reactor (GT-MHR) commercialization study under contract to the Department of Energy, Oakland Operations Office, DOE Contract No. DE-ACO3-01SF22343. The contract began June 18, 2001 and ended January 31, 2004.

The contract work scope covered a series of discrete tasks relating to commercialization of the GT-MHR. During the first year of performance, June 18, 2001 to June 30, 2002, the contract covered six (6) tasks, Tasks I through 6. Subsequently, four additional tasks were added, Tasks 7, 8, 10 and 11. There was no Task 9.

With the exception of Task 1, each of the contract Tasks involved the development of one or more discrete deliverable products. Task I covered activities performed by General Atomics as part of a several year fuel irradiation testing activity being conducted in cooperation with the European Union. The irradiation testing will not be completed for three or more years into the future. Future work by General Atomics on this irradiation test activity will be covered by a new contract.

For Tasks 2 through II (noting there was no Task 9), this final contract report documents the products produced. For Task 1, a summary of the status of the irradiation testing activity is provided.

2. Task 1 – Fuel Irradiation

2.1 Background

In 1994 the DOE sponsored work directed at improving the GA injected petroleum pitch compact formation process to produce compacts meeting both heavy metal contamination and SiC defect specifications with standard, 5-layer TRISO particles. TRISO particles chosen had been fabricated by HOBEG in Germany. The DOE-sponsored work on the compacting process achieved compacts meeting the GT-MHR specifications. This was accomplished by control of the impurities in the compact matrix material, careful control of the compact formation process and removing impurities from the compacts with gaseous HCl prior to final, high-temperature heat treatment.

In FY-95 the initial Modular Helium Reactor (MHR) fuel irradiation test (called MHR-1) was conceived to test the irradiation performance of these compacts. The irradiation was to be done in the High Flux Isotope Reactor (HFIR) at ORNL. An Irradiation Test Specification was written for MHR-1 and issued in April of 1995. This specification called for four fuel to be made for the irradiation test planned for the HFIR. A Fuel Sample Process Specification was developed and issued in August of 1995. This specification called for the use of a blended German TRISO particle batch that had been previously irradiated successfully by KFA (as spheres) in tests HRR-K5 and HFR-K6. In these tests no particle failures were observed after exposure to 9.7% FIMA, at 1090 to 1140 °C (fuel center, steady state) in the High Flux Reactor (HFR) at Petten for 634 days (26 HFR cycles). By using particles of proven performance, MHR-1 was planned to be a test of the performance of the compacts and proof of the new compacting process. Before these compacts could be tested in HFIR in a test designated MHR-1, the DOE GT-MHR program was cancelled and these compacts were stored at GA.

At the international review of the DOE/Minatom GT-MHR program in Paris in June 1997 Dr. Dominique Hittner, Framatome, coordinator of the European Commission's (EC) High Temperature Reactor program invited the US to participate in the European program. In response to this invitation GA proposed irradiation of the MHR-1 compacts in the HFR at Petten, The Netherlands. A Memorandum of Understanding (MOU) was signed between the EC's Joint Research Center (operator of the HFR at Petten) and GA in July of 2001 providing for conduct of an irradiation of the MHR-1 compacts. The EU High Temperature Reactor program (HTR) agreed to fund the irradiation as part of their Framework #5 budget cycle. Both parties intend that the post-irradiation examination and accident simulation tests of the irradiated compacts be funded as part of the EC's 6th Framework budget cycle. The irradiation test is to be called the HFR-EU2 and use the 0.36 grams U-235 compacts (previously prepared for HFIR) in the Petten HFR. Ten compacts are to be irradiated in the TRIO rig in the Petten HFR.

The European Commission plans two companion irradiations, HFR-EU1-bis and HFR-EU1. The HFR-EU1-bis and HFR-EU1 test is intended to test spheres of the Pebble Bed reactor at burnups higher than previously achieved. HFR-EU1-bis and HFR-EU1

are scheduled to begin early in 2004. This will be followed by HFR-EU2 starting later in 2004.

2.2 Irradiation Goals for HFR-EU2

HFR-EU2 is planned to test the latest GA compact fabrication technology. Primary goals for HFR-EU2 are, therefore, in order of priorities:

- demonstrate the thermoplastic resin process can be used to fabricate compacts meeting GT-MHR performance requirements
- demonstrate compact irradiation stability
- determine compact irradiation performance, particularly dimensional changes as a function of fluence as an set of data for prismatic HTR designs
- observe particle performance; check for consistency with HFR-K5/ K6
- provide material for core heatup simulation testing

2.3 Completed Work (Work performed under this contract, Phase 1 work)

- The test has been planned, designed, and was initially set to start irradiation in December of 2002. The test is now planned to start in the third quarter of 2004. The delay resulted from the Petten HFR shutdown when a possible weld defect was discovered in the reactor tank, that was later determined to be safe. There were additional delays in 2003 in getting the irradiation capsule fabricated.

- In January 2003, GA shipped, and the JCR at Petten received, a total of 15 compacts each containing 0.36 gms of U-235 per compact. Six of these compacts were tested in 1995 in the GA TRIGA reactor and shown to have no defects (Kr-85m R/B = 1.1 to 2.5 X 10^{-8}). The nine non-activated compacts were made under the same conditions and in the same manufacturing process run as the activated compacts.

- In December 2002, GA shipped four cylindrical pieces of H-451 nuclear grade graphite to Petten who will fabricate two sleeves to contain the compacts during irradiation in the TRIO rig in the Petten High Flux Reactor.

- A draft Test Specification for the HFR-EU-2 irradiation was received from Petten, reviewed and detailed comments generated by GA. GA has suggested additional improvements that can be made to this specification by the testing staff at Petten in 2003.

- A draft pre-irradiation report was prepared under this contract in 2003. This report provides the full details of the quality control measurements on the fuel particles and fuel compacts to be irradiated in HFR-EU2.

- The pre-irradiation report is GA document number 911022 entitled "HFR-EU2 Pre-Irradiation Report, dated 11/24/03 (DRAFT) was transmitted to DOE by letter to Ms.

Suibel Schuppner, DOE from Arkal S. shenoy, GA dated December 1, 2003. **For documentation purposes, a copy of the first page of this report is provided in the Appendix C.**

2.4 Follow-on Work Required

The follow-on work (to be accomplished under a new contract) is planned to be conducted in two phases identified as Phases 2 and 3.

Phase 2 Work (Years 2004-2006)

- Incorporate comments on the draft Pre-irradiation report from Petten scientists and engineers and complete the pre-irradiation report.
- Follow the final assembly of the capsule. Petten personnel have suggested that a visit to the High Flux Reactor may in order for January or February 2004 to review the assembly of the HFR-EU2 capsule and the related gas sampling station installation.
- Monitor the installation and initial startup irradiation of HFR-EU2. Currently the startup is scheduled for July or August 2004.
- Report on the initial gas release from HFR-EU2.
- Report on temperature results from the capsule.
- Report on the plans for the post-irradiation examination of the test.
- In 2005 and 2006 GA will monitor the operation of the capsule and report on gas release and temperature data coming from the HFR-EU2 capsule.
- In 2006 GA will assist in securing funding for Post-Irradiation Examination (PIE) of HFR-EU2 from the European Union and will also participate in the preparation and development of the Post-Irradiation Examination (PIE) Plan, including the PIE heating tests on compacts for HFR-EU2 and the plans for the completion of the irradiation and shipment of the capsule to the hot cells at Karlsruhe, Germany.

Phase-3 Work (Years 2007-2008)

- In 2007 and 2008 GA will follow the PIE of HFR-EU2 at the Karlsruhe hot cells and the monitor the PIE heatup tests on compacts also at the Karlsruhe hot cells.
- In 2008 a final PIE report will be prepared giving the complete irradiation and PIE results of the HFR-EU2 capsule.

3. Task 2 – Fuel Manufacturing Process Improvement

A summary of the work performed under this task was provided to DOE in the final report for the first year work entitled "GT-MHR Commercialization Study Final Technical Report for the period June 18, 2001 to June 30, 2002," GA-A24045, dated July 2002 transmitted to DOE by letter to DOE-OAK, Attn Phil Wong, LEPD, from Howard E. Burdick, GA dated July 9, 2002. **For documentation purposes, a copy of the first page of this report is provided in the Appendix A.**

References developed under this contract and referred to in GA-A24045 were transmitted by letter to Hannibal Joma, LLNL, DOE from Arkal Shenoy, GA, dated December 20, 2002. **For documentation purposes, a copy of the first page of each of the references referred to in GA-A240045 is provided in the Appendix A.**

4. Task 3 – NRC Interaction

A summary of the work performed under this task was provided to DOE in the final report for the first year work entitled "GT-MHR Commercialization Study Final Technical Report for the period June 18, 2001 to June 30, 2002," GA-A24045, dated July 2002 transmitted to DOE by letter to DOE-OAK, Attn Phil Wong, LEPD, from Howard E. Burdick, GA dated July 9, 2002. **For documentation purposes, a copy of the first page of this report is provided in the Appendix A.**

References developed under this contract and referred to in GA-A24045 were transmitted by letter to Hannibal Joma, LLNL, DOE from Arkal Shenoy, GA, dated December 20, 2002. **For documentation purposes, a copy of the first page of each of the references referred to in GA-A240045 is provided in the Appendix A.**

5. Task 4 – Plant Cost Evaluation

A summary of the work performed under this task was provided to DOE in the final report for the first year work entitled "GT-MHR Commercialization Study Final Technical Report for the period June 18, 2001 to June 30, 2002," GA-A24045, dated July 2002 transmitted to DOE by letter to DOE-OAK, Attn Phil Wong, LEPD, from Howard E. Burdick, GA dated July 9, 2002. **For documentation purposes, a copy of the first page of this report is provided in the Appendix A.**

References developed under this contract and referred to in GA-A24045 were transmitted to by letter to Hannibal Joma, LLNL, DOE from Arkal Shenoy, GA, dated December 20, 2002. **For documentation purposes, a copy of the first page of each of the references referred to in GA-A240045 is provided in the Appendix A.**

6. Task 5 – Waste Disposal Assessment

A summary of the work performed under this task was provided to DOE in the final report for the first year work entitled "GT-MHR Commercialization Study Final Technical Report for the period June 18, 2001 to June 30, 2002," GA-A24045, dated July 2002 transmitted to DOE by letter to DOE-OAK, Attn Phil Wong, LEPD, from Howard E. Burdick, GA dated July 9, 2002. **For documentation purposes, a copy of the first page of this report is provided in the Appendix A.**

The following reports were prepared under this task:

1. GA Report entitled "Assessment of GT-MHR Spent Fuel Characteristics and Repository Performance," PC-000502, dated April 2002.

2. GA Report entitled "Commercial GT-MHR Spent Fuel Disposal Confirmatory Test and Analysis Plan," PC-000503, dated June 2002.

These reports were transmitted by letter to Hannibal Joma, LLNL, DOE from Arkal Shenoy, GA, dated December 20, 2002. **For documentation purposes, a copy of the first page of each of the above reports is provided in the Appendix A.**

7. Task 6 – Final Report and Recommendations for Further Development Activities

A summary of the work performed under this task was provided to DOE in the final report for the first year work entitled "GT-MHR Commercialization Study Final Technical Report for the period June 18, 2001 to June 30, 2002," GA-A24045, dated July 2002 transmitted to DOE by letter to DOE-OAK, Attn Phil Wong, LEPD, from Howard E. Burdick, GA dated July 9, 2002. **For documentation purposes, a copy of the first page of this report is provided in the Appendix A.**

References developed under this contract and referred to in GA-A24045 were transmitted to by letter to Hannibal Joma, LLNL, DOE from Arkal Shenoy, GA, dated December 20, 2002. **For documentation purposes, a copy of the first page of each of the references referred to in GA-A240045 is provided in the Appendix A.**

In addition to the preparation of a final report for the first year work and preparation of recommendations for further development activities, monthly progress reports as required by the contract were prepared under this task. **For documentation purposes, a copy of the first page of each of the monthly progress reports from the beginning of the contract to the end of the contract are provided in the Appendix B.**

8. Task 7 – DOE Fuel Plan

The work scope of this task was to assist a DOE-HQ led Advanced Gas Reactor (AGR) fuel program planning effort by participating in each of the five working groups formed to develop an AGR Fuel Development and Qualification Program Plan.

GA provided the following under this task:

- Input to each of the three deliverables submitted by each of the working groups. GA's contributions to the Fuel Manufacture group and Fission Product Transport and Source Term group deliverables were particularly extensive. (A GA representative served as the lead for the Fuel Manufacture group)
- 5 GA engineers attended an August 2002 meeting at ORNL (per ORNL/INEEL request) to help develop the program plan
- Authored the Fuel Manufacture portions of the plan (Section 3.1 and Appendix A of the draft Fuel Plan)
- Contributed to the completion of a number of action items from the August 2002 meeting required for the draft Fuel Plan
- Assisted in drafting changes to the draft Fuel Plan to address DOE comments
- Participated in weekly conference calls
- Participated in QA conference calls
- Consulted with ORNL on fuel characterization technology
- Reviewed ORNL near-term coating development plan
- Reviewed draft of updated Appendix A of the Program Plan
- Interacted with INEEL, DOE-HQ, and DOE-OAK on contracting issues

The final overall program plan resulting from this DOE-HQ led effort is an ORNL issued report entitled "Technical Program Plan for the Advanced Gas Reactor Fuel Development and Qualification Program," ORNL/TM-2002/262, dated April 2003. **For documentation purposes, a copy of the first page of this report is provided in the Appendix C.**

9. Task 8 – MHR-2 Fuel Specification

The scope of this task was to develop a specification for GT-MHR fuel for a next fuel irradiation test.

The product of this task is GA document number 911025, entitled "Fuel Sample Product Specification for the Fuel Performance of Irradiation Test Capsule (MHR-2)," dated July 22, 2003. This document was transmitted to DOE-OAK (A. Richards, J. Hannibal, and G. Brown) and DOE-HQ (T. Miller) on 7-22-03. **For documentation purposes, a copy of the first page of this document is provided in the Appendix C.**

10. Task 10 - Advanced Fuel Plan

The scope of this task was preparation of a plan to develop coated particle fuel with higher temperature capability than the reference coated particle fuel addresses in Tasks 7 and 8.

The products of this task were the following reports:

1. GA Report entitled "Screening Tests for Selection of VHTR Advanced Fuel," PC-000510, dated 12-10-03. This document was transmitted to DOE by letter to DOE-OAK, Attn: Hannibal Joma, LEPD, from Howard E. Burdick, dated January 21, 2004.

2. GA Report entitled "Development Plan for Advanced High Temperature Coated-Particle Fuels," PC-000513, dated 1-20-04. This document was transmitted to DOE by letter to DOE-OAK, Attn: Hannibal Joma, LEPD, from Howard E. Burdick, dated January 21, 2004.

3. GA Report entitled "Effect of Use of Zirconium Carbide Coatings on the VHTR Core Nuclear Design," PC-000514, dated 12-19-03. This document was transmitted to DOE by letter to DOE-OAK, Attn: Hannibal Joma, LEPD, from Howard E. Burdick, dated January 21, 2004.

For documentation purposes, a copy of the first page of each of the above three reports is provided in the Appendix C.

11. Task 11 – VHTR Materials Survey

The scope of this task was to support the Idaho National Engineering and Environmental Laboratory (INEEL) in the development of a report identifying the materials technology development requirements for the Generation IV Very High Temperature Reactor (VHTR) using the GT-MHR material requirements as a starting point. The task work scope was performed over a one-month period during January 2003.

The final report was issued January 31, 2003 by INEEL as INEEL report INEEL/EXT-03-00141, entitled "Very High Temperature Reactor (VHTR), Survey of Materials Research and Development Needs to Support Early Deployment". **For documentation purposes, a copy of the first page of this report is provided in the Appendix C.**

Appendix A

Copies of the Cover Pages of Documents Produced During the First Contract Year June 18, 2001 through June 30, 2002

GA-A24045

GT-MHR COMMERCIALIZATION STUDY

Final Technical Report
for the Period
June18, 2001 through June 30, 2002

by
GT-MHR Staff

Contact: A. S. Shenoy

Prepared under
Oakland Operations Office
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General Atomics Project No. 30103
DATE PUBLISHED: July 2002

GENERAL ATOMICS INTERNAL CORRESPONDENCE

To: M. Labar **Memo No.** GT-MHR:JJS:004:02

From: J. Saurwein **Date:** June 12, 2002

Subject: Input to GT-MHR Commercialization Program Final Report for WBS 3.2 (Task 2)

1. SCOPE

This report documents the results of an assessment of state-of-the-art nondestructive testing (NDT) technologies to identify NDT methods that could potentially be employed for automated high-throughput Quality Control (QC) inspection of GT-MHR fuel particles and fuel compacts. The potential for application of the various NDT technologies that were considered is discussed, and recommendations for future work to develop improved QC methods are provided.

A primary objective of the assessment was to ascertain the feasibility of performing 100% inspection of coated particles in order to identify and to sort out defective particles. This capability would have the potential benefit of improving the overall quality of the fuel (i.e., by reducing the defective particle population) and also of improving product yield by eliminating rejection of entire populations due to the presence of small fractions of defective particles exceeding specification limits. A broader objective of the assessment was to identify improved QC methods that, while perhaps not suitable for 100% inspection, can be fully automated and integrated with the fuel manufacturing process line in order to provide timely and low-cost inspection of in-process material and product. Such improved QC methods are considered essential for economically viable mass production of fuel for commercial GT-MHRs because the QC methods that have been used historically for inspection of coated particle fuel employ obsolete technologies that are inherently time consuming and labor intensive. The assessment specifically included an evaluation of the potential application of laser technology to coated fuel particle inspection.

2. FUEL PRODUCT SPECIFICATIONS AND IRRADIATION PERFORMANCE

The properties of GT-MHR fuel kernels, coated particles, and compacts must satisfy numerous property requirements that are specified to ensure that the irradiation performance of the fuel meets the in-service requirements for the GT-MHR. In addition to the product specifications, process specifications on coating temperature, coating rate, and coating gas to total gas fraction are specified for PyC and SiC coating to ensure that coatings having microstructural properties consistent with good irradiation stability are produced. Adherence to these process specifications is essential because the microstructures of the coating layers are not adequately controlled by product specifications on measurable properties.

Statistical QC has historically been used for acceptance testing of GT-MHR type fuel, and the fuel product specifications must be met at the 95% confidence level. The specified properties are either discreet (i.e., good or bad, such as defect fractions) or variable (i.e., defined

U.S. Pre-Application Licensing Plan

for the

Gas Turbine - Modular Helium Reactor (GT-MHR)

Issued by:
General Atomics

DOE Contract No. DE-AC03-01SF22343

February, 2001

TO:	Distribution	**In reply, refer to:** MHR:MPL:02-11 Revision 1
FROM:	Malcolm LaBar	
DATE:	June 25, 2002	
SUBJECT:	Updated GT-MHR Plant Capital Cost Estimate	
CONTRACT:	DOE Contract No. DE-AC03-01SF22343	

Summary

As part of the GT-MHR Commercialization Study Project 30103 performed under the above contract, updated capital cost estimates have been developed for commercial Gas Turbine – Modular Helium Reactor (GT-MHR) plants. Estimates were developed for a Lead 4-module plant (the first plant constructed), a Replica plant (second plant built), and an nth-of-a-kind (NOAK) plant (eighth plant constructed). The unit overnight construction cost for the NOAK plant constructed was estimated to be $975/kWe. This compares to a unit construction cost for the NOAK plant estimated in 1995 of $1335/kWe. The reduced plant capital cost is due a combination of the following factors:

- Use of an updated approach for construction indirect costs that reflect current practices more directly suited to an unregulated electric utility industry.
- Use of updated approaches for owner's cost and project contingency that reflect updated practices for nuclear power plants.
- Use of bulk commodity procurement practices for materials.
- Use of construction craft labor rates representative of a composite craft rate made up of apprentices to journeymen.
- Use of higher learning factors (more representative of actual experience).

Background

The GT-MHR was originally conceptualized by General Atomics (GA) in the early 1990's. At the time the GT-MHR was conceptualized, GA was working with Bechtel, Stone & Webster, Oak Ridge National Laboratory, Gas Cooled Reactor Associates, and Combustion Engineering on development of the Modular High Temperature Gas-cooled Reactor (MHTGR) under the U.S. Department of Energy (DOE) Advanced Reactors Program. The MHTGR had enhanced safety characteristics (relative to other nuclear power plants) and employed a steam cycle energy conversion system. The GT-MHR concept retained the same high safety characteristics as the MHTGR but by using a direct gas turbine (Brayton)

GA-A24622
Appendix A

PC-000502
Revision 0
March 2002

GT-MHR

Assessment of GT-MHR Spent Fuel Characteristics and Repository Performance

Sponsored by the United States Department of Energy

PC-000503

Revision 0
WBS: 5.2

COMMERCIAL GT-MHR

SPENT FUEL DISPOSAL

CONFIRMATORY TEST AND ANALYSIS PLAN

June, 2002

Issued by General Atomics
for the Department of Energy
Contract No. DE-AC03-01SF22343

PROJECT NO. 30103

Appendix B

Copies of the Cover Pages of the Monthly Progress Reports Prepared During the Entire Contract Period June 18, 2001 through January 31, 2004

GA-A24622
Appendix B

GA-A23811

GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
June18 through July 31, 2001

by
GT-MHR Staff

Contact: A. S. Shenoy

Prepared under
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Appendix B

GA-A23811

GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
August 1 through August 31, 2001

by
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Contact: A. S. Shenoy

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GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
September 1 through September 30, 2001

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GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
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Contact: A. S. Shenoy

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GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
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Contact: A. S. Shenoy

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GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
January 1 through January 31, 2002

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GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
February 1 through February 28, 2002

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GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
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GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
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GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
May 1 through May 31, 2002

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No monthly progress report was prepared for June 2002 because a Final Report was prepared for all of the work from the beginning of the contract, June 18, 2001, through the end of June 2002. The final report is for this period is entitled "Final Technical Report for the Period June 18, 2001 through June 30, 2002, GAA24045 dated July 2002. For documentation of this report, a copy of the cover page is given in Appendix A.

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GT-MHR COMMERCIALIZATION STUDY

Technical Progress and Cost Management Report for the Period
July 1 through July 31, 2002

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GT-MHR COMMERCIALIZATION STUDY

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GT-MHR COMMERCIALIZATION STUDY

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by
GT-MHR Staff

Contact: A. S. Shenoy

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Appendix C

Copies of the Cover Pages of Documents Produced During the Contract Period July 1, 2002 through January 31, 2004

GENERAL ATOMICS

GA 1485 (REV. 04/03E)

ISSUE/RELEASE SUMMARY

☐ R & D X DV&S ☐ DESIGN ☐ T&E ☐ NA	APPVL LEVEL	DISC	QA LEVEL	SYS	DOC. TYPE	PROJECT	DOCUMENT NO.	REV
	5	N	N/A	11	RGE	30103	911022	0

TITLE:
HFR-EU2 Pre-Irradiation Report

CM APPROVAL/ DATE	REV	PREPARED BY	APPROVAL(S) ENGINEERING	QA	PROJECT	REVISION DESCRIPTION/ W.O. NO.
DRAFT 11/24/03	0	W. Scheffel	D. McEachern	V. Nicolayeff	A. Shenoy	Initial Issue 30103-300-00100

CONTINUE ON GA FORM 1485-1

NEXT INDENTURED DOCUMENT(S)

HFR / 01 / 4679

COMPUTER PROGRAM PIN(S)

☐ *SEE LIST OF EFFECTIVE PAGES

☐ GA PROPRIETARY INFORMATION

x NO GA PROPRIETARY INFORMATION

GENERAL ATOMICS

GA 1485 (REV. 04/03E)

ISSUE/RELEASE SUMMARY

☐ R & D X DV&S ☐ DESIGN ☐ T&E ☐ NA	APPVL LEVEL	DISC	QA LEVEL	SYS	DOC. TYPE	PROJECT	DOCUMENT NO.	REV
	5	N	N/A	N	SPE	30103	911025	0

TITLE:
Fuel Sample Product Specification for the Fuel Performance Irradiation Test Capsule (MHR-2)

CM APPROVAL/ DATE	REV	PREPARED BY	APPROVAL(S) ENGINEERING	QA	PROJECT	REVISION DESCRIPTION/ W.O. NO.
1 RELEASED JUL 22 2003	0	J. Saurwein 7/7/03 W. Scheffel 7/7/03	D. McEachern 7/7/03	V. Nicolayeff 7/8/03	A. Shenoy	Initial Issue 30103-800-00100

CONTINUE ON GA FORM 1485-1

NEXT INDENTURED DOCUMENT(S)

DOE-GT-MHR-100209, Rev 0

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☐ *SEE LIST OF EFFECTIVE PAGES

OAK RIDGE
NATIONAL LABORATORY
MANAGED BY UT-BATTELLE
FOR THE DEPARTMENT OF ENERGY

ORNL/TM-2002/262

Technical Program Plan for the Advanced Gas Reactor Fuel Development and Qualification Program

Advanced Gas Reactor Team

April 2003

UT-BATTELLE
ORNL-27 (4-00)

PC-000510
Revision 0

Screening Tests for Selection of VHTR Advanced Fuel

Issued by General Atomics
for the Department of Energy
Contract No. DE-AC03-01SF22343

GENERAL ATOMICS

PC-000513
Revision 0

Development Plan for Advanced High Temperature Coated-Particle Fuels

Issued by General Atomics
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GENERAL ATOMICS

GENERAL ATOMICS

GA 2175 (1199E)

PROJECT CONTROL ISSUE SUMMARY

	DOC. CODE	PROJECT	DOCUMENT NO.	REV.
	RGE	30103	PC-000514	0

TITLE: Effect of use of Zirconium Carbide Coatings on the VHTR Core Nuclear Design

CM APPROVAL/ DATE	REV.	PREPARED BY	APPROVALS		REVISION DESCRIPTION/ W.O. NO.
			RESOURCE/ SUPPORT	PROJECT	
ISSUED 2 DEC 1 9 2003	0	C. P. Ellis C. P. Ellis 12/18/03	D. W. McEachern V. Nicolayeff 12/18/03	A. S. Shenoy A.S. Shenoy	Initial Issue W.O. 30103 300 11000

* SEE LIST OF EFFECTIVE PAGES

☐ GA PROPRIETARY INFORMATION

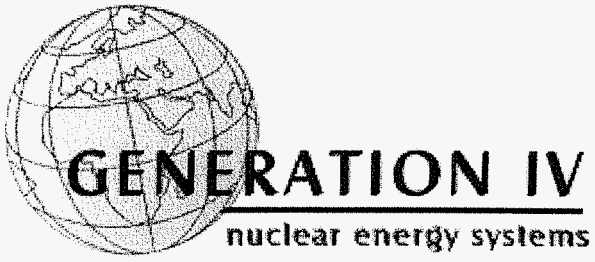
☒ NO GA PROPRIETARY INFORMATION

AAA 107 (08/2001)

INEEL/EXT-03-00141

Very High Temperature Reactor (VHTR)

Survey of Materials Research and Development Needs to Support Early Deployment



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