GA Technologies

GA-A--17100

DE83 014172

US/FRG UMBRELLA AGREEMENT FOR COOPERATION IN GCR DEVELOPMENT:

FUEL, FISSION PRODUCTS, AND GRAPHITE SUBPROGRAM

**QUARTERLY STATUS REPORT
FOR THE PERIOD
JANUARY 1, 1983 THROUGH MARCH 31, 1983**

**by
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**Prepared under
Contract DE-AT03-76ET35300
for the San Francisco Operations Office
Department of Energy**

**GA PROJECT 6400
DATE PUBLISHED: APRIL 1983**

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ABSTRACT

This report describes the status of the cooperative work being performed in the Fuel, Fission Product, and Graphite Subprogram under the "HTR-Implementing Agreement" of the United States/Federal Republic of Germany Umbrella Agreement for Cooperation in GCR Development. The status is described relative to the commitments in the "Subprogram Plan for Fuel, Fission Products, and Graphite," Revision 5, April 1982, and Revision 6, February 1983. The work described was performed during the period January 1 through March 31, 1983 in the HTGR Base Technology Program at Oak Ridge National Laboratory, the HTGR Fuel and Plant Technology Programs at GA Technologies Inc. (GA), and the Project HTR-Brennstoffkreislauf of the Entwicklungsgemeinschaft HTR at KFA Jülich, HRB Mannheim, INTERATOM Bensberg, HOBEG Hanau, and SIGRI Meitingen.

The requirements for and format of this Quarterly Status Report are specified in the "HTR Implementing Agreement" Procedures for Cooperation. Responsibility for preparation of the Quarterly Report alternates between GA and KFA.

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1. STATUS SUMMARY

The status of progress on the milestones for this first quarter of CY-83 as defined in Revision 6 of the Subprogram Plan is summarized in Table 1. The status of the work in each of the Work Breakdown Structure (WBS) elements of the Subprogram is described in Section 3 (see Appendix A for the Subprogram WBS). The major milestones for all of 1983 are shown in Table 2.

Technical highlights of the period were:

1. The semiannual subprogram management meeting was held at GA on February 15 through 16, 1983. All project work statements were reviewed, and the subprogram plan was updated. Immediately before the management meeting, Dr. Heinz Nabielek of KFA exchanged detailed technical information in visits to ORNL and GA.
2. David Hanson completed his 15-month assignment at KFA on March 25, 1983. The number of active PWS's on fission product exchange increased from three to six during this period. Hanson also contributed to two new PWS's on graphite corrosion model comparisons.
3. Core heatup simulation tests of FRG samples of low-enriched UO_2 TRISO were completed at GA. The fission gas release began to increase at $2000^{\circ}C$ and was complete at $2500^{\circ}C$, consistent with the performance models (FD-11).
4. Detailed hot cell examinations were performed on fuel specimens from R2-K13 capsule at KFA hot cells. Fuel rods were prepared for shipment to GA and ORNL and are awaiting licensing approval for the shipping cask (FD-15).

5. Ben Myers traveled to KFA for a three-week joint review of data selected for the joint US/FRG Fission Product Data Book (PWS-FP-2).

TABLE 1
MILESTONE STATUS FOR THE FIRST QUARTER OF CY-83
FROM REVISION 6 OF THE SUBPROGRAM PLAN

Milestone		PWS	Due Date	Completion Date	Responsible Party	Status
1. Fuel Development						
WBS 1.2	Issue report on GA evaluation of particles coated at HOBEG	FD-22	3/83	--	GA	Delayed
WBS 1.3	Present GA data system	FD-21	2/83	2/83	GA	Completed
WBS 1.5	Complete test of FRG fuel and issue report	FD-11	12/82	3/83	GA	Completed
	Issue report on SiC ring measurements	FD-8	12/82	--	KFA	Delayed to 7/83
2. Fission Product Behavior						
WBS 2.1	Issue responses to questionnaire	FP-1	12/82	--	KFA/IA/HRB	KFA, IA complete; HRB delayed to 4/83
WBS 2.2	Identify test data for calculation	FP-3	3/83	3/83	HRB	Completed
	Transfer data from laminar loop	FP-4	12/82	1/83	HRB	Completed
	Transfer data on FSV cycle 2	FP-4	9/82	2/83	GA	Completed
3. Graphite						
WBS 3.1	Complete HTK-6 irradiation	GD-1	6/82	2/83	ORNL	Completed
WBS 3.2	Provide improved ASR-IRG for evaluation	GD-11	2/82	--	KFA/SIGRI	Delayed to 6/83
WBS 3.2	Provide V-483T2 for characterization	GD-6	1/83	1/83	KFA	Completed
	Agree on test plan for KFA-HOVA	GD-6	3/83	3/83	ORNL/KFA	Completed

TABLE 2
MAJOR MILESTONES IN THE COOPERATIVE SUBPROGRAM FOR 1983
(Revision February 1983)

WBS Element and Milestone	PWS	Due Date	Responsible Party
1. Fuel Development			
1.1 Fuel Irradiation Tests			
1.1.1 Issue interim R2-K13 report	FD-15	6/83	KFA/GA
1.2 Fuel Process Development			
1.2.1 Issue joint report on coated particles	FD-22	12/.83	GA/HOBEG
1.3 Fuel Design Data and Specification			
1.3.1 Document HBK irradiations, 1977-82	FD-21	8/83	KFA
1.4 Pre- and Postirradiation Characterization			
1.4.1 Issue data on IMGA test of second set of FRG particles	FD-20	12/83	ORNL
1.5 Fuel Design, Performance Assessment, and Modeling			
1.5.1 Issue report on R2-K13 CHST results	FD-11	7/83	KFA
1.5.2 Issue final report on CHST results	FD-11	12/83	GA
2. Fission Product Behavior			
2.1 Release and Transport			
2.1.1 Issue recommended cesium data on release	FP-2	12/83	GA/KFA
2.1.2 Issue evaluation of GA/KFA release models	FP-5	5/83	GA
2.2 Methods Verification			
2.2.1 Issue report on benchmark case code validation	FP-3	9/83	HRB
2.2.2 Issue report on status of code verification	FP-3	12/83	GA

TABLE 2 (Continued)

WBS Element and Milestone	PWS	Due Date	Responsible Party
3. Graphite Development			
3.1 Irradiation Testing			
3.1.1 Document HTK test results	GD-1	10/83	ORNL
3.1.2 Summary report on 300°, 400°, 500°, and 600°C HLM irradiation	GD-2	6/83	KFA
3.1.3 Complete 500°C irradiation with TS-1621	GD-2	6/83	KFA
3.1.4 Report results of second irradiation step at 900°C	GD-4	4/83	KFA
3.2 Characterization of Properties			
3.2.1 Start of KFA HOVA experiment	GD-6	5/83	KFA
3.2.2 Start of corrosion tests in CFTL	GD-6	8/83	ORNL
3.3 Graphite Design Data and Specification			
3.3.1 Report on improved material V483T2	GD-12	6/83	SIGRI

2. SIGNIFICANT PROBLEMS

No significant technical problems are identified at the present time.

3. STATUS OF COOPERATION

3.1. FUEL DEVELOPMENT

Fuel Irradiation Tests, WBS 1.1

One Project Work Statement (PWS) is active in this Work Breakdown Structure (WBS) element, PWS-FD-15 (see Appendix B for all PWS titles). Detailed hot cell examinations were performed on fuel specimens from R2-K13 capsule at KFA hot cells. Fuel rods were prepared for shipment to GA and ORNL, and are awaiting licensing approval for the shipping cask.

Fuel Process Development, WBS 1.2

Forty kg of (Th-U)O₂ kernels were shipped from HOBEG for tests in the GA developmental coater (FD-22).

Fuel Design Data and Specification, WBS 1.3

One Project Work Statement is active, PWS FD-21. A summary of the format and types of data in the GA fuel data base was presented in February 1983 (FD-21).

Pre- and Postirradiation Characterization, WBS 1.4

Three Project Work Statements are active, FD-10, FD-14, and FD-20. Fuel specimens from irradiation tests HFR-K1, FRJ2-P22, BR2-P24, and AVR were identified for performance assessments in the IMGA/PGA at ORNL (FD-20).

Fuel Design, Performance Assessment and Modeling, WBS 1.5

Two Project Work Statements are active, FD-8 and FD-11. The final report on the Bongartz-Kovacs coated particle model has been completed (FD-8). Core heatup simulation tests on FRG samples of low enriched UO₂ TRISO were completed at GA. The fission gas release began to increase at 2000°C and was complete at 2500°C, consistent with performance models (FD-11).

3.2. FISSION PRODUCT BEHAVIOR

Fission Product Release and Transport, WBS 2.1

Three Project Work Statements are active, FP-1, FP-2, and FP-5. A questionnaire on tritium transport methods is being evaluated by HRB, INTERATOM, and AVR staffs (FP-1).

Ben Myers of GA and H. Nabilek of KFA performed a joint review of data selected for the Fission Product Data Book (FP-2).

Methods Verification, WBS 2.2

Three Project Work Statements are active, FP-3, FP-4, and FP-6. Benchmark comparisons on metallic fission product transport methods were completed by HRB and GA (FP-3). Data from the laminar loop test were transmitted to GA, and two documents on FSV plateout were transmitted to HRB for plateout code verification (FP-4). A new exchange was initiated between GA and AVR on the in-reactor effects of moisture on fission gas release (FP-6).

3.3. GRAPHITE DEVELOPMENT

Irradiation Testing, WBS 3.1

Four Project Work Statements are active in this area, GD-1, GD-2, GD-4, and GD-9. Preliminary examinations were completed on graphite specimens from ORNL capsules HTK-5 and -6. All graphites tested showed a close correlation between actual and calculated densification at 600° to 900°C (GD-1). Irradiation of reflector graphites continued in HFR-Petten at 500°C (GD-2).

Characterization of Properties, WBS 3.2

Three Project Work Statements are active in this area, GD-6, GD-10, and GD-11. An exchange was begun for corrosion tests on core support post graphites at the KFA Hova facility in return for inclusion of V483T2 graphite in the ORNL CSPT (GD-6). The delivery of ASR graphite is delayed further (GD-10).

Graphite Design Data and Specifications, WBS 3.3

Two Project Work Statements are active, GD-12 and GD-15. A previous draft PWS was made active on exchange of design methods for graphite corrosion modeling (GD-15).

Performance Assessment, Modeling, and Verification, WBS 3.4

Two Project Work Statements are active, GD-5 and GD-14. An earlier exchange on structural criteria for graphite components was reactivated (GD-5). A previous draft PWS was made active on exchange of graphite material modeling and failure criteria (GD-14).

Control Materials, WBS 3.5

There is no work under way in this area.

4. PROGRAMMATIC CHANGES

At the subprogram management meeting held February 15 through 16, 1983, the following additions and deletions were made in active Project Work Statements:

<u>PWS No.</u>	<u>Title</u>	<u>Action</u>
FD-19	Performance Data Sheets	Deleted.
FP-6	In-Reactor Effects of Moisture on Fission Gas Release	Approved as new PWS
GD-5	Structural Design Criteria for Graphite	Approved as new PWS; previously issued as draft
GD-6	Corrosion Characteristics of Core Support Graphite	Approved as new PWS
GD-14	Material Modeling and Fracture Criteria	Approved as new PWS; previously issued as draft
GD-15	Graphite Corrosion Modeling	Approved as new PWS; previously issued as draft

5. REPORTS EXCHANGED

Reports sent to FRG during the reporting period:

1. ORNL Staff, HTGR monthly reports for December 1982, January 1983, and February 1983.
2. Goodin, D. T., "Accident Condition Performance of HTGR Fuel," GA unpublished data, December 1982.
3. Burnette, R. D., "Status Report on Fort St. Vrain Coolant Radiochemistry to June 1981," GA unpublished data, 1981.
4. Burnette, R. D., "Status Report on Fort St. Vrain Coolant Radiochemistry to June 1982," GA unpublished data, 1982.
5. Burnette, R. D., "Cs and I Plateout in FSV at End of Cycle 1," GA unpublished data, 1980.
6. Burnette, R. D., "Iodine Plateout in FSV at End of Cycle 1," GA unpublished data, 1981.
7. Burnette, R. D., "Iodine Plateout in FSV at End of Cycle 2," GA unpublished data, 1982.
8. Hudritsch, W., "Plateout Code Development," GA unpublished data, February 1982.
9. Myers, B. F., "Joint KFA/GA Fission Product Data Book," GA unpublished data, July 1982.
10. Scheffel, W. J., "Semi-Annual Status Report for Period Ending March 1983," GA unpublished data, March 1983.

Reports received from FRG during the reporting period:

1. Mehner, A.-W., "Nachuntersuchungsprogram für das Bestrahlungsexperiment R2-K13," Tech Notiz HBK-TN-18/82, October 1982.
2. Schulze, R.-E., et al., "Graphitic Matrix Materials for Spherical HTR Fuel Elements," Jül Spez-167, July 1982.

3. HTA Staff, "HTA Semiannual Report, I/82, KFA - Arbeiten Zum Hochtemperatur," June 1982.
4. HTA Staff, "HTA Annual Report for 1981," June 1982.
5. HBK Staff, "HBK Projekt Quarterly Report," 3 Quartal 1982.
6. Hanson, D. L. and A.-W. Mehner, "Test Plan for Capsule R2-K13, KFA-HBK-1B-12/82," August 1982.
7. KFA Staff, "Pro Ergebnisbericht 1982," pages 94-104.
8. KFA Staff, "Overview of the KFA Research and Development Work for HTR Plants, Program of Work 1983," HTA-IB-2/83, February 1983.

6. CONCLUSIONS

The exchange is continuing satisfactorily.

The information transferred continues to be equitable for USA and FRG participants. The work scopes have been defined in all areas of exchange for 1983. The subprogram plan was updated (Revision 6) at a management meeting held February 15-16, 1983.

APPENDIX A

APPENDIX B
ACTIVE PROJECT WORK STATEMENTS

WBS Element and Title		Lead Org.	Status
1	Fuel Development		
1.1	Fuel irradiation tests		
	FD-15 Cooperative fuel element irradiation test of GA and HBK fuel (R2-K13)	KFA	In progress
1.2	Fuel process development		
	FD-22 Coated particle and QC process development	GA	In progress
1.3	Fuel design data and specification		
	FD-21 Design and specification data files	KFA	In progress
1.4	Pre- and postirradiation characterization		
	FD-10 Characterization and QC techniques for SiC coatings	KFA	In progress
	FD-14 Gamma spectroscopic examination of HTGR fuel elements	GA	In progress
	FD-20 Coated particle analysis by IMGA	ORNL	In progress
1.5	Fuel design, performance, and modeling		
	FD-11 Testing of GA and HBK fuel under hypothetical accident conditions	GA	In progress
	FD-8 Development of stress models for coated particles	GA	In progress
2	Fission Product Behavior		
2.1	Fission product release and transport		
	FP-1 Comparison of tritium design methods	GA	In progress
	FP-2 Fission product data handbook	KFA	In progress
	FP-5 Fission gas release model	GA	In progress
2.2	Methods verification		
	FP-3 Verification of fission product design methods and codes	HRB	In progress
	FP-4 Fission product plateout code verification	GA	In progress

WBS Element and Title		Lead Org.	Status
FP-6	In-Reactor effects of moisture on FGR	GA	In progress
3	Graphite Development		
3.1	Irradiation testing		
GD-1	KFA graphite irradiation experiment in HFIR at Oak Ridge	ORNL	In progress
GD-2	Irradiation of GA side reflector graphite in HFR Petten	KFA	In progress
GD-4	Graphite creep tests in Petten	KFA	In progress
GD-9	Irradiation of KFA side reflector and core support graphite in ORR	GA	Delay to FY-84
3.2	Characterization of properties		
GD-6	Corrosion characteristics of core support graphite	ORNL	In progress
GD-10	Study of the oxidative strength loss of KFA core support graphite ASR-1R	ORNL	In progress
GD-11	Characterization and evaluation of KFA core support graphite ASR-1R for oxidation characteristics	GA	Under review
3.3	Graphite design data and specifications		
GD-12	Characterization of core support structure graphite for acceptance/rejection strength tests in purchase specifications	GA	In progress
GD-15	Graphite corrosion modeling	GA	In progress
3.4	Performance assessment modeling and verification		
GD-5	Structural design criteria for graphite in GCR	GA	Work initiated
GD-14	Graphite material modeling and fracture criteria	GA	Work initiated