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**US/FRG UMBRELLA AGREEMENT
FOR COOPERATION IN GCR DEVELOPMENT
FUEL, FISSION PRODUCTS AND GRAPHITE
SUBPROGRAM**

**QUARTERLY STATUS REPORT
FOR THE PERIOD
APRIL 1, 1980 TO JUNE 1, 1980**

**by
T. D. GULDEN**

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

DATE PUBLISHED: JUNE 1980

GENERAL ATOMIC COMPANY

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PREFACE

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 1, March 1980. The work described is performed in the HTGR Base Technology Program at Oak Ridge National Laboratory and the HTGR Generic Technology Program at General Atomic Company.

The requirement for and format of this Quarterly Status Report are specified in the "HTR IMPLEMENTING AGREEMENT" Procedures for Cooperation.

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1. STATUS SUMMARY

The status of progress on the major milestones, as defined in the Subprogram Plan, for the third quarter of FY-80 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 the following sections (see Appendix A for the Subprogram WBS). Most of the work is proceeding well. However, some slippage in milestones is being experienced. Some problems are being encountered due to uncertainty in the National Programs and communication problems. We have not yet received a Quarterly Status Report from the German side.

Two major events this quarter were the startup of capsule R2K13 in the Studsvik Reactor and the beginning of preparations for a joint workshop on fission product/SiC reactions to be held in San Diego in October.

Table 1. Milestone* Status for the Third Quarter
of FY-80

<u>Milestone Due in Current Quarter</u>	<u>PWS</u>	<u>Due Date</u>	<u>Compl. Date</u>	<u>Resp. Party</u>	<u>Status</u>
<u>Fuel Development</u>					
1-1-1 Final PIE report on R2-B1	FD4	4/80	12/80	KFA	Delayed
1-1-2 Final PIE Report on DRGB2	FD5	4/80	-	KFA	No information on status
1-1-3 Begin irradiation of R2K13	FD15	4/80	5/80	ORNL	Capsule operating as designed
1-4-1 Complete revision of PWS-10	FD10	4/80	-	ORNL	Pending input from GA
1-4-5 Complete final draft of PWS-FD20	FD20	5/80	2/80	ORNL	Completed
<u>Held Over from Previous Quarter</u>					
1-4-4 Ship KFA Zuchtperle to GA	FD14	3/80	-	KFA	Shipment expected in May or June
3-1-1 Complete data analysis for capsule HTU-1	GD1	5/80	5/80	ORNL	Completed (see previous Quarterly for change from Subprogram Plan)
3-1-3 Begin irradiation of 300°C capsule in HFR Petten	GD2	3/80	-	KFA	Error in Subprogram Plan
3-1-5 Start creep capsule in HFR Petten	GD4	3/80	4/80	KFA	Completed

* Milestones taken from Table 4-1 of the "Fuel, Fission Product and Graphite Subprogram Plan"

2. SIGNIFICANT PROBLEMS

Problems currently affecting the cooperative work are as follows:

- continuation of the ORNL/KFA personnel exchange
- cost and complexity of radioactive materials shipment
- change in FRG program directions
- limited communications

The assignment of Dr. Cords from KFA to ORNL was completed in March 1980. No replacement has been provided. The assignment of Mike Kania from ORNL to KFA will be complete in August. Uncertainty in the U.S. program makes it difficult to designate a replacement at this time. Frank Homan has proposed to KFA that a KFA fuel specialist be sent to ORNL in the near term (possibly on a short term assignment) especially to participate in PWS-FD20. No response has yet been received to this proposal although KFA has previously indicated interest in this approach.

Shipment of irradiated fuel from KFA to GA and ORNL for PWS-FD14 and PWS-FD20 is requiring more effort than expected as well as some significant unplanned expenditures on the U.S. side. Future shipments of irradiated material should be well coordinated and minimized.

The FRG HTR fuel cycle program has taken a sharp budget cut that has forced the termination of most work relating to the HEU/Th cycle. However, it is expected that all work in the Fuel, Fission Product and Graphite Subprogram, including capsule R2K13, can proceed as planned.

We have not yet received a quarterly status report from KFA. However, we have received a Telex updating the status of most of their milestones.

3. STATUS OF COOPERATION

1. FUEL DEVELOPMENT

1-1 Fuel Irradiation Tests

There are three active Project Work Statements in this Work Breakdown Structure (WBS) element: PWS-FD4, PWS-FD5, and PWS-FD15 (see Appendix B for titles).

PWS-FD4 and FD5 are FRG responsibility. They involve completion of the postirradiation examination of previously completed cooperative irradiation tests on HEU fuel in the Studsvik Reactor (R2-B1) and in the DRAGON Reactor (DR-GB2), respectively. Both were to be completed by April 1980. The R2-B1 report has been delayed to December. We have not yet been informed of the current status of the DR-GB2 report.

A joint irradiation test (R2K13) in the Studsvik Reactor is committed under PWS-FD15. The capsule began operation in May and is performing well. A GA representative (W.J. Kovacs) is currently visiting KFA and Studsvik, and will expedite receipt of the required information on capsule startup and operation.

Additional possibilities for cooperation in the area of fuel irradiation testing are being explored during the visit of W.J. Kovacs to KFA in May.

1-2 Fuel Process Development

Planning for cooperation in this area will be pursued with Dr. H. Huschka from Hobeg during the next Subprogram Manager meeting in San Diego in September.

1-3 Fuel Design Data and Specification

The table of contents of the GA Fuel Design Data Manual was exchanged for the table of contents of the KFA document "Daten und Technologien des HTR Brennstoffkrieslaufs" (HTR Fuel Cycle Technology and Data). Exchange of the entire documents is now under consideration. KFA is beginning a systematic activity to develop a data base for licensing. Further cooperation in this area is being discussed during the visit of W.J. Kovacs to KFA and Hobeg.

1-4 Pre- and Postirradiation Characterization

There are six active or proposed Project Work Statements in this WBS area (FD9, FD10, FD12, FD13, FD14, FD20).

The work on FD9 has been deferred about one year. FD10 is nearing a final draft and should be ready for approval at the next Subprogram Manager meeting.

Both FD12 and FD13 are under ORNL cognizance. They involve evaluation of the permeability of BISO particles and comparison of PIE techniques (IMGA and PIAA) for failed fuel detection, respectively. The experimental work at ORNL has been completed. Only the work on the German side, data analysis, and reporting remain to be done.

Shipment of the gamma scanning standard (Zuchtperle) from KFA has been delayed by 2 or 3 months. This should not delay the work on FD14 significantly.

Consideration is being given to assigning a KFA specialist to ORNL to assist with the IMGA analysis for FD20.

1-5 Fuel Design, Performance Assessment and Modeling

There are three active Project Work Statements in this WBS area (FD8, FD11, FD18). Work on the TRISO particle stress model under FD8 and on fuel performance in accident conditions under FD11 remains on schedule for FY-80.

It is expected that PWS-FD18 will be terminated, due to its limited scope, and the cooperation continued on an information exchange basis.

A workshop on fission product/SiC reaction is scheduled for October in San Diego. Representatives from KFA, ORNL, and GA will participate. The goals are to review and evaluate available data, try to establish a consensus on mechanisms and kinetics, and to recommend directions for future work.

2. FISSION PRODUCT BEHAVIOR

2-1 Fission Product Release and Transport

There are two active Project Work Statements in this subprogram area (FP1 and FP2). ORNL has completed the reports on tritium and carbon-14 distributions committed in FP1.

The work to prepare a format for a fission product data book under FP2 is proceeding on schedule.

2-2 Methods Verification

Work in this area cannot proceed until KFA provides the revised draft of FP3. This is committed in July 1980.

3. GRAPHITE DEVELOPMENT

3-1 Irradiation Testing

There are four Project Work Statements in this WBS area, one under ORNL lead (GD1), two under KFA lead (GD2 and GD4), and one under GA lead (GD9).

The irradiation experiments under GD2 are scheduled to complete their reirradiation in November. The date of 3/80 shown in the Subprogram Plan was in error. The creep capsule under GD4 is scheduled to begin irradiation on 5 June 1980.

Execution of GD9 is contingent on the FY-81 budget at GA being sufficient to proceed with capsule OG-6. As a necessary precursor, capsule OG-5 is being irradiated during FY-80.

3-2 Characterization of Properties

There are four Project Work Statements in this WBS area. Three of these, GD6, GD10, and GD11, involve oxidation and the effect of oxidation on strength. Work on most of these is proceeding on schedule. The oxidation work being performed at GA on ASR-1RG graphite under GD11 has been suspended after finding relatively high oxidation rates, little better than for PGX. Further work in this area will be discussed during the visit of G.B. Engle to KFA in June. The fourth PWS in this area (GD12), involving the development of strength acceptance tests, is also on schedule.

3-3 Graphite Design Data and Specification

No active Project Work Statements.

Exchange of the GA Fuel Design Data Manual, which contains graphite as well as fuel and fission product data, with KFA could lead to cooperation in the development of design data.

3-4 Performance Assessment, Modeling and Verification

Two Project Work Statements (GD3 and GD5) have been completed in this WBS area. One additional PWS (GD13), involving cooperation in the analysis of a KFA experiment to help verify stress analysis methods, has been proposed, but agreement has not yet been reached. KFA has committed to providing a revised proposal in September 1980.

3-5 Control Materials

No cooperation is anticipated in the near term in this WBS area.

4. PROGRAMMATIC CHANGES

None this quarter.

5. REPORTS EXCHANGED

A system has been established at General Atomic to ensure that Quarterly and Semiannual Report and program planning documents are sent to KFA on a regular basis. The first reports will be sent in the next quarter.

REPORTS SENT TO KFA DURING THE CURRENT QUARTER

1. Field Task Proposal/Agreements for Assistant Secretary - Nuclear Energy, Program: AG-Converter, ORNL/CF-80/105.
2. Table of Contents, "Fuel Design Data Manual," GA Document No. 901866, Sept. 1979.
3. HTGR Base Program Monthly Progress Report for April 1980, F.J. Homan, Program Manager, ORNL/GCR/B-80-4.
4. HTGR Base Program Monthly Progress Report for May 1980, F.J. Homan, Program Manager, ORNL/GCR/B-80-5.
5. HTGR Base Program Monthly Progress Report for June 1980, F.J. Homan, Program Manager, ORNL/GCR-B-80/6.

6. "The Irradiated Microsphere Gamma Analyzer (IMGA) - An Integrated System for HTGR Coated Particle Fuel Performance Assessment," ORNL-5606.
7. "HTGR Experiment HRB-15B: Particle Loadings and Irradiation in the High Flux Isotope Reactor," ORNL/TM-6892.
8. "Performance of Fertile Particles Irradiated in HFIR Capsule HT-32," ORNL/TM-7035.
9. "Fission Product Pd-SiC Interaction in Irradiated Coated Particle Fuels," ORNL/TM-7203.

REPORTS RECEIVED FROM KFA IN THE CURRENT QUARTER

1. Table of Contents, "Daten und Technologien des HTR-Brennstoffkreislaufs," Jan. 1980.
2. "Materials Properties and Fission Product Retention of SiC Coatings," P. Krautwasser, et al., (translated at ORNL).
3. Zusammenstellung der vom IRW Gemeinsam mit beteiligten Instituten Angemeldeten Vorträge zur Reaktortagung 1980 des Deutschen Atomforums, e.v./KTG (25 bis 27 März 1980, Berlin), Jan. 1980. (Summary of the IRW contributions to the 1980 Deutschen Atomforum Reactor Meeting). Being translated at ORNL.
4. "The Brittle Ring Test: A Method for Measuring Strength and Young's Modulus on Coatings of HTR Fuel Particles," K. Bongartz, et al., J. Nucl. Mat. 62, 123-127 (1976).
5. "Zur Sprodbbruch-Statistic bei der Ermittlung de Festigkeit von Brennstoffteilchen-Hüllschichten," ("Brittle Fracture-Investigation of the Statistics of Fuel Particle Strength,") K. Bongartz and H. Schuster, Jül-1291, Mar. 1976.
6. "Bestrahlungsexperiment-Information," HBK Project, 2/80.

6. CONCLUSIONS AND RECOMMENDATIONS

The cooperation in the Fuel, Fission Product, and Graphite Subprogram is proceeding well, although some delays are being encountered. Some problems are being experienced due to uncertainties in the programs and difficulties in communication. The Project Work Statements will be updated during the next quarter for approval at the next Subprogram Manager Meeting.

Systems for the regular exchange of documents are being established, but are not yet fully operational.

APPENDIX A

WORK BREAKDOWN STRUCTURE

APPENDIX B LISTING OF ACTIVE PROJECT WORK STATEMENTS

		Lead Org.	Status
1.	FUEL DEVELOPMENT		
1-1	<u>Fuel Irradiation Tests</u>		
FD4	Postirradiation Examination of Accelerated Capsule Test R2-B1 & Evaluation	KFA	In progress
FD5	Postirradiation Examination of Real-Time LHTGR Qualification Test DR-GB2 with Large Size Specimens	KFA	In progress
FD15	Cooperative Fuel Element Irradiation Test of GA & HBK Fuel	KFA	In progress
1-4	<u>Pre and Postirradiation Characterization</u>		
FD9	Testing of GA & KFA Particles with Improved Coatings	KFA	Delayed 1 year
FD10	Characterization & QC Techniques for SiC Coatings	KFA	PWS being finalized
FD12	Quantification of Irradiation Induced Permeability in PyC Coatings	ORNL	In progress
FD13	Comparison of US & FRG Postirradiation Examination Procedures for Measurement of Statistically Significant Failure Fractions for Irradiated Coated Particle Fuel	ORNL	In progress
FD14	Gamma Spectroscopic Examination of HTGR Fuel Elements	GA	In progress
FD20	Coated Particle Analysis by IMGA	ORNL	PWS being finalized
1-5	<u>Fuel Design, Performance and Modeling</u>		
FD8	Develop Common Basis for the Mechanical Design of Particle Coating	GA	In progress
FD11	Testing of GA & HBK Fuel Under Hypothetical Accident Conditions	GA	In progress
FD18	Fuel Chemical Performance Modeling	ORNL	Cancellation considered
FD19	Critical Evaluation of Fuel Performance Data	KFA	PWS being developed
2.	FISSION PRODUCT BEHAVIOR		
2-1	<u>Fission Product Release & Transport</u>		
FP1	Analysis of H-3 & C-15 Transport & Distribution in HTR Primary Circuits	ORNL	In progress
FP2	Fission Product Data Handbook	GA	In progress
2-2	<u>Methods Verification</u>		
FP3	Verification of Fission Product Design Methods & Codes	GA	PWS being finalized
3.	GRAPHITE DEVELOPMENT		
3-1	<u>Irradiation Testing</u>		
GD1	KFA Graphite Irradiation Experiment in HFIR at Oak Ridge	ORNL	In progress
GD2	Irradiation of GA Side Reflector Graphite in HFR Petten	KFA	In progress
GD4	Continuation of Graphite Creep Test in HFR Petten	KFA	In progress
GD9	Irradiation of KFA Side Reflector & Core Support Graphites in ORR	GA	Pending resolution of US program
3-2	<u>Characterization of Properties</u>		
GD6	Characterization of Core Support Graphites for Oxidation Rate & Effects	GA	In progress
GD10	Study of the Oxidative Strength Loss of KFA Core Support Graphite ASR-1R	ORNL	In progress
GD11	Characterization & Evaluation of KFA Core Support Graphite ASR-1R for Oxidation Characteristics	GA	In progress
GD12	Characterization of Core Support Structure Graphites for Acceptance/Rejection Strength Test in Purchase Specifications	GA	In progress
3-4	<u>Performance Assessment, Modeling and Verification</u>		
GD13	Verification of Stress Computational Methods	KFA	PWS being prepared