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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 JANUARY 1, 1981 THROUGH MARCH 31, 1981

by
R. F. TURNER

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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 2, October 1980. The work described is performed in the HTGR Base Technology Program at Oak Ridge National Laboratory and the HTGR Fuel and Plant Technology Programs at General Atomic Company.

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

TABLE OF CONTENTS

ABSTRACT iii
1. STATUS SUMMARY 1
2. SIGNIFICANT PROBLEMS 4
3. STATUS OF COOPERATION 5
3.1. Fuel Development 5
3.2. Fission Product Behavior 7
3.3. Graphite Development 7
4. PROGRAMMATIC CHANGES 9
5. REPORTS EXCHANGES 10
6. CONCLUSIONS 12
APPENDIX A - WORK BREAKDOWN STRUCTURE 13
APPENDIX B - LISTING OF ACTIVE PROJECT WORK STATEMENTS 14

TABLES

1. Milestone status for the second quarter of FY-81 from Revision 2 of the subprogram plan 2

1. STATUS SUMMARY

The status of progress on the major milestones, as defined in Revision 2 of the Subprogram Plan, is summarized for the second quarter of FY-81 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).

The semiannual Subprogram Management Meeting is to be held in Jülich on March 30, 31, and April 1, 1981. Action items from that meeting will be reported in the next quarterly report.

Technical highlights of the period were:

1. Continued successful operation of fuel capsule R2K13 (PWS FD-15).

2. Reports written on Irradiation Induced Permeability Change in Pyrocarbon (FD-12) and Post-irradiation Analysis Technique Comparison on Coated Particles (FD-13).

3. Successful operation of graphite capsules HTK-4 at ORNL (GD-1) and GC-(300°C) at Petten (GD-2).

TABLE 1
MILESTONE STATUS FOR THE SECOND QUARTER OF FY-81 FROM
REVISION 2 OF THE SUBPROGRAM PLAN

Milestone	PWS	Due Date	Compl. Date	Resp. Party	Status
1. FUEL DEVELOPMENT					
1-1-1 Final PIE report on R2-B1	FD-4	4/80	--	KFA	Delayed
1-1-2 Final PIE report on DRGB2	FD-5	4/80	--	KFA	Delayed
1-4-1 Exchange QC Program outlines	FD-10	2/81	--	ORNL/ KFA	ORNL outline sent 12/80; KFA reply delayed to 3/81
1-4-2 Complete report on irradiation induced permeability	FD-12	3/81	3/81	ORNL	Completed
1-4-3 Final report on IMGA/PIAA comparison	FD-13	3/81	--	ORNL	KFA contribution delayed to 6/81
1-4-4 Ship KFA Zuchtperle to GA	FD-14	3/80	1/81	KFA	Particles delivered
1-5-1 Issue report on accident condition tests	FD-11	3/81	--	KFA	Delayed to 10/82 by furnace breakdown
2. FISSION PRODUCT BEHAVIOR					
2-2-1 Prepare Revised PWS	FP-3	7/80	1/81	KFA	Completed; further action planned from 12/80 meeting on PWS for plateout behavior

TABLE 1 (Continued)

Milestone	PWS	Due Date	Compl. Date	Resp. Party	Status
3. GRAPHITE DEVELOPMENT					
3-1-1 Report on capsule HTK-4	GD-1	8/80	--	ORNL	Capsule operating as planned; data by 6/81
3-1-2 Insert 300°C capsule in Petten	GD-2	11/80	--	KFA	Delayed to 4/81
3-2-1 Provide improved ASR-1RG from Sigri for evaluation	GD-11	12/80	--	KFA	Delayed to 6/81
3-2-2 Complete corrosion test on ASR-1R	GD-10	1/81	--	ORNL	Agreement not reached on scope; test on hold
3-3-1 Review graphite creep data	GD-12	3/81	--	GA	Delayed to 12/81

2. SIGNIFICANT PROBLEMS

Slippage in scheduled milestones by both sides is a concern.

There have been continuing efforts to establish a Project Work Statement on fission product plateout (PWS CC-1). This is slowed because the plateout research is organizationally outside of the Fuel, Core Fission Product, and Graphite program area at KFA.

The expected end-of-life exposure of the R2K13 fuel capsule has been lowered by 20% for fast sequence and 5% for fertile particle burn-up.

3. STATUS OF COOPERATION

3.1. FUEL DEVELOPMENT

3.1.1. Fuel Irradiation Tests

There are three active Project Work Statements in this Work Breakdown Structure (WBS) element: FD-4, FD-5, and FD-15 (see Appendix B for titles).

PWS FD-4 and FD-5 had milestones in December 1980 for the completion of the postirradiation examination reports of previously completed cooperative irradiation tests on HEU fuel in the Studsvik Reactor (R2-B1) and in the DRAGON Reactor (DR-GB2), respectively. The reports have not yet been received from KFA.

The R2K13 capsule (FD-15) continues to operate well in the Studsvik Reactor. The capsule was transferred to a new core position (A-9) in February 1981. The latest predictions of end-of-life exposure are lower than design by 20% on fast fluence and 50% on fertile particle burnup. The fuel performance data results are arriving promptly.

3.1.2. Fuel Process Development

A modified work scope for the proposed exchange on kernel, coating and QC techniques was received from KFA. The implementation will depend upon the availability of funding at KFA in 1981.

3.1.3. Fuel Design Data and Specification

There are no active milestones in this area. However, there is interest in expanding the cooperation. KFA has proposed an exchange of Performance Data Sheets and Design and Specification Data Files. There are two proposed Project Work Statements in this WBS area (FD-19 and FD-21).

3.1.4. Pre- and Postirradiation Characterization

There are five active Project Work Statements in this area (FD-10, FD-12, FD-13, FD-14, and FD-20). ORNL has distributed a program outline for FD-10 and is awaiting a similar outline on the KFA Diagram. ORNL completed a final report on Irradiation Induced Permeability of Pyrocarbon (FD-12). Particles were received at GA from KFA for gamma spectroscopic examination (FD-14). Fuel particles for IMGA examination were shipped to ORNL (FD-20).

3.1.5. Fuel Design, Performance Assessment and Modeling

There are two active Project Work Statements in this area (FD-8, FD-11). Unpublished data on a Stress-Strain Model of TRISO Fuel Particles was distributed by GA. The work on burst strength measurements at GA has been delayed because of funding priorities (FD-8).

Test plans were to be exchanged for testing under hypothetical accident conditions (FD-11). This exchange has been delayed.

3.2. FISSION PRODUCT BEHAVIOR

3.2.1. Fission Product Release and Transport

There are two active Project Work Statements in this Subprogram area (FP-1,FP-2). The work on FP-1 is continuing on a stretched out schedule agreed by ORNL and KFA.

The work on FP-2 is proceeding on schedule.

3.2.2. Methods Verification

Work is proceeding on the basis of the draft of PWS FP-3 which was agreed upon in December 1980, and submitted in writing by KFA in February 1981. The initiation of a Project Work Statement on plateout analysis (PW5-CC-1) was proposed at the "Specialists Meeting on Coolant Chemistry" in Germany in December 1980. Dr. von der Decken accepted an action item to draft a statement.

3.3. GRAPHITE DEVELOPMENT

3.3.1. Irradiation Testing

There are four Project Work Statements in this area, one under ORNL lead (GD-1), two under KFA lead (GD-2 and GD-4), and one under GA lead (GD-9).

The operation of irradiation capsule HTK-4 is continuing on schedule at ORNL (GD-1).

The KFA GC-(300 °C) capsule at Petten (GD-2) is delayed to April 1981.

The KFA graphite creep test at Petten was terminated because of fracture of the specimen (GD-4).

The planning for GD-9 is in progress for an irradiation in FY-82.

3.3.2. Characterization of Properties

There are two Project Work Statements in this area (GD-10 and GD-11), involving oxidation of core support graphite. There is a need to agree on the scope of tests under GD-10 between KFA and ORNL. Work on GD-11 can not begin at GA until the ASR-IRG is received from Sigri.

3.3.3. Graphite Design Data and Specification

A draft report on GD-12 is planned following a visit to GA by Sigri personnel in the spring of 1981.

3.3.4. Performance Assessment, Modeling, and Verification

There are currently no active Project Work Statements in this area. A PWS on stress verification is under consideration.

3.3.5. Control Materials

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

4. PROGRAMMATIC CHANGES

Mr. R. F. Turner has been designated as the U.S. Subprogram Manager, replacing Dr. T. D. Gulden.

5. REPORTS EXCHANGED

Reports Sent To KFA During The Current Quarter:

1. "Carbon-14 Production in the Peach Bottom HTGR Core," Report No. ORNL-5597.
2. Kasten, P. R. and F. J. Homan, "HTGR Program Annual Progress Report for Period Ending December 31, 1979," Report No. ORNL-5643.
3. "Simulated Fission Product-SiC Interaction in TRISO-Coated LEU and MEU HTGR Fuel Particles," Report No. ORNL/TM-6991.
4. "Characterization of SiC Coatings on HTGR Fuel Particles: Final Report," Report No. ORNL/TM-7571.
5. "A Stress-Strain Model of TRISO Fuel Particle Coatings," GA unpublished data.
6. Bullock, R., "Calculations-Irradiation Results and Property Data for 8 Coated Particle Batches," January 1981, unpublished data.
7. "Strontium Transport Data for HTGR Systems," GA-A13168.
8. "Cesium Transport Data for HTGR Systems," GA-A13990.
9. "The Measurement and Modelling of Post-irradiation Fission Product Release from HTGR Fuel Particles Under Accident Conditions," GA-A15018.
10. Simnad, N. T., "A Brief History of Power Reactor Fuels," GA-A16274.

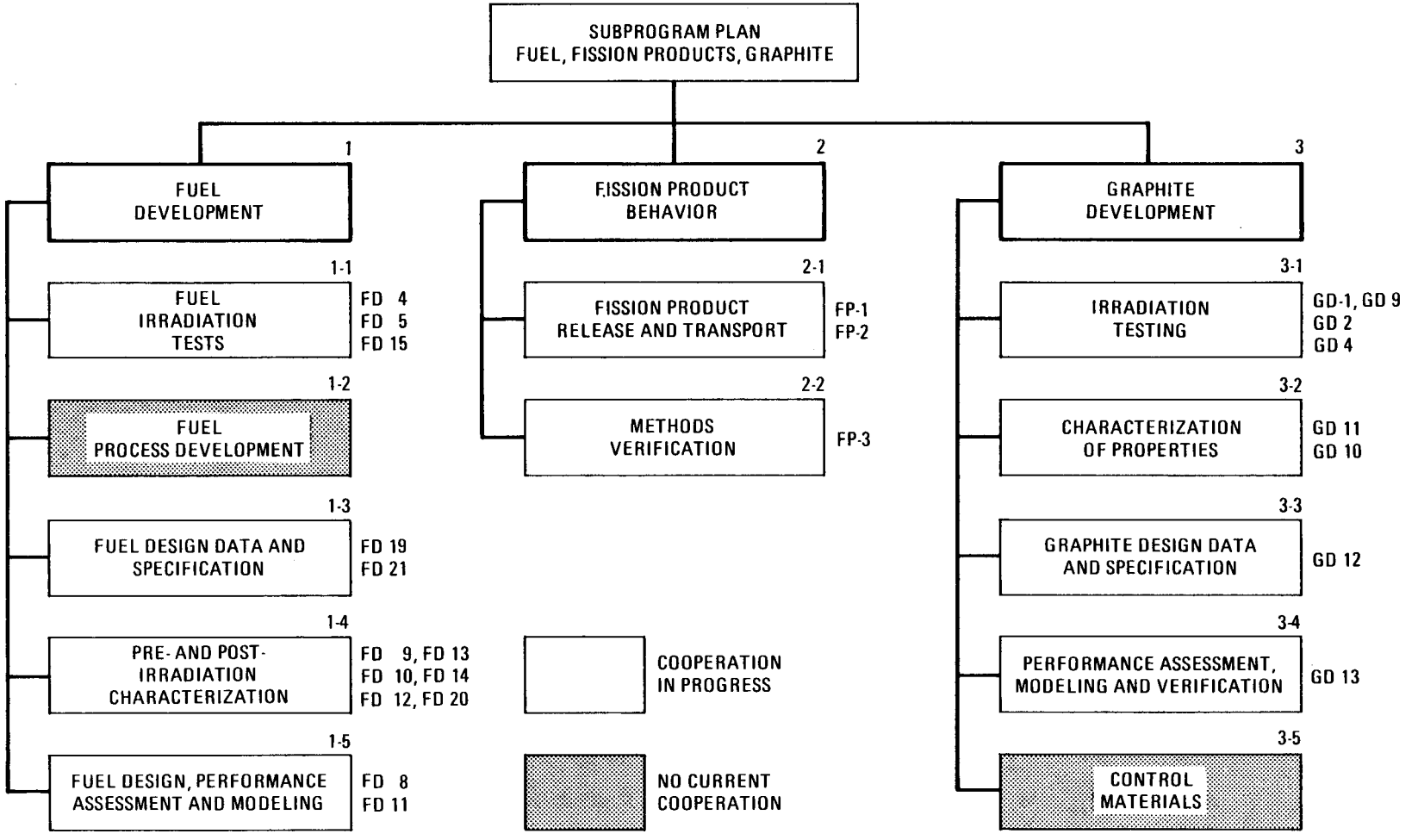
Reports Received From KFA In The Current Quarter:

1. HBK Project, "High Temperature Reactor Fuel Cycle Quarterly Report for Third Quarter 1980."
2. Hoag, G., "Irradiation of GA Side Reflector Graphite in HFR Petten at 500°C," Technical Note IRW-TN-6/81.

3. Nabielek, H., "Entwurf Projektbericht 1980:3.3.6 Spaltprodokte," January 1981.
4. Turnbull, J. A., et al., "The Diffusion Coefficients of Gaseous and Volatile Species During the Irradiation of Uranium Dioxide," RD/B/N4892, CEGB, August 1980.
5. Brown, P. E., A. J. Imms & H. Nabielek, "Strontium Retention in UO_2 Microspheres," Draft Report, Undated.
6. Reitsamer, G. and H. Wagner, "Radiale Konzentrationsverteilung von Cäsium und Europium in bestrahlten HTR-Brennstuffkernen," FZS BER No. A)163, CH-274/80, Österreichisches Forschungs aentrum seibersdorf gesmbh, Oktober 1980.
7. Nabielek, H. & K. Bonqartz, "The Combined Action of Pressure Vessel Failure, Amoeba Effect and SiC-Corrosion in Experiments BR2-P21 and BR2-P22," HBK-TN-14/80, KFA, October 1980.
8. Schenk, W & H. Nabielek, "Cesium Freisetzung aux $(Th,U)O_2$ bei Temperaturen Oberhalb 1700°C," IRW-TN-148/80, KFA November 1980.
9. Nabielek, H., "The Effect of Finite Precursor Halflife on R/B," Draft, February 1981.

6. CONCLUSIONS

The continuation of joint irradiation test programs is of particular importance to both sides in this exchange. The irradiations are continuing quite satisfactorily. The meeting on Fission Product Transport held in FRG during December 1980 should provide a basis for stronger exchange in Fission Product data. The milestones on all tasks should be updated during the subprogram management meeting on April 1, 1981 at KFA.


SUBPROGRAM PLAN
FUEL, FISSION PRODUCTS, GRAPHITE
1
FUEL DEVELOPMENT
1-1
FUEL IRRADIATION TESTS
FD 4
FD 5
FD 15
1-2
FUEL PROCESS DEVELOPMENT
1-3
FUEL DESIGN DATA AND SPECIFICATION
FD 19
FD 21
1-4
PRE- AND POST-IRRADIATION CHARACTERIZATION
FD 9, FD 13
FD 10, FD 14
FD 12, FD 20
1-5
FUEL DESIGN, PERFORMANCE ASSESSMENT AND MODELING
FD 8
FD 11
2
FISSION PRODUCT BEHAVIOR
2-1
FISSION PRODUCT RELEASE AND TRANSPORT
FP-1
FP-2
2-2
METHODS VERIFICATION
FP-3
COOPERATION IN PROGRESS
NO CURRENT COOPERATION
3
GRAPHITE DEVELOPMENT
3-1
IRRADIATION TESTING
GD-1, GD 9
GD 2
GD 4
3-2
CHARACTERIZATION OF PROPERTIES
GD 11
GD 10
3-3
GRAPHITE DESIGN DATA AND SPECIFICATION
GD 12
3-4
PERFORMANCE ASSESSMENT, MODELING AND VERIFICATION
GD 13
3-5
CONTROL MATERIALS

APPENDIX B

ACTIVE PROJECT WORK STATEMENTS

WBS ELEMENT AND TITLE		LEAD ORG.	STATUS
1.	FUEL DEVELOPMENT		
1-1	Fuel Irradiation Tests		
FD-4	Postirradiation Examination of Accelerated Capsule Test R2-B1 and Evaluation	KFA	To be completed
FD-5	Postirradiation Examination of Real-Time LHTGR Qualification Test DR-GB2 with Large Size Specimens	KFA	To be completed
FD-15	Cooperative Fuel Element Irradiation Test of GA and HBK Fuel (R2K13)	KFA	In Progress
1-3	Fuel Design Data and Specification		
FD-19	Performance Data Sheets	KFA	Proposal by KFA 10/80
FD-21	Design & Specification Data Files	KFA	Proposal by KFA 10/80
1-4	Pre- and Postirradiation Characterization		
FD-9	Testing of GA & KFA Particles with Improved Coatings	KFA	Deferred
FD-10	Characterization & QC Techniques for SiC Coatings	KFA	Information Exchange
FD-12	Quantification of Irradiation Induced Permeability of PyC Coatings	ORNL	Completed 3/81

	WBS ELEMENT AND TITLE	LEAD ORG.	STATUS
FD-13	Comparison of US & FRG Post-irradiation Examination Procedures for Measurements of Statistically Significant Failure Fractions for Irradiated Coated Particle Fuel	ORNL	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-8	Develop Common Basis for the Mechanical Design of Particle Coating	GA	In Progress
FD-11	Testing of GA & HBK Fuel Under Hypothetical Accident Conditions	GA	In Progress
2.	FISSION PRODUCT BEHAVIOR		
2-1	Fission Product Release and Transport		
FP-1	Analysis of H-3 & C-14 Transport & Distribution in HTR Primary Circuits	ORNL	In Progress
FP-2	Fission Product Data Handbook	KFA	In Progress
2-2	Methods Verification		
FP-3	Verification of Fission Product Design Methods and Codes	GA	In Progress
CC-1	Verification of Plateout Methods	GA	Work Statement Required
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 HFIR Petten	KFA	In Progress

	WBS ELEMENT AND TITLE	LEAD ORG.	STATUS
GD-4	Continuation of Graphite Creep Test in HFR Petten	KFA	In Progress
GD-9	Irradiation of KFA Side Reflector & Core Support Graphites in ORR	GA	Irradiations to begin in FY-82
3-2	Characterization of Properties		
GD-10	Study of the Oxidative Strength Loss of KFA Core Support Graphite ASR-1R	ORNL	Agreement on scope required
GD-11	Characterization & Evaluation of KFA Core Support Graphite ASR-1R for Oxidation Characteristics	GA	In Progress
3-3	Graphite Design Data and Specifications		
GD-12	Characterization of Core Support Structure Graphites for Acceptance/Rejection Strength Tests in Purchase Specifications	GA	In Progress
3-4	Performance Assessment, Modeling and Verification		
GD-13	Verification of Stress Calculational Methods	GA	PWS being developed