NRC FORM 189
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U.S. NUCLEAR REGULATORY COMMISSION

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

DATE OF PROPOSAL: 07-11-83

☐ NEW
☒ REVISION NO.

PROJECT TITLE: Fission Product Deposition on Aerosols

FIN NUMBER: B0815

NRC OFFICE: Office of Nuclear Regulatory Research, Division of Accident Evaluation

NRC B&R NUMBER: 60 19 02 01

DOE CONTRACTOR: UNION CARBIDE CORPORATION

SITE: OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE 37830

PATENT STATUS

This proposal is being transmitted in advance of patent review for evaluation purposes only. No further dissemination or publication shall be made without prior approval of the Assistant General Counsel for Patents, DOE.

CONTRACTOR/ORNL ACT. 41 32 55 14 5
DIV. 03

DOE B&R NUMBER: 40 10 01 06

COGNIZANT PERSONNEL	ORGANIZATION	FTS PHONE NUMBER	PERIOD OF PERFORMANCE
NRC PROJECT MANAGER: M. W. Jankowski	FSBR	472-4461	STARTING DATE: 04-01-83
OTHER NRC TECHNICAL STAFF			COMPLETION DATE: Continuing
DOE PROJECT MANAGER: W. R. Bibb	DOE-ORO	626-0742	
CONTRACTOR/ORNL PROG. DIR.: A.P. Malinauskas	CMO	624-0422	
PROG. MGR.: R.P. Wichner/T.S. Kress	CTD/ETD	624-6863/624-0561	
PROJ. MGR.: R. D. Spence	CTD	624-6782	
PRIN. INVESTIGATOR(S): R. D. Spence	CTD	624-6782	

STAFF YEARS OF EFFORT (Round to nearest tenth of a year)	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987
Direct Scientific/Technical	1.3	2.6	2.3	2.5	2.5
Other Direct	0.8	1.1	2.0	0.2	2.0
TOTAL DIRECT STAFF YEARS	2.1	3.7	4.3	2.7	4.5
COST PROPOSAL (OBLIGATIONS)	($ in Thousands)				
Direct Salaries (Cost Centers)	104	208	184	200	200
Material and Services (Excluding ADP)	32	44	80	10	80
ADP Support	2	4	4	4	4
Subcontracts and Consultants	0	0	0	0	0
Travel Expenses — Foreign	0	0	0	0	0
Travel Expenses — Domestic	2	4	4	4	4
Indirect Labor Costs (Cost Centers)					
Other (Specify) (GSO Change)	120	-90	60	29	7
General and Administrative (G&A/GPS)	40	80	82	66	87
TOTAL OPERATING COST (Obligations)	300	250	414	313	382
CAPITAL EQUIPMENT FIN CHARGED:	50	35	40	15	20
TOTAL PROJECT COST (Obligations)	350	285	454	328	402

FY 1984 MONTHLY FORECAST EXPENSE

OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH
37	37	37	37	37	37
APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER
33	24	24	24	24	24

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FIN NUMBER: B0815

DATE: 07-11-83

PROJECT TITLE:

Fission Product Deposition on Aerosols

DOE PROPOSING ORGANIZATION:

UNION CARBIDE CORPORATION
OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE 37830

FORECAST MILESTONE CHART: Schedule to Start— △ —Completed (Shown in Quarter Year)

PROVIDE ESTIMATED DOLLAR COST FOR EACH TASK FOR EACH FISCAL YEAR

TASK		FY 1983				FY 1984				FY 1985				FY 1986				FY 1987			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Subtask 1 Planning and Analysis	SCHEDULE	—																			
	COST	90				75				94				150				95			
Subtask 2 Static Tests	SCHEDULE	—																			
	COST	90				150				150				90				150			
Subtask 3 Dynamic Tests	SCHEDULE	—																			
	COST	50				150				150				59				150			
	SCHEDULE																				
	COST																				
	SCHEDULE																				
	COST																				
TOTAL ESTIMATED PROJECT COST		230				375				394				299				395			

PROJECT DESCRIPTION: (Provide narrative descriptions on NRC Form 189 page 3 of 3 for the following topics in the order listed. Check applicable block. If an item is not applicable, so state.)

- [X] 1. OBJECTIVE OR PROPOSED WORK
- [X] 2. SUMMARY OF PRIOR EFFORTS
- [X] 3. WORK TO BE PERFORMED AND EXPECTED RESULTS
- [X] 4. DESCRIPTION OF ANY FOLLOW-ON EFFORTS
- [X] 5. RELATIONSHIP TO OTHER PROJECTS
- [X] 6. REPORTING SCHEDULE
- [ ] 7. SUBCONTRACTOR INFORMATION
- [X] 8. LIST NEW CAPITAL EQUIPMENT REQUIRED
- [ ] 9. DESCRIBE SPECIAL FACILITIES REQUIRED
- [X] 10. CONFLICT OF INTEREST INFORMATION
- [X] 11. OBLIGATION ESTIMATES
- [X] 12. OTHER (SPECIFY):
  - (a) Quality Assurance and Control
  - (b) Cost and Milestone Charts

APPROVAL AUTHORITY SIGNATURE: ap Malcom Co

DATE: 9-14-83

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U.S. NUCLEAR REGULATORY COMMISSION

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

FIN NUMBER B0815

PROJECT TITLE:

Fission Product Deposition on Aerosols

ITEM NO.

1. OBJECTIVE OF PROPOSED WORK:

Summary

Current LWR accident consequence evaluations indicate that a principal mode of fission product movement in both the primary reactor vessel and in the containment system (in the gas phase) occurs by aerosol transport. Consequently, the rate of sorption of fission products onto aerosols and the sorption capacity of aerosol particles for fission products are key factors in accident consequence assessment.

A number of sorptive mechanisms are possible (e.g., condensation, chemisorption) depending on the temperature regime, chemical environment, and chemical makeup of the aerosol and the fission product species. These lead to a range of possible deposition rates and also a range of sorptive capacities of aerosol particles for fission products. Review of published work in this area has revealed a very small data base.

The objective of this task is to provide experimental data on the sorptive capacity of aerosols for certain key fission products. A secondary objective is to provide sorption rate data.

Additional Information

The work is divided into the following three subtask areas:

Subtask 1. Planning and Analysis. This subtask will provide a work plan to include (1) experiment objectives, (2) review of current data base, (3) experiment approach, and (4) experiment schedule. The work plan will be updated as needed as the work progresses.

The experiment approach and design will also be developed in this task. This includes selection of aerosol and fission product materials for tests and developing procedures for contacting them.

This task will also provide frequent data reports (as NRC interim reports) and topical reports which will include a data summary and correlations.

Necessary administrative activities are likewise provided under subtask 1.

Task 2. Static Tests. In this subtask, the adsorption isotherms of vapors of fission products onto captured aerosols will be measured at high temperatures. The captured aerosols will be samples of materials expected to be important contributors to aerosol formation inside the pressure vessel during an accident. These solid particles will be exposed to different concentrations of the fission product vapor, which will be tagged with an appropriate radioisotope. By monitoring the aerosol sample with a scintillation detector continuously during the exposure at each concentration and after purging the sample environment of the fission product vapor, the rate of adsorption, the quantity of adsorption, and the quantity of desorption will be determined.

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FIN NUMBER B0815

PROJECT TITLE:

Fission Product Deposition on Aerosols

ITEM NO.

1. OBJECTIVE OF PROPOSED WORK (Continued):

Prior to beginning routine adsorption isotherm measurements, the apparatus fabricated for this subtask will be used to make screening tests on a number of prospective aerosol candidates. The purpose of these screening tests is to rank the list of candidates in order of importance. Seven prospective candidates — silver, manganese oxide, chromium oxide, iron, iron oxide, tin oxide, and nickel — have been chosen for the screening tests based on a thermodynamic evaluation of their availability in a melting core and the volatility and melting points of the expected condensing form of each candidate. Depending on the screening tests, only some of these candidates will be included in later tests and other candidates may be added subsequently. Presently, the vapors to be tested are CsOH, CsI, and Te.

Subtask 3. Dynamic Tests. In this subtask, fission product vapor desposition onto aerosols and walls will be measured at high temperatures. Both the aerosol and the vapor will be radioactively tagged for these tests. The aerosol and vapor will flow cocurrently through a tube with an inert carrier gas. The exit flow from this tube can be diverted intermittently through a sample and monitor section. As the flow passes through this section, the aerosol is separated from the gas flow. After the aerosol has been removed, the vapor is condensed. After enough material has been trapped, the exit flow is diverted back to its normal course and the diversion section purged with clean carrier gas. Both traps (aerosol and vapor) are monitored continuously with scintillation detectors to give the quantity of aerosol trapped, the quantity of vapor deposited on the aerosol, the vapor concentration, and the quantity of vapor desorbed from the aerosol. At the conclusion of the test, the tube can be surveyed along its entire length to give the quantity of vapor and aerosol deposited with position. This survey can be compared to a similar survey made without aerosols to check deposition on the walls.

2. SUMMARY OF PRIOR EFFORTS:

Summary

This project was initiated in April 1983. The development of two major pieces of apparatus — a vapor generator and an aerosol generator — has dominated experimental effort. The concept for the experimental approach and a work plan draft were completed in October 1982. Extensive revisions were made to the work plan in March 1983, thus the original work plan was not published. A revised draft will be prepared by October 1983.

3. WORK TO BE PERFORMED AND EXPECTED RESULTS:

Summary

The major milestones and results of this work are the following [see also item 12(b)]:

PROJECT TITLE:

Fission Product Deposition on Aerosols

ITEM NO.

3. WORK TO BE PERFORMED AND EXPECTED RESULTS (Continued):

1. Fabricate test apparatus for static tests (milestone 2.a) — November 1983
2. Screening tests with CsOH and CsI to rank aerosols (milestone 2.b) — January 1984
3. Fabricate test apparatus for dynamic tests (milestone 3.a) — July 1984
4. Static tests completed for CsOH and CsI (milestone 2.c) — November 1984
5. Final report: CsOH and CsI Adsorption Isotherms (draft) (milestone 1.d) — October 1985
6. Dynamic tests completed for CsOH and CsI (milestone 3.b) — October 1985
7. Static tests completed for Te (milestone 2.d) — October 1985
8. Dynamic tests completed for Te (milestone 3.c) — March 1986
9. Final report: CsOH and CsI Dynamic Tests and Te Adsorption Isotherms (draft) (milestone 1.e) — October 1986
10. Static tests completed for other fission product species (milestone 2.e) — April 1987
11. Final report: Dynamic Tests for Te (draft) (milestone 1.f) — October 1987
12. Dynamic tests completed for other fission product species (milestone 3.d) — October 1987
13. Modify apparatus for condensing studies (milestone 3.e) — March 1988
14. Final report: Dynamic Tests and Adsorption Isotherms for Other Fission Products (milestone 1.g) — October 1988
15. Dynamic tests completed for condensing conditions (milestone 3.f) — March 1989
16. Final report: Dynamic Tests for Condensing Conditions (milestone 1.h) — October 1989

PROJECT TITLE:

Fission Product Deposition on Aerosols

ITEM NO.

3. WORK TO BE PERFORMED AND EXPECTED RESULTS (Continued):

FY 1984

The static test apparatus will be fabricated early in FY 1984. This apparatus will be used to screen the potential aerosol materials early in FY 1984 also, and then used to measure adsorption/desorption isotherms for CsOH and CsI and selected aerosol surfaces. The aerosol generator and dynamic test apparatus will be fabricated and tested. Dynamic tests with CsOH and CsI and selected aerosols will begin in FY 1984 and end in FY 1985.

FY 1985

The static tests with CsOH and CsI will be completed early in FY 1985 and a draft of the final report on these tests written during FY 1985. The static test apparatus will be modified for operation with Te vapor, screening tests made with Te vapor, and a series of static tests with Te vapor completed. The dynamic tests with CsOH and CsI will be completed and the system modified for Te vapor.

Beyond FY 1985

The dynamic tests with Te will be completed. Static and dynamic tests on other fission product species will be conducted. Also, dynamic tests under condensing conditions will be conducted. Final reports on the tests with CsOH and CsI, other fission product species, and condensing conditions will be prepared.

4. DESCRIPTION OF ANY FOLLOW-ON EFFORTS:

The results of these tests will be incorporated into fission product transport codes (e.g., TRAP-MELT) and employed in other accident evaluation projects (e.g., SASA). Since the data provided by this task are required for accident evaluation efforts, the results will also be applicable to PRA efforts.

5. RELATIONSHIP TO OTHER PROJECTS:

This work provides required information for NRC programs relating to LWR accident source term evaluation. For example, input data are provided to the TRAP-MELT code and should be useful in understanding the results of the PBF Severe Fuel Damage experiments and the Marviken experiments.

Programs which relate to PRA methods and application require this type of data to allow soundly-based accident consequence determinations.

The Severe Accident Sequences Analysis Program (SASA) will be aided by providing data to improve accident consequence evaluations.

PROJECT TITLE:

Fission Product Deposition on Aerosols

ITEM NO.

6. REPORTING SCHEDULE:

Progress will be reported monthly via the monthly highlights report.

Data reports (NRC Interim reports) will be provided soon after each test group.

The final reports listed under item 3 will be provided.

7. SUBCONTRACTOR INFORMATION:

Not applicable.

8. LIST NEW CAPITAL EQUIPMENT REQUIRED:

Description and Justification	Obligation Estimates FY-1984	FY-1985	FY-1986	FY-1987
(1) Instrumentation for the gamma monitoring and high temperature environment				
Gamma counter system	20	10	5	
Furnace	10	10	10	20
Flowmeters	5			
(2) Data analysis system	—	20	—	—
TOTAL	35	40	15	20

9. DESCRIBE SPECIAL FACILITIES REQUIRED:

Not applicable.

10. CONFLICT OF INTEREST INFORMATION:

There are no known relationships between this organization or its employees with industries regulated by the NRC and suppliers thereof that might give rise to an apparent or actual conflict of interest regarding the work described in this proposal.

PROJECT TITLE:
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11. OBLIGATION ESTIMATES:

Operating Expenses	Obligation Estimates FY-1983	FY-1984	FY-1985	FY-1986	FY-1987
(1) Cost Estimates	230	375	394	299	395
(2) Goods and Services on Order-GSO Estimate	120	30*	90	119	126
Less: Uncosted Balance 9/30	0	120	30	90	119
GSO Change	120	(90)	60	29	7
(3) TOTAL OBLIGATIONS-CHANGE	350	285	454	328	402

*Please note that an additional $88 K in FY-1984 is needed for adequate forward financing.

12. OTHER:

12(a). QUALITY ASSURANCE AND CONTROL:

Quality assurance procedures of the Chemical Technology Division and Union Carbide Nuclear Division will be adhered to.

12(b). COST AND MILESTONE CHARTS:

A. PROJECTED COST SCHEDULE

Costs	Prior Years	1983	1984	1985	1986	1987	1988	1989	Total Estimated Cost
Subtask 1	0	90	75	94	150	95	150	200	854
Subtask 2	0	90	150	150	90	150	0	0	630
Subtask 3	0	50	150	150	59	150	150	50	759
TOTAL COST	0	230	375	394	299	395	300	250	2243

NO. 12(b)

SUBTASK/MILESTONE SCHEDULE

SUBTASK/MILESTONE

Subtask 1. Planning and Analysis

a. Conceptual design of test apparatus

b. Work plan (draft); updated version(s)

c. Data reports (draft); NRC Interim reports (continuing activity)

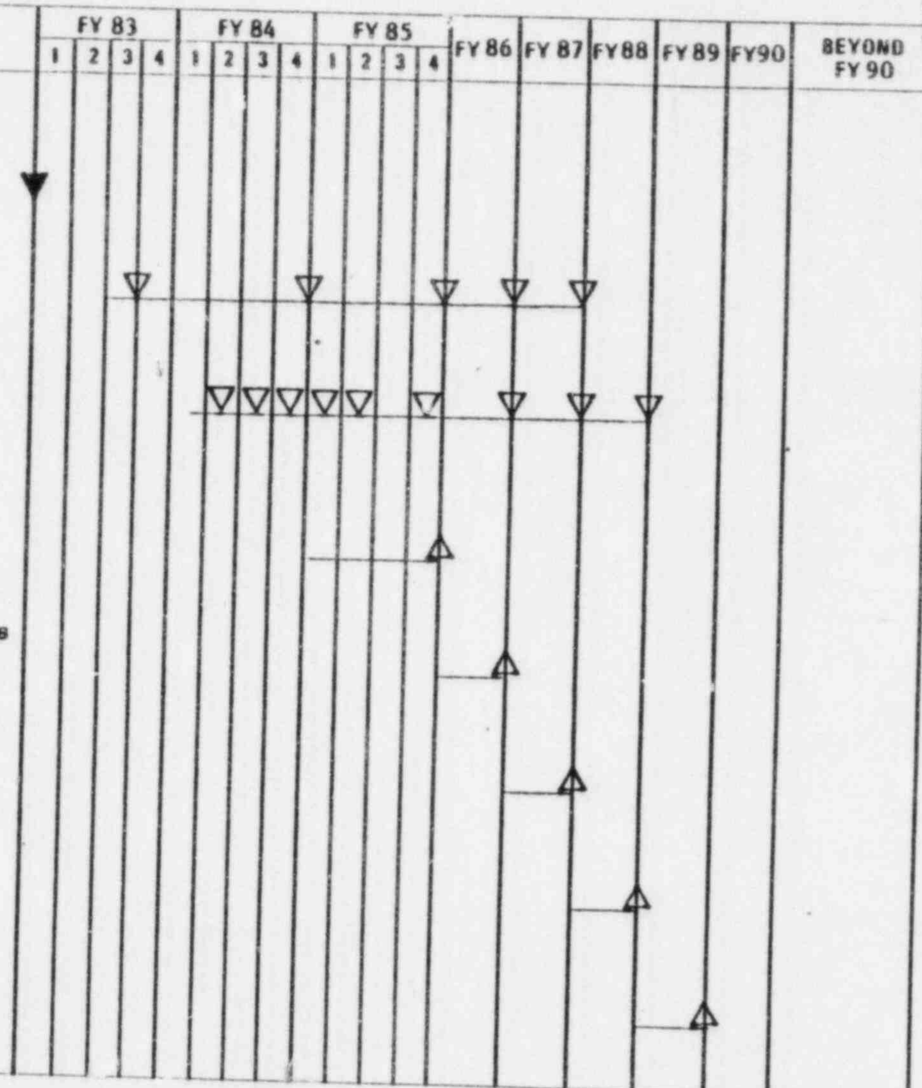
d. Final report: Isotherms for CsOH and CsI Vapor Adsorption onto Captured Aerosols (draft)

e. Final report: Deposition of CsOH and CsI Vapor onto Aerosols and Walls and Isotherms for Te

f. Final report: Deposition of Te Vapor onto Aerosols and Walls (draft)

g. Final report: Isotherms and Deposition Studies for Other Fission Product Species

h. Final report: Deposition Studies Under Condensing Conditions



NO. 12(b)

SUBTASK/MILESTONE SCHEDULE

SUBTASK/MILESTONE	FY 83				FY84				FY 85				FY 86	FY 87	FY88	FY89	FY90	BEYOND FY 90
	1	2	3	4	1	2	3	4	1	2	3	4						
Subtask 2. **Static Tests**																		
a. Fabricate test apparatus and acquire materials					Δ													
b. Screening tests with CsOH and CsI to rank aerosols					Δ													
c. Test series 1: CsOH and CsI adsorption/desorption onto/off captured aerosols								Δ										
d. Test series 2: Te adsorption/desorption onto/off captured aerosols												Δ						
e. Test series 3: adsorption/desorption tests with other fission product species														Δ				
Subtask 3. **Dynamic Tests**																		
a. Fabricate test apparatus and acquire materials							Δ											
b. Test series 4: CsOH and CsI deposition on aerosols and walls												Δ						
c. Test series 5: Te deposition on aerosols and walls													Δ					

NO. 12(b)

SUBTASK/MILESTONE SCHEDULE

SUBTASK/MILESTONE	FY 83 1	FY 83 2	FY 83 3	FY 83 4	FY 84 1	FY 84 2	FY 84 3	FY 84 4	FY 85 1	FY 85 2	FY 85 3	FY 85 4	FY 86	FY87	FY88	FY 89	FY90	BEYOND FY 90
d. Test series 6: deposition tests with other fission product species													—	—△				
e. Modify apparatus for condensing studies															△			
f. Test series 7: deposition studies under condensing conditions for the vapor															—	△		