



U.S. NUCLEAR REGULATORY COMMISSION

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

DATE OF PROPOSAL
7/20/83

☒ NEW
☐ REVISION NO.

PROJECT TITLE:
TRAP-MELT VALIDATION TESTS

FIN NUMBER
80488

NRC OFFICE
Office of Nuclear Regulatory Research; Division of Accident Evaluation

NRC S&R NUMBER
60 19 02 01

DOE CONTRACTOR
UNION CARBIDE CORPORATION

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 13 8
DIV. 03, 16

SITE
OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE 37830

DOE S&R NUMBER
40 10 01 06

COGNIZANT PERSONNEL

ORGANIZATION

FTS PHONE NUMBER

PERIOD OF PERFORMANCE

NRC PROJECT MANAGER

M. Jankowski

FSER

427-4461

STARTING DATE

April 1, 1982

OTHER NRC TECHNICAL STAFF

~~XXXXXXXXXXXXXXXXXXXX~~

FSER

427-4266

COMPLETION DATE

September 30, 1985

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

624-6863/0561

PROJ. MGR.: A.L. Wright

ETD

624-6878

PRIN. INVESTIGATOR(S): A.L. Wright

ETD

624-6878

STAFF YEARS OF EFFORT (Round to nearest tenth of a year)

FY 19 83

FY 19 84

FY 19 85

FY 1986

FY 1987

Direct Scientific/Technical

3.9

1.9

2.1

Other Direct

1.1

0.5

0.6

TOTAL DIRECT STAFF YEARS

5.0

2.4

2.7

0

0

COST PROPOSAL (OBLIGATIONS)

(\$ in thousands)

Direct Salaries (Cost Centers)

311

145

172

Material and Services (Excluding AOP)

122

65

95

AOP Support

2

5

10

Subcontracts and Consultants

138

50

0

Travel Expenses

Foreign

0

0

0

Domestic

17

5

8

Indirect Labor Costs (Cost Centers)

Other (Specify)

(GSO Change)

-135

-50

0

0

0

General and Administrative (G&A/GPS)

140

68

88

0

0

TOTAL OPERATING COST (Obligations)

595

288

373

0

0

CAPITAL EQUIPMENT

FIN CHARGED:

80488

20

12

0

0

0

TOTAL PROJECT COST (Obligations)

615

300

373

0

0

FY 1984

OCTOBER

NOVEMBER

DECEMBER

JANUARY

FEBRUARY

MARCH

MONTHLY FORECAST

EXPENSE

38

38

39

35

25

25

APRIL 25

MAY 25

JUNE 25

JULY 25

AUGUST 25

SEPTEMBER 25

8507130147 850415
PDR FOIA
ALVAREZB5-110 PDR

NRC FORM 189 Page 2 of 3 (2-81)		U.S. NUCLEAR REGULATORY COMMISSION				FIN NUMBER B0488											
PROJECT AND BUDGET PROPOSAL FOR NRC WORK						DATE 7/20/83											
PROJECT TITLE: TRAP-MELT VALIDATION TESTS																	
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 19 83		FY 19 84		FY 19 85		FY 19 86		FY 19 87							
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
1. Management and Analysis	SCHEDULE																
	COST	100		93		112		0									
2. Aerosol Transport Tests	SCHEDULE																
	COST	134		93		56		0									
3. Aerosol Resuspension Tests	SCHEDULE																
	COST	84		78		56		0									
4. Fission Product Transport Tests	SCHEDULE																
	COST	16		46		149		0									
5. Support for Marviken Experiments and Battelle Source Term Analysis	SCHEDULE																
	COST	416		40		0		0									
TOTAL ESTIMATED PROJECT COST		750		350		373		0									

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.)

<input checked="" type="checkbox"/> 1. OBJECTIVE OR PROPOSED WORK <input checked="" type="checkbox"/> 2. SUMMARY OF PRIOR EFFORTS <input checked="" type="checkbox"/> 3. WORK TO BE PERFORMED AND EXPECTED RESULTS <input checked="" type="checkbox"/> 4. DESCRIPTION OF ANY FOLLOW-ON EFFORTS <input checked="" type="checkbox"/> 5. RELATIONSHIP TO OTHER PROJECTS <input checked="" type="checkbox"/> 6. REPORTING SCHEDULE <input checked="" type="checkbox"/> 7. SUBCONTRACTOR INFORMATION <input checked="" type="checkbox"/> 8. LIST NEW CAPITAL EQUIPMENT REQUIRED	<input checked="" type="checkbox"/> 9. DESCRIBE SPECIAL FACILITIES REQUIRED <input checked="" type="checkbox"/> 10. CONFLICT OF INTEREST INFORMATION <input checked="" type="checkbox"/> 11. OBLIGATION ESTIMATES <input checked="" type="checkbox"/> 12. OTHER (SPECIFY): a. Quality Assurance and Control b. Cost and Milestone Charts 1) Project Cost Schedule 11) 189 Subtask/Milestone Charts
---	---

APPROVAL AUTHORITY SIGNATURE 	DATE 9-14-83
----------------------------------	-----------------

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

B0488

PROJECT TITLE:

TRAP-MELT VALIDATION TESTS

ITEM NO.

1. OBJECTIVE OF PROPOSED WORK:

Summary

The main objective of this project is to conduct experiments related to deposition and transport of aerosols and fission products in the reactor primary vessel under simulated LWR core-melt accident conditions. Test results will provide part of the data base needed for validation of models in the TRAP-MELT 2 code. The TRAP-MELT 2 code is being used in NRC-funded work at Battelle-Columbus Laboratories (BCL) to calculate aerosol and fission-product transport in the reactor coolant system (RCS) for postulated LWR core-melt accidents.

Additional Information

This work is divided into five subtasks:

Subtask 1 - Management and Analysis - Develop test plans, report and analyze experimental results, develop capability to run TRAP-MELT 2 code and other relevant aerosol codes, assess relevance of available models for predicting aerosol resuspension, provide assistance to NRC-RES, and coordinate with other NRC programs.

Subtask 2 - Aerosol Transport Tests - Design and perform experiments to investigate aerosol deposition and transport in a simulated "upper-plenum" geometry for a range of possible core-melt accident conditions. This work is coordinated with the CRI-II experiments performed in 80121. Experimental parameters include gas flow rate (aerosol "residence time"), aerosol material (metal or oxide aerosol), pipe wall temperature, and flow gas (inert gas vs. steam).

Subtask 3 - Aerosol Resuspension Tests - Design and perform experiments to investigate aerosol resuspension phenomena that might occur in the reactor pressure vessel under core-melt accident conditions. Test results will provide a basis for developing a resuspension correlation that could be included in the TRAP-MELT 2 code. Experimental parameters include aerosol material (metal or oxide aerosol), aerosol loading on collection surface, and system humidity.

Subtask 4 - Fission Product Transport Tests - Design and perform experiments to investigate the reactor vessel transport behavior of a mixture of simulated core-material aerosols/volatile fission-product species liberated under a range of core-melt accident conditions. This work is coordinated with CRI-II work performed in 80121, and with real-fuel release studies performed in 80127. Experimental parameters include the mixture of simulated core materials (PWR or BWR), test section temperatures, and test section steam/gas flow rates.

Subtask 5 - Support for Marviken Experiments and Battelle Source Term Analysis - Provide experimental and analytical support for the Marviken experiments to be performed in Sweden. Provide analytical support for source term analyses being conducted at Battelle-Columbus Laboratories. Starting in FY 1984, support for the Marviken project will be funded through 80831.

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

80488

PROJECT TITLE:

TRAP-MELT VALIDATION TESTS

ITEM NO.

2. SUMMARY OF PRIOR EFFORTS:

Summary

This project was started in mid-FY 1982. Efforts to date have been largely related to experimental set-up. The Aerosol Transport Test Section was constructed, ten preliminary tests were performed (using zinc and iron oxide as aerosol sources), and the first two experiments outlined in the test plan were performed. The Aerosol Resuspension Test Section was constructed and four preliminary experiments were performed. The "reference version" of the TRAP-MELT code (TRAP-MELT 1), and the QUICK aerosol code were made operational at ORNL. The QUICK code was used to analyze results from the preliminary Aerosol Transport Tests. At the request of NRC-RES, a review of the status of validation of the TRAP-MELT 2 code was written.

Experimental support for the Marviken project was provided through tests performed in the ORNL CRI-II facility; analytical support for the Marviken work was supplied through subcontracts with Battelle-Columbus Laboratories and Sandia National Laboratories. Analytical support for the Battelle Source Term Analysis consisted of analyses related to fission product chemical reactions, tellurium release, and BWR Standby Gas Treatment System operation.

Additional Information

The TRAP-MELT validation project is an extension of work performed in the LWR Aerosol Release and Transport (ART) Program (B0121). The aerosol generation equipment to be used in the TRAP-MELT project was developed in the ART program. The plasma torch aerosol generator (used in Subtasks 2 and 3) has been used in the ART program to generate high aerosol concentrations in closed vessels; the radio-frequency core-melt furnace (used in Subtask 4) has been used in the ART program to melt simulated one-kilogram core bundles.

The TRAP-MELT 2 code includes the aerosol behavior models included in the QUICK aerosol code. Since this is the case, it is appropriate to analyze the Aerosol Transport Test results using both TRAP-MELT 2 and QUICK.

3. WORK TO BE PERFORMED AND EXPECTED RESULTS:

Summary

All experiments planned in Subtasks 2-4 will be completed. A "quick-look" data report will be issued one month after each test, and a comprehensive data record report will be issued summarizing experimental results from each subtask. Experiments from Subtasks 2 and 4 will be analyzed using the TRAP-MELT 2 and QUICK codes. An assessment of the state of validation of TRAP-MELT 2, relative to comparison of calculational and test results, will be made. Experimental results from Subtask 3 will be used to develop an aerosol resuspension correlation that can be used in the TRAP-MELT 2 code. All TRAP-MELT project efforts will be coordinated with similar efforts ongoing at Idaho Falls (PBF SFD-2 tests) and in Sweden (Marviken tests).

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

B0488

PROJECT TITLE:

TRAP-MELT VALIDATION TESTS

ITEM NO.

Summary (Continued):

NOTE: Test conditions for experiments to be performed in Subtasks 2-4 are described in detail in the March 9, 1983 letter from A. L. Wright to Lisa Chan, NRC: "Description of Experiments Planned for the ORNL TRAP-MELT Verification Test Program."

FY 1984

Subtask 1. The TRAP-MELT 2 code will be made operational on the ORNL computer. Results from the Aerosol Transport Tests (Subtask 2) will be analyzed using TRAP-MELT 2 and QUICK. A survey of previous aerosol resuspension models and experiments will be completed. A draft report on the revised test plans for Subtasks 2-4 will be completed.

Subtask 2. All planned Aerosol Transport Tests will be completed. A "quick-look" data report will be issued one month after each test.

Subtask 3. All planned Aerosol Resuspension Tests will be completed. A "quick-look" data report will be issued one month after each test.

Subtask 4. Construction of the test section for the Fission Product Transport Tests will be completed.

FY 1985

Subtask 1. Results from the Fission Product Transport Tests (Subtask 4) will be analyzed using the TRAP-MELT 2 code. Based on results from the Aerosol Resuspension Tests (Subtask 3), a resuspension model will be developed that can be included in the TRAP-MELT 2 code. A report on the status of validation of the TRAP-MELT 2 code will be completed. Recommendations will be made to NRC-RES as to the status of validation of TRAP-MELT 2, and as to additional efforts needed to validate the code.

Subtask 2. The data record report for the Aerosol Transport Test series will be completed.

Subtask 3. The data record report for the Aerosol Resuspension Test series will be completed.

Subtask 4. Preliminary Fission Product Transport Tests will be performed, and all planned experiments will be completed. A "quick-look" data report will be issued one month after each test. The data record report for the Fission Product Transport Test series will be completed.

4. DESCRIPTION OF ANY FOLLOW-ON EFFORTS:

Follow-on efforts could include aerosol transport tests in other geometries and with multiple aerosol species, aerosol resuspension tests done under variable (pulsed) flow conditions and with other aerosol species, and fission-product transport tests utilizing the larger (10 kilogram) core-melt furnace.

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

B0488

PROJECT TITLE:

TRAP-MELT VALIDATION TESTS

ITEM NO.

5. RELATIONSHIP TO OTHER PROJECTS:

This project is closely coordinated with NRC-funded work at Battelle-Columbus Laboratory, where the TRAP-MELT 2 code was developed, with activities associated with the proposed Power-Burst Facility Severe-Fuel Damage Series-2 (PBF SFD-2) experiments at INEL in Idaho Falls, with activities related to the proposed Marviken experiments in Sweden, with the fission product chemistry work at Sandia, with NRC foreign-exchange agreement activities, and with similar DOE-funded research at other laboratories. At ORNL, the program is closely coordinated with the Marviken project support effort (B0831), with the PBF SFD-2 support effort (B0827), with the fission-product release studies performed in B0127, and with fission-product transport analyses performed as part of the Severe Accident Sequence Analysis Program (B0452).

6. REPORTING SCHEDULE:

Publications in FY 1983

1. T. S. Kress and A. L. Wright, "Status of Validation of the TRAP-MELT Computer Code for the Accident Source Term Reassessment Study (ASTRS)," [Draft submitted to NRC on June 22, 1983; draft will become part of ORNL/TM-8842, "Status of Validation of Computer Codes Used in the Accident Source Term Reassessment Study (BMI-2104)."]
2. R. A. Lorenz, E. C. Beahm, and R. P. Wichner, "Review of Tellurium Release Rates from LWR Fuel Elements and Aerosol Formation from Silver Control Rod Material" (February 28, 1983, letter report).
3. S. A. Hodge, "Standby Gas Treatment System Operation and Effectiveness Under Severe Accident Conditions" (May 4, 1983, letter report).
4. E. C. Beahm, R. P. Wichner, and R. A. Lorenz, "Overview of Chemical Reactions Involving Fission Product Iodine, Cesium, and Tellurium" (Draft to be submitted to NRC on July 25, 1983).

Expected Future Reports

Literature Survey on Aerosol Resuspension Models (Draft to be submitted to NRC November 1983).

Updated Test Plan for TRAP-MELT Validation Tests (Draft to be submitted to NRC January 1984).

Data Record Report for Aerosol Resuspension Tests (January 1985).

Data Record Report for Aerosol Transport Tests (March 1985).

Data Record Report for Fission Product Transport Tests (September 1985).

Report on Assessment of Test Results Relative to TRAP-MELT Validation (September 1985).

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

80488

PROJECT TITLE:

TRAP-MELT VALIDATION TESTS

ITEM NO.

7. SUBCONTRACTOR INFORMATION:

<u>Description and Justification</u>	<u>Cost Estimates</u>	
	<u>FY 1984</u>	<u>FY 1985</u>
1. Subcontract was opened in FY 1983 with Stuart K. Beal of S. Cohen and Associates. The proposed work involves review of various aerosol mechanisms that might be important in the reactor coolant system during LWR core-melt accidents. Present subcontract effort started in July 1983 and will end in December 1984.	10	0
2. A subcontract was opened with Battelle-Columbus Labs in FY 1983 to provide support for a Battelle staff member who is currently working at the Marviken project test site in Sweden.	40	0
TOTAL	<u>50</u>	<u>0</u>

8. LIST NEW CAPITAL EQUIPMENT REQUIRED:

<u>Description and Justification</u>	<u>Obligation Estimates</u>	
	<u>FY 1984</u>	<u>FY 1985</u>
1. Upgrade of plasma torch aerosol generator. A heat exchanger is needed for use with the plasma torch purchased in FY 1983.	6	0
2. Flow-meter for Fission Product Transport Tests. A flow-meter is necessary to make direct measurements of gas/steam flows.	3	0

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

B0488

PROJECT TITLE:

TRAP-MELT VALIDATION TESTS

ITEM NO.

8. LIST NEW CAPITAL EQUIPMENT REQUIRED (Continued):

Description and Justification	Obligation Estimates	
	FY 1984	FY 1985
3. Aerosol instrumentation for Aerosol Resuspension Tests. Additional instrumentation is needed to make direct measurements of resuspended aerosol mass and resuspended particle sizes.	3	0
TOTAL	<u>12</u>	<u>0</u>

9. DESCRIBE SPECIAL FACILITIES REQUIRED:

Experiments are being performed in the area of the existing CRI-II Facility in Building 4501 at ORNL. Aerosol and fission product simulant generation and characterization equipment developed in the Aerosol Release and Transport Program (B0121) are being used.

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.

11. OBLIGATION ESTIMATES:

Operating Expenses	Obligation Estimates			
	Prior Years	FY 1983	FY 1984	FY 1985
(1) Cost Estimates	217	750	350	373
(2) Goods and Services on Order-GSO Estimate	185	50*	0*	0
Less: Uncosted Balance 9/30	0	185	50	0
GSO Change	<u>185</u>	<u>-135</u>	<u>-50</u>	<u>0</u>
(3) TOTAL OBLIGATIONS - CHANGE	<u>402</u>	<u>615</u>	<u>300</u>	<u>373</u>

*Please note an additional \$55K in FY 1983 and \$112K in FY 1984 is needed for adequate forward financing.

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

80488

PROJECT TITLE:

TRAP-MELT VALIDATION TESTS

ITEM NO.

12. OTHER:

12a. QUALITY ASSURANCE AND CONTROL:

The tasks in this program are performed under the Quality Assurance requirements specified in the QA standards QA-L-3-100 (rev. 2), QA-L-14-100 (rev. 2), and QA-CT-20-100.

12b. COST AND MILESTONE CHARTS:

A. PROJECT COST SCHEDULE

<u>Costs</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>Total Estimated Cost</u>
Subtask 1	71	100	93	112	376
Subtask 2	41	134	93	56	324
Subtask 3	15	84	78	56	233
Subtask 4	15	16	46	149	226
Subtask 5	75	416	40	0	531

END

NO. 12b.

SUBTASK/MILESTONE SCHEDULE

SUBTASK/MILESTONE	FY 83				FY 84				FY 85				FY	FY	FY	FY	FY	BEYOND FY
	1	2	3	4	1	2	3	4	1	2	3	4						
1. Task 1: <u>Management and Analysis</u>																		
a. Incorporate TRAP-MELT 2 code on ORNL computer.				▽														
b. Complete survey on Aerosol Resuspension Models (draft report).	▽			◇														
c. Complete revised test plan (draft report).	▽			◇														
d. Analyze test results as they become available.				continuing activity														
e. Complete NUREG report on assessment of test results relative to TRAP-MELT validation.												△						
2. Task 2: <u>Aerosol Transport Tests</u>																		
a. Complete test section design and construction; complete scoping tests.			◆															
b. Start planned aerosol transport tests.			△	◇														
c. Issue "quick-look" data report for each test, one month after test completed.				continuing activity														
d. Complete planned aerosol transport tests.								△										
e. Complete aerosol transport test data record report.											▽							

TITLE: TRAP-MELT VALIDATION TESTS

ACTIVITY NO. 60 19 02 01
199A NO. 30488
OF
FTP/A NO.

SUBTASK/MILESTONE SCHEDULE

NO. 12b.

SUBTASK/MILESTONE	FY 83				FY 84				FY 85				FY	FY	FY	FY	FY	BEYOND FY
	1	2	3	4	1	2	3	4	1	2	3	4						
3. Task 3: <u>Aerosol Resuspension Tests</u>																		
a. Complete test section design and construction.				◆														
b. Start planned aerosol resuspension tests.	△			◇														
c. Issue "quick-look" data report for each test, one month after test completed.					continuing activity													
d. Complete aerosol resuspension tests.								△										
e. Complete aerosol resuspension test data record report.												▽						
4. Task 4: <u>Fission Product Transport Tests</u>																		
a. Complete test section design and construction.	▽							◇										
b. Start planned fission product transport tests.	△							◇										
c. Issue "quick-look" data report for each test, one month after test completed.									continuing activity									
d. Complete planned fission product transport tests.												△						
e. Complete fission product transport test data record report.																		▽