



## PROJECT AND BUDGET PROPOSAL FOR NRC WORK

DATE OF PROPOSAL

7/83

☒ NEW☐ REVISION NO.

## PROJECT TITLE

Posttest Fuel Examination (ORNL Fission Product Release Test Specimens)

PIN NUMBER

A2232

## NRC OFFICE

Nuclear Regulatory Research

NRC SAR NUMBER

60-19-02-01

## DOE CONTRACTOR

Argonne National Laboratory

CONTRACTOR ACCOUNT  
NUMBER

8M484

## SITE

Argonne, Illinois

DOE SAR NUMBER

40-10-01-06

## COGNIZANT PERSONNEL

## ORGANIZATION

## FTE PHONE NUMBER

## PERIOD OF PERFORMANCE

## NRC PROJECT MANAGER

L. K. Chan

DAE-FBB

427-4715

## STARTING DATE

10/01/81

## OTHER NRC TECHNICAL STAFF

## COMPLETION DATE

open

## DOE PROJECT MANAGER

R. J. Dalton

DOE-CH

972-2229

## CONTRACTOR-PROJECT MANAGER

B. R. T. Frost

ANL/MST

972-4928

## PRINCIPAL INVESTIGATOR(S)

R. V. Strain

E. A. Neimark

ANL/MST

972-5179

972-5177

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

FY 1983

FY 1984

FY 1985

FY 1986

FY

Direct Scientific/Technical

0.7

1.2

1.0

Other Direct (Grades)

0.5

0.6

0.5

## TOTAL DIRECT STAFF YEARS

1.2

1.8

1.5

## COST PROPOSAL

Direct Salaries

51

85

78

Materials and Services (Excluding ACP)

40

26

25

ACP Support

—

—

—

Subcontracts

—

—

—

Travel Expenses

Foreign  
Domestic

3

3

3

Division Overhead

26

42

39

Other (Specify) Reactor Program Administration

3

4

4

General and Administrative (17.3 %)

26

34

31

## TOTAL OPERATING COST

149

194\*

180

100

## CAPITAL EQUIPMENT

PIN CHARGED: A2232

4

23

—

## TOTAL PROJECT COST

153

217

180

100

FY 1984

OCTOBER

NOVEMBER

DECEMBER

JANUARY

FEBRUARY

MARCH

MONTHLY FORECAST  
EXPENSE

18

18

18

18

18

18

APRIL

MAY

JUNE

JULY

AUGUST

SEPTEMBER

18

18

18

18

18

19

## PROJECT AND BUDGET PROPOSAL FOR NRC WORK

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DATE

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## PROJECT TITLE

Posttest Fuel Examination (ORNL Fission Product Release Test Specimens)

## DOE PROPOSING ORGANIZATION

Argonne National Laboratory

FORECAST MILESTONE CHART: Scheduled 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			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
PTE of Specimens for "Low-temperature" Tests	SCHEDULE																				
	COST																				
Shielding of Scanning Auger Microscope	SCHEDULE																				
	COST																				
PTE of Specimens from "High-temperature" Tests	SCHEDULE																				
	COST																				
Material Disposal	SCHEDULE																				
	COST																				
Equipment Procurement	SCHEDULE																				
	COST																				
TOTAL ESTIMATED PROJECT COST																					

PROJECT DESCRIPTION: Provide narrative descriptions of the following tables in the order listed. Attach on plain paper to this NRC Form 189. If an item is not applicable, so state. \*Includes \$74K carryover from FY 83.

1. OBJECTIVE OF PROPOSED WORK
2. SUMMARY OF PRIOR EFFORTS
3. WORK TO BE PERFORMED AND EXPECTED RESULTS
4. DESCRIPTION OF ANY FOLLOW-ON EFFORTS
5. RELATIONSHIP TO OTHER PROJECTS
6. REPORTING SCHEDULE
7. SUBCONTRACTOR INFORMATION
8. LIST NEW CAPITAL EQUIPMENT REQUIRED
9. DESCRIBE SPECIAL FACILITIES REQUIRED
10. CONFLICT OF INTEREST INFORMATION

SEE NRC MANUAL CHAPTER 1102 FOR ADDITIONAL INFORMATION

APPROVAL AUTHORITY—SIGNATURE

DATE

## 1. Objective of Proposed Work

The objectives of this program are: (1) perform posttest examinations of irradiated commercial fuel rod specimens subjected to high-temperature fission-product release testing at ORNL; (2) develop information on fuel response and the mechanisms of fission-product release during these tests; (3) evaluate and interpret the examination results for applications to the study of reactor accidents and accident simulations; and (4) provide an independent check on uniformity of temperature and steam flow during the ORNL experiments. The examinations consist of optical and scanning electron microscopy, quantitative stereology, and microchemical characterization by scanning Auger and electron microprobe analysis. Both high-temperature-tested specimens and sibling fuel specimens in the as-irradiated condition are being examined. The examinations are performed at the Alpha-Gamma Hot Cell Facility at ANL on small specimens obtained from the fuel rod segments tested at ORNL. Included in this proposal are the examinations of "Phase I" tests, to be performed in FY 1982 and FY 1983, and any additional tests performed in FY 1984 and beyond.

## 2. Summary of Prior Efforts

This program was initiated at the end of FY 1982 with the arrival of specimens from ORNL's HI-1 (~1400°C) and HI-2 (~1700°C) tests. The microstructural character of the specimens was analyzed for fuel/cladding interactions, porosity distributions, fission-gas bubble morphology and location, cladding oxidation, and identification of specific fission-product concentrations. Conclusions were drawn as to the specimen temperature distribution during the test, cladding oxidation scenario, and fission-gas behavior/release as a function of test temperature. A draft "quick-look" report on the microstructural characterization results was issued in April. The microchemical characterization of HI-1 and HI-2 specimens (four additional specimens were received in the fourth quarter of FY 1983) was also completed with emphasis on the fuel/cladding interaction, the location of Cs and I fission products, and oxidation of the fuel. Three samples from the HI-3 test (~2000°C) were received in the fourth quarter of FY 1983 and work progressed on their microstructural characterization.

The information derived from the HI-1 and HI-2 examinations was conveyed to ANL's fission-product modeling effort (FASTGRASS, being developed under FYN No. A2016).

The shielding for the Auger microprobe was procured and installed. This will allow the examination of the hot fuel and cladding samples for oxidation of the fuel and cladding.

### 3. Work to be Performed and Expected Results

#### FY 1984

Microstructural and microchemical characterization will be completed on the HI-3 samples. Similar examinations will be performed on samples from HI-4, -5, and -6. These additional tests will be performed on fuel irradiated in different reactors (PWR and BWRs) to several different burnups and tested with varying steam flow-rates and temperature as variables. With the completion of these examinations, a relatively complete description of the mechanisms for fission-product release at temperatures  $<2000^{\circ}\text{C}$  should be available. The mechanisms derived will be interfaced with the FASTGRASS modeling efforts. Technical assistance will be provided to NRC and ORNL as directed by DAE/FBB in the areas of fission-product release from fuel at high temperatures. Quick-look reports will be issued approximately one month after the completion of the examination of each test's remains.

#### FY 1985

Pre- and posttest characterization of fuel specimens will be performed as the materials become available from the ORNL program. The release of fission products at temperatures greater than  $2000^{\circ}\text{C}$  will be emphasized. The results of the posttest characterization will be used in the further development and verification of the fission-product release models in FASTGRASS. Technical assistance will continue to be provided to NRC and ORNL as directed by DAE/FBB in the area of fission-product release from fuel at high temperature.

### 4. Description of Follow-on Efforts

Follow-on efforts in this program will depend upon the duration of the experimental program at ORNL. Should the examinations be wrapped up in FY 1985, then the work in FY 1986 will consist of writing final reports and waste disposal. Also, fuels characterization work directed toward specific technical issues will be performed as requested by DAE/FBB.

### 5. Relationship to Other Projects

This program has a direct interface with the ORNL program on high-temperature fission-product release. This relationship includes, but is not limited to, the joint selection of specimens for detailed examination, the coordination of specimen shipments, and joint participation in the correlation of test data with the posttest examination results. The program is also closely tied to Argonne's program on code development for fission-product release and fuel behavior. The posttest characterization will provide: (1) the mechanistic information required for the development of detailed fission-product release models; and (2) a data base that, in combination with the ORNL release measurements, will be used for verification of the computer models. The program will produce results that are of interest to the interpretation of the PBF severe fuel damage tests, and the TMI-2 postmortem. The program results can also be used to check the validity of the SASCHA and ORNL 10-kg melt tests on simulated fuel/fission-product mixtures.

6. Reporting Schedule

FY 1984 - Planned

R. V. Strain, Quick Look Report on the Examination of the HI-3 Test (1st Quarter).

R. V. Strain, Quick Look Report on the Examination of the HI-4 and HI-5 Tests (3rd Quarter).

R. V. Strain, Topical Report on PTE Performed on Tests through HI-5 (4th Quarter).

FY 1985 Planned

R. V. Strain, Quick Look Reports on Posttest Examinations (2nd, 4th Quarters).

R. V. Strain, Topical Report on PTE through 2nd Quarter of FY 1985 (4th Quarter).

7. Subcontractor Information

Not applicable.

8. Equipment Items

A computer costing \$46K is very desirable to facilitate Auger microprobe data collection, analysis, and presentation. The use in this program is principally in oxygen analyses of the fuel and cladding of specimens that have been exposed to highly oxidizing (steam) environments. Because the Auger microprobe is used in other programmatic work, the cost to this program will not exceed \$23K, and will likely be less if equipment funds from other programs can be obtained. No procurement action will be taken without prior approval of the NRC Project Manager.

9. Special Facilities Required

The examination of the ORNL specimens will be conducted in the Alpha-Gamma Hot Cell Facility at ANL-East. This facility has been engaged in reactor fuels and materials work for 18 years. Over the years its forte has become the in-depth examination of irradiated materials using a wide variety of examination techniques and sophisticated equipment. The facility's uniqueness derives from three principal sources: 1) a staff of senior materials people with extensive experience in understanding materials behavior; 2) an array of electron beam instruments adapted for interrogating irradiated materials including a scanning electron microscope, a scanning Auger microprobe, and an electron microprobe; and 3) proximity to other analytical instruments at ANL-E such as an ion microprobe and an ESCA Auger unit that are also capable of handling irradiated materials. The facility currently supports programs totaling approximately \$1.7M annually, including the costs to operate the facility and the balance of the programmatic effort. To replace such a facility would cost about \$50M and require about six years.

10. Conflict of Interest Information

Argonne National Laboratory presently conducts research for NRC and no conflict of interest is involved.