



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, D. C. 20555

*Erickson  
note page 4*

September 17, 1984

ACRS Members

LIST OF ACRS SUBCOMMITTEE MEETINGS SCHEDULED THROUGH DECEMBER 12, 1984

Attached is a list of public ACRS Subcommittee meetings currently scheduled.

If you are listed and cannot attend a meeting, or if you are not listed but would like to attend, please advise the ACRS Office. Most motels and hotels require a guaranteed reservation if arrival is to be after 6:00 p.m. Cancellation of guaranteed reservations must be made before noon of the scheduled day of arrival. Failure to use a room under these conditions involves forfeiture of the cost. Please advise the ACRS Office as soon as possible, if you cannot attend a meeting for which you are listed, so that the reservation can be cancelled in sufficient time.

*Thomas G. McCreless*  
Thomas G. McCreless  
Assistant Executive Director  
for Technical Activities

Attachment:  
Meeting Schedule

- cc: w/Attmt.
- ACRS Staff
- A. R. Bailey, SECY
- A. Bartlett, RES
- A. Black, CEO
- A. H. Burnett, SORT
- A. B. Cunningham, FC
- A. A. Denton, NRR
- R. C. DeYoung, IS (8)
- K. J. Dircks, EDO
- G. L. Edson, RES
- M. Gallispie, RES
- A. A. Hartfield, CRM
- M. A. Magee, SECY
- A. B. Minogue, RES (3)
- C. A. Norberg, EISS
- H. L. Ornstein, EDO
- T. Rehm, EDO
- E. E. Tucker, EEO
- P. Verran, NRR (10)

F. X. Gavigan, RAT, DOE  
H. P. Norin, NPD, DOE  
Regional Administrators,  
Regions 1-4

Hope Creek Generating Station Unit 1, Date to be determined (November/December), Salem County, NJ (El-Zeftawy). The Subcommittee will discuss certain design changes and modifications for the Hope Creek Generating Station. Attendance by the following is anticipated:

Dr. Siess  
Dr. Kerr

Dr. Okrent

Seismic Design of Piping, Date to be determined (November/December), Washington, DC (Igne). The Subcommittee will review draft reports issued by the NRC Piping Review Committee on Dynamic Loads and Load Combinations and Seismic Design requirements of piping. Attendance by the following is anticipated:

Dr. Siess  
Mr. Etherington  
Dr. Mark

Dr. Okrent  
Dr. Shewmon

Combined GESSAR II/Reliability and Probabilistic Assessment, December 4 and 5, 1984, location to be determined (Major/Savio), 8:30 a.m. This will be the second in a series of meetings to review the General Electric Standard Safety Analysis Report to extend the Final Design Approval so that it will be applicable to future plants. The meeting will focus on the GESSAR II treatment of severe accidents and the Probabilistic Risk Assessment performed in connection with the GESSAR II design. External events will be considered. Lodging will be announced later. Attendance by the following is anticipated:

Dr. Okrent  
Mr. Ebersole  
Mr. Etherington

Mr. Michelson  
Mr. Wylie

Safeguards and Security, December 12, 1984, 1717 H Street, NW, Washington, DC (Schiffers, McKinley), 8:30 a.m., Room 1046. The Subcommittee will review design features for protection against sabotage at commercial nuclear power reactors, to explore the potential consequences of nuclear sabotage at a nonpower reactor, and to hear ~~staff reviews and evaluate licensees'~~ security plans. Lodging will be announced later. Attendance by the following is anticipated:

Dr. Mark  
Dr. Carter  
Mr. Ebersole  
Mr. Michelson

Dr. Okrent  
Dr. Siess  
Mr. Wylie

Electrical Systems, Date to be determined, Washington, DC (El-Zeftawy/Savio). The Subcommittee will discuss Westinghouse Advanced Pressurized Water Reactor Integrated Control and Protection System. Attendance by the following is anticipated:

Dr. Kerr  
Mr. Ebersole  
Dr. Lewis

Dr. Mark  
Mr. Michelson  
Dr. Okrent

BUD-84:022

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Replaces GPO Form 14, Approved by NARA, June 1979

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NR 3307 DTG      2

6. FROM

L. A. GARVEY  
UNIVERSITY OF CALIFORNIA  
LOS ALAMOS NATIONAL LABORATORY  
LOS ALAMOS, NM 87545

7. OFFICIAL BUSINESS

*[Signature]* TIME      A.M.

8. DATE

SEPTEMBER 26, 1984

9. TO

U. S. NUCLEAR REGULATOR COMMISSION, MS 881-55  
SILVER SPRING, MD ATTN: DON CARLSON

UNCLAS/N O N W D/P A X

SUBJECT: NRC ORDER NO. 50-84-116, FORM 173

PER OUR TELEPHONE CONVERSATION 9-26-84; I AM SENDING YOU A COPY OF FORM 173 AND THE COVER LETTER FROM DOE - ALBUQUERQUE FOR NRC ORDER NO. 50-84-116.

BE BRIEF - ELIMINATE UNNECESSARY WORDS

11. COMMUNICATIONS CENTER SYMBOL

SEP 26 1 27 PM '84

12. ORIGINATOR (On separate sheet, enter Name, Routing Symbol, & Tel. No.)

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B/13

①

United States Government

Department of Energy

Albuquerque Operations Office

**memorandum**

## DATE:

REPLY TO: **890 11 884**  
ATTN OF: **ETD:ELB(1413)**SUBJECT: **FY 1984 NRC Authorization: Consequences of Sabotage at Non-Power Reactors (A7153)**TO: **E. D. Lathrop, Associate Director for Engineering Sciences, Los Alamos National Laboratory**Thru: **H. E. Valencia, Area Manager, Los Alamos Area Office***2 by R. Warren, Jr.*

The attached NRC Standard Order No. 30-84-116 has been accepted by the Albuquerque Operations Office. This order provides incremental funding for the subject project and requests that LANL submit a proposal based on the attached statement of work within 30 days.

Los Alamos National Laboratory is authorized to provide this assistance, without interference to DOE programs, as Reimbursable Work for Other Federal Agencies (Limitation 93). The DOE BAR Classification for this project is 40100105.

The \$93K will be included in the Notice of Obligational Limitation issued by LAAO. For a project anticipated to be supported by NRC beyond this authorization, please advise me when the accrued costs approach 90% of the authorized funding level. Certain projects may require notification before the 90% level is reached in order to assure an orderly close out. In these cases, based on your advice, we will make an early determination of NRC intent with respect to project continuation. Please assure that actual costs for this project do not exceed the total NRC obligation authority.

*Dennis L. Krens*  
Dennis L. Krens, 846-5203  
Director, Energy  
Technologies Division

## Attachment

## cc w/Att:

G. J. Garcia, BUD, 3244, LANL  
D. R. Ellis, B2MD, AL  
R. M. Sargent, FMD, AL  
L. N. Sullivan, QDC/RS, K552, LANL  
J. R. Ireland, QDC/K552, LANL  
T. R. Gibbs, BUD, 3242, LANL  
R. S. Brown, Jr., WBSB, NRC -  
D. Dandois, ORN, NRC

## cc w/o Att:

R. W. Barber, EP-341, DOE HQ

2

NRC FORM 178 (1-84)		U.S. NUCLEAR REGULATORY COMMISSION		ORDER NUMBER <b>80-84-116</b>
<b>STANDARD ORDER FOR DOE WORK</b>				DATE <b>SEP 6 1984</b>

ISSUED TO: (DOE Office) <b>Albuquerque Operations Office</b>	ISSUED BY: (NRC Office) <b>Office of Nuclear Material Safety and Safeguards</b>	ACCOUNTING CITATION APPROPRIATION SYMBOL <b>31X0200.604</b> BSR NUMBER <b>CO-19-02-00</b> PIN NUMBER <b>A 7153-4</b>					
PERFORMING ORGANIZATION AND LOCATION <b>Los Alamos National Laboratory (LANL)          Los Alamos, New Mexico 87545</b>		WORK PERIOD - THIS ORDER <table border="1"> <tr> <th>FROM</th> <th>ESTIMATED TO</th> </tr> <tr> <td><b>8/9/84</b></td> <td><b>9/30/86</b></td> </tr> </table>		FROM	ESTIMATED TO	<b>8/9/84</b>	<b>9/30/86</b>
FROM	ESTIMATED TO						
<b>8/9/84</b>	<b>9/30/86</b>						
PIN TITLE <b>Consequences of Sabotage at Non-Power Reactors</b>							

OBLIGATION AVAILABILITY PROVIDED BY:

A. THIS ORDER	\$ 93,000
B. TOTAL OF ORDERS PLACED PRIOR TO THIS DATE WITH THE PERFORMING ORGANIZATION UNDER THE SAME "APPROPRIATION SYMBOL" AND THE FIRST FOUR DIGITS OF THE "BSR NUMBER" CITED ABOVE.	\$ 1,220,000
C. TOTAL ORDERS TO DATE <span style="float: right;">(TOTAL A &amp; B)</span>	\$ 1,313,000
D. AMOUNT INCLUDED IN "C" APPLICABLE TO THE "PIN NUMBER" CITED IN THIS ORDER.	\$ 93,000

FINANCIAL FLEXIBILITY:

FUNDS WILL NOT BE REPROGRAMMED BETWEEN PINS. LINE B CONSTITUTES A LIMITATION ON OBLIGATIONS AUTHORIZED.



FUNDS MAY BE REPROGRAMMED NOT TO EXCEED ± 10% OF PIN LEVEL UP TO \$50K. LINE C CONSTITUTES A LIMITATION ON OBLIGATIONS AUTHORIZED.

STANDARD TERMS AND CONDITIONS (See NRC Manual Chapter 118E, Appendix Part 4) ARE PART OF THIS ORDER UNLESS OTHERWISE NOTED.

ATTACHMENTS: THE FOLLOWING ATTACHMENTS ARE HEREBY MADE A PART OF THIS ORDER: <input checked="" type="checkbox"/> STATEMENT OF WORK <input type="checkbox"/> ADDITIONAL TERMS AND CONDITIONS <input type="checkbox"/> OTHER	SECURITY: <input checked="" type="checkbox"/> WORK ON THIS ORDER INVOLVES CLASSIFIED INFORMATION. NRC FORM 187 IS ATTACHED. <input type="checkbox"/> WORK ON THIS ORDER INVOLVES UNCLASSIFIED SAFEGUARDED, PROPRIETARY, OR OTHER SENSITIVE INFORMATION. <input type="checkbox"/> WORK ON THIS ORDER IS UNCLASSIFIED AND NOT SENSITIVE.
<input type="checkbox"/> FEE RECOVERABLE WORK <input checked="" type="checkbox"/> NON-FEE RECOVERABLE WORK	

REMARKS (Reference the proposal by number and date, and indicate if the attached statement of work modifies the DOE proposal)

This order provides FY84 funding for initiation of this project as delineated in the attached statement of work. An NRC Form 189 based on the attached statement of work should be submitted in 5 copies to: Office of Nuclear Material Safety and Safeguards (Attn: Program Support Branch) within 30 days of the date of this order.

ISSUING AUTHORITY SIGNATURE:  <b>R. S. Brown, Jr.</b>	ACCEPTING ORGANIZATION SIGNATURE:  <b>Dennis L. Krens, Director          Energy Technologies Division</b>
TITLE <b>Assistant to the Director and Chief          Program Support Branch, NMSS</b>	TITLE <b>Dennis L. Krens, Director          Energy Technologies Division</b>
DATE <b>09/11/84</b>	

NRC FORM 178 (1-84)

**40-10-01-05 279,500.00**

**A 7153**

**9/11/84 L.P. A.D.**

CUT 24, 1984  
CUT 14

NRC FORM 100 (2-81) **US NUCLEAR REGULATORY COMMISSION** DATE OF PROPOSAL **10/1/84**  
**PROJECT AND BUDGET PROPOSAL FOR NRC WORK**  NEW  REVISION NO. **1**

PROJECT TITLE: **Consequences of Sabotage at Nonpower Reactors** FIN NUMBER: **A 7153-4**  
 NRC OFFICE: **NMSS** NRC BAR NUMBER: **50-19-02-00**  
 DOE CONTRACTOR: **Los Alamos National Laboratory** CONTRACTOR ACCOUNT NUMBER: **R21W**  
 SITE: **Los Alamos New Mexico** DOE BAR NUMBER:

COGNIZANT PERSONNEL	ORGANIZATION	FTS PHONE NUMBER	PERIOD OF PERFORMANCE
NRC PROJECT MANAGER <b>D. Carlson</b>	<b>NMSS</b>	<b>427-4712</b>	STARTING DATE <b>9/9/84</b>
OTHER NRC TECHNICAL STAFF			COMPLETION DATE <b>9/30/85</b>
DOE PROJECT MANAGER			
CONTRACTOR-PROJECT MANAGER <b>L. H. Sullivan</b>	<b>Q-00</b>	<b>843-9821</b>	
PRINCIPAL INVESTIGATOR(S) <b>T. F. Bott</b>	<b>Q-6</b>	<b>843-9207</b>	

STAFF YEARS OF EFFORT (Round to nearest tenth of a year)	FY 1984	FY 1985	FY	FY	FY
Direct Scientific/Technical	0.1	1.6			
" Direct (Graded)	0.0	0.3			
<b>TOTAL DIRECT STAFF YEARS</b>	<b>0.1</b>	<b>1.9</b>			

COST PROPOSAL		FY 1984	FY 1985	FY	FY	FY
Direct Salaries		5.7	106.4			
Material and Services (Excluding ADP)		1.8	15.3			
ADP Support		0.0	20.0			
Subcontractors		0.0	0.0			
Travel Expenses	Foreign Domestic	1.9	4.0			
Indirect Labor Costs		5.6	109.3			
Other (Specify)						
General and Administrative ( B)						
<b>TOTAL OPERATING COST</b>		<b>15.0</b>	<b>255.0</b>			
CAPITAL EQUIPMENT FIN CHARGED						
<b>TOTAL PROJECT COST</b>		<b>15.0</b>	<b>255.0</b>			

MONTHLY FORECAST EXPENSE	1985						
	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL
	21	21	21	21	21	21	21
	21	21	21	21	21	21	24

B114

DATE FOR 188  
2011

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

DATE

PROJECT TITLE

DDP PROPOSING ORGANIZATION

FORECAST W/ MILESTONE CHART SCHEDULE IS SHOWN - COMPLETE SCHEDULE IN QUARTER 3 END.  
PROVIDE ESTIMATED DOLLAR COST FOR EACH TASK FOR EACH FISCAL YEAR

TASK		FY 1984				FY 1985				FY 1986				FY 1987			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
1. Familiarization with nonpower reactors	SCHEDULE							△									
	COST		15 k					10 k									
2. Calculations of maximum and limiting Radiological Consequences	SCHEDULE							△									
	COST							75 k									
3. Calculation of Explosives or Incendiary devices required for maximum and limiting release	SCHEDULE								△								
	COST							75 k									
4. Calculations of explosives for Part 20 and 100 releases	SCHEDULE								△								
	COST							15 k									
5. Effect of unauthorized control manipulation	SCHEDULE											△					
	COST							35 k									
6. Effect of mitigating systems	SCHEDULE											△					
	COST							35 k									
7. Program Plan for FY 1986	SCHEDULE											△					
	COST							10 k									
	SCHEDULE																
	COST																
	SCHEDULE																
	COST																
TOTAL ESTIMATED PROJECT COST			15 k					255 k									

APPROVAL AUTHORITY-SIGNATURE

*[Handwritten Signature]*

DATE  
10/19/84

1. Objective of Proposed Work

a. Background

In 1979, the Los Alamos Scientific Laboratory conducted a study of the consequences of sabotage of nonpower reactors (NPRs). It was concluded that, within the constraints of this study, only one NPR had any potential for the release of significant amounts of fission product materials in the event of sabotage. Because of terrorist activities in other parts of the world, concerns of the ACRS about manipulation of reactor control systems, and concerns of a public interest group about the effects of incendiary devices on reactor components, this information should be supplemented with further technical information.

b. Objective

The objective of this work is to provide the NRC with technical information on the effects of malicious manipulation of reactor controls, blast effects from various quantities and types of explosives, and the use of incendiary devices on NPRs to assure a margin of public safety.

2. Summary of Prior Efforts

None

3. Work to be Performed and Expected Results

During the period from FY 1984 to 1986 Los Alamos will perform the following tasks.

a. Work Required

Task No. 1

Existing information in available sources, such as the NRC docket files, augmented by site-specific information provided by NRC staff and site visits will be conducted as necessary to (a) familiarize



task personnel with characteristics peculiar to each reactor and (b) obtain information necessary to aid in the calculation of the radiological consequences for three of the NPRs listed in Table I.

Within 1 month after initiation of task orders, Los Alamos shall provide a detailed work plan that identifies study milestones and their projected dates of accomplishment. Upon NRC review and approval of this plan, it will become the operating schedule for the overall task. The work plan is Appendix A to this proposal.

Task No. 2

Mathematical models or other appropriate methods will be developed and/or used to perform the following.

- a. Calculate the radiological release resulting from a total core meltdown, partial core meltdown, core disintegration and/or crushing, or other means that could damage severely the fuel in the reactor core. Because the key consideration is the fission product release associated with such incidents, the effects of using low-enriched uranium vs high-enriched uranium on the fission product release will be evaluated,

TABLE I  
LIST OF REACTORS

<u>Licensee</u>	<u>Docket No.</u>	<u>Power Level</u>	<u>Reactor Type</u>
National Bureau of Standards	50-184	20 MW	Tank
University of Missouri	50-186	10 MW	Tank
Georgia Institute of Technology	50-160	5 MW	Tank
Massachusetts Institute of Technology	50-20	5 MW	Tank
Union Carbide	50-54	5 MW	Pool
Rhode Island Atomic Energy Commission	50-193	2 MW	Pool
State University of New York	50-57	2 MW	Pool
University of Michigan	50-2	2 MW	Pool
University of Virginia	50-62	2 MW	Pool

- b. Determine, as a function of distance from the reactor, the total radiation dose (rem) to the whole body and the radiation dose (rem) to the thyroid from iodine exposure and identify any facility for which these could exceed 10 CFR 20 and 10 CFR 100 standards
- c. Determine the characteristics of the event that would limit it to less than Parts 20 and 100 standards.

Certain other parameters and assumptions should be considered when performing this task. These include and are limited to the following except as may be approved by the NMSS Project Manager (PM) in the future.

- a. The models or methods used to calculate the damage and the release shall assume that the reactor has been operating at the maximum power level authorized by the NRC license and that equilibrium of fission products was attained before the incident. This also will be evaluated if significant damage to the core or subsequent release is calculated to occur after a period of reactor shutdown.
- b. The study for facility shall be terminated and the basis for the conclusion documented in those cases in which the fission product inventory of the NPR is determined to be insufficient to create a risk to the public health and safety or those in which the fuel configuration or composition and/or the reactor construction or other factors is such as to limit the fuel damage and fission product release to a level that is insufficient to create a risk to the public health and safety.
- c. No assumptions are made regarding the saboteurs' capabilities nor is any design-basis threat associated with this task.
- d. For base-line considerations, it should be assumed that all reactor safety features fail upon initiation of the incident.
- e. The mean meteorological conditions at the site and the surrounding area should be considered when calculating the atmospheric dispersion of a release.

### Task No. 3

After Tasks 1 and 2 have been accomplished, mathematical models or other appropriate methods will be developed to calculate the amount of explosives and the amount of incendiary material needed to cause the limiting events described in Task 2 above. Calculations will be made for

events identified in Task No. 2. Calculations will be made for placement of explosives and incendiary devices at the reactor boundary and attached to reactor components.

Certain parameters and assumptions should be considered in those calculations. These include, and are limited to, the following except as may be approved by the NMSS project monitor (PM) in the future.

- a. The type of explosives and incendiary devices used to cause an event are assumed to be easily obtainable.
- b. Two opposing conditions will be considered in performing Task 3.
  1. Safeguards credit will be given for all physical barriers interposed between the explosives/incendiaries and the reactor fuel.
  2. The adversary will have access to all reactor components in carrying out the sabotage event.

#### Task No. 4

Upon completion of Task No. 3, for those cases in which the fission product release and estimated doses exceed 10 CFR 20 and 10 CFR 100 standards, calculations for the minimum amount of explosives and the minimum amount of incendiary material needed to cause the release will be made. The calculations shall be made for placement of explosives and incendiary devices in the reactor, attached to reactor components, and outside the structure containing the reactor. The parameters and assumptions employed in Task No. 3 will be used in this task.

#### Task No. 5

Upon completion of Task No. 3, reactor control systems and fuels shall be reviewed and evaluated to determine whether an unauthorized manipulation of such controls could cause any detrimental effects that may be identified in Task No. 2. Only credible scenarios and analytical assumptions shall be used, and these shall be reviewed and approved by the NMSS PM before the analyses are made.

#### Task No. 6:

Upon completion of Task No. 3, calculations for mitigating effects of full and partial operation of existing safety features associated with the operation of the reactor will be made. (These features are ignored in Task 3 to determine maximum consequences.) Additionally, safety measures and modifications as well as administrative procedures and practices that could be adopted and determine the degree to which these additional considerations would mitigate the consequences will be identified. Specific safeguards measures are excluded from consideration in this task.

#### Task 7: Program Plan and Schedule for the Remaining Reactors

Because of the developmental nature of this study, Los Alamos will approach this work in two phases. The first phase, to be completed in FY 1985, will develop the methodology and apply it to three reactors, which hereafter are referred to as lead reactors (LRs). After this phase of work, a detailed plan for completing the remaining five reactors will be formulated based on the data gained in the LR phase.

In the LR phase (FY 1985), three representative nonpower reactors (NPRs) will be fully analyzed by October 1, 1985. These reactors are the NBS reactor, the largest NPR representing tank reactors; the University of Missouri reactor, the largest enclosed pool reactor; and the Georgia Institute of Technology reactor because of the limited amount of cooling water for the reactor power level. Based on the results of these three calculations, a better estimate of the time and cost required to perform the remaining calculations can be made for FY 1986.

A detailed plan for applying the tools developed in Tasks 2 through 6 to the remaining five reactors in Table I will be formulated. This plan will attempt completion of the remaining reactors in as short a time as possible during FY 1986. This plan will be submitted to NRC for approval.

b. Meetings and Travel

Site visits for two analysts to the three reactors will be required. Three meetings with NRC sponsors in Washington, DC, for two people also will be required in FY 1985. Los Alamos representatives shall meet with the NMSS PM two to four times a year. Upon completion of the draft final report, Los Alamos representatives, upon request of the NMSS PM, will brief the NMSS staff in Washington, DC.

c. NRC Furnished Materials

NRC will furnish only reactor documentation that cannot be obtained by Los Alamos.

4. Description of Follow-On Efforts

Upon completion of the analysis in Tasks 1 through 6 a program plan and cost estimate for completion of the remaining five reactors in Table I will be submitted to NRC for the follow-on efforts.

5. Relationship to Other Projects

None

6. Reporting Schedule

Monthly letter status reports and a final report will be provided. All reports will be submitted to the NRC technical monitor. A distribution list for the final report should be provided by the NRC technical monitor. For any reports that will not be submitted according to the contract schedule, a written reason for the delay will be submitted to the technical monitor by the original scheduled date.

a. Monthly Letter Status Report

Los Alamos will submit a letter status report each month that summarizes the work performed during the previous month, personnel time expenditures during the previous month, and costs generated against the work effort. Any changes to cost projections or schedules will be indicated. The letter report will arrive at the NRC by the 20th of each month. In all monthly reports there will be a breakdown of (1) manpower costs; (2) costs incurred for direct salaries, material and services, ADP support, subcontracts, travel, general, and administrative and other related items; and (3) current obligation status information for the project.

The report shall be distributed as follows.

Donald M. Carlson, SG, NMSS - one copy

Office of the Director, NMSS (Attn: Program Support) - one copy

b. Interim Reports

Three draft interim report shall be furnished to the NMSS PM for Task 2, Task 3, and Tasks 5 and 6. After review by appropriate NRC personnel, the PM will provide comments on the draft report to Los Alamos National Laboratory within 60 days of receipt of each report. A revised interim report shall be submitted if deemed necessary by the NMSS PM.

c. Final Report

Los Alamos shall furnish two copies of a draft final report to the NMSS PM by June 30, 1986. The format of these documents shall be as specified for formal technical reports in NRC Manual Chapter 1102 and will provide

1. the on-site and off-site fission product release and dosage calculations associated with a total loss of coolant,
2. the quantities of explosives and incendiary material or a description of acts necessary to cause a limiting case incident,
3. the placement of explosives and incendiary materials in relation to the reactor,

4. a description of unauthorized manipulation of reactor controls and fuel to cause a limiting case incident,
5. the resulting consequences, and
6. appropriate alternative measures that can be implemented to mitigate a significant event (for example, reactor facility modifications, administrative procedures, and so on).

After review by appropriate NRC personnel, the PM will provide comments on the draft report to Los Alamos within 60 days of receipt of the report.

The performing organization shall revise the draft report based on the PM's comments and submit one camera-ready copy of the final report to the Document Management Branch, Technical Information and Document Control, NRC, to be published as a NUREG/CR series report, and a duplicate to the NMSS PM.

All draft reports, as well as final reports, shall be screened for Classified Information and appropriately marked in accordance with "NRC Classification Guide for Information Dealing with the Release and Dispersion of Radioactive Material (NRC-RDRM-1)," dated September 1982, and NRC Manual Chapter 1102.

7. Subcontractor Information

None

8. New Capital Equipment Required

None

9. Special Facilities Required

None

10. Conflict of Interest Information

None

11. Quality Assurance

All reports, plans, charts, graphs, schedules, and so on furnished under the terms of this statement of work are to be subject to internal review and shall reflect acceptance by an authorized management individual before submittal to NRC.



## APPENDIX A WORK PLAN

### I. INTRODUCTION

Because of the developmental nature of this study, Los Alamos will approach this work in two phases. The first phase, to be completed in FY 1985, will develop the methodology and apply it to three reactors, which hereafter are referred to as lead reactors (LRs). After this phase of work, a detailed plan for completing the remaining five reactors will be formulated based on the data gained in the LR phase.

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### II. TASK BREAKDOWN FOR LEAD REACTOR PHASE (FY 1985)

#### Task 1. Collection of Information and Familiarization With It

This task will be initiated immediately and will continue as required to gain a familiarity with the three LRs. Information available at Los Alamos will be supplemented by docket information from NRC and with site visits when sufficient familiarity is gained to make the visit meaningful.

#### Task 2. Calculation of Maximum Radiological Release

- a. Develop core inventory analyses and apply them to the three LRs for an operating history of the maximum authorized power level long enough to achieve equilibrium fission product levels. Both high- and low-enrichment fuels will be considered.
- b. Use a Master Logic Diagram (MLD) to identify potential physical modes of core disruption or other radionuclide sources for each LR.

- c. The maximum extent of core damage for each mode identified in the previous step and the fission product release associated with this damage will be determined using available methods. If no methods exist for a given requirement, an approximate and conservative analytical tool will be developed based on the best current knowledge.
- d. The effects of physical decontamination factors on the radionuclide transport will be calculated using currently accepted methods and site-specific information for each LR.
- e. The whole-body radiation dose and thyroid dose from iodine will be calculated in rem using currently accepted methods for the potential releases identified for each LR. Mean meteorological conditions at each LR will be assumed.
- f. This study will be terminated for those sites with no identified sequence leading to at least a 10 CFR Part 20 release.
- g. For those LRs that have sequences exceeding 10 CFR 20 or 10 CFR 100 releases, the extent of core damage leading to these releases will be calculated by scaling results from previous calculations in Task 2.d.
- h. All results from the foregoing calculations will be documented and submitted to NRC as an interim technical report.

### Task 3. Determination of Sources of Damage

- a. For each damage mode capable of resulting in at least a 10 CFR Part 20 or 100 release, the credible sources of such damage (for example, explosives and/or incendiary devices) will be identified.
- b. Using explosive yield, structural response, and other analyses, the amount and placement of damage sources resulting in the maximum release will be determined assuming no mitigating system functions and assuming that the adversary has direct access to all reactor components.
- c. The calculations of Task 3 will be repeated allowing safeguards credit for any physical barriers blocking direct access to the reactor fuel.
- d. The results of this task will be reported in an interim report to the NRC.

Task 4. Scaling of Damage Sources to 10 CFR 20 and 10 CFR 100

- a. The results of Task 3 will be scaled to determine the damage sources leading to 10 CFR 20 and 10 CFR 100 releases.
- b. The results of this task will be reported along with Task 3 in an interim report to the NRC.

Task 5. Determination of Misoperation Scenarios

- a. Using LR system descriptions, damage modes from Task 2, and damage sources from Task 3, a system logic model (fault-tree) approach will be used to determine sabotage scenarios resulting from unauthorized operation of reactor controls, systems, or fuels.
- b. The results of this task will be documented in an interim report for the NRC.

Task 6. Mitigating Systems Effects

- a. Using the sabotage scenarios developed in Task 5, the effect of mitigating systems on radionuclide release will be included using system logic models (fault trees) to determine the effects of both full and partial operation of mitigating systems.
- b. Using the insights of Task 6.a above additional or modified safety features or administrative practices that could be adopted will be identified.
- c. The results of this task will be documented along with Task 5 in an interim report for the NRC.

Task 7. Program Plan for FY 1986

Upon the conclusion of the LR analyses, a detailed plan for completing the remaining five nonpower reactors in FY 1986 will be formulated and submitted to the NRC.

Superseded by

NRC FORM 189  
(3-81)

U.S. NUCLEAR REGULATORY COMMISSION

DATE OF PROPOSAL  
10/1/84 Oct 29, 84 LT



PROJECT AND BUDGET PROPOSAL FOR NRC WORK

NEW  
 REVISION NO

PROJECT TITLE Consequences of Sabotage at Nonpower Reactors			FIN NUMBER A 7153-4
NRC OFFICE * NMSS			NRC B&R NUMBER 50-19-02-00
DOE CONTRACTOR Los Alamos National Laboratory			CONTRACTOR ACCOUNT NUMBER R21W
SITE Los Alamos New Mexico			DOE B&R NUMBER
COGNIZANT PERSONNEL	ORGANIZATION	FTS PHONE NUMBER	PERIOD OF PERFORMANCE
NRC PROJECT MANAGER D. Carlson	NMSS	427-4712	STARTING DATE 9/9/84
OTHER NRC TECHNICAL STAFF			COMPLETION DATE 9/30/85
DOE PROJECT MANAGER			
CONTRACTOR-PROJECT MANAGER L. H. Sullivan	Q-D0	843-9821	
PRINCIPAL INVESTIGATOR(S) T. F. Bott	Q-6	843-9207	

STAFF YEARS OF EFFORT (Round to nearest tenth of a year)	FY 1984	FY 1985	FY	FY	FY
Direct Scientific/Technical	0.1	1.6			
Other Direct (Graded)	0.0	0.3			
<b>TOTAL DIRECT STAFF YEARS</b>	<b>0.1</b>	<b>1.9</b>			

COST PROPOSAL		FY 1984	FY 1985	FY	FY	FY
Direct Salaries		5.7	106.4			
Material and Services (Excluding ADP)		1.8	15.3			
ADP Support		0.0	20.0			
Subcontracts		0.0	0.0			
Travel Expenses	Foreign					
	Domestic	1.9	4.0			
Indirect Labor Costs		5.6	109.3			
Other (Specify)						
General and Administrative (%)						
<b>TOTAL OPERATING COST</b>		<b>15.0</b>	<b>255.0</b>			
CAPITAL EQUIPMENT FIN CHARGED						
<b>TOTAL PROJECT COST</b>		<b>15.0</b>	<b>255.0</b>			

1985 MONTHLY FORECAST EXPENSE	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH
		21	21	21	21	21
MONTHLY FORECAST EXPENSE	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER
	21	21	21	21	21	24

B/15

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

DATE

TITLE

DDE PROPOSING ORGANIZATION

FORECAST MILESTONE CHART Scheduled to Start - Completed (Shown in Quarter Year)  
 PROVIDE ESTIMATED DOLLAR COST FOR EACH TASK FOR EACH FISCAL YEAR

TASK		FY 1984				FY 1985				FY				FY			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
1. Familiarization with nonpower reactors	SCHEDULE								△								
	COST		15 k						10 k								
2. Calculations of maximum and limiting Radiological Consequences	SCHEDULE								△								
	COST								75 k								
3. Calculation of Explosives or Incendiary devices required for maximum and limiting release	SCHEDULE								△								
	COST								75 k								
4. Calculations of explosives for Part 20 and 100 releases	SCHEDULE								△								
	COST								15 k								
5. Effect of unauthorized control manipulation	SCHEDULE								△								
	COST								35 k								
6. Effect of mitigating systems	SCHEDULE								△								
	COST								35 k								
7. Program Plan for FY 1986	SCHEDULE								△								
	COST								10 k								
	SCHEDULE																
	COST																
	SCHEDULE																
	COST																
	SCHEDULE																
	COST																
TOTAL ESTIMATED PROJECT COST			15 k						255 k								

APPROVAL AUTHORITY-SIGNATURE

*John P. Dulca*

DATE

10/2/84

1. Objective of Proposed Work

a. Background

In 1979, the Los Alamos Scientific Laboratory conducted a study of the consequences of sabotage of nonpower reactors (NPRs). It was concluded that, within the constraints of this study, only one NPR had any potential for the release of significant amounts of fission product materials in the event of sabotage. Because of terrorist activities in other parts of the world, concerns of the ACRS about manipulation of reactor control systems, and concerns of a public interest group about the effects of incendiary devices on reactor components, this information should be supplemented with further technical information.

b. Objective

The objective of this work is to provide the NRC with technical information on the effects of malicious manipulation of reactor controls and of the use of incendiary devices on NPRs to assure a margin of public safety.

2. Summary of Prior Efforts

None

3. Work to be Performed and Expected Results

During the period from FY 1984 to 1986 Los Alamos will perform the following tasks.

a. Work Required

Task No. 1

Existing information in available sources, such as the NRC docket files, augmented by site-specific information provided by NRC staff and site visits should be reviewed to (a) familiarize task personnel

with characteristics peculiar to each reactor and (b) obtain information necessary to aid in the calculation of the radiological consequences for three of the NPRs listed in Table I.

Within 1 month after initiation of task orders, Los Alamos shall provide a detailed work plan that identifies study milestones and their projected dates of accomplishment. Upon NRC review and approval of this plan, it will become the operating schedule for the overall task. The work plan is Appendix A to this proposal.

Task No. 2

Mathematical models or other appropriate methods will be developed and/or used to perform the following.

- a. Calculate the radiological release resulting from a total core meltdown, partial core meltdown, core disintegration and/or crushing, or other means that could damage severely the fuel in the reactor core. Because the key consideration is the fission product release associated with such incidents, the effects of using low-enriched uranium vs high-enriched uranium on the fission product release will be evaluated,

TABLE I  
LIST OF REACTORS

<u>Licensee</u>	<u>Docket No.</u>	<u>Power Level</u>	<u>Reactor Type</u>
National Bureau of Standards	50-184	20 MW	Tank
University of Missouri	50-186	10 MW	Tank
Georgia Institute of Technology	50-160	5 MW	Tank
Massachusetts Institute of Technology	50-20	5 MW	Tank
Union Carbide	50-54	5 MW	Pool
Rhode Island Atomic Energy Commission	50-193	2 MW	Pool
State University of New York	50-57	2 MW	Pool
University of Michigan	50-2	2 MW	Pool
University of Virginia	50-62	2 MW	Pool

- b. Determine, as a function of distance from the reactor, the total radiation dose (rem) to the whole body and the radiation dose (rem) to the thyroid from iodine exposure and identify any facility for which these could exceed 10 CFR 20 and 10 CFR 100 standards
- c. Determine the characteristics of the event that would limit it to less than Parts 20 and 100 standards.

Certain other parameters and assumptions should be considered when performing this task. These include and are limited to the following except as may be approved by the NMSS Project Manager (PM) in the future.

- a. The models or methods used to calculate the damage and the release shall assume that the reactor has been operating at the maximum power level authorized by the NRC license and that equilibrium of fission products was attained before the incident. This also will be evaluated if significant damage to the core or subsequent release is calculated to occur after a period of reactor shutdown.
- b. The study for facility shall be terminated and the basis for the conclusion documented in those cases in which the fission product inventory of the NPR is determined to be insufficient to create a risk to the public health and safety or those in which the fuel configuration or composition and/or the reactor construction or other factors is such as to limit the fuel damage and fission product release to a level that is insufficient to create a risk to the public health and safety.
- c. No assumptions are made regarding the saboteurs' capabilities nor is any design-basis threat associated with this task.
- d. For base-line considerations, it should be assumed that all reactor safety features fail upon initiation of the incident.
- e. The mean meteorological conditions at the site and the surrounding area should be considered when calculating the atmospheric dispersion of a release.

### Task No. 3

After Tasks 1 and 2 have been accomplished, mathematical models or other appropriate methods will be developed to calculate the amount of explosives and the amount of incendiary material needed to cause



the placement of explosives and incendiary devices at the reactor facility boundary and attached to reactor components.

Certain parameters and assumptions should be considered in those calculations. These include, and are limited to, the following except as may be approved by the NMSS project monitor (PM) in the future.

- a. The type of explosives and incendiary devices used to cause an event are assumed to be easily obtainable.
- b. Two opposing conditions will be considered in performing Task 3.
  1. Safeguards credit will be given for all physical barriers interposed between the explosives/incendiaries and the reactor fuel.
  2. The adversary will have access to all reactor components in carrying out the sabotage event.

#### Task No. 4

Upon completion of Task No. 3, for those cases in which the fission product release and estimated doses exceed 10 CFR 20 and 10 CFR 100 standards, calculate the amount of explosives and the amount of incendiary material needed to cause the release. The calculations shall be made for placement of explosives and incendiary devices attached to reactor components and outside the structure containing the reactor. The parameters and assumptions employed in Task No. 3 will be used in this task.

#### Task No. 5

Upon completion of Task No. 3, reactor control systems and fuels shall be reviewed and evaluated to determine whether an unauthorized manipulation of such controls could cause any detrimental effects that may be identified in Task No. 2. Only credible scenarios and analytical assumptions shall be used, and these shall be reviewed and approved by the NMSS PM before the analyses are made.

#### Task No. 6

Upon completion of Task No. 3, calculate the mitigating effects of full and partial operation of existing safety features associated with the operation of the reactor. (These features are ignored in Task 3 to

determine maximum consequences.) Identify additional safety measures and modifications as well as administrative procedures and practices that could be adopted and determine the degree to which these additional considerations would mitigate the consequences. Exclude specific safeguards measures from consideration in this task.

Task 7: Program Plan and Schedule for the Remaining Reactors

A detailed plan for applying the tools developed in Tasks 2 through 6 to the remaining five reactors in Table I will be formulated. This plan will attempt completion at the remaining reactors in as short a time as possible during FY 1986. This plan will be submitted to NRC for approval.

b. Meetings and Travel

Site visits for two analysts to the three reactors will be required. Three meetings with NRC sponsors in Washington, DC, for two people also will be required in FY 1985.

c. NRC Furnished Materials

NRC will furnish only reactor documentation that cannot be obtained by Los Alamos.

4. Description of Follow-On Efforts

Upon completion of the analysis in Tasks 1 through 6 a program plan and cost estimate for completion of the remaining five reactors in Table I will be submitted to NRC for the follow-on efforts.

5. Relationship to Other Projects

None

6. Reporting Schedule

Monthly letter status reports and a final report will be provided. All reports will be submitted to the NRC technical monitor. A distribution

list for the final report should be provided by the NRC technical monitor. For any reports that will not be submitted according to the contract schedule, a written reason for the delay will be submitted to the technical monitor by the original scheduled date.

a. Monthly Letter Status Report

Los Alamos will submit a letter status report each month that summarizes the work performed during the previous month, personnel time expenditures during the previous month, and costs generated against the work effort. Any changes to cost projections or schedules will be indicated. The letter report will arrive at the NRC by the 20th of each month. In all monthly reports there will be a breakdown of (1) manpower costs; (2) costs incurred for direct salaries, material and services, ADP support, subcontracts, travel, general, and administrative and other related items; and (3) current obligation status information for the project.

The report shall be distributed as follows.

Donald M. Carlson, SG, NMSS - one copy

Office of the Director, NMSS (Attn: Program Support) - one copy

b. Interim Reports

A draft interim report shall be furnished to the NMSS PM upon completion of each major task (that is, Tasks No. 2, 3, 4, and 5). After review by appropriate NRC personnel, the PM will provide comments on the draft report to Los Alamos National Laboratory within 60 days of receipt of each report. A revised interim report shall be submitted if deemed necessary by the NMSS PM.

c. Final Report

Los Alamos shall furnish two copies of a draft final report to the NMSS PM by June 30, 1986. The format of these documents shall be as specified for formal technical reports in NRC Manual Chapter 1102 and will provide

1. the on-site and off-site fission product release and dosage calculations associated with a total loss of coolant,
2. the quantities of explosives and incendiary material or a description of acts necessary to cause a limiting case incident,
3. the placement of explosives and incendiary materials in relation to the reactor,
4. a description of unauthorized manipulation of reactor controls and fuel to cause a limiting case incident,
5. the resulting consequences, and
6. appropriate alternative measures that can be implemented to mitigate a significant event (for example, reactor facility modifications, administrative procedures, and so on).

After review by appropriate NRC personnel, the PM will provide comments on the draft report to Los Alamos within 60 days of receipt of the report.

The performing organization shall revise the draft report based on the PM's comments and submit one camera-ready copy of the final report to the Document Management Branch, Technical Information and Document Control, NRC, to be published as a NUREG/CR series report, and a duplicate to the NMSS PM.

All draft reports, as well as final reports, shall be screened for Classified Information and appropriately marked in accordance with "NRC Classification Guide for Information Dealing with the Release and Dispersion of Radioactive Material (NRC-RDRM-1)," dated September 1982, and NRC Manual Chapter 1102.

7. Subcontractor Information

None

8. New Capital Equipment Required

None

9. Special Facilities Required

None

10. Conflict of Interest Information

None

APPENDIX A  
WORK PLAN

I. INTRODUCTION

Because of the developmental nature of this study, Los Alamos will approach this work in two phases. The first phase, to be completed in FY 1985, will develop the methodology and apply it to three reactors, which hereafter are referred to as lead reactors (LRs). After this phase of work, a detailed plan for completing the remaining five reactors will be formulated based on the data gained in the LR phase.

In the LR phase (FY 1985), three representative nonpower reactors (NPRs) will be fully analyzed by October 1, 1985. These reactors are the NBS reactor, the largest NPR representing tank reactors; the University of Missouri reactor, the largest enclosed pool reactor; and the Union Carbide reactor, the largest open pool type reactor. Based on the results of these three calculations, a better estimate of the time and cost required to perform the remaining calculations can be made for FY 1985.

II. TASK BREAKDOWN FOR LEAD REACTOR PHASE (FY 1985)

Task 1. Collection of Information and Familiarization With It

This task will be initiated immediately and will continue as required to gain a familiarity with the three LRs. Information available at Los Alamos will be supplemented by docket information from NRC and with site visits when sufficient familiarity is gained to make the visit meaningful.

Task 2. Calculation of Maximum Radiological Release

- a. Develop core inventory analyses and apply them to the three LRs for an operating history of the maximum authorized power level long enough to achieve equilibrium fission product levels. Both high- and low-enrichment fuels will be considered.
- b. Use a Master Logic Diagram (MLD) to identify potential physical modes of core disruption or other radionuclide sources for each LR.

- c. The maximum extent of core damage for each mode identified in the previous step and the fission product release associated with this damage will be determined using available methods. If no methods exist for a given requirement, an approximate and conservative analytical tool will be developed based on the best current knowledge.
- d. The effects of physical decontamination factors on the radionuclide transport will be calculated using currently accepted methods and site-specific information for each LR.
- e. The whole body radiation dose and thyroid dose from iodine will be calculated in rem using currently accepted methods for the potential releases identified for each LR. Mean meteorological conditions at each LR will be assumed.
- f. This study will be terminated for those sites with no identified sequence leading to at least a 10 CFR Part 20 release.
- g. For those LRs that have sequences exceeding 10 CFR 20 or 10 CFR 100 releases, the extent of core damage leading to these releases will be calculated by scaling of results from previous calculations in Task 2.d.
- h. All results from the foregoing calculations will be documented and submitted to NRC as an interim technical report.

### Task 3. Determination of Sources of Damage

- a. For each damage mode capable of resulting in at least a 10 CFR Part 20 or 100 release, the credible sources of such damage (for example, explosives or incendiary devices) will be identified.
- b. Using explosive yield, structural response, and other analyses, the amount and placement of damage sources resulting in the maximum release will be determined assuming no mitigating system functions and assuming that the adversary has direct access to all reactor components.
- c. The calculations of Task 3 will be repeated allowing safeguards credit for any physical barriers blocking direct access to the reactor fuel.
- d. The results of this task will be reported in an interim report to the NRC.

Task 4. Scaling of Damage Sources to 10 CFR 20 and 10 CFR 100

- a. The results of Task 3 will be scaled to determine the damage sources leading to 10 CFR 20 and 10 CFR 100 releases.
- b. The results of this task will be reported along with Task 3 in an interim report to the NRC.

Task 5. Determination of Misoperation Scenarios

- a. Using LR system descriptions, damage modes from Task 2, and damage sources from Task 3, a system logic model (fault-tree) approach will be used to determine sabotage scenarios resulting from unauthorized operation of reactor controls, systems, or fuels.
- b. The results of this task will be documented in an interim report for the NRC.

Task 6. Mitigating Systems Effects

- a. Using the sabotage scenarios developed in Task 5, the effect of mitigating systems on radionuclide release will be included using system logic models (fault trees) to determine the effects of both full and partial operation of mitigating systems.
- b. Using the insights of Task 6.a, above, identify additional or modified safety features or administrative practices that could be adopted.
- c. The results of this task will be documented in an interim report for the NRC.

Task 7. Program Plan for FY 1986

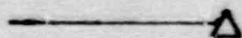
Upon the conclusion of the LR analyses, a detailed plan for completing the remaining five nonpower reactors in FY 1986 will be formulated and submitted to the NRC.



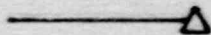
TASK 2

O N D J F M A M J J A S

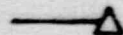
a. Core Inventory Calculations



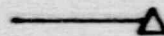
b. Identify Damage Modes



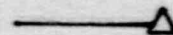
c. Determine Core Damage



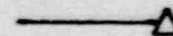
d. Radionuclide Release



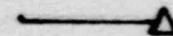
e. Whole Body Dose



f. Terminate Studies as Applicable



g. Part 20 and 100 Release Damage  
Determination



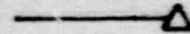
h. Report



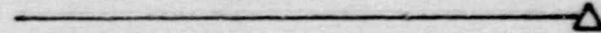
TASK 3

O N D J F M A M J J A S

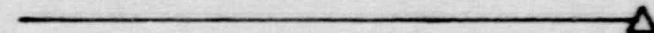
a. Identify Damage Sources



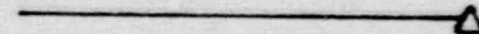
b. Calculate Amount of Damage Source



c. Include Effects of Safeguards Barriers

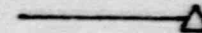


d. Report

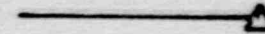


TASK 4

a. Scale Results of Task 3 to Part 20 and 100 Releases



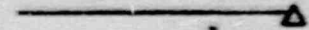
b. Report with Task 3



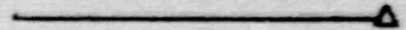
TASK 5

O N D J F M A M J J A S

a. Construct Logic Models for  
Scenarios

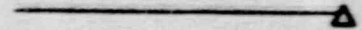


b. Report



TASK 6

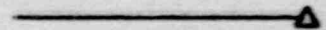
a. Construct Logic Models



b. Make Recommendations on  
Improved Safeguards

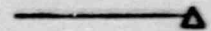


c. Report with Task 5



TASK 7

a. Submit Program Plan  
for FY 1986



Superseded by



PROJECT TITLE Consequences of Sabotage at Nonpower Reactors			FIN NUMBER A 7153-4
NRC OFFICE NMSS			NRC B&R NUMBER 50-19-02-00
DOE CONTRACTOR Los Alamos National Laboratory			CONTRACTOR ACCOUNT NUMBER R21W
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NRC PROJECT MANAGER D. Carlson	NMSS	427-4712	STARTING DATE 9/9/84
OTHER NRC TECHNICAL STAFF			COMPLETION DATE 9/30/85
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<b>TOTAL DIRECT STAFF YEARS</b>	<b>0.1</b>	<b>1.9</b>			
<b>COST PROPOSAL</b>					
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ADP Support	0.0	20.0			
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Travel Expenses					
Foreign					
Domestic	1.9	4.0			
Indirect Labor Costs	5.6	109.3			
Other (Specify)					
General and Administrative ( %)					
<b>TOTAL OPERATING COST</b>	<b>15.0</b>	<b>255.0</b>			
CAPITAL EQUIPMENT FIN CHARGED					
<b>TOTAL PROJECT COST</b>	<b>15.0</b>	<b>255.0</b>			

1985 MONTHLY FORECAST EXPENSE	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH
	21	21	21	21	21	21
APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	
	21	21	21	21	24	

B/15

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

DATE

TITLE

DDE PROPOSING ORGANIZATION

FORECAST MILESTONE CHART Sched. 10 51011 - Completed (Shown in Quarter 2 only)  
PROVIDE ESTIMATED DOLLAR COST FOR EACH TASK FOR EACH FISCAL YEAR

TASK		FY 1984				FY 1985				FY 1986				FY 1987			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
1. Familiarization with nonpower reactors	SCHEDULE							△									
	COST		15 k					10 k									
2. Calculations of maximum and limiting Radiological Consequences	SCHEDULE							△									
	COST							75 k									
3. Calculation of Explosives or Incendiary devices required for maximum and limiting release	SCHEDULE							△									
	COST							75 k									
4. Calculations of explosives for Part 20 and 100 releases	SCHEDULE							△									
	COST							15 k									
5. Effect of unauthorized control manipulation	SCHEDULE							△									
	COST							35 k									
6. Effect of mitigating systems	SCHEDULE							△									
	COST							35 k									
7. Program Plan for FY 1986	SCHEDULE							△									
	COST							10 k									
	SCHEDULE																
	COST																
	SCHEDULE																
	COST																
	SCHEDULE																
	COST																
TOTAL ESTIMATED PROJECT COST			15 k					255 k									

APPROVAL AUTHORITY-SIGNATURE

*John Pulcal*

DATE

10/2/84

## 1. Objective of Proposed Work

### a. Background

In 1979, the Los Alamos Scientific Laboratory conducted a study of the consequences of sabotage of nonpower reactors (NPRs). It was concluded that, within the constraints of this study, only one NPR had any potential for the release of significant amounts of fission product materials in the event of sabotage. Because of terrorist activities in other parts of the world, concerns of the ACRS about manipulation of reactor control systems, and concerns of a public interest group about the effects of incendiary devices on reactor components, this information should be supplemented with further technical information.

### b. Objective

The objective of this work is to provide the NRC with technical information on the effects of malicious manipulation of reactor controls and of the use of incendiary devices on NPRs to assure a margin of public safety.

## 2. Summary of Prior Efforts

None

## 3. Work to be Performed and Expected Results

During the period from FY 1984 to 1986 Los Alamos will perform the following tasks.

### a. Work Required

#### Task No. 1

Existing information in available sources, such as the NRC docket files, augmented by site-specific information provided by NRC staff and site visits should be reviewed to (a) familiarize task personnel

with characteristics peculiar to each reactor and (b) obtain information necessary to aid in the calculation of the radiological consequences for three of the NPRs listed in Table I.

Within 1 month after initiation of task orders, Los Alamos shall provide a detailed work plan that identifies study milestones and their projected dates of accomplishment. Upon NRC review and approval of this plan, it will become the operating schedule for the overall task. The work plan is Appendix A to this proposal.

#### Task No. 2

Mathematical models or other appropriate methods will be developed and/or used to perform the following.

- a. Calculate the radiological release resulting from a total core meltdown, partial core meltdown, core disintegration and/or crushing, or other means that could damage severely the fuel in the reactor core. Because the key consideration is the fission product release associated with such incidents, the effects of using low-enriched uranium vs high-enriched uranium on the fission product release will be evaluated,

TABLE I  
LIST OF REACTORS

<u>Licensee</u>	<u>Docket No.</u>	<u>Power Level</u>	<u>Reactor Type</u>
National Bureau of Standards	50-184	20 MW	Tank
University of Missouri	50-186	10 MW	Tank
Georgia Institute of Technology	50-160	5 MW	Tank
Massachusetts Institute of Technology	50-20	5 MW	Tank
Union Carbide	50-54	5 MW	Pool
Rhode Island Atomic Energy Commission	50-193	2 MW	Pool
State University of New York	50-57	2 MW	Pool
University of Michigan	50-2	2 MW	Pool
University of Virginia	50-62	2 MW	Pool

- b. Determine, as a function of distance from the reactor, the total radiation dose (rem) to the whole body and the radiation dose (rem) to the thyroid from iodine exposure and identify any facility for which these could exceed 10 CFR 20 and 10 CFR 100 standards
- c. Determine the characteristics of the event that would limit it to less than Parts 20 and 100 standards.

Certain other parameters and assumptions should be considered when performing this task. These include and are limited to the following except as may be approved by the NMSS Project Manager (PM) in the future.

- a. The models or methods used to calculate the damage and the release shall assume that the reactor has been operating at the maximum power level authorized by the NRC license and that equilibrium of fission products was attained before the incident. This also will be evaluated if significant damage to the core or subsequent release is calculated to occur after a period of reactor shutdown.
- b. The study for facility shall be terminated and the basis for the conclusion documented in those cases in which the fission product inventory of the NPR is determined to be insufficient to create a risk to the public health and safety or those in which the fuel configuration or composition and/or the reactor construction or other factors is such as to limit the fuel damage and fission product release to a level that is insufficient to create a risk to the public health and safety.
- c. No assumptions are made regarding the saboteurs' capabilities nor is any design-basis threat associated with this task.
- d. For base-line considerations, it should be assumed that all reactor safety features fail upon initiation of the incident.
- e. The mean meteorological conditions at the site and the surrounding area should be considered when calculating the atmospheric dispersion of a release.

### Task No. 3

After Tasks 1 and 2 have been accomplished, mathematical models or other appropriate methods will be developed to calculate the amount of explosives and the amount of incendiary material needed to cause



the placement of explosives and incendiary devices at the reactor facility boundary and attached to reactor components.

Certain parameters and assumptions should be considered in those calculations. These include, and are limited to, the following except as may be approved by the NMSS project monitor (PM) in the future.

- a. The type of explosives and incendiary devices used to cause an event are assumed to be easily obtainable.
- b. Two opposing conditions will be considered in performing Task 3.
  1. Safeguards credit will be given for all physical barriers interposed between the explosives/incendiaries and the reactor fuel.
  2. The adversary will have access to all reactor components in carrying out the sabotage event.

#### Task No. 4

Upon completion of Task No. 3, for those cases in which the fission product release and estimated doses exceed 10 CFR 20 and 10 CFR 100 standards, calculate the amount of explosives and the amount of incendiary material needed to cause the release. The calculations shall be made for placement of explosives and incendiary devices attached to reactor components and outside the structure containing the reactor. The parameters and assumptions employed in Task No. 3 will be used in this task.

#### Task No. 5

Upon completion of Task No. 3, reactor control systems and fuels shall be reviewed and evaluated to determine whether an unauthorized manipulation of such controls could cause any detrimental effects that may be identified in Task No. 2. Only credible scenarios and analytical assumptions shall be used, and these shall be reviewed and approved by the NMSS PM before the analyses are made.

#### Task No. 6

Upon completion of Task No. 3, calculate the mitigating effects of full and partial operation of existing safety features associated with the operation of the reactor. (These features are ignored in Task 3 to

determine maximum consequences.) Identify additional safety measures and modifications as well as administrative procedures and practices that could be adopted and determine the degree to which these additional considerations would mitigate the consequences. Exclude specific safeguards measures from consideration in this task.

Task 7: Program Plan and Schedule for the Remaining Reactors

A detailed plan for applying the tools developed in Tasks 2 through 6 to the remaining five reactors in Table I will be formulated. This plan will attempt completion at the remaining reactors in as short a time as possible during FY 1986. This plan will be submitted to NRC for approval.

b. Meetings and Travel

Site visits for two analysts to the three reactors will be required. Three meetings with NRC sponsors in Washington, DC, for two people also will be required in FY 1985.

c. NRC Furnished Materials

NRC will furnish only reactor documentation that cannot be obtained by Los Alamos.

4. Description of Follow-On Efforts

Upon completion of the analysis in Tasks 1 through 6 a program plan and cost estimate for completion of the remaining five reactors in Table I will be submitted to NRC for the follow-on efforts.

5. Relationship to Other Projects

None

6. Reporting Schedule

Monthly letter status reports and a final report will be provided. All reports will be submitted to the NRC technical monitor. A distribution

list for the final report should be provided by the NRC technical monitor. For any reports that will not be submitted according to the contract schedule, a written reason for the delay will be submitted to the technical monitor by the original scheduled date.

a. Monthly Letter Status Report

Los Alamos will submit a letter status report each month that summarizes the work performed during the previous month, personnel time expenditures during the previous month, and costs generated against the work effort. Any changes to cost projections or schedules will be indicated. The letter report will arrive at the NRC by the 20th of each month. In all monthly reports there will be a breakdown of (1) manpower costs; (2) costs incurred for direct salaries, material and services, ADP support, subcontracts, travel, general, and administrative and other related items; and (3) current obligation status information for the project.

The report shall be distributed as follows.

Donald M. Carlson, SG, NMSS - one copy

Office of the Director, NMSS (Attn: Program Support) - one copy

b. Interim Reports

A draft interim report shall be furnished to the NMSS PM upon completion of each major task (that is, Tasks No. 2, 3, 4, and 5). After review by appropriate NRC personnel, the PM will provide comments on the draft report to Los Alamos National Laboratory within 60 days of receipt of each report. A revised interim report shall be submitted if deemed necessary by the NMSS PM.

c. Final Report

Los Alamos shall furnish two copies of a draft final report to the NMSS PM by June 30, 1986. The format of these documents shall be as specified for formal technical reports in NRC Manual Chapter 1102 and will provide

1. the on-site and off-site fission product release and dosage calculations associated with a total loss of coolant,
2. the quantities of explosives and incendiary material or a description of acts necessary to cause a limiting case incident,
3. the placement of explosives and incendiary materials in relation to the reactor,
4. a description of unauthorized manipulation of reactor controls and fuel to cause a limiting case incident,
5. the resulting consequences, and
6. appropriate alternative measures that can be implemented to mitigate a significant event (for example, reactor facility modifications, administrative procedures, and so on).

After review by appropriate NRC personnel, the PM will provide comments on the draft report to Los Alamos within 60 days of receipt of the report.

The performing organization shall revise the draft report based on the PM's comments and submit one camera-ready copy of the final report to the Document Management Branch, Technical Information and Document Control, NRC, to be published as a NUREG/CR series report, and a duplicate to the NMSS PM.

All draft reports, as well as final reports, shall be screened for Classified Information and appropriately marked in accordance with "NRC Classification Guide for Information Dealing with the Release and Dispersion of Radioactive Material (NRC-RDRM-1)," dated September 1982, and NRC Manual Chapter 1102.

7. Subcontractor Information

None

8. New Capital Equipment Required

None

9. Special Facilities Required

None

10. Conflict of Interest Information

None

## APPENDIX A WORK PLAN

### I. INTRODUCTION:

Because of the developmental nature of this study, Los Alamos will approach this work in two phases. The first phase, to be completed in FY 1985, will develop the methodology and apply it to three reactors, which hereafter are referred to as lead reactors (LRs). After this phase of work, a detailed plan for completing the remaining five reactors will be formulated based on the data gained in the LR phase.

In the LR phase (FY 1985), three representative nonpower reactors (NPRs) will be fully analyzed by October 1, 1985. These reactors are the NBS reactor, the largest NPR representing tank reactors; the University of Missouri reactor, the largest enclosed pool reactor; and the Union Carbide reactor, the largest open pool type reactor. Based on the results of these three calculations, a better estimate of the time and cost required to perform the remaining calculations can be made for FY 1986.

### II. TASK BREAKDOWN FOR LEAD REACTOR PHASE (FY 1985)

#### Task 1. Collection of Information and Familiarization With It

This task will be initiated immediately and will continue as required to gain a familiarity with the three LRs. Information available at Los Alamos will be supplemented by docket information from NRC and with site visits when sufficient familiarity is gained to make the visit meaningful.

#### Task 2. Calculation of Maximum Radiological Release

- a. Develop core inventory analyses and apply them to the three LRs for an operating history of the maximum authorized power level long enough to achieve equilibrium fission product levels. Both high- and low-enrichment fuels will be considered.
- b. Use a Master Logic Diagram (MLD) to identify potential physical modes of core disruption or other radionuclide sources for each LR.

- c. The maximum extent of core damage for each mode identified in the previous step and the fission product release associated with this damage will be determined using available methods. If no methods exist for a given requirement, an approximate and conservative analytical tool will be developed based on the best current knowledge.
- d. The effects of physical decontamination factors on the radionuclide transport will be calculated using currently accepted methods and site-specific information for each LR.
- e. The whole body radiation dose and thyroid dose from iodine will be calculated in rem using currently accepted methods for the potential releases identified for each LR. Mean meteorological conditions at each LR will be assumed.
- f. This study will be terminated for those sites with no identified sequence leading to at least a 10 CFR Part 20 release.
- g. For those LRs that have sequences exceeding 10 CFR 20 or 10 CFR 100 releases, the extent of core damage leading to these releases will be calculated by scaling of results from previous calculations in Task 2.d.
- h. All results from the foregoing calculations will be documented and submitted to NRC as an interim technical report.

### Task 3. Determination of Sources of Damage

- a. For each damage mode capable of resulting in at least a 10 CFR Part 20 or 100 release, the credible sources of such damage (for example, explosives or incendiary devices) will be identified.
- b. Using explosive yield, structural response, and other analyses, the amount and placement of damage sources resulting in the maximum release will be determined assuming no mitigating system functions and assuming that the adversary has direct access to all reactor components.
- c. The calculations of Task 3 will be repeated allowing safeguards credit for any physical barriers blocking direct access to the reactor fuel.
- d. The results of this task will be reported in an interim report to the NRC.

Task 4. Scaling of Damage Sources to 10 CFR 20 and 10 CFR 100

- a. The results of Task 3 will be scaled to determine the damage sources leading to 10 CFR 20 and 10 CFR 100 releases.
- b. The results of this task will be reported along with Task 3 in an interim report to the NRC.

Task 5. Determination of Misoperation Scenarios

- a. Using LR system descriptions, damage modes from Task 2, and damage sources from Task 3, a system logic model (fault-tree) approach will be used to determine sabotage scenarios resulting from unauthorized operation of reactor controls, systems, or fuels.
- b. The results of this task will be documented in an interim report for the NRC.

Task 6. Mitigating Systems Effects

- a. Using the sabotage scenarios developed in Task 5, the effect of mitigating systems on radionuclide release will be included using system logic models (fault trees) to determine the effects of both full and partial operation of mitigating systems.
- b. Using the insights of Task 6.a, above, identify additional or modified safety features or administrative practices that could be adopted.
- c. The results of this task will be documented in an interim report for the NRC.

Task 7. Program Plan for FY 1986

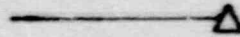
Upon the conclusion of the LR analyses, a detailed plan for completing the remaining five nonpower reactors in FY 1986 will be formulated and submitted to the NRC.



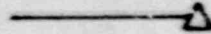
TASK 2

O N D J F M A M J J A S

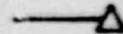
a. Core Inventory Calculations



b. Identify Damage Modes



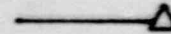
c. Determine Core Damage



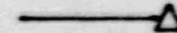
d. Radionuclide Release



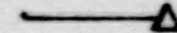
e. Whole Body Dose



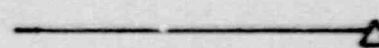
f. Terminate Studies as Applicable



g. Part 20 and 100 Release Damage  
Determination



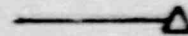
h. Report



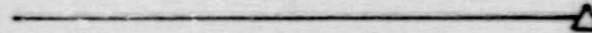
TASK 3

J N D J F M A M J J A S

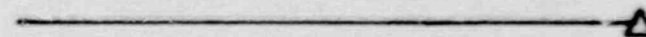
a. Identify Damage Sources



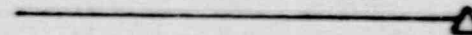
b. Calculate Amount of Damage Source



c. Include Effects of Safeguards Barriers

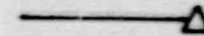


d. Report



TASK 4

a. Scale Results of Task 3 to Part 20 and 100 Releases



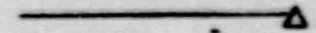
b. Report with Task 3



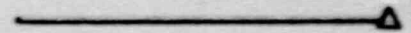
TASK 5

O N D J F M A M J J A S

a. Construct Logic Models for  
Scenarios

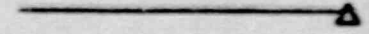


b. Report

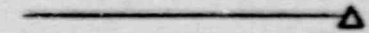


TASK 6

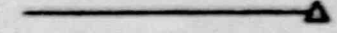
a. Construct Logic Models



b. Make Recommendations on  
Improved Safeguards



c. Report with Task 5



TASK 7

a. Submit Program Plan  
for FY 1986



DRAFT

NRC FORM 100 (REV 1984) US NUCLEAR REGULATORY COMMISSION DATE OF PROPOSAL 10/1/84

**PROJECT AND BUDGET PROPOSAL FOR NRC WORK**

NEW  REVISION NO.

**PROJECT TITLE**  
Consequences of Sabotage at Nonpower Reactors

**NRC OFFICE**  
NMSS

**DOE CONTRACTOR**  
Los Alamos National Laboratory

**SITE**  
Los Alamos New Mexico

**FIN NUMBER**  
A 7153-4

**NRC ORDER NUMBER**  
50-19-02-00

**CONTRACTOR ACCOUNT NUMBER**  
R21W

**DOE ORDER NUMBER**

ORGANIZANT PERSONNEL	ORGANIZATION	FTE PHONE NUMBER	IN-HOUSE PERFORMANCE
NRC PROJECT MANAGER D. Carlson	NMSS	427-4712	STARTING DATE 9/9/84
OTHER NRC TECHNICAL STAFF			COMPLETION DATE 9/30/85
DOE PROJECT MANAGER			
CONTRACTOR-PROJECT MANAGER L. H. Sullivan	Q-00	843-9821	
PRINCIPAL INVESTIGATOR(S) T. F. Bott	Q-6	843-9207	

STAFF YEARS OF EFFORT (Rounded to nearest tenth of a year)	FY 1984	FY 1985	FY	FY	FY	
Direct Scientific/Technical	0.1	1.6				
Other Direct (Indirect)	0.0	0.3				
<b>TOTAL DIRECT STAFF YEARS</b>	<b>0.1</b>	<b>1.9</b>				
<b>COST PROPOSAL</b>						
Direct Salaries	5.7 ?	106.4				
Material and Services (Excluding ADP)	1.8	15.3				
ADP Support	0.0	20.0				
Subcontractors	0.0	0.0				
Travel Expenses	1.9	4.0				
Indirect Labor Costs	5.6 ?	109.3				
Other (Specify)						
General and Administrative (BI)						
<b>TOTAL OPERATING COST</b>	<b>15.0 ?</b>	<b>255.0</b>				
<b>CAPITAL EQUIPMENT FIN CHARGED</b>						
<b>TOTAL PROJECT COST</b>	<b>15.0 ?</b>	<b>255.0</b>				
FY 1985	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH
MONTHLY FORECAST EXPENSE	21	21	21	21	21	21
	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER
	21	21	21	21	21	24

NRC FORM 100 (REV 1984)

①  
B/16

PROJECT AND BUDGET PROPOSAL FOR NRC WORK

DATE

PROJECT TITLE

172 was signed on Sept 11, 84. That means that 15k was spent in 14 days.

DEVELOPING ORGANIZATION

FORECAST BY GANTT CHART Shows cost to begin - Complete shown in Quarter 1 only.  
PROVIDE ESTIMATED DOLLAR COST FOR EACH TASK FOR EACH FISCAL YEAR

TASK		FY 1984				FY 1985				FY 1986				FY 1987			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
1. Familiarization with nonpower reactors	SCHEDULE																
	COST		15 k			10 k											
2. Calculations of maximum and limiting Radiological Consequence	SCHEDULE																
	COST					75 k											
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4. Calculations of explosives for Part 20 and 100 releases	SCHEDULE																
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	COST					10 k											
	SCHEDULE																
	COST																
	SCHEDULE																
	COST																
	SCHEDULE																
	COST																
TOTAL ESTIMATED PROJECT COST						15 k				255 k							

Does this include visit to sites?

APPROVAL AUTHORITY-SIGNATURE

DATE

2

1. Objective of Proposed Work

a. Background

In 1979, the Los Alamos Scientific Laboratory conducted a study of the consequences of sabotage of nonpower reactors (NPRs). It was concluded that, within the constraints of this study, only one NPR had any potential for the release of significant amounts of fission product materials in the event of sabotage. Because of terrorist activities in other parts of the world, concerns of the ACRS about manipulation of reactor control systems, and concerns of a public interest group about the effects of incendiary devices on reactor components, this information should be supplemented with further technical information.

b. Objective

*blast effects from various quantities and types of explosives,*

The objective of this work is to provide the NRC with technical information on the effects of malicious manipulation of reactor controls, and of the use of incendiary devices on NPRs to assure a margin of public safety.

2. Summary of Prior Efforts

None

3. Work to be Performed and Expected Results

During the period from FY 1984 to 1986 Los Alamos will perform the following tasks.

a. Work Required

Task No. 1

Existing information in available sources, such as the NRC docket files, augmented by site-specific information provided by NRC staff and site visits ~~should~~ <sup>shall</sup> be ~~reviewed~~ <sup>conducted</sup> to (a) familiarize task personnel

*as necessary*

3

with characteristics peculiar to each reactor and (b) obtain information necessary to aid in the calculation of the radiological consequences for three of the NPRs listed in Table 1.

Within 1 month after initiation of task orders, Los Alamos shall provide a detailed work plan that identifies study milestones and their projected dates of accomplishment. Upon NRC review and approval of this plan, it will become the operating schedule for the overall task. The work plan is Appendix A to this proposal.

Task No. 2

Mathematical models or other appropriate methods will be developed and/or used to perform the following.

- a. Calculate the radiological release resulting from a total core meltdown, partial core meltdown, core disintegration and/or crushing, or other means that could damage severely the fuel in the reactor core. Because the key consideration is the fission product release associated with such incidents, the effects of using low-enriched uranium vs high-enriched uranium on the fission product release will be evaluated.

TABLE 1  
LIST OF REACTORS

<u>Licensee</u>	<u>Docket No.</u>	<u>Power Level</u>	<u>Reactor Type</u>
National Bureau of Standards	50-184	20 MW	Tank
University of Missouri	50-186	10 MW	Tank
Georgia Institute of Technology	50-160	5 MW	Tank
Massachusetts Institute of Technology	50-20	5 MW	Tank
Union Carbide	50-54	5 MW	Pool
Rhode Island Atomic Energy Commission	50-193	2 MW	Pool
State University of New York	50-57	2 MW	Pool
University of Michigan	50-2	2 MW	Pool
University of Virginia	50-62	2 MW	Pool

4

- b. Determine, as a function of distance from the reactor, the total radiation dose (rem) to the whole body and the radiation dose (rem) to the thyroid from iodine exposure and identify any facility for which these could exceed 10 CFR 20 and 10 CFR 100 standards.
- c. Determine the characteristics of the event that would limit it to less than Parts 20 and 100 standards.

Certain other parameters and assumptions should be considered when performing this task. These include and are limited to the following except as may be approved by the NMSS Project Manager (PM) in the future.

- a. The models or methods used to calculate the damage and the release shall assume that the reactor has been operating at the maximum power level authorized by the NRC license and that equilibrium of fission products was attained before the incident. This also will be evaluated if significant damage to the core or subsequent release is calculated to occur after a period of reactor shutdown.
- b. The study for facility shall be terminated and the basis for the conclusion documented in those cases in which the fission product inventory of the NPR is determined to be insufficient to create a risk to the public health and safety or those in which the fuel configuration or composition and/or the reactor construction or other factors is such as to limit the fuel damage and fission product release to a level that is insufficient to create a risk to the public health and safety.
- c. No assumptions are made regarding the saboteurs' capabilities nor is any design-basis threat associated with this task.
- d. For base-line considerations, it should be assumed that all reactor safety features fail upon initiation of the incident.
- e. The mean meteorological conditions at the site and the surrounding area should be considered when calculating the atmospheric dispersion of a release.

### Task No. 3

After Tasks 1 and 2 have been accomplished, mathematical models or other appropriate methods will be developed to calculate the amount of explosives and the amount of incendiary material needed to cause the



*mitigating*

events identified in Task No. 2. Calculations will be made for the placement of explosives and incendiary devices at the reactor facility boundary and attached to reactor components.

Certain parameters and assumptions should be considered in those calculations. These include, and are limited to, the following except as may be approved by the NMSS project monitor (PM) in the future.

- a. The type of explosives and incendiary devices used to cause an event are assumed to be easily obtainable.
- b. Two opposing conditions will be considered in performing Task 3.
  - 1. Safeguards credit will be given for all physical barriers interposed between the explosives/incendiaries and the reactor fuel.
  - 2. The adversary will have access to all reactor components in carrying out the sabotage event.

Task No. 4

Upon completion of Task No. 3, for those cases in which the fission product release and estimated doses exceed 10 CFR 20 and 10 CFR 100 standards, calculate the amount of explosives and the amount of incendiary material needed to cause the release. The calculations shall be made for placement of explosives and incendiary devices attached to reactor components, and outside the structure containing the reactor. The parameters and assumptions employed in Task No. 3 will be used in this task.

Task No. 5

Upon completion of Task No. 3, reactor control systems and fuels shall be reviewed and evaluated to determine whether an unauthorized manipulation of such controls could cause any detrimental effects that may be identified in Task No. 2. Only credible scenarios and analytical assumptions shall be used, and these shall be reviewed and approved by the NMSS PM before the analyses are made.

Task No. 6

Upon completion of Task No. 3, calculate the mitigating effects of full and partial operation of existing safety features associated with the operation of the reactor. (These features are ignored in Task 3 to

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Additionally, identification of determine maximum consequences.) Identify additional safety measures and modifications as well as administrative procedures and practices that could be adopted and determine the degree to which these additional considerations would mitigate the consequences. <sup>will be made</sup> Exclude specific safeguards measures <sup>are excluded</sup> from consideration in this task.

Where are the first 11 addressed?

Task 7: Program Plan and Schedule for the Remaining Reactors

Insert Intro in Appendix

A detailed plan for applying the tools developed in Tasks 2 through 6 to the remaining five reactors in Table I will be formulated. This plan will attempt completion of the remaining reactors in as short a time as possible during FY 1986. This plan will be submitted to NRC for approval.

b. Meetings and Travel

Site visits for two analysts to the three reactors will be required. Three meetings with NRC sponsors in Washington, DC, for two people also will be required in FY 1985. LANL representatives shall meet with the NMSS PM two to four times a year. Upon completion of the draft final report, LANL representative, upon request of the NMSS PM, shall NRC Furnished Materials brief NMSS staff in Washington, D.C.

OK c.

NRC will furnish only reactor documentation that cannot be obtained by Los Alamos.

OK 4. Description of Follow-On Efforts

Upon completion of the analysis in tasks 1 through 6 a program plan and cost estimate for completion of the remaining five reactors in Table I will be submitted to NRC for the follow-on efforts.

✓ 5. Relationship to Other Projects

None

✓ 6. Reporting Schedule

Monthly letter status reports and a final report will be provided. All reports will be submitted to the NRC technical monitor. A distribution

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list for the final report should be provided by the NRC technical monitor. For any reports that will not be submitted according to the contract schedule, a written reason for the delay will be submitted to the technical monitor by the original scheduled date.

a. Monthly Letter Status Report

Los Alamos will submit a letter status report each month that summarizes the work performed during the previous month, personnel time expenditures during the previous month, and costs generated against the work effort. Any changes to cost projections or schedules will be indicated. The letter report will arrive at the NRC by the 20th of each month. In all monthly reports there will be a breakdown of (1) manpower costs; (2) costs incurred for direct salaries, material and services, ADP support, subcontracts, travel, general, and administrative and other related items; and (3) current obligation status information for the project.

The report shall be distributed as follows.

Donald M. Carlson, SG, NMSS - one copy

Office of the Director, NMSS (Attn: Program Support) - one copy

b. Interim Reports

A draft interim report shall be furnished to the NMSS PM upon completion of ~~each~~ major tasks (that is, Tasks No. 2, 3, 4, and 5). After review by appropriate NRC personnel, the PM will provide comments on the draft report to Los Alamos National Laboratory within 60 days of receipt of each report. A revised interim report shall be submitted if deemed necessary by the NMSS PM.

*and to conduct*

c. Final Report

Los Alamos shall furnish two copies of a draft final report to the NMSS PM by June 30, 1986. The format of these documents shall be as specified for formal technical reports in NRC Manual Chapter 1102 and will provide

*CF*

1. the on-site and off-site fission product release and dosage calculations associated with a total loss of coolant,
2. the quantities of explosives and incendiary material or a description of acts necessary to cause a limiting case incident,
3. the placement of explosives and incendiary materials in relation to the reactor,
4. a description of unauthorized manipulation of reactor controls and fuel to cause a limiting case incident,
5. the resulting consequences, and
6. appropriate alternative measures that can be implemented to mitigate a significant event (for example, reactor facility modifications, administrative procedures, and so on).

After review by appropriate NRC personnel, the PM will provide comments on the draft report to Los Alamos within 60 days of receipt of the report.

The performing organization shall revise the draft report based on the PM's comments and submit one camera-ready copy of the final report to the Document Management Branch, Technical Information and Document Control, NRC, to be published as a NUREG/CR series report, and a duplicate to the NMSS PM.

All draft reports, as well as final reports, shall be screened for Classified Information and appropriately marked in accordance with "NRC Classification Guide for Information Dealing with the Release and Dispersion of Radioactive Material (NRC-RDRM-1)," dated September 1982, and NRC Manual Chapter 1102.

✓ 7. Subcontractor Information

None

✓ 8. New Capital Equipment Required

None

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9. Special Facilities Required

None

10. Conflict of Interest Information

None

11. Track Quality Assurance Statement - See Para 1.

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APPENDIX A  
WORK PLAN

I. INTRODUCTION

Because of the developmental nature of this study, Los Alamos will approach this work in two phases. The first phase, to be completed in FY 1985, will develop the methodology and apply it to three reactors, which hereafter are referred to as lead reactors (LRs). After this phase of work, a detailed plan for completing the remaining five reactors will be formulated based on the data gained in the LR phase.

*Bring up to Task 7.*

In the LR phase (FY 1985), three representative nonpower reactors (NPRs) will be fully analyzed by October 1, 1985. These reactors are the NBS reactor, the largest NPR representing tank reactors; the University of Missouri reactor, the largest enclosed pool reactor, and the ~~Union Carbide~~ reactor, the largest open pool type reactor. Based on the results of these three calculations, a better estimate of the time and cost required to perform the remaining calculations can be made for FY 1985.

*Georgia Tech should be brought to MIT on long*

II. TASK BREAKDOWN FOR LEAD REACTOR PHASE (FY 1985)

Task 1. Collection of Information and Familiarization With It

This task will be initiated immediately and will continue as required to gain a familiarity with the three LR's. Information available at Los Alamos will be supplemented by docket information from NRC and with site visits when sufficient familiarity is gained to make the visit meaningful.

Task 2. Calculation of Maximum Radiological Release

- a. Develop core inventory analyses and apply them to the three LR's for an operating history of the maximum authorized power level long enough to achieve equilibrium fission product levels. Both high- and low-enrichment fuels will be considered.
- b. Use a Master Logic Diagram (MLD) to identify potential physical modes of core disruption or other radionuclide sources for each LR.

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- c. The maximum extent of core damage for each mode identified in the previous step and the fission product release associated with this damage will be determined using available methods. If no methods exist for a given requirement, an approximate and conservative analytical tool will be developed based on the best current knowledge.
- d. The effects of physical decontamination factors on the radionuclide transport will be calculated using currently accepted methods and site-specific information for each LR.
- e. The whole body radiation dose and thyroid dose from iodine will be calculated in rem using currently accepted methods for the potential releases identified for each LR. Mean meteorological conditions at each LR will be assumed.
- f. This study will be terminated for those sites with no identified sequence leading to at least a 10 CFR Part 20 release.
- g. For those LRs that have sequences exceeding 10 CFR 20 or 10 CFR 100 releases, the extent of core damage leading to these releases will be calculated by scaling of results from previous calculations in Task 2.d.
- h. All results from the foregoing calculations will be documented and submitted to NRC as an interim technical report.

### Task 3. Determination of Sources of Damage

- a. For each damage mode capable of resulting in at least a 10 CFR Part 20 or 100 release, the credible sources of such damage (for example, explosives<sup>and</sup> or incendiary devices) will be identified.
- b. Using explosive yield, structural response, and other analyses, the amount and placement of damage sources resulting in the maximum release will be determined assuming no mitigating system functions and assuming that the adversary has direct access to all reactor components.
- c. The calculations of Task 3 will be repeated allowing safeguards credit for any physical barriers blocking direct access to the reactor fuel.
- d. The results of this task will be reported in an interim report to the NRC.

Task 4. Scaling of Damage Sources to 10 CFR 20 and 10 CFR 100

- a. The results of Task 3 will be scaled to determine the damage sources leading to 10 CFR 20 and 10 CFR 100 releases.
- b. The results of this task will be reported along with Task 3 in an interim report to the NRC.

Task 5. Determination of Misoperation Scenarios

- a. Using LR system descriptions, damage modes from Task 2, and damage sources from Task 3, a system logic model (fault-tree) approach will be used to determine sabotage scenarios resulting from unauthorized operation of reactor controls, systems, or fuels.
- b. The results of this task will be documented in an interim report for the NRC.

Task 6. Mitigating Systems Effects

- a. Using the sabotage scenarios developed in Task 5, the effect of mitigating systems on radionuclide release will be included using system logic models (fault trees) to determine the effects of both full and partial operation of mitigating systems.
- b. Using the insights of Task 6.a, above, identify additional or modified safety features or administrative practices that could be adopted. <sup>identification of</sup> will be made.
- c. The results of this task will be documented in an interim report for the NRC.

*Safe shutdown systems*

Task 7. Program Plan for FY 1986

Upon the conclusion of the LR analysis, a detailed plan for completing the remaining five nonpower reactors in FY 1986 will be formulated and submitted to the NRC.



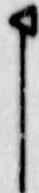
TASK 2

P R B D J J F M A M J J A S

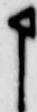
a. Core Inventory Calculations



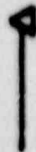
b. Identify Damage Nodes



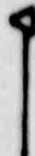
c. Determine Core Damage



d. Radionuclide Release



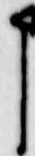
e. Whole Body Dose



f. Terminate Studies as Applicable



g. Part 20 and 100 Release Damage Determination



h. Report



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TASK 3 Assess  
G M D J J F M A M J J A S

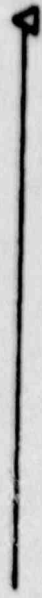
a. Identify Damage Sources



b. Calculate Amount of Damage  
Source



c. Include Effects of Safeguards  
Barriers

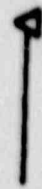


d. Report

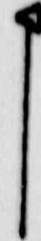


TASK 4

a. Scale Results of Task 3 to  
Part 20 and 100 Releases



b. Report with Task 3



O  
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F  
M  
A  
M  
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J  
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S

TASK 5

a. Construct Logic Models for Scenarios

b. Report

TASK 6

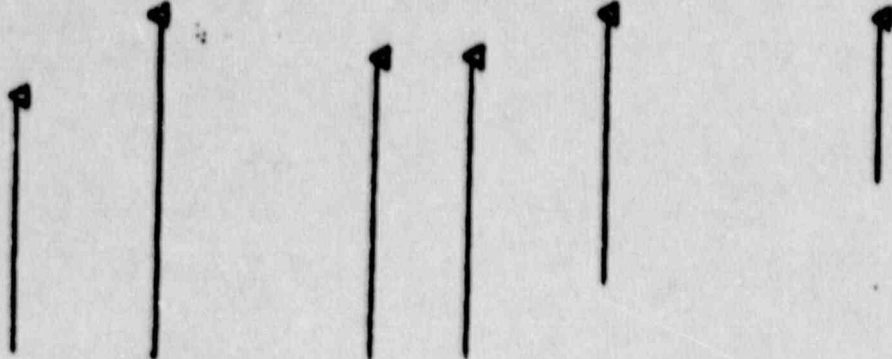
a. Construct Logic Models

b. Make Recommendations on Improved Safeguards

c. Report with Test 5

TASK 7

a. Submit Program Plan for FY 1985



NOTE TO FILE:

October 16, 1984

Reference: Los Alamos Letter ADC-84-P505, Dated October 9, 1984 From  
Allen L. Jennings To Donald M. Carlson

Per my conversation with Terry Bott this day, the proposal attached to the referenced letter will be amended to reflect our concerns which were discussed during the October 10, 1984, meeting here in NMSS. The following persons attended that meeting:

NRC

W.B.Brown  
R.R.Rentschler  
R.J.Dube  
C.J.Withee  
D.M.Carlson

LANL

T.F.Bott  
W.Gregory

Hence, no action will be taken on this letter.

  
D.M.C.