MAY 21 1986

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CWithee
JYardumian
DCarson
DKasun

Mr. James E. Hyder
Mail Stop K557
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Dear Jim:

Per Bill Zerwekh's request of March 18, 1986, we destroyed the preliminary report for the Nonpower Reactor Sabotage Study. The document (number Q-6-85-CI-1000 49-1-1-RD, dated October 9, 1985, classification Secret, transferred on LANL receipt number A-018400) was shredded on May 12, 1986.

Sincerely,

Carl J. Withee
Safeguards Reactor and Transportation
Licensing Branch
Division of Safeguards, NMSS

Donald M. Carlson
Safeguards Reactor and Transportation
Licensing Branch
Division of Safeguards, NMSS



| OFFICE | SGRT | SGRT | | | | | |
|---|---|---|---|---|---|---|---|
| SURNAME | CWithee:jr | DCarlson | | | | | |
| DATE | 5/20/86 | 5/ /86 | | | | | |

# LOS ALAMOS NATIONAL LABORATORY
# ENERGY DIVISION
# SAFETY ASSESSMENT GROUP

WILLIAM D. ZERWEKH
PRINCIPAL INVESTIGATOR

## NONPOWER REACTOR SABOTAGE STUDY

Los Alamos

B49

# NONPOWER REACTOR SABOTAGE STUDY

DEVELOPMENT OF FACILITY SPECIFIC SABOTAGE SCENARIOS

EXAMINATION OF POTENTIAL BUILDING RELEASE MECHANISMS

EXAMINATION OF CLIMATIC SPECIFIC DISPERSION ROUTES

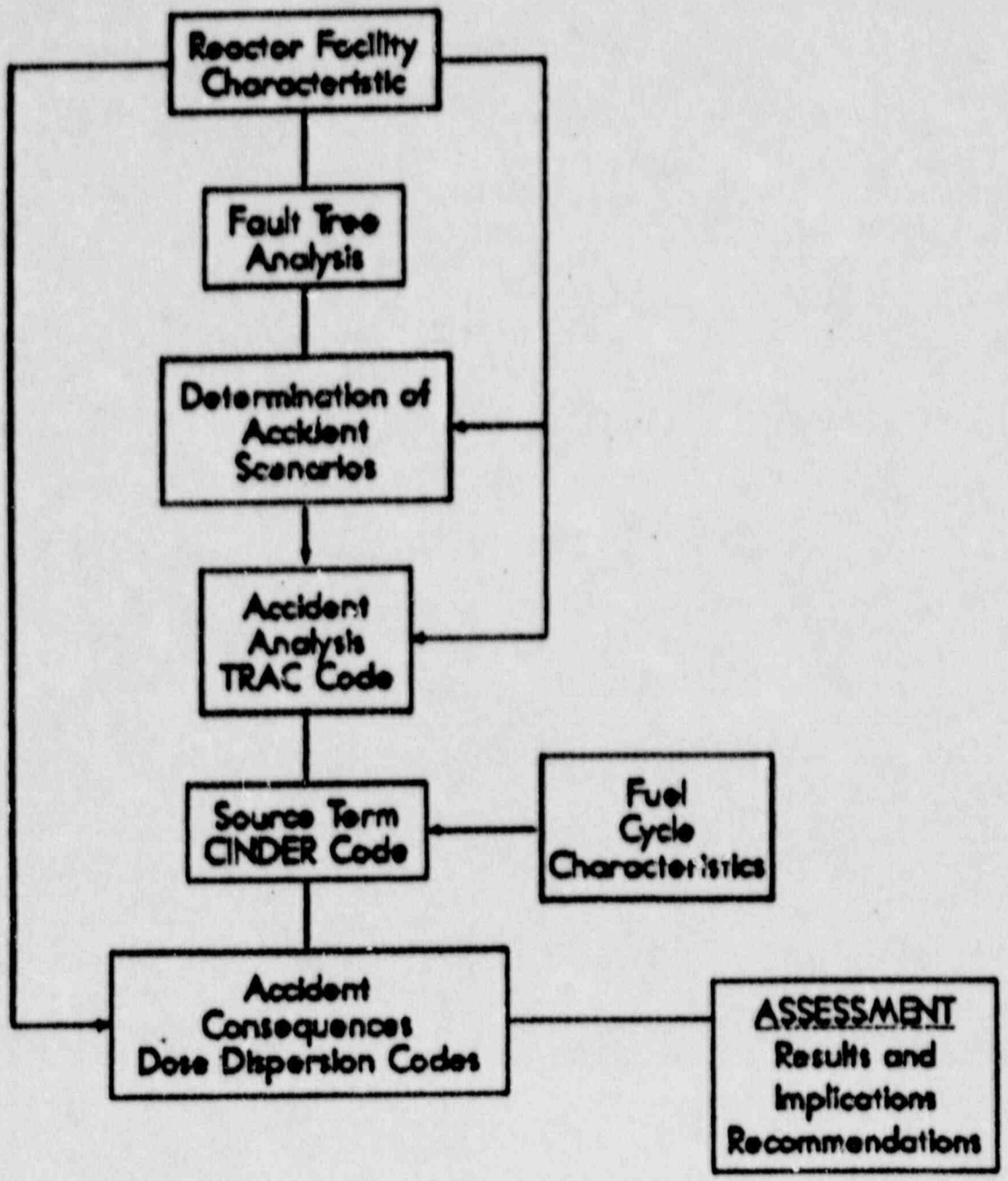
DETERMINATION OF THE QUANTITY OF RADIOACTIVE MATERIAL REQUIRED TO CAUSE A SIGNIFICANT POPULATION EXPOSURE

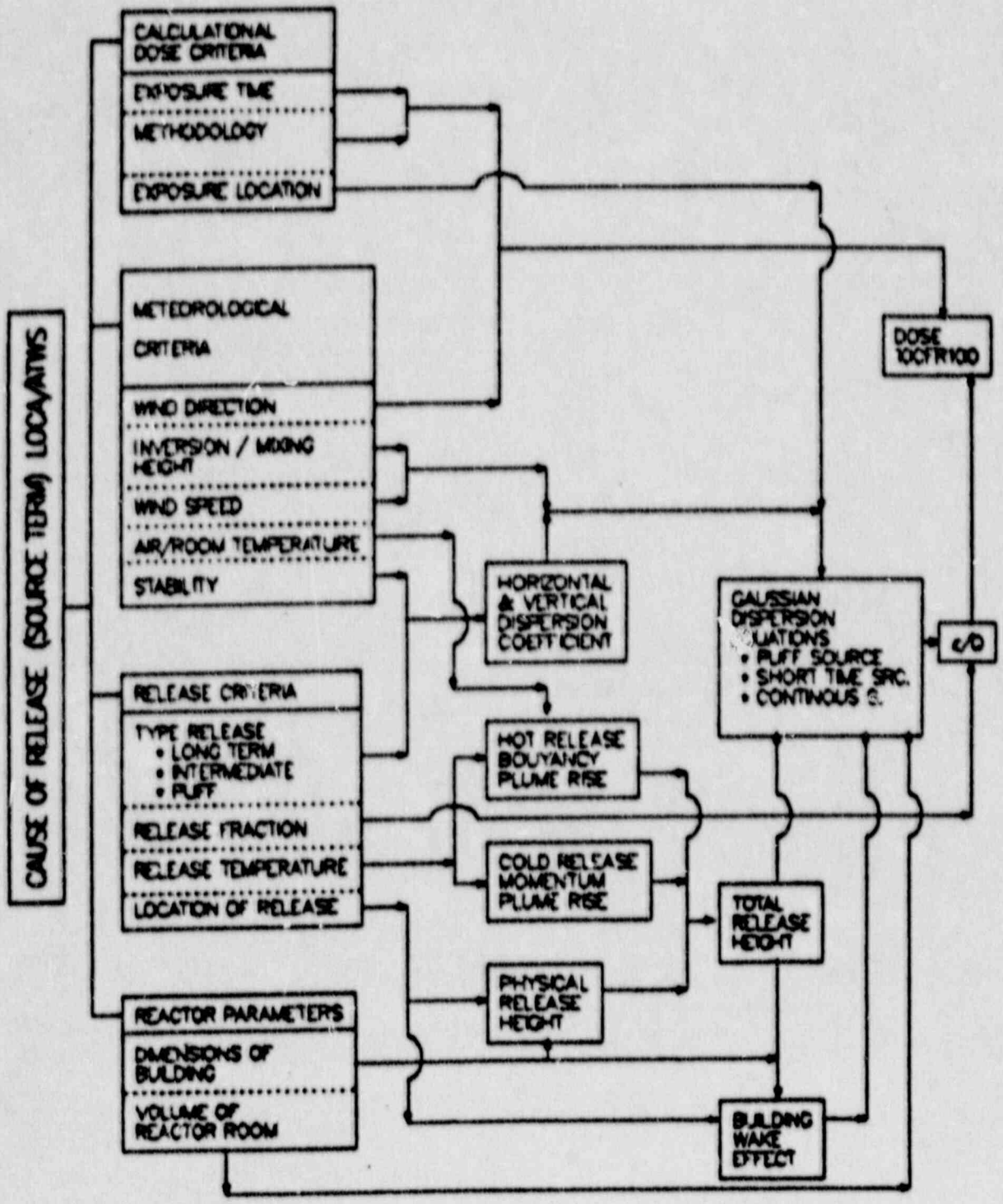
ESTIMATION OF PERCENT OF CORE DAMAGE TO RESULT IN SIGNIFICANT RELEASE

COMPARISON OF NECESSARY CORE DAMAGE TO SABOTAGE CAPABILITIES

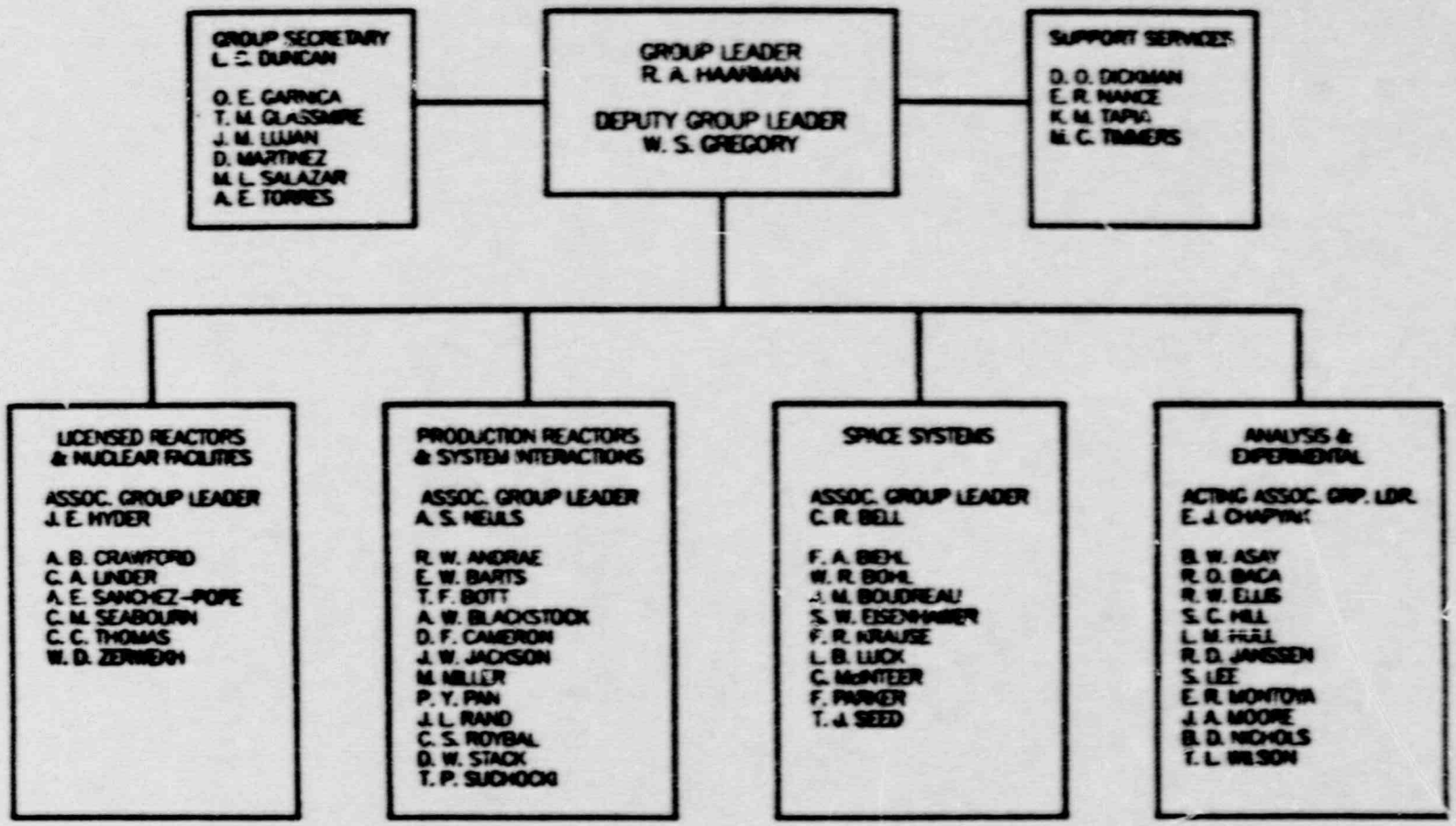
Los Alamos

# NONPOWER REACTOR SABOTAGE STUDY




CAUSE OF RELEASE (SOURCE TERM) LOCATIONS
CALCULATIONAL DOSE CRITERIA
EXPOSURE TIME
METHODOLOGY
EXPOSURE LOCATION
METEOROLOGICAL CRITERIA
WIND DIRECTION
INVERSION / MIXING HEIGHT
WIND SPEED
AIR/ROOM TEMPERATURE
STABILITY
RELEASE CRITERIA
TYPE RELEASE
• LONG TERM
• INTERMEDIATE
• PUFF
RELEASE FRACTION
RELEASE TEMPERATURE
LOCATION OF RELEASE
REACTOR PARAMETERS
DIMENSIONS OF BUILDING
VOLUME OF REACTOR ROOM
HORIZONTAL & VERTICAL DISPERSION COEFFICIENT
HOT RELEASE BOUYANCY PLUME RISE
COLD RELEASE MOMENTUM PLUME RISE
PHYSICAL RELEASE HEIGHT
TOTAL RELEASE HEIGHT
BUILDING WAKE EFFECT
GAUSSIAN DISPERSION
• PUFF SOURCE
• SHORT TIME SRC.
• CONTINOUS S.
DOSE 10CFR100

# GROUP Q-6

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# STATEMENT OF WORK

## CONSEQUENCES OF SABOTAGE AT NONPOWER REACTORS

FIN NO: A7153 BAR NO: 50-19-02-00

### 1.0 Background

In 1979, Los Alamos Scientific Laboratory conducted a study on the consequences of sabotage at nonpower reactors. It was concluded that, within the constraints of this study, only one nonpower reactor 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 by the ACRS about manipulation of reactor control systems, and concerns by a public interest group about the effects of incendiary devices on reactor components, staff believes that it would be prudent to supplement this study with further technical information to assure that the margin of safety provided to the public is maintained.

### 2.0 Work Required

Los Alamos National Laboratory shall determine and evaluate the risks and potential consequences of both a loss of coolant incident and the direct fuel damage which would be produced by: (a) blast effects from various quantities and types of explosives, (b) the production of heat from incendiary devices, and (c) the unauthorized manipulation of reactor controls and fuels at nonpower (NPRs) operating at 20 MW, 10 MW, 5 MW and 2 MW; and, for (a) and (b), at NPRs operating below 2 MW. Specifically designed mathematical models or other appropriate methods shall be used to determine the potential consequences of the events associated with (a), (b), and (c) above. Assessments shall include the consequences associated with core meltdown, partial core meltdown, and disintegration and/or crushing of the core and shall be compared against 10 CFR Parts 20 and 100 standards. Where applicable, the extent of fission product release shall be based upon NRC's re-evaluation of source term assumptions and findings.

Facilities shall be grouped by common design feature and analysis of a representative from each group shall be performed in the sequence of descending power.

| Licensee | Docket No. | Power Level | Reactor Type |
|---|---|---|---|
| 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 |

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Los Alamos National Laboratory shall perform the following tasks:

2.1 Task No. 1

A review of existing information in available sources such as the NRC docket files augmented by site-specific information provided by NRC staff and on site inspection visits shall be conducted 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 each of the NPRs listed above, as appropriate.

2.2 Task No. 2

Mathematical models and/or other appropriate methods, such as a master-logic diagram fault-tree approach similar to those used in other safety studies by LANL, shall be developed and/or used to:

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

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 which could exceed 10 CFR Parts 20 and 100 standards, and

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 releases shall assume that the reactor has been operating at the maximum power level authorized by NRC license and that equilibrium of fission products was attained prior to the incident. Note: If significant damage to the core or subsequent release is calculated to occur after a period of reactor shutdown, this shall also be evaluated,

b. 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, the study for that facility shall be terminated, and the basis for the conclusion documented,

c. No assumptions are made regarding the saboteurs' capabilities nor is there any design basis threat associated with this task,

d. For baseline considerations, it should be assumed that all reactor safety features fail upon initiation of the incident, and

e. The mean meteorological conditions at the site and the surrounding area should be considered when calculating the atmospheric dispersion of a release.

2.3 Task No. 3

After Tasks No. 1 and 2 have been accomplished, mathematical models or other appropriate methods shall be developed to calculate the amount of explosives and the amount of incendiary material needed to cause the maximum and the limiting events described in Task No. 2 above. Calculations shall be made for the placement of explosives and incendiary devices attached to reactor components and outside the structure containing the reactor.

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 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 shall be considered in performing Task 3:

   i. The adversary shall have access to all reactor components in carrying out the sabotage event.

   ii. Safeguards credit shall be given for all physical barriers interposed between the explosives/incendiaries and the reactor fuel, and

2.4 Task No. 4

Upon completion of Task No. 3, for those cases in which the fission product release and estimated doses exceed 10 CFR Parts 20 and 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 shall be utilized in this task.

2.5 Task No. 5

Upon completion of Task No. 3, a review and evaluation of reactor control systems and fuels shall be made 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 shall be reviewed and approved by the NMSS PM before the analyses are made.

2.6 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 under Task 3 to determine maximum consequences). Identify additional safety measures and modifications as well as administrative procedures and practices which 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.

3.0 Reporting Requirements

3.1 Monthly Letter Status Report

A monthly report shall be given which summarizes the progress of the tasks being performed including:

- o The work performed during the previous month.
- o Personnel time expenditures during the previous month.
- o Problems encountered and the proposed solutions.
- o Activities planned for the ensuing two months.
- o Costs generated against the work effort during the previous month (including direct salaries, materials and services, ADP support, subcontracts, travel, general or other related items).
- o Current obligation status information

The first monthly report shall provide the initial projections or indicate "no change in the cost and uncosted obligation projection." The report shall be due by the 15th of each month with distribution as follows:

Donald M. Carlson, SG, NMSS - one copy
Office of the Director, NMSS (ATTN: Program Support) - one copy

3.2 Interim Reports

A draft interim report shall be furnished to the NMSS PM upon completion of each major task (i.e., Tasks Nos. 2, 3, 4 and 5). After review by appropriate NRC personnel, the PM will provide comments on the draft report to LANL within sixty (60) days of receipt of each report. A revised interim report shall be submitted if deemed necessary by the NMSS PM.

3.3 Final Reports

LANL shall furnish two copies of draft final reports 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:

a. The on-site and off-site fission product release and dosage calculations associated with a total loss of coolant,

b. The quantities of explosives and incendiary material or description of acts necessary to cause a limiting case incident,

c. The placement of explosives and incendiary materials in relation to the reactor,

d. The description of unauthorized manipulation of reactor controls and fuel to cause a limiting case incident,

e. The resulting consequences, and

f. Appropriate alternative measures which can be implemented to mitigate a significant event (e.g., reactor facility modifications, administrative procedures, etc.).

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

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

3.4 Program Plan

Within one month after initiation of task orders, LANL shall provide a detailed work plan which identifies study milestones and their projected date of accomplishment. Upon NRC review and approval of this plan, it will then become the operating schedule for the overall task.

4.0 Meetings

LANL representative(s) shall meet with the NMSS Project Manager two to four times a year. Upon completion of the draft final report, LANL representatives, upon request of the NMSS PM, shall brief NMSS staff in Washington, DC.

All travel requires approval of the NMSS Project Manager.

5.0 NRC Furnished Material

None, except information in available sources such as NRC docket files.

6.0 Level of Effort

It is expected that approximately three and one half staff years of technical support will be required to satisfy the provisions of the Statement of Work.

7.0 Period of Performance

Performance for the overall task shall commence on the effective date of this agreement and continue through September 30, 1986.

8.0 Quality Assurance

For all draft and final technical reports delivered under this agreement, the LANL shall assure that an independent review and verification of all numerical computations and mathematical equations and deviations are performed by qualified contractor personnel other than the original author(s) of the reports. If the LANL proposes to verify/check less than 100 percent of all computations and mathematical equations and derivations in the report(s), (such as might be the case when there are a large number of routine, repetitive calculations), the LANL must first obtain written approval from the NMSS PM.

Computer-generated calculations will not require verification where the computer program has already been verified.

In addition, for all reports, including those which do not contain numerical analyses, a management review shall be conducted prior to submission to the NRC.

9.0 Technical Direction

Mr. Donald M. Carlson (FTS 427-4712) is designated the NMSS Project Manager for the purpose of assuring that the services required under this Statement of Work are delivered in accordance herewith. All technical instructions to the performing organization shall be issued through the NMSS PM. As used herein, technical instructions are those which provide details, suggest possible lines of inquiry, or otherwise complete the general scope of work set forth herein. Technical instructions shall not constitute new assignments or work or changes of such nature as to justify an adjustment in cost or peiod of performance. Directions for changes in cost or period of performance will be provided after receipt of an appropriate Standard Order for Work (SOW) (NRC Form 173) from the Director of the Office of Nuclear Material Safety and Safeguards (NMSS).

10.0 Disposal of Property

Prior to close out of this project, a reconciled report shall be developed by DOE to record available equipment and material purchased with NRC funds. This report should be developed as soon as possible after project completion or termination decision has been made, but not later than 60 days after the termination date. The report should be submitted to the NRC Division of Facilities and Operations Support, AD and the NMSS Project Manager.

11.0 DOE Acquired Material

The performing organization must notify the NMSS Project Manager prior to acquisition of any capital, ADP, or word processing equipment.

# PROJECT DESCRIPTIVE SUMMARY

OFFICE: NMSS Number: NMSS 85-12

PROJECT TITLE: "Consequences of Sabotage at Nonpower Reactors"

FIN NO.: A 7153-4

TYPE OF CONTRACT: DOE

CONTRACTOR: LANL

| FY BUDGET ($K): | FY83 | FY84 | FY85 | FY86 | FY87 |
|---|---|---|---|---|---|
| PRIOR: | 0 | 163 | | | |
| OPERATING: | | | 180 | | |
| FOLLOW-ON: | | | | 100 | 0 |

SCOPE OF WORK: LANL will determine and evaluate the onsite and offsite consequences of both a total loss of coolant incident and direct fuel damage which would be produced by blast effects from explosives, the production of thermal heat from incendiary devices and the unauthorized manipulation of reactor controls and fuels at nonpower reactors (NPRs) operating at 20 MW, 10 MW, 5 MW, and 2 MW. On a generic basis the contractor will determine and evaluate blast effects from explosives and thermal heat from incendiary devices, at NPRs operating below 2 MW. Since a key consideration is the fission product release associated with such incidents, the effects of using low enriched uranium (nominally 20%) versus high enriched uranium (90-93%) shall be evaluated. Specifically designed mathematical models or other appropriate methods shall be used to determine the quantities of explosives and incendiary material necessary to cause limiting case incidents and the resulting consequences. Assessment of the limiting case incidents shall include the consequences associated with core meltdown, partial core meltdown, and disintegration of the core.

USER NEED: Terrorist activities in other parts of the world indicate that it would be prudent to supplement available information on the consequences of sabotage at nonpower reactors to assure that the margin of safety provided to the public is maintained.

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PRODUCTS:

A report will be provided for NPRs detailing the radiological releases and total radiation dose to the whole body and the thyroid resulting from explosives, incendiaries and improper manipulation of controls and fuel. The reports will also identify the quantities of explosives and incendiary material necessary to cause the maximum and limiting case incidents and resulting consequences.

CONTINUATION OF PROJECTS:

None

JUSTIFICATION FOR SOURCE SELECTED AND DISCUSSION OF ALTERNATIVES:

LANL was selected for this project on the basis of the extensive experience that laboratory personnel have with NPRs and their associated characteristics. Subcontracting may be necessary for determining the effects of explosive and incendiary devices upon a reactor core because of the physics associated with these devices.