

REGULATORY COMMISSION  
WASHINGTON, D. C. 20555



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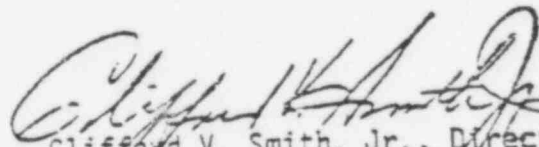
MEMORANDUM FOR: Saul Levine, Director  
Office of Nuclear Regulatory Research

FROM: Clifford V. Smith, Jr., Director  
Office of Nuclear Material Safety and Safeguards

SUBJECT: RESEARCH REQUIREMENT ON VULNERABILITY OF SPENT FUEL  
SHIPMENTS TO MALEVOLENT EVENTS (NMSS 78-7)

The attached NMSS Research Requirement formally expresses the Division of Safeguards needs for research support in the evaluation of the vulnerability of spent fuel shipments to malevolent events.

In accordance with SECY-77-1308, Procedures for Processing User Office Research Requirements, it is requested that a work scope, schedule, and cost estimate for the work needed to satisfy the requirement, as well as an estimate of the value effectiveness of the proposed research, be developed and submitted to my office for review. A. C. Giarratana is the NMSS point of contact for any clarification or amplification of the stated requirement.

  
Clifford V. Smith, Jr., Director  
Office of Nuclear Material Safety  
and Safeguards

Enclosure:  
NMSS Research Requirement to  
Evaluate the Vulnerability of  
Spent Fuel Shipments to  
Malevolent Events



Enclosure 841 066

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UNCLASSIFIED

NMSS SAFEGUARDS RESEARCH REQUIREMENT TO EVALUATE VULNERABILITIES  
OF SPENT FUEL SHIPMENTS TO MALEVOLENT EVENTS

BACKGROUND AND STATUS OF PROBLEM

At present, there are no specific physical protection requirements for safeguarding shipments of spent nuclear fuel. Transport standards which do exist are concerned primarily with safety, and are based on standards developed by the International Atomic Energy Agency (IAEA). There are four basic requirements for meeting these safety standards. These are:

- Adequate containment of radioactive material;
- Adequate control of radioactive emissions;
- Safe dissipation of decay heat; and,
- Prevention of criticality.

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In meeting safety standards requirements, the safeguards posture of spent LWR fuel shipments is enhanced, although the degree of inherent safeguards protection afforded by these requirements to some extent remains to be assessed. To complete such an assessment, NMSS needs information on the release source terms appropriate to a shipping cask exposed to an explosive attack in which the integrity of the cask is breached. There are, at present, a number of approved and licensed spent fuel shipping containers suitable for either truck or rail transport. These include legal weight truck packages with a capacity of one PWR or two BWR fuel assemblies; overweight truck packages with a capacity for three PWR or seven BWR fuel assemblies; and rail packages of seven to ten PWR or eighteen to twenty-four BWR assembly capacities.

Preliminary, classified investigations of the penetrability of spent fuel shipping cask exemplars by various kinds of explosive attack has revealed that shipping cask walls can be breached by a broad spectrum of explosive device configurations. While at this time conservative bounds can be determined, it is not possible to estimate precisely the radioactive release fractions that could result from an act of sabotage involving an explosive attack on a spent fuel shipping cask. Accordingly, it is necessary to refine the estimated effects of a successful attack to obtain a more exact definition of consequences.

Investigations to date have raised the following questions vis-a-vis the potential vulnerabilities of spent LWR fuel shipping casks to acts of sabotage involving explosives:

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- What adversary resource requirements need be assembled to, with a high degree of assurance, explosively breach a loaded spent LWR fuel shipping cask?
- What quantities of spent LWR fuel could be discharged from spent LWR fuel shipping casks subjected to a variety of explosive attacks?
- What portion of the radiation release fractions resulting from explosive breachings of spent LWR fuel shipping casks would be released in respirable aerosol forms?
- What could the range of potential consequences of such events in various environments?
- What are the safeguards implications?

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## RESEARCH REQUIREMENTS

### A. Functional Need

A requirement exists for investigating the vulnerabilities of spent LWR fuel shipping containers to acts of sabotage involving the employment of explosives; for the development of potential source terms resulting from such acts; and for the development of consequence estimates based on these source terms. Support is required for:

#### 1. Consequence Assessment

This capability is required to assist in the formulation of policy concerning safeguarding shipments of spent LWR fuel.

#### 2. Regulatory Design

This capability is required to provide a basis for supporting the development of safeguards regulations which may be required for the shipment of spent LWR fuel.

### B. Product Characteristics

1. Maximum radioactive release fractions from explosive ruptures of fully loaded spent LWR fuel shipping casks should be estimated. Data should be acquired from controlled laboratory tests of explosive disintegration of high burnup LWR fuel pellets and of explosive rupture of scale model spent fuel shipping casks loaded with surrogate fuel.

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2. The data from the controlled laboratory tests should be employed to extrapolate effects, including release fractions, of explosive breachings of fully loaded, full-size spent LWR fuel shipping casks.
3. The research products should include the range of volatile releases from explosive disintegrations of high burnup (30,000 MWd/t) LWR spent fuel pin segments and pellets; the proportions of particulates arising from such disintegrations which are in the respirable size range; the effects of spent LWR fuel shipping cask structural elements on the dynamics of explosive events, and the resulting interactions with and breakup of spent fuel samples; the estimated degree of plate out of volatile constituents on interior surfaces of spent LWR fuel shipping casks from explosively disintegrated LWR fuel; and radioactive release fractions relative to types and quantities of explosives employed in the spent LWR fuel explosive disintegration tests.
4. This research requirement product should include a data base describing the combinations of spent LWR fuel shipping containers and attack modes which would likely result in releases of radioactivity. The cask structures and attack modes should be correlated with the nature of damage inflicted on a shipping container, as well as with the internal cask pressures and temperatures associated with the attacks.
5. Employing radiological release source terms developed in the course of this research program or other NRC funded research programs, consequence estimates should be made for a variety of explosive attack model and associated release source terms. Consequence evaluations will be developed for 120 day, one, five, and ten year-old spent fuel.
6. Although those portions of the data base which provide details in safeguards vulnerabilities must be classified, the research product should, to the extent possible, provide an unclassified overview and appreciation of the range of potential risks and consequences of radioactive release fractions in aerosol forms.

#### C. Project Schedule

Preliminary evaluative data concerning results of explosive disintegrations of high burnup LWR fuel pellets and pin segments should be available by the end of FY79. Consequence estimates based on this test data should be available by early FY80.

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A decision point should be scheduled for early FY80 for NRC staff to evaluate program results and decide whether program results warrant further research.

#### IMPLICATIONS FOR SAFEGUARDS PROGRAMS

This is a high priority requirement, significantly impacting NRC's policy concerning the safeguarding of spent LWR fuel shipment and the development of regulatory upgrades in this area.

#### RESEARCH REQUIREMENT

In accordance with SECY-77-1308, Procedures for Processing User Office Research Requirements, it is requested that a work scope, schedule, and cost estimate for the work needed to satisfy the requirement, as well as an estimate of the value effectiveness of the proposed research, be developed by the Office of Research and submitted to the Office of Nuclear Material Safety and Safeguards for review.

#### RELATED ACTIVITIES IN OTHER AGENCIES

This research requirement could be met by a joint program with the Department of Energy (DOE), whose objectives in a currently funded program of similar nature appear complementary to those of NRC.

The DOE program to date has involved investigating the effects of various kinds of explosive attack on empty, obsolete, fuel casks designs, as well as on models of these casks. Access to data bases being developed by DOE and coordination with their continuing effort is essential. Continuation of this program into studies of the effects of explosive attack on casks and cask models of current design containing high burnup LWR fuel, is contemplated by DOE. The most recent Sandia Laboratories 189, which is attached, contains estimated costs of the DOE proposed program tests and validation studies.

Source terms developed from a joint undertaking could be used in consequence estimation methodologies recently developed, or now being developed under an NRC funded research program.

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