UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

December 19, 1979 SECY-79-187C

INFORMATION REPORT

For: The Commissioners

From: William J. Dircks, Director
Office of Nuclear Material Safety and Safeguards

Thru: Executive Director for Operations

Subject: IMPACT OF THE SAFEGUARDS UPGRADE RULE ON NONPOWER REACTOR LICENSEES

Purpose: To provide the Commissioners with the following information: a status report on the impact of the Safeguards Upgrade Rule on the 22 nonpower reactor (NPR) licensees listed in SECY 79-187B; review of safeguards measures in force at NPRs; the status of the reevaluation of the 100 rem/hr at 3 feet self-protection exemption criterion; and the status of NRC staff reviews and studies which might lead to giving safeguards credit for enrichment, type and form of the SSNM located at NPRs.

Discussion: Background

On July 24, 1979, the Commission held an open meeting on the impact of the Safeguards Upgrade Rule on nonpower reactor licensees (SECY 79-187B). The discussion concerned the staff recommendation that nonpower reactor licensees be deferred from implementing the requirements of the Safeguards Upgrade Rule and that in the interim the new Category II (§73.67) physical protection requirements as well as the current (§73.60) requirements be applied to nonpower reactor licensees with greater than formula quantities of SSNM. During the meeting the Commissioners asked questions concerning the number of Category I nonpower reactors that would be subject to the physical protection requirements of the Safeguards Upgrade Rule as well as what physical protection is presently in place at those nonpower reactors. The Commissioners were also concerned with what physical protection requirements were actually needed at Category I nonpower reactor facilities given the unique type form and enrichment level of the reactor fuel. This concern was expressed in relation to the amount of time nonpower reactors should be deferred from implementing the requirements of the Safeguards Upgrade Rule. The Commission asked the staff for an interim status report in 120 days which would give a more definitive explanation of the Category I nonpower reactor problem and actions being taken to determine the appropriate physical protection requirements for these facilities. This Commission paper is the interim status report.

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Nonpower Reactor Status

In response to an NRC inquiry, nonpower reactor licensees indicated by return letter the total amount of SSNM that will be required to operate each of their reactors. These responses will be the basis for new licensing actions setting new possession limits. The required amount of SSNM also provides a basis to reevaluate how many of the 22 nonpower reactor licensees, which are presently authorized to possess more than a formula quantity of SSNM, will no longer be in Category I. Four of the 22 NPR licensees indicated in their responses that they intend to operate with less than 5KGs of HEU. This would take them out of Category I. The remaining 18 may be able to go to Category II or III depending on safeguards policy decisions. The four licensees that will operate with less than 5 KGs are:

- Babcock and Wilcox, Lynchburg, Virginia
- Pennsylvania State University
- University of Missouri (Rolla)
- University of Washington

The remaining 18 nonpower reactor licensees have indicated that they would possess 5 KGs or more of HEU. Seven of these licensees are rated at 2 megawatt (MW) or higher and plan to take advantage of 100 rem/hr at 3 feet exemption by operating with sufficient frequency to be in Category II by virtue of their high levels of radiation (500 to 1,000 rem/hr). However, during temporary shutdowns for maintenance, core reloading operations and times when stored spent fuel might cool down; fuel elements could go under 100 rem/hr at 3 feet radiation levels and therefore these licensees could be subject to Category I requirements for short periods of time.

These seven are:

- Georgia Tech
- Massachusetts Institute of Technology
- National Bureau of Standards
- Rhode Island AEC
- Union Carbide, Tuxedo, New York
- University of Michigan
- University of Missouri (Columbia)

Four other licensed facilities are TRIGA reactors which have FLIP fuel that is arranged in clusters of four rods each. These reactors have a rated power of 1 MW and it would be extremely difficult to maintain the radiation levels of each individual fuel rod above 100 rem/hr at 3 feet. However, if a cluster of four rods is treated as one unit, the four licensees have indicated that they would be in Category II by virtue of the 100 rem/hr exemption. The staff has this design consideration under study. (A more detailed discussion of this issue is presented later in this paper.) These four licensees are:

- Oregon State University
- Texas A&M University
- University of Wisconsin
- Washington State University

There are seven remaining licensees of the 18 who have requested an authorized possession limit that would put them in Category I. These seven cannot maintain fuel at above 100 rem/hr exemption but have certain reactor design features and programs underway for which the licensee hopes to receive safeguards credit or which will drop their facility to Category II. These are:

- General Electric, Valliecitos, California
- University of California at Los Angeles (UCLA)
- General Atomic, La Jolla, California
- University of Virginia
- Westinghouse, Zion, Illinois
- Rensselaer Polytechnic Institute (RPI)
- Virginia Polytechnic Institute (VPI)

RPI and VPI have indicated that they plan to reduce their total HEU possession below a formula quantity in 1980 by shipping some fuel offsite. The University of Virginia is looking into the possibility of maintaining a sufficient amount of fuel above 100 rem/hr in order to stay in Category II. Westinghouse is investigating the feasibility of installing a reflector and reducing the core loading below a formula quantity. Three of the seven licensees have contiguous site considerations. That is they would like to be considered as two Category II sites rather than one Category I site based on the distance between facilities and other unique design features. Distances involved at these three licensees are all less than one mile. The decisions on this matter have not been made. The three licensees involved are:

- General Electric, Vallecitos, California
- University of California at Los Angeles (UCLA)
- General Atomic, La Jolla, California

Upgrade Rule Impacts on NPRs

NRR sent letters to 22 potential Category I NPR licensees asking each licensee to respond to 16 questions concerning the Upgrade Rule impacts on their facilities and to provide any additional information that they thought relevent which was not covered by the questions. All licensees stated they would take actions to go to Category II since the impact of fulfilling the physical security requirements of the Upgrade Rule would be extensive. A summary of the responses to the NRR letter regarding the potential upgrace rule impacts is in Enclosure 1.

Additionally eleven NPR licensees indicated that they could be exempted from the Upgrade Rule requirements based solely on the 100 rem/hr at 3 feet exemption as discussed earlier. However, the licensees cited a variety of problems that they may encounter. Enclosure 2 enumerates these problems and includes a table that has been developed to give a quick breakdown by licensee on the ease with which each one can maintain its fuel at the 100 rem/hr radiation level. Again it should be noted that some may not meet the radiation levels during short periods of time.

One course of action that the staff is investigating is the idea of requiring increased physical protection, on an interim basis, for the NPR SNM during the periods it is not self-protecting.

Current NPR Safeguards Measures in Force

Since late 1973 NPR licensees have been required to submit a physical security plan as part of their application for a license to operate. NPR licensees who possessed less than a formula quantity of SSNM were subject to the provisions of §50.34(c) and §73.40 and those who possessed more than a formula quantity of SSNM were subject to the provisions of §73.50 and §73.60, as applicable, in addition to §50.34(c) and §73.40. In 1974, the staff developed guidance in support of the foregoing requirements to aid applicants and licensees in the development of security plans to protect reactors against acts of sabotage. The guidance was contained in 3 documents and was sent to appropriate licensees. The guidance documents addressed security systems that were applicable to NPRs of three different power levels: (1) <250* kw, (2) ≥250 kw, but <5000 kw and (3) ≥5000 kw.

All of the currently approved security plans for the reactors in question were reviewed and analyzed with respect to preventing sabotage and a few were evaluated by NRR to determine the adequacy of their physical protection system to protect against the theft or diversion of SNM. All NPRs have been inspected against their security plans for compliance during the period 1975-1979. While some items of noncompliance have been noted, there was no adverse effect on public health and safety. In addition, staff members of NRR have visited and assessed 50 NPRs in the past two years. All 22 NPRs which SECY 79-187B listed as Category I facilities, based on authorized possession limits, have security systems in place and have been inspected and found in compliance with their security plans which are based on present requirements under §50.34(c), §73.40, §73.50 and §73.60, as applicable. The security systems at all 22 NPRs have been examined during visits by staff members of NRR.

*This is the Category limit for TRIGA reactors, the training reactor limit was > or <100 kw.

Summaries of physical protection measures in place at the seven NPRs potentially in Category I are outlined in Enclosure 3.

Ongoing Studies and Reviews

The following studies and activities in support of the program to develop safeguards requirements for Category I NPRs are ongoing.

o Intermediate Enrichments (SECY 79-213)

The Commission has directed the staff to request comments from the Departments of State and Energy on a technical study which examines, among other things, giving safeguards credit for SSNM of intermediate enrichments. If recommendations of this paper were adopted two NPRs would be affected immediately which could result in less stringent safeguards

o Credit for Type of Fuel

As a result of the Commission's decision to delay implementation of the Safeguards Upgrade Rule for the NPRs and because of uncertainties associated with safeguards requirements to protect SNM at NPRs, the staff initiated a technical study at Oak Ridge National Laboratory. Its purpose is to obtain technical information on the degree of difficulty, time required and efficiency of the processes which might be employed by a subnational group to reprocess irradiated and unirradiated nonpower reactor fuel into a chemical and physical form which is directly useable in a clandestine fission explosive. A preliminary report is due in early 1980.

o Credit for Fuel and Reactor Design

In addition to the physical security measures in place, the nonpower reactors have a variety of other design features which would make the theft of fuel elements difficult. The NRC staff has under consideration giving safeguards credit for these design features.

Five reactors have heavy plugs which prevent direct access to the fuel elements. Either these plugs have to be removed by a heavy crane or a series of unique maneuvers are necessary before fuel elements can be removed from the core. Either circumstance increases the likelihood of the theft act being detected and increases the technical know-how a thief must possess.

Four reactors are of the TRIGA design. The 70% enriched FLIP fuel used in these reactors is constructed with four fuel rods held together by a base plate and a locking mechanism. It is much easier for a licensee to maintain a whole cluster above the self protecting level instead of each individual fuel rod. Separating the fuel elements of a cluster requires either complicated manipulations or use of force with tools such as a hacksaw. This fuel design has caused the licensees to ask that a cluster be considered one unit and not as four separate rods for assessing dose rate. In addition, one of the TRIGA reactors has a state required metal grate locked over the top of the core.

Ten of the nonpower reactors which are expected to have a total of more than 5 kgs of U-235 in either exempt or nonexempt form have open reactors. Seven of these have an average of 200 gms or less of U-235 per element or rod. This means that in order to obtain 5 kgs of U-235 an adversary must take more than 25 elements or rods. Typically, most of the fuel elements or rods onsite are in the reactor core under 15 to 20 feet of water. There is considerable difficulty involved in hooking onto an individual fuel element at a depth of 15 to 20 feet even if one uses the facility's handling tool which is normally kept locked up with access to the key restricted. Thus, the number of elements involved and the difficulty of removal enhances the chance of discovery of a theft attempt.

o 100 rem/hr Criterion

Enclosure 3 of SECY 79-187B was a report on the ongoing program concerning the technical basis for the use of 100 rem/hr at 3 feet as a self-protection radiation level for SSNM. The report discussed a study done by Los Alamos Scientific Laboratory (LASL) which addressed the means to measure the radiation level near irradiated fuel, but did not deal with the technical basis for retaining or changing the 100 rem/hr criterion. The Safeguards staff is initiating a follow-on study to be conducted by LASL which would investigate the technical basis for this exemption criterion. As a result of this follow-on study the radiation levels needed for exemption from physical protection requirements could be changed. Study results are not expected until mid-1980.

o DOE Reduced Fuel Enrichment Program

Due to the concern over the proliferation of weapons-useable nuclear material, DOE has begun the U.S. Reduced-Enrichment Research and Test Reactor (RERTR) Program.

This program is investigating techniques of fuel design which will enable research and test reactors to operate with low enrichment fuel without substantial loss of capability. See Enclosure 4 for a more detailed explanation.

Summary: Based on responses to NRC staff letters and personal contact, the 22 NPR licensees listed in SECY 79-187B as potential Category I facilities all are taking actions to be a Category II or III facility. They will achieve this by either reducing the amount of SSNM in their possession, maintaining radiation levels of 100 rem/hr at 3 feet (except for short periods of time) or requesting NRC approval of security plans based on site-specific reactor and fuel design features. A chart summarizing how the 18 NPRs licensees, who will be authorized to possess greater than formula quantity of SSNM, propose to go to Category II or III by any of the foregoing actions is at Enclosure 5. Before definite NRC decisions can be made regarding the final categorization of NPRs the following issues should be resolved.

- o Safeguards credit for intermediate enrichments of fuel
- o Safeguards credit for fuel type
- o Safeguards credit for fuel and reactor design
- o Determination of contiguous site based on reasonable application of 10 CFR 73.60.
- o New radiation levels needed for exemption purposes and a decision to continue with 100 rem/hr exemption on an interim basis.

Presently all NPRs have physical security systems in place based on previous guidance promulgated by NRC. These facilities have all been inspected for compliance with their approved physical security plans and while some items of noncompliance were noted, none had adverse effects on the public health and safety.

All Category II/III NPRs are presently subject to the physical security requirements of §73.67 (Category II/III Rule) and on March 28, 1980 Category I NPRs will be, on an interim basis, subject to the physical security requirements of both §73.60 and §73.67.

The staff plans on continuing these physical security requirements for NPRs until such time as the five issues enumerated above are resolved and a recommendation is forwarded to the Commission for final physical security requirements at Category I NPRs.

Coordination: The Offices of Standards Development, Nuclear Reactor Regulations and Inspection and Enforcement have coordinated in the development of information presented in this paper. The Executive Legal Director has no legal objection to the information presented in this paper.

DEC 1 ^ 1979

William J. Dircks, Director
Office of Nuclear Material Safety
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Enclosures:
1. Upgrade Rule Impacts on NPRs
2. The Self-Protection Criterion: Implementation and Technical Basis Review
3. Present Security Measures Included in the Physical Security Plans of Potential Category I Non-Power Reactors
4. Reduced Fuel Enrichment Program
5. Category Status of NPRs

SUMMARY OF
UPGRADE RULE IMPACTS ON NPRs

NRR sent letters to 22 potential Category I NPR licensees asking each licensee to respond to 16 questions concerning the Upgrade Rule impacts on their facilities and to provide any additional information not covered by the questions. Licensees responded noting what they perceived as impacts that the Upgrade Rule would have at their facility. Some general complaints were voiced by many of the respondents. They are as follows: Universities should not and cannot be subjected to a restrictive security oriented atmosphere which is neither necessary nor conducive to learning.

Almost all cited examples of the harm that shutdowns of their research reactors would have on medicine, the nuclear industry and American leadership in research and specialized learning.

In responding to the question of costs associated with meeting the Safeguards Upgrade Rule requirements three cost categories were examined - one time, annual and shutdown. The table below represents the cost spreads of the majority of nonpower reactors at both universities and in private industry.

One Time	$ 250,000 to $1,000,000
Annual	$ 100,000 to $ 500,000
Shutdown	$1,000,000 to $2,000,000

In examining the impacts to university teaching programs if NPRs were to be shut down, each university indicated that from 5 to 10 classes would be eliminated, 3 to 20 faculty members could be cut and some students would have to change majors in order to graduate.

Some nonpower reactor licensees indicated the following impacts on U.S. nuclear industry if their reactors had to shut down. Examples are:

- No research reactor training program for Washington Public Power Supply System reactor operators (required for Reactor Operators and Senior Reactor Operators).

- Loss of:

  - Very short-lived radioisotope generator,
  - Cancer therapy by boron neutron capture,
  - Radiation synovectomy with dysprosium,
  - The availability of radioisotopes for use in cancer treatment at six area hospitals,
  - Only domestic production of yttrium-90 tagged microspheres for treatment of liver and cancers.

7. Damaged fuel elements cannot be used and may have to be specially shipped before they decay below 100 rem/hr.

8. Lightly loaded fuel elements cannot be kept above the 100 rem/hr level.

9. The exemption criterion encourages the shipment of fuel while it is above 100 rem/hr but these shipments now have to have added physical protection and this increases costs.

As indicated in SECY 79-187B Enclosure C the current validity of the 100 rem/hr at 3 feet self-protection exemption criterion has been questioned. Although an original petition for rulemaking to lower this value has been withdrawn, the staff is continuing with a study effort to reevaluate the technical basis for the exemption criterion. Because of the change in the perceived threat, the manner in which the original value was determined (see SECY 79-187B), recent questioning of this value, and the importance of the exact dose rate value in determining how many nonpower reactors can maintain an exemption from the Safeguards Upgrade requirements, the staff feels that this criterion should be reviewed.

A contractual effort is being initiated by the staff for a technical review of the criterion. This study will explore the possible basis for 1) retaining the 100 rem/hr value, 2) establishing some new value (either higher or lower), 3) developing a new criterion (e.g., a specific dose rate per gram of material or a minimum integrated dose value for all removal sequences), or 4) dropping the exemption all together.

The staff has received the final report on a study which describes a method for measuring the 100 rem/hr value under water. This study also provides curves for converting the measured dose rate underwater to comparable value for a distance of 3 feet in air. Since the conversion data are presented as a ratio of the in-air dose to the in-water dose, this study will also be useful if another dose rate value is chosen.

While the 100 rem/hr criterion is going to be reviewed by the staff, this review may take a year before the technical study is completed, the study results are analyzed, and a staff position is formulated. In the interim, the present exemption will remain effective. Thus, in this paper licensee operations have been evaluated against the 100 rem value.

TABLE 1

LICENSEE ABILITY TO KEEP FUEL
SELF-PROTECTING (ABOVE 100 Rem/hr)

Facility	Total SSNM Below 5kg	Can't Maintain 100 rem/hr	Can Maintain 100 Rem/hr Exemption: With Normal Operations	With Extra Effort (Estimated Cost)	Problems Identified by Licensee
1. Babcock and Wilcox	X	X			
2. Penn State Univ.	X				90 day decay period for spent fuel shipments.
3. Univ. of Mo (Rolla)	X	X			
4. Univ. of Washington	X	X			
5. Georgia Tech			X		Shipment when present fuel burn up.
6. MIT			X		
7. NBS			X		Emergency shutdowns would be problems.
8. Rhode Island AEC				X (minimal cost)	
9. Union Carbide			X		
10. Univ. of Michigan				X (minimal cost)	Fuel must cool before shipment and could go below 100 rem/hr.
11. Univ. of Missouri (Columbia)			X		Some spent fuel shipments have been delayed in the past.

TABLE I

LICENSEE ABILITY TO KEEP FUEL
SELF-PROTECTING (ABOVE 100 Rem/Hr)

Facility	Total SSNM Below 5kg	Can't Maintain 100 rem/hr	Can Maintain 100 Rem/hr Exemption: With Normal Operations	With Extra Effort (Estimated Cost)	Problems Identified by Licensee
12. Oregon State				X[1]	Shipment when present fuel is up.
13. Texas A&M				X[1]	
14. Univ. of Wisconsin				X[1] ($10,000/year)	Maintenance more difficult, power experiments affected.
15. Washington State Univ				X[1]	Emergency shutdowns may force them into Cat. I. Contradicts ALARA.
16. General Electric		X[2]			GETR is presently shutdown -- maintenance periods would be difficult.
17. UCLA		X[2]			
18. General Atomics		X[2]			
19. Univ. of Virginia		X[3]			Refueling periods, tightly loaded fuel elements, counter ALARA, some fuel elements leak fission gasses.

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SELF-PROTECTING (ABOVE 100 Rem/hr)

Facility	Total SSNM Below 5kg	Can't Maintain 100 rem/hr	Can Maintain 100 Rem/hr Exemption: With Normal Operations	With Extra Effort (Estimated Cost)	Problems Identified by Licensee
20. Westinghouse		X			
21. Rensselaer Poly Tech		X			
22. Virginia Poly Tech		X			

1/ Assumes fuel bundles of four are not readily separable.

2/ Could meet the exemption if they were two noncontiguous sites

3/ They will test their ability to meet the exemption criterion.

TABLE 1

LICENSEE ABILITY TO KEEP FUEL
SELF-PROTECTING (ABOVE 100 Rem/Hr)

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20. Westinghouse		X			
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1/ Assumes fuel bundles of four are not readily separable.

2/ Could meet the exemption if they were two noncontiguous sites.

3/ They will test their ability to meet the exemption criterion.

	A[3]	B	C	D	E	F	G
SECURITY DESIGN FEATURES IN PLACE							
Designated Security Areas	X	X	X	X	X	X	X
Fence Alarm System	X						X
Portal Alarm System			X		X	X[1]	X
Vault/Vault-Type-Room Alarm System		X	X	X	X		
Other Type Alarm System					X		X
Local Alarm Station	X	X		X	X		X
Remote Alarm Station	X	X	X	X	X	X[1]	X
Lock and Key System	X	X	X	X	X	X	X
On Site Communications System	X	X		X	X	X	X
Off Site Communications System	X	X		X	X	X	X
Isolation Zones	X						X
Physical Barriers	X	X	X	X	X	X	X
ADMINISTRATION CONTROLS IN EFFECT							
Training	X	X		X	X		
LLEA Liaison	X	X		X	X	X	X
Personnel Entrance Searches	X	X					X[2]
Personnel Exit Searches			X		X		X[2]
Personnel Badging System	X	X					
Personnel Registration System	X	X			X	X[1]	X
Personnel Escort System	X	X		X	X	X	X
Package Entrance Searches	X	X			X		X[2]
Package Exit Searches		X	X		X		X[2]
Personnel Surveillance of SNM			X		X	X	X
Security Contingency Procedures	X	X	X		X	X	X
Security Program Review Procedures	X	X	X		X	X	X
Test/Maintenance Procedures	X	X	X	X	X		X
Drills	X						X
Records System	X	X	X		X		X

Note 1: Systems are in place but not committed to in Security Plan.

Note 2: Searches are authorized but not required.

Note 3: Letters represent the seven potential Category I NPRs.

Reduced Fuel Enrichment Program

Due to concern over the proliferation of weapons-useable nuclear material, DOE has begun the U.S. Reduced-Enrichment Research and Test Reactor (RERTR) Program. This program is investigating techniques of fuel design which will enable research and test reactors to operate with low enrichment fuel without substantial loss of capability or flux levels.

This study is considering two ways of increasing the quantity of U-235 in the core when low enriched uranium is used. One method will be to make the core volume which is actual fuel meat as large as possible. The second and most promising technique is to increase the fraction of the fuel meat that is actual uranium.

The program has been split into near-term and long-term goals. The near-term goal is to demonstrate and implement enrichment reductions based on currently qualified fuel fabrication technology within the next two years. For many reactors with 90-93% enrichments, reductions to 45% will be made and for lower power reactors with large design margins, reductions to less than 20% enrichment will be made. Only a few high-performance MTR-type reactors, with high-density fuel and small design margins will not be affected by this phase.

The long-term goal is to show that essentially, all research and test reactors, with a few possible exceptions, can operate with less than 20% enriched fuel. This phase will develop advanced technology for handling current fuel compositions. The long-term project will take about three years of fuel development followed by two to three years of evaluation, demonstration, and commercial application.

The program will include a development of needed technology, fabrication of prototype fuel elements, demonstration of the fuel in actual operation, and providing technical support to ensure that a commercial supplier of the fuel is available. The present program is not intended to provide any financial assistance to facilities that convert to the new fuels.

LICENSEES	Type of Reactor	Current Status	NRC Projected Status	Maintain 100 rem/hr Exemption	100 rem/hr Exemption Based on Fuel Design	Possible Credit for Reactor Design Heavy Plugs, Grids, Cages, Etc.	Request for Non-Contiguous Site Consideration	Remarks
:orgia Tech	Tank	II	II	X				
II	Tank	II	II	X				
IS	Tank	II	II	X				
l AEC	Pool	II	II	X				
ıion Carbide	Pool	II	II	X				
ıiversity of Michigan	Pool	II	II	X				
niv. of Mo (Columbia)	Pool	II	II	X				
:egon State	Triga-Mk II	III	III		X			Must rely on cluster of four fuel rods being "not readily separable."
:xas A&M	Triga-Conv	II	II		X			"
niv. of Wisconsin	Triga-Conv	II	II		X			"
ashington State Univ.	Triga-Conv	II	II		X			"
- Valecitos	Tank	I	I				X	GETR is not running and fuel will eventually cool below 100 rem/hr.
niv. of California (Los Angeles)	Argonaut	I	I			X	X	
eneral Atomics (La Jolla)	Triga-Mk F	I	I			X	X	
niv. of Virginia	Pool	I	II					Will test their ability to maintain enough fuel exempt at a 100 rem/hr to be in Category II.
estinghouse	Tank	I	II			X		Is investigating the feasibility of using a reflector to reduce fuel needs below 5 kgs.
M	Critical Fac	I	II					Plan to reduce total HEU possession below 5 kgs by fall of 1980.
M	Argonaut	I	II			X		Plan to reduce total HEU possession below 5 kgs by 3/21/80.