NUREG-0699

Comments on the NRC Safety Research Program Budget for Fiscal Year 1982

Advisory Committee on Reactor Safeguards

U.S. Nuclear Regulatory Commission

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

July 17, 1980

Honorable John F. Ahearne
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Ahearne:

The Advisory Committee on Reactor Safeguards submits herewith its comments on the budget for FY 1982 of the Office of Nuclear Regulatory Research.

Only that portion of the budget relating to Program Support has been considered. The funding levels considered are those allocated by the EDO Staff in its preliminary markup of 2 July 1980 and those requested by RES in its reclama of 9 July 1980.

Comments on personnel requirements and allocations are included in a few instances where particularly appropriate.

Sincerely,

Milton S. Plesset

Milton S. Plesset
Chairman

Attachment:
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PART I

GENERAL COMMENTS

PART I: GENERAL COMMENTS

1. Introduction

The FY 1982 safety research budget is being formulated during a particularly complex era. On the one hand, there exists a large array of research needs for operating reactors and for reactors to be constructed that arise directly or indirectly from the implications of the Three Mile Island, Unit 2 (TMI-2) accident. On the other hand, national economic conditions place considerable emphasis on the need to control government expenditures. If those safety research areas which are judged to have potentially the greater impact in protecting the public health and safety are to receive the necessary priority, several steps will need to be taken, including the following:

- The NRC will have to provide policy guidance on the major open safety issues.
- The user offices will have to reevaluate their approach to formulating requests for research and strive to consider these in some broad framework which takes into account the major issues confronting the agency.
- Nuclear Regulatory Research (RES) will have to reevaluate its current and proposed programs in terms of risk-reduction potential and major regulatory needs.
- The NRC will have to judge whether some research, particularly that which involves large scale component testing or the application of existing methodology, should be the responsibility of the industry rather than of the NRC.
- The NRC may have to reduce sharply some research which is merely confirmatory in nature where there is good reason to believe that the current regulatory requirements provide adequate protection to the public.

We elaborate on some of these points below.

2. TMI-2 Accident Related Research Needs

For operating reactors and those under construction, the principal study areas that have come to the forefront following the TMI-2 accident include the following: the accomplishment of highly reliable shutdown heat removal; the study of anomalous transients and small loss of coolant accidents (LOCAs); the improvement of operator capability to understand and

respond to transients and accidents; a reexamination of the overall design adequacy with regard to the possible existence of relatively high probability accident sequences; and measures to deal with or mitigate degraded core and core melt accidents.

For reactors yet to be constructed, the additional issues of importance include the following: siting issues; the development of new general design criteria, for example, to deal with inadequacies in the single-failure criterion and with any new NRC policy on core melt accidents; possible major changes in system design approach, such as a dedicated, bunkered, shutdown heat removal system, vented-filtered containment, or other similar features; and a long-range NRC philosophy toward standard reactors.

Many of these topics require policy guidance from the NRC if an effective and timely NRC safety research program is to be implemented.

3. Reevaluation of Priorities for User Needs

In NUREG-0603, we recommended that the user offices give early attention to an evaluation of the priorities of their existing research requests in the light of their changed perceptions of safety research priorities. The NRC has established a procedure which requires that the user offices request or endorse most of the safety research program; for this and other reasons, it is important that these offices devote adequate attention to assessing their current and future safety research needs. The user offices have provided some comments on the proposed research program. However, we are not satisfied that this matter has received the needed attention, and recommend that the user offices devote the effort needed to develop a cohesive set of research requests formulated with the necessary perspective and within some broad framework of regulatory needs.

4. Reevaluation of Research Priorities

We and others have recommended that RES apply the methodology of risk assessment to its own program in order to define those areas having the greatest potential for improving the protection of the public health and safety. We recommend that RES give priority to such an effort during the next few months, both to provide an improved basis for setting priorities for FY 1982 and for an evaluation of possible changes in priority and funding level for FY 1981.

We recommend also that the NRC develop criteria for when safety research should be done by industry.

5. Class 9 Accidents

The general subject of Class 9 accidents, including but not limited to the proposed rulemaking on degraded cores and core melts, introduces a very important and complex research area. During the past several months, there has been developing a considerably expanded effort compared to the limited program previously pursued.

However the research program needs to be geared to providing that information most important to the NRC decision-making process as expeditiously as possible, and the appropriate resources should be assigned, not only in FY 1982 but earlier in FY 1981. It is therefore of overriding importance that policy guidance from the NRC and additional participation by the user offices be made available to RES at an early date. We believe that the proposed level of effort may fall short of what the NRC needs. For example, rather than a program that consecutively examines the different containment designs such as the large dry pressurized water reactor (PWR) containment, the ice-condenser containments, and the different boiling water reactor (BWR) containments for hydrogen control and core melt, RES should be addressing all of those containment types concurrently, by examining realistic design approaches.

6. Other Areas Requiring Emphasis

The NRC research program currently includes major expenditures for research on the large LOCA and for confirmatory research intended to demonstrate that the current regulatory requirements are adequately conservative in areas where this is quite likely to be the case. On the other hand, the current research program, and that proposed for FY 1982, lacks sufficient empnasis in many areas where either there are large uncertainties or there is reason to expect that a significant improvement in safety may be achievable. We believe that the FY 1982 program (and the FY 1981 program, as practicable) should be reoriented to provide appropriate emphasis on topics such as the following:

a) The proposed program includes considerable growth in areas related to operational safety. However, it still lacks significant, cohesive research on light water reactors (LWR) plant operational behavior as a function of design and control.

b) The impact of control systems and other nominally non-safety systems on safety has become a matter of increasing interest. A research program devoted to this matter should be formulated.

c) To complement the research program on operator error, a research program should be initiated to evaluate the effect of design errors on LWR safety and to provide a basis for the development and application of improved approaches to reduce the impact of design errors on safety. We recommend that such research be initiated in FY 1981 and given strong support in FY 1982.

d) The General Design Criteria should be reexamined, using among other things, probabilistic methodology, for the purpose of developing improvements in the current criteria.

In view of the above recommendations, we believe that a budget level of about $265 million for research program support is required for FY 1982. This recommendation is based on the assumption that the needed large shifts in programs and priorities will be made in the program description provided to us by RES during our review of this subject.

7. Specific Recommendations

The succeeding numbered chapters of this report contain our recommendations regarding the programs and funding levels for each of the eight decision units of the RES budget for FY 1982. The funding levels referred to, and given in Table 1, are those requested by RES and those resulting from the EDO's preliminary markup as of 2 July 1980.

We note with approval that the FY 1982 budget request has been presented in eight decision units rather than the fourteen used for the FY 1981 budget. The proposed regrouping of program subelements is more logical and coherent, more representative of the program objectives, and more amenable to effective management. There is no longer a separate decision unit for Improved Reactor Safety; the several program subelements that were formerly in this category have been distributed to the appropriate decision units of the new format. This change is responsive to and consistent with the recommendations in Chapter 15 of our report to the Congress on the FY 1981 budget (NUREG-0657).

Specific comments on the levels of funding for each decision unit and, in general, for each subelement are given in Part II, which follows. The recommendations of the ACRS are included in Table 1.

TABLE 1

PROGRAM SUPPORT BUDGET FOR FY 1982
(IN MILLIONS)

	EDO MARK	RES REQUEST	ACRS RECOMMENDATION
	7/2/80	7/9/80	7/12/80
1. LOCA AND TRANSIENT RESEARCH			
a. Semiscale	7.5	7.5	7.5
b. Separate Effects Experiments and Model Development	5.7	7.8	7.8
c. 3-D Program	5.0	6.0	5.0
d. Code Improvement and Maintenance	4.5	4.5	4.5
e. Code Assessment and Application	7.9	7.9	7.9
f. Fuel Behavior Under Operational Transients	6.4	6.4	6.4
g. Core Damage Beyond LOCA	11.1	12.1	11.1
h. PBF Operations	4.8	4.8	4.8
	52.9	57.0	55.0
2. LOFT			
a. Engineering and Analysis	10.4	10.4	10.4
b. Fuel	4.5	4.5	4.5
c. Instrumentation	10.0	10.0	10.0
d. Operations	9.5	9.5	9.5
e. Facility Support	13.6	13.6	13.6
	48.0	48.0	48.0

		EDO MARK	RES REQUEST	ACRS RECOMMENDATION
		7/2/80	7/9/80	7/12/80
3.	PLANT OPERATIONAL SAFETY			
	a. Man-Machine Interface	4.8	4.8	4.8
	b. Instrumentation and Electrical	7.3	7.3	7.3
	c. Plant Systems Behavior	1.5	1.5	1.5
	d. Mechanical Components Safety	8.4	9.0	9.0
	e. Structural Safety	5.5	6.5	6.5
	f. Fracture Mechanics	4.5	6.0	6.0
	g. Operating Effects On Materials	7.6	7.6	7.6
	h. Nondestructive Examination	3.4	3.4	3.4
		43.0	46.1	46.1
4.	SEVERE ACCIDENT PHENOMENA AND MITIGATION RESEARCH			
	a. Fuel Melt Behavior	9.0	10.5	} 18.7
	b. Fission Product Release and Transport	4.3	4.3	
	c. Severe Accident Mitigation	3.9	3.9	
	d. Fast Breeder Reactors	0	8.0	17.5
	e. Advanced Converter Reactors	0	2.0	1.3
		17.2	28.7	37.5

	EDO MARK	RES REQUEST	ACRS RECOMMENDATION
	7/2/80	7/9/80	7/12/80
5. SITING AND ENVIRONMENTAL RESEARCH			
a. Seismology and Geology	3.5	5.3	5.3
b. Meteorology and Hydrology	2.0	2.0	2.0
c. Airborne Effluents-Environmental Impacts	2.3	2.3	2.3
d. Aquatic Effluents-Environmental Impacts	1.8	1.8	1.8
e. Occupational Exposures and Health Effects	3.6	3.6	3.6
f. Socioeconomic Impacts	0.5	0.7	0.7
g. Siting Alternatives	0	0.4	0.4
h. Emergency Preparedness	0.5	0.5	1.0
	14.2	16.6	17.1
6. WASTE MANAGEMENT			
a. High Level Waste	16.3	16.7	16.3
b. Low Level Waste	5.5	5.5	5.5
c. Uranium Recovery	3.0	3.0	3.0
	24.8	25.2	24.8

		EDO MARK	RES REQUEST	ACRS RECOMMENDATION
		7/2/80	7/9/80	7/12/80
7.	SAFEGUARDS AND FUEL CYCLE SAFETY			
	a. Physical Protection	3.1	3.1	3.1
	b. Material Control and Accounting	1.4	1.7	1.7
	c. Threat and Strategy	0.4	0.4	0.4
	d. Fuel Cycle Facility Safety	1.3	2.0	2.0
	e. Decommissioning	1.6	1.6	1.6
	f. Transportation	0.8	0.8	0.8
	g. Effluent Control	1.2	1.2	1.2
	h. Product Safety	0.3	0.3	0.3
	i. Occupational Protection	0.6	0.6	0.6
		10.7	11.7	11.7
8.	SYSTEMS AND RELIABILITY ANALYSIS			
	a. Meteorology Development	5.0	5.7	5.7
	b. Reliability and Human Error Data Analysis	2.3	3.5	3.5
	c. Systems Analysis	10.4	13.1	13.1
	d. Consequences Analysis	1.2	2.5	2.5
		18.9	24.8	24.8
	TOTAL	229.7	258.1	265.0

PART II

SPECIFIC COMMENTS

1. LOCA AND TRANSIENT RESEARCH

1.1 Introduction

This item includes several programs which are directed toward improved understanding of reactor behavior in large break LOCAs and small break LOCAs, and there has been extensive reorientation of the program to emphasize the latter. In the past by far the greatest attention was given to large break LOCA problems. We strongly support the change of emphasis. Also included here is the improvement and assessment of codes which have as their objective an analytic description and understanding of LWR transients. The last group of programs in this item are directed toward the understanding of fuel and core behavior under conditions in which the core is inadequately cooled. Comments on these programs follow.

1.2 Semiscale (Item 1.a*)

This facility has shown itself to be increasingly useful as an experimental tool for contributing to an understanding of PWR transients. RES has undertaken a serious study of the limitations and scaling questions which arise in translating observations in Semiscale to full scale. We strongly approve and commend this effort. There are some modifications in Semiscale which should receive comment. One modification, Mod 2A, is already underway and includes improved simulation of the Westinghouse type PWR. The facility will have two steam generators with correct, full-height geometry, a highly desirable modification in view of our strong interest in natural circulation and reflux-boiling heat transfer. The modification will include a new pump, upgraded instrumentation, and a new core. Most essentially, a strong effort will be made to improve the thermal insulation in the facility. In view of the improved data that may be obtained from Mod 2A, we view its cost as moderate and support this effort.

A second modification of Semiscale which is under consideration is Mod 5 which would have a substantially higher cost of about $10 million. This modification would be directed toward the simulation of a Babcock and Wilcox (B&W) PWR and will involve not only a different core but two once-through steam generators. An integrated control system would be installed, and a new vessel would be required with vent valves and proper upper head geometry. The central question relating to this modification is its cost effectiveness and its potential contribution to code development for the description of transients which are peculiarly characteristic of B&W type plants. We view the Mod 5 program favorably since it will contribute to code assessment. As will be noted below, RES in general tends to underestimate the needs for code assessment. We support the amount requested by RES with a high priority.

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*These item numbers refer to the decision unit subelements in Table 1.

1.3 Separate Effects Experiments and Model Development (Item 1.b)

There are several programs grouped in this item which deserve some separate discussion. One of these is the Two Loop Test Apparatus (TLTA) which is presumed to do for BWRs what Semiscale does for PWRs. TLTA, however, is entirely inadequate for the purpose and should not be used to relate to licensing problems or to code assessment for BWRs. The facility is particularly misleading in applications to small break LOCAs. Since results from the present TLTA cannot be used for code assessment, we strongly recommend that no further work be done with the present facility and that it be replaced with a new facility. The cost of a useful, new TLTA depends very strongly upon the decision whether it should contain one fuel bundle, or several. The power requirements for a facility with more than one bundle are so large that proper steady-state conditions before initiation of a transient may not be attainable. The need for more than one bundle arises from concerns regarding asymmetry effects. Such asymmetries could very possibly be studied in a proposed Japanese facility, ROSA IV, in which case a single bundle TLTA facility would be acceptable. We support the construction of such a facility and urge its early implementation.

Another facility related to BWRs is the Steam Sector Test Facility which has the objective of studying BWR core spray behavior. The program is directed toward large break LOCAs and cannot readily be reoriented to small break problems. We recommend that the program be phased out in FY 1982.

Other programs in this area are FLECHT-SEASET at Westinghouse and Thermal Hydraulic Test Facility (THTF) at ORNL. FLECHT-SEASET has been reoriented to examine natural circulation. The facility has good steam generator representation and may be useful for code assessment. The facility is, however, limited to low pressure and the program should be phased out in FY 1982. The THTF at ORNL has not been productive of useful data and should be terminated at the earliest possible date. Tests are scheduled to end in FY 1980 and further expenditures should also end at that time.

We believe that the present effort in code assessment is inadequate. For an improved program additional experiments on separate effects are required. Many of these experiments would not require large facilities since the experimentation should be directed toward getting basic physical and engineering bases for the codes. RES should extend its efforts in this direction as soon as possible.

The model development program consists largely of relatively small projects in various university laboratories. We strongly endorse this kind of program as being useful, productive, and cost effective. At the same time the program provides a helpful interaction with an important part of the engineering and scientific community which should be extended and increased. This program suffers from the bureaucratic difficulties of getting contracts. The NRC should make a serious effort to resolve this difficulty.

As regards the budget request, we strongly support, with a high priority, the RES request for $7.8 million. Any further reduction in the original request would seriously jeopardize the program.

1.4. 3-D Program (Item 1.c)

This program is an international one involving Japan, the Federal Republic of Germany (FRG), and the United States and was begun when LWR safety research was preoccupied with large break LOCAs. It was with this problem in mind that two large facilities were designed and built in Japan. One, the Cylindrical Core Test Facility (CCTF), will be completed shortly. The second facility, the Slab Core Test Facility (SCTF) is under construction. Both facilities are limited to low pressure. An experimental program is planned in CCTF on natural circulation, and two-dimensional effects in core refill following a large LOCA are planned in SCTF. Both facilities, within their capabilities, are well constructed but suffer from an insufficient test engineering staff. It would be productive if the NRC would arrange for the assignment of two or three research engineers from the U.S. to facilitate the effort.

There was early appreciation in Japan of the low-pressure limitations of CCTF and SCTF, and they have undertaken the construction of a high-pressure facility, ROSA IV. This facility could be of such importance to the U.S. reactor safety program that NRC could readily justify the assignment in Japan of several engineers to participate in its design.

The German effort in the international 3-D program will consist primarily in the construction of the Upper Plenum Test Facility. This facility will presumably provide some information relating to special questions regarding large LOCAs. One is the so-called ECC bypass question which ceased to be of concern many years ago. The facility will also make some contributions to the interaction of hot leg injection with steam upflow through a core. This question relates to a special feature of German PWR design. We suggest that the NRC attempt to secure a redirection of the German program.

The U.S. contribution consists of two programs. One of these is the supply of experimental measuring devices for these large foreign research facilities. We have for some time urged the development of new and improved instrumentation which could be installed in operating power reactors and would encourage some contributions from the 3-D program to this end.

The second contribution from the U.S. consists in applying a bridge between the various tests in Japan and FRG by means of the TRAC computer code. RES should carefully consider whether this computational effort contributes effectively to the basic requirement of a useful code description of nuclear power plant transients.

As regards the budget for this subelement, we endorse the EDO funding level of $5 million.

1.5 Code Improvement and Maintenance (Item 1.d)

RES proposes to complete in FY 1982 best estimate codes for PWR and BWR systems. These codes will be adaptations of TRAC. RES appears to believe that TRAC has been adequately developed and assessed so that these efforts will be meaningful. We believe that TRAC has been inadequately developed and assessed in spite of the large effort that has been expended. Further work is necessary. It must be also pointed out that we have for some time recommended that RELAP-5 receive continued support. The effort is of basic significance for reactor safety; hopefully the level requested by RES and approved by the EDO will make a useful contribution. On this basis we endorse the level requested with a medium priority.

1.6 Code Assessment and Application (Item 1.e)

It has been already noted that the NRC code assessment is inadequate, particularly in the case of TRAC. In spite of a large effort, TRAC is not yet a code that is adequately developed and assessed. In some respects RELAP-5 has indicated greater promise with a smaller effort than TRAC has received. We recommend that both TRAC and RELAP-5 be continued. We endorse the RES request provided both TRAC and RELAP-5 are continued.

1.7 Fuel Behavior Under Operational Transients (Item 1.f)

The future function of this program, and especially the substantial fraction involved in supporting PBF has been of concern to us. We support the requested funding for this subelement of $6.4 million, for FY 1982, but believe that the continuing need for research on fuel behavior during operational transients should be reviewed by RES to determine whether future efforts in this area can be decreased.

1.8 Core Damage Beyond LOCA (Item 1.g)

The proposed program of in-pile and out-of-pile experiments and analysis on fuel element behavior and damage as a function of overheating and melting requires careful reevaluation. This program should be very closely coordinated with research efforts performed under the decision unit entitled, "Severe Accident Phenomena and Mitigation." The program should also represent a carefully considered joint judgment by NRR and RES that the experiments to be performed are likely to meet information needs commensurate with the relatively large cost of each experiment. In view of the limits on funding, the merits of participation in the ESSOR program require careful reconsideration to see if it should have a high priority.

We believe that the work in the areas of Post Accident Coolant Chemistry and the Hydrogen Studies are important outgrowths of the TMI-2 accident lessons learned and should continue.

We support the EDO funding level of $11.1 million.

1.9 PBF Operations (Item 1.h)

PBF is the only reactor in the country that is dedicated to studying the behavior of fuel in operational and short-period transients. It has provided useful licensing information. We continue to believe that its longer-term usefulness will depend on the new roles it may find in the study of fuel behavior under accident conditions. We support the funding for this subelement with the provisions expressed in Sections 1.7 and 1.8 above concerning the future role of PBF.

2. LOFT

2.1 Introduction

The LOFT facility is the only integral facility which models a PWR. The shortcomings of the facility are well known and relate for the most part to deficiencies in vertical dimensions. The nuclear core is slightly less than half the height of a PWR core. This reduced height introduces some uncertainty in translating the early quench observed in the large LOCA test in LOFT to a full-size system. Further, the height relationship between the core and the steam generators affects the interpretation of measurements of natural circulation heat transfer.

2.2 The LOFT Test Program

LOFT tests were for some time directed toward a design basis accident involving the instantaneous double-ended cold leg break (DECLB). Tests of this type have contributed to the understanding of this kind of accident and also have contributed to code assessment. In response to a strongly modified view of more immediate needs, the LOFT program was redirected in FY 1980 to the study of reactor transients which were the result of small breaks. The current plans call for further tests of this kind in FY 1981. Both the FY 1980 and the FY 1981 programs as now planned include other types of transients, including, particularly in FY 1981 tests concerned with anticipated transients without scram. The significant test proposed for FY 1982 is a DECLB at the higher core power of 16 kw/ft. No further small break tests are scheduled for FY 1982. A test has been proposed for FY 1983 with pressurized fuel.

Although we believe that LOFT will essentially complete its NRC mission in FY 1982 with NRC funding phased out at the end of FY 1982, the LOFT System could still be a valuable tool for the nuclear power industry. The LOFT installation could be offered to the nuclear industry to be operated with industry financial support as a facility which would enhance operational capabilities of the nuclear industry.

2.3 Recommendations

LOFT represents the largest single expenditure in the safety research budget so that its program must be considered with special care. We recommend that the tests through FY 1982 be adequately funded and that following the 1982 tests the facility be decommissioned unless it is taken over by the nuclear industry. The final tests to be run to the completion of the program should be carefully scrutinized and evaluated by RES to obtain the most useful final series. We would also wish to contribute to the choice of these tests. Efficient operation of the facility appears to require the requested level of support and therefore we endorse that level.

3. PLANT OPERATIONAL SAFETY

3.1 Introduction

The RES request for FY 1982 is consistent with that considered necessary and desirable for providing guidance for standards which licensees and applicants need for improvement of operation and maintenance of reactors in a safe and reliable manner. Funds requested have been increased over FY 1981 but are considered appropriate to provide the programmatic effort for NRC to demonstrate the leadership and guidance for correction of deficiencies in reactor operations indicated by lessons learned during the past year. The level of funding requested by RES for 1982 is $46.1 million. We support this level; however, a close review of the functional listing of programmatic items indicates that the allocation of requested funds may be improperly prioritized. Specific comments on the program subelements follow.

3.2 Man-Machine Interface (Item 3.a)

The requested level of funding for this subelement is $4.8 million. The work on developing improvements in instrumentation and information display is expected to have progressed by FY 1982 to a point where firm recommendations can be made for status monitoring and diagnostic display requirements. A systematic study is expected to be completed on instrumentation to follow the course of an accident and specific recommendations provided. Initial simulator experiments to study operator behavior should be completed.

Utility response to training requirements should be evaluated in FY 1982. A program of human factors measurements and improved instrumentation and control displays will be continued through FY 1983/1984. Detailed accomplishments for that program are as follows:

- Analyze the responsibilities of plant personnel with respect to normal and off-normal operation, inspection, testing, maintenance, and design.
- Relate these responsibilities to associated selection, training and management requirements.
- Analyze accident sequences to identify operator information requirements and to identify improvements in emergency response p cedures.
- Development and feasibility testing of concepts for computerized display and diagnostic systems.

- Conduct experiments to test the effectiveness and reliability of proposed improvements in display and diagnostic systems.

- Develop design requirements and regulatory review critical for operational aids to reactor operators and other plant personnel.

- Assess the net effect of such systems on risk.

- Determine the feasible and effective improvements in the capabilities and utilization of training simulators.

The man-machine interface programs have been initiated either as a result of NRR user requests, in response to the Congressional request for improved reactor research or as a direct result of the TMI action plan. These programs will provide data and information which will assist NRR in strengthening and revising license requirements to improve safety and reduce risks.

These programs are considered important to plant operational safety and should be continued and expanded within reasonable manpower and equipment resources.

3.3 Instrumentation and Electrical (Item 3.b)

The requested level of funding for the subelement is $7.3 million. Advanced two-phase instrumentation to follow the liquid level in nuclear power plants will be tested for possible use to alleviate TMI-type problems. Work on fire protection research concerning fire suppression systems which has been endorsed by NRR is scheduled for completion in FY 1982 and full scale replication tests of actual cable area configurations are scheduled to be in progress. LOCA tests will be completed in the qualification testing program and work will be initiated to address safety concerns from the environment of non-large LOCA accidents. Qualification testing and postmortem analysis will be performed on TMI-2 in conjunction with DOE sponsored programs during plant decontamination and recovery in FY 1982/1983.

A system review of generic safety related instrumentation and electrical equipment to identify the ability to withstand temperature and steam conditions, basic design problems, fabrication problems, wear, aging and other reliability problems should be initiated in FY 1982.

The fire protection and qualification testing programs are in support of SD's programs to develop regulatory guides and standards. In addition, tasks within these programs have been carried out at the request of NRR to investigate existing plant installations for adequacy. We believe, however, that the expense of fire replication tests is far too great for the information to be obtained and do not support this particular part of the program. Industry should be encouraged to perform more confirmatory testing of fire protection concepts.

The initiation of new programs, including problems with safety related instrumentation and electrical equipment, software verification and the study of nuclear plant electrical supply design problems, lead to increased funding needs. These areas have been identified in inspection and licensee event reports (LERs) as significant contributors to plant incidents. Work on these problems offers a potential for reducing the level of risk from accidents, will contribute to improve safe plant operations and should be supported with additional funds or diversion of funds from other programs which we do not support.

3.4 Plant Systems Behavior (Item 3.c)

RES has requested funding for this subelement at the level of $1.5 million. The test of a continuous on-line surveillance system to show how pattern recognition can be used to alert plant operators of anomalous conditions is expected to have completed its demonstration phase at the TVA Sequoyah plant by FY 1982. A significantly increased effort on assessing nuclear plant operational behavior should be initiated in FY 1982. This effort will include assessments of operational transients on system behavior, the safety consequences of shared systems within a plant and facility design requirements for safely coping with accident conditions. These programs demonstrate and develop diagnostic tools which will contribute to operator knowledge of plant conditions. Within the small fund allocation, priorities should be carefully reviewed to obtain the maximum benefit expected from each program task.

3.5 Mechanical Components Safety (Item 3.d)

The requested level of funding for this subelement is $9 million.

The Seismic Safety Margins Research Program (SSMRP) derives its support in large part from this portion of the subelement on Mechanical Components Safety and from a similar portion of the subelement on Structural Safety. We continue to support the SSMRP and recommend it be funded at the requested level for FY 1982. We reiterate our recommendation made previously in NUREG-0657 that the SSMRP be structured to provide input as early as is feasible into the broad safety policy considerations concerning the seismic design bases of nuclear power plants. This should include a timely preliminary evaluation of the seismic contribution to the probability of serious accidents and the principal contributors to uncertainty in such probability estimates. We hope to see significant results pertaining to these matters by the end of calendar year 1980.

The goal of the other programs in this subelement is to determine and enhance reliability under various accident and operating conditions; however, a successful approach still needs to be developed. It should begin with a definition of the NRC problems to be solved and the criteria to be used. Currently, considerable emphasis is being placed on seismic impact on mechanical components. Clearly, the great majority of potential accidents

and reliability problems in the life of a reactor do not involve earthquakes, and those that do are covered under another portion of the program. A great deal of industrial experience exists with many of the components in question and the program could profit greatly if this experience could be utilized.

3.6 Structural Safety (Item 3.e)

The requested level of funding for this subelement is $6.5 million. This program is well defined and well balanced among the several identified needs. We support funding at the requested level and offer the following comments:

- The program is oriented strongly toward questions relating to the safety of operating plants.

- Major emphasis is given to seismic-related problems, as is appropriate for structural safety.

- The research on flood effects and hazards is long overdue but now appears to be headed in the right direction. Some increase in this effort in both FY 1981 and FY 1982 would be warranted.

- The program for international cooperation is essential and should provide much useful information at low cost. It is important, however, that most of this effort should be conducted by RES rather than by independent contractors, and suitable allocations of manpower and travel funds should be made to permit this mode of operation.

- The division of seismic research programs, including the SSMRP, between the Structural and Mechanical Engineering Branches, requires special attention by RES to the interfaces between these programs.

- The nature of many of the problems related to structural safety is such that special attention should be given to the question of whether the needed research should be done by the NRC or by the industry.

- RES should maintain cognizance of the structural research being done by industry and should be in a position to utilize the results of it to the greatest extent practicable.

- A significant portion of the research in this program is to be done by independent contractors rather than by National Laboratories. The results of this action, in terms of cost, effectiveness, and timing, should be evaluated as the program progresses.

- The proposed research to determine the effectiveness of QA procedures, especially nondestructive testing methods for concrete, appears at this time to have little research content and to be of dubious value. At the minimum, it requires further evaluation and definition.

3.7 Fracture Mechanics (Item 3.f)

The requested funding for this subelement is $6 million. This is a good long-range program that is providing a sound basis for decisions on the integrity of pressure vessels. It should continue. The question of thermal shock in pressurized systems represents an important uncertainty to the integrity of the older reactor pressure vessels. This program has not been supported by NRR but should be actively pursued to provide a basis for decisions in this area. In the piping area, RES should continue to work with NRR to define programs which will provide an acceptable basis for reducing the number of constraints on primary piping systems while maintaining adequate safety margins.

3.8 Operating Effects on Materials (Item 3.g)

The requested level of funding is $7.6 million. The largest uncertainties in assuring the integrity of the primary pressure boundary are contributed by operating environment, radiation and water chemistry. The programs in this area address these issues in a sound, coherent manner. We look forward to a continuing definition and deployment of the new program on environmentally assisted cracking. The study of the Surry steam generator will be valuable in providing information on the relation between eddy current indications and actual defects that will aid the NRC in its decision on other operating steam generators. We are still concerned about the merits of the subsequent program and reiterate the comment made in NUREG-0603: "The work should be limited to the correlation between NDE indications and tube integrity until a careful study has indicated the positive contribution to be made by additional work." Substantial industrial participation in this program is to be encouraged and would aid in defining any future program.

3.9 Nondestructive Examination (Item 3.h)

The requested level of funding is $3.4 million. Periodic inspection of reactor components are regularly carried out to assure that no dangerous flaws are present. NRC must be capable of judging how reliable these techniques are and be able to develop criteria for the acceptability of new techniques. Several good programs are planned or in place to enhance this NRC capability. We are less certain that NRC should be funding several other programs which involve the development of new techniques to be used for inspections.

4. SEVERE ACCIDENT PHENOMENA AND MITIGATION RESEARCH

4.1 Introduction

Activities in this decision unit fall into two distinct categories, Severe Accident Phenomena, and Fast Breeder and Advanced Converter Reactors. The two will be discussed separately.

The work on Severe Accident Phenomena is closely tied to planned NRC rulemakings which will deal with degraded core cooling, power plant siting, and emergency planning. Because the rulemakings explore as yet uncharted regions, and because the NRC has as yet reached only preliminary positions concerning the rulemakings (especially in the area of degraded core cooling), it is difficult to judge whether the proposed work is appropriate to the needs.

We continue to recommend, as we have done repeatedly in previous reports, that a viable program in Fast Breeder and Advanced Converter Reactors should be continued.

4.2. Fuel Melt Behavior (Item 4.a)
Fission Product Release and Transport (Item 4.b)
Severe Accident Mitigation (Item 4.c)

These three subelements represent one of the highest priority research areas in the entire research program. The program should be formulated, structured, supported and directed in a manner such as to provide the information needed by the NRC in its planned rulemaking which will deal with degraded core cooling, in its actions on accident mitigation at high population density sites, and its efforts to provide a better understanding of the course of severe accidents, an understanding which might be important in the unlikely event of a real accident. The research areas involved are many, challenging and complex. RES is to be commended for its efforts to generate a proposed research program in a situation in which a minimum of guidance has been provided by the licensing staff and the NRC. However, we do not believe that the program, as proposed, is likely to provide the information likely to be needed by the NRC for its decision making on these matters during the next few years. We recommend that a high level task force containing appropriate representatives of NRR, RES and SD be established with the charter of recommending promptly the research program and resources required to meet the NRC needs. We also recommend that the NRC devote the necessary time to provide needed insight on safety philosophy and objectives which should guide this work.

We anticipate that the $18.7 million currently requested by RES for work on subelements 4.a, b, and c (which covers the LWR portion of this decision unit) is likely to be insufficient when the program receives better definition and that the currently defined emphasis is likely to change markedly.

We suggest the following as a possible approach to begin defining the program:

- Ascertain the major categories of information needed, including the following:

  1) Indian Point/Zion/Limerick/other high population density sites.

  2) The rulemakings on degraded core cooling, on environmental impact statements, on emergency planning and on power plant siting.

  3) The interim approach for small or low pressure containments.

  4) Policy guidance for near term construction permits.

  5) The understanding needed to provide appropriate operator guidance, should a potentially serious accident occur.

- Define the informational needs for each major category and the relevant time scale for the information to be developed.

We foresee that a major informational need of the decision making processes will be for sufficiently detailed conceptual design studies of potential mitigating features for the various reactor/containment combinations, including their costs, benefits, pros and cons, to enable proper judgments. Such studies should have a high priority and should be carried out concurrently. It is anticipated that high priority short- and long-term research needs will arise as a result of such studies and the overall program should be structured to have the flexibility and resources to pursue needed avenues expeditiously, as practical. We anticipate that significant changes are likely to be desirable in the currently proposed research program as the result of such an approach.

We believe that while the proposed funding level of $18.7 million currently may represent a reasonable floor on support for this research program for FY 1982, it would be prudent either to request an additional $5 to $10 million or to assure that flexibility to pursue needed research is readily achievable from related decision units.

4.3 Fast Breeder Reactors (Item 4.d)

Congress authorized $13.7 million for Liquid Metal Fast Breeder Reactor (LMFBR) research in FY 1980 and the House Appropriation Subcommittee has authorized $11.1 million for FY 1981, whereas the NRC and ACRS endorsed a level of $18 million for FY 1981. However, RES has proposed $8 million for FY 1982, while the EDO has proposed that no funds be provided or expended. It is expected by RES that 50% or more of its existing advanced reactor safety research resources would be redirected to resolution of degraded core cooling problems in LWRs.

At the same time, significant design and developmental efforts in the LMFBR area are underway outside the NRC. Department of Energy (DOE) is performing the conceptual design of a 1,000 MWe LMFBR plant (Conceptual Design Study) and intends to deliver a report to Congress next spring. DOE would hope to submit a Preliminary Safety Analysis Report (PSAR) on such a plant to NRC within a year of any Congressional approval. Clinch River Breeder Reactor (CRBR) design and procurement is proceeding, and DOE budget authority for FY 1980 is over $170 million. DOE is spending over $140 million in FY 1980 on breeder technology (including $36.5 million for LMFBR safety) and $76 million for Fast Flux Test Facility (FFTF) which achieved initial criticality this year and will likely achieve beneficial use next year. Other nations are pursuing commercialization of the LMFBR, and the French may market a 1,000 to 1,500 MWe unit by 1985 or so. All of the DOE effort cited above is proceeding with little or no input by NRC even though new safety concepts are under development and new safety precedents are being established.

In NUREG-0657 and in other reports, we have consistently supported an NRC LMFBR research program "based on the perception that many of the current safety problems associated with LWRs have resulted from the fact that safety research lagged behind reactor development." We have said also that, if foreign LMFBR technology is likely to be imported in the next 10-20 years, "it is important that the NRC program of safety research on advanced reactors be maintained to ensure an adequate technical basis for U.S. regulatory standards, guides, and criteria."

We reiterate our general support of such a program. Further, until a consensus is reached that the U.S. will not utilize LMFBR , we believe it important that the NRC ensure that a sound, long-range, LMFBR research and licensing activity exists within NRC. We believe that the NRC should have an input to DOE activities such as the Conceptual Design Study and the design of CRBR while they are in progress and that it should have considerable liaison with the DOE technology and FFTF activities. Further, we believe that the NRC should endeavor to keep aware of the safety criteria and design features of foreign plants having commercial potential. Such efforts will require people versed in and active in both licensing and research activities, but no effort is made here to separate one function from the other. However, it is important that these people cooperate closely and perhaps even be interchanged frequently.

It is difficult for us to comment on a specific budget level because no one has prepared a budget incorporating the licensing activities suggested above. However, we believe that the level recommended for FY 1981 as adjusted for inflation (thus a total of about $17 million) will allow both new and continuing work. We believe that expenditures of this magnitude are reasonable to complement a U.S. development effort which amounted to over $600 million in FY 1980. We believe that these funds should be set up in a separate account where they will not be utilized for LWR safety or other work. We do not endorse a decrease to $8.0 million; such

a reduction is too drastic and will not support an effective program. We recommend that at least $17.5 million be requested, not only because it is warranted, but also to minimize the possibility that Congress will act in such a manner as to direct funds from other high-priority work rather than appropriating money specifically for LMFBR work.

We continue to believe that greater priority should be given to accident delineation, accident prevention, and studies of alternate containment systems than has been the case. We believe that the priority given to analytical code development, especially that for SIMMER, should be decreased. We endorse the priority of the experimental program at SANDIA and the aerosol experimental and analysis programs. The aerosol work appears to need better coordination and focusing than it has received.

4.4 Advanced Converter Reactors (Item 4.e)

Advanced Converter Reactor research is centered almost entirely on gas cooled reactor studies, with about 75% of the effort directed toward Ft. St. Vrain and the remainder at more-generic topics. We support a level of about $1.3 million which will allow for a continuation of the Ft. St. Vrain effort; as with the LMFBR funds, these should be set up in a separate account. Studies will be directed primarily toward the long-term degradation and strength of the graphite, techniques to measure this strength, helium-air mixing under emergency cooling conditions, and frequency response to power variations in the system.

5. SITING AND ENVIRONMENTAL RESEARCH

5.1 Introduction

This decision unit includes eight subelements ranging from seismology, geology, meteorology, hydrology and the movement of radionuclides through the environment to the assessment and evaluation of occupational exposures, the planning for emergencies, and the evaluation of related socioeconomic impacts.

5.2 Seismology and Geology (Item 5.a)

This subelement is devoted primarily to developing a better understanding of the seismic and geologic behavior of several important regions of the U.S., and is responsive to our recommendation of several years ago for such a program. The studies are of considerable importance to the establishment of an improved seismic design basis for future LWRs and to an assessment of the seismic safety of existing LWRs. The causes of the significant earthquakes which have occurred in historic times east of the Rockies are important to understand if the NRC is to avoid excessive conservatism on the one hand or a significant underestimate of seismic risk on the other hand. The northwest portion of the U.S. poses similar concerns. We continue to place high priority on this research category and urge that the requested RES funding level of $5.3 million for FY 1982 be provided.

5.3 Meteorology and Hydrology (Item 5.b)

We reviewed the meteorological research underway within the Site Safety Research Branch. We endorse this work, particularly as it relates to the development of methods for handling the dispersion of airborne effluents over complex terrain and at greater distances and longer time periods from the point of release. We endorse also the careful review and evaluation being conducted by this group of the ARAC system, as well as the in-depth assessment of the available alternatives. It would appear unwise for the NRC to move forward with the implementation of the ARAC system at operating nuclear power plants without first having completed this work.

We also reviewed the hydrological research being conducted by the Site Safety Research Branch. This work pertains to the contamination of ground water, predictions of its movement and the development of methods for interdiction. We endorse this work and urge that it include the development of the basic information necessary for the establishment of acceptable criteria for the hydrological characteristics of nuclear power plant sites. One project that might be added to these efforts is a careful evaluation and assessment of methods that can be effectively applied

by municipal water purification facility personnel for removing radionuclides from surface and ground waters that have been contaminated by reactor effluents. The overall funding level requested for this subelement is considered satisfactory.

5.4 Airborne Effluents - Environmental Impacts (Item 5.c)

Projects reviewed within this subelement included those on "Radioiodine Pathway Analysis," "Early Effects of Inhaled Radionuclides," and "Acute Morbidity and Mortality from Nuclear Accidents." Although the first of these is considered important, we note that it is very similar to a Technical Assistance Project being conducted by the Radiological Assessment Branch. For this reason, we recommend that the two projects be combined. There is no need to do this work twice. Although we believe the last two projects would yield data useful for making better estimates of the health effects of accidental releases from nuclear power plants, we recommend that this work be carefully correlated with similar work underway within other Federal agencies. Such an evaluation may lead to changes that will make this research more productive.

Although we have in past years called for reduced efforts on improving models for the environmental transport and behavior of radionuclides under conditions of routine plant operations, the recent challenges to U.S. population dose estimates by scientists in Japan and the FRG show the need for a continuing effort in this subject area. We support the requested $2.3 million funding level for FY 1982.

5.5 Aquatic Effluents - Environmental Impacts (Item 5.d)

Although, in general, we endorse the NRC research on the liquid pathway, there is a need for a shift in its emphasis. To be specific, we recommend that this work be modified to place less emphasis on sediments and more on the sediment-biota interface and associated implications in terms of the resulting population dose. In addition, the work should be directed to the assessment of the behavior of specific radionuclides rather than to radioactive materials, in general. The specific nuclides selected should be those of primary public health interest. We endorse the requested FY 1982 funding level of $1.8 million.

5.6 Occupational Exposures and Health Effects (Item 5.e)

Projects covered in this subelement include those pertaining to Neutron Dosimetry and Effects, the Behavior and Health Effects of Ingested and Inhaled Radionuclides, and Epidemiological Studies of Exposed Populations. We endorse the projects on Improved Neutron Dosimetry and Effects Evaluation, and on "Decorporation Techniques for Radionuclides." However, we believe that the project relating to "Health Effects Assessment" is in need of better definition. Similarly, we believe that the project entitled, "Dosimetric Model - ALARA," should be more clearly defined,

particularly with respect to the newer types of data to be generated. Until this is done, we do not endorse this study. Overall, the requested funding level of $3.6 million for FY 1982 appears to be appropriate.

5.7 Socioeconomic Impacts (Item 5.f)

We have no comments on the projects within this subelement.

5.8 Siting Alternatives (Item 5.g)

Although we did not review any specific research projects in this category, we believe there are several problems that should be addressed. One would be to develop data and information related to the forthcoming rulemaking on siting. Specific aspects that need attention include the establishment of criteria for determining the acceptability of sites for single- as well as multiple-unit stations. With respect to the latter, we are particularly concerned about the lack of definitive approaches for evaluating their advantages and disadvantages. In order to address these problems, we recommend that a funding level of at least $0.4 million for FY 1982 be provided within this subelement.

5.9 Emergency Preparedness (Item 5.h)

We continue to be aware of the need for reliable and accurate instruments for assessing nuclear power plant radiation levels and releases under accident conditions. Since the data generated by such monitors will be used to make major decisions relative to post-accident actions, it is imperative that they yield data of as high quality as possible. Research to achieve these goals should be actively pursued and should include the application of up-to-date technology in the design of such equipment. Where monitors involve the use of portable field equipment, we want to caution that care be taken to assure that the people involved have a clear understanding as to the conditions under which such instruments would be used and the types of decisions that would be based on the data they generate.

We are pleased to see that a project on "Human Factor of Emergency Response" has been proposed as a new area for study within this subelement. There are several areas in which such research could be helpful in emergency preparedness. One would be to study the relative benefits of sheltering versus the use of potassium iodide (KI) pills for reducing radioiodine intakes among population groups. For example, will people be evacuating so rapidly that they will not take time to take KI pills? What can we expect of population groups during the initial phases of a reactor accident?

Another area for this type of research relates to trade-offs in accepting a given low dose now (with a probability of one) versus the possibility of a higher dose later (with a probability of less than one). An example of the application of the results of such studies would be controlled versus uncontrolled venting of reactor containments such as at TMI-2. To assure adequate support for these additional studies as well as those already proposed, we recommend that this subelement receive a funding level of $1 million for FY 1982.

5.10 Recommendations

We have observed during this review that the degree of overlap in research projects being conducted by RES and those being conducted as Technical Assistance Projects within other NRC divisions is increasing. In addition, there appears to be a lack of coordination in the research efforts between RES and NRR in areas such as emergency response alternatives, radionuclide transport, and environmental monitoring. We recommend that these matters be explored to reduce any possible duplication of effort and losses of research efficiency.

We were impressed with the extent of the workload of the RES members involved in monitoring research projects in this subject area. There is a clear need for at least one additional meteorologist within the Site Safety Research Branch and efforts should be made to employ at least one radiation biologist to provide in-house competence relative to the biological effects of ionizing radiation and associated countermeasure actions.

6. WASTE MANAGEMENT

6.1 Introduction

This decision unit includes research on the safety problems of handling and ultimate disposal of high and low level radioactive wastes and uranium mill tailings. The safe disposal of all these types of wastes has been and continues to represent a major public concern in the exploitation of nuclear energy for large scale power generation.

6.2 High Level Waste (Item 6.a)

We agree with the NRC staff that research work on high level waste handling and disposal should be vigorously pursued so that the necessary technical information is made available on a timely basis for decisions regarding licensing and regulatory activities. The ultimate safe disposal of these wastes poses one of the most difficult and complex problems in the nuclear fuel cycle.

We have observed continued improvement in RES and NMSS in managing the research work in this program. We believe that the major area in need of improvement is in the decision-making steps for selecting the research work realistically needed and in the setting of priorities. These matters assume greater importance when funding is limited. We have observed that increased attention and cooperation are being given to these matters by both NMSS and RES. However, the reviews, although frequent and extensive, have for the most part been made internally by the NRC staff. We recommend augmentation of the NRC reviews by including assistance and participation of outside qualified people. We suggest that consultants give special attention to the geological exploration needed for site characterization. The increased expertise and broader perspective that can be made available by judicious use of consultants can greatly assist the NRC in deciding how much research work is realistically needed and whether it should be supported by NRC or by other organizations, e.g., DOE.

We believe that the NRC should expedite its planned studies on the development of risk assessment methodology for potential early application of this technique to assist in the selection of research work to be undertaken and in setting priorities for it.

Based on our review of the research program, we believe that only a moderate reduction in funding can be accommodated before the timely completion of required research would become difficult and as a consequence, lead to delays by NRC in the licensing of repositories. We believe that this reduction can be arranged by a combination of deferrals and reductions of some of the research areas as determined by application of best judgements on the urgency and amount of information needed to answer specific questions.

We recommend a funding level of $16.3M in FY 1982 for this research program.

6.3 Low Level Waste (Item 6.b)

In NUREG-0657, we emphasized the need of sufficient research work to expedite the licensing and regulation of handling and disposal of low level radioactive wastes. We reiterate that position for FY 1982. We have urged the RES and NMSS Staffs to reexamine the FY 1982 program with the assistance and participation of outside consultants. Particular attention should be given to that work necessary to permit the NRC to make licensing decisions regarding low level waste. The existing situation mandates the selection of new disposal sites within the near future. Research related to the development of criteria for judging acceptability of such sites should be expedited.

We recommend a funding level of $5.5 million for this program.

6.4 Uranium Recovery (Item 6.c)

The disposal of uranium mill tailings which result from the uranium recovery and concentration operations on uranium ore has long been a public concern in connection with nuclear power generation.

We agree with the NRC Staff on the need for research on these problems. We recommend that the requested funding of $3 million be provided in order to deal satisfactorily with the large number of existent uranium mill tailings piles and to provide early guidance for the licensing and regulation of new mills so that the public safety problems encountered earlier can be avoided, or at least, ameliorated.

7. SAFEGUARDS AND FUEL CYCLE SAFETY

7.1 Introduction

In addition to subelements dealing with Safeguards and Fuel Cycle Facility Safety, this decision unit has subelements addressing the radiological problems of handling materials in situations other than those specifically covered in other decision units. Thus, subelements concerning Decommissioning, Transportation, Product Safety, and others, are included in this decision unit.

As a general observation it may be noted that the situations and materials proposed for study are those associated with the operation of LWRs. In a number of instances the scope of the proposed studies ought to be reconsidered, and possibly broadened, should the country's present policy concerning reprocessing and breeder reactors be changed by the time the FY 1982 Budget is in effect.

7.2 Physical Protection (Item 7.a)

A major fraction of the effort in this item will be devoted to applying techniques already developed for use in the licensing and regulatory process. Some work will be continued, and new work started, on spent fuel storage problems. Potential conflicts between safety and safeguards requirements for operating reactors will also be studied.

7.3 Material Control and Accounting (Item 7.b)

Here, also, a major fraction of the effort will be devoted to transferring developed techniques for use in the licensing and regulatory process. Increased attention will be given to determining the amount of material held up in processing equipment.

7.4 Threat and Strategy (Item 7.c)

This subelement is a small program to develop appropriate responses to threats or appropriate actions in the event of successful sabotage or theft. In our view, the work in this subelement would have a lower priority than the work in subelements 7.a or 7.b.

7.5 Fuel Cycle Facility Safety (Item 7.d)

A major research effort in this area is devoted to analyses of accident scenarios for aerosol generation in fuel cycle facilities and to development of realistic models for aerosol transport within such facilities and to atmospheric release points. We agree with the importance of this effort and support the RES plans for it. Another significant research effort in this program is that directed at the development and application of risk assessment methodology in the fuel cycle. We recommend funding of this subelement at the requested level.

7.6 Decommissioning (Item 7.e)

We have previously recommended a larger NRC research program on decommissioning. We continue to support this position. We recommend funding at the level requested by RES.

7.7 Transportation (Item 7.f)

We believe that the research studies related to safety in the transportation of radioactive materials is generally needed and endorse the requested level of funding for it.

7.8 Effluent Control (Item 7.g)

We agree with the RES on the need for this research program which is mainly directed at improving the accuracy in evaluating effluent control system performances in PWRs and fuel cycle facilities. In order to help achieve this objective, a major research effort will be made to obtain more accurate radionuclide source term data. We question the value of the study on the "Decontamination Effects on Radwaste Systems" and recommend that the study on an "Advanced PWR Effluent Treatment Model" be either combined with the one on "Source Term Measurements" or deleted. We recommend the requested funding level for this program.

7.9 Product Safety (Item 7.h)

This subelement is a new program. Logically, a first step would include developing an inventory of the products requiring consideration and a scale of relative public risks associated with these products. An adequate fraction of the total funds allotted to this subelement should be available for the purpose of a preliminary relative risk survey.

7.10 Occupational Protection (Item 7.i)

This subelement covers several projects related to the measurement and control of the buildup of radionuclides within reactor systems and to the post-accident decontamination of LWR plant sites. These efforts are in direct response to our recommendations over the past several years. We endorse these efforts and consider the requested funding levels to be adequate. We recommend, however, that consideration also be given to the expansion of related research on the reduction of occupational exposures associated with major maintenance and repair operations such as the replacement of steam generators. This work, coupled with ongoing research on fuel failures due to pellet-cladding interaction and radionuclide releases derived from PBF experiments, should provide the types of information necessary for making progress in controlling occupational exposures in LWRs.

7.11 Summary

The RES request for funds in this decision unit was $13.2 million, and the EDO markup $10.7 million.

Of these funds, $5.2 million has been requested by RES and $4.9 million has been approved by EDO for Safeguards (Items 7.a, b, c). This compares with $4.9 million for these items in FY 1981. There is the familiar difficulty of comparing the priority of work in this problematical field with work aimed at improving the operational safety of reactors; but, in view of the public interest and potential importance of possible acts of theft or sabotage, we believe that this work should be continued at about the existing level and that the amount requested by RES is in the low range of acceptability.

For the remaining items RES has requested $6.5 million, and the EDO has approved $5.8 million. We recommend funding at the level requested by RES, but suggest that the amount allocated to Occupational Protection (Item 7.i) should be increased sufficiently to support a meaningful study of crud build-up in LWRs.

In summary, for this decision unit we recommend funding at the level requested by RES.

8. SYSTEMS AND RELIABILITY ANALYSIS

8.1 Introduction

This decision unit, Systems and Reliability Analysis (SARA), includes many but not all of the programs which previously were grouped under the former decision unit entitled Risk Assessment. SARA has four subelements: Methodology Development; Reliability and Human Error Data Analysis; Systems Analysis; and Consequences Analysis.

We have previously given strong support to this research program. In NUREG-0657, we placed our highest research priorities on the FY 1981 decision units entitled Improved Reactor Safety and Risk Assessment; we recommended increases in the President's budget requests for these two decision units. The growing emphasis during recent months on the use of reliability and risk analyses and the development of quantitative risk criteria supports our recommendation.

We support growth in the SARA budget for FY 1982. The extent of growth which is needed depends in part on the extent to which probabilistic methodology is used in other research decision units and by other organizational entities within the NRC, particularly NRR and NMSS. The role, scope, priorities, and resources of the Interim Reliability Evaluation Program (IREP) will strongly influence the SARA budget requirements. Similarly, the role that SARA will play in the evaluation of probabilistic studies performed by industry will influence the SARA resource requirements for FY 1982.

The overall NRC resources in probabilistic and risk analysis must be substantial and the extent to which SARA will provide support to other groups in the NRC should be factored realistically into the FY 1982 budget.

In general, we support the work areas planned for FY 1982 under SARA. However, we believe that some aspects have not received sufficient priority and resources. These include the following:

- The early development of quality assurance criteria for probabilistic analyses to be used in the regulatory process.
- The early development of a changed approach to the single-failure criterion.
- An examination of possible weaknesses in current application of the single failure criterion.

- The development of a basis for an improved regulatory approach to minimizing significant design errors.

- The early development of information needed to determine the appropriate regulatory approach to control systems and to information needs of the reactor operator.

- An increased level of resources on the program to develop quantitative risk criteria.

- A considerable acceleration of the research program on flood risk to nuclear power plants.

- A large increase in emphasis and resources for the task on alternate decay heat removal systems, including consideration of sabotage.

- A considerable acceleration in the development of information needed to estimate the likely effect on risk of various potential design changes intended to prevent or mitigate the consequences of accidents leading to severe core damage or core melt in LWRs.

- A program to better define property damage from accidents involving large releases of radioactive materials, including the effect on societal resources.

- All necessary support for the proposed NRC rulemaking on accidents involving degraded cores and core melt.

Unless there are major resources made available for similar work elsewhere within the NRC, we believe that $24.8 million will be appropriate budget for SARA in FY 1982.

In any event, we recommend that the matters listed above be given priority in both FY 1981 and FY 1982, even if it means reducing other useful programs, ongoing and proposed, in this decision unit.

We note further that the Probabilistic Analysis Staff which is responsible for the research in this decision unit perform more scientific work in-house than that of many of the other organizational units. This must be taken into account in manpower allocations.

8.2 Methodology Development (Item 8.a)

The RES justification and planned accomplishments are reasonable. However, as discussed in Section 8.1, we believe that priority in this subelement should be given to the most pressing needs of the NRC. These needs include the following: the development of a methodology suitable for early use by the industry and the NRC in system and accident probability evaluation; quality assurance guidance and a peer review technique for probabilistic analyses performed by the NRC and the industry; flood risk to LWRs; and quantitative risk criteria.

Also, a methodology for evaluating the regulatory approach to LWR control systems should receive priority.

8.3 Reliability and Human Error Data Analysis (Item 8.b)

The proposed research program on human error should have the benefit of considerable interaction with Inspection and Enforcement (IE). Such interaction, if carried on down to include personnel from training and inspection, could be useful in both directions.

The large program proposed for LER failure rate analysis should be coordinated with the work of the Office of Analysis and Evaluation of Operational Data (AEOD), as well as similar efforts in NRR. This research program should be responsive to the needs of such groups.

While we agree that work on component failure rate and downtime is worthwhile, we recommend that this program, as well as that on Methodology Development, be evaluated to see if the proper priority is being given to systematic and common cause failures of all kinds, including sabotage.

8.4 Systems Analysis (Item 8.c)

Part of this subelement is focused on the IREP program, while part appears to consist of a collection of largely new FY 1981 programs involving the application of probabilistic analysis. Although we forsee a need for an applications program in addition to the IREP program, it is not clear how the currently proposed program interfaces with other NRC staff efforts. For example, the proposed effort involving a review of LERs and a study of operational occurrences should be supportive of AEOD, if performed.

The proposed effort in standardized relaibility design guidance, which appears to represent a reexamination of the single-failure criterion, might serve as the vehicle for research on this topic, and warrant greater emphasis in that case.

The task on risk-related resident inspection, if pursued, should be closely coordinated with IE.

The analysis of plant log data on forced outages requires better definition and coordination with the subelement 8.b if, performed.

As mentioned earlier, the tasks on alternate heat removal systems should receive much greater emphasis. This emphasis should be sufficient to provide a basis for regulatory decision making by the end of FY 82.

8.5 Consequences Analysis (Item 8.d)

It is important that the interface between this subelement and that on Systems Analysis, as well as the interface with the subelement on Severe Accident Phenomena and Mitigation, be defined. As a minimum, close coordination among these several efforts is required, and a group having an overall perspective on the entire LWR risk picture should be maintained.

As outlined in the NRC Staff document providing justification and planned accomplishments, the following should receive priority in this subelement: resolution of liquid pathways; support of the licensing office in power plant siting; design and emergency planning; and reexamination of nearby and distant effects of a large atmospheric release of radioactive material on property damage and societal resources.

9. SUMMARY

The recommendations in this report, if followed, would result in a total RES Budget for Program Support of $265 million. This is somewhat greater than the RES request of July 9, 1980, chiefly because of the recommended increases for Fast Breeder and Advanced Converter Reactor Research. This total is also significantly greater than the $229.7 million recommended by the EDO Staff on July 2, 1980.

The accident at TMI-2, the lessons learned from it, and the ensuing rulemaking proceedings, all seem to us to mandate the highest priority for research relating to the safety of LWRs, both those now operating or under construction and those yet to be designed or constructed. These considerations lead us to conclude that the highest priorities should be assigned to the following areas:

That research related to transients and small LOCAs in Decision Units 1 and 2.

Research on Plant Operational Safety: Decision Unit 3.

That research related to Severe Accident Phenomena and Mitigation in Decision Unit 4.

Support of the in-house and contract research related to Systems and Reliability Analysis: Decision Unit 8.

BIBLIOGRAPHY

Review and Evaluation of the Nuclear Regulatory Commission Safety Research Program for Fiscal Year 1981, NUREG-0657, February, 1980.

Comments on the Nuclear Regulatory Commission Safety Research Program Budget, NUREG-0603, July, 1979.

NOTE: The above reports are available for purchase from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, DC 20555, and the National Technical Information Service, Springfield, VA 22161.

GLOSSARY

ACRS	Advisory Committee on Reactor Safeguards
AEOD	Office for Analysis and Evaluation of Operational Data
ALARA	As Low As Reasonably Achievable
ARAC	Atmospheric Release Advisory Capability
B&W	Babcock and Wilcox
BWR	Boiling Water Reactor
CCTF	Cylindrical Core Test Facility
CRBR	Clinch River Breeder Reactor
DECLB	Double-Ended Cold Leg Break
DOE	Department of Energy
ECC	Emergency Core Cooling
EDO	Office of the Executive Director for Operations
ESSOR	Multi National Research Reactor Complex at Ispra, Italy
FFTF	Fast Flux Test Facility
FRG	Federal Republic of Germany
FY	Fiscal Year
IE	Office of Inspection and Enforcement
IREP	Interim Reliability Evaluation Program
LER	Licensee Event Report
LMFBR	Liquid Metal Fast Breeder Reactor
LOCA	Loss-of-Coolant Accident
LOFT	Loss of Fluid Test
LWR	Light Water Reactor

NDE	Nondestructive Examination
NMSS	Office of Nuclear Material Safety and Safeguards
NRC	Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation
NRU	Atomic Energy of Canada Ltd., Test Reactor
ORNL	Oak Ridge National Laboratory
PBF	Power Burst Facility
PSAR	Preliminary Safety Analyis Report
PWR	Pressuirzed Water Reactor
QA	Quality Assurance
RES	Office of Nuclear Regulatory Research
SARA	Systems and Reliability Analysis
SCTF	Slab Core Test Facility
SD	Office of Standards Development
SSMRP	Seismic Safety Margins Research Program
THTF	Thermal Hydraulic Test Facility
TLTA	Two Loop Test Apparatus
TMI-2	Three Mile Island, Unit 2
TRAC	Transient Reactor Analysis Code
TVA	Tennessee Valley Authority

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Recommendations of the Advisory Committee on Reactor Safeguards are presented to the Commissioners for their consideration for FY 82 budget for the NRC safety research program.

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