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

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MEMORANDUM FOR: Robert B. Minogue, Director
Office of Nuclear Regulatory Research

FROM: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

SUBJECT: INITIAL REVIEW OF NUCLEAR PLANT SEVERE ACCIDENT RESEARCH PLAN (Draft NUREG 0900)

This memorandum constitutes NRR's initial review of the "Nuclear Plant Severe Accident Research Plan", Draft NUREG-0900, January 28, 1982. We plan to work closely with RES in the further development and refinement of the overall research plan and its program elements. NRR will commit sufficient professional staff to assure that a productive relationship will be achieved.

In general, we find the research plan comprehensive and a workable format for the development of the program. In the enclosures we provide summary user needs and comments which reflect input from all the divisions in NRR. We expect to provide additional comments in a later document and after discussions with RES.

I would like to particularly emphasize the following:

1. The principal goals (and NRR needs) for the severe accident research program should be to help determine what, if any, additional operational, backfitting or design measures are needed to reduce risks on future and current generation plants. Each program element should be planned to meet our identified decision needs for FY 1984. Research after that time would be performed to confirm these decisions.

2. We are concerned about the apparent lack of a systemtic means for prioritization of the various elements in the program. Also, the proposed schedule appears out of phase with the scheduling of various NRR actions and does not seem to provide sufficient time to adequately address all the study areas listed. Previous risk assessment studies indicate tha not all study items included in the proposed program address unknowns and uncertainties which contribute significantly to severe accident risk and the resulting consequences to the public.

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3. The research plan does not discuss how it will cope with the differences between PWRs and BWRs and in plant specific containment designs. Our suggestion in this regard is that the research program be maintained as generic as feasible and that issues specific to specific design approaches be dealt with through cooperative activities with industry groups, owners groups and individual utilities. NRR will budget for staff to provide assistance in achieving this cooperation.

4. The program element, "Behavior of Damaged Fuel" appears to be very expensive and yet has no significant impact on how we envision procedures being developed or risk analyses being carried out. While we have need for empirical knowledge of severe accident phenomena, in comparison to knowledge to be gained from the TMI-2 core inspection, we question whether the PBF, NRU or some of the separate effects experiments will be cost effective.

Our other comments, some provided in the enclosures and others to be transmitted later, deal with concerns and suggestions for each program element. We note a need to establish a mechanism for review groups and also for peer review and, for many of the program elements, the need to validate computer codes. As I stated previously, NRR staff will be available to cooperate with RES in this further development of the research plan.

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosures:
As Stated

cc: W. Dircks
ACRS (16)

ENCLOSURE 1
NRR SUMMARY USER NEEDS
NUCLEAR PLANT SEVERE ACCIDENT
RESEARCH PLAN
NUREG-0900(DRAFT)

General

1. Applicability to current generation plants
2. Cost effective measures to achieve risk reduction and conform with the reactor safety goal when established
3. Improved knowledge of safety levels and margins
4. Establishment of industry responsibilities and joint participation

Specific

1. Improved identification of accident potentials and sequences
2. Knowledge of physical phenomena to validate analytical models and improve PRA estimates of severe accident sequences
3. Knowledge of physical phenomena to support emergency actions in the event of unpredicted accident sequences
4. Better understanding of the potentials for human error to aggravate or mitigate accidents
5. Instrumentation and equipment needs and qualification requirements for accident management and mitigation
6. Knowledge of physical phenomena pertaining to fission product release, transport and retention within containment system
7. Knowledge of challenges to containment integrity - (both deterministic and probabilistic)
8. Knowledge of contaiment failure modes and mechanisms - (both deterministic and probabilistic)
9. Effects of extreme external phenomena consideration on accident sequences, research needs, PRA estimates, and accident management

ENCLOSURE 2

SUMMARY AND GENERAL COMMENTS
NUCLEAR PLANT SEVERE ACCIDENT
RESEARCH PLAN
NUREG-0900 (DRAFT)

1. The overriding goals for the severe accident research program should be to help determine what, if any, additional operational, backfitting or design measures are needed to reduce risks on future and current generation plants. Priorities in schedules and funding should address NRR needs with each program element planned to meet our identified decision needs by FY84. Research after that time would be performed to confirm these decisions. The statement of objectives in the introduction and all program elements should be revised to reflect this comment.

2. We are concerned about the apparent lack of a systematic means for prioritization of the various elements in the program. Also, the proposed schedule appears out of phase with the scheduling of various NRR actions and does not seem to provide sufficient time to adequately address all the study areas listed. Based on our experience with the Zion/Indian Point severe accident study effort, we do not believe that adequate resources and time are available to perform all of the research elements proposed and so it is imperative to include an early effort in establishing priorities. Previous risk assessment studies (WASH-1400, RRSMAP, Zion PRA, NUREG-850, etc.) indicate that not all study items included in the proposed program address unknowns and uncertainties which contribute significantly to severe accident risk and the resulting consequences to the public.

   As a means of establishing a systematic prioritization scheme, we suggest that the plants be classified into several groups as appropriate and that currently available information from risk studies applicable to each class

be applied to identify what areas of research may have the greatest impact on the understanding and reduction of overall risk. This process would ensure that advantage is taken of previous work to enable a concentration of available resources in the most critical areas.

3. The program element, "Behavior of Damaged Fuel" appears to be very expensive and yet has no significant impact on how we envision procedures being developed or risk analysis being carried out. While we have need for empirical knowledge of severe accident phenomena, in comparison to knowledge to be gained from the TMI-2 core inspection, we question that PBF, NRU or certain of the separate effects experiments will be cost effective.

4. The research plan does not discuss how it will cope with the differences between PWRs and BWRs and in plant specific containment designs. Our suggestion in this regard is that the research program be maintained as generic as feasible and that issues specific to specific design approaches be dealt with through cooperative activities with industry groups, owners groups and individual utilities. NRR will budget for staff to provide assistance in accomplishing this cooperation.

5. We recommend that the research plan establish a mechanism to accomplish the beneficial aspects of technical and policy exchanges with industry and public groups on severe accidents. We suggest that the mechanism include nongovernment peer review and provide for periodic and formal comment on policy decisions affecting research planning and the interpretation of research results as well as informal exchanges. In particular, the

research plan should indicate the cooperative measures to be taken with IDCOR. We believe this approach will provide for greater ease in NRR's establishing industry and public acceptance of operational or equipment requirements that may result from the findings. We also believe that by improved coordination with industry, the research program can be made more cost effective in terms of risk reduction accomplishments.

6. On October 29, 1981 NRR provided comments on the "Draft Report of the NRC Fuel Testing Task Force." While most of our comments have been addressed in NUREG-0900, we have identified several that remain outstanding. The most important comment not so far addressed pertains to our support of the Task Force's recommendation for acceleration of the schedule for inspection of the TMI-2 core.

7. We endorse the inclusion of the program element, "Accident Management," to take into account the reality of human recovery actions in mitigating severe accident consequences. We find this element in need of substantial revision to recognize (1) coordination needs with industry, (2) the status of current human engineering research and accomplishments, (3) the specific objectives and limitations of accident management, (4) timing with respect to current generation plants, and (5) the need and means for validation of results and conclusions. We believe the accident management element should move forward as rapidly as possible as decisions on accident management potentials will significantly effect the progress of the many other elements of the program. A major goal to be accomplished by FY84 should be to contribute information for PRA evaluation of whether additional major safety equipment is needed for severe accident mitigation for current generation plants.

8. We do not find in any program element a research plan to investigate the modes and mechanisms of melt through of steel vessels. We believe improved knowledge of failure mechanisms and potentials for reactor vessels and metal BWR containment vessels by melt-through is a necessary goal of severe accident research.

9. For each program element, or groups of similar program elements, the research plan should provide for a research review group. Our suggestion is that these groups would consist of knowledgeable NRC personnel augmented by appropriate consultants. We recommend also that a senior research review group be established for overall periodic review of the program which would include senior NRC management augmented by appropriate consultants. In addition, we recommend nongovernment peer review groups for similar program elements and a separate peer review group to review the overall program.

10. The research plan does not explicitly identify how the effects of post-TMI-2 measures will be taken into account in risk estimates. While we assume this is implicit in those program elements pertaining to PRA, we believe discussion of this point should be provided, perhaps in the Introduction. We note that the IDCOR Program Plan (November 1981) deals expressly with this topic in Task 8, "Effect of Post-TMI Changes on the Overall Risk Profile." While we believe the principal effects of post-TMI-2 measures relate to accident prevention, many of these measures will also contribute to accident management.

11. We believe NUREG-0900 should be completed with cost information and a discussion of dependencies on programs described in decision units of the Long Range Research Plan (NUREG-0784) other than "Accident Evaluation and Mitigation." For example, it should be clarified whether program 6.3, "Structures," described in NUREG-0784 and largely included in Program Element 5.8, "Containment Failure Mode," is to be considered as part of the cost of the severe accident research program or its funding is to be justified under the needs for the decision unit,"Reactor and Facility Engineering." We believe similar clarification is needed for portions of such programs in human engineering, qualification of equipment, and probabilistic risk assessment. This would facilitate evaluation of cost-effectiveness in reducing risks from severe accidents.

12. The identification and discussion of related research programs underway by NRC, industry and foreign governments should be developed or strengthened for many of the program elements.

13. RES should consider establishing a program element for NUREG-0900 that would establish survivability and qualification requirements for the minimum set of instrumentation and equipment determined by other program elements, presumably 5.13, "Evaluation of Accident Mitigation Systems."

14. We observe that much of the formal output of the research program will be in the form of best-estimate computer codes that can be used to improve prediction of severe accident sequences and improve the accuracy

and confidence in probabilistic risk assessments. We caution that goals for the development of best-estimate computer codes and PRA predictions must go forward together with acquistion of empirical knowledge of severe accident phenomena. Such knowledge is needed to promote intelligent emergency actions in the event of accidents and accident sequences that were not predicted and considered by analyses of specific sequences.

15. Research program results, particularly computer codes, should be available in such a form that, if requested, they can be evaluated and used by organizations that did not participate in their development.

16. We believe a task should be established directed to the question of "completeness" of the present containment analysis. That is, we should attempt to assure that all threats to the containment are known and considered. This would include consideration of synergistic causes.

17. In establishing funding levels for the research planned in NUREG-0900, we express the concern that RES not downplay the other two-thirds of the safety equation; namely, reducing the frequency of initiating events (LOCAs, SBLOCAs, and transients), and core melt prevention. While we must not downplay the importance of research in shifting gears from degraded core rulemaking to standard plant decisions, we also must not downplay the importance of resolving other issues; pressurized thermal shock, USIs, and any generic issues or TMI Action Plan items that result in high importance in the current prioritization effort. A lot of work remains to be done on many important issues with regard to the resolution of these issues and the development of a good benefit-cost analysis for proposed fixes.

18. We believe it might be more efficient to combine Program Element 5.12, "Risk Reduction and Cost Analysis and Program Element 5.13, "Evaluation of Accident Mitigating Systems". These elements appear to be good candidates for taking the lead within the severe accident research program to establish cooperative activities with industry, particularly the IDCOR program.

NUCLEAR PLANT SEVERE ACCIDENT RESEARCH PLAN
NUREG-0900 (DRAFT)
COMMENTS BY SECTION

1.0 INTRODUCTION

2.0 INFORMATION NEEDS AND REGULATORY ISSUES

The material in the first two sections should be modified to address our Summary Comments 1,2, 4, 5, 9, 10, and 11.

3.0 STATE OF THE ART

We anticipate we will comment on this section following a more detailed review by the NRR staff, its contractors, and consultants.

4.0 PROGRAM LOGIC, SCHEDULE, AND INTERFACES

1. We anticipate we will comment on Table 1, "Severe Accident Research Program, Major Milestones," following a more detailed review by the NRR staff, its contractors, and consultants.
2. We believe this section should include a discussion on how the research plan will recognize differences between PWRs, and BWRs and in plant-specific containment designs. Our suggestion in this regard is that the research program be maintained as generic as feasible and that issues specific-to-specific design approaches be dealt with through cooperative activities with industry groups, owners groups or individual utilities. NRR will budget for staff to provide assistance in accomplishing this cooperation.

5.0 PROGRAM ELEMENTS

5.1 ACCIDENT LIKELIHOOD ANALYSIS

1. We judge this program element ambitious and optimistic, but highly worthwhile and needed. There is a key need for approaching comprehensiveness in the identification of accident potentials and sequences.

As comprehensiveness is approached or knowledge is established that near comprehensiveness has been achieved, the quality of many past NRR decisions can be better defended or improved and future decisions can be made with greater certainty. While many activities within NRR and within the NRC in general contribute to improvments in this area, this element and Program Element 2, "Severe Accident Sequence Analysis," offer a systematic and well organized approach to meeting this need.

2. We have previously endorsed the related Severe Accident Sequence Analysis (RR-RES-80-13/NRR-80-9) and we have recommended that PRA be used to determine which potential severe accident scenarios have sufficiently high probability for event tree construction in our comments on the "Draft Report of the NRC Fuel Testing Task Force" (Memorandum H. R. Denton to R. B. Minogue, October 29, 1981). We find that this program element makes more valuable the output of the SASA program and incorporates our October 29 comment satisfactorily.

3. We notice that this program element plans to estimate the contribution to risk originating in external events and sabotage. We appreciate the difficulty in this task but believe that these contributors should be included to the extent possible. Reference should be made to other RES programs dealing with external events.

4. We suggest that this program element be the vehicle to explore considerations of (a) organized military attacks and (b) post-accident recovery in the assessment of risk from severe accidents.

5.2 SEVERE ACCIDENT SEQUENCE ANALYSIS (SASA)

1. We note that the acronym ATOG (for Abnormal Transient Operator Guidelines) is a term coined by B&W, not NRR. NRR is developing operator guidelines for severe accidents which will be coordinated with the SASA program and Program Element 3, "Accident Management." Further NRR comments on coordination of these guidelines will be provided later.

2. Mention should be given to the extensive human factors engineering studies underway related to accident prevention in other RES and industry programs. It should be pointed out that SASA's goals relate primarily to accident management and the effects of human error and recovery actions on accident consequences and risk assessments. While SASA results may lead to improvements that may prevent accidents, the human engineering efforts to prevent accidents are the domain of other programs not included in the severe accident program.

3. Discussion should be provided on the means available to validate the results and conclusions of SASA. We presume these discussions would include the use of advanced training simulators and review of actual experiences with operational transients and accidents, as well as validation of the best-estimate computer codes describing accident behavior. In terms of human factors validation, cross reference to related programs of the Division of Facility Operations should be made and significant features of these programs discussed. This discussion should also be able to supply information on industry activities in this area.

4. A discussion should be provided on what RES believes to be the limitations on SASA. For instance, will SASA be able to give firm recommendations on when a safety action should be automated in preference to

operator action, or when strict procedures should be provided in place of operator guidelines based on symptoms?

5.3 ACCIDENT MANAGEMENT

1. We recognize that "Accident Management" is a terminology new to severe accident assessment that was developed to appreciate the reality of human recovery actions in aggravating or mitigating severe accident consequences. We endorse inclusion of this element in the research plan, but we find deficiencies in the planning as currently described in NUREG-0900. Substantial revisions are believed by NRR to be necessary to gain the maximum benefit from this highly important program element. These revisions are needed to recognize (1) coordination needs with industry, (2) the status of current human factors engineering research and accomplishments, (3) the specific objectives and limitations of accident management, (4) timing of deliverables with respect to current generation plants, and (5) the need and means for validation of results and conclusions. These and other revision needs are described below.

2. In a memorandum of October 29, 1981, pertaining to the NRC Fuel Testing Task Force Report, NRR noted that development of accident management strategies should be primarily the burden of industry. We now modify this comment in recognition that this extremely important topic must receive comprehensive NRC guidance and study. We believe, however, that for this task to be successful, close awareness of industry activities in accident management must be achieved, and that plant specific aspects of accident management should essentially be the burden of industry.

3. A major fault of this element as presently written is that it fails to recognize and comment on substantial human factors engineering efforts underway, and in fact, seems to be ignorant of these activities. For instance, the human factors aspects of the technical issues cited in Section 5.3.2 are being addressed by other programs--some quite successfully. This section should be rewritten to be coordinated with these activities and to augment the latter, if needed, for severe accident considerations.

4. NUREG-0900 states that the TMI-2 accident reinforced the idea that systematic studies of accident management would yield useful guidelines for emergency procedures under multiple failures. This is precisely what was required by TMI Action Plan (NUREG-0660) and clarified by NUREG-0737, Item 1.C.I, "Guidance for the Evaluation and Development of Procedure for Transients and Accidents." Guidelines have been developed for all four vendors and have been submitted to NRR for review. These guidelines are the result of a significant amount of effort by the vendors, several individual utilities, owners groups, INPO, and the NRC. Consequently, Section 5.3.4, "Background and Status" which refers only to the guidelines being developed by the SASA program should be revised. If desired, NRR can provide additional information in this area to reflect this current status.

5. In general, the description for this element is not detailed or specific enough to evaluate the usefulness of the expected results. For instance, it could encompass normal operations, to responses to alarms, to the worst imaginable accident in its goal to develop integrated strategies "..to optimize the capabilities to prevent, to arrest the progress of,

or to mitigate the consequences of potentially severe accidents." Additional detail is required to limit the scope of this research element to be able to integrate it with other research.

6. We belive a major goal of this element should be to contribute information for PRA evaluation of whether additional major safety equipment is needed for severe accident mitigation on current generation plants. We need to know if improved accident management strategies which included human factors developments in emergency procedures, operator guidelines, operator training and staffing, and control room design will contribute to risk reduction sufficiently that mitigation equipment need not be backfitted. At the present time, NRR is planning to approve revised emergency procedures and operator guidelines on the basis that no new equipment will be backfitted. We need confirmation of this approach by FY84 and request that Section 5.3.5, "Plan of Work as a Function of Time," be revised to reflect this need.

7. This element should address, or refer to another element or RES program, (1) an evaluation of the feasibility of control room simulator enhancements to model severe accidents for operator training and procedural validation use, and (2) an analysis of severe accident sequences to identify the need for revisions in control room indications and the content of current emergency operating procedure guidelines.

8. Section 5.3.5 states that within 24 months a preliminary report on accident management will be prepared based on input from other elements. Because of its importance to backfitting decisions, we believe the preparation of this report should move forward independently and not be paced by other elements. While this report may need revision as

as later information is provided, decisions to be made on an assessment of accident management potentials are of such significance that this element must proceed as expeditiously as possible.

9. As stated for the SASA program, a discussion should be provided pertaining to the means for validation of any quantitive results and conclusions from this element. Further, a discussion of the limitations of the information to be gained from this element should be provided.

10. The research plan should recognize an interface between this program element and Program Element 9, "Fission Product Release and Transport" pertaining to instrumentation to follow area concentrations and the and the physical and chemical states of important fission products and combustible gases throughout the course of an accident and in the recovery period.

5.4 BEHAVIOR OF DAMAGED FUEL

1. We have a major concern with this program element as a whole since it appears to be very expensive and yet has no significant impact on how we envision procedures being developed or risk analyses being carried out. As we stated in Summary Comment 8, we have need for empirical knowledge of severe accident phenomena. However, in comparison to empirical knowledge to be gained from the TMI-2 core inspection, we question whether the PBF, NRU or the separate effects experiments will be cost effective.

2. On October 29, 1981, NRR provided comments on the "Draft Report of the NRC Fuel Testing Task Force" (memorandum, H. R. Denton to R. B. Minogue). While most of our comments have been addressed in NUREG-0900, we have have identified several that remain outstanding. The most important comment not so far addressed pertains to our support of the Task Force's recommendation for acceleration of the schedule for inspection of the TMI-2 core. Other comments related to this program element pertained to the use of separate effects tests in preference to integral tests in reactors and clarification of the Task Force's concern about relocation of control materials in the core.

3. Although Table 5-1 indicates planning for experiments relating to "melt progression" and "debris characterization at vessel failure," we do not find planned research to investigate the modes and mechanisms of melt through of the reactor vessel. We believe improved knowledge of melt-through failure mechanisms and potentials is needed for reactor vessels and metal BWR containments.

4. Figure 5.4 should be revised in accordance with text for NRU and ESSOR experiments.

5.5 HYDROGEN GENERATION AND CONTROL

1. Our information needs for hydrogen management are listed below. We plan to discuss with RES at some future time how Program Element 5.5 relates to these needs.

GENERIC LWR

(1). Reliable H_2 and Steam Release Rates for Various Accident Sequences

(2). Transport and Mixing of H_2 Within Containment

(i) Jet Mixing

(ii) T, Spray Effects

(iii) " Items Above Require Experimental and Analytical Treatment

(3) Likelihood and Consequences of Local Detonations, Including Generation of Missiles

(4) Flammability Limits Under Various Conditions

(5) Effects on Inadvertent or Spurious Ignition on (4) Above

(6) Flame Propagation

(i) Flame Speed

(ii) Effects of Obstacles, Non-Homogeneities

(iii) Transition to Detonation or Quasi-Detonation

(7) Autoignition Under Break Release Conditions or Effects of Ignition Source in Breakflow Jet

(8) Non-Igniter H_2 Strategies

(i) Halon, CO_2 Inerting

(ii) O_2 Depletion

(iii) Passive Heat Removal

(9) Ex-Vessel (Core-on-the-floor) Hydrogen and Carbon Monoxide Production from Core-Water and Core-Conceret Interactions

ICE CONDENSER SPECIFIC

(1) Flame Propagation Through Unique Geometries; Ice Bed, Upper Plenum

(2) Igniter Performance Above Ice Bed (Including Downward Flame Propagation)

BWR Mk III

(1). Mixing, Combustion Above Suppression Pool

(2). Igniter Performance in H_2 Rich Atmosphere

The above listing includes NRR's needs regarding hydrogen management as perceived at this time. After further review of the proposed research plan, we will provide additional comment identifying the areas listed that may not be adequately addressed by the plan.

2. On page 5-42: We recommend that the following sentence be added to the last paragraph: "The results of these tests will then be extrapolated to full size containment, using the methodology developed in the analytical part of the program currently being sponsored by NRR."

3. It is not yet fully established that the combination of ignitor and water fogging present a much higher level of protection than either system alone, as stated on page 5-49.

4. On page 5-51, last paragraph, we prefer the words, "testing equipment under hydrogen burn conditions" be replaced by, "for predicting equipment response to hydrogen burn conditions."

5.6 FUEL STRUCTURE INTERACTION

1. We need information on hydrogen and carbon monoxide production from core/concrete and core/water interactions. While we believe RES may be sponsoring programs in these areas, we have not found them discussed in either NUREG-0784 or NUREG-0900.

2. Experimental and complementary analysis work ~~in~~ the area of core/water/concrete interactions should be continued. In particular, there is a need to better understand the behavior of a molten pool or resolidified

corium mass interacting with basemat materials. Consideration of non-condensible gas generation, combustibles generation, aerosol generation (both fission product and inert) and basemat penetration are important. The role of water on these interactions is important in considering the ultimate coolability of these materials, in particular, the cooling effect of water above a core-concrete interaction zone. Another important question is whether a finely-fragmented fuel mass (from a quench interaction) which initially forms a non-coolable debris bed remains non-coolable or evolves into a debris bed with larger particles which is coolable.

3. We see no need for an extensive program in the area of steam explosions. We believe that sufficient information exists for the determination of the kinetic-energy generation potential from such explosions. However, related programs (e.g., FITS) directed to understanding molten-core/water "quench" interactions (steam spikes) should be continued with emphasis on hydrogen production capability and rates of heat transfer.

5.7 CONTAINMENT ANALYSIS

1. The three comments provided for Program Element 6, "Fuel Structural Interaction," are also considered appropriate for this program element.

2. Section 5.7.2 lists "some issues related to containment threat." We believe a task should be established within this program element directed to the question of "completeness" of the present containment analysis. That is, we should attempt to assure that all threats to the containment are known and are considered. This would include consideration of synergistic causes.

3. It is not evident from reading this section that much thought has been given to BWR containment response to severe accidents. Are the codes CONTAIN and others suitable for use with BWR metal containments?

4. We believe a task should be established pertaining to property-damage consequences from liquid-pathway models. While site specific liquid-pathway studies should be the responsibility of industry, this research would provide background for a consistent methodology and aid NRR in its review of site specific studies.

5.8 CONTAINMENT FAILURE MODE

1. This program element should develop a statement defining containment failure. NRR will be happy to work closely with RES in developing this definition. The CONTAIN code and the other computer programs listed in Program Element 7 dealing with overall containment failure should be consistent with this definition.

2. This program element should provide for engineering studies of containment building leakage before structural failure. We desire that NUREG-0900 recognize the need for both analytical and experimental results in non-structural containment leakage prior to FY84. We believe this program should be coordinated with the "Containment Integrity Program" described in NUREG-0784 (page 6-25) which plans to test containment models with penetrations.

3. Because of the lack of information relating structural behavior and leakage, our present assessment of containment capacity has been very

conservative and with a reasonably high degree of confidence. However, such an assessment may not be realistic and may make mitigation measures unnecessarily complicated. We suggest, therefore, that the research plan include a task to establish a relationship between leakage and steel strain. The outcome of this research should help us to make more realistic assessment of the containment capacity.

4. On page 5-60, second sentence, the words "and leakage" should be inserted following "levels."

5. On page 5-63, last paragraph, the words "establishment of relation between steel strain and leakage" should be inserted.

5.9 FISSION PRODUCT RELEASE AND TRANSPORT

The research program in the fission product release and transport area is largely responsive to our licensing needs. All the programs included in this area are needed and will be useful in licensing. We have some comments, however, concerning the completeness of the program, concerning the emphasis placed on certain parts of the program and concerning the schedule of some programs. These are addressed below:

1. Completeness

   On pp. 3-5 it is stated that in consequence portion of PRA, "the problems are less those of completeness than of adequately modeling the severe accident phenomenology," and that "the perceived bias in these steps is (toward) exaggeration of the releases and consequences." Consequently, the fission product release and transport program emphasizes the theoretical and experimental investigation of those identified

processes which are perceived to contribute to this bias. This apparently has resulted in an incomplete research program. Although we believe that most of the major phenomena affecting fission product transport have been identified, the large uncertainty of fission product source term estimates will persist unless a conscious effort is made to identify all important phenomena. Therefore, the program should include investigation of:

a. Effects of fuel-coolant interaction on fission product transport. In particular, the potential of aerosol formation resulting from vigorous fuel-coolant interactions should be investigates.

b. Aerosol formation by depressurization. The presence of liquid water is assumed to result in effective fission product removal from the gas phase. Depressurization of this liquid has the potential for release of the fission products in aerosol form potentially in less contained locations (e.g., aux. bldgs.).

c. Re-entrainment of particulates deposited on surfaces.

d. Desorption of "plated-out" volatile fission products, potentially in a modified chemical form. This effect was observed following the venting of the TMI-2 atmosphere, when methyl iodide concentration reestablished itself to pre-vented concentrations.

Some, if not all, of these phenomena may be secondary effects. However, at present there exists no data base for such a conclusion. Therefore, the long-term research progam should be modified to address these phenomena.

2. Emphasis in Aerosol Testing

The emphasis of the long-term research concerning aerosol behavior appears centred on the present controversy concerning potential retention in the RCS. We believe that this issue should be addressed (by analysis) in the short-term. The emphasis in longer-term experimental work on aerosols should emphasize the validation of the aerosol codes presently in use and development. The planned RCS Aerosol Transport Tests do not appear to provide the best (most rigorous) conditions for such necessary code validation. (In particular, the early proposals for the Marviken tests appear to be lacking adequate instrumentation and parameter definition.)

3. Schedule of Fission Product Control Program

The research program investigating ESF performance in aerosol attenuation should be accelerated. The information to be developed in this program is urgently needed for adequate completion of the staff's review of PRAs currently in house. Completion of this work on the present schedule would only produce results "after-the-fact." Preliminary results of this program, particularly with respect to the effects of aerosols on in-containment fan-cooler/filtration units, should be produced in the first quarter of FY83. Also, the investigation of the effects of aerosols on ESFs should not be limited to "large sources predicted for the most severe accidents" but should address the concentrations expected for the full accident spectrum, including the DBA fisson product release accident addressed in 10 CFR 100.11.

4. Further information is needed pertaining to the selection, placement, survivability and qualification requirements for instrumentation to assist the management of severe accidents as described in Program Element 3 "Accident Management". Program Element 9 should plan to contribute and coordinate with related RES and industry research toward the assurance that suitable information will be available in the control room on area concentrations and the physical and chemical states of important fission products and combustible gases throughout the course of the accident and in the recovery period. In cooperation with Program Element 3 and other programs the amount and quality of accident management instrumentation needed should be reviewed together with how post-TMI-2 instrumentation improvements already, or soon-to-be, in place have met these needs.

5.10 RISK CODE DEVELOPMENT

1. We are likely to provide additional comments related to this program element in our review of the System and Reliability Analysis section of NUREG-0784.

2. It is important to have a good understanding of the reasons for differences in conclusions in the over one dozen risk studies performed since WASH-1400. If there are biases, either too conservative or too unconservative, we need these identified and understood. We request, therefore, that RES implement a program as quickly as possible to provide this understanding. In this way, for example, we could determine why RES PRA estimates for core melt are higher than industry's, if that is the case.

3. We request high priority for issuance of the IREP reports, issuance of the IREP Draft Revised Procedures Guide in April 82, and issuance of the IEEE/ANS Procedures Guide in FY 82.

4. By early 1984 NRR will need methodology to probabilistic treat the following uncertainties: human, total assessment of data, omissions of sequences, external events, fragilities and system interaction.

5. We are planning that by early 1984 the following items should be reasonably well quantified probabilistically: meltdown progression, hydrogen generation, concrete interactions, source terms and sabotage.

6. We question the need to develop the probabilistic MELCORR code on the schedule identified if its slower running parent (and deterministic) codes are not sufficiently verified.

7. MELCORR is described as a unified code. We believe that it should be developed so that major components would be capable of standing alone, both for operational and verification purposes.

8. MELCORR and other codes indicated for RES development in NUREG-0900 should be available in such a form that, if requested, they can be evaluated and used by organizations that did not participate in their development.

5.11 Accident Consequence and Risk Evaluation

1. We agree with the objectives and the needs for this program element. However, we believe its goals are implicit in Program Element 1, "Accident Likehood Analysis" and might be efficiently combined therewith.

2. As the objectives of this element serve to feed developing information back into other research elements we advise that advances in accident management should be particularly monitored, including industry developments. We foresee accident managment as the fastest developing topic in severe accident analysis.

3. We believe the research plan should consider or refer to an appropriate RES program the risk potential for severe accidents originating from plants in the cold shutdown mode. There have been two recent PWR LOCA's from the cold shutdown mode and we note that there are no technical specifications requiring while in this mode leak detection, ECCS operability and containment integrity.

5.12 RISK REDUCTION AND COST ANALYSIS

5.13 EVALUATION OF ACCIDENT MITIGATION SYSTEMS

1. We believe it might be more efficient to combine these program elements. Our comments provided below pertain to either.

2. These elements appear to be good candidates for taking the lead within the severe accident research program to establish cooperative activities with industry, particularly the IDCOR program.

3. There should be more emphasis on analyses of competing risks introduced by mitigation features or other risk reduction design changes. Without a thorough understanding of competing risks, risk reduction as a measure of safety benefit has limited utility. For amplification of this comment please refer to the paper by T. P. Speis, et.al., "Risk Reduction Associated with Severe Accident Mitigation Features-A Regulatory Perspective," December 4, 1981.

4. An important mitigation feature which needs further investigation is reliable long-term containment heat removal independent of the in-place active systems such as sprays and fan coolers. One such concept being considered by NRR is a passive heat-pipe system.

5.14 REGULATORY ANALYSIS AND STANDARDS DEVELOPMENT

1. We agree that this program element is needed. NRR has no comments at this time.