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

SEP 29 1980

MEMORANDUM FOR: T. Speis, Chief, Reactor Systems Branch, DSI

FROM: J. Meyer, Reactor Systems Branch, DSI

SUBJECT: UPDATE OF ZION/INDIAN POINT ACTION: TASK 3 "SEVERE ACCIDENT MITIGATION FEATURES"

This memo presents the status of the "Severe Accident Mitigation Features" (Task 3) portion of the ZION/INDIAN POINT TASK FORCE TASK ACTION PLAN, described in Mr. Denton's memorandum to distribution of March 17, 1980. It is important to update the action for three reasons: first, the approach being taken to resolve the Zion/Indian Point (Z/IP) Action has been expanded from that of this past winter to include consideration of plant-specific core degradation and core melt probabilities; second, there has been a considerable advancement in our technical understanding of the problems and potential of mitigation features, in part through extensive technology exchange meetings with the utilities and their contractors; and third, an unambiguous understanding of how we intend to proceed with the important final phase of this Task 3 action is key, in particular if we still want to meet the "Late Fall" milestone of a staff recommendation on mitigation features, requirements and criteria. This last point is all the more important because of the rather complex interfacing between RES, their contractors, various divisions within NRR, and our Technical Assistance contractors. For the above reasons I have put together this memorandum with the following Table of Contents:

I. REVIEW OF THE EXPANSION IN APPROACH

A major reason for proceeding with the Z/IP action was the initial judgment by the staff that the Zion and Indian Point Facilities represent a disproportionate

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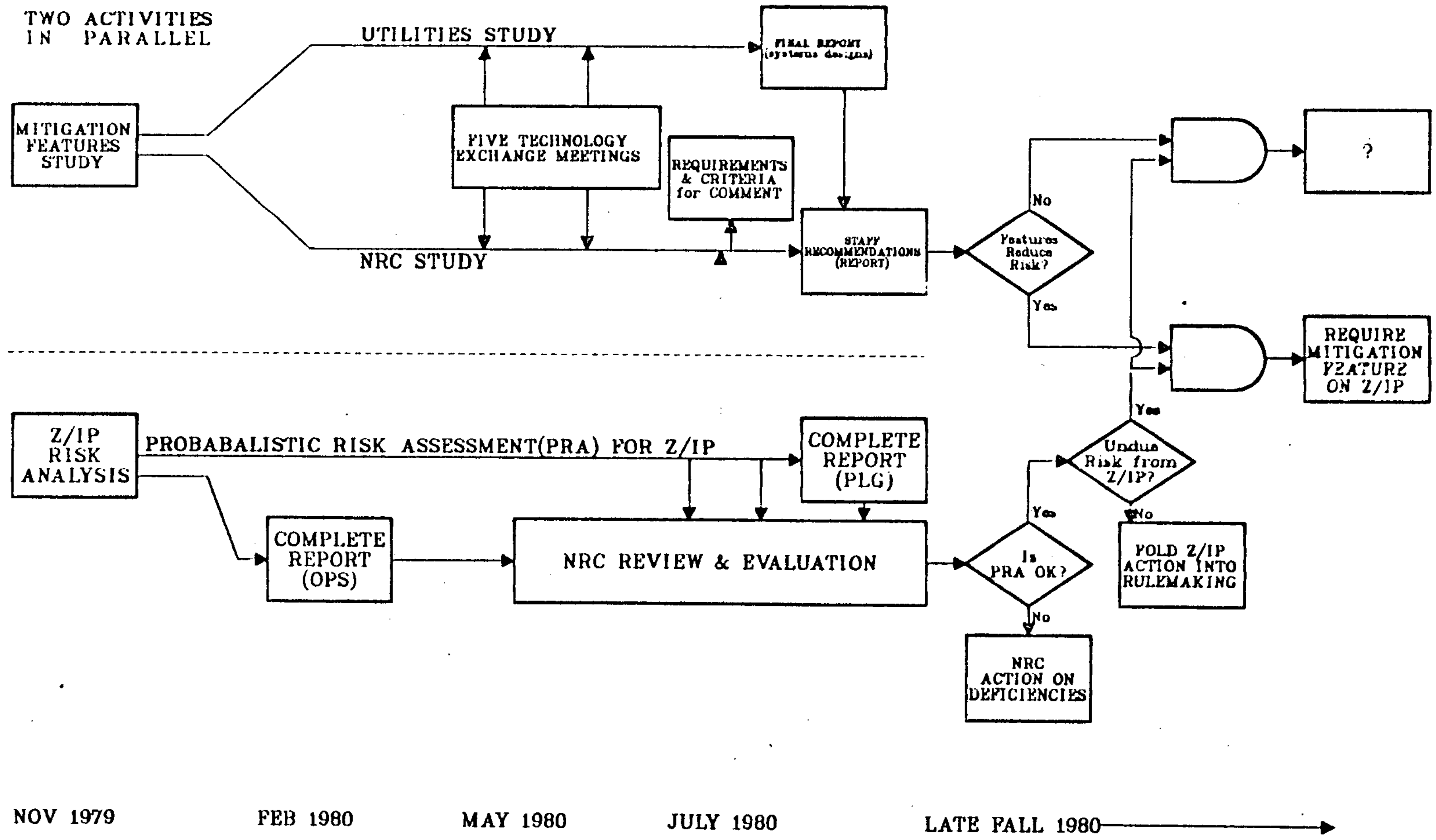
amount of societal risk from nuclear power in this country (approximately 30-40% of the total risk). This judgment was based, in part, on the fact that there are large population densities (Chicago/New York City) in the vicinity of these four units. This fact was translated into risk by a WASH-1400-type consequence analysis which analyzed the Surry reactor (WASH-1400 PWR) at various sites around the country. Thus the concern that Z/IP represent "undue risk" or "disproportionate risk" was based on the assumption that these specific plants, i.e., Zion and Indian Point, are not that much different in design, operation, and administration than the Surry facility. Further risk analyses, considering plant-specific characteristics, could result in determinations covering the full spectrum from greater societal risk than thought previously to societal risk considerably less than the WASH-1400 Surry PWR. It is the contention of the Z/IP utilities that the latter is true, that is, that the risk from any of the Z/IP units is considerably less than the WASH-1400 PWR. This is based on a "mini-WASH-1400" study conducted by Offshore Power Systems for the Z/IP utilities. The utility presented this position to Mr. Denton on May 30, 1980. Based in part on this position of the utilities, the approach for the Z/IP action was expanded to consider this new ingredient.

Previously, a decision on the need to use mitigation features for Z/IP was to be based on the answer to only one question, namely; Will the accident mitigation or accident prevention features under consideration substantially reduce the consequences of core melt to the extent that Z/IP no longer represent "undue risk" to the public? I have already stated how the original risk analysis determined "undue risk," namely by considering the impact of site characteristics (e.g., population density) on the radiological consequences while assuming the "Surry" reactor to be similar to Z/IP in terms of their reliabilities and accident probabilities. The anticipation at that time was that any additional risk analysis would play a minor role. As stated in the action plan (page 4) "Risk Analysis may be helpful in establishing general concepts of appropriate action, but will not be used quantitatively to rule out positive plant improvements." It was envisioned that the PAS IREP (risk) analysis of Z/IP, originally planned for completion this summer, would be helpful in pointing out "outliers" and in defining an appropriate set of accident sequences which constitute the major contribution to risk and could be used to further evaluate mitigation features.

Presently, the approach has been expanded to include plant-specific accident probabilities in formal risk-analysis framework as shown in Figure 1, a copy of a viewgraph I presented at the July 2, 1980, Class-9 ACRS subcommittee meeting in Los Angeles. The top activity, "Mitigation Features Study" is basically the original program described above culminating in a staff report which addresses the question: Do the mitigation features which were considered substantially reduce risk? Added to this activity now is a parallel one, "Z/IP Risk Analysis." The Reliability and Risk Assessment Branch of DST has the responsibility of reviewing the OPS risk analysis of Z/IP and the Pickard, Lowe and Garrick risk analysis of Z/IP (This in lieu of a PAS IREP analysis of Z/IP). The RRAB will then determine if these two risk analyses are technically satisfactory, and if so, if Z/IP represent undue risk. Only if it is the staff's judgment that Z/IP represent undue risk <u>and</u> that the mitigation features

FIGURE 1

UPDATE: APPROACH FOR ZION/INDIAN POINT ACTION



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can substantially reduce risk, will the staff recommend to the Commission that certain mitigation features be required. (If it is determined that they do not represent undue risk, the Action, as indicated, will be folded into the rulemaking.) Thus there was an expansion in the approach from an issue of improved safety to one which, added to the issue of improved safety, is the issue of meeting a risk-based safety goal.

II. COMMENT ON COMMISSION ACTIONS ON Z/IP

The Commission's Final Revised Order for Indian Point, SECY-80-182E, dated 5/29/80, established a "Task Force on Interim Action" which, among other items, was to perform "...a comparison of reactor accident risks at the I.P. site to reactor accident risks at other sites..." and "...a comparison of the reliability or accident probabilities of I.P. 2 and 3 to ...other reactor designs...." In the report of that task force, SECY-80-283, dated 6/12/80, the conclusion was drawn that "...the overall risk of the I.P. reactor is about the same as a typical reactor on a typical site." If this independent task force opinion is corroborated by the findings of the NRR staff and no new ingredients are introduced into the approach, then the probable staff recommendation to the Commission will be no "mitigation features" required (for the time being) for Z/IP.

III. SCHEDULE FOR Z/IP ACTION

Figure 1 also gives the schedule for the Z/IP action as of July 1, 1980. The controlling milestone is the "late-fall" (mid-December) decision date for whether or not to recommend requiring mitigation features. Based on this date, our staff report must be published and distributed during the second week in December. Thus our schedule (slightly updated from Figure 1) is the following:

October 1, 1980	Issue Preliminary Requirements and Criteria for Comment
October 17, 1980	First Drafts of All Chapters of Staff Report Completed
November 13, 1980	First Drafts of Report Completed for Internal Review
December 11, 1980	Publication of Staff Report

This report schedule depends somewhat on the utilities supplying their final report on their mitigation-features study by September. In recent discussions with George Klopp (CECo), I have been told that we will not see this report until the first week in January 1981. This possibility should be factored into any revisions to the above schedule. I am also assuming that the RRAB/DST will make its determination on the risk analysis by late fall. Of course, these milestones can only be met if the appropriate high priority is continued to be placed on them.

IV. PRESENT STRUCTURE OF PROGRAM AND LOGIC FOR RESOLVING ISSUES

In the March 17, 1980 Action Plan, the detailed structure of Task III, Severe Accident Mitigation Features, can be found on pages 26-40. The basic elements are:

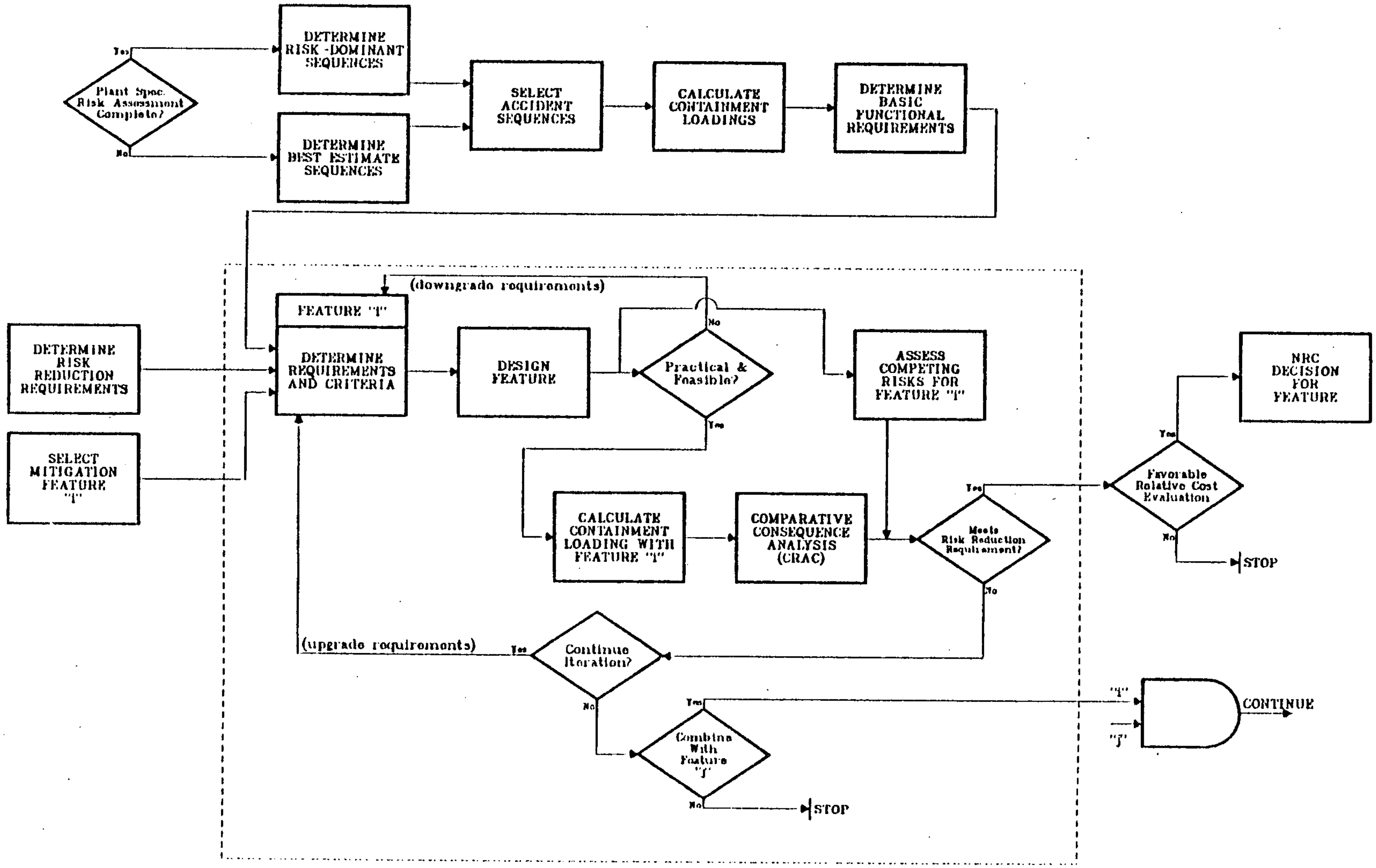
a.	FVCS	Pages 27-29
b.	H_2 Control	Pages 33-34
c.	Core Retention	Pages 35-38
d.	System Design Criteria	Pages 38-40
e.	Consequence Analyses	Pages 29-31
f.	Steam Explosions	Pages 31-33

The first three are the mitigation features under study. Element "e. Consequence Analyses" has been expanded somewhat and now includes the accident sequence analyses, with and without mitigation features present, required in order to make a judgement whether or not the features meet risk reduction requirements. Element "f. Steam Explosions" is a separate phenomenological study directed to updating the probability and consequences assumed for steam explosions in the WASH-1400 PWR study. Finally, element "d. System Design Criteria" is a program to establish requirements and criteria for mitigation features which are consistent with risk-reduction goals. It is not apparent in reviewing these elements just what the program structure is and what the logic is for resolving issues. Thus, I have incorporated these elements into a logic diagram shown in Figure 2. The diagram is set up to consider any of the three mitigation features or a combination thereof. The end product will be the determination of requirements and criteria for that feature (or combination of features) which meets the risk-reduction requirements and compares favorably with other options in terms of cost. The status and structure of the program can be understood by the following walk-through of Figure 2.

Accidents sequences have been selected for Z/IP mainly based on best estimates of those believed to dominate risk for Z/IP and those that present unique challenges to the Z/IP containments and to the mitigating systems. Actual "risk-dominant sequences" are being folded into the set from the two utility risk-analyses studies (OPS & PL&G) presently being reviewed by RRAB/DST.

Based on the set of sequences chosen, containment loading, i.e., pressure, temperature, and radiological, have been calculated using the MARCH/CORRAL codes. The phenomenology and associated uncertainties related to the containment loadings was the subject of Technology-Exchange Meetings 1 & 2 (Note document #7, Section VIII). Two other important technology/phenomenology areas are brought in at this point; namely, steam explosions and containment structural response analyses. These two areas as well as the containment

Figure 2 BASES FOR DEVELOPING Z/IP MITIGATING FEATURES: REQUIREMENTS & CRITERIA



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loading histories have an important bearing on the subsequent determination of "basic functional requirements." For example, a basic requirement may be that the mitigation feature be such that the quasi-static pressure loading of the containment does not rise above 100 psig for 48 hours.

Before considering specific features, the risk reduction requirements must be set. The general preliminary guideline that we have been working with is that the overall risk reduction factor should be at least a factor of ten. This, of course includes consideration of "competing risks."

Added to the three mitigation features that we have been considering all along is one other that the utilities have brought to our attention; namely, a set of modifications to the containment designs for Z/IP that will allow copious amounts of water to be present in the reactor cavity prior to vessel melt-through.

For the three major mitigation features under consideration the program structure is as indicated in the dotted box in Figure 2. For example, the principals in the FVCS effort (principally at Sandia) have performed conceptual designs, downgraded requirements based on impractical aspects of initial designs, and upgraded requirements based on a need to improve the risk reduction characteristics. This effort is a complex one, a key element of which is the comparative consequence analysis from which judgements on "risk-reduction" are based. An equally important activity is the determination of "competing risks" from these features and how the competing risks should be factored into the overall assessment. Once we have a feature which we believe is practical and meets the risk-reduction objective, then we will proceed with a cost comparison in order to make our final determination. It should be noted that there is enough flexibility in the logic to allow for combinations of features to be considered (e.g., hydrogen control plus a core retention device) with the same tests for this set as for the individual feature.

V. TECHNICAL ISSUES AND PLANS TO ADDRESS THEM

Again referring to Figure 2, I summarize here what I believe to be the remaining technical issues and our plans to address them. There have been only minor changes from the March 17, 1980 Z/IP Action Plan in terms of assignments, with one exception. Referring to Figure 1, the Probabalistic Risk Assessment review, a new part of the action, is the responsibility of RRAB/DST with support from PAS and DSI. I shall not comment further on this activity except to mention that DSI staff will be assisting DST in the assessment of Z/IP consequences, by performing MARCH/CORRAL/CRAC analyses as requested. I will outline the issues and plans using the headings in Figure 2.

A) Select Accident Sequences:

All that remains here is to fine-tune the set based on discussions with RRAB/DST and PAS/RES as to the appropriateness of adding the "HF" family of sequences and deleting the "AB-Burn" as recommended by the utilities (note Document #11 in Section VIII below).

B) Calculation of Containment Loadings:

Unfortunately many of the remaining technical issues lie in this category. It is unfortunate because analyses here drive many of the more practical considerations for specific mitigation features further down the path as indicated in Figure 2. For example, if the pressure rise time in the "steam pressure spike" varies from 30 sec to 300 sec, the vent rate requirements for an FVCS vary by that same order of magnitude (note p. 2 of Enclosure IV for meeting #4 summary which is referenced in Section VIII as document #9). As has been stated a number of times before, uncertainties in the pressure rise time are large.

It is convenient to use the containment-failure-mode notation of WASH-1400 in summarizing the issues and plans.

"α" (missile generation-steam explosion).

- Status: Assuming WASH-1400 probabilities, steam-explosion contribution to overall risk is considered small. In addition, present thinking is that the probabilities of containment failure due to missile generation are smaller than WASH-1400 values (see document #7). A major contribution to the staff position on steam explosions is being prepared by T. Theofanous at Purdue University (Staff Lead: J. Meyer).

- Remaining Issues: 1) LASL has a differing opinion regarding missile generation; 2) concern has been raised regarding steam-generator tube integrity following an in-vessel steam explosion which does not fail the vessel.

- Plans for Resolution: The LASL differing opinion is being addressed through our T.A. program at Purdue. The "steam-generator" issue, considered in Sandia report NUREG/CR 1518 is being addressed through our T.A. program at LASL. In addition to addressing the above specific problems, RES has a major steam-explosion effort underway using the FITS facility at Sandia. Although this is a long-term program relative to the Z/IP schedule, tests yet this summer and in early fall should shed some light on steam-explosion phenomenology, in particular the senstivity of explosion yield to ambient pressure.

"γ" (containment failure due to hydrogen burning)

- Status: Conservative quasi-static containment loading analyses are completed for up to 1500 Kg of H_2 for Z/IP (see document #8) (Staff Lead: J. Long).

- Remaining Issues: Little is known about how the H_2 will be released from the vessel, how it mixes or pockets, and how much steam accompanies it. Burning (deflagration) characteristics and limits need clarification. The possibility of dynamic loading of the Z/IP containment, from H_2-gas pocketing or near-sonic rapid burning needs further clarification. Evolution of hydrogen from molten core/concrete interaction, its burning and containment loading needs further study.

o Plans for Resolution: The characteristics of hydrogen burning, mixing, and exploding are being addressed by NRR/TA, RES and industry. BNL has a general overall hydrogen task which addresses the list of remaining issues above, on a time frame consistent with our schedule (although it has slipped somewhat due to the work BNL did on Sequoyah).

RES has a program in hydrogen-burning phenomena at Sandia which should shed considerable light on key hydrogen burn characteristics. In addition to the above NRR and RES programs directly addressing Z/IP concerns, there are a number of T.A. programs directed at the Sequoyah hydrogen issue which will have an important bearing on our overall assessment.

"δ" (containment failure due to steam overpressurization).

o Status: As with "γ", conservative loading analyses are basically complete (see Document #7) (Staff Lead: J. Meyer).

o Remaining Issues: The largest unknown is the characterization of the steam pressure spike both in terms of peak pressure and in rate of pressure rise. Two other unknowns are the contributions to the pressure histories from molten core/concrete interactions and from water in the reactor cavity.

o Plans for resolution: Two short-term experimental and complementary analytical programs are in place to address the steam pressure spike and the water in the cavity issue. Other programs are more long term (2-3 yrs). Specifically:

a. Our T.A. program at BNL has a task which addresses the questions of the steam spike as well as the gradual pressurization phenomena.

b. Sandia Laboratories has an RES-sponsored experimental program using the FITS facility which will have a dedicated set of tests to address spike phenomena.

c. Our T.A. program at ASA is addressing pressurization from molten core/ concrete interaction.

"ε" (containment base-mat melt-through)

o Status: Conservative base-mat melt-through times have been determined (see Document #7) (Staff Lead: A. Marchese)

o Remaining Issues: The impact of melt-through on overall risk has not been assessed. If only the "WASH-1400" atmospheric release is assumed, then contributions will probably be small. However, we know that sparging of activity out of the core melt, because of substantial gas generation from core/concrete interactions, will result in increased airborne releases, in particular releases of tellurium. When the liquid pathway is considered, the contribution to overall risk from melt-through will increase further for both plants, with one (Indian Point) leading over the other (Zion). There are the basic phenomenological uncertainties associated with core melt/concrete interaction that impact on containment pressure loadings which have been listed elsewhere.

- <u>Plans for Resolution</u>: As stated in the 3/17/80 action plan, the question of liquid pathway consequences will be folded into the overall assessment. Our T.A. program and the RES experimental program plans in the area of core melt/concrete interactions are extensive. Specifically:

  a. Our T.A. program at BNL is addressing the interactions of core melt with concrete in terms of the effect on containment loadings and base-mat penetration characteristics.

  b. The Hydrologic Engineering Branch has a program to integrate releases to the liquid pathway at Z/IP sites.

  c. RES has large core melt analytical and experimental programs at Sandia.

In addition to an understanding of the containment loading characteristics, two other aspects are key in calculating containment loadings and radiological consequences for determining basic functional requirements; namely, the progression of the actual accident sequences themselves and the ability to predict containment failure. For the former, we use the MARCH/CORRAL/CRAC codes as a basic framework to understand the accident scenarios and subsequent radiological consequences.

<u>MARCH/CORRAL/CRAC</u>

- <u>Status</u>: These codes are operational within NRR and at BNL, in addition of course to being operational at BCL and Sandia. The NRR activity (in-house and at BNL) is in three areas: 1) using the codes to estimate effects of mitigation features on containment loadings and radiological consequences; 2) using MARCH to better understand the sensitivity of containment loadings to unknowns described above; and 3) a determination of the limitations and verifiability of MARCH/CORRAL. (Staff Lead: J. Meyer)

- <u>Remaining Issues</u>: The basic issue here is the capability of the MARCH/CORRAL codes to predict reality. Just how much can we lean on these codes as we proceed with the Z/IP mitigation features program and establish requirements and criteria?

- <u>Plans for Resolution</u>: Both at BNL through our T.A. program and in-house programs are underway to systematically evaluate the capabilities and shortcomings of the MARCH/CORRAL/CRAC codes.

CONTAINMENT STRUCTURAL RESPONSE

- o Status: The meeting summary for Technology Exchange Meeting No. 5 (see Document No. 10) presents the status. Basically these containments (Z/IP) are stronger than we thought. They may be strong enough to handle most of the early (spike) pressure loadings as calculated by MARCH. This has important implications not only for establishing basic functional requirements for features, but also for whether (in the short term) features are needed at all. (Staff Lead: J. Meyer)

- o Remaining Issues: Although there is basic agreement on failure pressures (between NRC and the utilities), there are still major disagreements on failure locations and modes. Also, we do not know enough about containment failure under vacuum.

- o Plans for Resolution: Our T.A. program at LASL and the RES program at Sandia are addressing several of these issues. At this time it is not clear how many of these issues will be resolved before late fall.

C) Determination of Basic Functional Requirements:

Based on the program to date we are in a position to issue for comment preliminary general design guidance, criteria, and requirements for the mitigation features on the scheduled October 1, 1980 date given in Section III.

D) Mitigation Features:

Continuing the program structure shown in Figure 2, we now briefly review the status of the Z/IP activities for the three mitigation features considered. The logic within the dashed-box has been applied to all three. There has been no final determination for any of the features; this determination has been scheduled for this fall.

D-1 FVCSs

- o Status: The extensive work in this area to date, in particular by Sandia, has resulted in the basic information (conceptual designs and related consequences reduction assessment) needed to establish requirements and criteria for FVCSs (see Documents No. 1, 2, 5, 9). As mentioned above, the unknowns in the "containment loading" area limit any further advances in developing more specific requirements or criteria. (Staff Lead: J. Meyer)

- o Although I would judge the feasibility question for FVCS conceptual designs pretty well answered, there remain specific areas that will need further attention before specific recommendations can be made. Al Benjamin in Technology-Exchange meeting No. 4, noted problems with specific FVCS components which will have to be resolved. (Note pages 79-101 of Enclosure IV of Document No. 9.) Probably the more fundamental problems are the following:

   a. What are the "competing risks," that is, the new risks introduced by installing a particular FVCS?

b. What are the practical problems associated with backfit to the existing Z/IP plants? and

c. What are the consequence reduction factors from specific FVCSs as determined by completely consistent MARCH/CORRAL/CRAC analyses?

o Plans for Resolution: There are RES and NRR activities either in place or just getting started which, at this stage, cover all of the issues listed for the FVCS above. The biggest concern is that not enough will happen within the timeframe of 3-4 months.

D-2 Hydrogren Control

o Status: This mitigation feature program has not reached the maturity of the FVCS program. With the possible exception of hydrogen igniter for the Sequoyah plant, there are no specific conceptual designs per-se - just listings of potential candidates for controlled hydrogen burning or for burning suppression. Thus, referring to Figure 2, the exercises evaluating feasibility and comparative consequences have not been carried beyond a general discussion stage. Unfortunately, at this stage, there is no "panacea" candidate. There has been a large body of information related to hydrogen behavior and hydrogen control methods as indicated in Documents No. 8 and No. 16. (Staff Lead: J. Long)

o Remaining Issues: A basic issue is just how the individual candidate hydrogen control features behave in the hydrogen/air/steam/water-droplet atmosphere predicted in the evaluation of the containment loadings. For example, for a glow-plug igniter, at what concentration will hydrogen start burning, how much will burn, how invariant are the glow-plug burn characteristics to positioning near walls or floors or to its orientation?

Other issues include the competing risks resulting from installation of such devices and how to approach appropriate MARCH-type analyses assuming the functioning of the devices.

o Plan for Resolution: Programs are in place or getting started both in RES and in NRR that will go a long way to resolving some of the above issues. As stated before, the 3-4 month deadline is a real problem. In addition to our T.A. program at BNL addressing the above problems, LLNL is testing TVA glow-plug igniters in a program sponsored by CSB/DSI.

D-3 Core Retention Devices

o Status: Conceptual designs for core-catchers are being considered for Z/IP. Requirements and criteria have been discussed with the utilities (see Document No. 9, in particular, pages 149 ff of Enclosure IV). A letter was sent to the utilities requesting specific information and data on the reactor cavity area that will be important in considering backfit problems and feasibility for Z/IP. The minimal amount of space presently available is a serious constraint in the design of core retention systems for Z/IP. There is a consensus of opinion that the real payoff of a core retention device is not in its ability to slow-down or stop basemat penetration but in its ability to reduce the gases, aerosols, sparging of fission products, and combustible (hydrogen and methane) gases released to the containment atmosphere. (Staff Lead: A. Marchese)

- Remaining Issues: What is the role of "liquid pathway" releases in the assessment of consequence reduction due to the presence of a core retention device? What is the characterization of the fission product souce term reduction by installation of core retention materials? What are the heat-transfer, thermal hydraulics, penetration characteristics of conceptual designs? What practically can be backfitted into the Z/IP reactor cavities? What are the competing risks resulting from installation of a particular core retention device? These questions are key and must be answered as part of the interaction process given in Figure 2.

- Plants for Resolution: There are extensive RES and NRR programs addressing these issues and, again, the problem is whether enough information for decisionmaking will be forthcoming in the 3-4 month period. Our TA program at ASA is addressing the material interaction characteristics from molten core interactions with various candidate core retention materials that offer potential as backfit materials for the Z/IP plants.

E) Relative Cost Evaluation:

- Status: Cost estimates have been made for the Sandia conceptual designs and we have cost estimates for one or two of the hydrogen control and CRD candidates.

- Remaining Issues: Once specific designs are determined, cost estimates should fall into place.

- Plans for Resolution: Programs are in place to evaluate, on a consistant comparison basis, the costs of selected mitigation features.

IV. OUTLINE OF STAFF REPORT ON Z/IP MITIGATION FEATURES STUDY

It is an appropriate time in the Z/IP Action Program to get more specific regarding the objective, schedule, and outline of the subject report. It is also important to make staff assignments now to the various chapters that make up the report.

The objective of the report is to answer the following question for Zion and Indian Point: Will the mitigation features considered substantially reduce risk from the Zion and/or Indian Point nuclear power plants? In that sense the report will be a staff recommendation to the Commission. The justification for the recommendation will be a large portion of the report. If the answer to the above question is in the affirmative, then another major portion of the report will be the recommended mitigation feature requirements and criteria and the technical bases for those requirements and criteria.

The target date for publishing the report is December 11, 1980. This means that a completed draft should be typed by the second week in November. Thus, the first drafts of individual chapters must be completed by the second or third week in October. The publishing date is consistent with the NRR decision date for the Z/IP action of mid-December. If the Z/IP utilities report on mitigation features is late, there may have to be a delay in the report schedule.

In developing an outline for this report, I feel that it is logical and appropriate to follow the Figure 2 flowchart I put together for my ACRS "Class-9" Subcommittee presentation of 7/2/80. It is included here with additions as Figure 3. After the introductory chapter, the subsequent chapters follow the major blocks of work indicated in the figure. I have also assigned staff and TA, input responsibility to the various chapters. It will be the assigned staff's responsibility to write the chapter and do all the coordination with RES, TA and other NRR staff that have input to that particular subject.

Outline

I. Introduction: (J. Meyer)

A brief history of the Z/IP Action; End Use of this report in terms of decisionmaking in requiring (or not requiring) mitigation features on Z/IP; Outline of report in terms of Figure 3 logic.

II. Determination of Risk Reduction Requirements for Features (J. Meyer)

Justification for "factor of 10"; early-on rationale for risk reduction; feasibility of such a reduction (e.g., question of backfit); demonstrability of such an overall risk reduction goal (unknowns, uncertainties).

III. Selection of Accident Sequences

(J. Meyer with J. Carter, J. Long, E. Fenstermacher and T.A. input from BNL.) Selection process in terms of risk-dominant sequences and enveloping sequences; the "best set" of sequences; the analysis of containment loading terms (P(t), T(t), Aerosol (t), Source Term (t)) together with uncertainties and unknowns; and the best estimate containment failure modes, pressures, and locations.

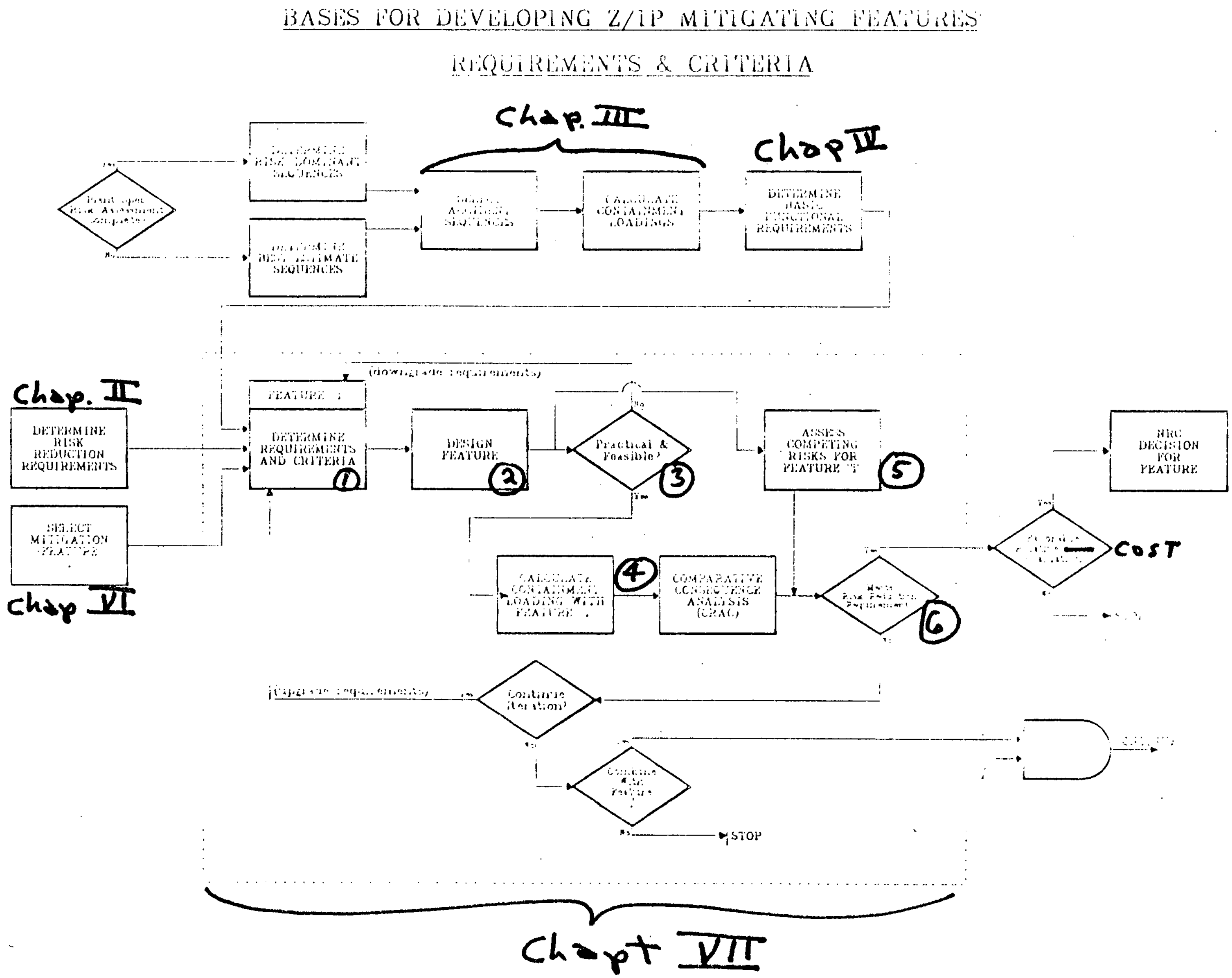
IV. Determination of Basic Functional Requirements and Criteria (A. Marchese)

Considering Sections II and III, present the basic functional requirements and criteria, e.g., prevent containment failure by overpressurization? by basemat melt-through? reduction in radiological source term relative to containment failure (decontamintation factors) by how much?

V. Assessment of the Consequences of Steam Explosions (J. Meyer with major input, including draft sections, from T. Theofanous of Purdue)

An assessment of the consequences of steam explosions for Z/IP relative to the probability and consequences assumed in WASH-1400.

FIGURE 3 (Taken from Figure 2)



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VI. Selection of Mitigation Features or Set of Features (J. Meyer) Listing of features; FVCSs; H_2 control, CRDs, water in the cavity.

VII. Assessment of Feature(s) (J. Meyer)

A. FVCS (J. Meyer with J. Carter and E. Fenstermacher and T.A. assistance from BNL)

1. Requirements and criteria (J. Meyer)
2. Conceptual Designs (J. Meyer)
3. Feasibility Question (J. Meyer) (e.g., Backfit capability)
4. Comparative MARCH/CORRAL/CRAC analysis (J. Carter/ E. Fenstermacher)
5. Competing Risks (J. Meyer) A consideration of the negative aspects of the feature in terms of system interactions; feature failures and other contributions
6. The Meeting of the Risk Reduction Requirements (J. Meyer)

B. H_2 Control (J. Long with J. Carter, E. Fenstermacher, and J. Meyer and T.A. assistance from BNL).

1. Requirements and criteria (J. Long)
2. Conceptual Designs (J. Long)
3. Feasibility Question (J. Long)
4. Comparative MARCH/CORRAL/CRAC analysis (J. Carter/E. Fenstermacher)
5. Competing Risks (J. Long) A consideration of the negative aspects of the feature in terms of system interactions; feature failures and other contributions
6. The Meeting of the Risk Reduction Requirements (J. Long)

C. Core Retention Devices (A. Marchese with J. Carter, E. Fenstermacher and T.A. assistance from BNL and ASA)

1. Requirements and criteria (A. Marchese)
2. Conceptual Designs (A. Marchese)
3. Feasibility Question (A. Marchese)
4. Comparative MARCH/CORRAL/CRAC analysis

5. Competing Risks (A. Marchese) A consideration of the negative aspects of the feature in terms of system interactions; feature failures and other contributions

6. The Meeting of the Risk Reduction Requirements (A. Marchese)

D. Combinations of Mitigation Features (J. Meyer) If deemed appropriate, this section will consider combinations of for example, H_2 control and core retention devices, which together result in meeting the risk-reduction goal. The details of this section will follow the outline under VII above.

VIII. Selection of Mitigation Feature (J. Meyer) Cost Benefit considerations; Reasons for choosing the option over the others (or determining that no options will do the job at reasonable cost).

IX. Final Staff Recommendation (J. Meyer) Conclusions and Recommendations for or against Mitigation Features based only on Risk Reduction and cost.

Appendices

A) Appropriateness of Using MARCH/CORRAL/CRAC in determining mitigation feature requirements (verification status, use in design of systems)

B) Outstanding Technical Issues

1. Steam Explosion

2. Pressure Spike

3. Debris Bed Characterization

4. Etc.

C) Z/IP Action as model for degraded/molten core rulemaking (lessons learned from Z/IP Action and application to rulemaking)

I will proceed under the assumption that this report has high priority and that the needed staff and T.A. will be provided in order to provide a quality job in the time frame indicated.

VII. Z/IP Action As Model For Rulemaking

As the Z/IP action progresses, it is becoming more evident that the Action will be an important ingredient in the upcoming Long-Term Rulemaking for Degraded Cores. In a range of important issues from conformance to various safety goals, through the role of risk analysis in licensing and the phenomenological and accident sequence progression unknowns and uncertainties, to the practical questions of backfit and engineering capability, the Z/IP action has become a test-bed and potential model for many of the rulemaking activities ahead. For these reasons, over and above the reasons for importance of the Z/IP mitigation features study itself, I think that divisional, office, and agency support for the proper completion of this action is crucial.

VIII. DOCUMENT LIST FOR Z/IP ACTION

Because there has been such a large number of meeting reports and technical reports published since the issuing of the 3/17/80 Z/IP Action Plan, I felt it appropriate to list them here:

Technical Reports

1. "Summary of the Zion/Indian Point Study," Walter B. Murfin, Sandia National Laboratories, NUREG/CR-1409, April 1980.

2. "Report of the Zion/Indian Point Study," Volume I, Sandia National Laboratories, NUREG/CR-1410, August 1980 (Advanced Draft Copies were made available to all interested parties).

3. "Report of the Zion/Indian Point Study," Volume II, Los Alamos Scientific Laboratory, NUREG/CR-1411, April 1980.

4. "Indian Point and Zion Near Site Study, Report to the NRC," CECo, CONEDCo, and PASNY, February 20, 1980.

5. "Mitigation of Severe Accident Study Report: Zion and Indian Point Nuclear Units," Westinghouse Water Reactor Divisions, March 1980.

6. "An Evaluation of the Residual Risk from the Indian Point Nuclear Power Plants," Offshore Power Systems, Report No. 35A96, May 1980.

Meeting Reports

7. Technology Exchange Meetings No. 1 & 2 "Core Melt Accident Sequences and Associated Phenomenology," Summary of Meetings, J. F. Meyer, NRC, July 9, 1980.

8. Technology Exchange Meeting No. 3 "Hydrogen Control," Summary of Meeting, J. K. Long, NRC, June 12, 1980.

9. Technology Exchange Meeting No. 4 "Filtered Vented Containment Systems and Core Retention Devices," Summary of Meeting, J. F. Meyer and A. Marchese, NRC, July 21, 1980.

10. Technology Exchange Meeting No. 5 "Containment Structural Response," Summary of Meeting, J. F. Meyer (NRC) July 31, 1980.

11. Utility Presentation to the NRC on "Core Melt Accident Sequences" (June 18, 1980 Meeting), Summary of Meeting, J. K. Long, NRC, July 31, 1980.

12. Summary of Meeting Held on December 20, 1979 with the Z/IP Utilities, G. Zech, NRC, Janaury 10, 1980.

13. Summary of Meeting Held on February 20, 1980 with Z/IP Utilities to Discuss Accident Mitigation Features, L. Olshan, NRC, February 21, 1980.

14. Summary of Meeting Held on May 30, 1980 to discuss status of Action Plan for Z/IP Between Utility Executives and H. Denton, L. Olshan, June 23, 1980.

15. Report of the Task Force on Interim Operation of Indian Point, E. Hanrahan and L. Bickwit, Jr., SECY-80-283, June 12, 1980.

Related Technical Reports

16. "The Behavior of Hydrogen During Accidents in Light Water Reactors," M. Berman et al, Sandia National Laboratories, NUREG/CR-1561, August 1980.

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