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

June 30, 1982

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Dr. Walter H. Jordan
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Oak Ridge, Tennessee 37830

In the Matter of
LONG ISLAND LIGHTING COMPANY
(Shoreham Nuclear Power Station, Unit 1)
Docket No. 50-322 (OL)

Enclosed is a clean and complete copy, with attachments, of the February 12, 1982 memorandum from William J. Dircks, Executive Director for Operations, to Paul Shewmon, Chairman of ACRS, which was previously supplied as an exhibit to the Staff's prefiled testimony on Contention 7B. It is the Staff's intention to substitute this clean and complete copy for that previously supplied when the Staff's prefiled testimony on Contention 7B is bound into the record.

Sincerely,

Richard J. Rawson
Counsel for NRC Staff

Enclosure as stated

cc (w/ encl.):
See page two

DESIGNATED ORIGINAL
Certified By

DS07

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

FEB 1 2 1982

MEMORANDUM FOR: Paul Shewmon, Chairman
Advisory Committee on Reactor Safeguards

FROM: William J. Dircks
Executive Director for Operations

SUBJECT: SYSTEMS INTERACTIONS

In the January 8, 1982 memorandum from J. J. Ray to me on this subject, the Acting Chairman stated the Committee's desire to hear from the staff concerning the systems interaction program at Indian Point-3, and the staff's plans for systems interaction reviews at all plants. As noted, a meeting with the cognizant ACRS subcommittee, originally scheduled for January 5, 1982, to discuss these matters was postponed because of a delay in the submittal by the licensee describing the Indian Point-3 systems interaction program. That submittal has now been received by NRC; and the subcommittee meeting has been rescheduled for February 26, 1982. Our suggestions for topics to be discussed at that meeting are provided in an enclosure to this memorandum.

The staff's licensing reviews already deal with some aspects of systems interaction. Applications for CPs and OLs are evaluated against the Standard Review Plan which requires interdisciplinary reviews of safety-grade equipment and addresses several different types of potential systems interactions. Two specific sections of the SRP (Sections 3.6 and 7.4) extend the reviews to include the adverse effect of nonsafety equipment, i.e., high energy lines and associated electrical circuits. The staff's evaluations of systems interactions occurring from high energy line breaks, jet-impingement, local flooding, and pipe whip are summarized in Section 3.6 of the SERs. The staff's evaluation of the environmental qualification of equipment is covered in Section 3.11 of the SERs. The evaluations of systems interaction due to masonry walls (IE Bulletin 80-11) are addressed in Section 3.12 of the SER. The staff's evaluations of potential interactions between reactor protection and control systems are addressed in Sections 7.2 and 7.4. (This includes the staff's evaluations of the applicant's response to IE Bulletin 79-27 and IE Notice 79-22). The staff's evaluations of interactions between fire protection systems and safety-grade systems are addressed in Section 9.5. Also, the quality assurance program which is followed during the design, construction, and operational phases for each plant can contribute to the prevention of introducing adverse systems interactions.

NRR continues in the confidence that current regulatory requirements and procedures provide an adequate degree of public health and safety. However, the frequency of events that adversely affect safety systems redundancy at LWRs justified the proposed NRR level of effort directed toward enhanced systems interactions analyses.

The level of effort currently given to systems interactions was established against the backdrop of many other regulatory programs that compete for limited staff and utility resources. Only the items cited above are routinely reviewed for all applications. No explicit requirement presently exists for operating plants or applicants to perform a comprehensive, systematic systems interaction analysis. Special, limited systems interactions analyses have been performed at Diablo Canyon and San Onofre-3 and have been described to the ACRS.

The staff views the forthcoming Indian Point-3 systems interactions review as the most comprehensive, systematic review to date, and also proposes to begin soon with reviews of four NTOL plants using two different methodologies for two plants each. Although the four plants have not yet been selected, the leading candidates are Seabrook, Perry, Midland-2 and San Onofre-3. The first two LWRs would begin next month using a Fault Tree/Interactive Failure Modes and Effects Analysis method. The other two LWRs would begin by July 1982 using a matrix-based digraph method. This phased program has been underway for more than a year, and is planned eventually to form a part of the NREP/SEP combined review program (ref. H. Denton, NRR, to R. Fraley, ACRS, memorandum, "Seismic-Induced and Other Interactions Between Non-Safety and Safety Systems", dated November 20, 1981). However, the staff recommends expediting the phased approach by requiring that systems interaction analyses be performed on the first group of NREP/SEP Phase III plants using the PASNY methodology. Subsequent NREP/SEP plants would perform systems interactions analyses using methodology that incorporates further improvements based on the conclusions from the pilot studies. An updated schedule showing the interrelationships of these programs is enclosed.

We do not believe it is appropriate at this time to elevate the efforts of all other applicants (much less licensees) by a regulatory requirement to perform a comprehensive systems interaction analysis. The reasons not to elevate the efforts of others at this time are: First, a comprehensive systems interaction evaluation appears to be a resource-intensive undertaking (a crude estimate is $2M) and the benefits of such an undertaking have not yet been measured. The pilot programs should measure the benefit, and refine and reduce the cost. Second, a requirement now would preempt the future possibility of a conclusion that the benefits do not justify the cost. Third, no acceptance criteria or guidelines have been established to judge the adequacy of such an effort. The pilot programs are believed to be needed for this purpose, also. Finally, development of a methodology for systems interactions analyses has been a complex problem. The analyses include topics outside the present scope of nuclear reactor safety review.

The Committee noted by the January 8, 1982 memorandum that "current probabilistic risk assessments (PRA) do not usually include a systematic examination of systems interactions and cannot be counted upon to provide adequate insight regarding possible improvements in safety and reliability." The staff also has stated that PASNY should not rely principally on PRA results in its systems interaction study (paragraph I.B of memorandum Conran to Thadani, "Meeting Summary and Status Report," 10/20/81, enclosed.) The staff believes that the systems interactions methodology can be usefully integrated with the scope of present-day PRAs, and the strengths of these two efforts offer opportunities for enhancing safety and effective utilization of both staff and utility resources.

The nonsafety-grade/safety-grade dependency information discovered by a systems interaction analysis is important for the accuracy of PRA results. PRA is a framework for assessing the safety implications of systems interactions.

We look forward to the February 26, 1982, meeting and welcome your comments on the suggested topics.

William J. Dircks
Executive Director for Operations

Enclosures:
1. Conran memo dated 10/20/81
2. Suggested topics
3. Updated schedule

ENCLOSURE 1

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

OCT 20 1981

Docket Nos.: 50-247
50-286

MEMORANDUM TO: Ashok Thadani, Chief AT
Reliability and Risk Assessment Branch
Division of Safety Technology, NRR

THRU: Franklin D. Coffman, Jr., Section Chief
Systems Interaction Section
Reliability and Risk Assessment Branch
Division of Safety Technology, NRR

FROM: James H. Conran, Principal Systems Engineer
Systems Interaction Section
Reliability and Risk Assessment Branch
Division of Safety Technology, NRR

SUBJECT: TRANSMITTAL OF MEETING SUMMARY AND STATUS REPORT

Attached is a combined "Meeting Summary and Status Report" relating to the Indian Point-3 systems interaction study effort. Th[illegible] report is principally a summary of discussions of a July 24, 1981 meeting [illegible]een the Systems Interaction staff and the Indian Point-3 licensee (P[illegible]) and their contractor (EBASCO). The purpose of that meeting was to discuss the staff's final review comments on PASNY's preliminary submittal describing the proposed IP-3 systems interaction study program. The report is in the format of a "Meeting Summary"; however, since the report also reflects developments subsequent to the meeting (e.g. as recent as the simulator trials at the Indian Point facility on September 23-24), it is also termed "Status Report".

James H. Conran
Systems Interaction Section
Reliability and Risk Assessment Branch
Division of Safety Technology, NRR

Attachments - Report as stated in text

cc: T. Murley - DST
M. Ernst - DST
J. Thoma - DL
J. Greismeyer - ACRS staff

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MEETING SUMMARY AND STATUS REPORT
FOR
MEETING WITH PASNY/EBASCO ON PROPOSED IP-3 SYSTEMS INTERACTION PROGRAM

JULY 24, 1981

Introduction and Background

A meeting was held in Bethesda, Md., on July 24, 1981 with representatives of the Power Authority of the State of New York (PASNY) and their contractor (EBASCO) to discuss the staff's comments on PASNY's "Preliminary" submittal on the proposed systems interaction study program to be performed at the Indian Point-3 facility. The "Preliminary" submittal (2 volumes) consisted of:

Volume I - description of the objectives and scope of the program, project organization, and criteria and methodology to be applied in identifying and evaluating systems interaction.

Volume II - extensive compilation of results of application of the proposed criteria and methodology to the AFW system, for the purpose of illustrating the workability of the proposed methodology and the depth of treatment of plant systems generally in the study.

The review of the PASNY submittal was performed by the NRC systems interaction staff (Reliability and Risk Assessment Branch) assisted by contractors (LLL and SAI) and a senior reviewer from the Auxiliary Systems Branch, NRR, experienced in the review of AFW systems. The review process in its entirety extended over nearly 4 months (April-July), and included review of a number of sections of the Pickard, Lowe, and Garrick Zion/Indian Point PRA study report (April 1981 Draft) now in the final stages of completion. (Explicit reference is made to "consideration of Z/IP PRA fault trees" in the description of the IP-3 proposed systems interaction study.)

The scope of the RRAB (and LLL/SAI) review effort included all aspects of the PASNY submittal; but the main focus of this part of the review was a critical review of proposed criteria and methodology. The Auxiliary Systems Branch reviewer concentrated primarily on Vol. II of the PASNY submittal (i.e., results of application of proposed methodology to the AFW system only) from the perspective of one knowledgeable in the details of specific system design and operation (see Enclosure 6). All questions and comments developed by this extensive review process were discussed preliminarily with PASNY/EBASCO project personnel via conference calls arranged periodically during the review process. The Detailed Agenda for the July 24 meeting (see Enclosure 2) reflects the final staff comments on the "Preliminary" PASNY submittal.

Discussion

The following summary of detailed discussions at the July 24 meeting is keyed to specific items on the Detailed Agenda for the meeting (Enclosure 2).

I.A. NRC Philosophy on SI Analysis

J. Conran presented an overview of current RRAB staff thinking on the systems interaction problem in general to properly frame the staff's comments on PASNY's proposed SI program. Enclosure 3 provided the outline for his presentation which summarized the ways that the NRR SI staff has "cross-cut" the overall SI topic, as its thinking has developed and evolved over the past 1 year. That presentation and subsequent discussion throughout the meeting developed the following important points:

o Systems interaction analysis involves (1) the systematic search for heretofore "hidden" or inadequately analyzed interconnections or couplings that link safety and non-safety systems in the reactor plant, and (2) the evaluation of the effects of non-safety system failure (or maloperation) propagated into the safety system by such interconnections/couplings.

o The SI staff stated that the treatment of SIs that aggravate accident conditions and exceed the capabilities of installed safety systems (in addition to SI's that degrade safety system capability) is considered to be within the scope of a comprehensive SI analysis. And methods are available for treating a number of types of SI's, as outlined in Enclosure 3. The SI staff acknowledged, however, that methods are not now available for treating comprehensively the so-called "higher-order" type SI's in interconnected systems. The capability does now exist for treating thoroughly specific events (or postulated events) involving higher-order SI's (e.g., as was done in the extensive analyses of the TMI-2 accident, the Crystal River loss-of-coolant event, the Brown's Ferry partial scram failure, etc.). But the SI staff believes that improved simulator/engineering analyzer capability must be developed if "higher-order" type SI's can be treated systematically and comprehensively in future SI studies.

o The staff emphasized that consideration of operating experience is an important element in the systems interaction analysis of a facility and should be treated explicitly in the IP-3 SI study. Extrapolation of events that have actually occurred is, of course, an effective and accepted method for identifying additional potential SI's with nexus to what has already actually occurred. Consideration of operating experience can also be useful in another important way. The suitability/workability of a proposed SI analysis methodology can be demonstrated if it can be shown that application of that methodology will identify and lead to correction of adverse systems interactions similar to those that have occurred in the past..

o With regard to the question of suitability/workability of various analytical methods for SI analysis purposes, the SI staff does not feel that Event Tree/Fault Tree methods have yet been satisfactorily demonstrated in the limited applications attempted to date (e.g. Sandia Phase I A-17 effort; or Battelle/BNL/LLL State-of-the Art surveys).* PASNY has proposed use of "dependency analysis" techniques (e.g., combining shutdown logic diagrams, safety system auxiliary diagrams, auxiliary safety system commonality diagrams, dependency

*Battelle, BNL, and LLL have continued efforts to adapt Event Tree/Fault Tree methodology for SI analysis purposes. Their efforts are reflected in Interim Guidance being developed; and Event Tree/Fault Tree methodology will be one proposed SI analysis technique tested in "pilot" reviews planned in the near future.

tables/matrices, FMEAs) as the primary means for identifying SI's in the IP-3 study. PASNY has proposed also the use or "consideration" of individual system Fault Trees (available from the IP-3 PRA study) as a supplemental means of identifying and evaluating SI's. This is acceptable to the staff; but PASNY should emphasize and concentrate efforts on application of "dependency analysis" methods in the actual performance of the IP-3 study.

I.B. Relationship Between PRA and SI

P. Alesso, LLL, presented an overview on the relationship between PRA and SI analysis, based on his background and experience in applying PRA techniques, and on perspectives gained from the RRAB/LLL/SAI review of both the PASNY SI submittal and Draft sections of the Z/IP-3 PRA report (provided separately by PASNY at RRAB's request to facilitate the SI submittal review). His presentation (see outline in Enclosure 4), and subsequent discussions throughout the meeting developed the following main points:

o Early PRA studies focused largely on safety systems, and (because of assumed independence between nonsafety and safety systems) did not treat nonsafety system-related effects to any great extent. This approach seemed valid in view of stringent criteria applied in the design and licensing review process (i.e., single failure criterion, separation criteria, etc.) for the express purpose of achieving and maintaining nonsafety/safety independence. Also, consideration was given in early PRA efforts to common-mode failure mechanisms and effects; but, again, the emphasis was on couplings (and their effects) between safety systems (not between safety and nonsafety systems). In this sense, some consider SI studies as merely an extension of the too-restrictive boundary conditions imposed in early PRA studies to encompass full treatment of common cause/common mode effects involving both nonsafety and safety systems. Consistent with this view, recent "enhanced" reliability and risk analyses (e.g., IREP and the Z/IP-3 PRA) do include significantly improved treatment of nonsafety front line and support systems.

o The SI staff does not agree with characterization of SI analysis as "just a part of an enhanced PRA" for the following reasons:

(1) SI analysis is a useful exercise and has inherent value completely aside and apart from PRA.The nonsafety/safety dependency information developed by SI analyses is certainly important in assuring the accuracy of PRA results (in fact, SI analysis must be regarded logically as a prerequisite to PRA). But nonsafety/safety dependency information can be used readily and effectively to improve safety in the context of the current "deterministic" licensing approach even if PRA is never done.

(2) Thinking of SI analysis as "simply a part of PRA" can lead to undue empahsis or reliance on use of analysis methods usually associated with PRA (i.e., Event Tree/Fault Tree Analysis), that have not yet been satisfactorily demonstrated (for SI analysis purposes) in applications attempted to date.*

*See footnote preceding page.

- As a final point in the area of PRA/SI relationship, PASNY stated that the results of the IP-3 PRA study would be an important factor in the final selection of specific systems to be treated in the IP-3 SI analysis. The SI staff stated that PASNY should not rely primarily on those PRA results in making such determinations regarding the critical parameters of the SI study. If the PRA is flawed by not taking into account some hidden dependency in the IP-3 systems that could be found by a SI analysis, there is a logical inconsistency in using the results of such a potentially flawed PRA (in any controlling manner) in determining scope or depth of treatment of the SI analysis. PRA results may be useful in <u>confirming</u> the selection of systems (for SI analysis) arrived at by applying the methods and criteria described by PASNY in their Preliminary submittal

II.A Definition of SI and Application of Single Failure Criterion

- PASNY and the SI staff agreed explicitly that the threshold for identification of adverse SI's will be a nonsafety system or component failure that leads to the defeat of one train of a safety system or engineered safety feature... even if the remaining trains of the affected safety system or ESF could perform the intended safety function. This is a more stringent criterion than the Single Failure Criterion currently applied in the licensing review process; but it was emphasized that it is specified by the staff at this point only as a SI search criterion. SI's identified by applying this search criterion <u>may</u> require design change or plant modification; but not necessarily so.

- The choice of the stringent search criterion discussed in the preceding stems from the SI staff's objective of assessing the effectiveness of existing deterministic criteria in achieving independence between safety and nonsafety systems. The assumption of nonsafety/safety systems independence (in accordance with existing design and licensing review criteria) forms an important part of the rationale for determinations of "adequate safety" for existing plants sans systematic and comprehensive analysis of nonsafety failure effects. If numerous nonsafety/safety system dependencies are found by application of the search criterion specified above, that could indicate a fundamentally different level of reliability in safety systems than is now assumed, and could (for example) indicate the need for reassessment of the adequacy of the Single Failure Criterion as currently applied.

II.B Interconnected Systems Interaction Analysis

o PASNY amplified in discussions at this meeting their description in the Preliminary submittal of how Shutdown Logic Diagrams (SLD's) Safety System Auxiliary Diagrams (SSAD's), and Auxiliary Safety System Commonality Diagrams (ASSCD's) will fit together with FMEAs and Fault Trees on individual systems, to identify and evaluate SI's (dependencies) in the IP-3 study. As the staff now understands it, SLD's, SSAD's, and ASSCD's are basically devices employed (1) for identifying the safety and support systems (including nonsafety systems) that are to be analyzed for interactions, and (2) for correlating and combining the results of FMEA's on individual systems in order to understand and portray how interconnections, couplings and dependencies among all systems can propogate nonsafety system failure(s) into the safety system. (PASNY also agreed to consider the use of matrix based methods, as suggested by the SI staff, as a refinement on the above mentioned methods in identifying dependencies among interconnected systems.)

In addition, as a supplemental device in searching for SIs, and as one of the principle methods for the evaluation of SI's identified, PASNY will use or "consider" Fault Trees on individual systems already available from the Z/IP-3 PRA. PASNY may develop new Fault Trees for systems covered in the SI analysis, if these systems were not covered or were not modeled in sufficient detail (for SI purposes) in the PRA. All SI's identified are not expected to require use of Fault Trees for evaluation; engineering judgment, based on and appropriately reflecting existing deterministic criteria, will be used in some cases.

o A staff concern regarding the effectiveness of PASNY's proposed method for generating system/component listings corresponding to required safety functions was resolved by PASNY's statement that Table 6.1 presented in Vol. 1 of the "Preliminary" submittal was not intended to be complete in that respect (e.g., it did not include the PORV) explicitly at the time, but would do so in the final submittal). At this point the table was intended for illustrative purposes only.

o PASNY's amplifying comments referred to in the preceding also answered specifically a staff concern regarding adequacy of the FMEA approach to be applied to all systems generally on the basis of conclusions drawn from the FMEA of the AFW system alone (see Fig. A-2.1 in Vol. II). Specifically the staff questioned the validity of "Acceptable" conclusions for various failure modes postulated in the AFW system, without considering possible combined effects of failures in other systems (e.g., due to failure of support systems shared by the AFW and other systems, or other coupling mechanisms).

o An important area of disagreement between the SI staff and PASNY all along has been the question of treatment of nonsafety control system failure effects, nonsafety power system failure effects, and nonsafety instrumentation failure effects. These types of SI's have played major roles in a number of very serious operating incidents, and are of great concern and are considered high priority aspects of the overall SI problem by the staff; but PASNY indicated in the Preliminary submittal that they intended to address these types of SIs only very limitedly or not at all in the IP-3 study.

-- With regard to the treatment of SI's involving nonsafety instrumentation failure effects, PASNY stated in their "Preliminary" submittal that they did not intend to treat latent-or-dynamic human error-induced failures within the scope of their SI analysis. Consistent with this position, they specifically excluded treatment of "... failures which deprive the operator of required information for normally controlling plant conditions, or which provide confusing or incorrect information to the operator..." A part of PASNY's rationale in this respect was that it was simply too difficult to predict and analyze the many ways in which an operator might act incorrectly.
The SI staff believes that it is possible to treat one specific importan type of interaction involving the human error as a coupling or linking mechanism. That type of SI has been termed "induced operator error" (see Enclosure 3), and involves a set of circumstances in which (1) a nonsafety system failure causes loss (particularly massive loss) of normal control instrumentation display, and (2) the operator is assumed to act correctly (procedurally speaking) on the basis of incorrect reading(s) produced by the initiating failure. Thus, the difficulty of trying to predict and analyze incorrect actions is eliminated.

PASNY appeared to understand and appreciate the staff's comment in this regard (provided in the initial meeting on 4/2/81), but has not yet explicitly committed to including treatment of this type SI within their intended scope of study. The SI staff continues to believe that the seriousness and likelihood of this kind of failure are both such as to warrant its treatment in the IP-3 SI study.

-- With regard to nonsafety control systems failure effects, PASNY merely referenced in their Preliminary submittal the PASNY response to IEB 79-22. This was somewhat confusing in that context because IEB 79-22 addressed control system failures only in the context of non-connected SI effects (specifically, high energy line break effects); also PASNY's response focused on only a few control systems. Further, there was no indication in the Preliminary submittal that PASNY intended to consider adequately nonsafety power system failure effects caused by or propagated by nonsafety control systems, The staff therefore considered this aspect of PASNY's Preliminary submittal inadequate.

Subsequently, PASNY added reference to their responses to IEB 79-27 and NUREG-0588 as applicable and sufficient in this context. PASNY considers anything much beyond that to fall within the scope of one or another Unresolved Safety Issue (e.g. A-47 Control Systems Dynamics), not assignable by requirement to an individual licensee for resoluiton. The staff understands PASNY's legalistic position in this regard, but has required that at a minimum PASNY's treatment of SI's in interconnected systems should consider explicitly nonsafety control system failure effects and nonsafety power system failure effects to a degree consistent with requirements imposed by current staff practice for detailed information regarding nonsafety system aspects of plant design, e.g., recent ICSB review questions to OL applicants in the SNUPPs project. (A copy of the ICSB review questions referred to have been provided to PASNY.)

Beyond this minimum reqoirement, the staff has requested that PASNY consider possible application of the Indian Point simulator in the treatment of "first-order" types of SI's (see Enclosure 3) involving nonsafety control and power systems. The SI staff believes that to the extent that such a training simulator accurately models at least direct interconnections between safety and nonsafety front line systems and their support systems, it may be possible to do more comprehensive and systematic analysis of their failure effects more easily and efficiently by use of the simulator. (It would not be necessary for the simulator to accurately model process couplings or systems dynamics to be useful in thisregard.) It should also be noted that a training simulator would appear to be an almost ideal tool to be applied in treating more systematically and comprehensively nonsafety instrumentation display failure effects (i.e., the induced operator error SI) as discussed in the preceding. PASNY has agreed to investigate these possibilities and has examined on a very preliminary basis some specific scenarios and failure combinations of particular interest in this respect. The SI staff was invited to observe and participate in initial trials on September 23-24, 1981 at the Indian Point Simulator facility. We believe that PASNY is to be commended for responding in this fashion, and in demonstrating the willingness to examine novel (potential) alternative approaches to this very difficult aspect of SI analysis.

II.C Non-connected Systems Interaction Analysis

- The staff considers the methods and criteria proposed by PASNY for use in identifying and evaluating seismic-initiated SI's to be acceptable. The methods and criteria proposed are similar to those which have been employed previously at the Diablo Canyon facility; but the staff has noted refinements introduced by PASNY in this area that should facilitate the evaluation and utilization of results obtained in the walk-down inspections of IP-3 systems.

o With regard to treatment of other (non-seismic) types of event-induced SI's, it appears that PASNY essentially proposes to perform "enhanced" versions of the kinds of analyses already required under existing licensing requirements in this regard (e.g., Fire Protection Analyses, Flooding Protection Analyses, HELB Analyses, etc.). The "enhanced" analyses as proposed would feature increased emphasis on, and more comprehensive consideration of, nonsafety components in the vicinity of safety system components that could be damaged by failure of the nonsafety components. This proposed effort appears to go considerably beyond what is now required under existing requirements although it relies heavily on methods and criteria in existing regulatory guidance. The staff believes that such enhanced treatment of nonseismic event-induced SI's can be safety beneficial; and the methods and criteria proposed by PASNY in this regard appear acceptable to the staff <u>within the scope intended by PASNY</u>.

PASNY's proposed approach however, considers only <u>direct</u> effects of event-induced nonsafety component failures on the functioning of safety systems, i.e., nonsafety (source)/safety (target) interactions. The SI staff believes that the IP-3 study should also include some consideration of effects of event-induced nonsafety component failures on important <u>nonsafety</u> systems functioning and the possible resulting impact on safety system functioning, i.e., nonsafety (source)/nonsafety (target) interactions and resulting effects on safety systems. PASNY's objections to including treatment of such interactions in the IP-3 study were based on concerns regarding how to bound such analyses (e.g., would <u>all</u> nonsafety (target) systems within an entire compartment have to be considered with regard to effects of an event-induced steam environment). The staff recognizes the validity of such concerns, and for that reason the subsequent to the July 24 meeting suggested a reasonably-bounded approach to an initial effort in this direction that could be accomplished within the scope of the IP-3 study.

As a first step in the suggested approach, PASNY would select (subject to agreement by the staff) a representative <u>high-energy</u> nonsafety system. The agreed upon (source) system would be walked-down while surveying the vicinity surrounding for (target) nonsafety systems <u>which had already been treated in the interconnected SI analysis phase of their study and had been shown to have safety significance</u>, i.e., could adversely affect, a safety function if their own (non-safety) functioning were impaired. If a situation is found in the walk-down of the (source) high energy system in which such (target) nonsafety systems could be damaged by failure of the high energy (source) nonsafety system, a potentially adverse "coincidence" or systems interaction would have been identified.

If such potentially adverse "coincidences" were found to occur frequently, that might indicate a need for extending such analyses generically. On the other hand, if no (or very few) such potentially adverse coincidences were identified, that could be taken as additional assurance that the existing licensing basis is adequate <u>without</u> the need for requiring or extending this type of SI analysis. The staff believes that this limited additional effort could contribute significantly toward better definition and understanding, if not complete resolution, of this unexplored aspect of the overall systems interaction question.

III.A Safety Classification Terminologies

- The staff emphasized that, because SI analysis involves extensively the treatment of systems ranging widely in degree of importance to safety, careful use must be made of the safety classification terms which properly reflect such differences. In this context, the SI staff provided to PASNY standard definitions for three most commonly-used safety classification terms (see Enclosure 5).

IV Schedule for Completion of IP-3 SI Analysis Progress

- PASNY agreed to prepare a Final IP-3 study submittal that incorporates or addresses the staff's review comments; the revised submittal is expected to be available in late-October.

- ACRS has tentatively scheduled a meeting of the appropriate sub-committee in mid-November to discuss the revised (Final) submittal.

- PASNY estimates that completion of the actual IP-3 SI analysis effort could take 6-12 months after initiation.

List of Attendees

Indian Point 3 Systems Interaction Study

July 24, 1981

L. Olshan	NRC
J. Kelly	SAI
P. Alesso	LLNL
J. O. Thoma	NRC
J. Lamberski	PASNY
W. D. Hamlin	PASNY
Y. Kishinevsky	PASNY
K. S. Sunder Raj	PASNY
Roberto L. Goyette	PASNY
George Wilverding	PASNY
S. S. Iyer	PASNY
Edward J. Borella	EBASCO
Ralph J. Giorgio	EBASCO
Michael G. Gagliardi	EBASCO
F. Coffman	NRC
E. Chelliah	NRC
J. Conran	NRC

Enclosure 1

DETAILED MEETING AGENDA

Discussion of Indian Point 3 Systems Interaction Analysis

July 24, 1981

I. INTRODUCTION/BACKGROUND

A. NRC Philosophy on SI Analysis (NRC)

1. Concentrate on safety/nonsafety system dependencies and nonsafety system failure effects

2. Consider significant operating experience in scoping SI analysis effort and in demonstrating effectiveness of methodology employed

B. Relationship between PRA and SI (NRC)

1. Historical perspective (PRA and SI essentially complementary)

2. Current efforts (More SI included in PRA)

3. Future direction (Comprehensive PRA could include SI)

II. DISCUSSION OF INITIAL IP-3 SUBMITTAL AND NRC REVIEW COMMENTS

A. Definition of SI and Application of Single Failure Criterion

1. Degradation of safety system vs defeat of safety function (NRC)

2. Treatment of SI that aggravate accident conditions or exceed safety system capability (NRC)

3. Identification of critical safety functions and corresponding plant systems/components (e.g., how is PORV treated?) (PASNY)

B. Interconnected Systems Interaction Analysis

1. How do shutdown logic diagrams, safety system auxiliary diagrams, and auxiliary safety system commonality diagrams fit together with FMEAs and PRA event trees/fault trees to identify adverse systems interactions? (Amplify on Vol. I description) (PASNY)

2. Treatment of nonsafety control system failure effects, nonsafety power supply effects, and nonsafety instrumentation display failure effects

a. 79-22 submittal inadequate for SI purposes (NRC)

Enclosure 2

-- considers only one type of environmentally induced failure

-- does not consider all nonsafety control systems

-- based on FW HELB analysis where break sizes/ locations are chosen for direct effects on <u>safety</u> systems

b. Misinterpretation by PASNY of NUREG-0578 "requirement" for nonsafety system analysis (NRC)

c. Possible alternative approaches for treatment in IP-3 SI program

-- investigate use of Indian Point simulator (PASNY)

-- comprehensive dependency analysis (e.g., digraph) (NRC)

-- current ICSB review approach, as reflected in SNUPPS questions provided to PASNY

C. Nonconnected Systems Interaction Analysis

1. Criteria/methodology presented in Vol. I appear generally very good (NRC)

2. Should take credit explicitly for SI analysis already done in fire protection, flooding, HELB analyses, etc. (NRC)

3. Describe in greater detail how and to-what-extent SRP/Reg. Guide guidance used for SI analyses in (2) will be applied in determining effects of fire, flooding, HELB, etc., on <u>nonsafety</u> control systems, power sources, instrumentation cabling, etc. (which could in turn adversely influence safety functions) (PASNY)

III. SAFETY CLASSIFICATION TERMINOLOGIES/IP-3 HEARING ISSUES

A. Use definitions developed in NRC TMI-1 Restart Hearing Testimony (NRC)

B. Systems Interaction--Major Issue in IP-3 Hearing (What is current hearing schedule?) (PASNY)

IV. SCHEDULE FOR COMPLETION OF IP-3 SI PROGRAM

A. Final Submittal/ACRS Meeting, Sept. 1981 (PASNY/NRC)

B. NRC Audit Review/Walk-Through (NRC)

C. SER on IP-3 SI Program, March 1982 (NRC)

SYSTEMS INTERACTION PROGRAM

SCOPE

- COMMON-CAUSE FAILURES THAT:
  - -- VIOLATE RCPB INTEGRITY
    (E.G., PIPE BREAK, RELIEF/ISOLATION VALVE FAILURE, PUMP SEAL FAILURE)
  - -- DEGRADE OR DEFEAT SAFETY SYSTEMS
    (SCRAM, ECCS, RHR, & ESF)
  - -- EXCEED SAFETY SYSTEM CAPABILITIES
    (E.G., EXTREME OVERPRESSURE, OVERCOOLING
- EMPHASIS ON NONSAFETY SYSTEM FAILURE EFFECTS
  - -- PROCESS & SUPPORT SYSTEMS
  - -- EQUIPMENT FAILURE & HUMAN ERROR
  - -- FAILURE TO OPERATE & INADVERTENT OPERATION

TYPES

- NONCONNECTED SYSTEMS INTERACTIONS
  (COUPLING IS BY SHARED SPACE OR ENVIRONMENT)
- INTERCONNECTED SYSTEMS INTERACTION
  A. FIRST-ORDER
  (CHARACTERIZED BY: DIRECT CONNECTIONS: "ONE-WAY" DEPENDENCE: NO SYSTEM DYNAMICS OR FEEDBACK EFFECTS INVOLVED)
  B. HIGHER ORDER
  (CHARACTERIZED BY: PROCESS COUPLING: SYSTEMS DYNAMICS EFFECTS)
- INDUCED HUMAN ERROR
  (INSTRUMENTATION DISPLAY ERROR: ASSUME PROCEDURALLY CORRECT OPERATOR ACTION)

Enclosure 3

METHODS

- WALK-THRU OR WALKDOWN
- ANALYTICAL METHODS

  (EVENT TREE/FAULT TREE, DEPENDENCY ANALYSIS, FMEA)
- EVALUATION & EXTRAPOLATION OF OPERATING EXPERIENCE
- SIMULATION METHODS
  - -- TRAINING SIMULATORS

    (INTERCONNECTIONS WELL-MODELED; DYNAMICS POORLY MODELED)
  - -- ENGINEERING ANALYZER

    (INTERCONNECTIONS & DYNAMICS WELL MODELED)

BASIC SAFETY FUNCTIONS

- ABILITY TO ACHIEVE & MAINTAIN ENTIRE CORE SUBCRITICAL
- ABILITY TO TRANSFER DECAY HEAT TO ULTIMATE HEAT SINK
- ABILITY TO MAINTAIN RCPB
- ABILITY TO PROVIDE ENGINEERED SAFETY FEATURES

I. PURPOSE OF PRESENTATION

- TO PRESENT THE SYSTEMS INTERACTION (SI) PROBLEM IN TERMS OF PROBABILITY RISK ASSESSMENT (PRA), AND

- TO STIMULATE DISCUSSION AND ENCOURAGE FEEDBACK FROM INTERESTED GROUPS.

Enclosure 4

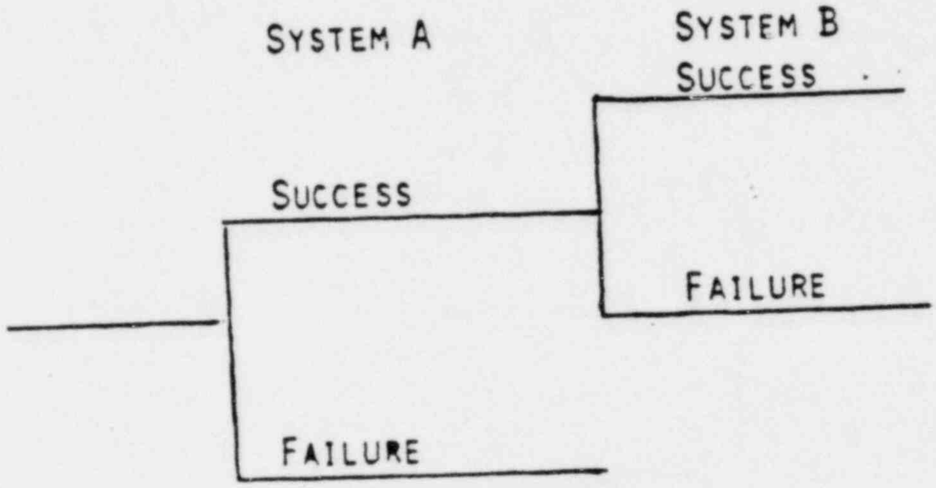
II. BACKGROUND

- EARLY REACTOR DESIGN WAS DONE WITHOUT FORMAL RISK ANALYSIS.
- THE NEED TO BALANCE THE LIKELIHOOD OF A POSTULATED SCENARIO WITH ITS CONSEQUENCES LED TO THE REACTOR SAFETY STUDY (RSS) 1975.
- SUBSEQUENT RISK ANALYSIS WAS PRA.

PRA

LEVEL 1: EVENT TREES:

- RELATES THE SAFETY FUNCTIONS TO SYSTEMS NECESSARY TO PREVENT A CORE DAMAGE.

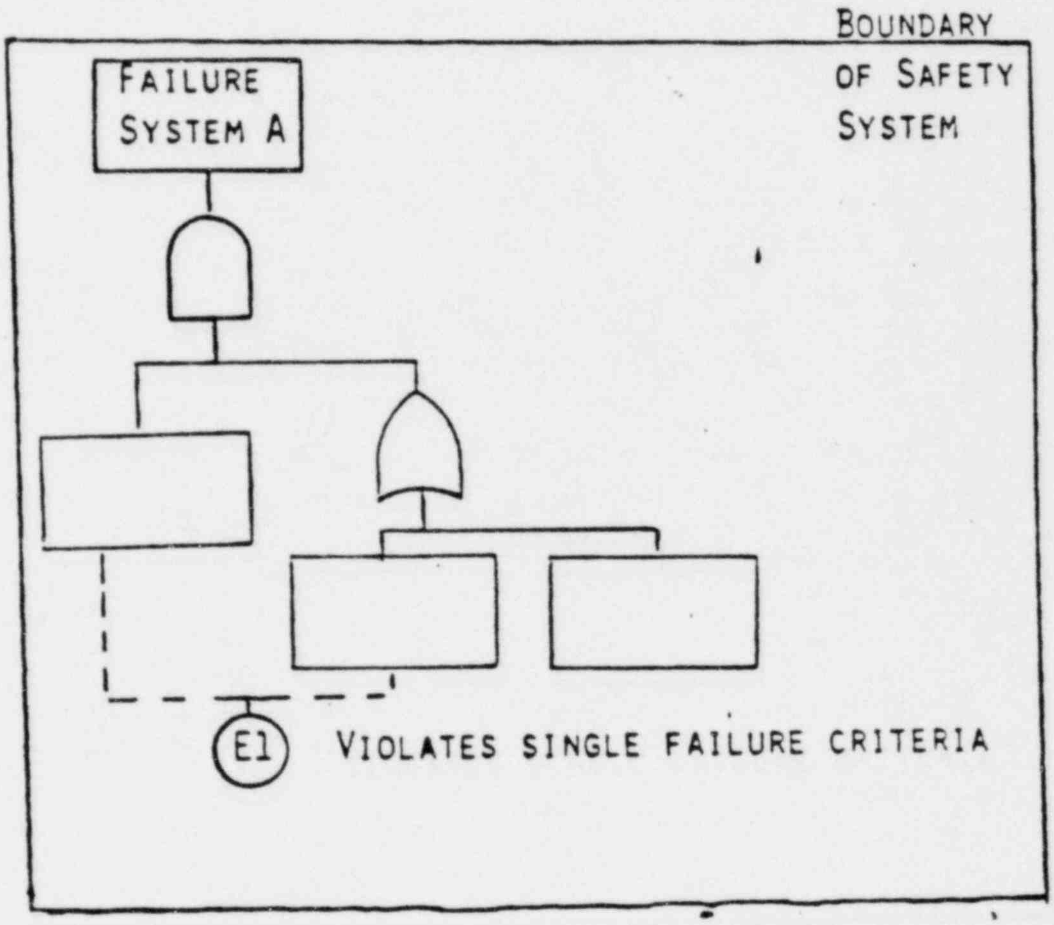


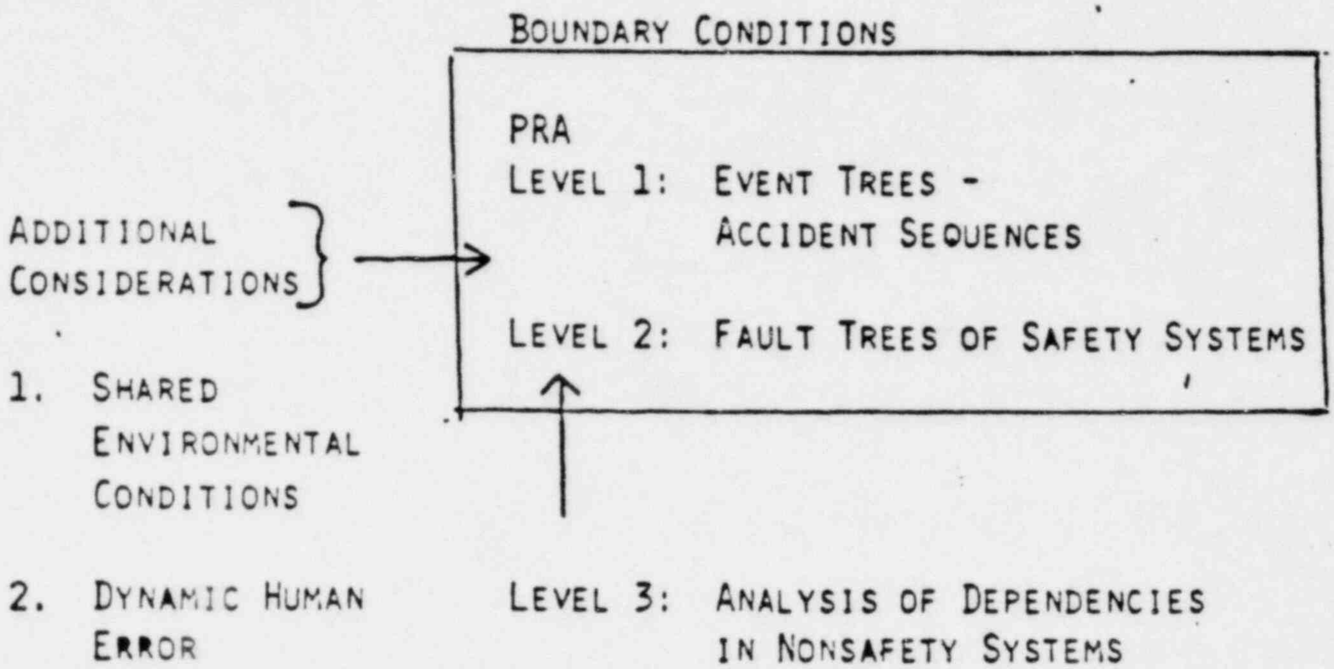
- THE RESULTS ARE ACCIDENT SEQUENCES. USUALLY SAFETY SYSTEMS ALONG WITH THE MAIN FEEDWATER SYSTEM.

PRA

LEVEL 2: FAULT TREES:

THESE WERE USED TO DETERMINE THE FAILURE PROBABILITY FOR EACH SAFETY SYSTEM WITHIN THE ACCIDENT SEQUENCE




BOUNDARY CONDITIONS
PRA
LEVEL 1: EVENT TREES - ACCIDENT SEQUENCES
LEVEL 2: FAULT TREES OF SAFETY SYSTEMS
ADDITIONAL CONSIDERATIONS
1. SHARED ENVIRONMENTAL CONDITIONS
2. DYNAMIC HUMAN ERROR
LEVEL 3: ANALYSIS OF DEPENDENCIES IN NONSAFETY SYSTEMS

PAST LIMITATIONS OF PRA

- LIMITED BOOLEAN COMPUTATIONAL ABILITY.
- LACK OF FAILURE RATE DATA

RESULTS

- SAFETY SYSTEM BOUNDARY CONDITION LIMITS.
- APPROXIMATION FOR NONSAFETY SYSTEMS

$$P(A \wedge B) \approx P(A) \cdot P(B)$$

(OMITS SOME DEPENDENCE FROM EACH ANALYSIS)

III. THE PROBLEM

HOWEVER, ACCIDENTS SUCH AS TMI, BROWN'S FERRY, AND CRYSTAL RIVER HAVE OCCURRED, THAT HAD NOT SURFACED EXPLICITLY IN PRA.

- O ARE THE MATHEMATICAL METHODS OF PRA INADEQUATE?
- O ARE THE BOUNDARY CONDITIONS TOO RESTRICTIVE?
- O IS A NEW UNIQUE APPROACH NECESSARY?

WHY ALL THE DIVERSITY IN METHODOLOGY?

POINTS OF VIEW

- O PRA STUDIES HAVE NOT FOUND SOME SIs BEFORE AND THEREFORE MUST BE INADEQUATE.

- O SIs SHOULD BE EXAMINED IN ISOLATION.

OTHER PROBLEMS

- O IDENTIFYING SYSTEMS INTERACTIONS
- O EVALUATING SYSTEMS INTERACTIONS
    - O LACK OF FAILURE RATE DATA (IF PRA METHODS USED)
    - O CRITICISMS OF SHORTCOMINGS/LIMITATIONS USING ENGINEERING JUDGMENT, DETERMINISTIC CRITERIA, HEURISTIC TECHNIQUES ETC.

COMPUTATIONAL EFFICIENCIES HAVE IMPROVED FOR HANDLING INDEPENDENT EVENTS

- INDEPENDENT MODULES
- SUPERCOMPONENTS

WHAT ABOUT METHODS OF HANDLING DEPENDENT EVENTS?

SUCH METHODS ARE METHODS OF SYSTEMS INTERACTIONS. THEY INCLUDE:

- HEURISTIC TECHNIQUES (HAZARD INDEX)
- GRAPHED BASED LOGIC ANALYSIS
- ENHANCED PRA

COMMON CAUSE FAILURE (CCF) ANALYSIS OVERVIEW

PROBABILITY MODELS HAVE BEEN DEVELOPED TO ESTIMATE COMMON CAUSE PROBABILITIES FROM DATA

PROBABILITY MODELS ARE BEING APPLIED TO LER AND NPRDS DATA TO OBTAIN CCF PROBABILITY ESTIMATES

CCF DATA ARE BEING CLASSIFIED BY SCENARIO VARIABLES TO IDENTIFY FACTORS CAUSING HIGH CCF PROBABILITIES

SUBJECTIVE ENGINEERING APPROACHES BEING DEVELOPED TO QUANTIFY CCF PROBABILITIES BY PLANT VARIABLES

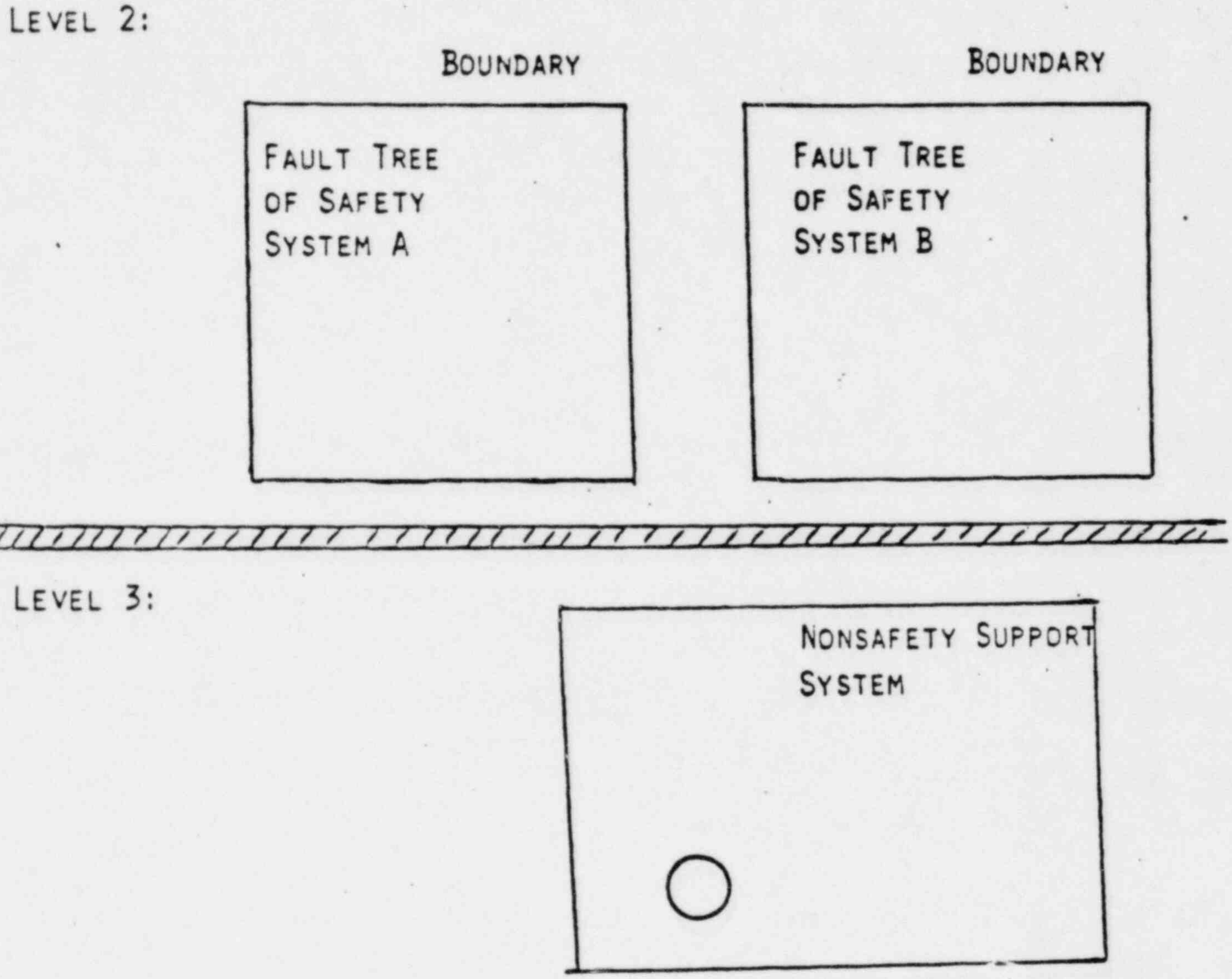
IV. ENHANCED PRA

THERE IS NOTHING FUNDAMENTALLY WRONG WITH THE MATHEMATICAL METHODS USED IN PRA.

ITS BOUNDARY CONDITIONS SHOULD BE EXTENDED WITH EMPHASIS ON DEPENDENT FAILURES SUCH AS:

- O SHARED ENVIRONMENTAL CONDITIONS
- O NONSAFETY SUPPORT SYSTEMS
- O DYNAMIC HUMAN ERROR

WE SEEK


LEVEL 2:
BOUNDARY
BOUNDARY
FAULT TREE OF SAFETY SYSTEM A
FAULT TREE OF SAFETY SYSTEM B
LEVEL 3:
NONSAFETY SUPPORT SYSTEM

V. SUMMARY

Systems interaction analysis can be an expansion of the boundary conditions of Probability Risk Assessment analysis using the same tools as the PRA, but developing a more detailed emphasis on dependent failures.

DEFINITION OF TERMS

Important to Safety

- Definition - From 10 CFR 50, Appendix A (General Design Criteria) - see first paragraph of "Introduction."

  "Those structures, systems, and components that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public."

- Encompasses the broad class of plant features, covered (not necessarily explicitly) in the General Design Criteria, that contribute in important way to safe operation and protection of the public in all phases and aspects of facility operation (i.e., normal oepration and transient control as well as accident mitigation).

- Includes Safety-Grade (or Safety-Related) as a subset.

Safety-Related

- Definition - From 10 CFR 100, Appendix A - see sections III.(c), VI.a.(1), and VI.b.(3).

  "Those structure, systems, or components designed to remain functional for the SSE (also termed 'safety features') necessary to assure required safety functions, i.e.:

  (1) the integrity of the reactor coolant pressure boundary;

  (2) the capability to shut down the reactor and maintain it in a safe shutdown condition; or

  (3) the capability to prevent or mitigate the consequences of accidents which could result in potential off-site exposures comparable to the guideline exposures of this part.

- Subset of "Important to Safety"

- Regulatory Guide 1.29 provides a LWR-generic, function-oriented listing of "safety-related" structures, systems, and components needed to provide or perform required safety functions. Additional information (e.g., NSSS type, BOP design A-E, etc.) is needed to generate the complete listing of safety-related SSC's for any specific facility.

  Note: The term "safety-related" also appears in 10 CFR 50, Appendix B (Q.A. Program Requirements); however, in that context it is framed in somewhat different language than its definition in 10 CFR 100, Appendix A. That difference in language between the two appendices has contributed to confusion and misunderstanding regarding the exact meaning of "safety-related" and its relationship to "important to safety" and "safety-grade." A revision to the language of Appendix B has been proposed to clarify this situation and remove any ambiquity in the meaning of these terms.

ENCLOSURE 5

Safety-Grade

- Term not used explicitly in regulations but widely used/applied by staff and industry in safety review process.

- Equivalent to "Safety-Related," i.e., both terms apply to the same subset of the broad class "Important to Safety."

ASB REVIEW COMMENTS

A-3.2 Loss of Air to Speed Controller TDAFW?

Not on Table A-3 or Fig. A-2.1

A-1.2 Did not consider loss of non-safety grade control systems. Justified by response to IE notice 79-22 via IPN-79-74, Oct. 11, 1979.

A-2.1.1 Acceptance criteria that AFW is delivered within 30 minutes of initial demand - How can this be backed up as the required time for AFW initiation for all accidents - It may take 30 minutes to boil dry but flow may have to be initiated earlier for the AFW system to "catch up" and prevent dryout.

Also, is dryout sufficient criteria since the accident analyses in Chapter 15 uses other criteria.

A-2.2.3 & A-2.2.5 What about toronado protection for the condensate storage tank?

Fig. A-2.1 Sheet 3 of 9 M-6, M-7 - Should mention that pumps are protected by automatic trip. (Will correct operator action assumption - JHC, per PASNY 7/24/81)

Should have PAS/RRAB look at Fault Trees and ICSB look at logic diagrams and electrical failures; on surface the electrical failures look OK.

General

Power/Air failures are evaluated with respect to individual components and their effect on the system. What about a combination of these components if one electrical/air failure can affect groups of components? For instance, a complete loss of A-C power (on & off) would affect many of the components in Fig. A-2.1. How is the scenario followed in this report?

ENCLOSURE 2

SUGGESTED TOPICS: SYSTEMS INTERACTION PROGRAM

ACRS MEETING, FEBRUARY 26, 1982

I. PASNY (INDIAN POINT 3 OWNER)

Description of the IP-3 Program

Scope and Magnitude of Program

Methodology

Criteria

Occupational Exposure Estimates for In-Situ Examinations

II. NRC STAFF

- NRC Systems Interaction Program
- Methodology
- Indian Point-3
- 4 Pilot Reviews
- All Plants
  - SEP/NREP
  - OL Reviews
  - CP:ML Plants

ENCLOSURE 3

UPDATED STATUS OF SYSTEMS INTERACTION PROGRAM

MILESTONE	STATUS
Evaluation of Diablo Canyon	10/80 (NUREG-0675, Supp 11)
Survey of Methods	1/81 (NUREG/CR-1859, 1896, 1901)
Evaluation of San Onofre 2/3	5/81 (NUREG-0712, Supp 2)
Selection of plants for demonstration analyses	2/82
Implementation of Indian Point-3 methodology on first NREP/SEP Phase III plants	10/82
Evaluation of Indian Point-3 Study	6/83
Evaluation of selected plants*	10/83
Issue Requirement & General Guidance Concerning Systems Interaction**	1/84
Issue Regulatory Guide	1/85

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*Includes measures of the benefits of the analyses and refinements to reduce future costs.

**Includes acceptance criteria within the Guidance and the scope of the requirements for future NREP/SEP-III plants.