



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555
NOV 13 1978

NRC PDR

Generic Task No. A-17

PROJECT: Generic Task No. A-17, Systems Interaction in Nuclear Power Plants

SUBJECT: SUMMARY OF MEETING WITH THE SUBCOMMITTEE ON PLANT ARRANGEMENTS OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

Members of the NRC staff met with the Subcommittee on Plant Arrangements of the Advisory Committee on Reactor Safeguards (ACRS) on October 25, 1978, in Washington, D. C. to develop information for consideration by the ACRS in its review of Task Action Plan A-17, Systems Interaction in Nuclear Power Plants, and the Zion Station Systems Interaction Study. Others who participated in the meeting were: (1) representatives of Commonwealth Edison Company and its consultant, Fluor Power Services (formerly Fluor Pioneer, Inc.), (2) representatives from Sandia Laboratories and (3) a representative of Oak Ridge National Laboratory, and (4) consultants to the ACRS. A list of participants is included with this meeting summary. Significant items of discussion and items of further action are summarized in the following paragraphs. A stenographic transcript of the meeting is available.

The ACRS subcommittee opened the meeting with identification of the kinds of information that the members thought should be brought out in this meeting. Typical of the kinds of information sought by the members was: (1) will the NRC staff's definition of systems interaction in any way limit what the staff might cover; (2) the extent to which WASH-1400 was studied to pick up pertinent information; (3) how were the LER's selected for the (Zion Station) study; (4) possibility of inductive coupling between circuits; (5) what is the condition of systems which are interacting, in other words, are systems assumed to be in working order or in a degraded or non-working condition; (6) how will the significance of interactions be evaluated; (7) importance of understanding the possibility of interactions during a plant faulted condition; (8) interactions between safety-related and non-safety-related systems which may act as a coupler to other safety-related systems; (9) rationale for limiting the scope of the study to certain plant conditions; and (10) events such as accidental actuation of fire protection sprays as contrasted to predicted accidents which come to some pre-established conclusion.

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The NRC Staff presented information on the current status of the task, including the recent action to extend the completion of Phase I by four months to September 1979. The NRC Staff commented on the relative effectiveness of using an experience base to analyze systems interaction and diagnose the things that go wrong compared to the difficulty of synthesizing events that have not yet happened. These kinds of comments were made to stress the importance of focusing our attention on the scope of inquiry for this task and the importance of feedback from the ACRS regarding which events are worthy of being done first.

Mr. Jack Hickman and Mr. Wally Crammond of Sandia Laboratories presented information on the work accomplished to date as well as an overview of the entire Phase I Task. The presentation is outlined in a series of viewgraphs that are enclosed with this meeting summary. During this presentation, members of the ACRS and consultants raised the following additional questions: (1) explain why the scope of interactions will be limited to plant Conditions I and II in light of the fact that we will be looking for interactions that are important to safety; (2) will we have to go back into the design phase or the process of building reliability to assess whether that (reliability) is adequate and proper; (3) is the methodology (described in this Task) really a new technique to audit the effectiveness of the design in the preliminary approval stages; (4) could this technique be used by the staff in reviewing the adequacy of design in preliminary applications; (5) how, for example, will the methodology handle events like plant compartment flooding where it (the flood) would endanger safety-related equipment; (6) concern that we are really attacking this problem in the wrong way, that is, should we first postulate an event or accident and then track it through systems to determine interactions rather than starting with a safety function as the top event and then determine by fault tree methodology how this top event can occur; (7) many of our problems relate to how a plant is operated rather than how it is designed, further, is testing the plant itself a threat to safety; (8) usefulness of making a list of questions (events) that can be used as the basis for determining how methodology would treat some of these things (events); (9) would it be considered appropriate to look at interactions that could collectively increase the probability of scram by a factor of two or ten; (10) what types of coupling will be considered under the broad categories of "spatial" coupling and "process" coupling; (11) need to consider fires as a special kind of coupling mechanism, also the need to consider inductive coupling between circuits; (12) will activities that aren't necessarily operational in terms of the functioning system itself be considered, for example, use of a welding machine that could introduce electro-magnetic coupling; (13) can the (fault tree) methodology dealt with events like valves locked into the wrong position; (14) can the methodology handle multiple interactions concurrently, for example, the event

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that caused the damage to the diesel generator unit at the Zion Station; (15) how we will treat interconnections between safety and non-safety related systems; (16) do we consider the act of failure of a component in one system as a potential interaction with another system; (17) will we consider the transient effects as a failure of a component occurs, that is the effects that may occur between the time that the system is in working order and the time that it has failed; (18) need to consider probabilities of failure and the fact that probabilities change with time, for example, fatigue failure on airplane wings; (19) concern with what effect this methodology may have on the design process, that is, we may cause the design to be executed for the purpose of meeting a regulation; (20) how do we plan to look at the vulnerability of equipment to (containment) over-temperature; (21) will we consider interactions caused by vibrations or small leaks; (22) will we include structural interactions, also, interactions that may be caused by, for example, train A instrument supported on a structural member with train B piping; (23) are individuals with design experience assigned to the task, since the ultimate objective of the activity is what gets back into the design process, and ultimately, can this methodology be used by the designer to evaluate the systems design; (24) does human error include the bypassing of a system; (25) how far will we go into the more subtle interactions for example, the same supplier for lube oil to independent lube oil systems.

Mr. John Anderson of Oak Ridge National Laboratory presented information related to the study being conducted in regard to the interaction between auxiliary control systems and protection systems, including safety systems. The summary of his presentation is enclosed with this meeting summary. Members of the ACRS and consultants raised certain questions and concerns about this study. Typical of the concerns are: (1) how will we address the lack of adequate or accurate information to the operator, including conflicting information from different sources; (2) comment that sometimes a partial loss of power can be a worse case than a total loss of power; (3) an observation that redundancy might involve three or four - channel operation to circumvent the problem of conflicting information or conflicting control function from two channels; (4) question about whether the uncontrolled injection of sodium hydroxide into the reactor coolant system would be covered by this study (the event that occurred on a B&W NSSS unit); (5) have we given thought to design improvements that might arise from the study; (6) will Sandia Laboratories and Oak Ridge National Laboratory use the same designation for plant systems.

The NRC Staff, and representatives of Edison Company and Fluor Power Services (formerly Fluor Pioneer, Inc.) presented information related

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to the Zion Station Systems Interaction Study. The study was presented in a report by Fluor Pioneer, Inc. dated June 16, 1978. The study was made in response to a recommendation by the ACRS in its letter of June 17, 1977. The effort concentrated on a review of about 9000 Licensee Event Reports (LER) that had occurred between 1969 and 1977.

Of the list of 9000 LER's, about 67 were determined to be significant enough for a detailed review. About 24 of these 67 events were judged to be applicable to Zion Station.

The Conclusions (Section V) from this study are included as an enclosure to this summary report. (The conclusions were inadvertently omitted from reproduced copies of the report that was made available to the ACRS subcommittee, but are in the bound volumes that were distributed under Docket Nos: 50-295 and 50-304.)

One of the significant matters that was discussed about the Zion Station study was that the loss of one of the direct current emergency busses will result in a plant scram which then challenges the plant shut down systems which are at least partially dependent on the direct current power that was lost.

The ACRS subcommittee members questioned whether Commonwealth Edison had a continuing program of reviewing and evaluating Licensee Event Reports, and also questioned what kind of program the NRC staff had to get information out to the industry. The NRC staff and Commonwealth Edison Company responded to this question. Commonwealth Edison Company depends fundamentally on NRC bulletins issued by the Office of Inspection and Enforcement and on feedback from industry. Also, a group of "design specialists" in the engineering department of Commonwealth Edison Company looks at Licensee Event Reports from the point of view of (plant) availability and specific problems. The NRC staff members explained that we review these events (LER's) from a very broad viewpoint, not just solely from a systems interaction viewpoint. Further, the NRC staff has currently underway several generic study efforts that are, in essence, system interaction types of reviews, such as the over-pressurization review.

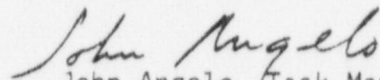
The ACRS subcommittee also questioned whether the NRR Working Group on Systems Interaction reviews Licensee Event Reports. Our answer was negative.

At the conclusion of this meeting, the members of the ACRS subcommittee and its consultants made the following comments and observations: (1) it may be useful to make a list (catalogue) of systems interaction questions which could serve as a basis for being able to test whether the methodology of Task A-17 is going to address the questions; (2) it

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may be useful to do a preliminary survey (Pilot scale basis) to show whether we are justified in limiting the scope of the task as we propose to limit it; (3) it would be useful if the NRC staff (and Sandia) could make some judgments on how far this kind of program could be applied; (4) it appears that we are reaching for "pie in the sky", a nearly impossible task; (5) we need a more comprehensive definition of "normal operation"; and (6) in what way can systems interaction have an effect upon the probability relationships that are used in deciding whether something is safe or not.

We agreed that we should give careful consideration to making a list or catalogue of events (interactions) that can be used to test the methodology of Task A-17 at some intermediate point. It appeared that January 1979 is a reasonable target date for establishing some further communication with the ACRS regarding this matter. We agreed to keep the staff members (Mr. Wright) informed of our progress in this matter.



John Angelo, Task Manager
Generic Task No. A-17
Division of Project Management

Enclosures:

1. List of Participants
2. Summary of Presentation by Sandia
Laboratories
3. Summary of Presentation by Oak
Ridge National Laboratory
4. Conclusions from Zion Station
Systems Interaction Study

cc:

See next page

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cc: Mr. Jack Hickman
Nuclear Fuel Cycle Systems Safety
Division 4412
Sandia Laboratories
Albuquerque, New Mexico 87115

K. Canady
Atomic Industrial Forum, Inc.
7101 Wisconsin Avenue
Washington, D. C. 20014

Mr. Mark Wisenberg
Tennessee Valley Authority
303 Power Building
Chattanooga, Tennessee 37401

ENCLOSURE 1

LIST OF PARTICIPANTS

ACRS SUBCOMMITTEE MEETING OF OCTOBER 25, 1978 ON

PLANT ARRANGEMENTS CONCERNING

TASK A-17, SYSTEMS INTERACTION IN NUCLEAR POWER PLANTS, AND

THE ZION STATION SYSTEMS INTERACTION STUDY

ACRS Subcommittee and Consultants:

Mr. Myer Bender
Dr. Stephen Lawroski
Dr. Dade Moeller
Dr. Jerome Ray

Mr. John Arnold
Mr. Epler
Mr. Michelson
Dean Palladino

Commonwealth Edison Company:

Mr. Cordell Reed
Mr. Jack Leider

Mr. Tom Tramm

Fluor Power Services:

Mr. Jerry Vellender (Formerly with Fluor Pioneer, Inc.)

Oak Ridge National Laboratory:

Mr. John Anderson

Idia Laboratories:

Mr. Jack Hickman

Mr. Wally Crammond

NRC:

Mr. Denwood F. Ross, Jr.
Mr. G. Zech
Mr. John Angelo

Mr. M. Taylor
Mr. A. Schwencer

Atomic Industrial Forum:

Mr. Ken Canady

ENCLOSURE NO. 2

SUMMARY OF PRESENTATION BY SANDIA LABORATORIES

PLANT ARRANGEMENTS SUBCOMMITTEE 10/25
SANDIA PRESENTATION BY J. HICKMAN

SYSTEMS INTERACTIONS METHODOLOGY APPLICATION

OBJECTIVES

DEVELOP A METHODOLOGY TO IDENTIFY AND EVALUATE SYSTEMS INTERACTIONS
IMPORTANT TO PUBLIC SAFETY

ASSESS THE STANDARD REVIEW PLAN TO DETERMINE COMPLETENESS OF THE PLAN
IN THE AREA OF SYSTEMS INTERACTIONS

DEVELOP A TECHNICAL BASE FOR CRITERIA, PROCEDURES, AND INFORMATION
REQUIREMENTS APPROPRIATE FOR USE BY APPLICANTS

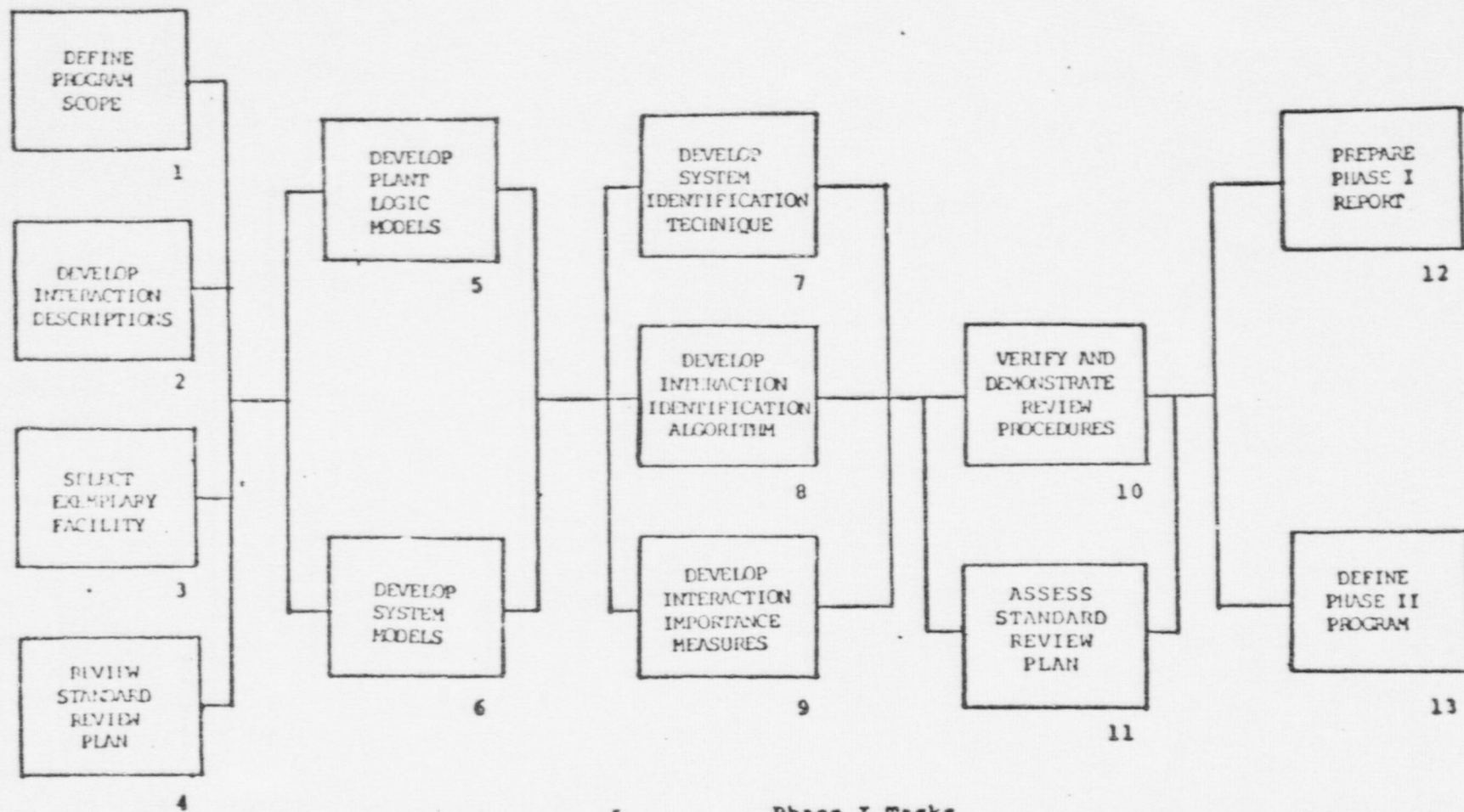
SYSTEMS INTERACTION METHODOLOGY

GOALS

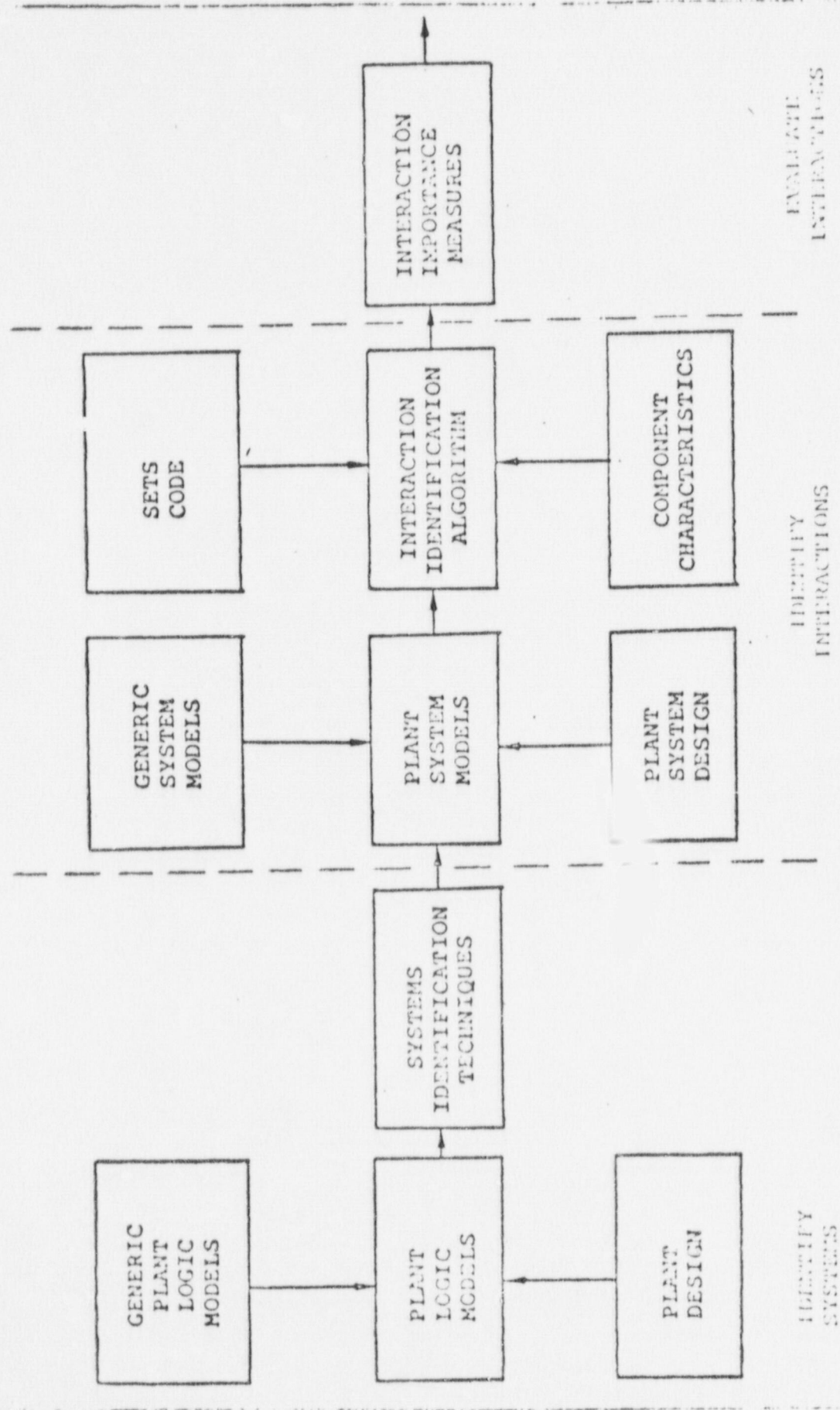
IDENTIFY IMPORTANT SYSTEMS

IDENTIFY POTENTIAL INTERACTIONS

EVALUATE INTERACTIONS



Phase I Tasks



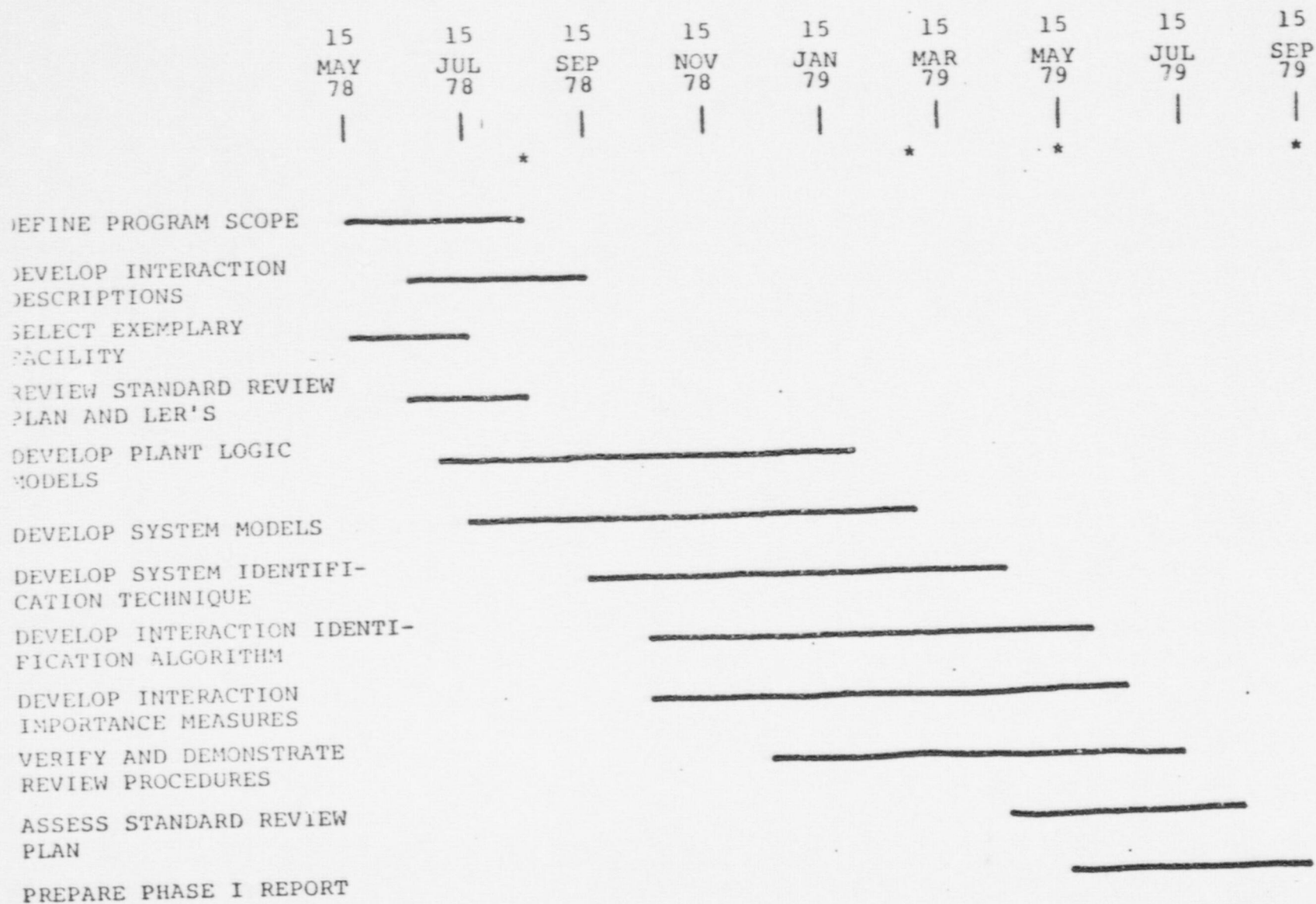
<u>Category</u>	<u>Within Scope</u>	<u>Methodology Applicable</u>
Plant Type	<p>PWR</p> <p>Westinghouse Dry Containment Ice Condenser Containment Babcock & Wilcox Combustion Engineering</p> <p>BWR</p> <p>General Electric Mark I Containment General Electric Mark III Containment</p>	All Others
Number of Units Per Site	Single	Multiple
Radioactive Material Sources	Reactor Core	Spent Fuel Pool Radwaste System
Plant Functions	Protection of RCS Pressure Boundary Reactor Shutdown Decay Heat Removal	Other Safety Related Function Requiring High Performance Re- liability
Plant Conditions (ANSI N18.2)	Normal Operations Incidents of Moderate Frequency	Infrequent Incidents Limiting Faults
Environmental Conditions (ANSI N18.2)	Normal	Flood, Earthquake, Hurricane, Tornado
Interactions	Process Coupling Spatial Coupling	Other Interactions

REPRESENTATIVE PLANTS

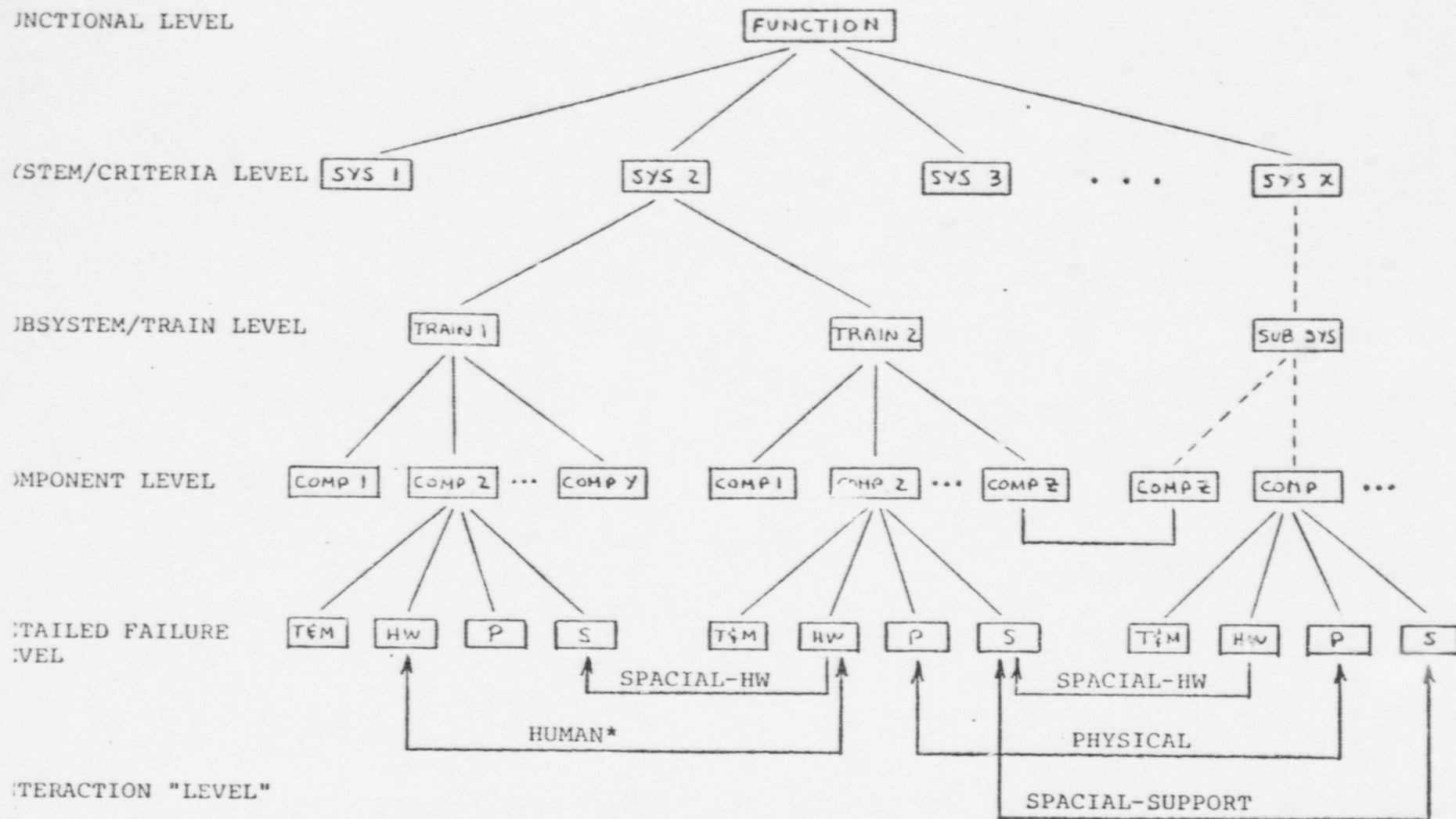
<u>Plant</u>	<u>Type</u>	<u>Nuclear Steam System Supplier</u>	<u>Containment Type</u>	<u>Architect- Engineer</u>	<u>Operator</u>
Surry	PWR	Westinghouse	Conventional	Stone & Webster	Virginia Electric & Power Co.
Sequoyah	PWR	Westinghouse	Ice Condenser	TVA	TVA
Oconee	PWR	Babcock & Wilcox	Conventional	Duke Power	Duke Power
Calvert Cliffs	PWR	Combustion Engineering	Conventional	Bechtel	Baltimore Gas & Electric
Peach Bottom	BWR	General Electric	Mark I	Bechtel	Philadelphia Electric Co.
Grand Gulf	BWR	General Electric	Mark III	Bechtel	Mississippi Power & Light Co.

EXEMPLARY FACILITY

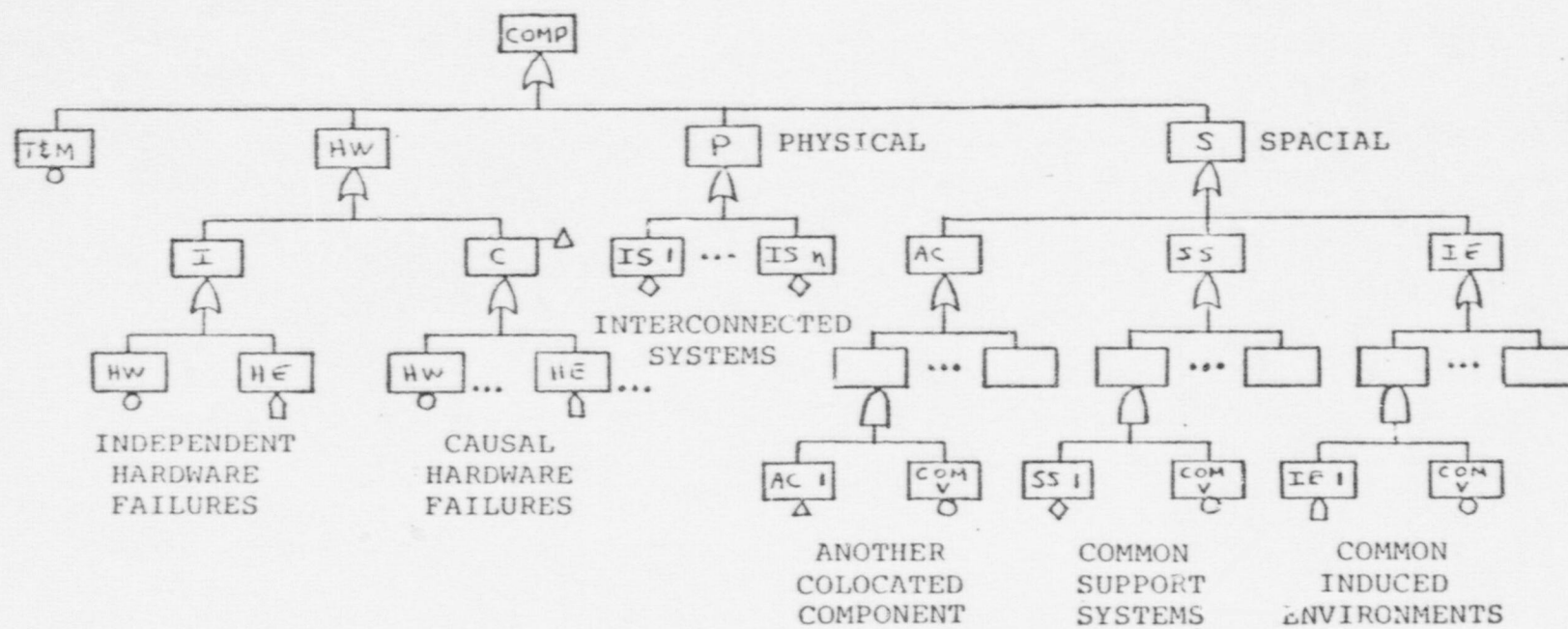
Watts Bar	PWR	Westinghouse	Ice Condenser	TVA	TVA
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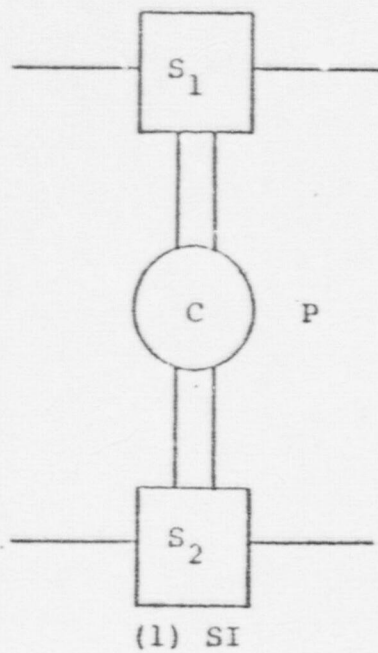
SYSTEMS INTERACTION PROGRAM SCHEDULE



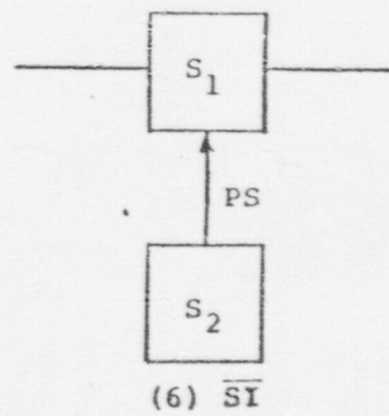
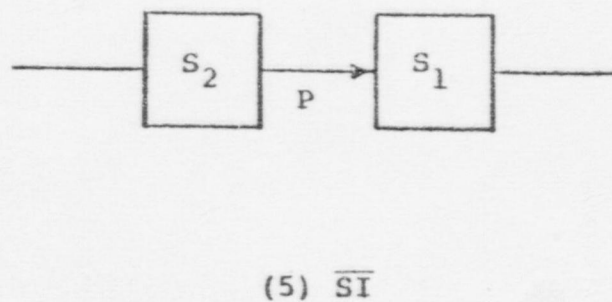
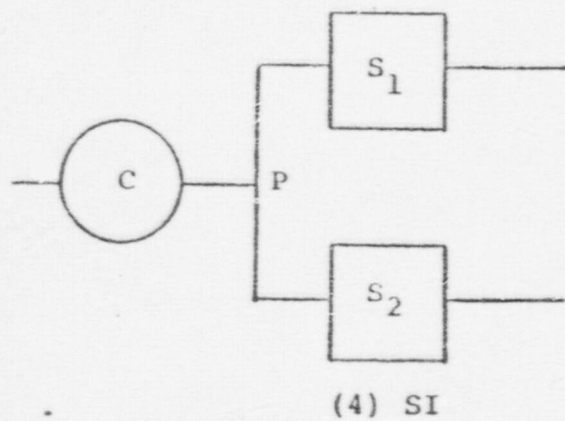
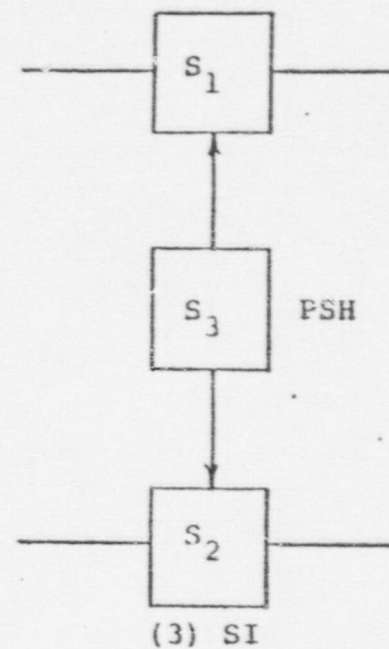
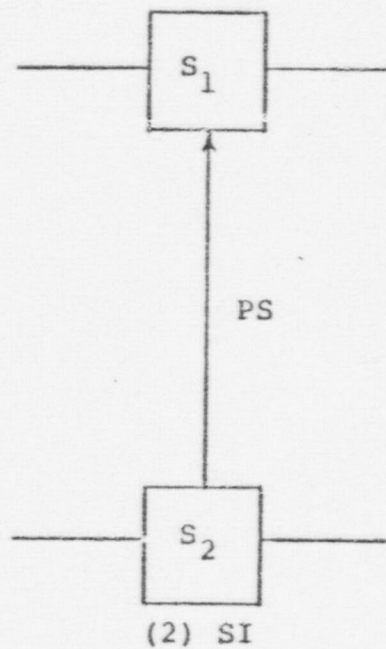
NOT SPECIFICALLY ADDRESSED IN THIS STUDY.



SHARED COMPONENT



SEPARATE COMPONENTS



ENCLOSURE NO. 3

SUMMARY OF PRESENTATION BY OAK RIDGE NATIONAL LABORATORIES

JOHN ANDERSON, ORNL

AUXILIARY CONTROL SYSTEM AND
PROTECTION SYSTEM INTERACTIONS
STUDY

OCTOBER 25, 1978

Notes - 10/25/78
Do not want to increase
Redundancy and the
of Control (Primary) system

H. E. Anderson

SCOPE:

TO IDENTIFY AND EVALUATE THE SAFETY
SIGNIFICANCE OF POSSIBLE INTERACTIONS
BETWEEN CONTROL AND SAFETY SYSTEMS.

- * ANALYSIS OF AUXILIARY CONTROL
SYSTEMS
- * POTENTIAL FOR DIRECT INTERACTION
- * CONTROL FAILURES RESULTING IN
CHALLENGE
- * EVALUATE PROTECTIVE CAPABILITY TO
MITIGATE THE CONSEQUENCES OF
INTERACTIONS

* USUALLY DEGRADED CONDITIONS

* RELATED STUDIES

POWER CONDITIONS } A19
NON I-E LOADS }

APPROACH:

- * EXAMINE A PARTICULAR PWR CONTROL SYSTEM. (B&W INTEGRATED CONTROL SYSTEM)
- * IDENTIFY CONTROLLED VARIABLES AND POTENTIAL FAILURE MODES.
- * EVALUATE LIMITING CONDITIONS RESULTING FROM FAILURES AND DETERMINE IF THEY ARE ADEQUATELY TREATED IN THE PSAR.
- * IDENTIFY PROTECTION CAPABILITY.

SUBSEQUENT TASKS: SIMILAR EVALUATION

- * BOILING WATER REACTORS
(BROWNS FERRY)
- * OTHER PRESSURIZED WATER REACTORS
COMBUSTION ENGINEERING
WESTINGHOUSE
- * EVALUATION OF PERTINENT LER's

B&W INTEGRATED CONTROL SYSTEM

* CONTROLLED VARIABLES

TURBINE THROTTLE

TURBINE BYPASS

STEAM PRESSURE RELIEF VALVES

MAIN FEEDWATER VALVES - 2 LOOPS

STARTUP FEEDWATER VALVES - 2 LOOPS

FEEDWATER PUMP SPEED - 2 LOOPS

EMERGENCY FEEDWATER ISOLATION
VALVES

EFFECTS OF FAILURES:

- * CONTROLLED VARIABLES EXAMINED INDIVIDUALLY IN RELATION TO PSAR.
- * MULTIPLE FAILURES EXAMINED TO A MORE LIMITED EXTENT.

OBSERVATIONS:

- * OPERABLE PARTS OF SYSTEM TEND TO COMPENSATE FOR PARTIAL FAILURES BY EXTENSIVE CROSS-LIMITING
- * FOR MULTIPLE FAILURES ONE PARAMETER TENDS TO DOMINATE (E.G. FEEDWATER)

FAILURE CONSEQUENCES:

- * FAILURES WITHIN THE SYSTEM TEND TO BE OF MINOR CONSEQUENCE.
- * FAILURES OF ACTUATORS OR CONTROLLED DEVICES ARE MORE TRAUMATIC, BUT CAN BE MANAGED BY MANUAL OVERRIDE, PROVIDED:

THE OPERATOR HAS ADEQUATE STATUS INFORMATION OF THE PROCESSES.

- * MOST SERIOUS CONSEQUENCE SO FAR DETERMINED IS RAPID COOLDOWN.

EVALUATION OF AN ACTUAL EVENT

- * WHOLESALE LOSS OF CONTROL AND INSTRUMENT POWER
- * AUTOMATIC SYSTEM BLIND AND MISBEHAVING.
- * OPERATOR INFORMATION WAS LIMITED AND HAD DIFFICULTY DETERMINING WHAT CORRECTIVE ACTION WAS NECESSARY.

INTERACTION EVALUATION:

- * PRIMARY PROTECTION SYSTEM (SCRAM)
RESPONDED CORRECTLY TO A REAL
CHALLENGE CREATED BY CONTROL FAILURE.
- * SECONDARY PROTECTION SYSTEM (ESFAS)
ALSO RESPONDED CORRECTLY TO A
POTENTIAL SAFETY PROBLEM (INADEQUATE
HEAT SINK).
- * ESFAS ACTION CONFOUNDED THE OPERATORS
EFFORTS TO REGAIN CONTROL.
- * LACK OF INFORMATION SERIOUSLY
DEGRADED OPERATOR PERFORMANCE.

PRELIMINARY CONCLUSIONS:

- * PROTECTION SYSTEMS ACTION WAS NEEDED AND CORRECT.
- * PROTECTIVE ACTION WAS SOMEWHAT DETRIMENTAL TO EFFORTS TO REGAIN CONTROL, BUT NOT INAPPROPRIATE.
- * CONTROL SYSTEM DID NOT INTERFERE WITH PROTECTION.
- * PRINCIPAL PROBLEM WAS
"CONTROL-CONTROL" INTERACTION
AND NOT
"CONTROL-PROTECTION" INTERACTION

STATUS SUMMARY

- * CONTROL AND INSTRUMENT SYSTEMS LACK:
CHANNELIZATION
REDUNDANCY
INDEPENDENCE

AS A RESULT, THEY MAY NOT PROVIDE
ESSENTIAL INFORMATION AND PERFORMANCE
IN SPITE OF FAILURES (AS IS EXPECTED
OF PROTECTION SYSTEMS).

DESIGN PRACTICE:

- * TO SOME EXTENT THESE FEATURES ARE EXPECTED OF GOOD DESIGNS
- * THEIR UTILITY HAS BEEN DEMONSTRATED IN RESEARCH REACTORS AND CANADIAN POWER REACTORS
- * THEY ARE NOT CURRENTLY REQUIRED BY REGULATIONS AND STANDARDS

CONTROL IMPROVEMENTS

- * PROTECTION CAN BE IMPROVED BY WELL DESIGNED CONTROL SYSTEMS WHICH AVERT SITUATIONS WHICH MAY REQUIRE PROTECTIVE ACTION, THEREBY REDUCING CHALLENGE.
- * THE REWARD IS DIRECT.
- * AVAILABILITY CAN CERTAINLY BE IMPROVED.
- * SOME REDUNDANCY AND DIVERSITY IN CONTROL SYSTEMS WOULD BE A GOOD INVESTMENT.

SUMMARY

- * THE CONSEQUENCE OF SEVERAL CONTROL MALFUNCTIONS HAS BEEN RAPID COOLDOWN.
- * SOME COOLDOWNS MIGHT HAVE BEEN AVERTED BY IMPROVED OR REDUNDANT CONTROL FEATURES.
- * LOSS OF INFORMATION DURING LOSS OF CONTROL POWER SOURCES IS SIGNIFICANT.
- * AVAILABILITY OF MORE DIRECT INFORMATION FROM THE PROTECTION SYSTEM DURING CONTROL UPSETS MAY AID OPERATOR RESPONSE
(PARAGRAPH 4.20 OF IEEE-279)

ENCLOSURE NO. 4

CONCLUSIONS FROM ZION STATION SYSTEMS INTERACTION STUDY

SECTION V

CONCLUSIONS

Several conclusions were reached as a result of this study. These are discussed below:

1. For the Zion plant, generic studies requested by the NRC and the implementation of their conclusions and recommendations involving such items as fire protection, pipe break, low temperature primary system overpressure, etc., have resulted in modifications which substantially reduce the possibility of the occurrence of a majority of the events studied.....
2. The following investigations and/or plant modifications are recommended by this study.
 - a. Following an evaluation of the benefits of J-tubes, which were installed in one of the steam generators on Unit #2, a determination should be made as to the need for modification of the steam generators (FPI #9920-3).
 - b. The containment spray pump diesel fuel oil tank vent and fill lines' susceptibility to being blocked and covered after a significant snowfall should be investigated and/or corrected (FPI #9923-5).
 - c. An investigation should be conducted to determine if ice can form on the Diesel Generator Room air inlet dampers to an extent that could be detrimental to the operation of the damper (FPI #9924-6).
 - d. Before initiation of any steam generator maintenance that has the potential to affect the pressure retaining capability of the steam generator tubes, appropriate methods should be included in the procedures to check the integrity of the tubes prior to re-turning the steam generator to operation (FPI #9951-17).
 - e. A program should be developed to survey electrical boxes containing open terminals which are used in safety or shutdown systems, and which are located in the Auxiliary Building, Safety Valve Rooms, pipe tunnels, and crib house to determine if they could be subject to entry of water. For those boxes in this category, the existence (or lack) of box drain holes should be determined by inspection. If drain holes are not found in these boxes, they should be added, or some other technique should be used to prevent potential shorting of the terminals by water accumulation (FPI #9943-1 and #9943-2).

3. The large number of indicators and annunciators at the Zion Station serve effectively to inform the operator of the presence of abnormal plant conditions including those associated with systems interaction events.
4. The approach used in this study was found to be a satisfactory method for investigating systems interaction events. The method was successful because the key project staff members were senior personnel who had extensive experience.
5. Although the study did determine that some systems interaction could occur at the Zion plant, these occurrences would not significantly degrade the safety and shutdown systems in the plant.