22/A-17

ATTENDANCE

NRC / SANDIA MEETING ON SYSTEMS INTERACTION - 18 JANUARY 1978
RM 013 NICHOLSON LANE BLDG.

NAME	ORGANIZATION
DAVE McClosky	SANDIA
JACK HICKMAN	SANDIA
G. ARLOTTO	NRC/OSD
M. KEHNEMUYI	"
V. Panciera	"
J. NORBERG	"
DICK DEBLASIO	"
SAM DIAB	"
JOHN ANGELO	NRC/NRR/DPM
TOM TELFORD	NRC/NRR/DOR
LAMBROS LOIS	NRC/DPM.

SYSTEMS INTERACTION PROGRAM

OBJECTIVES

- DEVELOP A REVIEW PROCEDURE FOR IDENTIFYING AND EVALUATING IMPORTANT SYSTEMS INTERACTIONS.
- REVIEW AND RECOMMEND APPROPRIATE CHANGES IN THE STANDARD REVIEW PLAN.
- DEVELOP CRITERIA AND GUIDELINES FOR APPLICANT'S EVALUATION.

PROGRAM RESULTS

A REVIEW PROCEDURE WHICH

- IDENTIFIES IMPORTANT SYSTEMS
- IDENTIFIES POTENTIAL INTERACTIONS
- EVALUATES INTERACTIONS

PHASE I

PROBLEM DEFINITION

REVIEW PROCEDURE DEVELOPMENT

REVIEW PROCEDURE VERIFICATION AND DEMONSTRATION

PHASE II

METHODOLOGY TRANSFER

APPLICANT GUIDELINES AND CRITERIA

RELEVANT ONGOING SANDIA PROGRAMS

REACTOR SYSTEM SAFETY

- RSS METHODOLOGY APPLICATIONS PROGRAM

REACTOR SAFEGUARDS

- INTEGRATED SAFEGUARDS SYSTEM STUDY

WEAPON SYSTEMS

- SETS CODE DEVELOPMENT
- SYSTEMS INTERACTION

RSS METHODOLOGY APPLICATIONS

P U R P O S E

LAY A FOUNDATION FOR FUTURE APPLICATIONS OF THE RSS METHODOLOGIES IN THE REGULATORY PROCESSES

RSS METHODOLOGY APPLICATIONS

O B J E C T I V E

(SYSTEM ANALYSES)

IDENTIFY THE ACCIDENT SEQUENCES THAT ARE THE MAJOR CONTRIBUTORS TO PUBLIC RISK FOR A REPRESENTATIVE SPECTRUM OF LWR DESIGNS

LWR POWER PLANTS UNDER STUDY

PWR

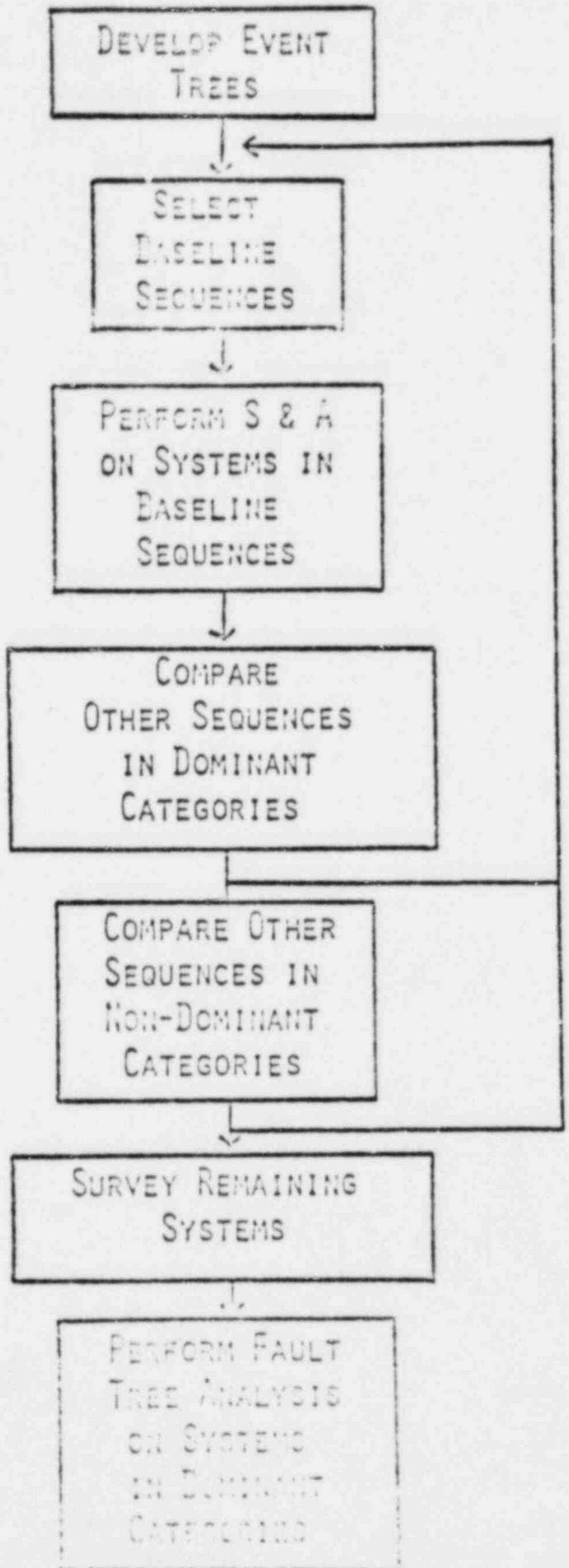
SEQUOYAH - TVA - WESTINGHOUSE ICE CONDENSER

OCONEE - DUKE POWER - BABCOCK AND WILCOX

CALVERT CLIFFS - BALTIMORE GAS AND ELECTRIC - COMBUSTION ENGINEERING

BWR

GRAND GULF - MISSISSIPPI POWER AND LIGHT - GENERAL ELECTRIC MARK III CONTAINMENT


DEVELOP EVENT TREES
SELECT BASELINE SEQUENCES
PERFORM S & A ON SYSTEMS IN BASELINE SEQUENCES
COMPARE OTHER SEQUENCES IN DOMINANT CATEGORIES
COMPARE OTHER SEQUENCES IN NON-DOMINANT CATEGORIES
SURVEY REMAINING SYSTEMS
PERFORM FAULT TREE ANALYSIS ON SYSTEMS

CRITERIA FOR ANALYSIS OF ENGINEERED SYSTEMS

ANALYSIS TYPE	PURPOSE	CRITERIA FOR USAGE
SURVEY	PROVIDE BASIC DESCRIPTION OF SYSTEM, AND QUALITATIVE COMPARISON WITH SIMILAR SYSTEM(S) IN WASH-1400	SYSTEM EXPECTED TO HAVE NO SIGNIFICANT IMPACT ON PUBLIC RISK BASED ON ITS POSITION IN THE EVENT TREE.
SURVEY AND ANALYSIS	COMPARE DOMINANT FAULT MODES OF SYSTEM WITH SIMILAR SYSTEM(S) IN WASH-1400	SYSTEM WHICH MAY HAVE SIGNIFICANT IMPACT ON RISK DUE TO ITS POSITION IN EVENT TREES.
FAULT TREE ANALYSIS	DELINEATE ALL IMPORTANT FAULT MODES OF SYSTEM AND CONFIRM DOMINANT FAULT MODES IDENTIFIED IN SURVEY AND ANALYSIS.	SYSTEM WHICH CONTRIBUTES DIRECTLY TO ACCIDENT SEQUENCES WHICH ARE DOMINANT CONTRIBUTORS OR WHICH APPEAR IN SEQUENCES IN DOMINANT RELEASE CATEGORIES AND ARE UNLIKE ANY PREVIOUSLY HAVING RECEIVED A FAULT TREE IN THIS STUDY OR WASH-1400.

METHODOLOGY

- Methodology and Criteria for Analysis of Engineered Systems for RSS Methodology Applications
- Proposed Format for Survey/Survey and Analysis/Fault Tree Analysis Reports

SYSTEMS ANALYSIS, SEQUOYAH

- Event Trees
  - Large LOCA
  - Small LOCA (S_1)
  - Small LOCA (S_2)
  - Transient Events
- Survey and Analysis
  - Electric Power (Emergency AC)
  - Auxiliary Feedwater
  - Containment Spray Injection
  - Containment Spray Recirculation
  - Ice Condenser/Air Return Fan System
  - Interfacing Systems
  - Service Water/Component Cooling Water
  - High Pressure Injection
  - Reactor Protection System
- Surveys
  - Containment Spray Recirculation/Heat Removal
  - Upper Head Injection
  - ECCS Actuation
  - Low Pressure Injection
  - Chemical Addition
  - Emergency Gas Treatment System (Secondary Containment)
  - Low Pressure Recirculation
  - High Pressure Recirculation
  - Containment Isolation

ACCIDENT SEQUENCES

- The Influence of Plant Differences Between Surry and Sequoyah #1 on Dominant Accident Sequence TMLB' - δ
- The Influence of Plant Differences Between Surry and Sequoyah #1 on Dominant Accident Sequence S_2C - δ
- The Influence of Plant Difference Between Surry and Sequoyah #1 on Dominant Accident Sequence V
- Sensitivity of Dominant Sequences to System Failure Probabilities
- Significance of RSS Accident Sequences in Release Categories PWR-4, 5, 6 and 7 to the Risk of the Sequoyah Plant
- New Accident Sequences for the Sequoyah Plant

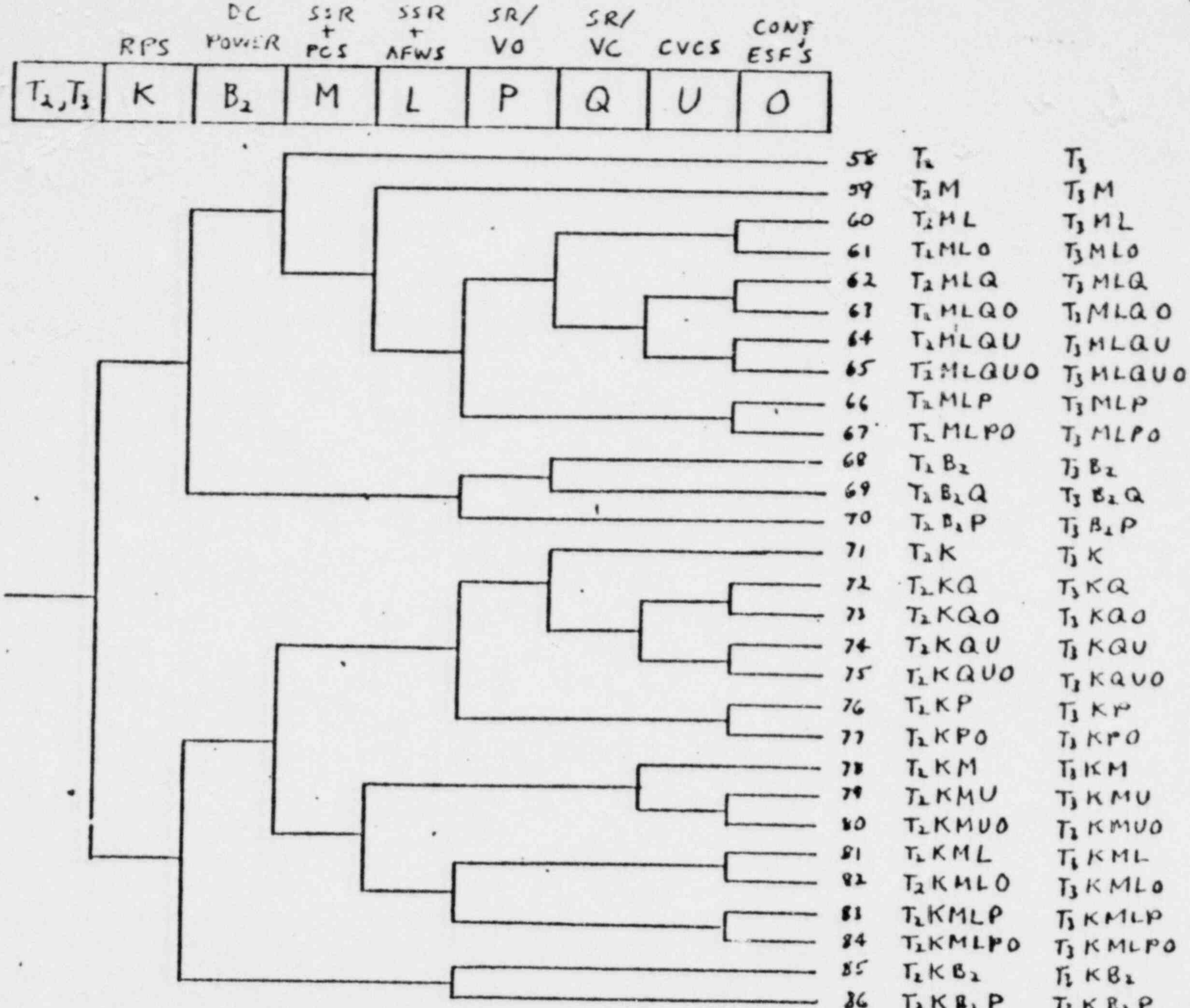


Figure 1.2. Sequoyah Transient Event Tree, T_2,T_3 Portion

INTEGRATED SAFEGUARDS SYSTEMS STUDY

PROGRAM GOALS

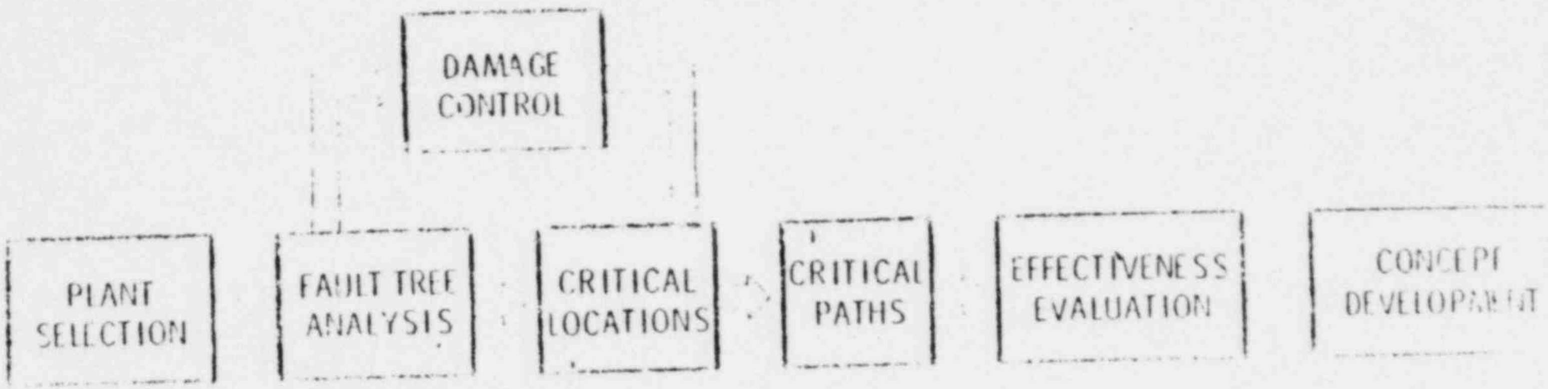
METHODOLOGY FOR SAFEGUARDS EFFECTIVENESS EVALUATIONS

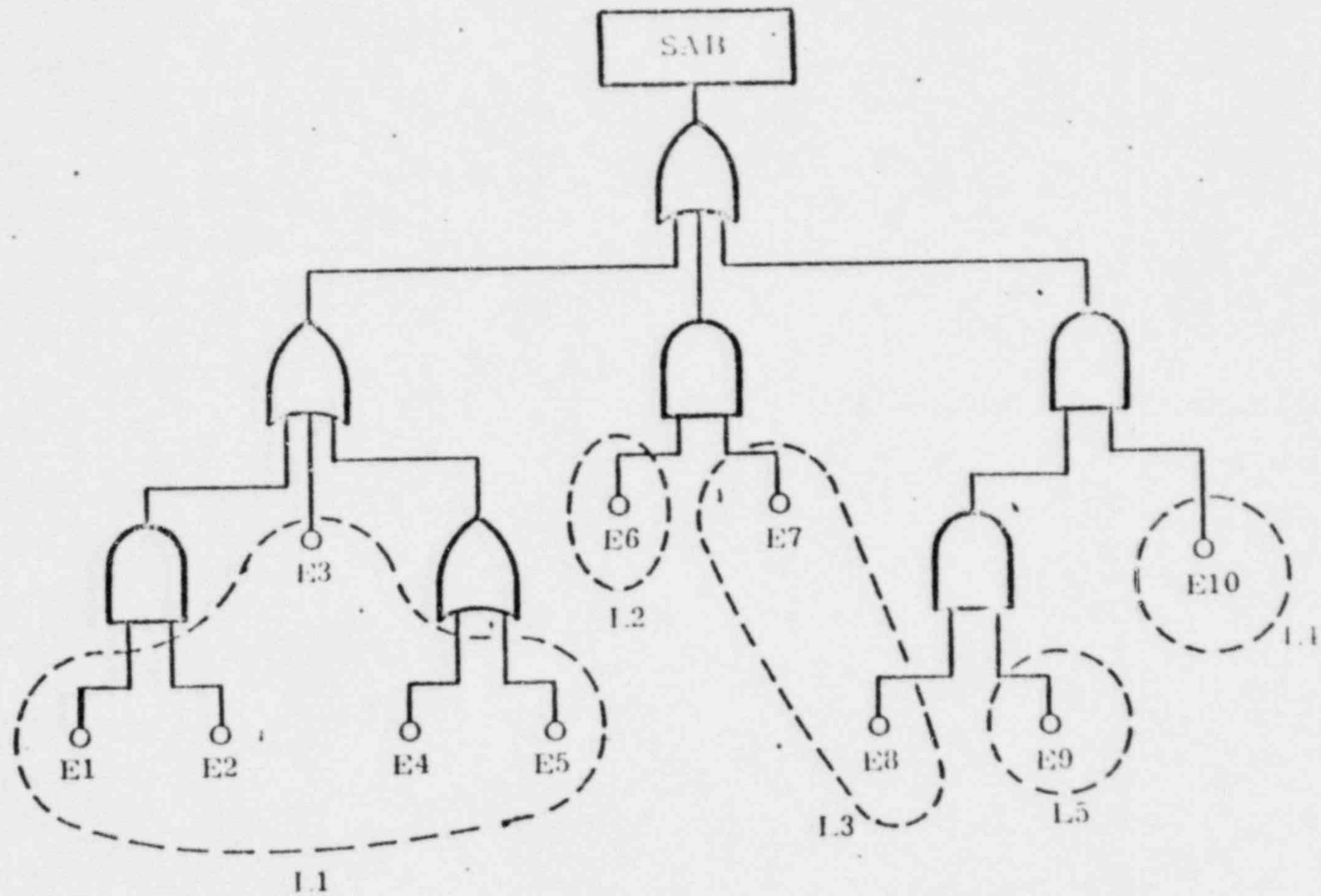
APPLICATION OF METHODOLOGY TO TYPICAL PLANT

CONCEPTUAL SAFEGUARDS SYSTEM DESIGN FOR LWRs

- GUIDELINES FOR SECURITY SYSTEM PERFORMANCE
- LOCATIONS REQUIRING ADDED PHYSICAL PROTECTION MEASURES
- LOCATIONS REQUIRING SPECIAL ADMINISTRATIVE CONTROLS

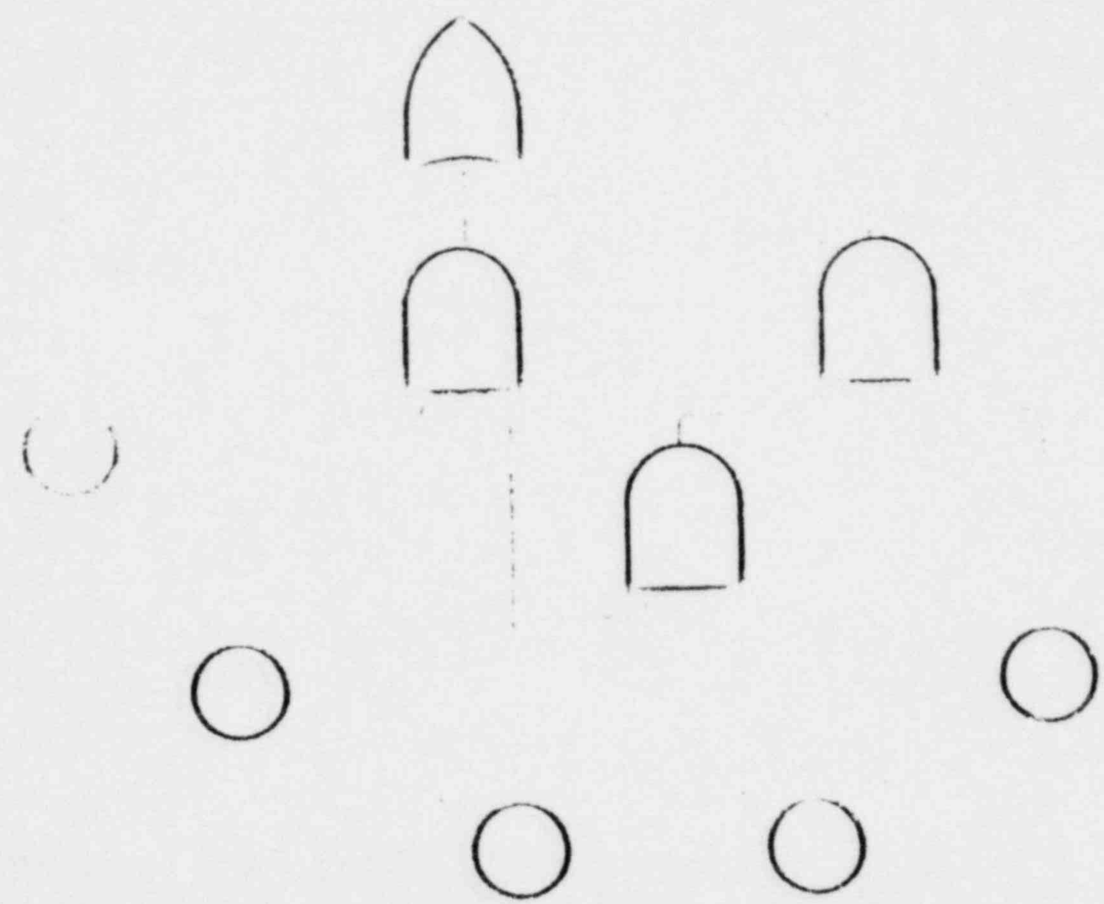
INTEGRATED SAFEGUARDS SYSTEM STUDY
PROJECT FLOW




SAB
E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
L1
L2
L3
L4
L5

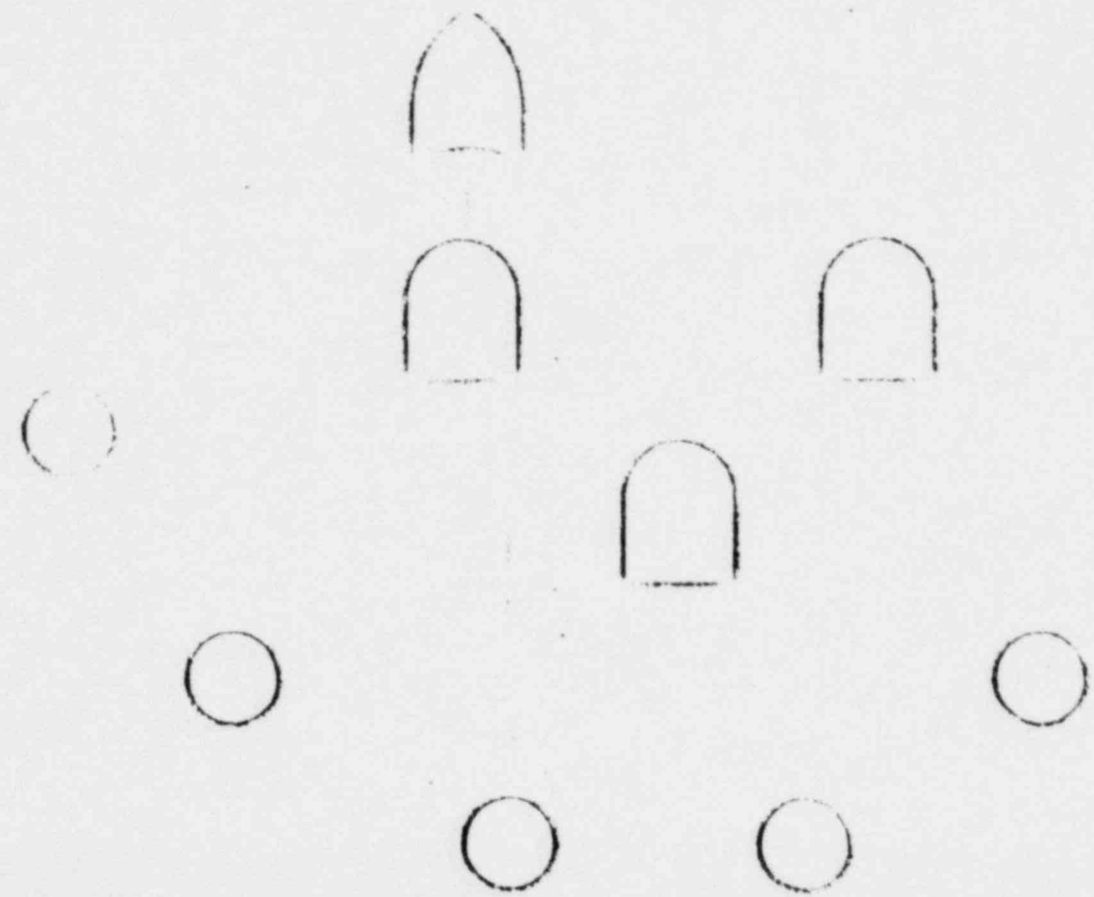
LOCATION TREE

$$SAB = L1 + (L2 * L3) + (L3 * L4 * L5)$$



COMPLEMENT SET

$\overline{[illegible]} = ([illegible] * \overline{L[illegible]}) + (\overline{L1} * \overline{L2} * \overline{L4}) + (\overline{L1} * \overline{L[illegible]} * \overline{L5})$



GENERIC SABOTAGE FAULT TREES FOR NUCLEAR POWER REACTORS

- PURPOSE

TO DEVELOP A SYSTEMATIC APPROACH THAT WILL:

1. IDENTIFY THE POTENTIAL SABOTAGE TARGETS IN NUCLEAR POWER REACTORS (VITAL SYSTEMS AND AREAS)
2. REDUCE TIME REQUIRED TO PERFORM THE ANALYSIS
3. FACILITATE THE APPLICATION OF THE ANALYSIS BY PERSONNEL OF THE UTILITIES AND THE NUCLEAR REGULATORY STAFF

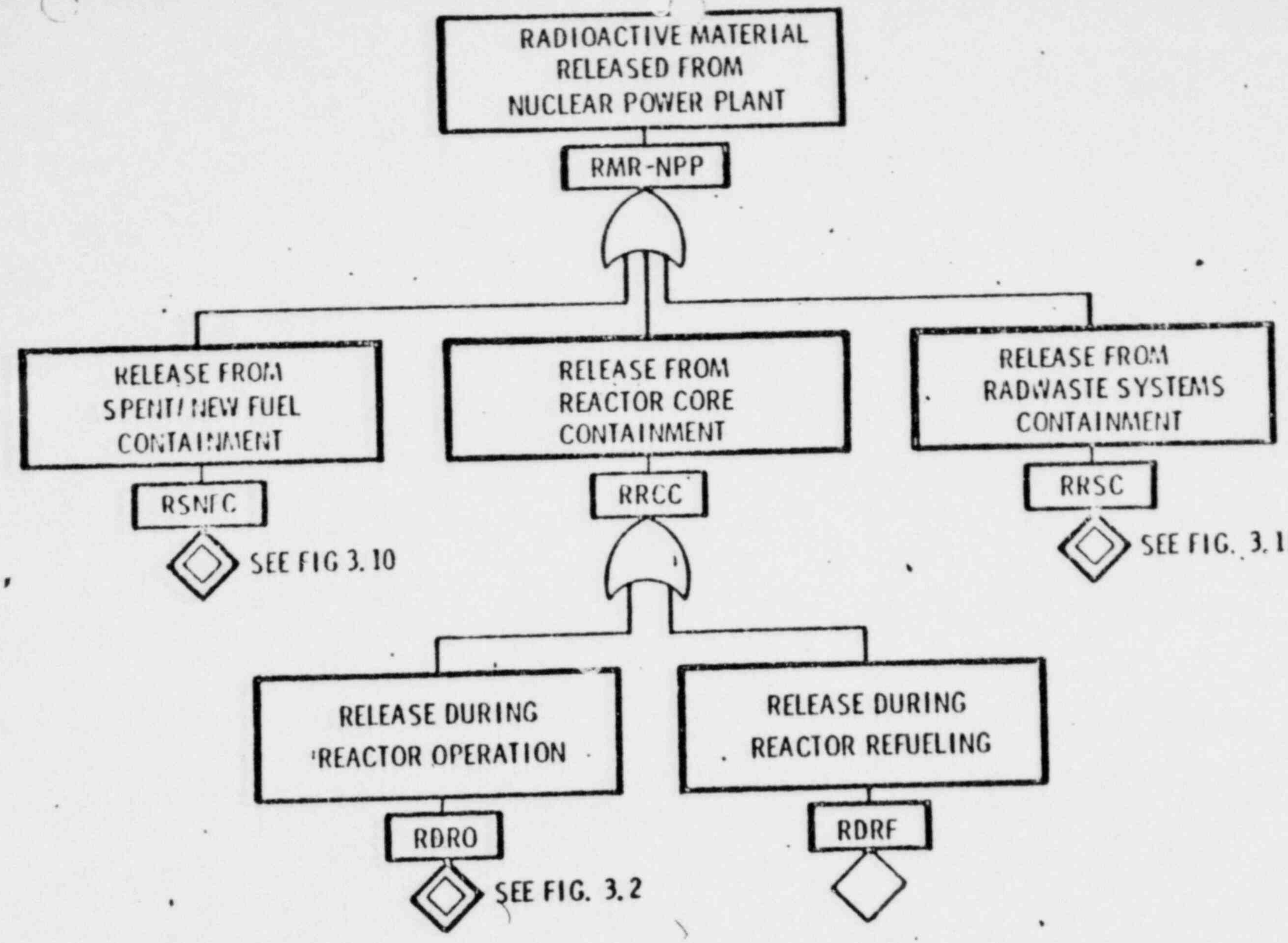


FIG. 3.1 GENERIC FAULT TREE FOR UNDESIRED EVENT

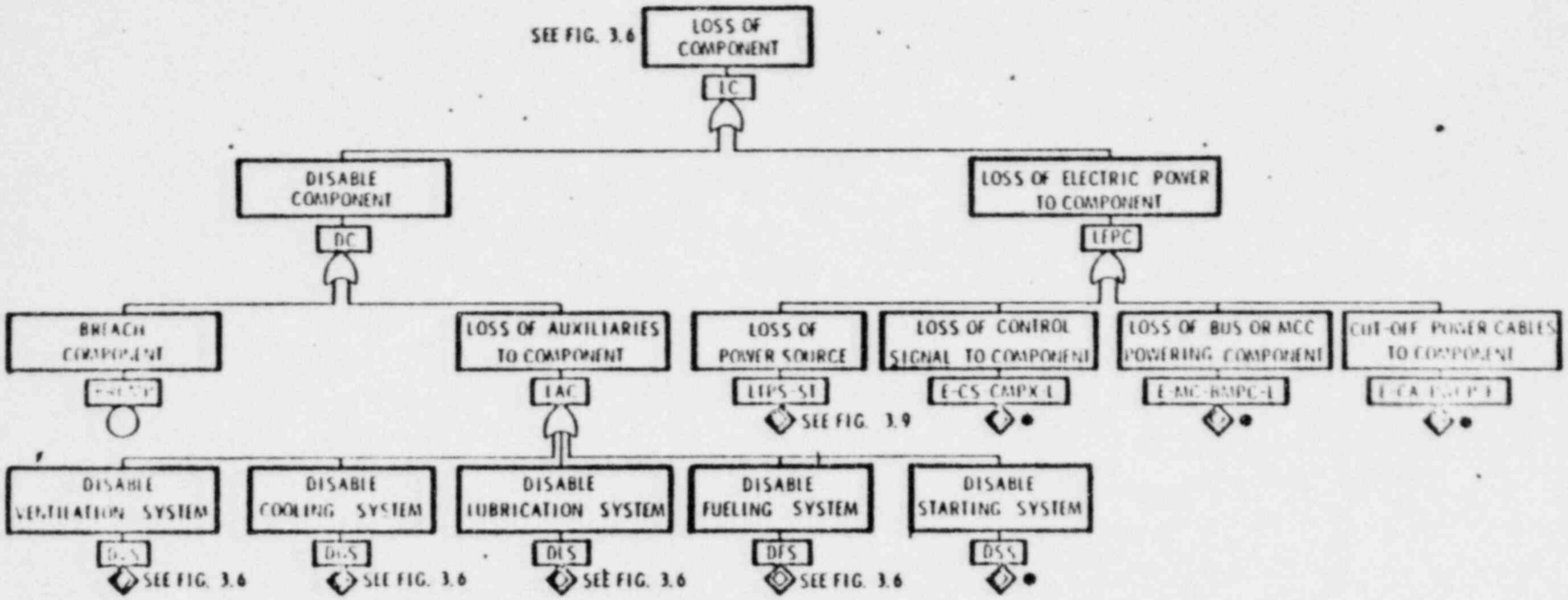
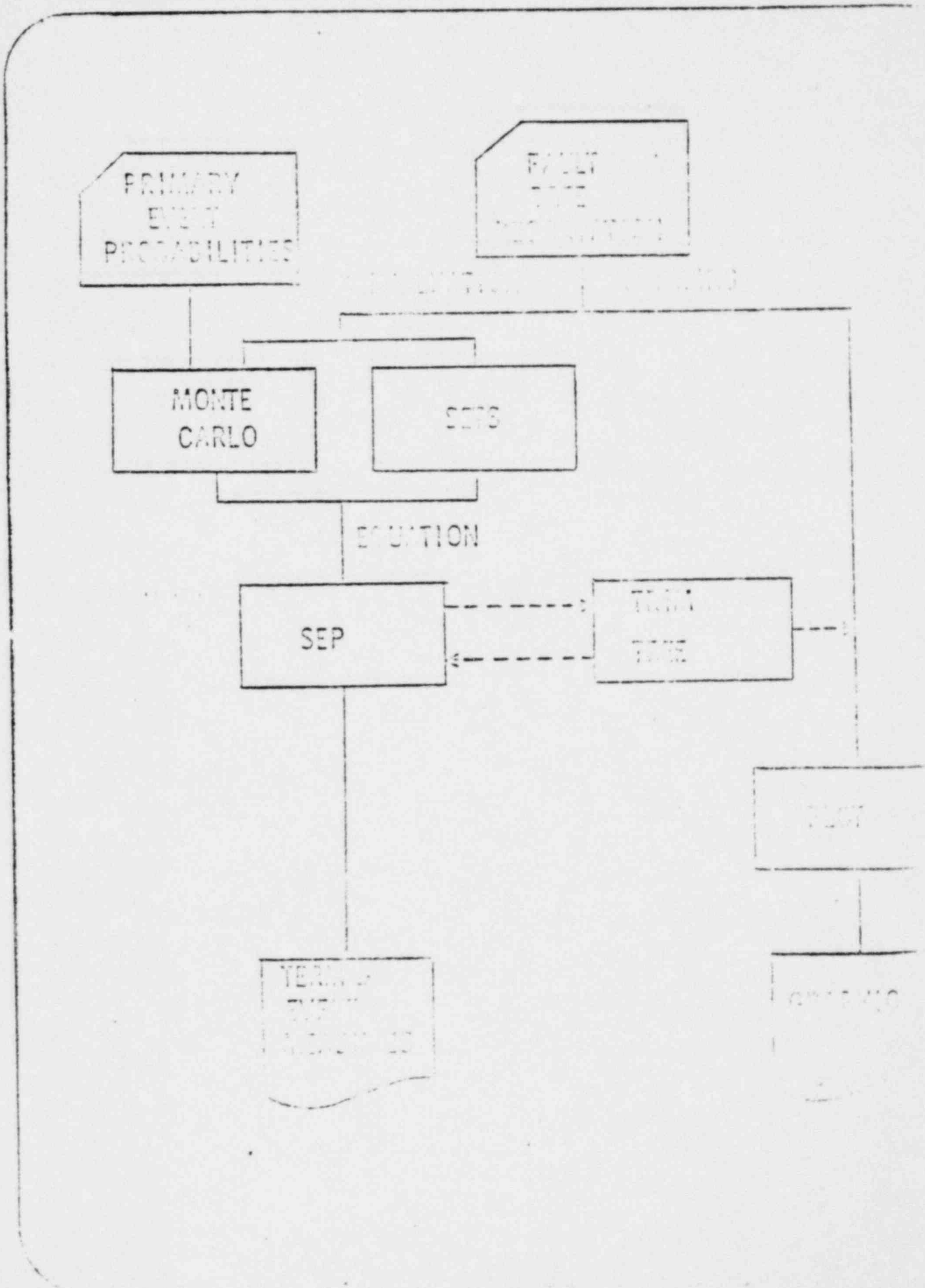


FIG. 3.7 GENERIC COMPONENT FAULT TREE


MONTE
CARLO
SEP

THE LOGIC EQUATION

$$U = \overbrace{A \cdot B \cdot C}^{\text{Term 1}} + \overbrace{A \cdot D \cdot F \cdot H}^{\text{Term 2}} + \ldots\ldots + \overbrace{Z \cdot Q \cdot H \cdot P \cdot S}^{N^{TH}\text{ Term}}$$

A, B, C — Initiating Events

- EACH TERM REPRESENTS A SUFFICIENT CONDITION FOR THE UNDESIRED EVENT
- EACH INITIATING EVENT IS A NECESSARY CONDITION WITHIN EACH TERM

DISTINCT COUNT

EQUATION $T = A \cdot B + A \cdot C + C \cdot D \cdot E$

EVENT MEASURE

EVENT	LOCATION
A	1
B	2
C	1
D	3
E	3

TERM MEASURES

TERM	NR OF LOCATIONS
$A \cdot C$	1
$A \cdot B$	2
$C \cdot D \cdot E$	2

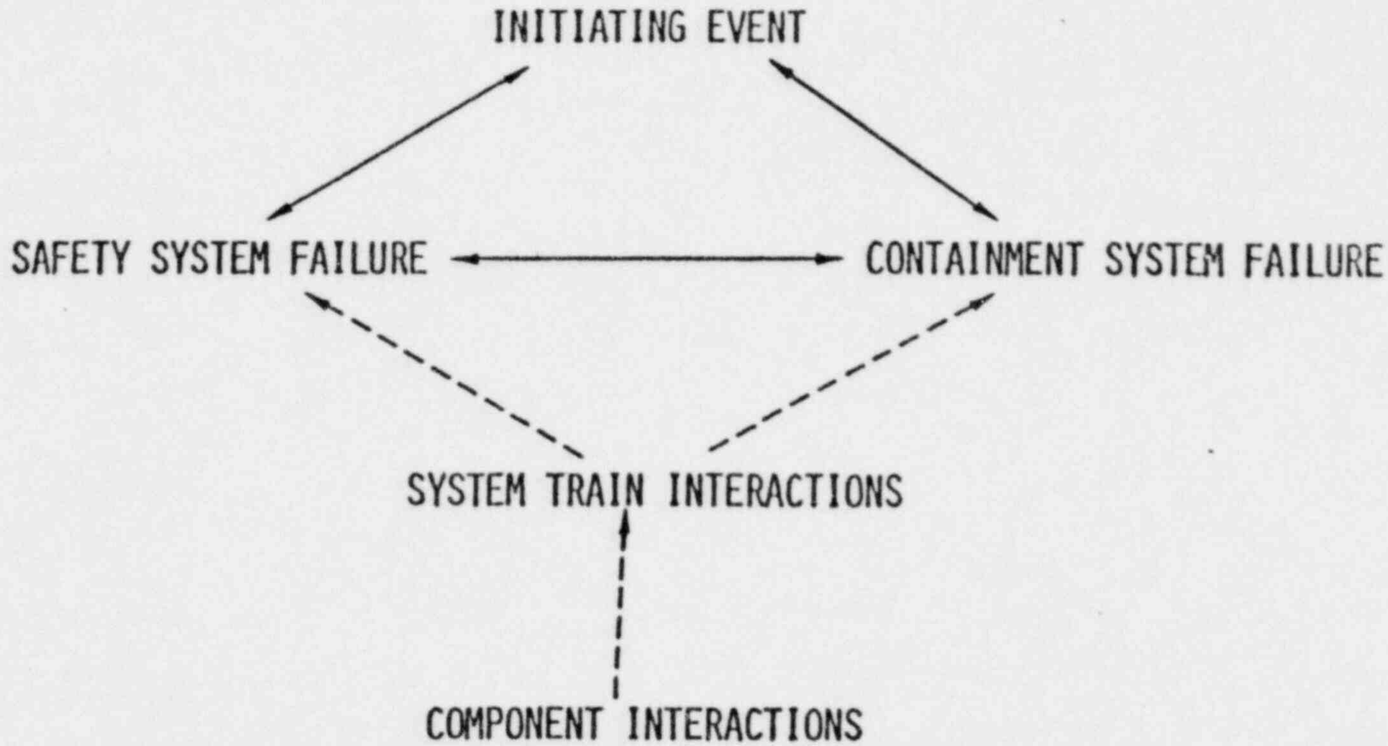
ACCIDENT SEQUENCES

INITIATING EVENT (LOCA, TRANSIENT, SEISMIC DISTURBANCE)

SAFETY SYSTEM FAILURE (ECCS, AUXILIARY FEEDWATER)

CONTAINMENT SYSTEM FAILURE (ISOLATION SYSTEM, SPRAYS)

SYSTEMS INTERACTION CATEGORIES



SYSTEM INTERACTION TYPES

COMMON COMPONENT

COMMON INTERNAL INITIATING EVENT SUSCEPTIBILITIES

COMMON EXTERNAL INITIATING EVENT SUSCEPTIBILITIES

COMMON ENVIRONMENTAL SUSCEPTIBILITIES

COMMON DESIGN

COMMON MANUFACTURER OR PROCESS

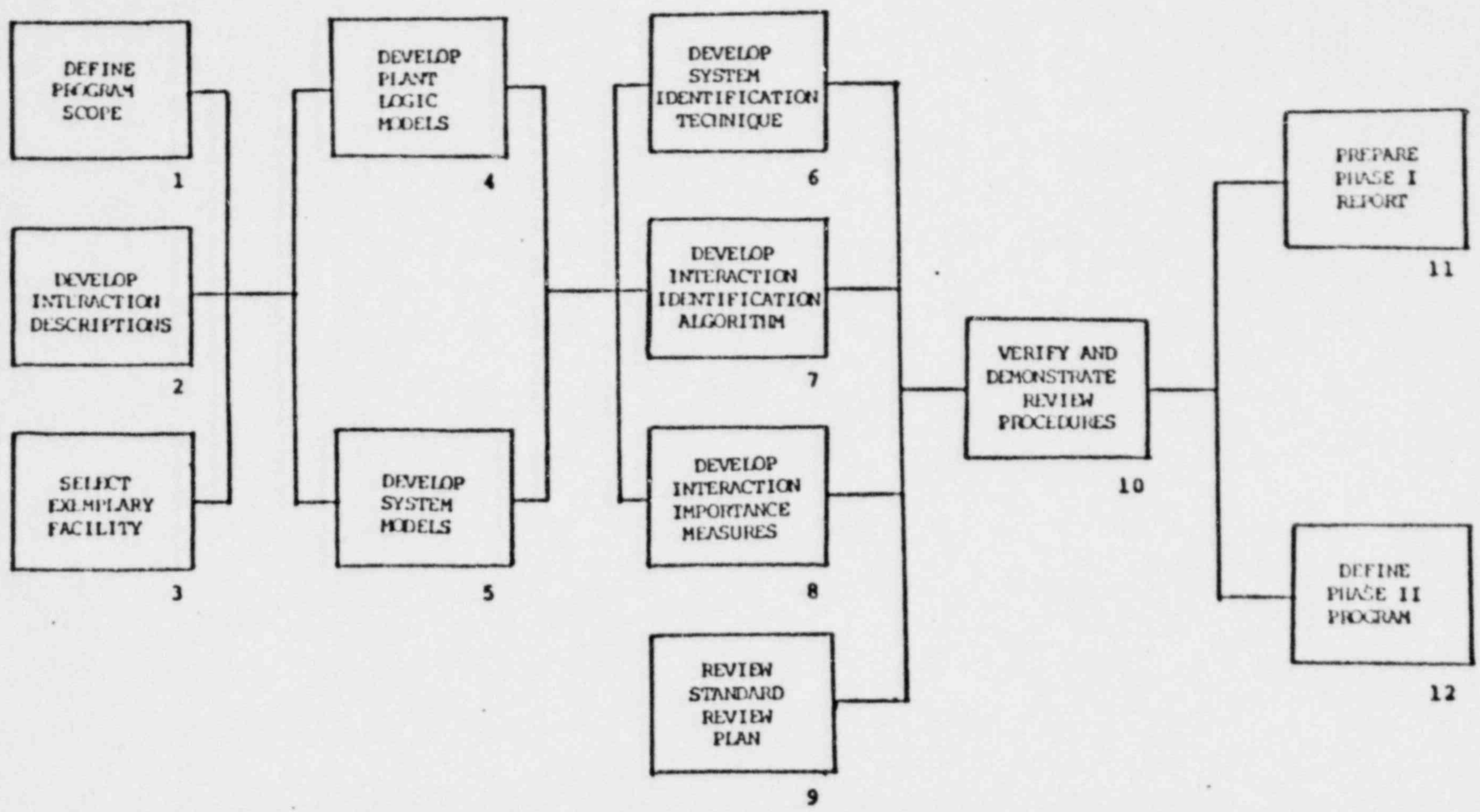
COMMON HUMAN INTERVENTION

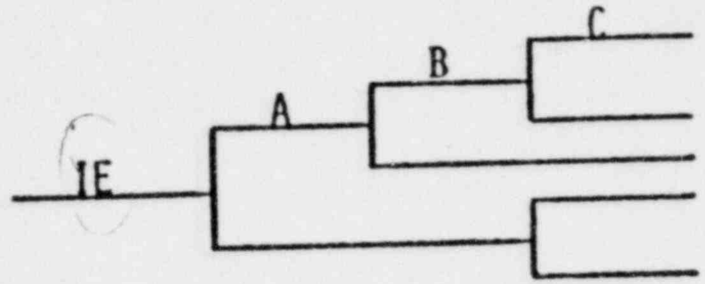
COMMON TECHNOLOGY

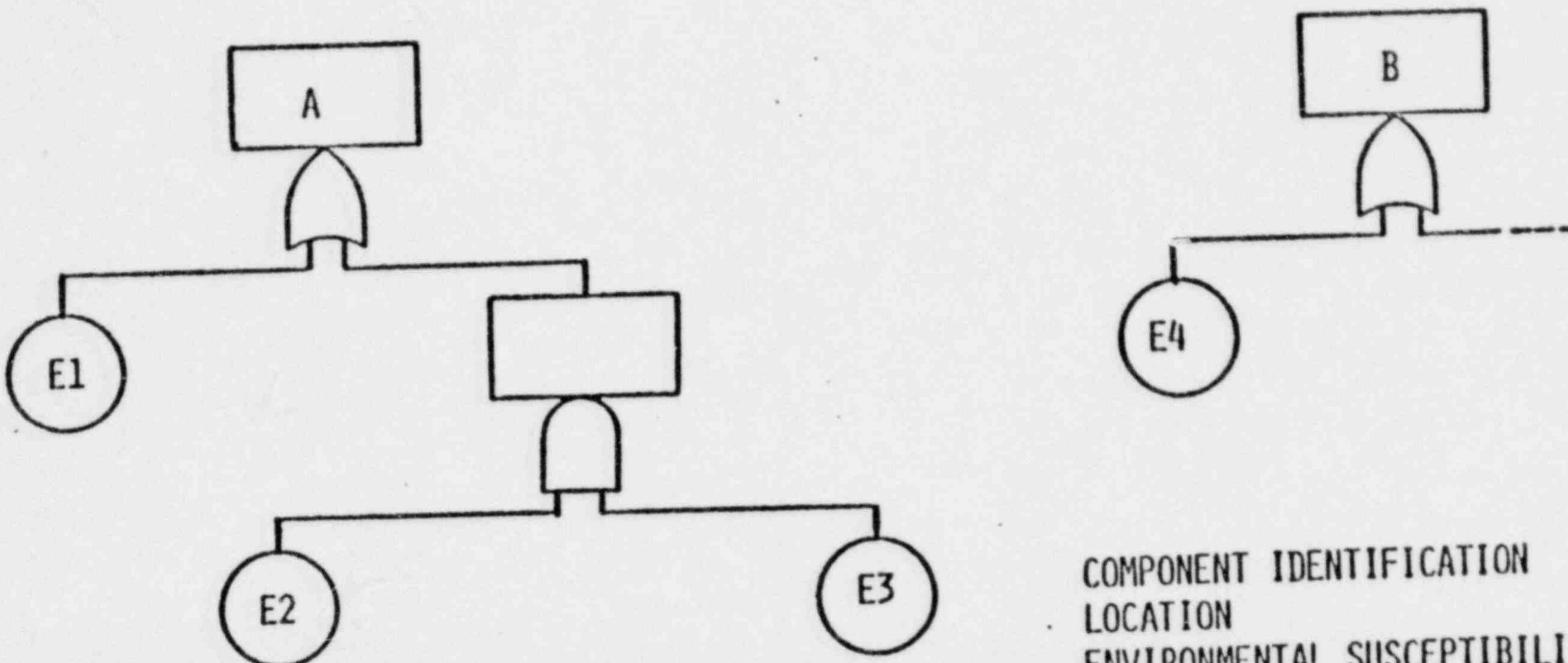
COMMON LOCATION

FAILURE CAUSE COUPLING

PHASE I TASKS







COMPONENT IDENTIFICATION
LOCATION
ENVIRONMENTAL SUSCEPTIBILITY
COMPONENT TYPE
MANUFACTURER

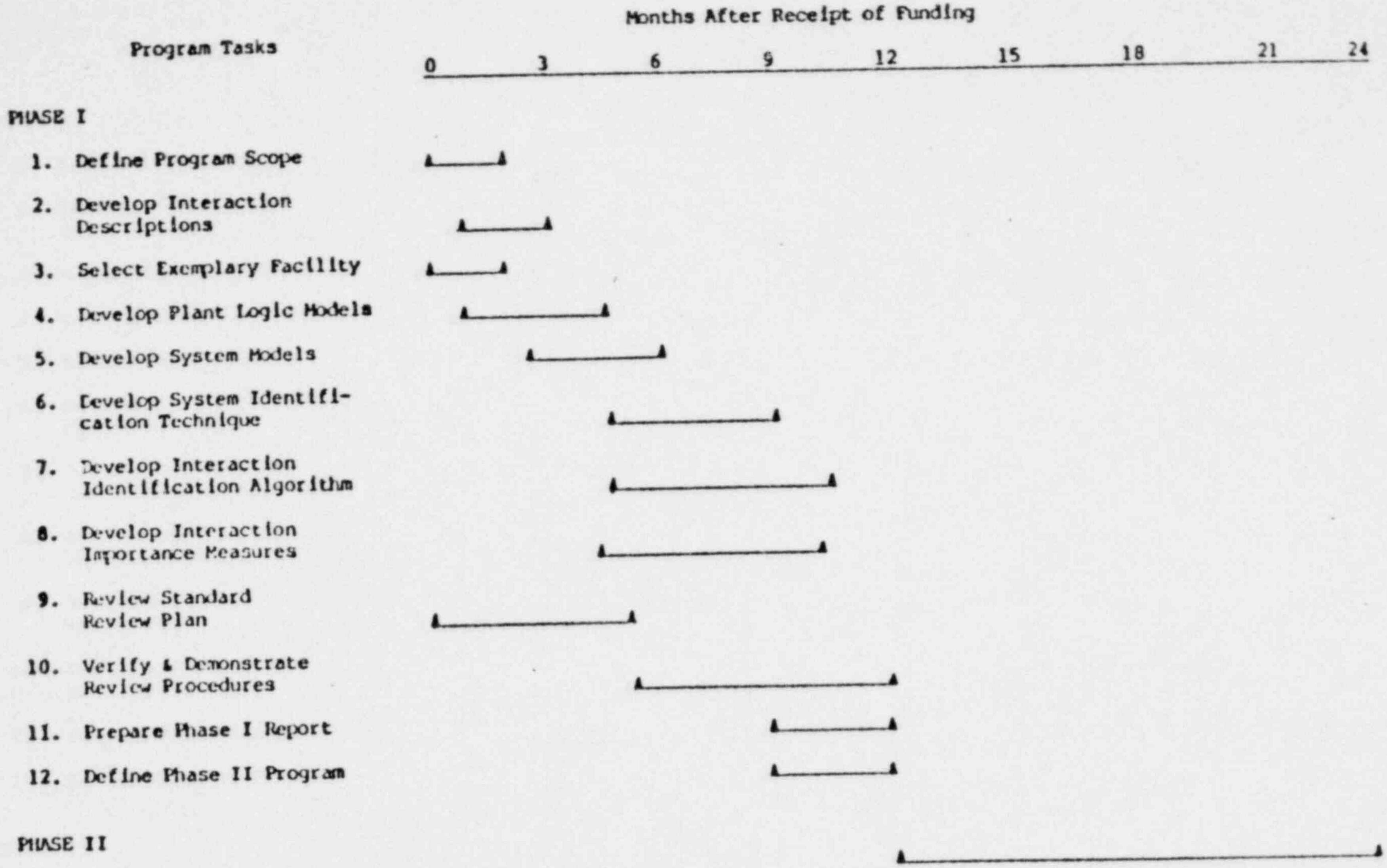


FIGURE 2. Program Timescales

TABLE I

MANPOWER ESTIMATES

Task	Man-months
PHASE I	
1. Define Program Scope	2
2. Define Interaction Descriptions	5
3. Select Exemplary Facility	1
4. Develop Plant Logic Models	4
5. Develop System Models	11
6. Develop Systems Identification Techniques	6
7. Develop Interaction Identification Algorithm	7
8. Develop Interaction Importance Measures	4
9. Review Standard Review Plan	4
10. Verify and Demonstrate Review Procedures	14
11. Prepare Phase I Report	7
12. Define Phase II Program	2
Total	67
PHASE II	30

Total Costs

Phase I	$440 K
Phase II	$200 K