

Licensee: Duke Power Company, et al.

Facility: Oconee Nuclear Station, Units 1, 2, and 3

SUBJECT: SUMMARY OF MAY 5, 1994, MEETING WITH DUKE POWER COMPANY ON KEOWEE
PROBABALISTIC RISK ASSESSMENT PROJECT

On May 5, 1994, NRC staff members met with representatives of Duke Power Company (DPC) at the Oconee site to review and discuss the Probabalistic Risk Assessment (PRA) being performed for the Keowee hydrostation. Meeting attendees are included as Enclosure 1. The meeting agenda is included as Enclosure 2 and copies of handouts provided during the meeting are included as Enclosure 3.

The meeting opened with a description of the Oconee emergency electrical system. The licensee included a description of the dynamic operation of the various operating modes of the system following a request from the NRC staff. Following this presentation, the PRA Team Leader described the objectives of the study, project scope, project team organization, task list, and schedule. Included in the schedule were periodic meetings with the NRC to review the status of the project. A discussion ensued as to the best method to schedule these periodic meetings. It was agreed that the meetings would be keyed to specific milestones, rather than to specific dates. The final topic prior to touring the Keowee hydrostation was a review of preliminary models which had been developed.

Following the formal presentations, the meeting attendees toured the Keowee hydrostation, various electrical components within the plant protected area, and the 230 kV switchyard. A short question and answer period was then held, during which it was suggested that the next meeting be held at the Duke corporate offices, after which the meeting adjourned.

/s/
Leonard A. Wiens, Project Manager
Project Directorate II-3
Division of Reactor Projects - I/II

Enclosures:

- 1. Meeting Attendees
- 2. Agenda
- 3. Handouts

cc w/enclosures:
See next page

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OFFICE	PDII-3/LA	PDII-3/PM	PDII-3/PO		
NAME	L. BERRY	L. WIENS	D. MATTHEWS		
DATE	5/25/94	5/26/94	5/26/94		

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UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

May 26, 1994

Docket Nos. 50-269, 50-270
and 50-287

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A handwritten signature in black ink, appearing to read "A. Wiens".

Leonard A. Wiens, Project Manager
Project Directorate II-3
Division of Reactor Projects - I/II

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2. Agenda
3. Handouts

cc w/enclosures:
See next page

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MEETING ATTENDEES

KEOWEE PRA MEETING

May 5, 1994

NAME	ORGANIZATION
Len Wiens	NRC/NRR
Dave Matthews	NRC/NRR
Steve Benesole	Duke/Oconee
Paul Kellogg	NRC/RII
Jeff Shackelford	NRC/RII
Stacey Rosenberg	NRC/NRR
Jim Meyer	SCIENTECH
Homayoon Dezfuli	SCIENTECH
R. E. Carroll, Jr	NRC/RII
Paul Harmon	NRC/Resident Insp
Virgil Beaston	NRC/NRR
Stuart Lewis	SAROS, Inc.
Duncan Brewer	Duke/GO
Mike Barrett	Duke/GO
P. M. Abraham	Duke/GO
Reed Severence	Duke/Oconee
Jeff Rowell	Duke/Oconee
Michael Bailey	Duke/Oconee
George Ridgeway	Duke/Oconee
Bryan Dolan	Duke/Oconee

AGENDA

May 5, 1994

- | | |
|--|------------------------|
| 8 a.m. - Introduction | Duke/NRC |
| 8:15 - Overview of Oconee Nuclear Station Emergency Power System | R. Severance |
| 8:30 - Overview of Keowee | R. Severance |
| 9:00 - Keowee PRA Plan/Tasks | D. Brewer |
| 9:30 - Break | |
| 9:40 - Preliminary Model | M. Barrett |
| 10:30 - Keowee Walkdown | J. Rowel/ R. Severance |
| 12:00 Noon - Lunch | |
| 1:00 - Switchyard and Blockhouse Walkdown | J. Rowel/ R. Severance |
| 2:30 - Post-Walkdown Comments and Questions | |

**DUKE POWER COMPANY
OCONEE NUCLEAR STATION
KEOWEE PRA PROJECT
NRC - DUKE MEETING**

MAY 5, 1994

AGENDA

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Keowee PRA Study

Project Plan and Task List

By Duncan Brewer
May 5, 1994

Outline

- Objectives of the Study
- Project Scope
- Project Team Organization
- Task List and Schedule

Objectives of the Study

- To Develop An Analytical Model Of The Keowee Hydro Station
- To Obtain An Estimate Of The Reliability Of Keowee As An Emergency Power Source
- Compare This Estimated Reliability To The Observed Reliability During Normal Operation, Emergency Tests And Functional Tests
- The Insights Gained From This Analysis Will Be Used To Complement Efforts Which Are Currently Underway To Address Keowee Reliability Concerns

Project Scope

- Utilize PRA Methods Such As Fault Trees, Reliability Data, Success Criteria, And Modeling Of Appropriate Human Actions.
- The Required Mission Of The Keowee Hydro Station Will Be To Start And Run To Provide Emergency Power To Oconee For All Probabilistically Significant Scenarios Resulting From Internal Initiating Events.
- The Model Will Include All Important Components At A Level Appropriate For Gathering Statistically Significant Data.

Project Scope

- Support systems important to the operation of Keowee will also be modeled.
- This project is estimated to be a 1.5 person-year effort conducted over a period of 12 - 18 months.

Project Team Organization

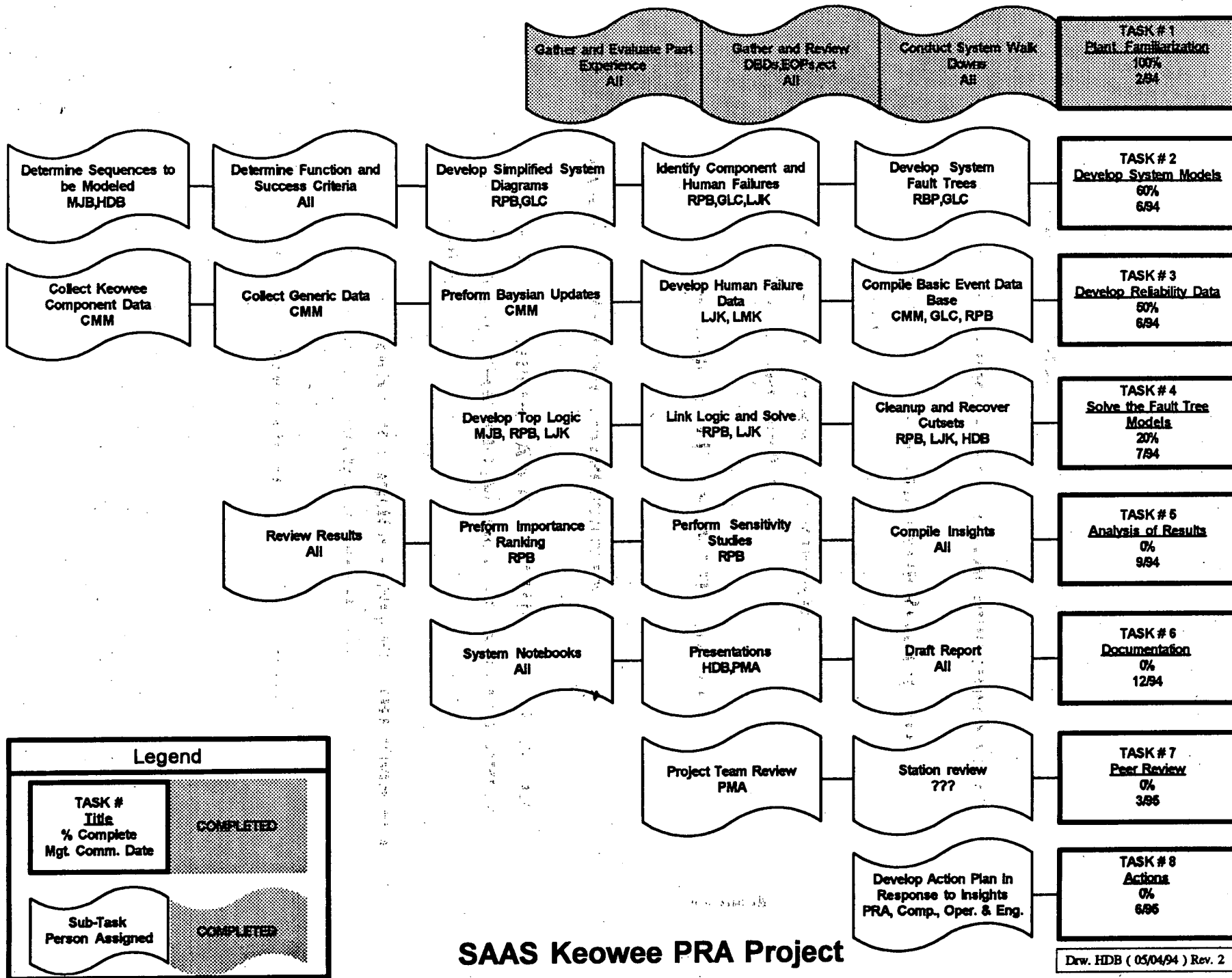
PM Abraham
Duncan Brewer
Gary Cruzan
Mike Barrett
Mike Misenheimer
Leo Kachnik
and Lee Kanipe
Robert Boyer
Wheeler Matthews
and Noel Clarkson
Reed Severance
and Jeff Rowell

Project Direction and Review
Project Leader
Electrical Systems
Sequence Analysis
Data Analysis
Human Reliability and Model Solution

Mechanical Systems and Model Solution
ONS - Operations, Site Support and
Review
ONS - Engineering, Site Engineering
Support and Review

Task List and Schedule

- Plant Familiarization 2/94
- Develop System Models 6/94
- Develop Reliability Data 6/94
- Solve the Fault Tree Models 7/94
- Analysis of Results 9/94
- Documentation 12/94
- Peer Review 3/95
- Actions 6/95



KEOWEE PRA PROJECT

MODELING DISCUSSION

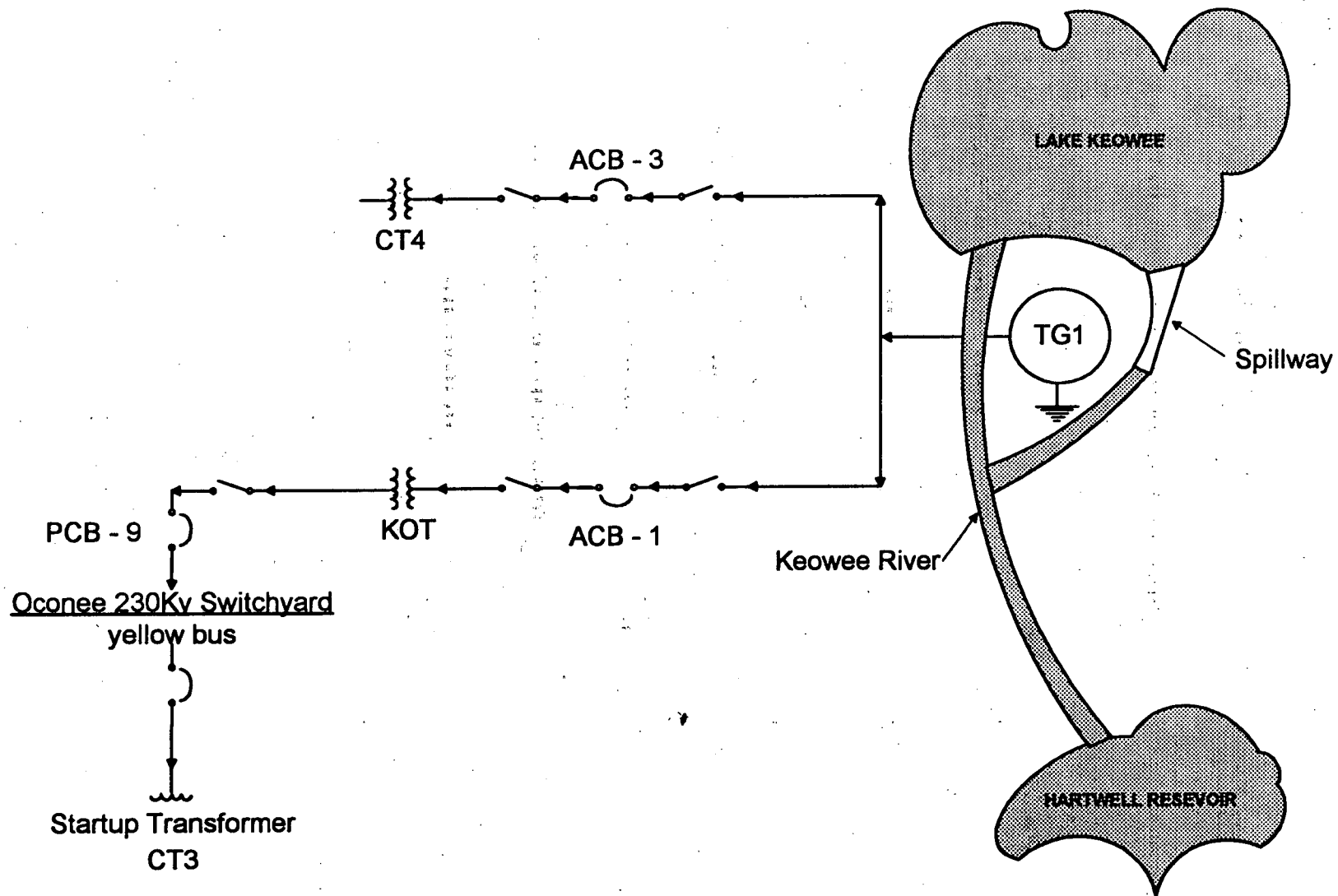
PRESENTED BY: MIKE BARRETT

5/5/94

KEOWEE PRA PROJECT

MODELING OBJECTIVES

- **ADDRESS ALL POTENTIAL MODES OF OPERATION OF THE KEOWEE UNITS**
- **INCLUDE ALL COMPONENTS/SYSTEMS NECESSARY FOR THE EMERGENCY OPERATION OF THE KEOWEE UNITS**
- **INCLUDE IN THE MODELS THE IMPORTANT FAILURE MODES THAT HAVE BEEN EXPERIENCED**



Keowee Startup Transformer Schematic

KEOWEE PRA PROJECT

MODELING SCOPE

- **THE UNDERGROUND PATH UP TO AND INCLUDING CT4**
- **THE OVERHEAD PATH UP TO AND INCLUDING CT3**
- **SWITCHYARD ISOLATION LOGIC**
- **WILL NOT DUPLICATE MODELS INCLUDED IN THE OCONEE PRA**
- **LEVEL OF DETAIL DICTATED BY DATA AVAILABILITY AND THE UNIQUENESS OF THE COMPONENT**
 - ⇒ **GOVERNOR - TREATED AS A SINGLE COMPONENT WITH PLANT SPECIFIC FAILURE DATA**
 - ⇒ **LUBE OIL PUMPS - USE GENERIC PUMP DATA**
 - ⇒ **ACBs - CONTROLS MODELED WITH GENRIC RELAY/COMPONENT DATA, OTHER PLANT SPECIFIC FAILURE MODES ARE INCLUDED WHERE NEEDED**

KEOWEE PRA PROJECT

TREES TO BE DEVELOPED

- **HIGH LEVEL LOGIC**

INCLUDES OPERATING MODE INFORMATION

**IDENTIFIES OVERHEAD/UNDERGROUND
ALIGNMENT**

**SHOWS TRANSFERS TO PRIMARY
SYSTEMS/COMPONENTS**

INCLUDES THE UNIT UNAVAILABILITY

- **PRIMARY SYSTEMS/COMPONENTS**

**DIRECTLY IMPORTANT TO THE SUCCESS OR
FAILURE OF THE KEOWEE UNITS TO SUPPLY
OCONEE**

**PAST FAILURES OR OPERATING PROBLEMS HAVE
HIGHLIGHTED THEIR SIGNIFICANCE**

NEEDED IN THE LOGIC OF THE HIGH LEVEL TREE

- **SUPPORT SYSTEMS/COMPONENTS**

**FAILURE LEADS TO THE FAILURE OF A PRIMARY
SYSTEM/COMPONENT**

KEOWEE PRA PROJECT

HIGH LEVEL LOGIC TREE

- **KEOWEE UNIT 1 IS ASSUMED TO BE DEDICATED TO THE UNDERGROUND PATH**
- **KEOWEE UNIT 2 IS ASSUMED TO BE DEDICATED TO THE OVERHEAD PATH**
- **KEOWEE UNIT 2 MAINTENANCE IS ASSUMED TO INCLUDE THE COMBINED UNAVAILABILITIES OF THE UNITS**
- **DUAL UNIT MAINTENANCE IS TO BE INCLUDED**
- **DEPICTS THE INFLUENCE OF THE PRIMARY SYSTEMS/COMPONENTS ON KEOWEE OPERATION**

KEOWEE PRA PROJECT

PRIMARY COMPONENTS/SYSTEMS

- Overhead Path
- Underground Path
- ACB-1
- ACB-2
- ACB-3
- Governor
- Generator
- Turbine
- Voltage Regulator
- Generator Excitation

KEOWEE PRA PROJECT

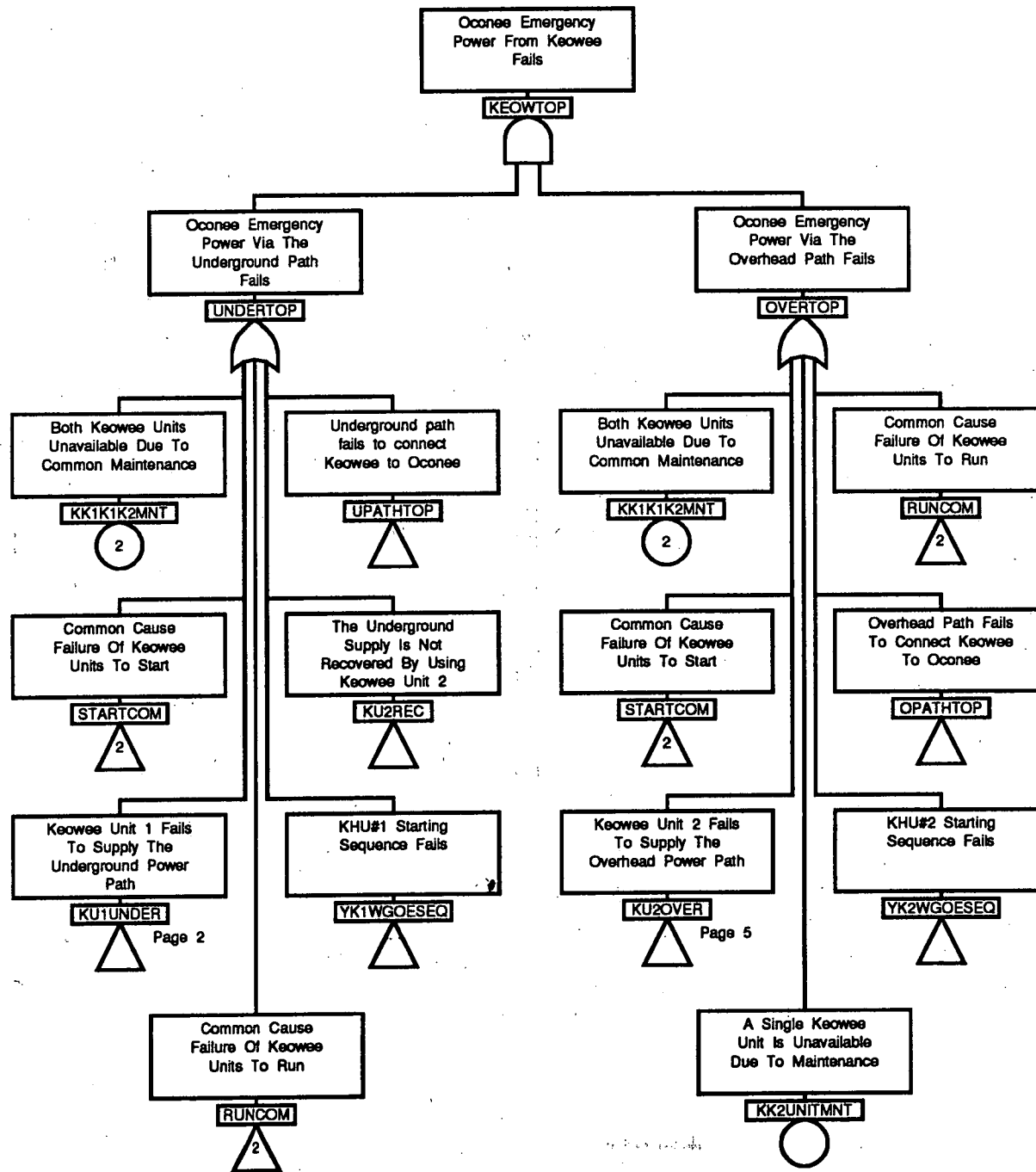
SUPPORT COMPONENTS/SYSTEMS

- **Emergency Start Signals**
- **External Grid Trouble Protection System**
- **AC Auxiliary Power System**
- **DC Auxiliary Power System**
- **Governor Air System**
- **Governor Oil System**
- **High Pressure Oil System**
- **Turbine Generator Cooling Water System**
- **Turbine Guide Bearing Oil System**
- **Turbine Sump Pump System**

KEOWEE PRA PROJECT

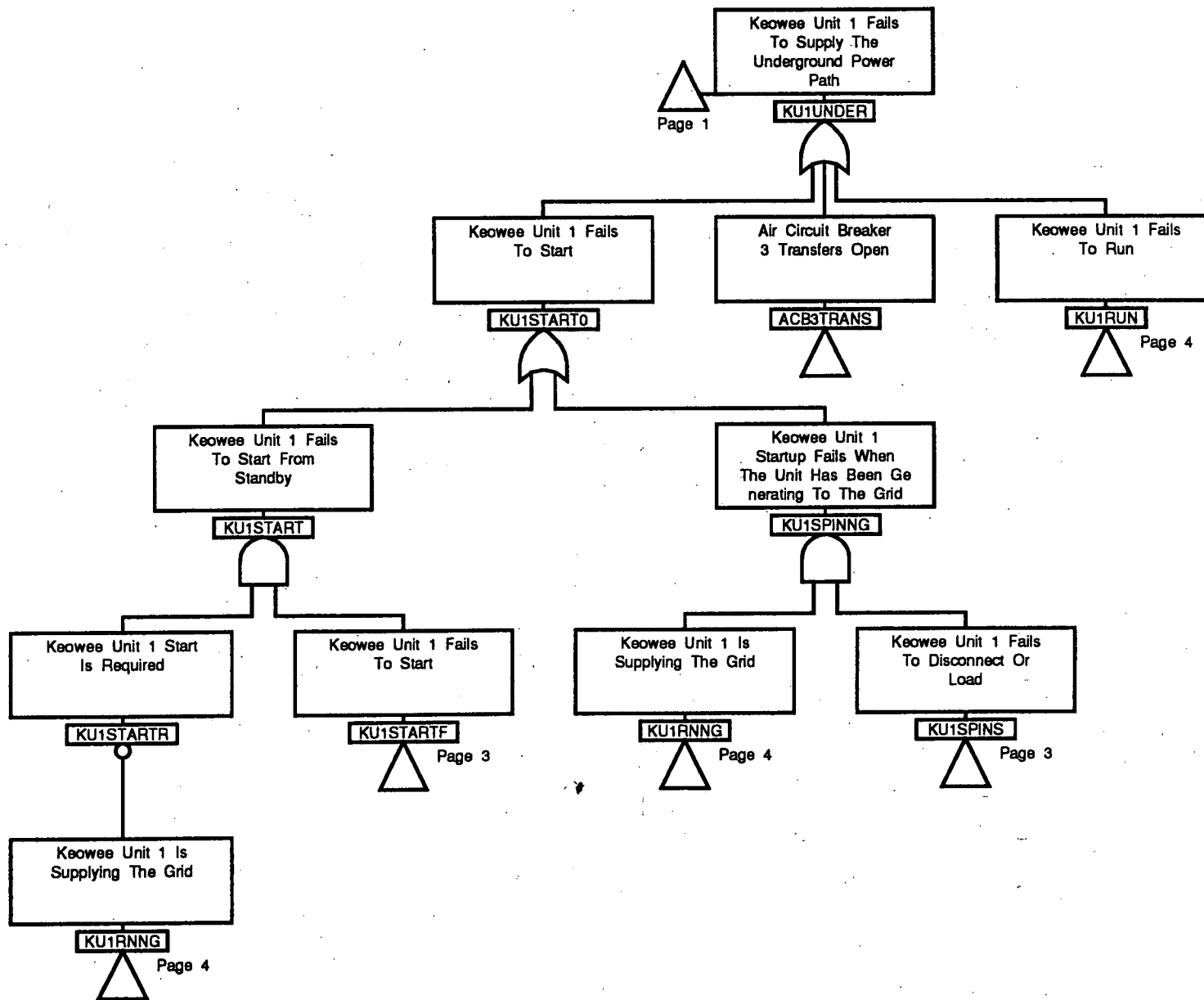
SUPPORT COMPONENTS/SYSTEMS (cont'd)

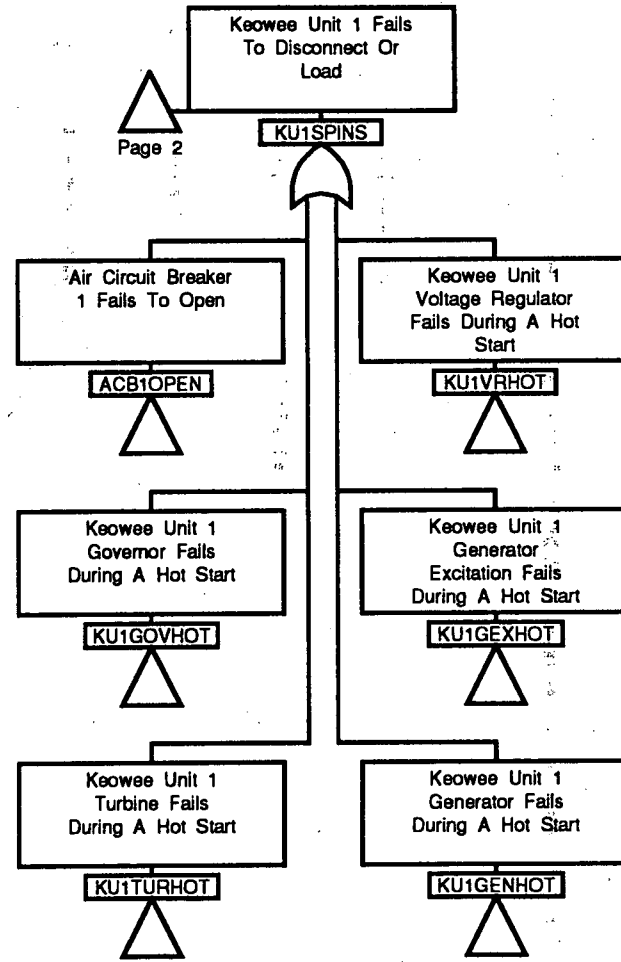
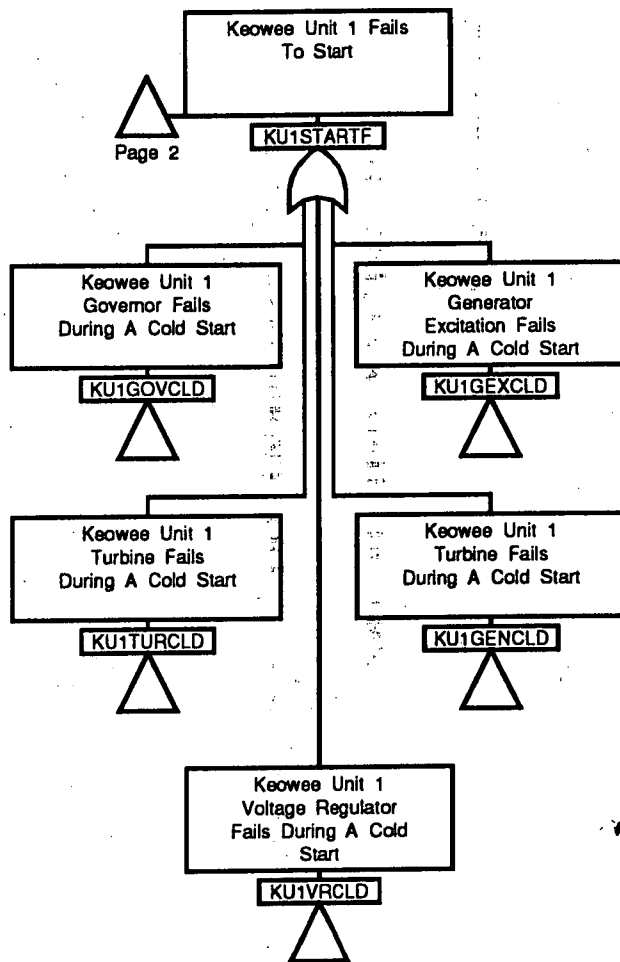
- Switchyard DC Power
- CT4
- Keowee Main Stepup Transformer
- ACB-4
- ACB-5
- ACB-6
- ACB-7
- ACB-8

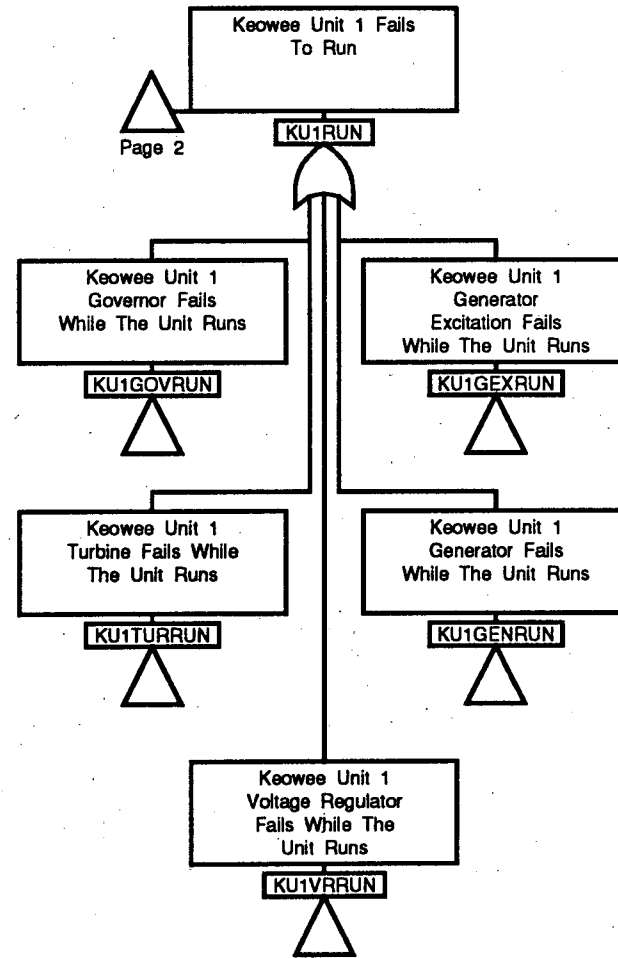
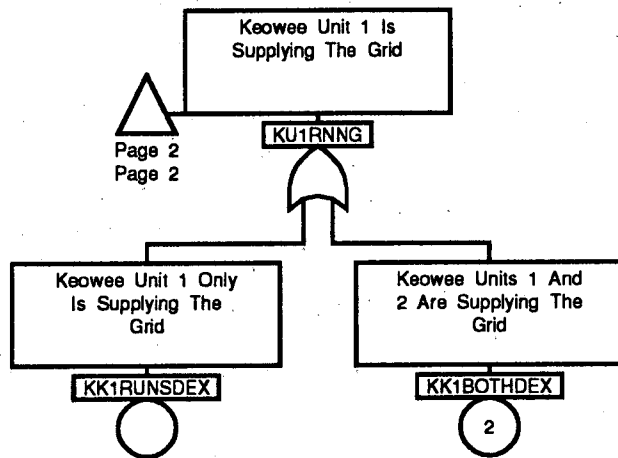


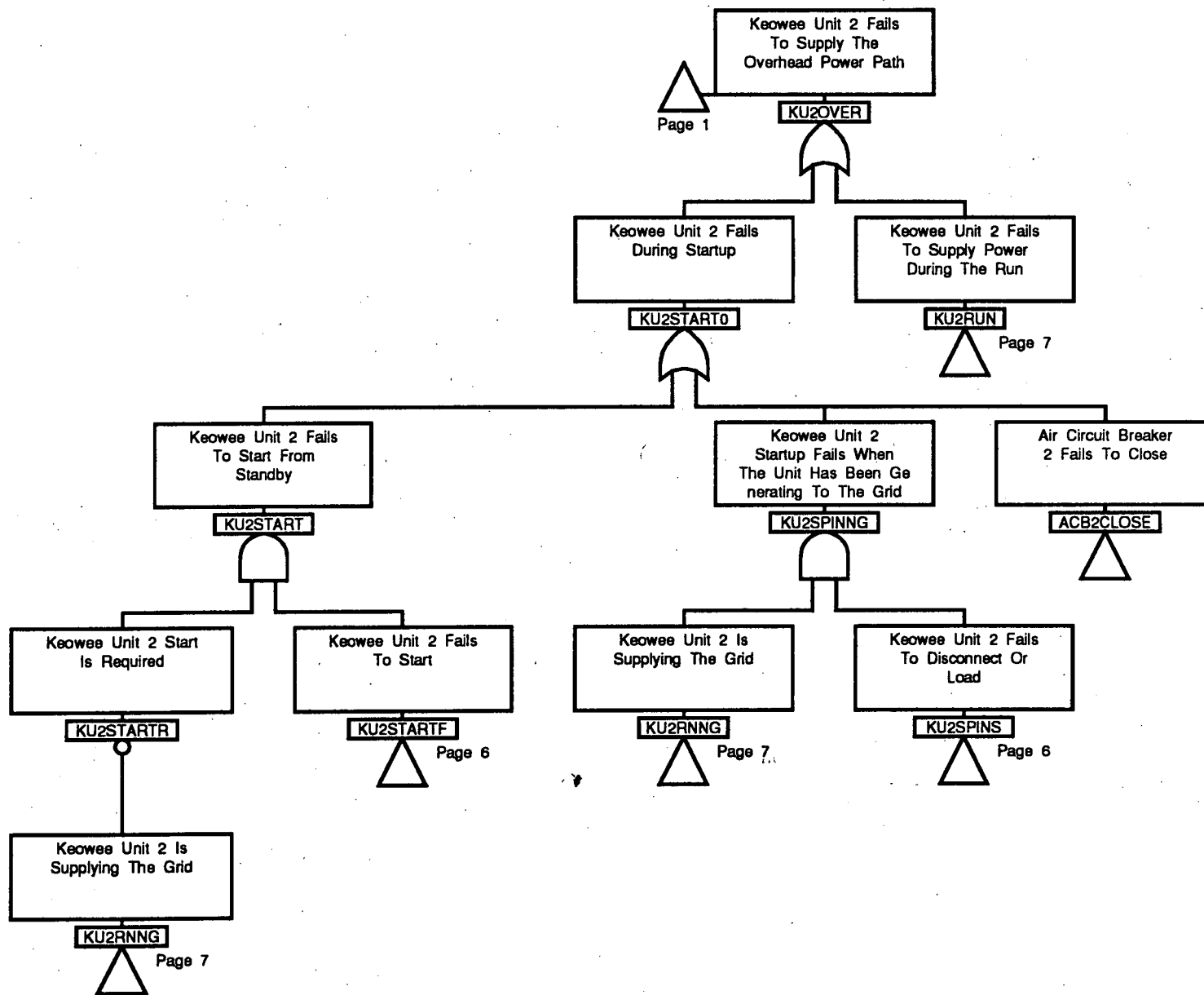
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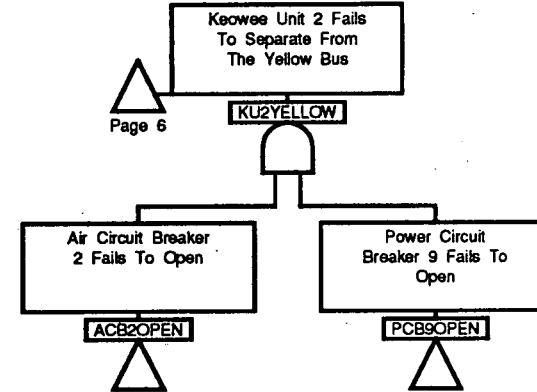
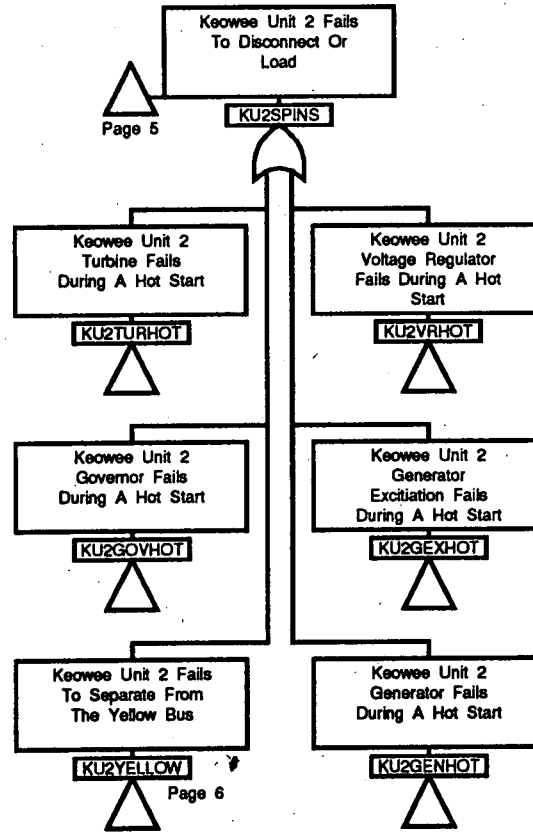
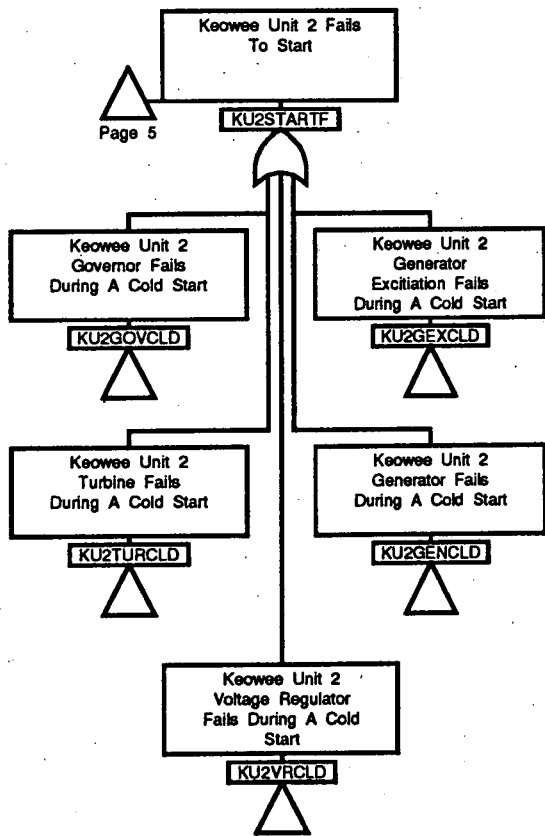
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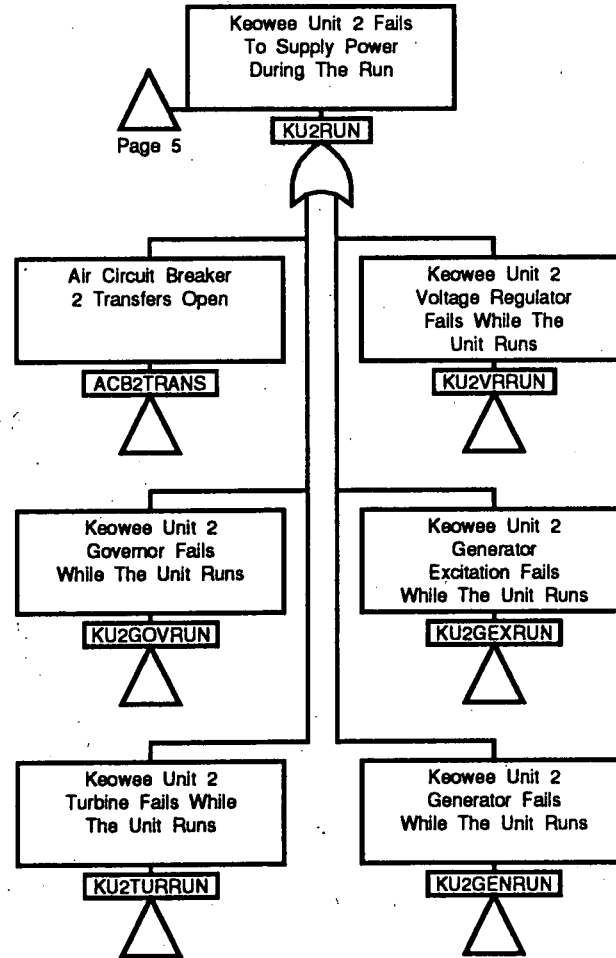
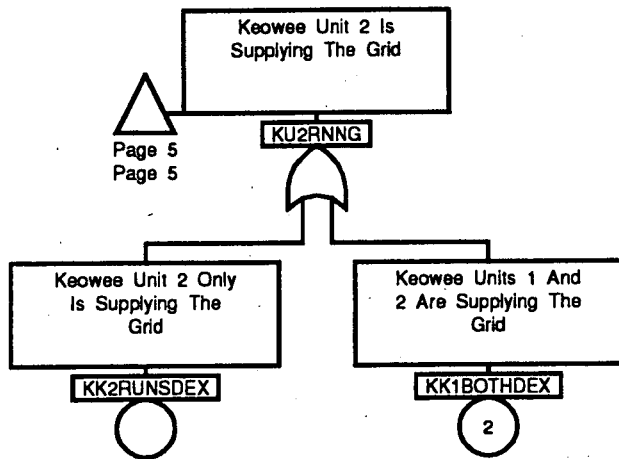












KEOWEE PRA PROJECT

EXAMPLE COMPONENT FAULT TREE ACB-1

- **TOP EVENT - AIR CIRCUIT BREAKER 1 FAILS TO OPEN**

- **FAILURE MODES**

ELECTRICAL/CONTROL

MECHANICAL

AIR PRESSURE

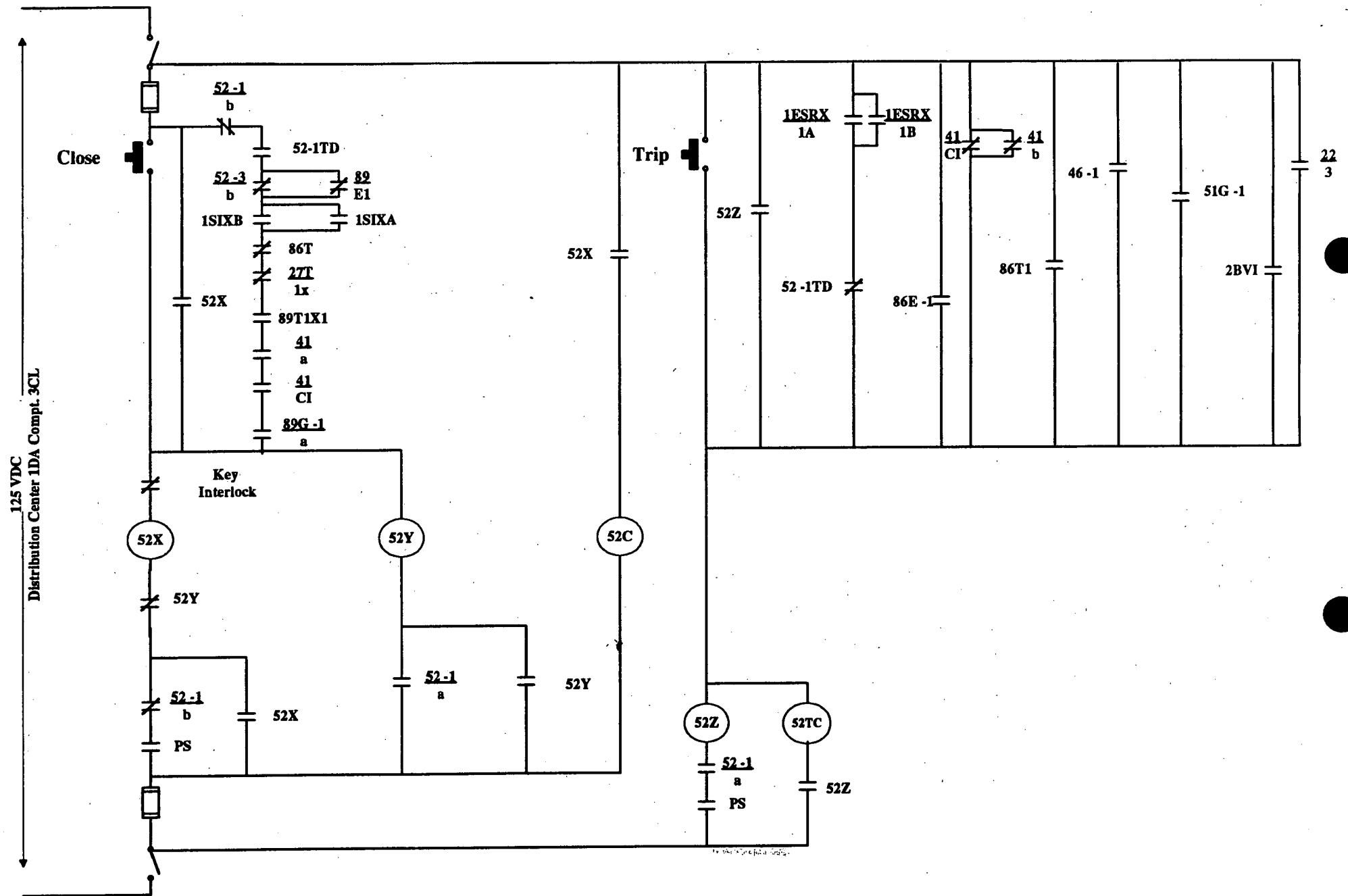
LATENT HUMAN ERRORS

- **LEVEL OF DETAIL**

CONTROL RELAYS AND TIMERS

BREAKER COMPONENT RELAYS AND SOLENOIDS

FUSES



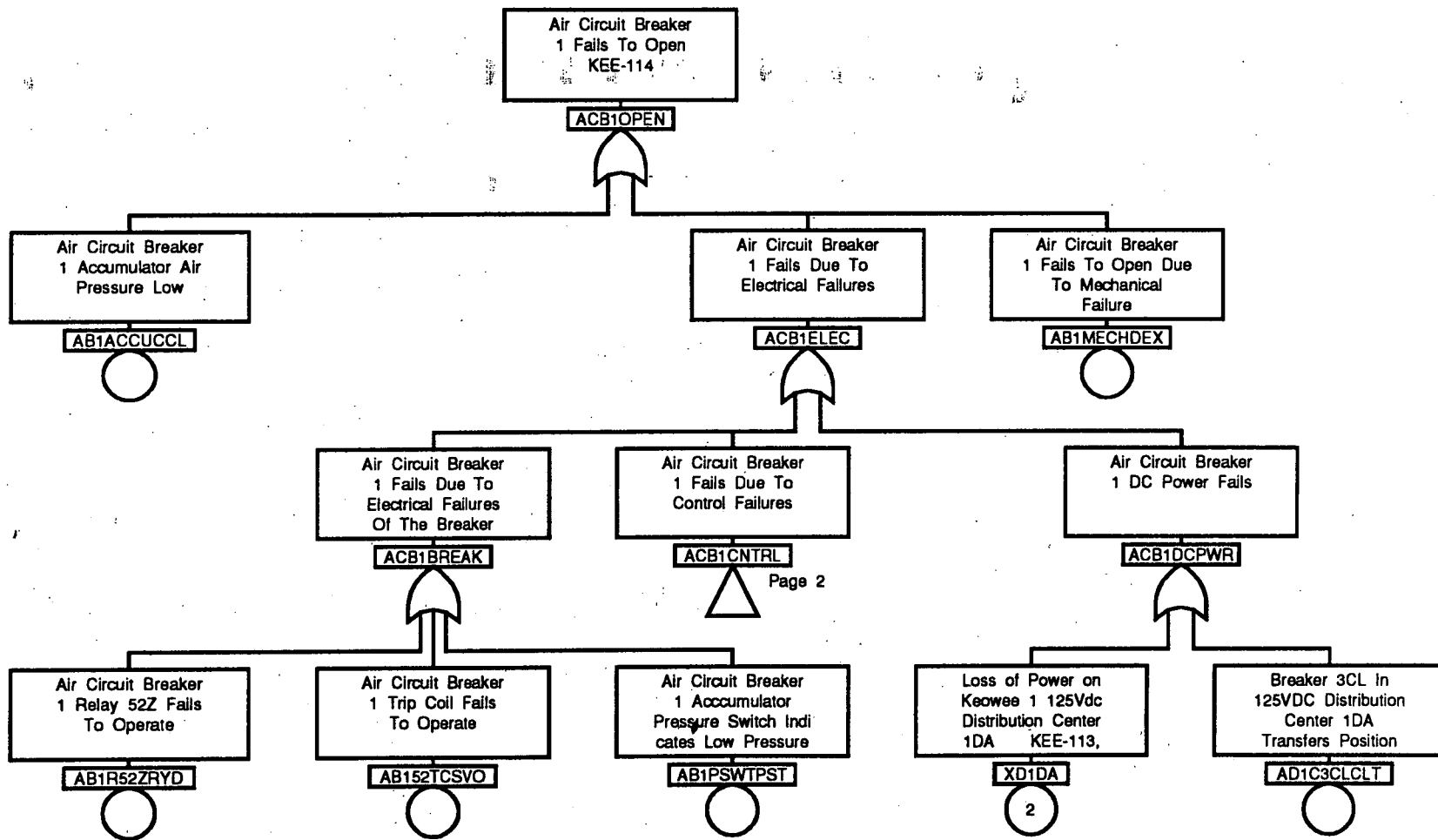
Simplified Air Circuit Breaker #1 Elementary Diagram

Device Name	Device	Operation
52Y	Relay and associated contacts	Anti-pump relay
52X	Relay and associated contacts	Breaker closing relay
52Z	Relay and associated contacts	Breaker trip relay
52C	Closing solenoid	When energized admits air to piston to close breaker
52TC	Tripping solenoid	When energized admits air to piston to open breaker
52-1/a	Auxiliary Contact off of ACB-1	Provides indication of the breaker position, closed when the breaker is closed, and open when the breaker is open
52-1/b	Auxiliary Contact off of ACB-1	Provides indication of the breaker position, closed when the breaker is open, and open when the breaker is closed
52-1TD	Time delay relay	Provides a 6 second time delay between the Keowee Emergency Start Signal and the closing of ACB-1
52-3/b	Auxiliary Contact off of ACB-3	Provides indication of the breaker position, closed when the breaker is open, and open when the breaker is closed
89/E1	Auxiliary Contact off of ACB-3 disconnect	Provides indication of the disconnect position, closed when the disconnect is open, and open when the disconnect is closed
1SIXA	Relay contact	Indicates that the switchyard isolation is complete, train A signal
1SIXB	Relay contact	Indicates that the switchyard isolation is complete, train B signal
86T	Lockout Relay on main stepup transformer (transformer number 1)	Provides indication of fault detection in the zone of transformer number 1
27T/1x	undervoltage relay	Provides indication of an undervoltage condition on transformer 1x, provides a means to prevent ACB-1 and ACB-2 from both closing in on the overhead path during an emergency start
89T1X1	Auxiliary Contact off of transformer number 1 disconnect	Provides indication of the disconnect position, closed when the disconnect is closed, and open when the disconnect is open
41/a	Auxiliary Contact off of generator field breaker	Provides indication of the breaker position, closed when the breaker is closed, and open when the breaker is open
41/b	Auxiliary Contact off of generator field breaker	Provides indication of the breaker position, closed when the breaker is open, and open when the breaker is closed
41/CI (N.O.)	Provides indication of the field breaker drawer position	Closed when the breaker is in service, open when the breaker drawer is in the withdrawn and disconnected position
89G-1/a	Auxiliary Contact off of ACB-1 disconnect	Provides indication of the disconnect position, closed when the disconnect is closed, and open when the disconnect is open
PS	Accumulator pressure switch	Actuates when the accumulator pressure is too low to allow breaker operation
1ESRX/1A	Keowee Unit 1 Emergency Start Auxiliary Relay, A train	Relay actuates when an emergency start signal is generated
1ESRX/1B	Keowee Unit 1 Emergency Start Auxiliary Relay, B train	Relay actuates when an emergency start signal is generated
86E-1	Generator Emergency Lockout Relay	Relay actuation occurs when generator faults are detected
86T1	Lockout Relay on main stepup transformer (transformer number 1)	Provides indication of fault detection in the zone of transformer number 1

May 3, 1994

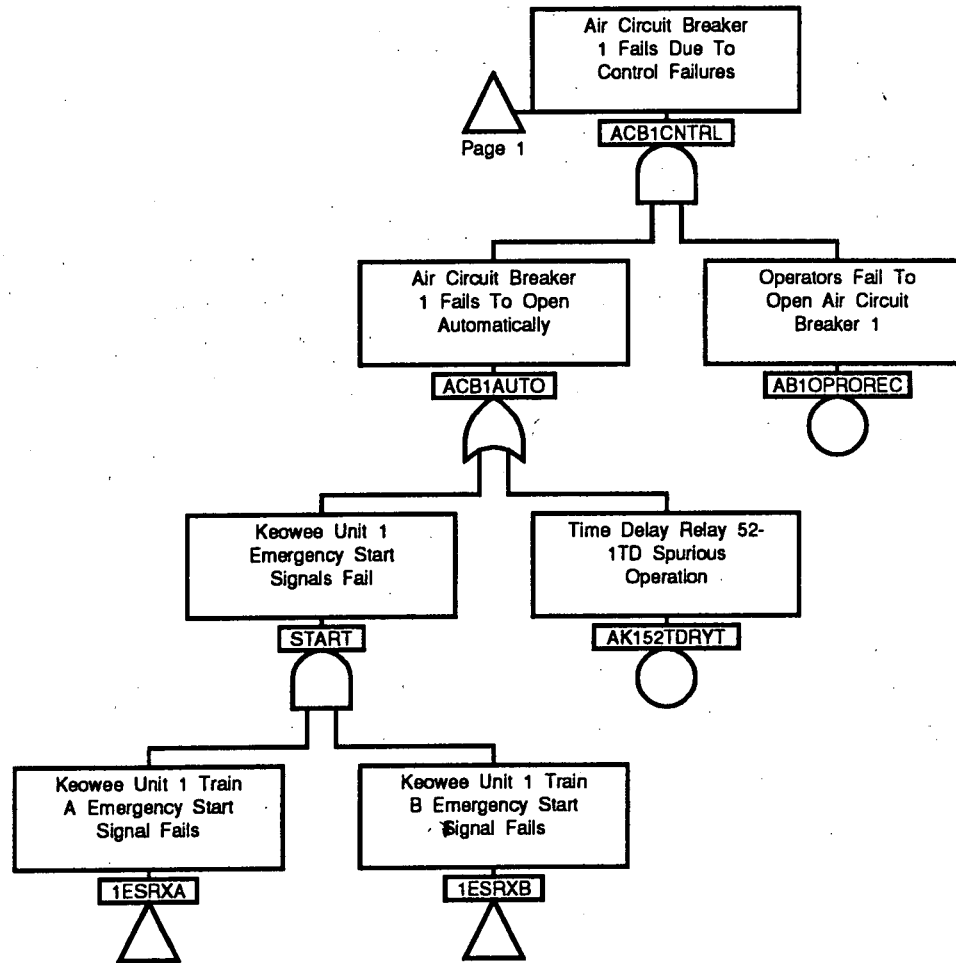
Air Circuit Breaker - 1

Device Name	Device	Operation
41/CI (N.C.)	Provides indication of the field breaker drawer position	Open when the breaker is in service, closed when the breaker drawer is in the withdrawn and disconnected position
46-1	Reverse phase or phase balance relay (negative sequence relay)	Actuates on detection of reversal or imbalance of the phases due to gross system disturbances
51G-1	Overcurrent relay	A voltage controlled overcurrent relay, actuates on an overcurrent condition coincident with an undervoltage condition
2BV1	Backup undervoltage relay	Provides backup protection in case of failure of other protective devices, includes a three second time delay
12/3	Overspeed switch	Indicates generator overspeed



Page 2

Page 1



Keowee Emergency Power
Information

Keowee PRA Meeting
May 5, 1994

SIGNALS STARTING KEOWEE:

MANUAL

- a) Emergency start switches in Oconee Control Room (Unit 1 & 2 shared)
- b) Emergency start switches in Cable Room

AUTOMATIC

- a) ES channel 1 or 2 of any Oconee unit
- b) Switchyard isolate (Degraded Grid Protection System)
- c) Main Feeder Bus Monitor Logic

PREREQUISITES:

1. Startup inhibit key switch in OPERATE position.
2. Emergency lockout relay reset.
3. Turbine guide bearing oil level satisfactory.
4. Thrust bearing oil level satisfactory.

STARTUP SEQUENCE:

1. ES signal energizes master relays.
2. Closes generator field, supply, and field flashing breakers.
3. Initiates overhead breaker trip.
4. Prevents operation of the governor speed changer by the auto synchronizer. (shutdown solenoid aux relay, partial shutdown solenoid, block dashpot bypass solenoid)
5. Auto synchronizer inhibited.
6. Normal lockout inhibit
7. Auto Governor Control (or load frequency control) inhibited.
8. Wicket Gates open toward limit of 50%. At turbine speed of 65rpm, gates go to emergency load position. Gate limit goes to 100%.
9. At 122rpm unit goes to governor control.
10. Underground available immediately due to alignment.
11. Overhead available after switchyard isolate (ACB-1 6.5 seconds, ACB-2 4 seconds). IF no switchyard isolate, manually sync and parallel to switchyard.

NORMAL LOCKOUT CAUSES:

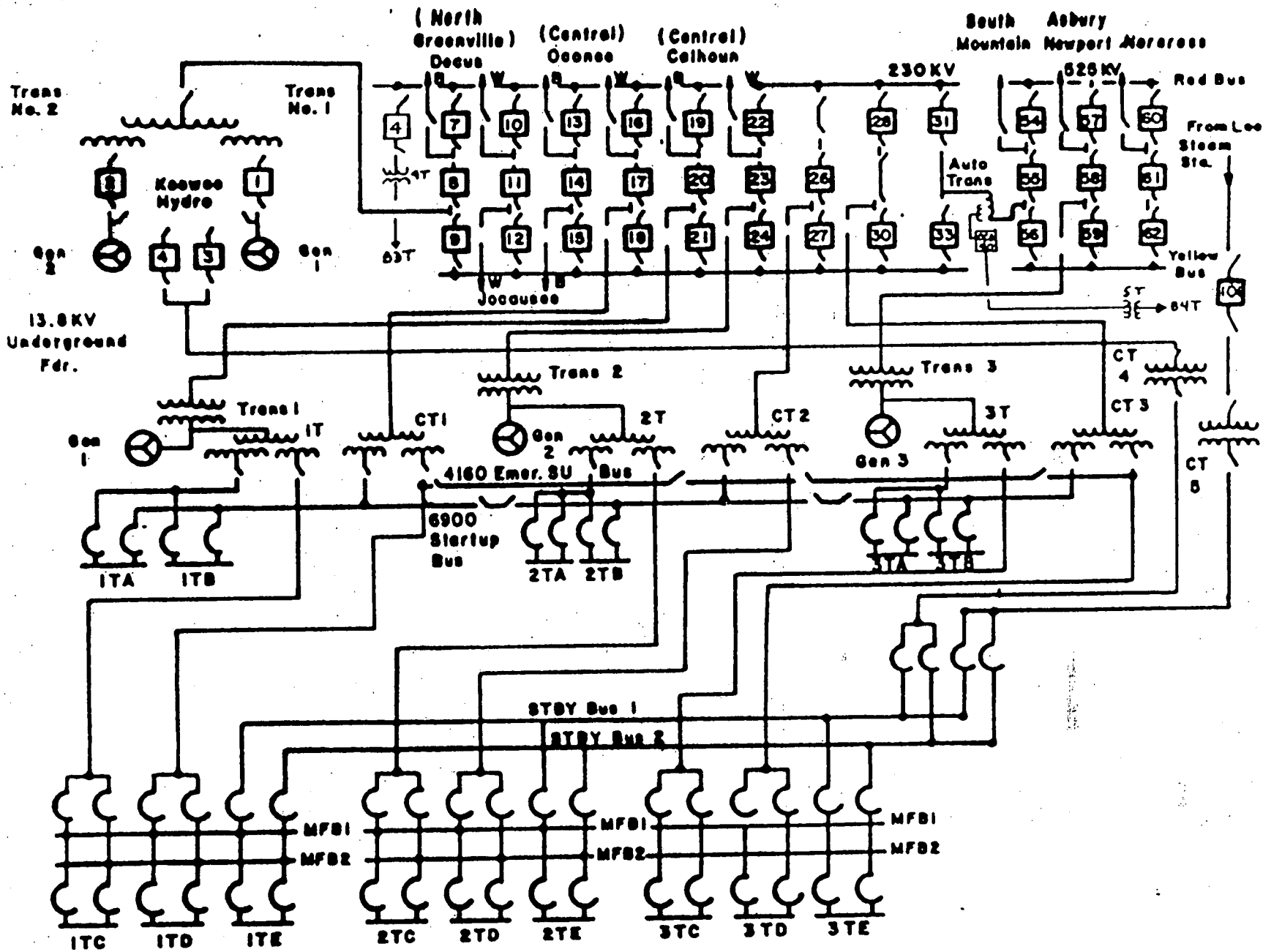
1. Generator field ground detector
2. Generator field overcurrent detector
3. Volts/Hz time delay relay
4. Max excitation timer
5. Loss of backup DC supply for generator AND transformer differential
6. Overspeed
7. Turbine guide bearing oil level low
8. Turbine guide bearing temperature high
9. Turbine packing box temperature high
10. Turbine packing box pressure low
11. Generator guide bearing temperature high
12. Thrust bearing temperature high
13. Generator bearing oil level high
14. Generator bearing oil level low
15. AC turbine guide bearing oil pump failure during startup
16. Governor oil pressure low

EMERGENCY LOCKOUT CAUSES:

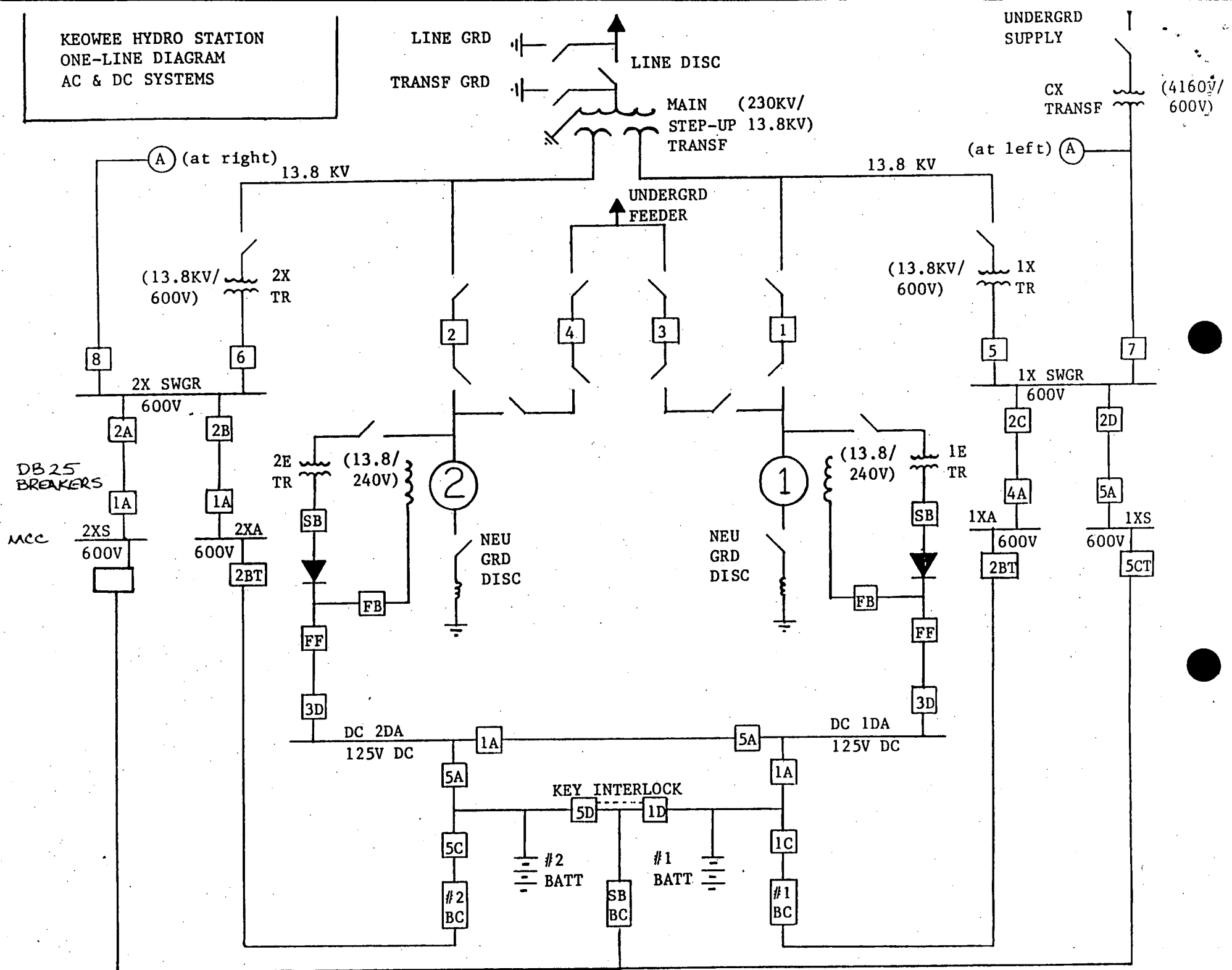
1. Generator CO₂ release
2. Generator bus differential
3. Generator neutral ground
4. Generator loss of field
5. Excitation transformer differential
6. Key inhibit switch

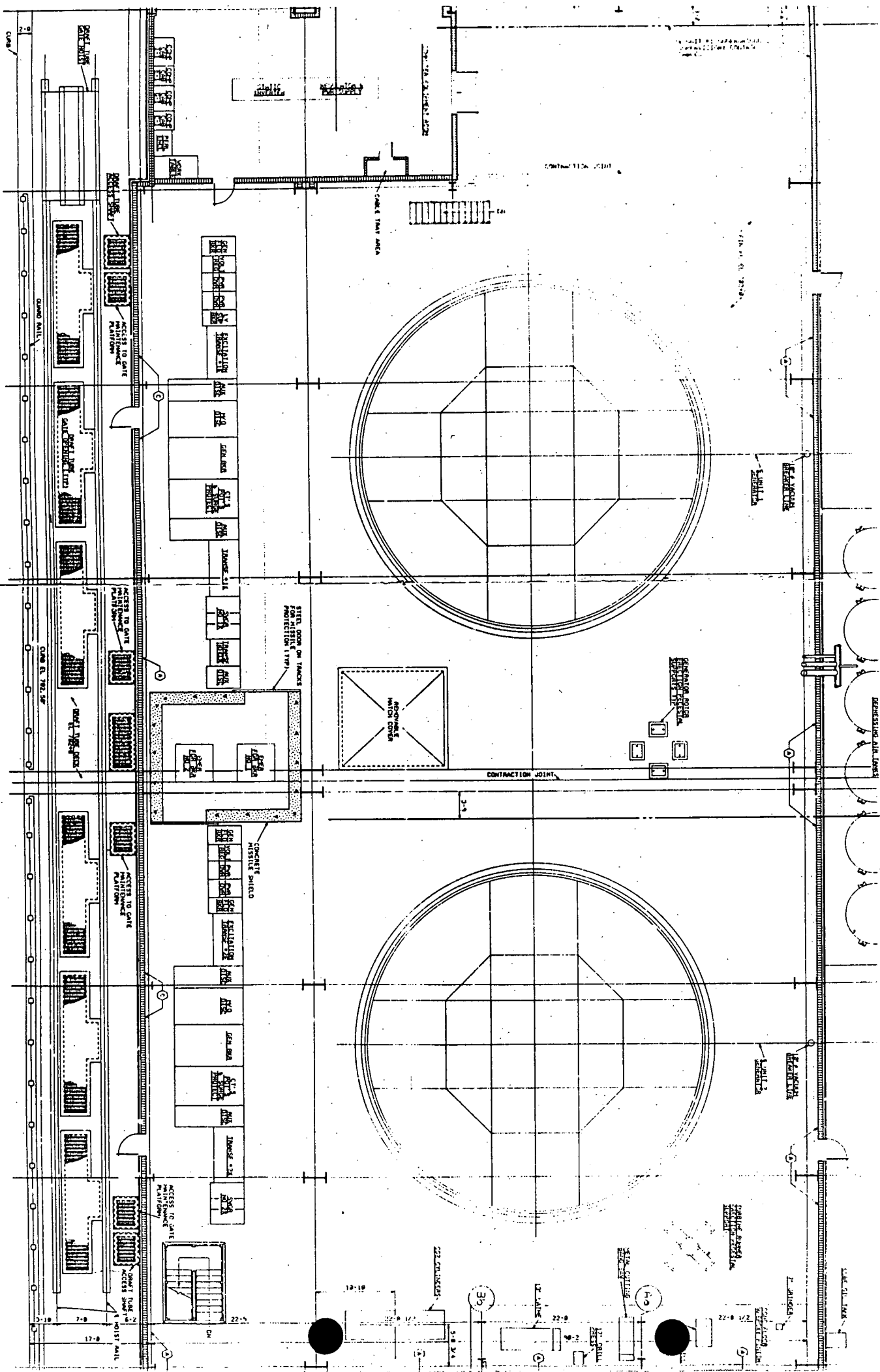
ALARM LOCKOUT CAUSES:

1. Generator vital equipment loss of DC voltage
2. Loss of generator metering and relay pots
3. Loss of gate shear pin
4. Turbine guide bearing oil pump alarm



KEOWEE HYDRO STATION
ONE-LINE DIAGRAM
AC & DC SYSTEMS





CUBS

STAIR

ACCESS TO GATE PLATFORM

ACCESS TO GATE PLATFORM

ACCESS TO GATE PLATFORM

ACCESS TO GATE PLATFORM

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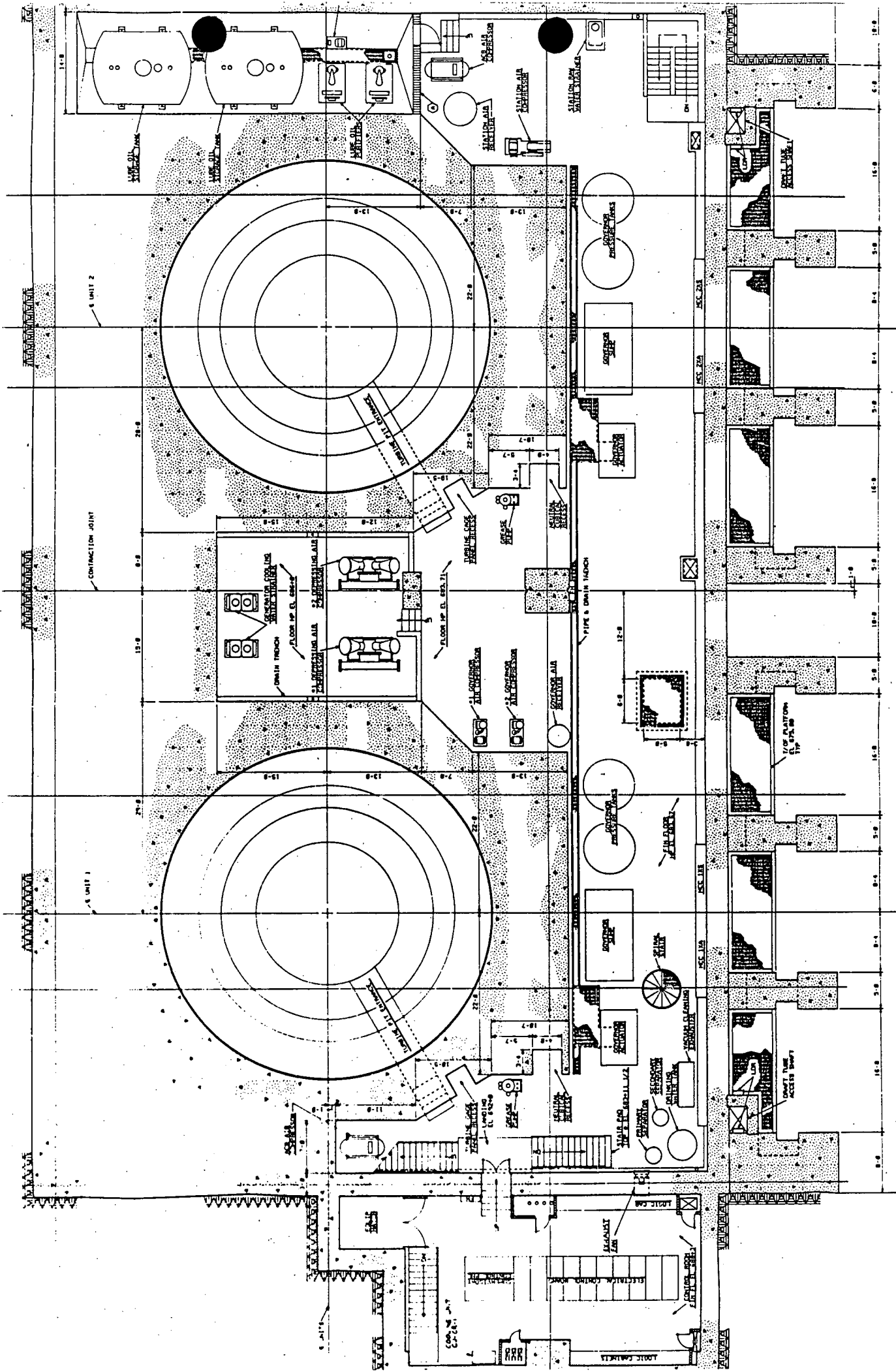
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CROSS SECTION AT & UNIT NO. 1
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