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SAND82–7212/4 of 4
AN, RG, XA
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Volume IV—Appendix B.9 Through B.19 and C

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INTERIM RELIABILITY-EVALUATION PROGRAM:

ANALYSIS OF THE MILLSTONE POINT UNIT 1 NUCLEAR POWER PLANT.

Volume IV.

Appendix B.9 through B.19 and C
May 1983

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Volume II

TABLE OF CONTENTS

Appendix B

Volume III

TABLE OF CONTENTS

Appendix B

Volume IV

TABLE OF CONTENTS

Appendix B

Page

Appendix C

Page

Volume II

LIST OF FIGURES

Appendix A

Appendix B

Volume III
LIST OF FIGURES
Appendix B

Volume IV
LIST OF FIGURES
Appendix B

Appendix C

Volume II

LIST OF TABLES

Appendix B

Volume III

LIST OF TABLES

Appendix B

Volume IV

LIST OF TABLES

Appendix B

Appendix C

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The authors acknowledge their responsibility for the final content of this report and for errors and omissions.

APPENDIX B.9

ISOLATION CONDENSER MAKEUP SYSTEM

B.9.1 Isolation Condenser Makeup System Description

B.9.1.1 Purpose

The purpose of the isolation condenser makeup (ICMUP) system is to provide makeup water to the shell side of the IC to compensate for water boiled off during IC system operation. Providing an adequate shell side inventory assures a sufficient heat sink for decay heat removal when the reactor is isolated from the main condenser.

B.9.1.2 Description and Configuration

Figure B.9-1 shows a simplified piping schematic of the IC makeup system. Makeup water originates from the main header of the fire water system by passing through valves FIRE-47, FIRE48, FIRE-49, and FIRE-50. An alternative source for makeup water from the condensate system is normally valved off via manual valve MW-60.

Water level on the shell side is controlled via regulation of AC powered MOV IC-10. This valve will fully open on low IC water level, and fully close on high IC water level. Remote manual operation from the control room is also possible, as well as local manual operation using a handwheel on the valve.

B.9.1.3 System Interfaces

System interfaces for the ICMUP system are shown in Table B.9-1.

B.9.1.4 Instrumentation and Control

The operation of ICMUP system is dependent on three level switches. Makeup water is automatically supplied upon receipt of a signal indicating low shell side level (69") from level a single switch (1347C). Closure of the makeup valve is dependent on receipt of a signal from either one of two level switches, indicating either high shell side level (80") or high-high shell side level (91") from level switches 1347A and B (see Figure B.9-2). Manual control is also possible via switch #301 on the control board. Table B.9-2 shows the various instruments and setpoints used.

B.9.1.5 Testing

There are four major tests of the ICMUP system.

SP 608.22 Isolation Condenser Makeup Check Valve Readiness Test

> This test checks the flow path through the makeup system check valve by manually increasing shell side water level and recording the change in level while the makeup valve is open. This test is performed during refueling outages.

SP 623.18 Emergency Systems Valve Position Check

This checks the valve position of MOV IC-10 weekly.

SP 627.1 Isolation Condenser Shell Side Water Level and Temperature Check

This checks the shell side level to determine if the level is within an appropriate range. (This check is required daily by plant Technical Specifications.)

OP 307-1 Isolation Condenser Valve Checklist

This weekly check is performed on all valves in the makeup supply line from the main header of the fire water system to the isolation condenser (i.e., valves FIRE-47, 48, 49, 50, ic-10, 11, and 12).

B.9.1.6 Maintenance

There is no routinely scheduled maintenance for this system. Maintenance is performed on an as-needed basis.

B.9.1.7 Technical Specifications

A. The limiting conditions for operation affecting the ICMUP system.

1) When reactor pressure is greater than 90 psig and irradiated fuel is in the reactor vessel, the isolation condenser must be operable (except as specified in part 2, below) and the shell side water level must be at least 66 inches.

2) If the isolation condenser is inoperable, reactor operation is restricted to 40 percent of full power.

B. Surveillance of the isolation condenser system

1) Isolation condenser system testing:

a. The shell side water level and temperature shall be checked daily.

b. Simulated automatic actuation and functional system testing shall be performed during each refueling outage or whenever major repairs are completed on the system.

B.9.1.8 Operation

Under normal operation shell side water level is automatically maintained between 69" and 80" by a series of level switches which open and close MOV IC-10 in the Makeup line.

Manual operation of the ICMUP system is accomplished via manipulation of the open/close switch #301 on control room pannel 903. Visual indication of shell side level is provided on a strip chart indicator.

Alarms are provided for low level, high level, and high high level using the same level sensors used for opening and closing MOV IC-10.

B.9.2 Analysis

B.9.2.1 Success/Failure Criteria

Successful operation of the ICMUP system requires the ability to deliver makeup water from the fire water system to the shell side of the IC within 40 minutes of actuation of the IC. Following this, intermittent operation is required as necessary until the reactor is depressurized or until an alternate decay heat removal system is utilized.

System failure occurs whenever the ICMUP system is unable to provide sufficient makeup water to compensate for boil off on the shell side of the IC. This can occur either 35 to 40 minutes following initial actuation of the IC, or during subsequent operation.

B.9.2.2 Assumptions

In this analysis the following assumptions are made:

1) The condensate system is not assumed as a possible source of makeup water as it is manually valved off due to environmental concerns over low level radiation release.

3) System overfill via the ICMUP system is not viewed as a failure, as the design of the IC takes into account the hydrostatic loading with the shell side filled.

2) No flow division is assumed via the grab sample line as its diameter is significantly smaller than the piping in the makeup line.

Table B.9-1

Isolation Condenser Makeup System Interfaces Failure Modes and Effects

Front Line System			Support System			Failure Mode	Failure Effect
System	Div.	Comp.	System	Div.	Comp.		
IC Makeup	MOV IC-10		AC Power	G/T	Bus E-1	Zero or low voltage	Valve fails as is
IC Makeup	Supply Header		Fire Pro-tect Sys.	---	Main Header	Loss of pressure	Inability to supply makeup water to IC

Table B.9-2

IC Makeup Instrumentation

Instrument	Function	Setpoint
LS 1347 A	High High Level Alarm and MOV IC-10 Close	91"
LS 1347 B	High Level Alarm and MOV IC-10 Close	80"
LS 1347 C	Low Level Alarm and MOV IC-10 Open	69"

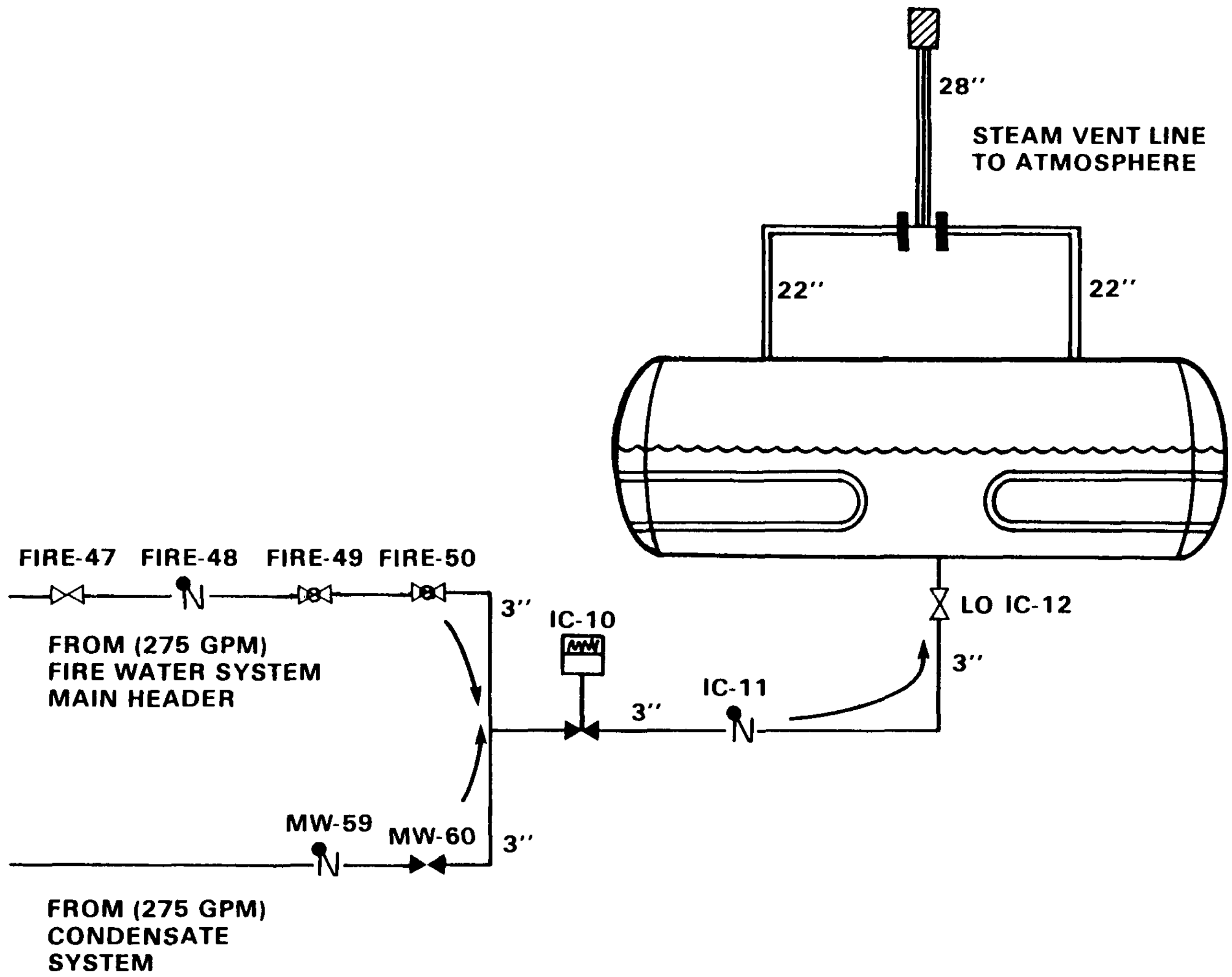


FIGURE B.9-1. ISOLATION CONDENSER MAKEUP SYSTEM

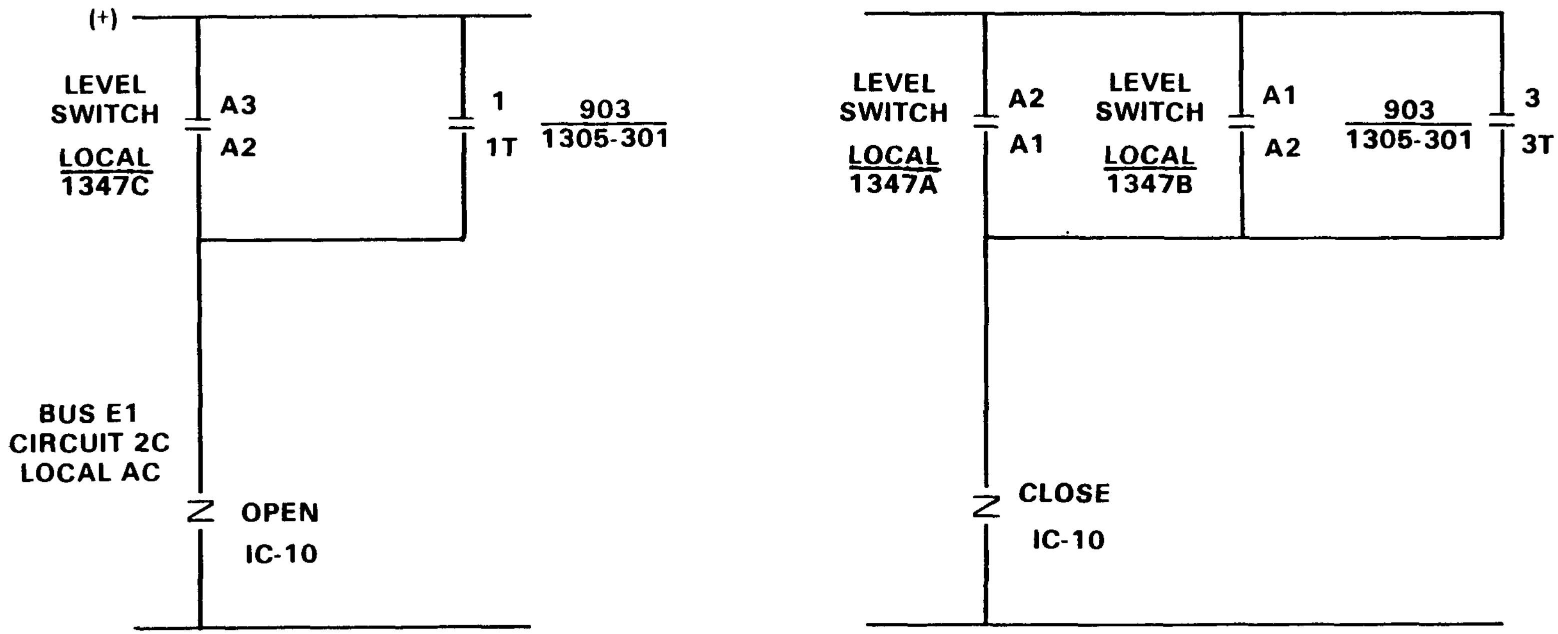


FIGURE B.9-2. IC MAKEUP CONTROL WIRE SCHEMATIC VALVE IC-10

ISOLATION CONDENSER MAKEUP SYSTEM

FAULT TREE AND FAULT SUMMARY SHEETS

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
ICM-12-XV-FRO FIRE-47-XV-FRO FIRE-49-XV-FRO FIRE-50-XV-FRO	Normally open manual valve fails to remain open	12000 hrs (Flow checked after each re-fueling outage)	Flow checked via procedure SP 608.22	3E-4
ICM-12-XV-TMC FIRE-47-XV-TMC FIRE-49-XV-TMC FIRE-50-XV-TMC	Normally open manual valve closed for test or maintenance	Weekly	Checklist OPS 307-1 completed weekly. Valves would only be closed to repair leakage or to service IC shell region	3.3E-6
ICM-11-CKV-FTO FIRE-48-CKV-FTO	Normally closed check valve fails to open	12000 hrs (during each refueling outage)	Operability checked via procedure SP 608.22	1.7E-3
ICM-11-CKV-TMC FIRE-48-CKV-TMC	Normally operable check valve is unable to open due to test or maintenance	Valve position checked weekly	Checklist OPS 307-1 completed weekly	3.3E-6
ICM-10-MOV-OPC	During the course of an accident operator closes makeup valve while makeup flow is required		Operator error. MOV will automatically reopen if low level signal persists	3E-3

MILLSTONE 1
SYSTEM ICMUP
SHEET #1

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
ICM-10-MOV-FTO	Motor operated valve fails to open on demand	12000 hrs (detection is during refueling outages)	Procedure SP 608.22 checks operability of valve	1.7E-2
ICM-10-MOV-TMC	Motor operated valve out of service for test or maintenance	Valve position checked weekly	Checklist OPS 307-1 completed weekly	3.3E-5
AC-E1-2C-FTC	AC Breaker fails to close	12000 hrs (detection is during refueling outage)	Event yields loss of control and motive power to MOV IC-10. Tested as per SP 608.22	1.7E-2
9031305-301-3RO	Contacts 3 & 3R of switch 301 fail to remain open	12000 hrs (detection is during refueling outage)	Event causes MOV IC-10 to fail closed. Tested as per SP 608.22	1.8E-4
LCL13051347C-XFC	Low level switch fails to close on low level condition in the isolation condenser	12000 hrs (detection is during refueling outage)	Event prevents MOV IC-10 from opening. Tested during the performance of SP 608.22	2.3E-3

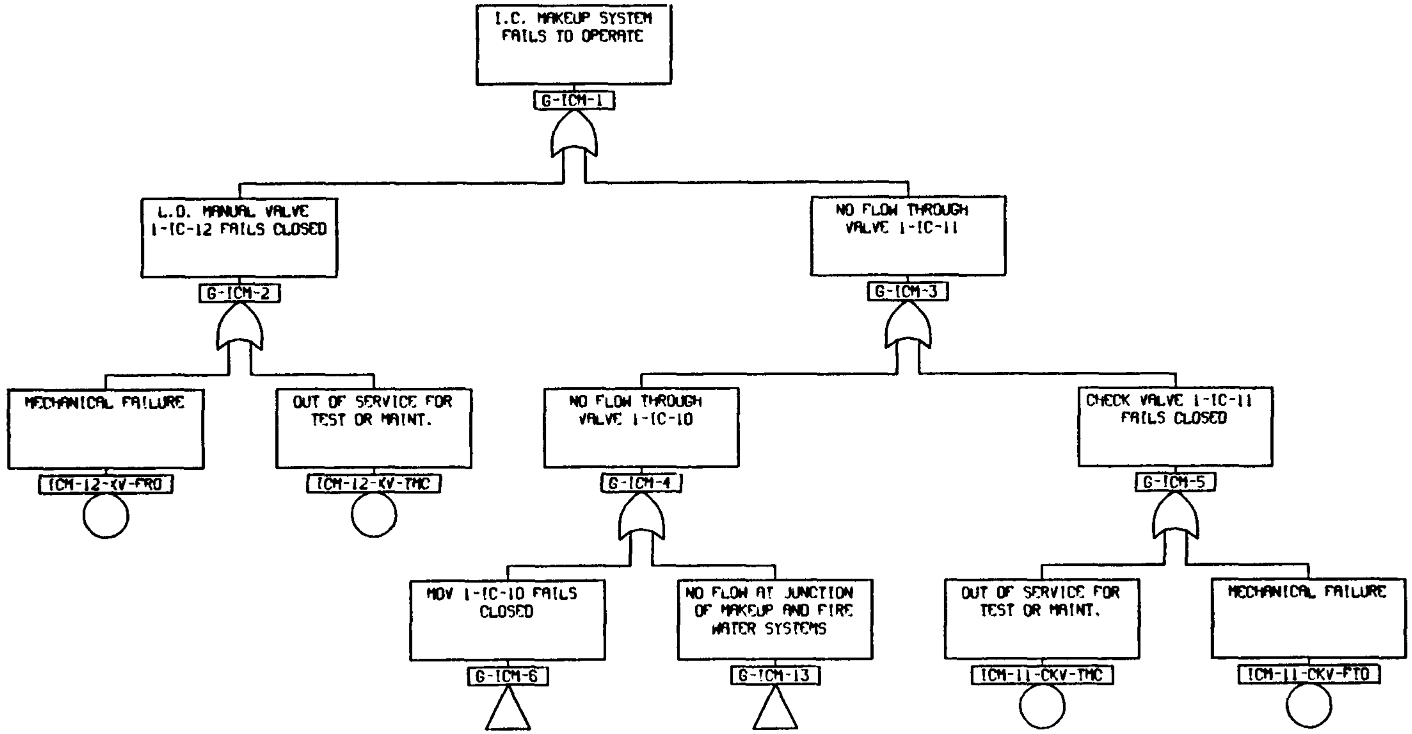
FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
LCL13051237A-XRO LCL13051237B-XRO	High level switch fails to remain open with an acceptable water level in the isolation condenser	12000 hrs (detection is during refueling outage)	Event causes MOV IC-10 to close prematurely, detected during the performance of SP 608.22	1.8E-4
LCL13051347A-OMC LCL13051347B-OMC LCL13051347C-OMC	Level sensor switch miscalibrated to the extent system function is defeated	12000 hrs (detection during refueling outage)	Event yields inability to control MOV IC-10 automatically, event detected during the performance of SP 608.22	1E-3
LCL13051347A-TOM LCL13051347B-TOM LCL13051347C-TOM	Level sensor switch out of service for test or maintenance	12000 hrs (detection during refueling outage)	Event yields inability to control MOV IC-10 automatically, event detected during the performance of SP 608.22	1E-2

MILLSTONE 1
SYSTEM ICMUP
SHEET #3

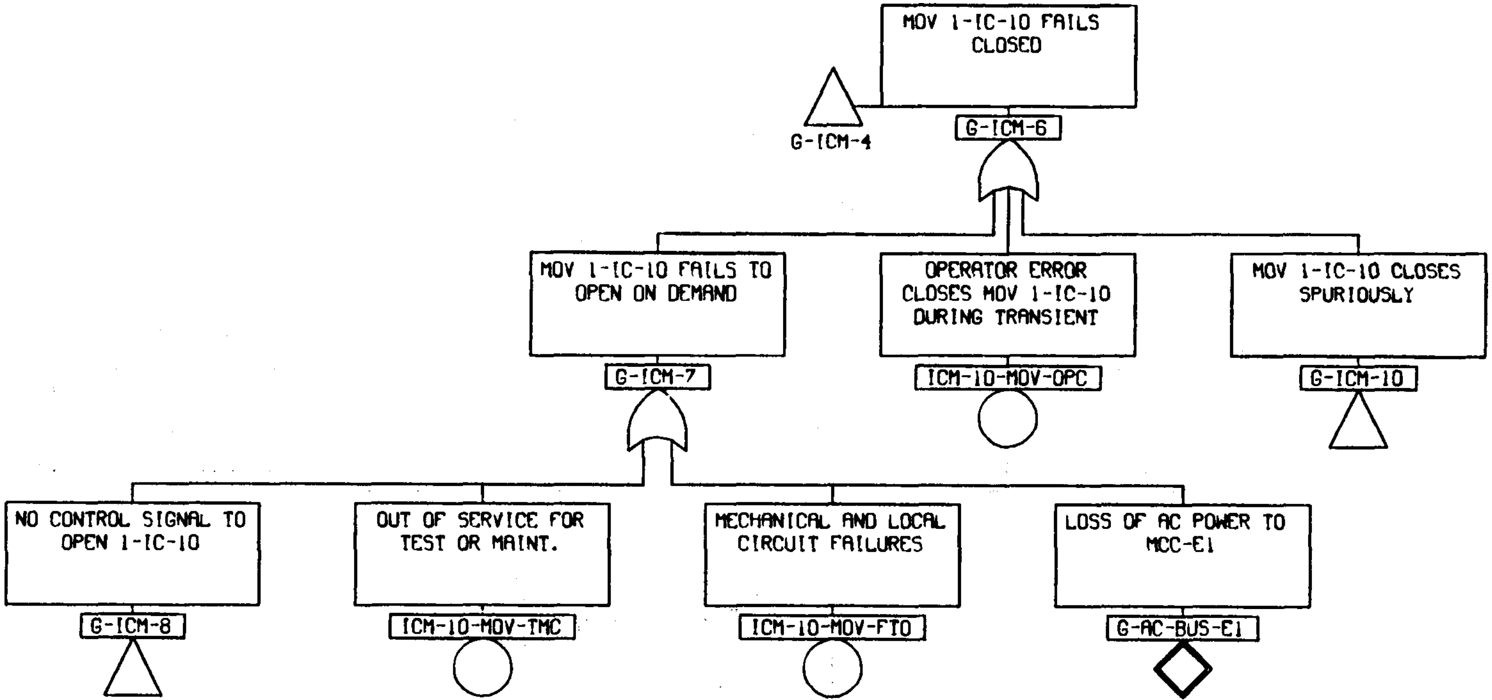
ICM FAULT TREE PAGE INDEX

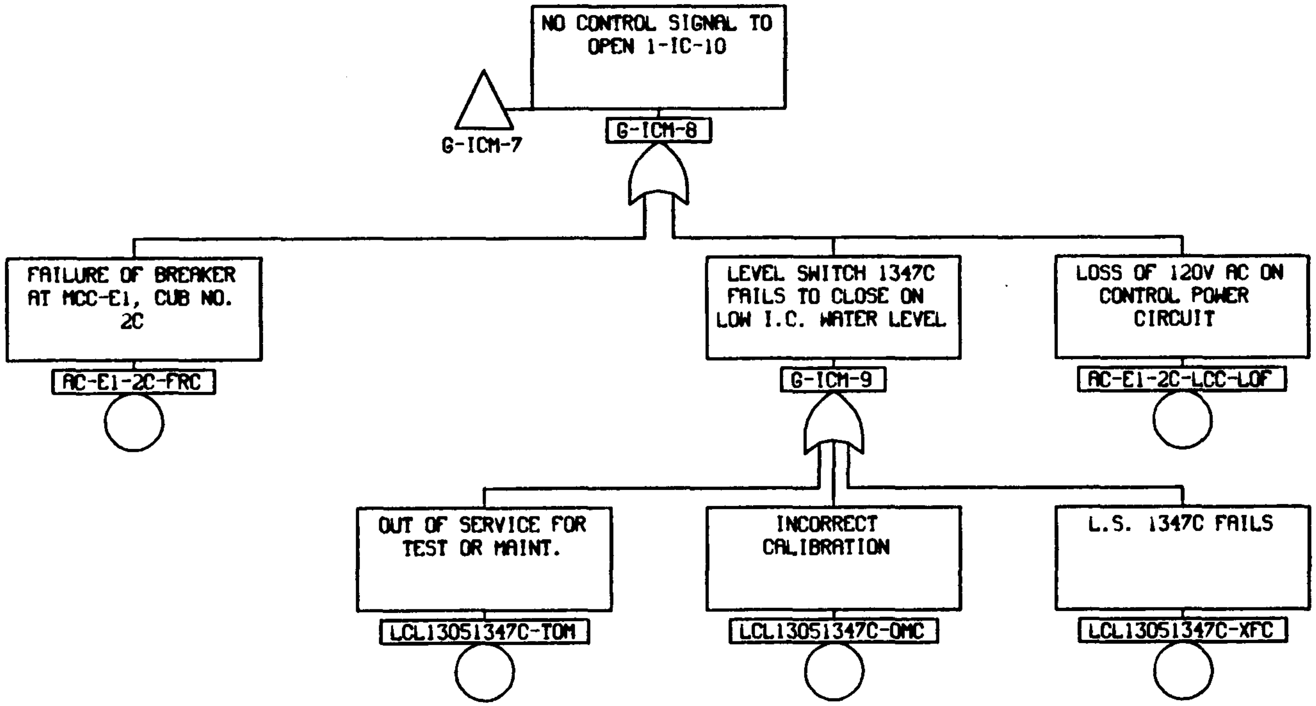
GATE NAME	DEFINED ON PAGE	TRANSFERS TO PAGE(S)
G-ICM-1	ICM-1	--
G-ICM-6	ICM-2	ICM-1
G-ICM-8	ICM-3	ICM-2
G-ICM-10	ICM-4	ICM-2
G-ICM-13	ICM-5	ICM-1
G-ICM-17	ICM-6	ICM-5



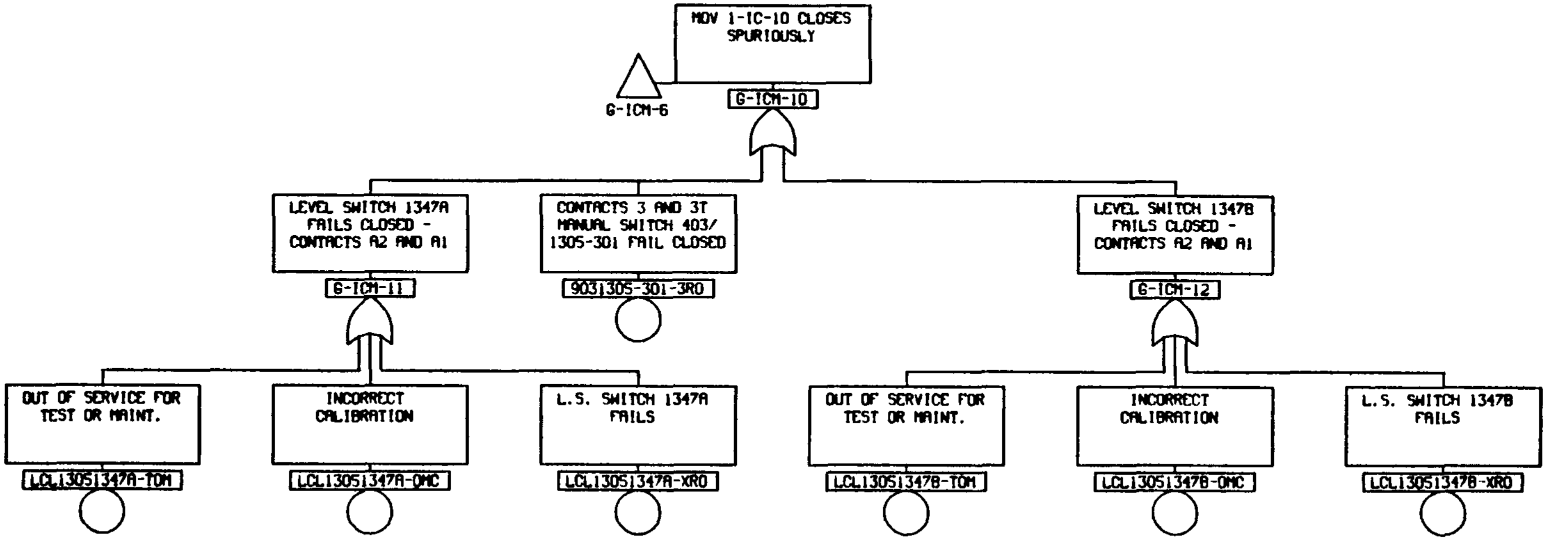
I.C. MAKEUP SYSTEM FAILS TO OPERATE
G-ICM-1
L.O. MANUAL VALVE 1-IC-12 FAILS CLOSED
G-ICM-2
NO FLOW THROUGH VALVE 1-IC-11
G-ICM-3
MECHANICAL FAILURE
ICM-12-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
ICM-12-XV-TMC
NO FLOW THROUGH VALVE 1-IC-10
G-ICM-4
CHECK VALVE 1-IC-11 FAILS CLOSED
G-ICM-5
MOV 1-IC-10 FAILS CLOSED
G-ICM-6
NO FLOW AT JUNCTION OF MAKEUP AND FIRE WATER SYSTEMS
G-ICM-13
OUT OF SERVICE FOR TEST OR MAINT.
ICM-11-CKV-TMC
MECHANICAL FAILURE
ICM-11-CKV-FTO

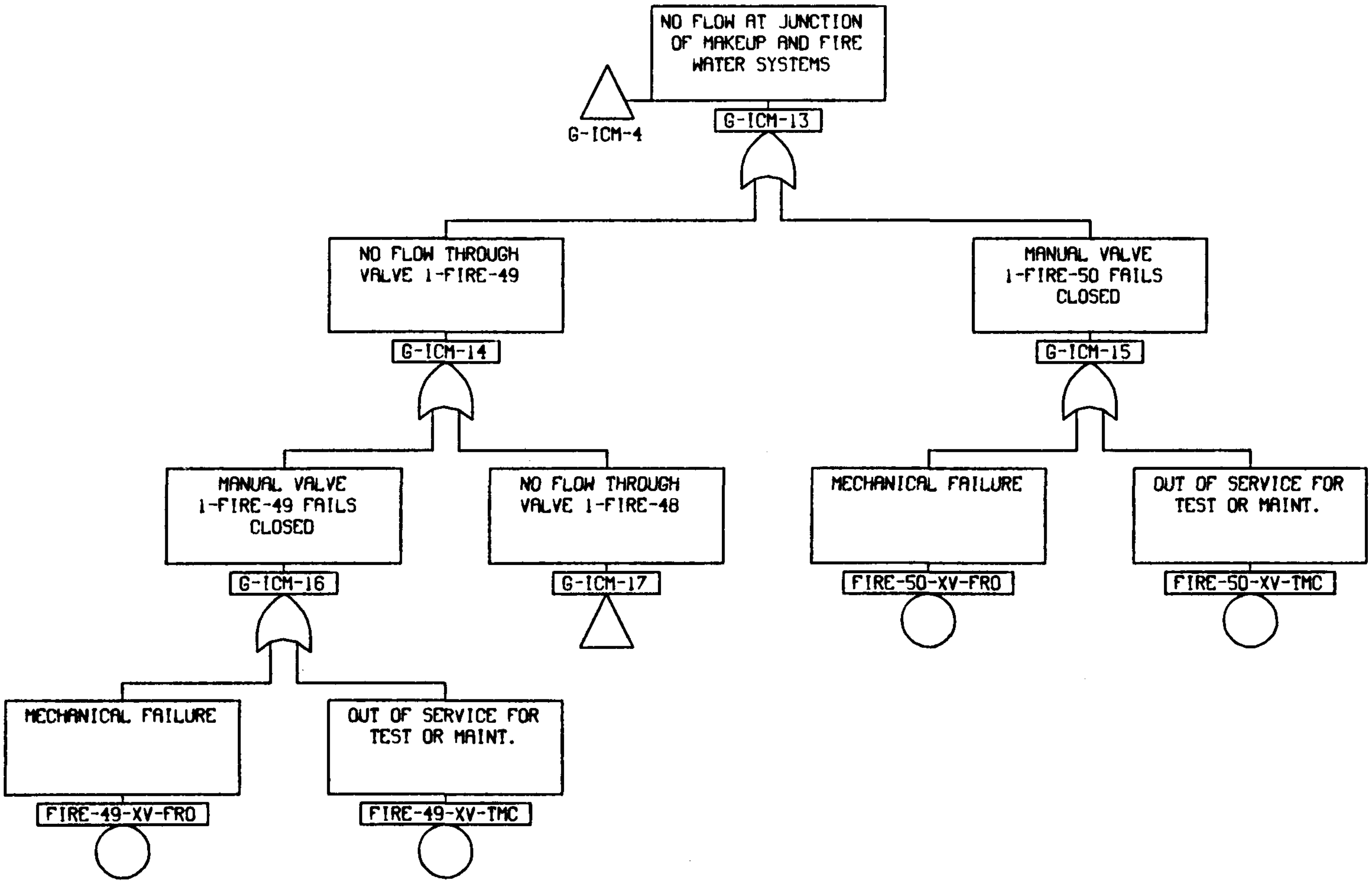
ICM-1

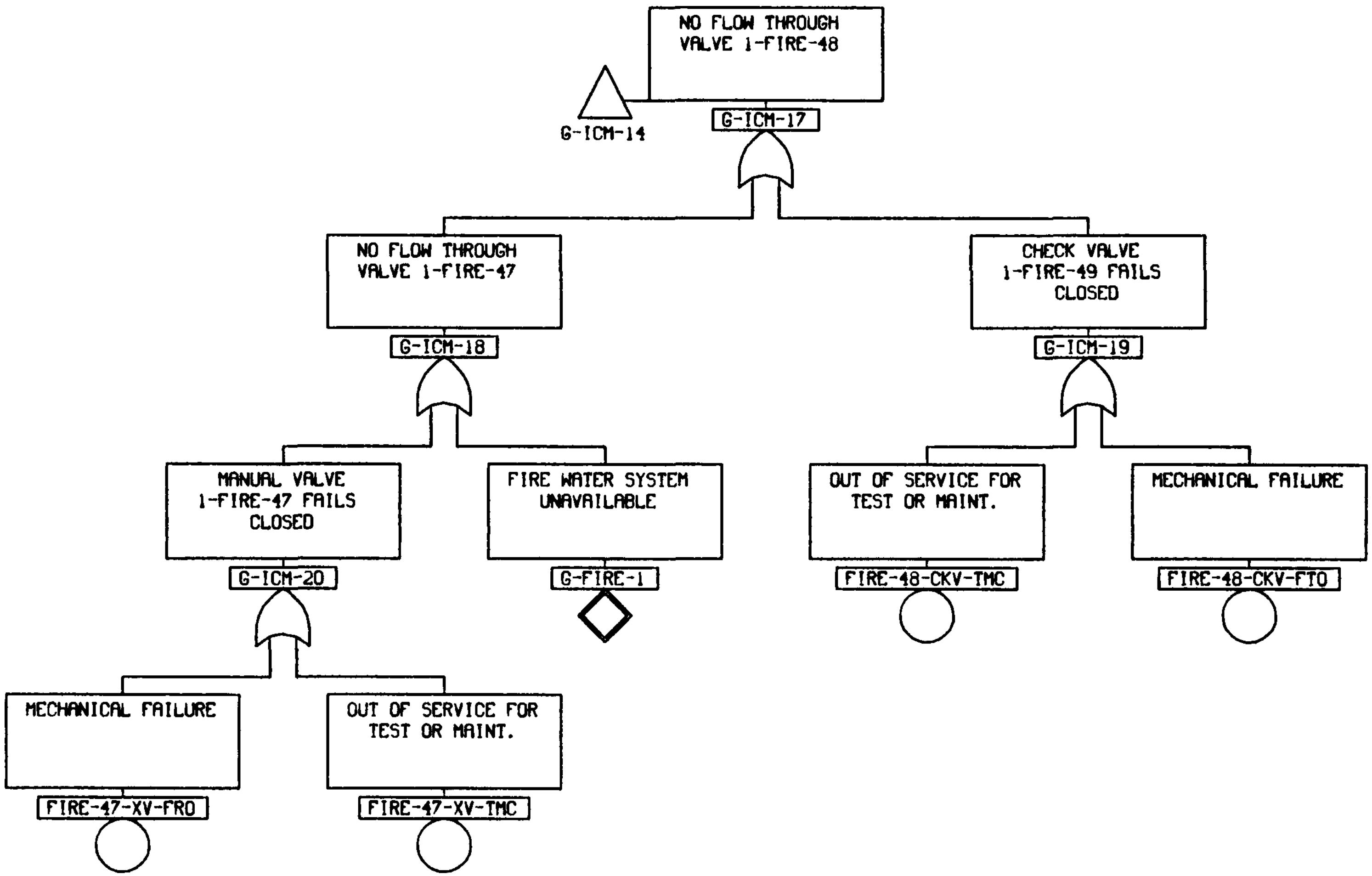

MOV 1-IC-10 FAILS CLOSED
G-ICM-6
G-ICM-4
MOV 1-IC-10 FAILS TO OPEN ON DEMAND
G-ICM-7
OPERATOR ERROR CLOSES MOV 1-IC-10 DURING TRANSIENT
ICM-10-MOV-OPC
MOV 1-IC-10 CLOSES SPURIOUSLY
G-ICM-10
NO CONTROL SIGNAL TO OPEN 1-IC-10
G-ICM-8
OUT OF SERVICE FOR TEST OR MAINT.
ICM-10-MOV-TMC
MECHANICAL AND LOCAL CIRCUIT FAILURES
ICM-10-MOV-FTO
LOSS OF AC POWER TO MCC-E1
G-AC-BUS-E1



NO CONTROL SIGNAL TO OPEN 1-IC-10
G-ICM-8
G-ICM-7
FAILURE OF BREAKER AT MCC-E1, CUB NO. 2C
AC-E1-2C-FRC
LEVEL SWITCH 1347C FAILS TO CLOSE ON LOW I.C. WATER LEVEL
G-ICM-9
LOSS OF 120V AC ON CONTROL POWER CIRCUIT
AC-E1-2C-LCC-LOF
OUT OF SERVICE FOR TEST OR MAINT.
LCL13051347C-TOM
INCORRECT CALIBRATION
LCL13051347C-OMC
L.S. 1347C FAILS
LCL13051347C-XFC


MOV 1-IC-10 CLOSES SPURIOUSLY
G-ICM-10
G-ICM-6
LEVEL SWITCH 1347A FAILS CLOSED - CONTACTS A2 AND A1
G-ICM-11
CONTACTS 3 AND 3T MANUAL SWITCH 403/ 1305-301 FAIL CLOSED
9031305-301-3RO
LEVEL SWITCH 1347B FAILS CLOSED - CONTACTS A2 AND A1
G-ICM-12
OUT OF SERVICE FOR TEST OR MAINT.
LCL13051347A-TOM
INCORRECT CALIBRATION
LCL13051347A-OMC
L.S. SWITCH 1347A FAILS
LCL13051347A-XRO
OUT OF SERVICE FOR TEST OR MAINT.
LCL13051347B-TOM
INCORRECT CALIBRATION
LCL13051347B-OMC
L.S. SWITCH 1347B FAILS
LCL13051347B-XRO


NO FLOW AT JUNCTION OF MAKEUP AND FIRE WATER SYSTEMS
G-ICM-13
G-ICM-4
NO FLOW THROUGH VALVE 1-FIRE-49
G-ICM-14
MANUAL VALVE 1-FIRE-50 FAILS CLOSED
G-ICM-15
MANUAL VALVE 1-FIRE-49 FAILS CLOSED
G-ICM-16
NO FLOW THROUGH VALVE 1-FIRE-48
G-ICM-17
MECHANICAL FAILURE
FIRE-50-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
FIRE-50-XV-TMC
MECHANICAL FAILURE
FIRE-49-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
FIRE-49-XV-TMC


NO FLOW THROUGH VALVE 1-FIRE-48
G-ICM-17
G-ICM-14
NO FLOW THROUGH VALVE 1-FIRE-47
G-ICM-18
CHECK VALVE 1-FIRE-49 FAILS CLOSED
G-ICM-19
MANUAL VALVE 1-FIRE-47 FAILS CLOSED
G-ICM-20
FIRE WATER SYSTEM UNAVAILABLE
G-FIRE-1
OUT OF SERVICE FOR TEST OR MAINT.
FIRE-48-CKV-TMC
MECHANICAL FAILURE
FIRE-48-CKV-FTO
MECHANICAL FAILURE
FIRE-47-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
FIRE-47-XV-TMC

APPENDIX B.10

VAPOR SUPPRESSION SYSTEM

B.10.1 Vapor Suppression System Description

B.10.1.1 Purpose

The purpose of the vapor suppression system is to provide overpressurization protection for the primary containment following a loss-of-coolant-accident. This system performs this function by providing a heat sink for the released steam. [Additionally the vapor suppression system supplies a heat sink for the automatic pressure relief system.]

B.10.1.2 Description and Configuration

The term "vapor suppression system", as applied in this report, means a conglomerate of the drywell, pressure suppression chamber (i.e., torus or wetwell), vent pipes, ring manifold, downcomer pipes and vacuum breaker valves. A schematic of the vapor suppression system is shown in Figure B.10-1.

The drywell is a steel pressure vessel with a spherical lower portion and cylindrical upper head. Access to the drywell may be made through the drywell head, a double door personnel air lock and a bolted equipment hatch. The drywell is connected to the torus by eight large circular vent pipes. The torus is a doughnut shaped steel pressure vessel which encircles the drywell and may be accessed through two manholes with double-gasketed covers.

The ring manifold, mounted approximately coaxially within the torus, and the downcomer pipes are designed to direct steam and water from the drywell, uniformly under the surface of the water in the torus. The vacuum breaker valves permit flow from the airspace in the suppression pool to the drywell to equalize pressure or to prevent collapse of the drywell walls due to a pressure differential.

B.10.1.3 System Interfaces

The vapor suppression system performs its function independently of all other plant systems. There are no components in the system that require cooling or AC or DC power.

B.10.1.4 Instrumentation and Control

The vapor suppression system is a pressure system which requires no instrumentation or control to operate. Instrumentation is provided to assure that the vapor suppression system is maintained in a condition which will allow it to perform its heat removal and pressure reduction function when required to do so. Table B.10-1 lists this instrumentation.

B.10.1.5 Testing

Testing of the vapor suppression system is performed to assure that it can perform its function. An integrated leak test of the system is performed along with numerous leak tests which are performed on components necessary to ensure vapor suppression system integrity. The following specific tests are also important:

SP 623.4 Suppression Chamber Water Level Check

The suppression chamber water level is checked daily to ascertain whether adequate water is in the suppression pool for post accident needs.

SP 623.5 Suppression Chamber Water Temperature Check

The suppression chamber water temperature is checked daily to ascertain whether suppression pool temperature exceeds specified limits.

B.10.1.6 Maintenance

There is no routinely scheduled maintenance for this system. Maintenance is performed on an as-needed basis.

B.10.1.7 Technical Specifications

During normal plant operation the following conditions must be maintained:

1. The water volume in the suppression chamber must be between 94,000 and 92,000 cubic feet (corresponding to a downcomer submergence of 4.9 and 4.7 ft., respectively). If both of the water level measuring systems are operable for six hours the reactor must be shut down within 24 hours.

2. The suppression pool water temperature, except during tests, must be 90^{o} F or less. (During tests the maximum temperature is 10^{o} F higher). The reactor is scrammed if water temperature in the torus reaches 110^{o}F.

3. Under normal conditions the drywell torus differential pressure must be at least 1 psig. If the differential pressure monitoring system is inoperable for six hours the plant must be shut down within 24 hours.

The technical specifications require that the above conditions be checked at least one per shift. Additionally, the suppression pool to reactor building instrumentation and set points must be checked every three months.

An integrated leak rate test must be performed at least three times every ten years with component leak rate tests performed on a more frequent basis.

B.10.1.8 Operation

In the event of a LOCA, steam is conducted from the drywell through the vent lines and into the ring header in the torus. From there, it is conducted through the downcomer pipes under the surface of the water in the torus. The steam is then condensed, limiting the pressure transient in the primary containment.

[In a similar fashion, steam released during safety/relief value operation passes through each valve and its associated discharge line to a point below the water level in the torus where it is condensed.]

During normal operation, the drywell atmosphere is inerted with nitrogen to prevent fuel-water interaction in the event of a loss-of-coolant accident.

B.10.2 Analysis

B.10.2.1 Success/Failure Criterion

Successful functioning of the vapor suppression system requires condensation of an adequate amount of steam generated by a LOCA to prevent primary containment overpressurization.

B.10.2.2 Assumptions

The vapor suppression system used in Millstone Point is essentially the same as that used in Peach Bottom, which was analyzed in WASH-1400. Thus, the assumptions used as the basis for determining the unavailability of the vapor suppression system at Peach Bottom were reviewed to determine their applicability for the Millstone analysis. On the basis of the similar design and applicable assumptions used in the WASH-1400 analysis, the availability for the vapor suppression system at Millstone was judged to be similar to that at Peach Bottom.

The median unavailabilities developed in the WASH-1400 analysis were used in this Millstone analysis. They are:

Probability of the vapor suppression system not functioning following a small LOCA = 1.6×10^{-3}

Probability of the vapor suppression system not functioning following a large LOCA = 4.6×10^{-5}.

Table B.10-1

Vapor Suppression Instrumentation

Instrument	Range	Normal
Suppression Pool Water Level	-10" to +10"	4" - 5"
Pressure Meter	-5 to +5 psig	atmospheric
Suppression Pool Water Temperature Recorder		<90°F

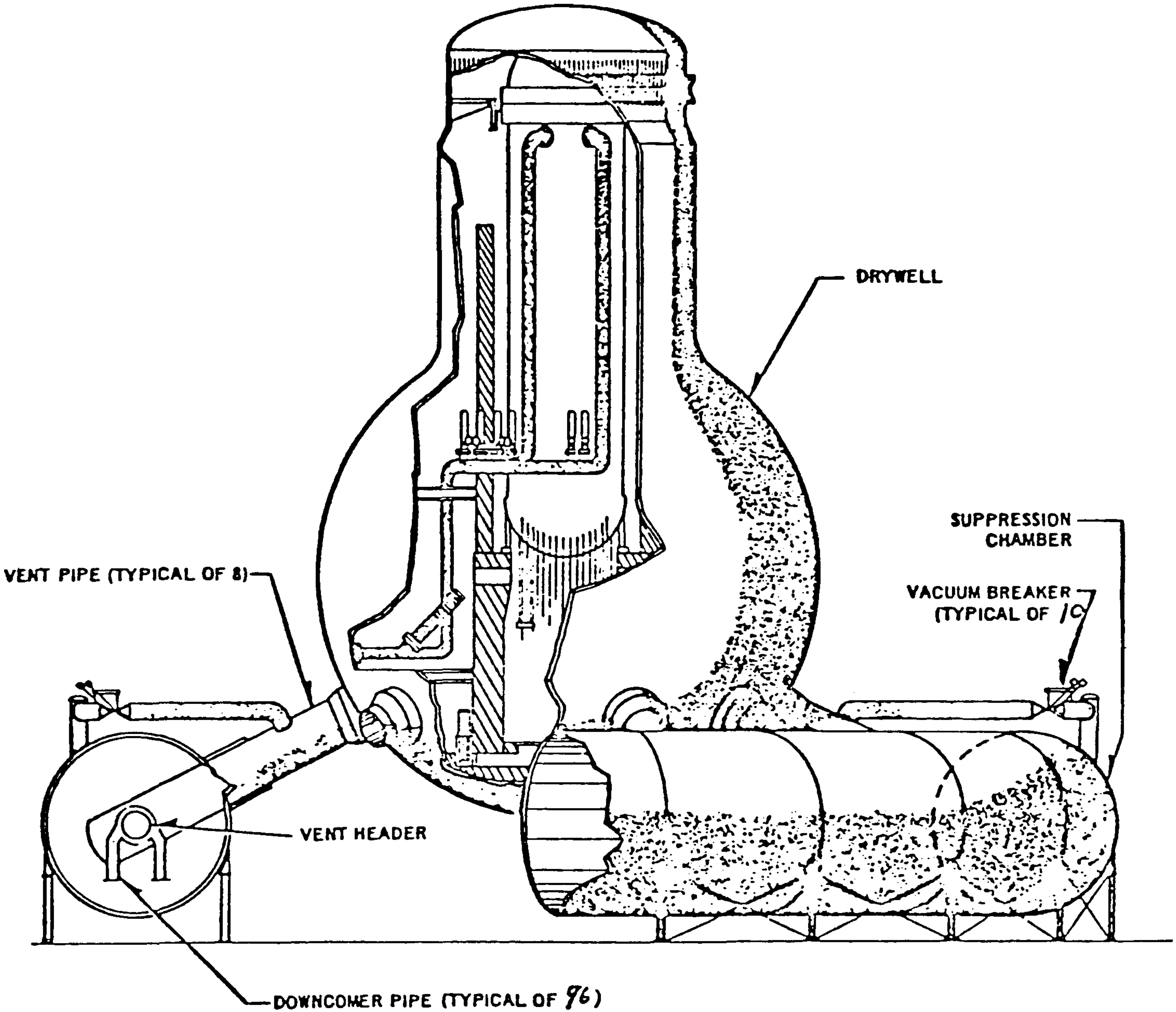


FIGURE B.10-1. VAPOR SUPPRESSION SYSTEM

APPENDIX B.11

STATION AIR SYSTEM

B.11.1 Station Air System Description

B.11.1.1 Purpose

The station air system provides clean dry air for pneumatic controls. The air system also provides utility air for pneumatic tools, filter system, tanks, and emergency breathing air. This analysis only considers the air supply to the main steam safety-relief valves and feedwater regulator valves.

B.11.1.2 Description and Configuration

The station air system includes both the instrument air and service systems (see Figure B.11-1 for the flow configuration of these plant air systems). The instrument air system consists of one teflon ring non-lubricated air compressor with intake filter and aftercooler, one receiver, one filter-dryer and associated piping. The function of the system is to supply instrument and control air for the entire station on a continuous basis and to provide a backup for the service and sparging air systems. The service and instrument air systems are interconnected at their respective receiver outlets.

The service air system consists of one teflon ring nonlubricated compressor with intake filter and aftercooler, one receiver and associated piping. The function of the system is to supply service air requirements on an intermittent basis for breathing and backwash operations, and to provide a backup for both the instrument air and sparging air systems.

Both the instrument and service air compressor normally operate continuously on an automatic load-unload basis. However, either compressor can meet total instrument and service air requirements operating alone. There is a backup instrument air supply to the drywell which provides air to vital equipment in the event that an air system failure were to occur. The backup air supply has two banks of cylinders, containing 3 bottles each which supply air to the drywell air supply line, ultimately feeding a header through a reducer which maintains pressure at 85 psig.

B.11.1.3 System Interfaces

System interfaces for the instrument air system are shown in Table B.11-1.

B.11.1.4 Instrumentation and Control

Automatic operation of the plant air system is dependent on several pressure alarm switches. When in the standby mode, the instrument and service air compressors start when air pressure in the instrument air header decreases to 85 psig. The service air compressor starts when the instrument air receiver pressure decreases to 90 psig or when the service air receiver pressure drops to 85 psig. Table B.11-2 shows the various instruments and setpoints used.

Manual control of both the service and instrument air compressors if possible via local control switches on each compressor. Figure B.11-2 shows the control circuitry used for manual and automatic system operation.

B.11.1.5 Testing

Standard preoperational tests were performed after installation, as indicated in OP 333. Since these systems are in continuous use, periodic testing is not required.

B.11.1.6 Maintenance

There is no routinely scheduled maintenance for this system; however, the maintenance is performed on an as-needed basis.

B.11.1.7 Technical Specification

There are no specific technical specifications for this system.

B.11.1.8 Operation

Under normal conditions, one compressor is operating in the automatic load-unload mode and one compressor is in the standby mode. When in standby mode, the instrument and service air compressors will both start when air pressure in the instrument air header decreases to 85 psig. The service air compressor will start when the instrument air receiver pressure decreases to 90 psig or if its receiver pressure drops to 85 psig. The plant air systems can also be used as a backup to the radwaste sparging air blowers. Check valves on the instrument and service air receiver inlets would close if the compressors shutdown or an air leak develops upstream of either receiver. A check valve on the instrument air receiver outlet closes in the case of an instrument air receiver leak or if the instrument air receiver drain was left open accidentally, preventing backup air from escaping. If both compressors become inoperative and the instrument air receiver outlet check valve closes, the service air receiver, which is larger than the instrument air receiver, has sufficient capacity to ensure a safe plant shudown. To prevent excessive loss of service air pressure, which may impair the capacity of the service air system to back up the instrument air system, a pressure regulator (SA-5) is provided in the service air supply line to the plant to prevent service air usage from drawing the receiver pressure below 80 psig.

The service air provides backup to the instrument air system. Should instrument air pressure fall below 93 psig, a cross connection with a pressure regulator (SA-23) is located between the instrument air receiver discharge and the service air receiver discharge to maintain instrument air pressure.

In addition to the aforementioned protective devices, the following have been provided to ensure continuous plant operation:

1) The instrument air backup to service air line has pressure control valves (IA-34 and IA-35) which maintain service air pressure at 85 psig on the service air header.

2) The service air receiver has a check valve on the outlet side to prevent backup instrument air from escaping in the event of leakage from the service air receiver.

In the event that both compressors are inoperative and the instrument air system becomes isolated from the service air system, the instrument air receiver has sufficient capacity to provide air (above 70 psig), to all essential equipment for at least four minutes after shutdown is initiated. In addition, each main steam isolation valve and pressure relief valve is provided with an accumulator which retains its initial air charge at a pressure of 105 psig by means of an inlet check valve. Each main steam isolation valve accumulator has sufficient capacity to close its respective valve while maintaining a pressure over 90 psig on the actuator.

The instrument air dryer consists of two drying towers, each containing: activated alumina as a desiccant, a 6.5 KW heater necessary for reactivating the desiccant, flow, moisture, temperature, and pressure indicators, a relief valve and two thermostats (over temp and under temp) with associated alarms. The unit also has a timer which controls the automatic operation of each tower.

In normal operation of the dryer, one tower is in service drying the instrument air) while the other tower is being activated. One tower will operate to dry air for four hours. After four hours a timer will automatically switch over the 4-way solenoid valve to the other tower and commence reactivation of the now shutdown tower.

B.11.2 Analysis

B.11.2.1 Success/Failure Criteria

Success of the plant air system requires that air be supplied to the main steam safety relief valves and feedwater regulator valves as needed for valve operation.

B.11.2.2 Assumptions

1) In this analysis, the following assumptions are made: There are many small lines diverging from the instrument header to the various equipment. It is assumed that no leak will develop in these equip- ment connections.

2) The valves on the small drain and trap lines are not included in the analysis.

3) A back-up compressor is connected to the station air system but it is not included in the analysis.

Table B.11-1

Station Air Interfaces Failure Mode and Effects

Primary System			Support System			Failure Mode	Failure Effect
System	Div.	Comp.	System	Div.	Comp.		
AIR		Station Air Compressor	TBSCCW		Pump Ht. Exch.	Loss of TBSCCW flow	Compressor overheats
AIR		Station Air Compressor motor	A/C	D/G	Bus 12C	Low or zero voltage	Motor concurrent failure to start or run (CFSR) possible motor burnout
Instrument AIR		Instr. Air Header pressure switch PS/5-3A	DC Pwr		Bus 11A2	Low or zero voltage	Compressor will not start or run automatically on low system pressure
Station AIR		Air Receiver low pressure switch PS/5-13B	DC Pwr		Bus 101A	Low or zero voltage	Unable to detect the low pressure in either air receiver and both compresssors will not start
Station AIR		PS/5-13A					
Air		Instrument Air Compressor	TBSCCW		Pump Ht. Exch.	Loss of TBSCCW flow	Compressor overheats
Air		Instrument Air Compressor Motor	AC	D/G	Bus 12F	Low or zero voltage	CFSR, possible motor burnout

Table B.11-2

Station Air System Instrumentation

Instrument	Function	Setpoint
PS 5-3	Instrument station air header low pressure alarm; starts compressor (either station or instrument air compressor)	< 85 psig
TS 5-5 PS 5-26	Station air compressor trip: temperature switch and pressure switch	trips at 330°F trips at 15 psig oil pressure
TS 5-6	Instrument Air Compressor trip; temperature switch	trips at 330°F
PS 5-27	pressure switch	trips at 15 psig oil pressure
PS 5-13A	Instrument air receiver low pressure switch; starts instrument air compressor	starts compressor at <90 psig air receiver pressure
PS 5-13B	Station air receiver low pressure switch; starts station air compressor	starts compressor at <85 psig air receiver pressure
PS 5-18	Instrument air low pressure alarm	85 psig

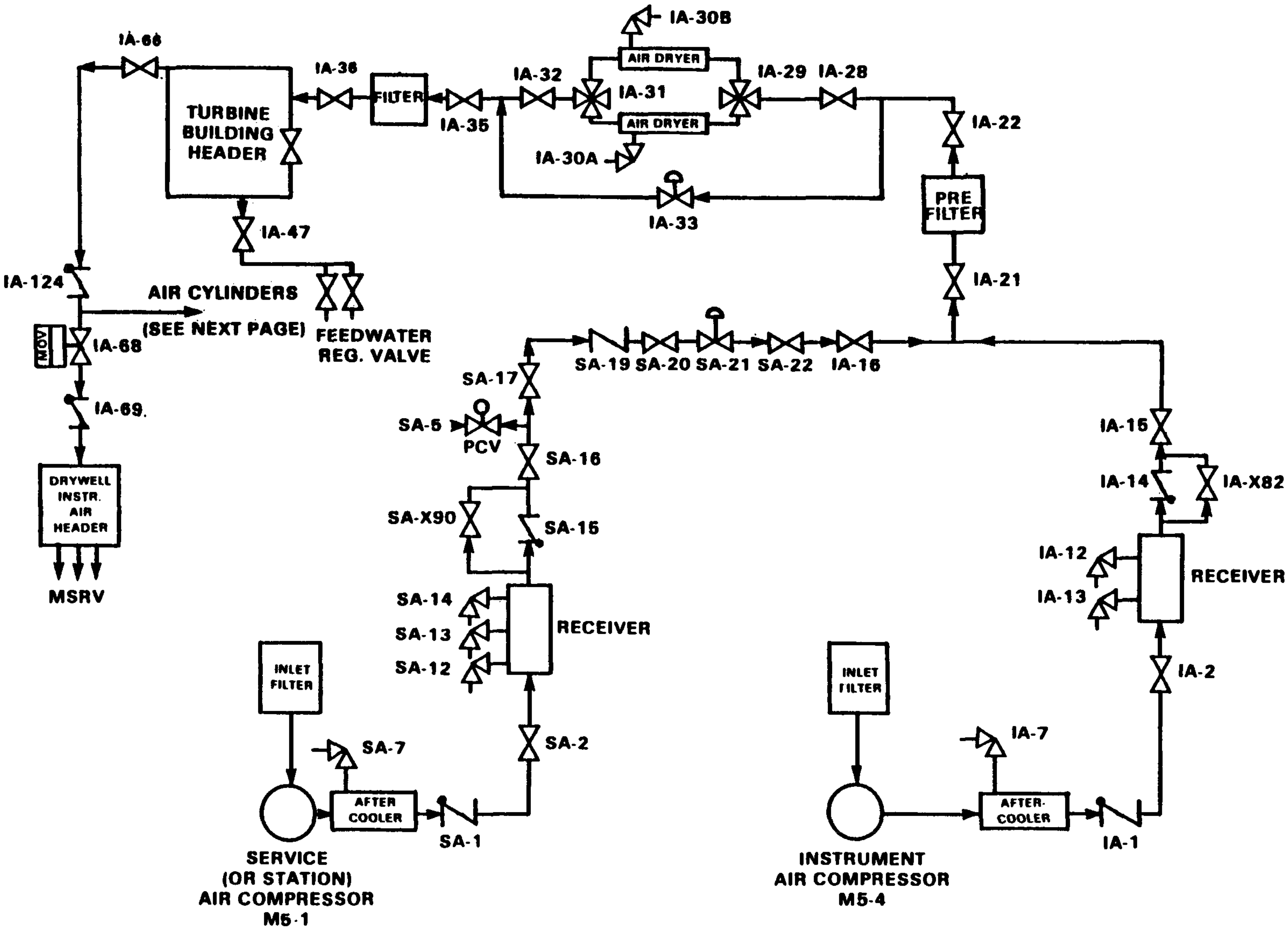


FIGURE B.11-1. SERVICE/INSTRUMENT AIR SYSTEM (SHEET 1 OF 2)

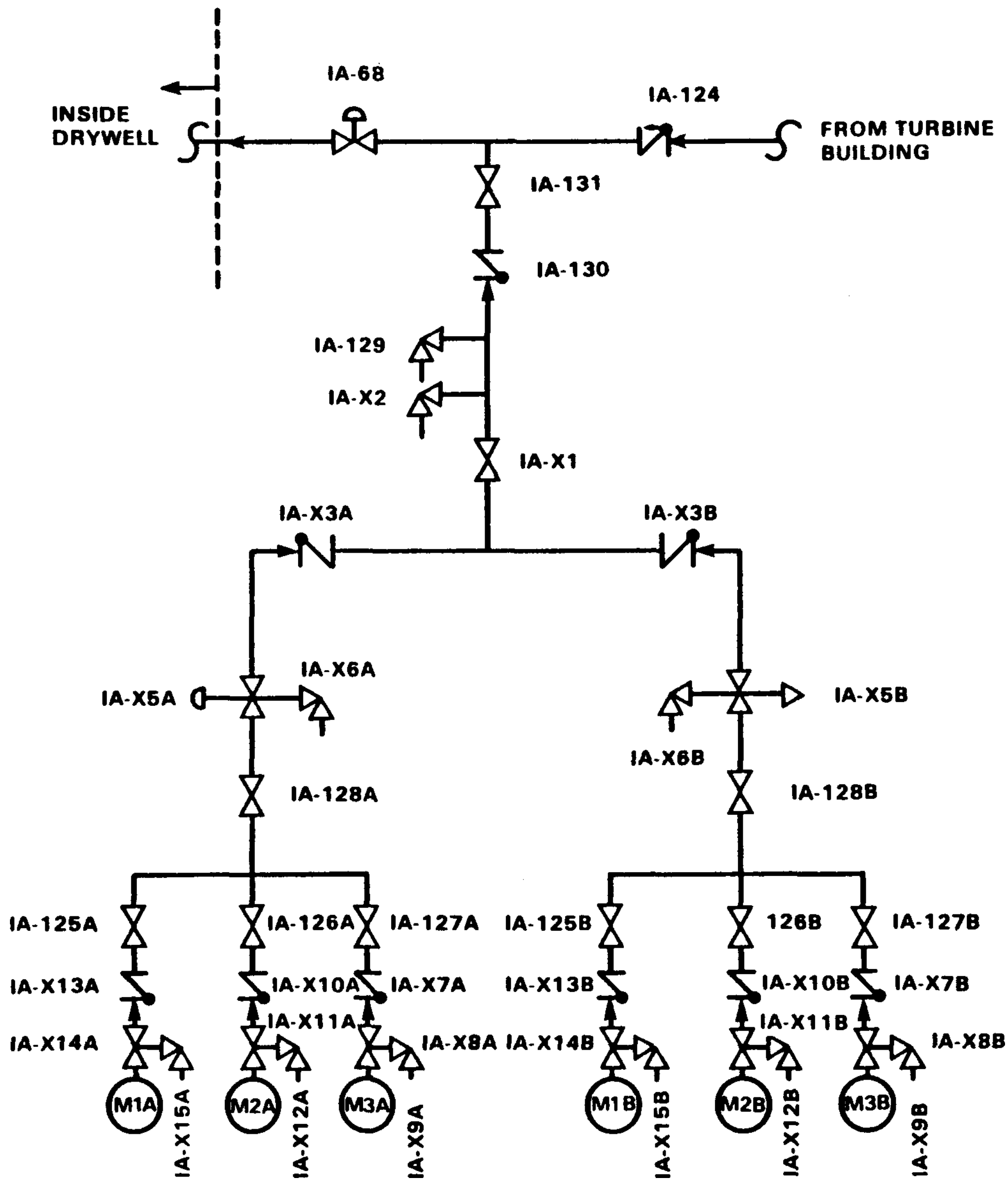


FIGURE B.11-1. INSTRUMENT AIR/AIR CYLINDERS (SHEET 2 OF 2)

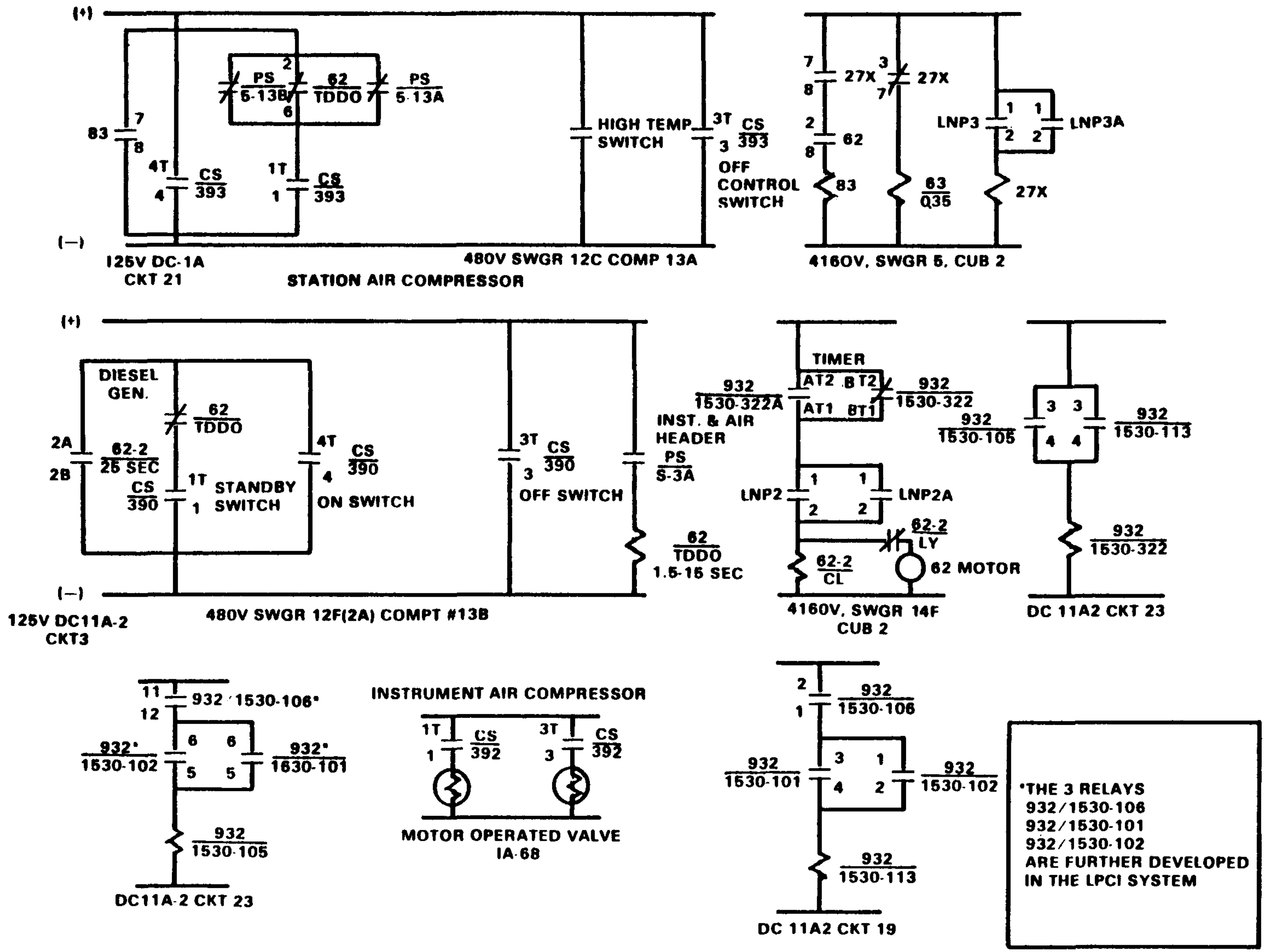


FIGURE B.11-2. STATION AIR SYSTEM CONTROL WIRING SCHEMATICS

STATION AIR SYSTEM

FAULT TREE AND FAULT SUMMARY SHEETS

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
IA-69-CKV-FRO IA-124-CKV-FRO IA-14-CKV-FRO IA-1-CKV-FRO SA-19-CKV-FRO SA-15-CKV-FRO IA-130-CKV-FRO SA-1-CKV-FRO IA-X7A-CKV-FRO IA-X10A-CKV-FRO IA-X13A-CKV-FRO IA-X3A-CKV-FRO IA-X7B-CKV-FRO IA-X10B-CKV-FRO IA-X13B-CKV-FRO IA-X3B-CKV-FRO	Check valve fails to remain open	Prompt	Continuously running system, loss of air flow would be noted immediately	7.2E-6
IA-69-CKV-TMC IA-124-CKV-TMC IA-14-CKV-TMC IA-1-CKV-TMC SA-19-CKV-TMC SA-15-CKV-TMC SA-1-CKV-TMC IA-X3B-CKV-TMC IA-X3A-CKV-TMC IA-X7A-CKV-TMC IA-X10A-CKV-TMC IA-X13A-CKV-TMC IA-130-CKV-TMC IA-X7B-CKV-TMC IA-X10B-CKV-TMC IA-X13B-CKV-TMC	Check valve is out of service for maintenance	Prompt	Continuously running system, loss of air flow would be immediately detected	3.0E-6

MILLSTONE 1
SYSTEM SIA
SHEET #1

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
IA-66-XV-FRO IA-36-XV-FRO IA-47-XV-FRO IA-35-XV-FRO IA-32-XV-FRO IA-31-XV-FRO IA-29-XV-FRO IA-28-XV-FRO IA-22-XV-FRO IA-21-XV-FRO IA-15-XV-FRO IA-X82-XV-FRO IA-2-XV-FRO IA-16-XV-FRO SA-22-XV-FRO SA-16-XV-FRO SA-17-XV-FRO SA-20-XV-FRO SA-X90-XV-FRO SA-2-XV-FRO IA-131-XV-FRO IA-128B-XV-FRO IA-127B-XV-FRO IA-126B-XV-FRO IA-125B-XV-FRO IA-X14B-XV-FRO IA-X8B-XV-FRO IA-X8A-XV-FRO IA-X11B-XV-FRO IA-X11A-XV-FRO IA-X14A-XV-FRO IA-125A-XV-FRO	Manual valve fails to remain open	Prompt	Continuously running system, loss of air flow is immediately noted	6.7E-6

MILLSTONE 1
SYSTEM SIA
SHEET #2

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
IA-126A-XV-FRO IA-127A-XV-FRO IA-128A-XV-FRO	Manual valve fails to remain open	Prompt	Cotinuously running system, loss of flow is immediately noted	6.7E-6
IA-66-XV-TMC IA-36-XV-TMC IA-47-XV-TMC IA-35-XV-TMC IA-32-XV-TMC IA-31-XV-TMC IA-29-XV-TMC IA-28-XV-TMC IA-22-XV-TMC IA-21-XV-TMC IA-15-XV-TMC IA-X82-XV-TMC IA-2-XV-TMC IA-16-XV-TMC SA-22-XV-TMC SA-20-XV-TMC SA-17-XV-TMC SA-16-XV-TMC SA-X90-XV-TMC SA-2-XV-TMC SA-131-XV-TMC IA-128B-XV-TMC IA-127B-XV-TMC IA-126B-XV-TMC IA-125B-XV-TMC IA-X14B-XV-TMC IA-X8B-XV-TMC IA-X8A-XV-TMC	Manual valve is out of service due to maintenance	Prompt	Air system is in operation continuously	3.0E-6

MILLSTONE 1
SYSTEM SIA
SHEET #3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
IA-X11B-XV-TMC IA-X11A-XV-TMC IA-X14A-XV-TMC IA-X8A-XV-TMC	Manual valve is out of service due to maintenance	Prompt	Air system is in operation contin-uously	3.0E-6
IA-126A-XV-TMC IA-125A-XV-TMC IA-127A-XV-TMC IA-128A-XV-TMC	Manual valve is out due to test or maintenance	Prompt	Continuously running system, loss of air flow is immediately detected	3.0E-6
IA-68-MOV-FRO	Motor operated valve fails to remain open	Prompt	Continuously oper-ating system	6.7E-5
IA-X1-PHV-FRO SA-21-PHV-FRO IA-X5B-PHV-FRO IA-33-PHV-FRO	Hydraulic/pneumatic valve fails to re-main open	Prompt	Continuously oper-ating system	7.2E-6
SA-21-PHV-TMC IA-33-PHV-TMC IA-X5B-PHV-TMC IA-X1-PHV-TMC IA-68-MOV-TMC	The valve is out of service test or maintenance	Prompt	Continuously oper-ating system	2.8E-6
SA-5-PHV-FTC	Pneumatic/hydraulic valve fails to close	Prompt		2.4E-6

MILLSTONE 1
SYSTEM SIA
SHEET #4

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
IA-12-SRV-FRC IA-X2-SRV-FRC IA-13-SRV-FRC IA-7-SRV-FRC SA-14-SRV-FRC SA-13-SRV-FRC SA-12-SRV-FRC IA-X12B-SRV-FRC IA-X15B-SRV-FRC IA-X9B-SRV-FRC IA-X6B-SRV-FRC IA-X6A-SRV-FRC SA-7-SRV-FRC IA-129-SRV-FRC IA-30B-SRV-FRO IA-30A-SRV-FRC IA-X9A-SRV-FRC IA-X15A-SRV-FRC	Safety relief valve fails to remain closed	Prompt	System pressure monitored	7.2E-5
IA-PF-FIL-LOF SA-PF-FIL-LOF IA-IF-FIL-LOF IA-F-FIL-LOF	Filter fails due to fouling	Prompt	System flow monitored	8.7E-3
SA-M53-TNK-LOF IA-M56-TNK-LOF IA-M1A-TNK-LOF IA-M2A-TNK-LOF IA-M3A-TNK-LOF IA-M1B-TNK-LOF IA-M2B-TNK-LOF IA-M3B-TNK-LOF	Air receiver leaks	Prompt		3.37E-4

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
IA-M54-CPR-OSP SA-M51-CPR-OSP	Operator stops compressor acci-dentally during accident			3E-3
IA-M54-CPR-LOF SA-M51-CPR-LOF	Mechanical faults of compressor	Prompt		7.2E-4
IA-M54-CPR-TOM SA-M51-CPR-TOM	Compressor is out of service for maintenance	Prompt		7.2E-4
AC-F3-2A-FTC AC-12F-13B-FTC AC-12C-13A-FTC	Breaker fails to close	Prompt		7.2E-5
906CS-392-1FC 906CS-390-1FC 906CS-390-4FC 906CS-393-1FC 906CS-393-4FC	Control switch con-tact pair fails to close	12000 hrs (refuel)	The system can run for the entire fuel cycle without manual actions	6.0E-4
906CS-392-FTE 906CS-390-FTE 906CS-393-FTE	Control switch fails to activate	12000 hrs (refuel)	The system may run for the entire fuel cycle without the need for operator action	1.7E-4

MILLSTONE 1
SYSTEM SIA
SHEET #6

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
IA-M54-CPR-OFS SA-M51-CPR-OFS IA-68-MOV-OFO	Operator fails to activate the control switch to start compressor or fails to open the M.O. valve			1.0E-2
IA-68-MOV-OPC	Operator inadvertantly closes valve IA-68			3.0E-3
90662-TDDO-XRC	Time delay relay contact pairs fail to remain closed	Prompt		7.2E-7
90662-TDDO-FTD	Relay coil fails to energize	Prompt		E-4
LCLPS-5-3A-XFC LCLTS-5-5-XFC LCLTS-5-6-XFC LCLPS-5-26-XFC LCLPS-5-27-XFC	Sensor switch fails to operate	Prompt		9.1E-6
LCLPS-5-13B-OMC LCLPS-5-13A-OMC LCLPS-5-27-OMC LCLTS-5-5-OMC LCLTS-5-6-OMC LCLPS-5-3A-OMC LCLPS-5-26-OMC	Operator miscalibrates the sensor			1E-3

MILLSTONE 1
SYSTEM SIA
SHEET #7

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
LCLPS-5-3A-TOM LCLPS-5-26-TOM LCLPS-5-27-TOM LCLTS-5-5-TOM LCLTS-5-6-TOM LCLPS-5-13A-TOM LCLPS-5-13B-TOM	Sensor is out for test or maintenance		Condition is detected at the following test	1E-2
926622-15-2FC 9321530-322-XFC 9321530-105-3FC 9321530-113-3FC 92683-7FC 92627X-2FC 926LNP-3-1FC 926LNP-3A-1FC 9321530-106-11FC 9321530-101-5FC 9321530-102-5FC 9321530-106-1FC 9321530-101-3FC 9321530-102-1FC 926LNP-2-1FC 926-LNP-2A-1FC	Relay contact pairs fail to close	Prompt		7.2E-6
926622-15-FTE 9321530-105-FTE 9321530-113-FTE 92683-FTE 92627X-FTE	Relay coil fails to renergize	Prompt		7.2E-6

MILLSTONE 1
SYSTEM SIA
SHEET #8

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
92662-FTE 9321530-106-FTE 9321530-101-FTE 9321530-102-FTE	Relay coil fails to energize		These coils are developed as part of the LPCI system.	
LCLPS-5-13A-XRC LCLPS-5-13B-XRC	Pressure switch fails to remain closed	Prompt		7.2E-7
92662-2RC 92627X-3RC	Contacts pair fails to remain closed	Prompt		2.4E-6
9321530-352A-XRC	Manual switch contact pair fails to remain closed	Prompt		7.2E-7
IA-M57A-HTX-LOF IA-M57B-HTX-LOF	Air dryer loss of function		Heat exchanger data from NPRDS	2E-4
IA-M55-HTX-LOF SA-M52-HTX-LOF IA-M52-HTX-LOF	After cooler loss of function		Heat exchanger data from NPRDS	2E-4

MILLSTONE 1
SYSTEM SIA
SHEET #9

SIA FAULT TREE PAGE INDEX

GATE NAME	DEFINED ON PAGE	TRANSFERS TO PAGE(S)
G-IA-APR	SIA-1	--
G-SIA-6	SIA-2	SIA-1, SIA-15
G-SIA-10	SIA-3	SIA-2
G-SIA-15	SIA-4	SIA-3
G-SIA-17	SIA-5	SIA-2,SIA-4
G-SIA-21	SIA-6	SIA-5
G-SIA-24	SIA-7	SIA-6
G-SIA-30	SIA-8	SIA-5
G-SIA-34	SIA-9	SIA-8
G-SIA-39	SIA-10	SIA-9
G-SIA-40	SIA-11	SIA-9,SIA-10
G-SIA-45	SIA-12	SIA-1
G-SIA-50	SIA-13	SIA-12
G-SIA-53	SIA-14	SIA-13
G-IA-FW-5A-PHV	SIA-15	--
G-IA-FW-5B-PHV	SIA-15	--
G-SIA-61	SIA-16	SIA-14
G-SIA-64	SIA-17	SIA-14
G-SIA-67	SIA-18	SIA-1
G-SIA-70	SIA-19	SIA-11
G-SIA-73	SIA-20	SIA-7
G-SIA-77	SIA-21	SIA-20
G-SIA-81	SIA-22	SIA-21,SIA-28
G-SIA-84	SIA-23	SIA-21
G-SIA-89	SIA-24	SIA-23
G-SIA-92	SIA-25	SIA-24
G-SIA-93	SIA-26	SIA-24
G-SIA-98	SIA-27	SIA-19
G-SIA-101	SIA-28	SIA-27
G-SIA-104	SIA-29	SIA-27
G-SIA-107	SIA-30	SIA-29
G-SIA-110	SIA-31	SIA-29
G-SIA-112	SIA-32	SIA-19
G-SIA-113	SIA-32	SIA-20
G-SIA-114	SIA-33	SIA-22
G-SIA-115	SIA-33	SIA-19
G-SIA-116	SIA-34	SIA-20
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G-SIA-125	SIA-39	SIA-12
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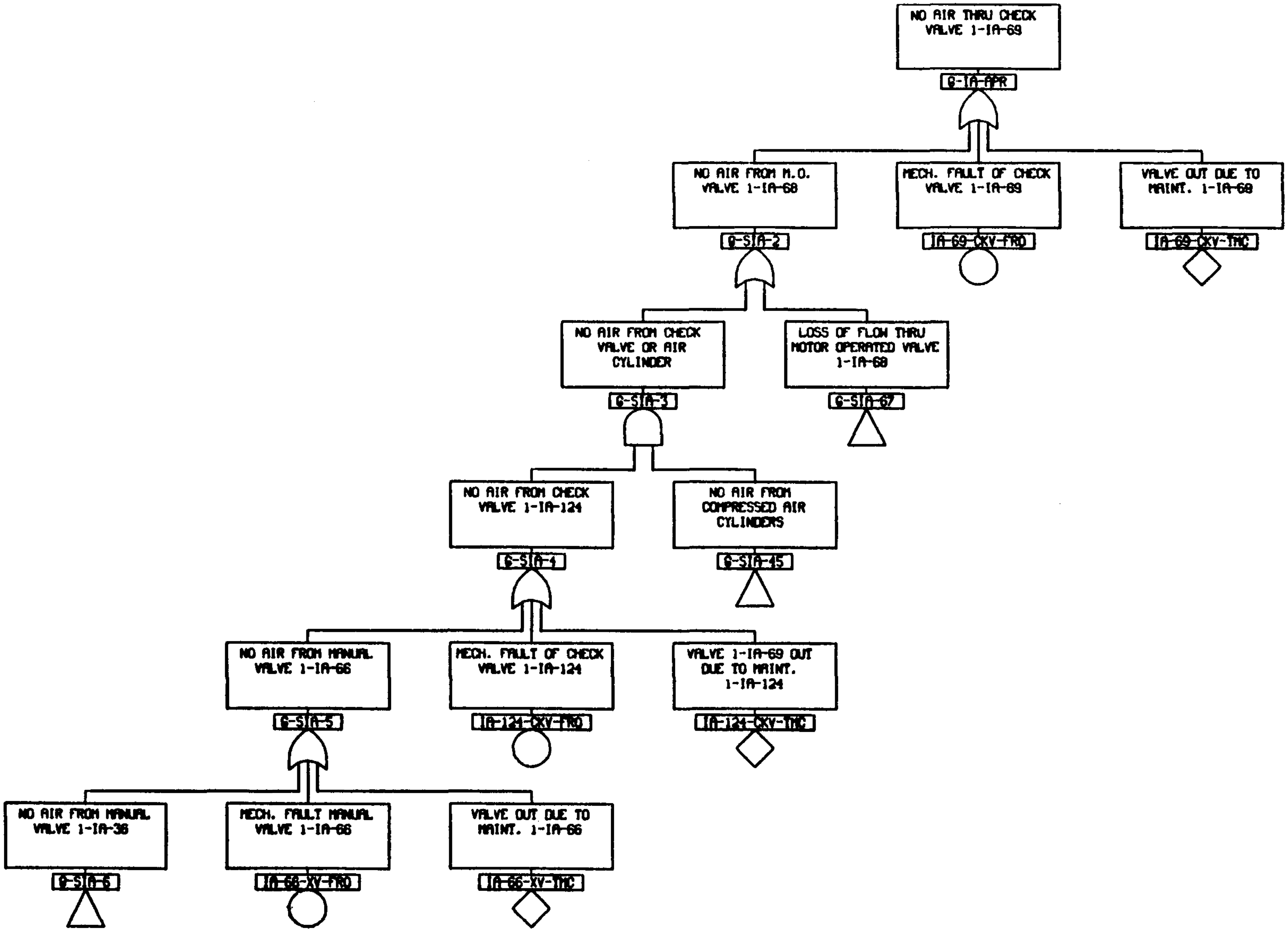
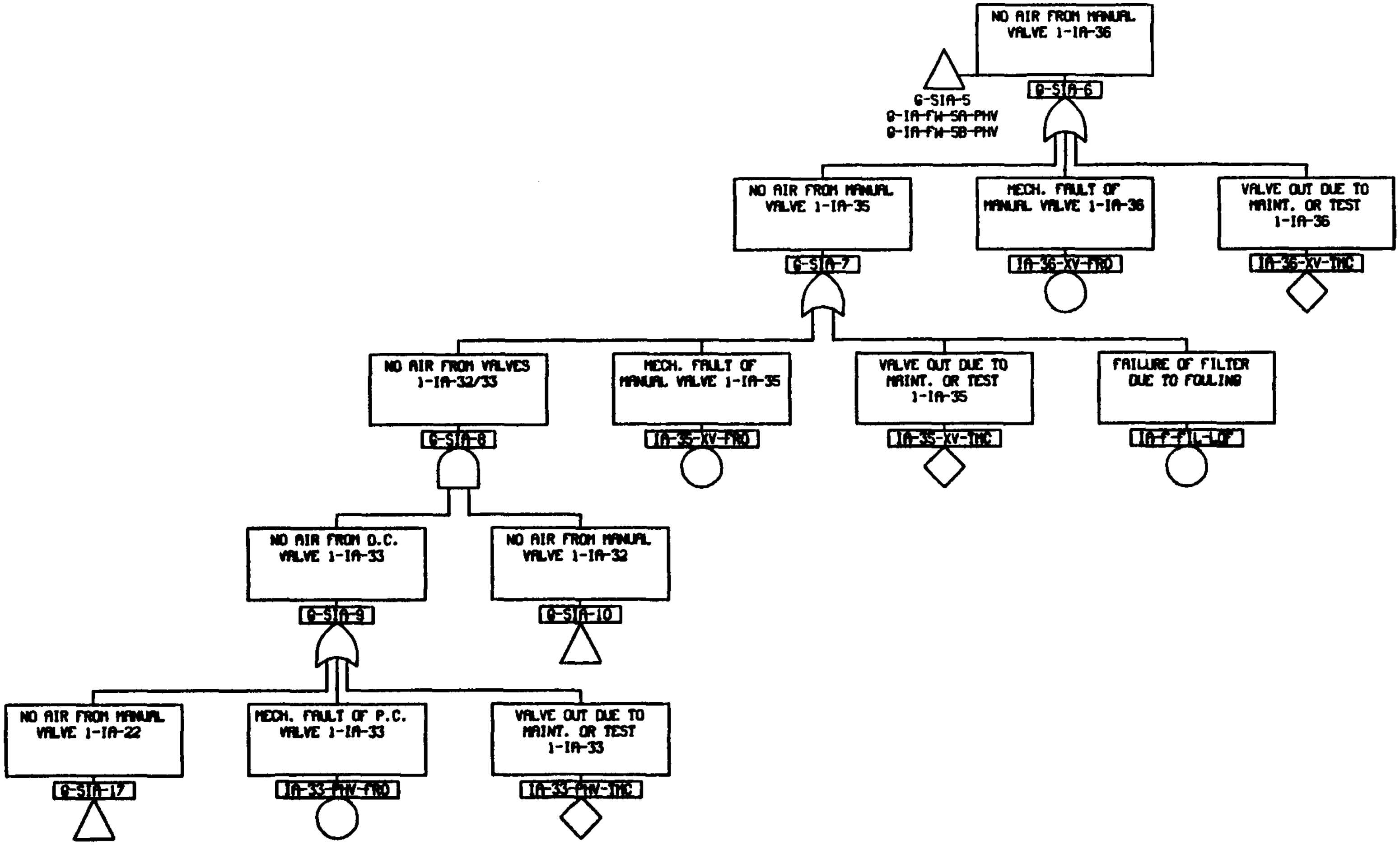
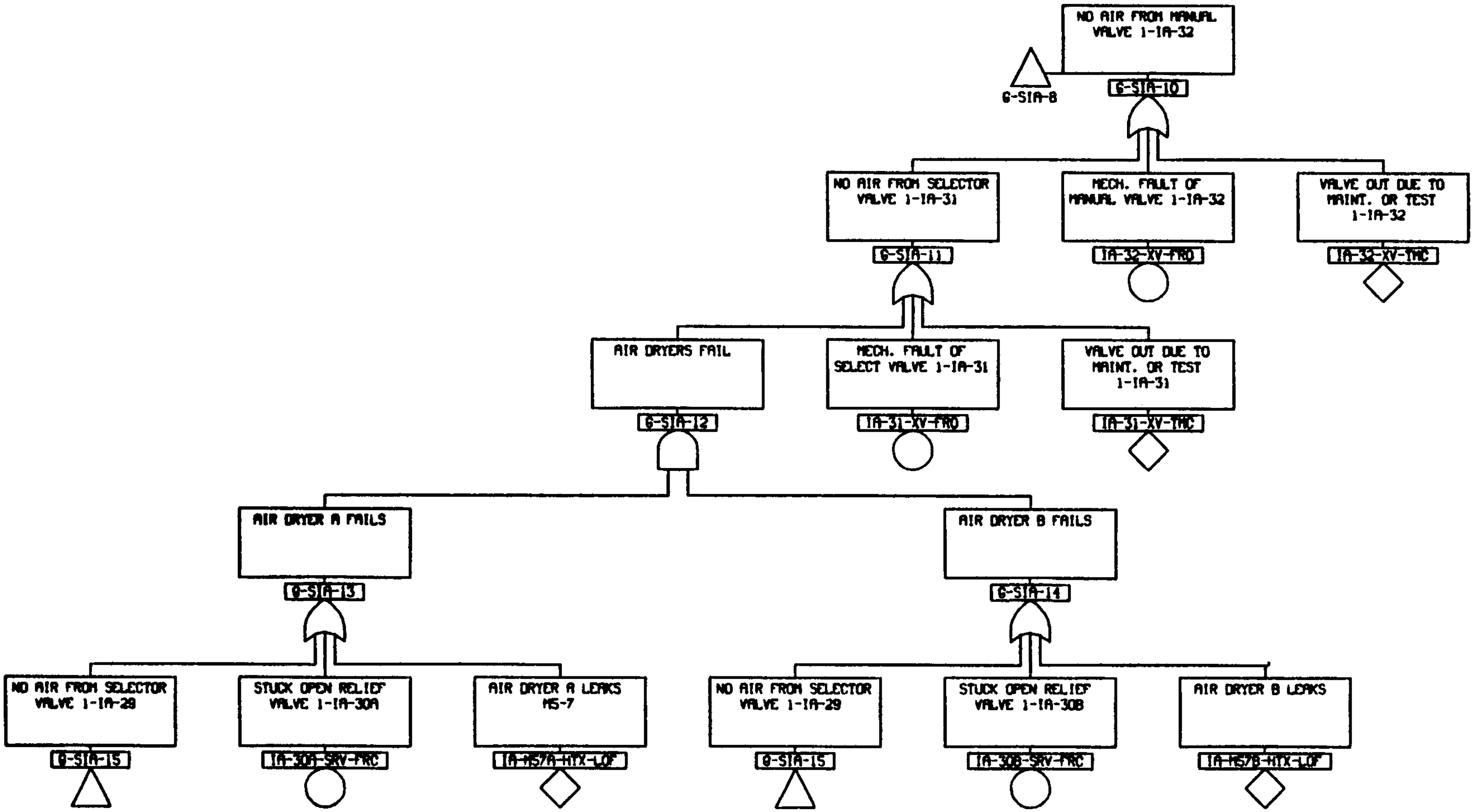
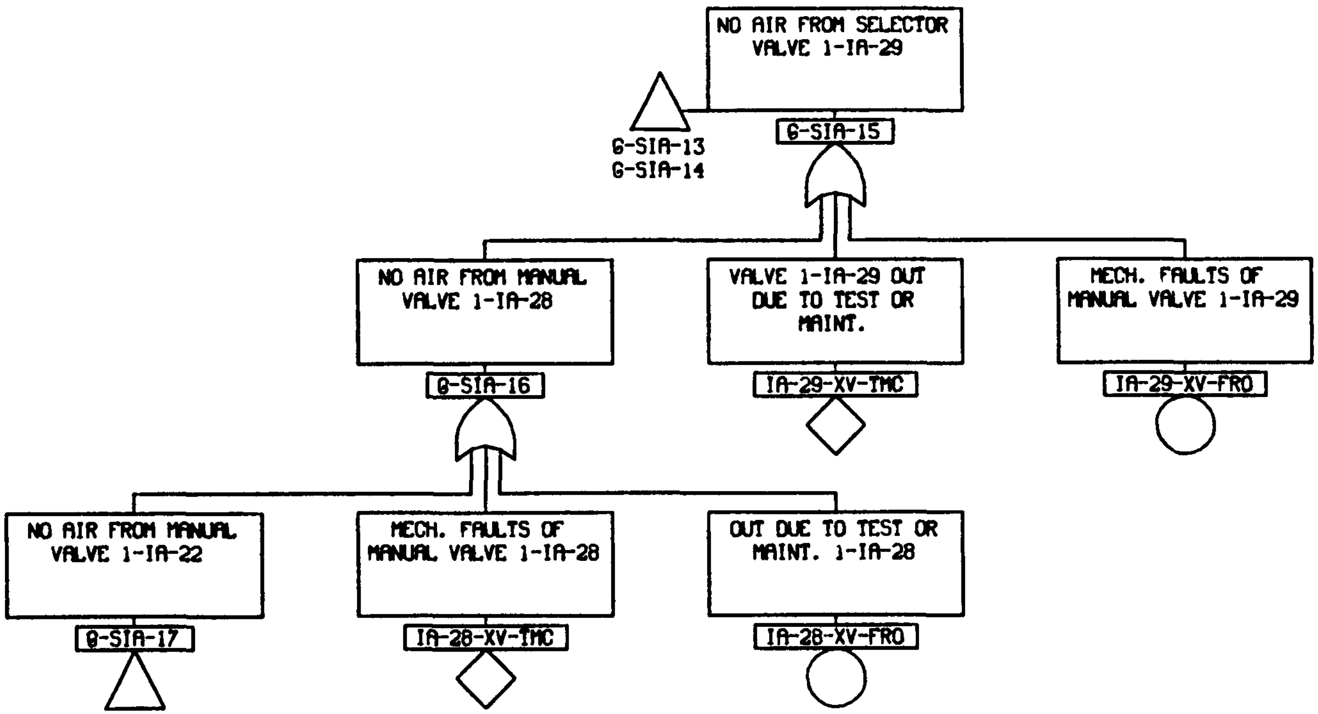
G-SIA-135	SIA-42	SIA-40

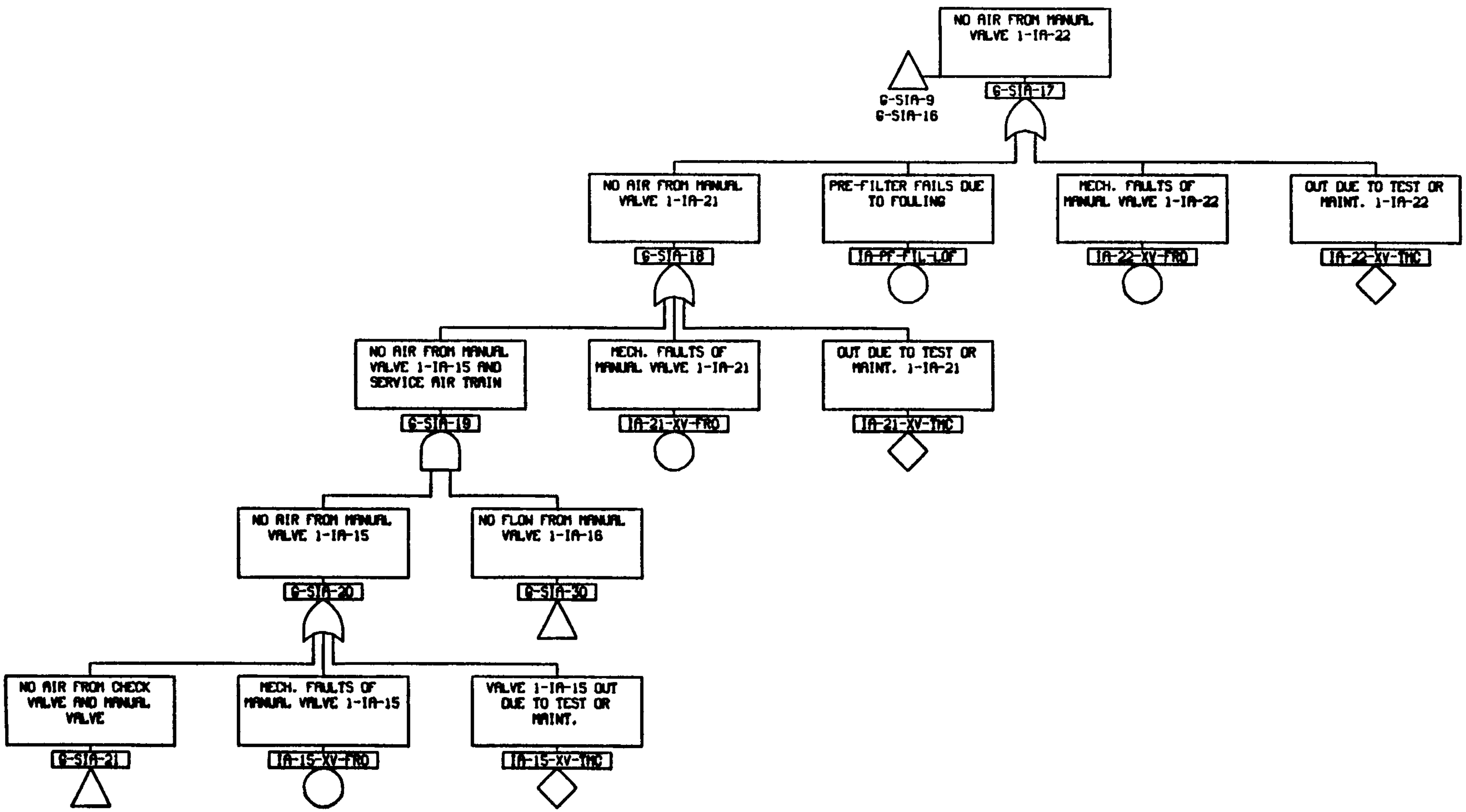

NO AIR THRU CHECK VALVE 1-IA-69
G-IA-APR
NO AIR FROM M.O. VALVE 1-IA-68
G-SIA-2
MECH. FAULT OF CHECK VALVE 1-IA-69
IA-69-CKV-FRO
VALVE OUT DUE TO MAINT. 1-IA-69
IA-69-CKV-TMC
NO AIR FROM CHECK VALVE OR AIR CYLINDER
G-SIA-3
LOSS OF FLOW THRU MOTOR OPERATED VALVE 1-IA-68
G-SIA-67
NO AIR FROM CHECK VALVE 1-IA-124
G-SIA-4
NO AIR FROM COMPRESSED AIR CYLINDERS
G-SIA-45
NO AIR FROM MANUAL VALVE 1-IA-66
G-SIA-5
MECH. FAULT OF CHECK VALVE 1-IA-124
IA-124-CKV-FRO
VALVE 1-IA-69 OUT DUE TO MAINT. 1-IA-124
IA-124-CKV-TMC
NO AIR FROM MANUAL VALVE 1-IA-36
G-SIA-6
MECH. FAULT MANUAL VALVE 1-IA-66
IA-66-XV-FRO
VALVE OUT DUE TO MAINT. 1-IA-66
IA-66-XV-TMC

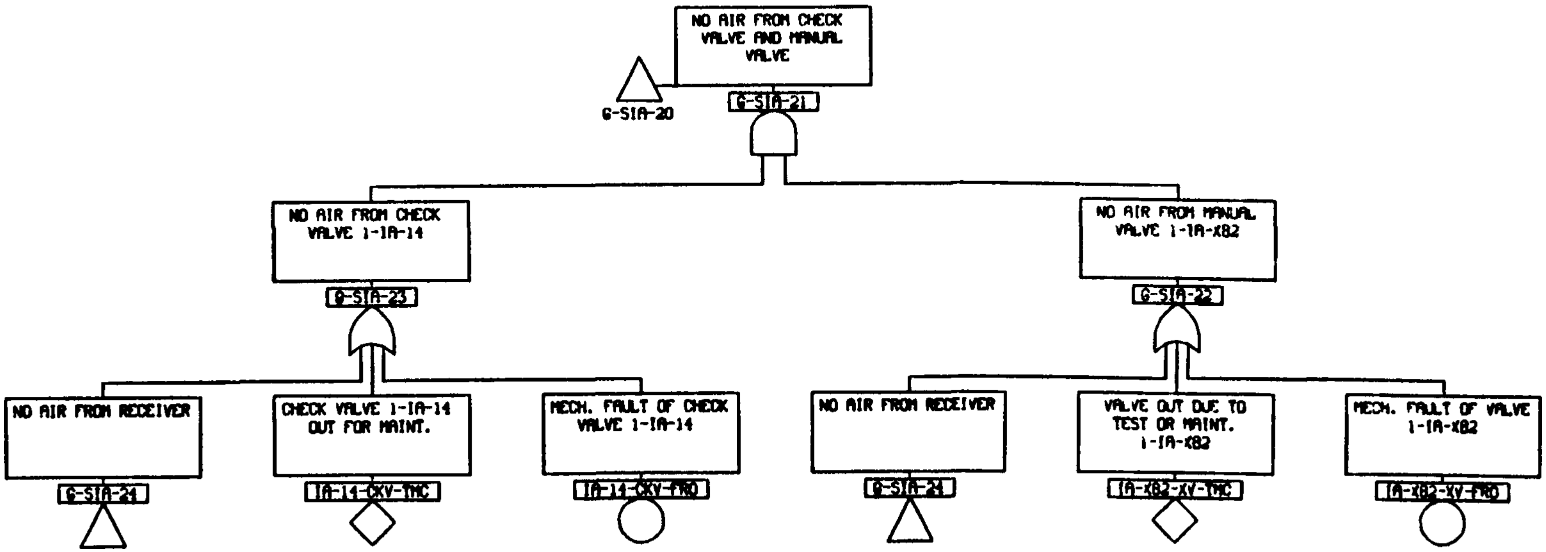

NO AIR FROM MANUAL VALVE 1-IA-36
G-SIA-6
G-SIA-5
G-IA-FW-5A-PHV
G-IA-FW-5B-PHV
NO AIR FROM MANUAL VALVE 1-IA-35
G-SIA-7
MECH. FAULT OF MANUAL VALVE 1-IA-36
IA-36-XV-FRO
VALVE OUT DUE TO MAINT. OR TEST 1-IA-36
IA-36-XV-TMC
NO AIR FROM VALVES 1-IA-32/33
G-SIA-8
MECH. FAULT OF MANUAL VALVE 1-IA-35
IA-35-XV-FRO
VALVE OUT DUE TO MAINT. OR TEST 1-IA-35
IA-35-XV-TMC
FAILURE OF FILTER DUE TO FOULING
IA-F-FIL-LOF
NO AIR FROM O.C. VALVE 1-IA-33
G-SIA-9
NO AIR FROM MANUAL VALVE 1-IA-32
G-SIA-10
NO AIR FROM MANUAL VALVE 1-IA-22
G-SIA-17
MECH. FAULT OF P.C. VALVE 1-IA-33
IA-33-PHV-FRO
VALVE OUT DUE TO MAINT. OR TEST 1-IA-33
IA-33-PHV-TMC


NO AIR FROM MANUAL VALVE 1-IA-32
G-SIA-10
G-SIA-8
NO AIR FROM SELECTOR VALVE 1-IA-31
G-SIA-11
MECH. FAULT OF MANUAL VALVE 1-IA-32
IA-32-XV-FRO
VALVE OUT DUE TO MAINT. OR TEST 1-IA-32
IA-32-XV-TMC
AIR DRYERS FAIL
G-SIA-12
MECH. FAULT OF SELECT VALVE 1-IA-31
IA-31-XV-FRO
VALVE OUT DUE TO MAINT. OR TEST 1-IA-31
IA-31-XV-TMC
AIR DRYER A FAILS
G-SIA-13
AIR DRYER B FAILS
G-SIA-14
NO AIR FROM SELECTOR VALVE 1-IA-29
G-SIA-15
STUCK OPEN RELIEF VALVE 1-IA-30A
IA-30A-SRV-FRC
AIR DRYER A LEAKS MS-7
IA-MS7A-HTX-LOF
NO AIR FROM SELECTOR VALVE 1-IA-29
G-SIA-15
STUCK OPEN RELIEF VALVE 1-IA-30B
IA-30B-SRV-FRC
AIR DRYER B LEAKS
IA-MS7B-HTX-LOF

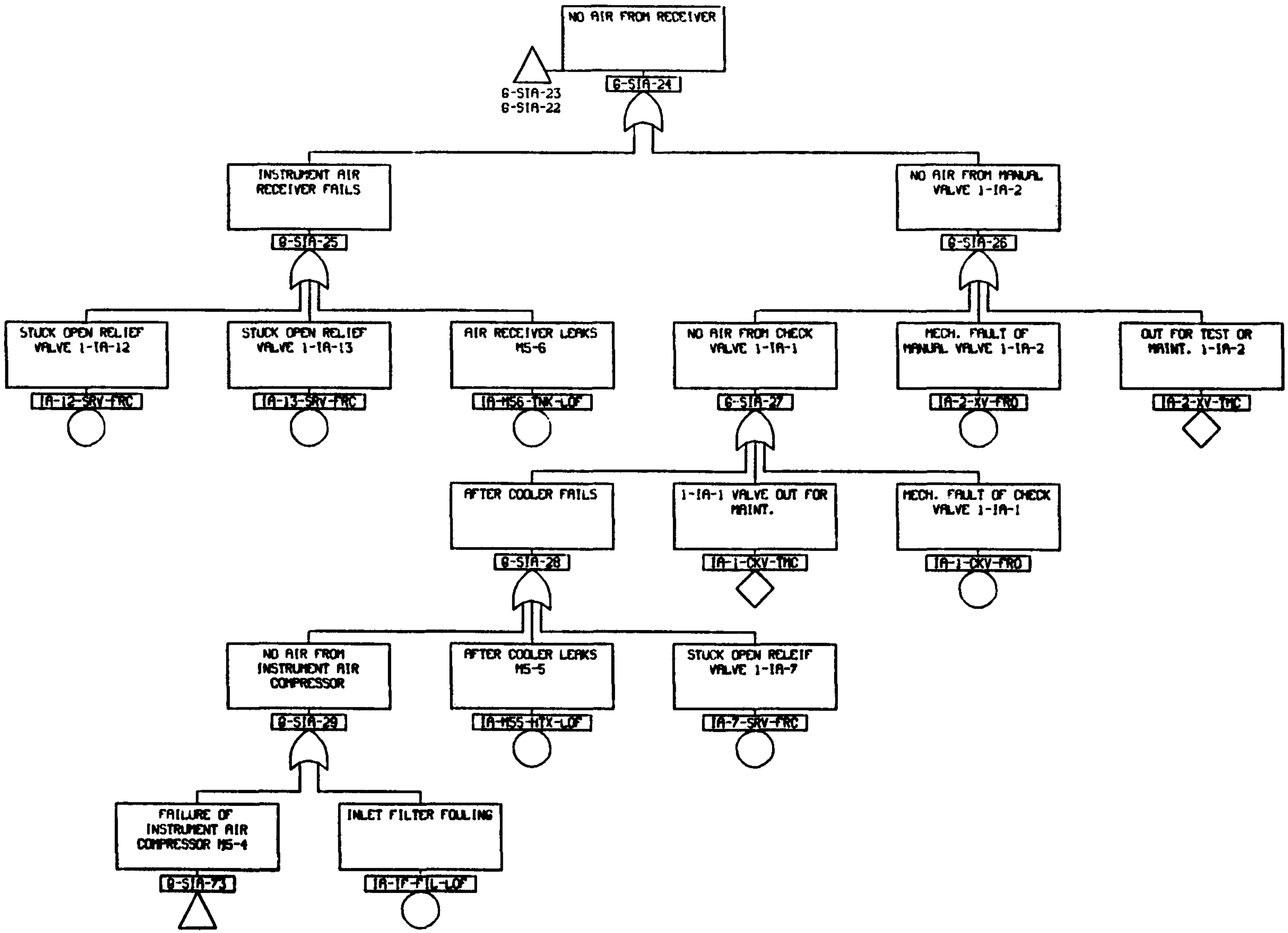

NO AIR FROM SELECTOR VALVE 1-IA-29
G-SIA-15
G-SIA-13
G-SIA-14
NO AIR FROM MANUAL VALVE 1-IA-28
G-SIA-16
VALVE 1-IA-29 OUT DUE TO TEST OR MAINT.
IA-29-XV-TMC
MECH. FAULTS OF MANUAL VALVE 1-IA-29
IA-29-XV-FRO
NO AIR FROM MANUAL VALVE 1-IA-22
G-SIA-17
MECH. FAULTS OF MANUAL VALVE 1-IA-28
IA-28-XV-TMC
OUT DUE TO TEST OR MAINT. 1-IA-28
IA-28-XV-FRO

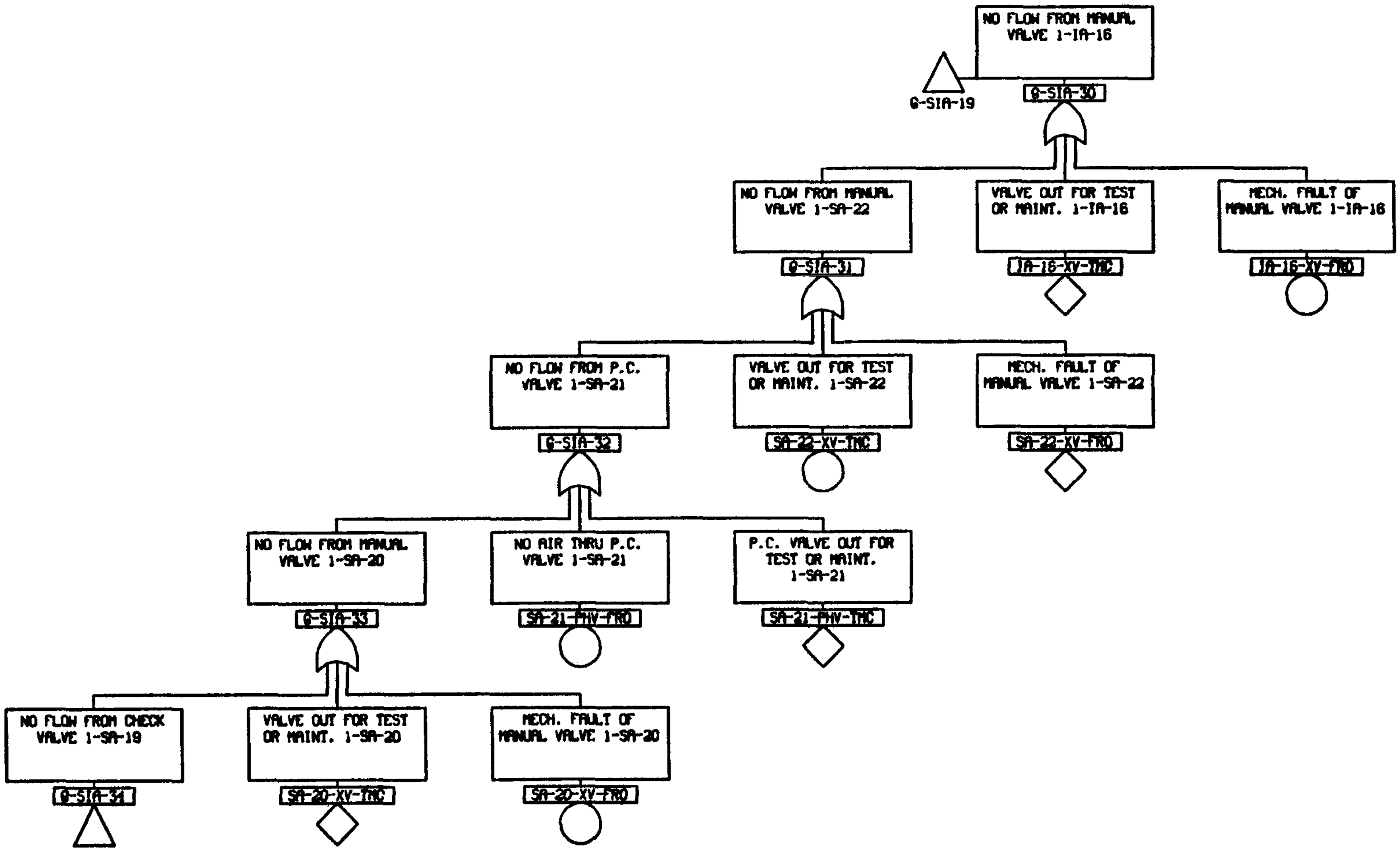
SIA-4

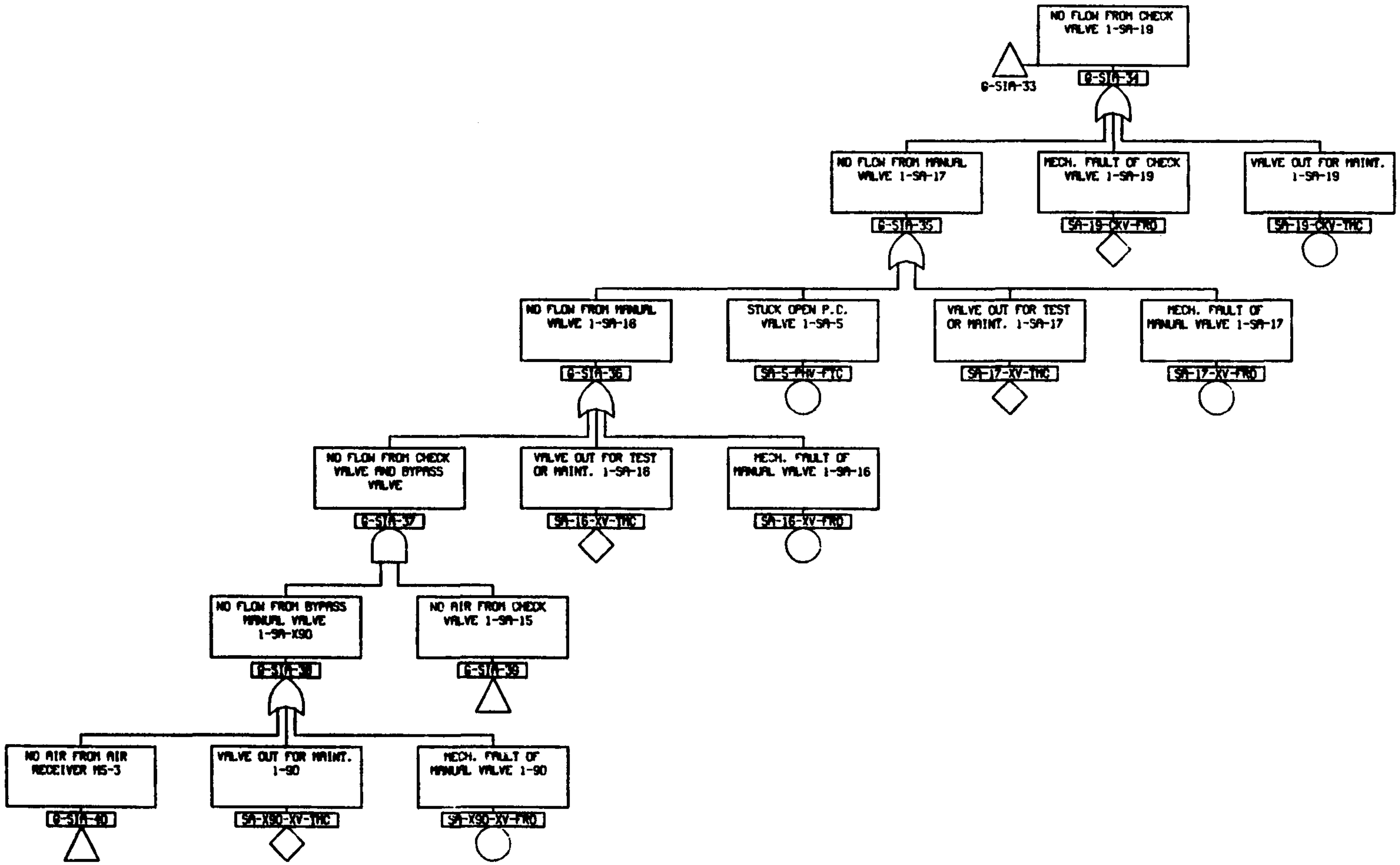

NO AIR FROM MANUAL VALVE 1-IA-22
G-SIA-17
G-SIA-9
G-SIA-16
NO AIR FROM MANUAL VALVE 1-IA-21
G-SIA-18
PRE-FILTER FAILS DUE TO FOULING
IA-PF-FIL-LOF
MECH. FAULTS OF MANUAL VALVE 1-IA-22
IA-22-XV-FRO
OUT DUE TO TEST OR MAINT. 1-IA-22
IA-22-XV-TMC
NO AIR FROM MANUAL VALVE 1-IA-15 AND SERVICE AIR TRAIN
G-SIA-19
MECH. FAULTS OF MANUAL VALVE 1-IA-21
IA-21-XV-FRO
OUT DUE TO TEST OR MAINT. 1-IA-21
IA-21-XV-TMC
NO AIR FROM MANUAL VALVE 1-IA-15
G-SIA-20
NO FLOW FROM MANUAL VALVE 1-IA-16
G-SIA-30
NO AIR FROM CHECK VALVE AND MANUAL VALVE
G-SIA-21
MECH. FAULTS OF MANUAL VALVE 1-IA-15
IA-15-XV-FRO
VALVE 1-IA-15 OUT DUE TO TEST OR MAINT.
IA-15-XV-TMC

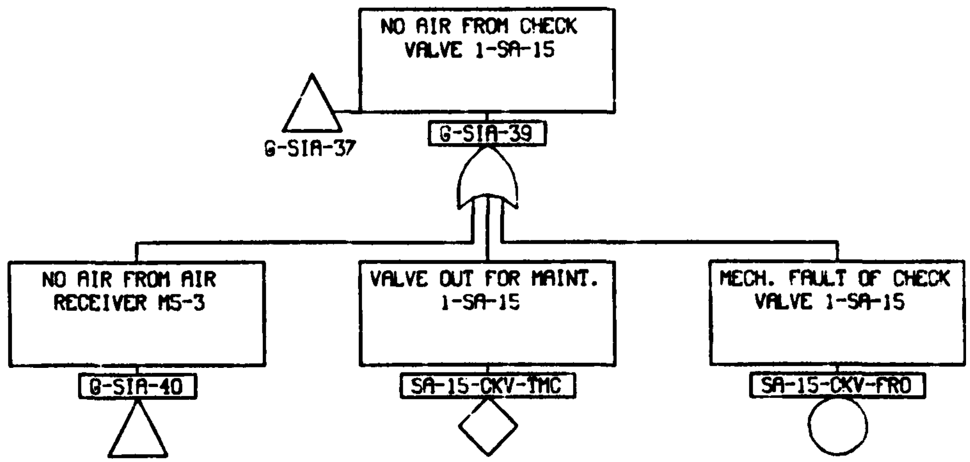


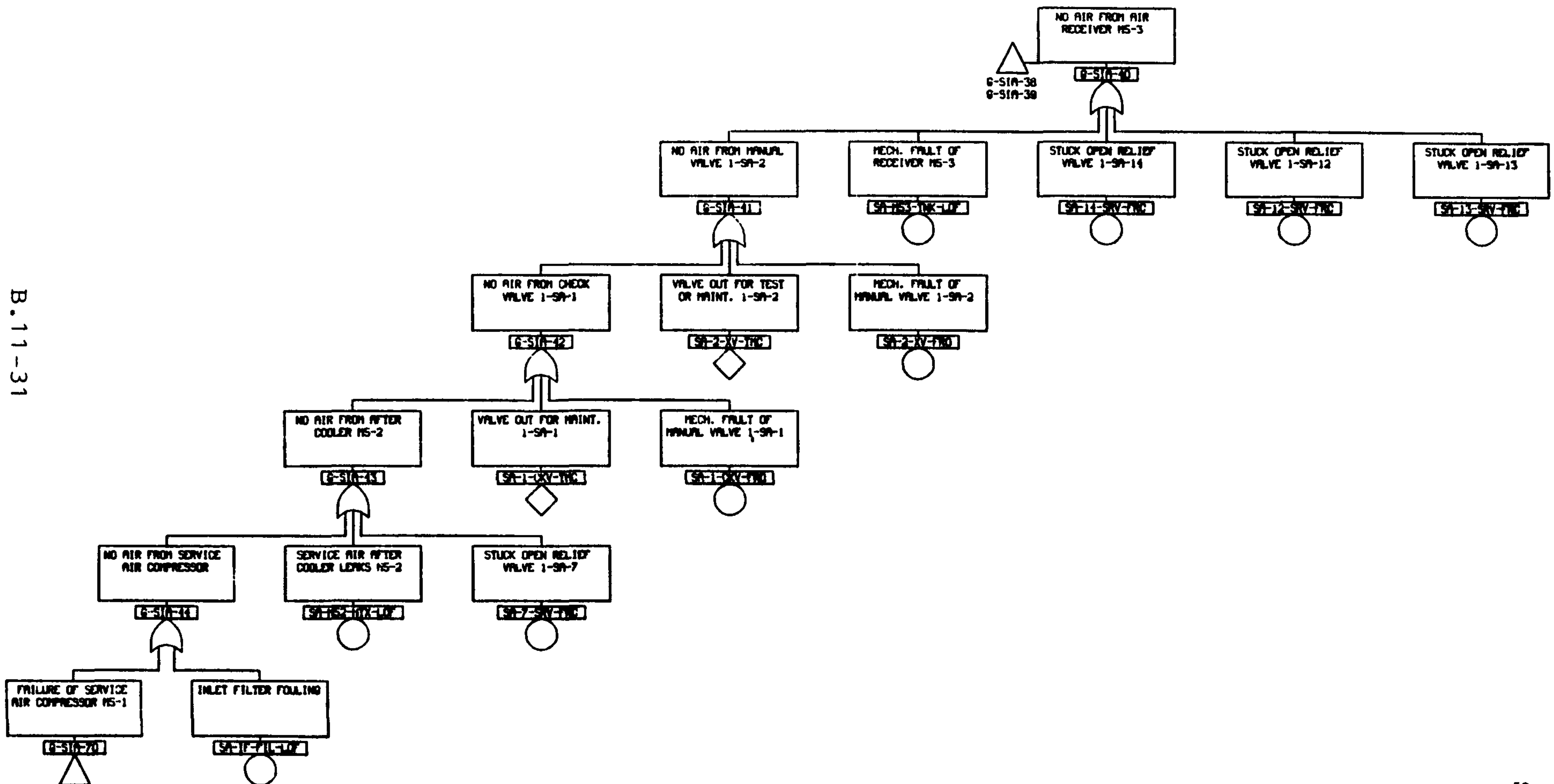
NO AIR FROM CHECK VALVE AND MANUAL VALVE
G-SIA-20
G-SIA-21
NO AIR FROM CHECK VALVE 1-IA-14
G-SIA-23
NO AIR FROM MANUAL VALVE 1-IA-XB2
G-SIA-22
NO AIR FROM RECEIVER
G-SIA-24
CHECK VALVE 1-IA-14 OUT FOR MAINT.
IA-14-CKV-TMC
MECH. FAULT OF CHECK VALVE 1-IA-14
IA-14-CKV-FRO
NO AIR FROM RECEIVER
G-SIA-24
VALVE OUT DUE TO TEST OR MAINT. 1-IA-XB2
IA-XB2-XV-TMC
MECH. FAULT OF VALVE 1-IA-XB2
IA-XB2-XV-FRO

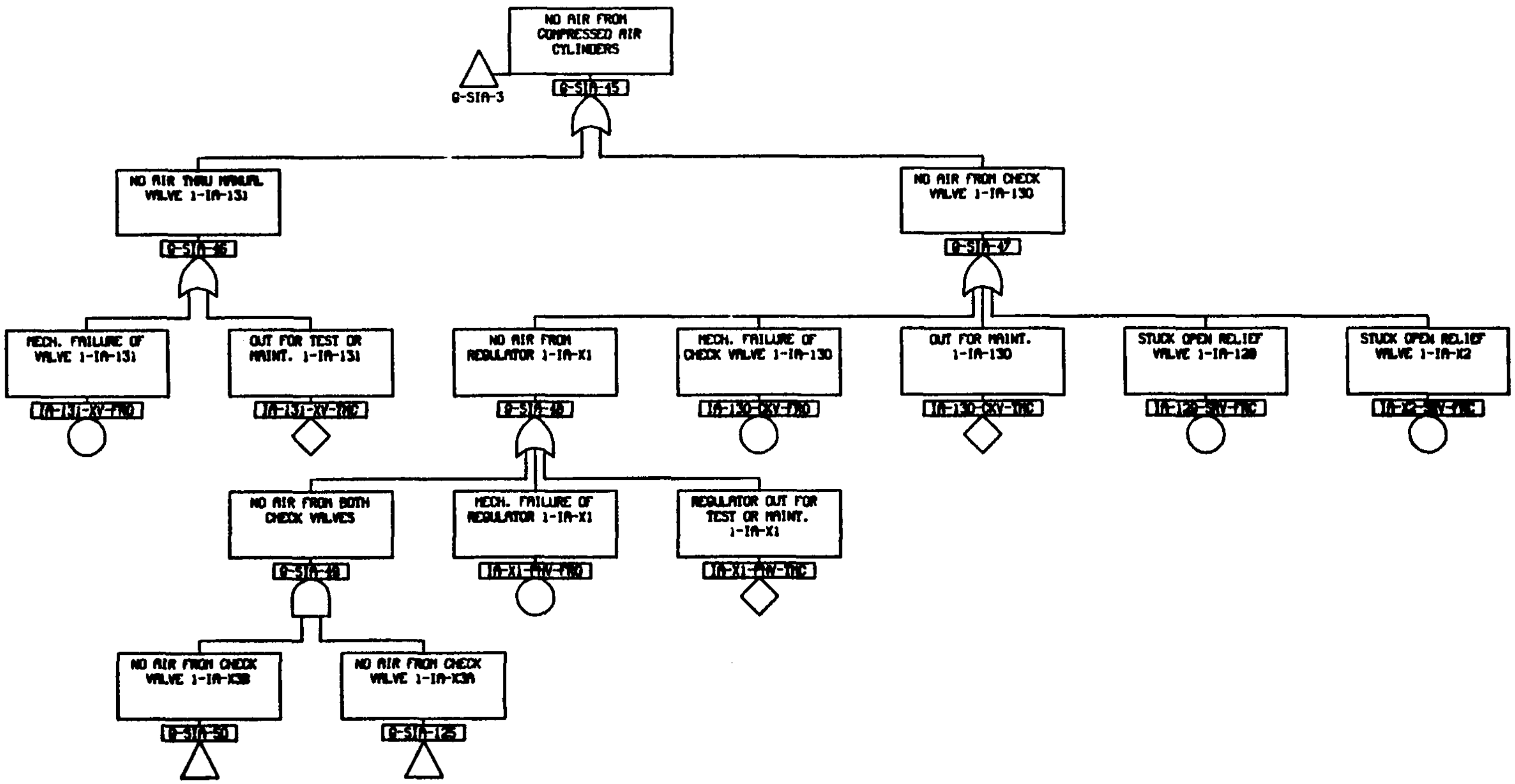

NO AIR FROM RECEIVER
G-SIA-24
G-SIA-23
G-SIA-22
INSTRUMENT AIR RECEIVER FAILS
G-SIA-25
NO AIR FROM MANUAL VALVE 1-IA-2
G-SIA-26
STUCK OPEN RELIEF VALVE 1-IA-12
IA-12-SRV-FRC
STUCK OPEN RELIEF VALVE 1-IA-13
IA-13-SRV-FRC
AIR RECEIVER LEAKS M5-6
IA-M56-TNK-LOF
NO AIR FROM CHECK VALVE 1-IA-1
G-SIA-27
MECH. FAULT OF MANUAL VALVE 1-IA-2
IA-2-XV-FRO
OUT FOR TEST OR MAINT. 1-IA-2
IA-2-XV-TMC
AFTER COOLER FAILS
G-SIA-28
1-IA-1 VALVE OUT FOR MAINT.
IA-1-CKV-TMC
MECH. FAULT OF CHECK VALVE 1-IA-1
IA-1-CKV-FRO
NO AIR FROM INSTRUMENT AIR COMPRESSOR
G-SIA-29
AFTER COOLER LEAKS M5-5
IA-M55-HTX-LOF
STUCK OPEN RELEIF VALVE 1-IA-7
IA-7-SRV-FRC
FAILURE OF INSTRUMENT AIR COMPRESSOR M5-4
G-SIA-73
INLET FILTER FOULING
IA-IF-FIL-LOF


NO FLOW FROM MANUAL VALVE 1-IA-16
G-SIA-30
G-SIA-19
NO FLOW FROM MANUAL VALVE 1-SA-22
G-SIA-31
VALVE OUT FOR TEST OR MAINT. 1-IA-16
IA-16-XV-TMC
MECH. FAULT OF MANUAL VALVE 1-IA-16
IA-16-XV-FRO
NO FLOW FROM P.C. VALVE 1-SA-21
G-SIA-32
VALVE OUT FOR TEST OR MAINT. 1-SA-22
SA-22-XV-TMC
MECH. FAULT OF MANUAL VALVE 1-SA-22
SA-22-XV-FRO
NO FLOW FROM MANUAL VALVE 1-SA-20
G-SIA-33
NO AIR THRU P.C. VALVE 1-SA-21
SA-21-PHV-FRO
P.C. VALVE OUT FOR TEST OR MAINT. 1-SA-21
SA-21-PHV-TMC
NO FLOW FROM CHECK VALVE 1-SA-19
G-SIA-34
VALVE OUT FOR TEST OR MAINT. 1-SA-20
SA-20-XV-TMC
MECH. FAULT OF MANUAL VALVE 1-SA-20
SA-20-XV-FRO

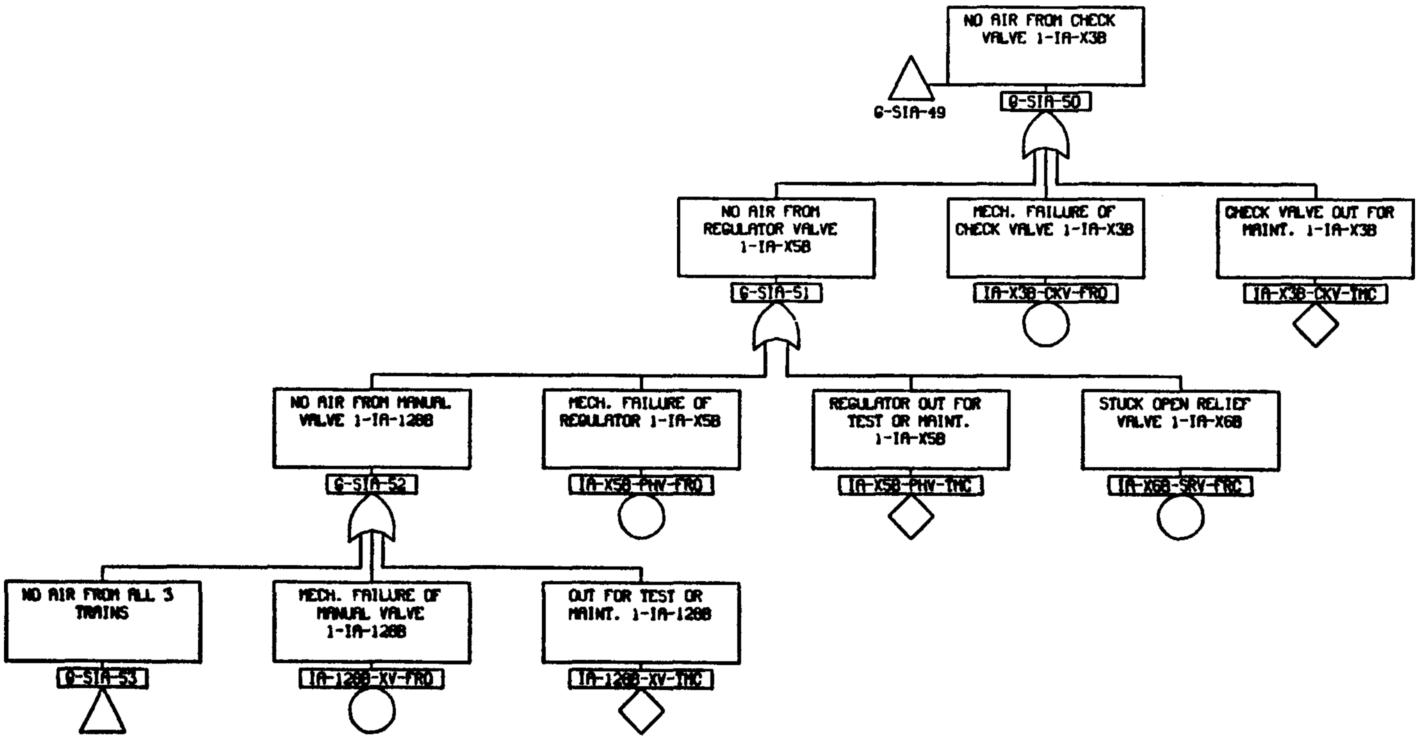

NO FLOW FROM CHECK VALVE 1-SA-18
G-SIA-34
G-SIA-33
NO FLOW FROM MANUAL VALVE 1-SA-17
G-SIA-35
MECH. FAULT OF CHECK VALVE 1-SA-19
SA-19-CKV-FRO
VALVE OUT FOR MAINT. 1-SA-19
SA-19-CKV-TMC
NO FLOW FROM MANUAL VALVE 1-SA-18
G-SIA-36
STUCK OPEN P.C. VALVE 1-SA-5
SA-5-PAV-FTC
VALVE OUT FOR TEST OR MAINT. 1-SA-17
SA-17-XV-TMC
MECH. FAULT OF MANUAL VALVE 1-SA-17
SA-17-XV-FRO
NO FLOW FROM CHECK VALVE AND BYPASS VALVE
G-SIA-37
VALVE OUT FOR TEST OR MAINT. 1-SA-16
SA-16-XV-TMC
MECH. FAULT OF MANUAL VALVE 1-SA-16
SA-16-XV-FRO
NO FLOW FROM BYPASS MANUAL VALVE 1-SA-X90
G-SIA-38
NO AIR FROM CHECK VALVE 1-SA-15
G-SIA-39
NO AIR FROM AIR RECEIVER MS-3
G-SIA-40
VALVE OUT FOR MAINT. 1-90
SA-X90-XV-TMC
MECH. FAULT OF MANUAL VALVE 1-90
SA-X90-XV-FRO

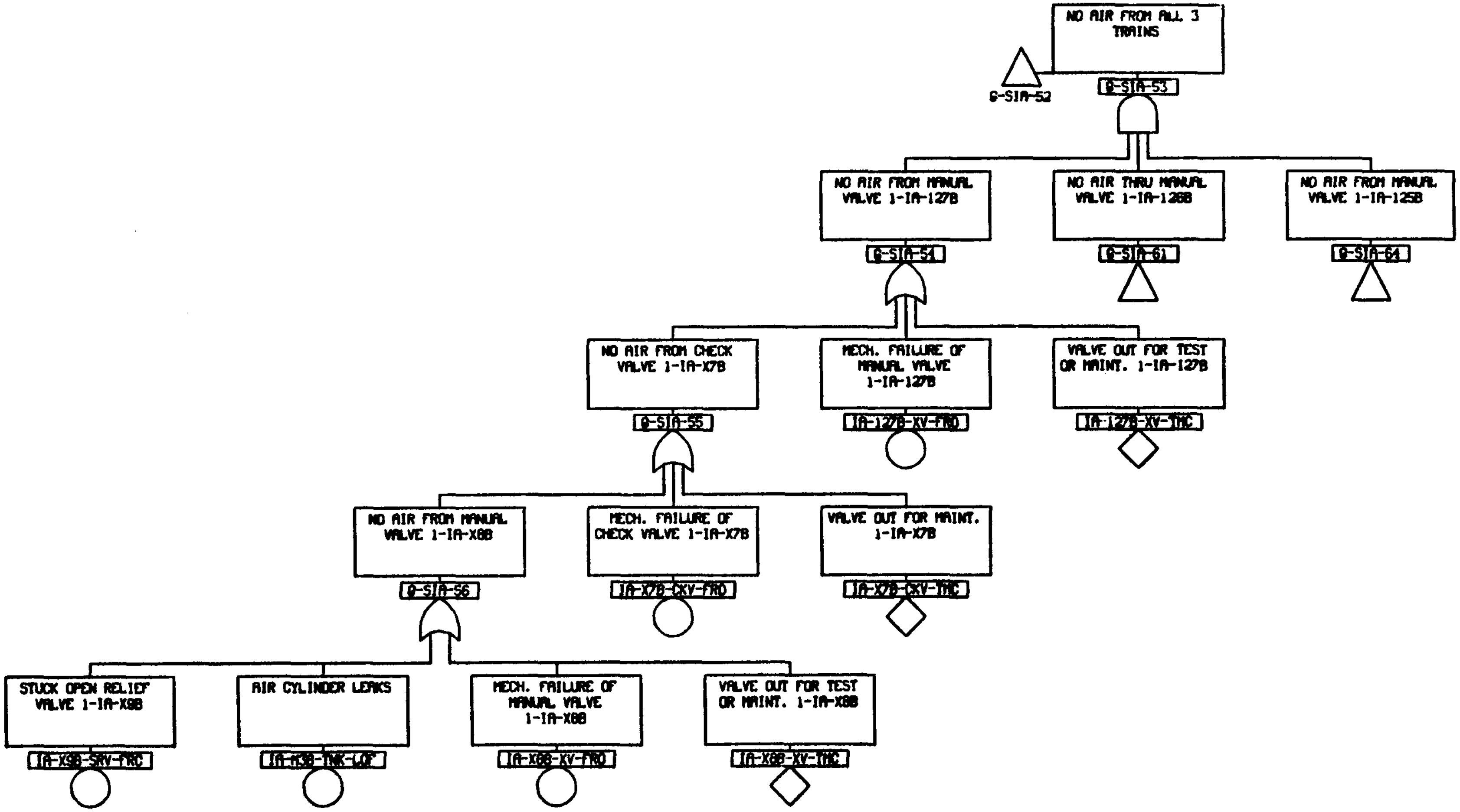

NO AIR FROM CHECK VALVE 1-SA-15
G-SIA-39
G-SIA-37
NO AIR FROM AIR RECEIVER MS-3
G-SIA-40
VALVE OUT FOR MAINT. 1-SA-15
SA-15-CKV-TMC
MECH. FAULT OF CHECK VALVE 1-SA-15
SA-15-CKV-FRO


NO AIR FROM AIR RECEIVER MS-3
G-SIA-40
G-SIA-38
G-SIA-39
NO AIR FROM MANUAL VALVE 1-SA-2
G-SIA-41
MECH. FAULT OF RECEIVER MS-3
SA-MS3-TNK-LOF
STUCK OPEN RELIEF VALVE 1-SA-14
SA-14-SRV-FMC
STUCK OPEN RELIEF VALVE 1-SA-12
SA-12-SRV-FMC
STUCK OPEN RELIEF VALVE 1-SA-13
SA-13-SRV-FMC
NO AIR FROM CHECK VALVE 1-SA-1
G-SIA-42
VALVE OUT FOR TEST OR MAINT. 1-SA-2
SA-2-XV-TMC
MECH. FAULT OF MANUAL VALVE 1-SA-2
SA-2-XV-FMO
NO AIR FROM AFTER COOLER MS-2
G-SIA-43
VALVE OUT FOR MAINT. 1-SA-1
SA-1-CKV-TMC
MECH. FAULT OF MANUAL VALVE 1-SA-1
SA-1-CKV-FMO
NO AIR FROM SERVICE AIR COMPRESSOR
SERVICE AIR AFTER COOLER LEAKS MS-2
STUCK OPEN RELIEF VALVE 1-SA-7
SA-7-SRV-FMC
FAILURE OF SERVICE AIR COMPRESSOR MS-1
G-SIA-70
INLET FILTER FOULING

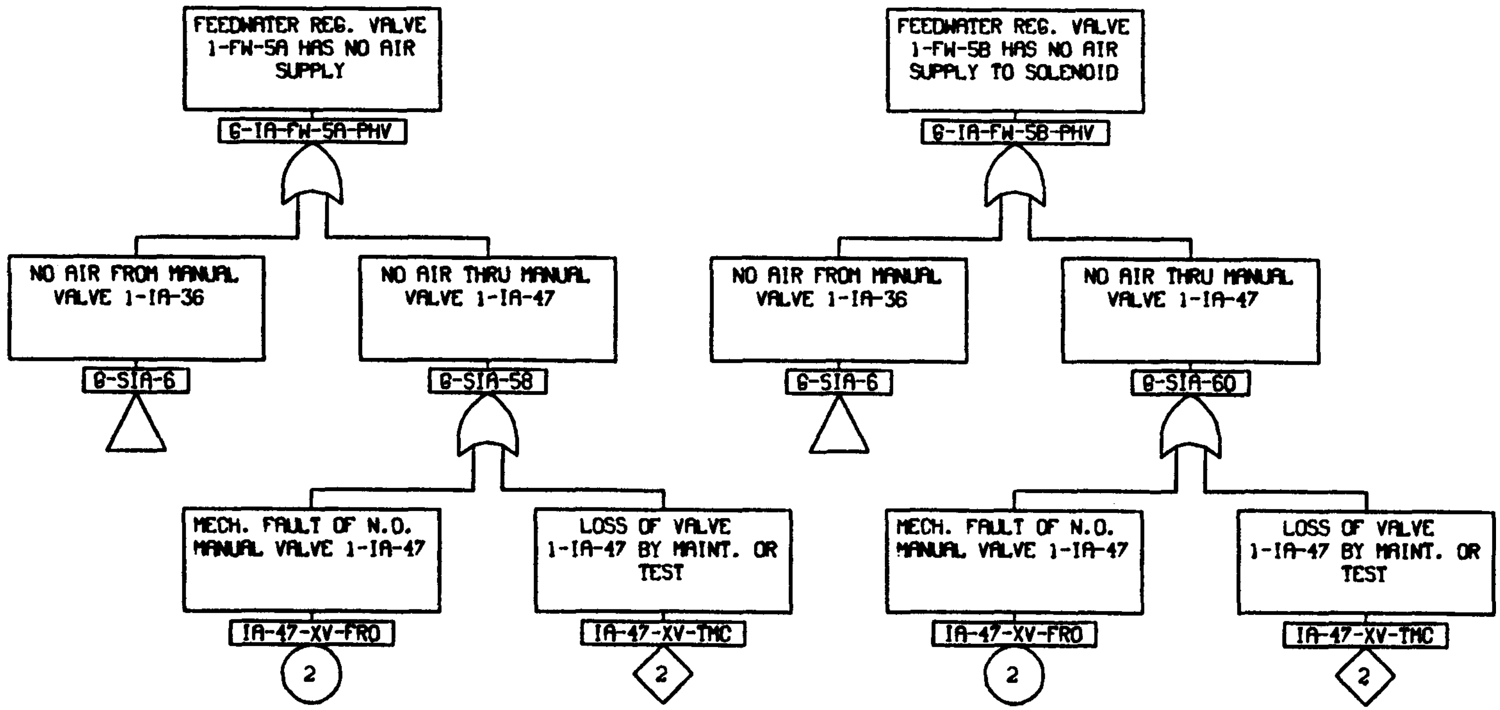


NO AIR FROM COMPRESSED AIR CYLINDERS
G-SIA-3
G-SIA-45
NO AIR THRU MANUAL VALVE 1-IA-131
G-SIA-46
NO AIR FROM CHECK VALVE 1-IA-130
G-SIA-47
MECH. FAILURE OF VALVE 1-IA-131
IA-131-XV-FNO
OUT FOR TEST OR MAINT. 1-IA-131
NO AIR FROM REGULATOR 1-IA-X1
MECH. FAILURE OF CHECK VALVE 1-IA-130
IA-130-CKV-FNO
OUT FOR MAINT. 1-IA-130
STUCK OPEN RELIEF VALVE 1-IA-128
STUCK OPEN RELIEF VALVE 1-IA-X2
NO AIR FROM BOTH CHECK VALVES
MECH. FAILURE OF REGULATOR 1-IA-X1
REGULATOR OUT FOR TEST OR MAINT. 1-IA-X1
NO AIR FROM CHECK VALVE 1-IA-X3B
G-SIA-50
NO AIR FROM CHECK VALVE 1-IA-X3A
G-SIA-125

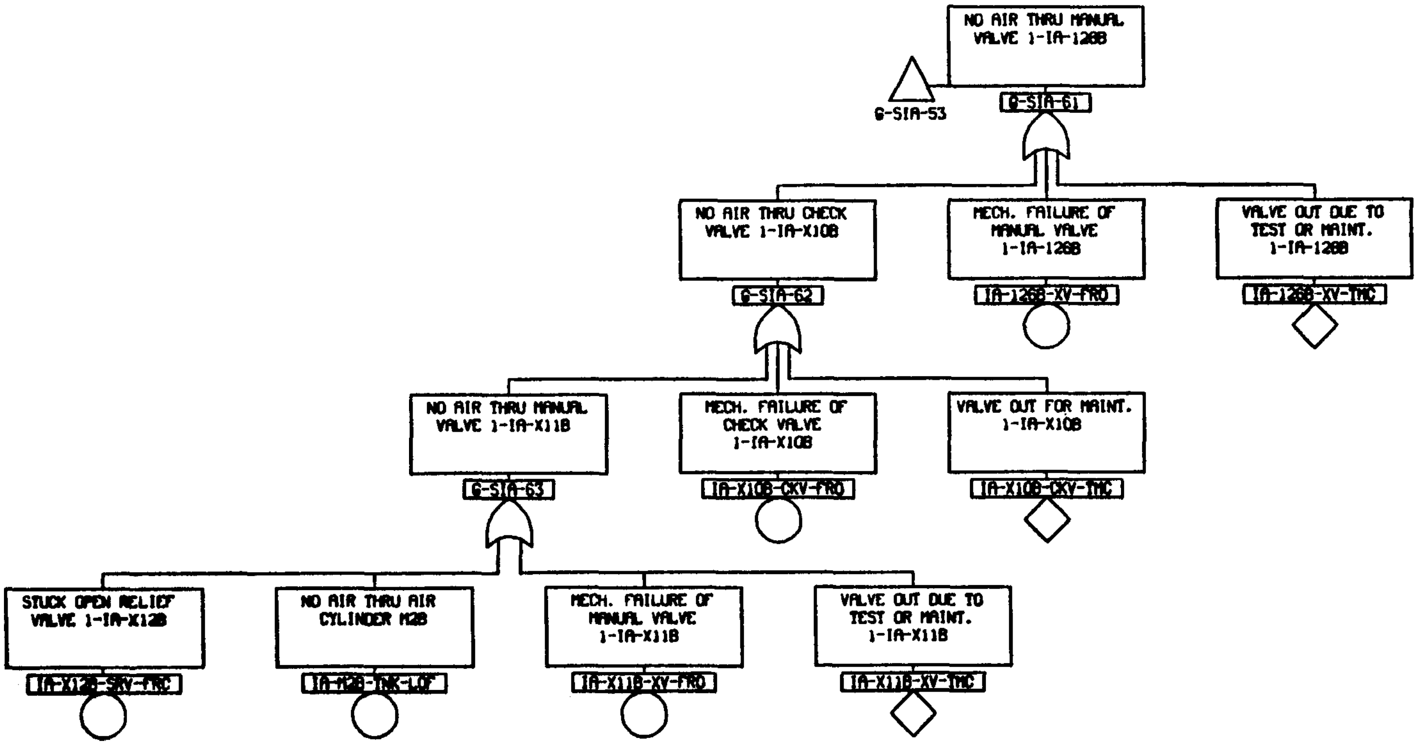

NO AIR FROM CHECK VALVE 1-IA-X3B
G-SIA-49
G-SIA-50
NO AIR FROM REGULATOR VALVE 1-IA-X5B
G-SIA-51
MECH. FAILURE OF CHECK VALVE 1-IA-X3B
IA-X3B-CKV-FRO
CHECK VALVE OUT FOR MAINT. 1-IA-X3B
IA-X3B-CKV-TMC
NO AIR FROM MANUAL VALVE 1-IA-128B
G-SIA-52
MECH. FAILURE OF REGULATOR 1-IA-X5B
IA-X5B-PWV-FRO
REGULATOR OUT FOR TEST OR MAINT. 1-IA-X5B
IA-X5B-PWV-TMC
STUCK OPEN RELIEF VALVE 1-IA-X6B
IA-X6B-SRV-FRC
NO AIR FROM ALL 3 TRAINS
G-SIA-53
MECH. FAILURE OF MANUAL VALVE 1-IA-128B
IA-128B-XV-FRO
OUT FOR TEST OR MAINT. 1-IA-128B
IA-128B-XV-TMC

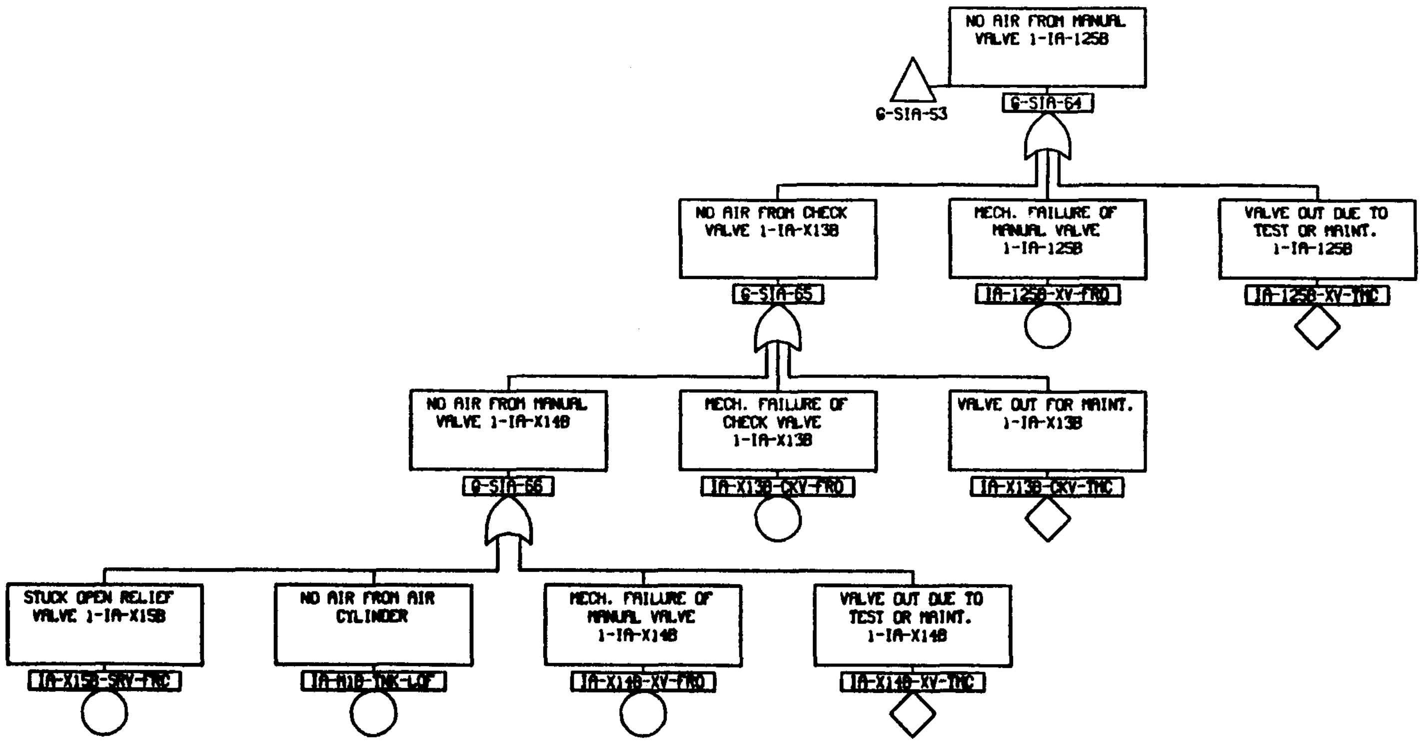

NO AIR FROM ALL 3 TRAINS
G-SIA-52
G-SIA-53
NO AIR FROM MANUAL VALVE 1-IA-127B
G-SIA-51
NO AIR THRU MANUAL VALVE 1-IA-128B
G-SIA-61
NO AIR FROM MANUAL VALVE 1-IA-125B
G-SIA-64
NO AIR FROM CHECK VALVE 1-IA-X7B
G-SIA-55
MECH. FAILURE OF MANUAL VALVE 1-IA-127B
IA-127B-XV-FRO
VALVE OUT FOR TEST OR MAINT. 1-IA-127B
IA-127B-XV-TMC
NO AIR FROM MANUAL VALVE 1-IA-X8B
G-SIA-56
MECH. FAILURE OF CHECK VALVE 1-IA-X7B
IA-X7B-CKV-FRO
VALVE OUT FOR MAINT. 1-IA-X7B
IA-X7B-CKV-TMC
STUCK OPEN RELIEF VALVE 1-IA-X9B
IA-X9B-SRV-FRC
AIR CYLINDER LEAKS
IA-K3B-TNK-LOF
MECH. FAILURE OF MANUAL VALVE 1-IA-X8B
IA-X8B-XV-FRO
VALVE OUT FOR TEST OR MAINT. 1-IA-X8B
IA-X8B-XV-TMC

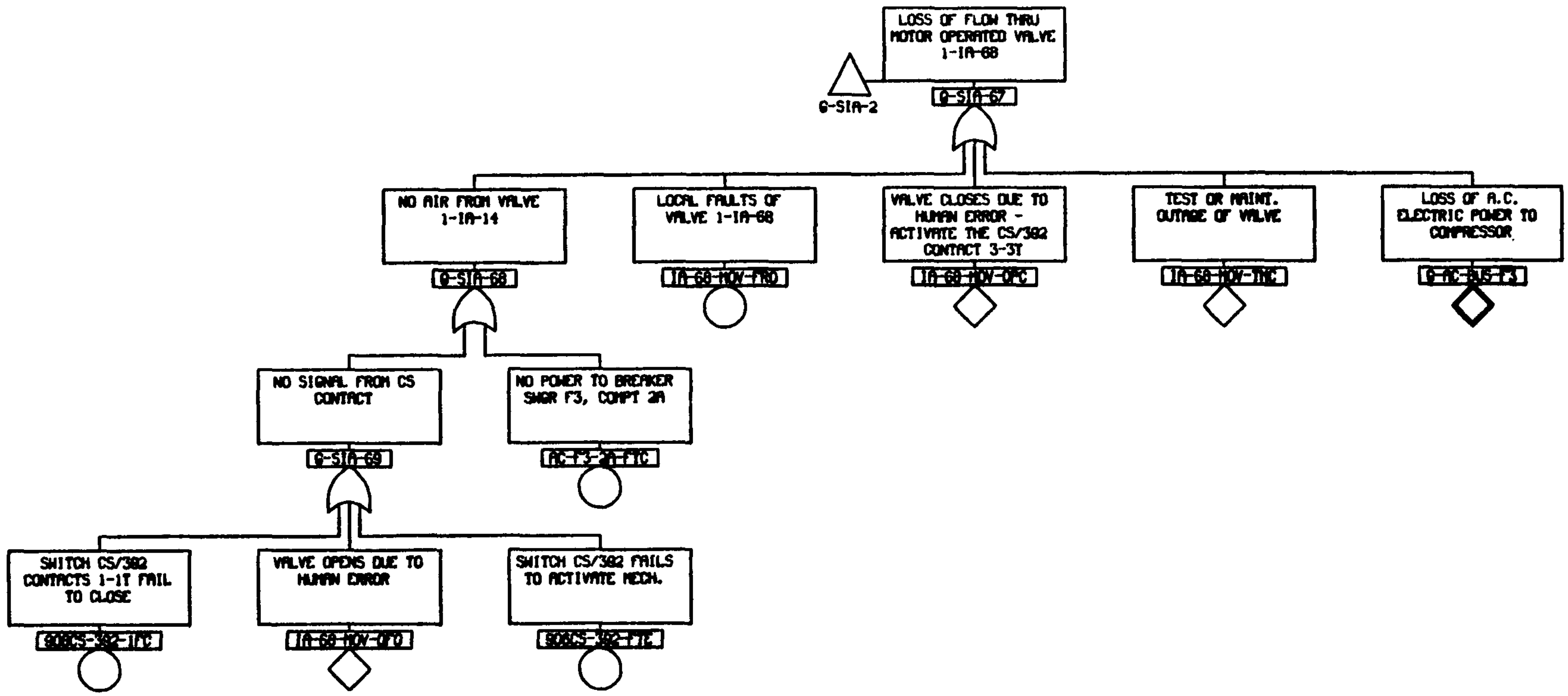
SIA-14


FEEDWATER REG. VALVE 1-FW-5A HAS NO AIR SUPPLY
G-IA-FW-5A-PHV
NO AIR FROM MANUAL VALVE 1-IA-36
G-SIA-6
NO AIR THRU MANUAL VALVE 1-IA-47
G-SIA-58
MECH. FAULT OF N.O. MANUAL VALVE 1-IA-47
IA-47-XV-FRO
2
LOSS OF VALVE 1-IA-47 BY MAINT. OR TEST
IA-47-XV-TMC
2
FEEDWATER REG. VALVE 1-FW-5B HAS NO AIR SUPPLY TO SOLENOID
G-IA-FW-5B-PHV
NO AIR FROM MANUAL VALVE 1-IA-36
G-SIA-6
NO AIR THRU MANUAL VALVE 1-IA-47
G-SIA-60
MECH. FAULT OF N.O. MANUAL VALVE 1-IA-47
IA-47-XV-FRO
2
LOSS OF VALVE 1-IA-47 BY MAINT. OR TEST
IA-47-XV-TMC
2

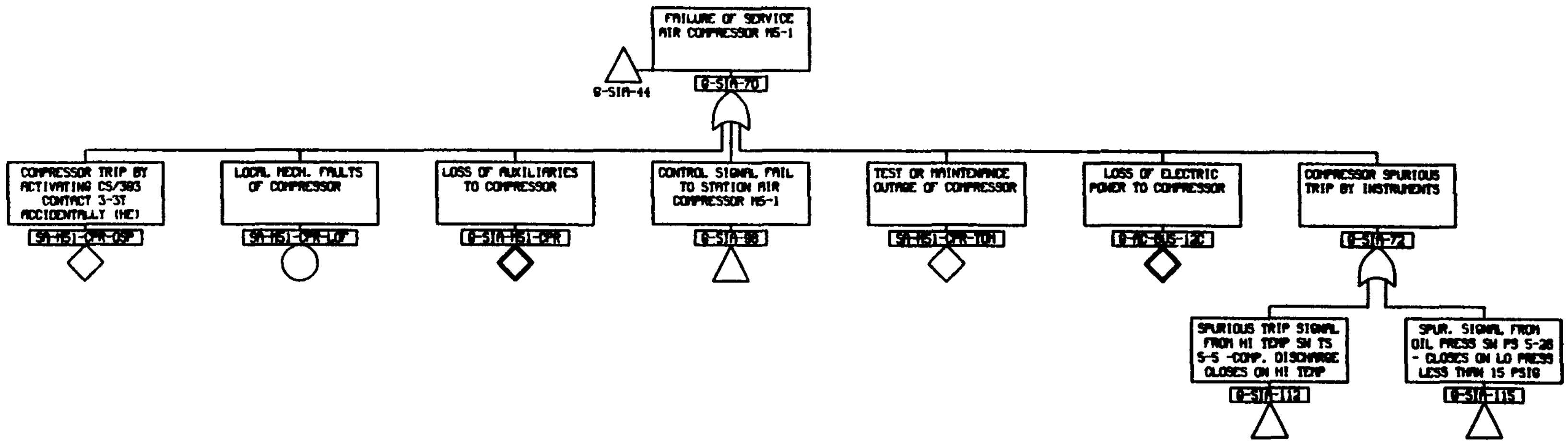
SIA-15

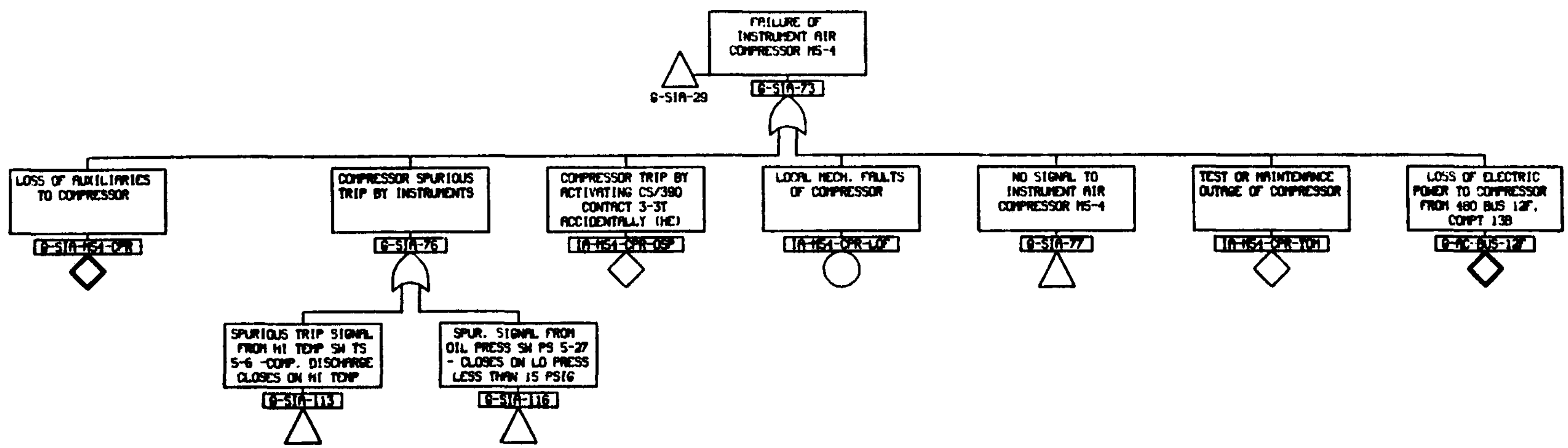

NO AIR THRU MANUAL VALVE 1-IA-128B
G-SIA-61
G-SIA-53
NO AIR THRU CHECK VALVE 1-IA-X10B
G-SIA-62
MECH. FAILURE OF MANUAL VALVE 1-IA-128B
IA-128B-XV-FRO
VALVE OUT DUE TO TEST OR MAINT. 1-IA-128B
IA-128B-XV-TMC
NO AIR THRU MANUAL VALVE 1-IA-X11B
G-SIA-63
MECH. FAILURE OF CHECK VALVE 1-IA-X10B
IA-X10B-CKV-FRO
VALVE OUT FOR MAINT. 1-IA-X10B
IA-X10B-CKV-TMC
STUCK OPEN RELIEF VALVE 1-IA-X12B
IA-X12B-SRV-FRC
NO AIR THRU AIR CYLINDER M2B
IA-M2B-TNK-LOF
MECH. FAILURE OF MANUAL VALVE 1-IA-X11B
IA-X11B-XV-FRO
VALVE OUT DUE TO TEST OR MAINT. 1-IA-X11B
IA-X11B-XV-TMC

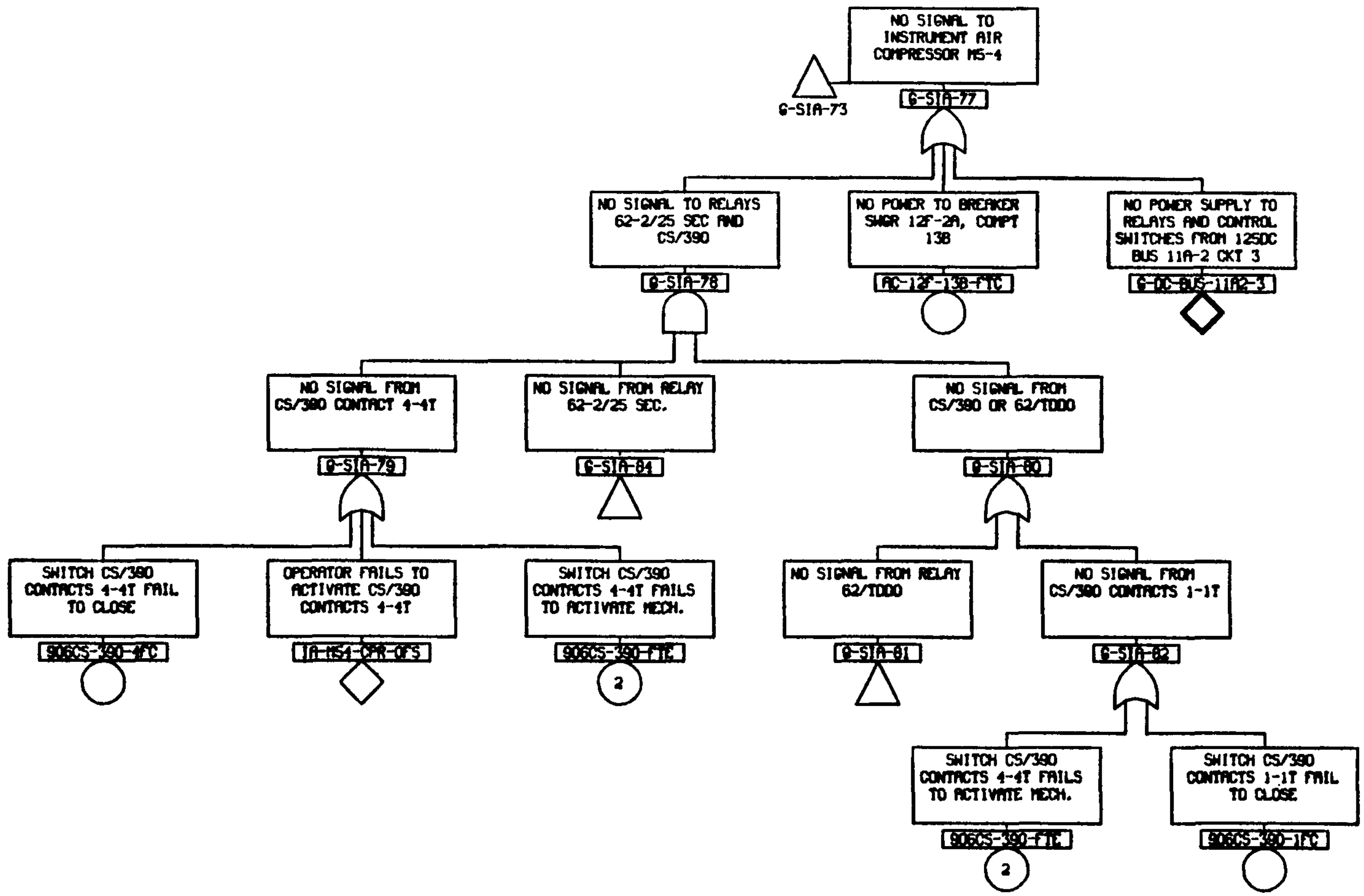

NO AIR FROM MANUAL VALVE 1-IA-125B
G-SIA-53
G-SIA-64
NO AIR FROM CHECK VALVE 1-IA-X13B
G-SIA-65
MECH. FAILURE OF MANUAL VALVE 1-IA-125B
IA-125B-XV-FRO
VALVE OUT DUE TO TEST OR MAINT. 1-IA-125B
IA-125B-XV-TMC
NO AIR FROM MANUAL VALVE 1-IA-X14B
G-SIA-66
MECH. FAILURE OF CHECK VALVE 1-IA-X13B
IA-X13B-CKV-FRO
VALVE OUT FOR MAINT. 1-IA-X13B
IA-X13B-CKV-TMC
STUCK OPEN RELIEF VALVE 1-IA-X15B
IA-X15B-SRV-FNC
NO AIR FROM AIR CYLINDER
IA-A1B-TNK-LOF
MECH. FAILURE OF MANUAL VALVE 1-IA-X14B
IA-X14B-XV-FRO
VALVE OUT DUE TO TEST OR MAINT. 1-IA-X14B
IA-X14B-XV-TMC



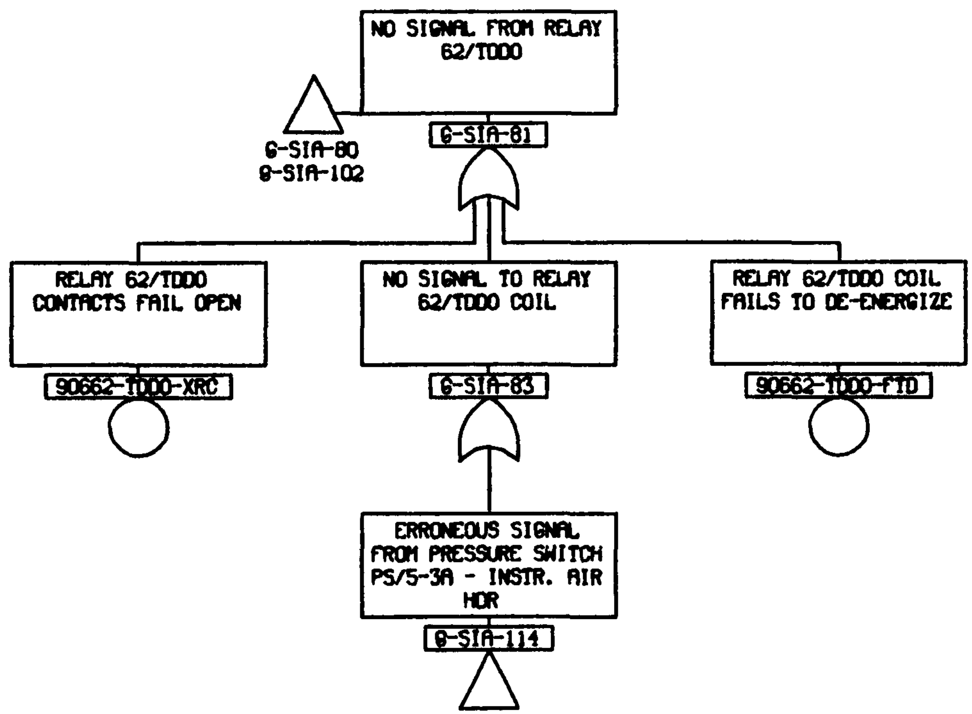
LOSS OF FLOW THRU MOTOR OPERATED VALVE 1-IA-68
G-SIA-67
G-SIA-2
NO AIR FROM VALVE 1-IA-14
G-SIA-68
LOCAL FAULTS OF VALVE 1-IA-68
IA-68-MOV-FRO
VALVE CLOSES DUE TO HUMAN ERROR - ACTIVATE THE CS/382 CONTACT 3-3T
IA-68-MOV-OFC
TEST OR MAINT. OUTAGE OF VALVE
IA-68-MOV-TMC
LOSS OF A.C. ELECTRIC POWER TO COMPRESSOR
G-AC-BUS-F3
NO SIGNAL FROM CS CONTACT
G-SIA-69
NO POWER TO BREAKER SWGR F3, COMPT 2A
AC-F3-2A-FTC
SWITCH CS/382 CONTACTS 1-1T FAIL TO CLOSE
908CS-382-1TC
VALVE OPENS DUE TO HUMAN ERROR
IA-68-MOV-OFO
SWITCH CS/382 FAILS TO ACTIVATE MECH.
908CS-382-FTE

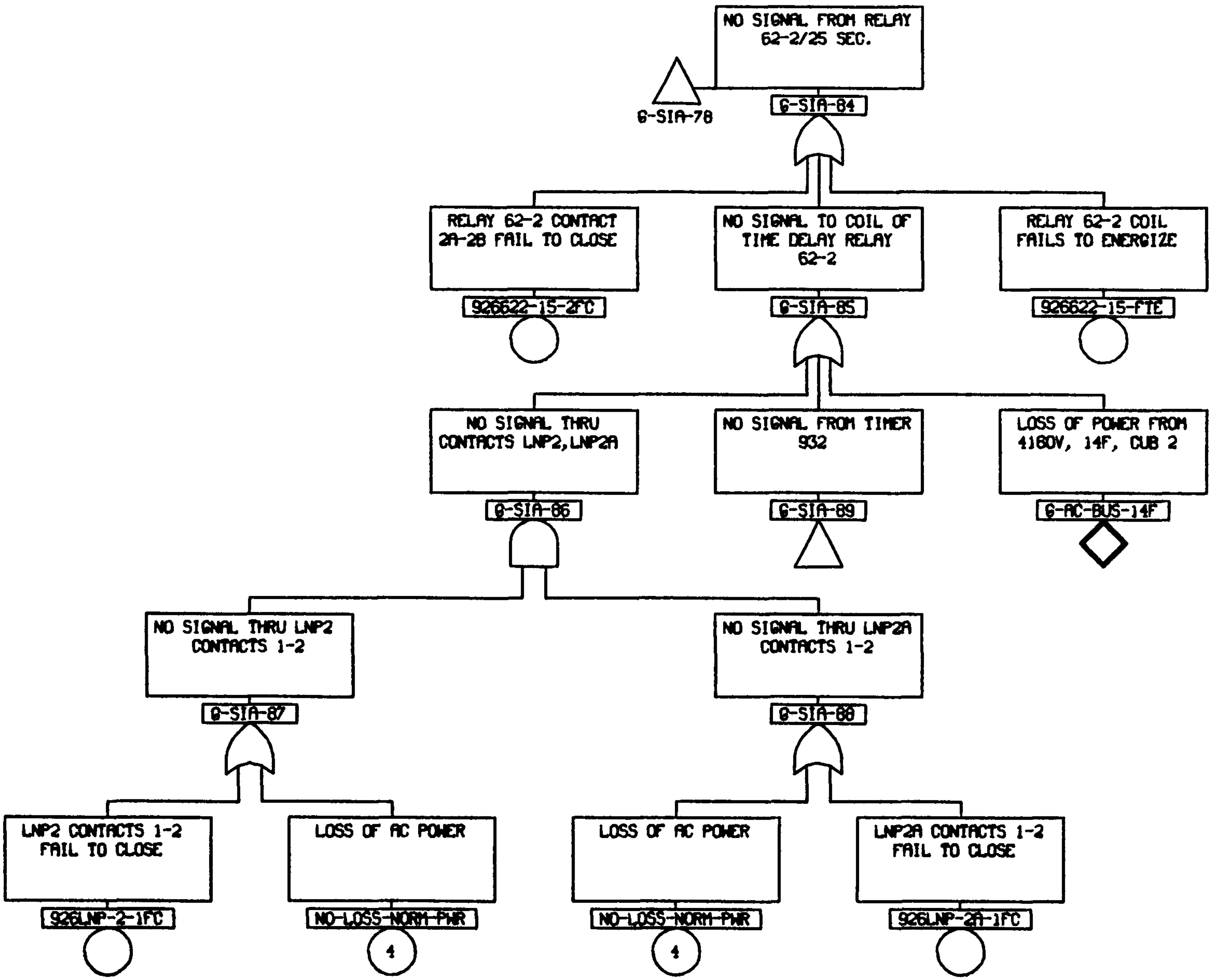

FAILURE OF SERVICE AIR COMPRESSOR MS-1
G-SIA-70
G-SIA-44
COMPRESSOR TRIP BY ACTIVATING CS/383 CONTACT 3-3T ACCIDENTALLY (HE)
SA-MS1-CMP-OSP
LOCAL MECH. FAULTS OF COMPRESSOR
SA-MS1-CMP-LOF
LOSS OF AUXILIARIES TO COMPRESSOR
G-SIA-MS1-CMP
CONTROL SIGNAL FAIL TO STATION AIR COMPRESSOR MS-1
G-SIA-98
TEST OR MAINTENANCE OUTAGE OF COMPRESSOR
SA-MS1-CMP-TOM
LOSS OF ELECTRIC POWER TO COMPRESSOR
G-AC-BUS-12C
COMPRESSOR SPURIOUS TRIP BY INSTRUMENTS
G-SIA-72
SPURIOUS TRIP SIGNAL FROM HI TEMP SW TS 5-5 -COMP. DISCHARGE CLOSES ON HI TEMP
G-SIA-112
SPUR. SIGNAL FROM OIL PRESS SW PS 5-28 - CLOSES ON LO PRESS LESS THAN 15 PSIG
G-SIA-115

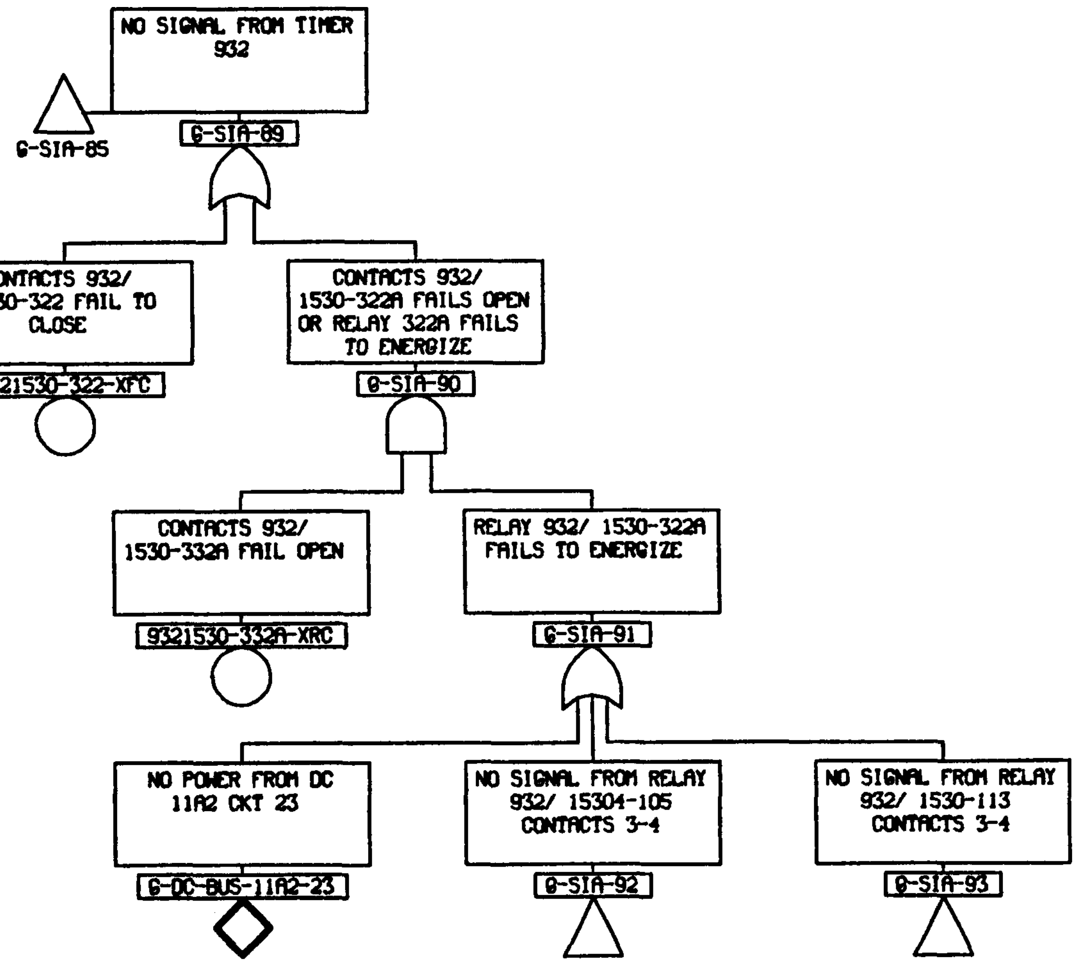

FAILURE OF INSTRUMENT AIR COMPRESSOR MS-4
G-SIA-73
G-SIA-29
LOSS OF AUXILIARIES TO COMPRESSOR
G-SIA-MS4-CMR
COMPRESSOR SPURIOUS TRIP BY INSTRUMENTS
G-SIA-76
COMPRESSOR TRIP BY ACTIVATING CS/390 CONTACT 3-3T ACCIDENTALLY (HE)
IA-MS4-CPR-OSP
LOCAL MECH. FAULTS OF COMPRESSOR
IA-MS4-CPR-LOF
NO SIGNAL TO INSTRUMENT AIR COMPRESSOR MS-4
G-SIA-77
TEST OR MAINTENANCE OUTAGE OF COMPRESSOR
IA-MS4-CPR-TOM
LOSS OF ELECTRIC POWER TO COMPRESSOR FROM 480 BUS 12F, COMPT 13B
G-AC-BUS-12F
SPURIOUS TRIP SIGNAL FROM HI TEMP SW TS 5-6 -COMP. DISCHARGE CLOSES ON HI TEMP
G-SIA-113
SPUR. SIGNAL FROM OIL PRESS SW PS 5-27 - CLOSES ON LO PRESS LESS THAN 15 PSIG
G-SIA-116

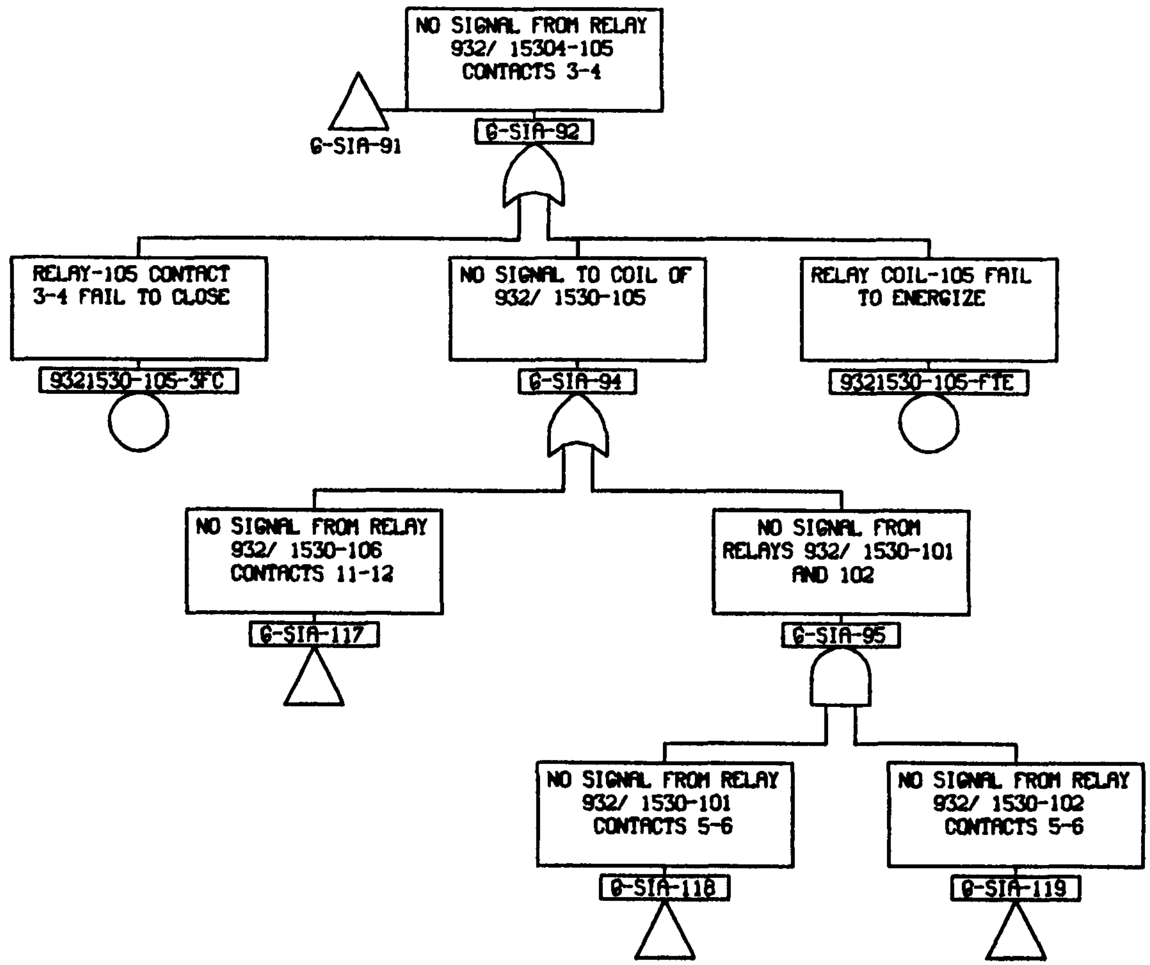


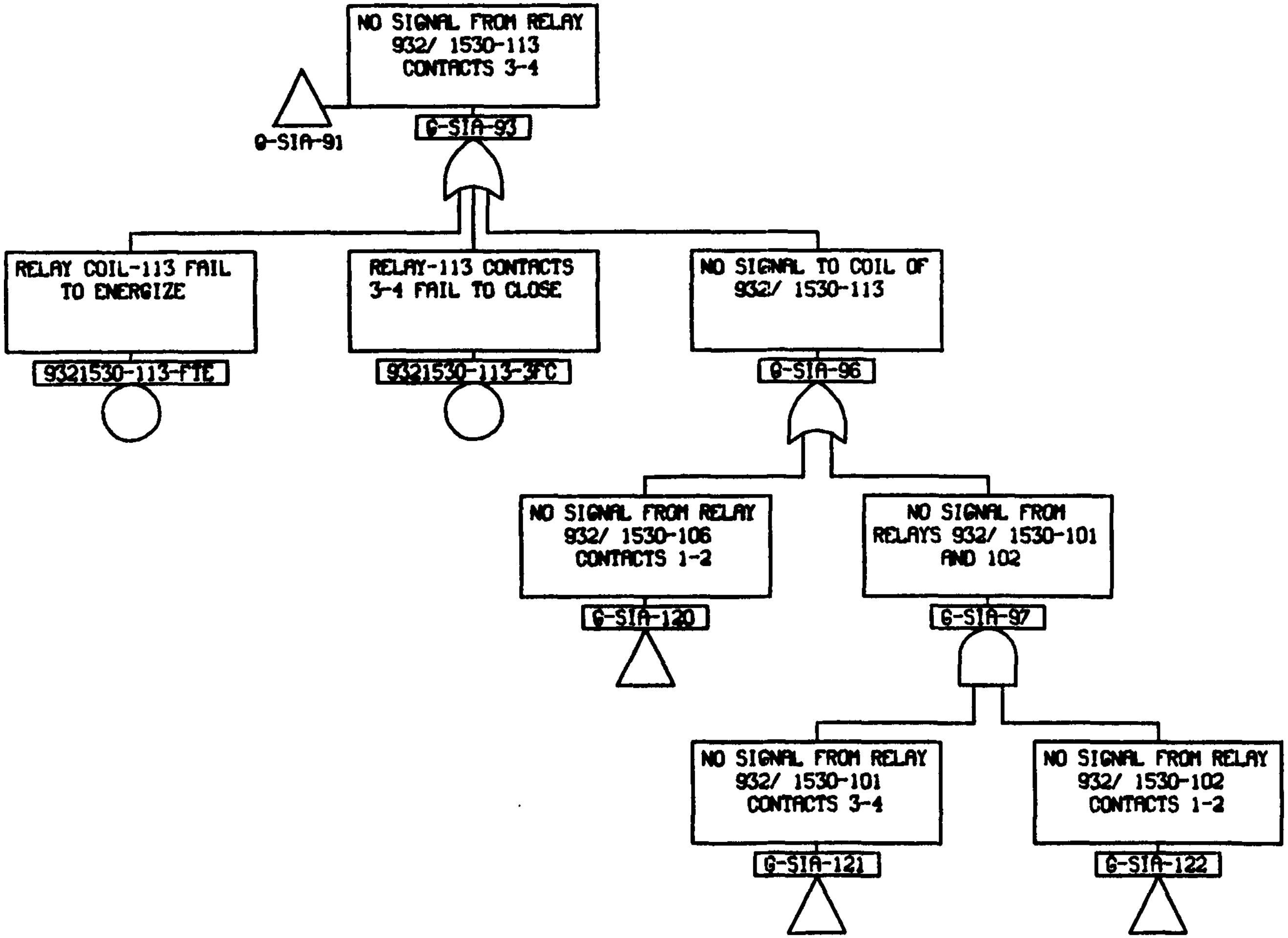
NO SIGNAL TO INSTRUMENT AIR COMPRESSOR M5-4
G-SIA-73
G-SIA-77
NO SIGNAL TO RELAYS 62-2/25 SEC AND CS/390
G-SIA-78
NO POWER TO BREAKER SWGR 12F-2A, COMPT 13B
AC-12F-13B-FTC
NO POWER SUPPLY TO RELAYS AND CONTROL SWITCHES FROM 125DC BUS 11A-2 CKT 3
G-DC-BUS-11A2-3
NO SIGNAL FROM CS/390 CONTACT 4-4T
G-SIA-79
NO SIGNAL FROM RELAY 62-2/25 SEC.
G-SIA-84
NO SIGNAL FROM CS/390 OR 62/TDDO
G-SIA-80
SWITCH CS/390 CONTACTS 4-4T FAIL TO CLOSE
906CS-390-4FC
OPERATOR FAILS TO ACTIVATE CS/390 CONTACTS 4-4T
IA-M54-CPR-OFS
SWITCH CS/390 CONTACTS 4-4T FAILS TO ACTIVATE MECH.
906CS-390-FTE
2
NO SIGNAL FROM RELAY 62/TDDO
G-SIA-81
NO SIGNAL FROM CS/390 CONTACTS 1-1T
G-SIA-82
SWITCH CS/390 CONTACTS 4-4T FAILS TO ACTIVATE MECH.
906CS-390-FTE
2
SWITCH CS/390 CONTACTS 1-1T FAIL TO CLOSE
906CS-390-1FC


NO SIGNAL FROM RELAY 62/TDDO
G-SIA-81
G-SIA-80
G-SIA-102
RELAY 62/TDDO CONTACTS FAIL OPEN
90662-TDDO-XRC
NO SIGNAL TO RELAY 62/TDDO COIL
G-SIA-83
RELAY 62/TDDO COIL FAILS TO DE-ENERGIZE
90662-TDDO-FTD
ERRONEOUS SIGNAL FROM PRESSURE SWITCH PS/5-3A - INSTR. AIR HDR
G-SIA-114

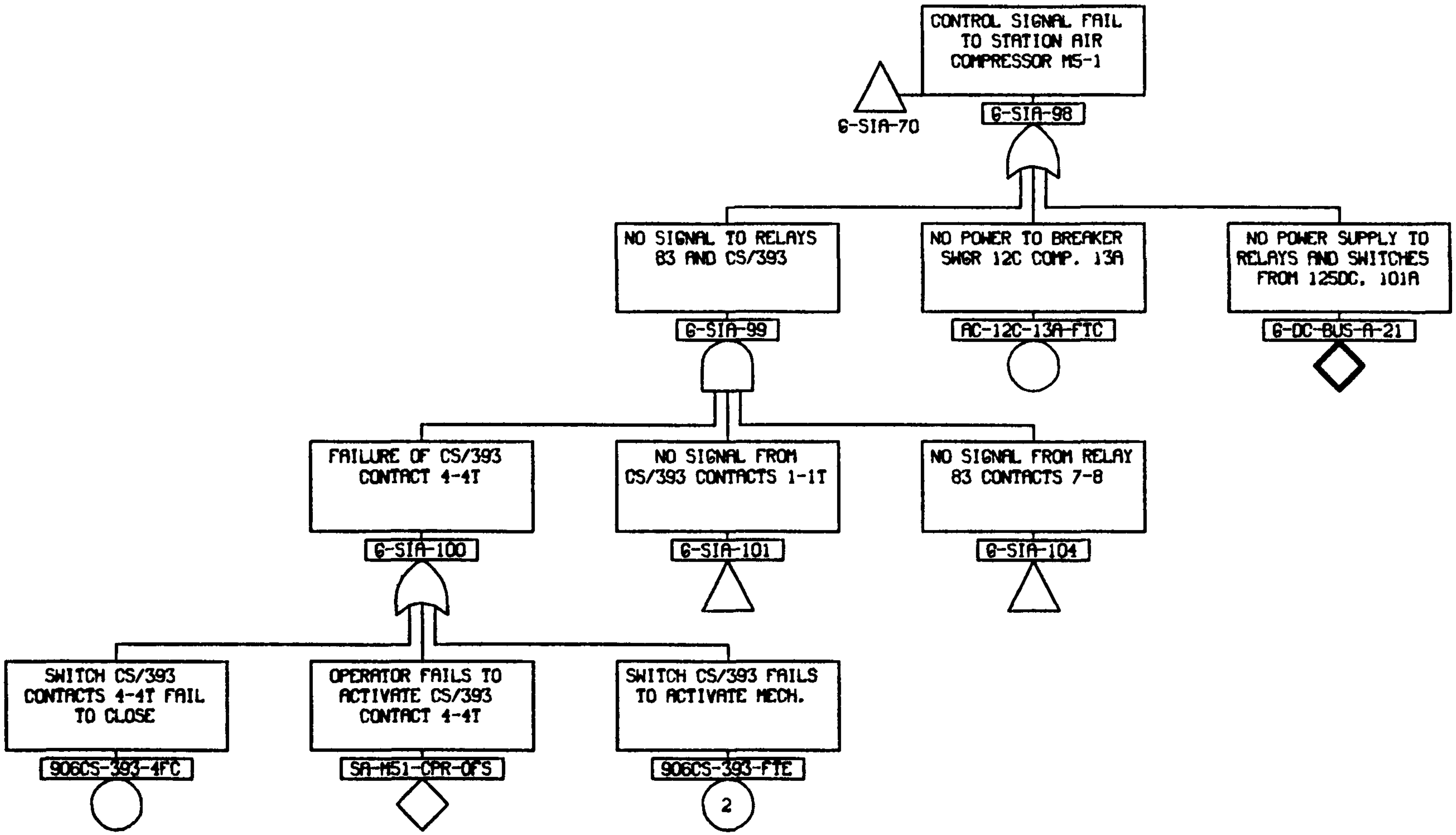

NO SIGNAL FROM RELAY 62-2/25 SEC.
G-SIA-84
G-SIA-78
RELAY 62-2 CONTACT 2A-2B FAIL TO CLOSE
926622-15-2FC
NO SIGNAL TO COIL OF TIME DELAY RELAY 62-2
G-SIA-85
RELAY 62-2 COIL FAILS TO ENERGIZE
926622-15-FTE
NO SIGNAL THRU CONTACTS LNP2,LNP2A
G-SIA-86
NO SIGNAL FROM TIMER 932
G-SIA-89
LOSS OF POWER FROM 4160V, 14F, CUB 2
G-AC-BUS-14F
NO SIGNAL THRU LNP2 CONTACTS 1-2
G-SIA-87
NO SIGNAL THRU LNP2A CONTACTS 1-2
G-SIA-88
LNP2 CONTACTS 1-2 FAIL TO CLOSE
926LNP-2-1FC
LOSS OF AC POWER
NO-LOSS-NORM-PWR
4
LOSS OF AC POWER
NO-LOSS-NORM-PWR
4
LNP2A CONTACTS 1-2 FAIL TO CLOSE
926LNP-2A-1FC

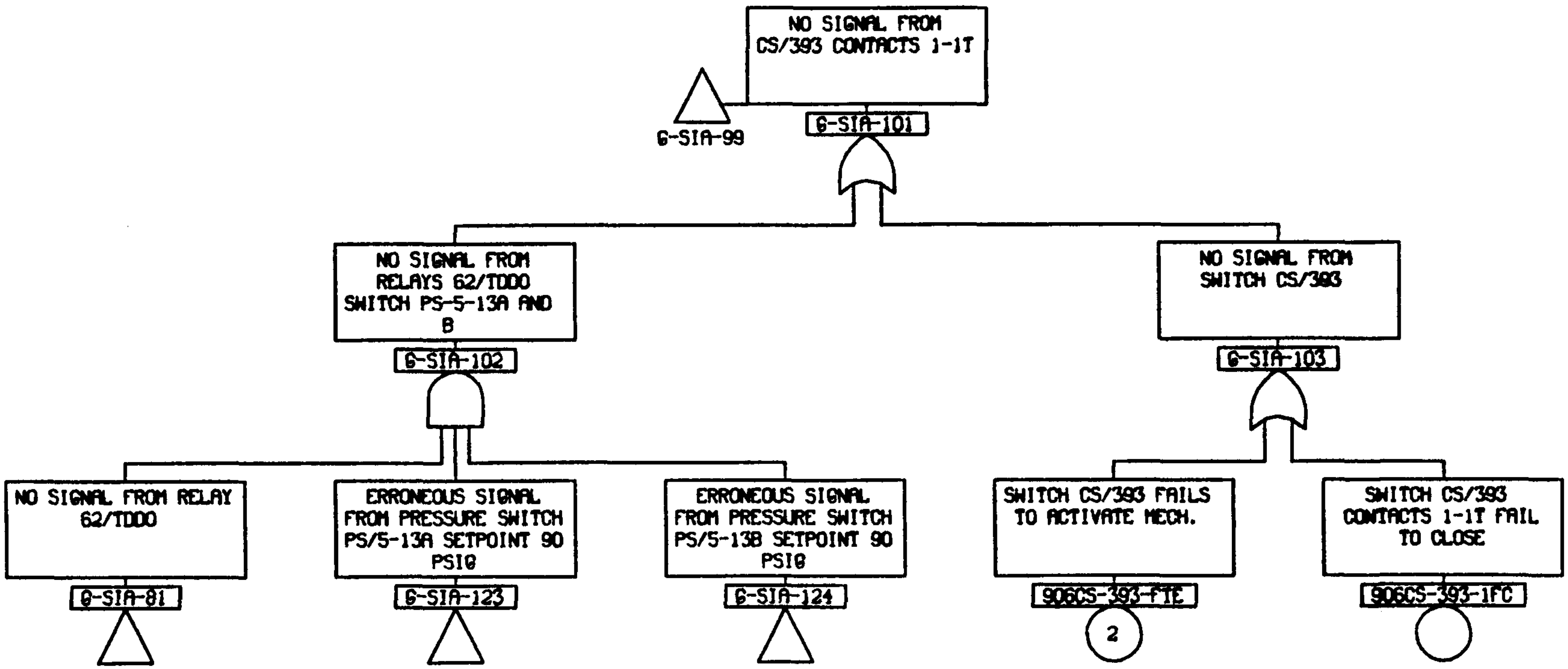

NO SIGNAL FROM TIMER 932
G-SIA-89
G-SIA-85
CONTACTS 932/ 1530-322 FAIL TO CLOSE
9321530-322-XFC
CONTACTS 932/ 1530-322A FAILS OPEN OR RELAY 322A FAILS TO ENERGIZE
G-SIA-90
CONTACTS 932/ 1530-332A FAIL OPEN
9321530-332A-XRC
RELAY 932/ 1530-322A FAILS TO ENERGIZE
G-SIA-91
NO POWER FROM DC 11A2 CKT 23
G-DC-BUS-11A2-23
NO SIGNAL FROM RELAY 932/ 15304-105 CONTACTS 3-4
G-SIA-92
NO SIGNAL FROM RELAY 932/ 1530-113 CONTACTS 3-4
G-SIA-93

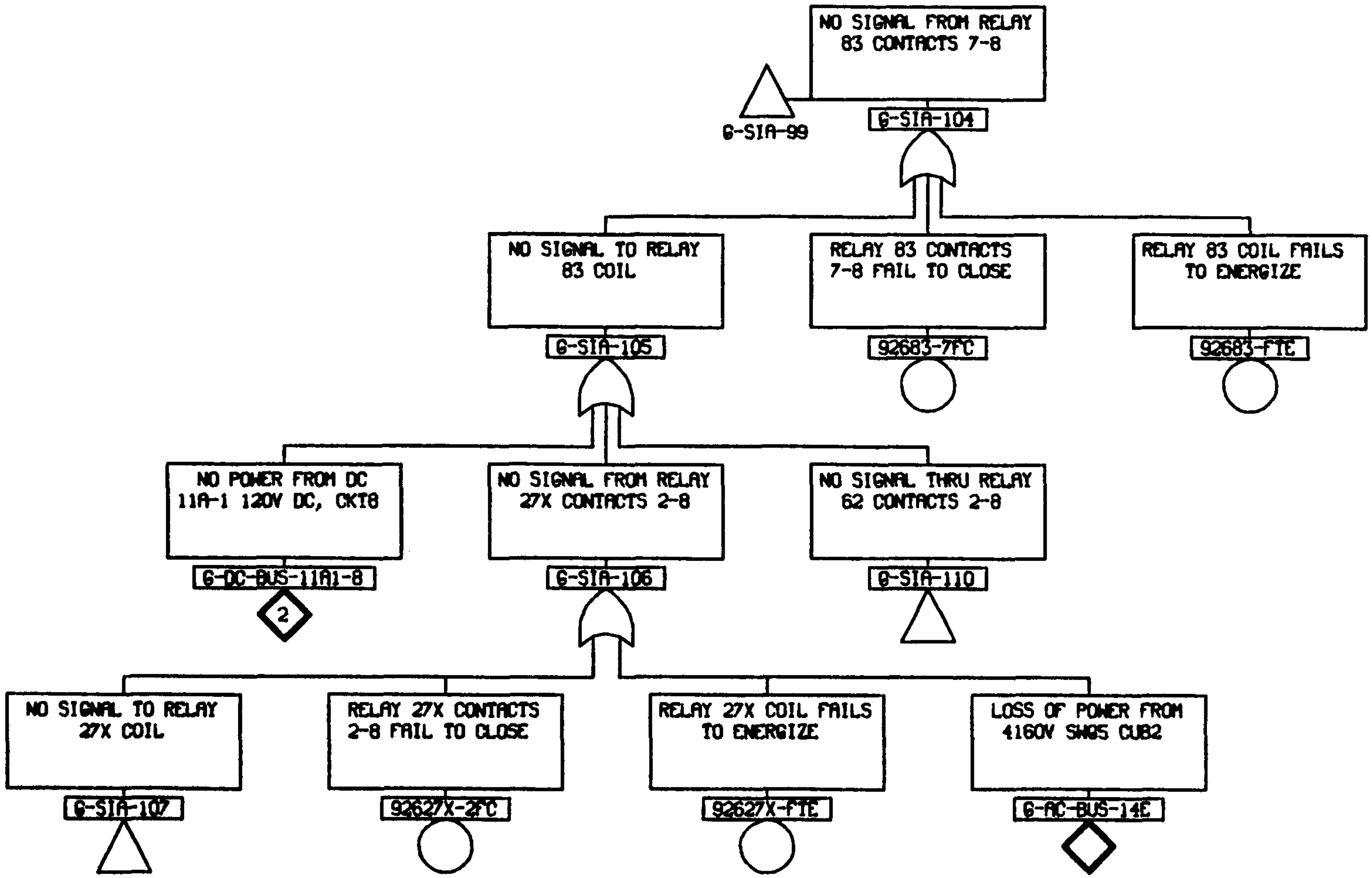

NO SIGNAL FROM RELAY 932/ 15304-105 CONTACTS 3-4
G-SIA-91
G-SIA-92
RELAY-105 CONTACT 3-4 FAIL TO CLOSE
9321530-105-3FC
NO SIGNAL TO COIL OF 932/ 1530-105
G-SIA-94
RELAY COIL-105 FAIL TO ENERGIZE
9321530-105-FTE
NO SIGNAL FROM RELAY 932/ 1530-106 CONTACTS 11-12
G-SIA-117
NO SIGNAL FROM RELAYS 932/ 1530-101 AND 102
G-SIA-95
NO SIGNAL FROM RELAY 932/ 1530-101 CONTACTS 5-6
G-SIA-118
NO SIGNAL FROM RELAY 932/ 1530-102 CONTACTS 5-6
G-SIA-119

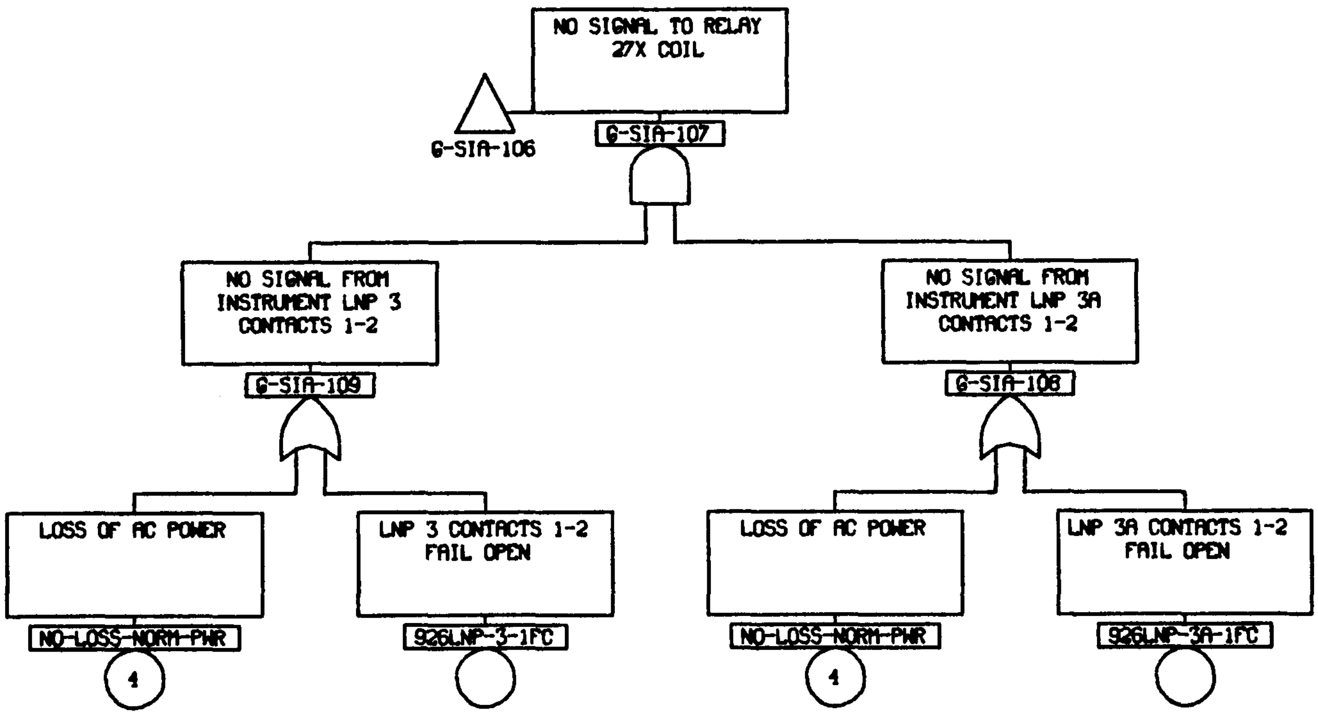


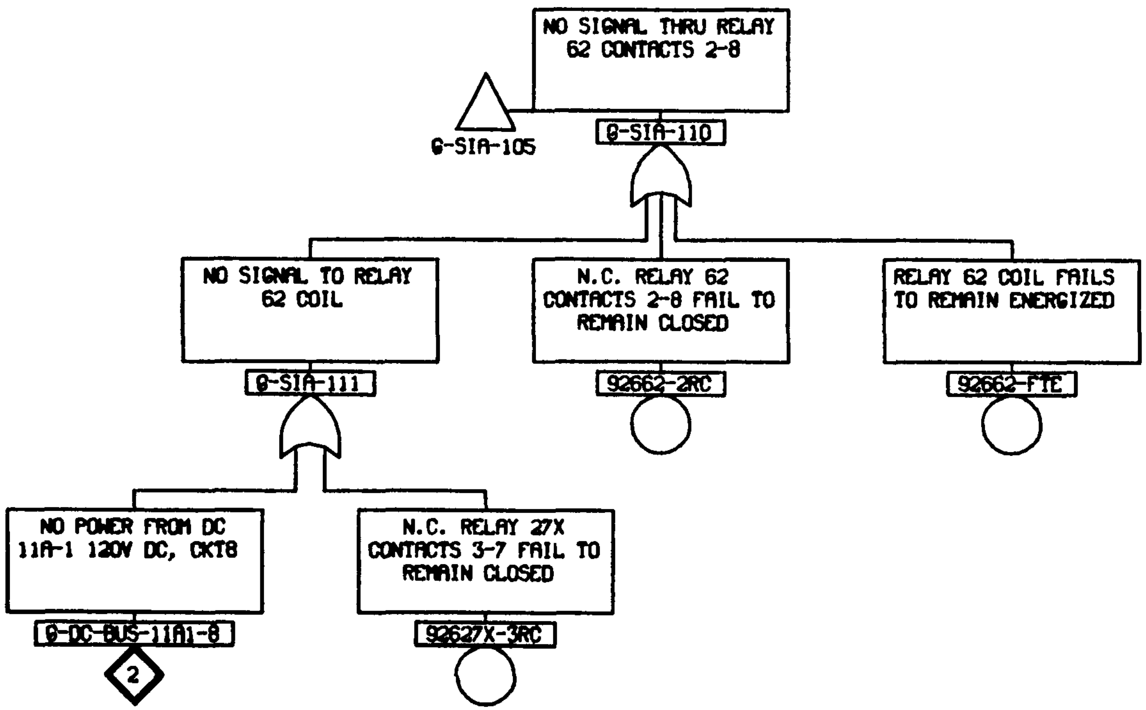
NO SIGNAL FROM RELAY 932/ 1530-113 CONTACTS 3-4
G-SIA-93
G-SIA-91
RELAY COIL-113 FAIL TO ENERGIZE
9321530-113-FTE
RELAY-113 CONTACTS 3-4 FAIL TO CLOSE
9321530-113-3FC
NO SIGNAL TO COIL OF 932/ 1530-113
G-SIA-96
NO SIGNAL FROM RELAY 932/ 1530-106 CONTACTS 1-2
G-SIA-120
NO SIGNAL FROM RELAYS 932/ 1530-101 AND 102
G-SIA-97
NO SIGNAL FROM RELAY 932/ 1530-101 CONTACTS 3-4
G-SIA-121
NO SIGNAL FROM RELAY 932/ 1530-102 CONTACTS 1-2
G-SIA-122


CONTROL SIGNAL FAIL TO STATION AIR COMPRESSOR M5-1
G-SIA-98
G-SIA-70
NO SIGNAL TO RELAYS 83 AND CS/393
G-SIA-99
NO POWER TO BREAKER SWGR 12C COMP. 13A
AC-12C-13A-FTC
NO POWER SUPPLY TO RELAYS AND SWITCHES FROM 125DC. 101A
G-DC-BUS-A-21
FAILURE OF CS/393 CONTACT 4-4T
G-SIA-100
NO SIGNAL FROM CS/393 CONTACTS 1-1T
G-SIA-101
NO SIGNAL FROM RELAY 83 CONTACTS 7-8
G-SIA-104
SWITCH CS/393 CONTACTS 4-4T FAIL TO CLOSE
906CS-393-4FC
OPERATOR FAILS TO ACTIVATE CS/393 CONTACT 4-4T
SA-M51-CPR-OFS
SWITCH CS/393 FAILS TO ACTIVATE MECH.
906CS-393-FTE
2

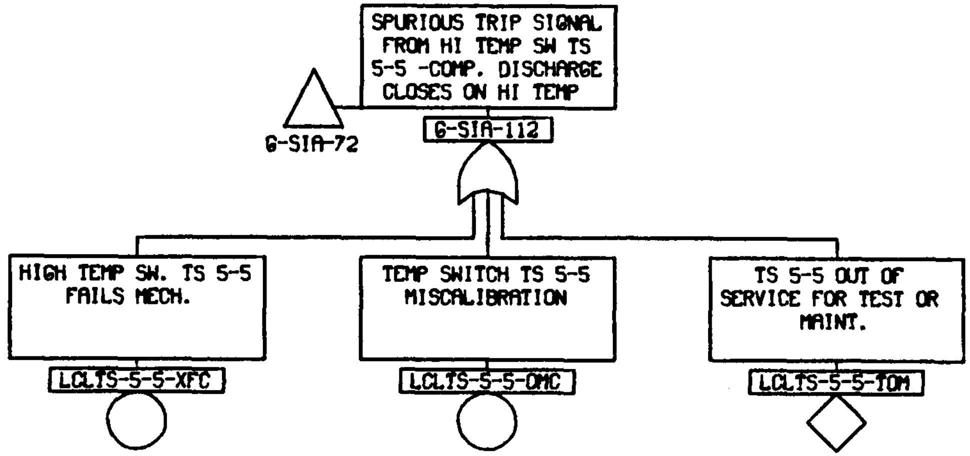

NO SIGNAL FROM CS/393 CONTACTS 1-1T
G-SIA-101
G-SIA-99
NO SIGNAL FROM RELAYS 62/TDDO SWITCH PS-5-13A AND B
G-SIA-102
NO SIGNAL FROM SWITCH CS/393
G-SIA-103
NO SIGNAL FROM RELAY 62/TDDO
G-SIA-81
ERRONEOUS SIGNAL FROM PRESSURE SWITCH PS/5-13A SETPOINT 90 PSIG
G-SIA-123
ERRONEOUS SIGNAL FROM PRESSURE SWITCH PS/5-13B SETPOINT 90 PSIG
G-SIA-124
SWITCH CS/393 FAILS TO ACTIVATE MECH.
906CS-393-FTE
2
SWITCH CS/393 CONTACTS 1-1T FAIL TO CLOSE
906CS-393-1FC

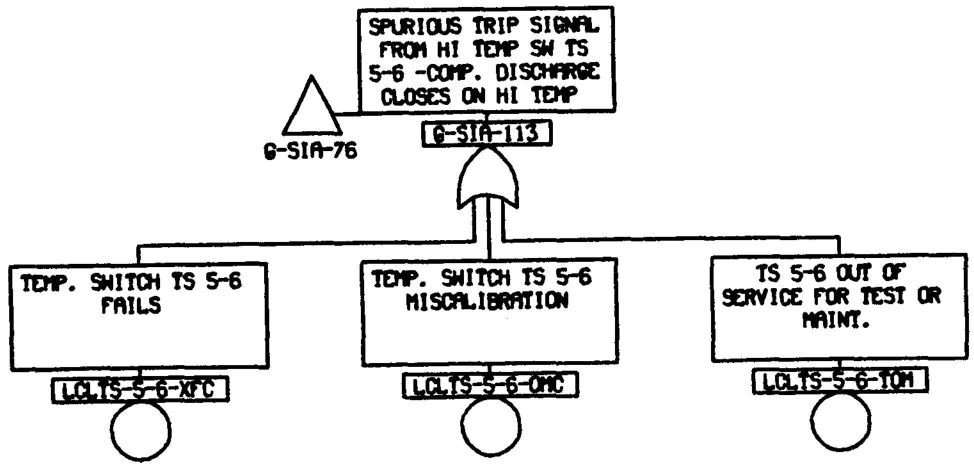

NO SIGNAL FROM RELAY 83 CONTACTS 7-8
G-SIA-104
G-SIA-99
NO SIGNAL TO RELAY 83 COIL
G-SIA-105
RELAY 83 CONTACTS 7-8 FAIL TO CLOSE
92683-7FC
RELAY 83 COIL FAILS TO ENERGIZE
92683-FTE
NO POWER FROM DC 11A-1 120V DC, CKT8
G-DC-BUS-11A1-8
2
NO SIGNAL FROM RELAY 27X CONTACTS 2-8
G-SIA-106
NO SIGNAL THRU RELAY 62 CONTACTS 2-8
G-SIA-110
NO SIGNAL TO RELAY 27X COIL
G-SIA-107
RELAY 27X CONTACTS 2-8 FAIL TO CLOSE
92627X-2FC
RELAY 27X COIL FAILS TO ENERGIZE
92627X-FTE
LOSS OF POWER FROM 4160V SWG5 CUB2
G-AC-BUS-14E

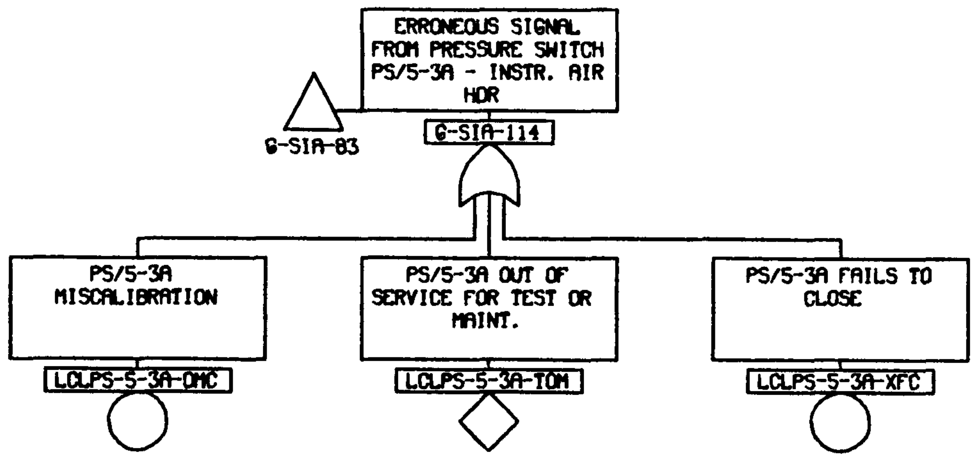

NO SIGNAL TO RELAY 27X COIL
G-SIA-106
G-SIA-107
NO SIGNAL FROM INSTRUMENT LNP 3 CONTACTS 1-2
G-SIA-109
NO SIGNAL FROM INSTRUMENT LNP 3A CONTACTS 1-2
G-SIA-108
LOSS OF AC POWER
NO-LOSS-NORM-PWR
4
LNP 3 CONTACTS 1-2 FAIL OPEN
926LNP-3-1FC
LOSS OF AC POWER
NO-LOSS-NORM-PWR
4
LNP 3A CONTACTS 1-2 FAIL OPEN
926LNP-3A-1FC

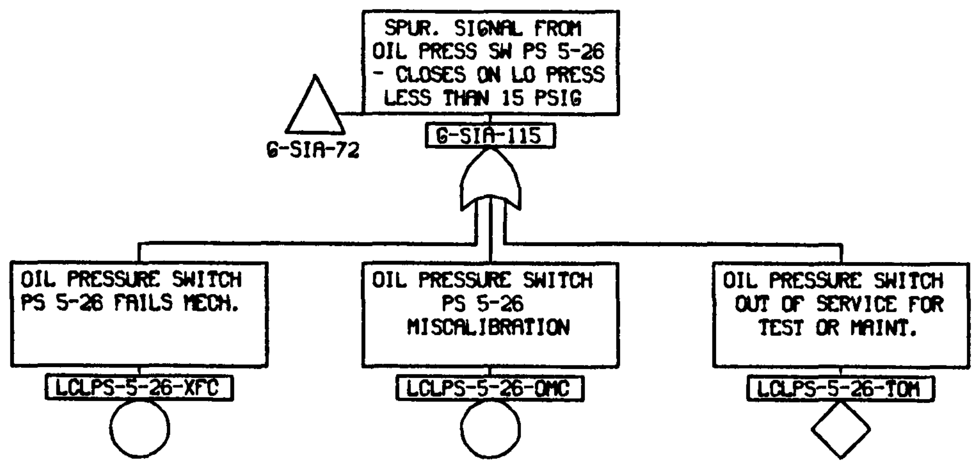

NO SIGNAL THRU RELAY 62 CONTACTS 2-8
G-SIA-110
G-SIA-105
NO SIGNAL TO RELAY 62 COIL
G-SIA-111
N.C. RELAY 62 CONTACTS 2-8 FAIL TO REMAIN CLOSED
92662-2RC
RELAY 62 COIL FAILS TO REMAIN ENERGIZED
92662-FTE
NO POWER FROM DC 11A-1 120V DC, CKT8
G-DC-BUS-11A1-8
2
N.C. RELAY 27X CONTACTS 3-7 FAIL TO REMAIN CLOSED
92627X-3RC

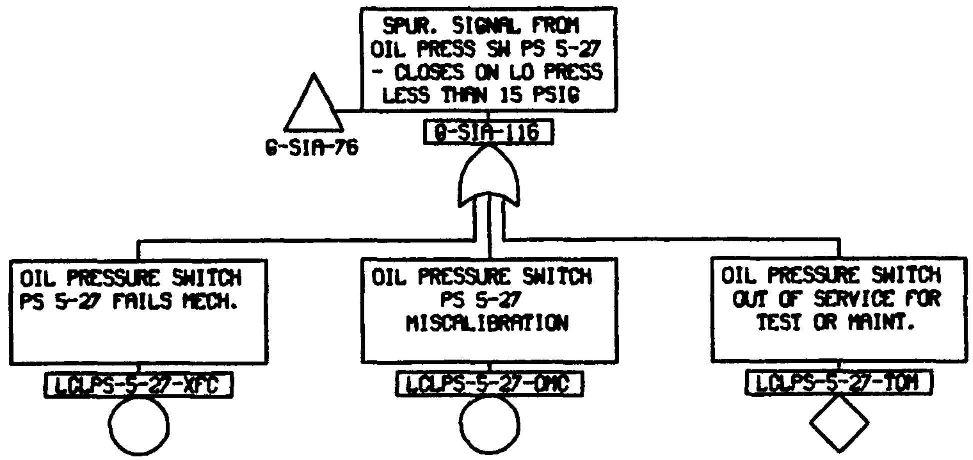
SIA-31

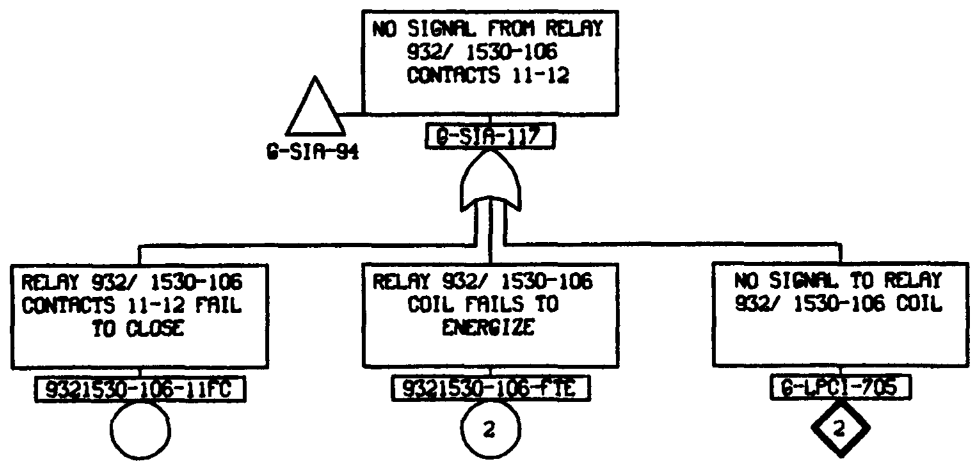

SPURIOUS TRIP SIGNAL FROM HI TEMP SW TS 5-5 -COMP. DISCHARGE CLOSES ON HI TEMP
G-SIA-112
G-SIA-72
HIGH TEMP SW. TS 5-5 FAILS MECH.
LCLTS-5-5-XFC
TEMP SWITCH TS 5-5 MISCALIBRATION
LCLTS-5-5-OMC
TS 5-5 OUT OF SERVICE FOR TEST OR MAINT.
LCLTS-5-5-TOM

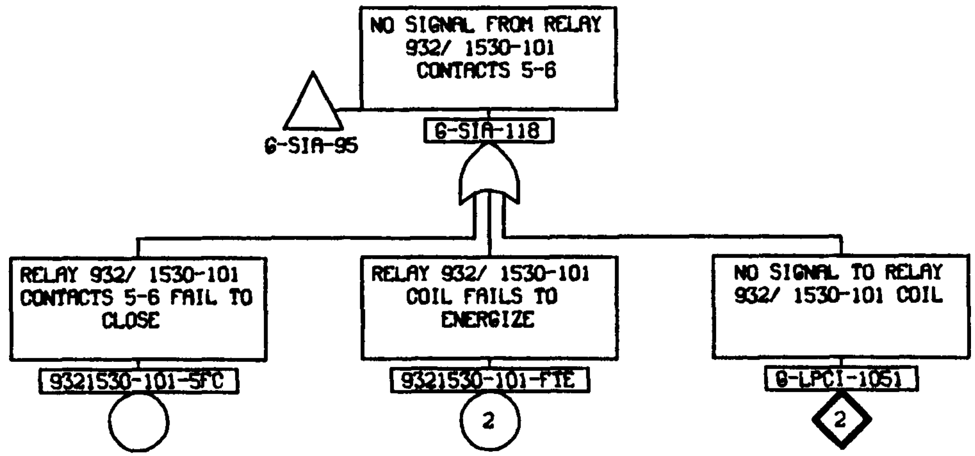

SPURIOUS TRIP SIGNAL FROM HI TEMP SW TS 5-6 -COMP. DISCHARGE CLOSES ON HI TEMP
G-SIA-113
G-SIA-76
TEMP. SWITCH TS 5-6 FAILS
LCLTS-5-6-XFC
TEMP. SWITCH TS 5-6 MISCALIBRATION
LCLTS-5-6-OMC
TS 5-6 OUT OF SERVICE FOR TEST OR MAINT.
LCLTS-5-6-TOM

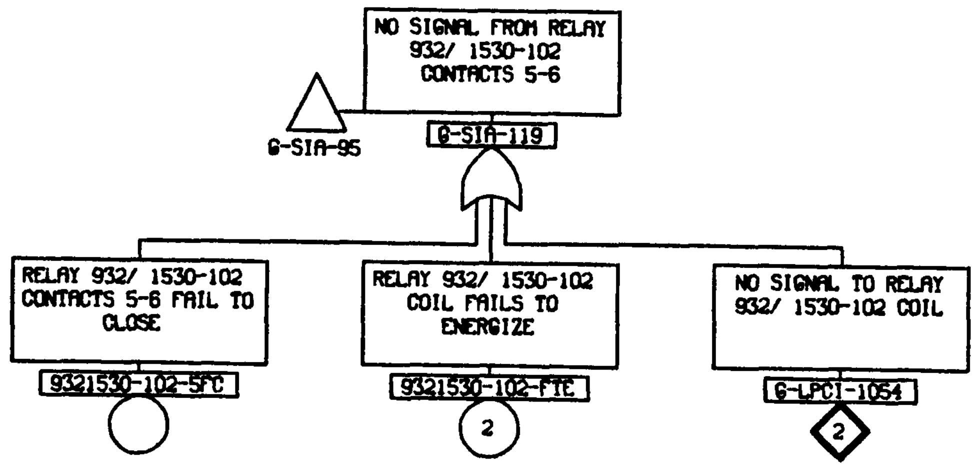

ERRONEOUS SIGNAL FROM PRESSURE SWITCH PS/5-3A - INSTR. AIR HDR
G-SIA-114
G-SIA-83
PS/5-3A MISCALIBRATION
LCLPS-5-3A-OMC
PS/5-3A OUT OF SERVICE FOR TEST OR MAINT.
LCLPS-5-3A-TOM
PS/5-3A FAILS TO CLOSE
LCLPS-5-3A-XFC

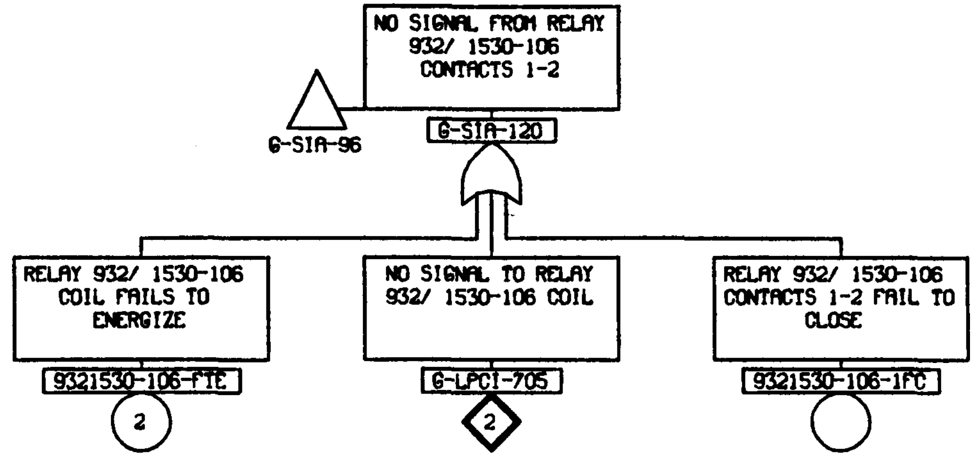

SPUR. SIGNAL FROM OIL PRESS SW PS 5-26 - CLOSES ON LO PRESS LESS THAN 15 PSIG
G-SIA-115
G-SIA-72
OIL PRESSURE SWITCH PS 5-26 FAILS MECH.
LCLPS-5-26-XFC
OIL PRESSURE SWITCH PS 5-26 MISCALIBRATION
LCLPS-5-26-OMC
OIL PRESSURE SWITCH OUT OF SERVICE FOR TEST OR MAINT.
LCLPS-5-26-TOM

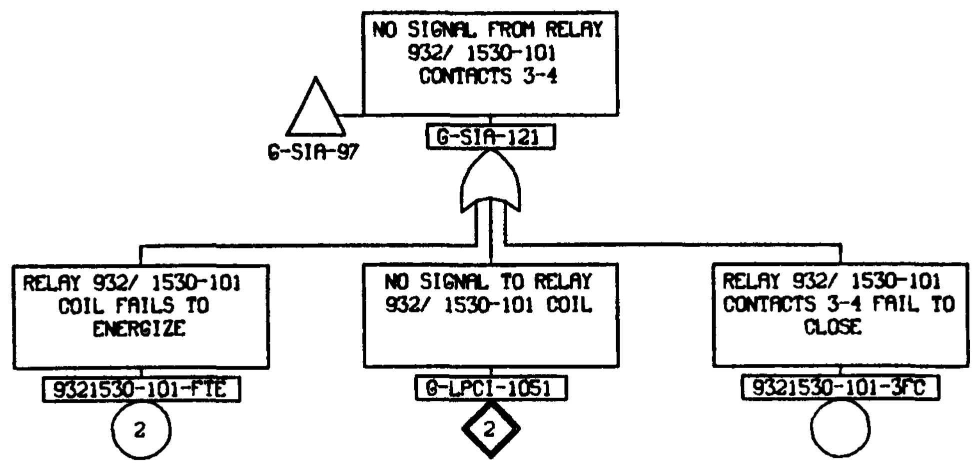

SPUR. SIGNAL FROM OIL PRESS SW PS 5-27 - CLOSES ON LO PRESS LESS THAN 15 PSIG
G-SIA-116
G-SIA-76
OIL PRESSURE SWITCH PS 5-27 FAILS MECH.
LCLPS-5-27-XFC
OIL PRESSURE SWITCH PS 5-27 MISCALIBRATION
LCLPS-5-27-OMC
OIL PRESSURE SWITCH OUT OF SERVICE FOR TEST OR MAINT.
LCLPS-5-27-TOM

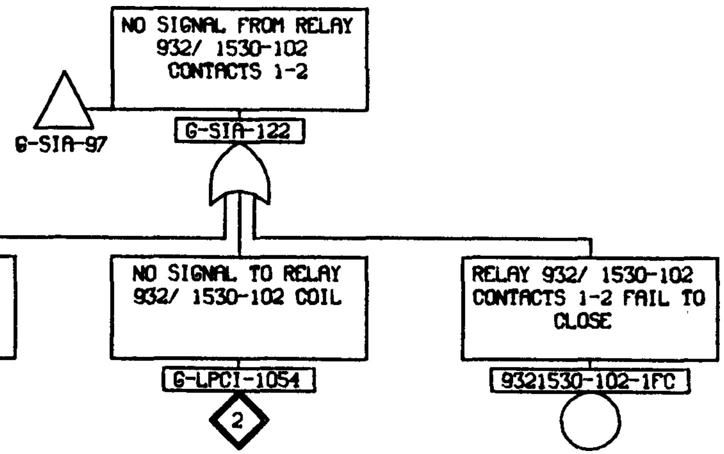

NO SIGNAL FROM RELAY 932/ 1530-106 CONTACTS 11-12
G-SIA-117
G-SIA-94
RELAY 932/ 1530-106 CONTACTS 11-12 FAIL TO CLOSE
9321530-106-11FC
RELAY 932/ 1530-106 COIL FAILS TO ENERGIZE
9321530-106-FTE
2
NO SIGNAL TO RELAY 932/ 1530-106 COIL
G-LPCI-705
2

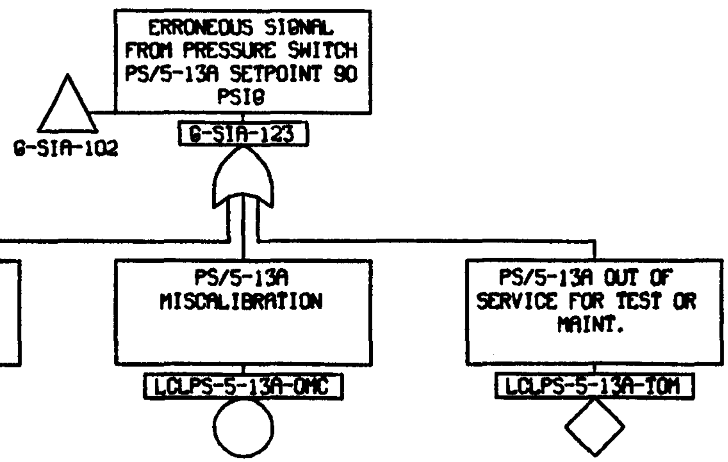

NO SIGNAL FROM RELAY 932/ 1530-101 CONTACTS 5-6
G-SIA-95
G-SIA-118
RELAY 932/ 1530-101 CONTACTS 5-6 FAIL TO CLOSE
9321530-101-5FC
RELAY 932/ 1530-101 COIL FAILS TO ENERGIZE
9321530-101-FTE
2
NO SIGNAL TO RELAY 932/ 1530-101 COIL
G-LPCI-1051
2

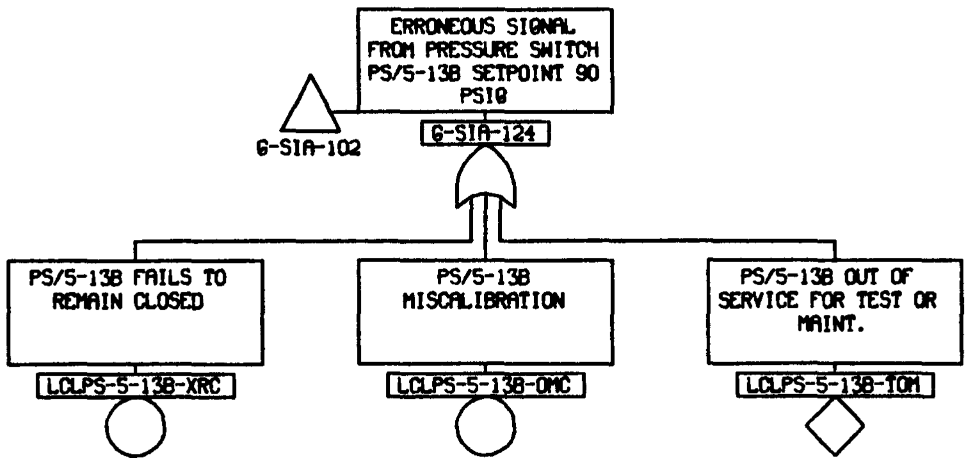

NO SIGNAL FROM RELAY 932/ 1530-102 CONTACTS 5-6
G-SIA-95
G-SIA-119
RELAY 932/ 1530-102 CONTACTS 5-6 FAIL TO CLOSE
9321530-102-5FC
RELAY 932/ 1530-102 COIL FAILS TO ENERGIZE
9321530-102-FTE
2
NO SIGNAL TO RELAY 932/ 1530-102 COIL
G-LPCI-1054
2

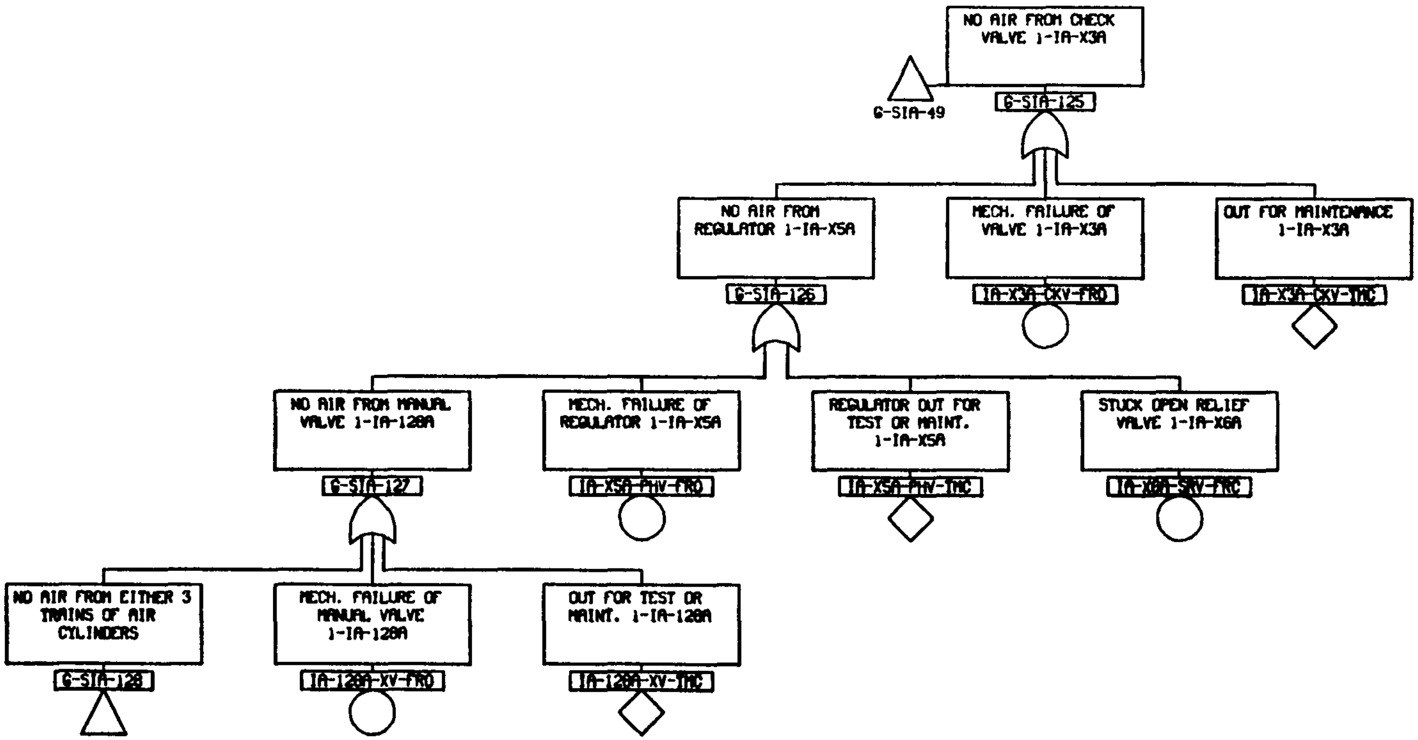

NO SIGNAL FROM RELAY 932/ 1530-106 CONTACTS 1-2
G-SIA-96
G-SIA-120
RELAY 932/ 1530-106 COIL FAILS TO ENERGIZE
9321530-106-FTE
2
NO SIGNAL TO RELAY 932/ 1530-106 COIL
G-LPCI-705
2
RELAY 932/ 1530-106 CONTACTS 1-2 FAIL TO CLOSE
9321530-106-1FC


NO SIGNAL FROM RELAY 932/ 1530-101 CONTACTS 3-4
G-SIA-97
G-SIA-121
RELAY 932/ 1530-101 COIL FAILS TO ENERGIZE
9321530-101-FTE
2
NO SIGNAL TO RELAY 932/ 1530-101 COIL
G-LPCI-1051
2
RELAY 932/ 1530-101 CONTACTS 3-4 FAIL TO CLOSE
9321530-101-3FC

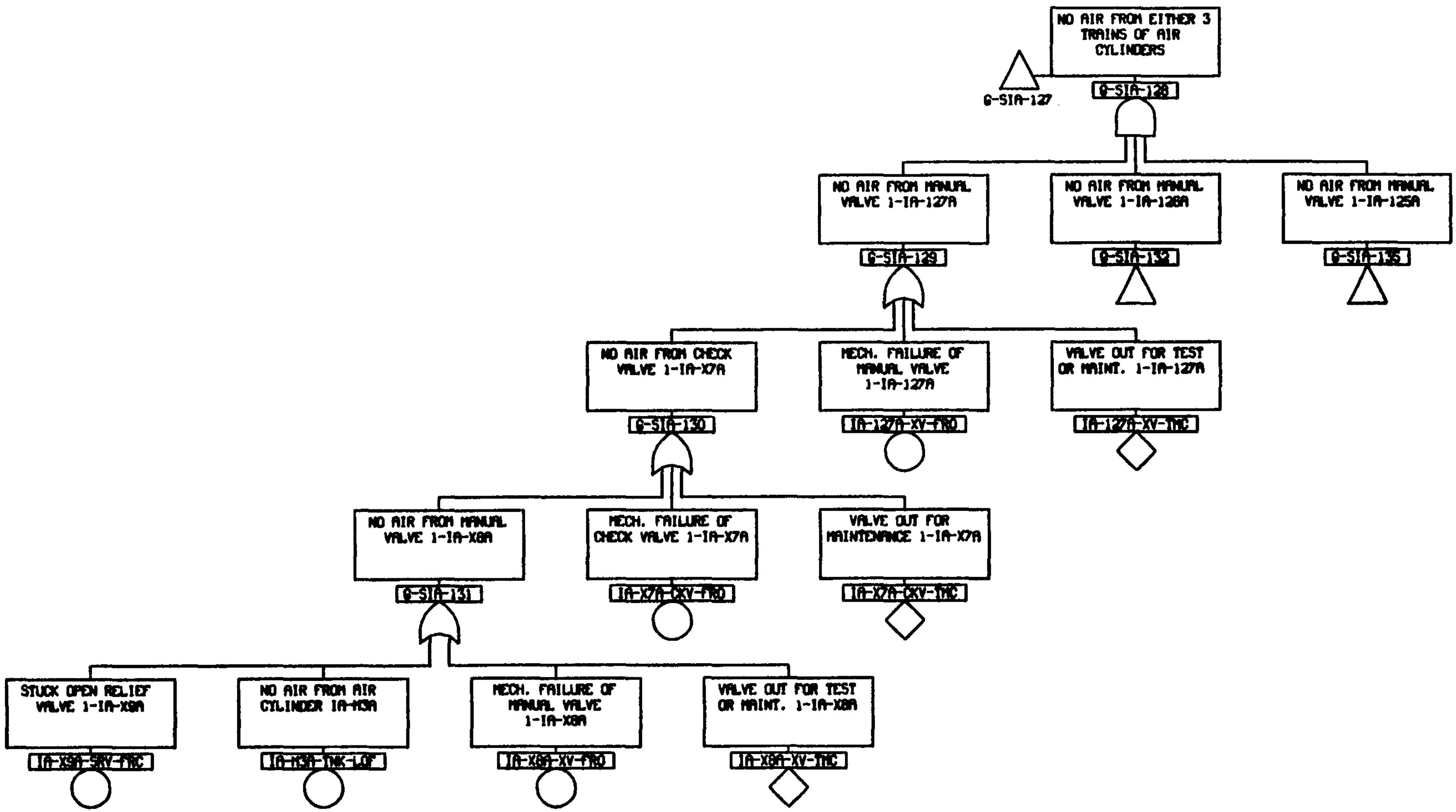

NO SIGNAL FROM RELAY 932/ 1530-102 CONTACTS 1-2
G-SIA-97
G-SIA-122
RELAY 932/ 1530-102 COIL FAILS TO ENERGIZE
9321530-102-FTE
2
NO SIGNAL TO RELAY 932/ 1530-102 COIL
G-LPCI-1054
2
RELAY 932/ 1530-102 CONTACTS 1-2 FAIL TO CLOSE
9321530-102-1FC


ERRONEOUS SIGNAL FROM PRESSURE SWITCH PS/5-13A SETPOINT 90 PSIG
G-SIA-102
G-SIA-123
PS/5-13A FAILS TO REMAIN CLOSED
LCLPS-5-13A-XRC
PS/5-13A MISCALIBRATION
LCLPS-5-13A-OMC
PS/5-13A OUT OF SERVICE FOR TEST OR MAINT.
LCLPS-5-13A-TOM

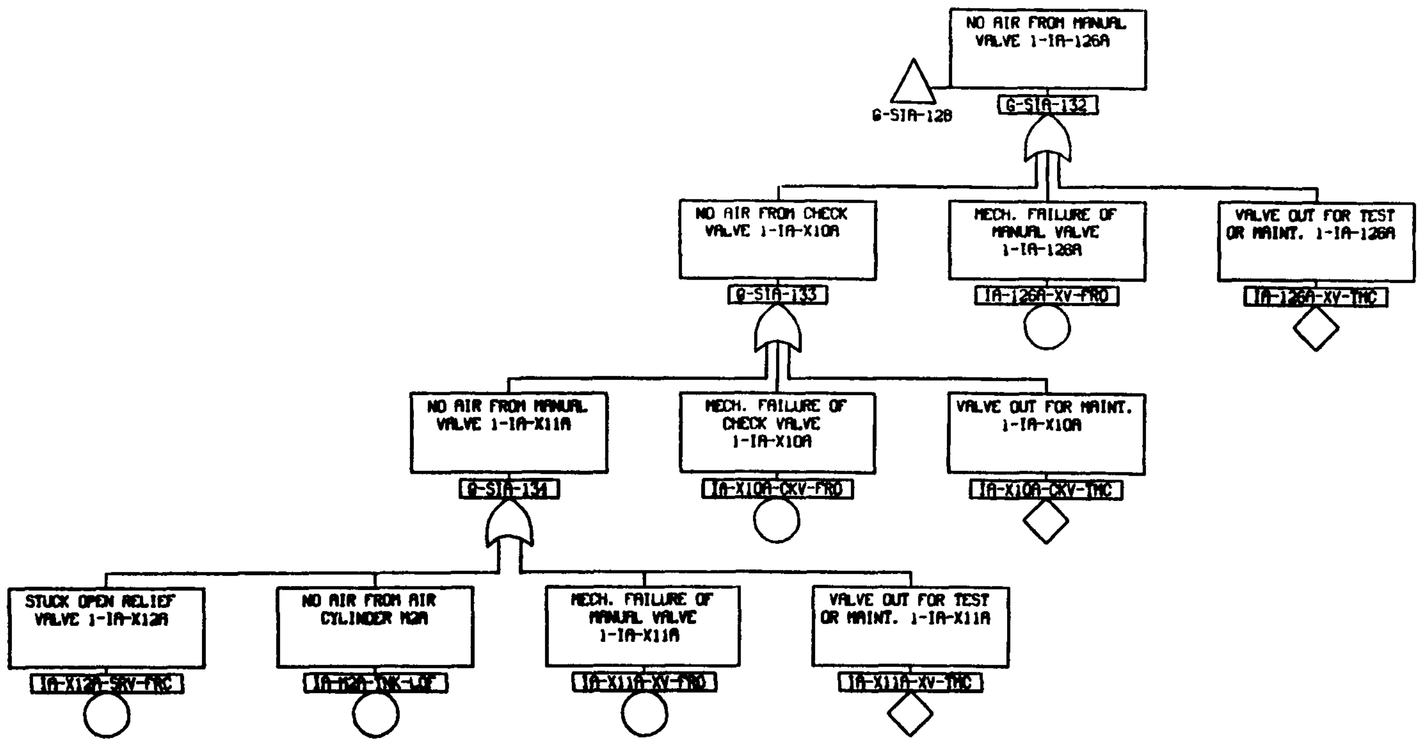

ERRONEOUS SIGNAL FROM PRESSURE SWITCH PS/5-13B SETPOINT 90 PSIG
G-SIA-124
G-SIA-102
PS/5-13B FAILS TO REMAIN CLOSED
LCLPS-5-13B-XRC
PS/5-13B MISCALIBRATION
LCLPS-5-13B-OMC
PS/5-13B OUT OF SERVICE FOR TEST OR MAINT.
LCLPS-5-13B-TOM

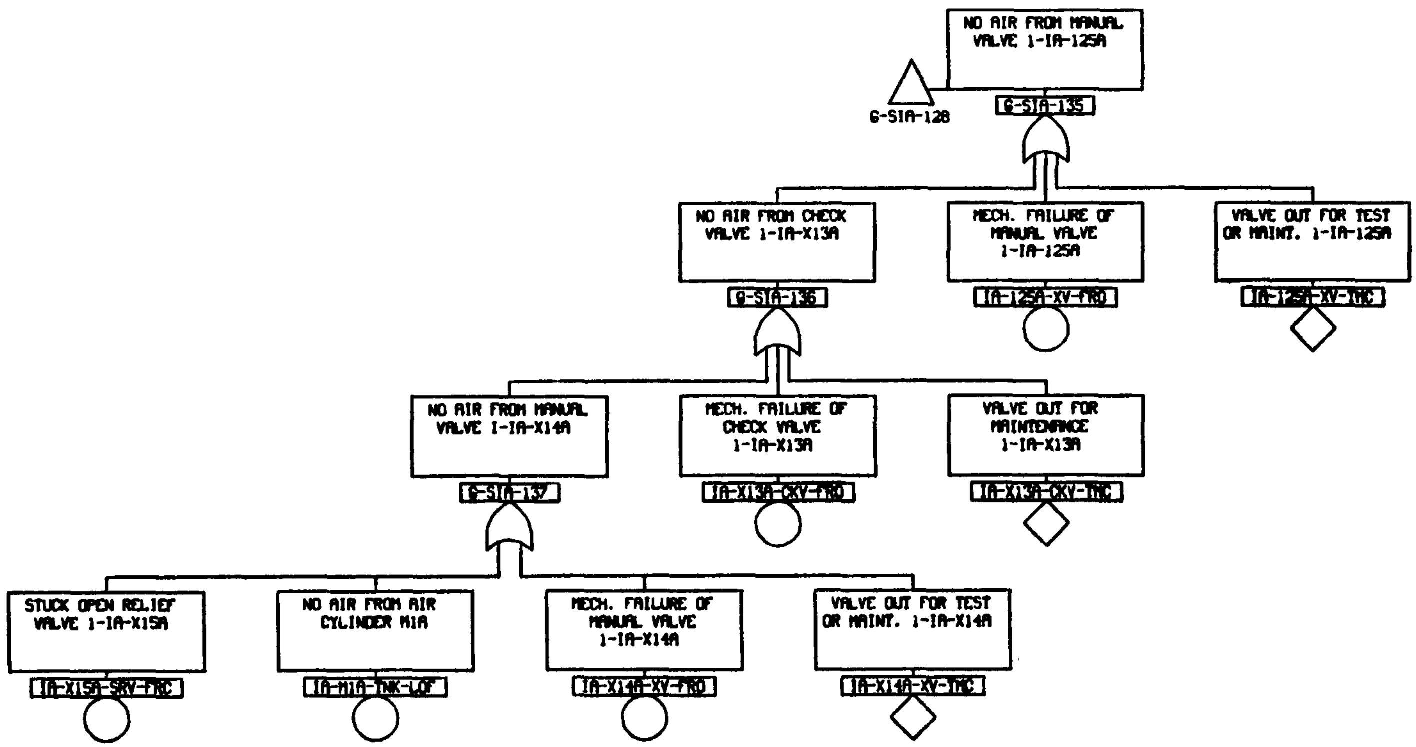

NO AIR FROM CHECK VALVE 1-IA-X3A
G-SIA-49
G-SIA-125
NO AIR FROM REGULATOR 1-IA-X5A
G-SIA-126
MECH. FAILURE OF VALVE 1-IA-X3A
IA-X3A-CKV-FRO
OUT FOR MAINTENANCE 1-IA-X3A
IA-X3A-CKV-TMC
NO AIR FROM MANUAL VALVE 1-IA-128A
G-SIA-127
MECH. FAILURE OF REGULATOR 1-IA-X5A
IA-X5A-PHV-FRO
REGULATOR OUT FOR TEST OR MAINT. 1-IA-X5A
IA-X5A-PHV-TMC
STUCK OPEN RELIEF VALVE 1-IA-X6A
IA-X6A-SRV-FRC
NO AIR FROM EITHER 3 TRAINS OF AIR CYLINDERS
G-SIA-128
MECH. FAILURE OF MANUAL VALVE 1-IA-128A
IA-128A-XV-FRO
OUT FOR TEST OR MAINT. 1-IA-128A
IA-128A-XV-TMC

B.11-60


NO AIR FROM EITHER 3 TRAINS OF AIR CYLINDERS
G-SIA-128
G-SIA-127
NO AIR FROM MANUAL VALVE 1-IA-127A
G-SIA-129
NO AIR FROM MANUAL VALVE 1-IA-128A
G-SIA-132
NO AIR FROM MANUAL VALVE 1-IA-125A
G-SIA-135
NO AIR FROM CHECK VALVE 1-IA-X7A
G-SIA-130
MECH. FAILURE OF MANUAL VALVE 1-IA-127A
IA-127A-XV-FRO
VALVE OUT FOR TEST OR MAINT. 1-IA-127A
IA-127A-XV-TMC
NO AIR FROM MANUAL VALVE 1-IA-X8A
G-SIA-131
MECH. FAILURE OF CHECK VALVE 1-IA-X7A
IA-X7A-CKV-FRO
VALVE OUT FOR MAINTENANCE 1-IA-X7A
IA-X7A-CKV-TMC
STUCK OPEN RELIEF VALVE 1-IA-X9A
IA-X9A-SRV-FRC
NO AIR FROM AIR CYLINDER IA-M3A
IA-M3A-TNK-LOF
MECH. FAILURE OF MANUAL VALVE 1-IA-X8A
IA-X8A-XV-FRO
VALVE OUT FOR TEST OR MAINT. 1-IA-X8A
IA-X8A-XV-TMC

SIA-40


NO AIR FROM MANUAL VALVE 1-IA-126A
G-SIA-132
G-SIA-128
NO AIR FROM CHECK VALVE 1-IA-X10A
G-SIA-133
MECH. FAILURE OF MANUAL VALVE 1-IA-126A
IA-126A-XV-FRO
VALVE OUT FOR TEST OR MAINT. 1-IA-126A
IA-126A-XV-TMC
NO AIR FROM MANUAL VALVE 1-IA-X11A
G-SIA-134
MECH. FAILURE OF CHECK VALVE 1-IA-X10A
IA-X10A-CKV-FRO
VALVE OUT FOR MAINT. 1-IA-X10A
IA-X10A-CKV-TMC
STUCK OPEN RELIEF VALVE 1-IA-X12A
IA-X12A-SRV-FRC
NO AIR FROM AIR CYLINDER M2A
IA-M2A-TNK-LOF
MECH. FAILURE OF MANUAL VALVE 1-IA-X11A
IA-X11A-XV-FRO
VALVE OUT FOR TEST OR MAINT. 1-IA-X11A
IA-X11A-XV-TMC



NO AIR FROM MANUAL VALVE 1-IA-125A
G-SIA-135
G-SIA-128
NO AIR FROM CHECK VALVE 1-IA-X13A
G-SIA-136
MECH. FAILURE OF MANUAL VALVE 1-IA-125A
IA-125A-XV-FRO
VALVE OUT FOR TEST OR MAINT. 1-IA-125A
IA-125A-XV-TMC
NO AIR FROM MANUAL VALVE 1-IA-X14A
G-SIA-137
MECH. FAILURE OF CHECK VALVE 1-IA-X13A
IA-X13A-CKV-FRO
VALVE OUT FOR MAINTENANCE 1-IA-X13A
IA-X13A-CKV-TMC
STUCK OPEN RELIEF VALVE 1-IA-X15A
IA-X15A-SRV-FRC
NO AIR FROM AIR CYLINDER M1A
IA-M1A-TNK-LOF
MECH. FAILURE OF MANUAL VALVE 1-IA-X14A
IA-X14A-XV-FRO
VALVE OUT FOR TEST OR MAINT. 1-IA-X14A
IA-X14A-XV-TMC

APPENDIX B.12

REACTOR BUILDING CLOSED COOLING WATER SYSTEM

B.12.1 Reactor Building Closed Cooling Water System Description

B.12.1.1 Purpose

During normal operation, the reactor building closed cooling water system (RBCCW) provides heat removal for motors and systems in the reactor building. Following a transient or when it is necessary to use the shutdown cooling system, the RBCCW cools the shutdown cooling system pumps and removes heat from the reactor via the shutdown cooling heat exchangers.

B.12.1.2 Description and Configuration

The RBCCW (Figure B.12.1) consists of three heat exchangers, two pumps and the necessary control and support equipment. Each of the three cooling water heat exchangers is cooled by the service water system and is designed for one-half system capacity during full power operation. Each of the pumps is assigned for full capacity of the system during full power operation. The cooling requirements of equipment served by the RBCCW during normal operation are:

Equipment	Normal Flow (gpm)	Heat Transfer (10^6 Btu/hr)
Fuel Pool Coolers	1250	7.84
Recirculation Pumps and Motors	100	1.00
Drywell Air Coolers	350	2.80
Nonregenerative Heat Exchangers	1760	57.00
Reactor Equipment Drain Tank	30	0.50
Filter Recirculation Coolers	6	0.02
Waste Concentrator Condenser	350	7.96
Sparging Air Compressors	72	0.36
Drywell Sump Cooler	30	0.50
Three Concentrator Waste Surge Tanks	15	0.24
Cleanup and Precoat Pump Coolers	40	0.12
	4003	78.34

Since the shutdown heat exchanger and shutdown pump cooler are not used during normal operation of the plant, they are not included in the above table.

The RBCCW support equipment includes an expansion tank and a chemical feeder. The expansion tank is located above the highest point of the system. The tank is carbon steel and is vented to the atmosphere. A chemical feeder is used for periodically injecting inhibitors into the system as determined necessary by periodic analysis. A level controller maintains the water level in the expansion tank with makeup being supplied from the demineralized water transfer system. A high level in the expansion tank is alarmed in the control room. All major pieces of equipment are equipped with pressure and temperature indicators.

In the shutdown cooling mode of operation, the RBCCW is aligned to cool the SDCS pumps and heat exchangers as shown in Figure B.12-2 by opening valve RC-39. This mode of operation was modelled for this IREP study.

B.12.1.3 System Interfaces

System Interfaces for the RBCCW are shown in Table B.12-1.

B.12.1.4 Instrumentation and Control

The RBCCW is manually controlled via pump (start/stop) and MOV (open/close) switches on the 906 control room panel and by manual valves controlling cooling water flow to the three heat exchangers.

Both RBCCW pumps receive a trip signal in the event that an LNP occurs. The operator must manually restart one of the pumps since there is no automatic start logic. The trip logic is shown in Figure B.12-3.

It is important to recognize that normal operation of the reactor requires operation of at least one RBCCW pump and heat exchanger cooling the reactor building loads. Without this cooling (reactor building HVAC units in particular) a reactor trip on high drywell pressure will occur.

B.12.1.5 Testing

The following tests and surveillance procedures are related to the RBCCW:

SP 608.6 Reactor Building Closed Cooling Water Pump and Discharge Check Valve Readiness Test

This test checks the ability of the RBCCW pump discharge check valves (2A and 2B) to open during monthly pump rotation (performed monthly coincident with pump rotation)

OPS 309C RBCCW Valve Checklist

B.12.1.6 Maintenance

The RBCCW is operated with only one pump running while in continuous service. Each month, the operating pump is shut down and the idle pump is put into service. Maintenance is performed on the non-operating pump (and associated equipment) only as required. There is no scheduled maintenance.

B.12.1.7 Technical Specifications

The operation of the RBCCW is not specified in the plant technical specifications.

B.12.1.8 Operation

Under normal operation of the RBCCW System, only one pump (either M4-IOA or M4-10B) and two heat exchangers are utilized. The RBCCW pumps are rotated monthly.

In the shutdown cooling mode of operation, both RBCCW pumps and all three heat exchangers (M4-9A, M4-9B and M4-9C) are utilized to provide a maximum heat sink capability. The operator must start the pump that is not running; both pumps following an LNP as there is no auto-start signal for this system.

B.12.2 Analysis

B.12.2.1 Success/Failure Criteria

For the purposes of the IREP Study, the only operating mode of the RBCCW examined was the shutdown cooling mode. In this mode, successful performance requires at least one operational pump and heat exchanger. Failure of the RBCCW is defined as failure to cool at least one SDCS pump or its associated SDCS heat exchanger via one RBCCW pump and heat exchanger.

B.12.2.2 Assumptions

In this analysis, the following assumptions are made:

1) It is assumed that the RBCCW is operating successfully prior to the time of transiant initiation. Thus, it is not possible for both RBCCW pumps or all RBCCW heat exchangers to be simultaneously out of service for test or maintenance. This configuration would prevent reactor operation, specifically, inability to cool the recirculating pumps and drywell HVAC units.

2) The RBCCW volumetric surge tank and additional makeup system are not modelled since their operation is necessary for RBCCW system operation and subsequent reactor operation. Since the surge tank is passive in nature and was working prior to the transient, we assume that reactor operation precedes the transient initiator, thus modelling of this portion of the RBCCW is not necessary.

3) It is assumed that only the shutdown cooling pumps and heat exchangers are of interest in this evaluation, hence only failure to cool these devices is modelled.

4) Dependence on DC Power is not assumed in the fault tree as a result of the fact that the allowable time period for starting shutdown cooling is long. DC power is needed for control power to start the RBCCW pumps.

Table B.12-1

RBCCW Interfaces Failure Mode and Effects

Primary System			Support System			Failure Mode	Failure Effect
System	Div.	Comp.	System	Div.	Comp.		
RBCCW		Pump 1A 1B	AC Pwr	 G/T D/G	 Bus 14E Bus 14F	Low or zero voltage	Pump failure to start or run, possible motor burnout
RBCCW		Pump 1A 1B	DC Pwr		 Bus 101B Bus 101A	Low or zero voltage	Precludes manual start; no local effect on running pump
RBCCW		Heat Exchanger 1A 1B 1C	SWS		Secondary side heat transfer	No flow	No rejection of RBCCW heat to ultimate heat sink
RBCCW		Non-essential header isolation valve (MOV)	AC Pwr		Bus E-2	Low or zero voltage	No flow from primary containment heat exchangers
RBCCW		Essential header isolation valve (MOV)	DC Pwr		Bus 101-AB-1	Low or zero	No flow from reactor and radwaste building heat exchangers

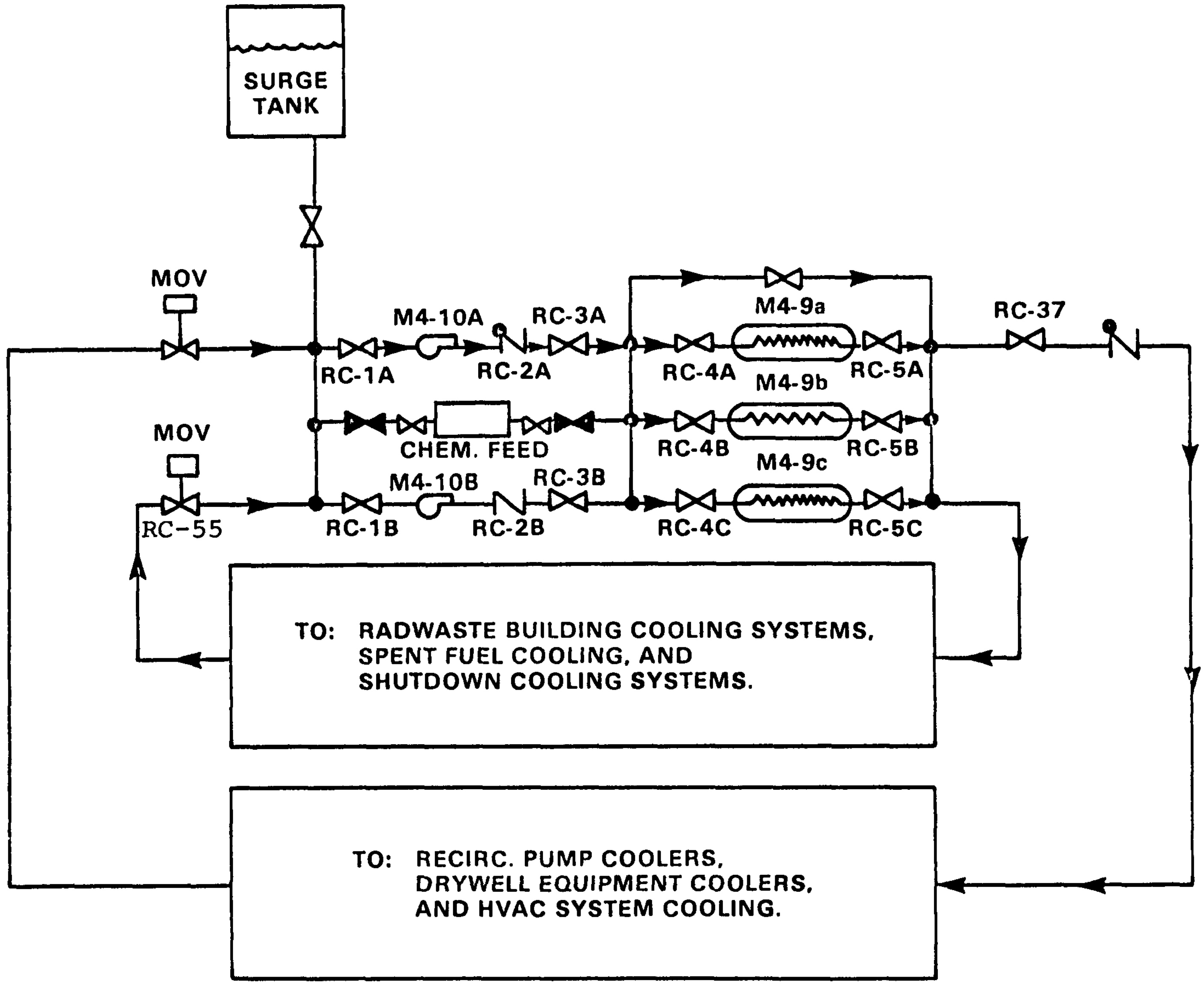


FIGURE B.12-1. REACTOR BUILDING CLOSED COOLING WATER SYSTEM

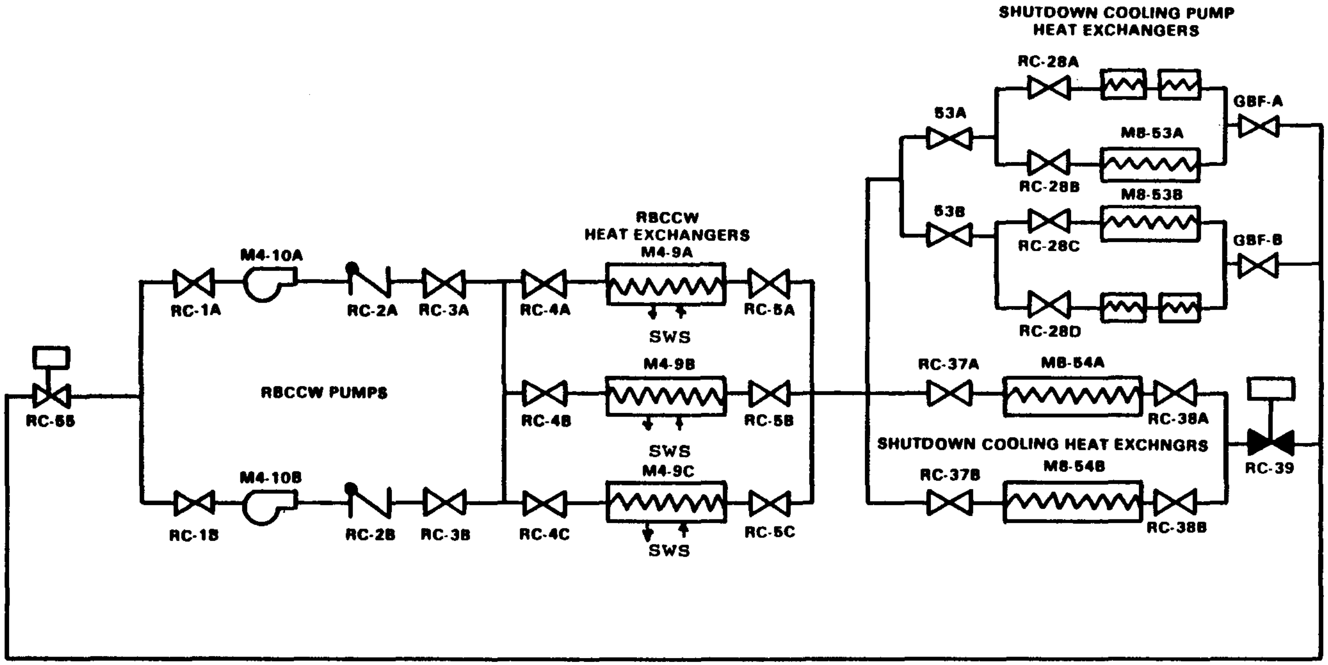


FIGURE B.12-2. REACTOR BUILDING CLOSED COOLING WATER SYSTEM (SHUTDOWN COOLING MODE)

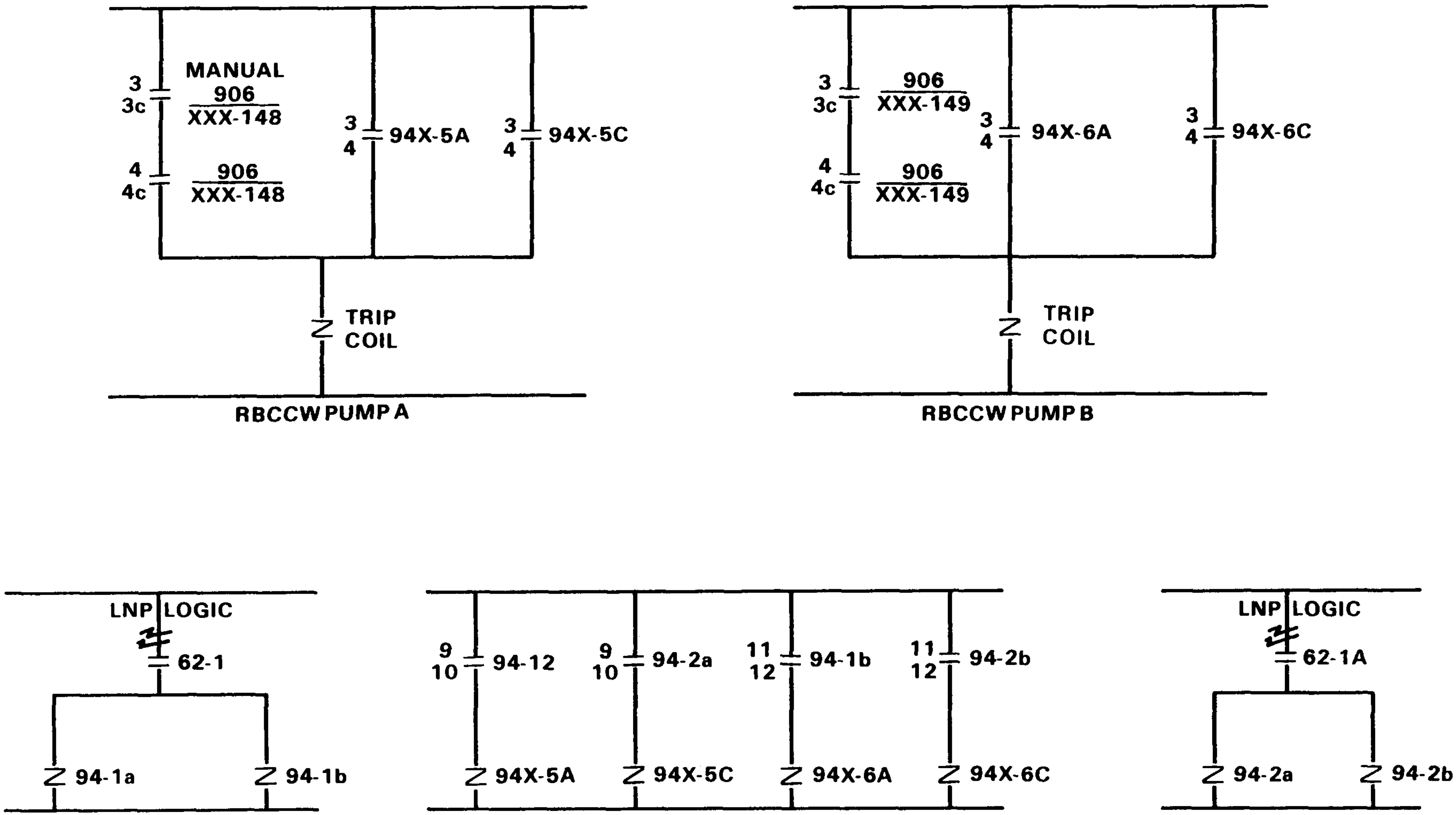


FIGURE B.12-3. RBCCW-LNP TRIP LOGIC

REACTOR BUILDING CLOSED COOLING WATER SYSTEM

FAULT TREE AND FAULT SUMMARY SHEETS

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
RCW-GBFA-XV-FRO RCW-GBFB-XV-FRO RCW-28A-XV-FRO RCW-28B-XV-FRO RCW-28C-XV-FRO RCW-28D-XV-FRO RCW-53A-XV-FRO RCW-53B-XV-FRO RCW-38A-XV-FRO RCW-37A-XV-FRO RCW-38B-XV-FRO RCW-37B-XV-FRO	Manual Valve fails to remain open	Prompt	Valves can be closed while shutdown cooling system is secured. RBCCW system is running continuously during plant operation	6.7E-6
RCW-GBFA-XV-TMC RCW-GBFB-XV-TMC RCW-28A-XV-TMC RCW-28B-XV-TMC RCW-28C-XV-TMC RCW-28D-XV-TMC RCW-53A-XV-TMC RCW-53B-XV-TMC RCW-38A-XV-TMC RCW-38B-XV-TMC RCW-37A-XV-TMC RCW-37B-XV-TMC	Manual valve closed for test or maint.	12000 hrs (detected during refueling outage)	Shutdown cooling initiated regularly at refueling	3.6E-5
RCW-39-MOV-FRO RCW-55-MOV-FRO	Motor operated valve fails to remain open	Prompt	Valve RC-39 can be closed when shutdown cooling system is secured	6.7E-6

MILLSTONE 1
SYSTEM RBCCW
SHEET #1

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
RCW-39-MOV-TMC RCW-55-MOV-TMC	Motor operated valve closed for test or maintenance	Prompt	RBCCW system is in continuous use	2.8E-6
RCW-39-MOV-OPC RCW-55-MOV-OPC	Operator closes motor operated valve	Prompt	RBCCW system is in in continuous use	3E-3
RCW-OFO	Operator fails to initiate shutdown cooling by not aligning RBCCW to SDCS			1E-2
RCW-4A-XV-FRO RCW-5A-XV-FRO RCW-4B-XV-FRO RCW-5B-XV-FRO RCW-4C-XV-FRO RCW-5C-XV-FRO	Manual valves on RBCCW heat exchangers fail to remain open	Prompt	RBCCW system is in continuous use	6.7E-6
RCW-4A-XV-TMC RCW-5A-XV-TMC RCW-4B-XV-TMC RCW-5B-XV-TMC RCW-4C-XV-TMC RCW-5C-XV-TMC	Manual valves on RBCCW heat exchangers closed for test or maintenance	Detected upon rotation of heat exchangers	Heat exchangers usually rotated monthly	2.8E-6
RCW-M49A-HTX-TOM RCW-M49B-HTX-TOM RCW-M49C-HTX-TOM	RBCCW heat exchangers out of service for test or maintenance	Detection upon rotation of heat exchangers	Heat exchangers rotated monthly	1.7E-5

MILLSTONE 1
SYSTEM RBCCW
SHEET #2

<u>FAULT SUMMARY SHEETS</u>

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
RCW-2A-CKV-FRO RCW-2B-CKV-FRO	RBCCW pump discharge check valve fails to remain open.	Prompt	System is in constant operation	7.2E-6
RCW-1A-XV-FRO RCW-3A-XV-FRO RCW-1B-XV-FRO RCW-3B-XV-FRO	RBCCW pump isolation valves fail to remain open	Prompt	The RBCCW pumps are normally running	6.7E-6
RCW-10A-MDP-FTR RCW-10B-MDP-FTR	RBCCW pump fails to continue running as a result of mechanical or electrical failures	Prompt	Pumps are normally running	7E-4
AC-14F-7-FRC AC-14E-6-FRC	4160 VAC switchgear supplying RBCCW pumps fails to remain closed	Prompt	Pumps are normally running	2.4E-5
RCW-10A-MDP-OSP RCW-10B-MDP-OSP	Operator error, stops RBCCW pumps			3E-3
RCW-1A-XV-TMC RCW-1B-XV-TMC	RBCCW pump isolation valves closed for test or maintenance	One month	SP 608.6 verifies path. Detection is during monthly pump rotation.	4.8E-6
RCW-2A-CKV-TMC RCW-2B-CKV-TMC	RBCCW pump discharge check valves closed for test or maintenance	One month	Detected during monthly pump rotation	5E-6

MILLSTONE 1
SYSTEM RBCCW
SHEET #3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
RCW-10A-MDP-TOM RCW-10B-MDP-TOM	RBCCW pump shutdown for test or maintenance	One month	Detected during monthly pump rotation	1E-3
92694-2B-FTD 906XXX-148-FTD LCL94X-5A-FTD LCL94X-5C-FTD 92694-1A-FTD 92694-2A-FTD 906XXX-149-FTD LCL94X-6A-FTD LCL94X-6C-FTD 92694-1B-FTD	Relay coil fails to deenergize	One month	With pump rotating on a monthly basis the trip coil and contact pair failure would be detected in the same time frame	6.7E-6
906XXX-148-3RO 906XXX-148-4RO LCL94X-5A-3RO LCL94X-5C-3RO 906XXX-149-3RO 906XXX-149-4RO LCL94X-6A-3RO LCL94X-6C-3RO	Relay contacts fail to remain open	One month	Detected during monthly pump rotation	3.6E-5
92694-1A-9FO 92694-2A-9FO 92694-1B-BFO 92694-2B-BFO	Relay contacts fail to open	12000 hrs (detected during refueling outages)	Tested as per SP 628.1 during refueling outages	1.8E-3

MILLSTONE 1
SYSTEM RBCCW
SHEET #4

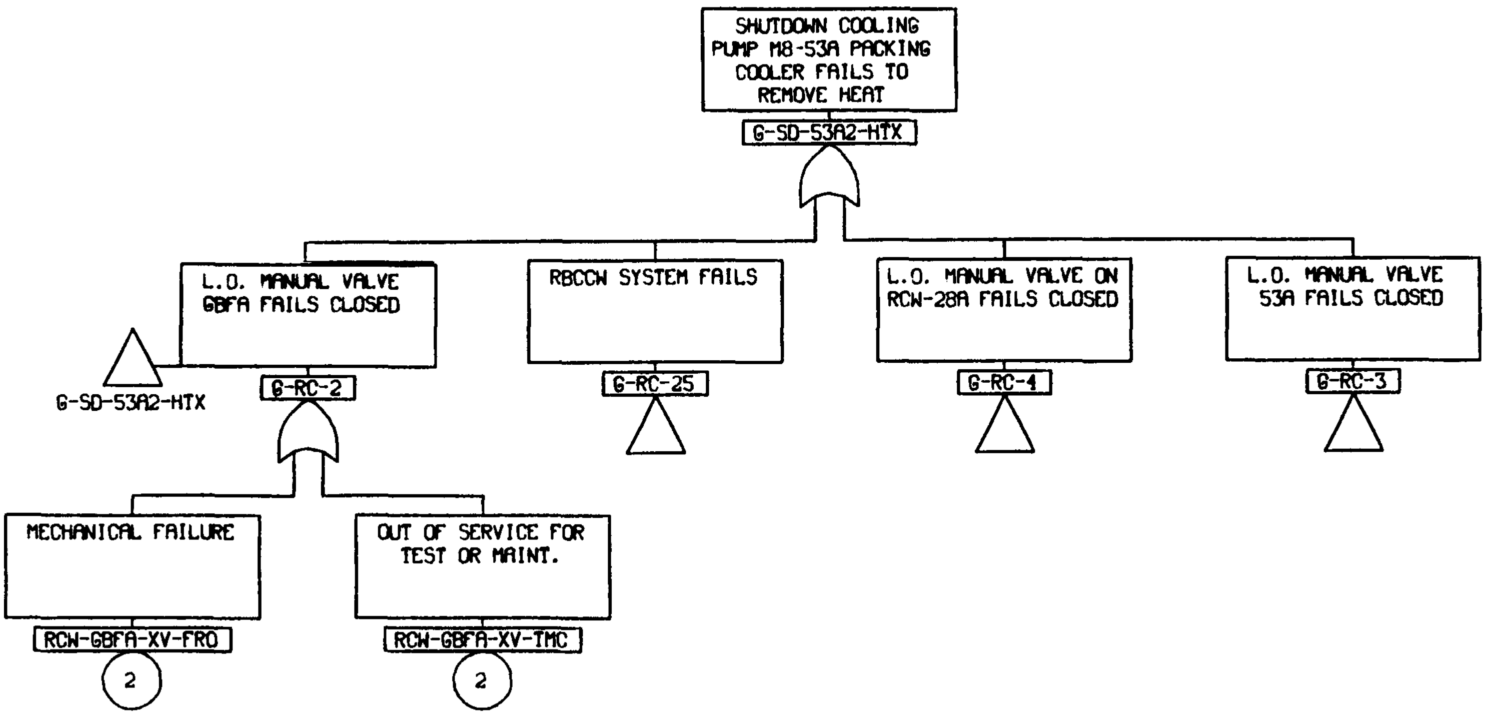
FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
92662-1-XFO 92662-1A-XFO	Spurious LNP trip signal remains after power is available	12000 hrs (detected during refueling outages)	Tested as per SP 628.1 an LNP signal is generated, and system auto-start capability is checked	2.0E-3
906XXX-148-OCS 906XXX-149-OCS	Operator places RBCCW pump switch in stop mode			3E-3
906XXX-148-1FC 906XXX-149-1FC	Series contact pair of control switches 148 and 149 fail to close. This results in failure of pump M4-10A and M4-10B	One month	Tested per SP 608.6	1E-4
906XXX-148-FTE 906XXX-149-FTE	Control switches 148 and 149 fail to energize. This results in failure of RBCCW pump M4-10A and M4-10B	One month	Tested per SP 608.6	1E-5
RCW-PUMP-A-RUN RCW-PUMP-B-RUN	One pump normally running 50% chance pump M4-10A or M4-10B			.5
RCW-10A-MDP-OFS RCW-10B-MDP-OFS	Operator fails to start pump	Prompt		1E-2
RCW-10A-MDP-FTS RCW-10B-MDP-FTS	Pump fails to start local fault	Prompt		1E-3

MILLSTONE 1
SYSTEM RBCCW
SHEET #5

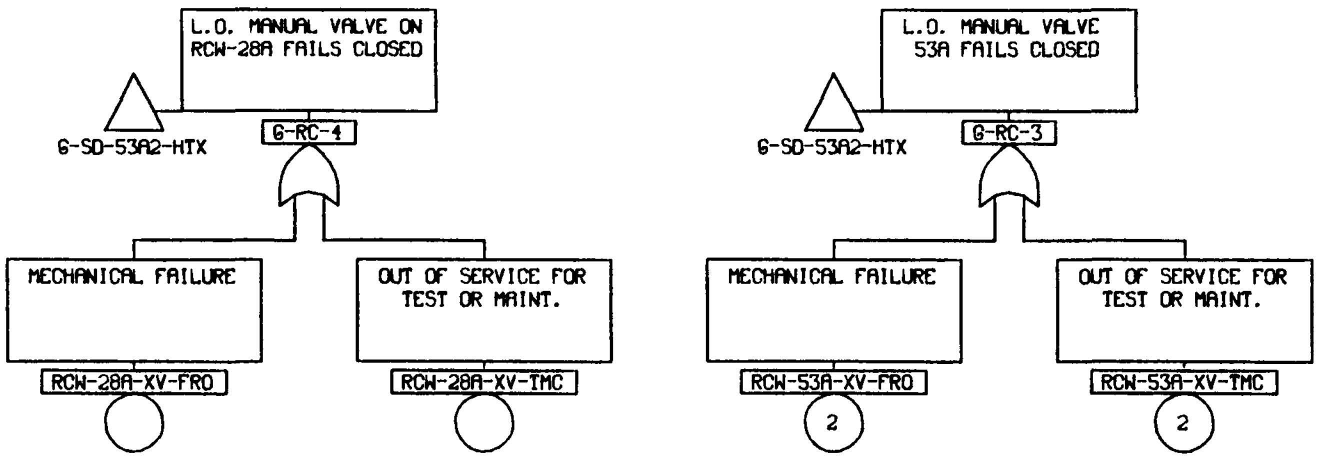
RBCCW FAULT TREE PAGE INDEX

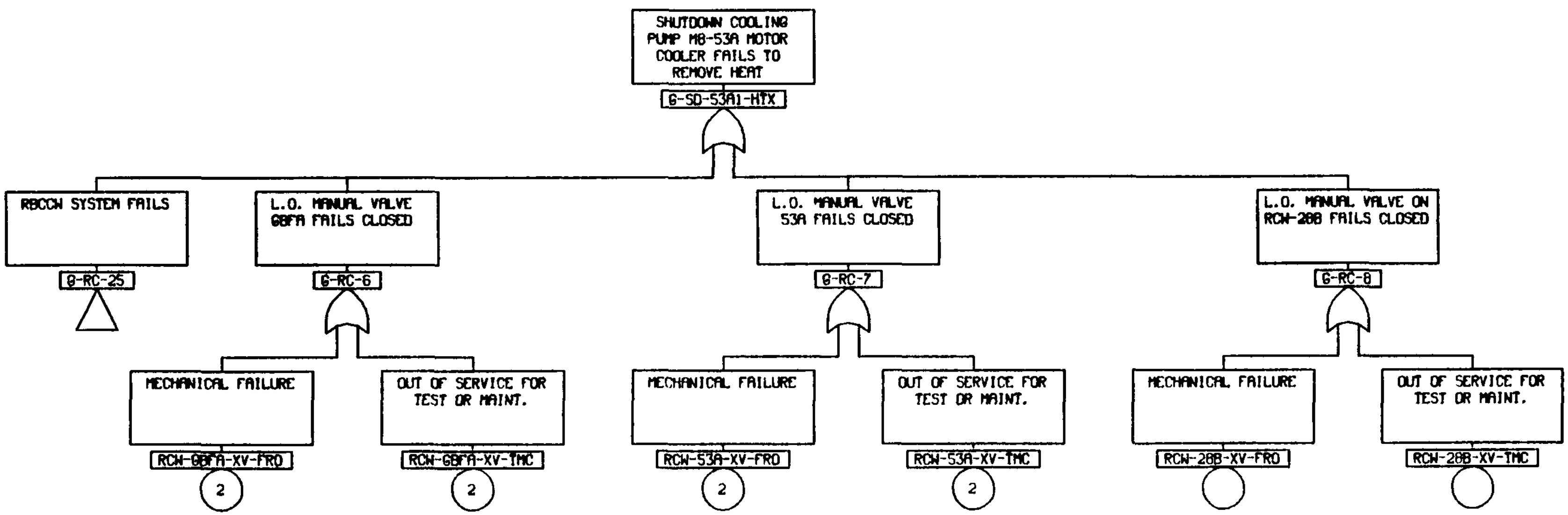
GATE NAME	DEFINED ON PAGE	TRANSFERS TO PAGE(S)
G-SD-53A2-HTX	RBCCW-1	--
G-RC-3	RBCCW-2	RBCCW-1
G-RC-4	RBCCW-2	RBCCW-1
G-SD-53A1-HTX	RBCCW-3	--
G-SD-53B1-HTX	RBCCW-4	--
G-SD-53B2-HTX	RBCCW-5	--
G-SD-54A-HTX	RBCCW-6	--
G-SD-54B-HTX	RBCCW-7	--
G-RC-25	RBCCW-8	RBCCW-1,RBCCW-3,RBCCW-4, RBCCW-5,RBCCW-6,RBCCW-7
G-RC-28	RBCCW-9	RBCCW-8
G-RC-31	RBCCW-10	RBCCW-9
G-RC-32	RBCCW-11	RBCCW-9
G-RC-33	RBCCW-12	RBCCW-9
G-RC-35	RBCCW-13	RBCCW-10,RBCCW-11
G-RC-41	RBCCW-14	RBCCW-10,RBCCW-11
G-RC-42	RBCCW-14	RBCCW-12,RBCCW-13
G-RC-43	RBCCW-15	RBCCW-11,RBCCW-12
G-RC-44	RBCCW-15	RBCCW-10,RBCCW-12
G-RC-61	RBCCW-16	RBCCW-22,RBCCW-23
G-RC-66	RBCCW-17	RBCCW-22,RBCCW-23
G-RC-71	RBCCW-18	RBCCW-16
G-RC-71A	RBCCW-19	RBCCW-18
G-RC-74	RBCCW-20	RBCCW-17
G-RC-74A	RBCCW-21	RBCCW-20
G-RC-77A	RBCCW-22	RBCCW-9
G-RC-77B	RBCCW-23	RBCCW-9
G-RC-81	RBCCW-24	RBCCW-23
G-RC-83	RBCCW-25	RBCCW-22
G-RC-85	RBCCW-26	RBCCW-18
G-RC-87A	RBCCW-27	RBCCW-18
G-RC-88A	RBCCW-28	RBCCW-18
G-RC-92	RBCCW-29	RBCCW-20
G-RC-94A	RBCCW-30	RBCCW-20
G-RC-95A	RBCCW-31	RBCCW-20

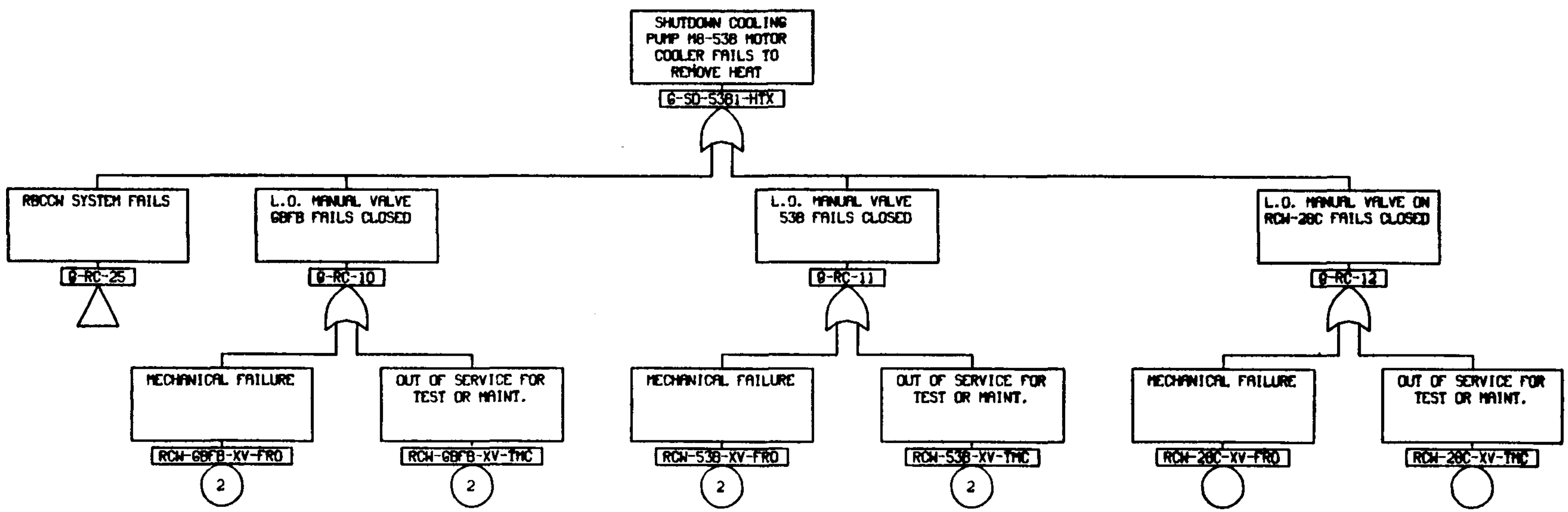


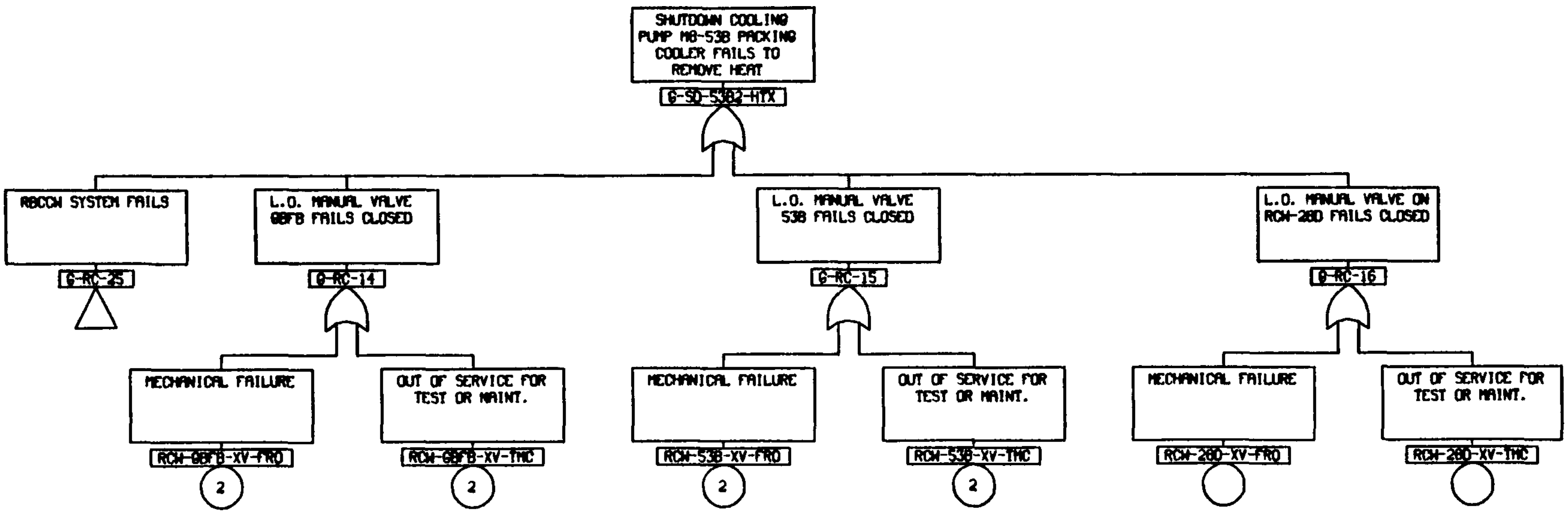
SHUTDOWN COOLING PUMP M8-53A PACKING COOLER FAILS TO REMOVE HEAT
G-SD-53A2-HTX
L.O. MANUAL VALVE GBFA FAILS CLOSED
G-RC-2
G-SD-53A2-HTX
RBCCW SYSTEM FAILS
G-RC-25
L.O. MANUAL VALVE ON RCW-28A FAILS CLOSED
G-RC-4
L.O. MANUAL VALVE 53A FAILS CLOSED
G-RC-3
MECHANICAL FAILURE
RCW-GBFA-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
RCW-GBFA-XV-TMC
2

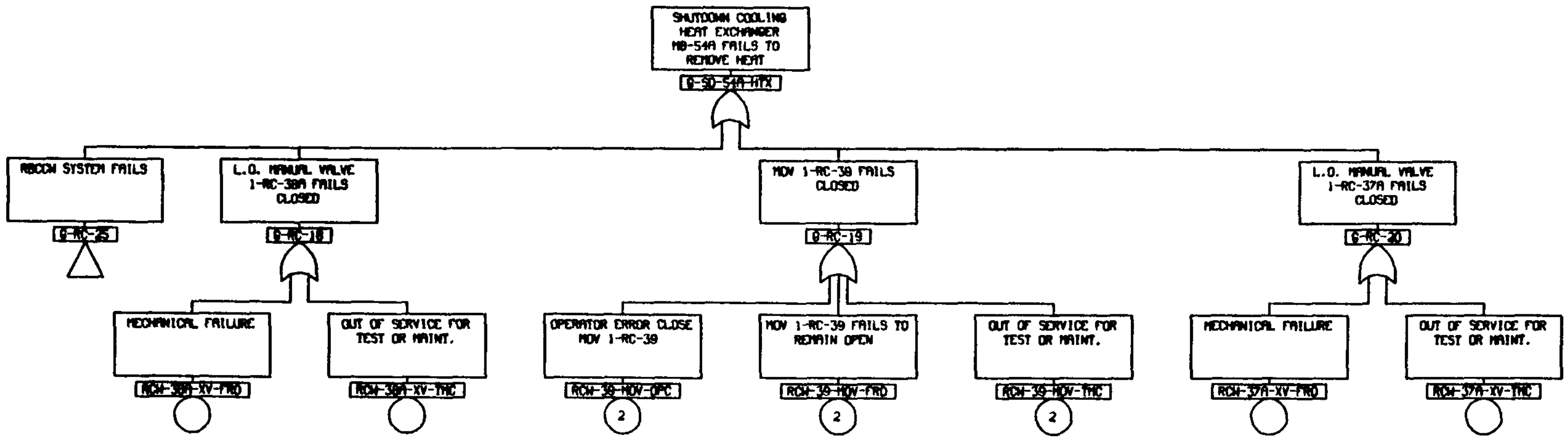
RBCCW-1

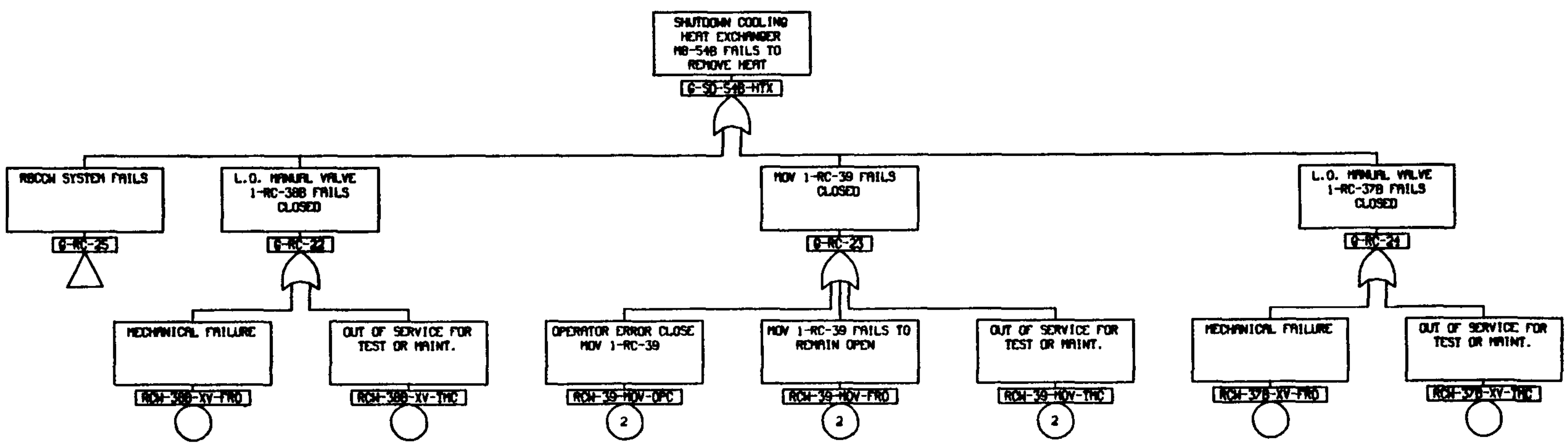

L.O. MANUAL VALVE ON RCW-28A FAILS CLOSED
G-RC-4
G-SD-53A2-HTX
MECHANICAL FAILURE
RCW-28A-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
RCW-28A-XV-TMC
L.O. MANUAL VALVE 53A FAILS CLOSED
G-RC-3
G-SD-53A2-HTX
MECHANICAL FAILURE
RCW-53A-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
RCW-53A-XV-TMC
2

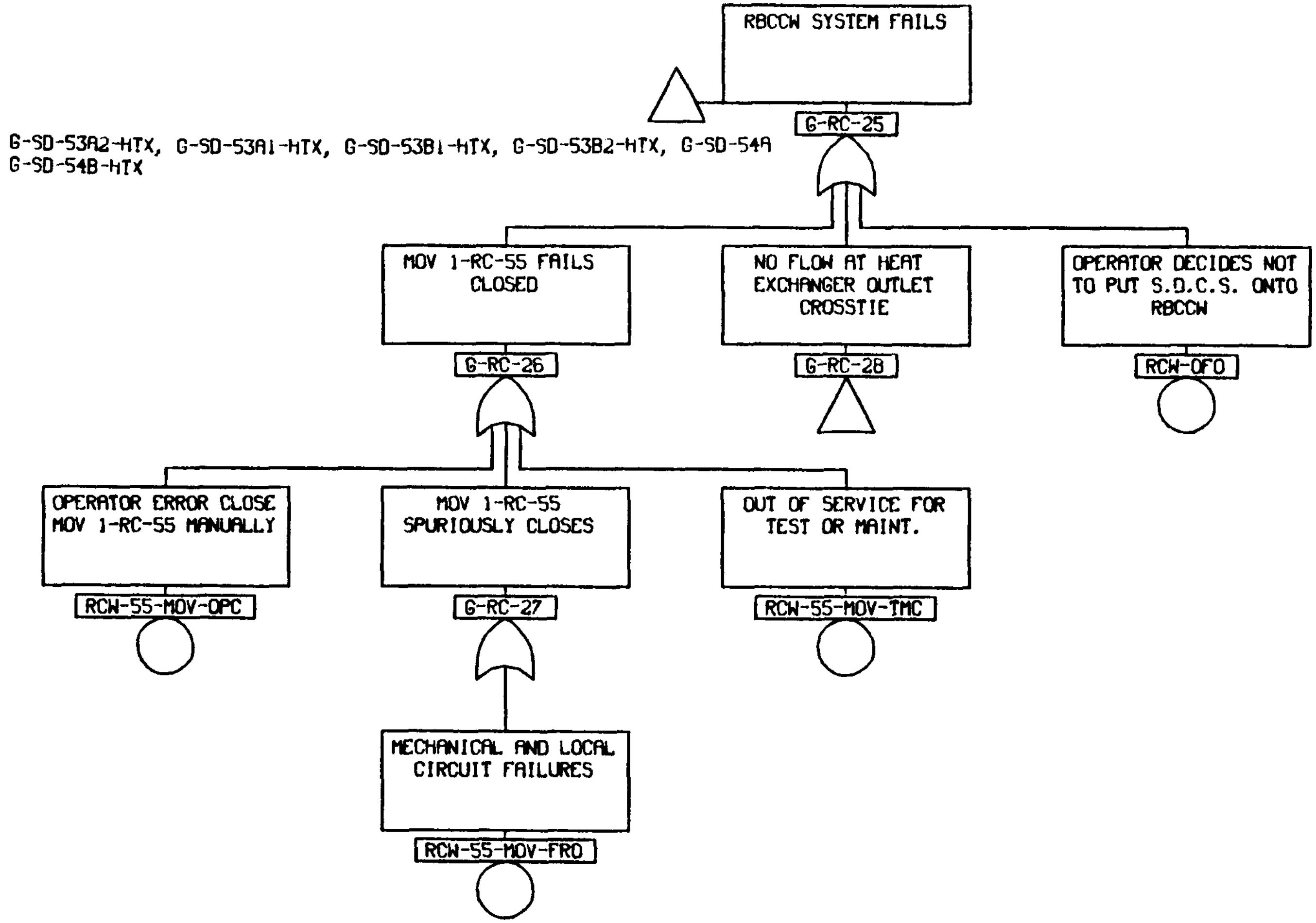

SHUTDOWN COOLING PUMP M8-53A MOTOR COOLER FAILS TO REMOVE HEAT
G-SD-53A1-HTX
RBCCW SYSTEM FAILS
G-RC-25
L.O. MANUAL VALVE 6BFA FAILS CLOSED
G-RC-6
L.O. MANUAL VALVE 53A FAILS CLOSED
G-RC-7
L.O. MANUAL VALVE ON RCW-28B FAILS CLOSED
G-RC-8
MECHANICAL FAILURE
RCW-6BFA-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
RCW-6BFA-XV-TMC
2
MECHANICAL FAILURE
RCW-53A-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
RCW-53A-XV-TMC
2
MECHANICAL FAILURE
RCW-28B-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
RCW-28B-XV-TMC


SHUTDOWN COOLING PUMP M8-538 MOTOR COOLER FAILS TO REMOVE HEAT
G-SD-5381-HTX
RBCCW SYSTEM FAILS
G-RC-25
L.O. MANUAL VALVE G8FB FAILS CLOSED
G-RC-10
L.O. MANUAL VALVE 538 FAILS CLOSED
G-RC-11
L.O. MANUAL VALVE ON RCW-28C FAILS CLOSED
G-RC-12
MECHANICAL FAILURE
RCW-G8FB-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
RCW-G8FB-XV-TMC
2
MECHANICAL FAILURE
RCW-538-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
RCW-538-XV-TMC
2
MECHANICAL FAILURE
RCW-28C-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
RCW-28C-XV-TMC

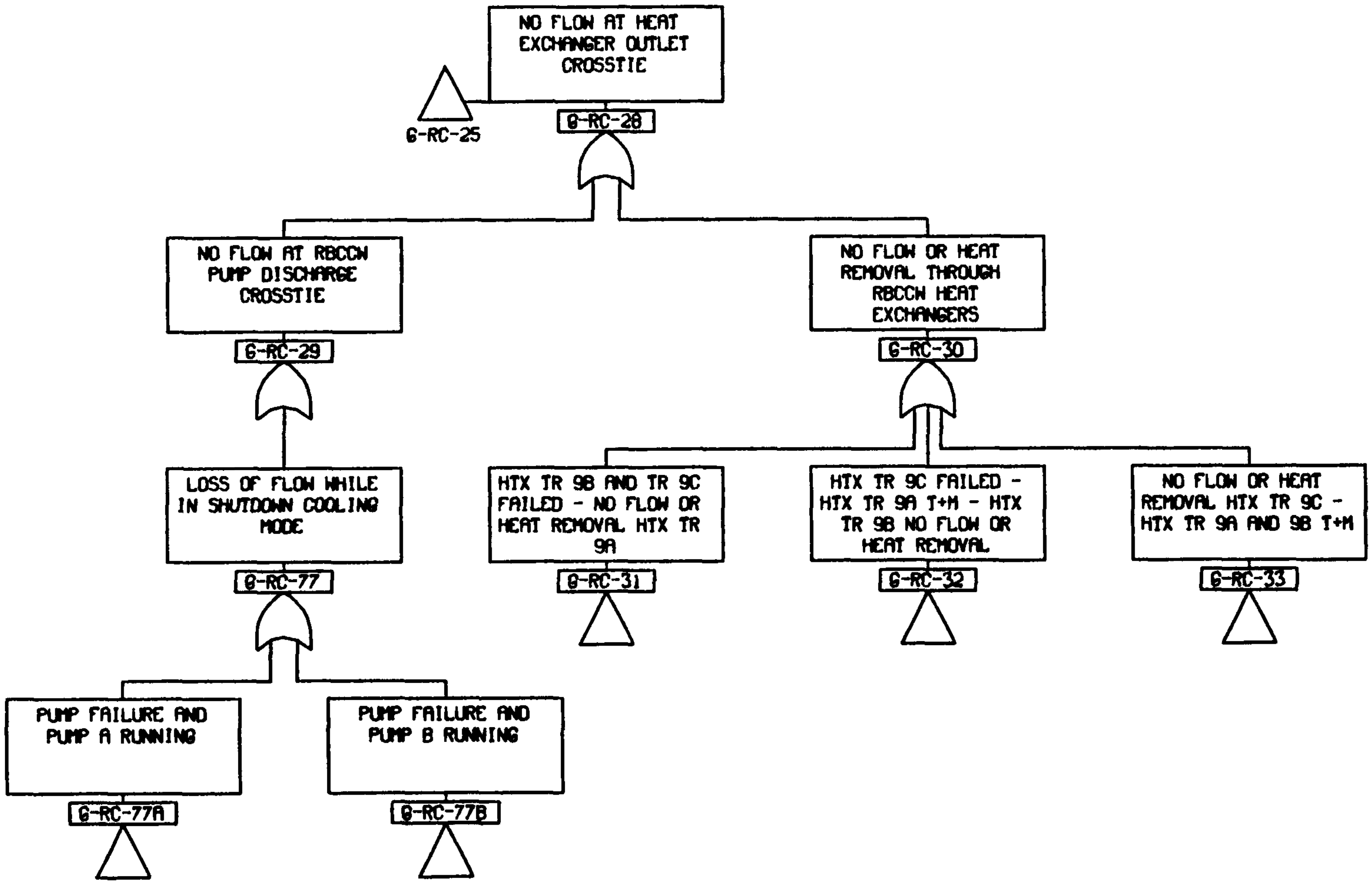

SHUTDOWN COOLING PUMP M8-53B PACKING COOLER FAILS TO REMOVE HEAT
G-SD-53B2-HTX
RBCCW SYSTEM FAILS
G-RC-25
L.O. MANUAL VALVE 8BFB FAILS CLOSED
G-RC-14
L.O. MANUAL VALVE 53B FAILS CLOSED
G-RC-15
L.O. MANUAL VALVE ON RCW-28D FAILS CLOSED
G-RC-16
MECHANICAL FAILURE
RCW-8BFB-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
RCW-8BFB-XV-TMC
2
MECHANICAL FAILURE
RCW-53B-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
RCW-53B-XV-TMC
2
MECHANICAL FAILURE
RCW-28D-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
RCW-28D-XV-TMC


SHUTDOWN COOLING HEAT EXCHANGER MB-54A FAILS TO REMOVE HEAT
G-SD-54A-HTX
RBCCW SYSTEM FAILS
G-RC-25
L.O. MANUAL VALVE 1-RC-38A FAILS CLOSED
G-RC-18
MOV 1-RC-39 FAILS CLOSED
G-RC-19
L.O. MANUAL VALVE 1-RC-37A FAILS CLOSED
G-RC-20
MECHANICAL FAILURE
RCW-38A-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
RCW-38A-XV-TMC
OPERATOR ERROR CLOSE MOV 1-RC-39
RCW-39-MOV-OPC
2
MOV 1-RC-39 FAILS TO REMAIN OPEN
RCW-39-MOV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
RCW-39-MOV-TMC
2
MECHANICAL FAILURE
RCW-37A-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
RCW-37A-XV-TMC

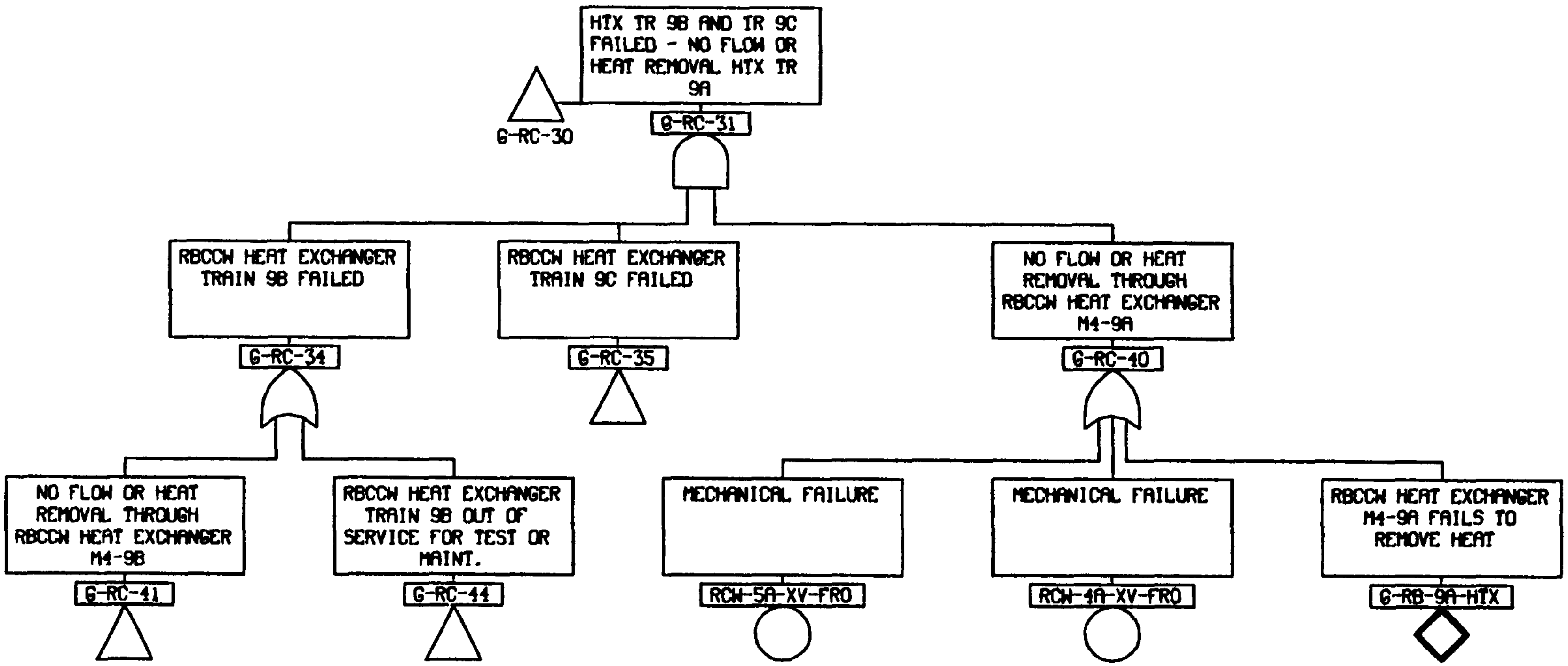

SHUTDOWN COOLING HEAT EXCHANGER MB-54B FAILS TO REMOVE HEAT
G-SD-54B-HTX
RBCCW SYSTEM FAILS
G-RC-25
L.O. MANUAL VALVE 1-RC-38B FAILS CLOSED
G-RC-22
MOV 1-RC-39 FAILS CLOSED
G-RC-23
L.O. MANUAL VALVE 1-RC-37B FAILS CLOSED
G-RC-24
MECHANICAL FAILURE
RCW-38B-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
RCW-38B-XV-TMC
OPERATOR ERROR CLOSE MOV 1-RC-39
RCW-39-MOV-OPC
2
MOV 1-RC-39 FAILS TO REMAIN OPEN
RCW-39-MOV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
RCW-39-MOV-TMC
2
MECHANICAL FAILURE
RCW-37B-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
RCW-37B-XV-TMC


RBCCW SYSTEM FAILS
G-RC-25
G-SD-53A2-HTX, G-SD-53A1-HTX, G-SD-53B1-HTX, G-SD-53B2-HTX, G-SD-54A
G-SD-54B-HTX
MOV 1-RC-55 FAILS CLOSED
G-RC-26
NO FLOW AT HEAT EXCHANGER OUTLET CROSSTIE
G-RC-28
OPERATOR DECIDES NOT TO PUT S.D.C.S. ONTO RBCCW
RCW-OFO
OPERATOR ERROR CLOSE MOV 1-RC-55 MANUALLY
RCW-55-MOV-OPC
MOV 1-RC-55 SPURIOUSLY CLOSES
G-RC-27
OUT OF SERVICE FOR TEST OR MAINT.
RCW-55-MOV-TMC
MECHANICAL AND LOCAL CIRCUIT FAILURES
RCW-55-MOV-FRO

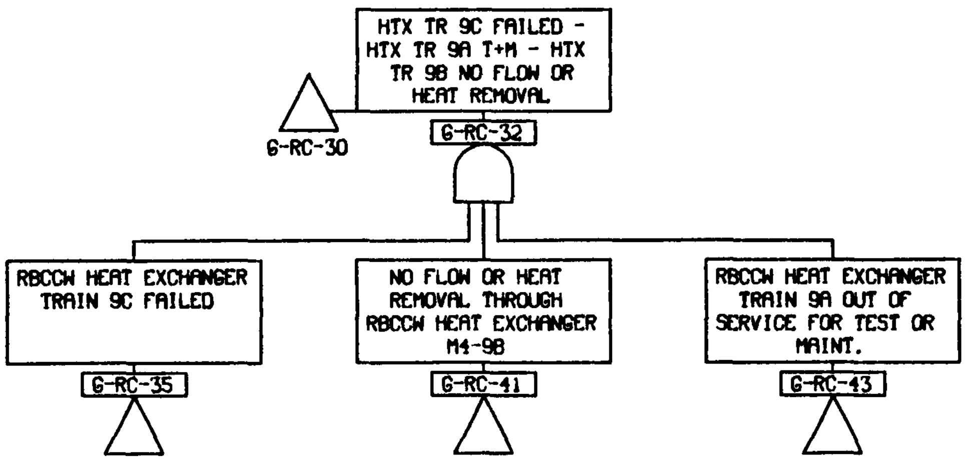
RBCCW-8

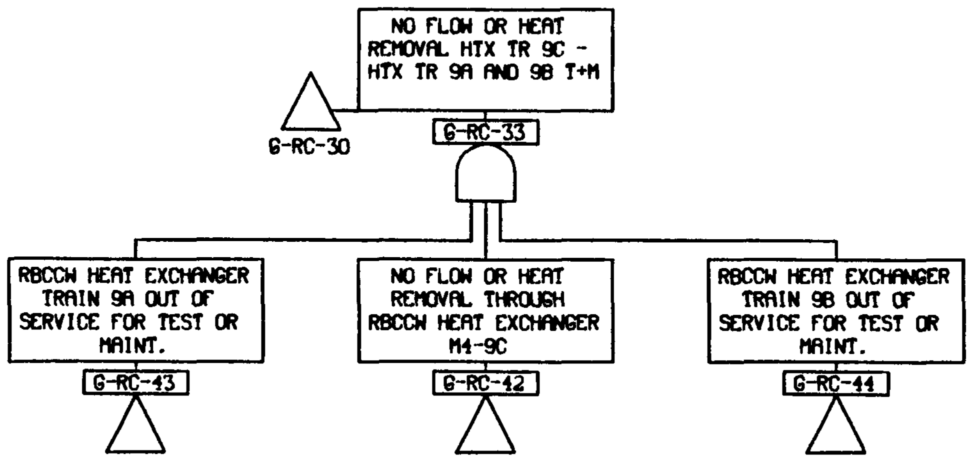


NO FLOW AT HEAT EXCHANGER OUTLET CROSSTIE
G-RC-28
G-RC-25
NO FLOW AT RBCCW PUMP DISCHARGE CROSSTIE
G-RC-29
NO FLOW OR HEAT REMOVAL THROUGH RBCCW HEAT EXCHANGERS
G-RC-30
LOSS OF FLOW WHILE IN SHUTDOWN COOLING MODE
G-RC-77
HTX TR 9B AND TR 9C FAILED - NO FLOW OR HEAT REMOVAL HTX TR 9A
G-RC-31
HTX TR 9C FAILED - HTX TR 9A T+M - HTX TR 9B NO FLOW OR HEAT REMOVAL
G-RC-32
NO FLOW OR HEAT REMOVAL HTX TR 9C - HTX TR 9A AND 9B T+M
G-RC-33
PUMP FAILURE AND PUMP A RUNNING
G-RC-77A
PUMP FAILURE AND PUMP B RUNNING
G-RC-77B

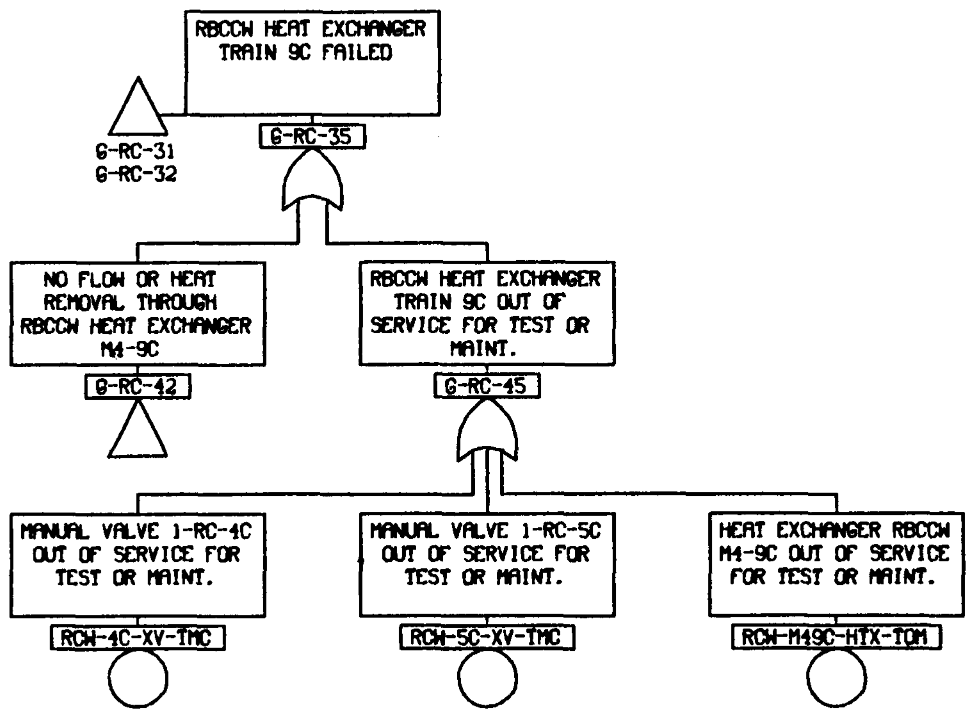

HTX TR 9B AND TR 9C FAILED - NO FLOW OR HEAT REMOVAL HTX TR 9A
G-RC-31
G-RC-30
RBCCW HEAT EXCHANGER TRAIN 9B FAILED
G-RC-34
RBCCW HEAT EXCHANGER TRAIN 9C FAILED
G-RC-35
NO FLOW OR HEAT REMOVAL THROUGH RBCCW HEAT EXCHANGER M4-9A
G-RC-40
NO FLOW OR HEAT REMOVAL THROUGH RBCCW HEAT EXCHANGER M4-9B
G-RC-41
RBCCW HEAT EXCHANGER TRAIN 9B OUT OF SERVICE FOR TEST OR MAINT.
G-RC-44
MECHANICAL FAILURE
RCW-5A-XV-FRO
MECHANICAL FAILURE
RCW-4A-XV-FRO
RBCCW HEAT EXCHANGER M4-9A FAILS TO REMOVE HEAT
G-RB-9A-HTX

RBCCW-10


HTX TR 9C FAILED - HTX TR 9A T+M - HTX TR 9B NO FLOW OR HEAT REMOVAL
G-RC-32
G-RC-30
RBCCW HEAT EXCHANGER TRAIN 9C FAILED
G-RC-35
NO FLOW OR HEAT REMOVAL THROUGH RBCCW HEAT EXCHANGER M4-9B
G-RC-41
RBCCW HEAT EXCHANGER TRAIN 9A OUT OF SERVICE FOR TEST OR MAINT.
G-RC-43

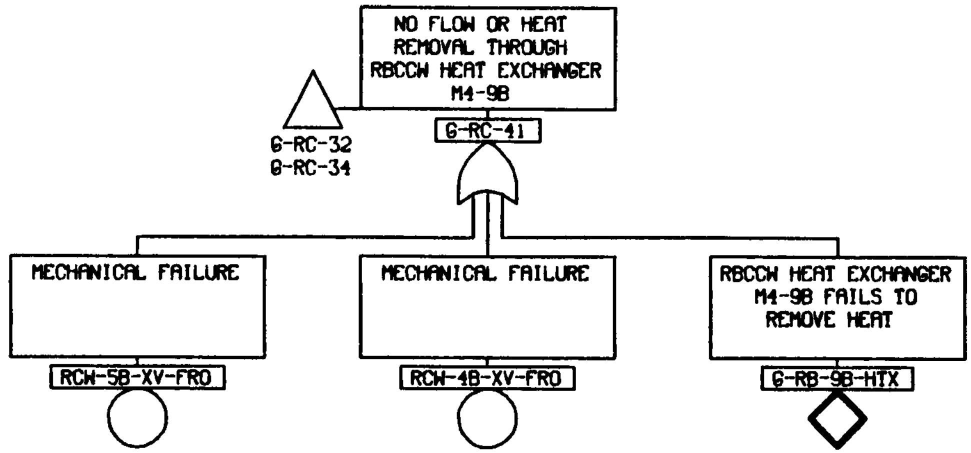

NO FLOW OR HEAT REMOVAL HTX TR 9C - HTX TR 9A AND 9B T+M
G-RC-33
G-RC-30
RBCCW HEAT EXCHANGER TRAIN 9A OUT OF SERVICE FOR TEST OR MAINT.
G-RC-43
NO FLOW OR HEAT REMOVAL THROUGH RBCCW HEAT EXCHANGER M4-9C
G-RC-42
RBCCW HEAT EXCHANGER TRAIN 9B OUT OF SERVICE FOR TEST OR MAINT.
G-RC-44

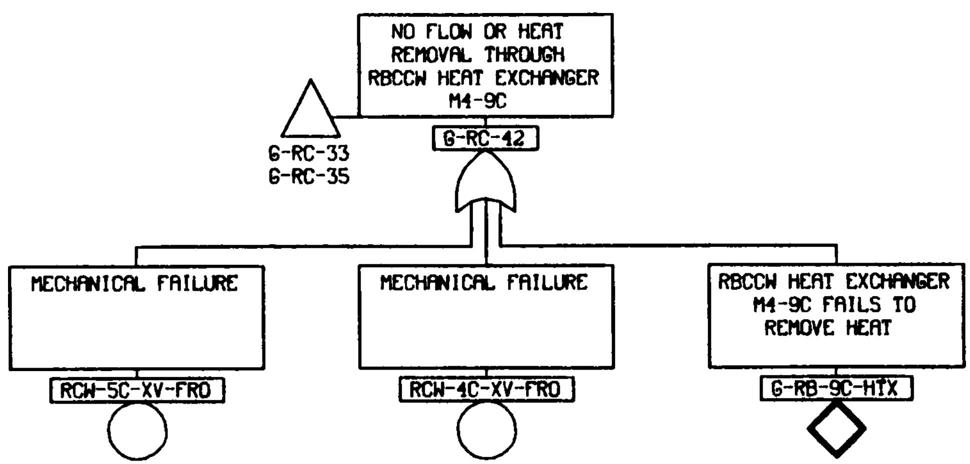
RBCCW-12



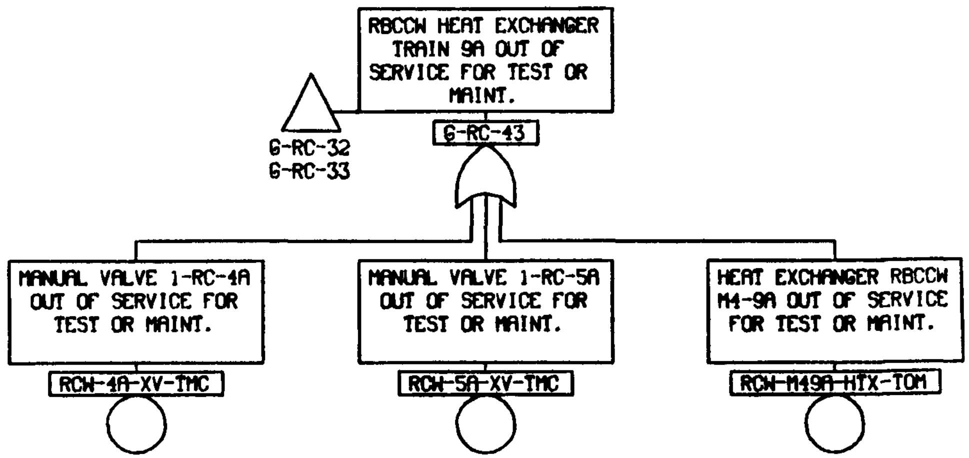
B.12-28

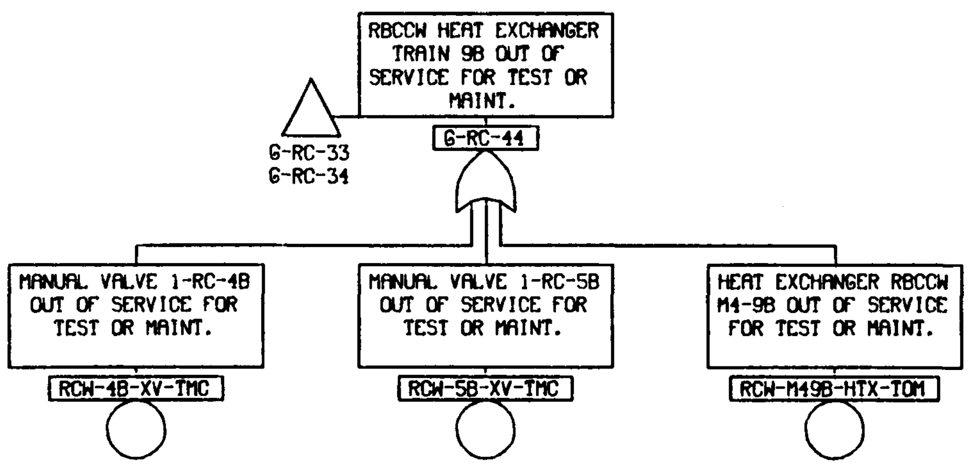
RBCCW-13

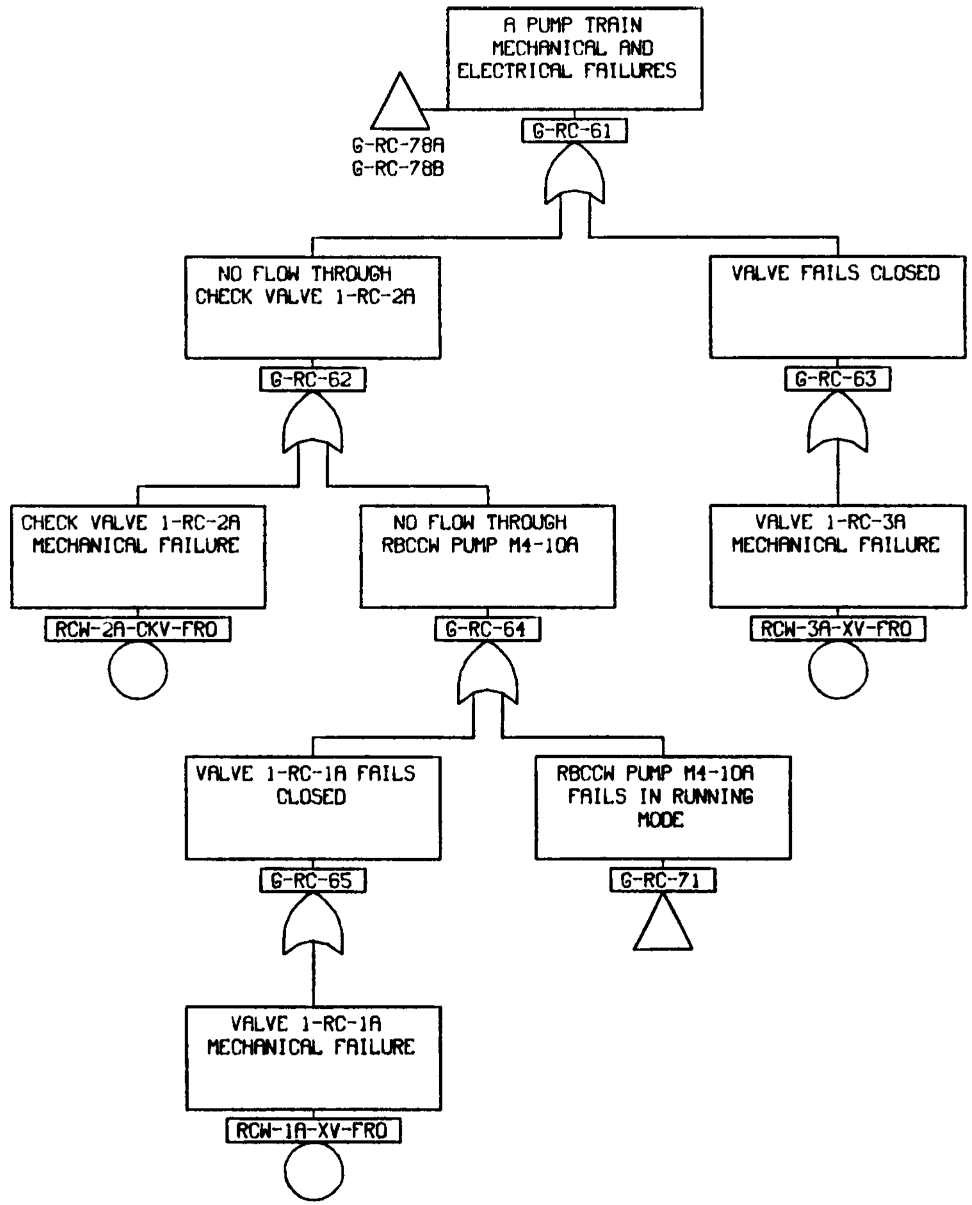

NO FLOW OR HEAT REMOVAL THROUGH RBCCW HEAT EXCHANGER M4-9B
G-RC-41
G-RC-32
G-RC-34
MECHANICAL FAILURE
RCW-5B-XV-FRO
MECHANICAL FAILURE
RCW-4B-XV-FRO
RBCCW HEAT EXCHANGER M4-9B FAILS TO REMOVE HEAT
G-RB-9B-HTX


NO FLOW OR HEAT REMOVAL THROUGH RBCCW HEAT EXCHANGER M4-9C
G-RC-42
G-RC-33
G-RC-35
MECHANICAL FAILURE
RCW-5C-XV-FRO
MECHANICAL FAILURE
RCW-4C-XV-FRO
RBCCW HEAT EXCHANGER M4-9C FAILS TO REMOVE HEAT
G-RB-9C-HTX

RBCCW-14

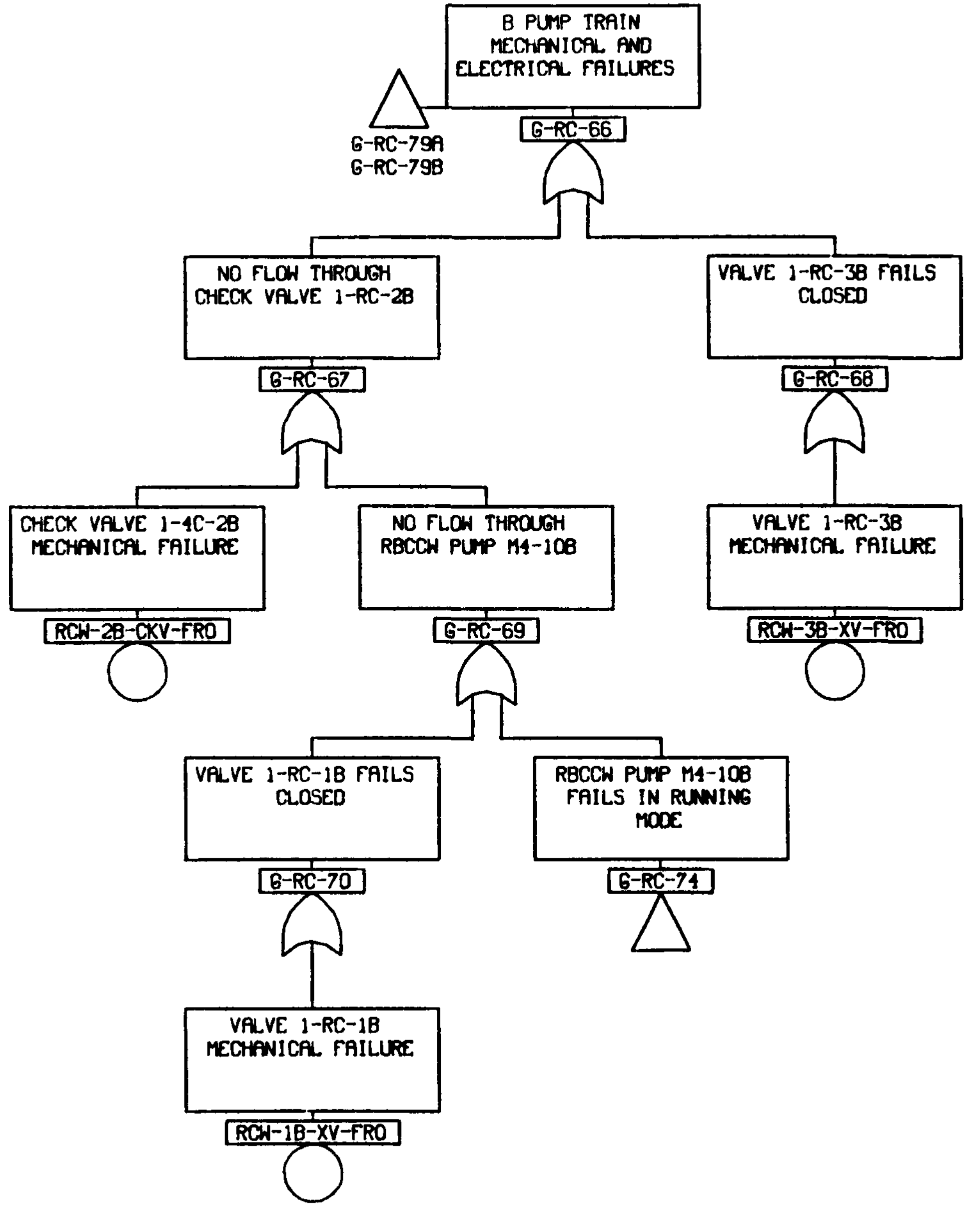

RBCCW HEAT EXCHANGER TRAIN 9A OUT OF SERVICE FOR TEST OR MAINT.
G-RC-43
G-RC-32
G-RC-33
MANUAL VALVE 1-RC-4A OUT OF SERVICE FOR TEST OR MAINT.
RCW-4A-XV-TMC
MANUAL VALVE 1-RC-5A OUT OF SERVICE FOR TEST OR MAINT.
RCW-5A-XV-TMC
HEAT EXCHANGER RBCCW M4-9A OUT OF SERVICE FOR TEST OR MAINT.
RCW-M49A-HTX-TOM

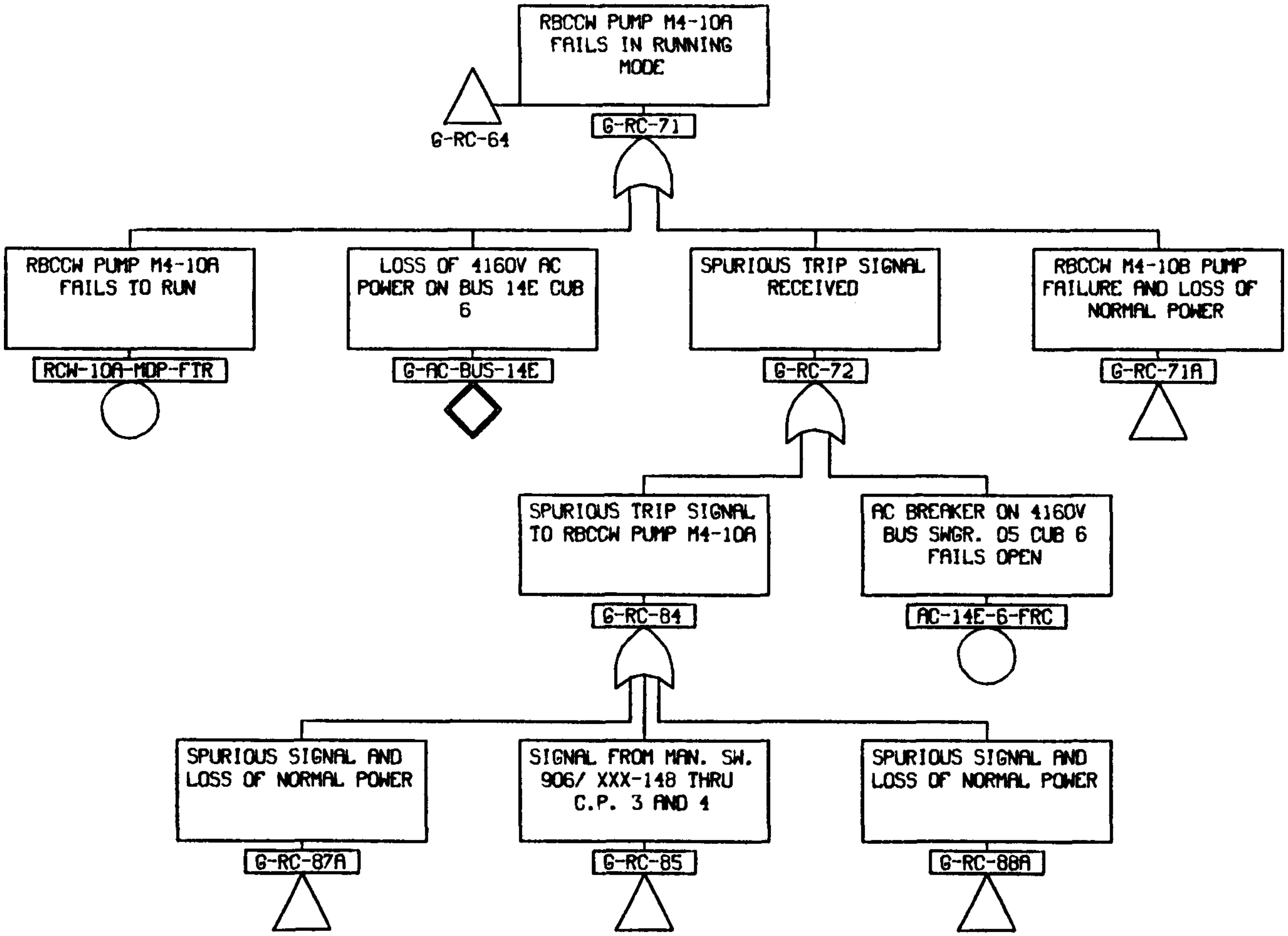

RBCCW HEAT EXCHANGER TRAIN 9B OUT OF SERVICE FOR TEST OR MAINT.
G-RC-44
G-RC-33
G-RC-34
MANUAL VALVE 1-RC-4B OUT OF SERVICE FOR TEST OR MAINT.
RCW-4B-XV-TMC
MANUAL VALVE 1-RC-5B OUT OF SERVICE FOR TEST OR MAINT.
RCW-5B-XV-TMC
HEAT EXCHANGER RBCCW M4-9B OUT OF SERVICE FOR TEST OR MAINT.
RCW-M49B-HTX-TOM



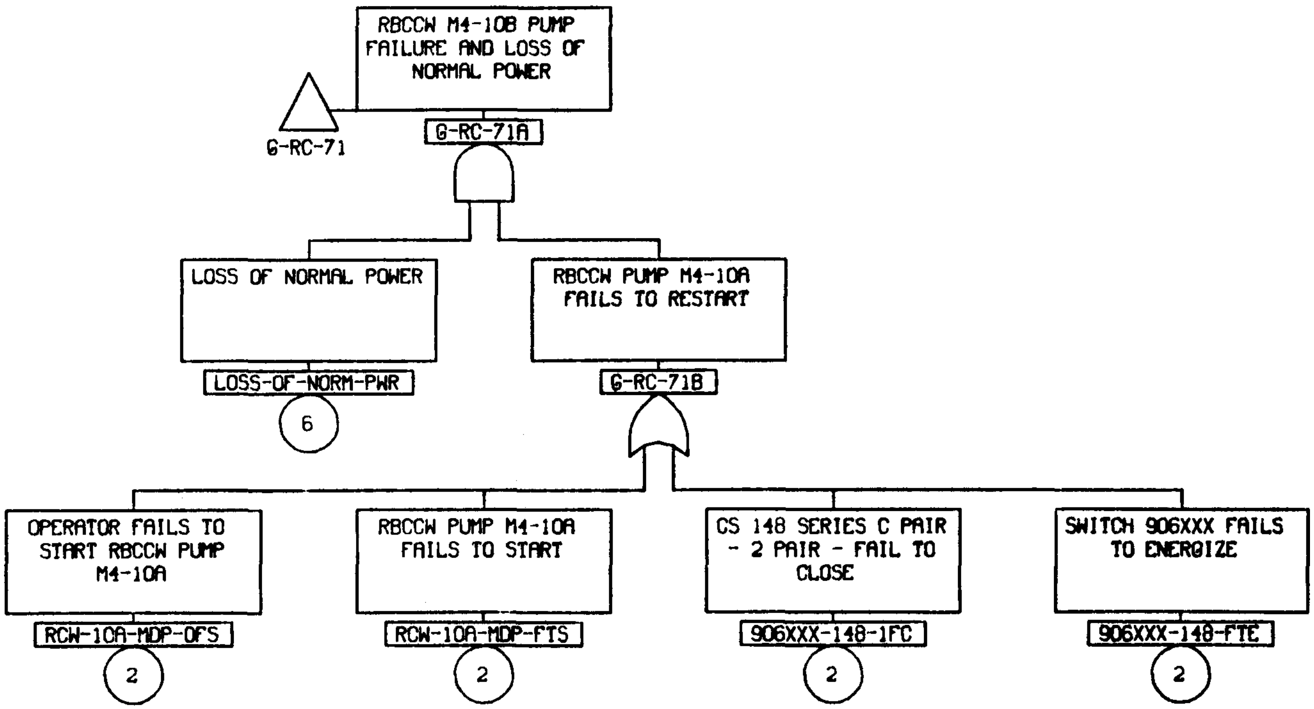
A PUMP TRAIN MECHANICAL AND ELECTRICAL FAILURES
G-RC-61
G-RC-78A
G-RC-78B
NO FLOW THROUGH CHECK VALVE 1-RC-2A
G-RC-62
VALVE FAILS CLOSED
G-RC-63
CHECK VALVE 1-RC-2A MECHANICAL FAILURE
RCW-2A-CKV-FRO
NO FLOW THROUGH RBCCW PUMP M4-10A
G-RC-64
VALVE 1-RC-3A MECHANICAL FAILURE
RCW-3A-XV-FRO
VALVE 1-RC-1A FAILS CLOSED
G-RC-65
RBCCW PUMP M4-10A FAILS IN RUNNING MODE
G-RC-71
VALVE 1-RC-1A MECHANICAL FAILURE
RCW-1A-XV-FRO

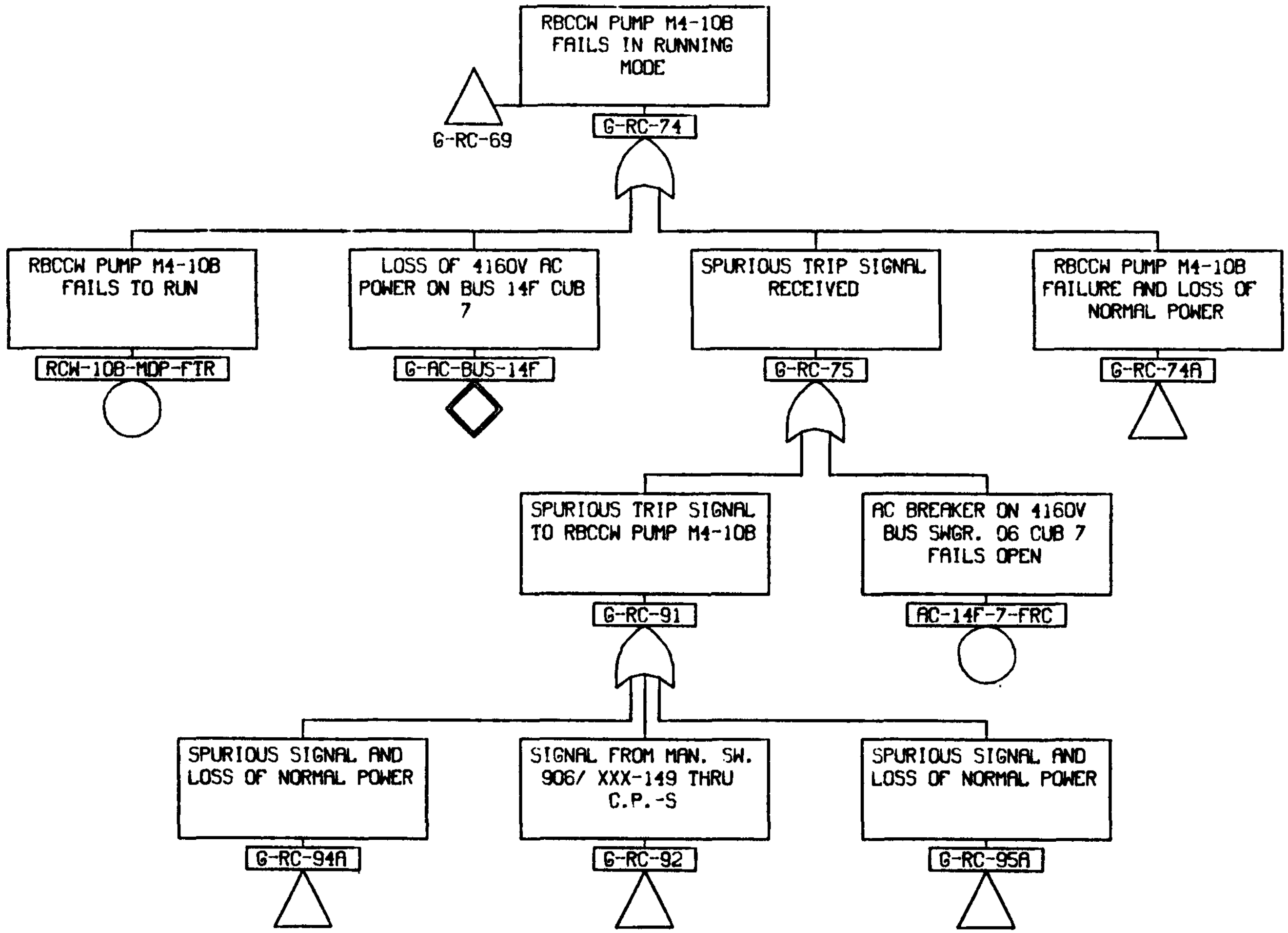
RBCCW-16

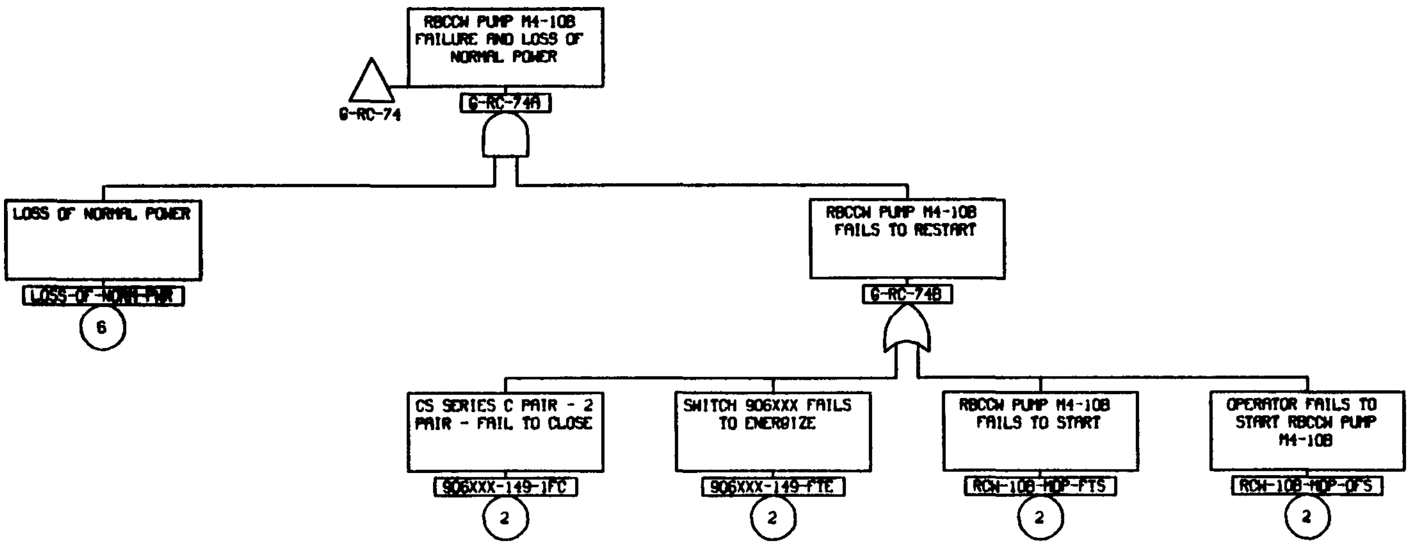

B PUMP TRAIN MECHANICAL AND ELECTRICAL FAILURES
G-RC-66
G-RC-79A
G-RC-79B
NO FLOW THROUGH CHECK VALVE 1-RC-2B
G-RC-67
VALVE 1-RC-3B FAILS CLOSED
G-RC-68
CHECK VALVE 1-4C-2B MECHANICAL FAILURE
RCW-2B-CKV-FRO
NO FLOW THROUGH RBCCW PUMP M4-10B
G-RC-69
VALVE 1-RC-3B MECHANICAL FAILURE
RCW-3B-XV-FRO
VALVE 1-RC-1B FAILS CLOSED
G-RC-70
RBCCW PUMP M4-10B FAILS IN RUNNING MODE
G-RC-74
VALVE 1-RC-1B MECHANICAL FAILURE
RCW-1B-XV-FRO



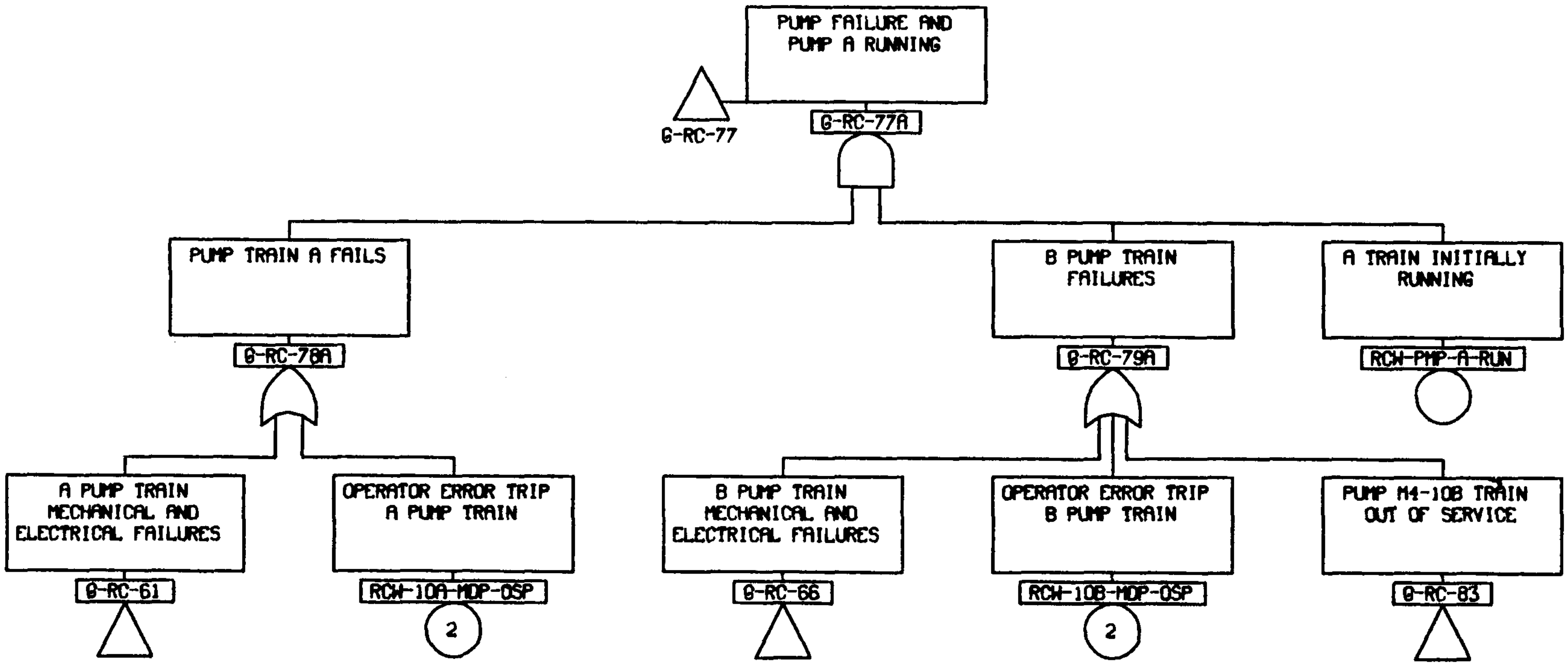
RBCCW PUMP M4-10A FAILS IN RUNNING MODE
G-RC-71
G-RC-64
RBCCW PUMP M4-10A FAILS TO RUN
RCW-10A-MDP-FTR
LOSS OF 4160V AC POWER ON BUS 14E CUB 6
G-AC-BUS-14E
SPURIOUS TRIP SIGNAL RECEIVED
G-RC-72
RBCCW M4-10B PUMP FAILURE AND LOSS OF NORMAL POWER
G-RC-71A
SPURIOUS TRIP SIGNAL TO RBCCW PUMP M4-10A
G-RC-84
AC BREAKER ON 4160V BUS SWGR. 05 CUB 6 FAILS OPEN
AC-14E-6-FRC
SPURIOUS SIGNAL AND LOSS OF NORMAL POWER
G-RC-87A
SIGNAL FROM MAN. SW. 906/ XXX-148 THRU C.P. 3 AND 4
G-RC-85
SPURIOUS SIGNAL AND LOSS OF NORMAL POWER
G-RC-88A


RBCCW M4-10B PUMP FAILURE AND LOSS OF NORMAL POWER
G-RC-71A
G-RC-71
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
6
RBCCW PUMP M4-10A FAILS TO RESTART
G-RC-71B
OPERATOR FAILS TO START RBCCW PUMP M4-10A
RCW-10A-MDP-OFS
2
RBCCW PUMP M4-10A FAILS TO START
RCW-10A-MDP-FTS
2
CS 148 SERIES C PAIR - 2 PAIR - FAIL TO CLOSE
906XXX-148-1FC
2
SWITCH 906XXX FAILS TO ENERGIZE
906XXX-148-FTE
2

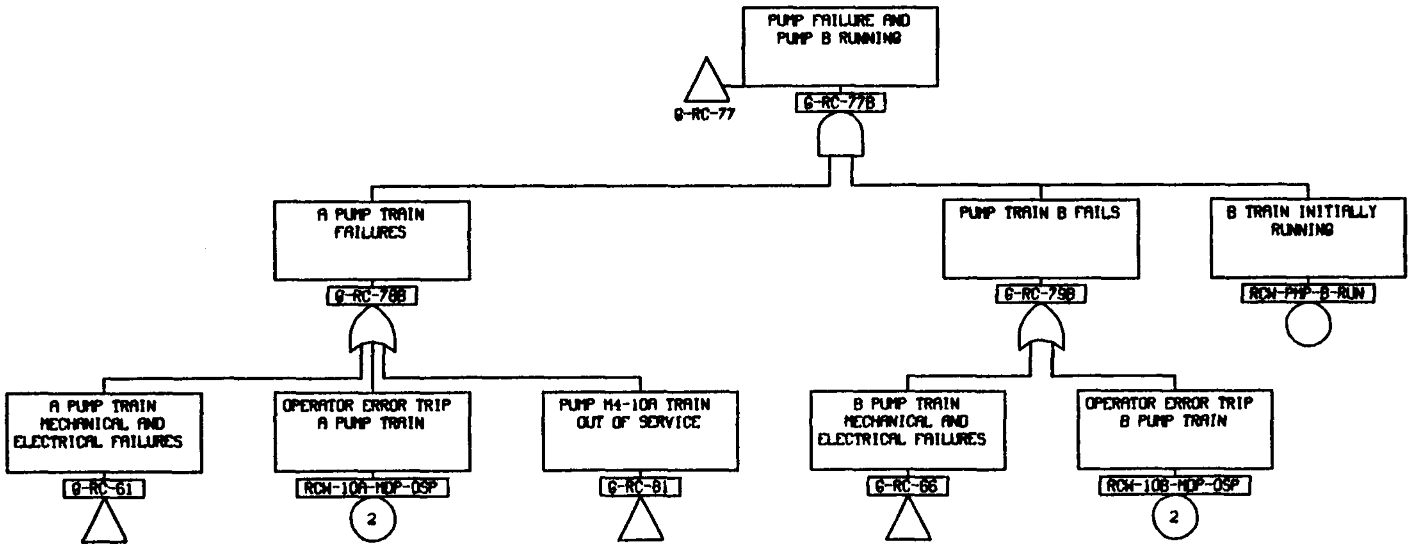

RBCCW PUMP M4-10B FAILS IN RUNNING MODE
G-RC-74
G-RC-69
RBCCW PUMP M4-10B FAILS TO RUN
RCW-10B-MDP-FTR
LOSS OF 4160V AC POWER ON BUS 14F CUB 7
G-AC-BUS-14F
SPURIOUS TRIP SIGNAL RECEIVED
G-RC-75
RBCCW PUMP M4-10B FAILURE AND LOSS OF NORMAL POWER
G-RC-74A
SPURIOUS TRIP SIGNAL TO RBCCW PUMP M4-10B
G-RC-91
AC BREAKER ON 4160V BUS SWGR. 06 CUB 7 FAILS OPEN
AC-14F-7-FRC
SPURIOUS SIGNAL AND LOSS OF NORMAL POWER
G-RC-94A
SIGNAL FROM MAN. SW. 906/ XXX-149 THRU C.P.-S
G-RC-92
SPURIOUS SIGNAL AND LOSS OF NORMAL POWER
G-RC-95A


RBCCW PUMP M4-10B FAILURE AND LOSS OF NORMAL POWER
G-RC-74A
G-RC-74
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
6
RBCCW PUMP M4-10B FAILS TO RESTART
G-RC-74B
CS SERIES C PAIR - 2 PAIR - FAIL TO CLOSE
906XXX-149-IFC
2
SWITCH 906XXX FAILS TO ENERGIZE
906XXX-149-FTE
2
RBCCW PUMP M4-10B FAILS TO START
RCW-10B-MDP-FTS
2
OPERATOR FAILS TO START RBCCW PUMP M4-10B
RCW-10B-MDP-OFS
2

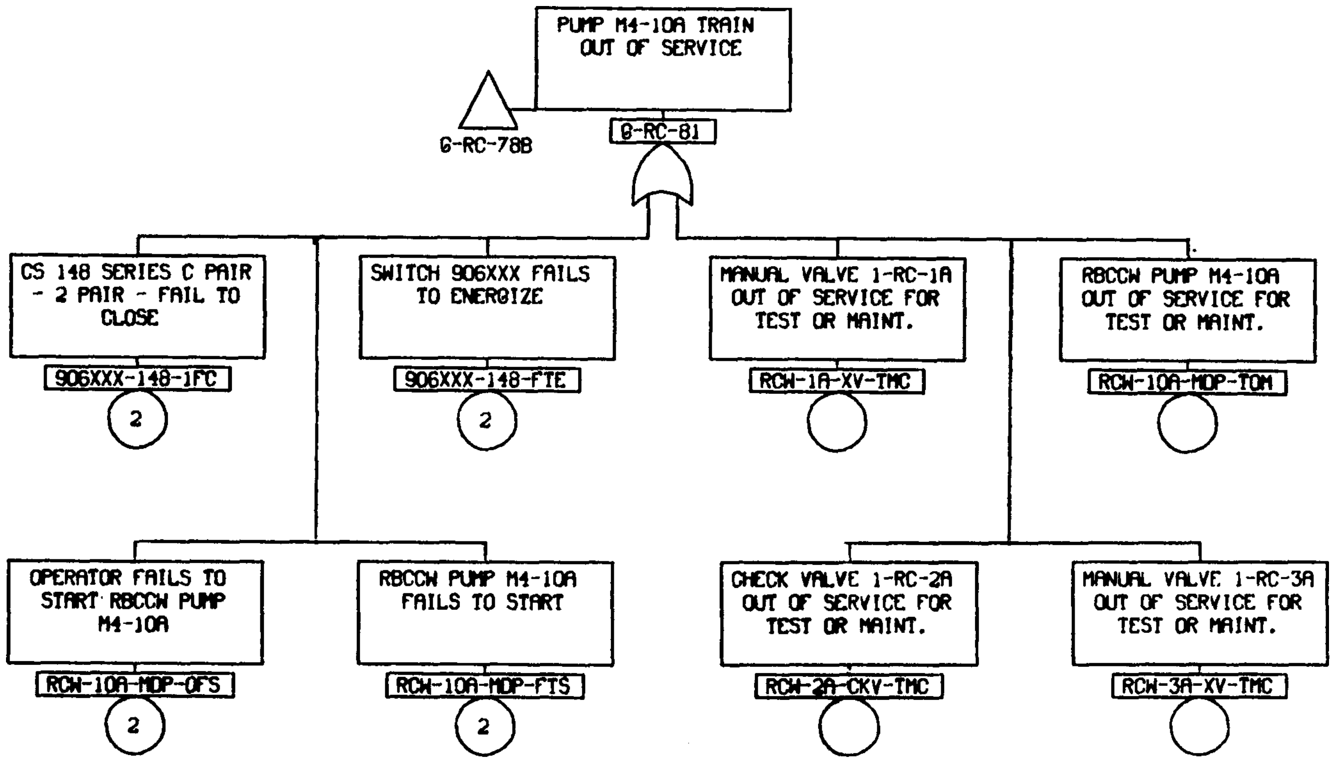
RBCCW-21

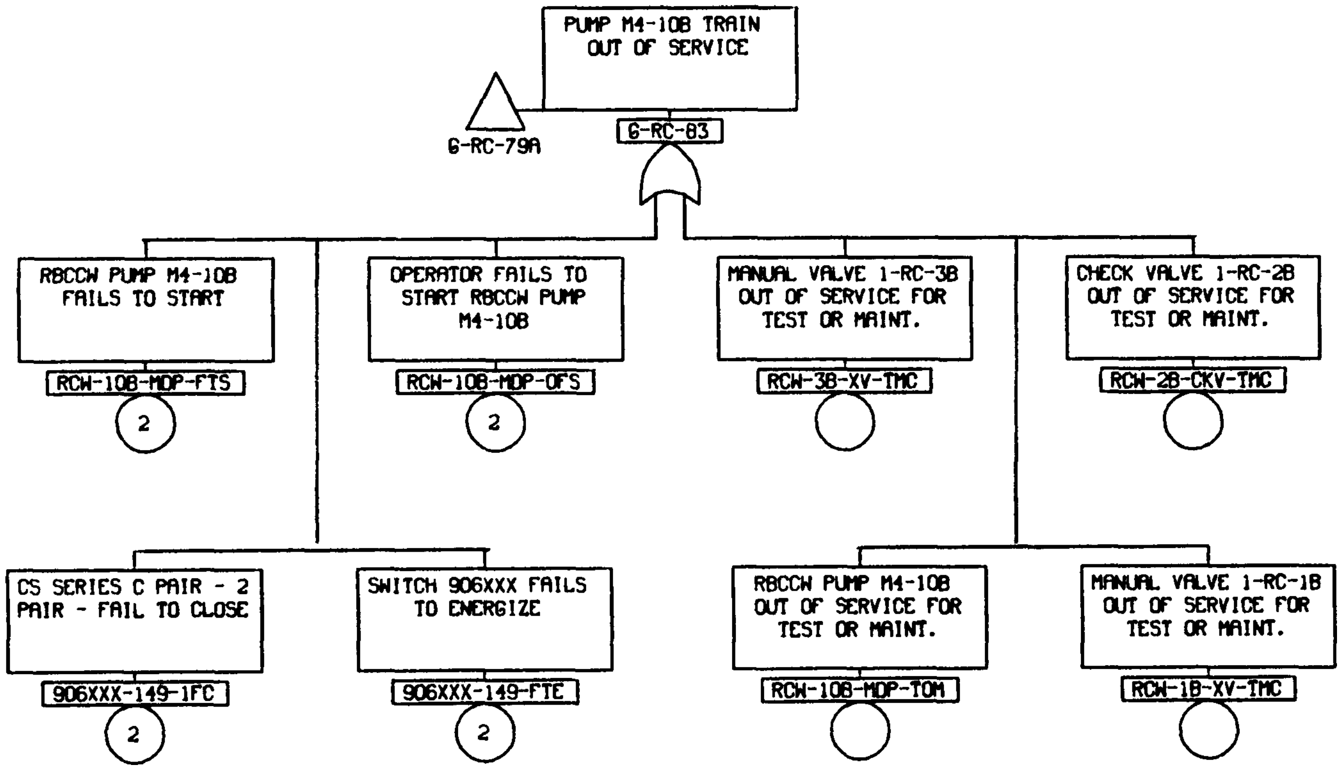

PUMP FAILURE AND PUMP A RUNNING
G-RC-77A
G-RC-77
PUMP TRAIN A FAILS
G-RC-78A
B PUMP TRAIN FAILURES
G-RC-79A
A TRAIN INITIALLY RUNNING
RCW-PMP-A-RUN
A PUMP TRAIN MECHANICAL AND ELECTRICAL FAILURES
G-RC-61
OPERATOR ERROR TRIP A PUMP TRAIN
RCW-10A-MDP-OSP
2
B PUMP TRAIN MECHANICAL AND ELECTRICAL FAILURES
G-RC-66
OPERATOR ERROR TRIP B PUMP TRAIN
RCW-10B-MDP-OSP
2
PUMP M4-10B TRAIN OUT OF SERVICE
G-RC-83

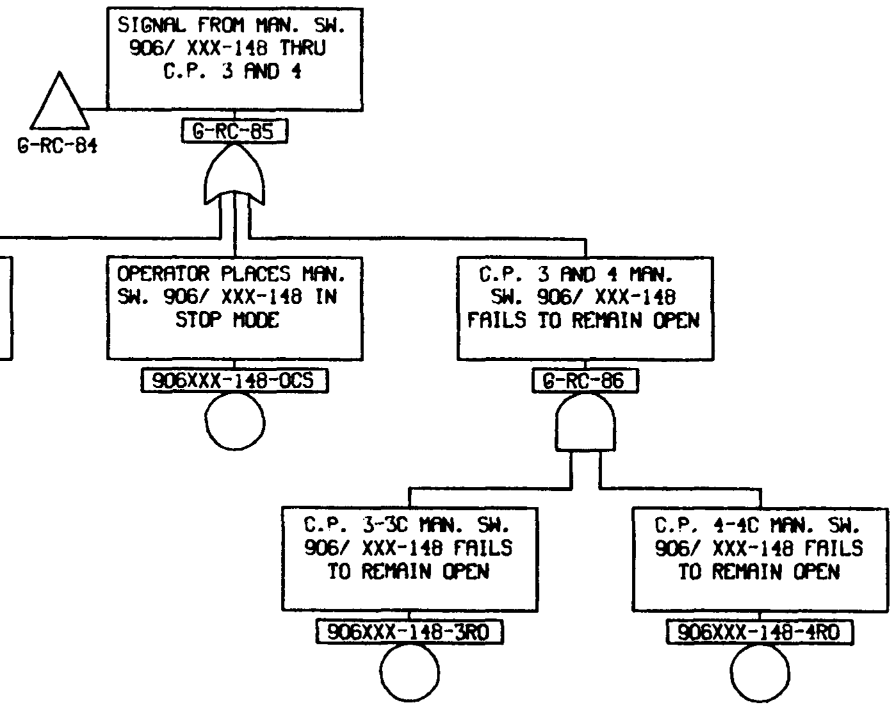
RBCCW-22


PUMP FAILURE AND PUMP B RUNNING
G-RC-77B
G-RC-77
A PUMP TRAIN FAILURES
G-RC-78B
PUMP TRAIN B FAILS
G-RC-79B
B TRAIN INITIALLY RUNNING
RCW-PMP-B-RUN
A PUMP TRAIN MECHANICAL AND ELECTRICAL FAILURES
G-RC-61
OPERATOR ERROR TRIP A PUMP TRAIN
RCW-10A-MDP-OSP
2
PUMP M4-10A TRAIN OUT OF SERVICE
G-RC-81
B PUMP TRAIN MECHANICAL AND ELECTRICAL FAILURES
G-RC-66
OPERATOR ERROR TRIP B PUMP TRAIN
RCW-10B-MDP-OSP
2

RBCCW-23

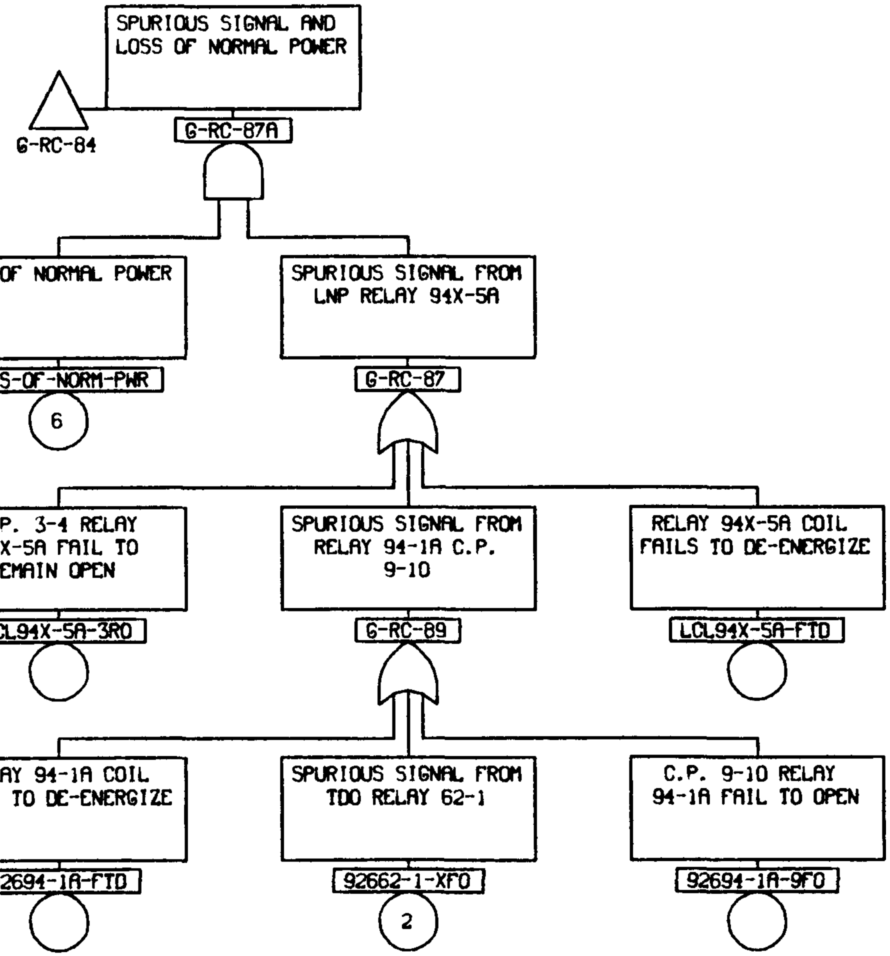

PUMP M4-10A TRAIN OUT OF SERVICE
G-RC-78B
G-RC-81
CS 148 SERIES C PAIR - 2 PAIR - FAIL TO CLOSE
906XXX-148-1FC
2
SWITCH 906XXX FAILS TO ENERGIZE
906XXX-148-FTE
2
MANUAL VALVE 1-RC-1A OUT OF SERVICE FOR TEST OR MAINT.
RCW-1A-XV-TMC
RBCCW PUMP M4-10A OUT OF SERVICE FOR TEST OR MAINT.
RCW-10A-MDP-TOM
OPERATOR FAILS TO START RBCCW PUMP M4-10A
RCW-10A-MDP-OFS
2
RBCCW PUMP M4-10A FAILS TO START
RCW-10A-MDP-FTS
2
CHECK VALVE 1-RC-2A OUT OF SERVICE FOR TEST OR MAINT.
RCW-2A-CKV-TMC
MANUAL VALVE 1-RC-3A OUT OF SERVICE FOR TEST OR MAINT.
RCW-3A-XV-TMC


PUMP M4-10B TRAIN OUT OF SERVICE
G-RC-83
G-RC-79A
RBCCW PUMP M4-10B FAILS TO START
RCW-10B-MDP-FTS
2
OPERATOR FAILS TO START RBCCW PUMP M4-10B
RCW-10B-MDP-OFS
2
MANUAL VALVE 1-RC-3B OUT OF SERVICE FOR TEST OR MAINT.
RCW-3B-XV-TMC
CHECK VALVE 1-RC-2B OUT OF SERVICE FOR TEST OR MAINT.
RCW-2B-CKV-TMC
CS SERIES C PAIR - 2 PAIR - FAIL TO CLOSE
906XXX-149-1FC
2
SWITCH 906XXX FAILS TO ENERGIZE
906XXX-149-FTE
2
RBCCW PUMP M4-10B OUT OF SERVICE FOR TEST OR MAINT.
RCW-10B-MDP-TOM
MANUAL VALVE 1-RC-1B OUT OF SERVICE FOR TEST OR MAINT.
RCW-1B-XV-TMC

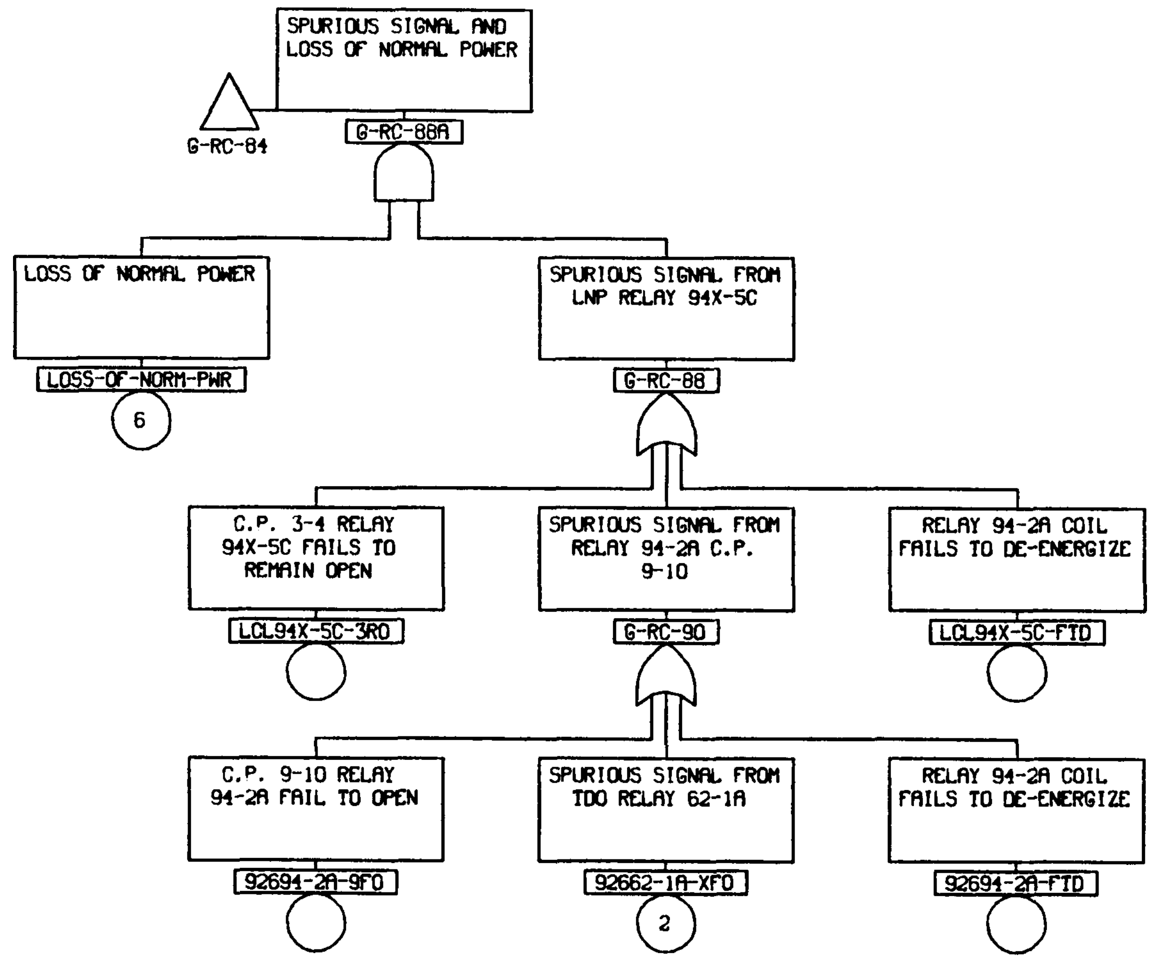


SIGNAL FROM MAN. SW. 906/ XXX-148 THRU C.P. 3 AND 4
G-RC-85
G-RC-84
MAN. SW. 906/ XXX-148 FAILS IN STOP MODE
906XXX-148-FTD
OPERATOR PLACES MAN. SW. 906/ XXX-148 IN STOP MODE
906XXX-148-OCS
C.P. 3 AND 4 MAN. SW. 906/ XXX-148 FAILS TO REMAIN OPEN
G-RC-86
C.P. 3-3C MAN. SW. 906/ XXX-148 FAILS TO REMAIN OPEN
906XXX-148-3RO
C.P. 4-4C MAN. SW. 906/ XXX-148 FAILS TO REMAIN OPEN
906XXX-148-4RO

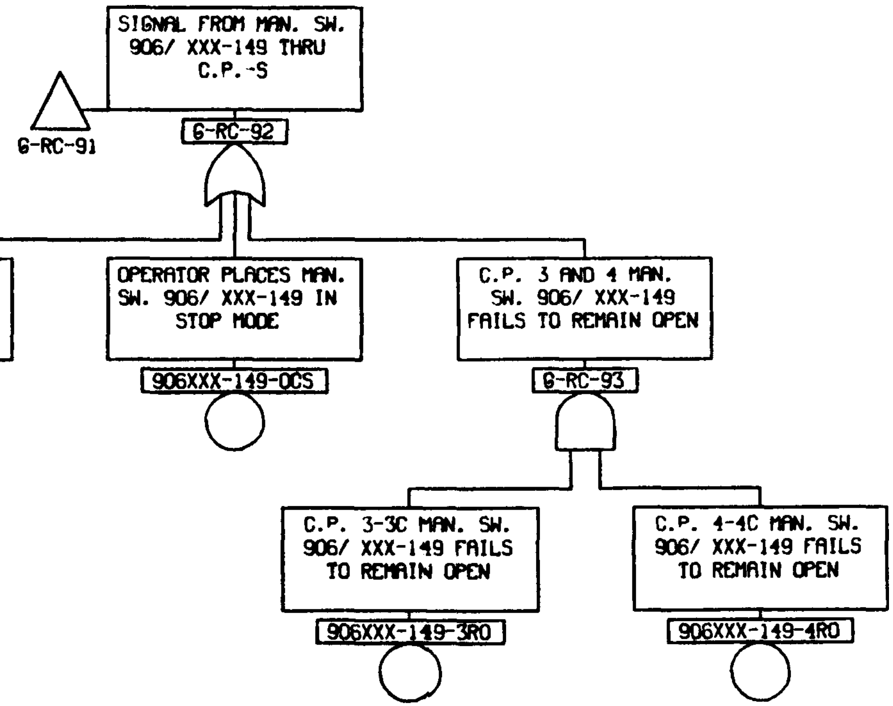
RBCCW-26

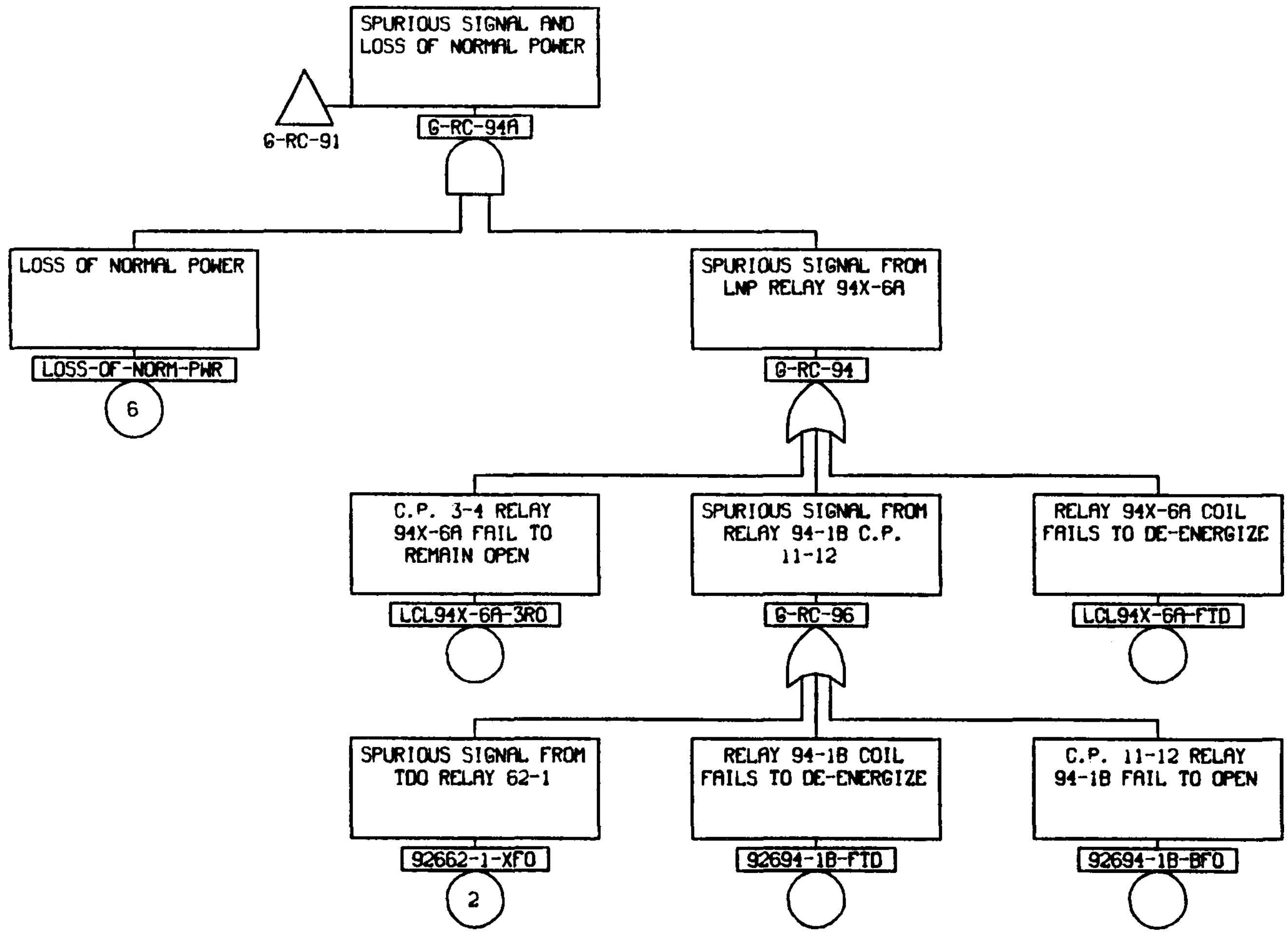

SPURIOUS SIGNAL AND LOSS OF NORMAL POWER
G-RC-87A
G-RC-84
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
6
SPURIOUS SIGNAL FROM LNP RELAY 94X-5A
G-RC-87
C.P. 3-4 RELAY 94X-5A FAIL TO REMAIN OPEN
LCL94X-5A-3RO
SPURIOUS SIGNAL FROM RELAY 94-1A C.P. 9-10
G-RC-89
RELAY 94X-5A COIL FAILS TO DE-ENERGIZE
LCL94X-5A-FTD
RELAY 94-1A COIL FAILS TO DE-ENERGIZE
92694-1A-FTD
SPURIOUS SIGNAL FROM TDO RELAY 62-1
92662-1-XFO
2
C.P. 9-10 RELAY 94-1A FAIL TO OPEN
92694-1A-9FO

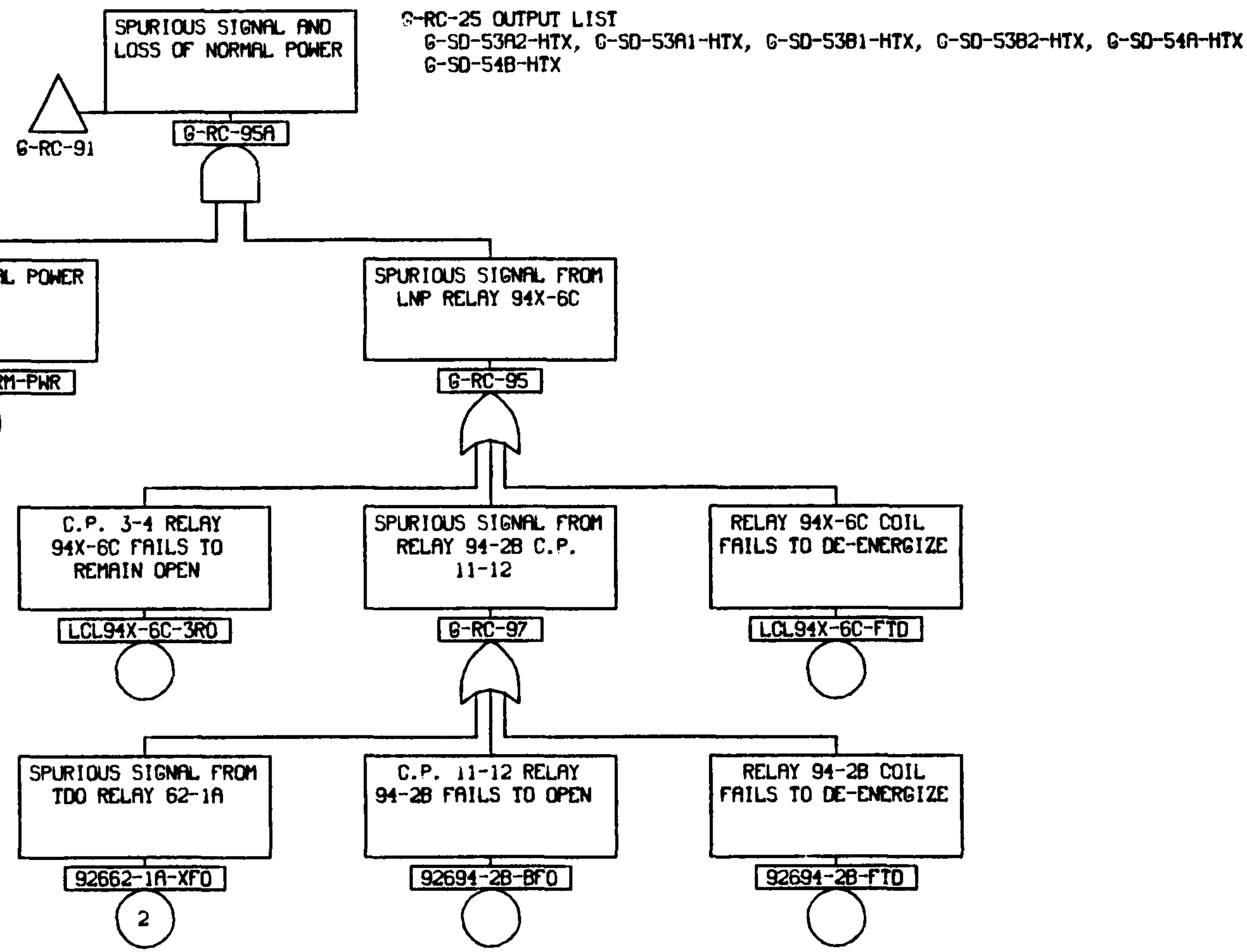
RBCCW-27


SPURIOUS SIGNAL AND LOSS OF NORMAL POWER
G-RC-84
G-RC-88A
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
6
SPURIOUS SIGNAL FROM LNP RELAY 94X-5C
G-RC-88
C.P. 3-4 RELAY 94X-5C FAILS TO REMAIN OPEN
LCL94X-5C-3RO
SPURIOUS SIGNAL FROM RELAY 94-2A C.P. 9-10
G-RC-90
RELAY 94-2A COIL FAILS TO DE-ENERGIZE
LCL94X-5C-FTD
C.P. 9-10 RELAY 94-2A FAIL TO OPEN
92694-2A-9FO
SPURIOUS SIGNAL FROM TDO RELAY 62-1A
92662-1A-XFO
2
RELAY 94-2A COIL FAILS TO DE-ENERGIZE
92694-2A-FTD

RBCCW-28


SIGNAL FROM MAN. SW. 906/ XXX-149 THRU C.P.-S
G-RC-91
G-RC-92
MAN. SW. 906/ XXX-149 FAILS IN STOP MODE
906XXX-149-FTD
OPERATOR PLACES MAN. SW. 906/ XXX-149 IN STOP MODE
906XXX-149-OCS
C.P. 3 AND 4 MAN. SW. 906/ XXX-149 FAILS TO REMAIN OPEN
G-RC-93
C.P. 3-3C MAN. SW. 906/ XXX-149 FAILS TO REMAIN OPEN
906XXX-149-3RO
C.P. 4-4C MAN. SW. 906/ XXX-149 FAILS TO REMAIN OPEN
906XXX-149-4RO


SPURIOUS SIGNAL AND LOSS OF NORMAL POWER
G-RC-94A
G-RC-91
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
6
SPURIOUS SIGNAL FROM LNP RELAY 94X-6A
G-RC-94
C.P. 3-4 RELAY 94X-6A FAIL TO REMAIN OPEN
LCL94X-6A-3RO
SPURIOUS SIGNAL FROM RELAY 94-1B C.P. 11-12
G-RC-96
RELAY 94X-6A COIL FAILS TO DE-ENERGIZE
LCL94X-6A-FTD
SPURIOUS SIGNAL FROM TDO RELAY 62-1
92662-1-XFO
2
RELAY 94-1B COIL FAILS TO DE-ENERGIZE
92694-1B-FTD
C.P. 11-12 RELAY 94-1B FAIL TO OPEN
92694-1B-BFO



SPURIOUS SIGNAL AND LOSS OF NORMAL POWER
G-RC-95A
G-RC-91
G-RC-25 OUTPUT LIST
G-SD-53A2-HTX, G-SD-53A1-HTX, G-SD-53B1-HTX, G-SD-53B2-HTX, G-SD-54A-HTX
G-SD-54B-HTX
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
6
SPURIOUS SIGNAL FROM LNP RELAY 94X-6C
G-RC-95
C.P. 3-4 RELAY 94X-6C FAILS TO REMAIN OPEN
LCL94X-6C-3RO
SPURIOUS SIGNAL FROM RELAY 94-2B C.P. 11-12
G-RC-97
RELAY 94X-6C COIL FAILS TO DE-ENERGIZE
LCL94X-6C-FTD
SPURIOUS SIGNAL FROM TDO RELAY 62-1A
92662-1A-XFO
2
C.P. 11-12 RELAY 94-2B FAILS TO OPEN
92694-2B-BFO
RELAY 94-2B COIL FAILS TO DE-ENERGIZE
92694-2B-FTD

APPENDIX B.13

TURBINE BUILDING SECONDARY CLOSED COOLING WATER SYSTEM

B.13.1 Turbine Building Secondary Closed Cooling Water System Description

B.13.1.1 Purpose

The purpose of the turbine building secondary closed cooling water (TBSCCW) system is to provide cooling water to varied equipment in the turbine and reactor buildings during normal operation and to essential equipment during accident conditions. The essential equipment serviced by the TBSCCW system during accident conditions are components of the plant air system and the feedwater/feedwater coolant injection (FWCI) system.

B.13.1.2 Description and Configuration

A simplified schematic of the TBSCCW system which includes only essential post-accident plant equipment cooled by the TBSCCW system is presented as Figure B.13-1. The essential equipment cooled by the TBSCCW system consists of the instrument and service air compressors, reactor feed pumps, condensate pumps and condensate booster pumps. The system is closed with a surge tank located above the highest point in the system to accommodate system fluctuations. There are two TBSCCW pumps that provide flow through the equipment coolers and the TBSCCW heat exchangers. The two heat exchangers transfer heat to the service water system.

B.12.1.3 System Interfaces

System interfaces for the TBSCCW system are identified in Table B.13-1.

B.13.1.4 Instrumentation and Control

The TBSCCW system operates on a continual basis during normal plant operation and normal shutdown conditions. There are no motor operated valves affecting flow to essential components. The two electric pumps, M4-15A and M4-15B may be operated from the control room by control switches CS/155 and CS/156, respectively.

If normal AC power is lost (an LNP occurs), pump M4-15A will automatically start with power from the gas turbine. Pump M4-15B receives a trip signal on LNP, and will automatically start only on closure of a 1 out of 2 twice combination of high drywell pressure contacts concurrent with the LNP signal. A timer is used to sequentially load pump M4-15B on a diesel powered bus. A schematic of the control circuitry is shown in Figure B.13-2.

Table B.13-2 shows the instrumentation used by the TBSCCW system.

B.13.1.5 Testing

The following test procedure is applicable to the TBSCCW System:

OP 608.7 Secondary Closed Cooling Water Pump and Discharge Check Valve Readiness Test

Monthly, the functional capability of each motor driven pump and associated discharge check valve is tested.

B.13.1.6 Maintenance

There is no specified maintenance schedule for this system. Maintenance is performed on an as needed basis.

B.13.1.7 Technical Specifications

There are no technical specifications explicitly associated with the operation of the TBSCCW system.

B.13.1.8 Operation

During normal operation, one of two TBSCCW pumps continually circulates water through the two heat exchangers to provide cooling for the essential components indicated in Figure B.13-1 and for a number of non-essential components. A surge tank is attached to the highest elevation of the system to compensate for system fluctuations.

The TBSCCW system is designed to continue uninterrupted operation during all transient or LOCA conditions except an LNP. During a sustained LNP, system pumps will start automatically as described in section B.13.1.4. Manual start of the pumps may also be attempted from the control room.

System alarms are provided in the control room for pump trip, low pump discharge pressure and low or high surge tank level. Operator actions are required to rectify any of these occurrences.

B.13.2 Analysis

B.13.2.1 Success/Failure Criteria

Successful functioning of the TBSCCW system is defined as the maintenance of cooling flow to all of the components indicated in Figure B.13-1 during normal and accident conditions. Successful cooling of each essential component requires that at least one of the TBSCCW pumps and heat exchangers functions and a cooling water flow path to the component is available. Thus, a "partial failure" of the TBSCCW system can occur if a flow path to a particular component is not available yet other components are being adequately cooled.

B.13.2.2 Assumptions

In this analysis, the following assumptions are made:

1) The sampling lines are not considered as diversion paths because they are significantly smaller in diameter than the TBSCCW lines from which they are drawn.

2) The failing open of a relief valve is assumed to affect only the cooling of the component directly associated with it and not the entire TBSCCW system. This assumption is based on the diameter on the relief valve intake.

3) Failures of the surge tank or associated valving were not considered to result in near term failures of the TBSCCW system. This assumption is based on the orientation of the surge tank at the highest elevation of the system.

4) During normal operation, each of the TBSCCW pumps is running 50 percent of the time; rotation of the pumps occurs on a weekly basis. This is based on discussions with plant personnel.

5) A signal to start TBSCCW system pump B after an LNP was analyzed as deriving only from the high drywell pressure sensors, because low reactor pressure concurrent with low reactor water level will not exist for FWCI actuation after an LNP.

Table B.13-1

TBSCCW System Interfaces Failure Modes and Effects

Primary System			Support System			Failure Mode	Fault Effect
System	Div.	Comp.	System	Div.	Comp.		
TBSCCW		Pump 1A 1B	AC Pwr	 G/T Diesel	 Bus 12E Bus 12F	Low or zero voltage	Pump fails to start or run concurrent failure to start or run
TBSCCW		Pump 1A 1B	DC Pwr		 Bus 101B Bus 101A	Low or zero voltage	Precludes manual start, no local effect on already running pump
TBSCCW		Heat Exchanger 1A 1B	SWS		Heat exchanger secondary side	Loss of flow	No heat removal from TBSCCW system

Table B.13-2

TBSCCW System Instrumentation

Sensors	Function	Setpoint
2205/1501-90A 2206/1501-90B 2205/1501-90C 2206/1501-90D	Hi drywell pressure indication, in conjunction with an LNP signal a pump start permissive is generated	1.8 psig

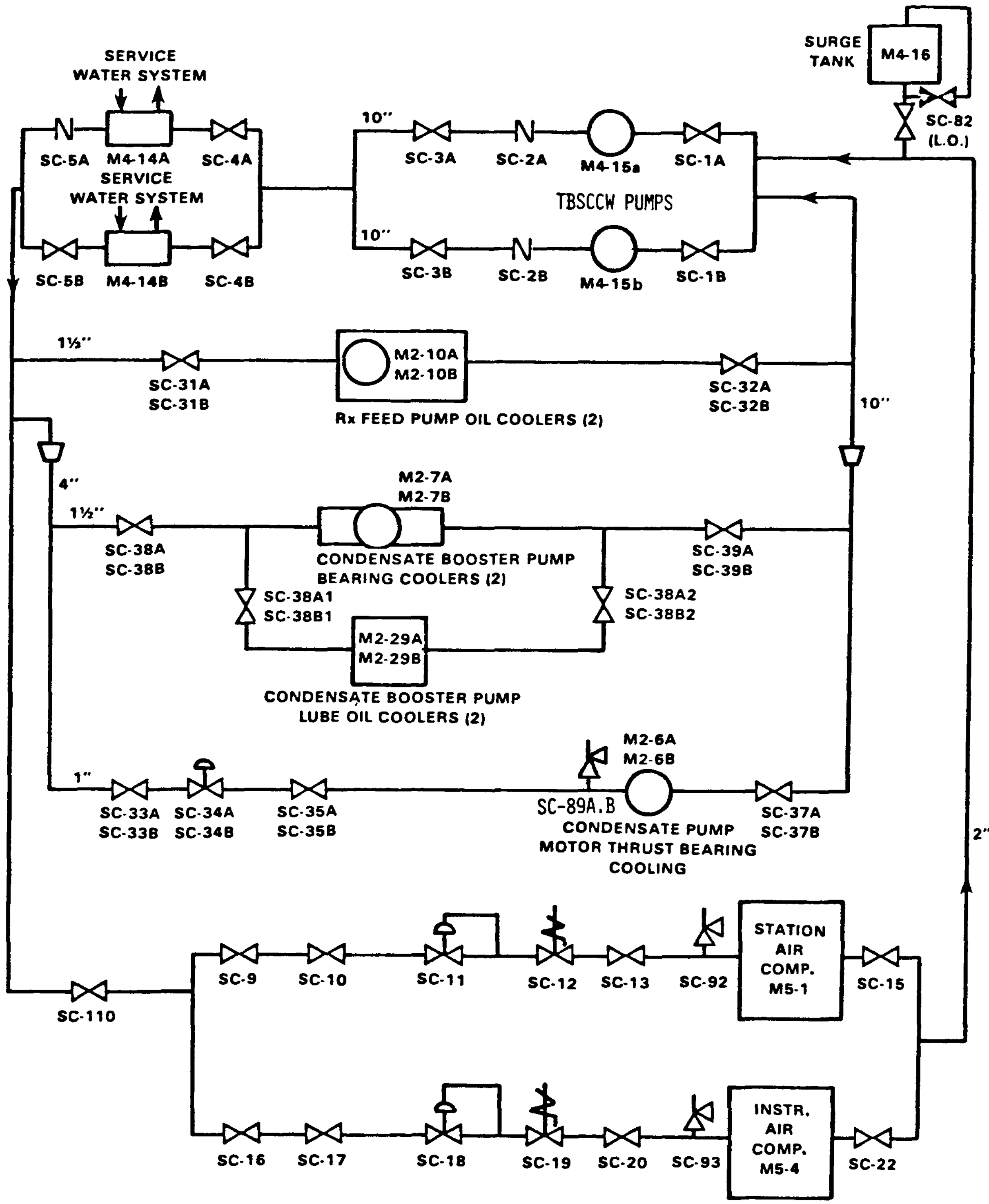


FIGURE B.13-1. TURBINE BUILDING SECONDARY CLOSED COOLING WATER (SIMPLIFIED DIAGRAM -- ONLY ESSENTIAL COMPONENTS SHOWN)

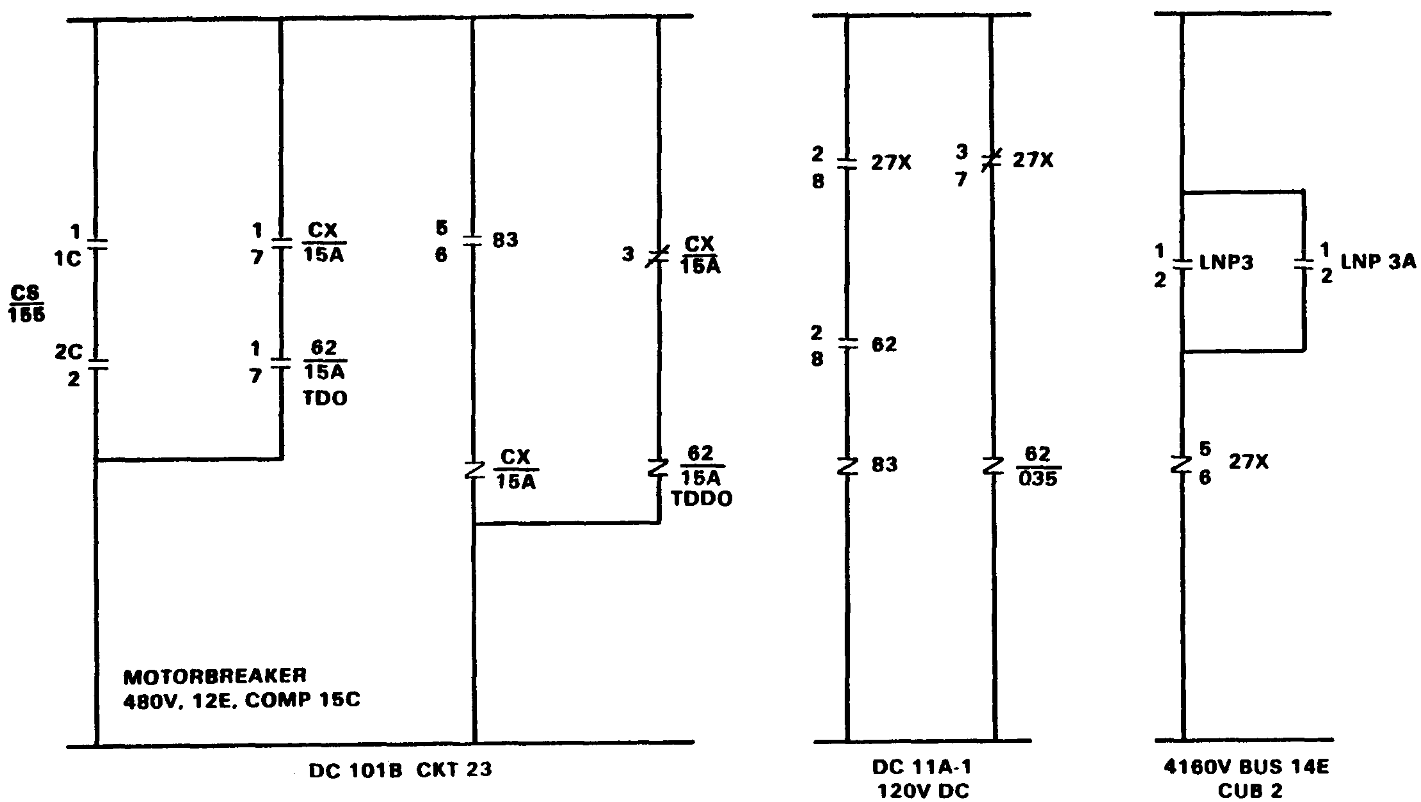


FIGURE B.13-2. TBSCCW SYSTEM CONTROL WIRING SCHEMATICS
PUMP M4-15A STARTING CIRCUIT (SHEET 1 OF 4)

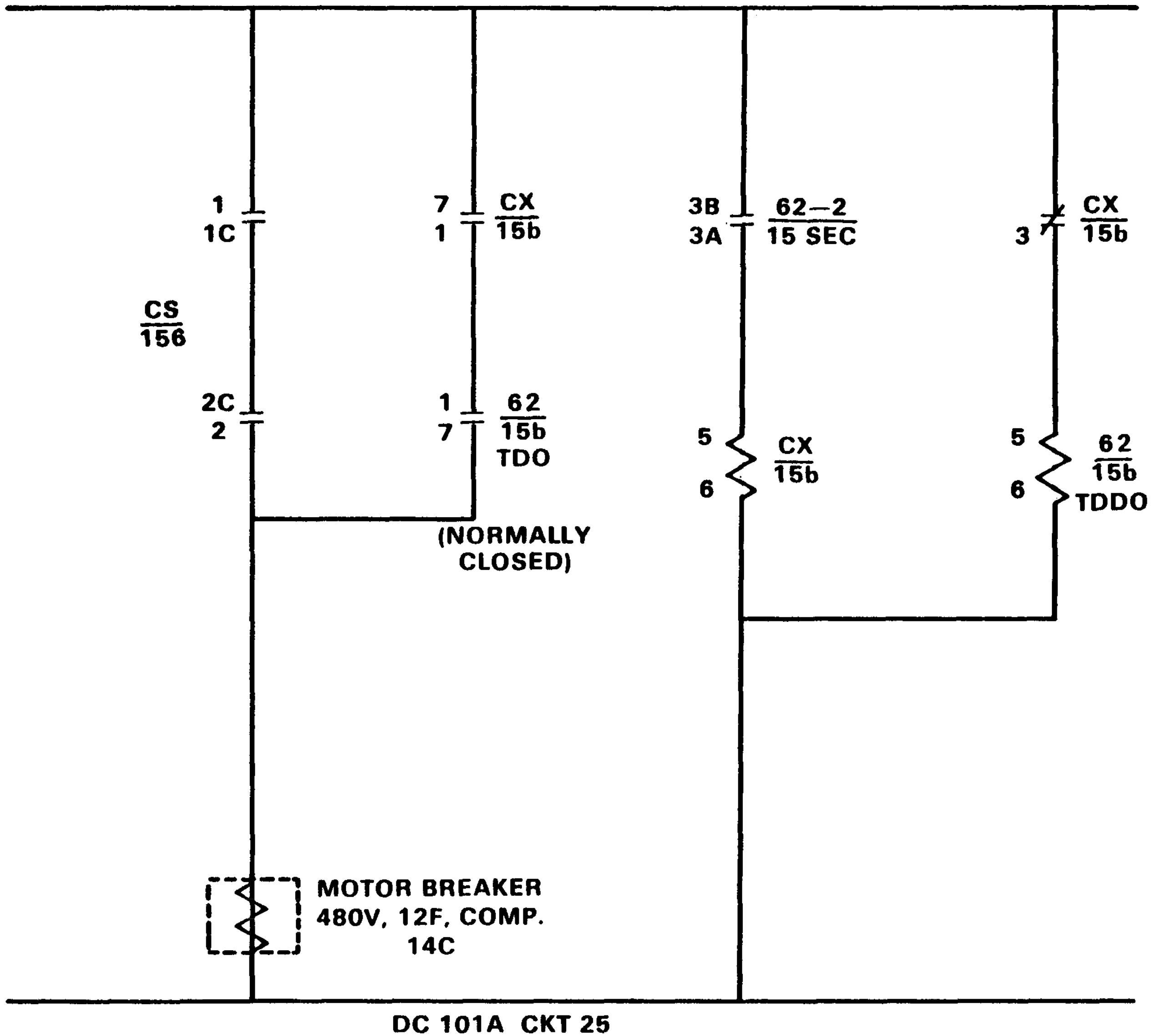


FIGURE B.13-2. TBSCCW SYSTEM CONTROL WIRING SCHEMATICS PUMP M4-15B STARTING CIRCUIT (SHEET 2 OF 4)

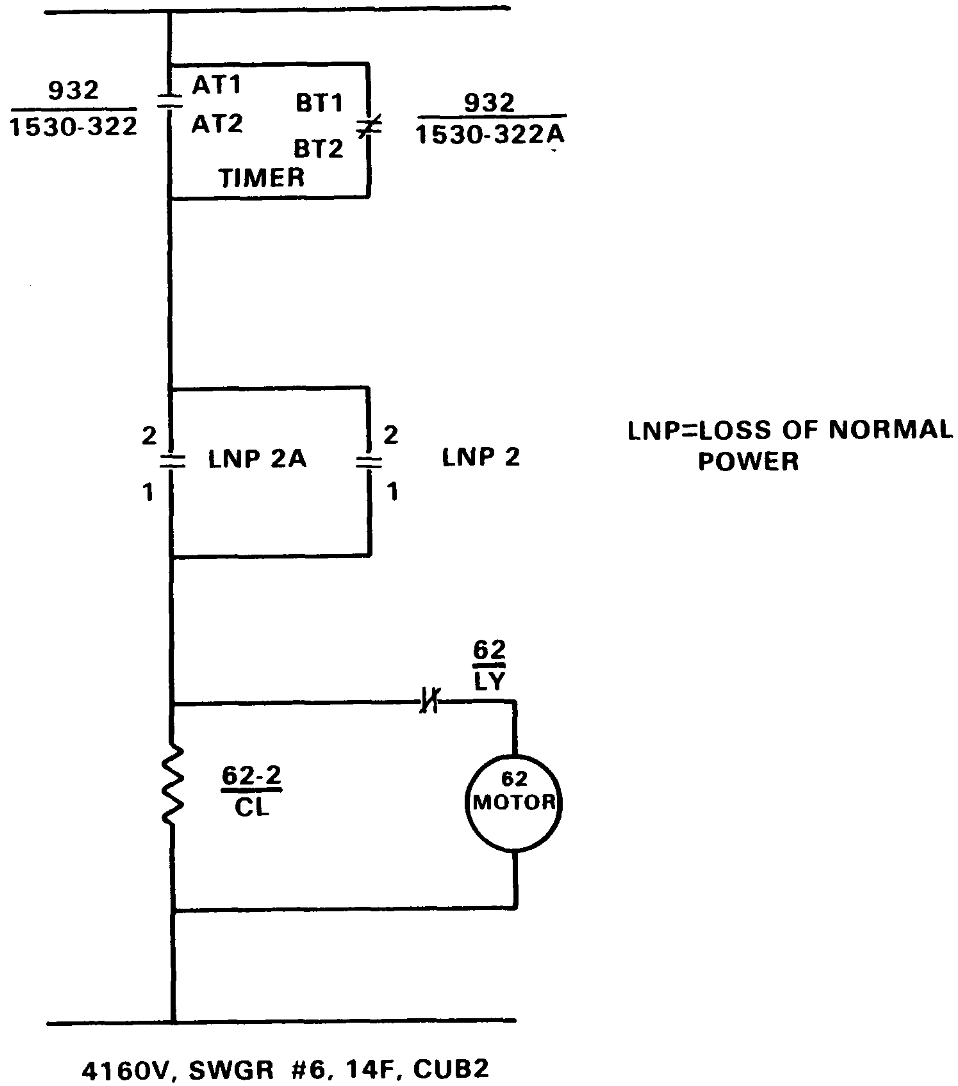
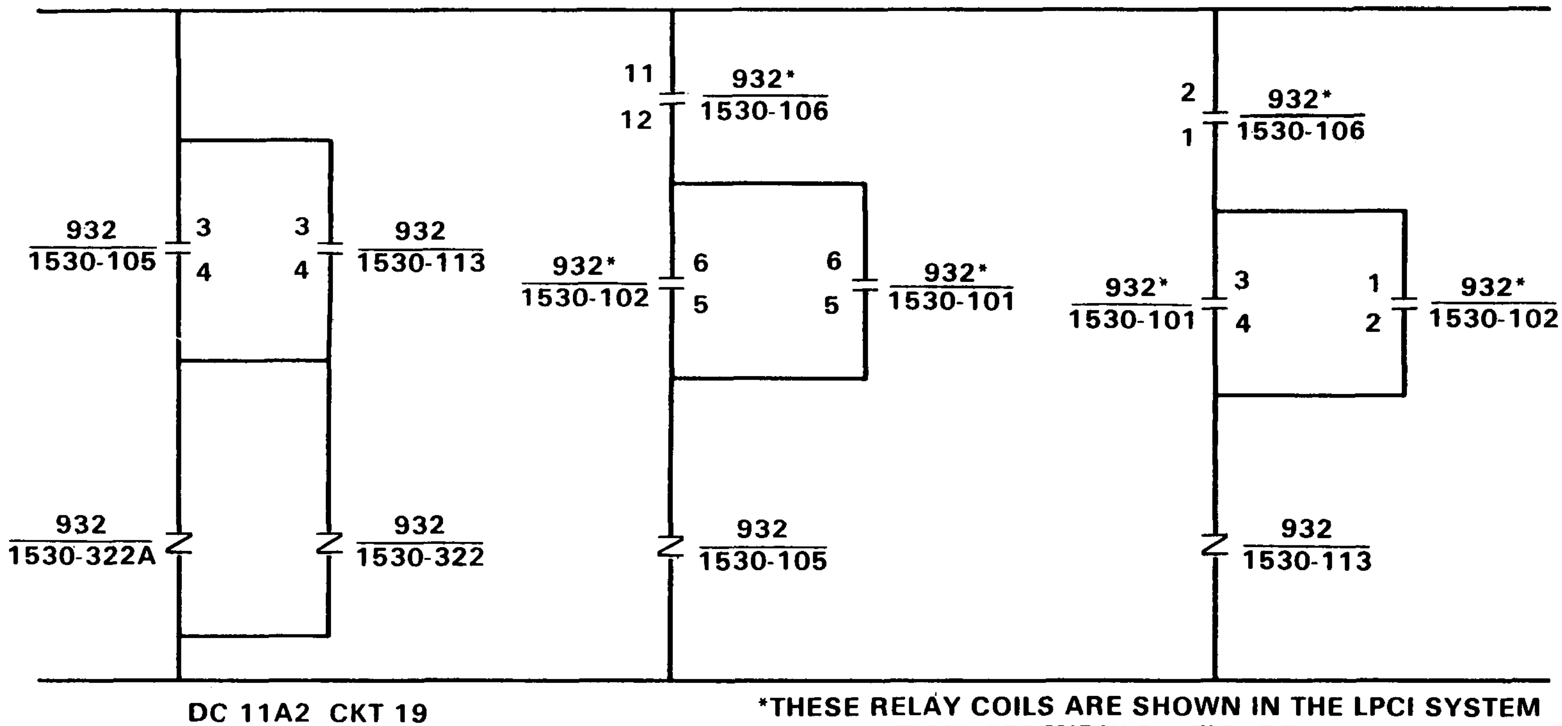


FIGURE B.13-2. TBSCCW SYSTEM CONTROL WIRING SCHEMATICS
PUMP M4-15B STARTING CIRCUIT (SHEET 3 OF 4)



*THESE RELAY COILS ARE SHOWN IN THE LPCI SYSTEM DESCRIPTION, APPENDIX B.5 FIGURE B.5-2.

FIGURE B.13-2. TBSCCW SYSTEM CONTROL WIRING SCHEMATICS PUMP M4-15B STARTING CIRCUIT (SHEET 4 OF 4)

TURBINE BUILDING SECONDARY CLOSED COOLING WATER SYSTEM

FAULT TREE AND FAULT SUMMARY SHEETS

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SC-31A-XV-FRO SC-31B-XV-FRO SC-32A-XV-FRO SC-32B-XV-FRO	N.O. manual valve fails to remain open due to mechanical failure of valve	Prompt	Reactor feed pump cooling flow affected	6.7E-6
SC-31A-XV-TMC SC-31B-XV-TMC SC-32A-XV-TMC SC-32B-XV-TMC	N.O. manual valve fails to remain open due to test or maintenance related unavailability or misposition	Prompt	Reactor feedpump cooling flow affected	2.8E-6
SC-38A1-XV-FRO SC-38A2-XV-FRO SC-38B1-XV-FRO SC-38B2-XV-FRO	N.O. manual valve fails to remain open due to mechanical failure of valve	Prompt	Condensate booster pump lube oil coolling flow affected	6.7E-6
SC-38A1-XV-TMC SC-38B1-XV-TMC SC-38A2-XV-TMC SC-38B2-XV-TMC	N.O. manual valve fails to remain open due to test or maintenance related unavailability or misposition	Prompt	Condensate booster pump lube oil cooling flow affected	2.8E-6
SC-33A-XV-FRO SC-33B-XV-FRO SC-35A-XV-FRO SC-35B-XV-FRO SC-37A-XV-FRO SC-37B-XV-FRO	N.O. manual valve fails to remain open due to mechanical failure of valve	Prompt	Condensate pump cooling flow affected	6.7E-6

MILLSTONE 1
SYSTEM TBSCCW
SHEET #1

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SC-33A-XV-TMC SC-33B-XV-TMC SC-35A-XV-TMC SC-35B-XV-TMC SC-37A-XV-TMC SC-37B-XV-TMC	N.O. manual valve fails to remain open due to test or maintenance related unavailability or misposition	Prompt	Condensate pump cooling flow affected	2.8E-6
SC-34A-PHV-FRO SC-34B-PHV-FRO SC-11-PHV-FRO SC-18-PHV-FRO	N.O. valve with position controlled by upstream water pressure fails to remain open due to mechanical fault	Prompt	Condensate pump, air compressor cooling flow affected	7.2E-6
SC-34A-PHV-TMC SC-34B-PHV-TMC SC-11-PHV-TMC SC-18-PHV-TMC	Sames as above except due to test maintenance related unavailability or misposition	Prompt	Condensate pump, air compressor cooling flow affected	2.8E-6
SC-89A-SRV-FRC SC-89B-SRV-FRC SC-92-SRV-FRC SC-93-SRV-FRC	N.C. relief valve fails open due to mechanical fault	Prompt	Condensate pump, air compressor cooling flow affected	7.2E-5
SC-12-SOV-FRO SC-19-SOV-FRO	Solenoid valve fails to remain open due to mechanical failure of valve or energizing coil	Prompt	Air compressor cooling; solenoid value operates on signal to operate compressor	6.7E-6

MILLSTONE 1
SYSTEM TBSCCW
SHEET #2

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SC-12-SOV-TMC SC-29-SOV-TMC	Solenoid valve fails to remain open due to test or maintenance related unavailability or error	Prompt	Air compressor cooling flow affected	0.0
SC-2A-CKV-FRO SC-2B-CKV-FRO	CK valve fails to remain open	Prompt		7.2E-6
SC-110-XV-FRO SC-9-XV-FRO SC-10-XV-FRO SC-13-XV-FRO SC-15-XV-FRO	N.O. manual valve fails to remain open due to mechanical failure of value	Prompt	Air compressor cooling flow affected	6.7E-6
SC-16-XV-FRO SC-17-XV-FRO SC-20-XV-FRO SC-22-XV-FRO	N.O. manual valve fails to remain open	Prompt	Air compressor cooling flow affected	6.7E-6
SC-110-XV-TMC SC-9-XV-TMC SC-10-XV-TMC SC-13-XV-TMC SC-15-XV-TMC	N.O. manual valve fails to remain open due to test or maintenance related unavailability or misposition	Prompt	Air compressor cooling flow affected	2.8E-6
SC-16-XV-TMC SC-17-XV-TMC SC-20-XV-TMC SC-22-XV-TMC	N.O. manual valve closed due to test/ maint.	Prompt	Air compressor cooling flow affected	2.8E-6

MILLSTONE 1
SYSTEM TBSCCW
SHEET #3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SC-1A-XV-FRO SC-3A-XV-FRO SC-4A-XV-FRO SC-5A-XV-FRO	N.O. manual valve fails to permit flow due to mechanical faults	Prompt	Pump M4-15A, heat exchanger M4-14A flow affected	6.7E-6
SC-1B-XV-FRO SC-3B-XV-FRO SC-4B-XV-FRO SC-5B-XV-FRO	N.O. manual valve fails to permit flow	Prompt	Pump M4-153, heat exchanger M4-14B flow affected	6.7E-6
SC-1A-XV-TMC SC-3A-XV-TMC	Manual valve fails to permit flow due to test or maintenance related unavailability or misposition	Prompt	Pump M4-15A, heat exchanger M4-14A section flow affected	2.8E-6
SC-1B-XV-TMC SC-3B-XV-TMC	Manual valve closed due to test/maint.	Prompt	Pump M4-15B, heat exchanger M4-14B flow affected	2.8E-6
SC-10A-HTX-LOF SC-10B-HTX-LOF	Rx feed pump oil cooler failure	Prompt	Rx feed pump is running during plant operation	2.0E-4
SC-7A-HTX-LOF SC-7B-HTX-LOF	Condensate booster pump bearing cooler failure	Prompt	Condensate booster pump is running during plant operation	2.0E-4
SC-29A-HTX-LOF SC-29B-HTX-LOF	Condensate booster pump lube oil cooler failure	Prompt	Lube oil pump failure would affect the condensate booster pump	2.0E-4

MILLSTONE 1
SYSTEM TBSCCW
SHEET #4

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SC-14A-HTX-LOF SC-14B-HTX-LOF	TBSCCW heat exchanger failure due to mechanical faults	Prompt	TBSCCW heat removal capability reduced, temp. increases will be detected	2E-4
SC-14A-HTX-TOM SC-14B-HTX-TOM	TBSCCW heat exchanger unavailable due to test or maintenance related outage or malfunction	Prompt	TBSCCW heat removal capability is reduced, temperature increases will be detected	0.0
SC-A-MDP-FSR SC-B-MDP-FSR	Failure of pump to continue running	Prompt	Failure of normally running pump	7.2E-4
SC-A-MDP-FSD SC-B-MDP-FSD	Failure of pump to start and continue running	Prompt		1.7E-3
22051501-90A-OMC 22051501-90C-OMC 22061501-90B-OMC 22061501-90D-OMC	Operator error in calibrating sensors	One month		1E-3
SC-A-MDP-TOM SC-B-MDP-TOM	Pump unavailable due to test or maintenance related outage or malfunction	Prompt		7.8E-4
AC-12F-14C-FRC AC-12E-15C-FRC	Pump fails due to mechanical fault of breaker	Prompt	Failure leads to failure of normally running pump	2.4E-5

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SC-A-MDP-OSP SC-B-MDP-OSP	Pump stops due to operator error	------	Control switch spring returns to normal	3E-3
SC-A-MDP-OFS SC-B-MDP-OFS	Operator fails to start pump	------		1E-2
906CS-155-FRD 906CS-156-FRD	Pump stops due to mechanical fault of control room switch	Prompt	Plant personnel indicate weekly rotation of TBSECW pumps A and B	8.4E-7
906CS-155-3RO 906CS-155-4RO 906CS-156-3RO 906CS-156-4RO	Pump stops due to failure of control switch N.O. remote contacts	Prompt		2.8E-6
LCL94X-42A-BRO	Pump B trips due to failure of N.O. LNP trip contact pair	Prompt		2.4E-6
LCL94X-42A-FTD	Pump B trips due to failure of coil to deenergize	Prompt		6.7E-6
92694-1B-FTD 92694-2B-FTD	Pump B trips due to failure of coil to deenergize (LNP CKT #1)	Prompt		6.7E-6

MILLSTONE 1
SYSTEM TBSCCW
SHEET #6

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
92694-1B-5FO 92694-2B-5FO	Pump B trips due to failure of contact to open	Prompt	Contact pair must open following an LNP trip	7.2E-6
92662-1-XFO 92662-1A-XFO	Pump B trips due to spurious signal	Prompt	92662-1-XFO includes contact 1-7 of relay 62-1 not opening, coil 62-1 not deen-ergizing, contact 3 of relay 2-1 not opening; coil 2-1 energizing	2E-3
906CS-156-FTE 906CS-155-FTE	Control switch fails to function	Prompt		6.7E-7
906CS-156-1FC 906CS-156-2FC 906CS-155-1FC 906CS-155-2FC	Manual start of pump not successful because relay con-tacts fail to close	Prompt		7.2E-6
906CX-15B-1FC AC-DG62-2-3AFC 9321530-322-1FC 9321530-105-3FC 926LNP-2-1FC 926LNP-2A-1FC 926-LNP-3-1FC 926LNP-3A-1FC 92683-5FC 92627X-2FC 906CX-15A-1FC	Actuation circuitry for pump B after LNP, contact pair fails to close	12000 hrs (detected during refueling outages)	Detected during the the performance of SP 628.1	1.8E-3

MILLSTONE 1
SYSTEM TBSCCW
SHEET #7

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
9321530-109-1FC 9321530-108-1FC 9321530-106-1FC	Actuation circuitry for pump B after LNP, contact pair fails to close	12000 hrs (detected during refueling outages)	Detected during the performance of SP 628.1	1.8E-3
9321530-106-BFC 9321530-113-3FC 9331530-208-3FC 9331530-209-3FC	Actuation circuitry for pump B after LNP, contact pair fails to close	12000 hrs (detected during refueling outages)	Detected during the performance of of SP 628.1	1.8E-3
9321530-101-FRE 9321530-102-FRE	Under voltage relays fail to remain energized	Prompt	Alarmed in CR	2.4E-6
90662-15A-1RC 90662-15B-1RC 906CX-15B-3RC 9321530-101-5RC 9321530-340A-1RC 9321530-341A-1RC 9321530-102-5RC LCL27-6B-5RC 9321530-101-3RC 9321530-102-1RC 906CX-15A-3RC 92662-2RC 92627X-3RC LCL27-6A-5RC	Contact pair fails to remain closed	12000 hrs (detected during refueling outages)	Detected during the performance of SP 628.1	6E-4
AC-14F-UVD-LOF	Failure of under-voltage detection circuit	Prompt		2.4E-6

MILLSTONE 1
SYSTEM TBSCCW
SHEET #8

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
9321530-105-FTE 9321530-113-FTE 9321530-106-FTE 9321530-108-FTE 9321530-322-FTE 9321530-208-FTE 906CX-15B-FTE 9321530-109-FTE 906CX-15A-FTE 92683-FTE 92627X-FTE 9331530-209-FTE	Relay coil fails to energize	Prompt		1E-4
22051501-90A-XFC 22061501-90B-XFC 22051501-90C-XFC 22061501-90D-XFC	HI drywell pressure switch fails to energize or contacts do not close	One month	Tested as per SP 412D, monthly	1.4E-4
9321530-340A-FRE 9321530-341A-FRE	Normally energized test switch fails to remain energized	12000 hrs (detected during refueling outages)	Detected during the performance of SP 628.1	6E-5
AC-DG62-2-FTE	Timing Circuit coil fails to energize	Prompt		4.6E-4
92662-FRE 90662-15B-FRE LCL27-6A-FRE LCL27-6B-FRE 90662-15A-FRE	Coil fails to remain energized	12000 hrs (detected during refueling outages)	detected during the performance of SP 628.1	6E-4

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
22051501-90A-TOM 22051501-90C-TOM 22061501-90B-TOM 22061501-90D-TOM	Sensor left un-available due to test/maintenance error	One momth	Tested as per SP 412D	1E-2
9321530-340A-TOM 9321530-341A-TOM	Test switch in test position	One month	Assumed unavailable due to test for 1 hr/month	1.4E-3
SC-2A-CKV-FTO SC-2B-CKV-FTO	Check valve fails to permit flow due to mechanical failure	Prompt	Check valves are in the flow path for for heat exchangers M4-14A or B	1E-4
SC-2A-CKV-TMC SC-2B-CKV-TMC	Check valve out of service for test/ maint.	Prompt	These check valves are in the flow path for heat exchangers M4-14A or B	3.0E-6
SC-4A-XV-TMC SC-4B-XV-TMC SC-5A-XV-TMC SC-5B-XV-TMC	Manual valve out of service for test/maint or left closed due to test/ maint.	Prompt	Supply to station/ instrument air compressors	0.0
SC-38A-XV-FRO SC-38B-XV-FRO SC-39A-XV-FRO SC-39B-XV-FRO	N.O. manual valve fails to remain open	Prompt	Condensate booster pump bearing cooling flow affected	6.7E-6

MILLSTONE 1
SYSTEM TBSCCW
SHEET #10

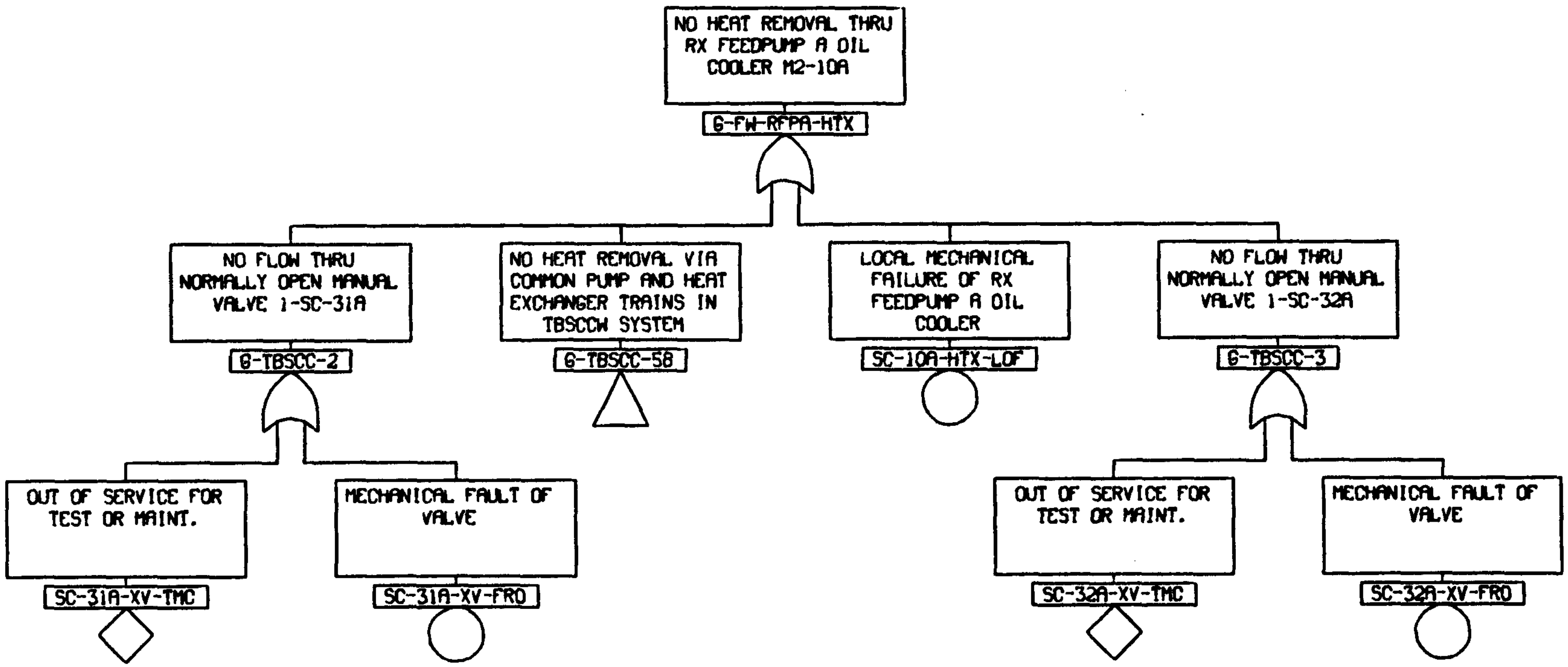
FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SC-38A-XV-TMC SC-38B-XV-TMC SC-39A-XV-TMC SC-39B-XV-TMC	N.O. manual valve fails to remain open due to test or maintenance	Prompt	Condensate booster pump bearing cooling flow affected	0

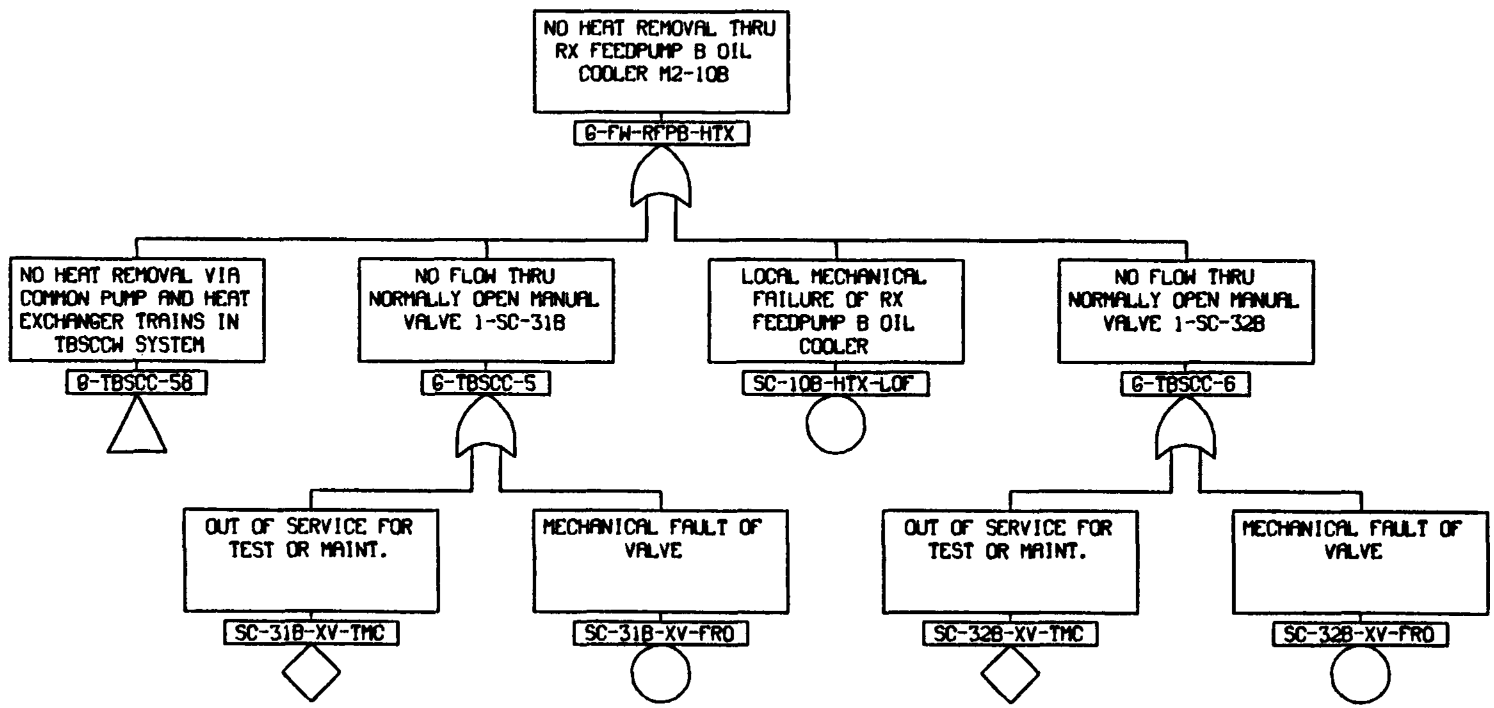
TBSCC FAULT TREE PAGE INDEX

GATE NAME	DEFINED ON PAGE	TRANSFERS TO PAGE(S)
G-FW-RFPA-HTX	TBSCC-1	--
G-FW-RFPB-HTX	TBSCC-2	--
G-FW-CPA-HTX	TBSCC-3	--
G-TBSCC-8	TBSCC-4	TBSCC-3
G-TBSCC-9	TBSCC-4	TBSCC-3
G-TBSCC-10	TBSCC-5	TBSCC-3
G-TBSCC-11	TBSCC-5	TBSCC-3
G-FW-CPB-HTX	TBSCC-6	--
G-TBSCC-13	TBSCC-7	TBSCC-6
G-TBSCC-14	TBSCC-7	TBSCC-6
G-TBSCC-15	TBSCC-8	TBSCC-6
G-TBSCC-16	TBSCC-8	TBSCC-6
G-TBSCC-17	TBSCC-9	TBSCC-11
G-TBSCC-20	TBSCC-10	TBSCC-14
G-FW-CBPA-HTX	TBSCC-11	--
G-TBSCC-24	TBSCC-12	TBSCC-11
G-TBSCC-25	TBSCC-12	TBSCC-11
G-TBSCC-25A	TBSCC-13	TBSCC-11
G-TBSCC-26	TBSCC-13	TBSCC-11
G-FW-CBPB-HTX	TBSCC-14	--
G-TBSCC-28	TBSCC-15	TBSCC-14
G-TBSCC-29	TBSCC-15	TBSCC-14
G-TBSCC-30	TBSCC-16	TBSCC-14
G-TBSCC-31	TBSCC-16	TBSCC-14
G-SIA-M51-CPR	TBSCC-17	--
G-TBSCC-33	TBSCC-18	TBSCC-17
G-TBSCC-34	TBSCC-18	TBSCC-17
G-TBSCC-35	TBSCC-19	TBSCC-17
G-TBSCC-36	TBSCC-19	TBSCC-17
G-TBSCC-37	TBSCC-20	TBSCC-17
G-TBSCC-38	TBSCC-20	TBSCC-17
G-TBSCC-39	TBSCC-21	TBSCC-17
G-SIA-M54-CPR	TBSCC-22	--
G-TBSCC-41	TBSCC-23	TBSCC-22
G-TBSCC-42	TBSCC-23	TBSCC-22
G-TBSCC-43	TBSCC-24	TBSCC-22
G-TBSCC-44	TBSCC-24	TBSCC-22
G-TBSCC-45	TBSCC-25	TBSCC-22
G-TBSCC-46	TBSCC-25	TBSCC-22
G-TBSCC-47	TBSCC-26	TBSCC-22
G-TBSCC-58	TBSCC-27	TBSCC-1,2,3,6,9,10,11,14, 17,22
G-TBSCC-60	TBSCC-28	TBSCC-27
G-TBSCC-63	TBSCC-29	TBSCC-27
G-TBSCC-67	TBSCC-30	TBSCC-27
G-TBSCC-71	TBSCC-31	TBSCC-28
G-TBSCC-75	TBSCC-32	TBSCC-28
G-TBSCC-79	TBSCC-33	TBSCC-28
G-TBSCC-82	TBSCC-34	TBSCC-28

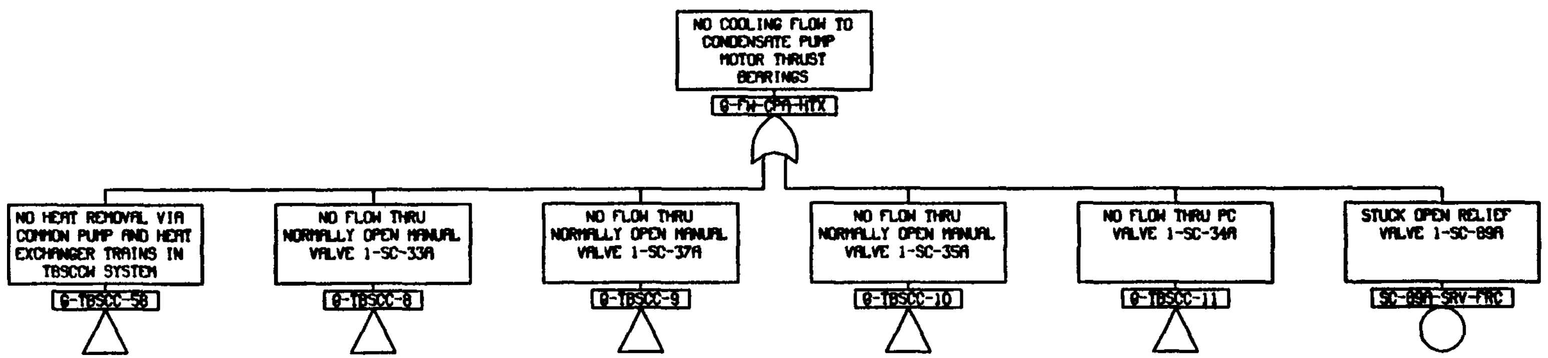
TBSCC FAULT TREE PAGE INDEX (Cont.)


NO HEAT REMOVAL THRU RX FEEDPUMP A OIL COOLER M2-10A
G-FW-RFPA-HTX
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-31A
G-TBSCC-2
NO HEAT REMOVAL VIA COMMON PUMP AND HEAT EXCHANGER TRAINS IN TBSCCW SYSTEM
G-TBSCC-5B
LOCAL MECHANICAL FAILURE OF RX FEEDPUMP A OIL COOLER
SC-10A-HTX-LOF
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-32A
G-TBSCC-3
OUT OF SERVICE FOR TEST OR MAINT.
SC-31A-XV-TMC
MECHANICAL FAULT OF VALVE
SC-31A-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-32A-XV-TMC
MECHANICAL FAULT OF VALVE
SC-32A-XV-FRO

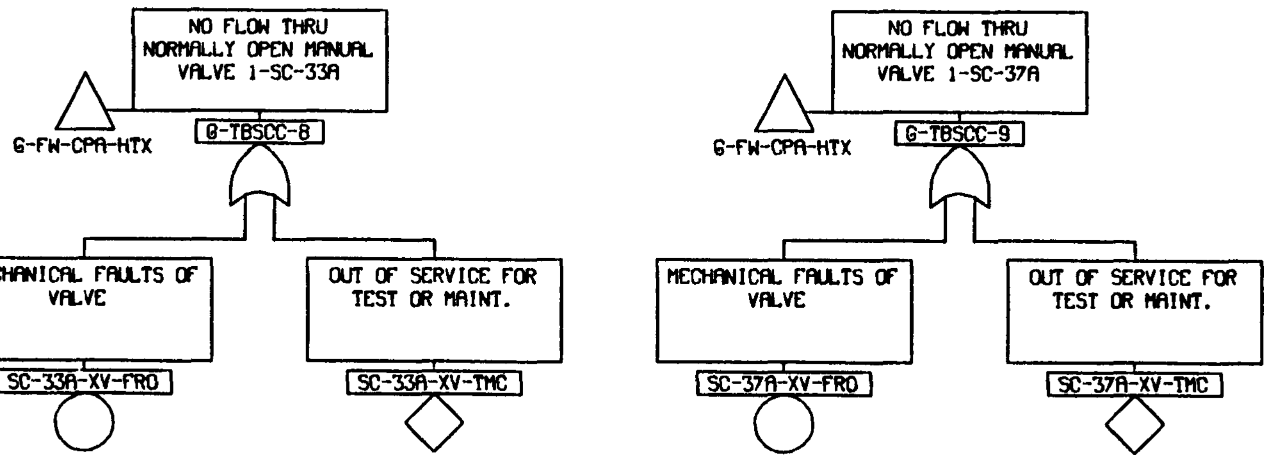
TBSCC-1



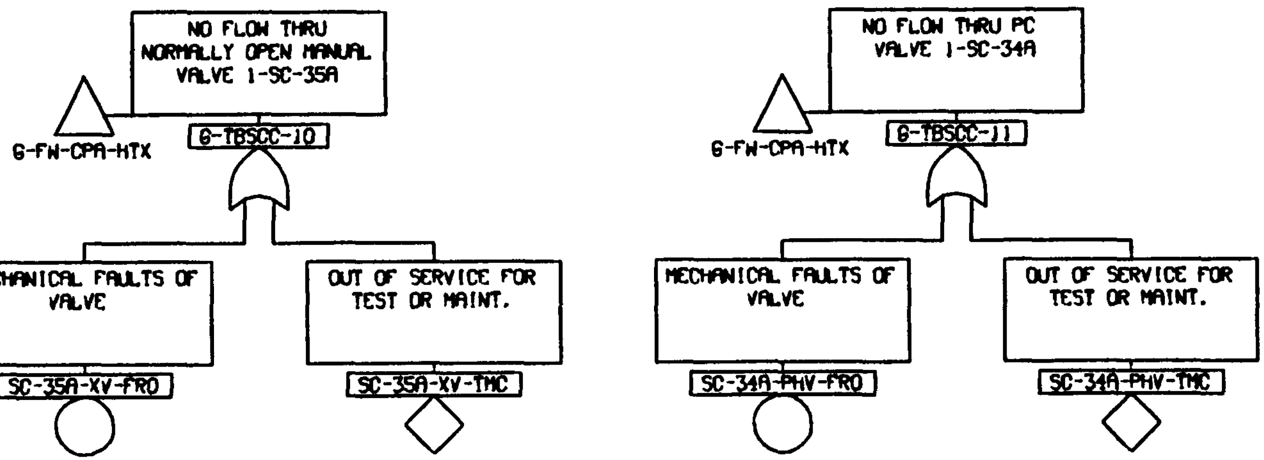
NO HEAT REMOVAL THRU RX FEEDPUMP B OIL COOLER M2-10B
G-FW-RFPB-HTX
NO HEAT REMOVAL VIA COMMON PUMP AND HEAT EXCHANGER TRAINS IN TBSCCW SYSTEM
G-TBSCC-58
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-31B
G-TBSCC-5
LOCAL MECHANICAL FAILURE OF RX FEEDPUMP B OIL COOLER
SC-10B-HTX-LOF
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-32B
G-TBSCC-6
OUT OF SERVICE FOR TEST OR MAINT.
SC-31B-XV-TMC
MECHANICAL FAULT OF VALVE
SC-31B-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-32B-XV-TMC
MECHANICAL FAULT OF VALVE
SC-32B-XV-FRO

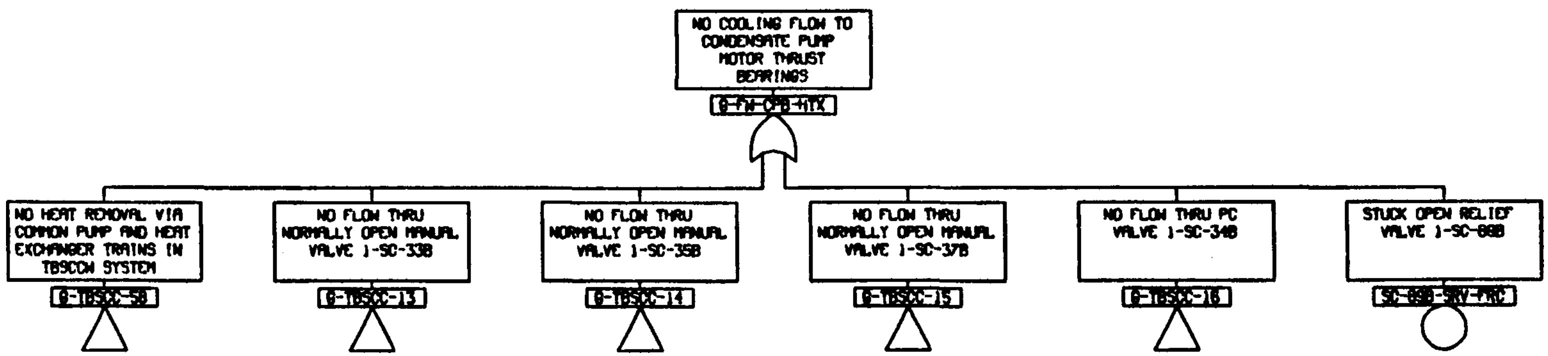


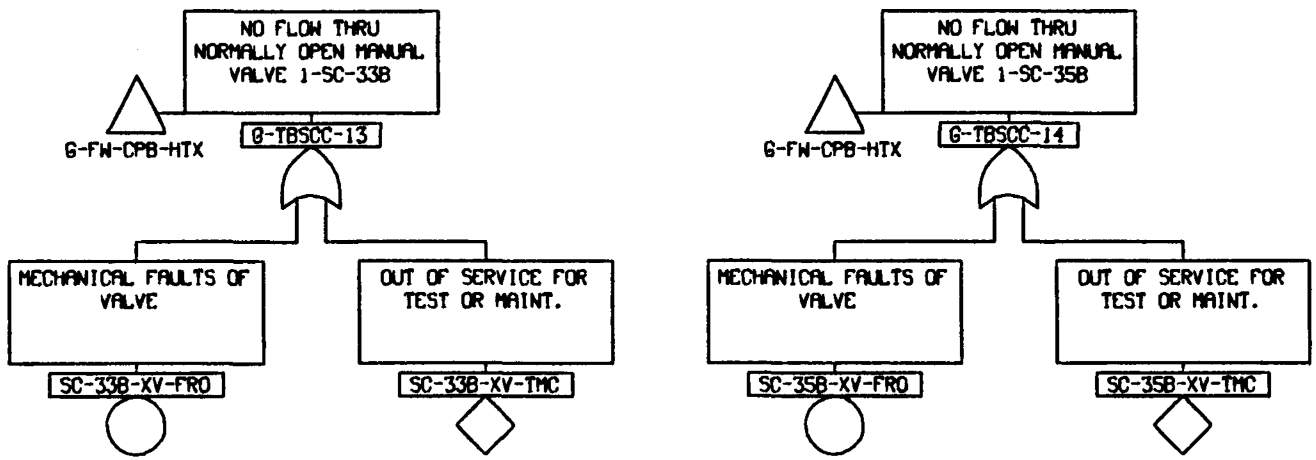
NO COOLING FLOW TO CONDENSATE PUMP MOTOR THRUST BEARINGS
G-FW-CPA-HTX
NO HEAT REMOVAL VIA COMMON PUMP AND HEAT EXCHANGER TRAINS IN TBSCCW SYSTEM
G-TBSCC-58
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-33A
G-TBSCC-8
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-37A
G-TBSCC-9
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-35A
G-TBSCC-10
NO FLOW THRU PC VALVE 1-SC-34A
G-TBSCC-11
STUCK OPEN RELIEF VALVE 1-SC-89A
SC-89A-SRV-FRC


NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-33A
G-FW-CPA-HTX
G-TBSCC-8
MECHANICAL FAULTS OF VALVE
SC-33A-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-33A-XV-TMC
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-37A
G-FW-CPA-HTX
G-TBSCC-9
MECHANICAL FAULTS OF VALVE
SC-37A-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-37A-XV-TMC

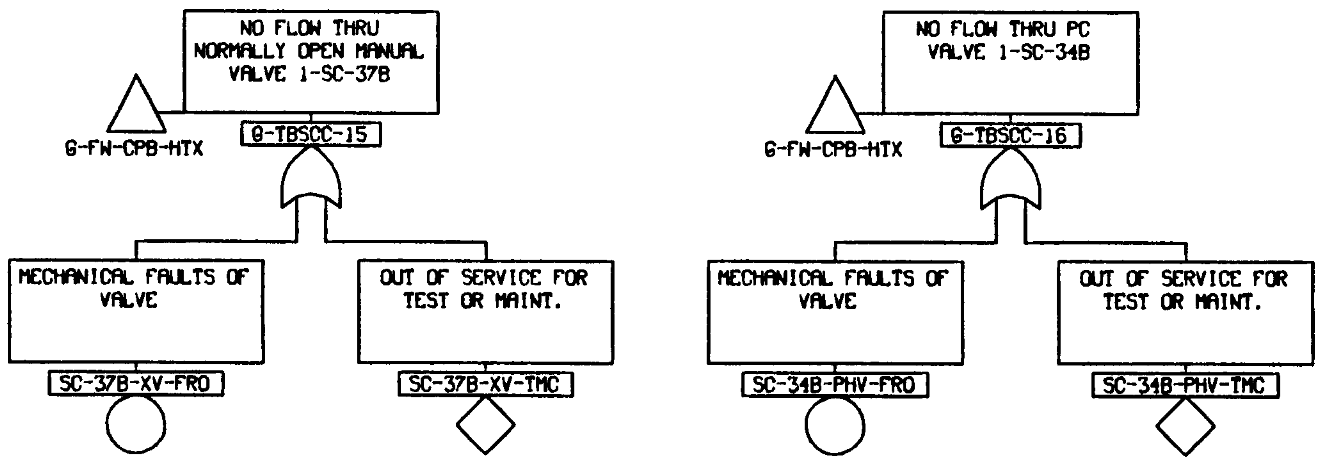
TBSCC-4


NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-35A
G-FW-CPA-HTX
G-TBSCC-10
MECHANICAL FAULTS OF VALVE
SC-35A-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-35A-XV-TMC
NO FLOW THRU PC VALVE 1-SC-34A
G-FW-CPA-HTX
G-TBSCC-11
MECHANICAL FAULTS OF VALVE
SC-34A-PHV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-34A-PHV-TMC

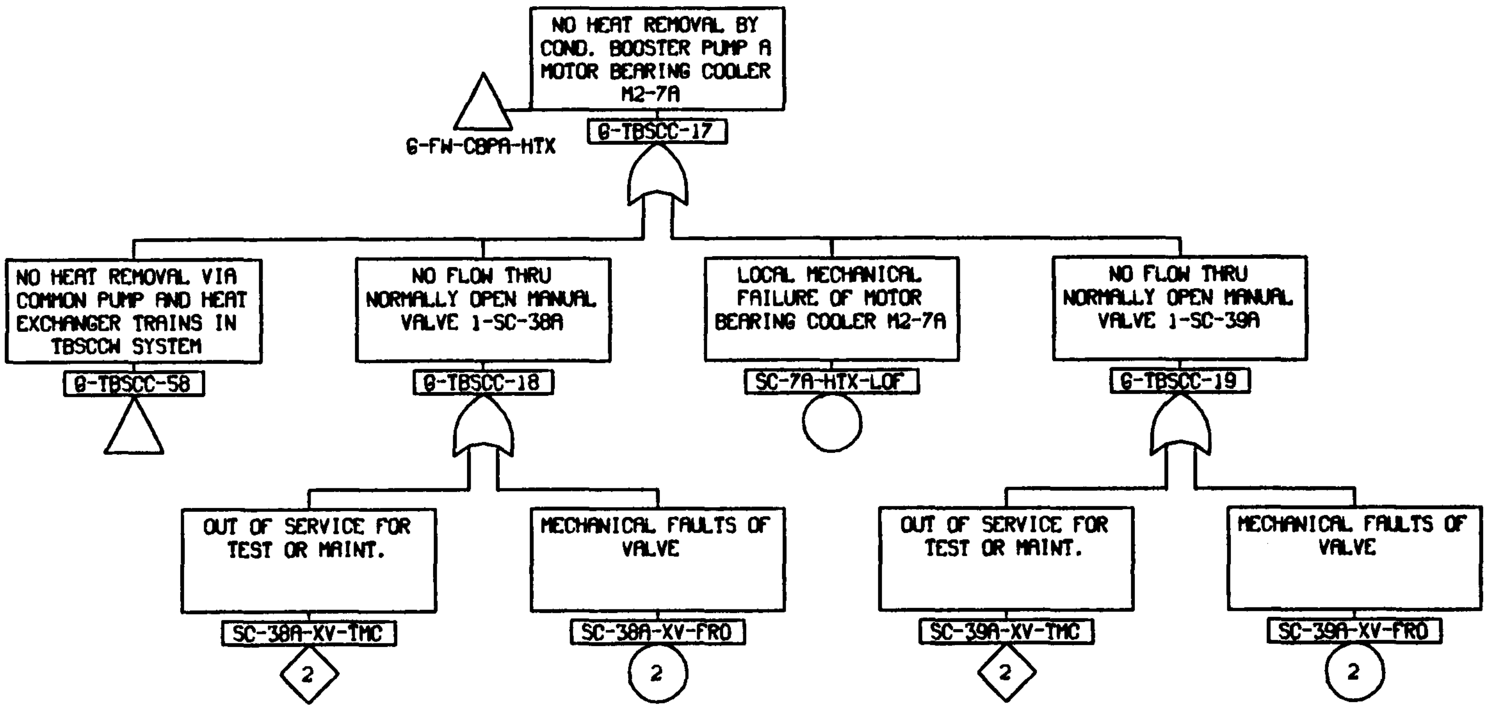

NO COOLING FLOW TO CONDENSATE PUMP MOTOR THRUST BEARINGS
G-FW-CPB-HTX
NO HEAT REMOVAL VIA COMMON PUMP AND HEAT EXCHANGER TRAINS IN TBSCCW SYSTEM
G-TBSCC-58
NO FLOW THRU NORMALLY OPEN MANUAL VALVE
G-TBSCC-13
NO FLOW THRU NORMALLY OPEN MANUAL VALVE
G-TBSCC-14
NO FLOW THRU NORMALLY OPEN MANUAL VALVE
G-TBSCC-15
NO FLOW THRU PC VALVE
G-TBSCC-16
STUCK OPEN RELIEF

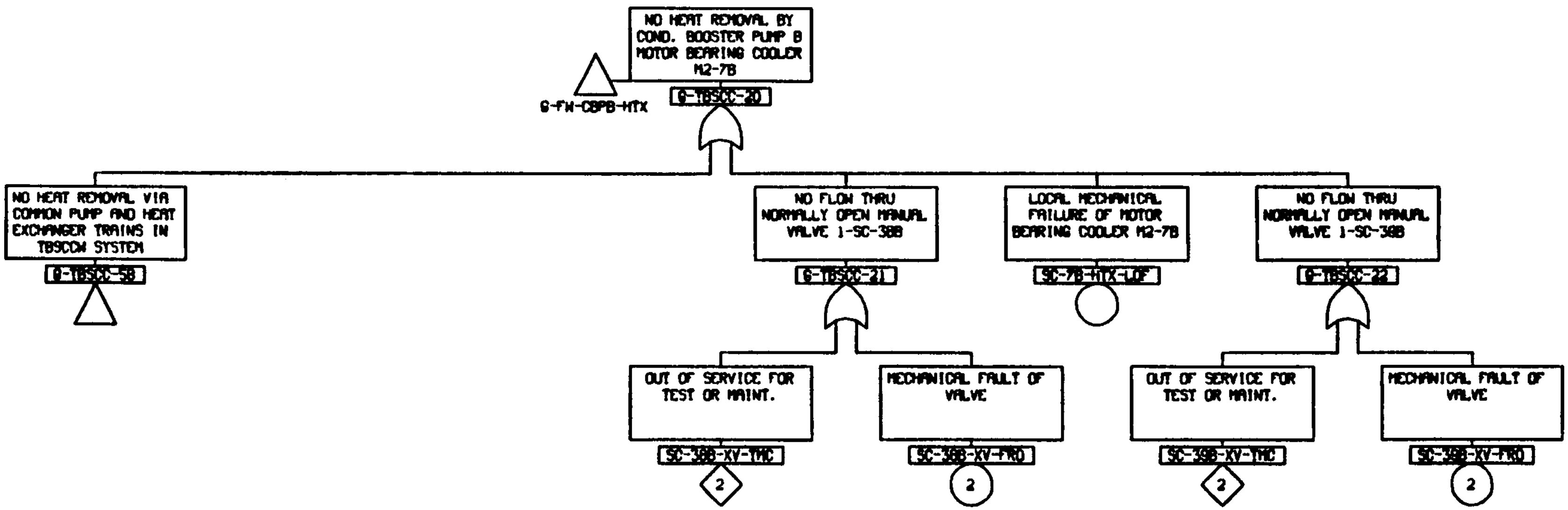

NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-33B
G-TBSCC-13
G-FW-CPB-HTX
MECHANICAL FAULTS OF VALVE
SC-33B-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-33B-XV-TMC
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-35B
G-TBSCC-14
G-FW-CPB-HTX
MECHANICAL FAULTS OF VALVE
SC-35B-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-35B-XV-TMC

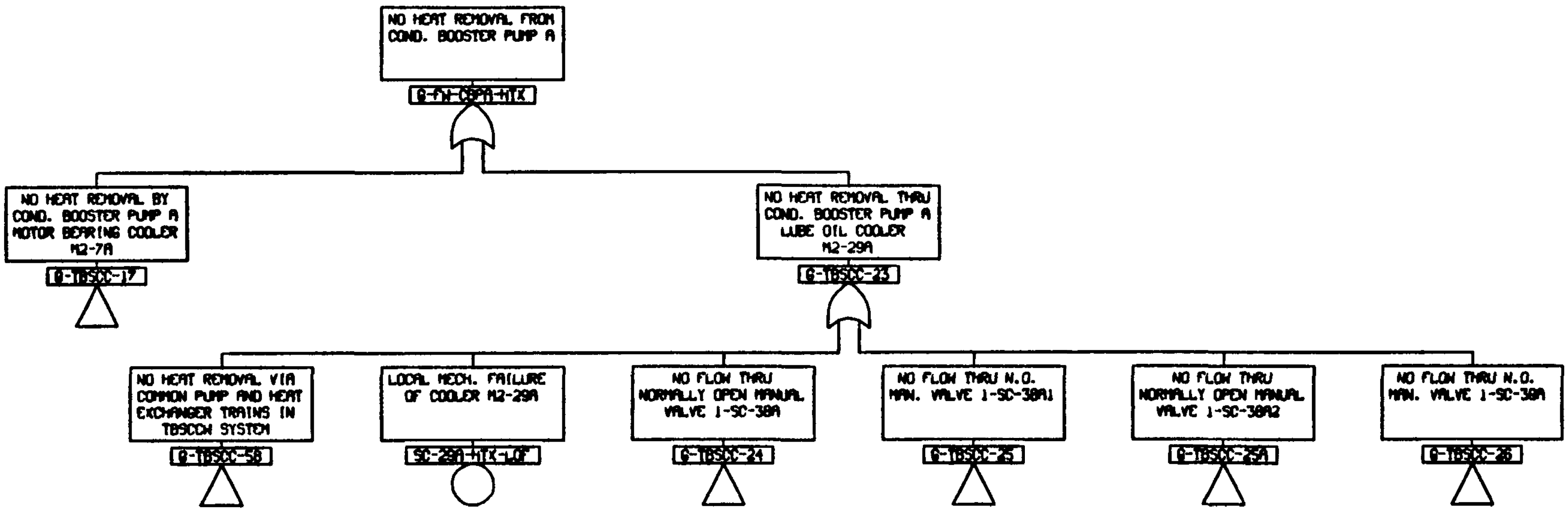
TBSCC-7

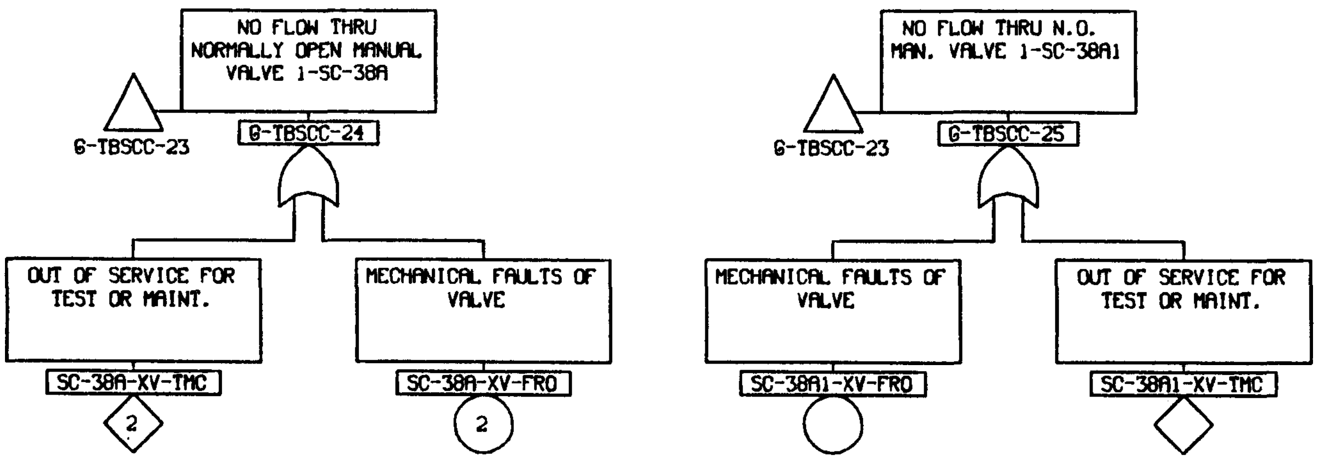

NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-37B
G-FW-CPB-HTX
G-TBSCC-15
MECHANICAL FAULTS OF VALVE
SC-37B-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-37B-XV-TMC
NO FLOW THRU PC VALVE 1-SC-34B
G-FW-CPB-HTX
G-TBSCC-16
MECHANICAL FAULTS OF VALVE
SC-34B-PHV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-34B-PHV-TMC

TBSCC-8

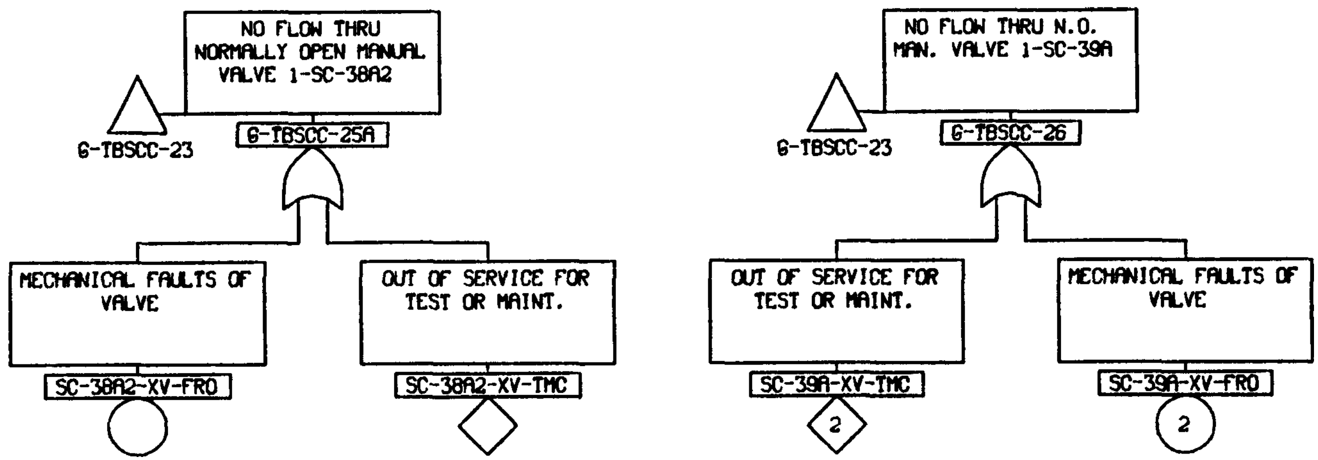

NO HEAT REMOVAL BY COND. BOOSTER PUMP A MOTOR BEARING COOLER M2-7A
G-TBSCC-17
G-FW-CBPA-HTX
NO HEAT REMOVAL VIA COMMON PUMP AND HEAT EXCHANGER TRAINS IN TBSCCW SYSTEM
G-TBSCC-58
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-38A
G-TBSCC-18
LOCAL MECHANICAL FAILURE OF MOTOR BEARING COOLER M2-7A
SC-7A-HTX-LOF
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-39A
G-TBSCC-19
OUT OF SERVICE FOR TEST OR MAINT.
SC-38A-XV-TMC
2
MECHANICAL FAULTS OF VALVE
SC-38A-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
SC-39A-XV-TMC
2
MECHANICAL FAULTS OF VALVE
SC-39A-XV-FRO
2

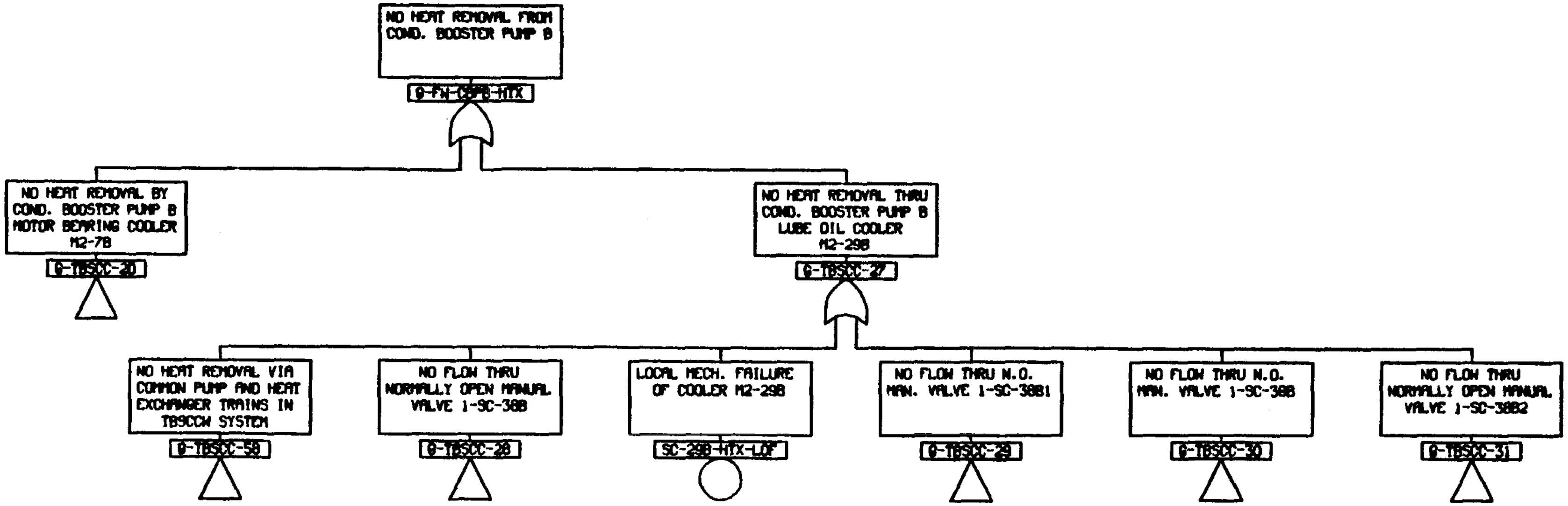

NO HEAT REMOVAL BY COND. BOOSTER PUMP B MOTOR BEARING COOLER M2-7B
G-TBSCC-20
G-FW-CBPB-HTX
NO HEAT REMOVAL VIA COMMON PUMP AND HEAT EXCHANGER TRAINS IN TBSCCW SYSTEM
G-TBSCC-58
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-38B
G-TBSCC-21
LOCAL MECHANICAL FAILURE OF MOTOR BEARING COOLER M2-7B
SC-7B-HTX-LOF
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-38B
G-TBSCC-22
OUT OF SERVICE FOR TEST OR MAINT.
SC-38B-XV-TMC
2
MECHANICAL FAULT OF VALVE
SC-38B-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
SC-39B-XV-TMC
2
MECHANICAL FAULT OF VALVE
SC-39B-XV-FRO
2


NO HEAT REMOVAL FROM COND. BOOSTER PUMP A
G-FW-CBPA-HTX
NO HEAT REMOVAL BY COND. BOOSTER PUMP A MOTOR BEARING COOLER M2-7A
G-TBSCC-17
NO HEAT REMOVAL THRU COND. BOOSTER PUMP A LUBE OIL COOLER M2-29A
G-TBSCC-23
NO HEAT REMOVAL VIA COMMON PUMP AND HEAT EXCHANGER TRAINS IN TBSCCW SYSTEM
G-TBSCC-58
LOCAL MECH. FAILURE OF COOLER M2-29A
SC-29A-HTX-LOF
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-38A
G-TBSCC-24
NO FLOW THRU N.O. MAN. VALVE 1-SC-38A1
G-TBSCC-25
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-38A2
G-TBSCC-25A
NO FLOW THRU N.O. MAN. VALVE 1-SC-38A
G-TBSCC-26

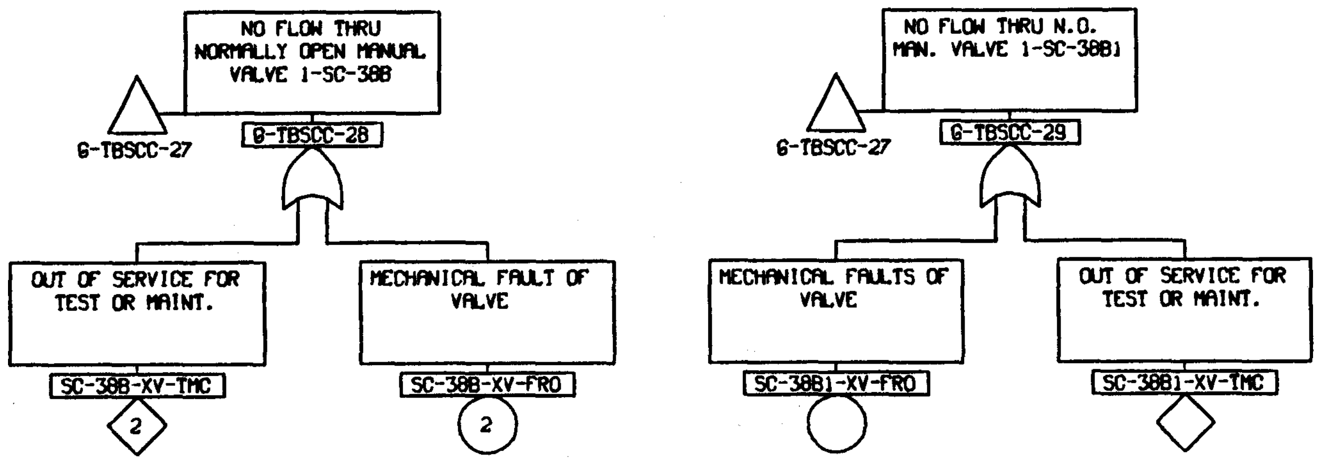

NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-38A
G-TBSCC-23
G-TBSCC-24
OUT OF SERVICE FOR TEST OR MAINT.
SC-38A-XV-TMC
2
MECHANICAL FAULTS OF VALVE
SC-38A-XV-FRO
2
NO FLOW THRU N.O. MAN. VALVE 1-SC-38A1
G-TBSCC-23
G-TBSCC-25
MECHANICAL FAULTS OF VALVE
SC-38A1-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-38A1-XV-TMC

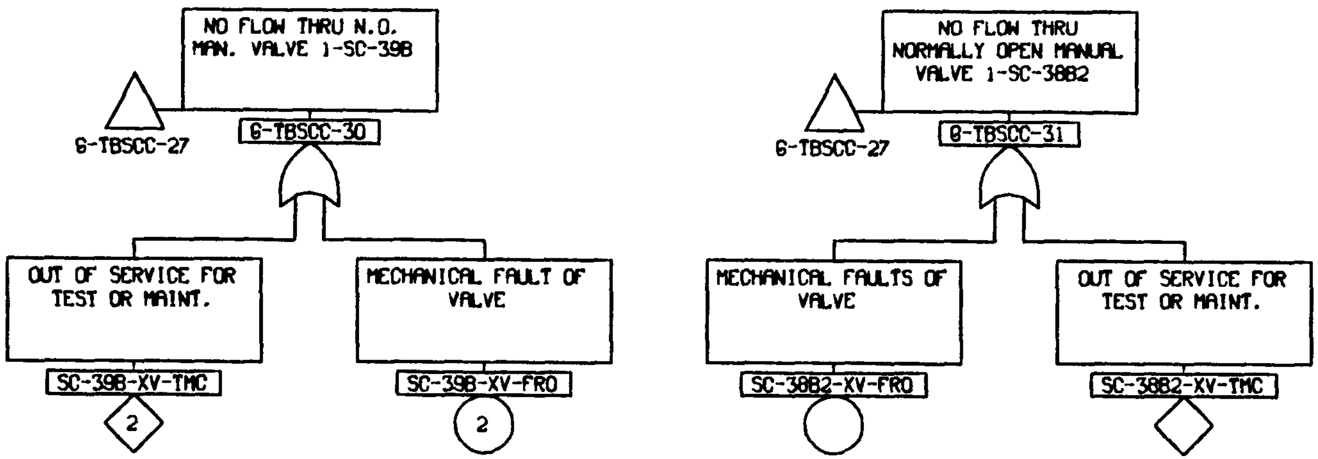
TBSCC-12

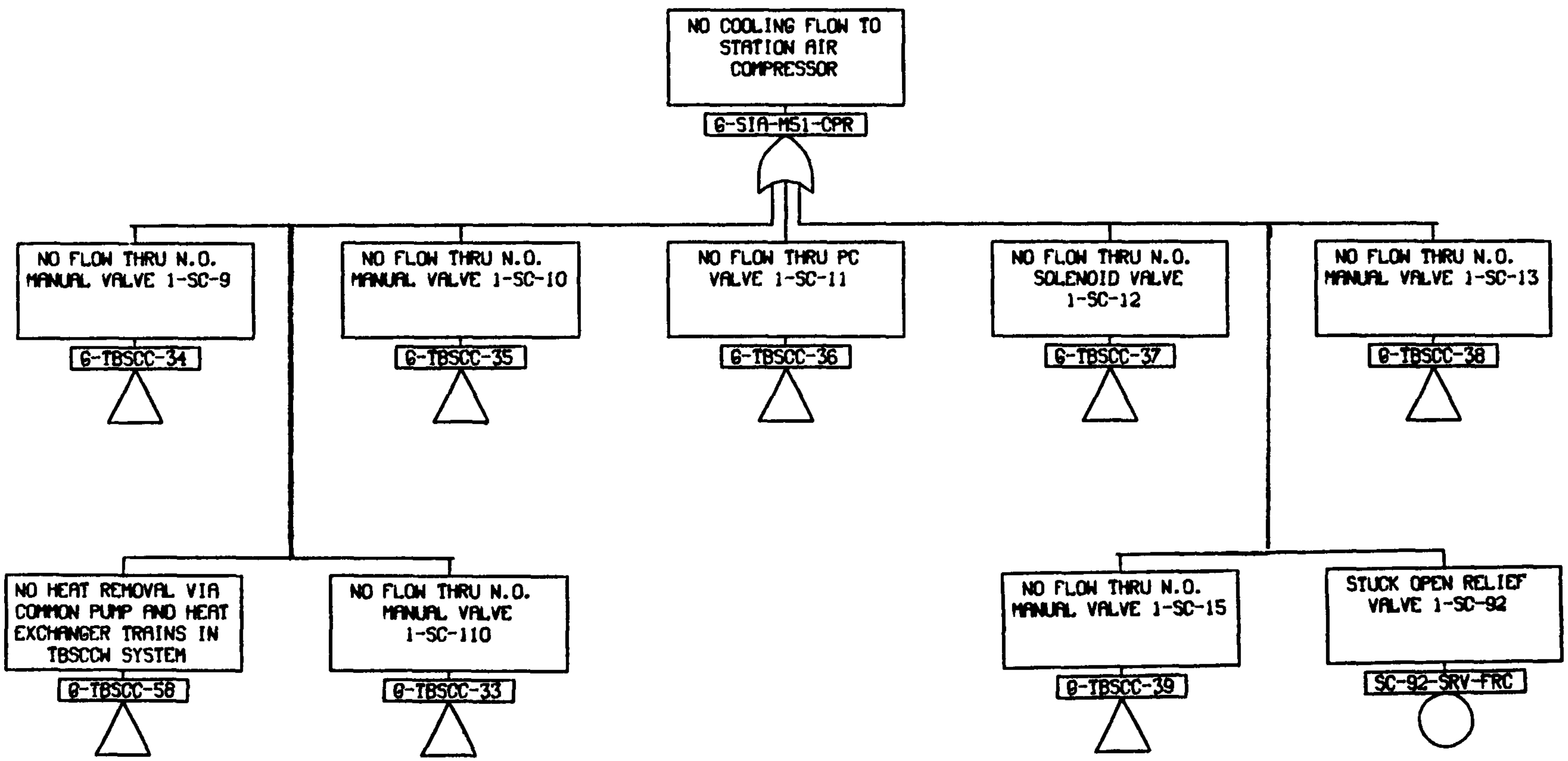

NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-38A2
G-TBSCC-23
G-TBSCC-25A
MECHANICAL FAULTS OF VALVE
SC-38A2-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-38A2-XV-TMC
NO FLOW THRU N.O. MAN. VALVE 1-SC-39A
G-TBSCC-23
G-TBSCC-26
OUT OF SERVICE FOR TEST OR MAINT.
SC-39A-XV-TMC
2
MECHANICAL FAULTS OF VALVE
SC-39A-XV-FRO
2


NO HEAT REMOVAL FROM COND. BOOSTER PUMP B
G-FW-CBPB-HTX
NO HEAT REMOVAL BY COND. BOOSTER PUMP B MOTOR BEARING COOLER M2-7B
G-TBSCC-20
NO HEAT REMOVAL THRU COND. BOOSTER PUMP B LUBE OIL COOLER M2-29B
G-TBSCC-27
NO HEAT REMOVAL VIA COMMON PUMP AND HEAT EXCHANGER TRAINS IN TBSCCW SYSTEM
G-TBSCC-58
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-38B
G-TBSCC-28
LOCAL MECH. FAILURE OF COOLER M2-29B
SC-29B-HTX-LOF
NO FLOW THRU N.O. MAN. VALVE 1-SC-38B1
G-TBSCC-29
NO FLOW THRU N.O. MAN. VALVE 1-SC-38B
G-TBSCC-30
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-38B2
G-TBSCC-31

TBSCC-14

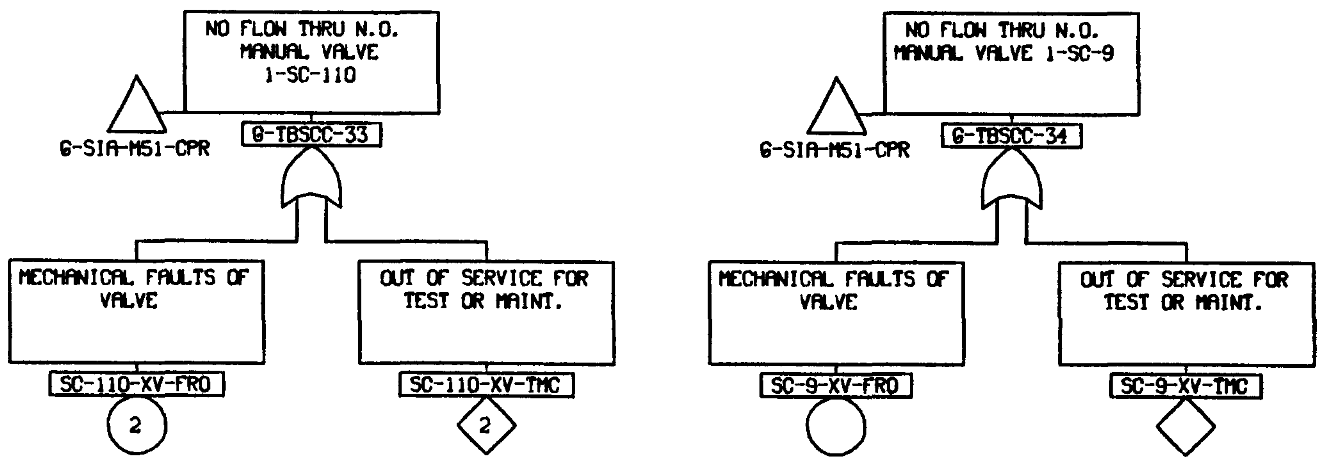

NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-38B
G-TBSCC-27
G-TBSCC-28
OUT OF SERVICE FOR TEST OR MAINT.
SC-38B-XV-TMC
2
MECHANICAL FAULT OF VALVE
SC-38B-XV-FRO
2
NO FLOW THRU N.O. MAN. VALVE 1-SC-38B1
G-TBSCC-27
G-TBSCC-29
MECHANICAL FAULTS OF VALVE
SC-38B1-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-38B1-XV-TMC

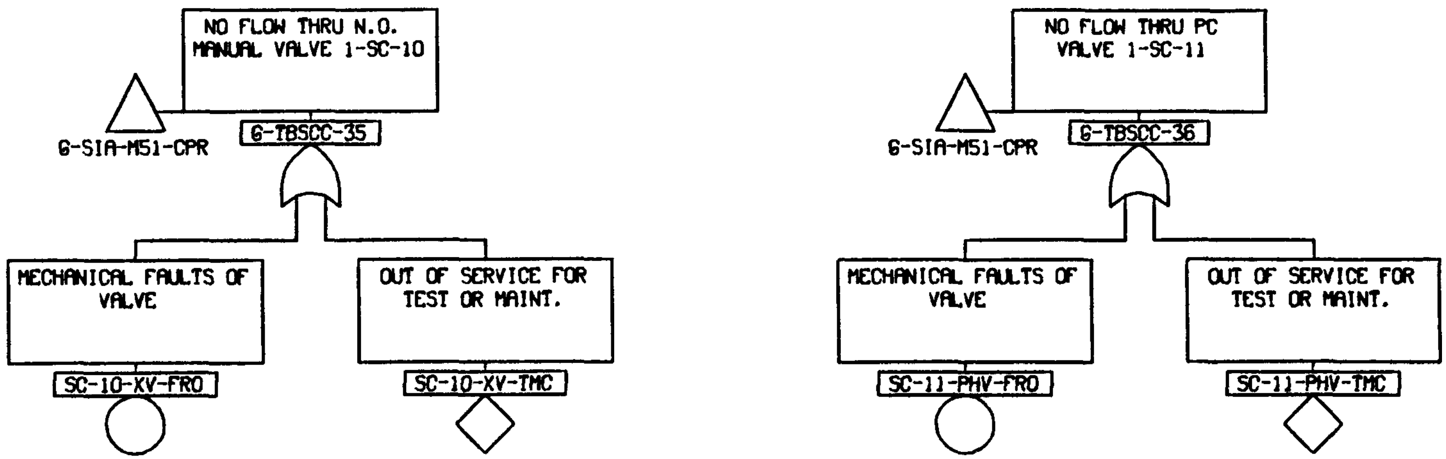

NO FLOW THRU N.O. MAN. VALVE 1-SC-39B
G-TBSCC-30
G-TBSCC-27
OUT OF SERVICE FOR TEST OR MAINT.
SC-39B-XV-TMC
2
MECHANICAL FAULT OF VALVE
SC-39B-XV-FRO
2
NO FLOW THRU NORMALLY OPEN MANUAL VALVE 1-SC-38B2
G-TBSCC-31
G-TBSCC-27
MECHANICAL FAULTS OF VALVE
SC-38B2-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-38B2-XV-TMC

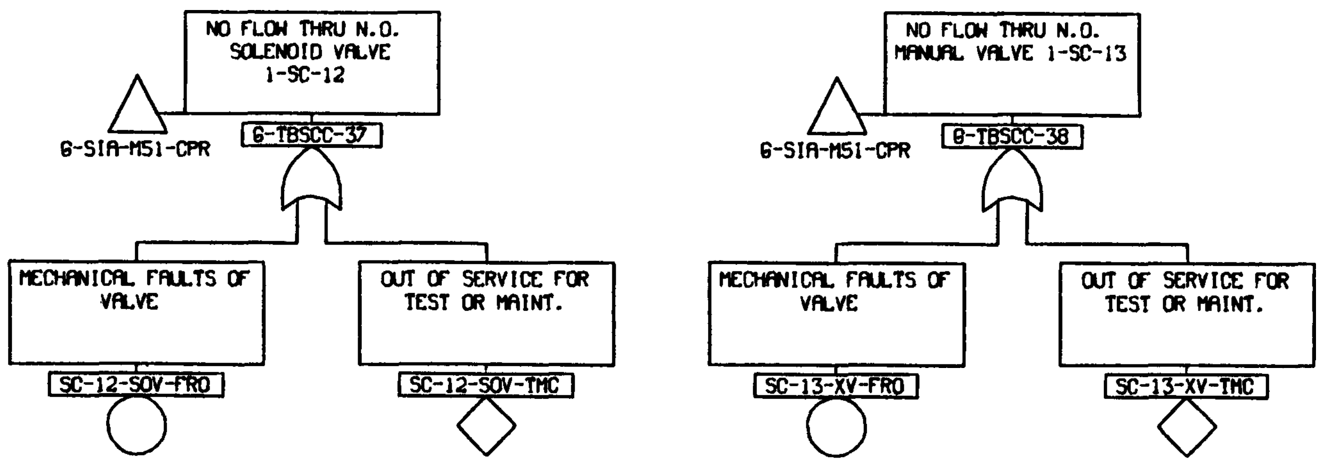


NO COOLING FLOW TO STATION AIR COMPRESSOR
G-SIA-MS1-CPR
NO FLOW THRU N.O. MANUAL VALVE 1-SC-9
G-TBSCC-34
NO FLOW THRU N.O. MANUAL VALVE 1-SC-10
G-TBSCC-35
NO FLOW THRU PC VALVE 1-SC-11
G-TBSCC-36
NO FLOW THRU N.O. SOLENOID VALVE 1-SC-12
G-TBSCC-37
NO FLOW THRU N.O. MANUAL VALVE 1-SC-13
G-TBSCC-38
NO HEAT REMOVAL VIA COMMON PUMP AND HEAT EXCHANGER TRAINS IN TBSCCW SYSTEM
G-TBSCC-58
NO FLOW THRU N.O. MANUAL VALVE 1-SC-110
G-TBSCC-33
NO FLOW THRU N.O. MANUAL VALVE 1-SC-15
G-TBSCC-39
STUCK OPEN RELIEF VALVE 1-SC-92
SC-92-SRV-FRC

TBSCC-17

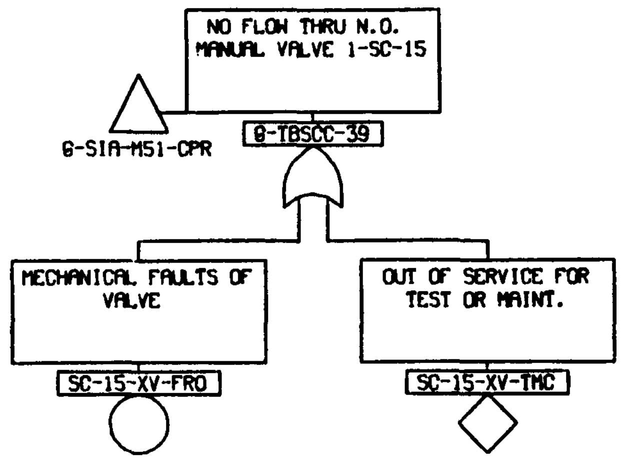

NO FLOW THRU N.O. MANUAL VALVE 1-SC-110
G-SIA-M51-CPR
G-TBSCC-33
MECHANICAL FAULTS OF VALVE
SC-110-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
SC-110-XV-TMC
2
NO FLOW THRU N.O. MANUAL VALVE 1-SC-9
G-SIA-M51-CPR
G-TBSCC-34
MECHANICAL FAULTS OF VALVE
SC-9-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-9-XV-TMC


NO FLOW THRU N.O. MANUAL VALVE 1-SC-10
G-SIA-M51-CPR
G-TBSCC-35
MECHANICAL FAULTS OF VALVE
SC-10-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-10-XV-TMC
NO FLOW THRU PC VALVE 1-SC-11
G-SIA-M51-CPR
G-TBSCC-36
MECHANICAL FAULTS OF VALVE
SC-11-PHV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-11-PHV-TMC

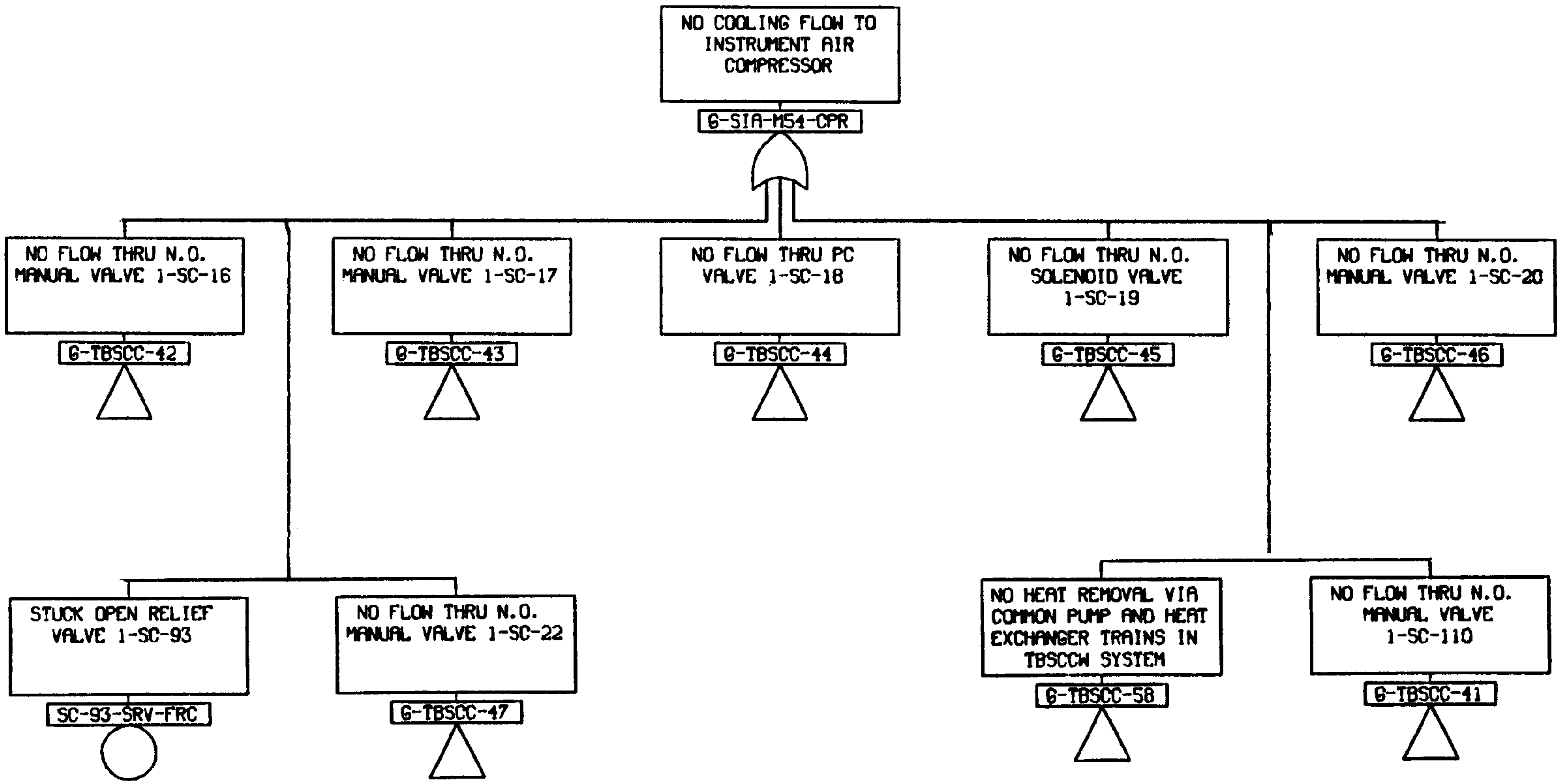


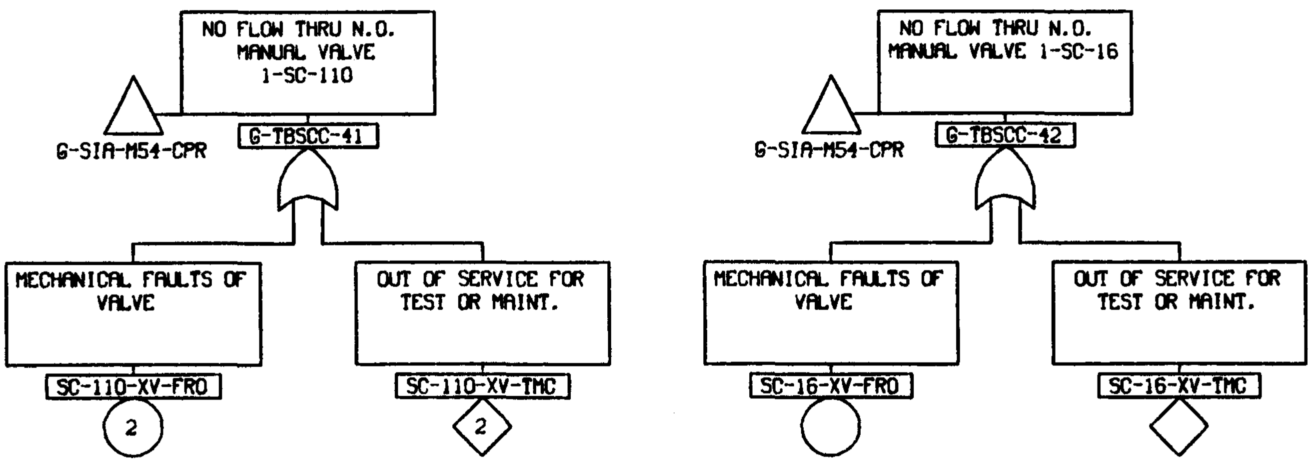
NO FLOW THRU N.O. SOLENOID VALVE 1-SC-12
G-TBSCC-37
G-SIA-M51-CPR
MECHANICAL FAULTS OF VALVE
SC-12-SOV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-12-SOV-TMC
NO FLOW THRU N.O. MANUAL VALVE 1-SC-13
G-TBSCC-38
G-SIA-M51-CPR
MECHANICAL FAULTS OF VALVE
SC-13-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-13-XV-TMC

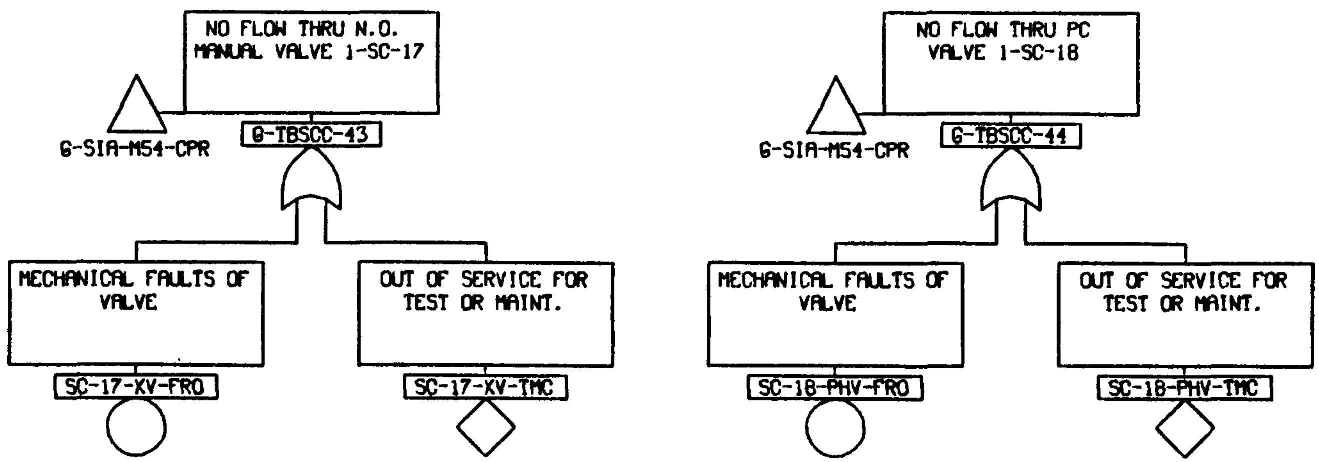
TBSCC-20


NO FLOW THRU N.O. MANUAL VALVE 1-SC-15
G-TBSCC-39
G-SIA-M51-CPR
MECHANICAL FAULTS OF VALVE
SC-15-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-15-XV-TMC

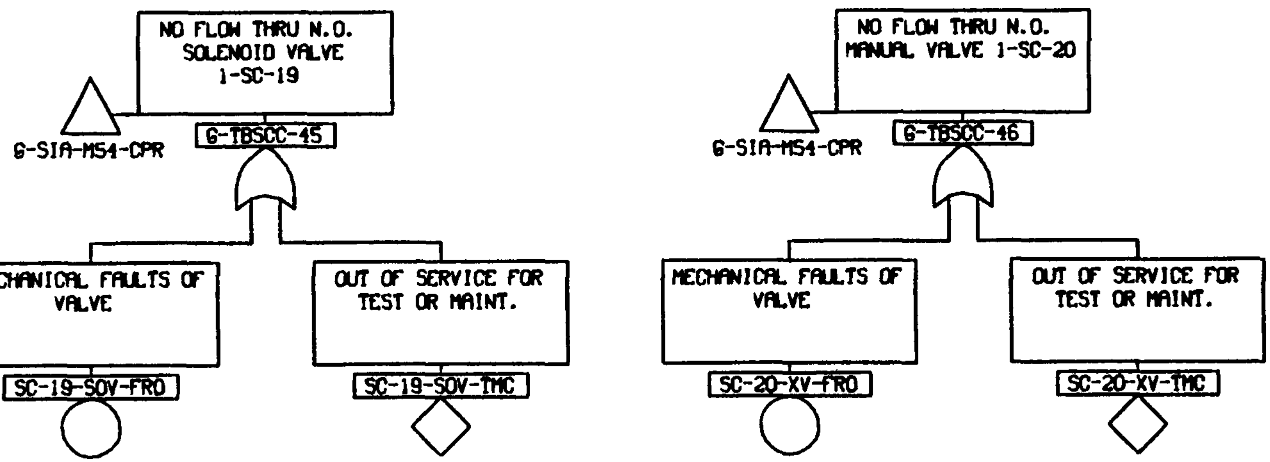
TBSCC-21

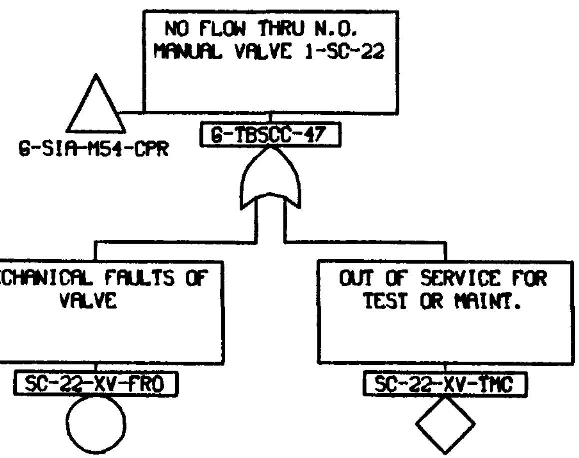

NO COOLING FLOW TO INSTRUMENT AIR COMPRESSOR
G-SIA-M54-CPR
NO FLOW THRU N.O. MANUAL VALVE 1-SC-16
G-TBSCC-42
NO FLOW THRU N.O. MANUAL VALVE 1-SC-17
G-TBSCC-43
NO FLOW THRU PC VALVE 1-SC-18
G-TBSCC-44
NO FLOW THRU N.O. SOLENOID VALVE 1-SC-19
G-TBSCC-45
NO FLOW THRU N.O. MANUAL VALVE 1-SC-20
G-TBSCC-46
STUCK OPEN RELIEF VALVE 1-SC-93
SC-93-SRV-FRC
NO FLOW THRU N.O. MANUAL VALVE 1-SC-22
G-TBSCC-47
NO HEAT REMOVAL VIA COMMON PUMP AND HEAT EXCHANGER TRAINS IN TBSCCW SYSTEM
G-TBSCC-58
NO FLOW THRU N.O. MANUAL VALVE 1-SC-110
G-TBSCC-41

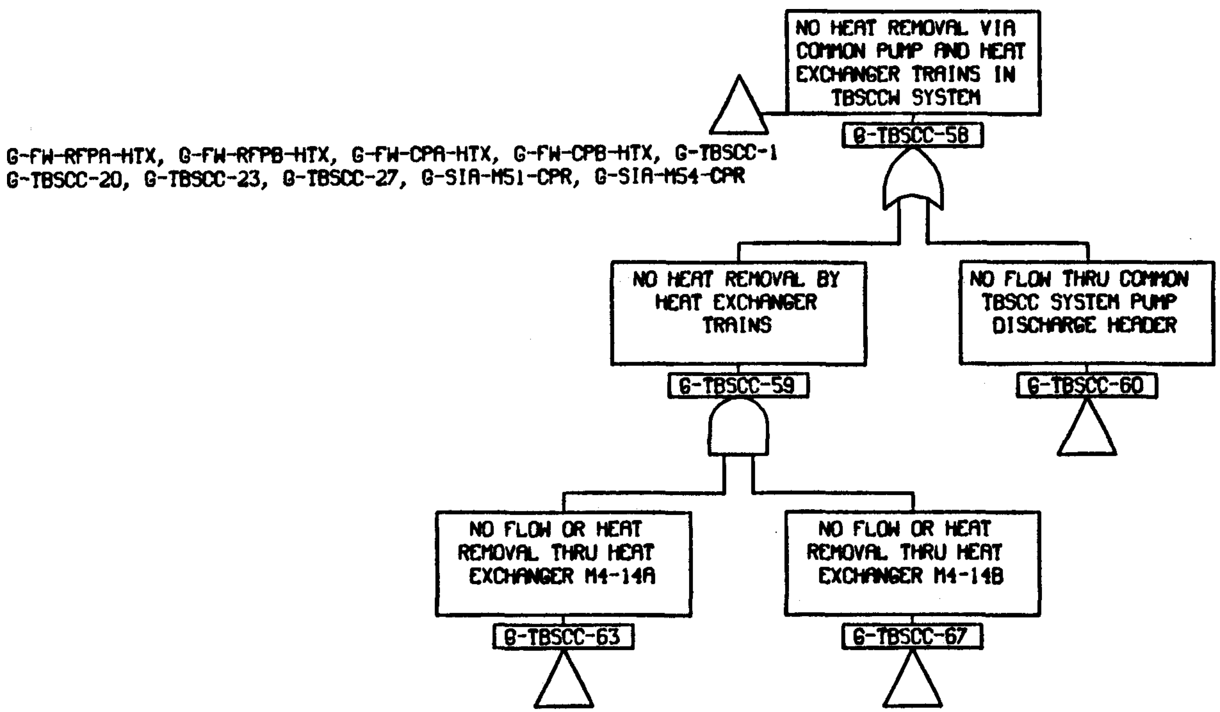

NO FLOW THRU N.O. MANUAL VALVE 1-SC-110
G-TBSCC-41
G-SIA-M54-CPR
MECHANICAL FAULTS OF VALVE
SC-110-XV-FRO
2
OUT OF SERVICE FOR TEST OR MAINT.
SC-110-XV-TMC
2
NO FLOW THRU N.O. MANUAL VALVE 1-SC-16
G-TBSCC-42
G-SIA-M54-CPR
MECHANICAL FAULTS OF VALVE
SC-16-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-16-XV-TMC

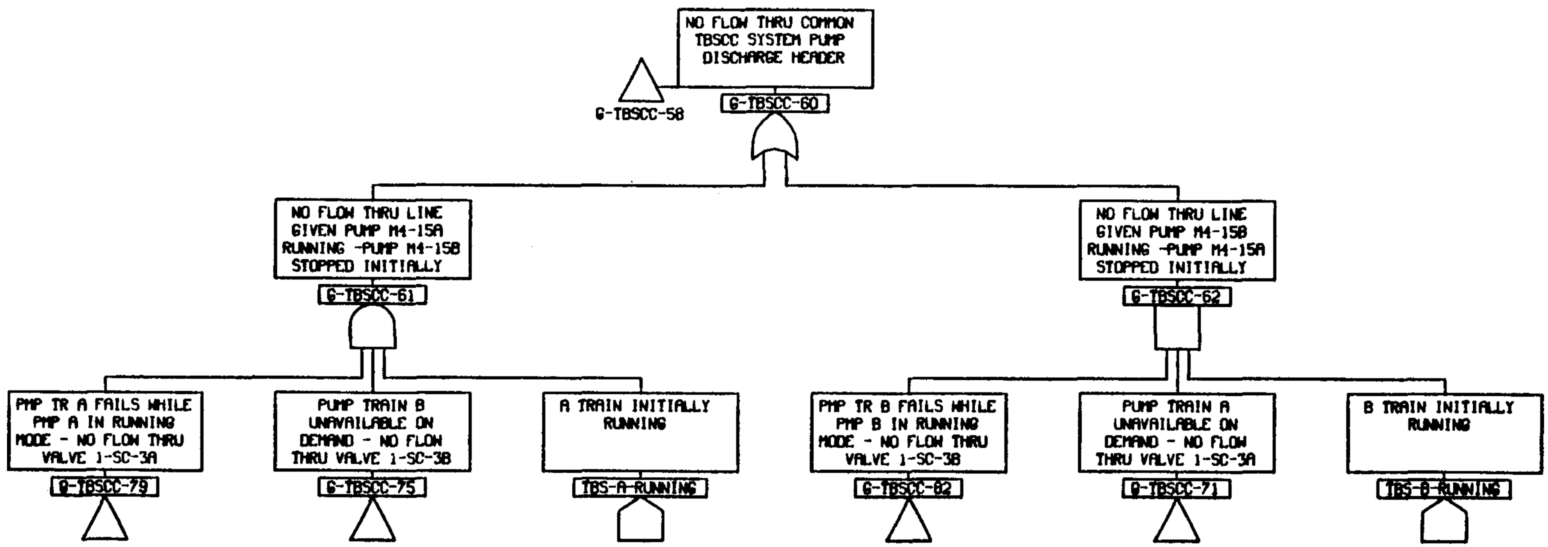

NO FLOW THRU N.O. MANUAL VALVE 1-SC-17
G-SIA-M54-CPR
G-TBSCC-43
MECHANICAL FAULTS OF VALVE
SC-17-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-17-XV-TMC
NO FLOW THRU PC VALVE 1-SC-18
G-SIA-M54-CPR
G-TBSCC-44
MECHANICAL FAULTS OF VALVE
SC-18-PHV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-18-PHV-TMC

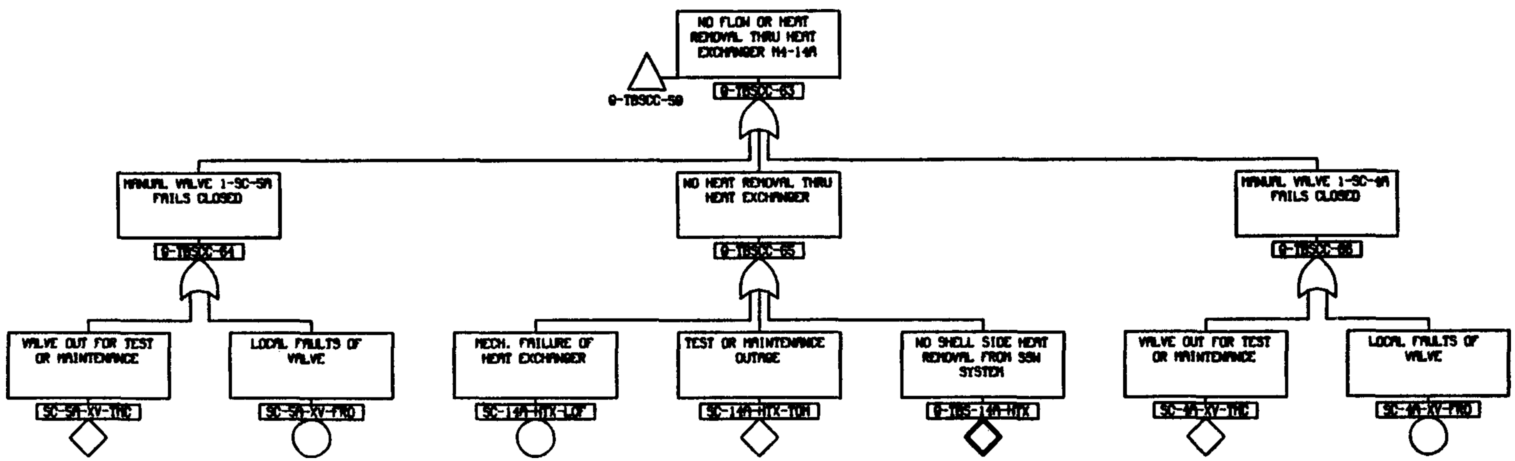
TBSCC-24


NO FLOW THRU N.O. SOLENOID VALVE 1-SC-19
G-SIA-M54-CPR
G-TBSCC-45
MECHANICAL FAULTS OF VALVE
SC-19-SOV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-19-SOV-TMC
NO FLOW THRU N.O. MANUAL VALVE 1-SC-20
G-SIA-M54-CPR
G-TBSCC-46
MECHANICAL FAULTS OF VALVE
SC-20-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-20-XV-TMC

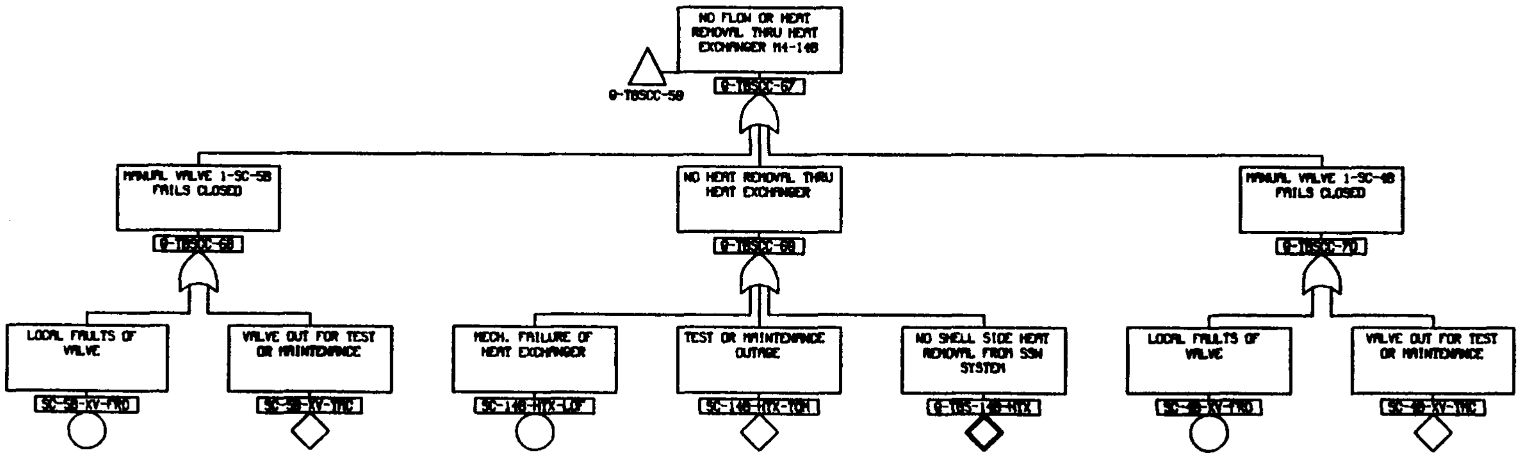

NO FLOW THRU N.O. MANUAL VALVE 1-SC-22
G-TBSCC-47
G-SIA-M54-CPR
MECHANICAL FAULTS OF VALVE
SC-22-XV-FRO
OUT OF SERVICE FOR TEST OR MAINT.
SC-22-XV-TMC

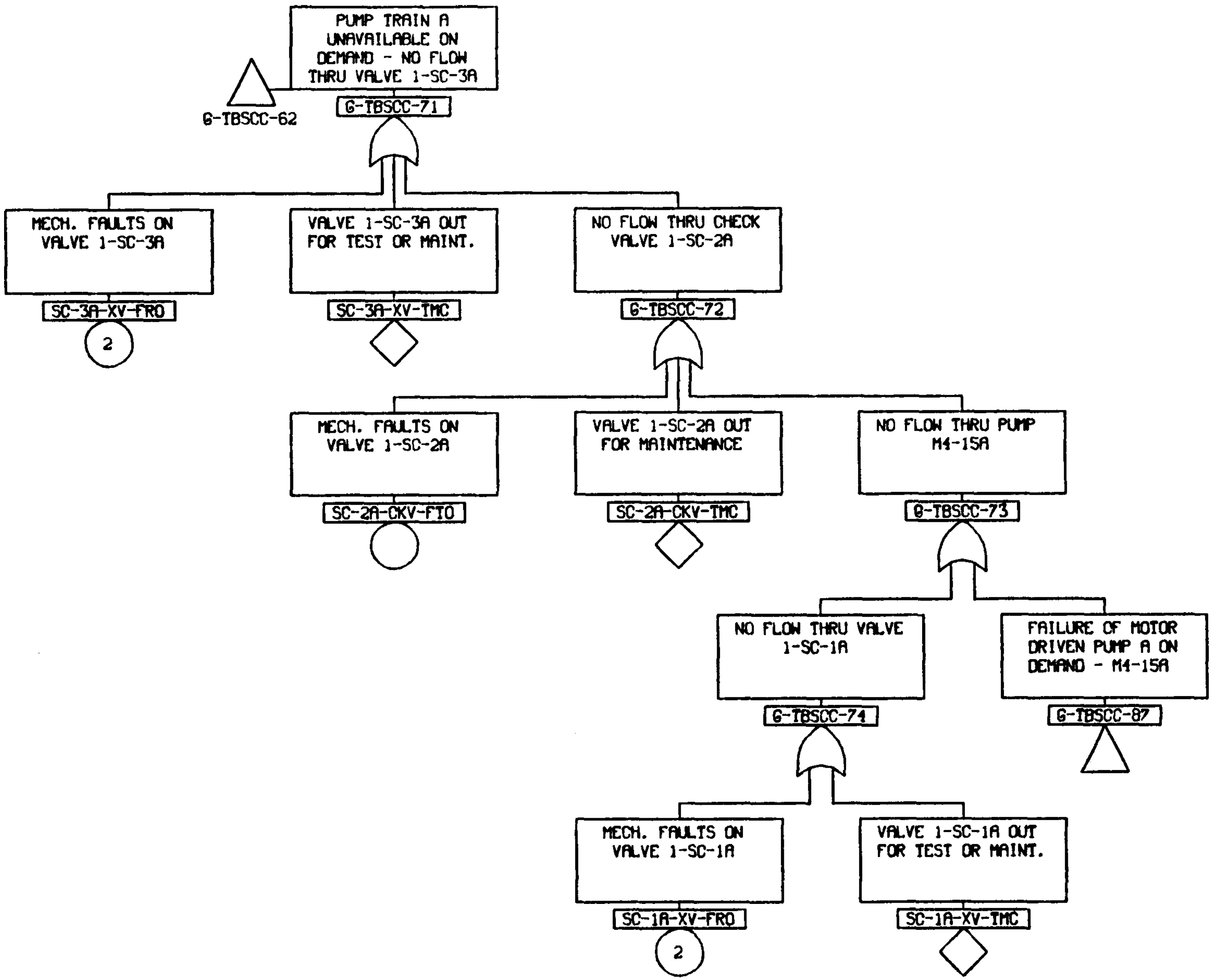

NO HEAT REMOVAL VIA COMMON PUMP AND HEAT EXCHANGER TRAINS IN TBSCCW SYSTEM
G-TBSCC-58
G-FW-RFPA-HTX, G-FW-RFPB-HTX, G-FW-CPA-HTX, G-FW-CPB-HTX, G-TBSCC-1
G-TBSCC-20, G-TBSCC-23, G-TBSCC-27, G-SIA-M51-CPR, G-SIA-M54-CPR
NO HEAT REMOVAL BY HEAT EXCHANGER TRAINS
G-TBSCC-59
NO FLOW THRU COMMON TBSCC SYSTEM PUMP DISCHARGE HEADER
G-TBSCC-60
NO FLOW OR HEAT REMOVAL THRU HEAT EXCHANGER M4-14A
G-TBSCC-63
NO FLOW OR HEAT REMOVAL THRU HEAT EXCHANGER M4-14B
G-TBSCC-67


NO FLOW THRU COMMON TBSCC SYSTEM PUMP DISCHARGE HEADER
G-TBSCC-60
G-TBSCC-58
NO FLOW THRU LINE GIVEN PUMP M4-15A RUNNING -PUMP M4-15B STOPPED INITIALLY
G-TBSCC-61
NO FLOW THRU LINE GIVEN PUMP M4-15B RUNNING -PUMP M4-15A STOPPED INITIALLY
G-TBSCC-62
PMP TR A FAILS WHILE PMP A IN RUNNING MODE - NO FLOW THRU VALVE 1-SC-3A
G-TBSCC-79
PUMP TRAIN B UNAVAILABLE ON DEMAND - NO FLOW THRU VALVE 1-SC-3B
G-TBSCC-75
A TRAIN INITIALLY RUNNING
TBS-A-RUNNING
PMP TR B FAILS WHILE PMP B IN RUNNING MODE - NO FLOW THRU VALVE 1-SC-3B
G-TBSCC-82
PUMP TRAIN A UNAVAILABLE ON DEMAND - NO FLOW THRU VALVE 1-SC-3A
G-TBSCC-71
B TRAIN INITIALLY RUNNING
TBS-B-RUNNING

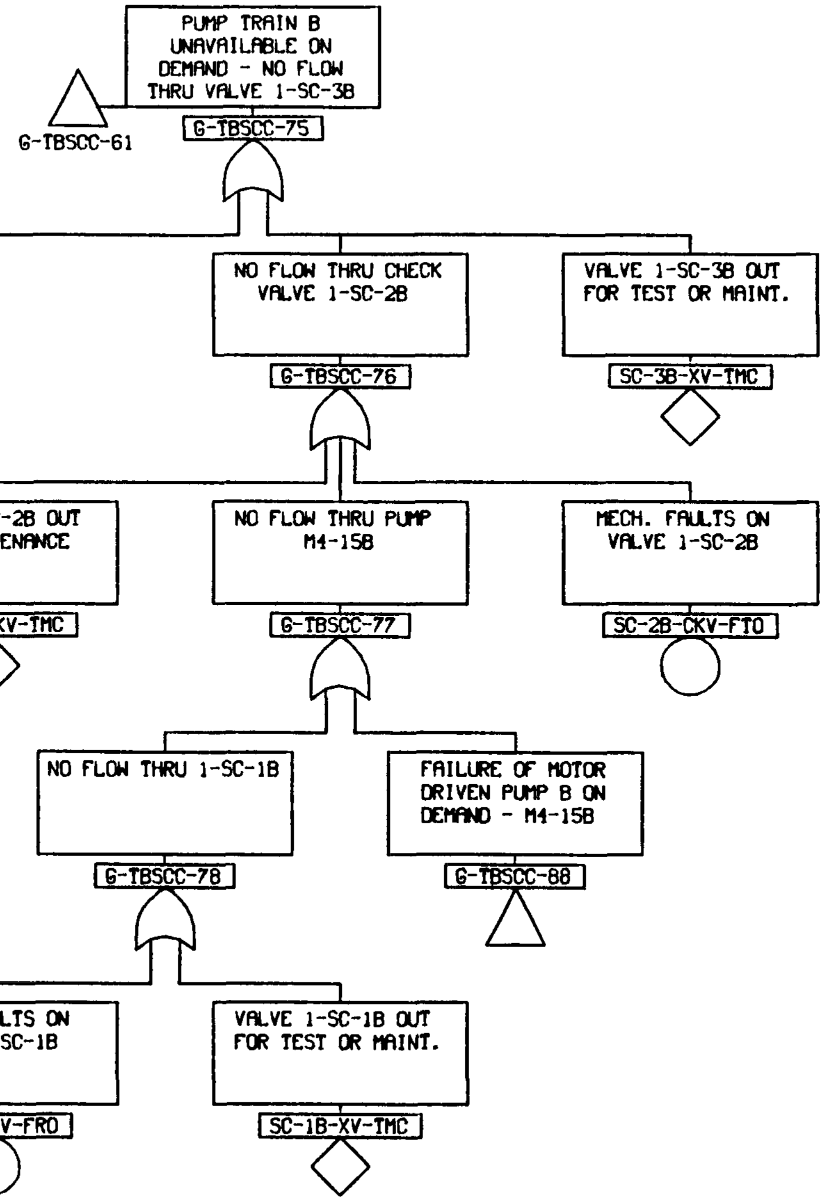

NO FLOW OR HEAT REMOVAL THRU HEAT EXCHANGER M4-14A
G-TBSCC-63
G-TBSCC-50
MANUAL VALVE 1-SC-5A FAILS CLOSED
G-TBSCC-64
NO HEAT REMOVAL THRU HEAT EXCHANGER
G-TBSCC-65
MANUAL VALVE 1-SC-4A FAILS CLOSED
G-TBSCC-66
VALVE OUT FOR TEST OR MAINTENANCE
SC-5A-XV-TMC
LOCAL FAULTS OF VALVE
SC-5A-XV-FRO
MECH. FAILURE OF HEAT EXCHANGER
SC-14A-HTX-LOF
TEST OR MAINTENANCE OUTAGE
SC-14A-HTX-TOM
NO SHELL SIDE HEAT REMOVAL FROM SSW SYSTEM
G-TBS-14A-HTX
VALVE OUT FOR TEST OR MAINTENANCE
SC-4A-XV-TMC
LOCAL FAULTS OF VALVE
SC-4A-XV-FRO

TBSCC-29

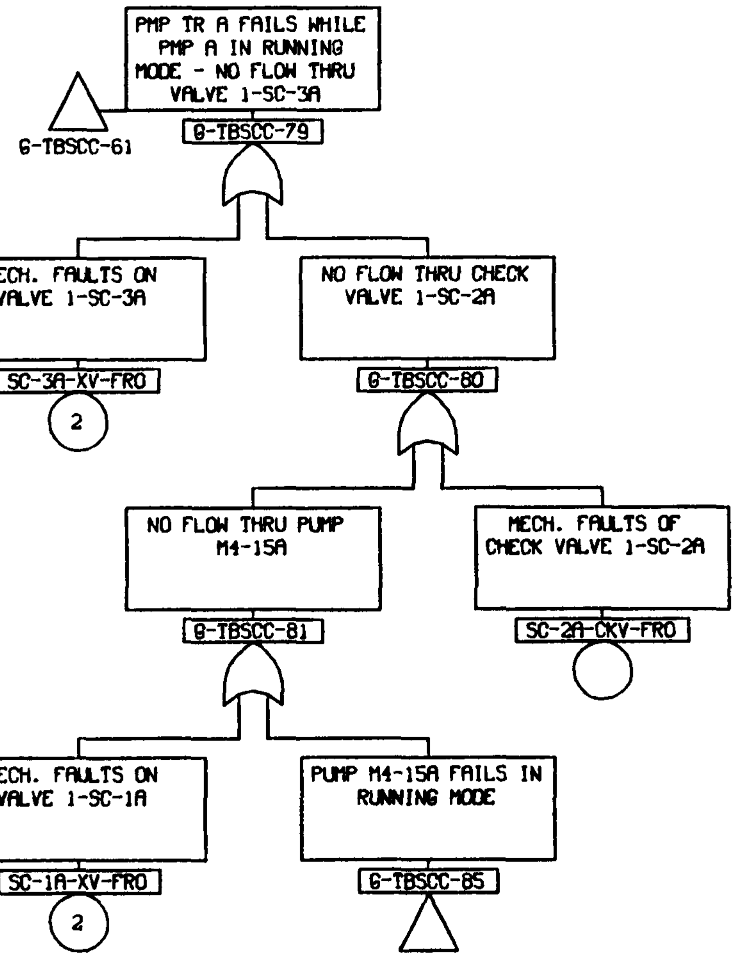

NO FLOW OR HEAT REMOVAL THRU HEAT EXCHANGER H4-14B
G-TBSCC-67
G-TBSCC-58
MANUAL VALVE 1-SC-5B FAILS CLOSED
G-TBSCC-68
NO HEAT REMOVAL THRU HEAT EXCHANGER
G-TBSCC-69
MANUAL VALVE 1-SC-4B FAILS CLOSED
G-TBSCC-70
LOCAL FAULTS OF VALVE
SC-5B-XV-FRO
VALVE OUT FOR TEST OR MAINTENANCE
SC-5B-XV-TMC
MECH. FAILURE OF HEAT EXCHANGER
SC-14B-HYX-LOF
TEST OR MAINTENANCE OUTAGE
SC-14B-HYX-TOM
NO SHELL SIDE HEAT REMOVAL FROM SSW SYSTEM
G-TBS-14B-HYX
LOCAL FAULTS OF VALVE
SC-4B-XV-FRO
VALVE OUT FOR TEST OR MAINTENANCE
SC-4B-XV-TMC

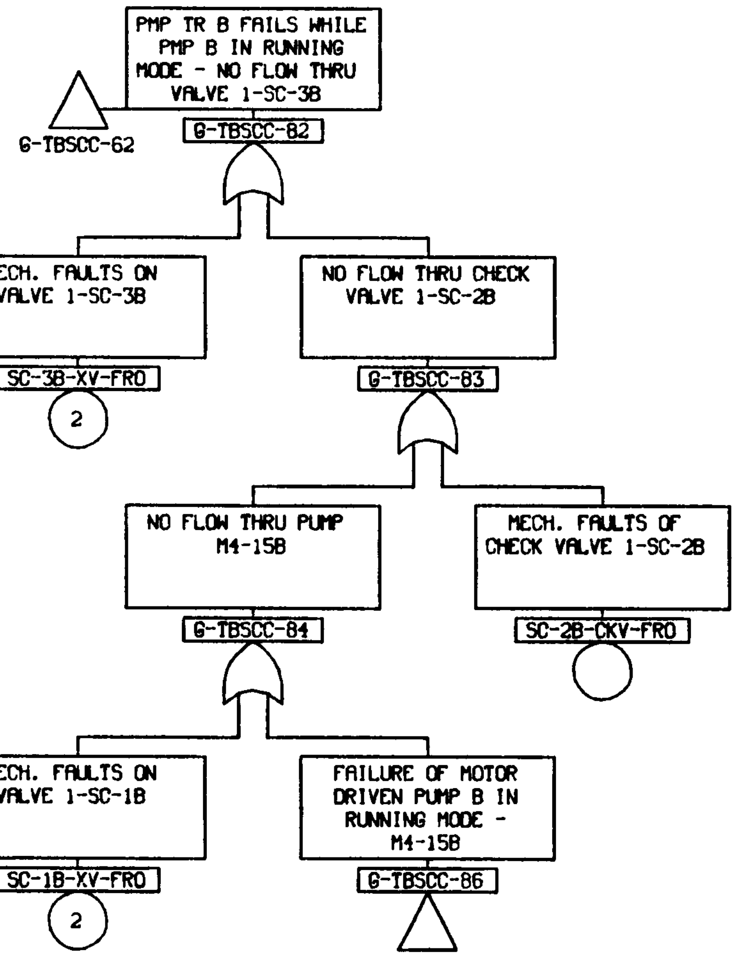

PUMP TRAIN A UNAVAILABLE ON DEMAND - NO FLOW THRU VALVE 1-SC-3A
G-TBSCC-71
G-TBSCC-62
MECH. FAULTS ON VALVE 1-SC-3A
SC-3A-XV-FRO
2
VALVE 1-SC-3A OUT FOR TEST OR MAINT.
SC-3A-XV-TMC
NO FLOW THRU CHECK VALVE 1-SC-2A
G-TBSCC-72
MECH. FAULTS ON VALVE 1-SC-2A
SC-2A-CKV-FTO
VALVE 1-SC-2A OUT FOR MAINTENANCE
SC-2A-CKV-TMC
NO FLOW THRU PUMP M4-15A
G-TBSCC-73
NO FLOW THRU VALVE 1-SC-1A
G-TBSCC-74
FAILURE OF MOTOR DRIVEN PUMP A ON DEMAND - M4-15A
G-TBSCC-87
MECH. FAULTS ON VALVE 1-SC-1A
SC-1A-XV-FRO
2
VALVE 1-SC-1A OUT FOR TEST OR MAINT.
SC-1A-XV-TMC

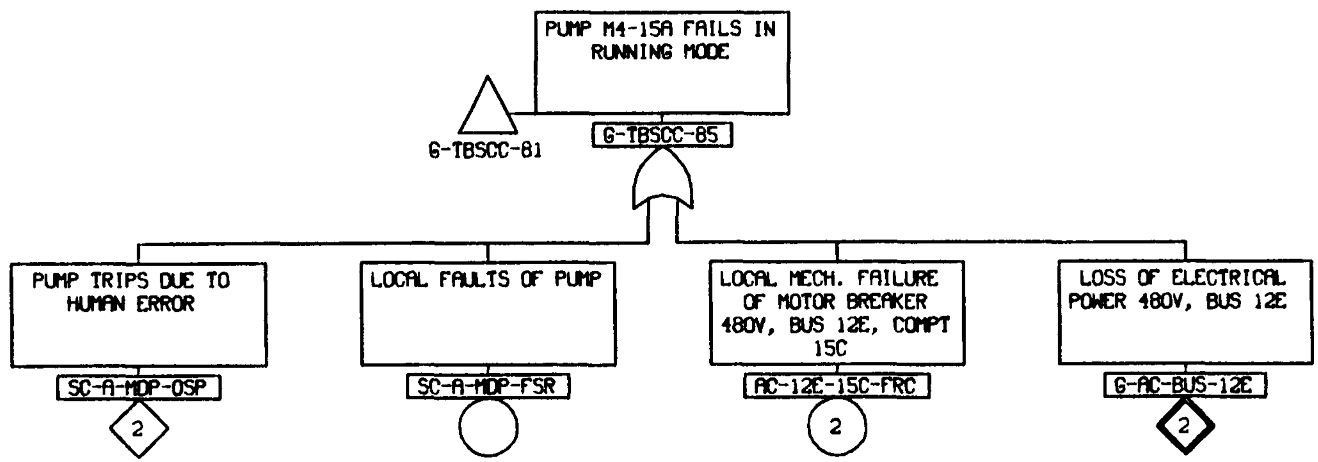
TBSCC-31

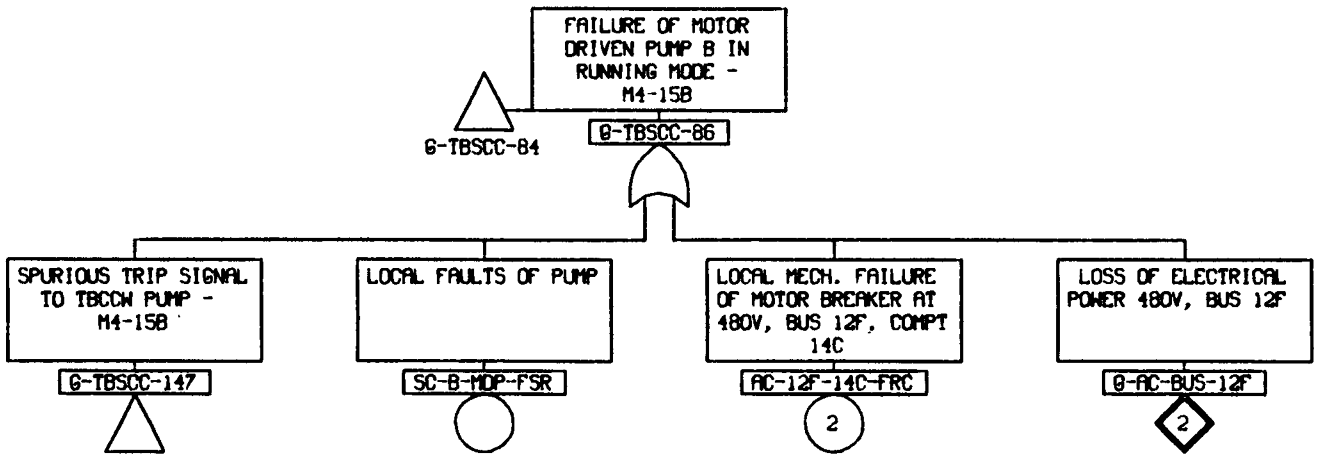

PUMP TRAIN B UNAVAILABLE ON DEMAND - NO FLOW THRU VALVE 1-SC-3B
G-TBSCC-75
G-TBSCC-61
MECH. FAULTS ON VALVE 1-SC-3B
SC-3B-XV-FRO
2
NO FLOW THRU CHECK VALVE 1-SC-2B
G-TBSCC-76
VALVE 1-SC-3B OUT FOR TEST OR MAINT.
SC-3B-XV-TMC
VALVE 1-SC-2B OUT FOR MAINTENANCE
SC-2B-CKV-TMC
NO FLOW THRU PUMP M4-15B
G-TBSCC-77
MECH. FAULTS ON VALVE 1-SC-2B
SC-2B-CKV-FTO
NO FLOW THRU 1-SC-1B
G-TBSCC-78
FAILURE OF MOTOR DRIVEN PUMP B ON DEMAND - M4-15B
G-TBSCC-88
MECH. FAULTS ON VALVE 1-SC-1B
SC-1B-XV-FRO
2
VALVE 1-SC-1B OUT FOR TEST OR MAINT.
SC-1B-XV-TMC

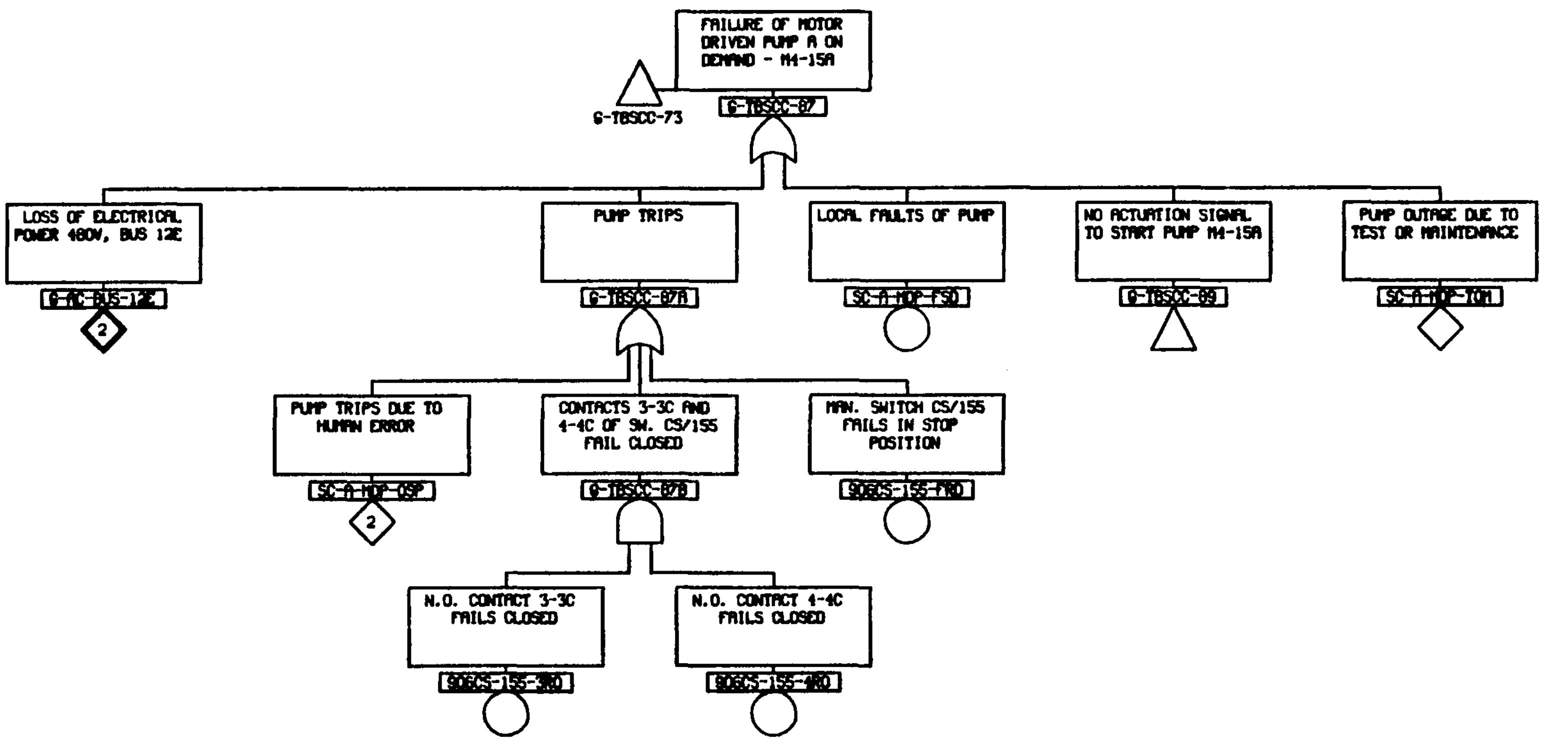
TBSCC-32


PMP TR A FAILS WHILE PMP A IN RUNNING MODE - NO FLOW THRU VALVE 1-SC-3A
G-TBSCC-79
G-TBSCC-61
MECH. FAULTS ON VALVE 1-SC-3A
SC-3A-XV-FRO
2
NO FLOW THRU CHECK VALVE 1-SC-2A
G-TBSCC-80
NO FLOW THRU PUMP M4-15A
G-TBSCC-81
MECH. FAULTS OF CHECK VALVE 1-SC-2A
SC-2A-CKV-FRO
MECH. FAULTS ON VALVE 1-SC-1A
SC-1A-XV-FRO
2
PUMP M4-15A FAILS IN RUNNING MODE
G-TBSCC-85

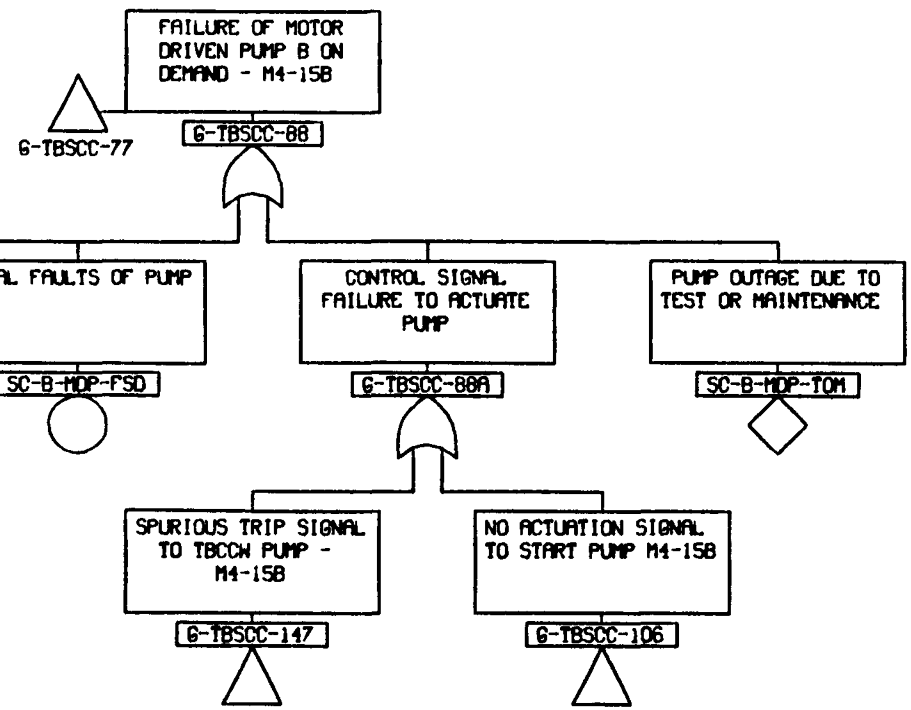

PMP TR B FAILS WHILE PMP B IN RUNNING MODE - NO FLOW THRU VALVE 1-SC-3B
G-TBSCC-82
G-TBSCC-62
MECH. FAULTS ON VALVE 1-SC-3B
SC-3B-XV-FRO
2
NO FLOW THRU CHECK VALVE 1-SC-2B
G-TBSCC-83
NO FLOW THRU PUMP M4-15B
G-TBSCC-84
MECH. FAULTS OF CHECK VALVE 1-SC-2B
SC-2B-CKV-FRO
MECH. FAULTS ON VALVE 1-SC-1B
SC-1B-XV-FRO
2
FAILURE OF MOTOR DRIVEN PUMP B IN RUNNING MODE - M4-15B
G-TBSCC-86


PUMP M4-15A FAILS IN RUNNING MODE
G-TBSCC-85
G-TBSCC-81
PUMP TRIPS DUE TO HUMAN ERROR
SC-A-MDP-OSP
2
LOCAL FAULTS OF PUMP
SC-A-MDP-FSR
LOCAL MECH. FAILURE OF MOTOR BREAKER 480V, BUS 12E, COMPT 15C
AC-12E-15C-FRC
2
LOSS OF ELECTRICAL POWER 480V, BUS 12E
G-AC-BUS-12E
2

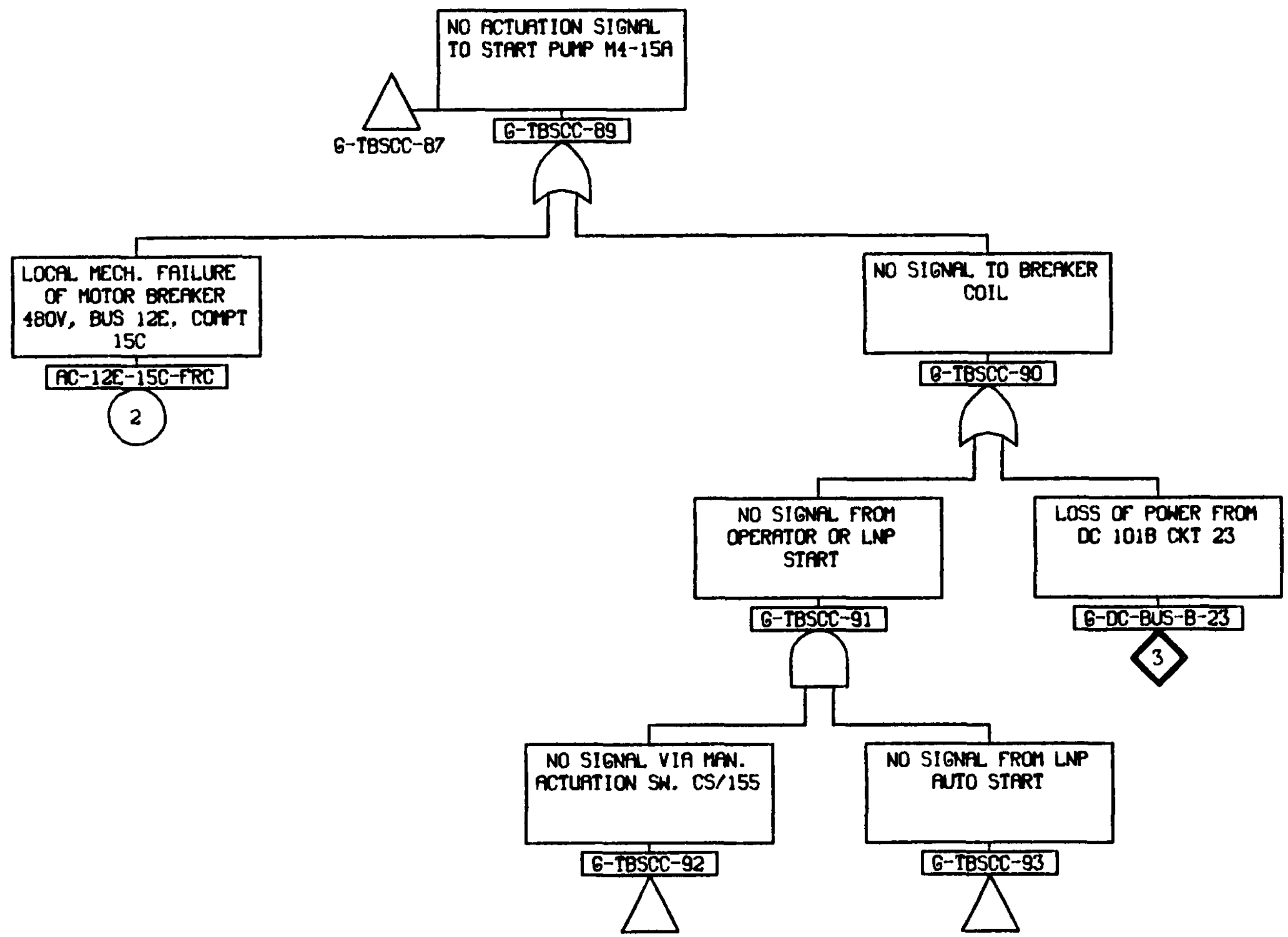

FAILURE OF MOTOR DRIVEN PUMP B IN RUNNING MODE - M4-15B
G-TBSCC-86
G-TBSCC-84
SPURIOUS TRIP SIGNAL TO TBCCW PUMP - M4-15B
G-TBSCC-147
LOCAL FAULTS OF PUMP
SC-B-MDP-FSR
LOCAL MECH. FAILURE OF MOTOR BREAKER AT 480V, BUS 12F, COMPT 14C
AC-12F-14C-FRC
2
LOSS OF ELECTRICAL POWER 480V, BUS 12F
G-AC-BUS-12F
2


FAILURE OF MOTOR DRIVEN PUMP A ON DEMAND - M4-15A
G-TBSCC-87
G-TBSCC-73
LOSS OF ELECTRICAL POWER 480V, BUS 12E
2
PUMP TRIPS
G-TBSCC-87A
LOCAL FAULTS OF PUMP
NO ACTUATION SIGNAL TO START PUMP M4-15A
G-TBSCC-89
PUMP OUTAGE DUE TO TEST OR MAINTENANCE
PUMP TRIPS DUE TO HUMAN ERROR
2
CONTACTS 3-3C AND 4-4C OF SW. CS/155 FAIL CLOSED
G-TBSCC-87B
MAN. SWITCH CS/155 FAILS IN STOP POSITION
N.O. CONTACT 3-3C FAILS CLOSED
N.O. CONTACT 4-4C FAILS CLOSED

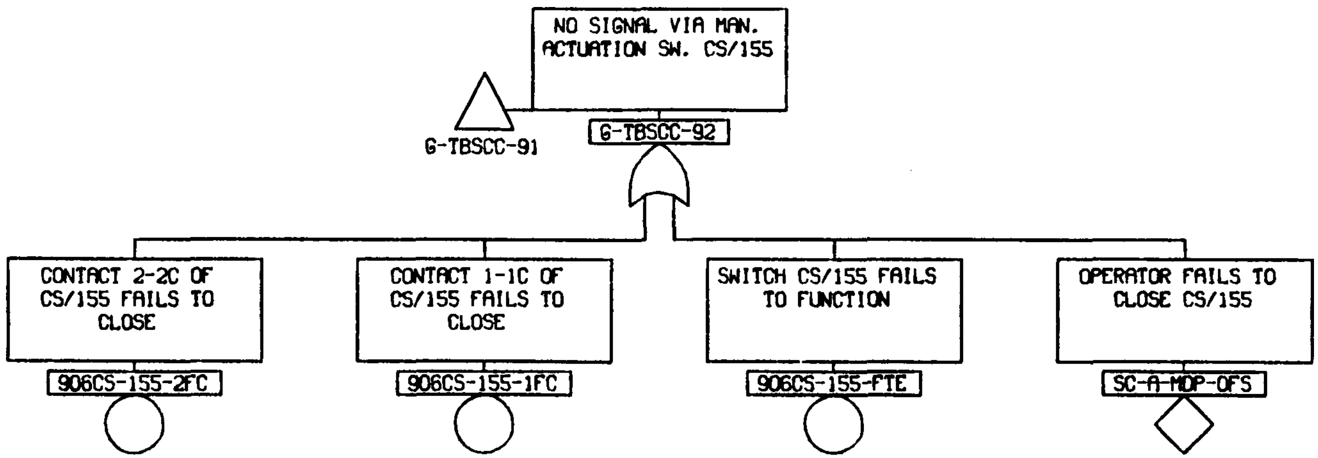
TBSCC-37

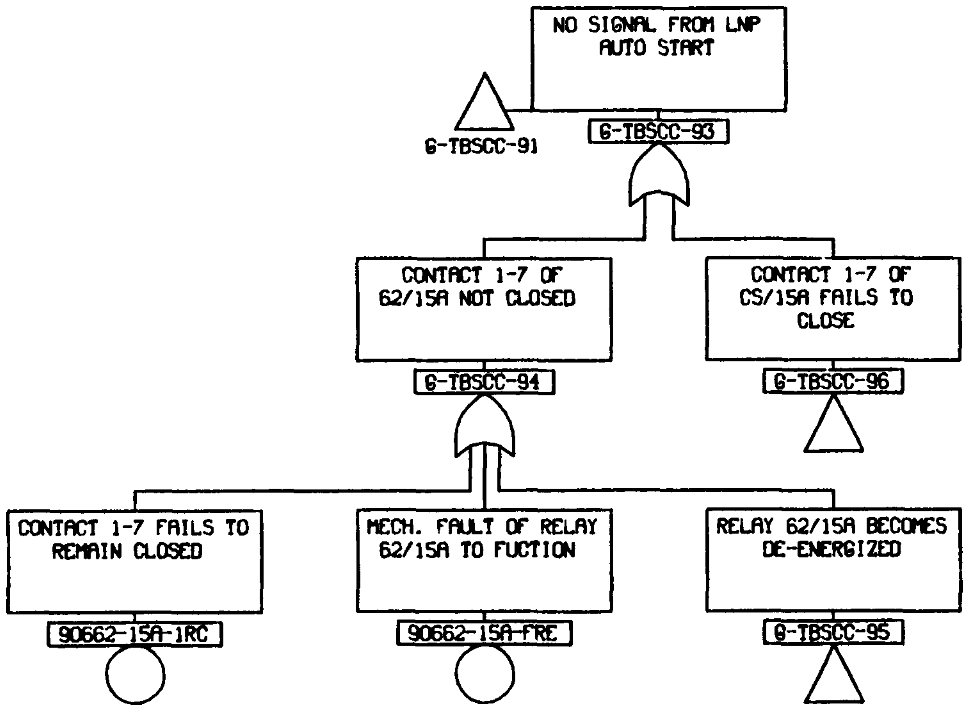

FAILURE OF MOTOR DRIVEN PUMP B ON DEMAND - M4-15B
G-TBSCC-88
G-TBSCC-77
LOSS OF ELECTRICAL POWER 480V, BUS 12F
G-AC-BUS-12F
2
LOCAL FAULTS OF PUMP
SC-B-MDP-FSD
CONTROL SIGNAL FAILURE TO ACTUATE PUMP
G-TBSCC-88A
PUMP OUTAGE DUE TO TEST OR MAINTENANCE
SC-B-MDP-TOM
SPURIOUS TRIP SIGNAL TO TBCCW PUMP - M4-15B
G-TBSCC-147
NO ACTUATION SIGNAL TO START PUMP M4-15B
G-TBSCC-106

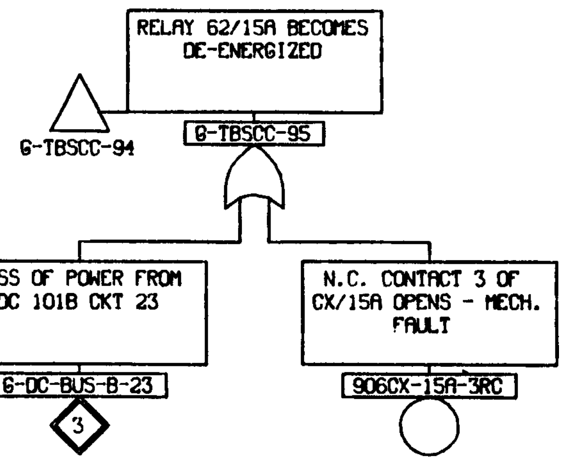
TBSCC-38

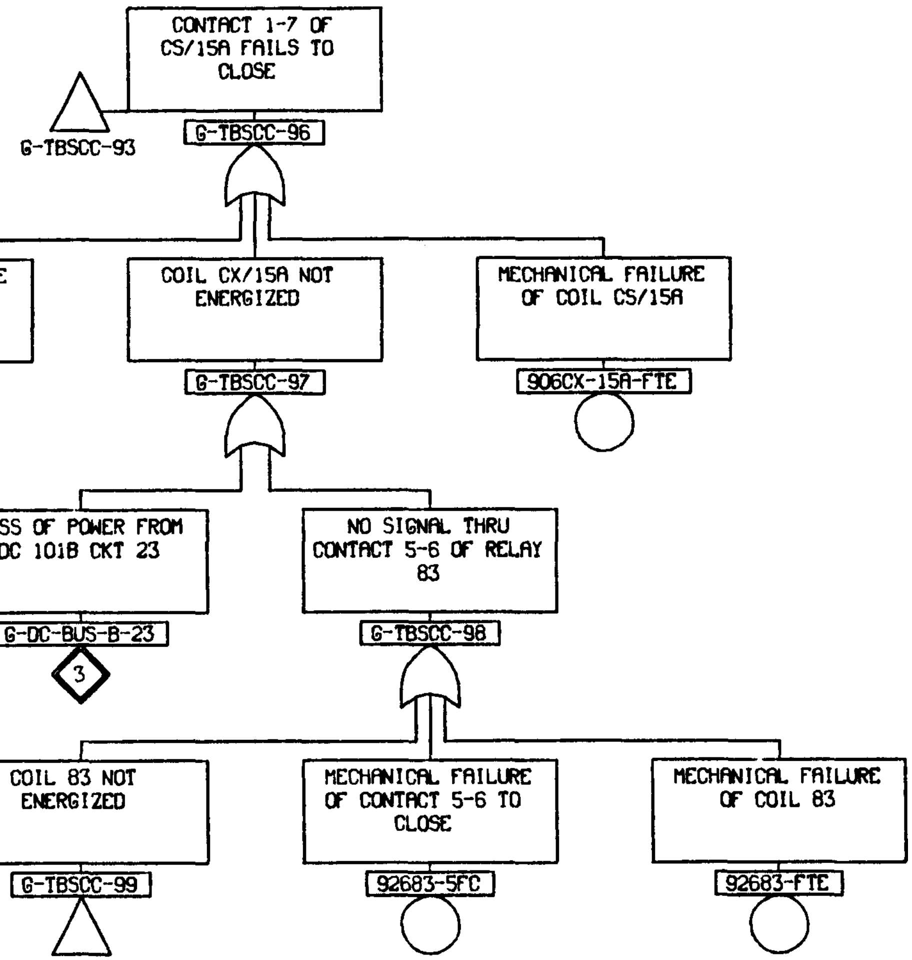

NO ACTUATION SIGNAL TO START PUMP M4-15A
G-TBSCC-89
G-TBSCC-87
LOCAL MECH. FAILURE OF MOTOR BREAKER 480V, BUS 12E, COMPT 15C
AC-12E-15C-FRC
2
NO SIGNAL TO BREAKER COIL
G-TBSCC-90
NO SIGNAL FROM OPERATOR OR LNP START
G-TBSCC-91
LOSS OF POWER FROM DC 101B CKT 23
G-DC-BUS-B-23
3
NO SIGNAL VIA MAN. ACTUATION SW. CS/155
G-TBSCC-92
NO SIGNAL FROM LNP AUTO START
G-TBSCC-93

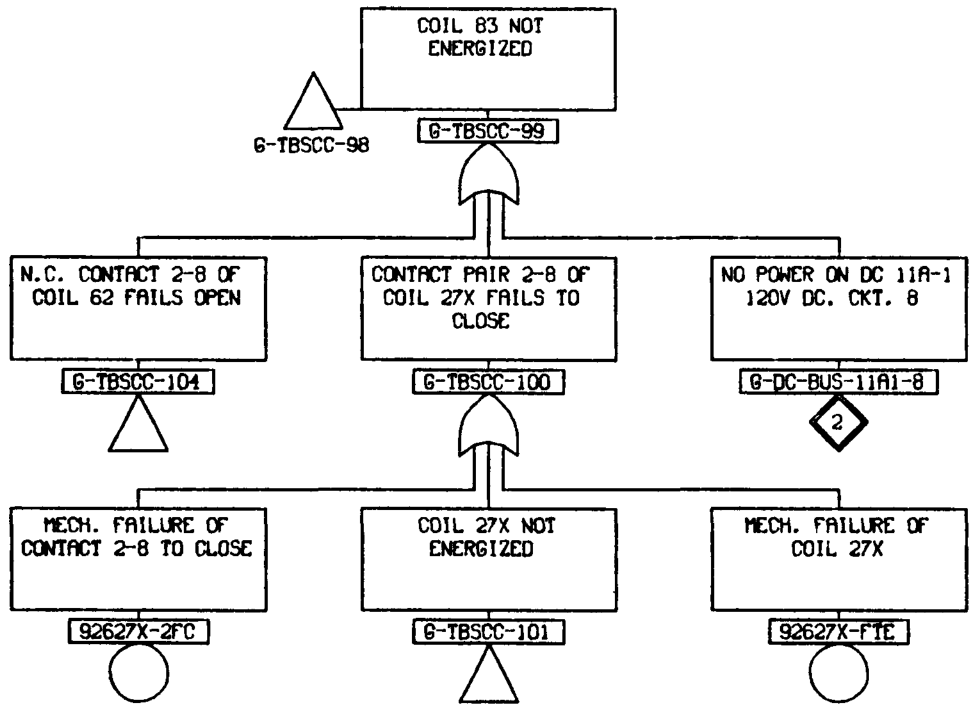
TBSCC-39

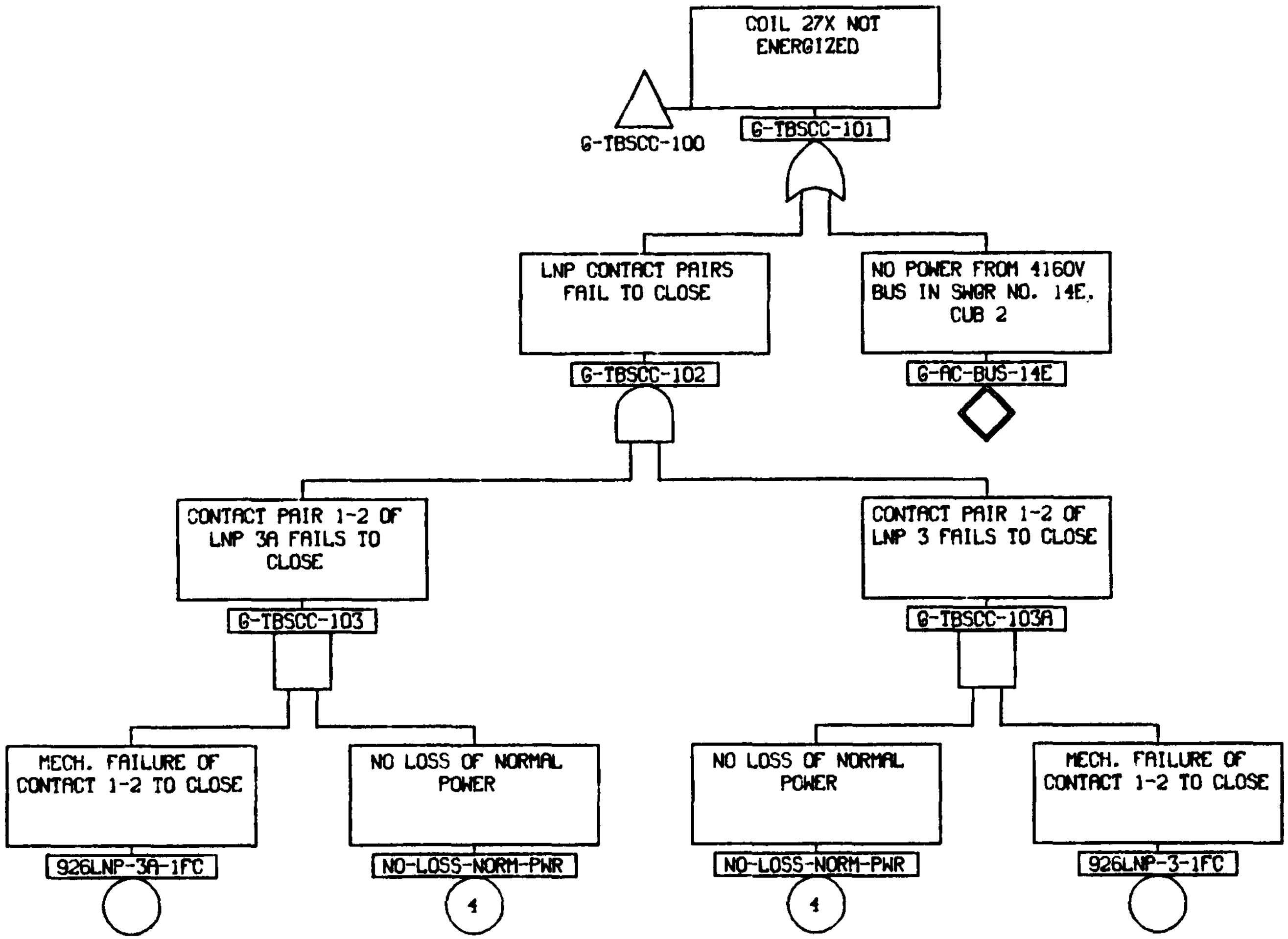

NO SIGNAL VIA MAN. ACTUATION SW. CS/155
G-TBSCC-92
G-TBSCC-91
CONTACT 2-2C OF CS/155 FAILS TO CLOSE
906CS-155-2FC
CONTACT 1-1C OF CS/155 FAILS TO CLOSE
906CS-155-1FC
SWITCH CS/155 FAILS TO FUNCTION
906CS-155-FTE
OPERATOR FAILS TO CLOSE CS/155
SC-A-MOP-OFS


NO SIGNAL FROM LNP AUTO START
G-TBSCC-91
G-TBSCC-93
CONTACT 1-7 OF 62/15A NOT CLOSED
CONTACT 1-7 OF CS/15A FAILS TO CLOSE
G-TBSCC-94
G-TBSCC-96
CONTACT 1-7 FAILS TO REMAIN CLOSED
MECH. FAULT OF RELAY 62/15A TO FUCTION
RELAY 62/15A BECOMES DE-ENERGIZED
90662-15A-1RC
90662-15A-FRE
G-TBSCC-95

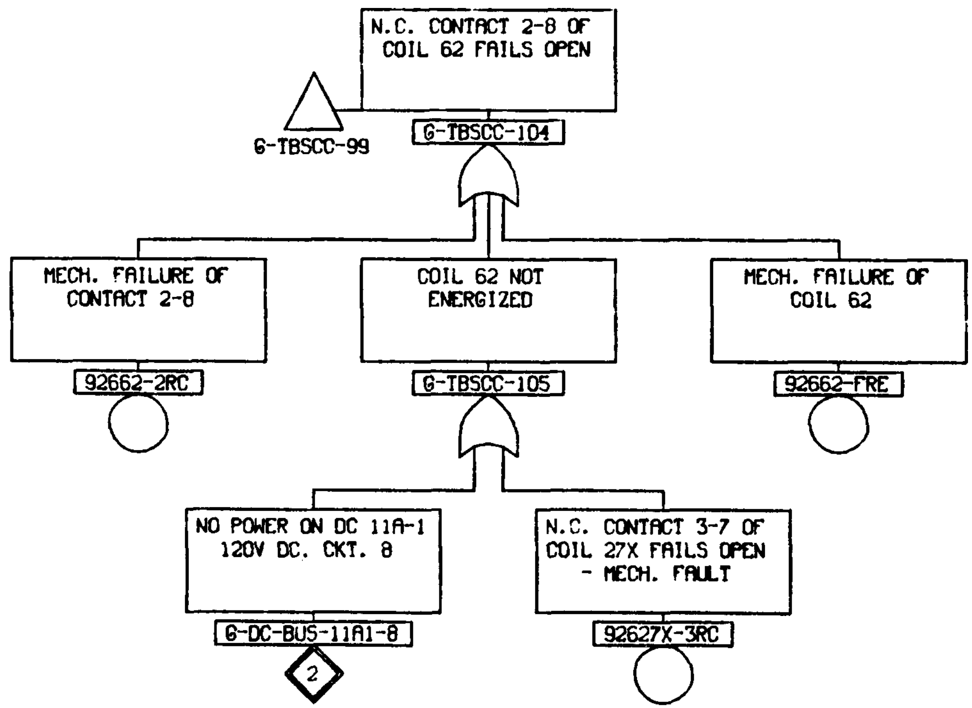

RELAY 62/15A BECOMES DE-ENERGIZED
G-TBSCC-95
G-TBSCC-94
LOSS OF POWER FROM DC 101B CKT 23
G-DC-BUS-B-23
3
N.C. CONTACT 3 OF CX/15A OPENS - MECH. FAULT
906CX-15A-3RC

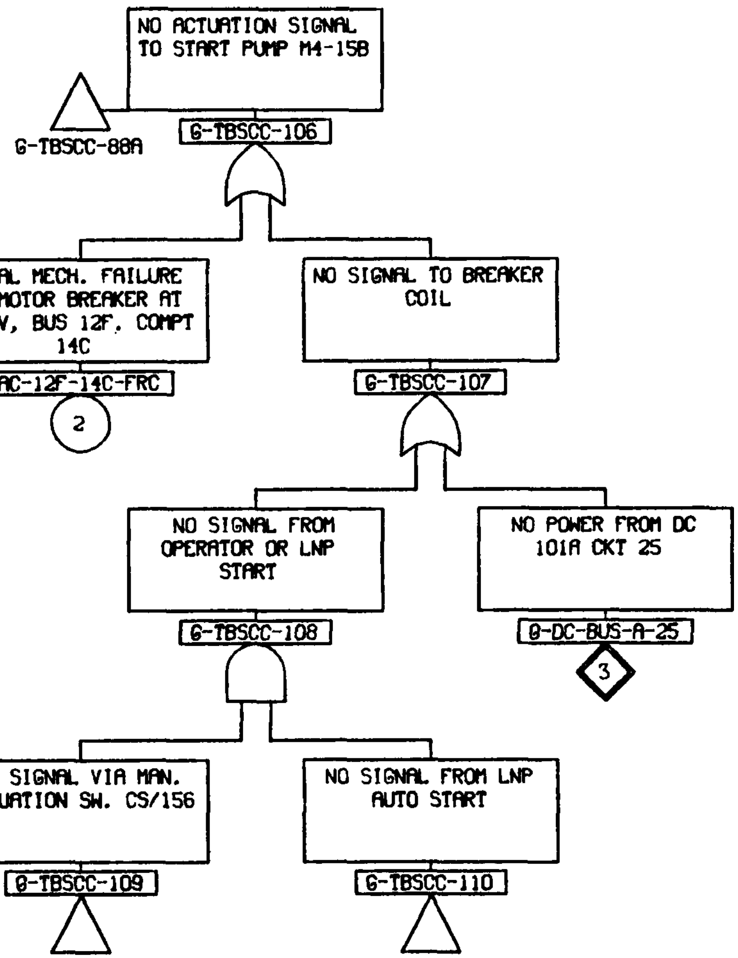

CONTACT 1-7 OF CS/15A FAILS TO CLOSE
G-TBSCC-96
G-TBSCC-93
MECHANICAL FAILURE OF CONTACT 1-7 TO CLOSE
906CX-15A-1FC
COIL CX/15A NOT ENERGIZED
G-TBSCC-97
MECHANICAL FAILURE OF COIL CS/15A
906CX-15A-FTE
LOSS OF POWER FROM DC 101B CKT 23
G-DC-BUS-B-23
3
NO SIGNAL THRU CONTACT 5-6 OF RELAY 83
G-TBSCC-98
COIL 83 NOT ENERGIZED
G-TBSCC-99
MECHANICAL FAILURE OF CONTACT 5-6 TO CLOSE
92683-5FC
MECHANICAL FAILURE OF COIL 83
92683-FTE

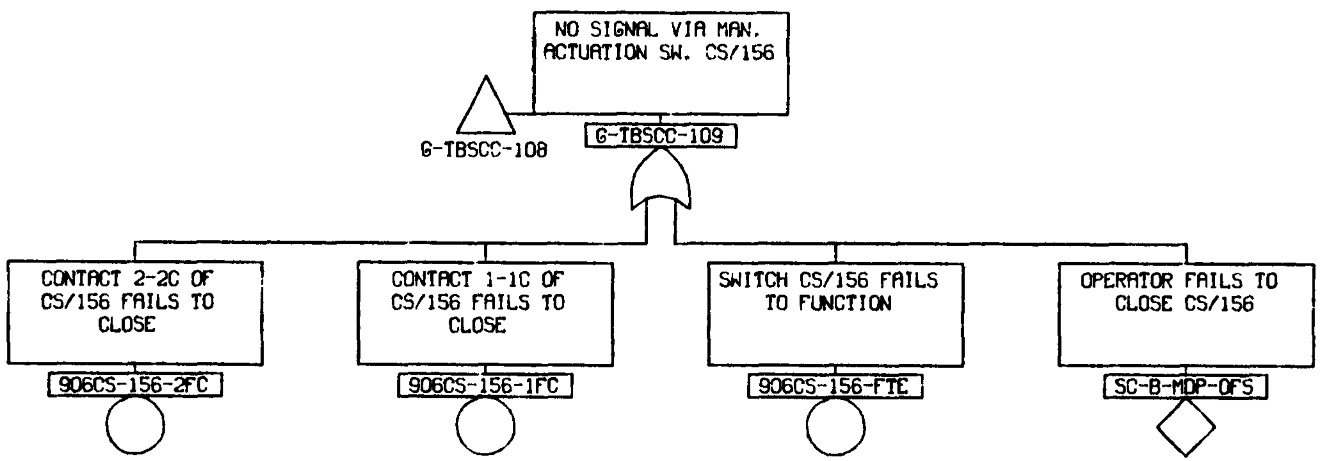

COIL 83 NOT ENERGIZED
G-TBSCC-99
G-TBSCC-98
N.C. CONTACT 2-8 OF COIL 62 FAILS OPEN
G-TBSCC-104
CONTACT PAIR 2-8 OF COIL 27X FAILS TO CLOSE
G-TBSCC-100
NO POWER ON DC 11A-1 120V DC. CKT. 8
G-DC-BUS-11A1-8
2
MECH. FAILURE OF CONTACT 2-8 TO CLOSE
92627X-2FC
COIL 27X NOT ENERGIZED
G-TBSCC-101
MECH. FAILURE OF COIL 27X
92627X-FTE

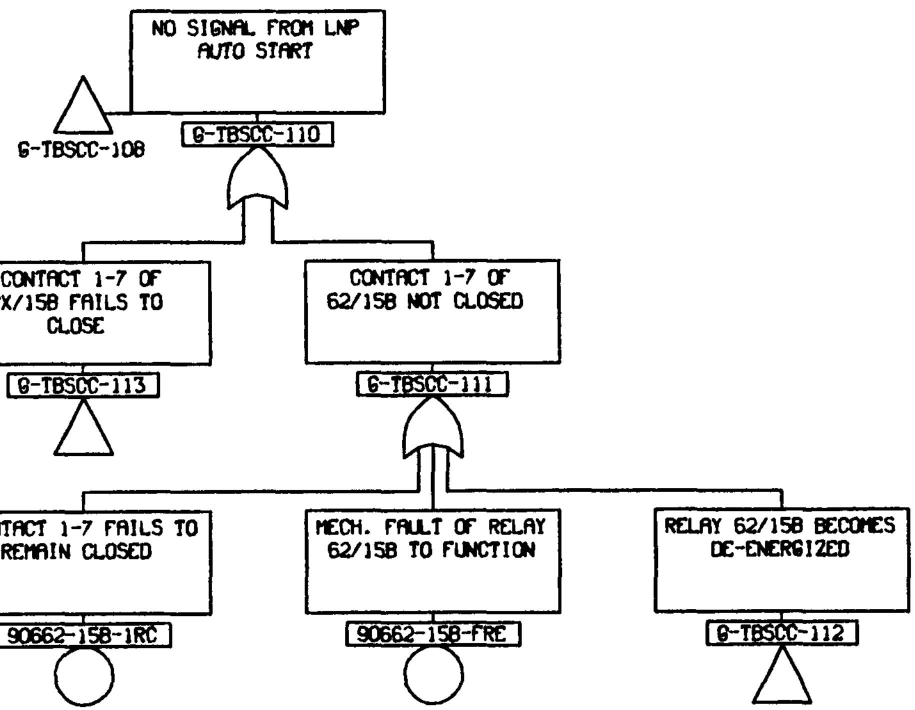


COIL 27X NOT ENERGIZED
G-TBSCC-101
G-TBSCC-100
LNP CONTACT PAIRS FAIL TO CLOSE
G-TBSCC-102
NO POWER FROM 4160V BUS IN SWGR NO. 14E, CUB 2
G-AC-BUS-14E
CONTACT PAIR 1-2 OF LNP 3A FAILS TO CLOSE
G-TBSCC-103
CONTACT PAIR 1-2 OF LNP 3 FAILS TO CLOSE
G-TBSCC-103A
MECH. FAILURE OF CONTACT 1-2 TO CLOSE
926LNP-3A-1FC
NO LOSS OF NORMAL POWER
NO-LOSS-NORM-PWR
4
NO LOSS OF NORMAL POWER
NO-LOSS-NORM-PWR
4
MECH. FAILURE OF CONTACT 1-2 TO CLOSE
926LNP-3-1FC

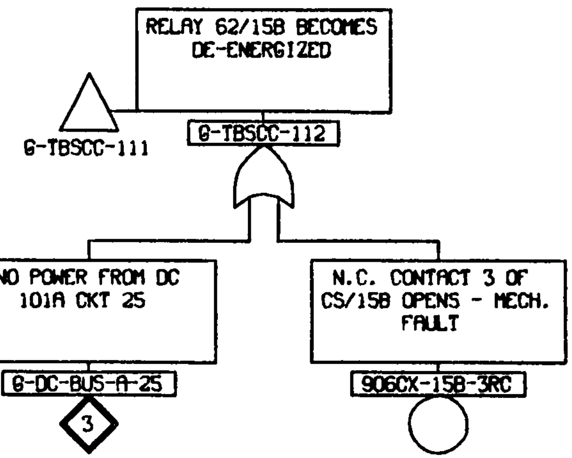

N.C. CONTACT 2-8 OF COIL 62 FAILS OPEN
G-TBSCC-99
G-TBSCC-104
MECH. FAILURE OF CONTACT 2-8
92662-2RC
COIL 62 NOT ENERGIZED
G-TBSCC-105
MECH. FAILURE OF COIL 62
92662-FRE
NO POWER ON DC 11A-1 120V DC. CKT. 8
G-DC-BUS-11A1-8
2
N.C. CONTACT 3-7 OF COIL 27X FAILS OPEN - MECH. FAULT
92627X-3RC

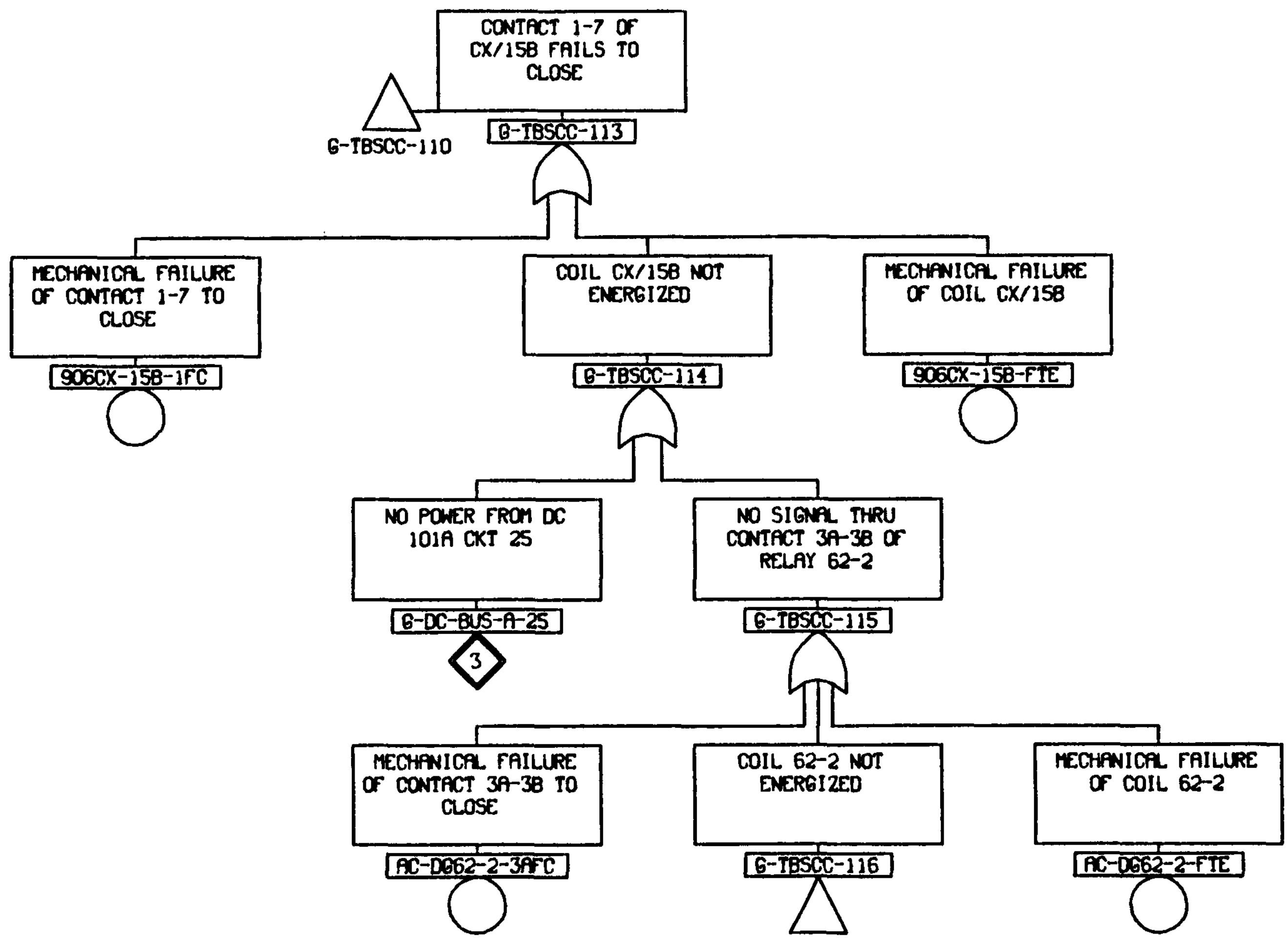

NO ACTUATION SIGNAL TO START PUMP M4-15B
G-TBSCC-106
G-TBSCC-88A
LOCAL MECH. FAILURE OF MOTOR BREAKER AT 480V, BUS 12F, COMPT 14C
AC-12F-14C-FRC
2
NO SIGNAL TO BREAKER COIL
G-TBSCC-107
NO SIGNAL FROM OPERATOR OR LNP START
G-TBSCC-108
NO POWER FROM DC 101A CKT 25
0-DC-BUS-A-25
3
NO SIGNAL VIA MAN. ACTUATION SW. CS/156
0-TBSCC-109
NO SIGNAL FROM LNP AUTO START
G-TBSCC-110


NO SIGNAL VIA MAN. ACTUATION SW. CS/156
G-TBSCC-109
G-TBSCC-108
CONTACT 2-2C OF CS/156 FAILS TO CLOSE
906CS-156-2FC
CONTACT 1-1C OF CS/156 FAILS TO CLOSE
906CS-156-1FC
SWITCH CS/156 FAILS TO FUNCTION
906CS-156-FTE
OPERATOR FAILS TO CLOSE CS/156
SC-B-MDP-OFS

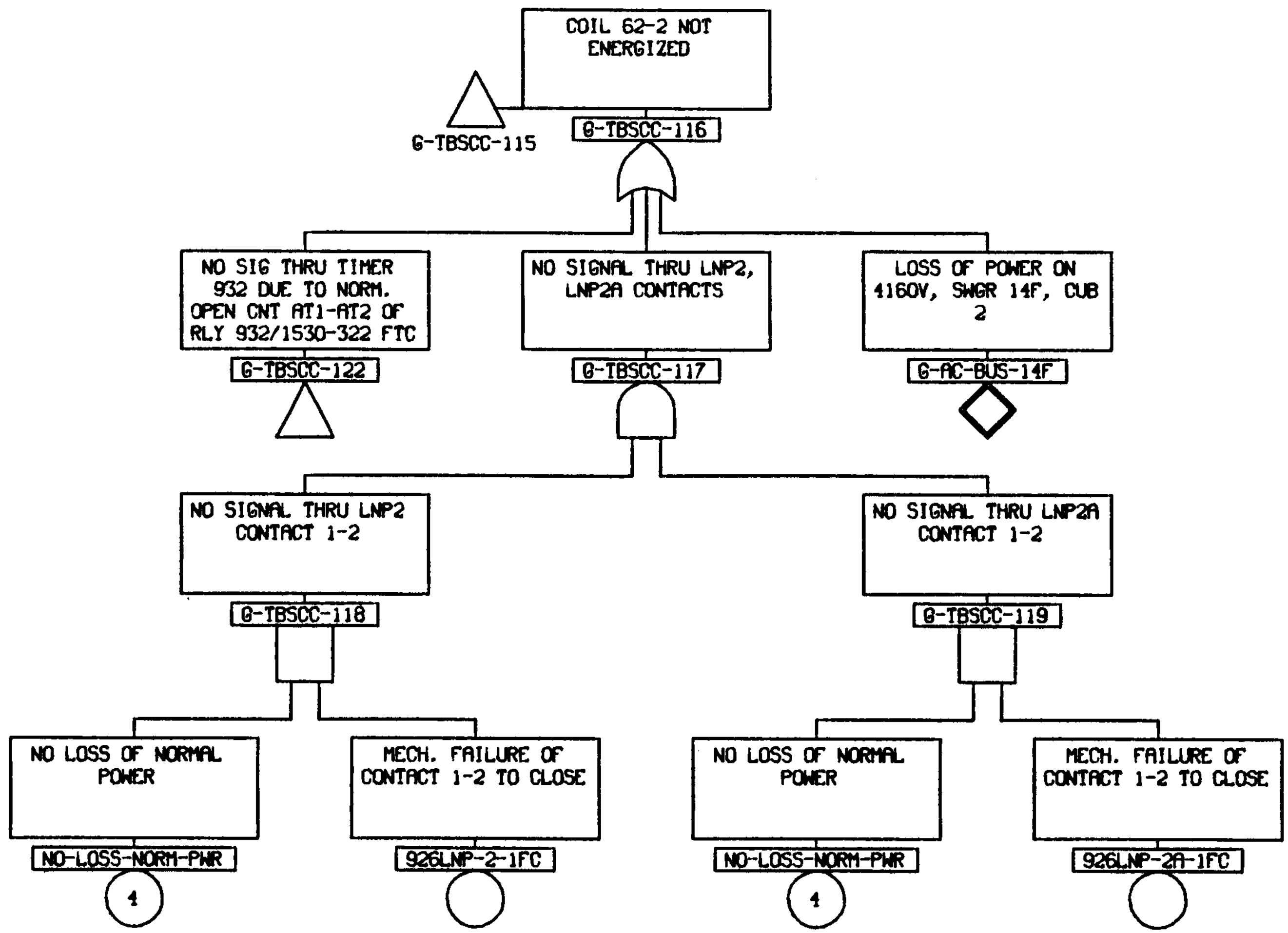

NO SIGNAL FROM LNP AUTO START
G-TBSCC-110
G-TBSCC-108
CONTACT 1-7 OF CX/15B FAILS TO CLOSE
G-TBSCC-113
CONTACT 1-7 OF 62/15B NOT CLOSED
G-TBSCC-111
CONTACT 1-7 FAILS TO REMAIN CLOSED
90662-15B-1RC
MECH. FAULT OF RELAY 62/15B TO FUNCTION
90662-15B-FRE
RELAY 62/15B BECOMES DE-ENERGIZED
G-TBSCC-112

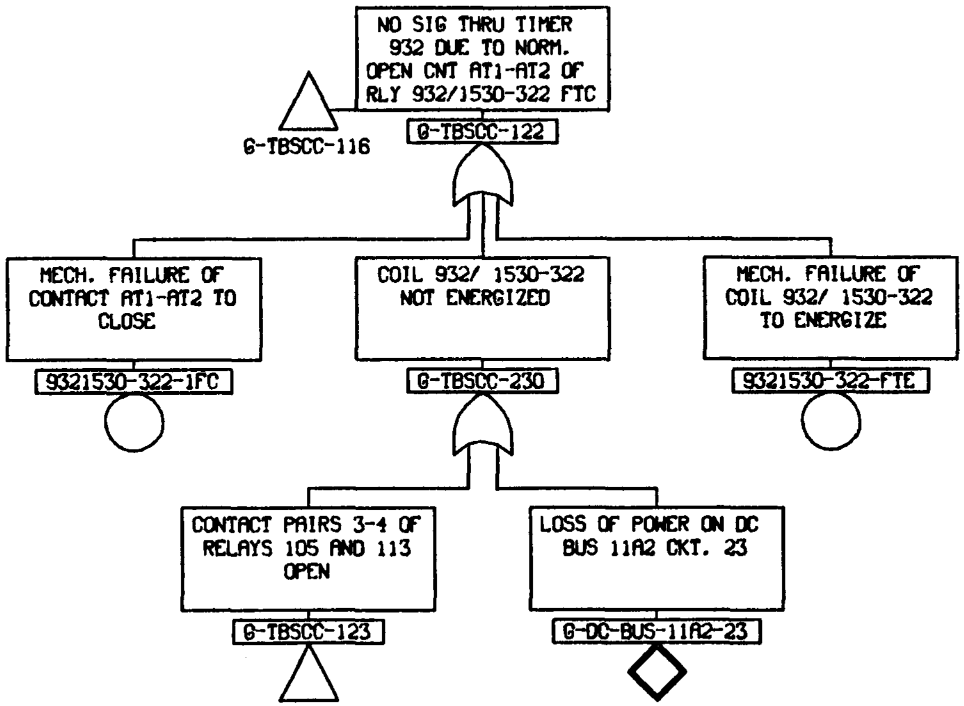
TBSCC-49

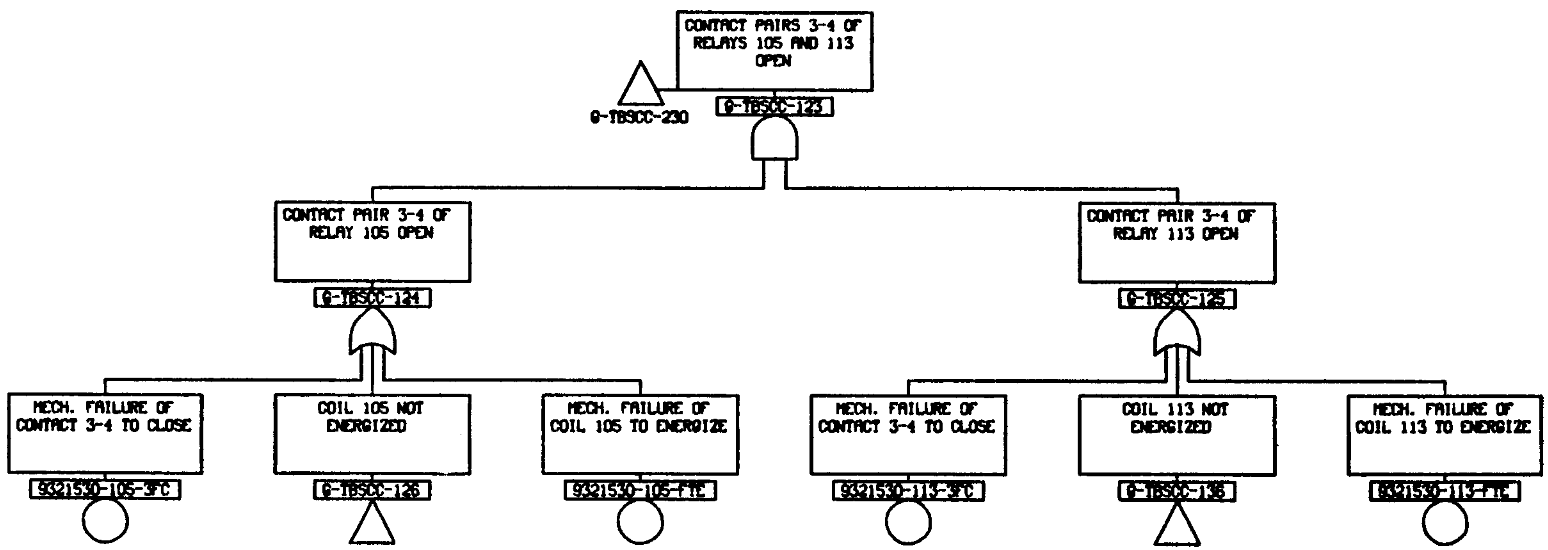

RELAY 62/15B BECOMES DE-ENERGIZED
G-TBSCC-112
G-TBSCC-111
NO POWER FROM DC 101A CKT 25
G-DC-BUS-A-25
3
N.C. CONTACT 3 OF CS/15B OPENS - MECH. FAULT
906CX-15B-3RC



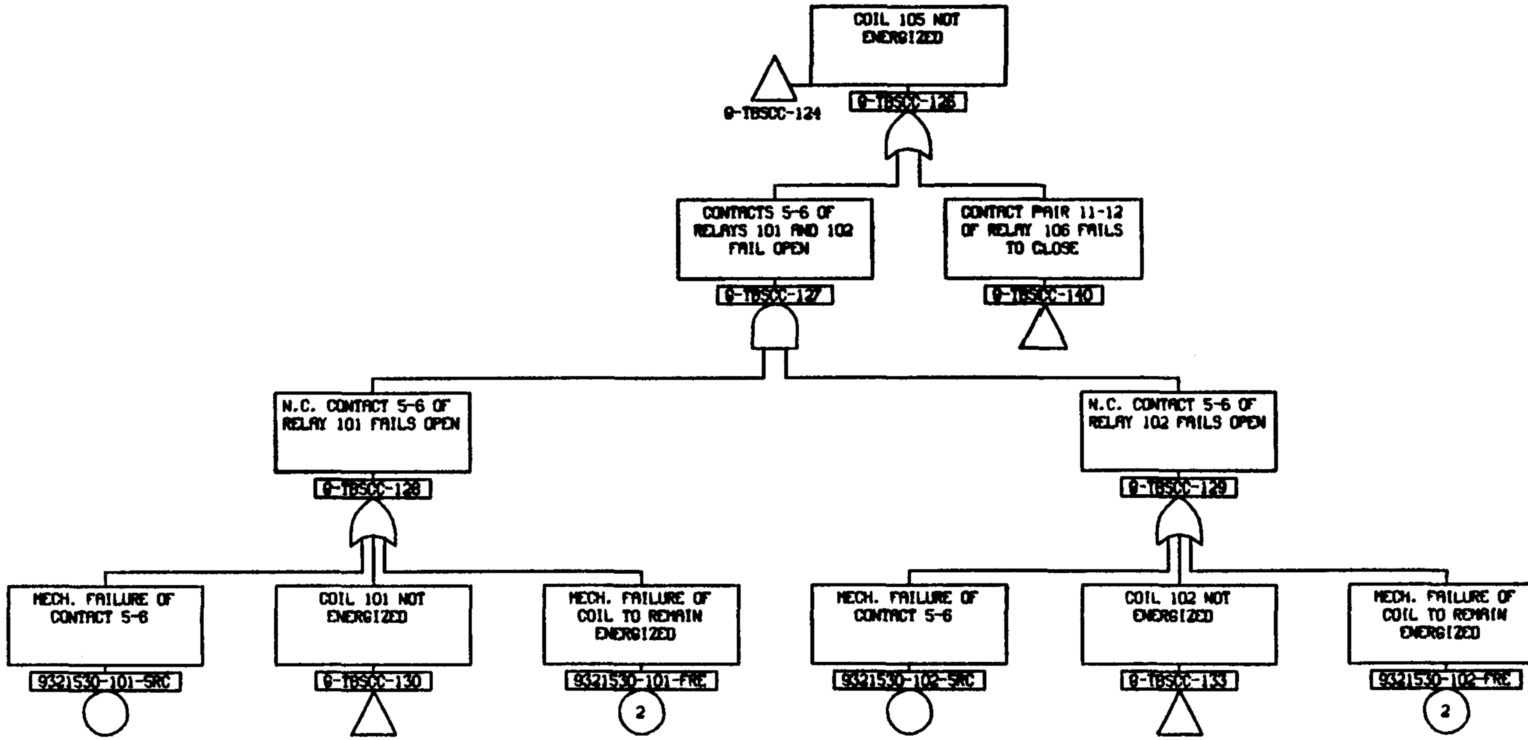
CONTACT 1-7 OF CX/15B FAILS TO CLOSE
G-TBSCC-113
G-TBSCC-110
MECHANICAL FAILURE OF CONTACT 1-7 TO CLOSE
906CX-15B-1FC
COIL CX/15B NOT ENERGIZED
G-TBSCC-114
MECHANICAL FAILURE OF COIL CX/15B
906CX-15B-FTE
NO POWER FROM DC 101A CKT 25
G-DC-BUS-A-25
3
NO SIGNAL THRU CONTACT 3A-3B OF RELAY 62-2
G-TBSCC-115
MECHANICAL FAILURE OF CONTACT 3A-3B TO CLOSE
AC-DG62-2-3AFC
COIL 62-2 NOT ENERGIZED
G-TBSCC-116
MECHANICAL FAILURE OF COIL 62-2
AC-DG62-2-FTE


COIL 62-2 NOT ENERGIZED
G-TBSCC-116
G-TBSCC-115
NO SIG THRU TIMER 932 DUE TO NORM. OPEN CNT AT1-AT2 OF RLY 932/1530-322 FTC
G-TBSCC-122
NO SIGNAL THRU LNP2, LNP2A CONTACTS
G-TBSCC-117
LOSS OF POWER ON 4160V, SWGR 14F, CUB 2
G-AC-BUS-14F
NO SIGNAL THRU LNP2 CONTACT 1-2
G-TBSCC-118
NO SIGNAL THRU LNP2A CONTACT 1-2
G-TBSCC-119
NO LOSS OF NORMAL POWER
NO-LOSS-NORM-PWR
4
MECH. FAILURE OF CONTACT 1-2 TO CLOSE
926LNP-2-1FC
NO LOSS OF NORMAL POWER
NO-LOSS-NORM-PWR
4
MECH. FAILURE OF CONTACT 1-2 TO CLOSE
926LNP-2A-1FC

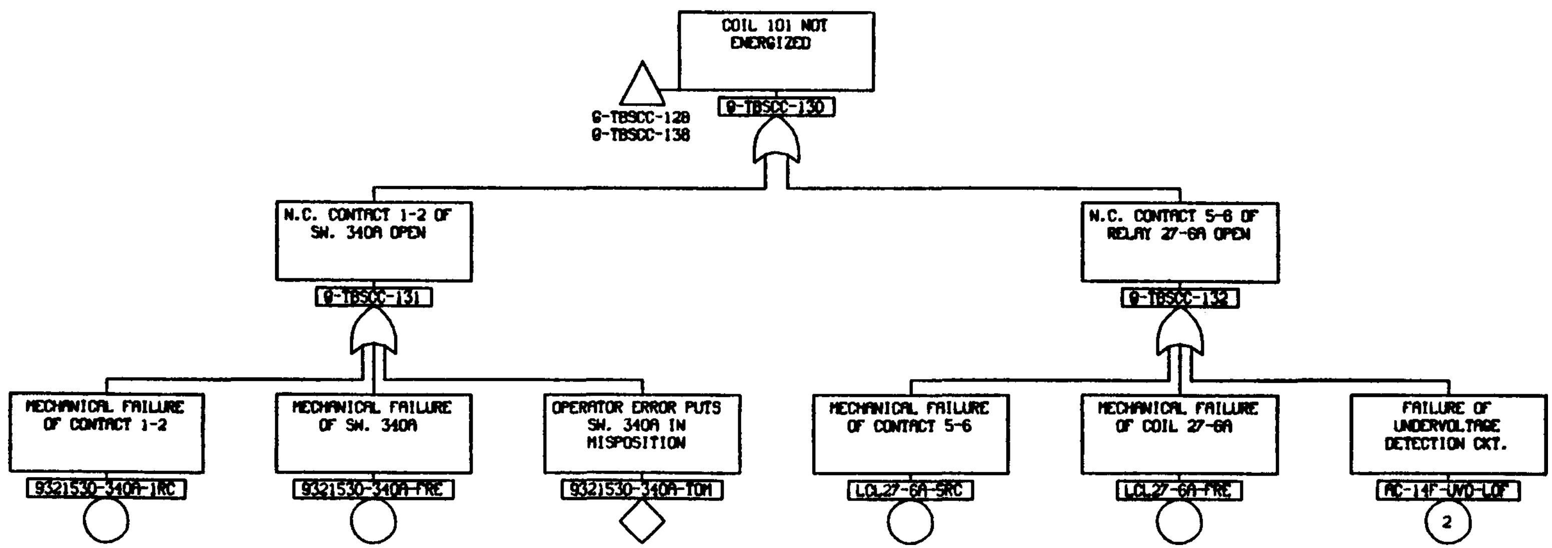

NO SIG THRU TIMER 932 DUE TO NORM. OPEN CNT AT1-AT2 OF RLY 932/1530-322 FTC
G-TBSCC-122
G-TBSCC-116
MECH. FAILURE OF CONTACT AT1-AT2 TO CLOSE
9321530-322-1FC
COIL 932/ 1530-322 NOT ENERGIZED
G-TBSCC-230
MECH. FAILURE OF COIL 932/ 1530-322 TO ENERGIZE
9321530-322-FTE
CONTACT PAIRS 3-4 OF RELAYS 105 AND 113 OPEN
G-TBSCC-123
LOSS OF POWER ON DC BUS 11A2 CKT. 23
G-DC-BUS-11A2-23

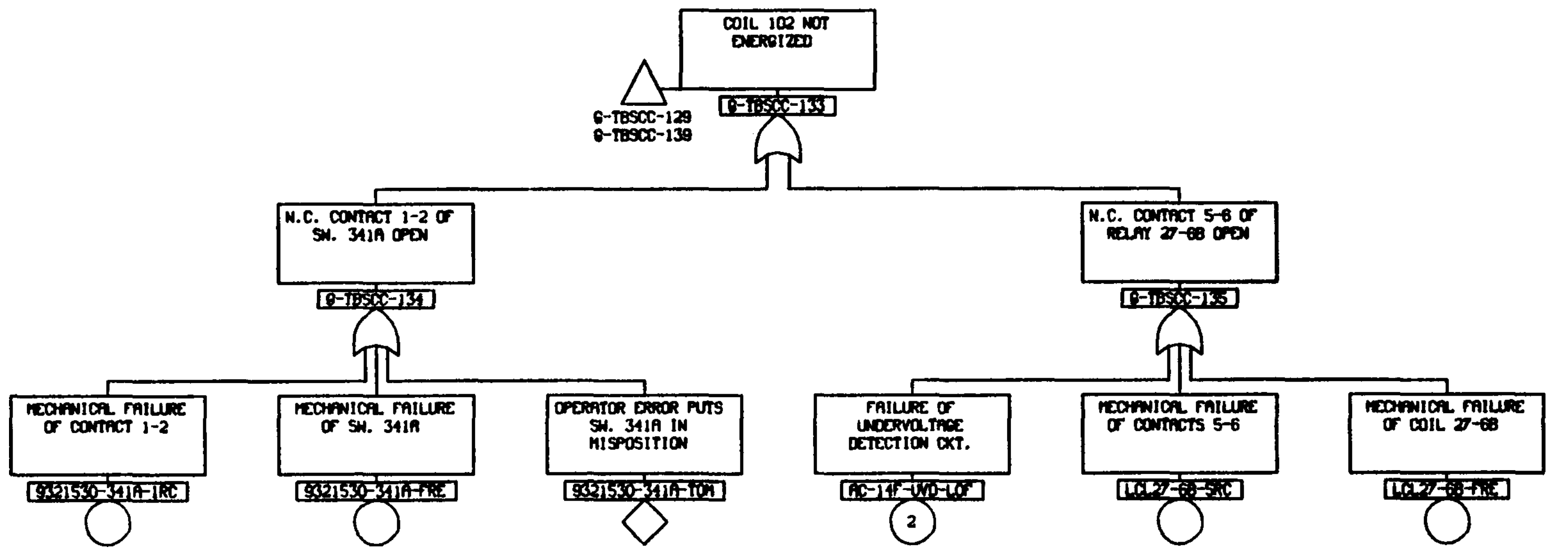

CONTACT PAIRS 3-4 OF RELAYS 105 AND 113 OPEN
G-TBSCC-123
G-TBSCC-230
CONTACT PAIR 3-4 OF RELAY 105 OPEN
G-TBSCC-124
CONTACT PAIR 3-4 OF RELAY 113 OPEN
G-TBSCC-125
MECH. FAILURE OF CONTACT 3-4 TO CLOSE
9321530-105-3FC
COIL 105 NOT ENERGIZED
G-TBSCC-126
MECH. FAILURE OF COIL 105 TO ENERGIZE
9321530-105-FTE
MECH. FAILURE OF CONTACT 3-4 TO CLOSE
9321530-113-3FC
COIL 113 NOT ENERGIZED
G-TBSCC-136
MECH. FAILURE OF COIL 113 TO ENERGIZE
9321530-113-FTE

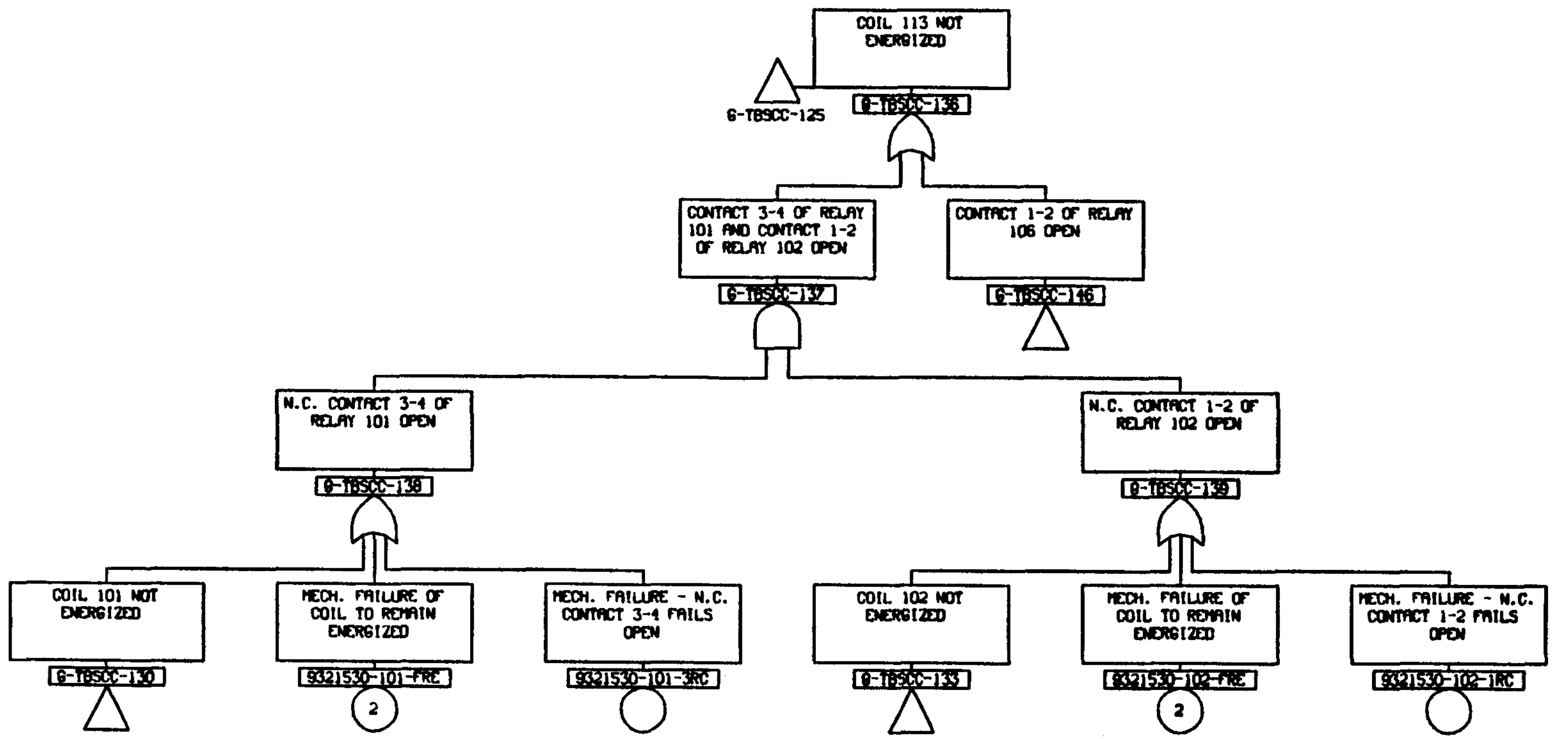
TBSCC-54


COIL 105 NOT ENERGIZED
0-TBSCC-126
0-TBSCC-124
CONTACTS 5-6 OF RELAYS 101 AND 102 FAIL OPEN
0-TBSCC-127
CONTACT PAIR 11-12 OF RELAY 106 FAILS TO CLOSE
0-TBSCC-140
N.C. CONTACT 5-6 OF RELAY 101 FAILS OPEN
0-TBSCC-128
N.C. CONTACT 5-6 OF RELAY 102 FAILS OPEN
0-TBSCC-129
MECH. FAILURE OF CONTACT 5-6
9321530-101-SRC
COIL 101 NOT ENERGIZED
0-TBSCC-130
MECH. FAILURE OF COIL TO REMAIN ENERGIZED
9321530-101-FRE
2
MECH. FAILURE OF CONTACT 5-6
9321530-102-SRC
COIL 102 NOT ENERGIZED
0-TBSCC-133
MECH. FAILURE OF COIL TO REMAIN ENERGIZED
9321530-102-FRE
2

TBSCC-55

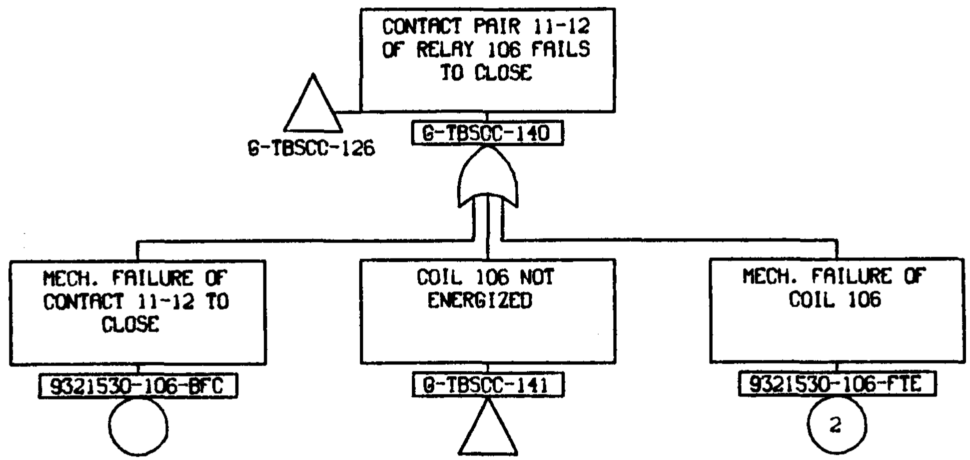

COIL 101 NOT ENERGIZED
0-TBSCC-130
0-TBSCC-128
0-TBSCC-138
N.C. CONTACT 1-2 OF SW. 340A OPEN
0-TBSCC-131
N.C. CONTACT 5-6 OF RELAY 27-6A OPEN
0-TBSCC-132
MECHANICAL FAILURE OF CONTACT 1-2
9321530-340A-1RC
MECHANICAL FAILURE OF SW. 340A
9321530-340A-FRE
OPERATOR ERROR PUTS SW. 340A IN MISPOSITION
9321530-340A-TOM
MECHANICAL FAILURE OF CONTACT 5-6
LCL27-6A-SRC
MECHANICAL FAILURE OF COIL 27-6A
LCL27-6A-FRE
FAILURE OF UNDERVOLTAGE DETECTION CKT.
AC-14F-UVD-LOF
2


COIL 102 NOT ENERGIZED
G-TBSCC-133
G-TBSCC-129
G-TBSCC-139
N.C. CONTACT 1-2 OF SW. 341A OPEN
G-TBSCC-134
N.C. CONTACT 5-6 OF RELAY 27-6B OPEN
G-TBSCC-135
MECHANICAL FAILURE OF CONTACT 1-2
9321530-341A-1RC
MECHANICAL FAILURE OF SW. 341A
9321530-341A-FRE
OPERATOR ERROR PUTS SW. 341A IN MISPOSITION
9321530-341A-TOM
FAILURE OF UNDERVOLTAGE DETECTION CKT.
AC-14F-UVD-LOF
2
MECHANICAL FAILURE OF CONTACTS 5-6
LCL27-6B-SRC
MECHANICAL FAILURE OF COIL 27-6B
LCL27-6B-FRE

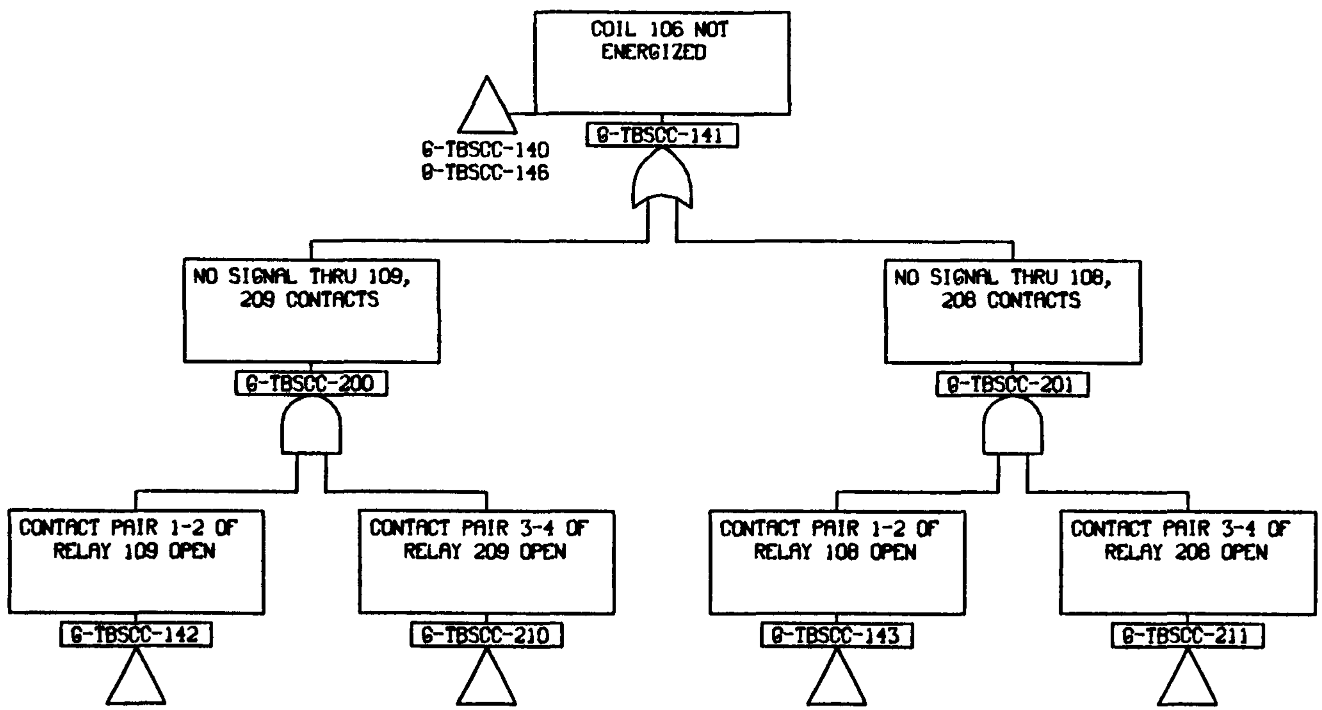


B.13-83

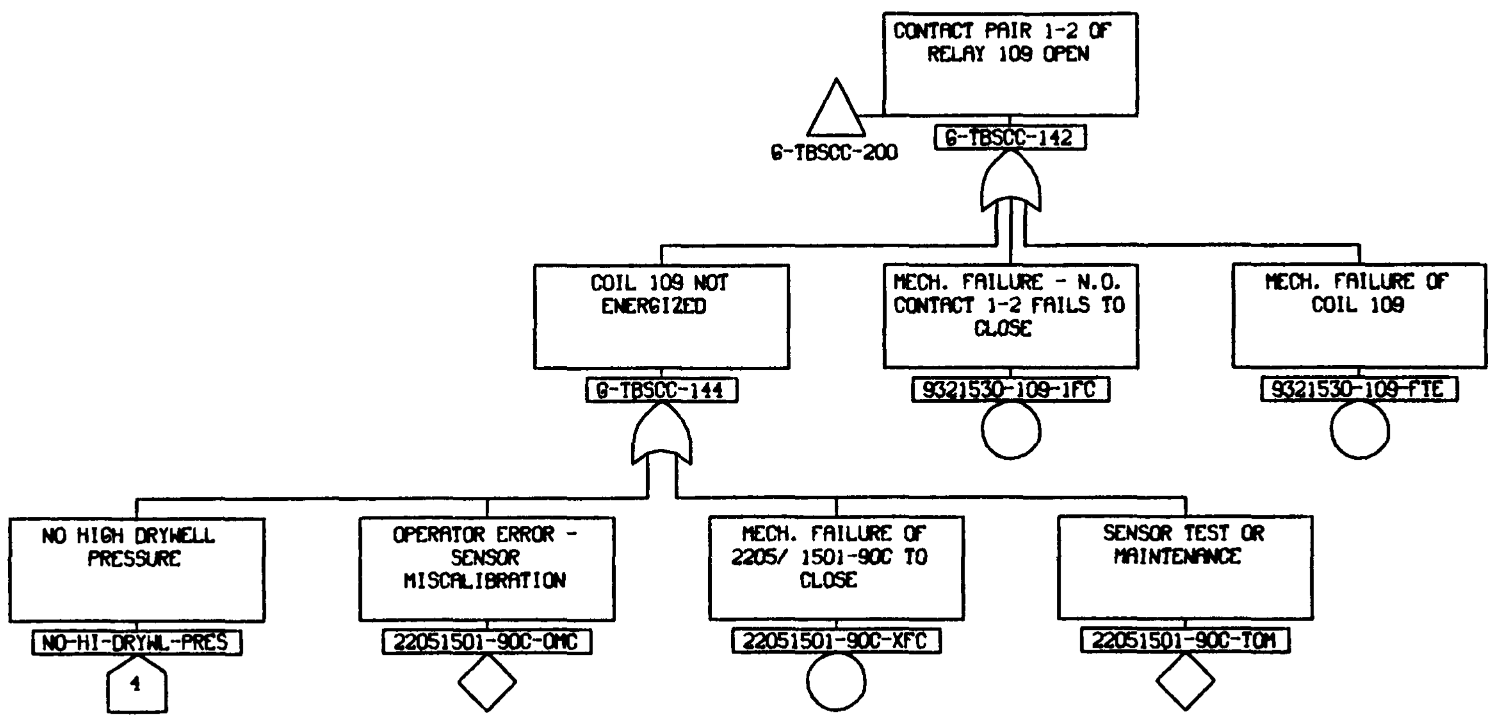
TBSCC-58

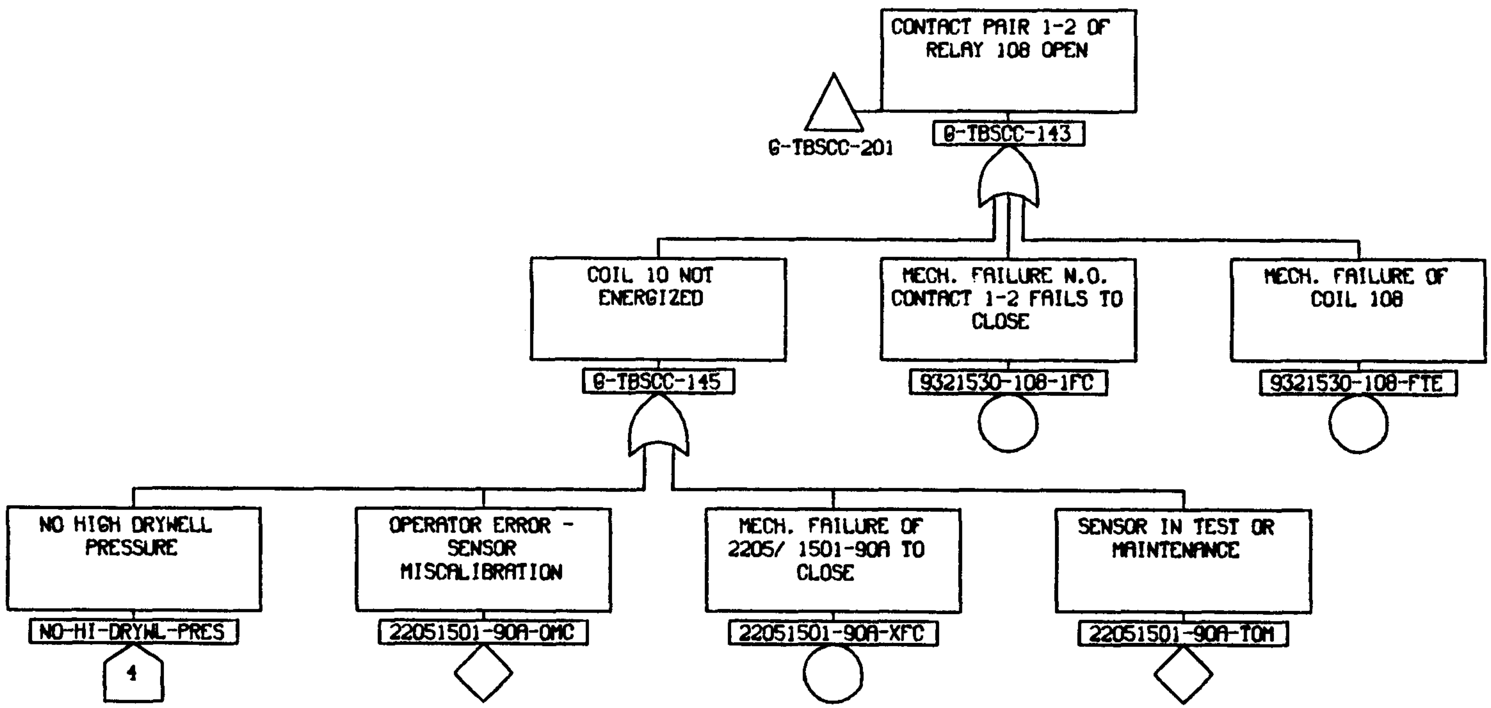

CONTACT PAIR 11-12 OF RELAY 106 FAILS TO CLOSE
G-TBSCC-140
G-TBSCC-126
MECH. FAILURE OF CONTACT 11-12 TO CLOSE
9321530-106-BFC
COIL 106 NOT ENERGIZED
G-TBSCC-141
MECH. FAILURE OF COIL 106
9321530-106-FTE
2

TBSCC-59

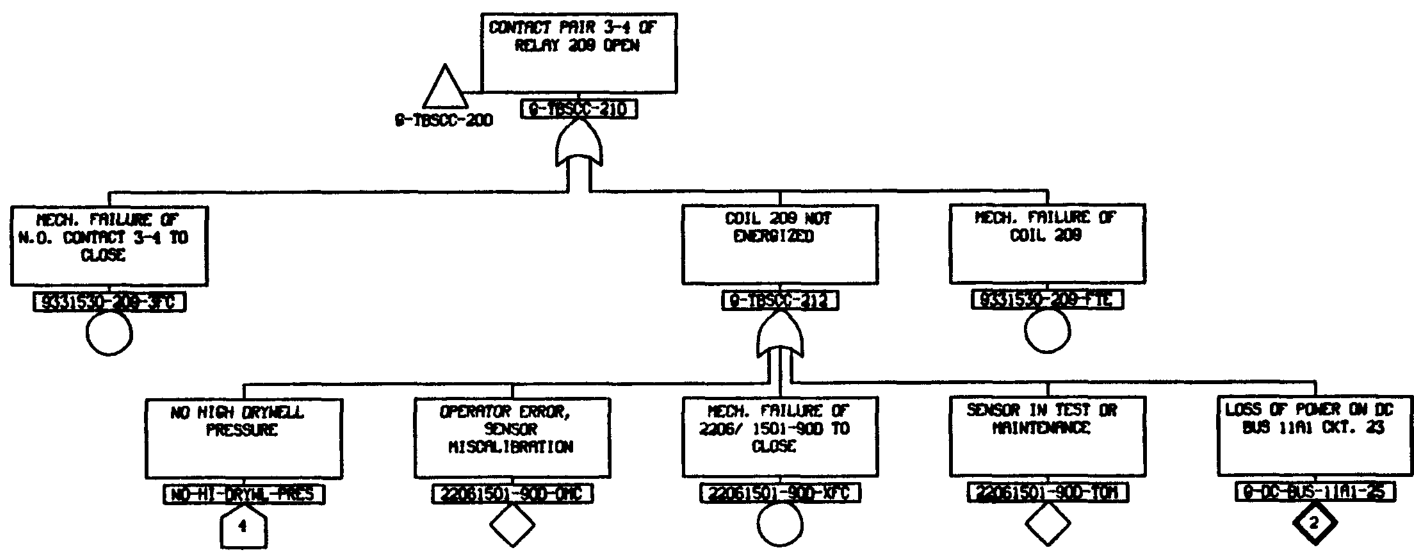

COIL 106 NOT ENERGIZED
G-TBSCC-141
G-TBSCC-140
G-TBSCC-146
NO SIGNAL THRU 109, 209 CONTACTS
G-TBSCC-200
NO SIGNAL THRU 108, 208 CONTACTS
G-TBSCC-201
CONTACT PAIR 1-2 OF RELAY 109 OPEN
G-TBSCC-142
CONTACT PAIR 3-4 OF RELAY 209 OPEN
G-TBSCC-210
CONTACT PAIR 1-2 OF RELAY 108 OPEN
G-TBSCC-143
CONTACT PAIR 3-4 OF RELAY 208 OPEN
G-TBSCC-211

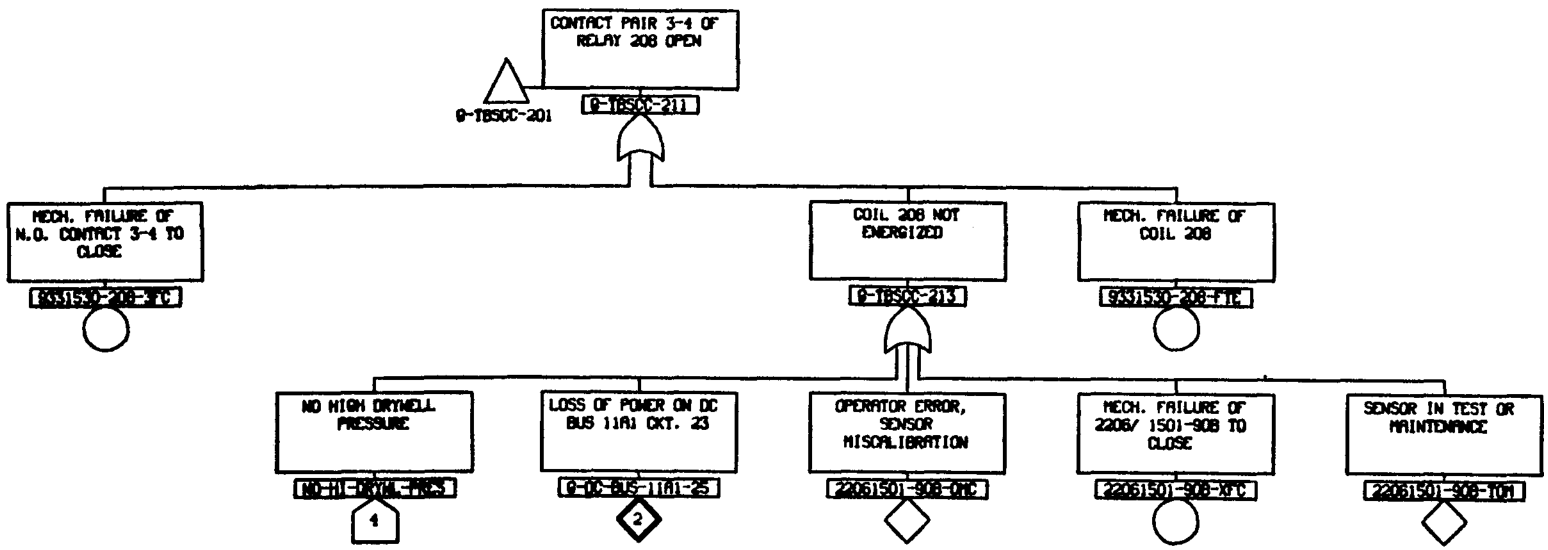
TBSCC-60


CONTACT PAIR 1-2 OF RELAY 109 OPEN
G-TBSCC-142
G-TBSCC-200
COIL 109 NOT ENERGIZED
G-TBSCC-144
MECH. FAILURE - N.O. CONTACT 1-2 FAILS TO CLOSE
9321530-109-1FC
MECH. FAILURE OF COIL 109
9321530-109-FTE
NO HIGH DRYWELL PRESSURE
NO-HI-DRYWL-PRES
4
OPERATOR ERROR - SENSOR MISCALIBRATION
22051501-90C-OMC
MECH. FAILURE OF 2205/ 1501-90C TO CLOSE
22051501-90C-XFC
SENSOR TEST OR MAINTENANCE
22051501-90C-TOM


CONTACT PAIR 1-2 OF RELAY 108 OPEN
G-TBSCC-143
G-TBSCC-201
COIL 10 NOT ENERGIZED
G-TBSCC-145
MECH. FAILURE N.O. CONTACT 1-2 FAILS TO CLOSE
9321530-108-1FC
MECH. FAILURE OF COIL 108
9321530-108-FTE
NO HIGH DRYWELL PRESSURE
NO-HI-DRYWL-PRES
4
OPERATOR ERROR - SENSOR MISCALIBRATION
22051501-90A-OMC
MECH. FAILURE OF 2205/ 1501-90A TO CLOSE
22051501-90A-XFC
SENSOR IN TEST OR MAINTENANCE
22051501-90A-TOM

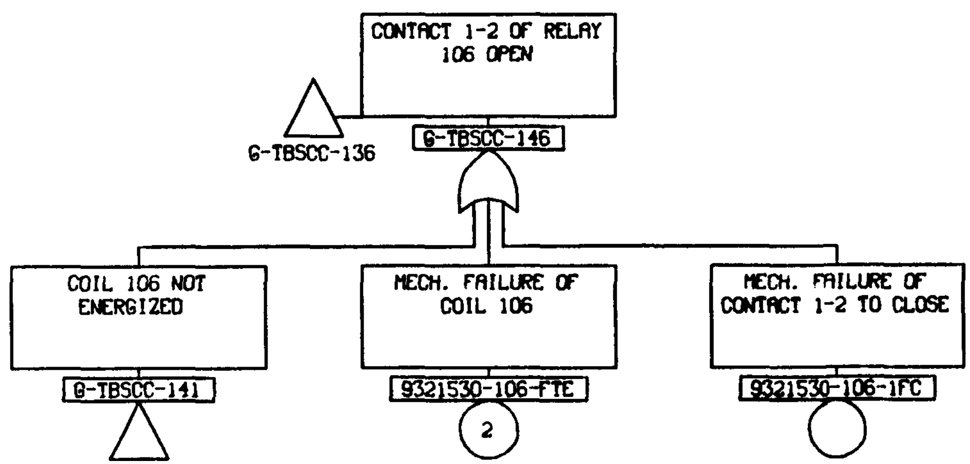
TBSCC-62


CONTACT PAIR 3-4 OF RELAY 209 OPEN
Q-TBSCC-210
Q-TBSCC-200
MECH. FAILURE OF N.O. CONTACT 3-4 TO CLOSE
9331530-209-3FC
COIL 209 NOT ENERGIZED
Q-TBSCC-212
MECH. FAILURE OF COIL 209
9331530-209-FTE
NO HIGH DRYWELL PRESSURE
NO-HI-DRYWL-PRES
4
OPERATOR ERROR, SENSOR MISCALIBRATION
22061501-900-OMC
MECH. FAILURE OF 2206/ 1501-900 TO CLOSE
22061501-900-XFC
SENSOR IN TEST OR MAINTENANCE
22061501-900-TOM
LOSS OF POWER ON DC BUS 11A1 CKT. 23
Q-DC-BUS-11A1-25
2

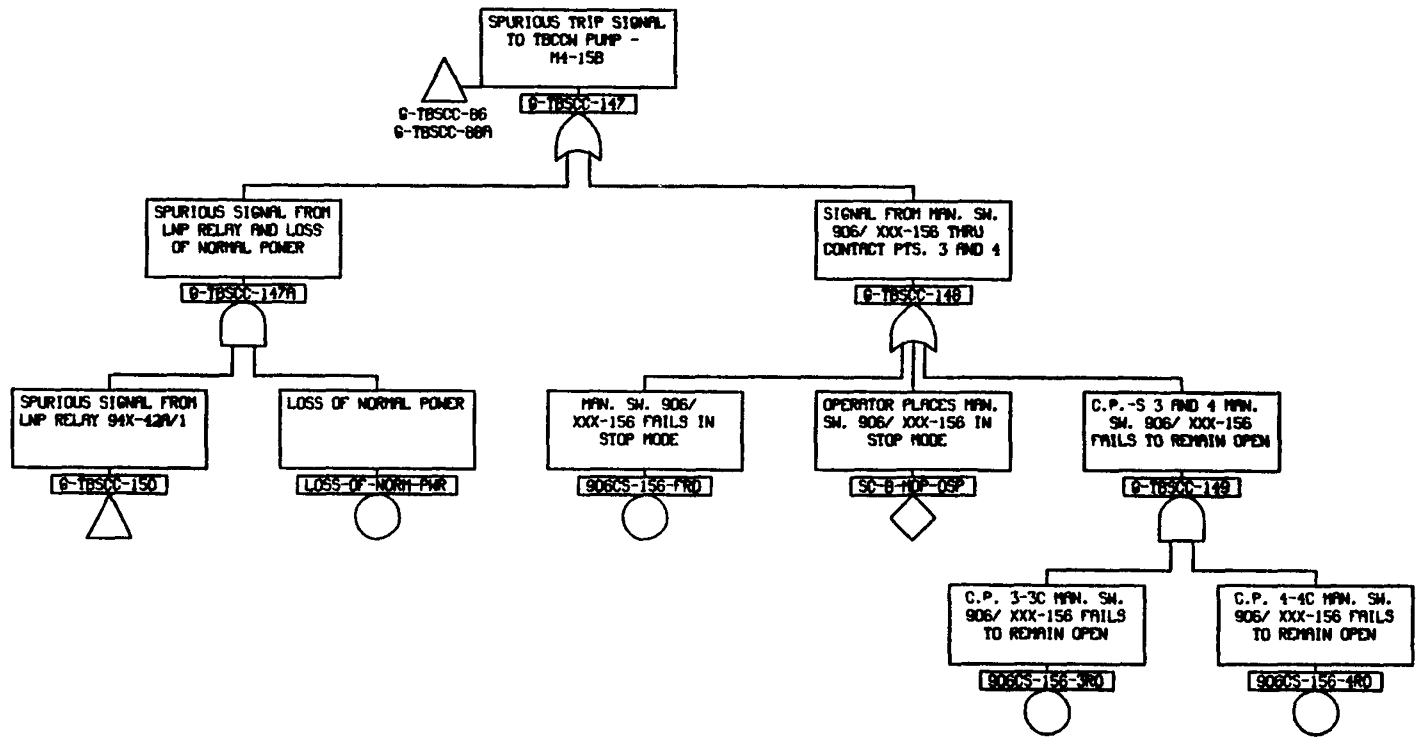


B.13-89

TBSCC-64

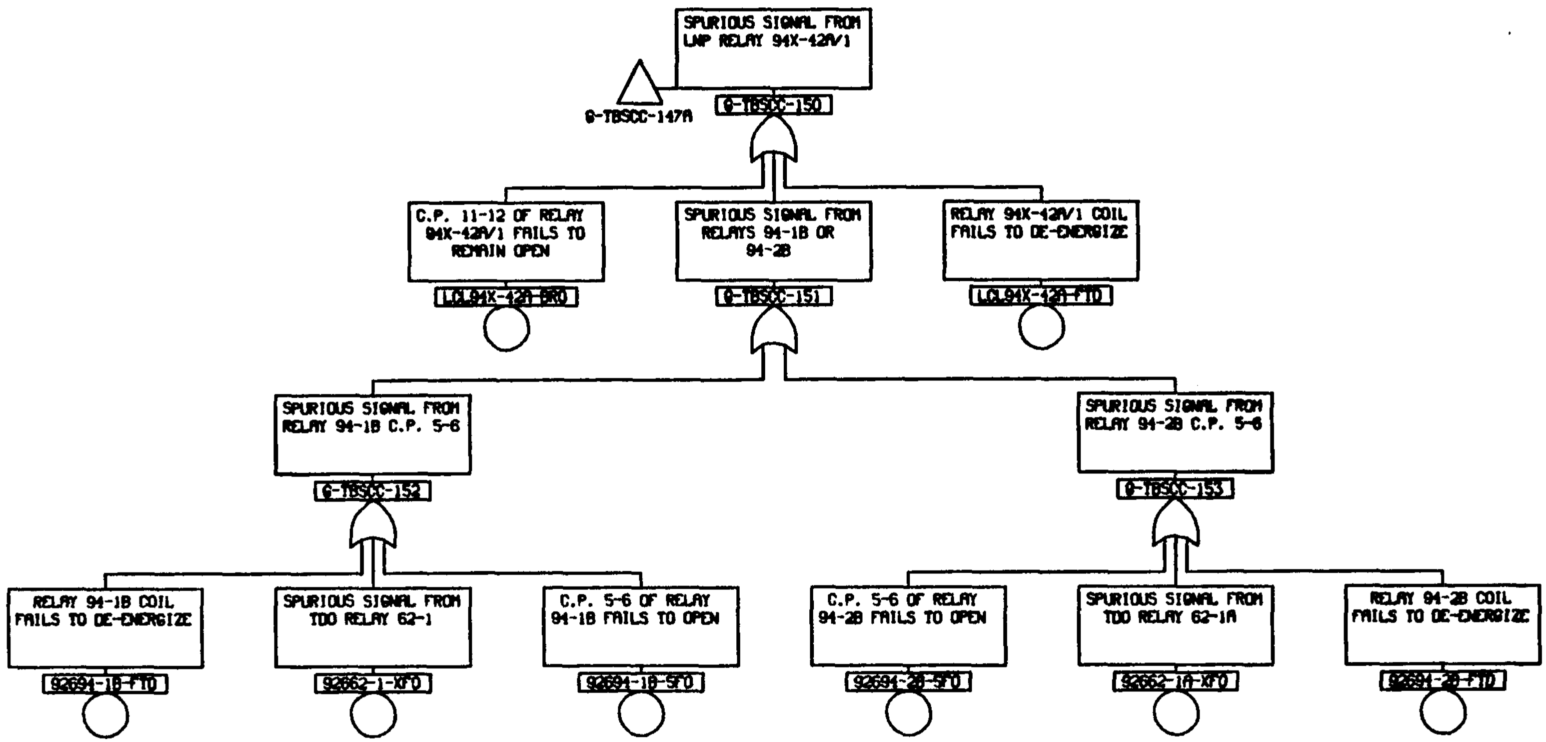


CONTACT 1-2 OF RELAY 106 OPEN
G-TBSCC-146
G-TBSCC-136
COIL 106 NOT ENERGIZED
G-TBSCC-141
MECH. FAILURE OF COIL 106
9321530-106-FTE
2
MECH. FAILURE OF CONTACT 1-2 TO CLOSE
9321530-106-1FC



SPURIOUS TRIP SIGNAL TO TBCCW PUMP - M4-15B
G-TBSCC-147
G-TBSCC-86
G-TBSCC-86A
SPURIOUS SIGNAL FROM LNP RELAY AND LOSS OF NORMAL POWER
G-TBSCC-147A
SIGNAL FROM MAN. SW. 906/ XXX-156 THRU CONTACT PTS. 3 AND 4
G-TBSCC-148
SPURIOUS SIGNAL FROM LNP RELAY 94X-42A/1
G-TBSCC-150
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
MAN. SW. 906/ XXX-156 FAILS IN STOP MODE
906CS-156-FRD
OPERATOR PLACES MAN. SW. 906/ XXX-156 IN STOP MODE
SC-B-HOP-OSP
C.P.-S 3 AND 4 MAN. SW. 906/ XXX-156 FAILS TO REMAIN OPEN
G-TBSCC-149
C.P. 3-3C MAN. SW. 906/ XXX-156 FAILS TO REMAIN OPEN
906CS-156-3RO
C.P. 4-4C MAN. SW. 906/ XXX-156 FAILS TO REMAIN OPEN
906CS-156-4RO

TBSCC-66


SPURIOUS SIGNAL FROM LNP RELAY 94X-42A/1
G-TBSCC-150
G-TBSCC-147A
C.P. 11-12 OF RELAY 94X-42A/1 FAILS TO REMAIN OPEN
LCL94X-42A-BRO
SPURIOUS SIGNAL FROM RELAYS 94-1B OR 94-2B
G-TBSCC-151
RELAY 94X-42A/1 COIL FAILS TO DE-ENERGIZE
LCL94X-42A-FTD
SPURIOUS SIGNAL FROM RELAY 94-1B C.P. 5-6
G-TBSCC-152
SPURIOUS SIGNAL FROM RELAY 94-2B C.P. 5-6
G-TBSCC-153
RELAY 94-1B COIL FAILS TO DE-ENERGIZE
92694-1B-FTD
SPURIOUS SIGNAL FROM TDO RELAY 62-1
92662-1-XFO
C.P. 5-6 OF RELAY 94-1B FAILS TO OPEN
92694-1B-SFO
C.P. 5-6 OF RELAY 94-2B FAILS TO OPEN
92694-2B-SFO
SPURIOUS SIGNAL FROM TDO RELAY 62-1A
92662-1A-XFO
RELAY 94-2B COIL FAILS TO DE-ENERGIZE
92694-2B-FTD

APPENDIX B.14

SERVICE WATER SYSTEM

B.14.1 Service Water System Description

B.14.1.1 Purpose

The purpose of the station service water system (SWS) is to supply cooling water from Long Island Sound to the station closed cooling systems and other direct cooling loads.

B.14.1.2 Description and Configuration

Figure B.14-1 illustrates a simplified piping schematic of the SWS. Four pumps provide seawater for secondary cooling to the RBCCW heat exchangers, the TBSCCW water heat exchangers, and direct cooling to the diesel generator. Each vertical centrifugal pump is capable of delivering 10,000 gpm. All four pumps supply a single 34inch header. Check and manual valves located in series provide a means of pump isolation from the supply header. Flow from the 34-inch header is directed through a self-cleaning strainer, going on to supply the various cooling loads. The self-cleaning SWS strainer includes a bypass with a normally closed butterfly valve (SW-19).

Normally open manual and butterfly valves provide isolation capability for the three RBCCW heat exchangers. The two TBSCCW heat exchangers can similarly be isolated by closure of two manual valves. Normally open manual valves (SW-26 and SW-27) provide isolation capability for the two diesel generator cooling water heat exchangers. Normally closed air operated valve SW-99 prevents flow from going through these heat exchangers reducing corrosion effects when the diesel generator is in a shutdown condition.

B.14.1.3 System Interfaces

System interfaces for the service water system are shown in Table B.14-1.

B.14.1.4 Instrumentation and Control

The SWS is in continual operation and consequently is not dependent on specific plant conditions for actuation. The design includes typical plant instrumentation for diagnostic surveillance of the various service water components.

Manual actuation of all four service water pumps is provided for on control panel 906. Automatic actuation is provided for pumps C and D after tripping on an LNP signal. Similarily, motor operated valve SW-9 isolates on an LNP signal and air operated valve SW-99 opens. Figure B.14-2 illustrates the control wiring schematics and Figure B.14-3 presents the loss of normal power circuits.

B.14.1.5 Testing

There are four tests of the service water system:

SP-608.5 Service Water System Readiness Test

This test, (performed monthly), examines each pump. For each operating pump motor current and discharge pressure are recorded. For each non-operating pump verification of the discharge check valve to seat is made by observing the pump shaft for reverse rotation. The pumps are rotated during this test with the above two steps repeated.

SP-608.16 SWS to TBCCW Heat Exchanger Power Operated Valve Readiness Test

This test, performed during each refueling outage, examines the operational readiness of the SWS to TBSCCW heat exchangers power operated valve. Specifically, power operated valve SW-9 is manually closed from control panel 906 and the closing time recorded. After test completion the power operated valve is reopened.

SP-617.1 Loss of Normal Power Relays Test

Performed during every refueling outage, this test provides a functional examination of all relays, breakers, and contactors required to operate in a "Loss of Normal Power" condition.

SP-688.1 Diesel Generator Operational Readiness Demonstration

This test (performed monthly) demonstrates the operational readiness of the diesel generator, the diesel starting air compressor, and the diesel fuel oil pumps. As a part of this examination verification of the operability of the normally closed diesel generator heat exchanger outlet valve (SW-99) is included.

OP-321 Service Water System Operating Procedure

This procedure provides detailed instruction for the service water system. It includes OP321-1, the service water valve checkoff list.

B.14.1.6 Maintenance

There is no scheduled maintenance for this system. Maintenance is performed on an as-needed basis.

B.14.1.7 Technical Specifications

The SWS is a continually operating system; consequently, there are no applicable technical specifications.

B.14.1.8 Operation

The SWS is in continuous operation during all modes of plant operation and during shutdown. Two or three pumps may be in service depending on the plant mode. One or two service water pumps, depending on plant operating conditions, are provided for standby service and are capable of being manually actuated from control room panel 906. The system is designed such that all heat exchanger outlet valves (with the exception of the diesel cooling water heat exchanger) are to be left wide open during normal operation.

Automatic actuation for two pumps occurs after an LNP signal. Service water pumps C and D are driven from the gas turbine and diesel generator, respectively. Air operated valve SW-99 opens to allow cooling flow through the diesel generator heat exchangers and motor operated valve SW-9 closes to isolate flow to the turbine building closed cooling water heat exchangers.

B.14.2 Analysis

B.14.2.1 Success/Failure Criteria

Successful operation of the SWS under a loss of normal power condition is to provide cooling water to the RBCCW heat exchangers, the TBSCCW system, and the diesel generator. Such success can be achieved if motor operated valve SW-9 isolates, if air operated valve SW-99 opens, and if one service water pump is brought on line.

Failure of the service water system would result in the inability of the TBSCCW heat exchanger to provide cooling to the feedwater coolant injection system pumps, failure of the diesel generator heat exchanger to provide cooling to the diesel, and failure of the RBCCW heat exchanger to provide heat removal to the shutdown cooling system during the first 20 hours of the accident. Consequently, one of the high pressure injection systems, the diesel generator, and the shutdown cooling system would be lost after an LNP event.

B.14.2.2 Assumptions

In this analysis, the following assumptions were made:

1) The bypass strainer butterfly valve, "failure to remain closed state," was not considered. If the valve were to open, only a limited unfiltered flow would reach the heat exchangers. Consequently, the potential for heat exchanger plugging is minimal.

2) Failures in the SWS are assumed to have a prompt detection interval, since the SWS is a continually running system.

Table B.14-1

Service Water Interfaces Failure Mode and Effects

Primary System			Support System			Failure Mode	Fault Effect
System	Div.	Comp.	System	Div.	Comp.		
SWS		Service water pump D	AC Power	Diesel	Bus 14F	Low or zero voltage	Pump "D" CFSR (concurrent failure to start or run)
		Service water pump C	AC Power	G/T	Bus 14E	Low or zero voltage	Pump "C" CFSR (concurrent failure to start or run)
SWS		Service water pump D	DC Power		Bus 101A	Low or zero voltage	Precludes manual start on LNP.
		Service water pump C	DC Power		Bus 101B	Low or zero voltage	Running pump not affected locally.
SWS		Service water pump A	DC Power		Bus 101B	Low or zero voltage	Precludes manual start
SWS		Service water pump B	DC Power		Bus 101A	Low or zero voltage	Precludes manual start
SWS		Service water pump C	DC Power		Bus 11A-1	Low or zero voltage	Precludes automatic start on LNP
SWS		Service water pump D	DC Power		Bus 11A-2	Low or zero voltage	Precludes automatic start on LNP
SWS		MOV SW-9	AC Power		Bus EF-7	Low or zero voltage	Precludes automatic or manual closure of SW-9

Table B.14-1 (Cont'd)

Service Water Interfaces Failure Mode and Effects

Primary System			Support System			Failure Mode	Fault Effect
System	Div.	Comp.	System	Div.	Comp.		
SWS		MOV SW-9	DC Power		Bus 11A-1	Low or zero voltage	Precludes automatic closure of SW-9
SWS		MOV SW-9	AC Power	G/T	Bus 14E	Low or zero voltage	Precludes automatic closure of SW-9
SWS		MOV SW-9	AC Power	Diesel	Bus 14F	Low or zero voltage	Precludes automatic closure of SW-9
SWS		Service water pump A	AC Power		Bus 14C	Low or zero voltage	Pump tails to run
SWS		Service water Pump B	AC Power		Bus 14D	Low or zero voltage	Pump tails to run

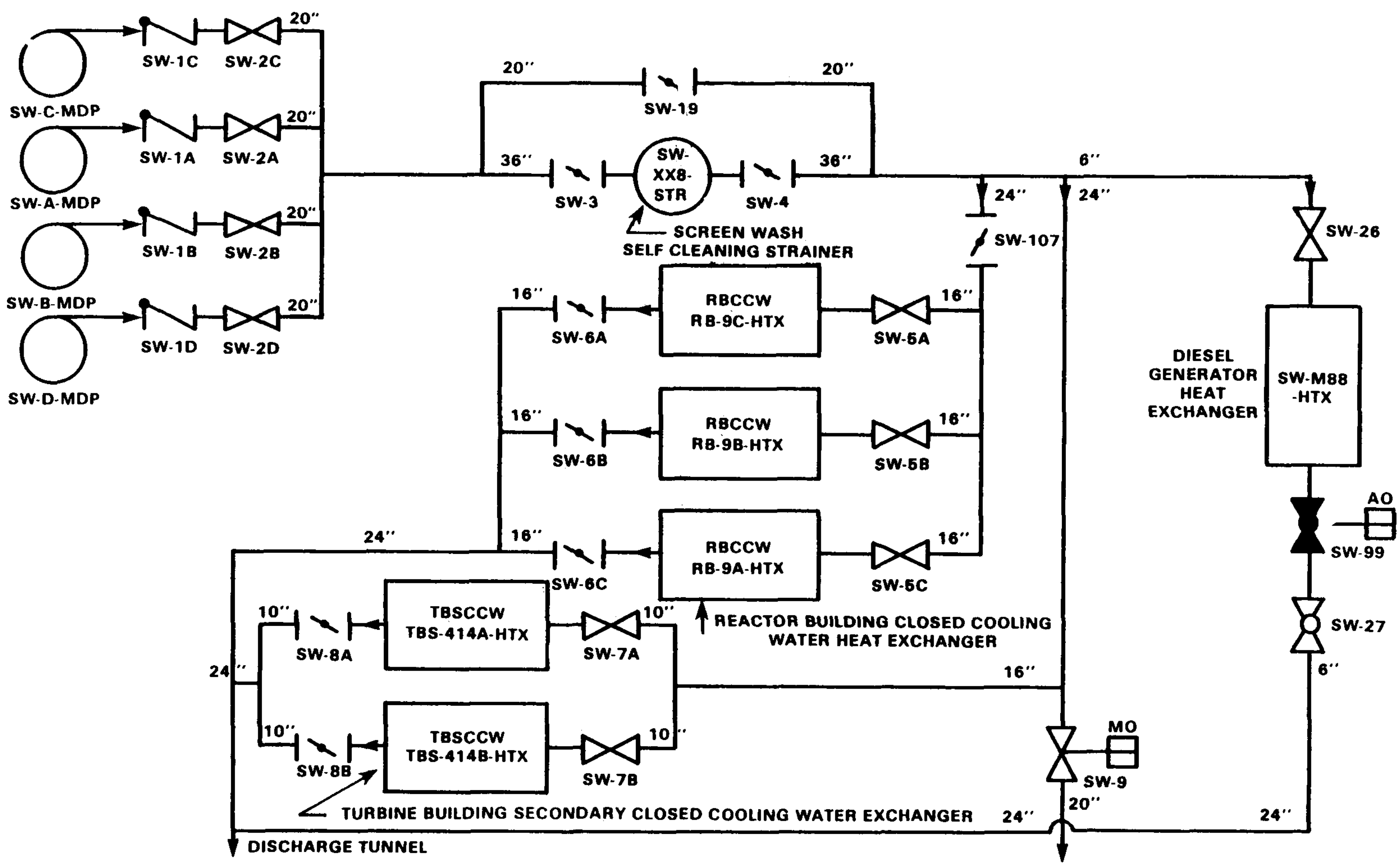


FIGURE B.14-1. SERVICE WATER SYSTEM

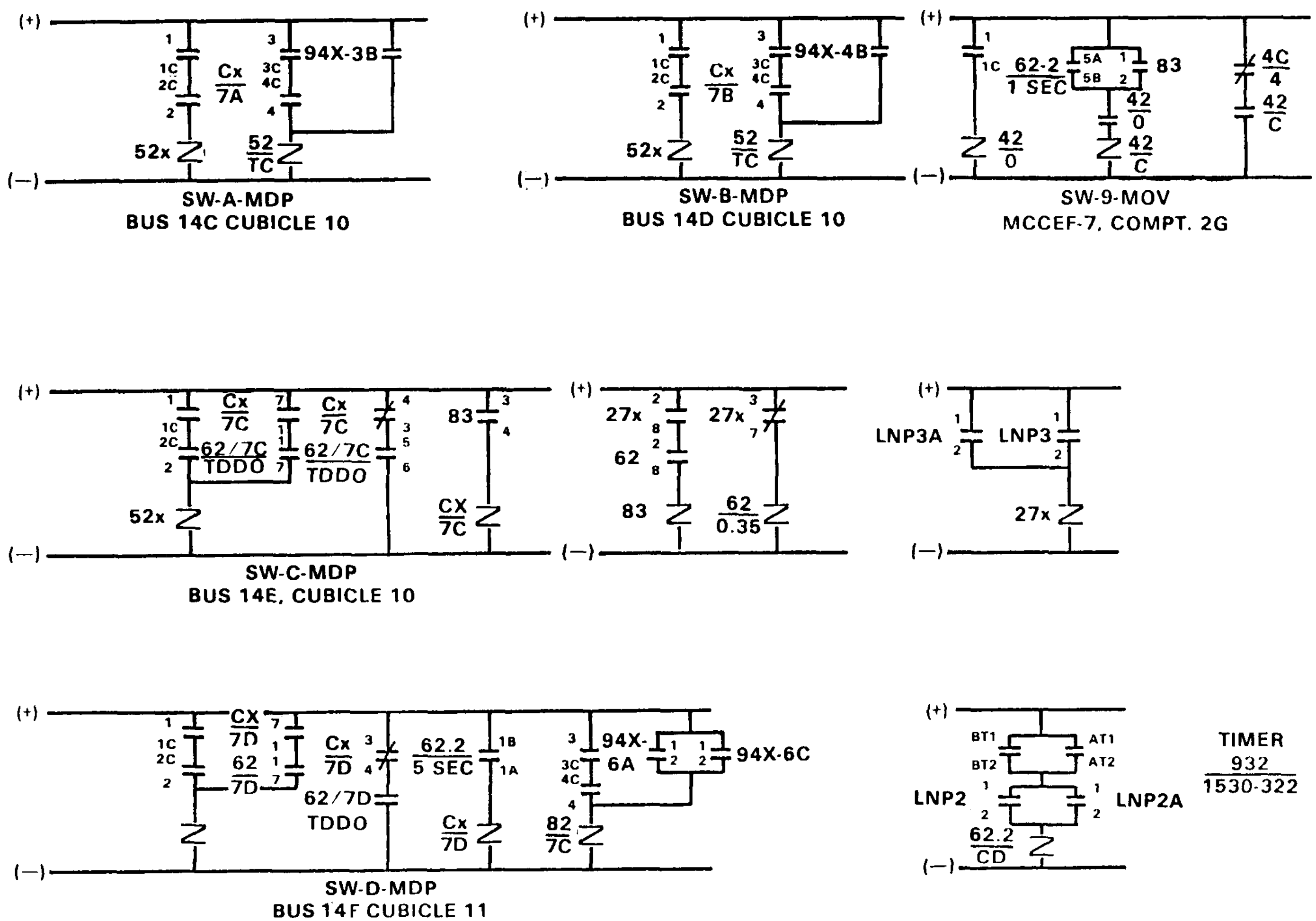


FIGURE B.14-2. SERVICE WATER SYSTEM CONTROL WIRING SCHEMATICS

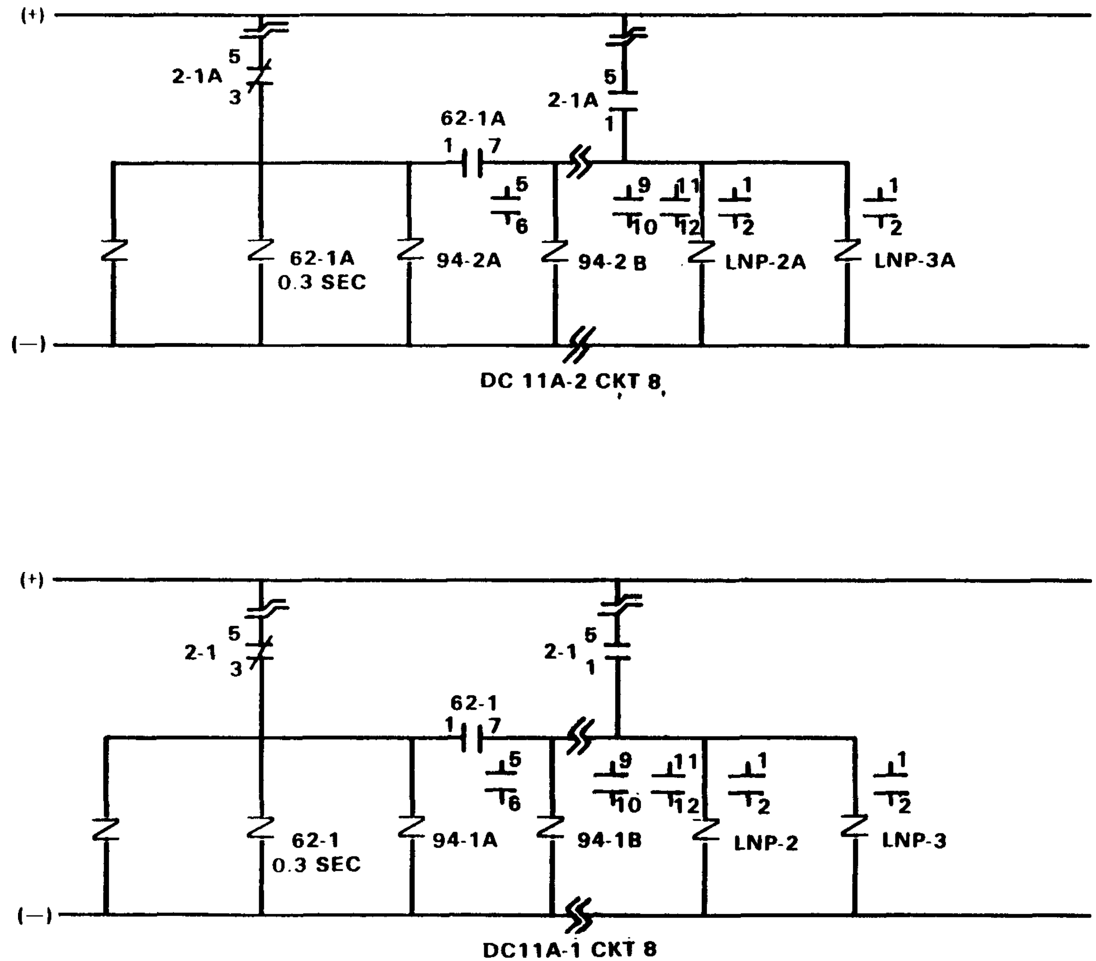


FIGURE B.14-3. SERVICE WATER SYSTEM LOSS OF NORMAL POWER CIRCUITS

SERVICE WATER SYSTEM

FAULT TREE AND FAULT SUMMARY SHEETS

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
RB-9A-HTX-TOM RB-9B-HTX-TOM RB-9C-HTX-TOM TBS-414A-HTX-TOM TBS-414B-HTX-TOM SW-M88-HTX-TOM	The heat exchanger is out of service due to maintenance or not returned to service after maintenance	Prompt	With a continuously running system the detection interval is assumed prompt	1.71E-5
RB-9A-HTX-LOF RB-9B-HTX-LOF RB-9C-HTX-LOF TBS-414A-HTX-LOF TBS-414B-HTX-LOF SW-M88-HTX-LOF	The heat exchanger is out of service due to a "loss of function," i.e. an inability to provide the necessary tube side heat transfer (e.g. plugged tubes)	Prompt	With a continuously running system the detection interval is assumed prompt	2.05E-4
SW-A-MDP-TOM SW-B-MDP-TOM SW-C-MDP-TOM SW-D-MDP-TOM	The motor driven pump is out of service during maintenance or not returned to service after maintenance or testing.	One month	Pumps tested per SP 608.5	5.7E-3
SW-A-MDP-LOF SW-B-MDP-LOF SW-C-MDP-LOF SW-D-MDP-LOF	The motor driven pump is out of service due to a "loss of function," i.e. an inability provide the required flow to the service water system.	One month	Pumps tested per SP 608.5	1.72E-3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SW-1A-CKV-TMC SW-1B-CKV-TMC SW-1C-CKV-TMC SW-1D-CKV-TMC	Check valve, supposed to be open, in actuality is closed due to being in maintenance or having been left in the closed position after maintenance	Prompt	Check valve tested per SP 608.5, monthly; continuous flow through valve	3E-6
SW-1A-CKV-FRO SW-1B-CKV-FRO SW-1C-CKV-FRO SW-1D-CKV-FRO	Check valve is open and is supposed to remain open but fails to do so.	Prompt	Check valve tested per SP 608.5, monthly; continuous flow through valve	7.2E-6
SW-2A-XV-TMC SW-2B-XV-TMC SW-2C-XV-TMC SW-2D-XV-TMC	Manual valve, supposed to be open, in actuality is closed due to being in maintenance or having been left in the closed position after maintenance.	Prompt	Manual valve tested per SP 608.5, monthly; continuous flow through valve	2.78E-6
SW-2A-XV-FRO SW-2B-XV-FRO SW-2C-XV-FRO SW-2D-XV-FRO	Manual valve is open and is supposed to remain open but fails to do so.	Prompt	Manual valve tested per SP 608.5, monthly; continuous flow through valve	6.67E-6

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SW-3-XV-TMC SW-4-XV-TMC SW-26-XV-TMC	Manual valve, supposed to be open, in actuality is closed due to being in maintenance or having been left in the closed position after maintenance	Prompt	With a continuously running system the detection interval is assumed prompt	2.78E-6
SW-3-XV-FRO SW-4-XV-FRO SW-26-XV-FRO	Manual valve is open and is supposed to be open but fails to do so	Prompt	With a continuously running system the detection interval is assumed prompt	6.67E-6
SW-5A-XV-FRO SW-5B-XV-FRO SW-5C-XV-FRO SW-6A-XV-FRO SW-6B-XV-FRO SW-6C-XV-FRO SW-7A-XV-FRO SW-7B-XV-FRO	Manual valve is open and is supposed to be open but fails to do so	Prompt	With a continuously running system the detection interval is assumed prompt	6.67E-6
SW-8A-XV-FRO SW-8B-XV-FRO SW-27-XV-FRO SW-107-XV-FRO	Manual valve is open and is supposed to be open but fails to do so	Prompt	With a continuously running system the detection interval is assumed prompt	6.67E-6

MILLSTONE 1
SYSTEM SW
SHEET #3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SW-5A-XV-TMC SW-5B-XV-TMC SW-5C-XV-TMC SW-6A-XV-TMC SW-6B-XV-TMC SW-6C-XV-TMC	Manual valve, supposed to be open, in actuality is closed due to being in maintenance or having been left in the closed position after maintenance	Prompt	With a continuously running system the detection interval is assumed prompt	2.78E-6
SW-7A-XV-TMC SW-7B-XV-TMC SW-8A-XV-TMC SW-8B-XV-TMC SW-27-XV-TMC SW-107-XV-TMC	Manual valve, supposed to be open, in actuality is closed due to being in maintenance or having been left in the closed position after maintenance	Prompt	With a continuously running system the detection interval is assumed prompt	2.78E-6
SW-448-STR-LOF	The self-cleaning strainer is out of service due to a loss of function. Loss of function is the inability to provide filtered flow (e.g. being plugged).	Prompt	With a continuously running system the detection interval is assumed prompt	2.38E-2
AC-14C-10-FTC AC-14D-10-FTC AC-14E-10-FTC AC-14F-11-FTC	Circuit Breaker fails to close	One month	Circuit Breaker tested per SP 608.5	1E-3

MILLSTONE 1
SYSTEM SW
SHEET #4

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
906CS-151-1FC 906CS-151-2FC 906CS-152-1FC 906CS-152-2FC 906CS-153-1FC 906CS-153-2FC 906CS-154-1FC 906CS-154-2FC	The contact pair (CP) of manual switches 151, 152, 153 and 154 fails to close	One month	Switch tested per SP 608.5	1.08E-4
906CS-151-FTE 906CS-152-FTE 906CS-153-FTE 906CS-154-FTE	Manual switches 151, 152, 153 and 154 fail to energize	One Month	Switches tested per SP 608.5	1E-4
SW-A-MDP-OFC SW-B-MDP-OFC SW-C-MDP-OFC SW-D-MDP-OFC	The operator fails to close manual switches 151, 152, 153 and 154	Prompt	With a continuously running system the detection interval is assumed prompt	5E-2
906CX-7D-1FC	Contact Pair 1-7 of relay CX/7D fails to close	12000 hrs. (detected during refueling outages)	Tested per SP 617.1	1.8E-3
906CX-7D-FTE	Relay CX/7D fails to energize	12000 hrs. (detected during refueling outages)	Tested per SP 617.1	1.67E-3
92662-2-1AFC	Contact pair 1A-1B of relay 62.2 fail to close	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.8E-3

MILLSTONE 1
SYSTEM SW
SHEET #5

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
92662-2-FTE	Relay coil 62.2 fails to energize	12000 hrs (detected during refueling outages)	Tested as per SP 617.1	1.67E-3
906CX-7C-1FC	Contact pair 1-7 of relay CX/7C fail to close	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.8E-3
906CS-7C-FTE	Relay CX/7C fails to energize	12000 hrs (detected during refueling outages)	Tested as per SP 617.1	1.67E-3
926-83-3FC	Contact pair 3-4 of relay 83 fails to close	12000 hrs (detected during refueling outages)	Tested per SP617.1	1.8E-3
90662-7C-1RC	Contact pair 1-7 of TDDO relay 62/7C fails to remain closed	12000 hrs (detected during refueling outages)	Tested per SP 617.1	6E-4
90662-7C-FRE	Relay 62/7C fails to remain energized	12000 hrs (detected during refueling outages)	Tested as per SP 617.1	6E-6
906CX-7C-3RC	Contact pair 3-4 of relay CX/7C fails to remain closed	12000 hrs (detected during refueling outages)	Tested per SP 617.1	6E-4
92627-X-2FC	Contact pair 2-8 of relay 27x fails to close	12000 hrs (detected during refueling outages)	Tested as per SP 617.1	1.8E-3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
92627-X-FTE	Relay 27x fails to energize	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.67E-3
926LNP-3-1FC	Contact pair 1-2 of LNP-3 circuit fails to close	12000 hrs (detected during refueling outages)	Tested as per SP 617.1	1.8E-3
926LNP-3A-1FC	Contact pair 1-2 of LNP-3a circuit fails to close	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.8E-3
926-62-2RC	Contact pair 2-8 of relay 62 fails to remain closed	12000 hrs (detected during refueling outages)	Tested per SP 617.1	6E-4
926-62-FRE	Relay 62 fails to remain energized	12000 hrs (detected during refueling outages)	Tested as per SP 617.1	6E-4
92627-X-3RC	Contact pair 3-7 of relay 27X fails to remain closed	12000 hrs (detected during refueling outages)	Tested as per SP 617.1	6E-4
90662-7D-1RC	Contact pair 1-7 of relay 62-7D fails to remain closed	12000 hrs (detected during refueling outages)	Tested as per SP 617.1	6E-4
906CX-7D-FRE	Relay CX7D fails to remain energized	12000 hrs (detected during refueling outages)	Tested per SP 617.1	6E-4

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
90662-7D-3RC	Contact pair 3-4 of relay 62/7D fails to remain closed	12000 hrs (detected during refueling outages)	Tested as per SP 617.1	6E-4
9321530-322-LOF	Timer 932/1530-322 "loss of function" Due to timer local faults no signal is provided to coil 622	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.8E-3
SW-99-PHV-FRO	Air operated valve SW-99-PHV is normally open and is supposed to remain open but fails to do so	One month	SW-99 indirectly tested per SP 688.1 (diesel generator	1E-4 test)
SW-99-PHV-TOM	Air operated valve SW-99-PHV is out of service due to maintenance or not returned to service after completed maintenance	One month	SW-99 indirectly tested as per SP 688.1 (diesel generator test)	4.7E-6
906CS-151-FTD 906CS-152-FTD 906CS-153-FTD 906CS-154-FTD	Manual switches 151, 152, 153, 154, fail to de-energize, thus failing in the stop mode.	One month	Tested per SP 608.5	1E-5

MILLSTONE 1
SYSTEM SW
SHEET #8

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SW-A-MDP-OPO SW-B-MDP-OPO SW-C-MDP-OPO SW-D-MDP-OPO	Operator inadvertently places manual switches 151, 152, 153 and 154 in the closed position	One month	Tested per SP 608.5	3.0E-3
906CS-151-3RO 906CS-152-3RO 906CS-153-3RO 906CS-154-3RO	Contact pair 3-3C of manual switches 151, 152, 153 and 154 fails to remain open.	One month	Tested per SP 608.5	1.0E-5
906CS-151-4RO 906CS-152-4RO 906CS-153-4RO 906CS-154-4RO	Contact pair 4-4C of manual switches 151, 152, 153 and 154 fails to remain open.	One month	Per SP 608.5	1.0E-5
LCL94X-3B-FTD	Relay coil 94X-3B fails to de-energize after LNP signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.7E-3
LCL94X-3B-9RO	Contact pair 9-10 of relay 94X-3B fails to remain open after a trip signal.	12000 hrs (detected during refueling outages)	Tested per SP 617.1	6E-4
92694-1A-5FO	Contact pair 5-6 of relay 94-1a fails to open after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.8E-3

MILLSTONE 1
SYSTEM SW
SHEET #9

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
92694-1A-FTD	Relay coil 94-1A fails to de-energize after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.7E-3
92694-2A-5FO	Contact pair 5-6 of relay 94-2A fails to open after a trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.8E-3
92694-2A-FTD	Relay coil 94-2A fails to de-energize after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.7E-3
92694-2B-FTD	Relay coil 94-2B fails to de-energize after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.7E-3
92694-2B-9FO	Contact pair 9-10 of relay 94-2B fails to open after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.8E-3
LCL94X-4B-FTD	Relay coil 94X-4B fails to de-energize after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.7E-3
LCL94X-4B-9RO	Contact pair 9-10 of relay 94X-413 fails to remain open after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	6E-4

MILLSTONE 1
SYSTEM SW
SHEET #10

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
92694-1B-FTD	Relay coil 94-1B fails to de-energize after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.7E-3
92694-1B-9FO	Contact pair 9-10 of relay 94-1b fails to open after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.8E-3
LCL94X-6A-1RO	Contact pair 1-2 of relay 94X-6A fails to remain open after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	6E-4
LCL94X-6A-FTD	Relay coil 94X-6A fails to de-energize after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.7E-3
92694-1B-BFO	Contact pair 11-12 of relay 94-1B fails to open after trip signal	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.8E-3
LCL94X-6C-FTD	Relay 94X-6C fails to de-energize after trip	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.7E-3
LCL94X-6C-1RO	Contact pair 1-2 of relay coil 94X-6C fails to remain open after trip	12000 hrs (detected during refueling outages)	Tested per SP 617.1	6E-4

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
92694-2B-BFO	Contact pair 11-12 of relay 94-2B fails to open	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.8E-3
SW-9-MOV-FTC	Motor operated valve SW-9 fails to close	12000 hrs (detected during refueling outages)	SW-9-MOV tested as per SP 608.16	1.67E-2
SW-9-MOV-TMO	Motor operated valve SW-9 required to be closed is in actuality open, and is incapable of being closed by any automatic signals, due to being in test or maintenance or having been left in the closed position after test or maintenance.	12000 hrs (detected during refueling outages)	SW-9-MOV tested as per SP 608.16	3.6E-4
AC-EF7-2G-FTC	Circuit Breaker AC-EF7-2G fails to close	12000 hrs (detected during refueling outages)	SW-9-MOV tested as per SP 608.16	1.67E-2
906CS-162-FTD	Manual switch 162 fails to de-energize	12000 hrs (detected during refueling outages)	Tested per SP 608.16	1.7E-3
SW-9-MOV-OPO	Operator inadvertently closes switch 162. This opens SW-9-MOV			3E-3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
906CS-162-1RO	Contact pair 1-1C of switch 162 fails to remain open	12000 hrs (detected during refueling outages)	Tested per SP 608.16	6E-4
92662-2-FTE	Relay 62.2 fails to energize	12000 hrs (detected during refueling outages)	Tested per SP 608.16	1.67E-3
92662-2-5AFC	Contact pair 5A-5B of relay 62.2 fail to close	12000 hrs (detected during refueling outages)	Tested per SP 608.16	1.8E-3
926-83-1FC	CP1-2 of relay 83 fails to close	12000 hrs (detected during refueling outages)	Tested per SP 608.16	1.8E-3
906CS-162-4RC	Contact pair 4C-4 of CS/162 fails to remain closed	12000 hrs (detected during refueling outages)	Tested per SP 608.16	6E-4
SW-C-MDP-SBY	SW-MDP is not running during a LNP event	Prompt	With a continuously running system the detection interval is assumed prompt	.5
926-83-FTE	Relay 83 fails to energize	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.67E-3

FAULT SUMMARY SHEETS

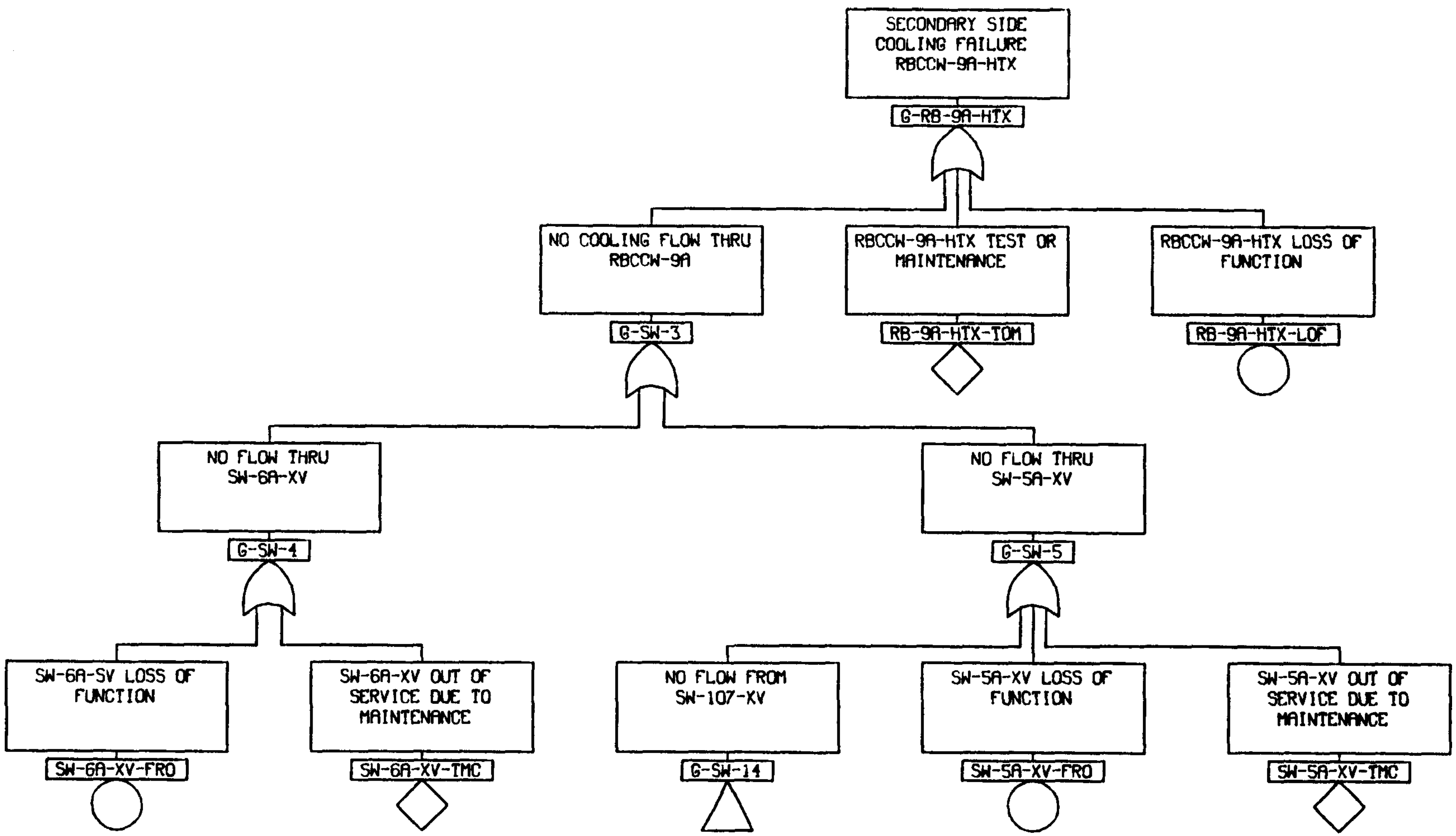
EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
926LNP-3-FTE 926LNP-3A-FTE	Relay LNP-3 or LNP-3A fails to energize	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.67E-3
926LNP-2-FTE 926LNP-2A-FTE	Relay LNP-2 or LNP-2A fails to energize	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.67E-3
926LNP-2-1FC 926LNP-2A-1FC	CP 1-2 of relay LNP-2 or LNP-2A fails to close	12000 hrs (detected during refueling outages)	Tested per SP 617.1	1.8E-3
SW-9-MOV-OFC	The operator fails to close manual switch for SW-9-MOV.	Prompt		.05

MILLSTONE 1
SYSTEM SW
SHEET #14

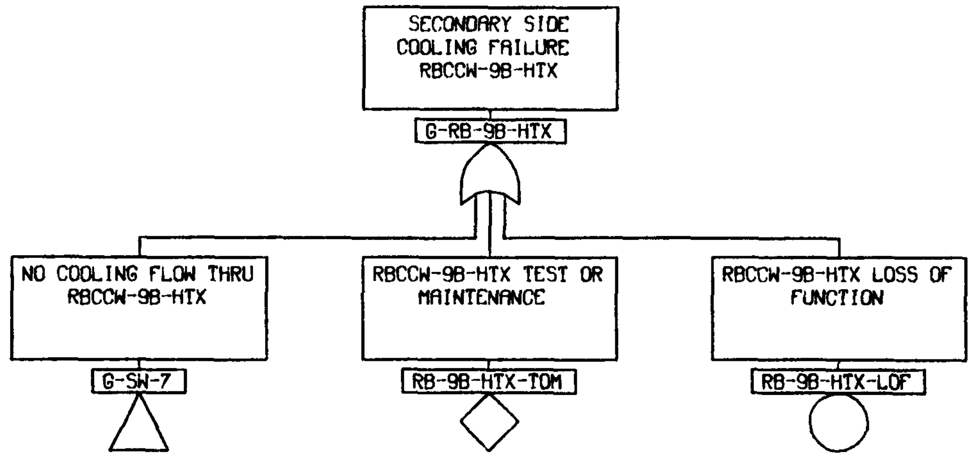
SW FAULT TREE PAGE INDEX

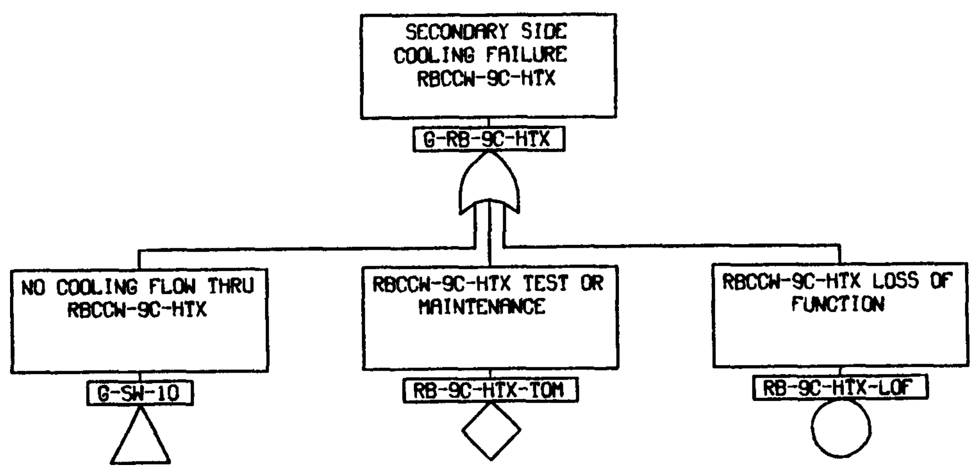
GATE NAME	DEFINED ON PAGE	TRANSFERS TO PAGE(S)
G-RB-9A-HTX	SW-1	--
G-RB-9B-HTX	SW-2	--
G-RB-9C-HTX	SW-2	--
G-SW-7	SW-3	SW-2
G-SW-10	SW-4	SW-2
G-SW-14	SW-5	SW-1,SW-3,SW-4
G-SW-15	SW-6	SW-5,SW-26,SW-27,SW-31
G-SW-18	SW-7	SW-6
G-SW-21	SW-8	SW-7
G-SW-25	SW-9	SW-7
G-SW-29	SW-10	SW-7
G-SW-33	SW-11	SW-7
G-SW-37	SW-12	SW-8
G-SW-40	SW-13	SW-9
G-SW-43	SW-14	SW-10
G-SW-47	SW-15	SW-14
G-SW-48A	SW-16	SW-14
G-SW-50	SW-17	SW-16
G-SW-54	SW-18	SW-17,SW-42
G-SW-56	SW-19	SW-18
G-SW-60	SW-20	SW-11
G-SW-63	SW-21	SW-20
G-SW-66	SW-22	SW-21
G-SW-68	SW-23	SW-21
G-SW-71	SW-24	SW-23,SW-42
G-TBS-14A-HTX	SW-25	--
G-TBS-14B-HTX	SW-25	--
G-SW-75	SW-26	SW-25
G-SW-79	SW-27	SW-25
G-AC-DG-HTX	SW-28	--
G-SW-83	SW-29	SW-28
G-SW-85	SW-30	SW-28
G-SW-86	SW-31	SW-28
G-SW-87	SW-32	SW-12
G-SW-89	SW-33	SW-32
G-SW-94	SW-34	SW-13
G-SW-96	SW-35	SW-34
G-SW-101	SW-36	SW-14
G-SW-103	SW-37	SW-20
G-SW-104	SW-38	SW-37
G-SW-106	SW-39	SW-37
G-SW-108	SW-40	SW-37
G-SW-110	SW-41	SW-44
G-SW-113	SW-42	SW-41
G-SW-116	SW-43	SW-41
G-SW-118	SW-44	SW-5,SW-26,SW-27,SW-31

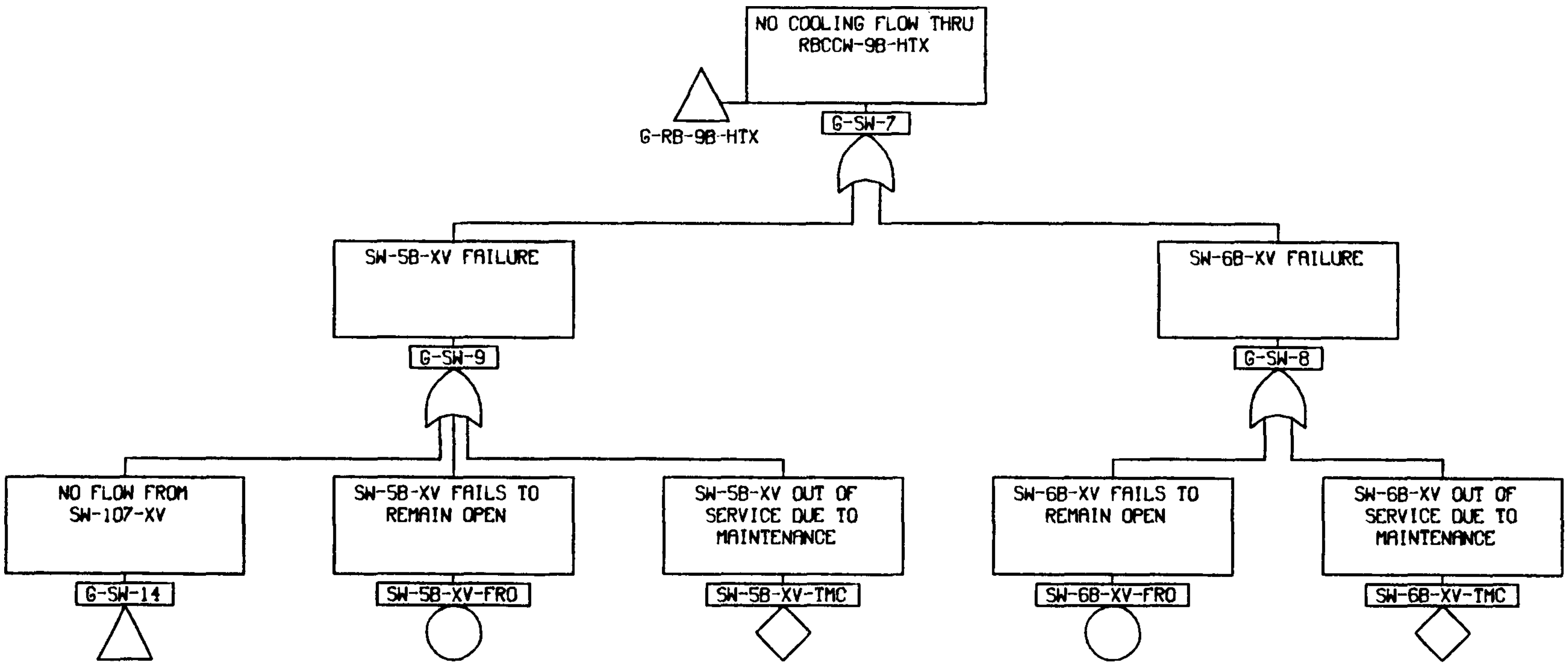
SW FAULT TREE PAGE INDEX (Cont.)


SECONDARY SIDE COOLING FAILURE RBCCW-9A-HTX
G-RB-9A-HTX
NO COOLING FLOW THRU RBCCW-9A
G-SW-3
RBCCW-9A-HTX TEST OR MAINTENANCE
RB-9A-HTX-TOM
RBCCW-9A-HTX LOSS OF FUNCTION
RB-9A-HTX-LOF
NO FLOW THRU SW-6A-XV
G-SW-4
NO FLOW THRU SW-5A-XV
G-SW-5
SW-6A-SV LOSS OF FUNCTION
SW-6A-XV-FRO
SW-6A-XV OUT OF SERVICE DUE TO MAINTENANCE
SW-6A-XV-TMC
NO FLOW FROM SW-107-XV
G-SW-14
SW-5A-XV LOSS OF FUNCTION
SW-5A-XV-FRO
SW-5A-XV OUT OF SERVICE DUE TO MAINTENANCE
SW-5A-XV-TMC

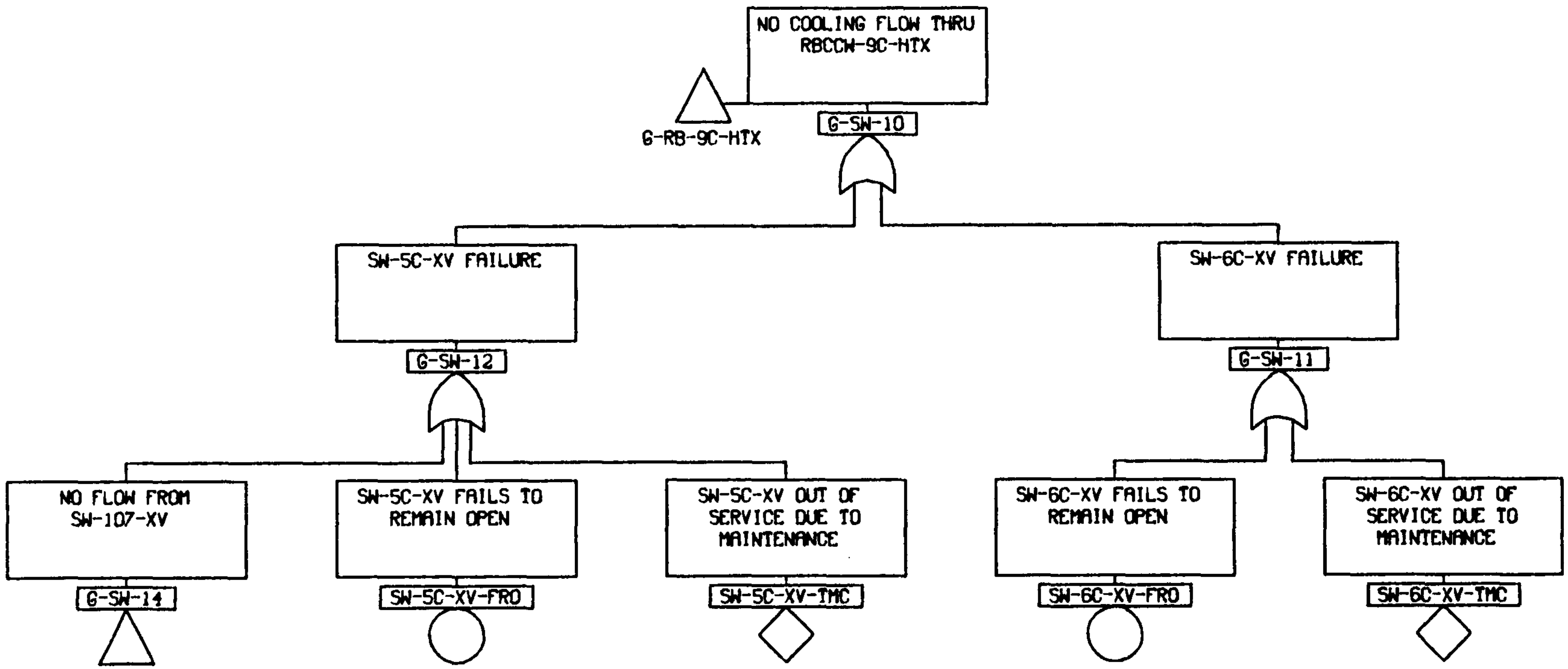
SW-1

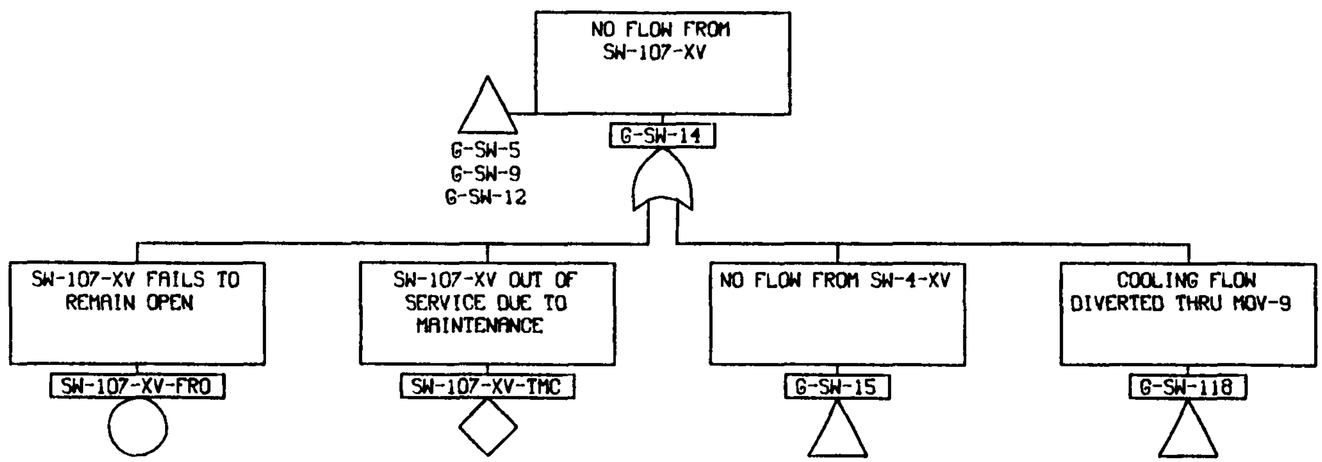

SECONDARY SIDE
COOLING FAILURE
RBCCW-9B-HTX
G-RB-9B-HTX
NO COOLING FLOW THRU
RBCCW-9B-HTX
G-SW-7
RBCCW-9B-HTX TEST OR
MAINTENANCE
RB-9B-HTX-TOM
RBCCW-9B-HTX LOSS OF
FUNCTION
RB-9B-HTX-LOF

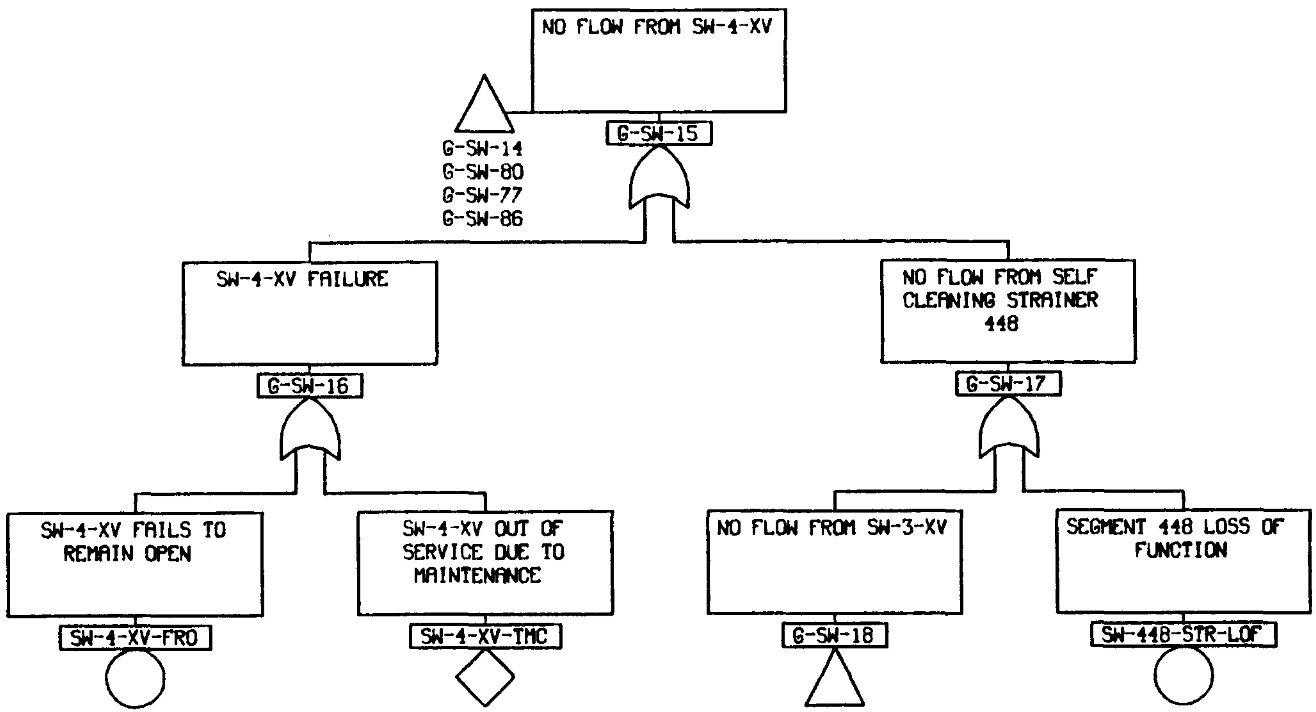

SECONDARY SIDE
COOLING FAILURE
RBCCW-9C-HTX
G-RB-9C-HTX
NO COOLING FLOW THRU
RBCCW-9C-HTX
G-SW-10
RBCCW-9C-HTX TEST OR
MAINTENANCE
RB-9C-HTX-TOM
RBCCW-9C-HTX LOSS OF
FUNCTION
RB-9C-HTX-LOF


NO COOLING FLOW THRU RBCCW-9B-HTX
G-RB-9B-HTX
G-SW-7
SW-5B-XV FAILURE
G-SW-9
SW-6B-XV FAILURE
G-SW-8
NO FLOW FROM SW-107-XV
G-SW-14
SW-5B-XV FAILS TO REMAIN OPEN
SW-5B-XV-FRO
SW-5B-XV OUT OF SERVICE DUE TO MAINTENANCE
SW-5B-XV-TMC
SW-6B-XV FAILS TO REMAIN OPEN
SW-6B-XV-FRO
SW-6B-XV OUT OF SERVICE DUE TO MAINTENANCE
SW-6B-XV-TMC

SW-3

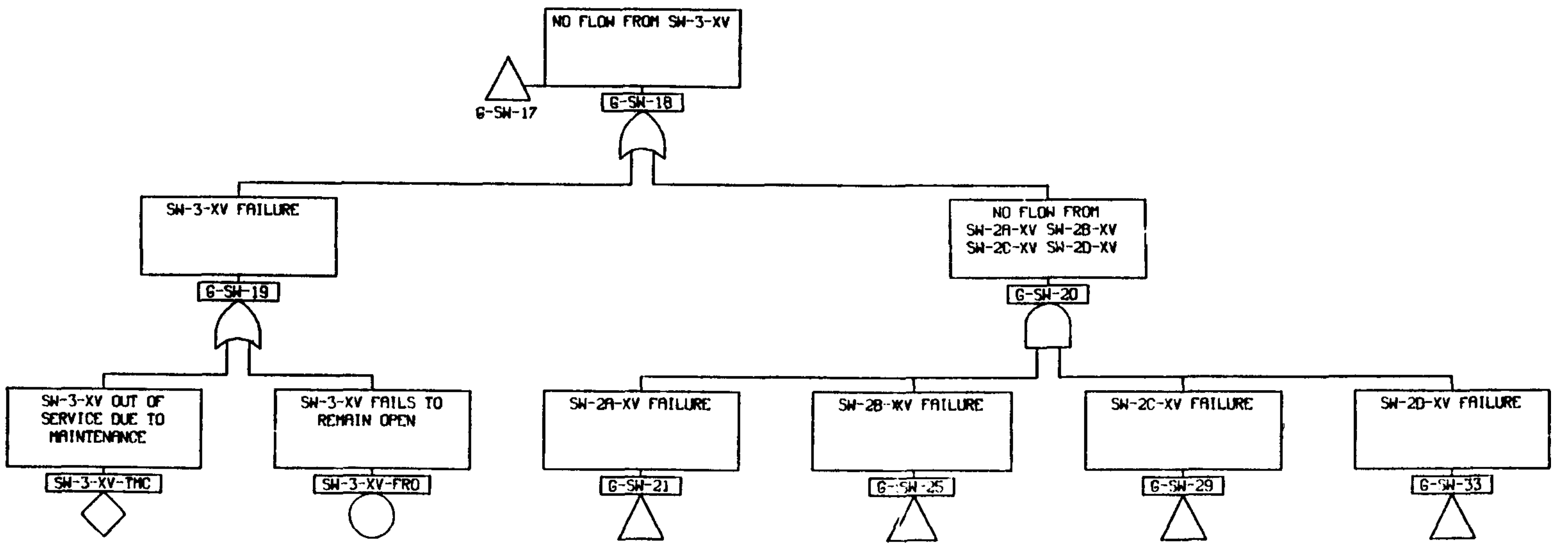

NO COOLING FLOW THRU RBCCW-9C-HTX
G-SW-10
G-RB-9C-HTX
SW-5C-XV FAILURE
G-SW-12
SW-6C-XV FAILURE
G-SW-11
NO FLOW FROM SW-107-XV
G-SW-14
SW-5C-XV FAILS TO REMAIN OPEN
SW-5C-XV-FRO
SW-5C-XV OUT OF SERVICE DUE TO MAINTENANCE
SW-5C-XV-TMC
SW-6C-XV FAILS TO REMAIN OPEN
SW-6C-XV-FRO
SW-6C-XV OUT OF SERVICE DUE TO MAINTENANCE
SW-6C-XV-TMC

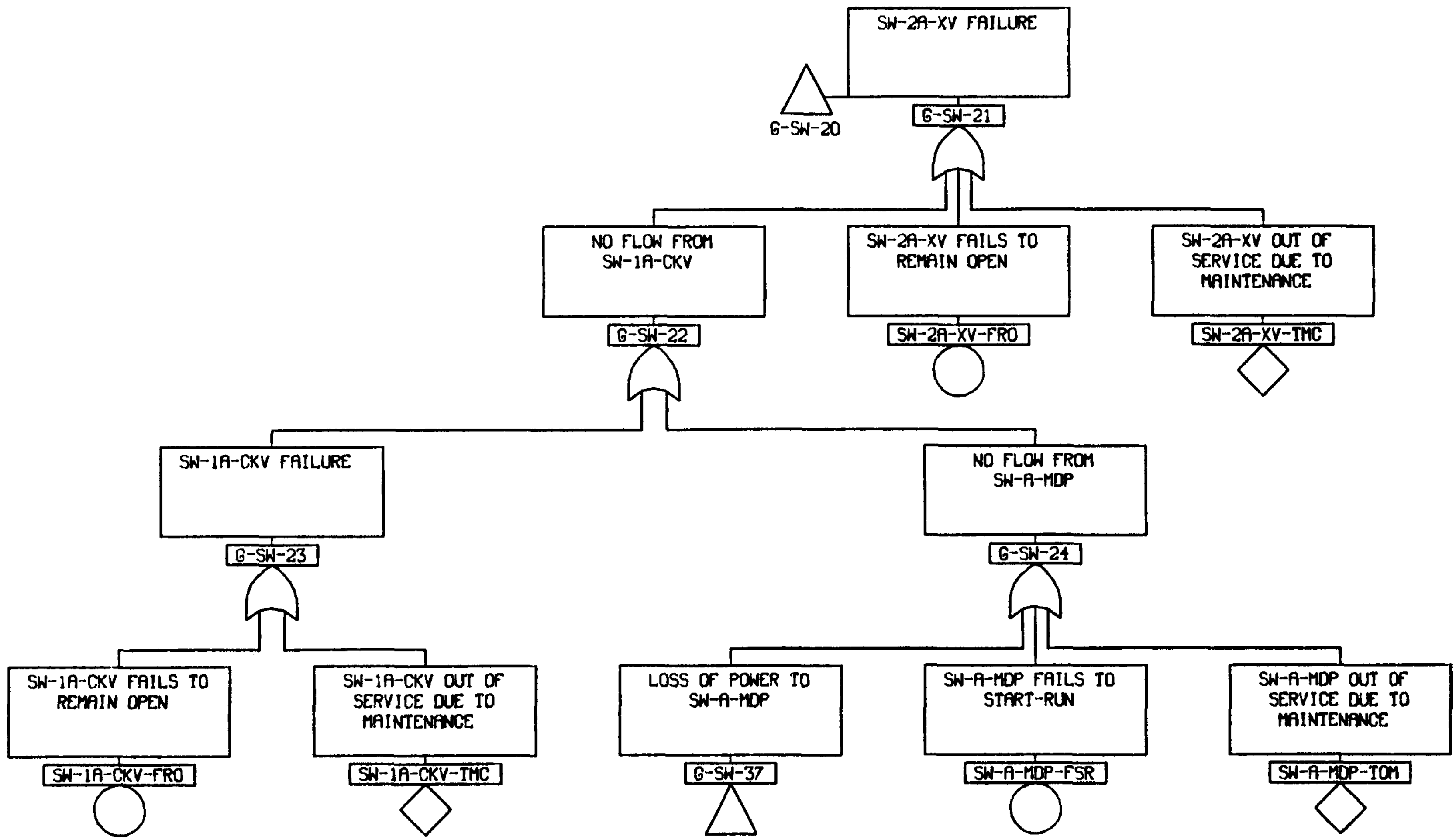

NO FLOW FROM SW-107-XV
G-SW-14
G-SW-5
G-SW-9
G-SW-12
SW-107-XV FAILS TO REMAIN OPEN
SW-107-XV-FRO
SW-107-XV OUT OF SERVICE DUE TO MAINTENANCE
SW-107-XV-TMC
NO FLOW FROM SW-4-XV
G-SW-15
COOLING FLOW DIVERTED THRU MOV-9
G-SW-118

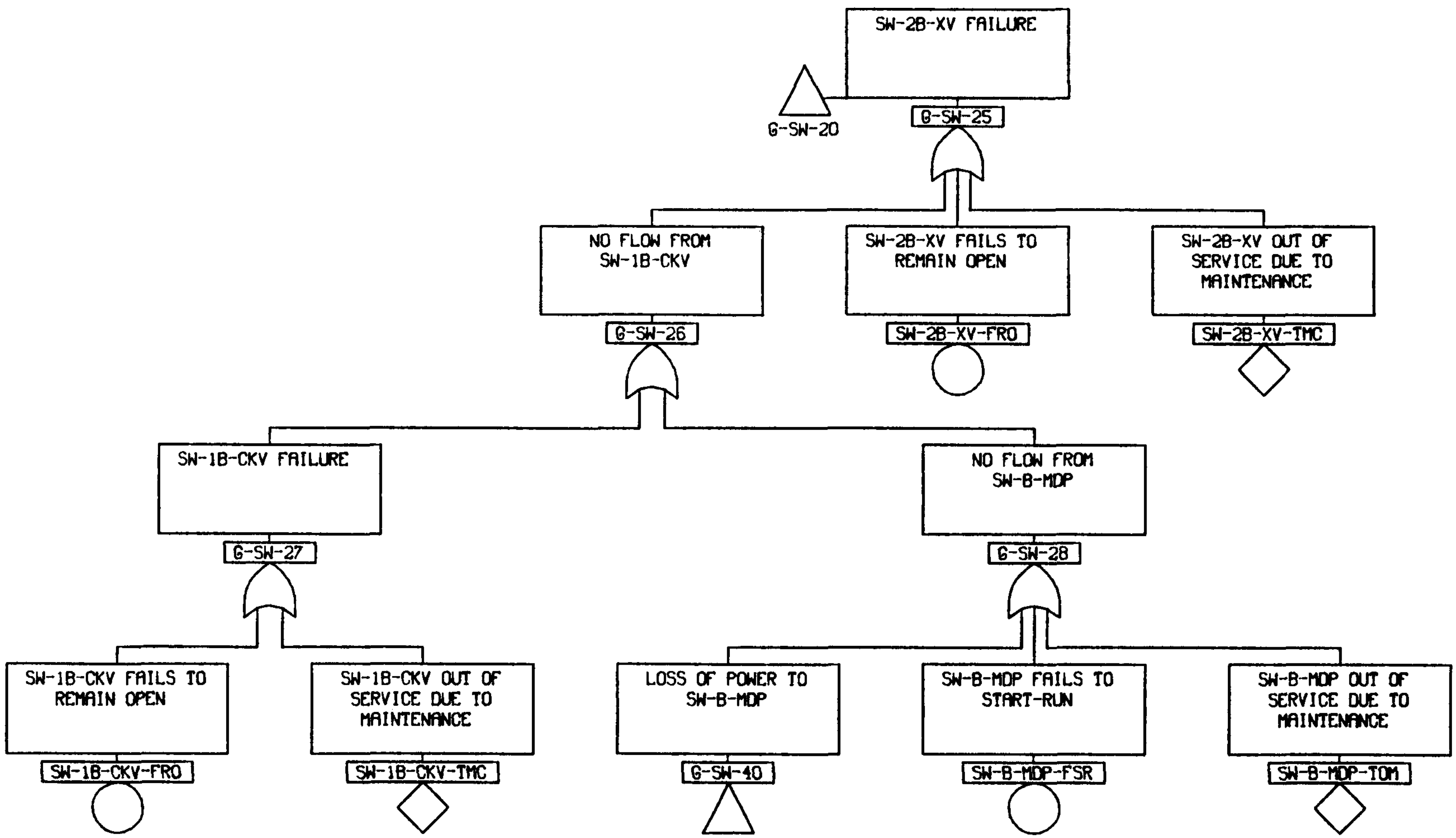


NO FLOW FROM SW-4-XV
G-SW-15
G-SW-14
G-SW-80
G-SW-77
G-SW-86
SW-4-XV FAILURE
G-SW-16
NO FLOW FROM SELF CLEANING STRAINER 448
G-SW-17
SW-4-XV FAILS TO REMAIN OPEN
SW-4-XV-FRO
SW-4-XV OUT OF SERVICE DUE TO MAINTENANCE
SW-4-XV-TMC
NO FLOW FROM SW-3-XV
G-SW-18
SEGMENT 448 LOSS OF FUNCTION
SW-448-STR-LOF

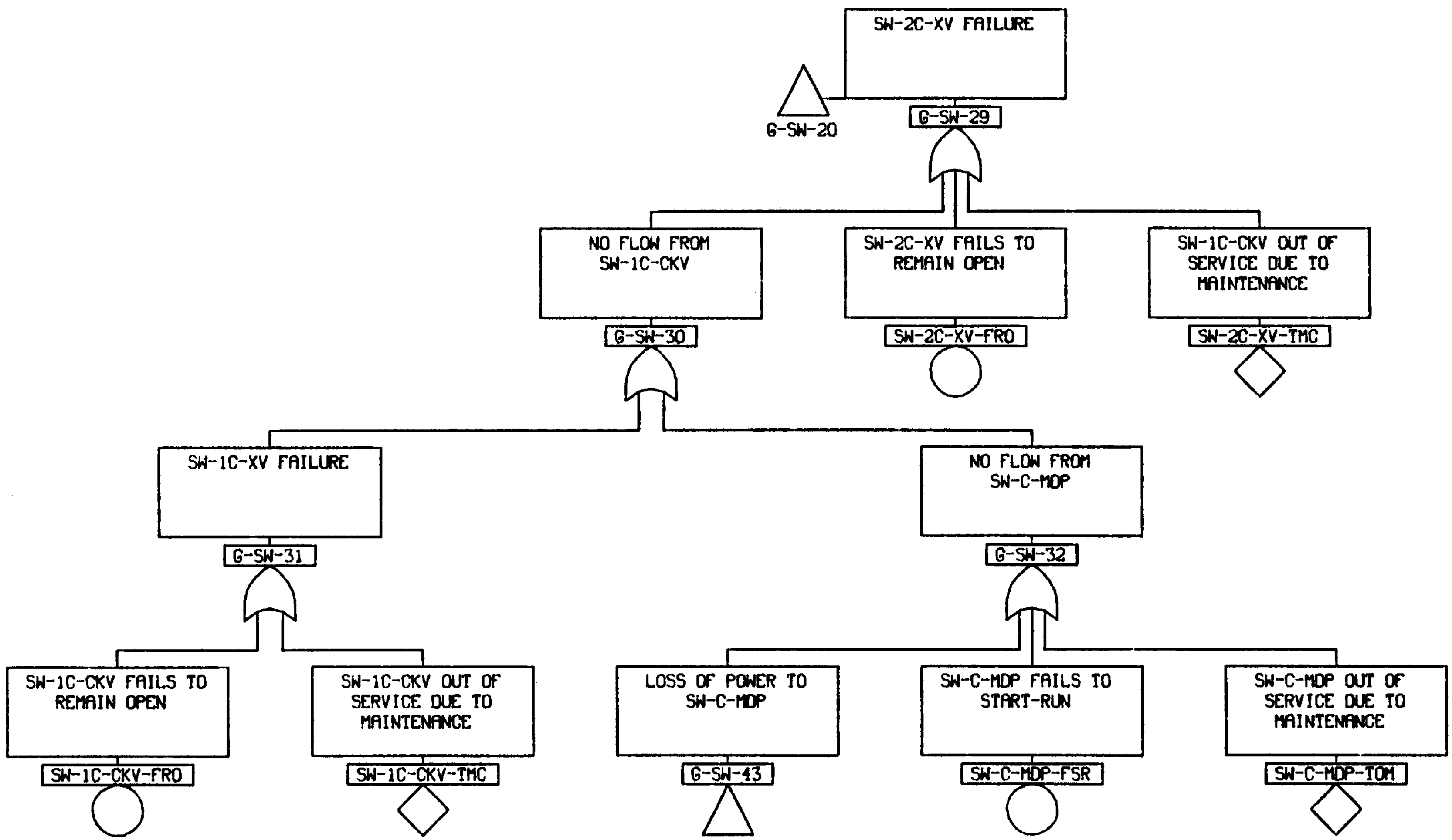
SW-6

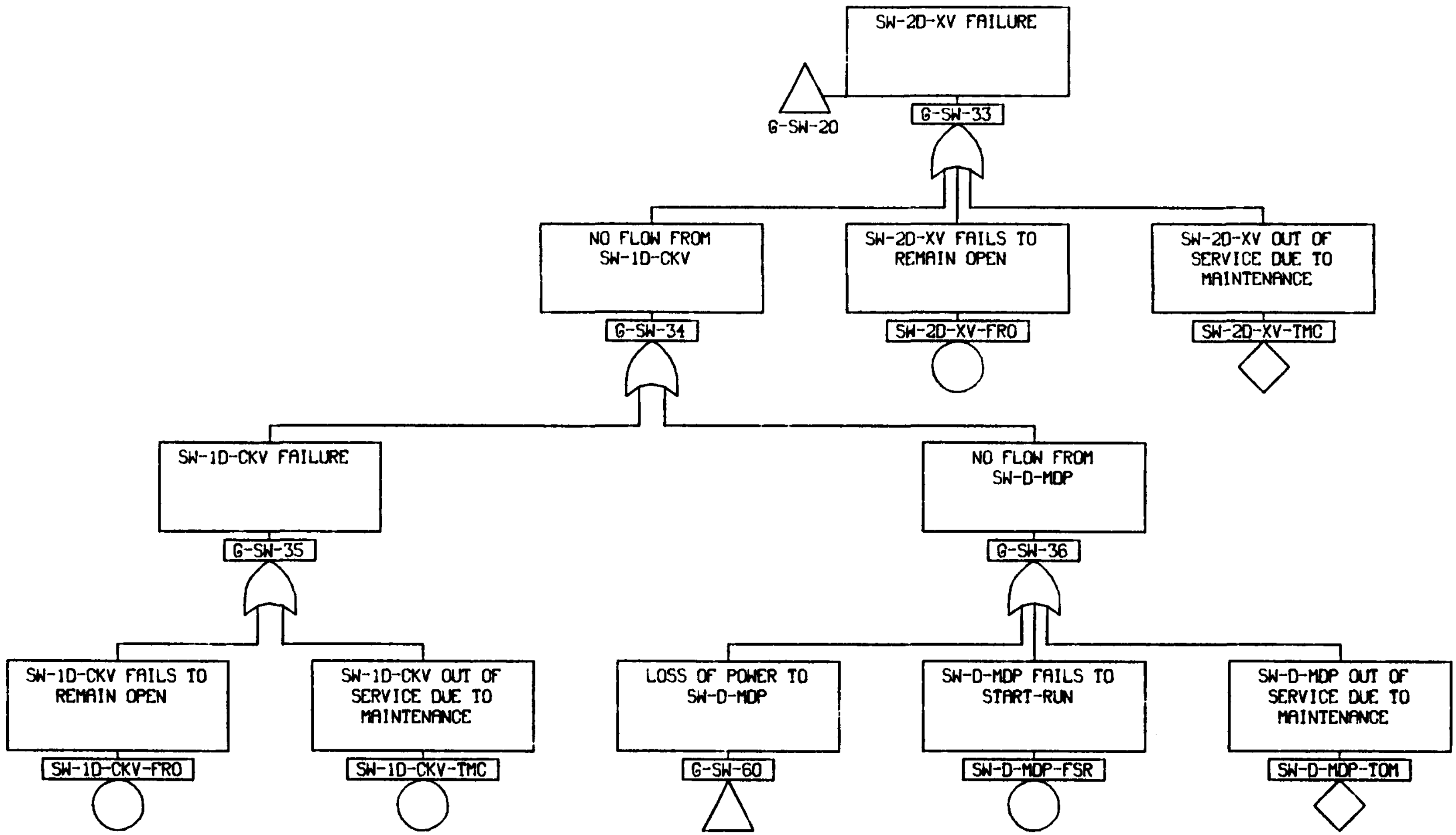

NO FLOW FROM SW-3-XV
G-SW-17
G-SW-18
SW-3-XV FAILURE
G-SW-19
NO FLOW FROM SW-2A-XV SW-2B-XV SW-2C-XV SW-2D-XV
G-SW-20
SW-3-XV OUT OF SERVICE DUE TO MAINTENANCE
SW-3-XV-TMC
SW-3-XV FAILS TO REMAIN OPEN
SW-3-XV-FRO
SW-2A-XV FAILURE
G-SW-21
SW-2B-XV FAILURE
G-SW-25
SW-2C-XV FAILURE
G-SW-29
SW-2D-XV FAILURE
G-SW-33

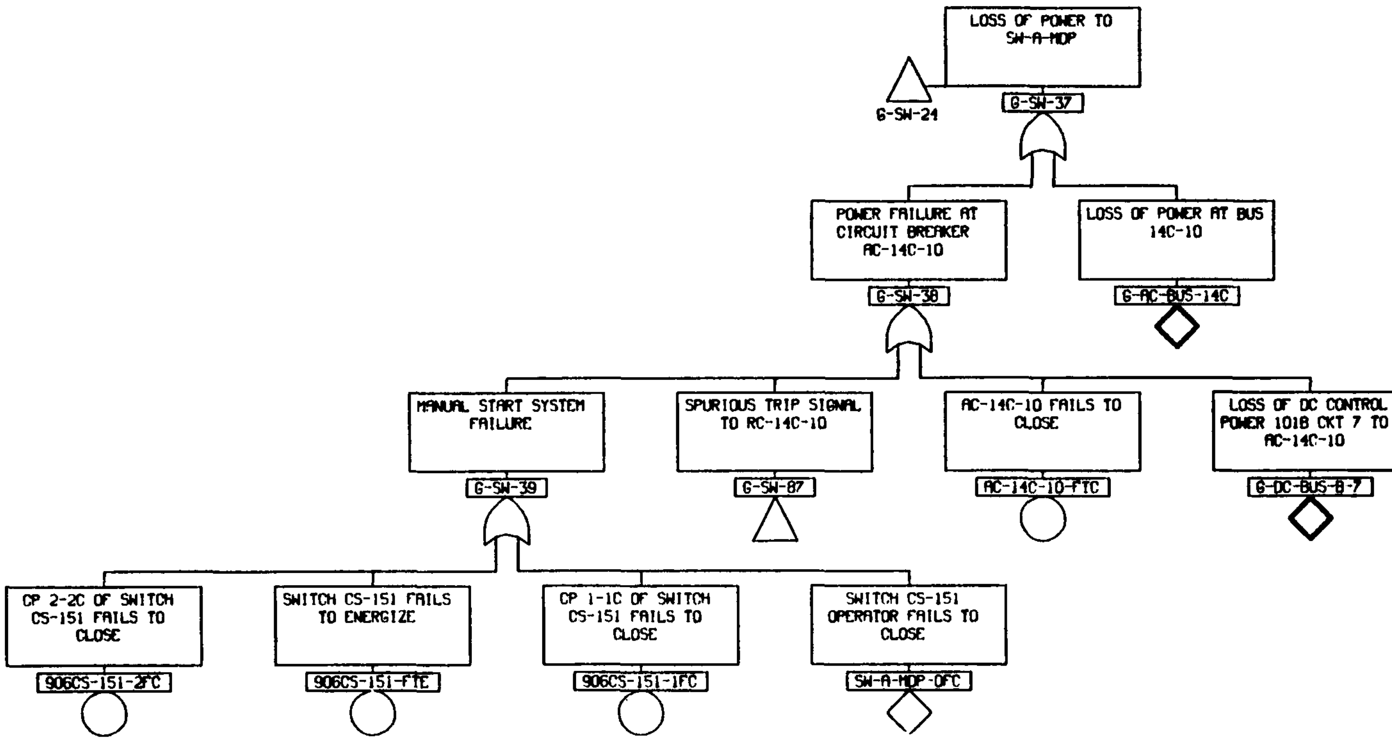

SW-2A-XV FAILURE
G-SW-21
G-SW-20
NO FLOW FROM SW-1A-CKV
G-SW-22
SW-2A-XV FAILS TO REMAIN OPEN
SW-2A-XV-FRO
SW-2A-XV OUT OF SERVICE DUE TO MAINTENANCE
SW-2A-XV-TMC
SW-1A-CKV FAILURE
G-SW-23
NO FLOW FROM SW-A-MDP
G-SW-24
SW-1A-CKV FAILS TO REMAIN OPEN
SW-1A-CKV-FRO
SW-1A-CKV OUT OF SERVICE DUE TO MAINTENANCE
SW-1A-CKV-TMC
LOSS OF POWER TO SW-A-MDP
G-SW-37
SW-A-MDP FAILS TO START-RUN
SW-A-MDP-FSR
SW-A-MDP OUT OF SERVICE DUE TO MAINTENANCE
SW-A-MDP-TOM

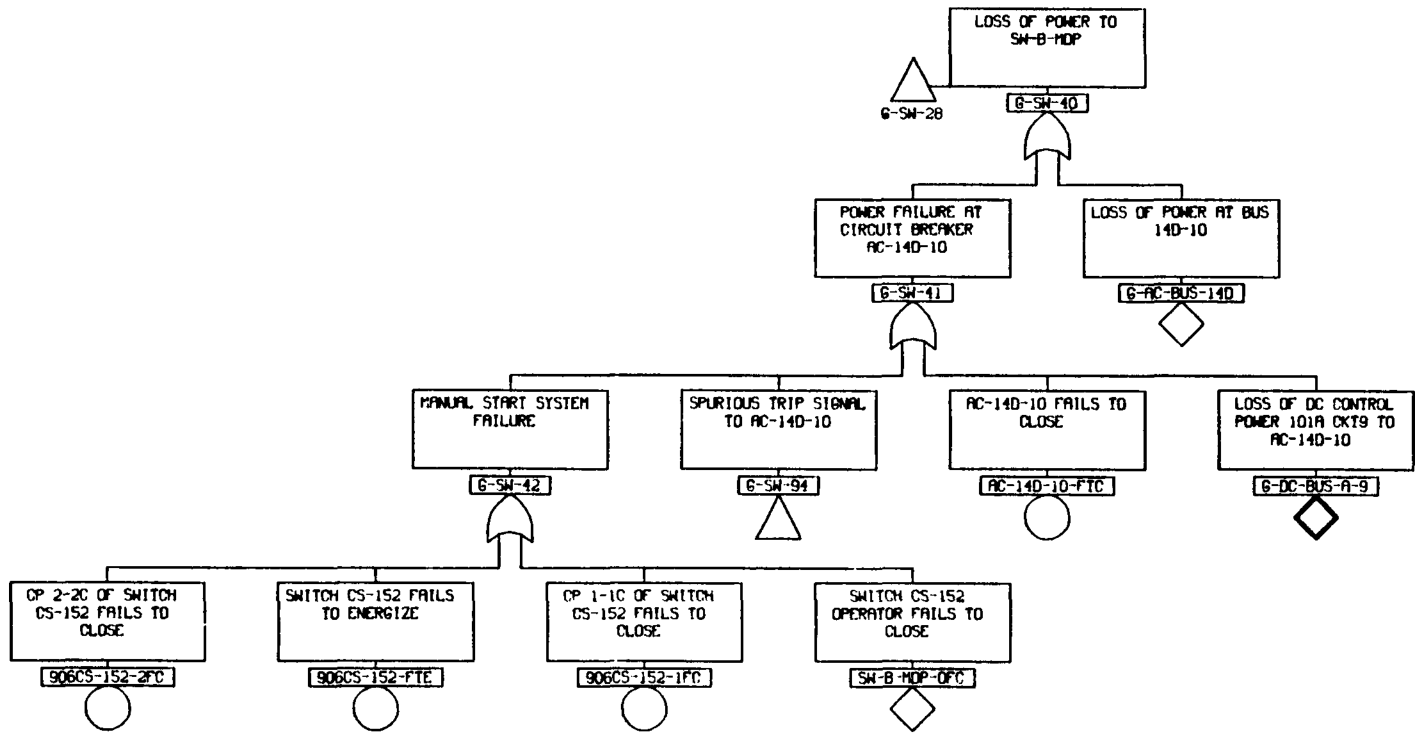

SW-2B-XV FAILURE
G-SW-20
G-SW-25
NO FLOW FROM SW-1B-CKV
SW-2B-XV FAILS TO REMAIN OPEN
SW-2B-XV OUT OF SERVICE DUE TO MAINTENANCE
G-SW-26
SW-2B-XV-FRO
SW-2B-XV-TMC
SW-1B-CKV FAILURE
NO FLOW FROM SW-B-MDP
G-SW-27
G-SW-28
SW-1B-CKV FAILS TO REMAIN OPEN
SW-1B-CKV OUT OF SERVICE DUE TO MAINTENANCE
LOSS OF POWER TO SW-B-MDP
SW-B-MDP FAILS TO START-RUN
SW-B-MDP OUT OF SERVICE DUE TO MAINTENANCE
SW-1B-CKV-FRO
SW-1B-CKV-TMC
G-SW-40
SW-B-MDP-FSR
SW-B-MDP-TOM

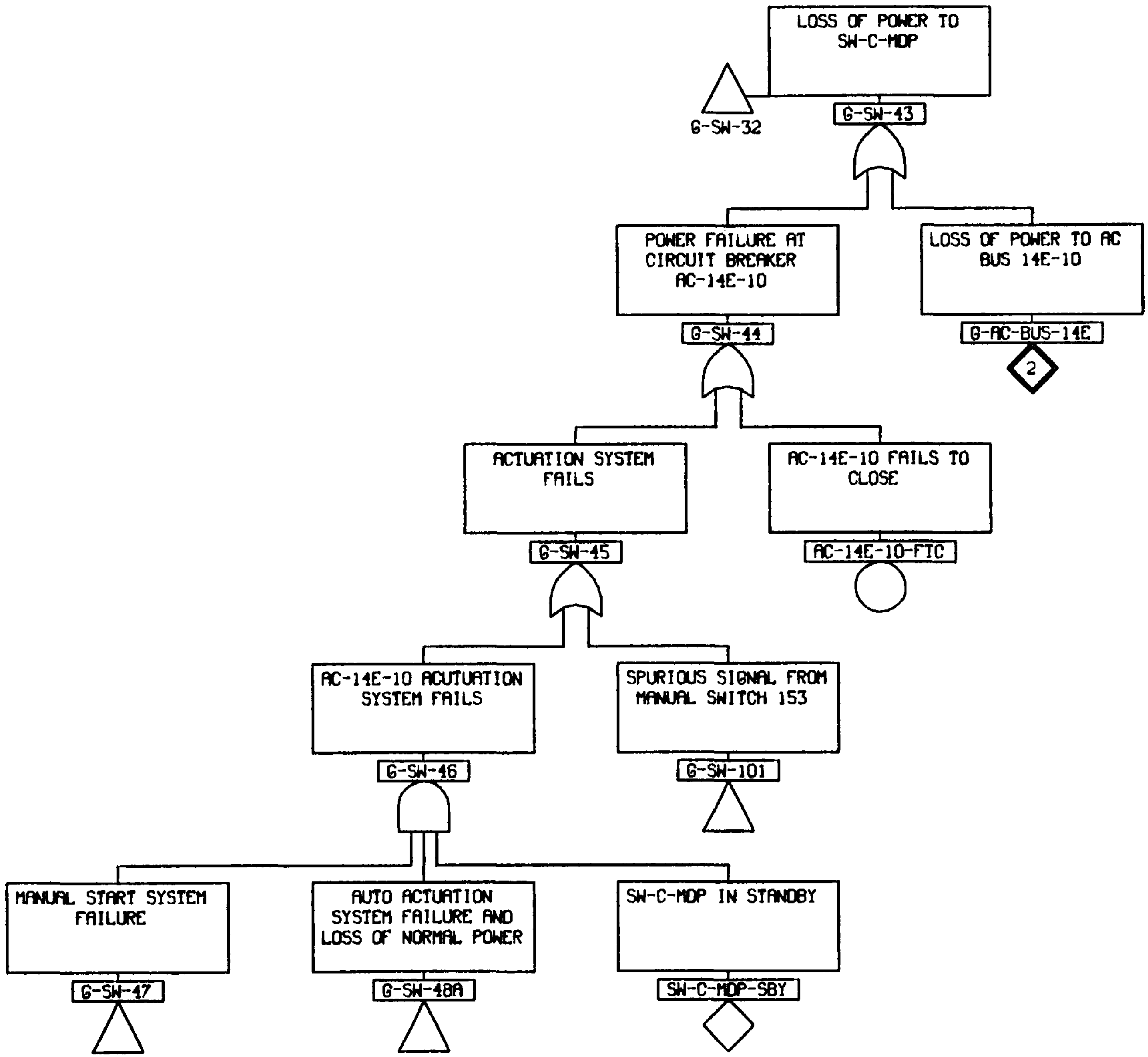
SW-9


SW-2C-XV FAILURE
G-SW-29
G-SW-20
NO FLOW FROM SW-1C-CKV
G-SW-30
SW-2C-XV FAILS TO REMAIN OPEN
SW-2C-XV-FRO
SW-1C-CKV OUT OF SERVICE DUE TO MAINTENANCE
SW-2C-XV-TMC
SW-1C-XV FAILURE
G-SW-31
NO FLOW FROM SW-C-MDP
G-SW-32
SW-1C-CKV FAILS TO REMAIN OPEN
SW-1C-CKV-FRO
SW-1C-CKV OUT OF SERVICE DUE TO MAINTENANCE
SW-1C-CKV-TMC
LOSS OF POWER TO SW-C-MDP
G-SW-43
SW-C-MDP FAILS TO START-RUN
SW-C-MDP-FSR
SW-C-MDP OUT OF SERVICE DUE TO MAINTENANCE
SW-C-MDP-TOM

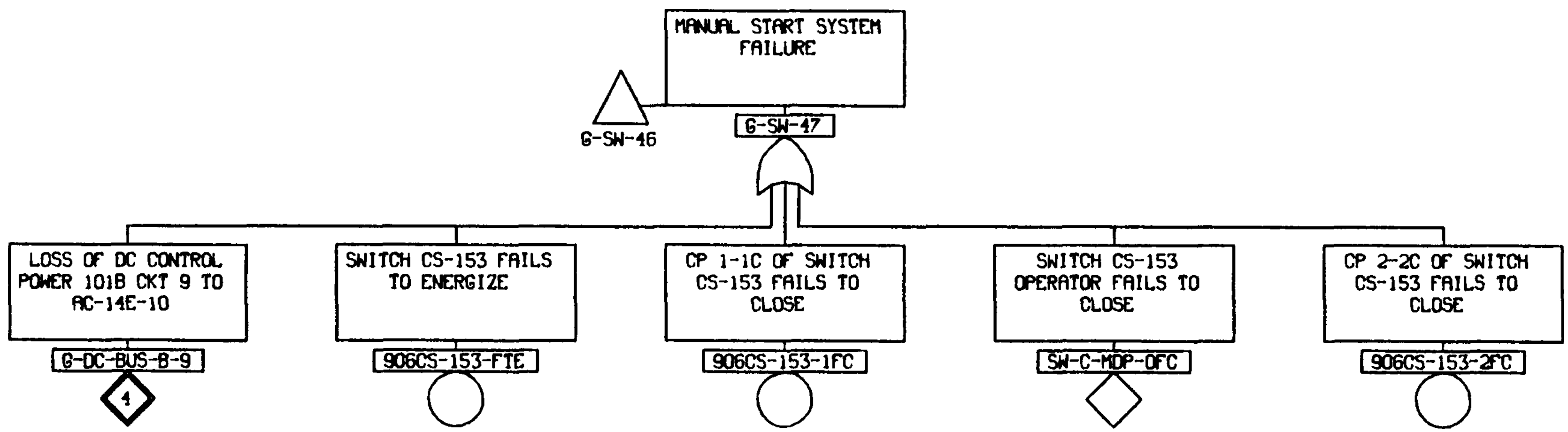

SW-2D-XV FAILURE
G-SW-20
G-SW-33
NO FLOW FROM SW-1D-CKV
G-SW-34
SW-2D-XV FAILS TO REMAIN OPEN
SW-2D-XV-FRO
SW-2D-XV OUT OF SERVICE DUE TO MAINTENANCE
SW-2D-XV-TMC
SW-1D-CKV FAILURE
G-SW-35
NO FLOW FROM SW-D-MDP
G-SW-36
SW-1D-CKV FAILS TO REMAIN OPEN
SW-1D-CKV-FRO
SW-1D-CKV OUT OF SERVICE DUE TO MAINTENANCE
SW-1D-CKV-TMC
LOSS OF POWER TO SW-D-MDP
G-SW-60
SW-D-MDP FAILS TO START-RUN
SW-D-MDP-FSR
SW-D-MDP OUT OF SERVICE DUE TO MAINTENANCE
SW-D-MDP-TOM

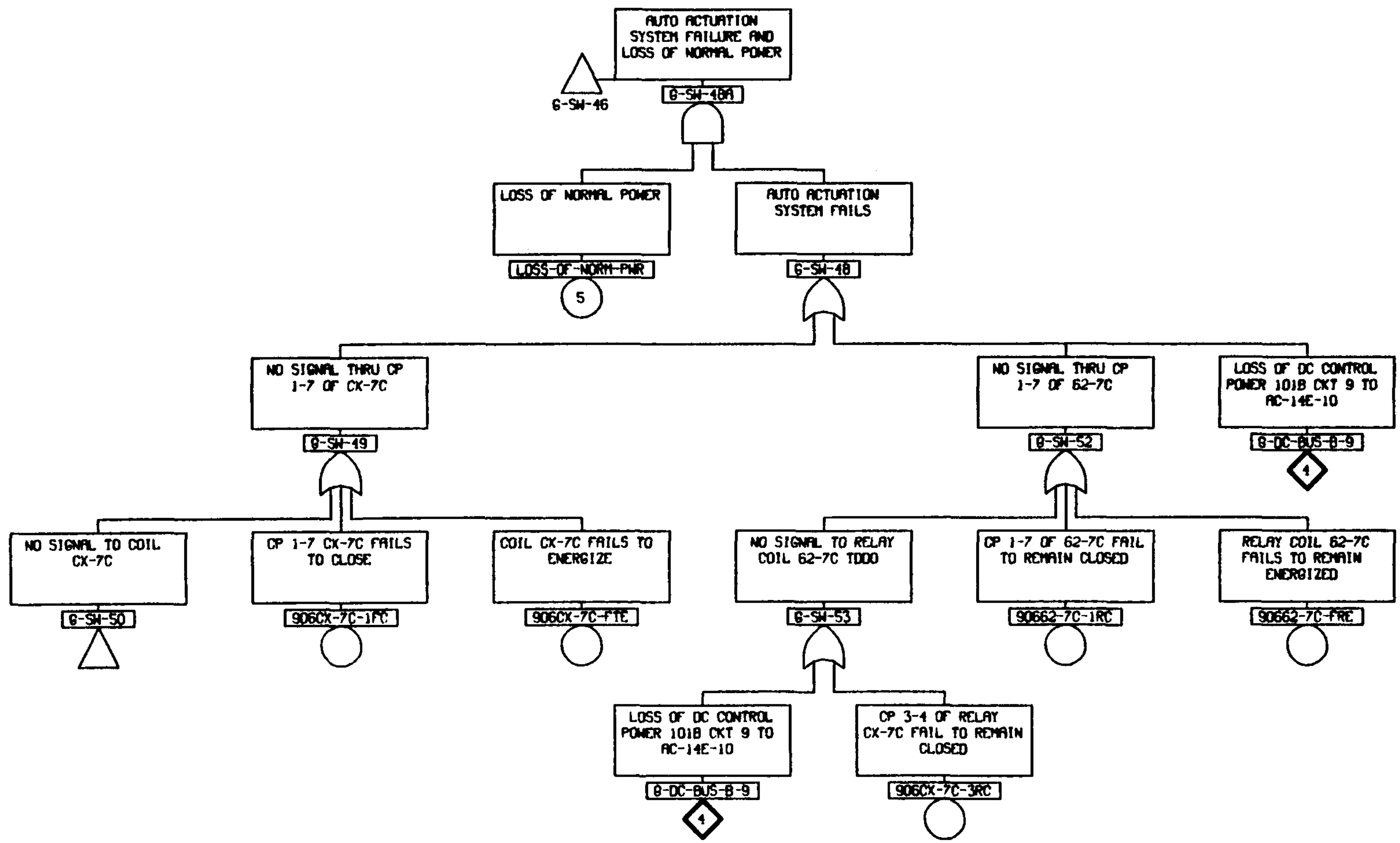

LOSS OF POWER TO SW-A-MDP
G-SW-37
G-SW-24
POWER FAILURE AT CIRCUIT BREAKER AC-14C-10
G-SW-38
LOSS OF POWER AT BUS 14C-10
G-AC-BUS-14C
MANUAL START SYSTEM FAILURE
G-SW-39
SPURIOUS TRIP SIGNAL TO AC-14C-10
G-SW-87
AC-14C-10 FAILS TO CLOSE
AC-14C-10-FTC
LOSS OF DC CONTROL POWER 101B CKT 7 TO AC-14C-10
G-DC-BUS-B-7
CP 2-2C OF SWITCH CS-151 FAILS TO CLOSE
906CS-151-2FC
SWITCH CS-151 FAILS TO ENERGIZE
906CS-151-FTE
CP 1-1C OF SWITCH CS-151 FAILS TO CLOSE
906CS-151-1FC
SWITCH CS-151 OPERATOR FAILS TO CLOSE
SW-A-MDP-OFC

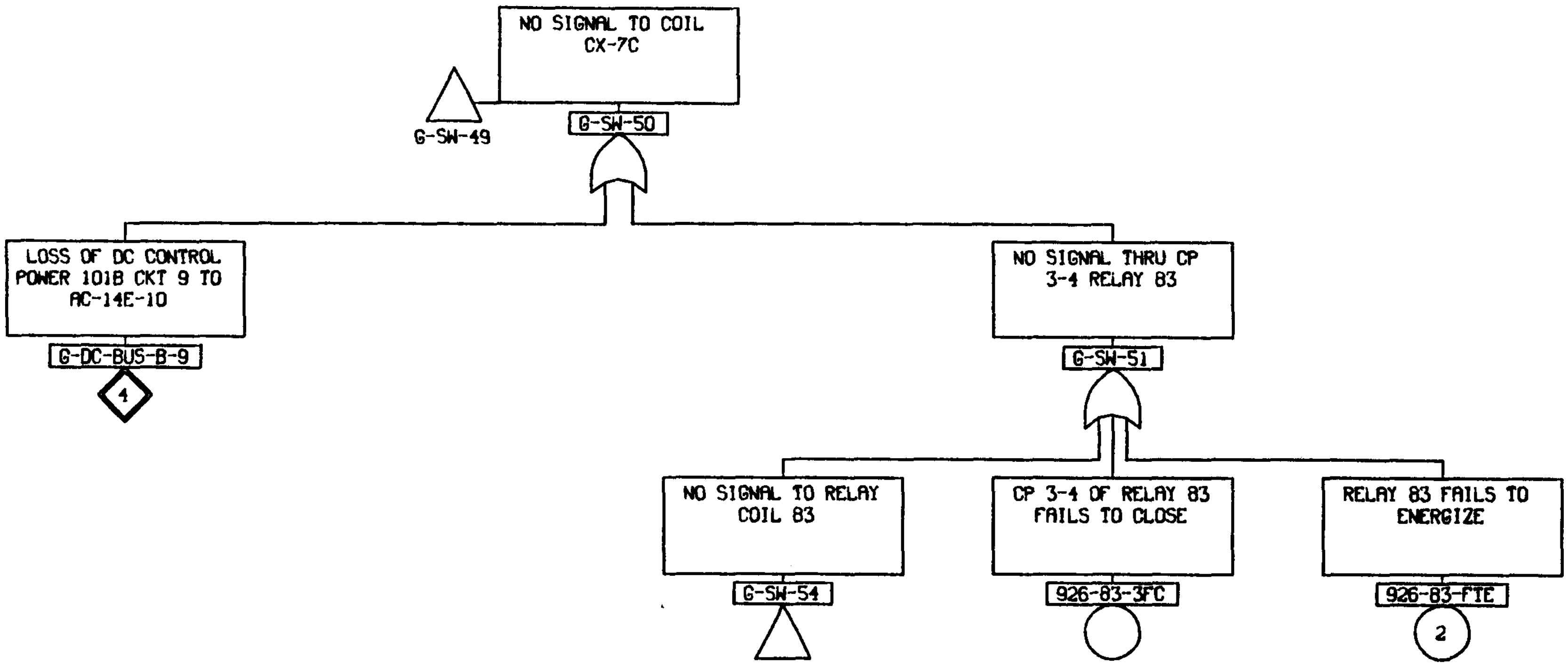

LOSS OF POWER TO SW-B-MDP
G-SW-40
G-SW-28
POWER FAILURE AT CIRCUIT BREAKER AC-14D-10
G-SW-41
LOSS OF POWER AT BUS 14D-10
G-AC-BUS-14D
MANUAL START SYSTEM FAILURE
G-SW-42
SPURIOUS TRIP SIGNAL TO AC-14D-10
G-SW-94
AC-14D-10 FAILS TO CLOSE
AC-14D-10-FTC
LOSS OF DC CONTROL POWER 101A CKT9 TO AC-14D-10
G-DC-BUS-A-9
CP 2-2C OF SWITCH CS-152 FAILS TO CLOSE
906CS-152-2FC
SWITCH CS-152 FAILS TO ENERGIZE
906CS-152-FTE
CP 1-1C OF SWITCH CS-152 FAILS TO CLOSE
906CS-152-1FC
SWITCH CS-152 OPERATOR FAILS TO CLOSE
SW-B-MDP-OFC

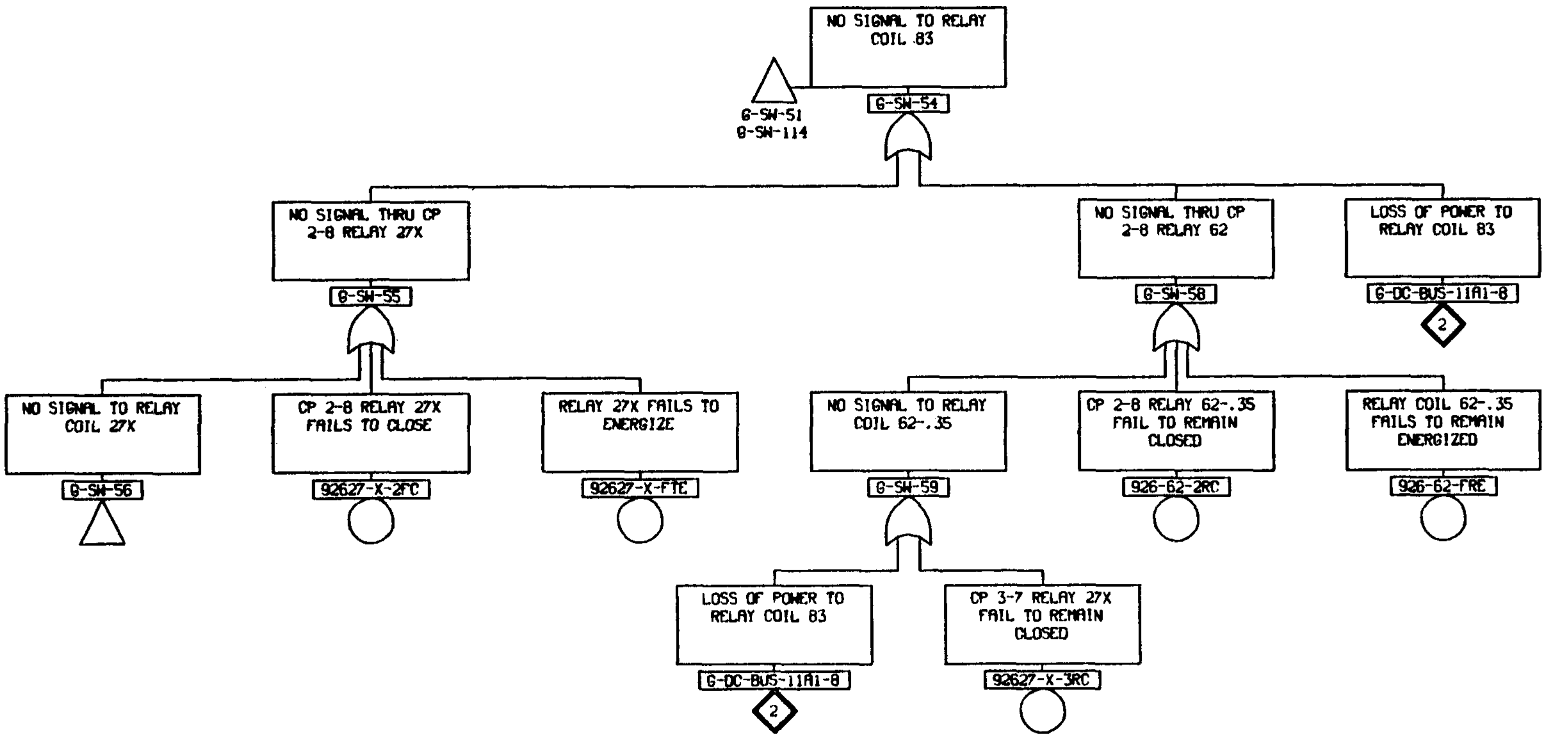


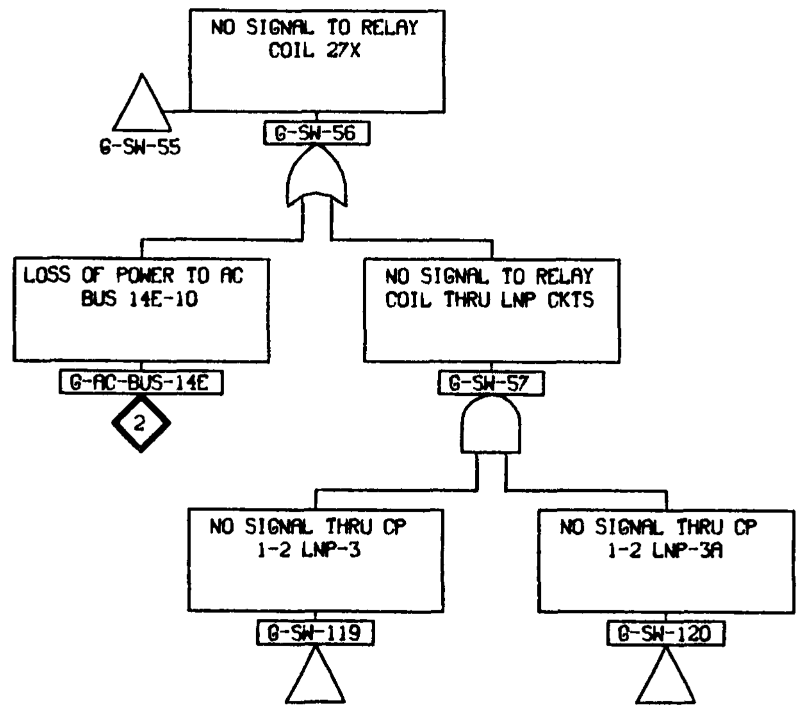
LOSS OF POWER TO SW-C-MDP
G-SW-32
G-SW-43
POWER FAILURE AT CIRCUIT BREAKER AC-14E-10
LOSS OF POWER TO AC BUS 14E-10
G-SW-44
G-AC-BUS-14E
2
ACTUATION SYSTEM FAILS
AC-14E-10 FAILS TO CLOSE
G-SW-45
AC-14E-10-FTC
AC-14E-10 ACUTUATION SYSTEM FAILS
SPURIOUS SIGNAL FROM MANUAL SWITCH 153
G-SW-46
G-SW-101
MANUAL START SYSTEM FAILURE
AUTO ACTUATION SYSTEM FAILURE AND LOSS OF NORMAL POWER
SW-C-MDP IN STANDBY
G-SW-47
G-SW-48A
SW-C-MDP-SBY


MANUAL START SYSTEM FAILURE
G-SW-47
G-SW-46
LOSS OF DC CONTROL POWER 101B CKT 9 TO AC-14E-10
G-DC-BUS-B-9
4
SWITCH CS-153 FAILS TO ENERGIZE
906CS-153-FTE
CP 1-1C OF SWITCH CS-153 FAILS TO CLOSE
906CS-153-1FC
SWITCH CS-153 OPERATOR FAILS TO CLOSE
SW-C-MDP-OFC
CP 2-2C OF SWITCH CS-153 FAILS TO CLOSE
906CS-153-2FC


AUTO ACTUATION SYSTEM FAILURE AND LOSS OF NORMAL POWER
G-SW-48A
G-SW-46
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
5
AUTO ACTUATION SYSTEM FAILS
G-SW-48
NO SIGNAL THRU CP 1-7 OF CX-7C
G-SW-49
NO SIGNAL THRU CP 1-7 OF 62-7C
G-SW-52
LOSS OF DC CONTROL POWER 101B CKT 9 TO AC-14E-10
G-DC-BUS-B-9
4
NO SIGNAL TO COIL CX-7C
G-SW-50
CP 1-7 CX-7C FAILS TO CLOSE
906CX-7C-1FC
COIL CX-7C FAILS TO ENERGIZE
906CX-7C-FTE
NO SIGNAL TO RELAY COIL 62-7C TDDO
G-SW-53
CP 1-7 OF 62-7C FAIL TO REMAIN CLOSED
90662-7C-1RC
RELAY COIL 62-7C FAILS TO REMAIN ENERGIZED
90662-7C-FRE
LOSS OF DC CONTROL POWER 101B CKT 9 TO AC-14E-10
G-DC-BUS-B-9
4
CP 3-4 OF RELAY CX-7C FAIL TO REMAIN CLOSED
906CX-7C-3RC

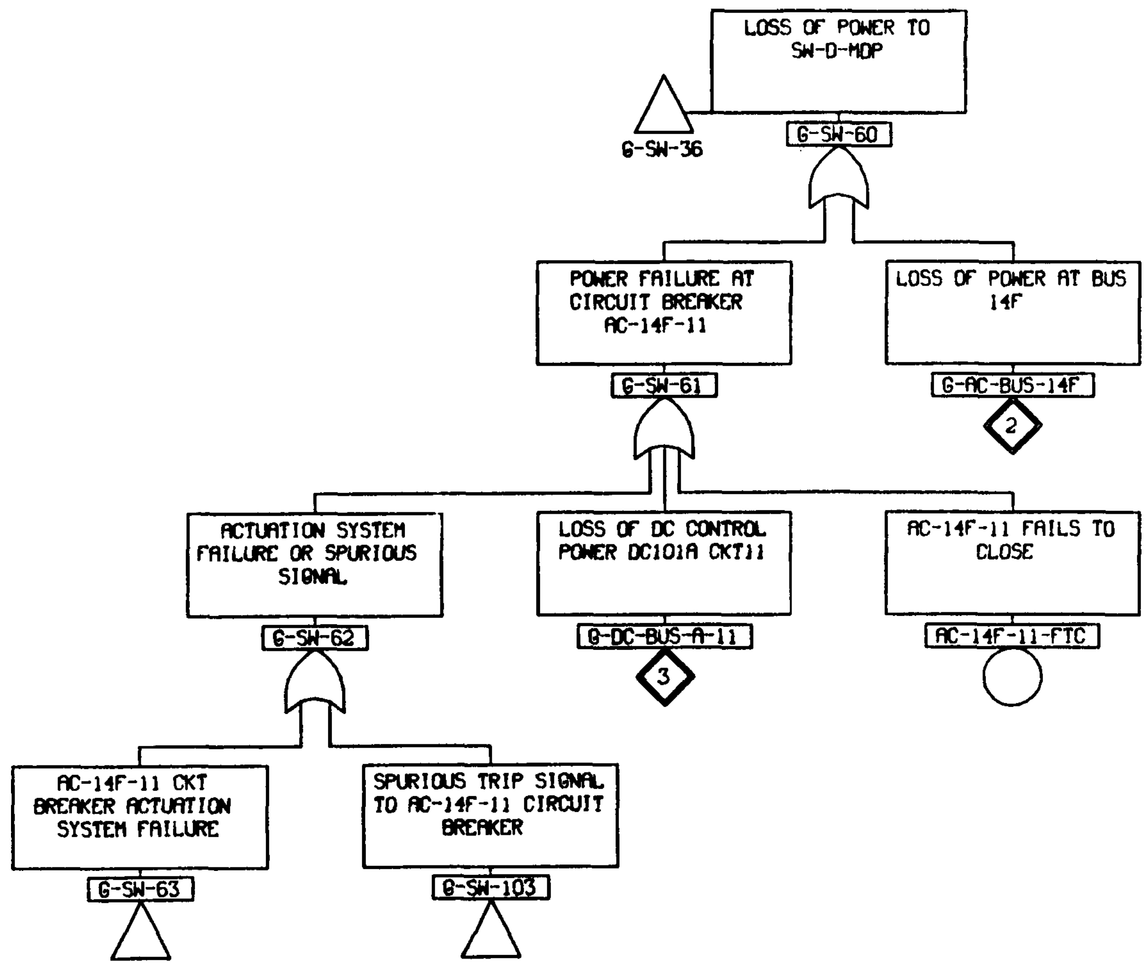

NO SIGNAL TO COIL CX-7C
G-SW-49
G-SW-50
LOSS OF DC CONTROL POWER 101B CKT 9 TO AC-14E-10
G-DC-BUS-B-9
4
NO SIGNAL THRU CP 3-4 RELAY 83
G-SW-51
NO SIGNAL TO RELAY COIL 83
G-SW-54
CP 3-4 OF RELAY 83 FAILS TO CLOSE
926-83-3FC
RELAY 83 FAILS TO ENERGIZE
926-83-FTE
2


NO SIGNAL TO RELAY COIL 83
G-SW-54
G-SW-51
G-SW-114
NO SIGNAL THRU CP 2-8 RELAY 27X
G-SW-55
NO SIGNAL THRU CP 2-8 RELAY 62
G-SW-58
LOSS OF POWER TO RELAY COIL 83
G-DC-BUS-11A1-8
2
NO SIGNAL TO RELAY COIL 27X
G-SW-56
CP 2-8 RELAY 27X FAILS TO CLOSE
92627-X-2FC
RELAY 27X FAILS TO ENERGIZE
92627-X-FTE
NO SIGNAL TO RELAY COIL 62-.35
G-SW-59
CP 2-8 RELAY 62-.35 FAIL TO REMAIN CLOSED
926-62-2RC
RELAY COIL 62-.35 FAILS TO REMAIN ENERGIZED
926-62-FRE
LOSS OF POWER TO RELAY COIL 83
G-DC-BUS-11A1-8
2
CP 3-7 RELAY 27X FAIL TO REMAIN CLOSED
92627-X-3RC

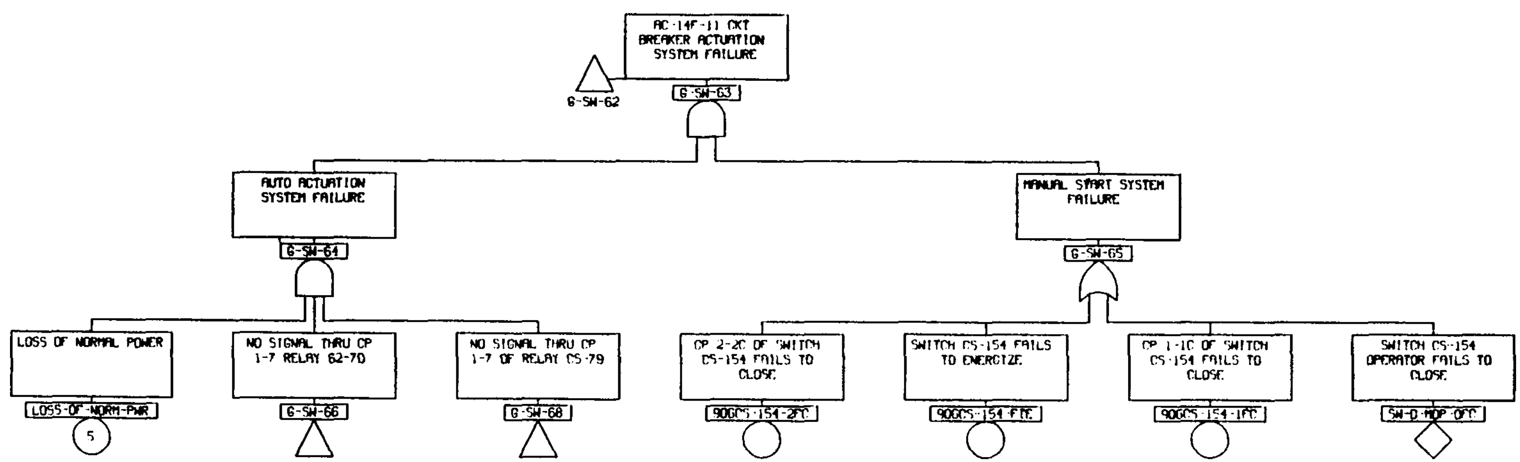


NO SIGNAL TO RELAY COIL 27X
G-SW-56
G-SW-55
LOSS OF POWER TO AC BUS 14E-10
G-AC-BUS-14E
2
NO SIGNAL TO RELAY COIL THRU LNP CKTS
G-SW-57
NO SIGNAL THRU CP 1-2 LNP-3
G-SW-119
NO SIGNAL THRU CP 1-2 LNP-3A
G-SW-120

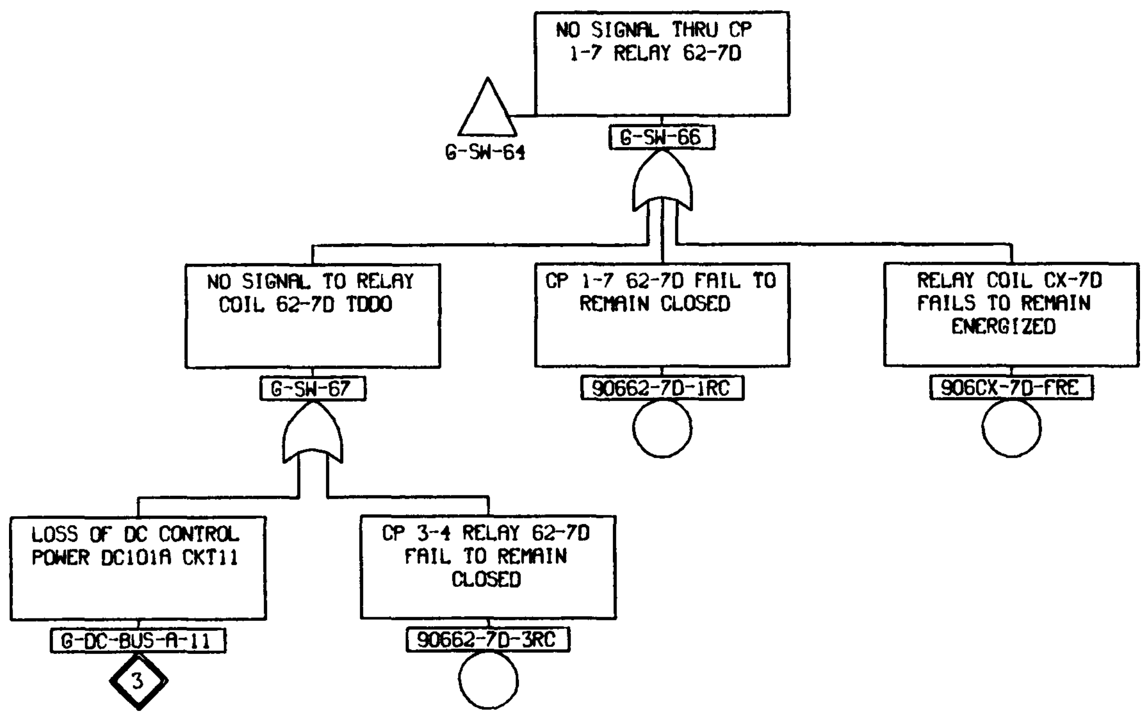
B.14-45

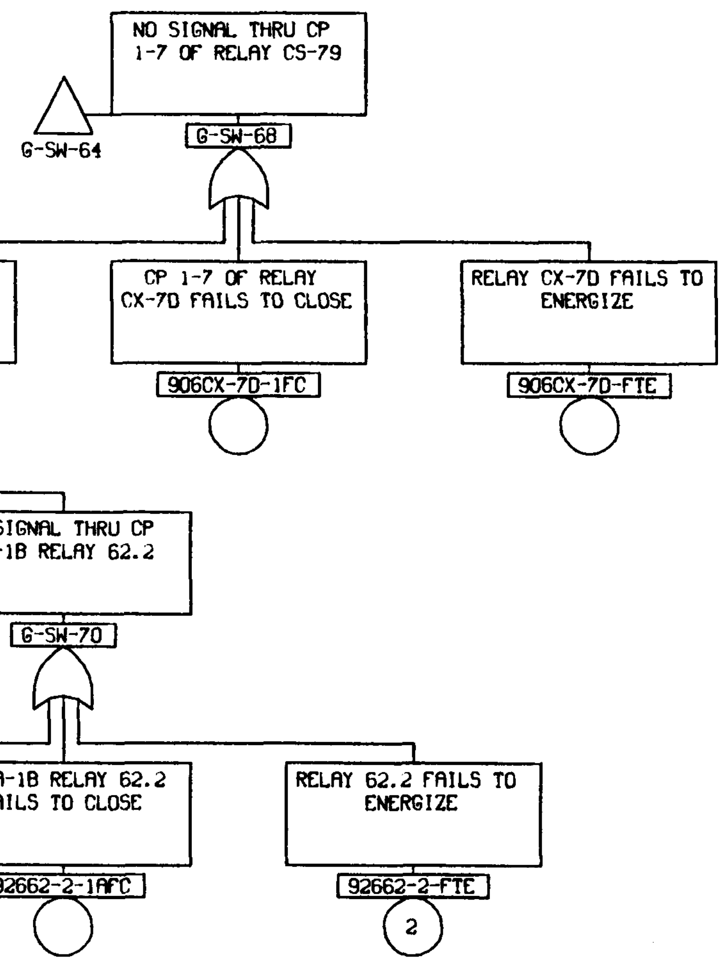

LOSS OF POWER TO SW-D-MDP
G-SW-36
G-SW-60
POWER FAILURE AT CIRCUIT BREAKER AC-14F-11
LOSS OF POWER AT BUS 14F
G-SW-61
G-AC-BUS-14F
2
ACTUATION SYSTEM FAILURE OR SPURIOUS SIGNAL
LOSS OF DC CONTROL POWER DC101A CKT11
AC-14F-11 FAILS TO CLOSE
G-SW-62
G-DC-BUS-A-11
3
AC-14F-11-FTC
AC-14F-11 CKT BREAKER ACTUATION SYSTEM FAILURE
SPURIOUS TRIP SIGNAL TO AC-14F-11 CIRCUIT BREAKER
G-SW-63
G-SW-103

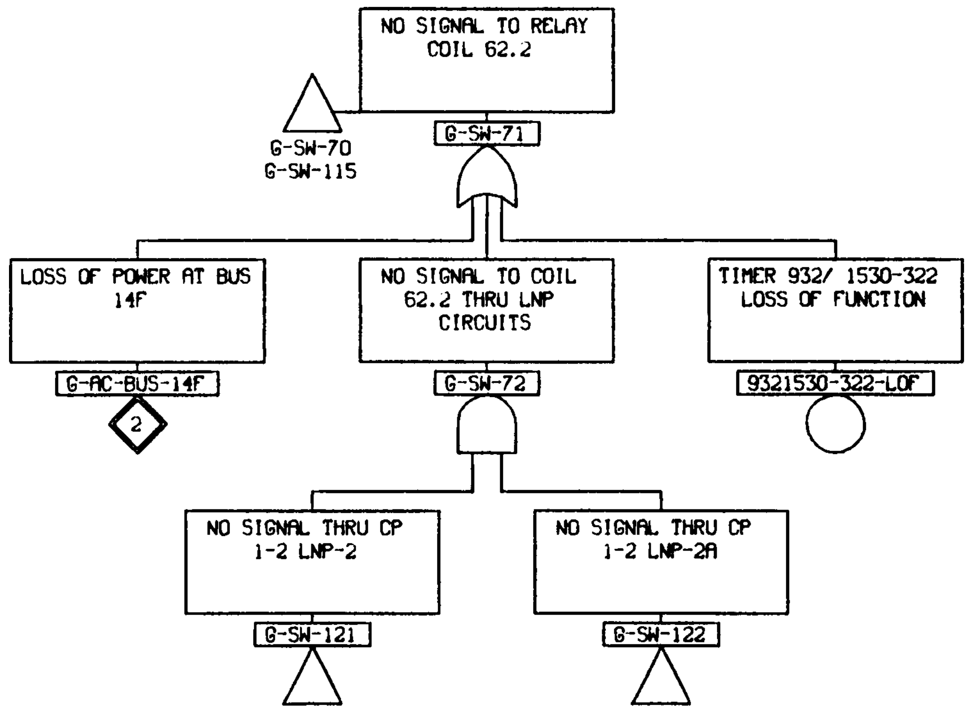
B.14-46

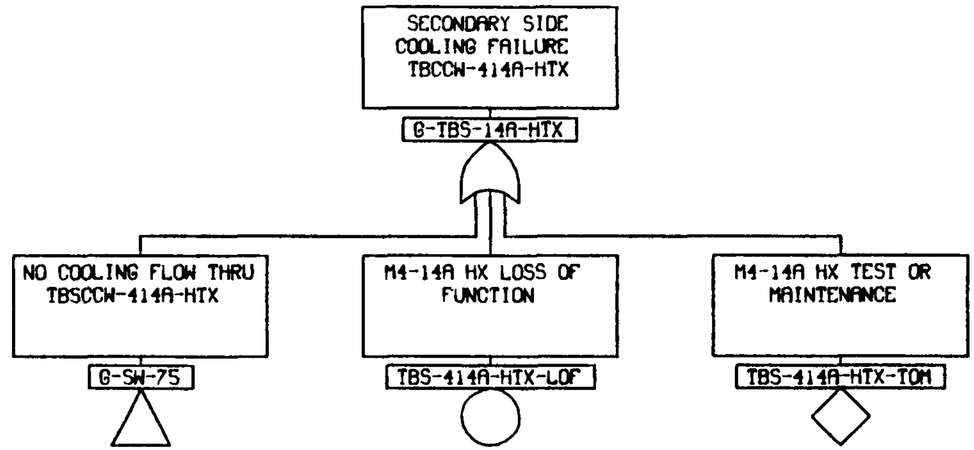


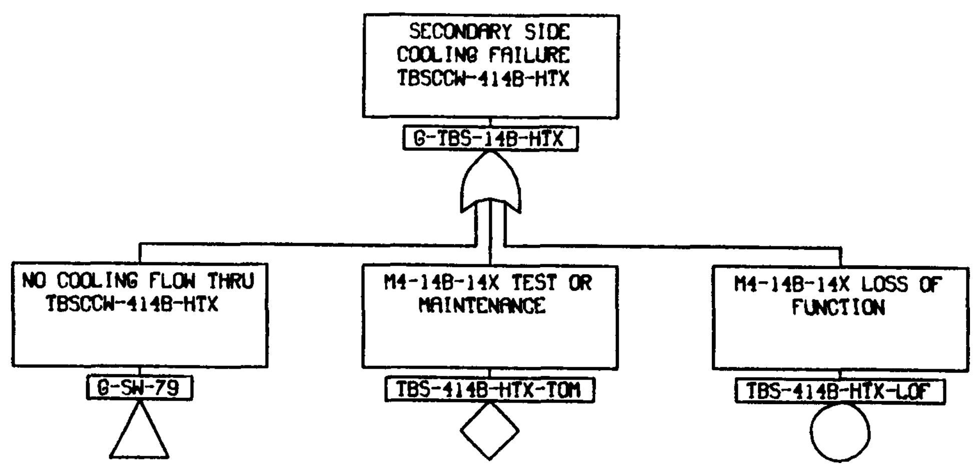
AC-14F-11 CKT BREAKER ACTUATION SYSTEM FAILURE
G-SW-63
G-SW-62
AUTO ACTUATION SYSTEM FAILURE
G-SW-64
MANUAL START SYSTEM FAILURE
G-SW-65
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
5
NO SIGNAL THRU CP 1-7 RELAY 62-70
G-SW-66
NO SIGNAL THRU CP 1-7 OF RELAY CS-79
G-SW-68
CP 2-2C OF SWITCH CS-154 FAILS TO CLOSE
90GCS-154-2FC
SWITCH CS-154 FAILS TO ENERGIZE
90GCS-154-FTE
CP 1-1C OF SWITCH CS-154 FAILS TO CLOSE
90GCS-154-1FC
SWITCH CS-154 OPERATOR FAILS TO CLOSE
SW-D-MOP-OFC

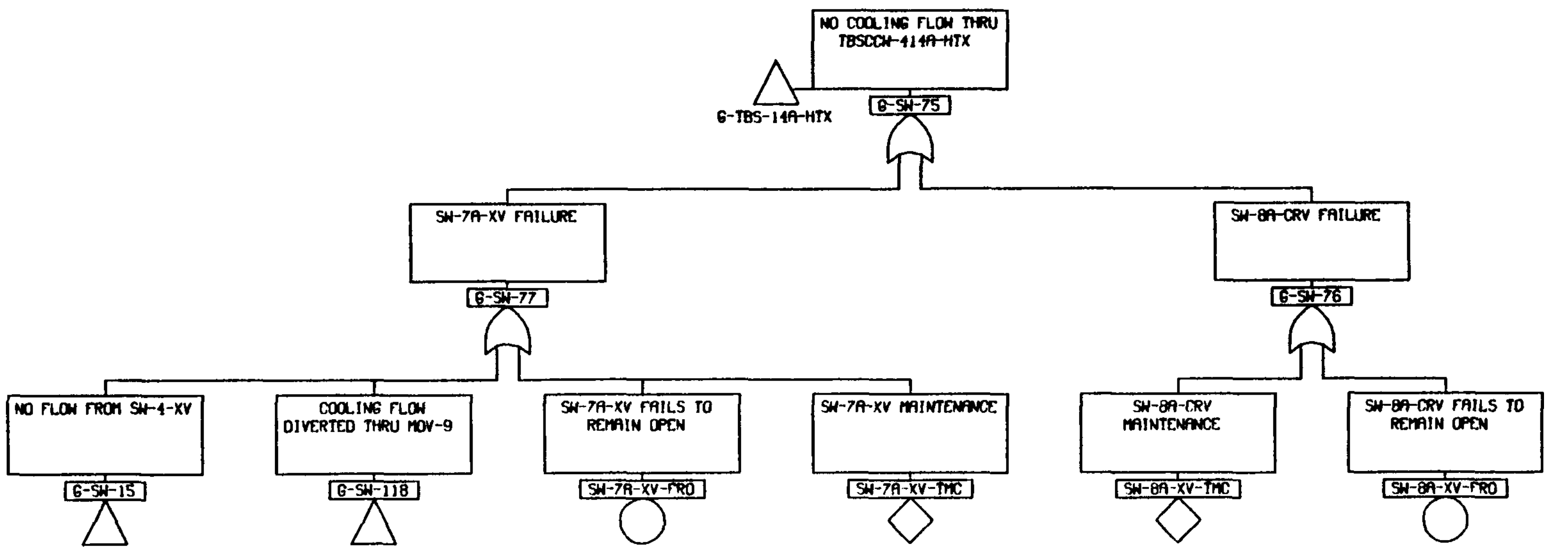

NO SIGNAL THRU CP 1-7 RELAY 62-7D
G-SW-66
G-SW-64
NO SIGNAL TO RELAY COIL 62-7D TDDO
G-SW-67
CP 1-7 62-7D FAIL TO REMAIN CLOSED
90662-7D-1RC
RELAY COIL CX-7D FAILS TO REMAIN ENERGIZED
906CX-7D-FRE
LOSS OF DC CONTROL POWER DC101A CKT11
G-DC-BUS-A-11
3
CP 3-4 RELAY 62-7D FAIL TO REMAIN CLOSED
90662-7D-3RC

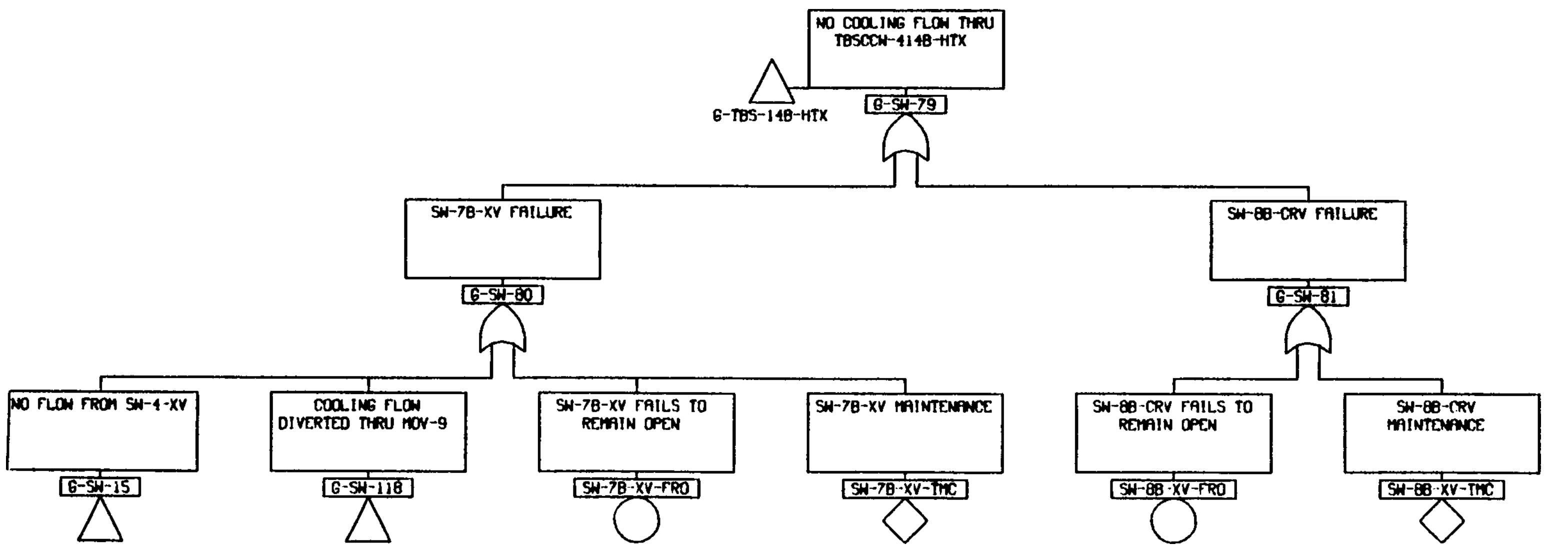

NO SIGNAL THRU CP 1-7 OF RELAY CS-79
G-SW-64
G-SW-68
NO SIGNAL TO RELAY COIL CX-79
G-SW-69
CP 1-7 OF RELAY CX-7D FAILS TO CLOSE
906CX-7D-1FC
RELAY CX-7D FAILS TO ENERGIZE
906CX-7D-FTE
LOSS OF DC CONTROL POWER DC101A CKT11
G-DC-BUS-A-11
3
NO SIGNAL THRU CP 1A-1B RELAY 62.2
G-SW-70
NO SIGNAL TO RELAY COIL 62.2
G-SW-71
CP 1A-1B RELAY 62.2 FAILS TO CLOSE
92662-2-1AFC
RELAY 62.2 FAILS TO ENERGIZE
92662-2-FTE
2

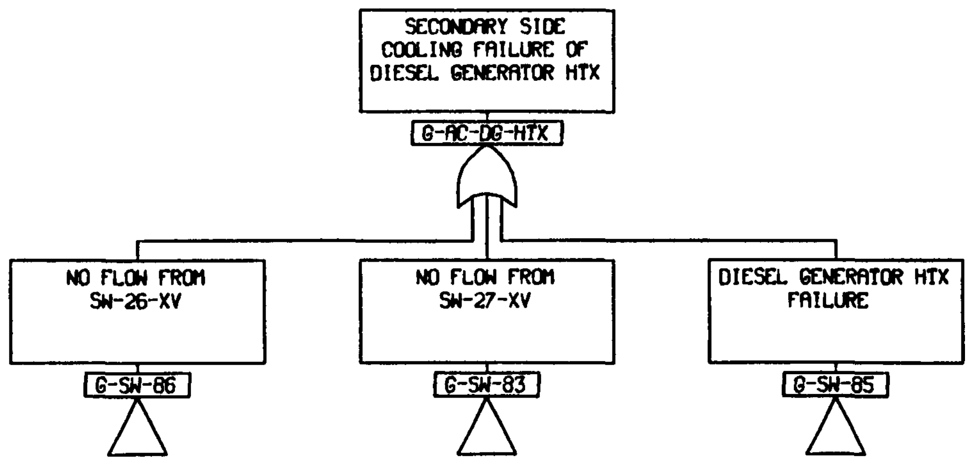

NO SIGNAL TO RELAY COIL 62.2
G-SW-71
G-SW-70
G-SW-115
LOSS OF POWER AT BUS 14F
G-AC-BUS-14F
2
NO SIGNAL TO COIL 62.2 THRU LNP CIRCUITS
G-SW-72
TIMER 932/ 1530-322 LOSS OF FUNCTION
9321530-322-LOF
NO SIGNAL THRU CP 1-2 LNP-2
G-SW-121
NO SIGNAL THRU CP 1-2 LNP-2A
G-SW-122

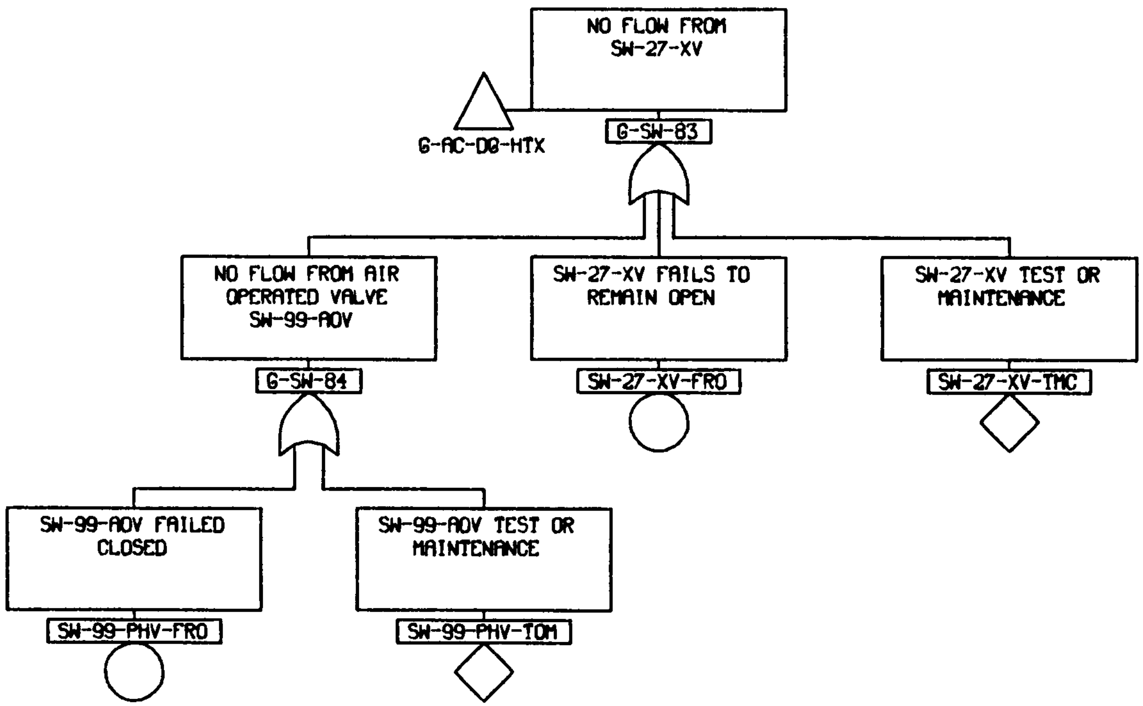

SECONDARY SIDE COOLING FAILURE TBCCW-414A-HTX
G-TBS-14A-HTX
NO COOLING FLOW THRU TBSCCW-414A-HTX
G-SW-75
M4-14A HX LOSS OF FUNCTION
TBS-414A-HTX-LOF
M4-14A HX TEST OR MAINTENANCE
TBS-414A-HTX-TOM

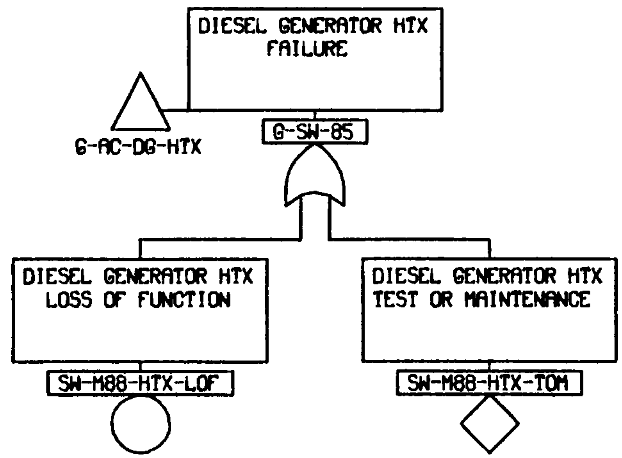

SECONDARY SIDE COOLING FAILURE TBSCCW-414B-HTX
G-TBS-14B-HTX
NO COOLING FLOW THRU TBSCCW-414B-HTX
G-SW-79
M4-14B-14X TEST OR MAINTENANCE
TBS-414B-HTX-TOM
M4-14B-14X LOSS OF FUNCTION
TBS-414B-HTX-LOF

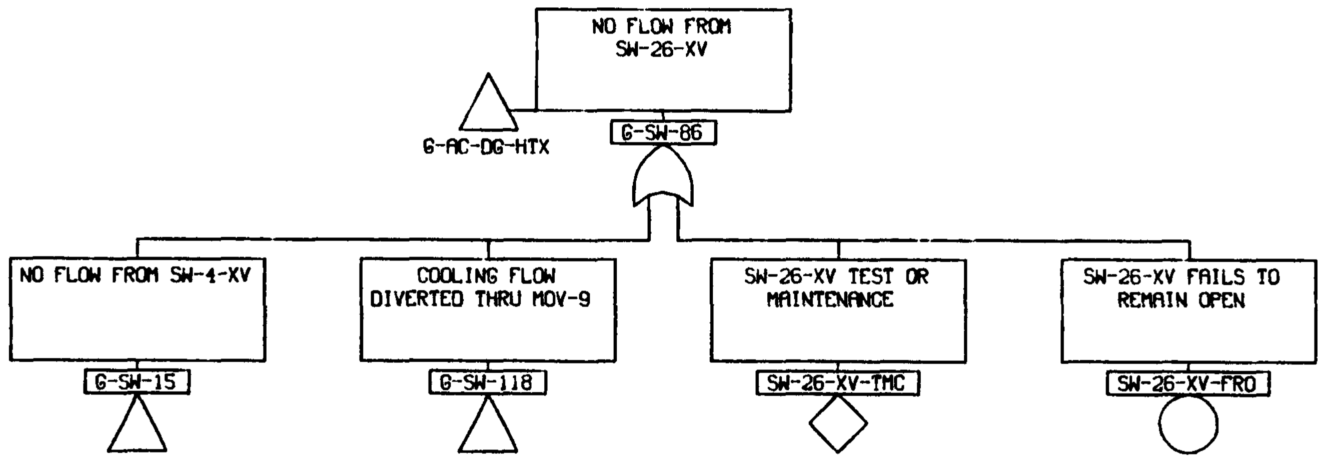

NO COOLING FLOW THRU TBSCCW-414A-HTX
G-SW-75
G-TBS-14A-HTX
SW-7A-XV FAILURE
G-SW-77
SW-8A-CRV FAILURE
G-SW-76
NO FLOW FROM SW-4-XV
G-SW-15
COOLING FLOW DIVERTED THRU MOV-9
G-SW-118
SW-7A-XV FAILS TO REMAIN OPEN
SW-7A-XV-FRO
SW-7A-XV MAINTENANCE
SW-7A-XV-TMC
SW-8A-CRV MAINTENANCE
SW-8A-XV-TMC
SW-8A-CRV FAILS TO REMAIN OPEN
SW-8A-XV-FRO


NO COOLING FLOW THRU TBSCCW-414B-HTX
G-SW-79
G-TBS-14B-HTX
SW-7B-XV FAILURE
G-SW-80
SW-8B-CRV FAILURE
G-SW-81
NO FLOW FROM SW-4-XV
G-SW-15
COOLING FLOW DIVERTED THRU MOV-9
G-SW-118
SW-7B-XV FAILS TO REMAIN OPEN
SW-7B-XV-FRO
SW-7B-XV MAINTENANCE
SW-7B-XV-TMC
SW-8B-CRV FAILS TO REMAIN OPEN
SW-8B-XV-FRO
SW-8B-CRV MAINTENANCE
SW-8B-XV-TMC

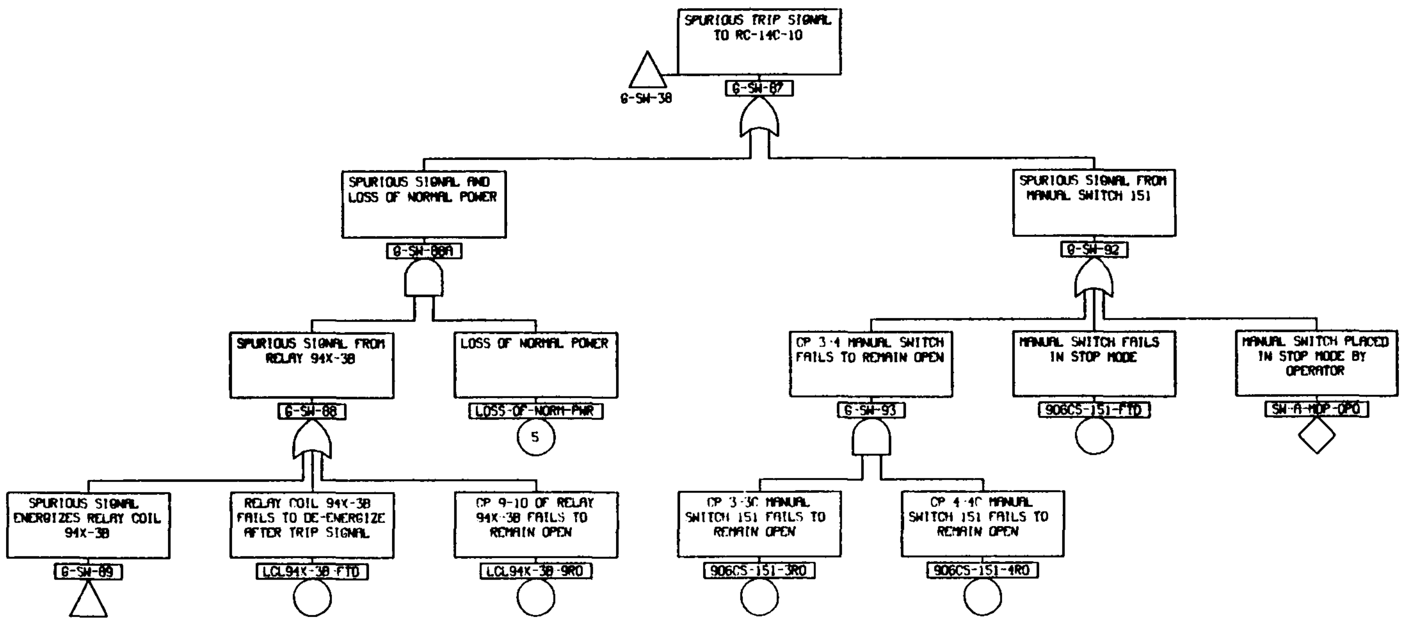

SECONDARY SIDE COOLING FAILURE OF DIESEL GENERATOR HTX
G-AC-DG-HTX
NO FLOW FROM SW-26-XV
G-SW-86
NO FLOW FROM SW-27-XV
G-SW-83
DIESEL GENERATOR HTX FAILURE
G-SW-85


NO FLOW FROM SW-27-XV
G-SW-83
G-AC-DG-HTX
NO FLOW FROM AIR OPERATED VALVE SW-99-AOV
G-SW-84
SW-27-XV FAILS TO REMAIN OPEN
SW-27-XV-FRO
SW-27-XV TEST OR MAINTENANCE
SW-27-XV-TMC
SW-99-AOV FAILED CLOSED
SW-99-PHV-FRO
SW-99-AOV TEST OR MAINTENANCE
SW-99-PHV-TOM

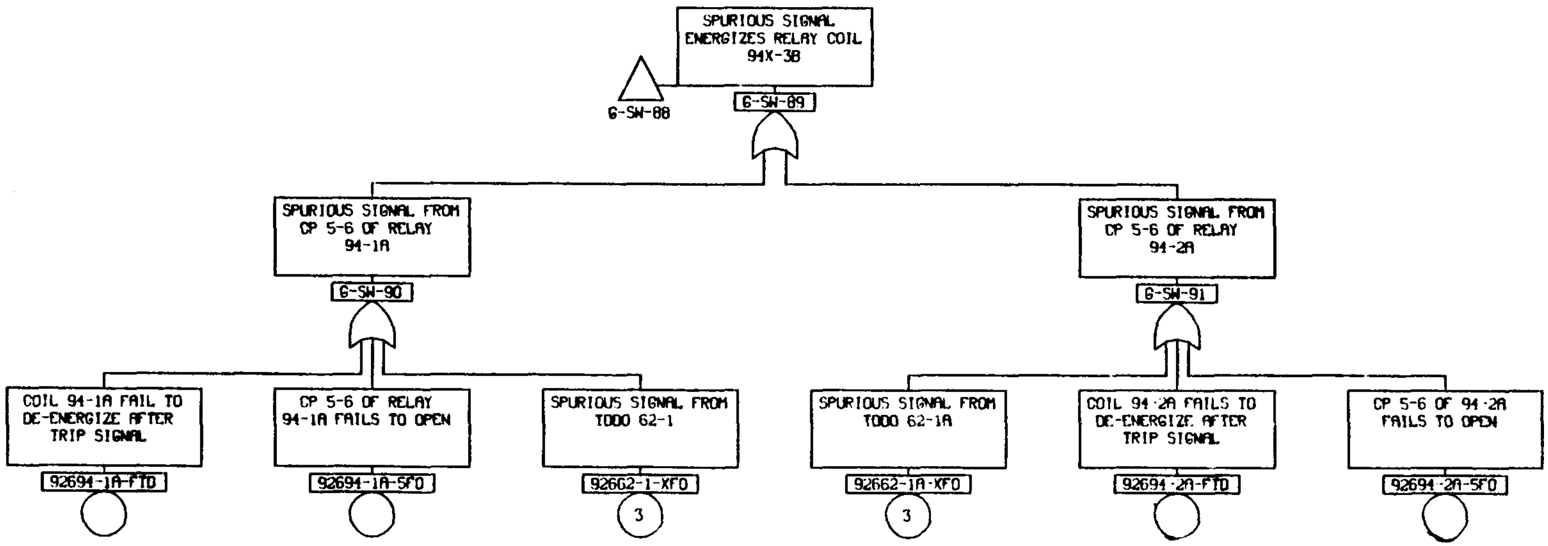

DIESEL GENERATOR HTX FAILURE
G-AC-DG-HTX
G-SW-85
DIESEL GENERATOR HTX LOSS OF FUNCTION
SW-M88-HTX-LOF
DIESEL GENERATOR HTX TEST OR MAINTENANCE
SW-M88-HTX-TOM


NO FLOW FROM SW-26-XV
G-SW-86
G-AC-DG-HTX
NO FLOW FROM SW-4-XV
G-SW-15
COOLING FLOW DIVERTED THRU MOV-9
G-SW-118
SW-26-XV TEST OR MAINTENANCE
SW-26-XV-TMC
SW-26-XV FAILS TO REMAIN OPEN
SW-26-XV-FRO

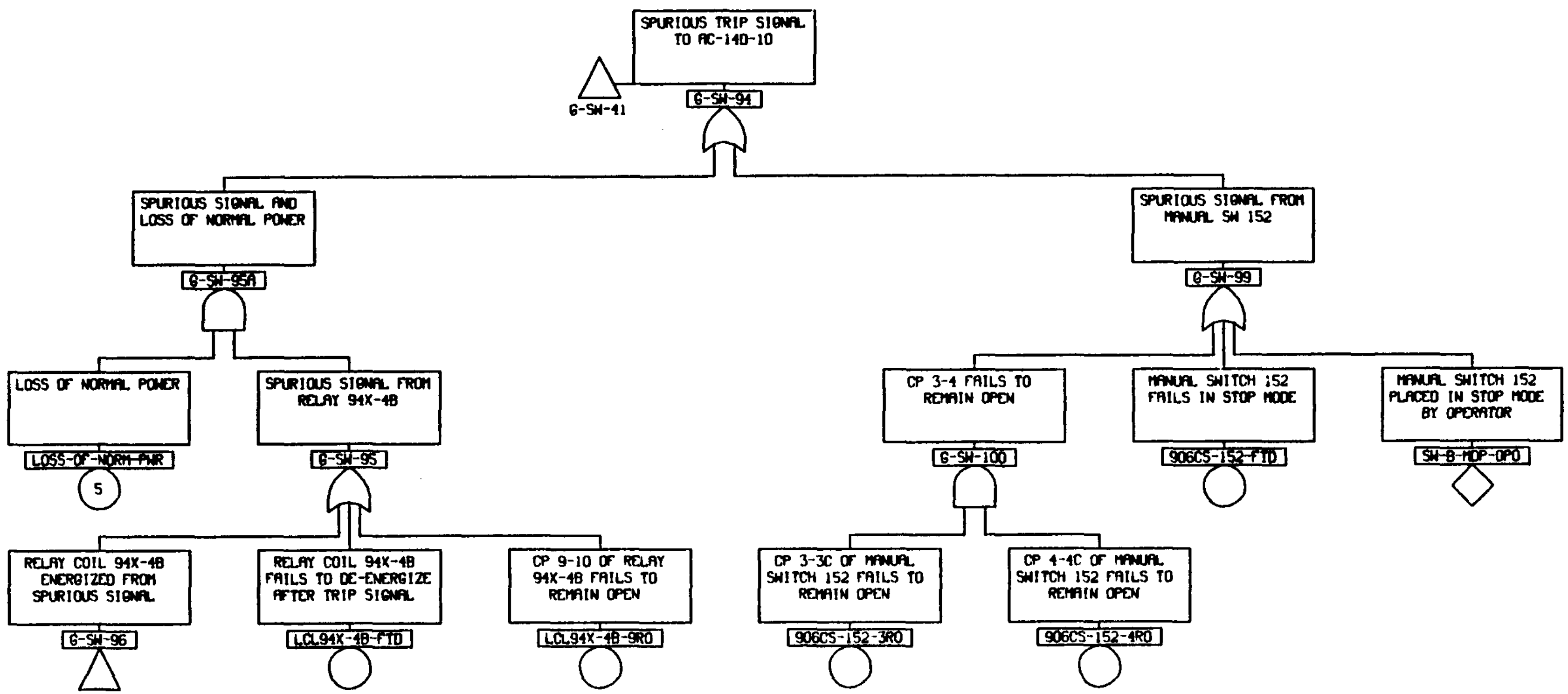
SW-31



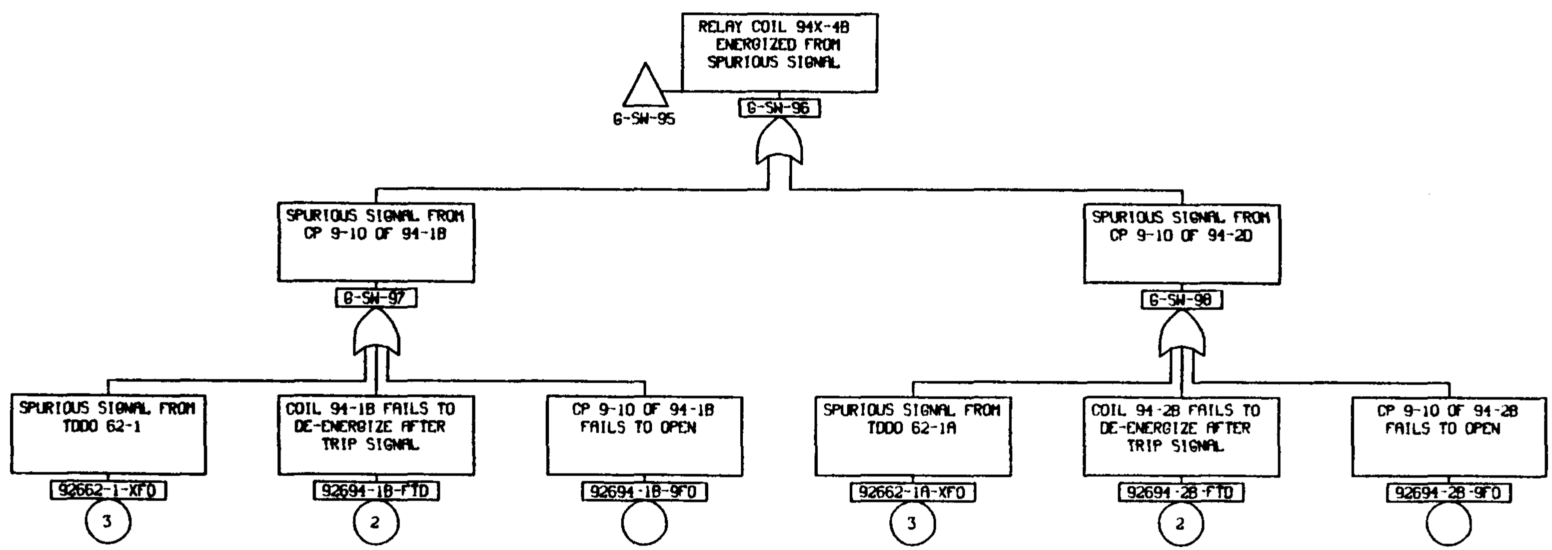
SPURIOUS TRIP SIGNAL TO RC-14C-10
G-SW-38
G-SW-87
SPURIOUS SIGNAL AND LOSS OF NORMAL POWER
G-SW-88A
SPURIOUS SIGNAL FROM MANUAL SWITCH 151
G-SW-92
SPURIOUS SIGNAL FROM RELAY 94X-3B
G-SW-88
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
5
CP 3-4 MANUAL SWITCH FAILS TO REMAIN OPEN
G-SW-93
MANUAL SWITCH FAILS IN STOP MODE
906CS-151-FTD
MANUAL SWITCH PLACED IN STOP MODE BY OPERATOR
SW-A-MOP-OPO
SPURIOUS SIGNAL ENERGIZES RELAY COIL 94X-3B
G-SW-89
RELAY COIL 94X-3B FAILS TO DE-ENERGIZE AFTER TRIP SIGNAL
LCL94X-3B-FTD
CP 9-10 OF RELAY 94X-3B FAILS TO REMAIN OPEN
LCL94X-3B-9RO
CP 3-3C MANUAL SWITCH 151 FAILS TO REMAIN OPEN
906CS-151-3RO
CP 4-4C MANUAL SWITCH 151 FAILS TO REMAIN OPEN
906CS-151-4RO



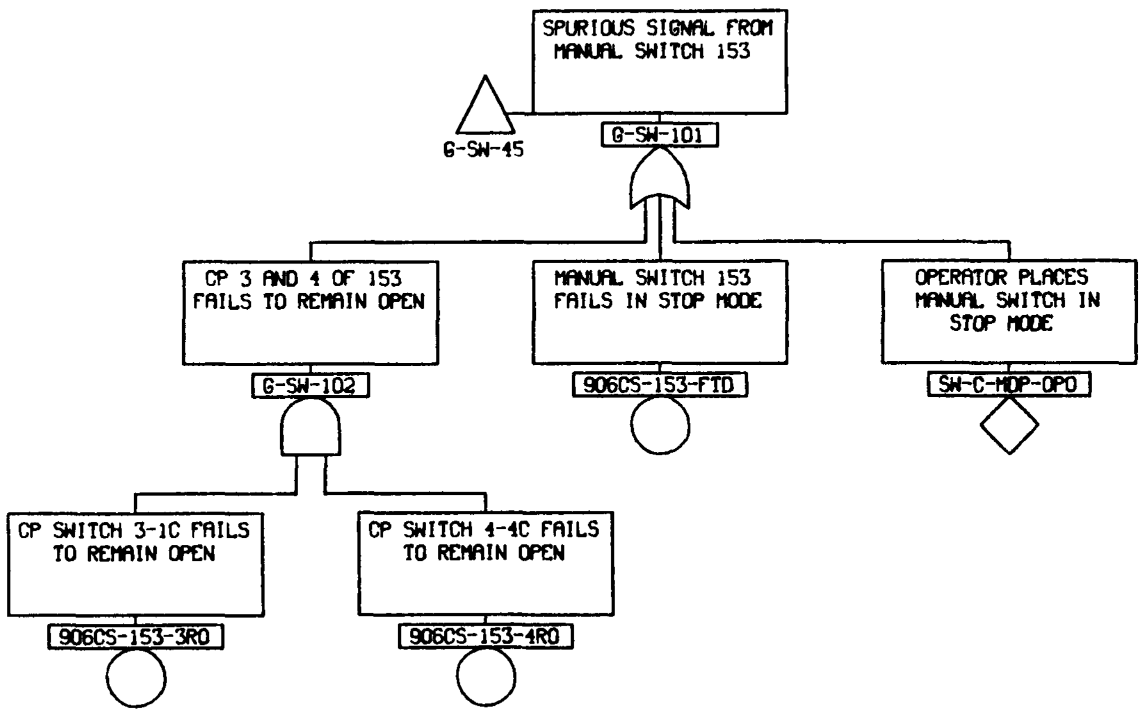
SPURIOUS SIGNAL ENERGIZES RELAY COIL 94X-3B
G-SW-88
G-SW-89
SPURIOUS SIGNAL FROM CP 5-6 OF RELAY 94-1A
G-SW-90
SPURIOUS SIGNAL FROM CP 5-6 OF RELAY 94-2A
G-SW-91
COIL 94-1A FAIL TO DE-ENERGIZE AFTER TRIP SIGNAL
92694-1A-FTD
CP 5-6 OF RELAY 94-1A FAILS TO OPEN
92694-1A-SFO
SPURIOUS SIGNAL FROM TODO 62-1
92662-1-XFO
3
SPURIOUS SIGNAL FROM TODO 62-1A
92662-1A-XFO
3
COIL 94-2A FAILS TO DE-ENERGIZE AFTER TRIP SIGNAL
92694-2A-FTD
CP 5-6 OF 94-2A FAILS TO OPEN
92694-2A-SFO

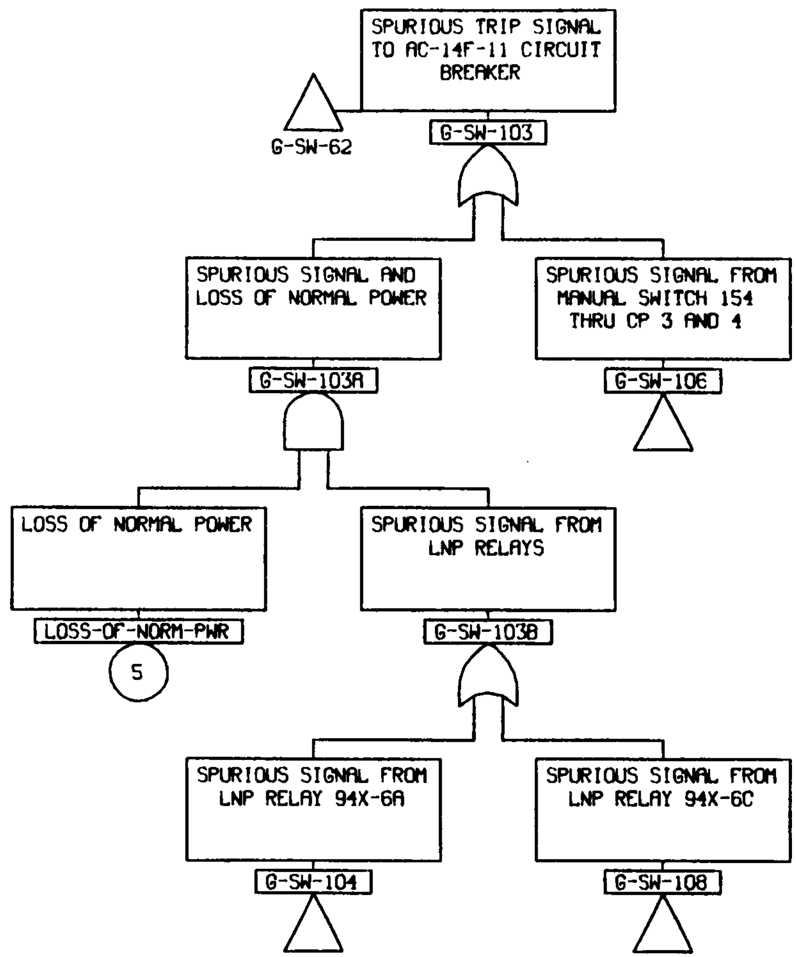


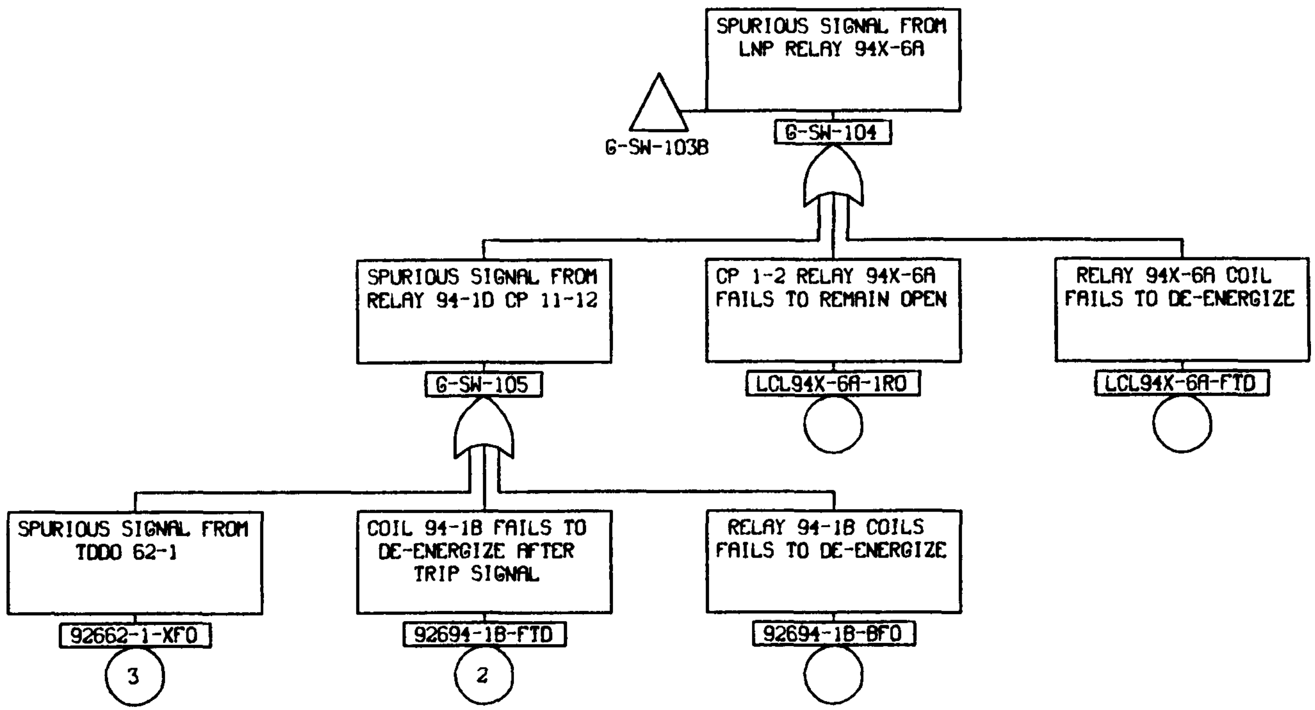
SPURIOUS TRIP SIGNAL TO AC-14D-10
G-SW-94
G-SW-41
SPURIOUS SIGNAL AND LOSS OF NORMAL POWER
G-SW-95A
SPURIOUS SIGNAL FROM MANUAL SW 152
G-SW-99
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
5
SPURIOUS SIGNAL FROM RELAY 94X-4B
G-SW-95
CP 3-4 FAILS TO REMAIN OPEN
G-SW-100
MANUAL SWITCH 152 FAILS IN STOP MODE
906CS-152-FTD
MANUAL SWITCH 152 PLACED IN STOP MODE BY OPERATOR
SW-B-MDP-OPO
RELAY COIL 94X-4B ENERGIZED FROM SPURIOUS SIGNAL
G-SW-96
RELAY COIL 94X-4B FAILS TO DE-ENERGIZE AFTER TRIP SIGNAL
LCL94X-4B-FTD
CP 9-10 OF RELAY 94X-4B FAILS TO REMAIN OPEN
LCL94X-4B-9RO
CP 3-3C OF MANUAL SWITCH 152 FAILS TO REMAIN OPEN
906CS-152-3RO
CP 4-4C OF MANUAL SWITCH 152 FAILS TO REMAIN OPEN
906CS-152-4RO

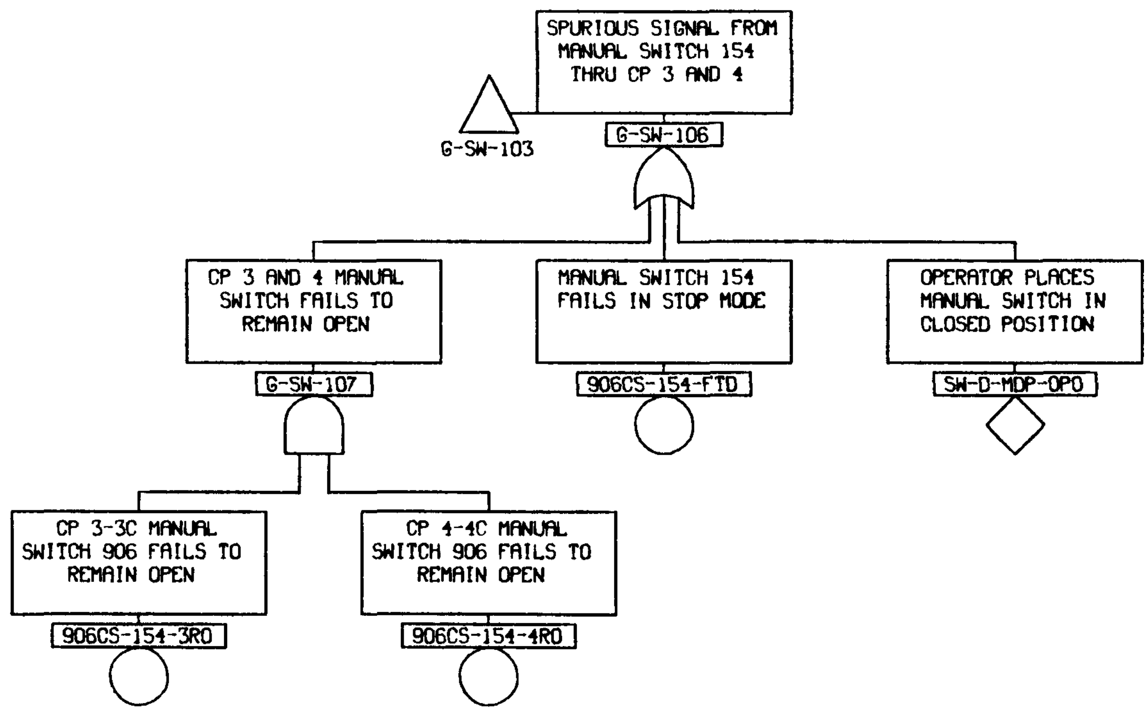


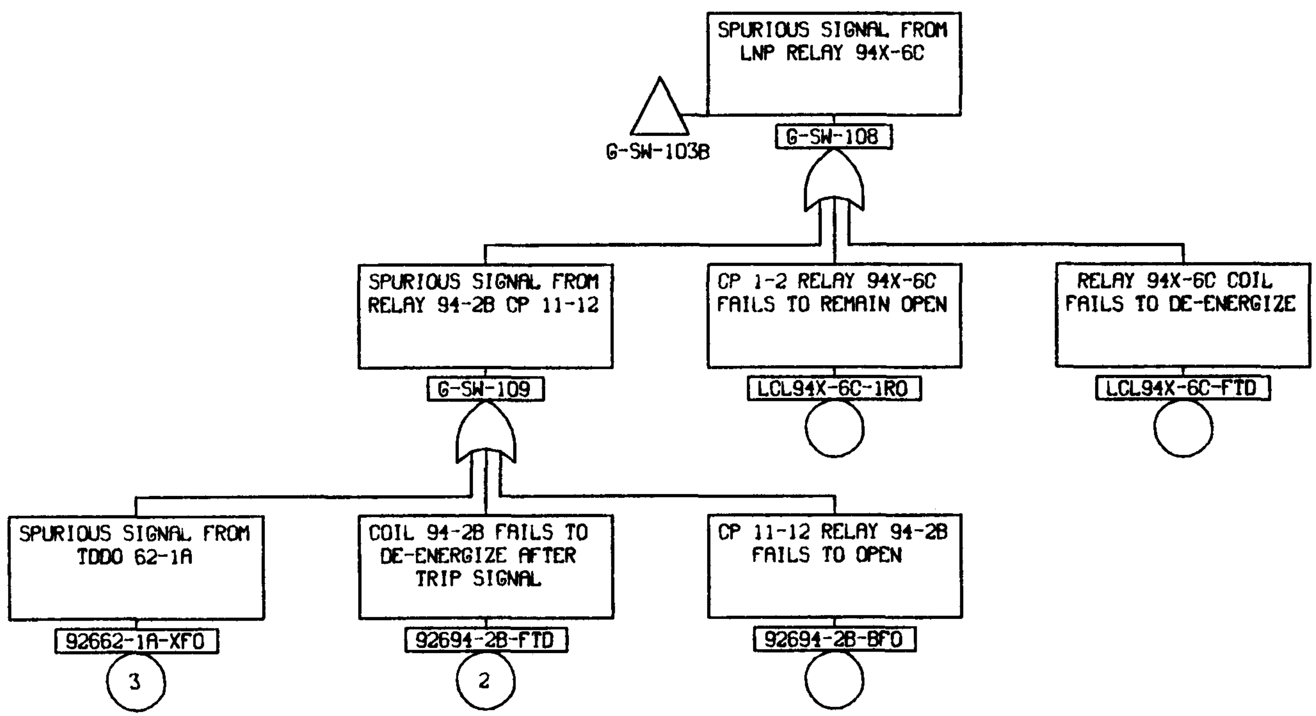
RELAY COIL 94X-4B ENERGIZED FROM SPURIOUS SIGNAL
G-SW-95
G-SW-96
SPURIOUS SIGNAL FROM CP 9-10 OF 94-1B
G-SW-97
SPURIOUS SIGNAL FROM CP 9-10 OF 94-2D
G-SW-98
SPURIOUS SIGNAL FROM TODO 62-1
92662-1-XFO
3
COIL 94-1B FAILS TO DE-ENERGIZE AFTER TRIP SIGNAL
92694-1B-FTD
2
CP 9-10 OF 94-1B FAILS TO OPEN
92694-1B-SFO
SPURIOUS SIGNAL FROM TODO 62-1A
92662-1A-XFO
3
COIL 94-2B FAILS TO DE-ENERGIZE AFTER TRIP SIGNAL
92694-2B-FTD
2
CP 9-10 OF 94-2B FAILS TO OPEN
92694-2B-SFO

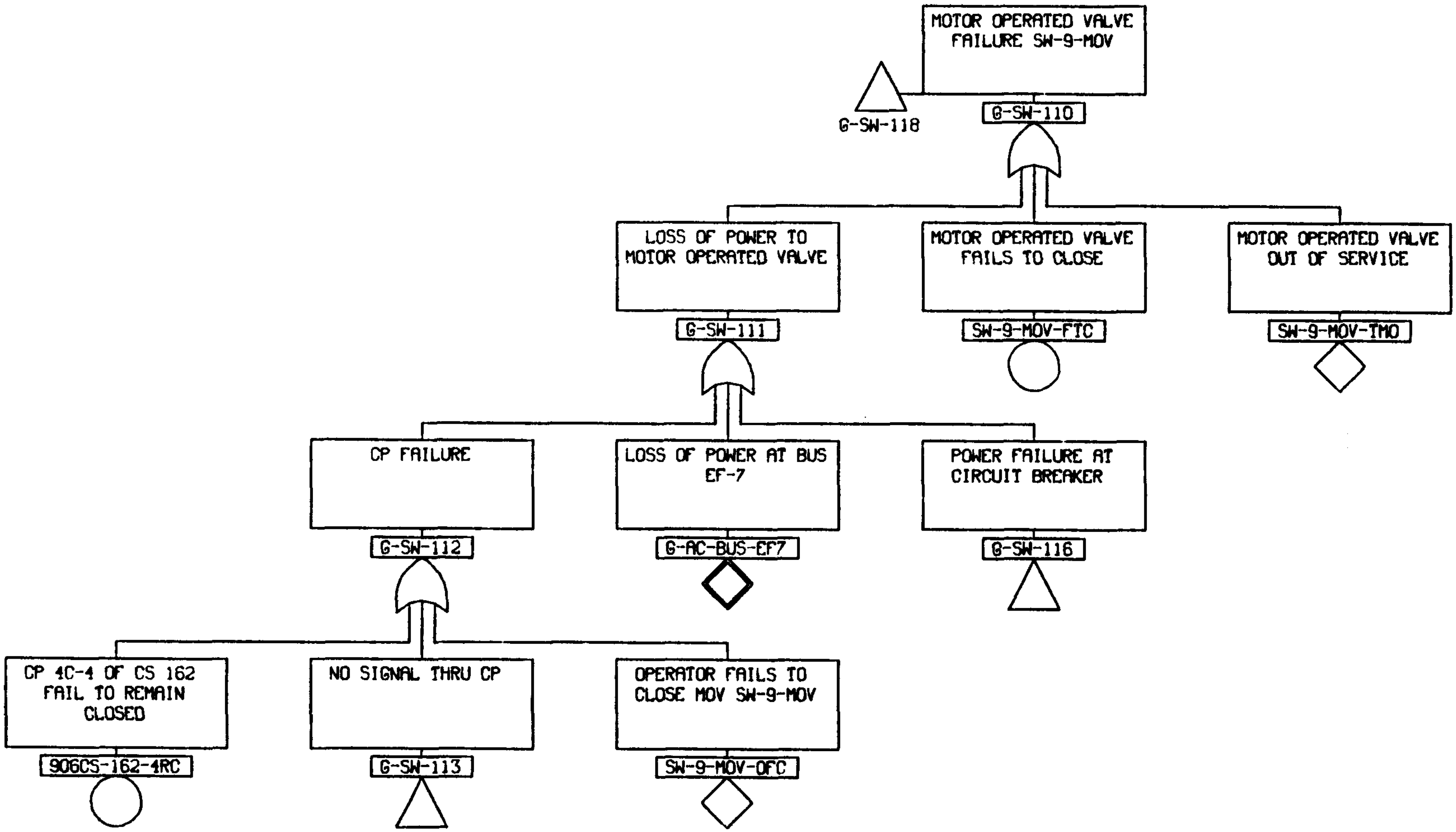

SPURIOUS SIGNAL FROM MANUAL SWITCH 153
G-SW-101
G-SW-45
CP 3 AND 4 OF 153 FAILS TO REMAIN OPEN
G-SW-102
MANUAL SWITCH 153 FAILS IN STOP MODE
906CS-153-FTD
OPERATOR PLACES MANUAL SWITCH IN STOP MODE
SW-C-MDP-OPO
CP SWITCH 3-1C FAILS TO REMAIN OPEN
906CS-153-3RO
CP SWITCH 4-4C FAILS TO REMAIN OPEN
906CS-153-4RO

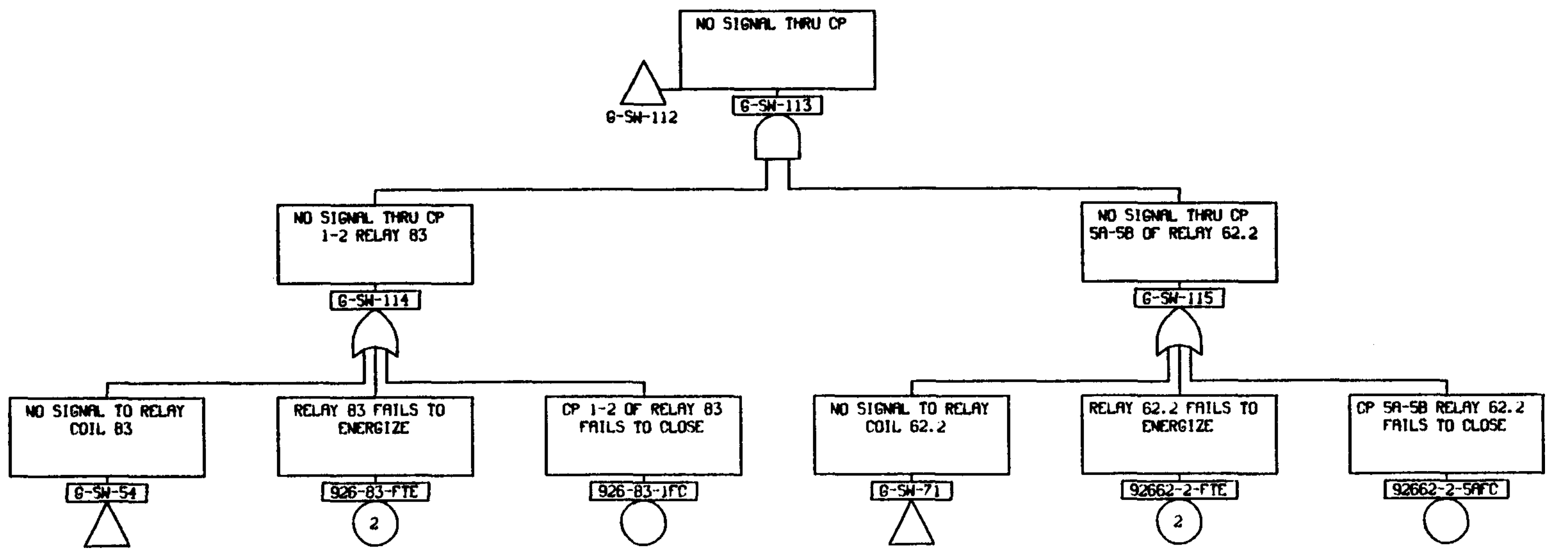

SPURIOUS TRIP SIGNAL TO AC-14F-11 CIRCUIT BREAKER
G-SW-103
G-SW-62
SPURIOUS SIGNAL AND LOSS OF NORMAL POWER
G-SW-103A
SPURIOUS SIGNAL FROM MANUAL SWITCH 154 THRU CP 3 AND 4
G-SW-106
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
5
SPURIOUS SIGNAL FROM LNP RELAYS
G-SW-103B
SPURIOUS SIGNAL FROM LNP RELAY 94X-6A
G-SW-104
SPURIOUS SIGNAL FROM LNP RELAY 94X-6C
G-SW-108

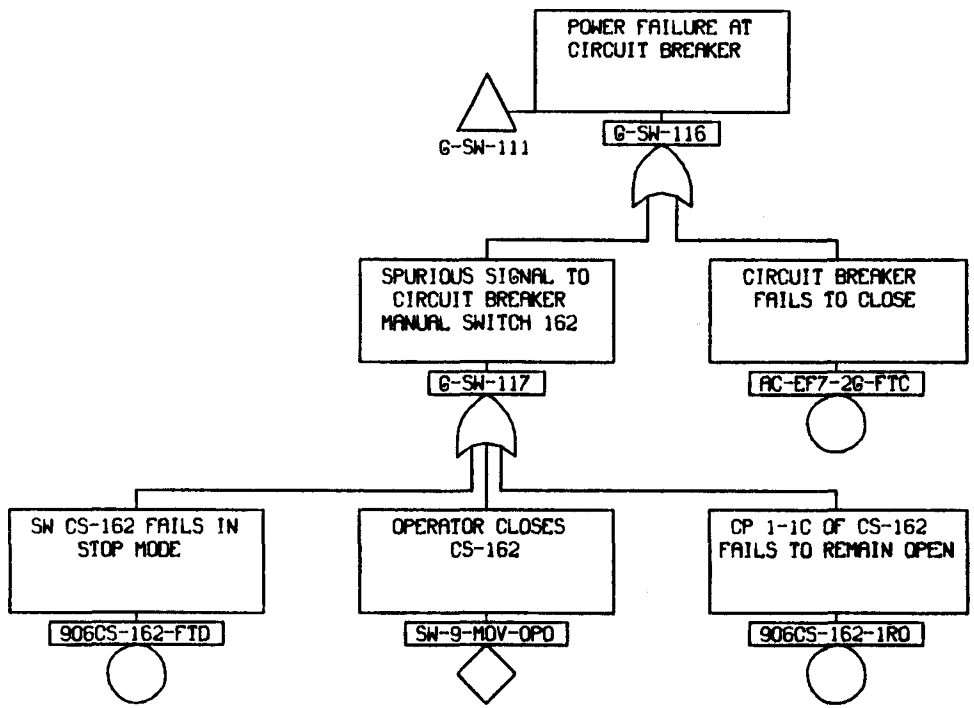

SPURIOUS SIGNAL FROM LNP RELAY 94X-6A
G-SW-104
G-SW-103B
SPURIOUS SIGNAL FROM RELAY 94-1D CP 11-12
G-SW-105
CP 1-2 RELAY 94X-6A FAILS TO REMAIN OPEN
LCL94X-6A-1RO
RELAY 94X-6A COIL FAILS TO DE-ENERGIZE
LCL94X-6A-FTD
SPURIOUS SIGNAL FROM TDDO 62-1
92662-1-XFO
3
COIL 94-1B FAILS TO DE-ENERGIZE AFTER TRIP SIGNAL
92694-1B-FTD
2
RELAY 94-1B COILS FAILS TO DE-ENERGIZE
92694-1B-BFO

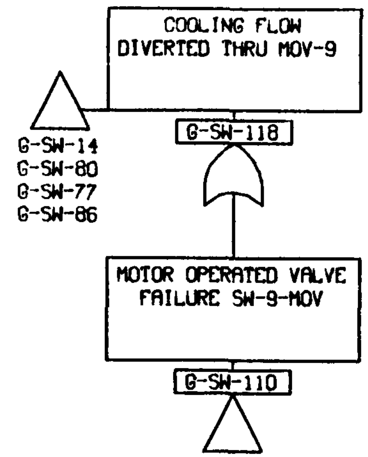

SPURIOUS SIGNAL FROM MANUAL SWITCH 154 THRU CP 3 AND 4
G-SW-103
G-SW-106
CP 3 AND 4 MANUAL SWITCH FAILS TO REMAIN OPEN
G-SW-107
MANUAL SWITCH 154 FAILS IN STOP MODE
906CS-154-FTD
OPERATOR PLACES MANUAL SWITCH IN CLOSED POSITION
SW-D-MDP-OPO
CP 3-3C MANUAL SWITCH 906 FAILS TO REMAIN OPEN
906CS-154-3RO
CP 4-4C MANUAL SWITCH 906 FAILS TO REMAIN OPEN
906CS-154-4RO

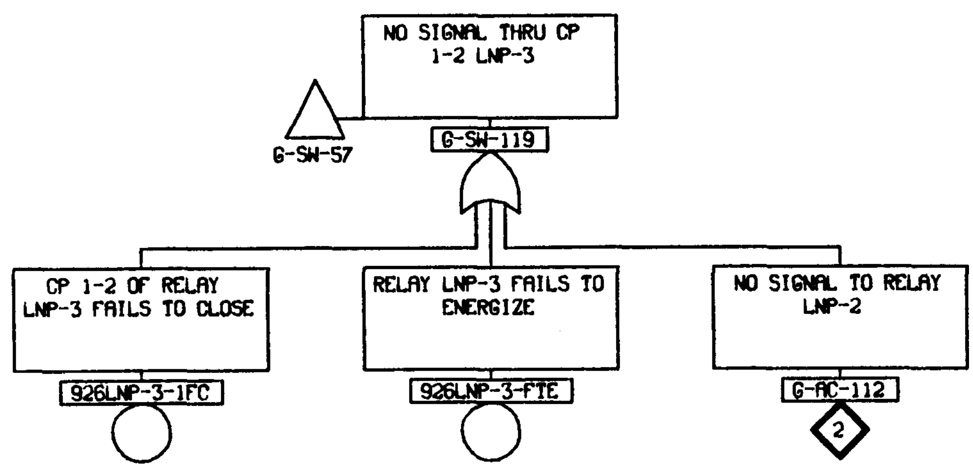

SPURIOUS SIGNAL FROM LNP RELAY 94X-6C
G-SW-108
G-SW-103B
SPURIOUS SIGNAL FROM RELAY 94-2B CP 11-12
G-SW-109
CP 1-2 RELAY 94X-6C FAILS TO REMAIN OPEN
LCL94X-6C-1RO
RELAY 94X-6C COIL FAILS TO DE-ENERGIZE
LCL94X-6C-FTD
SPURIOUS SIGNAL FROM TDDO 62-1A
92662-1A-XFO
3
COIL 94-2B FAILS TO DE-ENERGIZE AFTER TRIP SIGNAL
92694-2B-FTD
2
CP 11-12 RELAY 94-2B FAILS TO OPEN
92694-2B-BFO

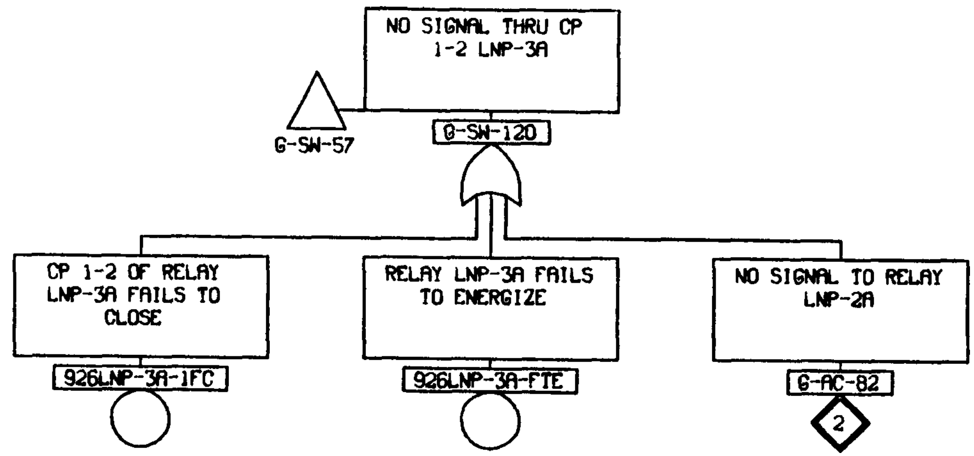

MOTOR OPERATED VALVE FAILURE SW-9-MOV
G-SW-110
G-SW-118
LOSS OF POWER TO MOTOR OPERATED VALVE
G-SW-111
MOTOR OPERATED VALVE FAILS TO CLOSE
SW-9-MOV-FTC
MOTOR OPERATED VALVE OUT OF SERVICE
SW-9-MOV-TMO
CP FAILURE
G-SW-112
LOSS OF POWER AT BUS EF-7
G-AC-BUS-EF7
POWER FAILURE AT CIRCUIT BREAKER
G-SW-116
CP 4C-4 OF CS 162 FAIL TO REMAIN CLOSED
906CS-162-4RC
NO SIGNAL THRU CP
G-SW-113
OPERATOR FAILS TO CLOSE MOV SW-9-MOV
SW-9-MOV-OFC

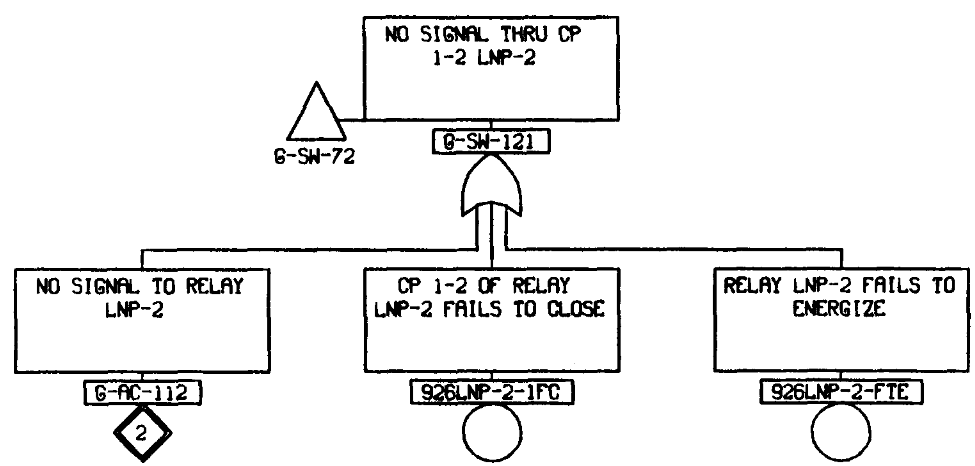

NO SIGNAL THRU CP
G-SW-112
G-SW-113
NO SIGNAL THRU CP 1-2 RELAY 83
G-SW-114
NO SIGNAL THRU CP 5A-5B OF RELAY 62.2
G-SW-115
NO SIGNAL TO RELAY COIL 83
G-SW-54
RELAY 83 FAILS TO ENERGIZE
926-83-FTE
2
CP 1-2 OF RELAY 83 FAILS TO CLOSE
926-83-1FC
NO SIGNAL TO RELAY COIL 62.2
G-SW-71
RELAY 62.2 FAILS TO ENERGIZE
92662-2-FTE
2
CP 5A-5B RELAY 62.2 FAILS TO CLOSE
92662-2-5AFC

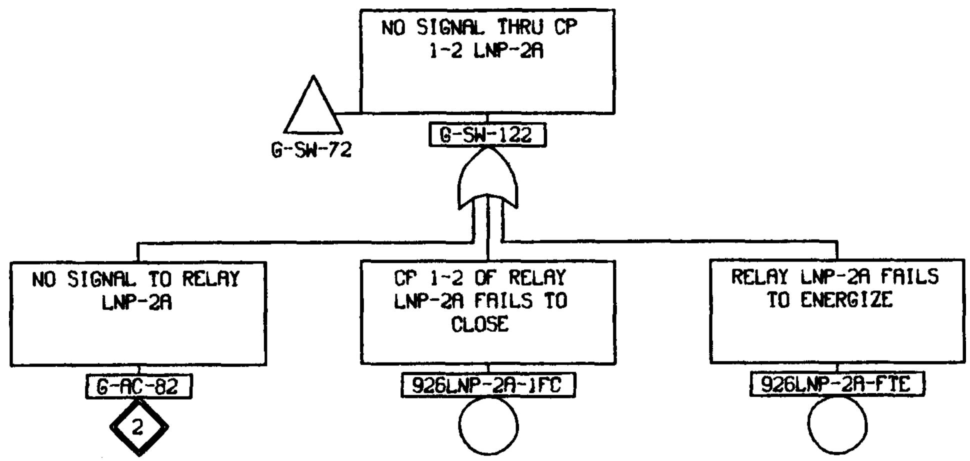

POWER FAILURE AT CIRCUIT BREAKER
G-SW-116
G-SW-111
SPURIOUS SIGNAL TO CIRCUIT BREAKER MANUAL SWITCH 162
G-SW-117
CIRCUIT BREAKER FAILS TO CLOSE
AC-EF7-2G-FTC
SW CS-162 FAILS IN STOP MODE
906CS-162-FTD
OPERATOR CLOSES CS-162
SW-9-MOV-OPO
CP 1-1C OF CS-162 FAILS TO REMAIN OPEN
906CS-162-1RO


COOLING FLOW DIVERTED THRU MOV-9
G-SW-118
G-SW-14
G-SW-80
G-SW-77
G-SW-86
MOTOR OPERATED VALVE FAILURE SW-9-MOV
G-SW-110


NO SIGNAL THRU CP 1-2 LNP-3
G-SW-119
G-SW-57
CP 1-2 OF RELAY LNP-3 FAILS TO CLOSE
926LNP-3-1FC
RELAY LNP-3 FAILS TO ENERGIZE
926LNP-3-FTE
NO SIGNAL TO RELAY LNP-2
G-AC-112
2


NO SIGNAL THRU CP 1-2 LNP-3A
G-SW-57
G-SW-120
CP 1-2 OF RELAY LNP-3A FAILS TO CLOSE
926LNP-3A-1FC
RELAY LNP-3A FAILS TO ENERGIZE
926LNP-3A-FTE
NO SIGNAL TO RELAY LNP-2A
G-AC-82
2


NO SIGNAL THRU CP 1-2 LNP-2
G-SW-72
G-SW-121
NO SIGNAL TO RELAY LNP-2
G-AC-112
2
CP 1-2 OF RELAY LNP-2 FAILS TO CLOSE
926LNP-2-1FC
RELAY LNP-2 FAILS TO ENERGIZE
926LNP-2-FTE



NO SIGNAL THRU CP 1-2 LNP-2A
G-SW-72
G-SW-122
NO SIGNAL TO RELAY LNP-2A
G-AC-82
2
CP 1-2 OF RELAY LNP-2A FAILS TO CLOSE
926LNP-2A-1FC
RELAY LNP-2A FAILS TO ENERGIZE
926LNP-2A-FTE

APPENDIX B.15

EMERGENCY SERVICE WATER SYSTEM

B.15.1 Emergency Service Water System Description

B.15.1.1 Purpose

A. The emergency service water (ESW) system provides a reliable long-term source of cooling water for the two LPCI heat exchangers which are designed to remove heat from the torus under the following conditions:

1) Initiation of the automatic pressure relief valve system

2) Loss of coolant accident

B. The ESW system also provides an inexhaustible source of sea water which can be used as an emergency coolant supply to keep the core covered, in the event that the normal fresh water supply is used up.

C. The ESW system can also be used to supply cooling to the RBCCW heat exchangers during shutdown and SWS outages.

B.15.1.2 Description and Configuration

Figure B.15-1 shows a simplified piping and equipment diagram of the ESW system. The ESW system consists of four pumps, two heat exchangers, piping, control instrumentation, and support equipment. The four pumps are grouped into two sets of two pumps. Each set of pumps provides 5000 gpm of seawater to one LPCI heat exchanger. Either set of pumps and its associated heat exchanger is capable of handling the heat load of the LPCI system. Since each set of pumps is individually piped to one of the heat exchangers, the result is two completely segregated emergency service water systems.

Both loops of the ESW system are provided with their own rotary basket strainer to filter the sea water. This prevents clogging of the LPCI heat exchanger tubes and increases system reliability. The ESW strainers will automatically backwash when the strainer d/p reaches 10 psig, removing any material picked up from the sea water.

ESW system piping is arranged so that there is an interconnection with the plant SWS. This ensures that the ESW system remains full of water, and minimizing the possibility of damaging the LPCI heat exchanger tube sheet with a water slug when the system is placed into operation.

B.15.1.3 System Interfaces

System interfaces for the ESW System are shown in Table B.15-1.

B.15.1.4 Instrumentation and Control

Table B.15-2 lists the various instruments and set points used. Most instruments are employed to detect the temperature and pressure variations in heat exchangers. Figure B.15-2 shows the control wiring schematics.

Pumps and valves are manually controlled from the Control Room Panel Switches (CRP 903). For a detailed discussion on controls see section B.15.1.8, Operation.

B.15.1.5 Testing

The following are the tests of the ESW system:

SP 623.10 Functional test when one ESW pump is inoperable

This daily test checks the LPCI system operability using procedure SP 622.7 and ESW readiness procedure SP 623.19.

SP 623.18 Emergency Systems Valve Position Check

The following valve positions are checked weekly on the control room panel: LPC-2A, -2C, -3A, -4A, -2B, -2D, -3B and -4B.

SP 623.19 Emergency Service Water System Operational Readiness Test

This is a quarterly test which checks pump discharge pressure, valve alignment, and system flow.

B.15.1.6 Maintenance

There is no routinely scheduled maintenance for the ESW system. Maintenance is performed on an as-needed basis.

B.15.1.7 Technical Specifications

A. Limiting conditions for operation:

1) From the time that one of the ESW pumps is made or found to be inoperable, reactor operation is permissible only during the following thirty days. If after this time period the pump is not back in service, then reactor operation is not permitted. Furthermore, operation is allowed only if all other active components of the containment cooling system are functional during the period when the pump is inoperable.

2) From the time that one active component in each containment cooling subsystem is made or found to be inoperable, reactor operation is permissible only during the following seven days. If after this time period the inoperable components have not been returned to service, then the reactor is shut down. Furthermore, operation is permitted during the following seven days <u>only</u> if the remaining active components in each containment cooling subsystem, in both core spray subsystems and both emergency power sources (assuming no available source of external power) are operable. These limiting conditions also apply if an active component of the LPCI and ESW systems, in one containment cooling subsystem, is made or found to be inoperable.

3) From the time that one LPCI and one ESW pump in each containment cooling subsystem is made or found to be inoperable, reactor operation is only permitted during the following four days. The allowance is based on the condition that the remaining active components of the containment cooling subsystems, both core spray subsystems and both emergency power sources (assuming no available source of external power) are operable. If not, then the reactor is shut down at the end of the indicated time period.

B. The surveillance requirements for the ESW system:

1) Emergency Service Water Subsystem Testing:

	Item	Frequency
a.	Pump and Valve Operability	Once/3 months
b.	Flow Rate Test Each containment cooling water pump shall deliver at least 2500 gpm against a system head of at least 446 feet.	After pump maintenance and every three months

2) When one emergency service water pump is determined to be inoperable the remaining pumps in that containment cooling subsystem and those pumps in the other containment cooling subsystem shall be immediately demonstrated to be operable. The remaining operable ESW pumps are to be tested daily until the out-of-service pump is brought back into service.

3) When it is determined that one active component in each containment cooling subsystem or an LPCI and ESW component in one of the containment cooling subsystems isinoperable the following becomes effective: the remaining active components in the containment cooling subsystems, both core spray subsystems and both emergency power sources shall be demonstrated to be operable immediately and daily thereafter. However, if any of the inoperable components are in the ESW system, then the daily test to demonstrate core spray operability may be omitted.

4) When it is determined that one LPCI and one ESW pump in each containment cooling subsystem are inoperable then the following becomes effective: the remaining active components in the containment cooling subsystems, both core spray subsystems and both emergency power sources shall be demonstrated to be operable immediately and daily thereafter.

B.15.1.8 Operation

ESW system operation is required to provide cooling to the LPCI heat exchangers. Following a transient or LOCA initiator, the ESW pumps trip if they are running (the pumps are normally in standby) and must be restarted manually. The pumps will trip on hi drywell pressure, low-low reactor water level and low reactor pressure, or LNP signals.

Once the operator determines that plant electrical loads will permit pump restart, the operator starts the ESW pump corresponding to the LPCI system train that is in operation for containment cooling. The ESW pumps are tripped because they are not required for several hours after the initiating event.

The heat exchanger outlet valve (LPC-4A, 4B; see Figure B.15-1) will automatically maintain the shell/tube differential pressure at the value selected by the operator.

B.15.2 Analysis

B.15.2.1 Success/Failure Criteria

Successful operation of the ESW system requires either pump A or pump C to remove heat from LPCI heat exchanger A, or pump B or D to remove heat from LPCI heat exchanger B, depending on the selected LPCI loop.

B.15.2.2 Assumptions

1) Human error is not considered in the operation of normally closed valves LPC-19, -20, -22, -23, and -24.

2) Small vent and relief valve lines on the LPCI heat exchangers are not considered in the analysis.

3) Two-inch piping and valves which are connected to the 16-inch piping, down stream of the strainer are not included in the analysis.

Table B.15-1

Emergency Service Water Interfaces   Failure Mode and Effects

Primary System			Support System			Failure Mode	Fault Effect
System	Div.	Comp.	System	Div.	Comp.		
ESWS		Pumps A and C	AC Pwr	DG	Bus 14F	Low or zero voltage	Pumps A and C fail to start or run
		Pumps B and D	AC Power	GT	Bus 14E	Low or zero voltage	Pumps B and D fail to start or run
ESWS		Pumps A, B, C, D	DC Power		Bus 101A	Low or zero voltage	Precludes manual start; no effect on running pump

Table B.15-2

Emergency Service Water System Instrumentation

Instrument	Function	Setpoint
Strainer d/p Hi DPS-10-4A/4B	High differential pressure alarm	10 psid
Heat exchanger inlet high temperature TE 1546 A(B)	High inlet temp. alarm	120^{o}F
Heat exchanger outlet high temp. TE 1547 A(B)	High outlet temp. alarm	150^{o}F
DP 1501-78A(B)	LPCI system heat exchanger low tube to shell differential pressure alarm	15 psid decreasing
PS 1561	RBCCW heat exchanger Emergency Service Water Supply High Pressure alarm	80 psig
2205/1501-90A 2206/1501-90B 2205/1501-90C 2206/1501-90D	Hi drywell pressure indication (trips ESW pumps)	2 psig
2205/263-72A 2206/263-72B 2205/263-72C 2206/263-72D	low Rx water level (ESW pump trips)	79" above the top of active fuel
2251/263-54A 2252/263-54B	low Rx pressure (ESW pump trips)	350 psig

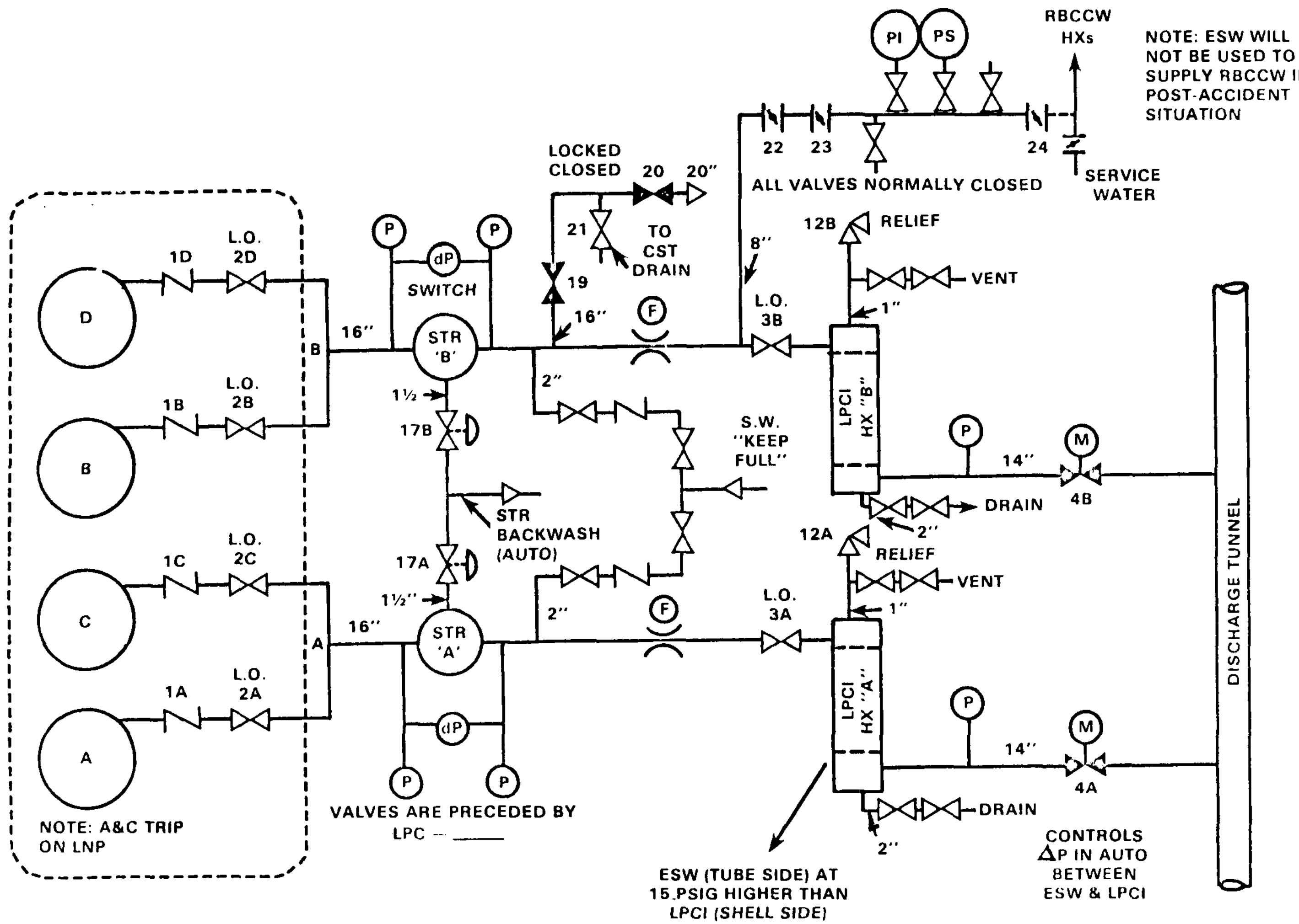


FIGURE B.15-1. EMERGENCY SERVICE WATER SYSTEM SIMPLIFIED PIPING AND EQUIPMENT DIAGRAM

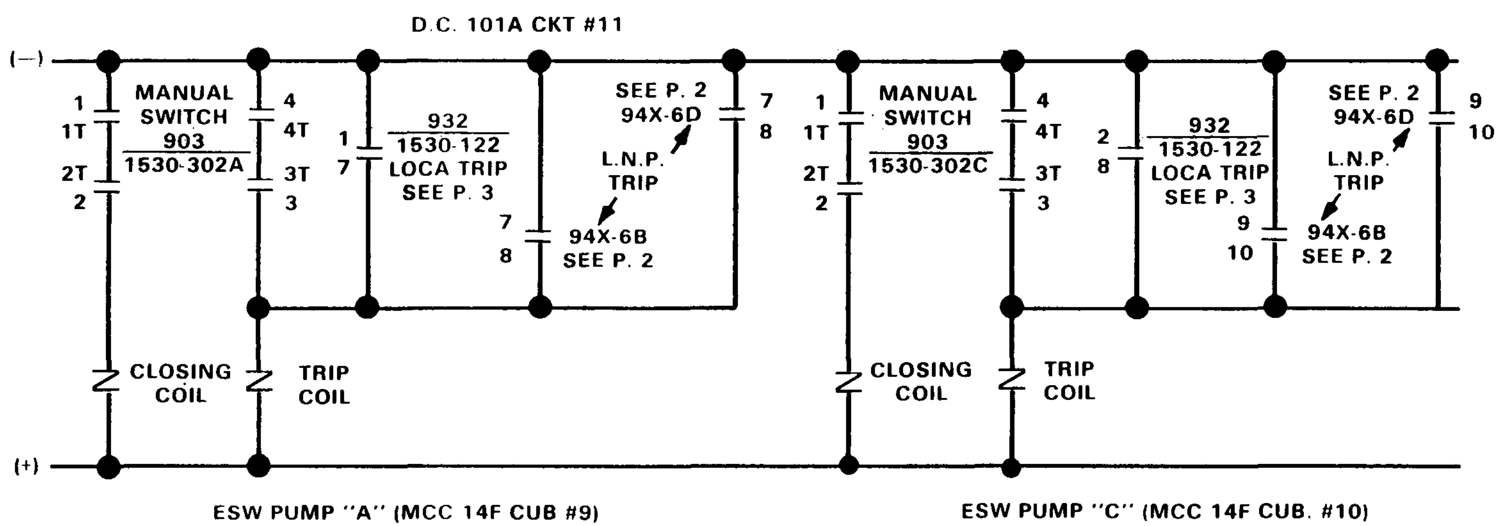


FIGURE B.15-2. ESW CONTROL WIRING SCHEMATICS (SHEET 1 OF 7)

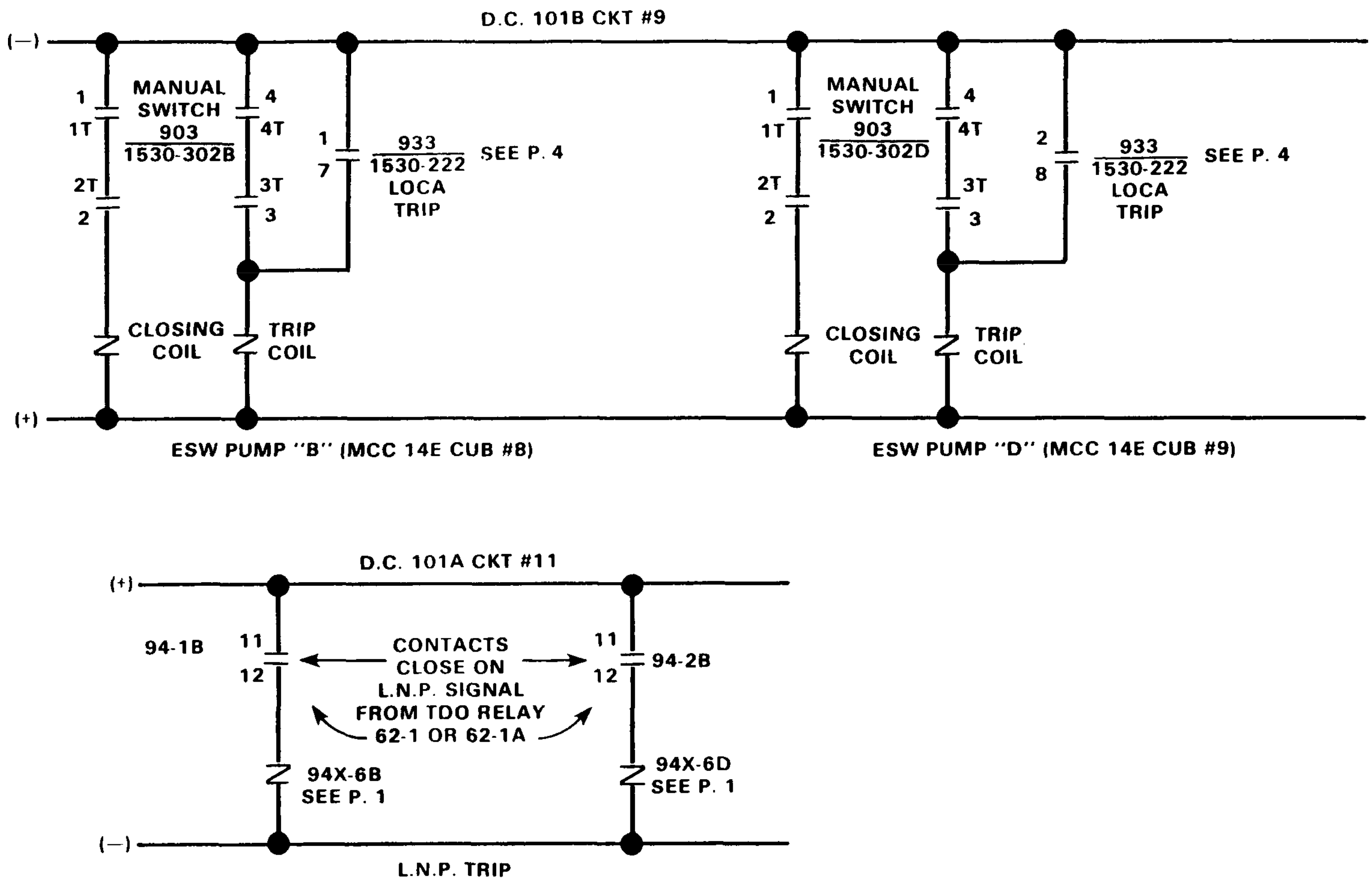


FIGURE B.15-2. ESW CONTROL WIRING SCHEMATICS (SHEET 2 OF 7)

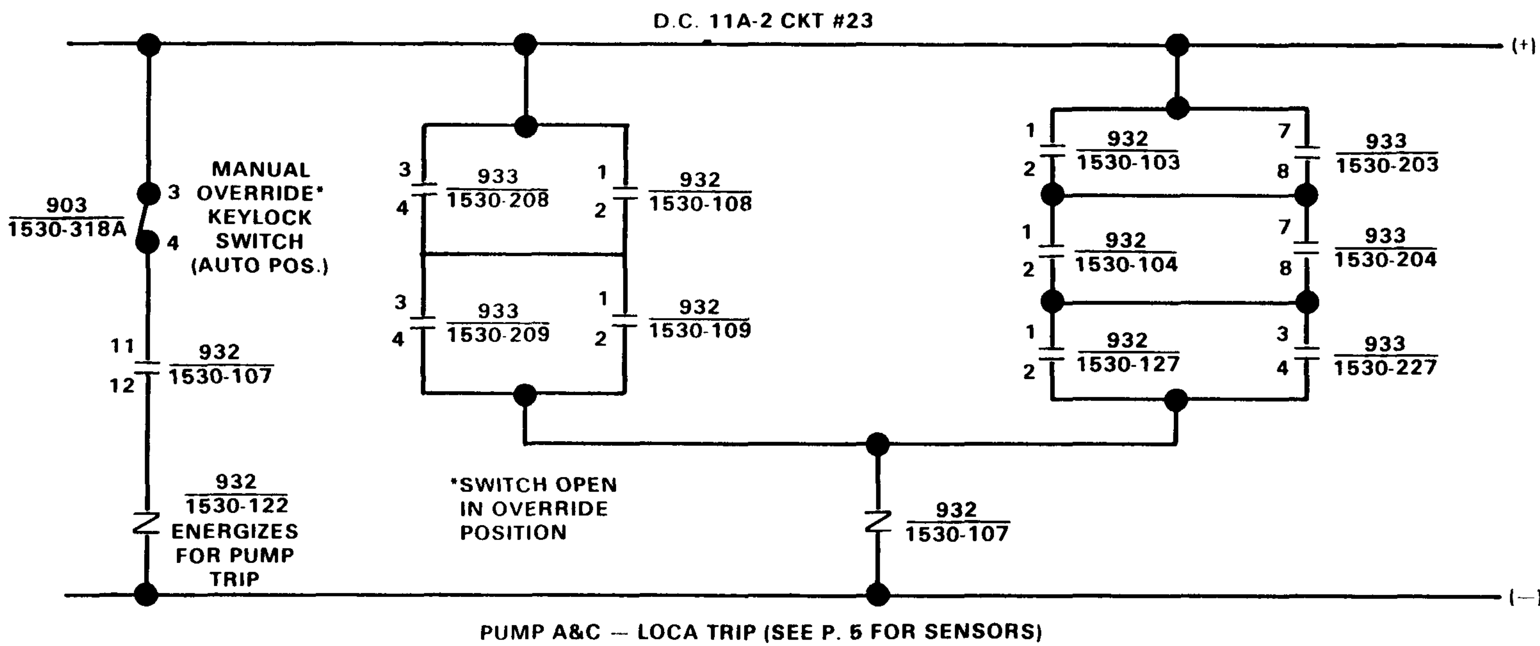


FIGURE B.15-2. ESW CONTROL WIRING SCHEMATICS (SHEET 3 OF 7)

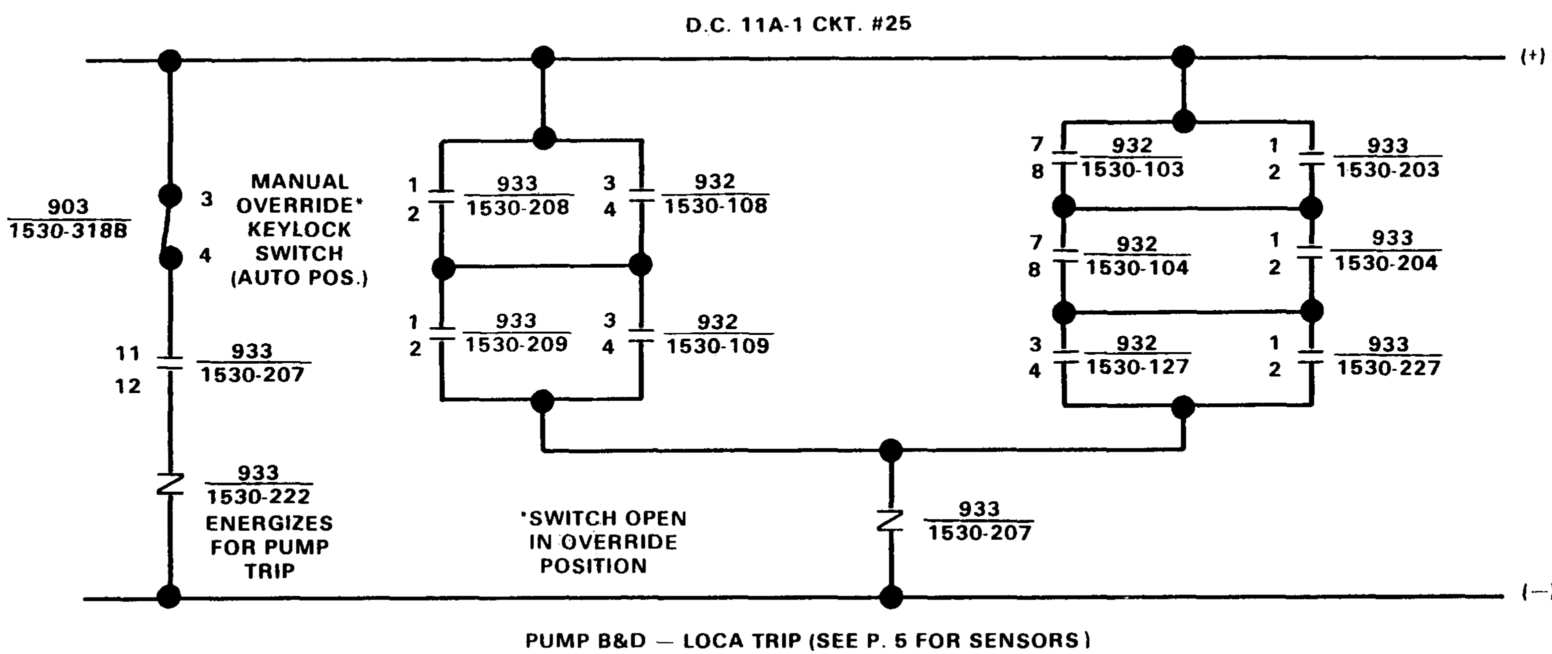


FIGURE B.15-2. ESW CONTROL WIRING SCHEMATICS (SHEET 4 OF 7)

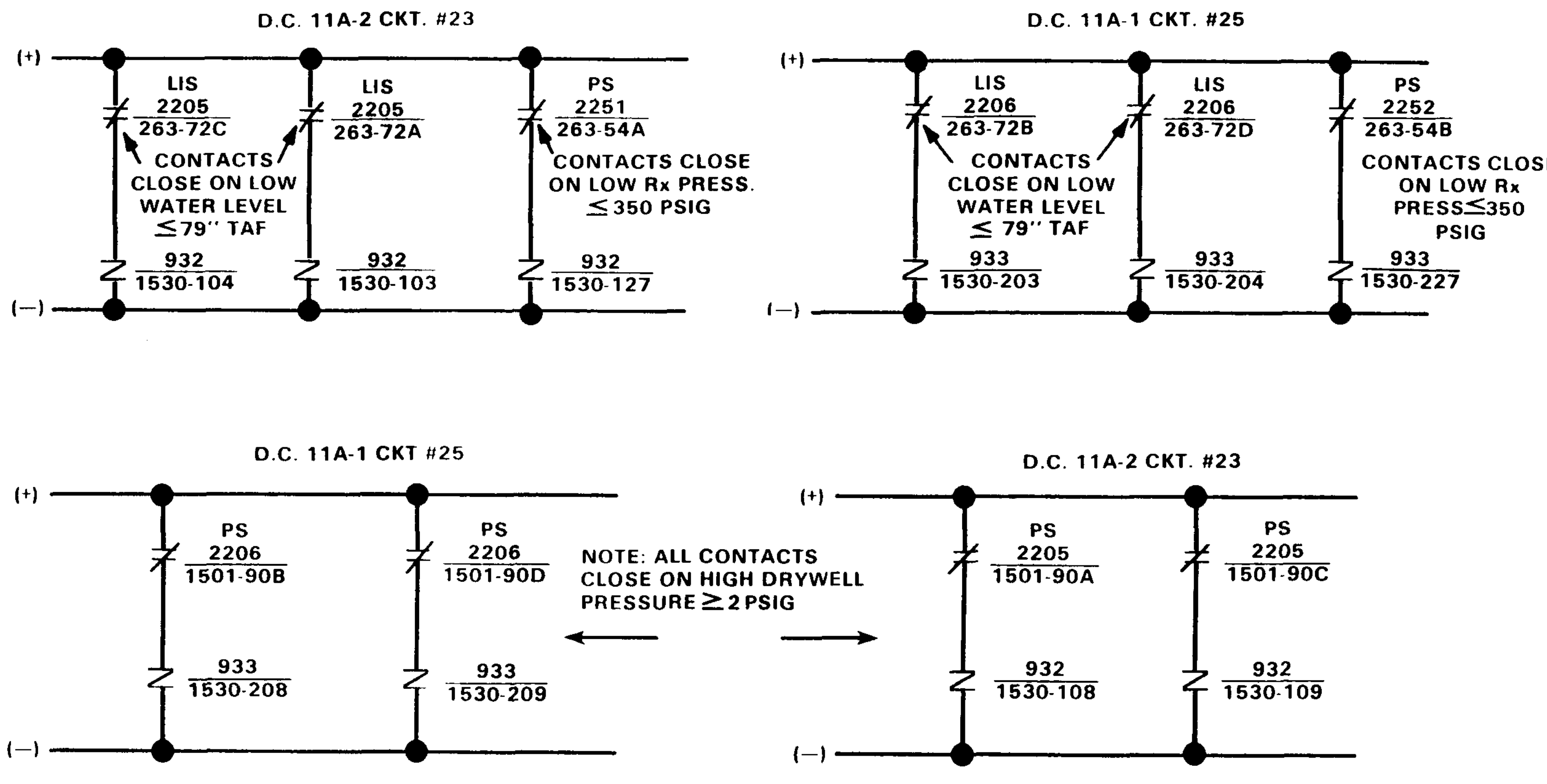


FIGURE B.15-2. ESW CONTROL WIRING SCHEMATICS (SHEET 5 OF 7)

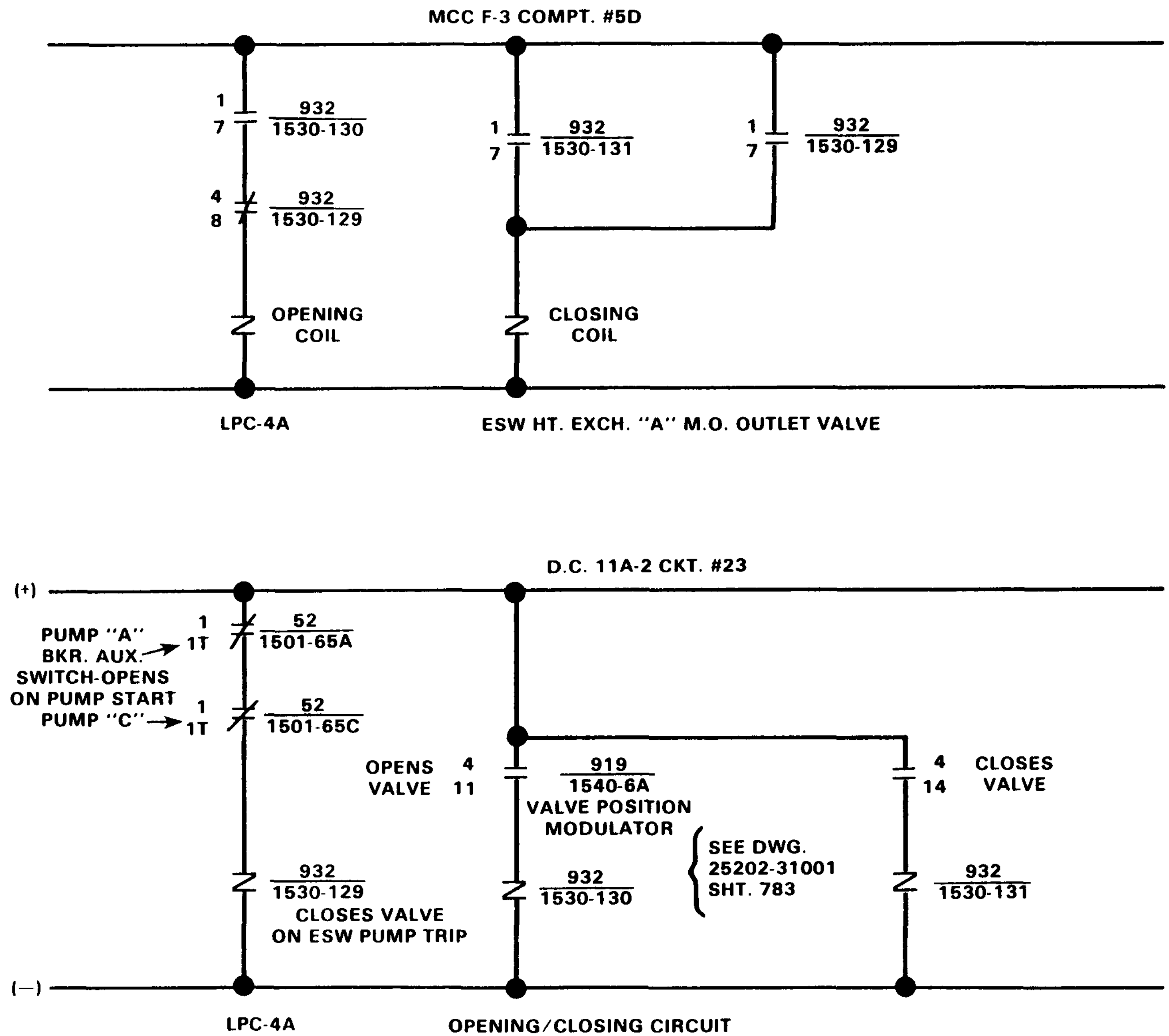
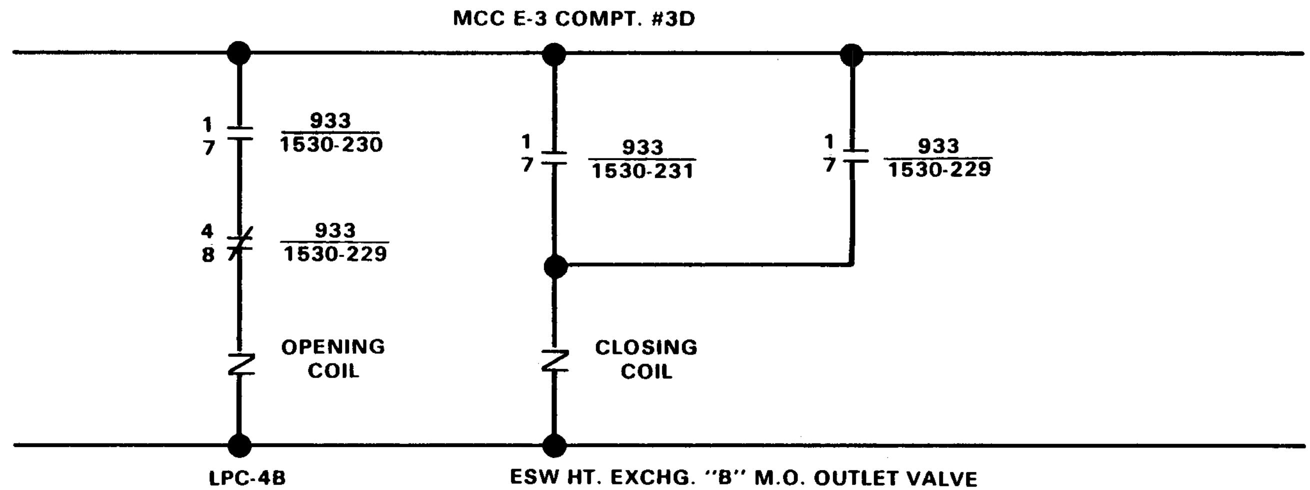


FIGURE B.15-2. ESW WIRING SCHEMATIC (SHEET 6 OF 7)



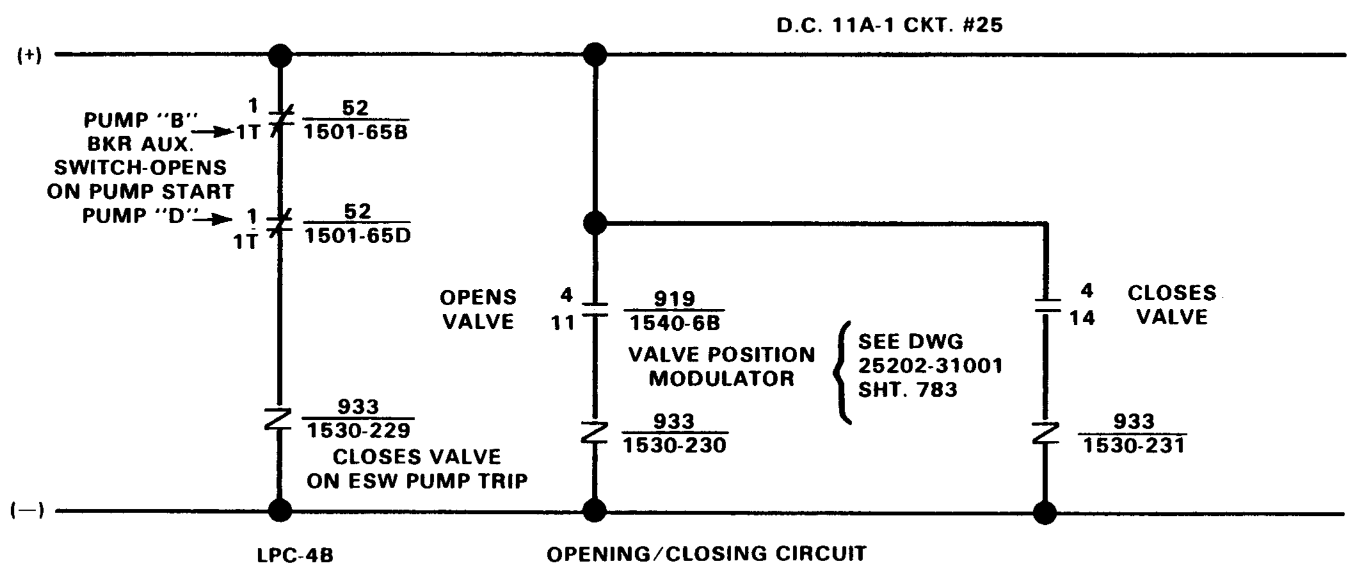


FIGURE B.15-2. ESW WIRING SCHEMATIC (SHEET 7 OF 7)

EMERGENCY SERVICE WATER SYSTEM

FAULT TREE AND FAULT SUMMARY SHEETS

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
LPC-A-HTX-LOF LPC-B-HTS-LOF	Loss of function in LPCI/CC heat exchangers, A & B	Quarterly detection	Includes T/M	3.7E-4
LPC-A-STR-LOF LPC-B-STR-LOF	Loss of function in ESW Rot. Strainers, A & B (plugged)	Quarterly detection	Quarterly system operability test SP 623.19	7.5E-5
LPC-A-ZZZ-LOF LPC-B-ZZZ-LOF	Failure of auto back-wash to clean Rot. Strainer "A" & "B"		The operator can clean the strainer easily	7.42E-4
LPC-3A-XV-FRO LPC-2A-XV-FRO LPC-2C-XV-FRO LPC-3B-XV-FRO LPC-2B-XV-FRO LPC-2D-XV-FRO	Manual valve fails to remain open	Quarterly detection	SP 623.19 quarterly system operational test checks system flow path	1E-4
LPC-19-XV-OPO LPC-20-XV-OPO	Operator opens normally closed valves (flow diversion)			3E-3
LPC-3A-XV-TMC LPC-2A-XV-TMC LPC-2C-XV-TMC LPC-3B-XV-TMC LPC-2B-XV-TMC LPC-2D-XV-TMC	Normally opened manual valve is closed due to test/maintenance	One week	Weekly valve position check SP 623.18	8.9E-6

MILLSTONE 1
SYSTEM ESW
SHEET #1

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
LPC-1A-CKV-FRO LPC-1C-CKV-FRO LPC-1B-CKV-FRO LPC-1D-CKV-FRO	Check valve fails to remain open	Quarterly detection	Tested during the performance of SP 623.19	1E-4
LPC-1A-CKV-TMC LPC-1A-CKV-TMC LPC-1A-CKV-TMC LPC-1A-CKV-TMC	Check valve is closed due to test and maintenance	Quarterly detection	Tested during the performance of SP 623.19	9.6E-6
LPC-A-MDP-FSR LPC-B-MDP-FSR LPC-C-MDP-FSR LPC-D-MDP-FSR	Motor driven pump fails to start	Quarterly detection	Tested during the performance of SP 623.19	1.72E-3
LPC-A-MDP-TOM LPC-B-MDP-TOM LPC-C-MDP-TOM LPC-D-MDP-TOM	Motor driven pump fails due to test/ maintenance	Quarterly detection	Tested during the performance of SP 623.19	1.5E-3
9031530-318A-3FO 9031530-318B-3FO	Contact pair of manual switch fails to open	Quarterly detection	Tested during the performance of SP 623.19	3.3E-5
LPC-A-MDP-OSP LPC-B-MDP-OSP LPC-C-MDP-OSP LPC-D-MDP-OSP	Operator erroneously places ESW pumps in stop mode			3E-3

MILLSTONE 1
SYSTEM ESW
SHEET #2

<u>FAULT SUMMARY SHEETS</u>

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
LPC-A-MDP-OFS LPC-B-MDP-OFS LPC-C-MDP-OFS LPC-D-MDP-OFS	Operator fails to start ESW pumps (fails to activate switch 903/1530-302A, B, C, & D)			1E-2
9321530-122-FTD LCL94X-6B-FTD 92694-1B-FTD LCL94X-6D-FTD 92694-2B-FTD 9331530-229-FTD 9321530-129-FTD	Relay coil fails to de-energize	Quarterly detection	Tested during the performance of SP 623.19	1E-4
9031530-302A-FTD 9031530-302B-FTD 9031530-302B-FTD 9031530-302D-FTD	Manual switch fails in stop mode	Quarterly detection	Tested during the performance of SP 623.19	1.08E-5
LCL94X-6B-FRD LCL94X-6D-FRD 9321530-131-FRD 9031530-3A-FRD 9331530-222-FRD 9331530-231-FRD 9031530-3B-FRD	Relay coil fails to remain de-energize	Quarterly	Tested during the performance of SP 623.19	1E-5

MILLSTONE 1
SYSTEM ESW
SHEET #3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
92694-1B-BFO 92662-1-XFO 92694-2B-BFO 926-1A-XFO 9321530-129-1FO 521501-65A-1FO 521501-65C-1FO 9331530-229-1FO 521501-65B-1FO 521501-65D-1FO	Relay contact pairs fail to open	Quarterly detection	Tested during the performance of SP 623.19	3.2E-4
9031530-318A-OFR 9031530-318B-OFR	Operator fails to push reset button		Operator inaction affects his ability to start pumps	1E-2
9031530-318A-FTE 9031530-302A-FTE 9031530-302C-FTE 9321530-130-FTE 2201A-1543A-FTE 9031530-302B-FTE 9031530-318B-FTE 9031530-302D-FTE 9331530-230-FTE 2201B-1543B-FTE	Relay coil fails to energize	Quarterly detection	Tested during the performance of SP 623.19	1E-4
AC-14F-9-FTC AC-14F-10-FTC AC-3F-5D-FTC AC-14E-8-FTC AC-14E-9-FTC AC-E3-3D-FTC	Pump breaker fails to close	Quarterly detection	Tested during the performance of SP 623.19	1E-3

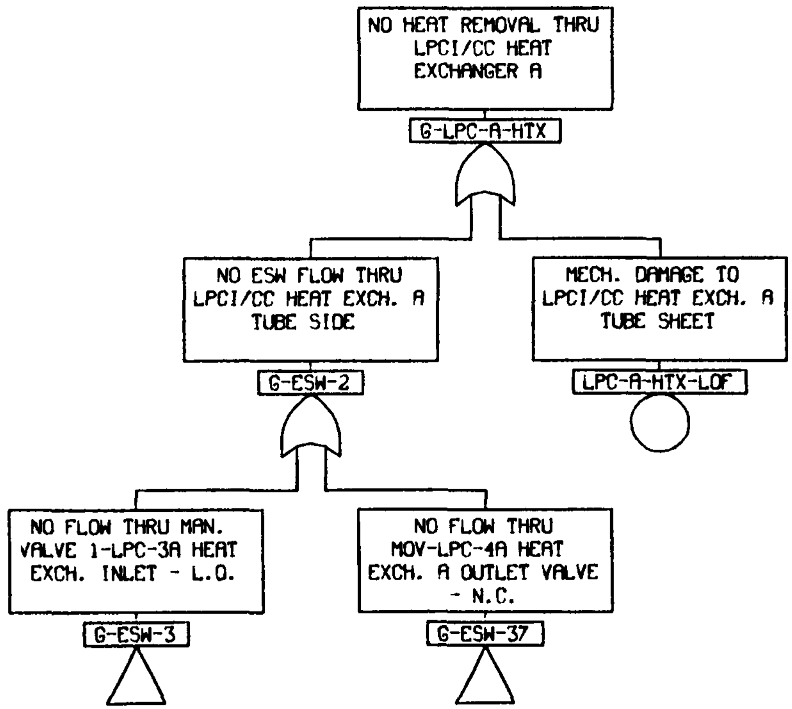
EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
9031530-302A-1FC 9031530-302A-2FC 9031530-302C-1FC 9031530-302C-2FC 9321530-130-1FC 9191540-6A-4FC 9031530-302B-1FC 9031530-302B-2FC 9031530-302D-1FC 9031530-302D-2FC 9331530-229-4FC 9331530-230-1FC 9191540-6B-4FC 9321530-129-4FC	Relay contact pairs fail to close	Quarterly detection	Tested during the performance of SP 623.19	3.24E-4
LPC-4A-MOV-TMC LPC-4B-MOV-TMC	M.O. valve is closed for maintenance/test	One week	Weekly valve posi-tioncheck, SP 623.18	5.3E-5
LPC-22-23-24-TMO	Valves on diversion path left open follow-ing test/maint.			3.6E-5
9191540-6B-4RO 933-1530-231-1RO 9321530-122-1RO LCL94X-6B-7RO LCL94X-6D-7RO 9331530-222-1RO 9331530-222-2RO 9321530-122-2RO	Contact pair fails to remain open	Quarterly detection	Tested during the performance of SP 623.19	1E-4

FAULT SUMMARY SHEETS

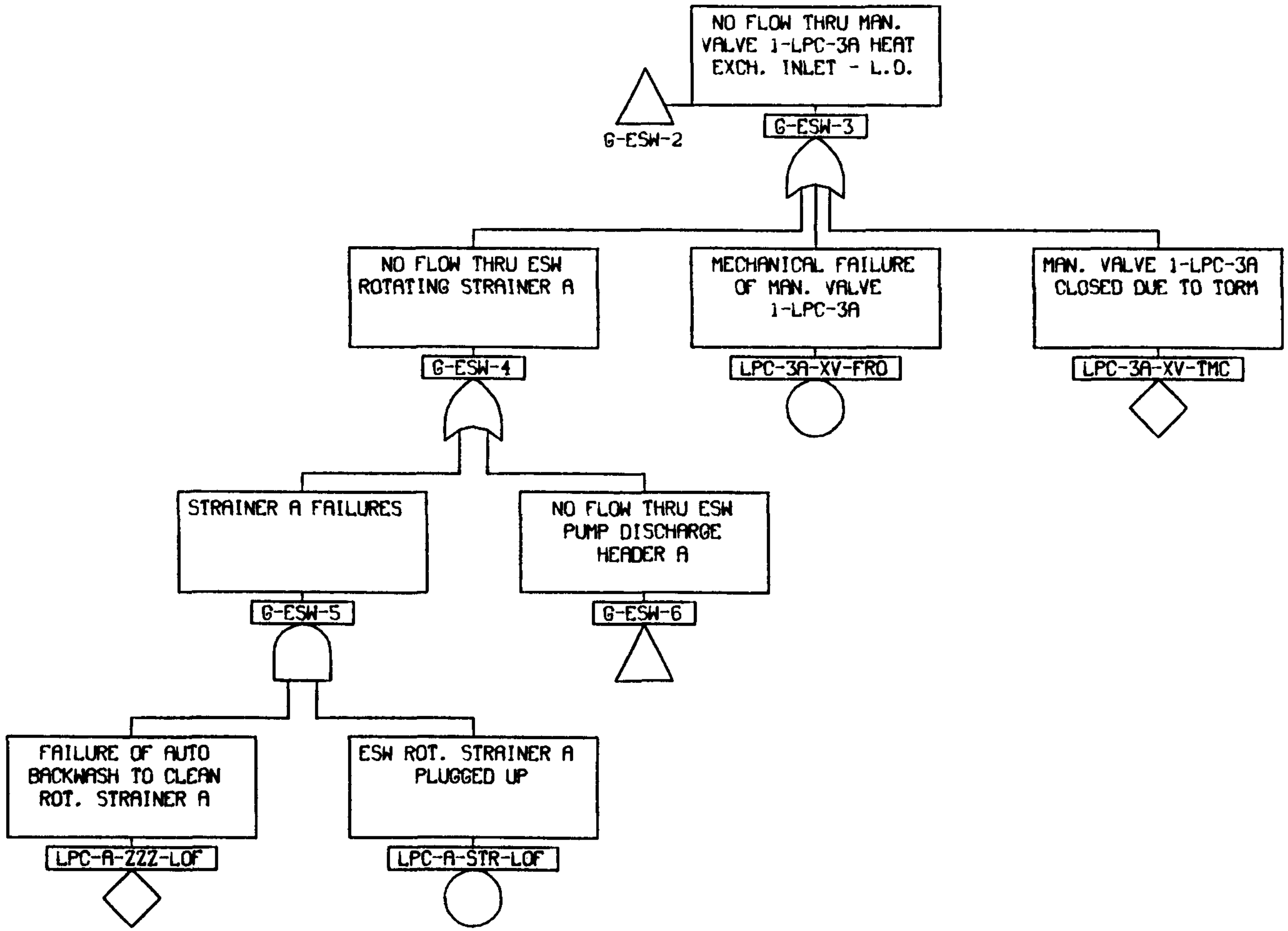
EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
LCL94X-6B-9RO LCL94X-6D-9RO 9321530-131-1RO 9191540-6A-4RO	Contact pair fails to remain open	Quarterly detection	Tested during the performance of SP 623.19	1E-4
9031530-302B-3RO 9031530-302B-4RO 9031530-302D-3RO 9031530-302D-4RO 9031530-302A-3RO 9031530-302C-4RO 9031530-302C-3RO 9031530-302A-4RO	Manual switch contact pair fails to remain open	Quarterly detection	Tested during the performance of SP 623.19	3.3E-5
LPC-4A-MOV-FTO LPC-4B-MOV-FTO	Motor operated valve fails to open	Quarterly detection	Tested during the performance of SP 623.19	1E-3
9031540-3A-OFR 9031540-3B-OFR	Operator fails to reset switch		The operator has a long time to perform this act	1E-2
2201A-1543A-TOM 2201B-1543B-TOM	Transmitter O.O.S. due to test/maintenance			1.0E-2
2201B-1543B-OMC 2201A-1543A-OMC	Operator miscalibration of transmitter			1E-3

EFW FAULT TREE PAGE INDEX

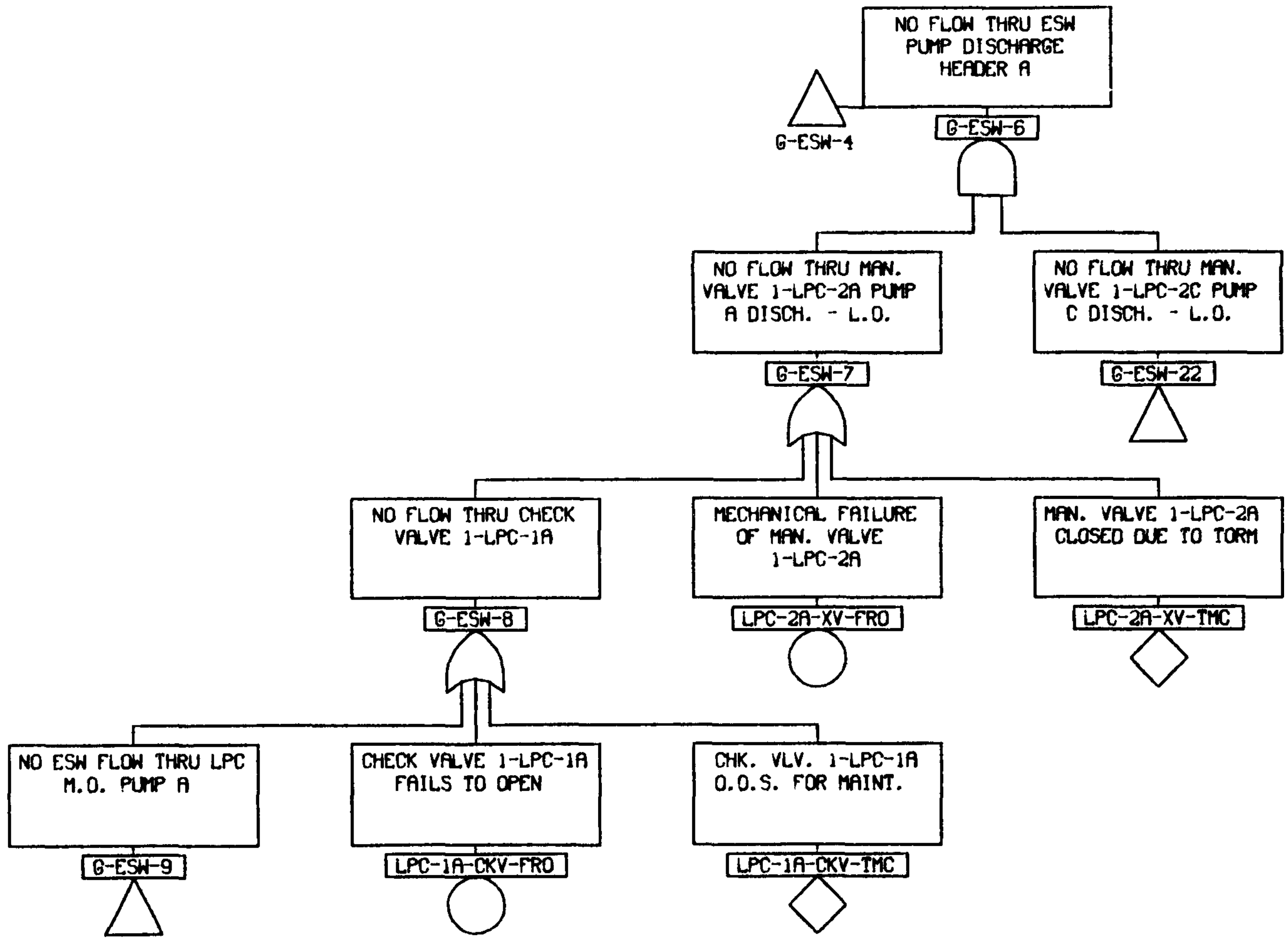
GATE NAME	DEFINED ON PAGE	TRANSFERS TO PAGE(S)
G-LPC-A-HTX	ESW-1	--
G-ESW-3	ESW-2	ESW-1
G-ESW-6	ESW-3	ESW-2
G-ESW-9	ESW-4	ESW-3
G-ESW-11	ESW-5	ESW-4
G-ESW-12	ESW-6	ESW-5
G-ESW-14	ESW-7	ESW-5
G-ESW-15	ESW-8	ESW-7,ESW-16
G-ESW-16	ESW-8	ESW-5
G-ESW-17	ESW-9	ESW-8,ESW-17
G-ESW-18	ESW-9	ESW-5
G-ESW-19	ESW-10	ESW-9,ESW-17
G-ESW-20	ESW-11	ESW-4
G-ESW-22	ESW-12	ESW-3
G-ESW-24	ESW-13	ESW-12
G-ESW-26	ESW-14	ESW-13
G-ESW-27	ESW-15	ESW-14
G-ESW-29	ESW-16	ESW-14
G-ESW-30	ESW-17	ESW-14
G-ESW-31	ESW-17	ESW-14
G-ESW-32	ESW-18	ESW-13
G-ESW-34	ESW-19	ESW-20
G-ESW-37	ESW-20	ESW-1
G-ESW-40	ESW-21	ESW-20
G-ESW-42	ESW-22	ESW-21
G-ESW-44	ESW-23	ESW-22
G-ESW-46	ESW-24	ESW-21
G-LPC-B-HTX	ESW-24	--
G-ESW-50	ESW-25	ESW-24
G-ESW-51	ESW-25	ESW-24
G-ESW-53	ESW-26	ESW-25
G-ESW-56	ESW-27	ESW-26
G-ESW-58	ESW-28	ESW-27
G-ESW-62	ESW-29	ESW-28,ESW-33
G-ESW-63	ESW-30	ESW-27
G-ESW-65	ESW-31	ESW-26
G-ESW-67	ESW-32	ESW-31
G-ESW-69	ESW-33	ESW-32
G-ESW-73	ESW-34	ESW-32
G-ESW-75	ESW-35	ESW-36
G-ESW-78	ESW-36	ESW-24
G-ESW-80	ESW-37	ESW-36
G-ESW-83	ESW-38	ESW-37
G-ESW-85	ESW-39	ESW-38
G-ESW-87	ESW-40	ESW-37


NO HEAT REMOVAL THRU LPCI/CC HEAT EXCHANGER A
G-LPC-A-HTX
NO ESW FLOW THRU LPCI/CC HEAT EXCH. A TUBE SIDE
G-ESW-2
MECH. DAMAGE TO LPCI/CC HEAT EXCH. A TUBE SHEET
LPC-A-HTX-LOF
NO FLOW THRU MAN. VALVE 1-LPC-3A HEAT EXCH. INLET - L.O.
G-ESW-3
NO FLOW THRU MOV-LPC-4A HEAT EXCH. A OUTLET VALVE - N.C.
G-ESW-37

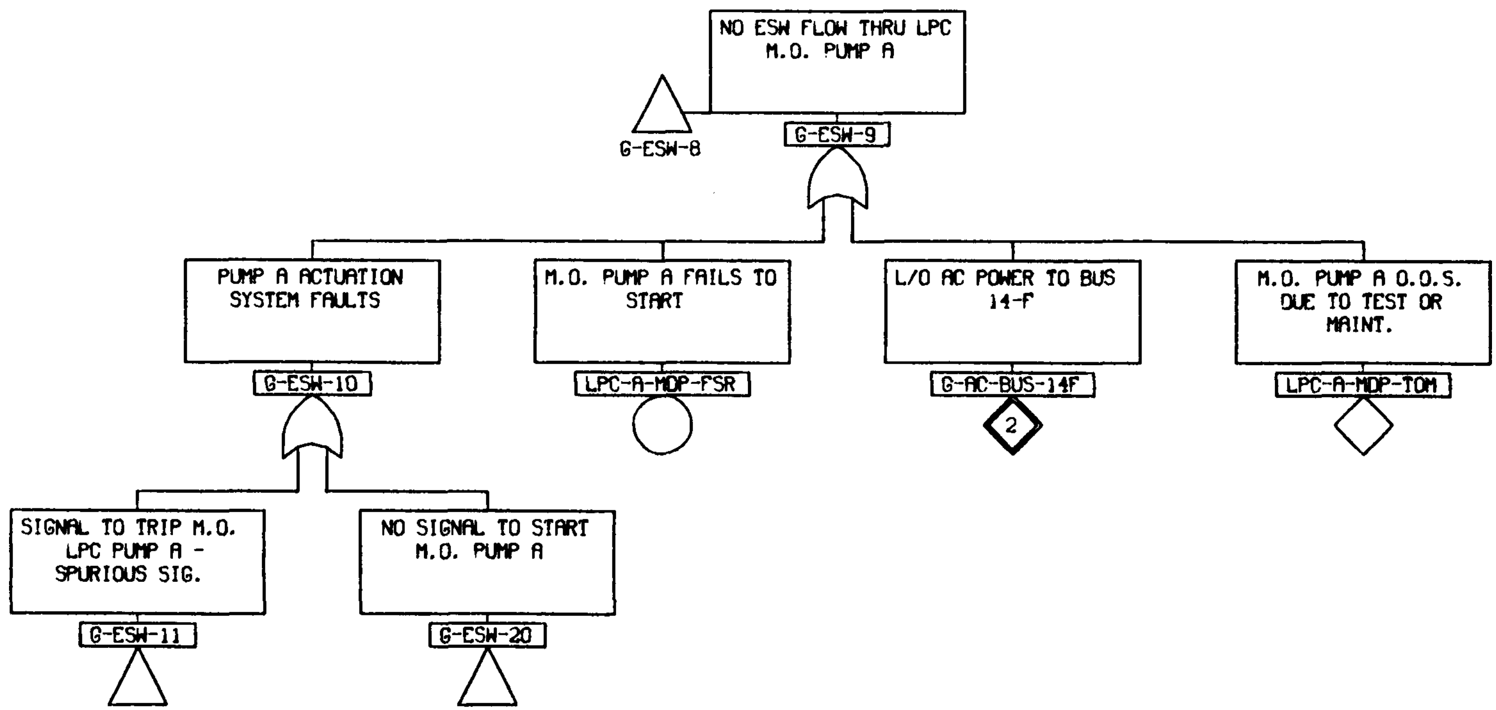
ESW-1

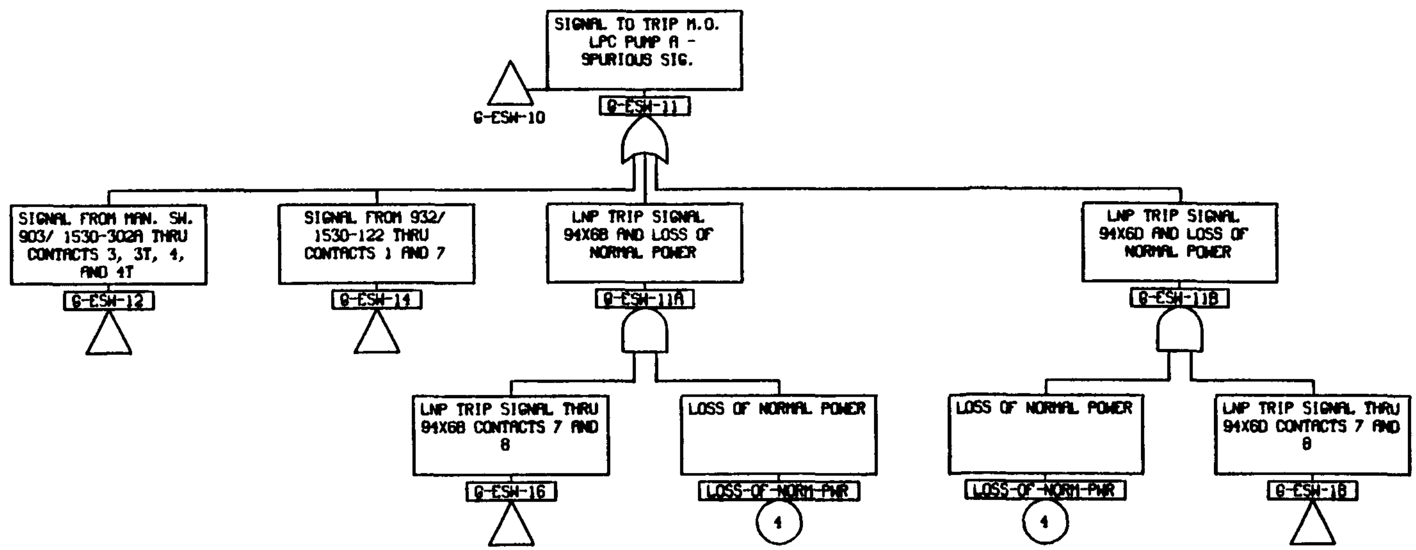

NO FLOW THRU MAN. VALVE 1-LPC-3A HEAT EXCH. INLET - L.O.
G-ESW-2
G-ESW-3
NO FLOW THRU ESW ROTATING STRAINER A
G-ESW-4
MECHANICAL FAILURE OF MAN. VALVE 1-LPC-3A
LPC-3A-XV-FRO
MAN. VALVE 1-LPC-3A CLOSED DUE TO TORM
LPC-3A-XV-TMC
STRAINER A FAILURES
G-ESW-5
NO FLOW THRU ESW PUMP DISCHARGE HEADER A
G-ESW-6
FAILURE OF AUTO BACKWASH TO CLEAN ROT. STRAINER A
LPC-A-ZZZ-LOF
ESW ROT. STRAINER A PLUGGED UP
LPC-A-STR-LOF

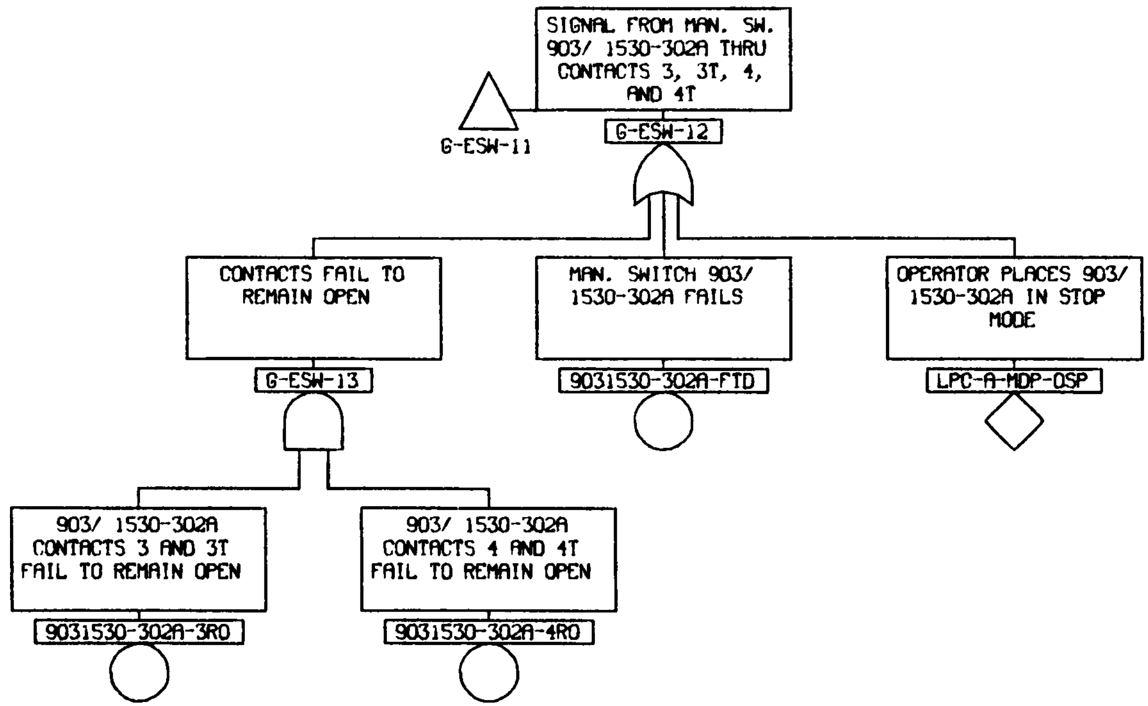
ESW-2


NO FLOW THRU ESW PUMP DISCHARGE HEADER A
G-ESW-6
G-ESW-4
NO FLOW THRU MAN. VALVE 1-LPC-2A PUMP A DISCH. - L.O.
G-ESW-7
NO FLOW THRU MAN. VALVE 1-LPC-2C PUMP C DISCH. - L.O.
G-ESW-22
NO FLOW THRU CHECK VALVE 1-LPC-1A
G-ESW-8
MECHANICAL FAILURE OF MAN. VALVE 1-LPC-2A
LPC-2A-XV-FRO
MAN. VALVE 1-LPC-2A CLOSED DUE TO TORM
LPC-2A-XV-TMC
NO ESW FLOW THRU LPC M.O. PUMP A
G-ESW-9
CHECK VALVE 1-LPC-1A FAILS TO OPEN
LPC-1A-CKV-FRO
CHK. VLV. 1-LPC-1A O.O.S. FOR MAINT.
LPC-1A-CKV-TMC

ESW-3

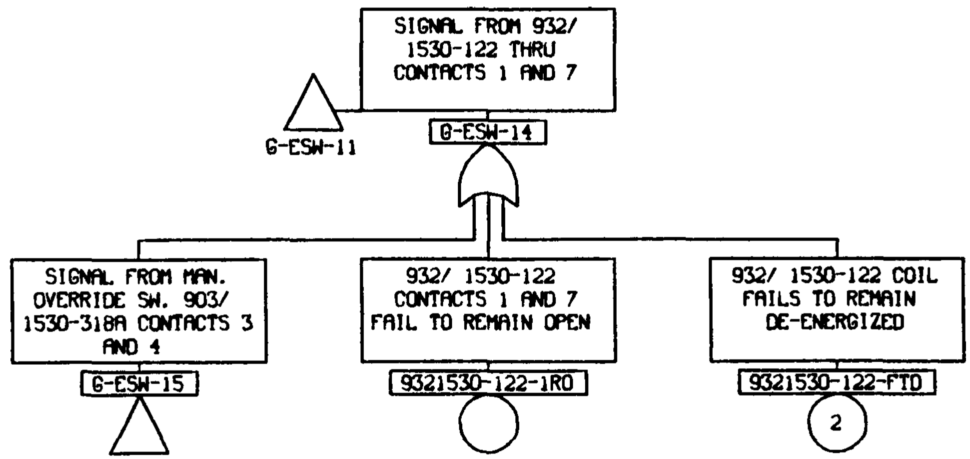

NO ESW FLOW THRU LPC M.O. PUMP A
G-ESW-9
G-ESW-8
PUMP A ACTUATION SYSTEM FAULTS
G-ESW-10
M.O. PUMP A FAILS TO START
LPC-A-MDP-FSR
L/O AC POWER TO BUS 14-F
G-AC-BUS-14F
2
M.O. PUMP A O.O.S. DUE TO TEST OR MAINT.
LPC-A-MDP-TOM
SIGNAL TO TRIP M.O. LPC PUMP A - SPURIOUS SIG.
G-ESW-11
NO SIGNAL TO START M.O. PUMP A
G-ESW-20


SIGNAL TO TRIP M.O. LPC PUMP A - SPURIOUS SIG.
G-ESW-11
G-ESW-10
SIGNAL FROM MAN. SW. 903/ 1530-302A THRU CONTACTS 3, 3T, 4, AND 4T
G-ESW-12
SIGNAL FROM 932/ 1530-122 THRU CONTACTS 1 AND 7
G-ESW-14
LNP TRIP SIGNAL 94X6B AND LOSS OF NORMAL POWER
G-ESW-11A
LNP TRIP SIGNAL 94X6D AND LOSS OF NORMAL POWER
G-ESW-11B
LNP TRIP SIGNAL THRU 94X6B CONTACTS 7 AND 8
G-ESW-16
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
4
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
4
LNP TRIP SIGNAL THRU 94X6D CONTACTS 7 AND 8
G-ESW-18


SIGNAL FROM MAN. SW. 903/ 1530-302A THRU CONTACTS 3, 3T, 4, AND 4T
G-ESW-12
G-ESW-11
CONTACTS FAIL TO REMAIN OPEN
G-ESW-13
MAN. SWITCH 903/ 1530-302A FAILS
9031530-302A-FTD
OPERATOR PLACES 903/ 1530-302A IN STOP MODE
LPC-A-MDP-OSP
903/ 1530-302A CONTACTS 3 AND 3T FAIL TO REMAIN OPEN
9031530-302A-3RO
903/ 1530-302A CONTACTS 4 AND 4T FAIL TO REMAIN OPEN
9031530-302A-4RO

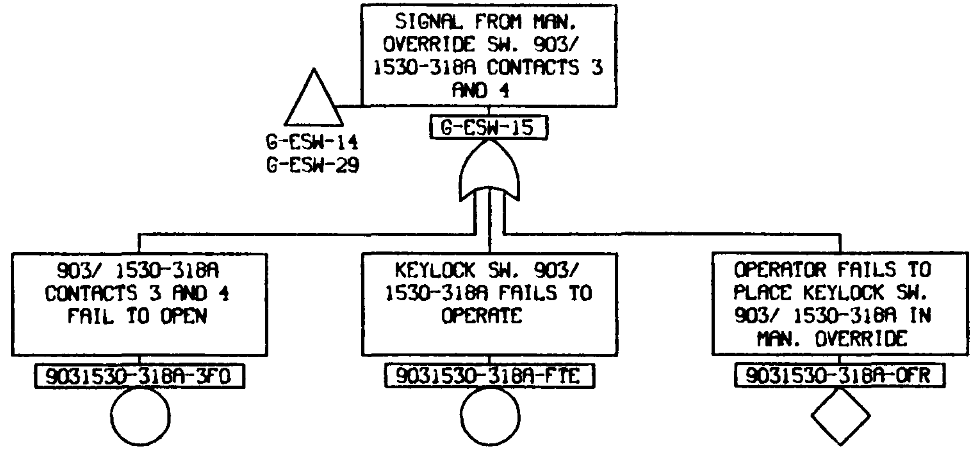
B.15-29

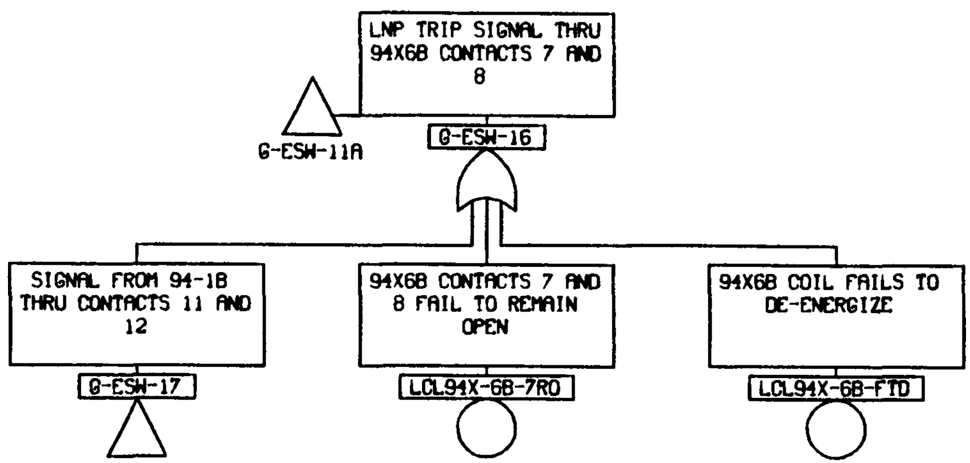
ESW-6

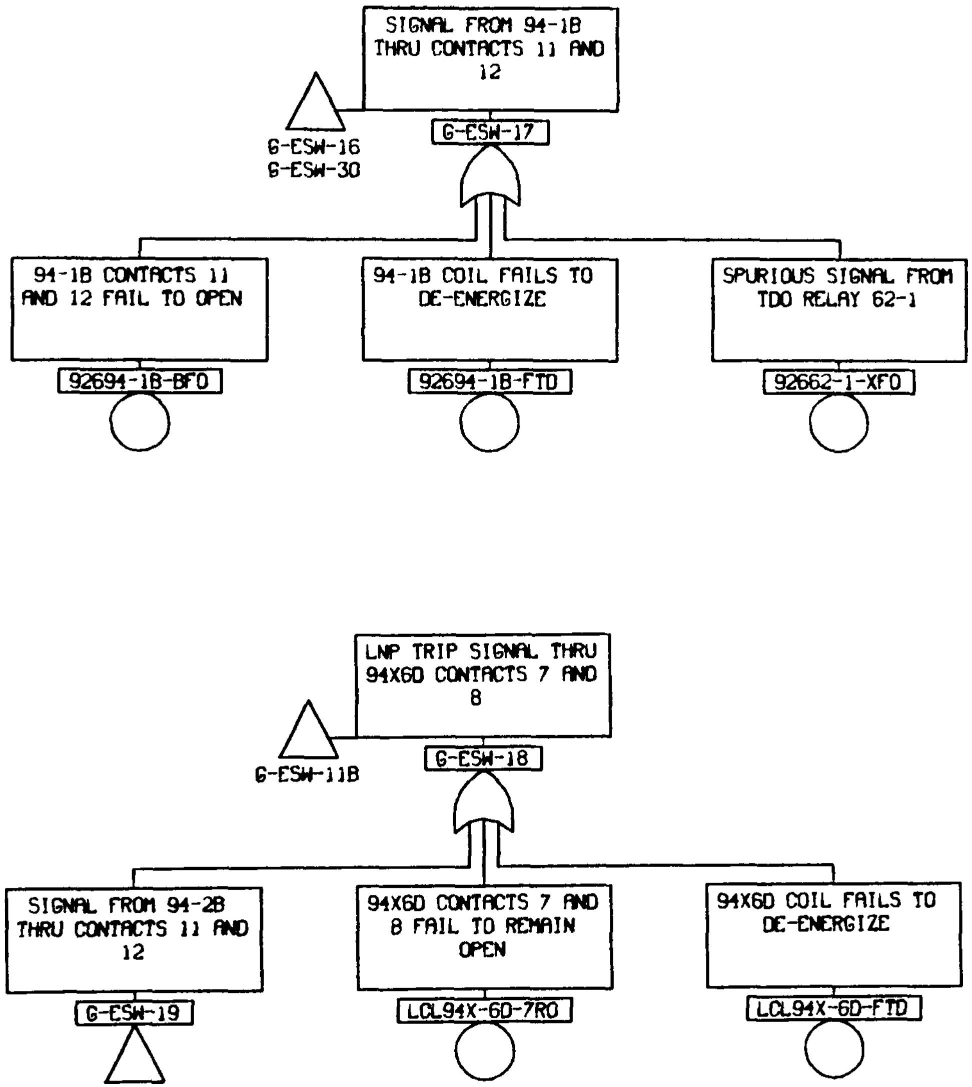

SIGNAL FROM 932/ 1530-122 THRU CONTACTS 1 AND 7
G-ESW-14
G-ESW-11
SIGNAL FROM MAN. OVERRIDE SW. 903/ 1530-318A CONTACTS 3 AND 4
G-ESW-15
932/ 1530-122 CONTACTS 1 AND 7 FAIL TO REMAIN OPEN
9321530-122-1RO
932/ 1530-122 COIL FAILS TO REMAIN DE-ENERGIZED
9321530-122-FTD
2

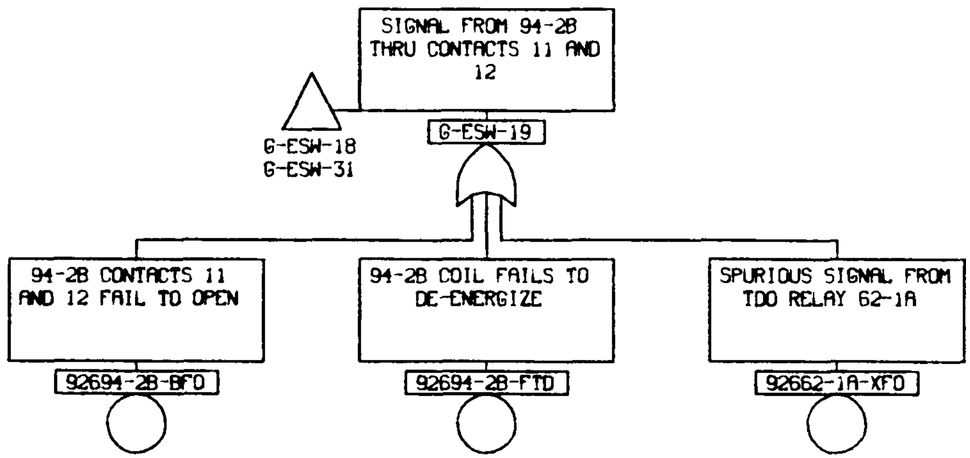
B.15-30

ESW-7

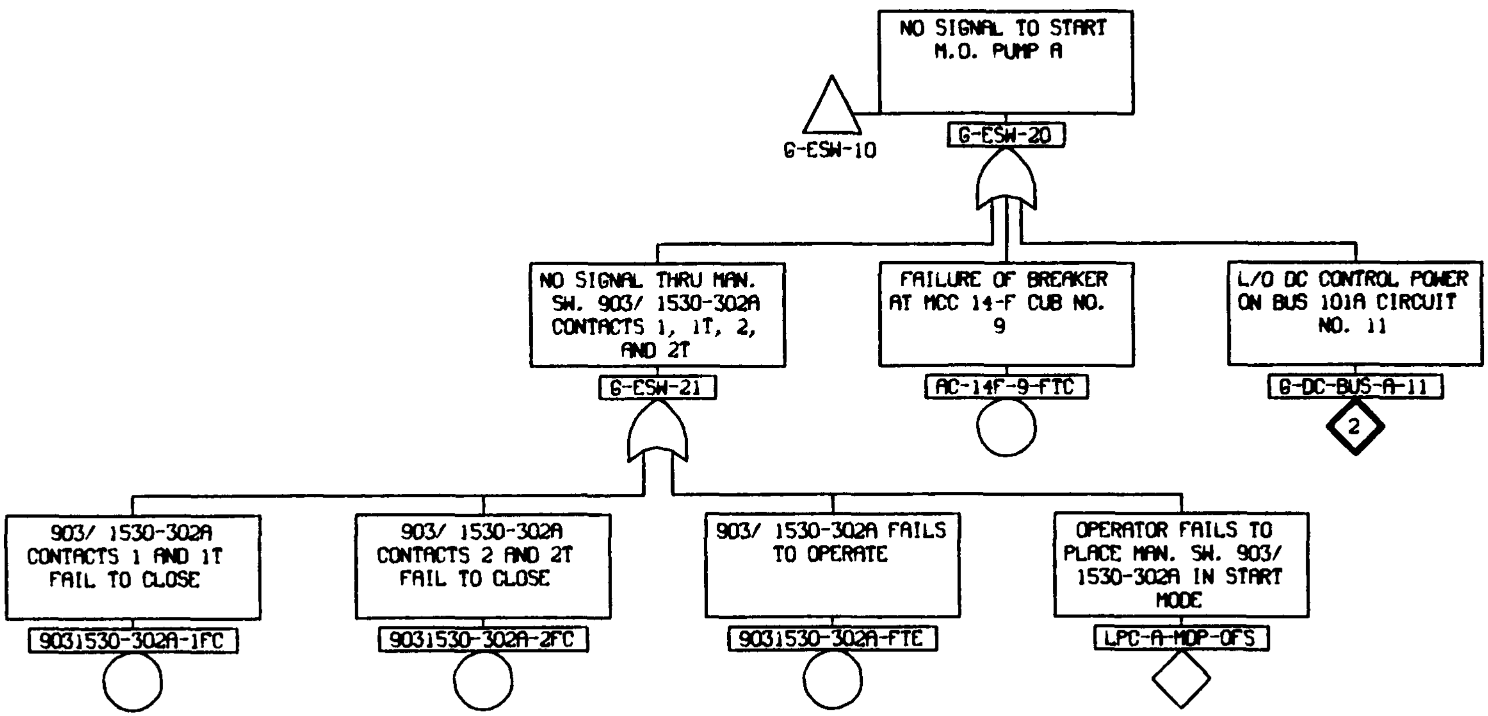

SIGNAL FROM MAN. OVERRIDE SW. 903/ 1530-318A CONTACTS 3 AND 4
G-ESW-15
G-ESW-14
G-ESW-29
903/ 1530-318A CONTACTS 3 AND 4 FAIL TO OPEN
9031530-318A-3FO
KEYLOCK SW. 903/ 1530-318A FAILS TO OPERATE
9031530-318A-FTE
OPERATOR FAILS TO PLACE KEYLOCK SW. 903/ 1530-318A IN MAN. OVERRIDE
9031530-318A-OFR

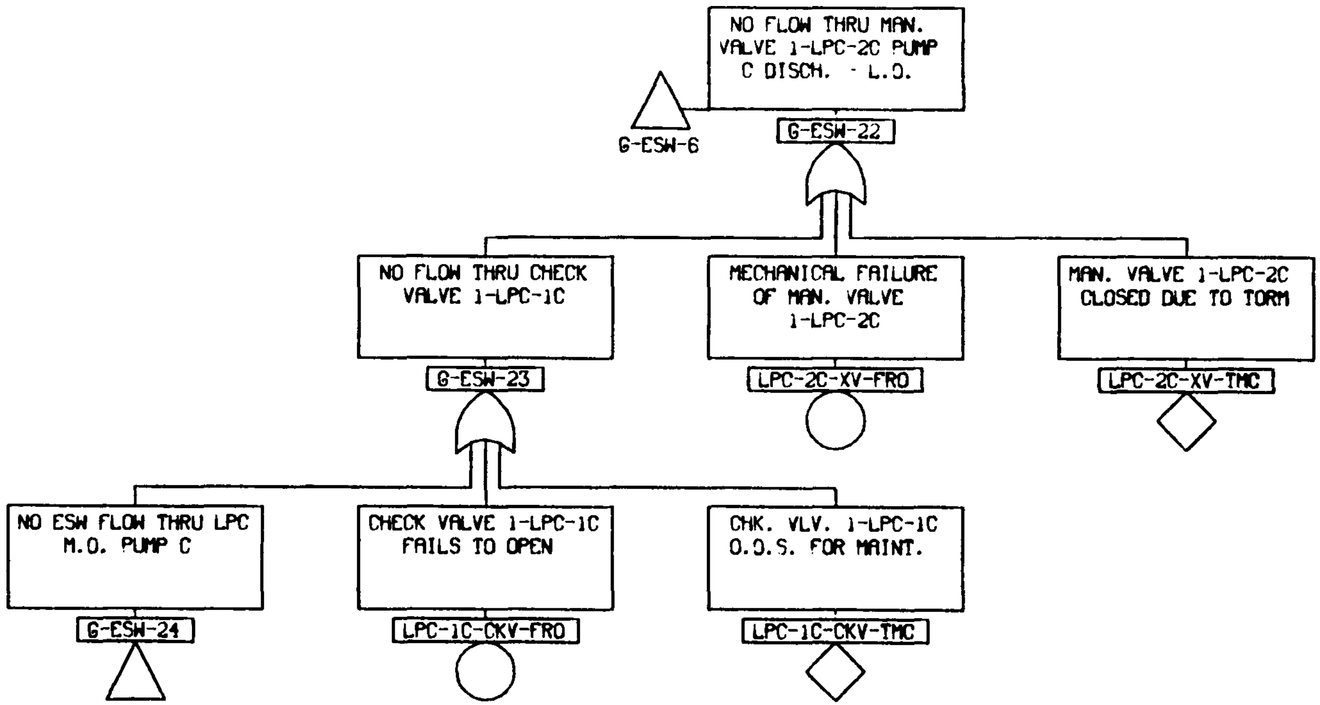

LNP TRIP SIGNAL THRU 94X6B CONTACTS 7 AND 8
G-ESW-16
G-ESW-11A
SIGNAL FROM 94-1B THRU CONTACTS 11 AND 12
G-ESW-17
94X6B CONTACTS 7 AND 8 FAIL TO REMAIN OPEN
LCL94X-6B-7RO
94X6B COIL FAILS TO DE-ENERGIZE
LCL94X-6B-FTD

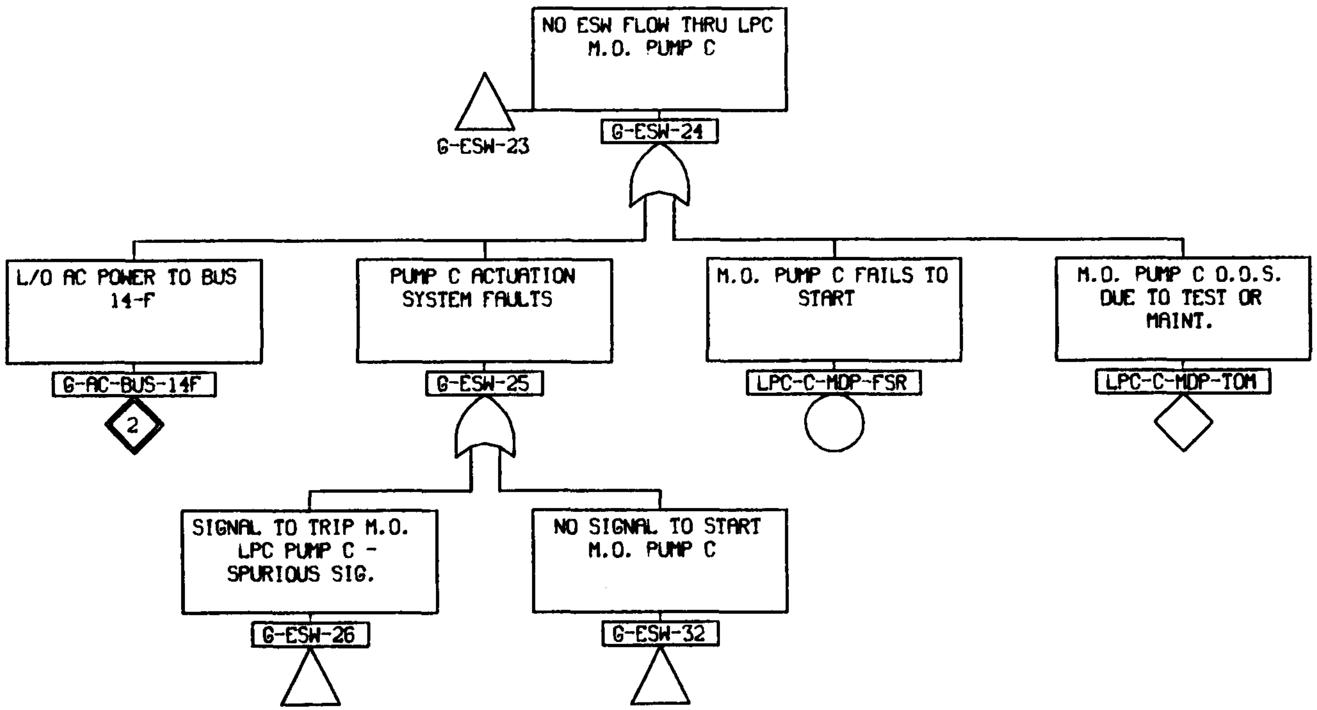

SIGNAL FROM 94-1B THRU CONTACTS 11 AND 12
G-ESW-17
G-ESW-16
G-ESW-30
94-1B CONTACTS 11 AND 12 FAIL TO OPEN
92694-1B-BFO
94-1B COIL FAILS TO DE-ENERGIZE
92694-1B-FTD
SPURIOUS SIGNAL FROM TDO RELAY 62-1
92662-1-XFO
LNP TRIP SIGNAL THRU 94X6D CONTACTS 7 AND 8
G-ESW-18
G-ESW-11B
SIGNAL FROM 94-2B THRU CONTACTS 11 AND 12
G-ESW-19
94X6D CONTACTS 7 AND 8 FAIL TO REMAIN OPEN
LCL94X-6D-7RO
94X6D COIL FAILS TO DE-ENERGIZE
LCL94X-6D-FTD

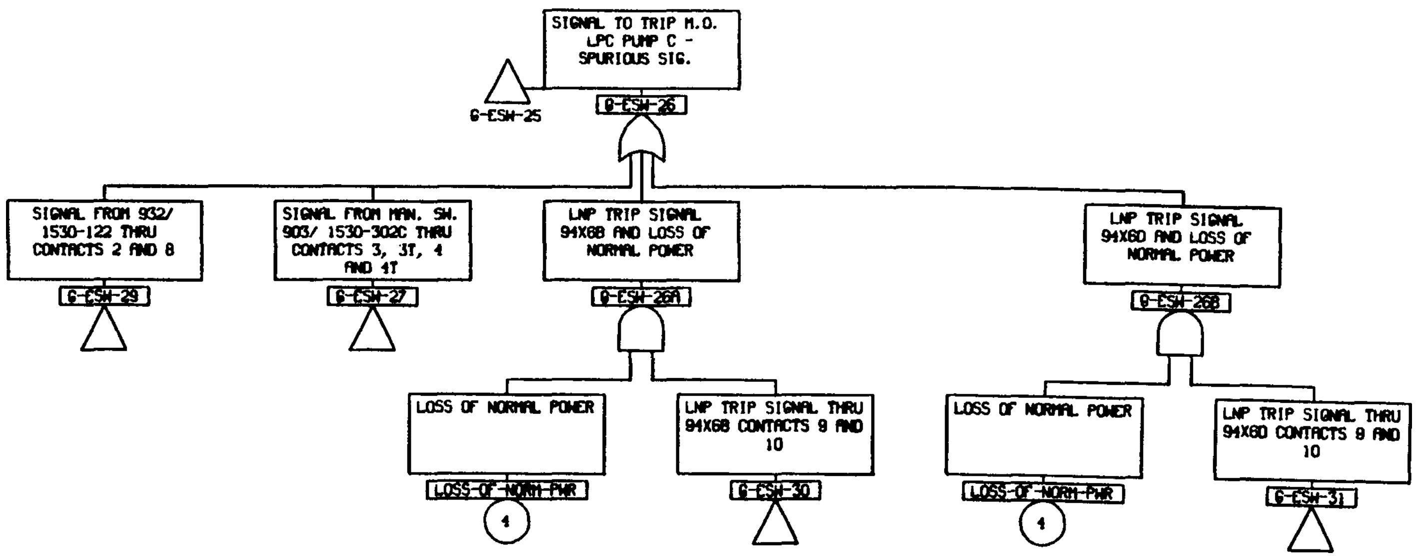

SIGNAL FROM 94-2B THRU CONTACTS 11 AND 12
G-ESW-19
G-ESW-18
G-ESW-31
94-2B CONTACTS 11 AND 12 FAIL TO OPEN
92694-2B-BFO
94-2B COIL FAILS TO DE-ENERGIZE
92694-2B-FTD
SPURIOUS SIGNAL FROM TDO RELAY 62-1A
92662-1A-XFO

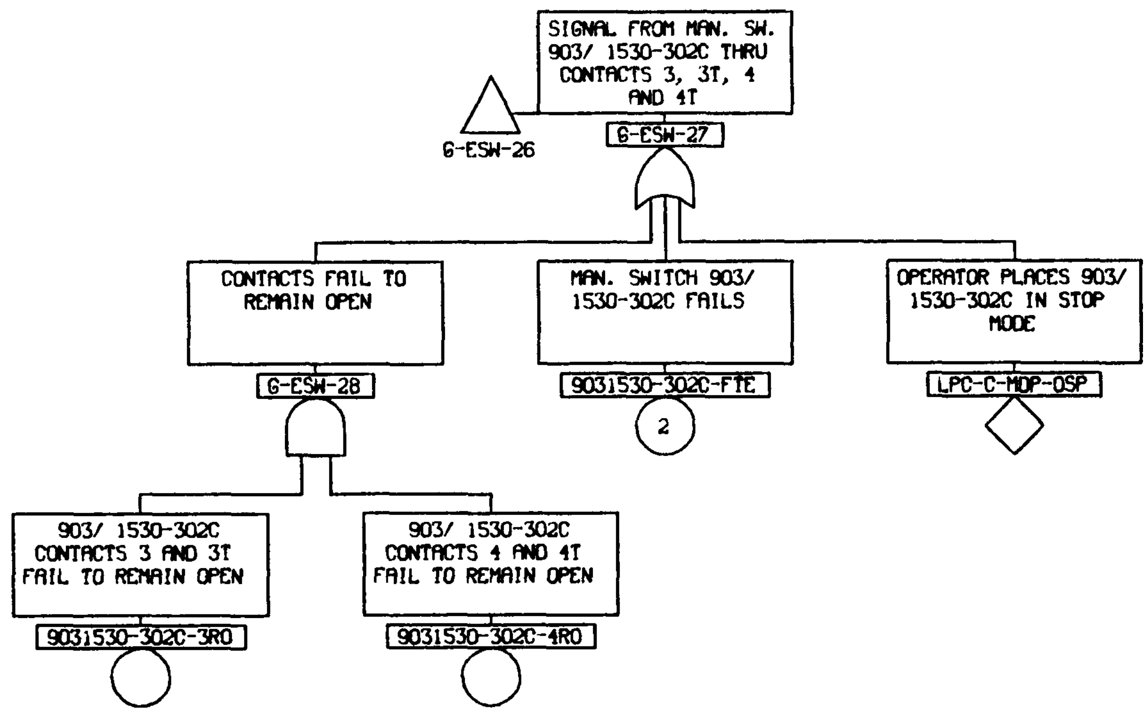
ESW-10

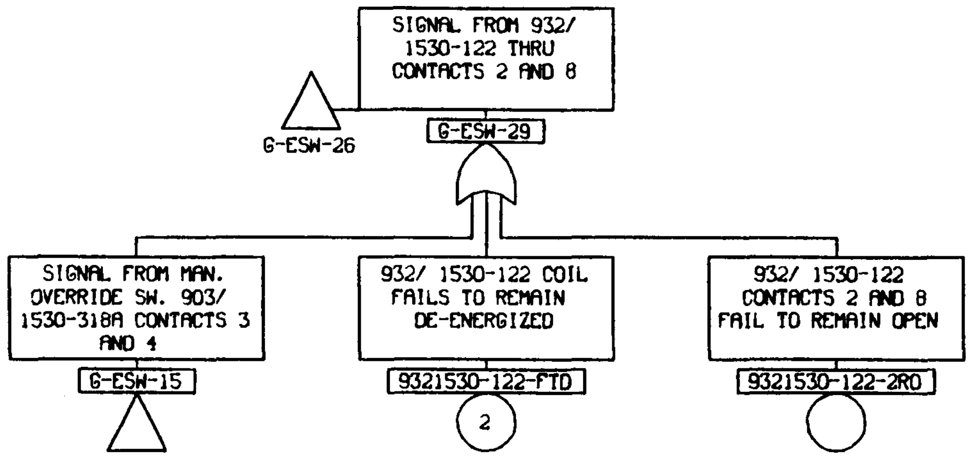

NO SIGNAL TO START M.O. PUMP A
G-ESW-20
G-ESW-10
NO SIGNAL THRU MAN. SW. 903/ 1530-302A CONTACTS 1, 1T, 2, AND 2T
G-ESW-21
FAILURE OF BREAKER AT MCC 14-F CUB NO. 9
AC-14F-9-FTC
L/O DC CONTROL POWER ON BUS 101A CIRCUIT NO. 11
G-DC-BUS-A-11
2
903/ 1530-302A CONTACTS 1 AND 1T FAIL TO CLOSE
9031530-302A-1FC
903/ 1530-302A CONTACTS 2 AND 2T FAIL TO CLOSE
9031530-302A-2FC
903/ 1530-302A FAILS TO OPERATE
9031530-302A-FTE
OPERATOR FAILS TO PLACE MAN. SW. 903/ 1530-302A IN START MODE
LPC-A-MOP-OFS

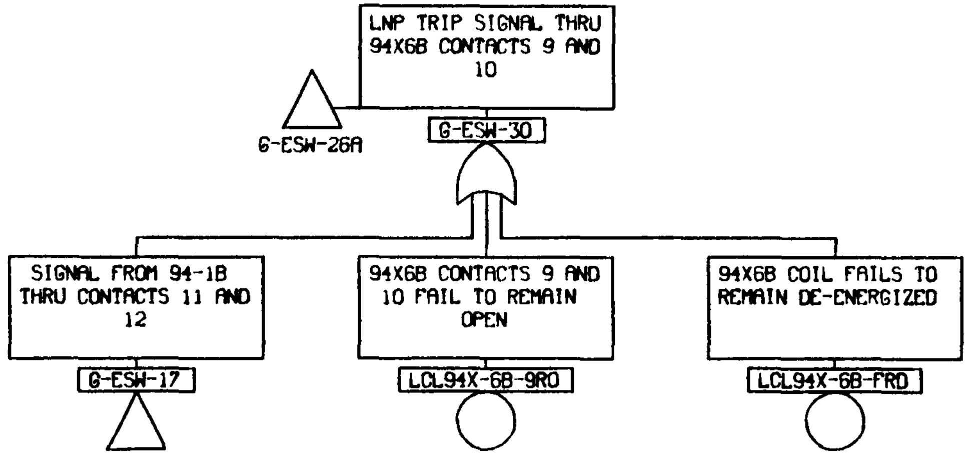

NO FLOW THRU MAN. VALVE 1-LPC-2C PUMP C DISCH. - L.O.
G-ESW-22
G-ESW-6
NO FLOW THRU CHECK VALVE 1-LPC-1C
G-ESW-23
MECHANICAL FAILURE OF MAN. VALVE 1-LPC-2C
LPC-2C-XV-FRO
MAN. VALVE 1-LPC-2C CLOSED DUE TO TORM
LPC-2C-XV-TMC
NO ESW FLOW THRU LPC M.O. PUMP C
G-ESW-24
CHECK VALVE 1-LPC-1C FAILS TO OPEN
LPC-1C-CKV-FRO
CHK. VLV. 1-LPC-1C O.O.S. FOR MAINT.
LPC-1C-CKV-TMC

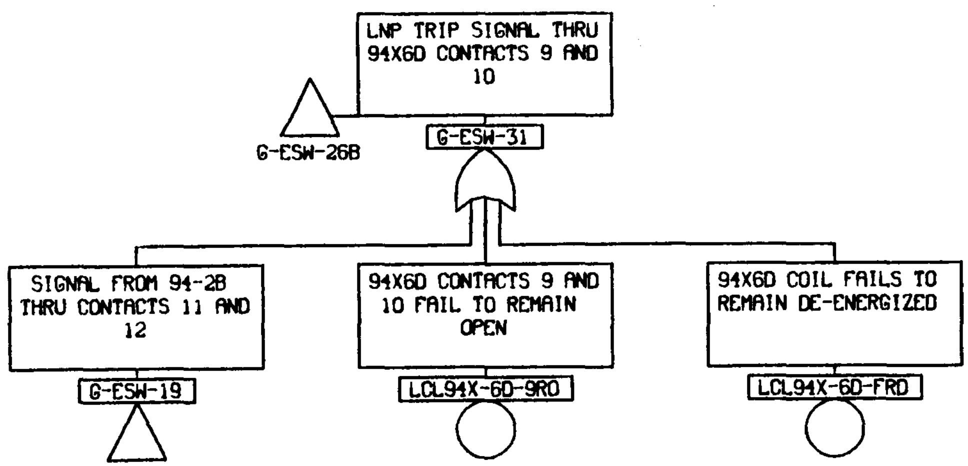

NO ESW FLOW THRU LPC M.O. PUMP C
G-ESW-24
G-ESW-23
L/O AC POWER TO BUS 14-F
G-AC-BUS-14F
2
PUMP C ACTUATION SYSTEM FAULTS
G-ESW-25
M.O. PUMP C FAILS TO START
LPC-C-MDP-FSR
M.O. PUMP C O.O.S. DUE TO TEST OR MAINT.
LPC-C-MDP-TOM
SIGNAL TO TRIP M.O. LPC PUMP C - SPURIOUS SIG.
G-ESW-26
NO SIGNAL TO START M.O. PUMP C
G-ESW-32

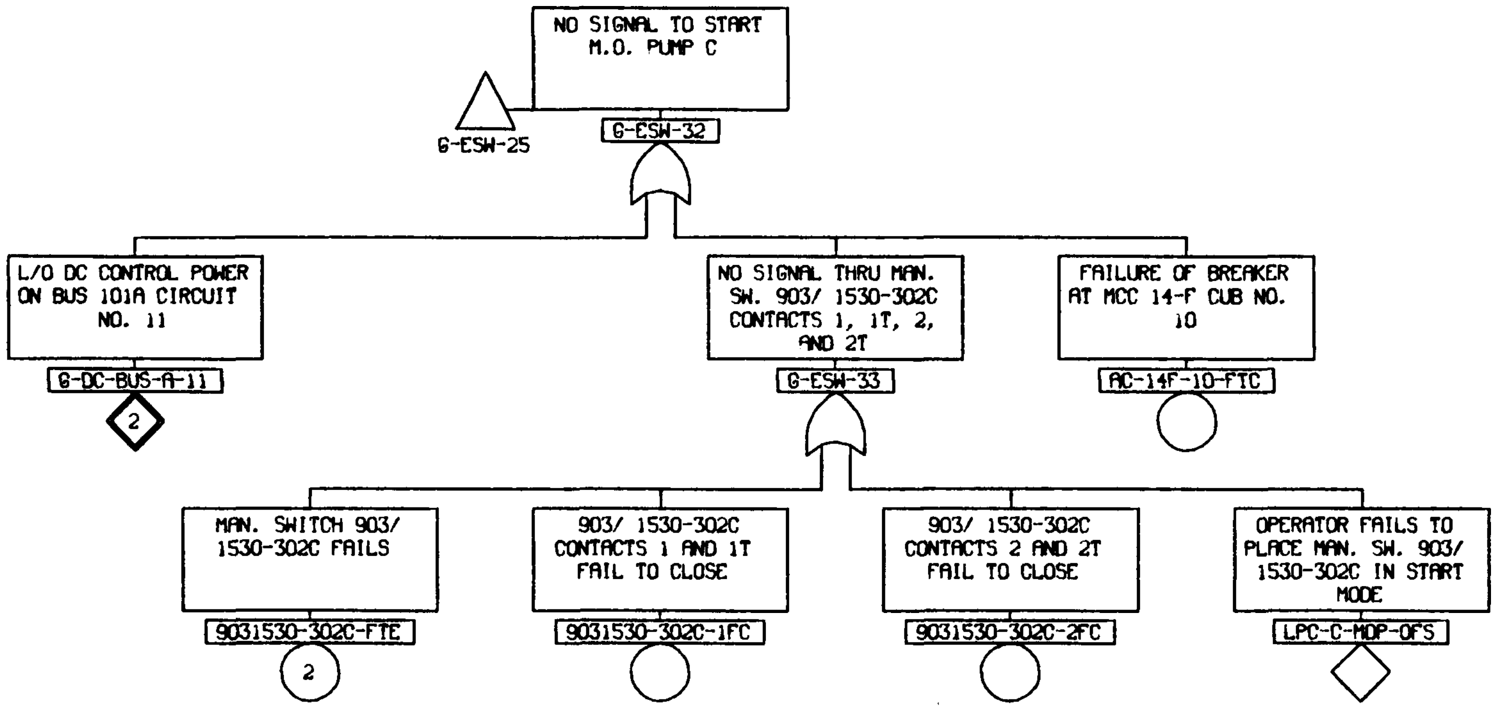

SIGNAL TO TRIP M.O. LPC PUMP C - SPURIOUS SIG.
G-ESW-26
G-ESW-25
SIGNAL FROM 932/ 1530-122 THRU CONTACTS 2 AND 8
G-ESW-29
SIGNAL FROM MAN. SW. 903/ 1530-302C THRU CONTACTS 3, 3T, 4 AND 4T
G-ESW-27
LNP TRIP SIGNAL 94X6B AND LOSS OF NORMAL POWER
G-ESW-26A
LNP TRIP SIGNAL 94X6D AND LOSS OF NORMAL POWER
G-ESW-26B
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
4
LNP TRIP SIGNAL THRU 94X6B CONTACTS 9 AND 10
G-ESW-30
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
4
LNP TRIP SIGNAL THRU 94X6D CONTACTS 9 AND 10
G-ESW-31


SIGNAL FROM MAN. SW. 903/ 1530-302C THRU CONTACTS 3, 3T, 4 AND 4T
G-ESW-27
G-ESW-26
CONTACTS FAIL TO REMAIN OPEN
G-ESW-28
MAN. SWITCH 903/ 1530-302C FAILS
9031530-302C-FTE
2
OPERATOR PLACES 903/ 1530-302C IN STOP MODE
LPC-C-MDP-OSP
903/ 1530-302C CONTACTS 3 AND 3T FAIL TO REMAIN OPEN
9031530-302C-3RO
903/ 1530-302C CONTACTS 4 AND 4T FAIL TO REMAIN OPEN
9031530-302C-4RO

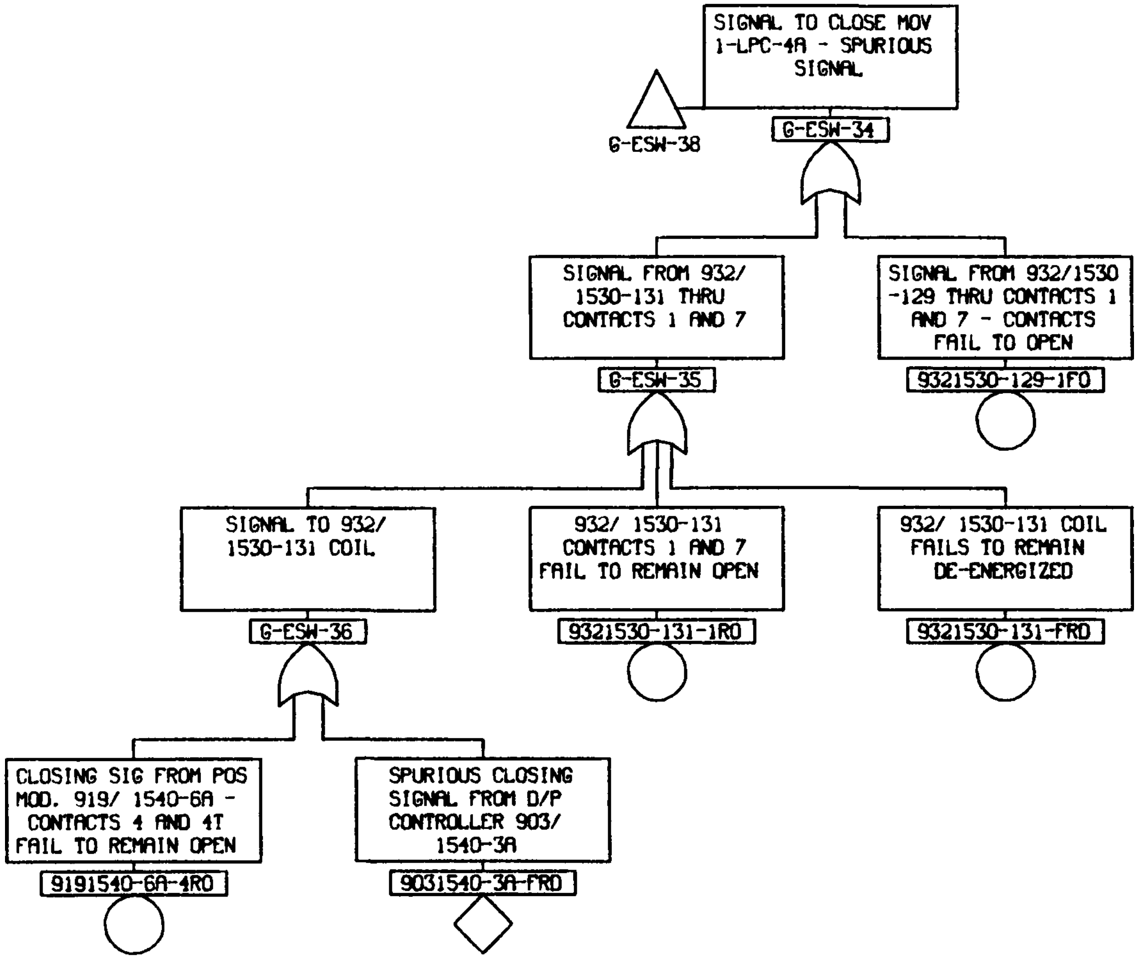

SIGNAL FROM 932/ 1530-122 THRU CONTACTS 2 AND 8
G-ESW-29
G-ESW-26
SIGNAL FROM MAN. OVERRIDE SW. 903/ 1530-318A CONTACTS 3 AND 4
G-ESW-15
932/ 1530-122 COIL FAILS TO REMAIN DE-ENERGIZED
9321530-122-FTD
2
932/ 1530-122 CONTACTS 2 AND 8 FAIL TO REMAIN OPEN
9321530-122-2RO


LNP TRIP SIGNAL THRU 94X6B CONTACTS 9 AND 10
G-ESW-30
G-ESW-26A
SIGNAL FROM 94-1B THRU CONTACTS 11 AND 12
G-ESW-17
94X6B CONTACTS 9 AND 10 FAIL TO REMAIN OPEN
LCL94X-6B-9RO
94X6B COIL FAILS TO REMAIN DE-ENERGIZED
LCL94X-6B-FRD

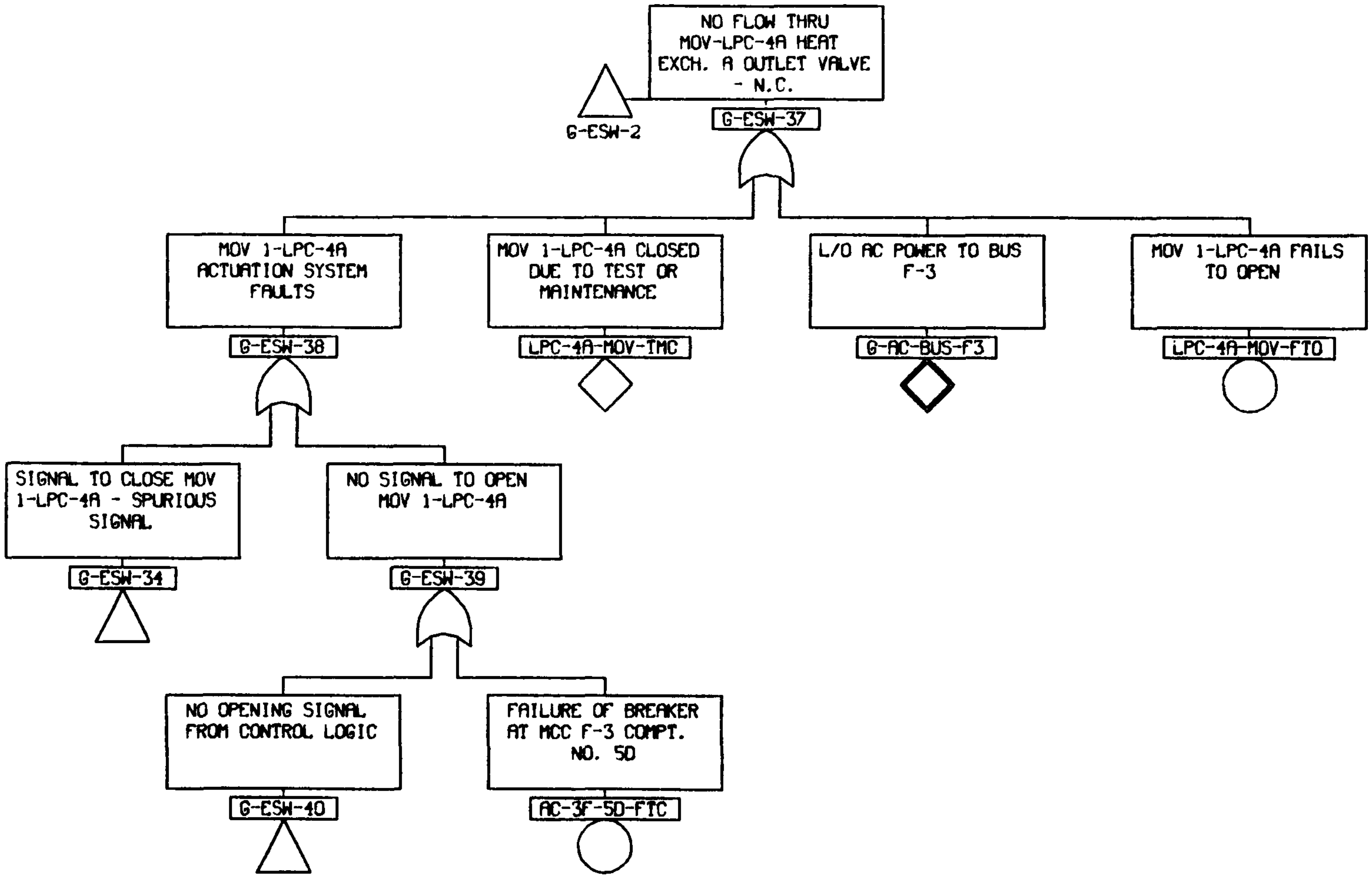

LNP TRIP SIGNAL THRU 94X6D CONTACTS 9 AND 10
G-ESW-31
G-ESW-26B
SIGNAL FROM 94-2B THRU CONTACTS 11 AND 12
G-ESW-19
94X6D CONTACTS 9 AND 10 FAIL TO REMAIN OPEN
LCL94X-6D-9RO
94X6D COIL FAILS TO REMAIN DE-ENERGIZED
LCL94X-6D-FRD

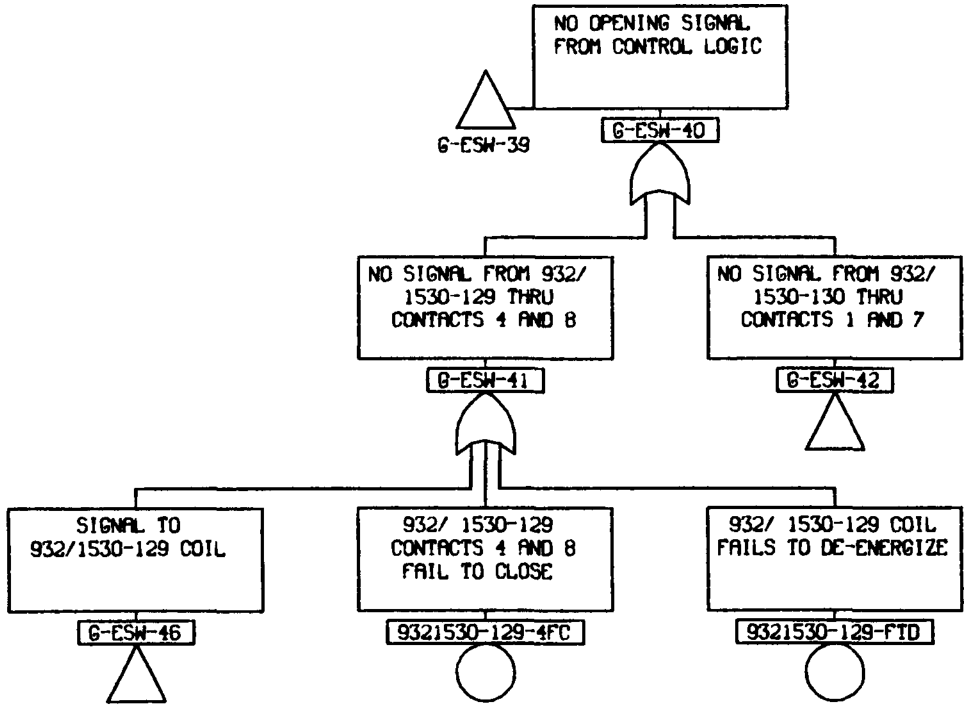

NO SIGNAL TO START M.O. PUMP C
G-ESW-32
G-ESW-25
L/O DC CONTROL POWER ON BUS 101A CIRCUIT NO. 11
G-DC-BUS-A-11
2
NO SIGNAL THRU MAN. SW. 903/ 1530-302C CONTACTS 1, 1T, 2, AND 2T
G-ESW-33
FAILURE OF BREAKER AT MCC 14-F CUB NO. 10
AC-14F-10-FTC
MAN. SWITCH 903/ 1530-302C FAILS
9031530-302C-FTE
2
903/ 1530-302C CONTACTS 1 AND 1T FAIL TO CLOSE
9031530-302C-1FC
903/ 1530-302C CONTACTS 2 AND 2T FAIL TO CLOSE
9031530-302C-2FC
OPERATOR FAILS TO PLACE MAN. SW. 903/ 1530-302C IN START MODE
LPC-C-MOP-OFS

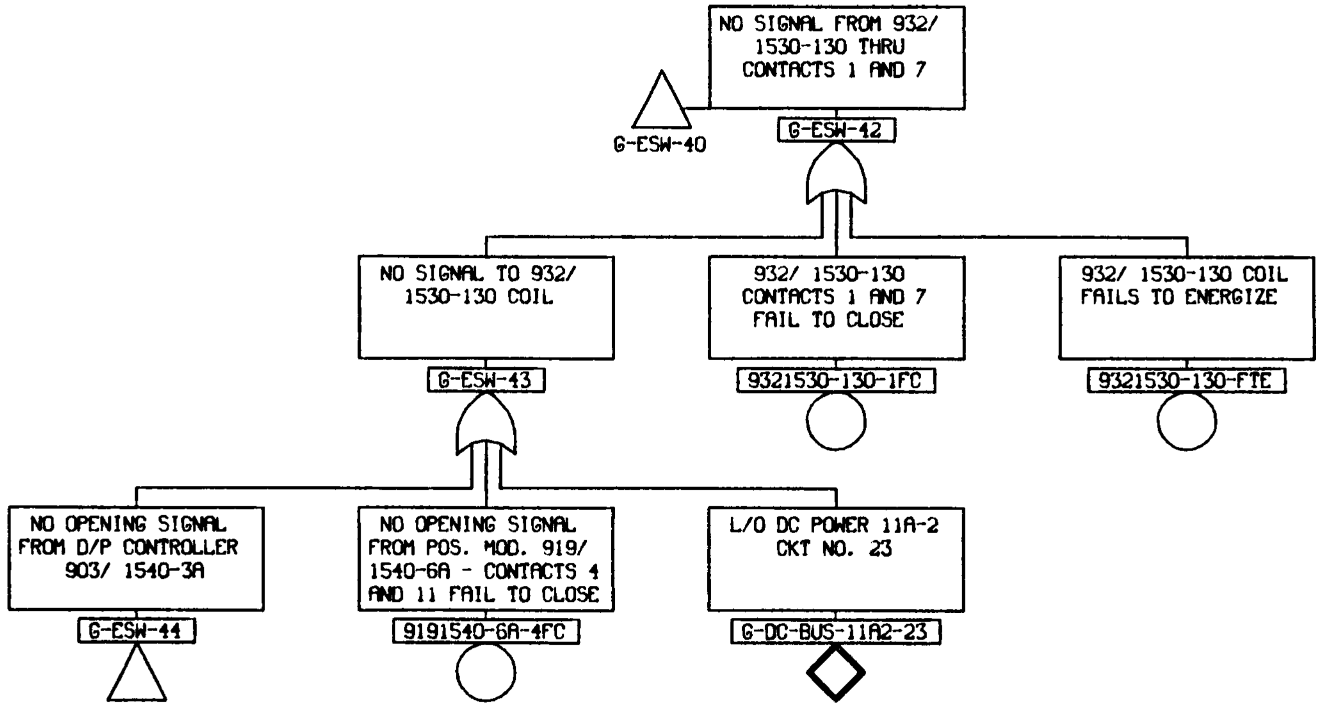
ESW-18


SIGNAL TO CLOSE MOV 1-LPC-4A - SPURIOUS SIGNAL
G-ESW-34
G-ESW-38
SIGNAL FROM 932/ 1530-131 THRU CONTACTS 1 AND 7
G-ESW-35
SIGNAL FROM 932/1530 -129 THRU CONTACTS 1 AND 7 - CONTACTS FAIL TO OPEN
9321530-129-1FO
SIGNAL TO 932/ 1530-131 COIL
G-ESW-36
932/ 1530-131 CONTACTS 1 AND 7 FAIL TO REMAIN OPEN
9321530-131-1RO
932/ 1530-131 COIL FAILS TO REMAIN DE-ENERGIZED
9321530-131-FRD
CLOSING SIG FROM POS MOD. 919/ 1540-6A - CONTACTS 4 AND 4T FAIL TO REMAIN OPEN
9191540-6A-4RO
SPURIOUS CLOSING SIGNAL FROM D/P CONTROLLER 903/ 1540-3A
9031540-3A-FRD

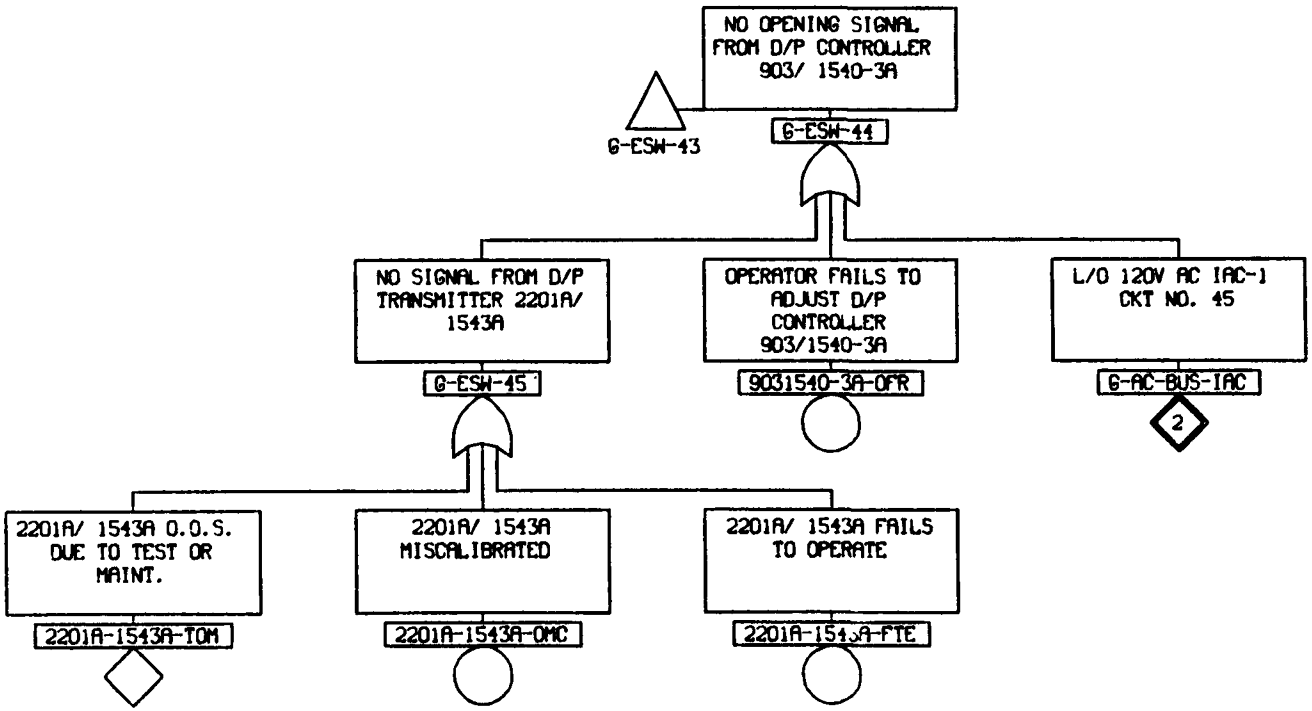
ESW-19

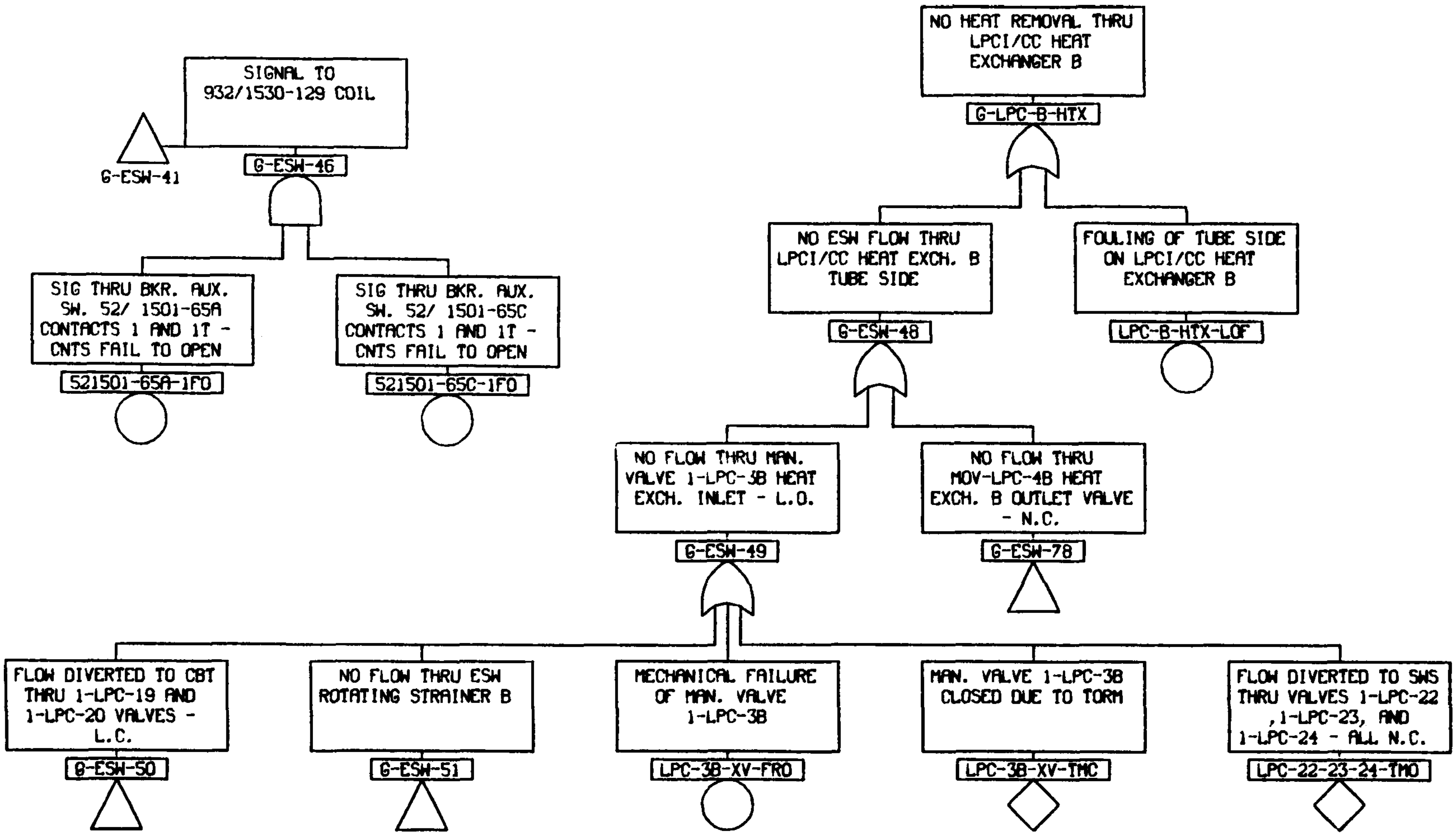

NO FLOW THRU MOV-LPC-4A HEAT EXCH. A OUTLET VALVE - N.C.
G-ESW-37
G-ESW-2
MOV 1-LPC-4A ACTUATION SYSTEM FAULTS
G-ESW-38
MOV 1-LPC-4A CLOSED DUE TO TEST OR MAINTENANCE
LPC-4A-MOV-TMC
L/O AC POWER TO BUS F-3
G-AC-BUS-F3
MOV 1-LPC-4A FAILS TO OPEN
LPC-4A-MOV-FTO
SIGNAL TO CLOSE MOV 1-LPC-4A - SPURIOUS SIGNAL
G-ESW-34
NO SIGNAL TO OPEN MOV 1-LPC-4A
G-ESW-39
NO OPENING SIGNAL FROM CONTROL LOGIC
G-ESW-40
FAILURE OF BREAKER AT MCC F-3 COMPT. NO. 5D
AC-3F-5D-FTC


NO OPENING SIGNAL FROM CONTROL LOGIC
G-ESW-40
G-ESW-39
NO SIGNAL FROM 932/ 1530-129 THRU CONTACTS 4 AND 8
G-ESW-41
NO SIGNAL FROM 932/ 1530-130 THRU CONTACTS 1 AND 7
G-ESW-42
SIGNAL TO 932/1530-129 COIL
G-ESW-46
932/ 1530-129 CONTACTS 4 AND 8 FAIL TO CLOSE
9321530-129-4FC
932/ 1530-129 COIL FAILS TO DE-ENERGIZE
9321530-129-FTD

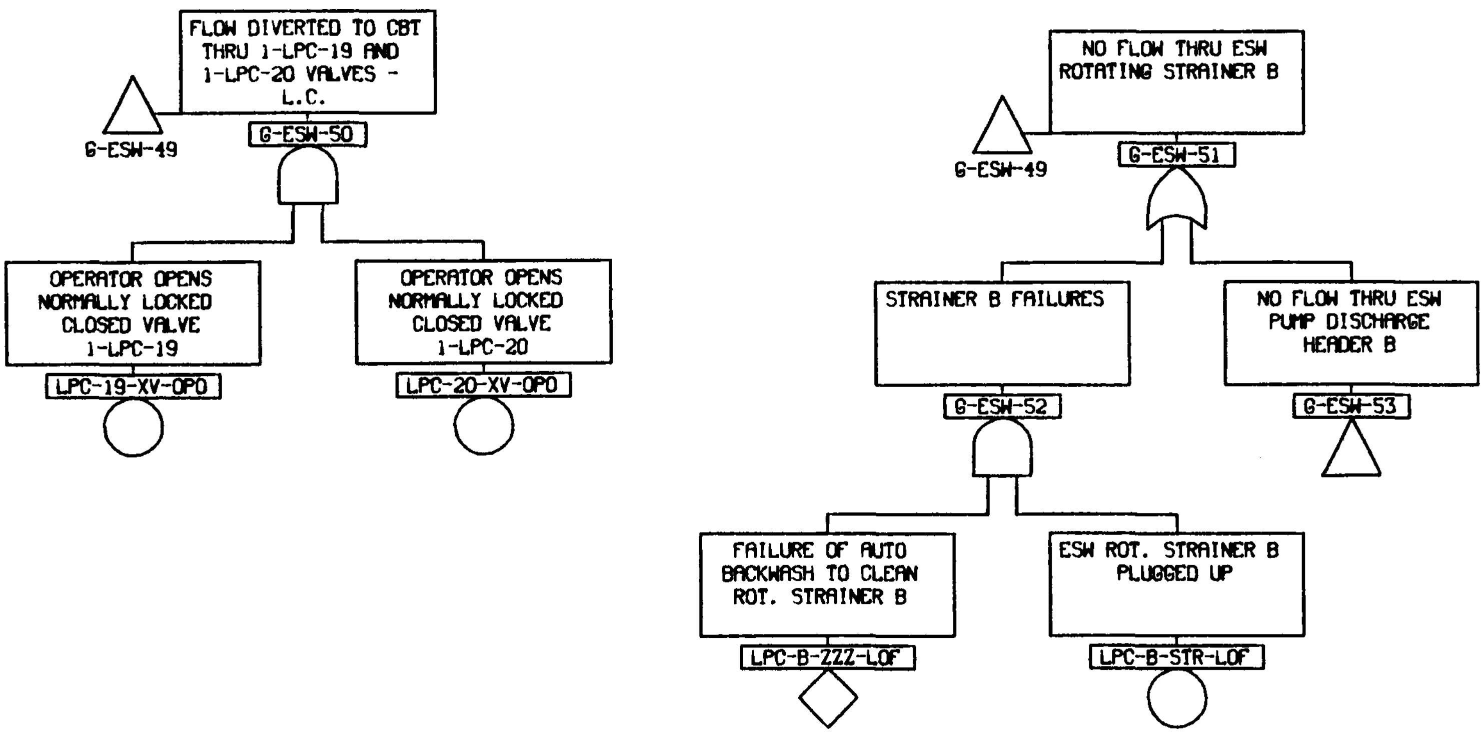


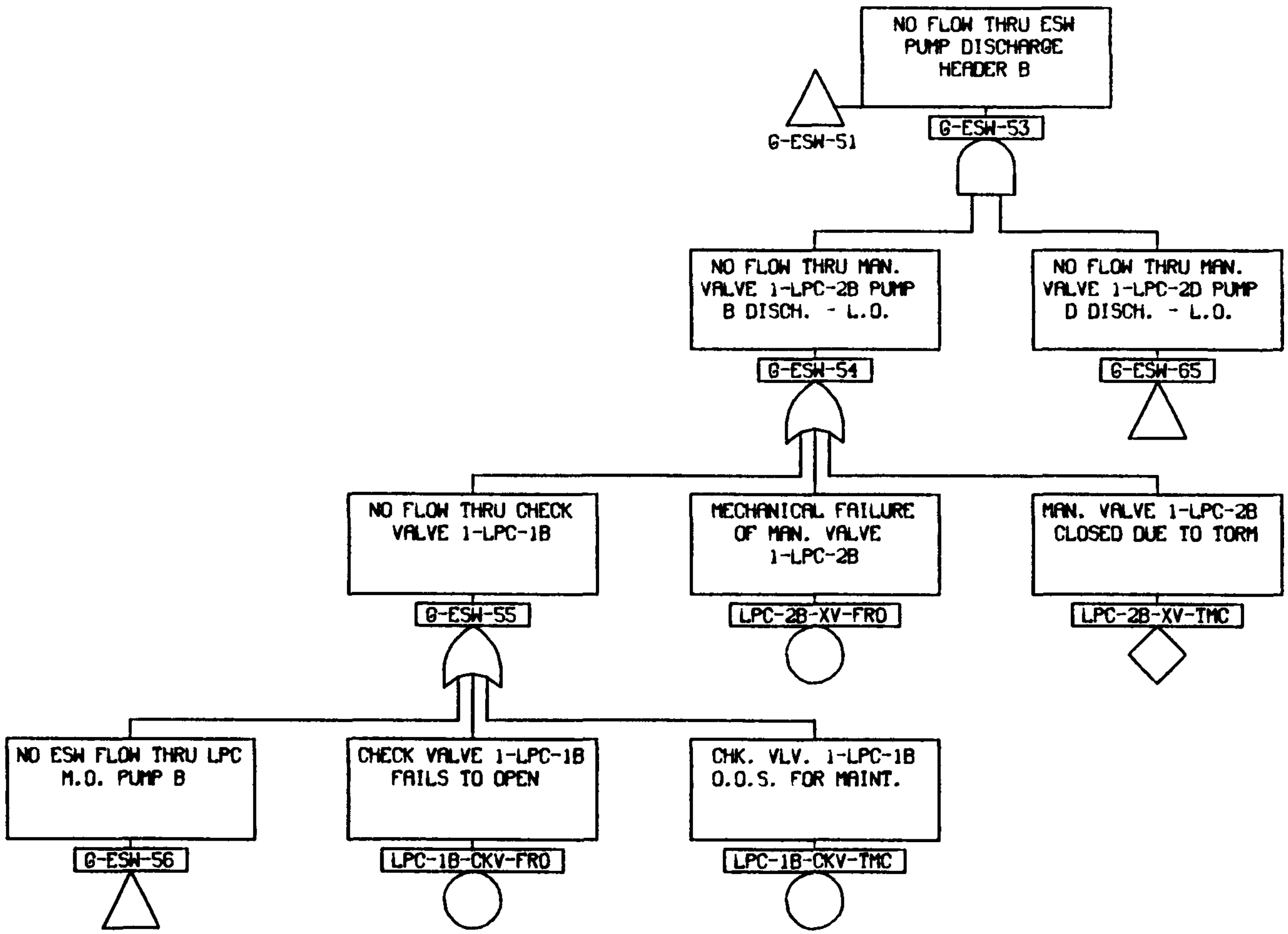
NO SIGNAL FROM 932/ 1530-130 THRU CONTACTS 1 AND 7
G-ESW-42
G-ESW-40
NO SIGNAL TO 932/ 1530-130 COIL
G-ESW-43
932/ 1530-130 CONTACTS 1 AND 7 FAIL TO CLOSE
9321530-130-1FC
932/ 1530-130 COIL FAILS TO ENERGIZE
9321530-130-FTE
NO OPENING SIGNAL FROM D/P CONTROLLER 903/ 1540-3A
G-ESW-44
NO OPENING SIGNAL FROM POS. MOD. 919/ 1540-6A - CONTACTS 4 AND 11 FAIL TO CLOSE
9191540-6A-4FC
L/O DC POWER 11A-2 CKT NO. 23
G-DC-BUS-11A2-23


NO OPENING SIGNAL FROM D/P CONTROLLER 903/ 1540-3A
G-ESW-44
G-ESW-43
NO SIGNAL FROM D/P TRANSMITTER 2201A/ 1543A
G-ESW-45
OPERATOR FAILS TO ADJUST D/P CONTROLLER 903/1540-3A
9031540-3A-OFR
L/O 120V AC IAC-1 CKT NO. 45
G-AC-BUS-IAC
2
2201A/ 1543A O.O.S. DUE TO TEST OR MAINT.
2201A-1543A-TOM
2201A/ 1543A MISCALIBRATED
2201A-1543A-OMC
2201A/ 1543A FAILS TO OPERATE
2201A-1543A-FTE

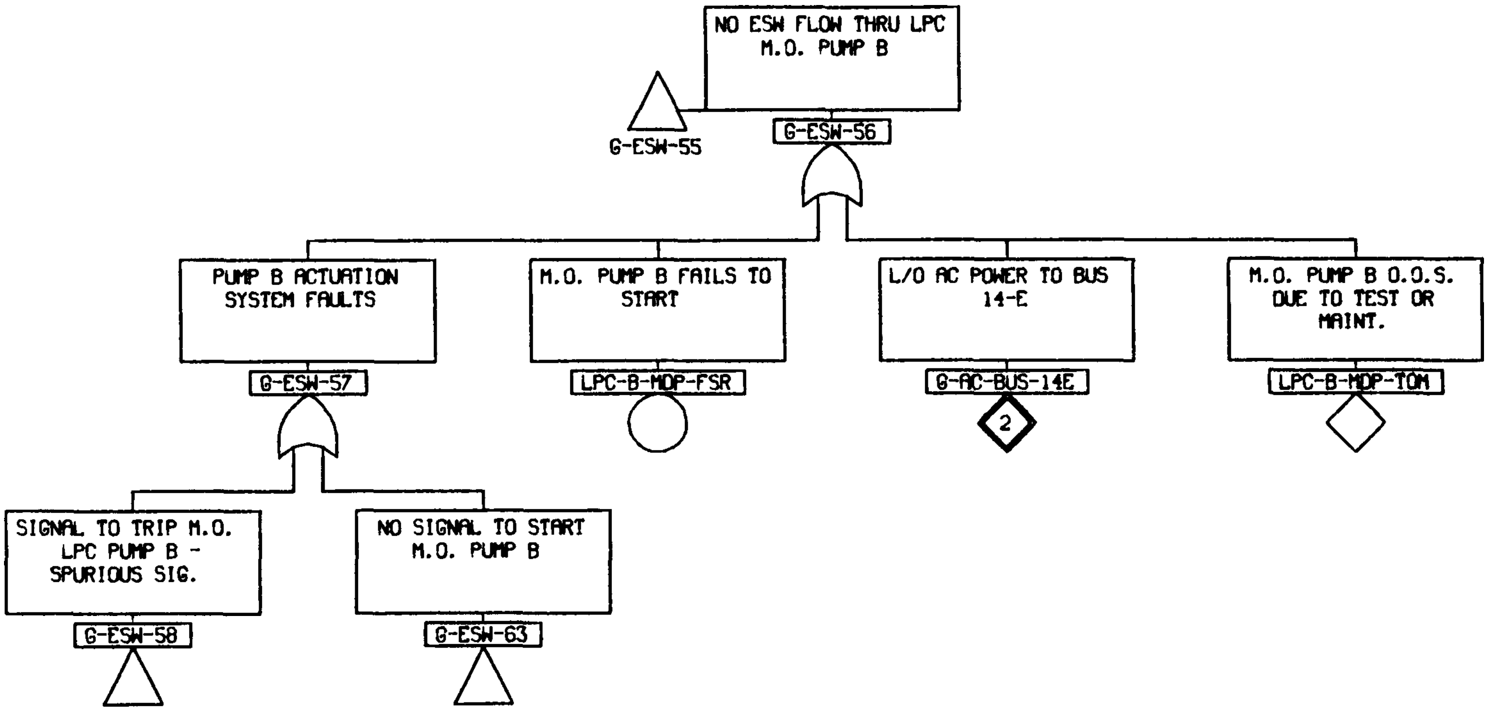


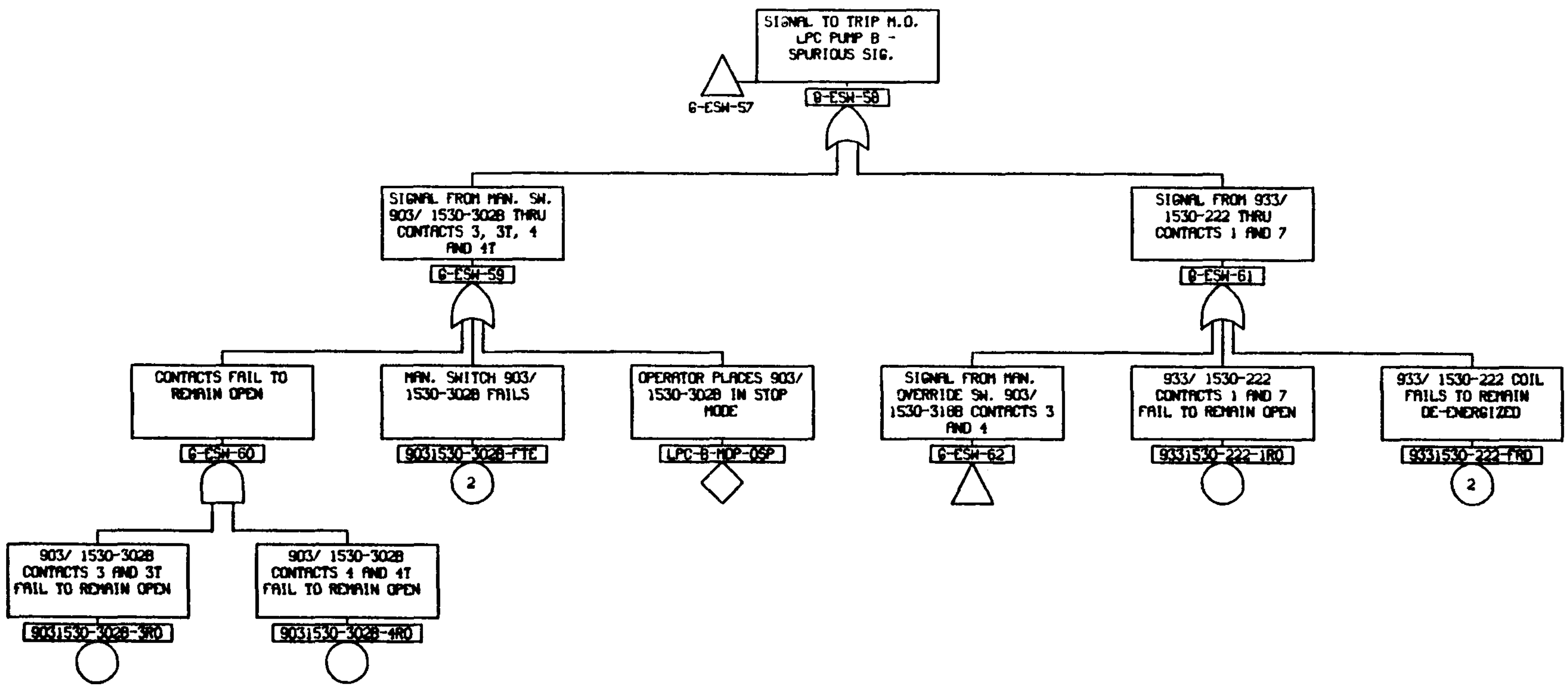
SIGNAL TO 932/1530-129 COIL
G-ESW-46
G-ESW-41
SIG THRU BKR. AUX. SW. 52/ 1501-65A CONTACTS 1 AND 1T - CNTS FAIL TO OPEN
521501-65A-1FO
SIG THRU BKR. AUX. SW. 52/ 1501-65C CONTACTS 1 AND 1T - CNTS FAIL TO OPEN
521501-65C-1FO
NO HEAT REMOVAL THRU LPCI/CC HEAT EXCHANGER B
G-LPC-B-HTX
NO ESW FLOW THRU LPCI/CC HEAT EXCH. B TUBE SIDE
G-ESW-48
FOULING OF TUBE SIDE ON LPCI/CC HEAT EXCHANGER B
LPC-B-HTX-LOF
NO FLOW THRU MAN. VALVE 1-LPC-3B HEAT EXCH. INLET - L.O.
G-ESW-49
NO FLOW THRU MOV-LPC-4B HEAT EXCH. B OUTLET VALVE - N.C.
G-ESW-78
FLOW DIVERTED TO CBT THRU 1-LPC-19 AND 1-LPC-20 VALVES - L.C.
G-ESW-50
NO FLOW THRU ESW ROTATING STRAINER B
G-ESW-51
MECHANICAL FAILURE OF MAN. VALVE 1-LPC-3B
LPC-3B-XV-FRO
MAN. VALVE 1-LPC-3B CLOSED DUE TO TORM
LPC-3B-XV-TMC
FLOW DIVERTED TO SWS THRU VALVES 1-LPC-22 ,1-LPC-23, AND 1-LPC-24 - ALL N.C.
LPC-22-23-24-TMO

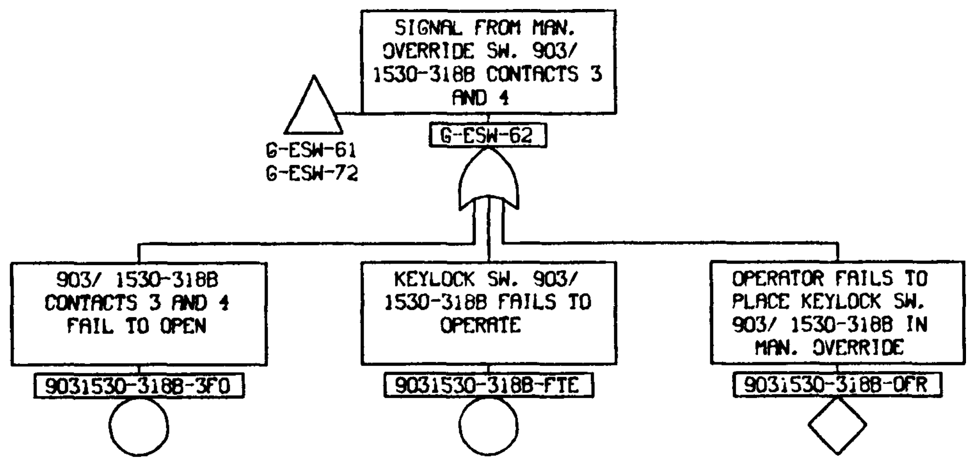

FLOW DIVERTED TO CBT THRU 1-LPC-19 AND 1-LPC-20 VALVES - L.C.
G-ESW-49
G-ESW-50
OPERATOR OPENS NORMALLY LOCKED CLOSED VALVE 1-LPC-19
LPC-19-XV-OPO
OPERATOR OPENS NORMALLY LOCKED CLOSED VALVE 1-LPC-20
LPC-20-XV-OPO
NO FLOW THRU ESW ROTATING STRAINER B
G-ESW-49
G-ESW-51
STRAINER B FAILURES
G-ESW-52
NO FLOW THRU ESW PUMP DISCHARGE HEADER B
G-ESW-53
FAILURE OF AUTO BACKWASH TO CLEAN ROT. STRAINER B
LPC-B-ZZZ-LOF
ESW ROT. STRAINER B PLUGGED UP
LPC-B-STR-LOF

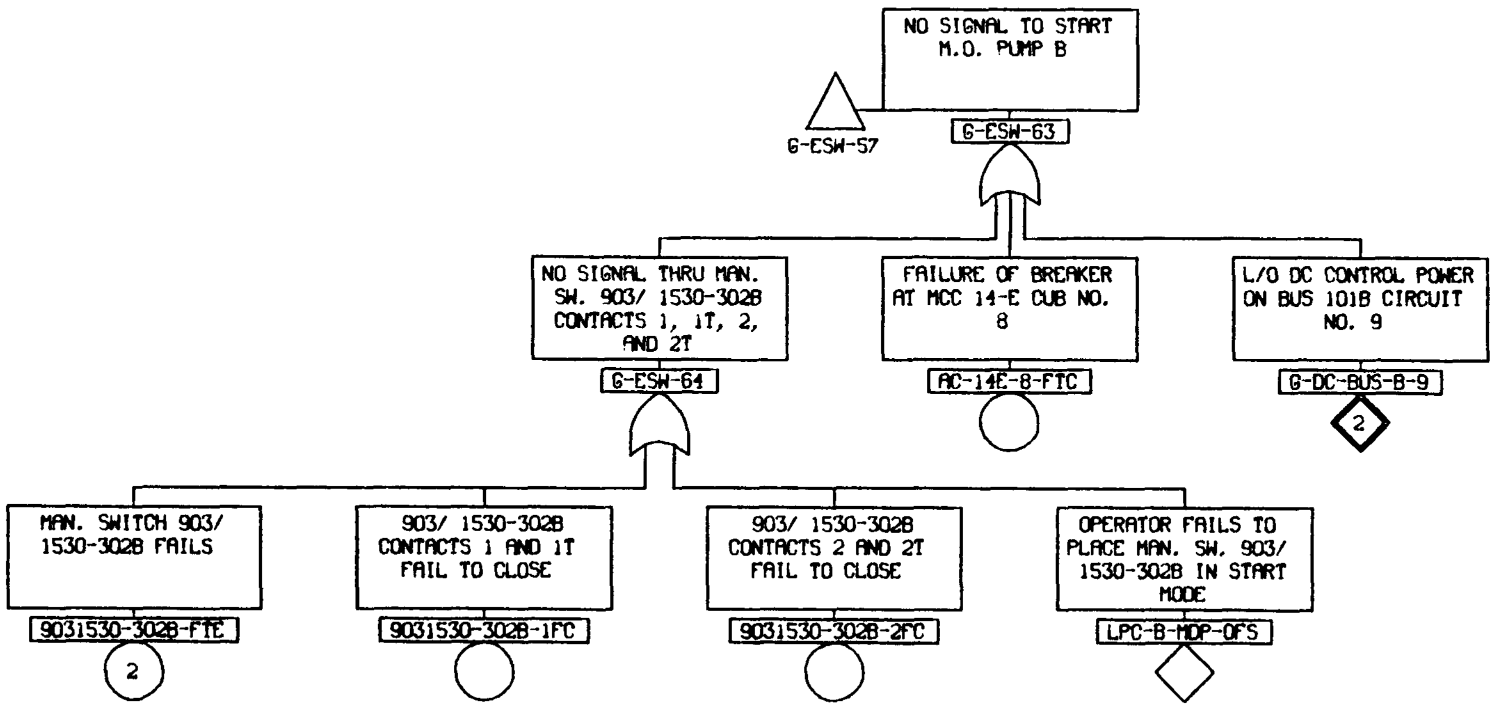


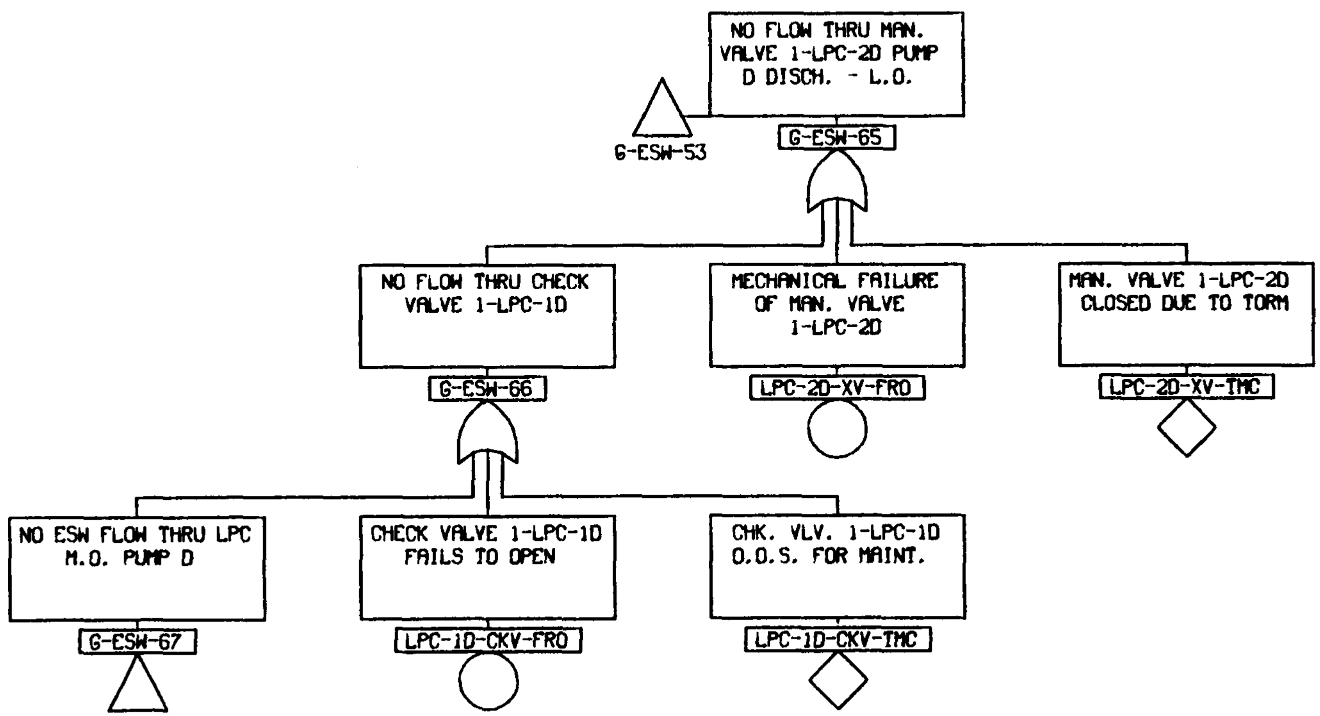
NO FLOW THRU ESW PUMP DISCHARGE HEADER B
G-ESW-51
G-ESW-53
NO FLOW THRU MAN. VALVE 1-LPC-2B PUMP B DISCH. - L.O.
NO FLOW THRU MAN. VALVE 1-LPC-2D PUMP D DISCH. - L.O.
G-ESW-54
G-ESW-65
NO FLOW THRU CHECK VALVE 1-LPC-1B
MECHANICAL FAILURE OF MAN. VALVE 1-LPC-2B
MAN. VALVE 1-LPC-2B CLOSED DUE TO TORM
G-ESW-55
LPC-2B-XV-FRO
LPC-2B-XV-TMC
NO ESW FLOW THRU LPC M.O. PUMP B
CHECK VALVE 1-LPC-1B FAILS TO OPEN
CHK. VLV. 1-LPC-1B O.O.S. FOR MAINT.
G-ESW-56
LPC-1B-CKV-FRO
LPC-1B-CKV-TMC

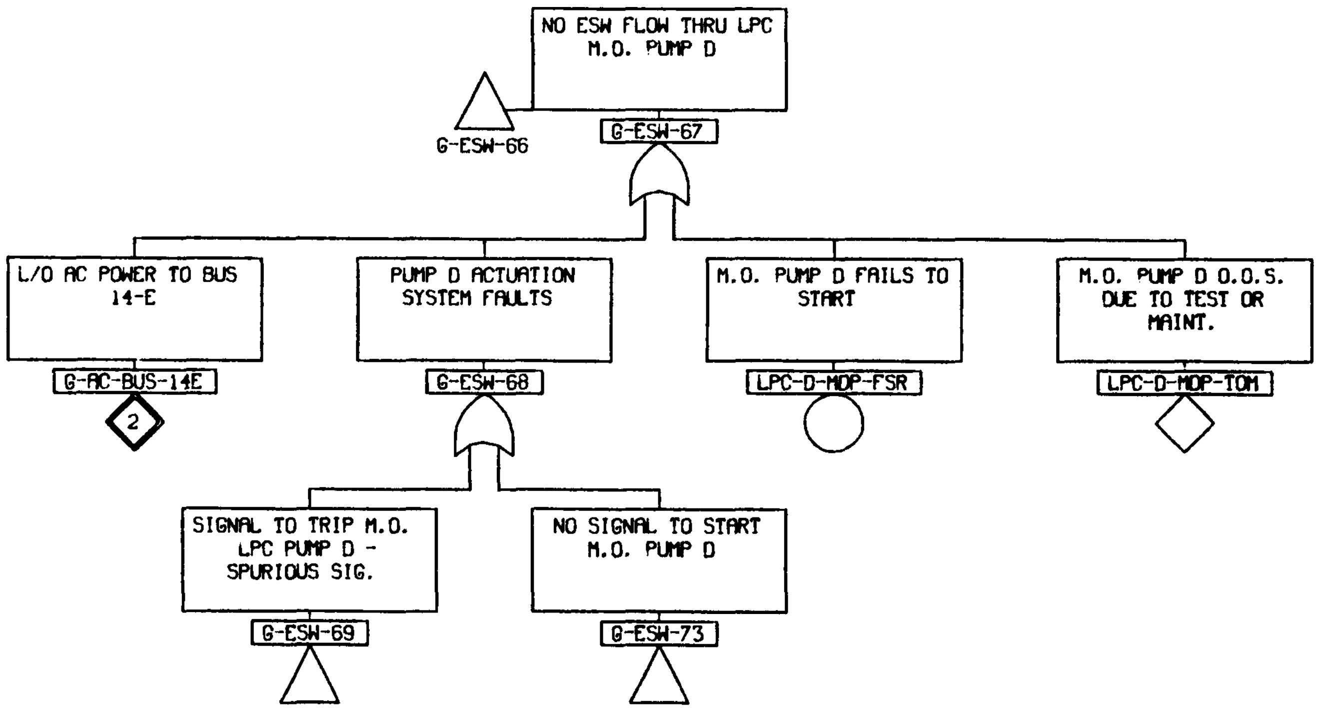

NO ESW FLOW THRU LPC M.O. PUMP B
G-ESW-56
G-ESW-55
PUMP B ACTUATION SYSTEM FAULTS
G-ESW-57
M.O. PUMP B FAILS TO START
LPC-B-MDP-FSR
L/O AC POWER TO BUS 14-E
G-AC-BUS-14E
2
M.O. PUMP B O.O.S. DUE TO TEST OR MAINT.
LPC-B-MDP-TOM
SIGNAL TO TRIP M.O. LPC PUMP B - SPURIOUS SIG.
G-ESW-58
NO SIGNAL TO START M.O. PUMP B
G-ESW-63

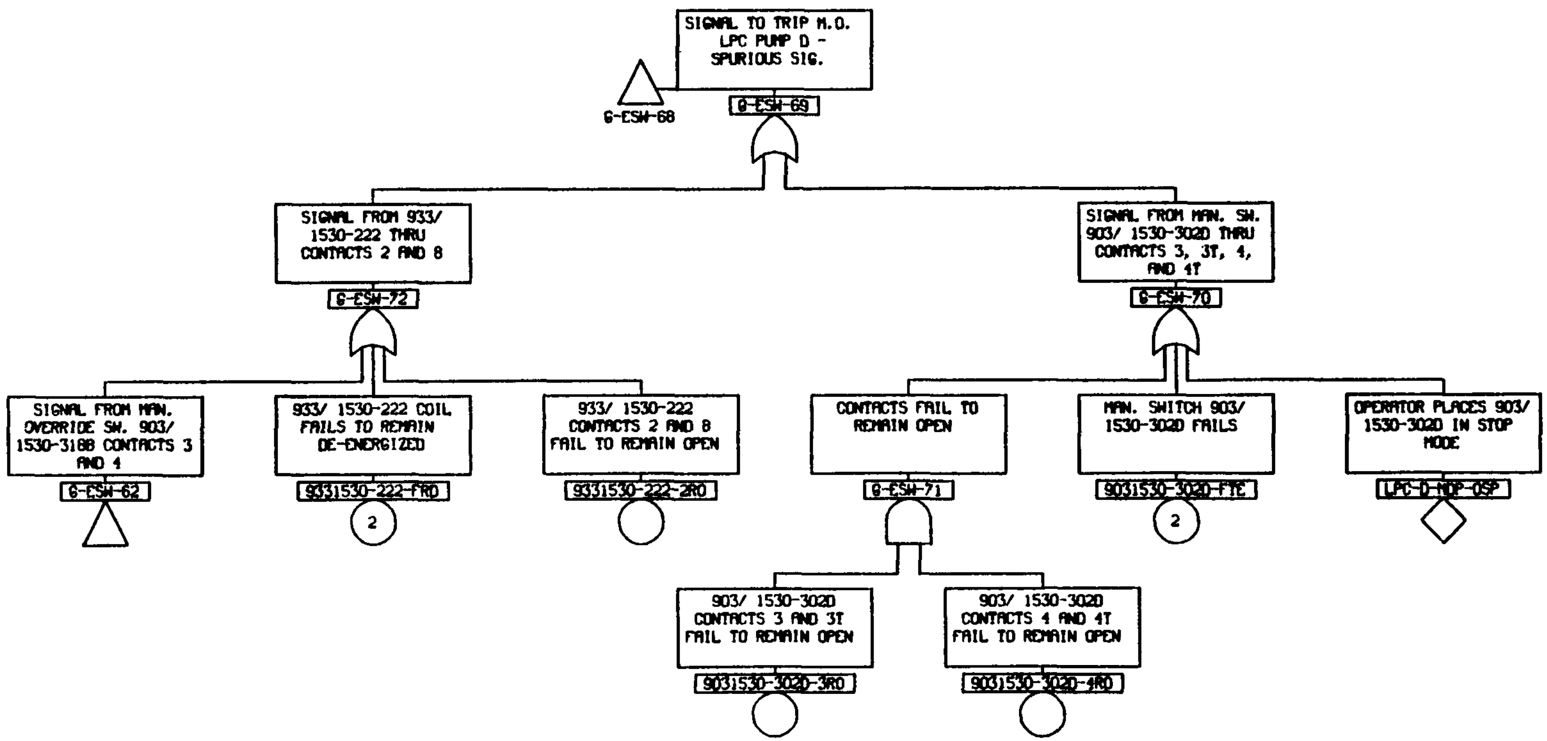

SIGNAL TO TRIP M.O. LPC PUMP B - SPURIOUS SIG.
G-ESW-58
G-ESW-57
SIGNAL FROM MAN. SW. 903/ 1530-302B THRU CONTACTS 3, 3T, 4 AND 4T
G-ESW-59
SIGNAL FROM 933/ 1530-222 THRU CONTACTS 1 AND 7
G-ESW-61
CONTACTS FAIL TO REMAIN OPEN
G-ESW-60
MAN. SWITCH 903/ 1530-302B FAILS
9031530-302B-FTE
2
OPERATOR PLACES 903/ 1530-302B IN STOP MODE
LPC-B-MDP-OSP
SIGNAL FROM MAN. OVERRIDE SW. 903/ 1530-318B CONTACTS 3 AND 4
G-ESW-62
933/ 1530-222 CONTACTS 1 AND 7 FAIL TO REMAIN OPEN
9331530-222-1RO
933/ 1530-222 COIL FAILS TO REMAIN DE-ENERGIZED
9331530-222-FRD
2
903/ 1530-302B CONTACTS 3 AND 3T FAIL TO REMAIN OPEN
9031530-302B-3RO
903/ 1530-302B CONTACTS 4 AND 4T FAIL TO REMAIN OPEN
9031530-302B-4RO

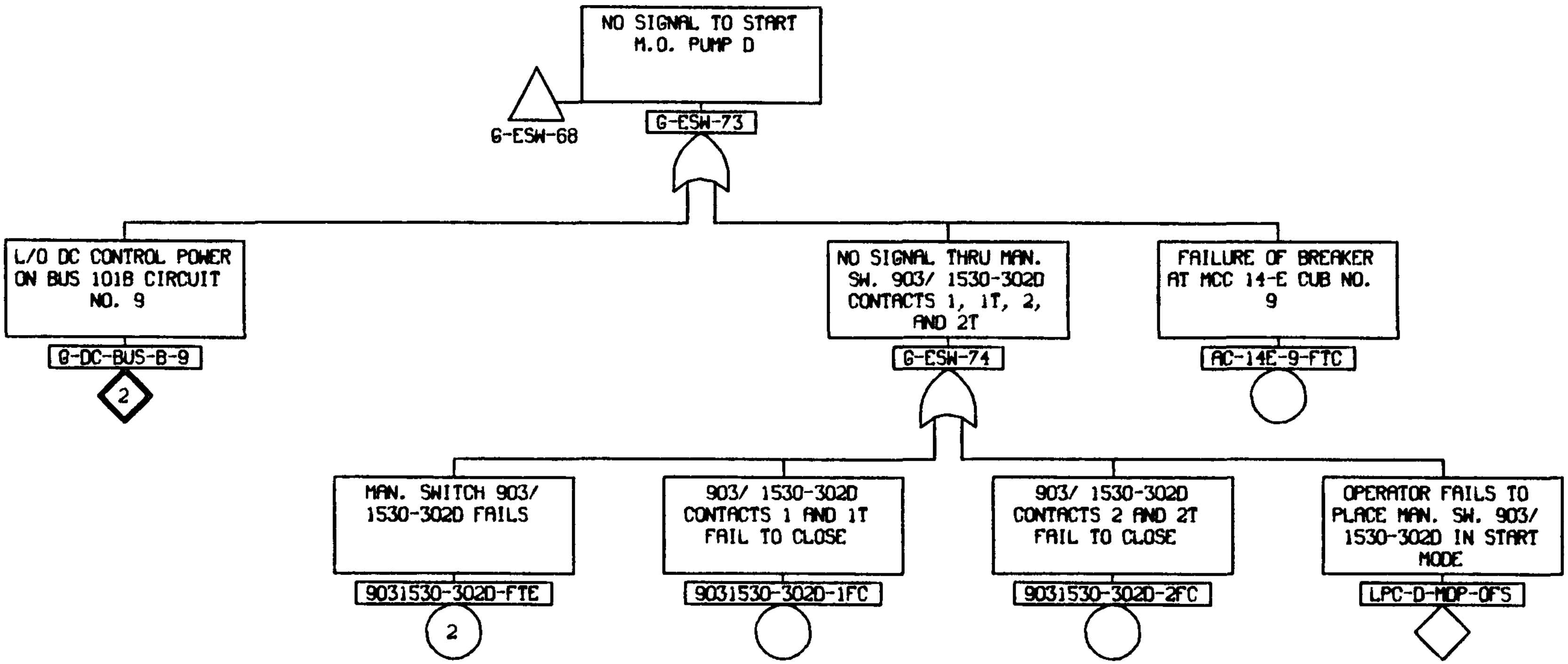

SIGNAL FROM MAN. OVERRIDE SW. 903/ 1530-318B CONTACTS 3 AND 4
G-ESW-62
G-ESW-61
G-ESW-72
903/ 1530-318B CONTACTS 3 AND 4 FAIL TO OPEN
9031530-318B-3FO
KEYLOCK SW. 903/ 1530-318B FAILS TO OPERATE
9031530-318B-FTE
OPERATOR FAILS TO PLACE KEYLOCK SW. 903/ 1530-318B IN MAN. OVERRIDE
9031530-318B-OFR


NO SIGNAL TO START M.O. PUMP B
G-ESW-63
G-ESW-57
NO SIGNAL THRU MAN. SW. 903/ 1530-302B CONTACTS 1, 1T, 2, AND 2T
G-ESW-64
FAILURE OF BREAKER AT MCC 14-E CUB NO. 8
AC-14E-8-FTC
L/O DC CONTROL POWER ON BUS 101B CIRCUIT NO. 9
G-DC-BUS-B-9
2
MAN. SWITCH 903/ 1530-302B FAILS
9031530-302B-FTE
2
903/ 1530-302B CONTACTS 1 AND 1T FAIL TO CLOSE
9031530-302B-1FC
903/ 1530-302B CONTACTS 2 AND 2T FAIL TO CLOSE
9031530-302B-2FC
OPERATOR FAILS TO PLACE MAN. SW. 903/ 1530-302B IN START MODE
LPC-B-MDP-OFS


NO FLOW THRU MAN. VALVE 1-LPC-2D PUMP D DISCH. - L.O.
G-ESW-65
G-ESW-53
NO FLOW THRU CHECK VALVE 1-LPC-1D
G-ESW-66
MECHANICAL FAILURE OF MAN. VALVE 1-LPC-2D
LPC-2D-XV-FRO
MAN. VALVE 1-LPC-2D CLOSED DUE TO TORM
LPC-2D-XV-TMC
NO ESW FLOW THRU LPC M.O. PUMP D
G-ESW-67
CHECK VALVE 1-LPC-1D FAILS TO OPEN
LPC-1D-CKV-FRO
CHK. VLV. 1-LPC-1D O.O.S. FOR MAINT.
LPC-1D-CKV-TMC

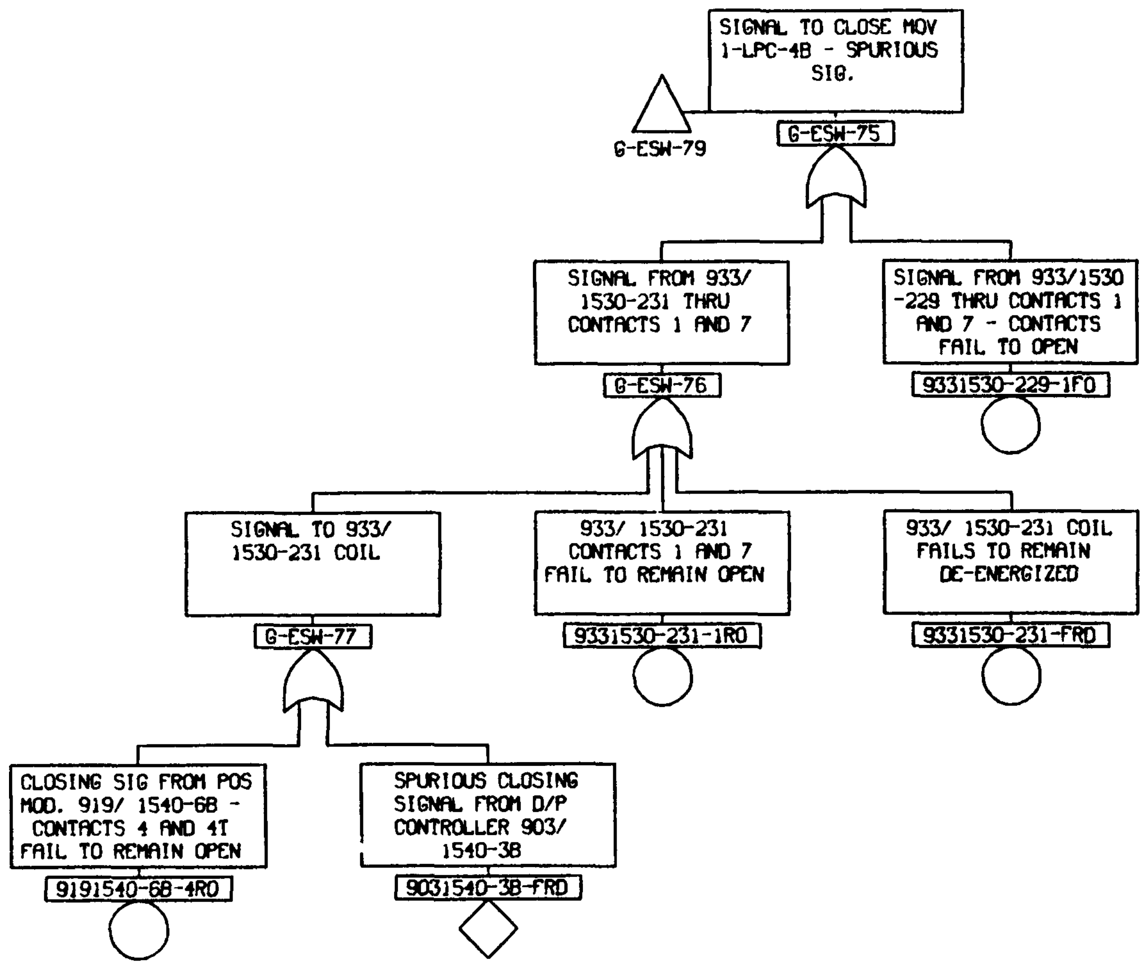

NO ESW FLOW THRU LPC M.O. PUMP D
G-ESW-67
G-ESW-66
L/O AC POWER TO BUS 14-E
G-AC-BUS-14E
2
PUMP D ACTUATION SYSTEM FAULTS
G-ESW-68
M.O. PUMP D FAILS TO START
LPC-D-MOP-FSR
M.O. PUMP D O.O.S. DUE TO TEST OR MAINT.
LPC-D-MOP-TOM
SIGNAL TO TRIP M.O. LPC PUMP D - SPURIOUS SIG.
G-ESW-69
NO SIGNAL TO START M.O. PUMP D
G-ESW-73

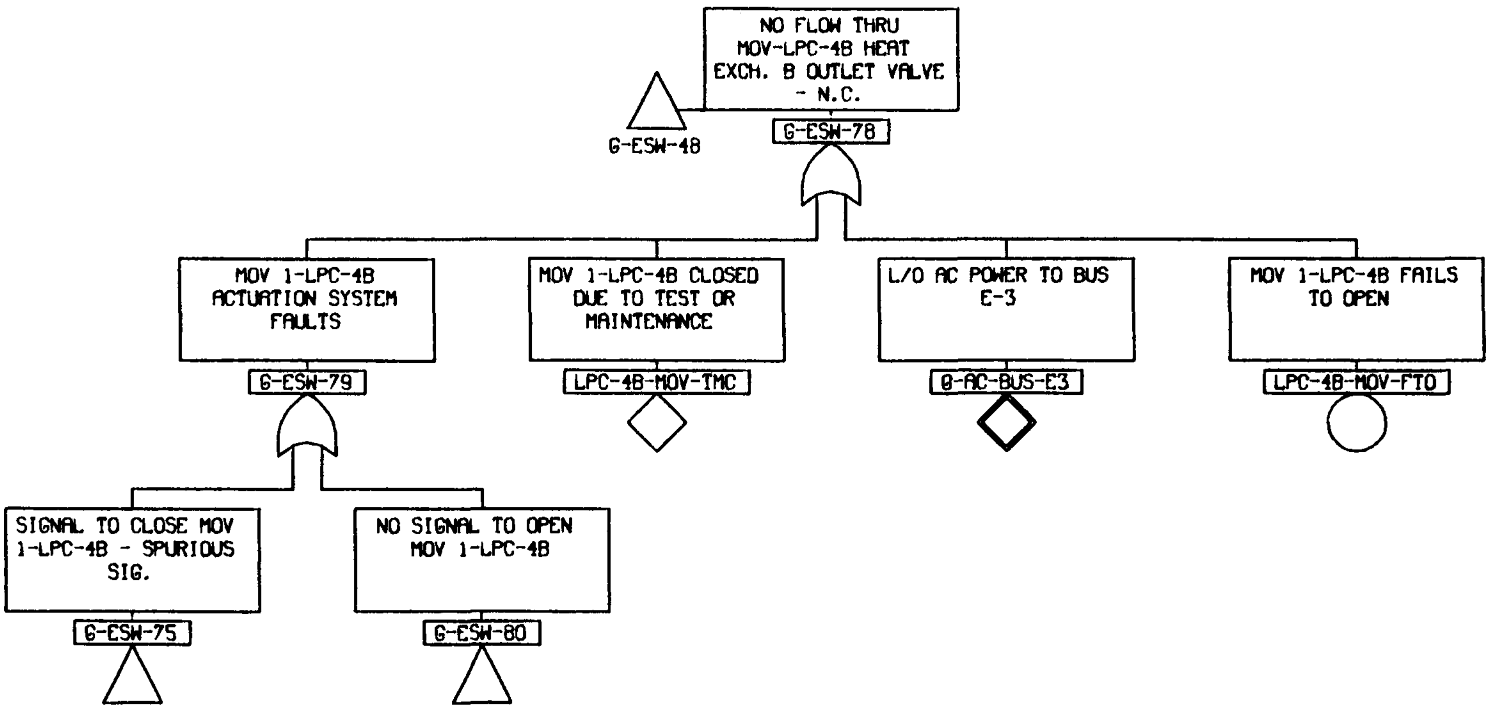

SIGNAL TO TRIP M.O. LPC PUMP D - SPURIOUS SIG.
G-ESW-69
G-ESW-68
SIGNAL FROM 933/ 1530-222 THRU CONTACTS 2 AND 8
G-ESW-72
SIGNAL FROM MAN. SW. 903/ 1530-302D THRU CONTACTS 3, 3T, 4, AND 4T
G-ESW-70
SIGNAL FROM MAN. OVERRIDE SW. 903/ 1530-318B CONTACTS 3 AND 4
G-ESW-62
933/ 1530-222 COIL FAILS TO REMAIN DE-ENERGIZED
9331530-222-FRD
2
933/ 1530-222 CONTACTS 2 AND 8 FAIL TO REMAIN OPEN
9331530-222-2RO
CONTACTS FAIL TO REMAIN OPEN
G-ESW-71
MAN. SWITCH 903/ 1530-302D FAILS
9031530-302D-FTE
2
OPERATOR PLACES 903/ 1530-302D IN STOP MODE
LPC-D-MOP-OSP
903/ 1530-302D CONTACTS 3 AND 3T FAIL TO REMAIN OPEN
9031530-302D-3RO
903/ 1530-302D CONTACTS 4 AND 4T FAIL TO REMAIN OPEN
9031530-302D-4RO


NO SIGNAL TO START M.O. PUMP D
G-ESW-73
G-ESW-68
L/O DC CONTROL POWER ON BUS 101B CIRCUIT NO. 9
G-DC-BUS-B-9
2
NO SIGNAL THRU MAN. SW. 903/ 1530-302D CONTACTS 1, 1T, 2, AND 2T
G-ESW-74
FAILURE OF BREAKER AT MCC 14-E CUB NO. 9
AC-14E-9-FTC
MAN. SWITCH 903/ 1530-302D FAILS
9031530-302D-FTE
2
903/ 1530-302D CONTACTS 1 AND 1T FAIL TO CLOSE
9031530-302D-1FC
903/ 1530-302D CONTACTS 2 AND 2T FAIL TO CLOSE
9031530-302D-2FC
OPERATOR FAILS TO PLACE MAN. SW. 903/ 1530-302D IN START MODE
LPC-D-MDP-OFS

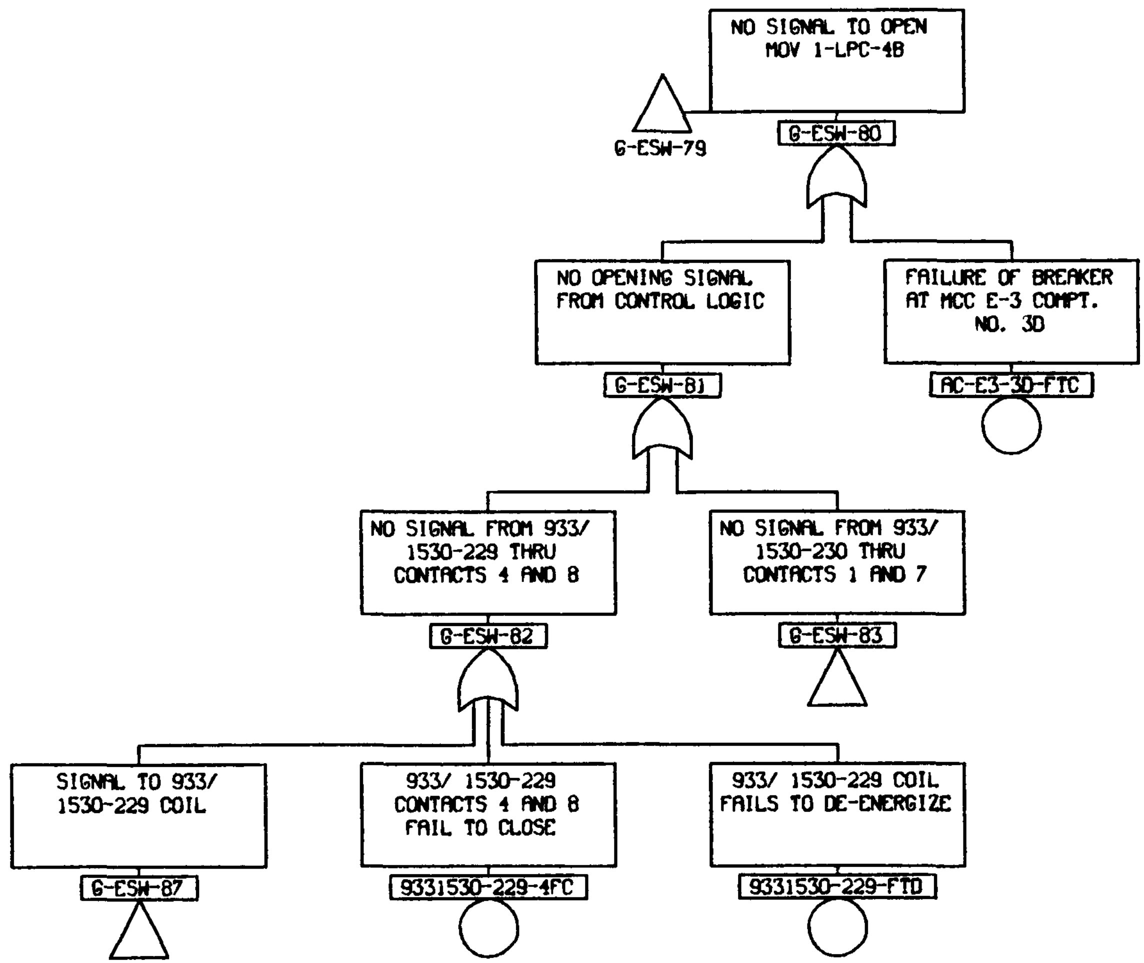
B.15-57

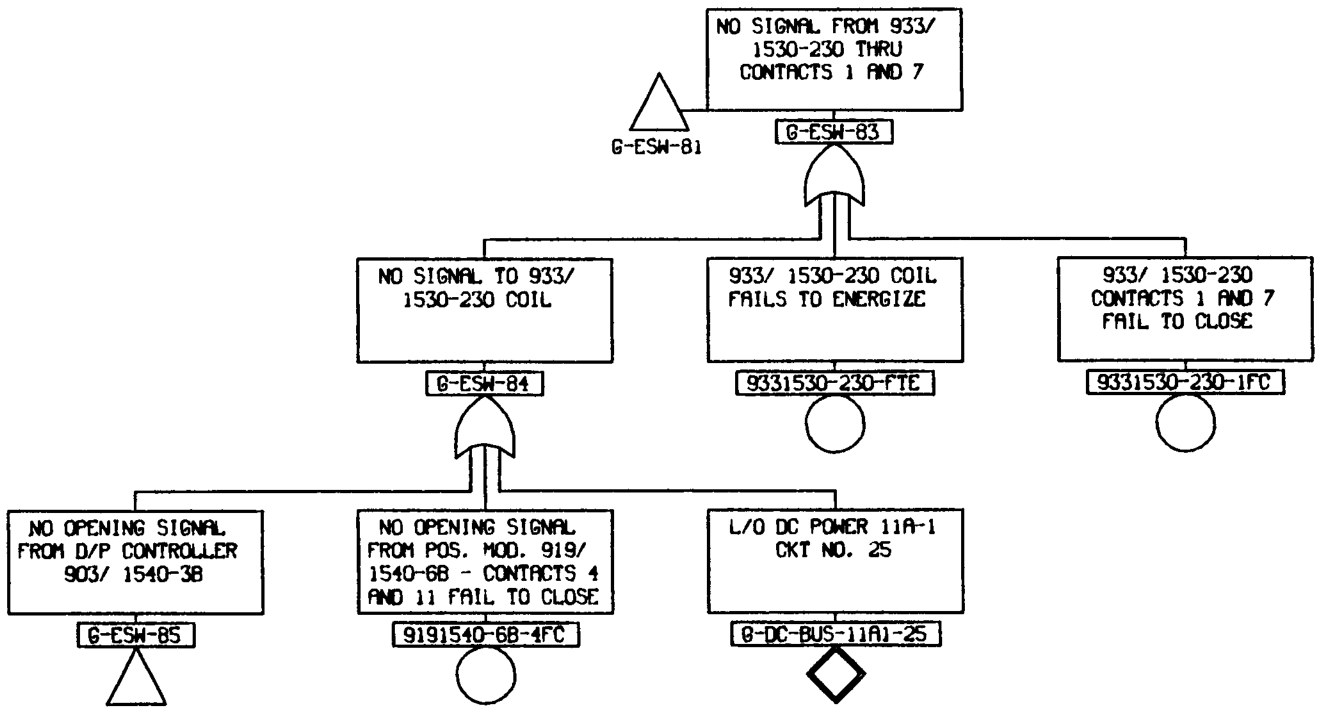
ESW-34

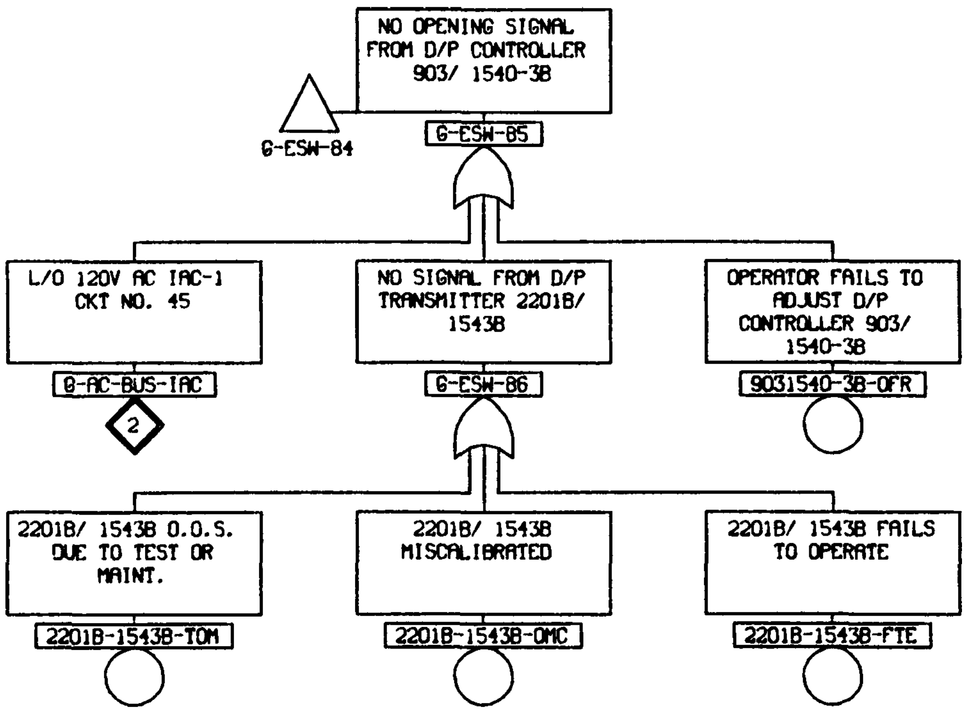

SIGNAL TO CLOSE MOV 1-LPC-4B - SPURIOUS SIG.
G-ESW-79
G-ESW-75
SIGNAL FROM 933/ 1530-231 THRU CONTACTS 1 AND 7
SIGNAL FROM 933/1530 -229 THRU CONTACTS 1 AND 7 - CONTACTS FAIL TO OPEN
G-ESW-76
9331530-229-1FO
SIGNAL TO 933/ 1530-231 COIL
933/ 1530-231 CONTACTS 1 AND 7 FAIL TO REMAIN OPEN
933/ 1530-231 COIL FAILS TO REMAIN DE-ENERGIZED
G-ESW-77
9331530-231-1RO
9331530-231-FRD
CLOSING SIG FROM POS MOD. 919/ 1540-6B - CONTACTS 4 AND 4T FAIL TO REMAIN OPEN
SPURIOUS CLOSING SIGNAL FROM D/P CONTROLLER 903/ 1540-3B
9191540-6B-4RO
9031540-3B-FRD

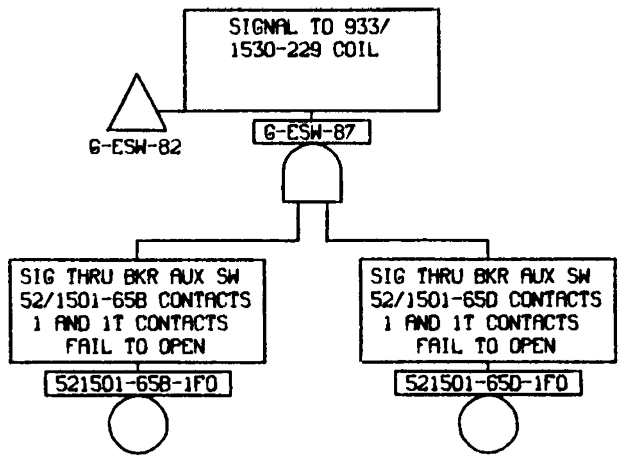


NO FLOW THRU MOV-LPC-4B HEAT EXCH. B OUTLET VALVE - N.C.
G-ESW-78
G-ESW-48
MOV 1-LPC-4B ACTUATION SYSTEM FAULTS
G-ESW-79
MOV 1-LPC-4B CLOSED DUE TO TEST OR MAINTENANCE
LPC-4B-MOV-TMC
L/O AC POWER TO BUS E-3
0-AC-BUS-E3
MOV 1-LPC-4B FAILS TO OPEN
LPC-4B-MOV-FTO
SIGNAL TO CLOSE MOV 1-LPC-4B - SPURIOUS SIG.
G-ESW-75
NO SIGNAL TO OPEN MOV 1-LPC-4B
G-ESW-80


NO SIGNAL TO OPEN MOV 1-LPC-4B
G-ESW-80
G-ESW-79
NO OPENING SIGNAL FROM CONTROL LOGIC
G-ESW-81
FAILURE OF BREAKER AT MCC E-3 COMPT. NO. 3D
AC-E3-3D-FTC
NO SIGNAL FROM 933/ 1530-229 THRU CONTACTS 4 AND 8
G-ESW-82
NO SIGNAL FROM 933/ 1530-230 THRU CONTACTS 1 AND 7
G-ESW-83
SIGNAL TO 933/ 1530-229 COIL
G-ESW-87
933/ 1530-229 CONTACTS 4 AND 8 FAIL TO CLOSE
9331530-229-4FC
933/ 1530-229 COIL FAILS TO DE-ENERGIZE
9331530-229-FTD


NO SIGNAL FROM 933/ 1530-230 THRU CONTACTS 1 AND 7
G-ESW-83
G-ESW-81
NO SIGNAL TO 933/ 1530-230 COIL
G-ESW-84
933/ 1530-230 COIL FAILS TO ENERGIZE
9331530-230-FTE
933/ 1530-230 CONTACTS 1 AND 7 FAIL TO CLOSE
9331530-230-1FC
NO OPENING SIGNAL FROM D/P CONTROLLER 903/ 1540-38
G-ESW-85
NO OPENING SIGNAL FROM POS. MOD. 919/ 1540-6B - CONTACTS 4 AND 11 FAIL TO CLOSE
9191540-6B-4FC
L/O DC POWER 11A-1 CKT NO. 25
G-DC-BUS-11A1-25


NO OPENING SIGNAL FROM D/P CONTROLLER 903/ 1540-3B
G-ESW-85
G-ESW-84
L/O 120V AC IAC-1 CKT NO. 45
B-AC-BUS-IAC
2
NO SIGNAL FROM D/P TRANSMITTER 2201B/ 1543B
G-ESW-86
OPERATOR FAILS TO ADJUST D/P CONTROLLER 903/ 1540-3B
9031540-3B-OFR
2201B/ 1543B O.O.S. DUE TO TEST OR MAINT.
2201B-1543B-TOM
2201B/ 1543B MISCALIBRATED
2201B-1543B-OMC
2201B/ 1543B FAILS TO OPERATE
2201B-1543B-FTE


SIGNAL TO 933/
1530-229 COIL
G-ESW-82
G-ESW-87
SIG THRU BKR AUX SW
52/1501-65B CONTACTS
1 AND 1T CONTACTS
FAIL TO OPEN
521501-65B-1FO
SIG THRU BKR AUX SW
52/1501-65D CONTACTS
1 AND 1T CONTACTS
FAIL TO OPEN
521501-65D-1FO

APPENDIX B.16

FIRE PROTECTION SYSTEM

B.16.1 Fire Protection System Description

B.16.1.1 Purpose

The purpose of the fire protection system (FPS) is to furnish water, in the event of fire, to remote points throughout the plant area. In addition, the FPS provides water to the isolation condenser makeup (ICMUP) system. In this study, the FPS is only considered for its ability to serve the ICMUP system.

B.16.1.2 Description and Configuration

The FPS, located between Units 1 and 2, consists of storage tanks, pumps, and the necessary piping to the fire fighting equipment. Figure B.16-1 shows a simplified piping schematic of the FPS.

Two water storage tanks provide water for the fire protection system. Each of the tanks has a capacity of 250,000 gallons and contains heating coils for freeze protection. The fire protection pumping system consists of two AC-driven pumps and one diesel driven pump. One of the AC driven pumps gets its AC power from Unit 1, the other from Unit 2. Each pump is activated by a signal from its own pressure switch, one of which is set at 85 psig with the other set at 95 psig. In the event both AC driven pumps fail to operate, the diesel driven pump is started by another pressure switch which is set at 75 psig and powered by the diesel battery. The diesel pump is started by its own set contained battery system which also maintains the battery through a charger runnning directly off the diesel. Both the electric and diesel-driven fire pumps deliver 2000 gpm at 100 psi discharge pressure, remaining in operation until they are manually shut down.

B.16.1.3 System Interfaces

System interfaces for the FPS are shown in table B.16-1.

B.16.1.4 Instrumentation and Control

Automatic actuation of the two motor-driven and dieseldriven pumps is performed by the use of three pressure switches set at 95 psig for pump P-82, 85 psig for pump M-7-6, and 75 psig for the diesel pump (M-7-7). Figure B.162 shows the simplified control wiring diagram of the two AC motordriven pumps.

As an example, in Figure B.16-2.1, the pressure switch PS-7-58 activates at 85 psig. This causes the closure of its contact, which in turn causes coil CR to become energized. Energizing coil CR causes the contacts of CR to close. This contact closure causes coil 42M to become energized, closing its contacts. Closure of the contacts on 42M initiates starting of the AC motor on pump M-7-6. It should be noted that closure of the contacts on CR will cause the circuit to become locked, and in order to stop the AC motor the operator has to use the push button switch to de-energize coil 42M.

Figure B.16-2.3 shows the simplified control wiring diagram for the diesel driven pump. The pressure switch PS-7-59 is set at 75 psig and will be actuated if the pressure goes below that setpoint. Actuation of PS-7-59 causes the actuation logic to provide a closure signal for both motor contacts 1 and 2. Closure of one of these contacts causes the corresponding battery to provide DC power for the starting motor. Just one of the batteries will provide sufficient power to cause the diesel to start.

B.16.1.5 Testing

The following tests are performed on a scheduled basis:

SP 680B Fire Pumps Auto Start Test

The pressure switch settings and fuel storage tank level are checked monthly. The MDPs and DDP are started and operated for 20 minutes.

SP 680G Daily Fire Protection System Fire Tank Water Level Check

The fire tank water level is checked daily.

SP 680K Diesel Fire Pump Fuel Oil Sample

Fuel oil viscosity and water sediment content are checked quarterly.

SP 680M Annual Fire Protection System Fire Pumps Flow Rate Test

The flow capabilities of the fire pumps, electric and diesel, are determined annually.

SP 788.3 Fire Pump Diesel Engine Batteries -- Weekly Surveillance

The electrolyte level and voltage of the fire pump diesel engine batteries are checked weekly.

B.16.1.6 Maintenance

There is no routinely scheduled maintenance for the FPS. Maintenance is performed on an as-needed basis.

B.16.1.7 Technical Specifications

The following are limiting conditions for operation:

1) The fire protection system shall be operable at all times with three high pressure pumps having a flow capacity of 1,800 gpm each, two water supplies of 200,000 gallons each, and a flow path capable of transferring water from the fire water tanks to the ICMUP system.

2) When one pump and/or one water supply becomes inoperable, it must be restored to operable status within 7 days, or else other means of redundancy are to be provided.

3) With two pumps inoperable, a continuous fire watch is established with backup fire suppression equipment for the turbine building within 1 hour; the FPS must be restored within 14 days.

B.16.1.8 Operation

Under normal operation, all pumps are in the OFF position and all valves are open. If the FPS line pressure drops, the motor-driven pump set at 95 psig will start first and, in case of failure, the second MDP's set at 85 psig will start to run. Finally, if both MDP fail, the diesel-driven pump will start at 75 psig. These pumps must be manually shut down, as described in the Instrumentation and Control section.

B.16.2 Analysis

B.16.2.1 Success/Failure Criteria

Water must be supplied in the FPS ring header adjacent to valve FIRE-47, the intake to the ICMUP system.

B.16.2.2 Assumptions

The effect of a jockey pump to maintain pressure in the FPS in the normal operation is not considered. Also, no credit is taken for the city water supply to the 200,000 gallon water storage tank.

Table B.16-1

FPS Interfaces Failure Modes and Effects

Primary System			Support System			Failure Mode	Fault Effect
System	Div.	Comp.	System	Div.	Comp.		
FPS	-	Pump M7-6	AC Pwr		MCC-CD6	Zero or low voltage	Pump does not start or stops running
FPS	-	Pump P-82	AC Pwr	Unit 2	-		

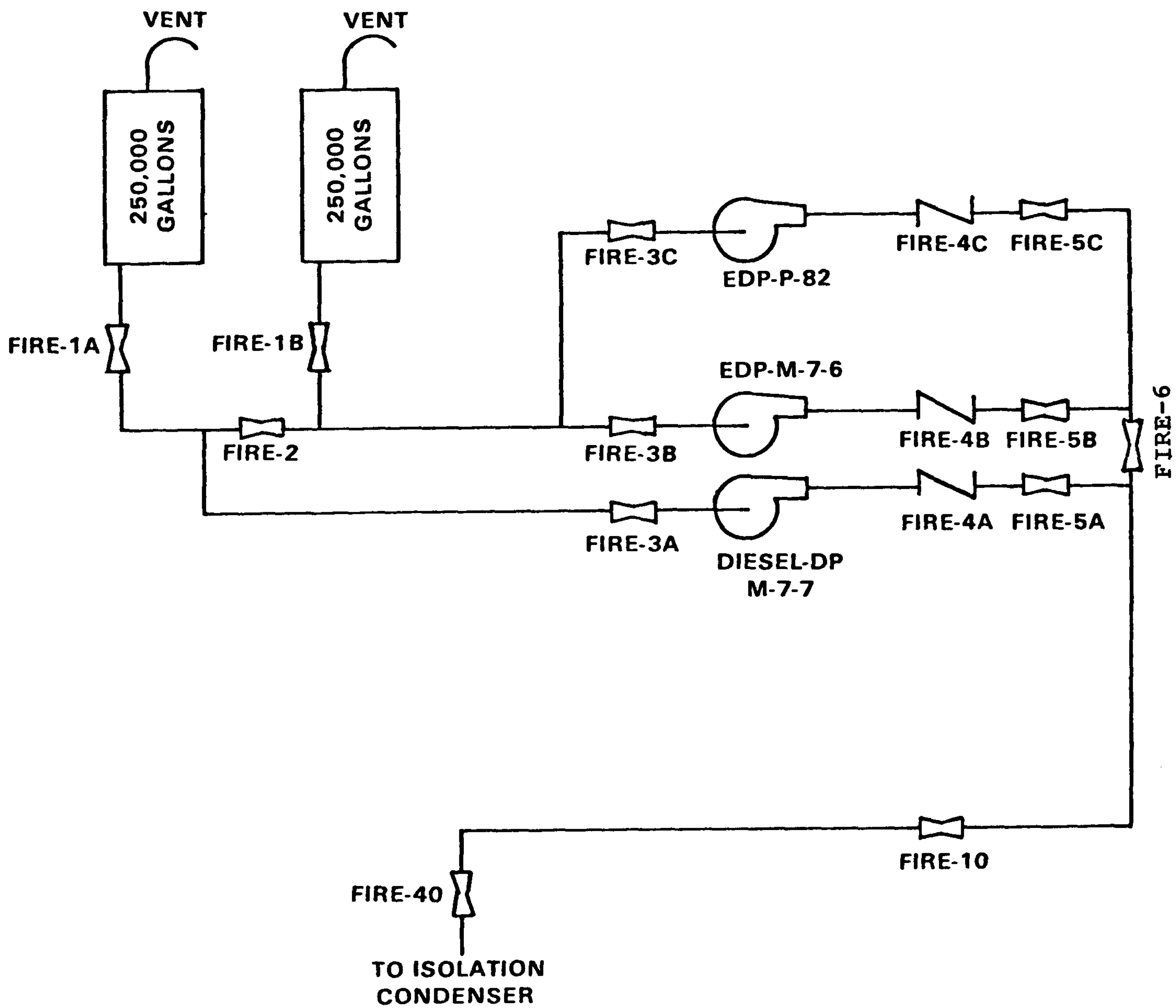


FIGURE B.16-1. SIMPLIFIED FIRE PROTECTION SYSTEM DIAGRAM

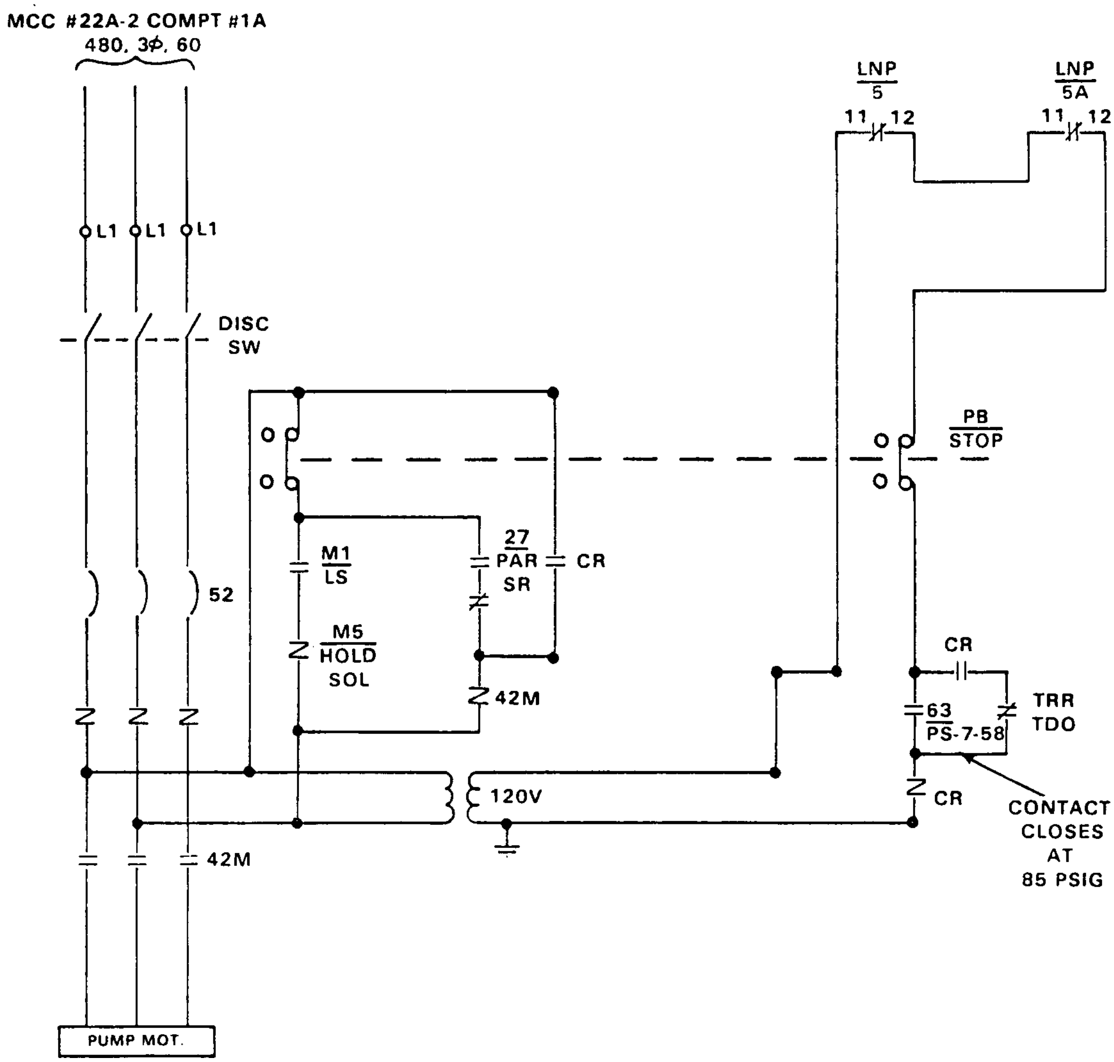


FIGURE B.16-2. CONTROL WIRE SCHEMATICS ELECTRIC DRIVEN PUMP M-7-8 (SHEET 1 OF 3)

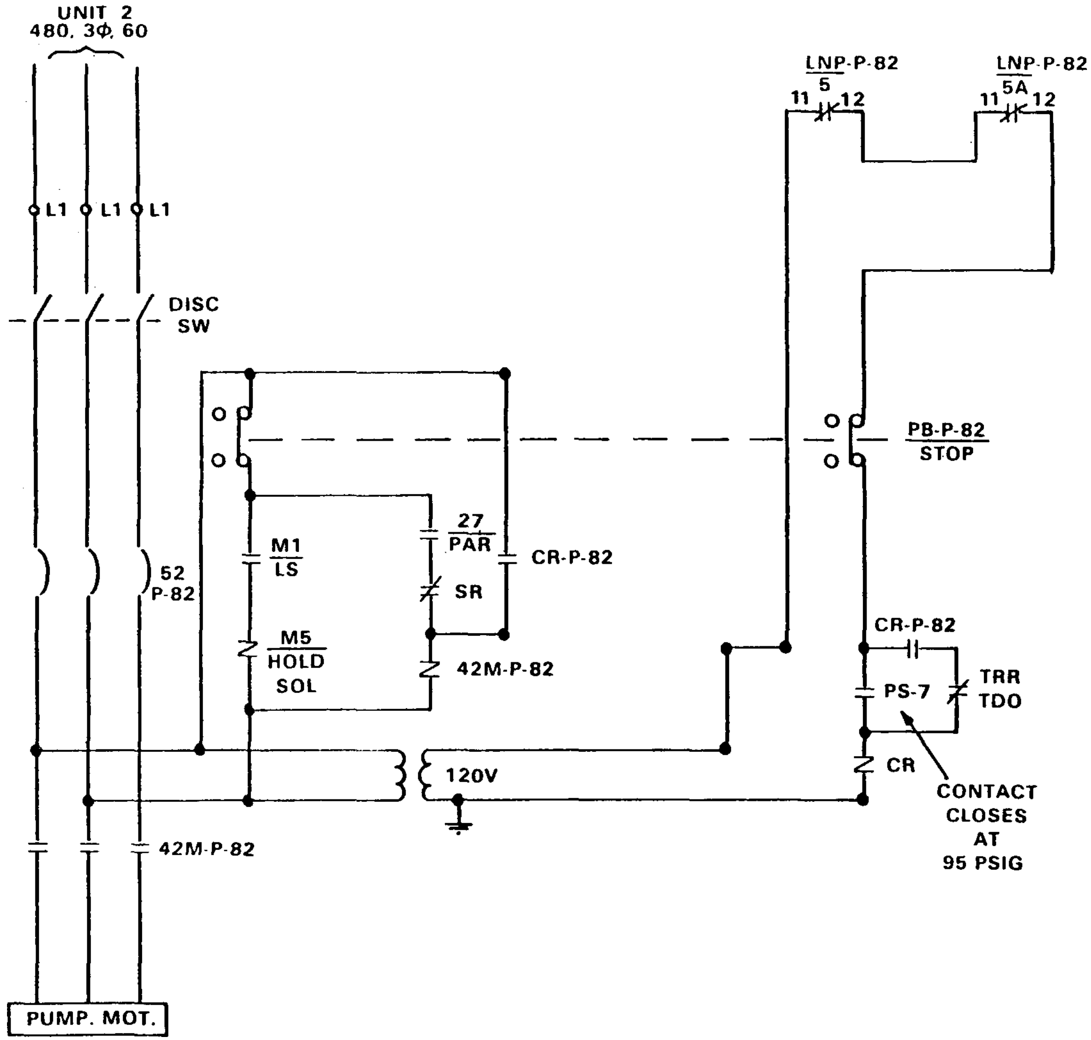


FIGURE B.16-2. CONTROL WIRE SCHEMATICS ELECTRIC DRIVEN PUMP P-82 (SHEET 2 OF 3)

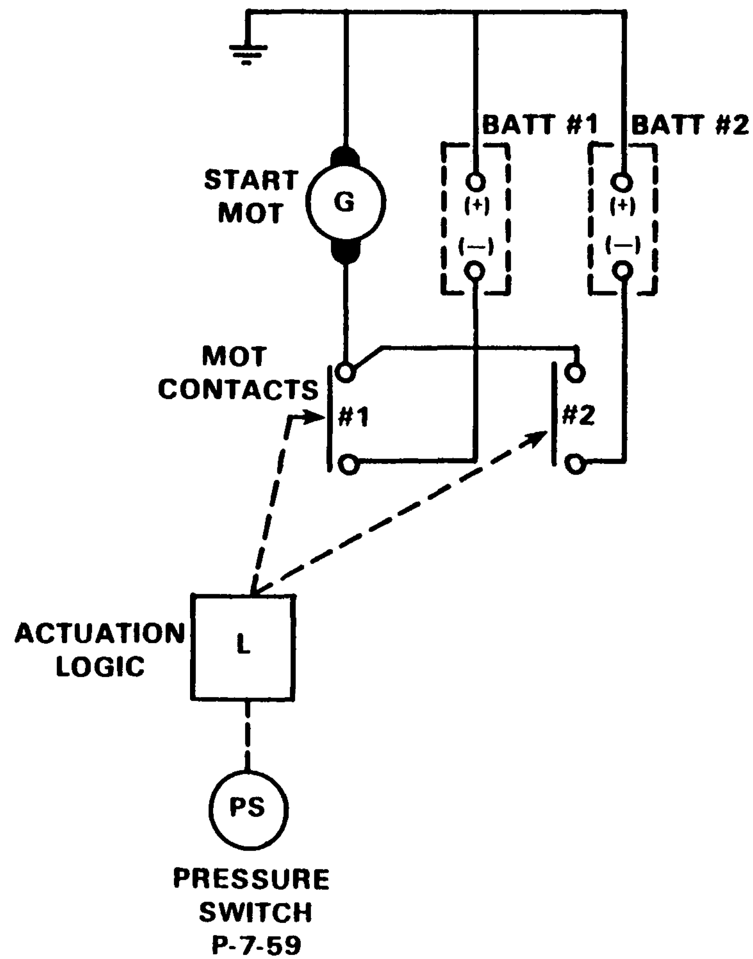


FIGURE B.16-2. CONTROL WIRE SCHEMATIC DIESEL DRIVEN FIRE PUMP M-7-7 & BATTERY CHARGES (SHEET 3 OF 3)

FIRE PROTECTION SYSTEM

FAULT TREE AND FAULT SUMMARY SHEETS

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
FIRE-4B-CKV-FTO FIRE-4A-CKV-FTO FIRE-4C-CKV-FTO	Check valve fails to open on demand	12000 hrs (detection is during fueling outage)	Valves must open stuck closed is failure mode	1.8E-3
FIRE-P-82-MDP-FSR FIRE-6-MDP-FSR	Local faults of motor driven pumps M7-6 and P-82	One month	R82 is unit #2 fire pump. SP 680K is flow rate test; SP 680B, pump test, is performed monthly	1.7E-3
FIRE-P82-MDP-TOM FIRE-6-MDP-TOM	Motor driven pump is out of service for test or maintenance	One month	P-82 test is performed based on unit #2 procedure	1.0E-3
FIRE-7-DDP-TOM	Diesel driven pump is out of service due to test or maintenance	One month	Maintenance is performed on an as needed basis	1.0E-3
FIRE-6B-TNK-NWTR FIRE-6A-TNK-NWTR	No water in the tanks	Water level is checked daily	SP-680G is performed as a daily check of the tank water level	0
FIRE-6B-TNK-TOM FIRE-6A-TNK-TOM	Tanks are out for test or maintenance	12000 hrs (Tested during refueling outage)	Tanks are tested individually in a staggered basis	0

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
FIRE-00-SMT-LOF	Diesel starting motor fails to start	One month	Pump start test SP 680B is performed monthly	5.4E-4
LCL-FIRE-DLG-LOF	Failure of actuation system	12000 hrs (detection is during refueling outage)	The entire actuation system, coils and contact pairs, are considered in this failure event	1E-3
LCL-FIRE-PBP-OFR LCL-FIRE-PB-OFR	Pump push button switch open due to human error (switch not reset)	One month	Monthly pump tests indirectly test these switches	0
926LNP-5-BFC 926LNP-5A-BFC	LNP and LNP 5 5A contract pair open	12000 hrs (detection is during refueling outage)		1.8E-3
FIRE-6B-TNK-LOF FIRE-6A-TNK-LOF	Local fauls in tank 6A and 6B	Tanks are checked daily	-200,000 gallon tanks -Failures are due to cracks and massive breaks in the tanks	0
FIRE-6B-TNK-HEAT FIRE-6A-TNK-HEAT	Water in the tank is frozen	Freeze protection system is checked but not on a regulator schedule	Form SP 680D is used	1.0×10^{-4}

MILLSTONE 1
SYSTEM FPS
SHEET #2

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
FIRE-40-XV-FRO FIRE-10-XV-FRO FIRE-6-XV-FRO FIRE-5B-XV-FRO FIRE-5A-XV-FRO FIRE-5C-XV-FRO FIRE-3A-XV-FRO FIRE-2-XV-FRO FIRE-3C-XV-FRO FIRE-3B-XV-FRO FIRE-1A-XV-FRO FIRE-1B-XV-FRO	Normally open manual valves fail to remain open	12000 hrs (detected during refueling outage)	Values will be used for repair on the components of the fire protection system	3E-4
FIRE-40-XV-TOM FIRE-10-XV-TOM FIRE-6-XV-TOM FIRE-5B-XV-TOM FIRE-5A-XV-TOM	Normally open manual valve closed for test or main-	Valve position checked weekly	SP-680A form completed weekly (valve lineup check)	3.3E-6
FIRE-5C-XV-TOM FIRE-3A-XV-TOM FIRE-2-XV-TOM FIRE-3C-XV-TOM FIRE-3B-XV-TOM FIRE-1A-XV-TOM FIRE-1B-XV-TOM	Normally open manual valve closed for test or maintenance	12000 hrs (detected during refueling outage)	Valves closed for maintenance on other system components	3.3E-6
AC-CD6-1A-FTC AC-unit #2	Circuit breaker fails to close on demand	One month	SP 680B (pump start test) performed monthly tests these breakers	1E-3

MILLSTONE 1
SYSTEM FPS
SHEET #3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
LCL-FIRE-P59-FTC LCLPS-758-FTC LCLPS-7301-FTC	Pressure switch fails to close	One month	Switches are calibrated annually SP 680-B, performed monthly, checks these switches	1.4E-4
LCLPS-7301-TOM LCLPS-758-TOM	Pressure switch is being tested or left in test mode	One month	SP 680-B is performed monthly	1E-2
LCLPS-7301-OMC LCLPS-758-OMC	Pressure switch mispositioned	One month	SP 680-B is performed monthly	1E-3
LCL-FIRE-PBP-FTC LCL-FIRE-PB-FTC	Push button switch fails to close on demand	One month	SP 680-B is performed monthly and indirectly tests these switches	1E-5
LCL-FIRE-42M-FTC	Contactor 42M fails to close	One month	SP 680-B is performed monthly and indirectly checks this contactor	1E-4
LCL-FIRE-P82-FTE LCL-FIRE-42M-FTE	Relay coil fails to energize	One month	SP 680-B, performed monthly, indirectly tests these coils	1E-4
LCL-FIRE-CRP-FTE LCL-FIRE-CR-FTE	Relay coil fails to energize	One month	SP 680-B, performed monthly, indirectly tests these coils	1E-4

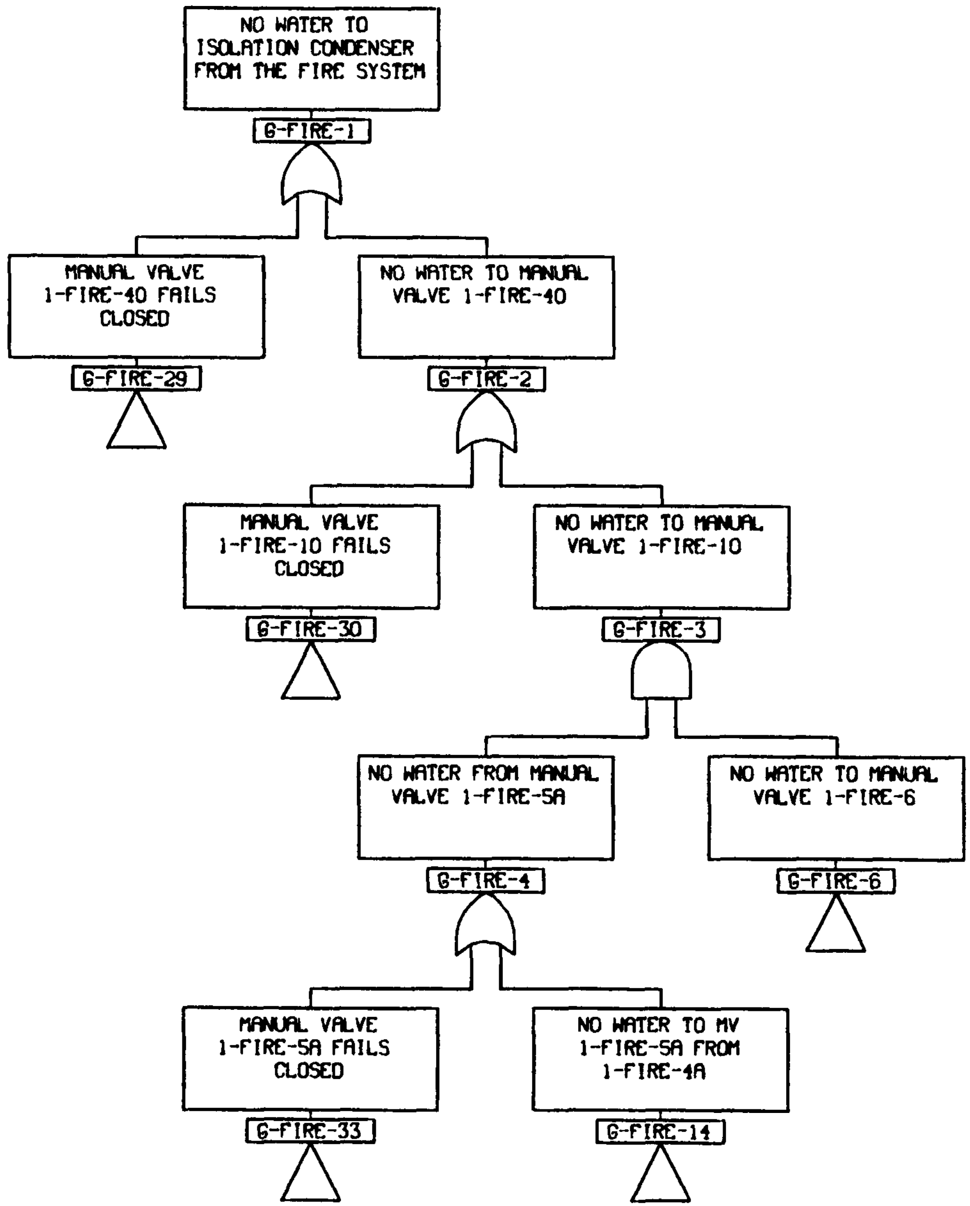
MILLSTONE 1
SYSTEM FPS
SHEET #4

FAULT SUMMARY SHEETS

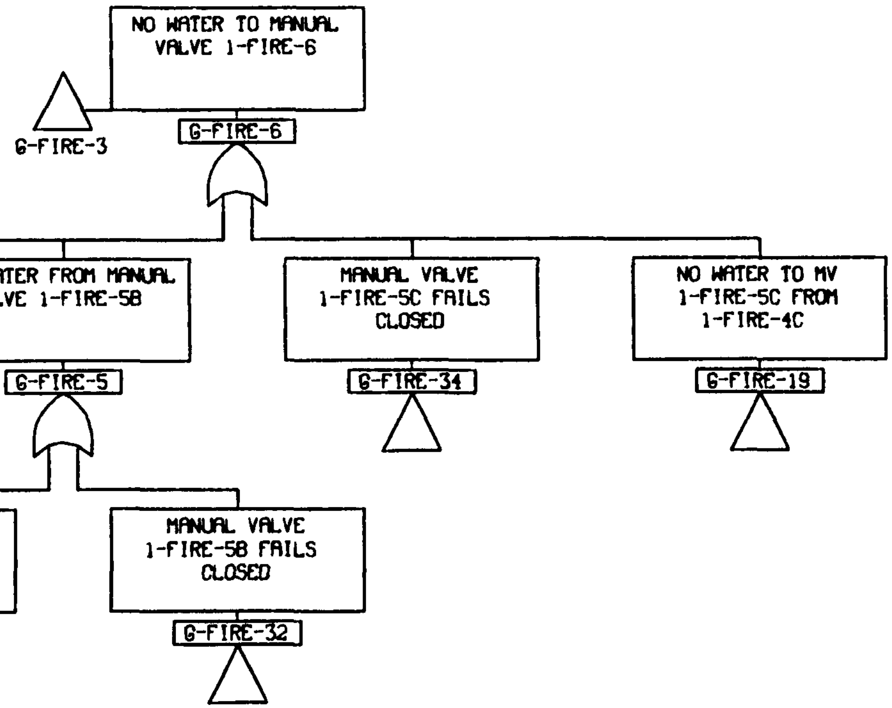
EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
LCL-FIRE-CRP-FTC LCL-FIRE-CR-FTC	Contacts fail to close	One month	SP 680B, performed monthly, indirectly tests these contacts	1E-4
LCL-FIRE-1-1FC LCL-FIRE-2-2FC	Diesel start contacts fail to close	One month	SP 680-B is performed monthly and indirectly tests these contacts	1E-4
LCL-1-BAT-LOF LCL-2-BAT-LOF	Battery local faults	One month	SP 788.3 battery check is performed weekly. SP 788.4--quarterly test	2.5E-4
FIRE-7-DDP-FSR	Diesel driven pump M7-7 fails to start or run	One month	SP 680B pump start test performed monthly	1.7E-3

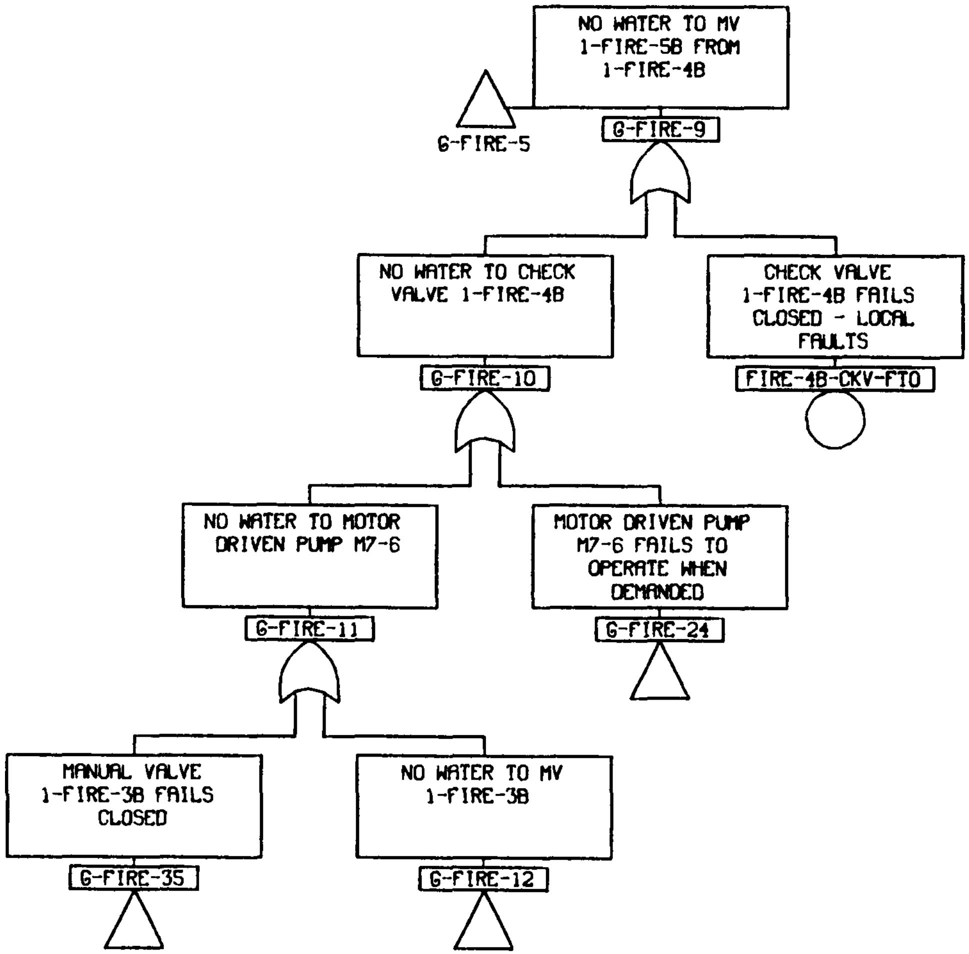
FPS FAULT TREE PAGE INDEX

GATE NAME	DEFINED ON PAGE	TRANSFERS TO PAGE(S)
G-FIRE-1	FIRE-1	--
G-FIRE-6	FIRE-2	FIRE-1
G-FIRE-9	FIRE-3	FIRE-2
G-FIRE-12	FIRE-4	FIRE-3
G-FIRE-14	FIRE-5	FIRE-1
G-FIRE-17	FIRE-6	FIRE-5
G-FIRE-19	FIRE-7	FIRE-2
G-FIRE-22	FIRE-8	FIRE-7
G-FIRE-24	FIRE-9	FIRE-3
G-FIRE-25	FIRE-10	FIRE-4,FIRE-6,FIRE-8
G-FIRE-26	FIRE-11	FIRE-4,FIRE-6,FIRE-8
G-FIRE-27	FIRE-12	FIRE-7
G-FIRE-28	FIRE-12	FIRE-5
G-FIRE-29	FIRE-13	FIRE-1
G-FIRE-30	FIRE-13	FIRE-1
G-FIRE-31	FIRE-14	FIRE-2
G-FIRE-32	FIRE-14	FIRE-2
G-FIRE-33	FIRE-14	FIRE-1
G-FIRE-34	FIRE-14	FIRE-2
G-FIRE-35	FIRE-15	FIRE-3
G-FIRE-36	FIRE-15	FIRE-4,FIRE-6,FIRE-8
G-FIRE-37	FIRE-15	FIRE-7
G-FIRE-38	FIRE-15	FIRE-5
G-FIRE-39	FIRE-16	FIRE-11
G-FIRE-40	FIRE-16	FIRE-10
G-FIRE-41	FIRE-17	FIRE-9
G-FIRE-44	FIRE-18	FIRE-17
G-FIRE-47	FIRE-19	FIRE-18
G-FIRE-50	FIRE-20	FIRE-12
G-FIRE-53	FIRE-21	FIRE-20
G-FIRE-56	FIRE-22	FIRE-21
G-FIRE-59	FIRE-23	FIRE-12
G-FIRE-62	FIRE-24	FIRE-23

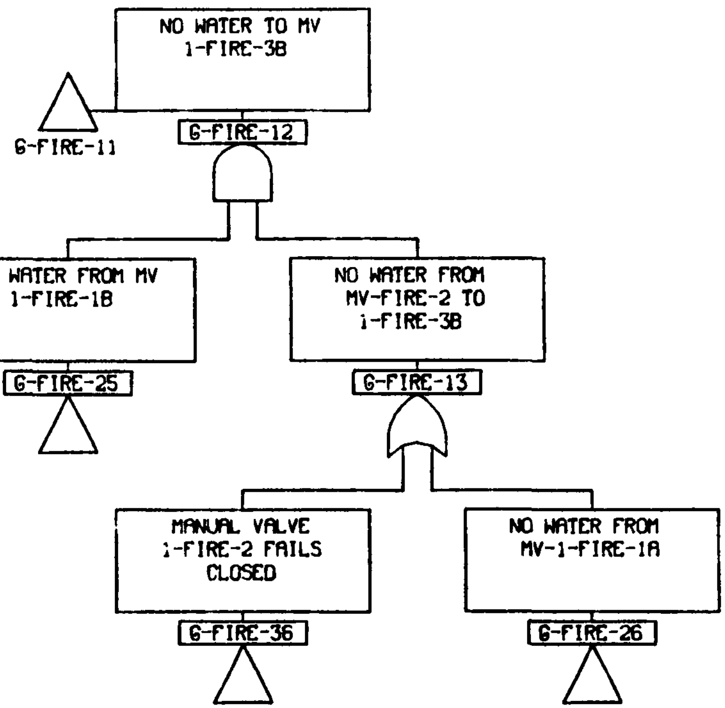

NO WATER TO ISOLATION CONDENSER FROM THE FIRE SYSTEM
G-FIRE-1
MANUAL VALVE 1-FIRE-40 FAILS CLOSED
G-FIRE-29
NO WATER TO MANUAL VALVE 1-FIRE-40
G-FIRE-2
MANUAL VALVE 1-FIRE-10 FAILS CLOSED
G-FIRE-30
NO WATER TO MANUAL VALVE 1-FIRE-10
G-FIRE-3
NO WATER FROM MANUAL VALVE 1-FIRE-5A
G-FIRE-4
NO WATER TO MANUAL VALVE 1-FIRE-6
G-FIRE-6
MANUAL VALVE 1-FIRE-5A FAILS CLOSED
G-FIRE-33
NO WATER TO MV 1-FIRE-5A FROM 1-FIRE-4A
G-FIRE-14

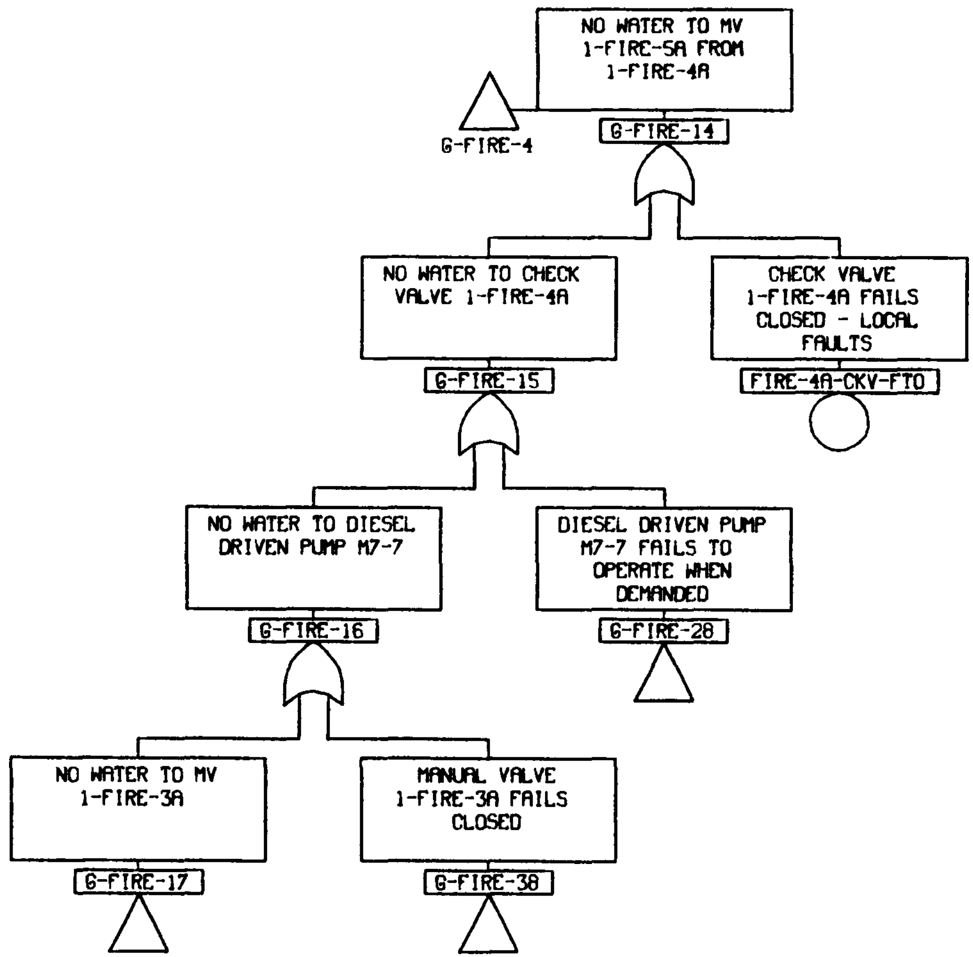
FIRE-1


NO WATER TO MANUAL VALVE 1-FIRE-6
G-FIRE-6
G-FIRE-3
MANUAL VALVE 1-FIRE-6 FAILS CLOSED
G-FIRE-31
NO WATER FROM MANUAL VALVE 1-FIRE-5B
G-FIRE-5
MANUAL VALVE 1-FIRE-5C FAILS CLOSED
G-FIRE-34
NO WATER TO MV 1-FIRE-5C FROM 1-FIRE-4C
G-FIRE-19
NO WATER TO MV 1-FIRE-5B FROM 1-FIRE-4B
G-FIRE-9
MANUAL VALVE 1-FIRE-5B FAILS CLOSED
G-FIRE-32

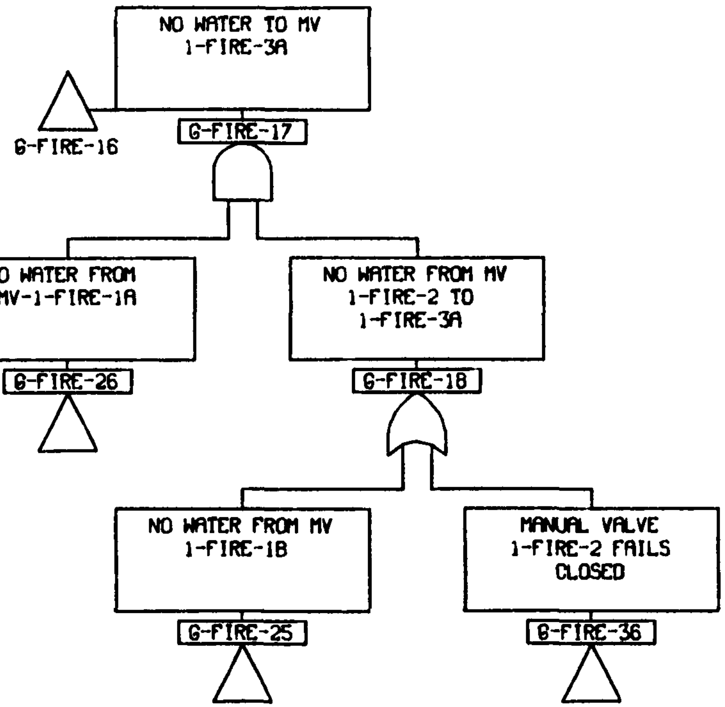

NO WATER TO MV 1-FIRE-5B FROM 1-FIRE-4B
G-FIRE-9
G-FIRE-5
NO WATER TO CHECK VALVE 1-FIRE-4B
G-FIRE-10
CHECK VALVE 1-FIRE-4B FAILS CLOSED - LOCAL FAULTS
FIRE-4B-CKV-FTO
NO WATER TO MOTOR DRIVEN PUMP M7-6
G-FIRE-11
MOTOR DRIVEN PUMP M7-6 FAILS TO OPERATE WHEN DEMANDED
G-FIRE-24
MANUAL VALVE 1-FIRE-3B FAILS CLOSED
G-FIRE-35
NO WATER TO MV 1-FIRE-3B
G-FIRE-12

FIRE-3

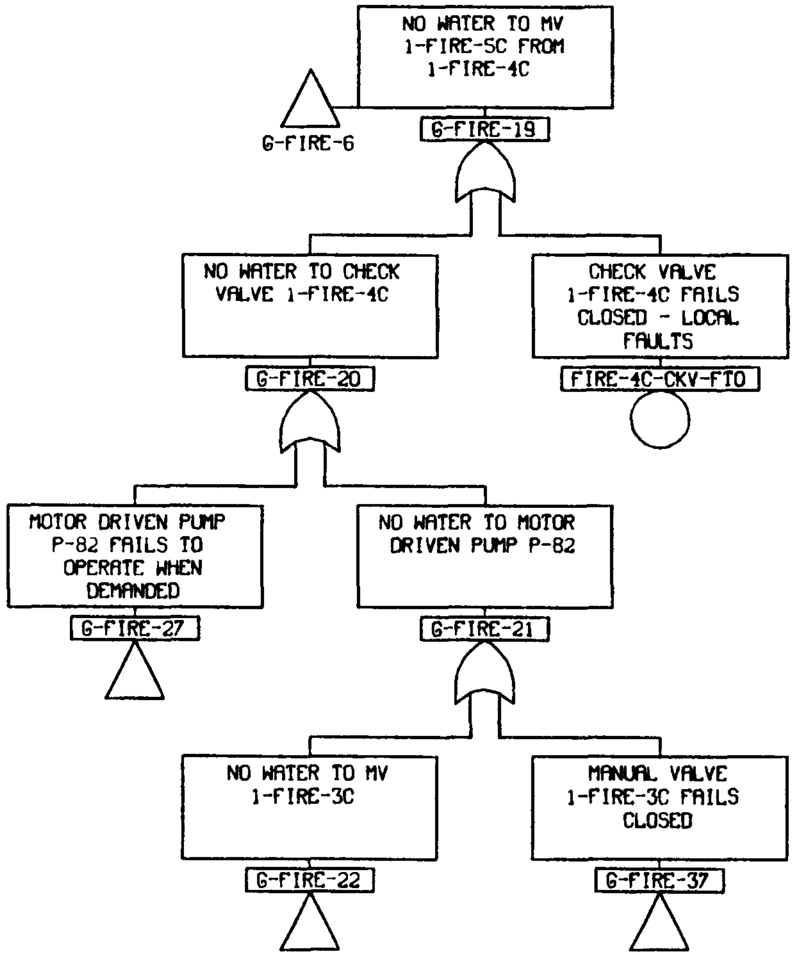

NO WATER TO MV 1-FIRE-3B
G-FIRE-11
G-FIRE-12
NO WATER FROM MV 1-FIRE-1B
NO WATER FROM MV-FIRE-2 TO 1-FIRE-3B
G-FIRE-25
G-FIRE-13
MANUAL VALVE 1-FIRE-2 FAILS CLOSED
NO WATER FROM MV-1-FIRE-1A
G-FIRE-36
G-FIRE-26

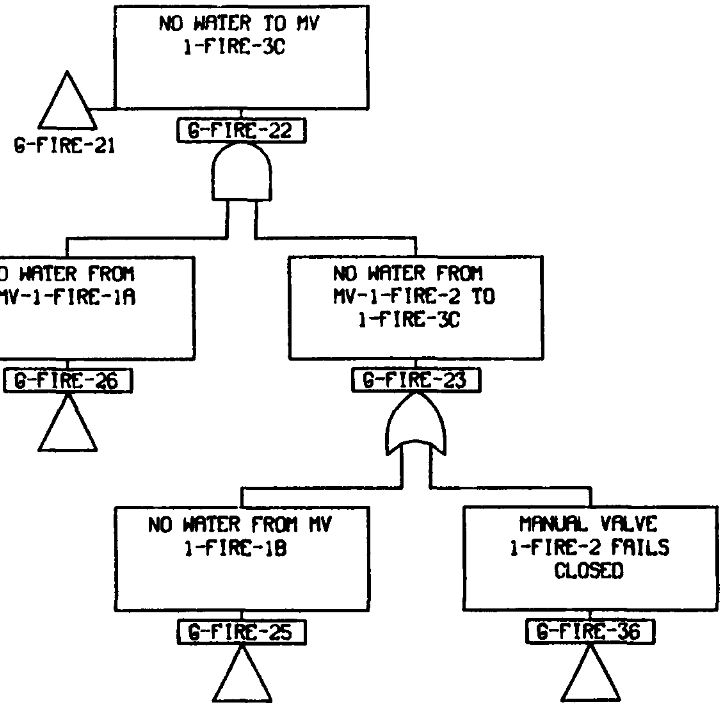

NO WATER TO MV 1-FIRE-5A FROM 1-FIRE-4A
G-FIRE-14
G-FIRE-4
NO WATER TO CHECK VALVE 1-FIRE-4A
G-FIRE-15
CHECK VALVE 1-FIRE-4A FAILS CLOSED - LOCAL FAULTS
FIRE-4A-CKV-FTO
NO WATER TO DIESEL DRIVEN PUMP M7-7
G-FIRE-16
DIESEL DRIVEN PUMP M7-7 FAILS TO OPERATE WHEN DEMANDED
G-FIRE-28
NO WATER TO MV 1-FIRE-3A
G-FIRE-17
MANUAL VALVE 1-FIRE-3A FAILS CLOSED
G-FIRE-38

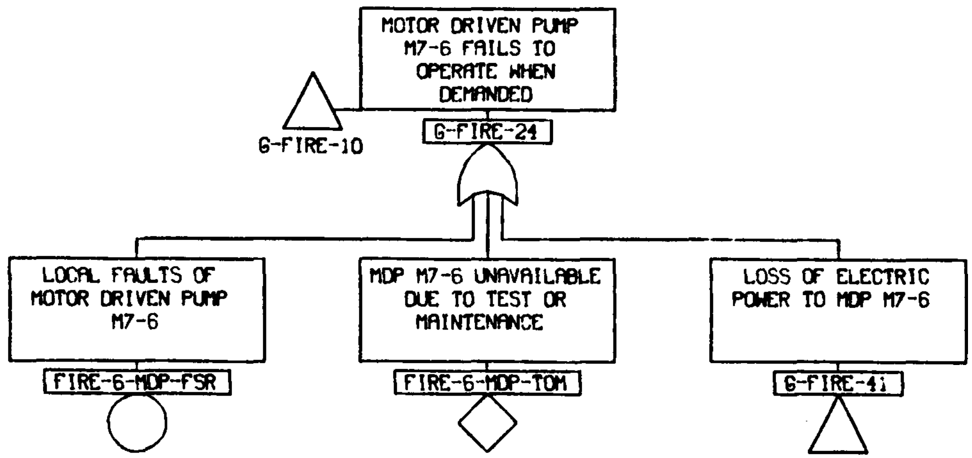
FIRE-5

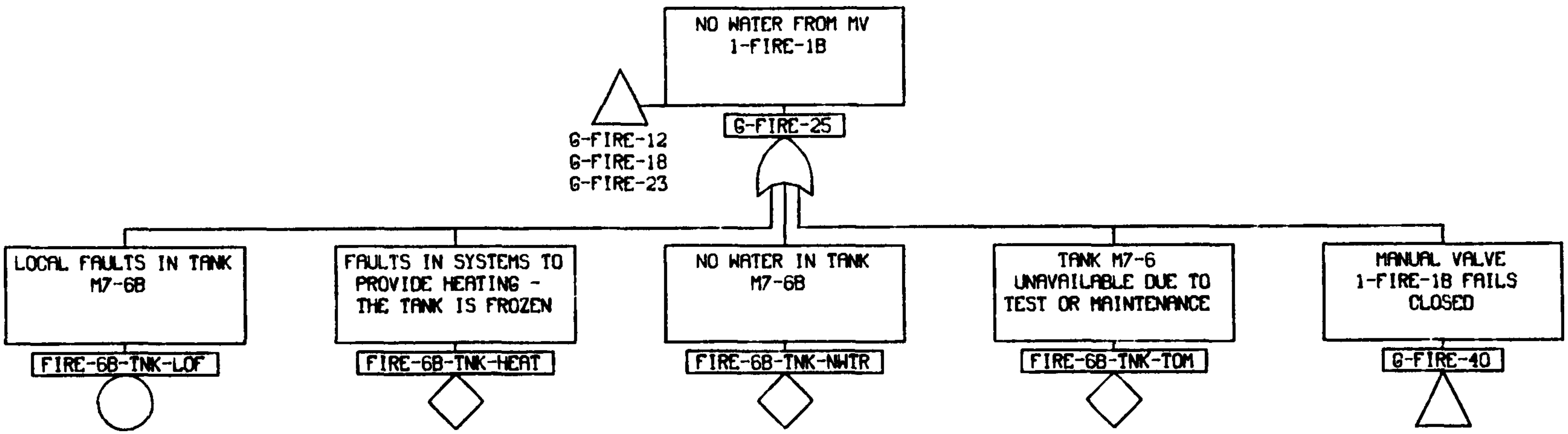

NO WATER TO MV 1-FIRE-3A
G-FIRE-17
G-FIRE-16
NO WATER FROM MV-1-FIRE-1A
G-FIRE-26
NO WATER FROM MV 1-FIRE-2 TO 1-FIRE-3A
G-FIRE-18
NO WATER FROM MV 1-FIRE-1B
G-FIRE-25
MANUAL VALVE 1-FIRE-2 FAILS CLOSED
G-FIRE-36

FIRE-6

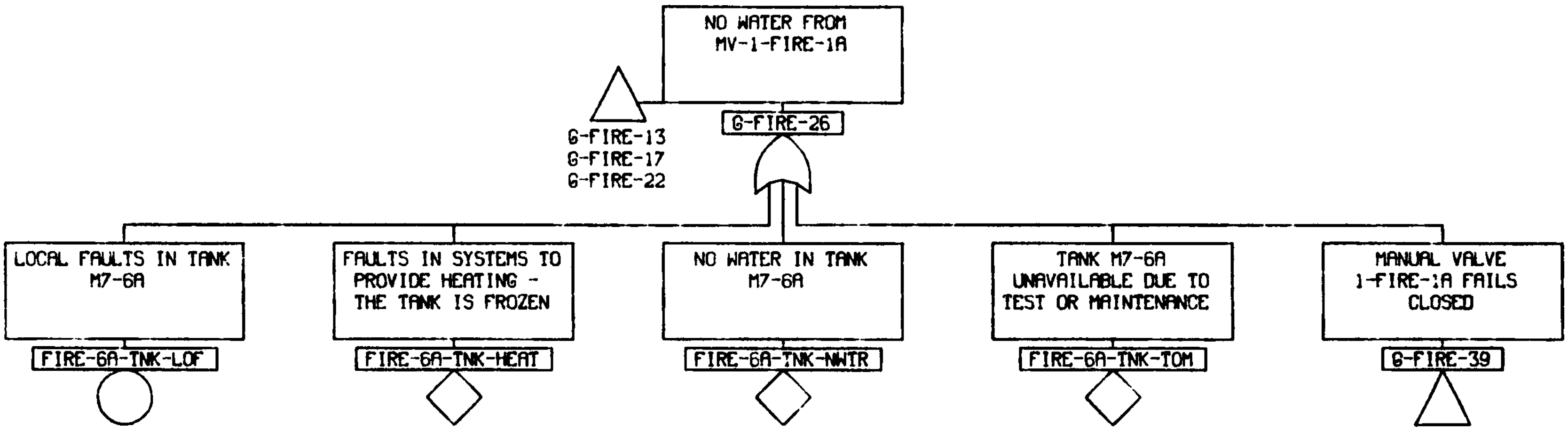

NO WATER TO MV 1-FIRE-5C FROM 1-FIRE-4C
G-FIRE-19
G-FIRE-6
NO WATER TO CHECK VALVE 1-FIRE-4C
G-FIRE-20
CHECK VALVE 1-FIRE-4C FAILS CLOSED - LOCAL FAULTS
FIRE-4C-CKV-FTO
MOTOR DRIVEN PUMP P-82 FAILS TO OPERATE WHEN DEMANDED
G-FIRE-27
NO WATER TO MOTOR DRIVEN PUMP P-82
G-FIRE-21
NO WATER TO MV 1-FIRE-3C
G-FIRE-22
MANUAL VALVE 1-FIRE-3C FAILS CLOSED
G-FIRE-37

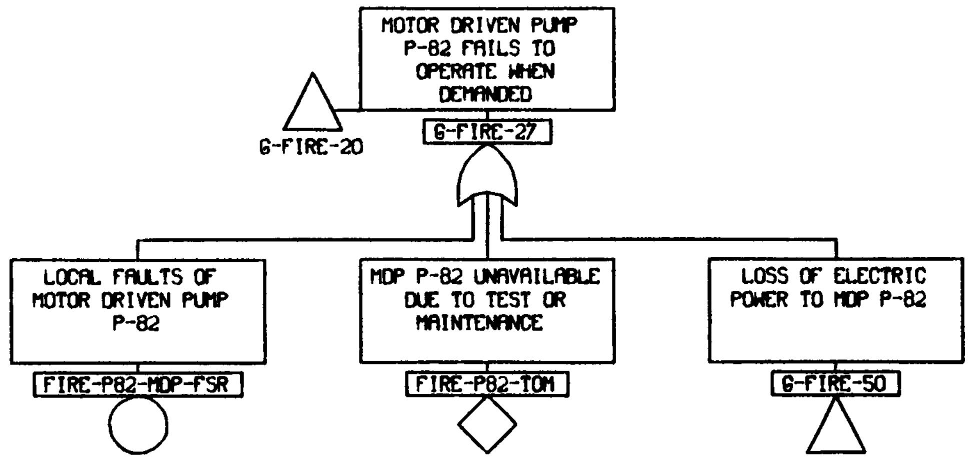

NO WATER TO MV
1-FIRE-3C
G-FIRE-21
G-FIRE-22
NO WATER FROM
MV-1-FIRE-1A
G-FIRE-26
NO WATER FROM
MV-1-FIRE-2 TO
1-FIRE-3C
G-FIRE-23
NO WATER FROM MV
1-FIRE-1B
G-FIRE-25
MANUAL VALVE
1-FIRE-2 FAILS
CLOSED
G-FIRE-36

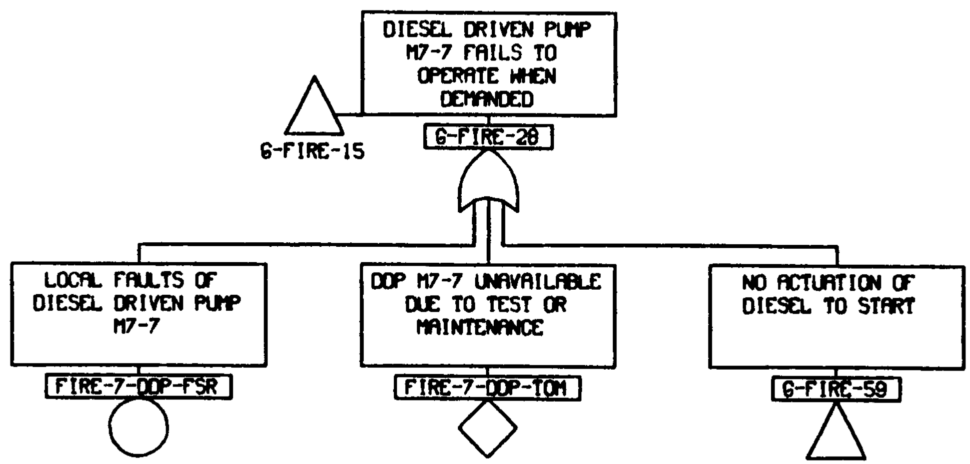

MOTOR DRIVEN PUMP M7-6 FAILS TO OPERATE WHEN DEMANDED
G-FIRE-24
G-FIRE-10
LOCAL FAULTS OF MOTOR DRIVEN PUMP M7-6
FIRE-6-MDP-FSR
MDP M7-6 UNAVAILABLE DUE TO TEST OR MAINTENANCE
FIRE-6-MDP-TOM
LOSS OF ELECTRIC POWER TO MDP M7-6
G-FIRE-41

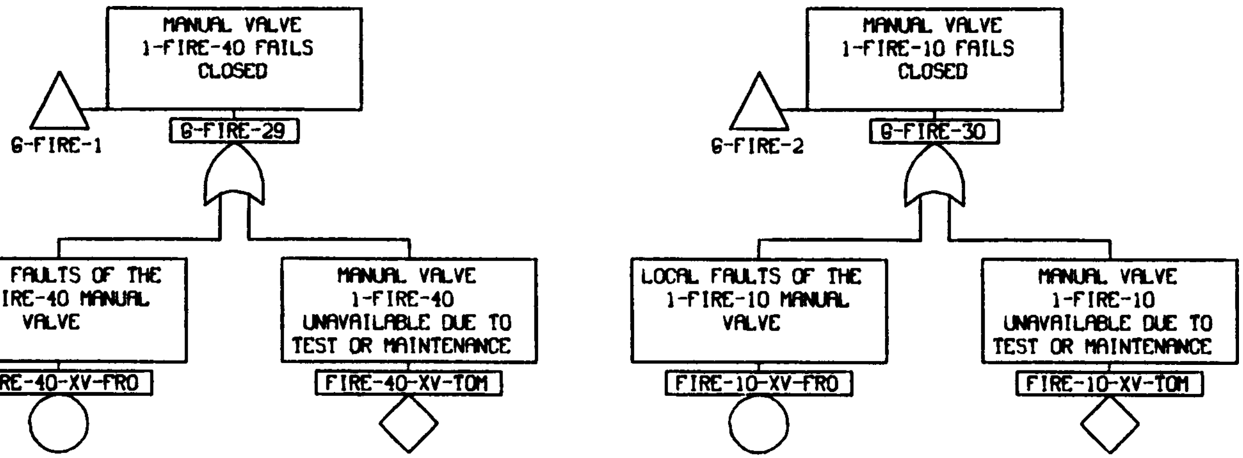

NO WATER FROM MV 1-FIRE-1B
G-FIRE-25
G-FIRE-12
G-FIRE-18
G-FIRE-23
LOCAL FAULTS IN TANK M7-6B
FIRE-6B-TNK-LOF
FAULTS IN SYSTEMS TO PROVIDE HEATING - THE TANK IS FROZEN
FIRE-6B-TNK-HEAT
NO WATER IN TANK M7-6B
FIRE-6B-TNK-NWTR
TANK M7-6 UNAVAILABLE DUE TO TEST OR MAINTENANCE
FIRE-6B-TNK-TOM
MANUAL VALVE 1-FIRE-1B FAILS CLOSED
G-FIRE-40

FIRE-10


NO WATER FROM MV-1-FIRE-1A
G-FIRE-26
G-FIRE-13
G-FIRE-17
G-FIRE-22
LOCAL FAULTS IN TANK M7-6A
FIRE-6A-TNK-LOF
FAULTS IN SYSTEMS TO PROVIDE HEATING - THE TANK IS FROZEN
FIRE-6A-TNK-HEAT
NO WATER IN TANK M7-6A
FIRE-6A-TNK-NWTR
TANK M7-6A UNAVAILABLE DUE TO TEST OR MAINTENANCE
FIRE-6A-TNK-TOM
MANUAL VALVE 1-FIRE-1A FAILS CLOSED
G-FIRE-39

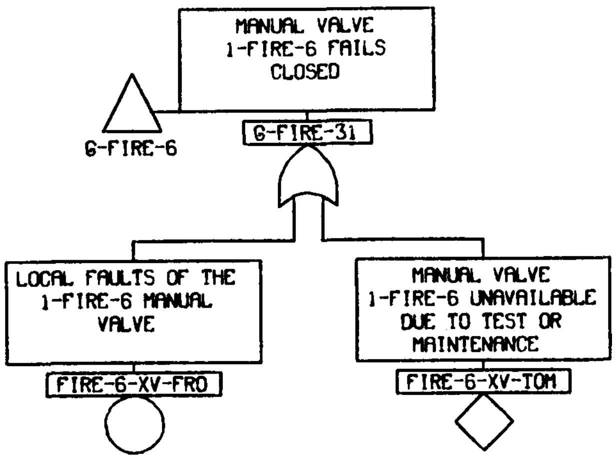

MOTOR DRIVEN PUMP P-82 FAILS TO OPERATE WHEN DEMANDED
G-FIRE-27
G-FIRE-20
LOCAL FAULTS OF MOTOR DRIVEN PUMP P-82
FIRE-P82-MDP-FSR
MDP P-82 UNAVAILABLE DUE TO TEST OR MAINTENANCE
FIRE-P82-TOM
LOSS OF ELECTRIC POWER TO MDP P-82
G-FIRE-50

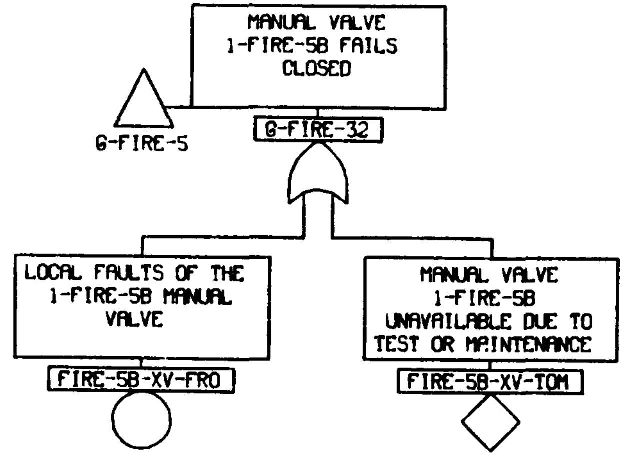

DIESEL DRIVEN PUMP M7-7 FAILS TO OPERATE WHEN DEMANDED
G-FIRE-28
G-FIRE-15
LOCAL FAULTS OF DIESEL DRIVEN PUMP M7-7
FIRE-7-DDP-FSR
DDP M7-7 UNAVAILABLE DUE TO TEST OR MAINTENANCE
FIRE-7-DDP-TOM
NO ACTUATION OF DIESEL TO START
G-FIRE-59

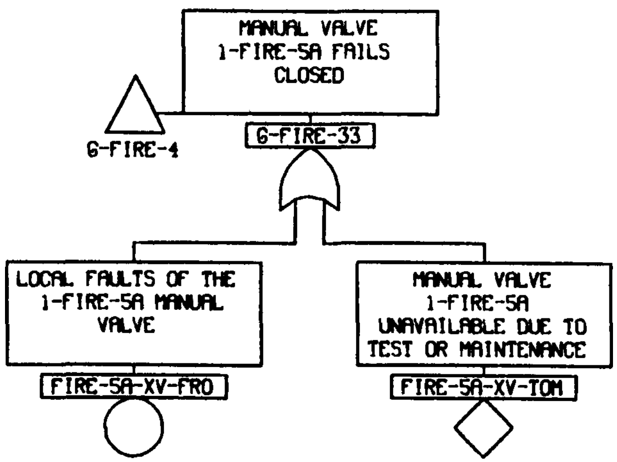


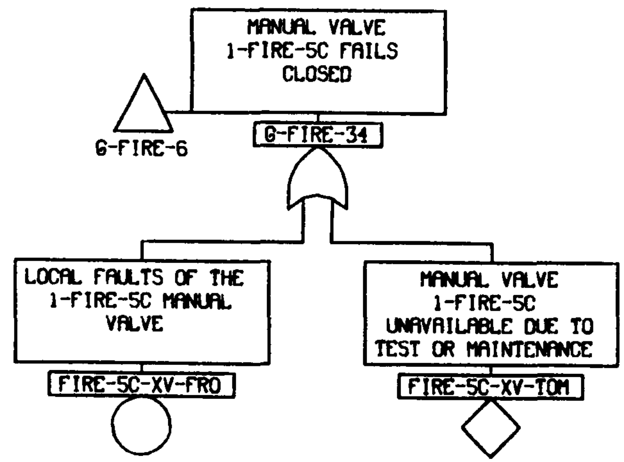
B.16-29

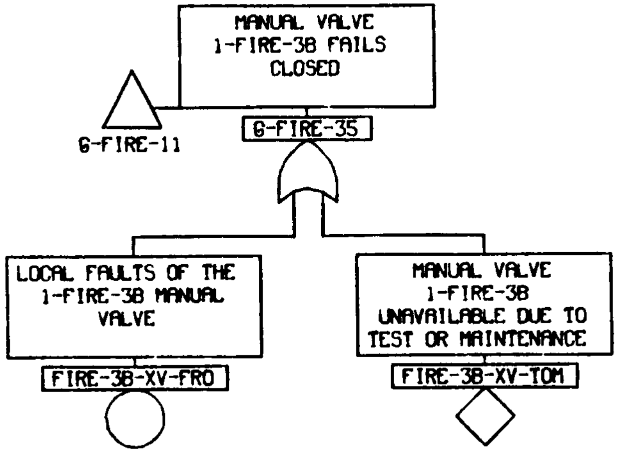
FIRE-13

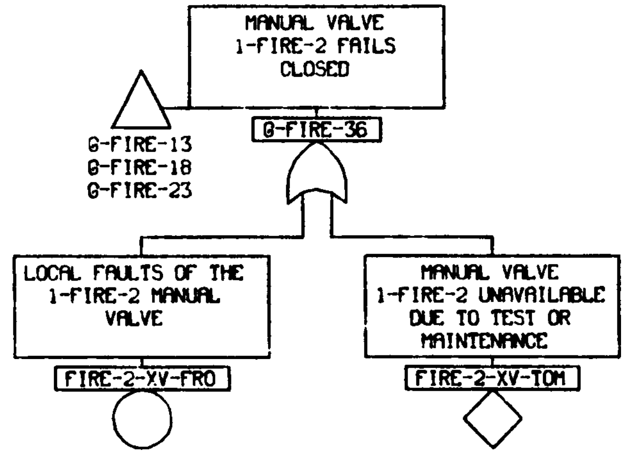

MANUAL VALVE
1-FIRE-6 FAILS
CLOSED
G-FIRE-6
G-FIRE-31
LOCAL FAULTS OF THE
1-FIRE-6 MANUAL
VALVE
MANUAL VALVE
1-FIRE-6 UNAVAILABLE
DUE TO TEST OR
MAINTENANCE
FIRE-6-XV-FRO
FIRE-6-XV-TOM

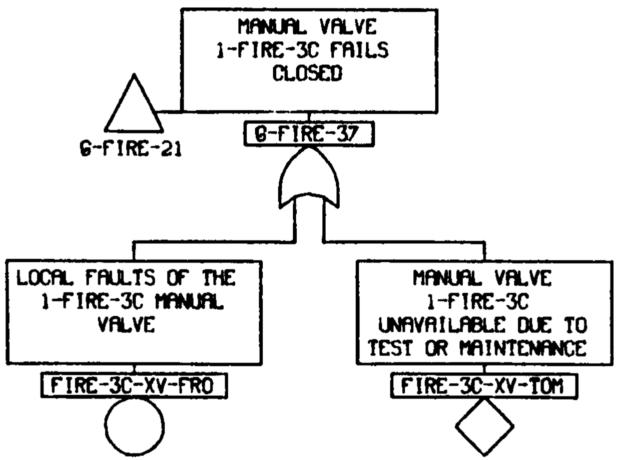

MANUAL VALVE
1-FIRE-5B FAILS
CLOSED
G-FIRE-5
G-FIRE-32
LOCAL FAULTS OF THE
1-FIRE-5B MANUAL
VALVE
MANUAL VALVE
1-FIRE-5B
UNAVAILABLE DUE TO
TEST OR MAINTENANCE
FIRE-5B-XV-FRO
FIRE-5B-XV-TOM

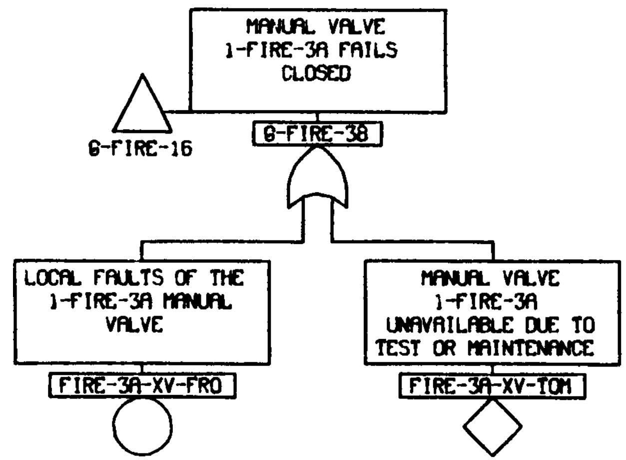

MANUAL VALVE
1-FIRE-5A FAILS
CLOSED
G-FIRE-4
G-FIRE-33
LOCAL FAULTS OF THE
1-FIRE-5A MANUAL
VALVE
MANUAL VALVE
1-FIRE-5A
UNAVAILABLE DUE TO
TEST OR MAINTENANCE
FIRE-5A-XV-FRO
FIRE-5A-XV-TOM

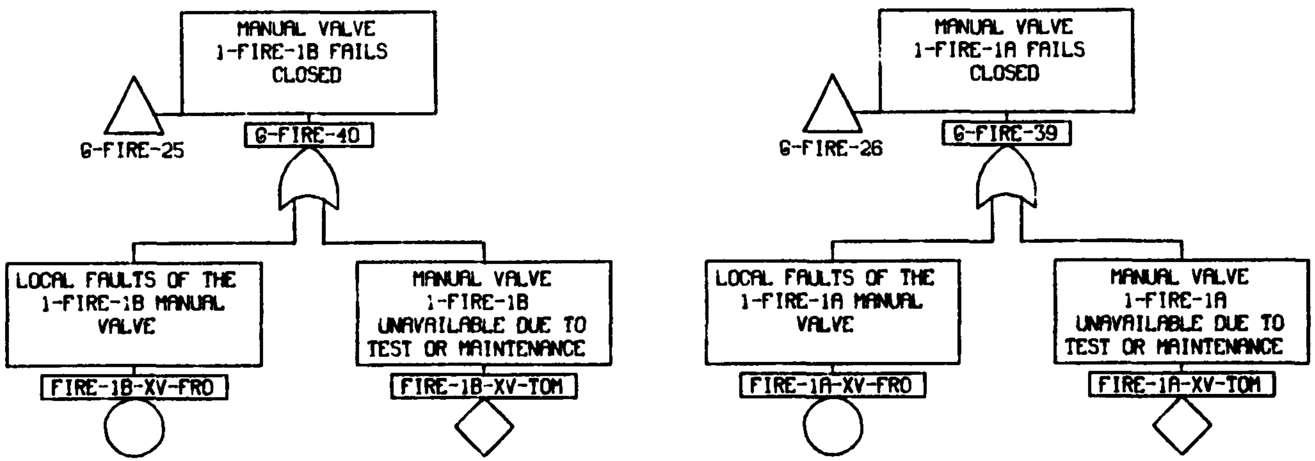

MANUAL VALVE
1-FIRE-5C FAILS
CLOSED
G-FIRE-6
G-FIRE-34
LOCAL FAULTS OF THE
1-FIRE-5C MANUAL
VALVE
MANUAL VALVE
1-FIRE-5C
UNAVAILABLE DUE TO
TEST OR MAINTENANCE
FIRE-5C-XV-FRO
FIRE-5C-XV-TOM

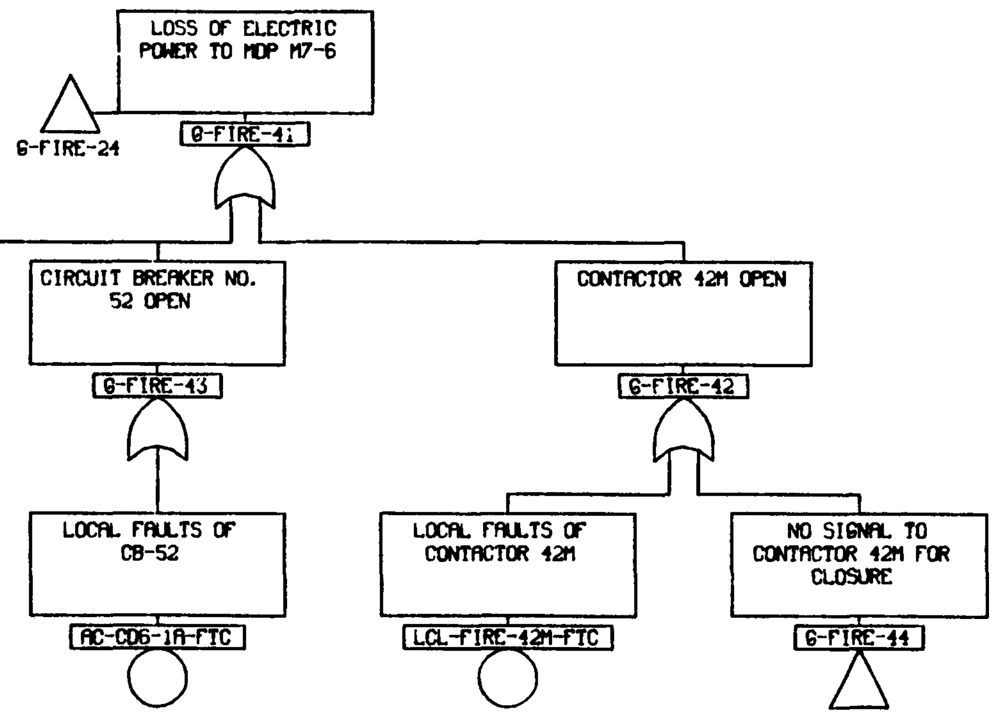

MANUAL VALVE 1-FIRE-3B FAILS CLOSED
G-FIRE-35
G-FIRE-11
LOCAL FAULTS OF THE 1-FIRE-3B MANUAL VALVE
FIRE-3B-XV-FRO
MANUAL VALVE 1-FIRE-3B UNAVAILABLE DUE TO TEST OR MAINTENANCE
FIRE-3B-XV-TOM


MANUAL VALVE 1-FIRE-2 FAILS CLOSED
G-FIRE-36
G-FIRE-13
G-FIRE-18
G-FIRE-23
LOCAL FAULTS OF THE 1-FIRE-2 MANUAL VALVE
FIRE-2-XV-FRO
MANUAL VALVE 1-FIRE-2 UNAVAILABLE DUE TO TEST OR MAINTENANCE
FIRE-2-XV-TOM

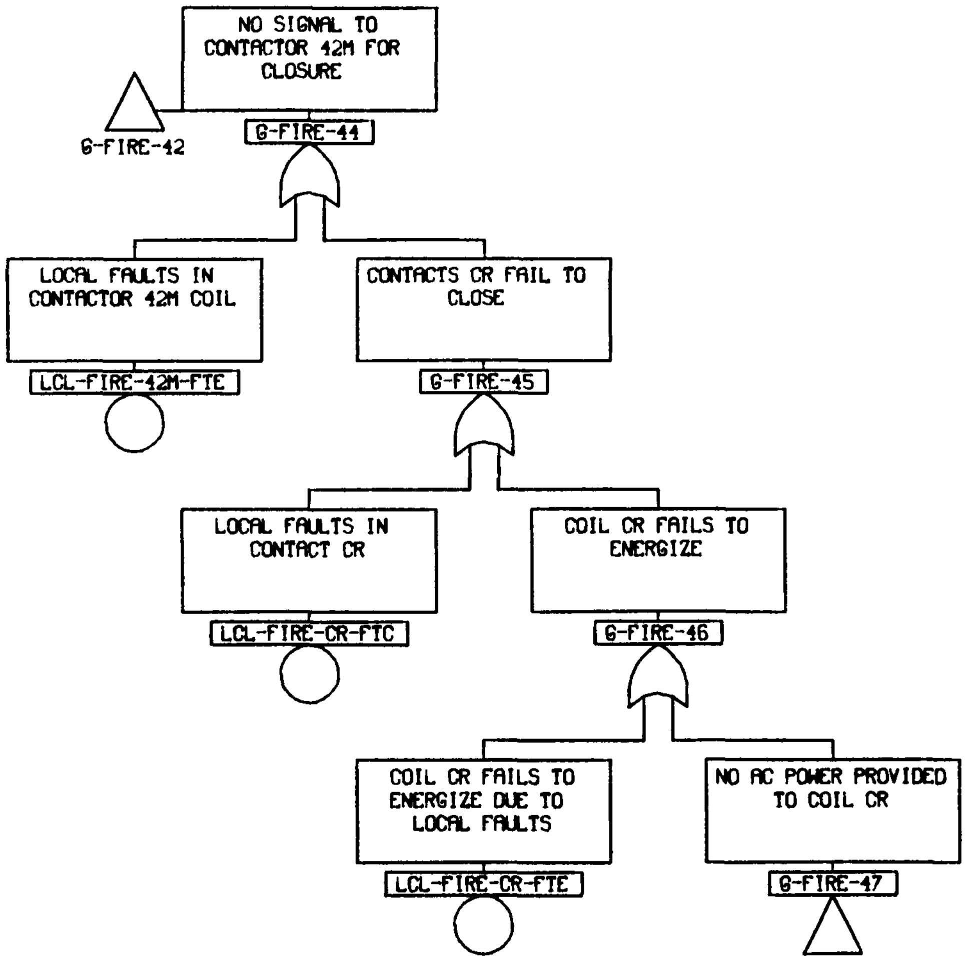

MANUAL VALVE 1-FIRE-3C FAILS CLOSED
G-FIRE-37
G-FIRE-21
LOCAL FAULTS OF THE 1-FIRE-3C MANUAL VALVE
FIRE-3C-XV-FRO
MANUAL VALVE 1-FIRE-3C UNAVAILABLE DUE TO TEST OR MAINTENANCE
FIRE-3C-XV-TOM

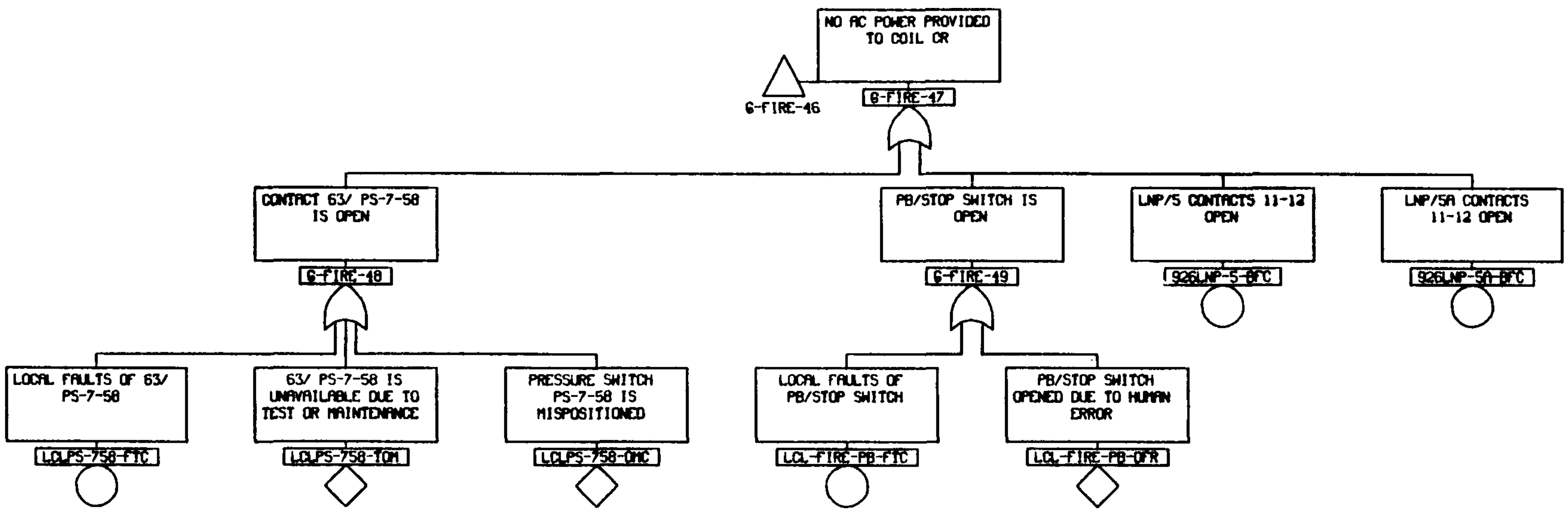

MANUAL VALVE 1-FIRE-3A FAILS CLOSED
G-FIRE-38
G-FIRE-16
LOCAL FAULTS OF THE 1-FIRE-3A MANUAL VALVE
FIRE-3A-XV-FRO
MANUAL VALVE 1-FIRE-3A UNAVAILABLE DUE TO TEST OR MAINTENANCE
FIRE-3A-XV-TOM

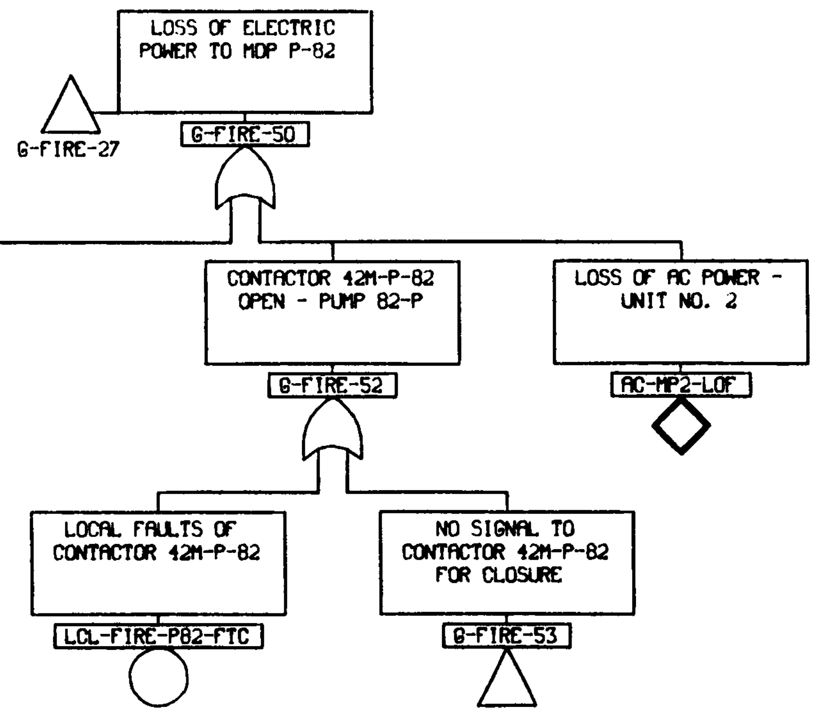

MANUAL VALVE 1-FIRE-1B FAILS CLOSED
G-FIRE-40
G-FIRE-25
LOCAL FAULTS OF THE 1-FIRE-1B MANUAL VALVE
FIRE-1B-XV-FRO
MANUAL VALVE 1-FIRE-1B UNAVAILABLE DUE TO TEST OR MAINTENANCE
FIRE-1B-XV-TOM
MANUAL VALVE 1-FIRE-1A FAILS CLOSED
G-FIRE-39
G-FIRE-26
LOCAL FAULTS OF THE 1-FIRE-1A MANUAL VALVE
FIRE-1A-XV-FRO
MANUAL VALVE 1-FIRE-1A UNAVAILABLE DUE TO TEST OR MAINTENANCE
FIRE-1A-XV-TOM

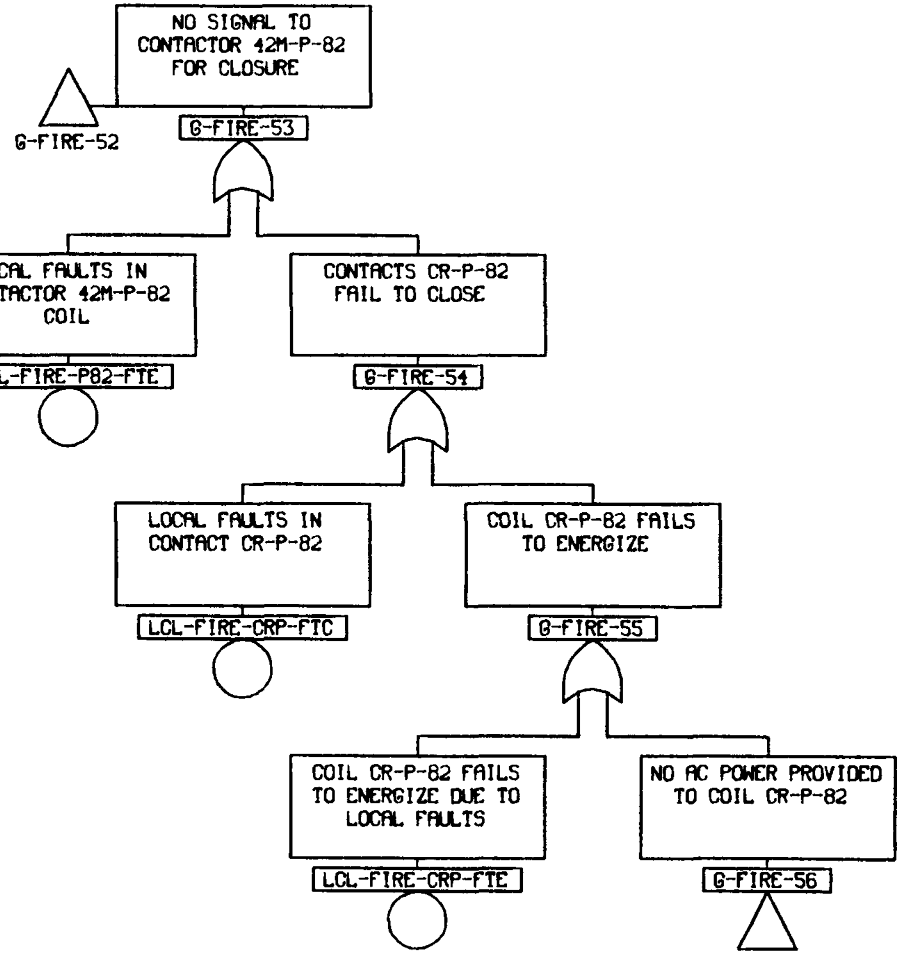


LOSS OF ELECTRIC POWER TO MDP M7-6
G-FIRE-41
G-FIRE-24
LOSS OF AC POWER ON CD6 COMPT NO. 1A
G-AC-BUS-CD6
CIRCUIT BREAKER NO. 52 OPEN
G-FIRE-43
CONTACTOR 42M OPEN
G-FIRE-42
LOCAL FAULTS OF CB-52
AC-CD6-1A-FTC
LOCAL FAULTS OF CONTACTOR 42M
LCL-FIRE-42M-FTC
NO SIGNAL TO CONTACTOR 42M FOR CLOSURE
G-FIRE-44

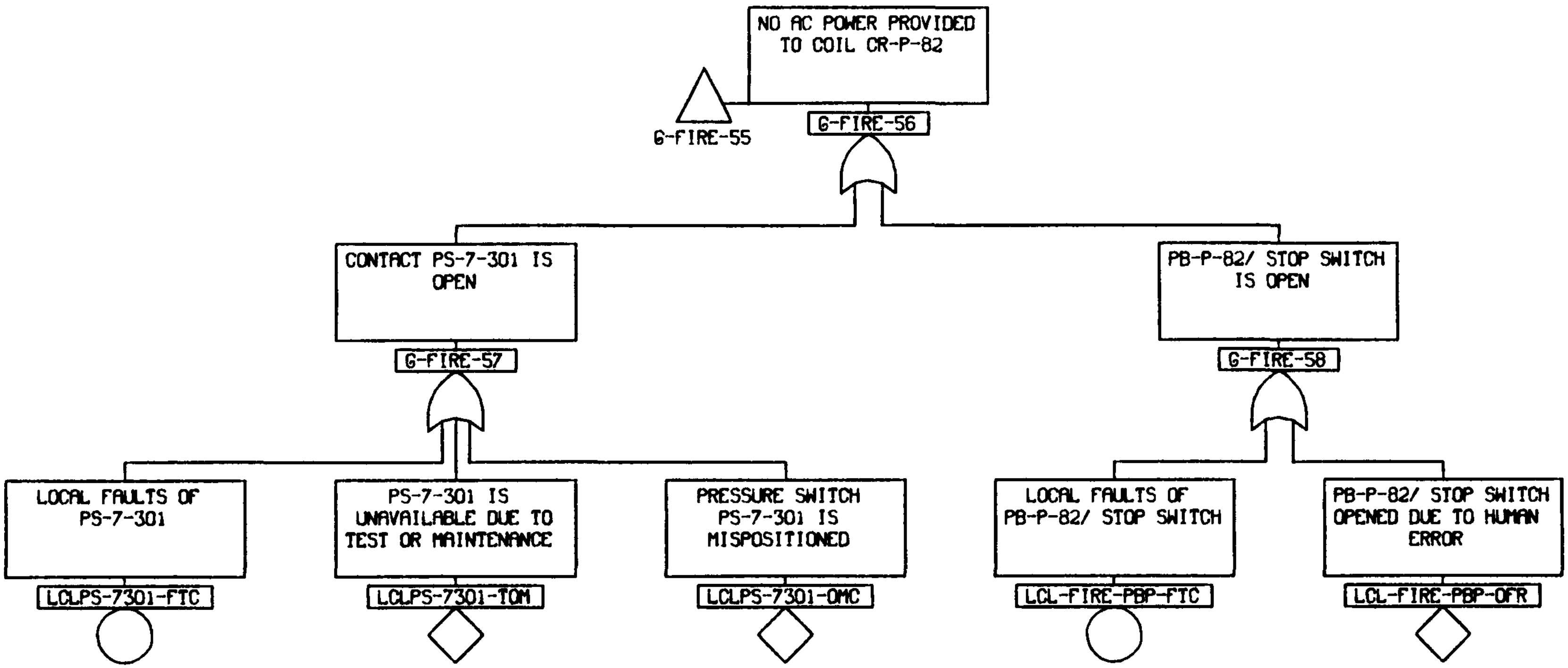

NO SIGNAL TO CONTACTOR 42M FOR CLOSURE
G-FIRE-44
G-FIRE-42
LOCAL FAULTS IN CONTACTOR 42M COIL
LCL-FIRE-42M-FTE
CONTACTS CR FAIL TO CLOSE
G-FIRE-45
LOCAL FAULTS IN CONTACT CR
LCL-FIRE-CR-FTC
COIL CR FAILS TO ENERGIZE
G-FIRE-46
COIL CR FAILS TO ENERGIZE DUE TO LOCAL FAULTS
LCL-FIRE-CR-FTE
NO AC POWER PROVIDED TO COIL CR
G-FIRE-47


NO AC POWER PROVIDED TO COIL CR
G-FIRE-47
G-FIRE-46
CONTACT 63/ PS-7-58 IS OPEN
G-FIRE-48
PB/STOP SWITCH IS OPEN
G-FIRE-49
LNP/5 CONTACTS 11-12 OPEN
926LNP-5-BFC
LNP/5A CONTACTS 11-12 OPEN
926LNP-5A-BFC
LOCAL FAULTS OF 63/ PS-7-58
LCLPS-758-FTC
63/ PS-7-58 IS UNAVAILABLE DUE TO TEST OR MAINTENANCE
LCLPS-758-TOM
PRESSURE SWITCH PS-7-58 IS MISPOSITIONED
LCLPS-758-OMC
LOCAL FAULTS OF PB/STOP SWITCH
LCL-FIRE-PB-FTC
PB/STOP SWITCH OPENED DUE TO HUMAN ERROR
LCL-FIRE-PB-OFR

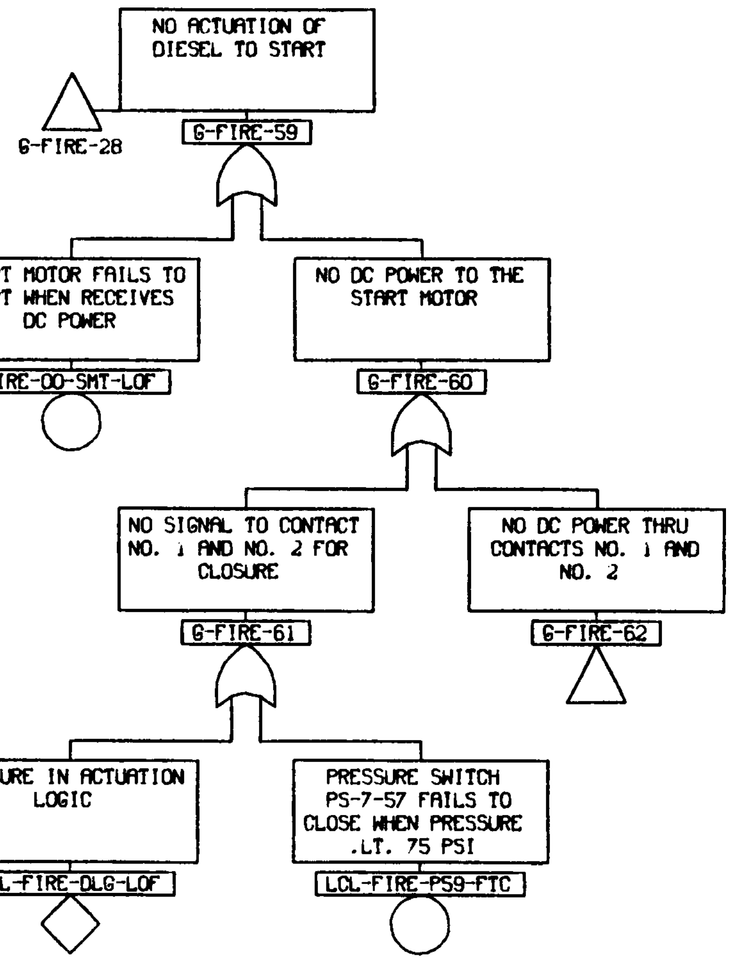

LOSS OF ELECTRIC POWER TO MDP P-82
G-FIRE-50
G-FIRE-27
CIRCUIT BREAKER NO. 52 OPEN PUMP P-82
G-FIRE-51
CONTACTOR 42M-P-82 OPEN - PUMP 82-P
G-FIRE-52
LOSS OF AC POWER - UNIT NO. 2
AC-MP2-LOF
LOCAL FAULTS OF CB-52-P-82
AC2-P82-BKR-FTC
LOCAL FAULTS OF CONTACTOR 42M-P-82
LCL-FIRE-P82-FTC
NO SIGNAL TO CONTACTOR 42M-P-82 FOR CLOSURE
G-FIRE-53


NO SIGNAL TO CONTACTOR 42M-P-82 FOR CLOSURE
G-FIRE-53
G-FIRE-52
LOCAL FAULTS IN CONTACTOR 42M-P-82 COIL
LCL-FIRE-P82-FTE
CONTACTS CR-P-82 FAIL TO CLOSE
G-FIRE-54
LOCAL FAULTS IN CONTACT CR-P-82
LCL-FIRE-CRP-FTC
COIL CR-P-82 FAILS TO ENERGIZE
G-FIRE-55
COIL CR-P-82 FAILS TO ENERGIZE DUE TO LOCAL FAULTS
LCL-FIRE-CRP-FTE
NO AC POWER PROVIDED TO COIL CR-P-82
G-FIRE-56

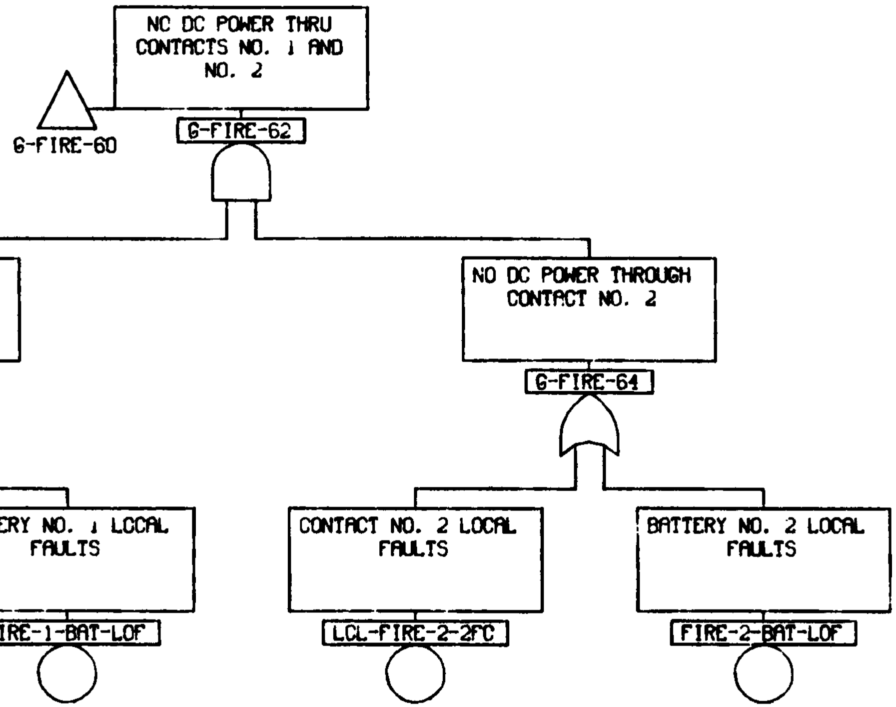
FIRE-21


NO AC POWER PROVIDED TO COIL CR-P-82
G-FIRE-56
G-FIRE-55
CONTACT PS-7-301 IS OPEN
G-FIRE-57
PB-P-82/ STOP SWITCH IS OPEN
G-FIRE-58
LOCAL FAULTS OF PS-7-301
LCLPS-7301-FTC
PS-7-301 IS UNAVAILABLE DUE TO TEST OR MAINTENANCE
LCLPS-7301-TOM
PRESSURE SWITCH PS-7-301 IS MISPOSITIONED
LCLPS-7301-OMC
LOCAL FAULTS OF PB-P-82/ STOP SWITCH
LCL-FIRE-PBP-FTC
PB-P-82/ STOP SWITCH OPENED DUE TO HUMAN ERROR
LCL-FIRE-PBP-OFR

B.16-39



FIRE-23


NC DC POWER THRU CONTACTS NO. 1 AND NO. 2
G-FIRE-62
G-FIRE-60
NO DC POWER THROUGH CONTACT NO. 1
G-FIRE-63
NO DC POWER THROUGH CONTACT NO. 2
G-FIRE-64
CONTACT NO. 1 LOCAL FAULTS
LCL-FIRE-1-1FC
BATTERY NO. 1 LOCAL FAULTS
FIRE-1-BAT-LOF
CONTACT NO. 2 LOCAL FAULTS
LCL-FIRE-2-2FC
BATTERY NO. 2 LOCAL FAULTS
FIRE-2-BAT-LOF

FIRE-24

APPENDIX B.17

EMERGENCY AC POWER SYSTEM

B.17.1 Emergency AC Power System Description

B.17.1.1 Purpose

The purpose of the emergency AC power system is to supply power, of the proper voltage, to selected emergency loads during periods when normal power is available and also during loss of normal power (LNP) conditions.

B.17.1.2 Description and Configuration

The emergency AC power system fulfills two primary functions, the distribution of power to emergency loads and the generation of power during LNP conditions.

The emergency AC power distribution consists of all, or portions thereof, of the following six systems:

1) 4160 volt AC System
2) 480 volt AC System
3) 480 volt Motor Control Centers
4) Vital AC System
5) Instrument AC System
6) Reactor Protection AC Supply System

The 4160 volt AC system consists of seven buses, 14A through 14G, and the associated breakers, transformers and controls. Buses 14B and 14D are tripped on an LNP signal. Buses 14A and 14C are fed from bus 14G. Bus 14G is directly supplied by the gas turbine generator. Bus 14E is fed indirectly from the gas turbine generator through bus 14C. Bus 14F is fed directly by the diesel generator. A one-line diagram of the 4160 volt AC system is shown in Figure B.17-1.

The loads (over 250 HP) that are supplied by buses 14A, 14C, 14E and 14F are shown in Table B.17-1.

There are four 480 volt buses, each fed from its own transformer. The high voltage side of each transformer receives power from breakers on 4160 volt bus 14C, D, E or F. The low voltage side of each transformer is fed to the 480 volt bus 12C, D, E or F. The turbine and plant auxiliary loads are fed from buses 12C and 12D and emergency or essential loads are fed from buses 12E and 12F. Bus 12D trips on an LNP.

Bus ties are provided between buses 12C and 12D and also between buses 12E and 12F. The tie between 12E and 12F is open and "racked out" to prevent paralleling the diesel and gas turbine through 14E and 14F. The following 480 volt AC buses are fed from the 4160 volt AC system:

1) Bus 12C is fed from bus 14C
2) Bus 12D is fed from bus 14D
3) Bus 12E is fed from bus 14E
4) Bus 12F is fed from bus 14F

A one-line diagram of the 480 volt AC system is shown in Figure B.17-2.

Each 480 volt AC bus has various motor control centers (MCCs) associated with it throughout the plant. The motor loads on the 480 volt buses usually range between 150 and 250 horsepower. All MCCs are shown on Figure B.17-2. (The MCCs powered through bus 12E are designated E1, E2, . . ., E7; the remaining MCCs are named in a similar manner.)

There are three sources of power to the vital AC System:

1) The AC motor driven MG set which receives its power from MCC E-5.

2) The DC motor driven MG set which receives its power from 101-AB-3.

3) The instrument vital (IV-1) transformer which receives its power from MCC F-5.

The vital AC system is normally supplied by a motor generator set which consists of an "AC" motor, a "DC" motor, a fly wheel and an "AC" generator. An alternate source of power to the vital AC system is through the instrument vital transformer. There is an automatic transfer switch to transfer the vital AC bus power supply from the motor generator set to the transformer.

Some of the plant loads which are supplied from the vital AC bus are:

1) The plant computer
2) Reactor recirculating pump speed control
3) Reactor feedwater regulating valve control
4) Reactor control rod position indications
5) Reactor power recorders on control room panel 905
6) Electric reactor pressure regulator
7) Main turbine supervisory equipment

The one-line diagram for the vital AC system is shown in Figure B.17-3.

The Instrument AC bus receives its power from either of two transformers. One supply is considered normal (from MCC E-4) and the other an emergency or "backup" supply (MCC F-5). There is an automatic transfer from normal supply to emergency supply if the normal supply is interrupted. When the normal supply is re-energized, an auto transfer back to the normal source is initiated. Indicating lights at the instrument bus in the control room tell the operator which of the two sources is supplying the bus.

The instrument AC system supplies power to:

1) Main Steam Isolation Valve Solenoids
2) +24V DC Battery Chargers
3) Radwaste Control Panel
4) Clean Up (CU) System Control Panel
5) main Control Room Panel Lights

The one-line diagram for the instrument AC system is shown in Figure B.17-3.

The reactor protection AC system consists of two buses, each supplied by an AC motor generator set. Bus RPS-A is fed from MCC E-5 through an AC M/G set and RPS-B is similarly fed from MCC F-5. An alternate AC power source for either (but not both) of the above buses is through the instrument reactor protection transformer which is powered from MCC E-4. The one-line diagram for the reactor protection AC system is shown in Figure B.17-3.

The emergency onsite AC power is supplied by a gas urbine generator and a diesel generator. The gas turbine and generator assembly is comprised of three major components and the auxiliary equipment required to support them. These components are: a gas generator (aircraft jet engine), a power turbine and an electric generator. The electric generator is rated at 10,000 KW continuous peak load, and at 11,500 KW emergency load.

The major supporting auxiliary systems consist of:

1) A compressed air system and starter motor

2) A fuel oil system

3) A turbine lubrication system (with AC and DC pumps)

4) An electric generator lube oil system (with AC and DC pumps)

5) Turning gear and a DC turning motor

6) A dedicated DC battery bus to supply DC control power on "black starts."

The gas turbine generator starts automatically on a loss of normal power and supplies 4160-volt loads, which are grouped into two categories:

1) Loads which will start automatically upon ECCS initiation signal for the FWCI system

2) Loads which will start automatically upon ECCS initiation signal for the core spray and LPCI systems.

Buses 14A and 14C supply loads in category (1), while bus 14E supplies loads in category (2). Table B.17-2 shows the emergency loads which the gas turbine generator supplies.

The diesel-driven emergency generator is a 2.7 megawatt, 900 rpm unit, which has an additional two-hour, 10 percent overload capacity. The unit supplies power to 4160-volt bus 14F.

The diesel is started by direct air injection into the cylinders from the diesel's own compressed air system. It can accept load within 10 seconds after a start signal and it can be fully loaded within 30 seconds. Within 10 seconds after a loss of normal power start signal, the diesel generator is loaded sequentially with the critical loads. Upon receiving a LOCA start signal, the diesel generator is loaded by the LPCI and core spray DC timers (in CRP 932 and 933) and the synchronous cycling timers. The engine trip device signals are negated during the LOCA condition.

The generator is sized to meet the starting and operating load requirements of the largest vital loads required under postulated accident conditions. These loads are grouped into two main categories:

1) Loads which will start automatically upon restoration of normal voltage supplied by the diesel generator as required under postulated accident conditions, and

2) Loads which may be required for safe shutdown and which can be started manually within the capacity of the diesel generator.

Alarms are provided to annunciate an overloaded condition; however, the generator load is not tripped from an overload condition.

Table B.17-3 indicates the emergency 4160- and 480-volt bus loads supplied by the diesel generator.

B.17.1.3 System Interfaces

Emergency AC System Interfaces are shown in Table B.17-4.

B.17.1.4 Instrumentation and Control

The instrumentation controlling initiation of the emergency ac power system consists of the following items:

1) Main generator lockout relays -- These relays detect a trip of the main turbine generator.

2) Normal station service transformer (NSST) supply breaker relays -- These relays detect a loss of AC power to the 4160 volt buses through supply breakers from the NSST.

3) Reserve station service transformer (RSST) supply breaker relays -- These relays detect a loss of AC power to the 4160 volt buses through supply breakers from the RSST.

4) RSST high side voltage relays -- These relays detect loss of AC power to the high side of the RSST.

5) Loss of normal power (LNP) relays -- These relays are energized by DC control power whenever there is a complete loss of normal AC power to the 4160 volt buses. They perform the following sequential operations upon receipt of the LNP signal:

    a) Strip loads on all 4160 volt buses

    b) Initiate start of the two emergency power sources

    c) Provide a permissive for the emergency power sources to close on selected 4160 volt buses.

There are two trains of logic (train "A" and "B"), either of which will actuate the emergency AC power system. As shown in Figure B.17-4, the LNP relays for either train are energized by a one-out-of-two-twice-type logic. The LNP actuation circuitry for the emergency AC power system is shown in Figure B.17-5.

B.17.1.5 Testing

There are four primary tests of the emergency AC power system, or its components:

SP 617.1 Loss of Normal Power (LNP) Relays

The objective of this procedure is to provide for the functional testing of all relays, breakers and contactors required to operate in the event of an LNP condition. The test also verifies the automatic start and load sequencing for the diesel and gas turbine generators. The procedure calls for manually closing the "load shedding" relays 94-1a and -2a and -1b and -2b and observing the appropriate breakers trip, and actuating the LNP relay contacts and observing the appropriate breakers or equipment trip. Also, a final LNP test is performed which incorporates all the previously checked relays. This test involves a momentary loss of AC power and results in starting the emergency generators, i.e., the diesel and the gas turbine. The test is conducted each refueling outage (~16.5 months or 12,000 hours).

SP 628.1 Integrated Simulated Automatic Actuation of FWCI, Core Spray, LPCI, Diesel and Gas Turbine Generators

The objective of this procedure is to demonstrate the capability of the diesel generator and gas turbine generator to start automatically and take on their respective ECCS loads on a loss of all external AC power. The procedure calls for initiating a "generator lockout," then initiating an ECCS signal by manually holding the "High Drywell Pressure" logic relays. The test is conducted each refueling outage.

SP 668.1 Diesel Generator Operational Readiness Demonstration

The objective of this procedure is to demonstrate the operational readiness of the diesel generator, the diesel starting air compressor and the diesel fuel oil transfer pumps. The procedure calls for starting and loading (2665kw) the diesel generator and operating it for about one hour. The test is conducted monthly (OP 338, which requires a similar test, is performed weekly and Form 668.1-1 is completed).

SP 668.2 Gas Turbine Emergency Fast Start Test

The objective of this procedure is to demonstrate the capability of the gas turbine generator to start within 48 seconds with AC power unavailable. The procedure calls for starting the gas turbine generator, loading it to at least 6MWe and running it for a period of about one hour. The test is conducted monthly.

B.17.1.6 Maintenance

There are three maintenance procedures that apply to scheduled maintenance of the emergency AC power system or its components.

MP 741.1 Gas Turbine Power Plant Cold Section Inspection

This procedure provides detailed instructions for inspecting the gas turbine compressor section. Although not spelled out in the procedure, this inspection is conducted once per refueling outage.

MP 742.3 Gas Turbine Power Plant Reduction Gear Inspection

This procedure, conducted annually or once per fuel, provides instructions for the inspection of the gas turbine reduction gear section.

MP 743.2 Diesel Engine Generating System (Annual 500 Hour Inspection)

This procedure provides instructions for performing the annual or 500 hour inspection. The inspection involves a tear down of critical parts of the engine and visually and mechanically inspecting these parts.

The remaining maintenance is performed on an as needed basis.

B.17.1.7 Technical Specifications

The emergency AC power system technical specifications are written in two parts, the limiting conditions for operation and the surveillance requirements associated with operation. Both parts are contained within the more encompassing technical specifications for the auxiliary electrical system.

There are two limiting conditions for operation which affect the emergency AC power system:

1) If the reactor is shut down, then it cannot be made critical unless <u>both</u> emergency power sources are operable, and

2) When the reactor is operating at power, the loss of either emergency power source is allowed for a limited time <u>only</u> if normal AC power is available and certain other conditions are <u>met.</u> In the case of the diesel generator being inoperable, continued reactor operation is allowed for seven days provided that the gas turbine and major core

cooling systems are operable. Operation with the gas turbine declared inoperable is allowed for only four days, with the requirement that both the diesel generator and major core cooling systems (FWCI excepted) be operable.

The two major surveillance requirements for the emergency AC power system are on the diesel generator and gas turbine.

1) The diesel generator is required to start once per month and be run at full load for at least one hour. Additional surveillance requires that the diesel be fast started once every refueling so that it is ready to accept a full load within 13 seconds.

2) The gas turbine must be fast started and ready to accept its full load within 48 seconds once per month. Once the generator is loaded, it must be capable of sustaining the full core cooling load (approximately 10 MWe assuming FWCI system operation).

B.17.1.8 Operation

The emergency AC power system operates in two modes. In the first mode, both the diesel generator and gas turbine are started automatically upon complete loss of the normal AC power supply. In the second mode, both emergency generators are started upon indication of accident conditions, even if normal AC power is available. This second mode of operation is desirable in the event there is a loss of normal AC power coincident with the accident.

In order to have a complete loss of normal AC power, both offsite power and the main turbine generator would have to be lost simultaneously. The main turbine generator is designed to "roll back" to meet plant load requirements upon loss of offsite power since the main condenser has 100 percent load bypass capability.

If there is a complete loss of normal AC power, the LNP (loss of normal power) master trip relays initiate complete load-shedding on the seven 4160V buses (14A through 14G) and selective load-shedding on 480V buses 12C, 12E and 12F. In addition, the 4160V buses 14B and 14D, and 480V bus 12D remain dead as long as the LNP conditions exist. Coincident with load-shedding, both the gas turbine and diesel generator receive fast start signals. As soon as both units are up to speed (13 sec. for the diesel and 48 sec. for the gas turbine), their breakers close onto dead buses without the delay caused by synchronizing checks.

The gas turbine control system initiates automatic closing of the 4160V gas turbine input circuit breaker to bus 14G, followed by the 4160V input breakers to buses 14A and 14C. Since the tie breaker between buses 14C and 14E does not trip for an LNP condition, re-energizing bus 14C also energizes bus 14E. In a similar manner the diesel emergency power source is automatically switched to bus 14F. The tie breaker from bus 14D to 14F does not reclose and therefore bus 14D is left deenergized under LNP conditions.

Upon successful restoration of power to all 4160V emergency AC buses, essential loads are picked up in sequence to avoid large voltage drops, as discussed in section B.17.1.2. Restoration of the 480V buses 12C, 12E and 12F is concurrent with restoration of their respective 4160V feeder buses 14C, 14E and 14F through the stepdown transformers.

During the maneuver of going from normal to emergency AC power, there is a brief power interruption to five of the six AC power distribution systems. These are: the 4160V AC system, the 480V AC system, the 480V MCCs, instrument AC and the reactor protection system. However, the vital AC system is not interrupted since losing power to the AC motor generator set causes an auto-transfer to the DC motor generator set. During this transfer, the flywheel provides sufficient inertia to maintain adequate voltage and frequency on the vital AC bus.

If there is indication of an accident, both the gas turbine and diesel generators will receive simultaneous start signals similar to those generated by the LNP condition. In this situation, a lo-lo reactor water level and/or a hi drywell pressure signal will, on a one-out-of-two-twice basis, initiate emergency generator fast start signals. Unlike the LNP start sequence scenario, only the gas turbine generator is autosynchronized (to 4160V bus 14G) while the diesel generator is left running for manual synchronization by the operator.

B.17.2 Analysis

B.17.2.1 Success/Failure Criteria

Success of the emergency AC power system requires the ability to produce AC power (from the gas turbine or diesel) and to deliver that power to the plant emergency loads. Partial success of the AC system is possible since it is a support system. It is possible to deliver power to some emergency loads and not to others. The failure to deliver emergency power to any one component (or bus) does not necessarily affect the ability of the system to supply power to the remaining loads.

B.17.2.2 Assumptions

The only assumption made in this analysis was that both offsite AC power and power from the main turbine generator were unavailable. By doing this, LNP conditions were assumed and the system was modeled in terms of its response to the complete loss of normal AC power.

Table B.17-1

Loads on 4160 Volt Emergency Buses

Bus		Load
14A	A	Reactor Recirc. MG Set
"	A & B	Reactor Feed Pump
14C	A & B	Circulating Water Pump
"	A & B	Condensate Pump
"	A & B	Condensate Booster Pump
"	A	Service Water Pump
"	A	TBCCW Pump
"	Emergency Consensate Transfer Pump	
14E		
"	C	Service Water Pump
"	B & D	Emergency Service Water Pump
"	B & D	LPCI Pump
"	B	Core Spray Pump
"	A	CRD Pump
"	A	RBCCW Pump
14F	D	Service Water Pump
"	A & C	Emergency Service Water Pump
"	A & C	LPCI Pump
"	A	Core Spray Pump
"	B	CRD Pump
"	B	RBCCW Pump

Table B.17-2

Emergency Loads Supplied by Gas Turbine Generator

Category I Loads

FWCI System

Reactor Feedwater Pump
Condensate Booster Pump
Condensate Pump
FWCI Instruments and Control

Category II Loads

Automatically Starting or Restarting Loads

Low Pressure Coolant Injection Pumps B and D
Core Spray Pump B
Service Water Pump C
Standby Gas Treatment Fan A
Battery Charger No. 1A
Emergency Lighting
Vital AC MG Set and Instrument AC Bus
Turbine Building Secondary Cooling Water Pump A
Emergency Air Handling Units
Service Air Compressor
Diesel Auxiliaries
Fire Pump House MCC
Emergency Service Water Pumps B and D
345-kV Switchyard Auxiliary Transformer
Emergency Condensate Transfer Pump
Reactor Feed Pumps A and B Seal Water and Lube Oil Pumps
Control Valves as required by the above system

Manually Started Shutdown Loads

Control Rod Drive Pump A
Reactor Building Cooling Water Pump A
Reactor Shutdown Cooling Water Pump A
Standby Liquid Control Pump A
Reactor Protection MG Set 1
Control Valves as required by the above systems

Table B.17-3

Emergency Loads Supplied by the Diesel Generator

Category I Loads
(Automatically Starting or Restarting Loads)

Low Pressure Coolant Injection Pumps A and C
Core Spray Pump A
Service Water Pump D
Standby Gas Treatment Fan B
Battery Charger No. 1 (1/2-hour delay)
Emergency AC Lighting
Vital and Instrument AC Buses
Turbine Building Secondary Cooling Water Pump B
Standby Liquid Control Heater
Emergency Air Handling Units
Instrument Air Compressor
Diesel Auxiliaries and Oil Transfer Pumps A and B
Control Valves as required by the above systems

Category II Loads
(Manually Started Shutdown Loads)

Standby Liquid Control Pump A
Reactor Building Cooling Water Pump B
Reactor Shutdown Cooling Water Pump B
Reactor Protection MG Set 1A
Control Rod Drive Pump B
Battery Charger No. 11A (1/2-hour delay)
Emergency Service Water Pumps A and C
Control Valves as required by the above systems

Table B.17-4

Emergency AC Power System Interfaces Failure Modes and Effects

Primary System			Support System			Failure Mode	Fault Effect
System	Div.	Comp.	System	Div.	Comp.		
Emergency AC Power	GT	--	DC		Bus 101B	Breaker fails to close on bus	No AC power to the emergency AC buses from the GT
Emergency AC Power	DG	--	DC		Bus 101A	Breaker fails to close on bus	No AC power to the AC buses from the DG; DG fails to start
Emergency AC Power	DG	Lube oil cooler, heat exch., air	SWS		Secondary side of DG coolers	Loss of flow	No heat removal from scavenge air, DG cooling and lube oil cooler heat exchanger, eventual DG failure
Emergency AC Power		LNP logic	DC		Bus 11A-1 Bus 11A-2	Loss of power on bus	Half of the LNP start logic for the diesel and the gas turbine is disabled by loss of power on either bus

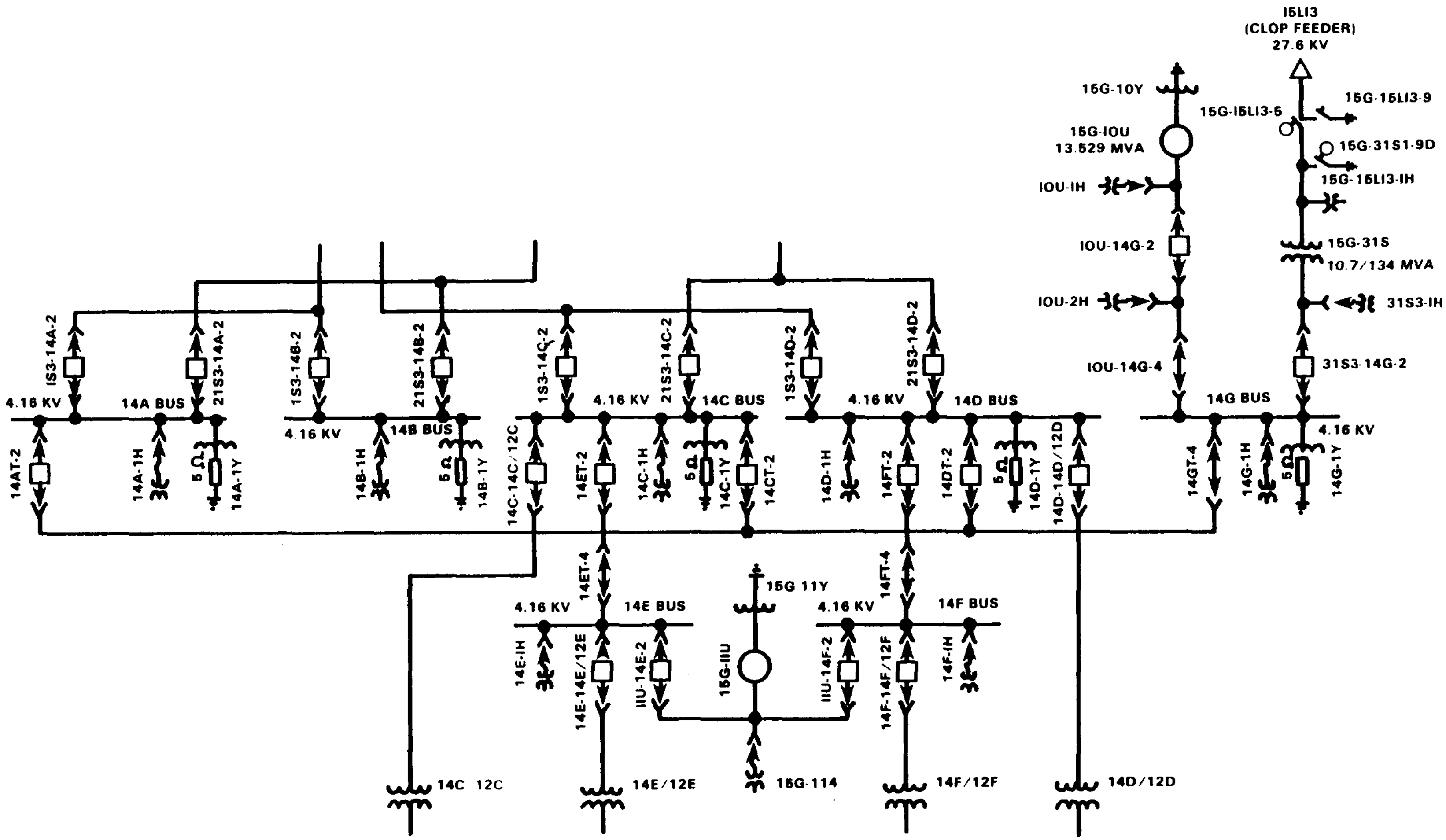


FIGURE B.17-1. 4160 VOLT AC SYSTEM

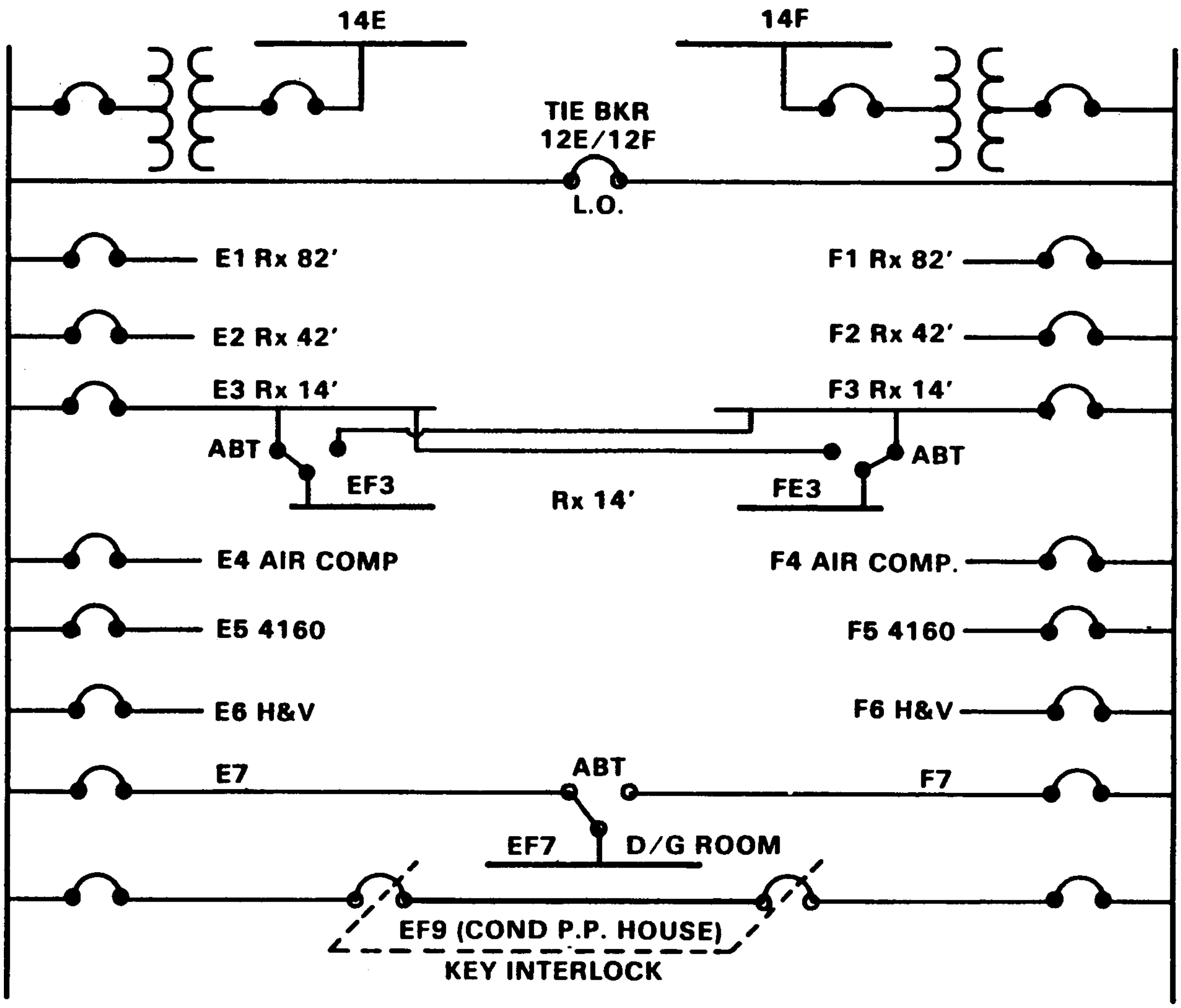


FIGURE B.17-2. 480 VOLT DISTRIBUTION 12E — 12F BUS (SHEET 1 OF 2)

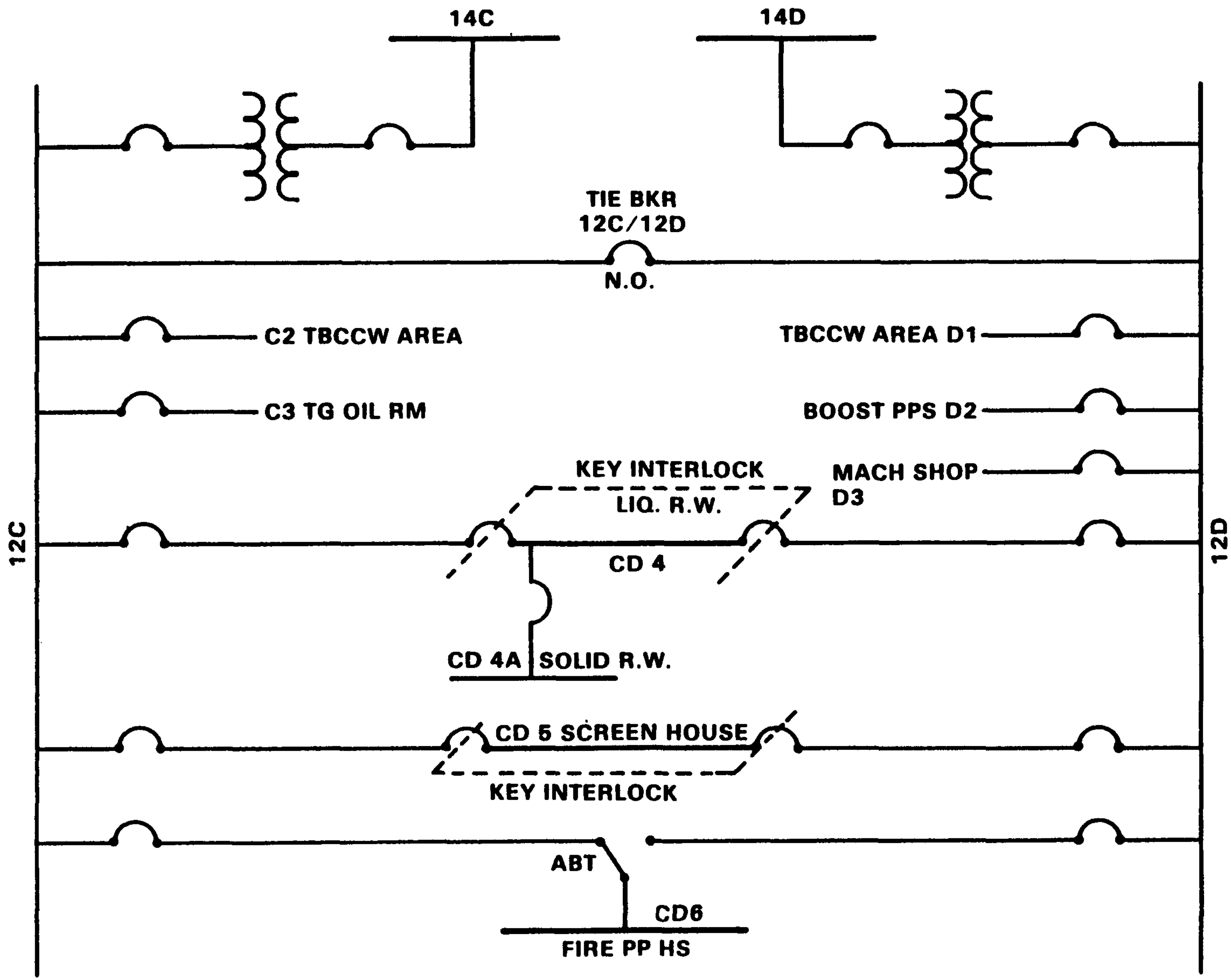


FIGURE B.17-2. 480 VOLT DISTRIBUTION 12C — 12D BUS (SHEET 2 OF 2)

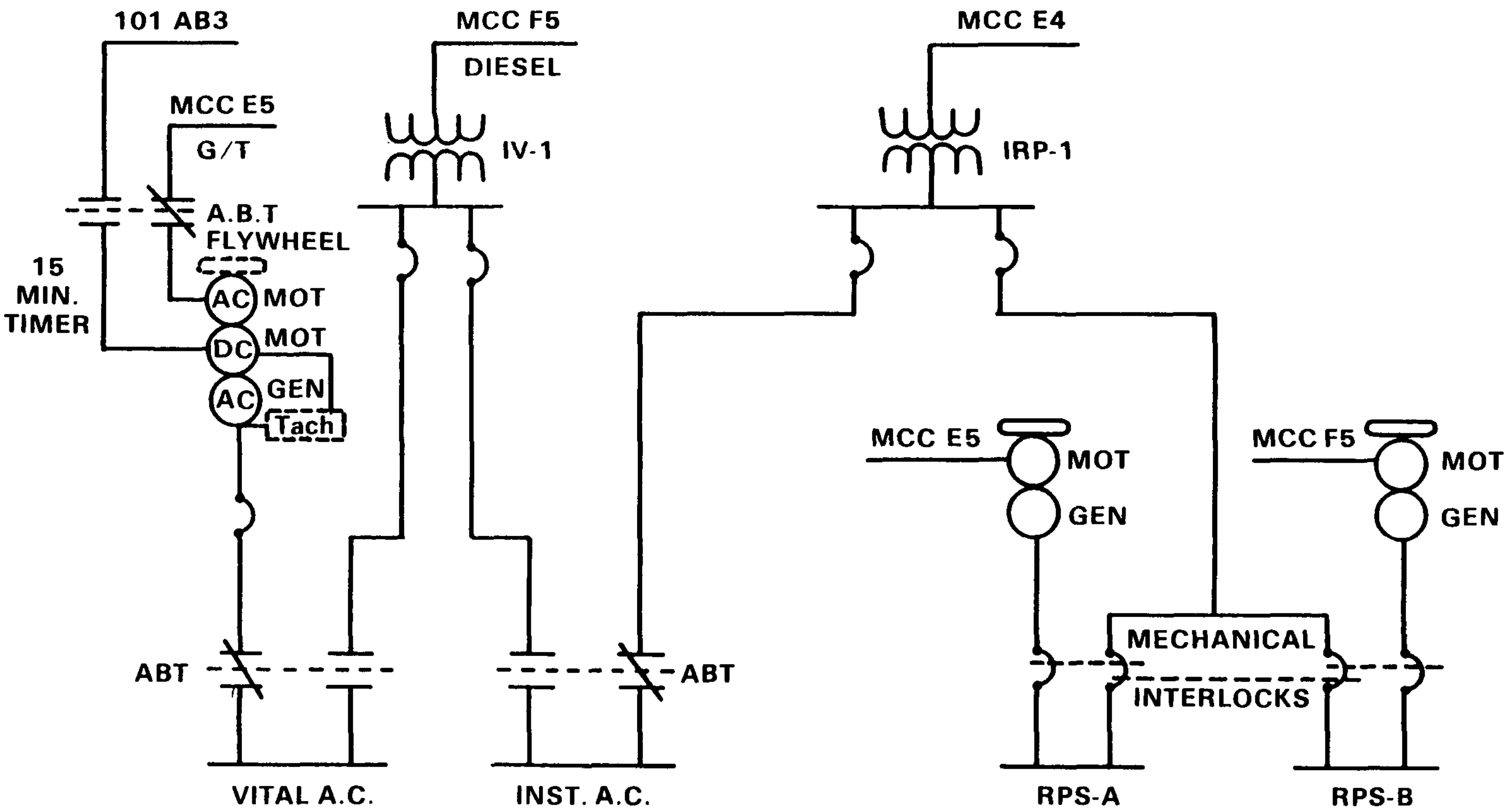


FIGURE B.17-3. VITAL AC — INSTRUMENT AC REACTOR PROTECTION BUSES

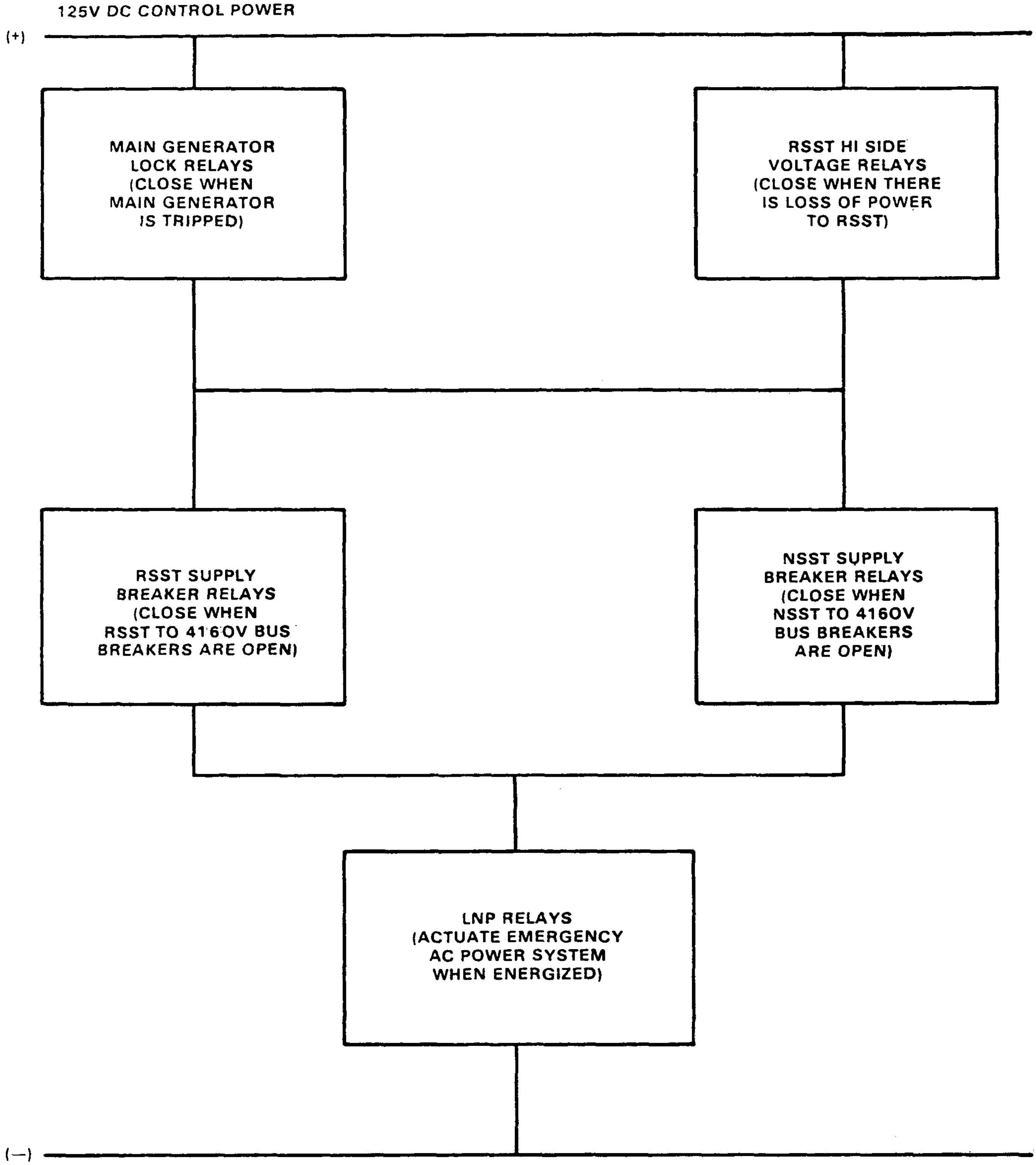
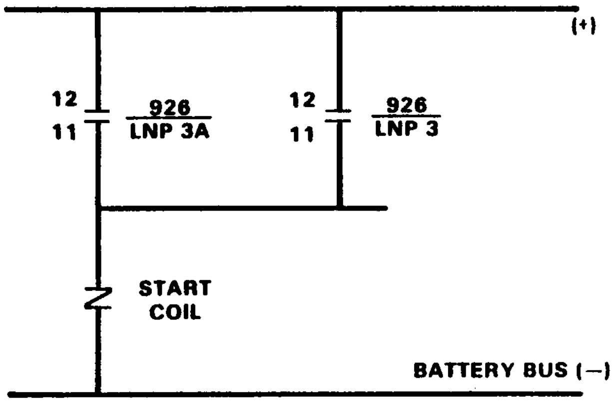
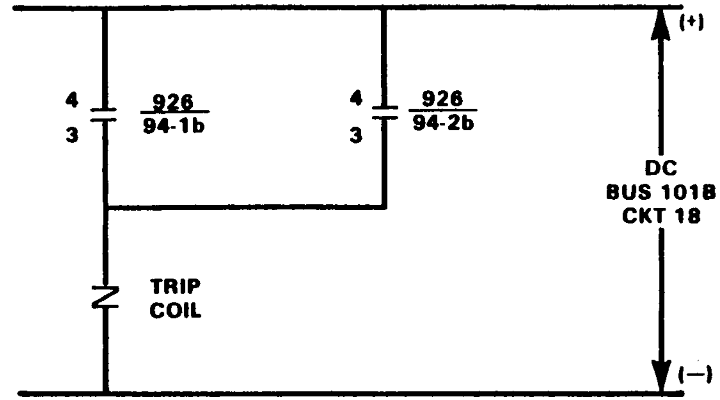


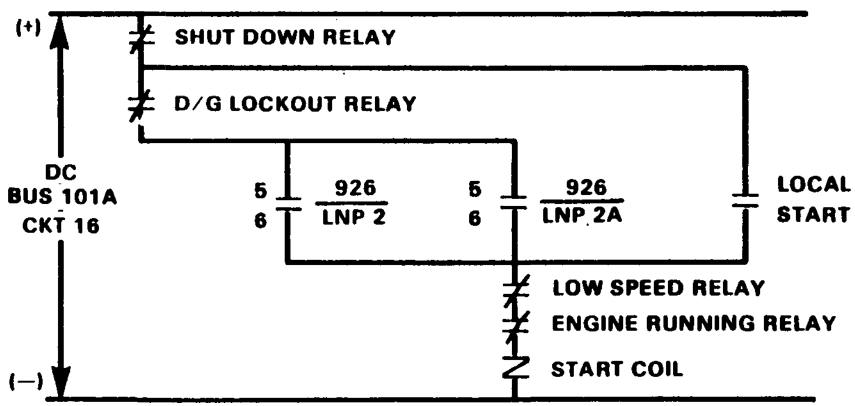
FIGURE B.17-4. TYPICAL LNP ACTUATION LOGIC TRAIN



GAS TURBINE/GENERATOR



FLANDERS CIRCUIT BREAKER
31S 3-14G-2
(MUST TRIP WHEN GAS TURBINE RUNS)



DIESEL GENERATOR START LOGIC

FIGURE B.17-5. EMERGENCY AC POWER SYSTEM CONTROL WIRING SCHEMATICS GENERATOR (DIESEL AND GAS TURBINE) START LOGIC (SHEET 1 OF 8)

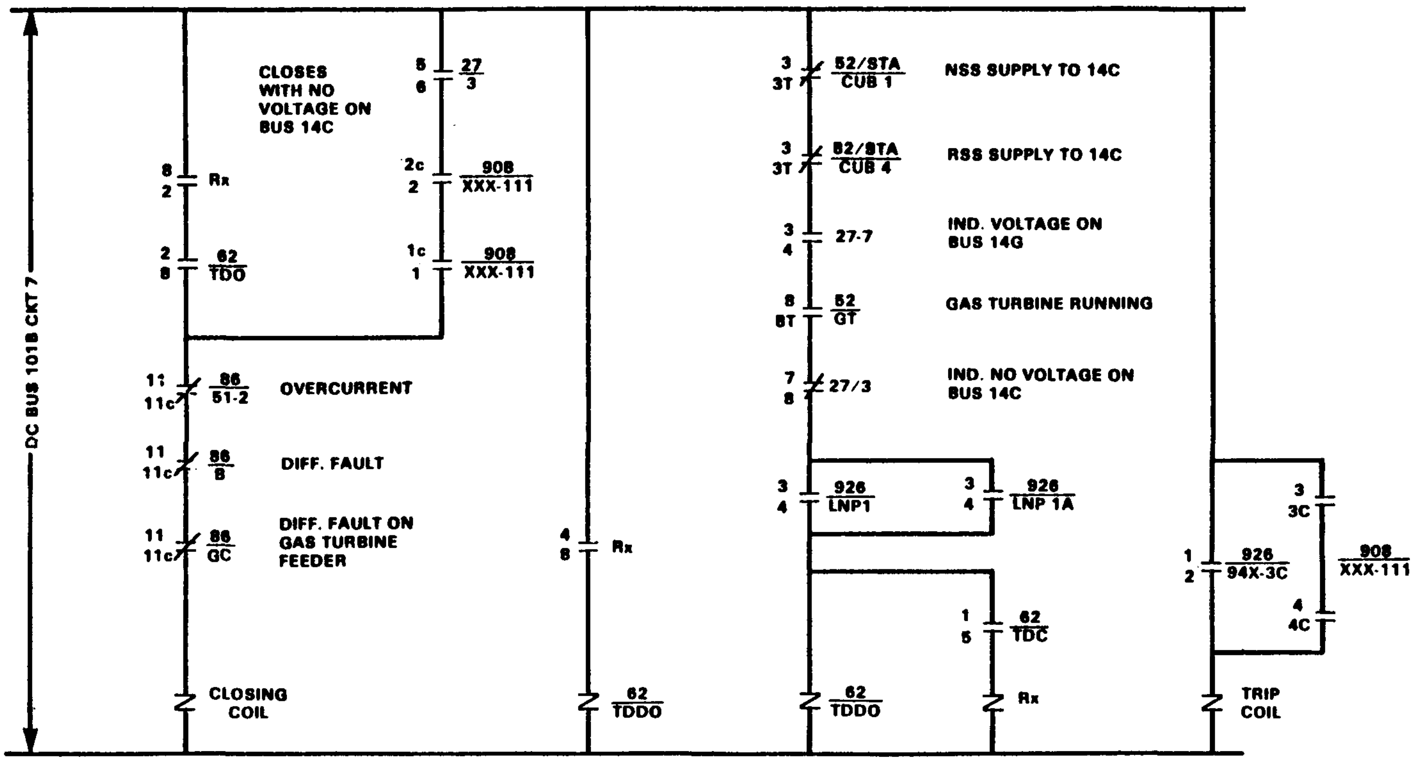


FIGURE B.17-5. EMERGENCY AC POWER SYSTEM CONTROL WIRING SCHEMATICS BREAKER 14CT-2 (BUS C-GAS TURBINE) CONTROL (SHEET 2 OF 8)

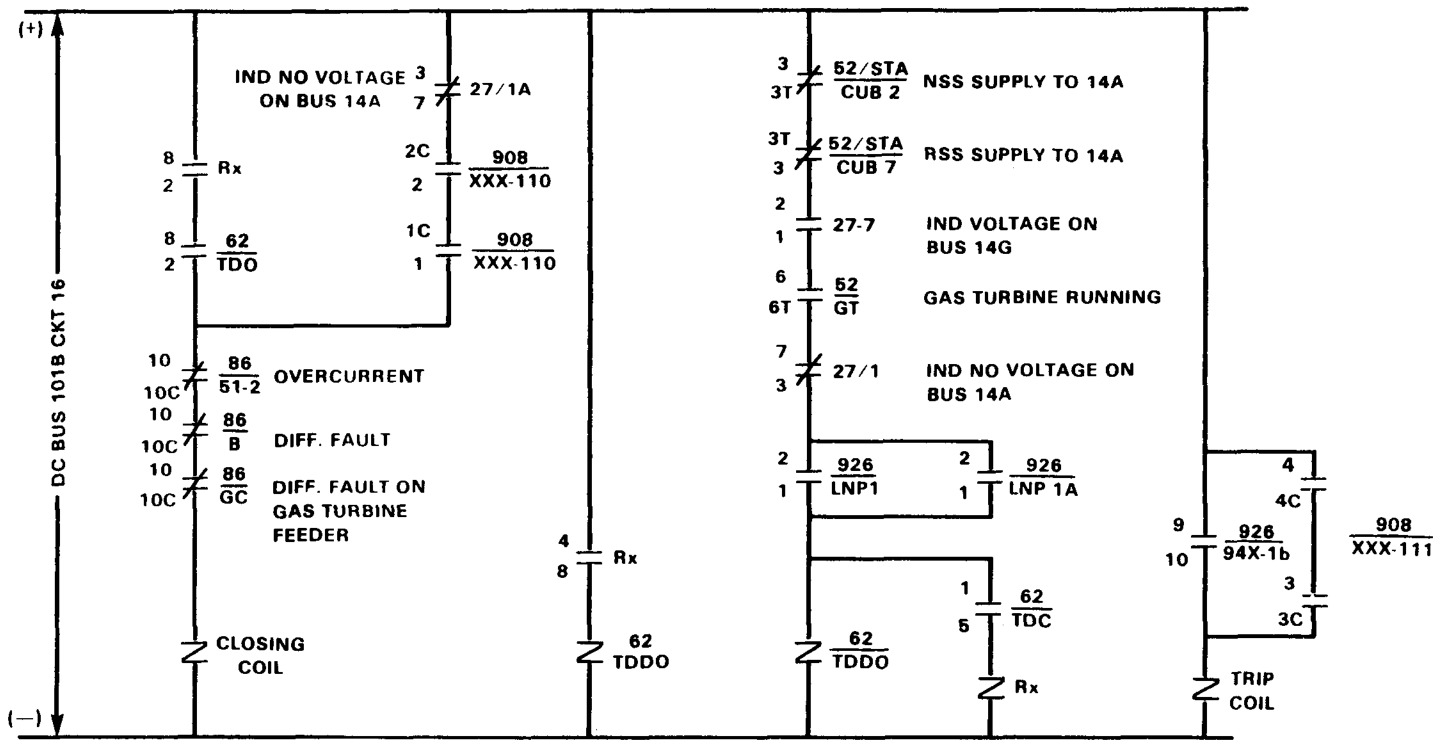
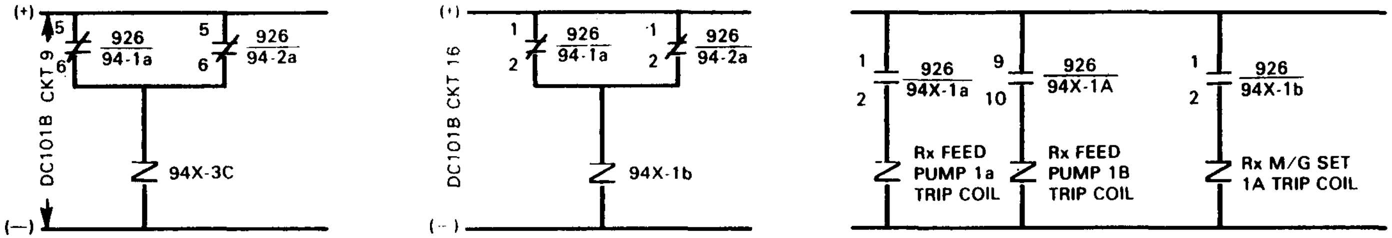
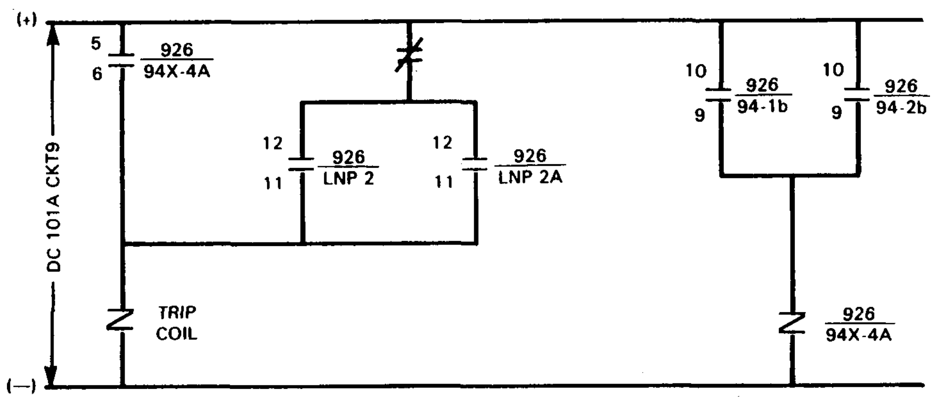


FIGURE B.17-5. EMERGENCY AC POWER SYSTEM CONTROL WIRING SCHEMATICS BREAKER 14AT-2 (BUS 14A — GAS TURBINE) CONTROL (SHEET 3 OF 8)



LOAD SHEDDING CIRCUITS



BREAKER 14FT-2 (BUSF-DIESEL) CONTROL

FIGURE B.17-5. EMERGENCY AC POWER SYSTEM CONTROL WIRING SCHEMATICS (SHEET 4 OF 8)

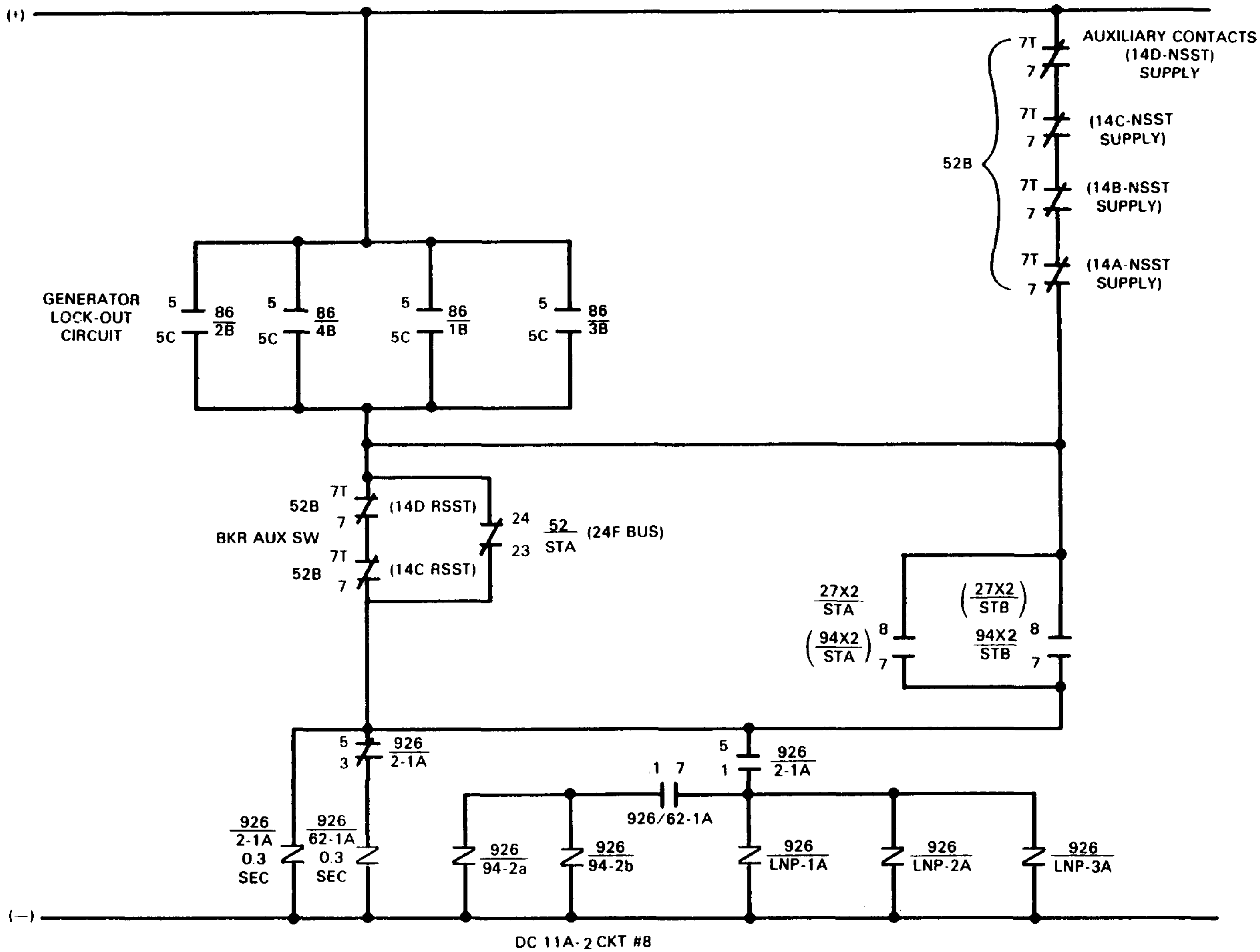


FIGURE B.17-5. EMERGENCY AC POWER SYSTEM CONTROL WIRING SCHEMATICS LNP RELAYS (SHEET 5 OF 8)

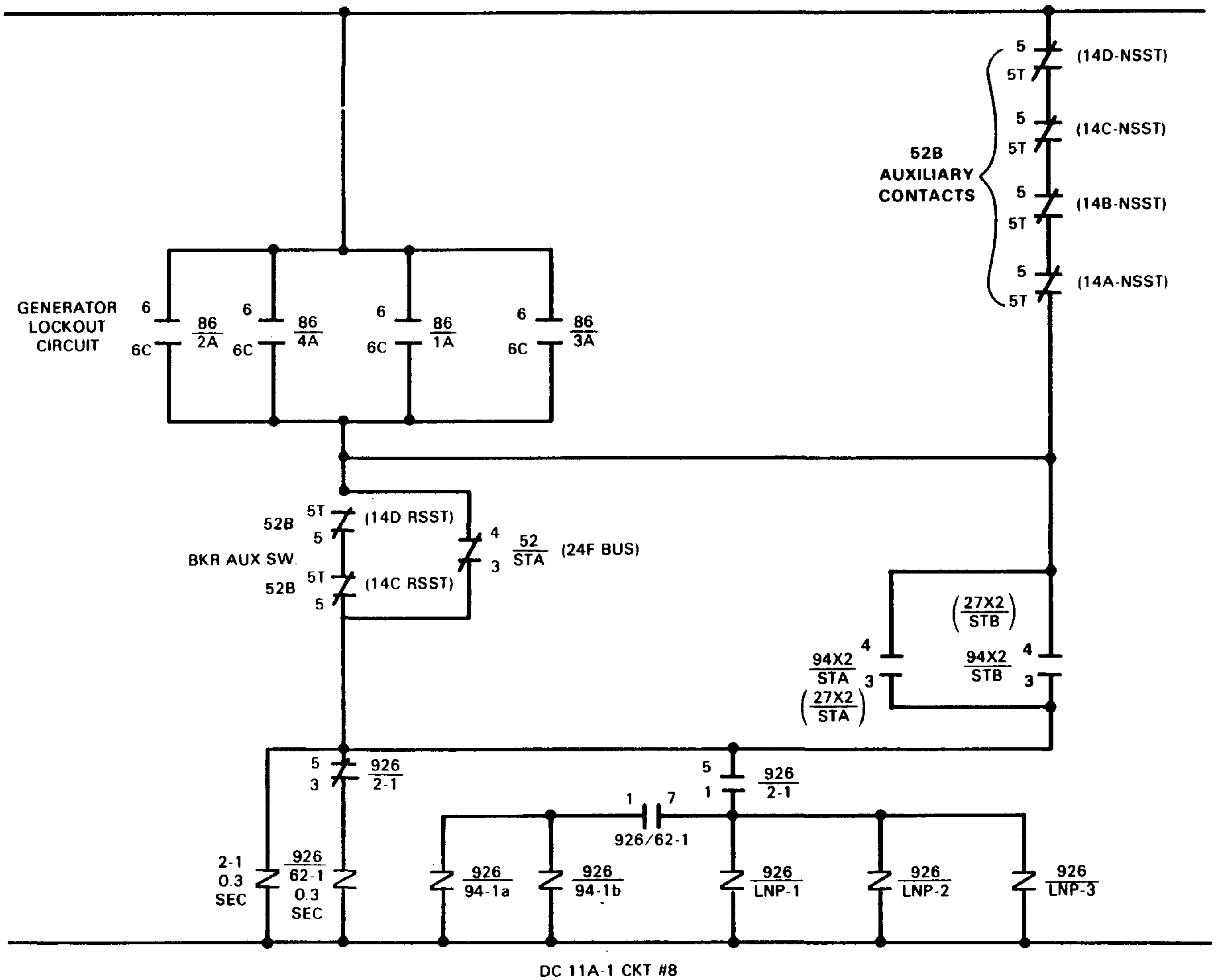


FIGURE B.17-5. EMERGENCY AC POWER SYSTEM CONTROL WIRING SCHEMATICS LNP RELAYS (SHEET 6 OF 8)

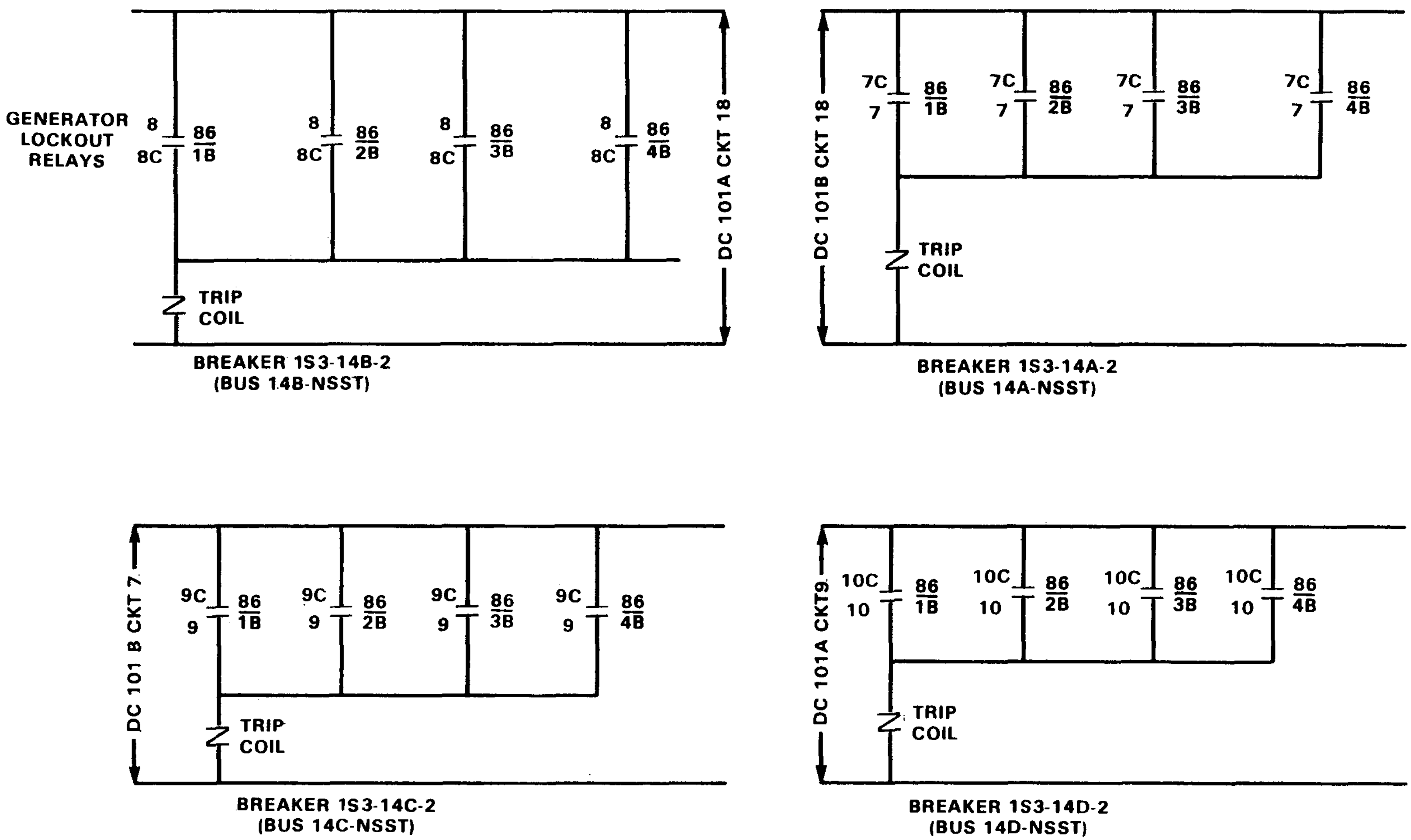


FIGURE B.17-5. EMERGENCY AC POWER SYSTEM CONTROL WIRING SCHEMATICS GENERATOR LOCK OUT TRIP SIGNALS (SHEET 7 OF 8)

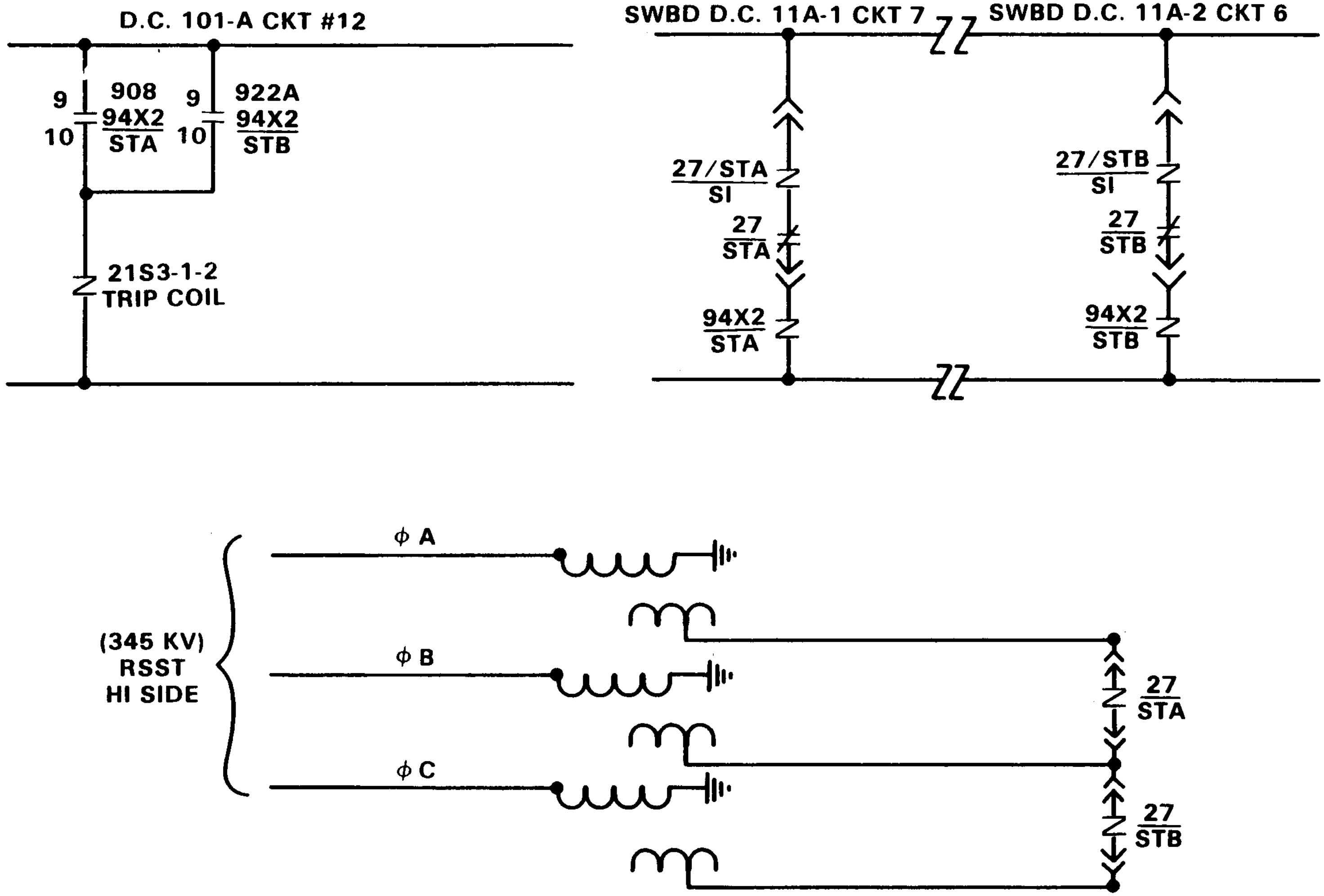


FIGURE B.17-5. EMERGENCY AC POWER SYSTEM CONTROL WIRING SCHEMATICS RESERVE STATION TRANSFORMER (RSST) VOLTAGE INDICATION (SHEET 8 OF 8)

EMERGENCY AC POWER SYSTEM

FAULT TREE AND FAULT SUMMARY SHEETS

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
AC-EF3-BUS-LOF AC-E1-BUS-LOF AC-E3-BUS-LOF AC-E4-BUS-LOF AC-E5-BUS-LOF AC-E6-BUS-LOF AC-E7-BUS-LOF AC-EF7-BUS-LOF AC-12E-BUS-LOF AC-14E-BUS-LOF AC-14C-BUS-LOF AC-14G-BUS-LOF AC-14F-BUS-LOF AC-FE3-BUS-LOF AC-F1-BUS-LOF AC-F3-BUS-LOF AC-F4-BUS-LOF AC-F5-BUS-LOF AC-F6-BUS-LOF AC-F7-BUS-LOF AC-12F-BUS-LOF AC-C2-BUS-LOF AC-C3-BUS-LOF AC-C6-BUS-LOF	Local fault on A.C. power bus	Prompt	L/O almost any of these buses would cause plant trip (except C-2, C-3, & C-6) annunciator alarm in the control room for these buses	$2.5x10^{-6}$
AC-12C-BUS-LOF AC-12D-BUS-LOF AC-14A-BUS-LOF AC-IAC-BUS-LOF AC-VAC-BUS-LOF	Local fault on A.C. power bus	Prompt	L/O any of these buses (except 12C, D) would cause plant trip, annunciated in the control room	$2.5x10^{-6}$

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
AC-RPSA-BUS-LOF AC-RPSB-BUS-LOF	Local fault on A.C. power bus	Prompt	Loss of either bus causes at least a "half seram"	2.5E-6
AC-EF3-BUS-TOM AC-E1-BUS-TOM AC-E3-BUS-TOM AC-E4-BUS-TOM AC-E5-BUS-TOM AC-E6-BUS-TOM AC-E7-BUS-TOM AC-EF7-BUS-TOM AC-F1-BUS-TOM AC-F3-BUS-TOM AC-F4-BUS-TOM AC-F5-BUS-TOM AC-F6-BUS-TOM AC-F7-BUS-TOM AC-12E-BUS-TOM AC-14E-BUS-TOM AC-14C-BUS-TOM AC-14G-BUS-TOM AC-14F-BUS-TOM AC-FE3-BUS-TOM AC-12F-BUS-TOM AC-C2-BUS-TOM AC-C3-BUS-TOM AC-C6-BUS-TOM AC-12C-BUS-TOM AC-14A-BUS-TOM	Test or maint. on A.C. power bus	N/A	Uncsheduled maint. only. For test or maint. to occur on almost any of these buses plant would be shutdown.	2.5E-6

MILLSTONE 1
SYSTEM AC
SHEET #2

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
AC-FE3-ABT-LOF AC-EF7-ABT-LOF AC-FE3-ABT-LOF AC-IAC-ABT-LOF AC-VAC-ABT-LOF AC-MG1-ABT-LOF	Auto-bus transfer fails to function		Although not in written procedures operations tests ABT function prior to LNP test (based on talk with/OPS) see OP 343 for VAC & IAC ABTS	3×10^{-1}
AC-12E-18A-FRC AC-12E-18C-FRC AC-12E-19C-FRC AC-12E-19B-FRC AC-12E-19D-FRC AC-12E-12B-FRC AC-14E12-12-FRC AC-14ET-2-FRC AC-12F-12B-FRC AC-14F12-12-FRC AC-12C-12B-FRC AC-14C12-13-FRC AC-MGVAC-NC-FRC AC-E5-10-FRC AC-RPSA-1-FRC AC-F5-1C-FRC AC-RPSB-1-FRC AC-F5-1C-FRC	Local fault on A.C. power circuit breaker (i.e. bkr fails to remain closed)	Prompt	A trip on almost any of these breakers would cause a plant shut-down alarmed in CR Note: tripping any RPS bkrs will cause "half scram"	2.5×10^{-5}

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
AC-IRP-4-FRC AC-E4-4C-FRC	Local fault on A.C. power circuit breaker	<24 hrs Light comes on in control room	Due to emerg. feed to IAC bus, whenever normal feed interrupted c.r. light "emergency source" comes on	$2.5x10^{-5}$
AC-IV-3-FRC AC-F5-1F-FRC AC-IV-4-FRC DC-AB3-1-FRC	Local fault on A.C. power breaker (i.e. fails to remain closed)		Not checked by any procedure - only evident on demand for A.C. power	$1x10^{-1}$
AC-12F-18A-FRC AC-12F-18C-FRC AC-12F-19C-FRC AC-12F-19B-FRC AC-12F-19A-FRC AC-12F-19D-FRC	Local fault on A.C. power breaker (i.e. breaker fails to remain closed)	Prompt	Plant may shutdown if one or more of these breakers trip, alarmed in the CR	$2.5x10^{-5}$
AC-12F-18A-OPO AC-12F-18C-OPO AC-12F-19C-OPO AC-12F-19B-OPO AC-12F-19A-OPO AC-12F-19D-OPO AC-12E-12B-OPO AC-14E12-12-OPO AC-14ET-2-OPO AC-12F-12B-OPO AC-14F12-12-OPO AC-12C-12B-OPO	Operator opens breaker during accident/LNP		Plant may shutdown if one or more breakers are opened	0.0

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
AC-12C-17B-FRC AC-12C-17C-FRC AC-12C-13D-FRC	Local fault on A.C. power breaker (i.e. fails to remain open)	Prompt	Breaker position alarmed in the CR	$2.5x10^{-5}$
AC-12C-17B-OPO AC-12C-17C-OPO AC-12C-13D-OPO AC-14C12-13-OPO AC-14CT-16-OPO AC-14AT2-1-OPO AC-12F-18A-OPO AC-12F-18C-OPO AC-12F-19C-OPO AC-12F-19B-OPO AC-12F-19A-OPO AC-12F-19D-OPO	Operator opens breaker during accident/LNP		Opening one or more of these breakers may cause plant shutdown. There is no procedure for opening the breakers following an accident	0.0
AC-12E-18A-TMO AC-12E-18C-TMO AC-12E-19C-TMO AC-12E-19B-TMO AC-12E-19A-TMO AC-12E-19D-TMO AC-12E-12B-TMO AC-14E12-12-TMO AC-14CT-16-TMO AC-12F-12B-TMO AC-14F12-12-TMO AC-14ET-2-TMO AC-12C-17B-TMO	Breaker open for test or maintenance		Unscheduled maint. only. Plant would have to be shutdown for maint. on almost any of these breakers	$1x10^{-6}$

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
AC-12C-17C-TMO AC-12C-13D-TMO AC-14C12-13-TMO AC-14AT2-1-TMO AC-IRP-4-TMO AC-IV-3-TMO AC-E4-4C-TMO AC-F5-IF-TMO AC-IV-4-TMO DC-AB3-1-TMO AC-12F-18A-TMO AC-12F-18C-TMO AC-12F-19C-TMO AC-12F-19B-TMO AC-12F-19A-TMO AC-12F-19D-TMO	Breaker open for test or maintenance		Unscheduled maint. only. Plant would have to be shutdown for maint. on almost any of these breakers	$1x10^{-6}$
AC-14E12-XFR-LOF AC-14F12-XFR-LOF AC-14C12-XFR-LOF	Local fault on step-down transformer (4160V to 480V)	Prompt	Would cause loss of A.C. supply to 480V buses which would produce c.r. alarm	$5x10^{-5}$
AC-IRP-XFR-LOF	Local fault on step-down transformer (480V to 120V)	<24 hrs	L/O power to IAC bus from IRP x-former would cause c.r. panel light to come on	$5x10^{-5}$

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
AC-14E12-XFR-TOM AC-14F12-XFR-TOM AC-14C12-XFR-TOM AC-IRP-XFR-TOM AC-IV-XFR-TOM	Transformer out of service for test or maintenance		Only unscheduled maint. - would probably have to be done with plant shutdown	$5x10^{-5}$
AC-14CT-16-FTC AC-14AT2-1-FTC	Breaker fails to close	12K hrs (once every refueling outage)	As per SP 617.1 and SP 628.1 (LNP test)	$1.7x10^{-2}$
AC-14AT2-1-FTO AC-14CT-16-FTO AC-14A-3-FTO AC-14A-4-FTO AC-14A-5-FTO AC-12T12-14B-FTO AC-1S14A-2-FTO AC-1S14B-1-FTO AC-1S14C-1-FTO AC-1S14D-1-FTO AC-14FT-2-FTO	Breaker fails to open	12K hrs (once every refueling outage)	SP 617.1 & 628.1 (LNP test) Note: bkr 12T12 only tested by SP 617.1 (tie bkr 12C-D)	$1.7x10^{-2}$
AC-21S24F-1-FTO	Breaker fails to open		Since RSST always energized, breaker on bus 24F may never be opened	$3x10^{-1}$

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
AC-GTG-LOF	Gas Turbine generator fails to start	One month	SP 668.2 tests every month SP 617.1 & 628.1 go through LNP & ECCS start every 12 K hr	$6x10^{-2}$
AC-GTG-TOM	Gas turbine generator out of service due to test or maint.		G/T O.O.S for ¼ hr every 720 hrs. due to coast-down time after monthly test start. (SP 668.2)	$2x10^{-3}$
AC-GTG-BAT-LOF	L/O Gas Turbine battery bus (provides power to start G/T during LNP)	One week (168 hrs)	"Black start" on G/T system per 617.1, 628.1 & weekly check of battery voltage & current OP 339-2	$2.5x10^{-4}$
LCL94X-1A-1FC LCL94X-1A-9FC LCL94X-1B-1FC LCL94X-4A-5FC	Relay contacts fail to close	12K hrs (once every refuel outage)	SP 617.1 & 628.1 tests load shedding ability	$1.8x10^{-3}$
LCL94X-1A-FTE LCL94X-1B-FTE LCL94X-4A-FTE	Relay coil fails to energize	12000 hrs (detected during refueling outages)	SP 617.1 & 628.1 tests load shedding ability	$1.7x10^{-3}$

MILLSTONE 1
SYSTEM AC
SHEET #8

<u>FAULT SUMMARY SHEETS</u>

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
92694-1A-1FC 92694-2A-1FC 92694-1B-9FC 92694-2B-9FC 92694-1B-3FC 92694-2B-3FC	Relay contacts fail to close	12K hrs (once envery refuel-outage)	Contact pair checked as per SP 617.1 Individually (Integrated system tests several contact prs. together SP 628.1)	$1.8x10^{-3}$
92694-1A-FTE 92694-2A-FTE 92694-1B-FTE 92694-2B-FTE	Relay coil fails to energize	12K hrs	SP617.1 & 628.1 tests coils in pairs (i.e. 1A & 2A) <u>not</u> separately, during refueling outages	$7x10^{-3}$
AC-DGN-LOF	Diesel generator fails to start	One week	Weekly test as per OP 338. Monthly test as per SP 668.1	$6x10^{-2}$
AC-DGN-TOM	Diesel generator O.O.S. for test or maintenance		Diesel not O.O.S. due to testing, only for <u>unscheduled</u> maintenance	$2x10^{-3}$
AC-12T12-14B-FRO	Breaker fails to remain open	<24 hrs.	Control room panel light on breaker would change status plus either 12C or 12D transformer would trip	$2.5x10^{-5}$
AC-12T12-14B-OPC	Operator closes Breaker	<24 hrs.		$3x10^{-3}$

MILLSTONE 1
SYSTEM AC
SHEET #9

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
926LNP-3A-BFC 926LNP-3-BFC 926LNP-1-3FC 926LNP-1A-3FC 926LNP-1-1FC 926LNP-1A-1FC 926LNP-2-5FC 926LNP-2A-5FC	LNP relay contacts fail to close	12K hrs.	SP 617.1 & 628.1 tests relays in pairs (i.e. 3 & 3A, etc.) not as separate units	7×10^{-3}
926LNP-2-BFC 926LNP-2A-BFC	LNP relay contacts fail to close	12K hrs (during refueling outages)	Contact pair specifically checked as per SP 617.1. Also SP 628.1 integrated test checks relays in pairs	1.8×10^{-3}
926LNP-3-FTE 926LNP-3A-FTE 926LNP-1-FTE 926LNP-1A-FTE	LNP relay coil fails to energize	12 K hrs. (once per refuel outage)	LNP coils tested in pairs (i.e. 3 & 3A, etc.) not individually as per SP 617.1 & 628.1	7×10^{-3}
92662-1-1FC 92662-1A-1FC	LNP relay contacts fail to close	12K hr.	Contact prs. on relays tested w/ relays in pairs (i.e. 1 & 1A) as per SP 617.1 & 628.1	7×10^{-3}

MILLSTONE 1
SYSTEM AC
SHEET #10

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
92662-1-FTE 92662-1A-FTE	LNP relay coil fails to energize	12000 hrs	Relay coils tested in pairs not separately as per SP 617 & 628.1	$7x10^{-3}$
LCL52-24F-WFC LCL52-24F-3FC	Aux breaker contacts fail to close		RSST always kept energized during LNP & integ. tests. Therefore 2153-1-2 breaker not tested	$3x10^{-2}$
AC-21S14C-14-FRO AC-21S14D-14-FRO AC-21S14A-14-FRO	4160V RSST tie breaker fails to remain open	Prompt (during LNP); <24 hours (normal operation)	During LNP if either 14A or 14C to RSST closed G/T would overload	$2.5x10^{-5}$
LCL52B-14CR-7RC LCL52B-14DR-7RC LCL52B-14CR-5RC LCL52B-14DR-5RC LCL52STA-14-3RC LCL52STA-7-3RC	4160V breaker aux switch contacts fail to remain closed	12K hrs (once every refuel)	SP 617.7 & 628.1 (LNP & integrated ECCS tests) tests each separately by virtue of being in series circuit	$6x10^{-4}$
922A86-3B-5FC 922A86-1B-5FC 922B86-2B-5FC 922B86-4B-5FC 922A86-3A-6FC 922A86-1A-6FC 922B86-2A-6FC	Gen lockout relay contacts fail to close	12K hrs	Relays tested in groups of 4 (i.e. 86-B's and 86-A's) by SP 617 & 628.1	$2.6x10^{-2}$

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
922B86-4A-6FC 922A86-1B-7FC 922A86-3B-7FC 922B86-2B-7FC 922B86-4B-7FC 922A86-1B-8FC 922A86-3B-8FC 922B86-2B-8FC 922B86-4B-8FC 922A86-1B-9FC 922A86-3B-9FC	Gen lockout relay contacts fail to close	12K hrs	Relays tested in groups of 4 (i.e. 86-B's and 86-A's) by SP 617 & 628.1	$2.6x10^{-2}$
922A86-2B-9FC 922A86-4B-9FC 922B86-1B-AFC 922B86-3B-AFC 922A86-2B-AFC 922A86-4B-AFC	Gen. lockout relay contacts fail to close	Integrated test of system every 12K hrs.	Relays tested in groups of 4 (i.e. 86-A's and 86-B's have 4 in each gp) by SP 617.1 & 628.1	$2.6x10^{-2}$
AC-GENLOC-3-LOF AC-GENLOC-1-LOF AC-GENLOC-2-LOF AC-GENLOC-4-LOF	Gen. lockout circuitry fails to provide a signal to "86" relays	12K hrs (once every refuel)	Tested individually since each "86" relay must be reset after test as per SP 617.1 & 628.1	$1.7x10^{-3}$
90894X2-STA-7FC 922A94X2-STB-7FC 90894X2-STA-3FC 922A94X2-STB-3FC 90894X2-STA-9FC 922A94X2-STB-9FC	Contacts on under voltage relays fail to close		Detects RSST hi-side under voltage, but RSST always energized during testing	$3x10^{-2}$

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
90894X2-STA-FTE 922A94X2-STB-FTE	Coil on under-voltage relay fails to energize		Detects RSST hi-side undervoltage, but RSST always energized during test	$3x10^{-2}$
AC-27-ST-XFC AC-27-STB-XFC	No signal from undervoltage relay (i.e. contacts fail to close)		Detects low voltage on RSST in-side, but but RSST always energized during testing	$3x10^{-2}$
922A86-3A-FTE 922A86-1A-FTE 922B86-2A-FTE 922B86-4A-FTE 922A86-1B-FTE 922A86-3B-FTE 922B86-2B-FTE 922B86-4B-FTE	Gen. lockout relay coil fails to energize	12K hr. (once every refuel)	Each "86" relay must be reset after testing by SP 617.1 & 628.1	$1.7x10^{-3}$
LCL86-512-BRC LCL86-B-BRC LCL86-GC-BRC LCL86-512-ARC LCL86-B-ARC LCL86-GC-ARC	Relay contacts fail to remain closed	12000 hrs (once every refule)	Tested separately (by virtue of being in series) in SP 617.1 & 628.1	$6x10^{-4}$

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
90862-14CT-2RC 908RX-14CT-4RC 90862-14AT-2RC 908RX-14AT-4RC LCL52-TOC-4RC	Relay contacts fail to remain closed	12K hrs. (once every refuel)	Tested by SP 617.1 SP 628.1	$6x10^{-4}$
90862-14CT-FRE 90862-14AT-FRE	Relay coil fails to remain energized	12000 hrs (detected during refueling outages)	Tested as per SP 617.1 & SP 628.1	$6x10^{-4}$
908RX-14CT-2FC 908RX-14AT-2FC 908TDPU-14CT-1FC 908TDPU-14AT-1FC LCL52-GT-8FC LCL52STA-1-3FC LCL27-3-7FC LCL27-7-3FC LCL52-GT-6FC LCL52STA-2-3FC LCL27-1-3FC LCL27-7-1FC	Relay contacts fail to close (Note: 52's ave aux switch contacts on breakers)	12000 hrs (detected during refueling outages)	Tested during the performance of SP 617.1 & SP 628.1	$1.8x10^{-3}$
980RX-14CT-FTE 908TDPU-14CT-FTE 908TDPU-14AT-FTE LCL27-7-FTE 908RX-14AT-FTE	Relay coil fails to energize	12K hrs (once every refuel)	Tested per SP 617.1 & 628.1	$1.7x10^{-3}$

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
LCL94X-3C-1FO 92694-1A-5FO 92694-2A-5FO 92662-1-XFO 92662-1A-XFO LCL94X-1B-9FO 92694-1A-1FO 92694-2A-1FO	Relay contacts fail to open	12000 hrs (detected during refueling outages)	Tested as per SP 617.1 & SP 628.1	1.8×10^{-3}
LCL94X-3C-FTD LCL27-3-FTD LCL94X-1B-FTD LCL27-1-FTD 92694-1A-FTD 92694-2A-FTD	Relay coil fails to de-energize	12000 hrs (detected during refueling outages)	Tested as per SP 617.1 & SP 628.1	1.7×10^{-3}
908CS-111-FRD 908CS-110-FRD	Control switch fails in tripped state	<24 hr in normal plant operation	Failure indication is breaker position light on 908 panel. Failure leads to failure to restore emergency loads after G/T starts	2.4×10^{-7}
908CS-111-3RO 908CS-111-4RO 908CS-110-3RO 908CS-110-4RO	Control switch contacts fail to remain open	<24 hrs	Failure is detected by change in breaker position light. Failure leads to loss of emergency loads.	6×10^{-8}

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
9262-1-3RC 9262-1A-3RC	Relay contacts fail to remain closed	12K hrs.	Relay 62-1 and 62-1A tested in parallel by SP 617.1 & SP 628.1	$2.5x10^{-3}$
AC-MG1-MGS-LOF AC-RPSA-MGS-LOF AC-RPSB-MGS-LOF	L/O motor-generator source of A.C. power	Prompt	Vital A.C. alarms and switches over to emergency source RPS not only alarms but produces at least a "half-scram"	$5x10^{-4}$
LCL52B-14AN-7FC LCL52B-14BN-7FC LCL52B-14CN-7FC LCL52B-14DN-7FC LCL52B-14AN-5FC LCL52B-14BN-5FC LCL52B-14CN-5FC LCL52B-14DN-5FC	Breaker aux. switch contacts fail to close	12K hr (once every refuel)	Contacts checked individually by SP 617.1	$1.8x10^{-3}$
926LNP-2-FTE 926-LNP-2A-FTE	LNP coil fails to energize	12 K hrs. (detected during refueling outages)	Each coil "proved" individually by ECCS test in SP 628.1.	$1.7x10^{-3}$
9262-1A-FTE 9262-1-FTE	Relay coil fails to energize	12000 hrs (detected during refueling outages)	2-1 and 2-1A coils tested by virtue of LNP2 and LNP2A as per SP 628.1	1.7E-3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
9262-1A-1FC 9262-1-1FC	Relay contacts fail to close	12K hrs. (detected during refueling outages)	Tested by SP 628.1, separately, as a result of test on LNP2A & LNP2	$1.8x10^{-3}$
AC-31S14G-4-FTO	Flanders bkr fails to open	One month	Opened prior to loading G/T on 14G per SP 668.2	$1x10^{-3}$
908CS-111-1FC 908CS-111-2FC 908CS-110-1FC 908CS-110-2FC	Contacts on control swicth fail to close		To be used in recovery only	
908CS-111-FTE 908CS-110-FTE	Control switch fails to operate		To be used in recovery only	
AC-14CT-16-OFC AC-14AT2-1-OFC	Operator fails to close breaker		To be used in recovery only	1.0
LCL27-3-5FC LCL27-1A-3FC	Relay contacts fail to close		Used in recovery only	
LCL27-1A-FTD	Relay coil fails to de-energize		Used in recovery only	

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
SW-DGN-HTX-LOF	LOF-Loss of service water cooling flow to the diesel generator HTX. This would result in the diesel generator HTX failure.	Prompt	The failure probability was determined by evaluating the diesel generator heat exchanger loss of function as a top event in the SWS fault tree	$7.14x10^{-2}$
AC-IV-XFR-LOF	Local fault on step-down transformer		This fault may not be detected	$2x10^{-1}$

MILLSTONE 1
SYSTEM AC
SHEET #18

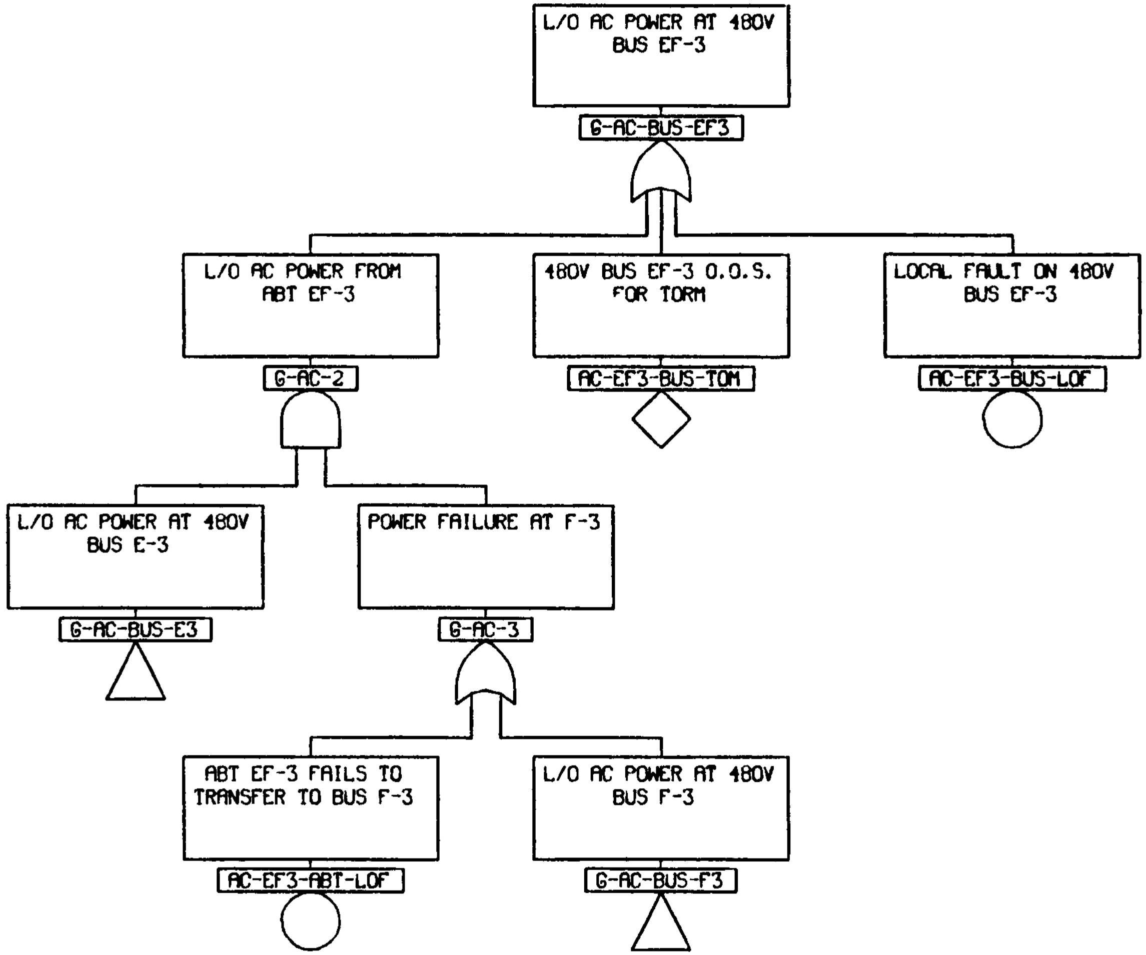
AC POWER FAULT TREE PAGE INDEX

GATE NAME	DEFINED ON PAGE	TRANSFERS TO PAGE(S)
G-AC-21	AC-10	AC-9
G-AC-26	AC-13	AC-12
G-AC-27	AC-14	AC-13,AC-39
G-AC-28	AC-15	AC-14
G-AC-31	AC-16	AC-15
G-AC-36	AC-17	AC-16
G-AC-37	AC-17	AC-16
G-AC-38	AC-18	AC-17,AC-19
G-AC-43	AC-37	AC-35
G-AC-44	AC-19	AC-16
G-AC-48A	AC-21	AC-20
G-AC-66	AC-30	AC-29
G-AC-75	AC-35	AC-34
G-AC-76	AC-36	AC-34
G-AC-80A	AC-39	AC-38
G-AC-81	AC-40	AC-15
G-AC-82	AC-40	AC-40,AC-66,AC-75,AC-89,AC-97
G-AC-83	AC-41	AC-40,AC-94
G-AC-86	AC-42	AC-41
G-AC-91	AC-43	AC-41
G-AC-94	AC-44	AC-43,AC-78,AC-81,AC-84,AC-87
G-AC-95	AC-44	AC-43,AC-78,AC-81,AC-84,AC-87
G-AC-96	AC-45	AC-41
G-AC-99	AC-46	AC-45,AC-79,AC-82,AC-88
G-AC-100	AC-46	AC-45,AC-79,AC-82,AC-88
G-AC-101	AC-47	AC-41
G-AC-102	AC-48	AC-47
G-AC-103	AC-48	AC-47
G-AC-104	AC-48	AC-47
G-AC-105	AC-48	AC-47
G-AC-106	AC-49	AC-42
G-AC-109	AC-50	AC-49,AC-58,AC-90
G-AC-110	AC-50	AC-49,AC-58,AC-90
G-AC-111	AC-51	AC-15
G-AC-112	AC-51	AC-51,AC-64,AC-73,AC-89,AC-97
G-AC-113	AC-52	AC-51,AC-93
G-AC-116	AC-53	AC-52
G-AC-121	AC-54	AC-52
G-AC-126	AC-55	AC-52
G-AC-131	AC-56	AC-52
G-AC-132	AC-57	AC-56
G-AC-133	AC-57	AC-56
G-AC-134	AC-57	AC-56
G-AC-135	AC-57	AC-56
G-AC-138	AC-59	AC-13
G-AC-139	AC-58	AC-53
G-AC-141	AC-60	AC-59
G-AC-146	AC-62	AC-61
G-AC-147	AC-62	AC-61

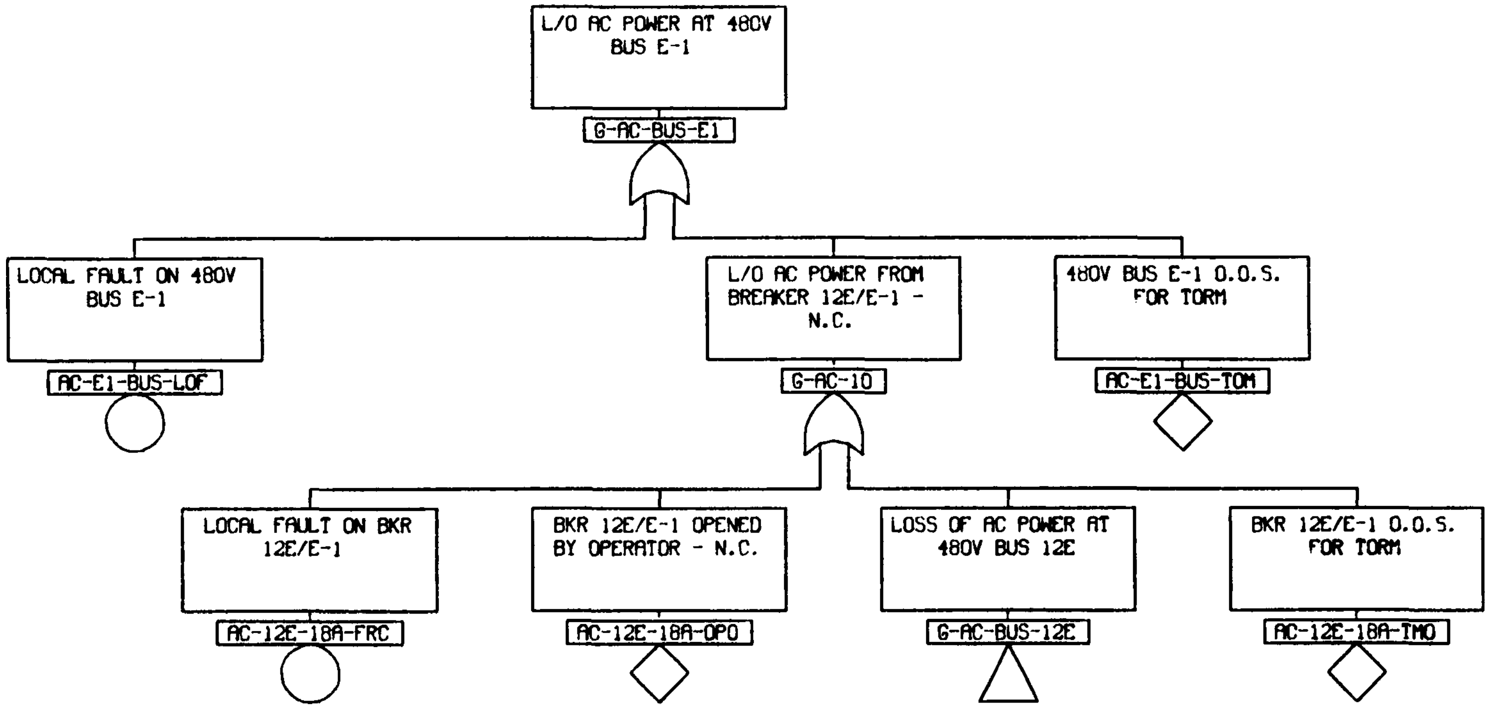
AC POWER FAULT TREE PAGE INDEX (Cont.)

GATE NAME	DEFINED ON PAGE	TRANSFERS TO PAGE(S)
G-AC-148	AC-61	AC-59
G-AC-151	AC-63	AC-60
G-AC-153	AC-64	AC-63
G-AC-155	AC-65	AC-63
G-AC-156	AC-65	AC-63
G-AC-157	AC-66	AC-64
G-AC-158	AC-67	AC-63
G-AC-159	AC-67	AC-63
G-AC-160	AC-68	AC-59
G-AC-163	AC-69	AC-39
G-AC-166	AC-70	AC-69
G-AC-173	AC-71	AC-69
G-AC-176	AC-72	AC-70
G-AC-178	AC-73	AC-72
G-AC-180	AC-74	AC-72
G-AC-181	AC-74	AC-72
G-AC-182	AC-75	AC-73
G-AC-183	AC-75	AC-72
G-AC-184	AC-75	AC-72
G-AC-185	AC-76	AC-69
G-AC-188	AC-77	AC-14,AC-48,AC-57,AC-74
G-AC-191	AC-78	AC-77
G-AC-192	AC-78	AC-77
G-AC-193	AC-79	AC-77
G-AC-194	AC-79	AC-77
G-AC-195	AC-80	AC-48,AC-57
G-AC-198	AC-81	AC-80
G-AC-199	AC-81	AC-80
G-AC-200	AC-82	AC-80
G-AC-201	AC-82	AC-80
G-AC-202	AC-83	AC-14,AC-48,Ac-57,AC-65
G-AC-205	AC-84	AC-83
G-AC-206	AC-84	AC-83
G-AC-207	AC-85	AC-83
G-AC-208	AC-85	AC-83
G-AC-209	AC-86	AC-21,AC-48,AC-57
G-AC-212	AC-87	AC-86
G-AC-213	AC-87	AC-86
G-AC-214	AC-88	AC-86
G-AC-215	AC-88	AC-86
G-AC-216	AC-89	AC-21
G-AC-221	AC-90	AC-42,AC-53
G-AC-227	AC-91	AC-14
G-AC-229	AC-92	AC-91
G-AC-231	AC-93	AC-18,AC-92,AC-98
G-AC-233	AC-94	AC-18,AC-92,AC-98
G-AC-234	AC-95	AC-93
G-AC-236	AC-96	AC-21
G-AC-240	AC-97	AC-96

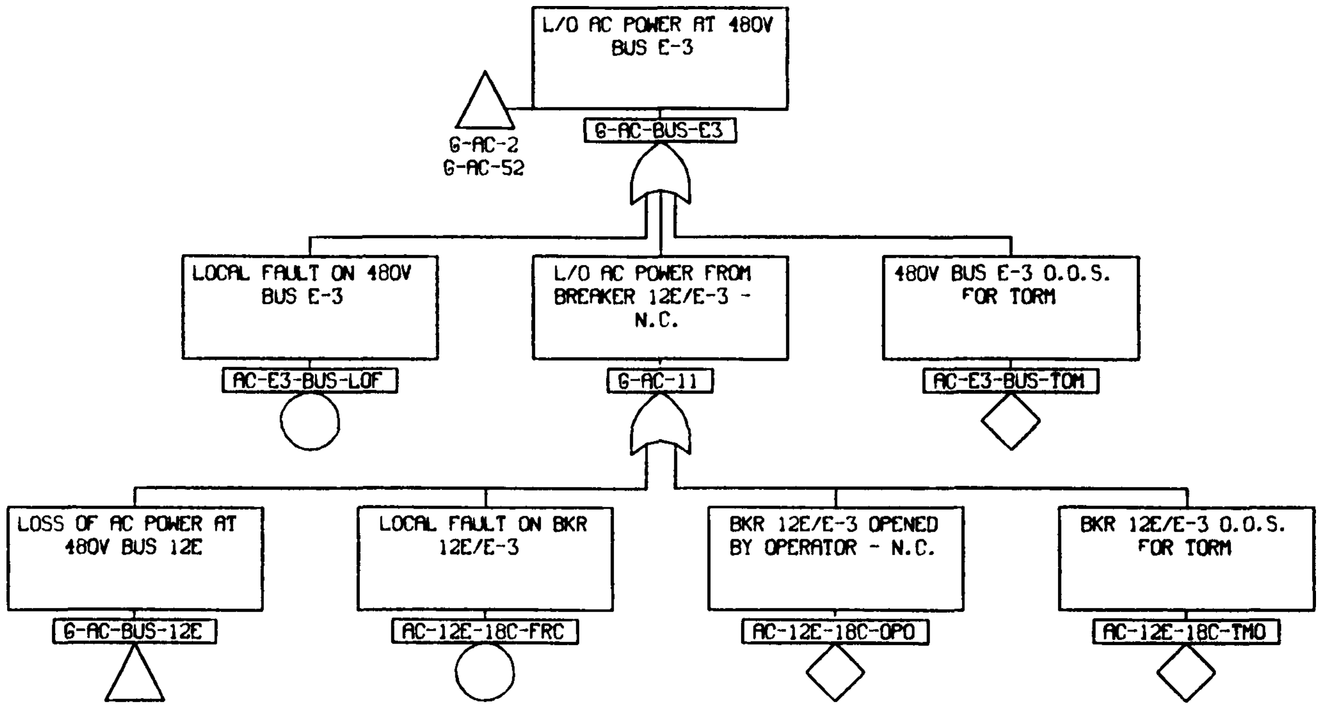
AC POWER FAULT TREE PAGE INDEX (Cont.)

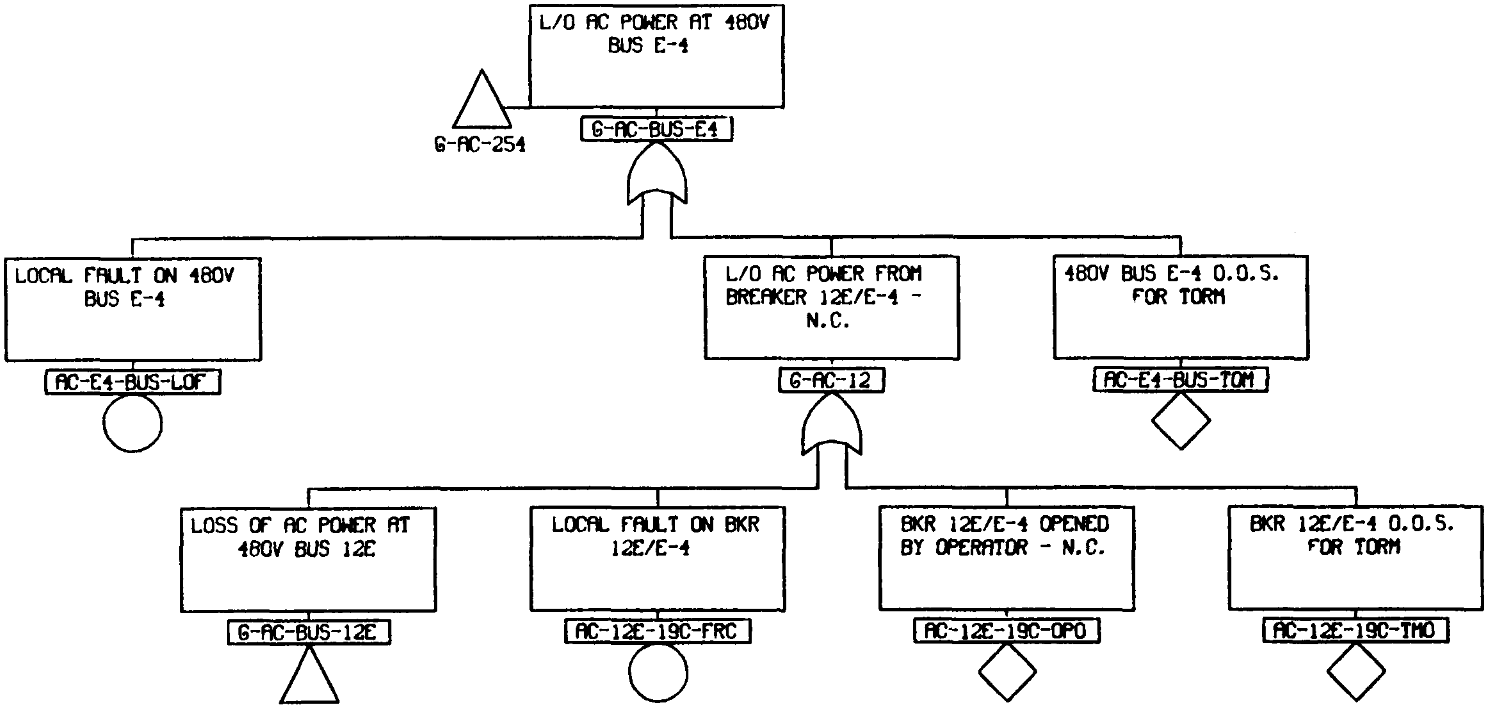

L/O AC POWER AT 480V BUS EF-3
G-AC-BUS-EF3
L/O AC POWER FROM ABT EF-3
G-AC-2
480V BUS EF-3 O.O.S. FOR TORM
AC-EF3-BUS-TOM
LOCAL FAULT ON 480V BUS EF-3
AC-EF3-BUS-LOF
L/O AC POWER AT 480V BUS E-3
G-AC-BUS-E3
POWER FAILURE AT F-3
G-AC-3
ABT EF-3 FAILS TO TRANSFER TO BUS F-3
AC-EF3-ABT-LOF
L/O AC POWER AT 480V BUS F-3
G-AC-BUS-F3

AC-1


L/O AC POWER AT 480V BUS E-1
G-AC-BUS-E1
LOCAL FAULT ON 480V BUS E-1
AC-E1-BUS-LOF
L/O AC POWER FROM BREAKER 12E/E-1 - N.C.
G-AC-10
480V BUS E-1 O.O.S. FOR TORM
AC-E1-BUS-TOM
LOCAL FAULT ON BKR 12E/E-1
AC-12E-18A-FRC
BKR 12E/E-1 OPENED BY OPERATOR - N.C.
AC-12E-18A-OPO
LOSS OF AC POWER AT 480V BUS 12E
G-AC-BUS-12E
BKR 12E/E-1 O.O.S. FOR TORM
AC-12E-18A-TMO

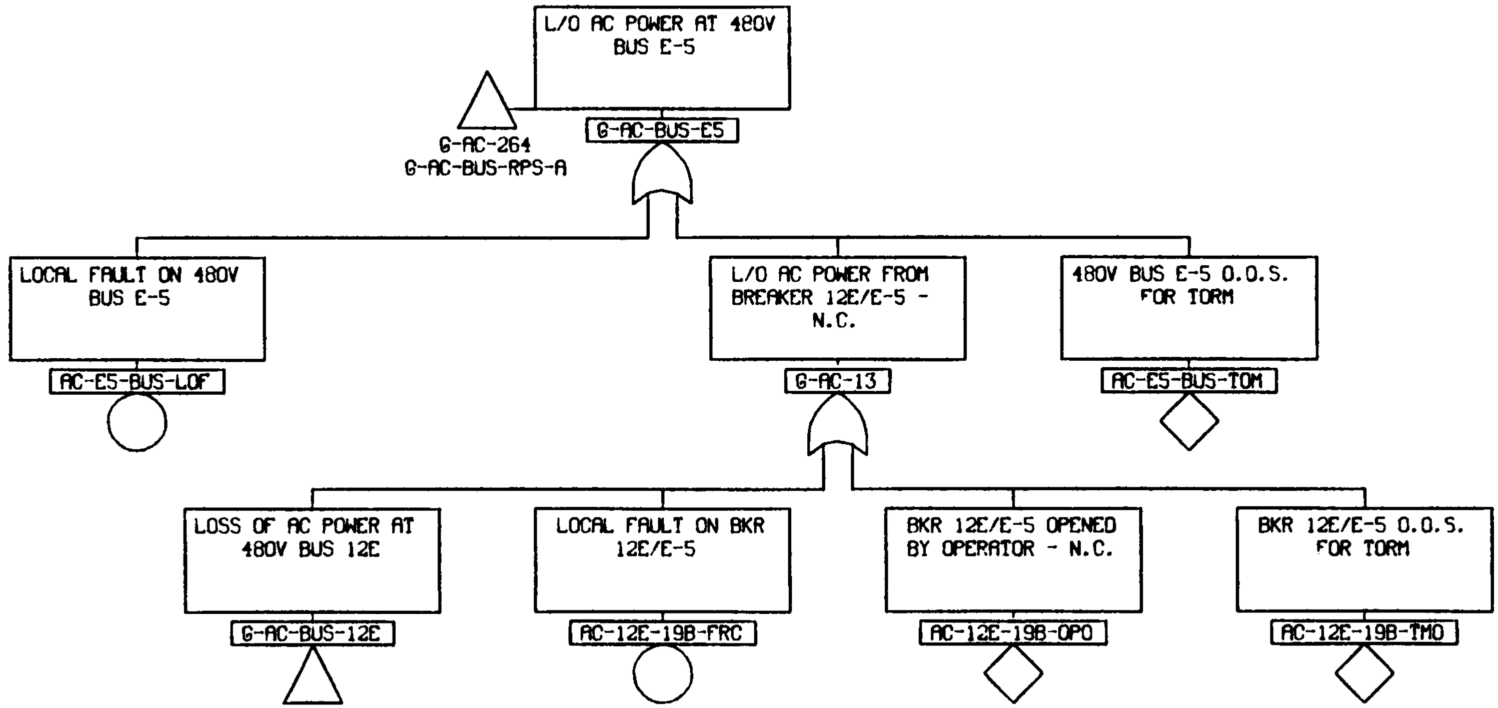
AC-2

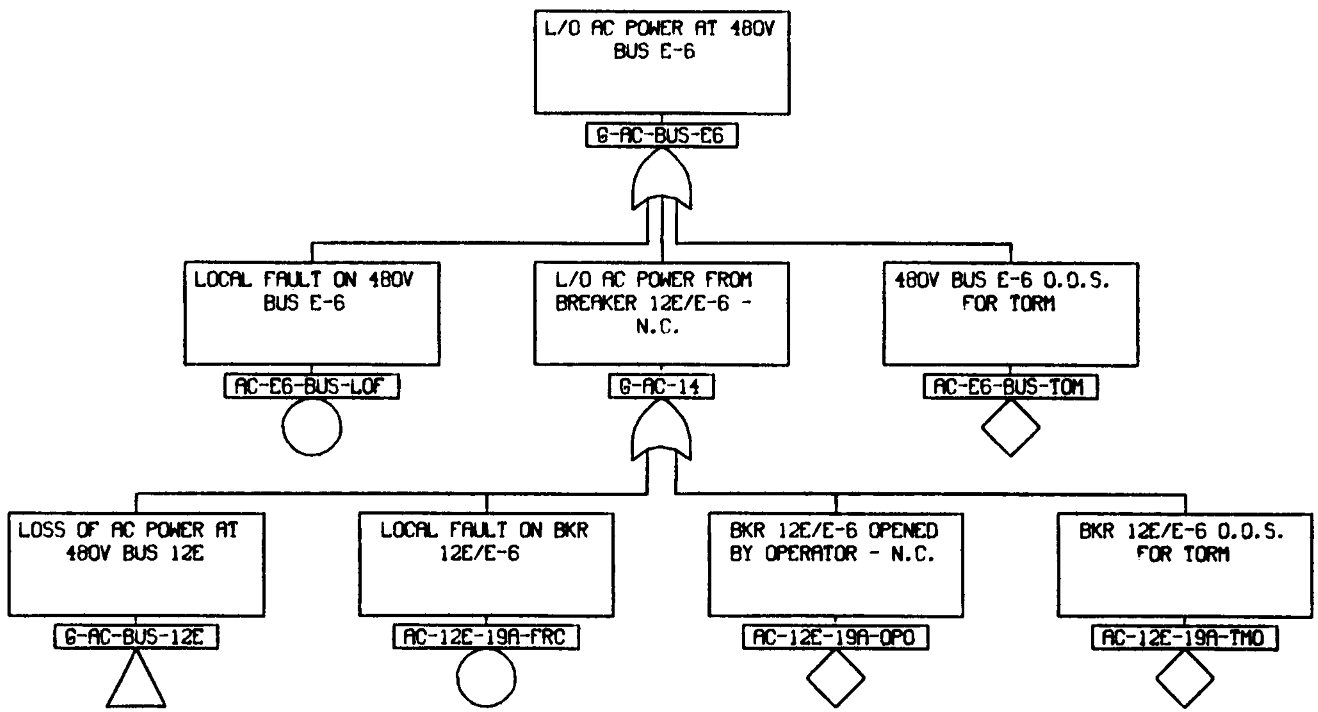

L/O AC POWER AT 480V BUS E-3
G-AC-BUS-E3
G-AC-2
G-AC-52
LOCAL FAULT ON 480V BUS E-3
AC-E3-BUS-LOF
L/O AC POWER FROM BREAKER 12E/E-3 - N.C.
G-AC-11
480V BUS E-3 O.O.S. FOR TORM
AC-E3-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12E
G-AC-BUS-12E
LOCAL FAULT ON BKR 12E/E-3
AC-12E-18C-FRC
BKR 12E/E-3 OPENED BY OPERATOR - N.C.
AC-12E-18C-OPO
BKR 12E/E-3 O.O.S. FOR TORM
AC-12E-18C-TMO



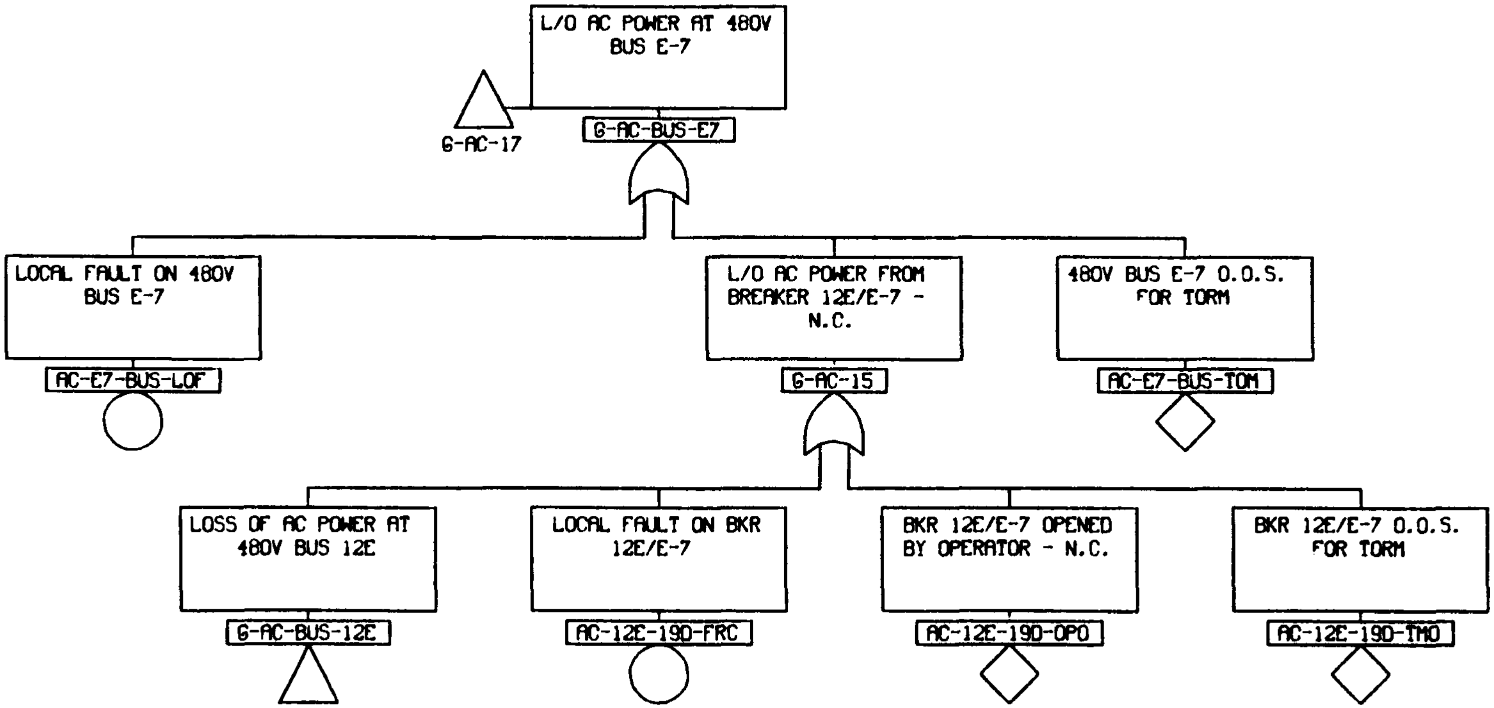
L/O AC POWER AT 480V BUS E-4
G-AC-BUS-E4
G-AC-254
LOCAL FAULT ON 480V BUS E-4
AC-E4-BUS-LOF
L/O AC POWER FROM BREAKER 12E/E-4 - N.C.
G-AC-12
480V BUS E-4 O.O.S. FOR TORM
AC-E4-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12E
G-AC-BUS-12E
LOCAL FAULT ON BKR 12E/E-4
AC-12E-19C-FRC
BKR 12E/E-4 OPENED BY OPERATOR - N.C.
AC-12E-19C-OPO
BKR 12E/E-4 O.O.S. FOR TORM
AC-12E-19C-TMO

AC-4

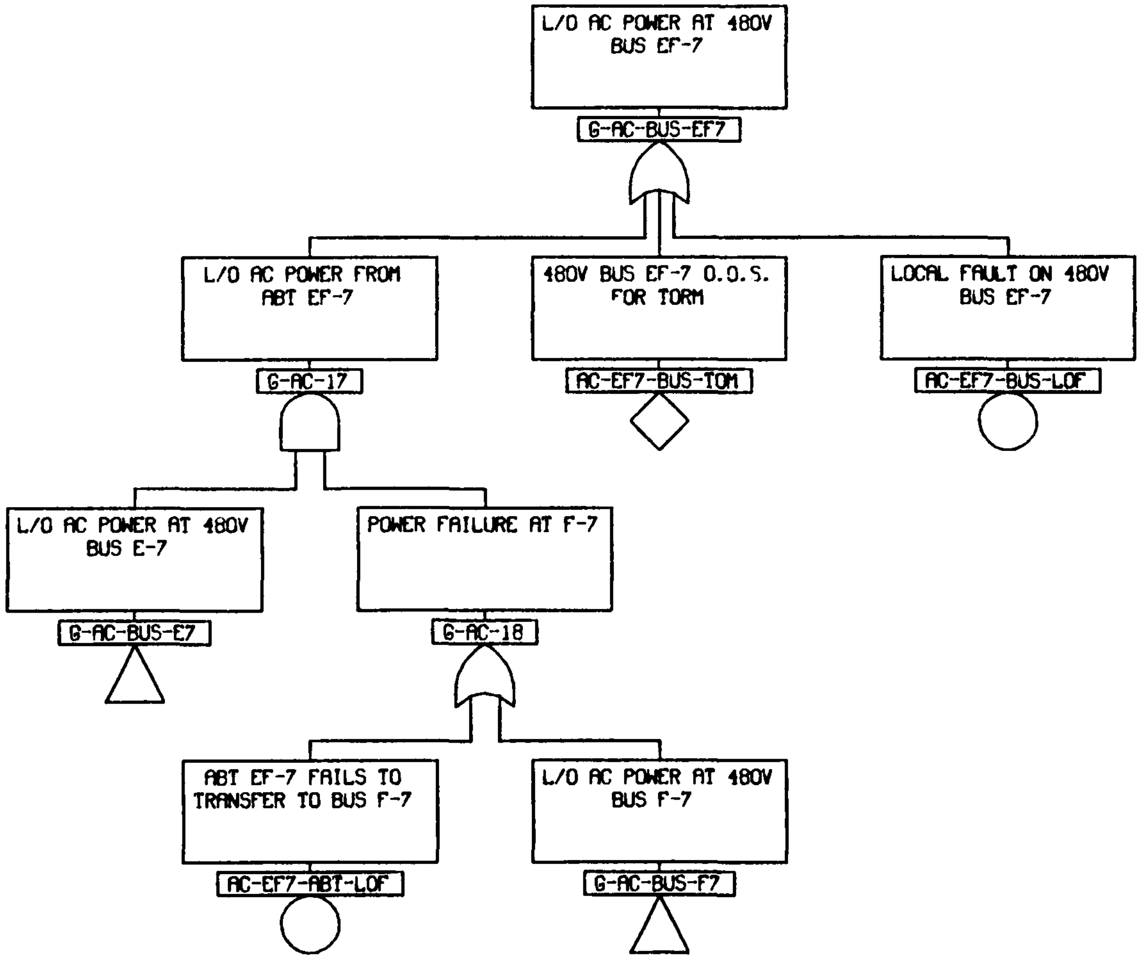

L/O AC POWER AT 480V BUS E-5
G-AC-BUS-E5
G-AC-264
G-AC-BUS-RPS-A
LOCAL FAULT ON 480V BUS E-5
AC-E5-BUS-LOF
L/O AC POWER FROM BREAKER 12E/E-5 - N.C.
G-AC-13
480V BUS E-5 O.O.S. FOR TORM
AC-E5-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12E
G-AC-BUS-12E
LOCAL FAULT ON BKR 12E/E-5
AC-12E-19B-FRC
BKR 12E/E-5 OPENED BY OPERATOR - N.C.
AC-12E-19B-OPO
BKR 12E/E-5 O.O.S. FOR TORM
AC-12E-19B-TMO

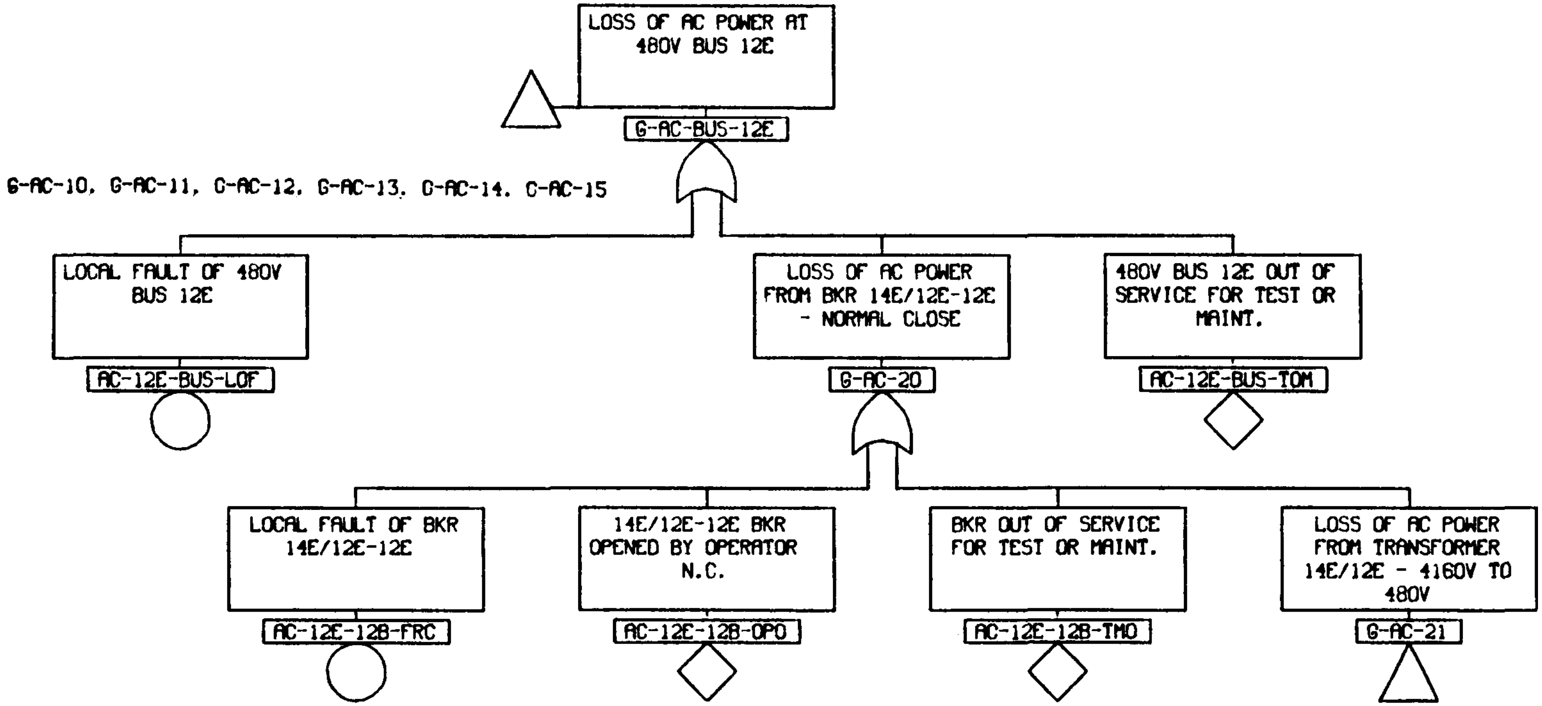


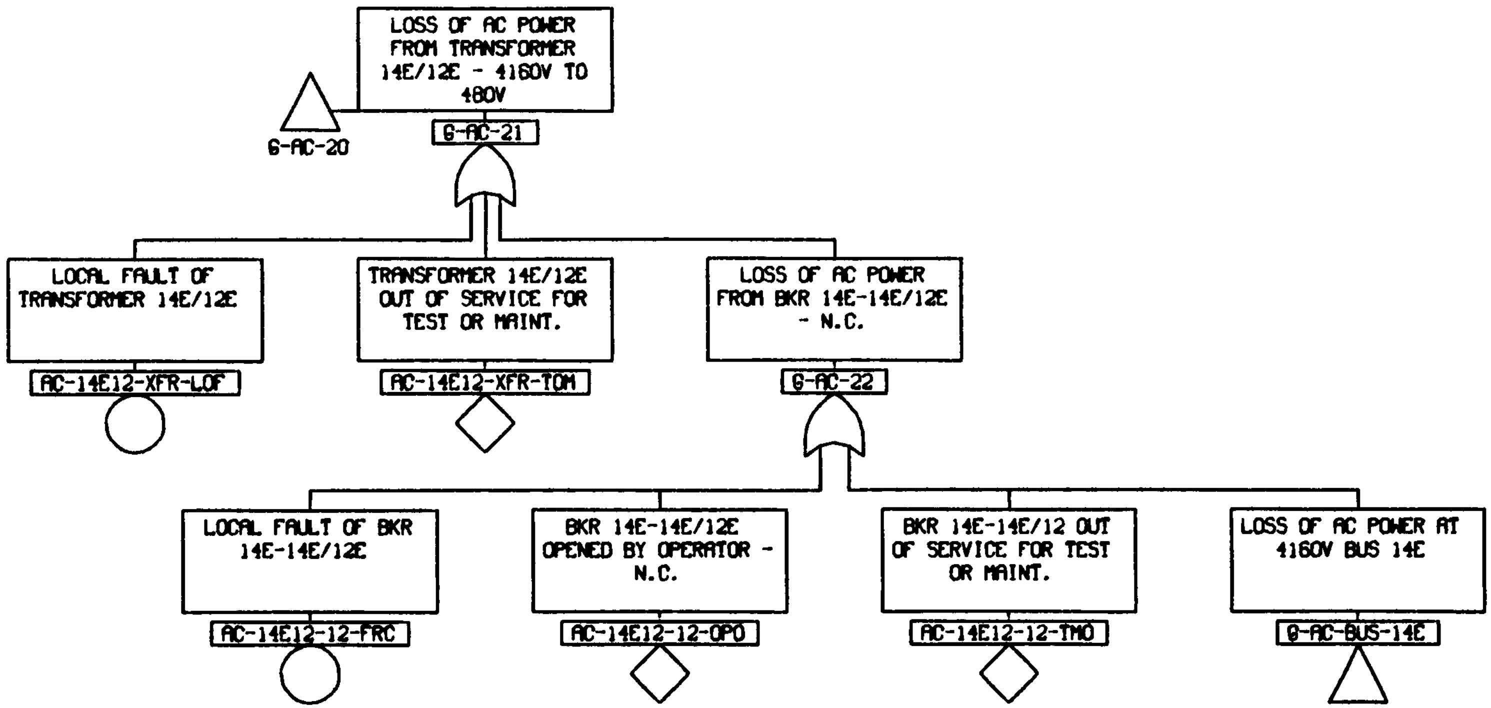
L/O AC POWER AT 480V BUS E-6
G-AC-BUS-E6
LOCAL FAULT ON 480V BUS E-6
AC-E6-BUS-LOF
L/O AC POWER FROM BREAKER 12E/E-6 - N.C.
G-AC-14
480V BUS E-6 O.O.S. FOR TORM
AC-E6-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12E
G-AC-BUS-12E
LOCAL FAULT ON BKR 12E/E-6
AC-12E-19A-FRC
BKR 12E/E-6 OPENED BY OPERATOR - N.C.
AC-12E-19A-OPO
BKR 12E/E-6 O.O.S. FOR TORM
AC-12E-19A-TMO

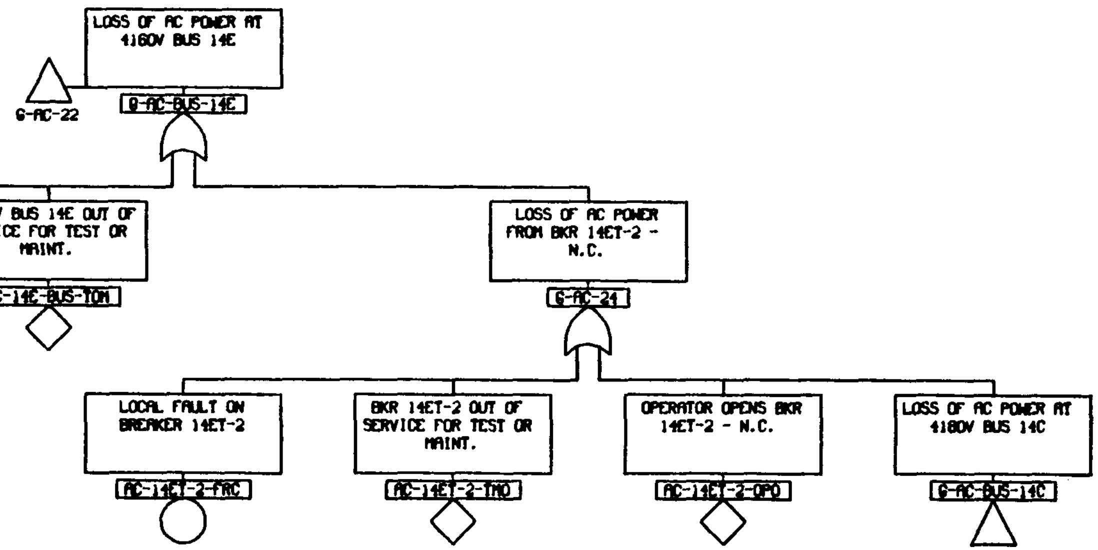

L/O AC POWER AT 480V BUS E-7
G-AC-BUS-E7
G-AC-17
LOCAL FAULT ON 480V BUS E-7
AC-E7-BUS-LOF
L/O AC POWER FROM BREAKER 12E/E-7 - N.C.
G-AC-15
480V BUS E-7 O.O.S. FOR TORM
AC-E7-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12E
G-AC-BUS-12E
LOCAL FAULT ON BKR 12E/E-7
AC-12E-19D-FRC
BKR 12E/E-7 OPENED BY OPERATOR - N.C.
AC-12E-19D-OPO
BKR 12E/E-7 O.O.S. FOR TORM
AC-12E-19D-TMO

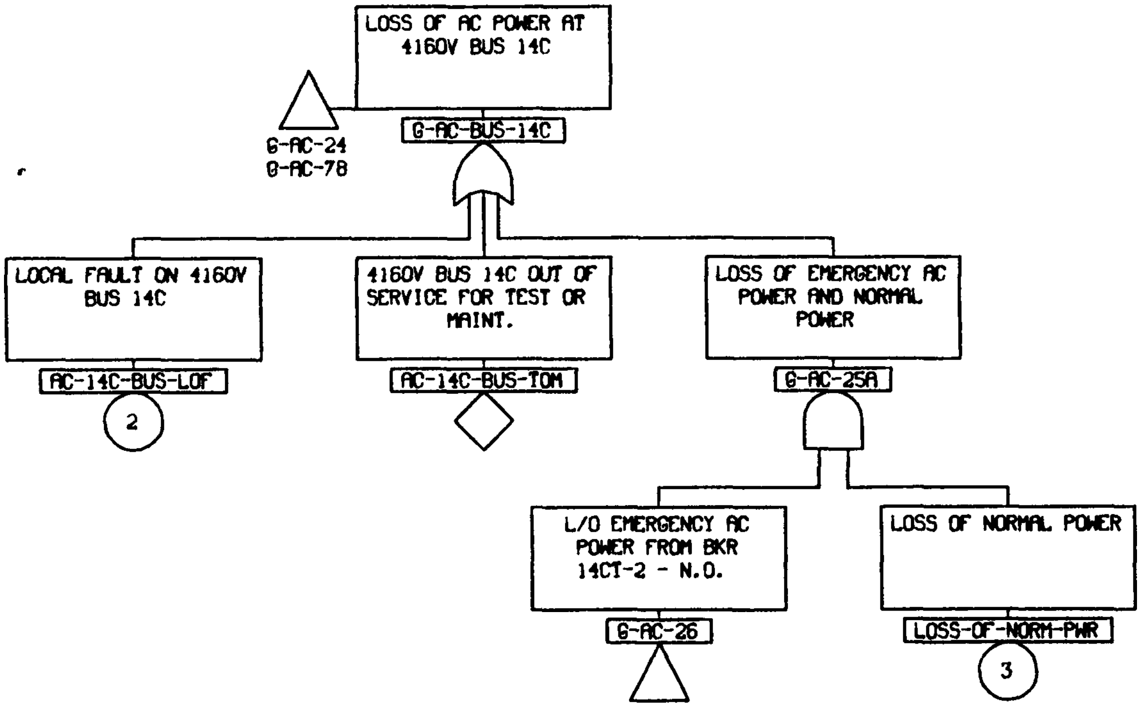
AC-7

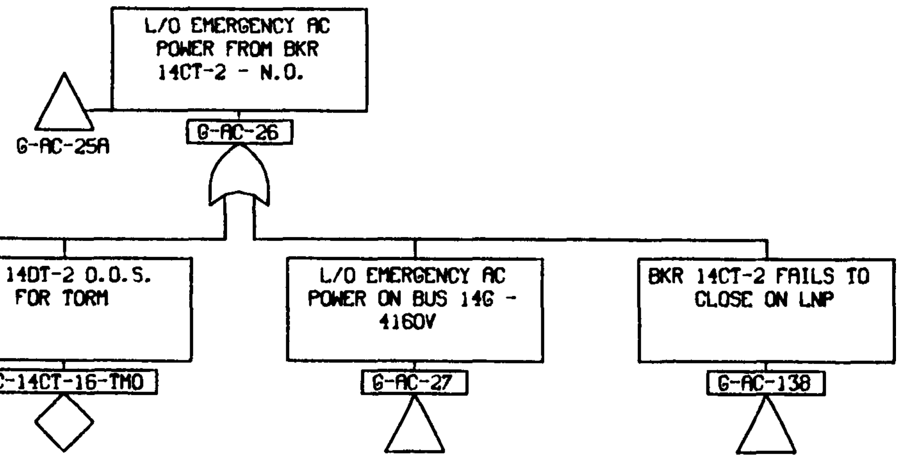

L/O AC POWER AT 480V BUS EF-7
G-AC-BUS-EF7
L/O AC POWER FROM ABT EF-7
G-AC-17
480V BUS EF-7 O.O.S. FOR TORM
AC-EF7-BUS-TOM
LOCAL FAULT ON 480V BUS EF-7
AC-EF7-BUS-LOF
L/O AC POWER AT 480V BUS E-7
G-AC-BUS-E7
POWER FAILURE AT F-7
G-AC-18
ABT EF-7 FAILS TO TRANSFER TO BUS F-7
AC-EF7-ABT-LOF
L/O AC POWER AT 480V BUS F-7
G-AC-BUS-F7

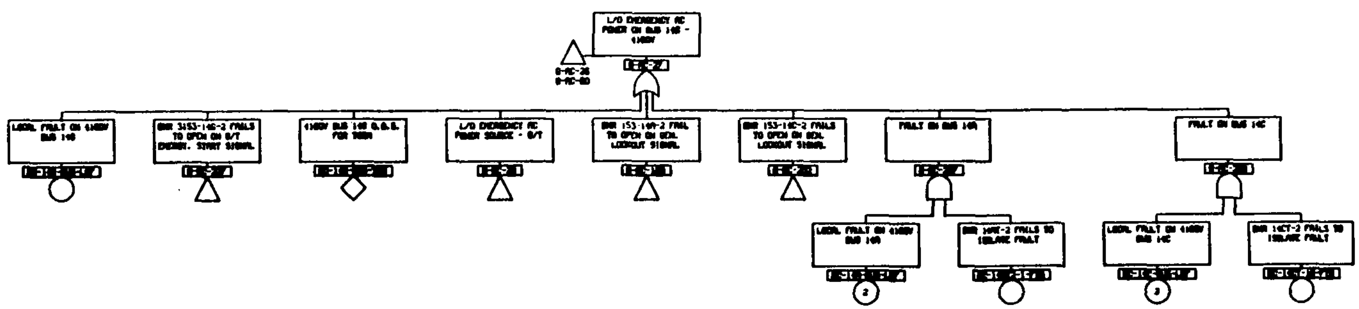

LOSS OF AC POWER AT 480V BUS 12E
G-AC-BUS-12E
G-AC-10, G-AC-11, G-AC-12, G-AC-13, G-AC-14, G-AC-15
LOCAL FAULT OF 480V BUS 12E
AC-12E-BUS-LOF
LOSS OF AC POWER FROM BKR 14E/12E-12E - NORMAL CLOSE
G-AC-20
480V BUS 12E OUT OF SERVICE FOR TEST OR MAINT.
AC-12E-BUS-TOM
LOCAL FAULT OF BKR 14E/12E-12E
AC-12E-12B-FRC
14E/12E-12E BKR OPENED BY OPERATOR N.C.
AC-12E-12B-OPO
BKR OUT OF SERVICE FOR TEST OR MAINT.
AC-12E-12B-TMO
LOSS OF AC POWER FROM TRANSFORMER 14E/12E - 4160V TO 480V
G-AC-21


LOSS OF AC POWER FROM TRANSFORMER 14E/12E - 4160V TO 480V
G-AC-21
G-AC-20
LOCAL FAULT OF TRANSFORMER 14E/12E
AC-14E12-XFR-LOF
TRANSFORMER 14E/12E OUT OF SERVICE FOR TEST OR MAINT.
AC-14E12-XFR-TOM
LOSS OF AC POWER FROM BKR 14E-14E/12E - N.C.
G-AC-22
LOCAL FAULT OF BKR 14E-14E/12E
AC-14E12-12-FRC
BKR 14E-14E/12E OPENED BY OPERATOR - N.C.
AC-14E12-12-OPO
BKR 14E-14E/12 OUT OF SERVICE FOR TEST OR MAINT.
AC-14E12-12-TMO
LOSS OF AC POWER AT 4160V BUS 14E
G-AC-BUS-14E

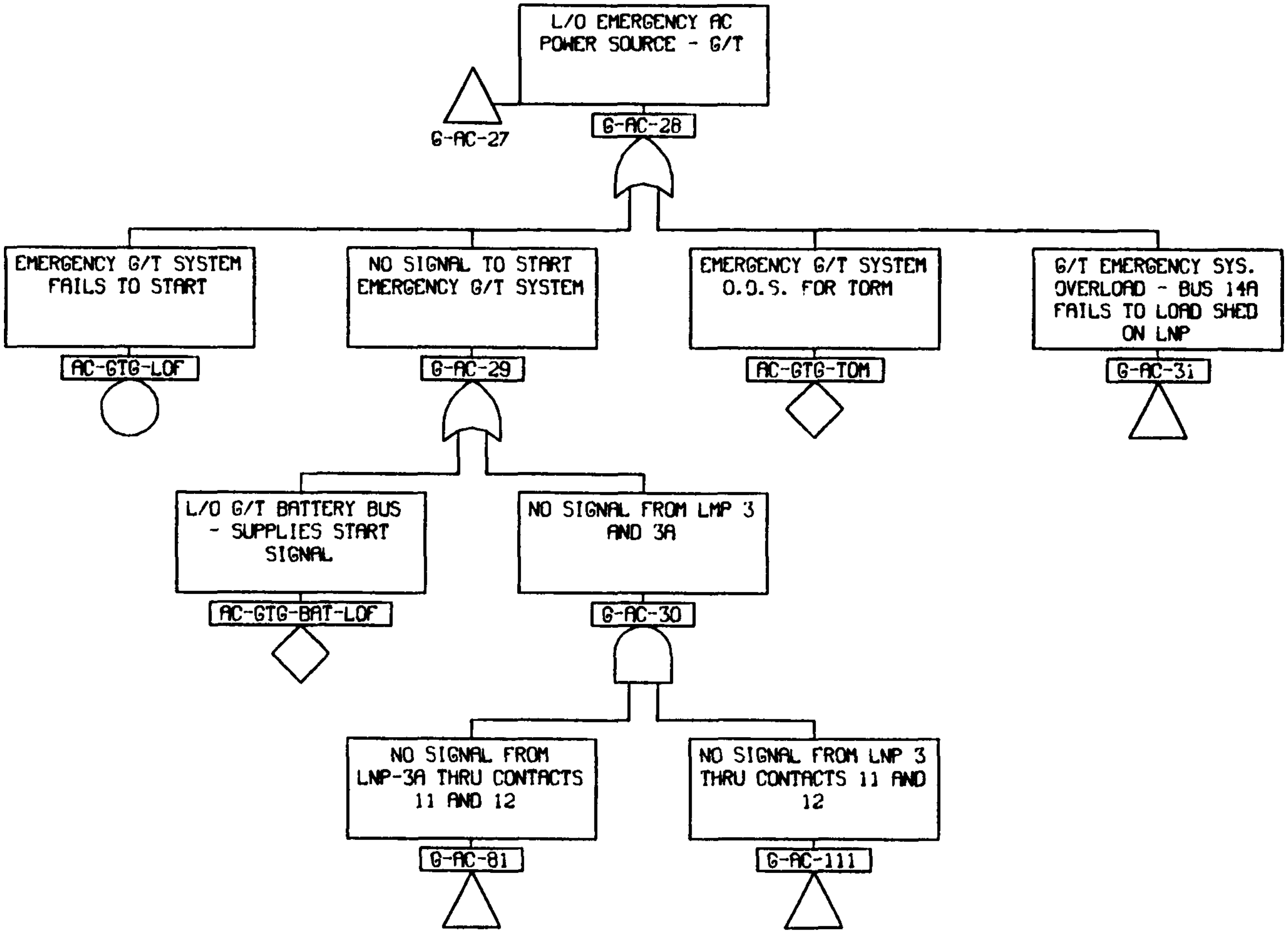

LOSS OF AC POWER AT 4160V BUS 14E
G-AC-BUS-14E
G-AC-22
LOCAL FAULT ON 4160V BUS 14E
AC-14E-BUS-LOF
4160V BUS 14E OUT OF SERVICE FOR TEST OR MAINT.
AC-14E-BUS-TOM
LOSS OF AC POWER FROM BKR 14ET-2 - N.C.
G-AC-24
LOCAL FAULT ON BREAKER 14ET-2
AC-14ET-2-FRC
BKR 14ET-2 OUT OF SERVICE FOR TEST OR MAINT.
AC-14ET-2-TMO
OPERATOR OPENS BKR 14ET-2 - N.C.
AC-14ET-2-OPO
LOSS OF AC POWER AT 4160V BUS 14C
G-AC-BUS-14C


LOSS OF AC POWER AT 4160V BUS 14C
G-AC-BUS-14C
G-AC-24
G-AC-78
LOCAL FAULT ON 4160V BUS 14C
AC-14C-BUS-LOF
2
4160V BUS 14C OUT OF SERVICE FOR TEST OR MAINT.
AC-14C-BUS-TOM
LOSS OF EMERGENCY AC POWER AND NORMAL POWER
G-AC-25A
L/O EMERGENCY AC POWER FROM BKR 14CT-2 - N.O.
G-AC-26
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
3


L/O EMERGENCY AC POWER FROM BKR 14CT-2 - N.O.
G-AC-26
G-AC-25A
LOCAL FAULT ON BKR 14CT-2
AC-14CT-16-FTC
BKR 14DT-2 O.O.S. FOR TORM
AC-14CT-16-TMO
L/O EMERGENCY AC POWER ON BUS 14G - 4160V
G-AC-27
BKR 14CT-2 FAILS TO CLOSE ON LNP
G-AC-138


L/O EMERGENCY AC POWER ON BUS 14B - 4160V
LOCAL FAULT ON 4160V BUS 14B
4160V BUS 14B O.O.S. FOR TEST
L/O EMERGENCY AC POWER SOURCE - O/T
BKR 153-14C-2 FAILS TO OPEN ON SEQ. LOCKOUT SIGNAL
FAULT ON BUS 14A
FAULT ON BUS 14C
LOCAL FAULT ON 4160V BUS 14A
LOCAL FAULT ON 4160V BUS 14C
BKR 14CT-2 FAILS TO ISOLATE FAULT

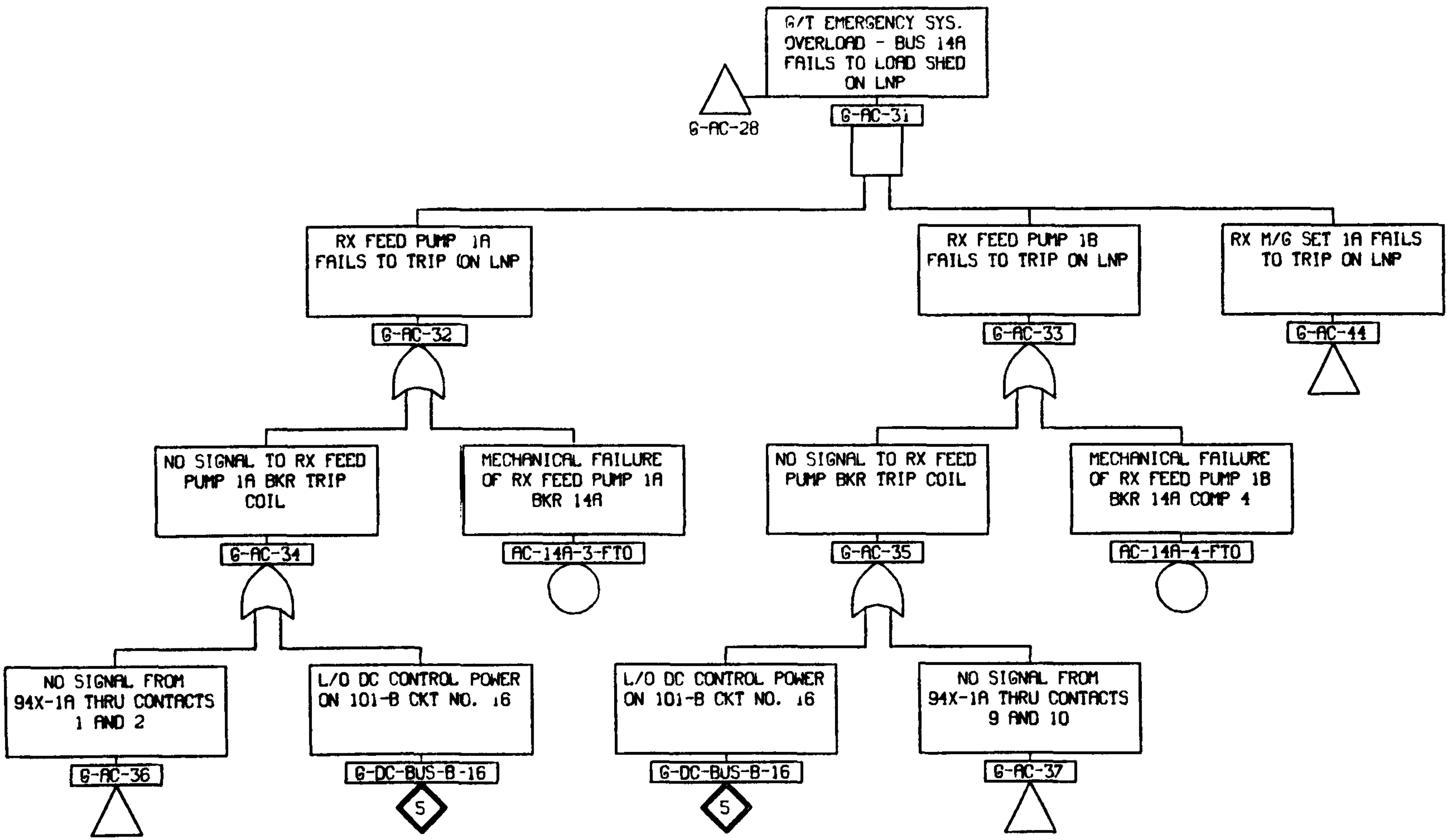
AC-14

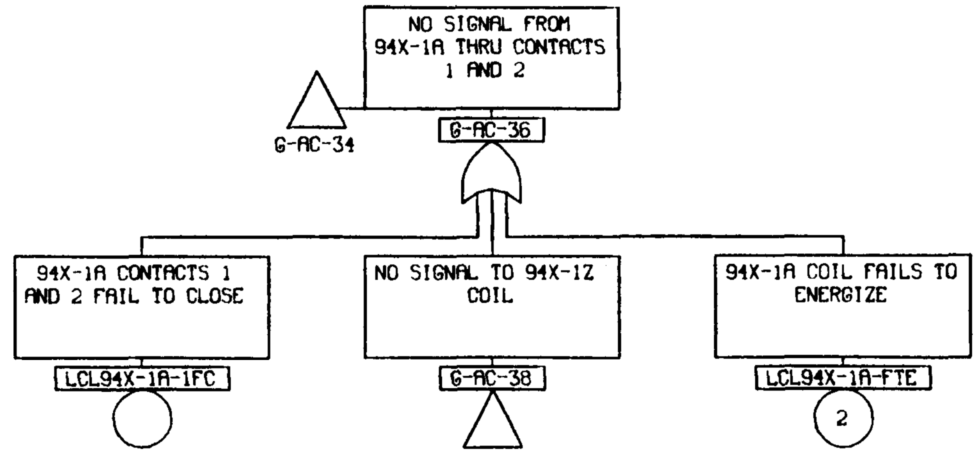


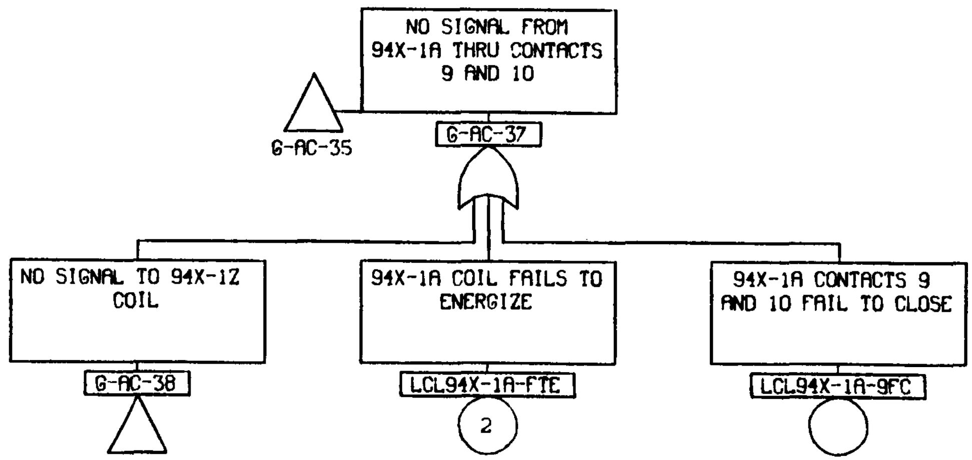
L/O EMERGENCY AC POWER SOURCE - G/T
G-AC-27
G-AC-28
EMERGENCY G/T SYSTEM FAILS TO START
AC-GTG-LOF
NO SIGNAL TO START EMERGENCY G/T SYSTEM
G-AC-29
EMERGENCY G/T SYSTEM O.O.S. FOR TORM
AC-GTG-TOM
G/T EMERGENCY SYS. OVERLOAD - BUS 14A FAILS TO LOAD SHED ON LNP
G-AC-31
L/O G/T BATTERY BUS - SUPPLIES START SIGNAL
AC-GTG-BAT-LOF
NO SIGNAL FROM LMP 3 AND 3A
G-AC-30
NO SIGNAL FROM LNP-3A THRU CONTACTS 11 AND 12
G-AC-81
NO SIGNAL FROM LNP 3 THRU CONTACTS 11 AND 12
G-AC-111

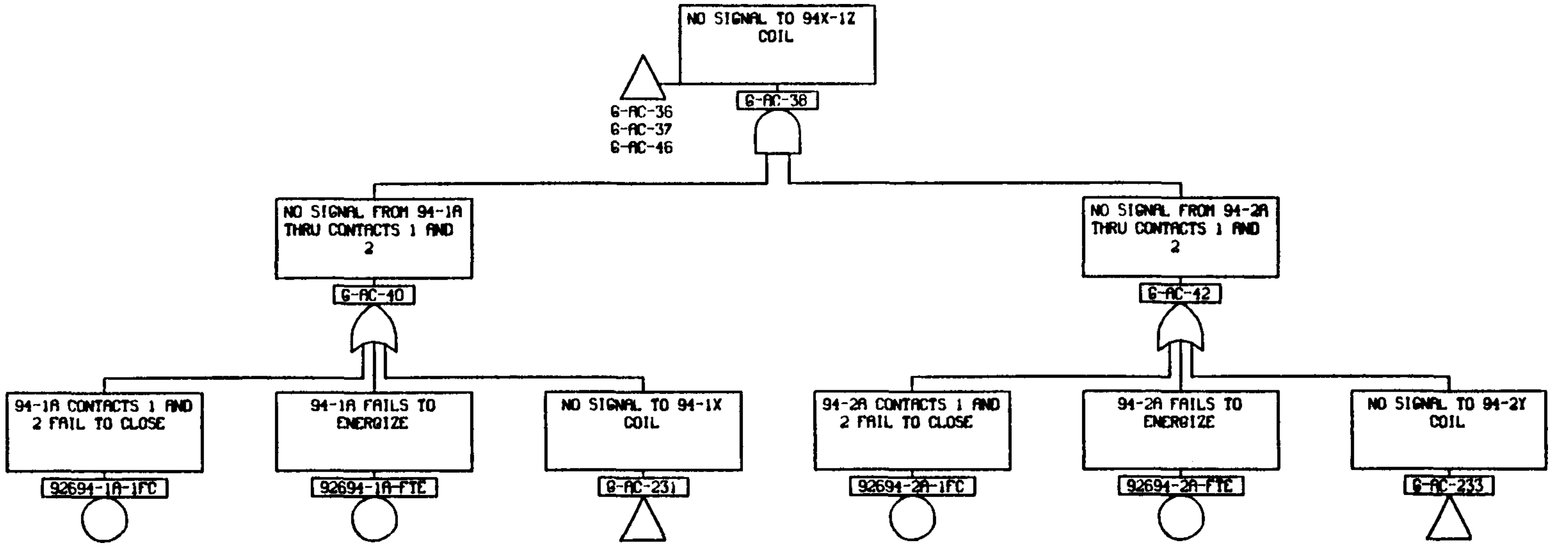
B.17-63

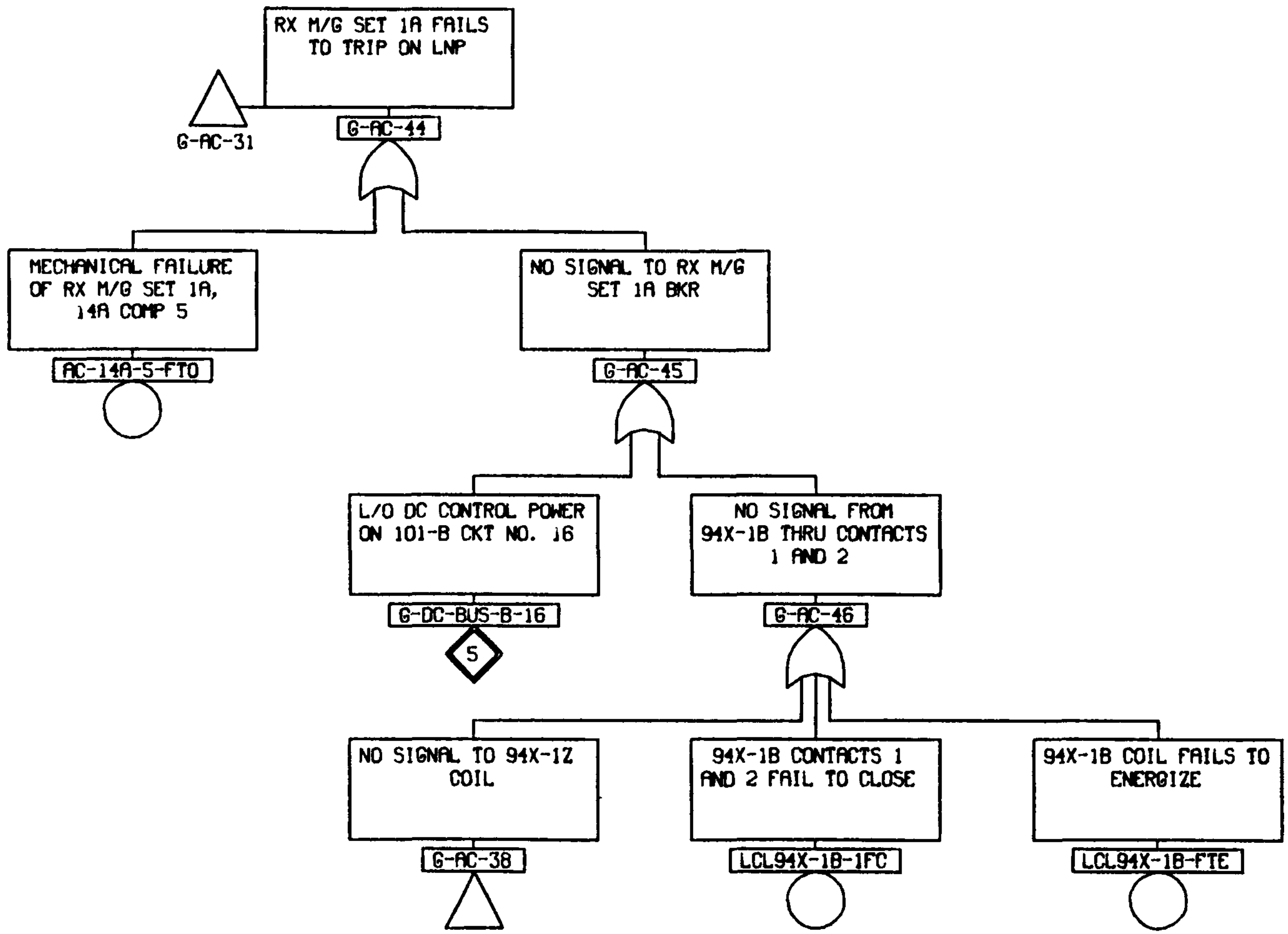
AC-15


G/T EMERGENCY SYS. OVERLOAD - BUS 14A FAILS TO LOAD SHED ON LNP
G-AC-31
G-AC-28
RX FEED PUMP 1A FAILS TO TRIP ON LNP
G-AC-32
RX FEED PUMP 1B FAILS TO TRIP ON LNP
G-AC-33
RX M/G SET 1A FAILS TO TRIP ON LNP
G-AC-44
NO SIGNAL TO RX FEED PUMP 1A BKR TRIP COIL
G-AC-34
MECHANICAL FAILURE OF RX FEED PUMP 1A BKR 14A
AC-14A-3-FTO
NO SIGNAL TO RX FEED PUMP BKR TRIP COIL
G-AC-35
MECHANICAL FAILURE OF RX FEED PUMP 1B BKR 14A COMP 4
AC-14A-4-FTO
NO SIGNAL FROM 94X-1A THRU CONTACTS 1 AND 2
G-AC-36
L/O DC CONTROL POWER ON 101-B CKT NO. 16
G-DC-BUS-B-16
5
L/O DC CONTROL POWER ON 101-B CKT NO. 16
G-DC-BUS-B-16
5
NO SIGNAL FROM 94X-1A THRU CONTACTS 9 AND 10
G-AC-37

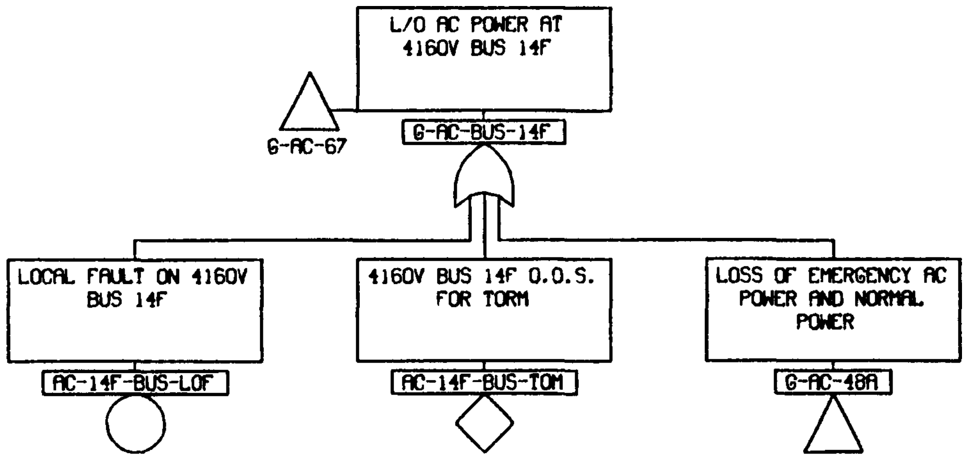

NO SIGNAL FROM 94X-1A THRU CONTACTS 1 AND 2
G-AC-34
G-AC-36
94X-1A CONTACTS 1 AND 2 FAIL TO CLOSE
LCL94X-1A-1FC
NO SIGNAL TO 94X-1Z COIL
G-AC-38
94X-1A COIL FAILS TO ENERGIZE
LCL94X-1A-FTE
2

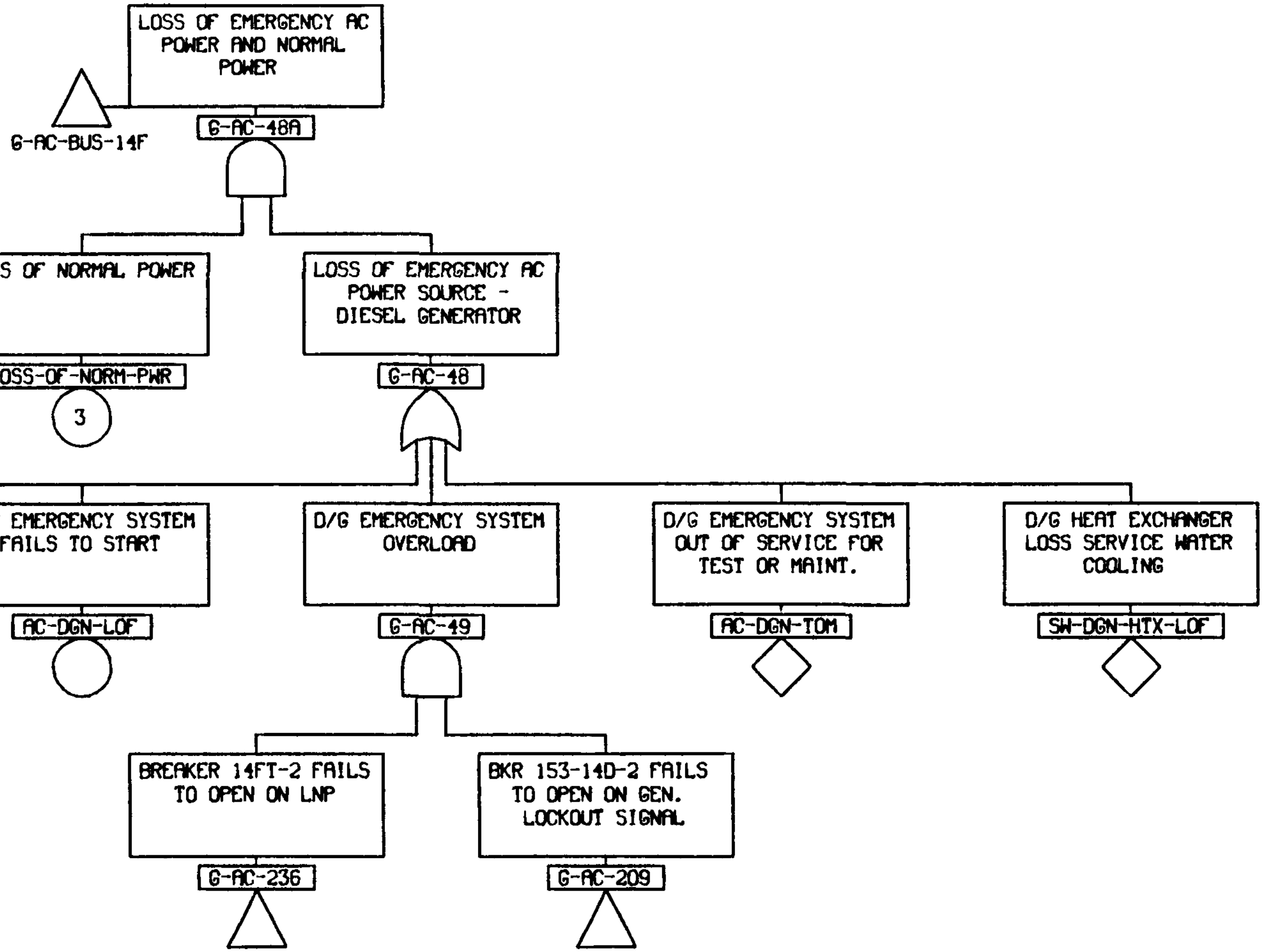

NO SIGNAL FROM 94X-1A THRU CONTACTS 9 AND 10
G-AC-35
G-AC-37
NO SIGNAL TO 94X-1Z COIL
G-AC-38
94X-1A COIL FAILS TO ENERGIZE
LCL94X-1A-FTE
2
94X-1A CONTACTS 9 AND 10 FAIL TO CLOSE
LCL94X-1A-9FC

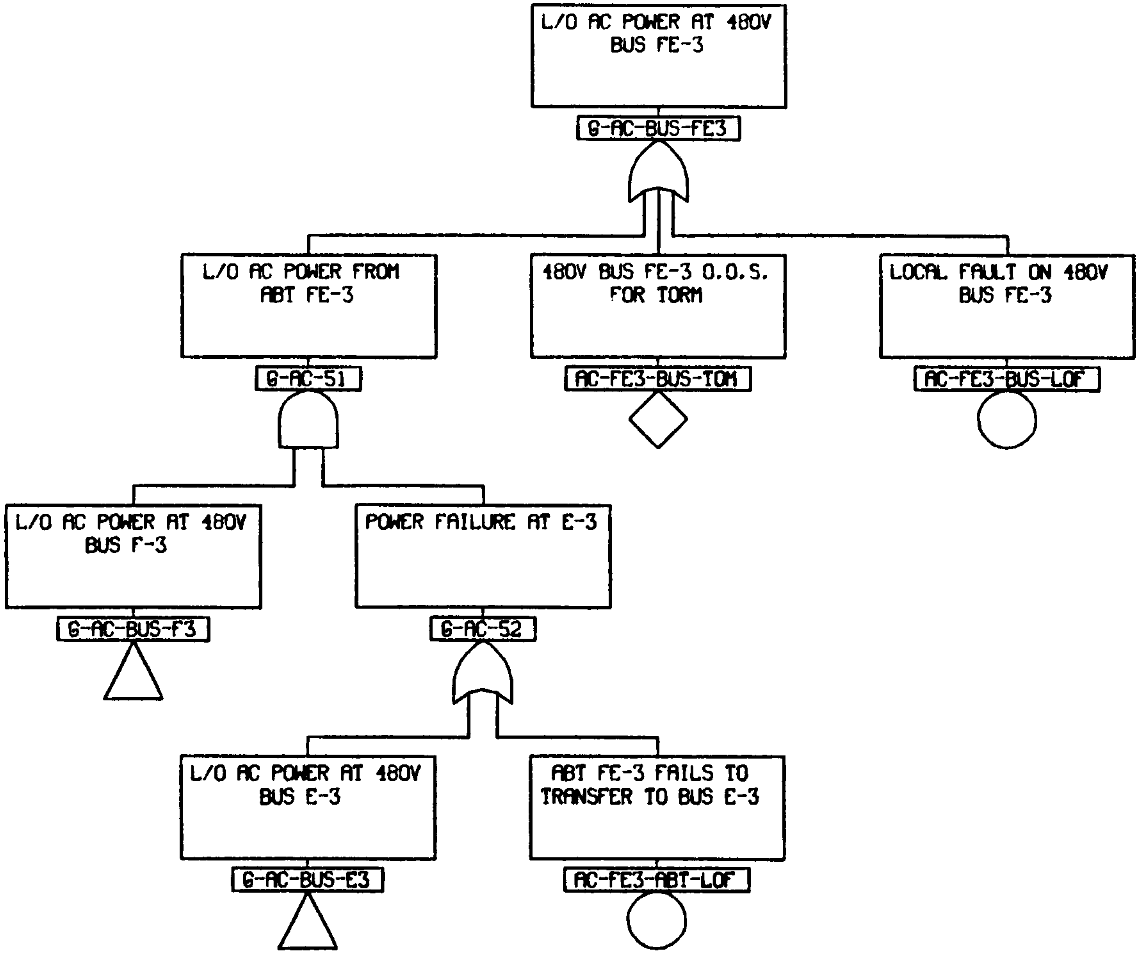

NO SIGNAL TO 94X-1Z COIL
G-AC-36
G-AC-37
G-AC-46
G-AC-38
NO SIGNAL FROM 94-1A THRU CONTACTS 1 AND 2
G-AC-40
NO SIGNAL FROM 94-2A THRU CONTACTS 1 AND 2
G-AC-42
94-1A CONTACTS 1 AND 2 FAIL TO CLOSE
92694-1A-1FC
94-1A FAILS TO ENERGIZE
92694-1A-FTE
NO SIGNAL TO 94-1X COIL
G-AC-231
94-2A CONTACTS 1 AND 2 FAIL TO CLOSE
92694-2A-1FC
94-2A FAILS TO ENERGIZE
92694-2A-FTE
NO SIGNAL TO 94-2Y COIL
G-AC-233

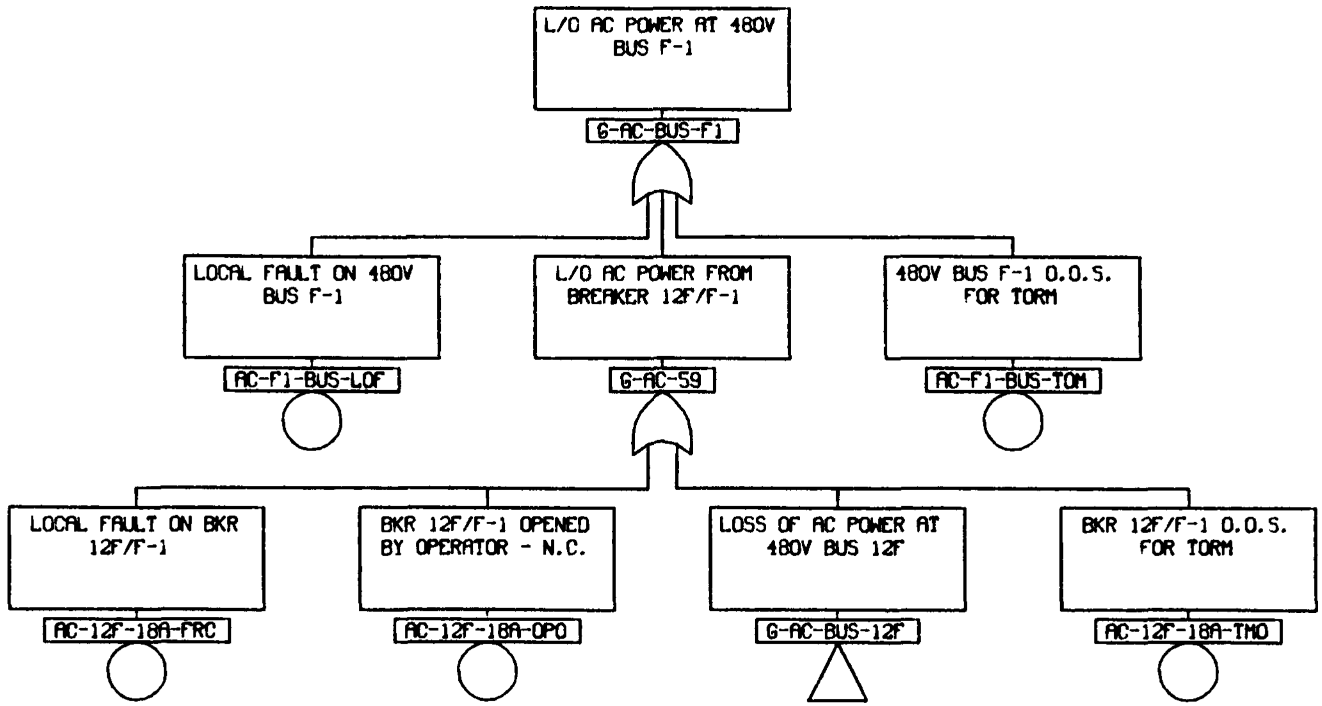


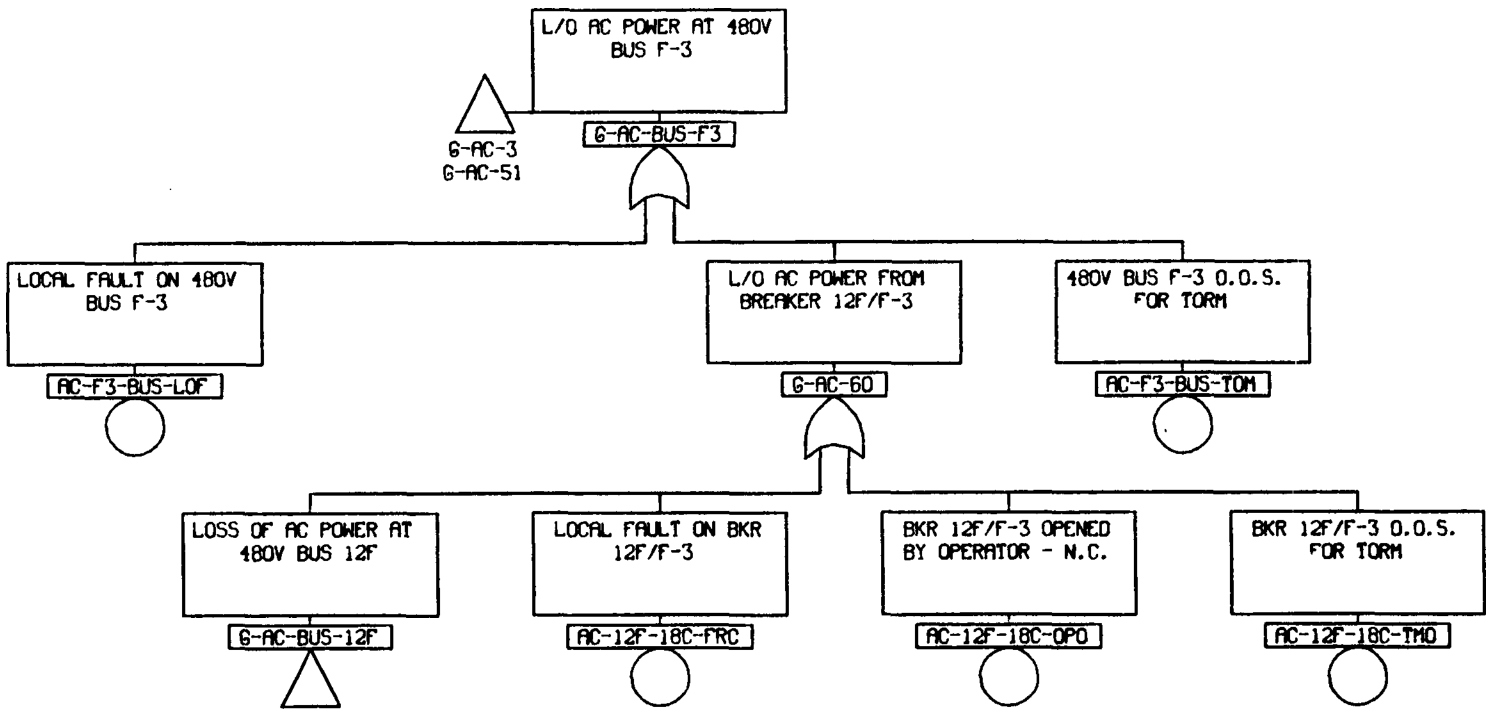
RX M/G SET 1A FAILS TO TRIP ON LNP
G-AC-44
G-AC-31
MECHANICAL FAILURE OF RX M/G SET 1A, 14A COMP 5
AC-14A-5-FTO
NO SIGNAL TO RX M/G SET 1A BKR
G-AC-45
L/O DC CONTROL POWER ON 101-B CKT NO. 16
G-DC-BUS-B-16
5
NO SIGNAL FROM 94X-1B THRU CONTACTS 1 AND 2
G-AC-46
NO SIGNAL TO 94X-1Z COIL
G-AC-38
94X-1B CONTACTS 1 AND 2 FAIL TO CLOSE
LCL94X-1B-1FC
94X-1B COIL FAILS TO ENERGIZE
LCL94X-1B-FTE

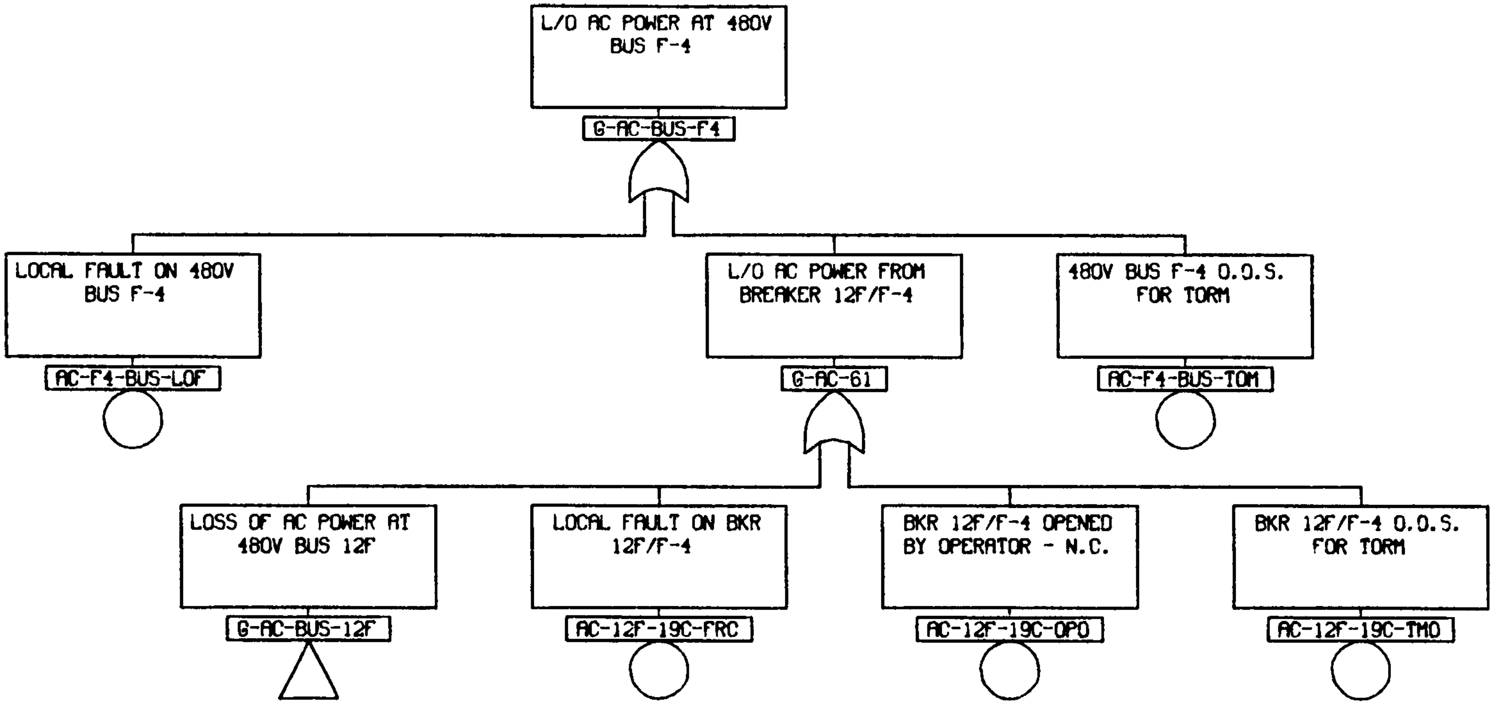

L/O AC POWER AT 4160V BUS 14F
G-AC-BUS-14F
G-AC-67
LOCAL FAULT ON 4160V BUS 14F
AC-14F-BUS-LOF
4160V BUS 14F O.O.S. FOR TORM
AC-14F-BUS-TOM
LOSS OF EMERGENCY AC POWER AND NORMAL POWER
G-AC-48A

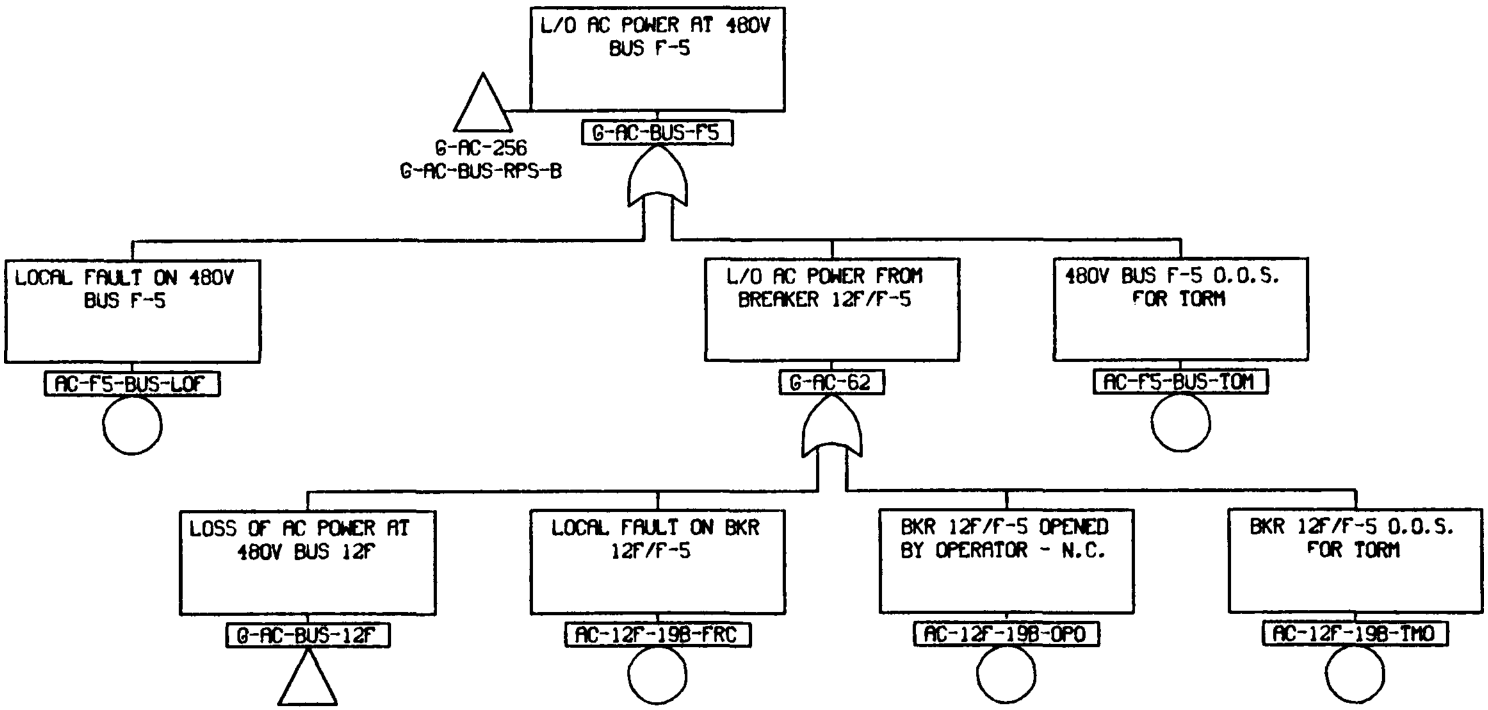

LOSS OF EMERGENCY AC POWER AND NORMAL POWER
G-AC-48A
G-AC-BUS-14F
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
3
LOSS OF EMERGENCY AC POWER SOURCE - DIESEL GENERATOR
G-AC-48
NO SIGNAL TO START EMERGENCY DIESEL GENERATOR SYSTEM
G-AC-216
D/G EMERGENCY SYSTEM FAILS TO START
AC-DGN-LOF
D/G EMERGENCY SYSTEM OVERLOAD
G-AC-49
D/G EMERGENCY SYSTEM OUT OF SERVICE FOR TEST OR MAINT.
AC-DGN-TOM
D/G HEAT EXCHANGER LOSS SERVICE WATER COOLING
SW-DGN-HTX-LOF
BREAKER 14FT-2 FAILS TO OPEN ON LNP
G-AC-236
BKR 153-14D-2 FAILS TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-209

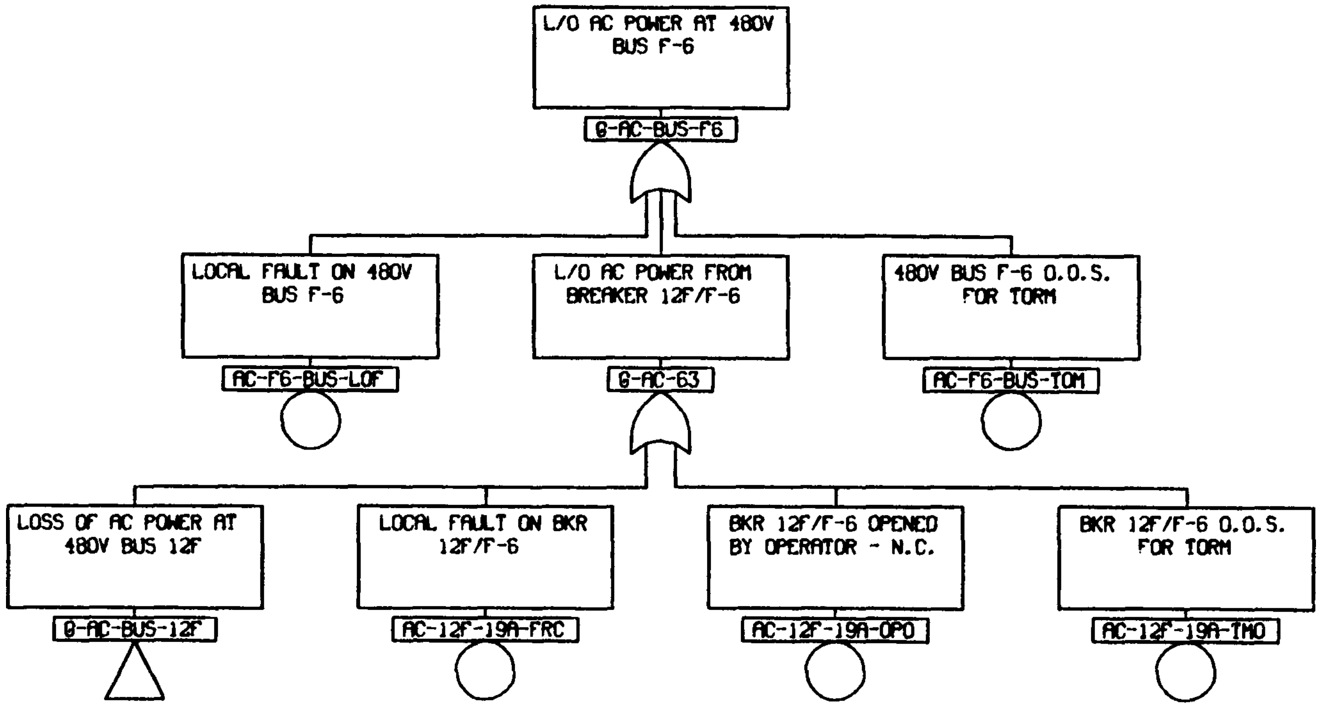

L/O AC POWER AT 480V BUS FE-3
G-AC-BUS-FE3
L/O AC POWER FROM ABT FE-3
G-AC-51
480V BUS FE-3 O.O.S. FOR TORM
AC-FE3-BUS-TOM
LOCAL FAULT ON 480V BUS FE-3
AC-FE3-BUS-LOF
L/O AC POWER AT 480V BUS F-3
G-AC-BUS-F3
POWER FAILURE AT E-3
G-AC-52
L/O AC POWER AT 480V BUS E-3
G-AC-BUS-E3
ABT FE-3 FAILS TO TRANSFER TO BUS E-3
AC-FE3-ABT-LOF

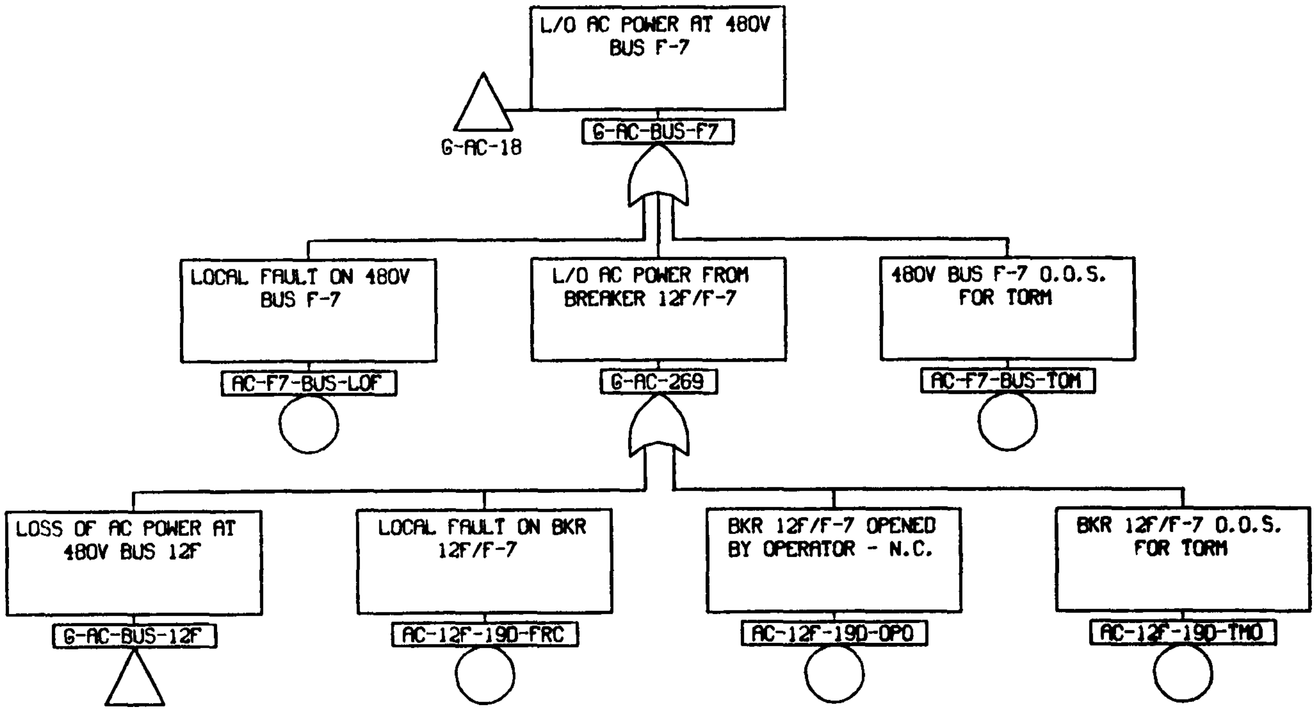

L/O AC POWER AT 480V BUS F-1
G-AC-BUS-F1
LOCAL FAULT ON 480V BUS F-1
AC-F1-BUS-LOF
L/O AC POWER FROM BREAKER 12F/F-1
G-AC-59
480V BUS F-1 O.O.S. FOR TORM
AC-F1-BUS-TOM
LOCAL FAULT ON BKR 12F/F-1
AC-12F-18A-FRC
BKR 12F/F-1 OPENED BY OPERATOR - N.C.
AC-12F-18A-OPO
LOSS OF AC POWER AT 480V BUS 12F
G-AC-BUS-12F
BKR 12F/F-1 O.O.S. FOR TORM
AC-12F-18A-TMO

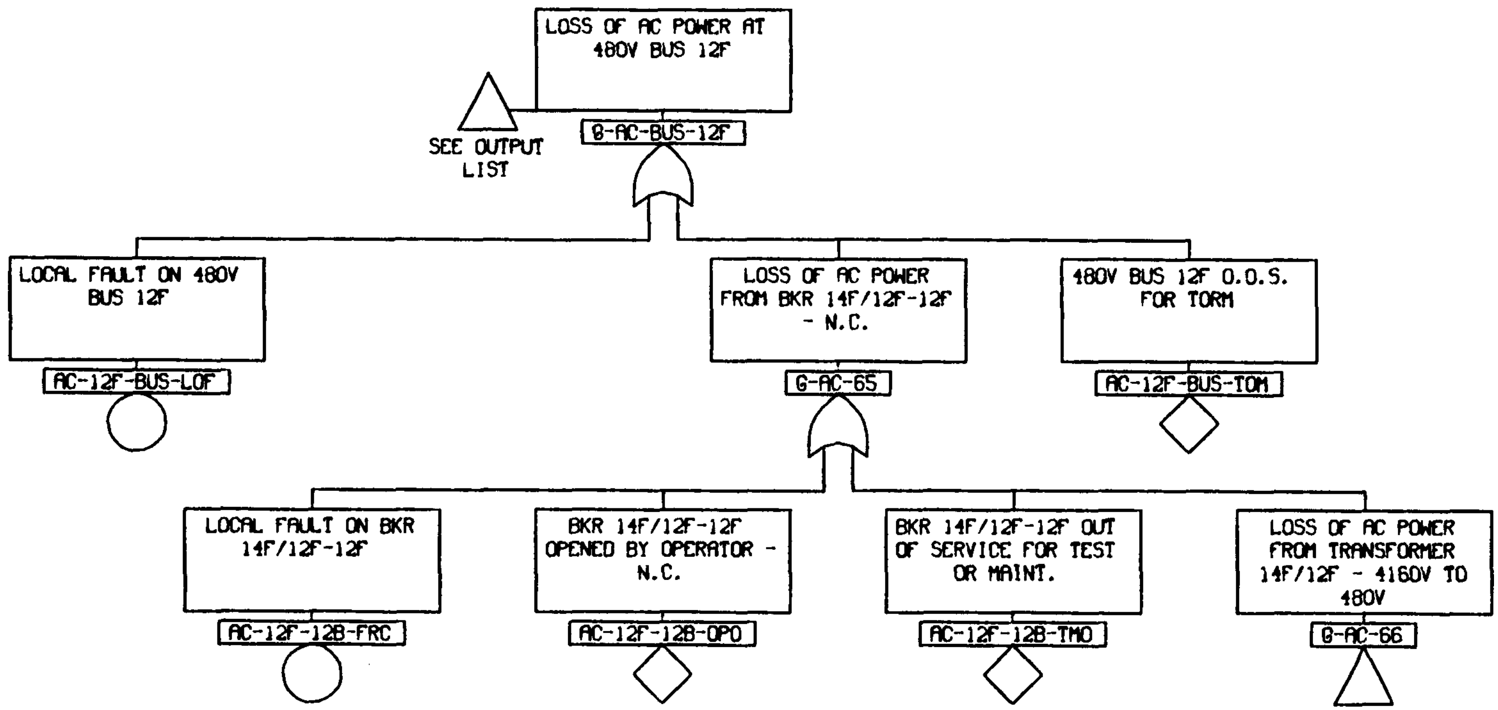

L/O AC POWER AT 480V BUS F-3
G-AC-BUS-F3
G-AC-3
G-AC-51
LOCAL FAULT ON 480V BUS F-3
AC-F3-BUS-LOF
L/O AC POWER FROM BREAKER 12F/F-3
G-AC-60
480V BUS F-3 O.O.S. FOR TORM
AC-F3-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12F
G-AC-BUS-12F
LOCAL FAULT ON BKR 12F/F-3
AC-12F-18C-FRC
BKR 12F/F-3 OPENED BY OPERATOR - N.C.
AC-12F-18C-OPO
BKR 12F/F-3 O.O.S. FOR TORM
AC-12F-18C-TMO


L/O AC POWER AT 480V BUS F-4
G-AC-BUS-F4
LOCAL FAULT ON 480V BUS F-4
AC-F4-BUS-LOF
L/O AC POWER FROM BREAKER 12F/F-4
G-AC-61
480V BUS F-4 O.O.S. FOR TORM
AC-F4-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12F
G-AC-BUS-12F
LOCAL FAULT ON BKR 12F/F-4
AC-12F-19C-FRC
BKR 12F/F-4 OPENED BY OPERATOR - N.C.
AC-12F-19C-OPO
BKR 12F/F-4 O.O.S. FOR TORM
AC-12F-19C-TMO

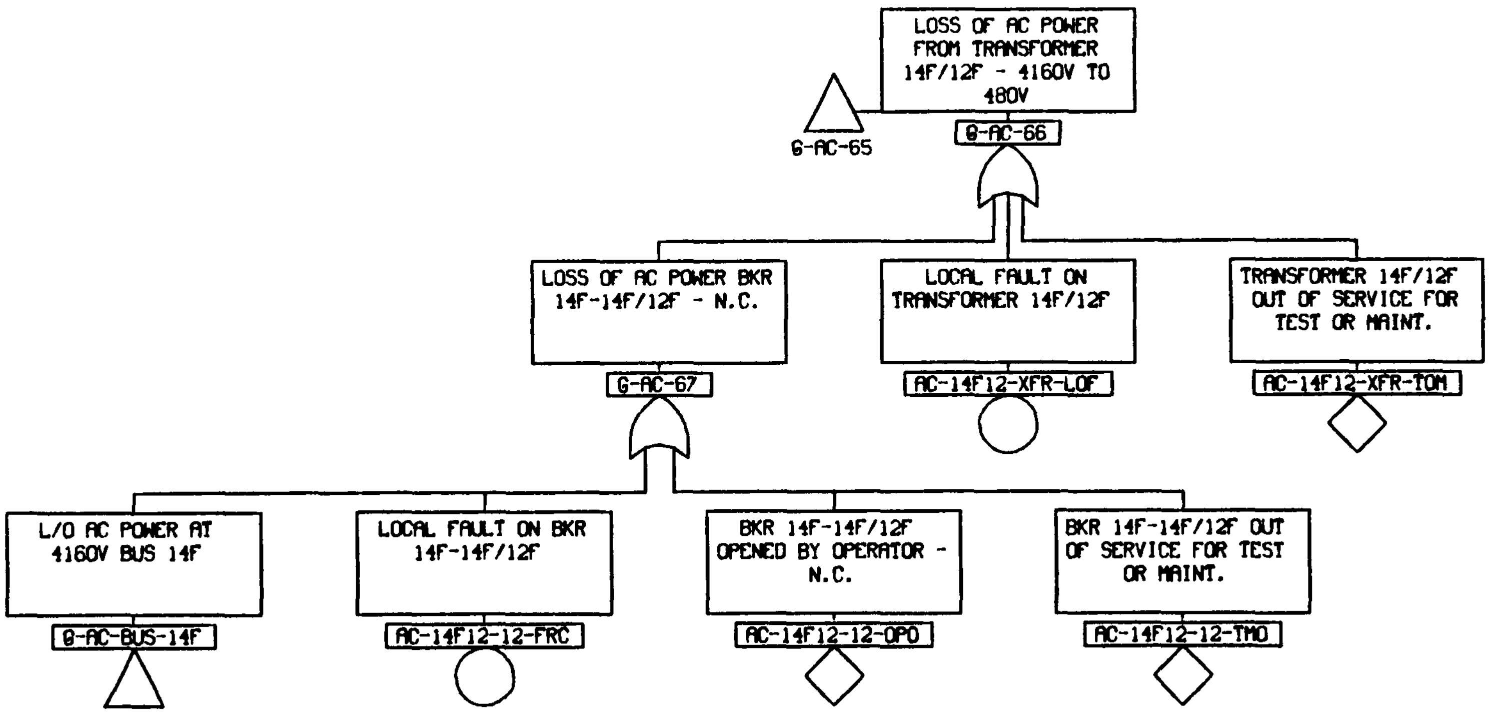

L/O AC POWER AT 480V BUS F-5
G-AC-BUS-F5
G-AC-256
G-AC-BUS-RPS-B
LOCAL FAULT ON 480V BUS F-5
AC-F5-BUS-LOF
L/O AC POWER FROM BREAKER 12F/F-5
G-AC-62
480V BUS F-5 O.O.S. FOR TORM
AC-F5-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12F
G-AC-BUS-12F
LOCAL FAULT ON BKR 12F/F-5
AC-12F-19B-FRC
BKR 12F/F-5 OPENED BY OPERATOR - N.C.
AC-12F-19B-OPO
BKR 12F/F-5 O.O.S. FOR TORM
AC-12F-19B-TMO

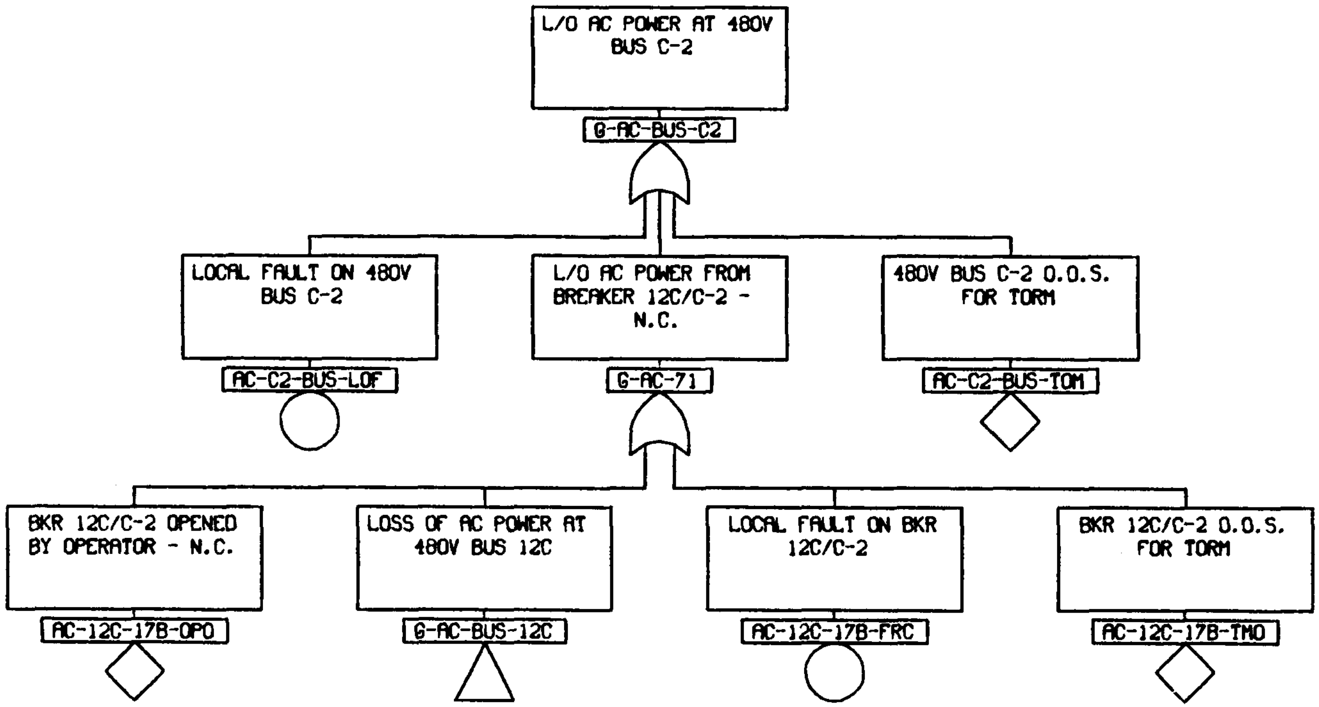

L/O AC POWER AT 480V BUS F-6
G-AC-BUS-F6
LOCAL FAULT ON 480V BUS F-6
AC-F6-BUS-LOF
L/O AC POWER FROM BREAKER 12F/F-6
G-AC-63
480V BUS F-6 O.O.S. FOR TORM
AC-F6-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12F
G-AC-BUS-12F
LOCAL FAULT ON BKR 12F/F-6
AC-12F-19A-FRC
BKR 12F/F-6 OPENED BY OPERATOR - N.C.
AC-12F-19A-OPO
BKR 12F/F-6 O.O.S. FOR TORM
AC-12F-19A-TMO


L/O AC POWER AT 480V BUS F-7
G-AC-BUS-F7
G-AC-18
LOCAL FAULT ON 480V BUS F-7
AC-F7-BUS-LOF
L/O AC POWER FROM BREAKER 12F/F-7
G-AC-269
480V BUS F-7 O.O.S. FOR TORM
AC-F7-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12F
G-AC-BUS-12F
LOCAL FAULT ON BKR 12F/F-7
AC-12F-19D-FRC
BKR 12F/F-7 OPENED BY OPERATOR - N.C.
AC-12F-19D-OPO
BKR 12F/F-7 O.O.S. FOR TORM
AC-12F-19D-TMO

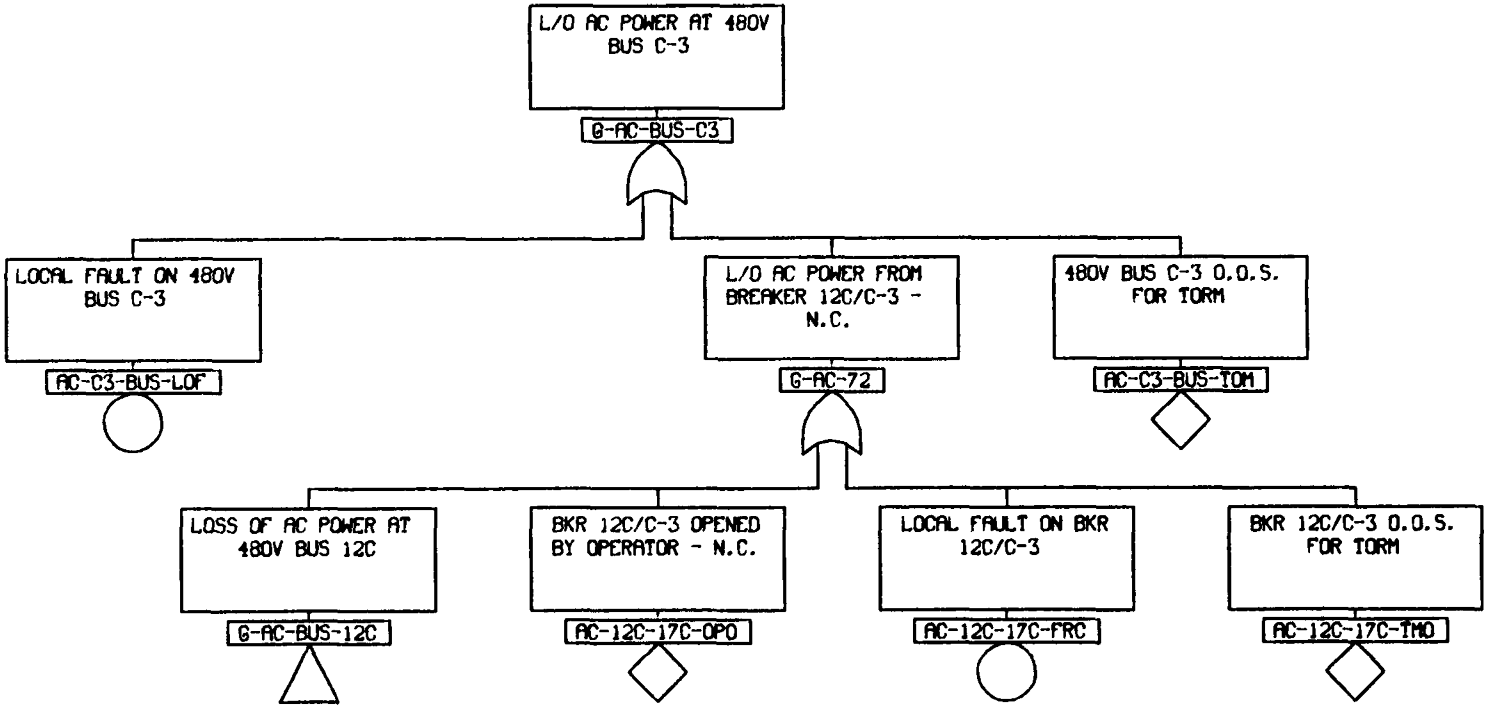


G-AC-BUS-12F OUTPUT LIST
G-AC-59, G-AC-60, G-AC-61, G-AC-62, G-AC-63, G-AC-269

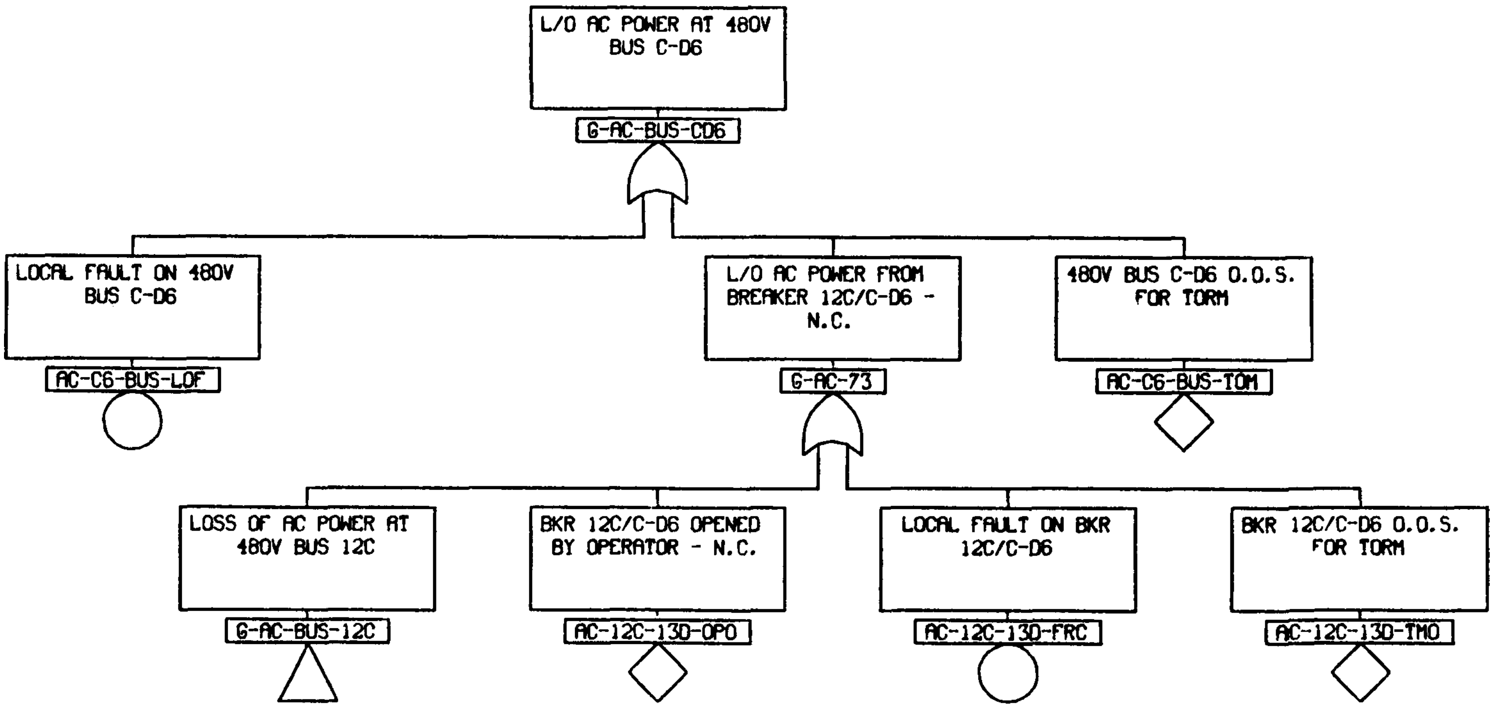

LOSS OF AC POWER FROM TRANSFORMER 14F/12F - 4160V TO 480V
G-AC-66
G-AC-65
LOSS OF AC POWER BKR 14F-14F/12F - N.C.
G-AC-67
LOCAL FAULT ON TRANSFORMER 14F/12F
AC-14F12-XFR-LOF
TRANSFORMER 14F/12F OUT OF SERVICE FOR TEST OR MAINT.
AC-14F12-XFR-TOM
L/O AC POWER AT 4160V BUS 14F
G-AC-BUS-14F
LOCAL FAULT ON BKR 14F-14F/12F
AC-14F12-12-FRC
BKR 14F-14F/12F OPENED BY OPERATOR - N.C.
AC-14F12-12-OPO
BKR 14F-14F/12F OUT OF SERVICE FOR TEST OR MAINT.
AC-14F12-12-TMO


L/O AC POWER AT 480V BUS C-2
G-AC-BUS-C2
LOCAL FAULT ON 480V BUS C-2
AC-C2-BUS-LOF
L/O AC POWER FROM BREAKER 12C/C-2 - N.C.
G-AC-71
480V BUS C-2 O.O.S. FOR TORM
AC-C2-BUS-TOM
BKR 12C/C-2 OPENED BY OPERATOR - N.C.
AC-12C-17B-OPO
LOSS OF AC POWER AT 480V BUS 12C
G-AC-BUS-12C
LOCAL FAULT ON BKR 12C/C-2
AC-12C-17B-FRC
BKR 12C/C-2 O.O.S. FOR TORM
AC-12C-17B-TMO

AC-31

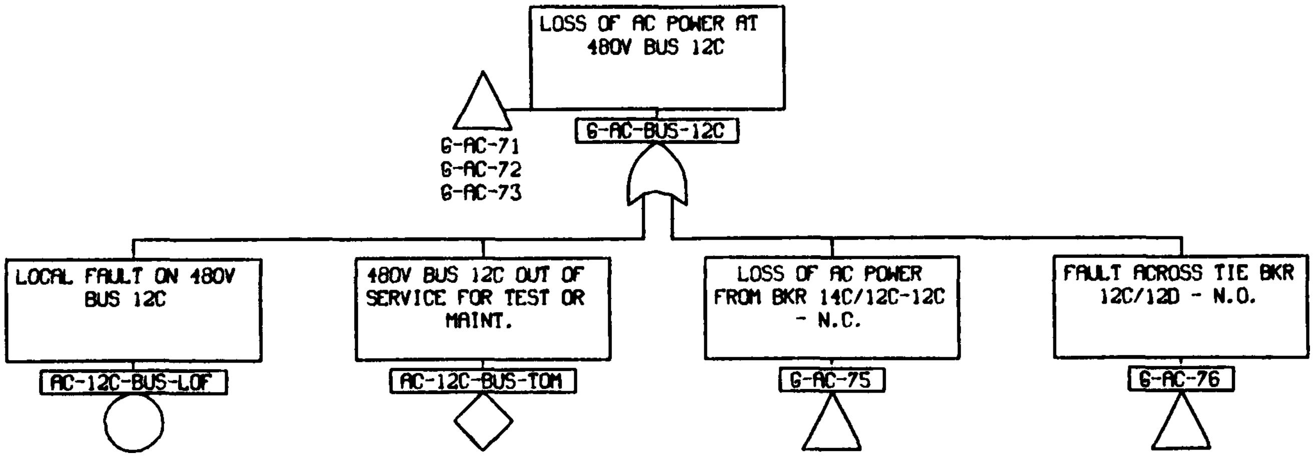

L/O AC POWER AT 480V BUS C-3
G-AC-BUS-C3
LOCAL FAULT ON 480V BUS C-3
AC-C3-BUS-LOF
L/O AC POWER FROM BREAKER 12C/C-3 - N.C.
G-AC-72
480V BUS C-3 O.O.S. FOR TORM
AC-C3-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12C
G-AC-BUS-12C
BKR 12C/C-3 OPENED BY OPERATOR - N.C.
AC-12C-17C-OPO
LOCAL FAULT ON BKR 12C/C-3
AC-12C-17C-FRC
BKR 12C/C-3 O.O.S. FOR TORM
AC-12C-17C-TMO

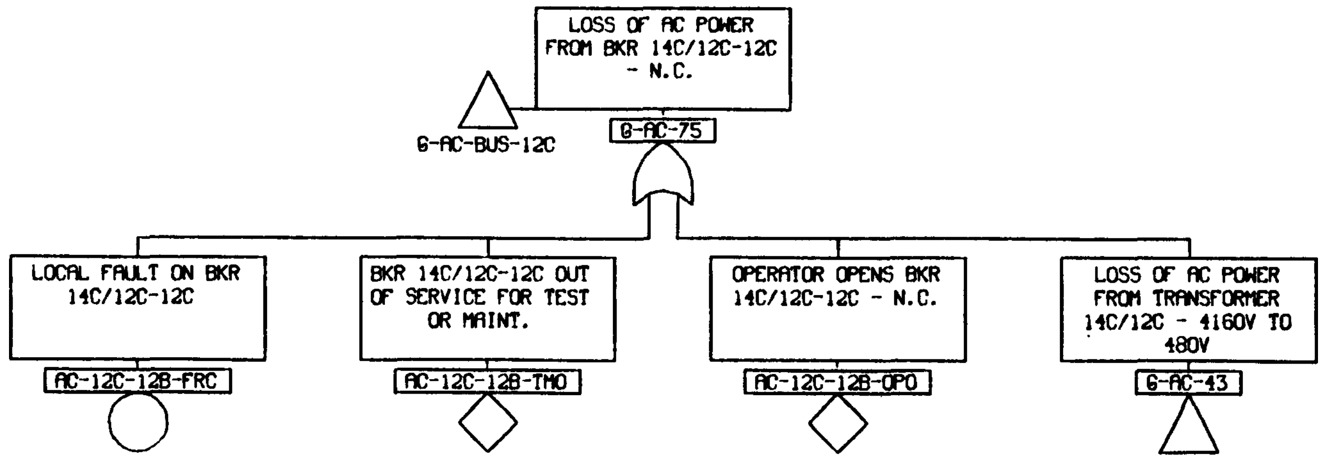
B.17-80

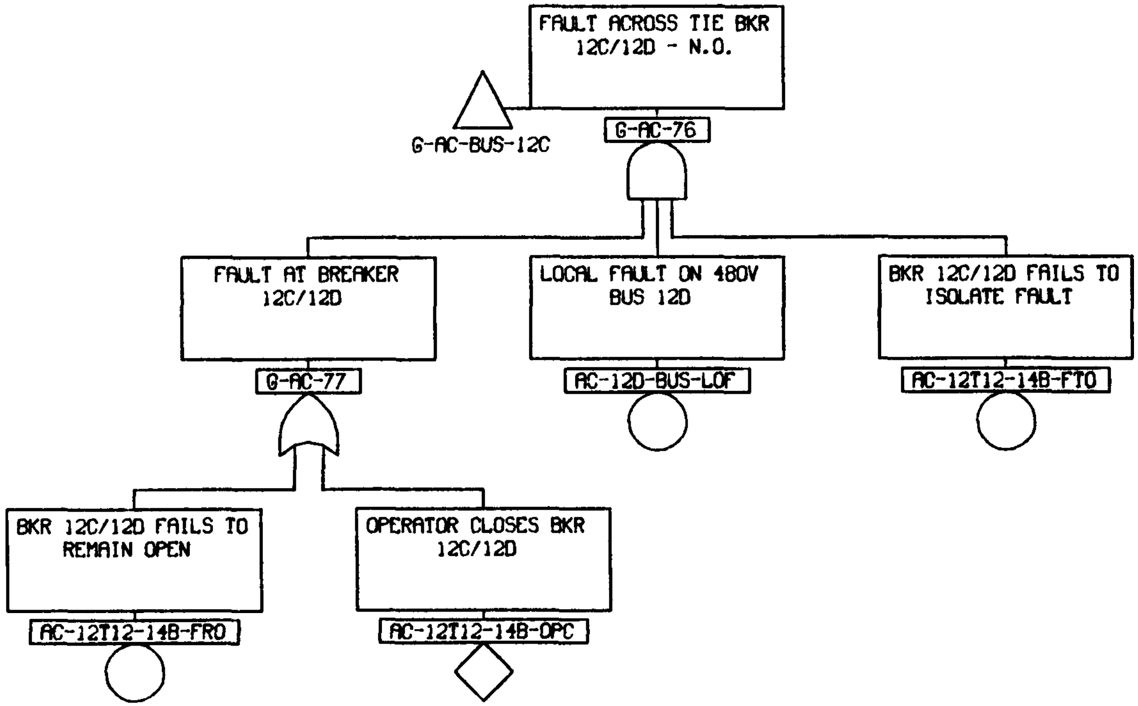


L/O AC POWER AT 480V BUS C-D6
G-AC-BUS-CD6
LOCAL FAULT ON 480V BUS C-D6
AC-C6-BUS-LOF
L/O AC POWER FROM BREAKER 12C/C-D6 - N.C.
G-AC-73
480V BUS C-D6 O.O.S. FOR TORM
AC-C6-BUS-TOM
LOSS OF AC POWER AT 480V BUS 12C
G-AC-BUS-12C
BKR 12C/C-D6 OPENED BY OPERATOR - N.C.
AC-12C-13D-OPO
LOCAL FAULT ON BKR 12C/C-D6
AC-12C-13D-FRC
BKR 12C/C-D6 O.O.S. FOR TORM
AC-12C-13D-TMO

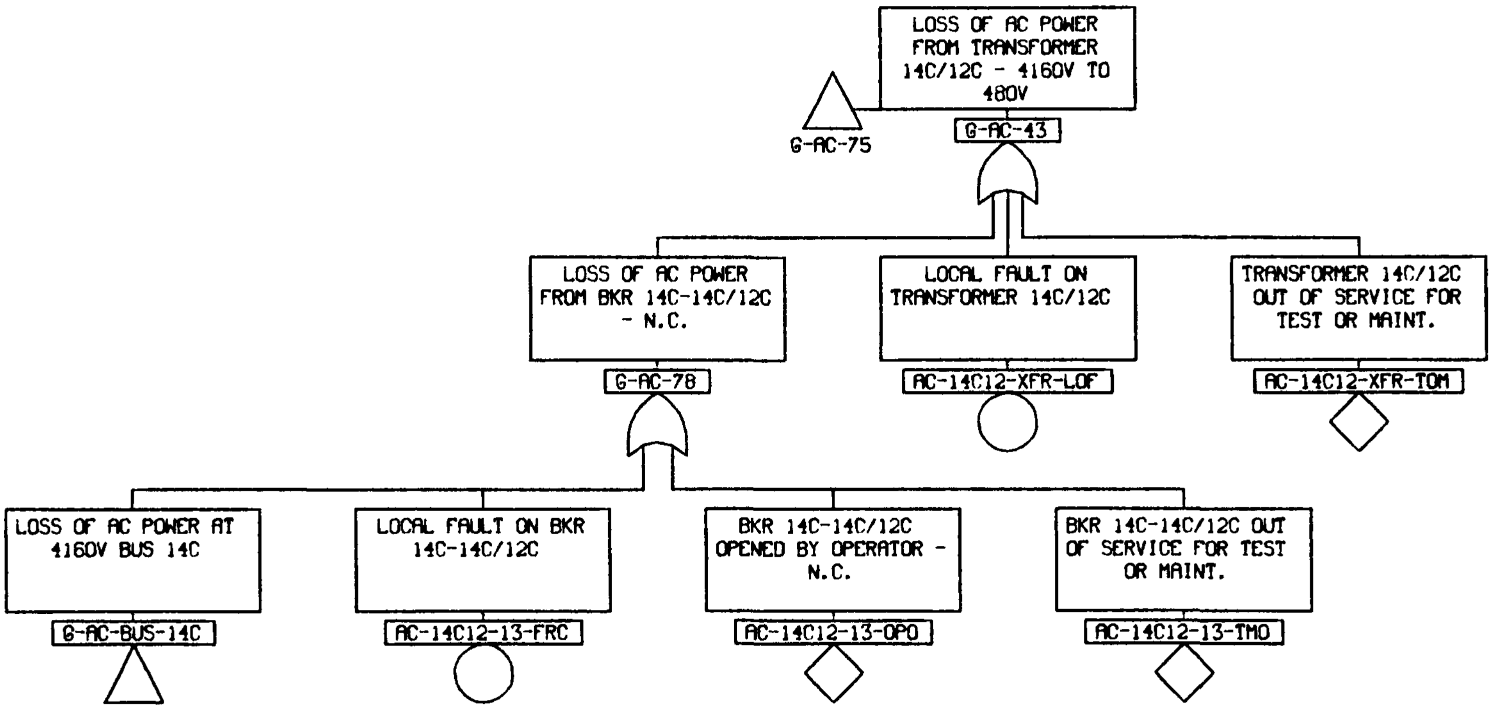
B.17-81

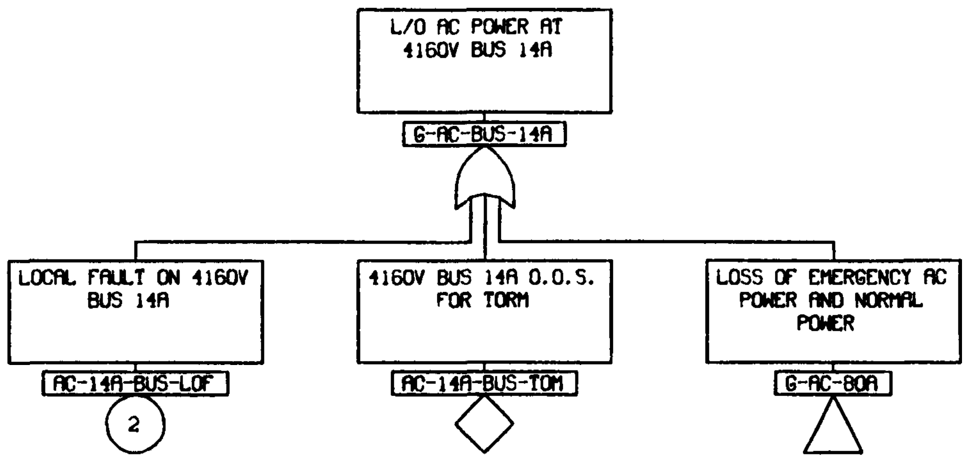

LOSS OF AC POWER AT 480V BUS 12C
G-AC-BUS-12C
G-AC-71
G-AC-72
G-AC-73
LOCAL FAULT ON 480V BUS 12C
AC-12C-BUS-LOF
480V BUS 12C OUT OF SERVICE FOR TEST OR MAINT.
AC-12C-BUS-TOM
LOSS OF AC POWER FROM BKR 14C/12C-12C - N.C.
G-AC-75
FAULT ACROSS TIE BKR 12C/12D - N.O.
G-AC-76

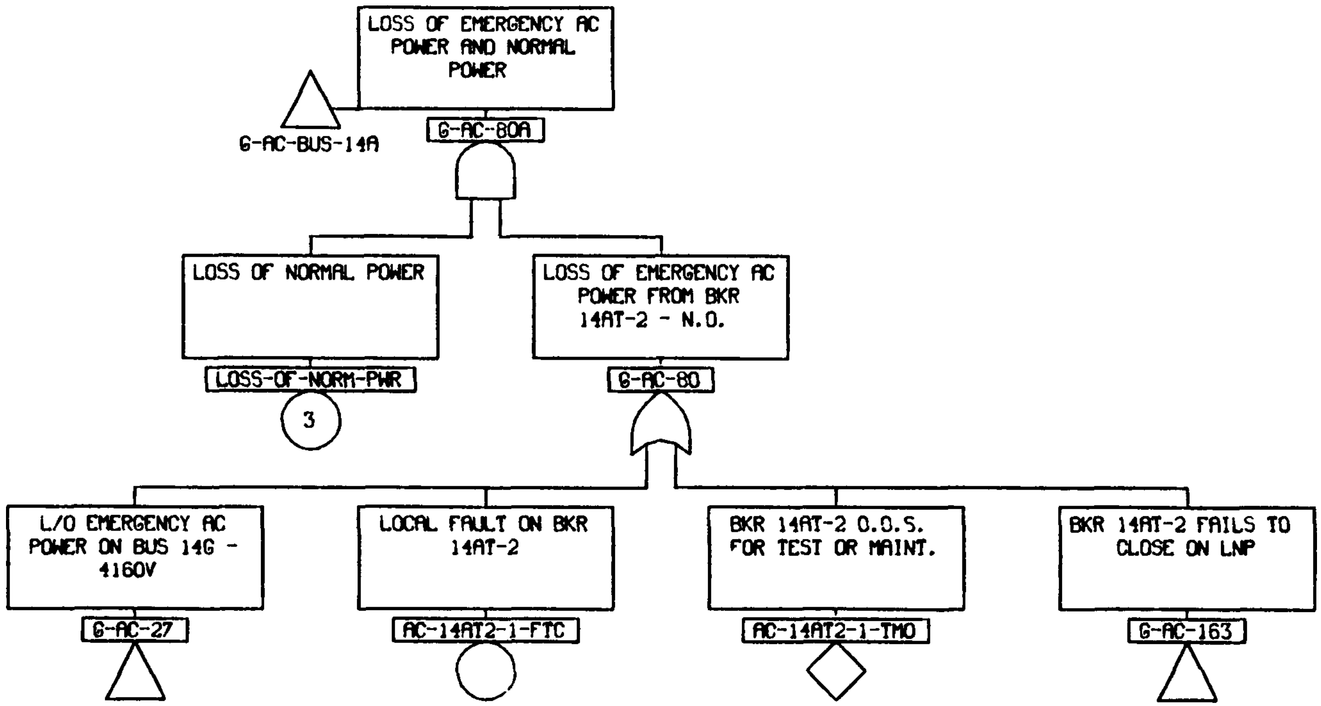

LOSS OF AC POWER FROM BKR 14C/12C-12C - N.C.
G-AC-75
G-AC-BUS-12C
LOCAL FAULT ON BKR 14C/12C-12C
AC-12C-12B-FRC
BKR 14C/12C-12C OUT OF SERVICE FOR TEST OR MAINT.
AC-12C-12B-TMO
OPERATOR OPENS BKR 14C/12C-12C - N.C.
AC-12C-12B-OPO
LOSS OF AC POWER FROM TRANSFORMER 14C/12C - 4160V TO 480V
G-AC-43

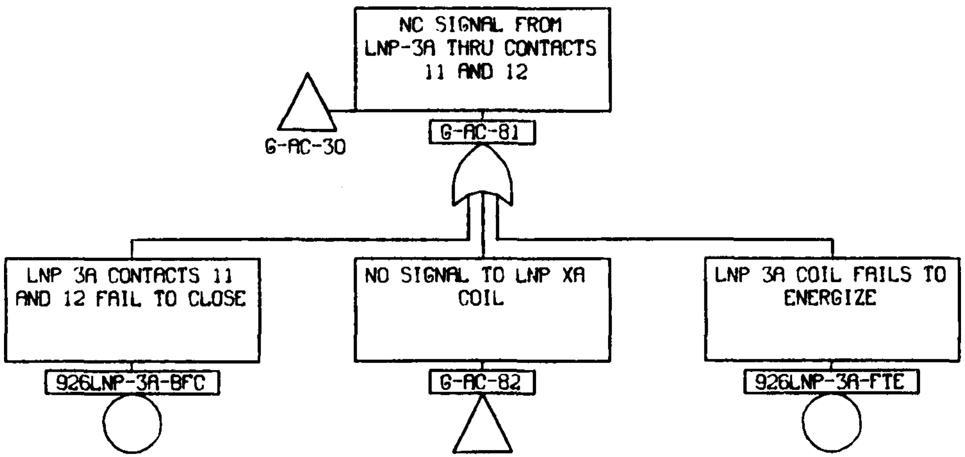


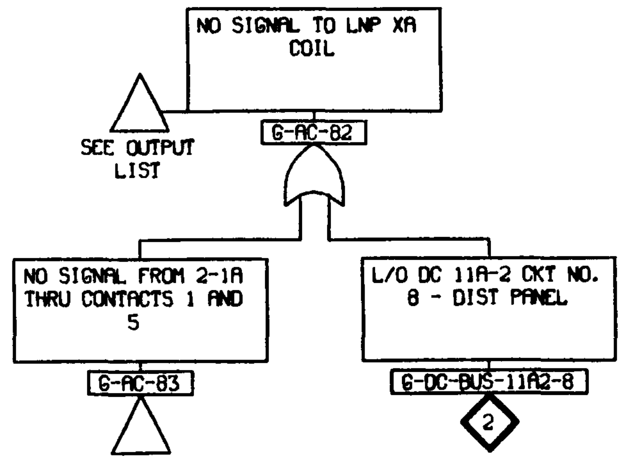
FAULT ACROSS TIE BKR 12C/12D - N.O.
G-AC-BUS-12C
G-AC-76
FAULT AT BREAKER 12C/12D
G-AC-77
LOCAL FAULT ON 480V BUS 12D
AC-12D-BUS-LOF
BKR 12C/12D FAILS TO ISOLATE FAULT
AC-12T12-14B-FTO
BKR 12C/12D FAILS TO REMAIN OPEN
AC-12T12-14B-FRO
OPERATOR CLOSES BKR 12C/12D
AC-12T12-14B-OPC


LOSS OF AC POWER FROM TRANSFORMER 14C/12C - 4160V TO 480V
G-AC-43
G-AC-75
LOSS OF AC POWER FROM BKR 14C-14C/12C - N.C.
G-AC-78
LOCAL FAULT ON TRANSFORMER 14C/12C
AC-14C12-XFR-LOF
TRANSFORMER 14C/12C OUT OF SERVICE FOR TEST OR MAINT.
AC-14C12-XFR-TOM
LOSS OF AC POWER AT 4160V BUS 14C
G-AC-BUS-14C
LOCAL FAULT ON BKR 14C-14C/12C
AC-14C12-13-FRC
BKR 14C-14C/12C OPENED BY OPERATOR - N.C.
AC-14C12-13-OPO
BKR 14C-14C/12C OUT OF SERVICE FOR TEST OR MAINT.
AC-14C12-13-TMO

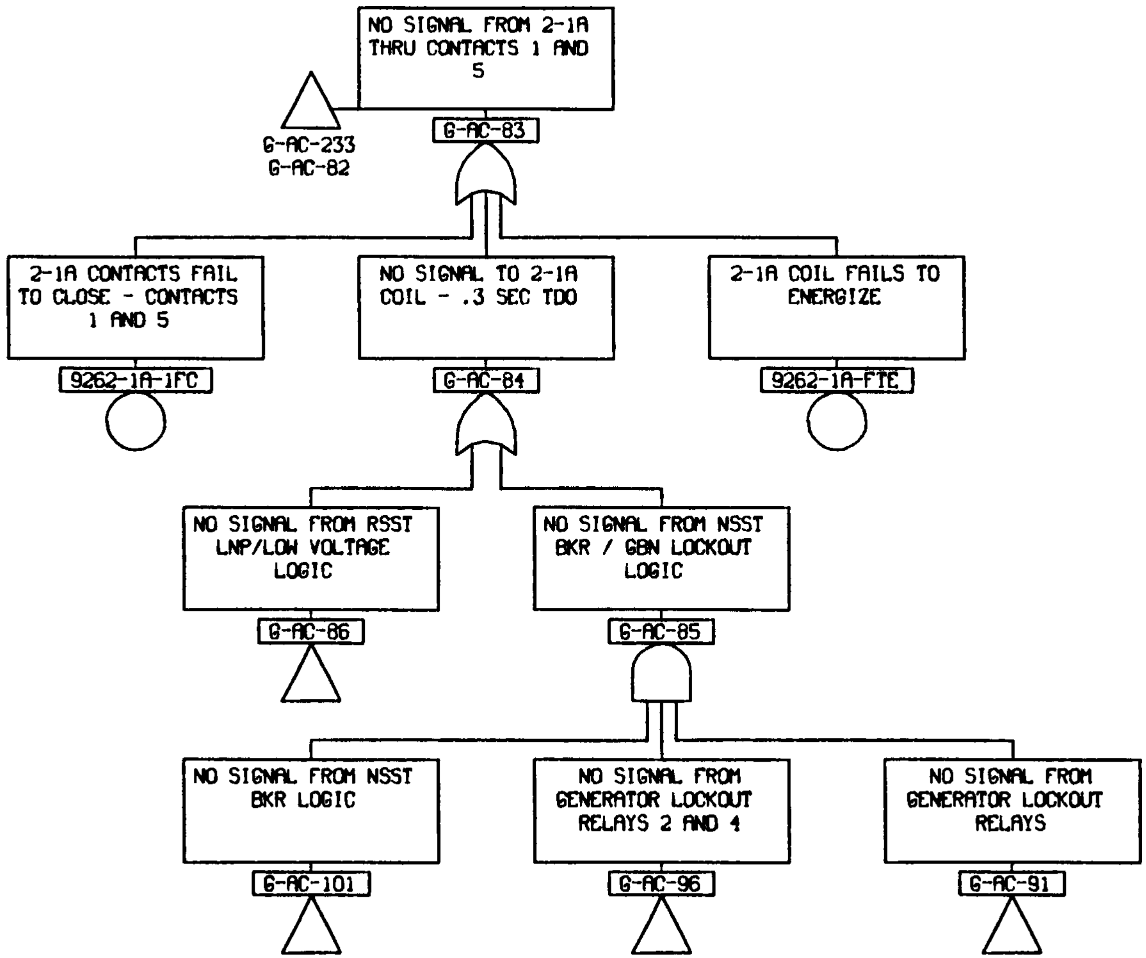

L/O AC POWER AT 4160V BUS 14A
G-AC-BUS-14A
LOCAL FAULT ON 4160V BUS 14A
AC-14A-BUS-LOF
2
4160V BUS 14A O.O.S. FOR TORM
AC-14A-BUS-TOM
LOSS OF EMERGENCY AC POWER AND NORMAL POWER
G-AC-BOA


LOSS OF EMERGENCY AC POWER AND NORMAL POWER
G-AC-80A
G-AC-BUS-14A
LOSS OF NORMAL POWER
LOSS-OF-NORM-PWR
3
LOSS OF EMERGENCY AC POWER FROM BKR 14AT-2 - N.O.
G-AC-80
L/O EMERGENCY AC POWER ON BUS 14G - 4160V
G-AC-27
LOCAL FAULT ON BKR 14AT-2
AC-14AT2-1-FTC
BKR 14AT-2 O.O.S. FOR TEST OR MAINT.
AC-14AT2-1-TMO
BKR 14AT-2 FAILS TO CLOSE ON LNP
G-AC-163



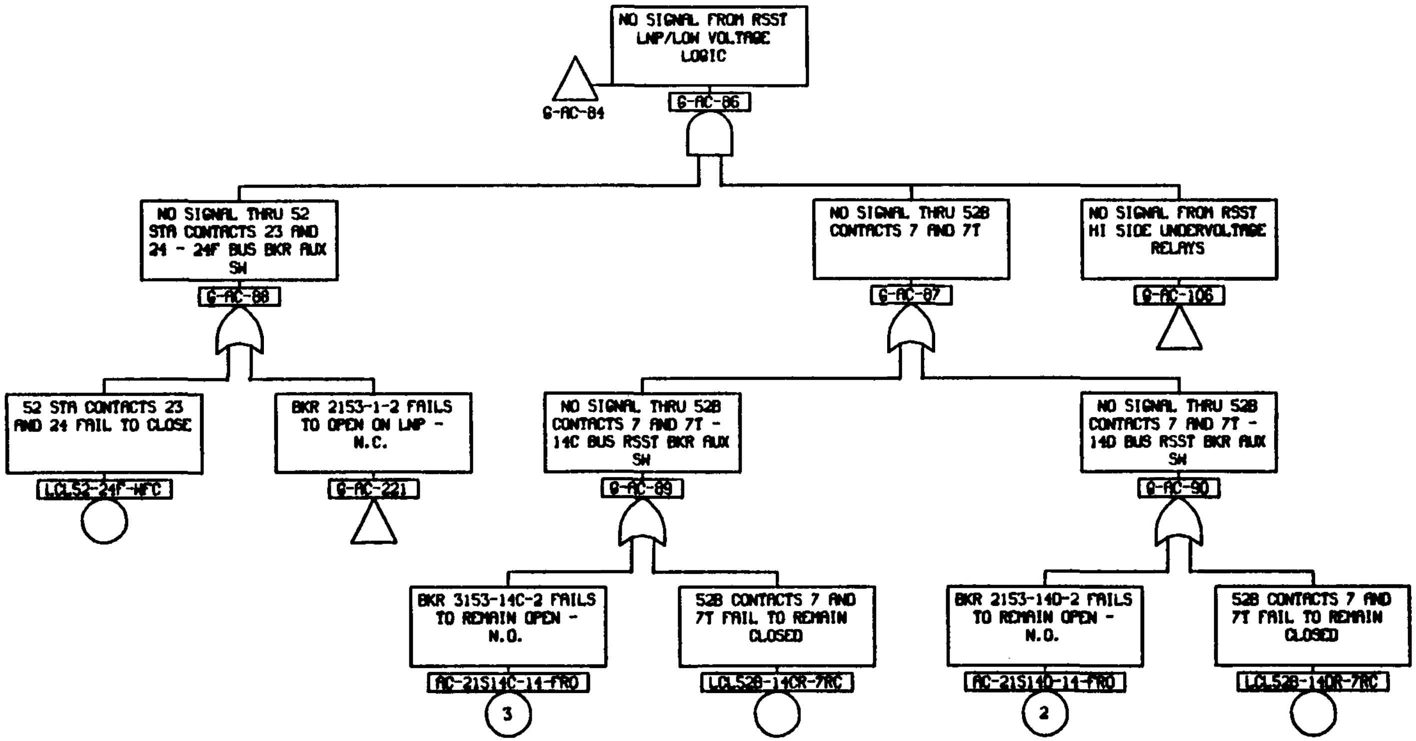


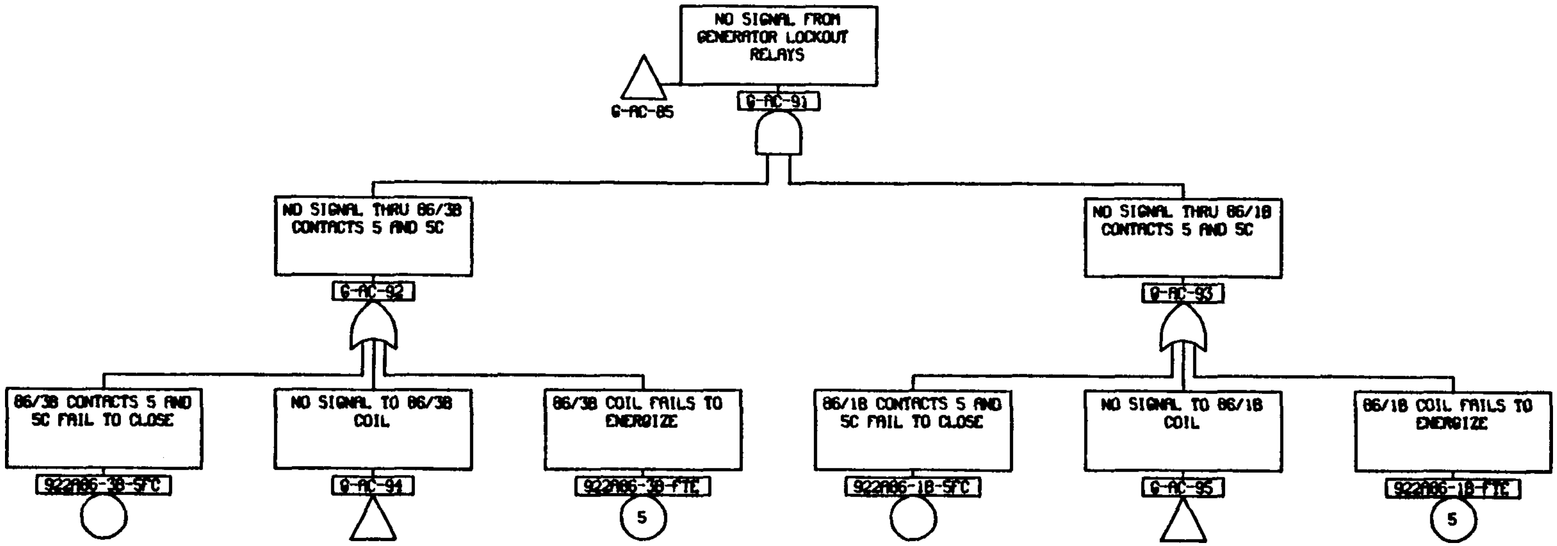
G-AC-82 OUTPUT LIST
G-AC-81, G-AC-157, G-AC-182, G-AC-219, G-AC-242


NO SIGNAL FROM 2-1A THRU CONTACTS 1 AND 5
G-AC-83
G-AC-233
G-AC-82
2-1A CONTACTS FAIL TO CLOSE - CONTACTS 1 AND 5
9262-1A-1FC
NO SIGNAL TO 2-1A COIL - .3 SEC TDO
G-AC-84
2-1A COIL FAILS TO ENERGIZE
9262-1A-FTE
NO SIGNAL FROM RSST LNP/LOW VOLTAGE LOGIC
G-AC-86
NO SIGNAL FROM NSST BKR / GBN LOCKOUT LOGIC
G-AC-85
NO SIGNAL FROM NSST BKR LOGIC
G-AC-101
NO SIGNAL FROM GENERATOR LOCKOUT RELAYS 2 AND 4
G-AC-96
NO SIGNAL FROM GENERATOR LOCKOUT RELAYS
G-AC-91

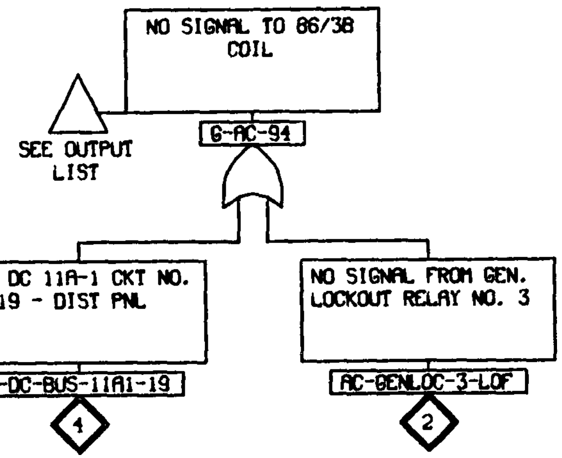
B.17-89

B.17-90

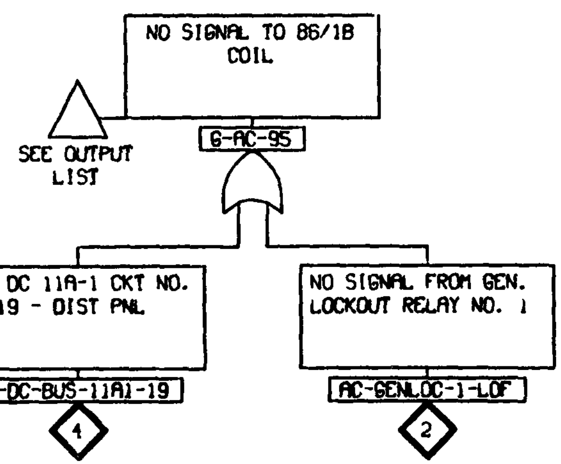

NO SIGNAL FROM RSST LNP/LOW VOLTAGE LOGIC
G-AC-84
G-AC-86
NO SIGNAL THRU 52 STA CONTACTS 23 AND 24 - 24F BUS BKR AUX SW
G-AC-88
NO SIGNAL THRU 52B CONTACTS 7 AND 7T
G-AC-87
NO SIGNAL FROM RSST HI SIDE UNDERVOLTAGE RELAYS
G-AC-106
52 STA CONTACTS 23 AND 24 FAIL TO CLOSE
LCL52-24F-HFC
BKR 2153-1-2 FAILS TO OPEN ON LNP - N.C.
G-AC-221
NO SIGNAL THRU 52B CONTACTS 7 AND 7T - 14C BUS RSST BKR AUX SW
G-AC-89
NO SIGNAL THRU 52B CONTACTS 7 AND 7T - 14D BUS RSST BKR AUX SW
G-AC-90
BKR 3153-14C-2 FAILS TO REMAIN OPEN - N.O.
AC-21S14C-14-FRO
3
52B CONTACTS 7 AND 7T FAIL TO REMAIN CLOSED
LCL52B-14CR-7RC
BKR 2153-14D-2 FAILS TO REMAIN OPEN - N.O.
AC-21S14D-14-FRO
2
52B CONTACTS 7 AND 7T FAIL TO REMAIN CLOSED
LCL52B-14DR-7RC



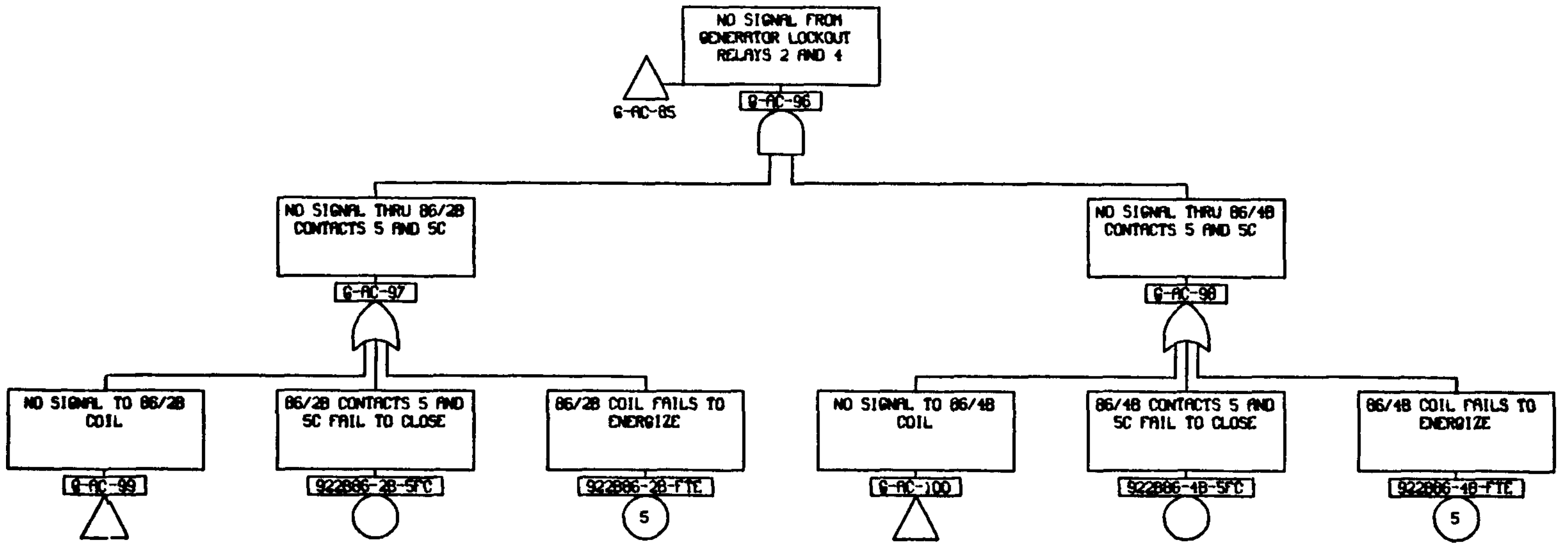
NO SIGNAL FROM GENERATOR LOCKOUT RELAYS
G-AC-91
G-AC-85
NO SIGNAL THRU 86/3B CONTACTS 5 AND 5C
G-AC-92
NO SIGNAL THRU 86/1B CONTACTS 5 AND 5C
G-AC-93
86/3B CONTACTS 5 AND 5C FAIL TO CLOSE
922A86-3B-SFC
NO SIGNAL TO 86/3B COIL
G-AC-94
86/3B COIL FAILS TO ENERGIZE
922A86-3B-FTE
5
86/1B CONTACTS 5 AND 5C FAIL TO CLOSE
922A86-1B-SFC
NO SIGNAL TO 86/1B COIL
G-AC-95
86/1B COIL FAILS TO ENERGIZE
922A86-1B-FTE
5



G-AC-94 OUTPUT LIST
G-AC-92, G-AC-192, G-AC-199, G-AC-206, G-AC-213

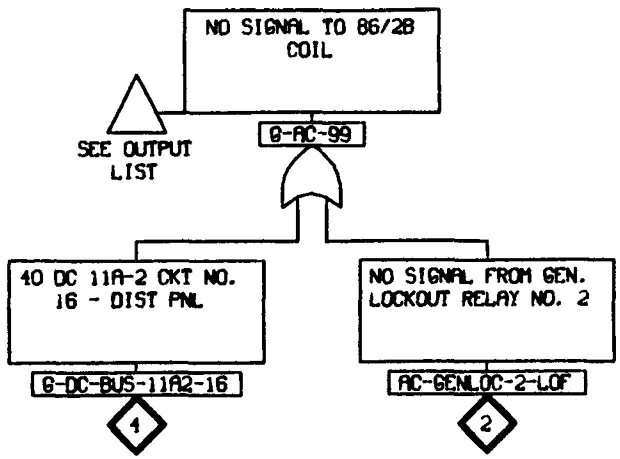


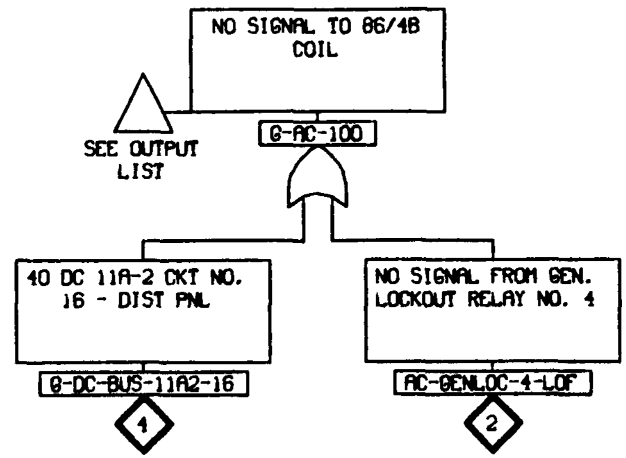
G-AC-95 OUTPUT LIST
G-AC-93, G-AC-191, G-AC-198, G-AC-205, G-AC-212



NO SIGNAL FROM GENERATOR LOCKOUT RELAYS 2 AND 4
G-AC-96
G-AC-85
NO SIGNAL THRU 86/2B CONTACTS 5 AND 5C
G-AC-97
NO SIGNAL THRU 86/4B CONTACTS 5 AND 5C
G-AC-98
NO SIGNAL TO 86/2B COIL
G-AC-99
86/2B CONTACTS 5 AND 5C FAIL TO CLOSE
922B86-2B-5FC
86/2B COIL FAILS TO ENERGIZE
922B86-2B-FTE
5
NO SIGNAL TO 86/4B COIL
G-AC-100
86/4B CONTACTS 5 AND 5C FAIL TO CLOSE
922B86-4B-5FC
86/4B COIL FAILS TO ENERGIZE
922B86-4B-FTE
5

B.17-93

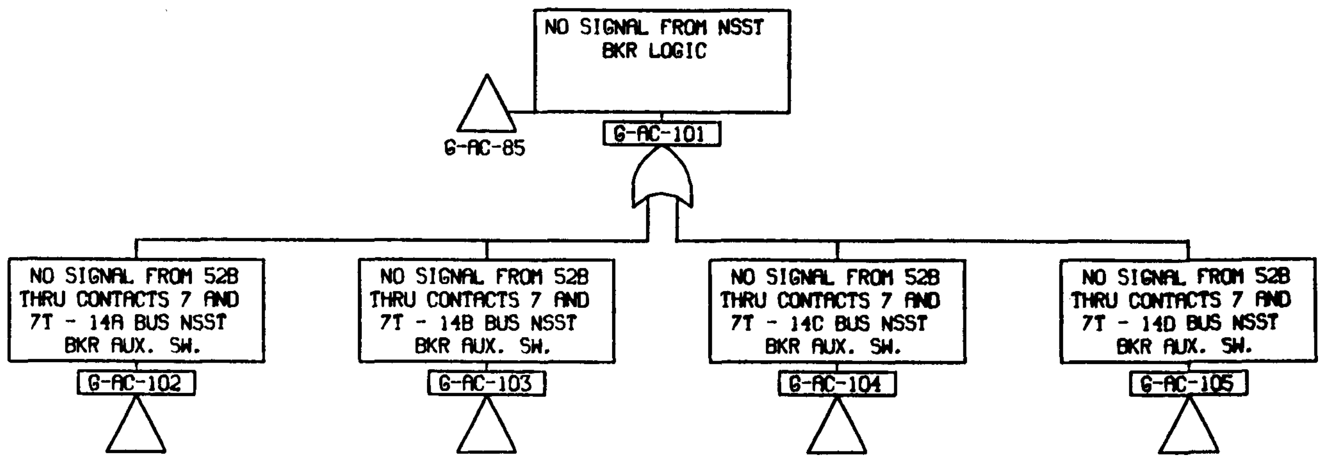


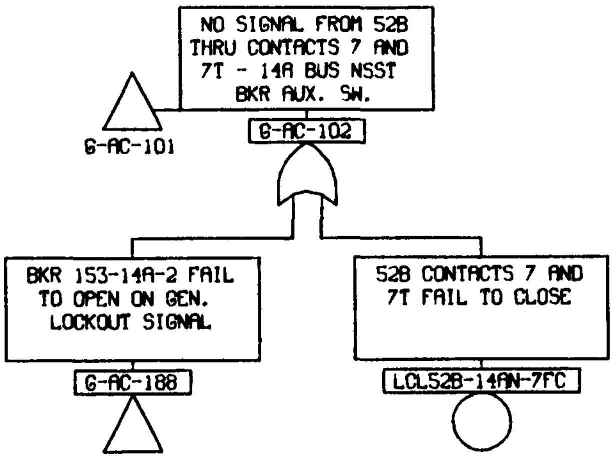


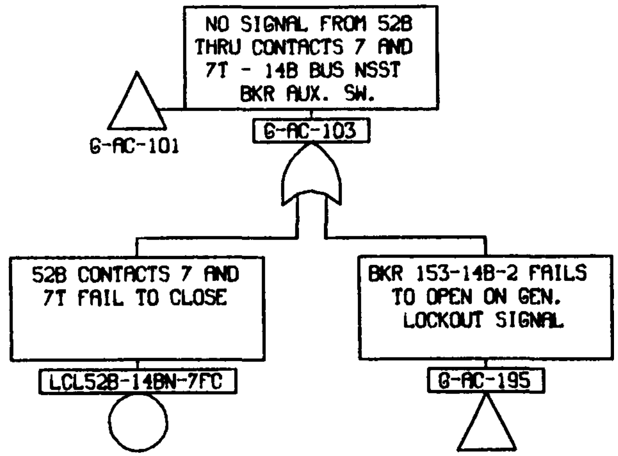
G-AC-99 OUTPUT LIST
G-AC-97, G-AC-193, G-AC-200, G-AC-207, G-AC-214

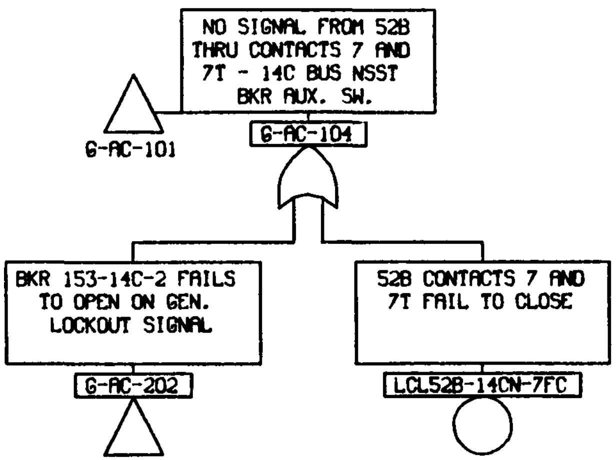
G-AC-100 OUTPUT LIST
G-AC-98, G-AC-194, G-AC-201, G-AC-208, G-AC-215

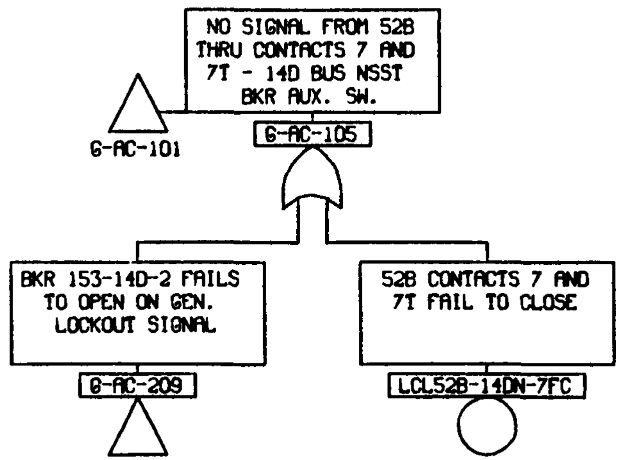
B.17-95

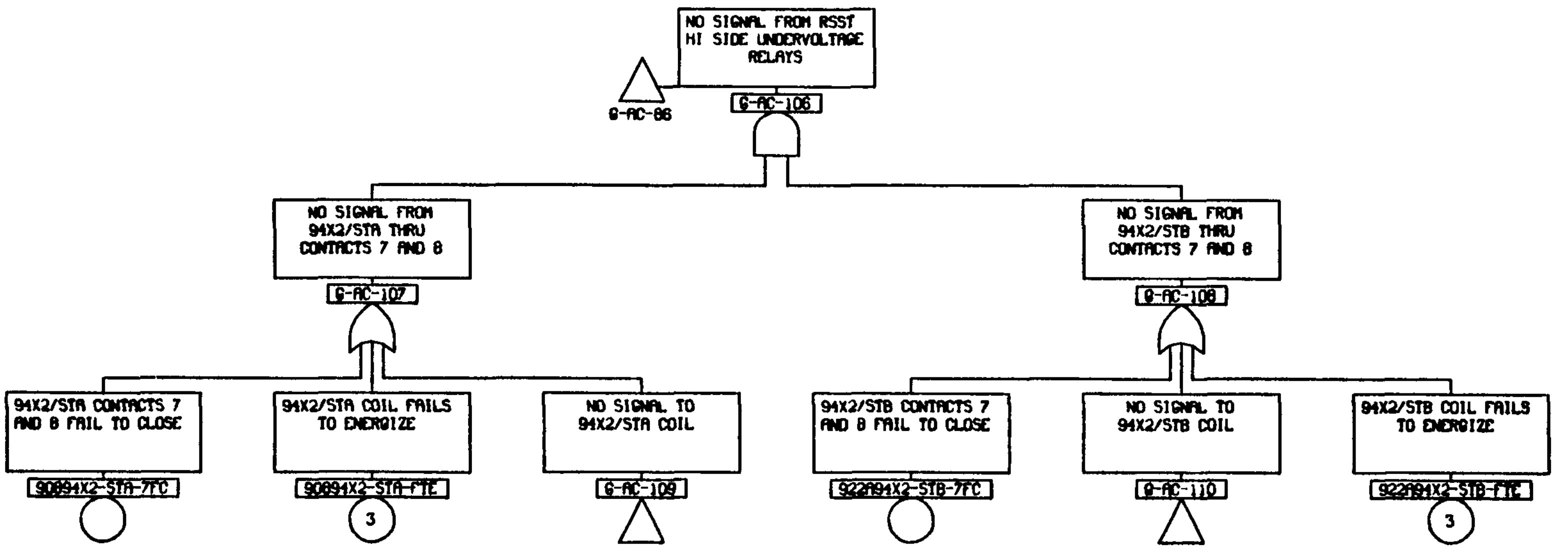

NO SIGNAL FROM NSST BKR LOGIC
G-AC-101
G-AC-85
NO SIGNAL FROM 52B THRU CONTACTS 7 AND 7T - 14A BUS NSST BKR AUX. SW.
G-AC-102
NO SIGNAL FROM 52B THRU CONTACTS 7 AND 7T - 14B BUS NSST BKR AUX. SW.
G-AC-103
NO SIGNAL FROM 52B THRU CONTACTS 7 AND 7T - 14C BUS NSST BKR AUX. SW.
G-AC-104
NO SIGNAL FROM 52B THRU CONTACTS 7 AND 7T - 14D BUS NSST BKR AUX. SW.
G-AC-105

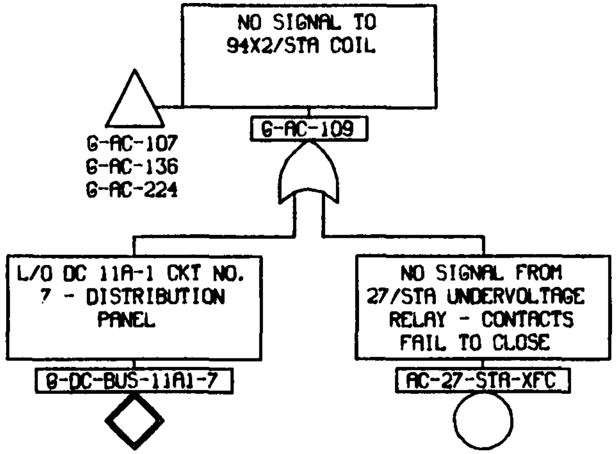

NO SIGNAL FROM 52B THRU CONTACTS 7 AND 7T - 14A BUS NSST BKR AUX. SW.
G-AC-102
G-AC-101
BKR 153-14A-2 FAIL TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-188
52B CONTACTS 7 AND 7T FAIL TO CLOSE
LCL52B-14AN-7FC

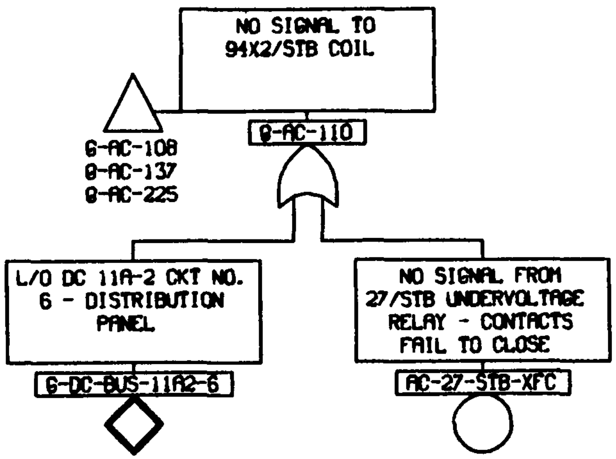

NO SIGNAL FROM 52B THRU CONTACTS 7 AND 7T - 14B BUS NSST BKR AUX. SW.
G-AC-103
G-AC-101
52B CONTACTS 7 AND 7T FAIL TO CLOSE
LCL52B-14BN-7FC
BKR 153-14B-2 FAILS TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-195

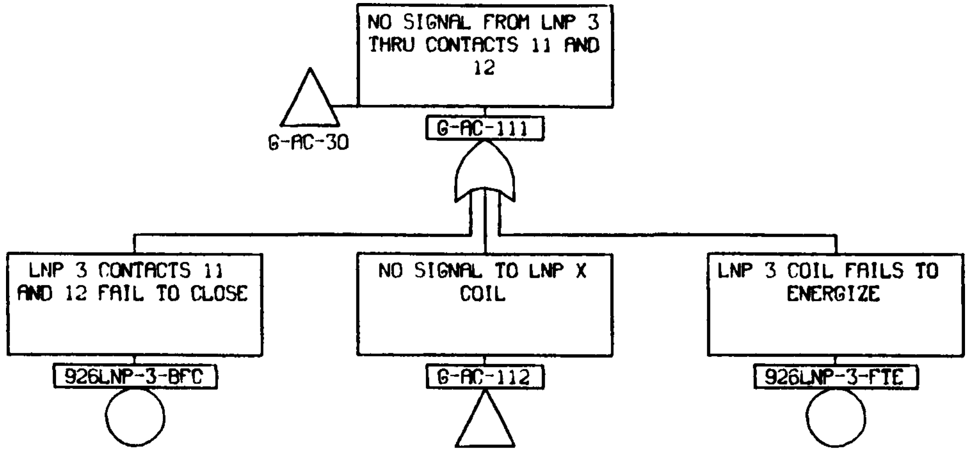

NO SIGNAL FROM 52B THRU CONTACTS 7 AND 7T - 14C BUS NSST BKR AUX. SW.
G-AC-104
G-AC-101
BKR 153-14C-2 FAILS TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-202
52B CONTACTS 7 AND 7T FAIL TO CLOSE
LCL52B-14CN-7FC

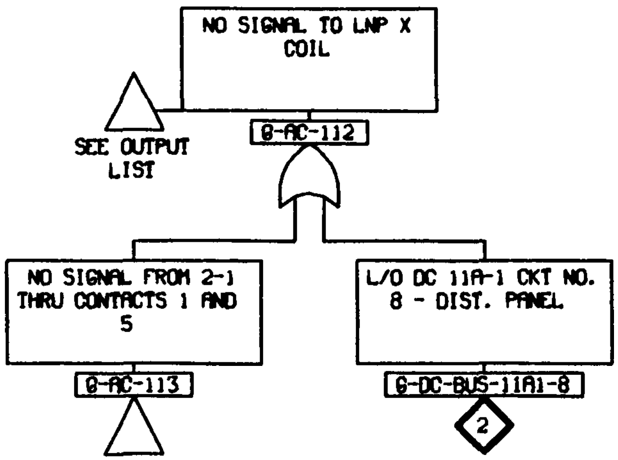

NO SIGNAL FROM 52B THRU CONTACTS 7 AND 7T - 14D BUS NSST BKR AUX. SW.
G-AC-105
G-AC-101
BKR 153-14D-2 FAILS TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-209
52B CONTACTS 7 AND 7T FAIL TO CLOSE
LCL52B-14DN-7FC


NO SIGNAL FROM RSST HI SIDE UNDERVOLTAGE RELAYS
G-AC-86
G-AC-106
NO SIGNAL FROM 94X2/STA THRU CONTACTS 7 AND 8
G-AC-107
NO SIGNAL FROM 94X2/STB THRU CONTACTS 7 AND 8
G-AC-108
94X2/STA CONTACTS 7 AND 8 FAIL TO CLOSE
90894X2-STA-7FC
94X2/STA COIL FAILS TO ENERGIZE
90894X2-STA-FTE
3
NO SIGNAL TO 94X2/STA COIL
G-AC-109
94X2/STB CONTACTS 7 AND 8 FAIL TO CLOSE
922A94X2-STB-7FC
NO SIGNAL TO 94X2/STB COIL
G-AC-110
94X2/STB COIL FAILS TO ENERGIZE
922A94X2-STB-FTE
3

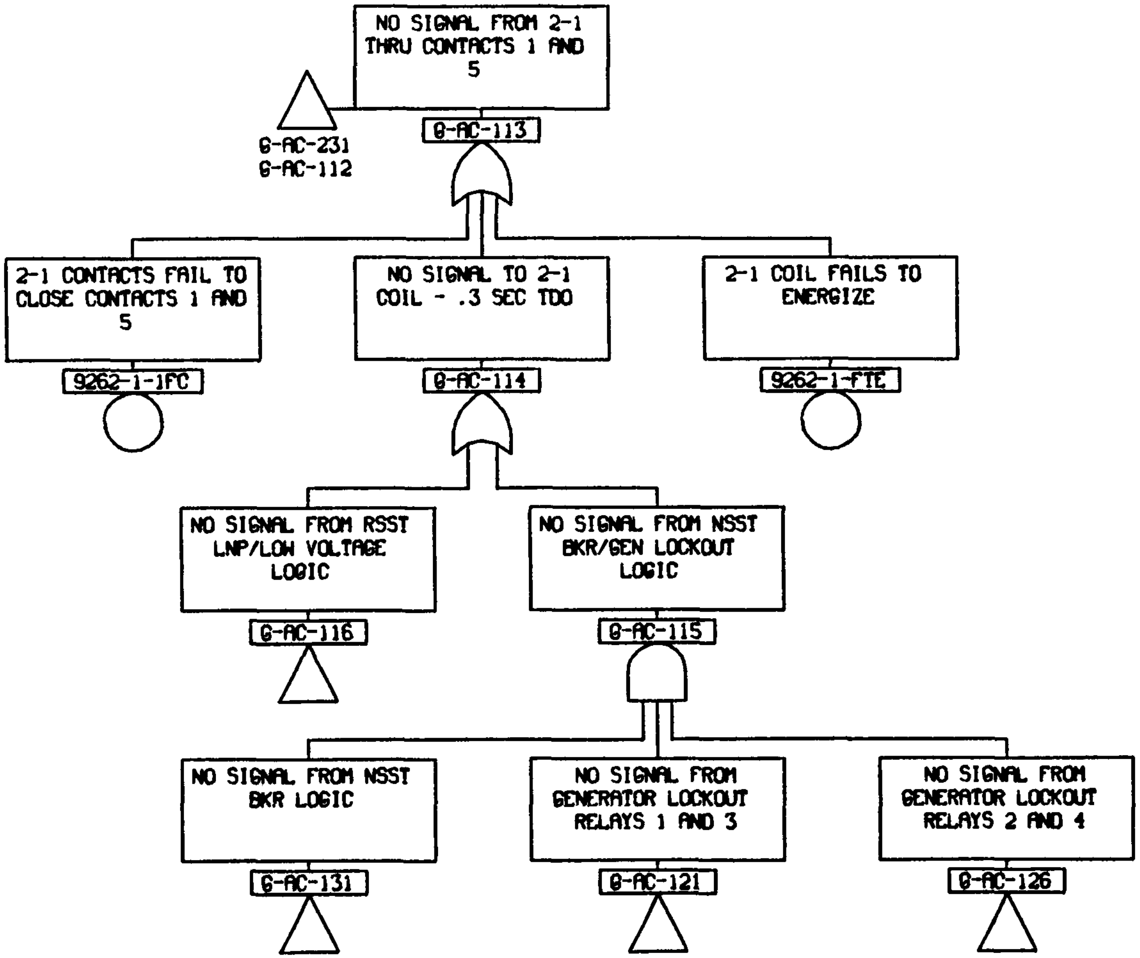

NO SIGNAL TO 94X2/STA COIL
G-AC-109
G-AC-107
G-AC-136
G-AC-224
L/O DC 11A-1 CKT NO. 7 - DISTRIBUTION PANEL
G-DC-BUS-11A1-7
NO SIGNAL FROM 27/STA UNDERVOLTAGE RELAY - CONTACTS FAIL TO CLOSE
AC-27-STA-XFC

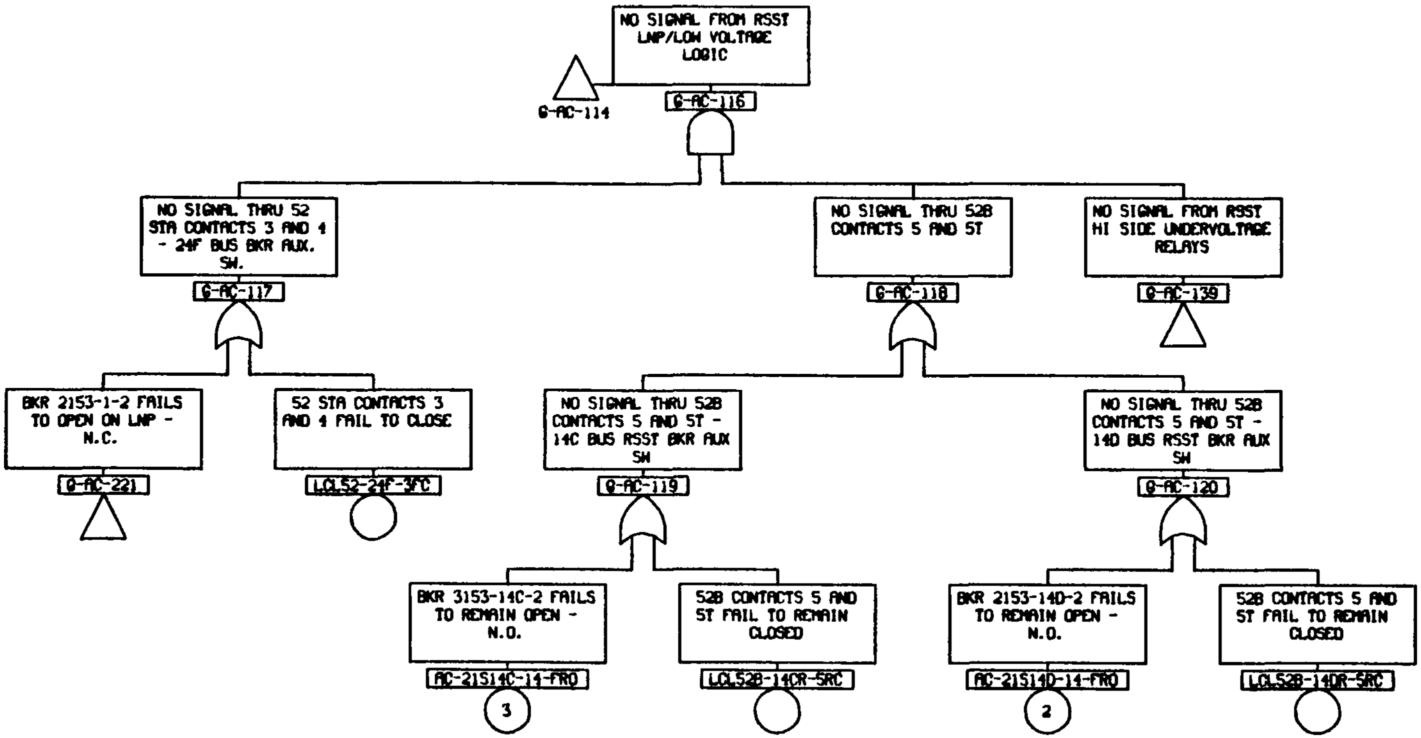

NO SIGNAL TO 94X2/STB COIL
G-AC-110
G-AC-108
G-AC-137
G-AC-225
L/O DC 11A-2 CKT NO. 6 - DISTRIBUTION PANEL
G-DC-BUS-11A2-6
NO SIGNAL FROM 27/STB UNDERVOLTAGE RELAY - CONTACTS FAIL TO CLOSE
AC-27-STB-XFC



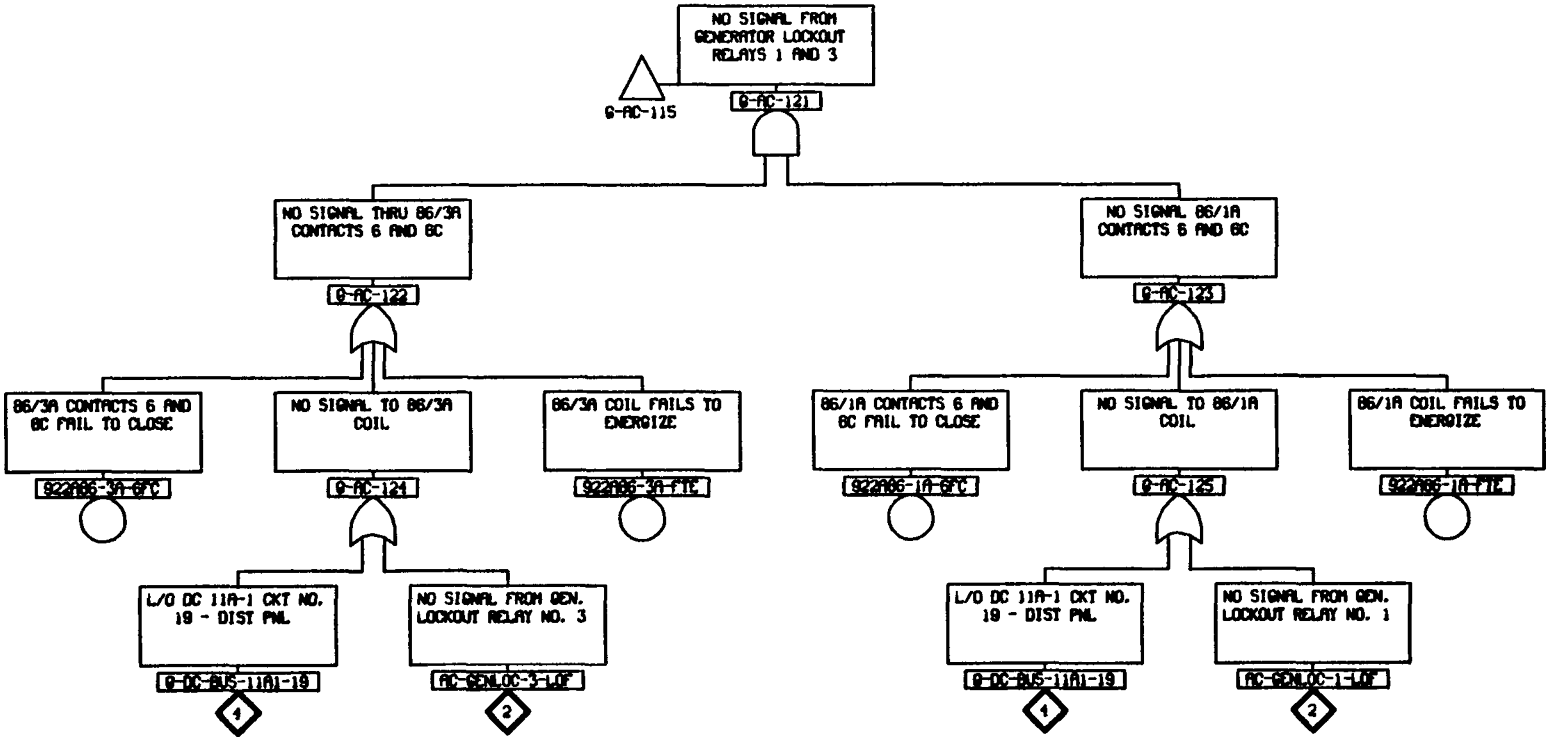


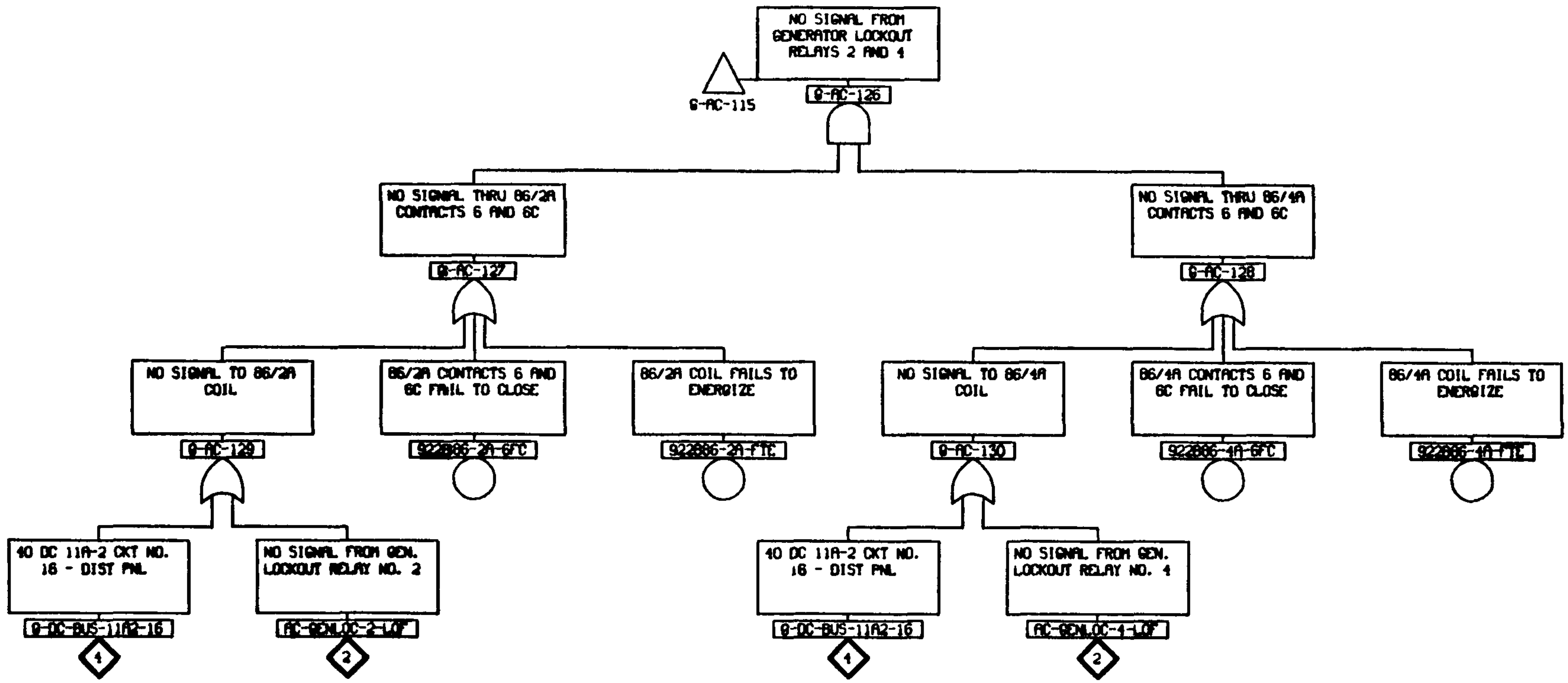
G-AC-112 OUTPUT LIST
G-AC-111, G-AC-154, G-AC-179, G-AC-218, G-AC-241

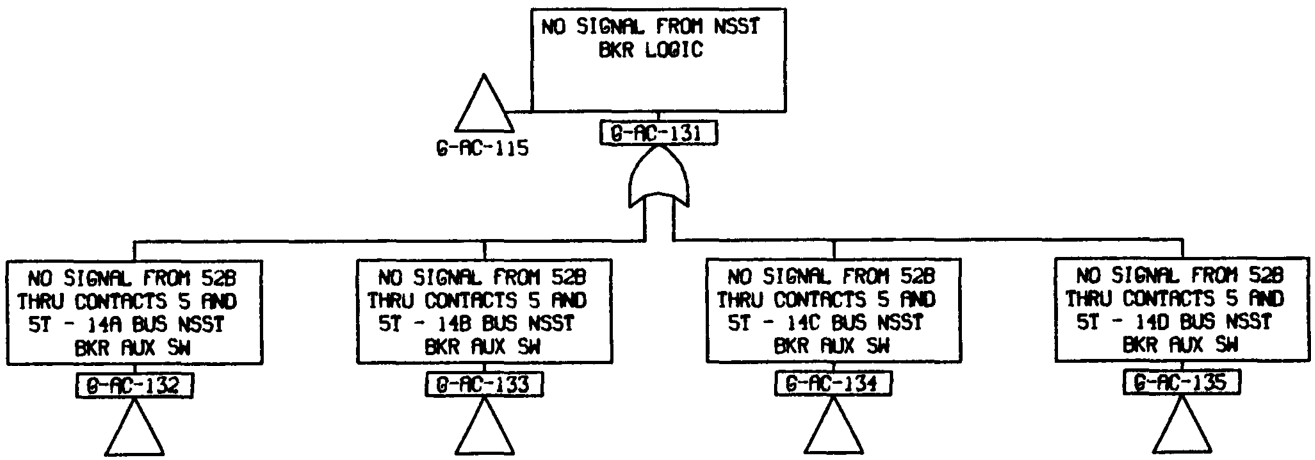

NO SIGNAL FROM 2-1 THRU CONTACTS 1 AND 5
G-AC-113
G-AC-231
G-AC-112
2-1 CONTACTS FAIL TO CLOSE CONTACTS 1 AND 5
9262-1-1FC
NO SIGNAL TO 2-1 COIL - .3 SEC TDO
G-AC-114
2-1 COIL FAILS TO ENERGIZE
9262-1-FTE
NO SIGNAL FROM RSST LNP/LOW VOLTAGE LOGIC
G-AC-116
NO SIGNAL FROM NSST BKR/GEN LOCKOUT LOGIC
G-AC-115
NO SIGNAL FROM NSST BKR LOGIC
G-AC-131
NO SIGNAL FROM GENERATOR LOCKOUT RELAYS 1 AND 3
G-AC-121
NO SIGNAL FROM GENERATOR LOCKOUT RELAYS 2 AND 4
G-AC-126

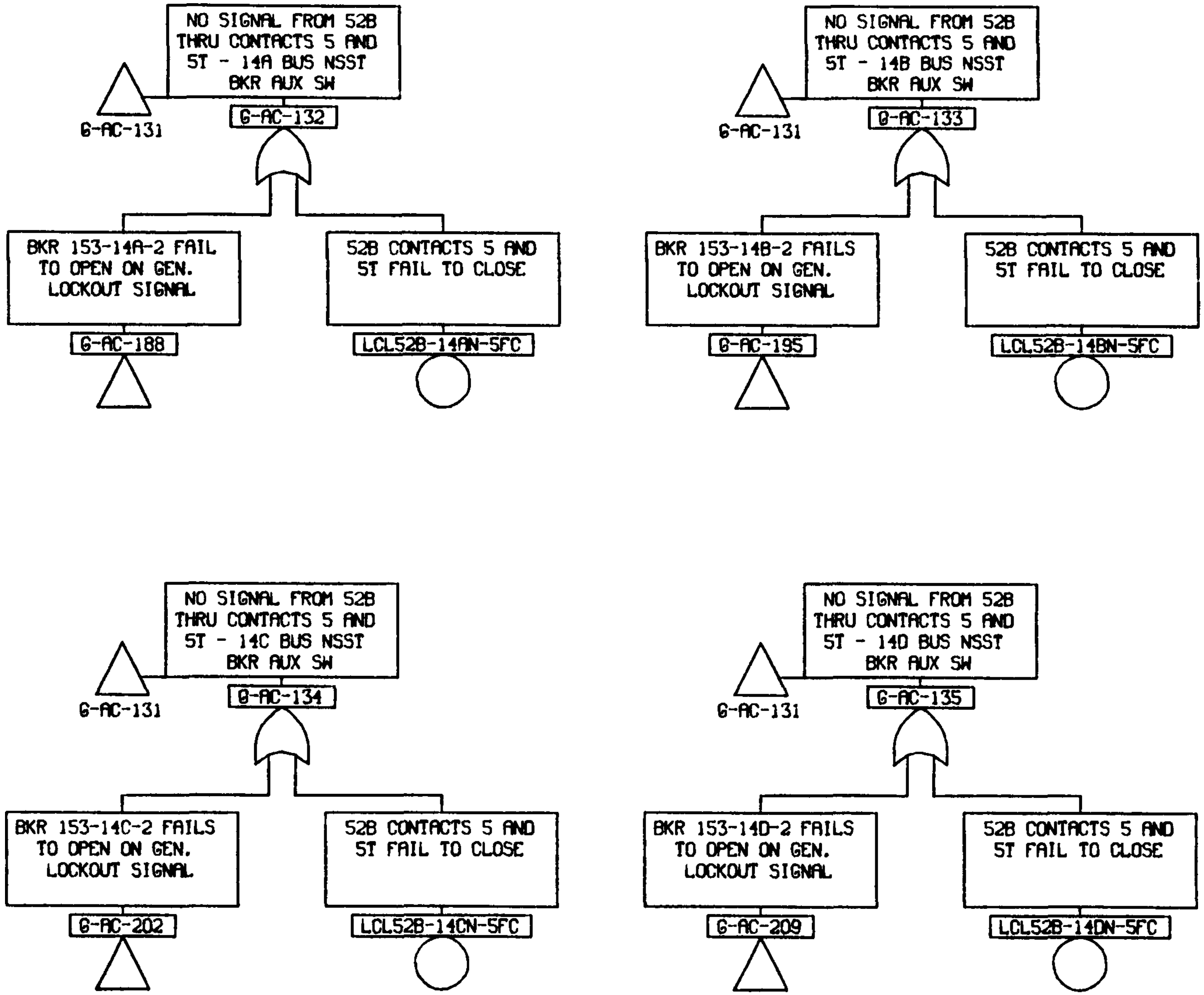


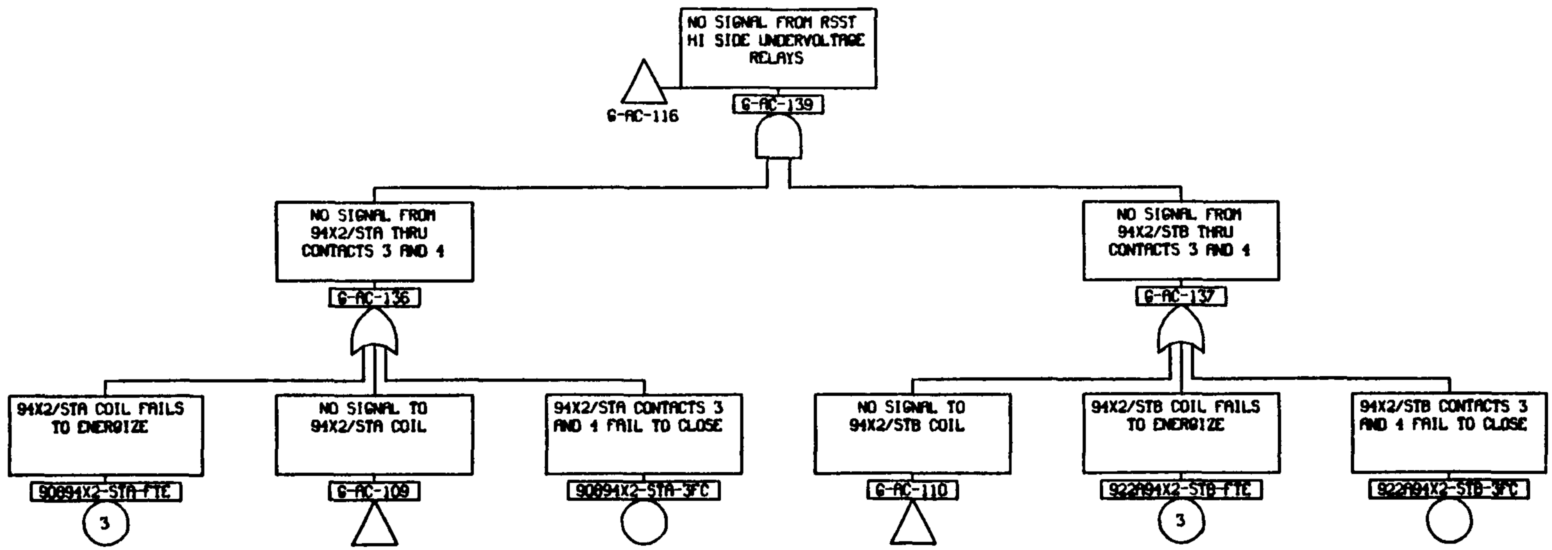
NO SIGNAL FROM RSST LNP/LOW VOLTAGE LOGIC
G-AC-116
G-AC-114
NO SIGNAL THRU 52 STA CONTACTS 3 AND 4 - 24F BUS BKR AUX. SW.
G-AC-117
NO SIGNAL THRU 52B CONTACTS 5 AND 5T
G-AC-118
NO SIGNAL FROM RSST HI SIDE UNDERVOLTAGE RELAYS
G-AC-139
BKR 2153-1-2 FAILS TO OPEN ON LNP - N.C.
G-AC-221
52 STA CONTACTS 3 AND 4 FAIL TO CLOSE
LCL52-24F-3FC
NO SIGNAL THRU 52B CONTACTS 5 AND 5T - 14C BUS RSST BKR AUX SW
G-AC-119
NO SIGNAL THRU 52B CONTACTS 5 AND 5T - 14D BUS RSST BKR AUX SW
G-AC-120
BKR 3153-14C-2 FAILS TO REMAIN OPEN - N.O.
AC-21S14C-14-FRO
3
52B CONTACTS 5 AND 5T FAIL TO REMAIN CLOSED
LCL52B-14CR-5RC
BKR 2153-14D-2 FAILS TO REMAIN OPEN - N.O.
AC-21S14D-14-FRO
2
52B CONTACTS 5 AND 5T FAIL TO REMAIN CLOSED
LCL52B-14DR-5RC


NO SIGNAL FROM GENERATOR LOCKOUT RELAYS 1 AND 3
G-AC-121
G-AC-115
NO SIGNAL THRU 86/3A CONTACTS 6 AND 6C
G-AC-122
NO SIGNAL 86/1A CONTACTS 6 AND 6C
G-AC-123
86/3A CONTACTS 6 AND 6C FAIL TO CLOSE
922A86-3A-6FC
NO SIGNAL TO 86/3A COIL
G-AC-124
86/3A COIL FAILS TO ENERGIZE
922A86-3A-FTE
86/1A CONTACTS 6 AND 6C FAIL TO CLOSE
922A86-1A-6FC
NO SIGNAL TO 86/1A COIL
G-AC-125
86/1A COIL FAILS TO ENERGIZE
922A86-1A-FTE
L/O DC 11A-1 CKT NO. 19 - DIST PNL
G-DC-BUS-11A1-19
1
NO SIGNAL FROM GEN. LOCKOUT RELAY NO. 3
AC-GENLOC-3-LOF
2
L/O DC 11A-1 CKT NO. 19 - DIST PNL
G-DC-BUS-11A1-19
1
NO SIGNAL FROM GEN. LOCKOUT RELAY NO. 1
AC-GENLOC-1-LOF
2


NO SIGNAL FROM GENERATOR LOCKOUT RELAYS 2 AND 4
G-AC-126
G-AC-115
NO SIGNAL THRU 86/2A CONTACTS 6 AND 6C
G-AC-127
NO SIGNAL THRU 86/4A CONTACTS 6 AND 6C
G-AC-128
NO SIGNAL TO 86/2A COIL
G-AC-129
86/2A CONTACTS 6 AND 6C FAIL TO CLOSE
922B86-2A-6FC
86/2A COIL FAILS TO ENERGIZE
922B86-2A-FTE
NO SIGNAL TO 86/4A COIL
G-AC-130
86/4A CONTACTS 6 AND 6C FAIL TO CLOSE
922B86-4A-6FC
86/4A COIL FAILS TO ENERGIZE
922B86-4A-FTE
40 DC 11A-2 CKT NO. 16 - DIST PNL
G-DC-BUS-11A2-16
NO SIGNAL FROM GEN. LOCKOUT RELAY NO. 2
AC-GENLOC-2-LOF
40 DC 11A-2 CKT NO. 16 - DIST PNL
G-DC-BUS-11A2-16
NO SIGNAL FROM GEN. LOCKOUT RELAY NO. 4
AC-GENLOC-4-LOF

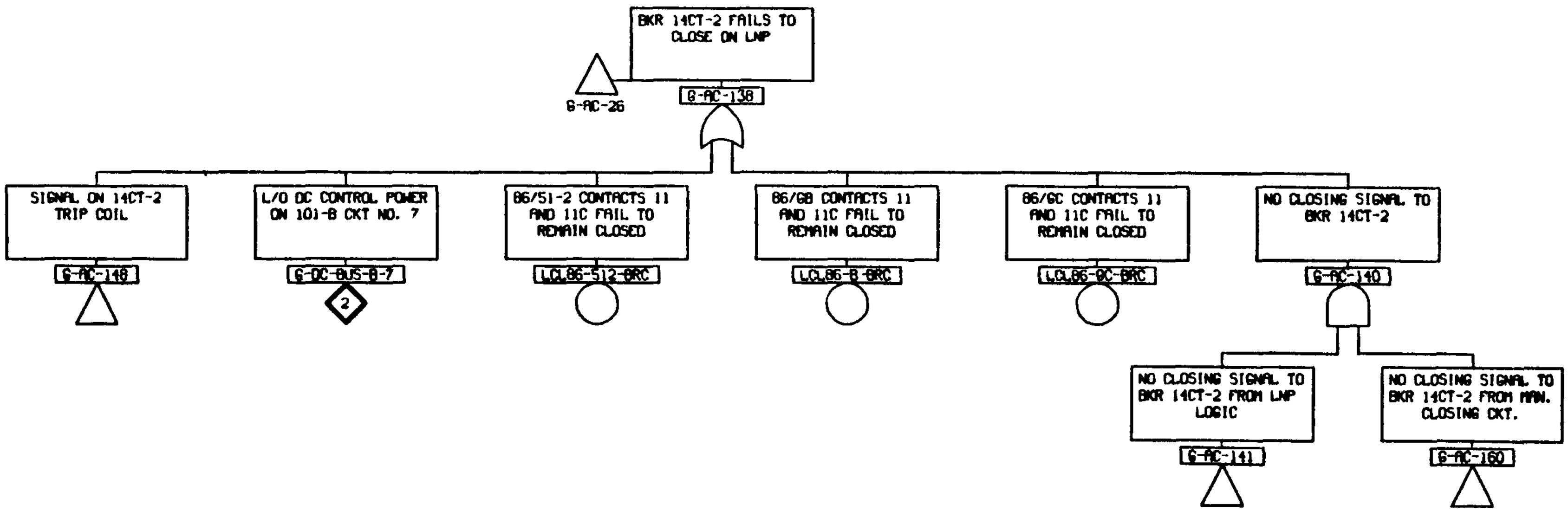

NO SIGNAL FROM NSST BKR LOGIC
G-AC-131
G-AC-115
NO SIGNAL FROM 52B THRU CONTACTS 5 AND 5T - 14A BUS NSST BKR AUX SW
G-AC-132
NO SIGNAL FROM 52B THRU CONTACTS 5 AND 5T - 14B BUS NSST BKR AUX SW
G-AC-133
NO SIGNAL FROM 52B THRU CONTACTS 5 AND 5T - 14C BUS NSST BKR AUX SW
G-AC-134
NO SIGNAL FROM 52B THRU CONTACTS 5 AND 5T - 14D BUS NSST BKR AUX SW
G-AC-135

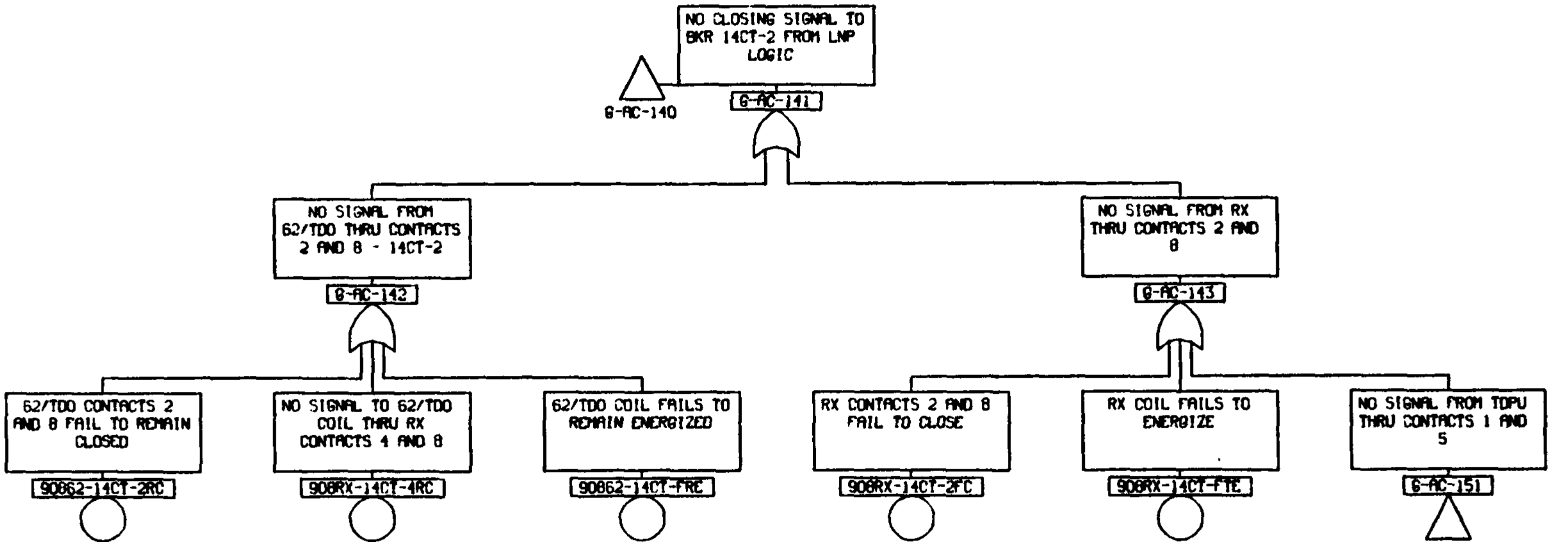

NO SIGNAL FROM 52B THRU CONTACTS 5 AND 5T - 14A BUS NSST BKR AUX SW
G-AC-132
G-AC-131
BKR 153-14A-2 FAIL TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-188
52B CONTACTS 5 AND 5T FAIL TO CLOSE
LCL52B-14AN-5FC
NO SIGNAL FROM 52B THRU CONTACTS 5 AND 5T - 14B BUS NSST BKR AUX SW
G-AC-133
G-AC-131
BKR 153-14B-2 FAILS TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-195
52B CONTACTS 5 AND 5T FAIL TO CLOSE
LCL52B-14BN-5FC
NO SIGNAL FROM 52B THRU CONTACTS 5 AND 5T - 14C BUS NSST BKR AUX SW
G-AC-134
G-AC-131
BKR 153-14C-2 FAILS TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-202
52B CONTACTS 5 AND 5T FAIL TO CLOSE
LCL52B-14CN-5FC
NO SIGNAL FROM 52B THRU CONTACTS 5 AND 5T - 14D BUS NSST BKR AUX SW
G-AC-135
G-AC-131
BKR 153-14D-2 FAILS TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-209
52B CONTACTS 5 AND 5T FAIL TO CLOSE
LCL52B-14DN-5FC



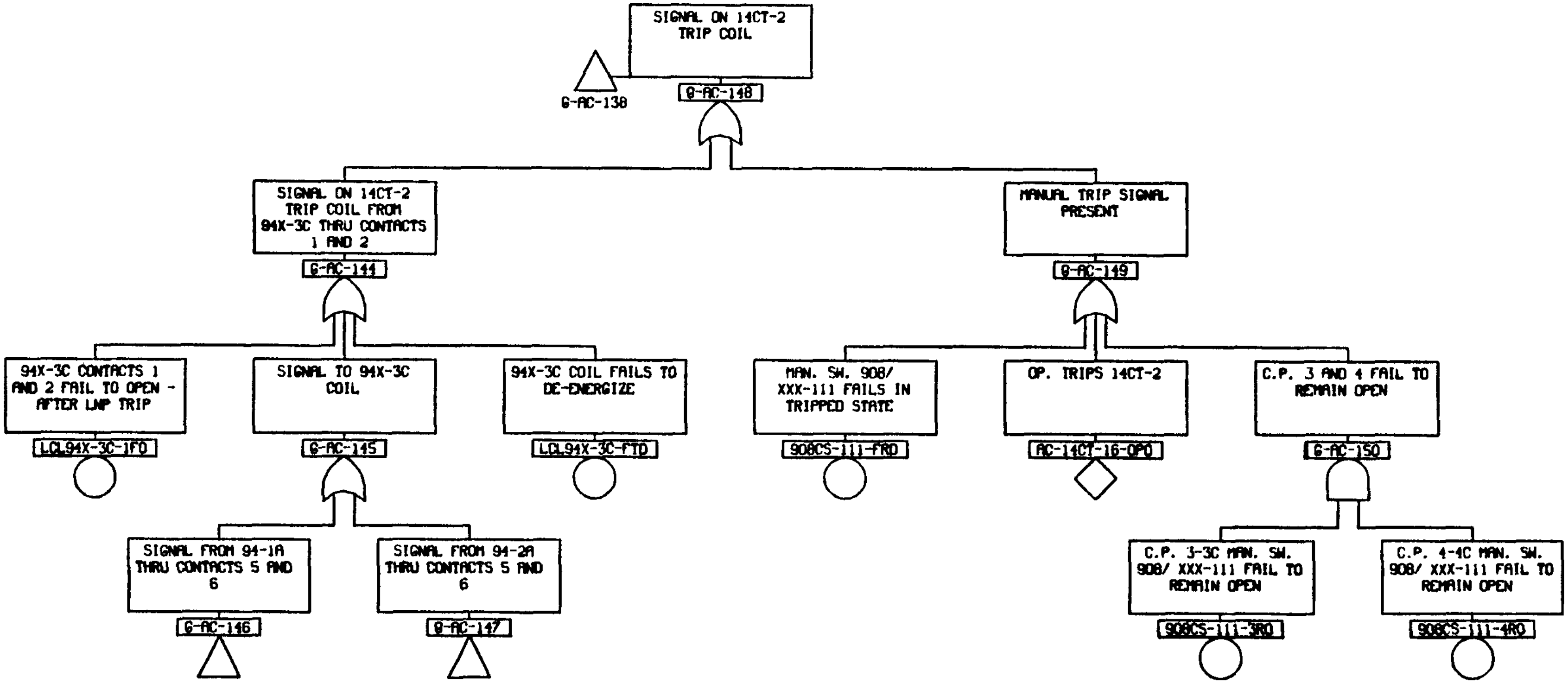
NO SIGNAL FROM RSST HI SIDE UNDERVOLTAGE RELAYS
G-AC-139
G-AC-116
NO SIGNAL FROM 94X2/STA THRU CONTACTS 3 AND 4
G-AC-136
NO SIGNAL FROM 94X2/STB THRU CONTACTS 3 AND 4
G-AC-137
94X2/STA COIL FAILS TO ENERGIZE
90894X2-STA-FTE
3
NO SIGNAL TO 94X2/STA COIL
G-AC-109
94X2/STA CONTACTS 3 AND 4 FAIL TO CLOSE
90894X2-STA-3FC
NO SIGNAL TO 94X2/STB COIL
G-AC-110
94X2/STB COIL FAILS TO ENERGIZE
922A94X2-STB-FTE
3
94X2/STB CONTACTS 3 AND 4 FAIL TO CLOSE
922A94X2-STB-3FC

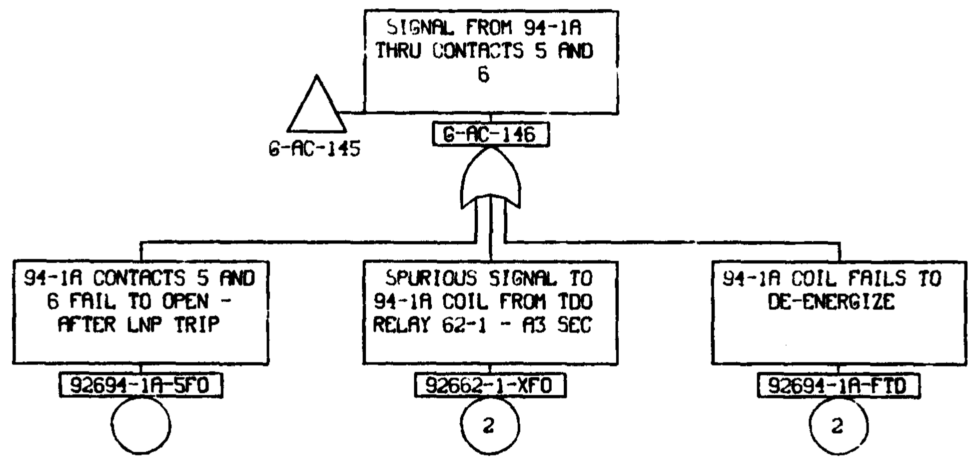
B.17-106

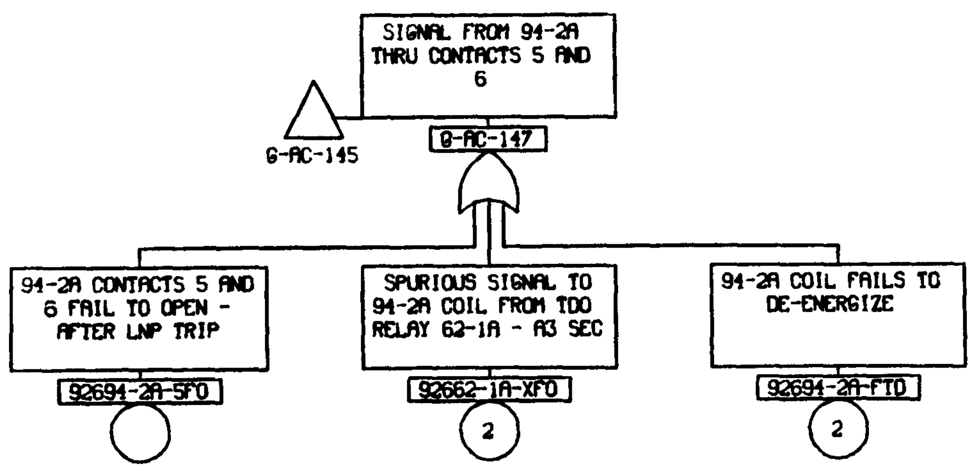

BKR 14CT-2 FAILS TO CLOSE ON LNP
G-AC-26
G-AC-138
SIGNAL ON 14CT-2 TRIP COIL
G-AC-148
L/O DC CONTROL POWER ON 101-B CKT NO. 7
G-DC-BUS-B-7
2
86/51-2 CONTACTS 11 AND 11C FAIL TO REMAIN CLOSED
LCL86-512-BRC
86/GB CONTACTS 11 AND 11C FAIL TO REMAIN CLOSED
LCL86-B-BRC
86/GC CONTACTS 11 AND 11C FAIL TO REMAIN CLOSED
LCL86-GC-BRC
NO CLOSING SIGNAL TO BKR 14CT-2
G-AC-140
NO CLOSING SIGNAL TO BKR 14CT-2 FROM LNP LOGIC
G-AC-141
NO CLOSING SIGNAL TO BKR 14CT-2 FROM MAN. CLOSING CKT.
G-AC-160

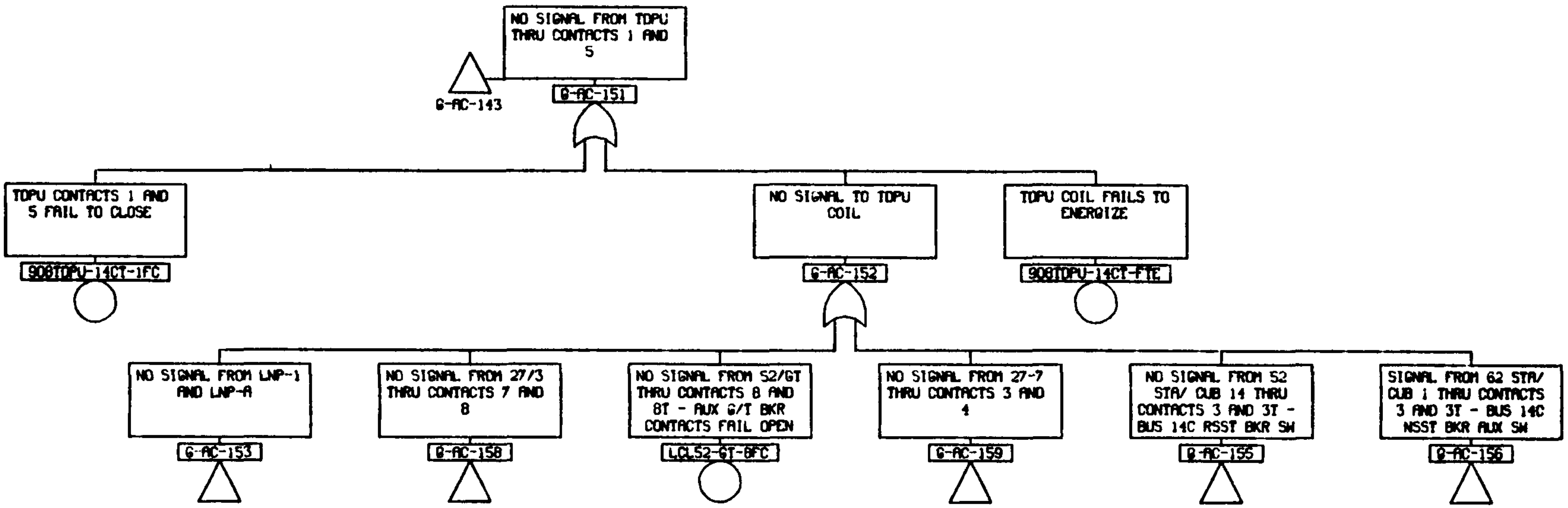


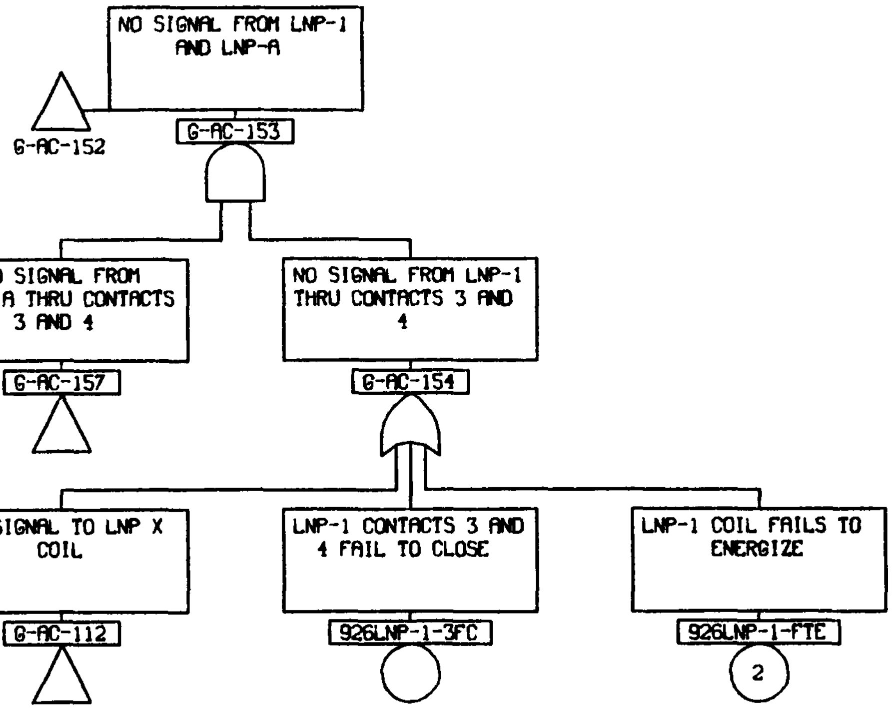
NO CLOSING SIGNAL TO BKR 14CT-2 FROM LNP LOGIC
6-AC-141
6-AC-140
NO SIGNAL FROM 62/TDO THRU CONTACTS 2 AND 8 - 14CT-2
6-AC-142
NO SIGNAL FROM RX THRU CONTACTS 2 AND 8
6-AC-143
62/TDO CONTACTS 2 AND 8 FAIL TO REMAIN CLOSED
90862-14CT-2RC
NO SIGNAL TO 62/TDO COIL THRU RX CONTACTS 4 AND 8
908RX-14CT-4RC
62/TDO COIL FAILS TO REMAIN ENERGIZED
90862-14CT-FRE
RX CONTACTS 2 AND 8 FAIL TO CLOSE
908RX-14CT-2FC
RX COIL FAILS TO ENERGIZE
908RX-14CT-FTE
NO SIGNAL FROM TDPU THRU CONTACTS 1 AND 5
6-AC-151

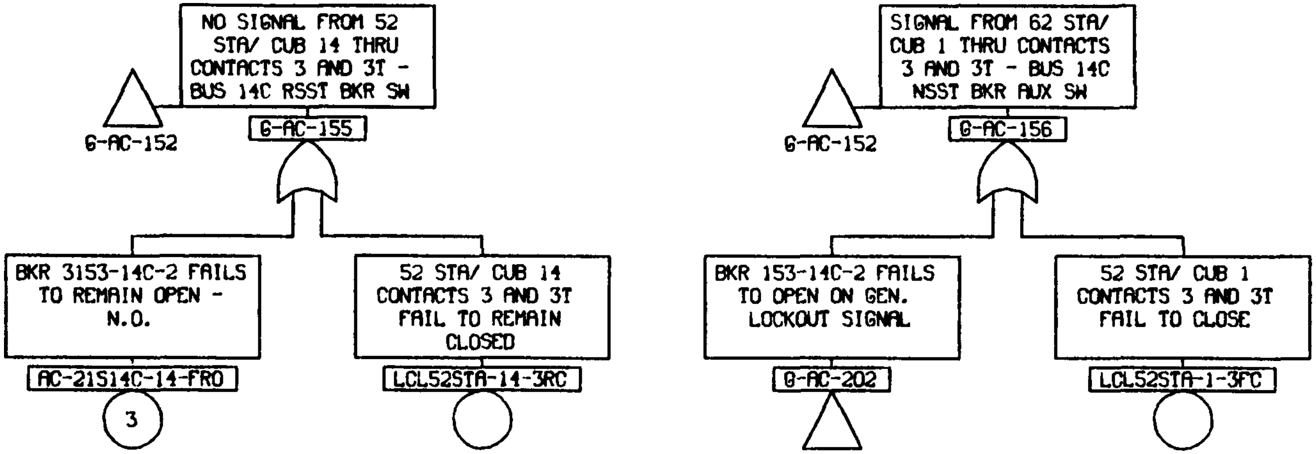

SIGNAL ON 14CT-2 TRIP COIL
G-AC-138
G-AC-148
SIGNAL ON 14CT-2 TRIP COIL FROM 94X-3C THRU CONTACTS 1 AND 2
G-AC-144
MANUAL TRIP SIGNAL PRESENT
G-AC-149
94X-3C CONTACTS 1 AND 2 FAIL TO OPEN - AFTER LNP TRIP
LCL94X-3C-1FO
SIGNAL TO 94X-3C COIL
G-AC-145
94X-3C COIL FAILS TO DE-ENERGIZE
LCL94X-3C-FTD
MAN. SW. 908/ XXX-111 FAILS IN TRIPPED STATE
908CS-111-FRD
OP. TRIPS 14CT-2
AC-14CT-16-OPO
C.P. 3 AND 4 FAIL TO REMAIN OPEN
G-AC-150
SIGNAL FROM 94-1A THRU CONTACTS 5 AND 6
G-AC-146
SIGNAL FROM 94-2A THRU CONTACTS 5 AND 6
G-AC-147
C.P. 3-3C MAN. SW. 908/ XXX-111 FAIL TO REMAIN OPEN
908CS-111-3RO
C.P. 4-4C MAN. SW. 908/ XXX-111 FAIL TO REMAIN OPEN
908CS-111-4RO

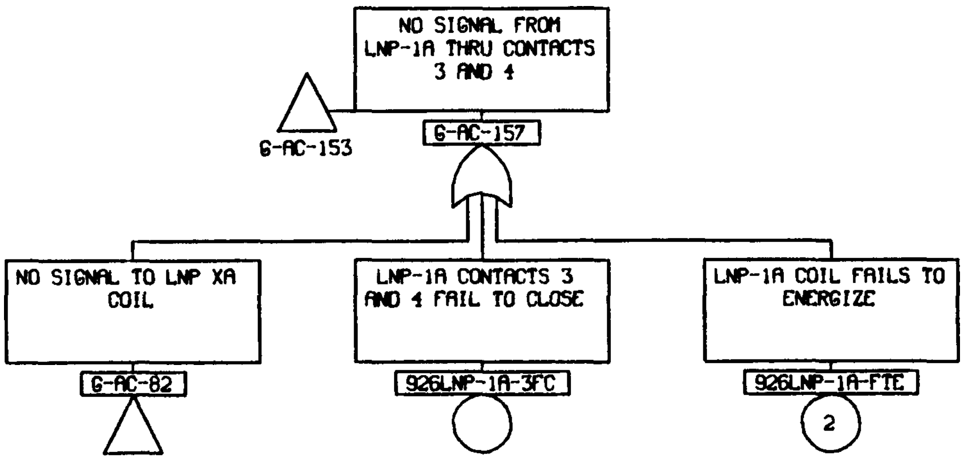

SIGNAL FROM 94-1A THRU CONTACTS 5 AND 6
G-AC-146
G-AC-145
94-1A CONTACTS 5 AND 6 FAIL TO OPEN - AFTER LNP TRIP
92694-1A-5FO
SPURIOUS SIGNAL TO 94-1A COIL FROM TDO RELAY 62-1 - A3 SEC
92662-1-XFO
2
94-1A COIL FAILS TO DE-ENERGIZE
92694-1A-FTD
2

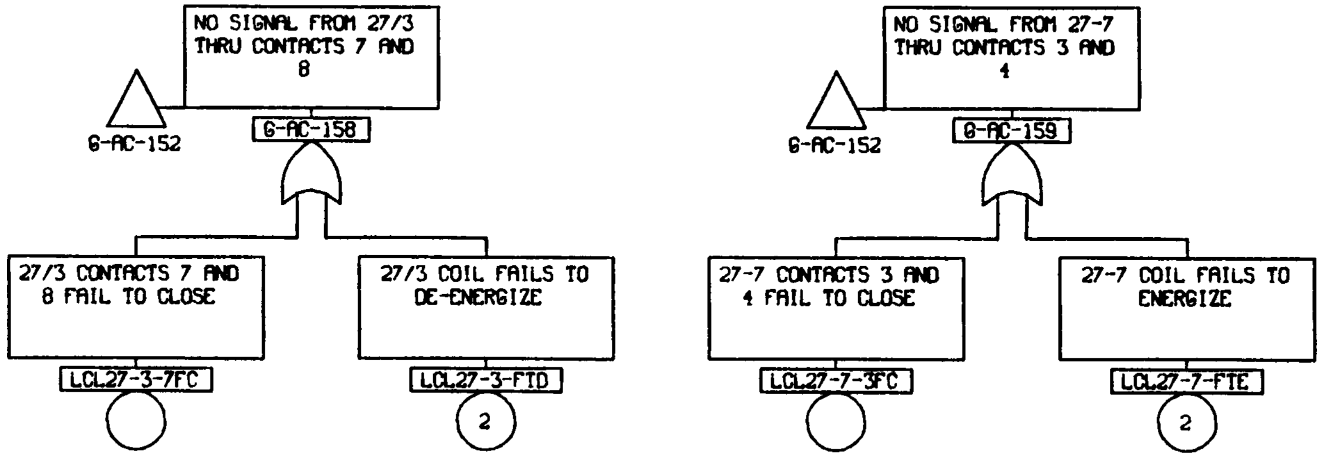

SIGNAL FROM 94-2A THRU CONTACTS 5 AND 6
G-AC-147
G-AC-145
94-2A CONTACTS 5 AND 6 FAIL TO OPEN - AFTER LNP TRIP
92694-2A-5FO
SPURIOUS SIGNAL TO 94-2A COIL FROM TDO RELAY 62-1A - A3 SEC
92662-1A-XFO
2
94-2A COIL FAILS TO DE-ENERGIZE
92694-2A-FTD
2

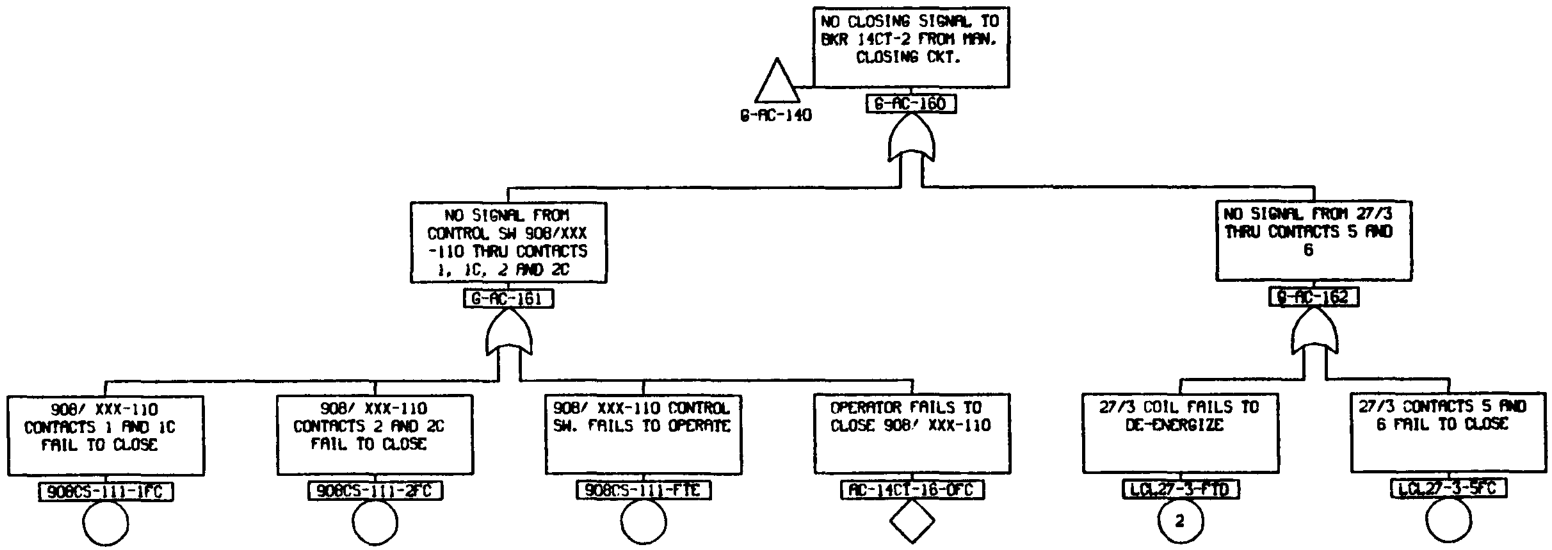

NO SIGNAL FROM TDPU THRU CONTACTS 1 AND 5
G-AC-151
G-AC-143
TDPU CONTACTS 1 AND 5 FAIL TO CLOSE
90BTDPU-14CT-1FC
NO SIGNAL TO TDPU COIL
G-AC-152
TDPU COIL FAILS TO ENERGIZE
90BTDPU-14CT-FTE
NO SIGNAL FROM LNP-1 AND LNP-A
G-AC-153
NO SIGNAL FROM 27/3 THRU CONTACTS 7 AND 8
G-AC-158
NO SIGNAL FROM 52/GT THRU CONTACTS 8 AND 8T - AUX G/T BKR CONTACTS FAIL OPEN
LCL52-GT-8FC
NO SIGNAL FROM 27-7 THRU CONTACTS 3 AND 4
G-AC-159
NO SIGNAL FROM 52 STA/ CUB 14 THRU CONTACTS 3 AND 3T - BUS 14C RSST BKR SW
G-AC-155
SIGNAL FROM 62 STA/ CUB 1 THRU CONTACTS 3 AND 3T - BUS 14C NSST BKR AUX SW
G-AC-156

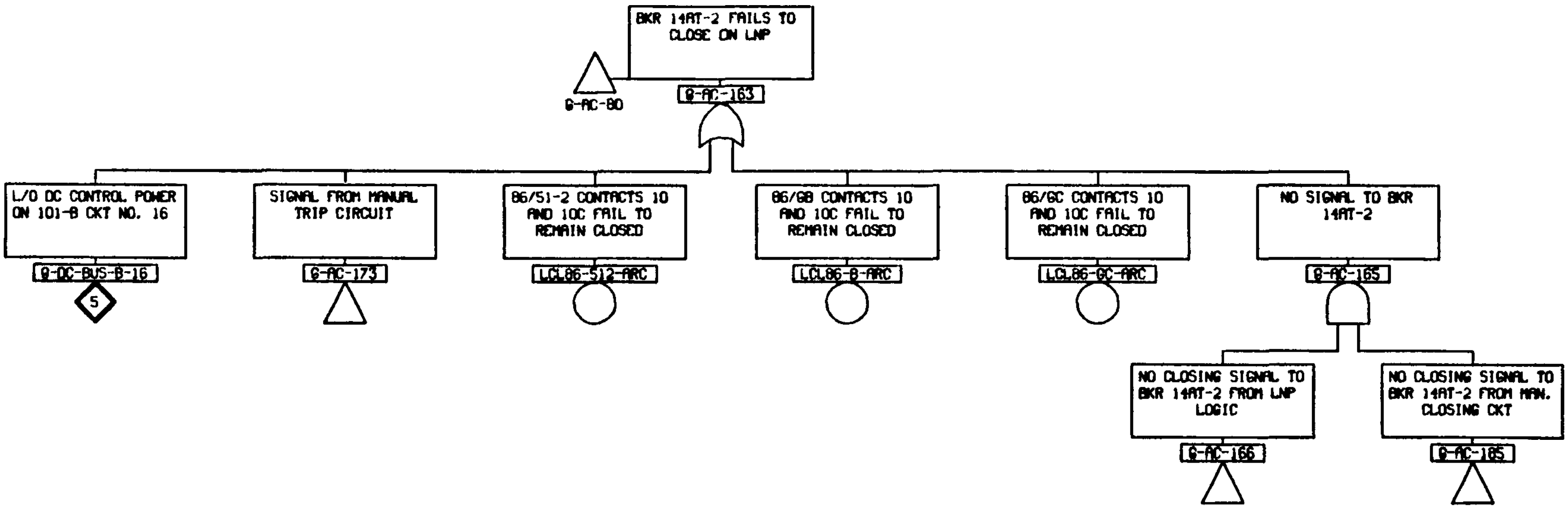

NO SIGNAL FROM LNP-1 AND LNP-A
G-AC-152
G-AC-153
NO SIGNAL FROM LNP-1A THRU CONTACTS 3 AND 4
G-AC-157
NO SIGNAL FROM LNP-1 THRU CONTACTS 3 AND 4
G-AC-154
NO SIGNAL TO LNP X COIL
G-AC-112
LNP-1 CONTACTS 3 AND 4 FAIL TO CLOSE
926LNP-1-3FC
LNP-1 COIL FAILS TO ENERGIZE
926LNP-1-FTE
2

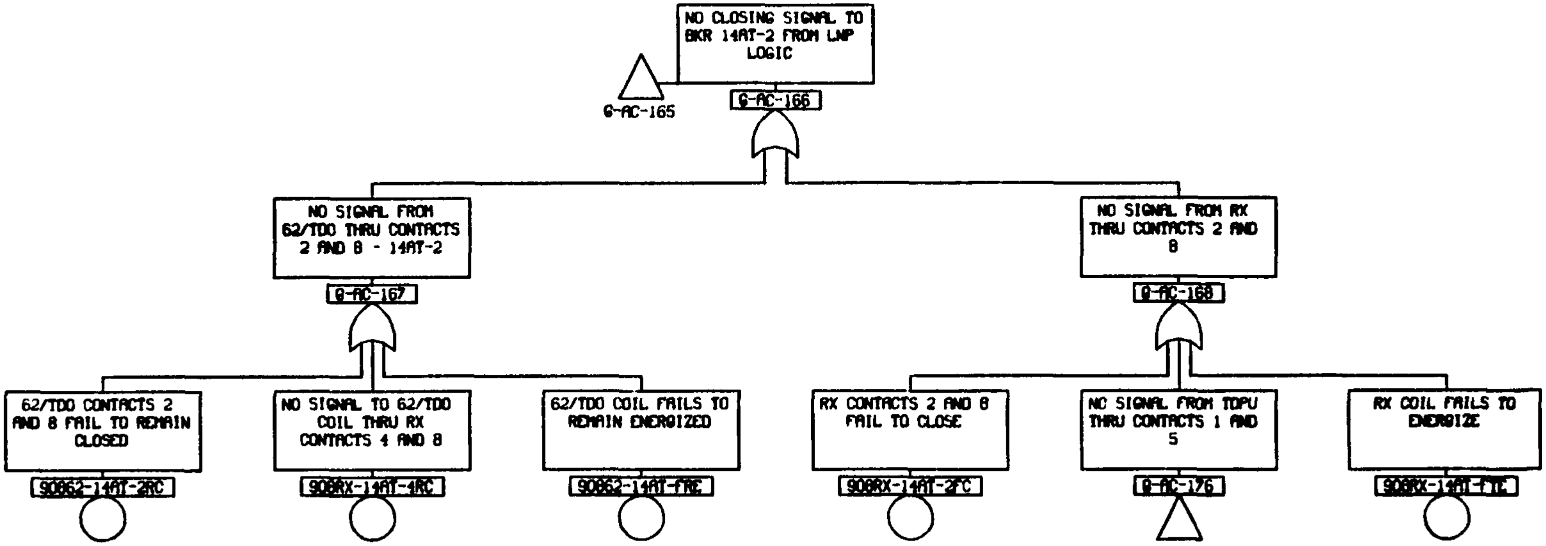

NO SIGNAL FROM 52 STA/ CUB 14 THRU CONTACTS 3 AND 3T - BUS 14C RSST BKR SW
G-AC-155
G-AC-152
BKR 3153-14C-2 FAILS TO REMAIN OPEN - N.O.
AC-21S14C-14-FRO
3
52 STA/ CUB 14 CONTACTS 3 AND 3T FAIL TO REMAIN CLOSED
LCL52STA-14-3RC
SIGNAL FROM 62 STA/ CUB 1 THRU CONTACTS 3 AND 3T - BUS 14C NSST BKR AUX SW
G-AC-156
G-AC-152
BKR 153-14C-2 FAILS TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-202
52 STA/ CUB 1 CONTACTS 3 AND 3T FAIL TO CLOSE
LCL52STA-1-3FC

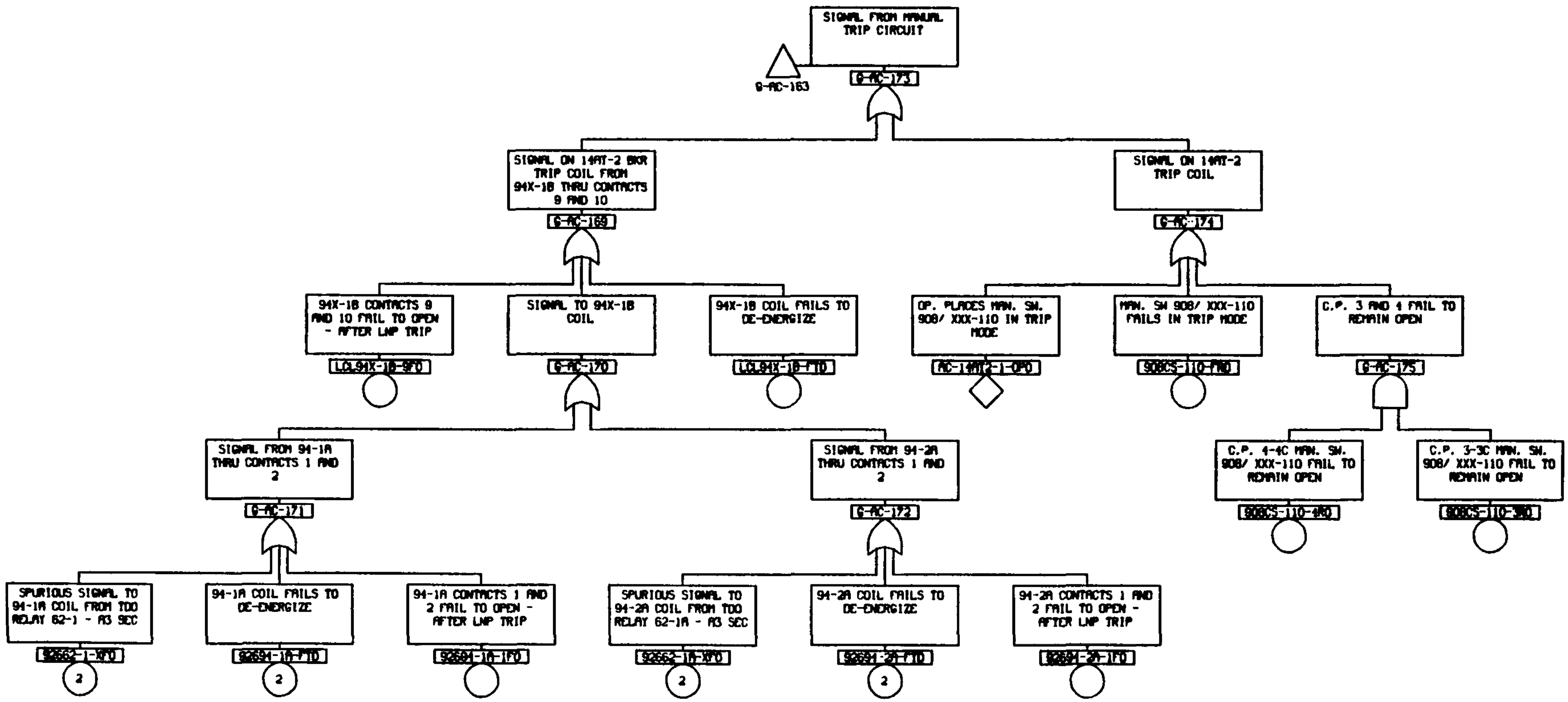

NO SIGNAL FROM LNP-1A THRU CONTACTS 3 AND 4
G-AC-157
G-AC-153
NO SIGNAL TO LNP XA COIL
G-AC-82
LNP-1A CONTACTS 3 AND 4 FAIL TO CLOSE
926LNP-1A-3FC
LNP-1A COIL FAILS TO ENERGIZE
926LNP-1A-FTE
2


NO SIGNAL FROM 27/3 THRU CONTACTS 7 AND 8
G-AC-152
G-AC-158
27/3 CONTACTS 7 AND 8 FAIL TO CLOSE
LCL27-3-7FC
27/3 COIL FAILS TO DE-ENERGIZE
LCL27-3-FTD
2
NO SIGNAL FROM 27-7 THRU CONTACTS 3 AND 4
G-AC-152
G-AC-159
27-7 CONTACTS 3 AND 4 FAIL TO CLOSE
LCL27-7-3FC
27-7 COIL FAILS TO ENERGIZE
LCL27-7-FTE
2


NO CLOSING SIGNAL TO BKR 14CT-2 FROM MAN. CLOSING CKT.
G-AC-160
G-AC-140
NO SIGNAL FROM CONTROL SW 908/XXX -110 THRU CONTACTS 1, 1C, 2 AND 2C
G-AC-161
NO SIGNAL FROM 27/3 THRU CONTACTS 5 AND 6
G-AC-162
908/ XXX-110 CONTACTS 1 AND 1C FAIL TO CLOSE
908CS-111-1FC
908/ XXX-110 CONTACTS 2 AND 2C FAIL TO CLOSE
908CS-111-2FC
908/ XXX-110 CONTROL SW. FAILS TO OPERATE
908CS-111-FTE
OPERATOR FAILS TO CLOSE 908/ XXX-110
AC-14CT-16-OFC
27/3 COIL FAILS TO DE-ENERGIZE
LCL27-3-FTD
2
27/3 CONTACTS 5 AND 6 FAIL TO CLOSE
LCL27-3-5FC

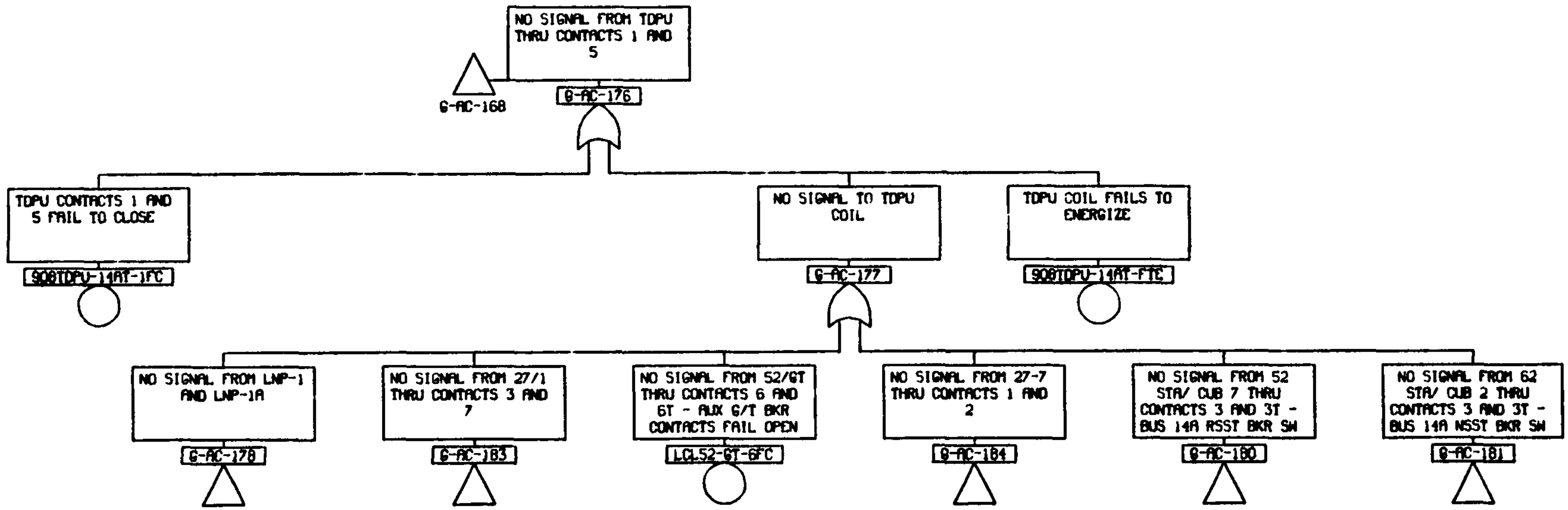

BKR 14AT-2 FAILS TO CLOSE ON LNP
G-AC-163
G-AC-80
L/O DC CONTROL POWER ON 101-B CKT NO. 16
G-DC-BUS-B-16
5
SIGNAL FROM MANUAL TRIP CIRCUIT
G-AC-173
86/51-2 CONTACTS 10 AND 10C FAIL TO REMAIN CLOSED
LCL86-512-ARC
86/GB CONTACTS 10 AND 10C FAIL TO REMAIN CLOSED
LCL86-B-ARC
86/GC CONTACTS 10 AND 10C FAIL TO REMAIN CLOSED
LCL86-GC-ARC
NO SIGNAL TO BKR 14AT-2
G-AC-165
NO CLOSING SIGNAL TO BKR 14AT-2 FROM LNP LOGIC
G-AC-166
NO CLOSING SIGNAL TO BKR 14AT-2 FROM MAN. CLOSING CKT
G-AC-185

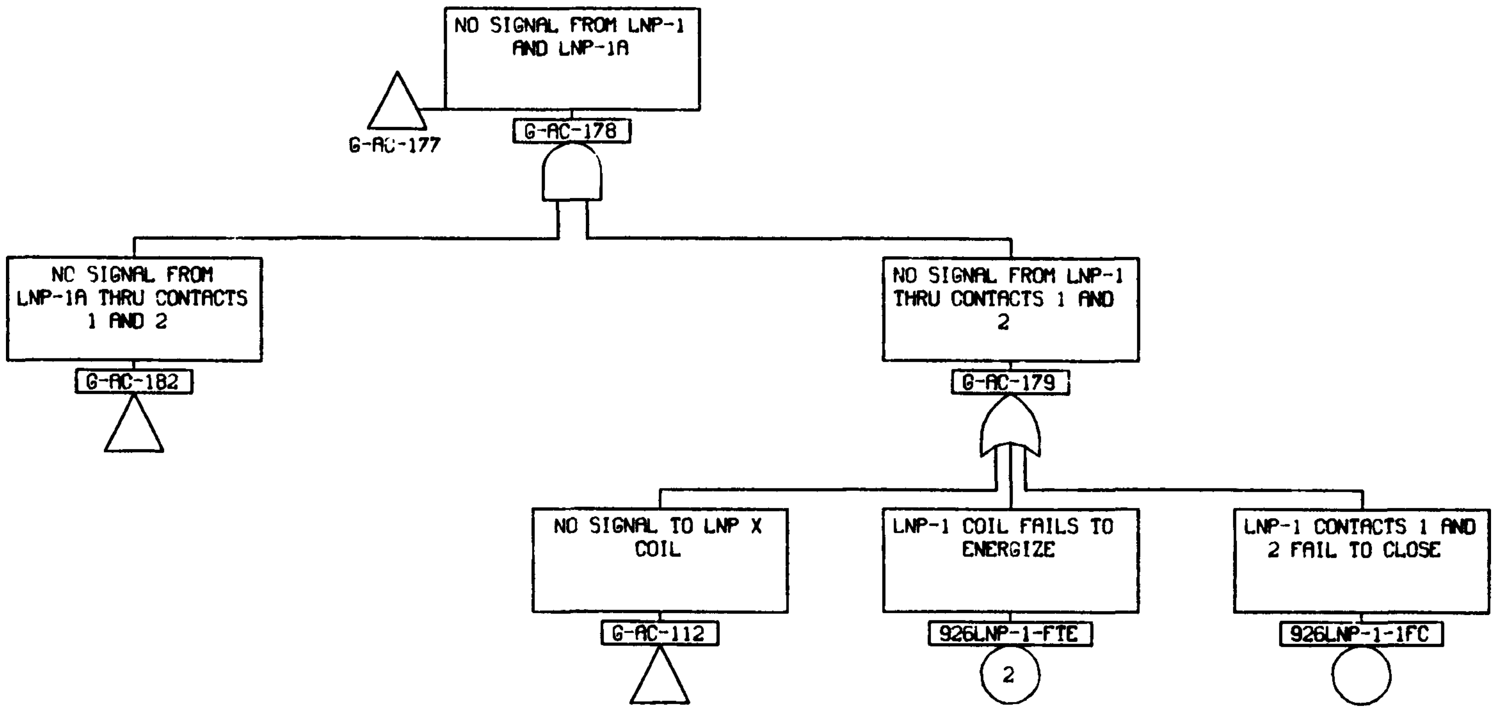

NO CLOSING SIGNAL TO BKR 14AT-2 FROM LNP LOGIC
G-AC-166
G-AC-165
NO SIGNAL FROM 62/TDO THRU CONTACTS 2 AND 8 - 14AT-2
G-AC-167
NO SIGNAL FROM RX THRU CONTACTS 2 AND 8
G-AC-168
62/TDO CONTACTS 2 AND 8 FAIL TO REMAIN CLOSED
9O862-14AT-2RC
NO SIGNAL TO 62/TDO COIL THRU RX CONTACTS 4 AND 8
9O8RX-14AT-4RC
62/TDO COIL FAILS TO REMAIN ENERGIZED
9O862-14AT-FRE
RX CONTACTS 2 AND 8 FAIL TO CLOSE
9O8RX-14AT-2FC
NO SIGNAL FROM TDPU THRU CONTACTS 1 AND 5
G-AC-176
RX COIL FAILS TO ENERGIZE
9O8RX-14AT-FTE

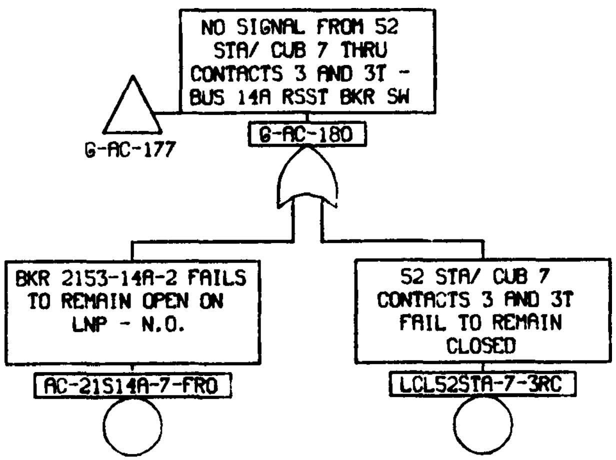


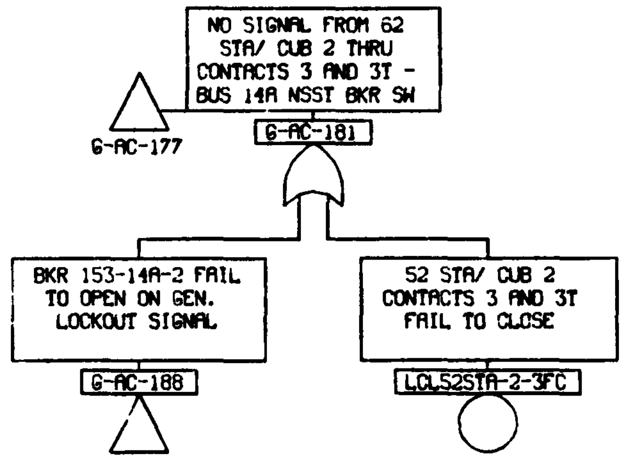
SIGNAL FROM MANUAL TRIP CIRCUIT
G-AC-173
G-AC-163
SIGNAL ON 14AT-2 BKR TRIP COIL FROM 94X-1B THRU CONTACTS 9 AND 10
G-AC-169
SIGNAL ON 14AT-2 TRIP COIL
G-AC-174
94X-1B CONTACTS 9 AND 10 FAIL TO OPEN - AFTER LNP TRIP
LCL94X-1B-9FO
SIGNAL TO 94X-1B COIL
G-AC-170
94X-1B COIL FAILS TO DE-ENERGIZE
LCL94X-1B-FTD
OP. PLACES MAN. SW. 908/ XXX-110 IN TRIP MODE
AC-14AT2-1-OPO
MAN. SW 908/ XXX-110 FAILS IN TRIP MODE
908CS-110-FMO
C.P. 3 AND 4 FAIL TO REMAIN OPEN
G-AC-175
SIGNAL FROM 94-1A THRU CONTACTS 1 AND 2
G-AC-171
SIGNAL FROM 94-2A THRU CONTACTS 1 AND 2
G-AC-172
C.P. 4-4C MAN. SW. 908/ XXX-110 FAIL TO REMAIN OPEN
908CS-110-4RO
C.P. 3-3C MAN. SW. 908/ XXX-110 FAIL TO REMAIN OPEN
908CS-110-3RO
SPURIOUS SIGNAL TO 94-1A COIL FROM TDO RELAY 62-1 - A3 SEC
92662-1-XFO
2
94-1A COIL FAILS TO DE-ENERGIZE
92694-1A-FTD
2
94-1A CONTACTS 1 AND 2 FAIL TO OPEN - AFTER LNP TRIP
92694-1A-1FO
SPURIOUS SIGNAL TO 94-2A COIL FROM TDO RELAY 62-1A - A3 SEC
92662-1A-XFO
2
94-2A COIL FAILS TO DE-ENERGIZE
92694-2A-FTD
2
94-2A CONTACTS 1 AND 2 FAIL TO OPEN - AFTER LNP TRIP
92694-2A-1FO

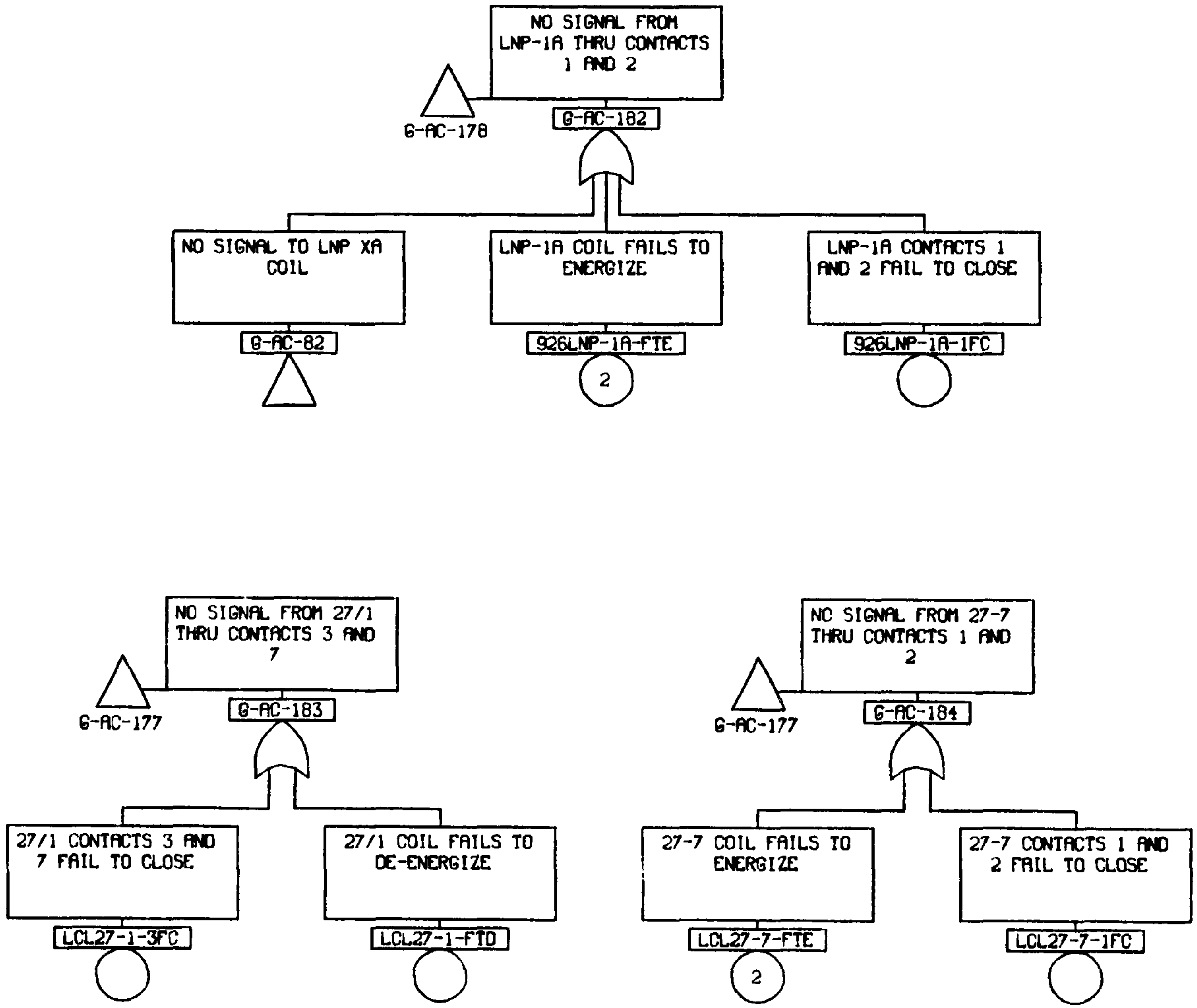
B.17-119

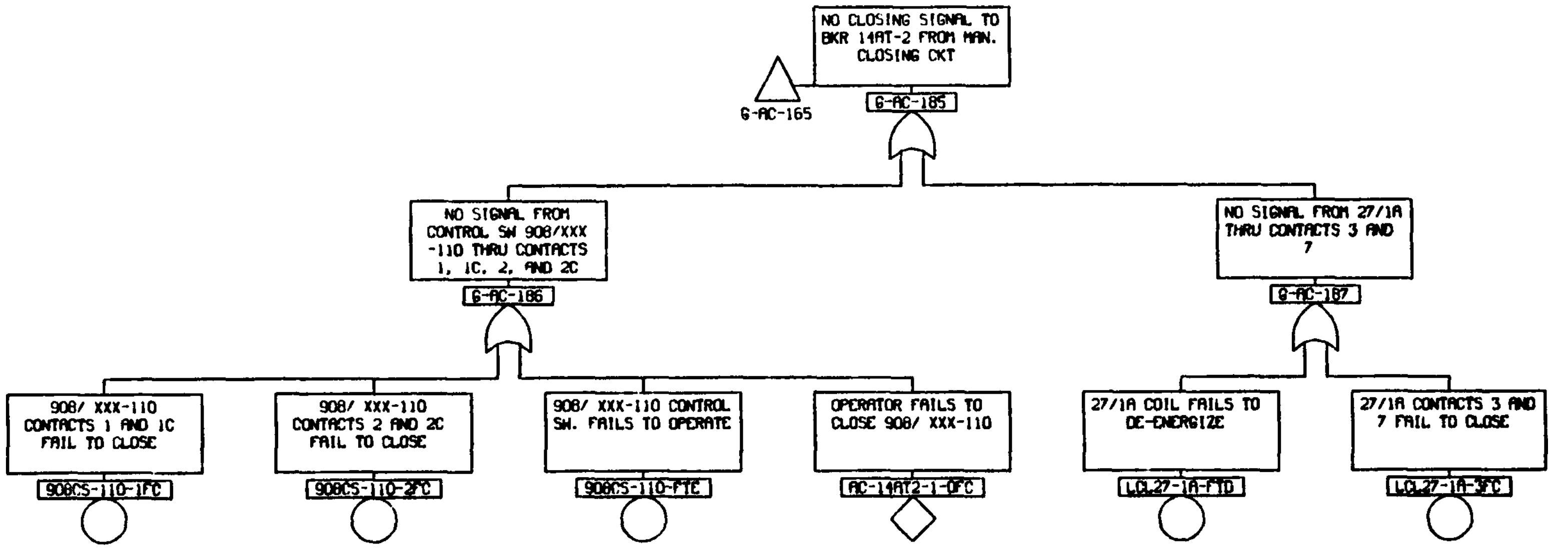

NO SIGNAL FROM TDPU THRU CONTACTS 1 AND 5
G-AC-168
G-AC-176
TDPU CONTACTS 1 AND 5 FAIL TO CLOSE
908TDPU-14AT-1FC
NO SIGNAL TO TDPU COIL
G-AC-177
TDPU COIL FAILS TO ENERGIZE
908TDPU-14AT-FTE
NO SIGNAL FROM LNP-1 AND LNP-1A
G-AC-178
NO SIGNAL FROM 27/1 THRU CONTACTS 3 AND 7
G-AC-183
NO SIGNAL FROM 52/GT THRU CONTACTS 6 AND 6T - AUX G/T BKR CONTACTS FAIL OPEN
LCL52-GT-6FC
NO SIGNAL FROM 27-7 THRU CONTACTS 1 AND 2
G-AC-184
NO SIGNAL FROM 52 STA/ CUB 7 THRU CONTACTS 3 AND 3T - BUS 14A RSST BKR SW
G-AC-180
NO SIGNAL FROM 62 STA/ CUB 2 THRU CONTACTS 3 AND 3T - BUS 14A NSST BKR SW
G-AC-181

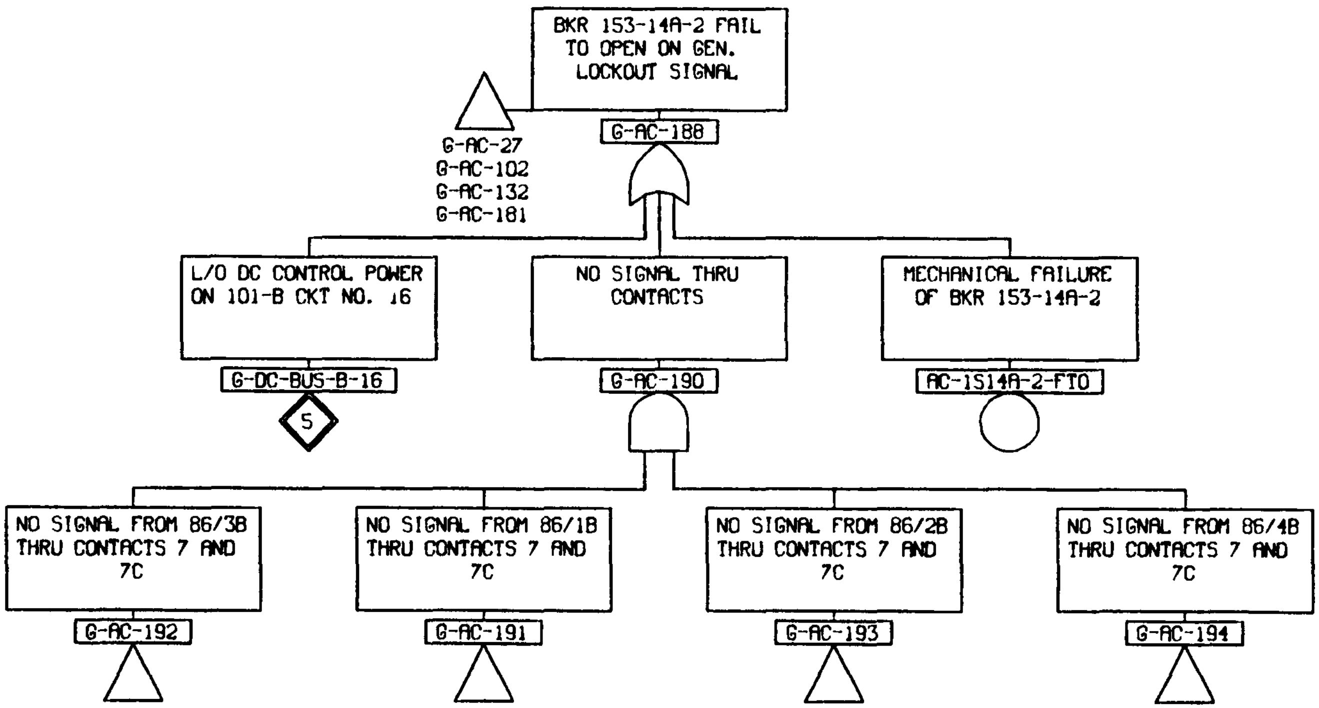

NO SIGNAL FROM LNP-1 AND LNP-1A
G-AC-178
G-AC-177
NO SIGNAL FROM LNP-1A THRU CONTACTS 1 AND 2
G-AC-182
NO SIGNAL FROM LNP-1 THRU CONTACTS 1 AND 2
G-AC-179
NO SIGNAL TO LNP X COIL
G-AC-112
LNP-1 COIL FAILS TO ENERGIZE
926LNP-1-FTE
2
LNP-1 CONTACTS 1 AND 2 FAIL TO CLOSE
926LNP-1-1FC

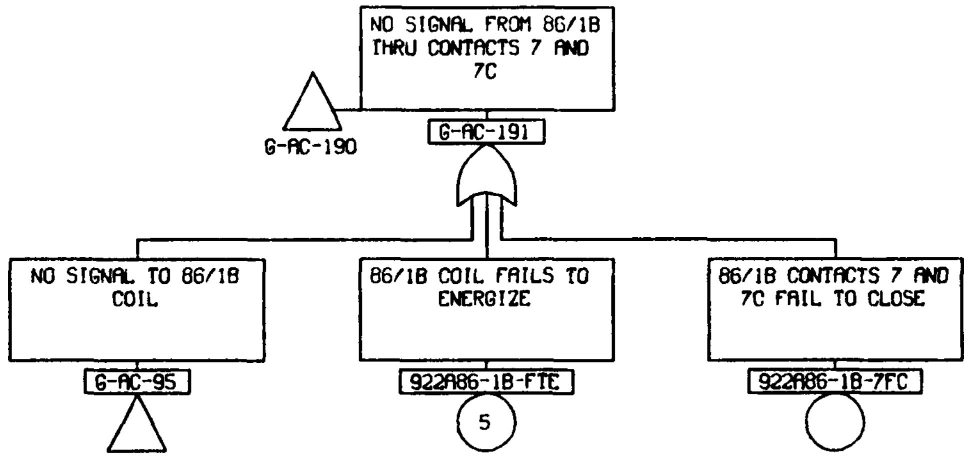

NO SIGNAL FROM 52 STA/ CUB 7 THRU CONTACTS 3 AND 3T - BUS 14A RSST BKR SW
G-AC-180
G-AC-177
BKR 2153-14A-2 FAILS TO REMAIN OPEN ON LNP - N.O.
AC-21S14A-7-FRO
52 STA/ CUB 7 CONTACTS 3 AND 3T FAIL TO REMAIN CLOSED
LCL52STA-7-3RC

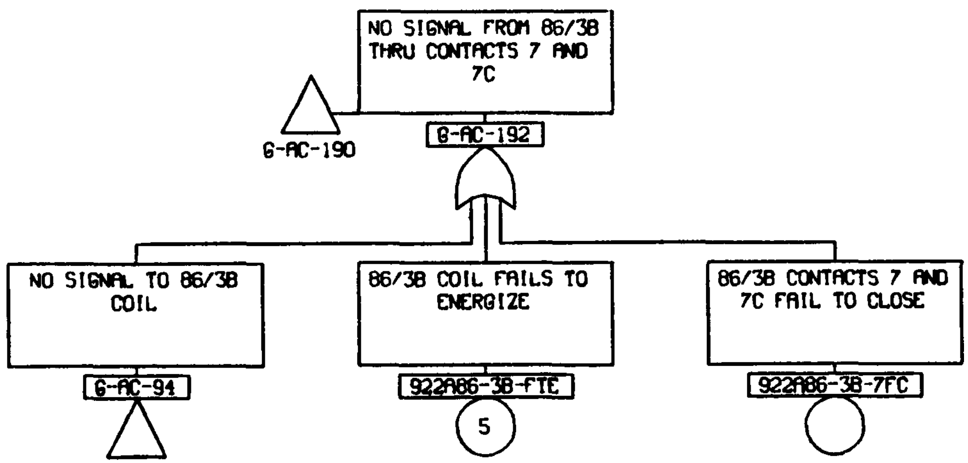

NO SIGNAL FROM 62 STA/ CUB 2 THRU CONTACTS 3 AND 3T - BUS 14A NSST BKR SW
G-AC-181
G-AC-177
BKR 153-14A-2 FAIL TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-188
52 STA/ CUB 2 CONTACTS 3 AND 3T FAIL TO CLOSE
LCL52STA-2-3FC

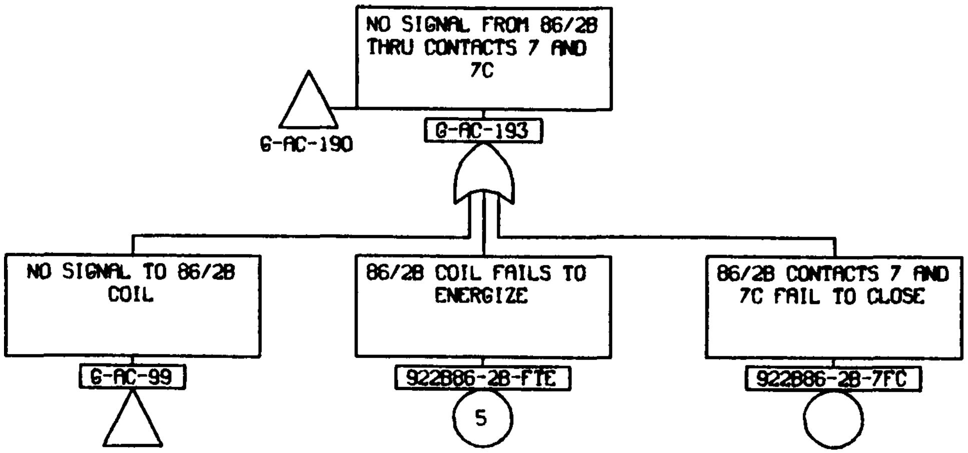

NO SIGNAL FROM LNP-1A THRU CONTACTS 1 AND 2
G-AC-178
G-AC-182
NO SIGNAL TO LNP XA COIL
G-AC-82
LNP-1A COIL FAILS TO ENERGIZE
926LNP-1A-FTE
2
LNP-1A CONTACTS 1 AND 2 FAIL TO CLOSE
926LNP-1A-1FC
NO SIGNAL FROM 27/1 THRU CONTACTS 3 AND 7
G-AC-177
G-AC-183
27/1 CONTACTS 3 AND 7 FAIL TO CLOSE
LCL27-1-3FC
27/1 COIL FAILS TO DE-ENERGIZE
LCL27-1-FTD
NO SIGNAL FROM 27-7 THRU CONTACTS 1 AND 2
G-AC-177
G-AC-184
27-7 COIL FAILS TO ENERGIZE
LCL27-7-FTE
2
27-7 CONTACTS 1 AND 2 FAIL TO CLOSE
LCL27-7-1FC

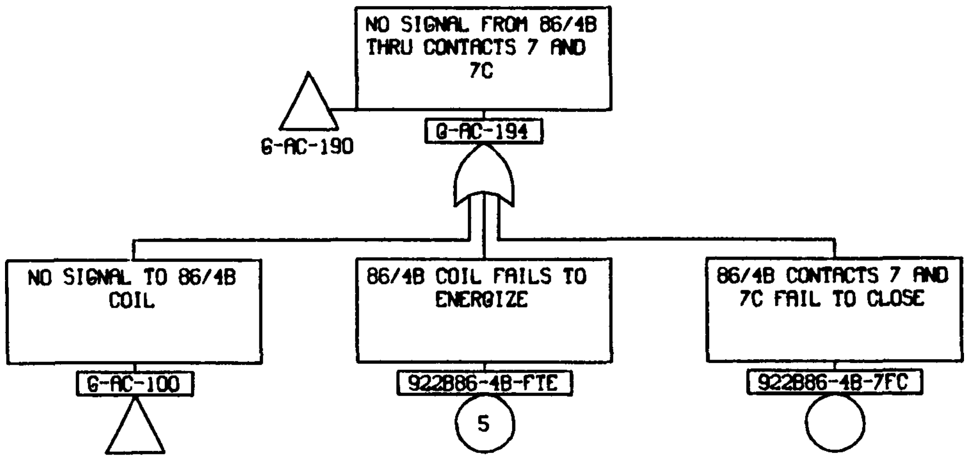

NO CLOSING SIGNAL TO BKR 14AT-2 FROM MAN. CLOSING CKT
G-AC-185
G-AC-165
NO SIGNAL FROM CONTROL SW 908/XXX -110 THRU CONTACTS 1, 1C, 2, AND 2C
G-AC-186
NO SIGNAL FROM 27/1A THRU CONTACTS 3 AND 7
G-AC-187
908/ XXX-110 CONTACTS 1 AND 1C FAIL TO CLOSE
908CS-110-1FC
908/ XXX-110 CONTACTS 2 AND 2C FAIL TO CLOSE
908CS-110-2FC
908/ XXX-110 CONTROL SW. FAILS TO OPERATE
908CS-110-FTC
OPERATOR FAILS TO CLOSE 908/ XXX-110
AC-14AT2-1-OFC
27/1A COIL FAILS TO DE-ENERGIZE
LCL27-1A-FTD
27/1A CONTACTS 3 AND 7 FAIL TO CLOSE
LCL27-1A-3FC

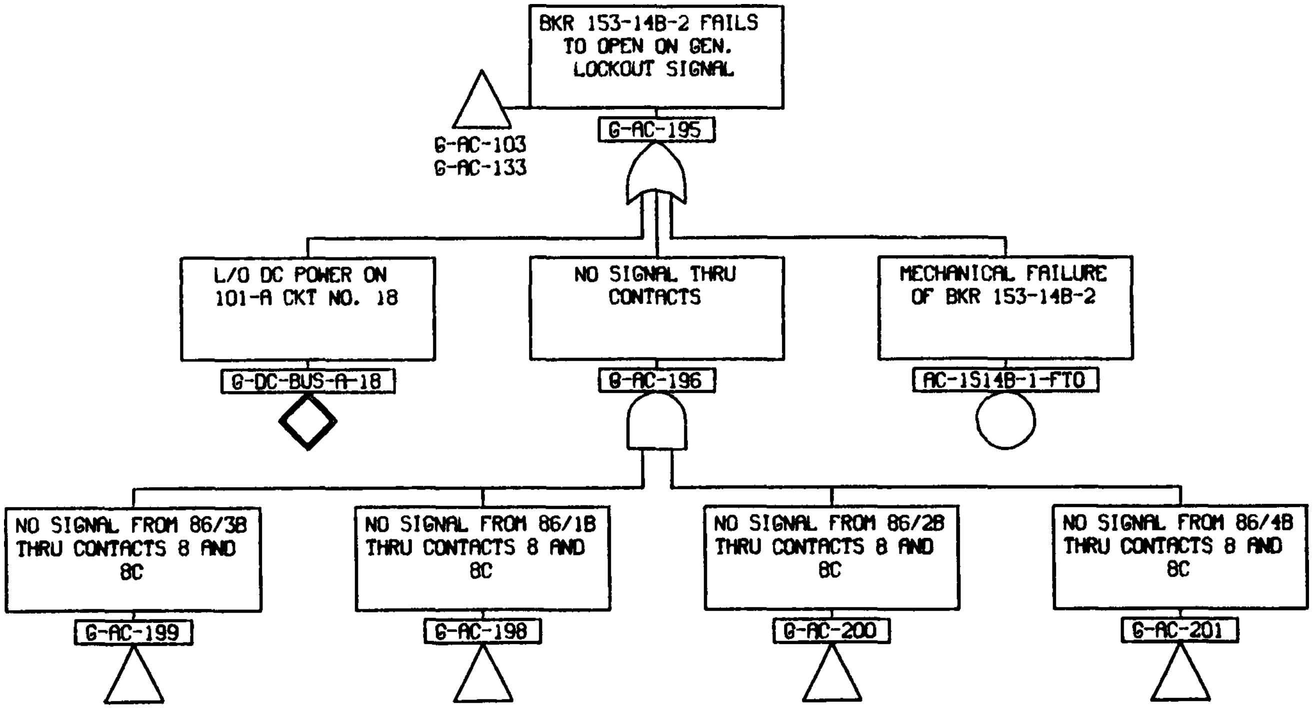

BKR 153-14A-2 FAIL TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-188
G-AC-27
G-AC-102
G-AC-132
G-AC-181
L/O DC CONTROL POWER ON 101-B CKT NO. 16
G-DC-BUS-B-16
5
NO SIGNAL THRU CONTACTS
G-AC-190
MECHANICAL FAILURE OF BKR 153-14A-2
AC-1S14A-2-FTO
NO SIGNAL FROM 86/3B THRU CONTACTS 7 AND 7C
G-AC-192
NO SIGNAL FROM 86/1B THRU CONTACTS 7 AND 7C
G-AC-191
NO SIGNAL FROM 86/2B THRU CONTACTS 7 AND 7C
G-AC-193
NO SIGNAL FROM 86/4B THRU CONTACTS 7 AND 7C
G-AC-194

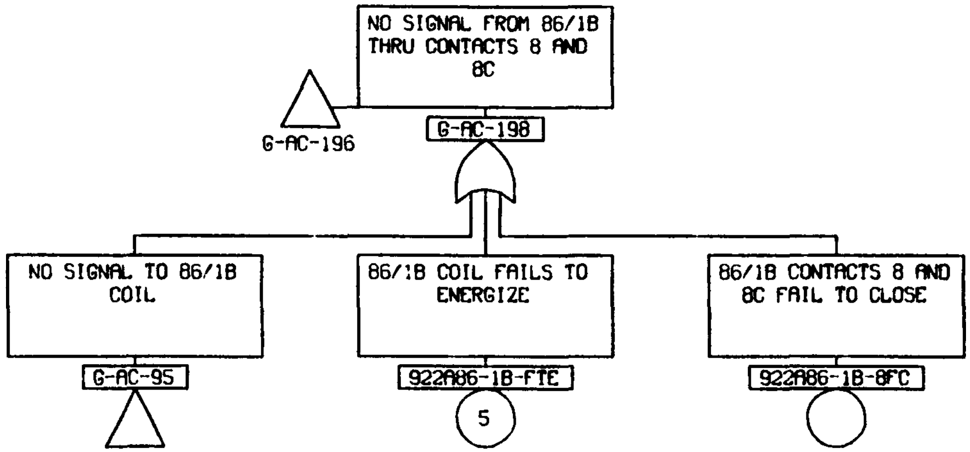

NO SIGNAL FROM 86/1B THRU CONTACTS 7 AND 7C
G-AC-191
G-AC-190
NO SIGNAL TO 86/1B COIL
G-AC-95
86/1B COIL FAILS TO ENERGIZE
922A86-1B-FTE
5
86/1B CONTACTS 7 AND 7C FAIL TO CLOSE
922A86-1B-7FC

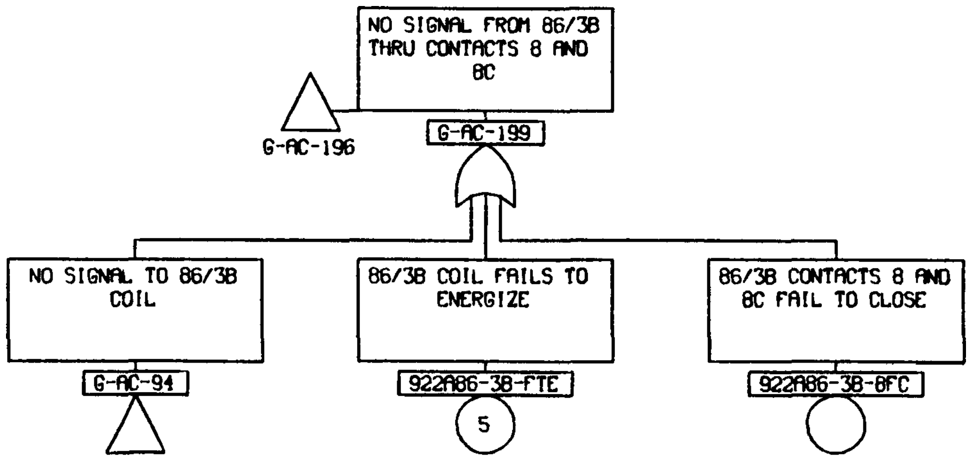

NO SIGNAL FROM 86/3B THRU CONTACTS 7 AND 7C
G-AC-192
G-AC-190
NO SIGNAL TO 86/3B COIL
G-AC-94
86/3B COIL FAILS TO ENERGIZE
922A86-3B-FTE
5
86/3B CONTACTS 7 AND 7C FAIL TO CLOSE
922A86-3B-7FC

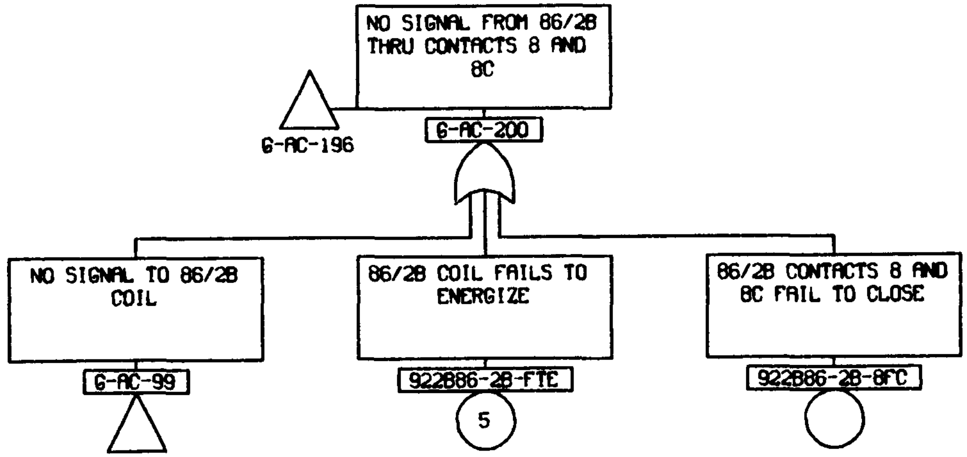

NO SIGNAL FROM 86/2B THRU CONTACTS 7 AND 7C
G-AC-190
G-AC-193
NO SIGNAL TO 86/2B COIL
G-AC-99
86/2B COIL FAILS TO ENERGIZE
922B86-2B-FTE
5
86/2B CONTACTS 7 AND 7C FAIL TO CLOSE
922B86-2B-7FC

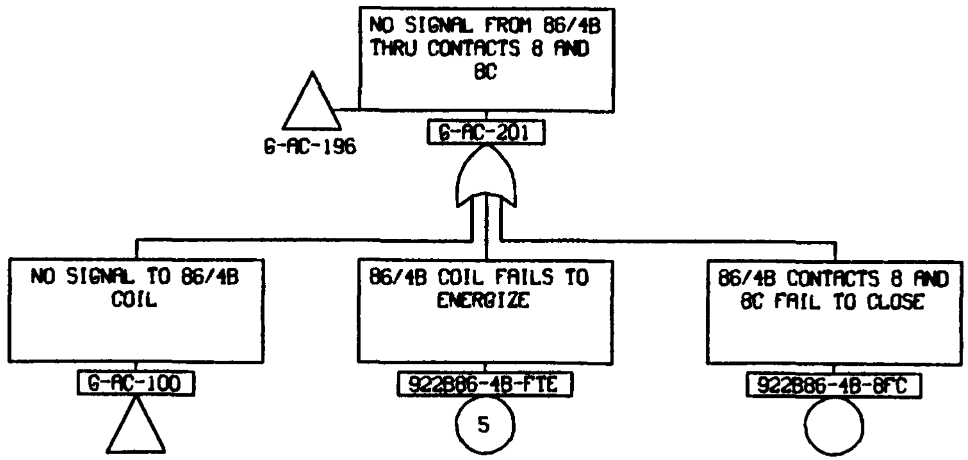

NO SIGNAL FROM 86/4B THRU CONTACTS 7 AND 7C
G-AC-190
G-AC-194
NO SIGNAL TO 86/4B COIL
G-AC-100
86/4B COIL FAILS TO ENERGIZE
922B86-4B-FTE
5
86/4B CONTACTS 7 AND 7C FAIL TO CLOSE
922B86-4B-7FC

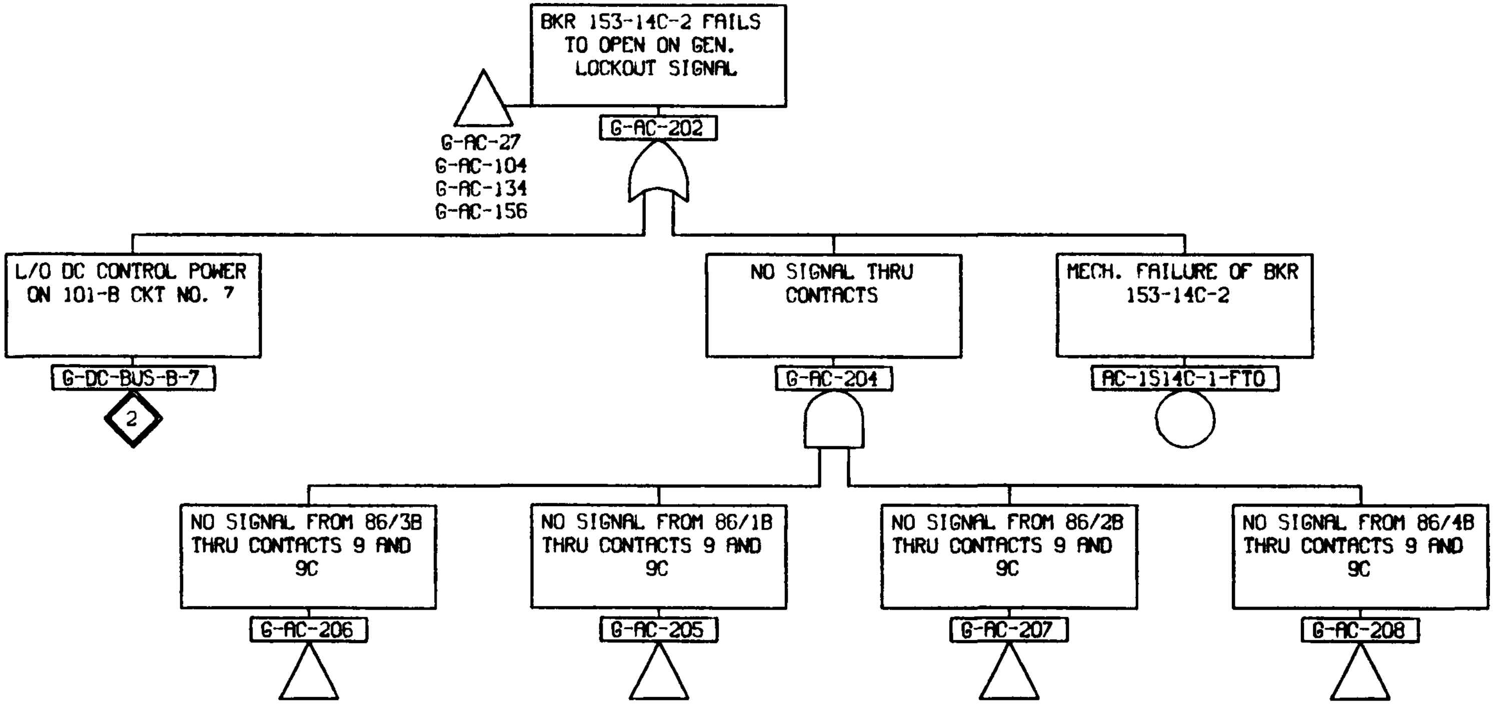

BKR 153-14B-2 FAILS TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-195
G-AC-103
G-AC-133
L/O DC POWER ON 101-A CKT NO. 18
G-DC-BUS-A-18
NO SIGNAL THRU CONTACTS
G-AC-196
MECHANICAL FAILURE OF BKR 153-14B-2
AC-1S14B-1-FTO
NO SIGNAL FROM 86/3B THRU CONTACTS 8 AND 8C
G-AC-199
NO SIGNAL FROM 86/1B THRU CONTACTS 8 AND 8C
G-AC-198
NO SIGNAL FROM 86/2B THRU CONTACTS 8 AND 8C
G-AC-200
NO SIGNAL FROM 86/4B THRU CONTACTS 8 AND 8C
G-AC-201

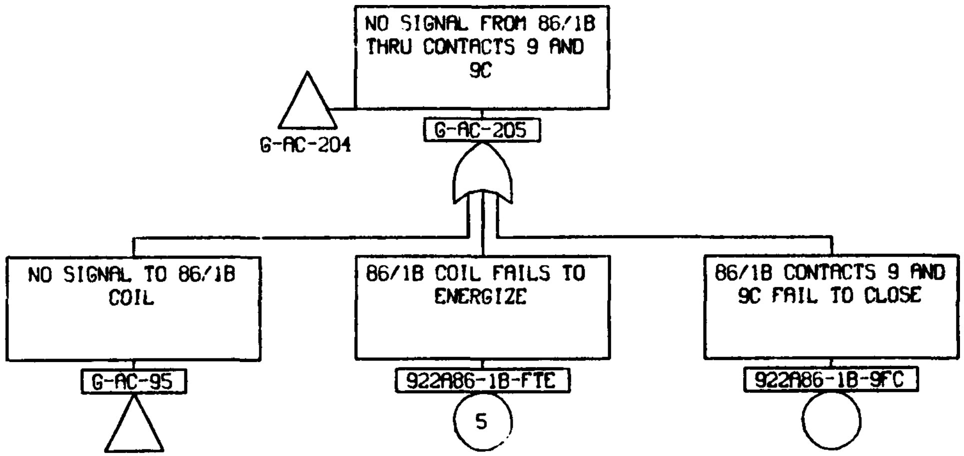

NO SIGNAL FROM 86/1B THRU CONTACTS 8 AND 8C
G-AC-196
G-AC-198
NO SIGNAL TO 86/1B COIL
G-AC-95
86/1B COIL FAILS TO ENERGIZE
922A86-1B-FTE
5
86/1B CONTACTS 8 AND 8C FAIL TO CLOSE
922A86-1B-8FC

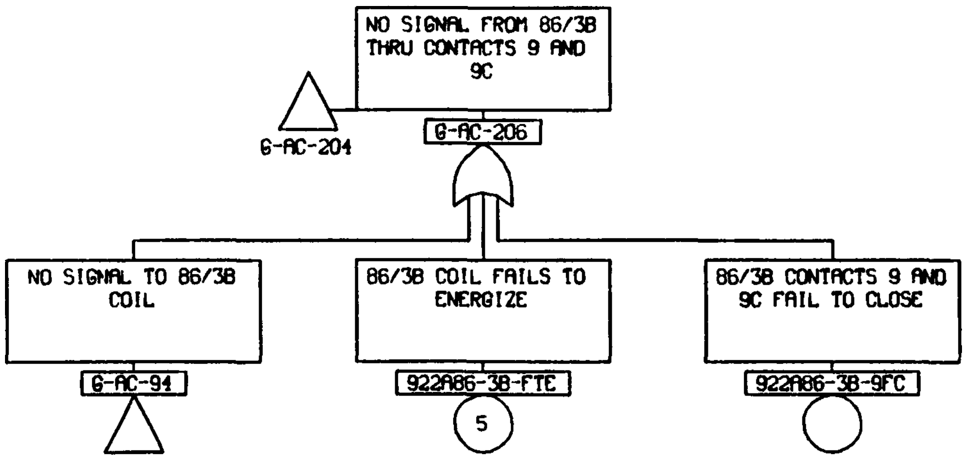

NO SIGNAL FROM 86/3B THRU CONTACTS 8 AND 8C
G-AC-196
G-AC-199
NO SIGNAL TO 86/3B COIL
G-AC-94
86/3B COIL FAILS TO ENERGIZE
922A86-3B-FTE
5
86/3B CONTACTS 8 AND 8C FAIL TO CLOSE
922A86-3B-8FC

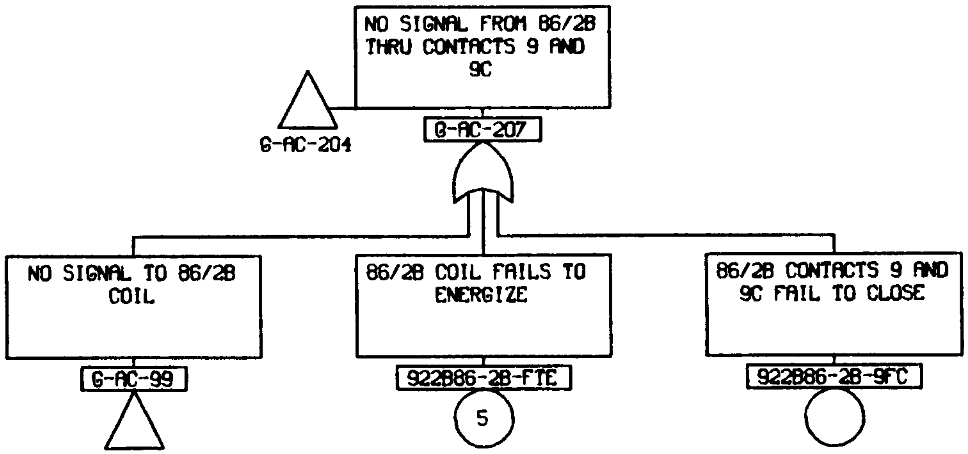

NO SIGNAL FROM 86/2B THRU CONTACTS 8 AND 8C
G-AC-196
G-AC-200
NO SIGNAL TO 86/2B COIL
G-AC-99
86/2B COIL FAILS TO ENERGIZE
922B86-2B-FTE
5
86/2B CONTACTS 8 AND 8C FAIL TO CLOSE
922B86-2B-8FC

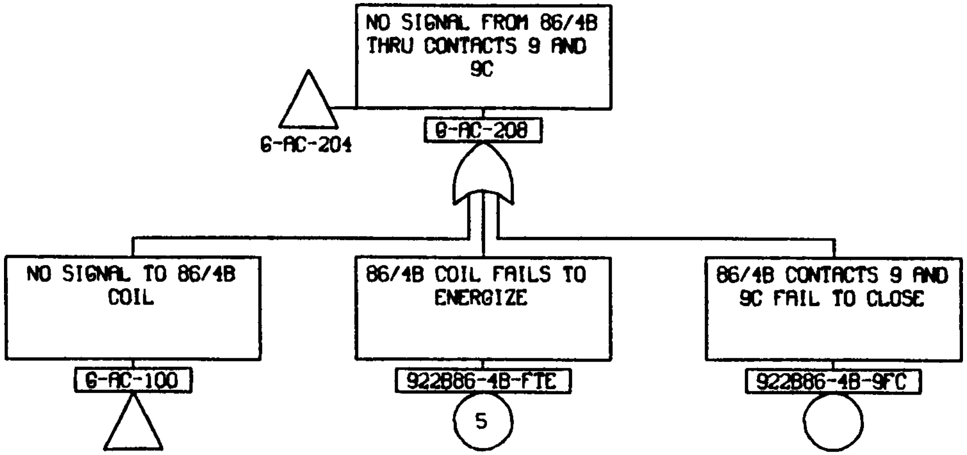

NO SIGNAL FROM 86/4B THRU CONTACTS 8 AND 8C
G-AC-196
G-AC-201
NO SIGNAL TO 86/4B COIL
G-AC-100
86/4B COIL FAILS TO ENERGIZE
922B86-4B-FTE
5
86/4B CONTACTS 8 AND 8C FAIL TO CLOSE
922B86-4B-8FC

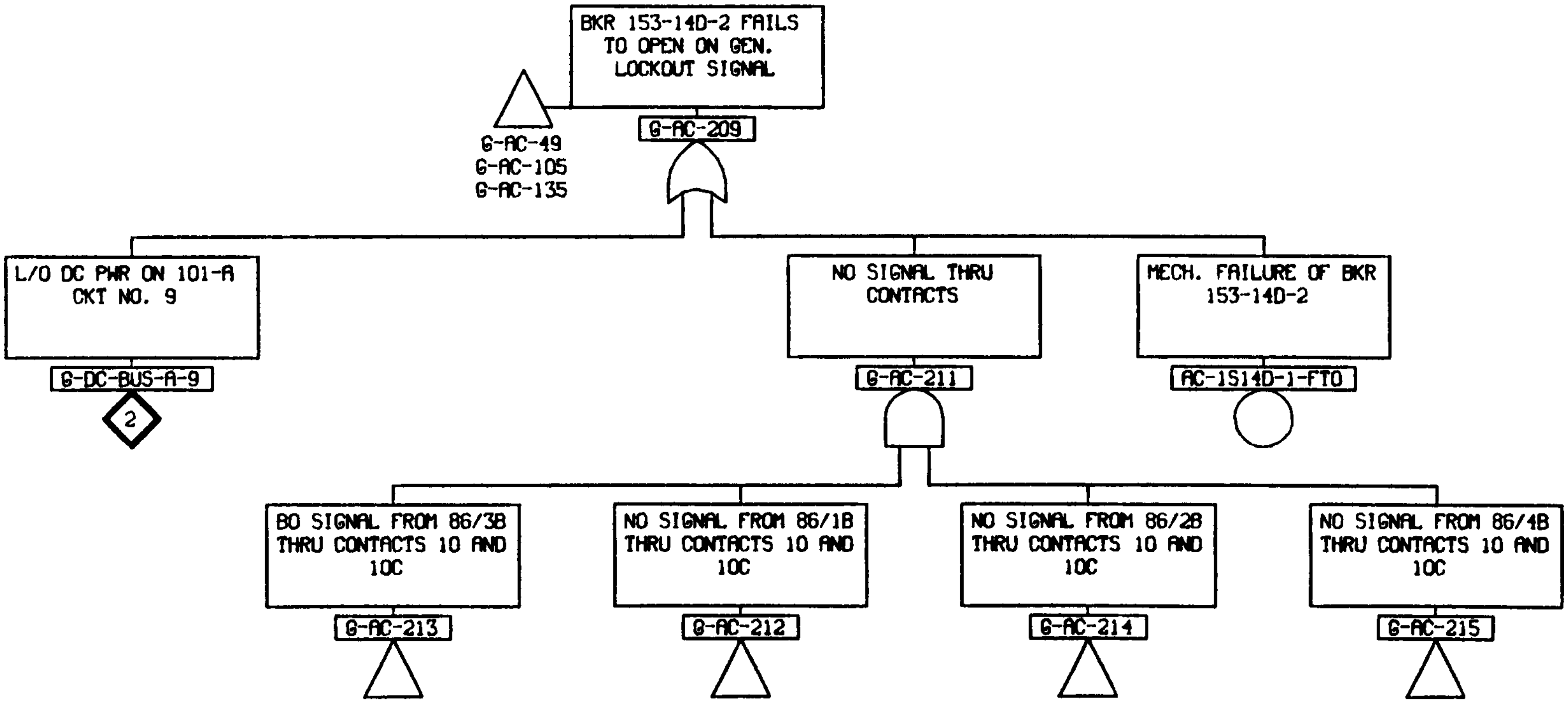

BKR 153-14C-2 FAILS TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-202
G-AC-27
G-AC-104
G-AC-134
G-AC-156
L/O DC CONTROL POWER ON 101-B CKT NO. 7
G-DC-BUS-B-7
2
NO SIGNAL THRU CONTACTS
G-AC-204
MECH. FAILURE OF BKR 153-14C-2
AC-1S14C-1-FTO
NO SIGNAL FROM 86/3B THRU CONTACTS 9 AND 9C
G-AC-206
NO SIGNAL FROM 86/1B THRU CONTACTS 9 AND 9C
G-AC-205
NO SIGNAL FROM 86/2B THRU CONTACTS 9 AND 9C
G-AC-207
NO SIGNAL FROM 86/4B THRU CONTACTS 9 AND 9C
G-AC-208

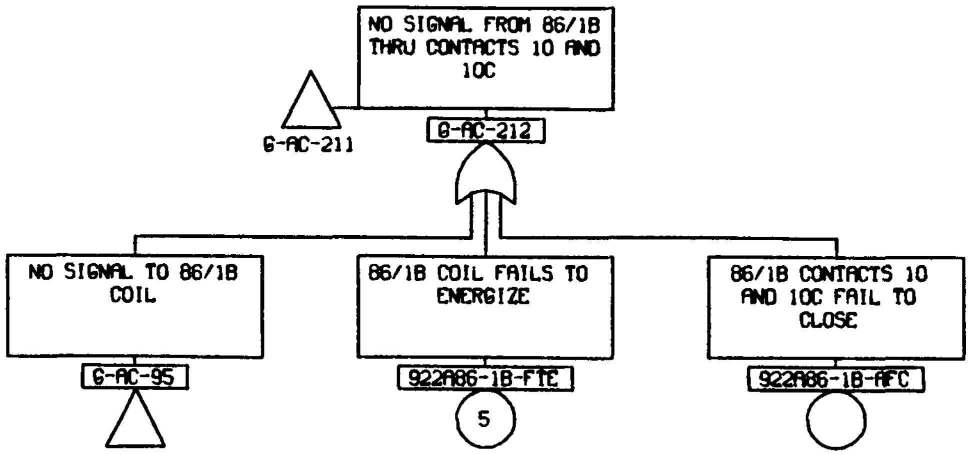

NO SIGNAL FROM 86/1B THRU CONTACTS 9 AND 9C
G-AC-205
G-AC-204
NO SIGNAL TO 86/1B COIL
G-AC-95
86/1B COIL FAILS TO ENERGIZE
922A86-1B-FTE
5
86/1B CONTACTS 9 AND 9C FAIL TO CLOSE
922A86-1B-9FC

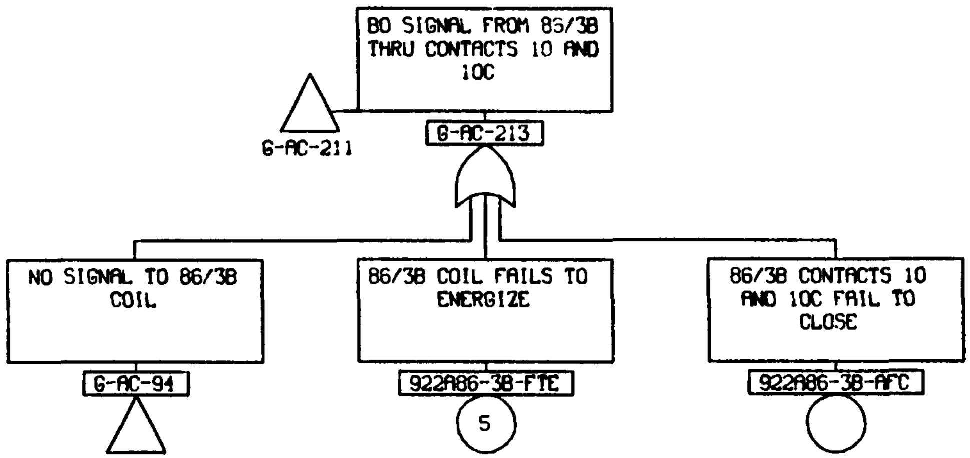

NO SIGNAL FROM 86/3B THRU CONTACTS 9 AND 9C
G-AC-206
G-AC-204
NO SIGNAL TO 86/3B COIL
G-AC-94
86/3B COIL FAILS TO ENERGIZE
922A86-3B-FTE
5
86/3B CONTACTS 9 AND 9C FAIL TO CLOSE
922A86-3B-9FC

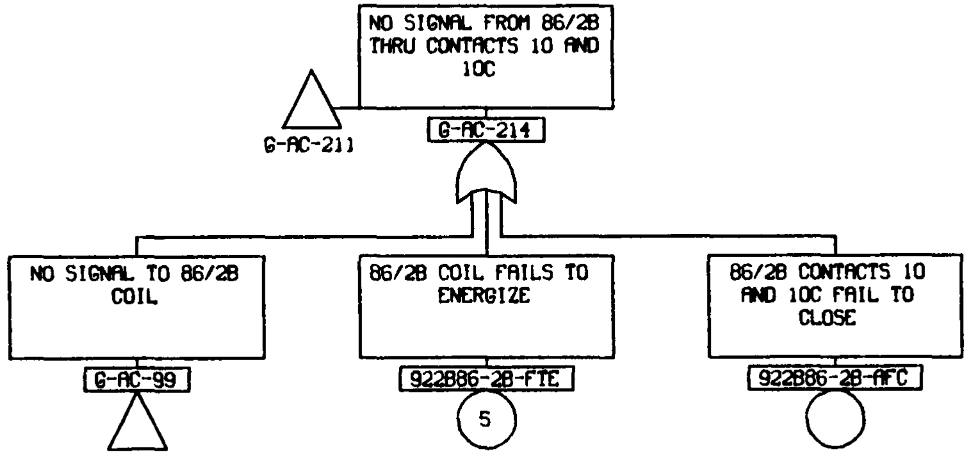

NO SIGNAL FROM 86/2B THRU CONTACTS 9 AND 9C
G-AC-204
G-AC-207
NO SIGNAL TO 86/2B COIL
86/2B COIL FAILS TO ENERGIZE
86/2B CONTACTS 9 AND 9C FAIL TO CLOSE
G-AC-99
922B86-2B-FTE
5
922B86-2B-9FC


NO SIGNAL FROM 86/4B THRU CONTACTS 9 AND 9C
G-AC-204
G-AC-208
NO SIGNAL TO 86/4B COIL
86/4B COIL FAILS TO ENERGIZE
86/4B CONTACTS 9 AND 9C FAIL TO CLOSE
G-AC-100
922B86-4B-FTE
5
922B86-4B-9FC

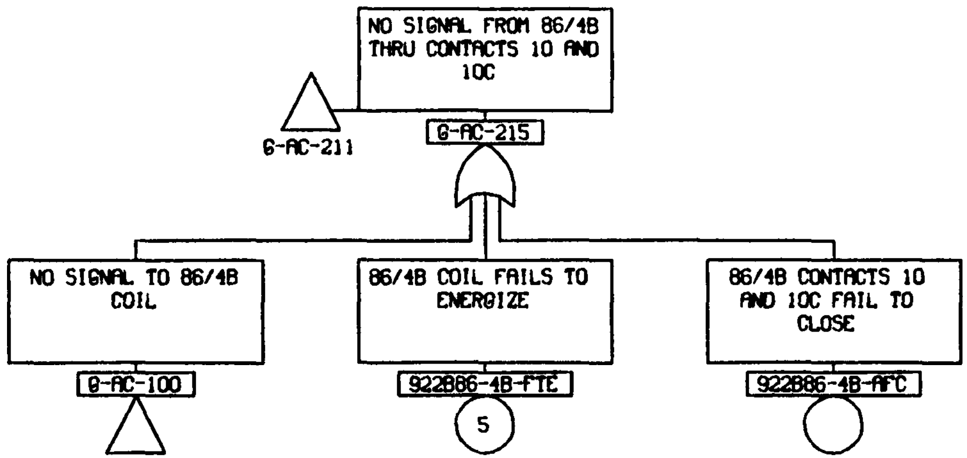

BKR 153-14D-2 FAILS TO OPEN ON GEN. LOCKOUT SIGNAL
G-AC-209
G-AC-49
G-AC-105
G-AC-135
L/O DC PWR ON 101-A CKT NO. 9
G-DC-BUS-A-9
2
NO SIGNAL THRU CONTACTS
G-AC-211
MECH. FAILURE OF BKR 153-14D-2
AC-1S14D-1-FTO
BO SIGNAL FROM 86/3B THRU CONTACTS 10 AND 10C
G-AC-213
NO SIGNAL FROM 86/1B THRU CONTACTS 10 AND 10C
G-AC-212
NO SIGNAL FROM 86/2B THRU CONTACTS 10 AND 10C
G-AC-214
NO SIGNAL FROM 86/4B THRU CONTACTS 10 AND 10C
G-AC-215


NO SIGNAL FROM 86/1B THRU CONTACTS 1O AND 1OC
G-AC-211
G-AC-212
NO SIGNAL TO 86/1B COIL
G-AC-95
86/1B COIL FAILS TO ENERGIZE
922A86-1B-FTE
5
86/1B CONTACTS 1O AND 1OC FAIL TO CLOSE
922A86-1B-AFC

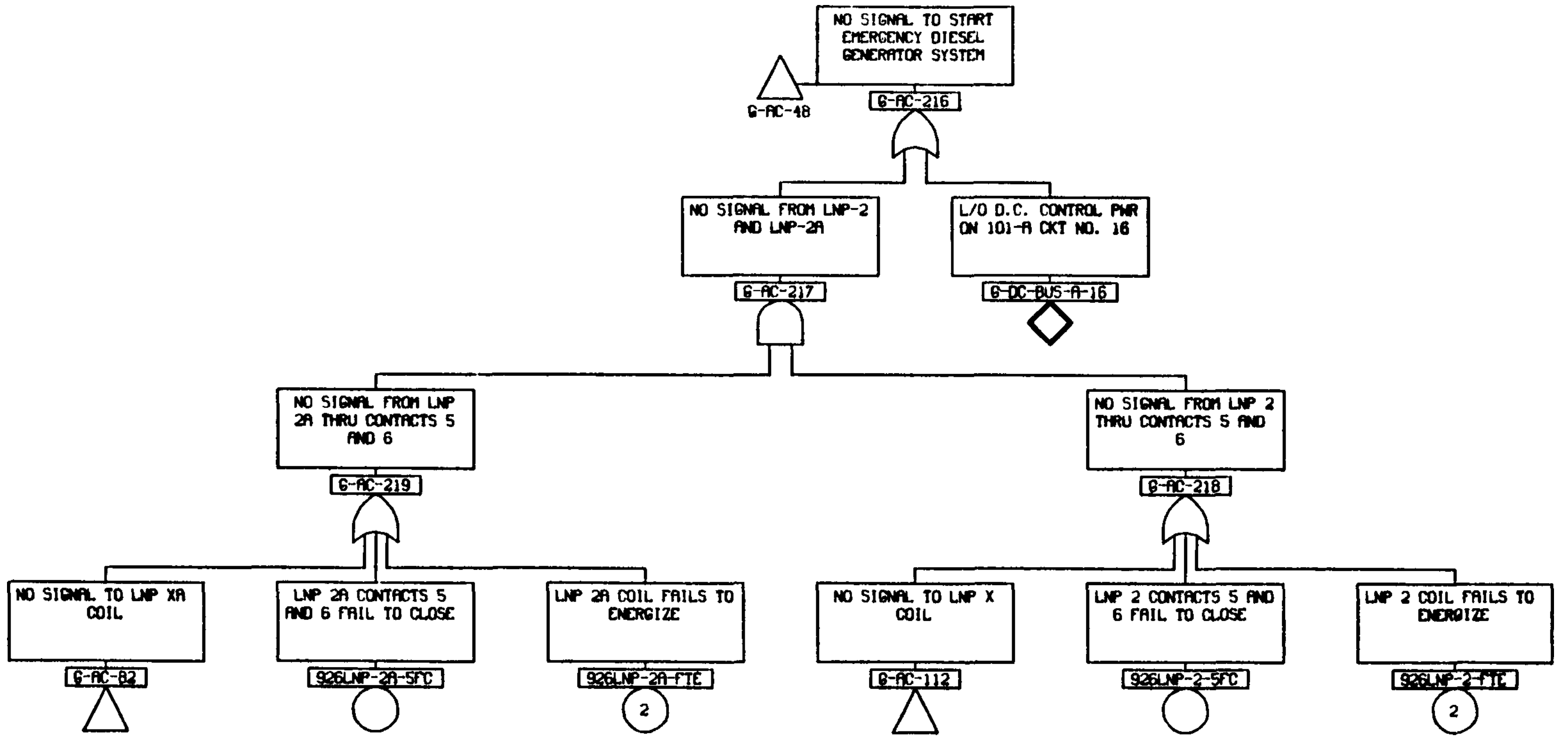

BO SIGNAL FROM 86/3B THRU CONTACTS 1O AND 1OC
G-AC-211
G-AC-213
NO SIGNAL TO 86/3B COIL
G-AC-94
86/3B COIL FAILS TO ENERGIZE
922A86-3B-FTE
5
86/3B CONTACTS 1O AND 1OC FAIL TO CLOSE
922A86-3B-AFC

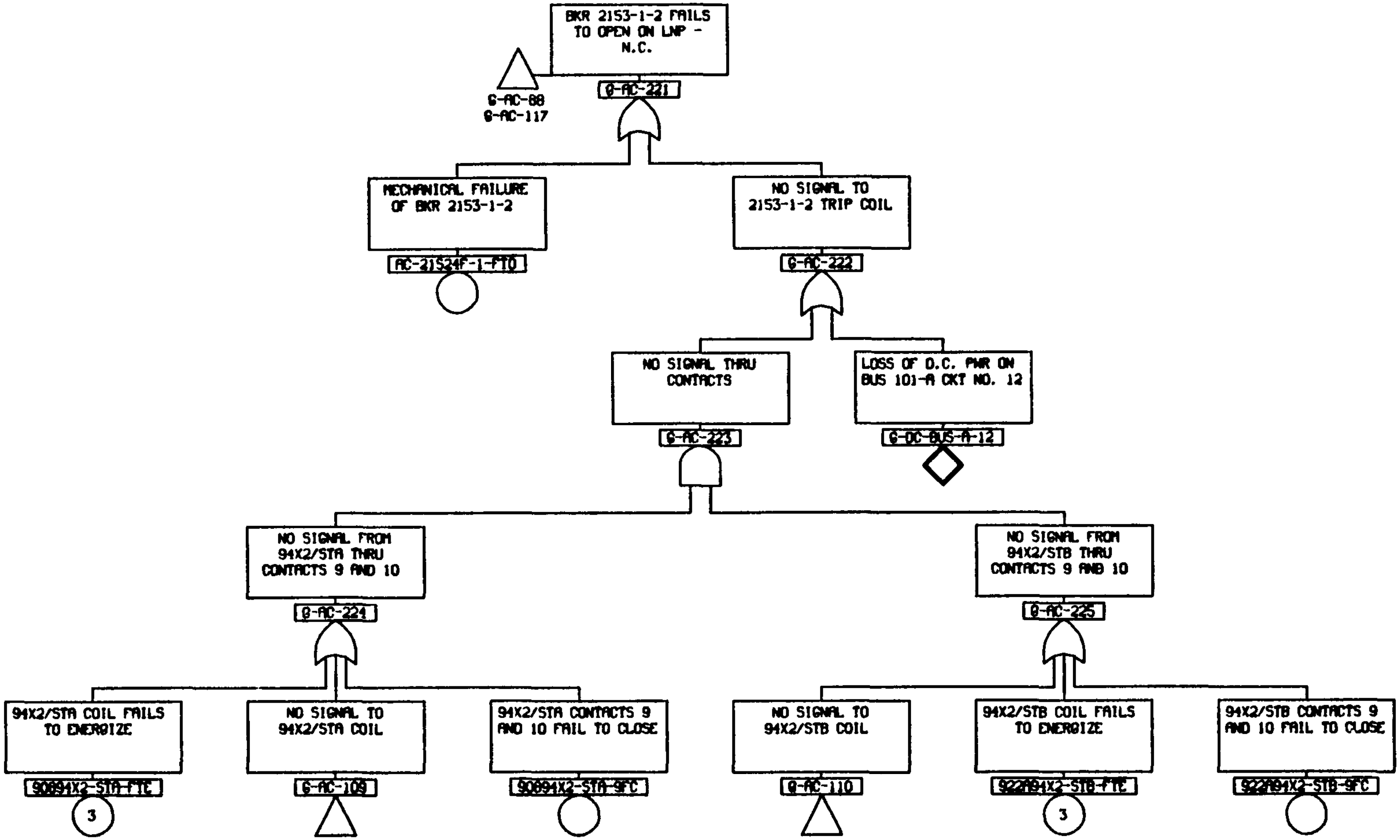


NO SIGNAL FROM 86/2B THRU CONTACTS 10 AND 10C
G-AC-211
G-AC-214
NO SIGNAL TO 86/2B COIL
86/2B COIL FAILS TO ENERGIZE
86/2B CONTACTS 10 AND 10C FAIL TO CLOSE
G-AC-99
922B86-2B-FTE
922B86-2B-AFC
5

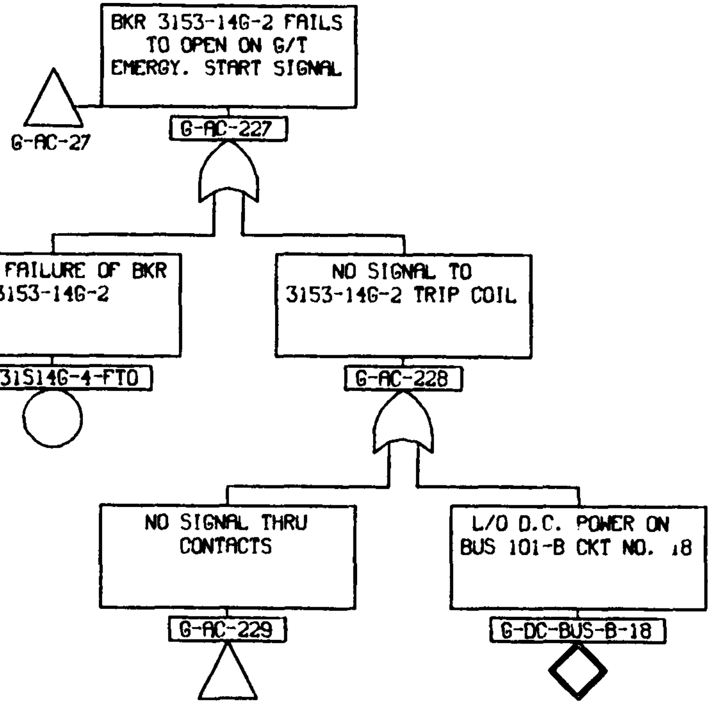


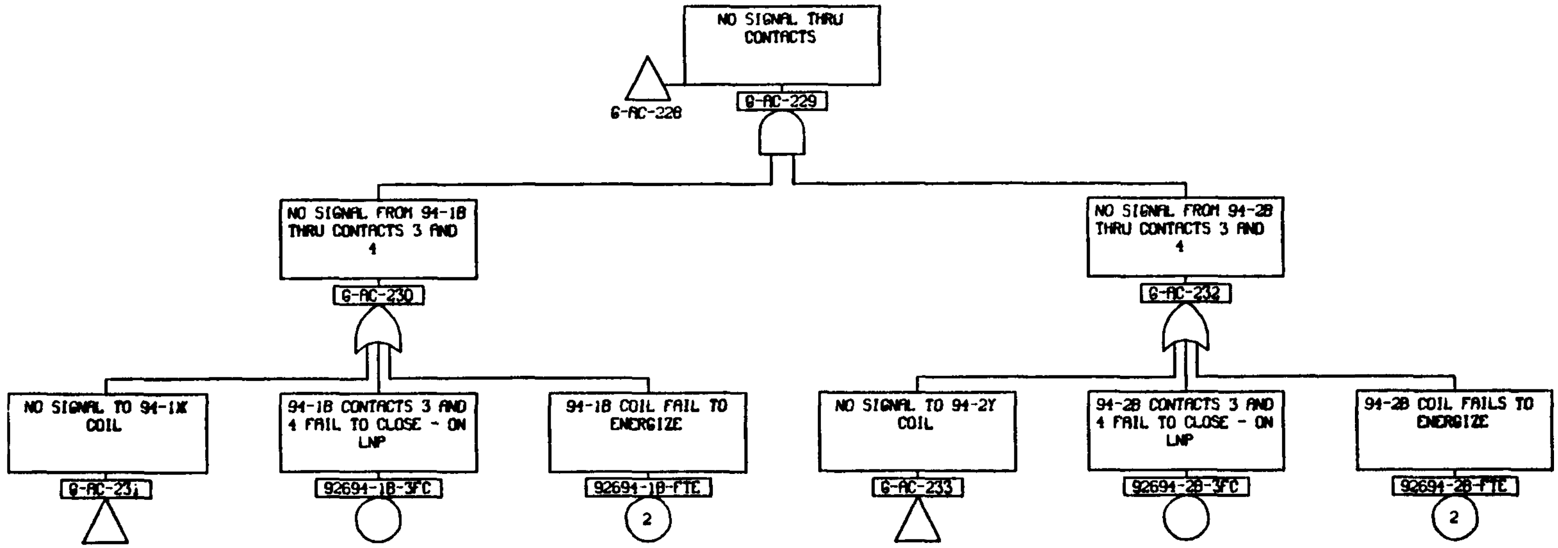
NO SIGNAL FROM 86/4B THRU CONTACTS 10 AND 10C
G-AC-211
G-AC-215
NO SIGNAL TO 86/4B COIL
86/4B COIL FAILS TO ENERGIZE
86/4B CONTACTS 10 AND 10C FAIL TO CLOSE
G-AC-100
922B86-4B-FTE
922B86-4B-AFC
5

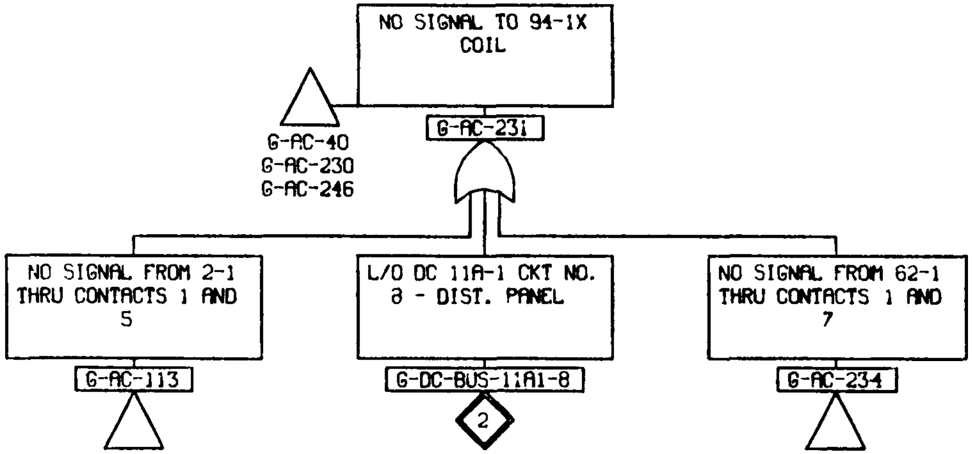

NO SIGNAL TO START EMERGENCY DIESEL GENERATOR SYSTEM
G-AC-216
G-AC-48
NO SIGNAL FROM LNP-2 AND LNP-2A
G-AC-217
L/O D.C. CONTROL PWR ON 101-A CKT NO. 16
G-DC-BUS-A-16
NO SIGNAL FROM LNP 2A THRU CONTACTS 5 AND 6
G-AC-219
NO SIGNAL FROM LNP 2 THRU CONTACTS 5 AND 6
G-AC-218
NO SIGNAL TO LNP XA COIL
G-AC-82
LNP 2A CONTACTS 5 AND 6 FAIL TO CLOSE
926LNP-2A-5FC
LNP 2A COIL FAILS TO ENERGIZE
926LNP-2A-FTE
2
NO SIGNAL TO LNP X COIL
G-AC-112
LNP 2 CONTACTS 5 AND 6 FAIL TO CLOSE
926LNP-2-5FC
LNP 2 COIL FAILS TO ENERGIZE
926LNP-2-FTE
2

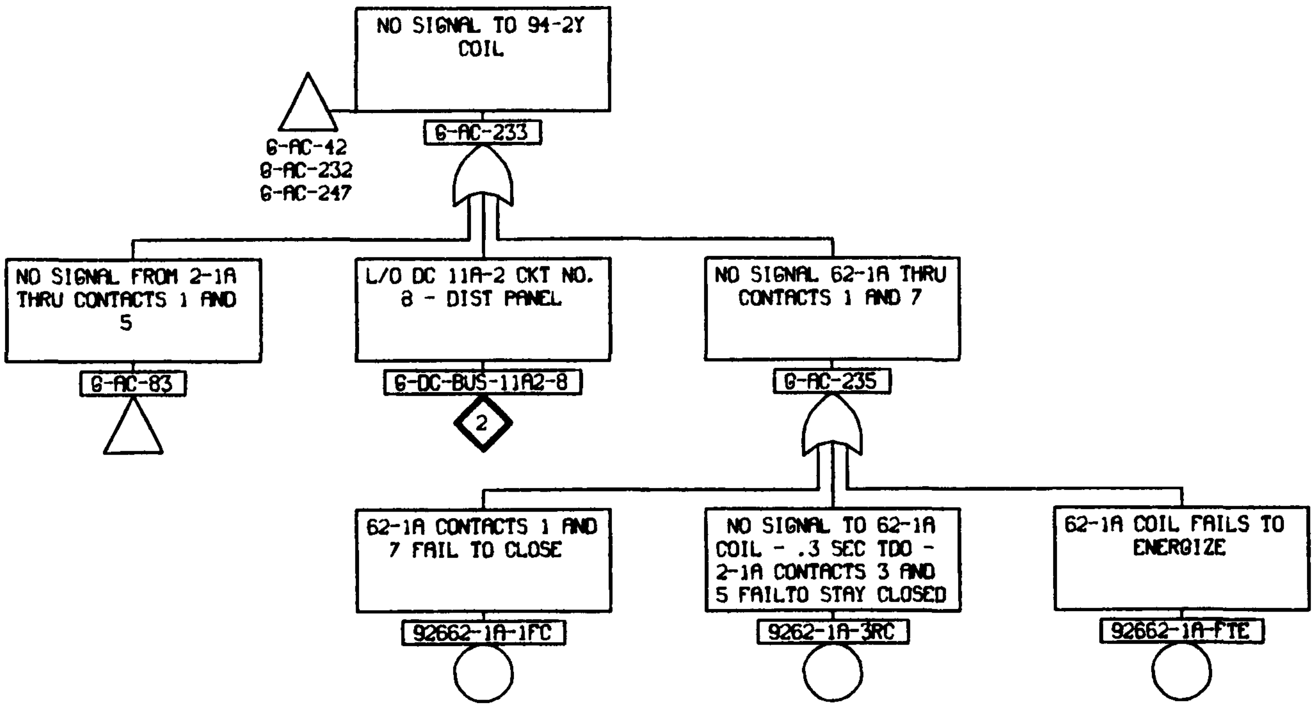


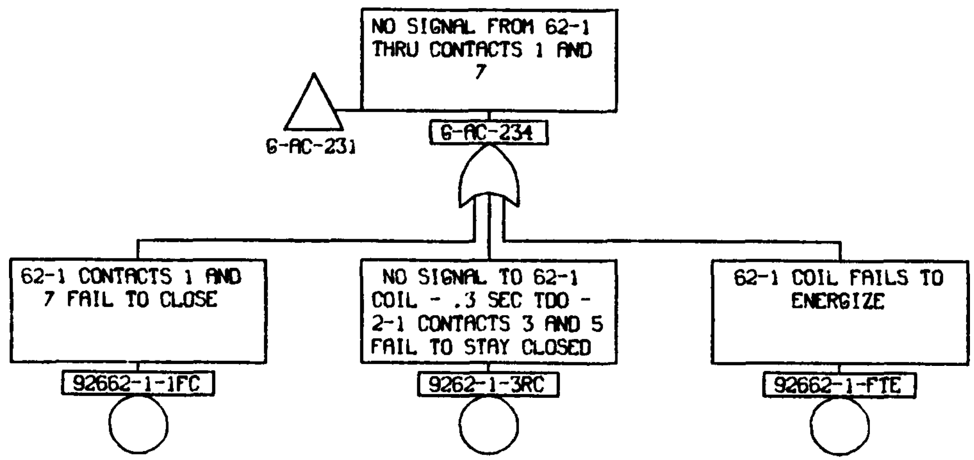
BKR 2153-1-2 FAILS TO OPEN ON LNP - N.C.
G-AC-221
G-AC-88
G-AC-117
MECHANICAL FAILURE OF BKR 2153-1-2
AC-21524F-1-FTO
NO SIGNAL TO 2153-1-2 TRIP COIL
G-AC-222
NO SIGNAL THRU CONTACTS
G-AC-223
LOSS OF D.C. PWR ON BUS 101-A CKT NO. 12
G-DC-BUS-A-12
NO SIGNAL FROM 94X2/STA THRU CONTACTS 9 AND 10
G-AC-224
NO SIGNAL FROM 94X2/STB THRU CONTACTS 9 AND 10
G-AC-225
94X2/STA COIL FAILS TO ENERGIZE
90894X2-STA-FTE
3
NO SIGNAL TO 94X2/STA COIL
G-AC-109
94X2/STA CONTACTS 9 AND 10 FAIL TO CLOSE
90894X2-STA-9FC
NO SIGNAL TO 94X2/STB COIL
G-AC-110
94X2/STB COIL FAILS TO ENERGIZE
922A94X2-STB-FTE
3
94X2/STB CONTACTS 9 AND 10 FAIL TO CLOSE
922A94X2-STB-9FC

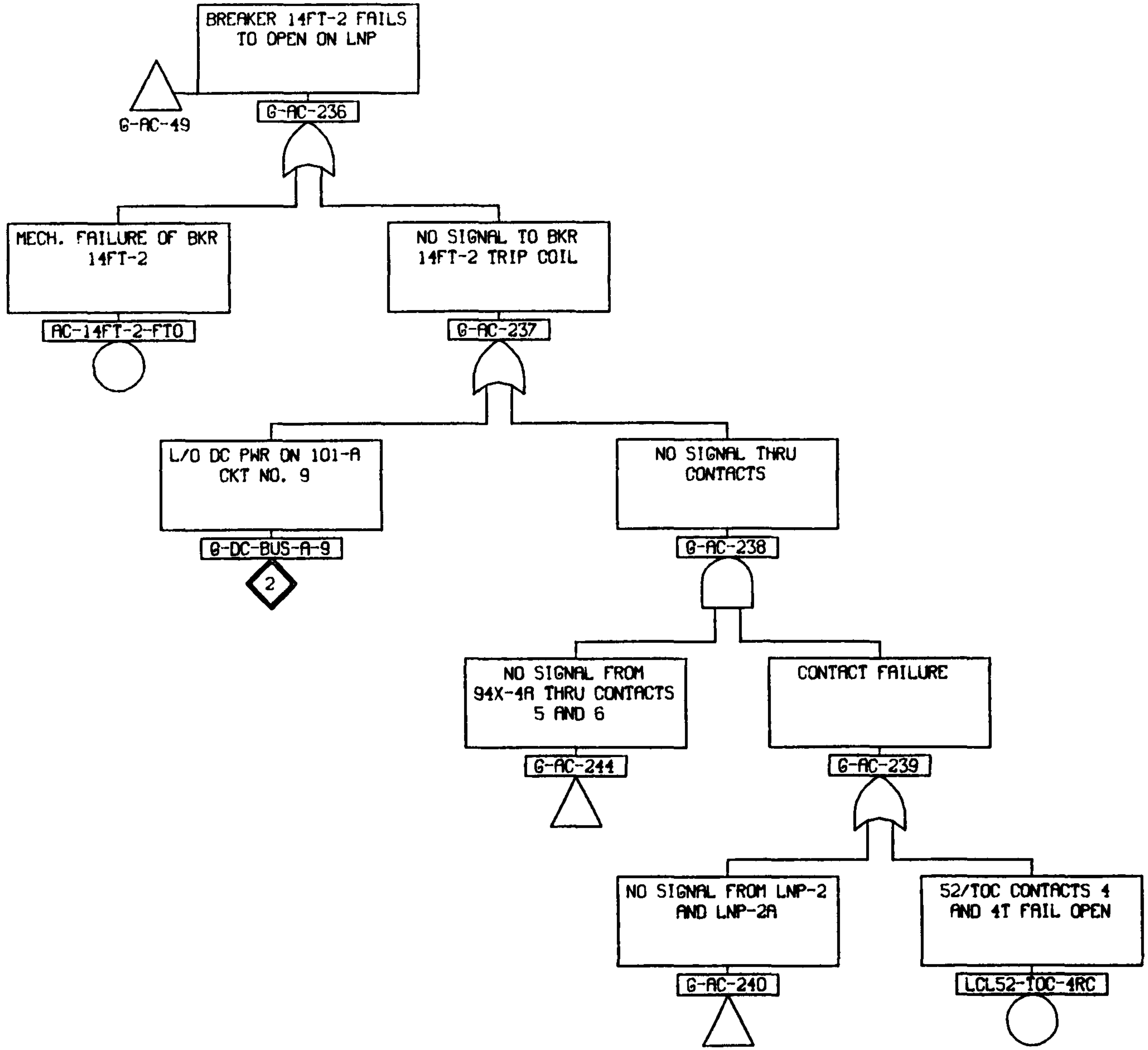

BKR 3153-14G-2 FAILS TO OPEN ON G/T EMERGY. START SIGNAL
G-AC-227
G-AC-27
MECH. FAILURE OF BKR 3153-14G-2
AC-315146-4-FTO
NO SIGNAL TO 3153-14G-2 TRIP COIL
G-AC-228
NO SIGNAL THRU CONTACTS
G-AC-229
L/O D.C. POWER ON BUS 101-B CKT NO. 18
G-DC-BUS-B-18

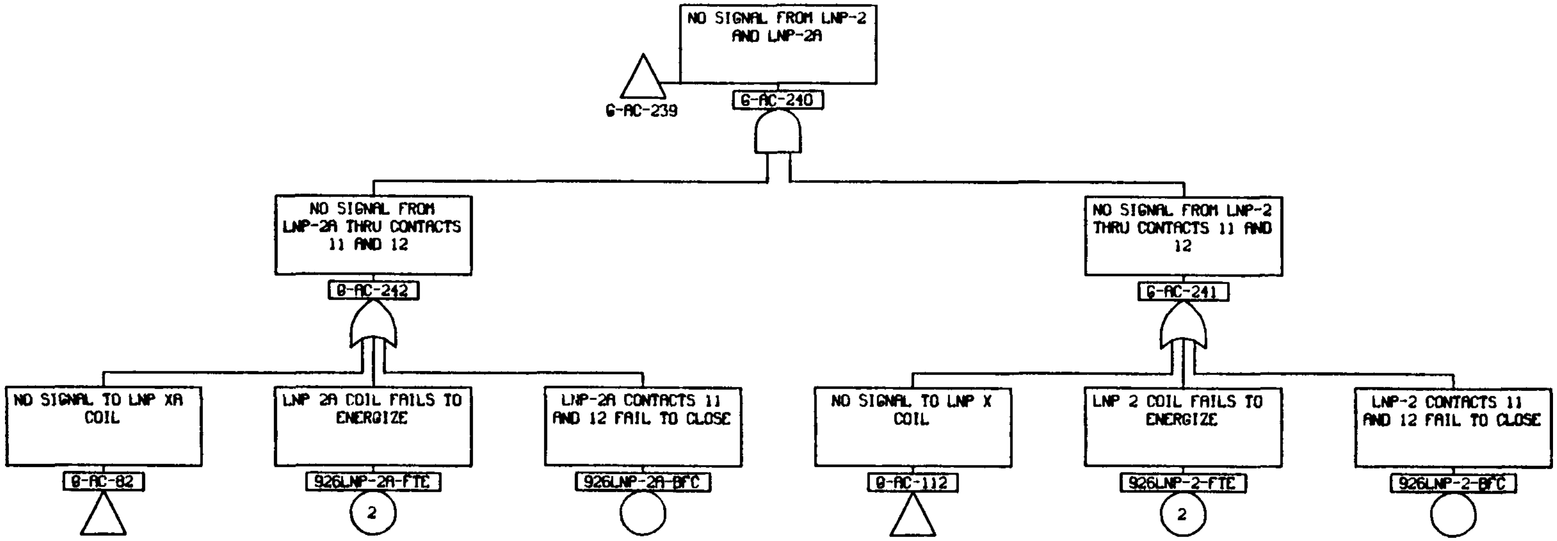

NO SIGNAL THRU CONTACTS
G-AC-229
G-AC-228
NO SIGNAL FROM 94-1B THRU CONTACTS 3 AND 4
G-AC-230
NO SIGNAL FROM 94-2B THRU CONTACTS 3 AND 4
G-AC-232
NO SIGNAL TO 94-1X COIL
G-AC-231
94-1B CONTACTS 3 AND 4 FAIL TO CLOSE - ON LNP
92694-1B-3FC
94-1B COIL FAIL TO ENERGIZE
92694-1B-FTE
2
NO SIGNAL TO 94-2Y COIL
G-AC-233
94-2B CONTACTS 3 AND 4 FAIL TO CLOSE - ON LNP
92694-2B-3FC
94-2B COIL FAILS TO ENERGIZE
92694-2B-FTE
2


NO SIGNAL TO 94-1X COIL
G-AC-231
G-AC-40
G-AC-230
G-AC-246
NO SIGNAL FROM 2-1 THRU CONTACTS 1 AND 5
G-AC-113
L/O DC 11A-1 CKT NO. 8 - DIST. PANEL
G-DC-BUS-11A1-8
2
NO SIGNAL FROM 62-1 THRU CONTACTS 1 AND 7
G-AC-234


NO SIGNAL TO 94-2Y COIL
G-AC-233
G-AC-42
G-AC-232
G-AC-247
NO SIGNAL FROM 2-1A THRU CONTACTS 1 AND 5
G-AC-83
L/O DC 11A-2 CKT NO. 8 - DIST PANEL
G-DC-BUS-11A2-8
2
NO SIGNAL 62-1A THRU CONTACTS 1 AND 7
G-AC-235
62-1A CONTACTS 1 AND 7 FAIL TO CLOSE
92662-1A-1FC
NO SIGNAL TO 62-1A COIL - .3 SEC TDO - 2-1A CONTACTS 3 AND 5 FAILTO STAY CLOSED
9262-1A-3RC
62-1A COIL FAILS TO ENERGIZE
92662-1A-FTE

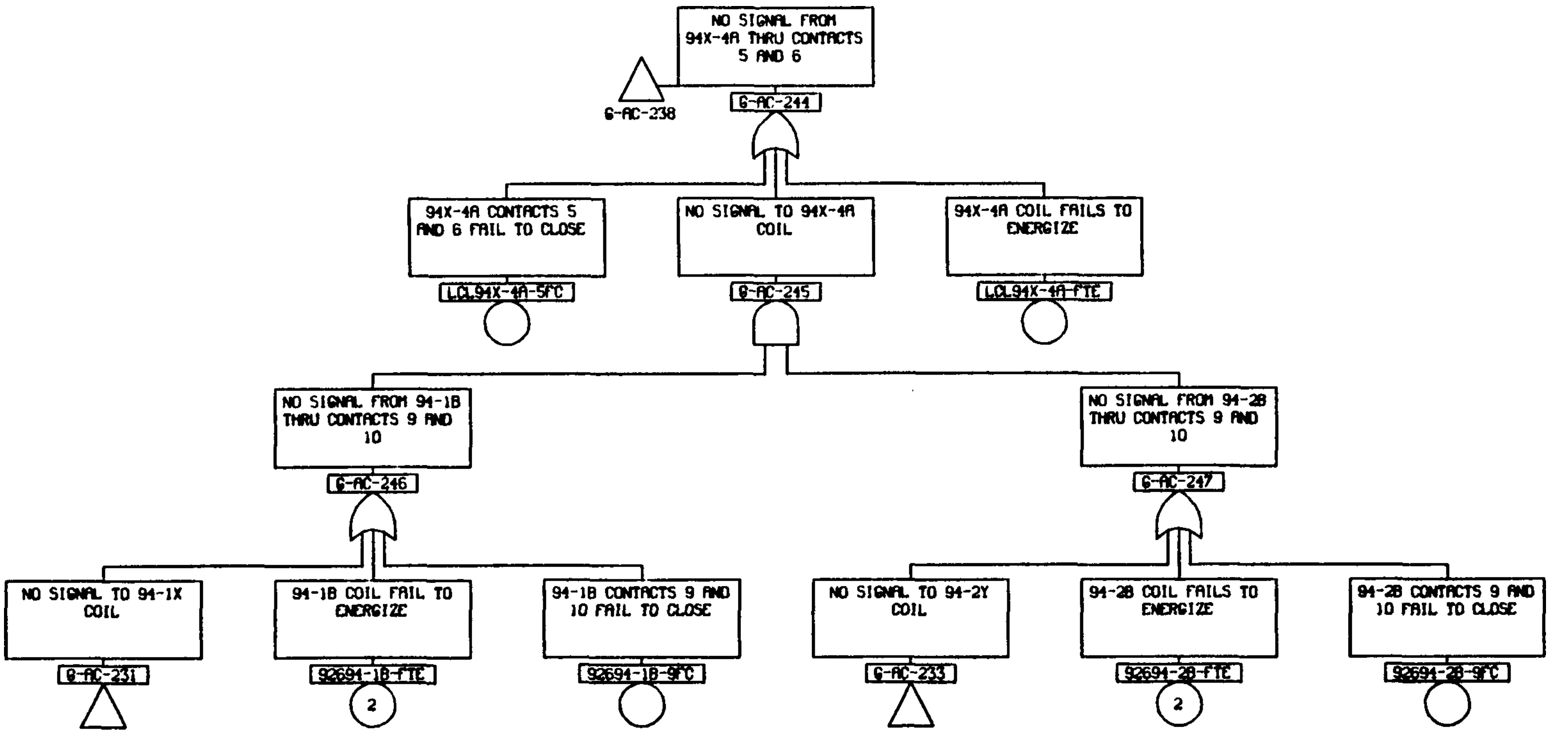

NO SIGNAL FROM 62-1 THRU CONTACTS 1 AND 7
G-AC-234
G-AC-231
62-1 CONTACTS 1 AND 7 FAIL TO CLOSE
92662-1-1FC
NO SIGNAL TO 62-1 COIL - .3 SEC TDO - 2-1 CONTACTS 3 AND 5 FAIL TO STAY CLOSED
9262-1-3RC
62-1 COIL FAILS TO ENERGIZE
92662-1-FTE

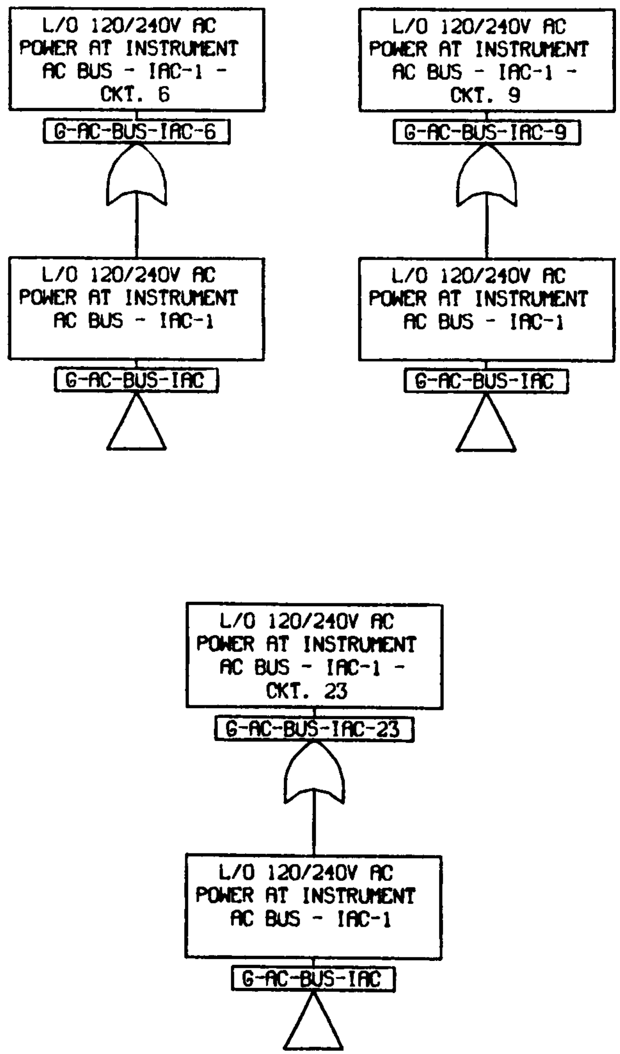

BREAKER 14FT-2 FAILS TO OPEN ON LNP
G-AC-49
G-AC-236
MECH. FAILURE OF BKR 14FT-2
AC-14FT-2-FTO
NO SIGNAL TO BKR 14FT-2 TRIP COIL
G-AC-237
L/O DC PWR ON 101-A CKT NO. 9
G-DC-BUS-A-9
2
NO SIGNAL THRU CONTACTS
G-AC-238
NO SIGNAL FROM 94X-4A THRU CONTACTS 5 AND 6
G-AC-244
CONTACT FAILURE
G-AC-239
NO SIGNAL FROM LNP-2 AND LNP-2A
G-AC-240
52/TOC CONTACTS 4 AND 4T FAIL OPEN
LCL52-TOC-4RC

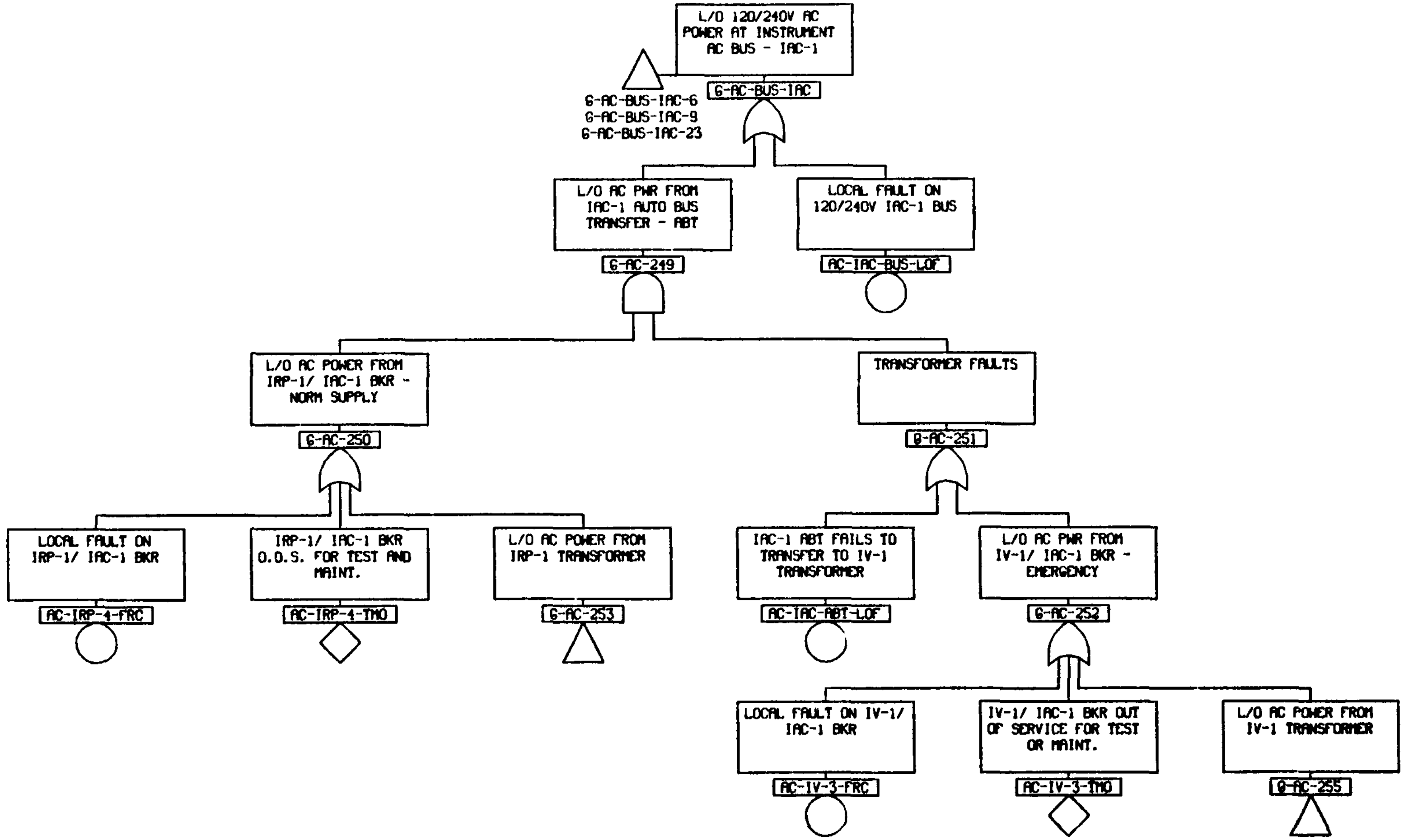


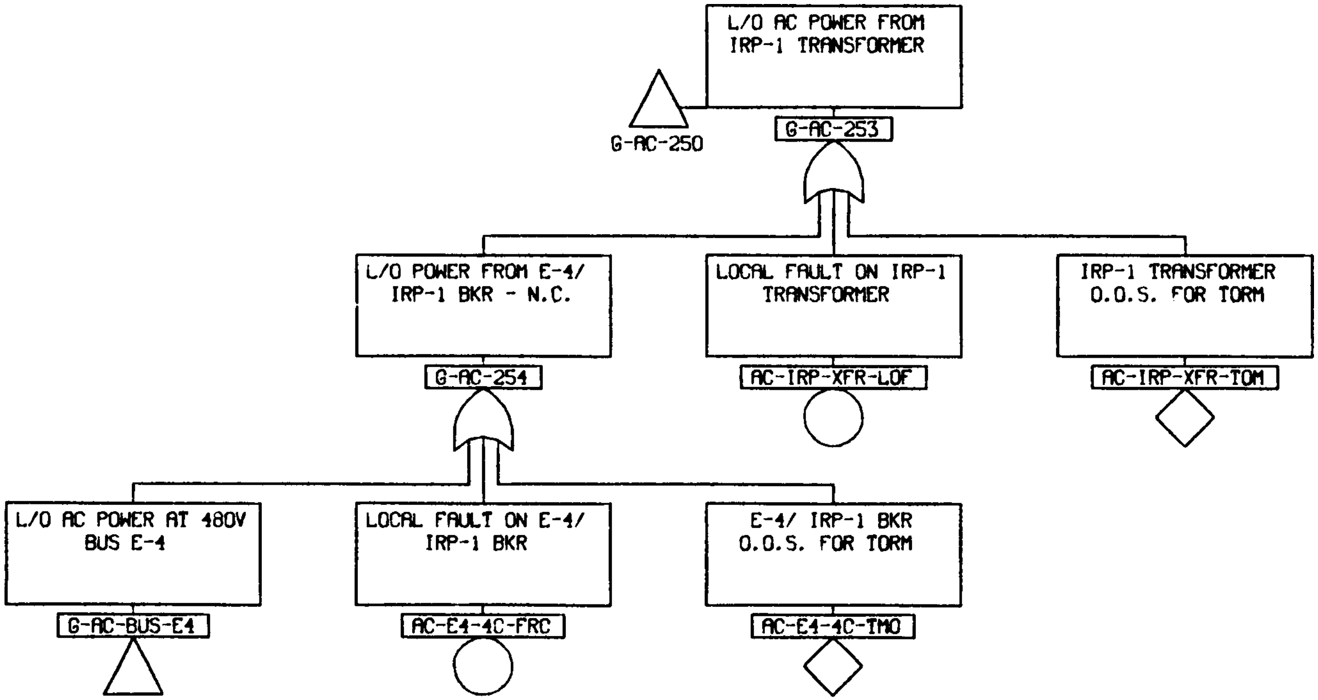
NO SIGNAL FROM LNP-2 AND LNP-2A
G-AC-240
G-AC-239
NO SIGNAL FROM LNP-2A THRU CONTACTS 11 AND 12
G-AC-242
NO SIGNAL FROM LNP-2 THRU CONTACTS 11 AND 12
G-AC-241
NO SIGNAL TO LNP XA COIL
G-AC-82
LNP 2A COIL FAILS TO ENERGIZE
926LNP-2A-FTE
2
LNP-2A CONTACTS 11 AND 12 FAIL TO CLOSE
926LNP-2A-BFC
NO SIGNAL TO LNP X COIL
G-AC-112
LNP 2 COIL FAILS TO ENERGIZE
926LNP-2-FTE
2
LNP-2 CONTACTS 11 AND 12 FAIL TO CLOSE
926LNP-2-BFC

B.17-145

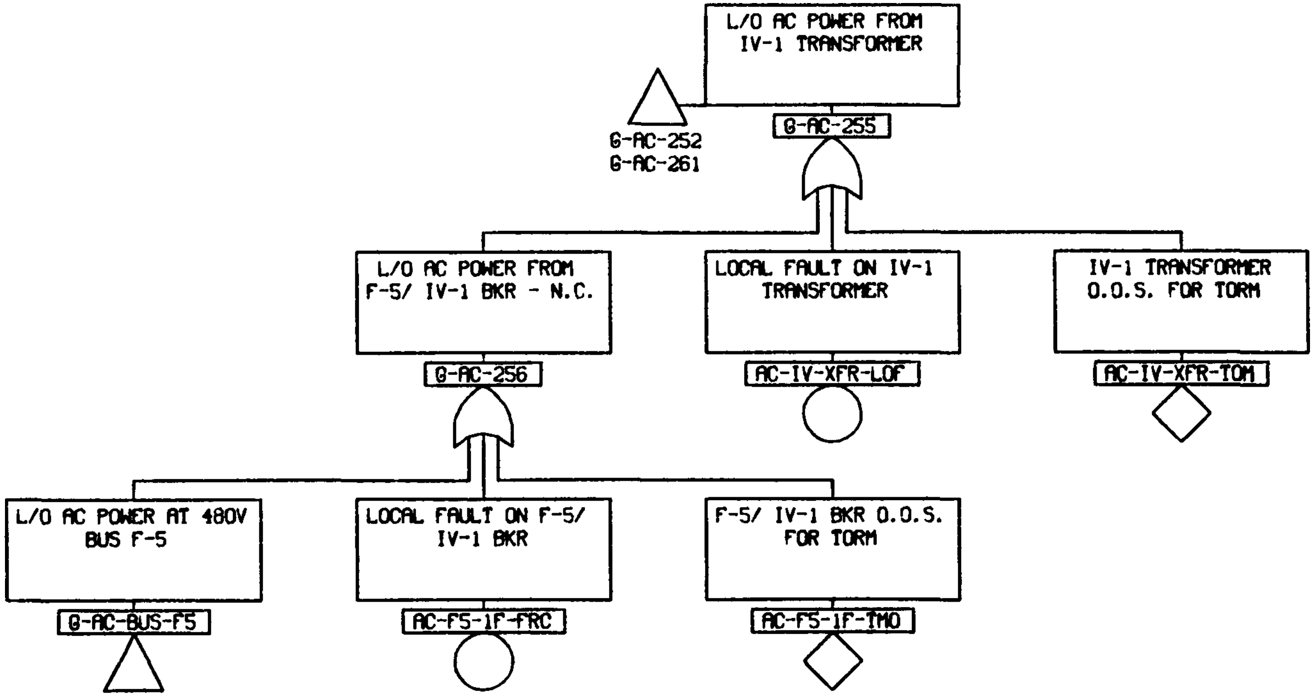

NO SIGNAL FROM 94X-4A THRU CONTACTS 5 AND 6
G-AC-244
G-AC-238
94X-4A CONTACTS 5 AND 6 FAIL TO CLOSE
LCL94X-4A-5FC
NO SIGNAL TO 94X-4A COIL
G-AC-245
94X-4A COIL FAILS TO ENERGIZE
LCL94X-4A-FTE
NO SIGNAL FROM 94-1B THRU CONTACTS 9 AND 10
G-AC-246
NO SIGNAL FROM 94-2B THRU CONTACTS 9 AND 10
G-AC-247
NO SIGNAL TO 94-1X COIL
G-AC-231
94-1B COIL FAIL TO ENERGIZE
92694-1B-FTE
2
94-1B CONTACTS 9 AND 10 FAIL TO CLOSE
92694-1B-9FC
NO SIGNAL TO 94-2Y COIL
G-AC-233
94-2B COIL FAILS TO ENERGIZE
92694-2B-FTE
2
94-2B CONTACTS 9 AND 10 FAIL TO CLOSE
92694-2B-9FC


L/O 120/240V AC POWER AT INSTRUMENT AC BUS - IAC-1 - CKT. 6
G-AC-BUS-IAC-6
L/O 120/240V AC POWER AT INSTRUMENT AC BUS - IAC-1
G-AC-BUS-IAC
L/O 120/240V AC POWER AT INSTRUMENT AC BUS - IAC-1 - CKT. 9
G-AC-BUS-IAC-9
L/O 120/240V AC POWER AT INSTRUMENT AC BUS - IAC-1
G-AC-BUS-IAC
L/O 120/240V AC POWER AT INSTRUMENT AC BUS - IAC-1 - CKT. 23
G-AC-BUS-IAC-23
L/O 120/240V AC POWER AT INSTRUMENT AC BUS - IAC-1
G-AC-BUS-IAC


L/O 120/240V AC POWER AT INSTRUMENT AC BUS - IAC-1
G-AC-BUS-IAC
G-AC-BUS-IAC-6
G-AC-BUS-IAC-9
G-AC-BUS-IAC-23
L/O AC PWR FROM IAC-1 AUTO BUS TRANSFER - ABT
G-AC-249
LOCAL FAULT ON 120/240V IAC-1 BUS
AC-IAC-BUS-LOF
L/O AC POWER FROM IRP-1/ IAC-1 BKR - NORM SUPPLY
G-AC-250
TRANSFORMER FAULTS
G-AC-251
LOCAL FAULT ON IRP-1/ IAC-1 BKR
AC-IRP-4-FRC
IRP-1/ IAC-1 BKR O.O.S. FOR TEST AND MAINT.
AC-IRP-4-TMO
L/O AC POWER FROM IRP-1 TRANSFORMER
G-AC-253
IAC-1 ABT FAILS TO TRANSFER TO IV-1 TRANSFORMER
AC-IAC-ABT-LOF
L/O AC PWR FROM IV-1/ IAC-1 BKR - EMERGENCY
G-AC-252
LOCAL FAULT ON IV-1/ IAC-1 BKR
AC-IV-3-FRC
IV-1/ IAC-1 BKR OUT OF SERVICE FOR TEST OR MAINT.
AC-IV-3-TMO
L/O AC POWER FROM IV-1 TRANSFORMER
G-AC-255

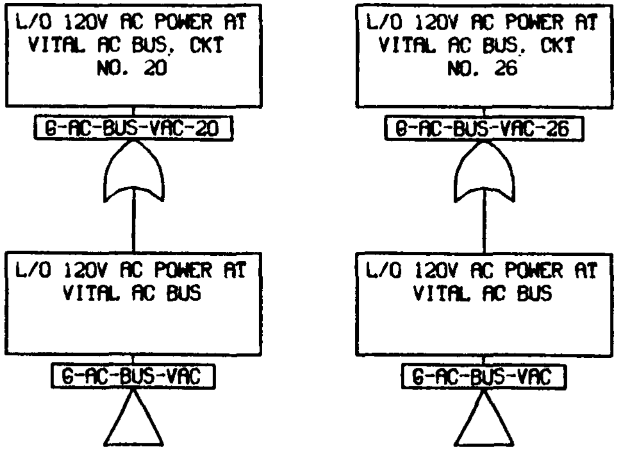


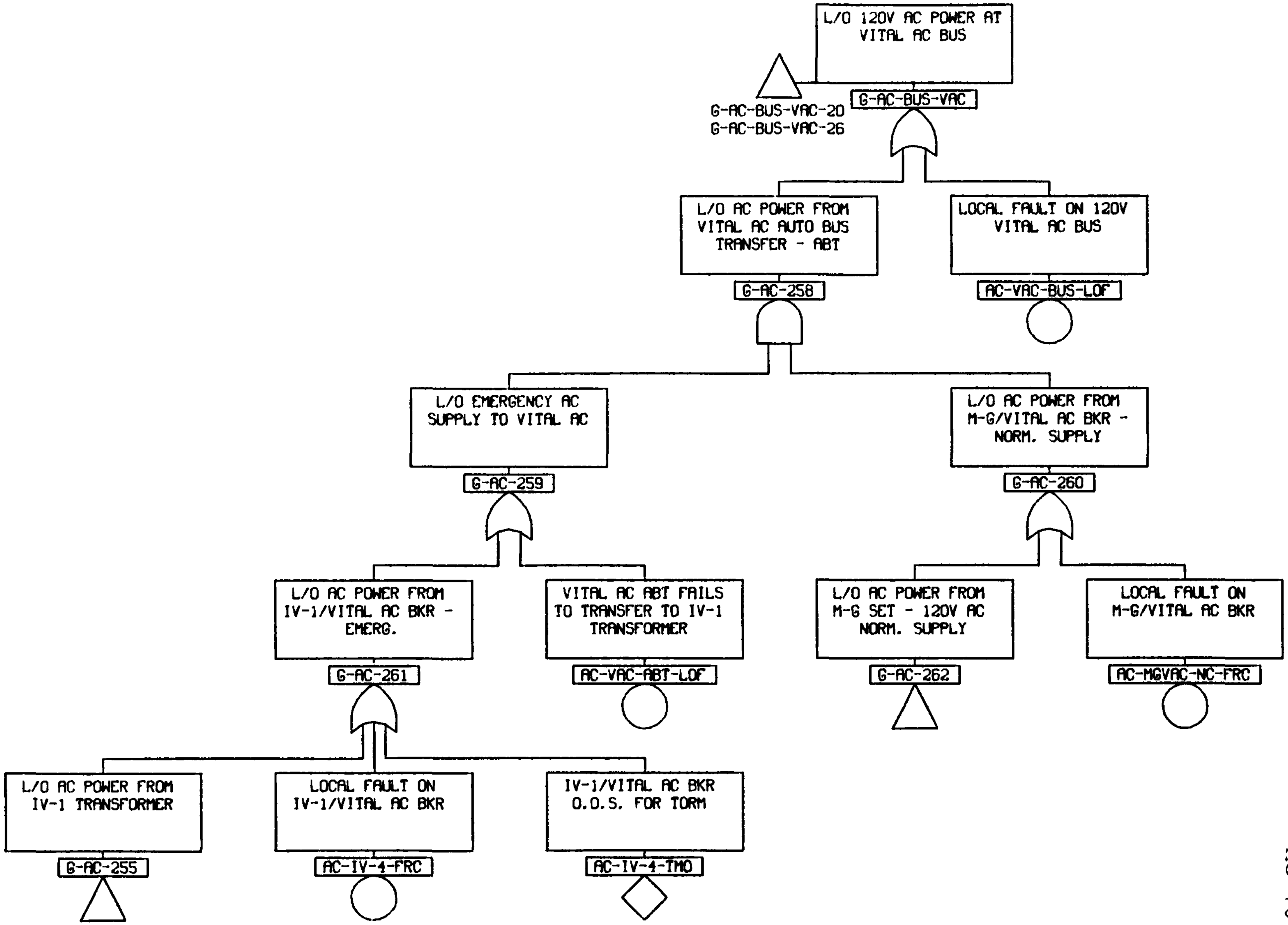
L/O AC POWER FROM IRP-1 TRANSFORMER
G-AC-253
G-AC-250
L/O POWER FROM E-4/ IRP-1 BKR - N.C.
G-AC-254
LOCAL FAULT ON IRP-1 TRANSFORMER
AC-IRP-XFR-LOF
IRP-1 TRANSFORMER O.O.S. FOR TORM
AC-IRP-XFR-TOM
L/O AC POWER AT 480V BUS E-4
G-AC-BUS-E4
LOCAL FAULT ON E-4/ IRP-1 BKR
AC-E4-4C-FRC
E-4/ IRP-1 BKR O.O.S. FOR TORM
AC-E4-4C-TMO

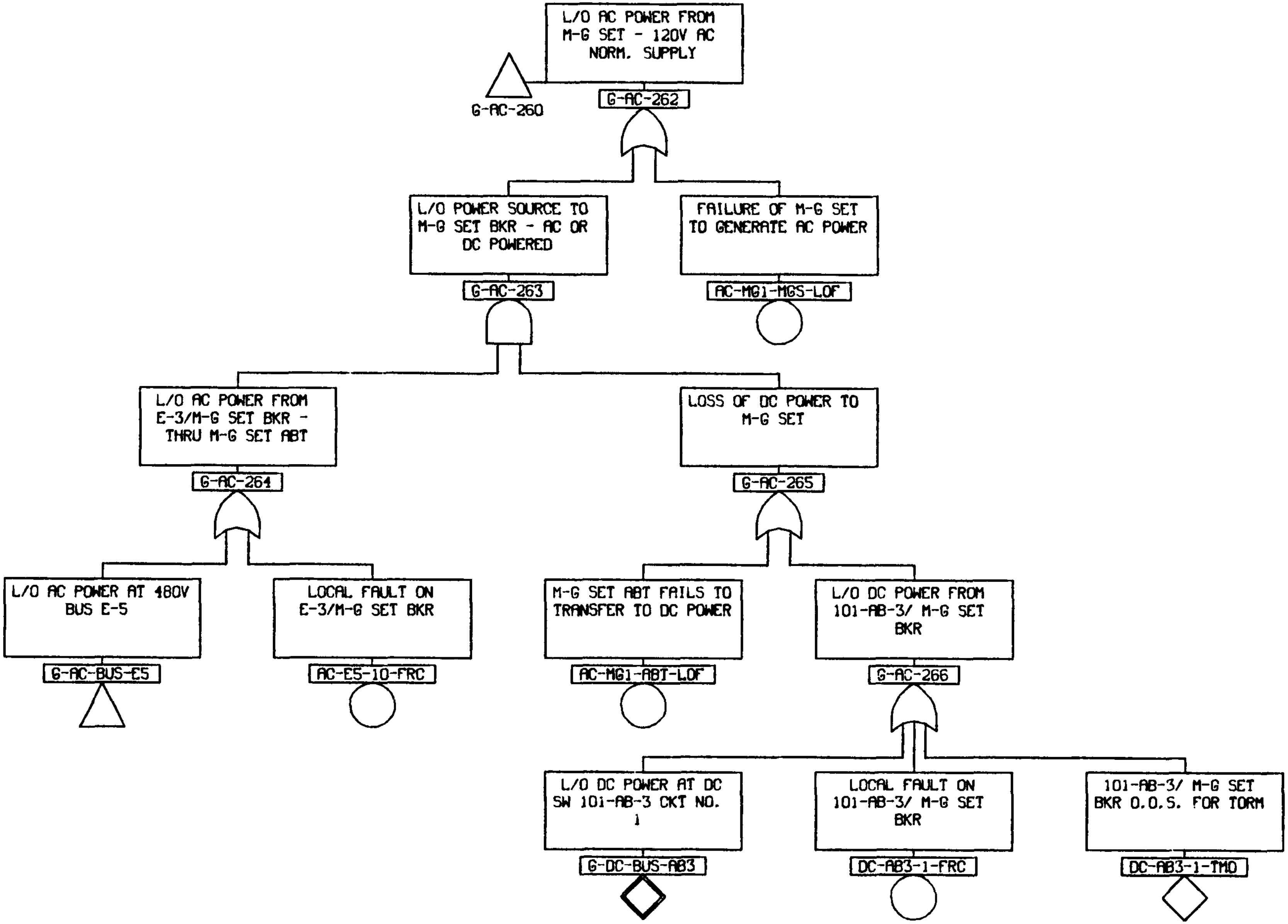


L/O AC POWER FROM IV-1 TRANSFORMER
G-AC-255
G-AC-252
G-AC-261
L/O AC POWER FROM F-5/ IV-1 BKR - N.C.
G-AC-256
LOCAL FAULT ON IV-1 TRANSFORMER
AC-IV-XFR-LOF
IV-1 TRANSFORMER O.O.S. FOR TORM
AC-IV-XFR-TOM
L/O AC POWER AT 480V BUS F-5
G-AC-BUS-F5
LOCAL FAULT ON F-5/ IV-1 BKR
AC-F5-1F-FRC
F-5/ IV-1 BKR O.O.S. FOR TORM
AC-F5-1F-TMO

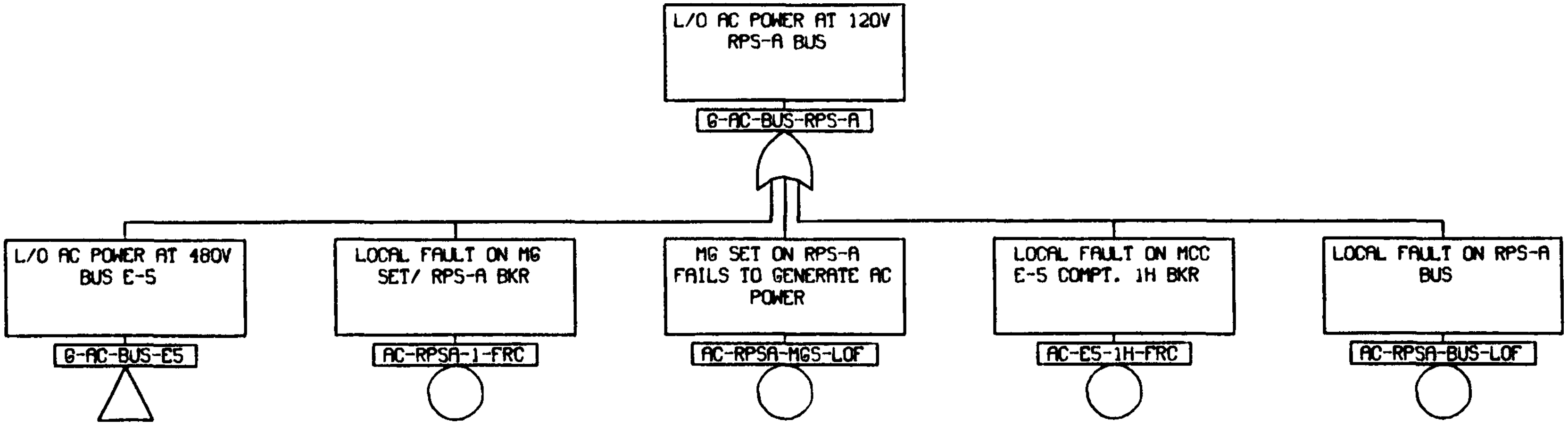
AC-102

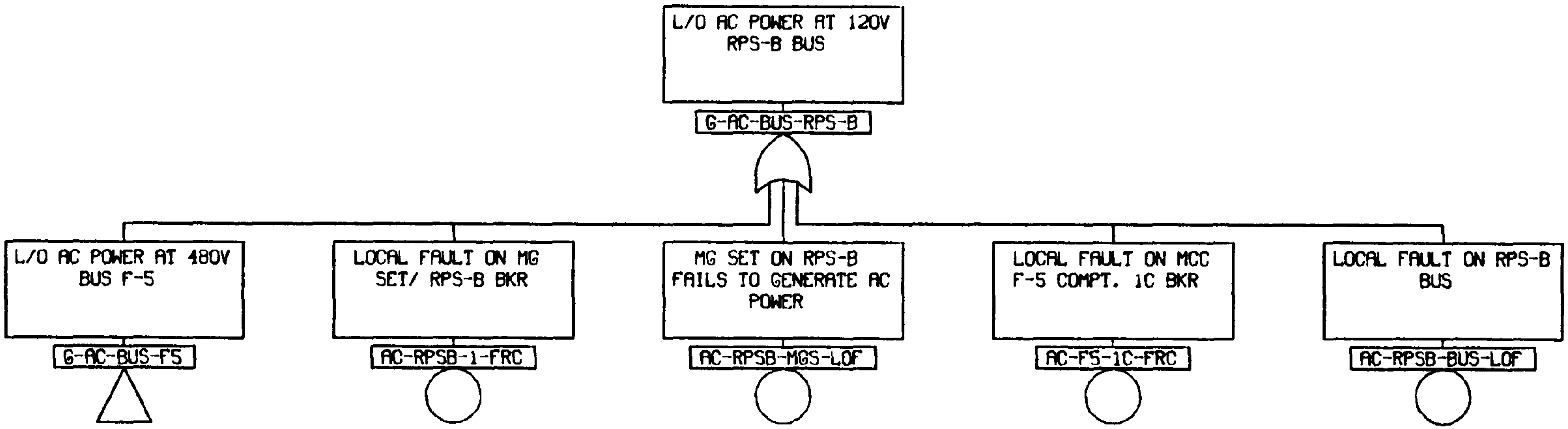

L/O 120V AC POWER AT VITAL AC BUS, CKT NO. 20
G-AC-BUS-VAC-20
L/O 120V AC POWER AT VITAL AC BUS
G-AC-BUS-VAC
L/O 120V AC POWER AT VITAL AC BUS, CKT NO. 26
G-AC-BUS-VAC-26
L/O 120V AC POWER AT VITAL AC BUS
G-AC-BUS-VAC


L/O 120V AC POWER AT VITAL AC BUS
G-AC-BUS-VAC
G-AC-BUS-VAC-20
G-AC-BUS-VAC-26
L/O AC POWER FROM VITAL AC AUTO BUS TRANSFER - ABT
G-AC-258
LOCAL FAULT ON 120V VITAL AC BUS
AC-VAC-BUS-LOF
L/O EMERGENCY AC SUPPLY TO VITAL AC
G-AC-259
L/O AC POWER FROM M-G/VITAL AC BKR - NORM. SUPPLY
G-AC-260
L/O AC POWER FROM IV-1/VITAL AC BKR - EMERG.
G-AC-261
VITAL AC ABT FAILS TO TRANSFER TO IV-1 TRANSFORMER
AC-VAC-ABT-LOF
L/O AC POWER FROM M-G SET - 120V AC NORM. SUPPLY
G-AC-262
LOCAL FAULT ON M-G/VITAL AC BKR
AC-MGVAC-NC-FRC
L/O AC POWER FROM IV-1 TRANSFORMER
G-AC-255
LOCAL FAULT ON IV-1/VITAL AC BKR
AC-IV-4-FRC
IV-1/VITAL AC BKR O.O.S. FOR TORM
AC-IV-4-TMO


L/O AC POWER FROM M-G SET - 120V AC NORM. SUPPLY
G-AC-262
G-AC-260
L/O POWER SOURCE TO M-G SET BKR - AC OR DC POWERED
G-AC-263
FAILURE OF M-G SET TO GENERATE AC POWER
AC-MG1-MGS-LOF
L/O AC POWER FROM E-3/M-G SET BKR - THRU M-G SET ABT
G-AC-264
LOSS OF DC POWER TO M-G SET
G-AC-265
L/O AC POWER AT 480V BUS E-5
G-AC-BUS-E5
LOCAL FAULT ON E-3/M-G SET BKR
AC-E5-10-FRC
M-G SET ABT FAILS TO TRANSFER TO DC POWER
AC-MG1-ABT-LOF
L/O DC POWER FROM 101-AB-3/ M-G SET BKR
G-AC-266
L/O DC POWER AT DC SW 101-AB-3 CKT NO. 1
G-DC-BUS-AB3
LOCAL FAULT ON 101-AB-3/ M-G SET BKR
DC-AB3-1-FRC
101-AB-3/ M-G SET BKR O.O.S. FOR TORM
DC-AB3-1-TMO

B.17-153


L/O AC POWER AT 120V RPS-A BUS
G-AC-BUS-RPS-A
L/O AC POWER AT 480V BUS E-5
G-AC-BUS-E5
LOCAL FAULT ON MG SET/ RPS-A BKR
AC-RPSA-1-FRC
MG SET ON RPS-A FAILS TO GENERATE AC POWER
AC-RPSA-MGS-LOF
LOCAL FAULT ON MCC E-5 COMPT. 1H BKR
AC-E5-1H-FRC
LOCAL FAULT ON RPS-A BUS
AC-RPSA-BUS-LOF


L/O AC POWER AT 120V RPS-B BUS
G-AC-BUS-RPS-B
L/O AC POWER AT 480V BUS F-5
G-AC-BUS-F5
LOCAL FAULT ON MG SET/ RPS-B BKR
AC-RPSB-1-FRC
MG SET ON RPS-B FAILS TO GENERATE AC POWER
AC-RPSB-MGS-LOF
LOCAL FAULT ON MCC F-5 COMPT. 1C BKR
AC-F5-1C-FRC
LOCAL FAULT ON RPS-B BUS
AC-RPSB-BUS-LOF

APPENDIX B.18

DC POWER SYSTEM

B.18.1 DC power System Description

B.18.1.1 Purpose

The DC power system provides a reliable, uninterruptible source of electric power to control circuits, motor control centers, radiation monitoring systems, and trip auxiliaries whether or not AC electric power is available.

B.18.1.2 Description and Configuration

The DC electric power system is composed of two systems, namely, the 125 volt DC station battery system and the ±24 volt dc system. Both of these systems fulfill two primary functions:

1) The distribution of power to uninterruptible loads

2) The sole source of power during a total loss of AC power (station blackout)

The DC power distribution consists of the following four subsystems:

1) 125 volt DC Continuous Buses (101A and 101B)
2) 125 volt DC Interruptible Bus (101AB-3)
3) 125 volt DC Motor Control Centers (101AB-1 and 101AB-2)
4) +24 volt DC Redundant "Channels"

The two continuous buses (101A and 101B) are each fed by a separate 125 volt DC battery and an associated battery charger. These buses are connected through manual bus transfers to the interruptible bus (101AB-3) and motor control centers (101AB-1 and 101AB-2) shown in Figure B.18-1. The remaining loads consist of vital control circuits connected to the continuous buses through manually operated breakers as shown in Table B.18-1.

The interruptible bus 101AB-3 may be fed by either continuous bus through a manual transfer switch. This transfer switch has a mechanical interlock which prevents the paralleling of bus 101A with bus 101B.

The interruptible bus supplies loads capable of withstanding the momentary transient due to a transfer from one continuous bus to another. The principal loads on 101AB-3 are shown in Table B.18-2.

The two motor control centers (101AB-1 and 101AB-2) have dual feeders with manual transfer; thus the failure of one feeder or its bus will not permanently disable the motor control centers.

The only exception to this transfer scheme is control power for the LPCI valves. The control power is transferred automatically to the available source to assure proper operation of the LPCI system. The auto transfer switches which transfer DC control power are designed so that a single failure cannot tie the two battery sources together. The transfer switch itself is mechanically interlocked allowing only one circuit to be energized at a time.

In addition, the switch is backed up by circuit breakers from each of the two DC sources.

The motor control centers furnish power to heavy loads (shown in Table B.18-2) which are connected only in an emergency condition. In general, these loads are motor loads such as an isolation valve.

The normal source of 125 volt DC power when AC is available is through the battery chargers, one of which is connected to each of the continuous buses with a third charger "floating" between them as shown in Figure B.18-1. In the event of a station blackout (loss of all AC), the DC load can be carried by the station batteries. These batteries are each sized to carry the connected load for 8 hours without recharging and have an individual capacity of 1950 ampere-hours.

The +24 volt DC system includes batteries, battery chargers, breakers, distribution panels and other auxiliary equipment. The system is arranged so that two batteries and two chargers make up one "channel" as shown in Figure B.18-2. The redundant "channels" are used to supply nominal ±24 volt DC power to contain instruments. The four batteries or any of the four battery chargers qualify as a valid source supplying the following instrument systems:

1) Neutron monitoring system, source range monitors and trip auxiliaries

2) Process radiation monitoring system and trip auxiliaries.

The normal source of +24 volt DC power when AC is available is through the battery chargers, one of which is connected to each of the four batteries. There are no ties or cross connections. Loss of either battery charger in one "channel" would lead to the loss of that "channel" when its associated battery was sufficiently discharged. The four 24 volt batteries have been sized to carry their required connected load for four hours without recharging. The batteries are sized 80 AH each.

B.18.1.3 System Interfaces

The DC power system is dependent only on 480V AC power being available to battery chargers 101A, 101B, and 101C from MCCs F-4, E-5 and F-5, respectively (see Figure 18.12.1). To avoid circular logic in the AC and DC power fault trees, because they are somewhat dependent on each other, it was assumed that the only source of DC power available was from the station batteries. Therefore, the three battery chargers and their associated 480 volt AC feeds have been deliberately left out of the DC power fault tree.

B.18.1.4 Instrumentation and Control

The DC power system is almost entirely manually operated, with the one exception of control power for the LPCI valves. All breakers and transfer zwitches are manually lined up as described previously in section B.18.1.2.

B.18.1.5 Testing

There are three primary tests of the two station batteries and associated equipment:

SP 780.1 Switchyard and Station Battery Weekly Test

The objective of this test is to measure the specific gravity and voltage of the pilot cells, the temperature of adjacent cells, and overall battery voltage. The test also verifies electrolyte level and compares the readings of the test with previous ones to determine if there is any battery degradation.

SP 780.2 Switchyard and Station Battery Quarterly Inspection

The objective of this inspection is to measure the specific gravity, temperature and voltage for all battery cells. This inspection is similar to SP 780.1 except that all cells are checked. Additionally, there is a check on minimum individual cell voltage vs. string average. The lowest individual cell voltage should be within 0.04 volts of the string average voltage.

SP 780.3 Load Test on Station Batteries

This test is performed once during each refuel outage (approximately once every 18 months). The objective of the test is to calculate the battery capacity in ampere hours by subjecting it to a known load over a period of about 8 hours. During the test, the battery is completely isolated from its respective bus and battery charger. Hourly surveillance is performed on each cell by measuring voltage and temperature. Cell connections are also checked to ensure they are not hot due to poor contact. Finally, all readings are compared with ones from previous tests to determine whether or not there is any significant battery deterioration.

B.18.1.6 Maintenance

Maintenance is performed on the DC power system as required. The station batteries have a scheduled annual maintenance program (MP 773.2) which inspects all components and cleans cell connecting straps and terminals if resistance readings exceed 65 ohms. Any unscheduled maintenance would come about as the result of poor test results from the three primary tests of section B.18.1.5. Maintenance Procedure MP 773.2 also spells out the measures to take based on failure of any of these tests.

B.18.1.7 Technical Specifications

The limiting conditions for operation affecting the DC power system are:

1) The reactor can not be made critical unless all station and switchyard 24 volt and 125 volt batteries and associated battery chargers are operable.

2) When the reactor is at power, if one of the two 125 volt or 24 volt battery systems becomes inoperable, then continued reactor operation is allowed for only seven days unless the system is made operable sooner.

The surveillance requirements for the DC power system refer specifically to the station batteries:

1) Every week the specific gravity and voltage of the pilot cell along with the temperature of adjacent cells and overall battery voltage is measured.

2) Every three months measurements of each cell voltage to the nearest 0.01 volt, specific gravity of each cell and temperature of every fifth cell are made.

3) At every refueling outage (approximately 18-month intervals) the station batteries are subjected to a performance test in accordance with the procedures described in Section 5.4 in IEEE Standard 450-1972, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Large Stationary Type Power Plant and Substation Lead Storage Batteries."

B.18.1.8 Operation

During normal operation of the 125 volt DC system, the two main buses 101A and 101B are energized from their respective batteries and battery chargers (see Figure B.18-1). The third battery charger (101C) is operable and on standby with its associated tie breakers to both main buses 101A and 101B open. The parallel tie breakers between buses 101A and 101B are open and will be alarmed in the control room if closed.

Motor control center 101AB-1 is energized by the manual transfer switch from the main bus 101A, and the alternate feed breaker on main bus 101B is open. Similarly, both motor control center 101AB-2 and interruptible bus 101AB-3 are energized by their respective manual transfer switches from bus 101B, and the alternate feed breakers on 101A are open.

All feed breakers on buses 101A, 101B, 101AB-1, 101AB-2 and 101AB-3 are closed except for spare breakers and emergency feeder breakers to the 4160 volt AC, 480 volt AC and 125 volt DC motor control centers (emergency feeder breakers are on buses 101A and 101B only). Closure of the emergency feeder breakers is allowed <u>only</u> when the emergency feed is required. The procedure calls for first opening the normal feeder breaker and then closing the emergency feeder breaker, thus preventing a crosstie between the two station batteries.

The 24 volt DC system is arranged so that two batteries and two chargers make up one "channel." One battery and its charger supplies a negative 24 volts and the other battery and its charger supplies a positive 24 volts. The connections are arranged so that both batteries utilize a common neutral or "return" leg. The transistor circuits which are used in the neutron monitoring and process radiation monitoring systems require both positive and negative voltage.

B.18.2 Analysis

B.18.2.1 Success/Failure Criteria

Successful operation of the DC power system requires the ability to feed all connected vital loads, whether or not AC power is available. Even with a total loss of AC power to the battery chargers, either battery must be able to sustain the full DC connected load for at least 8 hours.

System failure occurs whenever vital loads (DC power system top events) cannot be supplied with power.

B.18.2.2 Assumptions

Since the DC and AC power systems are interdependent, the assumption that AC power is unavailable was made in this analysis. This was necessary to avoid circular logic in the fault tree logic when the DC and AC power fault trees were merged.

In reality, both the chargers and the batteries are connected to the main DC buses 101A and 101B. Unless there is a total loss of AC power, the chargers will provide the DC power regardless of the presence of the batteries. However, in this analysis it is assumed that the only source of DC power is from the two station batteries.

The +24 volt battery system was left out of the DC power system fault tree since success or failure of this system does not affect core uncovery.

Table B.18-1

Loads on 125 Volt Continuous Buses

Bus	Load
101A	Turbine Emergency Bearing Oil Pump
"	4160V Bus Control Circuits
"	Diesel Generator Room
"	480V Bus Control Circuits
"	Control Room Distribution Panels (DC-11A2 normal supply and DC-11A1 emergency supply)
101B	Control Room Distribution Panels (DC-11A1 normal supply and DC-11A2 emergency supply)
"	4160V Bus Control Circuits
"	480V Bus Control Circuits
"	Diesel Generator Room

Table B.18-2

Principal Loads on the 125-Volt Interruptible Bus and Motor Control Centers

Bus	Load
101AB-3	Turbine Emergency Seal Oil Pump
"	Emergency Diesel Gen. Air Compressor
"	Fire Protection System Panels
"	Turbine Building Distribution Panel
"	Control Room Panel (VP-1F)
"	HVAC Control Panel
"	Vital AC M/G Set
101AB-1	Isolation Condenser MOV IC-3
"	LPCI Containment Spray Cooling System A
"	Isolation Condenser MOV IC-2
"	Emergency Reactor Recirc. Pump MG Set A
"	Shutdown Cooling System MOV's SD-2B and SD-4B
101AB-2	LPCI Containment Spray Cooling System B
"	Shutdown Cooling System MOV's SD-2A and SD-4A
"	Emergency Reactor Recirc Pump MG Set B

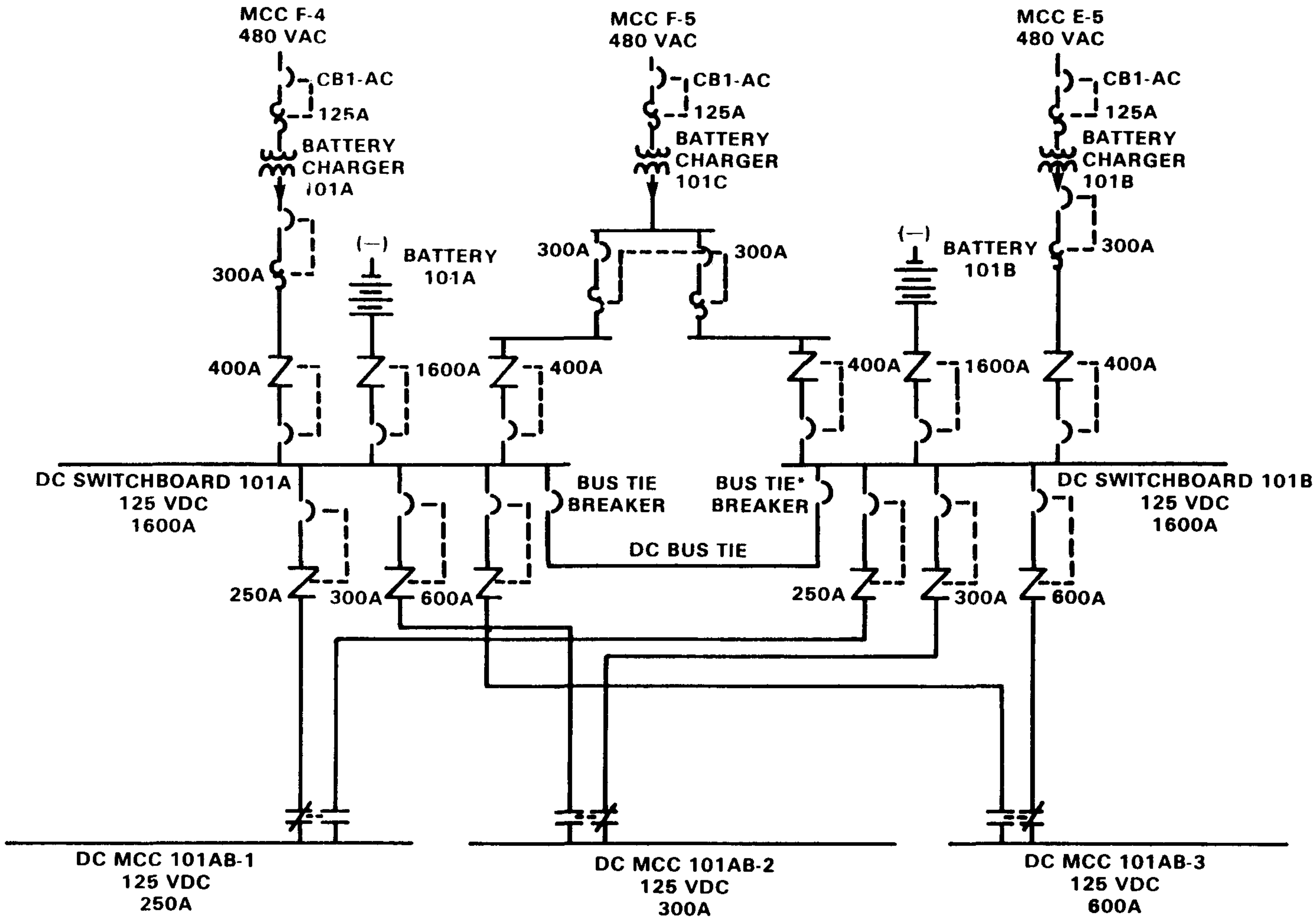


FIGURE B.18-1. MILLSTONE 1 D.C. POWER SYSTEM

*RECENTLY ADDED —

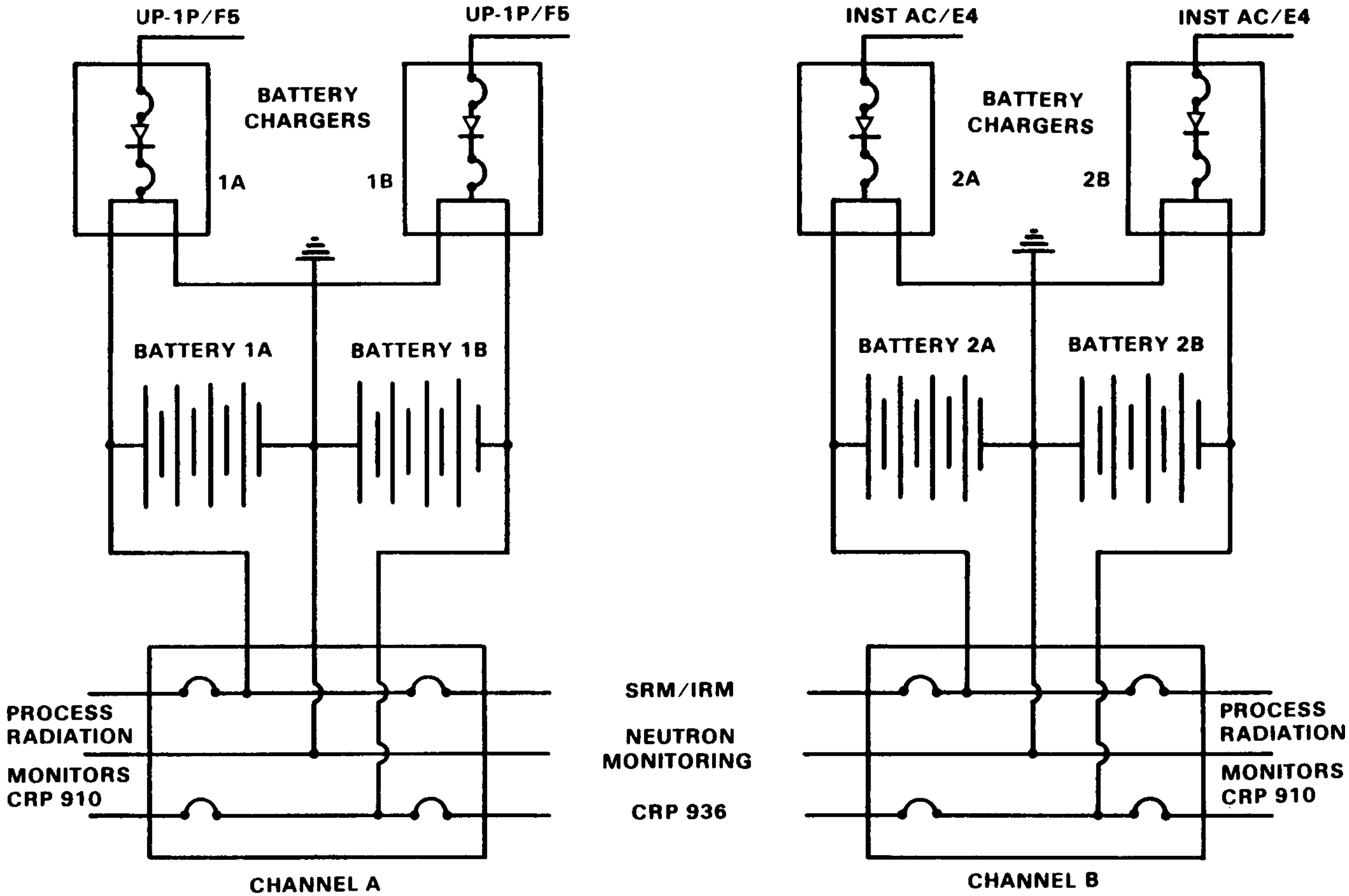


FIGURE B.18-2. 24 VOLT DC DISTRIBUTION SYSTEM

DC POWER SYSTEM

FAULT TREE AND FAULT SUMMARY SHEETS

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
DC-AB1-2D-FRC DC-AB1-5C-FRC DC-AB1-2E-FRC DC-AB1-8A-FRC DC-AB1-4C-FRC DC-AB1-3C-FRC DC-AB2-2D-FRC DC-AB2-3A-FRC DC-AB2-4D-FRC DC-AB2-3B-FRC DC-AB2-5C-FRC DC-AB2-4C-FRC DC-AB2-2E-FRC DC-AB2-6B-FRC DC-A-9-FRC DC-A-11-FRC DC-A-12-FRC DC-A-16-FRC DC-A-18-FRC DC-A-23-FRC DC-A-25-FRC DC-A-31-FRC DC-11A2-2-FRC DC-11A2-3-FRC DC-11A2-12-FRC DC-11A2-19-FRC DC-11A2-20-FRC DC-11A2-21-FRC DC-B-23-FRC DC-B-35-FRC DC-A-3-FRC DC-B-21-FRC	Circuit Breaker fails to remain closed	Prompt	A breaker failure would fail equipment whose operation is monitored	2.4E-5

MILLSTONE 1
SYSTEM DC
SHEET #1

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
DC-B-18-FRC DC-B-16-FRC DC-B-9-FRC	Circuit breaker fails to remain closed	Prompt	A breaker failure would fail equipment whose operation is monitored	2.4E-5
DC-B-7-FRC DC-B-29-FRC DC-11A1-2-FRC DC-11A1-3-FRC DC-11A1-7-FRC DC-11A1-8-FRC DC-11A1-13-FRC DC-11A1-22-FRC DC-11A1-25-FRC DC-11A1-26-FRC DC-A-2-FRC DC-B-34-FRC DC-A-35-FRC DC-B-2-FRC DC-A-34-FRC DC-B-1-FRC	Circuit Breaker fails to remain closed	Prompt	Breaker failure fails equipment that is monitored	2.4E-5
DC-TIEBKR-OPC	Operator Closes Tie Breaker	Annunciated immediately in control room	Procedures OP344A Section 7.7 allows tie breaker closure on failure of any two battery chargers.	3E-3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
DC-AB1-2D-TMO	Circuit Breaker open for test or maintenance	Prompt		1E-6
DC-AB1-5C-TMO				
DC-AB1-2E-TMO				
DC-AB1-8A-TMO				
DC-AB1-4C-TMO				
DC-AB1-3C-TMO				
DC-AB2-2D-TMO				
DC-AB2-3A-TMO				
DC-AB2-4D-TMO				
DC-AB2-3B-TMO				
DC-AB2-5C-TMO				
DC-AB2-4C-TMO				
DC-AB2-2E-TMO				
DC-AB2-6B-TMO				
DC-A-9-TMO				
DC-A-11-TMO				
DC-A-12-TMO				
DC-A-16-TMO				
DC-A-18-TMO				
DC-A-23-TMO				
DC-A-25-TMO				
DC-A-31-TMO				
DC-11A2-2-TMO				
DC-11A2-3-TMO				
DC-11A2-12-TMO				
DC-11A2-19-TMO				
DC-11A2-2Ø-TMO				
DC-11A2-21-TMO				
DC-B-23-TMO				
DC-B-21-TMO				
DC-B-18-TMO				

MILLSTONE 1
SYSTEM DC
SHEET #3

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
DC-B-16-TMO DC-B-9-TMO DC-B-7-TMO DC-B-29-TMO DC-11A1-2-TMO DC-11A1-3-TMO DC-11A1-7-TMO DC-11A1-8-TMO DC-11A1-13-TMO DC-11A1-22-TMO DC-11A1-25-TMO DC-11A1-26-TMO	Circuit Breaker open for test or maintenance	Prompt		1E-6
DC-B-ENRGZ-AB1 DC-A-ENRGZ-AB2 DC-A-ENRGZ-AB3	Status of Transfer Switch		Transfer switch cannot be changed while reactor is operating without tripping recirculation pumps.	.9999
DC-AB1-BUS-LOF DC-AB2-BUS-LOF DC-A-BUS-LOF DC-B-BUS-LOF DC-AB3-BUS-LOF	Short to return on Bus	Fault annunciated immediately	-loss of MCC Bus causes recirc. pump trip -loss of DC switchboard Bus causes alarms on charger and battery output.	2.64E-5 3.12E-5 5.04E-5 4.8E-5 5.6E-5
DC-AB1-BUS-UCF DC-AB2-BUS-UCF DC-AB3-BUS-UCF	Uncleared fault on bus	Fault annunciated immediately	loss of MCC Bus will trip reactor recirculation pump.	1.32E-5 1.56E-5 2.9E-5

FAULT SUMMARY SHEETS

EVENT	DESCRIPTION	DETECTION INTERVAL	COMMENTS	UNAVAILABILITY
DC-A-BATT-TMO DC-B-BATT-TMO	Station battery out of service for test or maintenance	One week	Tech. Specs. allow operation for 7 days with Battery out of service for test or maintenance	5.04E-4
DC-A-BATT-LOF DC-B-BATT-LOF	Loss of battery function	Weekly	Specific gravity check is overly conservative and performed weekly	2.5E-4
DC-AB1-TR-FRC DC-AB2-TR-FRC DC-AB3-TR-FRC	Bus transfer switch fails to remain closed	Prompt	Loss of Power immediately noted in control room	2.4E-5

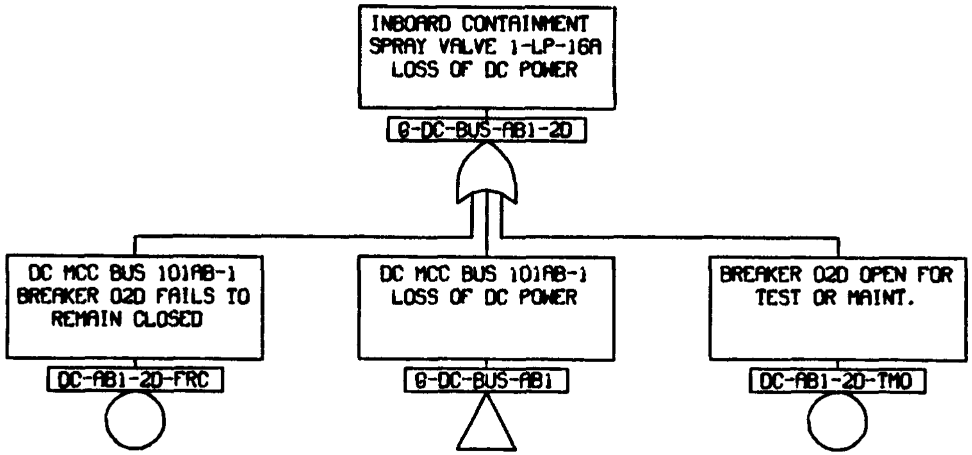
DC POWER FAULT TREE PAGE INDEX

GATE NAME	DEFINED ON PAGE	TRANSFERS TO PAGE(S)
G-DC-6	DC-36	DC-35
G-DC-7	DC-36	DC-35
G-DC-13	DC-38	DC-37
G-DC-14	DC-38	DC-37
G-DC-20	DC-40	DC-39
G-DC-21	DC-40	DC-39
G-DC-24	DC-42	DC-41
G-DC-27	DC-43	DC-41
G-DC-30	DC-44	DC-42
G-DC-31	DC-45	DC-43
G-DC-BUS-11A1-2	DC-26	--
G-DC-BUS-11A1-3	DC-27	--
G-DC-BUS-11A1-7	DC-33	--
G-DC-BUS-11A1-8	DC-28	--
G-DC-BUS-11A1-13	DC-29	--
G-DC-BUS-11A1-19	DC-34	--
G-DC-BUS-11A1-22	DC-30	--
G-DC-BUS-11A1-25	DC-31	--
G-DC-BUS-11A1-26	DC-32	--
G-DC-BUS-11A2-2	DC-13	--
G-DC-BUS-11A2-3	DC-14	--
G-DC-BUS-11A2-6	DC-21	--
G-DC-BUS-11A2-8	DC-19	--
G-DC-BUS-11A2-12	DC-15	--
G-DC-BUS-11A2-16	DC-20	--
G-DC-BUS-11A2-19	DC-16	--
G-DC-BUS-11A2-20	DC-17	--
G-DC-BUS-11A2-21	DC-18	--
G-DC-BUS-11A2-23	DC-22	--
G-DC-BUS-A	DC-41	DC-9-22,35,37,39
G-DC-BUS-B	DC-41	DC-23-35,37,39
G-DC-BUS-A-9	DC-9	--
G-DC-BUS-A-11	DC-9	--
G-DC-BUS-A-12	DC-10	--
G-DC-BUS-A-16	DC-10	--
G-DC-BUS-A-18	DC-11	--
G-DC-BUS-A-21	DC-12	--
G-DC-BUS-A-23	DC-11	--
G-DC-BUS-A-25	DC-12	--
G-DC-BUS-B-7	DC-25	--
G-DC-BUS-B-9	DC-25	--
G-DC-BUS-B-16	DC-24	--
G-DC-BUS-B-18	DC-24	--
G-DC-BUS-B-21	DC-23	--
G-DC-BUS-B-23	DC-23	--
G-DC-BUS-AB1	DC-35	DC-1,DC-2,DC-3,DC-4,
G-DC-BUS-AB2	DC-37	DC-5,DC-6,DC-7,DC-8
G-DC-BUS-AB3	DC-39	--

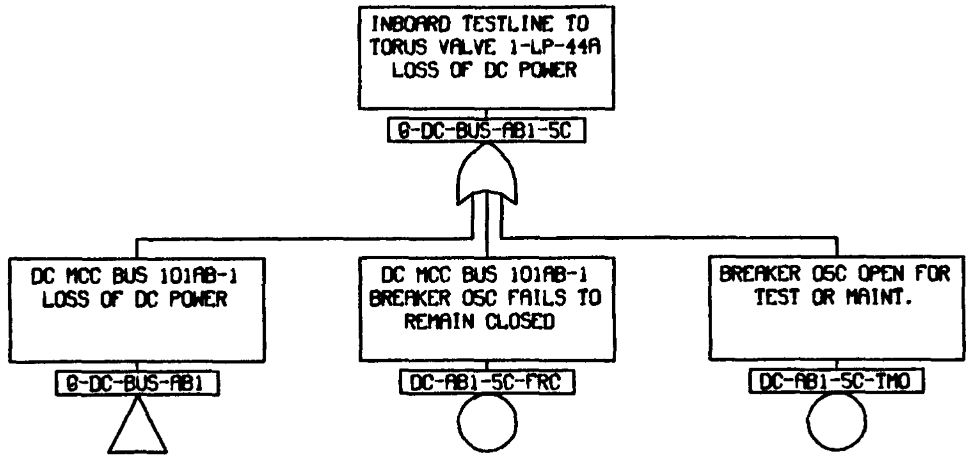
DC POWER FAULT TREE PAGE INDEX (Cont.)

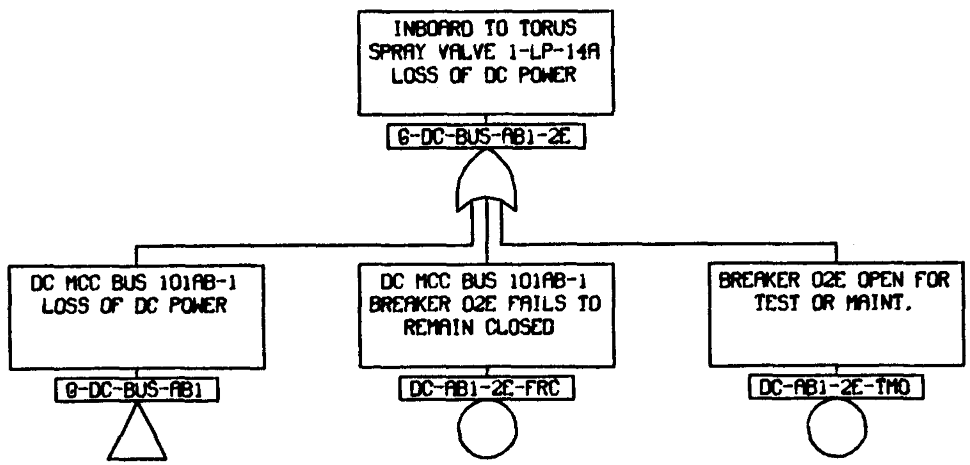
GATE NAME	DEFINED ON PAGE	TRANSFERS TO PAGE(S)
G-DC-BUS-AB1-2D	DC-1	--
G-DC-BUS-AB1-2E	DC-2	--
G-DC-BUS-AB1-3A	DC-4	--
G-DC-BUS-AB1-3C	DC-4	--
G-DC-BUS-AB1-4C	DC-3	--
G-DC-BUS-AB1-5C	DC-2	--
G-DC-BUS-AB1-8A	DC-3	--
G-DC-BUS-AB2-2D	DC-5	--
G-DC-BUS-AB2-2E	DC-8	--
G-DC-BUS-AB2-3A	DC-5	--
G-DC-BUS-AB2-3B	DC-6	--
G-DC-BUS-AB2-4C	DC-7	--
G-DC-BUS-AB2-4D	DC-6	--
G-DC-BUS-AB2-5C	DC-7	--
G-DC-BUS-AB2-6B	DC-8	--

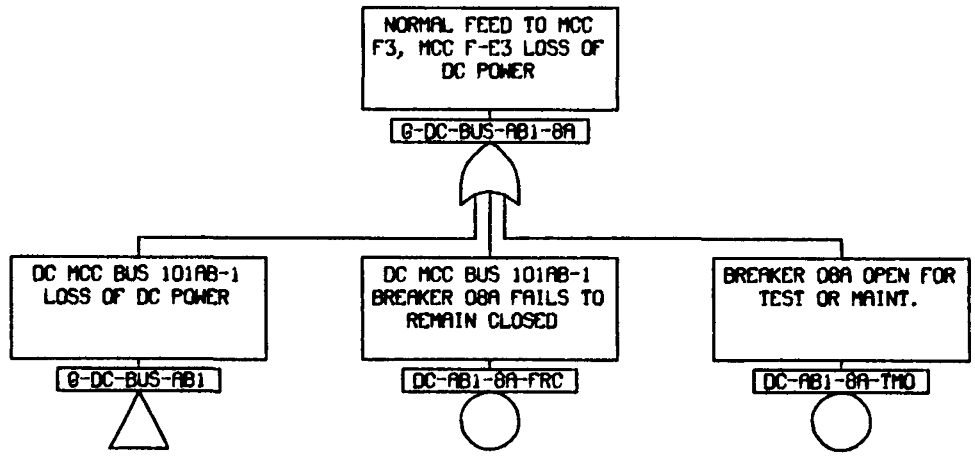
B.18-19

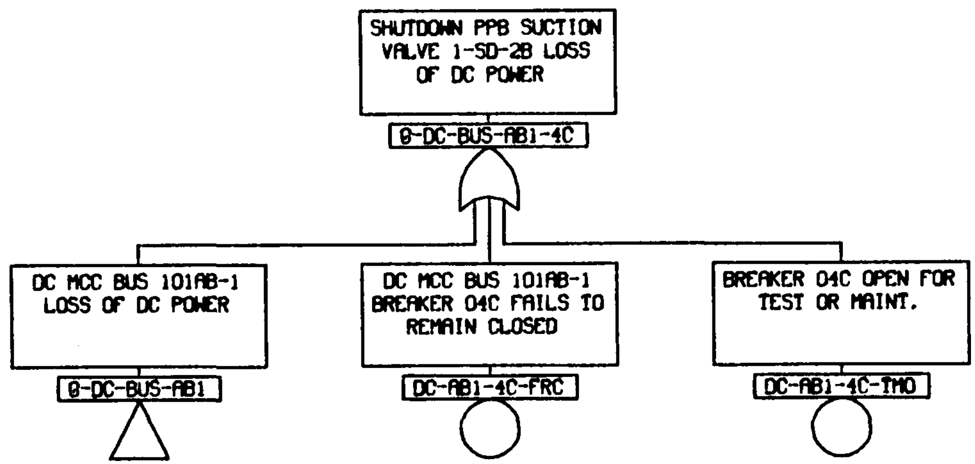


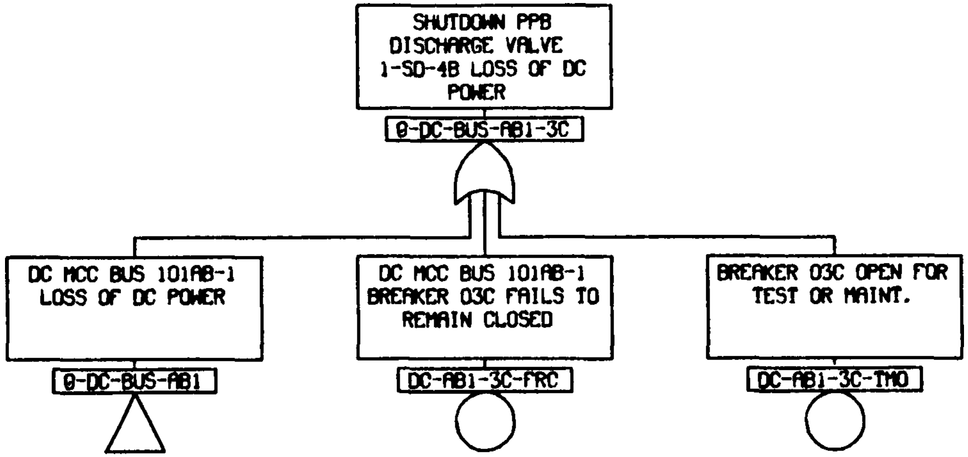
INBOARD CONTAINMENT SPRAY VALVE 1-LP-16A LOSS OF DC POWER
G-DC-BUS-AB1-2D
DC MCC BUS 101AB-1 BREAKER 02D FAILS TO REMAIN CLOSED
DC-AB1-2D-FRC
DC MCC BUS 101AB-1 LOSS OF DC POWER
G-DC-BUS-AB1
BREAKER 02D OPEN FOR TEST OR MAINT.
DC-AB1-2D-TMO

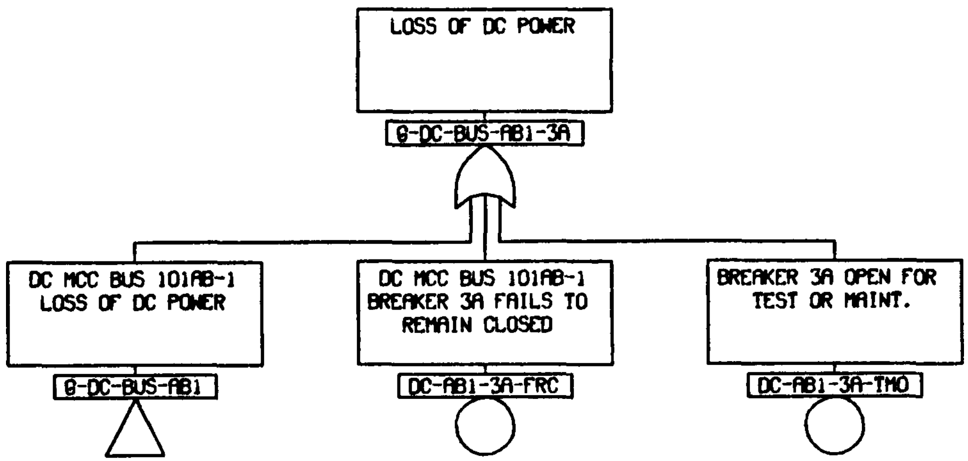

INBOARD TESTLINE TO TORUS VALVE 1-LP-44A LOSS OF DC POWER
G-DC-BUS-AB1-5C
DC MCC BUS 101AB-1 LOSS OF DC POWER
G-DC-BUS-AB1
DC MCC BUS 101AB-1 BREAKER 05C FAILS TO REMAIN CLOSED
DC-AB1-5C-FRC
BREAKER 05C OPEN FOR TEST OR MAINT.
DC-AB1-5C-TMO

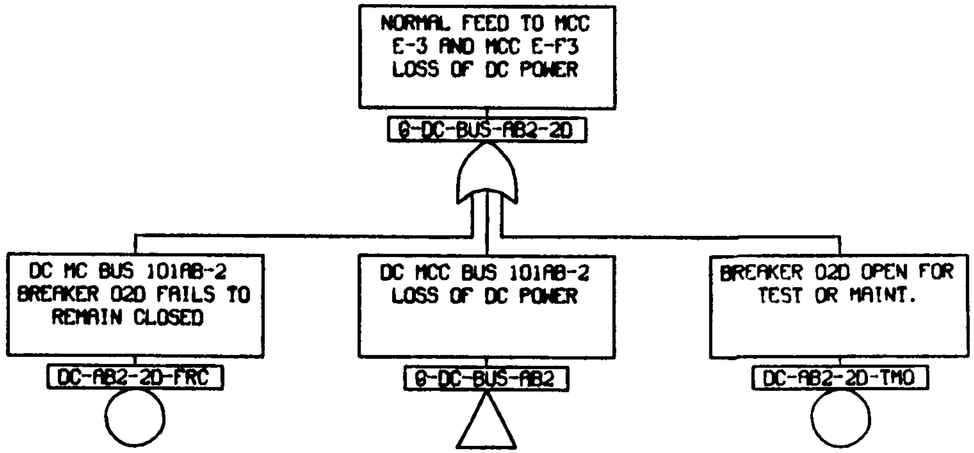

INBOARD TO TORUS SPRAY VALVE 1-LP-14A LOSS OF DC POWER
G-DC-BUS-AB1-2E
DC MCC BUS 101AB-1 LOSS OF DC POWER
G-DC-BUS-AB1
DC MCC BUS 101AB-1 BREAKER 02E FAILS TO REMAIN CLOSED
DC-AB1-2E-FRC
BREAKER 02E OPEN FOR TEST OR MAINT.
DC-AB1-2E-TMO

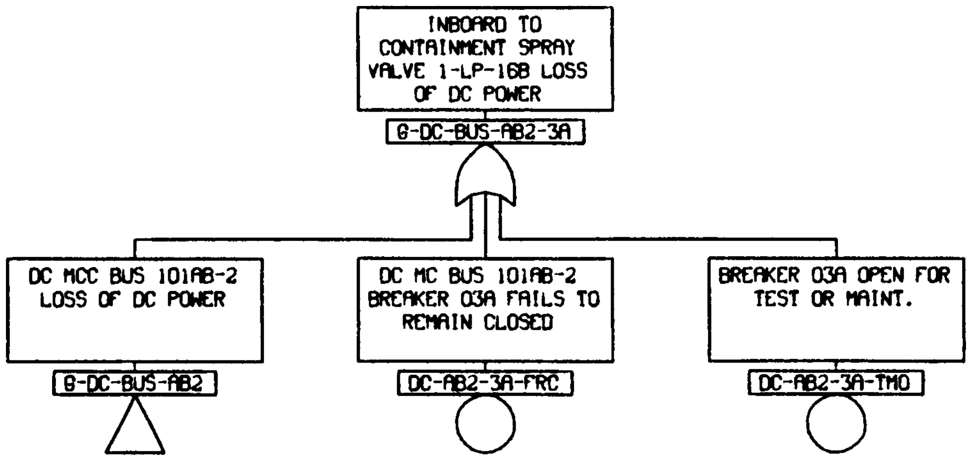

NORMAL FEED TO MCC F3, MCC F-E3 LOSS OF DC POWER
G-DC-BUS-AB1-8A
DC MCC BUS 101AB-1 LOSS OF DC POWER
G-DC-BUS-AB1
DC MCC BUS 101AB-1 BREAKER 08A FAILS TO REMAIN CLOSED
DC-AB1-8A-FRC
BREAKER 08A OPEN FOR TEST OR MAINT.
DC-AB1-8A-TMO


SHUTDOWN PPB SUCTION VALVE 1-SD-2B LOSS OF DC POWER
G-DC-BUS-AB1-4C
DC MCC BUS 101AB-1 LOSS OF DC POWER
G-DC-BUS-AB1
DC MCC BUS 101AB-1 BREAKER 04C FAILS TO REMAIN CLOSED
DC-AB1-4C-FRC
BREAKER 04C OPEN FOR TEST OR MAINT.
DC-AB1-4C-TMO

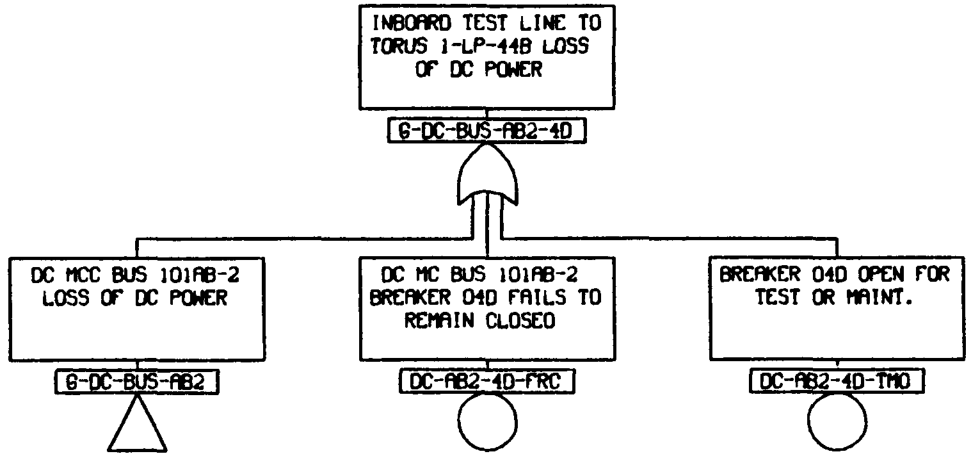

SHUTDOWN PPB DISCHARGE VALVE 1-SD-4B LOSS OF DC POWER
@-DC-BUS-AB1-3C
DC MCC BUS 101AB-1 LOSS OF DC POWER
@-DC-BUS-AB1
DC MCC BUS 101AB-1 BREAKER 03C FAILS TO REMAIN CLOSED
DC-AB1-3C-FRC
BREAKER 03C OPEN FOR TEST OR MAINT.
DC-AB1-3C-TMO

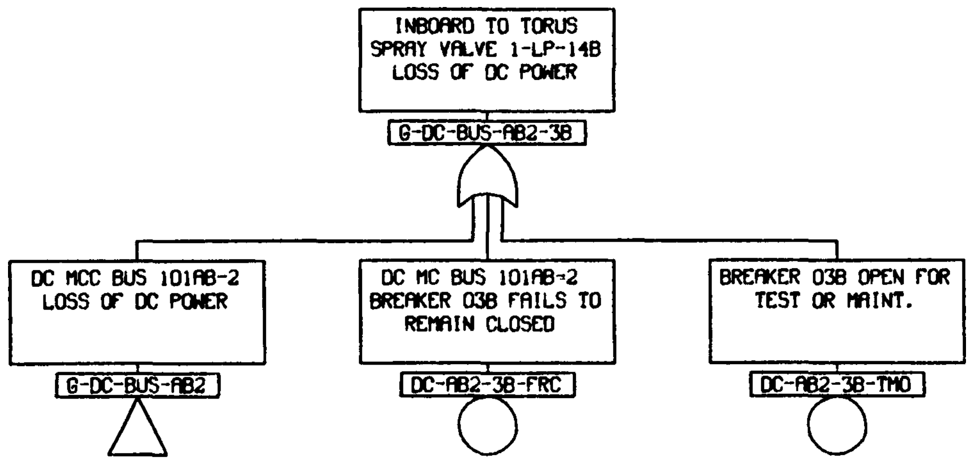

LOSS OF DC POWER
@-DC-BUS-AB1-3A
DC MCC BUS 101AB-1 LOSS OF DC POWER
@-DC-BUS-AB1
DC MCC BUS 101AB-1 BREAKER 3A FAILS TO REMAIN CLOSED
DC-AB1-3A-FRC
BREAKER 3A OPEN FOR TEST OR MAINT.
DC-AB1-3A-TMO

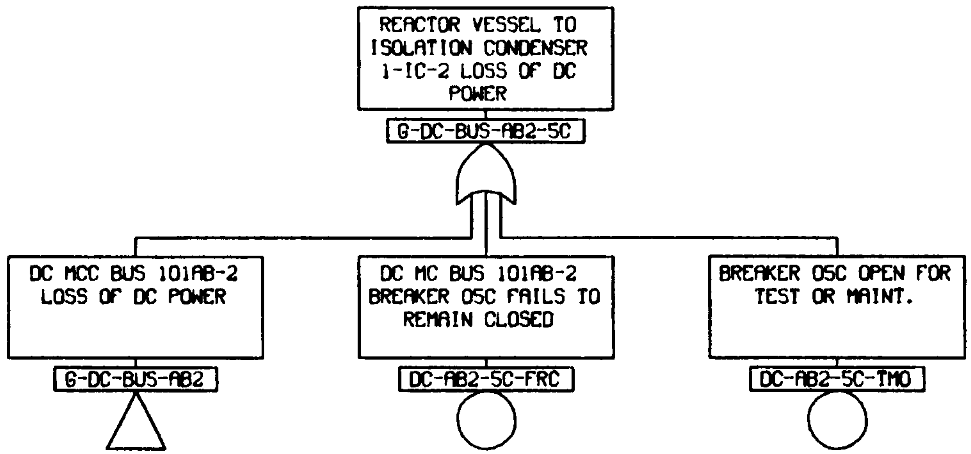

NORMAL FEED TO MCC E-3 AND MCC E-F3 LOSS OF DC POWER
G-DC-BUS-AB2-2D
DC MC BUS 101AB-2 BREAKER 02D FAILS TO REMAIN CLOSED
DC-AB2-2D-FRC
DC MCC BUS 101AB-2 LOSS OF DC POWER
G-DC-BUS-AB2
BREAKER 02D OPEN FOR TEST OR MAINT.
DC-AB2-2D-TMO

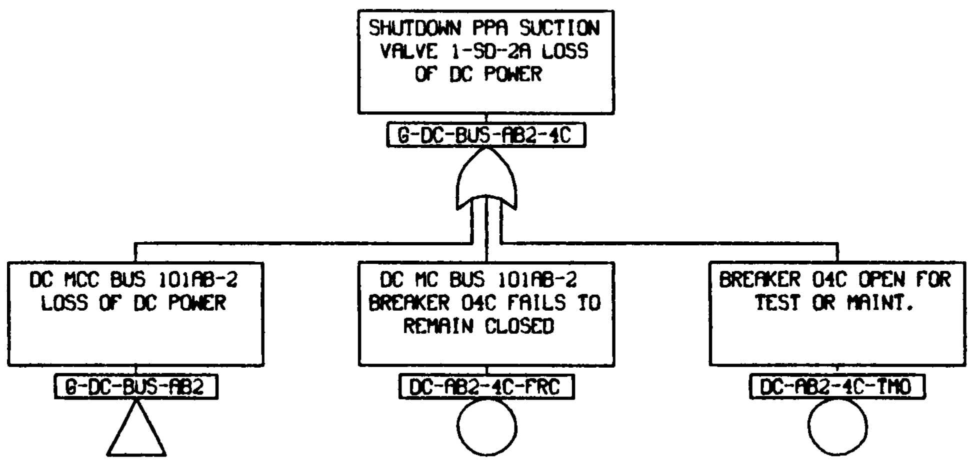

INBOARD TO CONTAINMENT SPRAY VALVE 1-LP-16B LOSS OF DC POWER
G-DC-BUS-AB2-3A
DC MCC BUS 101AB-2 LOSS OF DC POWER
G-DC-BUS-AB2
DC MC BUS 101AB-2 BREAKER 03A FAILS TO REMAIN CLOSED
DC-AB2-3A-FRC
BREAKER 03A OPEN FOR TEST OR MAINT.
DC-AB2-3A-TMO

DC-5

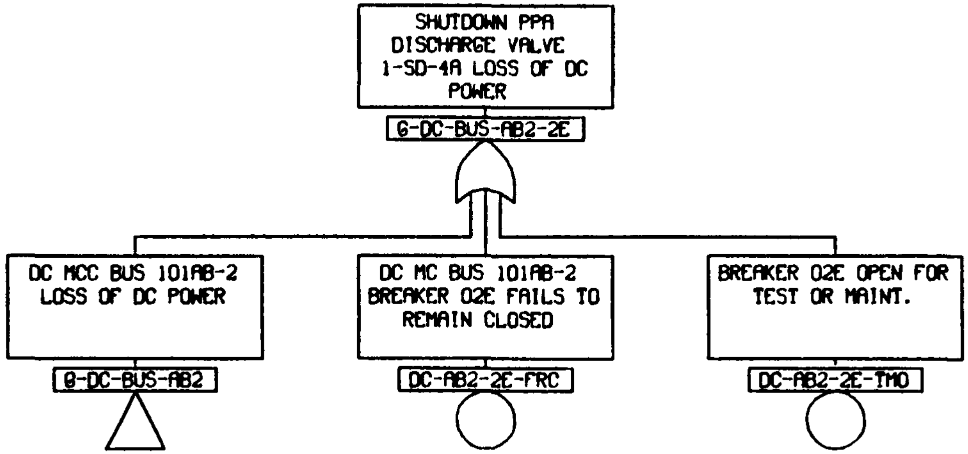

INBOARD TEST LINE TO TORUS 1-LP-44B LOSS OF DC POWER
G-DC-BUS-AB2-4D
DC MCC BUS 101AB-2 LOSS OF DC POWER
G-DC-BUS-AB2
DC MC BUS 101AB-2 BREAKER 04D FAILS TO REMAIN CLOSED
DC-AB2-4D-FRC
BREAKER 04D OPEN FOR TEST OR MAINT.
DC-AB2-4D-TMO

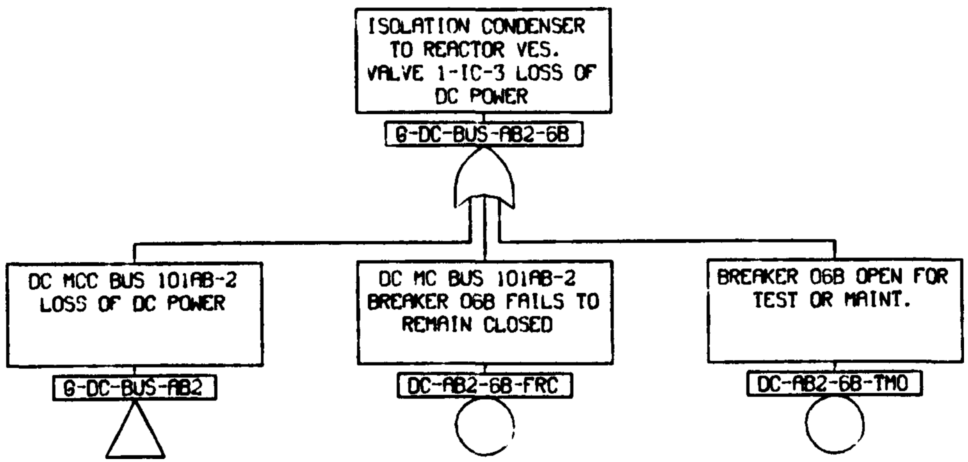

INBOARD TO TORUS SPRAY VALVE 1-LP-14B LOSS OF DC POWER
G-DC-BUS-AB2-3B
DC MCC BUS 101AB-2 LOSS OF DC POWER
G-DC-BUS-AB2
DC MC BUS 101AB-2 BREAKER 03B FAILS TO REMAIN CLOSED
DC-AB2-3B-FRC
BREAKER 03B OPEN FOR TEST OR MAINT.
DC-AB2-3B-TMO

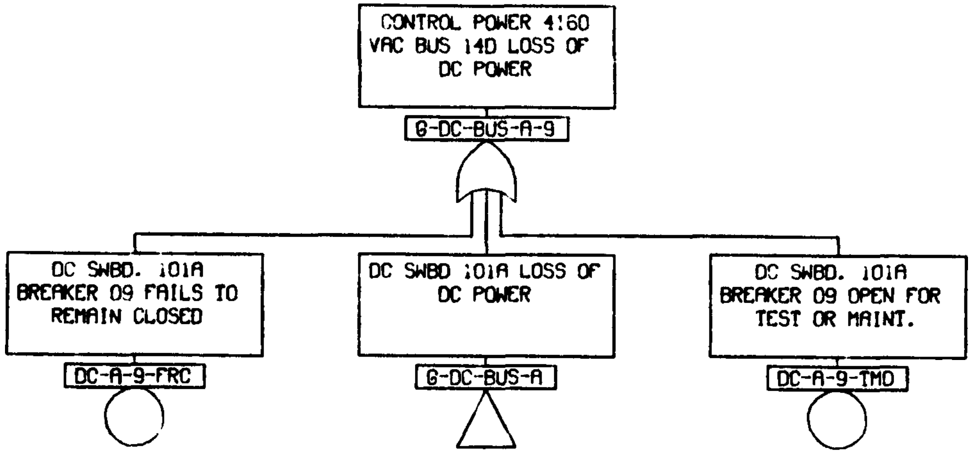

REACTOR VESSEL TO ISOLATION CONDENSER 1-IC-2 LOSS OF DC POWER
G-DC-BUS-AB2-5C
DC MCC BUS 101AB-2 LOSS OF DC POWER
G-DC-BUS-AB2
DC MC BUS 101AB-2 BREAKER 05C FAILS TO REMAIN CLOSED
DC-AB2-5C-FRC
BREAKER 05C OPEN FOR TEST OR MAINT.
DC-AB2-5C-TMO

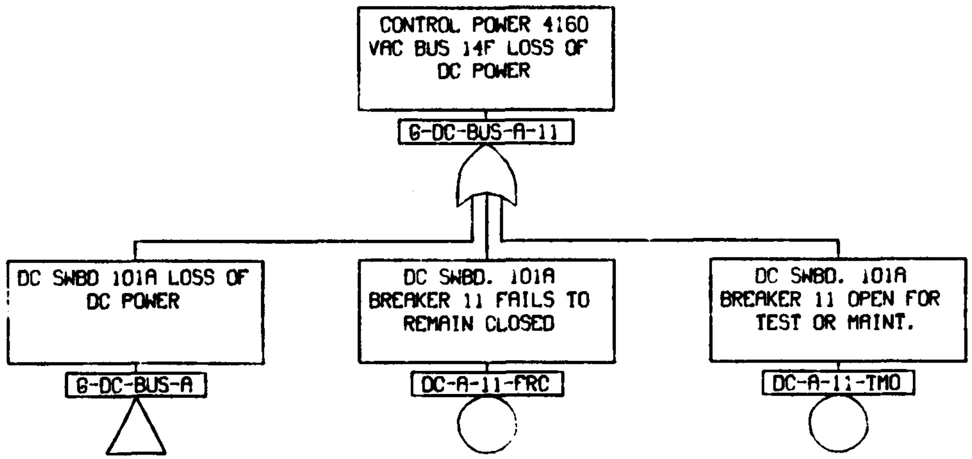

SHUTDOWN PPA SUCTION VALVE 1-SD-2A LOSS OF DC POWER
G-DC-BUS-AB2-4C
DC MCC BUS 101AB-2 LOSS OF DC POWER
G-DC-BUS-AB2
DC MC BUS 101AB-2 BREAKER 04C FAILS TO REMAIN CLOSED
DC-AB2-4C-FRC
BREAKER 04C OPEN FOR TEST OR MAINT.
DC-AB2-4C-TMO

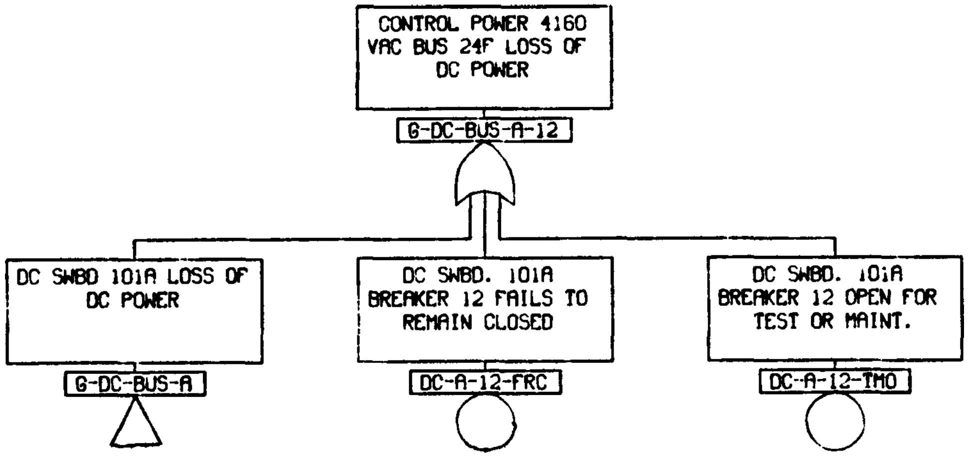
DC-7

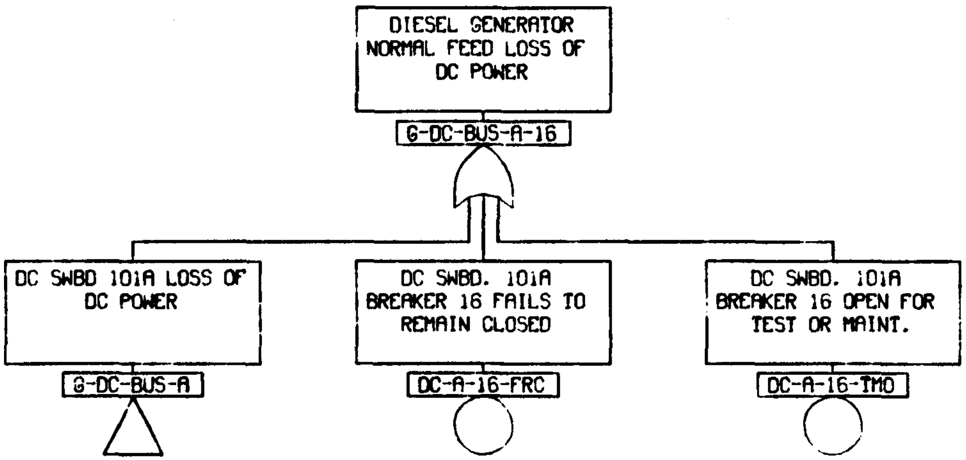

SHUTDOWN PPA DISCHARGE VALVE 1-SD-4A LOSS OF DC POWER
G-DC-BUS-AB2-2E
DC MCC BUS 101AB-2 LOSS OF DC POWER
G-DC-BUS-AB2
DC MC BUS 101AB-2 BREAKER 02E FAILS TO REMAIN CLOSED
DC-AB2-2E-FRC
BREAKER 02E OPEN FOR TEST OR MAINT.
DC-AB2-2E-TMO

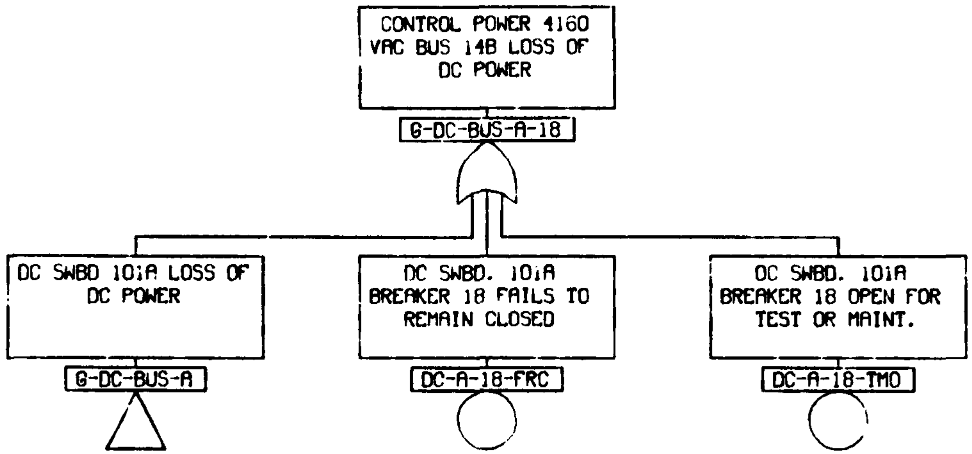

ISOLATION CONDENSER TO REACTOR VES. VALVE 1-IC-3 LOSS OF DC POWER
G-DC-BUS-AB2-6B
DC MCC BUS 101AB-2 LOSS OF DC POWER
G-DC-BUS-AB2
DC MC BUS 101AB-2 BREAKER 06B FAILS TO REMAIN CLOSED
DC-AB2-6B-FRC
BREAKER 06B OPEN FOR TEST OR MAINT.
DC-AB2-6B-TMO

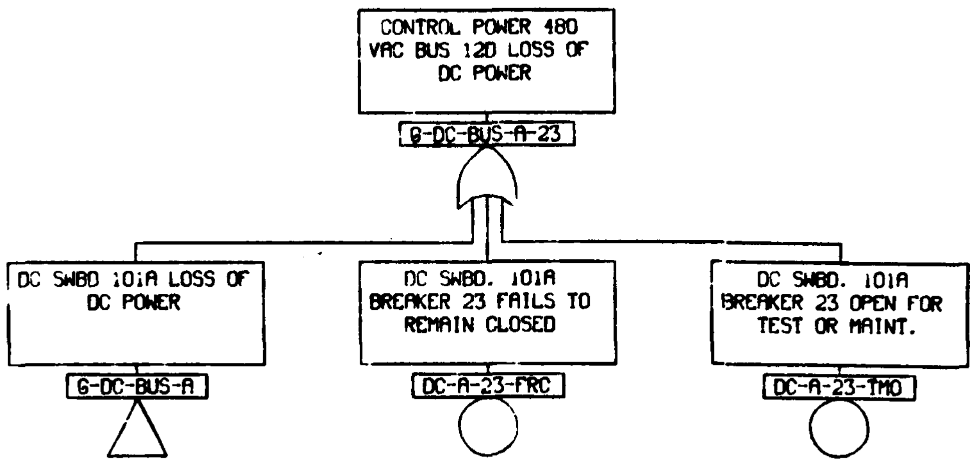

CONTROL POWER 4160 VAC BUS 14D LOSS OF DC POWER
G-DC-BUS-A-9
DC SWBD. 101A BREAKER 09 FAILS TO REMAIN CLOSED
DC-A-9-FRC
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD. 101A BREAKER 09 OPEN FOR TEST OR MAINT.
DC-A-9-TMO

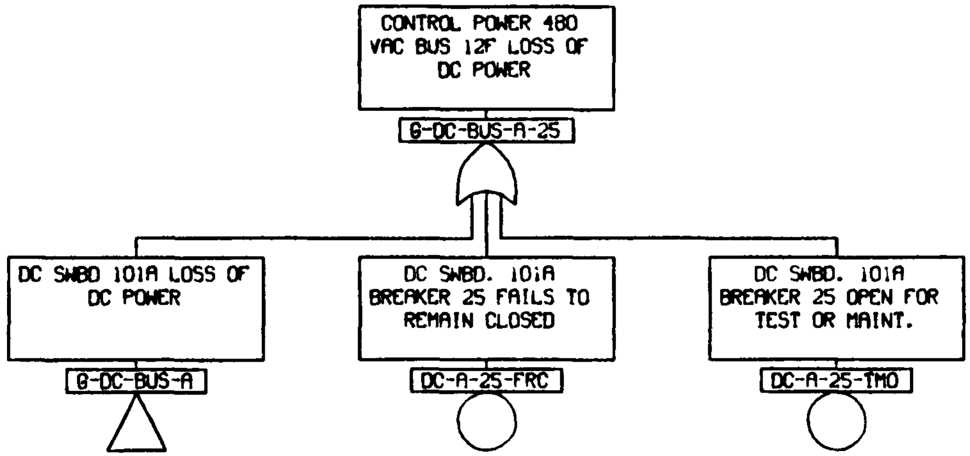

CONTROL POWER 4160 VAC BUS 14F LOSS OF DC POWER
G-DC-BUS-A-11
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD. 101A BREAKER 11 FAILS TO REMAIN CLOSED
DC-A-11-FRC
DC SWBD. 101A BREAKER 11 OPEN FOR TEST OR MAINT.
DC-A-11-TMO

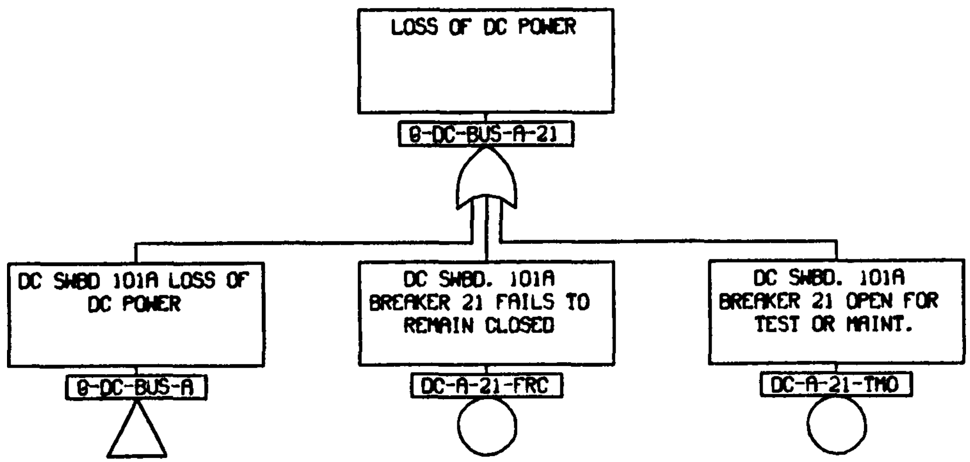

CONTROL POWER 4160 VAC BUS 24F LOSS OF DC POWER
G-DC-BUS-A-12
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD. 101A BREAKER 12 FAILS TO REMAIN CLOSED
DC-A-12-FRC
DC SWBD. 101A BREAKER 12 OPEN FOR TEST OR MAINT.
DC-A-12-TMO

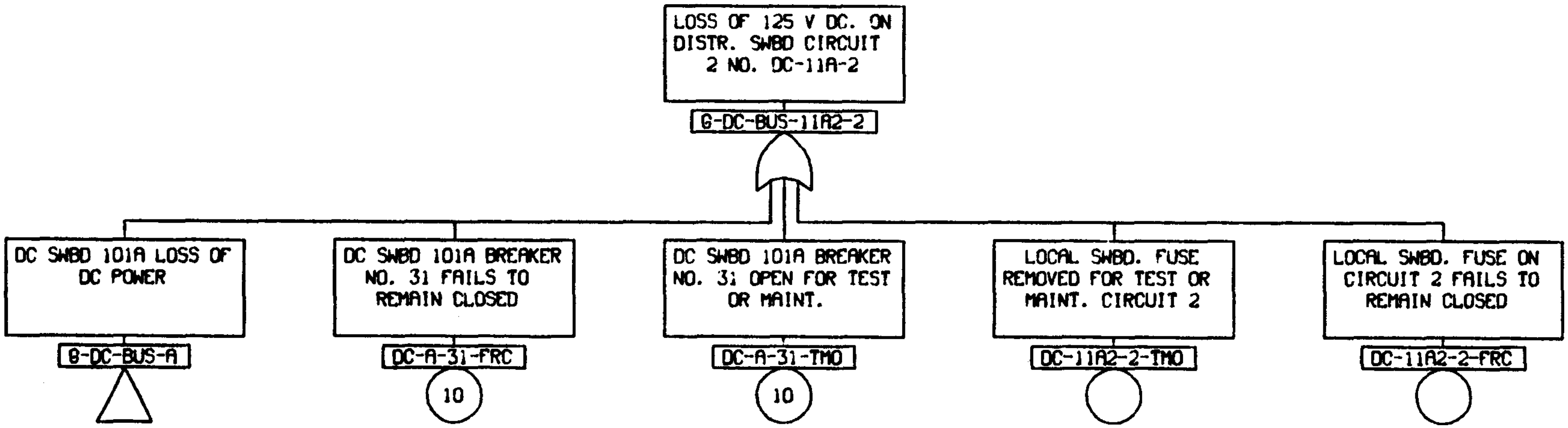

DIESEL GENERATOR NORMAL FEED LOSS OF DC POWER
G-DC-BUS-A-16
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD. 101A BREAKER 16 FAILS TO REMAIN CLOSED
DC-A-16-FRC
DC SWBD. 101A BREAKER 16 OPEN FOR TEST OR MAINT.
DC-A-16-TMO

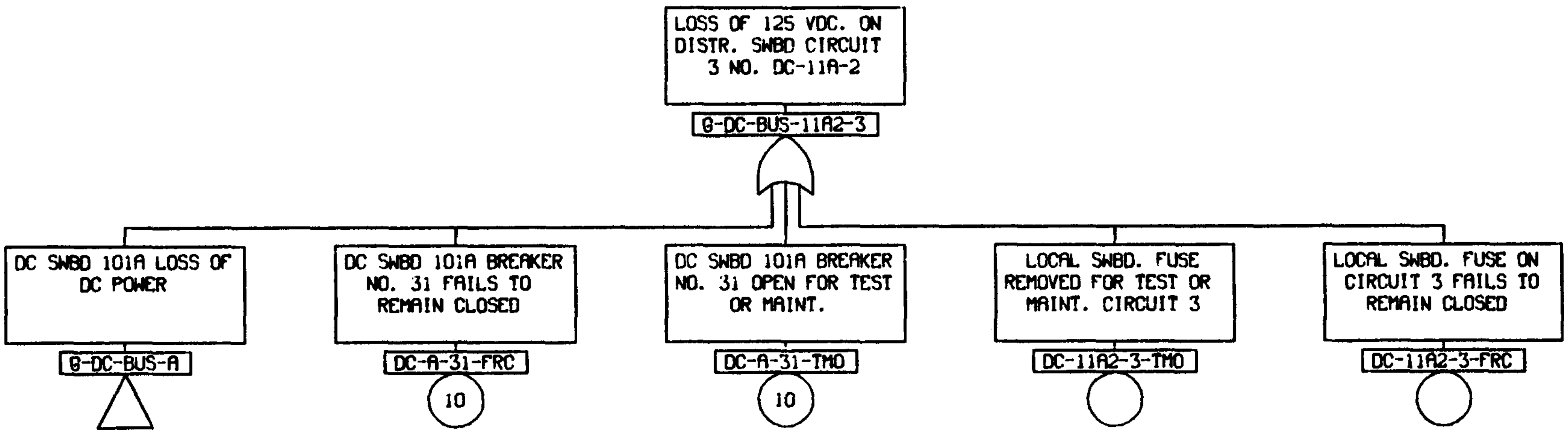

CONTROL POWER 4160 VAC BUS 14B LOSS OF DC POWER
G-DC-BUS-A-18
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD. 101A BREAKER 18 FAILS TO REMAIN CLOSED
DC-A-18-FRC
DC SWBD. 101A BREAKER 18 OPEN FOR TEST OR MAINT.
DC-A-18-TMO

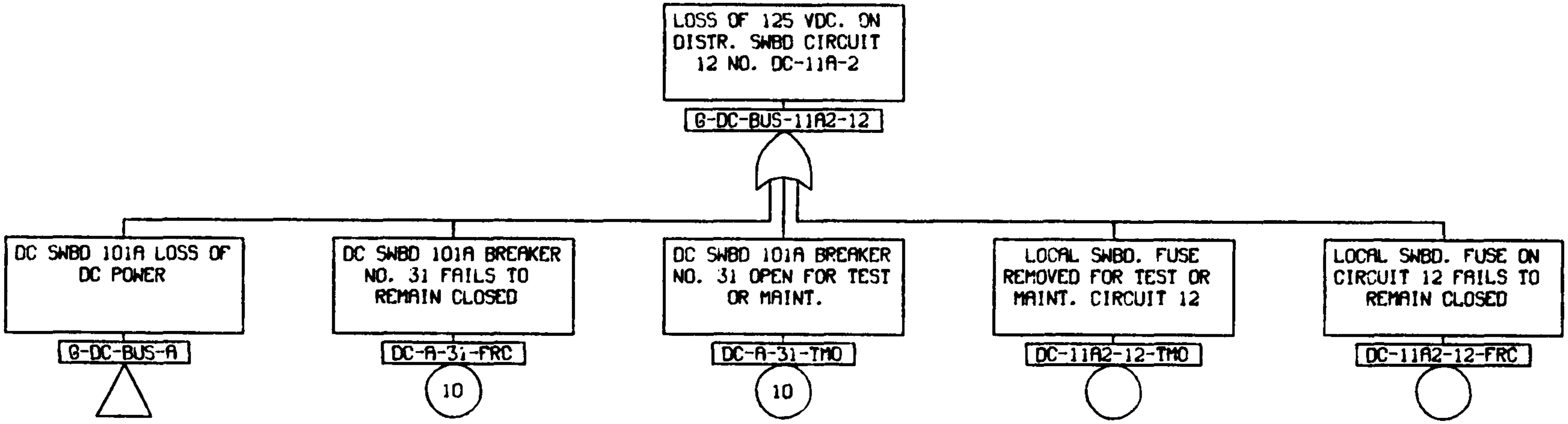

CONTROL POWER 480 VAC BUS 12D LOSS OF DC POWER
G-DC-BUS-A-23
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD. 101A BREAKER 23 FAILS TO REMAIN CLOSED
DC-A-23-FRC
DC SWBD. 101A BREAKER 23 OPEN FOR TEST OR MAINT.
DC-A-23-TMO

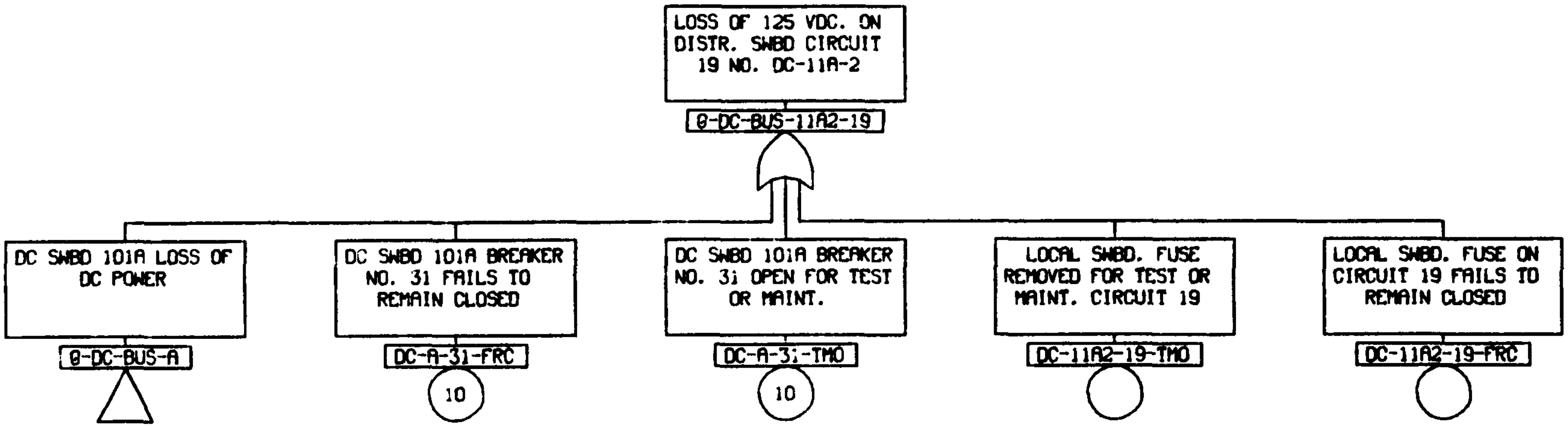

CONTROL POWER 480 VAC BUS 12F LOSS OF DC POWER
G-DC-BUS-A-25
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD. 101A BREAKER 25 FAILS TO REMAIN CLOSED
DC-A-25-FRC
DC SWBD. 101A BREAKER 25 OPEN FOR TEST OR MAINT.
DC-A-25-TMO

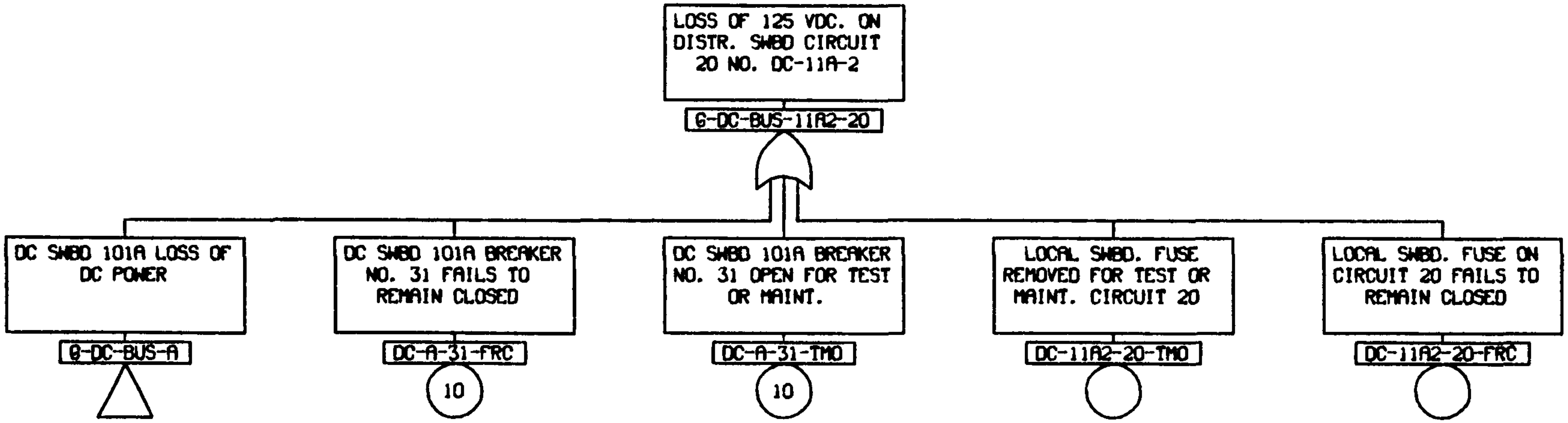

LOSS OF DC POWER
G-DC-BUS-A-21
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD. 101A BREAKER 21 FAILS TO REMAIN CLOSED
DC-A-21-FRC
DC SWBD. 101A BREAKER 21 OPEN FOR TEST OR MAINT.
DC-A-21-TMO

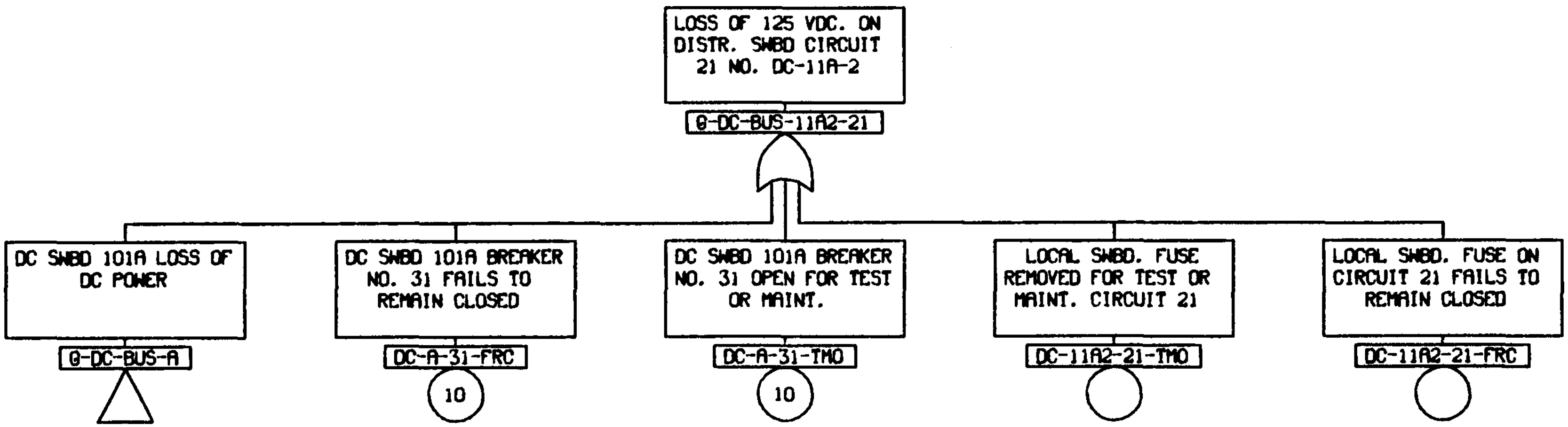

LOSS OF 125 V DC. ON DISTR. SWBD CIRCUIT 2 NO. DC-11A-2
G-DC-BUS-11A2-2
DC SWBD 101A LOSS OF DC POWER
B-DC-BUS-A
DC SWBD 101A BREAKER NO. 31 FAILS TO REMAIN CLOSED
DC-A-31-FRC
10
DC SWBD 101A BREAKER NO. 31 OPEN FOR TEST OR MAINT.
DC-A-31-TMO
10
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 2
DC-11A2-2-TMO
LOCAL SWBD. FUSE ON CIRCUIT 2 FAILS TO REMAIN CLOSED
DC-11A2-2-FRC


LOSS OF 125 VDC. ON DISTR. SWBD CIRCUIT 3 NO. DC-11A-2
G-DC-BUS-11A2-3
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD 101A BREAKER NO. 31 FAILS TO REMAIN CLOSED
DC-A-31-FRC
10
DC SWBD 101A BREAKER NO. 31 OPEN FOR TEST OR MAINT.
DC-A-31-TMO
10
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 3
DC-11A2-3-TMO
LOCAL SWBD. FUSE ON CIRCUIT 3 FAILS TO REMAIN CLOSED
DC-11A2-3-FRC

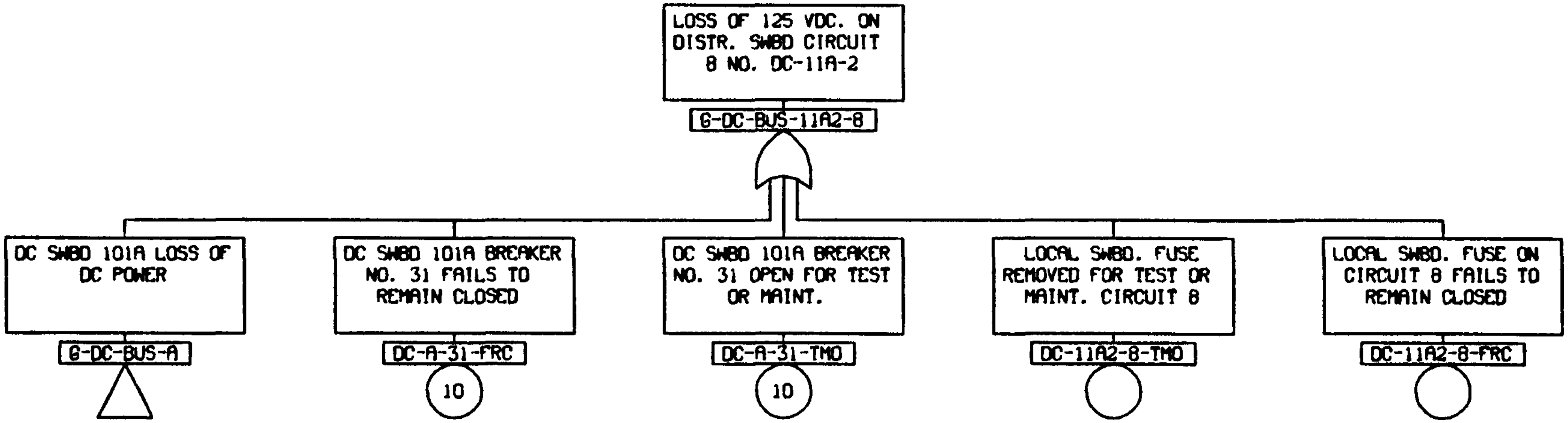

LOSS OF 125 VDC. ON DISTR. SWBD CIRCUIT 12 NO. DC-11A-2
G-DC-BUS-11A2-12
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD 101A BREAKER NO. 31 FAILS TO REMAIN CLOSED
DC-A-31-FRC
10
DC SWBD 101A BREAKER NO. 31 OPEN FOR TEST OR MAINT.
DC-A-31-TMO
10
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 12
DC-11A2-12-TMO
LOCAL SWBD. FUSE ON CIRCUIT 12 FAILS TO REMAIN CLOSED
DC-11A2-12-FRC

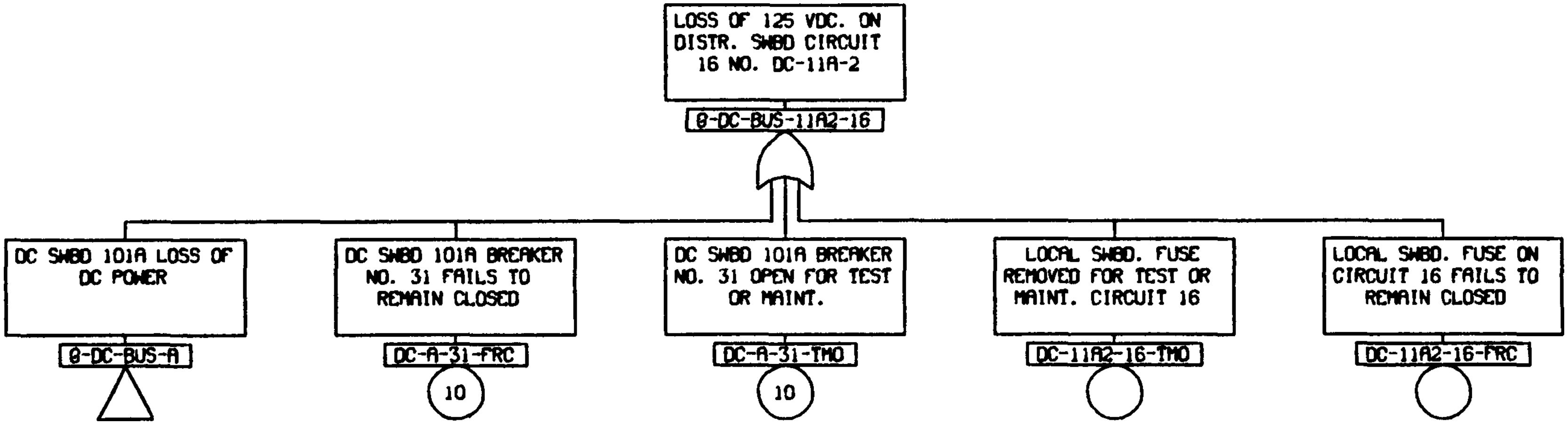

LOSS OF 125 VDC. ON DISTR. SWBD CIRCUIT 19 NO. DC-11A-2
0-DC-BUS-11A2-19
DC SWBD 101A LOSS OF DC POWER
0-DC-BUS-A
DC SWBD 101A BREAKER NO. 31 FAILS TO REMAIN CLOSED
DC-A-31-FRC
10
DC SWBD 101A BREAKER NO. 31 OPEN FOR TEST OR MAINT.
DC-A-31-TMO
10
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 19
DC-11A2-19-TMO
LOCAL SWBD. FUSE ON CIRCUIT 19 FAILS TO REMAIN CLOSED
DC-11A2-19-FRC

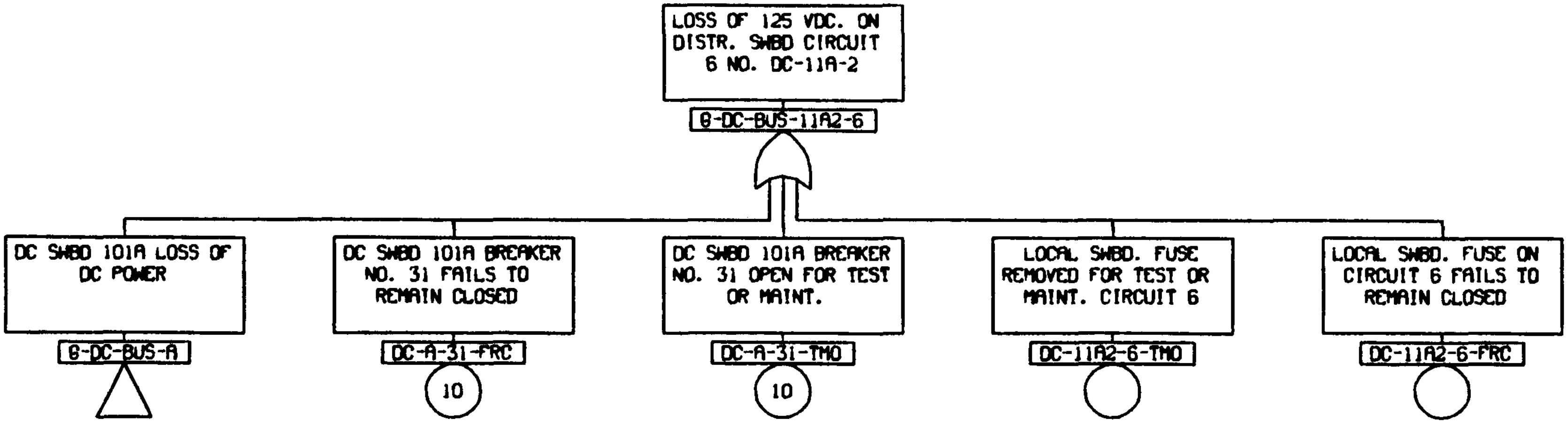

LOSS OF 125 VDC. ON DISTR. SWBD CIRCUIT 20 NO. DC-11A-2
G-DC-BUS-11A2-20
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD 101A BREAKER NO. 31 FAILS TO REMAIN CLOSED
DC-A-31-FRC
10
DC SWBD 101A BREAKER NO. 31 OPEN FOR TEST OR MAINT.
DC-A-31-TMO
10
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 20
DC-11A2-20-TMO
LOCAL SWBD. FUSE ON CIRCUIT 20 FAILS TO REMAIN CLOSED
DC-11A2-20-FRC



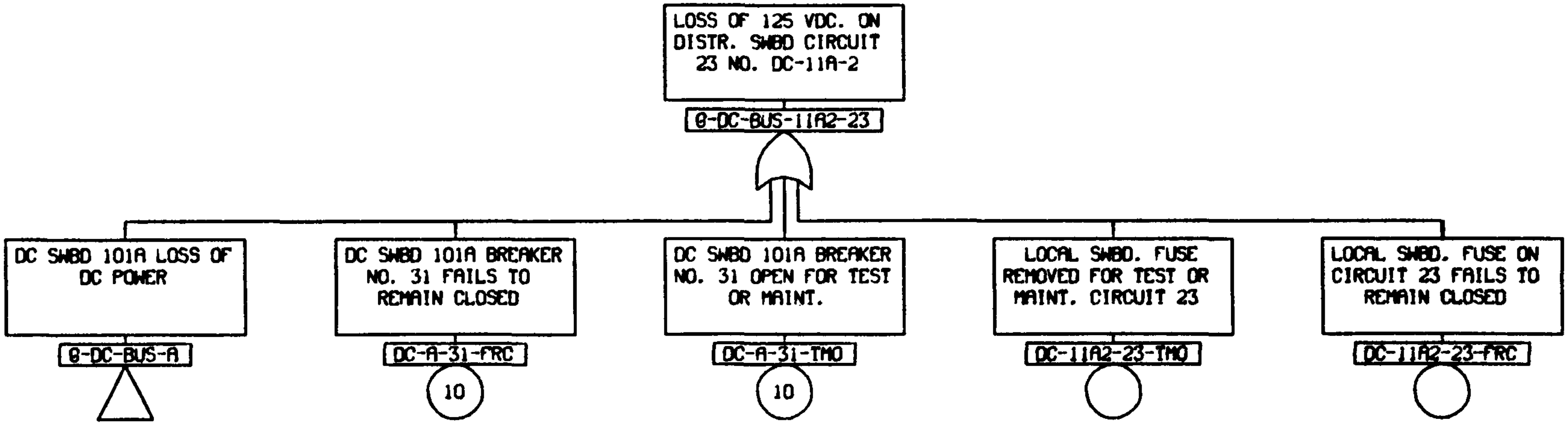
LOSS OF 125 VDC. ON DISTR. SWBD CIRCUIT 21 NO. DC-11A-2
G-DC-BUS-11A2-21
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD 101A BREAKER NO. 31 FAILS TO REMAIN CLOSED
DC-A-31-FRC
10
DC SWBD 101A BREAKER NO. 31 OPEN FOR TEST OR MAINT.
DC-A-31-TMO
10
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 21
DC-11A2-21-TMO
LOCAL SWBD. FUSE ON CIRCUIT 21 FAILS TO REMAIN CLOSED
DC-11A2-21-FRC


LOSS OF 125 VDC. ON DISTR. SWBD CIRCUIT 8 NO. DC-11A-2
G-DC-BUS-11A2-8
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
DC SWBD 101A BREAKER NO. 31 FAILS TO REMAIN CLOSED
DC-A-31-FRC
10
DC SWBD 101A BREAKER NO. 31 OPEN FOR TEST OR MAINT.
DC-A-31-TMO
10
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 8
DC-11A2-8-TMO
LOCAL SWBD. FUSE ON CIRCUIT 8 FAILS TO REMAIN CLOSED
DC-11A2-8-FRC

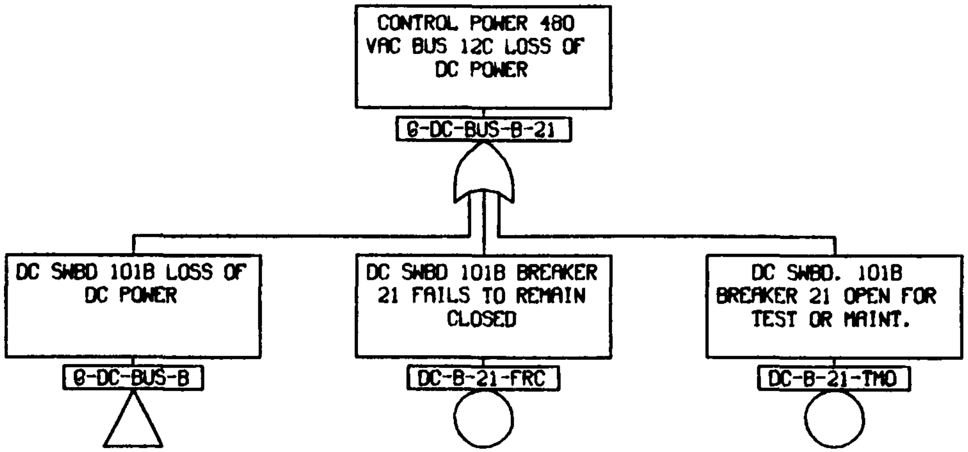

LOSS OF 125 VDC. ON DISTR. SWBD CIRCUIT 16 NO. DC-11A-2
0-DC-BUS-11A2-16
DC SWBD 101A LOSS OF DC POWER
0-DC-BUS-A
DC SWBD 101A BREAKER NO. 31 FAILS TO REMAIN CLOSED
DC-A-31-FRC
10
DC SWBD 101A BREAKER NO. 31 OPEN FOR TEST OR MAINT.
DC-A-31-TMO
10
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 16
DC-11A2-16-TMO
LOCAL SWBD. FUSE ON CIRCUIT 16 FAILS TO REMAIN CLOSED
DC-11A2-16-FRC

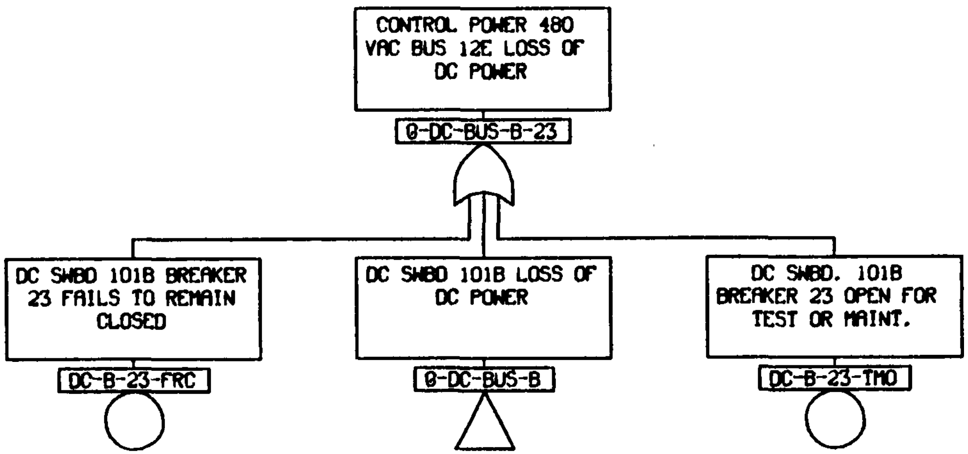

LOSS OF 125 VDC. ON DISTR. SWBD CIRCUIT 6 NO. DC-11A-2
B-DC-BUS-11A2-6
DC SWBD 101A LOSS OF DC POWER
B-DC-BUS-A
DC SWBD 101A BREAKER NO. 31 FAILS TO REMAIN CLOSED
DC-A-31-FRC
10
DC SWBD 101A BREAKER NO. 31 OPEN FOR TEST OR MAINT.
DC-A-31-TMO
10
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 6
DC-11A2-6-TMO
LOCAL SWBD. FUSE ON CIRCUIT 6 FAILS TO REMAIN CLOSED
DC-11A2-6-FRC

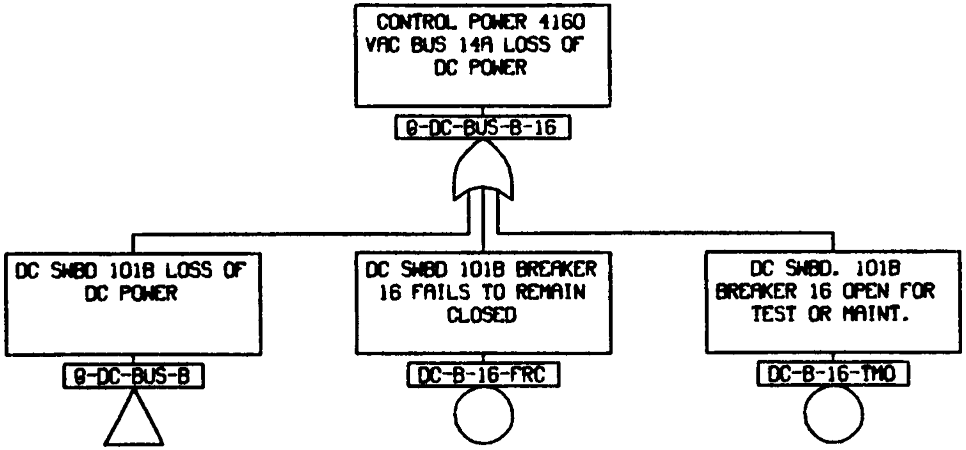
B.18-40

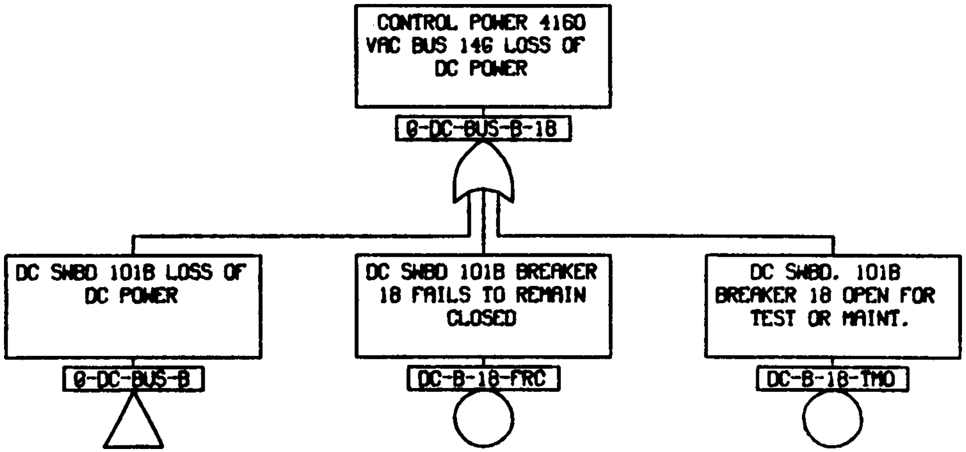


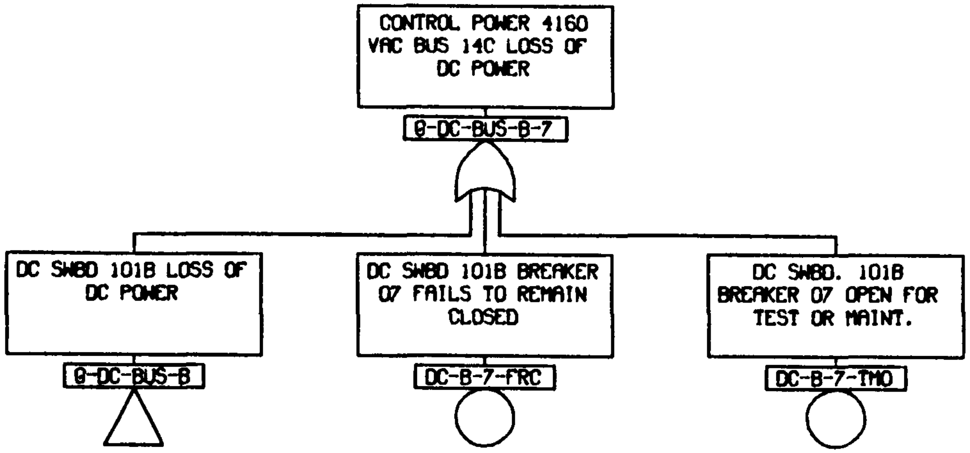
LOSS OF 125 VDC. ON DISTR. SWBD CIRCUIT 23 NO. DC-11A-2
@-DC-BUS-11A2-23
DC SWBD 101A LOSS OF DC POWER
@-DC-BUS-A
DC SWBD 101A BREAKER NO. 31 FAILS TO REMAIN CLOSED
DC-A-31-FRC
10
DC SWBD 101A BREAKER NO. 31 OPEN FOR TEST OR MAINT.
DC-A-31-TMO
10
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 23
DC-11A2-23-TMO
LOCAL SWBD. FUSE ON CIRCUIT 23 FAILS TO REMAIN CLOSED
DC-11A2-23-FRC

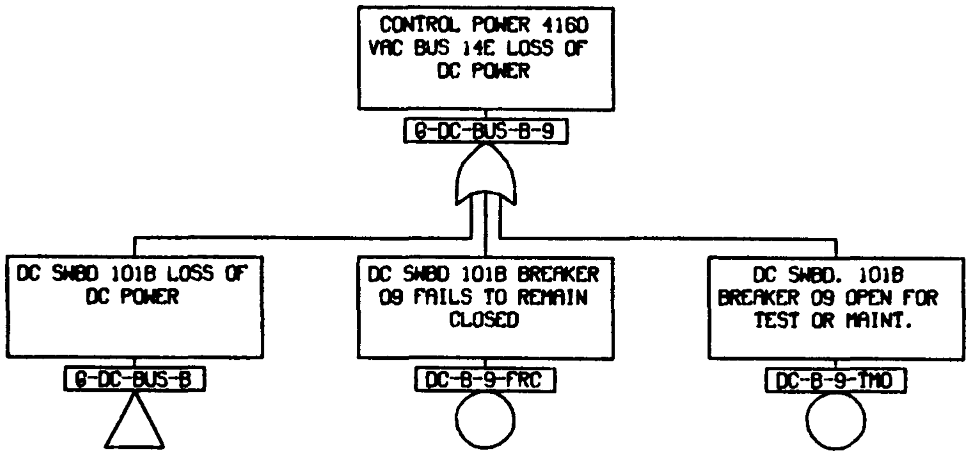

CONTROL POWER 480 VAC BUS 12C LOSS OF DC POWER
0-DC-BUS-B-21
DC SWBD 101B LOSS OF DC POWER
0-DC-BUS-B
DC SWBD 101B BREAKER 21 FAILS TO REMAIN CLOSED
DC-B-21-FRC
DC SWBD. 101B BREAKER 21 OPEN FOR TEST OR MAINT.
DC-B-21-TMO

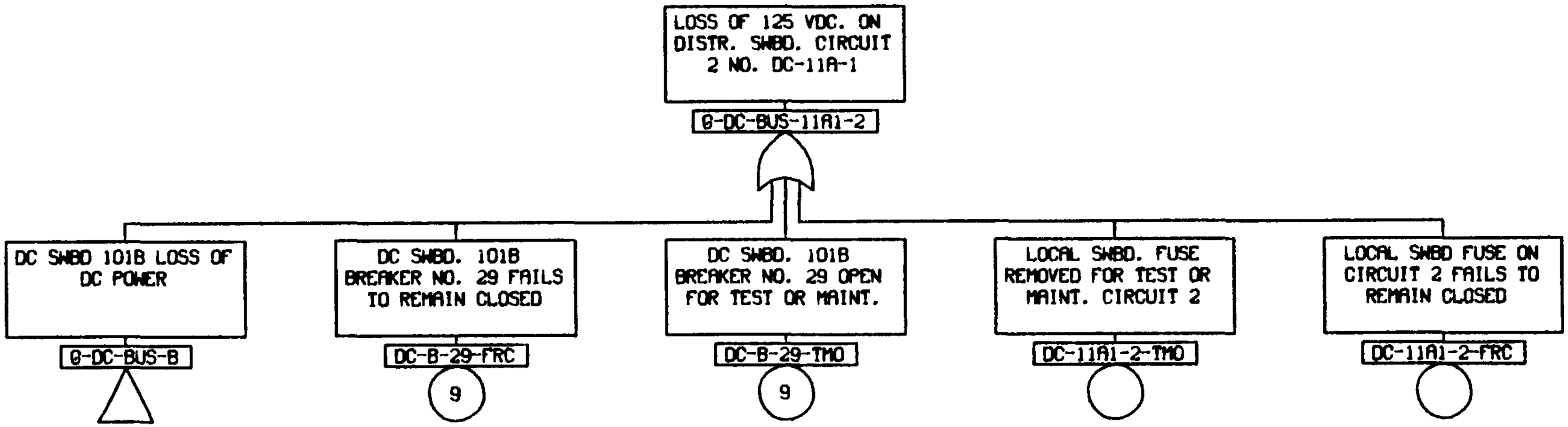

CONTROL POWER 480 VAC BUS 12E LOSS OF DC POWER
0-DC-BUS-B-23
DC SWBD 101B BREAKER 23 FAILS TO REMAIN CLOSED
DC-B-23-FRC
DC SWBD 101B LOSS OF DC POWER
0-DC-BUS-B
DC SWBD. 101B BREAKER 23 OPEN FOR TEST OR MAINT.
DC-B-23-TMO

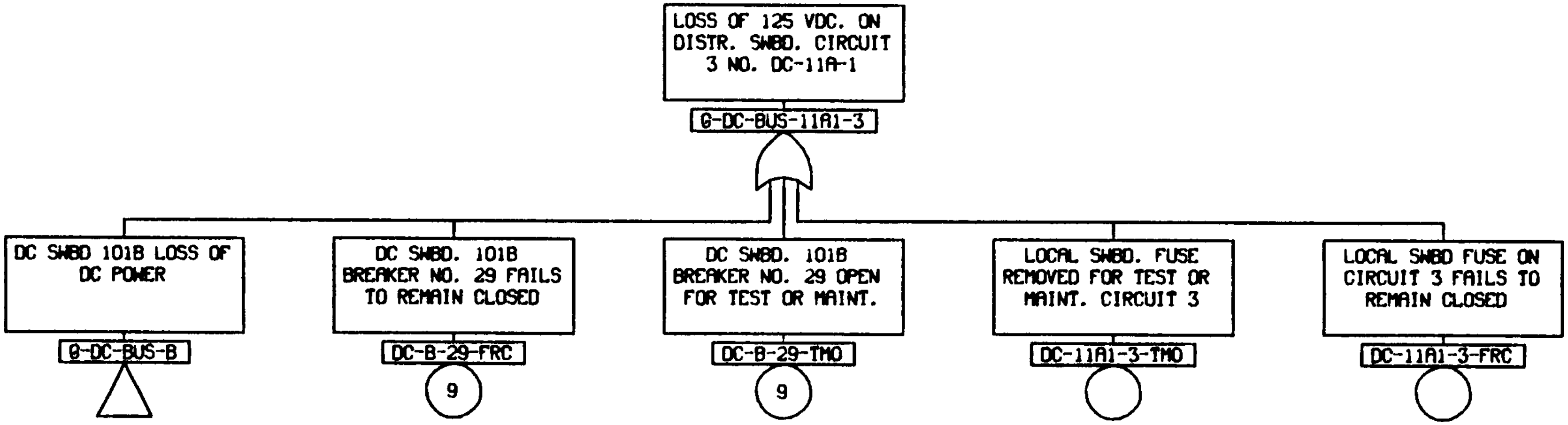

CONTROL POWER 4160 VAC BUS 14A LOSS OF DC POWER
Q-DC-BUS-B-16
DC SWBD 101B LOSS OF DC POWER
Q-DC-BUS-B
DC SWBD 101B BREAKER 16 FAILS TO REMAIN CLOSED
DC-B-16-FRC
DC SWBD. 101B BREAKER 16 OPEN FOR TEST OR MAINT.
DC-B-16-TMO

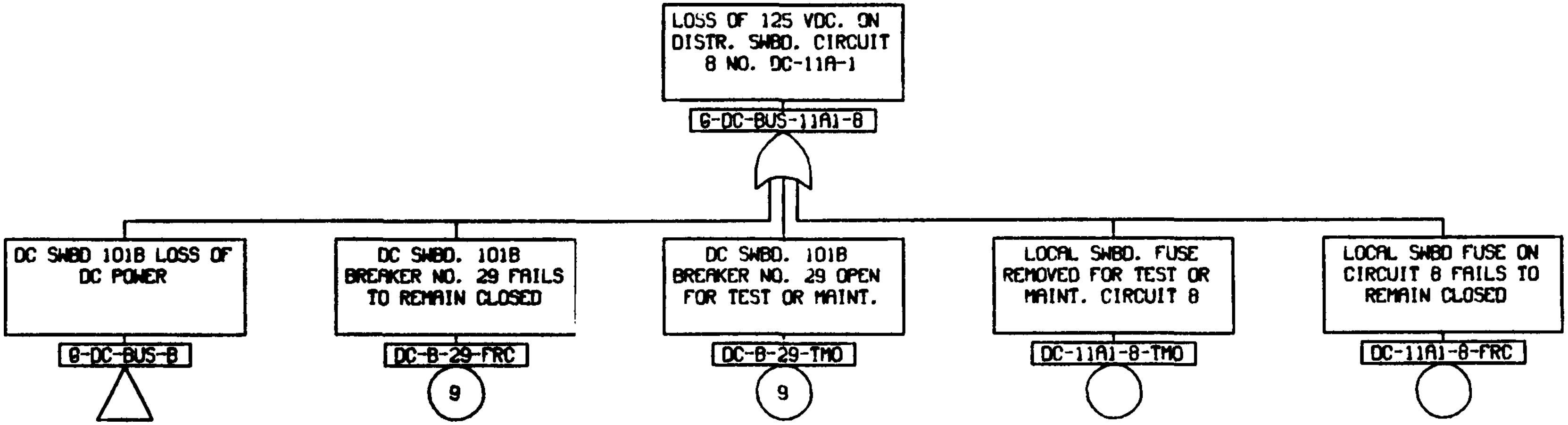

CONTROL POWER 4160 VAC BUS 14G LOSS OF DC POWER
Q-DC-BUS-B-18
DC SWBD 101B LOSS OF DC POWER
Q-DC-BUS-B
DC SWBD 101B BREAKER 18 FAILS TO REMAIN CLOSED
DC-B-18-FRC
DC SWBD. 101B BREAKER 18 OPEN FOR TEST OR MAINT.
DC-B-18-TMO

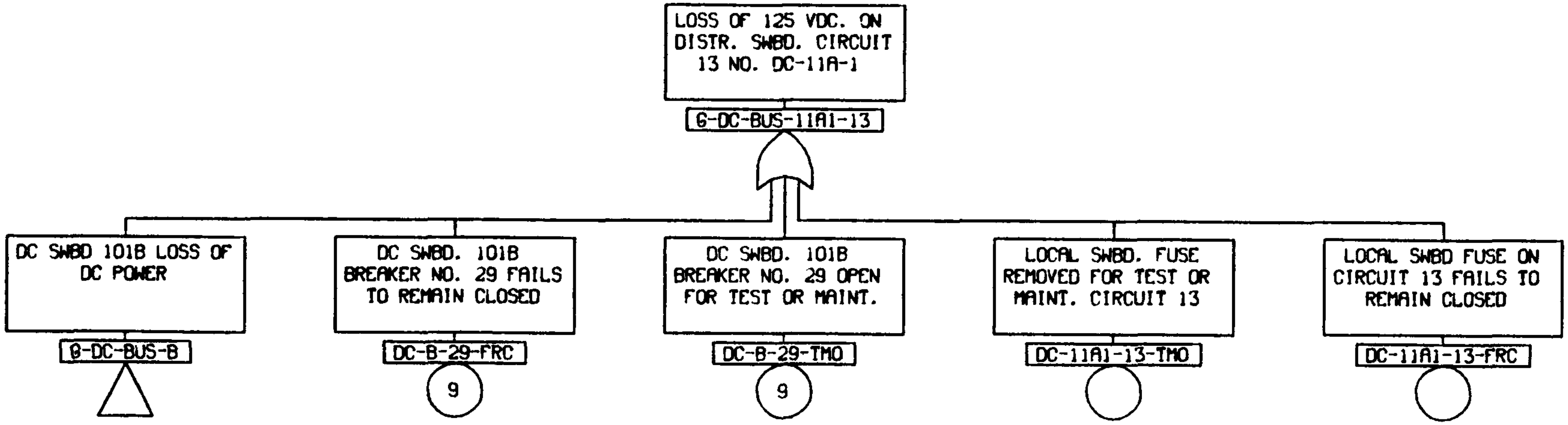

CONTROL POWER 4160 VAC BUS 14C LOSS OF DC POWER
Q-DC-BUS-B-7
DC SWBD 101B LOSS OF DC POWER
Q-DC-BUS-B
DC SWBD 101B BREAKER 07 FAILS TO REMAIN CLOSED
DC-B-7-FRC
DC SWBD. 101B BREAKER 07 OPEN FOR TEST OR MAINT.
DC-B-7-TMO

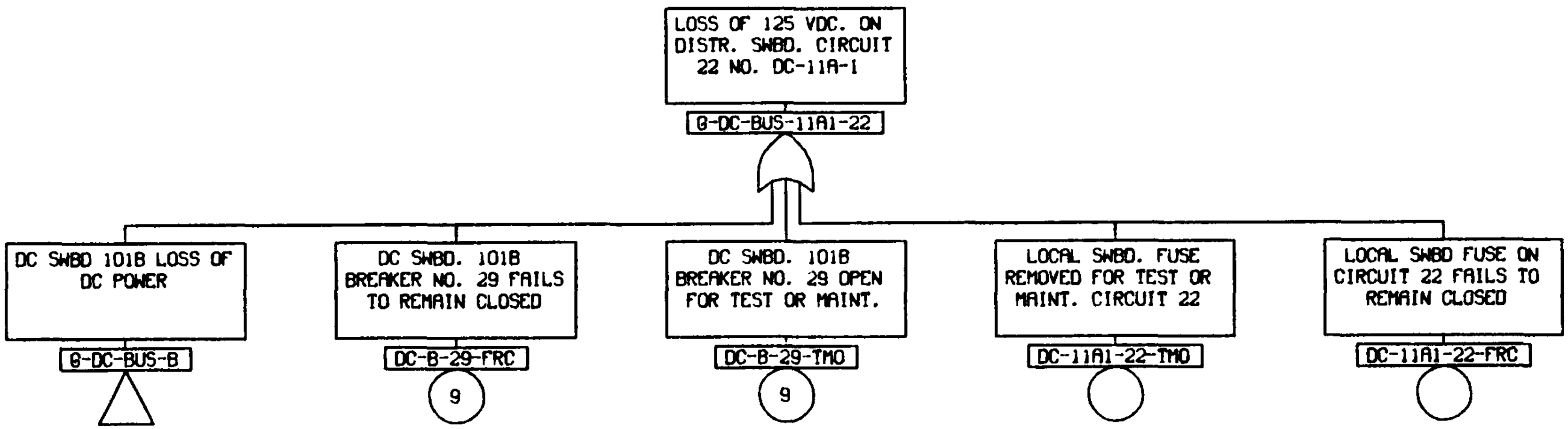

CONTROL POWER 4160 VAC BUS 14E LOSS OF DC POWER
Q-DC-BUS-B-9
DC SWBD 101B LOSS OF DC POWER
Q-DC-BUS-B
DC SWBD 101B BREAKER 09 FAILS TO REMAIN CLOSED
DC-B-9-FRC
DC SWBD. 101B BREAKER 09 OPEN FOR TEST OR MAINT.
DC-B-9-TMO

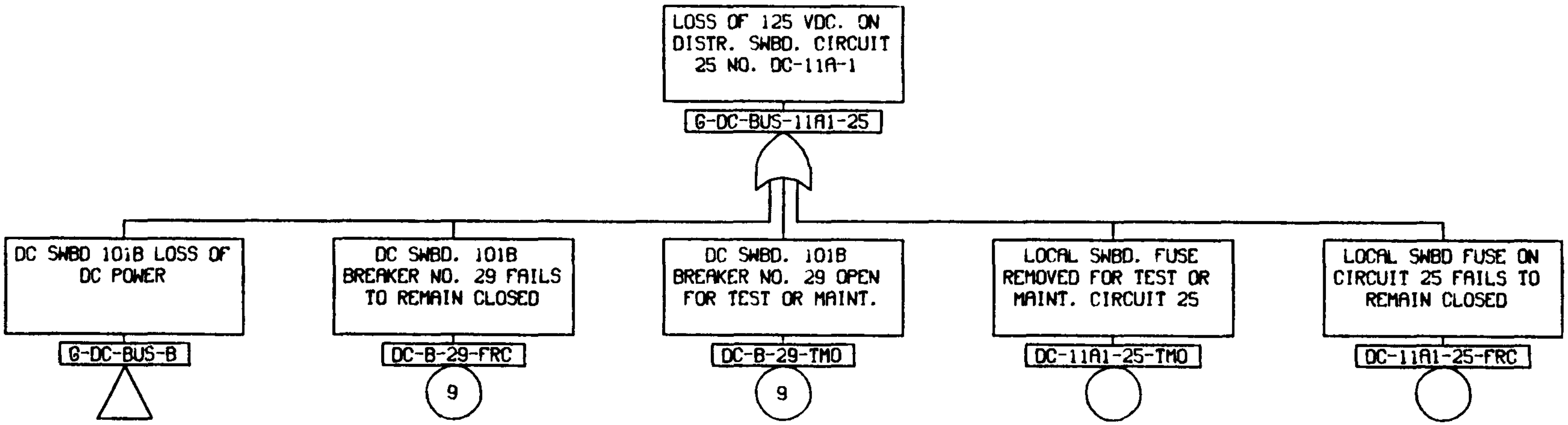

LOSS OF 125 VDC. ON DISTR. SWBD. CIRCUIT 2 NO. DC-11A-1
0-DC-BUS-11A1-2
DC SWBD 101B LOSS OF DC POWER
0-DC-BUS-B
DC SWBD. 101B BREAKER NO. 29 FAILS TO REMAIN CLOSED
DC-B-29-FRC
9
DC SWBD. 101B BREAKER NO. 29 OPEN FOR TEST OR MAINT.
DC-B-29-TMO
9
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 2
DC-11A1-2-TMO
LOCAL SWBD FUSE ON CIRCUIT 2 FAILS TO REMAIN CLOSED
DC-11A1-2-FRC

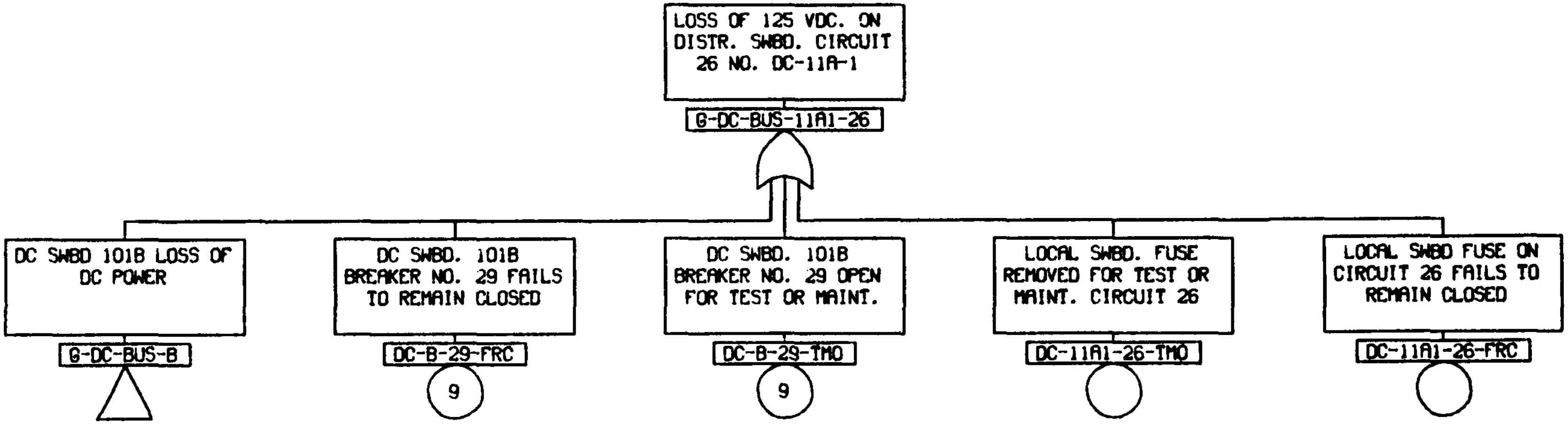

LOSS OF 125 VDC. ON DISTR. SWBD. CIRCUIT 3 NO. DC-11A-1
G-DC-BUS-11A1-3
DC SWBD 101B LOSS OF DC POWER
G-DC-BUS-B
DC SWBD. 101B BREAKER NO. 29 FAILS TO REMAIN CLOSED
DC-B-29-FRC
9
DC SWBD. 101B BREAKER NO. 29 OPEN FOR TEST OR MAINT.
DC-B-29-TMO
9
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 3
DC-11A1-3-TMO
LOCAL SWBD FUSE ON CIRCUIT 3 FAILS TO REMAIN CLOSED
DC-11A1-3-FRC

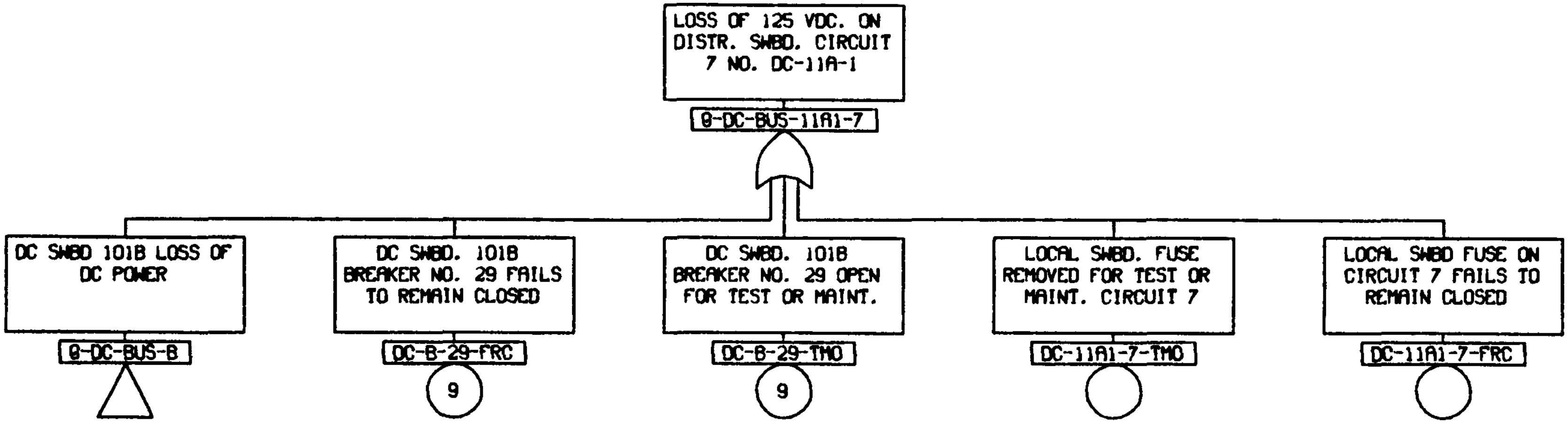

LOSS OF 125 VDC. ON DISTR. SWBD. CIRCUIT 8 NO. DC-11A-1
G-DC-BUS-11A1-8
DC SWBD 101B LOSS OF DC POWER
G-DC-BUS-B
DC SWBD. 101B BREAKER NO. 29 FAILS TO REMAIN CLOSED
DC-B-29-FRC
9
DC SWBD. 101B BREAKER NO. 29 OPEN FOR TEST OR MAINT.
DC-B-29-TMO
9
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 8
DC-11A1-8-TMO
LOCAL SWBD FUSE ON CIRCUIT 8 FAILS TO REMAIN CLOSED
DC-11A1-8-FRC

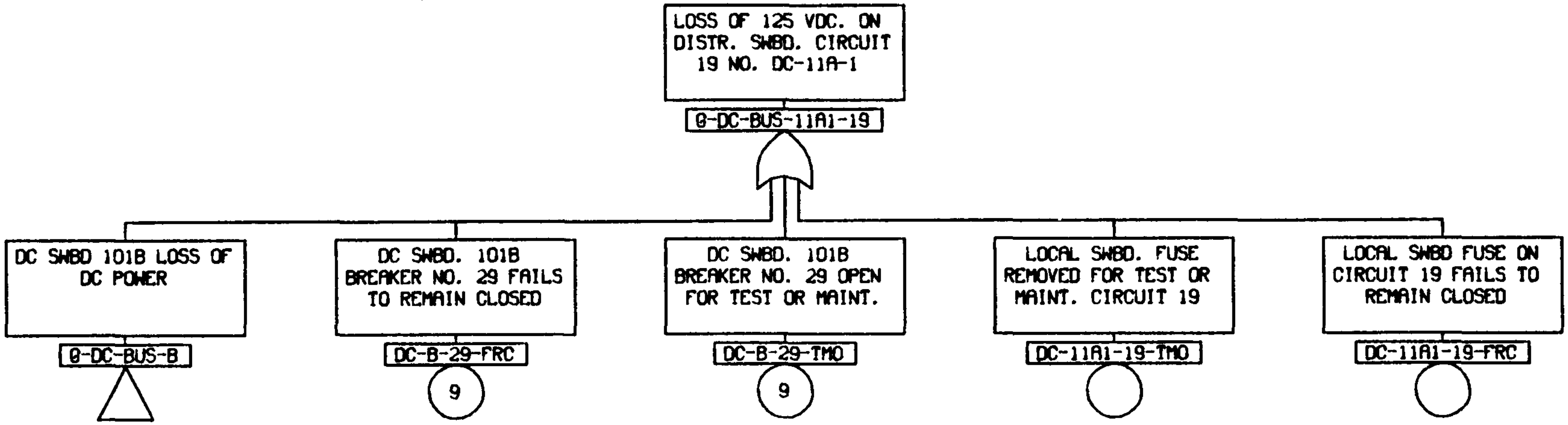

LOSS OF 125 VDC. ON DISTR. SWBD. CIRCUIT 13 NO. DC-11A-1
G-DC-BUS-11A1-13
DC SWBD 101B LOSS OF DC POWER
G-DC-BUS-B
DC SWBD. 101B BREAKER NO. 29 FAILS TO REMAIN CLOSED
DC-B-29-FRC
9
DC SWBD. 101B BREAKER NO. 29 OPEN FOR TEST OR MAINT.
DC-B-29-TMO
9
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 13
DC-11A1-13-TMO
LOCAL SWBD FUSE ON CIRCUIT 13 FAILS TO REMAIN CLOSED
DC-11A1-13-FRC

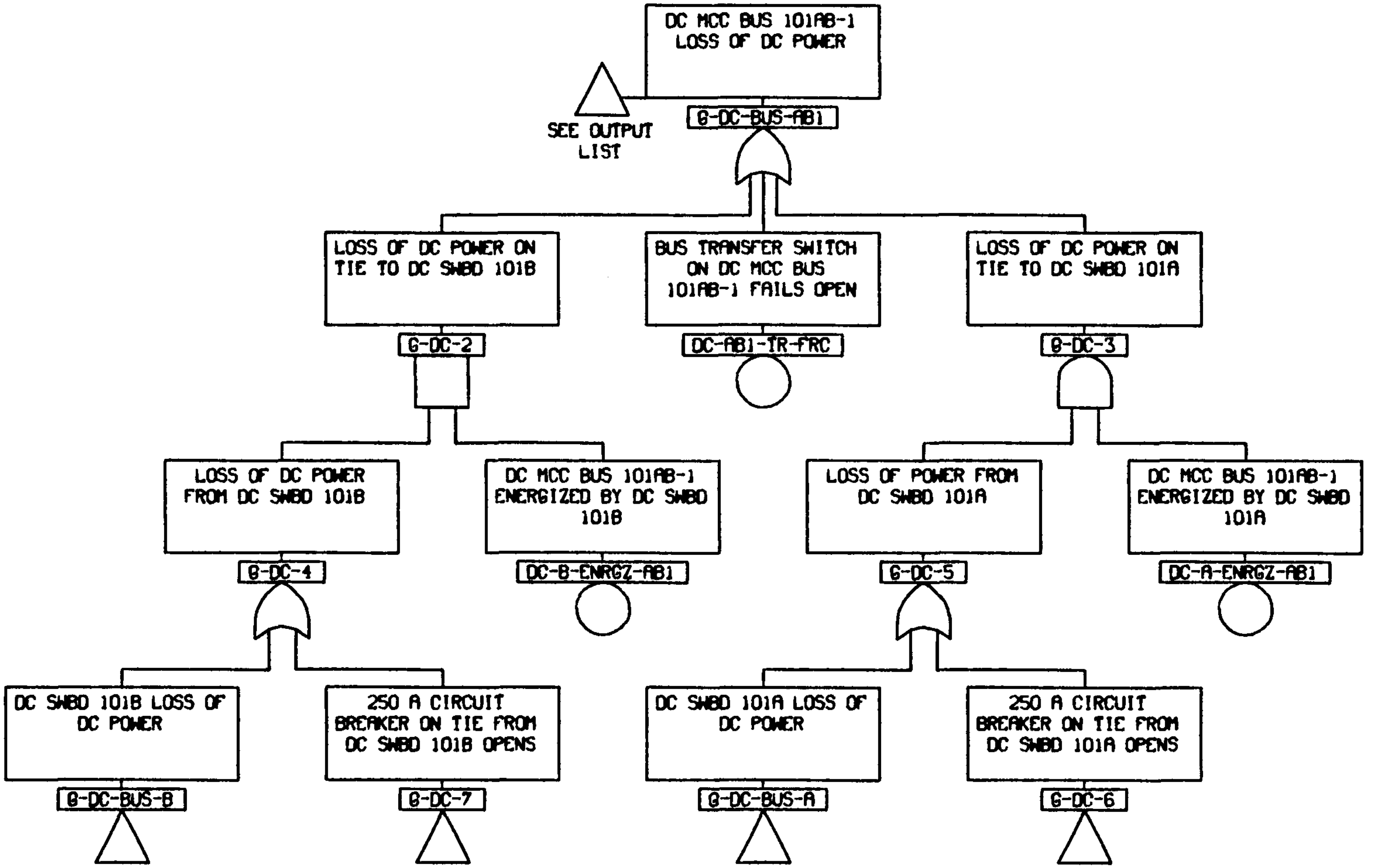

LOSS OF 125 VDC. ON DISTR. SWBD. CIRCUIT 22 NO. DC-11A-1
G-DC-BUS-11A1-22
DC SWBD 101B LOSS OF DC POWER
G-DC-BUS-B
DC SWBD. 101B BREAKER NO. 29 FAILS TO REMAIN CLOSED
DC-B-29-FRC
9
DC SWBD. 101B BREAKER NO. 29 OPEN FOR TEST OR MAINT.
DC-B-29-TMO
9
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 22
DC-11A1-22-TMO
LOCAL SWBD FUSE ON CIRCUIT 22 FAILS TO REMAIN CLOSED
DC-11A1-22-FRC


LOSS OF 125 VDC. ON DISTR. SWBD. CIRCUIT 25 NO. DC-11A-1
G-DC-BUS-11A1-25
DC SWBD 101B LOSS OF DC POWER
G-DC-BUS-B
DC SWBD. 101B BREAKER NO. 29 FAILS TO REMAIN CLOSED
DC-B-29-FRC
9
DC SWBD. 101B BREAKER NO. 29 OPEN FOR TEST OR MAINT.
DC-B-29-TMO
9
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 25
DC-11A1-25-TMO
LOCAL SWBD FUSE ON CIRCUIT 25 FAILS TO REMAIN CLOSED
DC-11A1-25-FRC

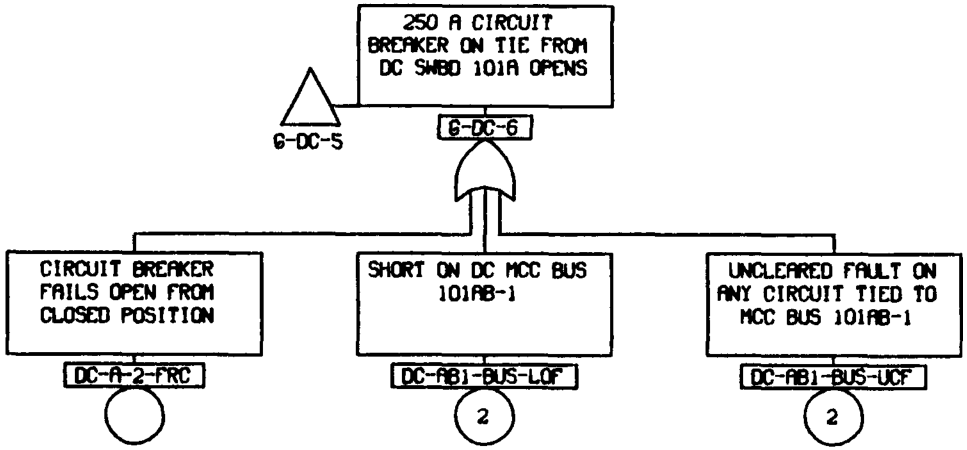

LOSS OF 125 VDC. ON DISTR. SWBD. CIRCUIT 26 NO. DC-11A-1
G-DC-BUS-11A1-26
DC SWBD 101B LOSS OF DC POWER
G-DC-BUS-B
DC SWBD. 101B BREAKER NO. 29 FAILS TO REMAIN CLOSED
DC-B-29-FRC
9
DC SWBD. 101B BREAKER NO. 29 OPEN FOR TEST OR MAINT.
DC-B-29-TMO
9
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 26
DC-11A1-26-TMO
LOCAL SWBD FUSE ON CIRCUIT 26 FAILS TO REMAIN CLOSED
DC-11A1-26-FRC

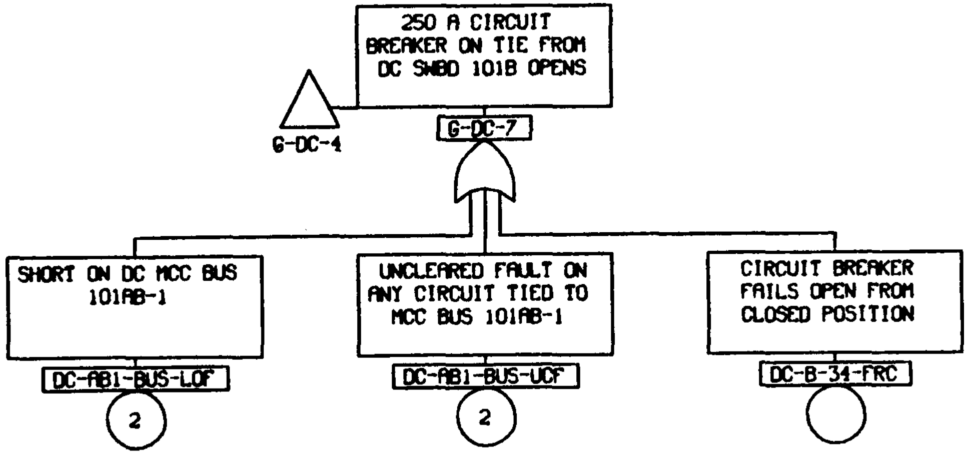

LOSS OF 125 VDC. ON DISTR. SWBD. CIRCUIT 7 NO. DC-11A-1
Q-DC-BUS-11A1-7
DC SWBD 101B LOSS OF DC POWER
Q-DC-BUS-B
DC SWBD. 101B BREAKER NO. 29 FAILS TO REMAIN CLOSED
DC-B-29-FRC
9
DC SWBD. 101B BREAKER NO. 29 OPEN FOR TEST OR MAINT.
DC-B-29-TMO
9
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 7
DC-11A1-7-TMO
LOCAL SWBD FUSE ON CIRCUIT 7 FAILS TO REMAIN CLOSED
DC-11A1-7-FRC

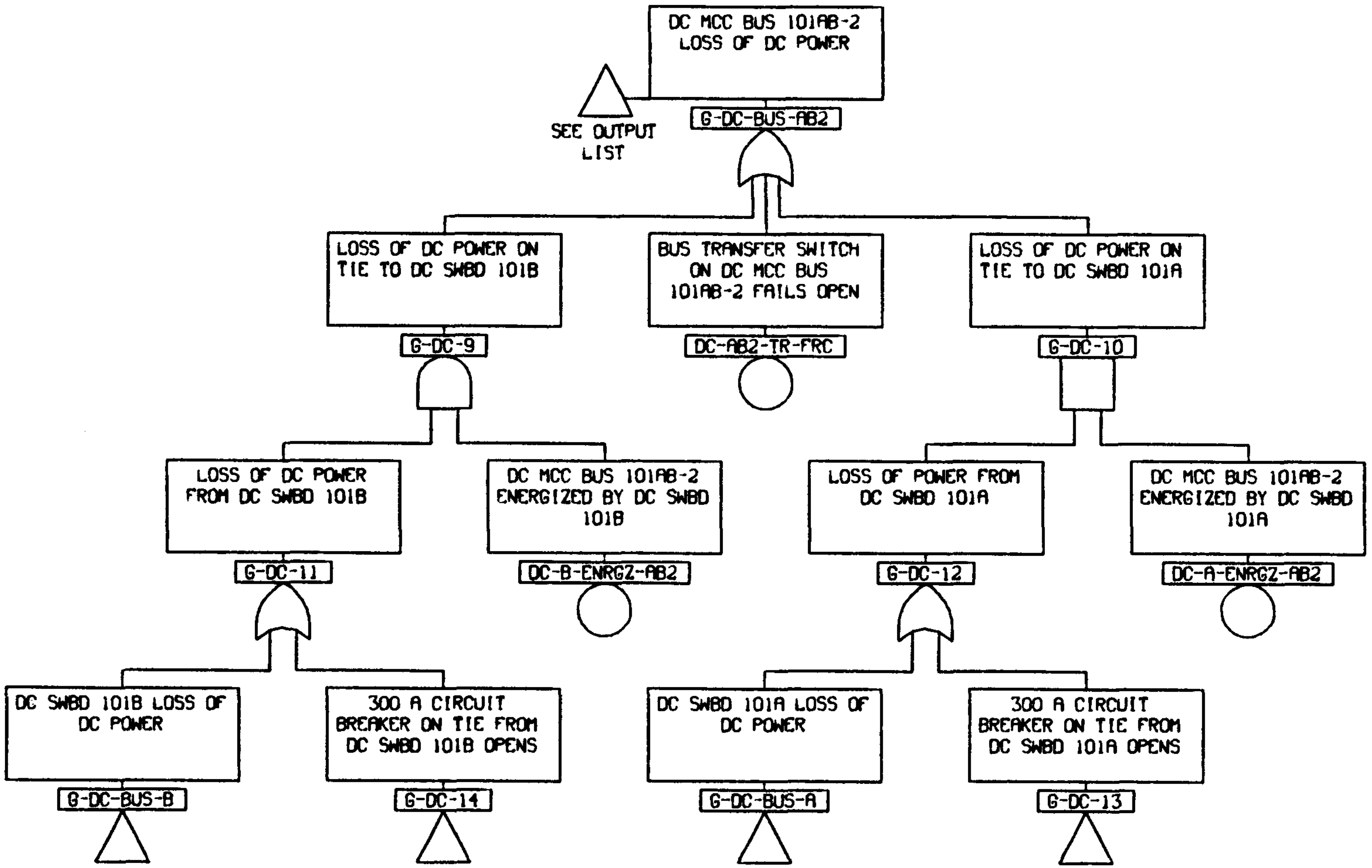

LOSS OF 125 VDC. ON DISTR. SWBD. CIRCUIT 19 NO. DC-11A-1
0-DC-BUS-11A1-19
DC SWBD 101B LOSS OF DC POWER
0-DC-BUS-B
DC SWBD. 101B BREAKER NO. 29 FAILS TO REMAIN CLOSED
DC-B-29-FRC
9
DC SWBD. 101B BREAKER NO. 29 OPEN FOR TEST OR MAINT.
DC-B-29-TMO
9
LOCAL SWBD. FUSE REMOVED FOR TEST OR MAINT. CIRCUIT 19
DC-11A1-19-TMO
LOCAL SWBD FUSE ON CIRCUIT 19 FAILS TO REMAIN CLOSED
DC-11A1-19-FRC



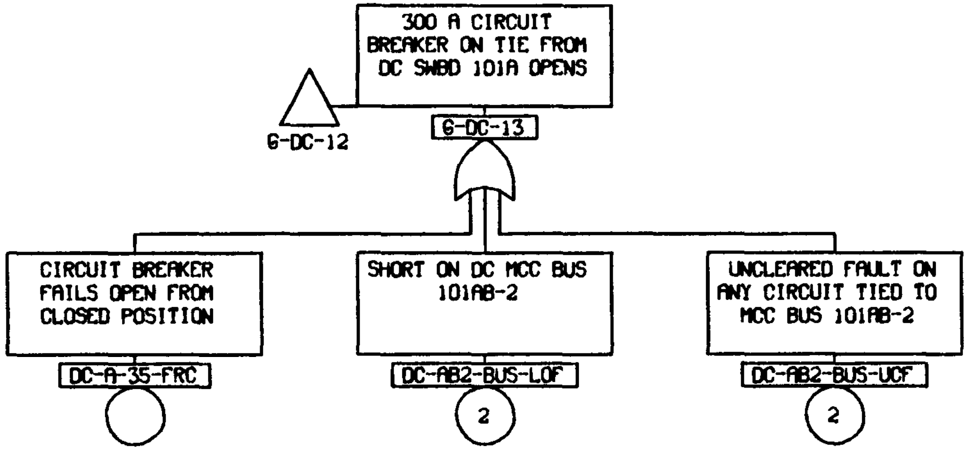
G-DC-BUS-AB1 OUTPUT LIST
G-DC-BUS-AB1-2D, G-DC-BUS-AB1-5C, G-DC-BUS-AB1-2E, G-DC-BUS-AB1-8A
G-DC-BUS-AB1-4C, G-DC-BUS-AB1-3C, G-DC-BUS-AB1-3A

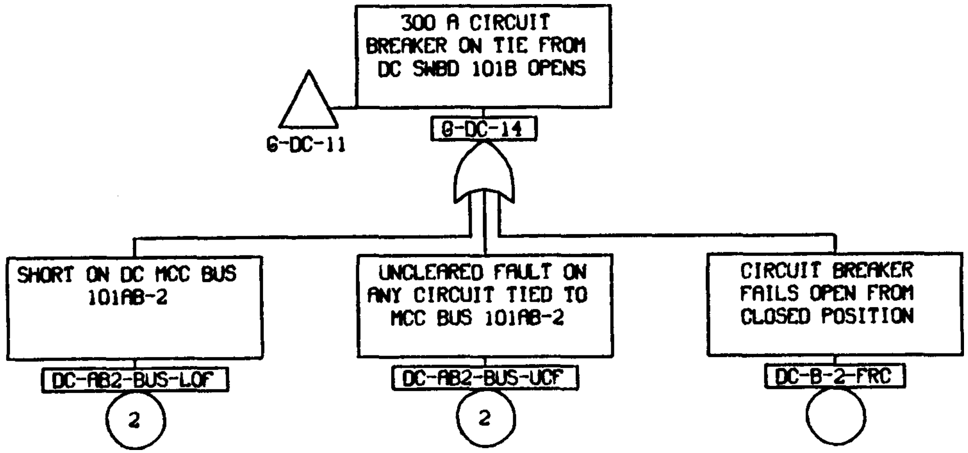

250 A CIRCUIT BREAKER ON TIE FROM DC SWBD 101A OPENS
G-DC-5
G-DC-6
CIRCUIT BREAKER FAILS OPEN FROM CLOSED POSITION
DC-A-2-FRC
SHORT ON DC MCC BUS 101AB-1
DC-AB1-BUS-LOF
2
UNCLEARED FAULT ON ANY CIRCUIT TIED TO MCC BUS 101AB-1
DC-AB1-BUS-UCF
2

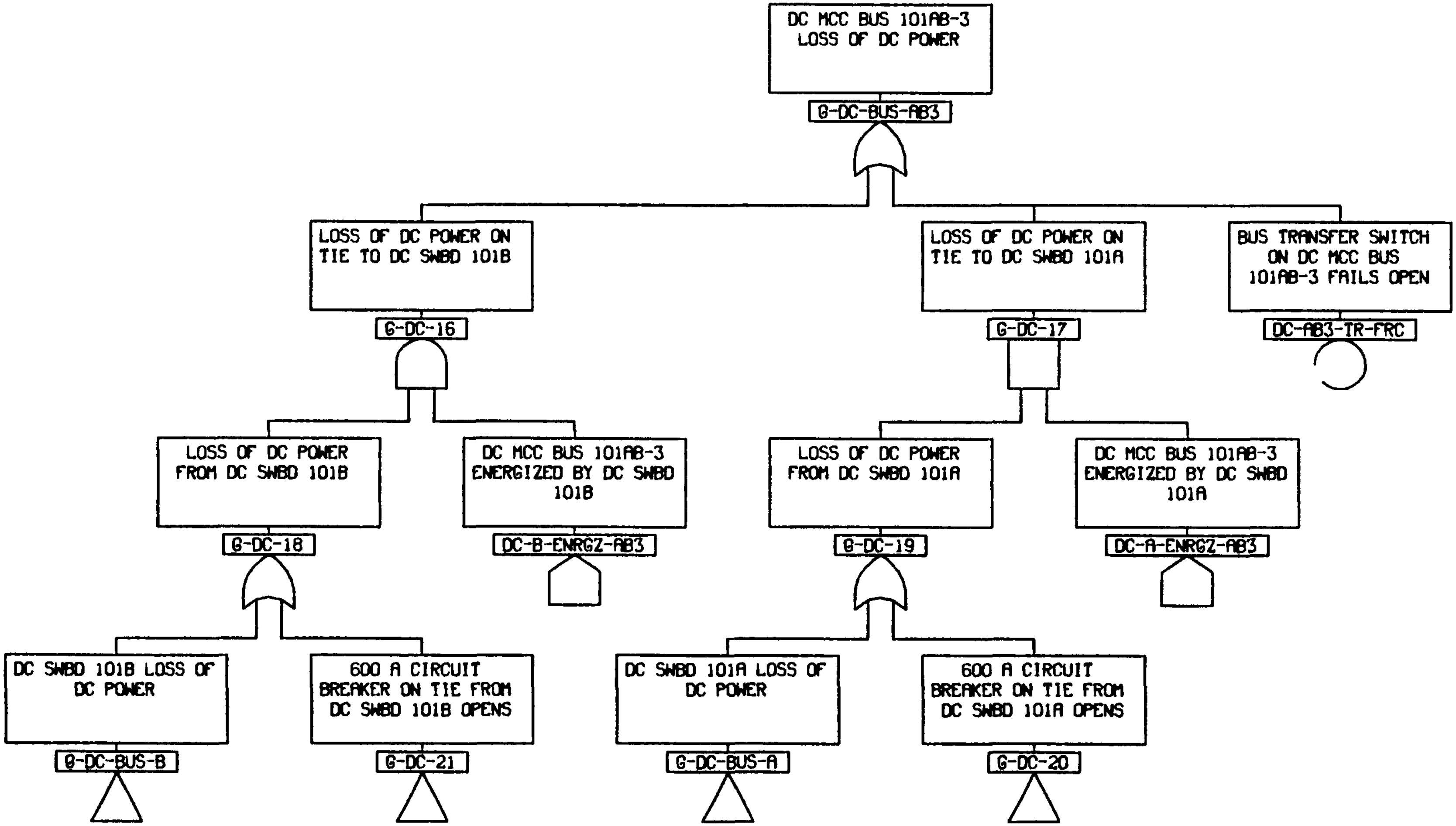

250 A CIRCUIT BREAKER ON TIE FROM DC SWBD 101B OPENS
G-DC-4
G-DC-7
SHORT ON DC MCC BUS 101AB-1
DC-AB1-BUS-LOF
2
UNCLEARED FAULT ON ANY CIRCUIT TIED TO MCC BUS 101AB-1
DC-AB1-BUS-UCF
2
CIRCUIT BREAKER FAILS OPEN FROM CLOSED POSITION
DC-B-34-FRC



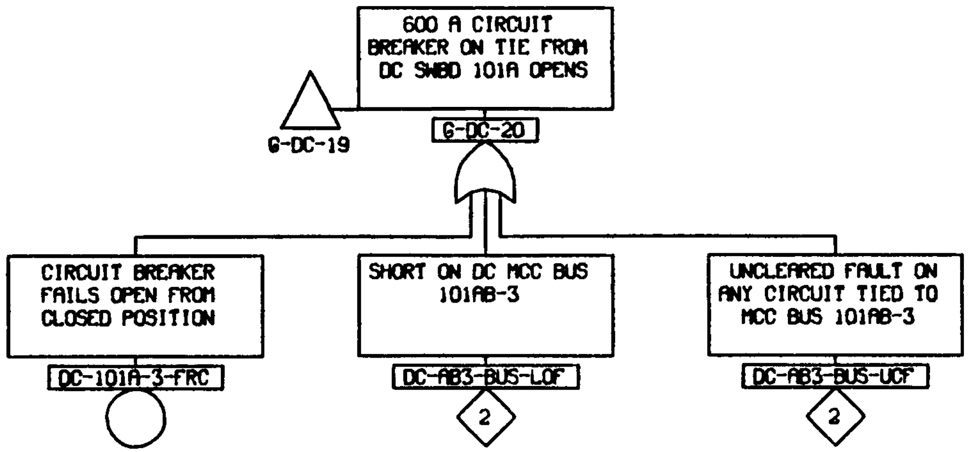
G-DC-BUS-AB2 OUTPUT LIST
G-DC-BUS-AB2-2D, G-DC-BUS-AB2-3A, G-DC-BUS-AB2-4D, G-DC-BUS-AB2-3B
G-DC-BUS-AB2-5C, G-DC-BUS-AB2-4C, G-DC-BUS-AB2-2E, G-DC-BUS-AB2-6B

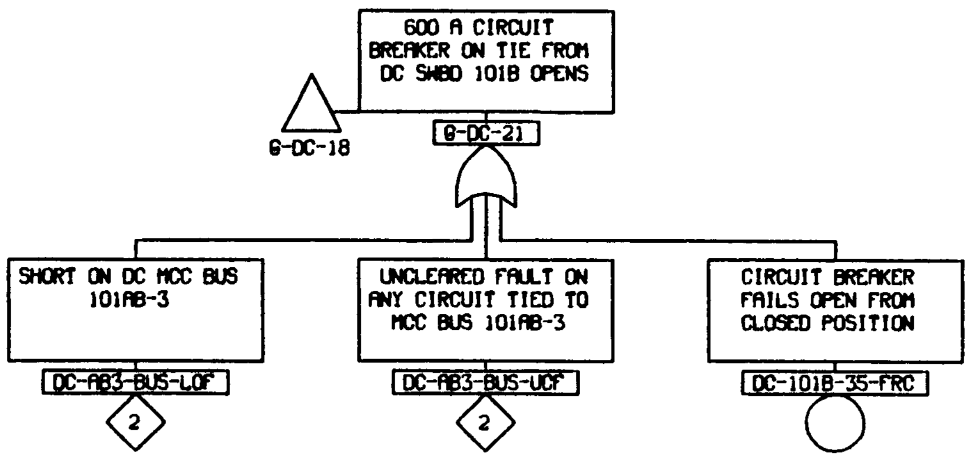

300 A CIRCUIT BREAKER ON TIE FROM DC SWBD 101A OPENS
G-DC-12
G-DC-13
CIRCUIT BREAKER FAILS OPEN FROM CLOSED POSITION
DC-A-35-FRC
SHORT ON DC MCC BUS 101AB-2
DC-AB2-BUS-LOF
2
UNCLEARED FAULT ON ANY CIRCUIT TIED TO MCC BUS 101AB-2
DC-AB2-BUS-UCF
2

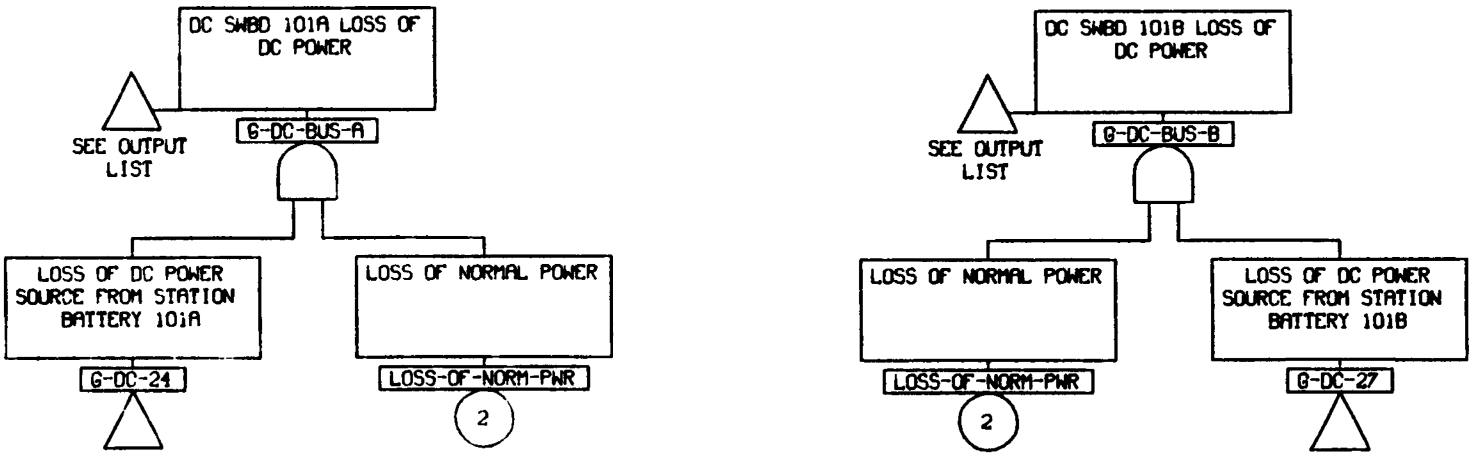

300 A CIRCUIT BREAKER ON TIE FROM DC SWBD 101B OPENS
G-DC-11
G-DC-14
SHORT ON DC MCC BUS 101AB-2
DC-AB2-BUS-LOF
2
UNCLEARED FAULT ON ANY CIRCUIT TIED TO MCC BUS 101AB-2
DC-AB2-BUS-UCF
2
CIRCUIT BREAKER FAILS OPEN FROM CLOSED POSITION
DC-B-2-FRC



DC MCC BUS 101AB-3 LOSS OF DC POWER
G-DC-BUS-AB3
LOSS OF DC POWER ON TIE TO DC SWBD 101B
G-DC-16
LOSS OF DC POWER ON TIE TO DC SWBD 101A
G-DC-17
BUS TRANSFER SWITCH ON DC MCC BUS 101AB-3 FAILS OPEN
DC-AB3-TR-FRC
LOSS OF DC POWER FROM DC SWBD 101B
G-DC-18
DC MCC BUS 101AB-3 ENERGIZED BY DC SWBD 101B
DC-B-ENRGZ-AB3
LOSS OF DC POWER FROM DC SWBD 101A
G-DC-19
DC MCC BUS 101AB-3 ENERGIZED BY DC SWBD 101A
DC-A-ENRGZ-AB3
DC SWBD 101B LOSS OF DC POWER
G-DC-BUS-B
600 A CIRCUIT BREAKER ON TIE FROM DC SWBD 101B OPENS
G-DC-21
DC SWBD 101A LOSS OF DC POWER
G-DC-BUS-A
600 A CIRCUIT BREAKER ON TIE FROM DC SWBD 101A OPENS
G-DC-20

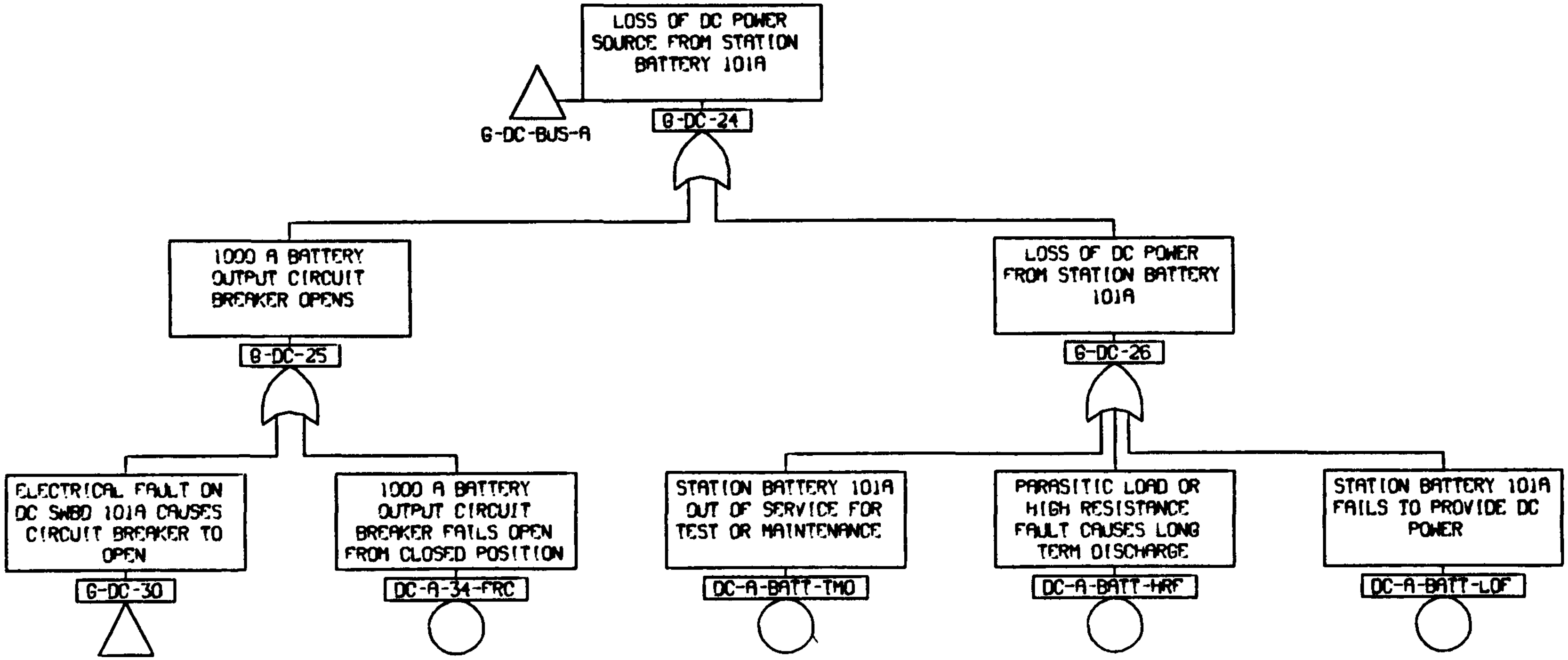

600 A CIRCUIT BREAKER ON TIE FROM DC SWBD 101A OPENS
G-DC-20
G-DC-19
CIRCUIT BREAKER FAILS OPEN FROM CLOSED POSITION
DC-101A-3-FRC
SHORT ON DC MCC BUS 101AB-3
DC-AB3-BUS-LOF
2
UNCLEARED FAULT ON ANY CIRCUIT TIED TO MCC BUS 101AB-3
DC-AB3-BUS-UCF
2

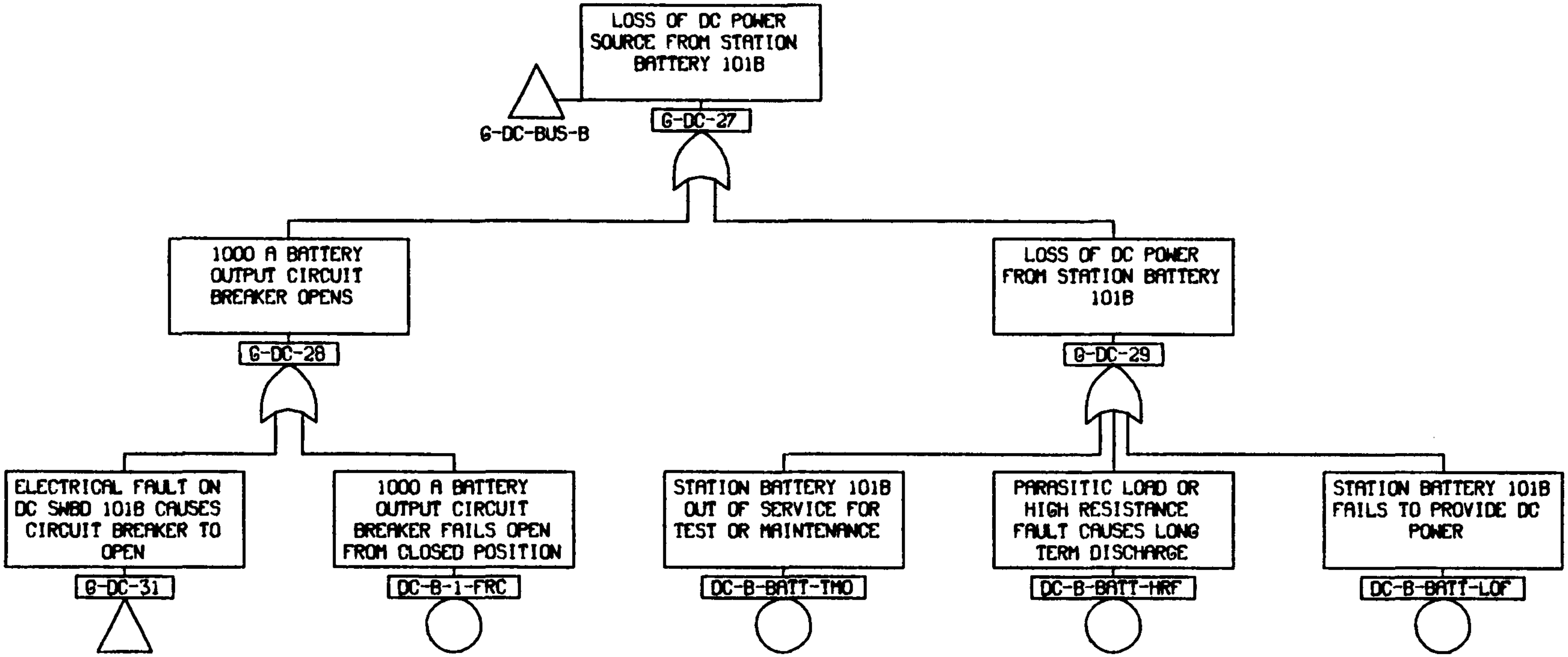

600 A CIRCUIT BREAKER ON TIE FROM DC SWBD 101B OPENS
G-DC-21
G-DC-18
SHORT ON DC MCC BUS 101AB-3
DC-AB3-BUS-LOF
2
UNCLEARED FAULT ON ANY CIRCUIT TIED TO MCC BUS 101AB-3
DC-AB3-BUS-UCF
2
CIRCUIT BREAKER FAILS OPEN FROM CLOSED POSITION
DC-101B-35-FRC

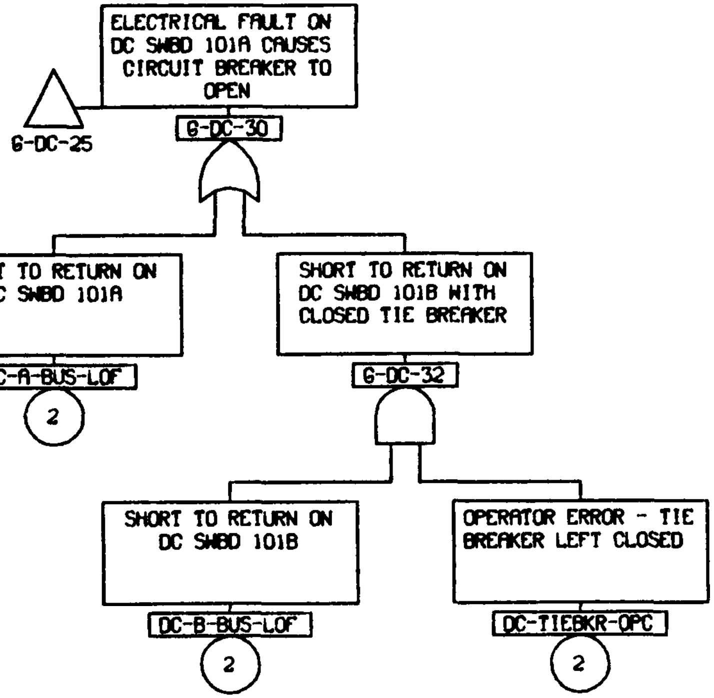


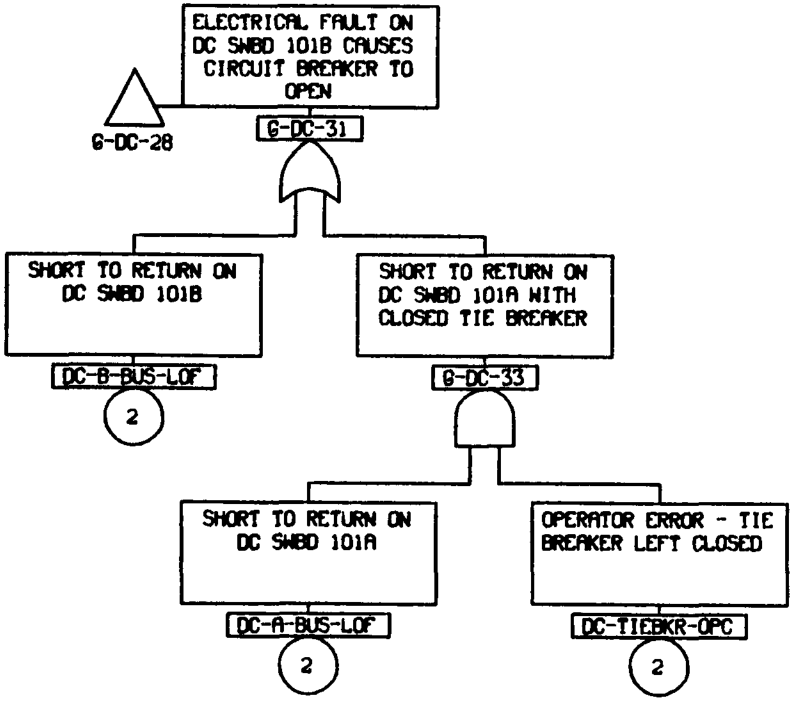
G-DC-BUS-A OUTPUT LIST
G-DC-BUS-A-9, G-DC-BUS-A-11, G-DC-BUS-A-12, G-DC-BUS-A-16, G-DC-BUS-A-18
G-DC-BUS-A-23, G-DC-BUS-A-25, G-DC-BUS-11A2-2, G-DC-BUS-11A2-3
G-DC-BUS-11A2-12, G-DC-BUS-11A2-19, G-DC-BUS-11A2-20, G-DC-BUS-11A2-21, G-DC-5
G-DC-12, G-DC-BUS-11A2-6, G-DC-BUS-11A2-8. G-DC-BUS-11A2-16, G-DC-BUS-11A2-23
G-DC-BUS-A-21, G-DC-19

G-DC-BUS-B OUTPUT LIST
G-DC-BUS-B-23, G-DC-BUS-B-21, G-DC-BUS-B-18, G-DC-BUS-B-16, G-DC-BUS-B-9
G-DC-BUS-B-7, G-DC-BUS-11A1-2, G-DC-BUS-11A1-3, G-DC-BUS-11A1-8
G-DC-BUS-11A1-13, G-DC-BUS-11A1-22, G-DC-BUS-11A1-25, G-DC-BUS-11A1-26
G-DC-BUS-11A1-7, G-DC-4, G-DC-11, G-DC-BUS-11A1-19, G-DC-18


LOSS OF DC POWER SOURCE FROM STATION BATTERY 101A
G-DC-24
G-DC-BUS-A
1000 A BATTERY OUTPUT CIRCUIT BREAKER OPENS
G-DC-25
LOSS OF DC POWER FROM STATION BATTERY 101A
G-DC-26
ELECTRICAL FAULT ON DC SWBD 101A CAUSES CIRCUIT BREAKER TO OPEN
G-DC-30
1000 A BATTERY OUTPUT CIRCUIT BREAKER FAILS OPEN FROM CLOSED POSITION
DC-A-34-FRC
STATION BATTERY 101A OUT OF SERVICE FOR TEST OR MAINTENANCE
DC-A-BATT-TMO
PARASITIC LOAD OR HIGH RESISTANCE FAULT CAUSES LONG TERM DISCHARGE
DC-A-BATT-HRF
STATION BATTERY 101A FAILS TO PROVIDE DC POWER
DC-A-BATT-LOF


LOSS OF DC POWER SOURCE FROM STATION BATTERY 101B
G-DC-BUS-B
G-DC-27
1000 A BATTERY OUTPUT CIRCUIT BREAKER OPENS
G-DC-28
LOSS OF DC POWER FROM STATION BATTERY 101B
G-DC-29
ELECTRICAL FAULT ON DC SWBD 101B CAUSES CIRCUIT BREAKER TO OPEN
G-DC-31
1000 A BATTERY OUTPUT CIRCUIT BREAKER FAILS OPEN FROM CLOSED POSITION
DC-B-1-FRC
STATION BATTERY 101B OUT OF SERVICE FOR TEST OR MAINTENANCE
DC-B-BATT-TMO
PARASITIC LOAD OR HIGH RESISTANCE FAULT CAUSES LONG TERM DISCHARGE
DC-B-BATT-HRF
STATION BATTERY 101B FAILS TO PROVIDE DC POWER
DC-B-BATT-LOF


ELECTRICAL FAULT ON DC SWBD 101A CAUSES CIRCUIT BREAKER TO OPEN
G-DC-30
G-DC-25
SHORT TO RETURN ON DC SWBD 101A
DC-A-BUS-LOF
2
SHORT TO RETURN ON DC SWBD 101B WITH CLOSED TIE BREAKER
G-DC-32
SHORT TO RETURN ON DC SWBD 101B
DC-B-BUS-LOF
2
OPERATOR ERROR - TIE BREAKER LEFT CLOSED
DC-TIEBKR-OPC
2


ELECTRICAL FAULT ON DC SWBD 101B CAUSES CIRCUIT BREAKER TO OPEN
G-DC-31
G-DC-28
SHORT TO RETURN ON DC SWBD 101B
DC-B-BUS-LOF
2
SHORT TO RETURN ON DC SWBD 101A WITH CLOSED TIE BREAKER
G-DC-33
SHORT TO RETURN ON DC SWBD 101A
DC-A-BUS-LOF
2
OPERATOR ERROR - TIE BREAKER LEFT CLOSED
DC-TIEBKR-OPC
2

APPENDIX B.19

THERP ANALYSIS

B.19.1 Human Reliability Analysis

Three different types of human error probabilities were used in this analysis. The first, generic human error rates, was used to represent an approximate error rate for large classes of events during the screening quantification process. The second, recovery credit, was used during the final quantification to account for operator actions to recover failed equipment. The third, technique for human error rate prediction (THERP) analysis, was used during the final quantification for specific human errors which were thought to be important from the screening quantification.

The generic human error rates were taken from NUREG/CR-1278, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications." A human factors (HF) specialist discussed with each systems analyst the type of actions which an operator might have to take for each system analyzed. This included actions during normal operation, maintenance, testing, or accident conditions which could affect a systems operability. The HF specialist then grouped these errors into large generic classes and supplied a number to be used during the screening quantification for each class of errors. These numbers are shown in Table B.19.1.

After the screening quantification was performed, the first step in the final quantification was to account for recovery actions. Credit was given for recovery by the operator if (a) written procedures existed which would cue the operator to the recovery action, and (b) the recovery action did not involve the repair of a functionally failed component. The probability of failure to recover was based on the time available to perform the recovery action and whether the action could be performed from the control room or had to be performed locally. The recovery factors used are listed in Table B.19.2, and were developed from a combination of information contained in the Big Rock Point PRA and expert opinions by the IREP analysis teams with the help of the IREP Quality Assurance team. These numbers were used for all the IREP studies. Recovery is explained in greater detail in Appendix C, Section C.2.2.1.

As a result of the screening quantification and after the application of recovery, it was found that the only human error which contributed significantly to risk was the failure to manually depressurize the reactor when high-pressure cooling was unavailable. It was then necessary to do a more detailed evaluation of this error by constructing a THERP tree to represent the operator's response.* The tree represents the operator's failure to correctly follow procedure OP516A to the point where it says to manually depressurize. This procedure requires the operator to interpret his situation and then refer to and follow a flow chart diagram to the manual depressurization step. The tree is shown in Figure B.19-1, and is analyzed both for the loss-of-normal-power and non-loss-of-normal-power cases.

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* THERP analysis and THERP trees are explained in detail in NUREG/CR-1278, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications."

Table B.19.1. Human Error Probabilities for Screening Quantification

Error Type	Probability (per act)
Errors of Omission	0.01
Failure to manually depressurize system[1]	0.03
Failure to restore (e.g., following a test or maintenance act)	0.01
Errors of Commission	0.003
Miscalibration	0.001
Backup Action[2]	0.05

[1]Because manually depressurizing the system involves significant and unique physical effects (e.g., possibly uncovering the core), this particular error of omission was assigned a higher value to reflect possible operator reluctance to perform this action. This value was used in the screening quantification for all conditions under which manual depressurization was required.

[2]This type of action is similar to the recovery actions which were generally considered in the final quantification as described in Appendix C, Section C.2.2.1. However, in a few situations, written procedures mandated that plant personnel check an automatic action. In these instances, the possibility of a human backup action was explicitly modeled on the fault trees, with 0.05-per-act used as the probability of failure to perform the backup action.

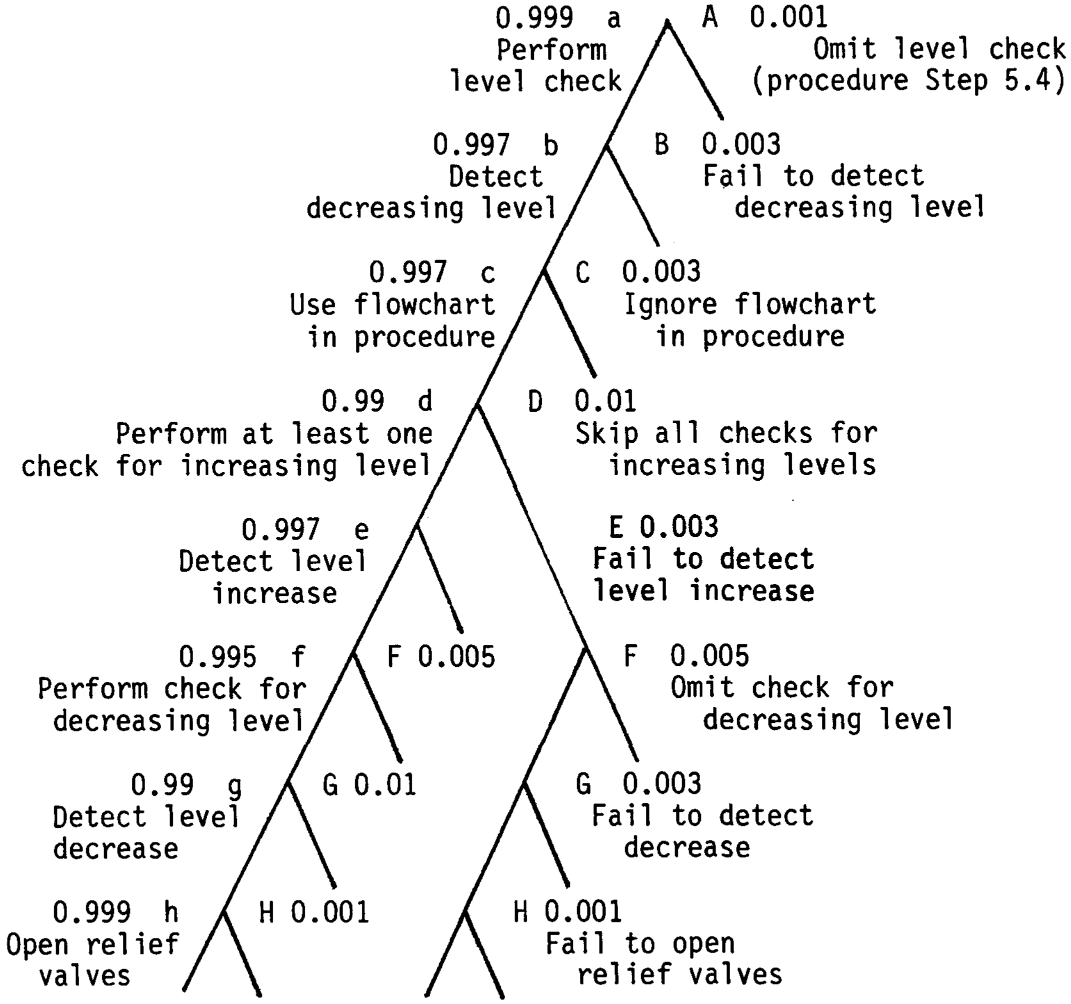
Table B.19.2. Recovery Factors for Final Quantification

Time Allowed for Action (minutes) Inside Control Room	Outside Control Room	Probability of Failure To Perform Action
< 5	< 65	1.0
5 to 10	65 to 70	0.25
10 to 20	70 to 80	0.10
20 to 30	80 to 90	0.05
30 to 60	90 to 120	0.03
> 60	> 120	0.01

Figure B.19-1. Failure to Open Manual Relief Valves After Loss of Feedwater.

Case (1): There has been no loss of normal power.

Probability of Failure = 0.0256 ≅ 0.03.



NOTE: Capital letter denotes failure; small letter denotes success.

Figure B.19-1. Continued.

Assumptions

(1) Total dependence among operators if more than one present--this is a conservative assumption; but there is no basis for a contrary assumption.

(2) Operator will fail to perform procedure correctly from memory if he chooses to ignore flowchart.

(3) On the flowchart, if any one "Level Increasing" test is responded to correctly, any others will also be responded to correctly (total dependence because of psychological set on repeated tasks).

(4) If any one of the relief valves is opened, all will be (total dependence because of a common task).

Events and Data Sources

Below is a description of each failure event on the THERP tree, along with the source table from NUREG/CR-1278, which was used to determine the failure probability for the event:

A. The operator fails to check the water level in the reactor vessel as required.
Table 20-20, Line 4. Lower limit of range used because checkoff seems non-critical in a short procedure under emergency conditions, with substantial time for performance of the step.

B. Given that the operator checks the water level, he fails to note that it is decreasing.
Table 2-7, Line 4.

C. The operator fails to use the flow chart in the procedure, but instead tries to act from memory.
Table 20-20, Line 4. Decision to use chart is treated as an independent step, because the flowchart is so unclear as to discourage use.

D. The operator fails to perform all three checks for increasing water level in the reactor vessel.
Table 20-20, Line 5. Flowchart treated as long procedure (> 10 steps).

E. Given that the operator checks for increasing water level at least once, he fails to note that it is not increasing.
Table 20-7, Line 4.

Figure B.19-1. Concluded.

F. The operator fails to perform the check for decreasing water level in the reactor vessel.
Table 20-20, Line 5. Lower limit used because of the advantage of visual presentation in the flowchart (all lines lead here). No such adjustment was made for D because of the confusing multiple branching at the beginning of the chart.

G. Given that the operator performs the check for decreasing water level, he fails to note that it is decreasing.
Table 20-7, Line 4. For the branch which includes Event E, the upper limit is used because of the set-reversal required in changing from a test for "increasing" to a test for "decreasing."

H. The operator successfully reaches the step calling for manually opening the relief valves to depressurize, but fails to do so.
Table 20-13, Line 2.

Case (2): There has been loss of normal power. The tree is the same, but the probability of F (omitting the flowchart step of checking for decreasing level) is increased to the upper limit of 0.05 because of the confusing side branch for checking the auxiliary generators. That step appears to lead to an exit from the flowchart.

Probability of Failure = 0.0697 ≅ 0.07.

Appendix C

Sequence Quantification

C.0 INTRODUCTION

This appendix presents the methodology used in the Millstone Point analysis to arrive at the point estimates of the accident sequence probabilities found in Chapter 8. Specifically, the translation from component and human error rates for basic fault tree events to an estimation for the probability of a particular accident sequence is described. Section C.1 demonstrates how basic event probabilities are calculated for each of the component and human error failure modes used in the analysis. The determination of initiating event probabilities and undeveloped event probabilities is also provided in Section C.1.

Section C.2 describes the procedure for the calculation of accident sequence probabilities given system fault trees and event probabilities. The procedure is a two step process consisting of a "screening" sequence probability estimation and a final sequence probability calculation. Section C.3 provides a detailed example of the quantification of a sequence probability.

C.1 Event Probability Estimation

In this section, the method of estimating basic, initiating and undeveloped event probabilities is described. The occurrence probabilities for the basic events involving hardware faults in each of the system fault trees were calculated primarily from the data in Table C-1. The data in Table C-1 are modified from Appendix III of WASH-1400 (NUREG-75/014, "Reactor Safety Study").[1] Basic events involving human error were estimated using data primarily from NUREG/CR-1278, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications" (Draft Report).[2] The sources of the initiating event probabilities were EPRI NP-801, "ATWS: A Reappraisal, PART III, Frequency of Anticipated Transients"[3], plant information and the data base supplied by the NRC for this study.

Section C.1.1 provides numerical examples of the calculation of various types of failure modes appearing as basic events in the system fault trees. Section C.1.2 provides the numerical estimates for the initiating events used in this study. Section C.1.3 describes how the probabilities of undeveloped events (i.e. events for which fault trees were not drawn) were developed. The failures of the Power Conversion System, Feedwater System, Vapor Suppression System and functioning of the safety/relief valves were the undeveloped events in the Millstone analysis.

C.1.1 Basic Event Probabilities

Basic events are those faults on the fault tree for which occurrence data exists and thus require no further logic development. They consist generally of component unavailabilities and human errors. The estimation of basic event failure probabilities and selected examples are discussed here. The probabilities of each basic event in the fault trees are included in the "Fault Tree Summary Sheets" in Appendix B.

C.1.1.1 Component Failure Probabilities

In the construction of the fault trees, the analysts identified system failure modes due to hardware faults or human error. This section describes the process by which estimations of the probabilities of the hardware faults were made. The human errors are discussed in Section C.1.1.2, and test and maintenance errors in Section C.1.1.3.

In general terms, the associated failure probabilities for hardware failure modes can be described as either "unavailabilities" (i.e., the probability of a component failing to function on demand) or "unreliabilities" (i.e., the probability of a component failing to continue functioning for some period of time). The basic data used for all IREP studies to quantify these hardware failures are modified from the WASH-1400 data base and are shown in Table C-1. The failure probabilities are shown in this table in three forms: (1) demand failure probabilities (probability of failure on demand, denoted as Q_D); (2) standby failure rates (failure per hour in a standby mode, denoted as λ_s); and (3) operating failure rates (failure per hour in an operating mode, denoted by λ_o).

The WASH-1400 data base was taken from a population which was tested at varying intervals but which, in general, were short (i.e., $\sim$ 1 month), and their values were used directly for similar components at Millstone. However, there were some components tested only at much longer intervals, and the calculation of values for these components is discussed below. Some components, such as control circuits for values and pumps, were built up from subcomponents whose failure probabilities existed in the data base in a similar fashion to what was done in WASH-1400.

<u>Failure Probabilities for Components Tested at Long Intervals</u>

In actuality, for bimodal components--that is, components required to change state (i.e., on-off, open-closed)--the total unavailability (Q) is composed of two parts: (1) a part which depends only on the number of demands (Q_D) and (2) a time-dependent part with some failure rate per hour (λ_s). If the actual demand is averaged over the test interval, then, algebraically, we have:

$$Q = Q_D + 1/2\ \lambda_s T$$

T = test interval.

In WASH-1400, using engineering judgement as to whether time-dependent or demand-dependent failure modes were dominant, they calculated either a probability of failure on demand (Q_D) or a standby failure rate (λ_s) for each component. This basically assumes all of the unavailability is either demand-related or time-related, with no mixing of modes.

For components tested at intervals similar to the data base, this makes no difference in the calculated unavailability. For components tested at much longer intervals, this can lead to non-conservatively underestimating the unavailability by an amount determined by the portion of time-dependent failure modes that actually exist.

Since WASH-1400, more data have been collected, albeit still weakly relating to this question. There is some evidence in (1) recent NUREG LER data summaries [4], (2) the NPRD data summary [5], and (3) the experience of people who are experts in the data field* of significant time-dependent failure modes for components typically termed "demand" components. However, since data are still scarce and the classification of a failure mode as time- or demand-related is somewhat subjective, the question is still unresolved.

In order to be conservative for the initial screening quantification, components tested at greater-than-one-month intervals had their unavailabilities calculated, assuming their failure modes were purely time related. This was done by taking Q from the data base and converting this to a λ_s based on an assumed monthly test interval:

(1) $$Q_{WASH-1400} = Q_D + 1/2\ \lambda_s\ T_{1m}$$
$$= 1/2\ \lambda_s\ T_{1m} \qquad \text{i.e., } Q_D = 0$$

(2) $$\lambda_s = 2Q_{WASH-1400}/720\text{ hr} \qquad T_{1m} = 720\text{ hr}$$

Given this failure rate, an unavailability for the component based on its actual test interval was calculated:

(3) $$Q_{actual} = 1/2\ \lambda_s\ T_{actual}$$
$$= 1/2\ 2Q_{WASH-1400}/720\text{ hr} \cdot T_{actual}$$
$$= n\ Q_{WASH-1400}$$

n = number of months in actual test interval.

The only components of this type which contributed significantly to the core melt frequency, were some circuit breakers, relays associated with the LNF logic, and an IC makeup valve which were tested only every refueling outage (i.e., every 17 months). Because of the indication that these components may have significant time-dependent failure modes, the unavailabilities were not changed in the final quantification. The significance of these components and their contribution to the total core melt frequency is discussed in the Summary and Chapter 8 of the main report. Further discussion of the whole data question can be found in the IREP Procedures Guide. [11]

C.1.1.1.1 Failure of Component to Start Function

This failure mode is applicable to components which have a pre-initiating event status different from that required after the initiating event. For active components, this failure mode implies the failure to "change state," e.g. the failure of a non-running pump to start, the failure of a closed valve to open or the failure of an open relay to close. For a passive

*Telephone conversations with W. E. Vesely and F. Leverenz of Battelle Columbus Laboratories, and J. Fragola and E. Lofgren of Science Applications, Inc.

component, this failure mode implies the failure to perform a post-initiating event function in its existing state, e.g. a normally open valve through which no flow normally passes fails to remain or be open when flow is required to pass.

Information describing this failure mode was available in terms of failure probability (q_d) or standby failure rates (λ_s). Both of these quantities depict the occurrence of failures which appear only when the component is required to function. Further, there is a relationship between λ_s and q_d which was discussed above. As will be illustrated by the examples, and as discussed previously, the analyst's engineering judgment was sometimes necessary in extrapolating failure information to specific cases, especially if test intervals were much longer than one month. (Test and maintenance outages can also contribute to the probability of a component not functioning on demand. However, because of the special nature of these contributions, their estimation is described separately in Section C.1.1.3.)

Example 1 Probability of Relay Failing to Energize on Demand (Switch failure probabilities calculated similarly)

From Table C-1, the median failure probability (q_d) for the energizing of a relay is 1E-4; the test interval is one month. In some cases, relays were tested at significantly longer intervals, e.g. at refueling outages or in other cases they are not tested at all during plant life. The estimates of their failure probabilities were generated as follows:

(A) Relay tested only at refueling

Refueling at Millstone occurs approximately every 17 months or approximately every 12000 hours.

From equation (3)

P{component failure to operate given refueling test interval}

= 17 x P{component failing to operate given monthly test interval}

$= 17 \times 10^{-4}$

$= 1.7 \times 10^{-3}$

(B) Relay not tested during plant life

To date, the Millstone Unit 1 has operated for 11 years or approximately 100,000 hours. To estimate the current probability of failure of relays which have never been tested, i.e. the probability of failure at the end of the 100,000 hour interval, it is necessary to use a variation of equation (3)

P{standby component failing to operate on demand at end of 100,000 hours}

$$= \lambda_s (t)$$

$$= (2.78 \times 10^{-7})(100{,}000)$$

$$= 2.8 \times 10^{-2}$$

where λ_s is calculated from equation (2)

Example 2 Probability of Valve Failing to Remain Open Upon Demand

In the Millstone analysis, it was found that some manual and motor operated valves (MOVs) were never tested or were tested only at refueling. To derive the failure probabilities for those valves tested only at refueling, the method described in Example 1(A) was initially used. However, it was decided, on the basis of engineering judgement, that application of this approach to normally open valves that had never been tested and were not required to change state on demand led to unrealistic (and overly conservative) estimates of the probability of this failure mode. In these instances, it was decided to use the upper bound of the range of the probability given in Table C-1:

P{never tested manual valve failure to remain open on demand}

$$= 3 \times 10^{-4}$$

P{never tested MOV failure to remain open on demand}

$$= 3 \times 10^{-4}$$

C.1.1.1.2 Failure of Component to Continue Functioning

This type of failure mode is applicable either to (i) components whose mode of operation after an initiating event remains unchanged from that prior to the initiating event or (ii) components which are successfully activated after an initiating event and must continue functioning. Operating failure rates, indicated by λ_o, are used for these estimates. The period of required continuous operation for many components after initial demand was assumed as 24 hours.

It should be noted that the estimation of the probability of this failure mode assumes that the initiating event has not, in itself, prevented continued operation of the component. This failure mode was significant primarily for pumps that must function or valves that must remain in position for some time after an initiating event; it was not generally significant for electrical components.

Example 3 <u>Failure of Pump to Continue Running</u>

To successfully perform its post-accident function, it was determined that certain components must continue to remain in position for 24 hours after their initial demand. In this example, the failure probability of a pump continuing to run for 24 hours is estimated.

From Table C-1, $\lambda_0 = 3 \times 10^{-5}\ hr^{-1}$

Assuming exponential distribution of failure times,

P{pump failing to continue running in interval (0,24 hours)}

$$= 1-e^{-\lambda_0 t}$$

$$\cong \lambda_0 t$$

$$= (3 \times 10^{-5})(24)$$

$$= 7.2 \times 10^{-4}$$

C.1.1.2 Human Error Probabilities

The treatment of human error probabilities in this analysis was a process consisting of two steps. In the first step, for use in the screening quantification described in Section C.2.1, the human error probabilities input for the basic events in the fault tree were derived from the generic data presented in NUREG/CR-1278, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications" (Draft Report).[2] The derivation of this data was based on the analysts' examinations of the particular failure modes and consultation with a human factors specialist to assure consistency among the input data. The resultant human error probabilities input for the screening quantification are shown in Table C-2.

As part of the final quantification process described in Section C.2.2, human errors that were found to contribute significantly to the probability of dominant sequences were to be reevaluated; this reevaluation would be performed to develop more realistic estimates of the prominent human errors than the conservative values used in the screening quantification. This reevaluation would entail the use of a "THERP" analysis to more rigorously derive a failure probability for the human error of interest. The THERP (Technique for Human Error Rate Prediction) approach is also developed in NUREG/CR-1278.

In the Millstone analysis, only one human error, the failure to manually depressurize the reactor system, was found to be a significant contributor to dominant accident sequences. As indicated in Table C-2, the value used in the screening quantification for failure to perform this act was 0.03. The value was used for all sequences regardless of the initiating event. Because this human error was a significant contributor to dominant sequences identified in the screening quantification, a THERP analysis was performed to develop a more realistic probability for this act. The results of the THERP analysis indicated that a value of 0.03 per act was only slightly conservative (the THERP analysis predicted 0.026 for the failure to manually depressurize) for most cases; however, a value of 0.07 per act was predicted as the failure rate for sequences in which the initiator was T_4, the loss of normal AC power. Accordingly, the estimated probability of some sequences with the T_4 initiator increased in the final quantification step. The THERP analysis for this act is presented in Appendix Section B.19.

C.1.1.3 Test and Maintenance Unavailabilities

In general, contributions to a component unavailability from test or maintenance acts arise from two sources: (i) the component is unavailable because it is in test or maintenance and (ii) the component is not functional when demanded due to a human error involved in returning the component to service after test or maintenance. In the Millstone analysis, these contributors were considered on a component level in the construction of the fault trees in contrast to the subsystem or train level consideration by other methodologies. To do this, significant interaction between the analysts and plant personnel was necessary to determine plant specific test and maintenance frequencies and times required for various test and maintenance acts. Also, the method of performing tests acts was examined particularly to determine the potential for returning a component to service prior to completion of the test. The contributions to unavailability from test and maintenance acts for each component were combined as presented in the "Fault Tree Summary Sheets" in Appendix B, but this combined total was developed by considering each of the elements described below.

<u>Unavailability Contribution Due to Time in Test</u>

When a test is performed on a component, it may require either placing the component in service or making the component unavailable for service, if needed. For example, the test of a standby pump involves starting and running the pump; thus, no contribution to the unavailability of the pump occurs simply because it is placed in test. Conversely, the testing of some components may require removing them from service, thus, introducing a contribution to the unavailability of the component. To determine the magnitude of this contribution requires knowledge of the time in test and the time between tests. Also, the method of testing is important, e.g. the possibility of readily returning the component to service should be considered. For this analysis, information on test intervals was derived from plant procedures and technical specifications; monthly test intervals were the most common, although some components were tested on a weekly, quarterly or refueling basis. Estimates of component test times for each component were based on experience of plant personnel. From this information, the only components for which a "significant" test time existed were sensors. (Pumps, air compressors and heat exchangers are either normally running or are placed in a running condition to perform the test; the cycling of valves requires only a matter of minutes.) The sensor test time was estimated as two hours. The method of testing sensors was such that, generally, the sensors were neither able to perform their function during this time nor was their output replaced by a failsafe signal; further, the sensors were not readily returnable to service. Under these conditions, the contribution to the unavailability was calculated as shown in the following example.

Example 4 Time in Test Contribution to Sensor Unavailability

For a sensor that is tested monthly with an average test time of two hours, the test time contribution to the unavailability can be calculated as:

P{Sensor unavailable because of test}

$$= \frac{\text{Avg. time (hours) for test/month}}{\text{Hours per month}}$$

$$= 2/720$$

$$= 2.78 \times 10^{-3}$$

Unavailability Contribution Due to Time in Maintenance

The Millstone plant has no scheduled maintenance, rather, maintenance is performed during plant shutdown or only on an as needed basis during operation. Therefore, the contribution to component unavailability was derived from knowledge of repair times and operating failure rates (assumed constant). Specifically, if N = the number of failures in the interval T, γ = the average component repair time and T_o = operating time of component in interval T, then

$$T_o = T - N\gamma$$

and

$$\lambda_o = N/T_o$$

$$N = \lambda_o(T - N\gamma)$$

$$= \lambda_o T - \lambda_o N\gamma$$

$$= \frac{\lambda_o T}{1+\lambda_o \gamma}$$

then

P {component is in maintenance upon demand}

$$= \frac{N\gamma}{T}$$

$$= \frac{\lambda_o \gamma}{1+\lambda_o \gamma}$$

$$\cong \lambda_o \gamma \qquad \text{if } \lambda_o \gamma << 1$$

The average component repair times, γ, used in this analysis were generally based on the operating experience of plant personnel (supplemented by maintenance records, where available) and are provided in Table C-3.

Unavailability Due to Error in Returning Component To Service From Test

Upon completion of a test, the possibility exists of incorrectly returning a component to service so that it may not function when demanded. For the analysis, a human error rate of 0.01 per act was used (see Table C-2). This human error rate was used as a blanket rate to model all of the potential human errors in properly returning a component to service. In addition, consideration was given to the detection time for these human errors. For example, some valves that are tested monthly are position checked on a weekly basis; thus, the error of incorrectly aligning a valve after its monthly test may well be discovered during its weekly position check. As another example, some errors in returning components to service would result in control room indications, thus their detection times would be expected to be very short, resulting in a negligible contribution to unavailability for these components. The following example will illustrate how these unavailabilities were evaluated:

Example 5 Contribution to Valve Unavailability Due to Error in Returning to Service from Test

If a manual valve is cycled monthly for test and position checked weekly, potential errors in returning the valve to its operational state exist. These errors include placing a failed valve back in service and leaving a functional valve incorrectly aligned. (Because of the probability of a valve failing and the significant nature of the act, it was judged that placing a failed valve back in service is much less likely than simply leaving a functional valve misaligned.) The error rate for failure to properly return a component to service after test is 0.01 per act. It is assumed that an error of incorrectly positioning a valve would be caught on the first weekly position check, thus the unavailability due to incorrectly returning the component to service is:

$$P\{\text{error per act}\}\cdot(\text{fraction of time error exists})$$

$$= (0.01)\left(\frac{\text{1 week to first check}}{\text{1 month between tests}}\right)$$

$$= (.01)(7/30)$$

$$= 2.33 \times 10^{-3}$$

If we include the possibility of error on the first weekly check, the value is not changed significantly.

Unavailability Due to Error in Returning a Component to Service from Maintenance

As was the case with returning components to service from test, errors may occur in the return of components to service from maintenance. Similarly, the exact causes of these errors were not defined, but were modeled by a blanket error rate of 0.01 per act. Therefore, as shown in Example 6, the contribution to unavailability due to incorrectly returning a component to service from maintenance is a function of the error rate, detection time, and the probability that the component required maintenance.

Example 6 Contribution to Valve Unavailability Due to Error in Returning to Service from Maintenance

If the manual valve in Example 5 were found to be defective upon its monthly test, then the potential error in returning it to service after maintenance would contribute to its unavailability.

P{Valve unavailable due to error in return to service from test}

= P{Valve requires maintenance} P{error per act}(fraction of time error exists)

$= [(\lambda_s)(720 \text{ hours})](0.01)(7/30)$

$= (2.8 \times 10^{-7})(720)(0.01)(7/30)$

$= 4.7 \times 10^{-7}$

C.1.2 Initiating Event Probabilities

As discussed in Chapter 4, two types of initiating events were analyzed for this study: loss-of-coolant accidents (LOCAs) and transients. The determination of each of the initiating event frequencies used in this analysis is discussed below.

C.1.2.1 LOCA Event Probabilities

The determination of the characteristics of the LOCA initiating events was based on the performance capabilities of the Millstone emergency core cooling systems. This capability is illustrated in the bar chart presented as Figure C-1 (also as Figure 4-1). This bar chart was adopted from the FSAR[6] and modified to preclude FWCI system operation as a response to a LOCA. This modification reduced the number of LOCA initiating events that had to be defined and was made in recognition that, for LOCA initiators, the feedwater system, of which FWCI is a part, is initially assumed available. Thus, the feedwater system as a whole was considered for LOCA initiator response, rather than simply the FWCI subsystem. (The FWCI subsystem response, however, does become important in the consideration of transient initiators, e.g. loss of normal power). Figure C-1 was further modified from that appearing in the FSAR to fit the system performance capabilities exactly to the selected break sizes. For example, the feedwater system, according to information in the FSAR, will provide adequate core cooling for liquid breaks up to about 0.22 ft^2; whereas this analysis credited feedwater mitigation for liquid breaks only to 0.20 ft^2. Such modifications were made to avoid using LOCA categories that were too finely defined for useful probabilistic analysis. These small modifications were in the conservative direction.

The resultant LOCA initiators, the systems required for mitigation and their probabilities of occurrence are provided in Table C-4.

C.1.2.2 Transient Event Probabilities

The transient initiating events that were used in the Millstone analysis were derived from two sources: EPRI NP-801[3] and plant specific considerations of the potential effects of the loss of various support systems.

The EPRI report provided the types and numbers of various transients that have occurred in the operation of BWRs through early 1978. The transients that were cataloged in EPRI NP-801 are listed as Table C-5. These transients, as well as the industry average occurrence probabilities assessed from EPRI NP-801, were analyzed to determine their applicability to the Millstone design. It was found that all of the transients in Table C-5 were potentially applicable to the Millstone design, with the exception of the inadvertent startup of a High Pressure Coolant Injection or Spray System (#33). Such a transient is not applicable because the high pressure emergency core cooling system of Millstone is the normally functioning FWCI, rather than a separate, standby system. It should also be noted that because of this unique design in which one feedwater train is qualified to emergency core cooling standards, the estimation of the probability of loss of all feedwater flow (#22) required a plant-specific approach.

The EPRI transient list was further condensed for the Millstone analysis by not considering the turbine trip with turbine bypass failure (#4) and electric load rejection with turbine bypass failure (#2) as separate initiators. This was done because the occurrence of the turbine bypass failure really represents a failure of the power conversion system (PCS) in conjunction with the actual initiating events: turbine trip (#3) or electric load rejection (#1). Because the turbine bypass failure is considered as contributing to a failure mode of the PCS, transients #2 and #4 were not separately considered to avoid "double counting."

The frequencies for the remaining transients found applicable from EPRI NP-801 are presented in Table C-6. The EPRI document included data on the number of occurrence of each of the transients over the lifetimes of each operating BWR. The frequencies indicated in Table C-6 to be from EPRI NP-801 data, were developed in assuming Millstone to be an "average" plant in terms of susceptibility to the transients. Thus, the ratio of total occurrences to total operating plant years was used as the Millstone frequency. As mentioned above, however, because of the unique design of the feedwater system, the estimation of the frequency of loss of all feedwater required a plant-specific approach. Therefore, a review of plant data was made and it was found that there had been no losses of all feedwater flow in the twelve years of plant operation at the time of this calculation. To develop the probability of this initiating event, the following assumptions were then made:

(1) The distribution of the occurrence times for a loss of all feedwater transient is exponential with unknown parameter (i.e. constant failure rate)

(2) To obtain a failure rate estimate from the twelve-year record in which no transients were observed, the conservative assumption that a loss of all feedwater transient was

(is) about to occur was made. Thus, the estimator of these transients would be

$$\hat{\lambda} = \frac{1 \text{ transient}}{12 \text{ years}} = 0.083 \text{ yr}^{-1}$$

(3) For this study, it was decided that the 50% upper confidence limit for λ, $\lambda_{50\%}$ would be used as an estimate for the loss of all feedwater transient frequency. This 50% confidence limit was used because of the realistic rather than conservative nature of this study.

With the above assumption, standard sampling techniques[7] show that the chi-square distribution may be used to obtain the 50% confidence limit for λ. In this example, there are $f = 2(n+1) = 2$ degrees of freedom, where n = total number of failures. Therefore,

$$\lambda_{50\%} = \frac{\hat{\lambda}\psi(2,50\%)}{f} = \frac{(0.083)(1.386)}{2} = 0.06 \frac{\text{transients}}{\text{year}}$$

It can be seen from Table C-6 that a few other plant specific transients and frequencies were considered in the Millstone analysis. These transients are those that result from a loss of a support system and its subsequent effect on a front line system. Specifically, they are loss of Turbine Building Secondary Closed Cooling Water, loss of Service Water, loss of Circulating Water and loss of Plant Air Compressors. The effects of such losses are described in Sections 4.2.2.1 through 4.2.2.4 of the main report. As was done for the loss of all feedwater transient, a review of plant data was made to develop occurrence frequencies for these transients. No such occurrences were found and the frequencies used in this analysis (0.06 per year) were developed in an identical manner to that for the loss of all feedwater transient.

Transient Grouping

To perform the sequence quantification in an efficient manner, it was necessary to partition the list of transient initiators into groups. This grouping was based on consideration of the effect that each transient would have on the plant systems required to mitigate the transient. Thus, for all transients in a given group, one can expect to define a major effect on plant operation that is a characteristic of that particular grouping. Further, grouping transients in this manner simplifies the sequence quantification by allowing the development of event trees in which the transient indicator can be considered independent of the subsequent events in the event tree. Five transient groupings resulted from the categorization of each transient initiator:

T_1: Most Transients - Transients placed into this grouping will, in all likelihood cause a plant trip, but in themselves do not imply the failure of a transient mitigating system.

T_2: Loss of Power Conversion System - Transients placed into this grouping cause a plant trip while simultaneously negating the normal heat removal path (i.e. through the main condenser) from the reactor.

T_3: Loss of Feedwater - Transients placed into this grouping cause a plant trip while simultaneously causing a loss of normal coolant flow to the reactor.

T_4: Loss of Normal AC Power - Two transients compose this category: loss of offsite power, and loss of auxiliary power transients. (N.B. The loss of auxiliary power transient as defined in EPRI NP-801 refers to losses of incoming power to the plant due to onsite failures such as the loss of an auxiliary transformer. It does not refer to losses of back-up power sources such as diesels.)

T_5: Inadvertent Opening of a Safety or Relief Valve - This transient is unique in that it resembles a small steam line break LOCA (less than 0.16 ft^2). Such a transient, however, releases steam through the suppression pool rather than directly into the drywell atmosphere. Thus, the automatic initiation of ECCS system due to high drywell pressure that would occur for a small break LOCA would not occur for a stuck open relief valve.

The frequencies of each of the five transient initiators are simply the sums of the individual transients, as shown in Table C-6.

C.1.3 Undeveloped Event Probabilities

For a few plant systems, detailed fault trees were not constructed to determine system unavailabilities; instead, actuarial data were used. This approach is appropriate when doing accident sequence analysis if (i) available actuarial data are judged applicable to the specific plant system and (ii) the system in question is independent from other plant systems so that common cause failures on a component level need not be considered. The data were input directly into SETS under the coding of undeveloped events, i.e. events for which fault tree development does not exist. The systems for which this approach was taken are identified below.

C.1.3.1 Power Conversion System (PCS)

The reliability of the Power Conversion System was important in two aspects of this study. One aspect is the potential of a loss of the PCS as an initiating event. In this respect, failure probabilities of any of the components of the PCS (i.e. main steam, turbine generator or turbine bypass, condenser, condensate or feedwater subsystems) contribute to the frequency of the loss of PCS as a transient (T_2) initiator. The derivation of this frequency is found in Section C.1.2.2.

The second aspect of PCS reliability relates to its function as a mitigating system responding to the T_1 type transient initiator (i.e. "most transients"). The event tree constructed for the T_1 transients has an explicit event depicting operation of the PCS (event H). As indicated in Section 5.2.2.2 of the main report, successful operation of the PCS entails successful functioning of the main steam, turbine-generator or turbine bypass, condenser, condensate and feedwater systems. Conversely, failure of the PCS on the T_1 tree could occur due to the failure to operate of any of the subsystems just mentioned. In fact, plant experience indicates that the main steam, turbine and condenser portions of the PCS are the most likely parts of the PCS to fail after a T_1 transient; the plant data indicated that the 5 failures of the PCS in 100 plant trips were due to failures of these components. However, because plant personnel felt that the PCS was more sensitive to a transient than the data indicated, a value of 0.1 per trip was used as the failure probability of PCS given a T_1 transient instead of 0.05 per trip.

C.1.3.2 Feedwater System (FWS)

As was the case for the Power Conversion System, the reliability of the Feedwater System involved two aspects. The first concerned its failure frequency as an initiating event, the T_3 transient. The derivation for this frequency is found in Section C.1.2.2.

The second aspect of the FWS reliability concerns its function as a mitigating system responding to the T_1, T_2, T_4, and T_5 transients and the LOCA events. This functioning is indicated by event C on the event trees. As for the PCS, the reliability estimate for the FWS in this instance must be a conditional probability, i.e. the probability of FWS failure given that the transient (or LOCA) has occurred. Plant data shows that there have been two losses of feedwater incidental to 113 plant trips; translating approximately to this study's conditional probability of loss of feedwater after a transient of 0.02 per demand. This value was judged applicable also to the LOCA analyses (N.B. A choice for event C on the T_1 transient event tree after a PCS loss results from the judgment that losses of PCS after a T_1 transient are dominated by main steam, turbine or condenser subsystem failures. The feedwater system can still operate successfully under these conditions.)

C.1.3.3 Vapor Suppression System (VSS)

The Vapor Suppression System is a passive system designed to mitigate the effects of a LOCA. Its function is depicted as event B on the LOCA system event trees. Failure of the VSS function implies failure to conduct an adequate amount of steam under the surface of the water in the torus where it would be condensed to prevent overpressure of the drywell. In WASH-1400 such a failure was found most likely to occur due to bypass leakage from the drywell to the torus airspace. This leakage would pressurize the torus airspace to the same level as the drywell, thus eliminating the driving force necessary to force LOCA steam from the drywell under the surface of the water in the torus. In the WASH-1400 analysis, it was found that the bypass area that could be tolerated for a large LOCA was equivalent to a 19 inch diameter pipe; the bypass area that could be tolerated for a small LOCA was equivalent to a 7 inch diameter pipe.

The WASH-1400 analysis was conducted for the Peach Bottom reactor which uses a Mark I containment, as does the Millstone reactor. Because the scope of this study did not include phenomenological analysis of LOCA accident progression, the dominant failure modes of the Millstone VSS were assumed to be the same as the Peach Bottom failure modes identified in WASH-1400. Accordingly, the median unavailabilities developed in WASH-1400 were also used in this analysis:

{Probability of VSS not performing function given Small LOCA} = 1.6×10^{-3}

{Probability of VSS not performing function given Large LOCA} = 4.6×10^{-5}

This first number is applicable to the small steam and liquid breaks; the second was used for the intermediate and large breaks.

C.1.3.4 Safety/Relief Valves

Two events involving the reactor safety/relief valves are noted on the Millstone transient event trees: failure to open automatically on high vessel pressure (event I) and failure to reclose (event J). The response of the safety/relief valves under these circumstances is independent of other plant systems.

The Millstone Unit 1 uses a two stage Target Rock design, similar to that used in the BWR analysis performed in WASH-1400. Therefore, the data used in WASH-1400 analysis were judged applicable to model the functioning of the safety/relief valves at Millstone:

P{safety/relief valve failing to open} = 3×10^{-3} per demand

P{safety/relief valve failing to close} = 1×10^{-2} per demand

C.2 Methodology of Accident Sequence Quantification

This section describes the two-step methodology used in the Millstone analysis to quantify accident sequences determined from the event tree analysis as leading to core melt. Each sequence involved an initiating event and the failure of one or more plant systems, whose failure probabilities were, in general, derived from the fault trees constructed for each system. In Section C.2.1, the technique used to arrive at a screening or initial estimate of the sequence probabilities is described. In Section C.2.2, the method for determining the final estimates of sequence probabilities, which considers recovery and human error in detail, is discussed.

C.2.1 Screening Quantification

In Chapter 5 and Appendix A, it was described how event trees were used to identify potential accident sequences leading to a core melt. These accident sequences were then quantified with the use of the Set Equation Transformation System (SETS) computer code developed by Sandia National Laboratories [8]. Theoretically, fault trees and initiating events could be simply input into SETS, linked to form the accident sequences of interest and quantified with input data to determine the probabilities of dominant accident sequences. However, such an approach is prohibitively costly because of the storage and time requirements needed by SETS or any other contemporary code to perform this task. Thus, various manipulations by the analysts were required to make the quantification process practical. The following subsections describe these manipulations and the major aspects of the process leading to the initial or "screening" estimation of dominant accident sequence probabilities.

C.2.1.1 Coding Fault Trees as Input for SETS

The first step in the quantification of accident sequences by SETS was the coding of the fault trees for input into SETS. The coding was done with the use of a uniform coding scheme for the basic fault tree events. This uniform scheme, provided as an Attachment to this Appendix, was used to assure that potential common cause failures of multiple systems were not overlooked because of inconsistent naming of basic events. After the various analysts had coded, input and debugged their fault trees, a single analyst reviewed the lists of basic events compiled for each fault tree as a rough check on the consistency of the nomenclature and failure data used by the team members. This review focused on known areas of potential common cause failures, such as common sensors or actuation relays.

C.2.1.2 Merging of Front Line and Support System Fault Trees

The top event of a fault tree (or any intermediate event) is represented in SETS by a Boolean expression. For efficiency in running SETS, it was decided to have SETS factor the Boolean expression for support systems into the expression for the front line systems they support; this is also known as merging the fault trees. (Similarly, merging of various support system fault trees was also performed.) Use of this technique allows the development of a single Boolean expression for the failure of a front line system which includes all plant failures contributing to front line system failure.

A problem involving circular logic was encountered at this stage of the quantification. This problem generally arises when two (or more) systems are dependent on each other for successful operation. Such mutual dependencies were found not to be as prevalent in the Millstone plant as for other plants analyzed in the IREP study. However, on one occasion a mutual dependency was encountered and was handled as follows.

A mutual dependency exists between the service water system (SWS) and the diesel generator at Millstone. Specifically, during a loss of offsite AC power, emergency power to the SWS is provided by the diesel generator. Additionally, continued operation of the diesel generator requires cooling by the SWS. Merging of the two fault trees results in a logic structure as shown in Figure C-2. This circular logic had to be eliminated by removing the dependence of these two systems upon each other. The important factor in determining the method to eliminate the system dependencies upon each other in the fault tree models is that a loss of service water does not result in an immediate failure of the diesel generator; the diesel will function without SWS cooling at least 1/2 to 1 hour (based on judgment of plant personnel).

As shown in Figure C-3, the SWS was analyzed, considering only component failures within the SWS. The dependence of the SWS on the diesel generator system was not considered at this time. The failure of the SWS due to the SWS component failures was input into the emergency AC power fault tree as an event that would fail the diesel generator. The dependence of the diesel generator on the SWS is thus modeled without a circular logic loop requiring the diesel generator to support itself.

In the sequence quantification, the SWS model used included the SWS dependence on the diesel generator. The diesel generator is not modeled with a direct dependence on this SWS model, although the SWS failures that do fail the diesel generator are included in the diesel generator model.

The SWS and diesel generator fault trees are no longer dependent upon each other. The SWS fault tree does include loss of power from the diesel generator as a developed event. However, the emergency AC power fault tree contains, as a failure of the diesel generator, the basic event "loss of cooling from the SWS." This event models the SWS faults that affect the diesel generator, but do not rely on the SWS fault tree.

C.2.1.3 Fault Tree Truncation

The result of the merging of the front line and support system fault trees by SETS as described in the previous section is a Boolean expression modeling a system unavailability. If this expression were to be depicted as a fault tree, such a tree would, on average, have a total of 2000 to 2500 gates and events. Combining a number of such trees to determine a sequence probability would result in expressions which are very difficult and costly to manipulate with available computer codes. Thus, it was decided to truncate the fault trees, or more accurately, truncate the equivalent Boolean expression used by SETS.

The primary criterion for truncation used in this analysis is the elimination of cutsets with probabilities of 1E-6 or less. (In a few cases, truncation was done by removing cutsets with six or more terms.) While the truncation criterion could have been applied to the fault tree as a whole, the manipulation and reduction of the complete tree by SETS is significantly more time consuming than consideration of the tree in sections. Thus, the truncation criterion was applied in a series of steps, starting from the bottom of the tree and moving through the top. The points at which the truncation criterion was applied were chosen based on the programmer's judgment; often they were 'and' gates at which there are likely to be numerous cutsets of 1E-6 probability or less. The truncation criterion was applied at approximately 30 intermediate gates to reduce the average tree. The truncated trees typically had 200 to 300 basic events and about 1000 cutsets.

C.2.1.4 Consideration of Initiating Event in Quantification of Fault Tree

In the construction of the fault trees, it was recognized that some method must be used to consider changes in the modeled system's availability as a function of the initiating event being considered. For example, the availability of an AC powered front-line system is clearly different for the simple T_1 transient (i.e. a transient which causes a plant trip but does not in itself imply the failure of a mitigating system) and a T_4 transient (i.e. loss of normal AC power transient). To accommodate this variability, the "external event" or "house event" was modeled into the fault trees. These events input into the logic gates and depict conditions that may occur rather than faults;

however, the logical processing of external events by SETS is identical to that for other basic events. To illustrate their use, Figure C-4 shows a house event indicating the presence of offsite power.

For the truncation process described in the previous section, '1' was input as the value for the external event in Figure C-4; this assures that none of the potential cutsets of the T_4 transient will be eliminated in the truncation process. However, when quantifying the fault trees, the valve for the external event is set to zero for all transients other than the T_4 transient and is set to '1' for the T_4 transient. This approach allows the construction of a single fault tree for all of the initiating events and allows the mathematical elimination of failure contributions from components not logically consistent with the chosen initiating event in the sequence quantification step. In this example, if offsite power is present (as is true for initiators other than T_4), input of zero for the external event will result in mathematical elimination of any failure contributions due to diesel failures.

C.2.1.5 Quantifying Sequences

The result of the steps performed in Sections C.2.1.1 through C.2.1.4 are Boolean expressions for systems which include cutsets whose probabilities are greater than or equal to 1E-6 based on the data presented in Section C.1. These Boolean expressions model failure modes due to support system failures as well as those due to failures within the system itself; the expressions also account for failure modes conditional on the initiating event. As described below, the Boolean expressions for various system failures were then combined with the appropriate initiating event to develop an accident sequence probability. A detailed example, the T_4S_{124} sequence, is provided as Section C.3.

It has been found for Surry and Peach Bottom[1] and confirmed in NUREG-0603/CR[9] that potential core melt accidents represent the overwhelming portion of the risk of operation of a nuclear power plant. Accordingly, only those sequences which were analyzed to result in core melt (see Appendix A) were quantified. In theory, for every core melt sequence, an initiator probability could be combined with the appropriate Boolean system models and be processed by SETS to determine the sequence probability. However, such an approach would surpass the storage capacity of SETS and entail high computer costs. For this reason and because various combinations of system successes and failures occur repeatedly in many of the sequence calculations, a more cost efficient approach was used to calculate sequence probabilities. This approach involved (i) running SETS to determine a Boolean expression to model mitigating system failures (ii) manually evaluating the effects of a complement event in the sequence analysis (iii) developing complex sequences from simpler combinations of system failures and (iv) factoring in an initiator probability to determine a complete sequence probability.

The performance of step (i) of the quantification was described earlier. As a result of using SETS, minimum cutsets with probabilities greater than or equal to 1E-6 are identified for the analyst. Step (ii) of the quantification approach implies the use of complement, i.e. success events and is necessary because most sequences involve some system successes. Because of the possibility of shared components among systems, when quantifying sequences involving successful operation of some systems, the consideration of the complement event allows the elimination of physically inconsistent occurrences in a sequence. That is, shared components of a functioning system and a failed system cannot themselves be simultaneously functioning and failed.

In theory, the complement event, or more accurately, the complement of the Boolean expression modeling system failure, can be generated by SETS, then simply factored into (by Boolean reduction) the sequence calculation. However, the size of the fault trees requiring complementing was found to be too large for SETS to handle. Thus, a manual approach was used to consider the effects of success events in the sequence analyses. An example is illustrative of this approach.

Example 7 Consideration of Success Events

It is desired to determine the probability of sequence $TA\overline{B}C$ where T represents an independent initiator of frequency 1E-4 per reactor year; A, B, C represent failed operation of systems A, B and C, respectively and $\overline{B}$ represents successful system operation.

From step (i) of the screening quantification, the minimum cutsets for the events A, B and C exist and are shown below. Components in the cutsets are represented by X_i, i = 1,2,...

A	B	C
$\{X_1\}$	$\{X_1, X_4\}$	$\{X_6\}$
$\{X_2, X_3, X_4\}$	$\{X_2, X_3\}$	$\{X_7, X_8\}$
$\{X_2, X_3, X_5\}$		
$\{X_2, X_5\}$		

It can be seen from the cutsets that system C is independent of the other systems in the sequence and in this example is also independent of the initiating event. Thus, its failure probability may be factored in with no further analysis.

By comparing the cutsets for systems A and B, however, it is noted that components X_1, X_2, X_3 and X_4 are common to both systems. Therefore, because system B functioned successfully, it is possible that some cutsets of A may not be applicable in this sequence because of physical impossibilities of A failing simultaneously with B functioning. In fact, if B has functioned successfully, the combination of X_2 and X_3 component failures cannot exist in a cutset of A, because failure of X_2 and X_3 would imply failure of B. Therefore, cutsets of A involving X_2 and X_3 may be eliminated as contributors to the unavailability of A for this sequence; specifically, cutsets $\{X_2, X_3, X_4\}$ and $\{X_2, X_3, X_5\}$ are eliminated. Conversely, cutset $\{X_1\}$ of A cannot be eliminated based on the presence of cutset $\{X_1, X_4\}$ of B because the failure of component X_1 would not, by itself, preclude successful functioning of B (i.e. both components X_1 and X_4 must fail to fail system B).

In summary, to consider system successes in a sequence, a manual comparison of system cutsets was made to remove logically inconsistent cutsets as contributors to failed systems (this process was employed to compare cutsets until the cutsets comprising approximately 90-95% of the sequence frequency had been examined); computerized complementing was not employed. Once the logically inconsistent cutsets were removed as contributors to a system's unavailability, the remaining contributors to the unavailability were added to determine the value the system's unavailability for the sequence under consideration. Availabilities for the systems depicted as working, i.e. the success events, were not explicitly calculated but were factored into the sequence estimates as '1'. This approach was used because the high reliability of the systems results in availabilities so close to '1' as to make no practical differences in the estimates of sequence probabilities; the numerical effect is a slight overestimation of the sequence probability.

These were a total of 137 sequences analyzed as leading to core melt for Millstone. Rather than analyze each sequence individually, it was observed that considerable computer costs could be saved by taking advantage of groupings of system failures and successes that are common to many systems. Therefore, step (iii) of the sequence quantification involved the development of the probabilities of more complex system combinations from the simpler ones. As mentioned previously, step (i) provided Boolean expressions to model system failures. If it was desired to model the sequences TABC and SBC$\bar{D}$, for example, the events B and C would first be multiplied (in a Boolean manner) with the use of the SETS code. The Boolean multiplication accounts for common mode failures and physical inconsistencies. The resulting product of B and C would be truncated as was done for the individual fault trees to remove cutsets with a probability of less than 1E-6. The resultant probability and cutsets would be stored. Then, for the sequence TABC, the Boolean expression for the product of B and C could be multiplied (in a Boolean manner) and truncated with SETS to derive a Boolean expression and cutsets for the combination ABC. As step (iv), the probability of the combination ABC could simply be multiplied by the independent initiator, T, to arrive at the total sequence probability. For the SBC$\bar{D}$ sequence, a comparison of the cutsets of the BC combination would be made with the cutsets of D to eliminate physically inconsistent contributors to the BC probability as described in step (ii). Then the resultant value of the BC combination would be multiplied by the independent initiator S to arrive at a total sequence probability. More complicated combinations of system successes and failures were developed in this manner to minimize the number of computer runs required to analyze all of the core melt sequences.

C.2.1.6 Results

The results of the screening quantification of the 137 core melt sequences identified in Appendix A are presented in Table C-7. Table C-7 also includes the independent factors of initiator frequency, undeveloped event probability and developed event probability which, when multiplied together, yield the sequence probability. (As was discussed in Section C.1.3, undeveloped events are independent of other events and their probabilities are based on actuarial data. The developed events are those for which fault trees were drawn and system interactions were considered.) Sequences whose probabilities were less than 1E-6 per reactor year were considered negligible (ε) contributors to the risk of operation of Millstone and were not considered further in this study. There were then left 72 sequences which were considered as significant contributors to the risk and were included in the final quantification step described in Section C.2.2.

C.2.2 Final Quantification

The final step in the quantification process was to review the 72 sequences identified by the screening quantification as having probabilities of at least 1E-6 per reactor year; the purpose of this review was to (i) credit operator recovery actions where appropriate and (ii) reevaluate sequences whose estimated probabilities are significantly affected by the human error data used in the screening quantification. The following two sections discuss these considerations in more detail. Section C.2.2.3 presents the results of the final quantification process.

C.2.2.1 Recovery Credit

For many sequences, the time from the start of the sequence to the time at which core melt is assumed as an inevitable outcome is sufficiently long to consider credit for some mitigating actions by plant personnel. Also, additional time may exist to consider operator actions to prevent containment overpressure failure. Because accounting for such recovery actions is difficult and somewhat subjective, it was performed as one of the last tasks of the quantification process when the sequences remaining to be considered were relatively few. The cutsets of these remaining sequences were then examined to determine if credit for prospective recovery actions would significantly change the sequence probability (i.e. results in approximately a 10 percent reduction, at minimum). If this was the case, recovery credit was evaluated and factored in.

In consultation with the IREP Quality Assurance Team, the IREP analysis teams developed a simple recovery model. Generally, recovery credit was considered if it involved actions that could be accomplished by an operator in the control room. However, if written procedures existed, or if significant time intervals were involved, recovery was also considered for some operator actions outside of the control room. Potential recovery actions were, therefore, related primarily to rectifying human error (e.g., valve misalignment) or to recovering the function of a component which is itself not damaged but whose expected automatic actuation mode does not function (e.g., sensor failure results in failure to provide a signal to valve). In no instance was credit given for recovery of components which have mechanically failed. Also, no credit was given for failures in the DC power system because of its complexity and the lack of procedures for rectifying faults in the system.

The time in which potential recovery actions had to be taken was considered in assigning the recovery credit. This recovery credit was input into the sequence quantification as a multiplying factor for the cutsets involving the recovery action. These factors are provided in Table C-8 as a function of the time allowed for the recovery. The first column of Table C-8 pertains to actions taken from the control room; the second relates to actions necessary outside of the control room. Thus, it can be seen that no credit would be given for reducing a cutset probability (i.e. multiplied by a factor of '1') for an operator action that must be taken from the control in less than five minutes; similarly no credit would be given for an operator action that must be taken outside of the control room within 65 minutes. (In fact, no critical operator actions were found to be required outside of the control room in less than two hours). It should be noted that the recovery factors presented in Table C-9 were used as guidelines by the analysts. Additional investigation was made to assure that the required action was not physically precluded because of accessibility, complexity or radiation problems.

An additional effect of recovery credit in the quantification process should also be mentioned. Besides reducing the probabilities of certain core melt sequences, application of a recovery action may simply change a core melt sequence of one type to a core melt sequence of another. Thus, an increase in probability of certain core melt sequences may occur due to a contribution from the core melt sequences that were only partially recovered. Accordingly, such contributions were considered in determining the final sequence probabilities presented in Section C.2.2.3.

The following sections describe the specific events in the Millstone analysis for which recovery credit was applied. With the exception of the recovery of a loss of offsite power, all of the recovery credit is due to actions by onsite plant personnel.

C.2.2.1.1 Recovery of Offsite Power

An EPRI report entitled, "Loss of Offsite Power in Nuclear Power Plants: Data and Analysis"[10], which provides a plant=specific analysis of losses of offsite power at operating plants in the U. S., was used to quantify the recovery of offsite power. A summary of the results is given below:

Time (Hours)	Probability of Failure to Recover Offsite Power
1/2	0.43
2	0.24
20	0.05

C.2.2.1.2 Isolation Condenser/Isolation Condenser Makeup

The isolation condenser (IC) and its makeup system provides a heat sink for decay heat after reactor shutdown. As described in Appendix A, in the event of a failure of the FWCI system and failure to blowdown, decay heat removal must be secured within one-half hour to prevent core melt. To secure this core heat removal, by the isolation condenser, valve IC-3 must be opened and normally open valves IC-1, IC-2 and IC-4 must remain open. Automatic actions are designed to assure this configuration, but in the event they do not, credit for operator actions to access the isolation condenser was given. This credit was for cutsets involving failures of the automatic actuation circuitry for the valves and was given because (i) redundant actuation circuitry was available from the control room, (ii) LOCA and transient procedure require verification of the IC function and (iii) in the event of a loss of normal AC power, the valves in question are either DC operated or are supplied by backup AC power. These cutsets were multiplied by a factor of 0.05 to credit operator recovery actions.

The success criteria for IC makeup is defined in Appendix A as the supply of makeup to the isolation condenser within two hours. A significant contributor to the unavailability of the makeup system is the failure of the normally closed valve IC-10 to open automatically. Recovery credit was assigned to cutsets involving this failure mode based on (i) the valve is also operable from the control room, (ii) adequate time exists for local operation of the valve, (iii) written procedures require verification of IC makeup and provide for local actions if makeup cannot be secured from the control room. These cutsets were multiplied by a factor of 0.01 to credit operator recovery actions.

C.2.2.1.3 Containment Cooling Mode of LPCI

The success criteria for this mode of LPCI operation was identified in Appendix A as 20 hours corresponding to the time in which this mode must be actuated to prevent primary containment overpressure failures. The operator has the ability to switch cooling paths from the initially selected path to any one of five alternative cooling paths and, because of this lengthy time for recovery, it was decided that only those cutsets with mechanical failures affecting both LPCI trains would not have a recovery factor assigned to them. A recovery factor of 0.01 was applied to the other cutsets to reflect the adequate time allowed for even local actions, if necessary.

C.2.2.1.4 Feedwater System

The success criteria for securing Feedwater System operation was established in Appendix A as one-half hour. For the Millstone analysis, the generic estimate for failure to recover feedwater used in WASH-1400 (for other than a loss of offsite power transient) was assumed applicable. Thus, the recovery factor for the feedwater system was 0.01.

C.2.2.2 Human Error Revision

As a result of the screening quantification which was based on the data presented in Table C-3, and after application of the recovery credit described in the preceding section, the only human error significantly contributing to the probability of a dominant sequence, was the failure to manually depressurize the system. Manual depressurization is denoted by event D in the event trees. In the screening quantification the value for failure to manually depressurize was 0.03 per act; this value was used for all cases in which manual depressurization was involved. For example, it was used both when normal AC was available and when offsite power was lost.

Because the human error of failure to manually depressurize was indicated as important in the screening quantification, a more detailed analysis of this error was performed to determine a more realistic value. The more detailed analysis consisted of the THERP tree analysis discussed in Appendix B-19. It was thought that the value of 0.03 per act used in the screening quantification was conservative, however, the THERP analysis revealed that this was not always the case. While the THERP analysis produced a failure probability of 0.026 per act for cases in which offsite power was available, it also showed that the higher value of about 0.07 per act was appropriate when offsite power was not available. Accordingly, not only were the sequences that passed the screening quantifications (i.e. those with probabilities of greater than 1E-6) reevaluated to include the new estimate for failure to manually depressurize, but also the possibility that other T_4 initiated sequences were now dominant that had not originally passed the screening quantifications had to be considered. It was found that all of the T_4 initiated sequences with failure to manually depressurize had already passed the screening quantification with the value of 0.03, thus, these probabilities were simply multiplied by a factor of (.07/.03) to account for the revised error estimate.

C.2.2.3 Results

The results of the final quantification of the 72 sequences that remained from the screening quantification step are presented in Table C-9. More exactly, Table C-9 lists the dominant sequences predicted for Millstone Unit 1, i.e., those core melt sequences whose estimated probabilities are greater than 1E-6. All other core melt sequences are estimated to have probabilities less than 1E-6 per reactor year. Also included in Table C-9 are the screening quantification values for the dominant accident sequences.

C.3 Quantification Example: Sequence T_4S_{124}

As illustrative of the sequence quantification process used in the Millstone analysis, the sequence T_4S_{124} will be presented as an example. This sequence, depicted on the event tree presented in Appendix A for the T_4 initiating event, can also be referred to either by the shorthand notation T_4KCD or by the more complete $T_4\overline{A}\overline{I}\overline{J}KCD\overline{G}$. Explicitly, the T_4S_{124} sequence involves the loss of normal AC power (T_4) initiating event; shutdown of the reactor ($\overline{A}$); opening and closing of the safety/relief valves ($\overline{I}$ and $\overline{J}$, respectively); failure of the isolation condenser (K); failure of the feedwater coolant injection system (C); failure to manually depressurize the system (D); and successful operation of the containment cooling mode of LPCI ($\overline{G}$). This sequence was predicted to result in a short (less than three hours) core melt time and a delayed radionuclide release time. The quantification of the T_4S_{124} sequence is described in detail in the following sections.

C.3.1 Screening Quantification

The T_4S_{124} sequence includes an initiating event (T_4), undeveloped events (I,J), and events for which fault trees were constructed to model failures. As described in Sections C.1.2.2 and C.1.3, the initiating and undeveloped events are independent of the other events in the sequence. The event D represents the failure of the operator to manually depressurize the system; the probability of this event occurring was also judged to be independent of other events in the sequence. Thus, to consider the effects of events T_4, I, J and D on the total sequence probability required simply multiplying their probabilities of occurrence with the balance of the sequence occurrence probability. The probability of occurrence of the balance of the T_4S_{124} sequence involves the determination of the probability of the combination of events $\overline{A}KC\overline{G}$. These events cannot be assumed to be independent, and accordingly, interactions among them must be considered.

As described in Section C.2.1.5, calculation of the probability of the combination of events $\bar{A}KC\bar{G}$ would occur by first using SETS to develop the Boolean expression and probability for the event combination KC. When using SETS to develop the cutsets for systems or combinations of systems in this sequence, the external ("house") event accounting for loss of normal AC power was set to '1' as described in Section C.2.1.4. Also, the truncation value of 1E-6 was used in this step resulting in an output from SETS of 1358 cutsets with probabilities of 1E-6 or greater for the event combination KC. The estimated probability of this event combination was 1.9E-2.

The Boolean expression for the combination KC was then manually compared with the Boolean expression for event G. (The Boolean expression for event G was produced by SETS using a truncation value of 1E-6.) The purpose of this comparison was to remove logically inconsistent cutsets from the combination $KC\bar{G}$ as described in Section C.2.1.5 (see Example 7). Performance of this step eliminated only a few logically inconsistent cutsets of the event combination KC when combined with the event $\bar{G}$ (i.e. successful functioning of containment cooling). At this point, the number of logically possible cutsets of the combination $KC\bar{G}$ was 1348. Their total probability was still 1.9E-2. This is also the value of the event combination KCG because the values of success events (e.g., $\bar{G}$) are taken as '1' in the quantification process.

Formally, the Boolean expression for the combination $KC\bar{G}$ should then have been compared with the cutsets of event A (failure of the Reactor Protection System) to determine logically inconsistent cutsets as was done for event G. This was not necessary, however, because a review of the cutsets output by SETS for the fault tree constructed the Reactor Protection System revealed that (i) the only system on which the RPS was dependent to perform its function was DC power and (ii) failures of the DC power system did not appear in the dominant cutsets of the RPS system, but were related to failures of manual scram as backup to automatic actions. Therefore, the RPS was judged independent of other systems in the T_4S_{124} sequence and its probability of success, taken as '1' could be simply factored into the sequence calculation. The probability of the combination $\bar{A}KC\bar{G}$ was, then, 1.9E-2.

Multiplying the value of $\bar{A}KC\bar{G}$ with the independent probabilities for T_4 (0.20 from Section C.1.2.2), D (0.03 from C.1.1.2), and $\bar{I}$ and $\bar{J}$ yields a value for the T_4S_{124} sequence at the screening quantification stage of

$$P\{T_4S_{124}\} = P\{T_4\}\ P\{\bar{I}\}\ P\{\bar{J}\}\ P\{\bar{A}KC\bar{G}\}\ P\{D\}$$

$$= (0.20)(1)(1)(1.9E\text{-}2)(0.03)$$

$$= 1.1E\text{-}4 \text{ per Reactor Year}$$

Clearly, the T_4S_{124} sequence cannot be eliminated as a significant contributor to the core melt probability on the basis of the screening quantification. Thus, it was necessary to reevaluate the sequence in the final quantification stage to include recovery and more exact human error data in the sequence probability estimate.

A sampling of the dominant cutsets or groupings of cutsets for the T_4S_{124} sequence (or more exactly, the $\bar{A}KC\bar{G}$ portion of the sequence) is provided in Table C-10. The probability of the T_4S_{124} sequence at the screening stage is due to many small contributors which are too numerous to list; e.g. as seen in Table C-10 the largest cutset contributed only three percent of the total sequence probability. This cutset involved failure of the gas turbine generator, which results in failure of FWCI, coupled with failure of the isolation condenser due to an operator error in failing to place valve IC-3 in the "auto" position (thus preventing its automatic opening on demand). Table C-10 also shows some sample groupings of cutsets based on the similarity of components in the cutsets. Even when considered in this manner, the probability of the T_4S_{124} sequence can be seen as due to numerous diverse sources.

C.3.2 Final Quantification

As described in Section C.2.2, final quantification of sequences identified as dominant in the screening quantification required consideration of possible recovery actions and a more realistic evaluation of significant human errors. After application of the recovery factors described in the following paragraphs, the only human error that was part of a sequence cutset contributing at least 10 percent to the total sequence probability was the failure to manually depressurize the system. The probability of this independent event was increased from 0.03 used in the screening quantification to 0.07 for the final quantification. (The basis for this reevaluation was presented in Section C.2.2.2.) The estimate of the sequence probability with this revision alone would be 2.66E-4 per reactor year.

Recovery actions for the T_4S_{124} sequence were possible for the loss of normal AC initiating event and the loss of the isolation condenser. The recovery of offsite power was the easier of the two to consider and was done first; in this way the analysis could be terminated at this point if the application of the recovery factor for offsite power reduced the sequence probability to less than 1E-6 per reactor year. However, because offsite power must be recovered within one-half hour to prevent a core melt from this sequence, application of a recovery factor for offsite power (see Section C.2.2.1.1) of 0.43 only reduces the sequence probability to 1.1E-4 per reactor year.

Thus, there remained to consider a recovery factor for the isolation condenser. As discussed in Section C.2.2.1.2, a recovery factor of 0.05 may be applied to cutsets involving failures of the automatic actuation circuitry for valves IC-1, IC-2, IC-3 and IC-4. This recovery factor was a function of possible operator actions from the control room and a one-half hour recovery period. A review of the sequence cutsets revealed that cutsets containing recoverable isolation condenser faults comprise approximately 78 percent of the sequence probability. The effect of the application of the recovery factor to these cutsets reduces the screening quantification value of 1.9E-2 to 4.92E-3 for the event combination $\bar{A}KC\bar{G}$.

The final quantification value for the T_4S_{124} sequence was determined by considering both the possible recovery actions and the revised human error estimate, as shown below.

$$P\{T_4S_{124}\} = P\{T_4\}\ P\{T_4 \text{ not recovered}\}\ P\{\bar{I}\}\ P\{\bar{J}\}\ P\{D \text{ revised}\} \times$$
$$P\{\bar{A}K\bar{C}\bar{G} \text{ revised to consider probability of recovering recoverable faults in } K\}$$
$$= (0.20)(0.43)(1)(1)(0.07)(4.92E\text{-}3)$$
$$= 2.96E\text{-}5 \text{ per reactor year}$$

The dominant contributors to the final quantification value are shown in Table C-11. As can be seen from that table, the probability of the T_4S_{124} sequence is distributed over a number of cutsets. The most significant grouping of cutsets contributes only about 12 percent of the total core melt probability.

C.4 Assignment of Dominant Sequences to Release Categories

To gain a measure of the risk of operation of a nuclear plant requires both an assessment of the probabilities of certain accident sequences and an understanding of the consequences of those sequences. As stated before, the accident sequences of concern in this analysis are those leading to core melt. These sequences have been identified and their probabilities presented in the report. To assess the consequences of these accident sequences requires some consideration of the phenomenology of each accident sequence.

Battelle Columbus Laboratories was given a list of the dominant sequences leading to core melt. They then analyzed each sequence and assigned containment failure mode probabilities and release categories based on similar plants in WASH-1400 and the Reactor Safety Study Methodology Applications Program (RSSMAP). A discussion and tables of the results appear in Chapter 8 of the main report.

Table C-1a Mechanical Component Failure Rate Data
(from WASH-1400, Table III 4-1)

COMPONENT & FAILURE MODE	FAILURE RATE TYPE	ASSESSED RANGE		MEDIAN	EF
Pumps (includes driver):					
Motor & turbine driven (generic class):					
Failure to start on demand:	D (A)	3E-4	3E-3	1E-3	3
Failure to run, given start (normal environments):	0	3E-6	3E-4	3E-5	10
Failure to run, given start (extreme, post accident environments inside containment):	0	1E-4	1E-2	1E-3	10
Failure to run, given start (post accident, after environmental recovery):	D	3E-5	3E-3	3E-4	10
Turbine driven pumps:					
Failure to start on demand:	D	1E-3	1E-2	3E-3	3 A
Failure to run, given start (normal environment):	0	1E-5	1E-4	3E-5	3 A
Valves:					
Motor operated:					
Failure to operate (includes driver):	D (B)	3E-4	3E-3	1E-3	3
Failure to remain open (plug):	D (C)	3E-5	3E-4	1E-4	3
Failure to remain open (plug):	s	1E-7	1E-6	3E-7	3
Rupture:	s	1E-9	1E-7	1E-8	10
Solenoid operated:					
Failure to operate:	D (D)	3E-4	3E-3	1E-3	3
Failure to remain open (plug):	D	3E-5	3E-4	1E-4	3
Rupture:	s	1E-9	1E-7	1E-8	10
Air-fluid operated:					
Failure to operate:	D (B)	1E-4	1E-3	3E-4	3
Failure to remain open (plug):	D	3E-5	3E-4	1E-4	3
Failure to remain open (plug):	s	1E-7	1E-6	3E-7	3
Rupture:	s	1E-9	1E-7	1E-8	10
Check valves:					
Failure to open:	D	3E-5	3E-4	1E-4	3
Internal leak (severe):	D	1E-7	1E-6	3E-7	3
Rupture:	s	1E-9	1E-7	1E-8	10
Vacuum Valve:					
Failure to operate:	D	1E-5	1E-4	3E-5	3

Table C-1a (Concluded)

COMPONENT & FAILURE MODE	FAILURE RATE TYPE	ASSESSED RANGE		MEDIAN	EF	
Manual Valve:						
Failure to operate:	D	3E-5	3E-4	1E-4	3	A
Failure to remain open (plug):	D	3E-5	3E-4	1E-4	3	
Rupture:	s	1E-9	1E-7	1E-8	10	
Primary Safety Valves (PWRs):						
Failure to open:	D	1E-3	1E-2	3E-3	3	R
Premature open:	s	1E-6	1E-5	3E-6	3	R
Failure to reclose (given valve open):	D (E)	3E-3	3E-2	1E-2	3	R
Primary safety valves (BWRs):						
Failure to open:	D	3E-3	3E-2	1E-2	3	R
Premature open:	s	1E-6	1E-5	3E-6	3	R
Failure to reclose (given valve open):	D	1E-3	1E-2	3E-3	3	R
Test Valves, Flow Meters, Orifices:						
Failure to remain open (plug):	D	1E-4	1E-3	3E-4	3	
Rupture:	s	1E-9	1E-7	1E-8	10	
Pipes						
Pipe ≤ 3-inch diameter (per section):						
Rupture/plug:	s + 0	3E-11	3E-8	1E-9	30	
Pipe > 3-inch diameter (per section):						
Rupture/plug:	s + 0	3E-12	3E-9	1E-10	30	
Clutch, Mechanical:						
Failure to operate:	D (D)	1E-4	1E-3	3E-4	3	
Scram Rods (Single):						
Failure to insert:	D	3E-5	3E-4	1E-4	3	

Table C-1b Electrical Component Failure Rate Data
(from WASH-1400, Table III 4-2)

COMPONENT & FAILURE MODE	FAILURE RATE TYPE	ASSESSED RANGE		MEDIAN	EF
Clutch, Electrical:					
Failure to operate:	D (B)	1E-4	1E-3	3E-4	3
Premature disengagement:	0	1E-7	1E-5	1E-6	10
Motors, Electric:					
Failure to start:	D (B)	1E-4	1E-3	3E-4	3
Failure to run, given start (normal environment):	0	3E-6	3E-5	1E-5	3
Failure to run, given start (extreme environment):	0	1E-4	1E-2	1E-3	10
Relays:					
Failure to energize:	D (B)	3E-5	3E-4	1E-4	3
Failure of NO contacts to close, given energized:	0	1E-7	1E-6	3E-7	3
Failure of NC contacts by opening, given not energized:	0	3E-8	3E-7	1E-7	3
Short across NO/NC contact:	0	1E-9	1E-7	1E-8	10
Coil open:	0	1E-8	1E-6	1E-7	10
Coil short to power:	0	1E-9	1E-7	1E-8	10
Circuit Breakers:					
Failure to transfer:	D (B)	3E-4	3E-3	1E-3	3
Premature transfer:	0	3E-7	3E-6	1E-6	3
Switches:					
Limit:					
Failure to operate:	D	1E-4	1E-3	3E-4	3
Torque:					
Failure to operate:	D	3E-5	3E-4	1E-4	3
Pressure:					
Failure to operate:	D	3E-5	3E-4	1E-4	3
Manual:					
Failure to transfer:	D	3E-6	3E-5	1E-5	3
Switch Contacts:					
Failure of NO contacts to close, given switch operation:	0	1E-8	1E-6	1E-7	10
Failure of NC by opening, given no switch operation:	0	3E-9	3E-7	3E-8	10
Short across NO/NC contact:	0	1E-9	1E-7	1E-8	10

Table C-1b (Concluded)

COMPONENT & FAILURE MODE	FAILURE RATE TYPE	ASSESSED RANGE		MEDIAN	EF
Battery Power System (Wet Cell):					
Failure to provide proper output:	s	1E-6	1E-5	3E-6	3
Transformers:					
Open circuit primary or secondary:	0	3E-7	3E-6	1E-6	3
Short primary to secondary:	0	3E-7	3E-6	1E-6	3
Solid State Devices, Hipower Applications (Diodes, Transistors, etc.):					
Fails to function:	0	3E-7	3E-5	3E-6	10
Fails shorted:	0	1E-7	1E-5	1E-6	10
Solid State Devices, Low Power Applications:					
Fails to function:	0	1E-7	1E-5	1E-6	10
Fails shorted:	0	1E-8	1E-6	1E-7	10
Diesels (Complete Plant):					
Failure to start:	D	1E-2	1E-1	3E-2	3
Failure to run, emergency conditions, given start:	0	3E-4	3E-2	3E-3	10
Diesels (Engine Only):					
Failure to run, emergency conditions, given start:	0	3E-5	3E-3	3E-4	10
Instrumentation--General (Includes transmitter, amplifier and output device):					
Failure to operate:	0	1E-7	1E-5	1E-6	10
Shift in calibration:	0	3E-6	3E-4	3E-5	10
Fuses:					
Failure to open:	D	3E-6	3E-5	1E-5	3
Premature open:	0	3E-7	3E-6	1E-6	3
Wires (typical circuits, several joints):					
Open circuit:	0	1E-6	1E-5	3E-6	3
Short to ground:	0	3E-8	3E-6	3E-7	10
Short to power:	0	1E-9	1E-7	1E-8	10
Terminal Boards:					
Open connection:	0	1E-8	1E-6	1E-7	10
Short to adjacent circuit:	0	1E-9	1E-7	1E-8	10

NOTES:

(A) Demand probabilities are based on the presence of proper input control signals. For turbine pumps, the effect of failures of valves, sensors, and other auxiliary hardware may result in significantly higher overall failure rates for turbine driven pump systems.

(B) Demand probabilities are based on presence of proper input control signals.

(C) Plug probabilities are given in demand probability, and per hour rates, since phenomena are generally time-dependent, but plugged condition may only be detected upon a demand of the system.

(D) Demand probabilities are based on presence of proper input control signals.

(E) These rates are based on LERs for B&W pressurizer PORV failure to reseat given the valve has opened.

ABBREVIATIONS:

(1) For failure rate type abbreviations:
D = demand failure rate--failures per demand
O = operating failure rate--failures per hour of operation
S = standby failure rate--failures per hour of standby
S+D = standby or operating failure rate--failures per hour

(2) Remarks (last column) abbreviations:
R = failure rate shown is a revision of WASH-1400 value
A = failure rate shown is in addition to WASH-1400 failure rates.

Table C-2 Human Error Probabilities for Screening Quantification

Error Type	Probability (per act)
Errors of Omission	0.01
Failure to manually depressurize system[1]	0.03
Failure to restore (e.g., following a test or maintenance act)	0.01
Errors of Commission	0.003
Miscalibration	0.001
Backup Action[2]	0.05

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[1]Because manually depressurizing the system involves significant and unique physical effects (e.g., possibly uncovering the core), this particular error of omission was assigned a higher value to reflect possible operator reluctance to perform this action. This value was used in the screening quantification for all conditions under which manual depressurization was required.

[2]This type of action is similar to the recovery actions which were generally considered in the final quantification as described in Appendix C, Section C.2.2.1. However, in a few situations, written procedures mandated that plant personnel check an automatic action. In these instances, the possibility of a human backup action was explicitly modeled on the fault trees, with 0.05-per-act used as the probability of failure to perform the backup action.

Table C-3 Millstone Average Component Repair Times

Component	Repair Time, γ, (hours)
Valve (all types)	10
Pump (except SWS)	24
Pump (SWS)	168
Relay	1
Heat Exchanger	2

(N.B. Heat Exchanger times were determined from NPRDS data)

Table C-4 LOCA Initiating Event Summary

Initiating Event	Mitigating System Requirements	Probability[1] (Per Reactor Year)
Small Steam Break (SSB) (up to 0.16 ft^2)	Feedwater System or 2 of 4 LPCI pumps and APRS or 1 of 2 LPCS pumps and APRS	1×10^{-3}
Small Liquid Break (SLB) (up to 0.15 ft^2)	Feedwater System or 2 of 4 LPCI pumps and APRS or 1 of 2 LPCS pumps and APRS	1×10^{-3}
Intermediate Steam Break (ISB) (0.16 ft^2 - 0.19 ft^2)	Feedwater System or 2 of 4 LPCI pumps or 1 of 2 LPCS pumps and APRS	1×10^{-4}
Intermediate Liquid Break (ILB) (0.15 ft^2 - 0.2 ft^2)	Feedwater System or 2 of 4 LPCI pumps and APRS or 1 of 2 LPCS pumps	1×10^{-4}
Large Steam Break (LSB) (0.19 ft^2 - 2.2 ft^2)	Feedwater System or 2 of 4 LPCI pumps or 1 of 2 LPCS pumps	1×10^{-4}
Large Liquid Break (LLB) (0.2 ft^2 - 5.8 ft^2)	2 of 4 LPCI pumps or 1 of 2 LPCS pumps	1×10^{-4}

[1] Break probabilities are taken from WASH-1400.

Table C-5 BWR Transient Categories From EPRI NP-801

1. Electric Load Rejection
2. Electric Load Rejection with Turbine Bypass Valve Failure
3. Turbine Trip
4. Turbine Trip with Turbine Bypass Valve Failure
5. Main Stream Isolation Valve Closure
6. Inadvertent Closure of One MSIV (Rest Open)
7. Partial MSIV Closure
8. Loss of Normal Condenser Vacuum
9. Pressure Regulator Fails Open
10. Pressure Regulator Fails Closed
11. Inadvertent Opening of a Safety/Relief Valve (Stuck)
12. Turbine Bypass Fails Open
13. Turbine Bypass or Control Valves Cause Increase Pressure (Closed)
14. Recirculation Control Failure-Increasing Flow
15. Recirculation Control Failure-Decreasing Flow
16. Trip of One Recirculation Pump
17. Trip of All Recirculation Pumps
18. Abnormal Startup of Idle Recirculation Pump
19. Recirculation Pump Seizure
20. Feedwater-Increasing Flow at Power
21. Loss of Feedwater Heater
22. Loss of All Feedwater Flow
23. Trip of One Feedwater Pump (or Condensate Pump)
24. Feedwater-Low Flow
25. Low Feedwater Flow During Startup or Shutdown
26. High Feedwater Flow During Startup or Shutdown
27. Rod Withdraw at Power
28. High Flux Due to Rod Withdrawal at Startup
29. Inadvertent Insertion of Rod or Rods
30. Detected Fault in Reactor Protection System
31. Loss of Offsite Power
32. Loss of Auxiliary Power (Loss of Auxiliary Transformer)
33. Inadvertent Startup of HPCI/HPCS
34. SCRAM Due to Plant Occurrences
35. Spurious Trip via Instrumentation, RPS Fault
36. Manual SCRAM-No Out-of-Tolerance Condition
37. Cause Unknown

Table C-6 Transient Classes and Frequencies

CLASS	TRANSIENT	FREQUENCY (PER YR)		SOURCE OF DATA
T_1	MOST TRANSIENTS	6.60		
	Electric Load Rejection		1.04	NP-801
	Turbine Trip		1.41	NP-801
	Partial MSIV Closure		.04	NP-801
	Pressure Regulator Fails Closed		.14	NP-801
	Turbine Bypass Fails Open		.04	NP-801
	Control Valves Fail Closed		.51	NP-801
	Recirc Control Failure-Increasing Flow		.24	NP-801
	Recirc Control Failure-Deceasing Flow		.06	NP-801
	Trip of One Recirc Pump		.02	NP-801
	Trip of All Recirc Pumps		.06	NP-801
	Abnormal Startup of Idle Recirc Pump		ε	NP-801
	Recirc Pump Seizure		ε	NP-801
	Loss of Feedwater Heating		.02	NP-801
	Trip of One Feedwater Pump		.20	NP-801
	Feedwater-Low Flow		.43	NP-801
	Low Feedwater During Startup or Shutdown		.33	NP-801
	High Feedwater During Startup or Shutdown		.10	NP-801
	Rod Withdrawal at Power		ε	NP-801
	High Flux Due to Rod Withdrawal at Startup		.04	NP-801
	Inadvertent Insertion of Rod or Rods		.10	NP-801
	Scram Due to Plant Occurrences		.35	NP-801
	Spurious Trip via Instrumentation, RPS Fault		1.16	NP-801
	Manual Scram, No Out-of-Tolerance Condition		.27	NP-801
	Cause Unknown		.02	NP-801
	Detected Fault in RPS		.02	NP-801
T_2	LOSS OF POWER CONVERSION SYSTEM*	2.14		
	MSIV Closure		.67	NP-801
	Closure of 1 MSIV		.08	NP-801
	Loss of Condenser Vacuum		.67	NP-801
	Feedwater-Increasing Flow		.31	NP-801
	Pressure Regulator Fails Open		.29	NP-801
	Loss of Circulating Water System		.06	Plant Data
	Loss of Plant Air Compressors		.06	Plant Data
T_3	LOSS OF FEEDWATER	.18		
	Loss of All Feedwater Flow		.06	Plant Data
	Loss of Turbine Building Closed Cooling Water System		.06	Plant Data
	Loss of Service Water System		.06	Plant Data
T_4	LOSS OF NORMAL AC POWER	.20		
	Loss of Offsite Power		.16	NP-801
	Loss of Auxiliary Power		.04	NP-801
T_5	SAFETY/RELIEF VALVE TRANSIENT	.20		
	Inadvertent Opening of a S/R Valve		.20	NP-801

* Other than loss of feedwater

Table C-7 Summary Results of Screening Quantification Key to Accident Sequence Symbols

EVENT TREE SYMBOL	FRONT LINE SYSTEM FAILURE
A	Reactor Protection System (RPS)
B	Vapor Suppression (VS)
C	Feedwater System (or Feedwater Coolant Injection System)(FW) or (FWCI)
D	Manual Depressurization (MDP) or Automatic Pressure Release System (APR)
E	Low Pressure Coolant Injection System (LPCI)
F	Core Spray System (CS)
G	Containment Cooling Mode of LPCI (CC)
H	Power Conversion System (PCS)
I	Safety/Relief Valve Open (S/R VO)
J	Safety/Relief Valve Reclose (S/R VR)
K	Isolation Condenser System (IC)
L	Isolation Condenser Makeup System (ICMUP)
M	Shutdown Cooling System (SDC)
T_1	All Transient (except T_2, T_3, T_4, and T_5) Initiators
T_2	Loss of PCS Transient Initiator
T_3	Loss of All Feedwater Transient
T_4	Loss of Normal AC Power
T_5	Safety Relief Valve Transients (Inadvertent Openings)
SB	Small Break (Steam and Liquid)
ISB	Intermediate Steam Break
LSB	Large Steam Break
ILB	Intermediate Liquid Break
LLB	Large Liquid Break

Table C-7 (cont'd) Dominant Accident Sequences Obtained Through Screening Quantifications

T_1-59	2.6×10^{-4}	T_2-128	3.9×10^{-5}	T_4-102	1.3×10^{-4}	T_4-134	1.5×10^{-4}
T_1-62	2.3×10^{-6}	T_2-134	1.3×10^{-6}	T_4-105	2.2×10^{-2}	T_4-135	1.5×10^{-6}
T_1-65	2.9×10^{-6}	T_2-137	2.3×10^{-5}	T_4-108	1.3×10^{-2}	T_4-136	1.1×10^{-4}
T_1-68	3.1×10^{-5}	T_2-140	1.7×10^{-5}	T_4-109	5.8×10^{-5}	T_4-137	1.6×10^{-4}
T_1-72	3.3×10^{-5}	T_3-144	3.1×10^{-5}	T_4-110	5.8×10^{-3}	T_4-138	4.9×10^{-5}
T_1-81	1.6×10^{-5}	T_3-147	4.0×10^{-5}	T_4-111	2.5×10^{-3}	T_4-140	1.6×10^{-6}
T_1-85	1.2×10^{-5}	T_3-148	1.2×10^{-6}	T_4-112	2.7×10^{-3}	T_5-176	2.0×10^{-4}
T_1-94	7.1×10^{-6}	T_3-150	4.3×10^{-4}	T_4-115	5.5×10^{-5}	T_5-179	2.0×10^{-5}
T_1-98	5.3×10^{-6}	T_3-151	2.5×10^{-6}	T_4-118	7.6×10^{-4}	T_5-188	1.2×10^{-5}
T_2-102	8.5×10^{-4}	T_3-157	1.2×10^{-5}	T_4-121	3.5×10^{-4}	T_5-190	1.6×10^{-6}
T_2-105	7.4×10^{-6}	T_3-160	2.2×10^{-4}	T_4-122	2.5×10^{-6}	SB-2	3.0×10^{-5}
T_2-108	9.6×10^{-6}	T_3-167	5.2×10^{-5}	T_4-123	1.8×10^{-4}	SB-9	5.6×10^{-6}
T_2-111	1.0×10^{-4}	T_3-168	1.3×10^{-6}	T_4-124	2.7×10^{-4}	SB-11	3.2×10^{-6}
T_2-115	1.1×10^{-4}	T_3-170	9.7×10^{-5}	T_4-125	8.8×10^{-5}	ISB-14	1.5×10^{-6}
T_2-121	2.8×10^{-6}	T_3-171	1.3×10^{-6}	T_4-128	2.4×10^{-5}	ILB-26	1.5×10^{-6}
T_2-124	5.2×10^{-5}	T_3-173	1.4×10^{-6}	T_4-131	2.5×10^{-4}	LSB-38	1.5×10^{-6}

Table C-7 (Continued)
T_1: Most Transient

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
T_1-59	T_1HLMG	6.60	0.1	4.0×10^{-4}	2.6×10^{-4}
T_1-62	T_1HLCMG	6.60	2×10^{-3}	1.7×10^{-4}	2.3×10^{-6}
T_1-65	T_1HLCEMG	6.60	2×10^{-3}	2.2×10^{-4}	2.9×10^{-6}
T_1-66	T_1HLCEF	6.60	2×10^{-3}	6.8×10^{-6}	ε
T_1-67	T_1HLCEFG	6.60	2.6×10^{-3}	3.4×10^{-6}	ε
T_1-168	T_1HLCD	6.60	6×10^{-5}	7.9×10^{-2}	3.1×10^{-5}
T_1-69	T_1HLCDG	6.60	6×10^{-5}	4.5×10^{-4}	ε
T_1-72	T_1HKMG	6.60	0.1	5.0×10^{-5}	3.3×10^{-5}
T_1-75	T_1HKCMG	6.60	2×10^{-3}	ε	ε
T_1-78	T_1HKCEMG	6.60	2×10^{-3}	6.6×10^{-5}	ε
T_1-79	T_1HKCEF	6.60	2×10^{-3}	ε	ε
T_1-80	T_1HKCEFG	6.60	2×10^{-3}	ε	ε

Table C-7 (Continued)

T_1: Most Transient

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
T_1-81	T_1HKCD	6.60	6×10^{-5}	4.1×10^{-2}	1.6×10^{-5}
T_1-82	T_1HKCDG	6.60	6×10^{-5}	1.5×10^{-4}	ϵ
T_1-85	T_1HJMG	6.60	1.8×10^{-3}	1.0×10^{-3}	1.2×10^{-5}
T_1-88	T_1HJCMG	6.60	3.6×10^{-5}	2.5×10^{-5}	ϵ
T_1-91	T_1HJCEMG	6.60	3.6×10^{-5}	1.7×10^{-3}	ϵ
T_1-92	T_1HJCEF	6.60	3.6×10^{-5}	3.8×10^{-4}	ϵ
T_1-93	T_1HJCEFG	6.60	3.6×10^{-5}	1.3×10^{-4}	ϵ
T_1-94	T_1HJCD	6.60	1.1×10^{-6}	N/A	7.1×10^{-6}
T_1-95	T_1HJCDG	6.60	1.1×10^{-6}	1.4×10^{-2}	ϵ
T_1-96	T_1HI	6.60	0.1	N/A	ϵ
T_1-98	T_1AH	6.60	8×10^{-7}	N/A	5.3×10^{-6}

Table C-7 (Continued)

T_2: Loss of PCS (Excluding Feedwater) Transients

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
T_2-102	T_2LMG	2.14	N/A	4.0×10^{-4}	8.5×10^{-4}
T_2-105	T_2LCMG	2.14	0.02	1.7×10^{-4}	7.4×10^{-6}
T_2-108	T_2LCEMG	2.14	0.02	2.2×10^{-4}	9.6×10^{6}
T_2-109	T_2LCEF	2.14	0.02	6.8×10^{-6}	ε
T_2-110	T_2LCEFG	2.14	0.02	3.4×10^{-6}	ε
T_2-111	T_2LCD	2.14	6×10^{-4}	7.9×10^{-2}	1.0×10^{-4}
T_2-112	T_2LCDG	2.14	6×10^{-4}	4.5×10^{-4}	ε
T_2-115	T_2KMG	2.14	N/A	5.0×10^{-5}	1.0×10^{-4}
T_2-118	T_2KCMG	2.14	0.02	ε	ε
T_2-121	T_2KCEMG	2.14	0.02	6.6×10^{-5}	2.8×10^{-6}
T_2-122	T_2KCEF	2.14	0.02	ε	ε

Table C-7 (Continued)

T_2: Loss of PCS (Excluding Feedwater) Transients

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
T_2-123	T_2KCEFG	2.14	0.02	ε	ε
T_2-124	T_2KCD	2.14	6×10^{-4}	4.1×10^{-2}	5.2×10^{-5}
T_2-125	T_2KCDG	2.14	6×10^{-4}	1.5×10^{-4}	ε
T_2-128	T_2JMG	2.14	1.8×10^{-2}	1.0×10^{-3}	3.9×10^{-5}
T_2-131	T_2JCMG	2.14	3.6×10^{-4}	2.5×10^{-5}	ε
T_2-134	T_2JCEMG	2.14	3.6×10^{-4}	1.7×10^{-3}	1.3×10^{-6}
T_2-135	T_2JCEF	2.14	3.6×10^{-4}	3.8×10^{-4}	ε
T_2-136	T_2JCEFG	2.14	3.6×10^{-4}	1.3×10^{-4}	ε
T_2-137	T_2JCD	2.14	1.1×10^{-5}	N/A	2.3×10^{-5}
T_2-138	T_2JCDG	2.14	1.1×10^{-5}	1.4×10^{-2}	ε
T_2-139	T_2I	2.14	N/A	N/A	ε
T2-140	T2A	2.14	8 x 10-6	N/A	1.7 x 10-5

Table C-7 (Continued)

T_3: Loss of All Feedwater Transients

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
T_3-144	T_3LMG	0.18	N/A	1.7×10^{-4}	3.1×10^{-5}
T_3-147	T_3LEMG	0.18	N/A	2.2×10^{-4}	4.0×10^{-5}
T_3-148	T_3LEF	0.18	N/A	6.8×10^{-6}	1.2×10^{-6}
T_3-149	T_3LEFG	0.18	N/A	3.4×10^{-6}	ε
T_3-150	T_3LD	0.18	0.03	7.9×10^{-2}	4.3×10^{-4}
T_3-151	T_3LDG	0.18	0.03	4.5×10^{-4}	2.5×10^{-6}
T_3-154	T_3KMG	0.18	N/A	ε	ε
T_3-157	T_3KEMG	0.18	N/A	6.6×10^{-5}	1.2×10^{-5}
T_3-158	T_3KEF	0.18	N/A	ε	ε
T_3-159	T_3KEFG	0.18	N/A	ε	ε
T_3-160	T_3KD	0.18	0.03	4.1×10^{-2}	2.2×10^{-4}
T_3-161	T_3KDG	0.18	0.03	1.5×10^{-4}	ε

Table C-7 (Continued)

T_3: Loss of All Feedwater Transients

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
T_3-164	T_3JMG	0.18	1.8×10^{-2}	2.5×10^{-5}	ε
T_3-167	T_3JEMG	0.18	1.8×10^{-2}	1.6×10^{-3}	5.2×10^{-6}
T_3-168	T_3JEF	0.18	1.8×10^{-2}	3.8×10^{-4}	1.3×10^{-6}
T_3-169	T_3JEFG	0.18	1.8×10^{-2}	1.3×10^{-4}	ε
T_3-170	T_3JD	0.18	5.4×10^{-4}	N/A	9.7×10^{-5}
T_3-171	T_3JDG	0.18	5.4×10^{-4}	1.4×10^{-2}	1.3×10^{-6}
T_3-172	T_3I	0.18	N/A	ε	ε
T_3-173	T_3A	0.18	8.0×10^{-6}	N/A	1.4×10^{-6}

Table C-7 (Continued)

T_4: Loss of Normal AC Power Transients

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
T_4-102	T_4LMG	0.2	N/A	6.3×10^{-4}	1.3×10^{-4}
T_4-105	T_4LCMG	0.2	N/A	1.1×10^{-1}	2.2×10^{-2}
T_4-108	T_4LCEMG	0.2	N/A	6.4×10^{-2}	1.3×10^{-2}
T_4-109	T_4LCEF	0.2	N/A	2.9×10^{-4}	5.8×10^{-5}
T_4-110	T_4LCEFG	0.2	N/A	2.9×10^{-2}	5.8×10^{-3}
T_4-111	T_4LCD	0.2	0.07	1.8×10^{-1}	2.5×10^{-3}
T_4-112	T_4LCDG	0.2	0.07	1.9×10^{-1}	2.7×10^{-3}
T_4-115	T_4KMG	0.2	N/A	2.7×10^{-4}	5.5×10^{-5}
T_4-118	T_4KCMG	0.2	N/A	2.8×10^{-3}	7.6×10^{-4}
T_4-121	T_4KCEMG	0.2	N/A	1.7×10^{-3}	3.5×10^{-4}
T_4-122	T_4KCEF	0.2	N/A	1.3×10^{-5}	2.5×10^{-6}
T_4-123	T_4KCEFG	0.2	N/A	8.9×10^{-4}	1.8×10^{-4}

Table C-7 (Continued)

T_4: Loss of Normal AC Power Transients

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
T_4-124	T_4KCD	0.2	0.07	1.9×10^{-2}	2.7×10^{-4}
T_4-125	T_4KCDG	0.2	0.07	6.3×10^{-3}	8.8×10^{-5}
T_4-128	T_4JMG	0.2	1.8×10^{-2}	6.8×10^{-3}	2.4×10^{-5}
T_4-131	T_4JCMG	0.2	1.8×10^{-2}	7.0×10^{-2}	2.5×10^{-4}
T_4-134	T_4JCEMG	0.2	1.8×10^{-2}	4.3×10^{-2}	1.5×10^{-4}
T_4-135	T_4JCEF	0.2	1.8×10^{-2}	4.1×10^{-4}	1.5×10^{-6}
T_4-136	T_4JCEFG	0.2	1.8×10^{-2}	2.9×10^{-2}	1.1×10^{-4}
T_4-137	T_4JCD	0.2	1.3×10^{-3}	6.2×10^{-1}	1.6×10^{-4}
T_4-138	T_4JCDG	0.2	1.3×10^{-3}	1.9×10^{-1}	4.9×10^{-5}
T_4-139	T_4I	0.2	N/A	ϵ	ϵ
T_4-140	T_4A	0.2	8×10^{-6}	N/A	1.6×10^{-6}

Table C-7 (Continued)

T_5: Safety/Relief Valve Transients (Inadvertent Openings)

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
T_5-176	T_5MG	0.2	N/A	1.0×10^{-3}	2.0×10^{-4}
T_5-179	T_5HMG	0.2	0.1	1.0×10^{-3}	2.0×10^{-5}
T_5-182	T_5HCMG	0.2	0.002	2.5×10^{-5}	ϵ
T_5-185	T_5HCEMG	0.2	0.002	1.2×10^{-3}	ϵ
T_5-186	T_5HCEF	0.2	0.002	3.8×10^{-4}	ϵ
T_5-187	T_5HCEFG	0.2	0.002	1.3×10^{-4}	ϵ
T_5-188	T_5HCD	0.2	6×10^{-5}	N/A	1.2×10^{-5}
T_5-189	T_5HCDG	0.2	6×10^{-5}	1.4×10^{-2}	ϵ
T_5-190	T_5A	0.2	8×10^{-6}	N/A	1.6×10^{-6}

Table C-7 (Continued)

LOCA SB Sequences

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
SB-2	(SB)G	2×10^{-3}	N/A	1.5×10^{-2}	3×10^{-5}
SB-4	(SB)CG	2×10^{-3}	0.02	3.1×10^{-3}	ε
SB-6	(SB)CEG	2×10^{-3}	0.02	9.1×10^{-3}	ε
SB-7	(SB)CEF	2×10^{-3}	0.02	2.6×10^{-4}	ε
SB-8	(SB)CEFG	2×10^{-3}	0.02	1.3×10^{-4}	ε
SB-9	(SB)CD	2×10^{-3}	0.02	1.4×10^{-1}	5.6×10^{-6}
SB-10	(SB)CDG	2×10^{-3}	0.02	5.7×10^{-5}	ε
SB-11	(SB)B	2×10^{-3}	1.6×10^{-3}	N/A	3.2×10^{-6}
SB-12	(SB)A	2×10^{-3}	8×10^{-6}	N/A	ε

Table C-7 (Continued)

LOCA ISB Sequences

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
ISB-14	(ISB)G	1×10^{-4}	N/A	1.5×10^{-2}	1.5×10^{-6}
ISB-16	(ISB)CG	1×10^{-4}	0.02	3.1×10^{-3}	ϵ
ISB-18	(ISB)CEG	1×10^{-4}	0.02	9.1×10^{-3}	ϵ
ISB-19	(ISB)CEF	1×10^{-4}	0.02	2.6×10^{-4}	ϵ
ISB-20	(ISB)CEFG	1×10^{-4}	0.02	1.3×10^{-4}	ϵ
ISB-21	(ISB)CED	1×10^{-4}	0.02	8.5×10^{-4}	ϵ
ISB-22	(ISB)CEDG	1×10^{-4}	0.02	5.7×10^{-5}	ϵ
ISB-23	(ISB)B	1×10^{-4}	4.6×10^{-5}	N/A	ϵ
ISB-24	(ISB)A	1×10^{-4}	8×10^{-6}	N/A	ϵ

Table C-7 (Continued)

LOCA ILB Sequences

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
ILB-26	(ILB)G	1×10^{-4}	N/A	1.5×10^{-2}	1.5×10^{-6}
ILB-28	(ILB)CG	1×10^{-4}	0.02	1.5×10^{-2}	ε
ILB-30	(ILB)CFG	1×10^{-4}	0.02	ε	ε
ILB-31	(ILB)CFE	1×10^{-4}	0.02	2.6×10^{-4}	ε
ILB-32	(ILB)CFEG	1×10^{-4}	0.02	1.3×10^{-4}	ε
ILB-33	(ILB)CFD	1×10^{-4}	0.02	8.1×10^{-6}	ε
ILB-34	(ILB)CFDG	1×10^{-4}	0.02	ε	ε
ILB-35	(ILB)B	1×10^{-4}	4.6×10^{-5}	N/A	ε
ILB-36	(ILB)A	1×10^{-4}	8×10^{-6}	N/A	ε

Table C-7 (Continued)

LOCA LSB Sequences

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
LSB-38	(LSB)G	1×10^{-4}	N/A	1.5×10^{-2}	1.5×10^{-6}
LSB-40	(LSB)CG	1×10^{-4}	0.02	3.1×10^{-3}	ε
LSB-42	(LSB)CEG	1×10^{-4}	0.02	9.1×10^{-3}	ε
LSB-43	(LSB)CEF	1×10^{-4}	0.02	2.5×10^{-4}	ε
LSB-44	(LSB)CEFG	1×10^{-4}	0.02	1.3×10^{-4}	ε
LSB-45	(LSB)B	1×10^{-4}	4.6×10^{-5}	N/A	ε
LSB-46	(LSB)A	1×10^{-4}	8×10^{-6}	N/A	ε

Table C-7 (Concluded)

LOCA LLB Sequences

SEQUENCE NUMBER	SEQUENCE DESCRIPTION	TRANSIENT FREQUENCY/YR	UNDEVELOPED EVENTS PROBABILITY	DEVELOPED EVENTS PROBABILITY	SEQUENCE FREQUENCY
LLB-48	(LLB)G	1×10^{-4}	N/A	3.1×10^{-3}	ϵ
LLB-50	(LLB)EG	1×10^{-4}	N/A	9.13×10^{-3}	ϵ
LLB-51	(LLB)EF	1×10^{-4}	N/A	2.6×10^{-4}	ϵ
LLB-52	(LLB)EFG	1×10^{-4}	N/A	1.3×10^{-4}	ϵ
LLB-53	(LLB)B	1×10^{-4}	4.6×10^{-5}	N/A	ϵ
LSB-54	(LLB)A	1×10^{-4}	8×10^{-6}	N/A	ϵ

Table C-8 Recovery Factors for Final Quantification

Time Allowed for Action (minutes) Inside Control Room	Outside Control Room	Probability of Failure To Perform Action
< 5	< 65	0.1
5 to 10	65 to 70	0.25
10 to 20	70 to 80	0.10
20 to 30	80 to 90	0.05
30 to 60	90 to 120	0.03
> 60	> 120	0.01

Table C-9 Summary Results of Final Quantification

Sequence	Screening Value (per reactor-year)	Final Value (per reactor-year)
T_4JCD	1.6E-4	7E-5
T_4JCEFG	1.1E-4	4E-5
T_4KCEFG	1.8E-4	3E-5
T_4KCD	2.7E-4	3E-5
T_4LCD	2.6E-3	3E-5
T_2A	1.7E-5	2E-5
T_4JCDG	4.9E-5	2E-5
T_4JCMG	2.5E-4	1E-5
T_4LCEFG	5.8E-3	1E-5
T_4LCMG	2.2E-2	1E-5
T_4KCDG	8.8E-5	1E-5
T_4KCMG	7.6E-4	9E-6
T_5MG	2.0E-4	7E-6
T_4LCDG	2.6E-3	6E-6
T_2LMG	8.5E-4	6E-6
T_1AH	5.3E-6	5E-6
(SB)B	3.2E-6	3E-6
T_2JMG	3.9E-5	2E-6
T_4JCEMG	1.5E-4	2E-6
T_4LCEMG	1.3E-2	2E-6
T_1HLMG	2.6E-4	2E-6
T_4A	1.6E-6	2E-6
T_5A	1.6E-6	2E-6
T_3LD	4.3E-4	1E-6
T_4KCEF	2.5E-6	1E-6

Table C-10 Sample Contributors to Sequence T_4S_{124} Probability (Screening Stage)

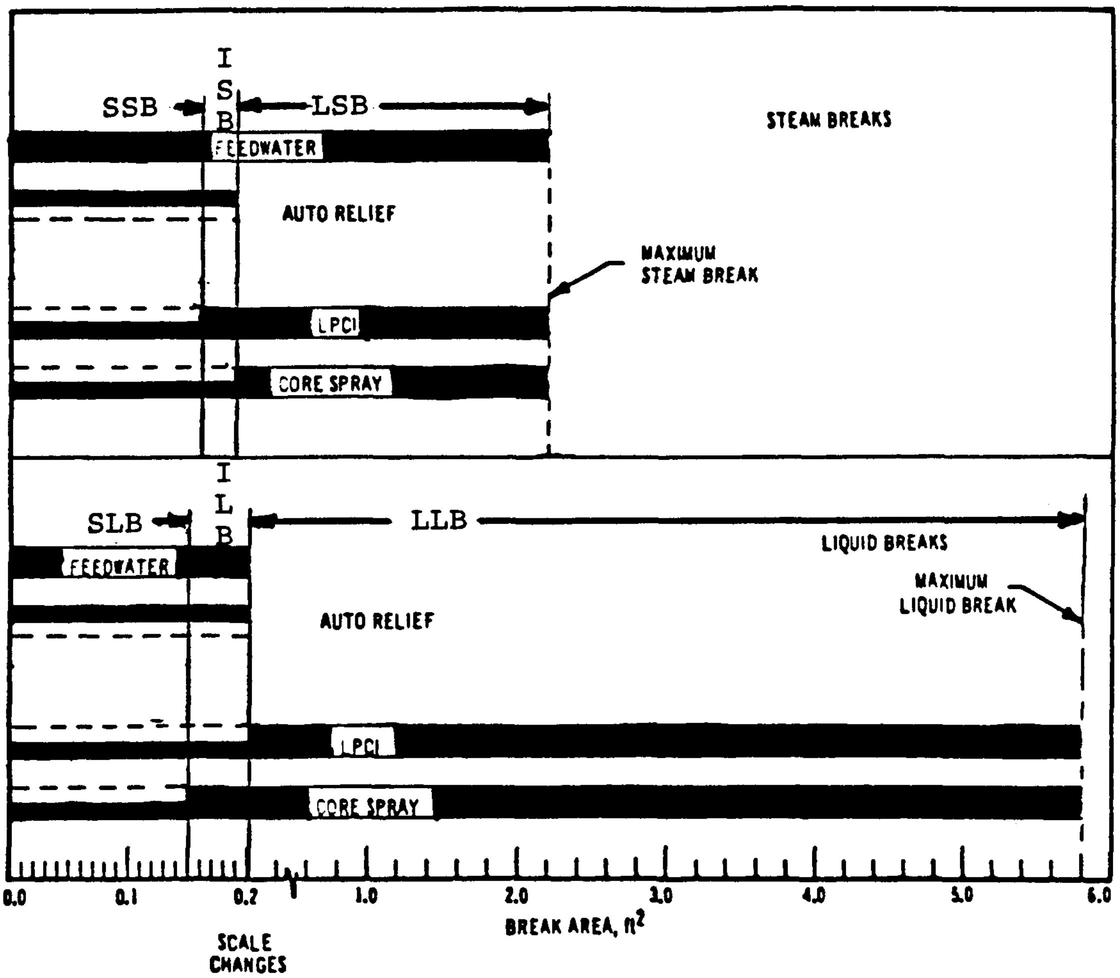
Contributor (AKCG) Cutsets	Description	Probability[1] (% of Total)
(AC-GTG-LOF)(903595-312-OFR)	FWCI failure due to loss of function of gas turbine coupled with operator error in setting auto switch for IC-3	3.6×10^{-6} (4%)
(AC-GTG-LOF)(IC-1-MOV-OPC) (AC-GTG-LOF)(IC-1-MOV-OPC) (AC-GTG-LOF)(IC-3-MOV-OPC) (AC-GTG-LOF)(IC-4-MOV-OPC)	FWCI failure due to loss of function of gas turbine coupled with operator error in closing valve required for IC operation	4.3×10^{-6} (4%)
(AC-GTG-LOF)(IC-1-MOV-TMC) (AC-GTG-LOF)(IC-2-MOV-TMC) (AC-GTG-LOF)(IC-3-MOV-TMC) (AC-GTG-LOF)(IC-4-MOV-TMC)	FWCI failure due to loss of function of gas turbine coupled with valve required for IC operation out for test or maintenance	2.8×10^{-6} (3%)

[1] Probabilities of cutsets for $(\bar{A}KC\bar{G})$ multiplied by 0.006 to account for independent factors of $P\{T_4\}$, $P\{\bar{I}\}$, $P\{\bar{J}\}$, and $P\{D\}$.

Table C-11 Sample Contributors to Sequence T_4S_{124} Probability (Final Stage)

Contributor[1] (Cutsets of $\bar{A}KC\bar{G}$)	Probability[2]; (% of total)
(AC-GTG-LOF)(903595-312-OFR)	1.8×10^{-7}; 1%
(AC-GTG-LOF)(IC-1-MOV-OPC)	2.2×10^{-7}; 1%
(AC-GTG-LOF)(IC-2-MOV-OPC)	
(AC-GTG-LOF)(IC-3-MOV-OPC)	
(AC-GTG-LOF)(IC-4-MOV-OPC)	
(AC-GTG-LOF)(IC-1-MOV-TMC)	2.8×10^{-6}; 12%
(AC-GTG-LOF)(IC-2-MOV-TMC)	
(AC-GTG-LOF)(IC-3-MOV-TMC)	
(AC-GTG-LOF)(IC-4-MOV-TMC)	

[1] Descriptions of contributors found in Table C-11.
[2] Probabilities of cutsets for ($\bar{A}KC\bar{G}$) multiplied by 0.006 to account for independent factors of $P\{T_4\}$, $P\{\bar{I}\}$, $P\{\bar{J}\}$, and P{D revised}.



1. A full bar indicates the system is capable of mitigating the break on its own.

2. A half bar indicates the system requires the assistance of another system with the opposite half bar (i.e., match upper and lower half bars for each type of break).

Figure C-1 MILLSTONE EMERGENCY CORE COOLING SYSTEMS (ECCS) PERFORMANCE CAPABILITY

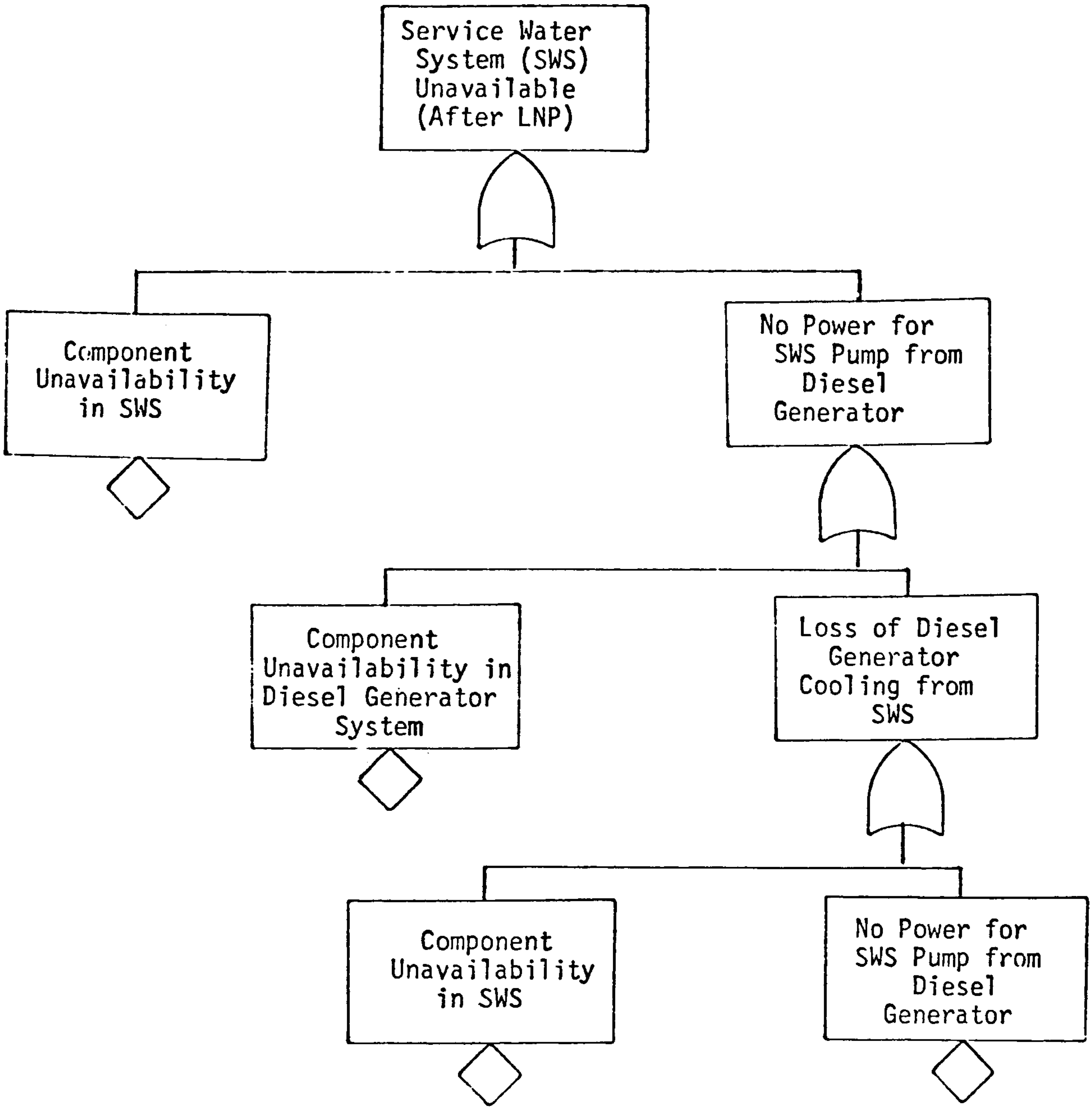
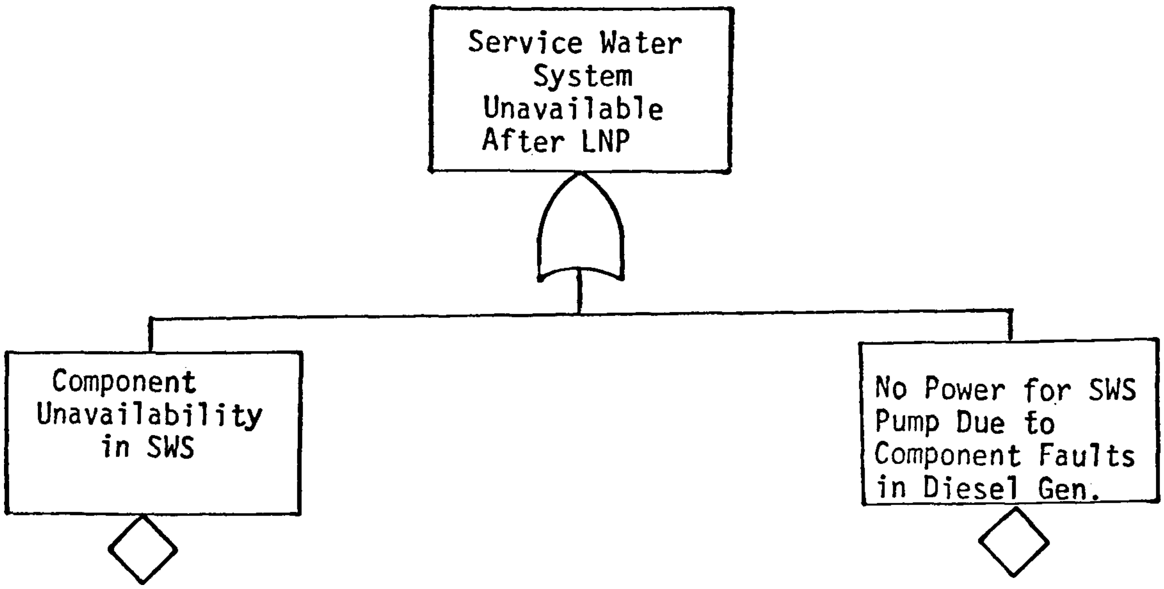
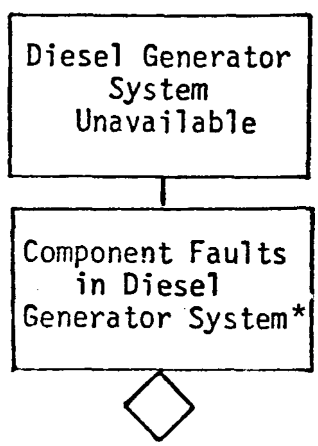


Figure C.2. Circular Logic in Millstone Analysis
(Failure of SWS can occur due to loss of power from diesel generator; diesel generator can fail to provide power due to loss of cooling from SWS)





*Includes basic event Loss of Cooling from SWS"

Figure C.3. Resolution of Circular Logic of SWS and Diesel Generator

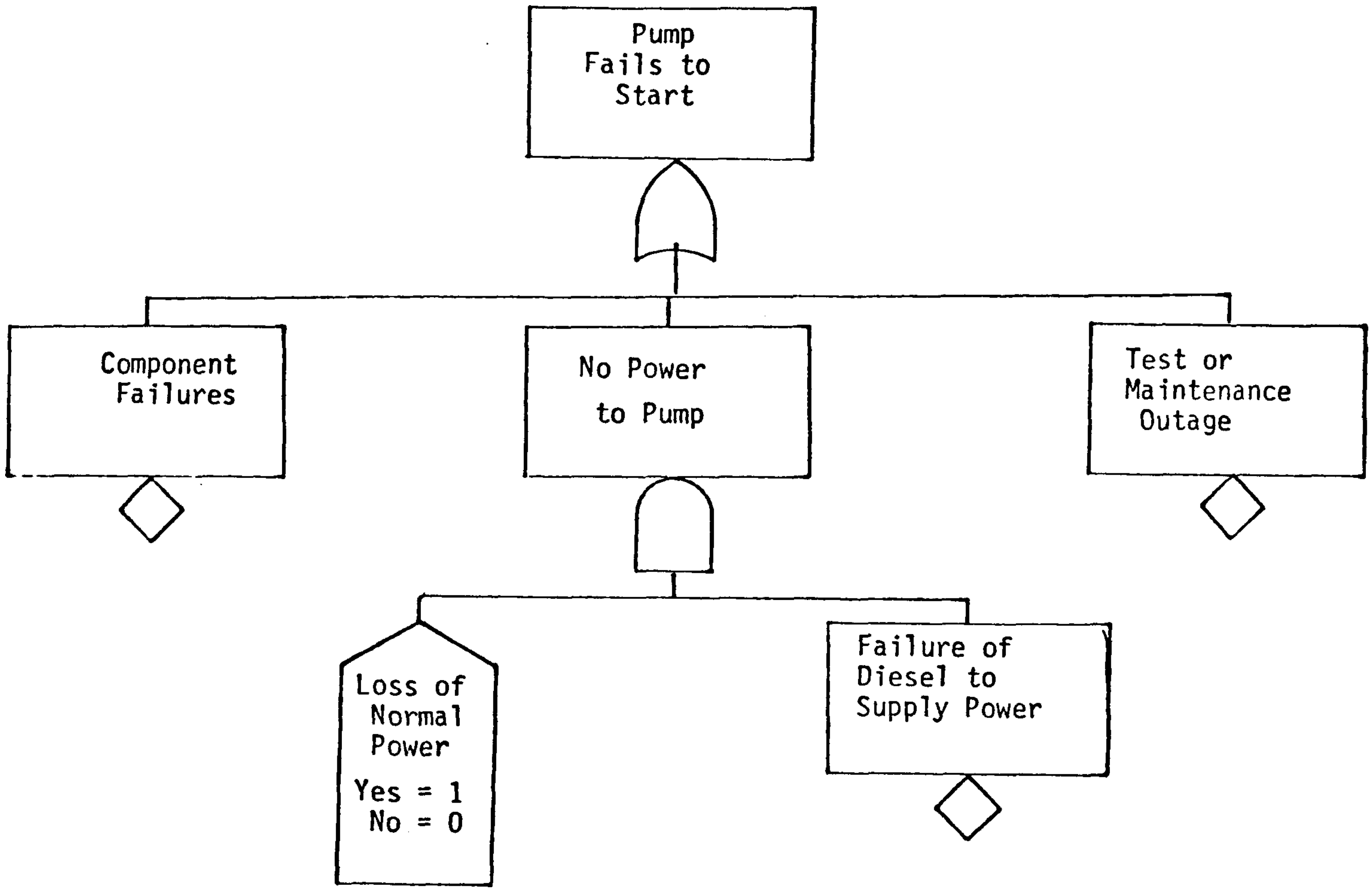


Figure C.4. Use of External Event to Consider Transient Initiator

APPENDIX C ATTACHMENT

EVENT CODING

This attachment summarizes the scheme used for coding basic faults as input into SETS.

1) VALVES

Valves will be coded as follows:

SYS-CID-TYP-CFM

Where:

1. SYS-CID is the unique valve identifier taken from the P&ID of the system. SYS is a 2-4 letter code signifying the system and CID is the valve number.

examples: CS-5A
LP-7A
SD-5

(Note: Valve numbers on the P&IDs are usually preceded by a "1-", e.g., 1-CS-5A. Always discard the "1-" when coding a valve SYS-CID)

2. TYP is the valve type, taken from the following table.

COMPONENT	TYP
Motor Operated Valve	MOV
Pneumatic/Hydraulic Valve	PHV
Solenoid Operated Valve	SOV
Manual Valve	XV
Check Valve	CKV
Safety/Relief Valve	SRV

3. CFM is the particular component failure mode of the basic event, taken from the following table.

FAILURE MODE	CFM
Fails to open - A valve which is closed and is supposed to open when needed, fails to do so.	FTO
Fails to close - A valve which is open and is supposed to close when needed, fails to do so.	FTC
Fails to remain open - A Valve which is open and is supposed to remain open, fails to do so.	FRO
Fails to remain closed - A valve which is closed and is supposed to remain closed, fails to do so.	FRC

FAILURE MODE	CFM
Operator opens valve - During the course of an accident, the operator acts to open a valve which should be closed.	OPO
Operator closes valve - During the course of an accident, the operator acts to close a valve which should remain open.	OPC
Operator fails to open valve - During the course of an accident, the operator fails to open a valve which should be opened.	OFO
Operator fails to close valve - During the course of an accident, the operator fails to close a valve which should be closed.	OFC
Test or maintenance (open) - A valve which is supposed to be closed is in actuality open, and is incapable of being closed by any automatic signals, due to being in test, maintenance, or having been left in the open position after test or maintenance.	TMO
Test or maintenance (closed) - A valve which is supposed to be open is in actuality closed, and is incapable of being opened by any automatic signal, due to being in test, maintenance, or having been left in the closed position after test or maintenance.	TMC

IMPORTANT NOTE: IN the above two cases, if a valve is in the wrong position but is in service and capable of being returned to the correct position by an automatic signal, use the following codes:

Instead of TMO	ILO
Instead of TMC	ILC

2) CIRCUIT BREAKERS (INCLUDING VALVE MOTOR CONTACTORS)
Circuit breakers will be coded as follows:

SYS-BUS-CUB-CFM

Where:

1. SYS is either AC or DC
2. BUS is the bus number the breaker is on (eliminate hyphens in bus numbers)
3. CUB is the cubicle or circuit number the breaker is contained in
4. CFM is the particular component failure mode (use the same ones as for valves)

3) RELAYS, SENSORS, & SWITCHES
Relays, sensors, and switches will be coded as follows:

CRPSYS-CID-CFM

Where:

1. CRPSYS-CID is the unique identifier taken from the control wiring diagrams. Each relay or sensor has a designation of the form $\frac{CRP}{SYS\text{-}CID}$, therefore relay number $\frac{932}{1530\text{-}105A}$ would be coded as:

   9321530-105A-CFM

   The full length of CRPSYS-CID cannot exceed 12 characters

2. CFM is the particular component failure mode of the basic event, taken from the following table.

FAILURE MODE	CFM	
Fails to de-energize - similar to fails to open	FTD	
Fails to energize - similar to fails to close	FTE	
Fails to remain de-energized - similar to fails to remain open	FRD	
Fails to remain energized - similar to fails to remain closed	FRE	
Operator miscalibrates - the operator has miscalibrated a sensor to the extent of it not being able to perform its function	OMC	
Test or maintenance - A sensor is out of service and incapable of performing its function, due to being in test, maintenance, or having been left out of service following test or maintenance. (Also, a switch is out of position)	TOM	
Contact pair fails to open	XFO	
Contact pair fails to close	XFC	where X is the lowest contact number in the pair*
Contact pair fails to remain open	XRO	
Contact pair fails to remain closed	XRC	

IMPORTANT NOTE: Concerning operator action to move switches, the action should be coded using the component the switch actuates. Thus, the failure "operator fails to close manual switch $\frac{904}{595\text{-}318A}$" which would open valve 1-SD-5 should be coded as SD-5-MOV-OFO. The only exception to this is if the switch is a reset or logic isolation (test) switch, in which case, an error not related to a test or maintenance would use:

Operator fails to reset	OFR

*If the lowest number in the contact pair is 10 or above, substitute letters for the designation, e.g., 10 becomes A, 11 becomes B etc.

4) PUMPS

Pumps will be coded as follows:

SYS-CID-TYP-CFM

Where:

1. SYS-CID is the unique pump identifier. For SYS, use the 2-4 letter code associated with the valves which are in the system containing the pump.

   For CID, use only the letter from the pump designation on the P&ID: example: core spray pump "A" is designated as pump 1401A. SYS-CID becomes CS-A.

2. TYP is the pump type, as follows.

COMPONENT	TYP
Motor Driven Pump	MDP
Turbine Driven Pump	TDP

3. CFM is the particular component failure made of the basic event, taken from the following table.

FAILURE MODE	CFM
Fails to run	FSR
Fails to stop	FSP
Test or maintenance (out of service)	TOM
Operator stops pump	OSP
Operator starts pump	OST
Operator fails to start pump	OFS
Operator fails to stop pump	OFP
Fails to start	FSD

5) OTHER COMPONENTS:

All other components will be coded as follows:

SYS-CID-TYP-CFM

Where:

1. SYS is the 2-4 letter system code taken directly from plant nomenclature, as used previously.

2. CID is the unique component identifier (number) also taken directly from plant nomenclature.

3. TYP is the component type, as follows:

COMPONENT	TYP
Heat Exchanger	HTX
Tank	TNK
Pipe	PIP
Bus	BUS
Electrical Cable	CBL
Battery	BAT
Transformer	XFR
Battery Charger	BCG
Inverter	INV
Diesel Generator	DGN
Gas Turbine Generator	GTG
Local Control Circuit	LCC
Train	TRN
Strainer	STR
Nozzle	NOZ
Fuse	FUS
Other	ZZZ
Undervoltage Detection Circuit	UVD

4. CFM - is the particular component failure mode as follows:

FAILURE MODE	CFM
Loss of function - the component does not function as required by the system success criteria.	LOF
Test or maintenance (out of service).	TOM
Operator fails to activate.	OFA
Operator fails to deactivate - During the course of an accident, the operator fails to take an action which he should.	OFD
Operator activates.	OPA
Operator deactivates - During the course of an accident, the operator takes an erroneous action.	OPD

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