Appendix D

Fault Trees

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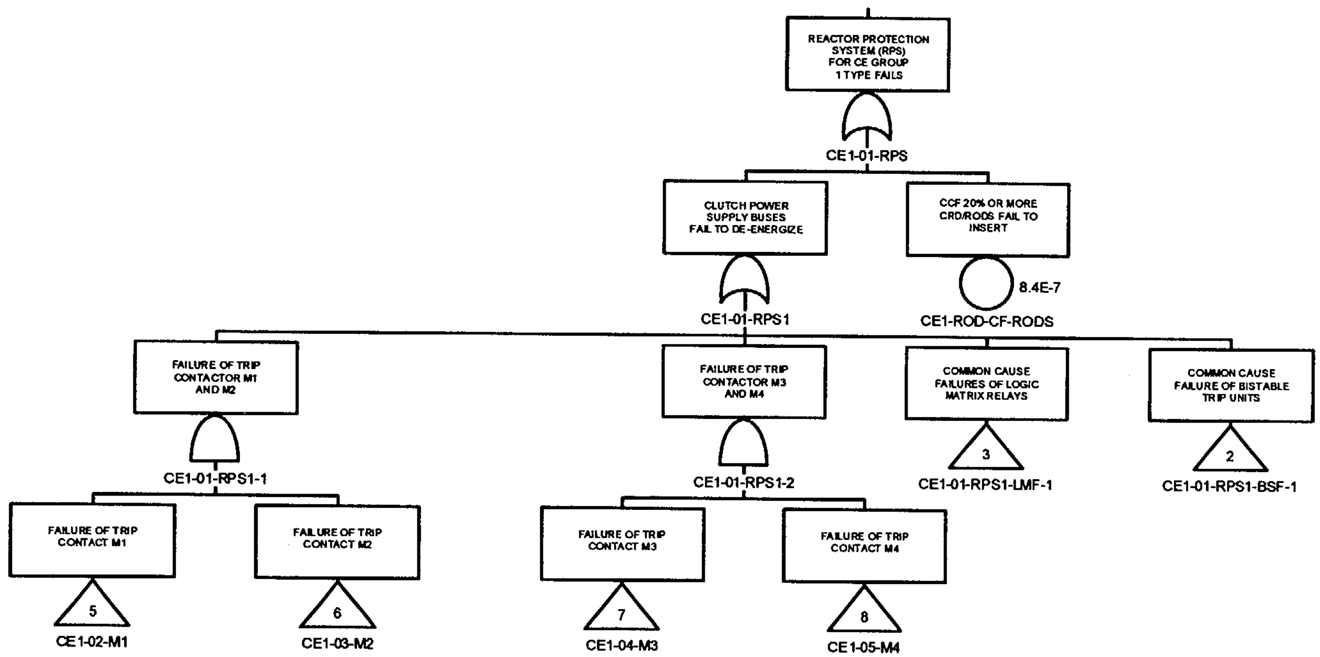
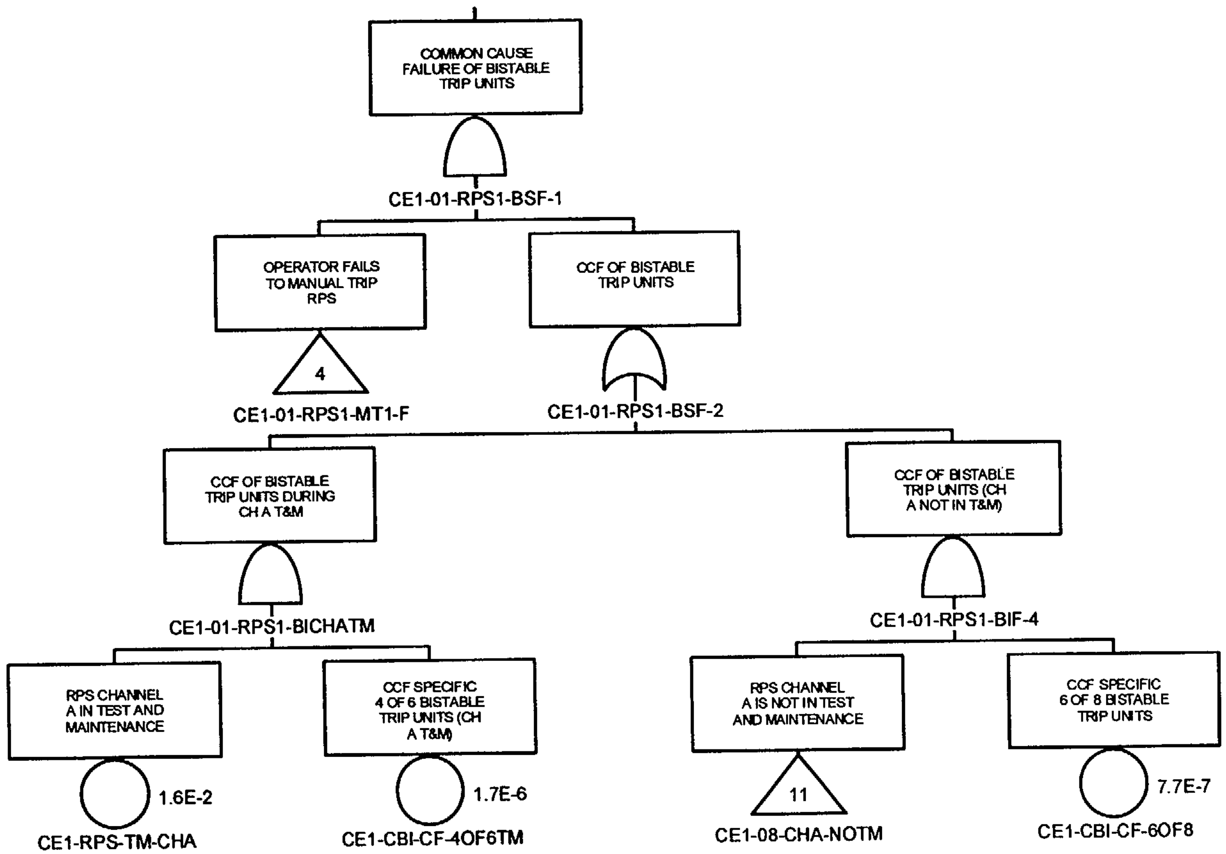
Fault Trees

This appendix presents the reactor protection system (RPS) fault trees representing the Combustion Engineering RPS designs. The number near the bottom of transfer gates indicates the fault tree page number (shown in the lower right corner of the fault tree border) where the logic is transferred.

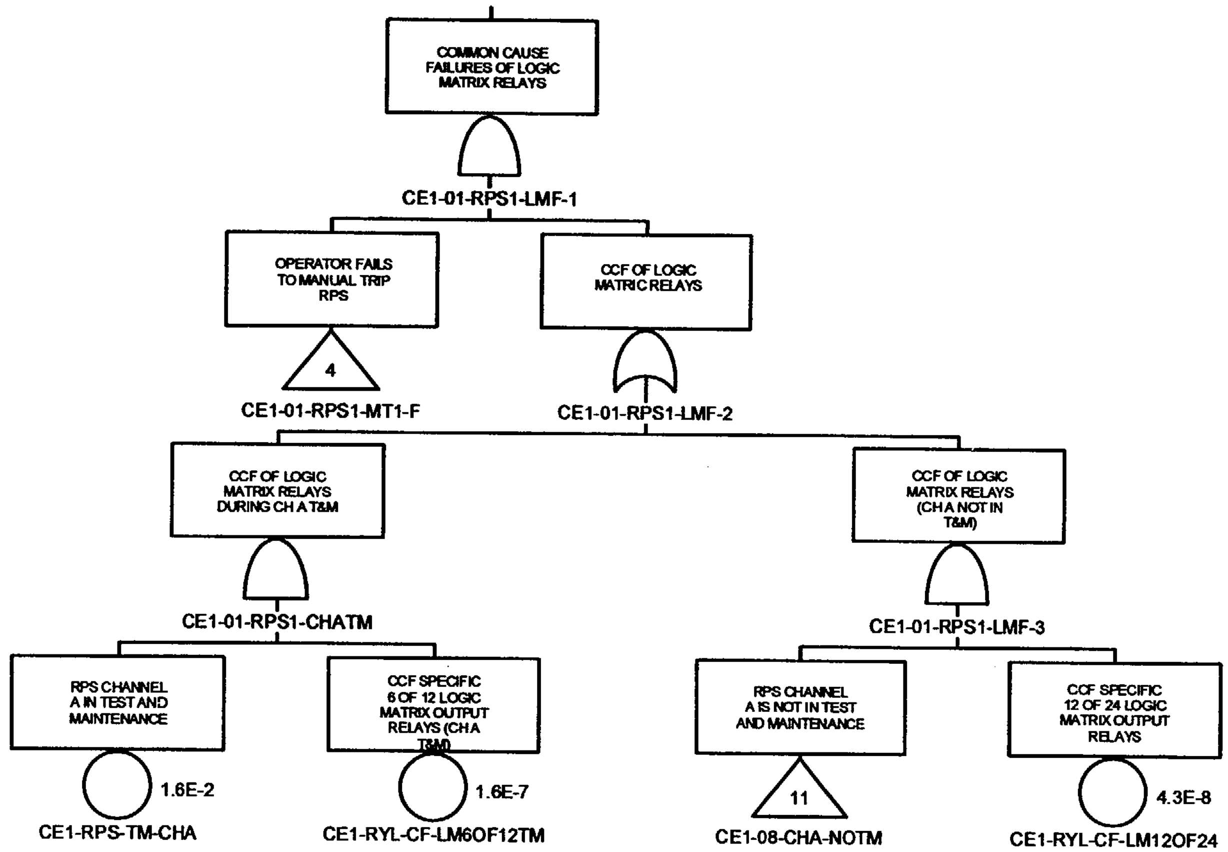
COMBUSTION ENGINEERING RPS GROUP 1 MODEL



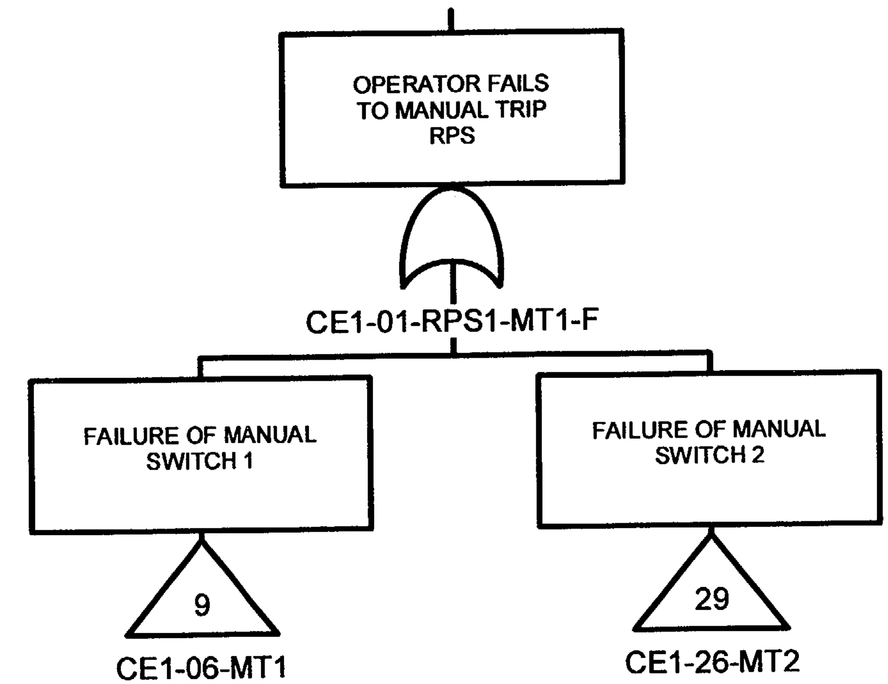
CE1-01-RPS - REACTOR PROTECTION SYSTEM (RPS) FOR CE GROUP 1 TYPE FAILS 2001/10/05 Page 1



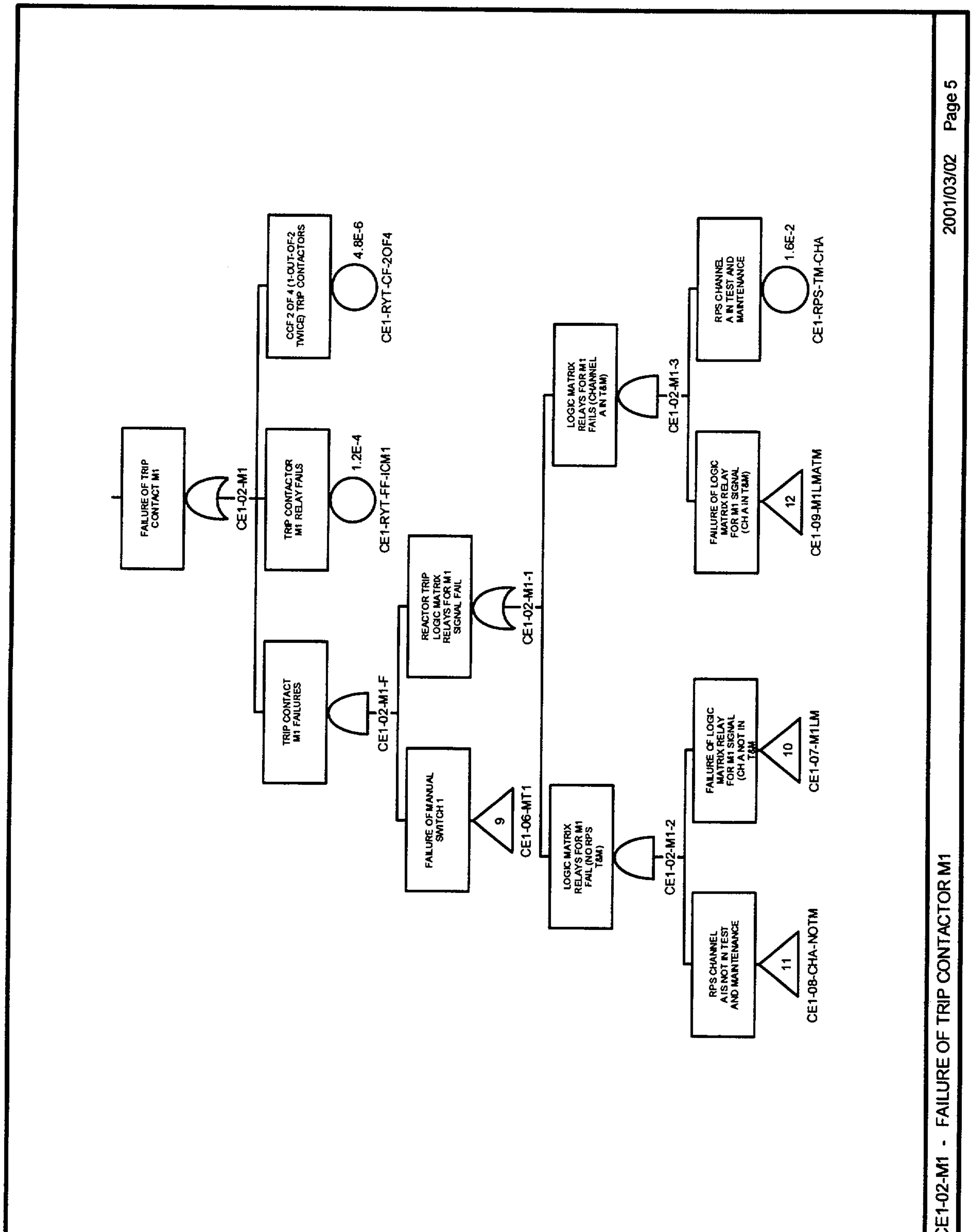
CE1-01-RPS1-BSF-1 - COMMON CAUSE FAILURE OF BISTABLE TRIP UNITS 2001/03/02 Page 2

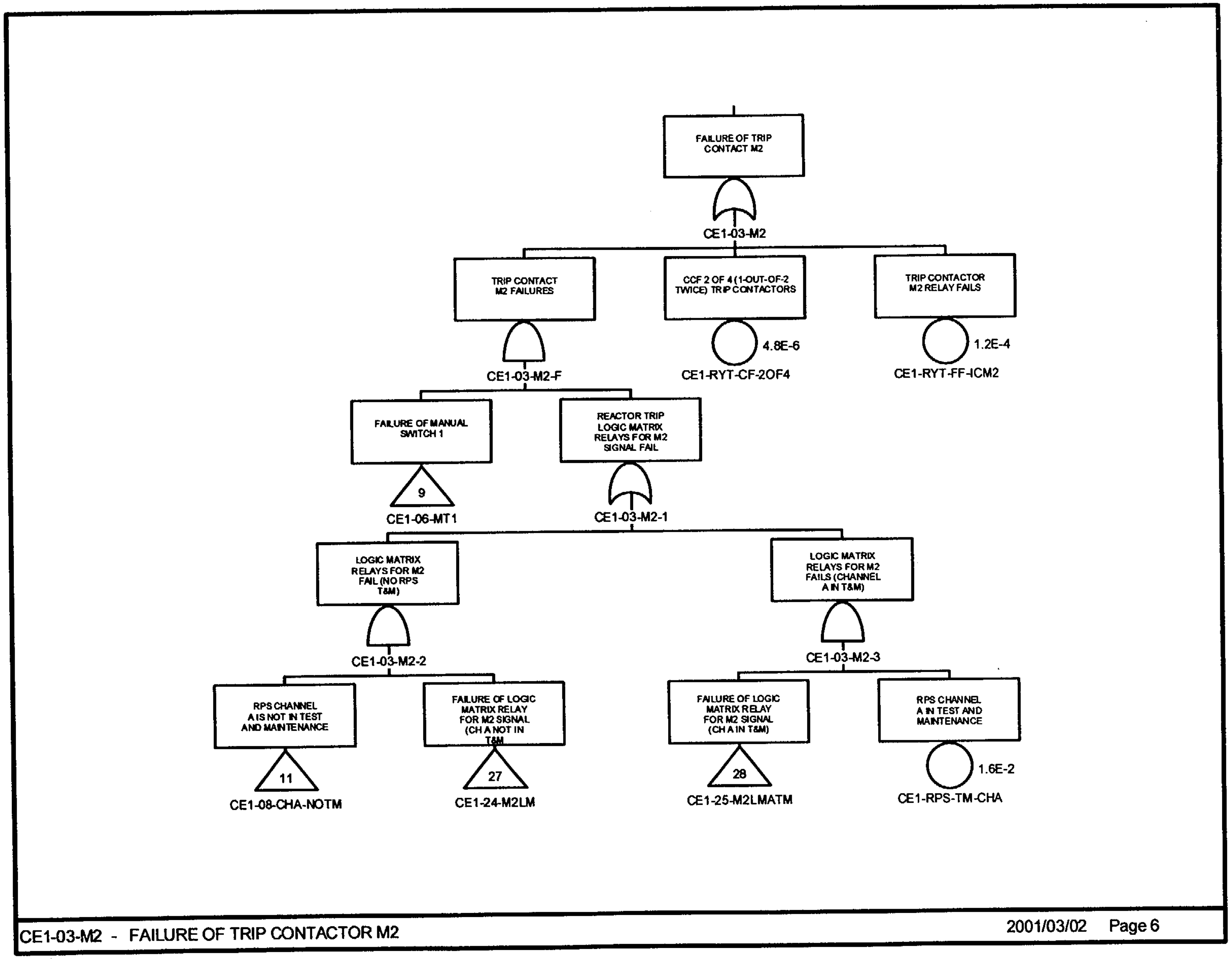


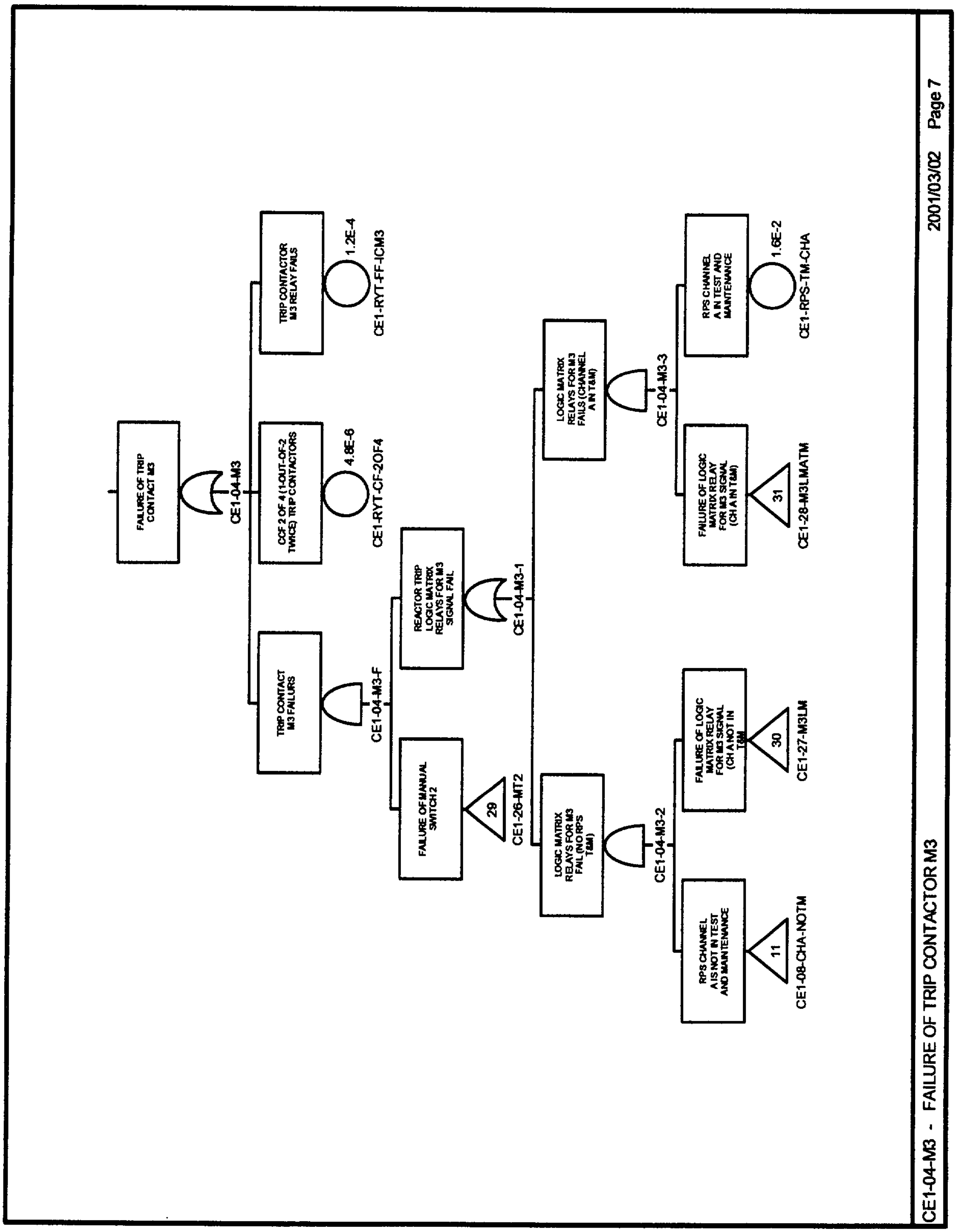
CE1-01-RPS1-LMF-1 - COMMON CAUSE FAILURES OF LOGIC MATRIX RELAYS 2001/03/02 Page 3

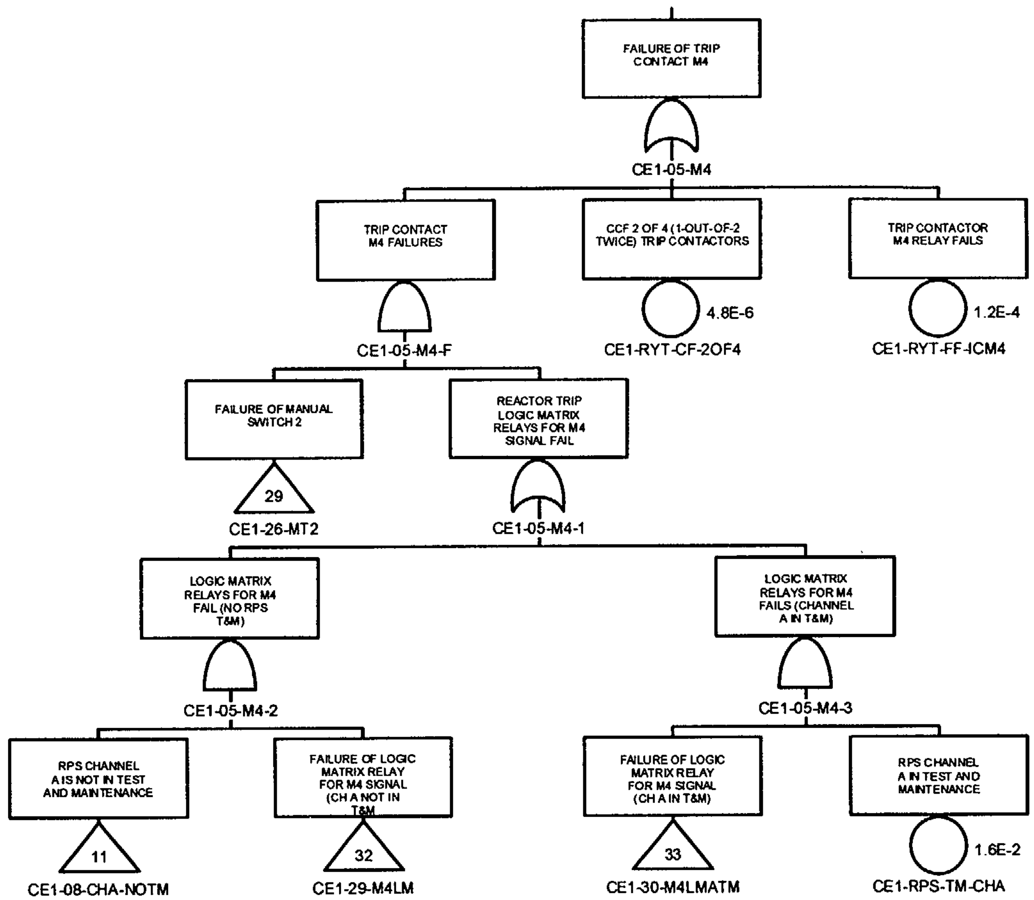


CE1-01-RPS1-MT1-F - OPERATOR FAILS TO MANUAL TRIP RPS 2001/03/02 Page 4

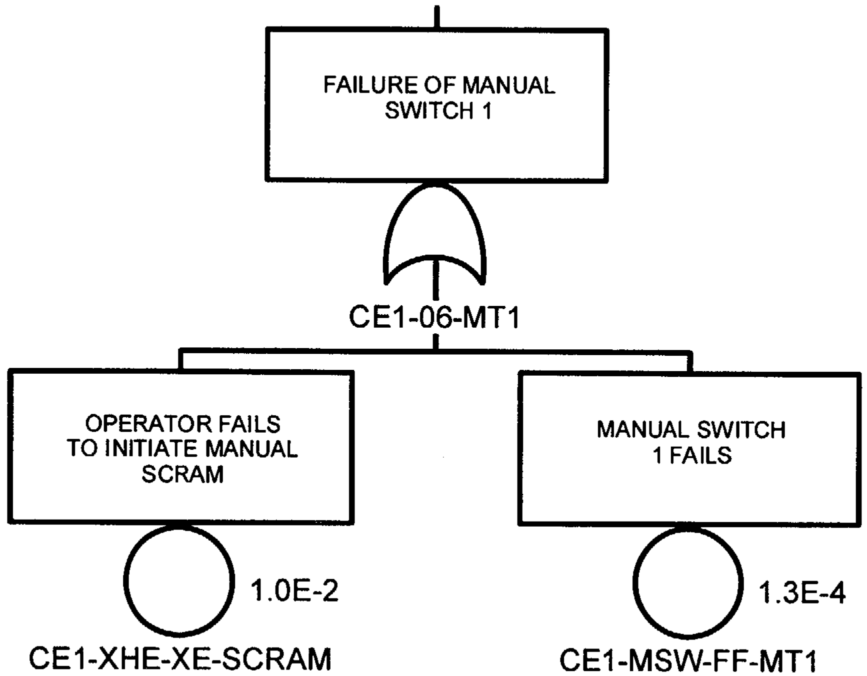

FAILURE OF TRIP CONTACT M1
CE1-02-M1
TRIP CONTACT M1 FAILURES
TRIP CONTACTOR M1 RELAY FAILS
1.2E-4
CE1-RYT-FF-ICM1
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CONTACTORS
4.8E-6
CE1-RYT-CF-2OF4
CE1-02-M1-F
FAILURE OF MANUAL SWITCH 1
9
CE1-06-MT1
REACTOR TRIP LOGIC MATRIX RELAYS FOR M1 SIGNAL FAIL
CE1-02-M1-1
LOGIC MATRIX RELAYS FOR M1 FAIL (NO RPS T&M)
CE1-02-M1-2
LOGIC MATRIX RELAYS FOR M1 FAILS (CHANNEL A IN T&M)
CE1-02-M1-3
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
11
CE1-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR M1 SIGNAL (CH A NOT IN T&M)
10
CE1-07-M1LM
FAILURE OF LOGIC MATRIX RELAY FOR M1 SIGNAL (CH A IN T&M)
12
CE1-09-M1LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE1-RPS-TM-CHA
CE1-02-M1 - FAILURE OF TRIP CONTACTOR M1
2001/03/02 Page 5


FAILURE OF TRIP CONTACT M2
CE1-03-M2
TRIP CONTACT M2 FAILURES
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CONTACTORS
TRIP CONTACTOR M2 RELAY FAILS
CE1-03-M2-F
4.8E-6
CE1-RYT-CF-2OF4
1.2E-4
CE1-RYT-FF-ICM2
FAILURE OF MANUAL SWITCH 1
REACTOR TRIP LOGIC MATRIX RELAYS FOR M2 SIGNAL FAIL
9
CE1-06-MT1
CE1-03-M2-1
LOGIC MATRIX RELAYS FOR M2 FAIL (NO RPS T&M)
LOGIC MATRIX RELAYS FOR M2 FAILS (CHANNEL A IN T&M)
CE1-03-M2-2
CE1-03-M2-3
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
FAILURE OF LOGIC MATRIX RELAY FOR M2 SIGNAL (CH A NOT IN T&M)
FAILURE OF LOGIC MATRIX RELAY FOR M2 SIGNAL (CH A IN T&M)
RPS CHANNEL A IN TEST AND MAINTENANCE
11
CE1-08-CHA-NOTM
27
CE1-24-M2LM
28
CE1-25-M2LMATM
1.6E-2
CE1-RPS-TM-CHA
CE1-03-M2 - FAILURE OF TRIP CONTACTOR M2
2001/03/02 Page 6

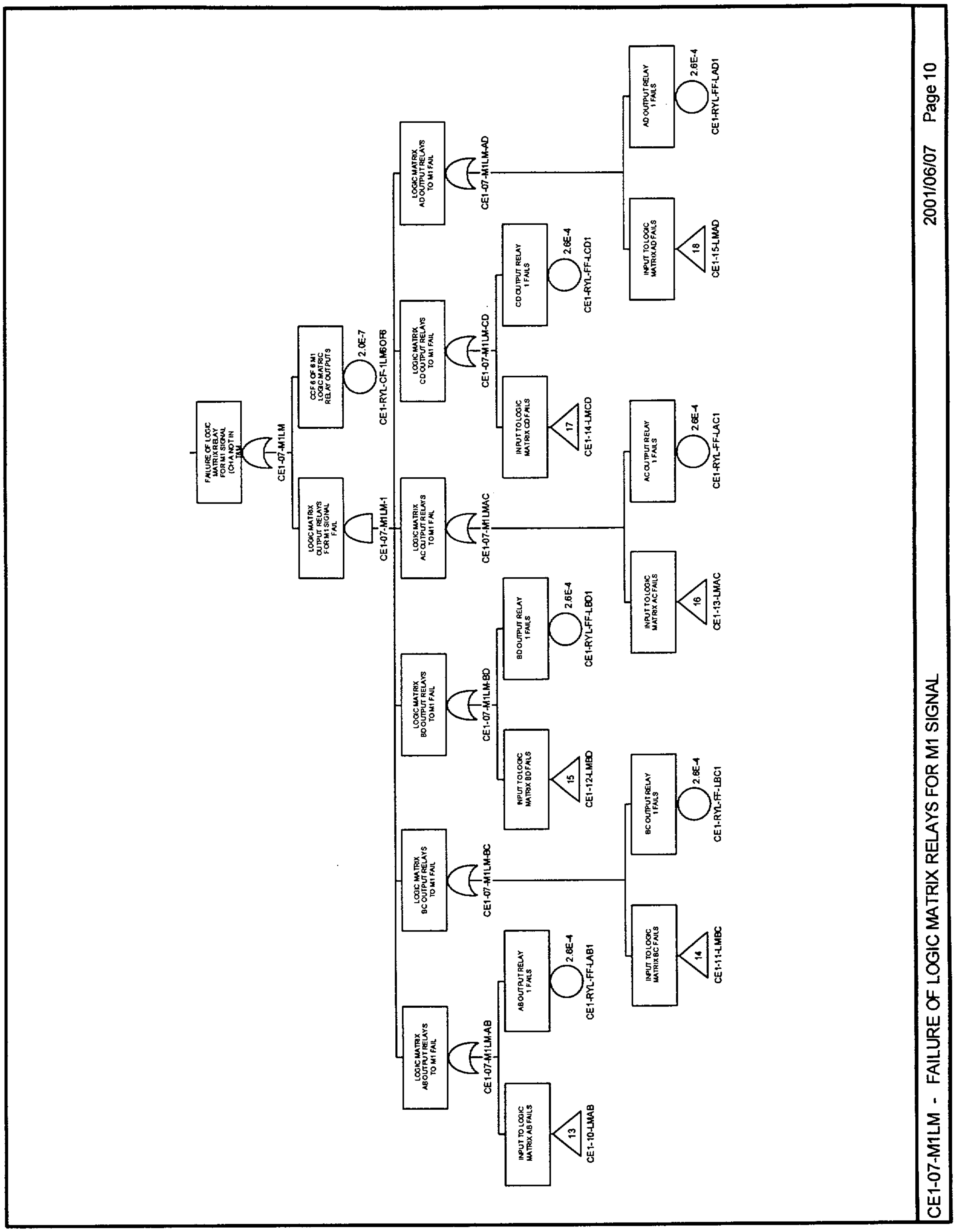

FAILURE OF TRIP CONTACT M3
CE1-04-M3
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CONTACTORS
4.8E-6
CE1-RYT-CF-2OF4
TRIP CONTACTOR M3 RELAY FAILS
1.2E-4
CE1-RYT-FF-ICM3
TRIP CONTACT M3 FAILURS
CE1-04-M3-F
FAILURE OF MANUAL SWITCH 2
29
CE1-26-MT2
REACTOR TRIP LOGIC MATRIX RELAYS FOR M3 SIGNAL FAIL
CE1-04-M3-1
LOGIC MATRIX RELAYS FOR M3 FAIL (NO RPS T&M)
CE1-04-M3-2
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
11
CE1-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR M3 SIGNAL (CH A NOT IN T&M)
30
CE1-27-M3LM
LOGIC MATRIX RELAYS FOR M3 FAILS (CHANNEL A IN T&M)
CE1-04-M3-3
FAILURE OF LOGIC MATRIX RELAY FOR M3 SIGNAL (CH A IN T&M)
31
CE1-28-M3LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE1-RPS-TM-CHA
CE1-04-M3 - FAILURE OF TRIP CONTACTOR M3
2001/03/02 Page 7

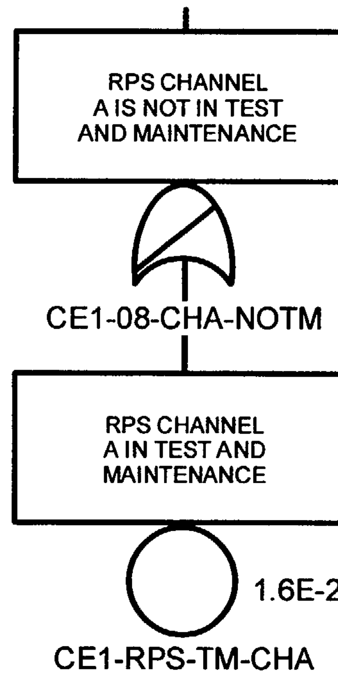


CE1-05-M4 - FAILURE OF TRIP CONTACTOR M4 2001/03/02 Page 8

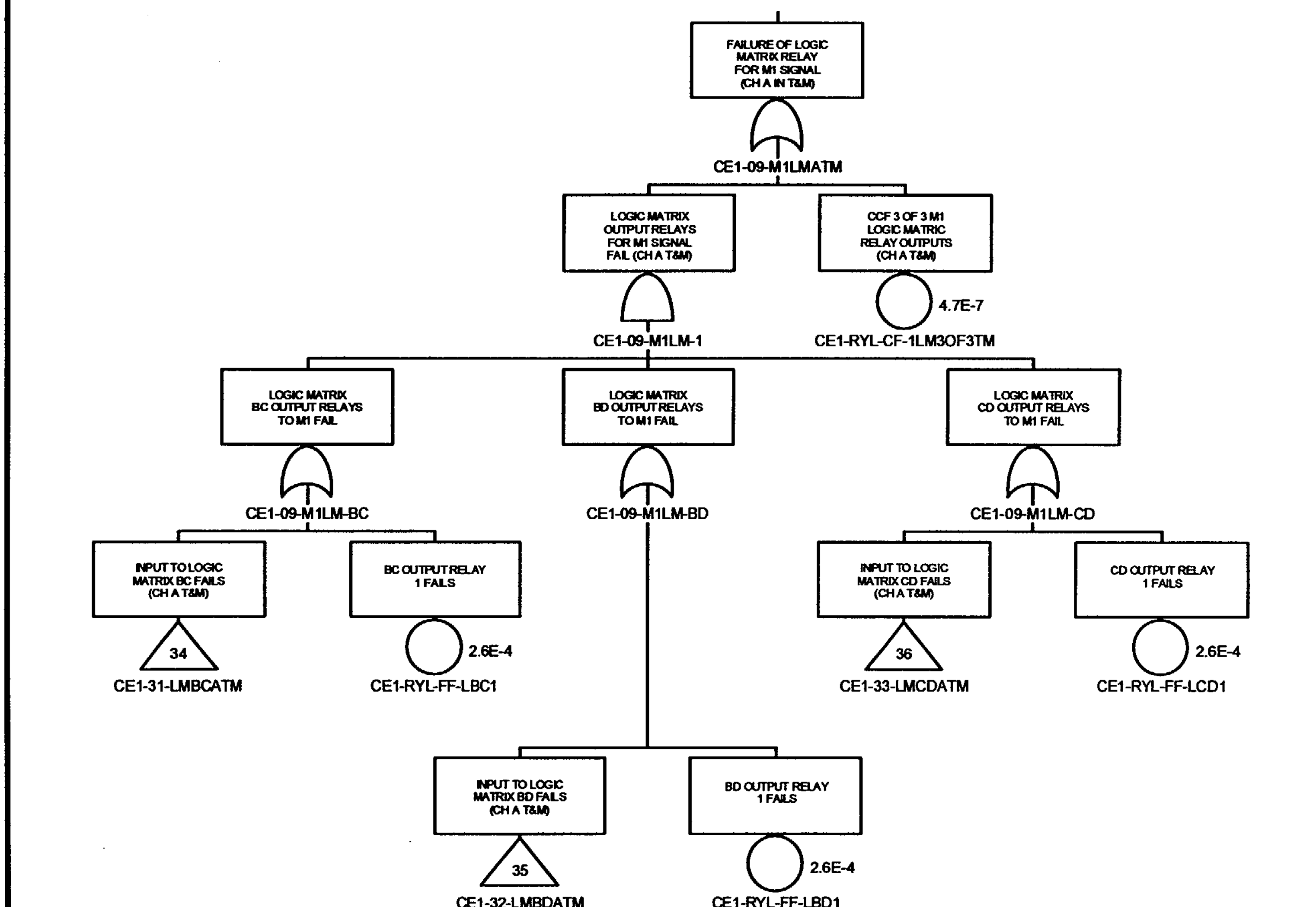


CE1-06-MT1 - MANUAL TRIP 1 FAILS 2001/03/02 Page 9

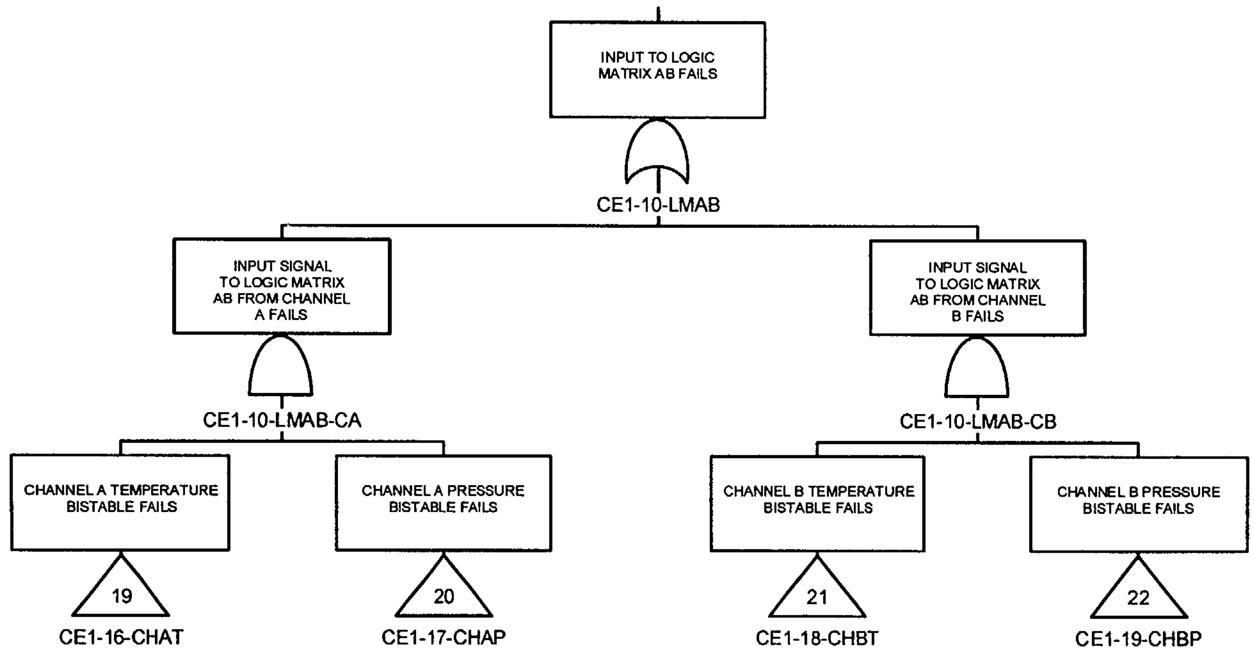

FAILURE OF LOGIC MATRIX RELAY FOR M1 SIGNAL (CH A NOT IN TM)
CE1-07-M1LM
LOGIC MATRIX OUTPUT RELAYS FOR M1 SIGNAL FAIL
CE1-07-M1LM-1
CCF 6 OF 6 M1 LOGIC MATRIC RELAY OUTPUTS
2.0E-7
CE1-RYL-CF-1LM6OF6
LOGIC MATRIX AB OUTPUT RELAYS TO M1 FAIL
CE1-07-M1LM-AB
LOGIC MATRIX BC OUTPUT RELAYS TO M1 FAIL
CE1-07-M1LM-BC
LOGIC MATRIX BD OUTPUT RELAYS TO M1 FAIL
CE1-07-M1LM-BD
LOGIC MATRIX AC OUTPUT RELAYS TO M1 FAIL
CE1-07-M1LMAC
LOGIC MATRIX CD OUTPUT RELAYS TO M1 FAIL
CE1-07-M1LM-CD
LOGIC MATRIX AD OUTPUT RELAYS TO M1 FAIL
CE1-07-M1LM-AD
INPUT TO LOGIC MATRIX AB FAILS
13
CE1-10-LMAB
AB OUTPUT RELAY 1 FAILS
2.6E-4
CE1-RYL-FF-LAB1
INPUT TO LOGIC MATRIX BC FAILS
14
CE1-11-LMBC
BC OUTPUT RELAY 1 FAILS
2.6E-4
CE1-RYL-FF-LBC1
INPUT TO LOGIC MATRIX BD FAILS
15
CE1-12-LMBD
BD OUTPUT RELAY 1 FAILS
2.6E-4
CE1-RYL-FF-LBD1
INPUT TO LOGIC MATRIX AC FAILS
16
CE1-13-LMAC
AC OUTPUT RELAY 1 FAILS
2.6E-4
CE1-RYL-FF-LAC1
INPUT TO LOGIC MATRIX CD FAILS
17
CE1-14-LMCD
CD OUTPUT RELAY 1 FAILS
2.6E-4
CE1-RYL-FF-LCD1
INPUT TO LOGIC MATRIX AD FAILS
18
CE1-15-LMAD
AD OUTPUT RELAY 1 FAILS
2.6E-4
CE1-RYL-FF-LAD1
CE1-07-M1LM - FAILURE OF LOGIC MATRIX RELAYS FOR M1 SIGNAL
2001/06/07 Page 10



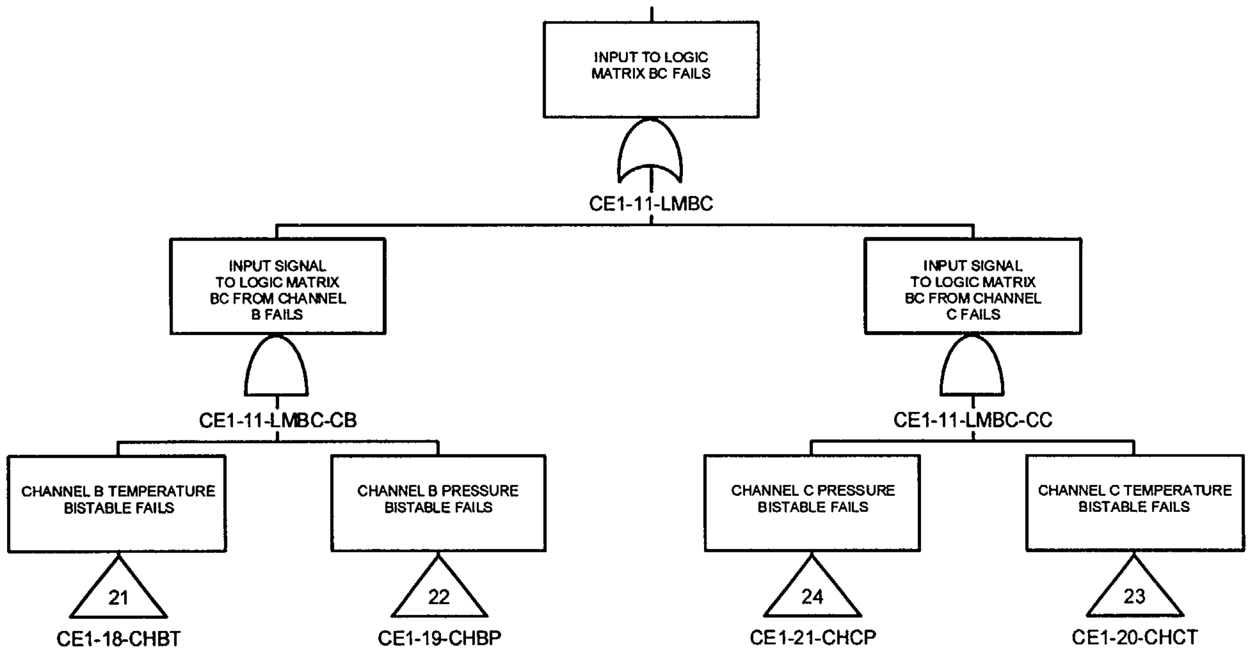
CE1-08-CHA-NOTM - RPS CHANNEL A NOT IN TEST AND MAINTENANCE 2001/03/02 Page 11



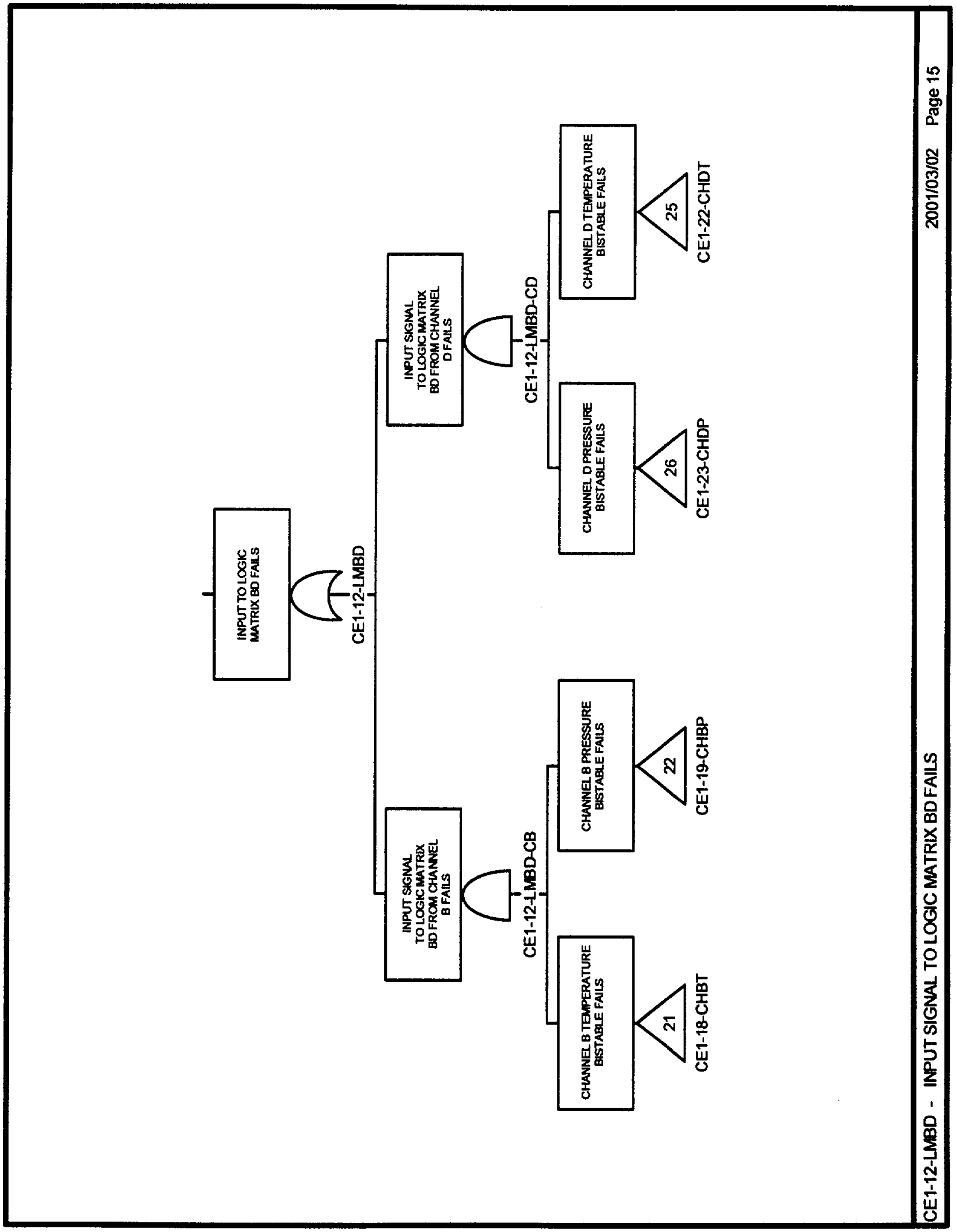
CE1-09-M1LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR M1 SIGNAL (CH A T&M) 2001/06/07 Page 12

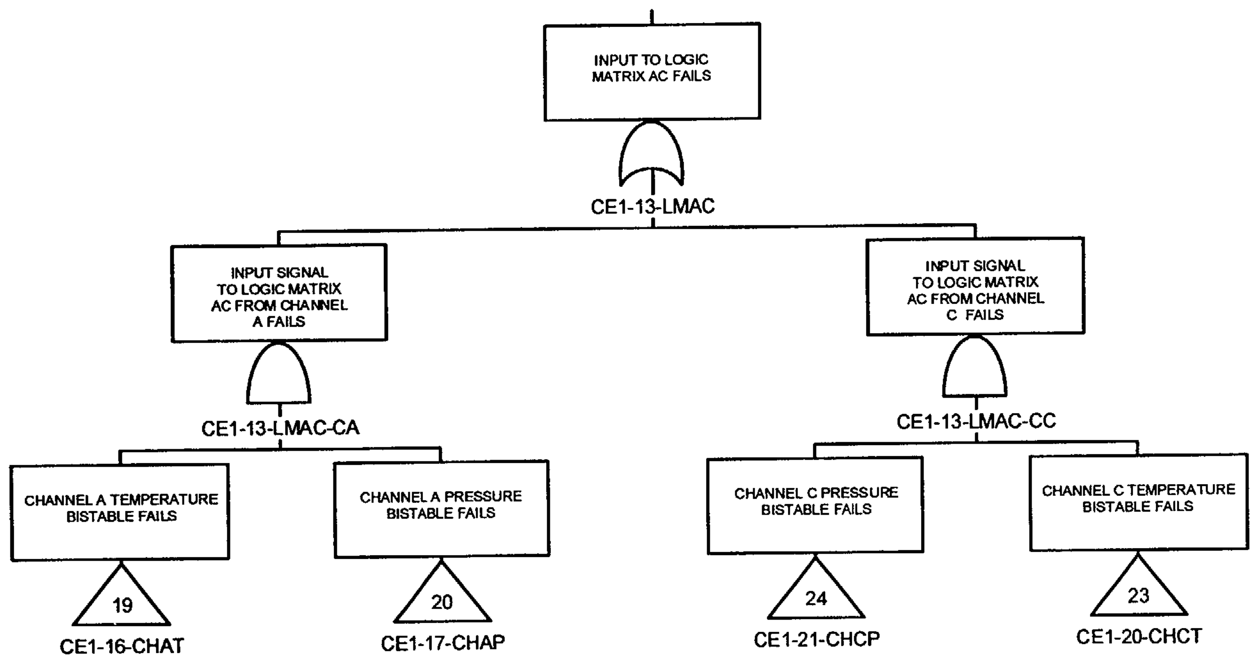


CE1-10-LMAB - INPUT SIGNAL TO LOGIC MATRIX AB FAILS 2001/03/02 Page 13

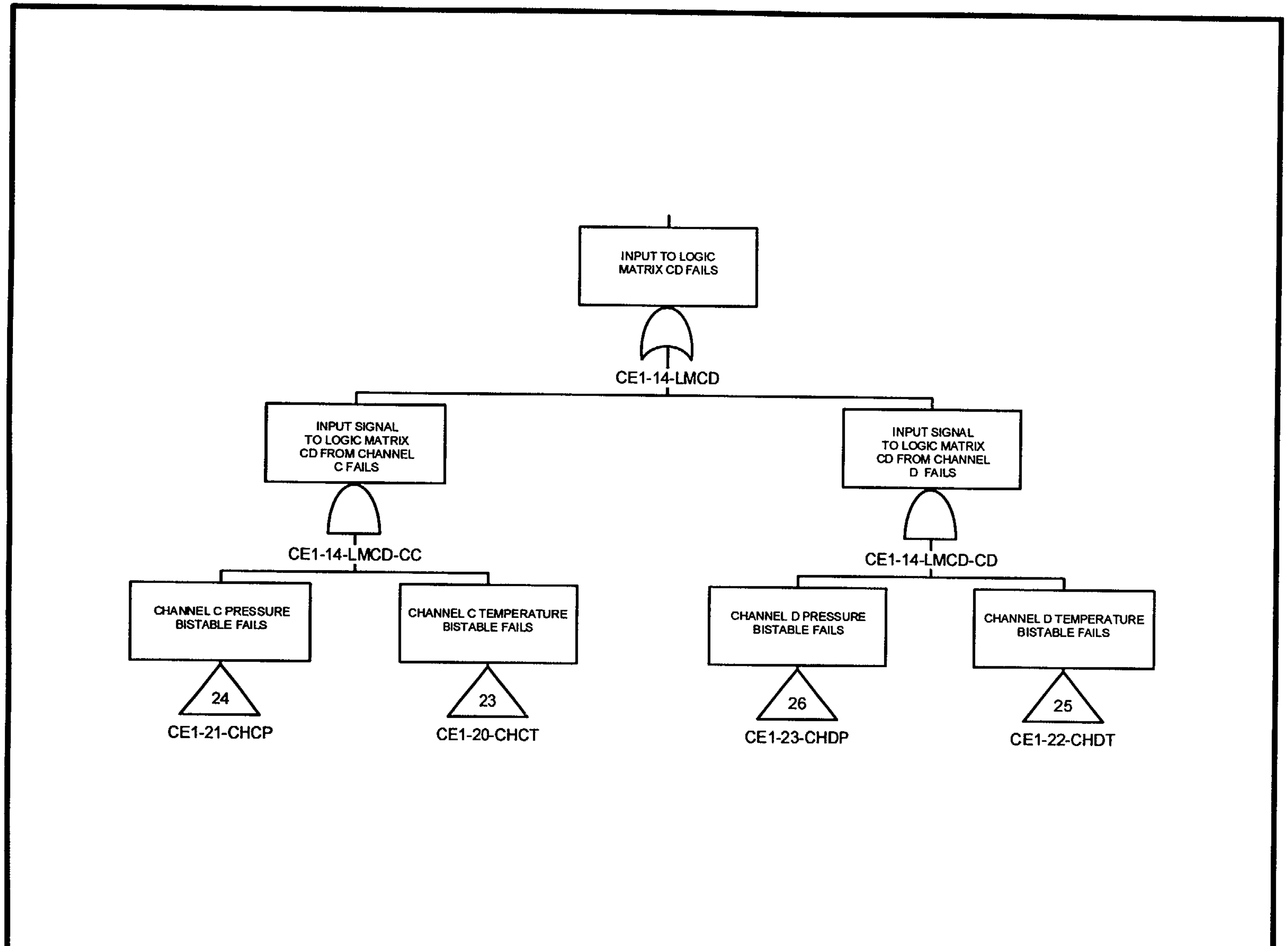


CE1-11-LMBC - INPUT SIGNAL TO LOGIC MATRIX BC FAILS 2001/03/02 Page 14

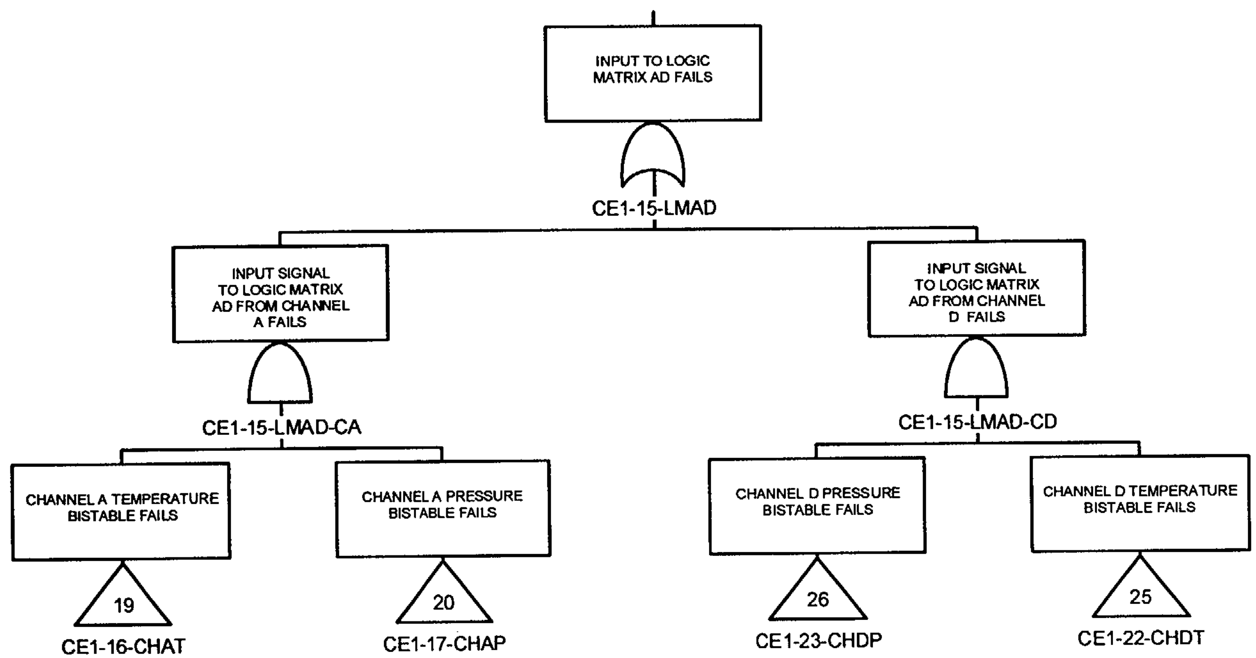

INPUT TO LOGIC MATRIX BD FAILS
CE1-12-LMBD
INPUT SIGNAL TO LOGIC MATRIX BD FROM CHANNEL B FAILS
CE1-12-LMBD-CB
INPUT SIGNAL TO LOGIC MATRIX BD FROM CHANNEL D FAILS
CE1-12-LMBD-CD
CHANNEL B TEMPERATURE BISTABLE FAILS
21
CE1-18-CHBT
CHANNEL B PRESSURE BISTABLE FAILS
22
CE1-19-CHBP
CHANNEL D PRESSURE BISTABLE FAILS
26
CE1-23-CHDP
CHANNEL D TEMPERATURE BISTABLE FAILS
25
CE1-22-CHDT
CE1-12-LMBD - INPUT SIGNAL TO LOGIC MATRIX BD FAILS
2001/03/02
Page 15



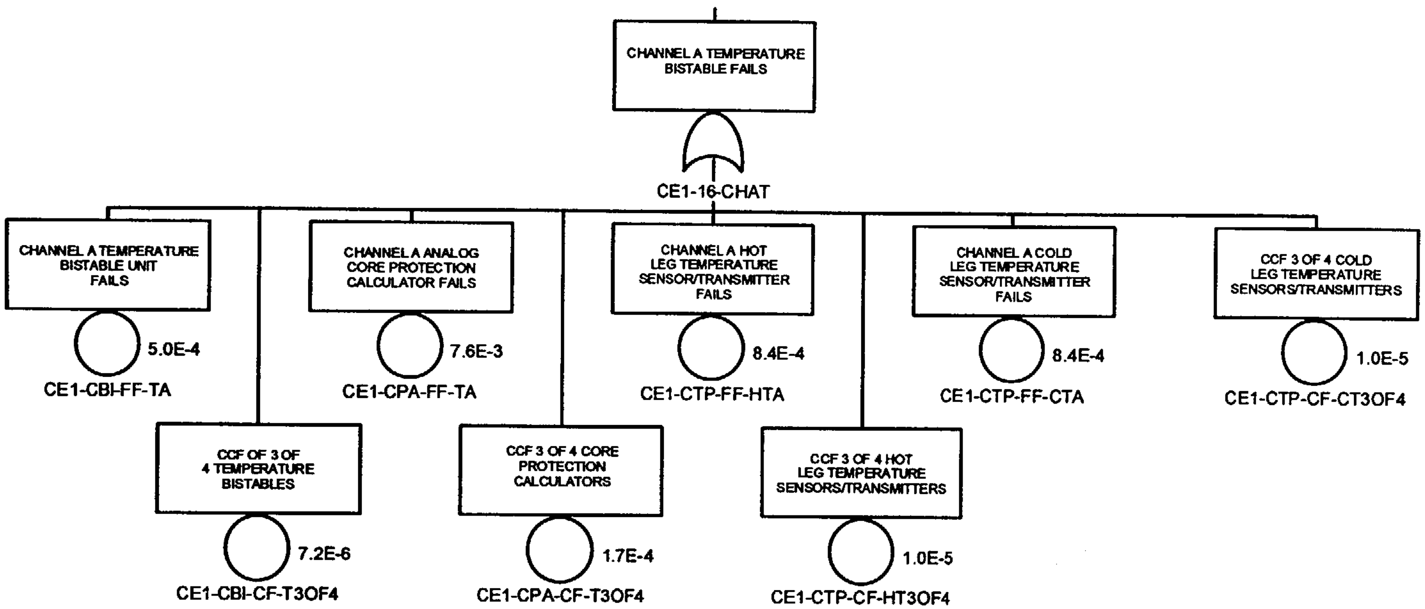
CE1-13-LMAC - INPUT SIGNAL TO LOGIC MATRIX AC FAILS 2001/03/02 Page 16



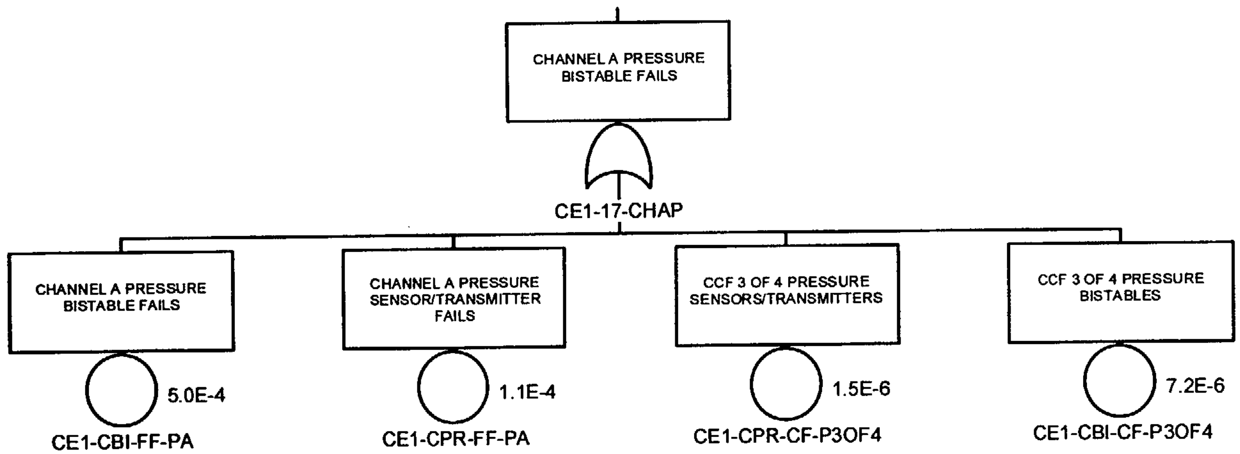
CE1-14-LMCD - INPUT SIGNAL TO LOGIC MATRIX CD FAILS 2001/03/02 Page 17



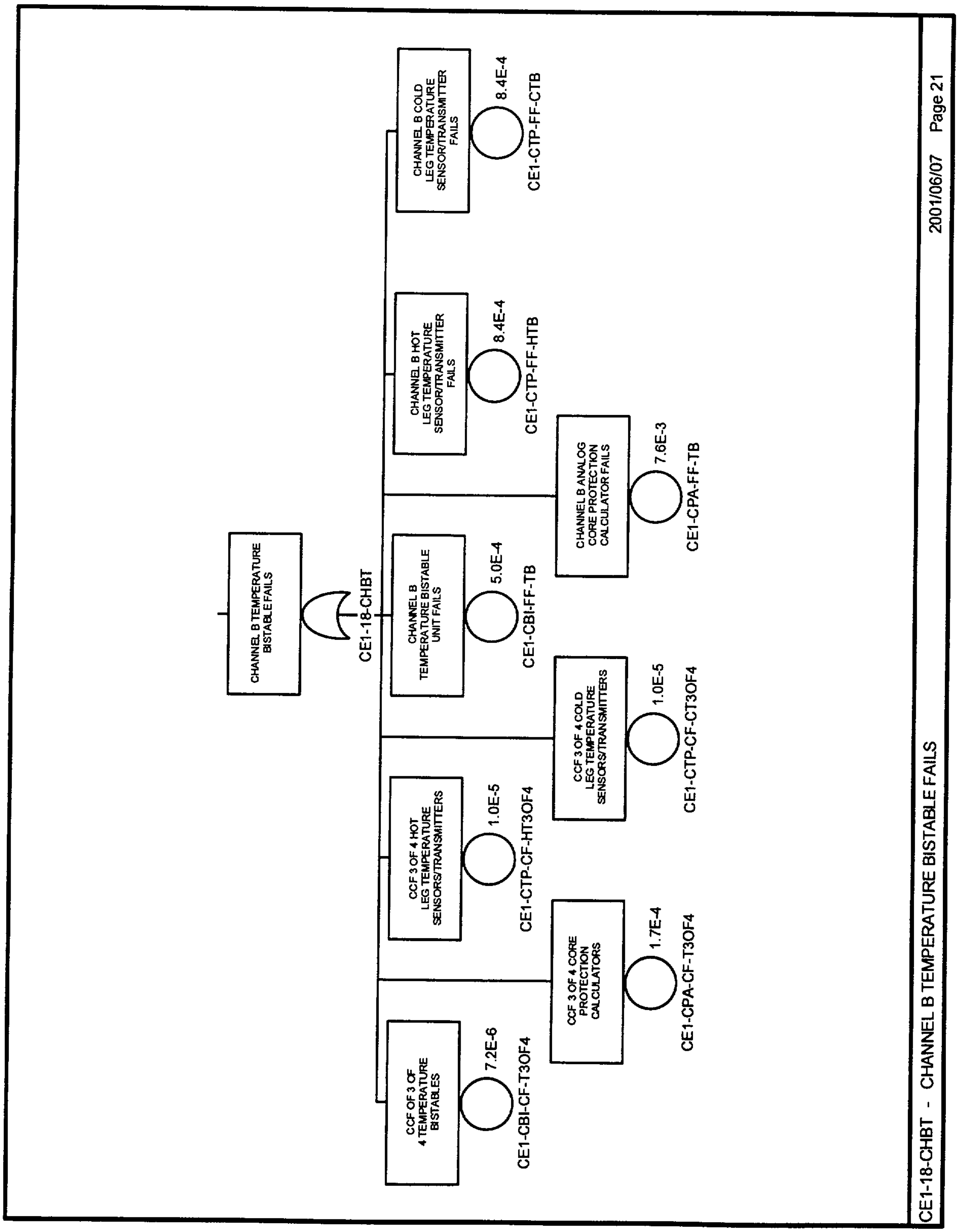
CE1-15-LMAD - INPUT SIGNAL TO LOGIC MATRIX AD FAILS 2001/03/02 Page 18

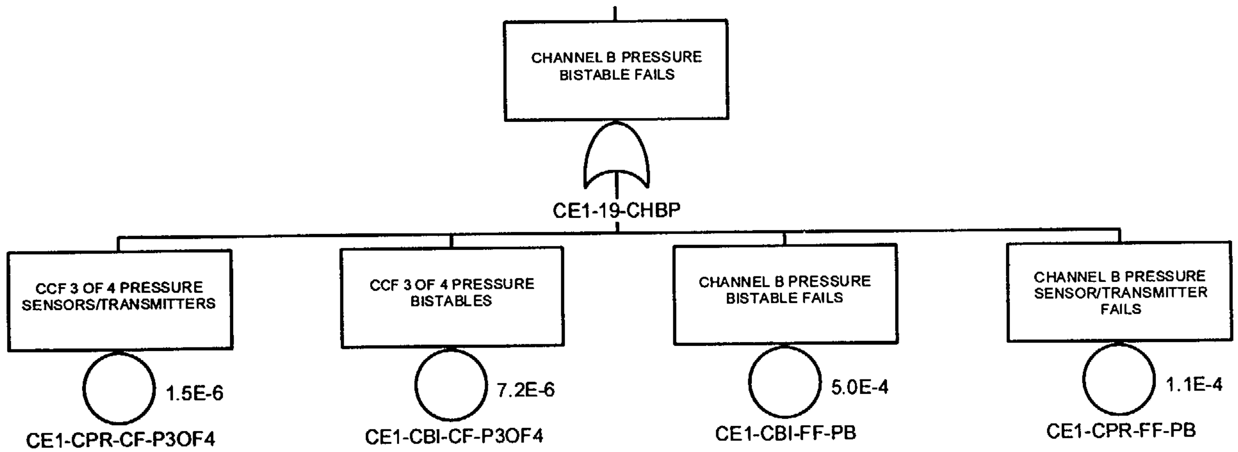


CE1-16-CHAT - CHANNEL A TEMPERATURE BISTABLE FAILS 2001/06/07 Page 19

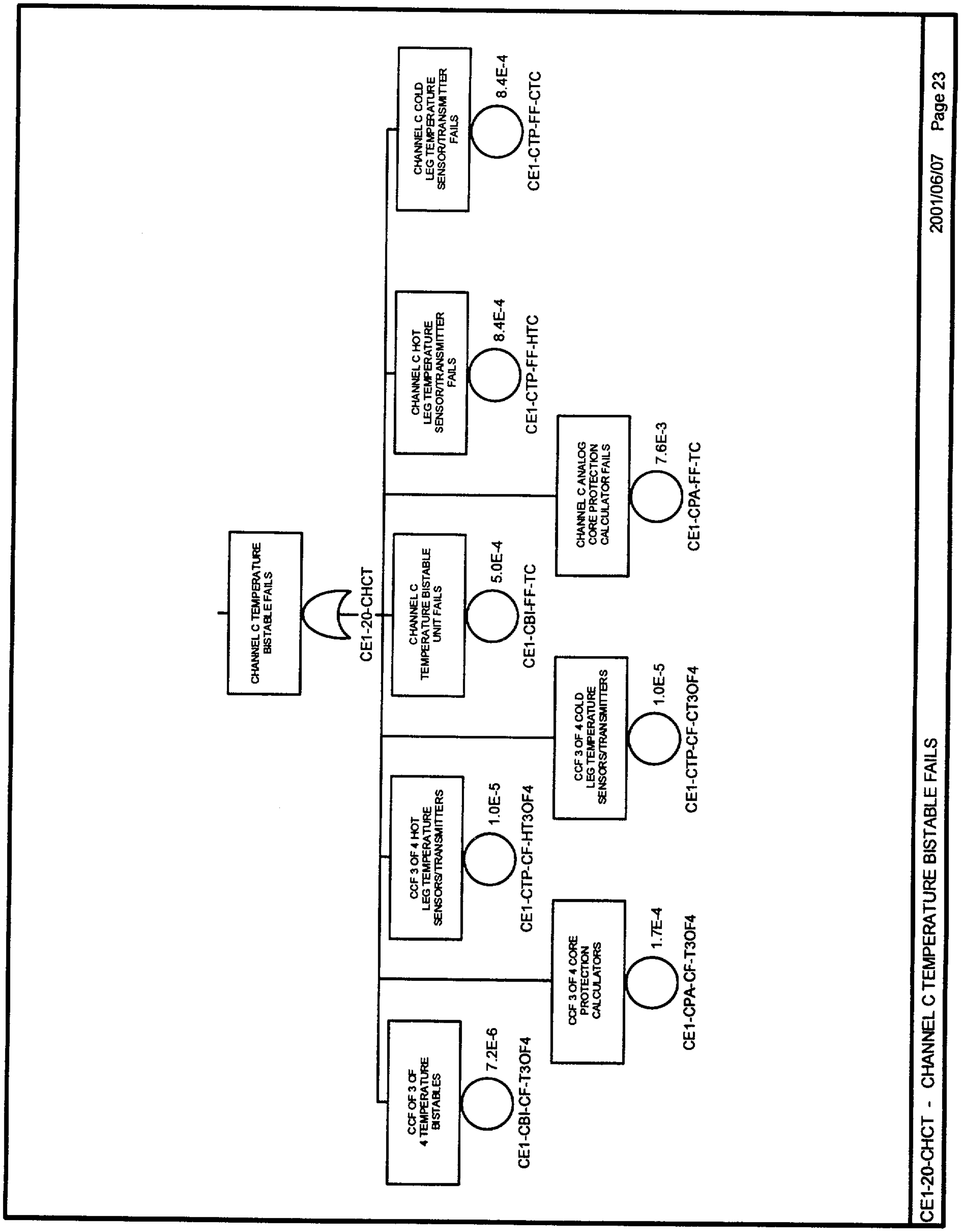


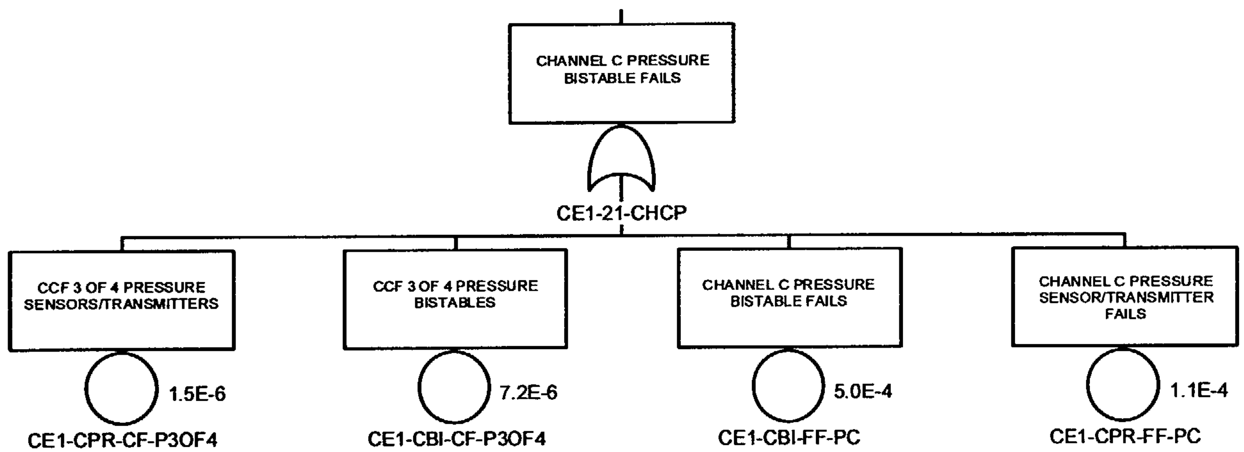
CE1-17-CHAP - CHANNEL A PRESSURE BISTABLE FAILS 2001/03/02 Page 20


CHANNEL B TEMPERATURE BISTABLE FAILS
CE1-18-CHBT
CCF OF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE1-CBI-CF-T3OF4
CCF 3 OF 4 CORE PROTECTION CALCULATORS
1.7E-4
CE1-CPA-CF-T3OF4
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE1-CTP-CF-HT3OF4
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE1-CTP-CF-CT3OF4
CHANNEL B TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE1-CBI-FF-TB
CHANNEL B ANALOG CORE PROTECTION CALCULATOR FAILS
7.6E-3
CE1-CPA-FF-TB
CHANNEL B HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE1-CTP-FF-HTB
CHANNEL B COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE1-CTP-FF-CTB
CE1-18-CHBT - CHANNEL B TEMPERATURE BISTABLE FAILS
2001/06/07 Page 21

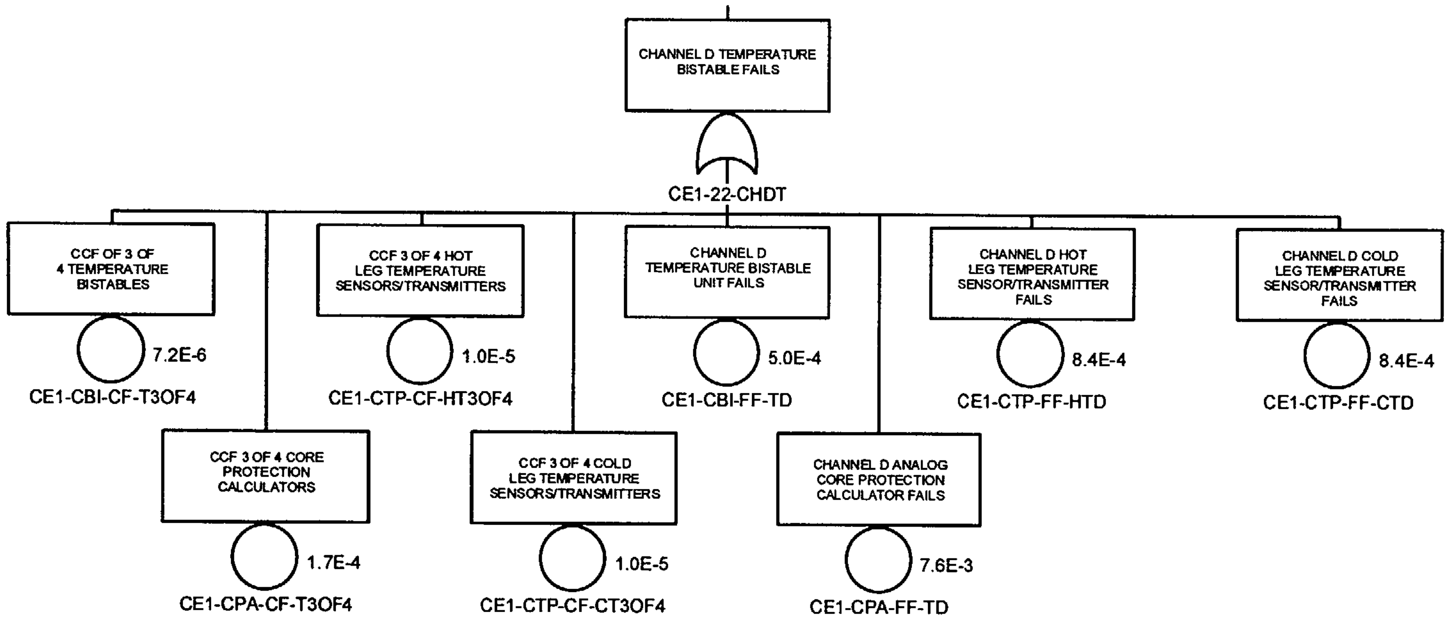


CE1-19-CHBP - CHANNEL B PRESSURE BISTABLE FAILS 2001/03/02 Page 22

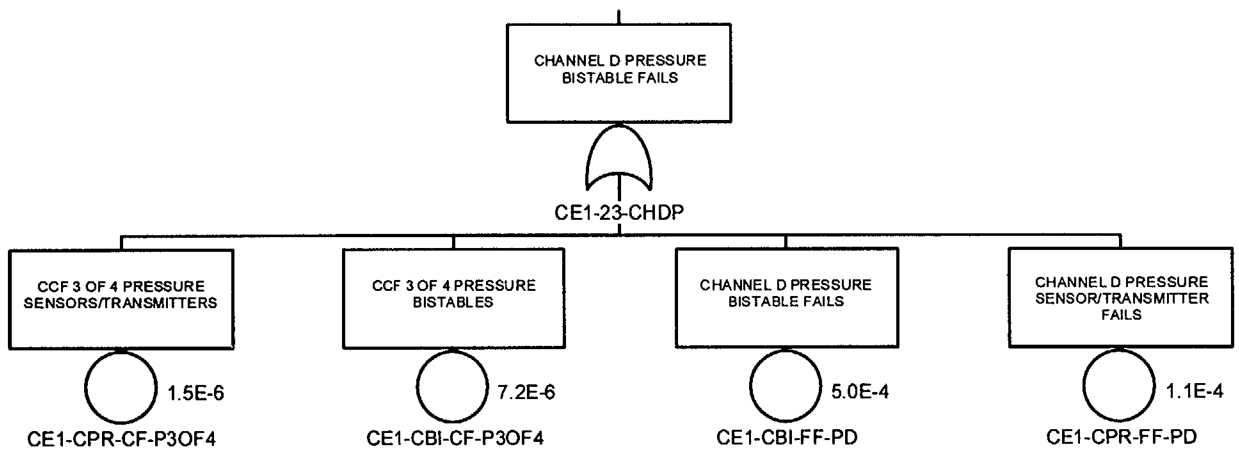

CHANNEL C TEMPERATURE BISTABLE FAILS
CE1-20-CHCT
CCF OF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE1-CBI-CF-T3OF4
CCF 3 OF 4 CORE PROTECTION CALCULATORS
1.7E-4
CE1-CPA-CF-T3OF4
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE1-CTP-CF-HT3OF4
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE1-CTP-CF-CT3OF4
CHANNEL C TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE1-CBI-FF-TC
CHANNEL C ANALOG CORE PROTECTION CALCULATOR FAILS
7.6E-3
CE1-CPA-FF-TC
CHANNEL C HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE1-CTP-FF-HTC
CHANNEL C COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE1-CTP-FF-CTC
CE1-20-CHCT - CHANNEL C TEMPERATURE BISTABLE FAILS
2001/06/07 Page 23



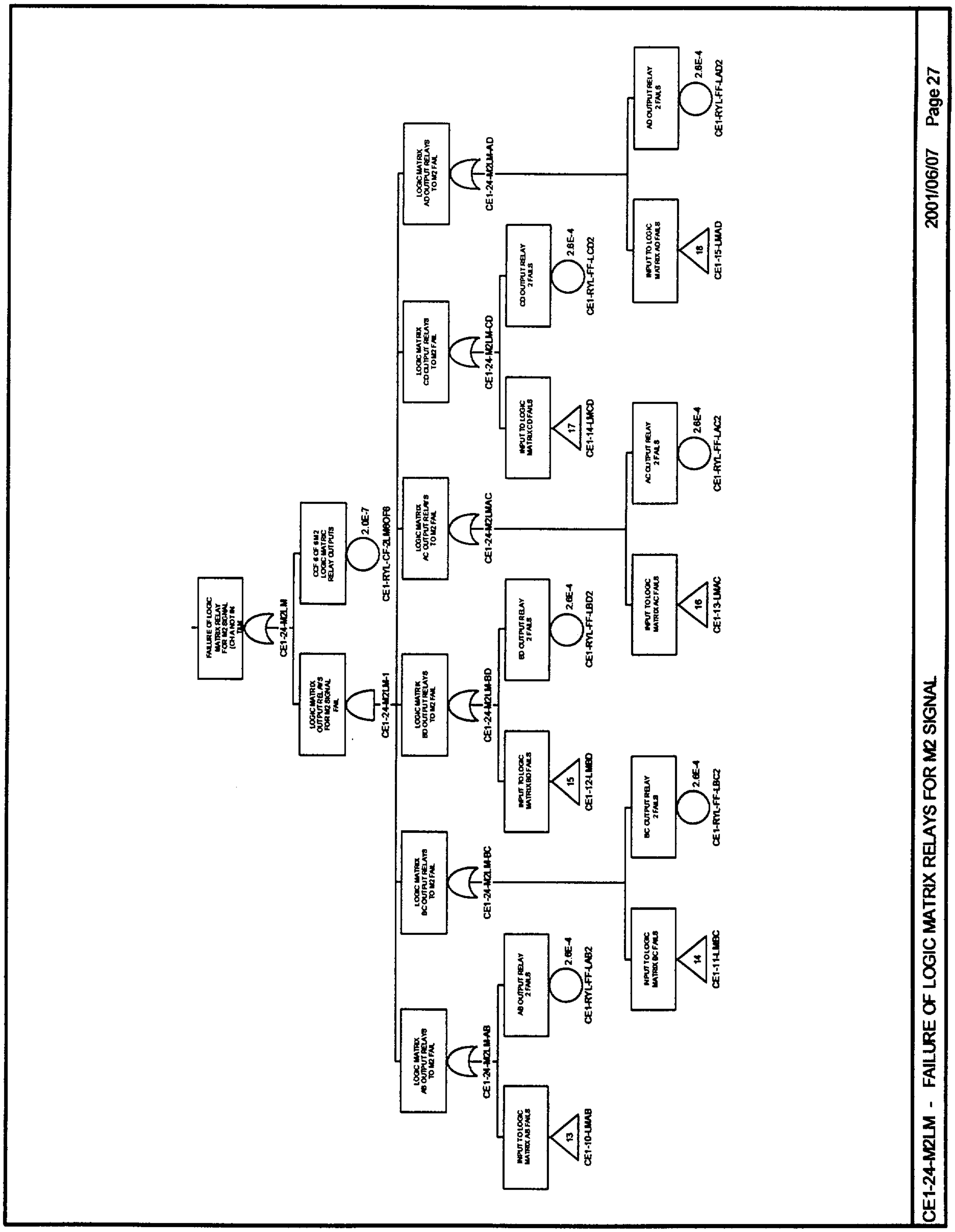
CE1-21-CHCP - CHANNELC PRESSURE BISTABLE FAILS 2001/03/02 Page 24

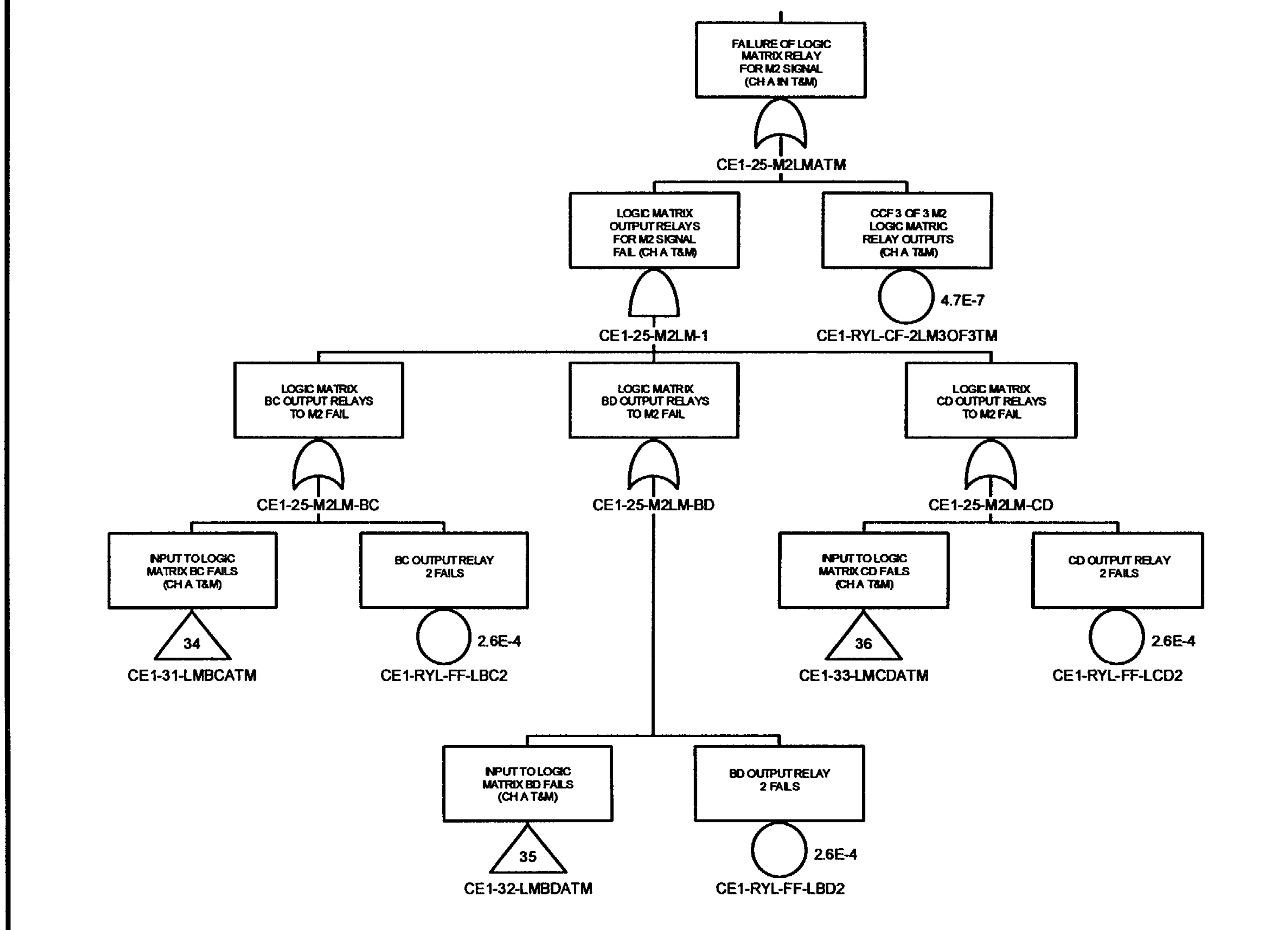


CE1-22-CHDT - CHANNEL D TEMPERATURE BISTABLE FAILS 2001/06/07 Page 25

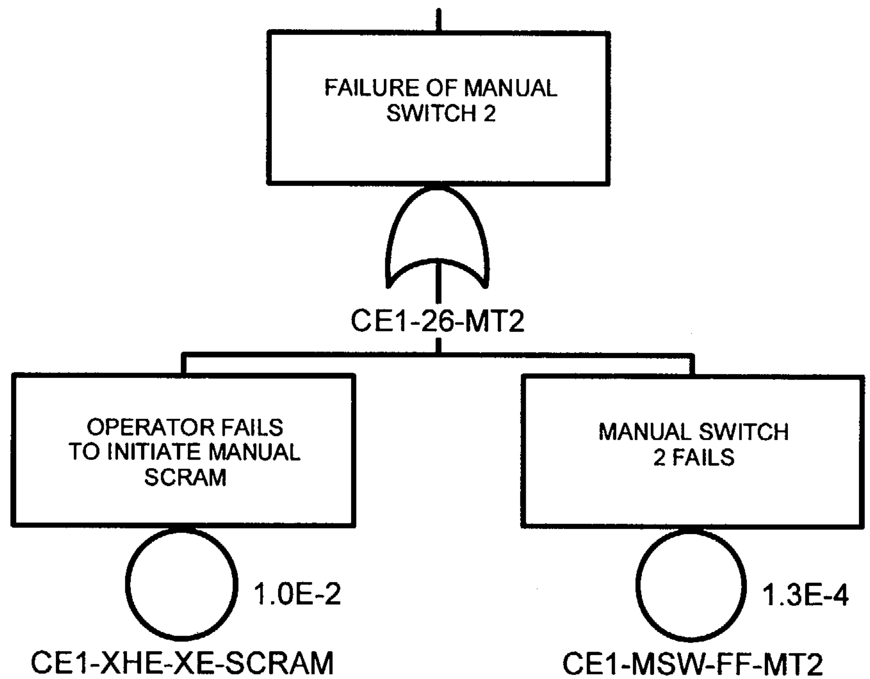


CE1-23-CHDP - CHANNEL D PRESSURE BISTABLE FAILS 2001/03/02 Page 26

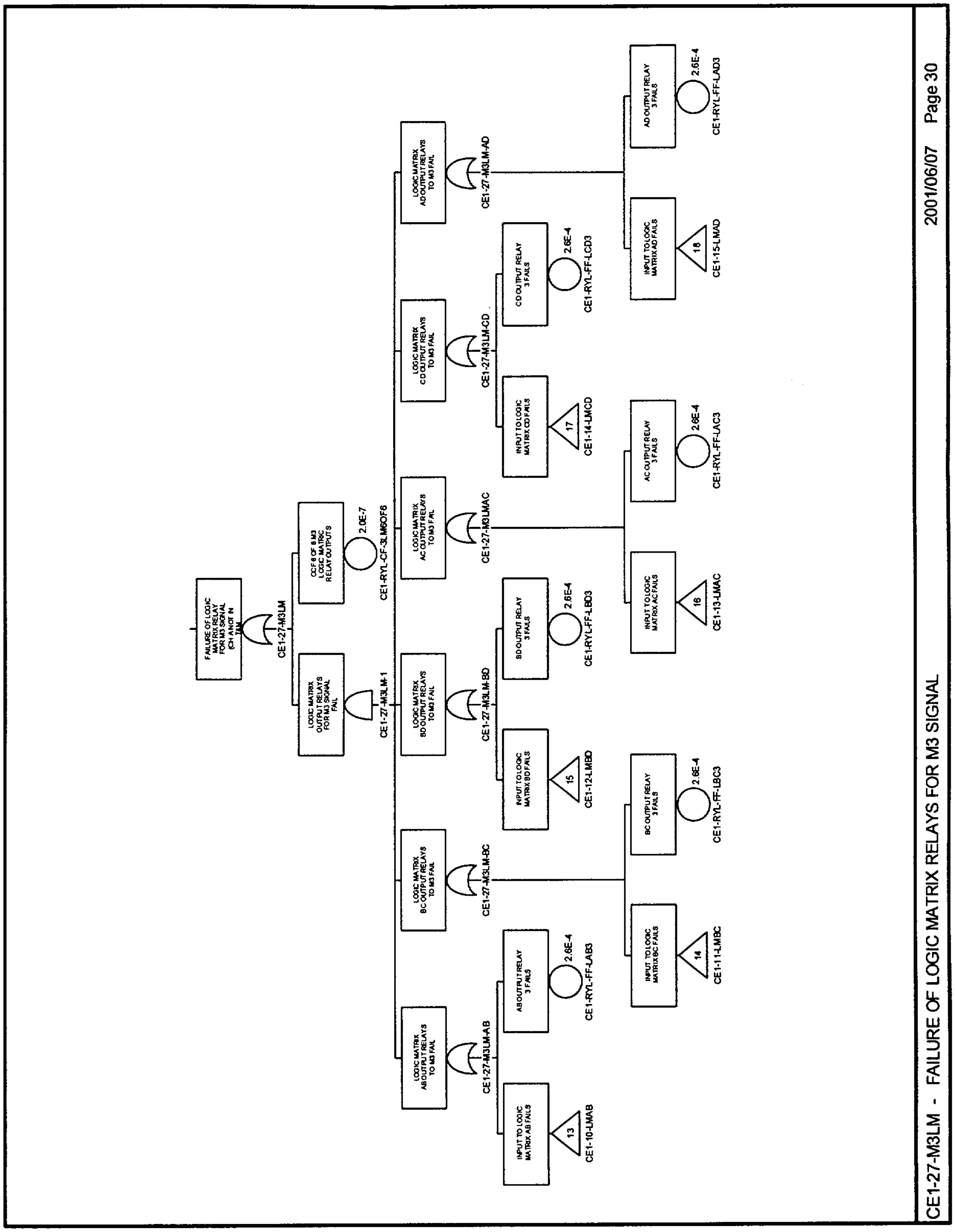

CE1-24-M2LM - FAILURE OF LOGIC MATRIX RELAYS FOR M2 SIGNAL
2001/06/07 Page 27
CE1-24-M2LM
CE1-24-M2LM-1
CE1-RYL-CF-2LM6OF6
2.0E-7
CE1-24-M2LM-AB
CE1-24-M2LM-BC
CE1-24-M2LM-BD
CE1-24-M2LMAC
CE1-24-M2LM-CD
CE1-24-M2LM-AD
CE1-10-LMAB
CE1-RYL-FF-LAB2
CE1-11-LMBC
CE1-RYL-FF-LBC2
CE1-12-LMBD
CE1-RYL-FF-LBD2
CE1-13-LMAC
CE1-RYL-FF-LAC2
CE1-14-LMCD
CE1-RYL-FF-LCD2
CE1-15-LMAD
CE1-RYL-FF-LAD2
2.8E-4

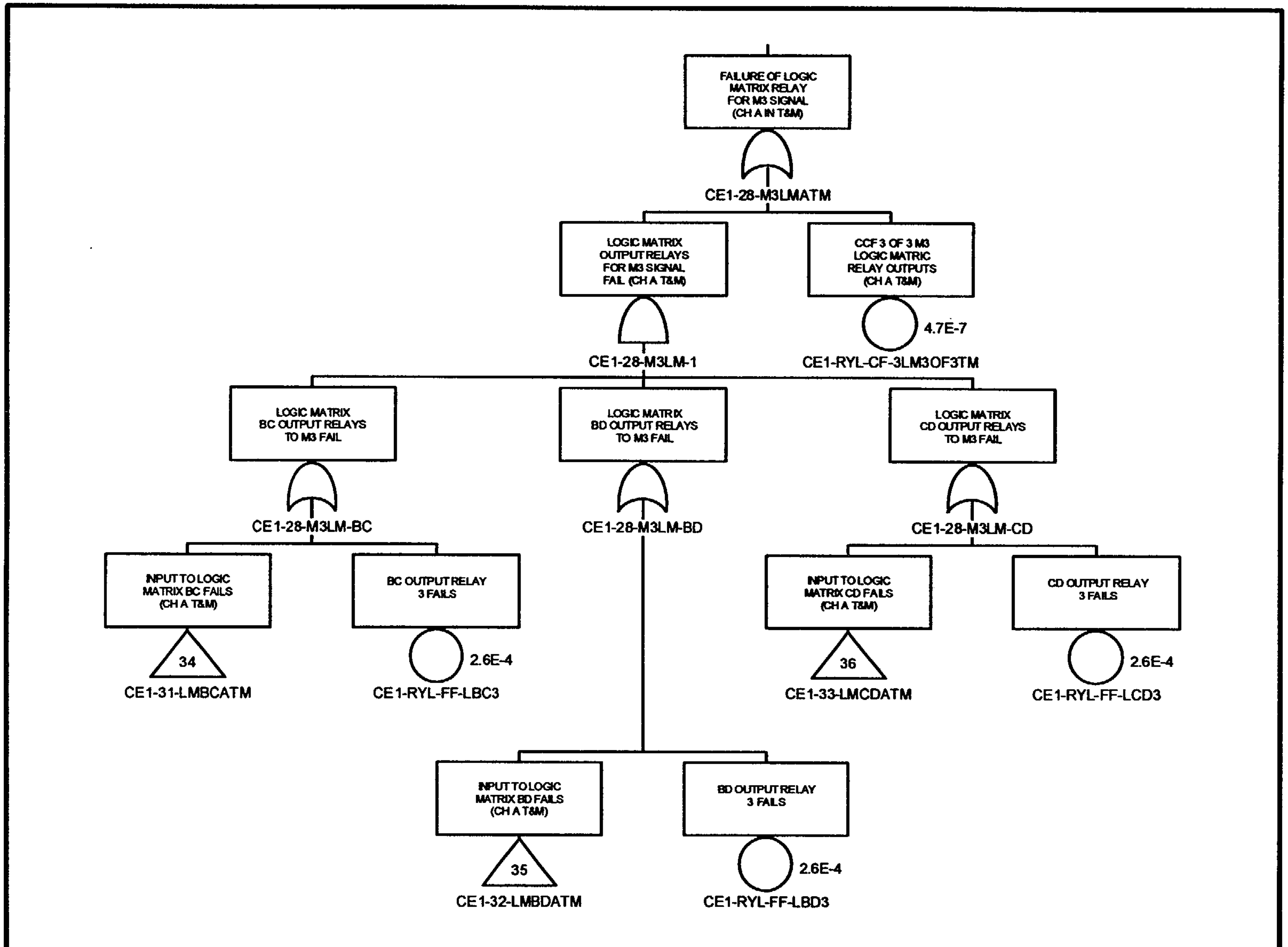


CE1-25-M2LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR M2 SIGNAL (CH A T&M) 2001/06/07 Page 28

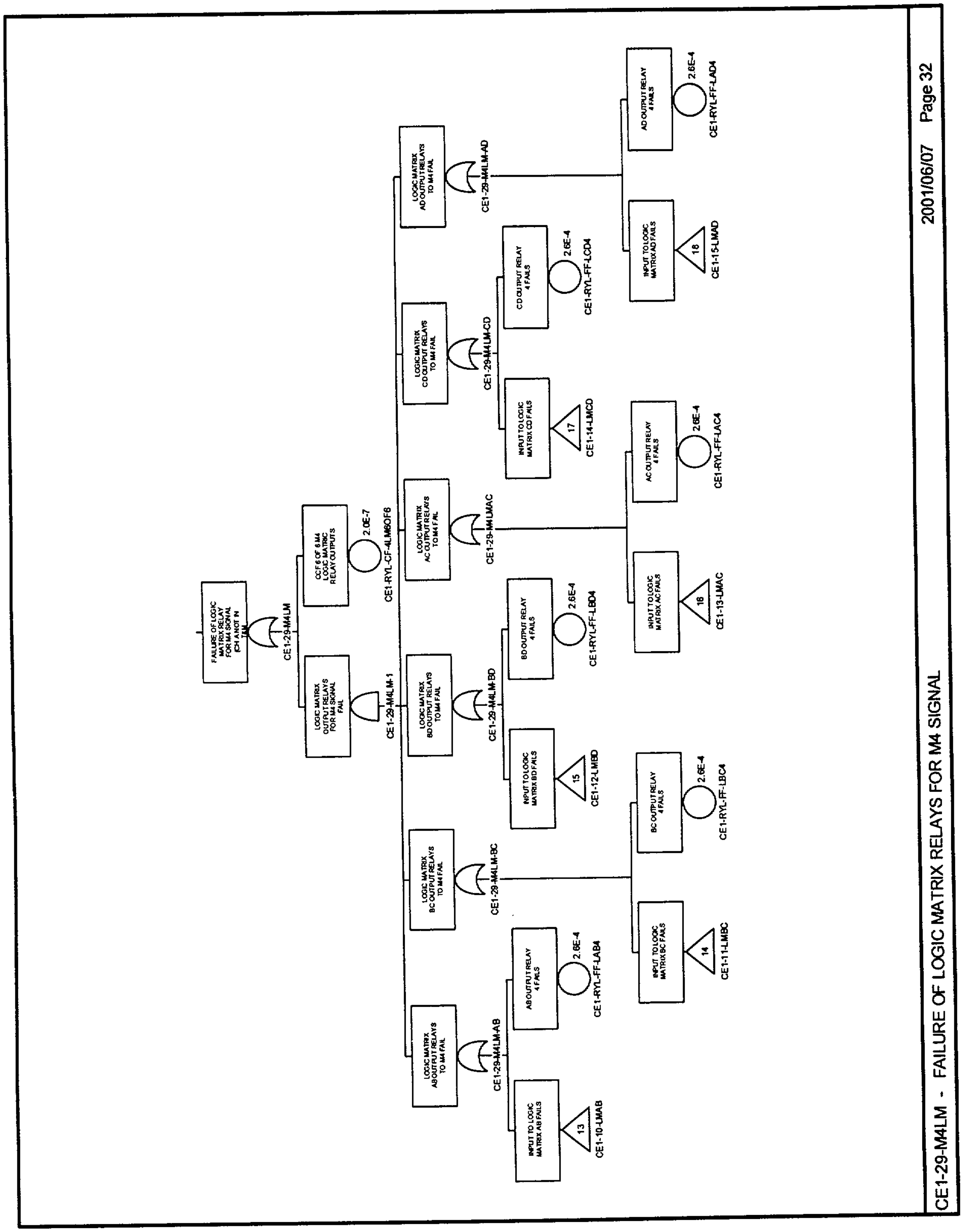


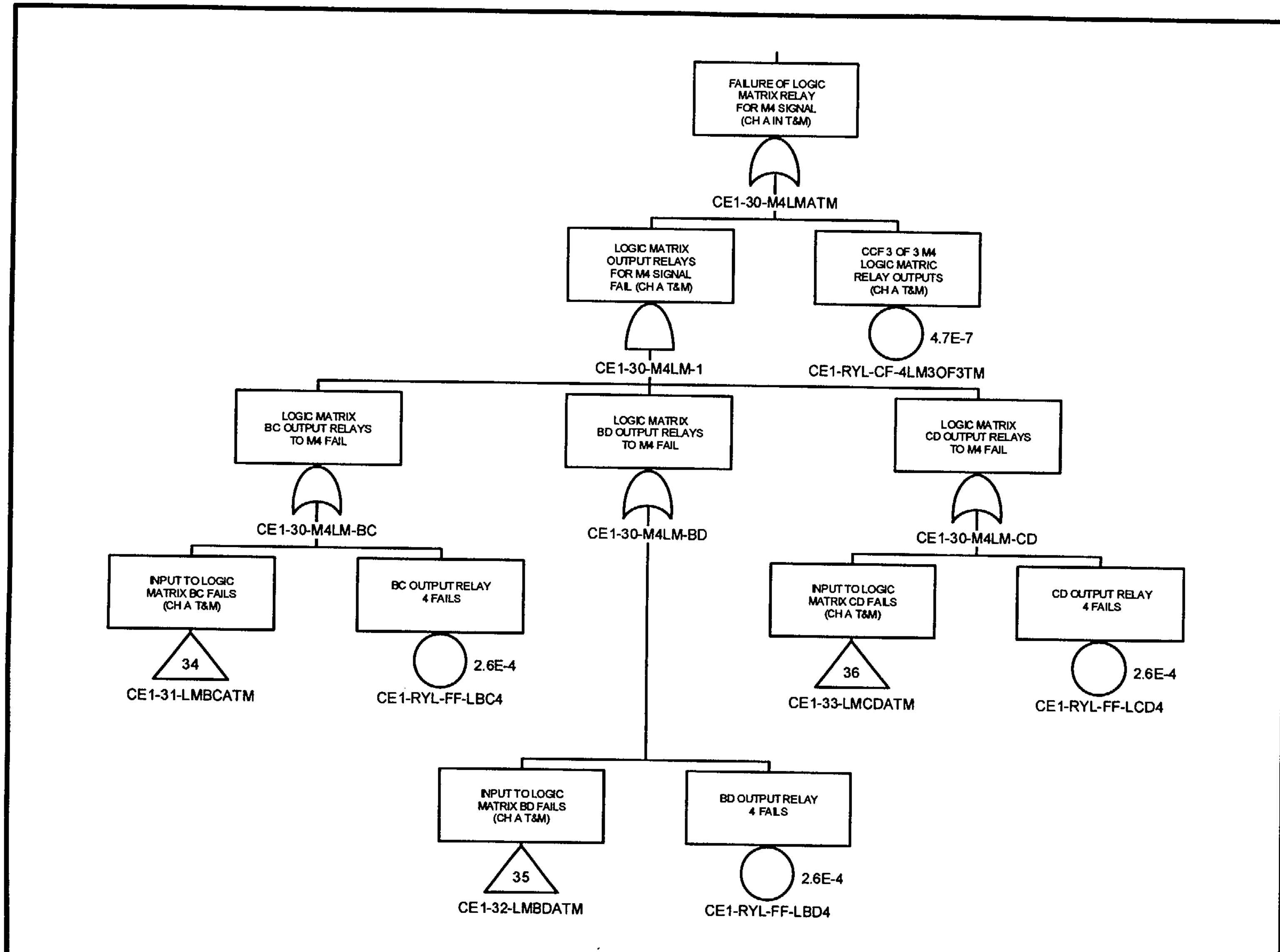
CE1-26-MT2 - MANUAL TRIP 2 FAILS 2001/03/02 Page 29


CE1-27-M3LM
CE1-27-M3LM-1
CE1-RYL-CF-3LM6OF6
2.0E-7
CE1-27-M3LM-AB
CE1-27-M3LM-BC
CE1-27-M3LM-BD
CE1-27-M3LMAC
CE1-27-M3LM-CD
CE1-27-M3LM-AD
CE1-10-LMAB
CE1-11-LMBC
CE1-12-LMBD
CE1-13-LMAC
CE1-14-LMCD
CE1-15-LMAD
13
14
15
16
17
18
CE1-RYL-FF-LAB3
CE1-RYL-FF-LBC3
CE1-RYL-FF-LBD3
CE1-RYL-FF-LAC3
CE1-RYL-FF-LCD3
CE1-RYL-FF-LAD3
2.6E-4
CE1-27-M3LM - FAILURE OF LOGIC MATRIX RELAYS FOR M3 SIGNAL
2001/06/07 Page 30

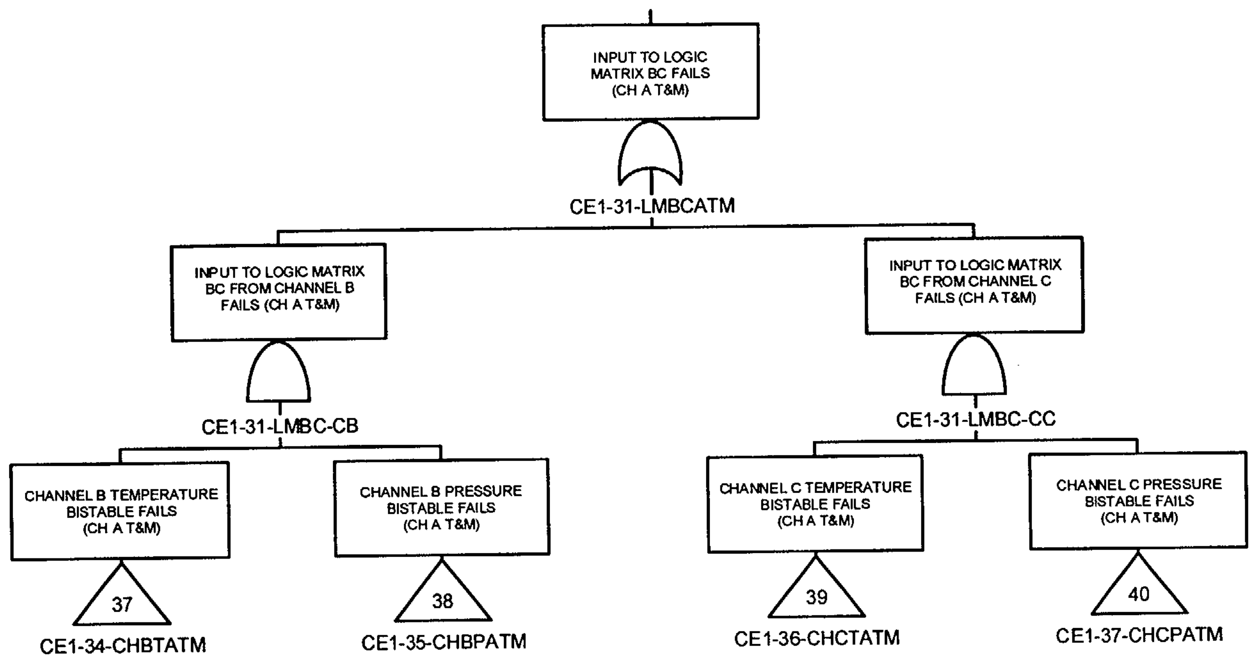


CE1-28-M3LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR M3 SIGNAL (CH A T&M) 2001/06/07 Page 31

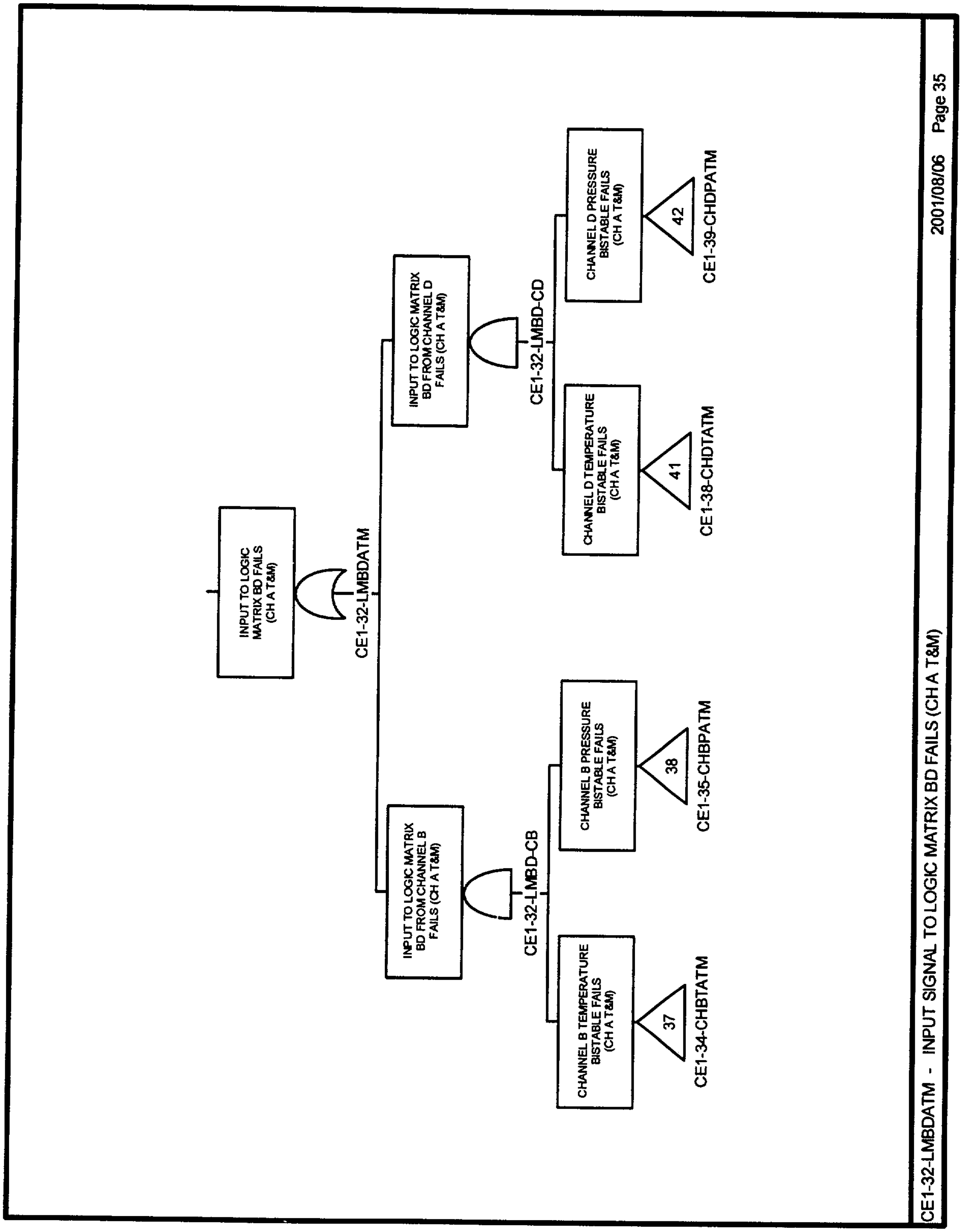

CE1-29-M4LM - FAILURE OF LOGIC MATRIX RELAYS FOR M4 SIGNAL
2001/06/07 Page 32
CE1-29-M4LM
CE1-29-M4LM-1
CE1-RYL-CF-4LM6OF6
2.0E-7
CE1-29-M4LM-AB
CE1-29-M4LM-BC
CE1-29-M4LM-BD
CE1-29-M4LMAC
CE1-29-M4LM-CD
CE1-29-M4LM-AD
CE1-10-LMAB
CE1-RYL-FF-LAB4
CE1-11-LMBC
CE1-RYL-FF-LBC4
CE1-12-LMBD
CE1-RYL-FF-LBD4
CE1-13-LMAC
CE1-RYL-FF-LAC4
CE1-14-LMCD
CE1-RYL-FF-LCD4
CE1-15-LMAD
CE1-RYL-FF-LAD4
2.6E-4

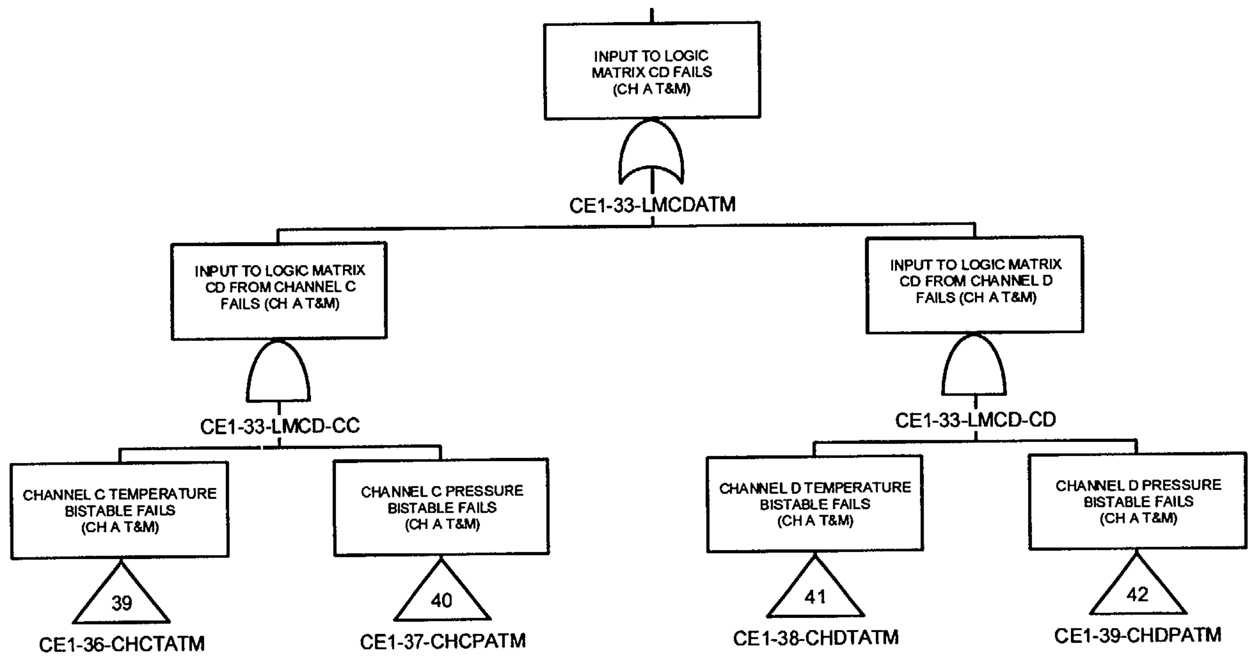


CE1-30-M4LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR M4 SIGNAL (CH A T&M) 2001/06/07 Page 33

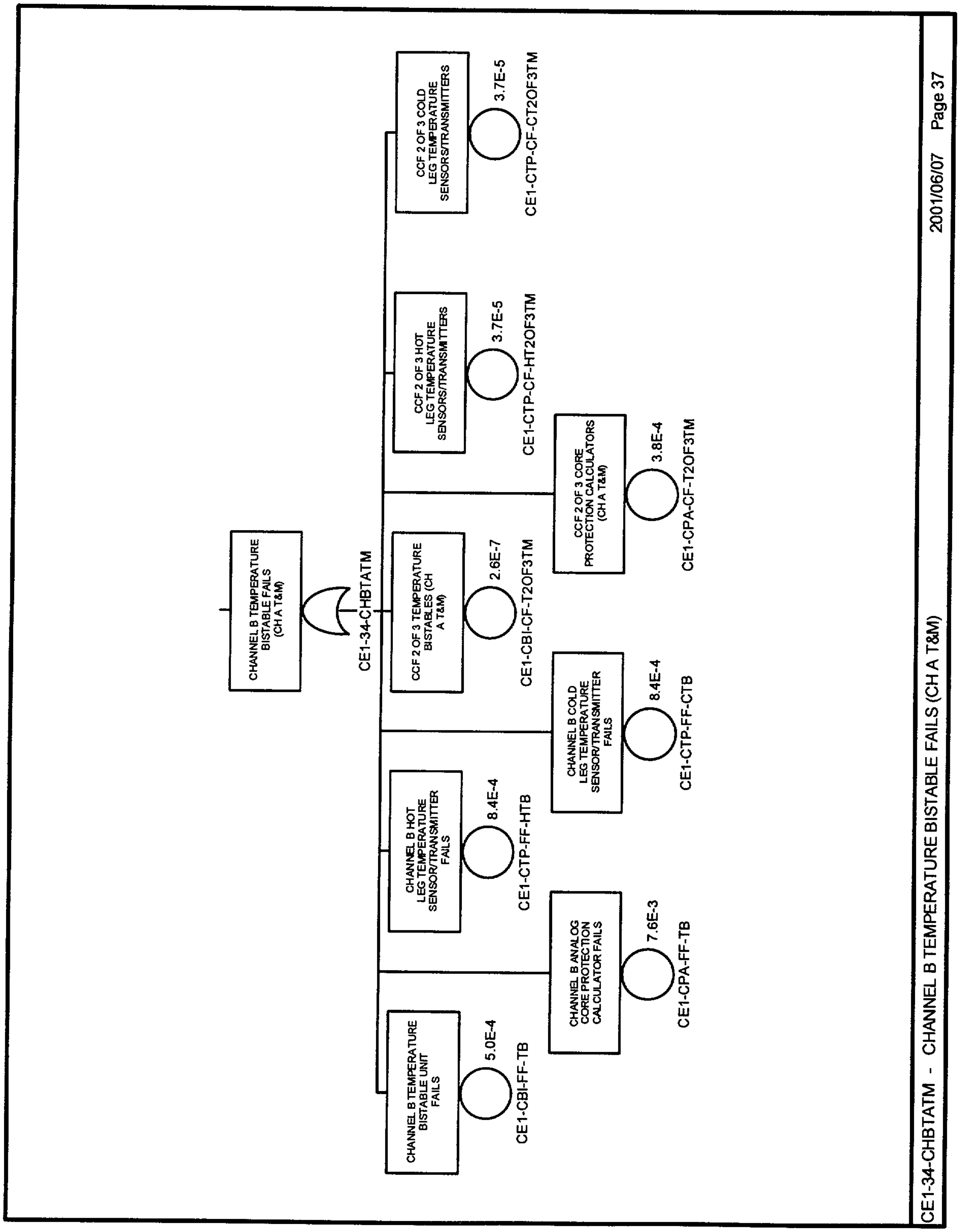


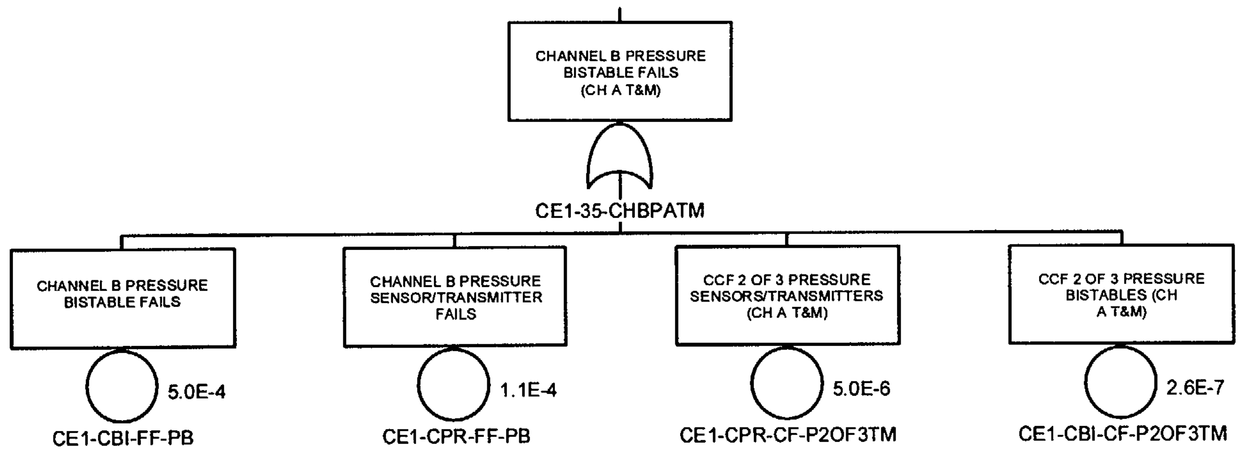
CE1-31-LMBCATM - INPUT SIGNAL TO LOGIC MATRIX BC FAILS (CH A T&M) 2001/08/06 Page 34


INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
CE1-32-LMBDATM
INPUT TO LOGIC MATRIX BD FROM CHANNEL B FAILS (CH A T&M)
CE1-32-LMBD-CB
INPUT TO LOGIC MATRIX BD FROM CHANNEL D FAILS (CH A T&M)
CE1-32-LMBD-CD
CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M)
37
CE1-34-CHBTATM
CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M)
38
CE1-35-CHBPATM
CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
41
CE1-38-CHDTATM
CHANNEL D PRESSURE BISTABLE FAILS (CH A T&M)
42
CE1-39-CHDPATM
CE1-32-LMBDATM - INPUT SIGNAL TO LOGIC MATRIX BD FAILS (CH A T&M)
2001/08/06
Page 35

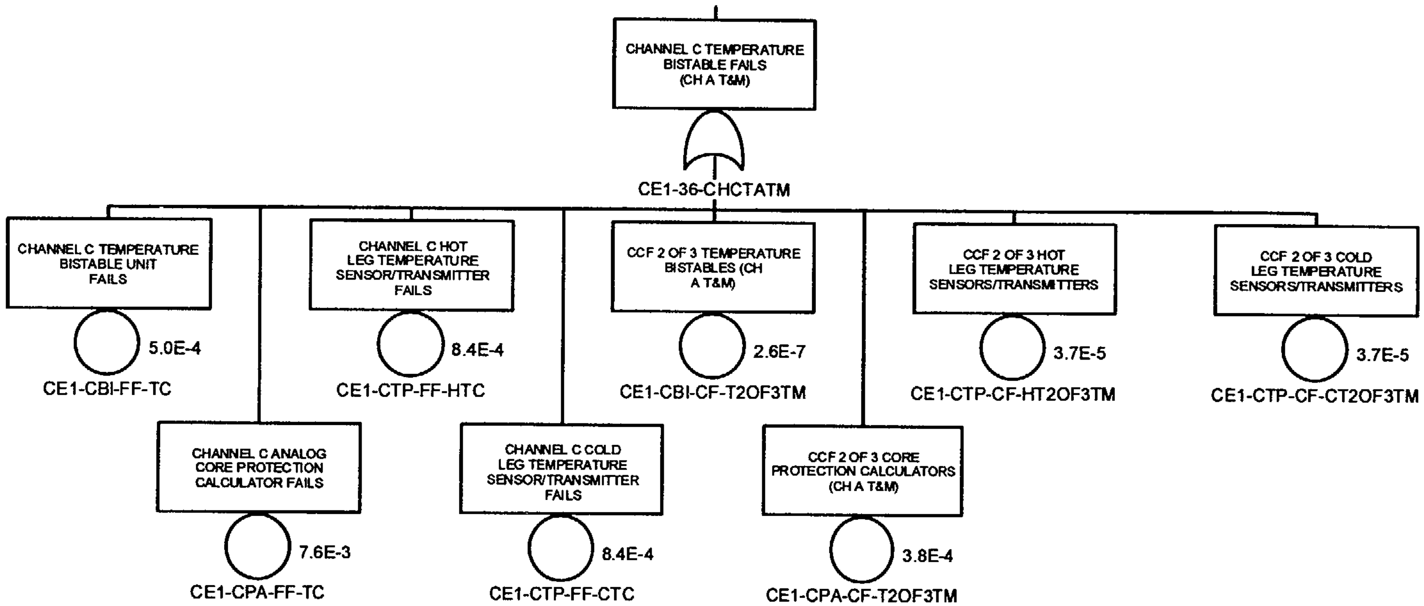


CE1-33-LMCDATM - INPUT SIGNAL TO LOGIC MATRIX CD FAILS (CH A T&M) 2001/08/06 Page 36

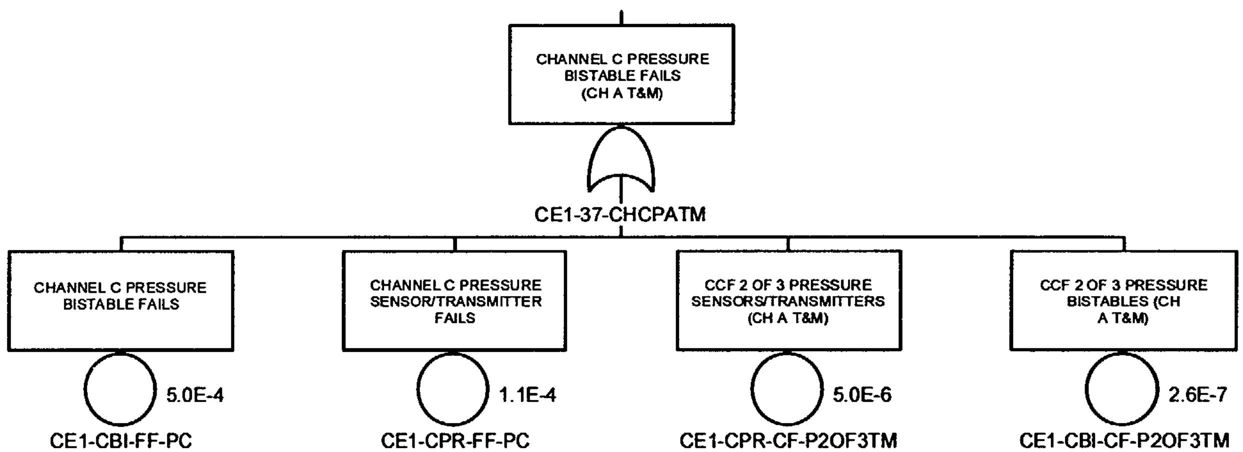

CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M)
CE1-34-CHBTATM
CHANNEL B TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE1-CBI-FF-TB
CHANNEL B ANALOG CORE PROTECTION CALCULATOR FAILS
7.6E-3
CE1-CPA-FF-TB
CHANNEL B HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE1-CTP-FF-HTB
CHANNEL B COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE1-CTP-FF-CTB
CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
2.6E-7
CE1-CBI-CF-T2OF3TM
CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
3.8E-4
CE1-CPA-CF-T2OF3TM
CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE1-CTP-CF-HT2OF3TM
CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE1-CTP-CF-CT2OF3TM
CE1-34-CHBTATM - CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M)
2001/06/07 Page 37



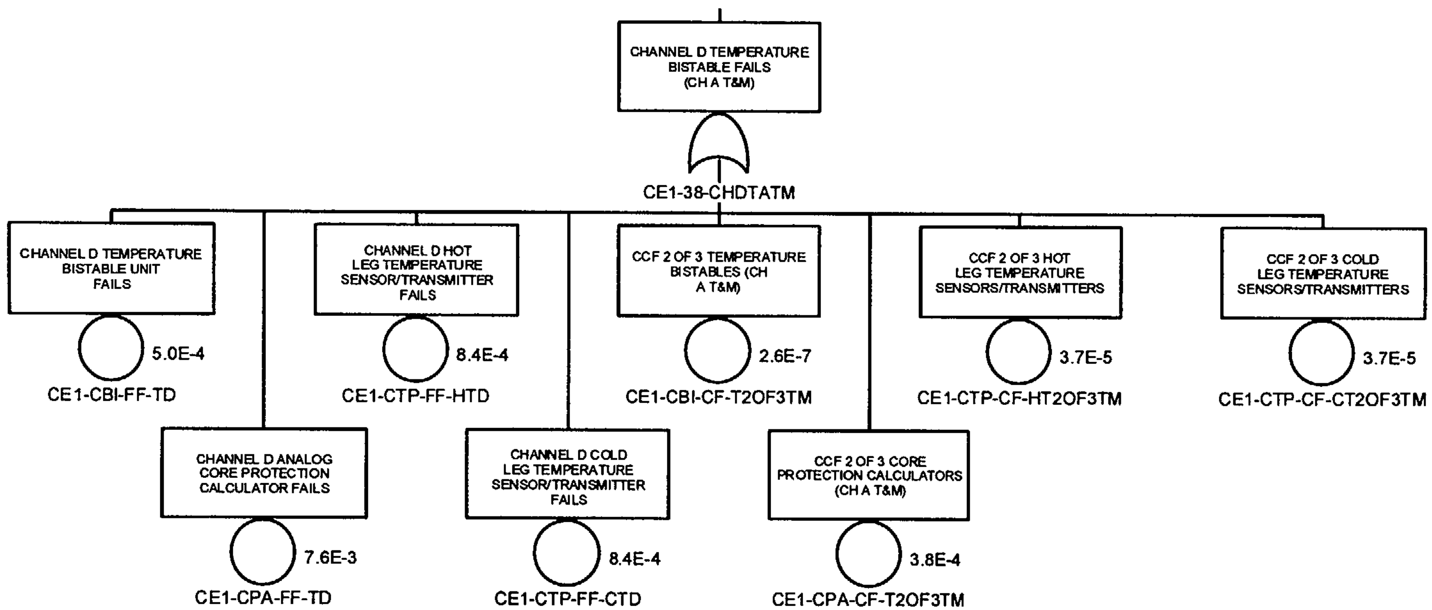
CE1-35-CHBPATM - CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M) 2001/03/02 Page 38



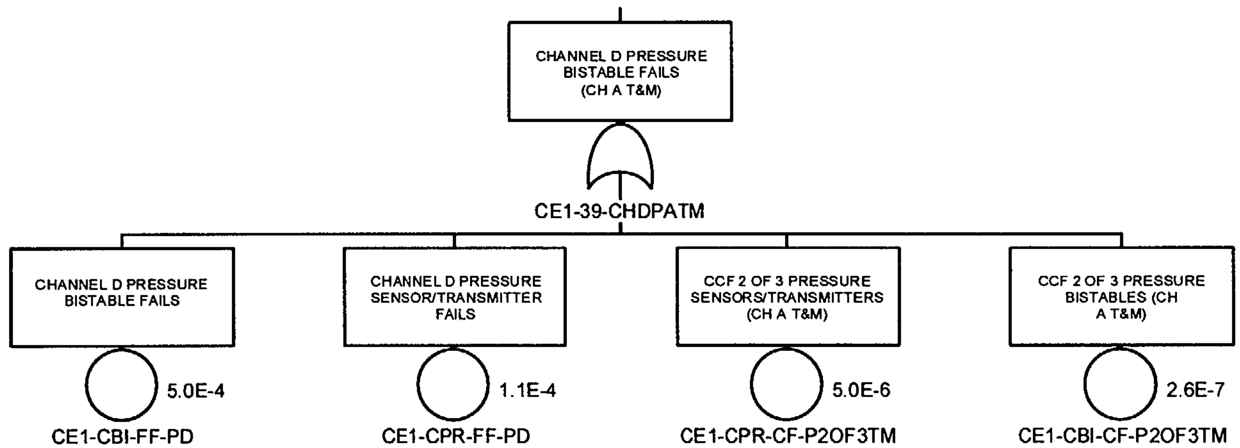
CE1-36-CHCTATM - CHANNELC TEMPERATURE BISTABLE FAILS (CH A T&M) 2001/06/07 Page 39



CE1-37-CHCPATM - CHANNELC PRESSURE BISTABLE FAILS (CH A T&M) 2001/03/02 Page 40

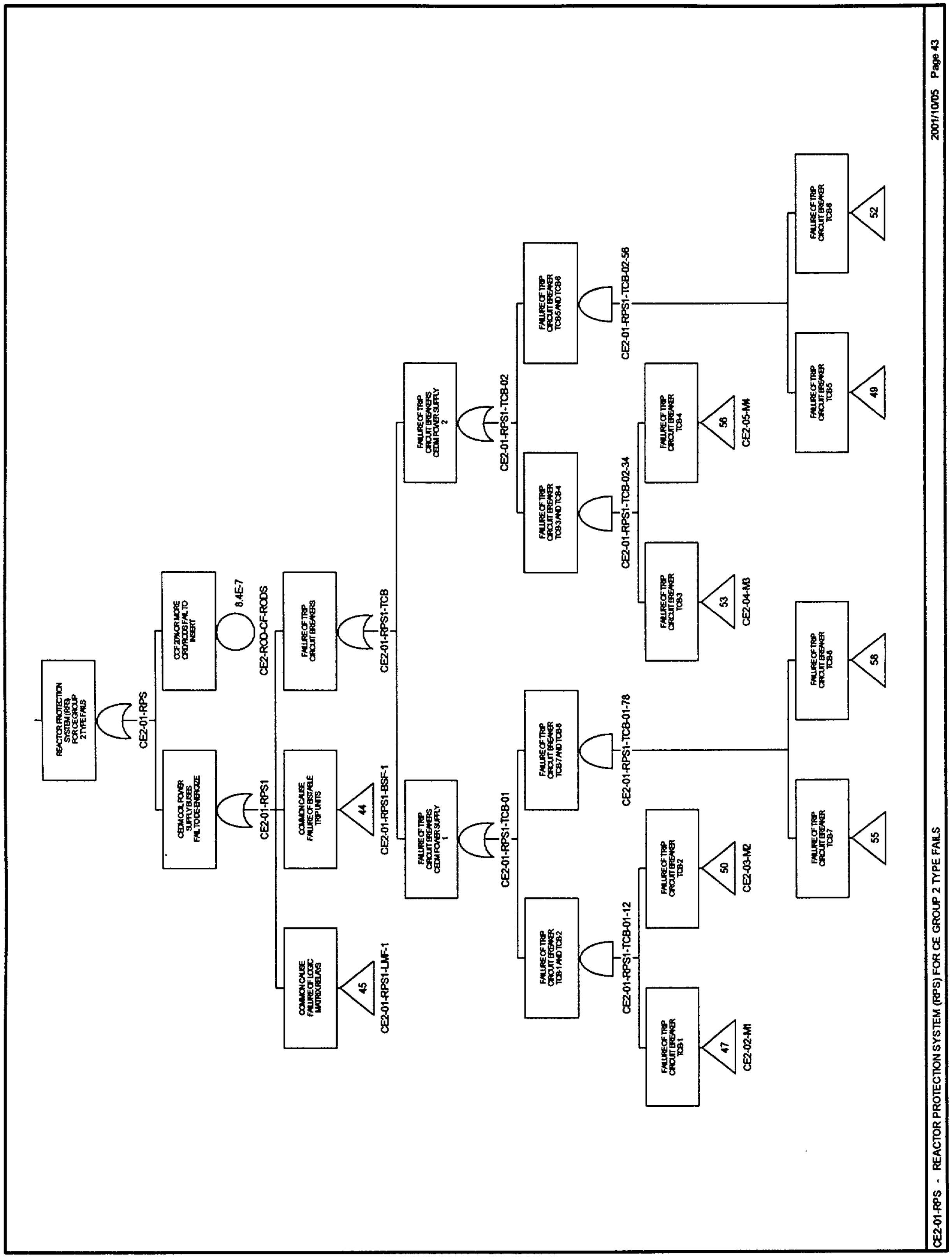


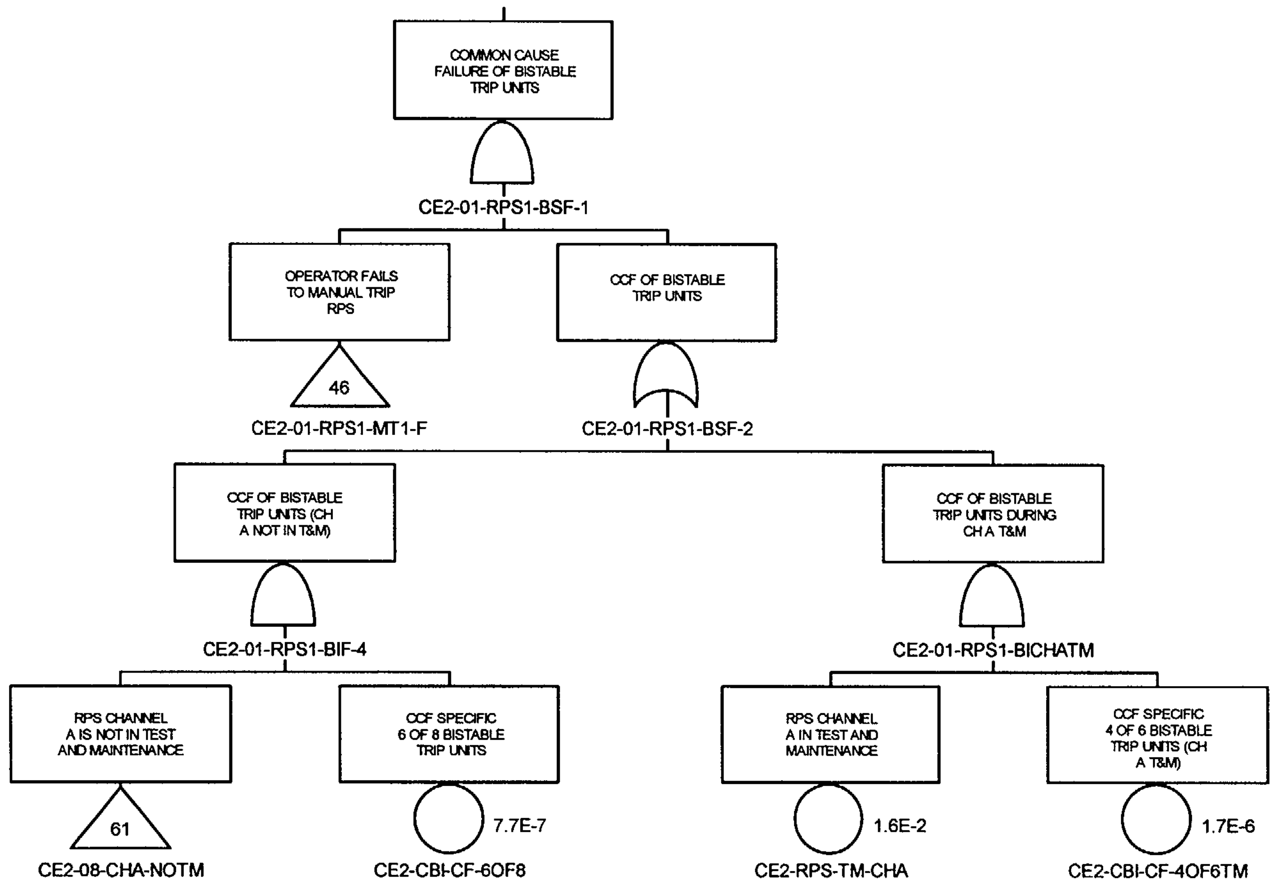
CE1-38-CHDTATM - CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M) 2001/06/07 Page 41



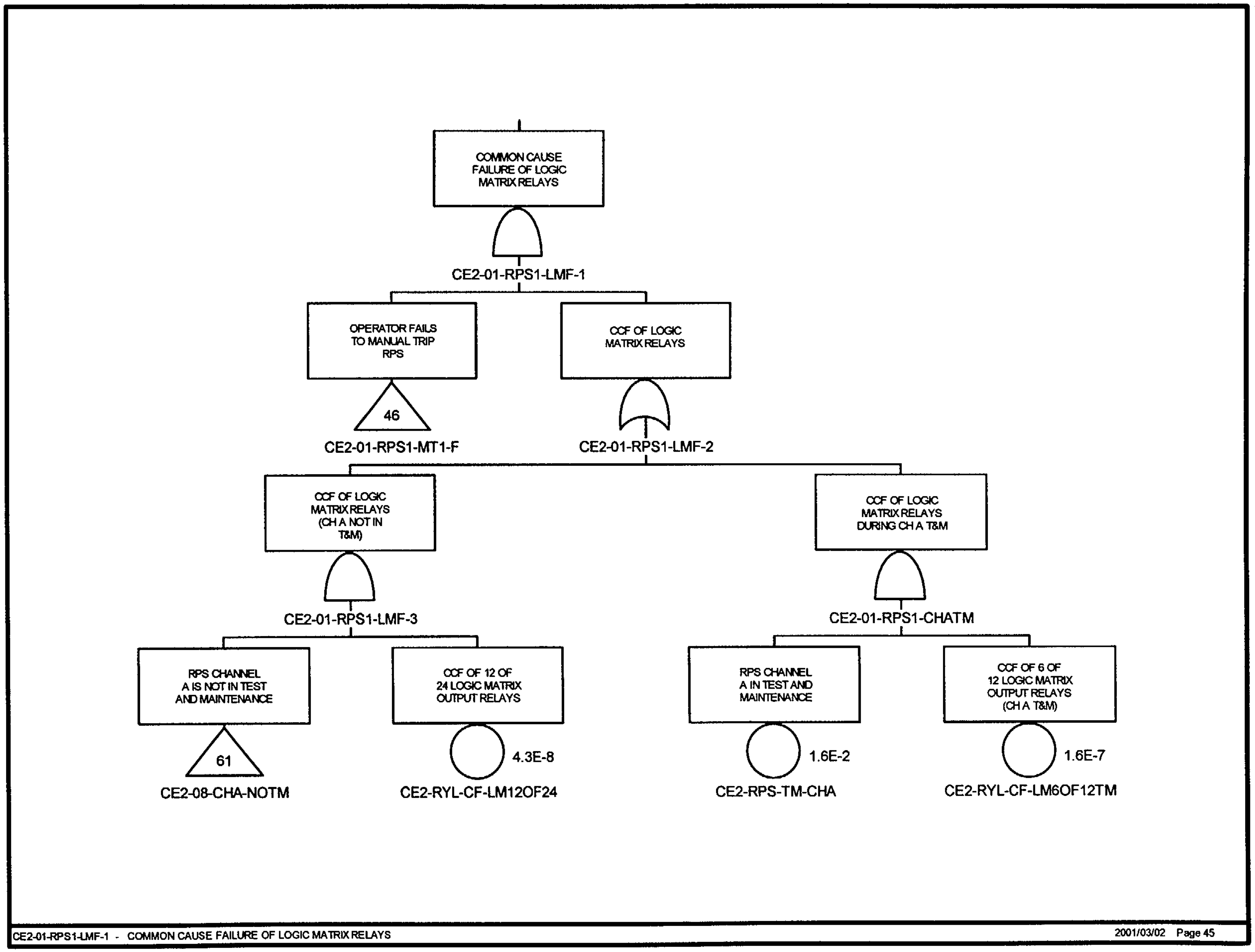
CE1-39-CHDPATM - CHANNELD PRESSURE BISTABLE FAILS (CH A T&M) 2001/03/02 Page 42

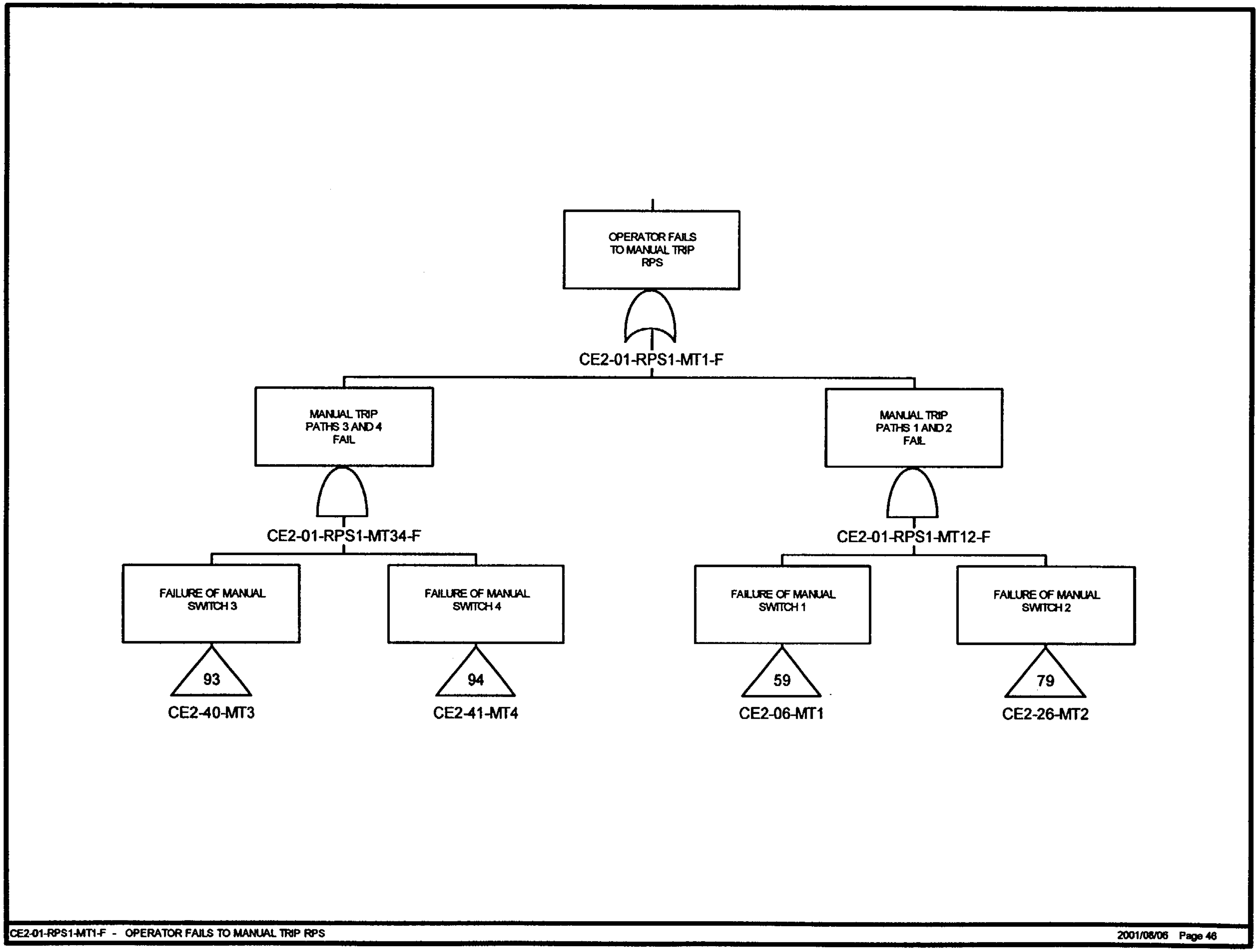
COMBUSTION ENGINEERING RPS GROUP 2 MODEL

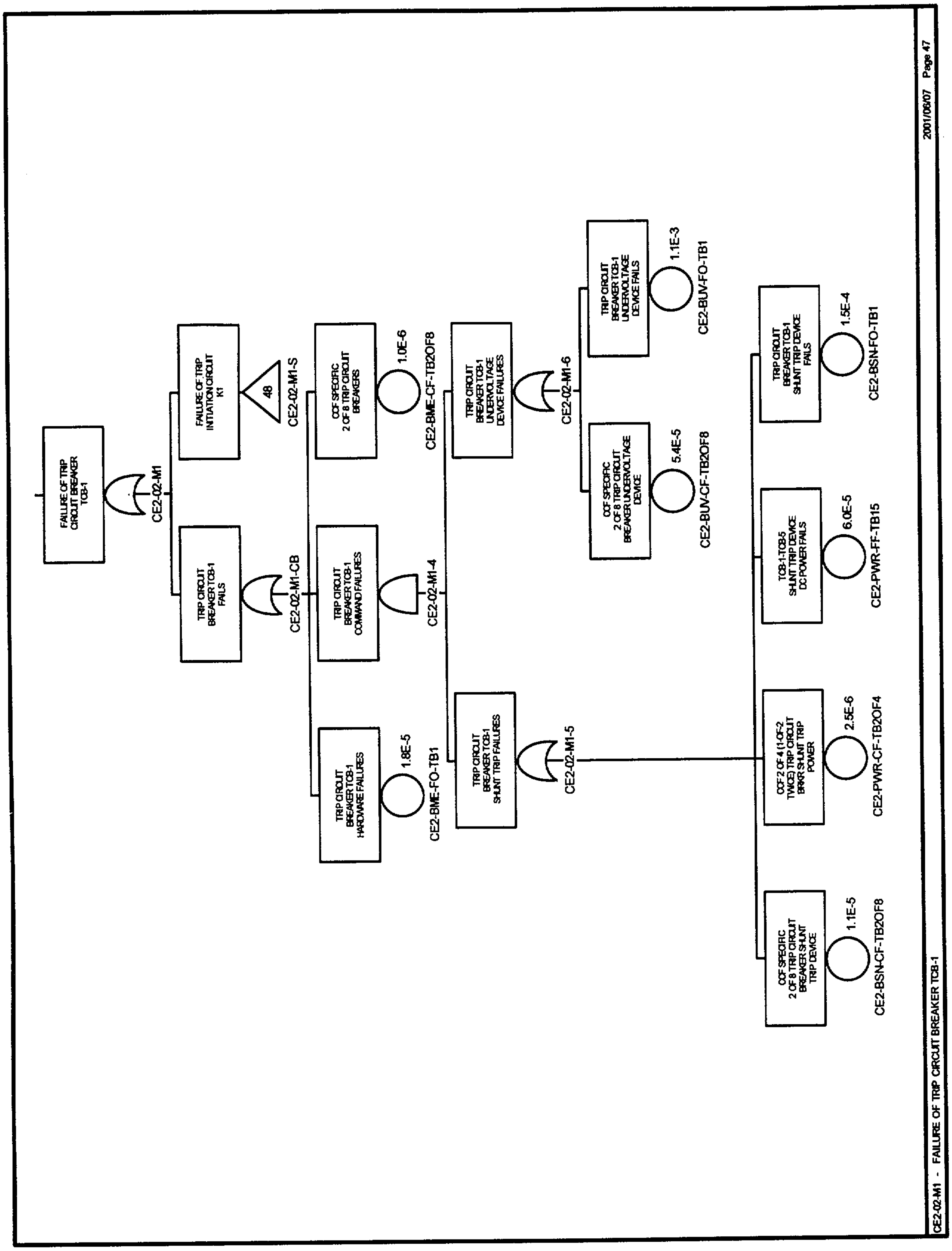

REACTOR PROTECTION SYSTEM (RPS) FOR CE GROUP 2 TYPE FAILS
CE2-01-RPS
CE2-01-RPS1
CE2-ROD-CF-RODS
8.4E-7
CE2-01-RPS1-TCB
CE2-01-RPS1-BSF-1
CE2-01-RPS1-LMF-1
44
45
CE2-01-RPS1-TCB-01
CE2-01-RPS1-TCB-02
CE2-01-RPS1-TCB-01-12
CE2-01-RPS1-TCB-01-78
CE2-01-RPS1-TCB-02-34
CE2-01-RPS1-TCB-02-56
CE2-02-M1
CE2-03-M2
CE2-04-M3
CE2-05-M4
47
50
53
56
55
58
49
52
CE2-01-RPS - REACTOR PROTECTION SYSTEM (RPS) FOR CE GROUP 2 TYPE FAILS
2001/10/05 Page 43



CE2-01-RPS1-BSF-1 - COMMON CAUSE FAILURE OF BISTABLE TRIP UNITS 2001/03/02 Page 44


COMMON CAUSE FAILURE OF LOGIC MATRIX RELAYS
CE2-01-RPS1-LMF-1
OPERATOR FAILS TO MANUAL TRIP RPS
46
CE2-01-RPS1-MT1-F
CCF OF LOGIC MATRIX RELAYS
CE2-01-RPS1-LMF-2
CCF OF LOGIC MATRIX RELAYS (CH A NOT IN T&M)
CE2-01-RPS1-LMF-3
CCF OF LOGIC MATRIX RELAYS DURING CH A T&M
CE2-01-RPS1-CHATM
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
61
CE2-08-CHA-NOTM
CCF OF 12 OF 24 LOGIC MATRIX OUTPUT RELAYS
4.3E-8
CE2-RYL-CF-LM12OF24
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE2-RPS-TM-CHA
CCF OF 6 OF 12 LOGIC MATRIX OUTPUT RELAYS (CH A T&M)
1.6E-7
CE2-RYL-CF-LM6OF12TM
CE2-01-RPS1-LMF-1 - COMMON CAUSE FAILURE OF LOGIC MATRIX RELAYS
2001/03/02 Page 45


OPERATOR FAILS TO MANUAL TRIP RPS
CE2-01-RPS1-MT1-F
MANUAL TRIP PATHS 3 AND 4 FAIL
CE2-01-RPS1-MT34-F
MANUAL TRIP PATHS 1 AND 2 FAIL
CE2-01-RPS1-MT12-F
FAILURE OF MANUAL SWITCH 3
93
CE2-40-MT3
FAILURE OF MANUAL SWITCH 4
94
CE2-41-MT4
FAILURE OF MANUAL SWITCH 1
59
CE2-06-MT1
FAILURE OF MANUAL SWITCH 2
79
CE2-26-MT2
CE2-01-RPS1-MT1-F - OPERATOR FAILS TO MANUAL TRIP RPS
2001/08/06 Page 46


FAILURE OF TRIP CIRCUIT BREAKER TCB-1
CE2-02-M1
FAILURE OF TRIP INITIATION CIRCUIT K1
48
CE2-02-M1-S
TRIP CIRCUIT BREAKER TCB-1 FAILS
CE2-02-M1-CB
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE2-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-1 COMMAND FAILURES
CE2-02-M1-4
TRIP CIRCUIT BREAKER TCB-1 HARDWARE FAILURES
1.8E-5
CE2-BME-FO-TB1
TRIP CIRCUIT BREAKER TCB-1 UNDERVOLTAGE DEVICE FAILURES
CE2-02-M1-6
TRIP CIRCUIT BREAKER TCB-1 SHUNT TRIP FAILURES
CE2-02-M1-5
TRIP CIRCUIT BREAKER TCB-1 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE2-BUV-FO-TB1
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE2-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-1 SHUNT TRIP DEVICE FAILS
1.5E-4
CE2-BSN-FO-TB1
TCB-1-TCB-5 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE2-PWR-FF-TB15
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE2-PWR-CF-TB2OF4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE2-BSN-CF-TB2OF8
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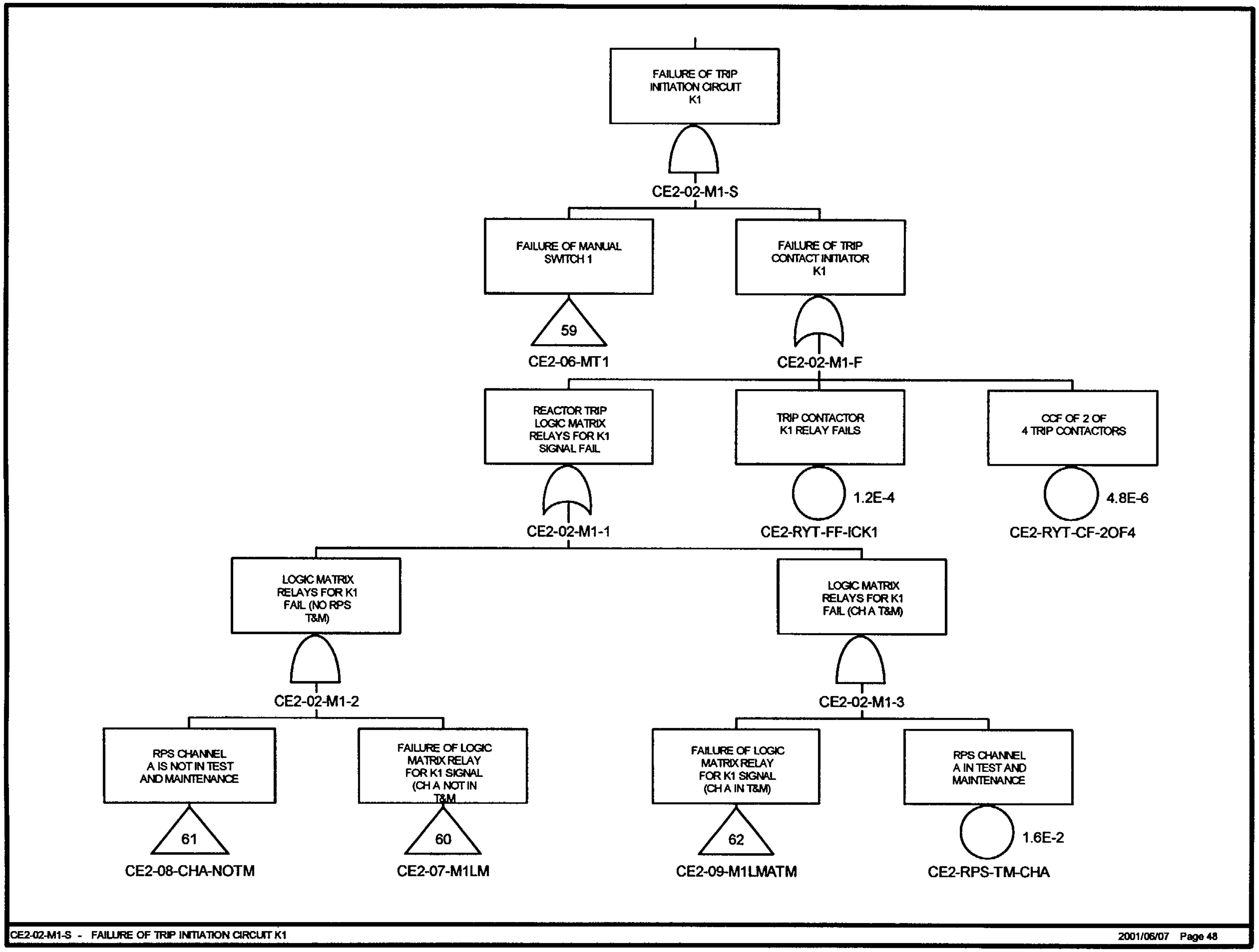
CE2-02-M1 - FAILURE OF TRIP CIRCUIT BREAKER TCB-1


FAILURE OF TRIP INITIATION CIRCUIT K1
CE2-02-M1-S
FAILURE OF MANUAL SWITCH 1
59
CE2-06-MT1
FAILURE OF TRIP CONTACT INITIATOR K1
CE2-02-M1-F
REACTOR TRIP LOGIC MATRIX RELAYS FOR K1 SIGNAL FAIL
CE2-02-M1-1
TRIP CONTACTOR K1 RELAY FAILS
1.2E-4
CE2-RYT-FF-ICK1
CCF OF 2 OF 4 TRIP CONTACTORS
4.8E-6
CE2-RYT-CF-2OF4
LOGIC MATRIX RELAYS FOR K1 FAIL (NO RPS T&M)
CE2-02-M1-2
LOGIC MATRIX RELAYS FOR K1 FAIL (CH A T&M)
CE2-02-M1-3
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
61
CE2-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A NOT IN T&M
60
CE2-07-M1LM
FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A IN T&M)
62
CE2-09-M1LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE2-RPS-TM-CHA
CE2-02-M1-S - FAILURE OF TRIP INITIATION CIRCUIT K1
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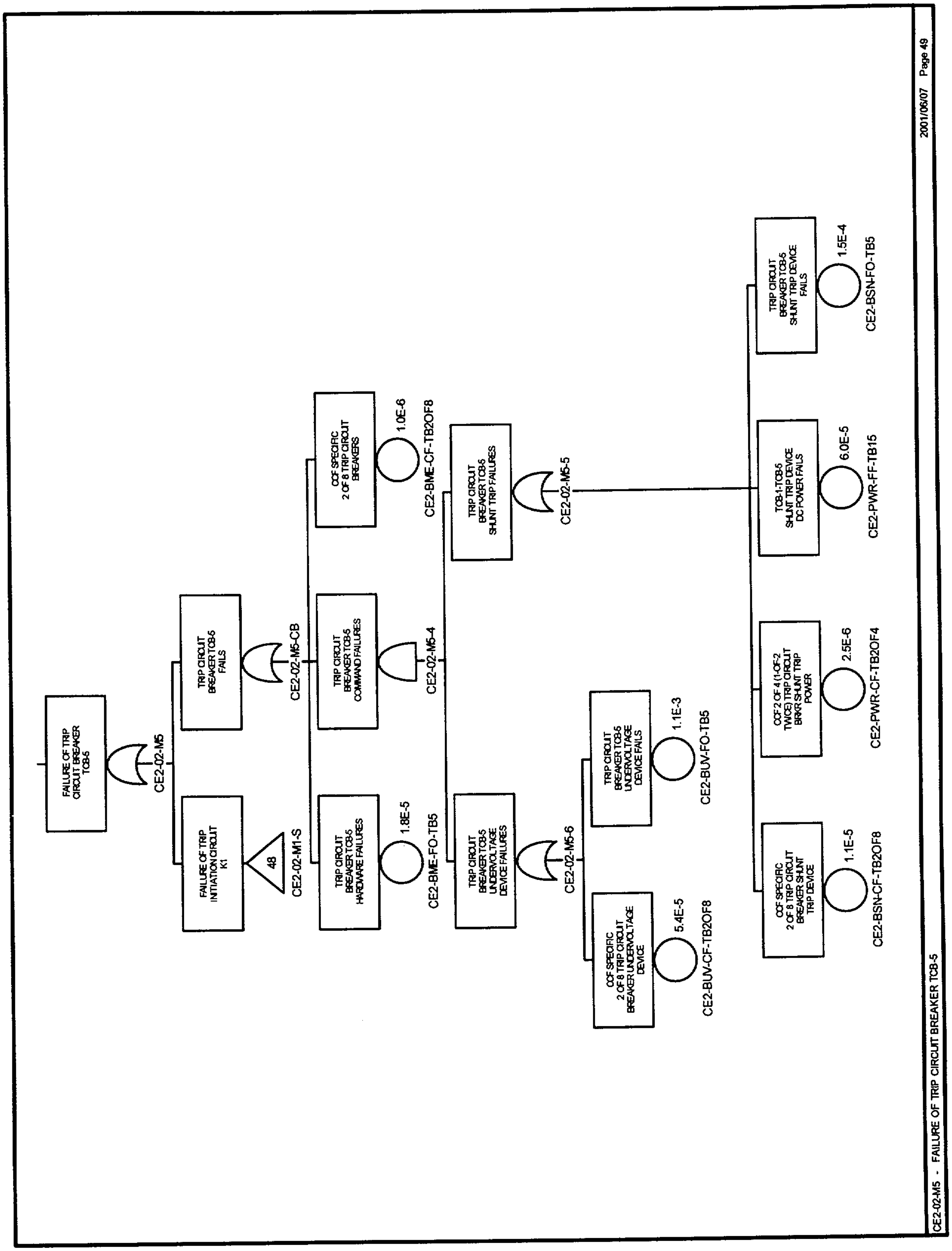

FAILURE OF TRIP CIRCUIT BREAKER TCB-5
CE2-02-M5
FAILURE OF TRIP INITIATION CIRCUIT K1
48
CE2-02-M1-S
TRIP CIRCUIT BREAKER TCB-5 FAILS
CE2-02-M5-CB
TRIP CIRCUIT BREAKER TCB-5 HARDWARE FAILURES
1.8E-5
CE2-BME-FO-TB5
TRIP CIRCUIT BREAKER TCB-5 COMMAND FAILURES
CE2-02-M5-4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE2-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-5 UNDERVOLTAGE DEVICE FAILURES
CE2-02-M5-6
TRIP CIRCUIT BREAKER TCB-5 SHUNT TRIP FAILURES
CE2-02-M5-5
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE2-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-5 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE2-BUV-FO-TB5
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE2-BSN-CF-TB2OF8
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE2-PWR-CF-TB2OF4
TCB-1-TCB-5 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE2-PWR-FF-TB15
TRIP CIRCUIT BREAKER TCB-5 SHUNT TRIP DEVICE FAILS
1.5E-4
CE2-BSN-FO-TB5
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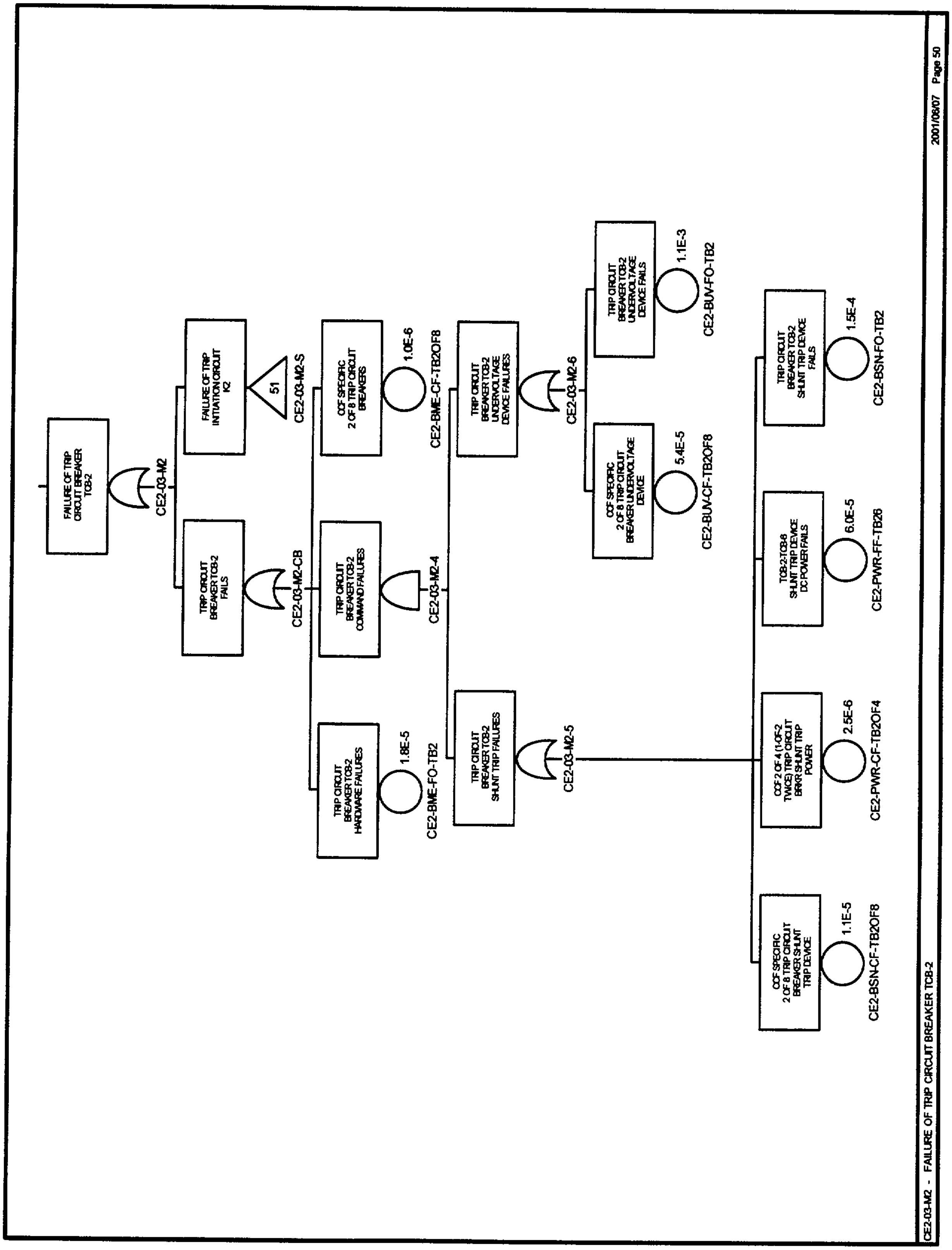
CE2-02-M5 - FAILURE OF TRIP CIRCUIT BREAKER TCB-5


FAILURE OF TRIP CIRCUIT BREAKER TCB-2
CE2-03-M2
FAILURE OF TRIP INITIATION CIRCUIT K2
51
CE2-03-M2-S
TRIP CIRCUIT BREAKER TCB-2 FAILS
CE2-03-M2-CB
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE2-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-2 COMMAND FAILURES
CE2-03-M2-4
TRIP CIRCUIT BREAKER TCB-2 HARDWARE FAILURES
1.8E-5
CE2-BME-FO-TB2
TRIP CIRCUIT BREAKER TCB-2 UNDERVOLTAGE DEVICE FAILURES
CE2-03-M2-6
TRIP CIRCUIT BREAKER TCB-2 SHUNT TRIP FAILURES
CE2-03-M2-5
TRIP CIRCUIT BREAKER TCB-2 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE2-BUV-FO-TB2
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE2-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-2 SHUNT TRIP DEVICE FAILS
1.5E-4
CE2-BSN-FO-TB2
TCB-2-TCB-6 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE2-PWR-FF-TB26
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE2-PWR-CF-TB2OF4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE2-BSN-CF-TB2OF8
CE2-03-M2 - FAILURE OF TRIP CIRCUIT BREAKER TCB-2
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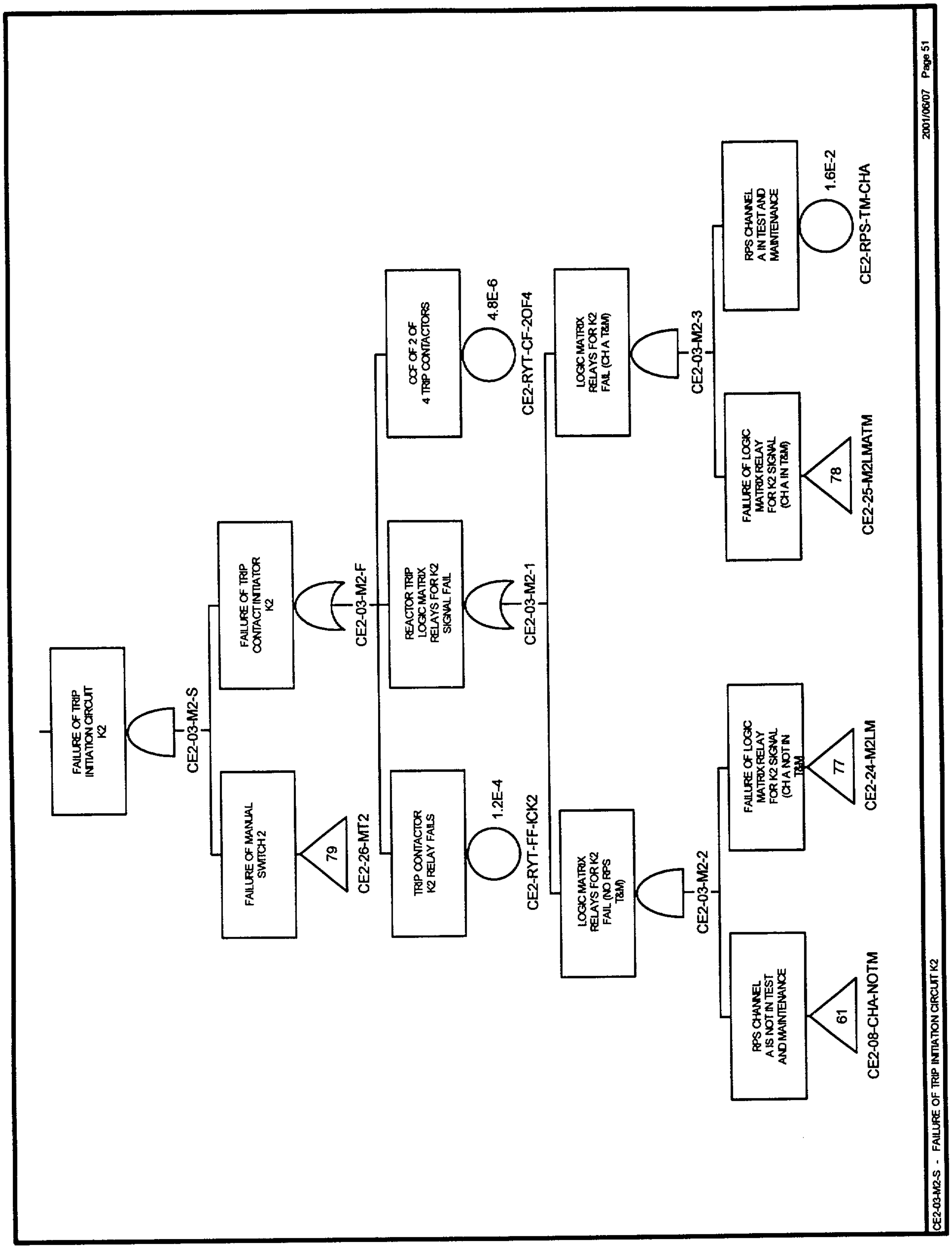
FAILURE OF TRIP INITIATION CIRCUIT K2
CE2-03-M2-S
FAILURE OF MANUAL SWITCH 2
79
CE2-26-MT2
FAILURE OF TRIP CONTACT INITIATOR K2
CE2-03-M2-F
TRIP CONTACTOR K2 RELAY FAILS
1.2E-4
CE2-RYT-FF-ICK2
REACTOR TRIP LOGIC MATRIX RELAYS FOR K2 SIGNAL FAIL
CE2-03-M2-1
CCF OF 2 OF 4 TRIP CONTACTORS
4.8E-6
CE2-RYT-CF-2OF4
LOGIC MATRIX RELAYS FOR K2 FAIL (NO RPS T&M)
CE2-03-M2-2
LOGIC MATRIX RELAYS FOR K2 FAIL (CH A T&M)
CE2-03-M2-3
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
61
CE2-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR K2 SIGNAL (CH A NOT IN T&M)
77
CE2-24-M2LM
FAILURE OF LOGIC MATRIX RELAY FOR K2 SIGNAL (CH A IN T&M)
78
CE2-25-M2LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE2-RPS-TM-CHA
CE2-03-M2-S - FAILURE OF TRIP INITIATION CIRCUIT K2
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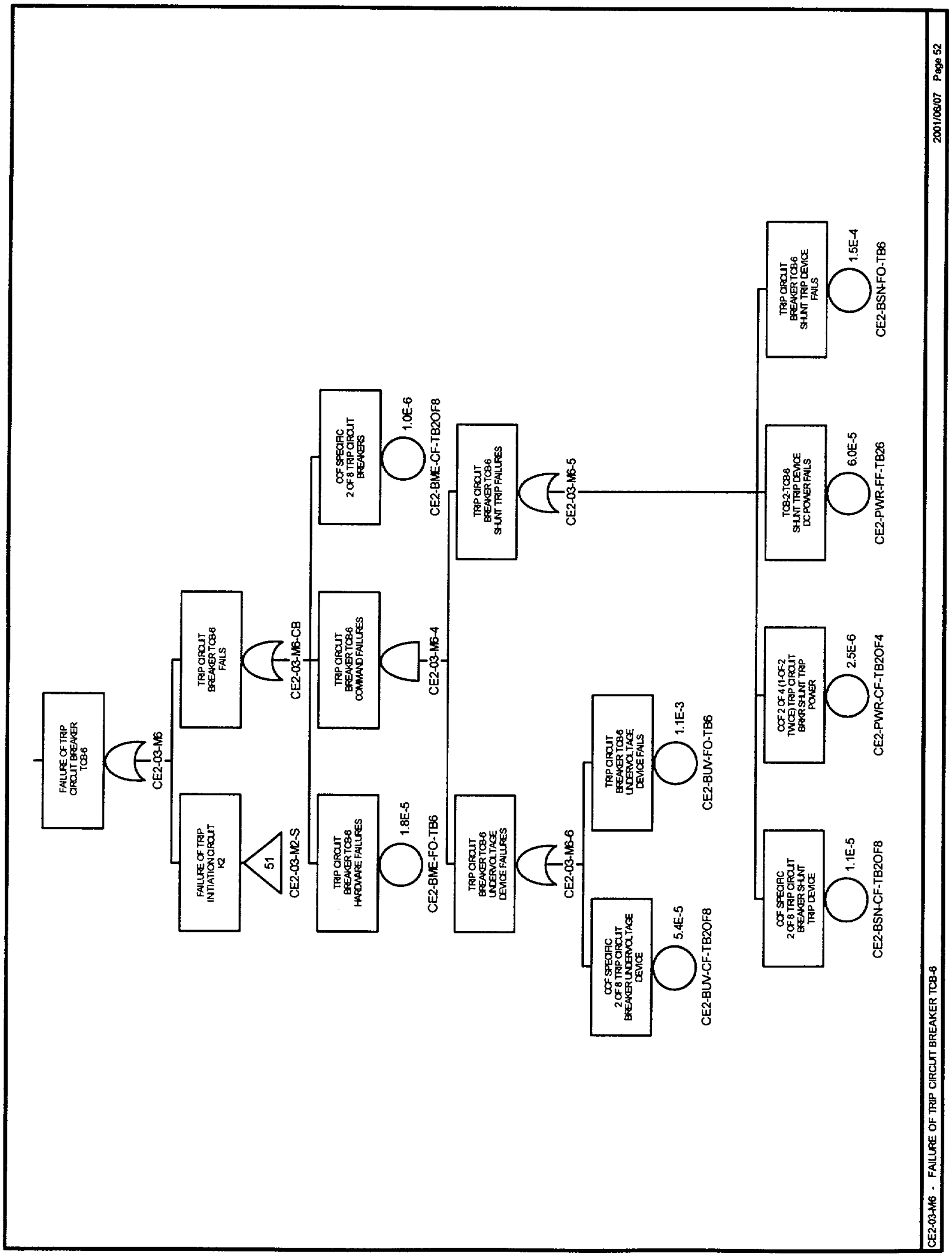

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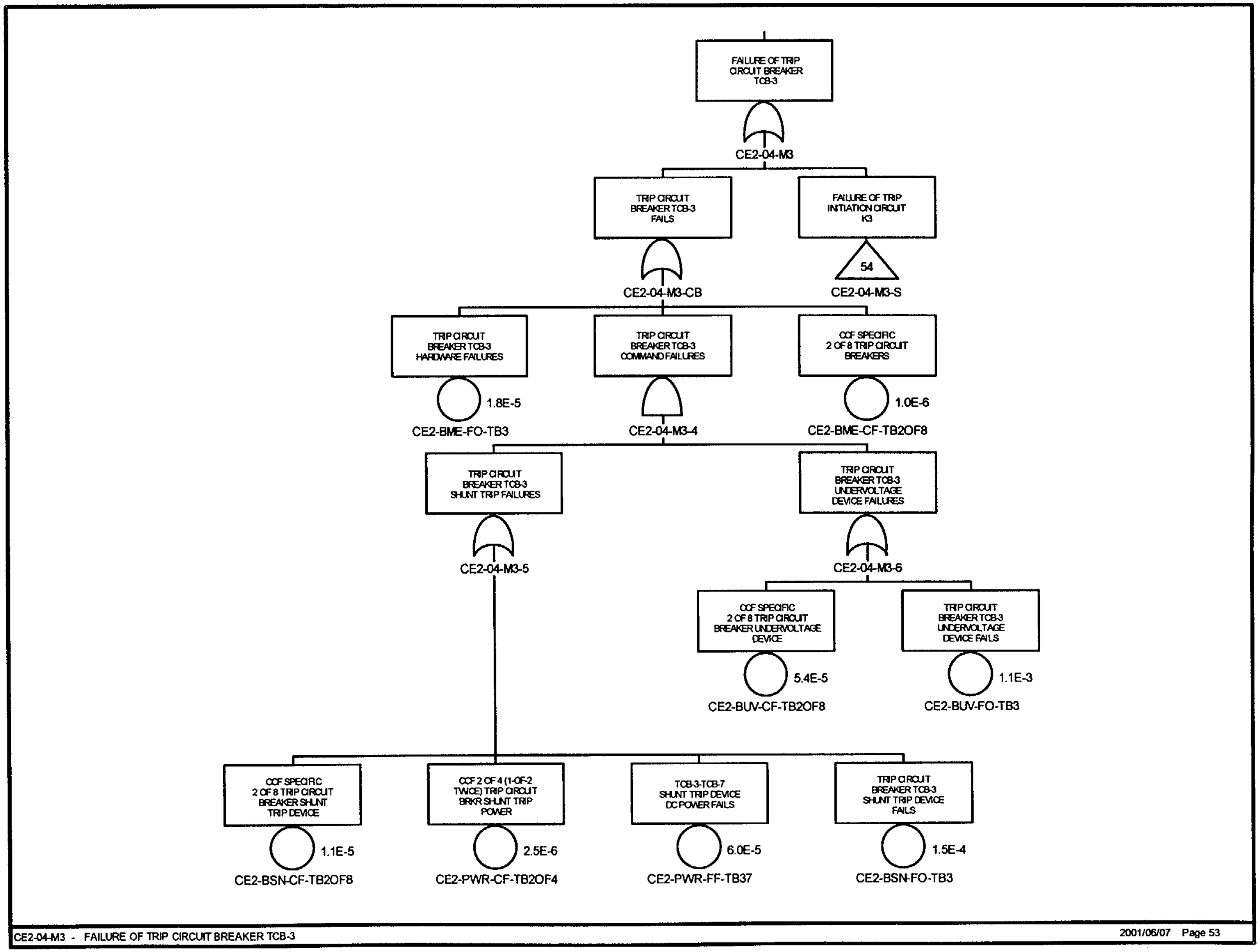
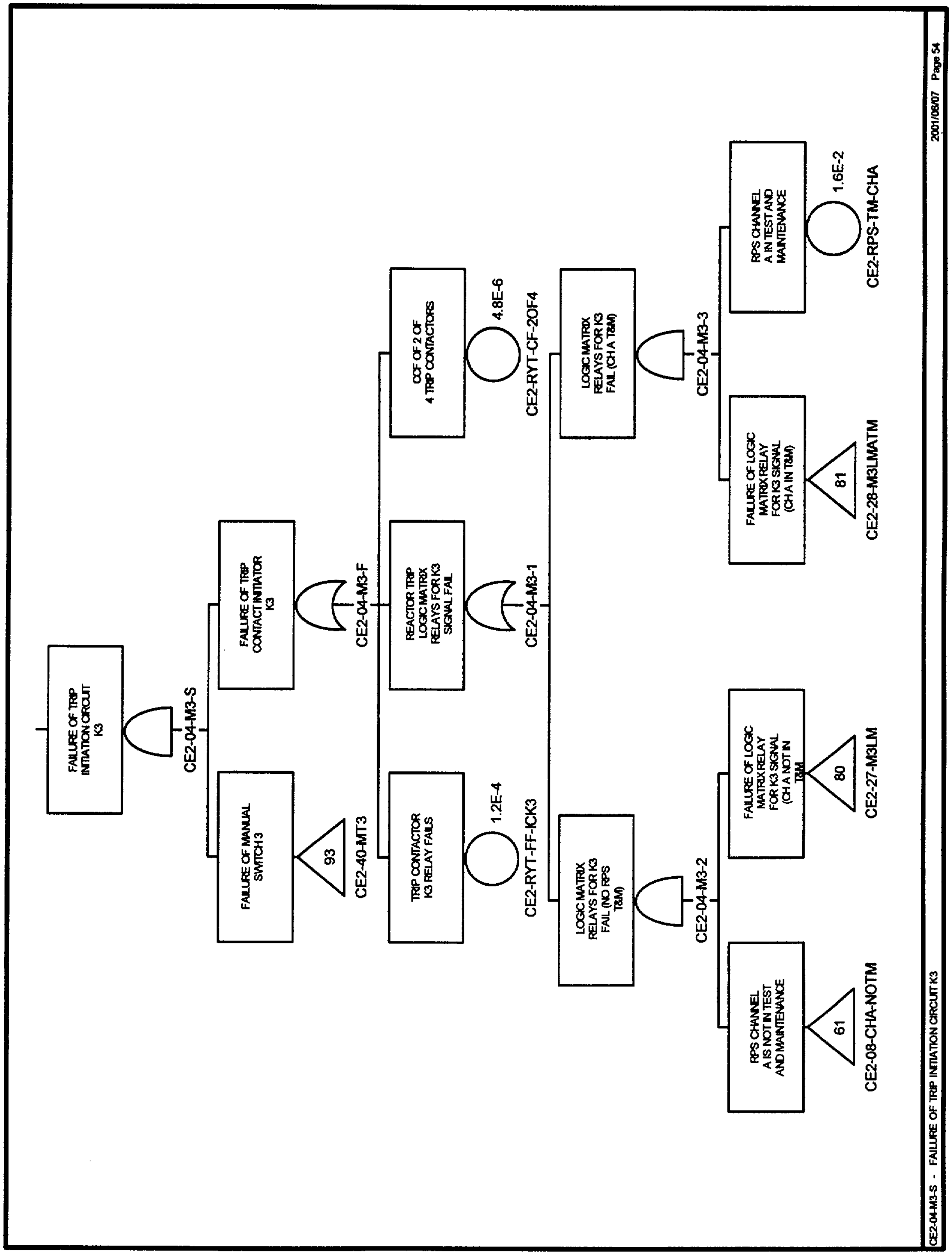
FAILURE OF TRIP CIRCUIT BREAKER TCB-6
CE2-03-M6
FAILURE OF TRIP INITIATION CIRCUIT K2
51
CE2-03-M2-S
TRIP CIRCUIT BREAKER TCB-6 FAILS
CE2-03-M6-CB
TRIP CIRCUIT BREAKER TCB-6 HARDWARE FAILURES
1.8E-5
CE2-BME-FO-TB6
TRIP CIRCUIT BREAKER TCB-6 COMMAND FAILURES
CE2-03-M6-4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE2-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-6 UNDERVOLTAGE DEVICE FAILURES
CE2-03-M6-6
TRIP CIRCUIT BREAKER TCB-6 SHUNT TRIP FAILURES
CE2-03-M6-5
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE2-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-6 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE2-BUV-FO-TB6
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE2-BSN-CF-TB2OF8
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE2-PWR-CF-TB2OF4
TCB-2-TCB-6 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE2-PWR-FF-TB26
TRIP CIRCUIT BREAKER TCB-6 SHUNT TRIP DEVICE FAILS
1.5E-4
CE2-BSN-FO-TB6
CE2-03-M6 - FAILURE OF TRIP CIRCUIT BREAKER TCB-6


FAILURE OF TRIP CIRCUIT BREAKER TCB-3
CE2-04-M3
TRIP CIRCUIT BREAKER TCB-3 FAILS
CE2-04-M3-CB
FAILURE OF TRIP INITIATION CIRCUIT K3
54
CE2-04-M3-S
TRIP CIRCUIT BREAKER TCB-3 HARDWARE FAILURES
1.8E-5
CE2-BME-FO-TB3
TRIP CIRCUIT BREAKER TCB-3 COMMAND FAILURES
CE2-04-M3-4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE2-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-3 SHUNT TRIP FAILURES
CE2-04-M3-5
TRIP CIRCUIT BREAKER TCB-3 UNDERVOLTAGE DEVICE FAILURES
CE2-04-M3-6
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE2-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-3 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE2-BUV-FO-TB3
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE2-BSN-CF-TB2OF8
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE2-PWR-CF-TB2OF4
TCB-3-TCB-7 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE2-PWR-FF-TB37
TRIP CIRCUIT BREAKER TCB-3 SHUNT TRIP DEVICE FAILS
1.5E-4
CE2-BSN-FO-TB3
CE2-04-M3 - FAILURE OF TRIP CIRCUIT BREAKER TCB-3
2001/06/07 Page 53



FAILURE OF TRIP INITIATION CIRCUIT K3
CE2-04-M3-S
FAILURE OF MANUAL SWITCH 3
93
CE2-40-MT3
FAILURE OF TRIP CONTACT INITIATOR K3
CE2-04-M3-F
TRIP CONTACTOR K3 RELAY FAILS
1.2E-4
CE2-RYT-FF-ICK3
REACTOR TRIP LOGIC MATRIX RELAYS FOR K3 SIGNAL FAIL
CE2-04-M3-1
CCF OF 2 OF 4 TRIP CONTACTORS
4.8E-6
CE2-RYT-CF-2OF4
LOGIC MATRIX RELAYS FOR K3 FAIL (NO RPS T&M)
CE2-04-M3-2
LOGIC MATRIX RELAYS FOR K3 FAIL (CH A T&M)
CE2-04-M3-3
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
61
CE2-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR K3 SIGNAL (CH A NOT IN T&M)
80
CE2-27-M3LM
FAILURE OF LOGIC MATRIX RELAY FOR K3 SIGNAL (CH A IN T&M)
81
CE2-28-M3LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE2-RPS-TM-CHA
CE2-04-M3-S - FAILURE OF TRIP INITIATION CIRCUIT K3
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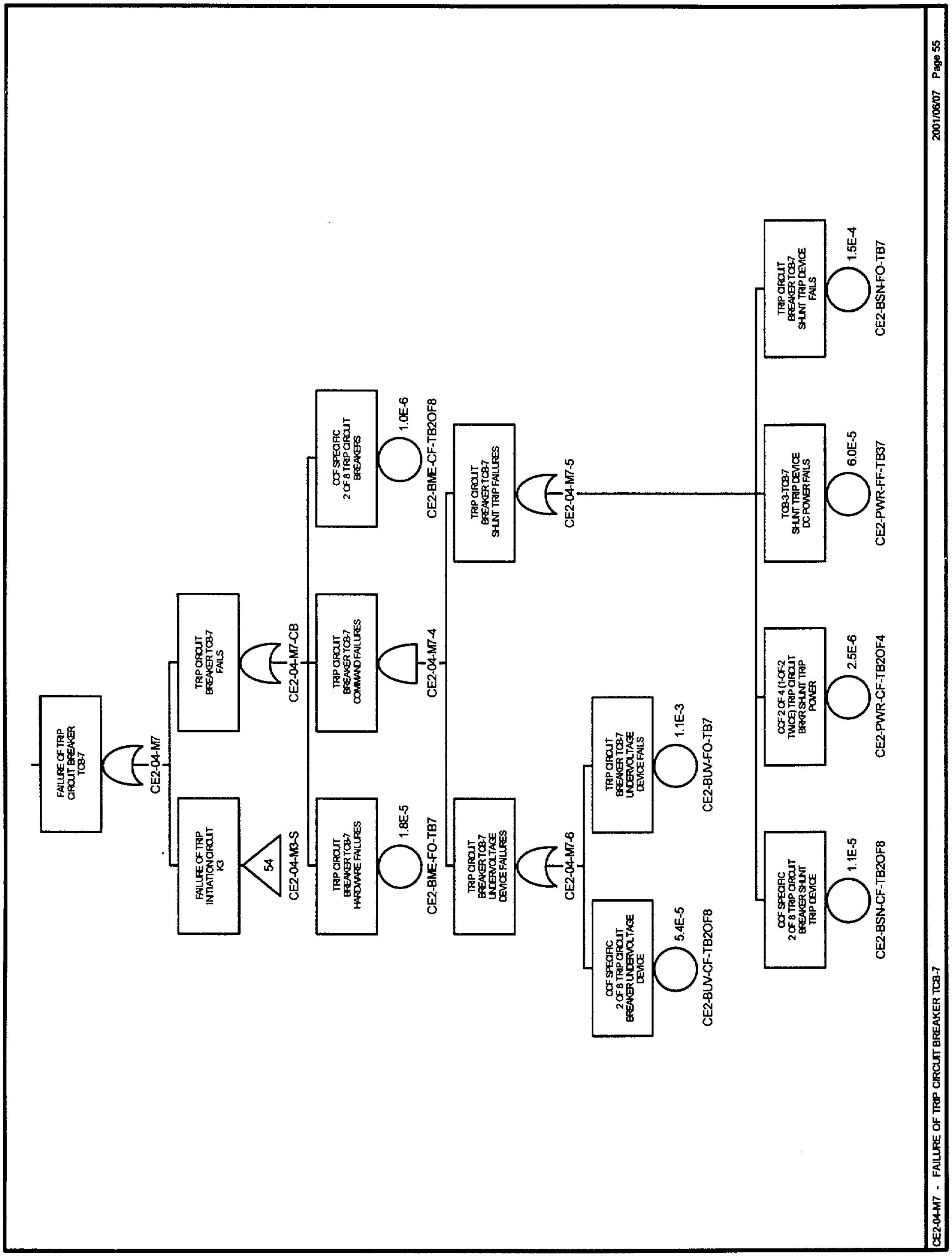
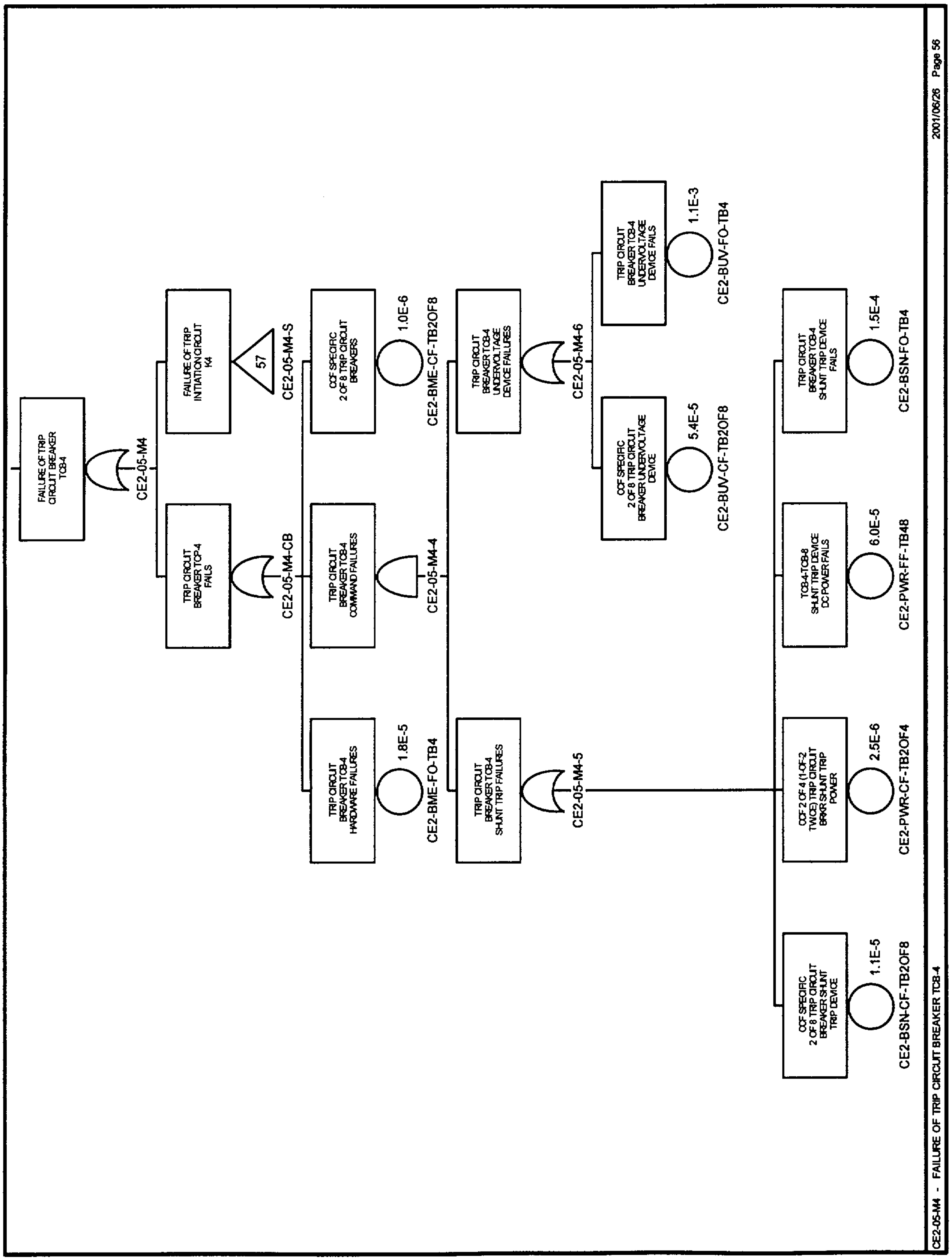
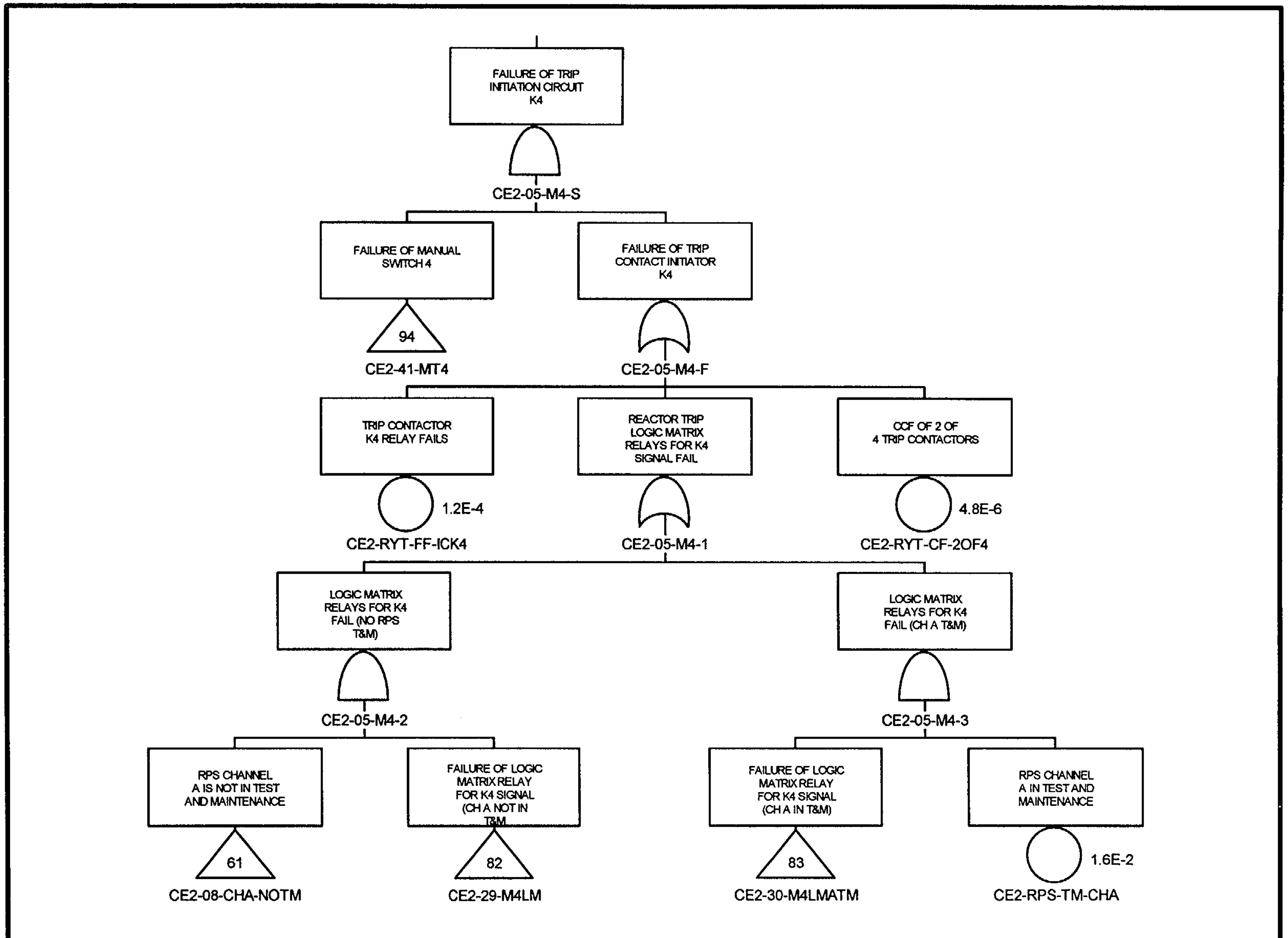
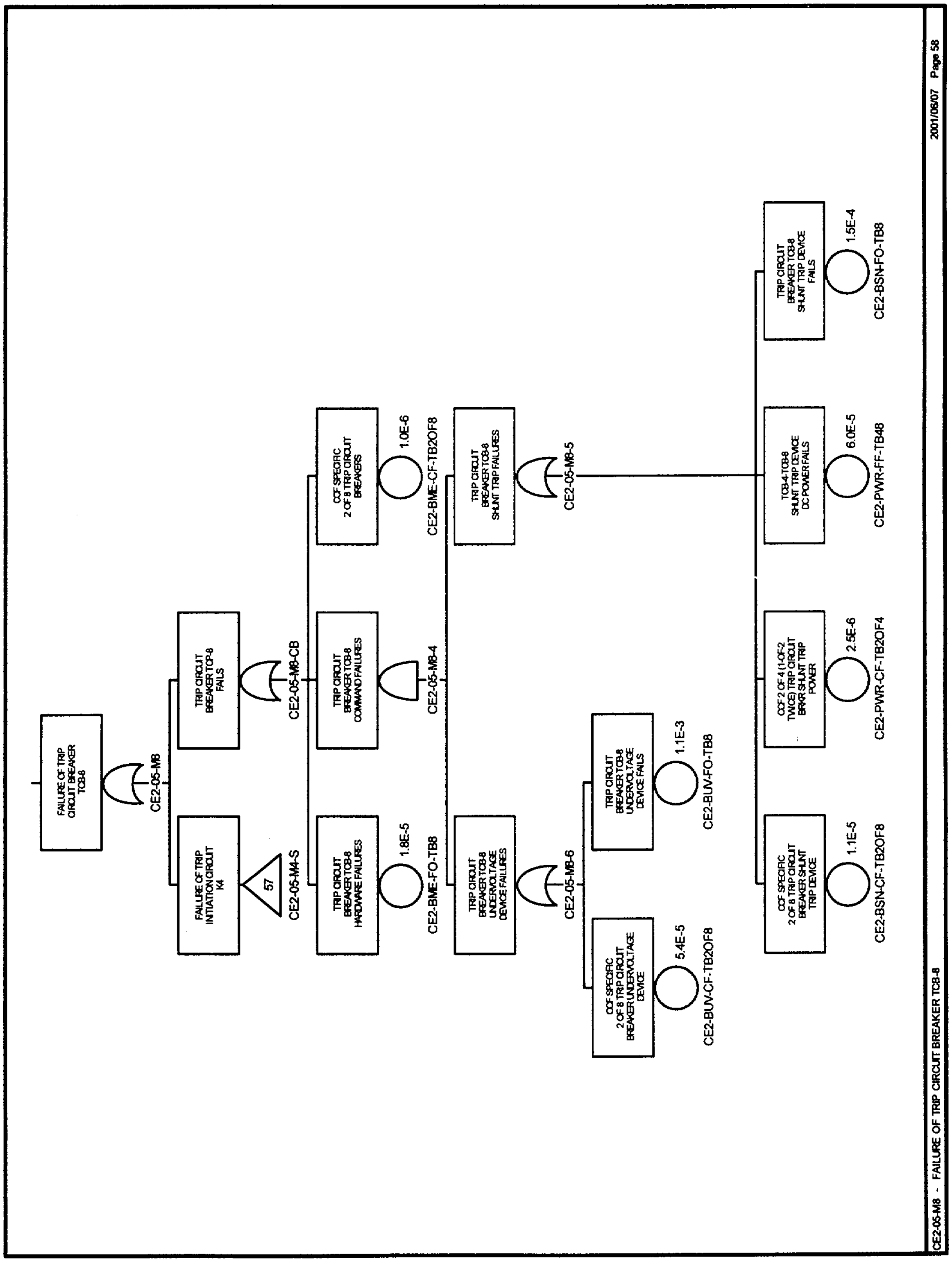
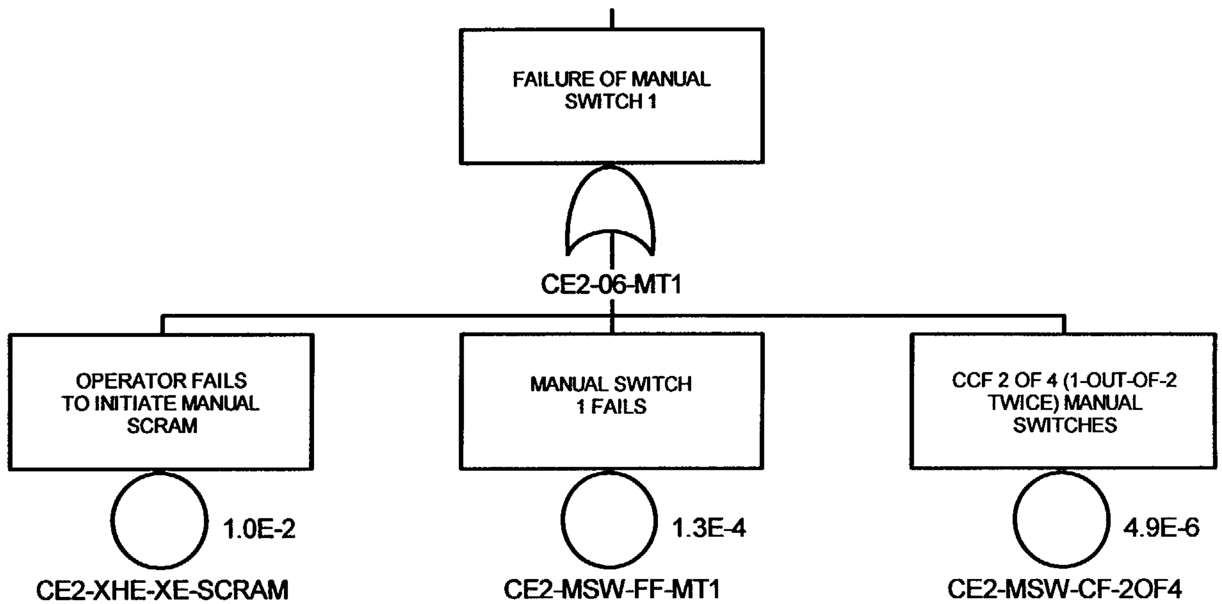

FAILURE OF TRIP CIRCUIT BREAKER TCB-7
CE2-04-M7
FAILURE OF TRIP INITIATION CIRCUIT K3
54
CE2-04-M3-S
TRIP CIRCUIT BREAKER TCB-7 FAILS
CE2-04-M7-CB
TRIP CIRCUIT BREAKER TCB-7 HARDWARE FAILURES
1.8E-5
CE2-BME-FO-TB7
TRIP CIRCUIT BREAKER TCB-7 COMMAND FAILURES
CE2-04-M7-4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE2-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-7 UNDERVOLTAGE DEVICE FAILURES
CE2-04-M7-6
TRIP CIRCUIT BREAKER TCB-7 SHUNT TRIP FAILURES
CE2-04-M7-5
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE2-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-7 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE2-BUV-FO-TB7
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE2-BSN-CF-TB2OF8
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE2-PWR-CF-TB2OF4
TCB-3-TCB-7 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE2-PWR-FF-TB37
TRIP CIRCUIT BREAKER TCB-7 SHUNT TRIP DEVICE FAILS
1.5E-4
CE2-BSN-FO-TB7
CE2-04-M7 - FAILURE OF TRIP CIRCUIT BREAKER TCB-7
2001/06/07 Page 55


FAILURE OF TRIP CIRCUIT BREAKER TCB-4
CE2-05-M4
FAILURE OF TRIP INITIATION CIRCUIT K4
57
CE2-05-M4-S
TRIP CIRCUIT BREAKER TCP-4 FAILS
CE2-05-M4-CB
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE2-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-4 COMMAND FAILURES
CE2-05-M4-4
TRIP CIRCUIT BREAKER TCB-4 HARDWARE FAILURES
1.8E-5
CE2-BME-FO-TB4
TRIP CIRCUIT BREAKER TCB-4 UNDERVOLTAGE DEVICE FAILURES
CE2-05-M4-6
TRIP CIRCUIT BREAKER TCB-4 SHUNT TRIP FAILURES
CE2-05-M4-5
TRIP CIRCUIT BREAKER TCB-4 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE2-BUV-FO-TB4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE2-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-4 SHUNT TRIP DEVICE FAILS
1.5E-4
CE2-BSN-FO-TB4
TCB-4-TCB-8 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE2-PWR-FF-TB48
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE2-PWR-CF-TB2OF4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE2-BSN-CF-TB2OF8
CE2-05-M4 - FAILURE OF TRIP CIRCUIT BREAKER TCB-4
2001/06/26 Page 56

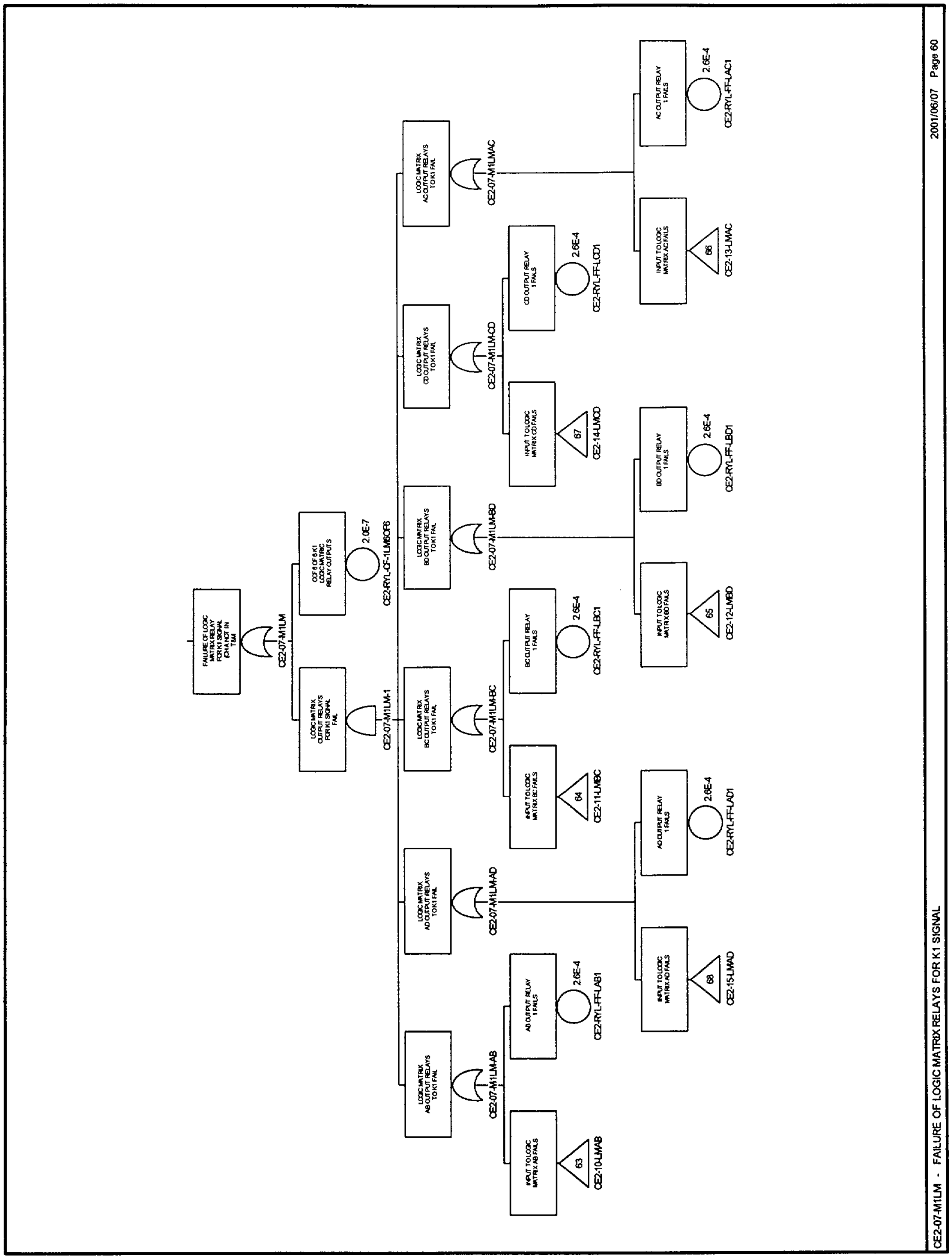


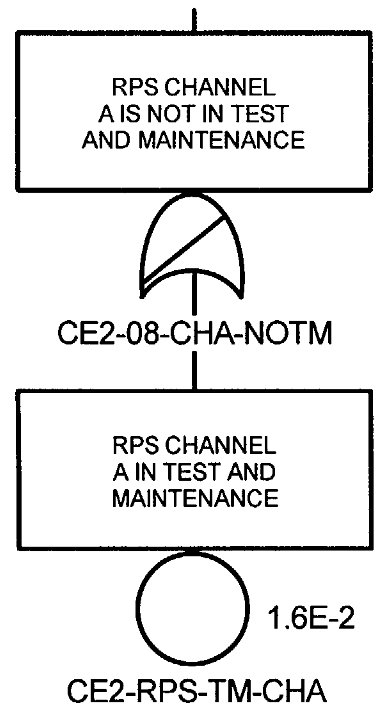
CE2-05-M4-S - FAILURE OF TRIP INITIATION CIRCUIT K4 2001/06/07 Page 57


FAILURE OF TRIP CIRCUIT BREAKER TCB-8
CE2-05-M8
FAILURE OF TRIP INITIATION CIRCUIT K4
57
CE2-05-M4-S
TRIP CIRCUIT BREAKER TCB-8 FAILS
CE2-05-M8-CB
TRIP CIRCUIT BREAKER TCB-8 HARDWARE FAILURES
1.8E-5
CE2-BME-FO-TB8
TRIP CIRCUIT BREAKER TCB-8 COMMAND FAILURES
CE2-05-M8-4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE2-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-8 UNDERVOLTAGE DEVICE FAILURES
CE2-05-M8-6
TRIP CIRCUIT BREAKER TCB-8 SHUNT TRIP FAILURES
CE2-05-M8-5
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE2-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-8 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE2-BUV-FO-TB8
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE2-BSN-CF-TB2OF8
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE2-PWR-CF-TB2OF4
TCB-4-TCB-8 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE2-PWR-FF-TB48
TRIP CIRCUIT BREAKER TCB-8 SHUNT TRIP DEVICE FAILS
1.5E-4
CE2-BSN-FO-TB8
CE2-05-M8 - FAILURE OF TRIP CIRCUIT BREAKER TCB-8
2001/06/07 Page 58

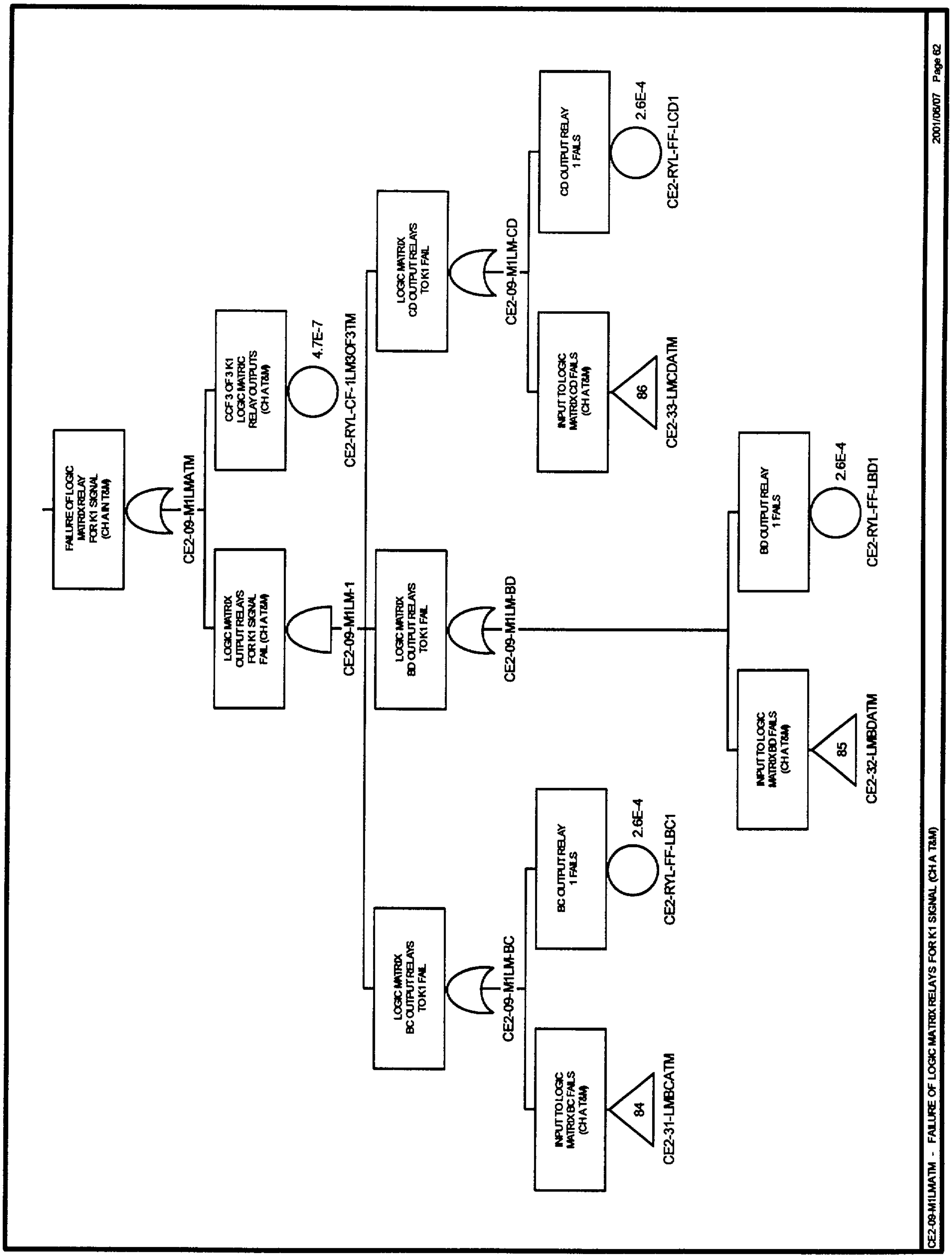


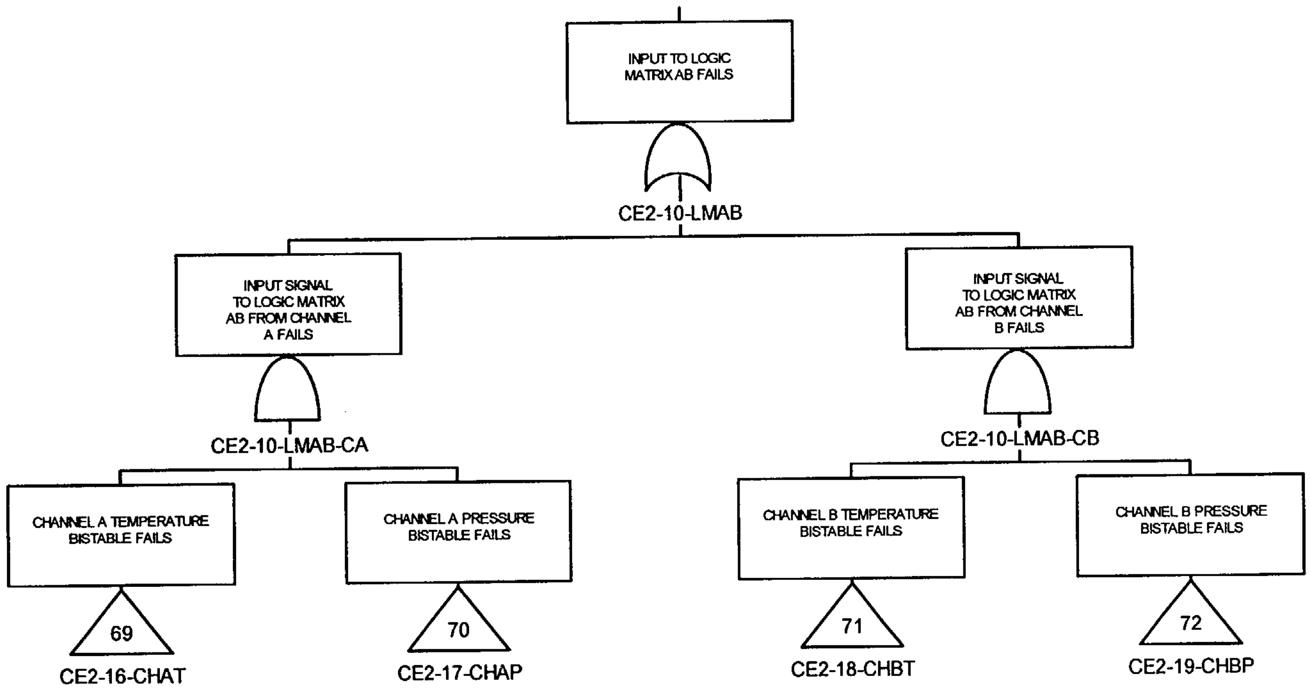
CE2-06-MT1 - MANUAL TRIP 1 FAILS 2001/03/02 Page 59


CE2-07-M1LM
CE2-07-M1LM-1
CE2-RYL-CF-1LM6OF6
2.0E-7
CE2-07-M1LM-AB
CE2-07-M1LM-AD
CE2-07-M1LM-BC
CE2-07-M1LM-BD
CE2-07-M1LM-CD
CE2-07-M1LMAC
CE2-10-LMAB
63
CE2-RYL-FF-LAB1
2.6E-4
CE2-15-LMAD
68
CE2-RYL-FF-LAD1
2.6E-4
CE2-11-LMBC
64
CE2-RYL-FF-LBC1
2.6E-4
CE2-12-LMBD
65
CE2-RYL-FF-LBD1
2.6E-4
CE2-14-LMCD
67
CE2-RYL-FF-LCD1
2.6E-4
CE2-13-LMAC
66
CE2-RYL-FF-LAC1
2.6E-4
CE2-07-M1LM - FAILURE OF LOGIC MATRIX RELAYS FOR K1 SIGNAL
2001/06/07 Page 60



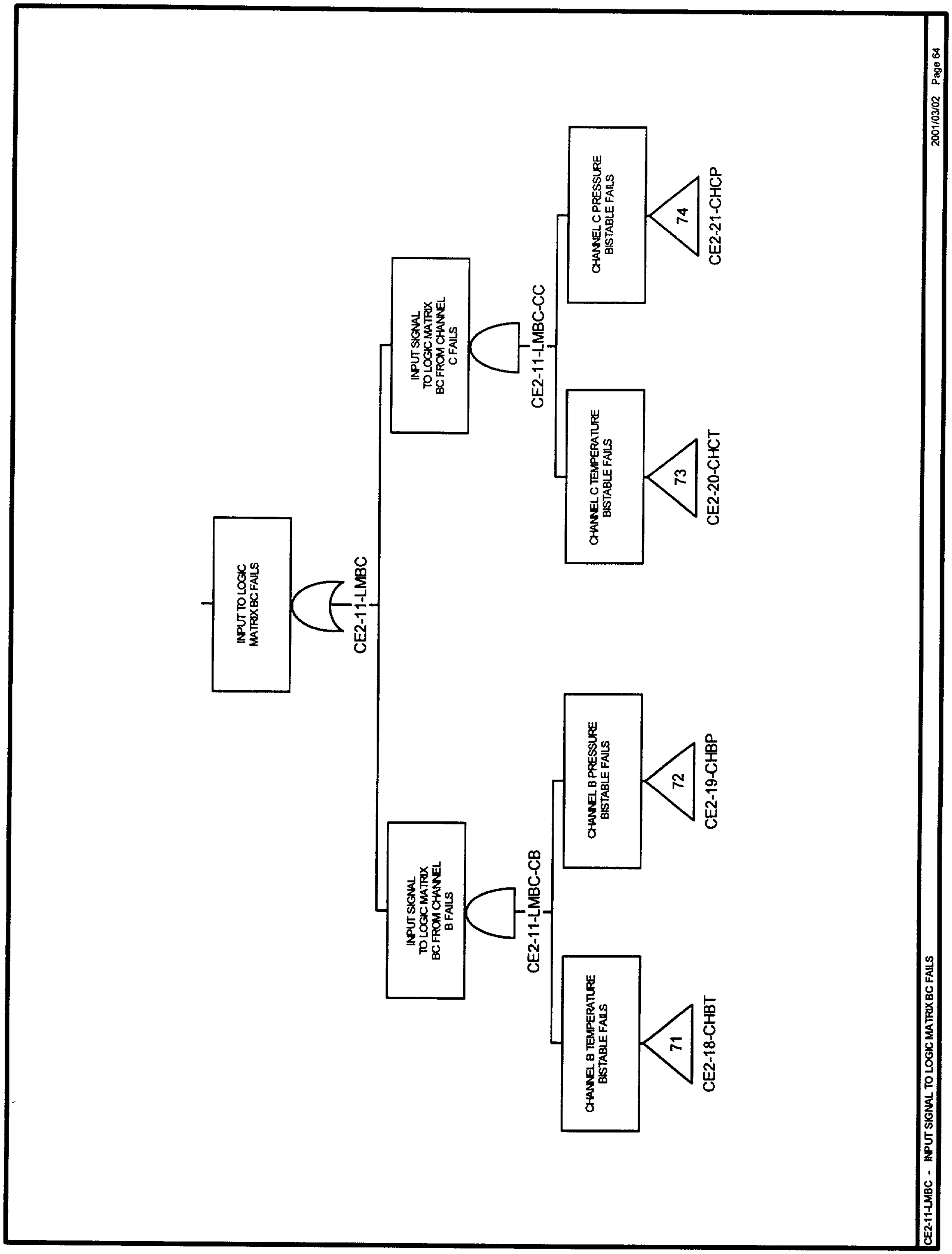
CE2-08-CHA-NOTM - RPS CHANNEL A NOT IN TEST AND MAINTENANCE 2001/03/02 Page 61

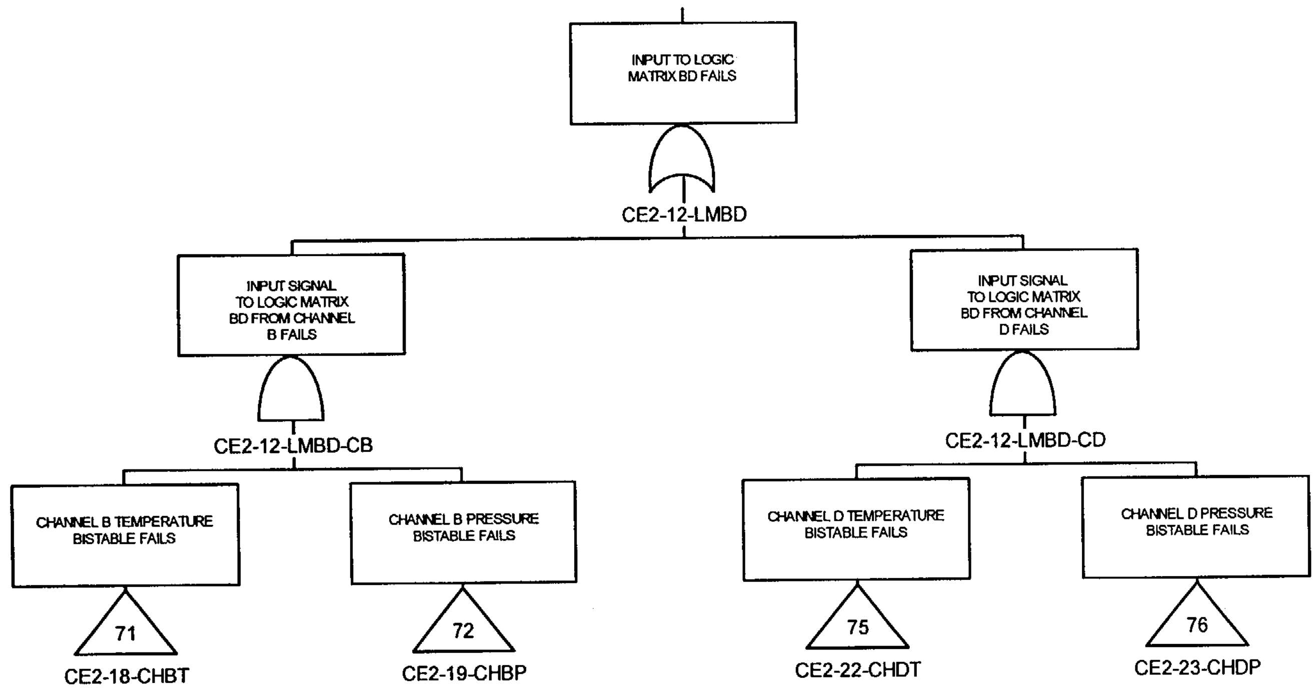

FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A IN T&M)
CE2-09-M1LMATM
CCF 3 OF 3 K1 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
4.7E-7
CE2-RYL-CF-1LM3OF3TM
LOGIC MATRIX OUTPUT RELAYS FOR K1 SIGNAL FAIL (CH A T&M)
CE2-09-M1LM-1
LOGIC MATRIX CD OUTPUT RELAYS TO K1 FAIL
CE2-09-M1LM-CD
CD OUTPUT RELAY 1 FAILS
2.6E-4
CE2-RYL-FF-LCD1
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
86
CE2-33-LMCDATM
LOGIC MATRIX BD OUTPUT RELAYS TO K1 FAIL
CE2-09-M1LM-BD
BD OUTPUT RELAY 1 FAILS
2.6E-4
CE2-RYL-FF-LBD1
INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
85
CE2-32-LMBDATM
LOGIC MATRIX BC OUTPUT RELAYS TO K1 FAIL
CE2-09-M1LM-BC
BC OUTPUT RELAY 1 FAILS
2.6E-4
CE2-RYL-FF-LBC1
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
84
CE2-31-LMBCATM
CE2-09-M1LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR K1 SIGNAL (CH A T&M)
2001/06/07 Page 62



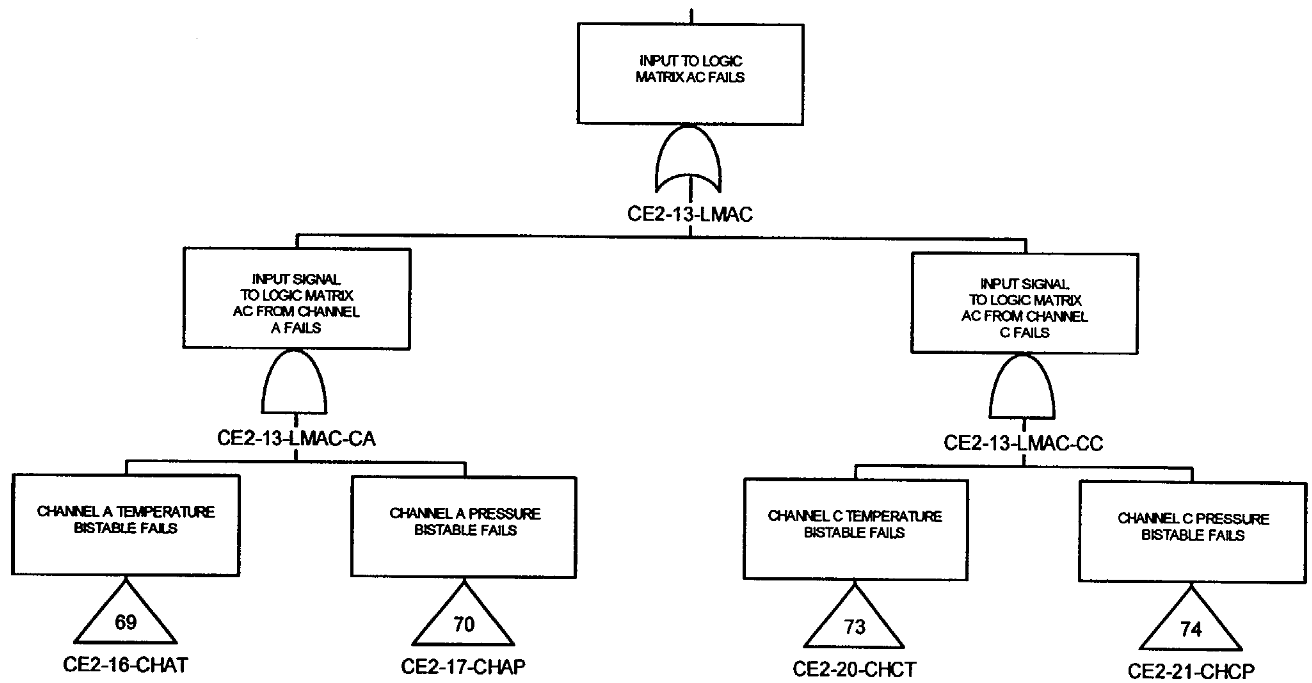
CE2-10-LMAB - INPUT SIGNAL TO LOGIC MATRIX AB FAILS

2001/03/02 Page 63


INPUT TO LOGIC MATRIX BC FAILS
CE2-11-LMBC
INPUT SIGNAL TO LOGIC MATRIX BC FROM CHANNEL B FAILS
CE2-11-LMBC-CB
INPUT SIGNAL TO LOGIC MATRIX BC FROM CHANNEL C FAILS
CE2-11-LMBC-CC
CHANNEL B TEMPERATURE BISTABLE FAILS
71
CE2-18-CHBT
CHANNEL B PRESSURE BISTABLE FAILS
72
CE2-19-CHBP
CHANNEL C TEMPERATURE BISTABLE FAILS
73
CE2-20-CHCT
CHANNEL C PRESSURE BISTABLE FAILS
74
CE2-21-CHCP
CE2-11-LMBC - INPUT SIGNAL TO LOGIC MATRIX BC FAILS
2001/03/02 Page 64

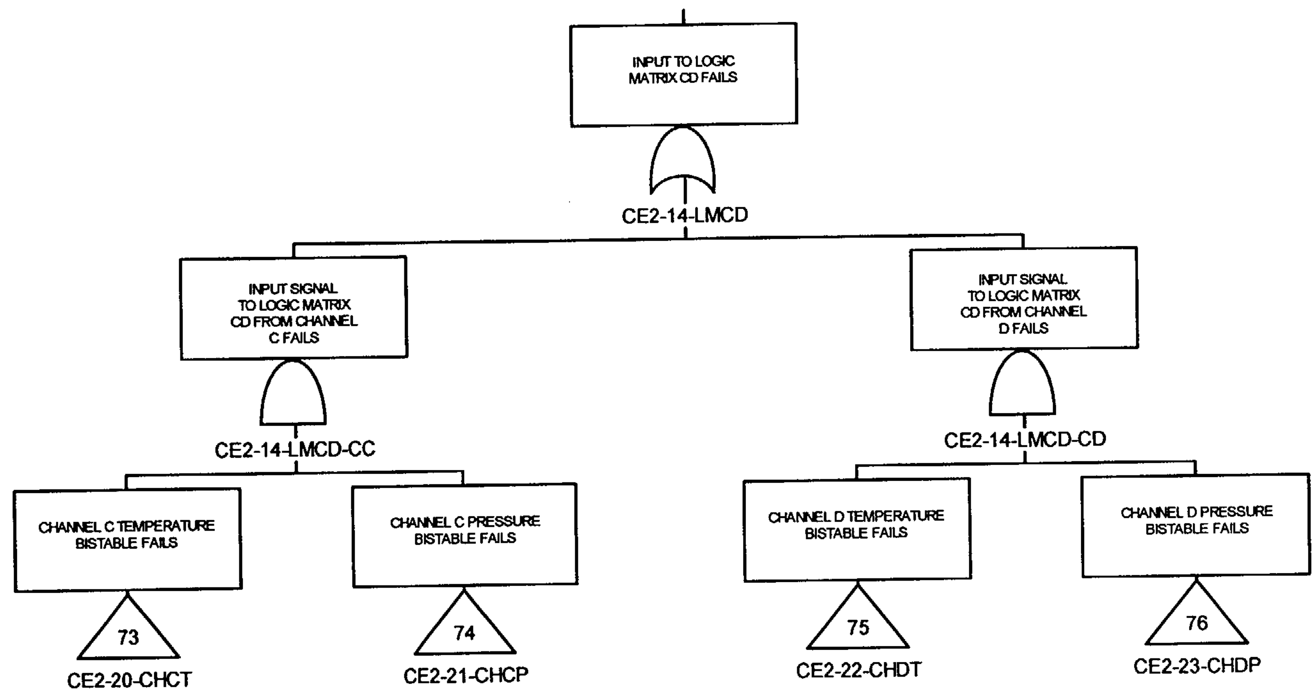


CE2-12-LMBD - INPUT SIGNAL TO LOGIC MATRIX BD FAILS 2001/03/02 Page 65



CE2-13-LMAC - INPUT SIGNAL TO LOGIC MATRIX AC FAILS

2001/03/02 Page 66



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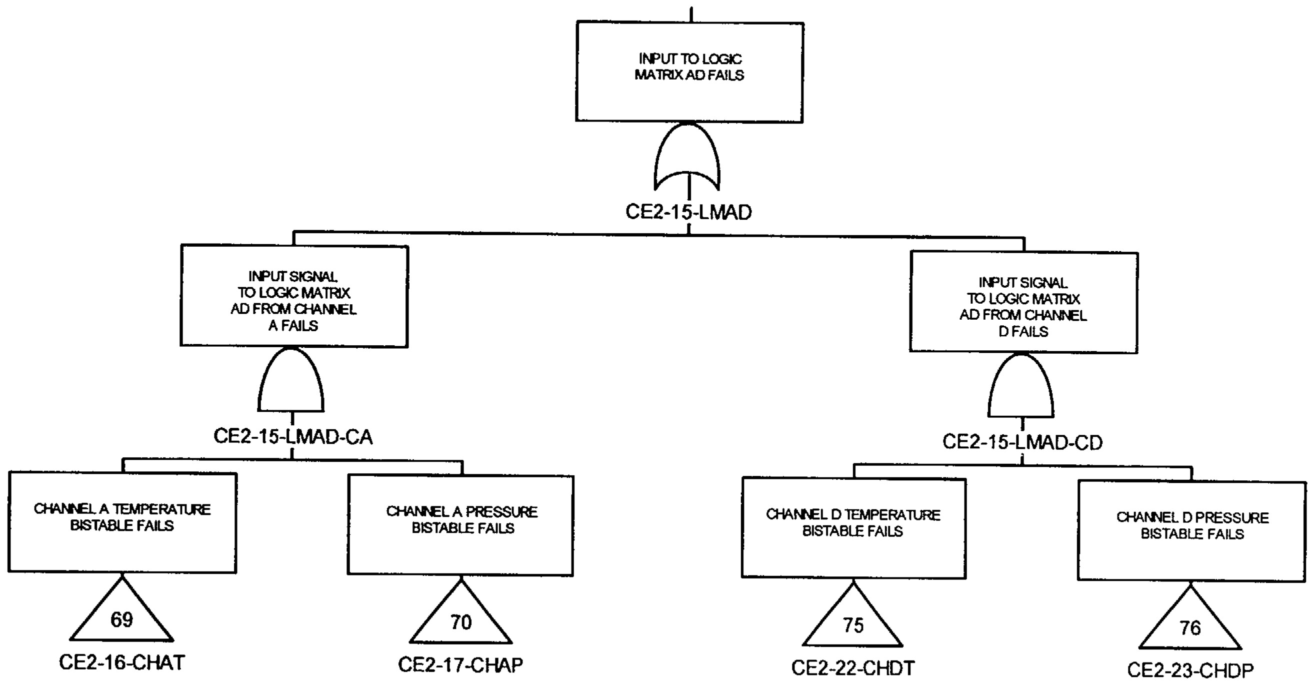
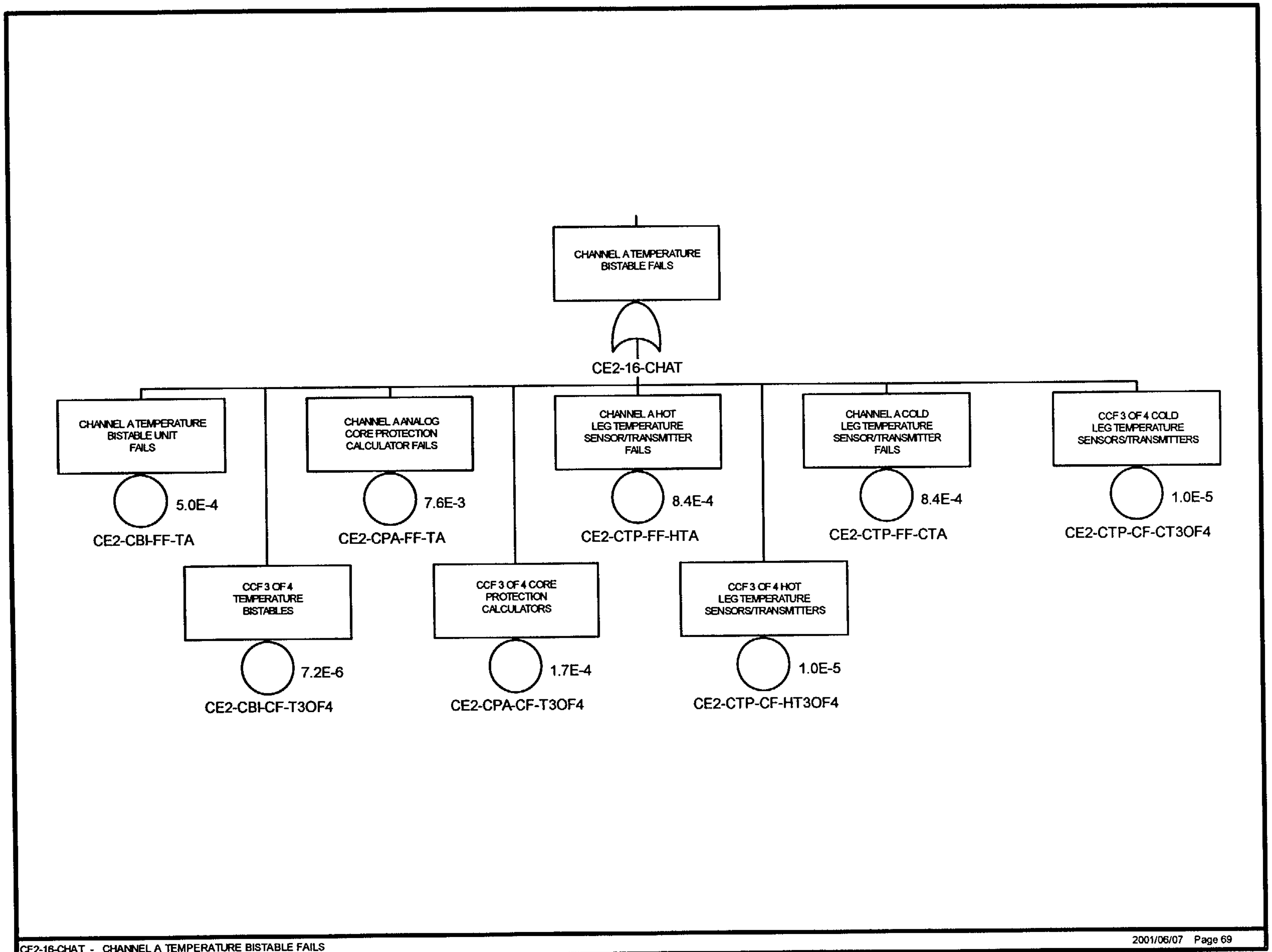
CE2-14-LMCD - INPUT SIGNAL TO LOGIC MATRIX CD FAILS

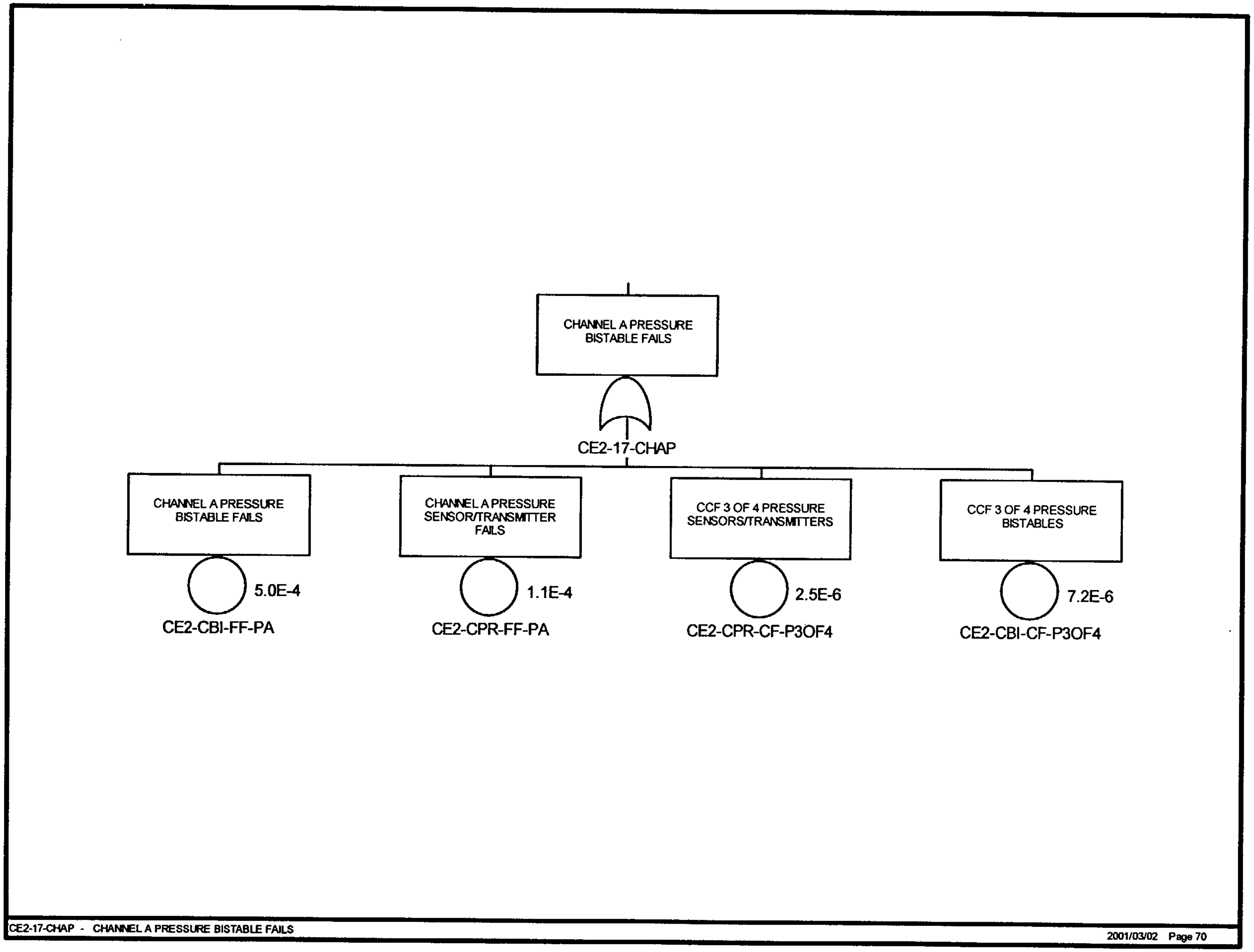


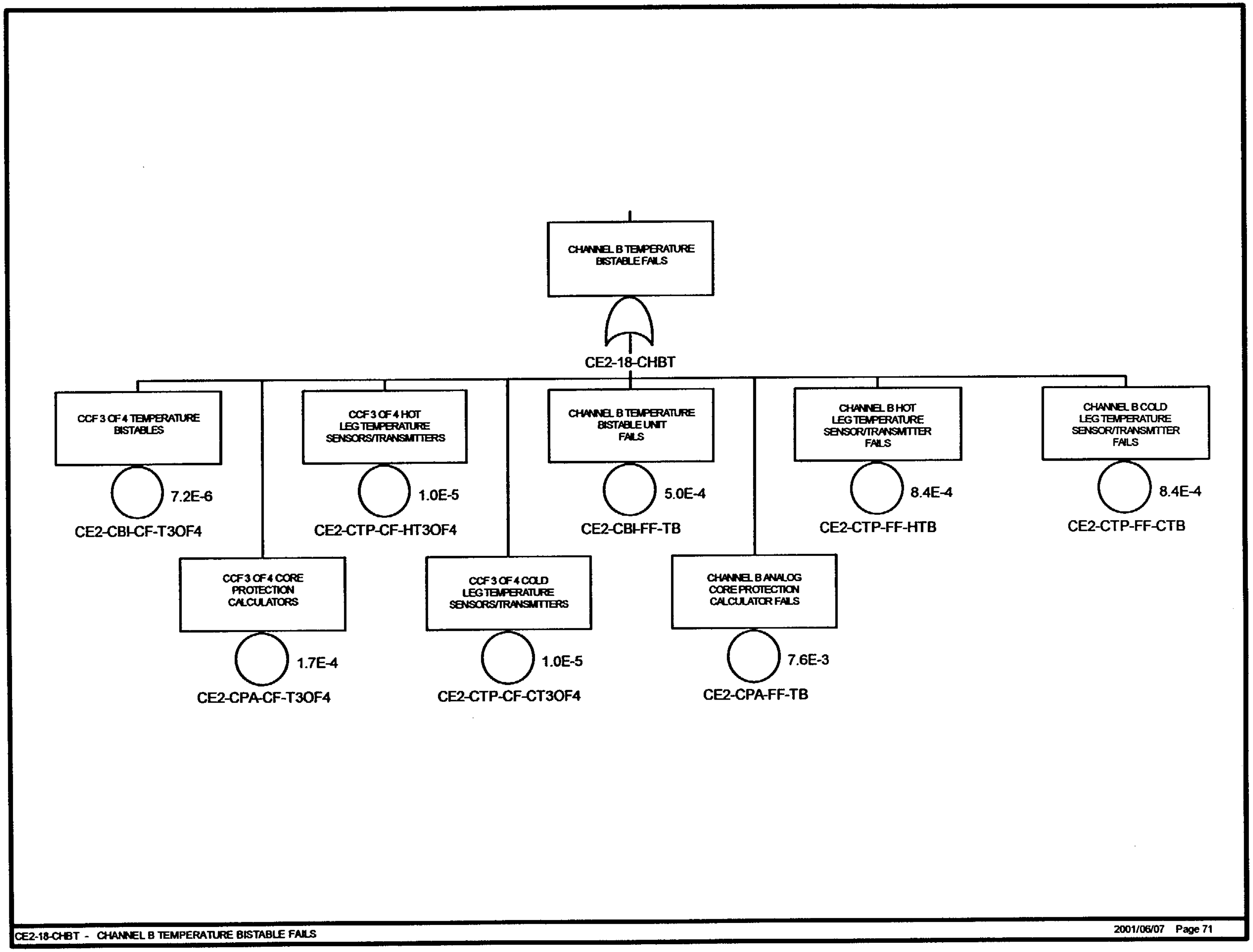
CE2-15-LMAD - INPUT SIGNAL TO LOGIC MATRIX AD FAILS

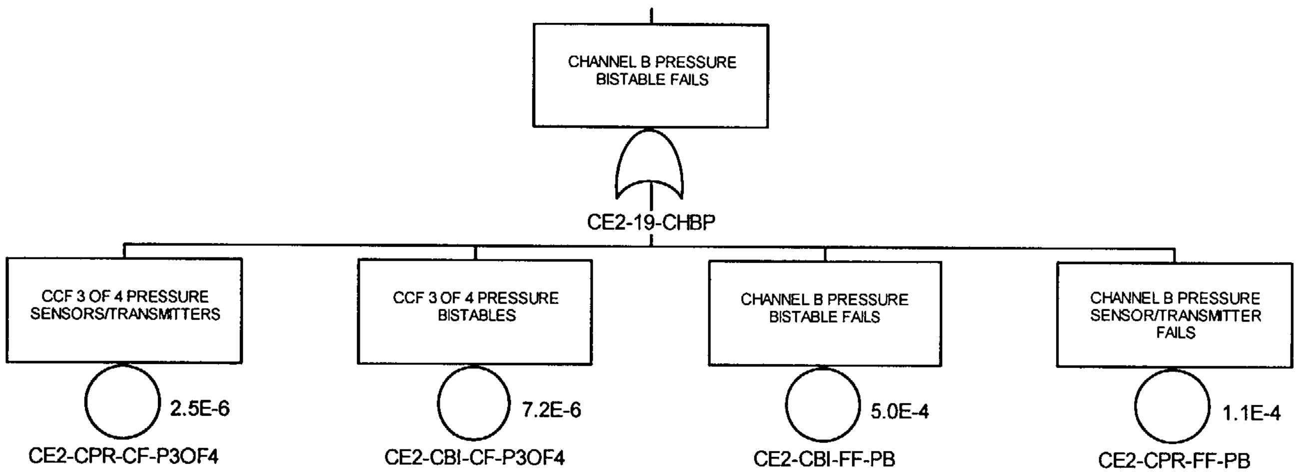
2001/03/02 Page 68



CHANNEL A TEMPERATURE BISTABLE FAILS
CE2-16-CHAT
CHANNEL A TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE2-CBI-FF-TA
CCF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE2-CBI-CF-T3OF4
CHANNEL A ANALOG CORE PROTECTION CALCULATOR FAILS
7.6E-3
CE2-CPA-FF-TA
CCF 3 OF 4 CORE PROTECTION CALCULATORS
1.7E-4
CE2-CPA-CF-T3OF4
CHANNEL A HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-HTA
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE2-CTP-CF-HT3OF4
CHANNEL A COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-CTA
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE2-CTP-CF-CT3OF4
CE2-16-CHAT - CHANNEL A TEMPERATURE BISTABLE FAILS
2001/06/07 Page 69


CHANNEL A PRESSURE BISTABLE FAILS
CE2-17-CHAP
CHANNEL A PRESSURE BISTABLE FAILS
5.0E-4
CE2-CBI-FF-PA
CHANNEL A PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE2-CPR-FF-PA
CCF 3 OF 4 PRESSURE SENSORS/TRANSMITTERS
2.5E-6
CE2-CPR-CF-P3OF4
CCF 3 OF 4 PRESSURE BISTABLES
7.2E-6
CE2-CBI-CF-P3OF4
CE2-17-CHAP - CHANNEL A PRESSURE BISTABLE FAILS
2001/03/02 Page 70


CHANNEL B TEMPERATURE BISTABLE FAILS
CE2-18-CHBT
CCF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE2-CBI-CF-T3OF4
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE2-CTP-CF-HT3OF4
CHANNEL B TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE2-CBI-FF-TB
CHANNEL B HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-HTB
CHANNEL B COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-CTB
CCF 3 OF 4 CORE PROTECTION CALCULATORS
1.7E-4
CE2-CPA-CF-T3OF4
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE2-CTP-CF-CT3OF4
CHANNEL B ANALOG CORE PROTECTION CALCULATOR FAILS
7.6E-3
CE2-CPA-FF-TB
CE2-18-CHBT - CHANNEL B TEMPERATURE BISTABLE FAILS
2001/06/07 Page 71



CE2-19-CHBP - CHANNEL B PRESSURE BISTABLE FAILS

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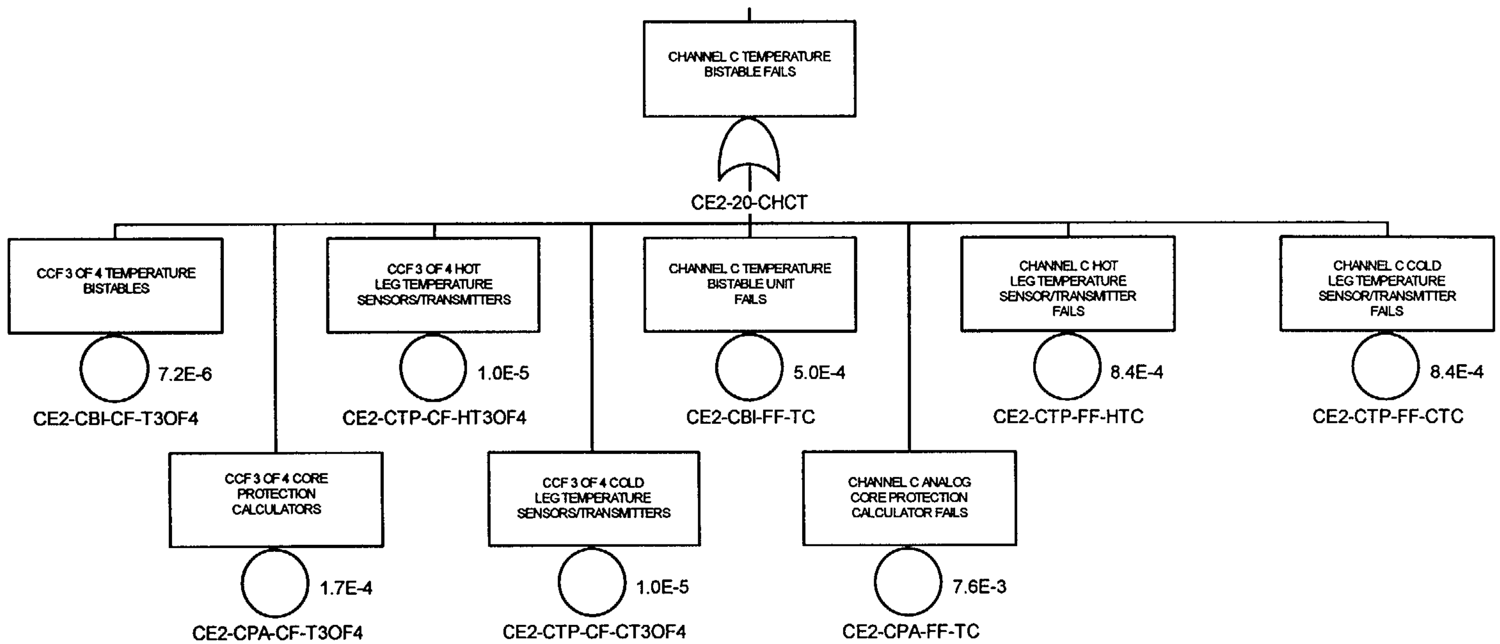
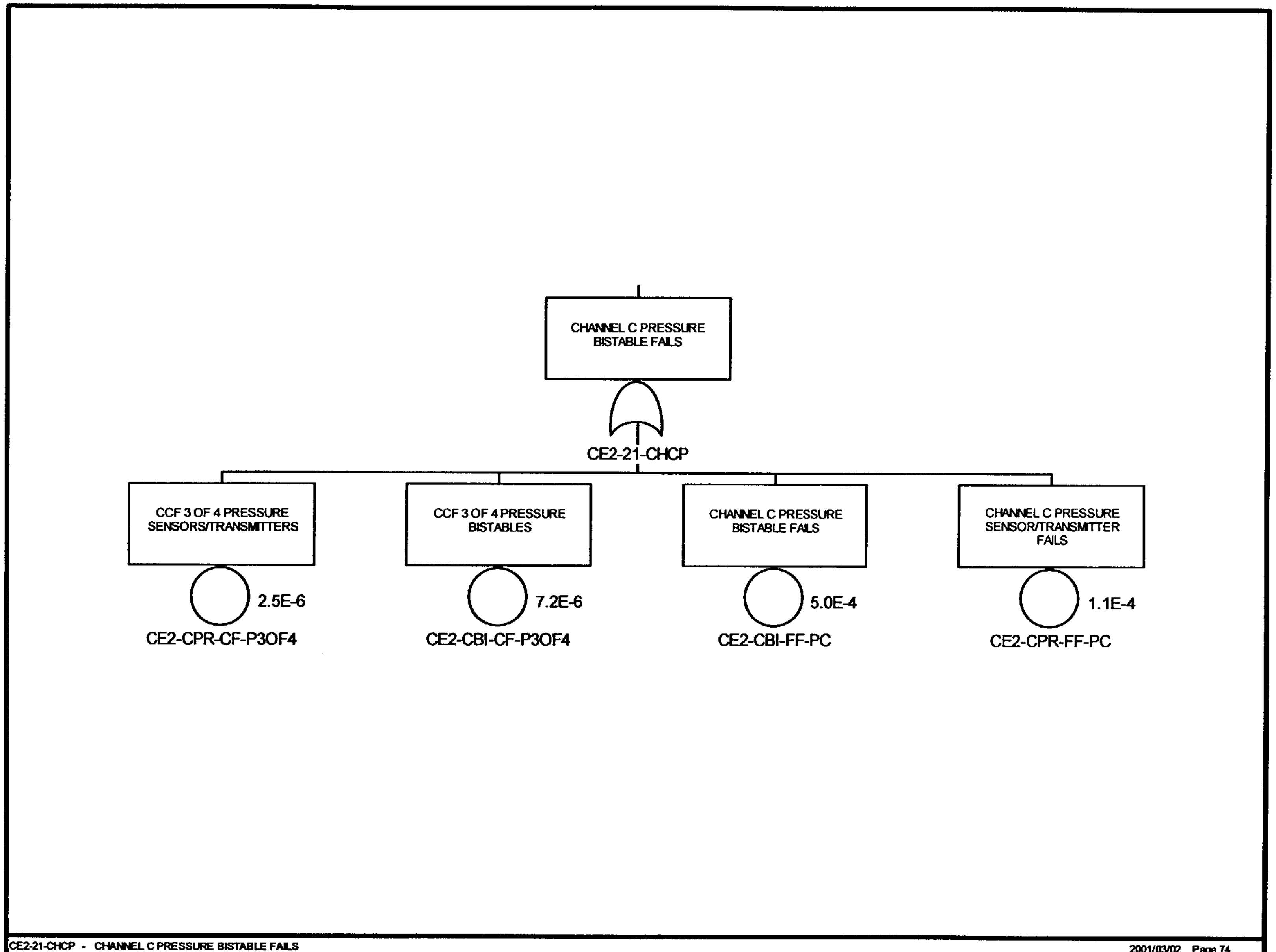
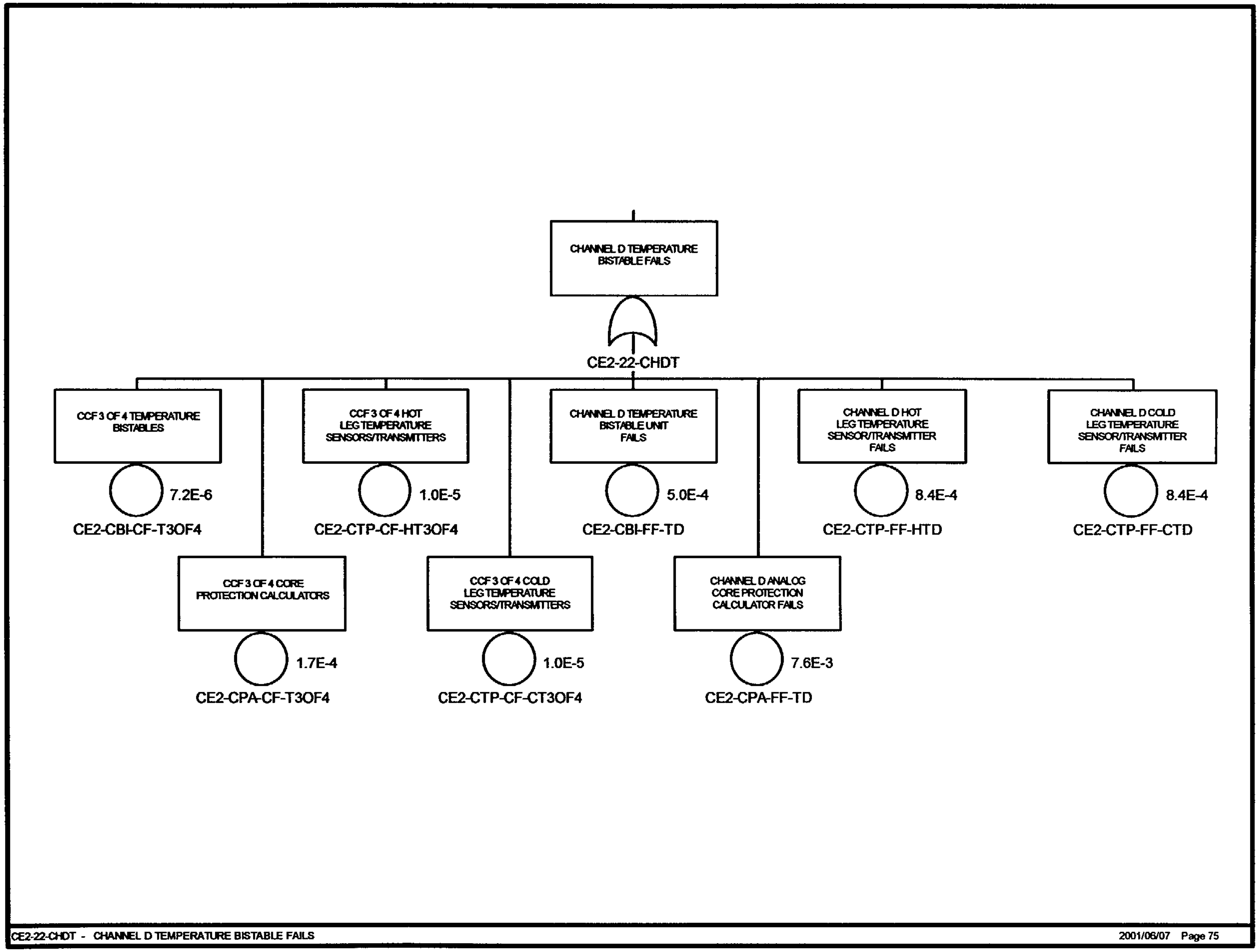
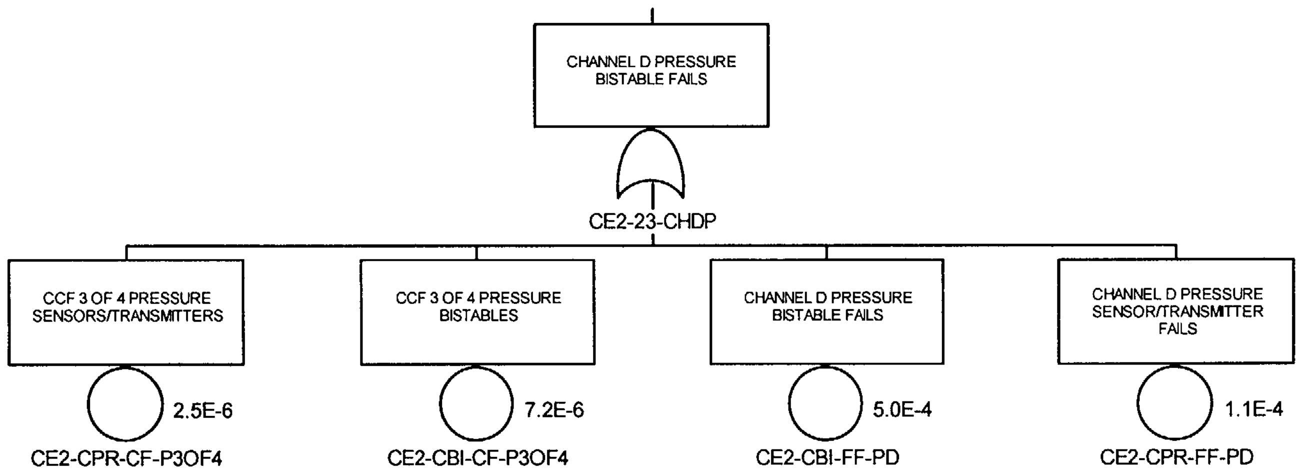


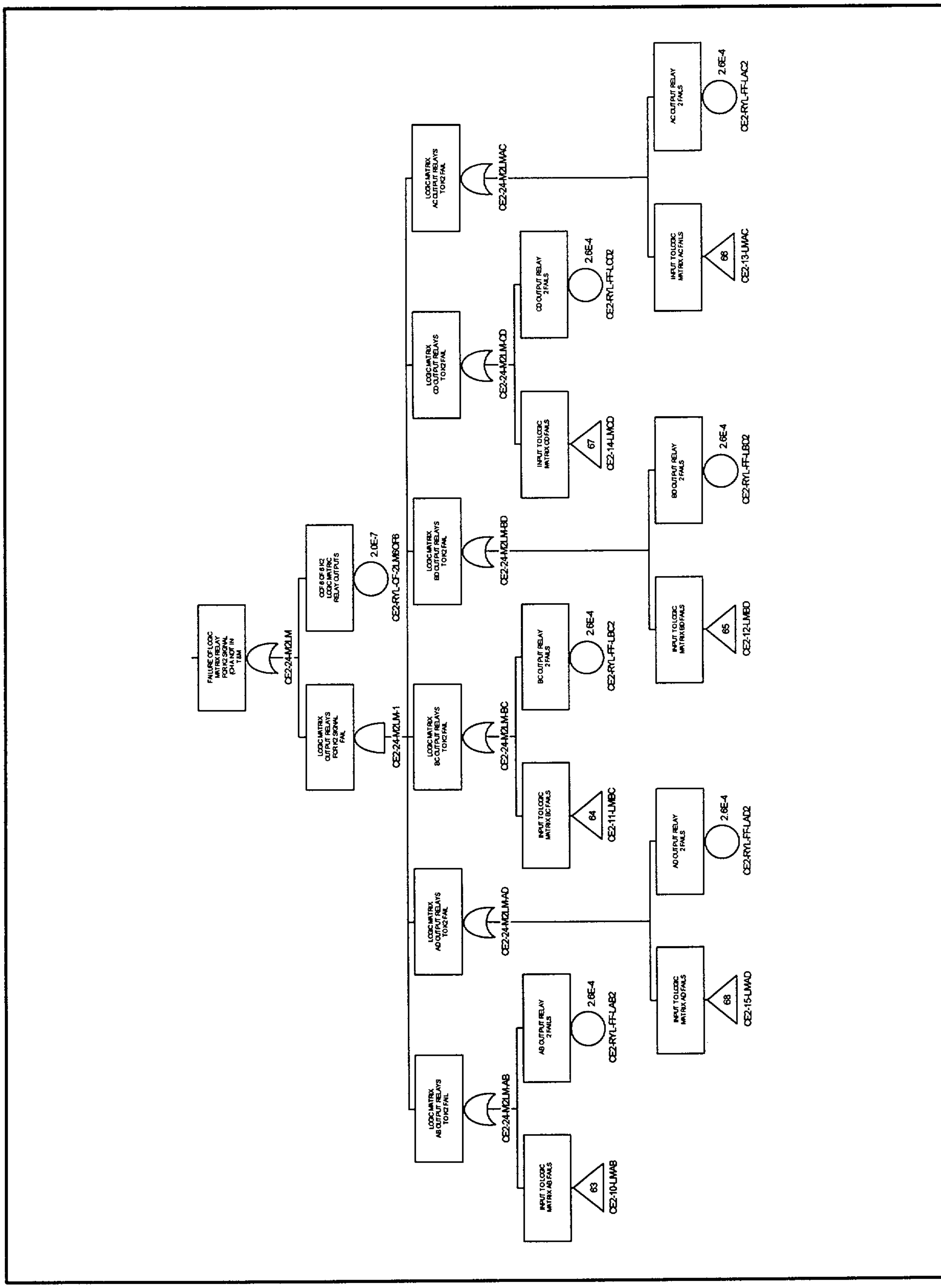
CE2-20-CHCT - CHANNEL C TEMPERATURE BISTABLE FAILS 2001/06/07 Page 73


CHANNEL C PRESSURE BISTABLE FAILS
CE2-21-CHCP
CCF 3 OF 4 PRESSURE SENSORS/TRANSMITTERS
2.5E-6
CE2-CPR-CF-P3OF4
CCF 3 OF 4 PRESSURE BISTABLES
7.2E-6
CE2-CBI-CF-P3OF4
CHANNEL C PRESSURE BISTABLE FAILS
5.0E-4
CE2-CBI-FF-PC
CHANNEL C PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE2-CPR-FF-PC
CE2-21-CHCP - CHANNEL C PRESSURE BISTABLE FAILS
2001/03/02 Page 74

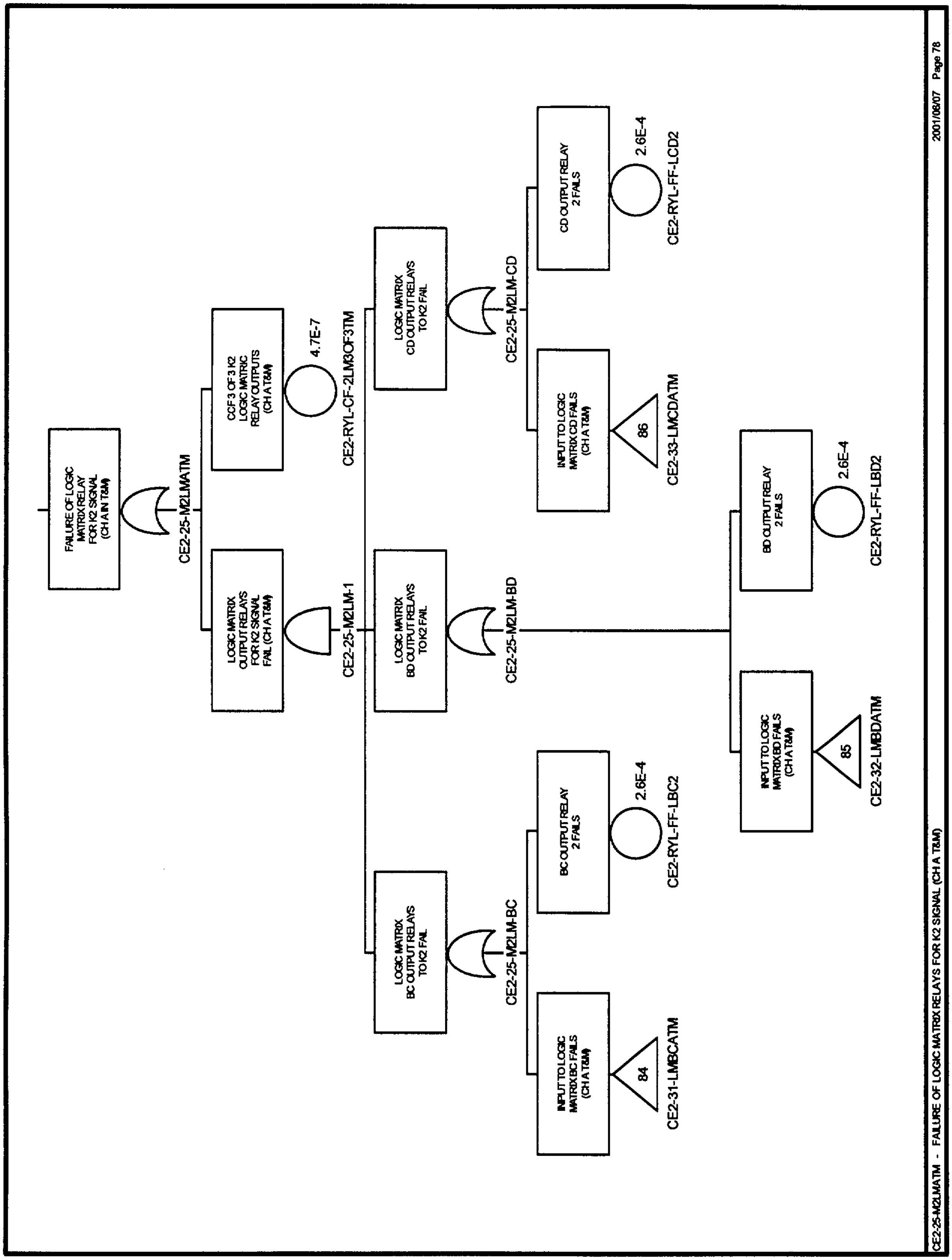

CHANNEL D TEMPERATURE BISTABLE FAILS
CE2-22-CHDT
CCF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE2-CBI-CF-T3OF4
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE2-CTP-CF-HT3OF4
CHANNEL D TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE2-CBI-FF-TD
CHANNEL D HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-HTD
CHANNEL D COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-CTD
CCF 3 OF 4 CORE PROTECTION CALCULATORS
1.7E-4
CE2-CPA-CF-T3OF4
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE2-CTP-CF-CT3OF4
CHANNEL D ANALOG CORE PROTECTION CALCULATOR FAILS
7.6E-3
CE2-CPA-FF-TD
CE2-22-CHDT - CHANNEL D TEMPERATURE BISTABLE FAILS
2001/06/07 Page 75

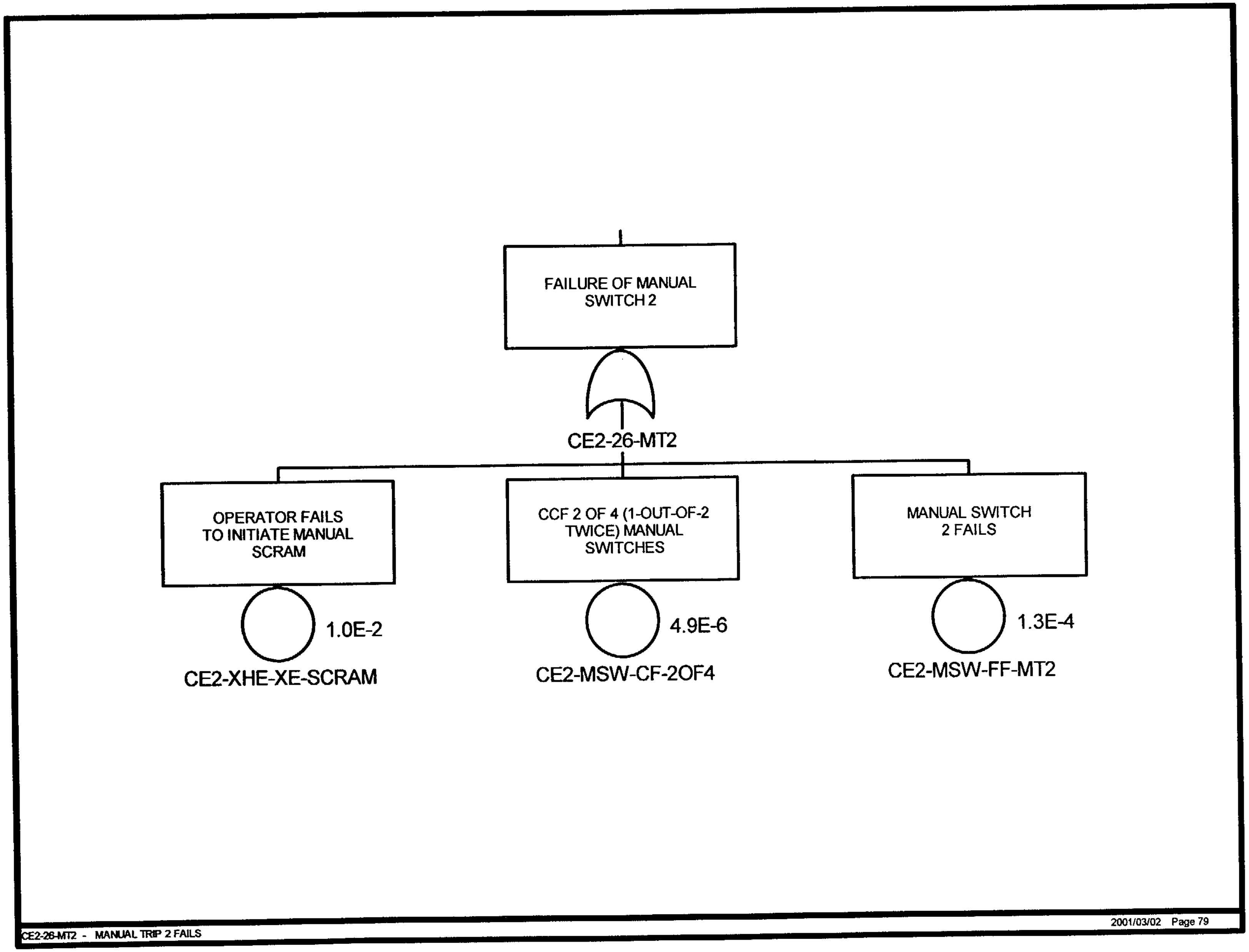


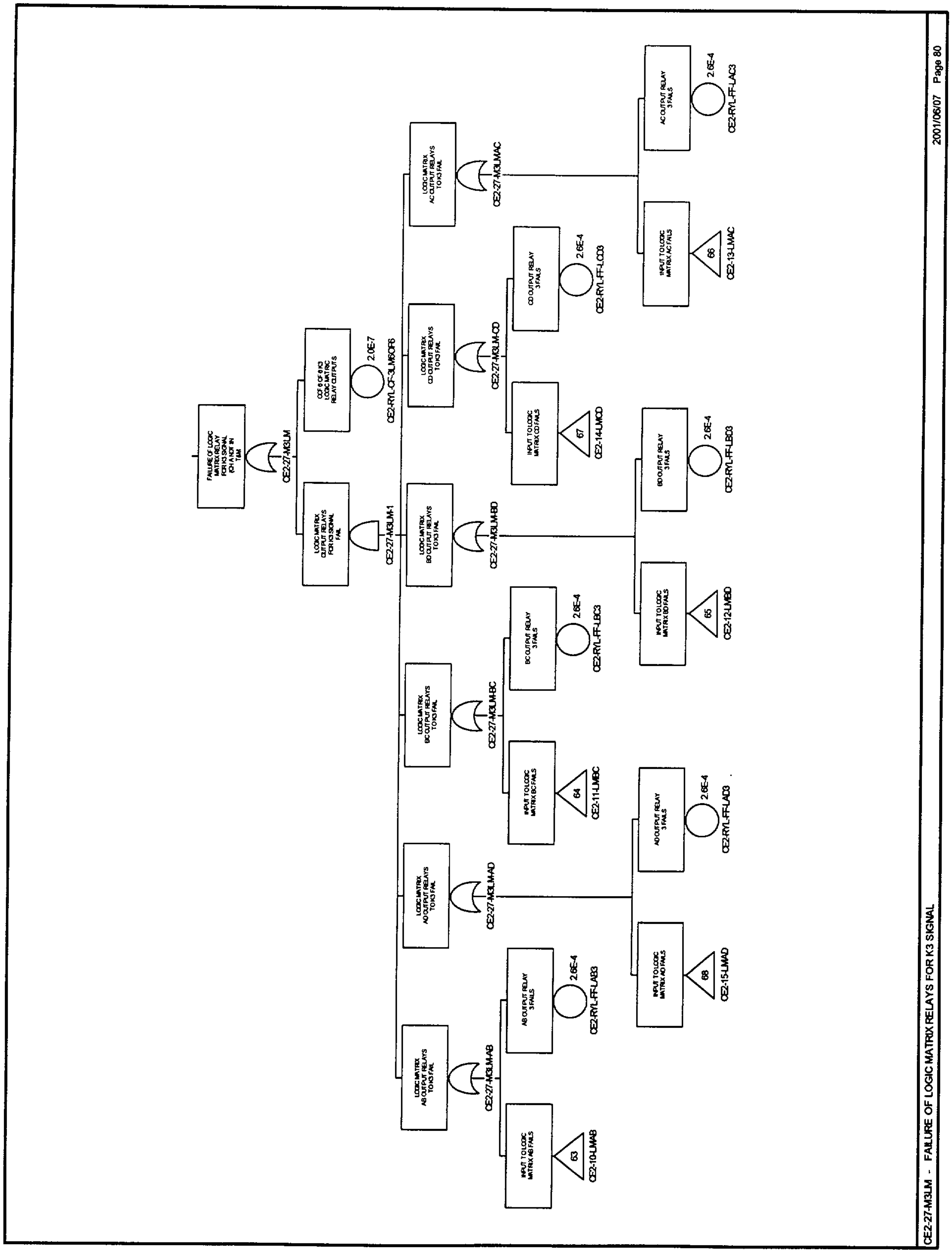
CE2-23-CHDP - CHANNEL D PRESSURE BISTABLE FAILS 2001/03/02 Page 76

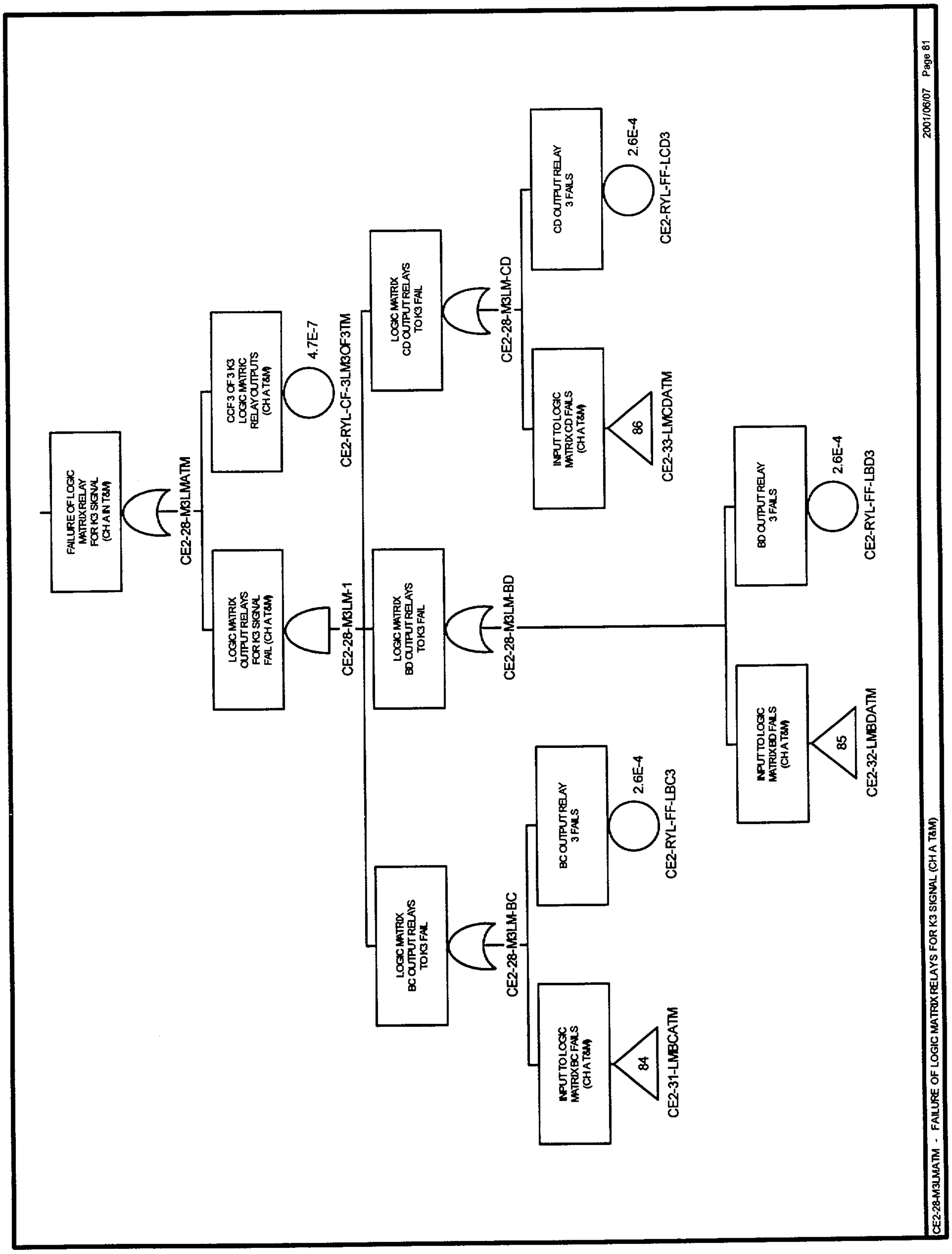


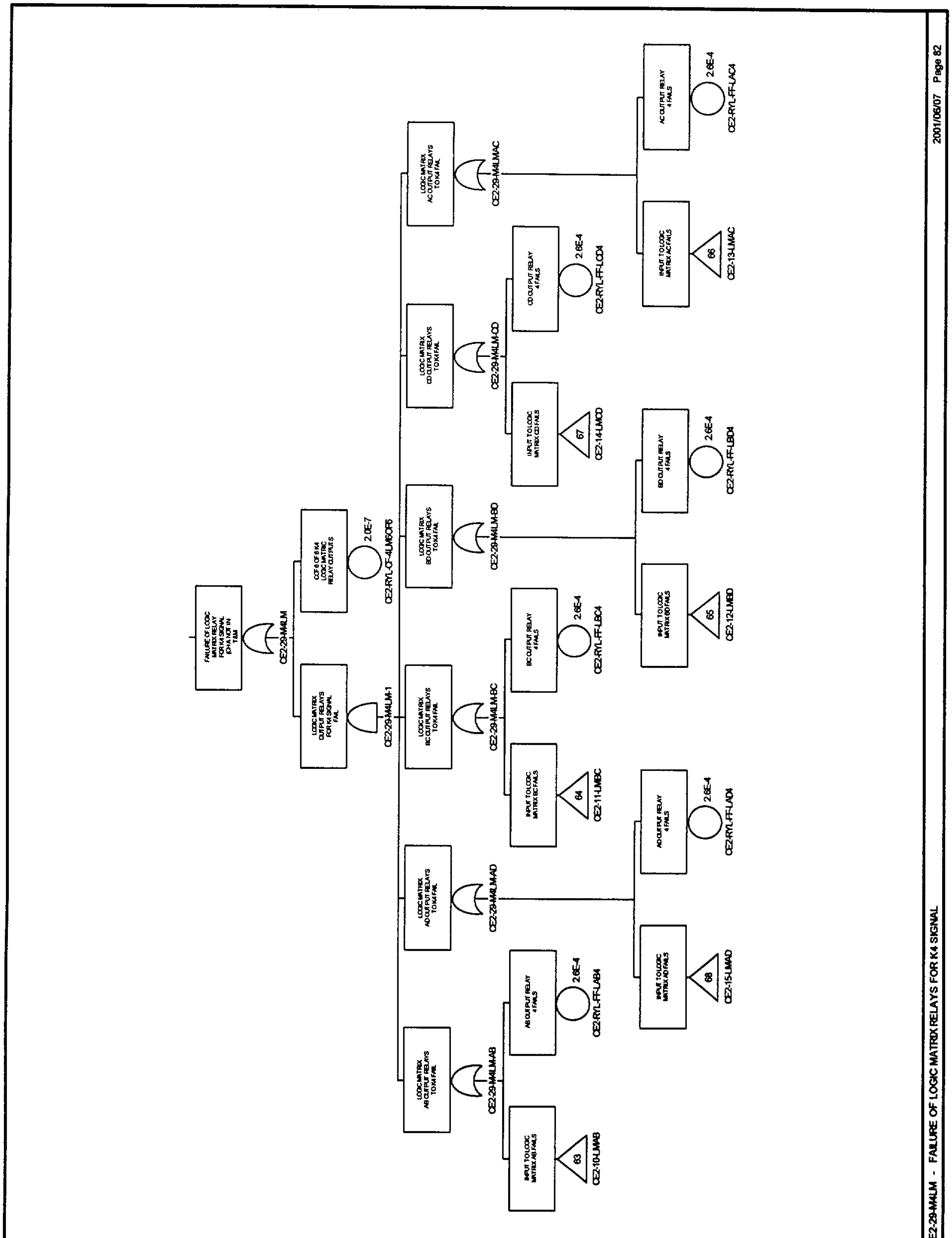
CE2-24-M2LM - FAILURE OF LOGIC MATRIX RELAYS FOR K2 SIGNAL


FAILURE OF LOGIC MATRIX RELAY FOR K2 SIGNAL (CH A IN T&M)
CE2-25-M2LMATM
LOGIC MATRIX OUTPUT RELAYS FOR K2 SIGNAL FAIL (CH A T&M)
CE2-25-M2LM-1
CCF 3 OF 3 K2 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
4.7E-7
CE2-RYL-CF-2LM3OF3TM
LOGIC MATRIX BC OUTPUT RELAYS TO K2 FAIL
CE2-25-M2LM-BC
LOGIC MATRIX BD OUTPUT RELAYS TO K2 FAIL
CE2-25-M2LM-BD
LOGIC MATRIX CD OUTPUT RELAYS TO K2 FAIL
CE2-25-M2LM-CD
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
84
CE2-31-LMBCATM
BC OUTPUT RELAY 2 FAILS
2.6E-4
CE2-RYL-FF-LBC2
INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
85
CE2-32-LMBDATM
BD OUTPUT RELAY 2 FAILS
2.6E-4
CE2-RYL-FF-LBD2
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
86
CE2-33-LMCDATM
CD OUTPUT RELAY 2 FAILS
2.6E-4
CE2-RYL-FF-LCD2
CE2-25-M2LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR K2 SIGNAL (CH A T&M)
2001/08/07 Page 78

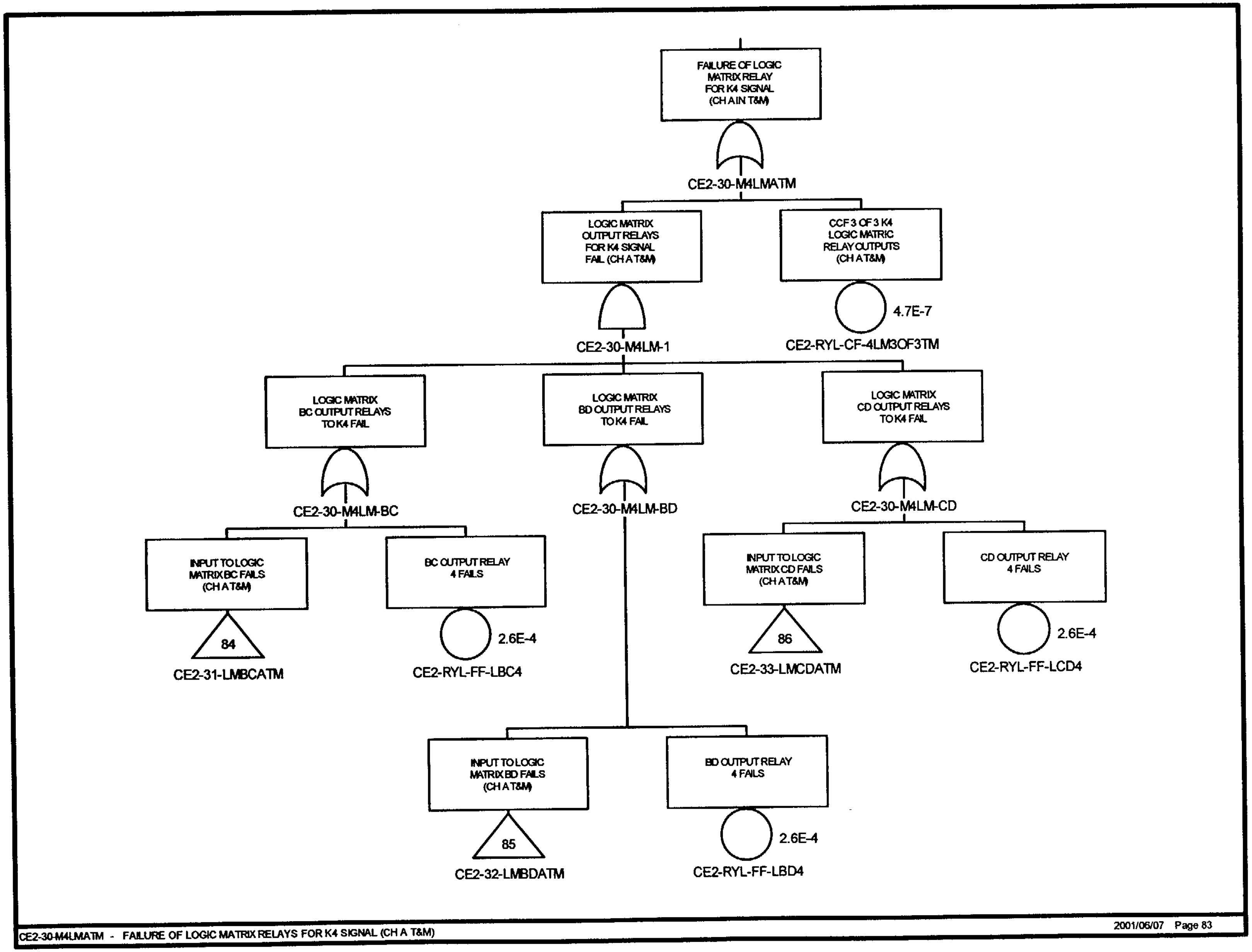

FAILURE OF MANUAL SWITCH 2
CE2-26-MT2
OPERATOR FAILS TO INITIATE MANUAL SCRAM
1.0E-2
CE2-XHE-XE-SCRAM
CCF 2 OF 4 (1-OUT-OF-2 TWICE) MANUAL SWITCHES
4.9E-6
CE2-MSW-CF-2OF4
MANUAL SWITCH 2 FAILS
1.3E-4
CE2-MSW-FF-MT2
CE2-26-MT2 - MANUAL TRIP 2 FAILS
2001/03/02 Page 79


CE2-27-M3LM
CE2-27-M3LM-1
CE2-RYL-CF-3LM6OF6
2.0E-7
CE2-27-M3LM-AB
CE2-27-M3LM-AD
CE2-27-M3LM-BC
CE2-27-M3LM-BD
CE2-27-M3LM-CD
CE2-27-M3LMAC
63
CE2-10-LMAB
CE2-RYL-FF-LAB3
2.6E-4
68
CE2-15-LMAD
CE2-RYL-FF-LAD3
2.6E-4
64
CE2-11-LMBC
CE2-RYL-FF-LBC3
2.6E-4
65
CE2-12-LMBD
CE2-RYL-FF-LBD3
2.6E-4
67
CE2-14-LMCD
CE2-RYL-FF-LCD3
2.6E-4
66
CE2-13-LMAC
CE2-RYL-FF-LAC3
2.6E-4
CE2-27-M3LM - FAILURE OF LOGIC MATRIX RELAYS FOR K3 SIGNAL
2001/06/07 Page 80


CE2-28-M3LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR K3 SIGNAL (CH A T&M)
2001/06/07 Page 81
FAILURE OF LOGIC MATRIX RELAY FOR K3 SIGNAL (CH A IN T&M)
CE2-28-M3LMATM
LOGIC MATRIX OUTPUT RELAYS FOR K3 SIGNAL FAIL (CH A T&M)
CE2-28-M3LM-1
CCF 3 OF 3 K3 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
4.7E-7
CE2-RYL-CF-3LM3OF3TM
LOGIC MATRIX CD OUTPUT RELAYS TO K3 FAIL
CE2-28-M3LM-CD
LOGIC MATRIX BD OUTPUT RELAYS TO K3 FAIL
CE2-28-M3LM-BD
LOGIC MATRIX BC OUTPUT RELAYS TO K3 FAIL
CE2-28-M3LM-BC
CD OUTPUT RELAY 3 FAILS
2.6E-4
CE2-RYL-FF-LCD3
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
86
CE2-33-LMCDATM
BD OUTPUT RELAY 3 FAILS
2.6E-4
CE2-RYL-FF-LBD3
INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
85
CE2-32-LMBDATM
BC OUTPUT RELAY 3 FAILS
2.6E-4
CE2-RYL-FF-LBC3
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
84
CE2-31-LMBCATM



CE2-29-M4LM - FAILURE OF LOGIC MATRIX RELAYS FOR K4 SIGNAL
2001/06/07 Page 82
CE2-29-M4LM
CE2-29-M4LM-1
CE2-RYL-CF-4LM6OF6
2.0E-7
CE2-29-M4LM-AB
CE2-29-M4LM-AD
CE2-29-M4LM-BC
CE2-29-M4LM-BD
CE2-29-M4LM-CD
CE2-29-M4LMAC
CE2-10-LMAB
CE2-RYL-FF-LAB4
CE2-15-LMAD
CE2-RYL-FF-LAD4
CE2-11-LMBC
CE2-RYL-FF-LBC4
CE2-12-LMBD
CE2-RYL-FF-LBD4
CE2-14-LMCD
CE2-RYL-FF-LCD4
CE2-13-LMAC
CE2-RYL-FF-LAC4
2.6E-4
63
64
65
66
67
68


FAILURE OF LOGIC MATRIX RELAY FOR K4 SIGNAL (CH A IN T&M)
CE2-30-M4LMATM
LOGIC MATRIX OUTPUT RELAYS FOR K4 SIGNAL FAIL (CH A T&M)
CCF 3 OF 3 K4 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
4.7E-7
CE2-RYL-CF-4LM3OF3TM
CE2-30-M4LM-1
LOGIC MATRIX BC OUTPUT RELAYS TO K4 FAIL
LOGIC MATRIX BD OUTPUT RELAYS TO K4 FAIL
LOGIC MATRIX CD OUTPUT RELAYS TO K4 FAIL
CE2-30-M4LM-BC
CE2-30-M4LM-BD
CE2-30-M4LM-CD
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
84
CE2-31-LMBCATM
BC OUTPUT RELAY 4 FAILS
2.6E-4
CE2-RYL-FF-LBC4
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
86
CE2-33-LMCDATM
CD OUTPUT RELAY 4 FAILS
2.6E-4
CE2-RYL-FF-LCD4
INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
85
CE2-32-LMBDATM
BD OUTPUT RELAY 4 FAILS
2.6E-4
CE2-RYL-FF-LBD4
CE2-30-M4LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR K4 SIGNAL (CH A T&M)
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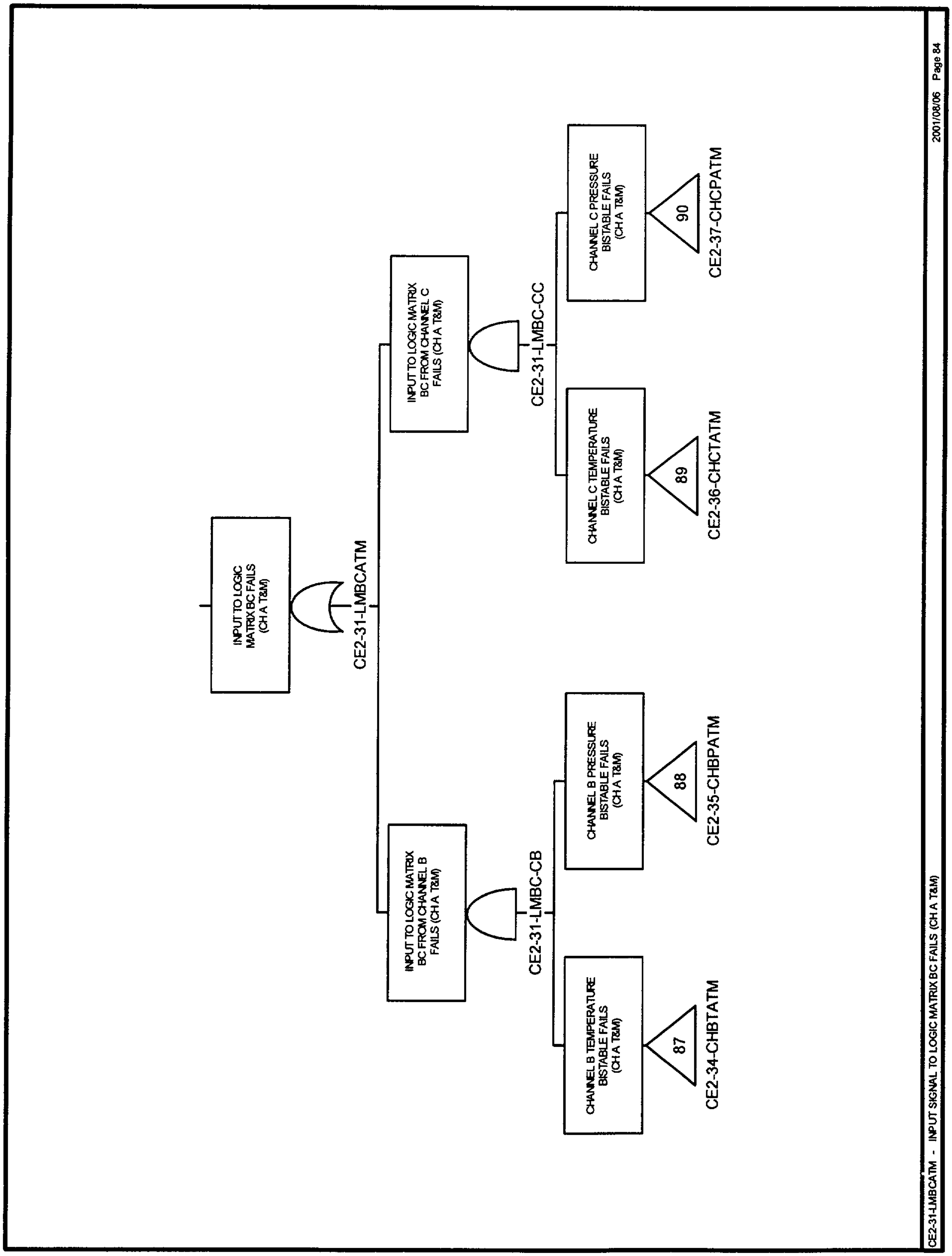
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
CE2-31-LMBCATM
INPUT TO LOGIC MATRIX BC FROM CHANNEL B FAILS (CH A T&M)
CE2-31-LMBC-CB
INPUT TO LOGIC MATRIX BC FROM CHANNEL C FAILS (CH A T&M)
CE2-31-LMBC-CC
CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M)
87
CE2-34-CHBTATM
CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M)
88
CE2-35-CHBPATM
CHANNEL C TEMPERATURE BISTABLE FAILS (CH A T&M)
89
CE2-36-CHCTATM
CHANNEL C PRESSURE BISTABLE FAILS (CH A T&M)
90
CE2-37-CHCPATM
CE2-31-LMBCATM - INPUT SIGNAL TO LOGIC MATRIX BC FAILS (CH A T&M)
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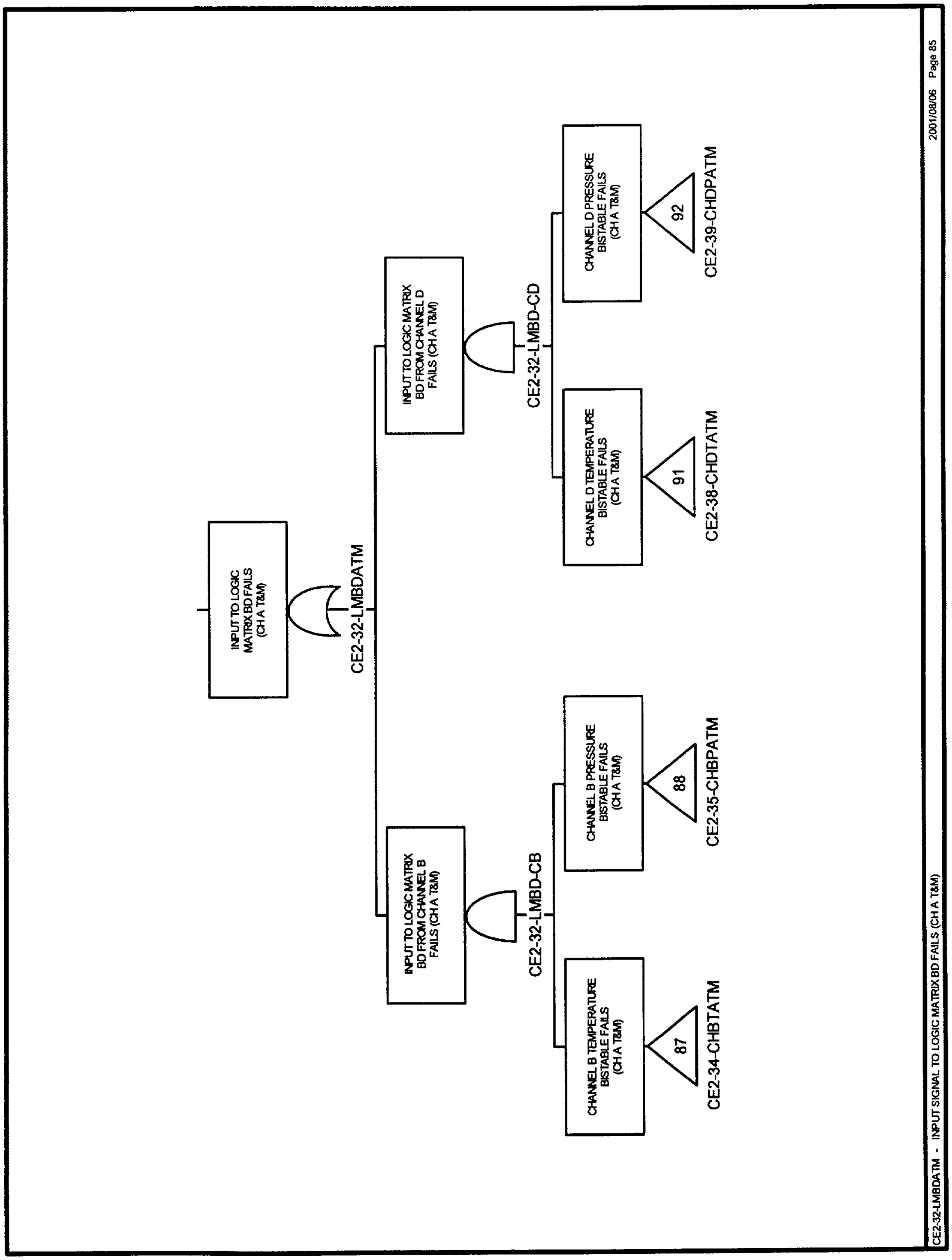
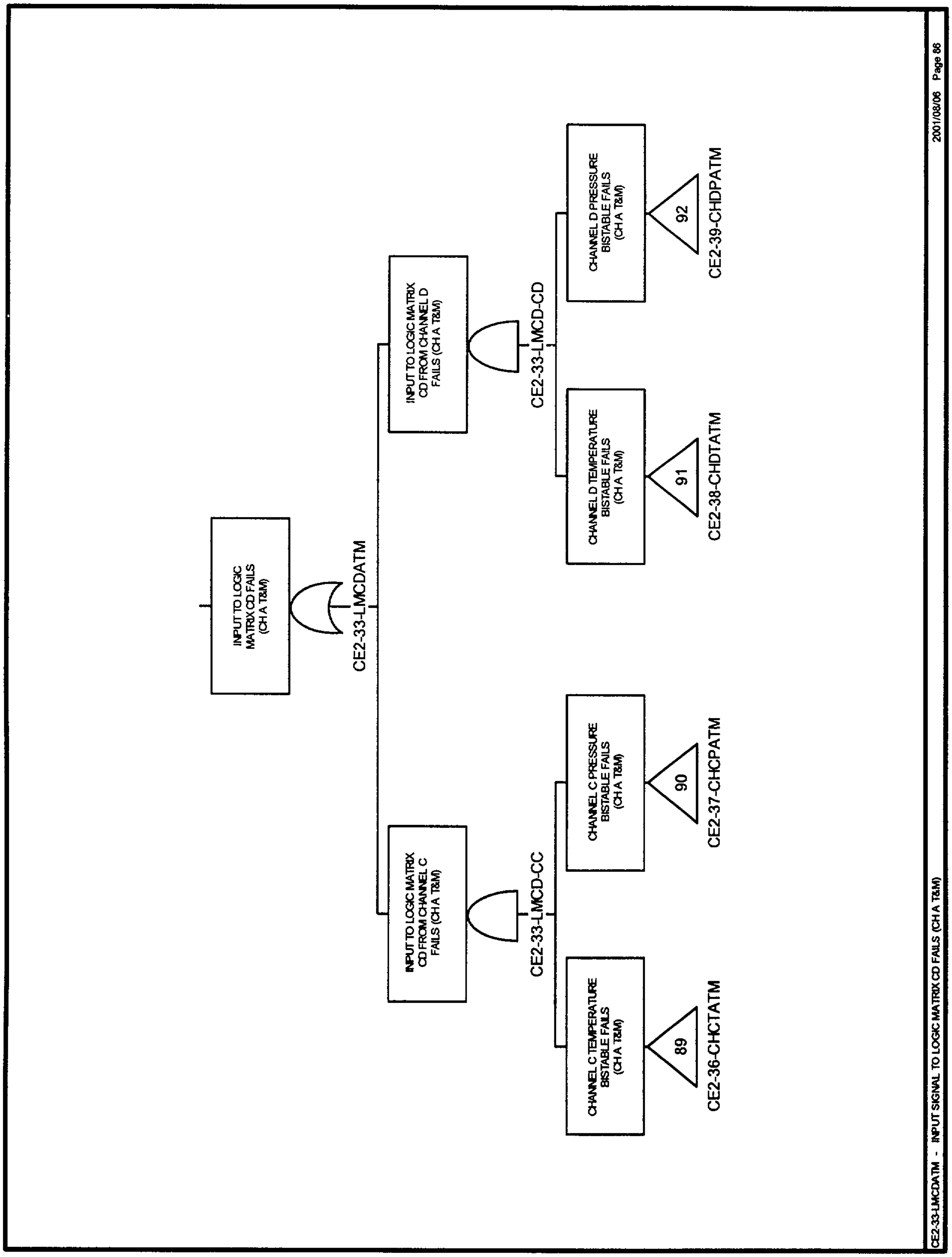
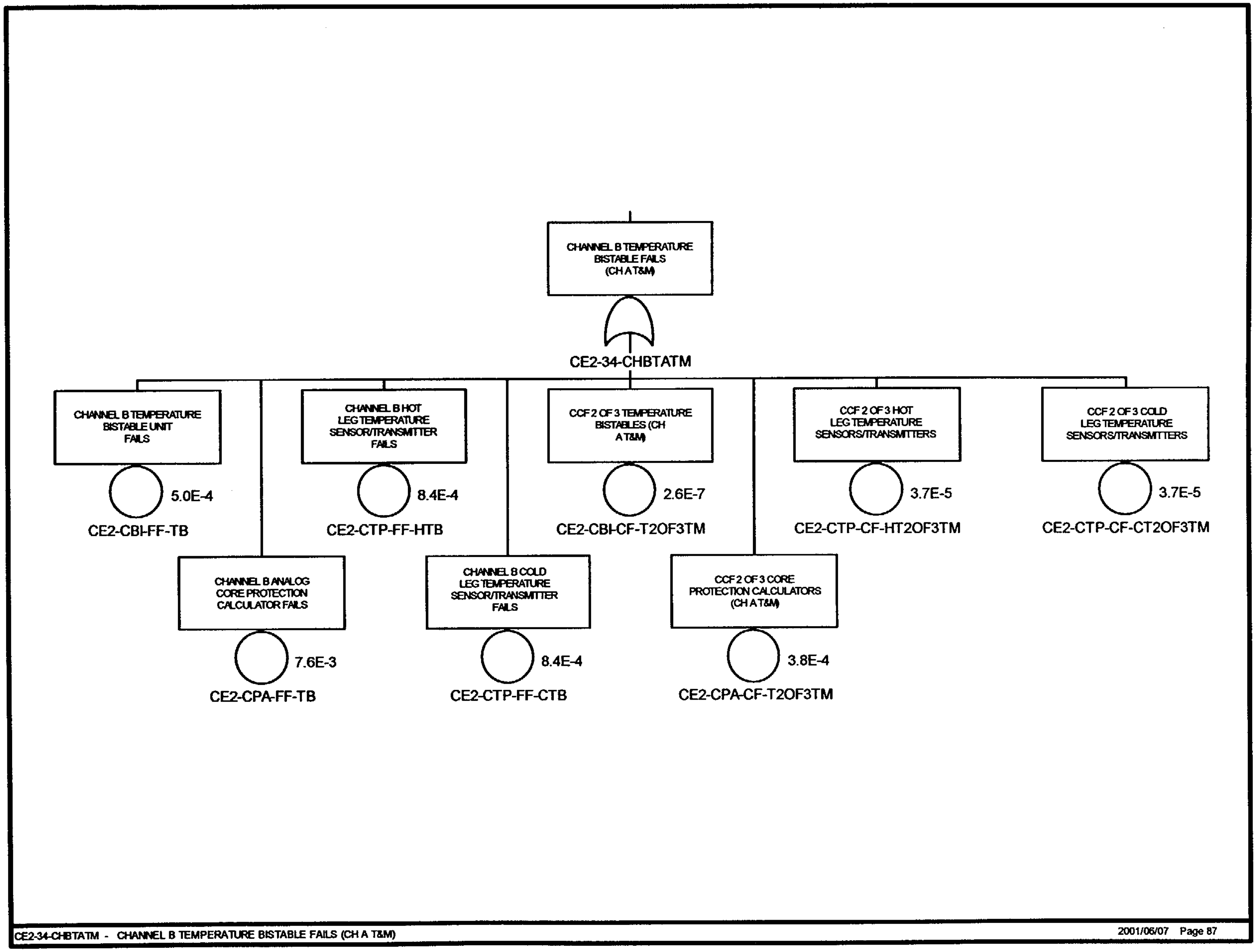
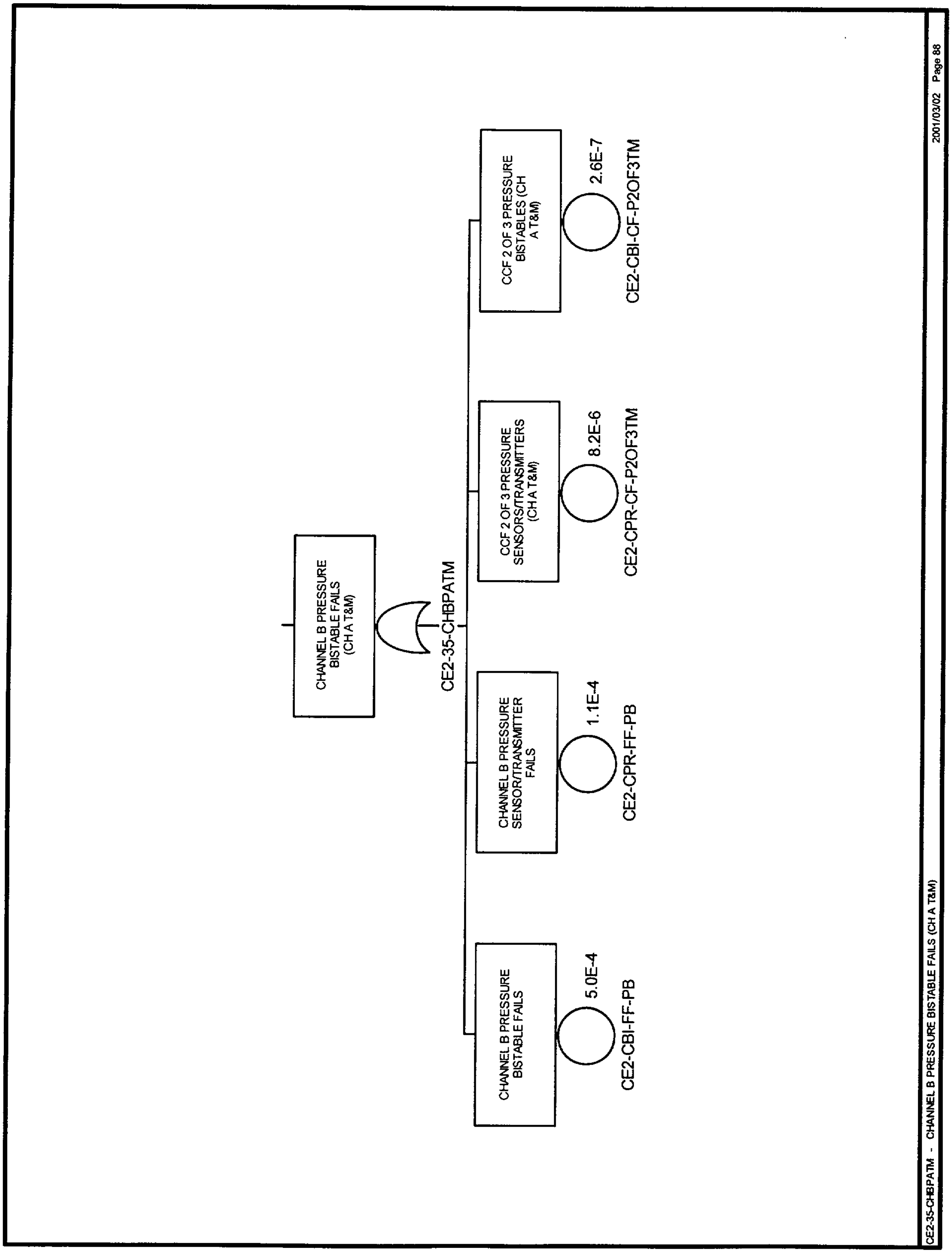

INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
CE2-32-LMBDATM
INPUT TO LOGIC MATRIX BD FROM CHANNEL B FAILS (CH A T&M)
CE2-32-LMBD-CB
INPUT TO LOGIC MATRIX BD FROM CHANNEL D FAILS (CH A T&M)
CE2-32-LMBD-CD
CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M)
87
CE2-34-CHBTATM
CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M)
88
CE2-35-CHBPATM
CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
91
CE2-38-CHDTATM
CHANNEL D PRESSURE BISTABLE FAILS (CH A T&M)
92
CE2-39-CHDPATM
CE2-32-LMBDATM - INPUT SIGNAL TO LOGIC MATRIX BD FAILS (CH A T&M)
2001/08/06 Page 85


INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
CE2-33-LMCDATM
INPUT TO LOGIC MATRIX CD FROM CHANNEL C FAILS (CH A T&M)
CE2-33-LMCD-CC
INPUT TO LOGIC MATRIX CD FROM CHANNEL D FAILS (CH A T&M)
CE2-33-LMCD-CD
CHANNEL C TEMPERATURE BISTABLE FAILS (CH A T&M)
89
CE2-36-CHCTATM
CHANNEL C PRESSURE BISTABLE FAILS (CH A T&M)
90
CE2-37-CHCPATM
CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
91
CE2-38-CHDTATM
CHANNEL D PRESSURE BISTABLE FAILS (CH A T&M)
92
CE2-39-CHDPATM
CE2-33-LMCDATM - INPUT SIGNAL TO LOGIC MATRIX CD FAILS (CH A T&M)
2001/08/06 Page 86


CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M)
CE2-34-CHBTATM
CHANNEL B TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE2-CBI-FF-TB
CHANNEL B ANALOG CORE PROTECTION CALCULATOR FAILS
7.6E-3
CE2-CPA-FF-TB
CHANNEL B HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-HTB
CHANNEL B COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-CTB
CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
2.6E-7
CE2-CBI-CF-T2OF3TM
CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
3.8E-4
CE2-CPA-CF-T2OF3TM
CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE2-CTP-CF-HT2OF3TM
CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE2-CTP-CF-CT2OF3TM
CE2-34-CHBTATM - CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M)
2001/06/07 Page 87


CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M)
CE2-35-CHBPATM
CHANNEL B PRESSURE BISTABLE FAILS
5.0E-4
CE2-CBI-FF-PB
CHANNEL B PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE2-CPR-FF-PB
CCF 2 OF 3 PRESSURE SENSORS/TRANSMITTERS (CH A T&M)
8.2E-6
CE2-CPR-CF-P2OF3TM
CCF 2 OF 3 PRESSURE BISTABLES (CH A T&M)
2.6E-7
CE2-CBI-CF-P2OF3TM
CE2-35-CHBPATM - CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M)
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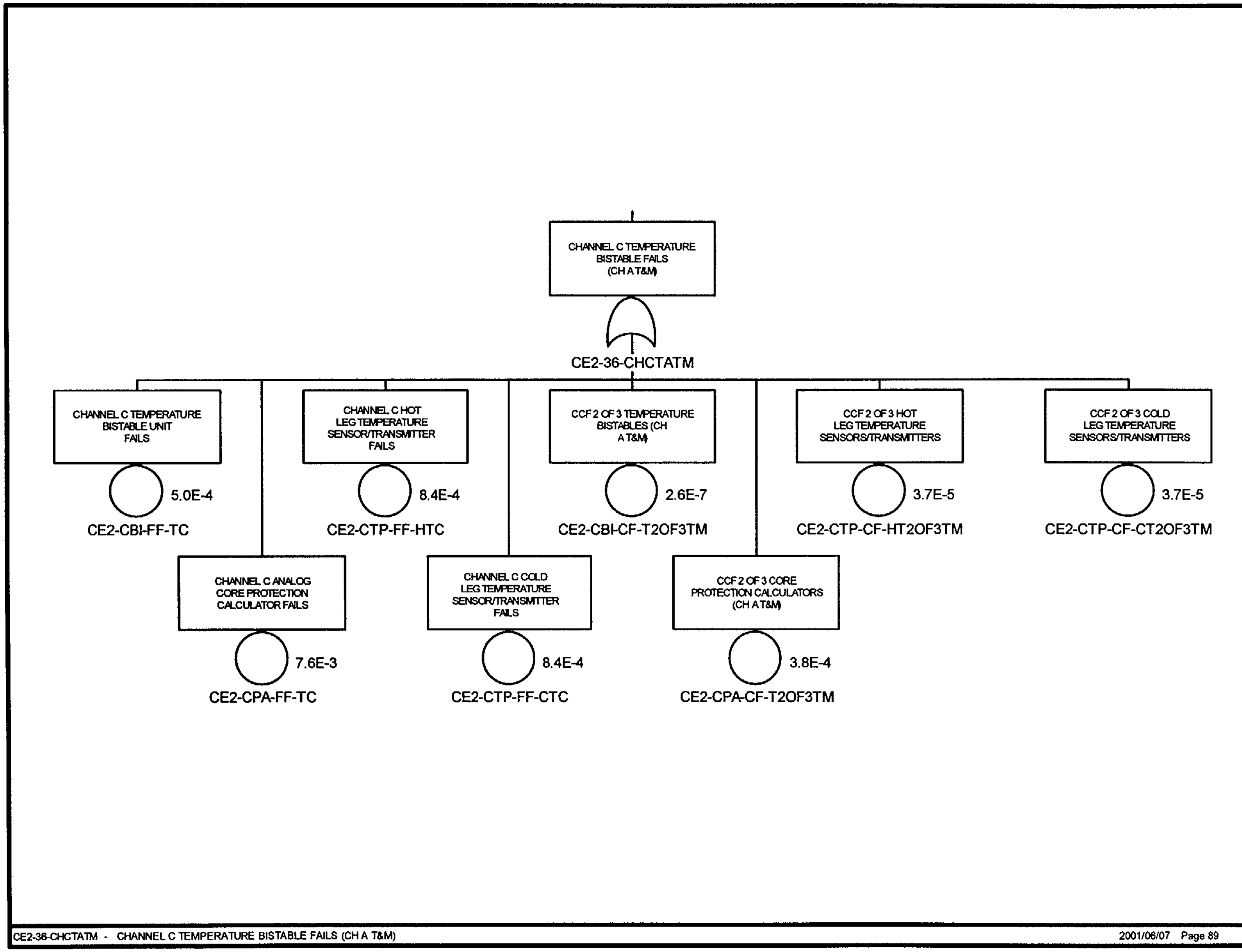
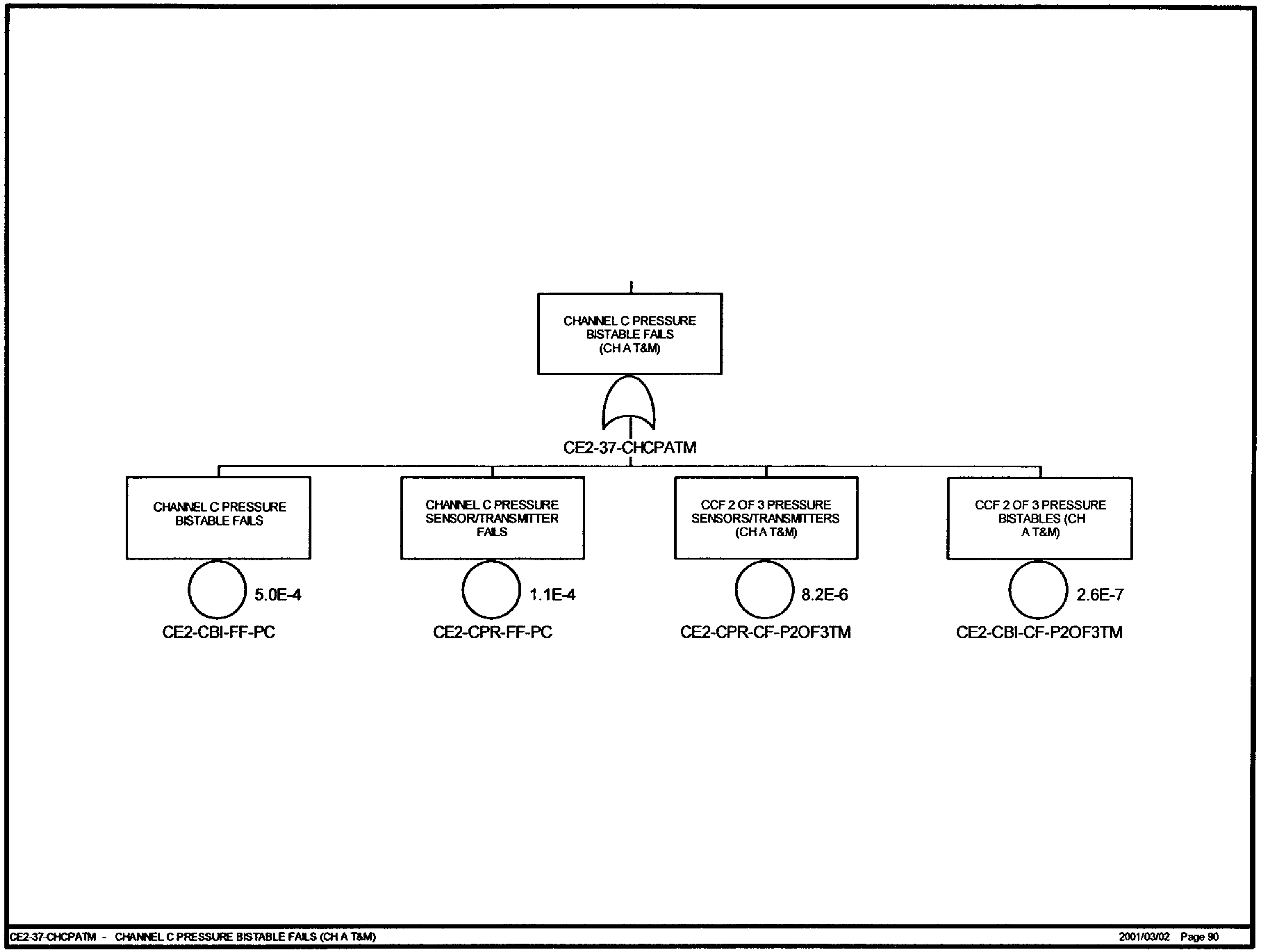
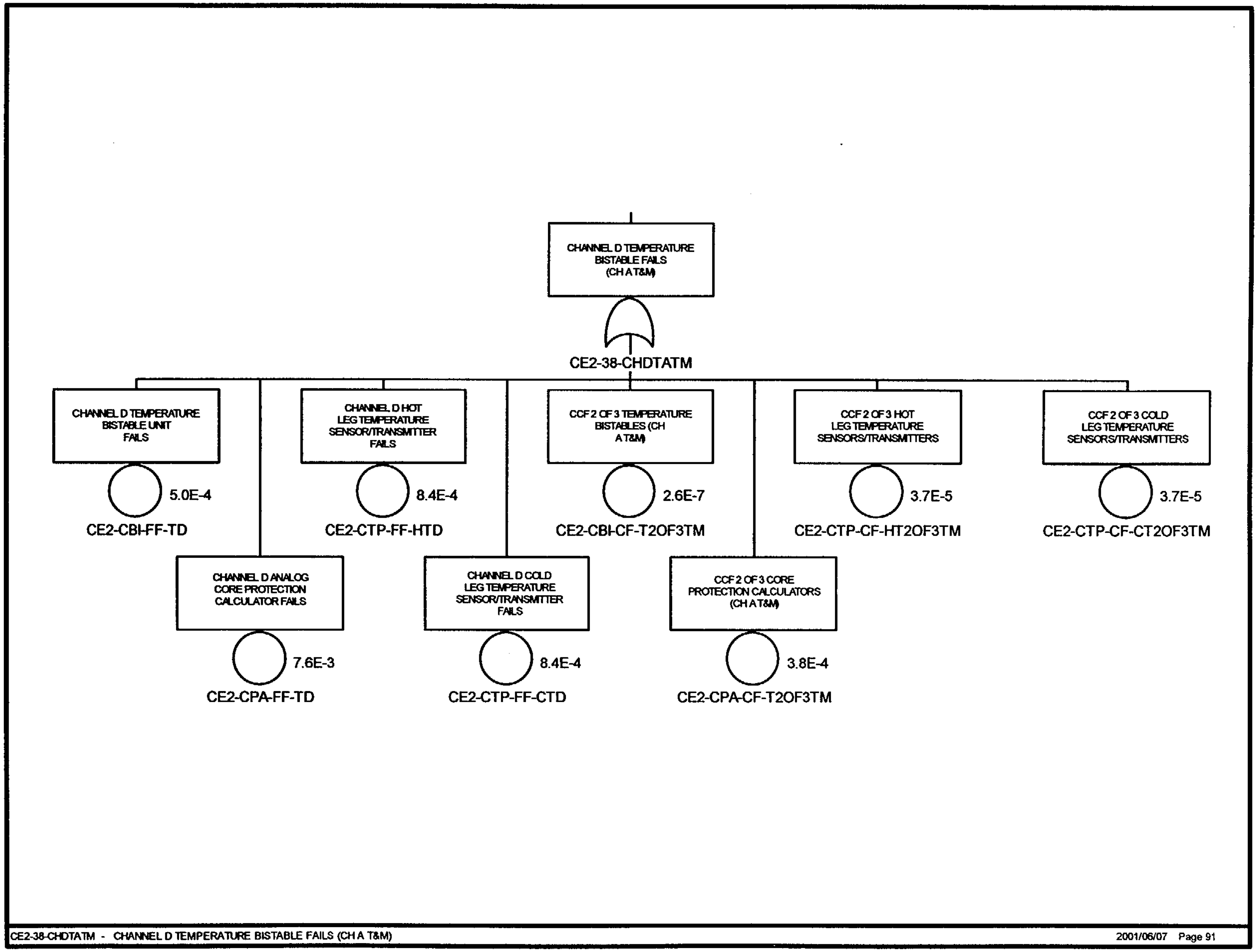
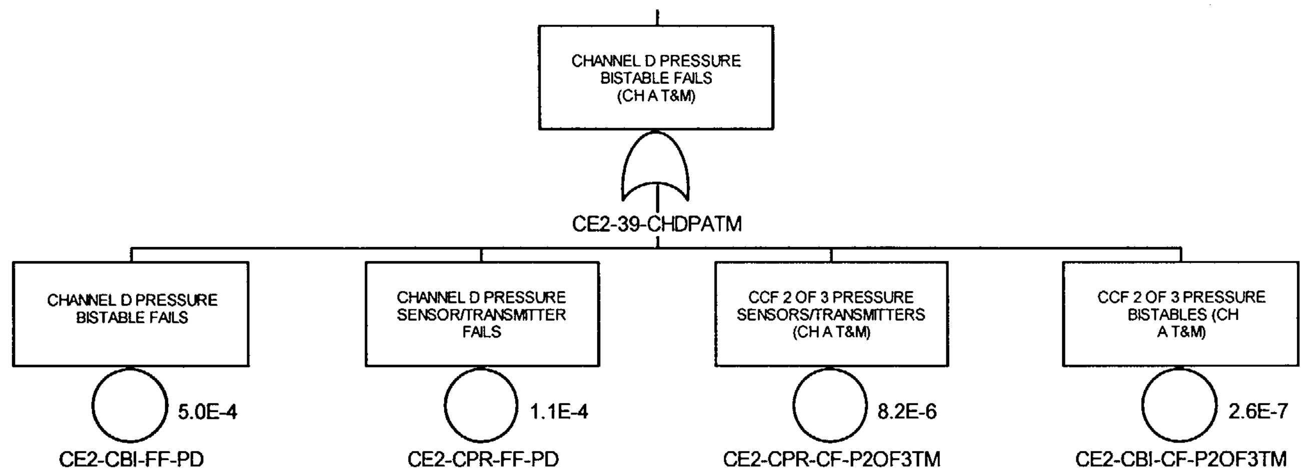
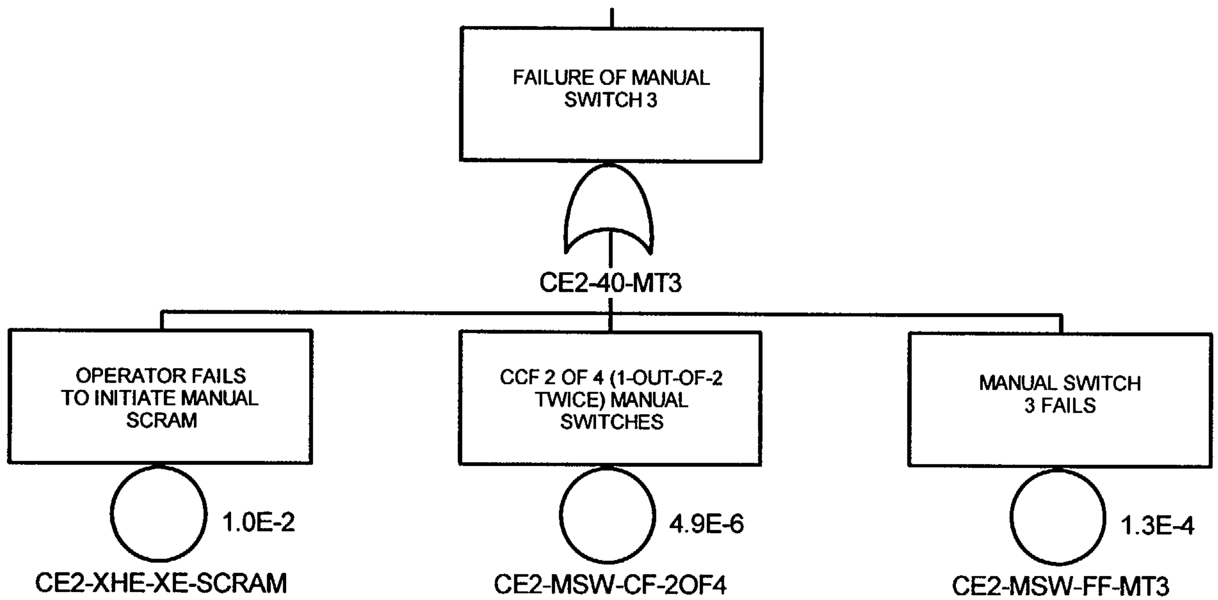

CHANNEL C TEMPERATURE BISTABLE FAILS (CH A T&M)
CE2-36-CHCTATM
CHANNEL C TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE2-CBI-FF-TC
CHANNEL C ANALOG CORE PROTECTION CALCULATOR FAILS
7.6E-3
CE2-CPA-FF-TC
CHANNEL C HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-HTC
CHANNEL C COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-CTC
CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
2.6E-7
CE2-CBI-CF-T2OF3TM
CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
3.8E-4
CE2-CPA-CF-T2OF3TM
CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE2-CTP-CF-HT2OF3TM
CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE2-CTP-CF-CT2OF3TM
CE2-36-CHCTATM - CHANNEL C TEMPERATURE BISTABLE FAILS (CH A T&M)
2001/06/07 Page 89


CHANNEL C PRESSURE BISTABLE FAILS (CH A T&M)
CE2-37-CHCPATM
CHANNEL C PRESSURE BISTABLE FAILS
5.0E-4
CE2-CBI-FF-PC
CHANNEL C PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE2-CPR-FF-PC
CCF 2 OF 3 PRESSURE SENSORS/TRANSMITTERS (CH A T&M)
8.2E-6
CE2-CPR-CF-P2OF3TM
CCF 2 OF 3 PRESSURE BISTABLES (CH A T&M)
2.6E-7
CE2-CBI-CF-P2OF3TM
CE2-37-CHCPATM - CHANNEL C PRESSURE BISTABLE FAILS (CH A T&M)
2001/03/02 Page 90


CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
CE2-38-CHDTATM
CHANNEL D TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE2-CBI-FF-TD
CHANNEL D ANALOG CORE PROTECTION CALCULATOR FAILS
7.6E-3
CE2-CPA-FF-TD
CHANNEL D HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-HTD
CHANNEL D COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE2-CTP-FF-CTD
CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
2.6E-7
CE2-CBI-CF-T2OF3TM
CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
3.8E-4
CE2-CPA-CF-T2OF3TM
CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE2-CTP-CF-HT2OF3TM
CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE2-CTP-CF-CT2OF3TM
CE2-38-CHDTATM - CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
2001/06/07 Page 91



CE2-39-CHDPATM - CHANNEL D PRESSURE BISTABLE FAILS (CH A T&M) 2001/03/02 Page 92



CE2-40-MT3 - FAILURE OF MANUAL SWITCH 3

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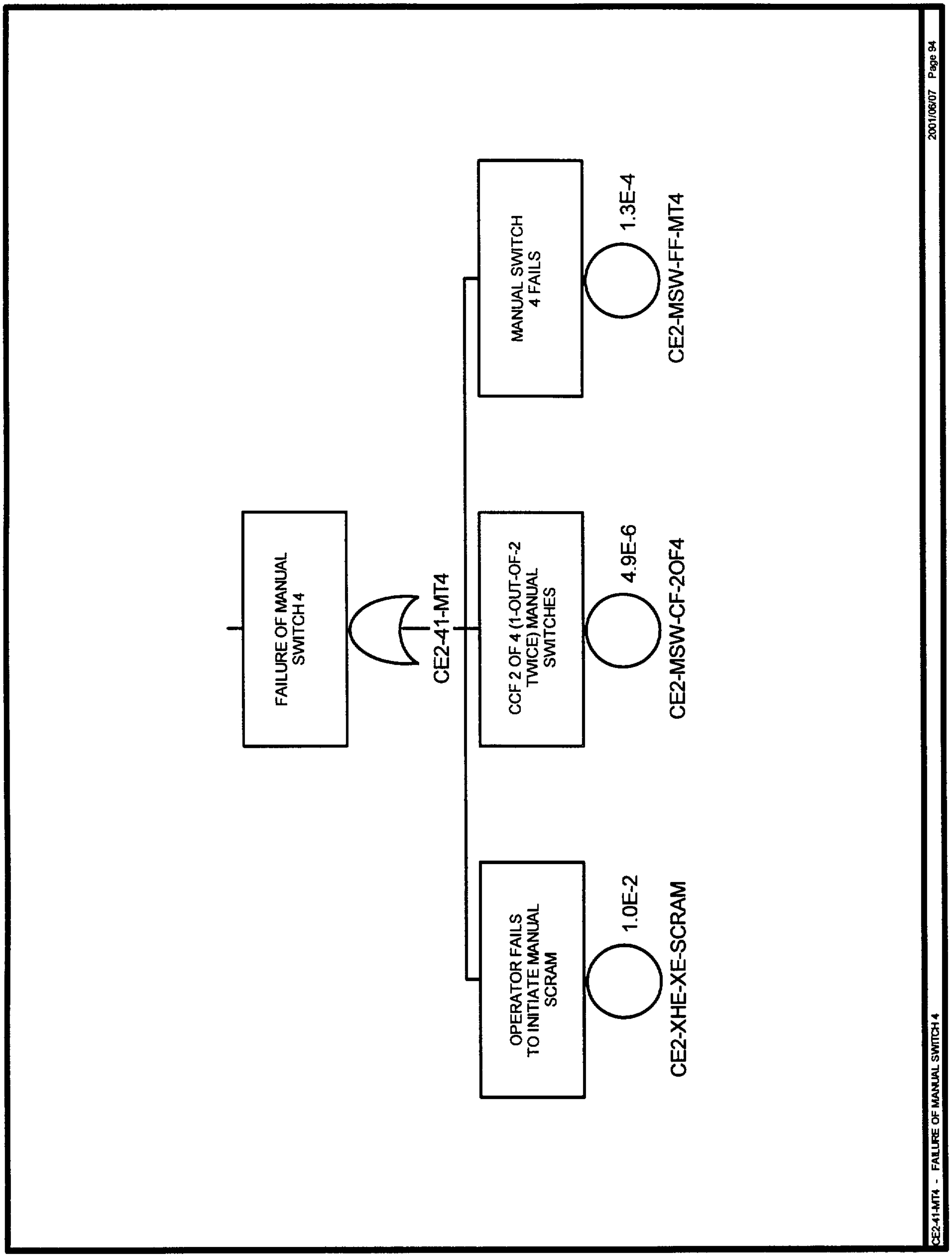
FAILURE OF MANUAL SWITCH 4
CE2-41-MT4
OPERATOR FAILS TO INITIATE MANUAL SCRAM
1.0E-2
CE2-XHE-XE-SCRAM
CCF 2 OF 4 (1-OUT-OF-2 TWICE) MANUAL SWITCHES
4.9E-6
CE2-MSW-CF-2OF4
MANUAL SWITCH 4 FAILS
1.3E-4
CE2-MSW-FF-MT4
CE2-41-MT4 - FAILURE OF MANUAL SWITCH 4
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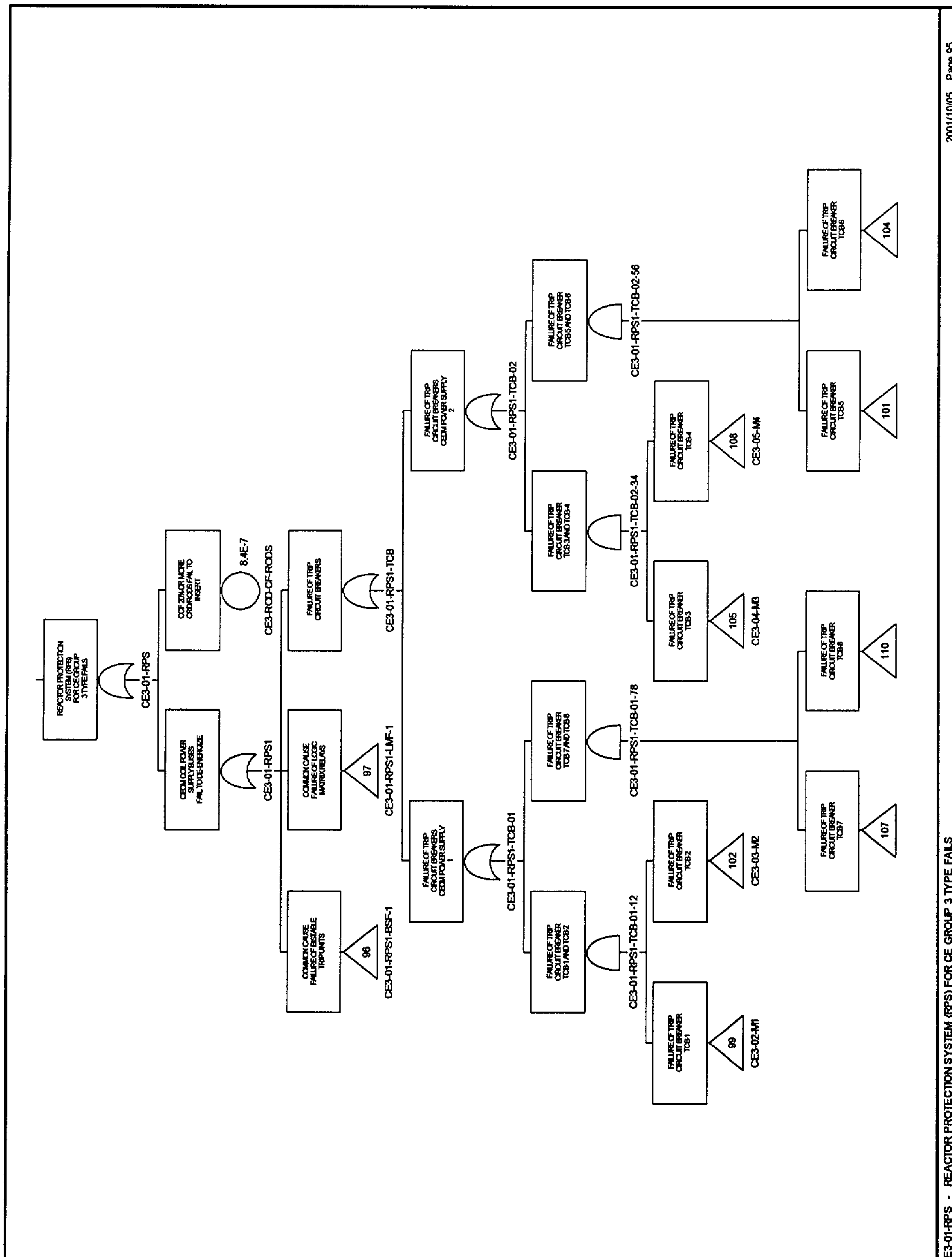
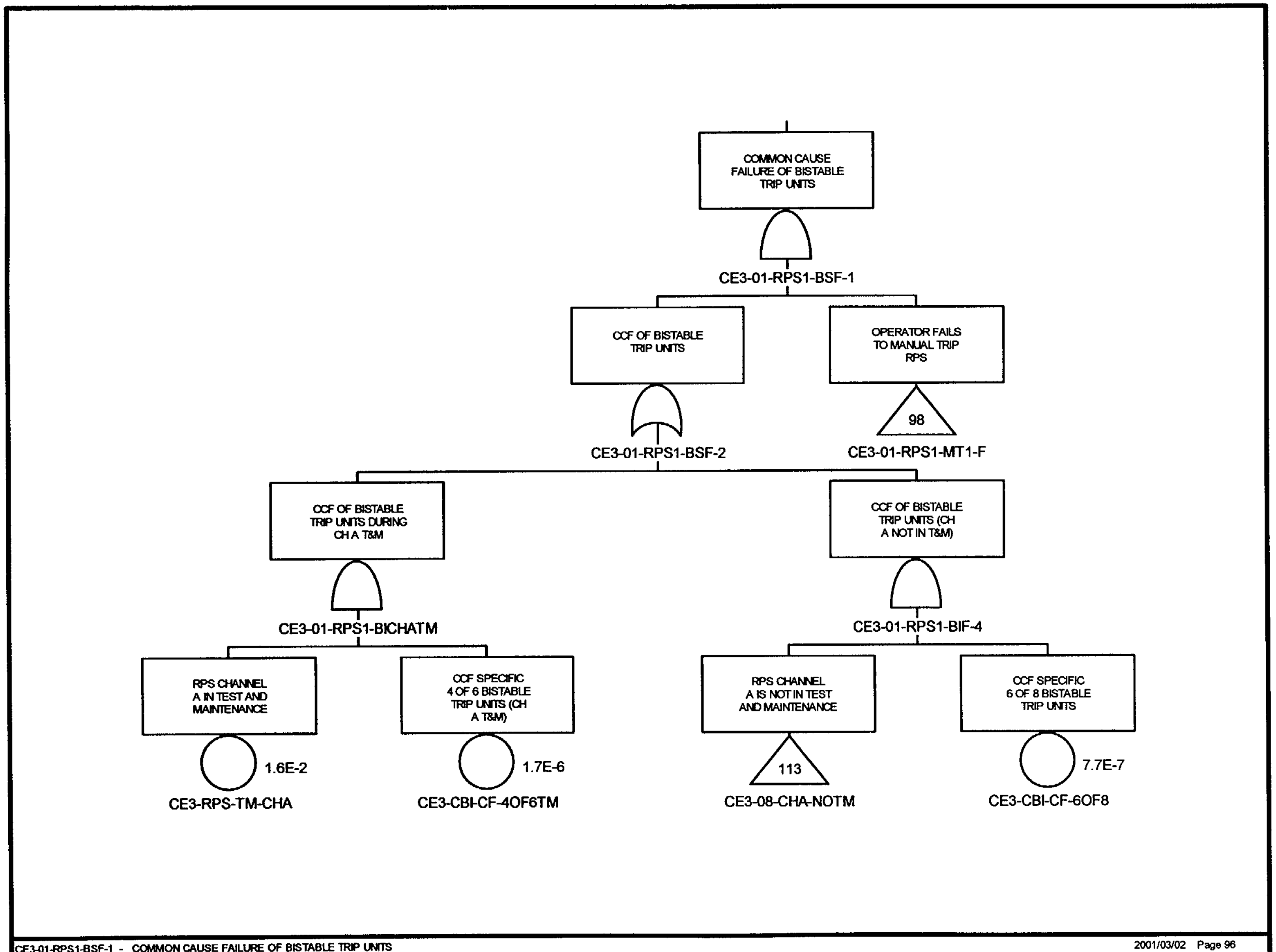
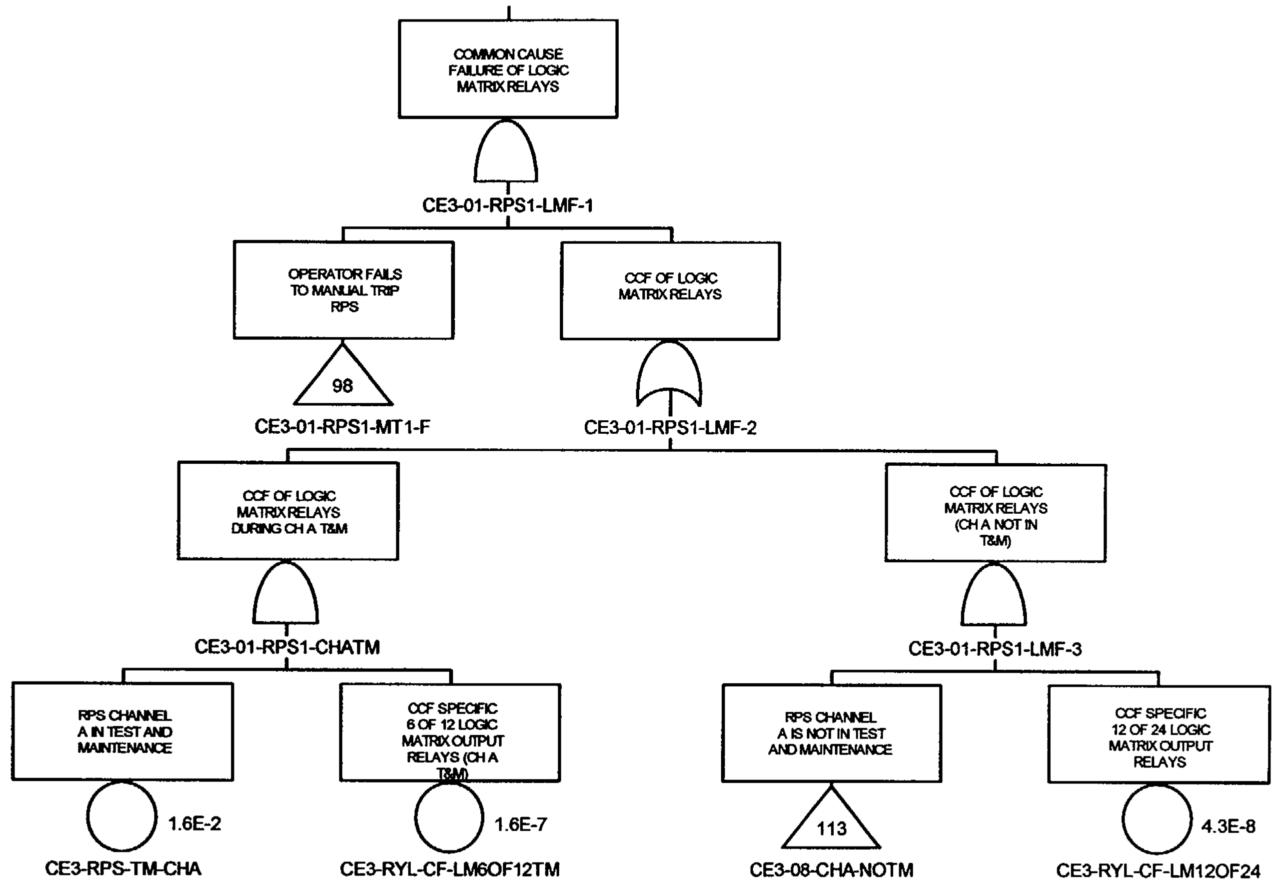
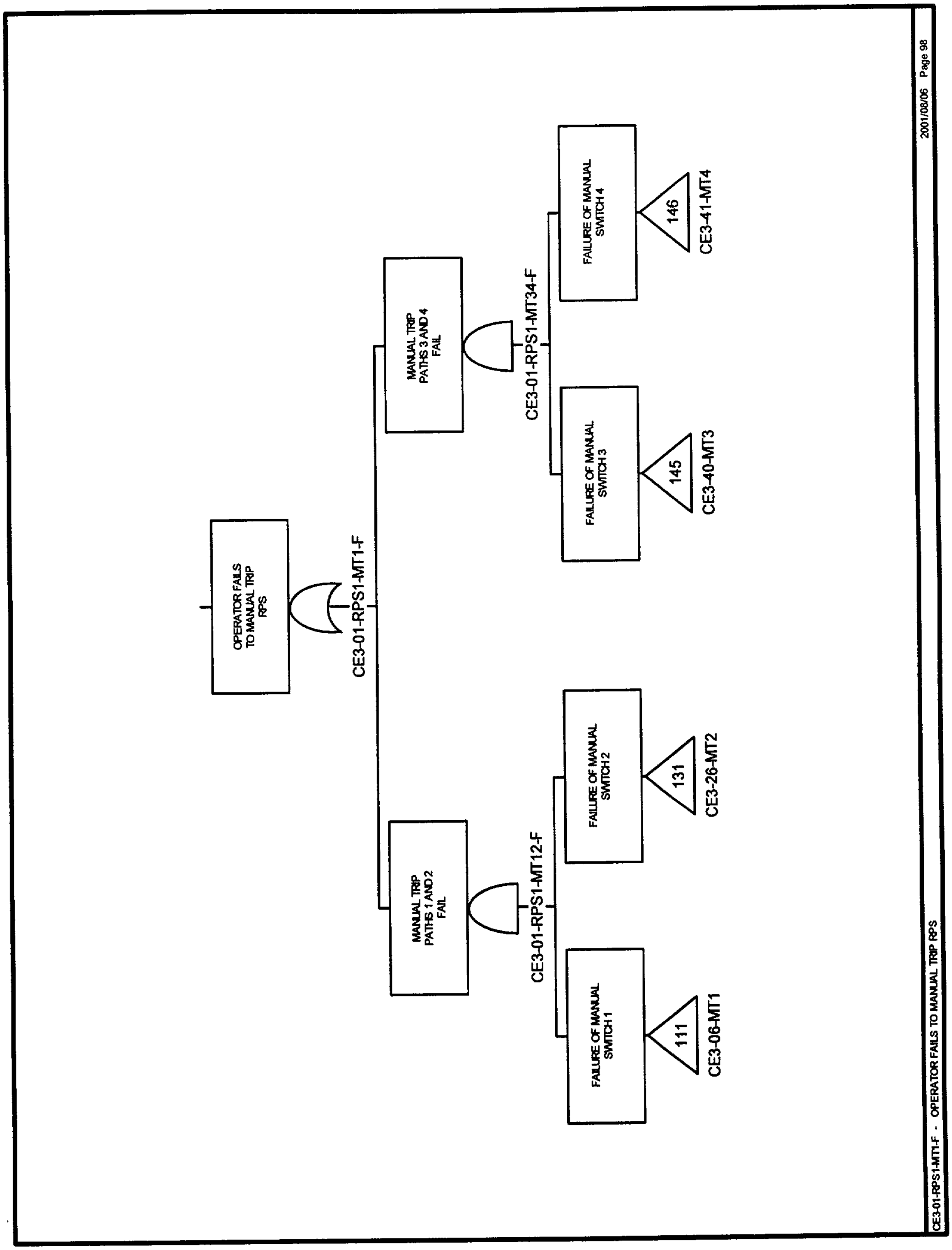
COMBUSTION ENGINEERING RPS GROUP 3 MODEL


REACTOR PROTECTION SYSTEM (RPS) FOR CE GROUP 3 TYPE FAILS
CE3-01-RPS
CEDM COIL POWER SUPPLY BUSES FAIL TO DE-ENERGIZE
CE3-01-RPS1
CCF 20% OR MORE CRD RODS FAIL TO INSERT
8.4E-7
CE3-ROD-CF-RODS
COMMON CAUSE FAILURE OF BISTABLE TRIP UNITS
96
CE3-01-RPS1-BSF-1
COMMON CAUSE FAILURE OF LOGIC MATRIX RELAYS
97
CE3-01-RPS1-LMF-1
FAILURE OF TRIP CIRCUIT BREAKERS
CE3-01-RPS1-TCB
FAILURE OF TRIP CIRCUIT BREAKERS CEDM POWER SUPPLY 1
CE3-01-RPS1-TCB-01
FAILURE OF TRIP CIRCUIT BREAKERS CEDM POWER SUPPLY 2
CE3-01-RPS1-TCB-02
FAILURE OF TRIP CIRCUIT BREAKER TCB1 AND TCB2
CE3-01-RPS1-TCB-01-12
FAILURE OF TRIP CIRCUIT BREAKER TCB7 AND TCB8
CE3-01-RPS1-TCB-01-78
FAILURE OF TRIP CIRCUIT BREAKER TCB3 AND TCB4
CE3-01-RPS1-TCB-02-34
FAILURE OF TRIP CIRCUIT BREAKER TCB5 AND TCB6
CE3-01-RPS1-TCB-02-56
FAILURE OF TRIP CIRCUIT BREAKER TCB1
99
CE3-02-M1
FAILURE OF TRIP CIRCUIT BREAKER TCB2
102
CE3-03-M2
FAILURE OF TRIP CIRCUIT BREAKER TCB3
105
CE3-04-M3
FAILURE OF TRIP CIRCUIT BREAKER TCB4
108
CE3-05-M4
FAILURE OF TRIP CIRCUIT BREAKER TCB7
107
FAILURE OF TRIP CIRCUIT BREAKER TCB8
110
FAILURE OF TRIP CIRCUIT BREAKER TCB5
101
FAILURE OF TRIP CIRCUIT BREAKER TCB6
104
CE3-01-RPS - REACTOR PROTECTION SYSTEM (RPS) FOR CE GROUP 3 TYPE FAILS
2001/10/05 Page 95


COMMON CAUSE FAILURE OF BISTABLE TRIP UNITS
CE3-01-RPS1-BSF-1
CCF OF BISTABLE TRIP UNITS
CE3-01-RPS1-BSF-2
OPERATOR FAILS TO MANUAL TRIP RPS
98
CE3-01-RPS1-MT1-F
CCF OF BISTABLE TRIP UNITS DURING CH A T&M
CE3-01-RPS1-BICHATM
CCF OF BISTABLE TRIP UNITS (CH A NOT IN T&M)
CE3-01-RPS1-BIF-4
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE3-RPS-TM-CHA
CCF SPECIFIC 4 OF 6 BISTABLE TRIP UNITS (CH A T&M)
1.7E-6
CE3-CBI-CF-4OF6TM
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
113
CE3-08-CHA-NOTM
CCF SPECIFIC 6 OF 8 BISTABLE TRIP UNITS
7.7E-7
CE3-CBI-CF-6OF8
CE3-01-RPS1-BSF-1 - COMMON CAUSE FAILURE OF BISTABLE TRIP UNITS
2001/03/02 Page 96



CE3-01-RPS1-LMF-1 - COMMON CAUSE FAILURE OF LOGIC MATRIX RELAYS 2001/03/02 Page 97


OPERATOR FAILS TO MANUAL TRIP RPS
CE3-01-RPS1-MT1-F
MANUAL TRIP PATHS 1 AND 2 FAIL
CE3-01-RPS1-MT12-F
MANUAL TRIP PATHS 3 AND 4 FAIL
CE3-01-RPS1-MT34-F
FAILURE OF MANUAL SWITCH 1
111
CE3-06-MT1
FAILURE OF MANUAL SWITCH 2
131
CE3-26-MT2
FAILURE OF MANUAL SWITCH 3
145
CE3-40-MT3
FAILURE OF MANUAL SWITCH 4
146
CE3-41-MT4
CE3-01-RPS1-MT1-F - OPERATOR FAILS TO MANUAL TRIP RPS
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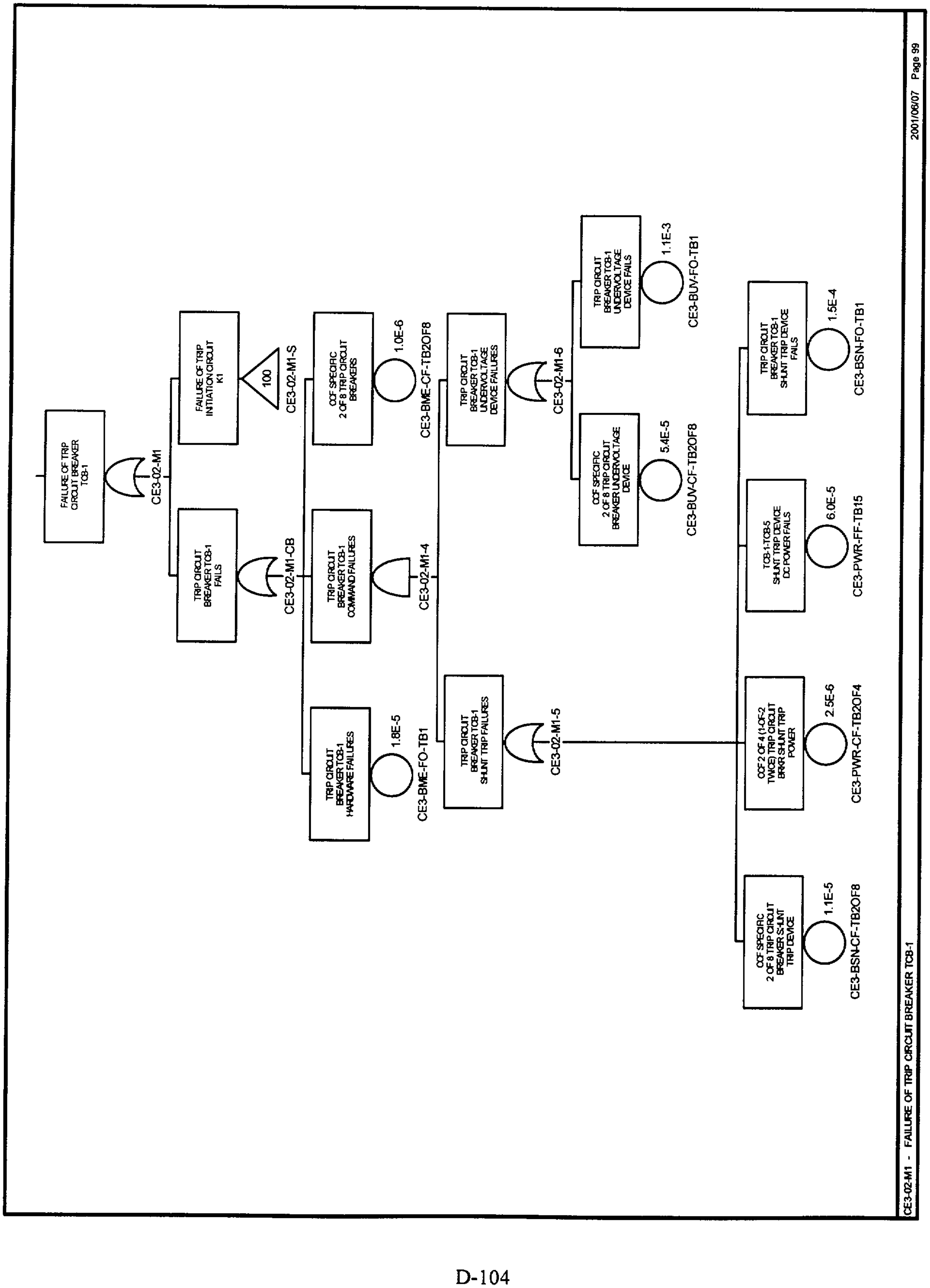
FAILURE OF TRIP CIRCUIT BREAKER TCB-1
CE3-02-M1
TRIP CIRCUIT BREAKER TCB-1 FAILS
CE3-02-M1-CB
FAILURE OF TRIP INITIATION CIRCUIT K1
100
CE3-02-M1-S
TRIP CIRCUIT BREAKER TCB-1 HARDWARE FAILURES
1.8E-5
CE3-BME-FO-TB1
TRIP CIRCUIT BREAKER TCB-1 COMMAND FAILURES
CE3-02-M1-4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE3-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-1 SHUNT TRIP FAILURES
CE3-02-M1-5
TRIP CIRCUIT BREAKER TCB-1 UNDERVOLTAGE DEVICE FAILURES
CE3-02-M1-6
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE3-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-1 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE3-BUV-FO-TB1
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE3-BSN-CF-TB2OF8
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE3-PWR-CF-TB2OF4
TCB-1-TCB-5 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE3-PWR-FF-TB15
TRIP CIRCUIT BREAKER TCB-1 SHUNT TRIP DEVICE FAILS
1.5E-4
CE3-BSN-FO-TB1
CE3-02-M1 - FAILURE OF TRIP CIRCUIT BREAKER TCB-1
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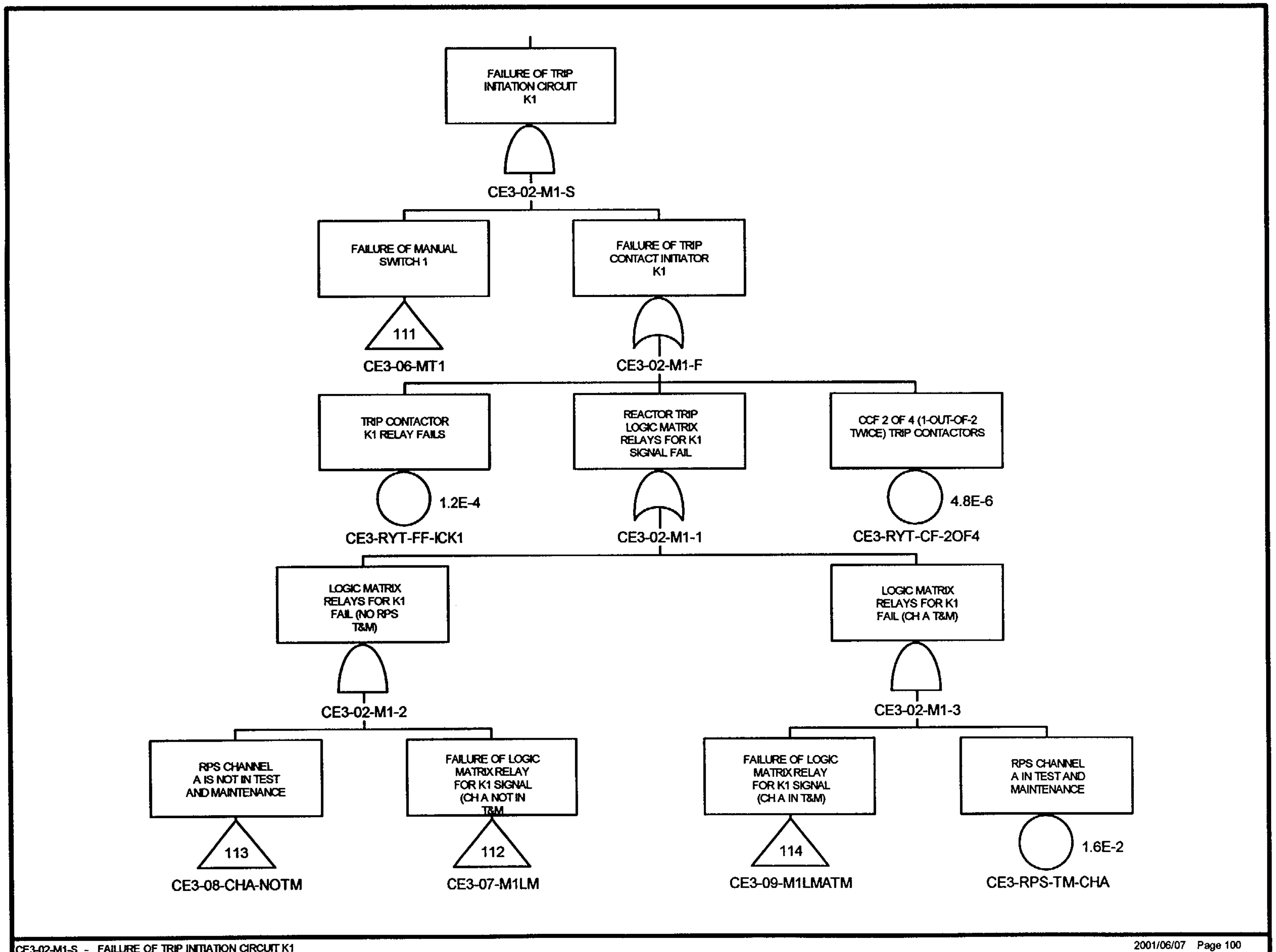
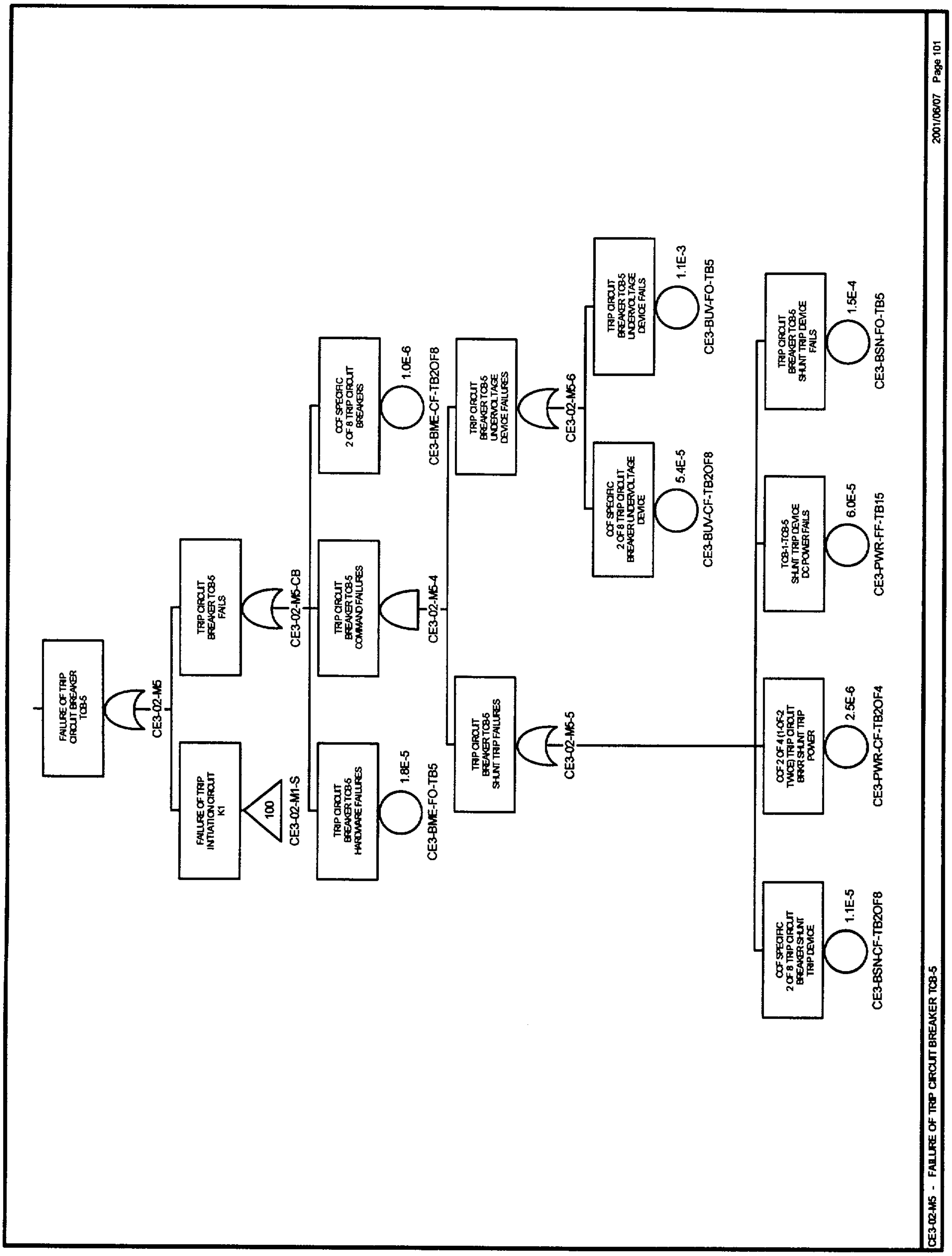


FAILURE OF TRIP INITIATION CIRCUIT K1
CE3-02-M1-S
FAILURE OF MANUAL SWITCH 1
111
CE3-06-MT1
FAILURE OF TRIP CONTACT INITIATOR K1
CE3-02-M1-F
TRIP CONTACTOR K1 RELAY FAILS
1.2E-4
CE3-RYT-FF-ICK1
REACTOR TRIP LOGIC MATRIX RELAYS FOR K1 SIGNAL FAIL
CE3-02-M1-1
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CONTACTORS
4.8E-6
CE3-RYT-CF-2OF4
LOGIC MATRIX RELAYS FOR K1 FAIL (NO RPS T&M)
CE3-02-M1-2
LOGIC MATRIX RELAYS FOR K1 FAIL (CH A T&M)
CE3-02-M1-3
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
113
CE3-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A NOT IN T&M)
112
CE3-07-M1LM
FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A IN T&M)
114
CE3-09-M1LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE3-RPS-TM-CHA
CE3-02-M1-S - FAILURE OF TRIP INITIATION CIRCUIT K1
2001/06/07 Page 100


FAILURE OF TRIP CIRCUIT BREAKER TCB-5
CE3-02-M5
FAILURE OF TRIP INITIATION CIRCUIT K1
100
CE3-02-M1-S
TRIP CIRCUIT BREAKER TCB-5 FAILS
CE3-02-M5-CB
TRIP CIRCUIT BREAKER TCB-5 HARDWARE FAILURES
1.8E-5
CE3-BME-FO-TB5
TRIP CIRCUIT BREAKER TCB-5 COMMAND FAILURES
CE3-02-M5-4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE3-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-5 SHUNT TRIP FAILURES
CE3-02-M5-5
TRIP CIRCUIT BREAKER TCB-5 UNDERVOLTAGE DEVICE FAILURES
CE3-02-M5-6
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE3-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-5 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE3-BUV-FO-TB5
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE3-BSN-CF-TB2OF8
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE3-PWR-CF-TB2OF4
TCB-1-TCB-5 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE3-PWR-FF-TB15
TRIP CIRCUIT BREAKER TCB-5 SHUNT TRIP DEVICE FAILS
1.5E-4
CE3-BSN-FO-TB5
CE3-02-M5 - FAILURE OF TRIP CIRCUIT BREAKER TCB-5
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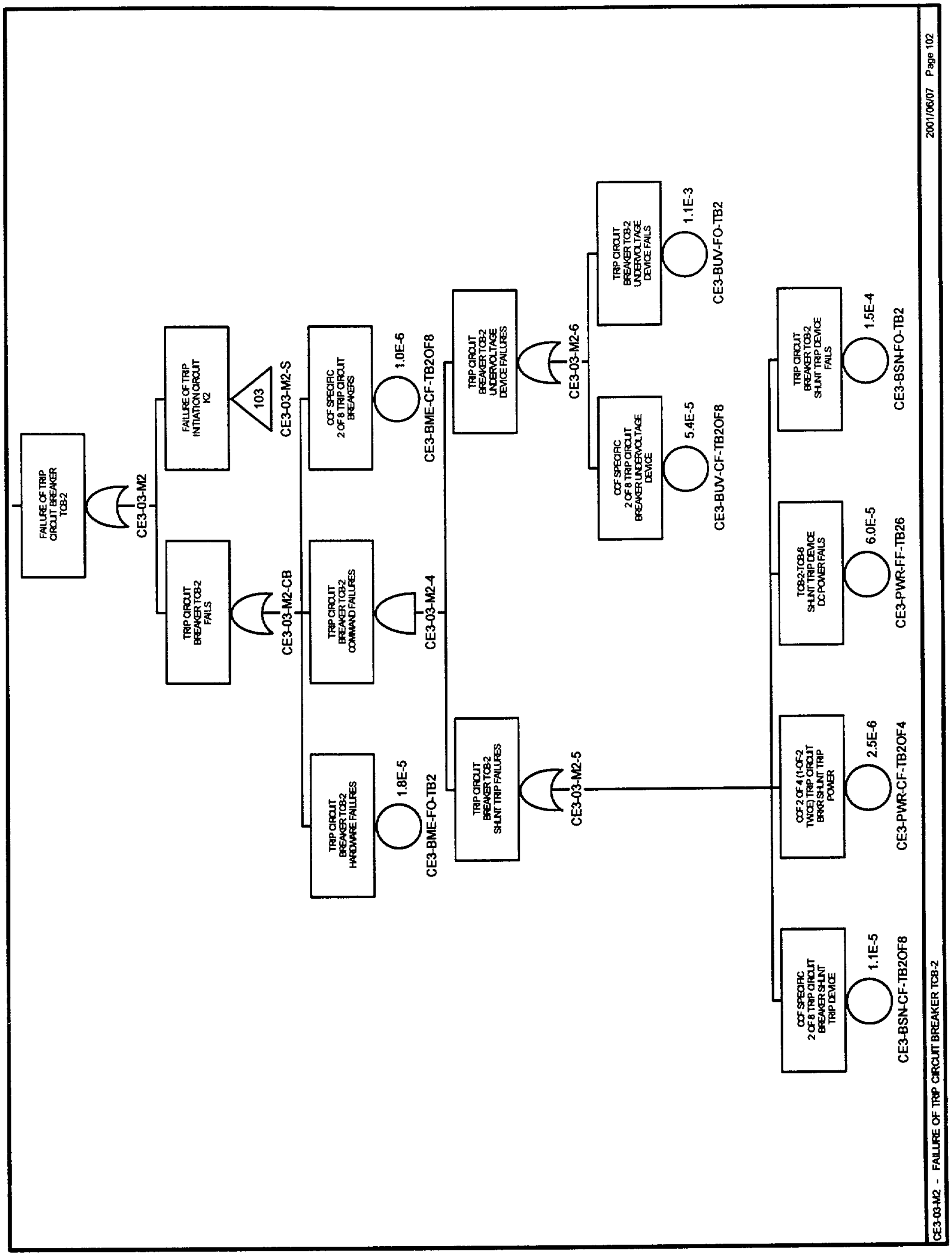
FAILURE OF TRIP CIRCUIT BREAKER TCB-2
CE3-03-M2
FAILURE OF TRIP INITIATION CIRCUIT K2
103
CE3-03-M2-S
TRIP CIRCUIT BREAKER TCB-2 FAILS
CE3-03-M2-CB
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE3-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-2 COMMAND FAILURES
CE3-03-M2-4
TRIP CIRCUIT BREAKER TCB-2 HARDWARE FAILURES
1.8E-5
CE3-BME-FO-TB2
TRIP CIRCUIT BREAKER TCB-2 UNDERVOLTAGE DEVICE FAILURES
CE3-03-M2-6
TRIP CIRCUIT BREAKER TCB-2 SHUNT TRIP FAILURES
CE3-03-M2-5
TRIP CIRCUIT BREAKER TCB-2 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE3-BUV-FO-TB2
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE3-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-2 SHUNT TRIP DEVICE FAILS
1.5E-4
CE3-BSN-FO-TB2
TCB-2-TCB-6 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE3-PWR-FF-TB26
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE3-PWR-CF-TB2OF4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE3-BSN-CF-TB2OF8
CE3-03-M2 - FAILURE OF TRIP CIRCUIT BREAKER TCB-2
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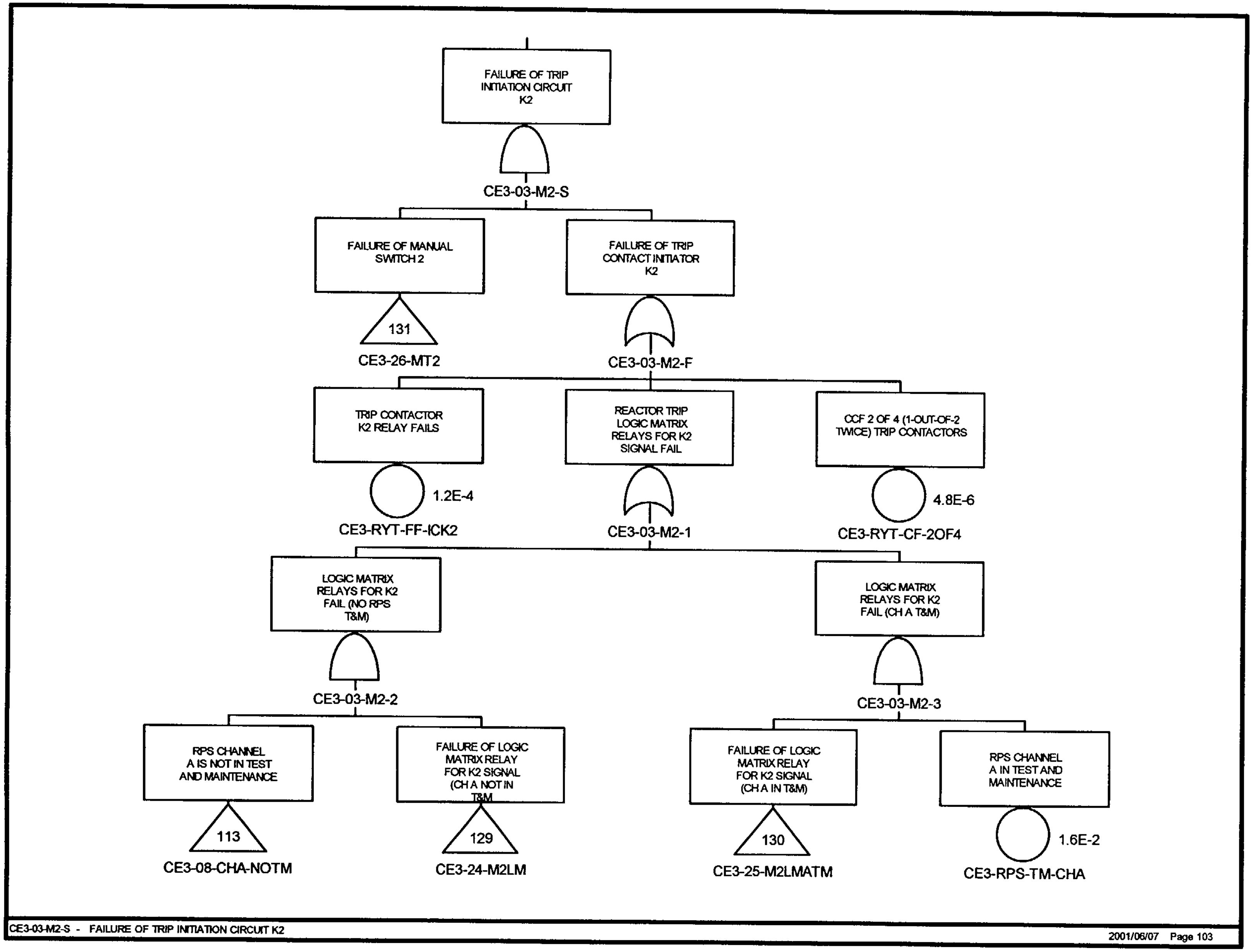
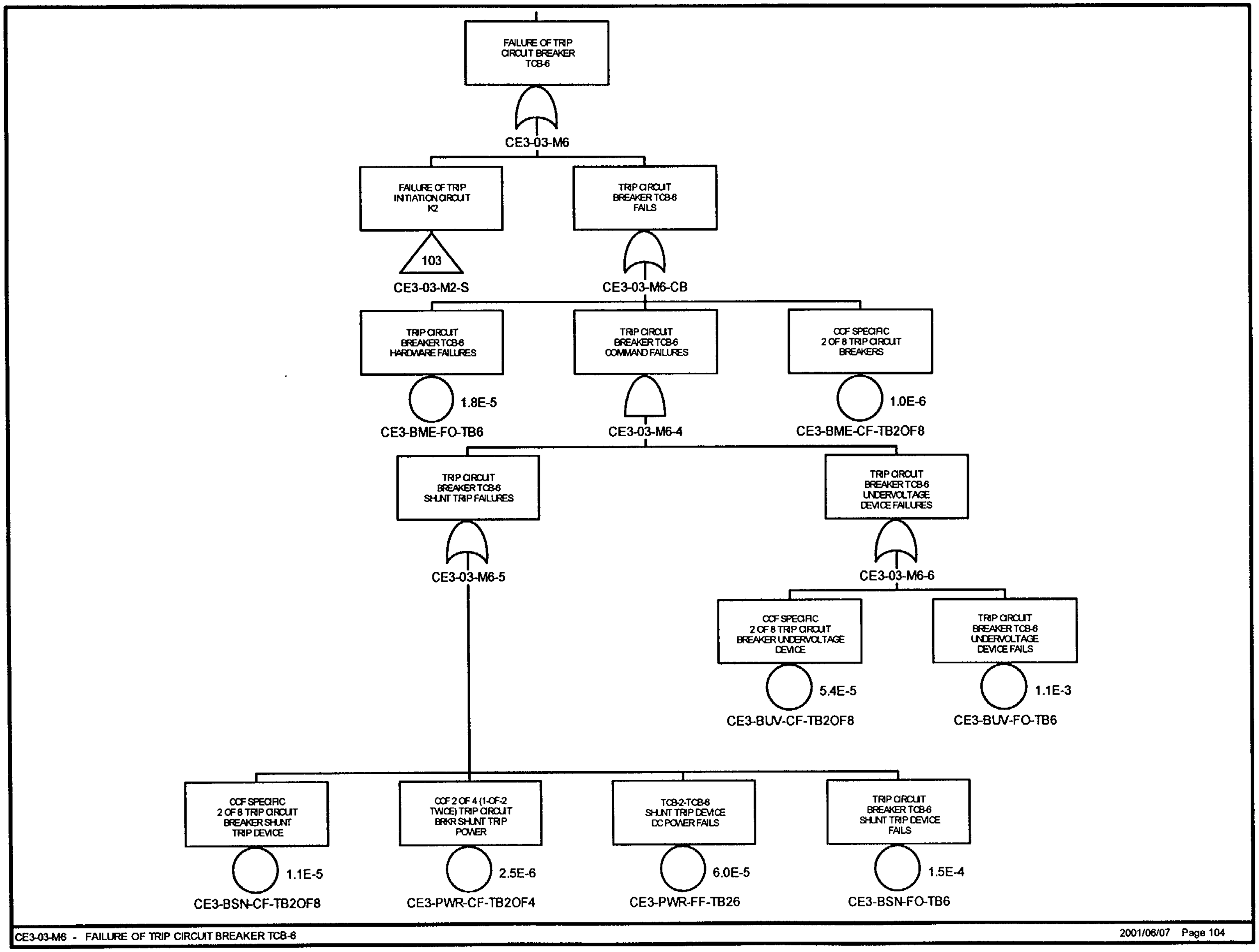

FAILURE OF TRIP INITIATION CIRCUIT K2
CE3-03-M2-S
FAILURE OF MANUAL SWITCH 2
131
CE3-26-MT2
FAILURE OF TRIP CONTACT INITIATOR K2
CE3-03-M2-F
TRIP CONTACTOR K2 RELAY FAILS
1.2E-4
CE3-RYT-FF-ICK2
REACTOR TRIP LOGIC MATRIX RELAYS FOR K2 SIGNAL FAIL
CE3-03-M2-1
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CONTACTORS
4.8E-6
CE3-RYT-CF-2OF4
LOGIC MATRIX RELAYS FOR K2 FAIL (NO RPS T&M)
CE3-03-M2-2
LOGIC MATRIX RELAYS FOR K2 FAIL (CH A T&M)
CE3-03-M2-3
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
113
CE3-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR K2 SIGNAL (CH A NOT IN T&M)
129
CE3-24-M2LM
FAILURE OF LOGIC MATRIX RELAY FOR K2 SIGNAL (CH A IN T&M)
130
CE3-25-M2LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE3-RPS-TM-CHA
CE3-03-M2-S - FAILURE OF TRIP INITIATION CIRCUIT K2
2001/06/07 Page 103


FAILURE OF TRIP CIRCUIT BREAKER TCB-6
CE3-03-M6
FAILURE OF TRIP INITIATION CIRCUIT K2
103
CE3-03-M2-S
TRIP CIRCUIT BREAKER TCB-6 FAILS
CE3-03-M6-CB
TRIP CIRCUIT BREAKER TCB-6 HARDWARE FAILURES
1.8E-5
CE3-BME-FO-TB6
TRIP CIRCUIT BREAKER TCB-6 COMMAND FAILURES
CE3-03-M6-4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE3-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-6 SHUNT TRIP FAILURES
CE3-03-M6-5
TRIP CIRCUIT BREAKER TCB-6 UNDERVOLTAGE DEVICE FAILURES
CE3-03-M6-6
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE3-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-6 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE3-BUV-FO-TB6
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE3-BSN-CF-TB2OF8
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE3-PWR-CF-TB2OF4
TCB-2-TCB-6 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE3-PWR-FF-TB26
TRIP CIRCUIT BREAKER TCB-6 SHUNT TRIP DEVICE FAILS
1.5E-4
CE3-BSN-FO-TB6
CE3-03-M6 - FAILURE OF TRIP CIRCUIT BREAKER TCB-6
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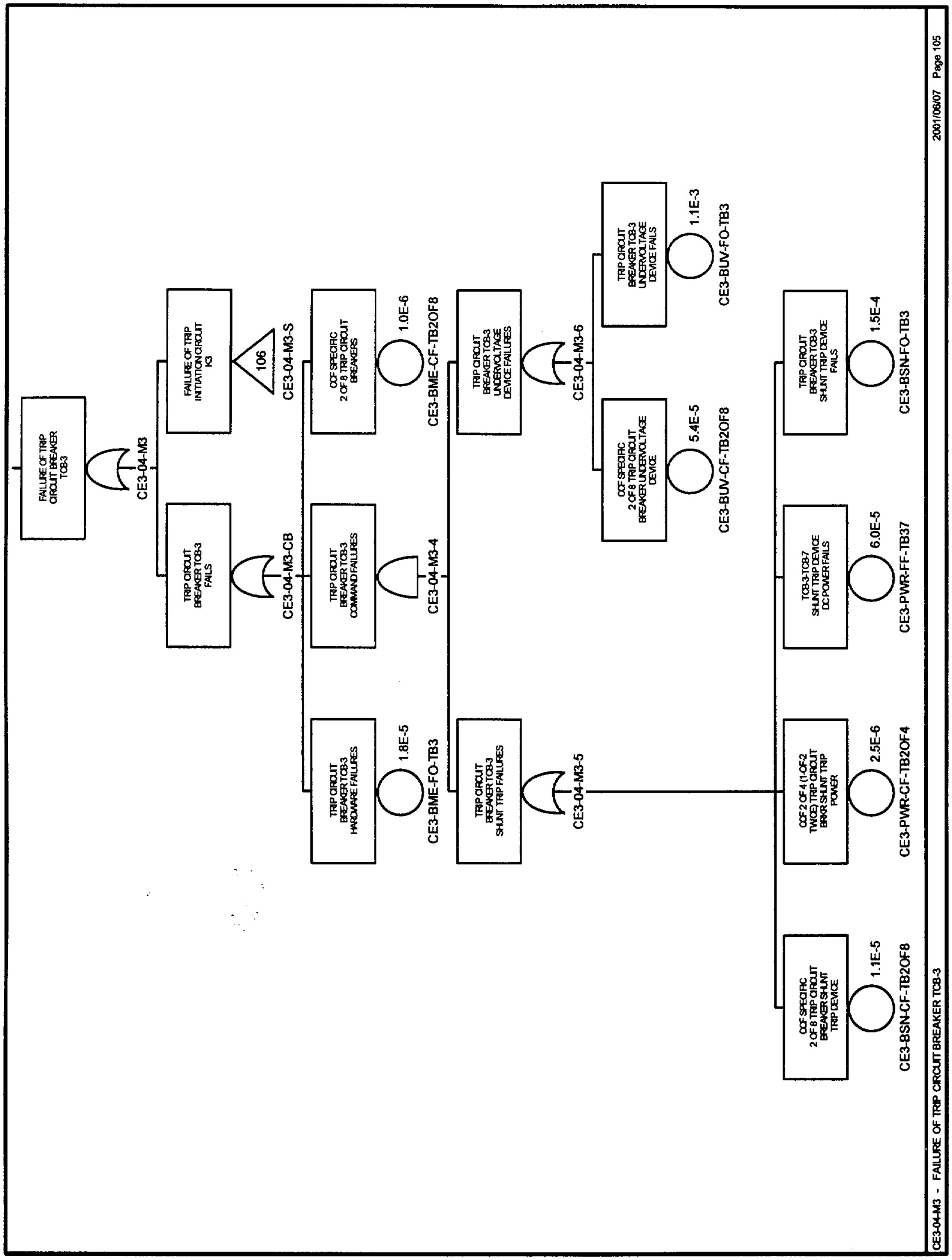

FAILURE OF TRIP CIRCUIT BREAKER TCB-3
CE3-04-M3
TRIP CIRCUIT BREAKER TCB-3 FAILS
CE3-04-M3-CB
FAILURE OF TRIP INITIATION CIRCUIT K3
106
CE3-04-M3-S
TRIP CIRCUIT BREAKER TCB-3 HARDWARE FAILURES
1.8E-5
CE3-BME-FO-TB3
TRIP CIRCUIT BREAKER TCB-3 COMMAND FAILURES
CE3-04-M3-4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE3-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-3 SHUNT TRIP FAILURES
CE3-04-M3-5
TRIP CIRCUIT BREAKER TCB-3 UNDERVOLTAGE DEVICE FAILURES
CE3-04-M3-6
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE3-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-3 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE3-BUV-FO-TB3
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE3-BSN-CF-TB2OF8
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE3-PWR-CF-TB2OF4
TCB-3-TCB-7 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE3-PWR-FF-TB37
TRIP CIRCUIT BREAKER TCB-3 SHUNT TRIP DEVICE FAILS
1.5E-4
CE3-BSN-FO-TB3
CE3-04-M3 - FAILURE OF TRIP CIRCUIT BREAKER TCB-3
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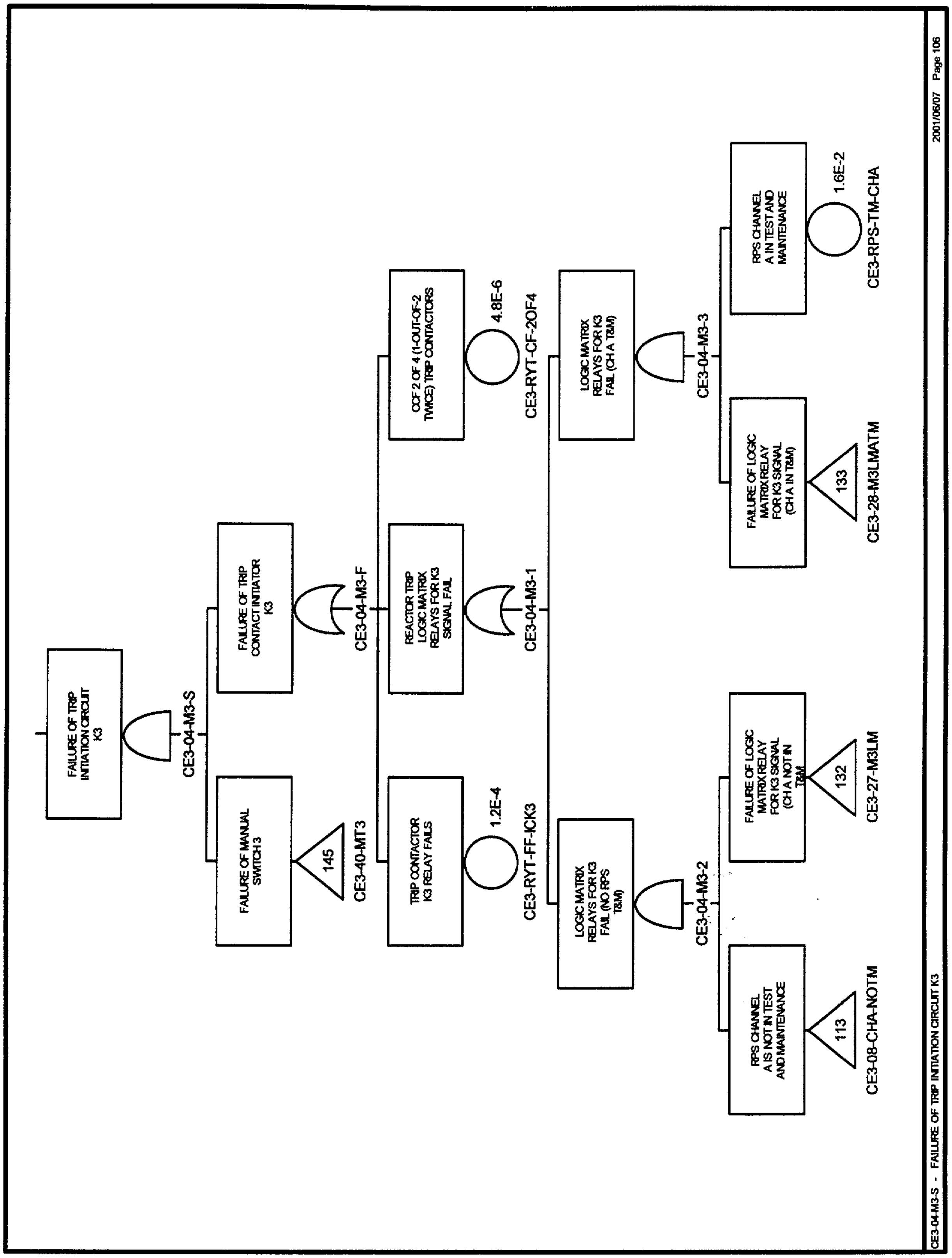
FAILURE OF TRIP INITIATION CIRCUIT K3
CE3-04-M3-S
FAILURE OF MANUAL SWITCH 3
145
CE3-40-MT3
FAILURE OF TRIP CONTACT INITIATOR K3
CE3-04-M3-F
TRIP CONTACTOR K3 RELAY FAILS
1.2E-4
CE3-RYT-FF-ICK3
REACTOR TRIP LOGIC MATRIX RELAYS FOR K3 SIGNAL FAIL
CE3-04-M3-1
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CONTACTORS
4.8E-6
CE3-RYT-CF-2OF4
LOGIC MATRIX RELAYS FOR K3 FAIL (NO RPS T&M)
CE3-04-M3-2
LOGIC MATRIX RELAYS FOR K3 FAIL (CH A T&M)
CE3-04-M3-3
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
113
CE3-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR K3 SIGNAL (CH A NOT IN T&M)
132
CE3-27-M3LM
FAILURE OF LOGIC MATRIX RELAY FOR K3 SIGNAL (CH A IN T&M)
133
CE3-28-M3LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE3-RPS-TM-CHA
CE3-04-M3-S - FAILURE OF TRIP INITIATION CIRCUIT K3
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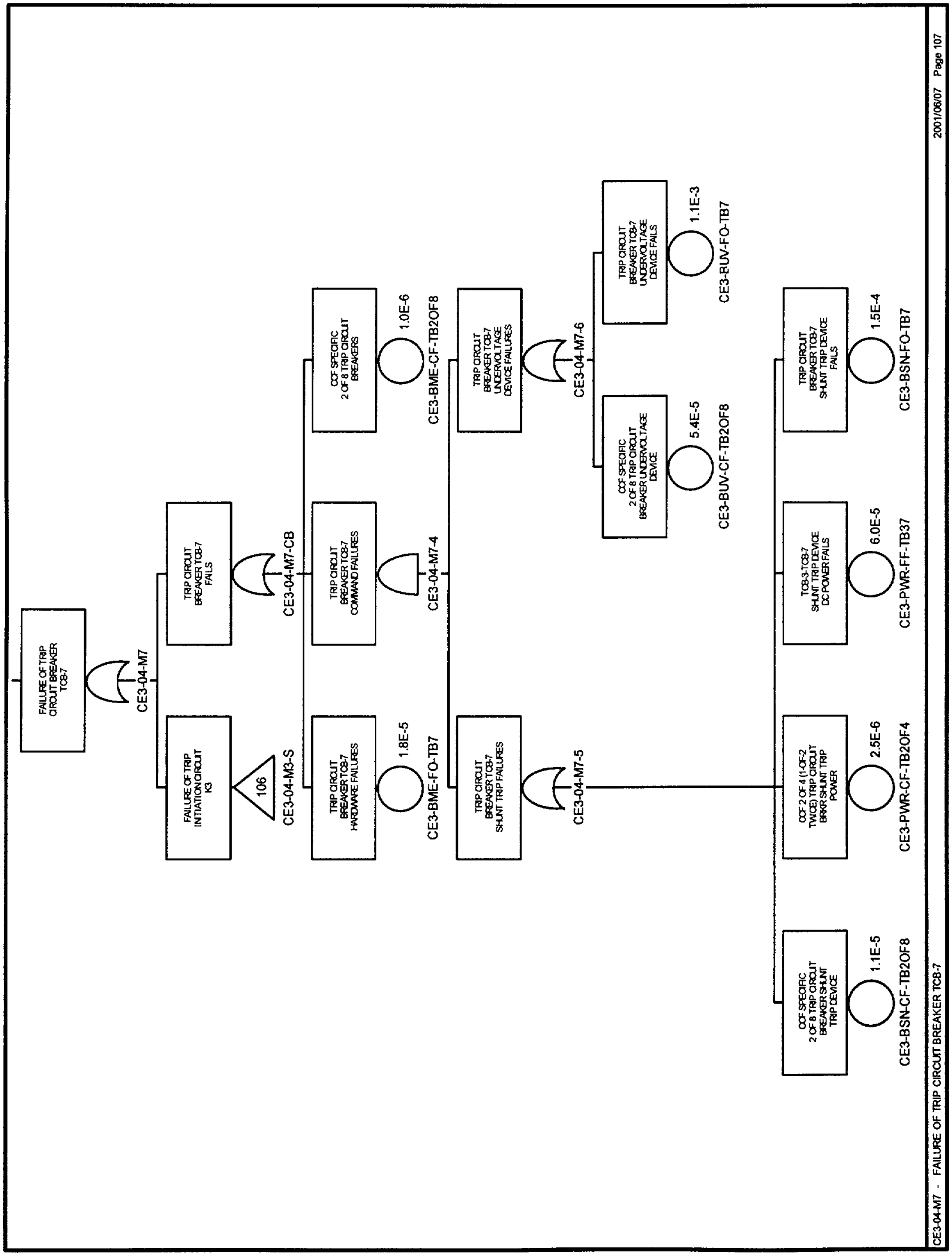
FAILURE OF TRIP CIRCUIT BREAKER TCB-7
CE3-04-M7
FAILURE OF TRIP INITIATION CIRCUIT K3
106
CE3-04-M3-S
TRIP CIRCUIT BREAKER TCB-7 FAILS
CE3-04-M7-CB
TRIP CIRCUIT BREAKER TCB-7 HARDWARE FAILURES
1.8E-5
CE3-BME-FO-TB7
TRIP CIRCUIT BREAKER TCB-7 COMMAND FAILURES
CE3-04-M7-4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE3-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-7 SHUNT TRIP FAILURES
CE3-04-M7-5
TRIP CIRCUIT BREAKER TCB-7 UNDERVOLTAGE DEVICE FAILURES
CE3-04-M7-6
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE3-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-7 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE3-BUV-FO-TB7
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE3-BSN-CF-TB2OF8
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE3-PWR-CF-TB2OF4
TCB-3-TCB-7 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE3-PWR-FF-TB37
TRIP CIRCUIT BREAKER TCB-7 SHUNT TRIP DEVICE FAILS
1.5E-4
CE3-BSN-FO-TB7
CE3-04-M7 - FAILURE OF TRIP CIRCUIT BREAKER TCB-7
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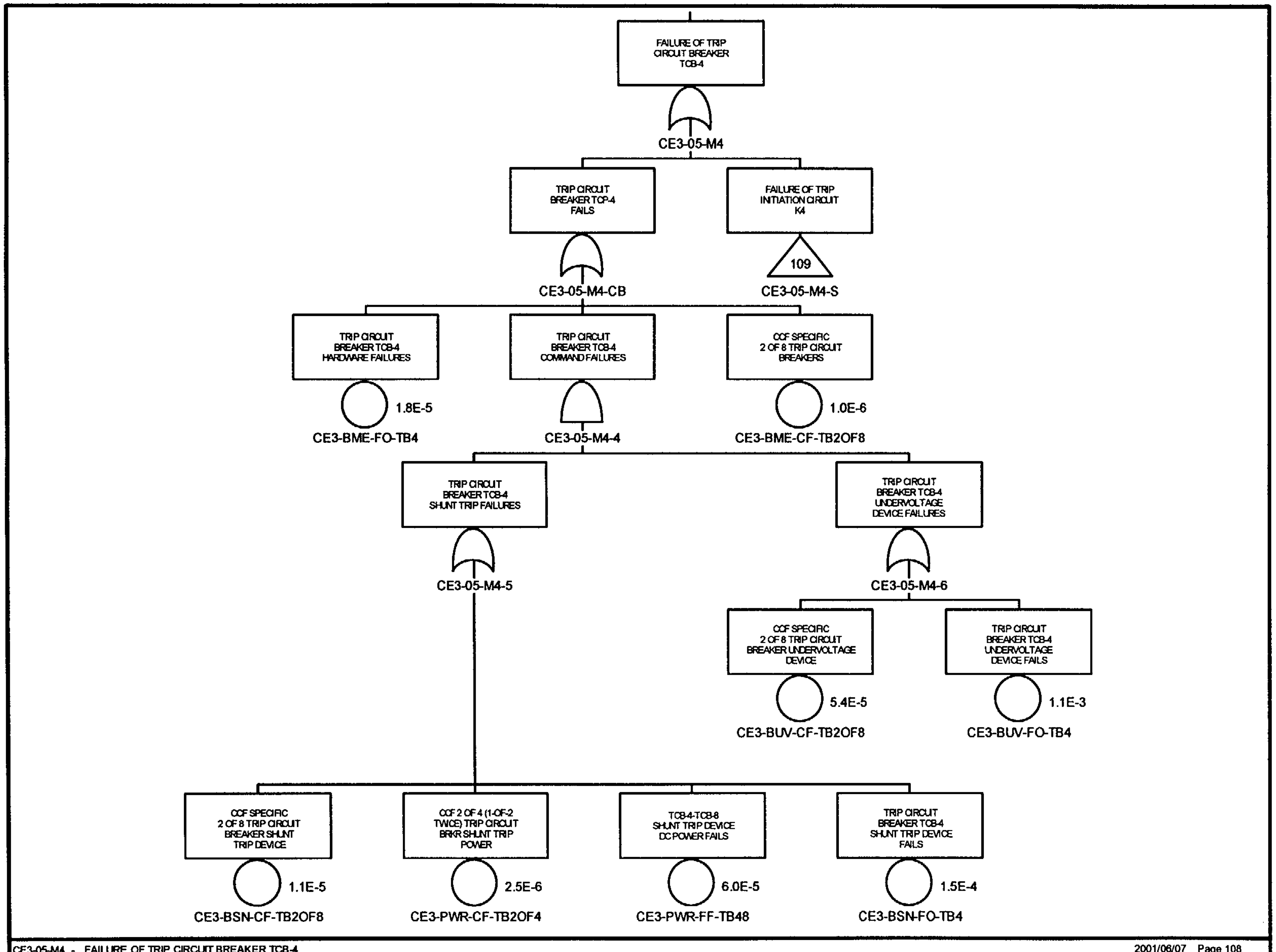

FAILURE OF TRIP CIRCUIT BREAKER TCB-4
CE3-05-M4
TRIP CIRCUIT BREAKER TCP-4 FAILS
FAILURE OF TRIP INITIATION CIRCUIT K4
109
CE3-05-M4-CB
CE3-05-M4-S
TRIP CIRCUIT BREAKER TCB-4 HARDWARE FAILURES
TRIP CIRCUIT BREAKER TCB-4 COMMAND FAILURES
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.8E-5
CE3-BME-FO-TB4
CE3-05-M4-4
1.0E-6
CE3-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-4 SHUNT TRIP FAILURES
TRIP CIRCUIT BREAKER TCB-4 UNDERVOLTAGE DEVICE FAILURES
CE3-05-M4-5
CE3-05-M4-6
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
TRIP CIRCUIT BREAKER TCB-4 UNDERVOLTAGE DEVICE FAILS
5.4E-5
CE3-BUV-CF-TB2OF8
1.1E-3
CE3-BUV-FO-TB4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
TCB-4-TCB-8 SHUNT TRIP DEVICE DC POWER FAILS
TRIP CIRCUIT BREAKER TCB-4 SHUNT TRIP DEVICE FAILS
1.1E-5
CE3-BSN-CF-TB2OF8
2.5E-6
CE3-PWR-CF-TB2OF4
6.0E-5
CE3-PWR-FF-TB48
1.5E-4
CE3-BSN-FO-TB4
CE3-05-M4 - FAILURE OF TRIP CIRCUIT BREAKER TCB-4
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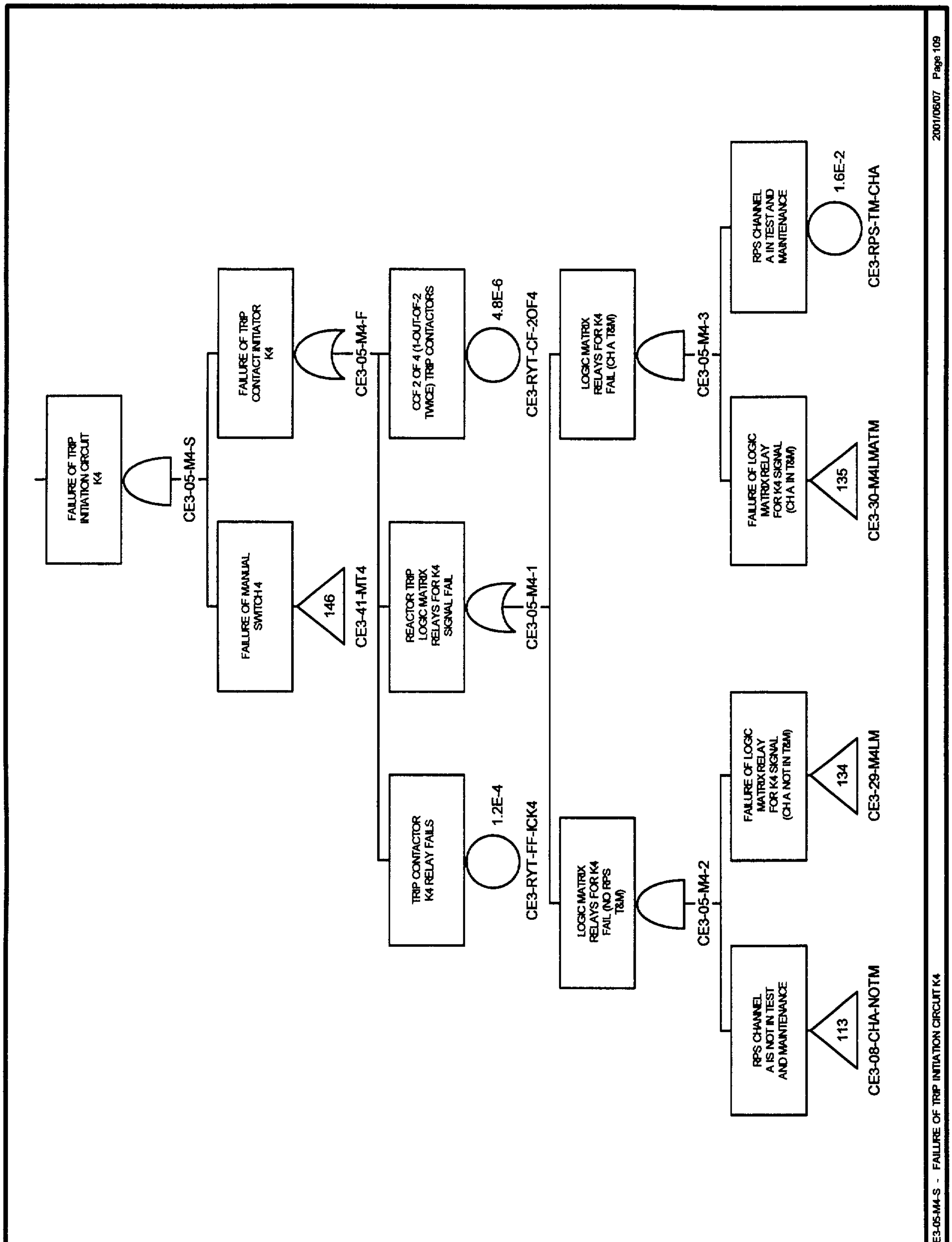
FAILURE OF TRIP INITIATION CIRCUIT K4
CE3-05-M4-S
FAILURE OF MANUAL SWITCH 4
146
CE3-41-MT4
FAILURE OF TRIP CONTACT INITIATOR K4
CE3-05-M4-F
TRIP CONTACTOR K4 RELAY FAILS
1.2E-4
CE3-RYT-FF-ICK4
REACTOR TRIP LOGIC MATRIX RELAYS FOR K4 SIGNAL FAIL
CE3-05-M4-1
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CONTACTORS
4.8E-6
CE3-RYT-CF-2OF4
LOGIC MATRIX RELAYS FOR K4 FAIL (NO RPS T&M)
CE3-05-M4-2
LOGIC MATRIX RELAYS FOR K4 FAIL (CH A T&M)
CE3-05-M4-3
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
113
CE3-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR K4 SIGNAL (CH A NOT IN T&M)
134
CE3-29-M4LM
FAILURE OF LOGIC MATRIX RELAY FOR K4 SIGNAL (CH A IN T&M)
135
CE3-30-M4LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE3-RPS-TM-CHA
CE3-05-M4-S - FAILURE OF TRIP INITIATION CIRCUIT K4
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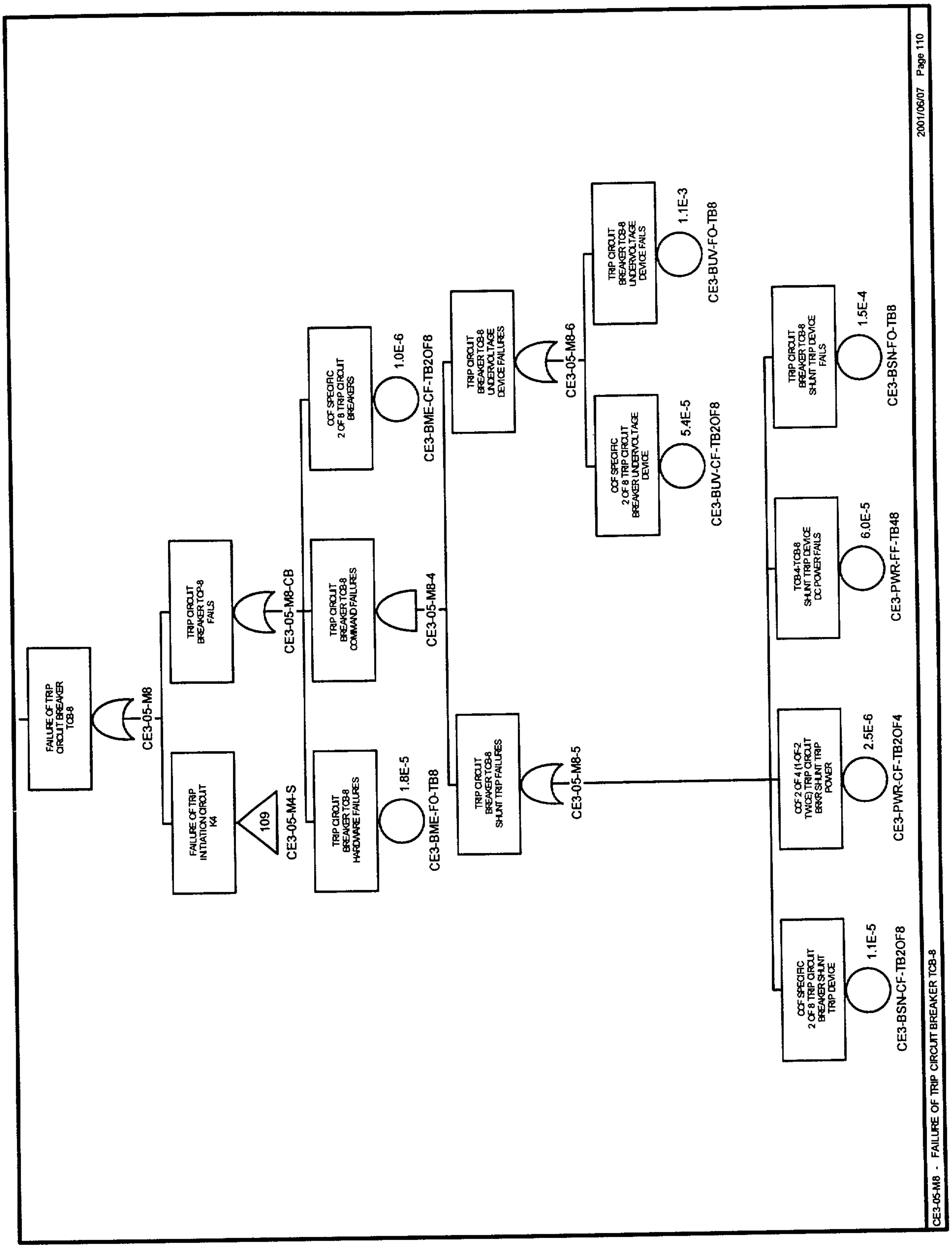
FAILURE OF TRIP CIRCUIT BREAKER TCB-8
CE3-05-M8
FAILURE OF TRIP INITIATION CIRCUIT K4
109
CE3-05-M4-S
TRIP CIRCUIT BREAKER TCB-8 FAILS
CE3-05-M8-CB
TRIP CIRCUIT BREAKER TCB-8 HARDWARE FAILURES
1.8E-5
CE3-BME-FO-TB8
TRIP CIRCUIT BREAKER TCB-8 COMMAND FAILURES
CE3-05-M8-4
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
1.0E-6
CE3-BME-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-8 SHUNT TRIP FAILURES
CE3-05-M8-5
TRIP CIRCUIT BREAKER TCB-8 UNDERVOLTAGE DEVICE FAILURES
CE3-05-M8-6
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
5.4E-5
CE3-BUV-CF-TB2OF8
TRIP CIRCUIT BREAKER TCB-8 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE3-BUV-FO-TB8
CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
1.1E-5
CE3-BSN-CF-TB2OF8
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE3-PWR-CF-TB2OF4
TCB-4,TCB-8 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE3-PWR-FF-TB48
TRIP CIRCUIT BREAKER TCB-8 SHUNT TRIP DEVICE FAILS
1.5E-4
CE3-BSN-FO-TB8
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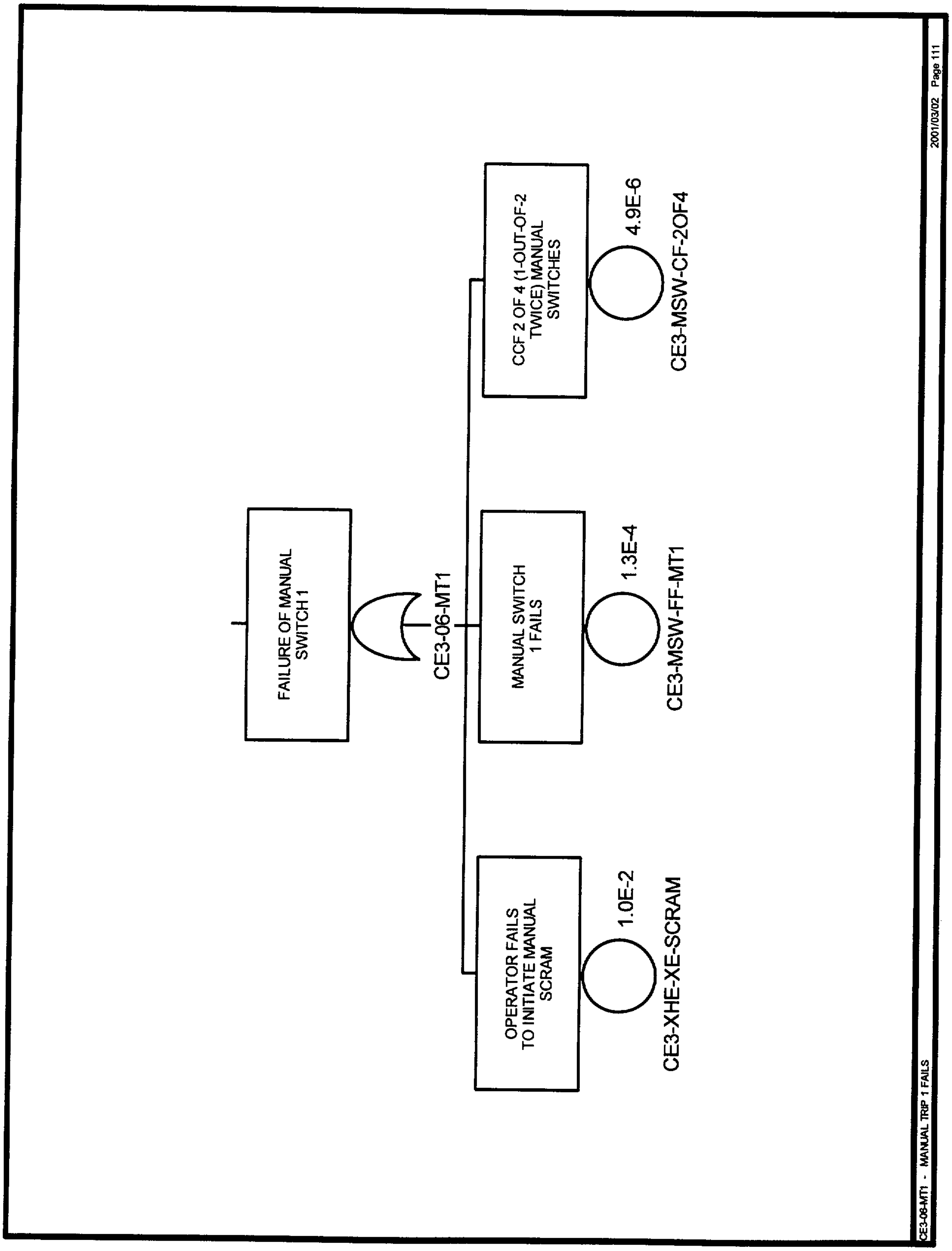
CE3-05-M8 - FAILURE OF TRIP CIRCUIT BREAKER TCB-8


FAILURE OF MANUAL SWITCH 1
CE3-06-MT1
OPERATOR FAILS TO INITIATE MANUAL SCRAM
1.0E-2
CE3-XHE-XE-SCRAM
MANUAL SWITCH 1 FAILS
1.3E-4
CE3-MSW-FF-MT1
CCF 2 OF 4 (1-OUT-OF-2 TWICE) MANUAL SWITCHES
4.9E-6
CE3-MSW-CF-2OF4
CE3-06-MT1 - MANUAL TRIP 1 FAILS
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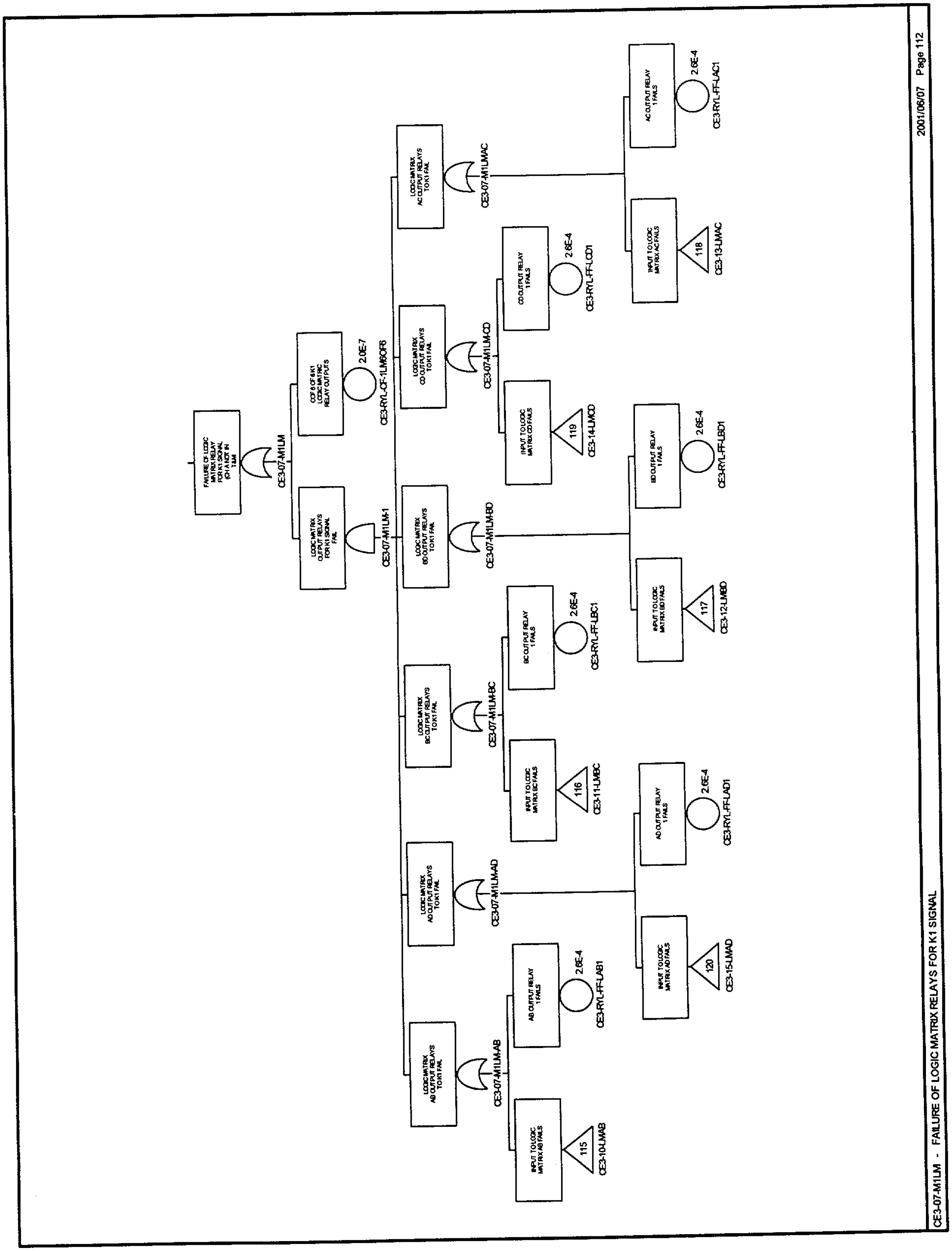
CE3-07-M1LM
CE3-07-M1LM-1
CE3-RYL-CF-1LM6OF6
2.0E-7
CE3-07-M1LMAC
CE3-07-M1LM-CD
CE3-07-M1LM-BD
CE3-07-M1LM-BC
CE3-07-M1LMAD
CE3-07-M1LM-AB
CE3-RYL-FF-LAC1
2.6E-4
CE3-13-LMAC
118
CE3-RYL-FF-LCD1
2.6E-4
CE3-14-LMCD
119
CE3-RYL-FF-LBD1
2.6E-4
CE3-12-LMBD
117
CE3-RYL-FF-LBC1
2.6E-4
CE3-11-LMBC
116
CE3-RYL-FF-LAD1
2.6E-4
CE3-15-LMAD
120
CE3-RYL-FF-LAB1
2.6E-4
CE3-10-LMAB
115
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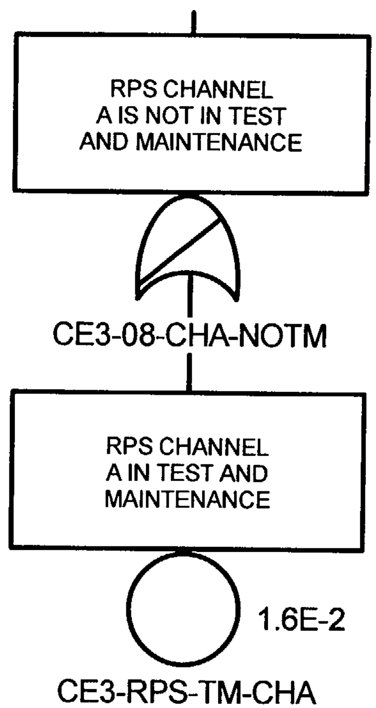
CE3-07-M1LM - FAILURE OF LOGIC MATRIX RELAYS FOR K1 SIGNAL



CE3-08-CHA-NOTM - RPS CHANNEL A NOT IN TEST AND MAINTENANCE

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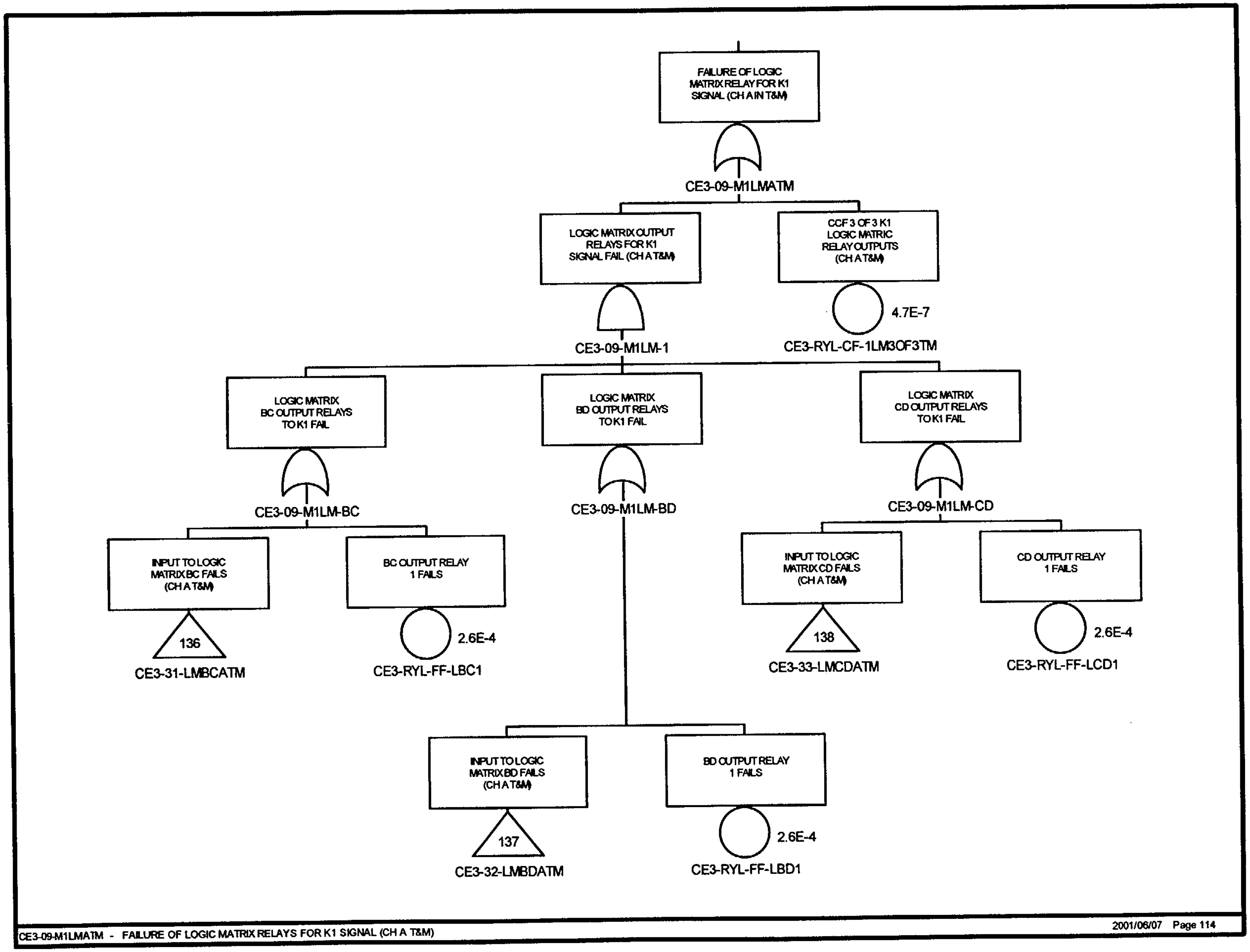
FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A IN T&M)
CE3-09-M1LMATM
LOGIC MATRIX OUTPUT RELAYS FOR K1 SIGNAL FAIL (CH A T&M)
CCF 3 OF 3 K1 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
4.7E-7
CE3-09-M1LM-1
CE3-RYL-CF-1LM3OF3TM
LOGIC MATRIX BC OUTPUT RELAYS TO K1 FAIL
LOGIC MATRIX BD OUTPUT RELAYS TO K1 FAIL
LOGIC MATRIX CD OUTPUT RELAYS TO K1 FAIL
CE3-09-M1LM-BC
CE3-09-M1LM-BD
CE3-09-M1LM-CD
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
BC OUTPUT RELAY 1 FAILS
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
CD OUTPUT RELAY 1 FAILS
136
2.6E-4
138
2.6E-4
CE3-31-LMBCATM
CE3-RYL-FF-LBC1
CE3-33-LMCDATM
CE3-RYL-FF-LCD1
INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
BD OUTPUT RELAY 1 FAILS
137
2.6E-4
CE3-32-LMBDATM
CE3-RYL-FF-LBD1
CE3-09-M1LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR K1 SIGNAL (CH A T&M)
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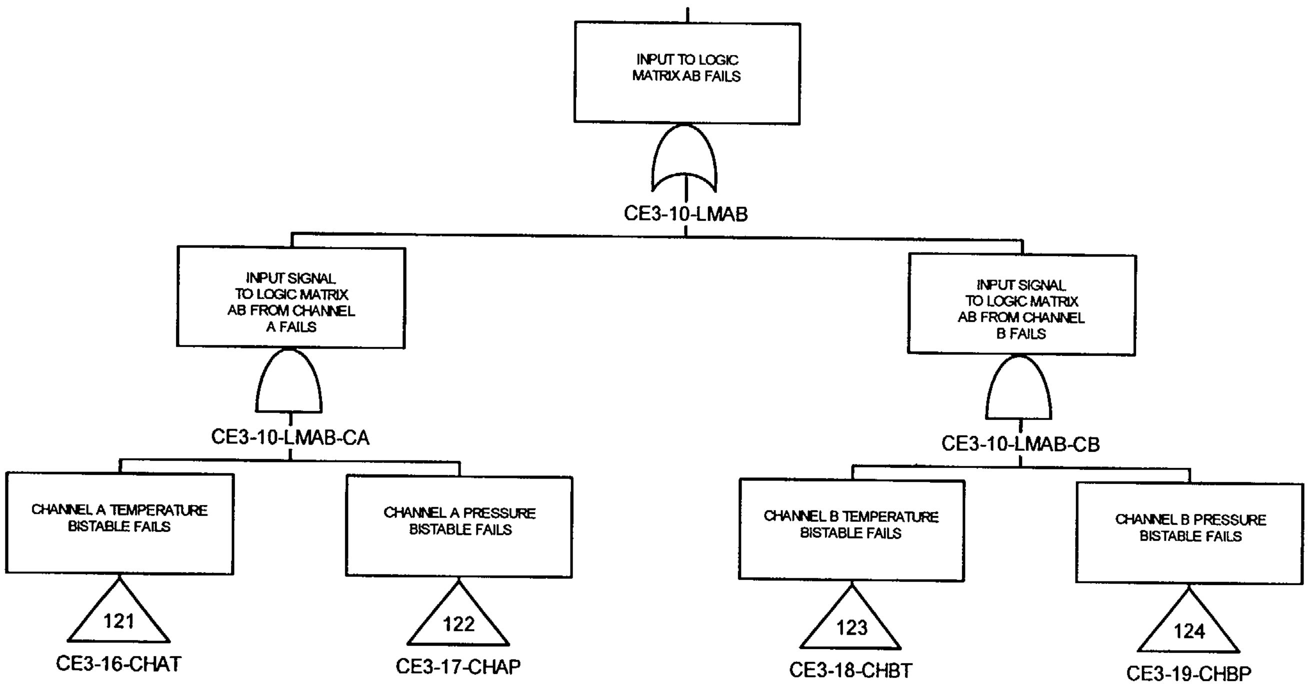

CE3-10-LMAB - INPUT SIGNAL TO LOGIC MATRIX AB FAILS

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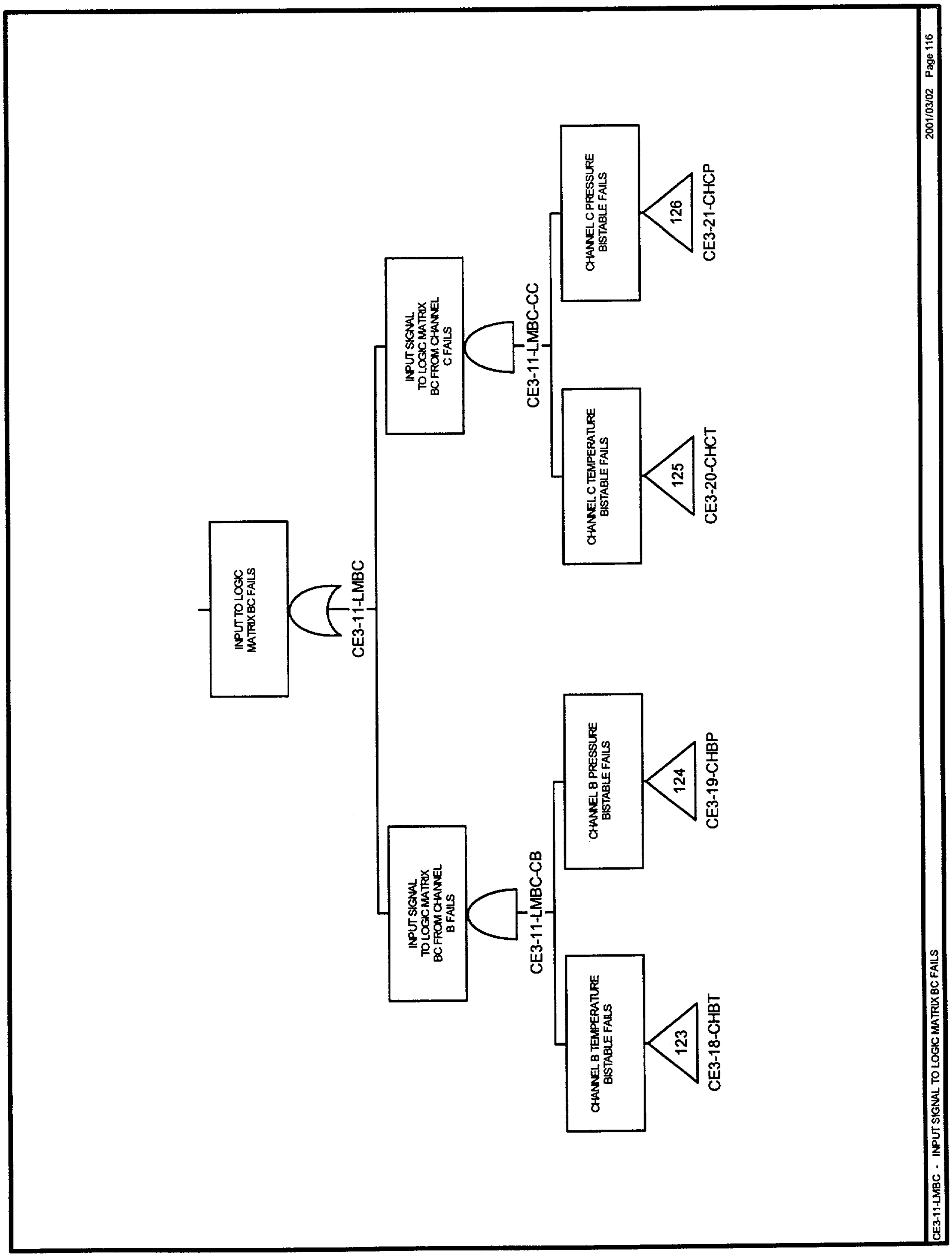
INPUT TO LOGIC MATRIX BC FAILS
CE3-11-LMBC
INPUT SIGNAL TO LOGIC MATRIX BC FROM CHANNEL B FAILS
CE3-11-LMBC-CB
INPUT SIGNAL TO LOGIC MATRIX BC FROM CHANNEL C FAILS
CE3-11-LMBC-CC
CHANNEL B TEMPERATURE BISTABLE FAILS
123
CE3-18-CHBT
CHANNEL B PRESSURE BISTABLE FAILS
124
CE3-19-CHBP
CHANNEL C TEMPERATURE BISTABLE FAILS
125
CE3-20-CHCT
CHANNEL C PRESSURE BISTABLE FAILS
126
CE3-21-CHCP
CE3-11-LMBC - INPUT SIGNAL TO LOGIC MATRIX BC FAILS
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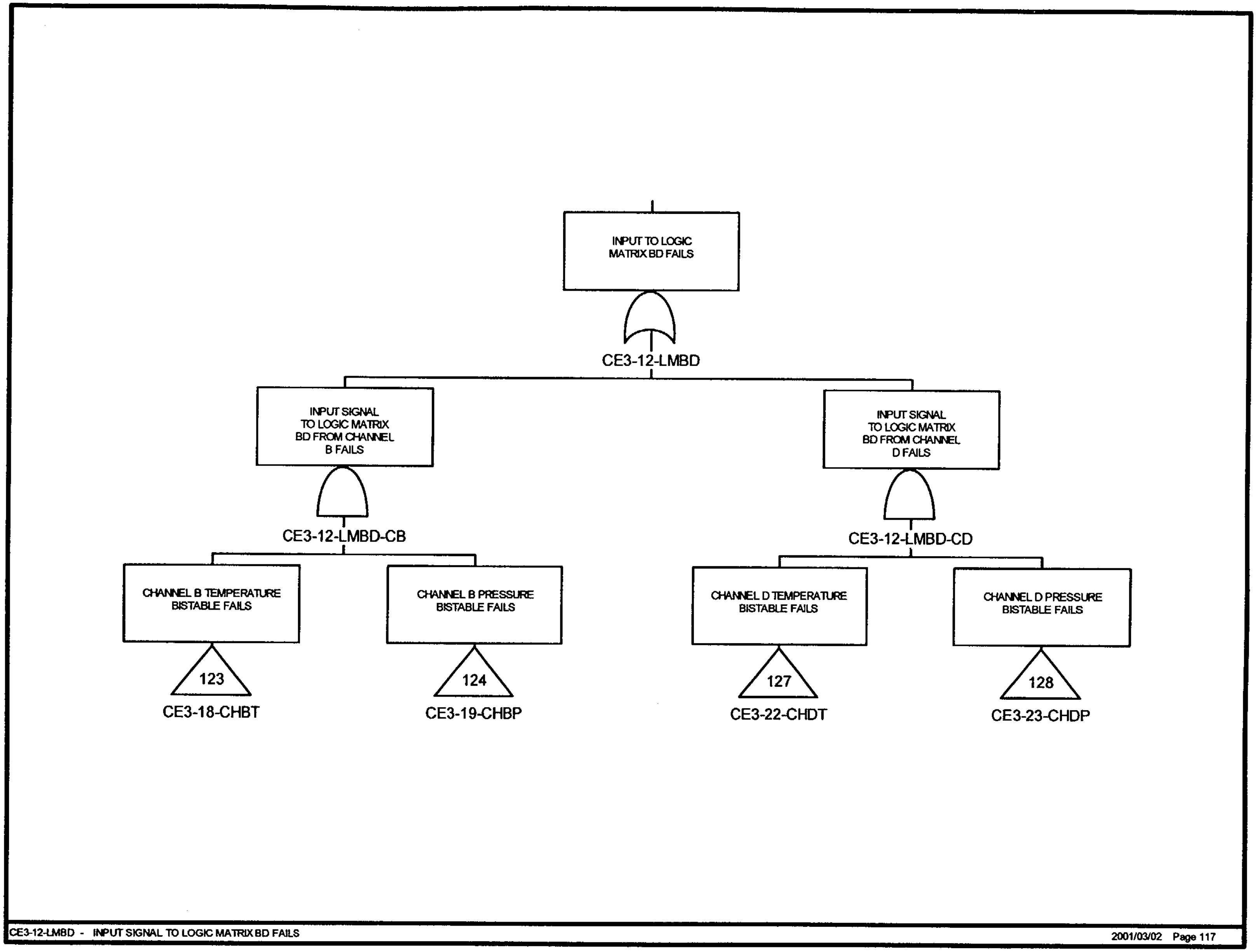
INPUT TO LOGIC MATRIX BD FAILS
CE3-12-LMBD
INPUT SIGNAL TO LOGIC MATRIX BD FROM CHANNEL B FAILS
CE3-12-LMBD-CB
INPUT SIGNAL TO LOGIC MATRIX BD FROM CHANNEL D FAILS
CE3-12-LMBD-CD
CHANNEL B TEMPERATURE BISTABLE FAILS
123
CE3-18-CHBT
CHANNEL B PRESSURE BISTABLE FAILS
124
CE3-19-CHBP
CHANNEL D TEMPERATURE BISTABLE FAILS
127
CE3-22-CHDT
CHANNEL D PRESSURE BISTABLE FAILS
128
CE3-23-CHDP
CE3-12-LMBD - INPUT SIGNAL TO LOGIC MATRIX BD FAILS
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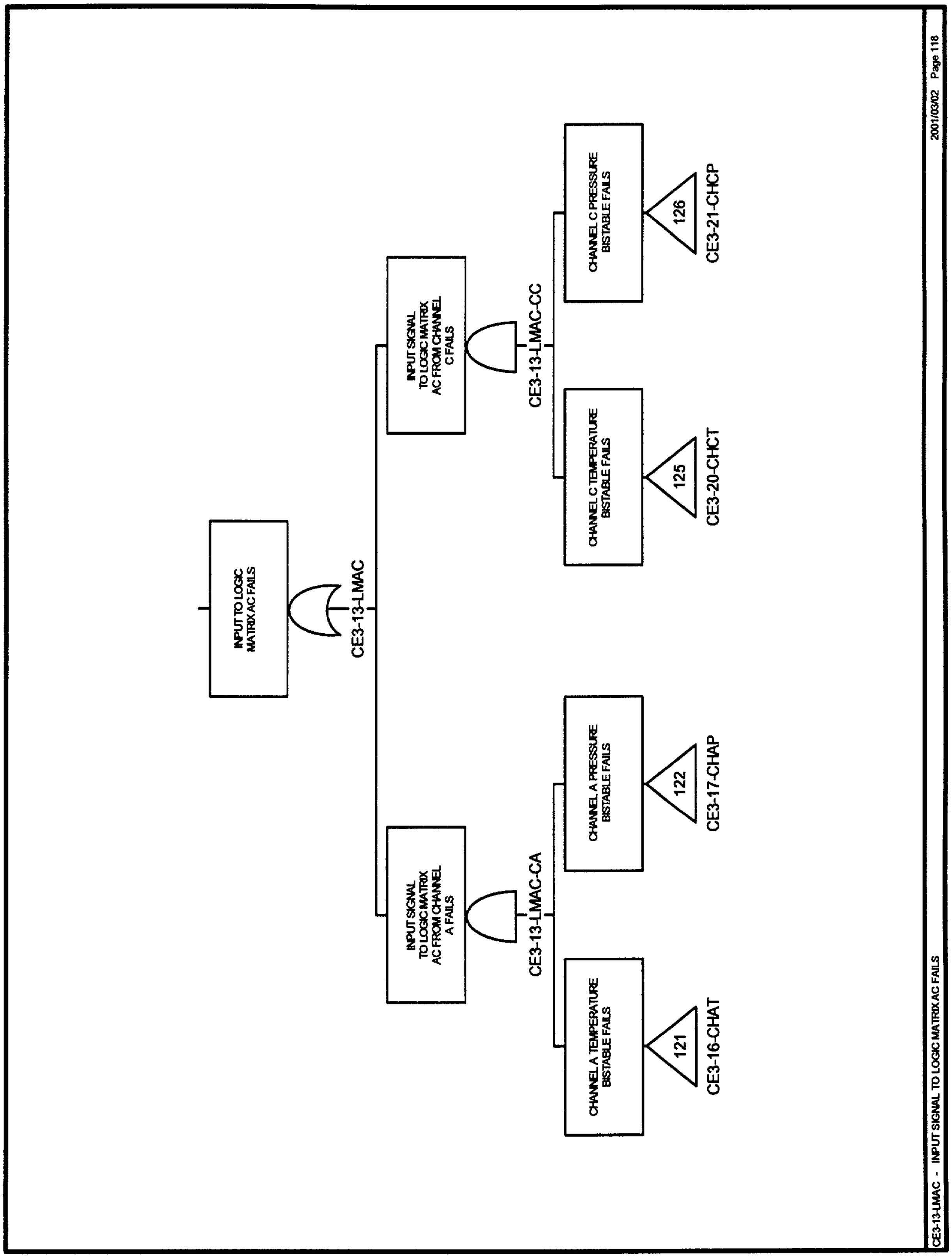
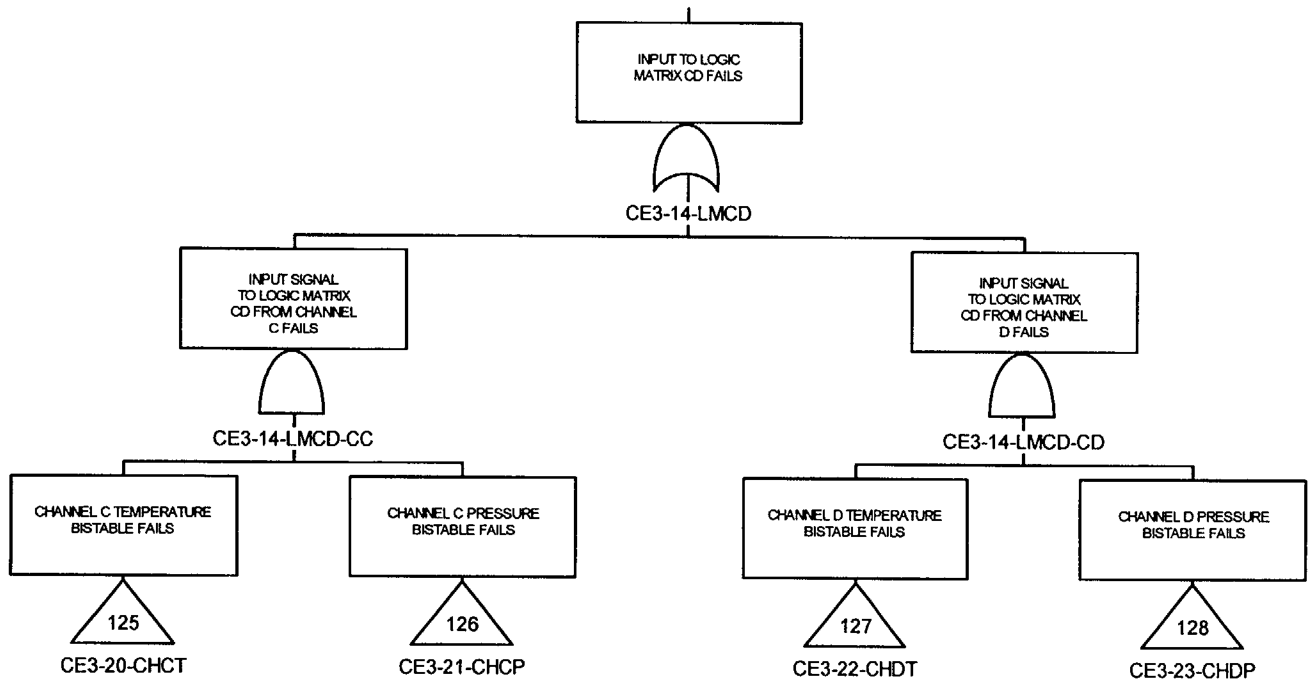
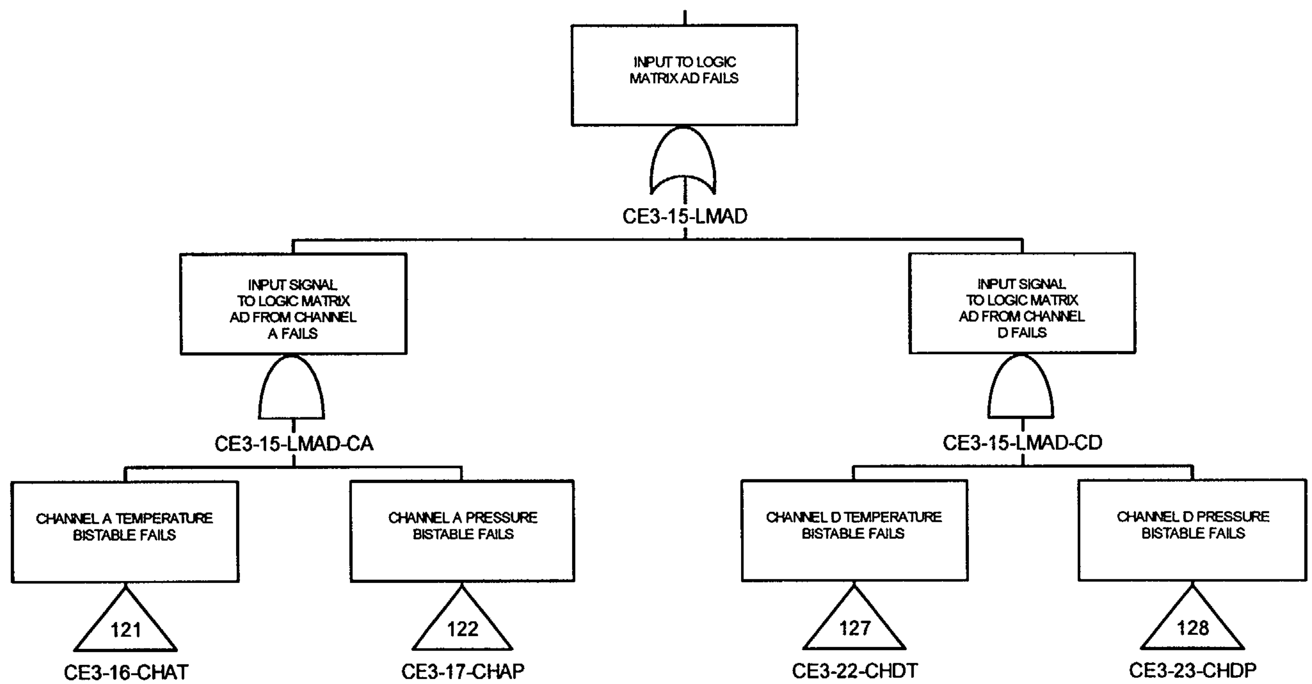
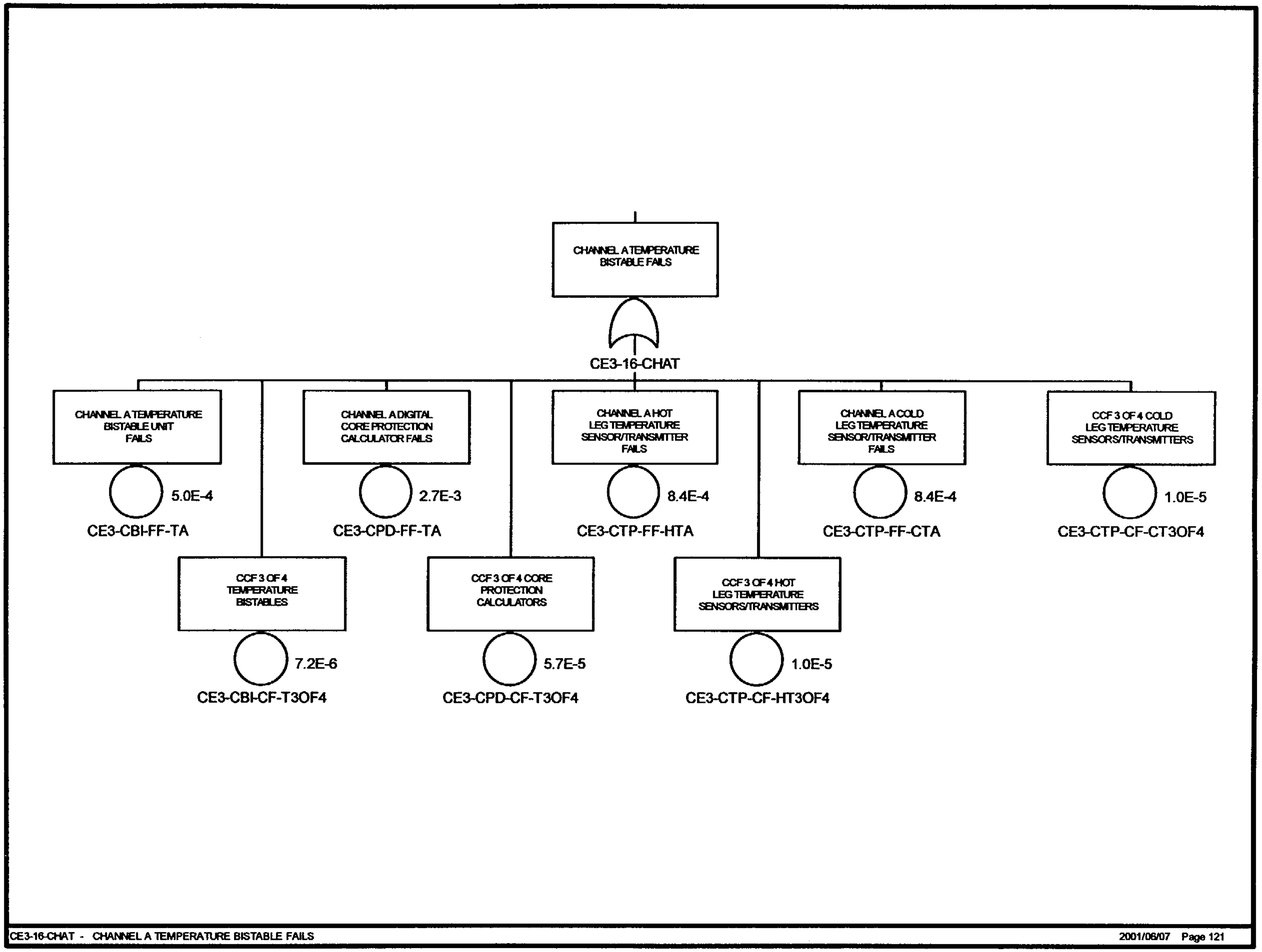

INPUT TO LOGIC MATRIX AC FAILS
CE3-13-LMAC
INPUT SIGNAL TO LOGIC MATRIX AC FROM CHANNEL A FAILS
CE3-13-LMAC-CA
INPUT SIGNAL TO LOGIC MATRIX AC FROM CHANNEL C FAILS
CE3-13-LMAC-CC
CHANNEL A TEMPERATURE BISTABLE FAILS
121
CE3-16-CHAT
CHANNEL A PRESSURE BISTABLE FAILS
122
CE3-17-CHAP
CHANNEL C TEMPERATURE BISTABLE FAILS
125
CE3-20-CHCT
CHANNEL C PRESSURE BISTABLE FAILS
126
CE3-21-CHCP
CE3-13-LMAC - INPUT SIGNAL TO LOGIC MATRIX AC FAILS
2001/03/02 Page 118



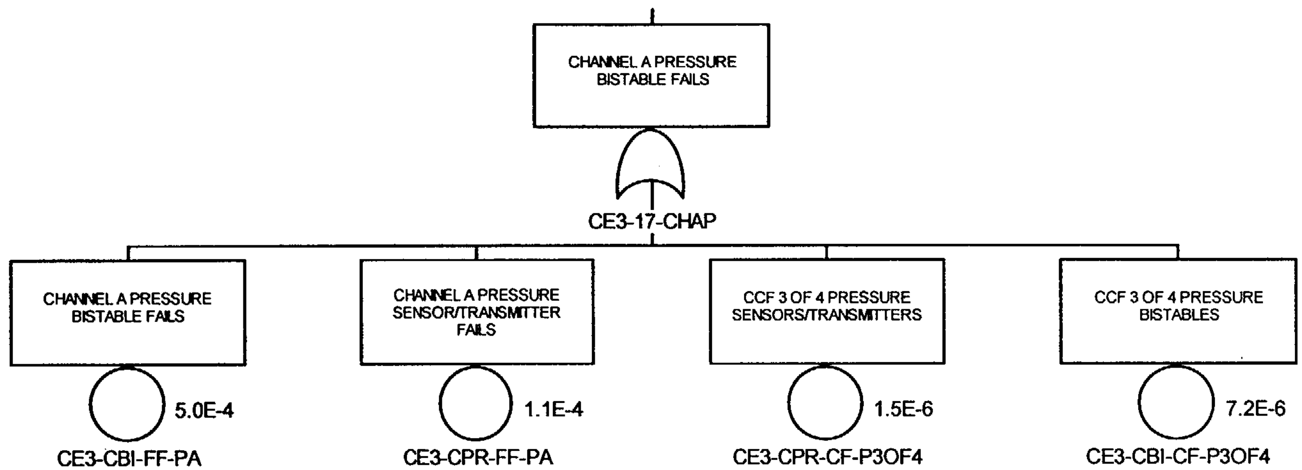
CE3-14-LMCD - INPUT SIGNAL TO LOGIC MATRIX CD FAILS 2001/03/02 Page 119



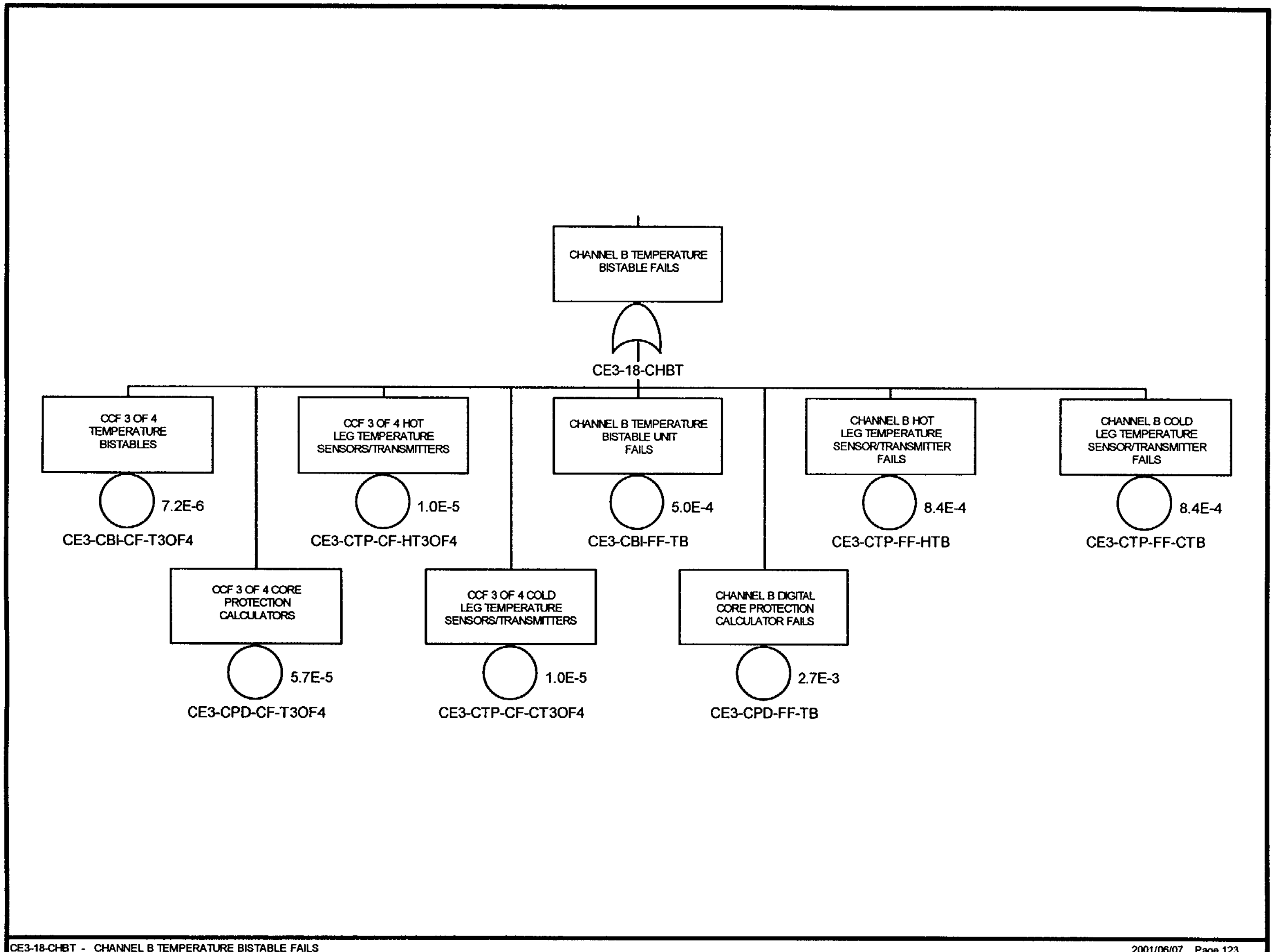
CE3-15-LMAD - INPUT SIGNAL TO LOGIC MATRIX AD FAILS

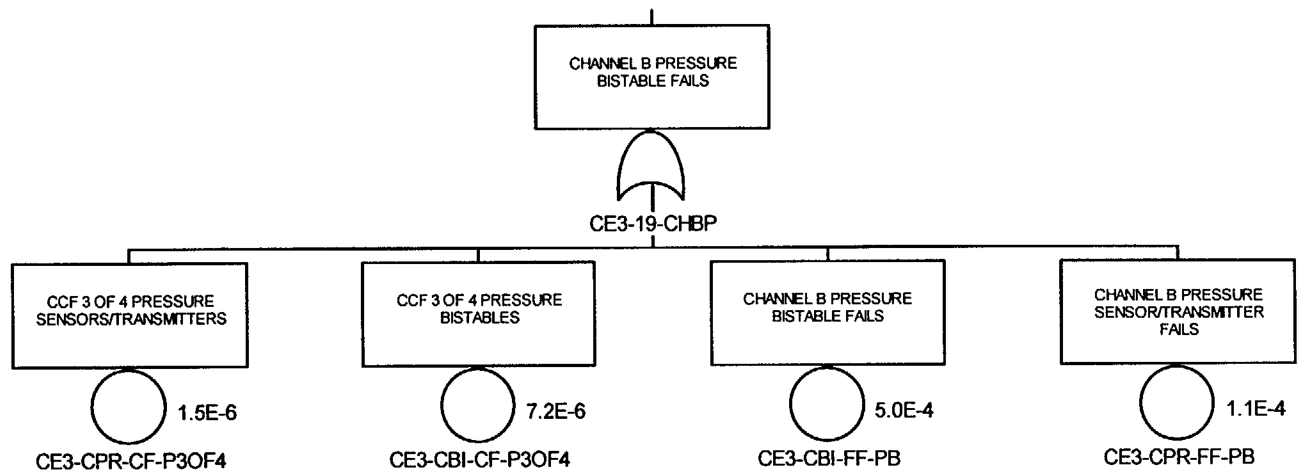


CHANNEL A TEMPERATURE BISTABLE FAILS
CE3-16-CHAT
CHANNEL A TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE3-CBI-FF-TA
CHANNEL A DIGITAL CORE PROTECTION CALCULATOR FAILS
2.7E-3
CE3-CPD-FF-TA
CHANNEL A HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-HTA
CHANNEL A COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-CTA
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE3-CTP-CF-CT3OF4
CCF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE3-CBI-CF-T3OF4
CCF 3 OF 4 CORE PROTECTION CALCULATORS
5.7E-5
CE3-CPD-CF-T3OF4
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE3-CTP-CF-HT3OF4
CE3-16-CHAT - CHANNEL A TEMPERATURE BISTABLE FAILS
2001/06/07 Page 121



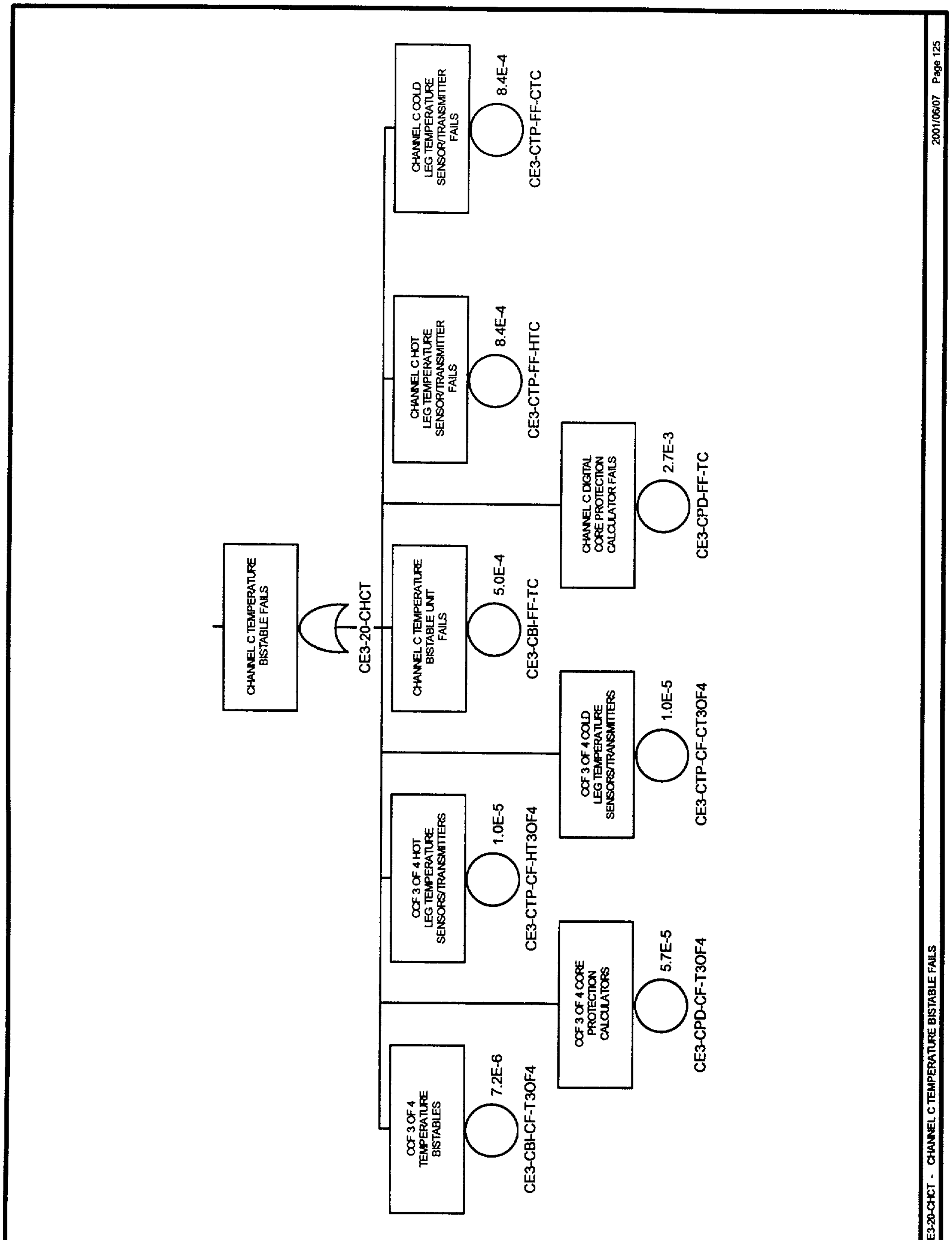
CE3-17-CHAP - CHANNEL A PRESSURE BISTABLE FAILS 2001/03/02 Page 122

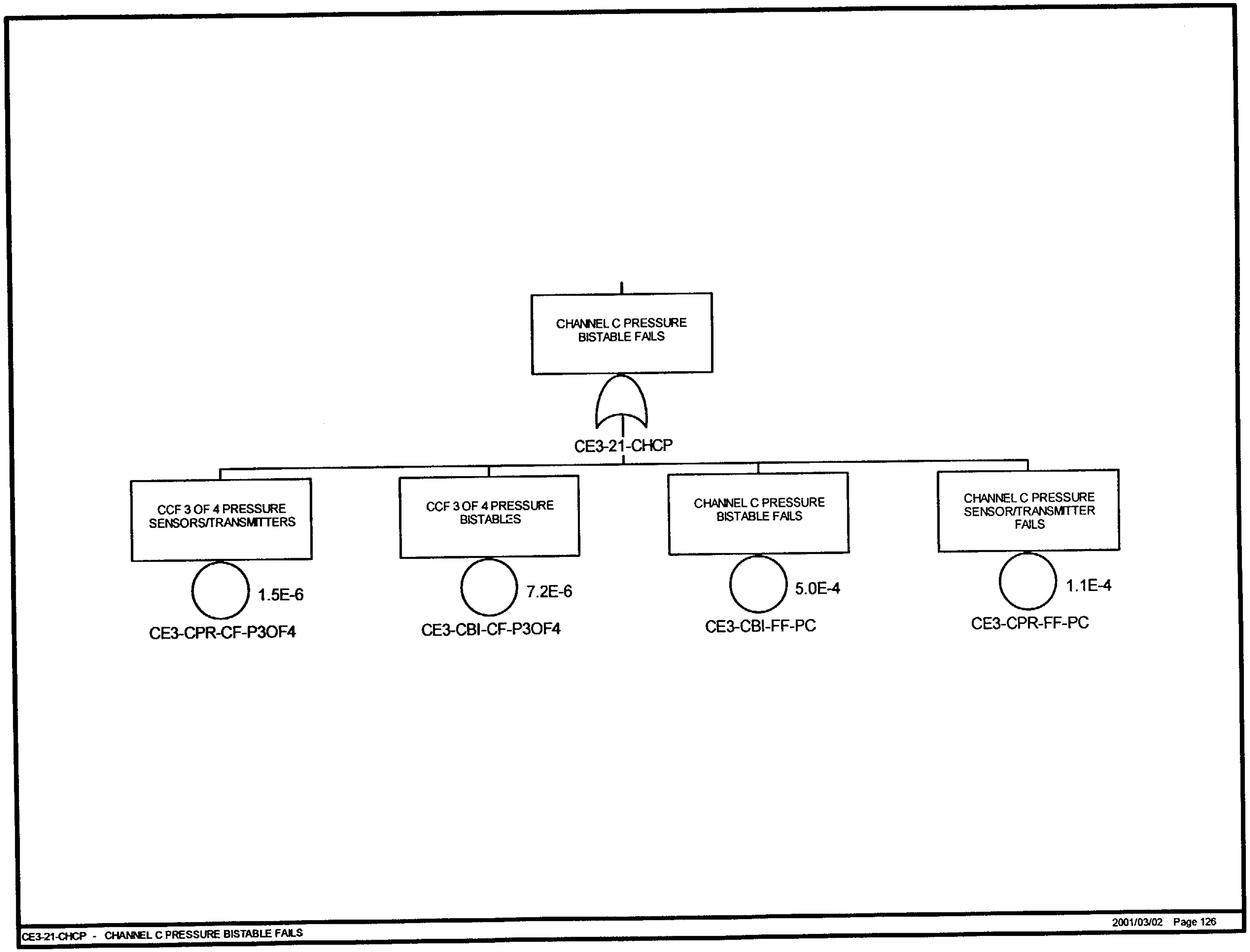

CHANNEL B TEMPERATURE BISTABLE FAILS
CE3-18-CHBT
CCF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE3-CBI-CF-T3OF4
CCF 3 OF 4 CORE PROTECTION CALCULATORS
5.7E-5
CE3-CPD-CF-T3OF4
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE3-CTP-CF-HT3OF4
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE3-CTP-CF-CT3OF4
CHANNEL B TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE3-CBI-FF-TB
CHANNEL B DIGITAL CORE PROTECTION CALCULATOR FAILS
2.7E-3
CE3-CPD-FF-TB
CHANNEL B HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-HTB
CHANNEL B COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-CTB
CE3-18-CHBT - CHANNEL B TEMPERATURE BISTABLE FAILS
2001/06/07 Page 123

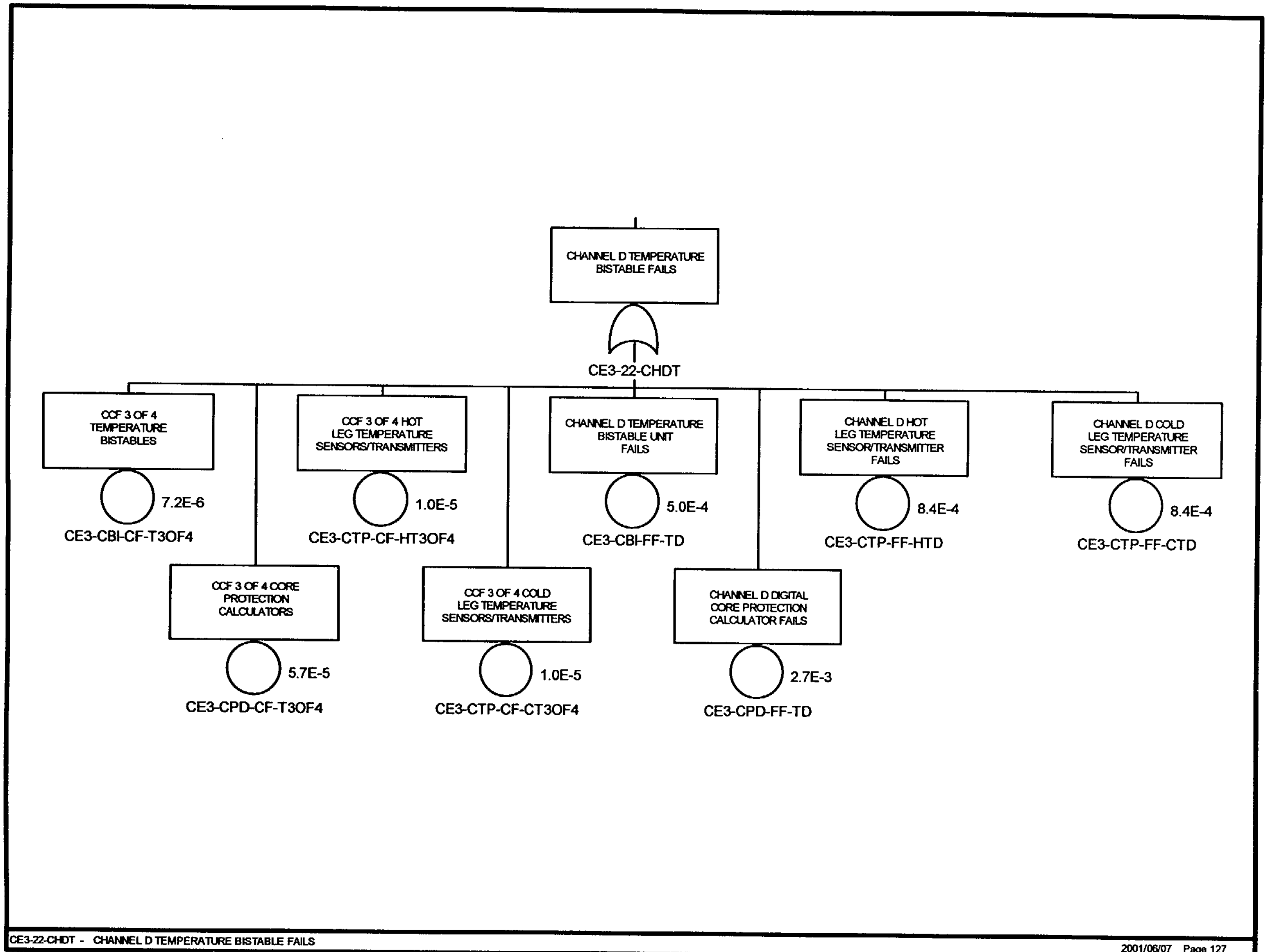


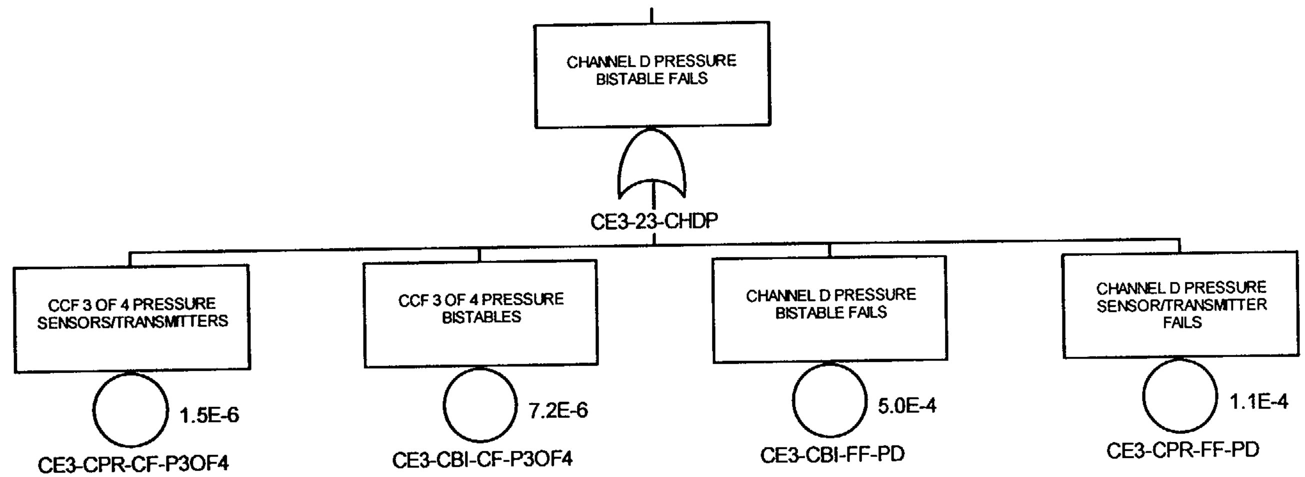
CE3-19-CHBP - CHANNEL B PRESSURE BISTABLE FAILS

2001/03/02 Page 124


CHANNEL C TEMPERATURE BISTABLE FAILS
CE3-20-CHCT
CCF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE3-CBI-CF-T3OF4
CCF 3 OF 4 CORE PROTECTION CALCULATORS
5.7E-5
CE3-CPD-CF-T3OF4
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE3-CTP-CF-HT3OF4
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE3-CTP-CF-CT3OF4
CHANNEL C TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE3-CBI-FF-TC
CHANNEL C DIGITAL CORE PROTECTION CALCULATOR FAILS
2.7E-3
CE3-CPD-FF-TC
CHANNEL C HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-HTC
CHANNEL C COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-CTC
CE3-20-CHCT - CHANNEL C TEMPERATURE BISTABLE FAILS
2001/06/07 Page 125

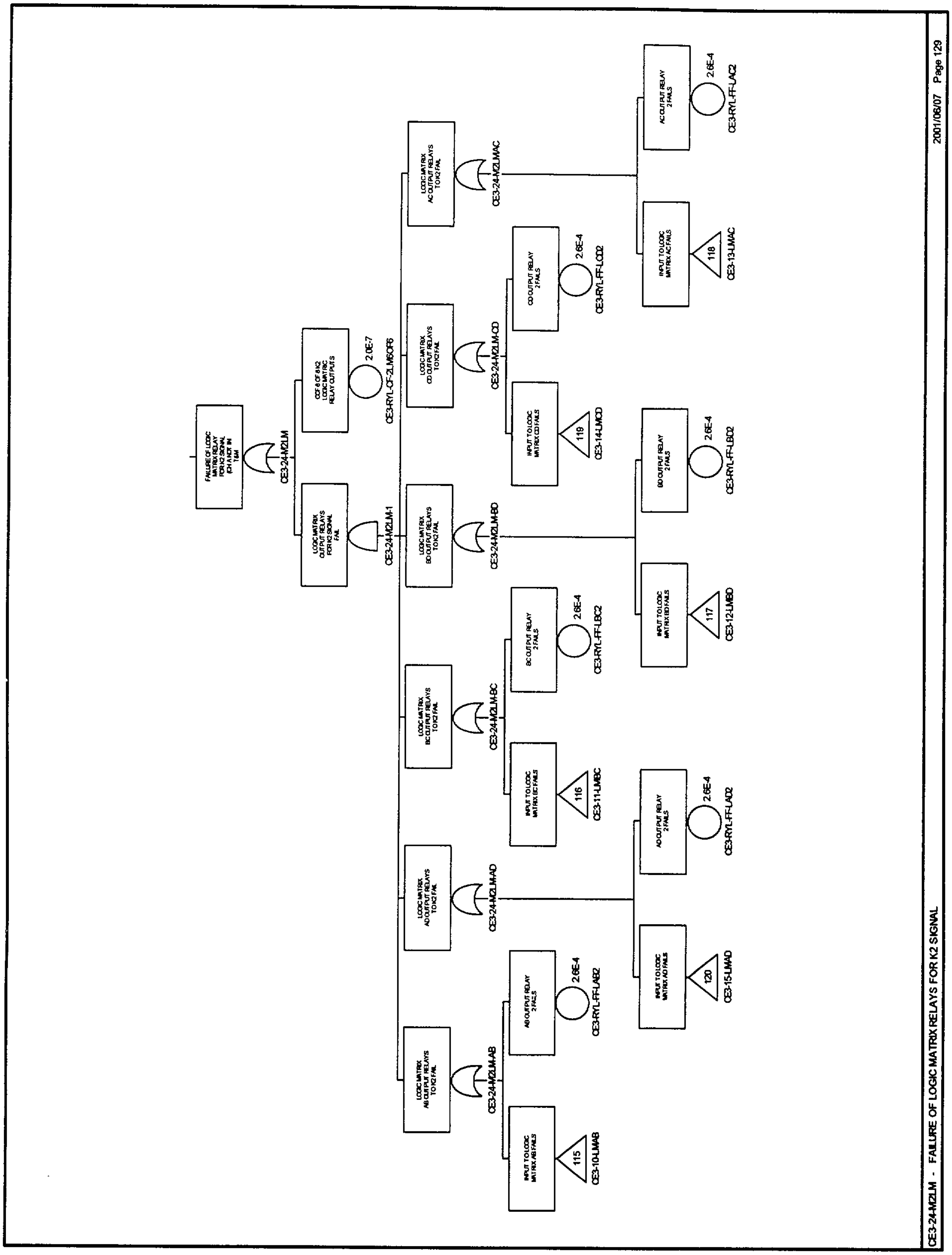

CHANNEL C PRESSURE BISTABLE FAILS
CE3-21-CHCP
CCF 3 OF 4 PRESSURE SENSORS/TRANSMITTERS
1.5E-6
CE3-CPR-CF-P3OF4
CCF 3 OF 4 PRESSURE BISTABLES
7.2E-6
CE3-CBI-CF-P3OF4
CHANNEL C PRESSURE BISTABLE FAILS
5.0E-4
CE3-CBI-FF-PC
CHANNEL C PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE3-CPR-FF-PC
CE3-21-CHCP - CHANNEL C PRESSURE BISTABLE FAILS
2001/03/02 Page 126

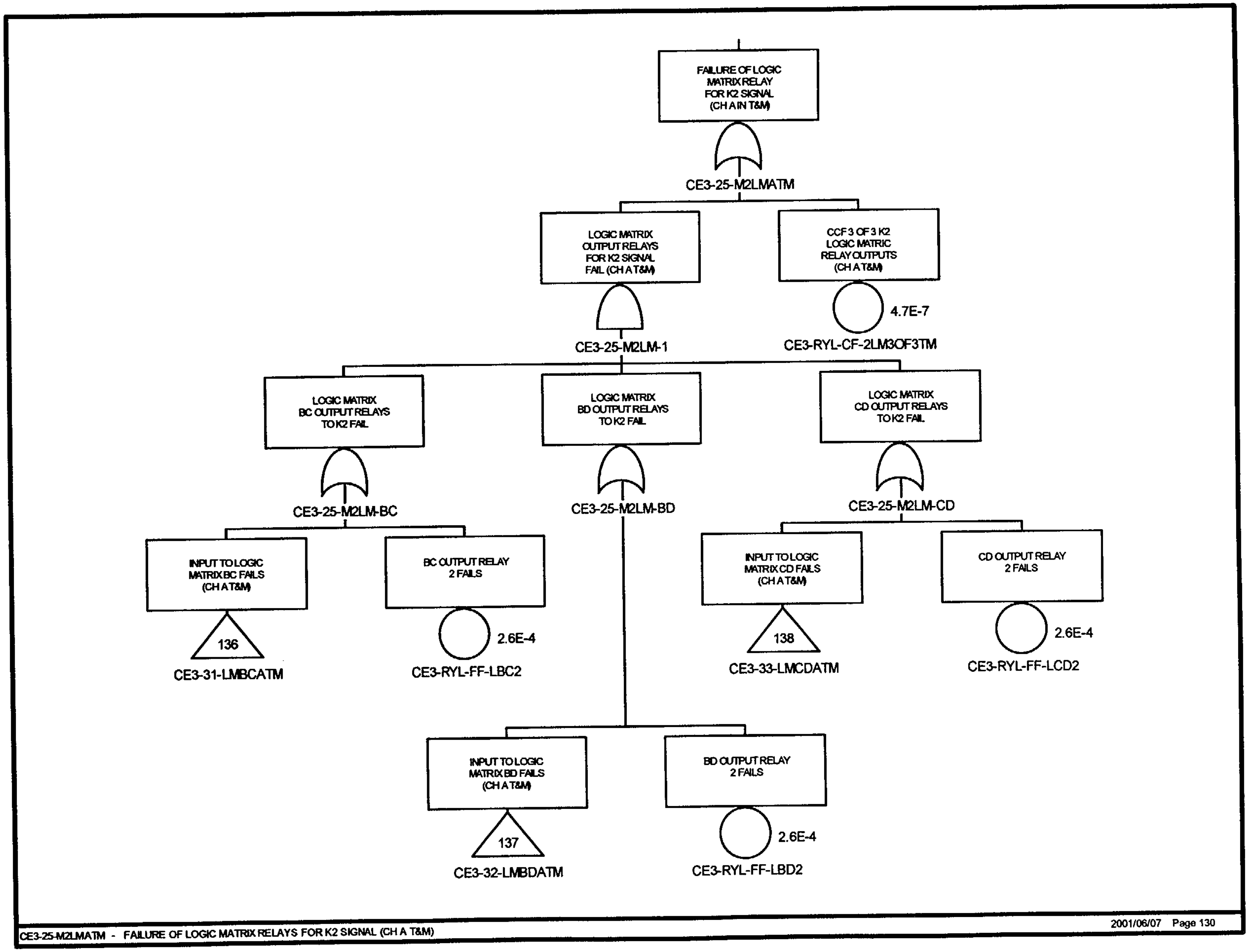

CHANNEL D TEMPERATURE BISTABLE FAILS
CE3-22-CHDT
CCF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE3-CBI-CF-T3OF4
CCF 3 OF 4 CORE PROTECTION CALCULATORS
5.7E-5
CE3-CPD-CF-T3OF4
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE3-CTP-CF-HT3OF4
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE3-CTP-CF-CT3OF4
CHANNEL D TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE3-CBI-FF-TD
CHANNEL D DIGITAL CORE PROTECTION CALCULATOR FAILS
2.7E-3
CE3-CPD-FF-TD
CHANNEL D HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-HTD
CHANNEL D COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-CTD
CE3-22-CHDT - CHANNEL D TEMPERATURE BISTABLE FAILS
2001/06/07 Page 127

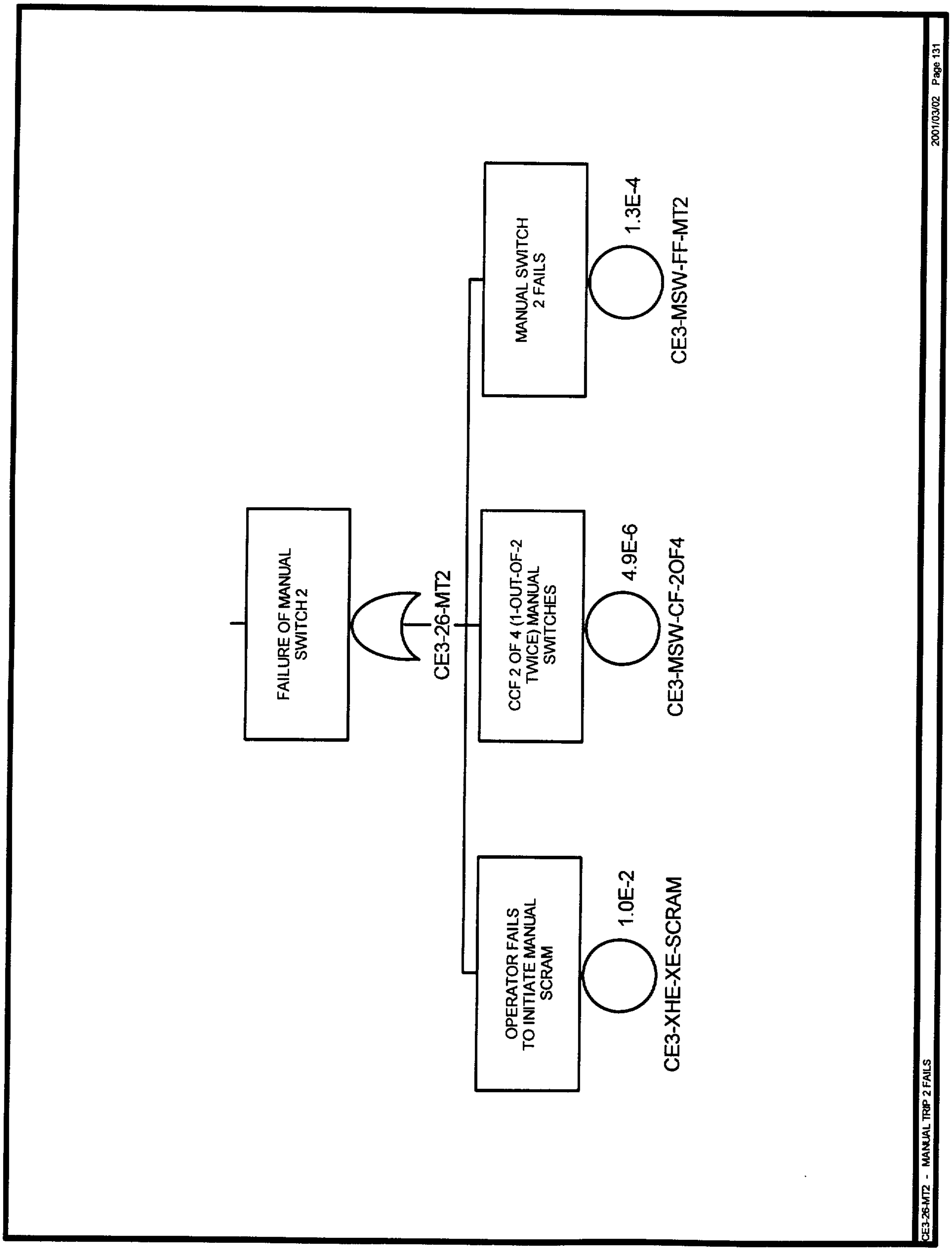


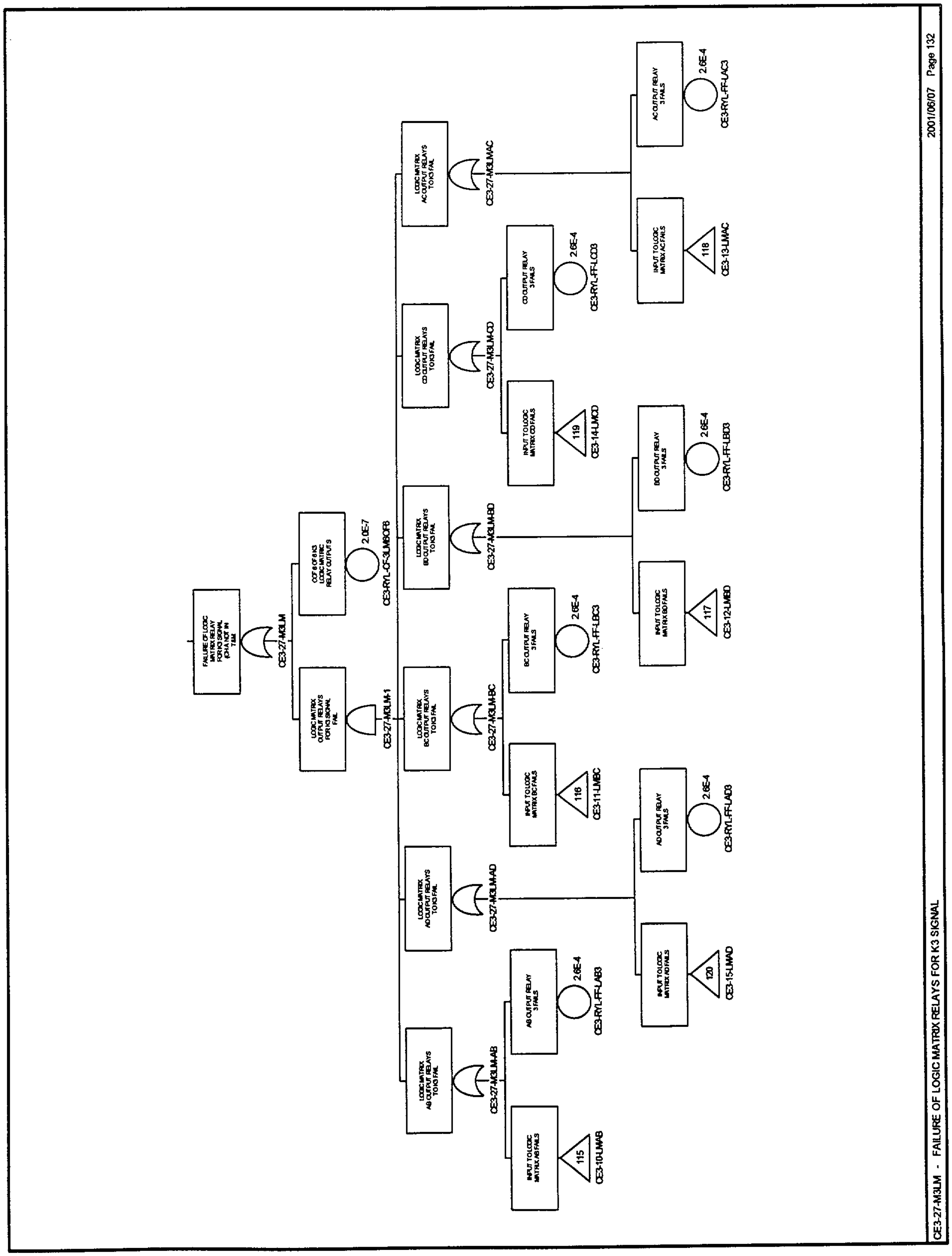
CE3-23-CHDP - CHANNEL D PRESSURE BISTABLE FAILS

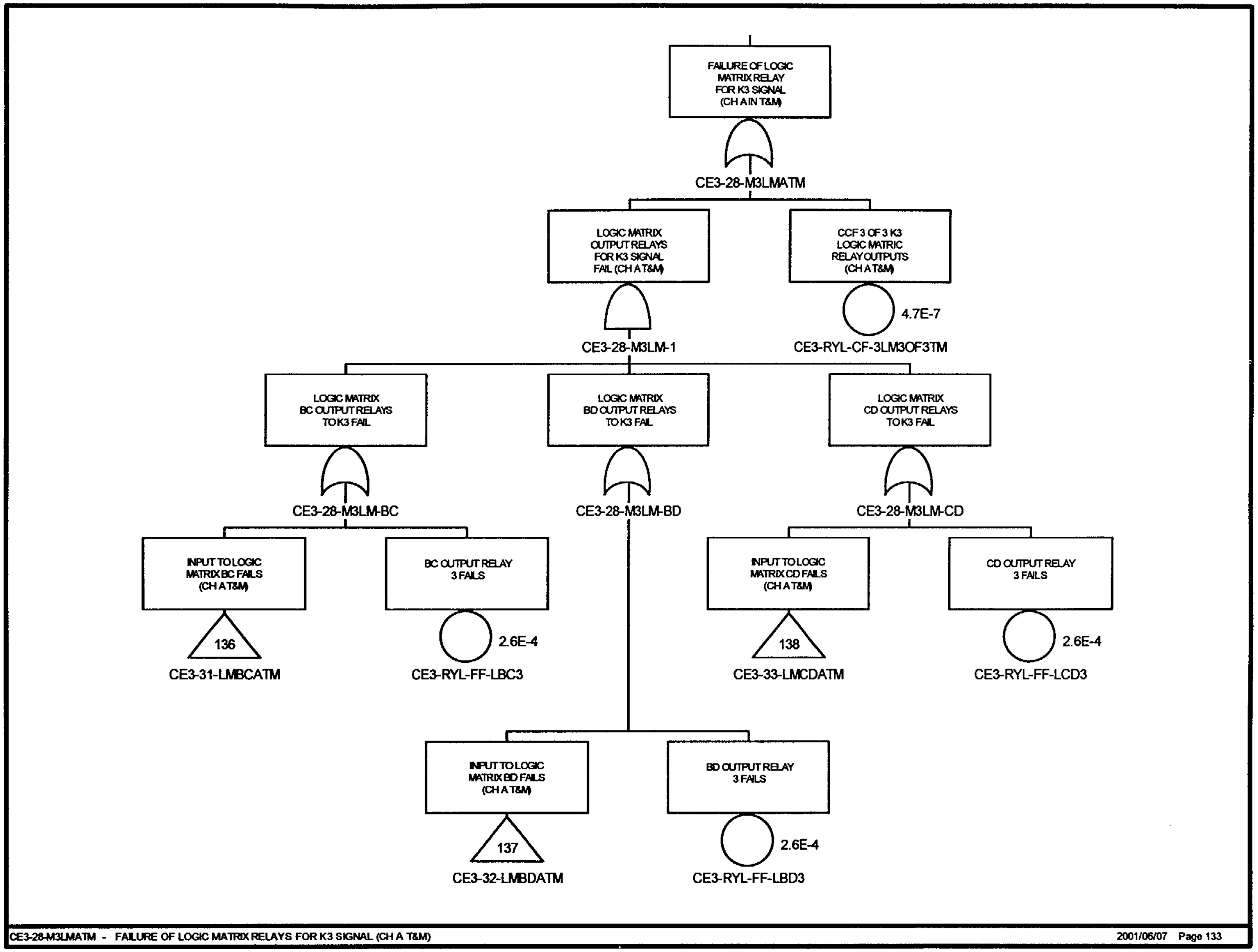
2001/03/02 Page 128

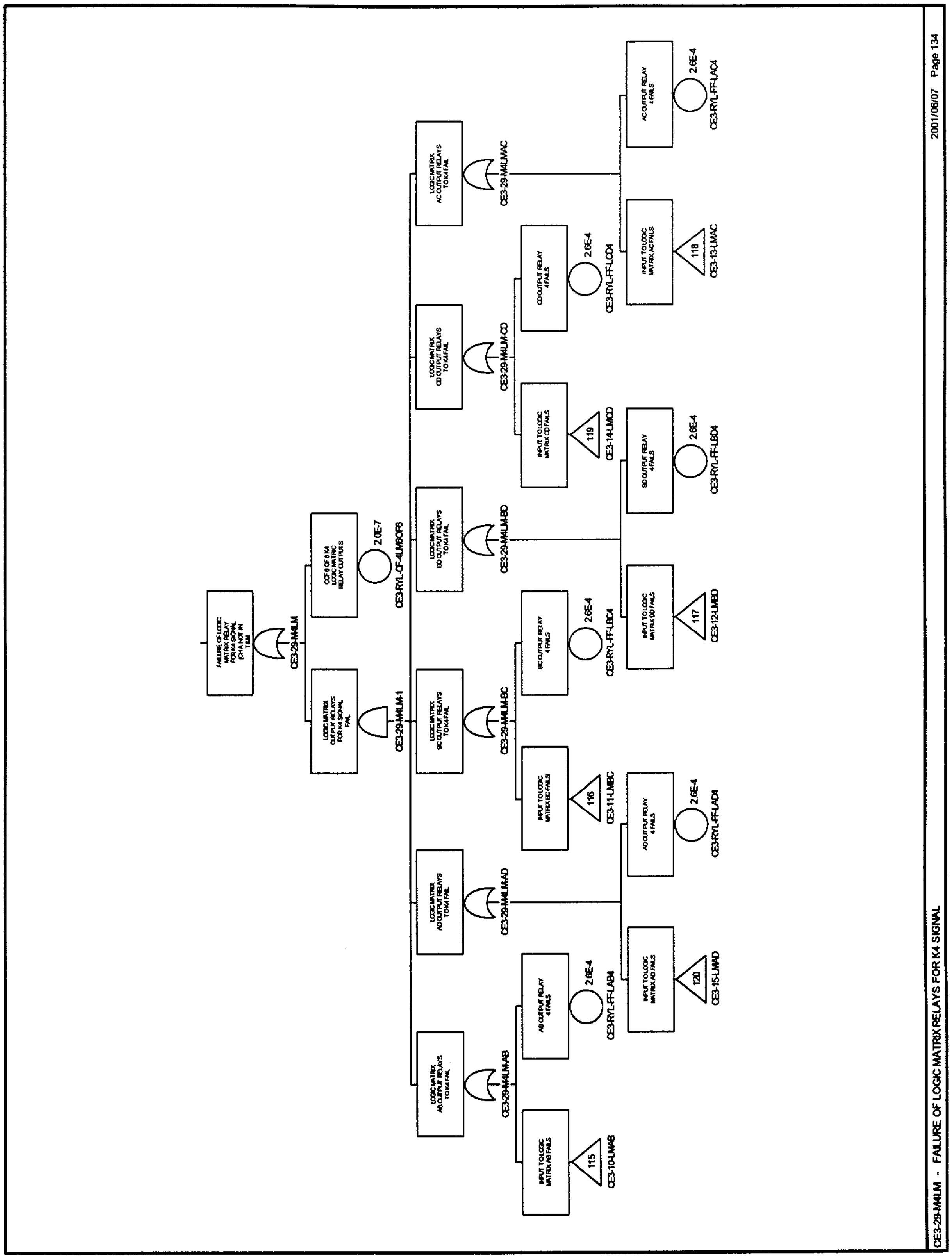

CE3-24-M2LM - FAILURE OF LOGIC MATRIX RELAYS FOR K2 SIGNAL
2001/06/07 Page 129
CE3-24-M2LM
CE3-24-M2LM-1
CE3-RYL-CF-2LM6OF6
2.0E-7
CE3-24-M2LM-AB
CE3-24-M2LM-AD
CE3-24-M2LM-BC
CE3-24-M2LM-BD
CE3-24-M2LM-CD
CE3-24-M2LMAC
CE3-10-LMAB
115
CE3-RYL-FF-LAB2
2.6E-4
CE3-15-LMAD
120
CE3-RYL-FF-LAD2
2.6E-4
CE3-11-LMBC
116
CE3-RYL-FF-LBC2
2.6E-4
CE3-12-LMBD
117
CE3-RYL-FF-LBD2
2.6E-4
CE3-14-LMCD
119
CE3-RYL-FF-LCD2
2.6E-4
CE3-13-LMAC
118
CE3-RYL-FF-LAC2
2.6E-4

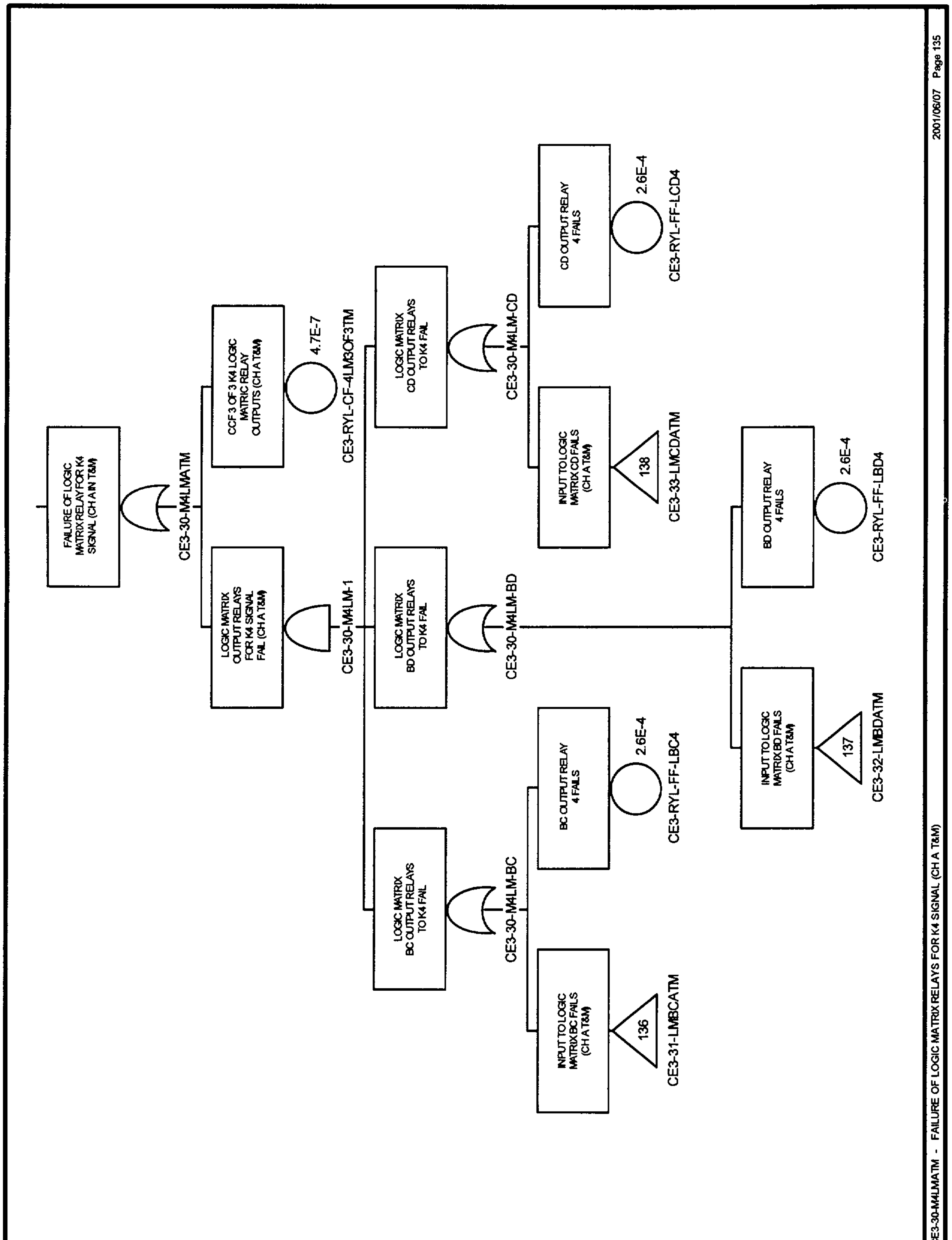

FAILURE OF LOGIC MATRIX RELAY FOR K2 SIGNAL (CH A IN T&M)
CE3-25-M2LMATM
LOGIC MATRIX OUTPUT RELAYS FOR K2 SIGNAL FAIL (CH A T&M)
CCF 3 OF 3 K2 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
4.7E-7
CE3-25-M2LM-1
CE3-RYL-CF-2LM3OF3TM
LOGIC MATRIX BC OUTPUT RELAYS TO K2 FAIL
LOGIC MATRIX BD OUTPUT RELAYS TO K2 FAIL
LOGIC MATRIX CD OUTPUT RELAYS TO K2 FAIL
CE3-25-M2LM-BC
CE3-25-M2LM-BD
CE3-25-M2LM-CD
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
BC OUTPUT RELAY 2 FAILS
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
CD OUTPUT RELAY 2 FAILS
136
2.6E-4
138
2.6E-4
CE3-31-LMBCATM
CE3-RYL-FF-LBC2
CE3-33-LMCDATM
CE3-RYL-FF-LCD2
INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
BD OUTPUT RELAY 2 FAILS
137
2.6E-4
CE3-32-LMBDATM
CE3-RYL-FF-LBD2
CE3-25-M2LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR K2 SIGNAL (CH A T&M)
2001/06/07 Page 130

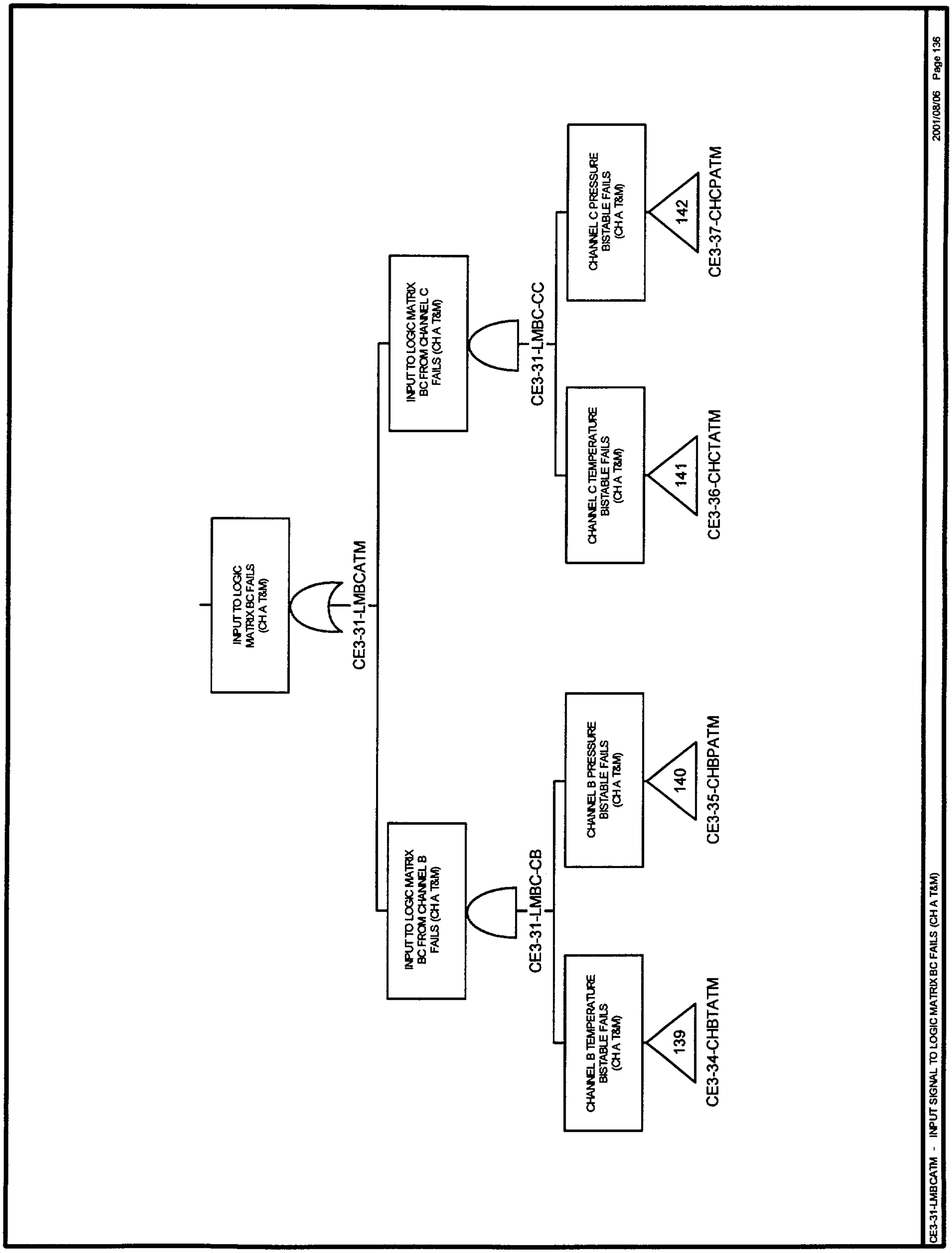

FAILURE OF MANUAL SWITCH 2
CE3-26-MT2
OPERATOR FAILS TO INITIATE MANUAL SCRAM
1.0E-2
CE3-XHE-XE-SCRAM
CCF 2 OF 4 (1-OUT-OF-2 TWICE) MANUAL SWITCHES
4.9E-6
CE3-MSW-CF-2OF4
MANUAL SWITCH 2 FAILS
1.3E-4
CE3-MSW-FF-MT2
CE3-26-MT2 - MANUAL TRIP 2 FAILS
2001/03/02 Page 131


CE3-27-M3LM
CE3-27-M3LM-1
2.0E-7
CE3-RYL-CF-3LMBOF6
CE3-27-M3LM-AB
CE3-27-M3LM-AD
CE3-27-M3LM-BC
CE3-27-M3LM-BD
CE3-27-M3LM-CD
CE3-27-M3LMAC
115
CE3-10-LMAB
2.6E-4
CE3-RYL-FF-LAB3
120
CE3-15-LMAD
2.6E-4
CE3-RYL-FF-LAD3
116
CE3-11-LMBC
2.6E-4
CE3-RYL-FF-LBC3
117
CE3-12-LMBD
2.6E-4
CE3-RYL-FF-LBD3
119
CE3-14-LMCD
2.6E-4
CE3-RYL-FF-LCD3
118
CE3-13-LMAC
2.6E-4
CE3-RYL-FF-LAC3
CE3-27-M3LM - FAILURE OF LOGIC MATRIX RELAYS FOR K3 SIGNAL
2001/06/07 Page 132


FAILURE OF LOGIC MATRIX RELAY FOR K3 SIGNAL (CH A IN T&M)
CE3-28-M3LMATM
LOGIC MATRIX OUTPUT RELAYS FOR K3 SIGNAL FAIL (CH A T&M)
CE3-28-M3LM-1
CCF 3 OF 3 K3 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
4.7E-7
CE3-RYL-CF-3LM3OF3TM
LOGIC MATRIX BC OUTPUT RELAYS TO K3 FAIL
CE3-28-M3LM-BC
LOGIC MATRIX BD OUTPUT RELAYS TO K3 FAIL
CE3-28-M3LM-BD
LOGIC MATRIX CD OUTPUT RELAYS TO K3 FAIL
CE3-28-M3LM-CD
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
136
CE3-31-LMBCATM
BC OUTPUT RELAY 3 FAILS
2.6E-4
CE3-RYL-FF-LBC3
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
138
CE3-33-LMCDATM
CD OUTPUT RELAY 3 FAILS
2.6E-4
CE3-RYL-FF-LCD3
INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
137
CE3-32-LMBDATM
BD OUTPUT RELAY 3 FAILS
2.6E-4
CE3-RYL-FF-LBD3
CE3-28-M3LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR K3 SIGNAL (CH A T&M)
2001/06/07 Page 133


CE3-29-M4LM
CE3-29-M4LM-1
CE3-RYL-CF-4LMBOF6
2.0E-7
CE3-29-M4LM-AB
CE3-29-M4LM-AD
CE3-29-M4LM-BC
CE3-29-M4LM-BD
CE3-29-M4LM-CD
CE3-29-M4LMAC
115
CE3-10-LMAB
2.6E-4
CE3-RYL-FF-LAB4
120
CE3-15-LMAD
2.6E-4
CE3-RYL-FF-LAD4
116
CE3-11-LMBC
2.6E-4
CE3-RYL-FF-LBC4
117
CE3-12-LMBD
2.6E-4
CE3-RYL-FF-LBD4
119
CE3-14-LMCD
2.6E-4
CE3-RYL-FF-LCD4
118
CE3-13-LMAC
2.6E-4
CE3-RYL-FF-LAC4
CE3-29-M4LM - FAILURE OF LOGIC MATRIX RELAYS FOR K4 SIGNAL
2001/06/07 Page 134


FAILURE OF LOGIC MATRIX RELAY FOR K4 SIGNAL (CH A IN T&M)
CE3-30-M4LMATM
CCF 3 OF 3 K4 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
4.7E-7
CE3-RYL-CF-4LM3OF3TM
LOGIC MATRIX OUTPUT RELAYS FOR K4 SIGNAL FAIL (CH A T&M)
CE3-30-M4LM-1
LOGIC MATRIX CD OUTPUT RELAYS TO K4 FAIL
CE3-30-M4LM-CD
LOGIC MATRIX BD OUTPUT RELAYS TO K4 FAIL
CE3-30-M4LM-BD
LOGIC MATRIX BC OUTPUT RELAYS TO K4 FAIL
CE3-30-M4LM-BC
CD OUTPUT RELAY 4 FAILS
2.6E-4
CE3-RYL-FF-LCD4
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
138
CE3-33-LMCDATM
BD OUTPUT RELAY 4 FAILS
2.6E-4
CE3-RYL-FF-LBD4
INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
137
CE3-32-LMBDATM
BC OUTPUT RELAY 4 FAILS
2.6E-4
CE3-RYL-FF-LBC4
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
136
CE3-31-LMBCATM
CE3-30-M4LMATM - FAILURE OF LOGIC MATRIX RELAYS FOR K4 SIGNAL (CH A T&M)
2001/06/07 Page 135


INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
CE3-31-LMBCATM
INPUT TO LOGIC MATRIX BC FROM CHANNEL B FAILS (CH A T&M)
CE3-31-LMBC-CB
INPUT TO LOGIC MATRIX BC FROM CHANNEL C FAILS (CH A T&M)
CE3-31-LMBC-CC
CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M)
139
CE3-34-CHBTATM
CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M)
140
CE3-35-CHBPATM
CHANNEL C TEMPERATURE BISTABLE FAILS (CH A T&M)
141
CE3-36-CHCTATM
CHANNEL C PRESSURE BISTABLE FAILS (CH A T&M)
142
CE3-37-CHCPATM
CE3-31-LMBCATM - INPUT SIGNAL TO LOGIC MATRIX BC FAILS (CH A T&M)
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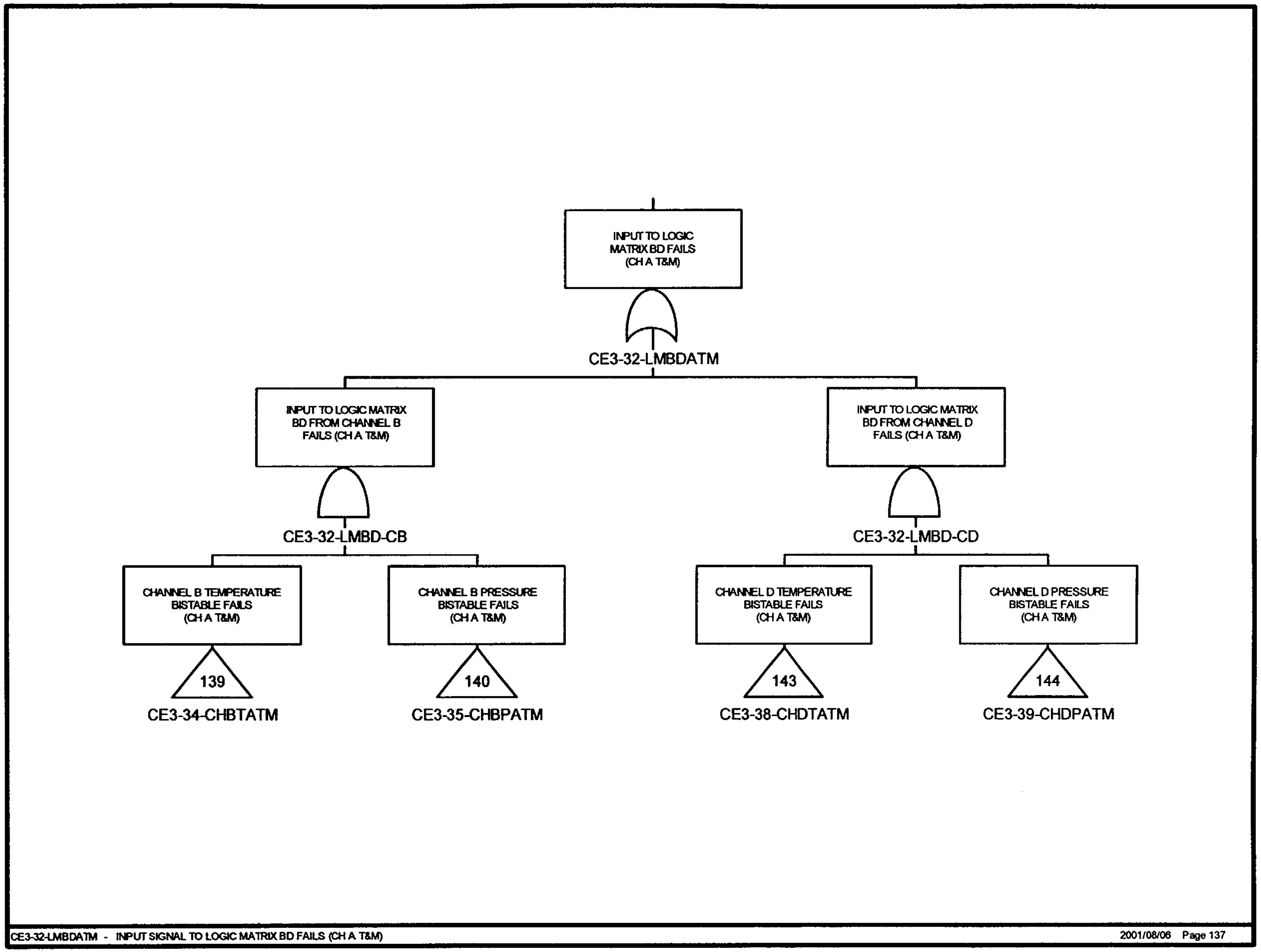
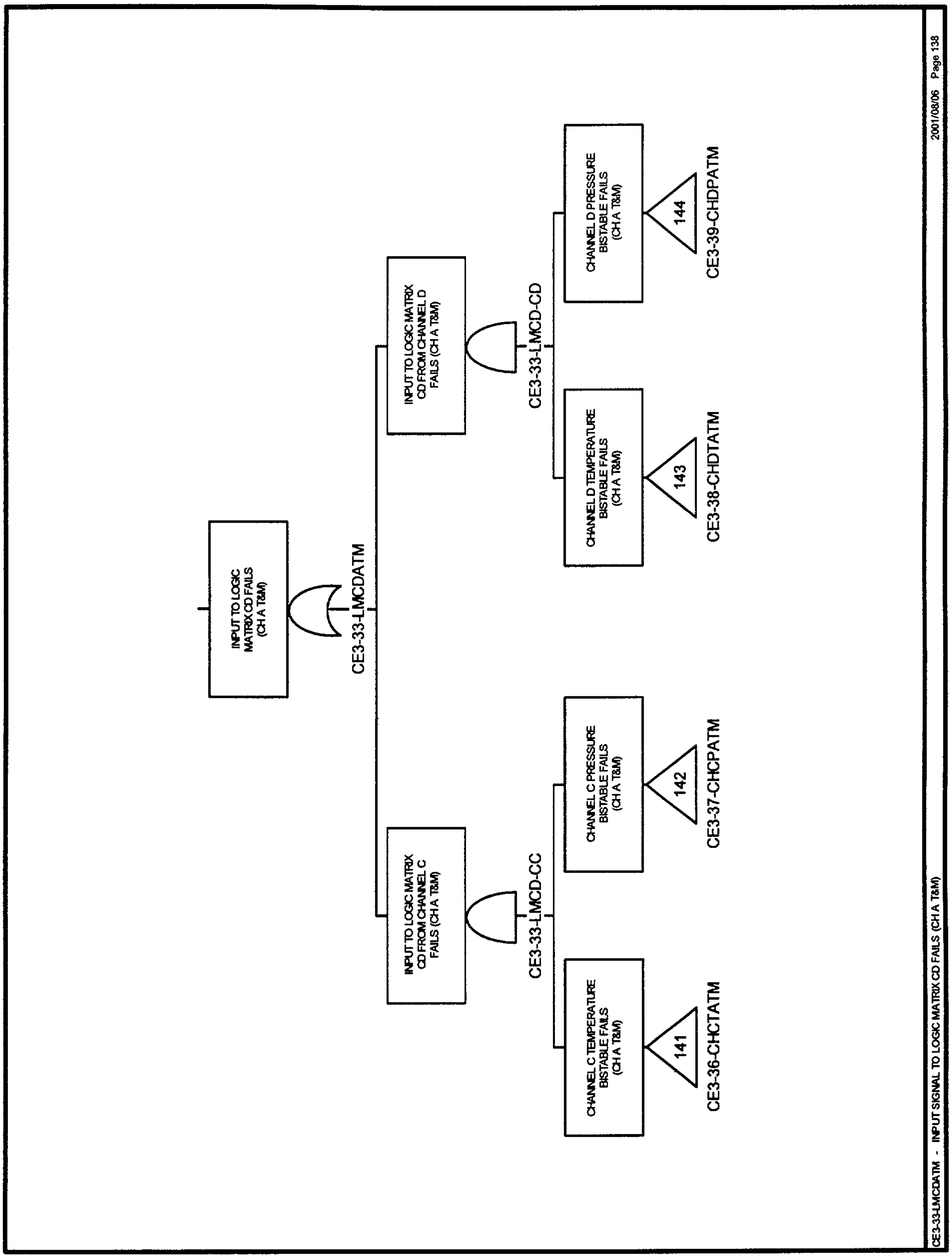
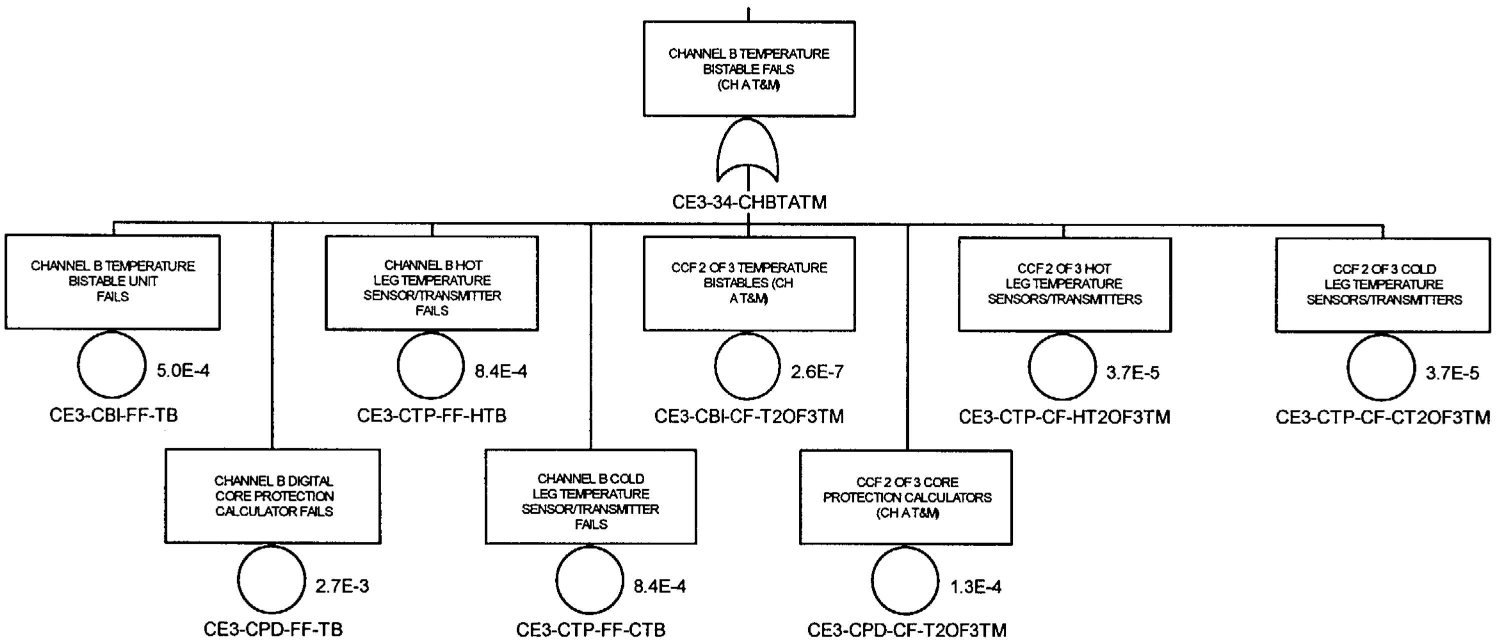
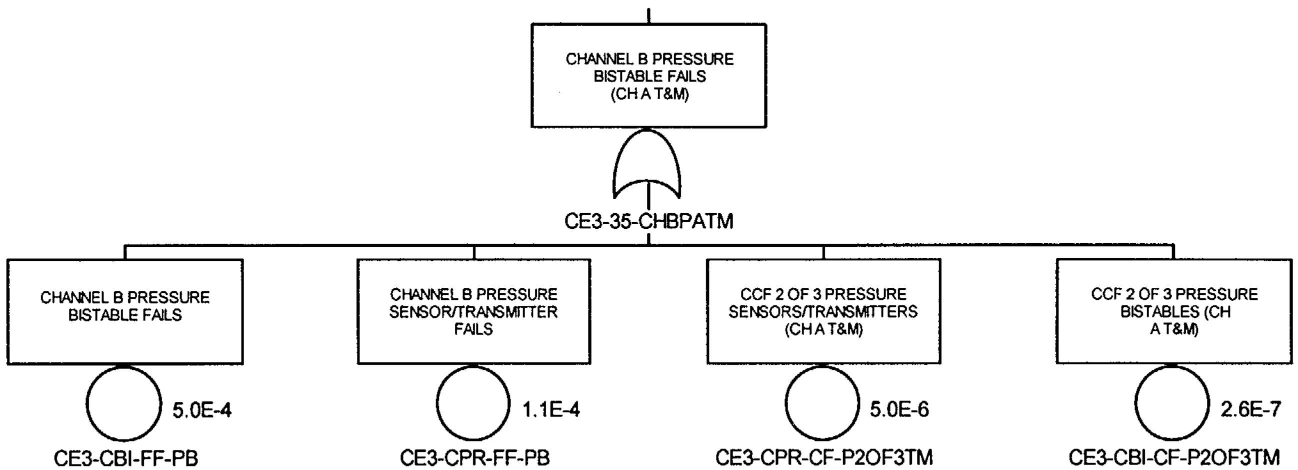

INPUT TO LOGIC
MATRIX BD FAILS
(CH A T&M)
CE3-32-LMBDATM
INPUT TO LOGIC MATRIX
BD FROM CHANNEL B
FAILS (CH A T&M)
CE3-32-LMBD-CB
INPUT TO LOGIC MATRIX
BD FROM CHANNEL D
FAILS (CH A T&M)
CE3-32-LMBD-CD
CHANNEL B TEMPERATURE
BISTABLE FAILS
(CH A T&M)
139
CE3-34-CHBTATM
CHANNEL B PRESSURE
BISTABLE FAILS
(CH A T&M)
140
CE3-35-CHBPATM
CHANNEL D TEMPERATURE
BISTABLE FAILS
(CH A T&M)
143
CE3-38-CHDTATM
CHANNEL D PRESSURE
BISTABLE FAILS
(CH A T&M)
144
CE3-39-CHDPATM
CE3-32-LMBDATM - INPUT SIGNAL TO LOGIC MATRIX BD FAILS (CH A T&M)
2001/08/06 Page 137



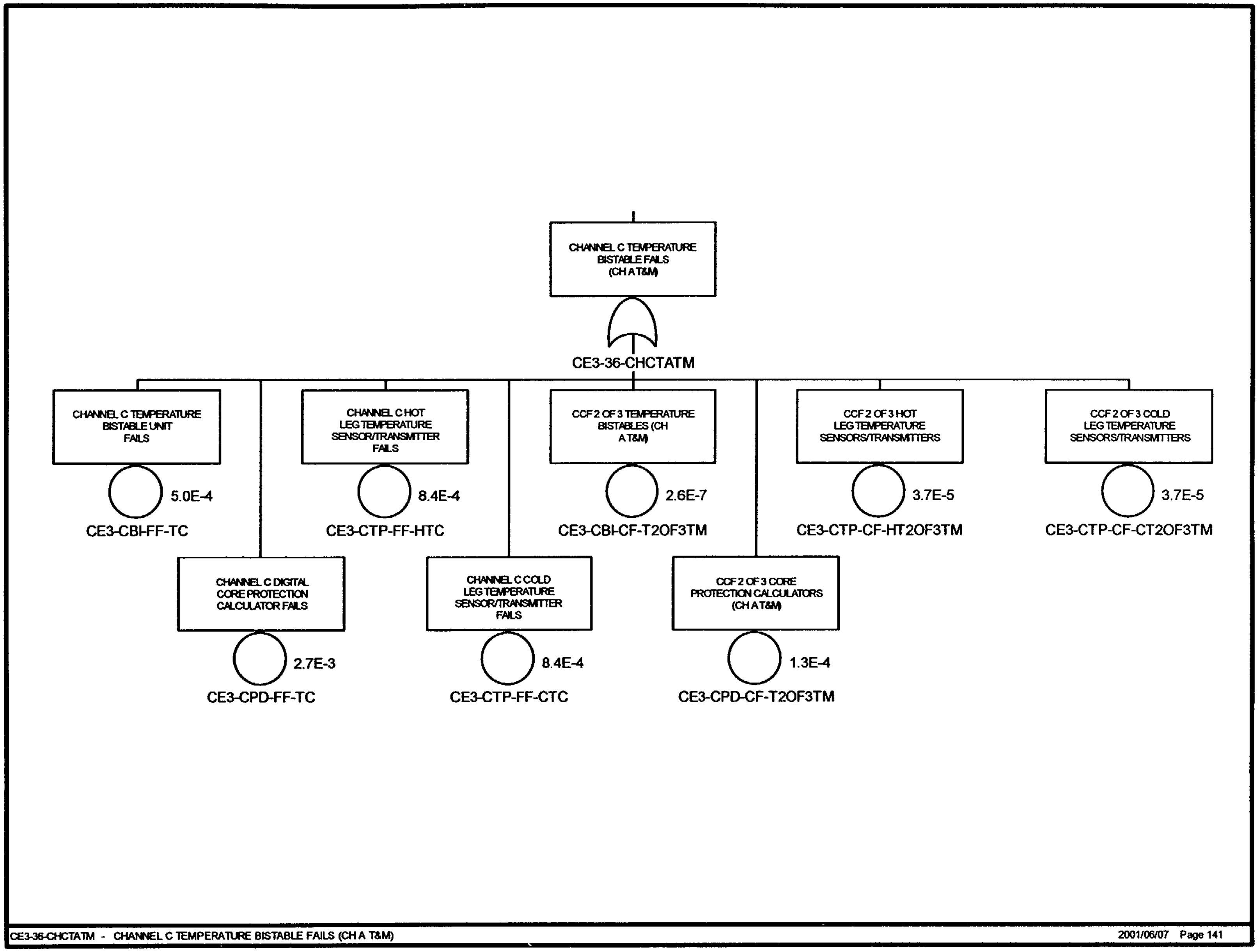
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
CE3-33-LMCDATM
INPUT TO LOGIC MATRIX CD FROM CHANNEL C FAILS (CH A T&M)
CE3-33-LMCD-CC
INPUT TO LOGIC MATRIX CD FROM CHANNEL D FAILS (CH A T&M)
CE3-33-LMCD-CD
CHANNEL C TEMPERATURE BISTABLE FAILS (CH A T&M)
141
CE3-36-CHCTATM
CHANNEL C PRESSURE BISTABLE FAILS (CH A T&M)
142
CE3-37-CHCPATM
CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
143
CE3-38-CHDTATM
CHANNEL D PRESSURE BISTABLE FAILS (CH A T&M)
144
CE3-39-CHDPATM
CE3-33-LMCDATM - INPUT SIGNAL TO LOGIC MATRIX CD FAILS (CH A T&M)
2001/08/06 Page 138

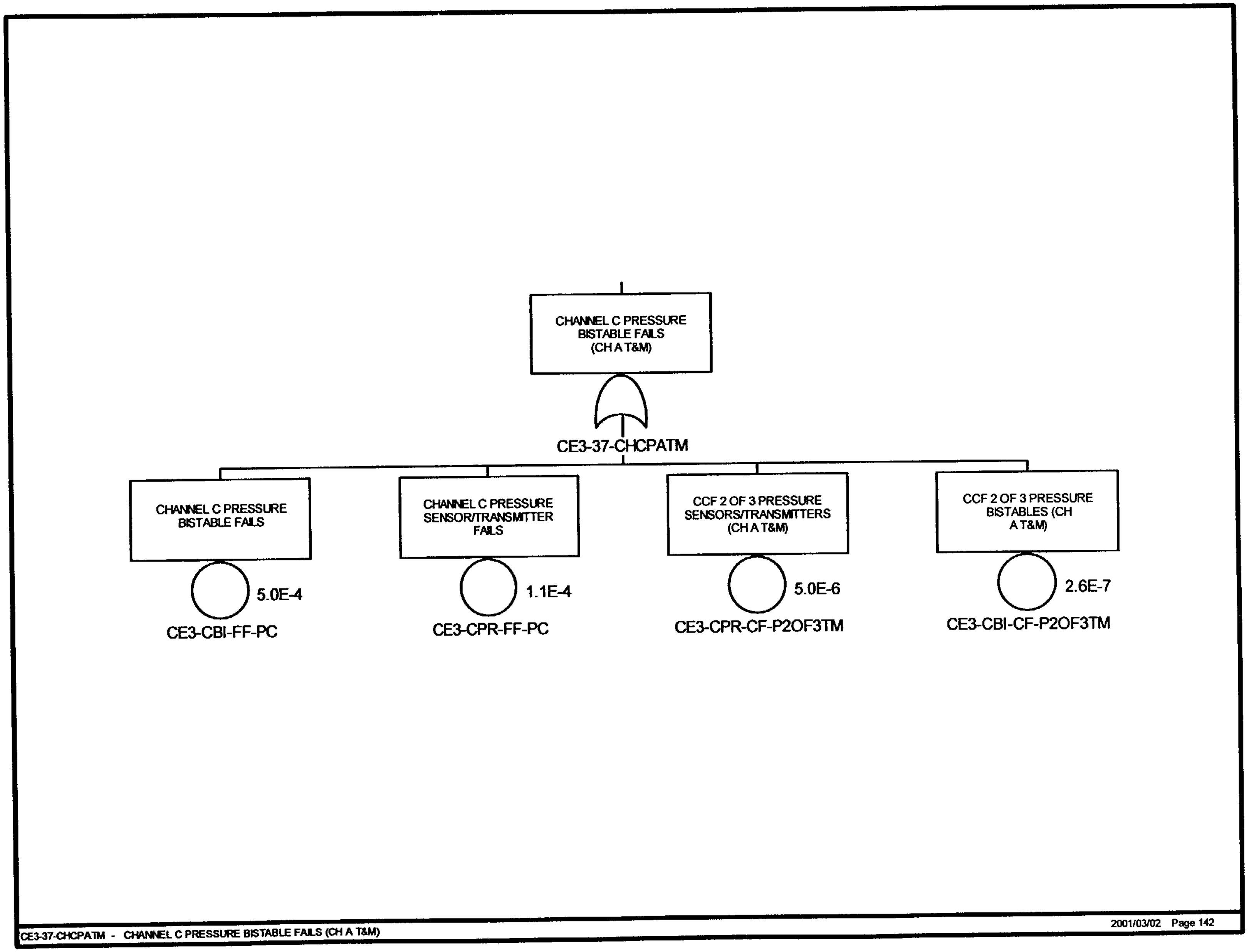


CE3-34-CHBTATM - CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M) 2001/06/07 Page 139

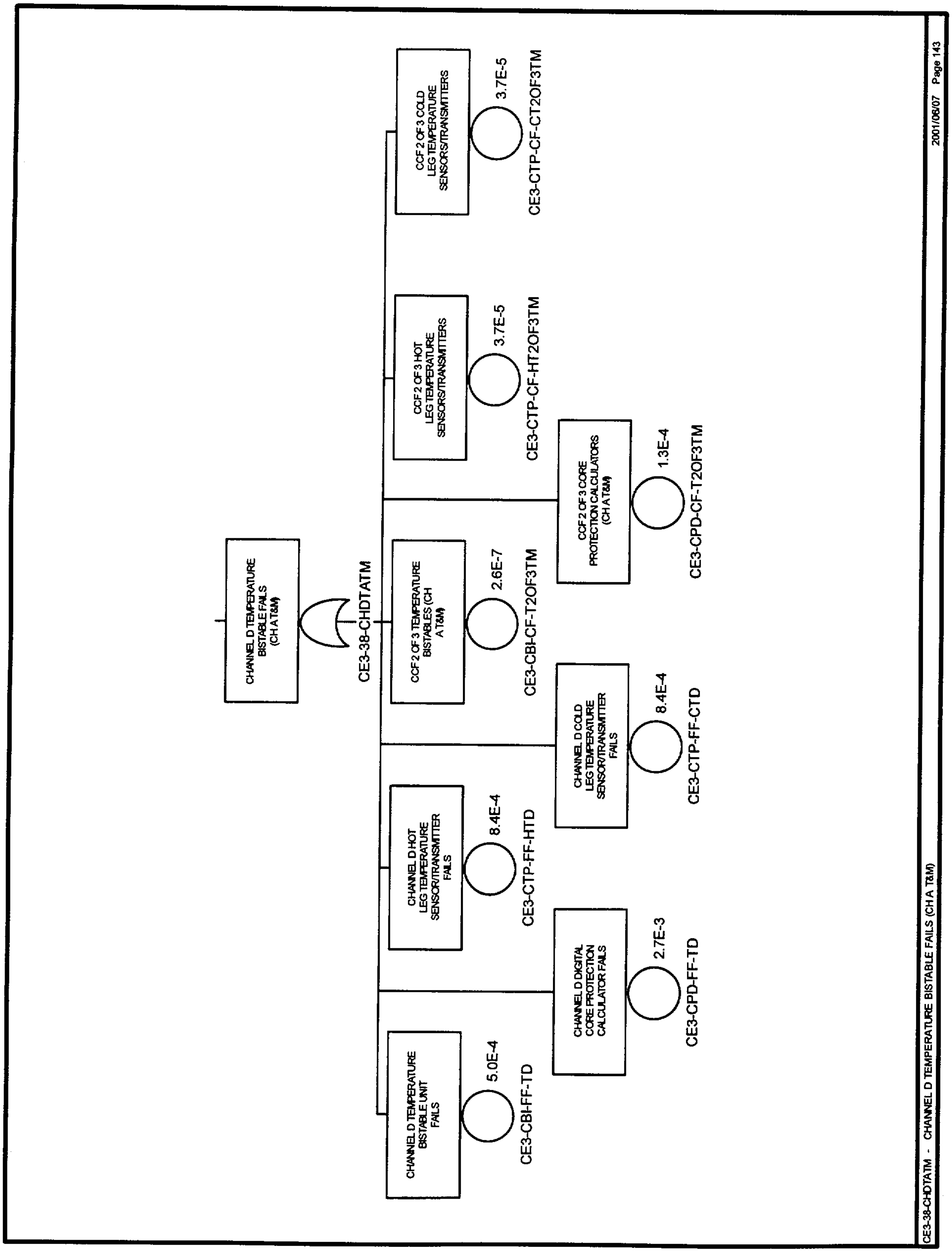


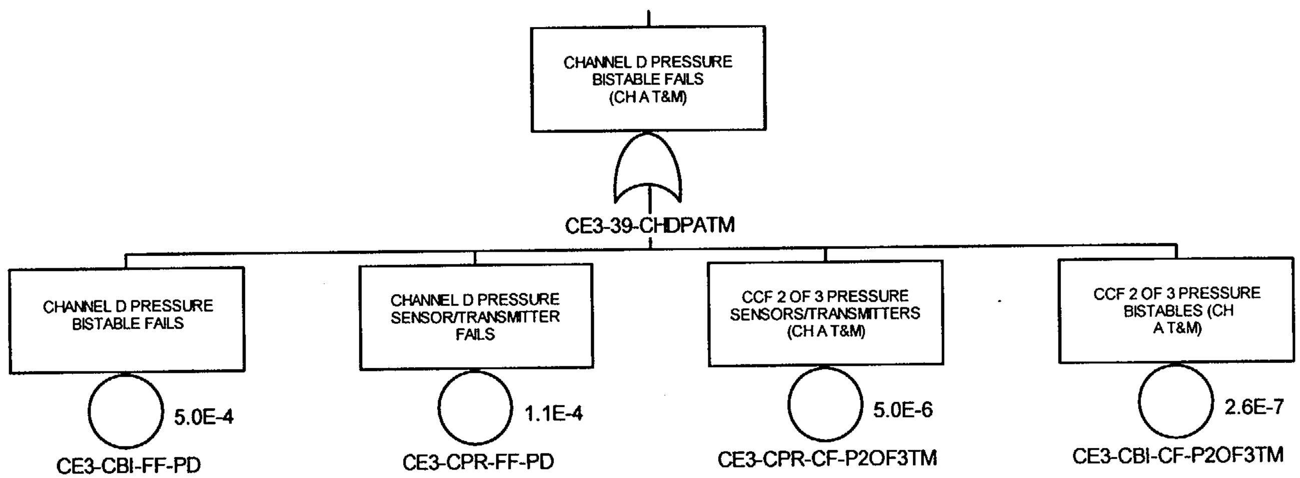
CE3-35-CHBPATM - CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M) 2001/03/02 Page 140


CHANNEL C TEMPERATURE BISTABLE FAILS (CH A T&M)
CE3-36-CHCTATM
CHANNEL C TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE3-CBI-FF-TC
CHANNEL C HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-HTC
CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
2.6E-7
CE3-CBI-CF-T2OF3TM
CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE3-CTP-CF-HT2OF3TM
CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE3-CTP-CF-CT2OF3TM
CHANNEL C DIGITAL CORE PROTECTION CALCULATOR FAILS
2.7E-3
CE3-CPD-FF-TC
CHANNEL C COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-CTC
CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
1.3E-4
CE3-CPD-CF-T2OF3TM
CE3-36-CHCTATM - CHANNEL C TEMPERATURE BISTABLE FAILS (CH A T&M)
2001/06/07 Page 141



CHANNEL C PRESSURE BISTABLE FAILS (CH A T&M)
CE3-37-CHCPATM
CHANNEL C PRESSURE BISTABLE FAILS
5.0E-4
CE3-CBI-FF-PC
CHANNEL C PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE3-CPR-FF-PC
CCF 2 OF 3 PRESSURE SENSORS/TRANSMITTERS (CH A T&M)
5.0E-6
CE3-CPR-CF-P2OF3TM
CCF 2 OF 3 PRESSURE BISTABLES (CH A T&M)
2.6E-7
CE3-CBI-CF-P2OF3TM
CE3-37-CHCPATM - CHANNEL C PRESSURE BISTABLE FAILS (CH A T&M)
2001/03/02 Page 142


CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
CE3-38-CHDTATM
CHANNEL D TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE3-CBI-FF-TD
CHANNEL D DIGITAL CORE PROTECTION CALCULATOR FAILS
2.7E-3
CE3-CPD-FF-TD
CHANNEL D HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-HTD
CHANNEL D COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE3-CTP-FF-CTD
CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
2.6E-7
CE3-CBI-CF-T2OF3TM
CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
1.3E-4
CE3-CPD-CF-T2OF3TM
CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE3-CTP-CF-HT2OF3TM
CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE3-CTP-CF-CT2OF3TM
CE3-38-CHDTATM - CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
2001/06/07 Page 143



CE3-39-CHDPATM - CHANNEL D PRESSURE BISTABLE FAILS (CH A T&M)

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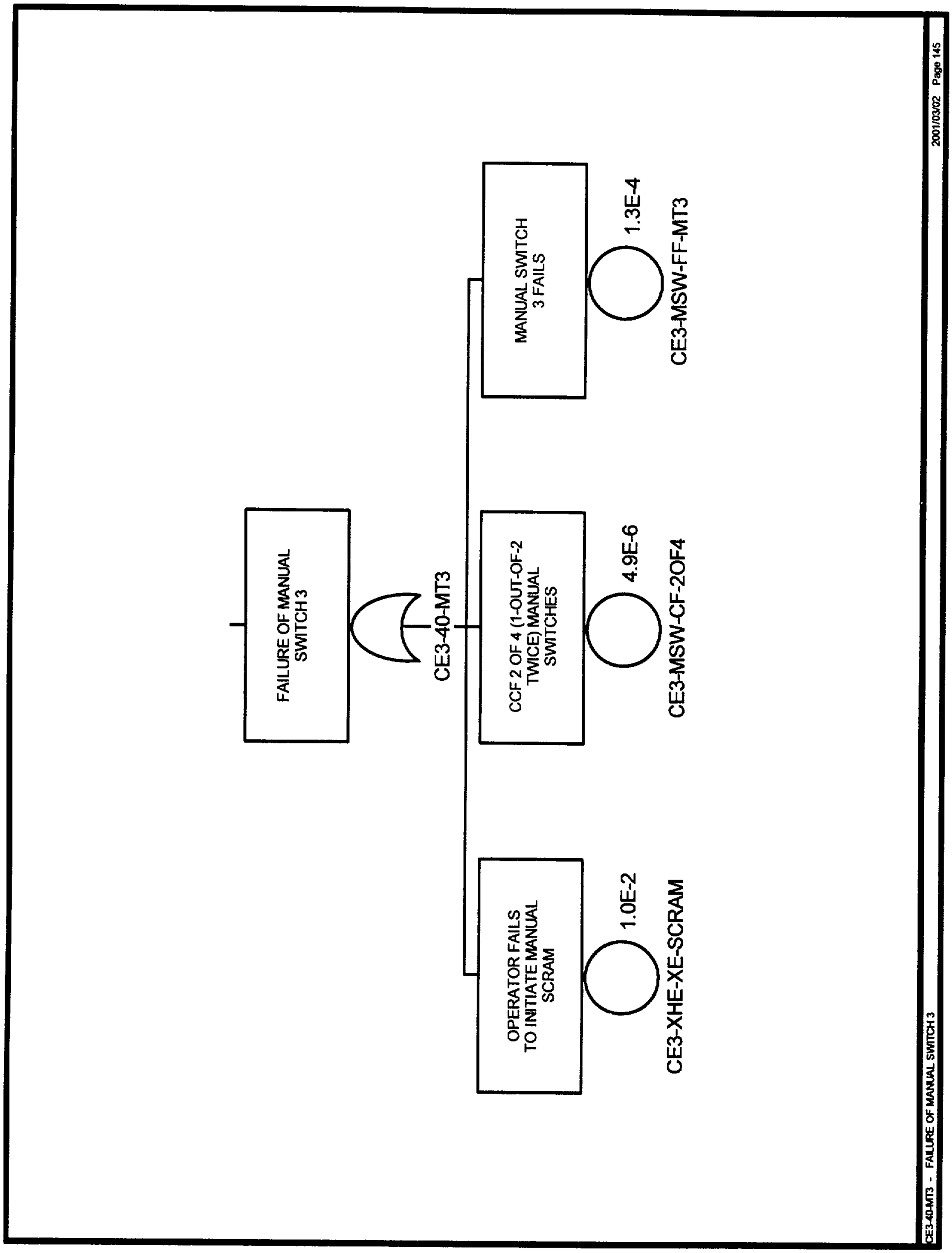
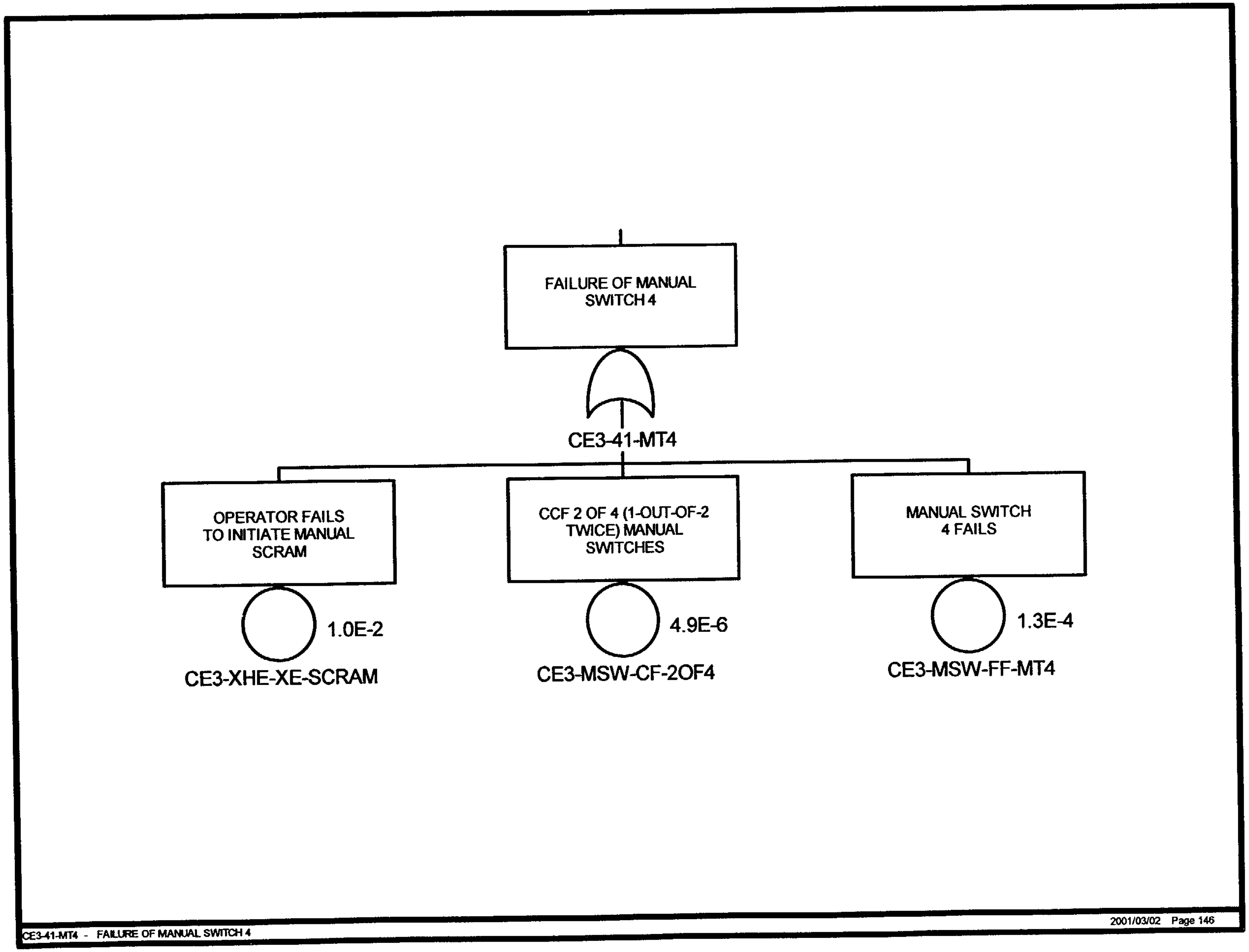
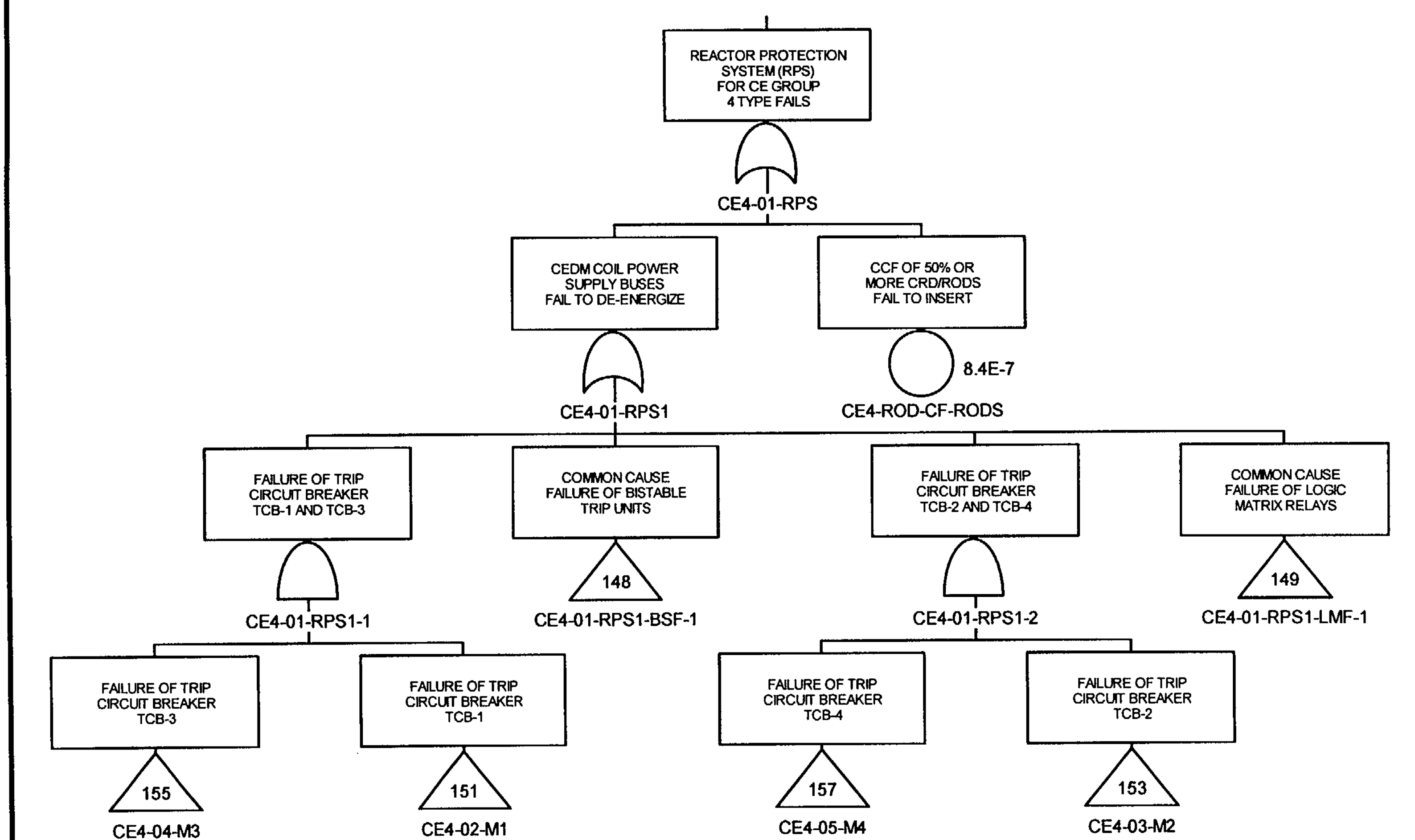
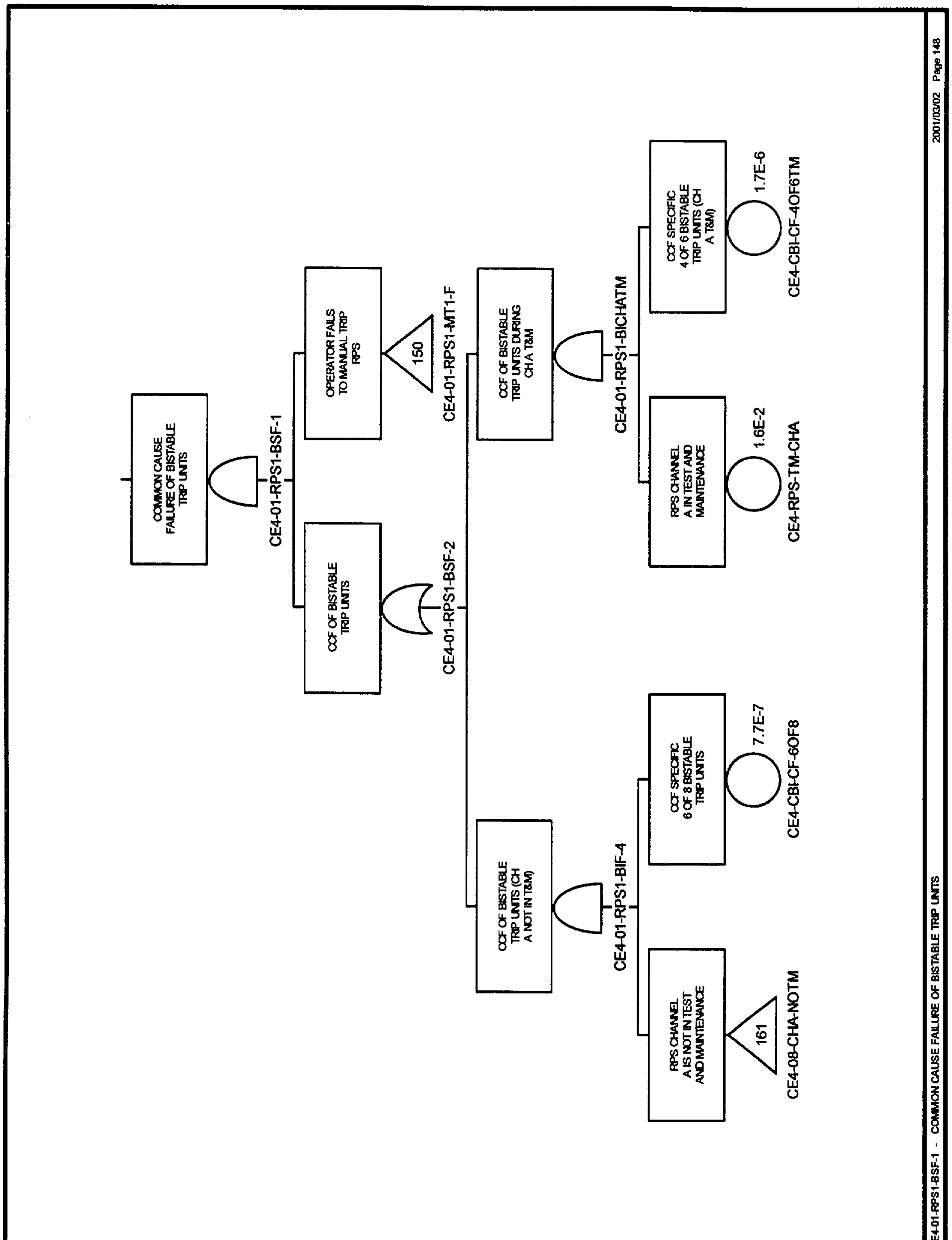

FAILURE OF MANUAL SWITCH 3
CE3-40-MT3
OPERATOR FAILS TO INITIATE MANUAL SCRAM
1.0E-2
CE3-XHE-XE-SCRAM
CCF 2 OF 4 (1-OUT-OF-2 TWICE) MANUAL SWITCHES
4.9E-6
CE3-MSW-CF-2OF4
MANUAL SWITCH 3 FAILS
1.3E-4
CE3-MSW-FF-MT3
CE3-40-MT3 - FAILURE OF MANUAL SWITCH 3
2001/03/02 Page 145

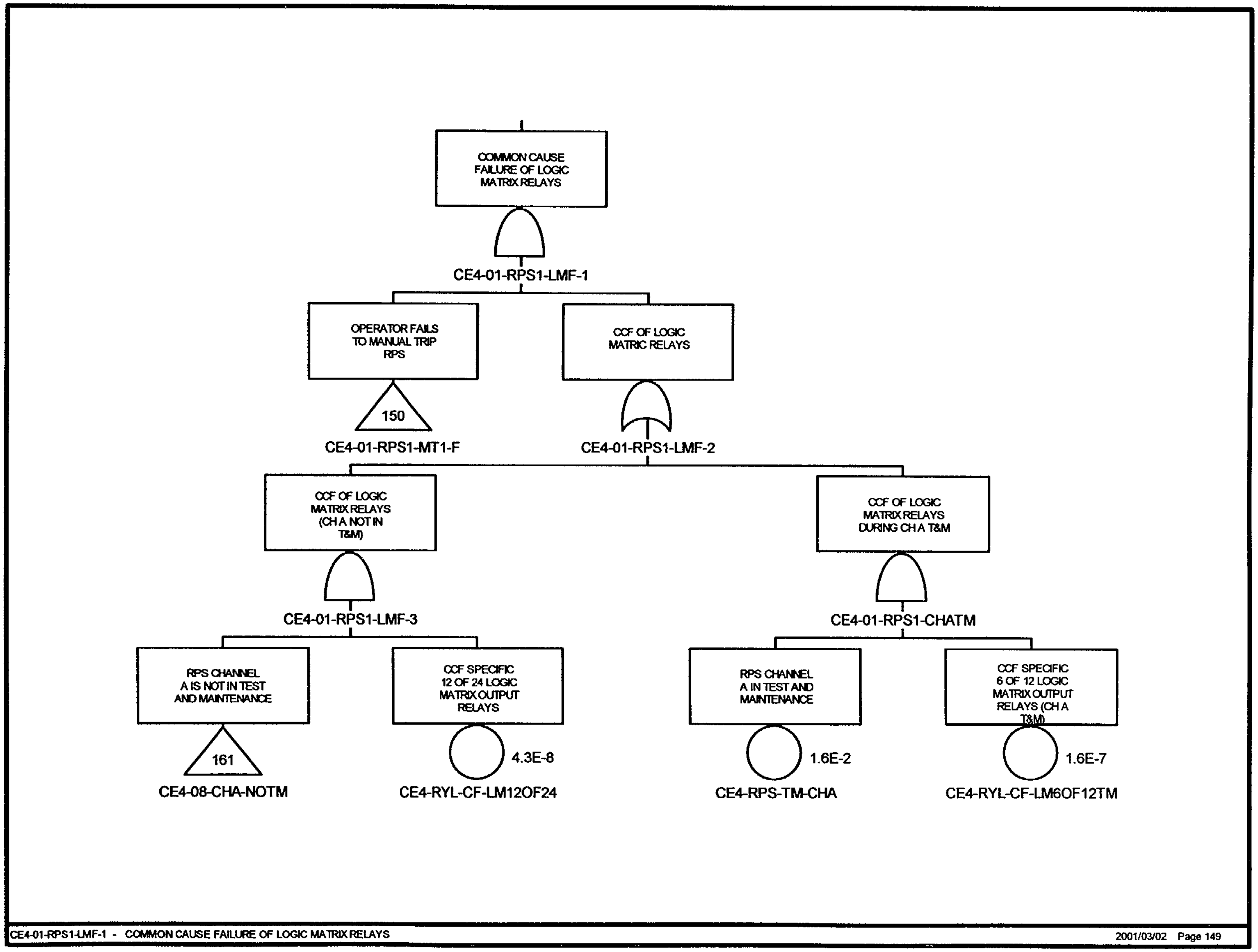

FAILURE OF MANUAL SWITCH 4
CE3-41-MT4
OPERATOR FAILS TO INITIATE MANUAL SCRAM
1.0E-2
CE3-XHE-XE-SCRAM
CCF 2 OF 4 (1-OUT-OF-2 TWICE) MANUAL SWITCHES
4.9E-6
CE3-MSW-CF-2OF4
MANUAL SWITCH 4 FAILS
1.3E-4
CE3-MSW-FF-MT4
CE3-41-MT4 - FAILURE OF MANUAL SWITCH 4
2001/03/02 Page 146

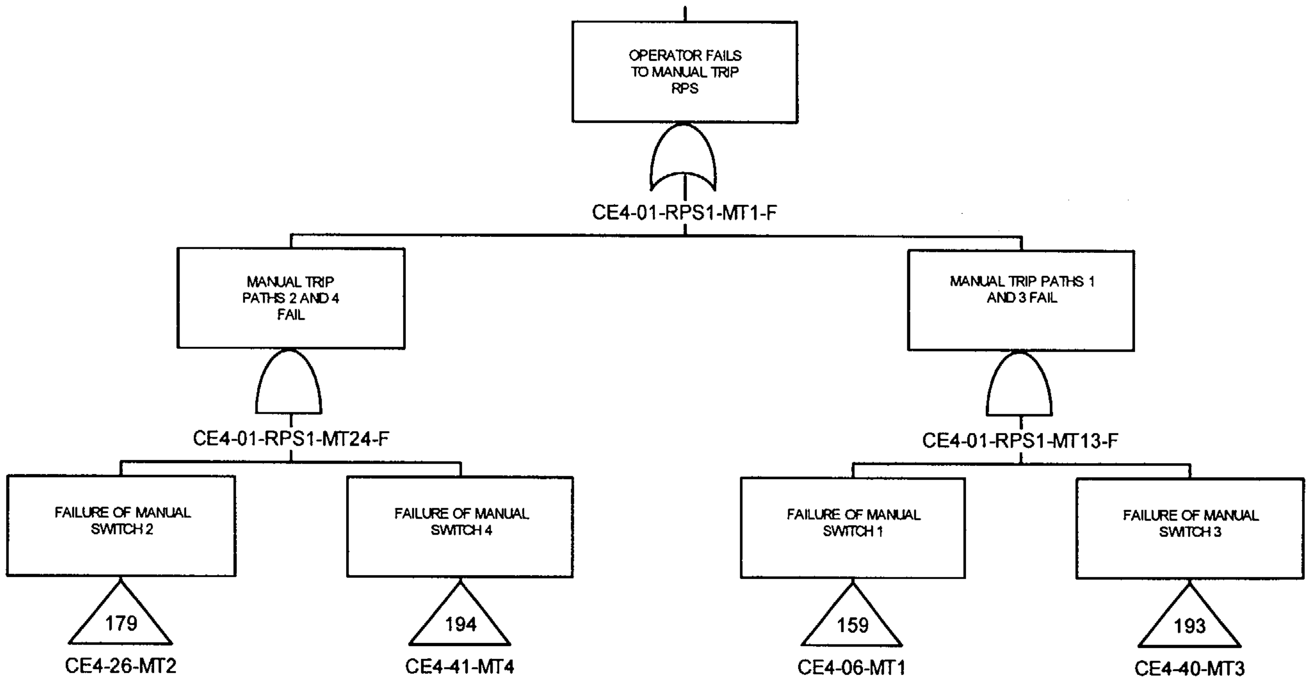
COMBUSTION ENGINEERING RPS GROUP 4 MODEL



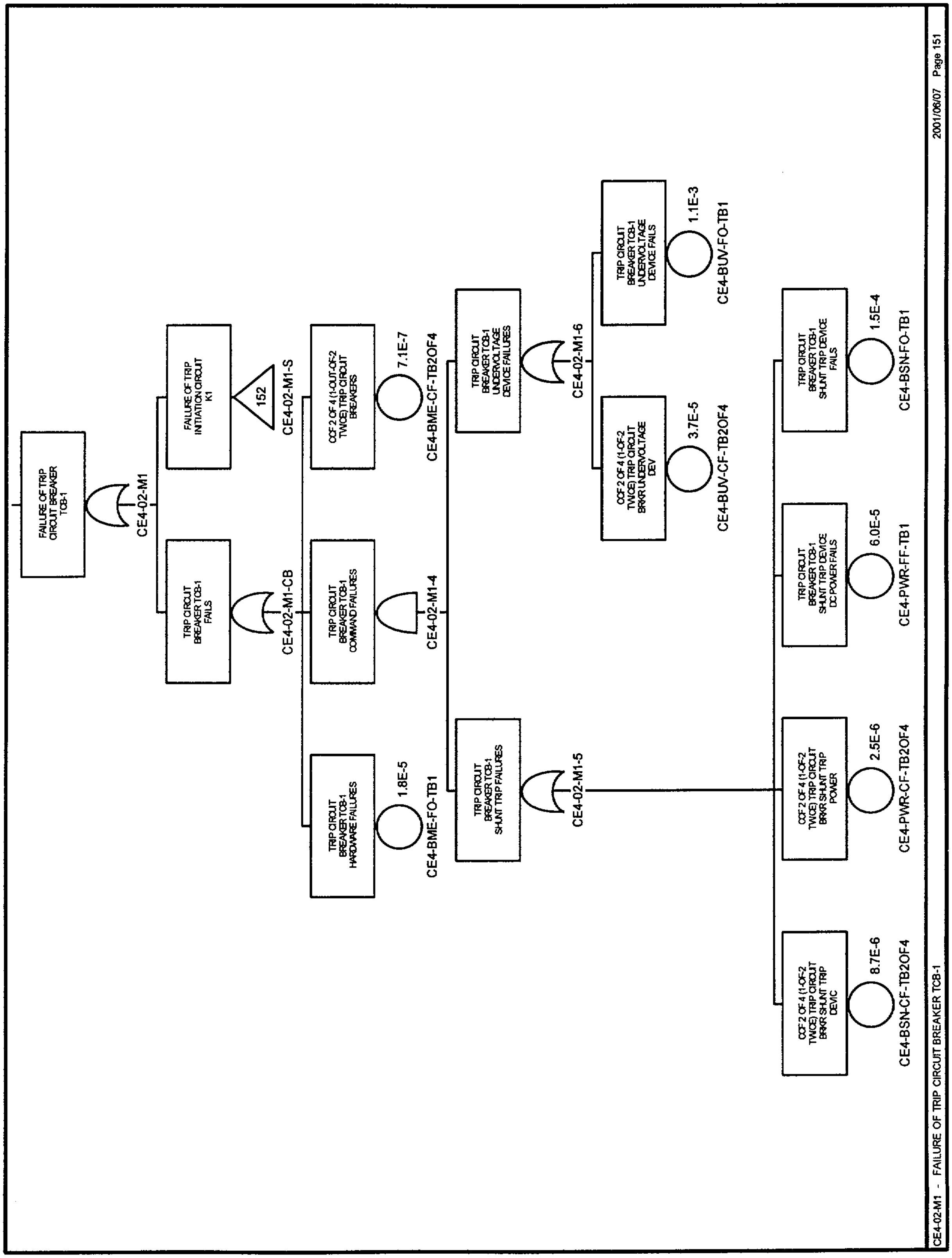
CE4-01-RPS - REACTOR PROTECTION SYSTEM (RPS) FOR CE GROUP 4 TYPE FAILS 2001/06/07 Page 147


COMMON CAUSE FAILURE OF BISTABLE TRIP UNITS
CE4-01-RPS1-BSF-1
CCF OF BISTABLE TRIP UNITS
CE4-01-RPS1-BSF-2
OPERATOR FAILS TO MANUAL TRIP RPS
150
CE4-01-RPS1-MT1-F
CCF OF BISTABLE TRIP UNITS (CH A NOT IN T&M)
CE4-01-RPS1-BIF-4
CCF OF BISTABLE TRIP UNITS DURING CH A T&M
CE4-01-RPS1-BICHATM
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
161
CE4-08-CHA-NOTM
CCF SPECIFIC 6 OF 8 BISTABLE TRIP UNITS
7.7E-7
CE4-CBI-CF-6OF8
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE4-RPS-TM-CHA
CCF SPECIFIC 4 OF 6 BISTABLE TRIP UNITS (CH A T&M)
1.7E-6
CE4-CBI-CF-4OF6TM
CE4-01-RPS1-BSF-1 - COMMON CAUSE FAILURE OF BISTABLE TRIP UNITS
2001/03/02 Page 148

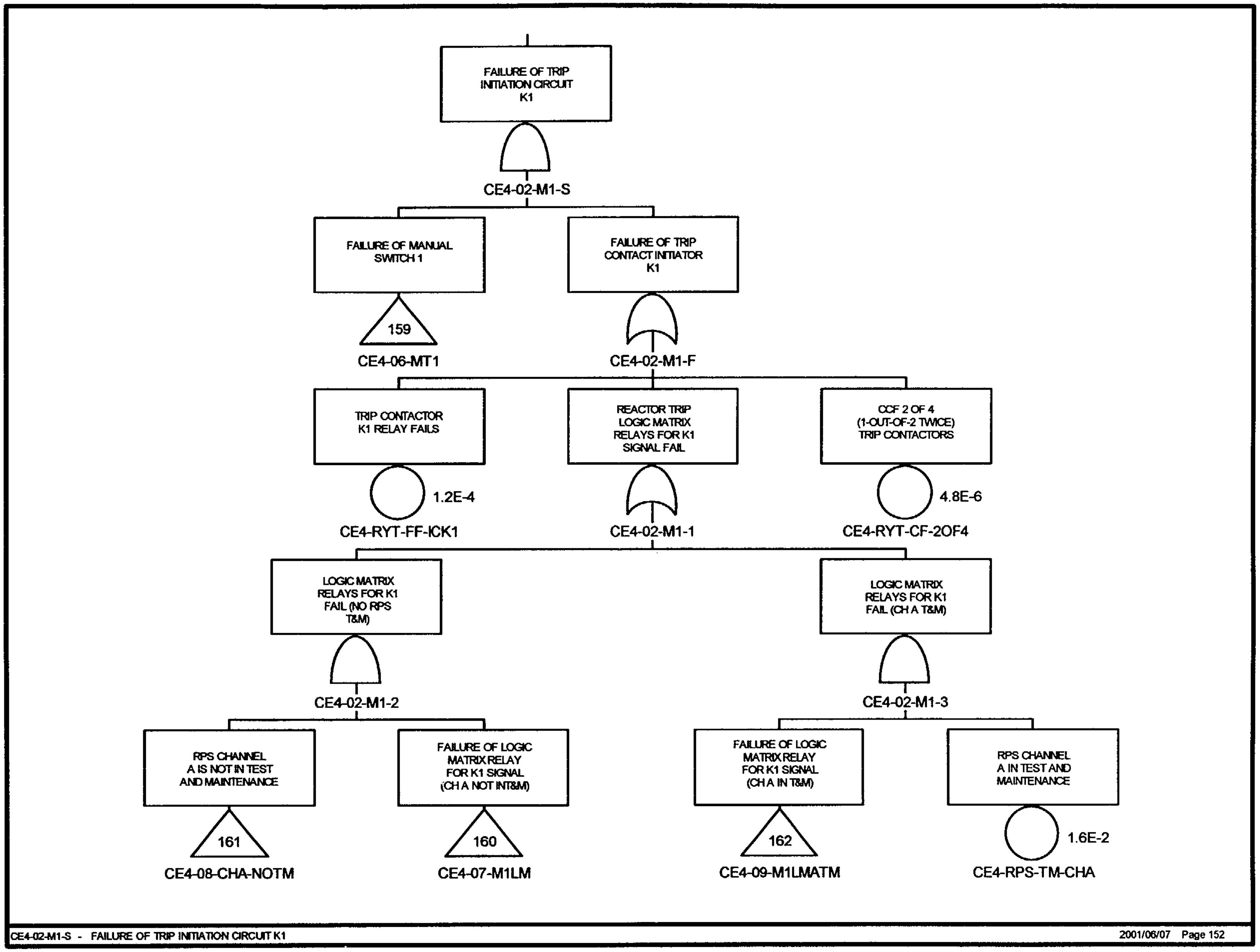

COMMON CAUSE FAILURE OF LOGIC MATRIX RELAYS
CE4-01-RPS1-LMF-1
OPERATOR FAILS TO MANUAL TRIP RPS
150
CE4-01-RPS1-MT1-F
CCF OF LOGIC MATRIC RELAYS
CE4-01-RPS1-LMF-2
CCF OF LOGIC MATRIX RELAYS (CH A NOT IN T&M)
CE4-01-RPS1-LMF-3
CCF OF LOGIC MATRIX RELAYS DURING CH A T&M
CE4-01-RPS1-CHATM
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
161
CE4-08-CHA-NOTM
CCF SPECIFIC 12 OF 24 LOGIC MATRIX OUTPUT RELAYS
4.3E-8
CE4-RYL-CF-LM12OF24
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE4-RPS-TM-CHA
CCF SPECIFIC 6 OF 12 LOGIC MATRIX OUTPUT RELAYS (CH A T&M)
1.6E-7
CE4-RYL-CF-LM6OF12TM
CE4-01-RPS1-LMF-1 - COMMON CAUSE FAILURE OF LOGIC MATRIX RELAYS
2001/03/02 Page 149

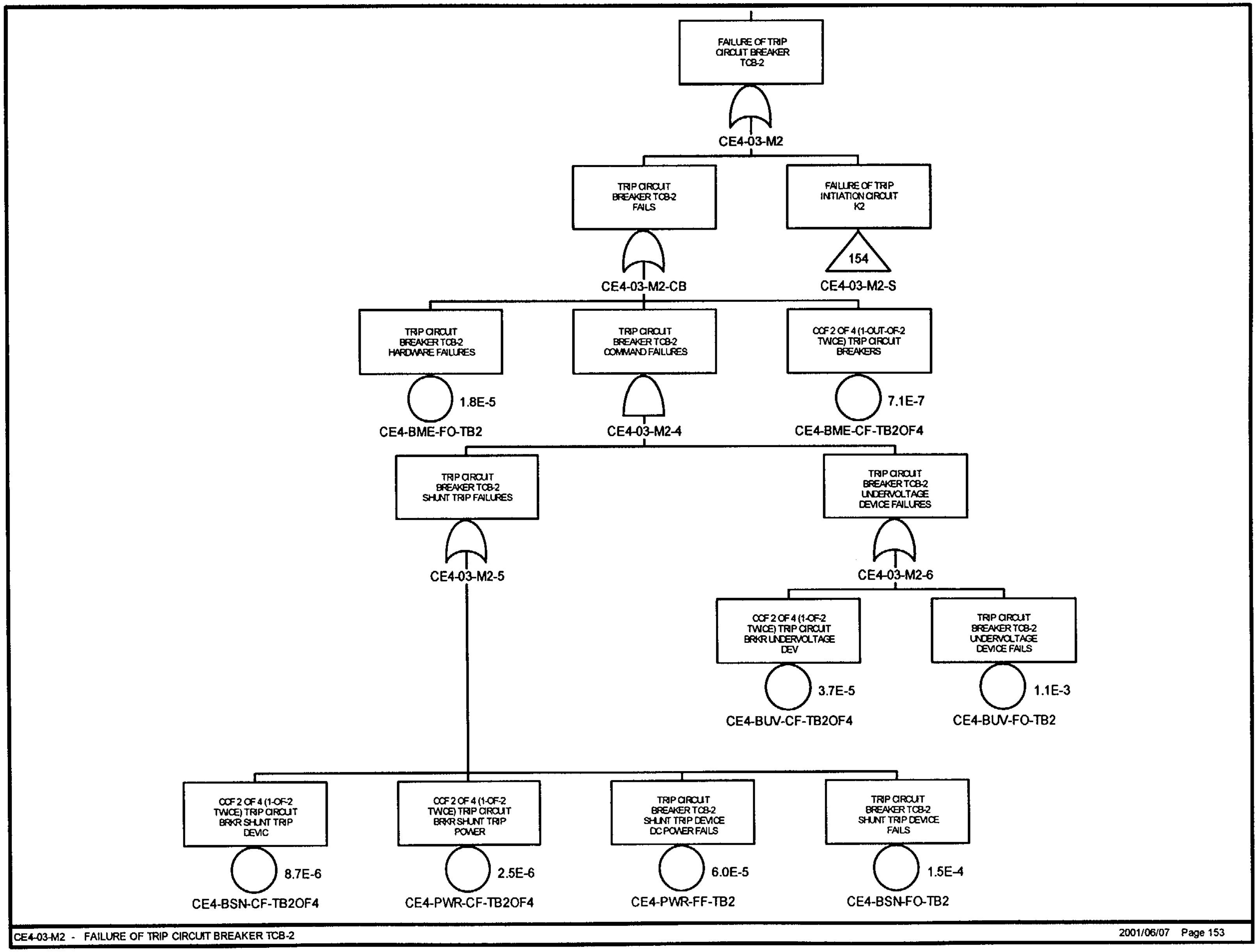


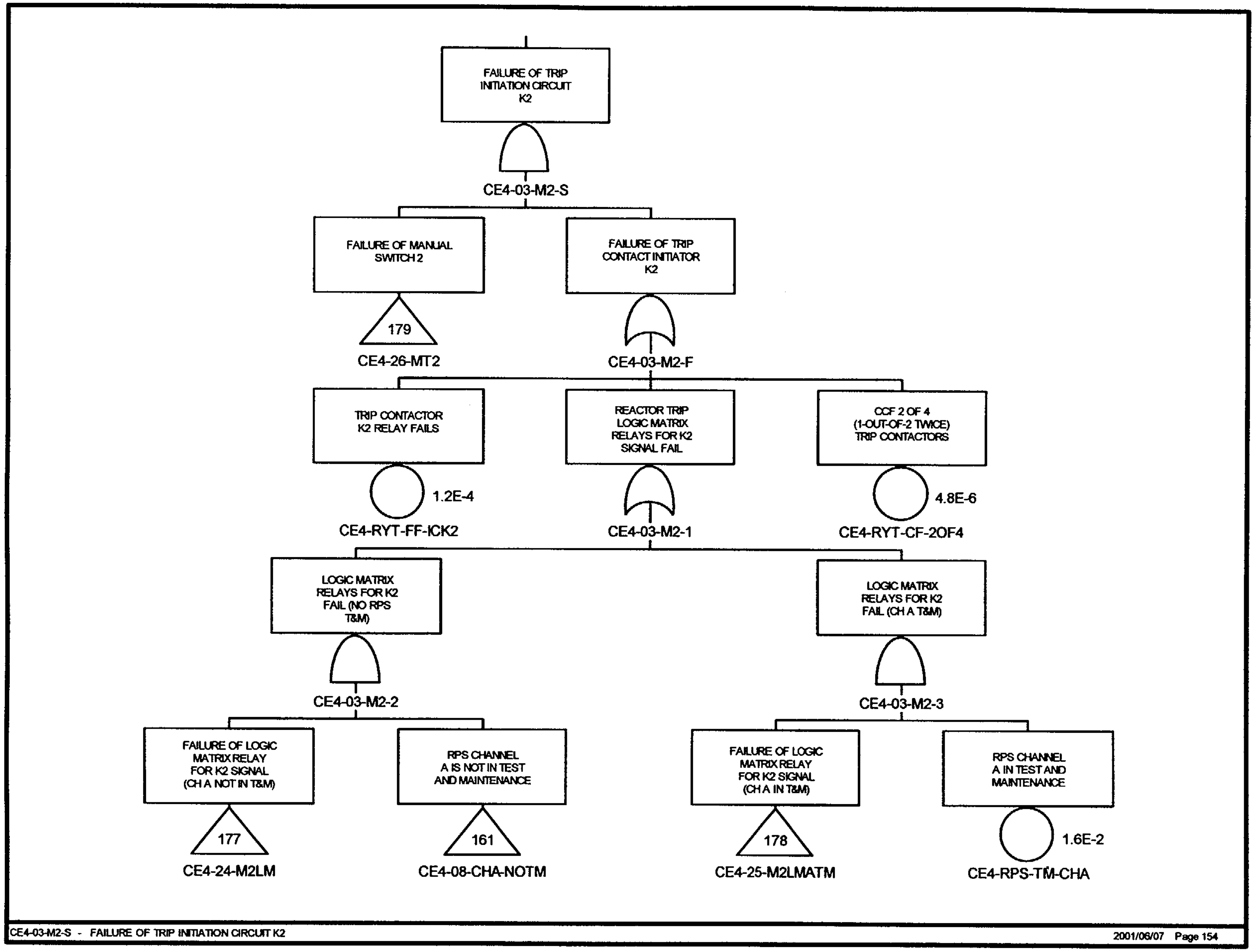
CE4-01-RPS1-MT1-F - OPERATOR FAILS TO MANUAL TRIP RPS 2001/08/06 Page 150



FAILURE OF TRIP CIRCUIT BREAKER TCB-1
CE4-02-M1
TRIP CIRCUIT BREAKER TCB-1 FAILS
CE4-02-M1-CB
FAILURE OF TRIP INITIATION CIRCUIT K1
152
CE4-02-M1-S
TRIP CIRCUIT BREAKER TCB-1 HARDWARE FAILURES
1.8E-5
CE4-BME-FO-TB1
TRIP CIRCUIT BREAKER TCB-1 COMMAND FAILURES
CE4-02-M1-4
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CIRCUIT BREAKERS
7.1E-7
CE4-BME-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-1 SHUNT TRIP FAILURES
CE4-02-M1-5
TRIP CIRCUIT BREAKER TCB-1 UNDERVOLTAGE DEVICE FAILURES
CE4-02-M1-6
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR UNDERVOLTAGE DEV
3.7E-5
CE4-BUV-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-1 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE4-BUV-FO-TB1
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP DEVIC
8.7E-6
CE4-BSN-CF-TB2OF4
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE4-PWR-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-1 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE4-PWR-FF-TB1
TRIP CIRCUIT BREAKER TCB-1 SHUNT TRIP DEVICE FAILS
1.5E-4
CE4-BSN-FO-TB1
CE4-02-M1 - FAILURE OF TRIP CIRCUIT BREAKER TCB-1
2001/06/07 Page 151


FAILURE OF TRIP INITIATION CIRCUIT K1
CE4-02-M1-S
FAILURE OF MANUAL SWITCH 1
159
CE4-06-MT1
FAILURE OF TRIP CONTACT INITIATOR K1
CE4-02-M1-F
TRIP CONTACTOR K1 RELAY FAILS
1.2E-4
CE4-RYT-FF-ICK1
REACTOR TRIP LOGIC MATRIX RELAYS FOR K1 SIGNAL FAIL
CE4-02-M1-1
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CONTACTORS
4.8E-6
CE4-RYT-CF-2OF4
LOGIC MATRIX RELAYS FOR K1 FAIL (NO RPS T&M)
CE4-02-M1-2
LOGIC MATRIX RELAYS FOR K1 FAIL (CH A T&M)
CE4-02-M1-3
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
161
CE4-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A NOT INT&M)
160
CE4-07-M1LM
FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A IN T&M)
162
CE4-09-M1LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE4-RPS-TM-CHA
CE4-02-M1-S - FAILURE OF TRIP INITIATION CIRCUIT K1
2001/06/07 Page 152


FAILURE OF TRIP CIRCUIT BREAKER TCB-2
CE4-03-M2
TRIP CIRCUIT BREAKER TCB-2 FAILS
CE4-03-M2-CB
FAILURE OF TRIP INITIATION CIRCUIT K2
154
CE4-03-M2-S
TRIP CIRCUIT BREAKER TCB-2 HARDWARE FAILURES
1.8E-5
CE4-BME-FO-TB2
TRIP CIRCUIT BREAKER TCB-2 COMMAND FAILURES
CE4-03-M2-4
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CIRCUIT BREAKERS
7.1E-7
CE4-BME-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-2 SHUNT TRIP FAILURES
CE4-03-M2-5
TRIP CIRCUIT BREAKER TCB-2 UNDERVOLTAGE DEVICE FAILURES
CE4-03-M2-6
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR UNDERVOLTAGE DEV
3.7E-5
CE4-BUV-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-2 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE4-BUV-FO-TB2
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP DEVIC
8.7E-6
CE4-BSN-CF-TB2OF4
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE4-PWR-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-2 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE4-PWR-FF-TB2
TRIP CIRCUIT BREAKER TCB-2 SHUNT TRIP DEVICE FAILS
1.5E-4
CE4-BSN-FO-TB2
CE4-03-M2 - FAILURE OF TRIP CIRCUIT BREAKER TCB-2
2001/06/07 Page 153


FAILURE OF TRIP INITIATION CIRCUIT K2
CE4-03-M2-S
FAILURE OF MANUAL SWITCH 2
179
CE4-26-MT2
FAILURE OF TRIP CONTACT INITIATOR K2
CE4-03-M2-F
TRIP CONTACTOR K2 RELAY FAILS
1.2E-4
CE4-RYT-FF-ICK2
REACTOR TRIP LOGIC MATRIX RELAYS FOR K2 SIGNAL FAIL
CE4-03-M2-1
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CONTACTORS
4.8E-6
CE4-RYT-CF-2OF4
LOGIC MATRIX RELAYS FOR K2 FAIL (NO RPS T&M)
CE4-03-M2-2
LOGIC MATRIX RELAYS FOR K2 FAIL (CH A T&M)
CE4-03-M2-3
FAILURE OF LOGIC MATRIX RELAY FOR K2 SIGNAL (CH A NOT IN T&M)
177
CE4-24-M2LM
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
161
CE4-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR K2 SIGNAL (CH A IN T&M)
178
CE4-25-M2LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE4-RPS-TM-CHA
CE4-03-M2-S - FAILURE OF TRIP INITIATION CIRCUIT K2
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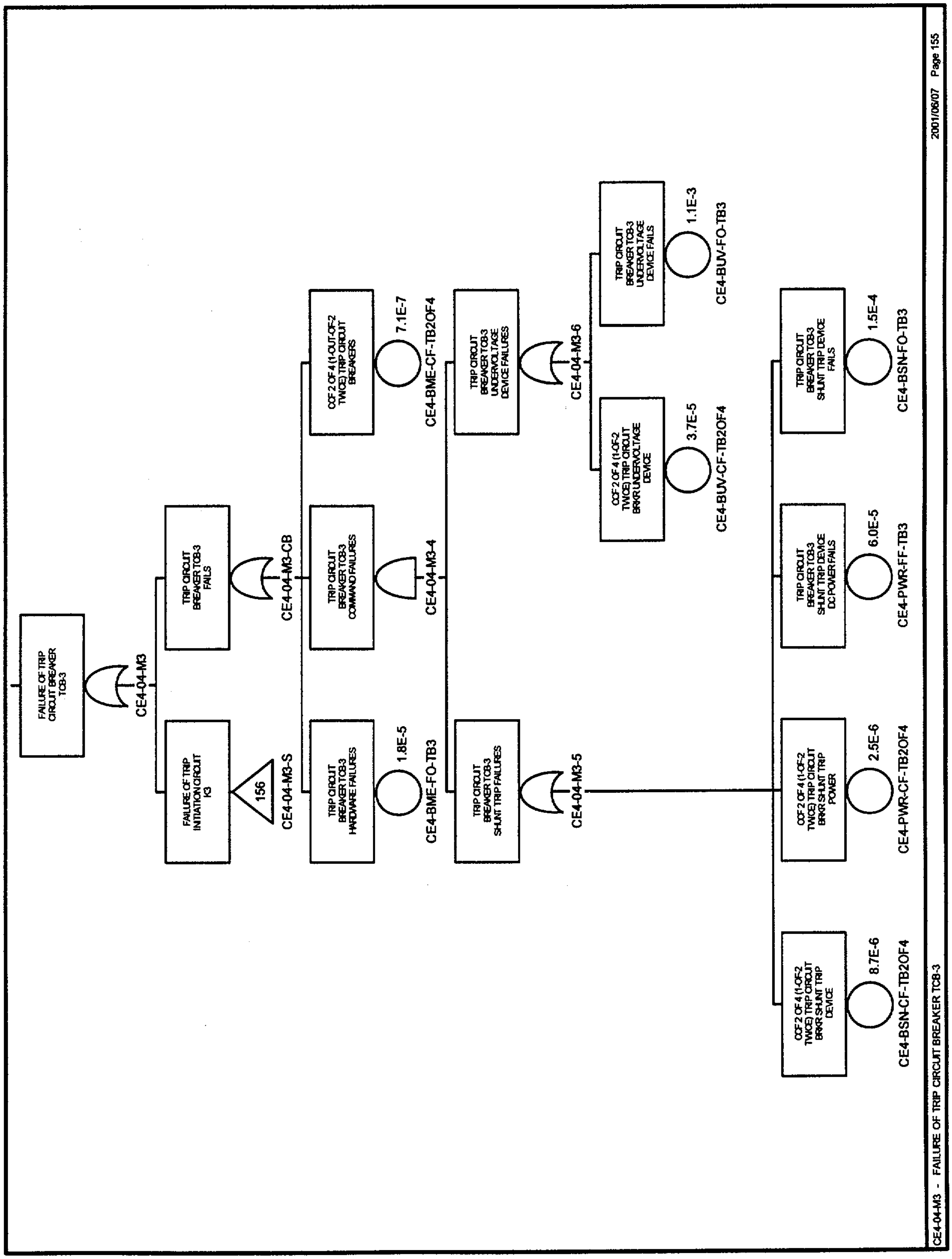
FAILURE OF TRIP CIRCUIT BREAKER TCB-3
CE4-04-M3
FAILURE OF TRIP INITIATION CIRCUIT K3
156
CE4-04-M3-S
TRIP CIRCUIT BREAKER TCB-3 FAILS
CE4-04-M3-CB
TRIP CIRCUIT BREAKER TCB-3 HARDWARE FAILURES
1.8E-5
CE4-BME-FO-TB3
TRIP CIRCUIT BREAKER TCB-3 COMMAND FAILURES
CE4-04-M3-4
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CIRCUIT BREAKERS
7.1E-7
CE4-BME-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-3 SHUNT TRIP FAILURES
CE4-04-M3-5
TRIP CIRCUIT BREAKER TCB-3 UNDERVOLTAGE DEVICE FAILURES
CE4-04-M3-6
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR UNDERVOLTAGE DEVICE
3.7E-5
CE4-BUV-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-3 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE4-BUV-FO-TB3
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP DEVICE
8.7E-6
CE4-BSN-CF-TB2OF4
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE4-PWR-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-3 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE4-PWR-FF-TB3
TRIP CIRCUIT BREAKER TCB-3 SHUNT TRIP DEVICE FAILS
1.5E-4
CE4-BSN-FO-TB3
CE4-04-M3 - FAILURE OF TRIP CIRCUIT BREAKER TCB-3
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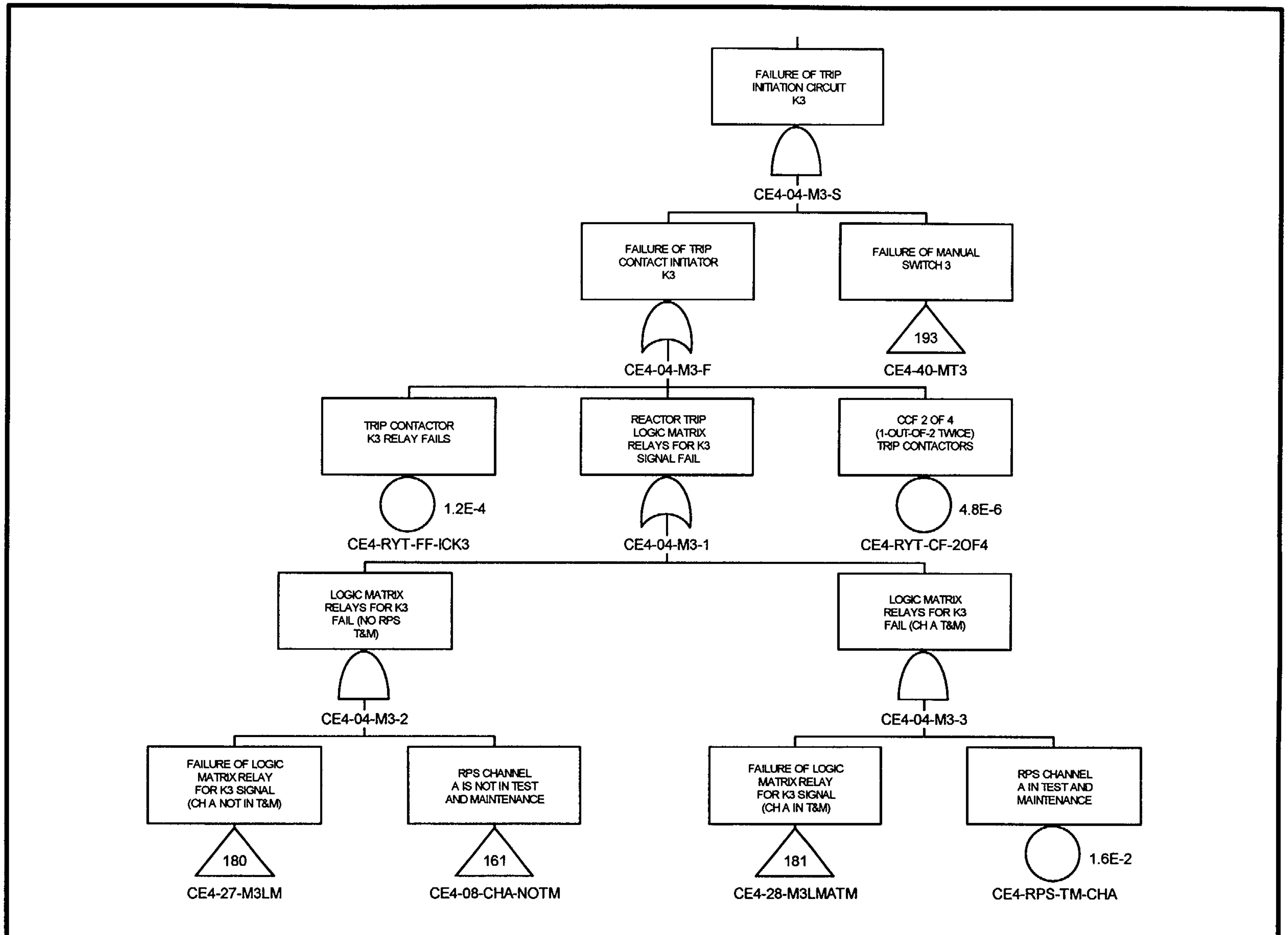
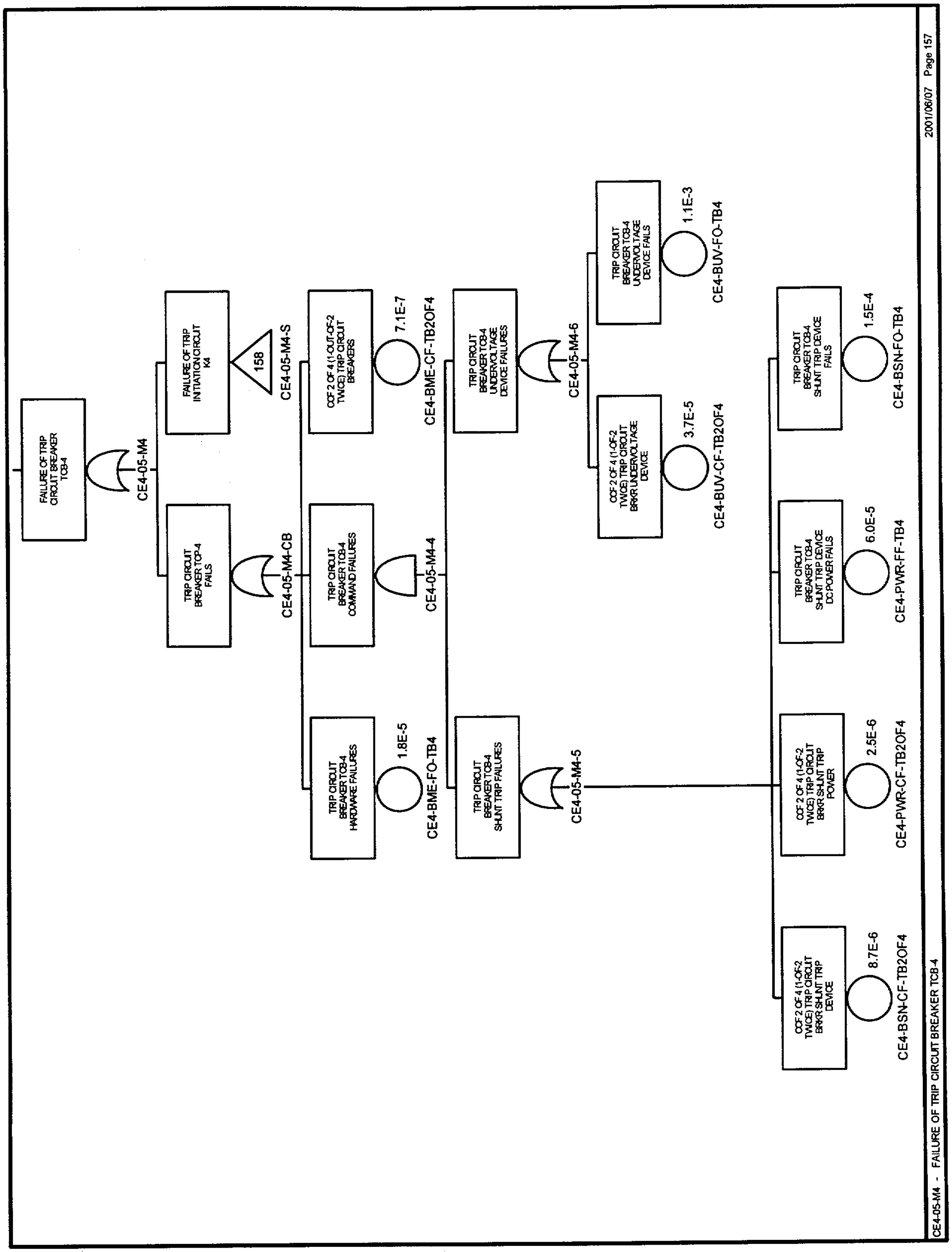


CE4-04-M3-S - FAILURE OF TRIP INITIATION CIRCUIT K3 2001/06/07 Page 156


FAILURE OF TRIP CIRCUIT BREAKER TCB-4
CE4-05-M4
TRIP CIRCUIT BREAKER TCB-4 FAILS
CE4-05-M4-CB
FAILURE OF TRIP INITIATION CIRCUIT K4
158
CE4-05-M4-S
TRIP CIRCUIT BREAKER TCB-4 HARDWARE FAILURES
1.8E-5
CE4-BME-FO-TB4
TRIP CIRCUIT BREAKER TCB-4 COMMAND FAILURES
CE4-05-M4-4
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CIRCUIT BREAKERS
7.1E-7
CE4-BME-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-4 SHUNT TRIP FAILURES
CE4-05-M4-5
TRIP CIRCUIT BREAKER TCB-4 UNDERVOLTAGE DEVICE FAILURES
CE4-05-M4-6
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR UNDERVOLTAGE DEVICE
3.7E-5
CE4-BUV-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-4 UNDERVOLTAGE DEVICE FAILS
1.1E-3
CE4-BUV-FO-TB4
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP DEVICE
8.7E-6
CE4-BSN-CF-TB2OF4
CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
2.5E-6
CE4-PWR-CF-TB2OF4
TRIP CIRCUIT BREAKER TCB-4 SHUNT TRIP DEVICE DC POWER FAILS
6.0E-5
CE4-PWR-FF-TB4
TRIP CIRCUIT BREAKER TCB-4 SHUNT TRIP DEVICE FAILS
1.5E-4
CE4-BSN-FO-TB4
CE4-05-M4 - FAILURE OF TRIP CIRCUIT BREAKER TCB-4
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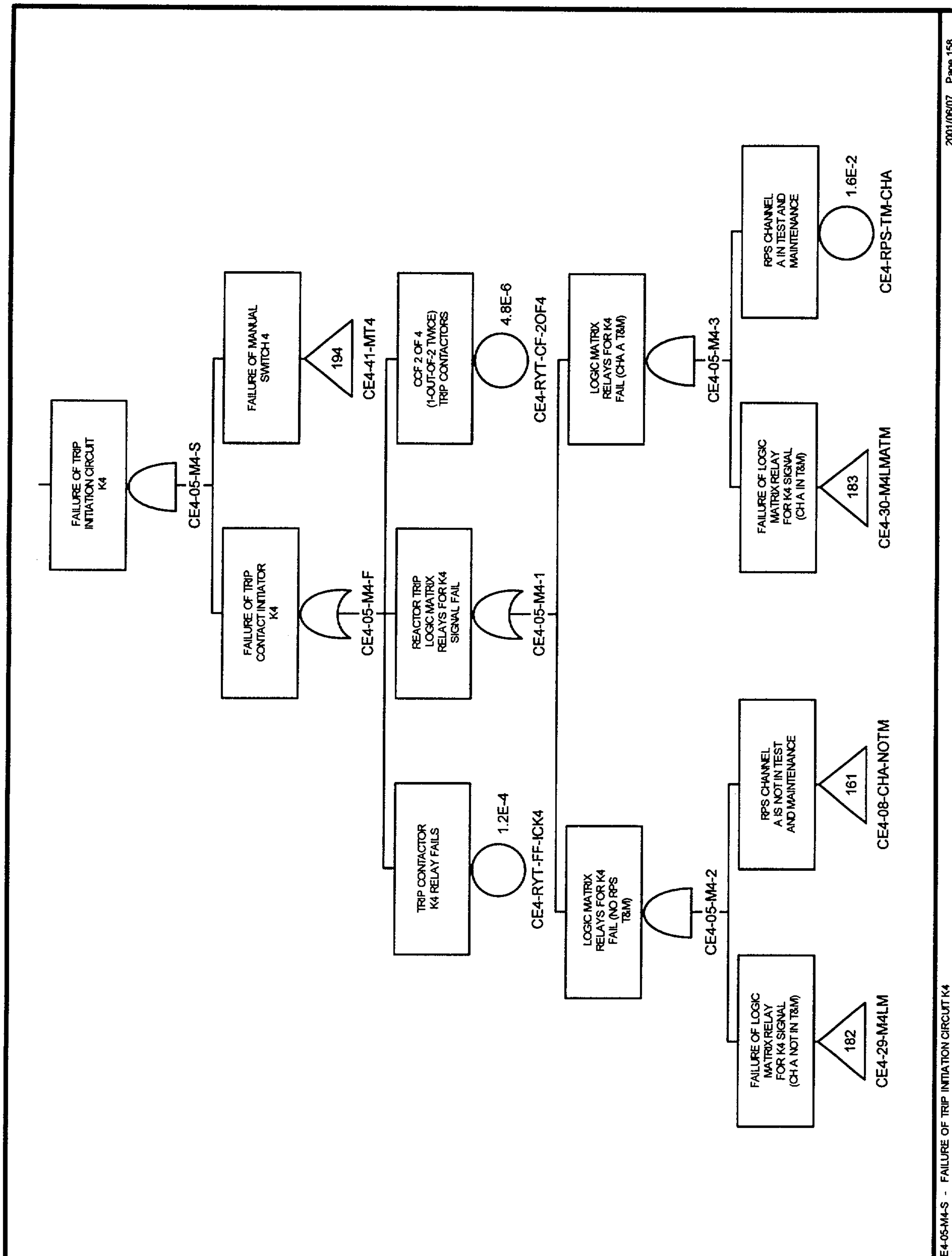

FAILURE OF TRIP INITIATION CIRCUIT K4
CE4-05-M4-S
FAILURE OF TRIP CONTACT INITIATOR K4
CE4-05-M4-F
FAILURE OF MANUAL SWITCH 4
194
CE4-41-MT4
TRIP CONTACTOR K4 RELAY FAILS
1.2E-4
CE4-RYT-FF-ICK4
REACTOR TRIP LOGIC MATRIX RELAYS FOR K4 SIGNAL FAIL
CE4-05-M4-1
CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CONTACTORS
4.8E-6
CE4-RYT-CF-2OF4
LOGIC MATRIX RELAYS FOR K4 FAIL (NO RPS T&M)
CE4-05-M4-2
LOGIC MATRIX RELAYS FOR K4 FAIL (CHA A T&M)
CE4-05-M4-3
FAILURE OF LOGIC MATRIX RELAY FOR K4 SIGNAL (CH A NOT IN T&M)
182
CE4-29-M4LM
RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE
161
CE4-08-CHA-NOTM
FAILURE OF LOGIC MATRIX RELAY FOR K4 SIGNAL (CH A IN T&M)
183
CE4-30-M4LMATM
RPS CHANNEL A IN TEST AND MAINTENANCE
1.6E-2
CE4-RPS-TM-CHA
CE4-05-M4-S - FAILURE OF TRIP INITIATION CIRCUIT K4
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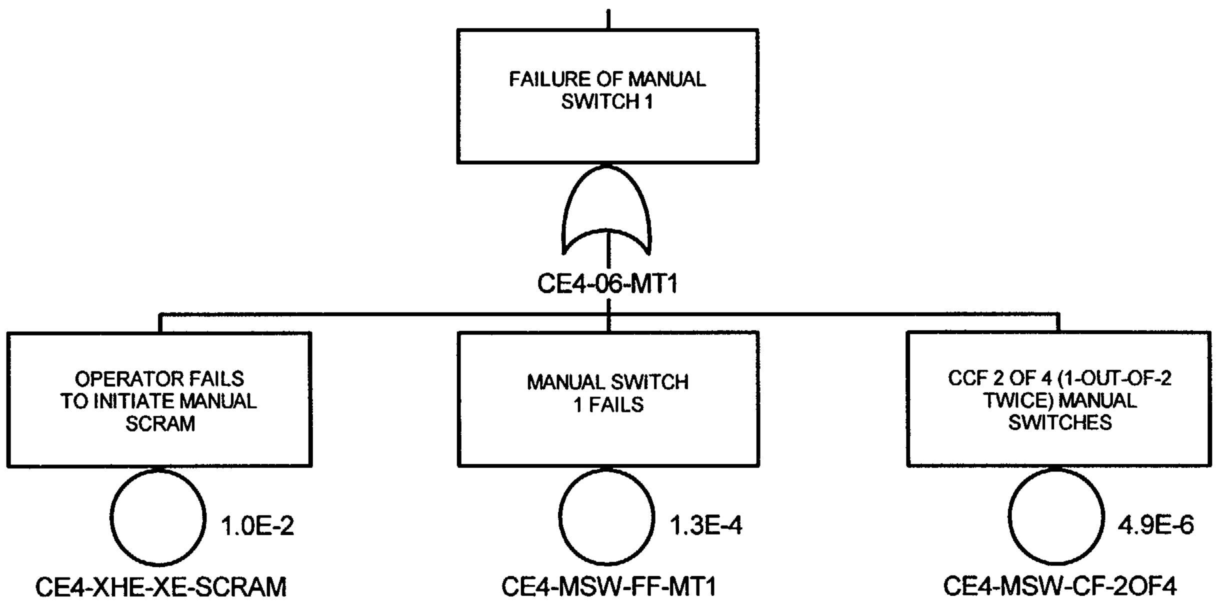
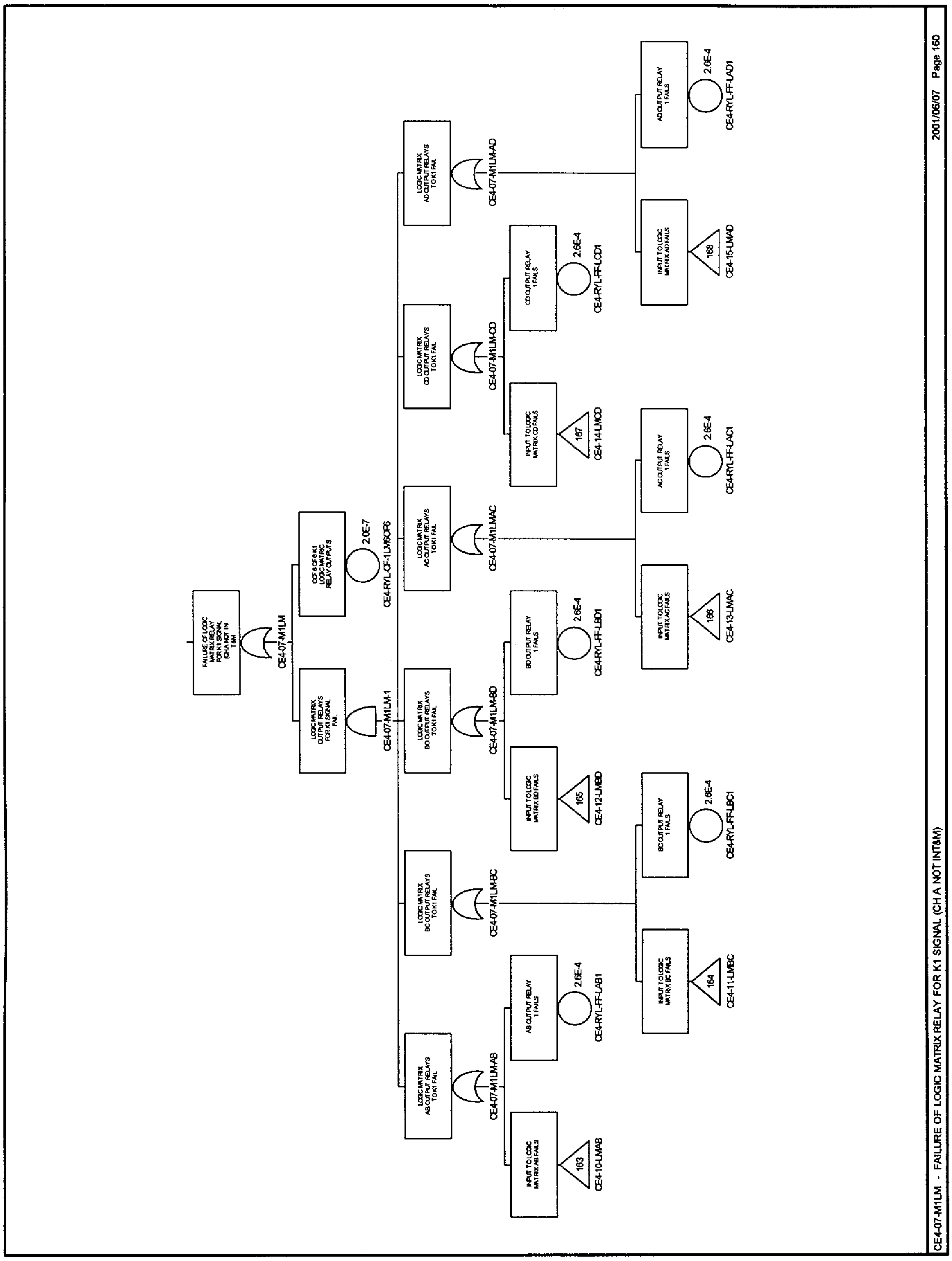
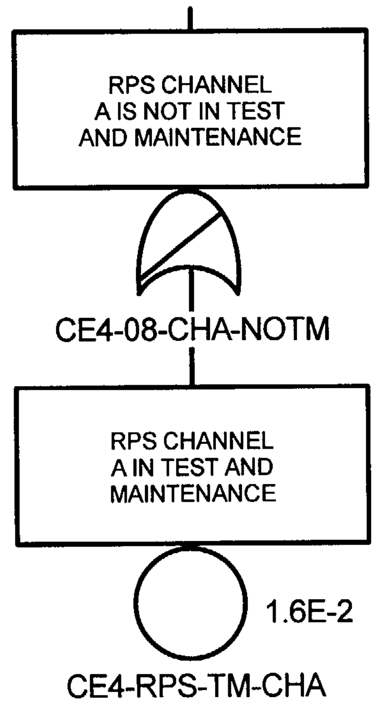


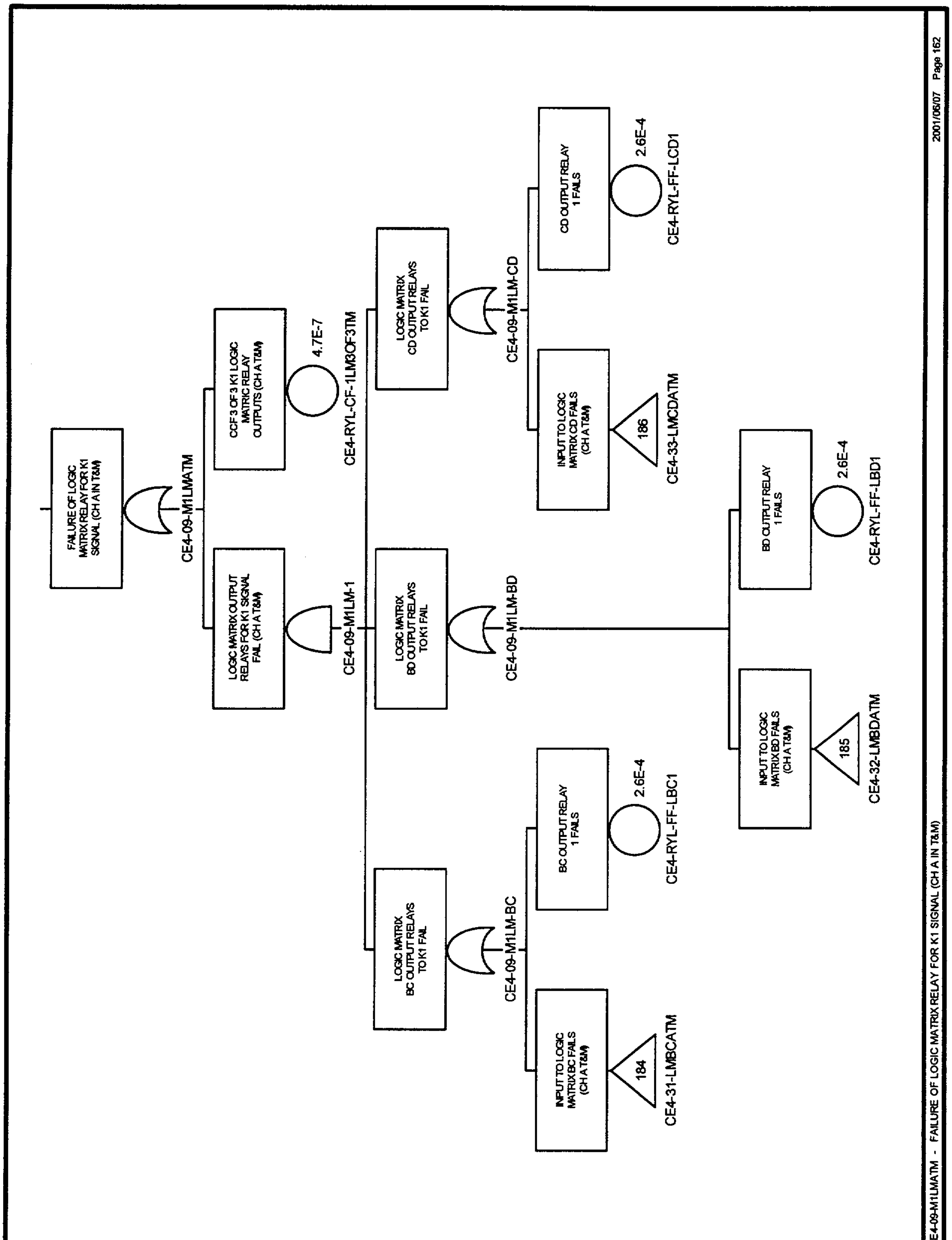
CE4-06-MT1 - FAILURE OF MANUAL SWITCH 1 2001/03/02 Page 159

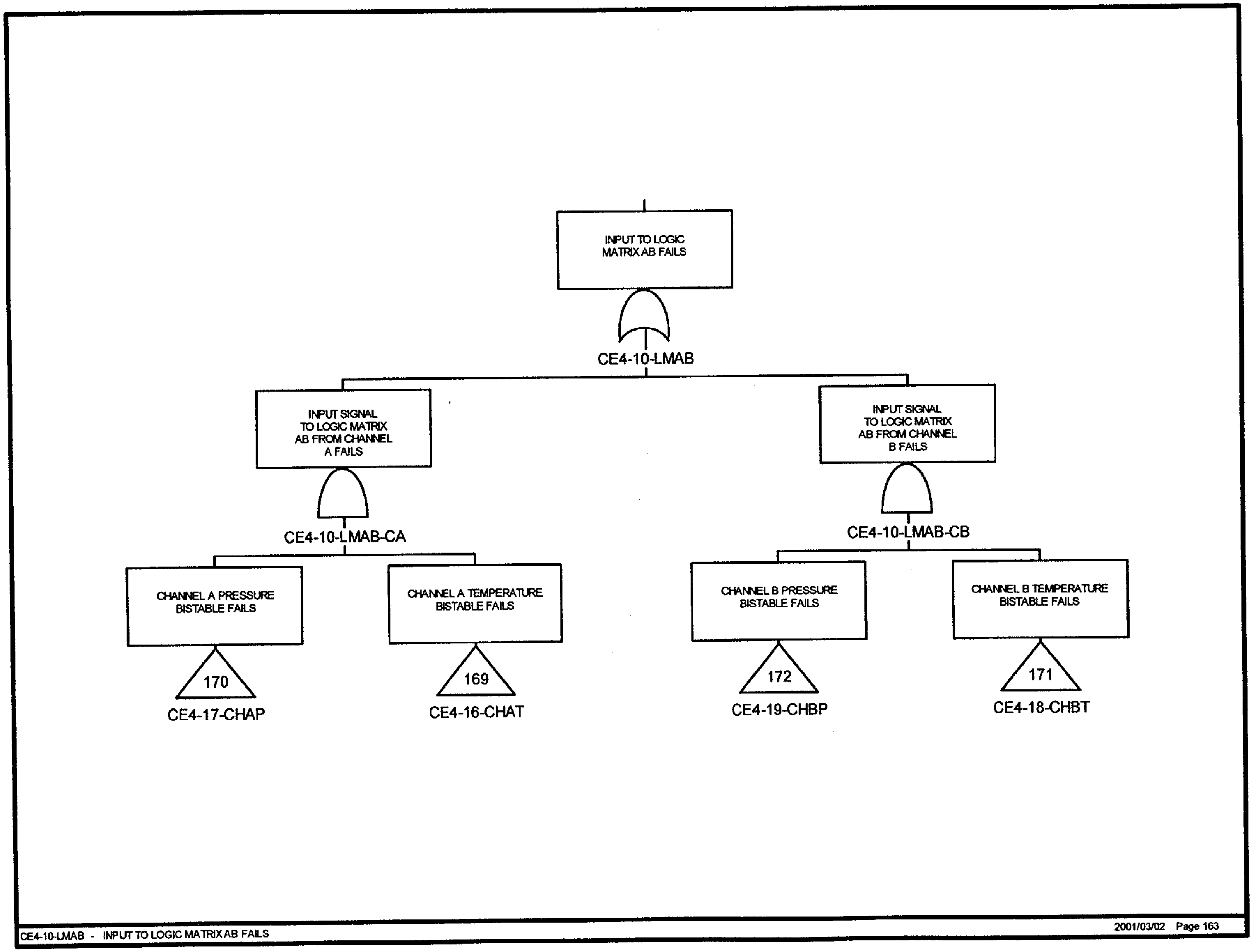

FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A NOT IN T&M)
CE4-07-M1LM
LOGIC MATRIX OUTPUT RELAYS FOR K1 SIGNAL FAIL
CE4-07-M1LM-1
CCF 6 OF 6 K1 LOGIC MATRIC RELAY OUTPUTS
2.0E-7
CE4-RYL-CF-1LM6OF6
LOGIC MATRIX AB OUTPUT RELAYS TO K1 FAIL
CE4-07-M1LM-AB
LOGIC MATRIX BC OUTPUT RELAYS TO K1 FAIL
CE4-07-M1LM-BC
LOGIC MATRIX BD OUTPUT RELAYS TO K1 FAIL
CE4-07-M1LM-BD
LOGIC MATRIX AC OUTPUT RELAYS TO K1 FAIL
CE4-07-M1LMAC
LOGIC MATRIX CD OUTPUT RELAYS TO K1 FAIL
CE4-07-M1LM-CD
LOGIC MATRIX AD OUTPUT RELAYS TO K1 FAIL
CE4-07-M1LM-AD
INPUT TO LOGIC MATRIX AB FAILS
163
CE4-10-LMAB
AB OUTPUT RELAY 1 FAILS
2.6E-4
CE4-RYL-FF-LAB1
INPUT TO LOGIC MATRIX BC FAILS
164
CE4-11-LMBC
BC OUTPUT RELAY 1 FAILS
2.6E-4
CE4-RYL-FF-LBC1
INPUT TO LOGIC MATRIX BD FAILS
165
CE4-12-LMBD
BD OUTPUT RELAY 1 FAILS
2.6E-4
CE4-RYL-FF-LBD1
INPUT TO LOGIC MATRIX AC FAILS
166
CE4-13-LMAC
AC OUTPUT RELAY 1 FAILS
2.6E-4
CE4-RYL-FF-LAC1
INPUT TO LOGIC MATRIX CD FAILS
167
CE4-14-LMCD
CD OUTPUT RELAY 1 FAILS
2.6E-4
CE4-RYL-FF-LCD1
INPUT TO LOGIC MATRIX AD FAILS
168
CE4-15-LMAD
AD OUTPUT RELAY 1 FAILS
2.6E-4
CE4-RYL-FF-LAD1
CE4-07-M1LM - FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A NOT INT&M)
2001/06/07 Page 160

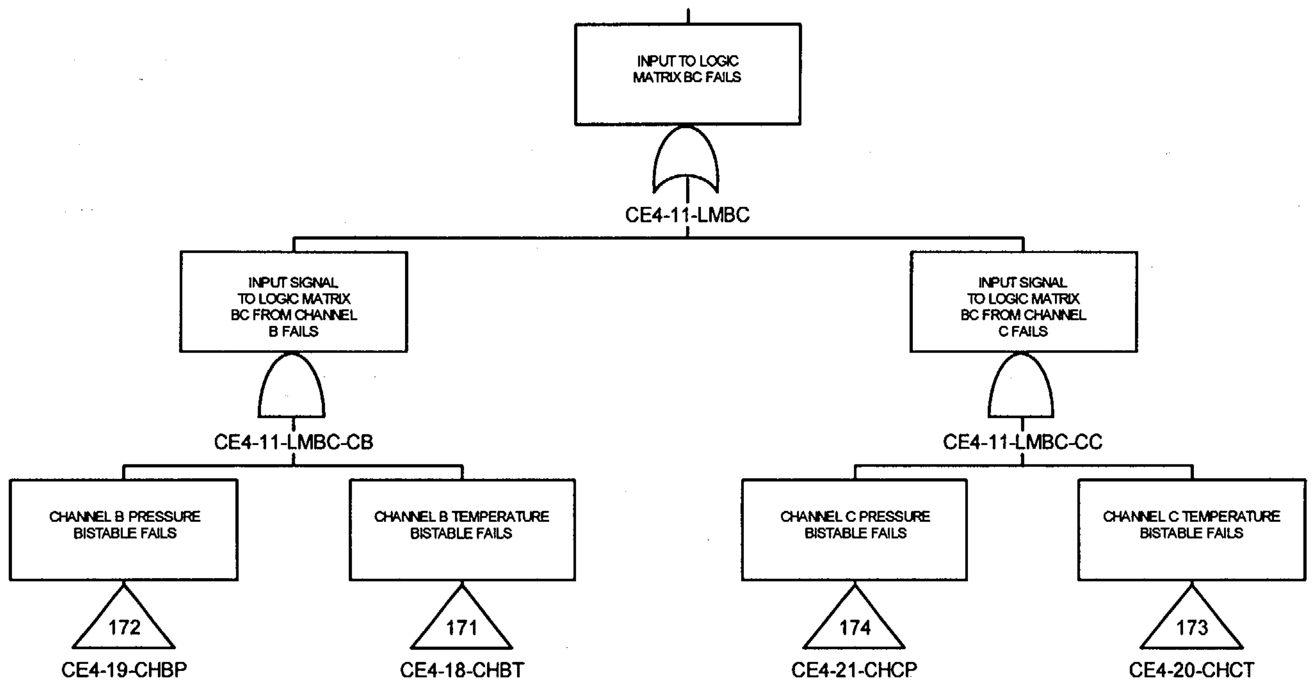


CE4-08-CHA-NOTM - RPS CHANNEL A IS NOT IN TEST AND MAINTENANCE

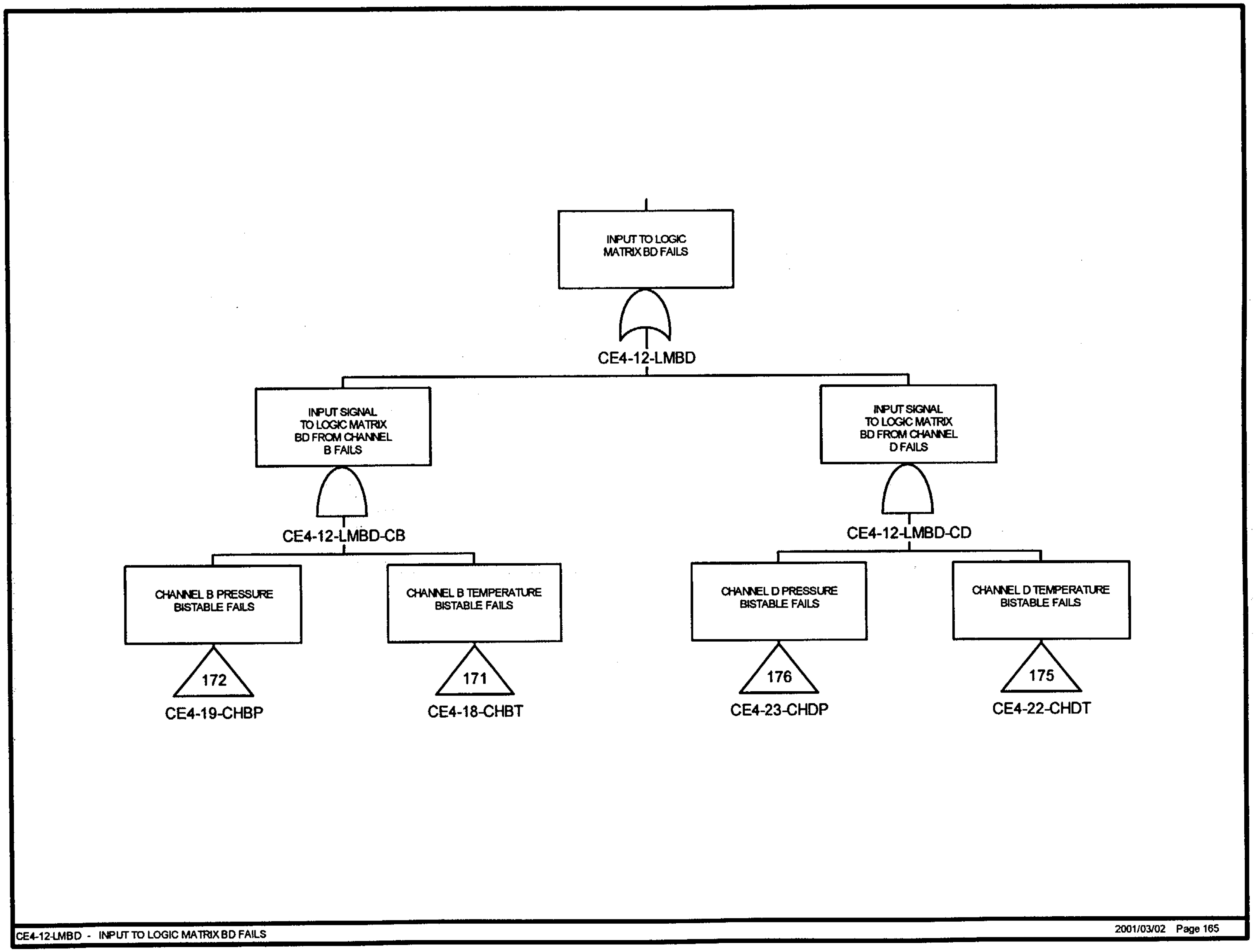
2001/03/02 Page 161

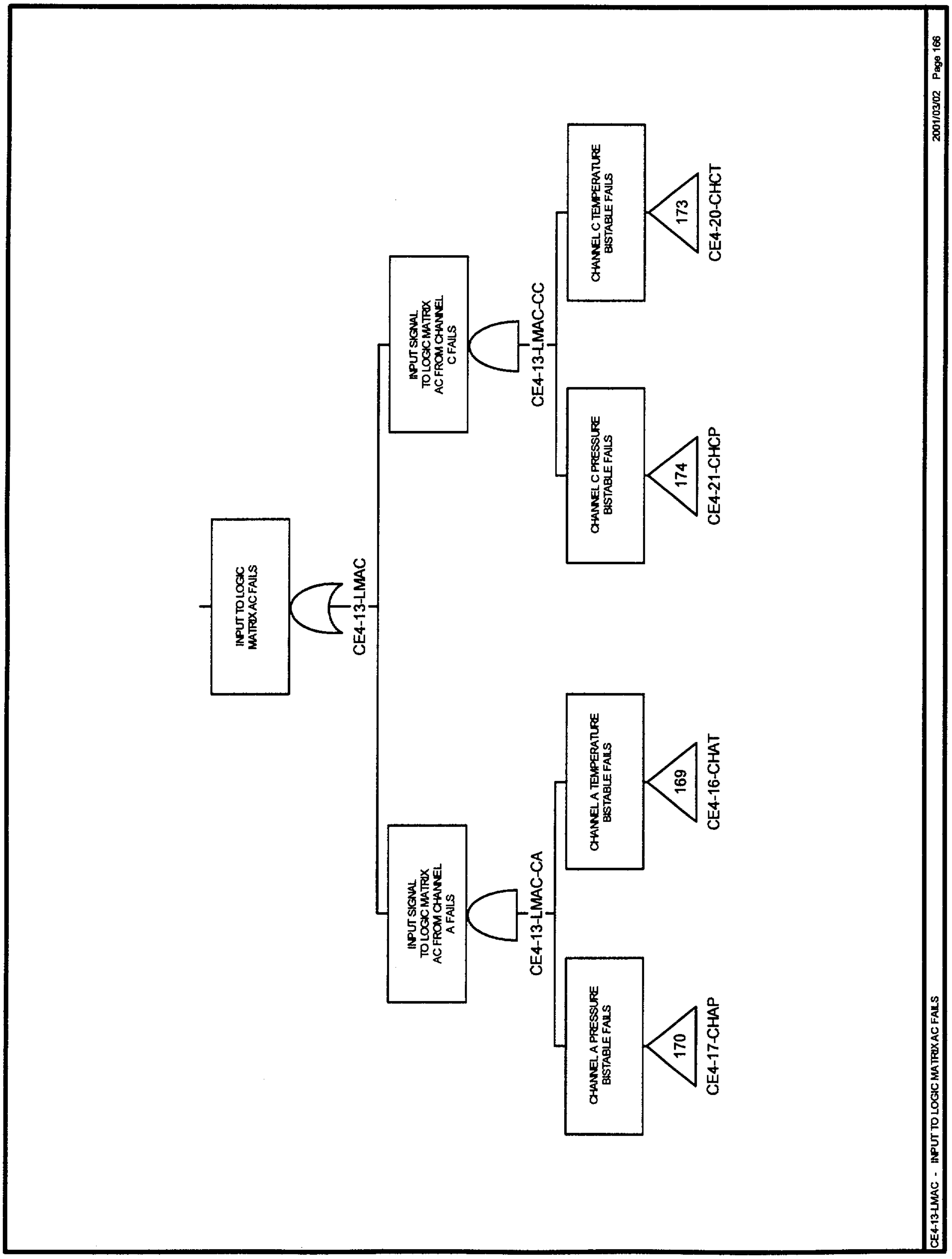

FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A IN T&M)
CE4-09-M1LMATM
LOGIC MATRIX OUTPUT RELAYS FOR K1 SIGNAL FAIL (CH A T&M)
CE4-09-M1LM-1
CCF 3 OF 3 K1 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
4.7E-7
CE4-RYL-CF-1LM3OF3TM
LOGIC MATRIX BC OUTPUT RELAYS TO K1 FAIL
CE4-09-M1LM-BC
LOGIC MATRIX BD OUTPUT RELAYS TO K1 FAIL
CE4-09-M1LM-BD
LOGIC MATRIX CD OUTPUT RELAYS TO K1 FAIL
CE4-09-M1LM-CD
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
184
CE4-31-LMBCATM
BC OUTPUT RELAY 1 FAILS
2.6E-4
CE4-RYL-FF-LBC1
INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
185
CE4-32-LMBDATM
BD OUTPUT RELAY 1 FAILS
2.6E-4
CE4-RYL-FF-LBD1
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
186
CE4-33-LMCDATM
CD OUTPUT RELAY 1 FAILS
2.6E-4
CE4-RYL-FF-LCD1
CE4-09-M1LMATM - FAILURE OF LOGIC MATRIX RELAY FOR K1 SIGNAL (CH A IN T&M)
2001/06/07 Page 162

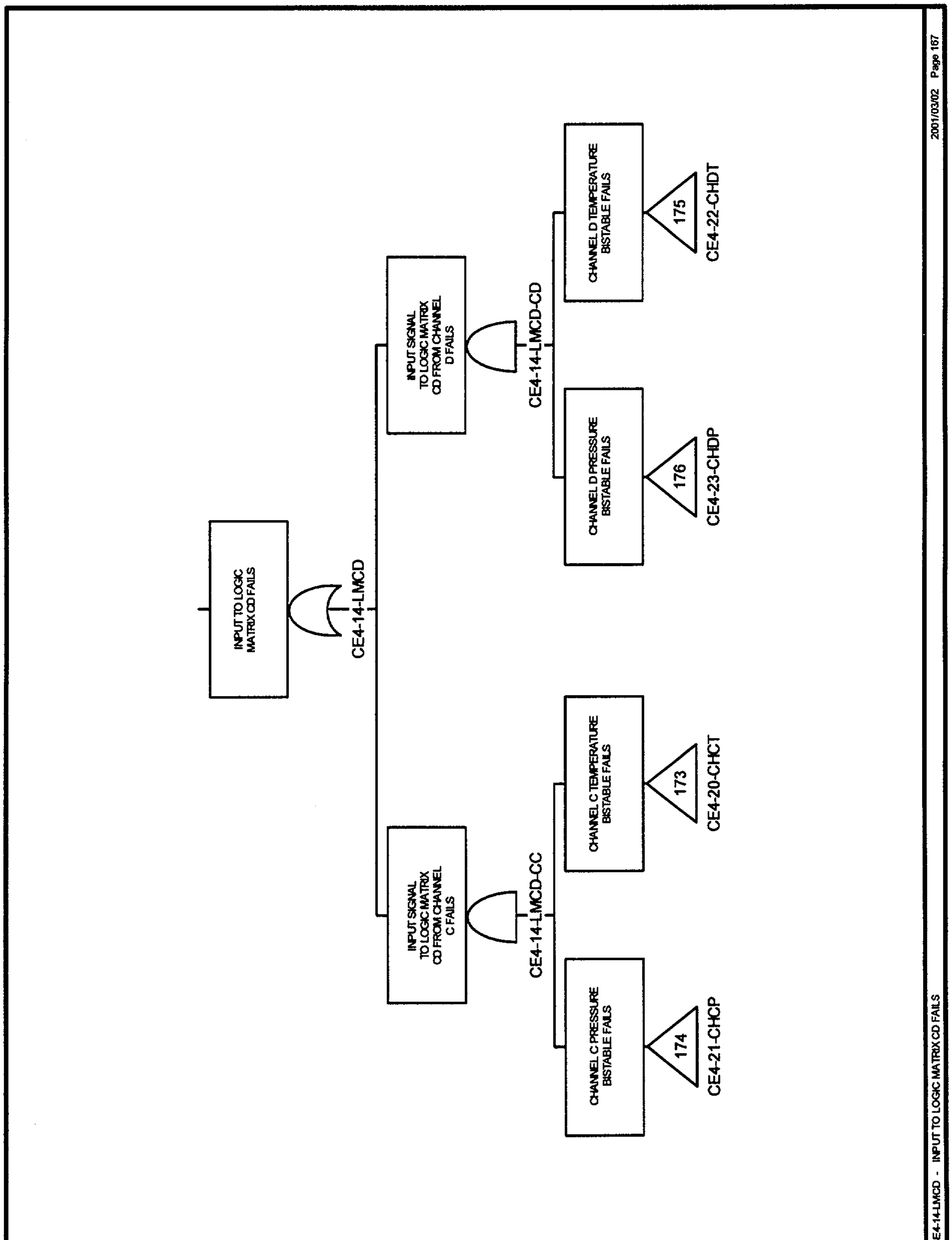

INPUT TO LOGIC MATRIX AB FAILS
CE4-10-LMAB
INPUT SIGNAL TO LOGIC MATRIX AB FROM CHANNEL A FAILS
INPUT SIGNAL TO LOGIC MATRIX AB FROM CHANNEL B FAILS
CE4-10-LMAB-CA
CE4-10-LMAB-CB
CHANNEL A PRESSURE BISTABLE FAILS
CHANNEL A TEMPERATURE BISTABLE FAILS
CHANNEL B PRESSURE BISTABLE FAILS
CHANNEL B TEMPERATURE BISTABLE FAILS
170
169
172
171
CE4-17-CHAP
CE4-16-CHAT
CE4-19-CHBP
CE4-18-CHBT
CE4-10-LMAB - INPUT TO LOGIC MATRIX AB FAILS
2001/03/02 Page 163

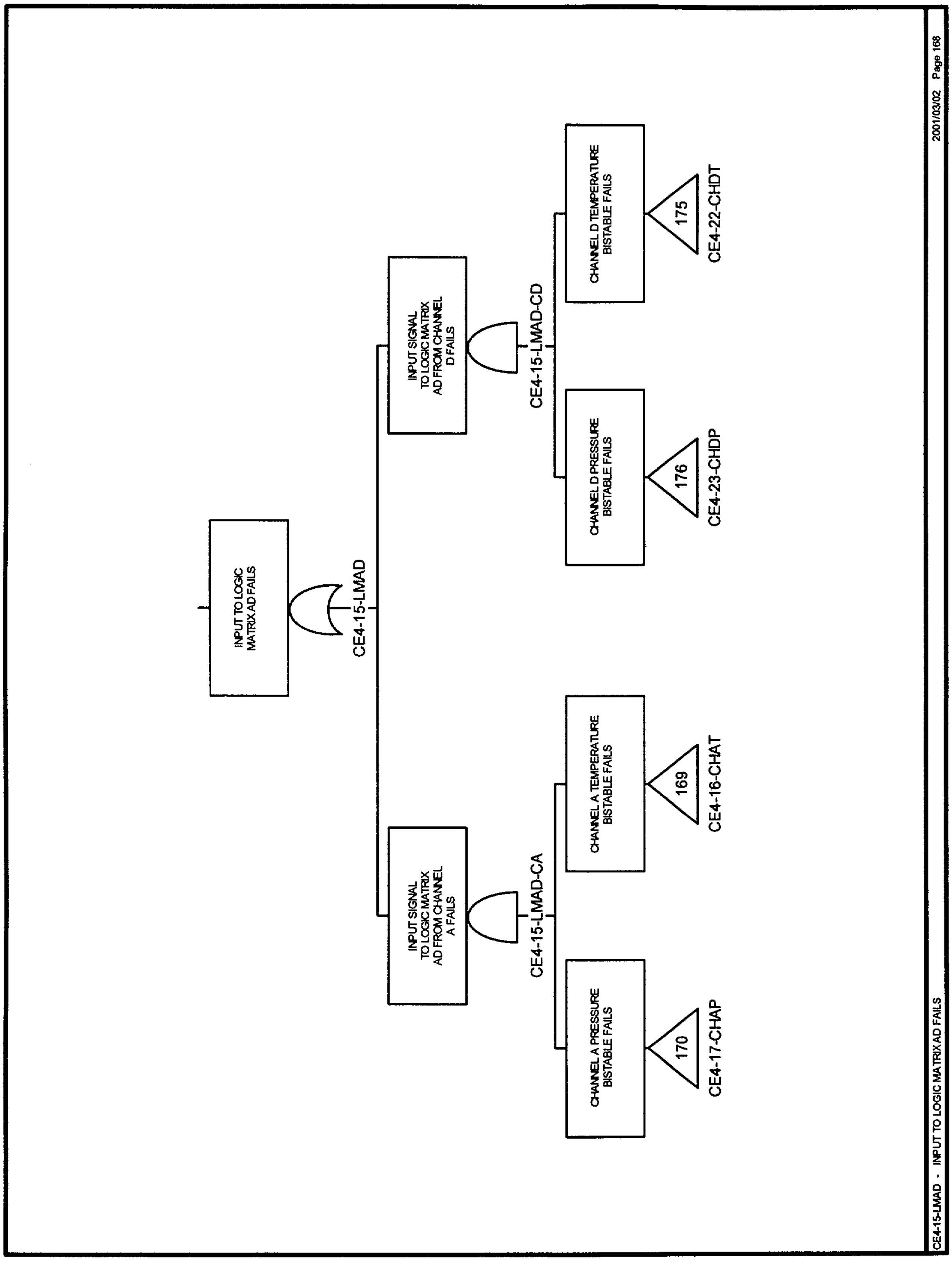


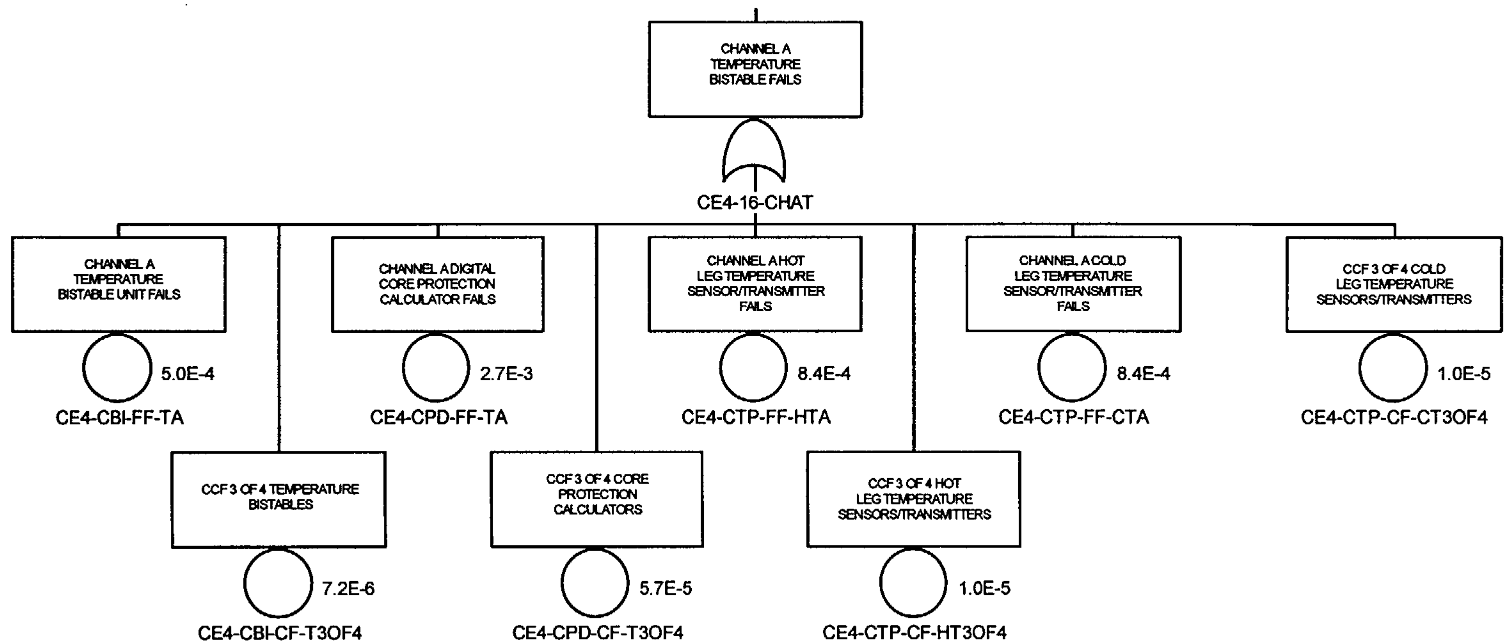
CE4-11-LMBC - INPUT TO LOGIC MATRIX BC FAILS 2001/03/02 Page 164


INPUT TO LOGIC MATRIX BD FAILS
CE4-12-LMBD
INPUT SIGNAL TO LOGIC MATRIX BD FROM CHANNEL B FAILS
INPUT SIGNAL TO LOGIC MATRIX BD FROM CHANNEL D FAILS
CE4-12-LMBD-CB
CE4-12-LMBD-CD
CHANNEL B PRESSURE BISTABLE FAILS
CHANNEL B TEMPERATURE BISTABLE FAILS
CHANNEL D PRESSURE BISTABLE FAILS
CHANNEL D TEMPERATURE BISTABLE FAILS
172
CE4-19-CHBP
171
CE4-18-CHBT
176
CE4-23-CHDP
175
CE4-22-CHDT
CE4-12-LMBD - INPUT TO LOGIC MATRIX BD FAILS
2001/03/02 Page 165

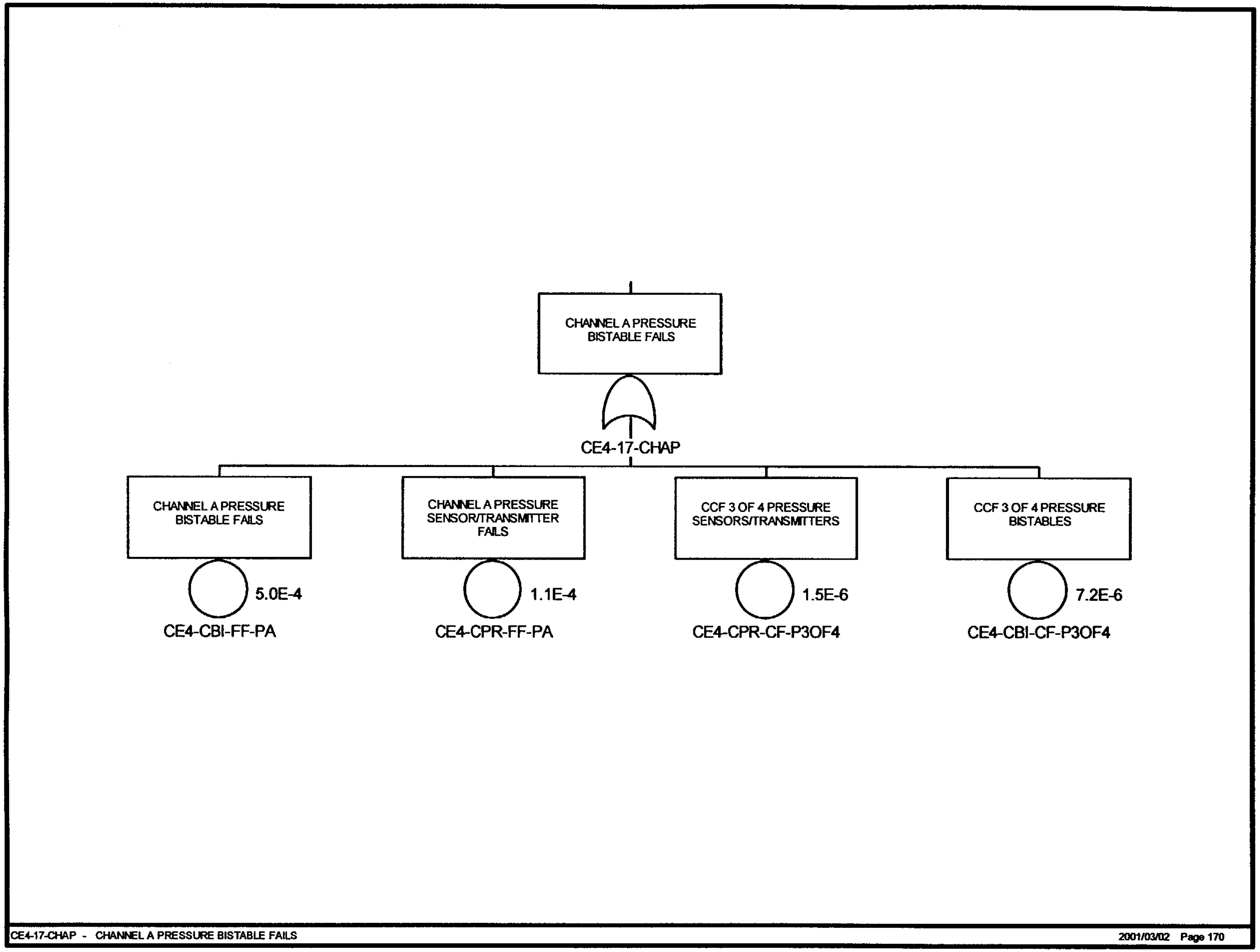

INPUT TO LOGIC MATRIX AC FAILS
CE4-13-LMAC
INPUT SIGNAL TO LOGIC MATRIX AC FROM CHANNEL A FAILS
CE4-13-LMAC-CA
INPUT SIGNAL TO LOGIC MATRIX AC FROM CHANNEL C FAILS
CE4-13-LMAC-CC
CHANNEL A PRESSURE BISTABLE FAILS
170
CE4-17-CHAP
CHANNEL A TEMPERATURE BISTABLE FAILS
169
CE4-16-CHAT
CHANNEL C PRESSURE BISTABLE FAILS
174
CE4-21-CHCP
CHANNEL C TEMPERATURE BISTABLE FAILS
173
CE4-20-CHCT
CE4-13-LMAC - INPUT TO LOGIC MATRIX AC FAILS
2001/03/02 Page 166

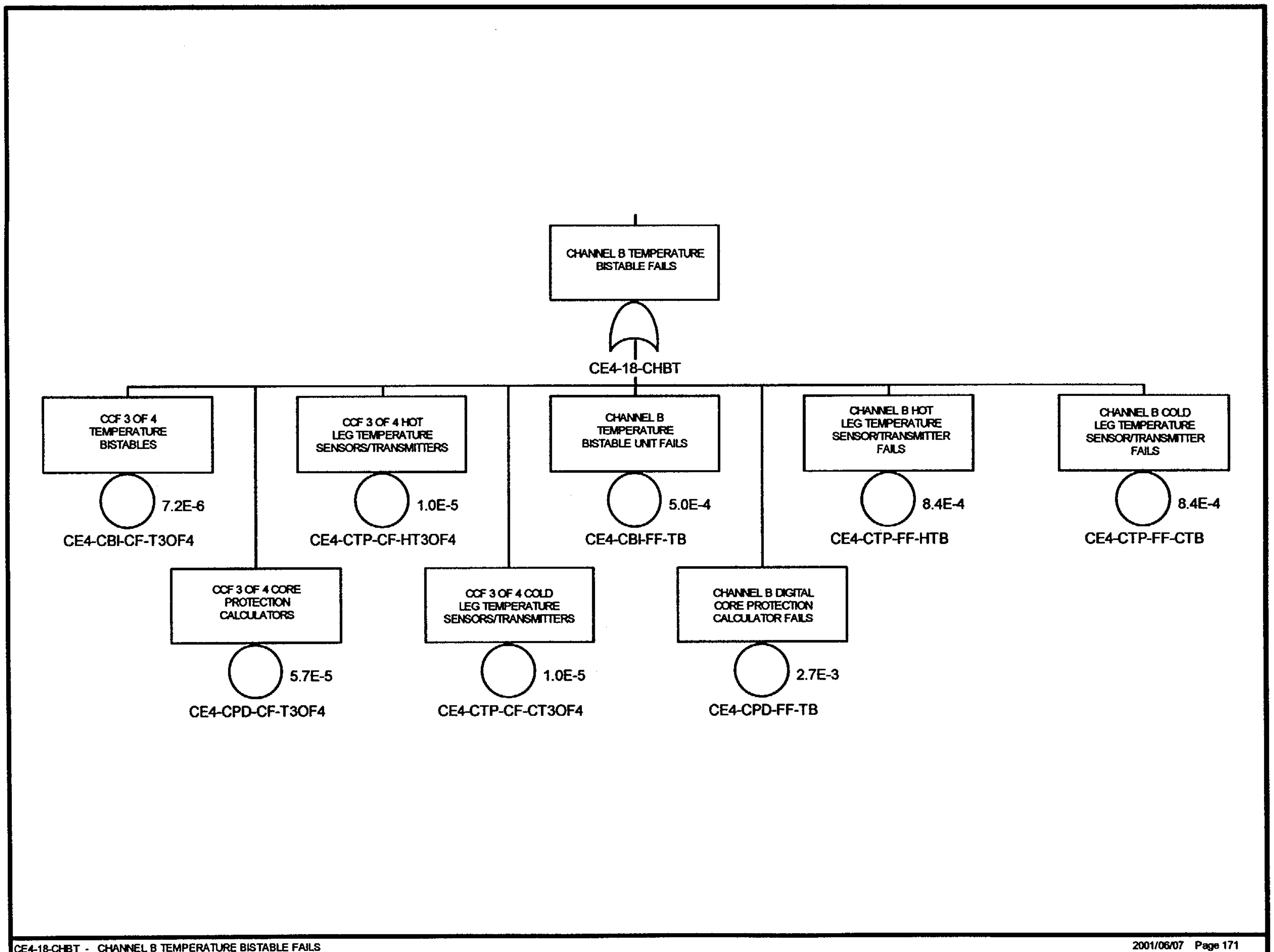

INPUT TO LOGIC MATRIX CD FAILS
CE4-14-LMCD
INPUT SIGNAL TO LOGIC MATRIX CD FROM CHANNEL C FAILS
CE4-14-LMCD-CC
INPUT SIGNAL TO LOGIC MATRIX CD FROM CHANNEL D FAILS
CE4-14-LMCD-CD
CHANNEL C PRESSURE BISTABLE FAILS
174
CE4-21-CHCP
CHANNEL C TEMPERATURE BISTABLE FAILS
173
CE4-20-CHCT
CHANNEL D PRESSURE BISTABLE FAILS
176
CE4-23-CHDP
CHANNEL D TEMPERATURE BISTABLE FAILS
175
CE4-22-CHDT
CE4-14-LMCD - INPUT TO LOGIC MATRIX CD FAILS
2001/03/02 Page 167


INPUT TO LOGIC MATRIX AD FAILS
CE4-15-LMAD
INPUT SIGNAL TO LOGIC MATRIX AD FROM CHANNEL A FAILS
CE4-15-LMAD-CA
INPUT SIGNAL TO LOGIC MATRIX AD FROM CHANNEL D FAILS
CE4-15-LMAD-CD
CHANNEL A PRESSURE BISTABLE FAILS
170
CE4-17-CHAP
CHANNEL A TEMPERATURE BISTABLE FAILS
169
CE4-16-CHAT
CHANNEL D PRESSURE BISTABLE FAILS
176
CE4-23-CHDP
CHANNEL D TEMPERATURE BISTABLE FAILS
175
CE4-22-CHDT
CE4-15-LMAD - INPUT TO LOGIC MATRIX AD FAILS
2001/03/02 Page 168

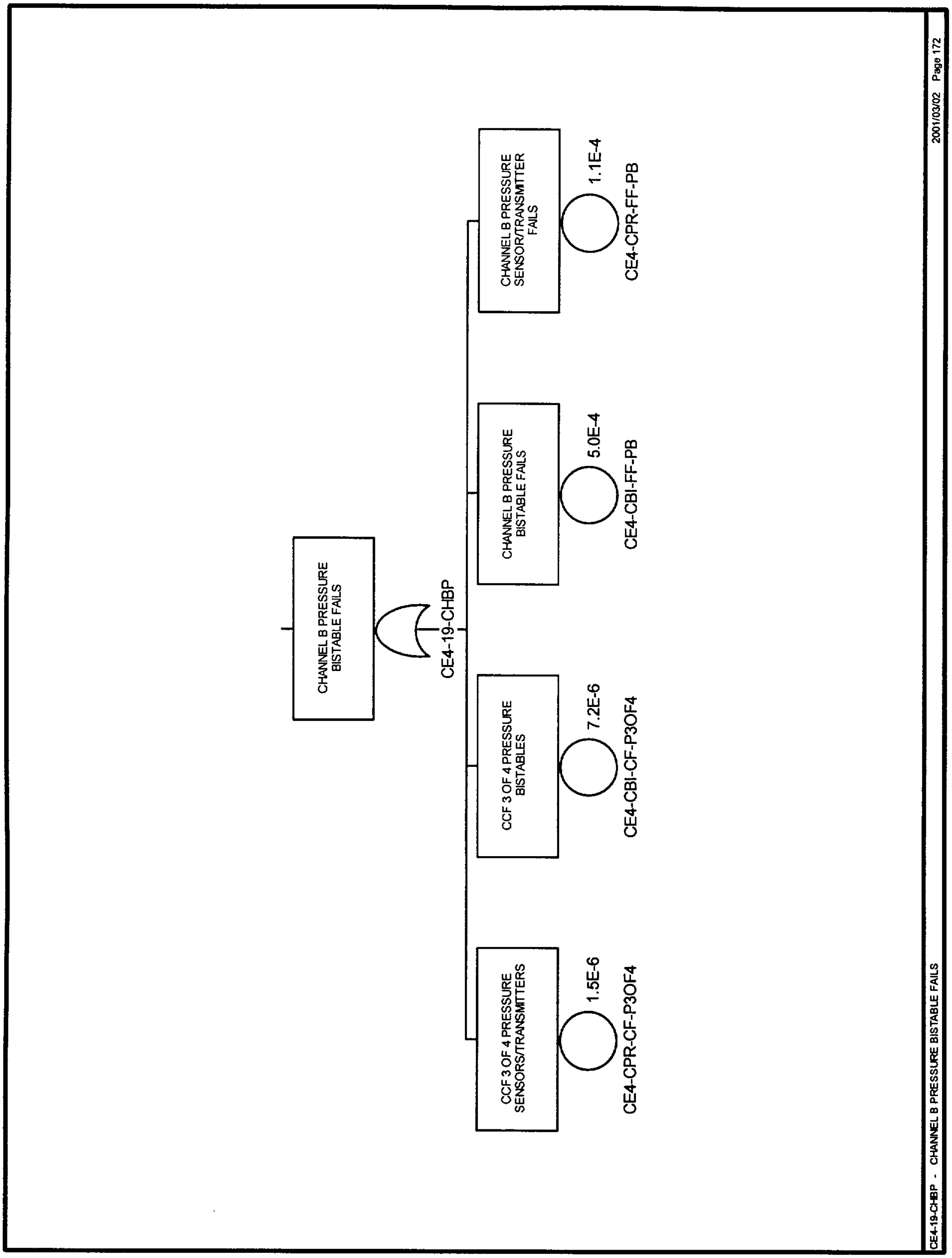


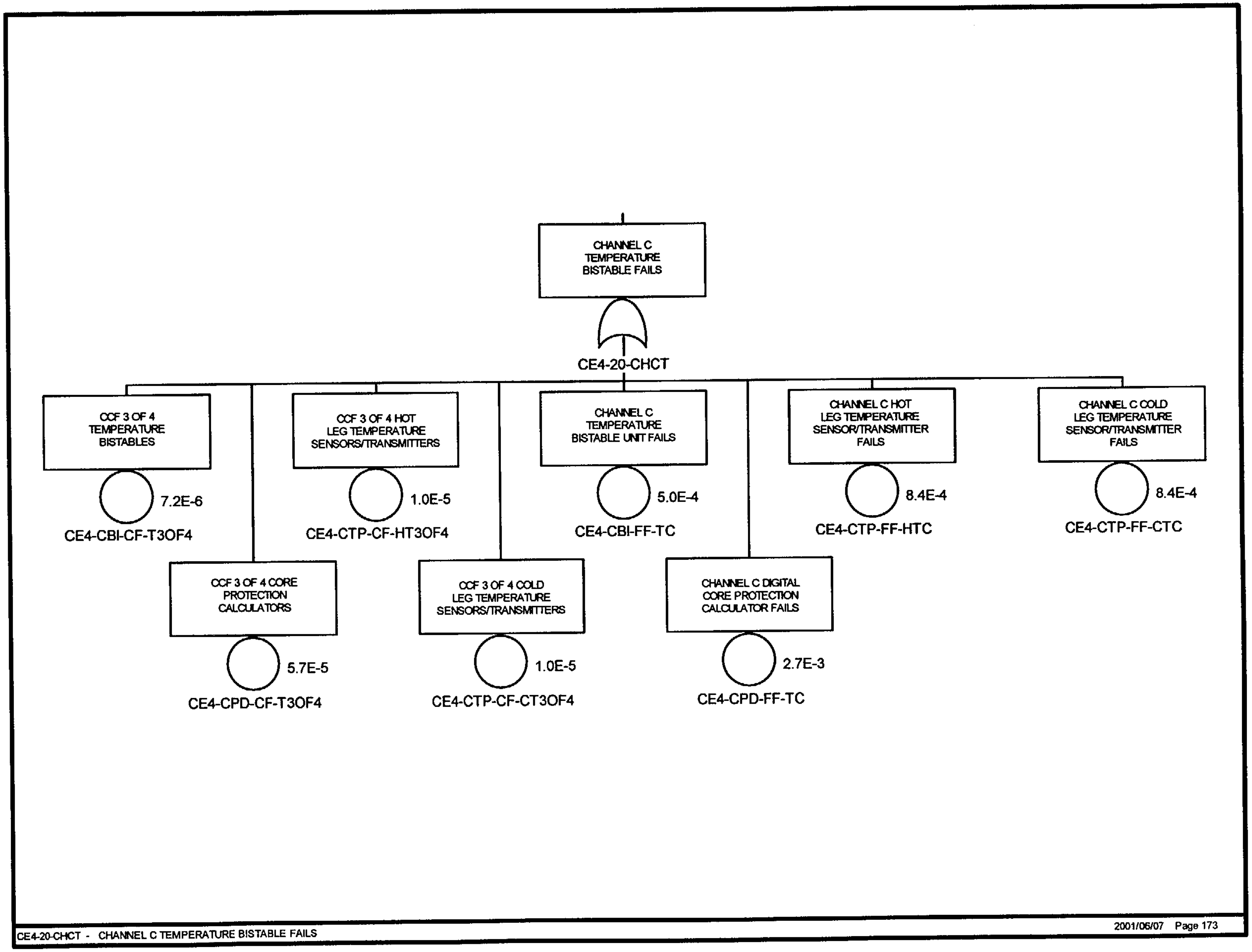
CE4-16-CHAT - CHANNEL A TEMPERATURE BISTABLE FAILS 2001/06/07 Page 169

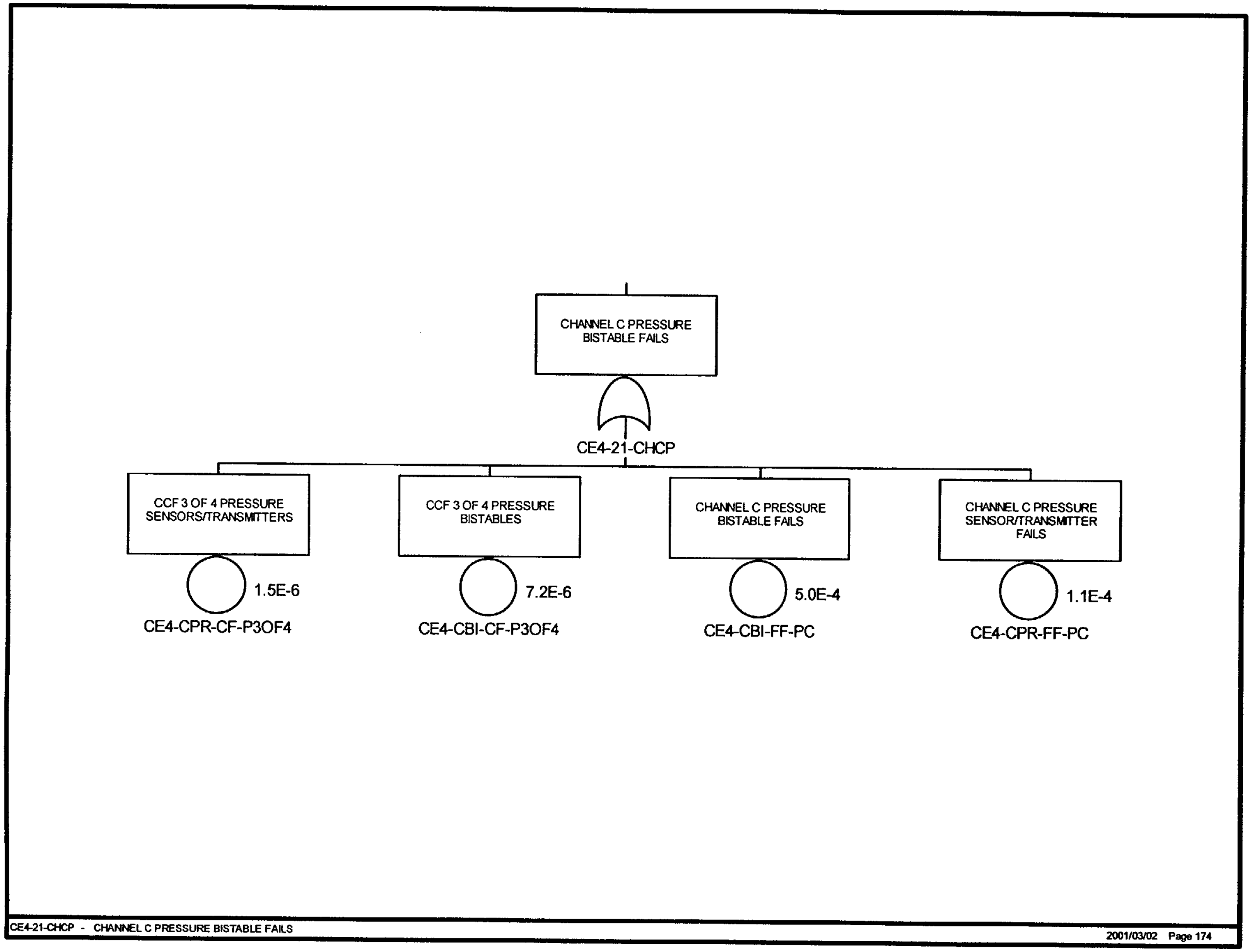

CHANNEL A PRESSURE BISTABLE FAILS
CE4-17-CHAP
CHANNEL A PRESSURE BISTABLE FAILS
5.0E-4
CE4-CBI-FF-PA
CHANNEL A PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE4-CPR-FF-PA
CCF 3 OF 4 PRESSURE SENSORS/TRANSMITTERS
1.5E-6
CE4-CPR-CF-P3OF4
CCF 3 OF 4 PRESSURE BISTABLES
7.2E-6
CE4-CBI-CF-P3OF4
CE4-17-CHAP - CHANNEL A PRESSURE BISTABLE FAILS
2001/03/02 Page 170

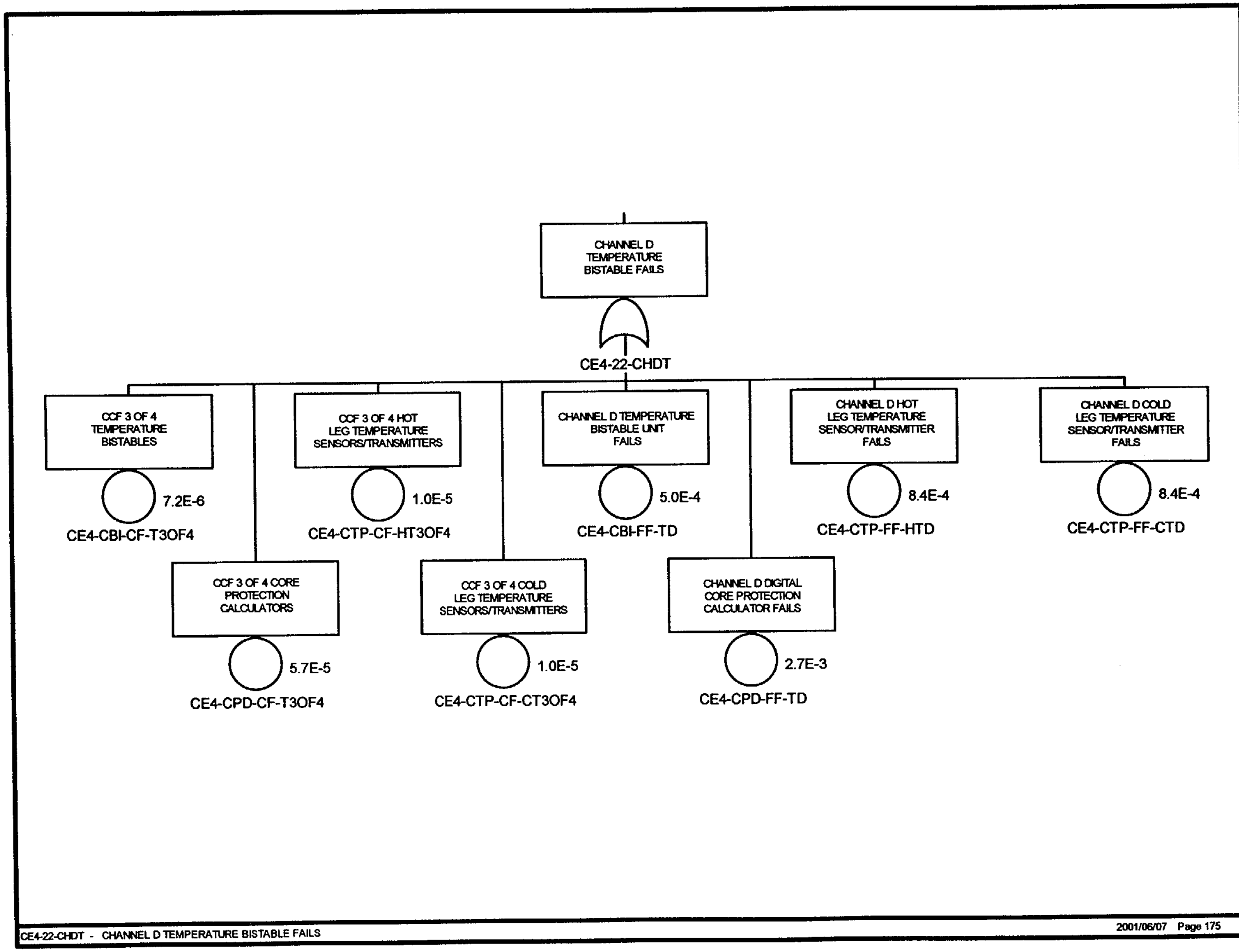


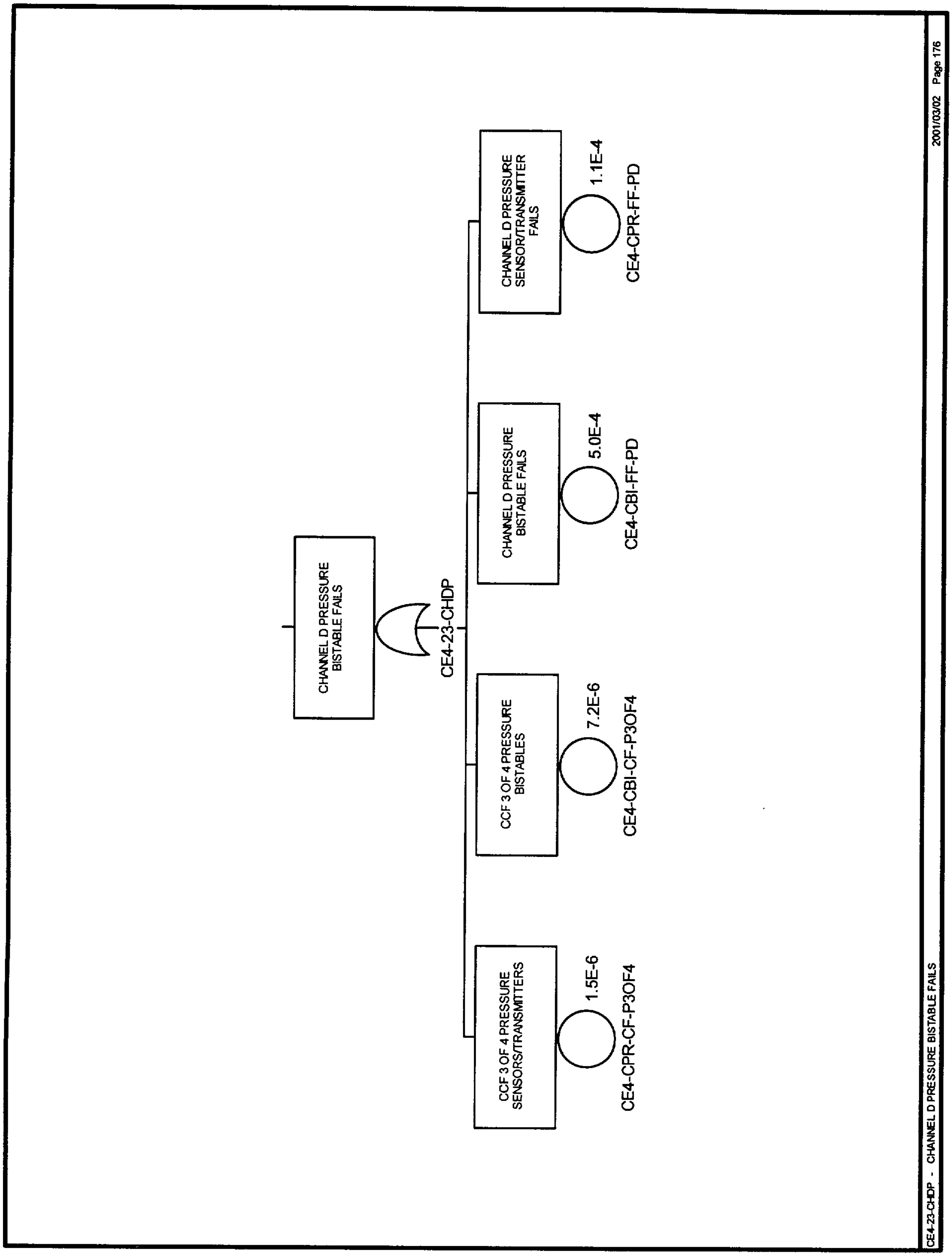
CHANNEL B TEMPERATURE BISTABLE FAILS
CE4-18-CHBT
CCF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE4-CBI-CF-T3OF4
CCF 3 OF 4 CORE PROTECTION CALCULATORS
5.7E-5
CE4-CPD-CF-T3OF4
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE4-CTP-CF-HT3OF4
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE4-CTP-CF-CT3OF4
CHANNEL B TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE4-CBI-FF-TB
CHANNEL B DIGITAL CORE PROTECTION CALCULATOR FAILS
2.7E-3
CE4-CPD-FF-TB
CHANNEL B HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE4-CTP-FF-HTB
CHANNEL B COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE4-CTP-FF-CTB
CE4-18-CHBT - CHANNEL B TEMPERATURE BISTABLE FAILS
2001/06/07 Page 171

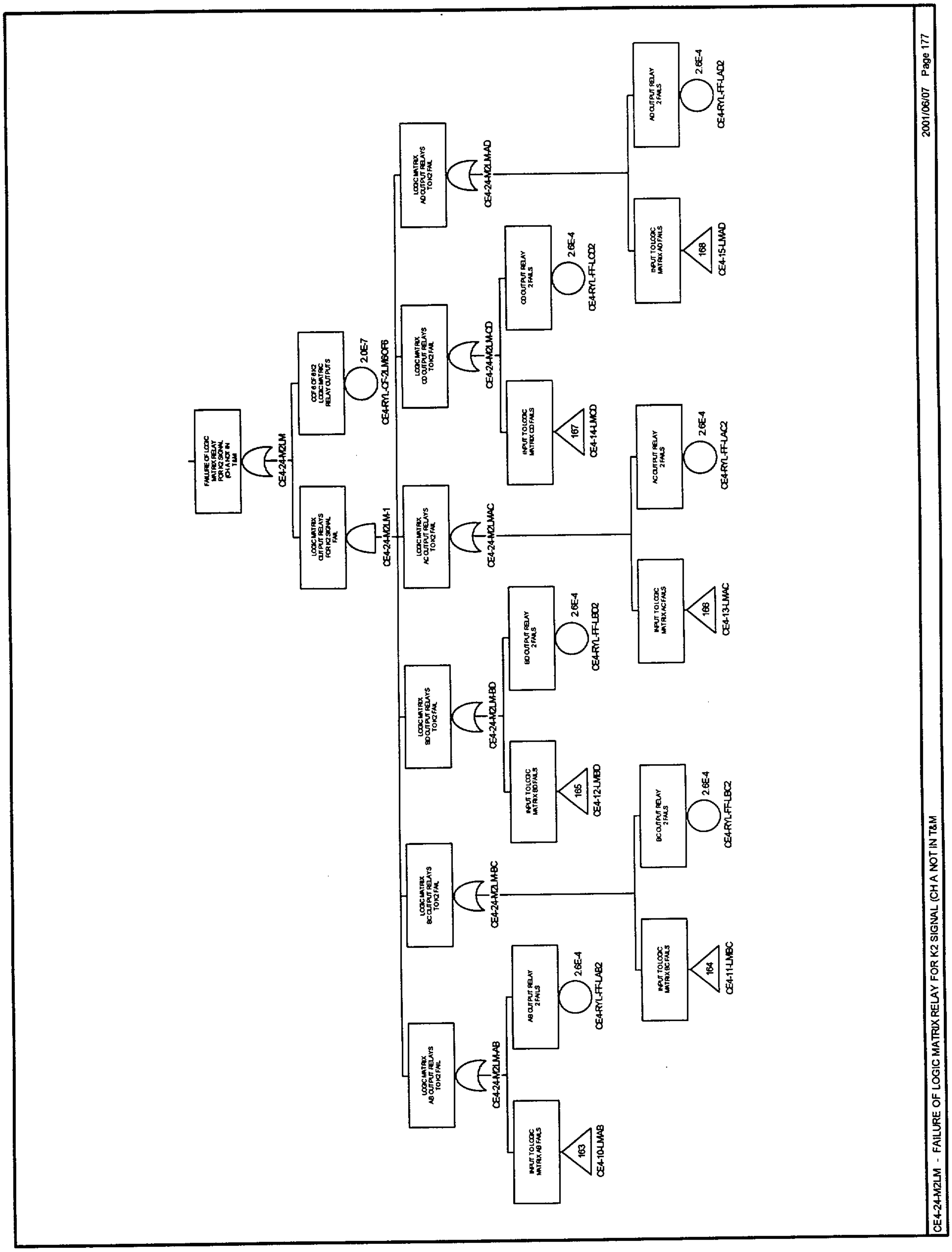

CHANNEL B PRESSURE BISTABLE FAILS
CE4-19-CHBP
CCF 3 OF 4 PRESSURE SENSORS/TRANSMITTERS
1.5E-6
CE4-CPR-CF-P3OF4
CCF 3 OF 4 PRESSURE BISTABLES
7.2E-6
CE4-CBI-CF-P3OF4
CHANNEL B PRESSURE BISTABLE FAILS
5.0E-4
CE4-CBI-FF-PB
CHANNEL B PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE4-CPR-FF-PB
CE4-19-CHBP - CHANNEL B PRESSURE BISTABLE FAILS
2001/03/02 Page 172

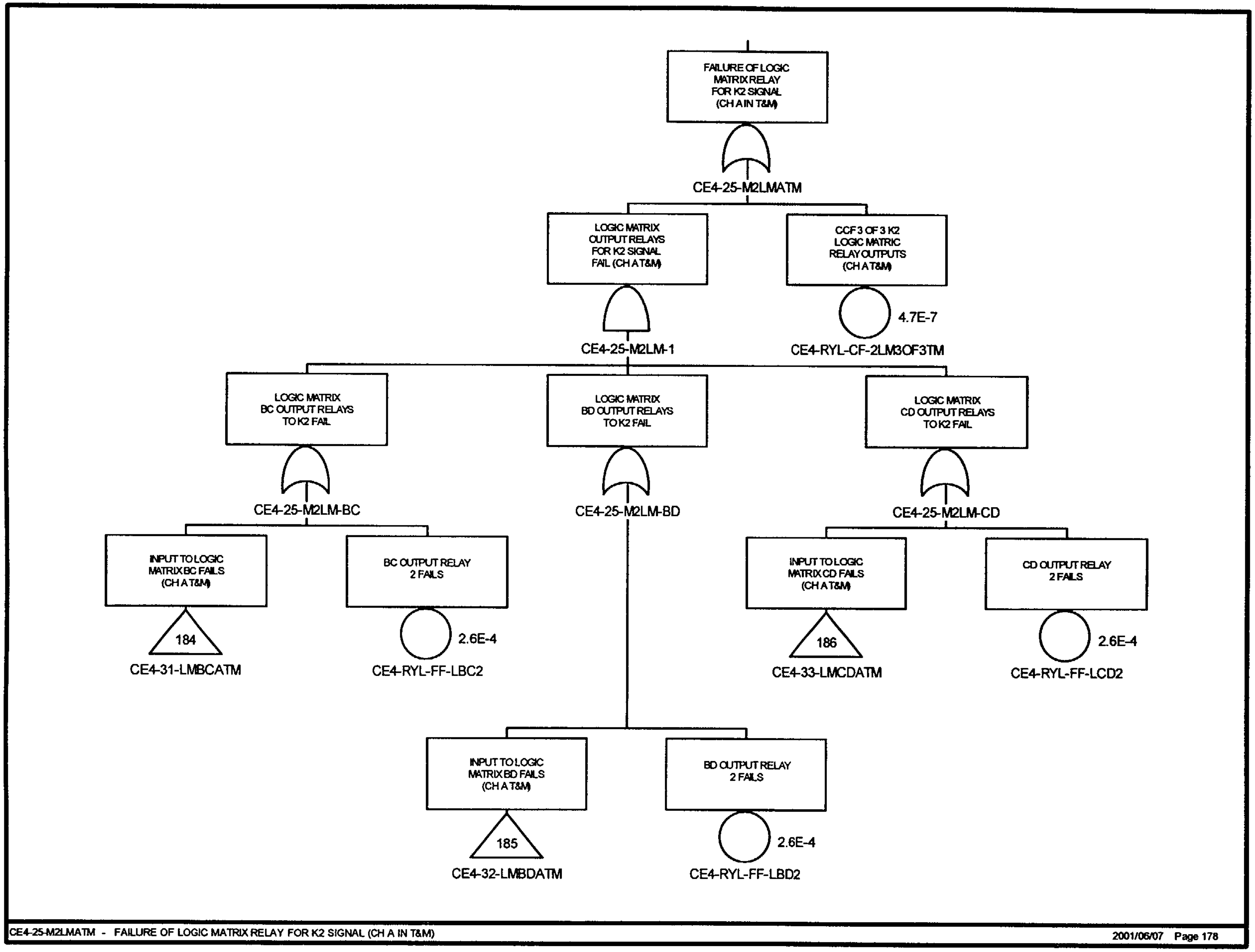

CHANNEL C TEMPERATURE BISTABLE FAILS
CE4-20-CHCT
CCF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE4-CBI-CF-T3OF4
CCF 3 OF 4 CORE PROTECTION CALCULATORS
5.7E-5
CE4-CPD-CF-T3OF4
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE4-CTP-CF-HT3OF4
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE4-CTP-CF-CT3OF4
CHANNEL C TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE4-CBI-FF-TC
CHANNEL C DIGITAL CORE PROTECTION CALCULATOR FAILS
2.7E-3
CE4-CPD-FF-TC
CHANNEL C HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE4-CTP-FF-HTC
CHANNEL C COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE4-CTP-FF-CTC
CE4-20-CHCT - CHANNEL C TEMPERATURE BISTABLE FAILS
2001/06/07 Page 173

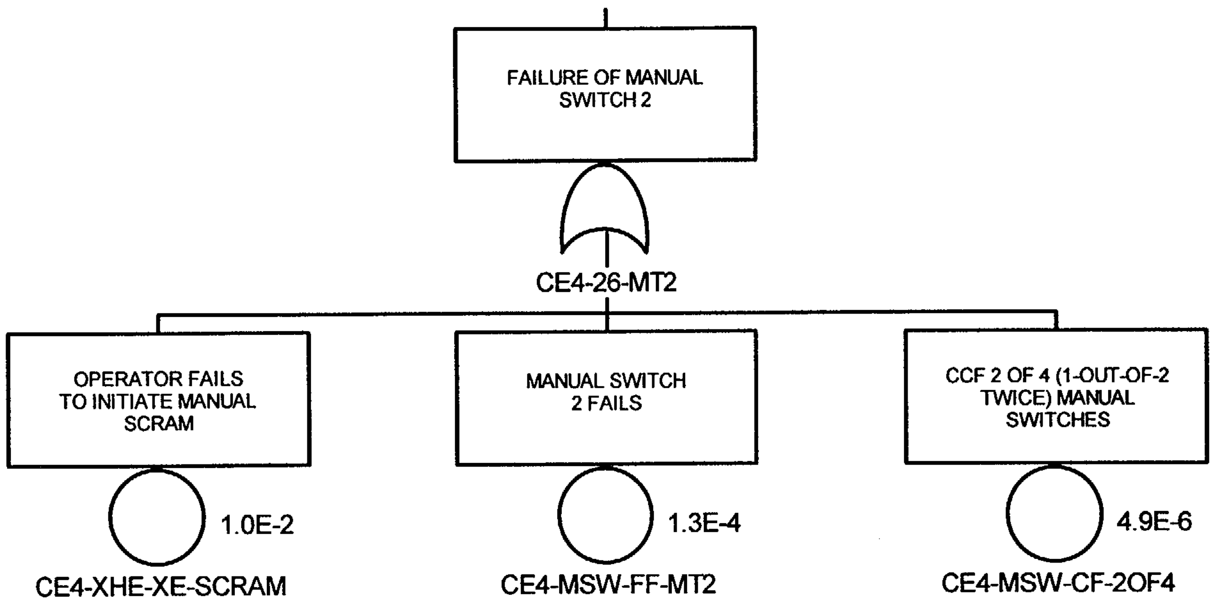

CHANNEL C PRESSURE BISTABLE FAILS
CE4-21-CHCP
CCF 3 OF 4 PRESSURE SENSORS/TRANSMITTERS
1.5E-6
CE4-CPR-CF-P3OF4
CCF 3 OF 4 PRESSURE BISTABLES
7.2E-6
CE4-CBI-CF-P3OF4
CHANNEL C PRESSURE BISTABLE FAILS
5.0E-4
CE4-CBI-FF-PC
CHANNEL C PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE4-CPR-FF-PC
CE4-21-CHCP - CHANNEL C PRESSURE BISTABLE FAILS
2001/03/02 Page 174


CHANNEL D TEMPERATURE BISTABLE FAILS
CE4-22-CHDT
CCF 3 OF 4 TEMPERATURE BISTABLES
7.2E-6
CE4-CBI-CF-T3OF4
CCF 3 OF 4 CORE PROTECTION CALCULATORS
5.7E-5
CE4-CPD-CF-T3OF4
CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE4-CTP-CF-HT3OF4
CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
1.0E-5
CE4-CTP-CF-CT3OF4
CHANNEL D TEMPERATURE BISTABLE UNIT FAILS
5.0E-4
CE4-CBI-FF-TD
CHANNEL D DIGITAL CORE PROTECTION CALCULATOR FAILS
2.7E-3
CE4-CPD-FF-TD
CHANNEL D HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE4-CTP-FF-HTD
CHANNEL D COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE4-CTP-FF-CTD
CE4-22-CHDT - CHANNEL D TEMPERATURE BISTABLE FAILS
2001/06/07 Page 175

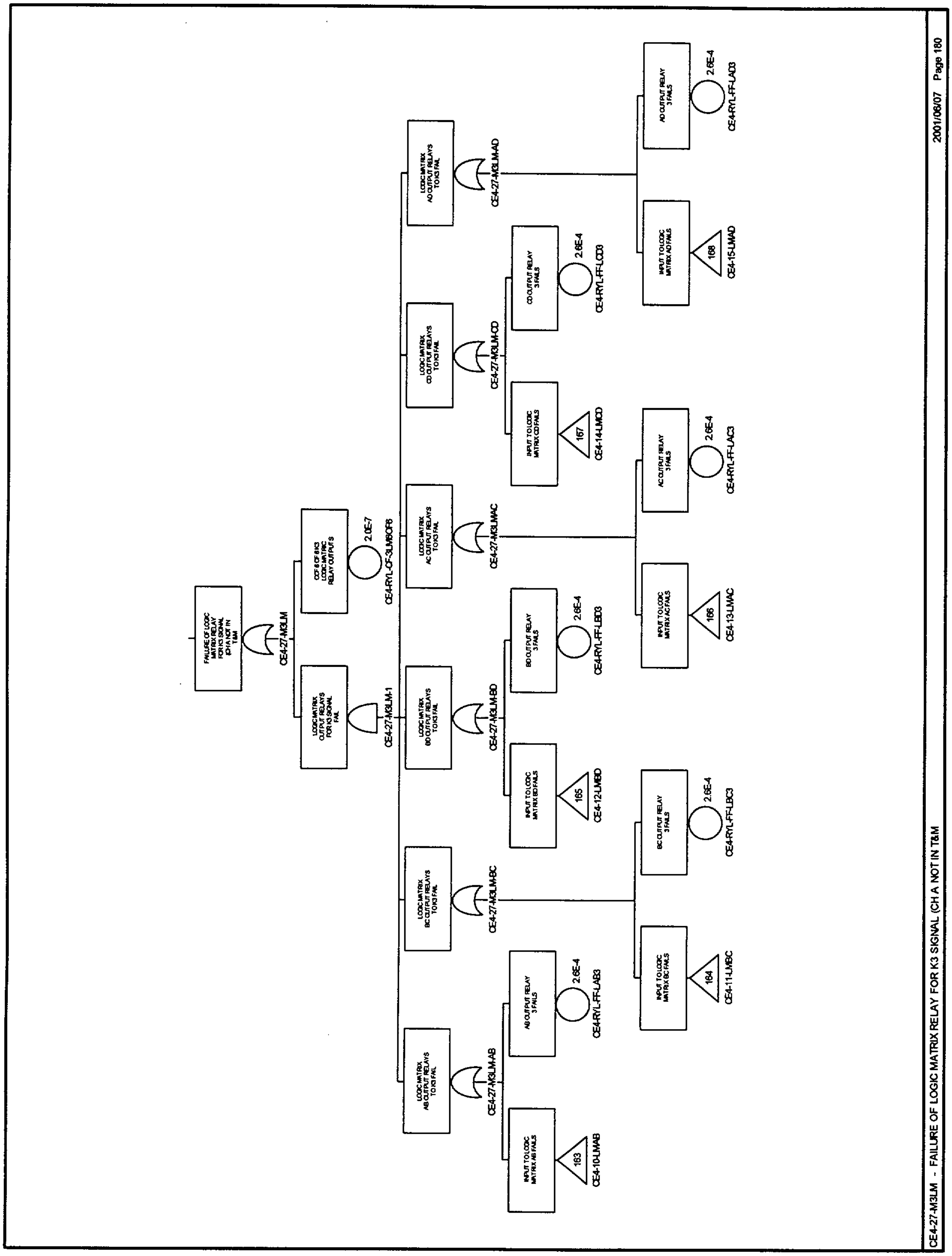

CHANNEL D PRESSURE BISTABLE FAILS
CE4-23-CHDP
CCF 3 OF 4 PRESSURE SENSORS/TRANSMITTERS
1.5E-6
CE4-CPR-CF-P3OF4
CCF 3 OF 4 PRESSURE BISTABLES
7.2E-6
CE4-CBI-CF-P3OF4
CHANNEL D PRESSURE BISTABLE FAILS
5.0E-4
CE4-CBI-FF-PD
CHANNEL D PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE4-CPR-FF-PD
CE4-23-CHDP - CHANNEL D PRESSURE BISTABLE FAILS
2001/03/02 Page 176

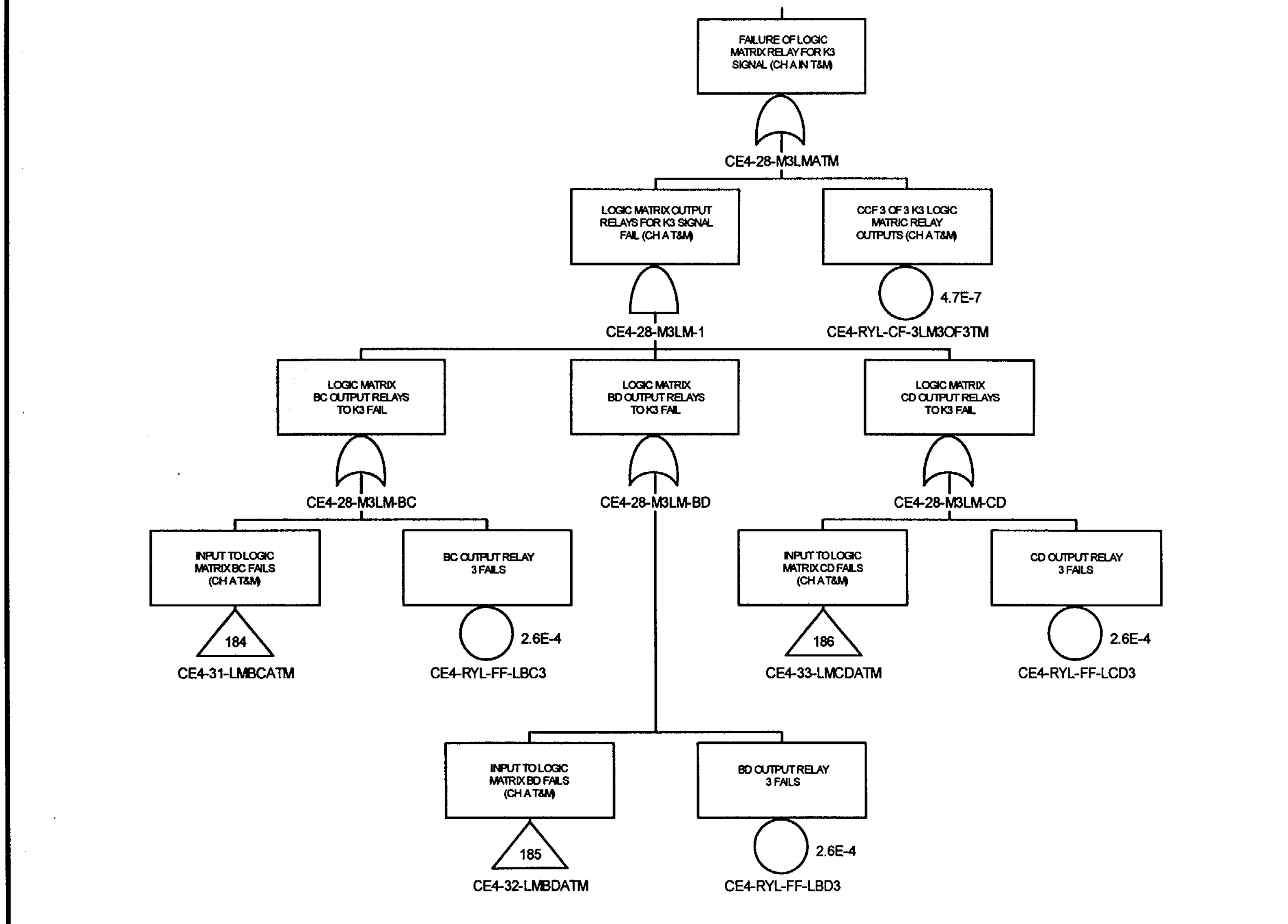

CE4-24-M2LM
CE4-24-M2LM-1
2.0E-7
CE4-RYL-CF-2LM6OF6
CE4-24-M2LM-AB
CE4-24-M2LM-BC
CE4-24-M2LM-BD
CE4-24-M2LMAC
CE4-24-M2LM-CD
CE4-24-M2LM-AD
163
CE4-10-LMAB
2.6E-4
CE4-RYL-FF-LAB2
164
CE4-11-LMBC
2.6E-4
CE4-RYL-FF-LBC2
165
CE4-12-LMBD
2.6E-4
CE4-RYL-FF-LBD2
166
CE4-13-LMAC
2.6E-4
CE4-RYL-FF-LAC2
167
CE4-14-LMCD
2.6E-4
CE4-RYL-FF-LCD2
168
CE4-15-LMAD
2.6E-4
CE4-RYL-FF-LAD2
CE4-24-M2LM - FAILURE OF LOGIC MATRIX RELAY FOR K2 SIGNAL (CH A NOT IN T&M
2001/06/07 Page 177


FAILURE OF LOGIC MATRIX RELAY FOR K2 SIGNAL (CH A IN T&M)
CE4-25-M2LMATM
LOGIC MATRIX OUTPUT RELAYS FOR K2 SIGNAL FAIL (CH A T&M)
CCF 3 OF 3 K2 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
4.7E-7
CE4-RYL-CF-2LM3OF3TM
CE4-25-M2LM-1
LOGIC MATRIX BC OUTPUT RELAYS TO K2 FAIL
LOGIC MATRIX BD OUTPUT RELAYS TO K2 FAIL
LOGIC MATRIX CD OUTPUT RELAYS TO K2 FAIL
CE4-25-M2LM-BC
CE4-25-M2LM-BD
CE4-25-M2LM-CD
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
184
CE4-31-LMBCATM
BC OUTPUT RELAY 2 FAILS
2.6E-4
CE4-RYL-FF-LBC2
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
186
CE4-33-LMCDATM
CD OUTPUT RELAY 2 FAILS
2.6E-4
CE4-RYL-FF-LCD2
INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
185
CE4-32-LMBDATM
BD OUTPUT RELAY 2 FAILS
2.6E-4
CE4-RYL-FF-LBD2
CE4-25-M2LMATM - FAILURE OF LOGIC MATRIX RELAY FOR K2 SIGNAL (CH A IN T&M)
2001/06/07 Page 178

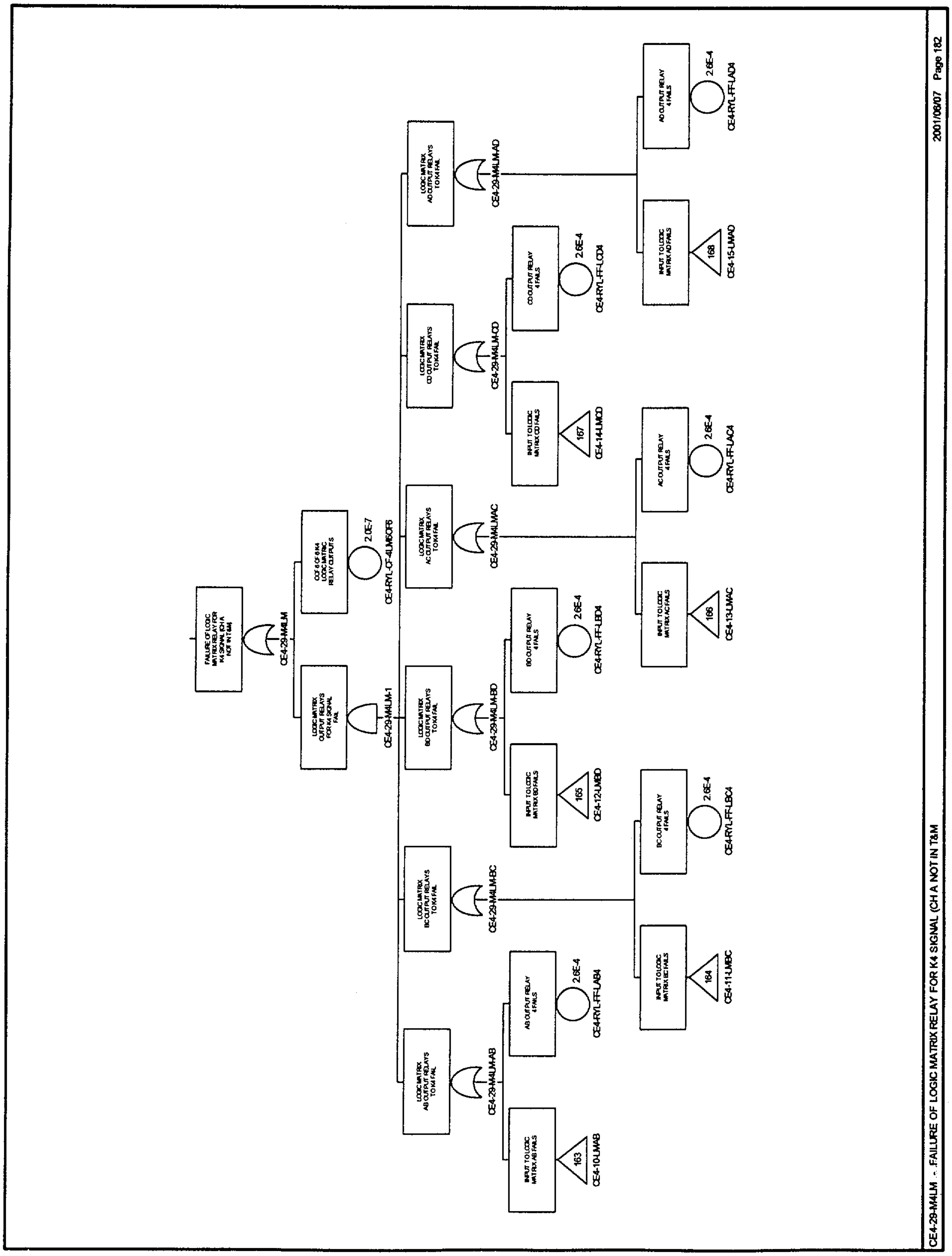


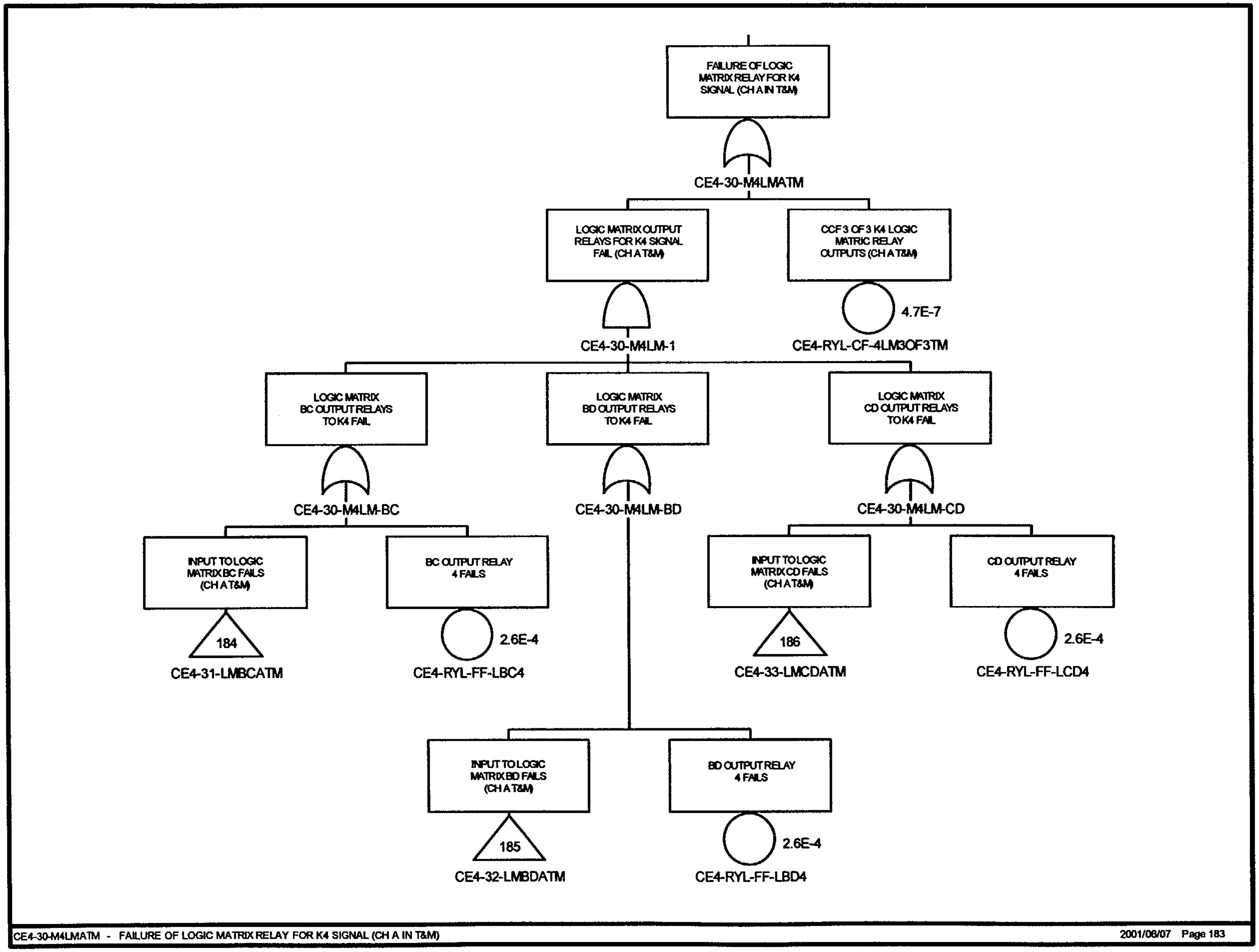
CE4-26-MT2 - FAILURE OF MANUAL SWITCH 2 2001/03/02 Page 179


FAILURE OF LOGIC MATRIX RELAY FOR K3 SIGNAL (CH A NOT IN T&M)
CE4-27-M3LM
LOGIC MATRIX OUTPUT RELAYS FOR K3 SIGNAL FAIL
CE4-27-M3LM-1
CCF 6 OF 6 K3 LOGIC MATRIC RELAY OUTPUTS
2.0E-7
CE4-RYL-CF-3LM6OF6
LOGIC MATRIX AB OUTPUT RELAYS TO K3 FAIL
CE4-27-M3LM-AB
LOGIC MATRIX BC OUTPUT RELAYS TO K3 FAIL
CE4-27-M3LM-BC
LOGIC MATRIX BD OUTPUT RELAYS TO K3 FAIL
CE4-27-M3LM-BD
LOGIC MATRIX AC OUTPUT RELAYS TO K3 FAIL
CE4-27-M3LM-AC
LOGIC MATRIX CD OUTPUT RELAYS TO K3 FAIL
CE4-27-M3LM-CD
LOGIC MATRIX AD OUTPUT RELAYS TO K3 FAIL
CE4-27-M3LM-AD
INPUT TO LOGIC MATRIX AB FAILS
163
CE4-10-LMAB
AB OUTPUT RELAY 3 FAILS
2.6E-4
CE4-RYL-FF-LAB3
INPUT TO LOGIC MATRIX BC FAILS
164
CE4-11-LMBC
BC OUTPUT RELAY 3 FAILS
2.6E-4
CE4-RYL-FF-LBC3
INPUT TO LOGIC MATRIX BD FAILS
165
CE4-12-LMBD
BD OUTPUT RELAY 3 FAILS
2.6E-4
CE4-RYL-FF-LBD3
INPUT TO LOGIC MATRIX AC FAILS
166
CE4-13-LMAC
AC OUTPUT RELAY 3 FAILS
2.6E-4
CE4-RYL-FF-LAC3
INPUT TO LOGIC MATRIX CD FAILS
167
CE4-14-LMCD
CD OUTPUT RELAY 3 FAILS
2.6E-4
CE4-RYL-FF-LCD3
INPUT TO LOGIC MATRIX AD FAILS
168
CE4-15-LMAD
AD OUTPUT RELAY 3 FAILS
2.6E-4
CE4-RYL-FF-LAD3
CE4-27-M3LM - FAILURE OF LOGIC MATRIX RELAY FOR K3 SIGNAL (CH A NOT IN T&M
2001/06/07 Page 180



CE4-28-M3LMATM - FAILURE OF LOGIC MATRIX RELAY FOR K3 SIGNAL (CH A IN T&M) 2001/06/07 Page 181


CE4-29-M4LM - .FAILURE OF LOGIC MATRIX RELAY FOR K4 SIGNAL (CH A NOT IN T&M
2001/08/07 Page 182
CE4-29-M4LM
CE4-29-M4LM-1
CE4-RYL-CF-4LM6OF6
2.0E-7
CE4-29-M4LM-AB
CE4-29-M4LM-BC
CE4-29-M4LM-BD
CE4-29-M4LMAC
CE4-29-M4LM-CD
CE4-29-M4LM-AD
163
CE4-10-LMAB
164
CE4-11-LMBC
165
CE4-12-LMBD
166
CE4-13-LMAC
167
CE4-14-LMCD
168
CE4-15-LMAD
2.6E-4
CE4-RYL-FF-LAB4
2.6E-4
CE4-RYL-FF-LBC4
2.6E-4
CE4-RYL-FF-LBD4
2.6E-4
CE4-RYL-FF-LAC4
2.6E-4
CE4-RYL-FF-LCD4
2.6E-4
CE4-RYL-FF-LAD4


FAILURE OF LOGIC MATRIX RELAY FOR K4 SIGNAL (CH A IN T&M)
CE4-30-M4LMATM
LOGIC MATRIX OUTPUT RELAYS FOR K4 SIGNAL FAIL (CH A T&M)
CCF 3 OF 3 K4 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
4.7E-7
CE4-RYL-CF-4LM3OF3TM
CE4-30-M4LM-1
LOGIC MATRIX BC OUTPUT RELAYS TO K4 FAIL
LOGIC MATRIX BD OUTPUT RELAYS TO K4 FAIL
LOGIC MATRIX CD OUTPUT RELAYS TO K4 FAIL
CE4-30-M4LM-BC
CE4-30-M4LM-BD
CE4-30-M4LM-CD
INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
184
CE4-31-LMBCATM
BC OUTPUT RELAY 4 FAILS
2.6E-4
CE4-RYL-FF-LBC4
INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
186
CE4-33-LMCDATM
CD OUTPUT RELAY 4 FAILS
2.6E-4
CE4-RYL-FF-LCD4
INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
185
CE4-32-LMBDATM
BD OUTPUT RELAY 4 FAILS
2.6E-4
CE4-RYL-FF-LBD4
CE4-30-M4LMATM - FAILURE OF LOGIC MATRIX RELAY FOR K4 SIGNAL (CH A IN T&M)
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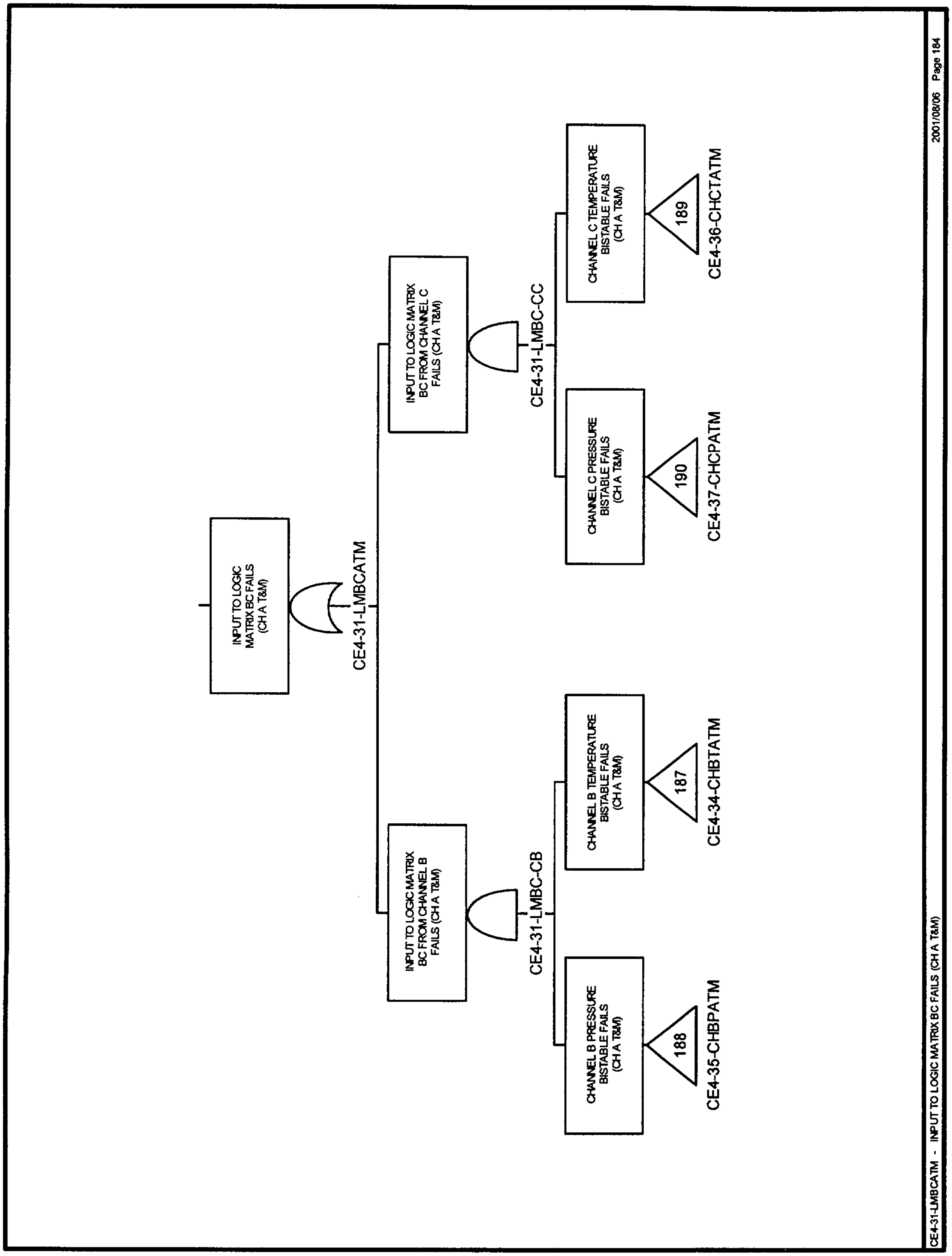
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INPUT TO LOGIC MATRIX BC FROM CHANNEL B FAILS (CH A T&M)
CE4-31-LMBC-CB
INPUT TO LOGIC MATRIX BC FROM CHANNEL C FAILS (CH A T&M)
CE4-31-LMBC-CC
CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M)
188
CE4-35-CHBPATM
CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M)
187
CE4-34-CHBTATM
CHANNEL C PRESSURE BISTABLE FAILS (CH A T&M)
190
CE4-37-CHCPATM
CHANNEL C TEMPERATURE BISTABLE FAILS (CH A T&M)
189
CE4-36-CHCTATM
CE4-31-LMBCATM - INPUT TO LOGIC MATRIX BC FAILS (CH A T&M)
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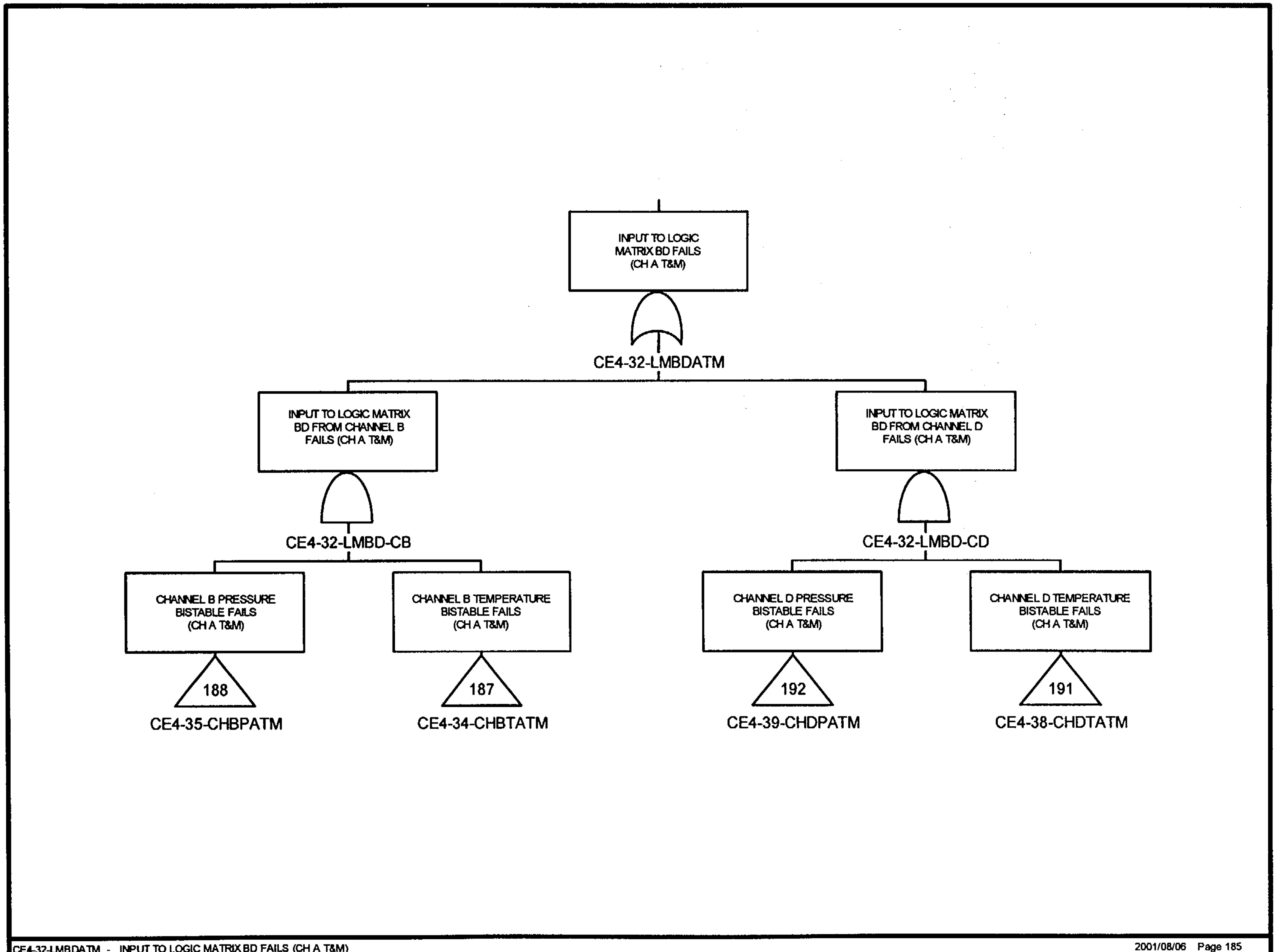
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CE4-32-LMBD-CB
CE4-32-LMBD-CD
CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M)
CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M)
CHANNEL D PRESSURE BISTABLE FAILS (CH A T&M)
CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
188
CE4-35-CHBPATM
187
CE4-34-CHBTATM
192
CE4-39-CHDPATM
191
CE4-38-CHDTATM
CE4-32-LMBDATM - INPUT TO LOGIC MATRIX BD FAILS (CH A T&M)
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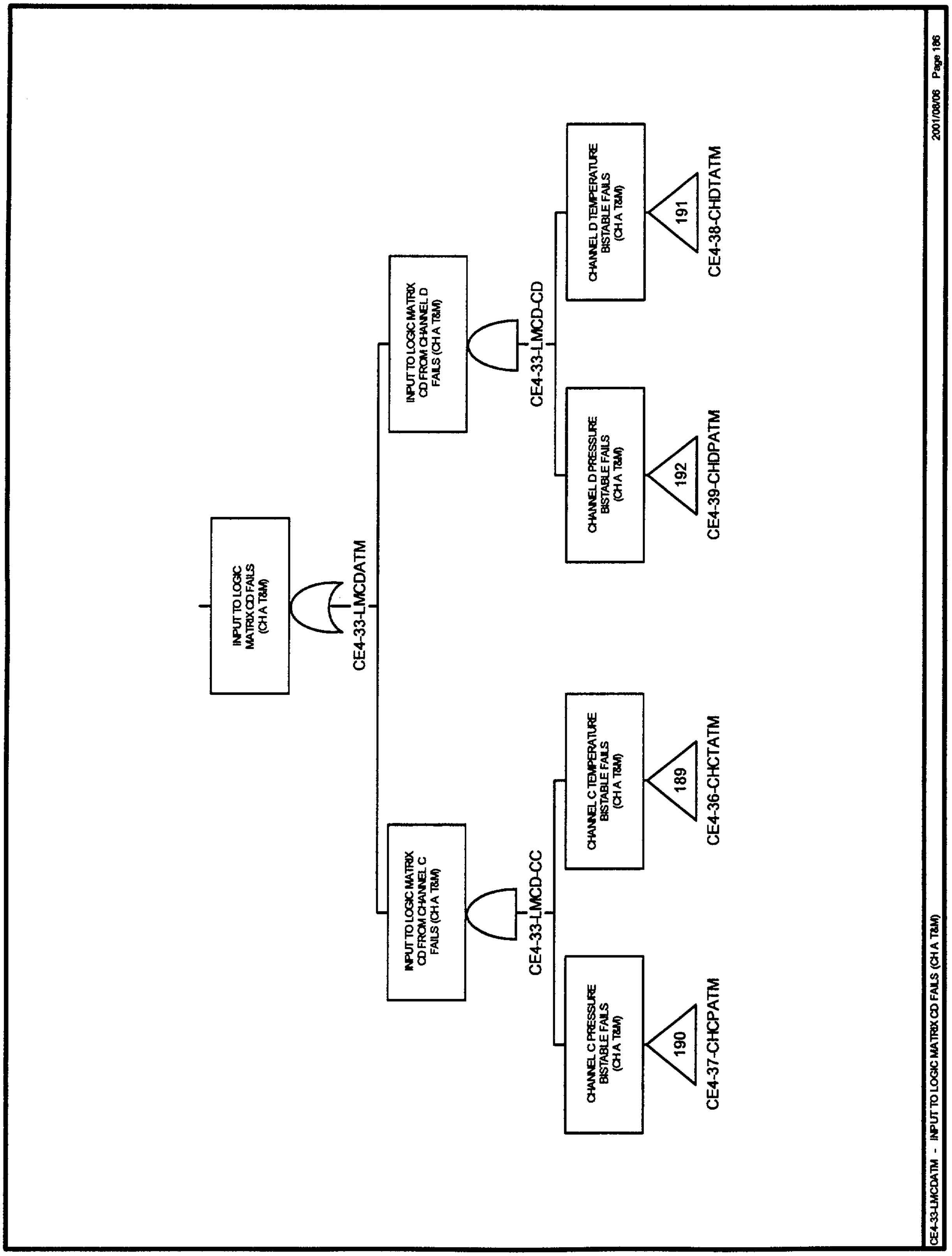
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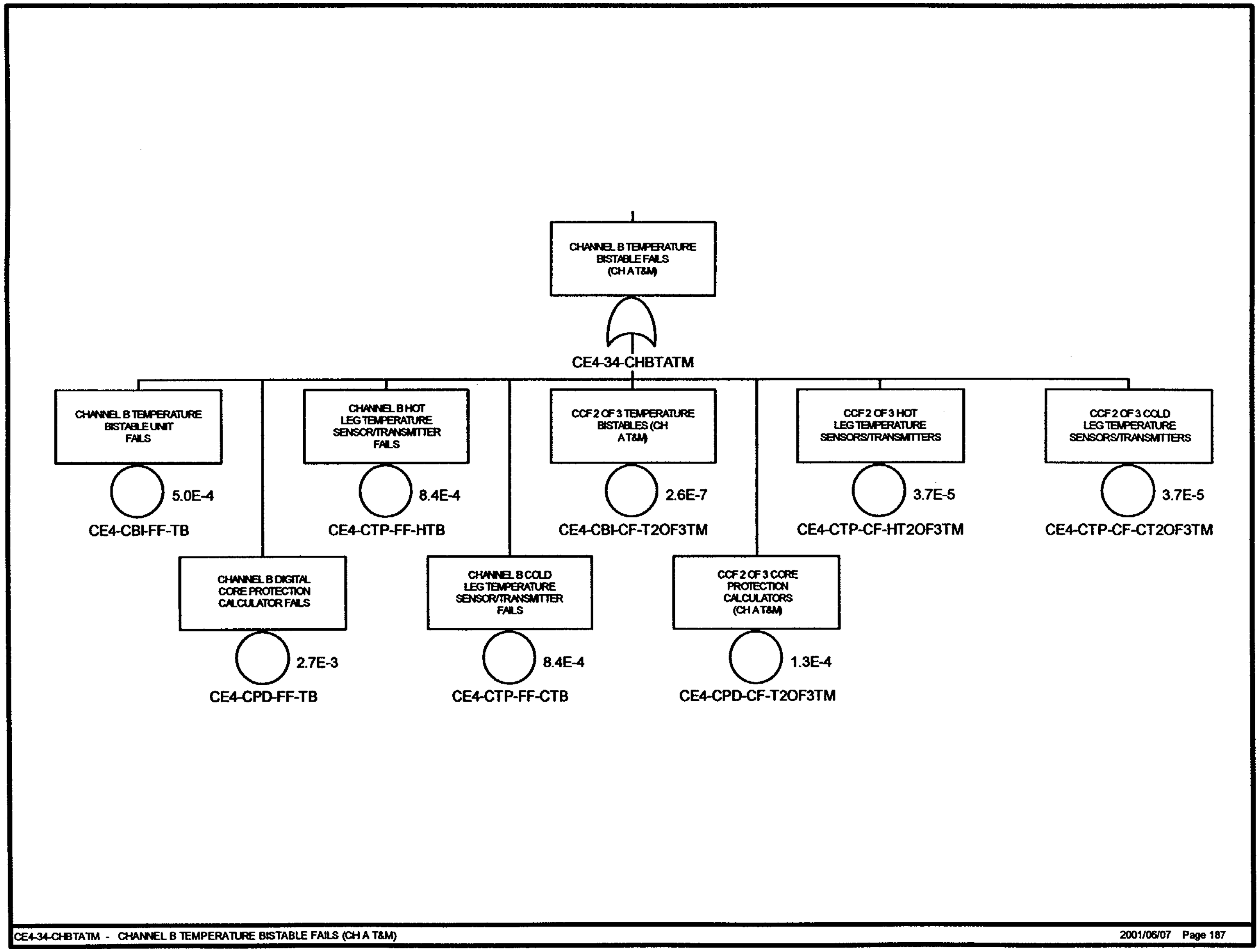
CE4-33-LMCD-CC
INPUT TO LOGIC MATRIX CD FROM CHANNEL D FAILS (CH A T&M)
CE4-33-LMCD-CD
CHANNEL C PRESSURE BISTABLE FAILS (CH A T&M)
190
CE4-37-CHCPATM
CHANNEL C TEMPERATURE BISTABLE FAILS (CH A T&M)
189
CE4-36-CHCTATM
CHANNEL D PRESSURE BISTABLE FAILS (CH A T&M)
192
CE4-39-CHDPATM
CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
191
CE4-38-CHDTATM
CE4-33-LMCDATM - INPUT TO LOGIC MATRIX CD FAILS (CH A T&M)
2001/08/06 Page 186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CHANNEL B TEMPERATURE BISTABLE UNIT FAILS
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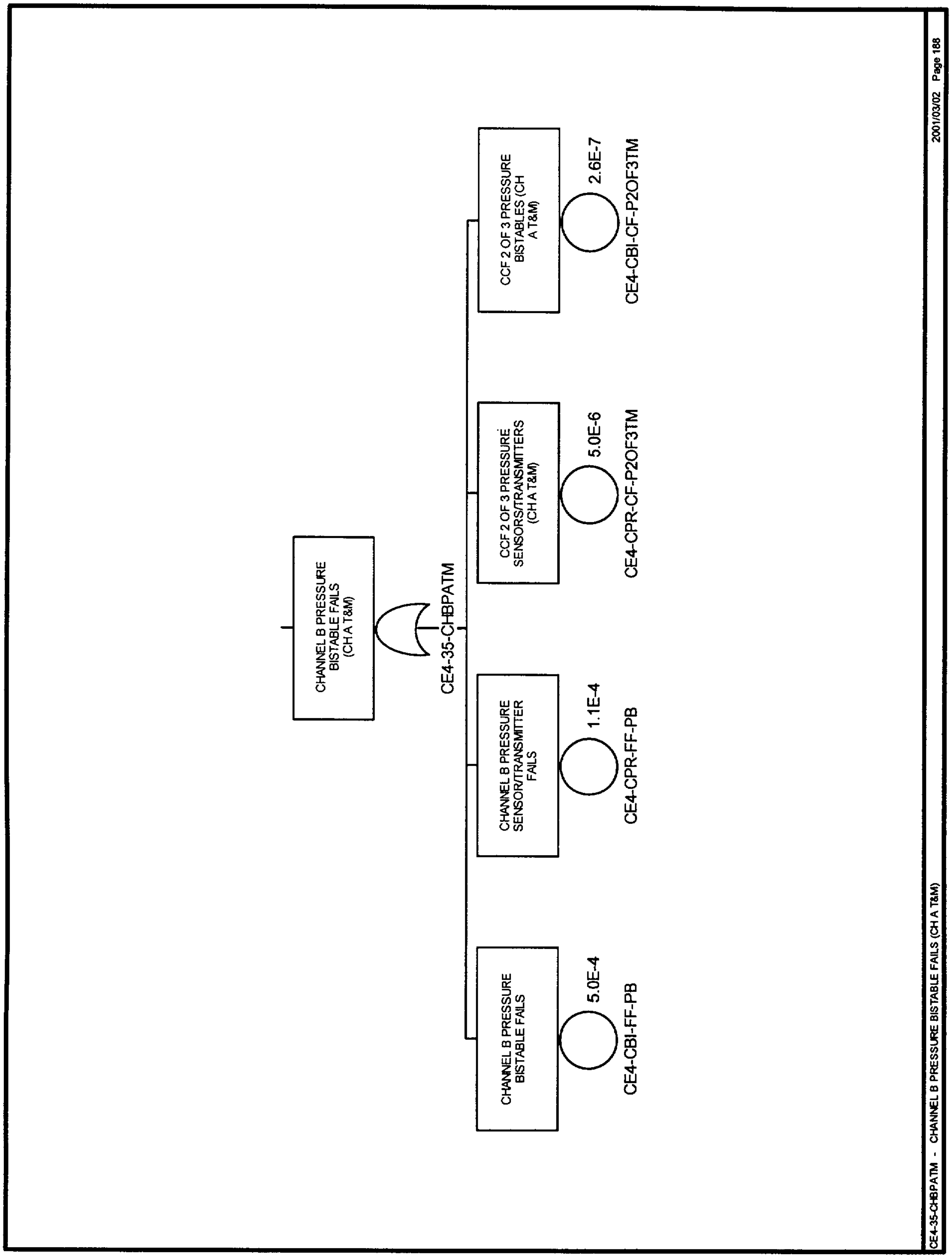
CE4-CBI-FF-TB
CHANNEL B DIGITAL CORE PROTECTION CALCULATOR FAILS
2.7E-3
CE4-CPD-FF-TB
CHANNEL B HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE4-CTP-FF-HTB
CHANNEL B COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE4-CTP-FF-CTB
CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
2.6E-7
CE4-CBI-CF-T2OF3TM
CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
1.3E-4
CE4-CPD-CF-T2OF3TM
CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE4-CTP-CF-HT2OF3TM
CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE4-CTP-CF-CT2OF3TM
CE4-34-CHBTATM - CHANNEL B TEMPERATURE BISTABLE FAILS (CH A T&M)
2001/06/07 Page 187



CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M)
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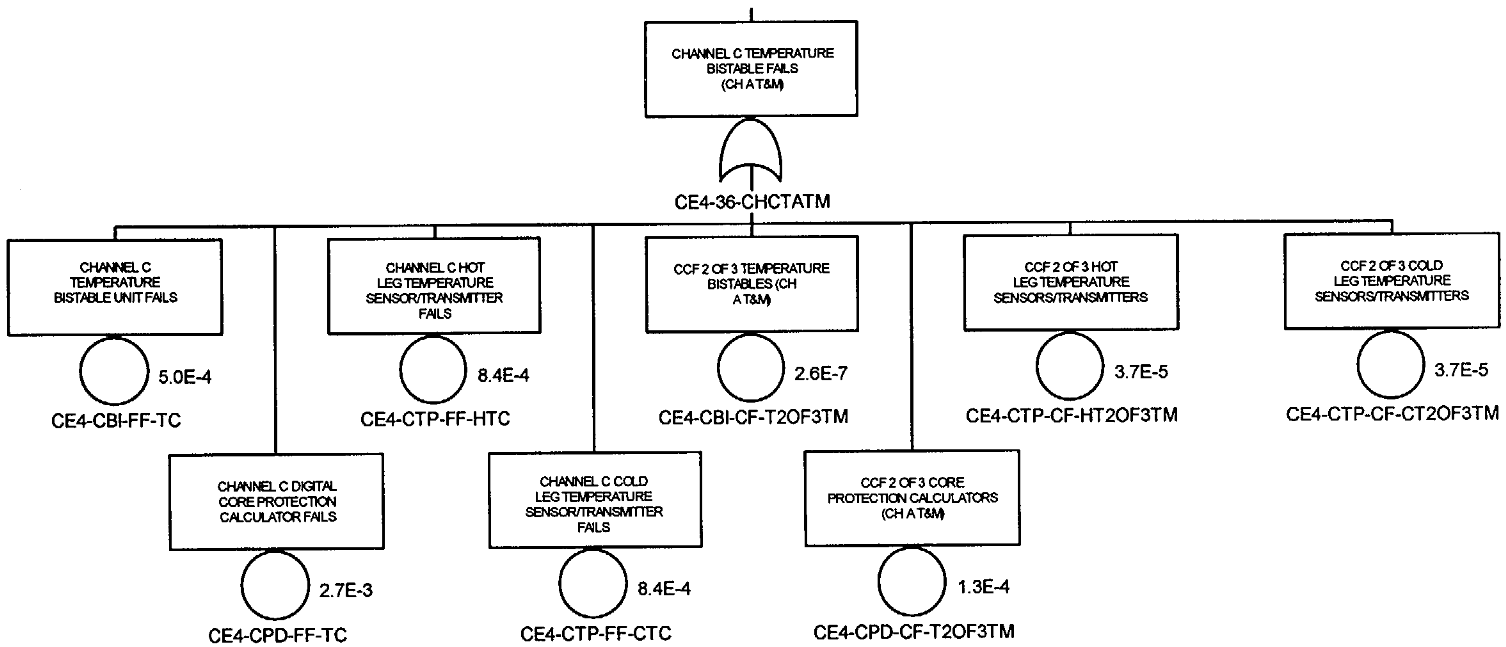
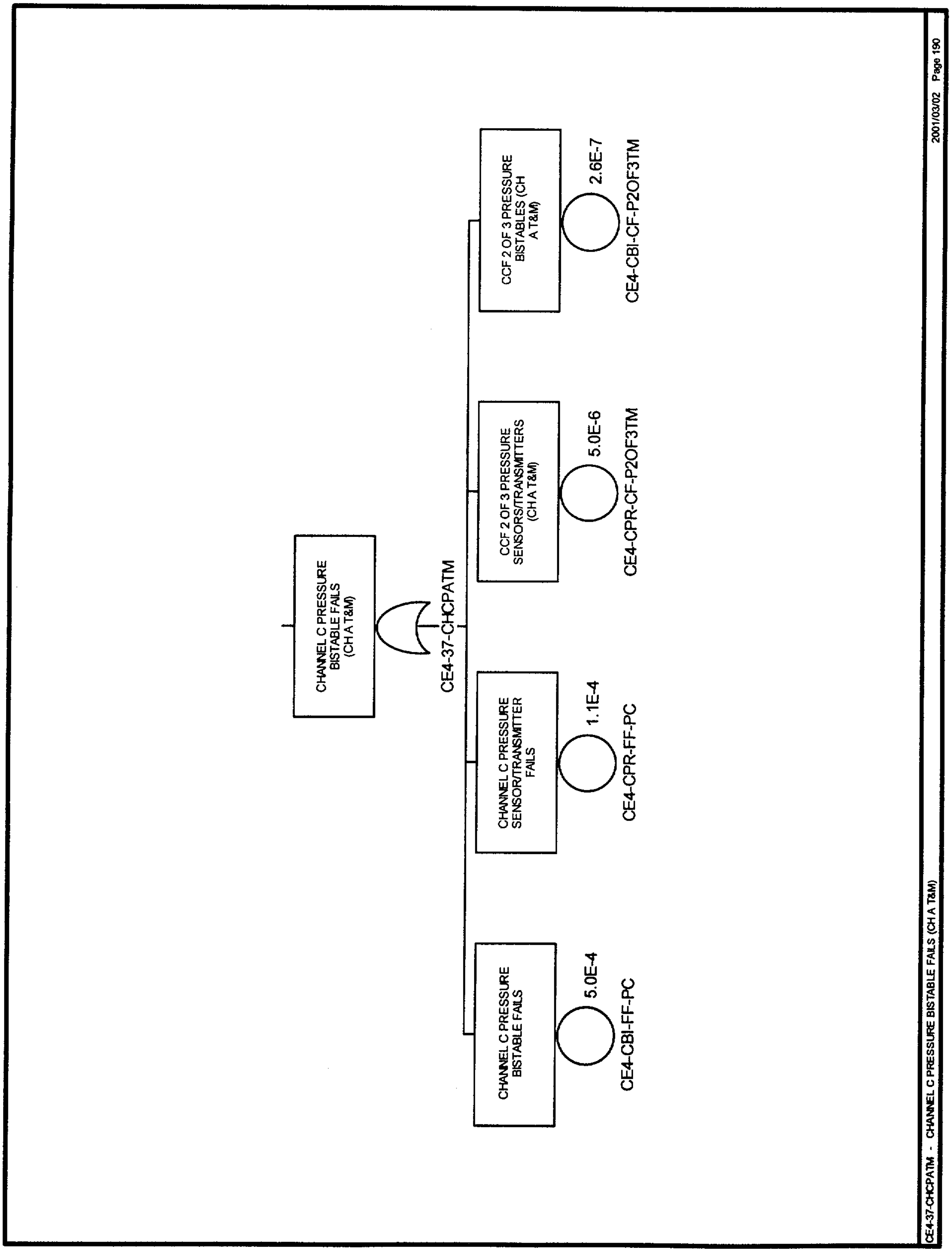
CHANNEL B PRESSURE BISTABLE FAILS
5.0E-4
CE4-CBI-FF-PB
CHANNEL B PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE4-CPR-FF-PB
CCF 2 OF 3 PRESSURE SENSORS/TRANSMITTERS (CH A T&M)
5.0E-6
CE4-CPR-CF-P2OF3TM
CCF 2 OF 3 PRESSURE BISTABLES (CH A T&M)
2.6E-7
CE4-CBI-CF-P2OF3TM
CE4-35-CHBPATM - CHANNEL B PRESSURE BISTABLE FAILS (CH A T&M)
2001/03/02 Page 188



CE4-36-CHCTATM - CHANNEL C TEMPERATURE BISTABLE FAILS (CH A T&M) 2001/06/07 Page 189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CE4-CBI-FF-PC
CHANNEL C PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE4-CPR-FF-PC
CCF 2 OF 3 PRESSURE SENSORS/TRANSMITTERS (CH A T&M)
5.0E-6
CE4-CPR-CF-P2OF3TM
CCF 2 OF 3 PRESSURE BISTABLES (CH A T&M)
2.6E-7
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CE4-37-CHCPATM - CHANNEL C PRESSURE BISTABLE FAILS (CH A T&M)
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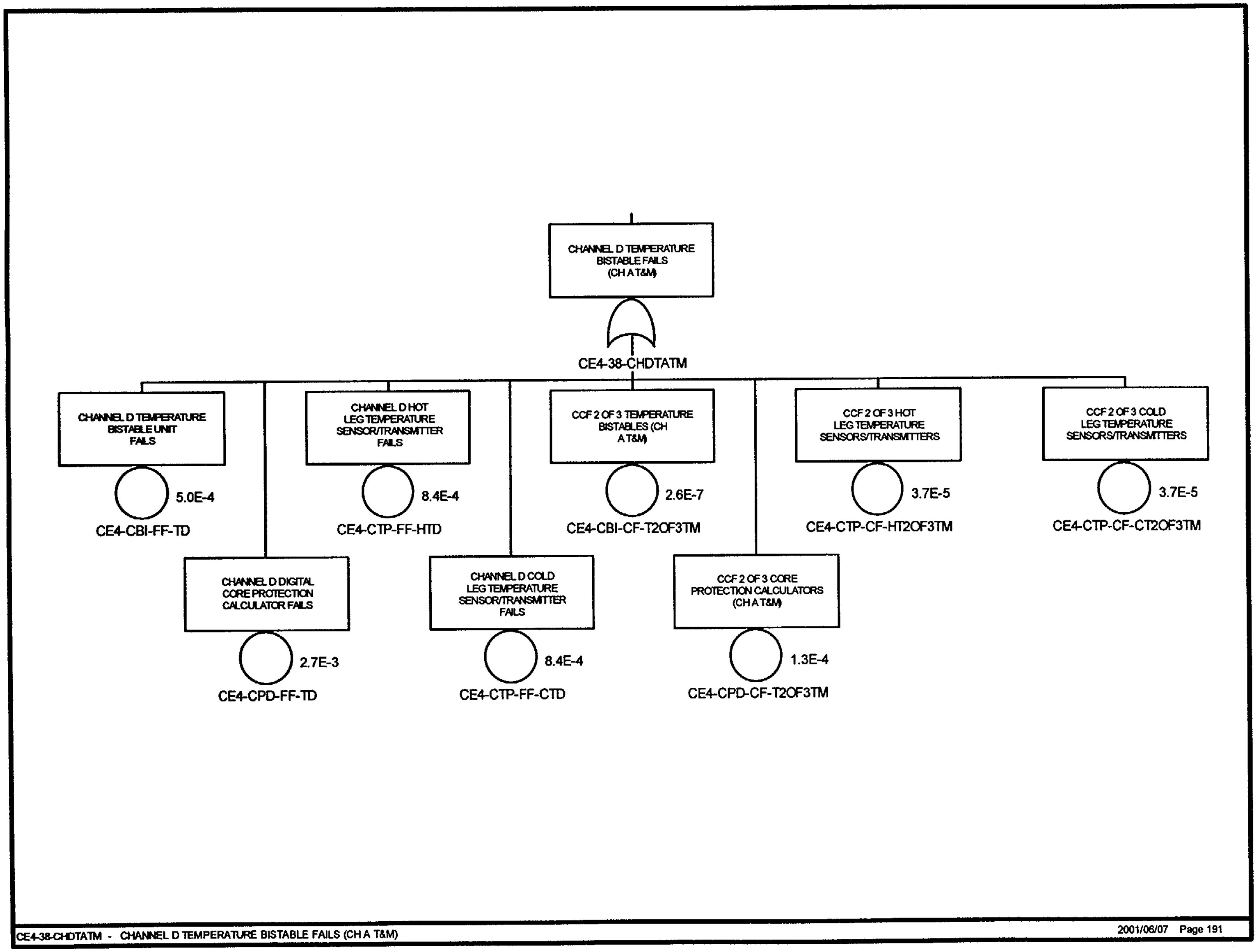

CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
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CHANNEL D TEMPERATURE BISTABLE UNIT FAILS
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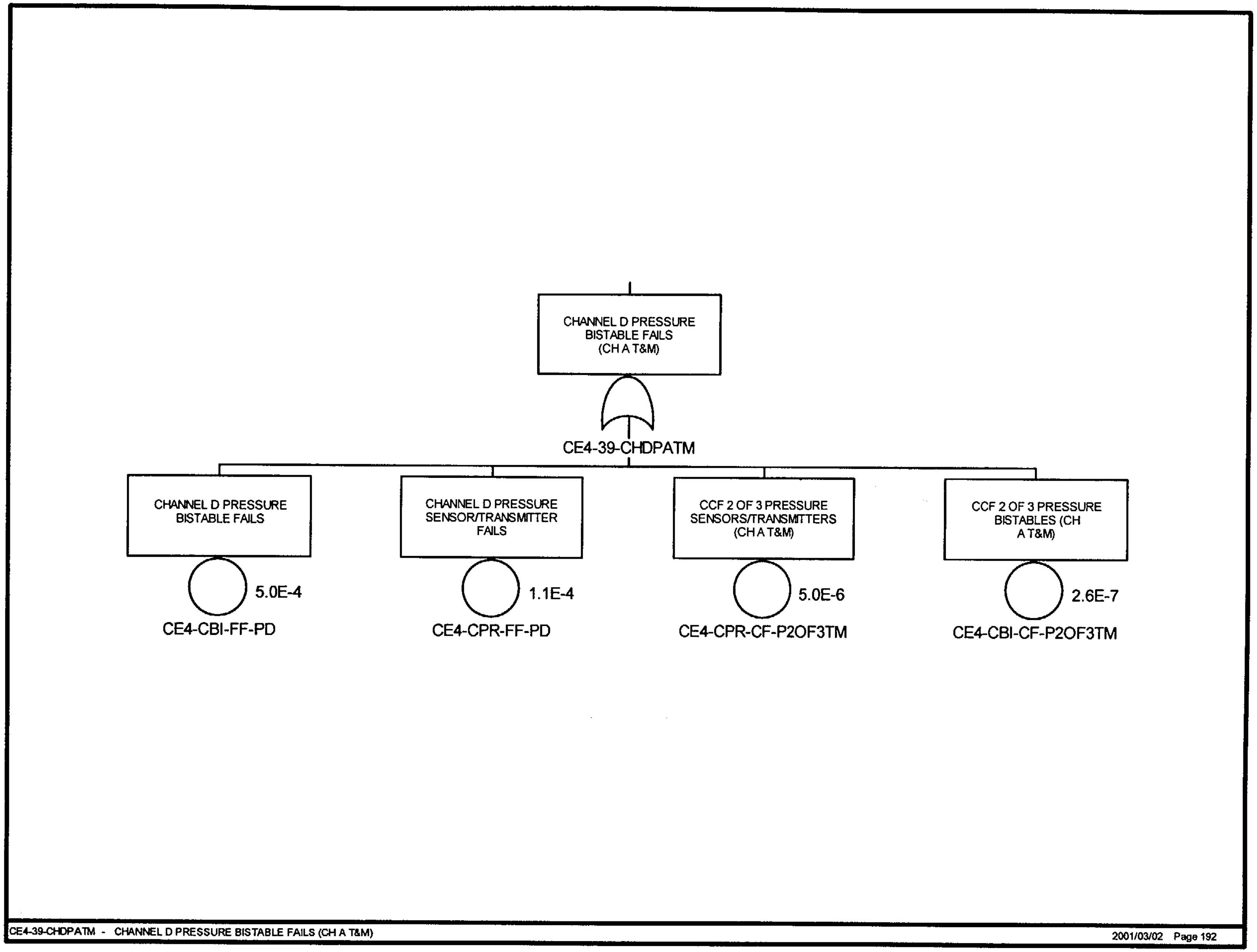
CE4-CBI-FF-TD
CHANNEL D DIGITAL CORE PROTECTION CALCULATOR FAILS
2.7E-3
CE4-CPD-FF-TD
CHANNEL D HOT LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE4-CTP-FF-HTD
CHANNEL D COLD LEG TEMPERATURE SENSOR/TRANSMITTER FAILS
8.4E-4
CE4-CTP-FF-CTD
CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
2.6E-7
CE4-CBI-CF-T2OF3TM
CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
1.3E-4
CE4-CPD-CF-T2OF3TM
CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE4-CTP-CF-HT2OF3TM
CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
3.7E-5
CE4-CTP-CF-CT2OF3TM
CE4-38-CHDTATM - CHANNEL D TEMPERATURE BISTABLE FAILS (CH A T&M)
2001/06/07 Page 191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CHANNEL D PRESSURE BISTABLE FAILS
5.0E-4
CE4-CBI-FF-PD
CHANNEL D PRESSURE SENSOR/TRANSMITTER FAILS
1.1E-4
CE4-CPR-FF-PD
CCF 2 OF 3 PRESSURE SENSORS/TRANSMITTERS (CH A T&M)
5.0E-6
CE4-CPR-CF-P2OF3TM
CCF 2 OF 3 PRESSURE BISTABLES (CH A T&M)
2.6E-7
CE4-CBI-CF-P2OF3TM
CE4-39-CHDPATM - CHANNEL D PRESSURE BISTABLE FAILS (CH A T&M)
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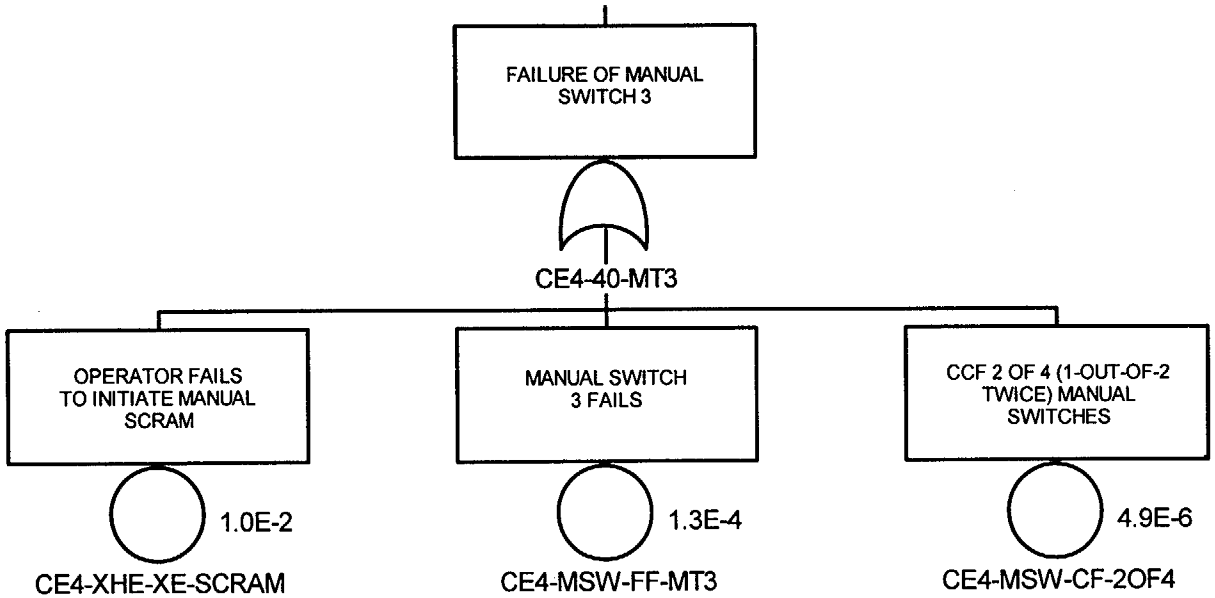

CE4-40-MT3 - FAILURE OF MANUAL SWITCH 3

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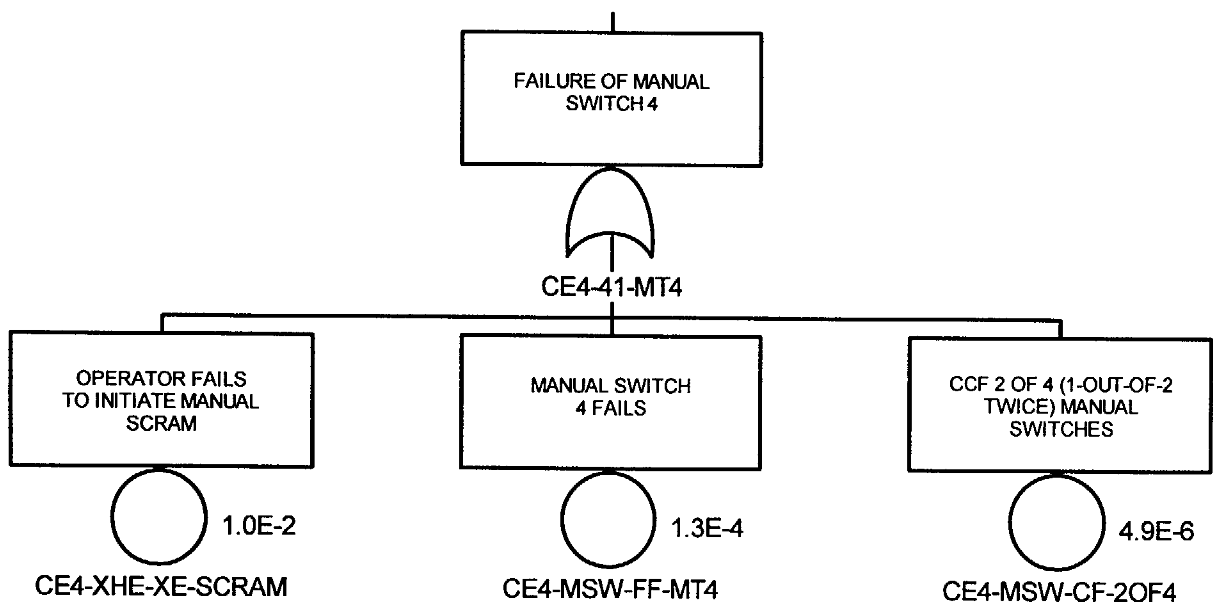

CE4-41-MT4 - FAILURE OF MANUAL SWITCH 4

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Appendix E

Common-Cause Failure Analysis

Appendix E

Common-Cause Failure Analysis

E-1. INTRODUCTION

This appendix presents general information on common-cause failure (CCF) and special techniques developed for the reactor protection system (RPS) study. Sections discuss background, methodology, the RPS CCF database, the prior, special software developed for this study, calculation of CCF basic event (BE) probabilities, and sensitivities. Throughout the section, component codes (e.g., CPR) are used when referring to components used in the RPS study. These codes are defined in the acronym list at the beginning of this report.

E-1.1 CCF Event Definition

A CCF event consists of component failures that meet four criteria: (1) two or more individual components fail or are degraded, including failures during demand, in-service testing, or deficiencies that would have resulted in a failure if a demand signal had been received; (2) components fail within a selected period of time, such that success of the probabilistic risk assessment (PRA) mission would be uncertain; (3) component failures result from a single shared cause and coupling mechanism; and (4) component failures are not due to failures of equipment outside the established component boundary.

Two data sources are used to select equipment failure reports to be reviewed for CCF event identification. The first is the Nuclear Plant Reliability Data System (NPRDS), which contains component failure information. The second one is the Sequence Coding and Search System (SCSS), which contains Licensee Event Reports (LERs).

The CCF event identification process includes review of failure data to identify CCF events and independent failure event counts. The identification process allows the analyst to consistently screen failures and identify CCF events. The CCF event coding process provides guidance for the analyst to consistently code CCF events. Sufficient information is recorded to ensure accuracy and consistency. Additionally, the CCF events are stored in a format that allows PRA analysts to review the events and develop understanding of CCF phenomenology.

E-1.2 Approach

The calculation of a CCF BE probability is a multi-step process. The fault trees developed for the RPS study identified CCF events that contributed to the possible failure of the RPS to successfully initiate a reactor trip. The data review and calculation of those CCF BE probabilities were driven by those needs. Figure E-1 shows a process flow diagram outlining the steps necessary to calculate a CCF BE probability. The step involving analysis of failure events is discussed in Appendices A and C. Fault tree development, defining CCF BE criteria, and component boundary definitions are discussed in Section 2 of the main body of this report.

This appendix presents a brief review of the CCF calculations to familiarize the reader with the terminology. More information can be found in the report *Common-Cause Failure Database and Analysis System: Event Definition and Classification.* [E-1]

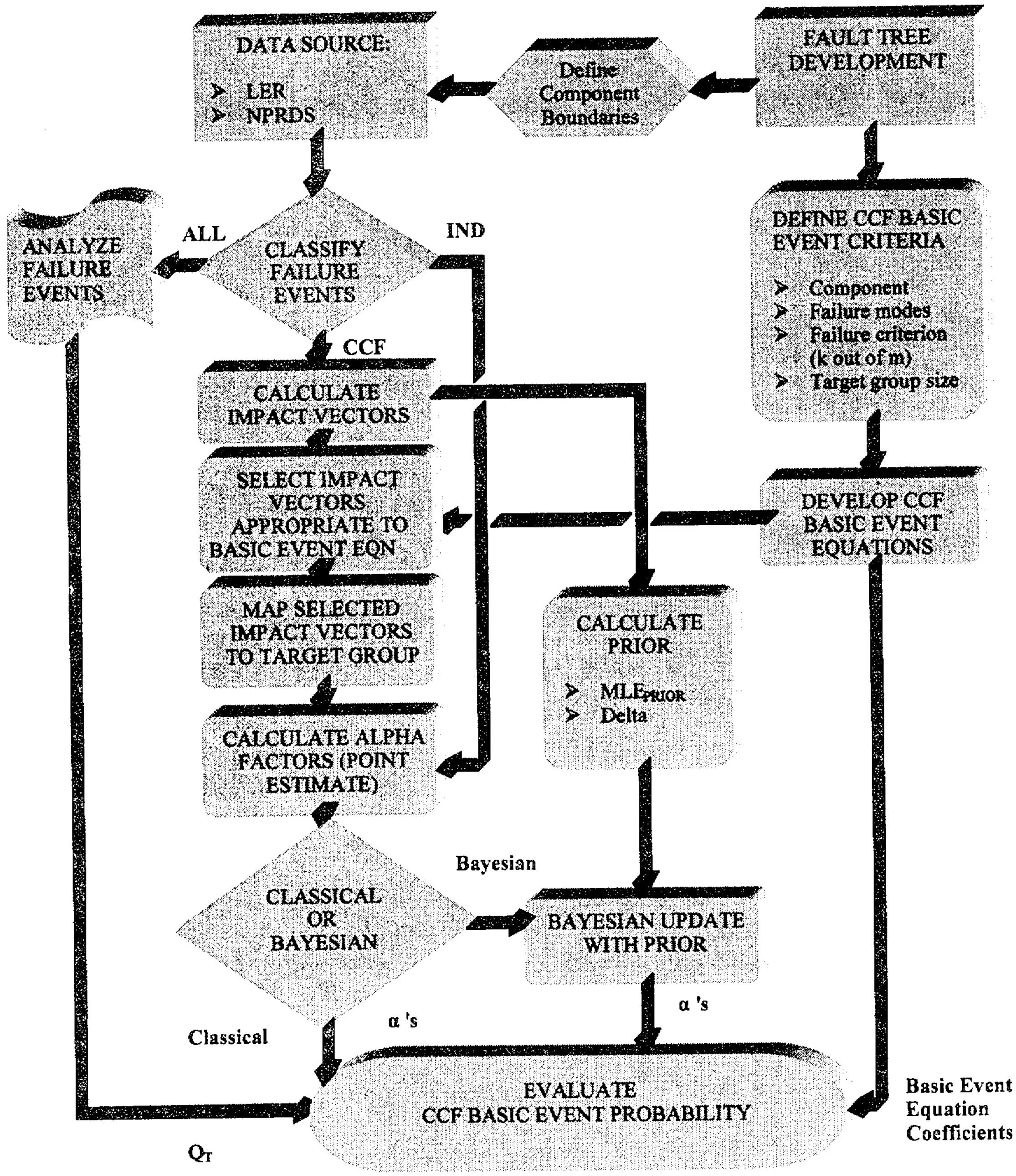


Figure E-1. CCF process flow diagram.

E-2. CCF MODEL

This section presents information on the type of CCF model used in this study and describes the process of developing the CCF BE equation.

E-2.1 Alpha Model

In order to estimate the probability of a common-cause event involving k specific components in a common-cause component group (CCCG) of size m, a model needed to be selected from among the available models. Available models included the Basic Parameter model, the Beta model, the Multiple Greek Letter (MGL) model, and the Alpha Factor model.

The parametric Alpha Factor model was chosen because the alpha factor model (1) is multi-parameter and can handle any redundancy level, (2) is based on ratios of failure rates, which makes the assessment of its parameters easier when no statistical data are available, and (3) has a simpler statistical model, and produces more accurate point estimates, as well as uncertainty distributions, compared to other parametric models having the above two properties.

The alpha factor model estimates CCF frequencies from a set of ratios of failures and the total component failure rate. The parameters of the model are

Q_T ≡ total failure probability of each component (includes independent and common-cause events)

$\alpha^{(m)}_k$ ≡ fraction of the total probability of failure events that occur in the system involving the failure of k components in a system of m components due to a common-cause.

E-2.2 CCF Basic Event Equation Development

The CCF basic event probabilities are calculated using the alpha factor model. The alpha factor model requires coefficients for each alpha factor k based on the number of combinations of k components that will fail the system of components and the total number of k out of m combinations. Variations of the logic in the RPS affect the number of combinations that will fail the system of components. The first type is any k of m combinations. A special case is one-out-of-two-twice logic. Another special case of any k of m is when more than one component in a channel must fail to fail the channel, called *specific failure criterion.*

E-2.2.1 Alpha Factor Model

The form of the CCF BE equation for <u>any</u> k out of m components failing is given by Equation E-1 for *staggered* testing:

$$Q_{CCF} = Q_T \sum_{i=k}^{m} \frac{\binom{m}{i}}{\binom{m-1}{i-1}} \alpha_i^{(m)} = Q_T \sum_{i=k}^{m} \frac{m}{i} \alpha_i^{(m)} \qquad \text{E-1}$$

where:

$\alpha^{(\mu)}_i$	=	the ratio of i and only i CCF failures to total failures in a system of m components
m	=	the number of total components in the component group
k	=	the failure criteria for a number of component failures in the component group
Q_T	=	the random failure probability (total)
Q_{CCF}	=	the failure probability of k and greater than k components due to CCF

The BE probability for a specific k failures out of a system of m components (assuming a staggered testing scheme) is shown in Equation E-2.

$$Q_{CCF} = Q_T \sum_{i=k}^{m} \frac{C_i}{\binom{m-1}{i-1}} \alpha_i^{(m)} \quad \text{E-2}$$

where:

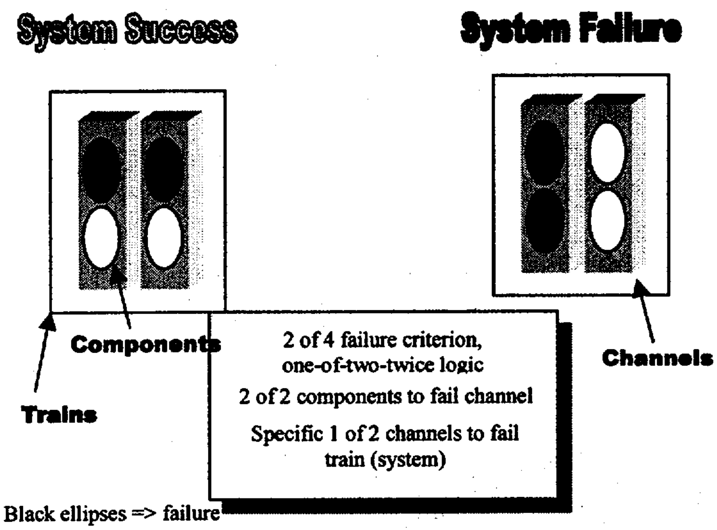
α_i	=	the ratio of i and only i CCF failures to total failures
m	=	the number of total rods in the component group
k	=	the failure criteria for a number of rod failures in the component group
Q_T	=	the random failure probability (total)
Q_{CCF}	=	the failure probability of k and greater than k components due to CCF
C_i	≡	number of combinations of k component failures that will fail the system

E-2.2.2 Any k of m Logic

The failure criterion, any k of m, is used to represent system logic that requires k failures out of m components to fail the component system. All combinations of k of m will fail the component system. An example of this in the RPS system is the simple sensor/transmitter logic where 3 of 4 pressure transmitters will fail the high pressure trip signal to the RPS channels. Another example is the rod failure criteria, in which the rods may fail in any combination of 20 percent, or more, and the rod insertion is considered failed. The failure criterion is described in shorthand as k/m. Equation E-1 is used for these types of logic.

E-2.2.3 One-Out-of-Two-Twice Logic

An example of a one-out-of-two-twice logic failure criterion is shown in Figure E-2. This example applies to the 2/4 BME CCF event used in the fault trees. In this example, the failure criterion is described in shorthand as 2/4. This is based on failure of two of two components to fail a channel and specific failure of one of two channels to fail a train. Some of the combinations of four component failures will fail two channels, but no trains (e.g., those combinations where two failures are in each of two trains). Some combinations of four will fail an entire train. An example is shown in the failure side of Figure E-2. The valid failure combinations are counted, and the sum becomes the C_i term in Equation E-2. When a component is taken out of service for maintenance, it is placed in a non-tripped (bypassed) status. The possible combinations are counted with the component always failed. This maintenance event is described in shorthand as 1/3 |4.

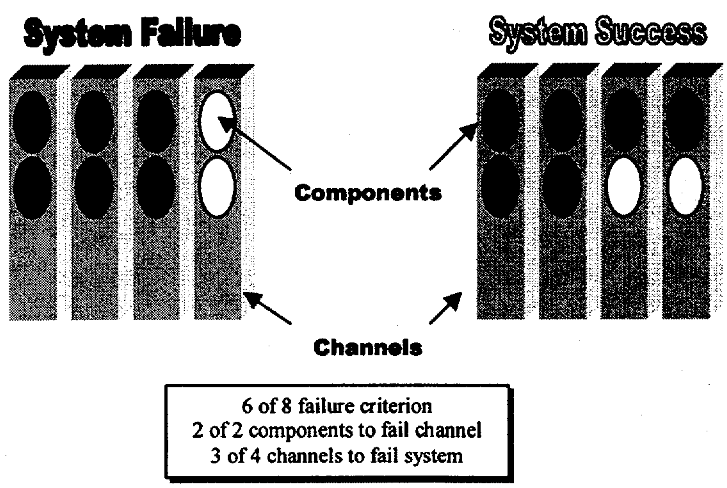


Note: Black ellipses => failure
White ellipses => success

Figure E-2. Example of a one-of-two-twice logic failure criterion for a 2-out-of-4 system.

E-2.2.4 Specific Failure Criterion

An example of a specific failure criterion is shown in Figure E-3. This example applies to the 6/8 CBI CCF event used in the fault trees. In this example, the failure criterion is described in shorthand as 6/8. This is based on specific criteria of failure of two of two components to fail a channel and failure of at least three of four channels to fail the system or function. Some of the combinations of six component failures will fail three channels, e.g., those combinations where two failures are in each of three channels). Some combinations of six will fail only two channels, e.g., those combinations that have less than two failures in a channel. The valid failure combinations are counted, and the sum becomes the C_i term in Equation E-2. When a channel is taken out of service for maintenance, it is placed in a non-tripped status. The criteria then become two of two components and two or more of the remaining three channels. This maintenance event is described in shorthand as 4/6 |8.



Note: Black ellipses => failure
White ellipses => success

Figure E-3. Example of a specific failure criterion.

A subset of *specific failure criterion* is *unique failure criterion.* Unique failure criteria are calculated according to Equation E-2 using terms C_i that are counted by hand to satisfy less obvious failure criteria. The failure criterion is described in shorthand as *k/m* U.

E-2.2.5 CCF BE Probability Equations

Table E-1 shows the CCF BE probability equations used in the CE RPS study. All of the equations are based on staggered testing.

Table E-1. Failure criteria and basic event equation table.

Failure Criteria			
Channel or Train Level	Component (within channel or train)	Shorthand Criterion [a]	Basic Event Probability Equations
1/2	2/2	2/4 [b]	$(\alpha_4 + 4\alpha_3/3 + 2\alpha_2/3) * Q_T$
3/4	1/1	3/4	Equation E-1
3/4	1/1	2/3 |4	Equation E-1
1/4	2/2	2/8 [b]	$(\alpha_8 + 8\alpha_7/7 + 28\alpha_6/21 + 56\alpha_5/35 + 54\alpha_4/35 + 24\alpha_3/21 + 4\alpha_2/7) * Q_T$
3/4	2/2	6/8 [b]	$(\alpha_8 + 8\alpha_7/7 + 4\alpha_6/21) * Q_T$
3/4	2/2	4/6 |8 [b]	$(\alpha_8 + 8\alpha_7/7 + 16\alpha_6/21 + 12\alpha_5/35 + 3\alpha_4/35) * Q_T$
6/6	1/1	6/6	$(\alpha_6) * Q_T$
6/6	1/1	3/3 |6 U [c]	$(\alpha_6 + 3\alpha_5/5 + 3\alpha_4/10 + 1\alpha_3/10) * Q_T$
6/6	2/4	12/24 U [c]	$(\alpha_{24} + 24\alpha_{23}/23 + 132\alpha_{22}/253 + 440\alpha_{21}/1771 + 990\alpha_{20}/8855 + 1584\alpha_{19}/33649 + 1848\alpha_{18}/100947 + 1584\alpha_{17}/245157 + 990\alpha_{16}/490314 + 440\alpha_{15}/817190 + 132\alpha_{14}/1144066 + 24\alpha_{13}/1352078 + 2\alpha_{12}/1352078) * Q_T$
6/6	2/4	6/12 |24 U [c]	$(\alpha_{24} + 24\alpha_{23}/23 + 306\alpha_{22}/253 + 1632\alpha_{21}/1771 + 6120\alpha_{20}/8855 + 17136\alpha_{19}/33649 + 37128\alpha_{18}/100947 + 63648\alpha_{17}/245157 + 87516\alpha_{16}/490314 + 97240\alpha_{15}/817190 + 87516\alpha_{14}/1144066 + 63648\alpha_{13}/1352078 + 37128\alpha_{12}/1352078 + 17136\alpha_{11}/1144066 + 6120\alpha_{10}/817190 + 1632\alpha_9/490314 + 306\alpha_8/245157 + 36\alpha_7/100947 + 2\alpha_6/33649) * Q_T$
7/36	1/1	7/36	Equation E-1

a. Shorthand criteria with the form x/y |z are maintenance events involving one channel or train taken out of service due to maintenance.

b. This criterion is based on the one-out-of-two logic described in Section E-2.2.3.

c. This criterion is based on the specific failure criterion described in Section E-2.2.4.

E-3. CCF PARAMETER DEVELOPMENT

This section discusses in detail the parameters, tools, and treatments developed specifically for the RPS study. Specifically, it describes the development of a PWR RPS-specific prior, how CCF BE probabilities are calculated, application of the safety function knowledge, and special application of the Bayesian update process.

E-3.1 CCF Calculation Methodology

Three techniques are discussed in this section. These techniques are used to facilitate the estimation of plant-specific CCF probabilities from industry experience. One technique is the *impact vector* method, which is used to classify events according to the level of impact of common-cause events and the associated uncertainties in numerical terms. The second is impact vector specialization, in which impact vectors are modified to reflect the likelihood of the occurrence of the event in the specific system of interest. This technique is called *mapping*. The third technique is the estimation of alpha factors from the mapped impact vectors. Each technique is described briefly. More information on CCF methodology can be found in NUREG/CR-5485.[E-2]

E-3.1.1 Impact Vector

An impact vector is a numerical representation of a CCF event. For a CCCG of size m, an impact vector has m+1 elements. The k+1 element, denoted by F_k, equals one if failure of exactly k components occurred, and zero otherwise. This applies to those situations where the component degradation values equal 1.0 and the time delay and coupling strength are 1.0. For those cases where these parameters are less than 1.0, the following techniques are used to develop an impact vector.

E-3.1.1.1 Impact Vector Equations. The values of the different elements (F_k) of the impact vector can be calculated based on the possible combinations of failures and non-failures. Equation E-4 shows, in general, how an element of the impact vector is calculated based on a degraded component state:

$$F_k^{(m)} = \sum_{l=0}^{\binom{m}{k}} \prod_{i=0}^{k} (p_i) \prod_{j=0}^{m-k} \left(1 - p_j\right) \qquad \text{E-4}$$

where:

m	=	the number of elements in the group
k	=	the number of failures out of the group of m
i	=	the failure elements of the l^{th} combination of k out of m failures
j	=	the non-failure elements of the l^{th} combination of k out of m failures
p	=	the weight or probability of the failure of each component (component degradation value)

Two additional parameters are coded with each CCF event: q represents the timing factor, and c represents the shared cause factor. The impact vector is then modified to reflect these parameters in the following manner:

$$\begin{aligned} I_{CCF} &= \left[cqF_0^{(m)}, cqF_1^{(m)}, \ldots, cqF_m^{(m)}\right] \\ I_{c_1} &= \left[(1-cq)(1-p_1), (1-cq)p_1, 0, \ldots, 0\right] \\ &\vdots \\ I_{c_m} &= \left[(1-cq)(1-p_m), (1-cq)p_m, 0, \ldots, 0\right] \end{aligned} \qquad \text{E-5}$$

where:

c	=	shared cause factor
q	=	timing factor

Finally, the average impact vector is obtained by adding I_{CCF} and the I_c's, element by element.

E-3.1.1.2 Treatment of Uncertainty in Determining the Loss of Component Safety Function. During the review of the NPRDS and LER data for the RPS study there was some uncertainty about whether the safety function of the piece of equipment under scrutiny was compromised due to the failure mechanism. The uncertainty in this judgment is due to either (1) unclear text in the event narrative, or (2) the component could be required to perform in different modes in the fault trees. For example, if a temperature detector fails high, it could either cause a spurious trip or contribute to preventing a trip, depending on the parameter being measured.

To document the safety function impact, an additional field (FM2) was added to the database. When the analyst was uncertain about the status of the safety function, UKN (unknown) was entered in this field. Otherwise the field was coded FS for a fail-safe failure mode or NFS for a non-fail-safe failure mode.

This information was used in estimating component failure rates or Q_T's in Appendix C. The method is to calculate a ratio (NFS Ratio) of the failures identified as NFS to those that are identified as either FS or NFS. The NFS ratio was then applied by multiplying the count of UKN events by the NFS ratio and adding that to the NFS count.

The CCF data were treated in a similar manner. The method chosen to implement this treatment is to multiply each element of the average impact vector (for those CCF events designated as UKN) by the NFS ratio the same as the treatment of coupling strength and time delay. This effectively provides consistency between the CCF alpha parameter calculation and the Q_T calculation. A list of the component-specific ratios is given in Table E-2.

$$NFS\,Ratio = \frac{NFS + 0.5}{NFS + FS + 1.0}$$

Table E-2. Component NFS ratios.

Component	FS Count	NFS Count	NFS Ratio
BME	255	37	0.13
BSN	15	19	0.56
BUV	71	91	0.56
CBI	448	583	0.57
CPR	234	287	0.55
CTP	199	226	0.53
RYT	20	13	0.40
RYL	20	5	0.21
ROD	1	12	0.89

E-3.1.2 Mapping of Data

E-3.1.2.1 Exposed Population versus Component Group Size. There is a difference between the concepts of exposed population and the CCCG size. The exposed population is a data analysis concept, and CCCG size is a modeling concept. An example of the difference is provided in the context of the RPS study.

PWR plants contain up to 40 bistables in the RPS. In most cases, the actual number of installed bistables in a particular plant represents the exposed population. This would apply to failures due to design faults and setpoint drift. Table A-2 shows the installed population count basis used in this study. In some cases, the exposed population can be less than the installed population. This would apply to the failure of several bistables in one channel, due to inadequate cooling.

For a given trip scenario, one or more bistables are required to function in each channel. The CCCG size is the number of bistables required per channel times the number of channels. This varies as the number of modeled trip parameters changes, depending upon the channel design. Therefore, it is possible to have events with in-plant populations of up to 24 components, and the modeled events have a CCCG from two up to the exposed population.

An impact vector represents a CCF event in a specific group of components of exposed population size *m*. A collection of impact vectors used to calculate the CCF BE probability for a particular component may contain impact vectors of many different exposed population sizes (e.g., events that occur in different plants or different systems). In this case, the impact vectors are mapped to the CCCG size of interest.

E-3.1.2.2 Mapping Techniques. An impact vector will be mapped up, mapped down, or unchanged depending upon the relationship between the original system and the target system CCCG. The process for determining the equations for mapping has been written into a program to allow mapping from any size system to any other size system. The equations that describe the mapping process are discussed below.

There are three general routines for mapping, depending on the relationship between the original impact vectors and the system of interest. Mapping down is performed when the impact vector exposed population size is larger than the target group size, and mapping up is performed when the impact vector exposed population size is smaller than the target group size. In the special case where the impact vector has been coded as a "lethal shock," the impact vector for the new system of *m* components contains a 1.0 in the F_m position. To illustrate the mapping process, mapping down and mapping up equations are presented for CCCGs of three and five in Equations E-6 and E-7.

Mapping Down (5 ⇒ 3)

$$
\begin{aligned}
F_1^{(3)} &= 3/5F_1^{(5)} + 3/5F_2^{(5)} + 3/10F_3^{(5)} \\
F_2^{(3)} &= 3/10F_2^{(5)} + 3/5F_3^{(5)} + 3/5F_4^{(5)} \\
F_3^{(3)} &= 1/10F_3^{(5)} + 2/5F_4^{(5)} + F_5^{(5)}
\end{aligned}
\qquad \text{E-6}
$$

Mapping Up (3 ⇒ 5)

$$
\begin{aligned}
F_1^{(5)} &= 5/3(1-\rho)^2 F_1^{(3)} \\
F_2^{(5)} &= 7/3\rho(1-\rho)^1 F_1^{(3)} + (1-\rho)^2 F_2^{(3)} \\
F_3^{(5)} &= \rho^2 F_1^{(3)} + 2\rho(1-\rho)^1 F_2^{(3)} + (1-\rho)^2 F_3^{(3)} \\
F_4^{(5)} &= \rho^2 F_2^{(3)} + 2\rho(1-\rho)^1 F_3^{(3)} \\
F_5^{(5)} &= \rho^2 F_3^{(3)}
\end{aligned}
\qquad \text{E-7}
$$

The parameter ρ in Equation E-7 is called the *mapping up* parameter. It is the probability that the non-lethal shock or cause would have failed a single component added to the system. One equation for estimating ρ is given by Equation E-8[E-3]

$$
\rho = \frac{\sum_{i=1}^{m} i(i-1)f_i}{(m-1)\sum_{i=1}^{m} i(f_i)} \qquad \text{E-8}
$$

where

m = the number of elements in the group (CCCG)
f_i = the i^{th} element of the generic impact vector.

This method works well when the system sizes are close to one another (e.g., mapping from size 2 to size 3 or 4) or when at least one of the component degradation values is less than 1.0. When all of the component degradation values are equal to 1.0, ρ is also equal to 1.0. When used in the *mapping up* equations for the RPS data, this method tends to overestimate the probability that components added to a system will exhibit the same lethal shock-like behavior. Examination of trends in the unmapped RPS data shows that as the number of components in a system increases, the likelihood of lethal behavior in that group of components decreases rapidly. Based on these observed trends and empirical studies, a value of 0.85 was established for ρ.

E-3.1.3 Estimation of CCF Alpha Factors

Once the impact vectors are calculated for the target group, the number of events in each impact category (n_k, Equation E-9) can be calculated by adding the corresponding elements of the impact vectors. That is, with n CCF events,

$$n_k = \sum_{j=1}^{n} F_k(j) \qquad \text{E-9}$$

where:

$F_k(i)$ = the k^{th} element of the impact vector for event i.

The parameters of the alpha-factor model, Equation E-10, can be estimated using the following maximum likelihood estimators (MLE):

$$\alpha_k^{(m)} = \frac{n_k}{\sum_{k=1}^{m} n_k} \qquad \text{E-10}$$

E-3.2 Development of an RPS-Specific Prior Distribution

E-3.2.1 Background

The Bayesian approach utilizes the concept of a prior distribution. The prior reflects the analyst's the current evidence about the parameter before the data are collected. In this study, the prior distribution is developed using a generic data set that is combined in a given way to produce the prior distribution. This prior is then updated with the specific component CCF data. The updated distribution is known as the posterior distribution. The posterior represents the best knowledge about the parameter after incorporating the current evidence.

E-3.2.2 PWR RPS CCF Prior Event Population

For this study, prior distributions were developed based on the common-cause data collected during the course of the RPS studies. The resultant priors represent generic data, which are updated with component specific evidence in the Bayesian update.

The RPS prior uses components from the PWR vendors. Thus, there is a large variation in the group sizes. These group sizes range from 2 to 130 with the average group size equal to 23.7.

The Combustion Engineering CCF data set contains 65 events, which is sufficient to build a prior. However, the prior built from these few events, did not exhibit enough smoothness to be used with small amounts of specific data. Therefore, the Babcock & Wilcox, Combustion Engineering, and Westinghouse RPS CCF events were pooled together and used in the estimation of the prior distributions for this study. This pooled, PWR, RPS data set contains 366 CCF events.

E-3.2.3 Prior Distribution Mean Values

The Babcock & Wilcox, Combustion Engineering, and Westinghouse CCF data were mapped to a CCCG of size 2. This data set was then used to estimate the prior distributions for this CCCG size. This process was continued for CCCG sizes of 3 to 24 and 36. Table E-3 shows the sums of each element (n_k) of the impact vectors for each CCCG, which are the results of the mapping. Table E-4 shows the maximum likelihood estimators (MLE) for each component CCCG size. The MLE is estimated by Equation E-11:

$$MLE_i = \frac{n_i}{\sum_{j=1}^{m} n_j} \qquad \text{E-11}$$

where

m	=	CCCG
n_j	=	the sum of the j^{th} element of the impact vector, over all events
n_1	=	sum of the first element and the Adjusted Independent
Adjusted Independent	=	(Ind. Event Count * Mapped CCCG)/Average CCCG.

The CCF prior distributions for RPS system, derived from the complete set of Babcock & Wilcox, Combustion Engineering, and Westinghouse RPS data, provide initial estimates for each $\alpha^{(m)}{}_k$ by mapping the data to each CCCG of interest, summing the impact vector elements for each CCF event, adding the number of independent events for the CCCG being considered to the $\alpha^{(m)}{}_1$ term, and normalizing across the alphas for the CCCG so that they add up to one. These estimates are taken to be the mean values for each prior distribution.

Table E-3. PWR RPS prior, sums of impact vector elements.

Group Size	Adjusted Independents	Prior Σn_k Vector
2	144.2	[6.01e+01, 5.80e+00]
3	216.2	[7.91e+01, 1.12e+01, 1.96e+00]
4	288.3	[9.56e+01, 1.52e+01, 4.36e+00, 9.34e-01]
5	360.4	[1.10e+02, 2.00e+01, 5.75e+00, 2.01e+00, 6.88e-01]
6	432.5	[1.22e+02, 2.42e+01, 7.99e+00, 2.52e+00, 1.22e+00, 5.55e-01]
7	504.5	[1.33e+02, 2.84e+01, 9.58e+00, 3.74e+00, 1.43e+00, 8.81e-01, 4.60e-01]
8	576.6	[1.43e+02, 3.24e+01, 1.11e+01, 5.05e+00, 1.81e+00, 1.02e+00, 6.96e-01, 3.85e-01]
9	648.7	[1.51e+02, 3.66e+01, 1.25e+01, 5.81e+00, 2.68e+00, 1.20e+00, 7.95e-01, 5.80e-01, 3.25e-01]
10	720.8	[1.59e+02, 4.08e+01, 1.40e+01, 6.67e+00, 3.31e+00, 1.62e+00, 8.95e-01, 6.50e-01, 5.00e-01, 2.74e-01]
11	792.9	[1.66e+02, 4.48e+01, 1.54e+01, 7.61e+00, 3.85e+00, 2.05e+00, 1.10e+00, 7.15e-01, 5.52e-01, 4.41e-01, 2.33e-01]
12	864.9	[1.73e+02, 4.89e+01, 1.66e+01, 8.63e+00, 4.38e+00, 2.46e+00, 1.35e+00, 8.36e-01, 5.92e-01, 4.82e-01, 3.94e-01, 1.97e-01]
13	937.0	[1.79e+02, 5.17e+01, 1.84e+01, 9.20e+00, 5.15e+00, 2.89e+00, 1.59e+00, 1.00e+00, 6.68e-01, 5.04e-01, 4.33e-01, 3.55e-01, 1.68e-01]
14	1009.1	[1.85e+02, 5.44e+01, 2.00e+01, 9.83e+00, 5.71e+00, 3.49e+00, 1.80e+00, 1.19e+00, 7.81e-01, 5.52e-01, 4.40e-01, 3.96e-01, 3.21e-01, 1.42e-01]
15	1081.2	[1.91e+02, 5.71e+01, 2.16e+01, 1.06e+01, 5.95e+00, 4.28e+00, 2.00e+00, 1.36e+00, 9.16e-01, 6.31e-01, 4.68e-01, 3.93e-01, 3.67e-01, 2.90e-01, 1.21e-01]
16	1153.3	[1.97e+02, 5.94e+01, 2.30e+01, 1.15e+01, 6.59e+00, 4.35e+00, 2.56e+00, 1.51e+00, 1.06e+00, 7.31e-01, 5.23e-01, 4.06e-01, 3.60e-01, 3.43e-01, 2.62e-01,
24	1729.9	[2.35e+02, 7.38e+01, 3.28e+01, 1.78e+01, 1.07e+01, 7.35e+00, 4.97e+00, 3.29e+00, 2.25e+00, 1.64e+00, 1.26e+00, 9.82e-01, 7.64e-01, 5.84e-01, 4.46e-01, 3.47e-01, 2.78e-01, 2.35e-01, 2.25e-01, 2.43e-01, 2.52e-01, 2.04e-01, 1.09e-01, 2.80e-02]
36	2702.7	[2.78e+02, 1.00e+02, 4.83e+01, 2.78e+01, 1.78e+01, 1.26e+01, 9.37e+00, 7.29e+00, 5.84e+00, 4.41e+00, 3.25e+00, 2.39e+00, 1.78e+00, 1.36e+00, 1.09e+00, 9.10e-01, 7.81e-01, 6.70e-01, 5.62e-01, 4.58e-01, 3.65e-01, 2.94e-01, 2.44e-01, 2.09e-01, 1.81e-01, 1.54e-01, 1.34e-01, 1.30e-01, 1.47e-01, 1.76e-01, 1.95e-01, 1.81e-01, 1.31e-01, 6.96e-02, 2.39e-02, 3.98e-03]

Table E-4. PWR RPS prior, maximum likelihood estimators of α_k.

Group Size	MLE Vector
2	[9.72e-01, 2.76e-02]
3	[9.57e-01, 3.64e-02, 6.36e-03]
4	[9.49e-01, 3.77e-02, 1.08e-02, 2.31e-03]
5	[9.43e-01, 4.01e-02, 1.15e-02, 4.02e-03, 1.38e-03]
6	[9.38e-01, 4.10e-02, 1.35e-02, 4.26e-03, 2.06e-03, 9.39e-04]
7	[9.35e-01, 4.17e-02, 1.41e-02, 5.48e-03, 2.09e-03, 1.29e-03, 6.74e-04]
8	[9.32e-01, 4.20e-02, 1.44e-02, 6.55e-03, 2.35e-03, 1.32e-03, 9.01e-04, 4.99e-04]
9	[9.30e-01, 4.26e-02, 1.46e-02, 6.75e-03, 3.12e-03, 1.40e-03, 9.23e-04, 6.74e-04, 3.77e-04]
10	[9.28e-01, 4.30e-02, 1.47e-02, 7.03e-03, 3.49e-03, 1.71e-03, 9.43e-04, 6.85e-04, 5.27e-04, 2.89e-04]
11	[9.26e-01, 4.33e-02, 1.48e-02, 7.35e-03, 3.72e-03, 1.98e-03, 1.06e-03, 6.90e-04, 5.32e-04, 4.26e-04, 2.25e-04]
12	[9.24e-01, 4.36e-02, 1.48e-02, 7.69e-03, 3.90e-03, 2.19e-03, 1.21e-03, 7.45e-04, 5.27e-04, 4.30e-04, 3.51e-04, 1.76e-04]
13	[9.24e-01, 4.28e-02, 1.52e-02, 7.61e-03, 4.27e-03, 2.39e-03, 1.32e-03, 8.30e-04, 5.53e-04, 4.17e-04, 3.58e-04, 2.94e-04, 1.39e-04]
14	[9.23e-01, 4.21e-02, 1.55e-02, 7.60e-03, 4.41e-03, 2.70e-03, 1.39e-03, 9.16e-04, 6.04e-04, 4.27e-04, 3.40e-04, 3.06e-04, 2.48e-04, 1.10e-04]
15	[9.23e-01, 4.14e-02, 1.57e-02, 7.70e-03, 4.32e-03, 3.10e-03, 1.45e-03, 9.83e-04, 6.65e-04, 4.58e-04, 3.40e-04, 2.85e-04, 2.66e-04, 2.10e-04, 8.78e-05]
16	[9.23e-01, 4.06e-02, 1.57e-02, 7.89e-03, 4.50e-03, 2.97e-03, 1.75e-03, 1.03e-03, 7.22e-04, 5.00e-04, 3.58e-04, 2.77e-04, 2.46e-04, 2.34e-04, 1.79e-04, 7.03e-05]
24	[9.24e-01, 3.47e-02, 1.54e-02, 8.35e-03, 5.05e-03, 3.46e-03, 2.34e-03, 1.55e-03, 1.06e-03, 7.71e-04, 5.92e-04, 4.62e-04, 3.59e-04, 2.75e-04, 2.10e-04, 1.63e-04, 1.31e-04, 1.11e-04, 1.06e-04, 1.15e-04, 1.18e-04, 9.62e-05, 5.13e-05, 1.32e-05]
36	[9.23e-01, 3.10e-02, 1.50e-02, 8.61e-03, 5.51e-03, 3.90e-03, 2.90e-03, 2.26e-03, 1.81e-03, 1.37e-03, 1.00e-03, 7.40e-04, 5.52e-04, 4.22e-04, 3.37e-04, 2.82e-04, 2.42e-04, 2.07e-04, 1.74e-04, 1.42e-04, 1.13e-04, 9.09e-05, 7.55e-05, 6.48e-05, 5.60e-05, 4.78e-05, 4.16e-05, 4.04e-05, 4.56e-05, 5.46e-05, 6.03e-05, 5.59e-05, 4.06e-05, 2.16e-05, 7.40e-06, 1.23e-06]

E-3.2.4 Uncertainty Distribution

To characterize the uncertainty in the common-cause alpha factors for the RPS, a distribution was associated with each alpha factor in the equation used to estimate each CCF basic event probability (Table E-1). To complete the uncertainty analysis, distributions were needed for the alpha factors, $\alpha^{(m)}{}_{k}\ldots\alpha^{(m)}{}_{m}$.

In accordance with the methods explained in Section A-2.1.2.1, the prior distributions of the $\alpha^{(m)}{}_{k}$ are assumed to be beta distributions. When $\alpha^{(m)}{}_{k}$ has a beta prior distribution for the probability of an occurrence, and occurrence data are generated from a binomial distribution with this probability, the posterior distribution from a Bayesian update is also a beta distribution. Thus, beta distributions are conjugate prior distributions for binomial data, and are a natural choice for the uncertainty in the CCF alpha factors.

E-3.2.4.1 Uncertainty in the Prior Alpha Factors. The particular beta distribution for each alpha factor remains to be determined. With the means based on MLE estimates from the data, just a single beta distribution parameter remains to be determined for each $\alpha^{(m)}{}_{k}$. Beta distributions are typically characterized by two parameters, α and β. The mean is $\alpha/(\alpha + \beta)$. In the remaining subsections, we focus on estimating the parameter $\delta \equiv \alpha + \beta$, for each $\alpha^{(m)}{}_{k}$. As δ increases, the variance of the uncertainty distribution decreases. The following three-step approach was used to estimate the prior distribution δ parameters.

E-3.2.4.2 Constrained Noninformative Distributions for CCF Factors. The first step was to fit a constrained noninformative (CN) prior distribution for each $\alpha^{(m)}{}_{k}$, *for* $k = 2, \ldots, m$. In this step, the variance of the selected beta distribution maximizes the entropy, subject to the constraint that the mean matches the estimated probability of loss of k of m components by common-cause. In practice, knowledge of the constrained mean leads to an estimate of the alpha parameter of the desired beta distribution. Figure E-4 shows the relationship between the fixed mean and the alpha parameter of the beta distribution about the mean.

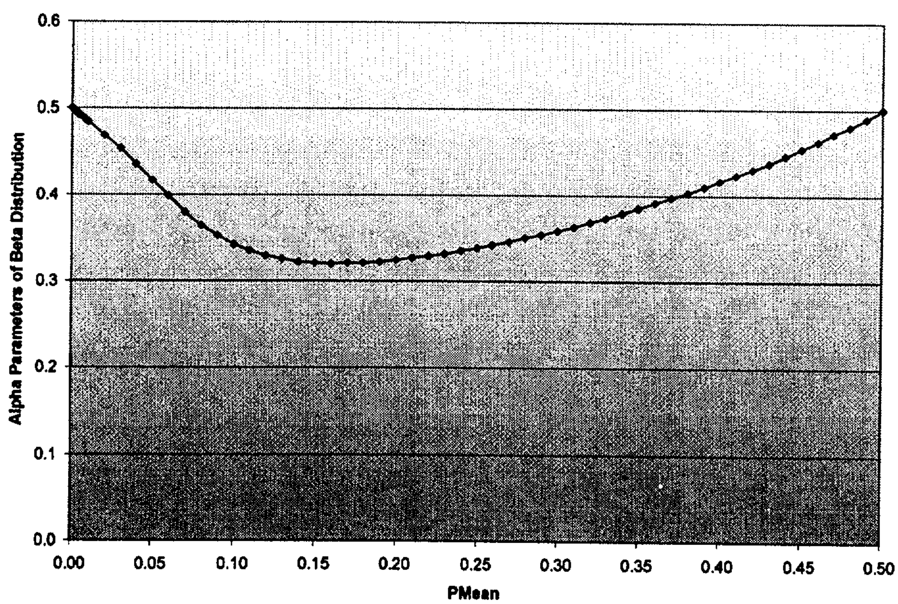


Figure E-4. Constrained non-informative prior alpha calculation.

When the fixed mean is very small (i.e., less than 0.001), the alpha parameter of the fitted CN distribution is approximately 0.50. Given an α parameter, $\delta = \alpha/mean$. Further details of the method are found in the "Alternate Method" subsection of Section A-2.1.2.1.

The application of the CN distribution assumes that the $\alpha^{(m)}{}_k$ are statistically independent. It results in a different δ parameter for each CCF $\alpha^{(m)}{}_k$. However, the sum of the $\alpha^{(m)}{}_k$ from 1 to m equals 1.0, and they are not statistically independent.

E-3.2.4.3 Dirichlet Distributions for CCF Factors. In this step of the procedure to estimate the prior distributions, we use the Dirichlet distribution. The Dirichlet distribution provides a convenient framework that reflects the dependence and uses a common δ value. The Dirichlet distribution is a multinominal counterpart to a beta distribution function. The marginal distribution for each parameter is a beta distribution. Equation E-12 shows the Dirichlet density function:

$$\pi(x_1,\ldots,x_m) = \frac{\Gamma(A_1 + A_2 + \ldots, + A_m)}{\Gamma(A_1)\ldots\Gamma(A_m)} x_1^{A_1-1} x_2^{A_2-1} \ldots x_m^{A_m-1} \qquad \text{E-12}$$

In this equation, the $x_1,\ldots,x_m$ act like multinomial distribution probabilities and are required to sum to 1 (for example, if $m = 2$ then x_1 could be the probability of an event occurring and x_2 would be the probability of it not occurring). The A_k's $[k = 1,\ldots, m]$ are the parameters of the distribution and act like the count of events in each of the m categories of the multinomial distribution.

When Equation E-12 is applied to the CCF data, the $\{\alpha^{(m)}{}_k\}$, for $k = 1,\ldots, m$ are substituted for the x_k. The set of alpha parameters $\{\alpha^{(m)}{}_k\}$ is taken to have a joint Dirichlet distribution. In this case, for any single $\alpha^{(m)}{}_k$, the marginal distribution is a beta distribution with parameters $\alpha_k = A_k$ and β_k = the sum of the remaining A_i, $i = 1,\ldots,m$, with i not equal to k. As above, $\delta_k \equiv (\alpha_k + \beta_k)$. Thus, the δ is constant for each of the $\alpha^{(m)}{}_k$ with the Dirichlet distribution since in each case $\delta_k = \delta = \Sigma A_k$.

The mean of each common-cause $\alpha^{(m)}{}_k$, factor is α_k/δ. Given the mean values and δ, the parameters of the uncertainty distributions are thus determined. As above, the smaller the value of δ, the greater the uncertainty.

E-3.2.4.4 Calculation of a Common Delta Parameter. A reasonable choice for the common value of δ is the geometric mean of the δ_k parameters computed in step one. If the magnitudes between the estimated CCF alphas are not large, the geometric mean will result in uncertainty distributions that are not too skewed. Since the prior common-cause mean is α_k/δ, the beta distribution alpha parameter α_k is the mean times δ. From Figure E-4, low mean values lead to CN α_k parameters around 0.5. Since the chosen δ was calculated from the CN δ's, the resulting α_k parameters will center about 0.5, which is generally not too small. Small values for the alpha parameter of a beta distribution must be avoided, since they result in extremely skewed distributions. The results of the calculation of the δ for the prior distribution are shown in Table E-5.

E-3.2.5 Updating the Prior Distributions with the Data

The resulting prior distributions can now be estimated with the specific RPS CCF data. The mean of the posterior uncertainty distribution (E-13) that results from updating a beta prior distribution with the observed data is a weighted average of the mean of the prior distribution and the maximum likelihood estimate *(f_k/d)* from the data, as follows:

$$\alpha_{k\ Post}^{(m)} = \alpha_{k\ Prior}^{(m)} * \frac{\delta}{\delta + d} + \frac{f_k}{d} * \frac{d}{d + \delta} \qquad \text{E-13}$$

where:

$\alpha^{(m)}_{k\,Post}$	=	posterior alpha factor for exactly k failures among m components in one event
$\alpha^{(m)}_{k\,Prior}$	=	prior alpha factor for exactly k failures among m components in one event
δ	≡	the prior distribution common delta parameter
f_k	=	the sum of the k^{th} impact vector elements for the component, CCCG (m), and degree of CCF loss (k) under consideration
d	=	the sum of all the impact vector elements for the CCCG (m) and component under consideration

E-3.2.6 Data Selection

Component failure data were selected from the RPS CCF database to match the criteria of each defined CCF basic event used in the fault trees. Data for the component of interest included events in which the Safety Function is either NFS or UKN. The associated component independent failure count was extracted from the database as outlined in Appendix C. In those cases where the independent failure data were pooled across selected PWR vendors, the CCF data were pooled using the same vendor criteria.

E-3.3 CCF Basic Event Probability Results

E-3.3.1 Bayesian Update Results

Table E-6 shows the results of the CCF BE calculations updated with the beta prior for those components modeled in the fault trees. The Failure Criterion designation for each component points to an equation in Table E-1.

Table E-7 shows the lognormal uncertainty parameters for the CCF BEs. Error propagation using the equations in Table E-1, the beta distributions described in Section E-3.2.4.1, and the lognormal uncertainty distribution for Q_T leads to lognormal uncertainty distributions on the estimated BE probabilities. The process, leading to lognormal distributions, is explained in Section A-2.2.

E-3.3.2 Classical Results

The classical or no prior influence results are of no interest for Combustion Engineering. With little or no CCF data for most of the components, all classical results are << 1.0E-10.

Table E-5. RPS prior, constrained noninformative δ and the average of δ.

Group Size	Delta Vector	Delta Average	Delta Geometric Mean
2	[1.69e+01, 1.69e+01]	16.9	16.9
3	[9.89e+00, 1.23e+01, 7.71e+01]	33.1	21.1
4	[7.87e+00, 1.19e+01, 4.36e+01, 2.15e+02]	69.6	30.6
5	[7.21e+00, 1.04e+01, 4.09e+01, 1.22e+02, 3.60e+02]	108.3	42.3
6	[6.21e+00, 1.02e+01, 3.51e+01, 1.16e+02, 2.41e+02, 5.32e+02]	156.7	56.7
7	[5.97e+00, 1.01e+01, 3.38e+01, 8.97e+01, 2.37e+02, 3.85e+02, 7.41e+02]	214.6	74.2
8	[5.80e+00, 1.00e+01, 3.30e+01, 7.48e+01, 2.11e+02, 3.76e+02, 5.55e+02, 1.00e+03]	283.3	94.4
9	[5.19e+00, 9.91e+00, 3.27e+01, 7.26e+01, 1.59e+02, 3.57e+02, 5.41e+02, 7.41e+02, 1.32e+03]	360.2	115.6
10	[5.09e+00, 9.84e+00, 3.24e+01, 6.94e+01, 1.42e+02, 2.92e+02, 5.30e+02, 7.29e+02, 9.47e+02, 1.72e+03]	448.1	140.2
11	[5.01e+00, 9.78e+00, 3.21e+01, 6.65e+01, 1.33e+02, 2.52e+02, 4.67e+02, 7.24e+02, 9.38e+02, 1.17e+03, 2.22e+03]	547.4	167.4
12	[4.94e+00, 9.73e+00, 3.21e+01, 6.36e+01, 1.27e+02, 2.26e+02, 4.12e+02, 6.71e+02, 9.47e+02, 1.16e+03, 1.42e+03, 2.84e+03]	659.3	197.2
13	[4.92e+00, 9.87e+00, 3.14e+01, 6.42e+01, 1.16e+02, 2.07e+02, 3.77e+02, 6.02e+02, 9.03e+02, 1.20e+03, 1.39e+03, 1.70e+03,	784.6	229.5
14	[4.89e+00, 1.00e+01, 3.09e+01, 6.43e+01, 1.12e+02, 1.84e+02, 3.57e+02, 5.46e+02, 8.27e+02, 1.17e+03, 1.47e+03, 1.63e+03, 2.01e+03, 4.53e+03]	924.8	264.5
15	[4.88e+00, 1.01e+01, 3.05e+01, 6.35e+01, 1.14e+02, 1.59e+02, 3.43e+02, 5.08e+02, 7.51e+02, 1.09e+03, 1.47e+03, 1.75e+03, 1.88e+03, 2.37e+03, 5.68e+03]	1081.4	302.3
16	[4.87e+00, 1.03e+01, 3.04e+01, 6.20e+01, 1.10e+02, 1.67e+02, 2.85e+02, 4.82e+02, 6.92e+02, 9.99e+02, 1.39e+03, 1.80e+03, 2.03e+03, 2.13e+03, 2.78e+03, 7.09e+03]	1254.4	342.1
24	[4.94e+00, 1.28e+01, 3.10e+01, 5.83e+01, 9.71e+01, 1.43e+02, 2.12e+02, 3.22e+02, 4.70e+02, 6.48e+02, 8.43e+02, 1.08e+03, 1.39e+03, 1.81e+03, 2.38e+03, 3.06e+03, 3.82e+03, 4.51e+03, 4.71e+03, 4.35e+03, 4.21e+03, 5.18e+03, 9.72e+03, 3.78e+04]	3621.3	763.9
36	[4.87e+00, 1.41e+01, 3.19e+01, 5.66e+01, 8.92e+01, 1.27e+02, 1.71e+02, 2.20e+02, 2.75e+02, 3.64e+02, 4.95e+02, 6.75e+02, 9.05e+02, 1.18e+03, 1.48e+03, 1.77e+03, 2.06e+03, 2.40e+03, 2.86e+03, 3.52e+03, 4.41e+03, 5.49e+03, 6.61e+03, 7.70e+03, 8.91e+03, 1.04e+04, 1.20e+04, 1.24e+04, 1.09e+04, 9.13e+03, 8.26e+03, 8.92e+03, 1.23e+04, 2.31e+04, 6.74e+04, 4.04e+05]	17522.5	1708.9

Table E-6. Bayesian update CCF basic event results.

Basic Event Name	Failure Criterion	QT Mean	CCF Basic Event Failure Probability	Updated Alpha Vector	Event Description
CE Group 1					
CE1-CBI-CF-4OF6TM	4/6 |8	5.00E-04	1.72E-06	[9.33e-01, 4.18e-02, 1.43e-02, 6.17e-03, 2.10e-03, 1.15e-03, 7.75e-04, 4.29e-04]	CCF SPECIFIC 4 OF 6 BISTABLE TRIP UNITS (CH A T&M)
CE1-CBI-CF-6OF8	6/8	5.00E-04	7.66E-07	[9.33e-01, 4.18e-02, 1.43e-02, 6.17e-03, 2.10e-03, 1.15e-03, 7.75e-04, 4.29e-04]	CCF SPECIFIC 6 OF 8 BISTABLE TRIP UNITS
CE1-CBI-CF-P2OF3TM	2/3 |4	5.00E-04	2.55E-05	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 2 OF 3 PRESSURE BISTABLES (CH A T&M)
CE1-CBI-CF-P3OF4	3/4	5.00E-04	7.21E-06	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 3 OF 4 PRESSURE BISTABLES
CE1-CBI-CF-T2OF3TM	2/3 |4	5.00E-04	2.55E-05	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
CE1-CBI-CF-T3OF4	3/4	5.00E-04	7.21E-06	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF OF 3 OF 4 TEMPERATURE BISTABLES
CE1-CPA-CF-T2OF3TM	2/3 |4	7.60E-03	3.77E-04	[9.54e-01, 2.79e-02, 1.13e-02, 6.62e-03]	CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
CE1-CPA-CF-T3OF4	3/4	7.60E-03	1.65E-04	[9.54e-01, 2.79e-02, 1.13e-02, 6.62e-03]	CCF 3 OF 4 CORE PROTECTION CALCULATORS
CE1-CPR-CF-P2OF3TM	2/3 |4	1.10E-04	5.03E-06	[9.57e-01, 3.19e-02, 8.89e-03, 1.90e-03]	CCF 2 OF 3 PRESSURE SENSORS/TRANSMITTERS (CH A T&M)
CE1-CPR-CF-P3OF4	3/4	1.10E-04	1.51E-06	[9.57e-01, 3.19e-02, 8.89e-03, 1.90e-03]	CCF 3 OF 4 PRESSURE SENSORS/TRANSMITTERS
CE1-CTP-CF-CT2OF3TM	2/3 |4	8.40E-04	3.73E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
CE1-CTP-CF-CT3OF4	3/4	8.40E-04	1.02E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
CE1-CTP-CF-HT2OF3TM	2/3 |4	8.40E-04	3.73E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
CE1-CTP-CF-HT3OF4	3/4	8.40E-04	1.02E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
CE1-ROD-CF-RODS	7/36	1.70E-05	8.40E-07	[9.23e-01, 3.10e-02, 1.49e-02, 8.60e-03, 5.51e-03, 3.90e-03, 2.90e-03, 2.26e-03, 1.81e-03, 1.37e-03, 1.00e-03, 7.40e-04, 5.52e-04, 4.22e-04, 3.37e-04, 2.82e-04, 2.42e-04, 2.07e-04, 1.74e-04, 1.42e-04, 1.13e-04, 9.09e-05, 7.54e-05, 6.47e-05, 5.60e-05, 4.78e-05, 4.16e-05, 4.03e-05, 4.56e-05, 5.46e-05, 6.03e-05, 5.59e-05, 4.06e-05, 2.15e-05, 7.40e-06, 1.23e-06]	CCF 20% OR MORE CRD/RODS FAIL TO INSERT
CE1-RYL-CF-1LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 M1 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE1-RYL-CF-1LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 M1 LOGIC MATRIC RELAY OUTPUTS

Table E-6. Bayesian update CCF basic event results. (Continued)

Basic Event Name	Failure Criterion	QT Mean	CCF Basic Event Failure Probability	Updated Alpha Vector	Event Description
CE1-RYL-CF-2LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 M2 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE1-RYL-CF-2LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 M2 LOGIC MATRIC RELAY OUTPUTS
CE1-RYL-CF-3LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 M3 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE1-RYL-CF-3LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 M3 LOGIC MATRIC RELAY OUTPUTS
CE1-RYL-CF-4LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 M4 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE1-RYL-CF-4LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 M4 LOGIC MATRIC RELAY OUTPUTS
CE1-RYL-CF-LM12OF24	12/24 U	2.60E-04	4.29E-08	[9.26e-01, 3.42e-02, 1.52e-02, 8.22e-03, 4.98e-03, 3.40e-03, 2.30e-03, 1.52e-03, 1.04e-03, 7.59e-04, 5.83e-04, 4.55e-04, 3.54e-04, 2.71e-04, 2.06e-04, 1.61e-04, 1.29e-04, 1.09e-04, 1.04e-04, 1.13e-04, 1.17e-04, 9.47e-05, 5.05e-05, 1.30e-05]	CCF SPECIFIC 12 OF 24 LOGIC MATRIX OUTPUT RELAYS
CE1-RYL-CF-LM6OF12TM	6/12 24 U	2.60E-04	1.58E-07	[9.26e-01, 3.42e-02, 1.52e-02, 8.22e-03, 4.98e-03, 3.40e-03, 2.30e-03, 1.52e-03, 1.04e-03, 7.59e-04, 5.83e-04, 4.55e-04, 3.54e-04, 2.71e-04, 2.06e-04, 1.61e-04, 1.29e-04, 1.09e-04, 1.04e-04, 1.13e-04, 1.17e-04, 9.47e-05, 5.05e-05, 1.30e-05]	CCF SPECIFIC 6 OF 12 LOGIC MATRIX OUTPUT RELAYS (CH A T&M)
CE1-RYT-CF-2OF4	2/4	1.20E-04	4.78E-06	[9.52e-01, 3.59e-02, 1.03e-02, 2.20e-03]	CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CONTACTORS
CE Group 2					
CE2-BME-CF-TB2OF8	2/8	1.80E-05	9.97E-07	[9.35e-01, 4.04e-02, 1.38e-02, 6.28e-03, 2.25e-03, 1.27e-03, 8.65e-04, 4.79e-04]	CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
CE2-BSN-CF-TB2OF8	2/8	1.50E-04	1.06E-05	[9.25e-01, 4.01e-02, 1.38e-02, 1.64e-02, 2.24e-03, 1.26e-03, 8.60e-04, 4.76e-04]	CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
CE2-BUV-CF-TB2OF8	2/8	1.10E-03	5.43E-05	[9.42e-01, 3.60e-02, 1.23e-02, 5.60e-03, 2.01e-03, 1.13e-03, 7.71e-04, 4.27e-04]	CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
CE2-CBI-CF-4OF6TM	4/6 |8	5.00E-04	1.72E-06	[9.33e-01, 4.18e-02, 1.43e-02, 6.17e-03, 2.10e-03, 1.15e-03, 7.75e-04, 4.29e-04]	CCF SPECIFIC 4 OF 6 BISTABLE TRIP UNITS (CH A T&M)
CE2-CBI-CF-6OF8	6/8	5.00E-04	7.66E-07	[9.33e-01, 4.18e-02, 1.43e-02, 6.17e-03, 2.10e-03, 1.15e-03, 7.75e-04, 4.29e-04]	CCF SPECIFIC 6 OF 8 BISTABLE TRIP UNITS
CE2-CBI-CF-P2OF3TM	2/3 |4	5.00E-04	2.55E-05	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 2 OF 3 PRESSURE BISTABLES (CH A T&M)
CE2-CBI-CF-P3OF4	3/4	5.00E-04	7.21E-06	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 3 OF 4 PRESSURE BISTABLES

Table E-6. Bayesian update CCF basic event results. (Continued)

Basic Event Name	Failure Criterion	QT Mean	CCF Basic Event Failure Probability	Updated Alpha Vector	Event Description
CE2-CBI-CF-T2OF3TM	2/3 |4	5.00E-04	2.55E-05	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
CE2-CBI-CF-T3OF4	3/4	5.00E-04	7.21E-06	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 3 OF 4 TEMPERATURE BISTABLES
CE2-CPA-CF-T2OF3TM	2/3 |4	7.60E-03	3.77E-04	[9.54e-01, 2.79e-02, 1.13e-02, 6.62e-03]	CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
CE2-CPA-CF-T3OF4	3/4	7.60E-03	1.65E-04	[9.54e-01, 2.79e-02, 1.13e-02, 6.62e-03]	CCF 3 OF 4 CORE PROTECTION CALCULATORS
CE2-CPR-CF-P2OF3TM	2/3 |4	1.10E-04	5.03E-06	[9.57e-01, 3.19e-02, 8.89e-03, 1.90e-03]	CCF 2 OF 3 PRESSURE SENSORS/TRANSMITTERS (CH A T&M)
CE2-CPR-CF-P3OF4	3/4	1.10E-04	1.51E-06	[9.57e-01, 3.19e-02, 8.89e-03, 1.90e-03]	CCF 3 OF 4 PRESSURE SENSORS/TRANSMITTERS
CE2-CTP-CF-CT2OF3TM	2/3 |4	8.40E-04	3.73E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
CE2-CTP-CF-CT3OF4	3/4	8.40E-04	1.02E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
CE2-CTP-CF-HT2OF3TM	2/3 |4	8.40E-04	3.73E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
CE2-CTP-CF-HT3OF4	3/4	8.40E-04	1.02E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
CE2-MSW-CF-2OF4	2/4	1.34E-04	4.95E-06	[9.55e-01, 3.33e-02, 9.53e-03, 2.04e-03]	CCF 2 OF 4 (1-OUT-OF-2 TWICE) MANUAL SWITCHES
CE2-PWR-CF-TB2OF4	2/4	6.00E-05	2.51E-06	[9.49e-01, 3.77e-02, 1.08e-02, 2.31e-03]	CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
CE2-ROD-CF-RODS	7/36	1.70E-05	8.40E-07	[9.23e-01, 3.10e-02, 1.49e-02, 8.60e-03, 5.51e-03, 3.90e-03, 2.90e-03, 2.26e-03, 1.81e-03, 1.37e-03, 1.00e-03, 7.40e-04, 5.52e-04, 4.22e-04, 3.37e-04, 2.82e-04, 2.42e-04, 2.07e-04, 1.74e-04, 1.42e-04, 1.13e-04, 9.09e-05, 7.54e-05, 6.47e-05, 5.60e-05, 4.78e-05, 4.16e-05, 4.03e-05, 4.56e-05, 5.46e-05, 6.03e-05, 5.59e-05, 4.06e-05, 2.15e-05, 7.40e-06, 1.23e-06]	CCF 20% OR MORE CRD/RODS FAIL TO INSERT
CE2-RYL-CF-1LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K1 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE2-RYL-CF-1LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K1 LOGIC MATRIC RELAY OUTPUTS
CE2-RYL-CF-2LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K2 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE2-RYL-CF-2LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K2 LOGIC MATRIC RELAY OUTPUTS

Table E-6. Bayesian update CCF basic event results. (Continued)

Basic Event Name	Failure Criterion	QT Mean	CCF Basic Event Failure Probability	Updated Alpha Vector	Event Description
CE2-RYL-CF-3LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K3 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE2-RYL-CF-3LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K3 LOGIC MATRIC RELAY OUTPUTS
CE2-RYL-CF-4LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K4 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE2-RYL-CF-4LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K4 LOGIC MATRIC RELAY OUTPUTS
CE2-RYL-CF-LM12OF24	12/24 U	2.60E-04	4.29E-08	[9.26e-01, 3.42e-02, 1.52e-02, 8.22e-03, 4.98e-03, 3.40e-03, 2.30e-03, 1.52e-03, 1.04e-03, 7.59e-04, 5.83e-04, 4.55e-04, 3.54e-04, 2.71e-04, 2.06e-04, 1.61e-04, 1.29e-04, 1.09e-04, 1.04e-04, 1.13e-04, 1.17e-04, 9.47e-05, 5.05e-05, 1.30e-05]	CCF OF 12 OF 24 LOGIC MATRIX OUTPUT RELAYS
CE2-RYL-CF-LM6OF12TM	6/12 24 U	2.60E-04	1.58E-07	[9.26e-01, 3.42e-02, 1.52e-02, 8.22e-03, 4.98e-03, 3.40e-03, 2.30e-03, 1.52e-03, 1.04e-03, 7.59e-04, 5.83e-04, 4.55e-04, 3.54e-04, 2.71e-04, 2.06e-04, 1.61e-04, 1.29e-04, 1.09e-04, 1.04e-04, 1.13e-04, 1.17e-04, 9.47e-05, 5.05e-05, 1.30e-05]	CCF OF 6 OF 12 LOGIC MATRIX OUTPUT RELAYS (CH A T&M)
CE2-RYT-CF-2OF4	2/4	1.20E-04	4.78E-06	[9.52e-01, 3.59e-02, 1.03e-02, 2.20e-03]	CCF 2 OF 4 (1-OUT-OF-2 TWICE) K RELAYS
CE Group 3					
CE3-BME-CF-TB2OF8	2/8	1.80E-05	9.97E-07	[9.35e-01, 4.04e-02, 1.38e-02, 6.28e-03, 2.25e-03, 1.27e-03, 8.65e-04, 4.79e-04]	CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKERS
CE3-BSN-CF-TB2OF8	2/8	1.50E-04	1.06E-05	[9.25e-01, 4.01e-02, 1.38e-02, 1.64e-02, 2.24e-03, 1.26e-03, 8.60e-04, 4.76e-04]	CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER SHUNT TRIP DEVICE
CE3-BUV-CF-TB2OF8	2/8	1.10E-03	5.43E-05	[9.42e-01, 3.60e-02, 1.23e-02, 5.60e-03, 2.01e-03, 1.13e-03, 7.71e-04, 4.27e-04]	CCF SPECIFIC 2 OF 8 TRIP CIRCUIT BREAKER UNDERVOLTAGE DEVICE
CE3-CBI-CF-4OF6TM	4/6 |8	5.00E-04	1.72E-06	[9.33e-01, 4.18e-02, 1.43e-02, 6.17e-03, 2.10e-03, 1.15e-03, 7.75e-04, 4.29e-04]	CCF SPECIFIC 4 OF 6 BISTABLE TRIP UNITS (CH A T&M)
CE3-CBI-CF-6OF8	6/8	5.00E-04	7.66E-07	[9.33e-01, 4.18e-02, 1.43e-02, 6.17e-03, 2.10e-03, 1.15e-03, 7.75e-04, 4.29e-04]	CCF SPECIFIC 6 OF 8 BISTABLE TRIP UNITS
CE3-CBI-CF-P2OF3TM	2/3 |4	5.00E-04	2.55E-05	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 2 OF 3 PRESSURE BISTABLES (CH A T&M)
CE3-CBI-CF-P3OF4	3/4	5.00E-04	7.21E-06	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 3 OF 4 PRESSURE BISTABLES
CE3-CBI-CF-T2OF3TM	2/3 |4	5.00E-04	2.55E-05	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
CE3-CBI-CF-T3OF4	3/4	5.00E-04	7.21E-06	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 3 OF 4 TEMPERATURE BISTABLES

Table E-6. Bayesian update CCF basic event results. (Continued)

Basic Event Name	Failure Criterion	QT Mean	CCF Basic Event Failure Probability	Updated Alpha Vector	Event Description
CE3-CPD-CF-T2OF3TM	2/3 |4	2.70E-03	1.35E-04	[9.55e-01, 2.87e-02, 1.53e-02, 8.14e-04]	CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
CE3-CPD-CF-T3OF4	3/4	2.70E-03	5.73E-05	[9.55e-01, 2.87e-02, 1.53e-02, 8.14e-04]	CCF 3 OF 4 CORE PROTECTION CALCULATORS
CE3-CPR-CF-P2OF3TM	2/3 |4	1.10E-04	5.03E-06	[9.57e-01, 3.19e-02, 8.89e-03, 1.90e-03]	CCF 2 OF 3 PRESSURE SENSORS/TRANSMITTERS (CH A T&M)
CE3-CPR-CF-P3OF4	3/4	1.10E-04	1.51E-06	[9.57e-01, 3.19e-02, 8.89e-03, 1.90e-03]	CCF 3 OF 4 PRESSURE SENSORS/TRANSMITTERS
CE3-CTP-CF-CT2OF3TM	2/3 |4	8.40E-04	3.73E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
CE3-CTP-CF-CT3OF4	3/4	8.40E-04	1.02E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
CE3-CTP-CF-HT2OF3TM	2/3 |4	8.40E-04	3.73E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
CE3-CTP-CF-HT3OF4	3/4	8.40E-04	1.02E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
CE3-MSW-CF-2OF4	2/4	1.34E-04	4.95E-06	[9.55e-01, 3.33e-02, 9.53e-03, 2.04e-03]	CCF 2 OF 4 (1-OUT-OF-2 TWICE) MANUAL SWITCHES
CE3-PWR-CF-TB2OF4	2/4	6.00E-05	2.51E-06	[9.49e-01, 3.77e-02, 1.08e-02, 2.31e-03]	CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
CE3-ROD-CF-RODS	7/36	1.70E-05	8.40E-07	[9.23e-01, 3.10e-02, 1.49e-02, 8.60e-03, 5.51e-03, 3.90e-03, 2.90e-03, 2.26e-03, 1.81e-03, 1.37e-03, 1.00e-03, 7.40e-04, 5.52e-04, 4.22e-04, 3.37e-04, 2.82e-04, 2.42e-04, 2.07e-04, 1.74e-04, 1.42e-04, 1.13e-04, 9.09e-05, 7.54e-05, 6.47e-05, 5.60e-05, 4.78e-05, 4.16e-05, 4.03e-05, 4.56e-05, 5.46e-05, 6.03e-05, 5.59e-05, 4.06e-05, 2.15e-05, 7.40e-06, 1.23e-06]	CCF 20% OR MORE CRD/RODS FAIL TO INSERT
CE3-RYL-CF-1LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K1 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE3-RYL-CF-1LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K1 LOGIC MATRIC RELAY OUTPUTS
CE3-RYL-CF-2LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K2 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE3-RYL-CF-2LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K2 LOGIC MATRIC RELAY OUTPUTS
CE3-RYL-CF-3LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K3 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE3-RYL-CF-3LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K3 LOGIC MATRIC RELAY OUTPUTS

Table E-6. Bayesian update CCF basic event results. (Continued)

Basic Event Name	Failure Criterion	QT Mean	CCF Basic Event Failure Probability	Updated Alpha Vector	Event Description
CE3-RYL-CF-4LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K4 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE3-RYL-CF-4LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K4 LOGIC MATRIC RELAY OUTPUTS
CE3-RYL-CF-LM12OF24	12/24 U	2.60E-04	4.29E-08	[9.26e-01, 3.42e-02, 1.52e-02, 8.22e-03, 4.98e-03, 3.40e-03, 2.30e-03, 1.52e-03, 1.04e-03, 7.59e-04, 5.83e-04, 4.55e-04, 3.54e-04, 2.71e-04, 2.06e-04, 1.61e-04, 1.29e-04, 1.09e-04, 1.04e-04, 1.13e-04, 1.17e-04, 9.47e-05, 5.05e-05, 1.30e-05]	CCF SPECIFIC 12 OF 24 LOGIC MATRIX OUTPUT RELAYS
CE3-RYL-CF-LM6OF12TM	6/12 24 U	2.60E-04	1.58E-07	[9.26e-01, 3.42e-02, 1.52e-02, 8.22e-03, 4.98e-03, 3.40e-03, 2.30e-03, 1.52e-03, 1.04e-03, 7.59e-04, 5.83e-04, 4.55e-04, 3.54e-04, 2.71e-04, 2.06e-04, 1.61e-04, 1.29e-04, 1.09e-04, 1.04e-04, 1.13e-04, 1.17e-04, 9.47e-05, 5.05e-05, 1.30e-05]	CCF SPECIFIC 6 OF 12 LOGIC MATRIX OUTPUT RELAYS (CH A T&M)
CE3-RYT-CF-2OF4	2/4	1.20E-04	4.78E-06	[9.52e-01, 3.59e-02, 1.03e-02, 2.20e-03]	CCF 2 OF 4 (1-OUT-OF-2 TWICE) K RELAYS
CE Group 4					
CE4-BME-CF-TB2OF4	2/4	1.80E-05	7.07E-07	[9.52e-01, 3.54e-02, 1.01e-02, 2.17e-03]	CCF 2 OF 4 (1-OUT-OF-2 TWICE) TRIP CIRCUIT BREAKERS
CE4-BSN-CF-TB2OF4	2/4	1.50E-04	8.73E-06	[9.31e-01, 5.00e-02, 1.67e-02, 2.55e-03]	CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP DEVIC
CE4-BUV-CF-TB2OF4	2/4	1.10E-03	3.65E-05	[9.60e-01, 2.99e-02, 8.55e-03, 1.83e-03]	CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR UNDERVOLTAGE DEV
CE4-CBI-CF-4OF6TM	4/6 |8	5.00E-04	1.72E-06	[9.33e-01, 4.18e-02, 1.43e-02, 6.17e-03, 2.10e-03, 1.15e-03, 7.75e-04, 4.29e-04]	CCF SPECIFIC 4 OF 6 BISTABLE TRIP UNITS (CH A T&M)
CE4-CBI-CF-6OF8	6/8	5.00E-04	7.66E-07	[9.33e-01, 4.18e-02, 1.43e-02, 6.17e-03, 2.10e-03, 1.15e-03, 7.75e-04, 4.29e-04]	CCF SPECIFIC 6 OF 8 BISTABLE TRIP UNITS
CE4-CBI-CF-P2OF3TM	2/3 |4	5.00E-04	2.55E-05	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 2 OF 3 PRESSURE BISTABLES (CH A T&M)
CE4-CBI-CF-P3OF4	3/4	5.00E-04	7.21E-06	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 3 OF 4 PRESSURE BISTABLES
CE4-CBI-CF-T2OF3TM	2/3 |4	5.00E-04	2.55E-05	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 2 OF 3 TEMPERATURE BISTABLES (CH A T&M)
CE4-CBI-CF-T3OF4	3/4	5.00E-04	7.21E-06	[9.52e-01, 3.66e-02, 9.41e-03, 1.87e-03]	CCF 3 OF 4 TEMPERATURE BISTABLES
CE4-CPD-CF-T2OF3TM	2/3 |4	2.70E-03	1.35E-04	[9.55e-01, 2.87e-02, 1.53e-02, 8.14e-04]	CCF 2 OF 3 CORE PROTECTION CALCULATORS (CH A T&M)
CE4-CPD-CF-T3OF4	3/4	2.70E-03	5.73E-05	[9.55e-01, 2.87e-02, 1.53e-02, 8.14e-04]	CCF 3 OF 4 CORE PROTECTION CALCULATORS

Table E-6. Bayesian update CCF basic event results. (Continued)

Basic Event Name	Failure Criterion	QT Mean	CCF Basic Event Failure Probability	Updated Alpha Vector	Event Description
CE4-CPR-CF-P2OF3TM	2/3 |4	1.10E-04	5.03E-06	[9.57e-01, 3.19e-02, 8.89e-03, 1.90e-03]	CCF 2 OF 3 PRESSURE SENSORS/TRANSMITTERS (CH A T&M)
CE4-CPR-CF-P3OF4	3/4	1.10E-04	1.51E-06	[9.57e-01, 3.19e-02, 8.89e-03, 1.90e-03]	CCF 3 OF 4 PRESSURE SENSORS/TRANSMITTERS
CE4-CTP-CF-CT2OF3TM	2/3 |4	8.40E-04	3.73E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 2 OF 3 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
CE4-CTP-CF-CT3OF4	3/4	8.40E-04	1.02E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 3 OF 4 COLD LEG TEMPERATURE SENSORS/TRANSMITTERS
CE4-CTP-CF-HT2OF3TM	2/3 |4	8.40E-04	3.73E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 2 OF 3 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
CE4-CTP-CF-HT3OF4	3/4	8.40E-04	1.02E-05	[9.58e-01, 3.23e-02, 7.86e-03, 1.68e-03]	CCF 3 OF 4 HOT LEG TEMPERATURE SENSORS/TRANSMITTERS
CE4-MSW-CF-2OF4	2/4	1.34E-04	4.95E-06	[9.55e-01, 3.33e-02, 9.53e-03, 2.04e-03]	CCF 2 OF 4 (1-OUT-OF-2 TWICE) MANUAL SWITCHES
CE4-PWR-CF-TB2OF4	2/4	6.00E-05	2.51E-06	[9.49e-01, 3.77e-02, 1.08e-02, 2.31e-03]	CCF 2 OF 4 (1-OF-2 TWICE) TRIP CIRCUIT BRKR SHUNT TRIP POWER
CE4-ROD-CF-RODS	7/36	1.70E-05	8.40E-07	[9.23e-01, 3.10e-02, 1.49e-02, 8.60e-03, 5.51e-03, 3.90e-03, 2.90e-03, 2.26e-03, 1.81e-03, 1.37e-03, 1.00e-03, 7.40e-04, 5.52e-04, 4.22e-04, 3.37e-04, 2.82e-04, 2.42e-04, 2.07e-04, 1.74e-04, 1.42e-04, 1.13e-04, 9.09e-05, 7.54e-05, 6.47e-05, 5.60e-05, 4.78e-05, 4.16e-05, 4.03e-05, 4.56e-05, 5.46e-05, 6.03e-05, 5.59e-05, 4.06e-05, 2.15e-05, 7.40e-06, 1.23e-06]	CCF OF 20% OR MORE CRD/RODS FAIL TO INSERT
CE4-RYL-CF-1LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K1 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE4-RYL-CF-1LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K1 LOGIC MATRIC RELAY OUTPUTS
CE4-RYL-CF-2LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K2 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE4-RYL-CF-2LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K2 LOGIC MATRIC RELAY OUTPUTS
CE4-RYL-CF-3LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K3 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE4-RYL-CF-3LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K3 LOGIC MATRIC RELAY OUTPUTS
CE4-RYL-CF-4LM3OF3TM	3/3 6 U	2.60E-04	4.66E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 3 OF 3 K4 LOGIC MATRIC RELAY OUTPUTS (CH A T&M)
CE4-RYL-CF-4LM6OF6	6/6	2.60E-04	2.02E-07	[9.49e-01, 3.38e-02, 1.12e-02, 3.51e-03, 1.70e-03, 7.75e-04]	CCF 6 OF 6 K4 LOGIC MATRIC RELAY OUTPUTS

Table E-6. Bayesian update CCF basic event results. (Continued)

Basic Event Name	Failure Criterion	QT Mean	CCF Basic Event Failure Probability	Updated Alpha Vector	Event Description
CE4-RYL-CF-LM12OF24	12/24 U	2.60E-04	4.29E-08	[9.26e-01, 3.42e-02, 1.52e-02, 8.22e-03, 4.98e-03, 3.40e-03, 2.30e-03, 1.52e-03, 1.04e-03, 7.59e-04, 5.83e-04, 4.55e-04, 3.54e-04, 2.71e-04, 2.06e-04, 1.61e-04, 1.29e-04, 1.09e-04, 1.04e-04, 1.13e-04, 1.17e-04, 9.47e-05, 5.05e-05, 1.30e-05]	CCF SPECIFIC 12 OF 24 LOGIC MATRIX OUTPUT RELAYS
CE4-RYL-CF-LM6OF12TM	6/12 24 U	2.60E-04	1.58E-07	[9.26e-01, 3.42e-02, 1.52e-02, 8.22e-03, 4.98e-03, 3.40e-03, 2.30e-03, 1.52e-03, 1.04e-03, 7.59e-04, 5.83e-04, 4.55e-04, 3.54e-04, 2.71e-04, 2.06e-04, 1.61e-04, 1.29e-04, 1.09e-04, 1.04e-04, 1.13e-04, 1.17e-04, 9.47e-05, 5.05e-05, 1.30e-05]	CCF SPECIFIC 6 OF 12 LOGIC MATRIX OUTPUT RELAYS (CH A T&M)
CE4-RYT-CF-2OF4	2/4	1.20E-04	4.78E-06	[9.52e-01, 3.59e-02, 1.03e-02, 2.20e-03]	CCF 2 OF 4 (1-OUT-OF-2 TWICE) K RELAYS
CE Sensitivity					
CEX-CBI-CF-6OF9TM	6/9 |12	5.00E-04	5.44E-07	[9.25e-01, 4.30e-02, 1.50e-02, 7.77e-03, 3.82e-03, 2.03e-03, 1.09e-03, 6.69e-04, 4.73e-04, 3.86e-04, 3.15e-04, 1.58e-04]	CCF Specific 6 OF 9 BISTABLES Three trip parameters
CEX-CBI-CF-9OF12	9/12	5.00E-04	2.99E-07	[9.25e-01, 4.30e-02, 1.50e-02, 7.77e-03, 3.82e-03, 2.03e-03, 1.09e-03, 6.69e-04, 4.73e-04, 3.86e-04, 3.15e-04, 1.58e-04]	CCF Specific 9 OF 12 BISTABLES Three trip parameters

Table E-7. Lognormal uncertainty distributions for CCF events.

Basic Event Name	Median	EF	CCF Failure Probability Low	CCF Mean Failure Probability	CCF Failure Probability Upper
CE1-CBI-CF-4OF6TM	4.95E-07	13.39	3.70E-08	1.72E-06	6.63E-06
CE1-CBI-CF-6OF8	1.44E-07	20.28	7.08E-09	7.66E-07	2.91E-06
CE1-CBI-CF-P2OF3TM	1.00E-05	9.46	1.06E-06	2.55E-05	9.49E-05
CE1-CBI-CF-P3OF4	1.94E-06	14.35	1.35E-07	7.21E-06	2.79E-05
CE1-CBI-CF-T2OF3TM	1.00E-05	9.46	1.06E-06	2.55E-05	9.49E-05
CE1-CBI-CF-T3OF4	1.94E-06	14.35	1.35E-07	7.21E-06	2.79E-05
CE1-CPA-CF-T2OF3TM	2.38E-04	4.84	4.93E-05	3.77E-04	1.15E-03
CE1-CPA-CF-T3OF4	8.65E-05	6.47	1.34E-05	1.65E-04	5.60E-04
CE1-CPR-CF-P2OF3TM	2.33E-06	7.67	3.04E-07	5.03E-06	1.79E-05
CE1-CPR-CF-P3OF4	4.81E-07	12.07	3.99E-08	1.51E-06	5.81E-06
CE1-CTP-CF-CT2OF3TM	2.80E-05	3.50	7.99E-06	3.73E-05	9.78E-05
CE1-CTP-CF-CT3OF4	5.13E-06	6.89	7.45E-07	1.02E-05	3.53E-05
CE1-CTP-CF-HT2OF3TM	2.80E-05	3.50	7.99E-06	3.73E-05	9.78E-05
CE1-CTP-CF-HT3OF4	5.13E-06	6.89	7.45E-07	1.02E-05	3.53E-05
CE1-ROD-CF-RODS	2.41E-07	13.47	1.79E-08	8.40E-07	3.24E-06
CE1-RYL-CF-1LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE1-RYL-CF-1LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE1-RYL-CF-2LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE1-RYL-CF-2LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE1-RYL-CF-3LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE1-RYL-CF-3LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE1-RYL-CF-4LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE1-RYL-CF-4LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE1-RYL-CF-LM12OF24	9.38E-09	17.58	5.34E-10	4.29E-08	1.65E-07
CE1-RYL-CF-LM6OF12TM	5.36E-08	11.27	4.75E-09	1.58E-07	6.04E-07
CE1-RYT-CF-2OF4	2.92E-06	5.12	5.71E-07	4.78E-06	1.49E-05
CE2-BME-CF-TB2OF8	7.13E-07	3.85	1.85E-07	9.97E-07	2.74E-06
CE2-BSN-CF-TB2OF8	3.94E-06	10.12	3.89E-07	1.06E-05	3.98E-05
CE2-BUV-CF-TB2OF8	3.03E-05	5.90	5.14E-06	5.43E-05	1.79E-04
CE2-CBI-CF-4OF6TM	4.95E-07	13.39	3.70E-08	1.72E-06	6.63E-06
CE2-CBI-CF-6OF8	1.44E-07	20.28	7.08E-09	7.66E-07	2.91E-06
CE2-CBI-CF-P2OF3TM	1.00E-05	9.46	1.06E-06	2.55E-05	9.49E-05
CE2-CBI-CF-P3OF4	1.94E-06	14.35	1.35E-07	7.21E-06	2.79E-05
CE2-CBI-CF-T2OF3TM	1.00E-05	9.46	1.06E-06	2.55E-05	9.49E-05
CE2-CBI-CF-T3OF4	1.94E-06	14.35	1.35E-07	7.21E-06	2.79E-05
CE2-CPA-CF-T2OF3TM	2.38E-04	4.84	4.93E-05	3.77E-04	1.15E-03
CE2-CPA-CF-T3OF4	8.65E-05	6.47	1.34E-05	1.65E-04	5.60E-04
CE2-CPR-CF-P2OF3TM	2.33E-06	7.67	3.04E-07	5.03E-06	1.79E-05
CE2-CPR-CF-P3OF4	4.81E-07	12.07	3.99E-08	1.51E-06	5.81E-06
CE2-CTP-CF-CT2OF3TM	2.80E-05	3.50	7.99E-06	3.73E-05	9.78E-05
CE2-CTP-CF-CT3OF4	5.13E-06	6.89	7.45E-07	1.02E-05	3.53E-05
CE2-CTP-CF-HT2OF3TM	2.80E-05	3.50	7.99E-06	3.73E-05	9.78E-05
CE2-CTP-CF-HT3OF4	5.13E-06	6.89	7.45E-07	1.02E-05	3.53E-05
CE2-MSW-CF-2OF4	3.28E-06	4.45	7.38E-07	4.95E-06	1.46E-05
CE2-PWR-CF-TB2OF4	1.37E-06	6.07	2.27E-07	2.51E-06	8.34E-06
CE2-ROD-CF-RODS	2.41E-07	13.47	1.79E-08	8.40E-07	3.24E-06
CE2-RYL-CF-1LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06

Table E-7. Lognormal uncertainty distributions for CCF events. (Continued)

Basic Event Name	Median	EF	CCF Failure Probability Low	CCF Mean Failure Probability	CCF Failure Probability Upper
CE2-RYL-CF-1LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE2-RYL-CF-2LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE2-RYL-CF-2LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE2-RYL-CF-3LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE2-RYL-CF-3LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE2-RYL-CF-4LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE2-RYL-CF-4LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE2-RYL-CF-LM12OF24	9.38E-09	17.58	5.34E-10	4.29E-08	1.65E-07
CE2-RYL-CF-LM6OF12TM	5.36E-08	11.27	4.75E-09	1.58E-07	6.04E-07
CE2-RYT-CF-2OF4	2.92E-06	5.12	5.71E-07	4.78E-06	1.49E-05
CE3-BME-CF-TB2OF8	7.13E-07	3.85	1.85E-07	9.97E-07	2.74E-06
CE3-BSN-CF-TB2OF8	3.94E-06	10.12	3.89E-07	1.06E-05	3.98E-05
CE3-BUV-CF-TB2OF8	3.03E-05	5.90	5.14E-06	5.43E-05	1.79E-04
CE3-CBI-CF-4OF6TM	4.95E-07	13.39	3.70E-08	1.72E-06	6.63E-06
CE3-CBI-CF-6OF8	1.44E-07	20.28	7.08E-09	7.66E-07	2.91E-06
CE3-CBI-CF-P2OF3TM	1.00E-05	9.46	1.06E-06	2.55E-05	9.49E-05
CE3-CBI-CF-P3OF4	1.94E-06	14.35	1.35E-07	7.21E-06	2.79E-05
CE3-CBI-CF-T2OF3TM	1.00E-05	9.46	1.06E-06	2.55E-05	9.49E-05
CE3-CBI-CF-T3OF4	1.94E-06	14.35	1.35E-07	7.21E-06	2.79E-05
CE3-CPD-CF-T2OF3TM	9.29E-05	4.13	2.25E-05	1.35E-04	3.83E-04
CE3-CPD-CF-T3OF4	3.40E-05	5.38	6.32E-06	5.73E-05	1.83E-04
CE3-CPR-CF-P2OF3TM	2.33E-06	7.67	3.04E-07	5.03E-06	1.79E-05
CE3-CPR-CF-P3OF4	4.81E-07	12.07	3.99E-08	1.51E-06	5.81E-06
CE3-CTP-CF-CT2OF3TM	2.80E-05	3.50	7.99E-06	3.73E-05	9.78E-05
CE3-CTP-CF-CT3OF4	5.13E-06	6.89	7.45E-07	1.02E-05	3.53E-05
CE3-CTP-CF-HT2OF3TM	2.80E-05	3.50	7.99E-06	3.73E-05	9.78E-05
CE3-CTP-CF-HT3OF4	5.13E-06	6.89	7.45E-07	1.02E-05	3.53E-05
CE3-MSW-CF-2OF4	3.28E-06	4.45	7.38E-07	4.95E-06	1.46E-05
CE3-PWR-CF-TB2OF4	1.37E-06	6.07	2.27E-07	2.51E-06	8.34E-06
CE3-ROD-CF-RODS	2.41E-07	13.47	1.79E-08	8.40E-07	3.24E-06
CE3-RYL-CF-1LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE3-RYL-CF-1LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE3-RYL-CF-2LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE3-RYL-CF-2LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE3-RYL-CF-3LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE3-RYL-CF-3LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE3-RYL-CF-4LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE3-RYL-CF-4LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE3-RYL-CF-LM12OF24	9.38E-09	17.58	5.34E-10	4.29E-08	1.65E-07
CE3-RYL-CF-LM6OF12TM	5.36E-08	11.27	4.75E-09	1.58E-07	6.04E-07
CE3-RYT-CF-2OF4	2.92E-06	5.12	5.71E-07	4.78E-06	1.49E-05
CE4-BME-CF-TB2OF4	4.24E-07	5.28	8.03E-08	7.07E-07	2.24E-06
CE4-BSN-CF-TB2OF4	2.89E-06	11.53	2.51E-07	8.73E-06	3.33E-05
CE4-BUV-CF-TB2OF4	1.71E-05	7.59	2.25E-06	3.65E-05	1.30E-04
CE4-CBI-CF-4OF6TM	4.95E-07	13.39	3.70E-08	1.72E-06	6.63E-06
CE4-CBI-CF-6OF8	1.44E-07	20.28	7.08E-09	7.66E-07	2.91E-06
CE4-CBI-CF-P2OF3TM	1.00E-05	9.46	1.06E-06	2.55E-05	9.49E-05

Table E-7. Lognormal uncertainty distributions for CCF events. (Continued)

Basic Event Name	Median	EF	CCF Failure Probability Low	CCF Mean Failure Probability	CCF Failure Probability Upper
CE4-CBI-CF-P3OF4	1.94E-06	14.35	1.35E-07	7.21E-06	2.79E-05
CE4-CBI-CF-T2OF3TM	1.00E-05	9.46	1.06E-06	2.55E-05	9.49E-05
CE4-CBI-CF-T3OF4	1.94E-06	14.35	1.35E-07	7.21E-06	2.79E-05
CE4-CPD-CF-T2OF3TM	9.29E-05	4.13	2.25E-05	1.35E-04	3.83E-04
CE4-CPD-CF-T3OF4	3.40E-05	5.38	6.32E-06	5.73E-05	1.83E-04
CE4-CPR-CF-P2OF3TM	2.33E-06	7.67	3.04E-07	5.03E-06	1.79E-05
CE4-CPR-CF-P3OF4	4.81E-07	12.07	3.99E-08	1.51E-06	5.81E-06
CE4-CTP-CF-CT2OF3TM	2.80E-05	3.50	7.99E-06	3.73E-05	9.78E-05
CE4-CTP-CF-CT3OF4	5.13E-06	6.89	7.45E-07	1.02E-05	3.53E-05
CE4-CTP-CF-HT2OF3TM	2.80E-05	3.50	7.99E-06	3.73E-05	9.78E-05
CE4-CTP-CF-HT3OF4	5.13E-06	6.89	7.45E-07	1.02E-05	3.53E-05
CE4-MSW-CF-2OF4	3.28E-06	4.45	7.38E-07	4.95E-06	1.46E-05
CE4-PWR-CF-TB2OF4	1.37E-06	6.07	2.27E-07	2.51E-06	8.34E-06
CE4-ROD-CF-RODS	2.41E-07	13.47	1.79E-08	8.40E-07	3.24E-06
CE4-RYL-CF-1LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE4-RYL-CF-1LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE4-RYL-CF-2LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE4-RYL-CF-2LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE4-RYL-CF-3LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE4-RYL-CF-3LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE4-RYL-CF-4LM3OF3TM	9.22E-08	19.32	4.77E-09	4.66E-07	1.78E-06
CE4-RYL-CF-4LM6OF6	2.42E-08	29.58	8.18E-10	2.02E-07	7.15E-07
CE4-RYL-CF-LM12OF24	9.38E-09	17.58	5.34E-10	4.29E-08	1.65E-07
CE4-RYL-CF-LM6OF12TM	5.36E-08	11.27	4.75E-09	1.58E-07	6.04E-07
CE4-RYT-CF-2OF4	2.92E-06	5.12	5.71E-07	4.78E-06	1.49E-05
CEX-CBI-CF-6OF9TM	1.31E-07	16.05	8.16E-09	5.44E-07	2.10E-06
CEX-CBI-CF-9OF12	5.12E-08	21.96	2.33E-09	2.99E-07	1.12E-06

REFERENCES

E-1. F. M. Marshall et. al., *Common-Cause Failure Database and Analysis System: Event Definition and Classification*, NUREG/CR-6268, Vol. 2, June 1998.

E-2. U.S. NRC, *Guidelines on Modeling Common-Cause Failures in Probabilistic Risk Assessment*, NUREG/CR-5485, Nov. 1998.

E-3. Kvam, Paul, *Estimation Techniques for Common Cause Failure Data with Different System Sizes*, Technometrics, Volume 38, No. 4, pages 382-388, 1996.