NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

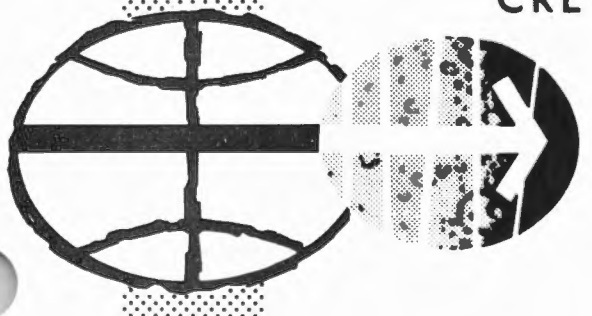
APOLLO 17

ALL LAUNCH DATES

BASIC
CSM MALFUNCTION PROCEDURES

PREPARED BY

FLIGHT PLANNING BRANCH
CREW PROCEDURES DIVISION



MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

AUGUST 7, 1972

APOLLO 17

CSM MALFUNCTION PROCEDURES

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G & C MALFUNCTION INDEX

1 ABNORMAL VEHICLE DYNAMICS DURING SPS THRUSTING

2 FDAI ATT ERROR ABNORMAL

3 FDAI RATE IND ABNORMAL

4 FDAI TOTAL ATTITUDE DISPLAY ABNORMAL

5 FDAI FAILS TO SLEW WITH ORDEAL

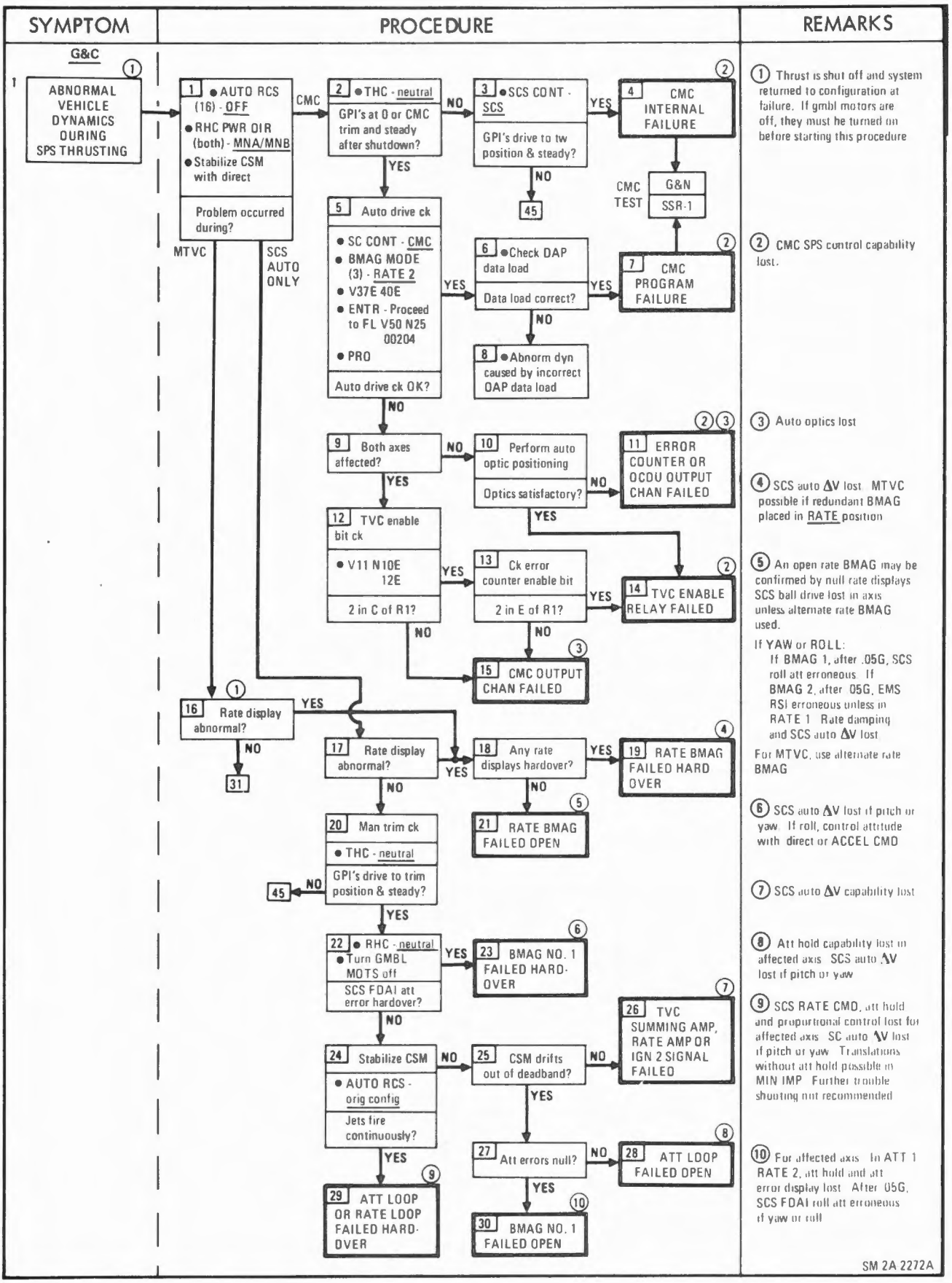
6 FDAI TOTAL ATT DOES NOT RESPOND TO GDC ALIGN

7 GPI/FUEL PRESS IND(S) PEGGED OR ZERO

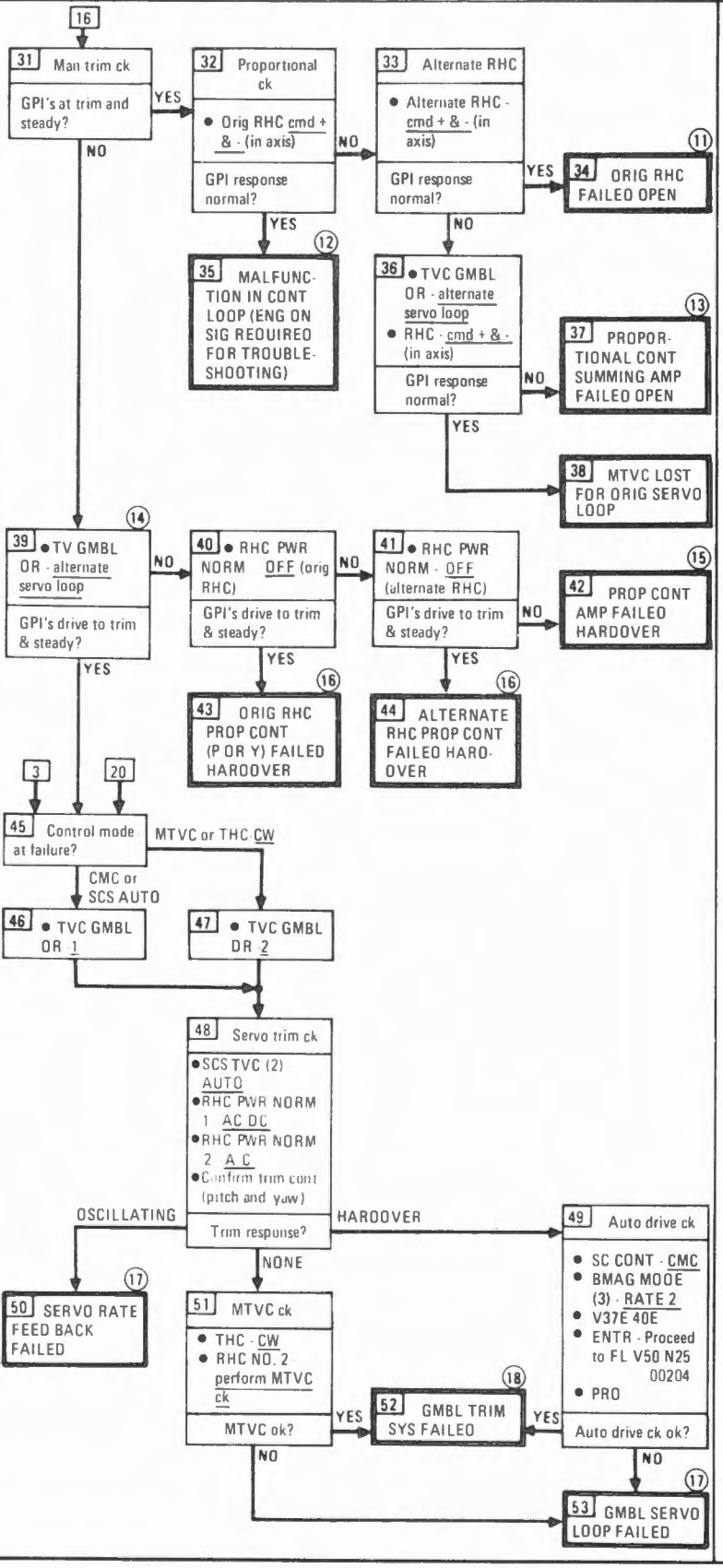
8 BMAG 1 (2) TEMP

YELLOW

A ABNORMAL VEHICLE DYNAMICS (NON-SPS THRUSTING LM-INACTIVE)


SYMPTOM
PROCEDURE
REMARKS
G&C
ABNORMAL VEHICLE DYNAMICS DURING SPS THRUSTING
1 • AUTO RCS (16) - OFF
• RHC PWR OIR (both) - MNA/MNB
• Stabilize CSM with direct
Problem occurred during?
CMC
MTVC
SCS AUTO ONLY
2 • THC - neutral
GPI's at 0 or CMC trim and steady after shutdown?
NO
YES
3 • SCS CONT - SCS
GPI's drive to tw position & steady?
YES
NO
45
4 CMC INTERNAL FAILURE
CMC TEST
G&N SSR-1
5 Auto drive ck
• SC CONT - CMC
• BMAG MODE (3) - RATE 2
• V37E 40E
• ENTR - Proceed to FL V50 N25 00204
• PRO
Auto drive ck OK?
6 • Check DAP data load
Data load correct?
YES
NO
7 CMC PROGRAM FAILURE
8 • Abnorm dyn caused by incorrect DAP data load
9 Both axes affected?
NO
YES
10 Perform auto optic positioning
Optics satisfactory?
NO
YES
11 ERROR COUNTER OR OCDU OUTPUT CHAN FAILED
12 TVC enable bit ck
• V11 N10E 12E
2 in C of R1?
13 Ck error counter enable bit
2 in E of R1?
14 TVC ENABLE RELAY FAILED
15 CMC OUTPUT CHAN FAILED
16 Rate display abnormal?
31
17 Rate display abnormal?
18 Any rate displays hardover?
19 RATE BMAG FAILED HARD OVER
20 Man trim ck
• THC - neutral
GPI's drive to trim position & steady?
21 RATE BMAG FAILED OPEN
22 • RHC - neutral
• Turn GMBL MOTS off
SCS FDAI att error hardover?
23 BMAG NO. 1 FAILED HARD-OVER
24 Stabilize CSM
• AUTO RCS - orig config
Jets fire continuously?
25 CSM drifts out of deadband?
26 TVC SUMMING AMP, RATE AMP OR IGN 2 SIGNAL FAILED
27 Att errors null?
28 ATT LOOP FAILED OPEN
29 ATT LOOP OR RATE LOOP FAILED HARD-OVER
30 BMAG NO. 1 FAILED OPEN
(1) Thrust is shut off and system returned to configuration at failure. If gmbl motors are off, they must be turned on before starting this procedure
(2) CMC SPS control capability lost.
(3) Auto optics lost
(4) SCS auto ΔV lost MTVC possible if redundant BMAG placed in RATE position
(5) An open rate BMAG may be confirmed by null rate displays SCS ball drive lost in axis unless alternate rate BMAG used.
If YAW or ROLL:
If BMAG 1, after .05G, SCS roll att erroneous If BMAG 2, after 05G, EMS RSI erroneous unless in RATE 1 Rate damping and SCS auto ΔV lost
For MTVC, use alternate rate BMAG
(6) SCS auto ΔV lost if pitch or yaw If roll, control attitude with direct or ACCEL CMD
(7) SCS auto ΔV capability lost
(8) Att hold capability lost in affected axis SCS auto ΔV lost if pitch or yaw
(9) SCS RATE CMD, att hold and proportional control lost for affected axis SC auto ΔV lost if pitch or yaw Translations without att hold possible in MIN IMP Further trouble shooting not recommended
(10) For affected axis In ATT 1 RATE 2, att hold and att error display lost After 05G, SCS FDAI roll att erroneous if yaw or roll
SM 2A 2272A

1
(CONT)

SYMPTOM	PROCEDURE	REMARKS
G&C 1 (Cont)		(11) SCS proportional control and MTVC lost for failed RHC. (12) One probable failure could be loss of MTVC integrator in which case during MTVC the gimbal position directly follows the stick position. (13) SCS proportional control and MTVC lost for both RHC's. (14) If THC - CW at time of failure, servo No. 2 being used, select servo No. 1. (15) No MTVC capability. RATE CMD lost in affected axis. Att hold possible if RHC's locked (or neutral) or RHC PWR NORM (2) - OFF. Disable affected axis if direct used. (16) MTVC and proportional cont available with unaffected RHC, if affected RHC power is off (RHC PWR NORM - OFF) or RHC locked. (17) Affected servo lost for all ΔV's. (18) CMC ΔV unaffected. On affected servo, SCS auto ΔV and trim lost, but MTVC without trim remains.

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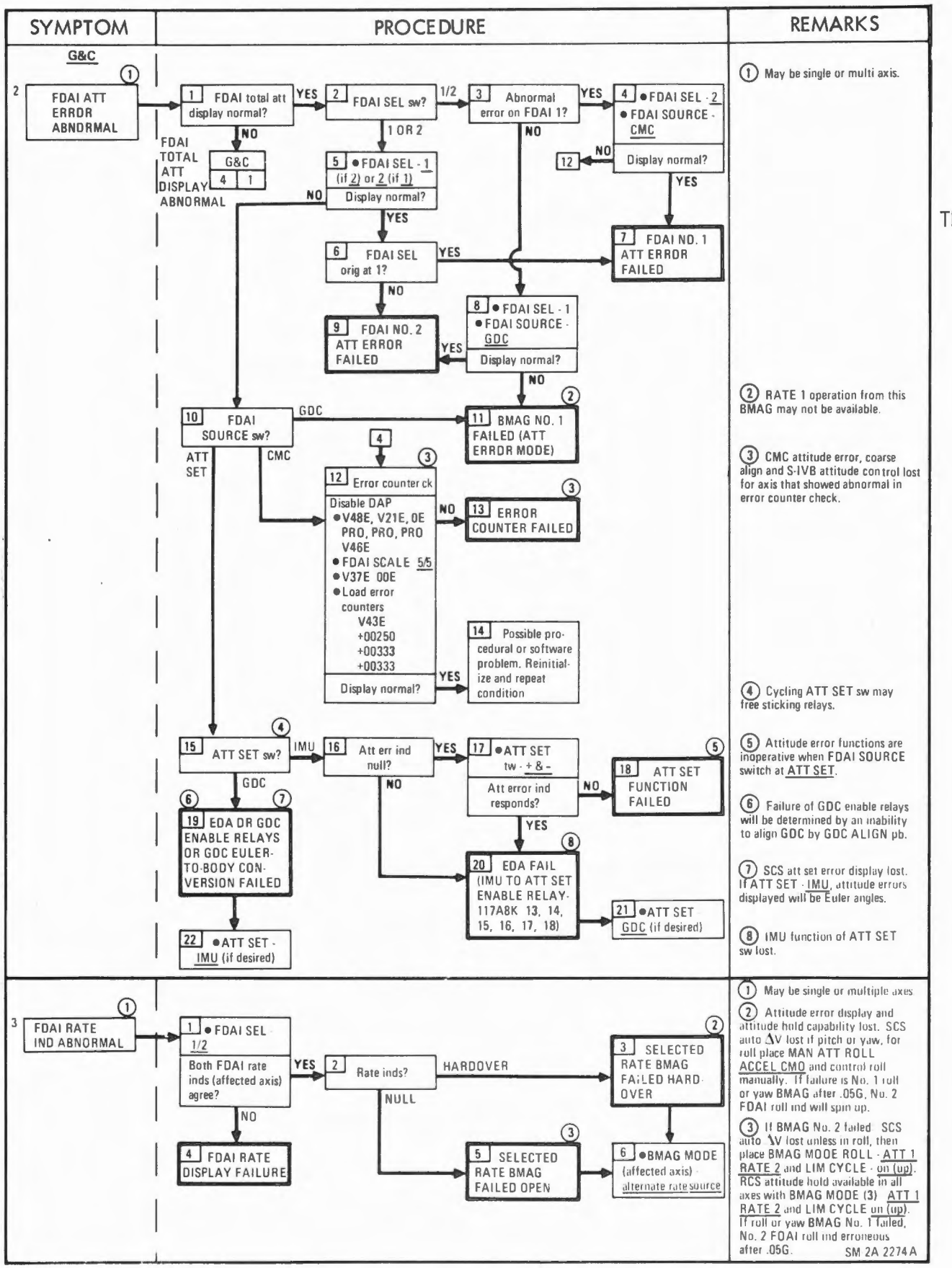
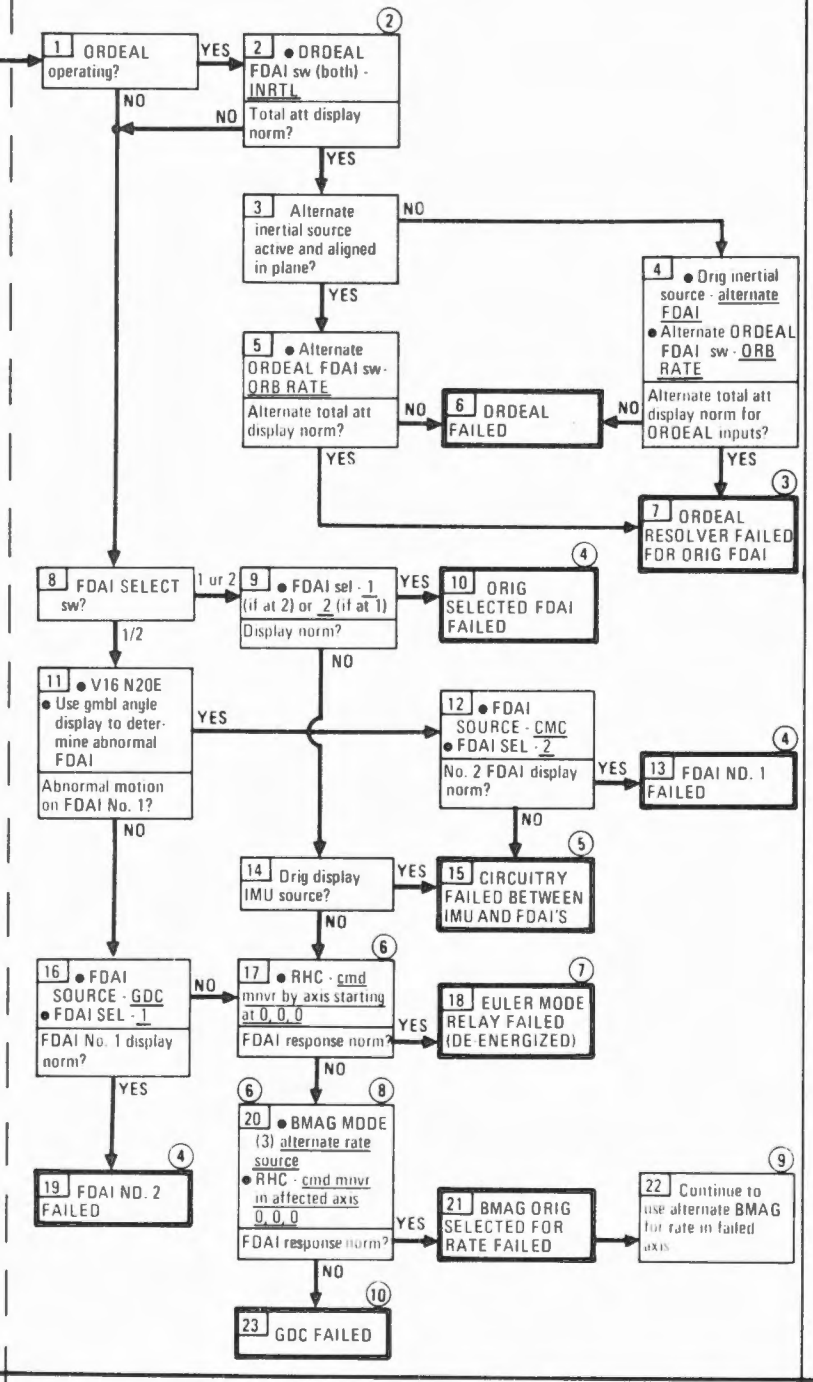
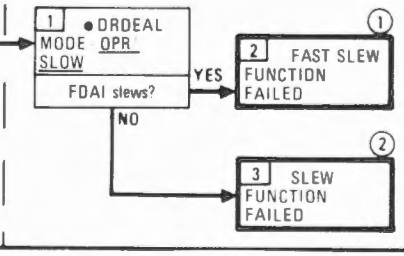

SYMPTOM
PROCEDURE
REMARKS
G&C
2
FDAI ATT ERRDR ABNORMAL
1
1 FDAI total att display normal?
YES
2 FDAI SEL sw?
1/2
3 Abnormal error on FDAI 1?
YES
4 • FDAI SEL - 2 • FDAI SOURCE - CMC
Display normal?
NO
12
YES
7 FDAI NO. 1 ATT ERRDR FAILED
NO
FDAI TOTAL ATT DISPLAY ABNORMAL
G&C 4 1
1 OR 2
5 • FDAI SEL - 1 (if 2) or 2 (if 1)
Display normal?
NO
YES
6 FDAI SEL orig at 1?
YES
NO
8 • FDAI SEL - 1 • FDAI SOURCE - GDC
Display normal?
YES
9 FDAI NO. 2 ATT ERROR FAILED
NO
2
10 FDAI SOURCE sw?
GDC
11 BMAG NO. 1 FAILED (ATT ERRDR MODE)
ATT SET
CMC
4
3
12 Error counter ck
Disable DAP
• V48E, V21E, 0E PRO, PRO, PRO V46E
• FDAI SCALE 5/5
• V37E 00E
• Load error counters V43E +00250 +00333 +00333
Display normal?
NO
13 ERROR COUNTER FAILED
YES
14 Possible procedural or software problem. Reinitialize and repeat condition
4
15 ATT SET sw?
IMU
16 Att err ind null?
YES
17 • ATT SET tw - + & -
Att error ind responds?
NO
5
18 ATT SET FUNCTION FAILED
YES
GDC
6
7
19 EDA DR GDC ENABLE RELAYS OR GDC EULER-TO-BODY CONVERSION FAILED
NO
8
20 EDA FAIL (IMU TO ATT SET ENABLE RELAY- 117A8K 13, 14, 15, 16, 17, 18)
21 • ATT SET - GDC (if desired)
22 • ATT SET - IMU (if desired)
3
1
FDAI RATE IND ABNORMAL
1 • FDAI SEL 1/2
Both FDAI rate inds (affected axis) agree?
YES
2 Rate inds?
HARDOVER
2
3 SELECTED RATE BMAG FAILED HARD-OVER
NULL
NO
4 FDAI RATE DISPLAY FAILURE
3
5 SELECTED RATE BMAG FAILED OPEN
6 • BMAG MODE (affected axis) - alternate rate source
SM 2A 2274 A
(1) May be single or multi axis.
(2) RATE 1 operation from this BMAG may not be available.
(3) CMC attitude error, coarse align and S-IVB attitude control lost for axis that showed abnormal in error counter check.
(4) Cycling ATT SET sw may free sticking relays.
(5) Attitude error functions are inoperative when FDAI SOURCE switch at ATT SET.
(6) Failure of GDC enable relays will be determined by an inability to align GDC by GDC ALIGN pb.
(7) SCS att set error display lost. If ATT SET - IMU, attitude errors displayed will be Euler angles.
(8) IMU function of ATT SET sw lost.
(1) May be single or multiple axes
(2) Attitude error display and attitude hold capability lost. SCS auto ΔV lost if pitch or yaw, for roll place MAN ATT ROLL ACCEL CMD and control roll manually. If failure is No. 1 roll or yaw BMAG after .05G, No. 2 FDAI roll ind will spin up.
(3) If BMAG No. 2 failed SCS auto ΔV lost unless in roll, then place BMAG MODE ROLL - ATT 1 RATE 2 and LIM CYCLE - on (up). RCS attitude hold available in all axes with BMAG MODE (3) ATT 1 RATE 2 and LIM CYCLE on (up). If roll or yaw BMAG No. 1 failed, No. 2 FDAI roll ind erroneous after .05G.

2 THRU 3

4 IRU 5

SYMPTOM	PROCEDURE	REMARKS
G&C 4 FDAI TOTAL ATTITUDE DISPLAY ABNORMAL		(1) For GDC FDAI total attitude, if rate display(s) also hardover, enter "FDAI Rate Ind Abnormal" procedure. (2) Assumes inertial reference for orbital rate FDAI is aligned in plane. (3) Use alternate FDAI for subsequent orbital rate displays. (4) Confirm FDAI failure by placing alternate inertial source on affected FDAI. Normal total attitude with alternate inertial source indicative of Golden G relay failure. (5) Any failure of IMU itself would have been indicated by ISS light. (6) The FDAI can be aligned to 0, 0, 0 by the GDC align pb. (7) Attempt only single-axis maneuvers in order pitch, yaw and roll. This failure has no effect after .05 G since Euler mode relays are disabled. (8) Assumes alternate rate source operable. (9) After .05 G, if BMAG No. 1 fails in yaw or roll, FDAI Roll Att will be erroneous, if BMAG No. 2 fails in yaw or roll, EMS RSI attitude will be erroneous unless RATE 1 selected. (10) Entry capability can be determined from GDC FDAI roll ind and EMS RSI response when a yaw maneuver is commanded with .05 G sw and EMS ROLL sw CB (up). Total attitude capability lost for affected axis. After .05 G, if failure axis is YAW EMS RSI invalid ROLL No. 2 FDAI roll ind invalid.
5 FDAI FAILS TO SLEW WITH ORDEAL		(1) Slew FDAI at slow rate (2) With an in plane GDC alignment, FDAI pitch angle may be set by pressing GDC align pb and slewing pitch att set tw

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SYMPTOM	PROCEDURE	REMARKS
G&C 6 FDAI TOTAL ATT DOES NOT RESPOND TO GDC ALIGN (1)	1 Monitor FDAI for response to vehicle motion. Response normal? YES → 2 • FDAI SEL - 1 or 2 • FDAI SOURCE - ATT SET • ATT SET - GDC. FDAI indicates att error in axis? YES → 3 GDC ALIGN FUNCTION LOST (2)(3). NO → 4 GDC ALIGN ATT SET ENABLE FUNCTION LOST (3). NO → G&C 4 8 FDAI TOTAL ATT DISPLAY ABNORMAL	(1) May be single or multiple axes. (2) Att set error displays still operational. (3) GDC can be aligned to an arbitrary position by: a. Fly CSM to indicated attitude to which GDC is to be aligned. b. Disable GDC. c. Fly CSM to prescribed inertial attitude (star or visual reference). d. Re-enable GDC.
7 GPI/FUEL PRESS IND(S) PEGGED OR ZERO	1 Both inds (of pair) pegged or zero? NO → 2 One pitch (fuel) and one yaw (oxid) abnormal? NO → 3 Ind usage for fuel? NO → 4 DISPLAY FAILED. YES → 5 EDA 15 VDC PWR SUPPLY FAILURE (1). YES → 6 LOSS OF ONE PRESS DISPLAY (2). YES → 7 Ind usage for fuel press? NO → 8 GPI problem occurred during? CMC → 9 Occurred during CMC trim test? YES → G&C 1 5 ABNORMAL VEHICLE DYNAMICS DURING SPS THRUSTING. NO → G&C 1 51 ABNORMAL VEHICLE DYNAMICS DURING SPS THRUSTING. MTVC OR THC-CW → G&C 1 16 ABNORMAL VEHICLE DYNAMICS DURING SPS THRUSTING. SCS AUTO. YES → 10 Are all four ind pegged or zero? YES → 11 TANK PRESS SIG CONDITIONING FAILURE (3). NO → 12 TANK PRESSURE ABNORMAL (2)	(1) Total attitude, attitude error & rate display lost for one FDAI (2) Check GPI operation during first gimbal drive and trim check (3) Utilize MSFN to monitor tank press.
8 BMAG 1 (2) TEMP YELLOW lt on if temp <168 >172	1 • BMAG PWR OFF (Affected BMAG) Temp lt goes out? NO → 4 C/W FAILURE. YES → 2 After 30 min • BMAG PWR ON (Affected BMAG) BMAG lt on and stays on continuously? YES → 3 BMAG FAILED UNDERTEMP (1). NO → 5 BMAG FAILED OVERTEMP (1)(2) → 6 • BMAG PWR OFF (Affected BMAG). Turn on affected BMAG 30 min prior to use	(1) BMAG rate information relatively unaffected by temperature out-of-tolerance. However attitude error information degrades 4 per degree out of tolerance (2) Time that the BMAG TEMP lt is off is an indication of the temperature rate increase and period of accuracy for subsequent BMAG use

6 THRU 8

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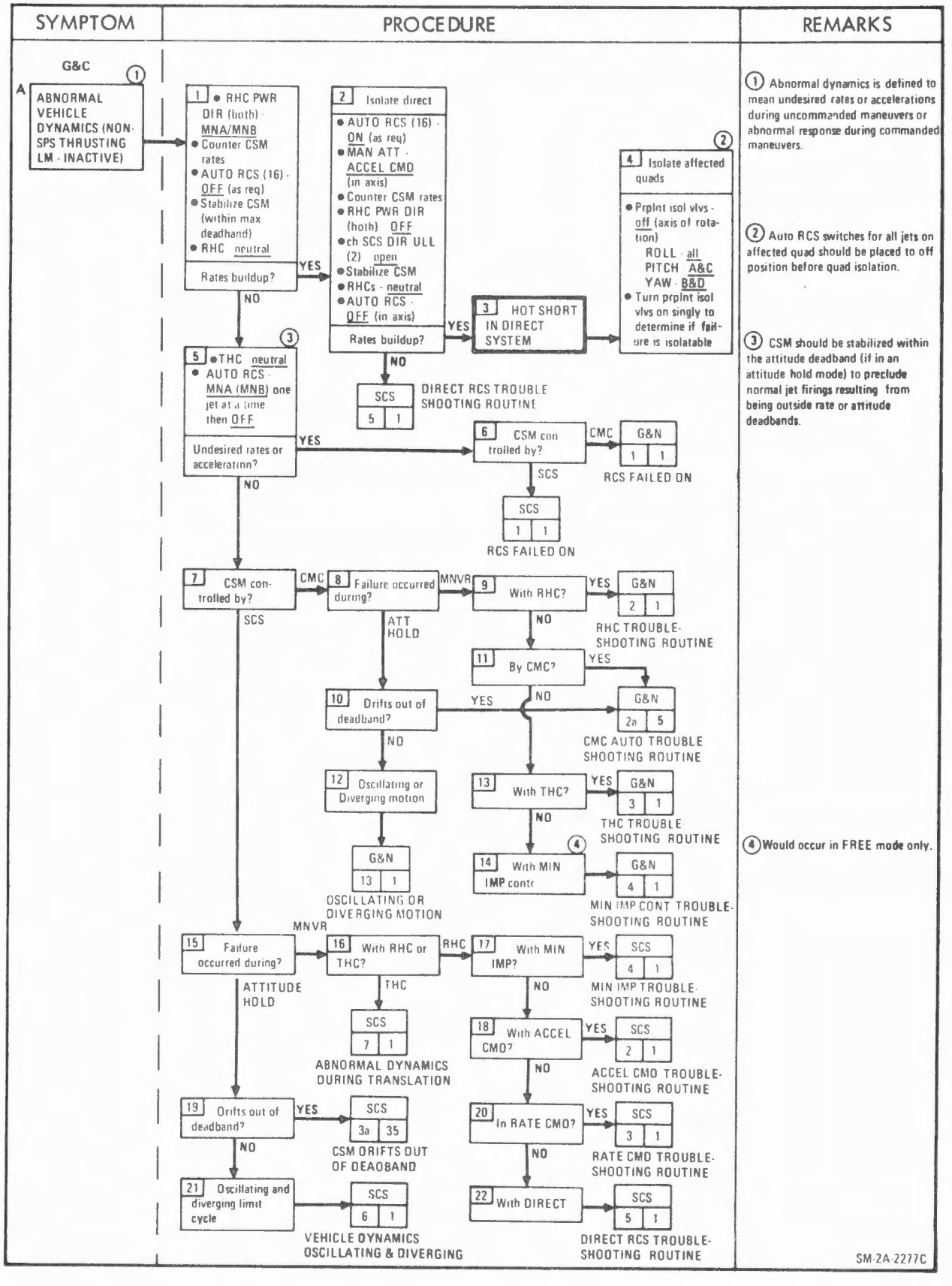
SYMPTOM
PROCEDURE
REMARKS
G&C
A
ABNORMAL VEHICLE DYNAMICS (NON-SPS THRUSTING LM - INACTIVE)
1 • RHC PWR DIR (both) - MNA/MNB
• Counter CSM rates
• AUTO RCS (16) - OFF (as req)
• Stabilize CSM (within max deadband)
• RHC neutral
Rates buildup?
YES
NO
2 Isolate direct
• AUTO RCS (16) - ON (as req)
• MAN ATT - ACCEL CMD (in axis)
• Counter CSM rates
• RHC PWR DIR (both) OFF
• ch SCS DIR ULL (2) open
• Stabilize CSM
• RHCs - neutral
• AUTO RCS - OFF (in axis)
Rates buildup?
YES
NO
3 HOT SHORT IN DIRECT SYSTEM
4 Isolate affected quads
• Prplnt isol vlvs - off (axis of rotation)
ROLL - all
PITCH A&C
YAW - B&D
• Turn prplnt isol vlvs on singly to determine if failure is isolatable
SCS 5 1 DIRECT RCS TROUBLE SHOOTING ROUTINE
5 •THC neutral
• AUTO RCS - MNA (MNB) one jet at a time then OFF
Undesired rates or acceleration?
YES
NO
6 CSM controlled by?
CMC
G&N 1 1 RCS FAILED ON
SCS
SCS 1 1 RCS FAILED ON
7 CSM controlled by?
CMC
SCS
8 Failure occurred during?
MNVR
ATT HOLD
9 With RHC?
YES
G&N 2 1 RHC TROUBLE-SHOOTING ROUTINE
NO
11 By CMC?
YES
NO
10 Drifts out of deadband?
YES
G&N 2a 5 CMC AUTO TROUBLE SHOOTING ROUTINE
NO
12 Oscillating or Diverging motion
G&N 13 1 OSCILLATING OR DIVERGING MOTION
13 With THC?
YES
G&N 3 1 THC TROUBLE SHOOTING ROUTINE
NO
14 With MIN IMP contr
4
G&N 4 1 MIN IMP CONT TROUBLE-SHOOTING ROUTINE
15 Failure occurred during?
MNVR
ATTITUDE HOLD
16 With RHC or THC?
RHC
THC
SCS 7 1 ABNORMAL DYNAMICS DURING TRANSLATION
17 With MIN IMP?
YES
SCS 4 1 MIN IMP TROUBLE-SHOOTING ROUTINE
NO
18 With ACCEL CMD?
YES
SCS 2 1 ACCEL CMD TROUBLE-SHOOTING ROUTINE
NO
19 Drifts out of deadband?
YES
SCS 3a 35 CSM DRIFTS OUT OF DEADBAND
NO
20 In RATE CMD?
YES
SCS 3 1 RATE CMD TROUBLE-SHOOTING ROUTINE
NO
21 Oscillating and diverging limit cycle
SCS 6 1 VEHICLE DYNAMICS OSCILLATING & DIVERGING
22 With DIRECT
SCS 5 1 DIRECT RCS TROUBLE-SHOOTING ROUTINE
1 Abnormal dynamics is defined to mean undesired rates or accelerations during uncommanded maneuvers or abnormal response during commanded maneuvers.
2 Auto RCS switches for all jets on affected quad should be placed to off position before quad isolation.
3 CSM should be stabilized within the attitude deadband (if in an attitude hold mode) to preclude normal jet firings resulting from being outside rate or attitude deadbands.
4 Would occur in FREE mode only.
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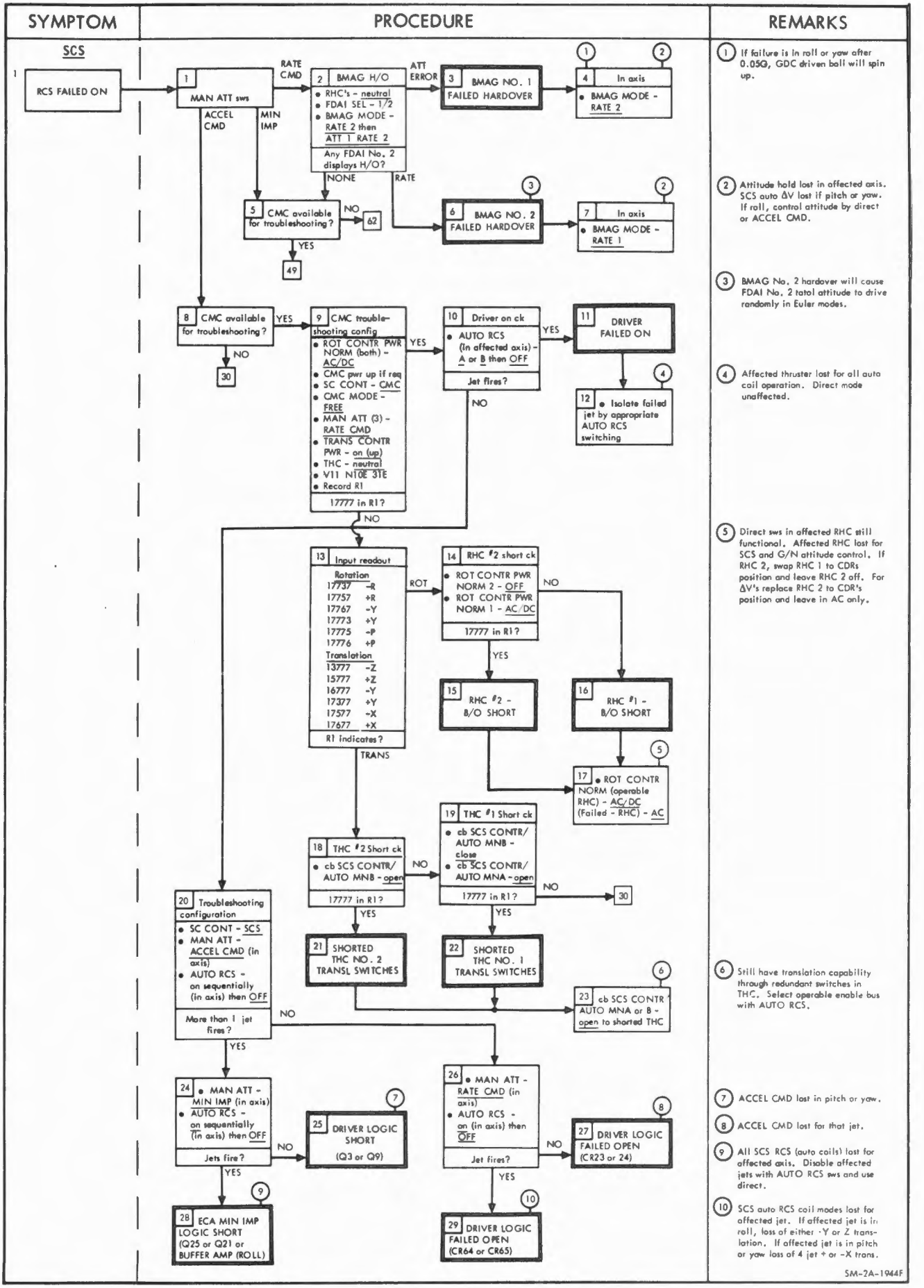
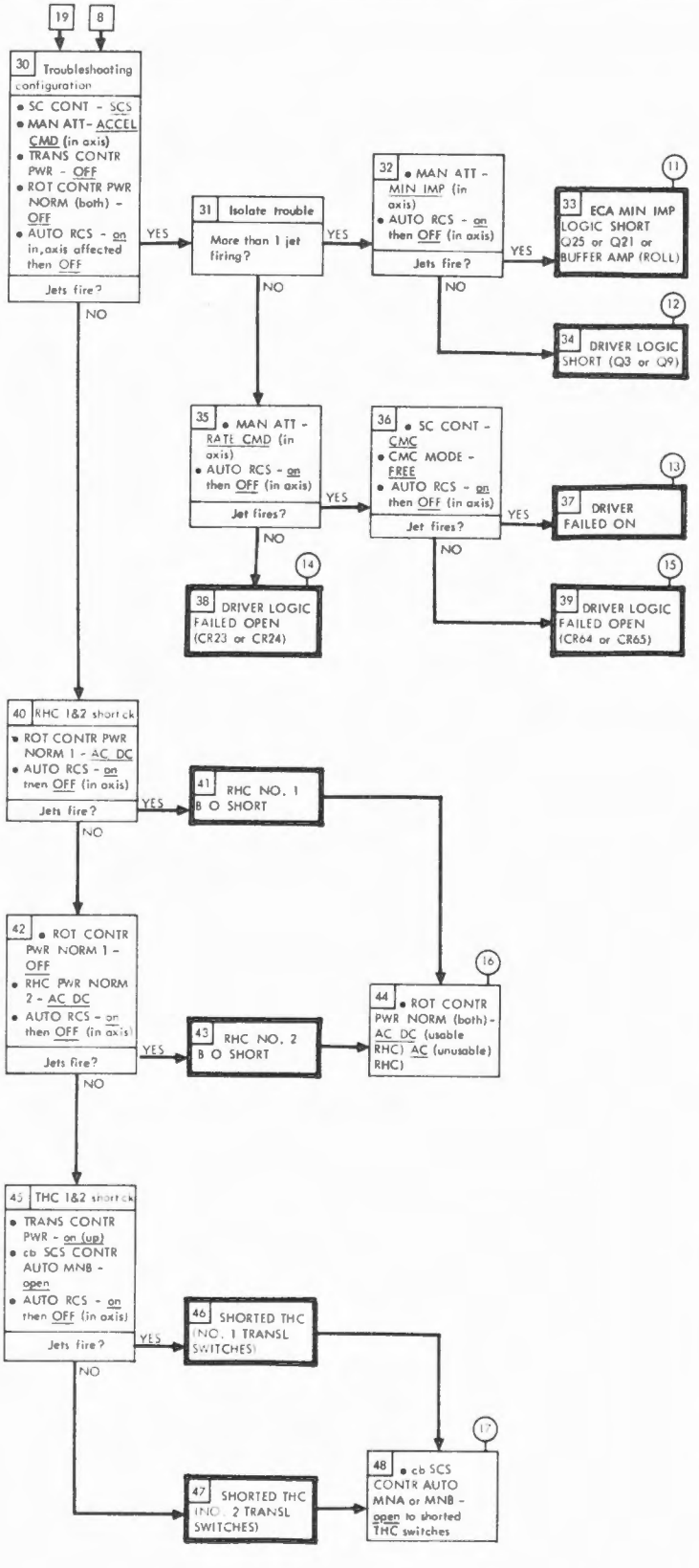
SCS MALFUNCTION INDEX


SYMPTOM
PROCEDURE
REMARKS
SCS
1
RCS FAILED ON
1 MAN ATT sws
RATE CMD
ACCEL CMD
MIN IMP
2 BMAG H/O
• RHC's - neutral
• FDAI SEL - 1/2
• BMAG MODE - RATE 2 then ATT 1 RATE 2
Any FDAI No. 2 displays H/O?
ATT ERROR
NONE
RATE
3 BMAG NO. 1 FAILED HARDOVER
4 In axis
• BMAG MODE - RATE 2
5 CMC available for troubleshooting?
NO
62
YES
49
6 BMAG NO. 2 FAILED HARDOVER
7 In axis
• BMAG MODE - RATE 1
8 CMC available for troubleshooting?
YES
NO
30
9 CMC troubleshooting config
• ROT CONTR PWR NORM (both) - AC/DC
• CMC pwr up if req
• SC CONT - CMC
• CMC MODE - FREE
• MAN ATT (3) - RATE CMD
• TRANS CONTR PWR - on (up)
• THC - neutral
• V11 N100E 31E
• Record R1
17777 in R1?
YES
NO
10 Driver on ck
• AUTO RCS (In affected axis) - A or B then OFF
Jet fires?
YES
NO
11 DRIVER FAILED ON
12 • Isolate failed jet by appropriate AUTO RCS switching
13 Input readout
Rotation
17737 -R
17757 +R
17767 -Y
17773 +Y
17775 -P
17776 +P
Translation
13777 -Z
15777 +Z
16777 -Y
17377 +Y
17577 -X
17677 +X
R1 indicates?
ROT
TRANS
14 RHC #2 short ck
• ROT CONTR PWR NORM 2 - OFF
• ROT CONTR PWR NORM 1 - AC/DC
17777 in R1?
NO
YES
15 RHC #2 - B/O SHORT
16 RHC #1 - B/O SHORT
17 • ROT CONTR NORM (operable RHC) - AC/DC (Failed - RHC) - AC
18 THC #2 Short ck
• cb SCS CONTR/ AUTO MNB - open
17777 in R1?
NO
YES
19 THC #1 Short ck
• cb SCS CONTR/ AUTO MNB - close
• cb SCS CONTR/ AUTO MNA - open
17777 in R1?
NO
YES
30
20 Troubleshooting configuration
• SC CONT - SCS
• MAN ATT - ACCEL CMD (in axis)
• AUTO RCS - on sequentially (in axis) then OFF
More than 1 jet fires?
NO
YES
21 SHORTED THC NO. 2 TRANSL SWITCHES
22 SHORTED THC NO. 1 TRANSL SWITCHES
23 cb SCS CONTR AUTO MNA or B - open to shorted THC
24 • MAN ATT - MIN IMP (in axis)
• AUTO RCS - on sequentially (in axis) then OFF
Jets fire?
NO
YES
25 DRIVER LOGIC SHORT (Q3 or Q9)
26 • MAN ATT - RATE CMD (in axis)
• AUTO RCS - on (in axis) then OFF
Jet fires?
NO
YES
27 DRIVER LOGIC FAILED OPEN (CR23 or 24)
28 ECA MIN IMP LOGIC SHORT (Q25 or Q21 or BUFFER AMP (ROLL)
29 DRIVER LOGIC FAILED OPEN (CR64 or CR65)
1 If failure is in roll or yaw after 0.05G, GDC driven ball will spin up.
2 Attitude hold lost in affected axis. SCS auto ΔV lost if pitch or yaw. If roll, control attitude by direct or ACCEL CMD.
3 BMAG No. 2 hardover will cause FDAI No. 2 total attitude to drive randomly in Euler modes.
4 Affected thruster lost for all auto coil operation. Direct mode unaffected.
5 Direct sws in affected RHC still functional. Affected RHC lost for SCS and G/N attitude control. If RHC 2, swap RHC 1 to CDRs position and leave RHC 2 off. For ΔV's replace RHC 2 to CDR's position and leave in AC only.
6 Still have translation capability through redundant switches in THC. Select operable enable bus with AUTO RCS.
7 ACCEL CMD lost in pitch or yaw.
8 ACCEL CMD lost for that jet.
9 All SCS RCS (auto coils) lost for affected axis. Disable affected jets with AUTO RCS sws and use direct.
10 SCS auto RCS coil modes lost for affected jet. If affected jet is in roll, loss of either -Y or Z translation. If affected jet is in pitch or yaw loss of 4 jet + or -X trans.
SM-2A-1944F

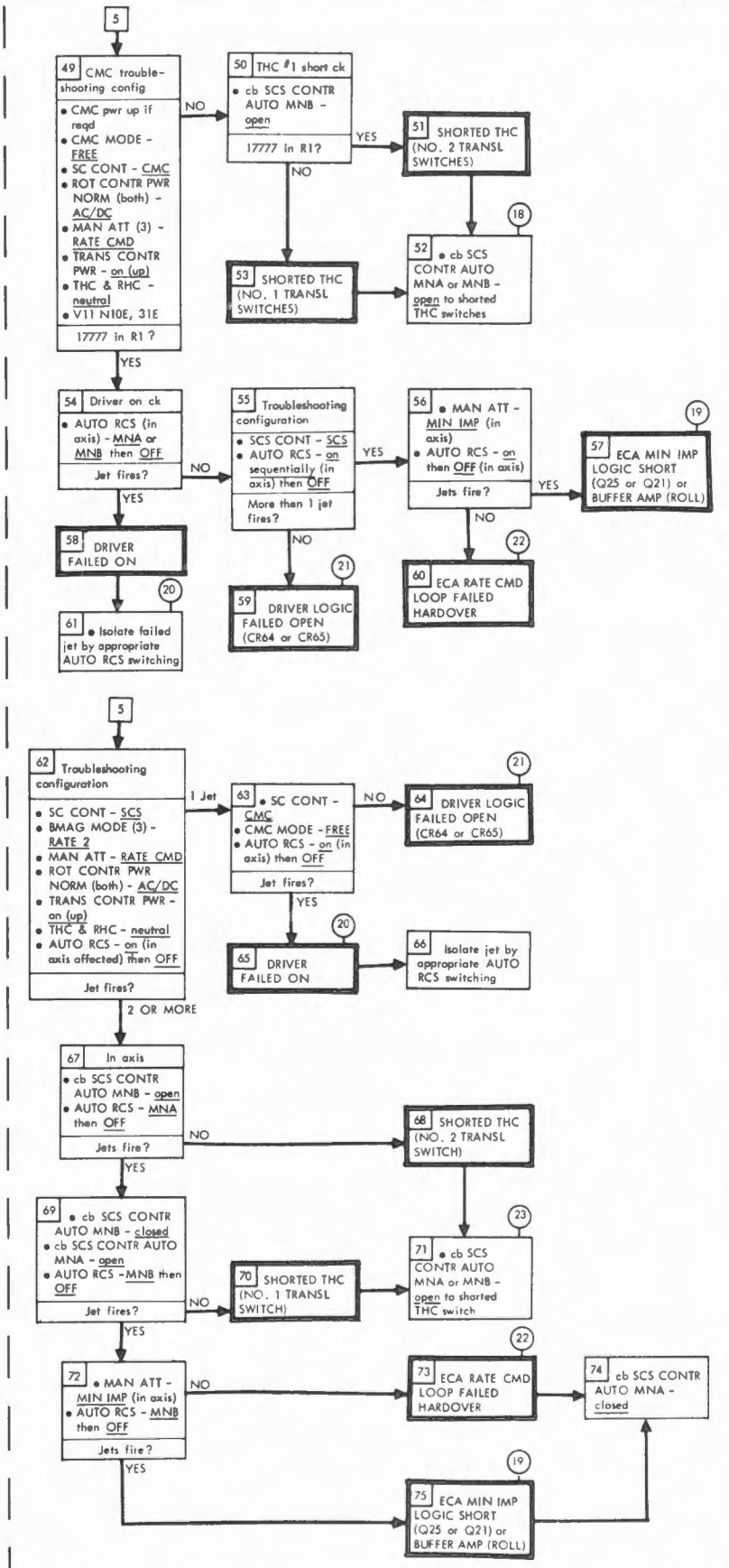
1
ONT)

SYMPTOM	PROCEDURE	REMARKS
SCS 1 Cont		(11) All SCS RCS (auto coils) lost for affected axis. Disable affected jets with AUTO RCS sws and use direct control. (12) ACCEL CMD lost in pitch or yaw. Use alternate quad pair for roll. (13) This jet lost for all SCS & G N control modes. Disable jet with AUTO RCS sws and use direct control. (14) ACCEL CMD lost for this jet. (15) SCS AUTO RCS coil modes lost for affected jet. If affected jet is in roll loss of either Y or Z trans. If affected jet is in pitch or yaw, loss of 4 jet + or -X trans. (16) Direct sws in affected RHC still functional. Affected RHC lost for SCS and G N attitude control. If RHC 2, swap RHC 1 to CDR s position and leave RHC 2 off. For ΔV's replace RHC 2 to CDR's position and leave in AC only. (17) Still have translation capability through redundant sws in THC. Select operable enable bus with AUTO RCS.

SYMPTOM	PROCEDURE	REMARKS

SCS

1 cont



(18) Still have translation capability through redundant sws in THC. Select operable enable bus with AUTO RCS.

(19) All SCS RCS (auto coils) lost for affected axis. Disable affected jets with AUTO RCS sws and use direct control.

(20) This jet lost for SCS & G&N control modes. Use direct control in affected axis.

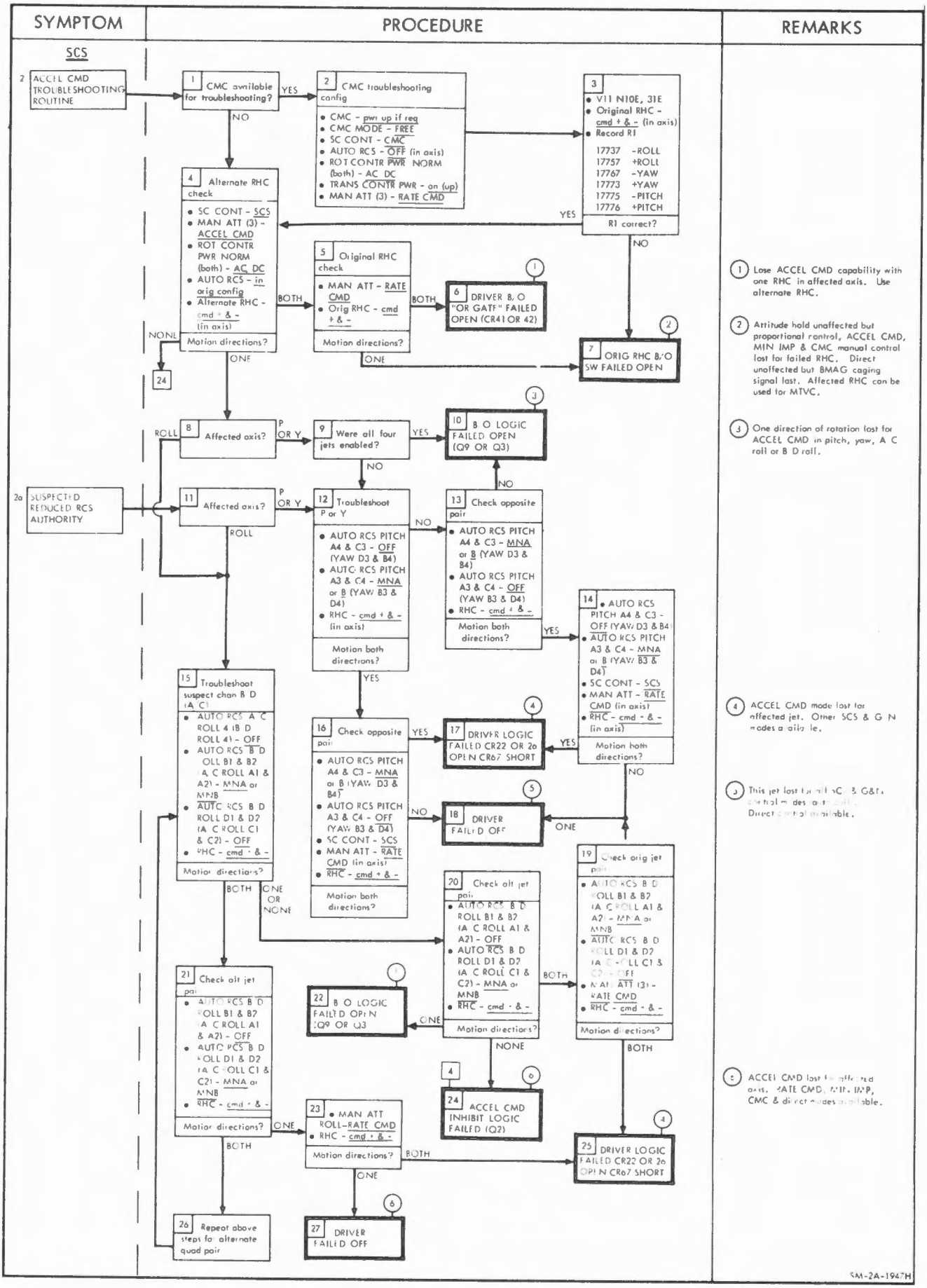
(21) SCS AUTO RCS coil modes lost for affected jet. If affected jet is in roll loss of either +Y or Z trans. If affected jet is in pitch or yaw loss of 4 jet + or -X trans.

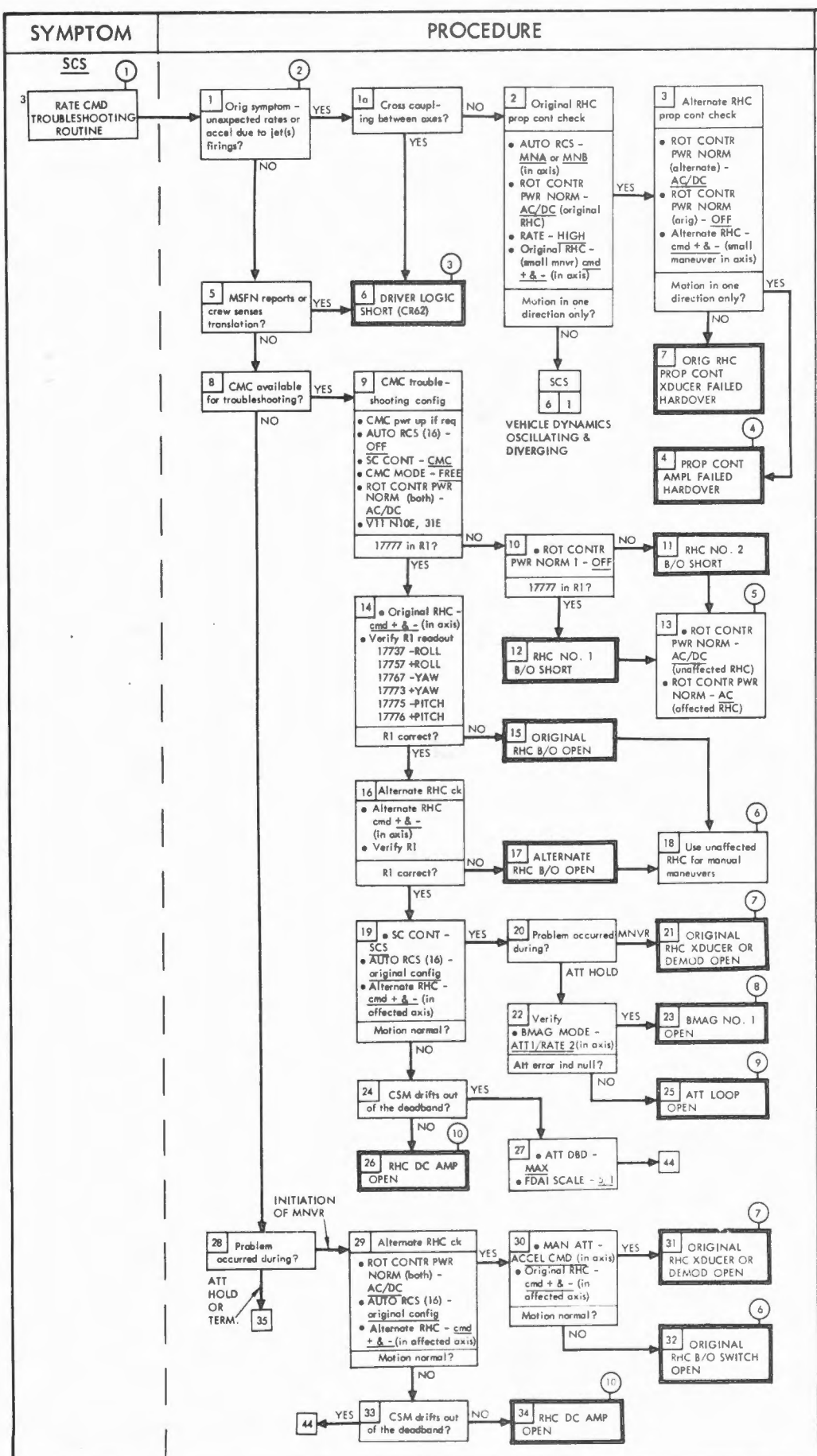
(22) SCS RATE CMD, attitude hold & prop cont lost for affected jet. SCS auto ΔV lost if pitch or yaw but operable in roll in ACCEL CMD. Translation without attitude hold possible in MIN IMP or ACCEL CMD.

(23) Still have translation capability through redundant sws in THC. Select operable enable bus with AUTO RCS.

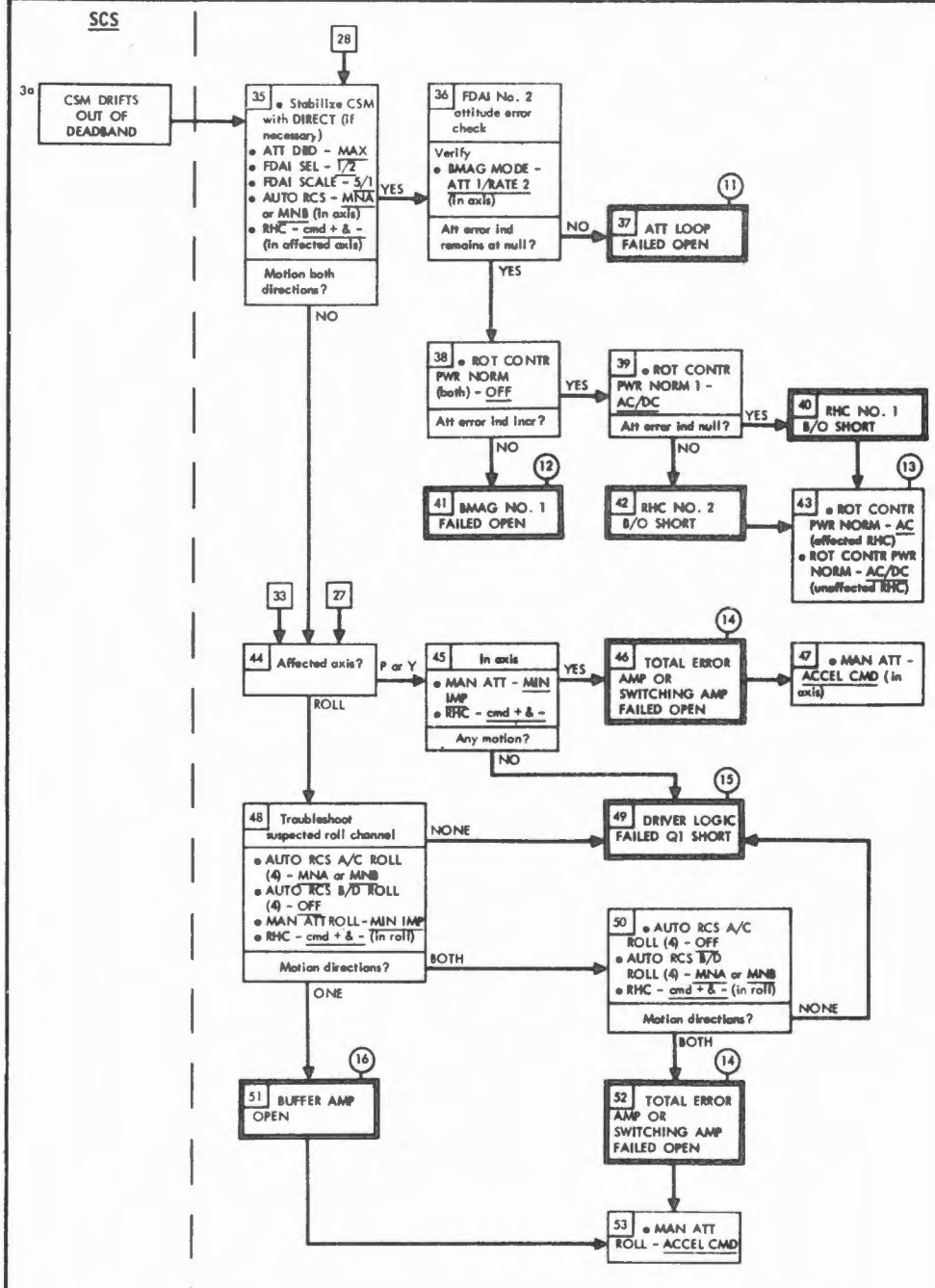
SM-2A-1946F

2 HRU 2a


SYMPTOM
PROCEDURE
REMARKS
SCS
2 ACCEL CMD TROUBLESHOOTING ROUTINE
1 CMC available for troubleshooting?
YES
NO
2 CMC troubleshooting config
• CMC - pwr up if req
• CMC MODE - FREE
• SC CONT - CMC
• AUTO RCS - OFF (in axis)
• ROT CONTR PWR NORM (both) - AC DC
• TRANS CONTR PWR - on (up)
• MAN ATT (3) - RATE CMD
3
• V11 N10E, 31E
• Original RHC - cmd + & - (in axis)
• Record R1
17737 -ROLL
17757 +ROLL
17767 -YAW
17773 +YAW
17775 -PITCH
17776 +PITCH
R1 correct?
YES
NO
4 Alternate RHC check
• SC CONT - SCS
• MAN ATT (3) - ACCEL CMD
• ROT CONTR PWR NORM (both) - AC DC
• AUTO RCS - in orig config
• Alternate RHC - cmd + & - (in axis)
Motion directions?
NONE
ONE
BOTH
5 Original RHC check
• MAN ATT - RATE CMD
• Orig RHC - cmd + & -
Motion directions?
BOTH
ONE
6 DRIVER B/O "OR GATE" FAILED OPEN (CR41 OR 42)
7 ORIG RHC B/O SW FAILED OPEN
24
8 Affected axis?
ROLL
P OR Y
9 Were all four jets enabled?
YES
NO
10 B O LOGIC FAILED OPEN (Q9 OR Q3)
2a SUSPECTED REDUCED RCS AUTHORITY
11 Affected axis?
ROLL
P OR Y
12 Troubleshoot P or Y
• AUTO RCS PITCH A4 & C3 - OFF (YAW D3 & B4)
• AUTO RCS PITCH A3 & C4 - MNA or B (YAW B3 & D4)
• RHC - cmd + & - (in axis)
Motion both directions?
NO
YES
13 Check opposite pair
• AUTO RCS PITCH A4 & C3 - MNA or B (YAW D3 & B4)
• AUTO RCS PITCH A3 & C4 - OFF (YAW B3 & D4)
• RHC - cmd + & -
Motion both directions?
YES
NO
14
• AUTO RCS PITCH A4 & C3 - OFF (YAW D3 & B4)
• AUTO RCS PITCH A3 & C4 - MNA or B (YAW B3 & D4)
• SC CONT - SCS
• MAN ATT - RATE CMD (in axis)
• RHC - cmd + & - (in axis)
Motion both directions?
YES
NO
15 Troubleshoot suspect chan B D (A C)
• AUTO RCS A C ROLL 4 (B D ROLL 4) - OFF
• AUTO RCS B D ROLL B1 & B2 (A C ROLL A1 & A2) - MNA or MNB
• AUTO RCS B D ROLL D1 & D2 (A C ROLL C1 & C2) - OFF
• RHC - cmd + & -
Motion directions?
BOTH
ONE OR NONE
16 Check opposite pair
• AUTO RCS PITCH A4 & C3 - MNA or B (YAW D3 & B4)
• AUTO RCS PITCH A3 & C4 - OFF (YAW B3 & D4)
• SC CONT - SCS
• MAN ATT - RATE CMD (in axis)
• RHC - cmd + & -
Motion both directions?
YES
NO
17 DRIVER LOGIC FAILED CR22 OR 26 OPEN CR67 SHORT
18 DRIVER FAILED OFF
ONE
19 Check orig jet pair
• AUTO RCS B D ROLL B1 & B2 (A C ROLL A1 & A2) - MNA or MNB
• AUTO RCS B D ROLL D1 & D2 (A C ROLL C1 & C2) - OFF
• MAN ATT (3) - RATE CMD
• RHC - cmd + & -
Motion directions?
BOTH
20 Check alt jet pair
• AUTO RCS B D ROLL B1 & B2 (A C ROLL A1 & A2) - OFF
• AUTO RCS B D ROLL D1 & D2 (A C ROLL C1 & C2) - MNA or MNB
• RHC - cmd + & -
Motion directions?
BOTH
ONE
NONE
21 Check alt jet pair
• AUTO RCS B D ROLL B1 & B2 (A C ROLL A1 & A2) - OFF
• AUTO RCS B D ROLL D1 & D2 (A C ROLL C1 & C2) - MNA or MNB
• RHC - cmd + & -
Motion directions?
ONE
BOTH
22 B O LOGIC FAILED OPEN (Q9 OR Q3)
23
• MAN ATT ROLL-RATE CMD
• RHC - cmd + & -
Motion directions?
BOTH
ONE
24 ACCEL CMD INHIBIT LOGIC FAILED (Q2)
25 DRIVER LOGIC FAILED CR22 OR 26 OPEN CR67 SHORT
26 Repeat above steps for alternate quad pair
27 DRIVER FAILED OFF
(1) Lose ACCEL CMD capability with one RHC in affected axis. Use alternate RHC.
(2) Attitude hold unaffected but proportional control, ACCEL CMD, MIN IMP & CMC manual control lost for failed RHC. Direct unaffected but BMAG caging signal lost. Affected RHC can be used for MTVC.
(3) One direction of rotation lost for ACCEL CMD in pitch, yaw, A C roll or B D roll.
(4) ACCEL CMD mode lost for affected jet. Other SCS & G N modes available.
(5) This jet lost for all SCS & G&N control modes except ACCEL CMD. Direct control available.
(6) ACCEL CMD lost for affected axis. RATE CMD, MIN IMP, CMC & direct modes available.
SM-2A-1947H


SYMPTOM
PROCEDURE
REMARKS
SCS
RATE CMD TROUBLESHOOTING ROUTINE
1 Orig symptom - unexpected rates or accel due to jet(s) firings?
YES
NO
1a Cross coupling between axes?
YES
NO
2 Original RHC prop cont check
• AUTO RCS - MNA or MNB (in axis)
• ROT CONTR PWR NORM - AC/DC (original RHC)
• RATE - HIGH
• Original RHC - (small mnvr) cmd + & - (in axis)
Motion in one direction only?
YES
NO
3 Alternate RHC prop cont check
• ROT CONTR PWR NORM (alternate) - AC/DC
• ROT CONTR PWR NORM (orig) - OFF
• Alternate RHC - cmd + & - (small maneuver in axis)
Motion in one direction only?
YES
NO
5 MSFN reports or crew senses translation?
YES
NO
6 DRIVER LOGIC SHORT (CR62)
7 ORIG RHC PROP CONT XDUCER FAILED HARDOVER
SCS 6 1
VEHICLE DYNAMICS OSCILLATING & DIVERGING
4 PROP CONT AMPL FAILED HARDOVER
8 CMC available for troubleshooting?
YES
NO
9 CMC trouble-shooting config
• CMC pwr up if req
• AUTO RCS (16) - OFF
• SC CONT - CMC
• CMC MODE - FREE
• ROT CONTR PWR NORM (both) - AC/DC
• VTT N10E, 31E
17777 in R1?
NO
YES
10 • ROT CONTR PWR NORM 1 - OFF
17777 in R1?
NO
YES
11 RHC NO. 2 B/O SHORT
12 RHC NO. 1 B/O SHORT
13 • ROT CONTR PWR NORM - AC/DC (unaffected RHC)
• ROT CONTR PWR NORM - AC (affected RHC)
14 • Original RHC - cmd + & - (in axis)
• Verify R1 readout
17737 -ROLL
17757 +ROLL
17767 -YAW
17773 +YAW
17775 -PITCH
17776 +PITCH
R1 correct?
NO
YES
15 ORIGINAL RHC B/O OPEN
16 Alternate RHC ck
• Alternate RHC cmd + & - (in axis)
• Verify R1
R1 correct?
NO
YES
17 ALTERNATE RHC B/O OPEN
18 Use unaffected RHC for manual maneuvers
19 • SC CONT - SCS
• AUTO RCS (16) - original config
• Alternate RHC - cmd + & - (in affected axis)
Motion normal?
YES
NO
20 Problem occurred during?
MNVR
ATT HOLD
21 ORIGINAL RHC XDUCER OR DEMOD OPEN
22 Verify
• BMAG MODE - ATT/RATE 2 (in axis)
Att error ind null?
YES
NO
23 BMAG NO. 1 OPEN
24 CSM drifts out of the deadband?
YES
NO
25 ATT LOOP OPEN
26 RHC DC AMP OPEN
27 • ATT DBD - MAX
• FDAI SCALE - 5 1
44
INITIATION OF MNVR
28 Problem occurred during?
ATT HOLD OR TERM.
35
29 Alternate RHC ck
• ROT CONTR PWR NORM (both) - AC/DC
• AUTO RCS (16) - original config
• Alternate RHC - cmd + & - (in affected axis)
Motion normal?
YES
NO
30 • MAN ATT - ACCEL CMD (in axis)
• Original RHC - cmd + & - (in affected axis)
Motion normal?
YES
NO
31 ORIGINAL RHC XDUCER OR DEMOD OPEN
32 ORIGINAL RHC B/O SWITCH OPEN
33 CSM drifts out of the deadband?
YES
NO
34 RHC DC AMP OPEN
44
1 Assumes full thruster operation except in roll.
2 Assumes RCS thrusters fail on where identified in the "A" flow.
3 Failure causes translation when rotation cmds given. Attitude hold RATE CMD & MIN IMP lost in one direction for affected axis (pitch, yaw, A/C roll, B/D roll). Translation without attitude hold possible with MAN ATT - MIN IMP.
4 For PROP CONT AMP failed hardover, MTVC and RATE CMD lost in affected axis. Attitude hold possible if RHC's locked (or neutral) or if ROT CONTR PWR NORM (both) - OFF. Disable thrusters in affected axis if direct used.
5 Direct sws in affected RHC still functional. One RHC lost; however, RATE CMD mode in failed RHC still possible when breakout switches closed in same axis by operable RHC. MTVC ok when ROT CONTR PWR NORM (affected RHC) is at AC
6 Attitude hold unaffected but prop cont, ACCEL CMD, MIN IMP & CMC man cont lost for failed RHC. Direct unaffected but BMAG caging signal lost. Affected RHC can be used for MTVC.
7 SCS prop cont & MTVC lost for failed RHC.
8 For affected axis: In ATT 1 RATE 2, att hold & att error display lost. SCS auto ΔV possible if roll, by controlling attitude manually. After .05 G, SCS FDAI roll attitude erroneous if yaw or roll.
9 Attitude hold capability lost in affected axis. SCS auto ΔV lost if pitch or yaw, but possible if roll by placing MAN ATT ROLL - ACCEL CMD.
10 SCS prop cont & MTVC lost for both RHCs.
SM-2A-1950C

SYMPTOM	PROCEDURE	REMARKS



(11) Attitude hold capability lost in affected axis. SCS auto ΔV lost if pitch or yaw, but possible if roll by placing MAN ATT ROLL - ACCEL CMD.

(12) For affected axis: In ATT 1 RATE 2, att hold & att error display lost. SCS auto ΔV possible if roll, by controlling att manually. After .05 G, SCS FDAI roll attitude erroneous if yaw or roll.

(13) Direct sws in affected RHC still functional. One RHC lost; however, RATE CMD mode in failed RHC still possible when breakout switches closed in same axis by operable RHC. MTVC ok when ROT CONTR PWR NORM (affected RHC) is at AC.

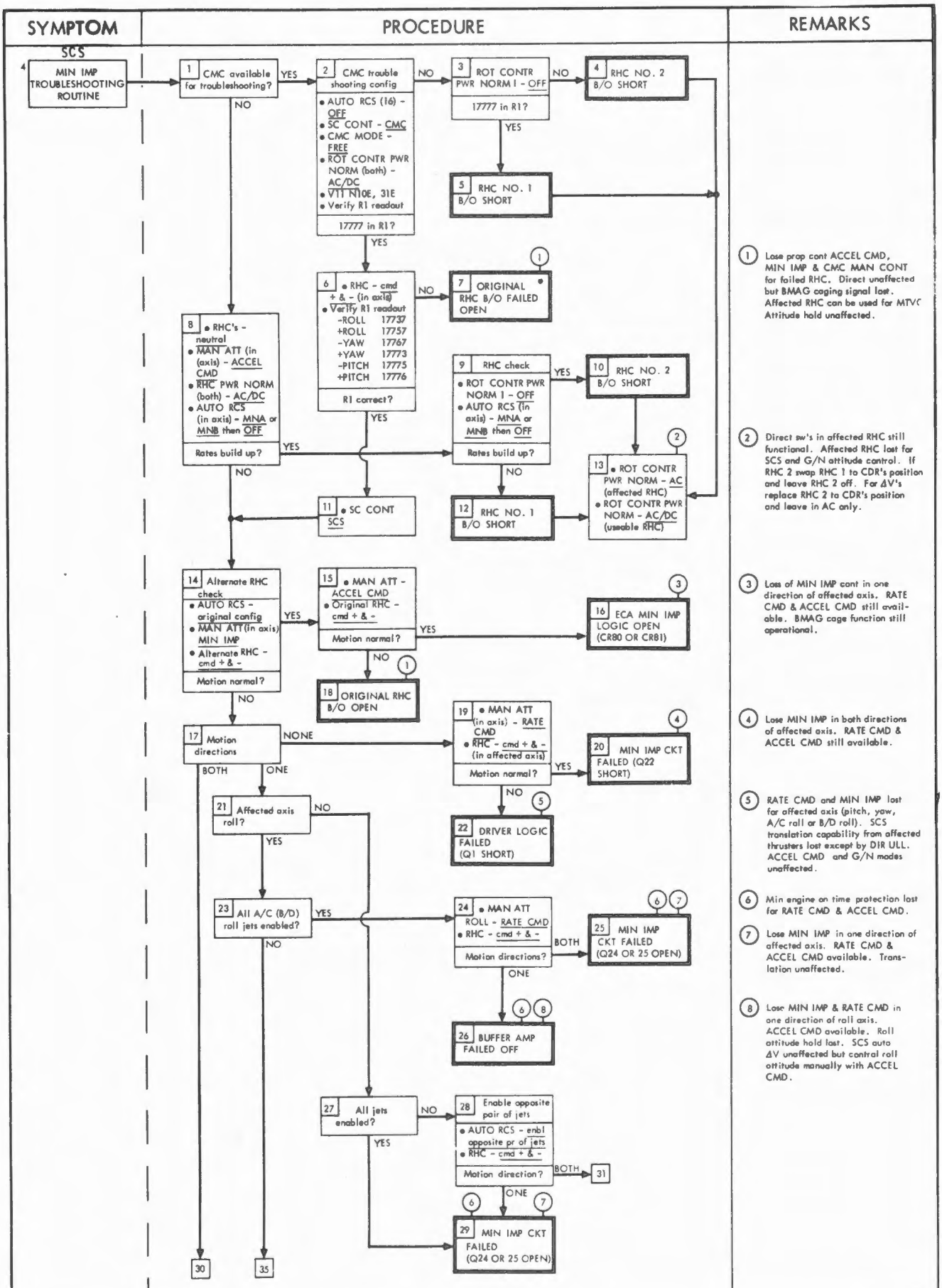
(14) All RATE CMD & attitude hold capability lost for affected axis. Translation possible with MAN ATT sw in RATE CMD & attitude control in affected axis by direct or MIN IMP.

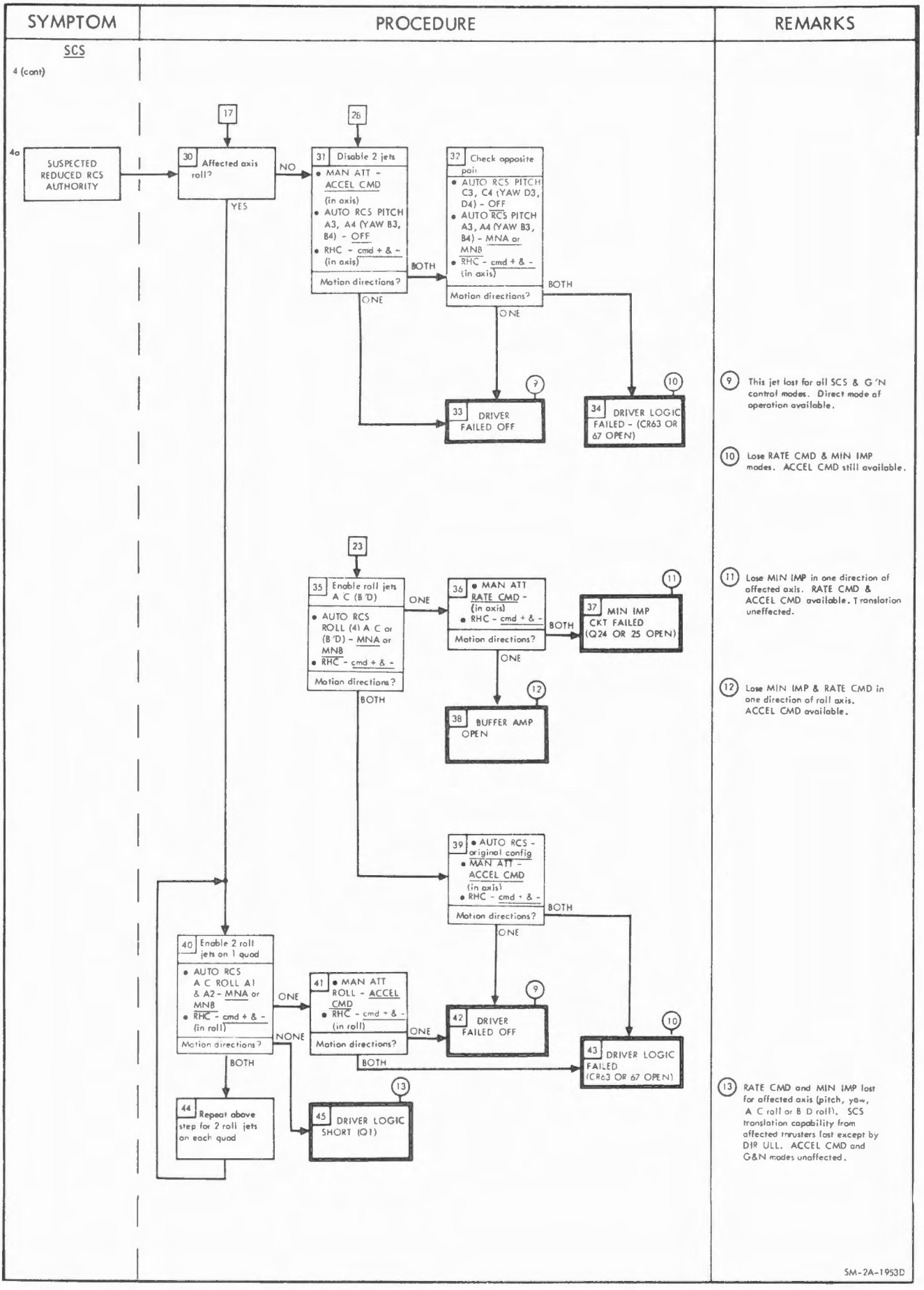
(15) Lose all SCS modes except ACCEL CMD. No Translation on affected axis. Direct control available.

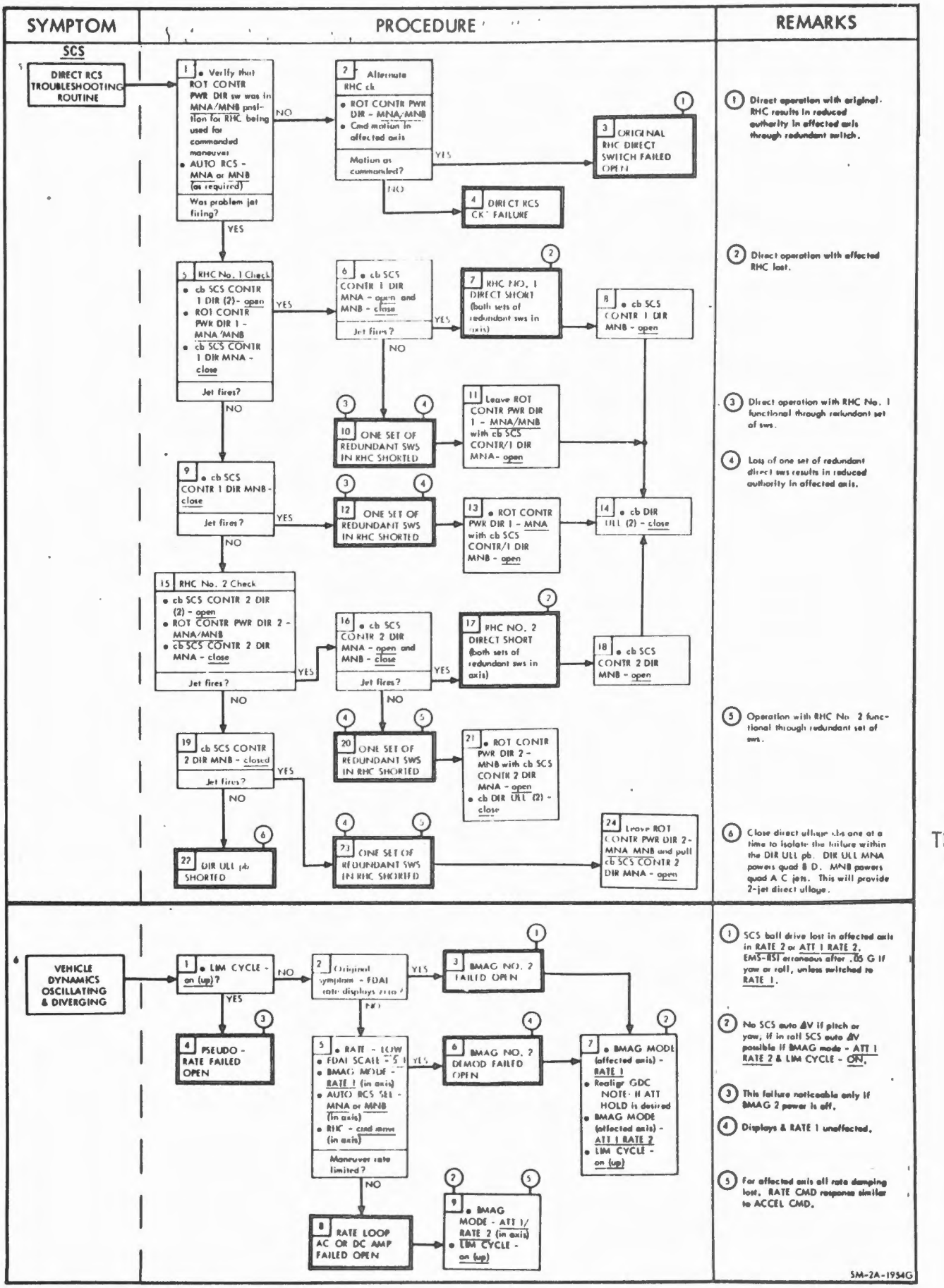
(16) One polarity lost in RATE CMD & MIN IMP. Translation capability remains but attitude hold lost.

3a

SM-2A-195IC

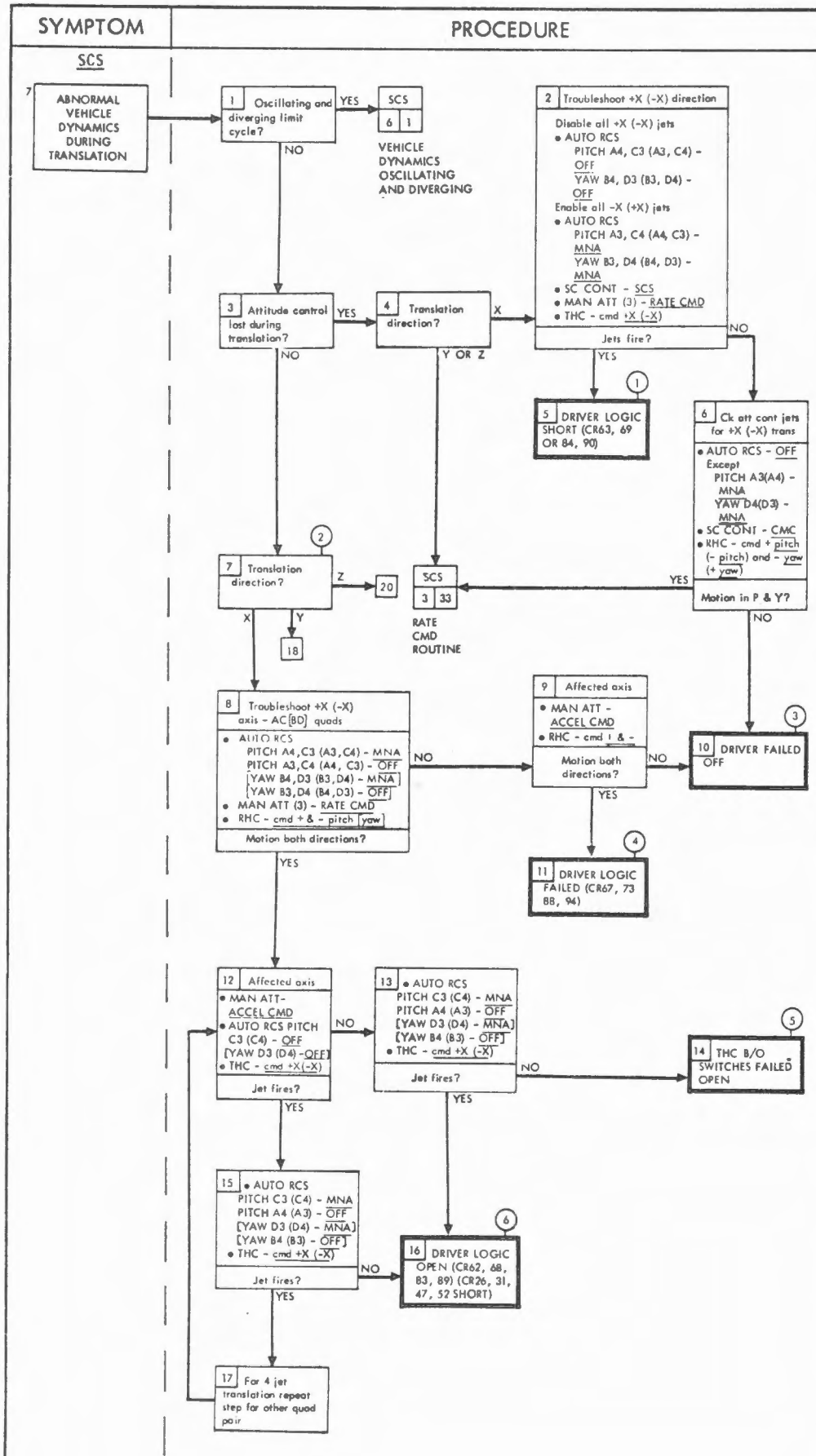

SYMPTOM
PROCEDURE
REMARKS
SCS
4 MIN IMP TROUBLESHOOTING ROUTINE
1 CMC available for troubleshooting?
YES
NO
2 CMC trouble shooting config
• AUTO RCS (16) - OFF
• SC CONT - CMC
• CMC MODE - FREE
• ROT CONTR PWR NORM (both) - AC/DC
• VTI N10E, 31E
• Verify R1 readout
17777 in R1?
NO
3 ROT CONTR PWR NORM 1 - OFF
17777 in R1?
NO
4 RHC NO. 2 B/O SHORT
YES
5 RHC NO. 1 B/O SHORT
6 • RHC - cmd + & - (in axis)
• Verify R1 readout
-ROLL 17737
+ROLL 17757
-YAW 17767
+YAW 17773
-PITCH 17775
+PITCH 17776
R1 correct?
NO
7 ORIGINAL RHC B/O FAILED OPEN
1
8 • RHC's - neutral
• MAN ATT (in (axis) - ACCEL CMD
• RHC PWR NORM (both) - AC/DC
• AUTO RCS (in axis) - MNA or MNB then OFF
Rates build up?
YES
NO
9 RHC check
• ROT CONTR PWR NORM 1 - OFF
• AUTO RCS (in axis) - MNA or MNB then OFF
Rates build up?
YES
10 RHC NO. 2 B/O SHORT
NO
12 RHC NO. 1 B/O SHORT
2
13 • ROT CONTR PWR NORM - AC (affected RHC)
• ROT CONTR PWR NORM - AC/DC (unusable RHC)
11 • SC CONT SCS
14 Alternate RHC check
• AUTO RCS - original config
• MAN ATT (in axis) MIN IMP
• Alternate RHC - cmd + & -
Motion normal?
YES
NO
15 • MAN ATT - ACCEL CMD
• Original RHC - cmd + & -
Motion normal?
YES
3
16 ECA MIN IMP LOGIC OPEN (CR80 OR CR81)
NO
1
18 ORIGINAL RHC B/O OPEN
17 Motion directions
NONE
BOTH
ONE
19 • MAN ATT (in axis) - RATE CMD
• RHC - cmd + & - (in affected axis)
Motion normal?
YES
4
20 MIN IMP CKT FAILED (Q22 SHORT)
NO
5
22 DRIVER LOGIC FAILED (Q1 SHORT)
21 Affected axis roll?
NO
YES
23 All A/C (B/D) roll jets enabled?
YES
NO
24 • MAN ATT ROLL - RATE CMD
• RHC - cmd + & -
Motion directions?
BOTH
ONE
6 7
25 MIN IMP CKT FAILED (Q24 OR 25 OPEN)
6 8
26 BUFFER AMP FAILED OFF
27 All jets enabled?
NO
YES
28 Enable opposite pair of jets
• AUTO RCS - enbl opposite pr of jets
• RHC - cmd + & -
Motion direction?
BOTH
31
ONE
6
7
29 MIN IMP CKT FAILED (Q24 OR 25 OPEN)
30
35
1 Lose prop cont ACCEL CMD, MIN IMP & CMC MAN CONT for failed RHC. Direct unaffected but BMAG caging signal lost. Affected RHC can be used for MTVC Attitude hold unaffected.
2 Direct sw's in affected RHC still functional. Affected RHC lost for SCS and G/N attitude control. If RHC 2 swap RHC 1 to CDR's position and leave RHC 2 off. For ΔV's replace RHC 2 to CDR's position and leave in AC only.
3 Loss of MIN IMP cont in one direction of affected axis. RATE CMD & ACCEL CMD still available. BMAG cage function still operational.
4 Lose MIN IMP in both directions of affected axis. RATE CMD & ACCEL CMD still available.
5 RATE CMD and MIN IMP lost for affected axis (pitch, yaw, A/C roll or B/D roll). SCS translation capability from affected thrusters lost except by DIR ULL. ACCEL CMD and G/N modes unaffected.
6 Min engine on time protection lost for RATE CMD & ACCEL CMD.
7 Lose MIN IMP in one direction of affected axis. RATE CMD & ACCEL CMD available. Translation unaffected.
8 Lose MIN IMP & RATE CMD in one direction of roll axis. ACCEL CMD available. Roll attitude hold lost. SCS auto ΔV unaffected but control roll attitude manually with ACCEL CMD.
SM-2A-1952D


SYMPTOM
PROCEDURE
REMARKS
SCS
4 (cont)
4a
SUSPECTED REDUCED RCS AUTHORITY
30 Affected axis roll?
NO
YES
17
26
31 Disable 2 jets
• MAN ATT - ACCEL CMD (in axis)
• AUTO RCS PITCH A3, A4 (YAW B3, B4) - OFF
• RHC - cmd + & - (in axis)
Motion directions?
BOTH
ONE
32 Check opposite pair
• AUTO RCS PITCH C3, C4 (YAW D3, D4) - OFF
• AUTO RCS PITCH A3, A4 (YAW B3, B4) - MNA or MNB
• RHC - cmd + & - (in axis)
Motion directions?
BOTH
ONE
33 DRIVER FAILED OFF
34 DRIVER LOGIC FAILED - (CR63 OR 67 OPEN)
9 This jet lost for all SCS & G'N control modes. Direct mode of operation available.
10 Lose RATE CMD & MIN IMP modes. ACCEL CMD still available.
23
35 Enable roll jets A C (B D)
• AUTO RCS ROLL (4) A C or (B D) - MNA or MNB
• RHC - cmd + & -
Motion directions?
ONE
BOTH
36 • MAN ATT RATE CMD - (in axis)
• RHC - cmd + & -
Motion directions?
BOTH
ONE
37 MIN IMP CKT FAILED (Q24 OR 25 OPEN)
38 BUFFER AMP OPEN
11 Lose MIN IMP in one direction of affected axis. RATE CMD & ACCEL CMD available. Translation uneffected.
12 Lose MIN IMP & RATE CMD in one direction of roll axis. ACCEL CMD available.
39 • AUTO RCS - original config
• MAN ATT - ACCEL CMD (in axis)
• RHC - cmd + & -
Motion directions?
BOTH
ONE
40 Enable 2 roll jets on 1 quad
• AUTO RCS A C ROLL A1 & A2 - MNA or MNB
• RHC - cmd + & - (in roll)
Motion directions?
ONE
NONE
BOTH
41 • MAN ATT ROLL - ACCEL CMD
• RHC - cmd + & - (in roll)
Motion directions?
ONE
BOTH
42 DRIVER FAILED OFF
43 DRIVER LOGIC FAILED (CR63 OR 67 OPEN)
44 Repeat above step for 2 roll jets on each quad
45 DRIVER LOGIC SHORT (Q1)
13 RATE CMD and MIN IMP lost for affected axis (pitch, yaw, A C roll or B D roll). SCS translation capability from affected thrusters lost except by DIR ULL. ACCEL CMD and G&N modes unaffected.
SM-2A-1953D


SYMPTOM
PROCEDURE
REMARKS
SCS
DIRECT RCS TROUBLESHOOTING ROUTINE
1 • Verify that ROT CONTR PWR DIR sw was in MNA/MNB position for RHC being used for commanded maneuver • AUTO RCS - MNA or MNB (as required) Was problem jet firing?
NO
2 Alternate RHC cb • ROT CONTR PWR DIR - MNA/MNB • Cmd motion in affected axis Motion as commanded?
YES
3 ORIGINAL RHC DIRECT SWITCH FAILED OPEN
NO
4 DIRECT RCS CK FAILURE
YES
5 RHC No. 1 Check • cb SCS CONTR 1 DIR (2) - open • ROT CONTR PWR DIR 1 - MNA/MNB • cb SCS CONTR 1 DIR MNA - close Jet fires?
YES
6 • cb SCS CONTR 1 DIR MNA - open and MNB - close Jet fires?
YES
7 RHC NO. 1 DIRECT SHORT (both sets of redundant sws in axis)
8 • cb SCS CONTR 1 DIR MNB - open
NO
10 ONE SET OF REDUNDANT SWS IN RHC SHORTED
11 Leave ROT CONTR PWR DIR 1 - MNA/MNB with cb SCS CONTR/1 DIR MNA - open
9 • cb SCS CONTR 1 DIR MNB - close Jet fires?
YES
12 ONE SET OF REDUNDANT SWS IN RHC SHORTED
13 • ROT CONTR PWR DIR 1 - MNA with cb SCS CONTR/1 DIR MNB - open
14 • cb DIR ULL (2) - close
NO
15 RHC No. 2 Check • cb SCS CONTR 2 DIR (2) - open • ROT CONTR PWR DIR 2 - MNA/MNB • cb SCS CONTR 2 DIR MNA - close Jet fires?
YES
16 • cb SCS CONTR 2 DIR MNA - open and MNB - close Jet fires?
YES
17 RHC NO. 2 DIRECT SHORT (both sets of redundant sws in axis)
18 • cb SCS CONTR 2 DIR MNB - open
NO
19 cb SCS CONTR 2 DIR MNB - closed Jet fires?
YES
NO
20 ONE SET OF REDUNDANT SWS IN RHC SHORTED
21 • ROT CONTR PWR DIR 2 - MNB with cb SCS CONTR 2 DIR MNA - open • cb DIR ULL (2) - close
22 DIR ULL pb SHORTED
23 ONE SET OF REDUNDANT SWS IN RHC SHORTED
24 Leave ROT CONTR PWR DIR 2 - MNA MNB and pull cb SCS CONTR 2 DIR MNA - open
(1) Direct operation with original RHC results in reduced authority in affected axis through redundant switch.
(2) Direct operation with affected RHC lost.
(3) Direct operation with RHC No. 1 functional through redundant set of sws.
(4) Loss of one set of redundant direct sws results in reduced authority in affected axis.
(5) Operation with RHC No. 2 functional through redundant set of sws.
(6) Close direct ullage cbs one at a time to isolate the failure within the DIR ULL pb. DIR ULL MNA powers quad B D. MNB powers quad A C jets. This will provide 2-jet direct ullage.
VEHICLE DYNAMICS OSCILLATING & DIVERGING
1 • LIM CYCLE - on (up)?
NO
2 Original symptom - FDAI rate displays zero?
YES
3 BMAG NO. 2 FAILED OPEN
NO
YES
4 PSEUDO - RATE FAILED OPEN
5 • RATE - LOW • FDAI SCALE - 5 ° • BMAG MODE - RATE 1 (in axis) • AUTO RCS SEL - MNA or MNB (in axis) • RHC - cmd rmvd (in axis) Maneuver rate limited?
YES
6 BMAG NO. 2 DEMOD FAILED OPEN
7 • BMAG MODE (affected axis) - RATE 1 • Realign GDC NOTE: If ATT HOLD is desired • BMAG MODE (affected axis) - ATT 1 RATE 2 • LIM CYCLE - on (up)
NO
8 RATE LOOP AC OR DC AMP FAILED OPEN
9 • BMAG MODE - ATT 1/ RATE 2 (in axis) • LIM CYCLE - on (up)
(1) SCS ball drive lost in affected axis in RATE 2 or ATT 1 RATE 2. EMS-RSI erroneous after .05 G if yaw or roll, unless switched to RATE 1.
(2) No SCS auto ΔV if pitch or yaw; if in roll SCS auto ΔV possible if BMAG mode - ATT 1 RATE 2 & LIM CYCLE - ON.
(3) This failure noticeable only if BMAG 2 power is off.
(4) Displays & RATE 1 unaffected.
(5) For affected axis all rate damping lost, RATE CMD response similar to ACCEL CMD.
SM-2A-1954G

5 THR 6

SYMPTOM	PROCEDURE	REMARKS



(1) This failure causes translation jets opposite to selected direction to fire. Attitude control during translations will be lost in one axis (pitch or yaw). For + or -X trans, disable thrusters in affected axis and control attitude with direct. (Translations will be 2 jet.) Or for +X trans, use DIR ULL and control attitude with direct.

(2) If CMC is available, operation of B/O switches in THC may be checked per G&N 3 step 1.

(3) All auto coil capability lost for this thruster. Direct available.

(4) Affected jet lost for SCS RATE CMD, MIN IMP and auto coil translations. ACCEL CMD and G&N modes unaffected.

(5) Translation capability lost in affected axis. If problem is in the +X axis, direct ullage capability remains.

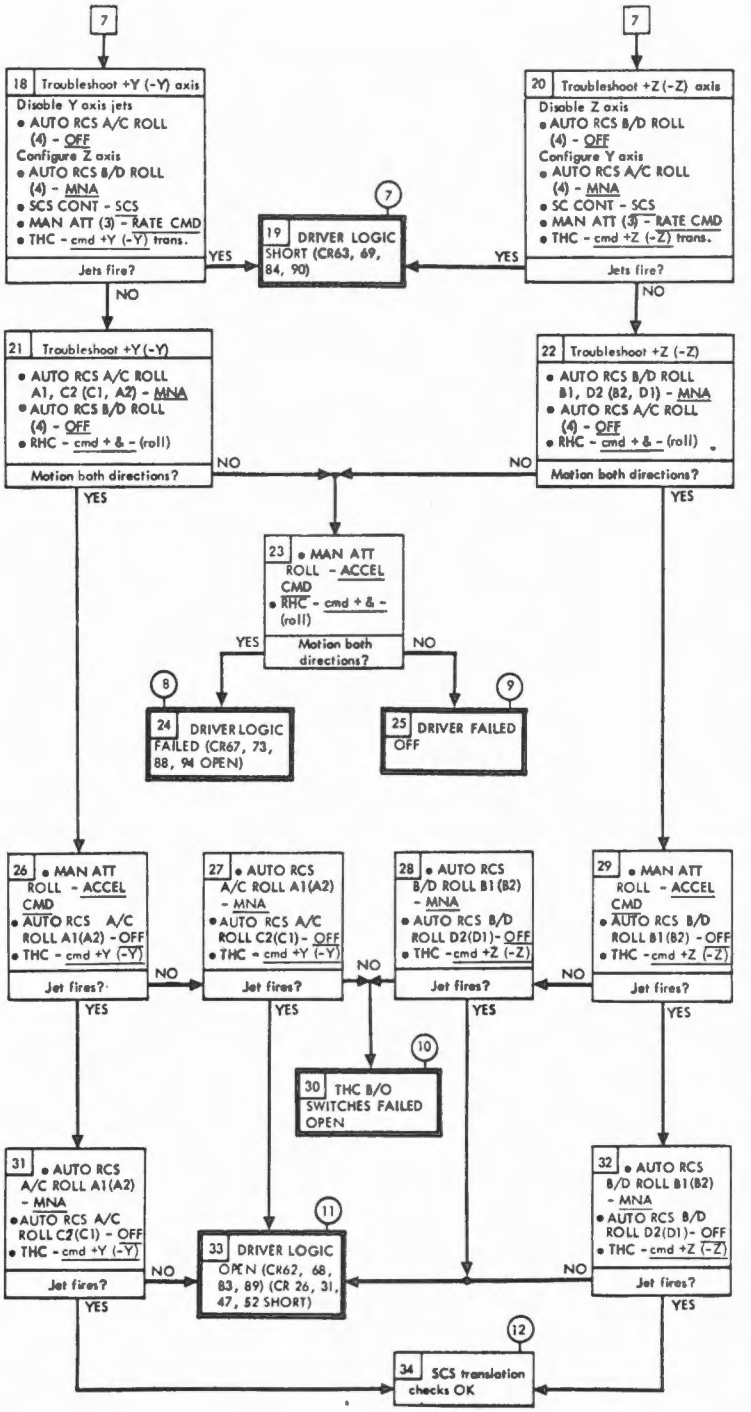
(6) Affected jet lost for all auto-coil translations. Rotation capability unaffected.

7

SYMPTOM	PROCEDURE	REMARKS

SCS

7 (Cont)



(7) One direction of Y or Z translation lost.

(8) Affected jet lost for SCS RATE CMD, MIN IMP and auto coil translations. ACCEL CMD and G/N modes unaffected.

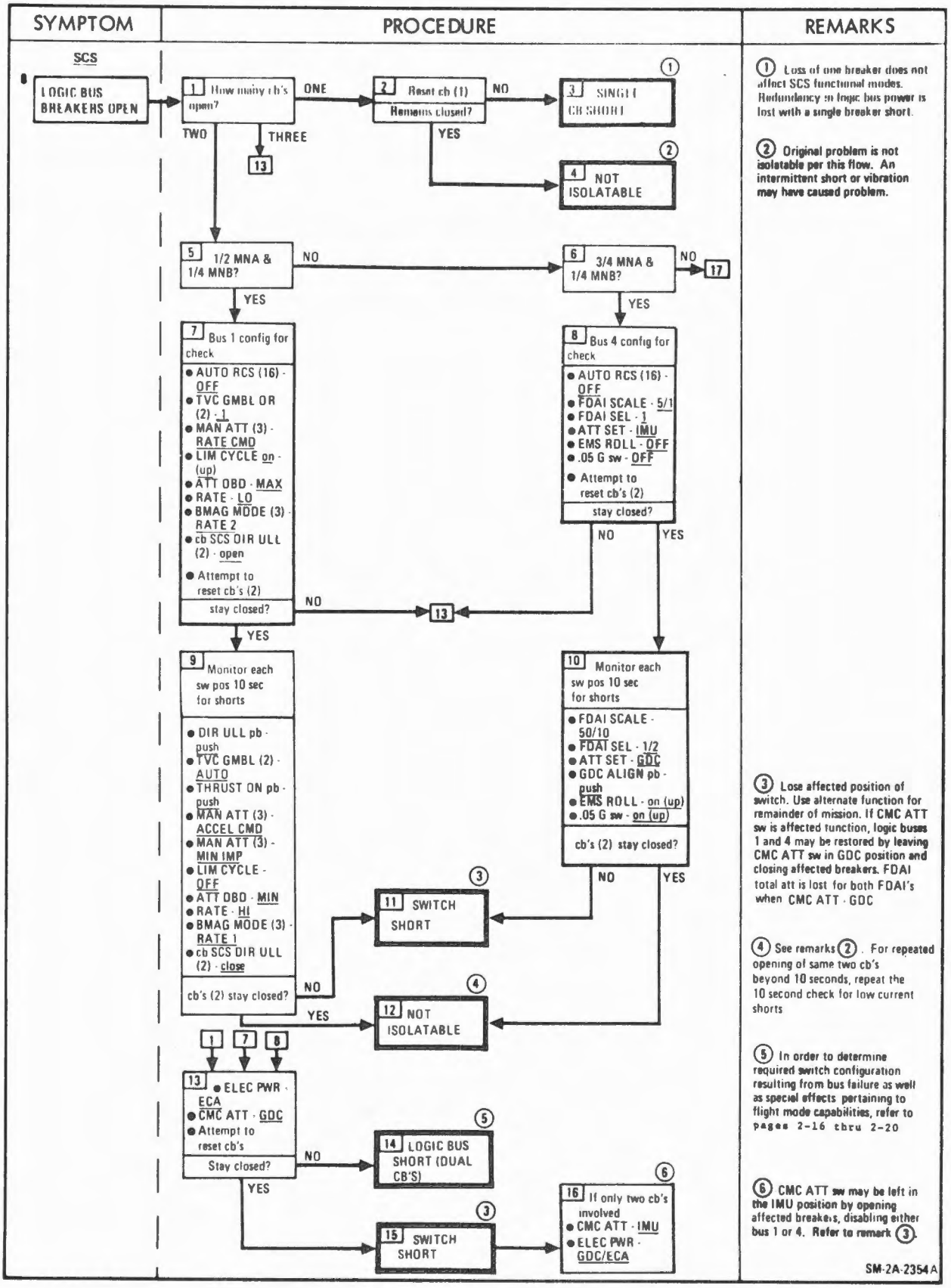
(9) All auto coil capability lost for this thruster. Direct available.

(10) Translation capability lost in affected axis. If problem is in the +X axis, direct ullage capability remains.

(11) Affected jet lost for all auto-coil translations. Rotation capability unaffected.

(12) Abnormal dynamics may be due to thruster degradation.

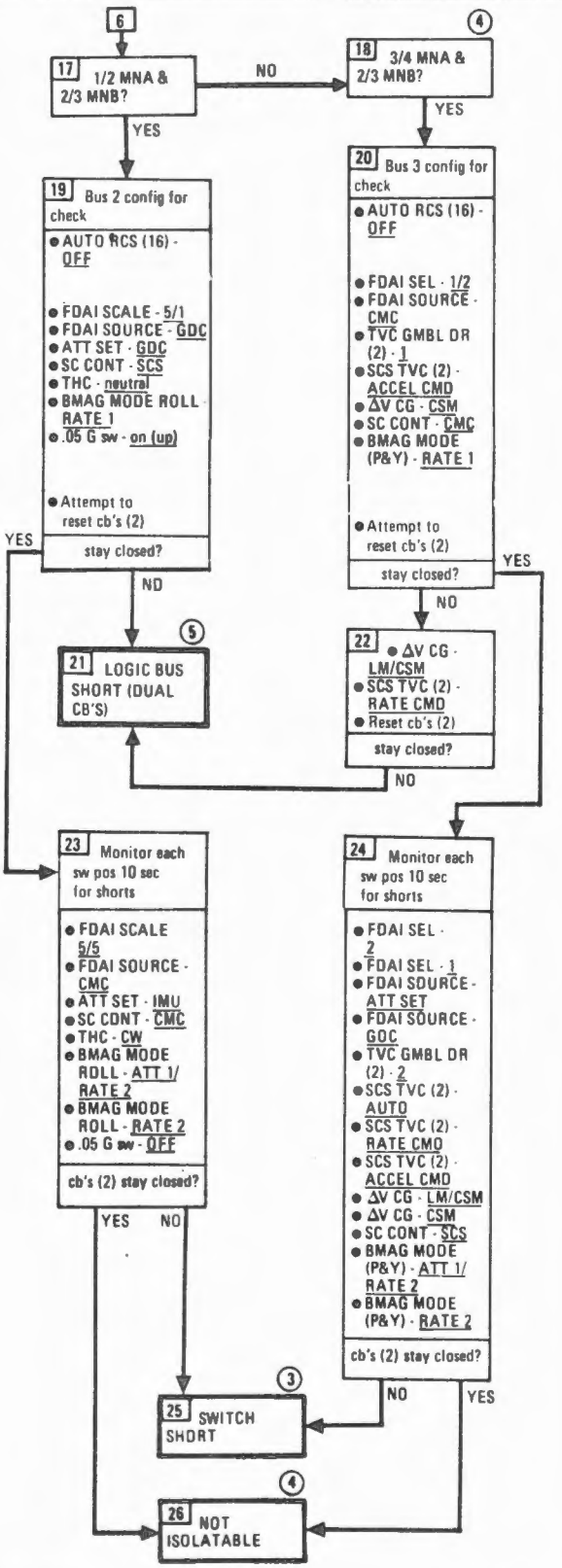
7 (CONT


SYMPTOM
PROCEDURE
REMARKS
SCS
LOGIC BUS BREAKERS OPEN
1 How many cb's open?
ONE
TWO
THREE
2 Reset cb (1) Remains closed?
NO
YES
3 SINGLE CB SHORT
4 NOT ISOLATABLE
13
5 1/2 MNA & 1/4 MNB?
NO
YES
6 3/4 MNA & 1/4 MNB?
NO
17
YES
7 Bus 1 config for check
• AUTO RCS (16) - OFF
• TVC GMBL OR (2) - 1
• MAN ATT (3) - RATE CMD
• LIM CYCLE on - (up)
• ATT OBD - MAX
• RATE - LO
• BMAG MODE (3) - RATE 2
• cb SCS DIR ULL (2) - open
• Attempt to reset cb's (2)
stay closed?
NO
YES
8 Bus 4 config for check
• AUTO RCS (16) - OFF
• FDAI SCALE - 5/1
• FDAI SEL - 1
• ATT SET - IMU
• EMS RDLL - OFF
• .05 G sw - OFF
• Attempt to reset cb's (2)
stay closed?
NO
YES
9 Monitor each sw pos 10 sec for shorts
• DIR ULL pb - push
• TVC GMBL (2) - AUTO
• THRUST ON pb - push
• MAN ATT (3) - ACCEL CMD
• MAN ATT (3) - MIN IMP
• LIM CYCLE - OFF
• ATT OBD - MIN
• RATE - HI
• BMAG MODE (3) - RATE 1
• cb SCS DIR ULL (2) - close
cb's (2) stay closed?
NO
YES
10 Monitor each sw pos 10 sec for shorts
• FDAI SCALE - 50/10
• FDAI SEL - 1/2
• ATT SET - GDC
• GDC ALIGN pb - push
• EMS RDLL - on (up)
• .05 G sw - on (up)
cb's (2) stay closed?
NO
YES
11 SWITCH SHORT
12 NOT ISOLATABLE
1 7 8
13 • ELEC PWR - ECA
• CMC ATT - GDC
• Attempt to reset cb's
Stay closed?
NO
YES
14 LOGIC BUS SHORT (DUAL CB'S)
15 SWITCH SHORT
16 If only two cb's involved
• CMC ATT - IMU
• ELEC PWR - GDC/ECA
(1) Loss of one breaker does not affect SCS functional modes. Redundancy in logic bus power is lost with a single breaker short.
(2) Original problem is not isolatable per this flow. An intermittent short or vibration may have caused problem.
(3) Lose affected position of switch. Use alternate function for remainder of mission. If CMC ATT sw is affected function, logic buses 1 and 4 may be restored by leaving CMC ATT sw in GDC position and closing affected breakers. FDAI total att is lost for both FDAI's when CMC ATT - GDC
(4) See remarks (2). For repeated opening of same two cb's beyond 10 seconds, repeat the 10 second check for low current shorts
(5) In order to determine required switch configuration resulting from bus failure as well as special effects pertaining to flight mode capabilities, refer to pages 2-16 thru 2-20
(6) CMC ATT sw may be left in the IMU position by opening affected breakers, disabling either bus 1 or 4. Refer to remark (3).
SM-2A-2354A

SYMPTOM	PROCEDURE	REMARKS

SCS (Cont)

8



SM-2A-2355A

8 (CON

CONTROL	SCS LOGIC BUS POWER LOSS							
	BUS 1		BUS 2		BUS 3		BUS 4	
	FUNCTION(S) LOST	CORRECTIVE ACTION SELECT	FUNCTION(S) LOST	CORRECTIVE ACTION SELECT	FUNCTION(S) LOST	CORRECTIVE ACTION SELECT	FUNCTION(S) LOST	CORRECTIVE ACTION SELECT
FDAI SCALE			5/5	5/1 50/15			50/15	5/5 5/1
FDAI SEL					1 & 2	1/2	1/2	1 2
FDAI SOURCE			CMC	GDC	ATT SET GDC	CMC		
ATT SET			IMU	GDC			GDC	IMU
MAN ATT (3)	ACCEL CMD MIN IMP	RATE CMD						
LIM CYCLE	OFF	on (up)						
ATT DBD	MIN	MAX						
RATE	HI	LO						
THC			CW	neutral				
SC CONT			CMC	CMC	SCS	CMC		
BMAG MODE (3)	RATE 1	ATT 1/RATE 2 RATE 2	(R) RATE 2 ATT 1/RATE 2	(R) RATE 1	(P,Y) RATE 2 ATT 1/RATE 2	(P,Y) RATE 1		
DIR ULL pb	push (logic only)	———						
THRUST ON pb	push							
GDC ALIGN							push	———
SCS TVC (2)					all	———		
ΔVCG					LM/CSM	CSM		
EMS ROLL							on (up)	OFF
.05 G sw			OFF	OFF			.05 G	OFF
TVC GMBL DR (2)	AUTO	1 2			2	1 AUTO		

SCS Logic Bus Power Loss

SM-2A-2409

MODE EFFECT	BUS 1 LOSS	BUS 2 LOSS	BUS 3 LOSS	BUS 4 LOSS
CMC CONTROL MODE (SC CONT - CMC)	• No affect	• CMC attitude control may exist since G&N power not affected by LOGIC BUS 2 short	• No affect	• No affect
RCS CONTROL	Direct RCS: • Operational including direct ullage	Direct RCS: • Operational including direct ullage	Direct RCS: • Operational including direct ullage	Direct RCS: • Operational including direct ullage
	SCS/SM RCS: • Control modes restricted to positions shown for BUS 1 corrective action, page 2-16	SCS/SM RCS: • P & Y not affected • For manual roll BMAG MODE (R) - RATE 1 MAN ATT (R) - RATE CMD, ACCEL CMD or MIN IMP • For SCS att hold (R) BMAG MODE (R) - ATT 1/RATE 2 LIM CYCLE - on (up)	SCS SM/CM RCS: • MAN ATT (3) - ACCEL CMD operational (CMC or SCS) • MAN ATT (3) - MIN IMP operational if THC - CW • MAN ATT (R) - RATE CMD operational if THC-CW & SC CONT - CMC • MAN ATT (P,Y) - RATE CMD operational if THC-CW & BMAG MODE - RATE 1 or ATT 1/RATE 2 & LIM CYCLE - on (up)	SCS/SM RCS: • No affect
	SCS/CM RCS: • Use direct RCS only • Disable auto RCS RCS CMD - OFF or AUTO RCS (12) - OFF • Use single ring only	SCS/CM RCS: • P & Y not affected • Roll axis BMAG MODE (R) - RATE 1 MAN ATT (R) - RATE CMD or ACCEL CMD • .05 G function operational		SCS/CM RCS: • Roll to yaw coupling loss for post .05 G

SCS Logic Bus Power Loss (Special Effects) SM-2A-2410

MODE EFFECT	BUS 1 LOSS	BUS 2 LOSS	BUS 3 LOSS	BUS 4 LOSS
SPS CONTROL	Gimbal Control: • SCS auto TVC functional • MTVC rate cmd functional with: BMAG MODE (P,Y) - ATT 1/RATE 2 or RATE 2 • No direct ullage (for logic) • ACCEL CMD operational • THC-CW operational • If servo 1 failure TVC GMBL DR (2) - 2	Gimbal Control: • SC CONT - CMC (simultaneous CMC & SCS TVC occurs) • CMC ΔV capability exists if: SCS TVC (2) - ACCEL CMD SCS trim to 0.0° • Auto switchover function lost - switch to 2 by TVC GMBL DR (2) - 2	Gimbal Control: • SCS auto TVC lost • MTVC - Rate cmd operational with RATE 1 only • Accel cmd operational with RATE 2 (P,Y) • Manual switch to servo 2 with TVC GMBL DR - 2 is lost - Use: TVC GMBL DR (2) - AUTO THC-CW	Gimbal Control: • No affect
	Thrust on/off: • CMC thrust on not affected • Ullage - THC +X or DIR ULL as backup (no direct ullage for logic function) • SCS thrust on SPS THRUST - on (up) only • SCS thrust termination ΔV THRUST A (B) - OFF	Thrust on/off: • No affect	Thrust on/off: • CMC thrust on not affected • THRUST ON pb operational if THC-CW • ΔV ind operational (for thrust termination)	Thrust on/off: • No affect

SCS Logic Bus Power Loss (Special Effects)

SM-2A-2411

MODE EFFECT	BUS 1 LOSS	BUS 2 LOSS	BUS 3 LOSS	BUS 4 LOSS
THC	• No affect	• THC-CW function lost - use SC CONT - SCS	• No affect	• No affect
DISPLAYS	Pre/Post .05 G: • All displays operational except RATE 1 (No source for rate display or for att ref)	Pre- .05 G: • FDAI SEL - 1/2 operational except (ball 2) att error • CMC source (ball 1) operational except CDU error • Total att, att error (ball 2) lost if: FDAI SOURCE - CMC FDAI SEL - 2 • Att error lost if: FDAI SOURCE - ATT SET ATT SET - IMU • FDAI SCALE - 5/5 lost • Yaw rate display indicates roll coupling • R & P rate display normal • BMAG R, P, Y att error (ball 2) lost if: FDAI SEL - 1/2 or FDAI SOURCE - GDC	Pre/Post .05 G: • FDAI SEL - 1/2 operational • FDAI SEL - 1 & 2 lost (for both CMC or GDC) • FDAI SOURCE - ATT SET function lost • All displays (rate, att error, total att) valid for FDAI SEL - 1/2 only • BMAG 1 & 2 rate valid	Pre/Post .05 G: • FDAI SCALE - 50/15 lost • FDAI SEL - 1 or 2 only • FDAI SOURCE - CMC or GDC operational • GDC & RSI align lost

SCS Logic Bus Power Loss (Special Effects)

SM-2A-2412

MODE EFFECT	BUS 1 LOSS	BUS 2 LOSS	BUS 3 LOSS	BUS 4 LOSS
		Post .05 G: • FDAI SEL - 1/2 operational • Ball 1 - CMC source operational • Ball 2 - CMC source lost • SCS - total att, rate display, att errors normal		Post .05 G: • Display of roll to yaw coupling not void (actual coupling does not exist)

SCS Logic Bus Power Loss (Special Effects)

SM-2A-2413

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G & N MALFUNCTION INDEX

1 RCS FAILED ON

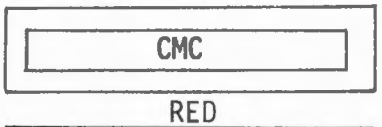
2 RHC TROUBLESHOOTING ROUTINE

2a CMC AUTO TROUBLESHOOTING ROUTINE

2b SUSPECTED REDUCED RCS AUTHORITY

3 THC TROUBLESHOOTING ROUTINE

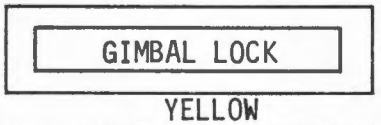
4 MIN IMP CONT TROUBLESHOOTING ROUTINE

5 

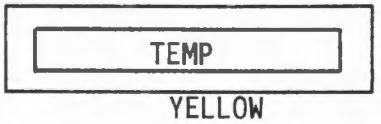
RED

6 

RED

7 

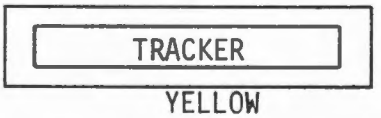
YELLOW

8 

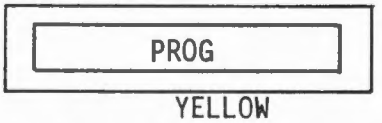
YELLOW

9 

YELLOW

10 

YELLOW

11 

YELLOW

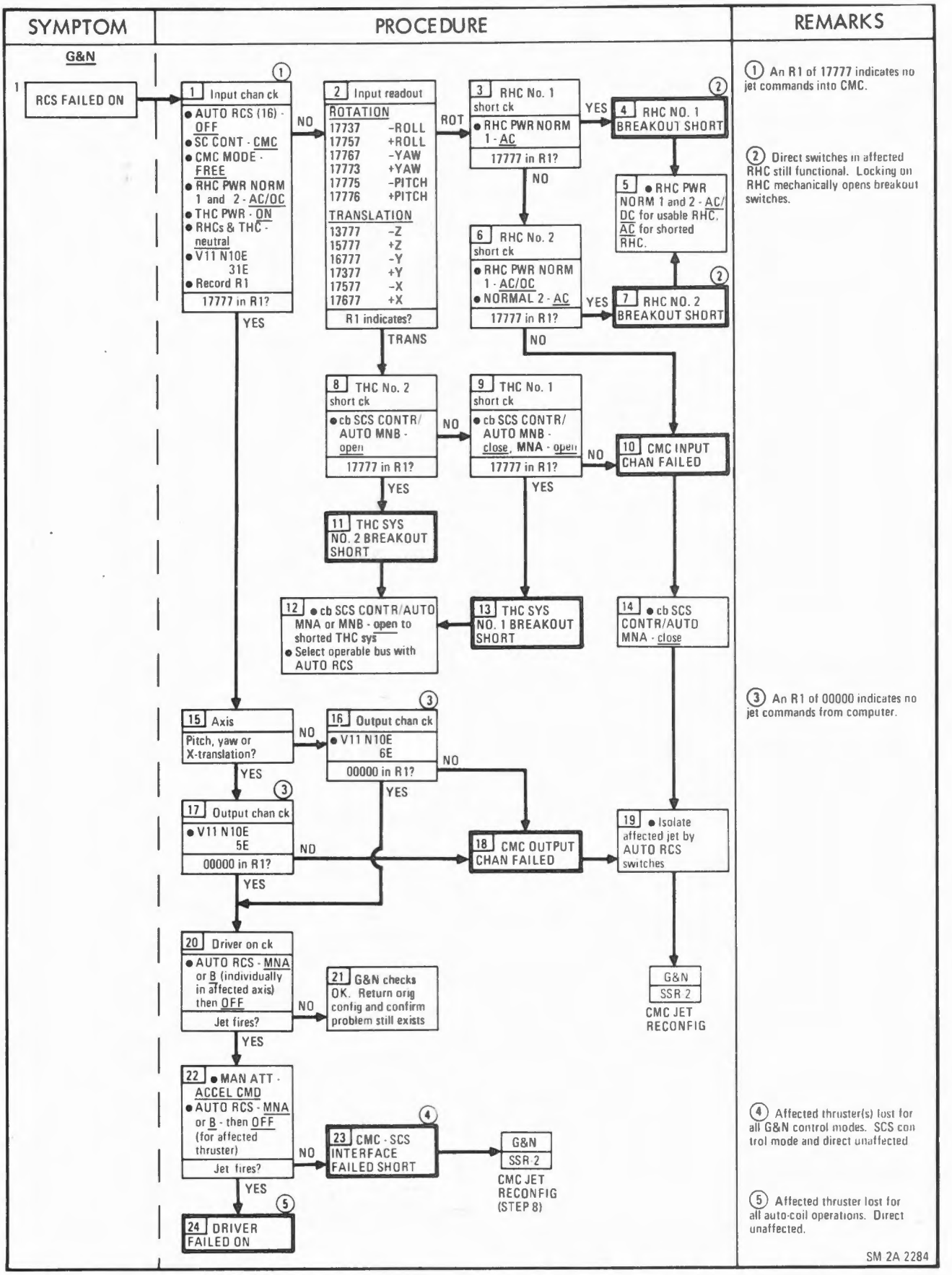
12 ALARM CODES

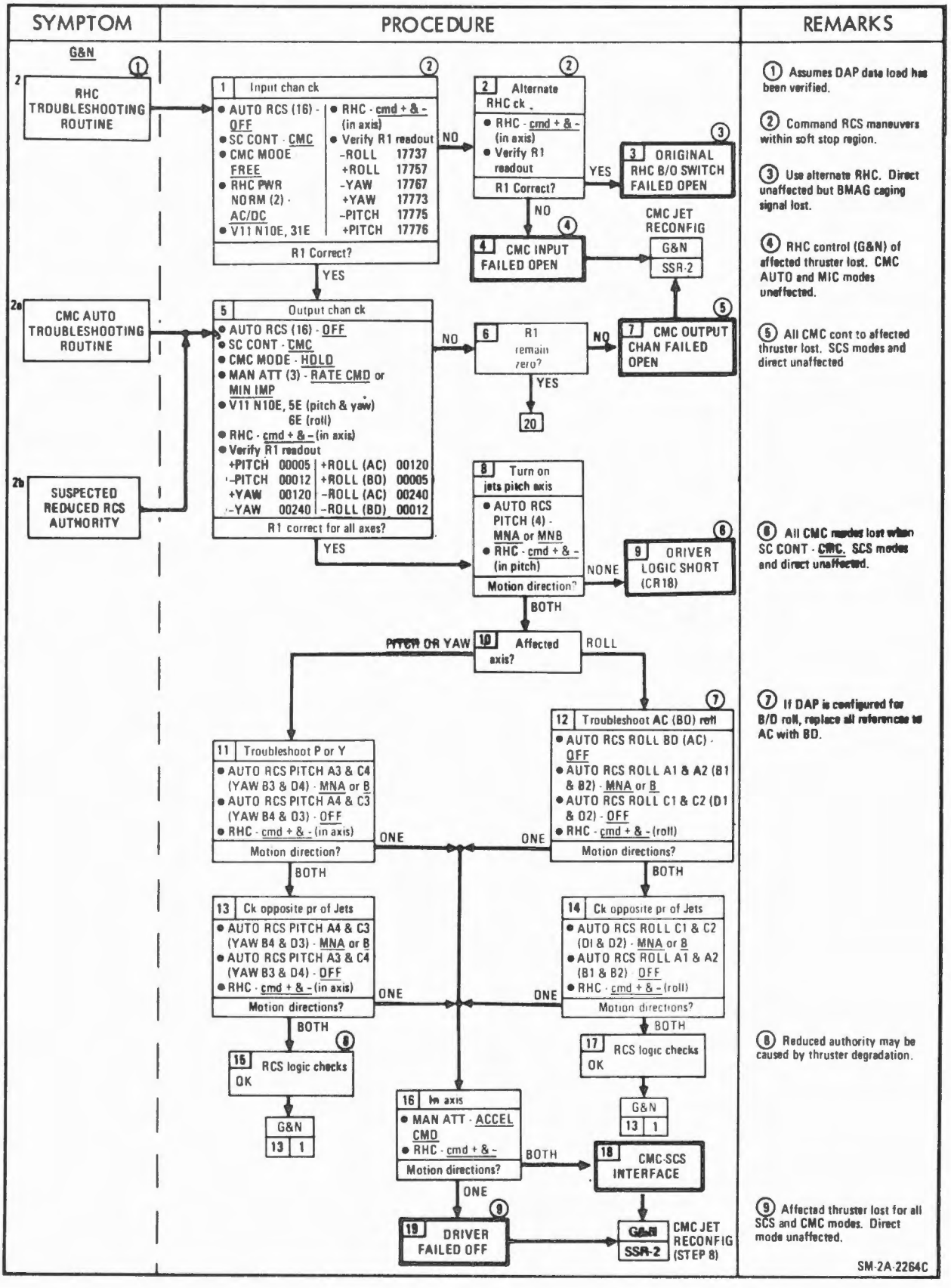
13 OSCILLATING OR DIVERGING MOTION

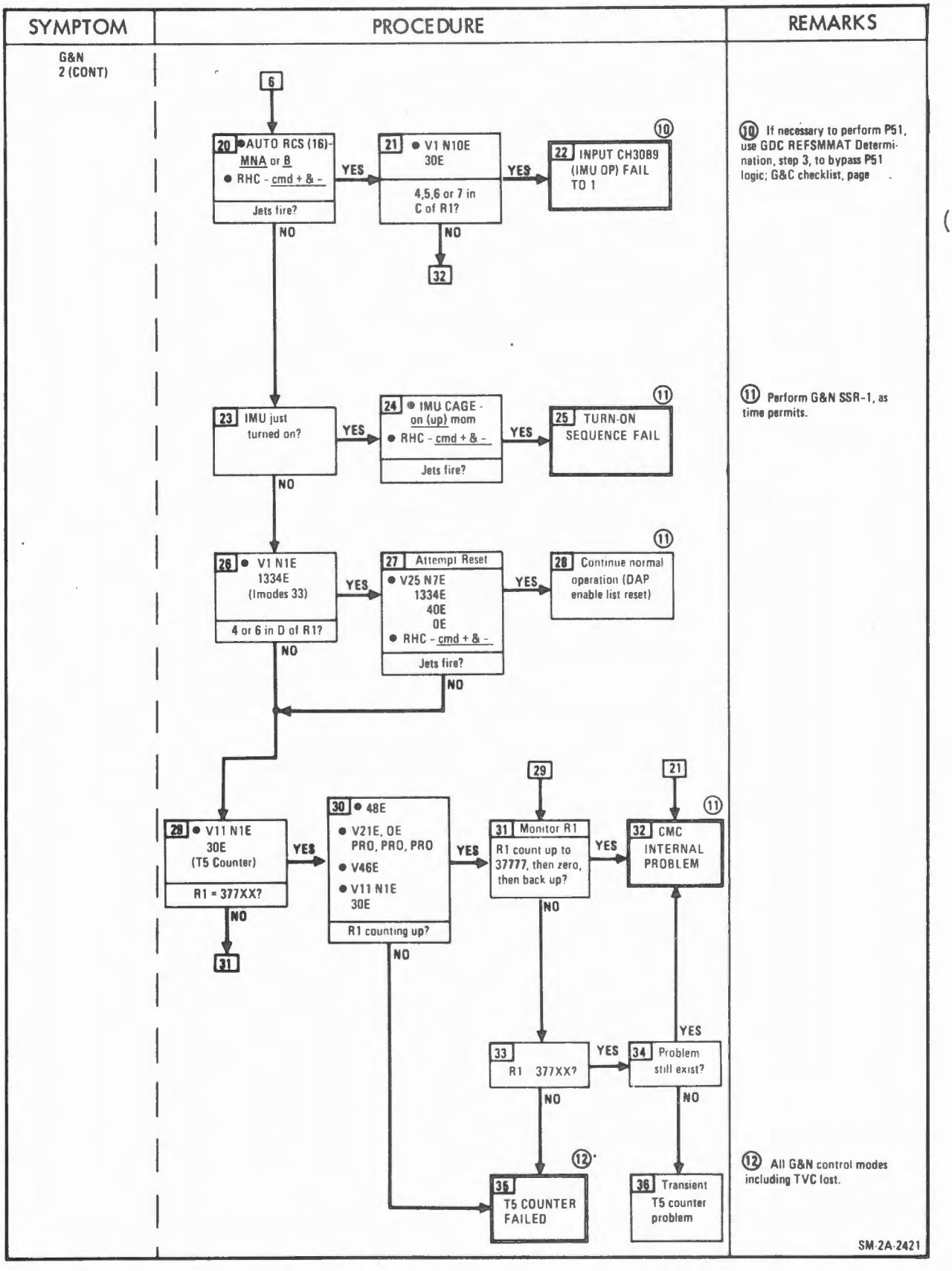
SSR-1 CMC TEST

SSR-2 CMC JET RE-CONFIG

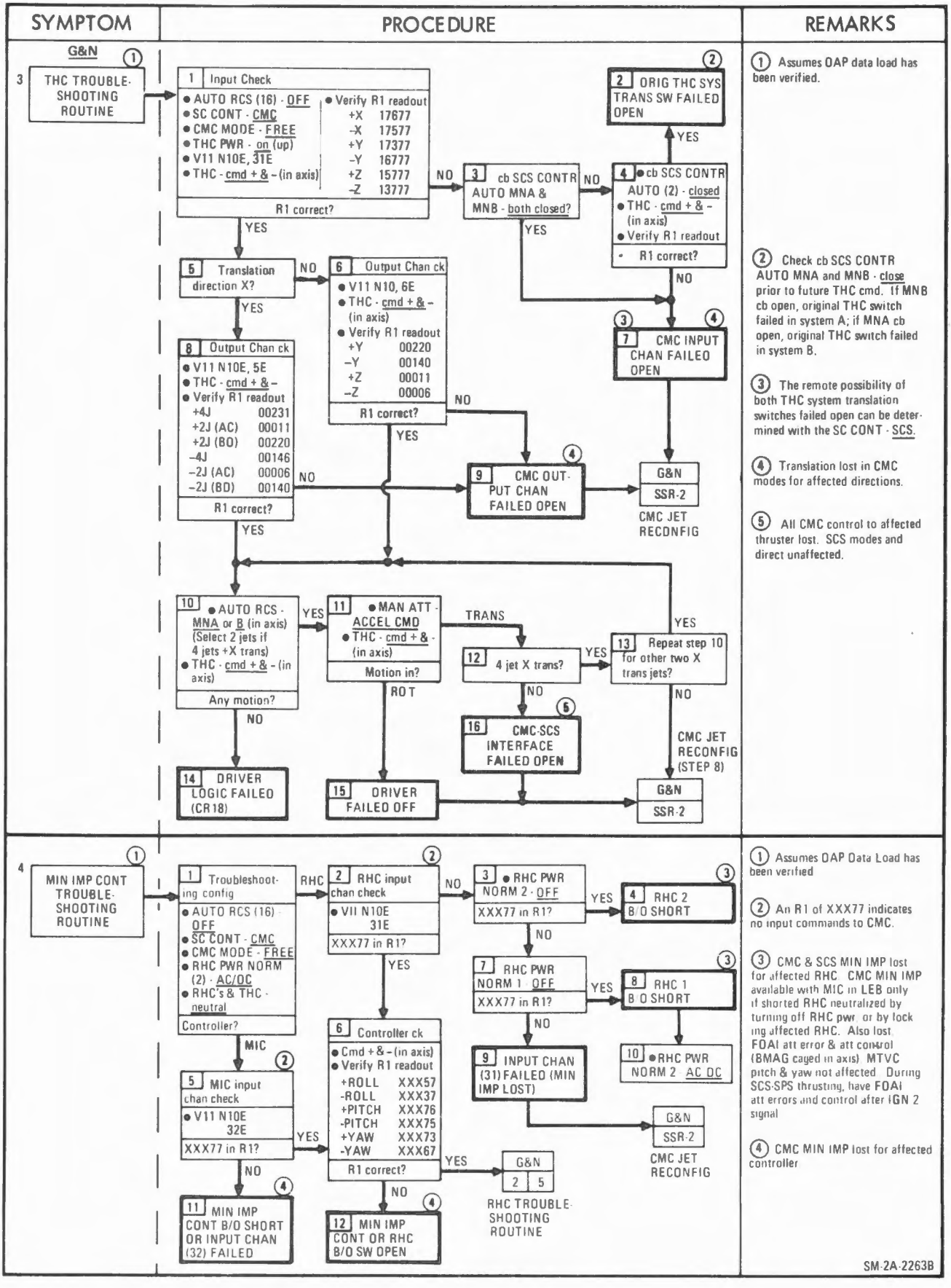
SSR-3 FRESH START

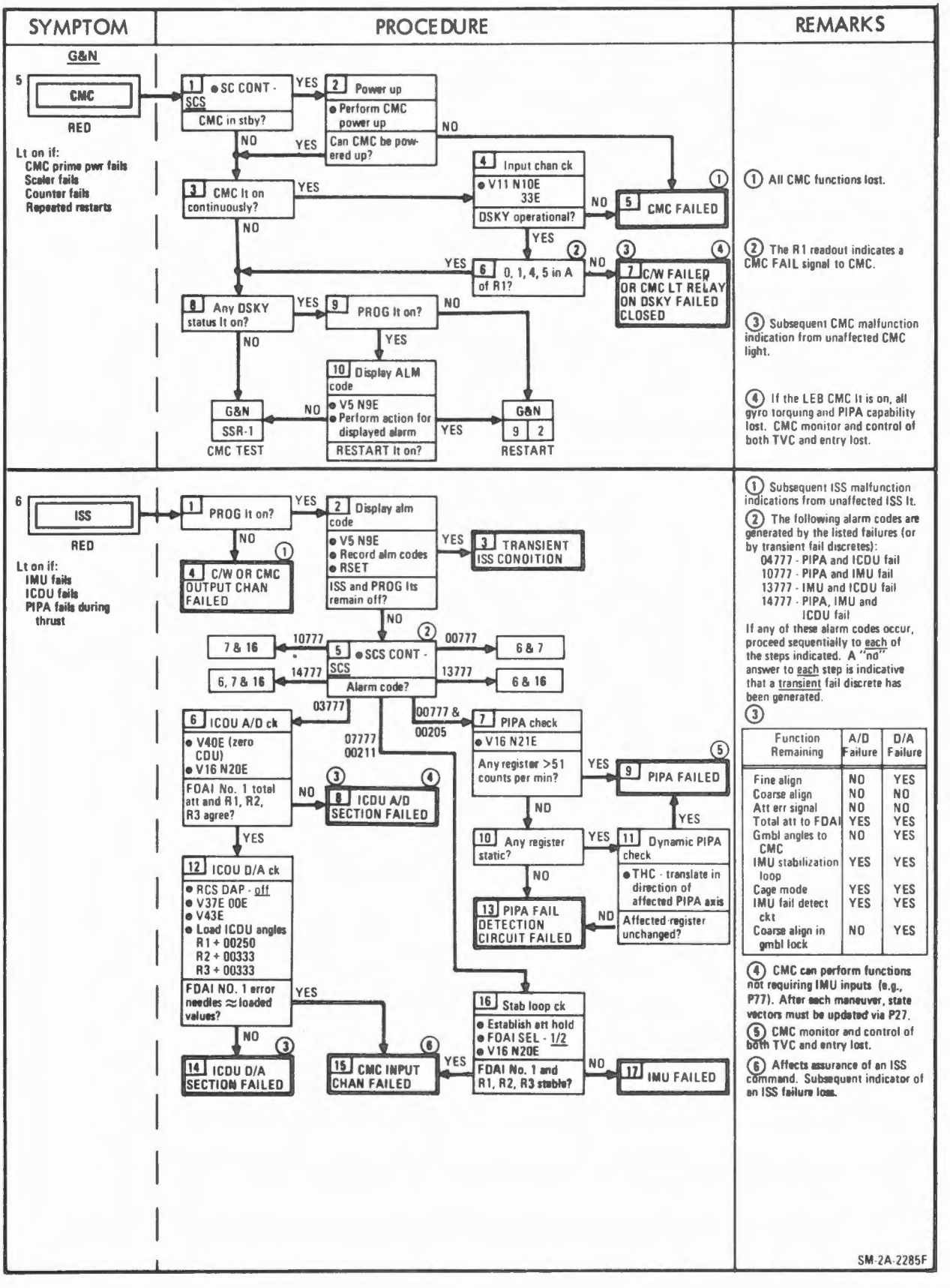

SYMPTOM
PROCEDURE
REMARKS
G&N
1
RCS FAILED ON
1 Input chan ck
• AUTO RCS (16) - OFF
• SC CONT - CMC
• CMC MODE - FREE
• RHC PWR NORM 1 and 2 - AC/OC
• THC PWR - ON
• RHCs & THC - neutral
• V11 N10E 31E
• Record R1
17777 in R1?
NO
YES
2 Input readout
ROTATION
17737 -ROLL
17757 +ROLL
17767 -YAW
17773 +YAW
17775 -PITCH
17776 +PITCH
TRANSLATION
13777 -Z
15777 +Z
16777 -Y
17377 +Y
17577 -X
17677 +X
R1 indicates?
ROT
TRANS
3 RHC No. 1 short ck
• RHC PWR NORM 1 - AC
17777 in R1?
YES
NO
4 RHC NO. 1 BREAKOUT SHORT
5 • RHC PWR NORM 1 and 2 - AC/DC for usable RHC, AC for shorted RHC.
6 RHC No. 2 short ck
• RHC PWR NORM 1 - AC/OC
• NORMAL 2 - AC
17777 in R1?
YES
NO
7 RHC NO. 2 BREAKOUT SHORT
8 THC No. 2 short ck
• cb SCS CONTR/AUTO MNB - open
17777 in R1?
NO
YES
9 THC No. 1 short ck
• cb SCS CONTR/AUTO MNB - close, MNA - open
17777 in R1?
NO
YES
10 CMC INPUT CHAN FAILED
11 THC SYS NO. 2 BREAKOUT SHORT
12 • cb SCS CONTR/AUTO MNA or MNB - open to shorted THC sys
• Select operable bus with AUTO RCS
13 THC SYS NO. 1 BREAKOUT SHORT
14 • cb SCS CONTR/AUTO MNA - close
15 Axis
Pitch, yaw or X-translation?
NO
YES
16 Output chan ck
• V11 N10E 6E
00000 in R1?
NO
YES
17 Output chan ck
• V11 N10E 5E
00000 in R1?
NO
YES
18 CMC OUTPUT CHAN FAILED
19 • Isolate affected jet by AUTO RCS switches
20 Driver on ck
• AUTO RCS - MNA or B (individually in affected axis) then OFF
Jet fires?
NO
YES
21 G&N checks OK. Return orig config and confirm problem still exists
G&N
SSR 2
CMC JET RECONFIG
22 • MAN ATT - ACCEL CMD
• AUTO RCS - MNA or B - then OFF (for affected thruster)
Jet fires?
NO
YES
23 CMC - SCS INTERFACE FAILED SHORT
G&N
SSR 2
CMC JET RECONFIG (STEP 8)
24 DRIVER FAILED ON
1 An R1 of 17777 indicates no jet commands into CMC.
2 Direct switches in affected RHC still functional. Locking on RHC mechanically opens breakout switches.
3 An R1 of 00000 indicates no jet commands from computer.
4 Affected thruster(s) lost for all G&N control modes. SCS control mode and direct unaffected
5 Affected thruster lost for all auto-coil operations. Direct unaffected.
SM 2A 2284


SYMPTOM
PROCEDURE
REMARKS
G&N
2 RHC TROUBLESHOOTING ROUTINE
2a CMC AUTO TROUBLESHOOTING ROUTINE
2b SUSPECTED REDUCED RCS AUTHORITY
1 Input chan ck
• AUTO RCS (16) - OFF
• SC CONT - CMC
• CMC MODE - FREE
• RHC PWR NORM (2) - AC/DC
• V11 N10E, 31E
• RHC - cmd + & - (in axis)
• Verify R1 readout
-ROLL 17737
+ROLL 17757
-YAW 17767
+YAW 17773
-PITCH 17775
+PITCH 17776
R1 Correct?
NO
YES
2 Alternate RHC ck
• RHC - cmd + & - (in axis)
• Verify R1 readout
R1 Correct?
YES
NO
3 ORIGINAL RHC B/O SWITCH FAILED OPEN
4 CMC INPUT FAILED OPEN
CMC JET RECONFIG
G&N
SSR-2
5 Output chan ck
• AUTO RCS (16) - OFF
• SC CONT - CMC
• CMC MODE - HOLD
• MAN ATT (3) - RATE CMD or MIN IMP
• V11 N10E, 5E (pitch & yaw) 6E (roll)
• RHC - cmd + & - (in axis)
• Verify R1 readout
+PITCH 00005 | +ROLL (AC) 00120
-PITCH 00012 | +ROLL (BO) 00005
+YAW 00120 | -ROLL (AC) 00240
-YAW 00240 | -ROLL (BO) 00012
R1 correct for all axes?
NO
YES
6 R1 remain zero?
NO
YES
7 CMC OUTPUT CHAN FAILED OPEN
20
8 Turn on jets pitch axis
• AUTO RCS PITCH (4) - MNA or MNB
• RHC - cmd + & - (in pitch)
Motion direction?
NONE
BOTH
9 ORIVER LOGIC SHORT (CR18)
10 Affected axis?
PITCH OR YAW
ROLL
11 Troubleshoot P or Y
• AUTO RCS PITCH A3 & C4 (YAW B3 & D4) - MNA or B
• AUTO RCS PITCH A4 & C3 (YAW B4 & D3) - OFF
• RHC - cmd + & - (in axis)
Motion direction?
ONE
BOTH
12 Troubleshoot AC (BO) roll
• AUTO RCS ROLL BD (AC) - OFF
• AUTO RCS ROLL A1 & A2 (B1 & B2) - MNA or B
• AUTO RCS ROLL C1 & C2 (D1 & D2) - OFF
• RHC - cmd + & - (roll)
Motion directions?
ONE
BOTH
13 Ck opposite pr of Jets
• AUTO RCS PITCH A4 & C3 (YAW B4 & D3) - MNA or B
• AUTO RCS PITCH A3 & C4 (YAW B3 & D4) - OFF
• RHC - cmd + & - (in axis)
Motion directions?
ONE
BOTH
14 Ck opposite pr of Jets
• AUTO RCS ROLL C1 & C2 (D1 & D2) - MNA or B
• AUTO RCS ROLL A1 & A2 (B1 & B2) OFF
• RHC - cmd + & - (roll)
Motion directions?
ONE
BOTH
15 RCS logic checks OK
G&N 13 1
16 In axis
• MAN ATT - ACCEL CMD
• RHC - cmd + & -
Motion directions?
BOTH
ONE
17 RCS logic checks OK
G&N 13 1
18 CMC-SCS INTERFACE
19 DRIVER FAILED OFF
G&N SSR-2
CMC JET RECONFIG (STEP 8)
1 Assumes DAP data load has been verified.
2 Command RCS maneuvers within soft stop region.
3 Use alternate RHC. Direct unaffected but BMAG caging signal lost.
4 RHC control (G&N) of affected thruster lost. CMC AUTO and MIC modes unaffected.
5 All CMC cont to affected thruster lost. SCS modes and direct unaffected
6 All CMC modes lost when SC CONT - CMC. SCS modes and direct unaffected.
7 If DAP is configured for B/D roll, replace all references to AC with BD.
8 Reduced authority may be caused by thruster degradation.
9 Affected thruster lost for all SCS and CMC modes. Direct mode unaffected.
SM-2A-2264C


SYMPTOM
PROCEDURE
REMARKS
G&N
2 (CONT)
6
20 • AUTO RCS (16)- MNA or B
• RHC - cmd + & -
Jets fire?
YES
21 • V1 N10E 30E
4,5,6 or 7 in C of R1?
YES
22 INPUT CH3089 (IMU OP) FAIL TO 1
10
NO
32
NO
23 IMU just turned on?
YES
24 • IMU CAGE - on (up) mom
• RHC - cmd + & -
Jets fire?
YES
25 TURN-ON SEQUENCE FAIL
11
NO
26 • V1 N1E 1334E (Imodes 33)
4 or 6 in D of R1?
YES
27 Attempt Reset
• V25 N7E 1334E 40E 0E
• RHC - cmd + & -
Jets fire?
YES
28 Continue normal operation (DAP enable list reset)
11
NO
NO
29 • V11 N1E 30E (T5 Counter)
R1 = 377XX?
YES
30 • 48E
• V21E, 0E PRO, PRO, PRO
• V46E
• V11 N1E 30E
R1 counting up?
YES
29
31 Monitor R1
R1 count up to 37777, then zero, then back up?
YES
21
32 CMC INTERNAL PROBLEM
11
NO
NO
31
NO
33 R1 377XX?
YES
34 Problem still exist?
YES
NO
NO
12
35 T5 COUNTER FAILED
36 Transient T5 counter problem
10 If necessary to perform P51, use GDC REFSMMAT Determination, step 3, to bypass P51 logic; G&C checklist, page .
11 Perform G&N SSR-1, as time permits.
12 All G&N control modes including TVC lost.
SM-2A-2421

3 THRU 4


SYMPTOM
PROCEDURE
REMARKS
G&N
3 THC TROUBLE-SHOOTING ROUTINE (1)
1 Input Check
• AUTO RCS (16) - OFF
• SC CONT - CMC
• CMC MODE - FREE
• THC PWR - on (up)
• V11 N10E, 31E
• THC - cmd + & - (in axis)
• Verify R1 readout
+X 17677
-X 17577
+Y 17377
-Y 16777
+Z 15777
-Z 13777
R1 correct?
NO
3 cb SCS CONTR AUTO MNA & MNB - both closed?
NO
4 • cb SCS CONTR AUTO (2) - closed
• THC - cmd + & - (in axis)
• Verify R1 readout
R1 correct?
YES
2 ORIG THC SYS TRANS SW FAILED OPEN
YES
NO
3 4 7 CMC INPUT CHAN FAILED OPEN
YES
5 Translation direction X?
NO
6 Output Chan ck
• V11 N10, 6E
• THC - cmd + & - (in axis)
• Verify R1 readout
+Y 00220
-Y 00140
+Z 00011
-Z 00006
R1 correct?
NO
YES
8 Output Chan ck
• V11 N10E, 5E
• THC - cmd + & -
• Verify R1 readout
+4J 00231
+2J (AC) 00011
+2J (BD) 00220
-4J 00146
-2J (AC) 00006
-2J (BD) 00140
R1 correct?
NO
4 9 CMC OUTPUT CHAN FAILED OPEN
G&N SSR-2
CMC JET RECONFIG
YES
10 • AUTO RCS - MNA or B (in axis) (Select 2 jets if 4 jets +X trans)
• THC - cmd + & - (in axis)
Any motion?
YES
11 • MAN ATT - ACCEL CMD
• THC - cmd + & - (in axis)
Motion in?
TRANS
ROT
12 4 jet X trans?
YES
13 Repeat step 10 for other two X trans jets?
YES
NO
NO
5 16 CMC-SCS INTERFACE FAILED OPEN
CMC JET RECONFIG (STEP 8)
NO
14 DRIVER LOGIC FAILED (CR18)
15 DRIVER FAILED OFF
G&N SSR-2
(1) Assumes OAP data load has been verified.
(2) Check cb SCS CONTR AUTO MNA and MNB - close prior to future THC cmd. If MNB cb open, original THC switch failed in system A; if MNA cb open, original THC switch failed in system B.
(3) The remote possibility of both THC system translation switches failed open can be determined with the SC CONT - SCS.
(4) Translation lost in CMC modes for affected directions.
(5) All CMC control to affected thruster lost. SCS modes and direct unaffected.
4 MIN IMP CONT TROUBLE-SHOOTING ROUTINE (1)
1 Troubleshooting config
• AUTO RCS (16) - OFF
• SC CONT - CMC
• CMC MODE - FREE
• RHC PWR NORM (2) - AC/OC
• RHC's & THC - neutral
Controller?
RHC
2 RHC input chan check
• V11 N10E 31E
XXX77 in R1?
NO
YES
3 • RHC PWR NORM 2 - OFF
XXX77 in R1?
YES
3 4 RHC 2 B/O SHORT
NO
7 RHC PWR NORM 1 OFF
XXX77 in R1?
YES
3 8 RHC 1 B/O SHORT
NO
9 INPUT CHAN (31) FAILED (MIN IMP LOST)
10 • RHC PWR NORM 2 AC OC
G&N SSR-2
CMC JET RECONFIG
MIC
2 5 MIC input chan check
• V11 N10E 32E
XXX77 in R1?
YES
NO
4 11 MIN IMP CONT B/O SHORT OR INPUT CHAN (32) FAILED
6 Controller ck
• Cmd + & - (in axis)
• Verify R1 readout
+ROLL XXX57
-ROLL XXX37
+PITCH XXX76
-PITCH XXX75
+YAW XXX73
-YAW XXX67
R1 correct?
YES
G&N 2 5
RHC TROUBLE-SHOOTING ROUTINE
NO
4 12 MIN IMP CONT OR RHC B/O SW OPEN
(1) Assumes OAP Data Load has been verified
(2) An R1 of XXX77 indicates no input commands to CMC.
(3) CMC & SCS MIN IMP lost for affected RHC. CMC MIN IMP available with MIC in LEB only if shorted RHC neutralized by turning off RHC pwr or by locking affected RHC. Also lost FOAI att error & att control (BMAG caged in axis). MTVC pitch & yaw not affected. During SCS-SPS thrusting, have FOAI att errors and control after IGN 2 signal
(4) CMC MIN IMP lost for affected controller
SM-2A-2263B

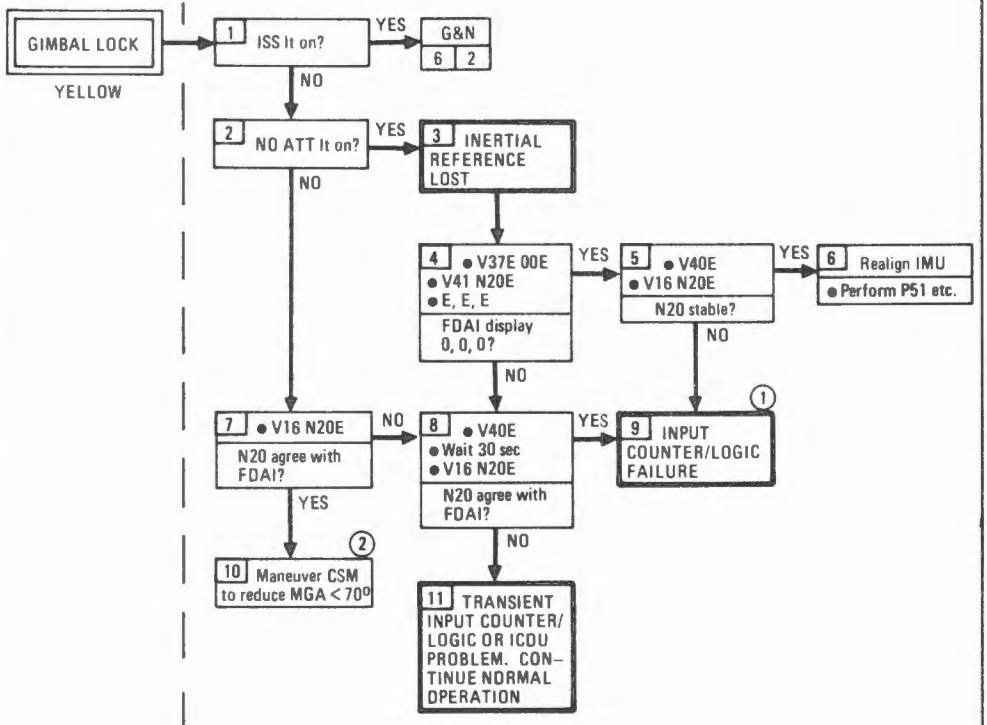

SYMPTOM
PROCEDURE
REMARKS
G&N
5
CMC
RED
Lt on if:
CMC prime pwr fails
Scaler fails
Counter fails
Repeated restarts
1 • SC CONT - SCS
CMC in stby?
YES
2 Power up
• Perform CMC power up
Can CMC be powered up?
NO
YES
NO
3 CMC lt on continuously?
YES
4 Input chan ck
• V11 N10E 33E
DSKY operational?
NO
5 CMC FAILED
1
YES
NO
6 0, 1, 4, 5 in A of R1?
YES
NO
2
3
4
7 C/W FAILED OR CMC LT RELAY ON DSKY FAILED CLOSED
8 Any DSKY status lt on?
YES
9 PROG lt on?
NO
YES
NO
10 Display ALM code
• V5 N9E
• Perform action for displayed alarm
RESTART lt on?
NO
YES
G&N
SSR-1
CMC TEST
G&N
9 2
RESTART
1 All CMC functions lost.
2 The R1 readout indicates a CMC FAIL signal to CMC.
3 Subsequent CMC malfunction indication from unaffected CMC light.
4 If the LEB CMC lt is on, all gyro torquing and PIPA capability lost. CMC monitor and control of both TVC and entry lost.
6
ISS
RED
Lt on if:
IMU fails
ICDU fails
PIPA fails during thrust
1 PROG lt on?
YES
NO
2 Display alm code
• V5 N9E
• Record alm codes
• RSET
ISS and PROG lts remain off?
YES
NO
3 TRANSIENT ISS CONDITION
1
4 C/W OR CMC OUTPUT CHAN FAILED
2
5 • SCS CONT - SCS
Alarm code?
10777
7 & 16
00777
6 & 7
14777
6, 7 & 16
13777
6 & 16
03777
00777 & 00205
07777 00211
6 ICDU A/D ck
• V40E (zero CDU)
• V16 N20E
FDAI No. 1 total att and R1, R2, R3 agree?
NO
3
4
8 ICDU A/D SECTION FAILED
YES
7 PIPA check
• V16 N21E
Any register >51 counts per min?
YES
5
9 PIPA FAILED
NO
10 Any register static?
YES
11 Dynamic PIPA check
• THC - translate in direction of affected PIPA axis
Affected register unchanged?
NO
YES
NO
13 PIPA FAIL DETECTION CIRCUIT FAILED
12 ICDU D/A ck
• RCS DAP - off
• V37E 00E
• V43E
• Load ICDU angles
R1 + 00250
R2 + 00333
R3 + 00333
FDAI NO. 1 error needles ≈ loaded values?
YES
NO
3
14 ICDU D/A SECTION FAILED
6
15 CMC INPUT CHAN FAILED
16 Stab loop ck
• Establish att hold
• FDAI SEL - 1/2
• V16 N20E
FDAI No. 1 and R1, R2, R3 stable?
YES
NO
17 IMU FAILED
1 Subsequent ISS malfunction indications from unaffected ISS lt.
2 The following alarm codes are generated by the listed failures (or by transient fail discretes):
04777 - PIPA and ICDU fail
10777 - PIPA and IMU fail
13777 - IMU and ICDU fail
14777 - PIPA, IMU and ICDU fail
If any of these alarm codes occur, proceed sequentially to each of the steps indicated. A "no" answer to each step is indicative that a transient fail discrete has been generated.
3
Function Remaining | A/D Failure | D/A Failure
Fine align | NO | YES
Coarse align | NO | NO
Att err signal | NO | NO
Total att to FDAI | YES | YES
Gmbl angles to CMC | NO | YES
IMU stabilization loop | YES | YES
Cage mode | YES | YES
IMU fail detect ckt | YES | YES
Coarse align in gmbl lock | NO | YES
4 CMC can perform functions not requiring IMU inputs (e.g., P77). After each maneuver, state vectors must be updated via P27.
5 CMC monitor and control of both TVC and entry lost.
6 Affects assurance of an ISS command. Subsequent indicator of an ISS failure loss.
SM-2A-2285F

SYMPTOM	PROCEDURE	REMARKS

G&N

7 GIMBAL LOCK

YELLOW

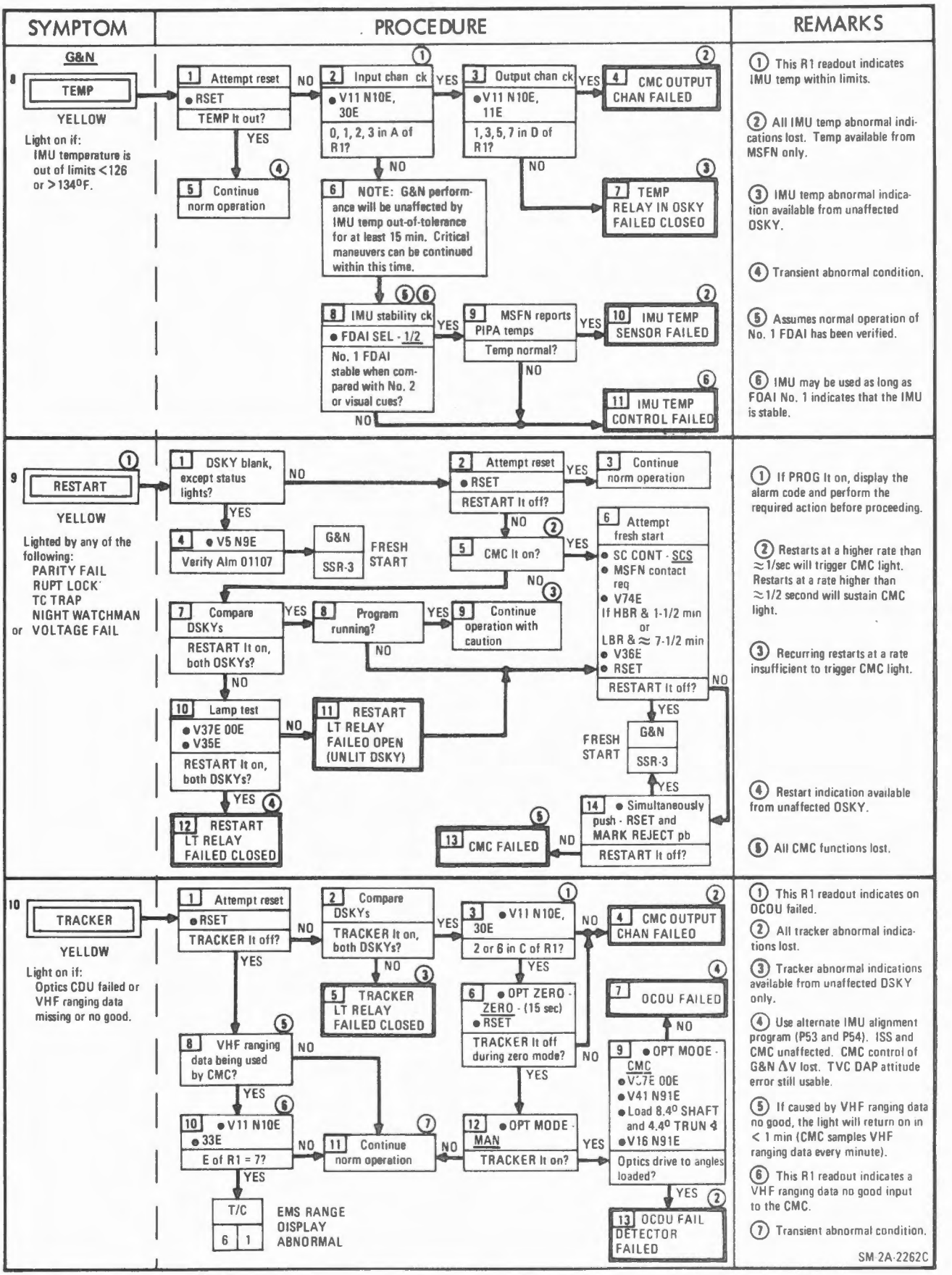


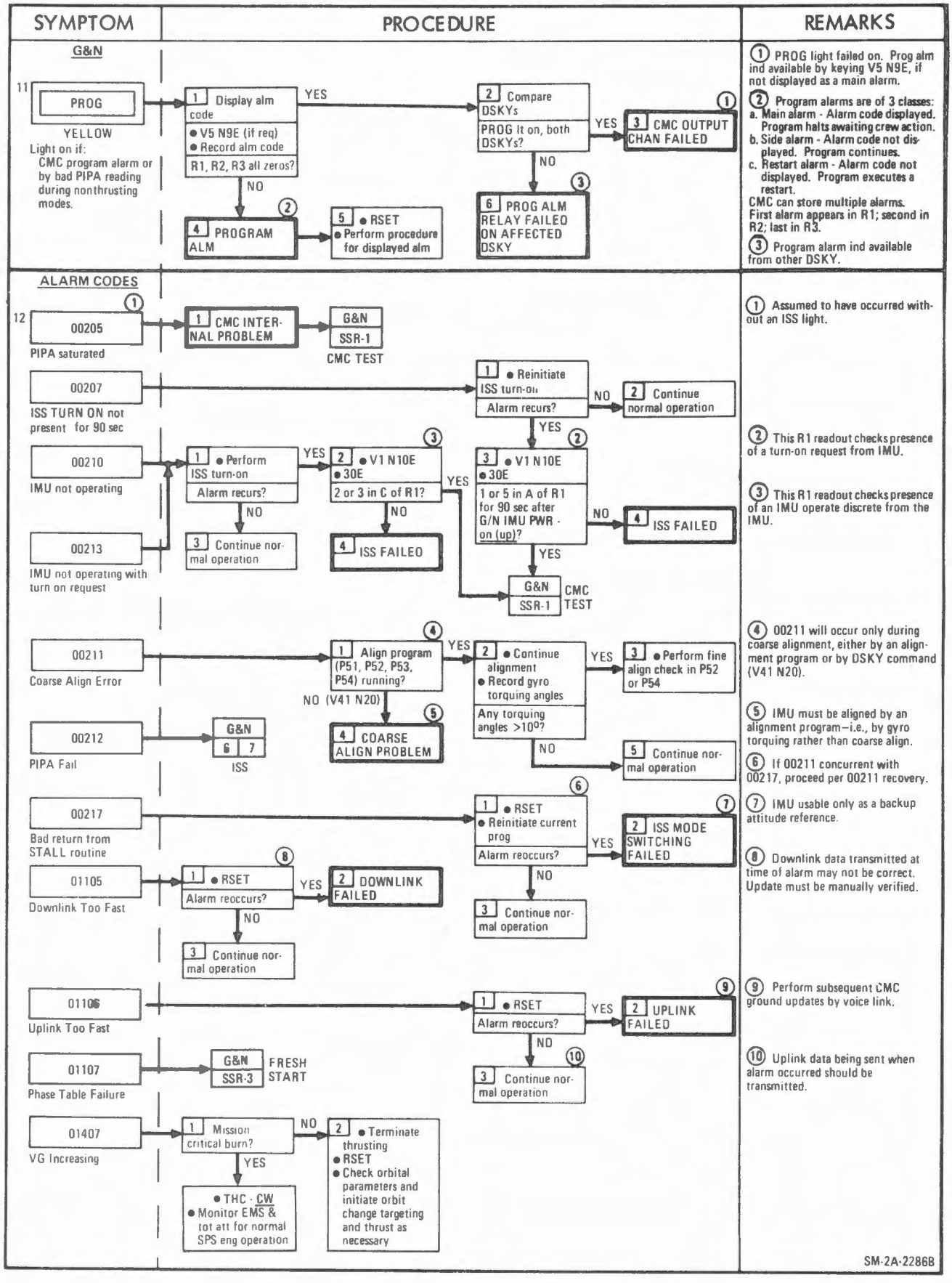
7

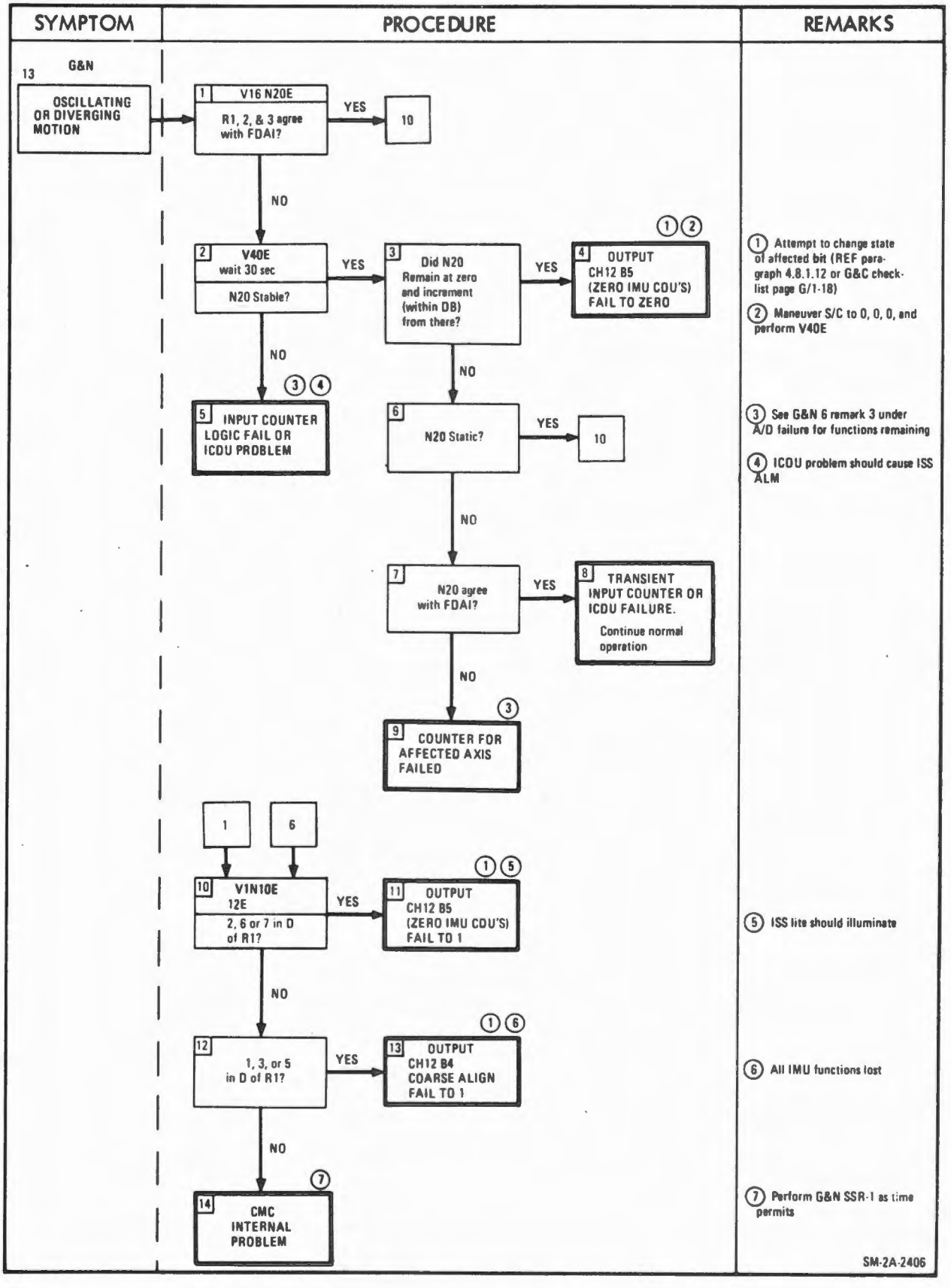
(1) If yaw axis failed, IMU will coarse align unless Saturn OAP and AVE G selected, or perform continuous V40E. See G&N 6 Remark (3) under A/D failure for functions remaining.

(2) If MGA already < 70°, perform SSR-1 as time permits.

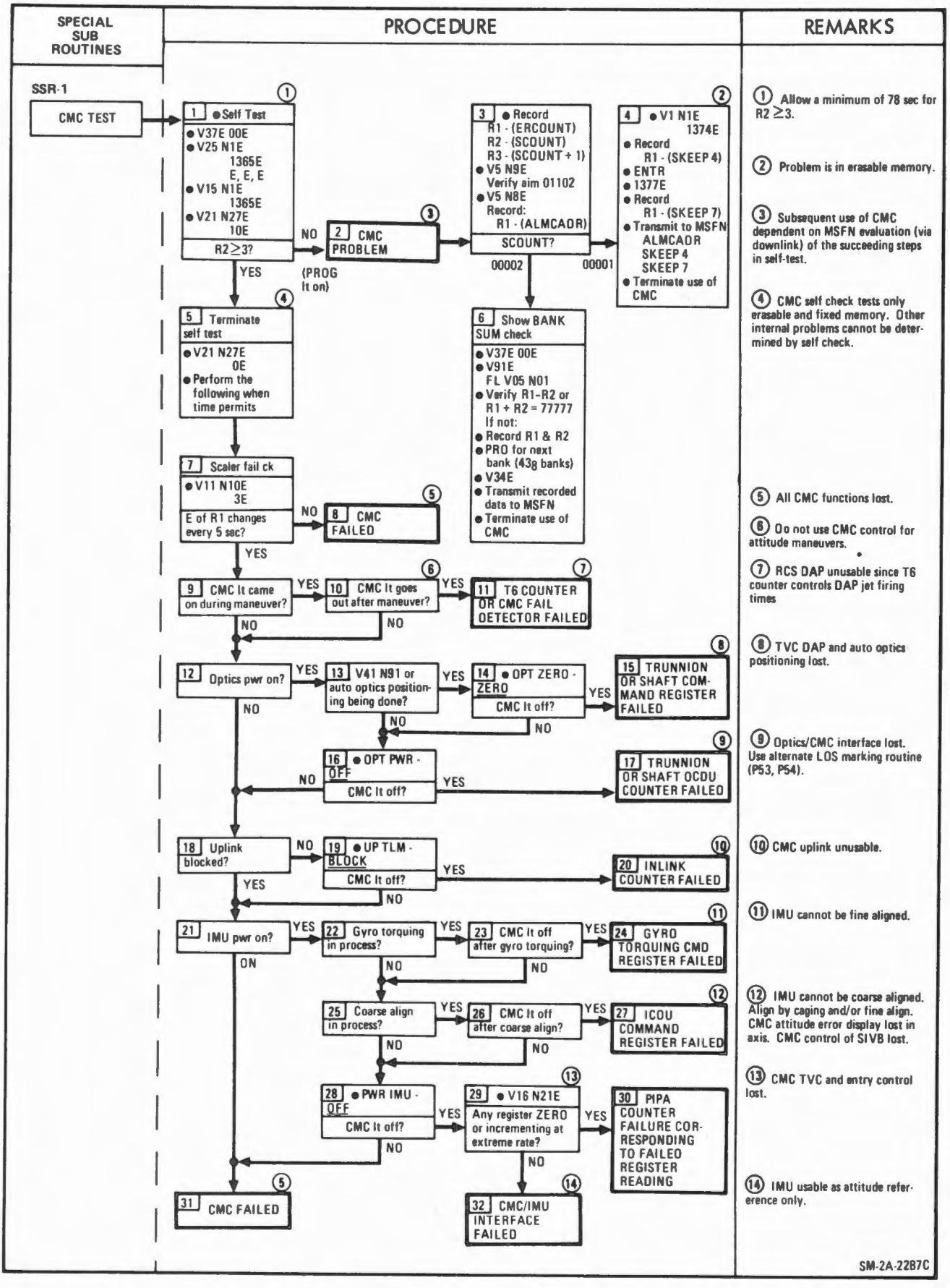
SM-2A-2363


SYMPTOM
PROCEDURE
REMARKS
8
G&N
TEMP
YELLOW
Light on if:
IMU temperature is out of limits <126 or >134°F.
1 Attempt reset
• RSET
TEMP lt out?
NO
YES
2 Input chan ck
• V11 N10E, 30E
0, 1, 2, 3 in A of R1?
YES
3 Output chan ck
• V11 N10E, 11E
1, 3, 5, 7 in D of R1?
YES
4 CMC OUTPUT CHAN FAILED
NO
5 Continue norm operation
6 NOTE: G&N performance will be unaffected by IMU temp out-of-tolerance for at least 15 min. Critical maneuvers can be continued within this time.
7 TEMP RELAY IN OSKY FAILED CLOSED
8 IMU stability ck
• FDAI SEL - 1/2
No. 1 FDAI stable when compared with No. 2 or visual cues?
YES
9 MSFN reports PIPA temps
Temp normal?
YES
10 IMU TEMP SENSOR FAILED
NO
11 IMU TEMP CONTROL FAILED
1 This R1 readout indicates IMU temp within limits.
2 All IMU temp abnormal indications lost. Temp available from MSFN only.
3 IMU temp abnormal indication available from unaffected OSKY.
4 Transient abnormal condition.
5 Assumes normal operation of No. 1 FDAI has been verified.
6 IMU may be used as long as FOAI No. 1 indicates that the IMU is stable.
9
RESTART
YELLOW
Lighted by any of the following:
PARITY FAIL
RUPT LOCK
TC TRAP
NIGHT WATCHMAN
or VOLTAGE FAIL
1 DSKY blank, except status lights?
NO
YES
2 Attempt reset
• RSET
RESTART lt off?
YES
3 Continue norm operation
4 • V5 N9E
Verify Alm 01107
G&N
SSR-3
FRESH START
5 CMC lt on?
NO
YES
6 Attempt fresh start
• SC CONT - SCS
• MSFN contact req
• V74E
If HBR & 1-1/2 min or LBR & ≈ 7-1/2 min
• V36E
• RSET
RESTART lt off?
NO
YES
7 Compare DSKYs
RESTART lt on, both OSKYs?
YES
8 Program running?
YES
9 Continue operation with caution
NO
NO
10 Lamp test
• V37E 00E
• V35E
RESTART lt on, both DSKYs?
NO
11 RESTART LT RELAY FAILED OPEN (UNLIT DSKY)
YES
12 RESTART LT RELAY FAILED CLOSED
FRESH START
G&N
SSR-3
YES
14 • Simultaneously push - RSET and MARK REJECT pb
RESTART lt off?
NO
13 CMC FAILED
1 If PROG lt on, display the alarm code and perform the required action before proceeding.
2 Restarts at a higher rate than ≈1/sec will trigger CMC light. Restarts at a rate higher than ≈1/2 second will sustain CMC light.
3 Recurring restarts at a rate insufficient to trigger CMC light.
4 Restart indication available from unaffected OSKY.
5 All CMC functions lost.
10
TRACKER
YELLOW
Light on if:
Optics CDU failed or VHF ranging data missing or no good.
1 Attempt reset
• RSET
TRACKER lt off?
NO
YES
2 Compare DSKYs
TRACKER lt on, both DSKYs?
YES
3 • V11 N10E, 30E
2 or 6 in C of R1?
NO
YES
4 CMC OUTPUT CHAN FAILED
NO
5 TRACKER LT RELAY FAILED CLOSED
6 • OPT ZERO - ZERO - (15 sec)
• RSET
TRACKER lt off during zero mode?
NO
YES
7 OCDU FAILED
NO
8 VHF ranging data being used by CMC?
NO
YES
9 • OPT MODE - CMC
• V37E 00E
• V41 N91E
• Load 8.4° SHAFT and 4.4° TRUN
• V16 N91E
Optics drive to angles loaded?
YES
10 • V11 N10E
• 33E
E of R1 = 7?
NO
YES
11 Continue norm operation
NO
12 • OPT MODE - MAN
TRACKER lt on?
YES
13 OCDU FAIL DETECTOR FAILED
T/C
6 1
EMS RANGE DISPLAY ABNORMAL
1 This R1 readout indicates on OCOU failed.
2 All tracker abnormal indications lost.
3 Tracker abnormal indications available from unaffected DSKY only.
4 Use alternate IMU alignment program (P53 and P54). ISS and CMC unaffected. CMC control of G&N ΔV lost. TVC DAP attitude error still usable.
5 If caused by VHF ranging data no good, the light will return on in < 1 min (CMC samples VHF ranging data every minute).
6 This R1 readout indicates a VHF ranging data no good input to the CMC.
7 Transient abnormal condition.
SM 2A-2262C


SYMPTOM
PROCEDURE
REMARKS
G&N
11
PROG
YELLOW
Light on if:
CMC program alarm or by bad PIPA reading during nonthrusting modes.
1 Display alm code
• V5 N9E (if req)
• Record alm code
R1, R2, R3 all zeros?
YES
NO
2 Compare DSKYs
PROG lt on, both DSKYs?
YES
NO
3 CMC OUTPUT CHAN FAILED
4 PROGRAM ALM
5 • RSET
• Perform procedure for displayed alm
6 PROG ALM RELAY FAILED ON AFFECTED DSKY
ALARM CODES
12
00205
PIPA saturated
1 CMC INTERNAL PROBLEM
G&N SSR-1
CMC TEST
00207
ISS TURN ON not present for 90 sec
1 • Reinitiate ISS turn-on
Alarm recurs?
NO
2 Continue normal operation
YES
00210
IMU not operating
1 • Perform ISS turn-on
Alarm recurs?
2 • V1 N10E
• 30E
2 or 3 in C of R1?
3 • V1 N10E
• 30E
1 or 5 in A of R1 for 90 sec after G/N IMU PWR - on (up)?
4 ISS FAILED
3 Continue normal operation
4 ISS FAILED
00213
IMU not operating with turn on request
G&N SSR-1 CMC TEST
00211
Coarse Align Error
1 Align program (P51, P52, P53, P54) running?
2 • Continue alignment
• Record gyro torquing angles
Any torquing angles >10°?
3 • Perform fine align check in P52 or P54
NO (V41 N20)
4 COARSE ALIGN PROBLEM
5 Continue normal operation
00212
PIPA Fail
G&N 6 7 ISS
00217
Bad return from STALL routine
1 • RSET
• Reinitiate current prog
Alarm reoccurs?
2 ISS MODE SWITCHING FAILED
3 Continue normal operation
01105
Downlink Too Fast
1 • RSET
Alarm reoccurs?
2 DOWNLINK FAILED
3 Continue normal operation
01106
Uplink Too Fast
1 • RSET
Alarm reoccurs?
2 UPLINK FAILED
3 Continue normal operation
01107
Phase Table Failure
G&N SSR-3 FRESH START
01407
VG Increasing
1 Mission critical burn?
YES
• THC - CW
• Monitor EMS & tot att for normal SPS eng operation
NO
2 • Terminate thrusting
• RSET
• Check orbital parameters and initiate orbit change targeting and thrust as necessary
1 PROG light failed on. Prog alm ind available by keying V5 N9E, if not displayed as a main alarm.
2 Program alarms are of 3 classes:
a. Main alarm - Alarm code displayed. Program halts awaiting crew action.
b. Side alarm - Alarm code not displayed. Program continues.
c. Restart alarm - Alarm code not displayed. Program executes a restart.
CMC can store multiple alarms. First alarm appears in R1; second in R2; last in R3.
3 Program alarm ind available from other DSKY.
1 Assumed to have occurred without an ISS light.
2 This R1 readout checks presence of a turn-on request from IMU.
3 This R1 readout checks presence of an IMU operate discrete from the IMU.
4 00211 will occur only during coarse alignment, either by an alignment program or by DSKY command (V41 N20).
5 IMU must be aligned by an alignment program—i.e., by gyro torquing rather than coarse align.
6 If 00211 concurrent with 00217, proceed per 00211 recovery.
7 IMU usable only as a backup attitude reference.
8 Downlink data transmitted at time of alarm may not be correct. Update must be manually verified.
9 Perform subsequent CMC ground updates by voice link.
10 Uplink data being sent when alarm occurred should be transmitted.
SM-2A-2286B


SYMPTOM
PROCEDURE
REMARKS
13 G&N
OSCILLATING OR DIVERGING MOTION
1 V16 N20E
R1, 2, & 3 agree with FDAI?
YES
10
NO
2 V40E
wait 30 sec
N20 Stable?
YES
3 Did N20 Remain at zero and increment (within DB) from there?
YES
4 OUTPUT CH12 B5 (ZERO IMU COU'S) FAIL TO ZERO
NO
5 INPUT COUNTER LOGIC FAIL OR ICDU PROBLEM
6 N20 Static?
YES
10
NO
7 N20 agree with FDAI?
YES
8 TRANSIENT INPUT COUNTER OR ICDU FAILURE. Continue normal operation
NO
9 COUNTER FOR AFFECTED AXIS FAILED
1
6
10 V1N10E 12E
2, 6 or 7 in D of R1?
YES
11 OUTPUT CH12 B5 (ZERO IMU COU'S) FAIL TO 1
NO
12 1, 3, or 5 in D of R1?
YES
13 OUTPUT CH12 B4 COARSE ALIGN FAIL TO 1
NO
14 CMC INTERNAL PROBLEM
(1) Attempt to change state of affected bit (REF paragraph 4.8.1.12 or G&C checklist page G/1-18)
(2) Maneuver S/C to 0, 0, 0, and perform V40E
(3) See G&N 6 remark 3 under A/D failure for functions remaining
(4) ICDU problem should cause ISS ALM
(5) ISS lite should illuminate
(6) All IMU functions lost
(7) Perform G&N SSR-1 as time permits
SM-2A-2406

13

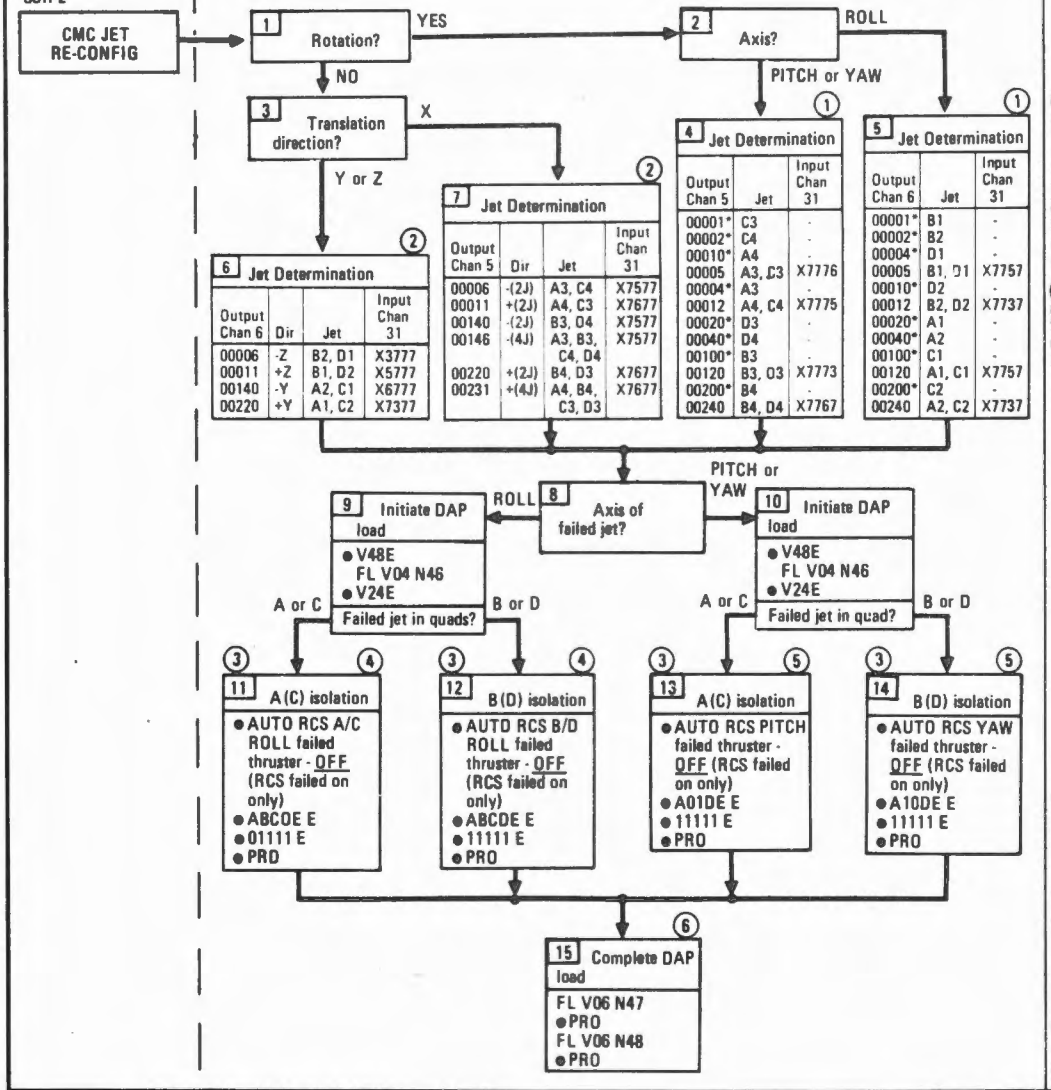

SPECIAL SUB ROUTINES
PROCEDURE
REMARKS
SSR-1
CMC TEST
1 ● Self Test
● V37E 00E
● V25 N1E
1365E
E, E, E
● V15 N1E
1365E
● V21 N27E
10E
R2≥3?
NO
YES
2 CMC PROBLEM
(PROG lt on)
3 ● Record
R1 - (ERCOUNT)
R2 - (SCOUNT)
R3 - (SCOUNT + 1)
● V5 N9E
Verify aim 01102
● V5 N8E
Record:
R1 - (ALMCAOR)
SCOUNT?
00002
00001
4 ● V1 N1E
1374E
● Record
R1 - (SKEEP 4)
● ENTR
● 1377E
● Record
R1 - (SKEEP 7)
● Transmit to MSFN
ALMCAOR
SKEEP 4
SKEEP 7
● Terminate use of CMC
6 Show BANK SUM check
● V37E 00E
● V91E
FL V05 N01
● Verify R1-R2 or R1 + R2 = 77777
If not:
● Record R1 & R2
● PRO for next bank (43g banks)
● V34E
● Transmit recorded data to MSFN
● Terminate use of CMC
5 Terminate self test
● V21 N27E
0E
● Perform the following when time permits
7 Scaler fail ck
● V11 N10E
3E
E of R1 changes every 5 sec?
NO
YES
8 CMC FAILED
9 CMC lt came on during maneuver?
YES
10 CMC lt goes out after maneuver?
YES
NO
11 T6 COUNTER OR CMC FAIL DETECTOR FAILED
12 Optics pwr on?
YES
NO
13 V41 N91 or auto optics positioning being done?
YES
NO
14 ● OPT ZERO - ZERO
CMC lt off?
YES
NO
15 TRUNNION OR SHAFT COMMAND REGISTER FAILED
16 ● OPT PWR - OFF
CMC lt off?
NO
YES
17 TRUNNION OR SHAFT OCDU COUNTER FAILED
18 Uplink blocked?
NO
YES
19 ● UP TLM - BLOCK
CMC lt off?
YES
NO
20 INLINK COUNTER FAILED
21 IMU pwr on?
YES
ON
22 Gyro torquing in process?
YES
NO
23 CMC lt off after gyro torquing?
YES
NO
24 GYRO TORQUING CMD REGISTER FAILED
25 Coarse align in process?
YES
NO
26 CMC lt off after coarse align?
YES
NO
27 ICOU COMMAND REGISTER FAILED
28 ● PWR IMU - OFF
CMC lt off?
YES
NO
29 ● V16 N21E
Any register ZERO or incrementing at extreme rate?
YES
NO
30 PIPA COUNTER FAILURE CORRESPONDING TO FAILED REGISTER READING
31 CMC FAILED
32 CMC/IMU INTERFACE FAILED
(1) Allow a minimum of 78 sec for R2 ≥3.
(2) Problem is in erasable memory.
(3) Subsequent use of CMC dependent on MSFN evaluation (via downlink) of the succeeding steps in self-test.
(4) CMC self check tests only erasable and fixed memory. Other internal problems cannot be determined by self check.
(5) All CMC functions lost.
(6) Do not use CMC control for attitude maneuvers.
(7) RCS DAP unusable since T6 counter controls DAP jet firing times
(8) TVC DAP and auto optics positioning lost.
(9) Optics/CMC interface lost. Use alternate LOS marking routine (P53, P54).
(10) CMC uplink unusable.
(11) IMU cannot be fine aligned.
(12) IMU cannot be coarse aligned. Align by caging and/or fine align. CMC attitude error display lost in axis. CMC control of SIVB lost.
(13) CMC TVC and entry control lost.
(14) IMU usable as attitude reference only.
SM-2A-2287C

SPECIAL SUB-ROUTINES

SSR-2

CMC JET RE-CONFIG

PROCEDURE



Output Chan 5	Dir	Jet	Input Chan 31
00006	-(2J)	A3, C4	X7577
00011	+(2J)	A4, C3	X7677
00140	-(2J)	B3, O4	X7577
00146	-(4J)	A3, B3, C4, D4	X7577
00220	+(2J)	B4, D3	X7677
00231	+(4J)	A4, B4, C3, D3	X7677

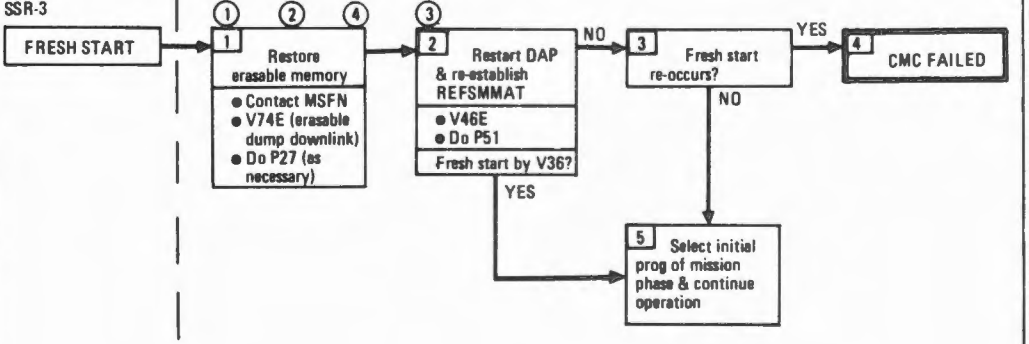
Output Chan 6	Dir	Jet	Input Chan 31
00006	-Z	B2, D1	X3777
00011	+Z	B1, D2	X5777
00140	-Y	A2, C1	X6777
00220	+Y	A1, C2	X7377

Output Chan 5	Jet	Input Chan 31
00001*	C3	-
00002*	C4	-
00010*	A4	-
00005	A3, C3	X7776
00004*	A3	-
00012	A4, C4	X7775
00020*	D3	-
00040*	D4	-
00100*	B3	-
00120	B3, O3	X7773
00200*	B4	-
00240	B4, D4	X7767

Output Chan 6	Jet	Input Chan 31
00001*	B1	-
00002*	B2	-
00004*	D1	-
00005	B1, D1	X7757
00010*	D2	-
00012	B2, D2	X7737
00020*	A1	-
00040*	A2	-
00100*	C1	-
00120	A1, C1	X7757
00200*	C2	-
00240	A2, C2	X7737

SSR-3

FRESH START



REMARKS

(1) Starred (*) outputs are single jet commands. For RCS failed on, the failed jet is the indicated jet. For output channel failed open, the failed jet is the corresponding jet in the rotational couple, e.g., command + pitch. Should observe 00005 in chan 5 (A3, C3 + pitch couple). If observe 00004, C3 can not be commanded on by CMC.

(2) If R1 (output chan) contains a number not listed, determine the failed jet from the R1 (output) readout when a rotation command is given.

(3) In R1, A is vehicle configuration:
- 0 - No DAP
- 1 - CSM only
- 2 - CSM + LM (asc + des)
- 3 - CSM + SIVB
- 6 - CSM + LM (asc only)

In R1, B is quad A/C for X translation:
- 0 - FAIL A/C
- 1 - USE A/C

In R1, C is quad B/D for X translation:
- 0 - FAIL B/D
- 1 - USE B/D

In R1, D is DAP deadband:
- 0 - 0.5°
- 1 - 5.0°

E is the DAP rate:
- 0 - 0.05°/sec
- 1 - 0.20°/sec
- 2 - 0.5°/sec
- 3 - 2.0°/sec

In R2, A is roll selection
- 0 - Use B/D
- 1 - Use A/C

(4) Translation (Y or Z) will be single jet and result in excessive RCS prpint consumption.

(5) Rotations (pitch or yaw) will be single jet. X translations will be 2 jet.

(6) N47 and N48 display other DAP parameters assumed to be correct.

(1) State vector and CMC time should be updated. All nonpad-loaded parameters, except time & state vector, will be properly updated by CMC programs in their proper sequence as if CMC had just been turned on when fresh start occurred.

(2) Extended V74 permits MSFN to examine all pertinent erasable locations to determine if any parameters need reloading.

(3) DAP is shut off by fresh start & must be re-initiated by V46.

(4) REFSMFLG, SURFFLAG, HDSUPFLG, LMOONFLG, CMOONFLG, and NODOPO 1 flag are not changed by fresh start. All other flagwords are reset by fresh start. Flags are set again by performance of CMC programs in normal sequence.

SM-2A-228BC

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SPS MALFUNCTION INDEX

1 SPS PRESS
YELLOW

1a FUEL AND/OR OXID PRESS HIGH

1b FUEL AND/OR OXID PRESS LOW

1c FUEL AND OXID $\Delta P > 20$ PSI

2 PITCH (YAW) GMBL 1 (2)
YELLOW

3 SPS PREMATURE SHUTDOWN

3a NO SPS IGNITION

4 SPS ENG DOES NOT SHUTDOWN AUTO

4a SPS THRUST LT ON (NON THRUSTING)

5 SPS Pc ABNORMAL

6 SPS He VLV tb-ABNORMAL

7 He PRESS LOW OR DECR

8 GN2 A(B) PRESS LOW

8a SPS INJ VLV PARTIALLY OPEN

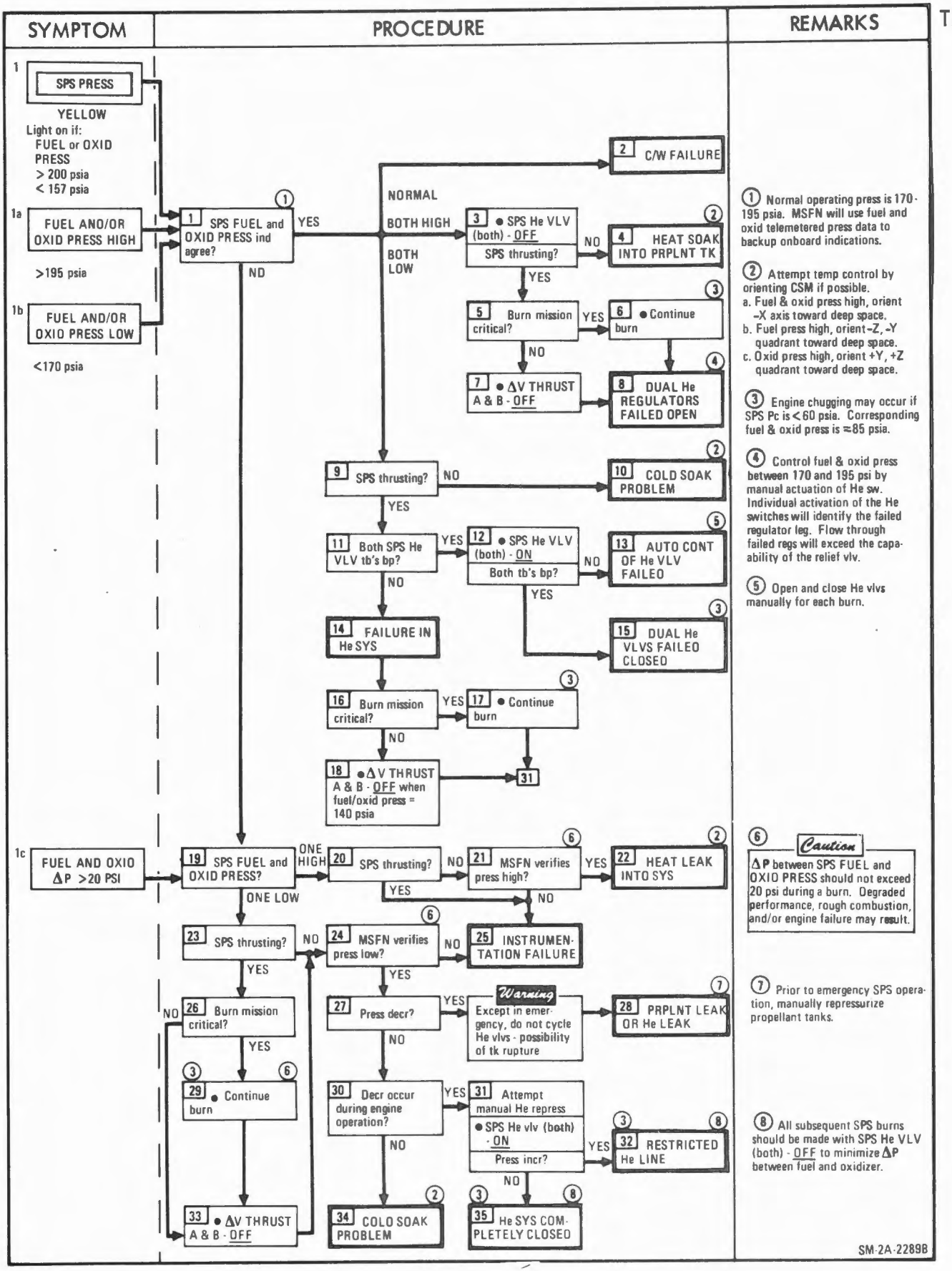
9 SPS INJ VLV IND ABNORMAL

10 NO PRPLNT TEMP CONTROL

11 NO RESPONSE OF SPS OXID VLV tb DURING FLOW ADJUST

12 SPS OXIDE UNBAL IND ERRATIC OR PEGGED

13 SPS OXID (FUEL) QTY IND READOUT ABNORMAL


SYMPTOM
PROCEDURE
REMARKS
1 SPS PRESS
YELLOW
Light on if:
FUEL or OXID PRESS
> 200 psia
< 157 psia
1a FUEL AND/OR OXID PRESS HIGH
>195 psia
1b FUEL AND/OR OXID PRESS LOW
<170 psia
1c FUEL AND OXID ΔP >20 PSI
1 SPS FUEL and OXID PRESS ind agree?
YES
NO
NORMAL
BOTH HIGH
BOTH LOW
2 C/W FAILURE
3 • SPS He VLV (both) - OFF
SPS thrusting?
NO
4 HEAT SOAK INTO PRPLNT TK
YES
5 Burn mission critical?
YES
6 • Continue burn
NO
7 • ΔV THRUST A & B - OFF
8 DUAL He REGULATORS FAILED OPEN
9 SPS thrusting?
NO
10 COLD SOAK PROBLEM
YES
11 Both SPS He VLV tb's bp?
YES
12 • SPS He VLV (both) - ON
Both tb's bp?
NO
13 AUTO CONT OF He VLV FAILED
YES
15 DUAL He VLVS FAILED CLOSED
NO
14 FAILURE IN He SYS
16 Burn mission critical?
YES
17 • Continue burn
NO
18 • ΔV THRUST A & B - OFF when fuel/oxid press = 140 psia
31
19 SPS FUEL and OXID PRESS?
ONE HIGH
ONE LOW
20 SPS thrusting?
NO
YES
21 MSFN verifies press high?
YES
NO
22 HEAT LEAK INTO SYS
23 SPS thrusting?
NO
YES
24 MSFN verifies press low?
NO
YES
25 INSTRUMENTATION FAILURE
26 Burn mission critical?
NO
YES
27 Press decr?
YES
NO
Warning
Except in emergency, do not cycle He vlvs - possibility of tk rupture
28 PRPLNT LEAK OR He LEAK
29 • Continue burn
30 Decr occur during engine operation?
YES
NO
31 Attempt manual He repress
• SPS He vlv (both) - ON
Press incr?
YES
NO
32 RESTRICTED He LINE
33 • ΔV THRUST A & B - OFF
34 COLD SOAK PROBLEM
35 He SYS COMPLETELY CLOSED
(1) Normal operating press is 170-195 psia. MSFN will use fuel and oxid telemetered press data to backup onboard indications.
(2) Attempt temp control by orienting CSM if possible.
a. Fuel & oxid press high, orient -X axis toward deep space.
b. Fuel press high, orient -Z, -Y quadrant toward deep space.
c. Oxid press high, orient +Y, +Z quadrant toward deep space.
(3) Engine chugging may occur if SPS Pc is < 60 psia. Corresponding fuel & oxid press is ≈85 psia.
(4) Control fuel & oxid press between 170 and 195 psi by manual actuation of He sw. Individual activation of the He switches will identify the failed regulator leg. Flow through failed regs will exceed the capability of the relief vlv.
(5) Open and close He vlvs manually for each burn.
(6) Caution
ΔP between SPS FUEL and OXID PRESS should not exceed 20 psi during a burn. Degraded performance, rough combustion, and/or engine failure may result.
(7) Prior to emergency SPS operation, manually repressurize propellant tanks.
(8) All subsequent SPS burns should be made with SPS He VLV (both) - OFF to minimize ΔP between fuel and oxidizer.
SM-2A-2289B

SYMPTOM

2 PITCH (YAW) GMBL 1 (2)

YELLOW

Light on if:

Overcurrent occurs in respective drive motor or gimbal actuator.

PROCEDURE

1 After SPS shutdown and before SPS GMBL MOT shutdown
- TVC GMBL DR PITCH (YAW) - 1 (2)
- Perform gimbal trim check

Gimbal control maintained? NO → YES → 4 C/W FAILURE

Caution
Gimbal drive circuits are not C/B protected. Before proceeding with step 2, MSFN may be able to provide failure identification.

2 DC load check
- DC IND sel - FC 1 (2, 3)
- SPS GMBL MOT PITCH (YAW) - 1 (2) - Start and hold for check

Amps abnormally high? NO → 5 OVERCURRENT SENSOR FAILED (3); YES → 3 GIMBAL MOTOR FAILED (2)

REMARKS

(1) Automatic transfer from the primary system to secondary occurs with an overcurrent provided the TVC GMBL DR switch is at AUTO.

(2) For subsequent ΔV's, place TVC GMBL DR sw to alternate servo position in affected axis.

(3) Selected gimbal motor is operational when SPS Pitch (Yaw) 1 (2) cb is opened while affected gimbal motor switch is held at START. However, overcurrent protection and switchover capability will not be available. Close the cb to turn off the gimbal motor.

---

3 SPS PREMATURE SHUTDOWN

1 Single or dual bank? DUAL → 2 SC CONT mode? CMC → 3 Output chan ck
- ΔV THRUST (2) - OFF
- Recycle to ignition in P40
- FL V99 N40
- PRO
- V01 N10E, 11E

1 in A of R1? NO → 4 CMC INTERNAL PROBLEM (2) → G&N SSR-1 CMC TEST

YES → 5 CMC-SCS INTERFACE FAILED OPEN (3, 4)

SINGLE / SCS

3a NO SPS IGNITION

6 All SPS INJ VLV ind (4) CLOSE? NO → 7 VLV PAIR FAILED CLOSED (5)

YES → 8 cb SPS He VLV or cb PILOT VLVS - open? YES → 9 ENG VLV CKTRY FAILED (5)

NO → 10 SC CONT mode? SCS → 11 EMS ΔV counter ≤ - 0.1 fps YES → 12 EMS COUNTER RESET PREMATURELY (6, 3)

CMC

NO → 13 SPS THRUST lt - on?

NO → 14
- ΔV THRUST (2) - OFF
- AUTO RCS SEL +X (4) - OFF
- THC - cmd +X
- THRUST ON pb - push

SPS THRUST lt on? YES → 16 ONE BANK FAILED (7)

YES → 13

15 Output chan ck
- ΔV THRUST (2) - OFF
- Recycle to ignition in P40
- FL V99 N40
- PRO
- V01 N10E, 11E

1 in A or R1? YES → 17 SPS THRUST lt - on

NO → 20 CMC INTERNAL PROBLEM (2) → G&N SSR-1 CMC TEST

NO → 21 CMC-SCS INTERFACE FAILED OPEN (3, 4)

18
- THC - CW
- THC - cmd +X
- THRUST ON pb - push

SPS THRUST lt - on? YES → 19 SC CONT ENABLE PWR LOST (8)

NO →

22
- cb DIR ULL (2) - open
- DIR ULL pb - push
- THRUST ON pb - push

SPS THRUST lt - on? YES → 23 +X TRANS LOGIC FAILED (9)

NO → 24 EMS-SC INTERFACE FAILED SHORT (10)

REMARKS

(1) Troubleshooting assumes original switch positions at time of shutdown.

(2) All G&N SPS capability lost.

(3) Manual on-off procedure
a. At TIG -1 min, SPS THRUST - DIR ON
b. At TIG, ΔV THRUST A(B) - NORM
c. At TIG +3 sec, ΔV THRUST B(A) - NORM (if dual bank)
d. Terminate burn on ΔV or time by ΔV THRUST (2) - OFF.

(4) G&N SPS on-off control lost. TVC DAP unaffected.

(5) ΔV capability lost for affected bank.

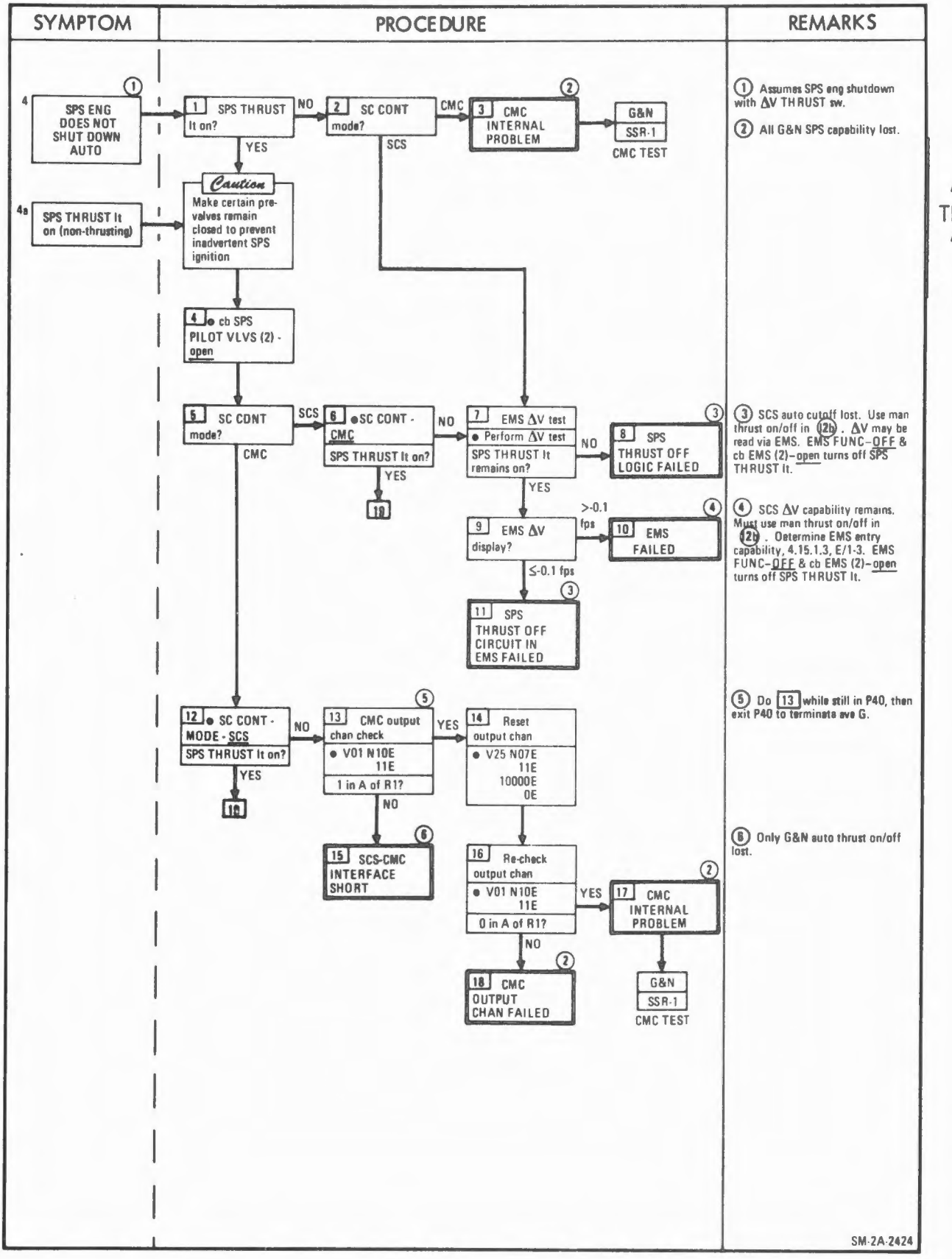
(6) Perform EMS ΔV test and if OK, use ΔV counter to monitor burn. Use manual on-off procedure (Remark 3).

(7) Affected bank may still be available using SPS THRUST - DIR ON. Alternate bank unaffected.

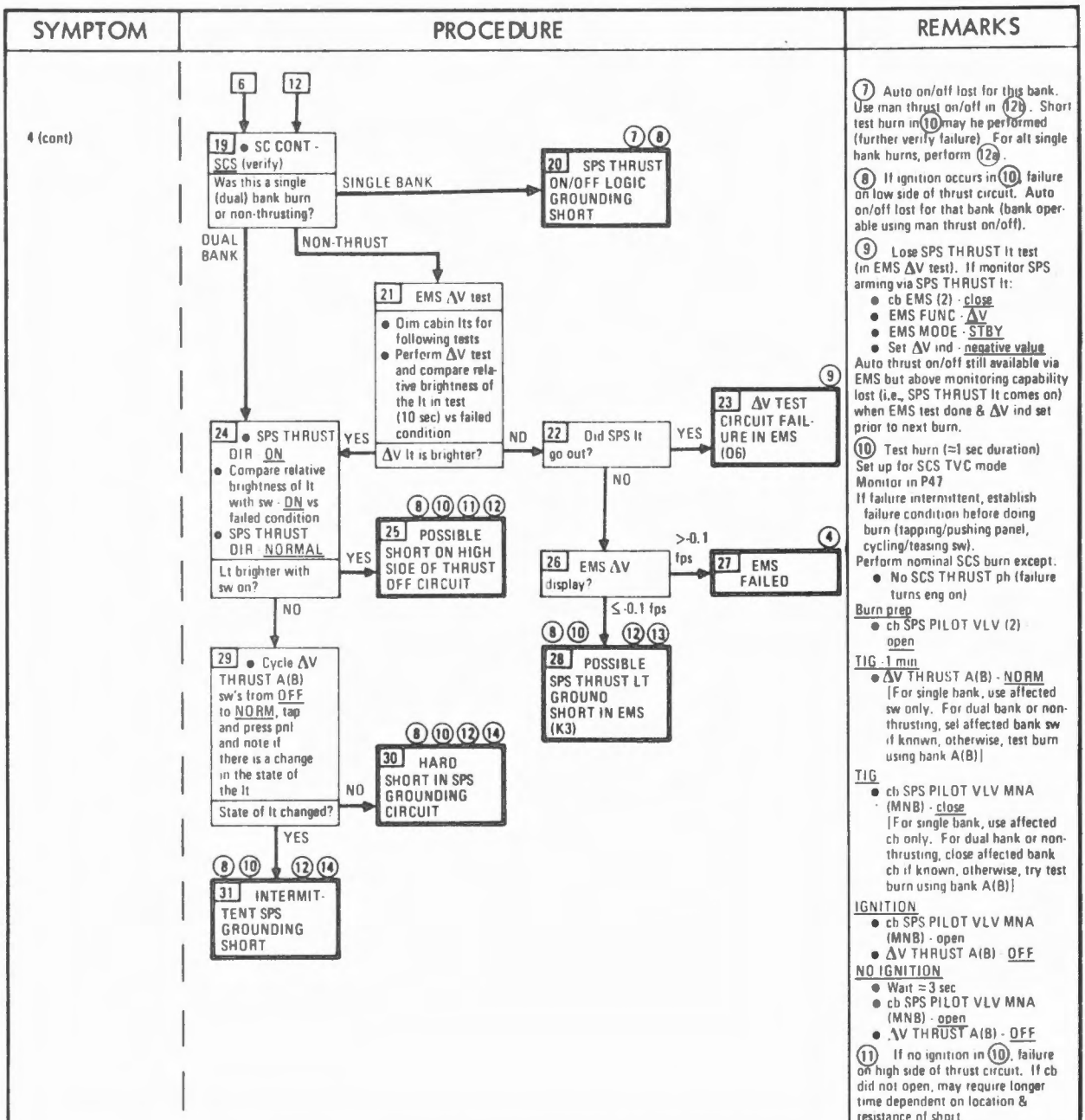
(8) THC must be CW for SCS ΔV capability. SCS auto ΔV lost.

(9) For SCS ΔV use DIR ULL pb for eng or initiation +X TRANS logic function lost).

(10) CMC ΔV capability unaffected. SCS ΔV auto on-off lost. For SCS ΔV use manual on-off procedure (Remark 3).


SYMPTOM
PROCEDURE
REMARKS
4 SPS ENG DOES NOT SHUT DOWN AUTO
1 SPS THRUST It on?
NO
2 SC CONT mode?
CMC
3 CMC INTERNAL PROBLEM
G&N SSR-1 CMC TEST
YES
SCS
4a SPS THRUST It on (non-thrusting)
Caution
Make certain pre-valves remain closed to prevent inadvertent SPS ignition
4 ● cb SPS PILOT VLVS (2) - open
5 SC CONT mode?
SCS
6 ●SC CONT - CMC SPS THRUST It on?
NO
7 EMS ΔV test
● Perform ΔV test
SPS THRUST It remains on?
NO
8 SPS THRUST OFF LOGIC FAILED
YES
CMC
19
9 EMS ΔV display?
>-0.1 fps
10 EMS FAILED
≤-0.1 fps
11 SPS THRUST OFF CIRCUIT IN EMS FAILED
12 ● SC CONT - MODE - SCS SPS THRUST It on?
NO
13 CMC output chan check
● V01 N10E 11E
1 in A of R1?
YES
14 Reset output chan
● V25 N07E 11E 10000E 0E
NO
15 SCS-CMC INTERFACE SHORT
16 Re-check output chan
● V01 N10E 11E
0 in A of R1?
YES
17 CMC INTERNAL PROBLEM
NO
18 CMC OUTPUT CHAN FAILED
G&N SSR-1 CMC TEST
1 Assumes SPS eng shutdown with ΔV THRUST sw.
2 All G&N SPS capability lost.
3 SCS auto cutoff lost. Use man thrust on/off in 12b. ΔV may be read via EMS. EMS FUNC–OFF & cb EMS (2)–open turns off SPS THRUST It.
4 SCS ΔV capability remains. Must use man thrust on/off in 12b. Determine EMS entry capability, 4.15.1.3, E/1-3. EMS FUNC–OFF & cb EMS (2)–open turns off SPS THRUST It.
5 Do 13 while still in P40, then exit P40 to terminate ave G.
6 Only G&N auto thrust on/off lost.
SM-2A-2424

4 THRU 4a



(7) Auto on/off lost for this bank. Use man thrust on/off in (12b). Short test burn in (10) may be performed (further verify failure). For alt single bank burns, perform (12a).

(8) If ignition occurs in (10), failure on low side of thrust circuit. Auto on/off lost for that bank (bank operable using man thrust on/off).

(9) Lose SPS THRUST lt test (in EMS ΔV test). If monitor SPS arming via SPS THRUST lt:

- cb EMS (2) - close
- EMS FUNC - ΔV
- EMS MODE - STBY
- Set ΔV ind - negative value

Auto thrust on/off still available via EMS but above monitoring capability lost (i.e., SPS THRUST lt comes on) when EMS test done & ΔV ind set prior to next burn.

(10) Test burn (≈1 sec duration)
Set up for SCS TVC mode
Monitor in P47
If failure intermittent, establish failure condition before doing burn (tapping/pushing panel, cycling/teasing sw).
Perform nominal SCS burn except:

- No SCS THRUST ph (failure turns eng on)

Burn prep

- cb SPS PILOT VLV (2) - open

TIG -1 min

- ΔV THRUST A(B) - NORM

[For single bank, use affected sw only. For dual bank or non-thrusting, sel affected bank sw if known, otherwise, test burn using bank A(B)]

TIG

- cb SPS PILOT VLV MNA (MNB) - close

[For single bank, use affected cb only. For dual bank or non-thrusting, close affected bank cb if known, otherwise, try test burn using bank A(B)]

IGNITION

- cb SPS PILOT VLV MNA (MNB) - open
- ΔV THRUST A(B) - OFF

NO IGNITION

- Wait ≈3 sec
- cb SPS PILOT VLV MNA (MNB) - open
- ΔV THRUST A(B) - OFF

(11) If no ignition in (10), failure on high side of thrust circuit. If cb did not open, may require longer time dependent on location & resistance of short.

REMARKS (CON'T)

(12) Alternate thrust proced (after fault isolated)

a. SPS THRUST lt circuit failure or normal single bank burns (using alt bank)
Perform nominal burn except:
Burn prep
- EMS FUNC - OFF
- cb EMS (2) - close

ECO
- EMS FUNC - OFF
- cb EMS (2) - open (turns SPS THRUST lt off)

b. Man thrust on/off using failed bank (for dual bank operation)
Perform nominal burn except:
Burn prep
- cb SPS PILOT VLV (2) - open (verify)
- EMS FUNC - OFF (verify)
- cb EMS (2) - close

TIG -1 min
- cb SPS PILOT VLV (operable bank) - close
- ΔV THRUST (2) - NORM

IGN +3 sec
- cb SPS PILOT VLV (failed bank) - close

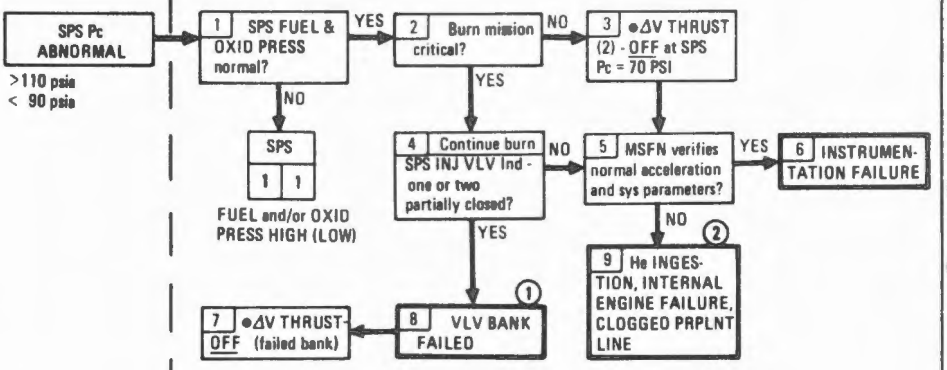
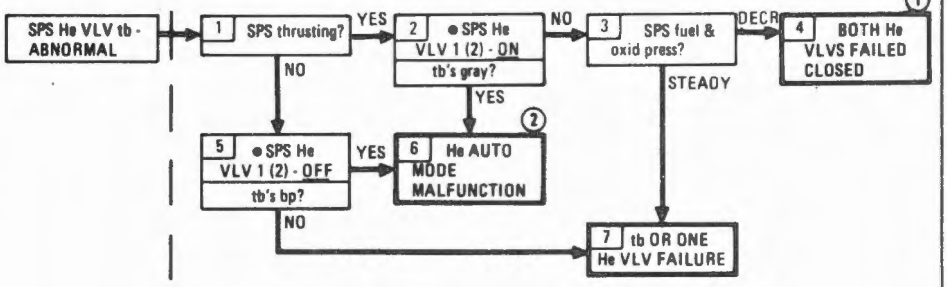
xxxxxxxxxxxxxxxxxx
x x
If SCS THC - +X THRUST ON pb - push
x x
xxxxxxxxxxxxxxxxxx

ECO [LOI: ECO -40 sec / TEI: ECO -10 sec]
- cb SPS PILOT VLV (failed bank) - open
- Use normal shutdown for operable bank
- cb EMS (2) - open

(13) If no ignition in (10), failure in SPS THRUST lt circuit. Auto on/off exists for both banks. Ignore SPS THRUST lt as cue for eng armed & thrust on/off. cb EMS (2) - open turns off SPS THRUST lt.

(14) If no ignition in (10), failure in alt bank. Repeat (10) to further isolate failure. If SPS THRUST lt no longer on, short may have fused, or if intermittent, short may be lost temporarily. If short cannot be re-established (tapping, cycling, etc.), both banks available (use auto thrust on/off).

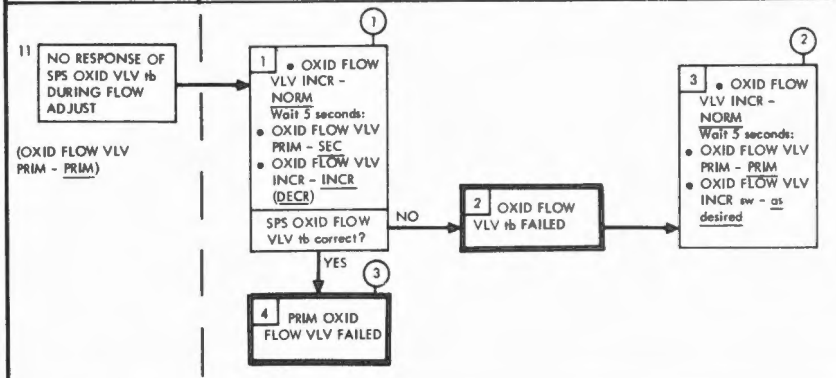
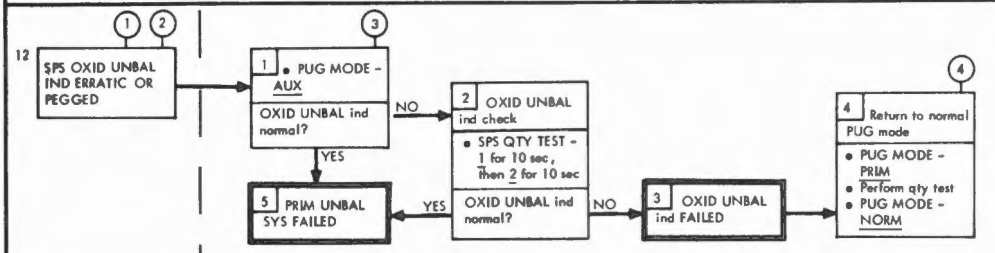
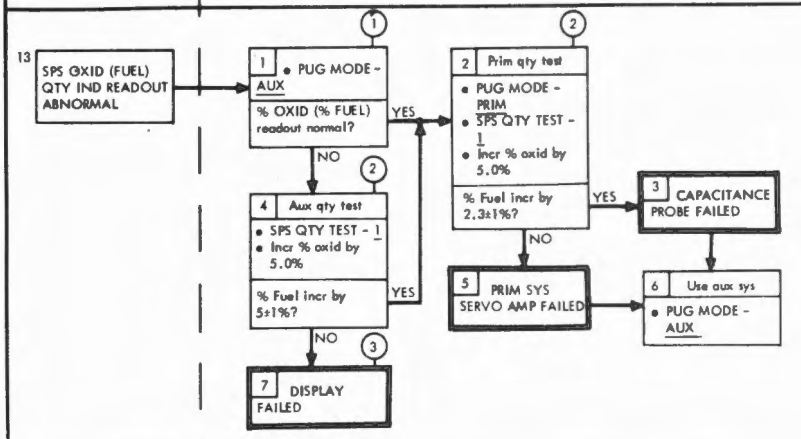
SM-2A-2425

SYMPTOM	PROCEDURE	REMARKS
● SPS Pc ABNORMAL >110 psia < 90 psia		(1) Failed bank should not be used except in an emergency. (2) SPS engine operable until engine indications require shutdown. Engine chugging may occur if SPS Pc is < 60 psi.
● SPS He VLV tb - ABNORMAL		(1) SPS engine operable until engine indications require shutdown. Engine chugging may occur if Pc is < 60 psi. Corresponding fuel & oxid pressure is ≈85 psia. (2) Open and close He valves manually for each burn.

SM-2A-14610

SYMPTOM	PROCEDURE	REMARKS
7 He PRESS LOW OR DECR	1 MSFN verifies SPS He PRESS low or decr? (1) YES → 2 LEAK IN He SUPPLY (2); NO → 3 He INSTRUMENTATION FAILURE	(1) MSFN will monitor redundant He press instrumentation. (2) He depletion imminent. SPS engine operable until engine indications require shutdown. Engine chugging may occur if SPS Pc is <60 psi. Corresponding fuel & oxid pressure is ≈85 psia.
8 GN2 A (B) PRESS LOW 400 PSI 8a SPS INJ VLV PARTIALLY OPEN	1 Ind check • SPS PRESS IND sw – N2A, (N2B), He Press normal? NO → 2 IND FAILED; YES → 3 GN_2 A (B) LEAK OR FAILED SNSR (1) → 4 • Operate engine on alternate bank	(1) Operation at <350 psi results in partially open ball vlvs and hazardous engine operation.
9 SPS INJ VLV IND ABNORMAL One open during non-thrusting One or two closed during burn period (or burn attempt)	1 SPS thrusting? YES → 2 Double or single bank operation? DOUBLE → 3 • Continue burn MSFN verifies vlv closed? YES → 4 ONE PAIR OF BALL VLVS FAILED CLOSED (1); NO → 6 INSTRUMENTATION FAILURE SINGLE → 5 INSTRUMENTATION FAILURE NO → 7 MFSN verifies vlv open? YES → 8 ONE PAIR OF BALL VLVS FAILED OPEN (1) → 10 • ΔV THRUST (Failed bank) – OFF (2); NO → 9 INSTRUMENTATION FAILURE	(1) SPS operable on redundant bank if one bank failed. (2) Failed bank should not be used except in an emergency.
10 NO PRPLNT TEMP CONTROL (1)	1 SPS PRPLNT TEMP ind? LOW AND DECR → 2 • SYS TEST (2) – 5A SPS oxid line temp low? NO → 3 INSTRUMENTATION FAILURE; YES → 6 • SPS LINE HTRS – A/B Temp incr? YES → 7 SPS LINE HTRS A INSUFFICIENT OR FAILED OFF; NO → 10 SPS LINE HTRS A & A/B FAILED OFF (4) HIGH AND INCR → 4 • SYS TEST (2) – 5A SPS oxid line temp high? YES → 5 SPS LINE HTRS FAILED ON → 9 • cb SPS LINE HTRS (2) – open; NO → 8 INSTRUMENTATION FAILURE (3)	(1) Normal range 45-75°F. (2) Assumes CSM not in inertial hold mode which might normally result in differences between SPS prplnt temp and SPS oxid line temp. (3) Use oxid line temp for SPS prplnt temp. (4) Prplnt temp may be incr by CSM orientation or by firing SPS engine. At 27°F the propellants become slushy and the fuel & oxid ratio becomes unpredictable.

SM-2A-1462K

SYMPTOM	PROCEDURE	REMARKS
11 NO RESPONSE OF SPS OXID VLV tb DURING FLOW ADJUST (OXID FLOW VLV PRIM - PRIM)		(1) OXID FLOW VLV INCR sw cannot operate unless power applied through a thrust on signal or through the SPS QTY TEST sw. If flow vlv position was changed by the SPS QTY TEST sw, % FUEL & % OXID quantity readouts must be returned to original values. (2) The secondary sliding gate vlv must be in the nominal flow position (rather than INCR or DECR) before switching to the prim oxid flow vlv or misalignment of the secondary vlv could make the primary vlv inoperative. (3) Sec vlv has sufficient range to compensate for prim vlv failure in any position and still provide vlv openings for INCR, NORM or DECR oxid flow.
12 SPS OXID UNBAL IND ERRATIC OR PEGGED		(1) Assumes qty indicating sys normal. (2) The unbalance meter will behave erratically for approximately 25 seconds after engine ignition. This is caused by propellant dynamics. (3) Assumes CSM is still thrusting. If thrust has terminated, proceed with step 2. (4) Actuation of SPS QTY TEST sw here will realign digital display to prim sys.
13 SPS OXID (FUEL) QTY IND READOUT ABNORMAL		(1) Assumes SPS is still thrusting. If thrusting terminated before step 1 is complete, proceed to step 4. (2) Complete thrusting prior to qty test. (3) MSFN must now supply any prplnt quantity data.

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RCS MALFUNCTION INDEX

1 SM RCS A(BCD)

YELLOW

1a SM RCS PKG TEMP LOW

1b SM RCS PKG TEMP HIGH

1c SM RCS SEC FUEL PRESS LOW

1d SM RCS SEC FUEL PRESS HIGH

2 SM RCS He PRESS LOW OR DECR

2a SM RCS PRPLNT QTY LOW OR DECR

3 CM RCS 1(2)

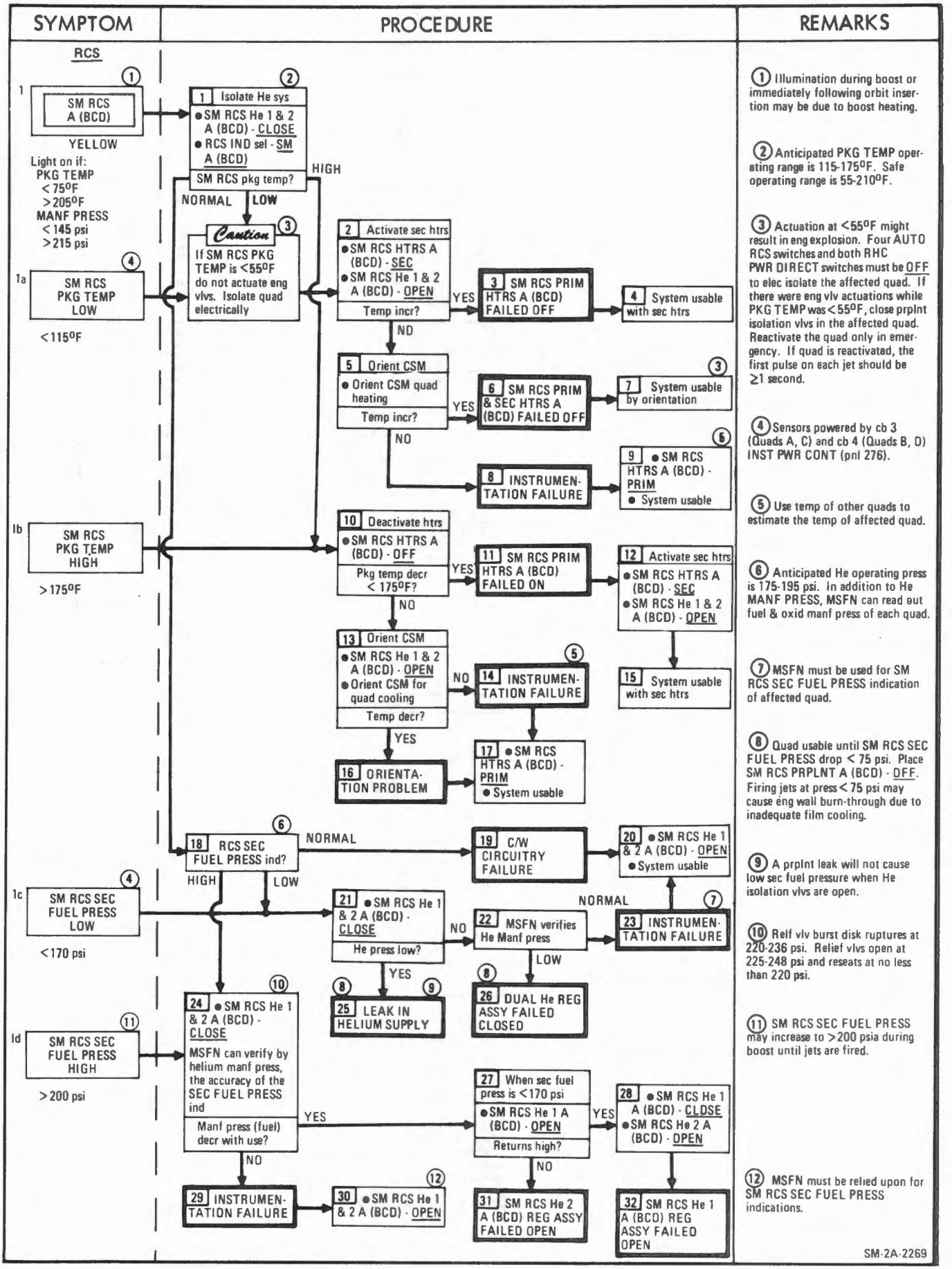
YELLOW

3a CM RCS MANF PRESS HIGH

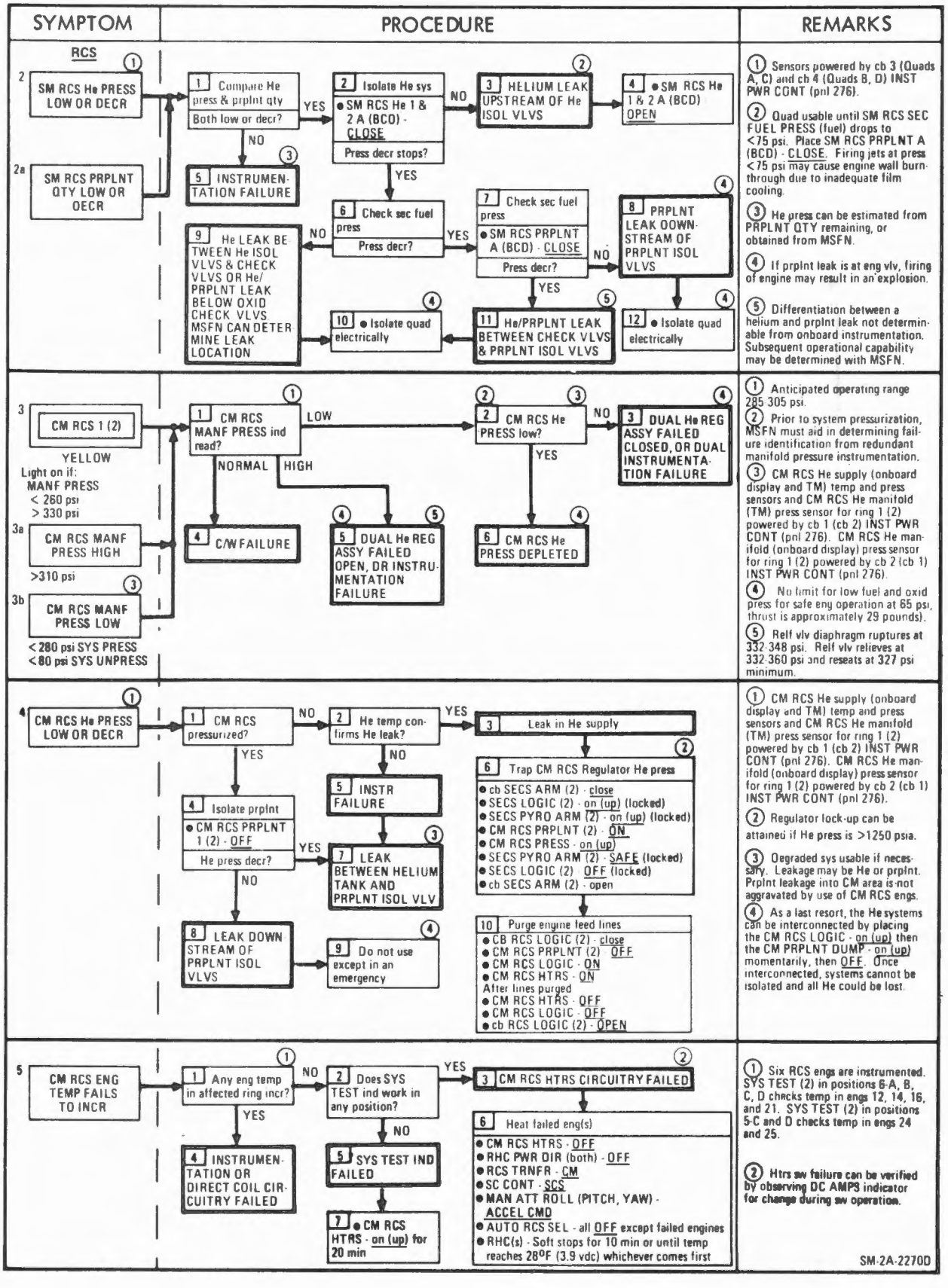
3b CM RCS MANF PRESS LOW

4 CM RCS He PRESS LOW OR DECR

5 CM RCS ENG TEMP FAILS TO INCR


SYMPTOM
PROCEDURE
REMARKS
RCS
1
SM RCS A (BCD)
YELLOW
Light on if:
PKG TEMP
< 75°F
> 205°F
MANF PRESS
< 145 psi
> 215 psi
1 Isolate He sys
• SM RCS He 1 & 2 A (BCD) - CLOSE
• RCS IND sel - SM A (BCD)
SM RCS pkg temp?
HIGH
NORMAL
LOW
Caution
If SM RCS PKG TEMP is <55°F do not actuate eng vlvs. Isolate quad electrically
1a
SM RCS PKG TEMP LOW
<115°F
2 Activate sec htrs
• SM RCS HTRS A (BCD) - SEC
• SM RCS He 1 & 2 A (BCD) - OPEN
Temp incr?
YES
NO
3 SM RCS PRIM HTRS A (BCD) FAILED OFF
4 System usable with sec htrs
5 Orient CSM
• Orient CSM quad heating
Temp incr?
6 SM RCS PRIM & SEC HTRS A (BCD) FAILED OFF
7 System usable by orientation
8 INSTRUMENTATION FAILURE
9 • SM RCS HTRS A (BCD) - PRIM
• System usable
1b
SM RCS PKG TEMP HIGH
>175°F
10 Deactivate htrs
• SM RCS HTRS A (BCD) - OFF
Pkg temp decr < 175°F?
11 SM RCS PRIM HTRS A (BCD) FAILED ON
12 Activate sec htrs
• SM RCS HTRS A (BCD) - SEC
• SM RCS He 1 & 2 A (BCD) - OPEN
13 Orient CSM
• SM RCS He 1 & 2 A (BCD) - OPEN
• Orient CSM for quad cooling
Temp decr?
14 INSTRUMENTATION FAILURE
15 System usable with sec htrs
16 ORIENTATION PROBLEM
17 • SM RCS HTRS A (BCD) - PRIM
• System usable
18 RCS SEC FUEL PRESS ind?
NORMAL
HIGH
LOW
19 C/W CIRCUITRY FAILURE
20 • SM RCS He 1 & 2 A (BCD) - OPEN
• System usable
1c
SM RCS SEC FUEL PRESS LOW
<170 psi
21 • SM RCS He 1 & 2 A (BCD) - CLOSE
He press low?
NO
YES
22 MSFN verifies He Manf press
NORMAL
LOW
23 INSTRUMENTATION FAILURE
25 LEAK IN HELIUM SUPPLY
26 DUAL He REG ASSY FAILED CLOSED
1d
SM RCS SEC FUEL PRESS HIGH
>200 psi
24 • SM RCS He 1 & 2 A (BCD) - CLOSE
MSFN can verify by helium manf press, the accuracy of the SEC FUEL PRESS ind
Manf press (fuel) decr with use?
YES
NO
27 When sec fuel press is <170 psi
• SM RCS He 1 A (BCD) - OPEN
Returns high?
YES
NO
28 • SM RCS He 1 A (BCD) - CLOSE
• SM RCS He 2 A (BCD) - OPEN
29 INSTRUMENTATION FAILURE
30 • SM RCS He 1 & 2 A (BCD) - OPEN
31 SM RCS He 2 A (BCD) REG ASSY FAILED OPEN
32 SM RCS He 1 A (BCD) REG ASSY FAILED OPEN
(1) Illumination during boost or immediately following orbit insertion may be due to boost heating.
(2) Anticipated PKG TEMP operating range is 115-175°F. Safe operating range is 55-210°F.
(3) Actuation at <55°F might result in eng explosion. Four AUTO RCS switches and both RHC PWR DIRECT switches must be OFF to elec isolate the affected quad. If there were eng vlv actuations while PKG TEMP was <55°F, close prplnt isolation vlvs in the affected quad. Reactivate the quad only in emergency. If quad is reactivatad, the first pulse on each jet should be ≥1 second.
(4) Sensors powered by cb 3 (Quads A, C) and cb 4 (Quads B, D) INST PWR CONT (pnl 276).
(5) Use temp of other quads to estimate the temp of affected quad.
(6) Anticipated He operating press is 175-195 psi. In addition to He MANF PRESS, MSFN can read out fuel & oxid manf press of each quad.
(7) MSFN must be used for SM RCS SEC FUEL PRESS indication of affected quad.
(8) Quad usable until SM RCS SEC FUEL PRESS drop < 75 psi. Place SM RCS PRPLNT A (BCD) - OFF. Firing jets at press < 75 psi may cause eng wall burn-through due to inadequate film cooling.
(9) A prplnt leak will not cause low sec fuel pressure when He isolation vlvs are open.
(10) Relf vlv burst disk ruptures at 220-236 psi. Relief vlvs open at 225-248 psi and reseats at no less than 220 psi.
(11) SM RCS SEC FUEL PRESS may increase to >200 psia during boost until jets are fired.
(12) MSFN must be relied upon for SM RCS SEC FUEL PRESS indications.
SM-2A-2269

2 HRU 5


SYMPTOM
PROCEDURE
REMARKS
RCS
2 SM RCS He PRESS LOW OR DECR
2a SM RCS PRPLNT QTY LOW OR DECR
1 Compare He press & prplnt qty
Both low or decr?
YES
NO
2 Isolate He sys
• SM RCS He 1 & 2 A (BCO) - CLOSE
Press decr stops?
NO
YES
3 HELIUM LEAK UPSTREAM OF He ISOL VLVS
4 • SM RCS He 1 & 2 A (BCD) OPEN
5 INSTRUMENTATION FAILURE
6 Check sec fuel press
Press decr?
NO
YES
7 Check sec fuel press
• SM RCS PRPLNT A (BCD) - CLOSE
Press decr?
NO
YES
8 PRPLNT LEAK DOWNSTREAM OF PRPLNT ISOL VLVS
9 He LEAK BETWEEN He ISOL VLVS & CHECK VLVS OR He/PRPLNT LEAK BELOW OXID CHECK VLVS MSFN CAN DETERMINE LEAK LOCATION
10 • Isolate quad electrically
11 He/PRPLNT LEAK BETWEEN CHECK VLVS & PRPLNT ISOL VLVS
12 • Isolate quad electrically
1 Sensors powered by cb 3 (Quads A, C) and cb 4 (Quads B, D) INST PWR CONT (pnl 276).
2 Quad usable until SM RCS SEC FUEL PRESS (fuel) drops to <75 psi. Place SM RCS PRPLNT A (BCD) - CLOSE. Firing jets at press <75 psi may cause engine wall burnthrough due to inadequate film cooling.
3 He press can be estimated from PRPLNT QTY remaining, or obtained from MSFN.
4 If prplnt leak is at eng vlv, firing of engine may result in an explosion.
5 Differentiation between a helium and prplnt leak not determinable from onboard instrumentation. Subsequent operational capability may be determined with MSFN.
3 CM RCS 1 (2)
YELLOW
Light on if:
MANF PRESS
< 260 psi
> 330 psi
3a CM RCS MANF PRESS HIGH
>310 psi
3b CM RCS MANF PRESS LOW
<280 psi SYS PRESS
<80 psi SYS UNPRESS
1 CM RCS MANF PRESS ind read?
LOW
NORMAL
HIGH
2 CM RCS He PRESS low?
NO
YES
3 DUAL He REG ASSY FAILED CLOSED, OR DUAL INSTRUMENTATION FAILURE
4 C/W FAILURE
5 DUAL He REG ASSY FAILED OPEN, OR INSTRUMENTATION FAILURE
6 CM RCS He PRESS DEPLETED
1 Anticipated operating range 285-305 psi.
2 Prior to system pressurization, MSFN must aid in determining failure identification from redundant manifold pressure instrumentation.
3 CM RCS He supply (onboard display and TM) temp and press sensors and CM RCS He manifold (TM) press sensor for ring 1 (2) powered by cb 1 (cb 2) INST PWR CONT (pnl 276). CM RCS He manifold (onboard display) press sensor for ring 1 (2) powered by cb 2 (cb 1) INST PWR CONT (pnl 276).
4 No limit for low fuel and oxid press for safe eng operation at 65 psi, thrust is approximately 29 pounds).
5 Relf vlv diaphragm ruptures at 332-348 psi. Relf vlv relieves at 332-360 psi and reseats at 327 psi minimum.
4 CM RCS He PRESS LOW OR DECR
1 CM RCS pressurized?
NO
YES
2 He temp confirms He leak?
YES
NO
3 Leak in He supply
4 Isolate prplnt
• CM RCS PRPLNT 1 (2) - OFF
He press decr?
YES
NO
5 INSTR FAILURE
6 Trap CM RCS Regulator He press
• cb SECS ARM (2) - close
• SECS LOGIC (2) - on (up) (locked)
• SECS PYRO ARM (2) - on (up) (locked)
• CM RCS PRPLNT (2) - ON
• CM RCS PRESS - on (up)
• SECS PYRO ARM (2) - SAFE (locked)
• SECS LOGIC (2) - OFF (locked)
• cb SECS ARM (2) - open
7 LEAK BETWEEN HELIUM TANK AND PRPLNT ISOL VLV
8 LEAK DOWNSTREAM OF PRPLNT ISOL VLVS
9 Do not use except in an emergency
10 Purge engine feed lines
• CB RCS LOGIC (2) - close
• CM RCS PRPLNT (2) - OFF
• CM RCS LOGIC - ON
• CM RCS HTRS - ON
After lines purged
• CM RCS HTRS - OFF
• CM RCS LOGIC - OFF
• cb RCS LOGIC (2) - OPEN
1 CM RCS He supply (onboard display and TM) temp and press sensors and CM RCS He manifold (TM) press sensor for ring 1 (2) powered by cb 1 (cb 2) INST PWR CONT (pnl 276). CM RCS He manifold (onboard display) press sensor for ring 1 (2) powered by cb 2 (cb 1) INST PWR CONT (pnl 276).
2 Regulator lock-up can be attained if He press is >1250 psia.
3 Degraded sys usable if necessary. Leakage may be He or prplnt. Prplnt leakage into CM area is not aggravated by use of CM RCS engs.
4 As a last resort, the He systems can be interconnected by placing the CM RCS LOGIC - on (up) then the CM PRPLNT DUMP - on (up) momentarily, then OFF. Once interconnected, systems cannot be isolated and all He could be lost.
5 CM RCS ENG TEMP FAILS TO INCR
1 Any eng temp in affected ring incr?
NO
YES
2 Does SYS TEST ind work in any position?
YES
NO
3 CM RCS HTRS CIRCUITRY FAILED
4 INSTRUMENTATION OR DIRECT COIL CIRCUITRY FAILED
5 SYS TEST IND FAILED
6 Heat failed eng(s)
• CM RCS HTRS - OFF
• RHC PWR DIR (both) - OFF
• RCS TRNFR - CM
• SC CONT - SCS
• MAN ATT ROLL (PITCH, YAW) - ACCEL CMD
• AUTO RCS SEL - all OFF except failed engines
• RHC(s) - Soft stops for 10 min or until temp reaches 28°F (3.9 vdc) whichever comes first
7 • CM RCS HTRS - on (up) for 20 min
1 Six RCS engs are instrumented. SYS TEST (2) in positions 6-A, B, C, D checks temp in engs 12, 14, 16, and 21. SYS TEST (2) in positions 5-C and D checks temp in engs 24 and 25.
2 Htrs sw failure can be verified by observing DC AMPS indicator for change during sw operation.
SM-2A-2270D

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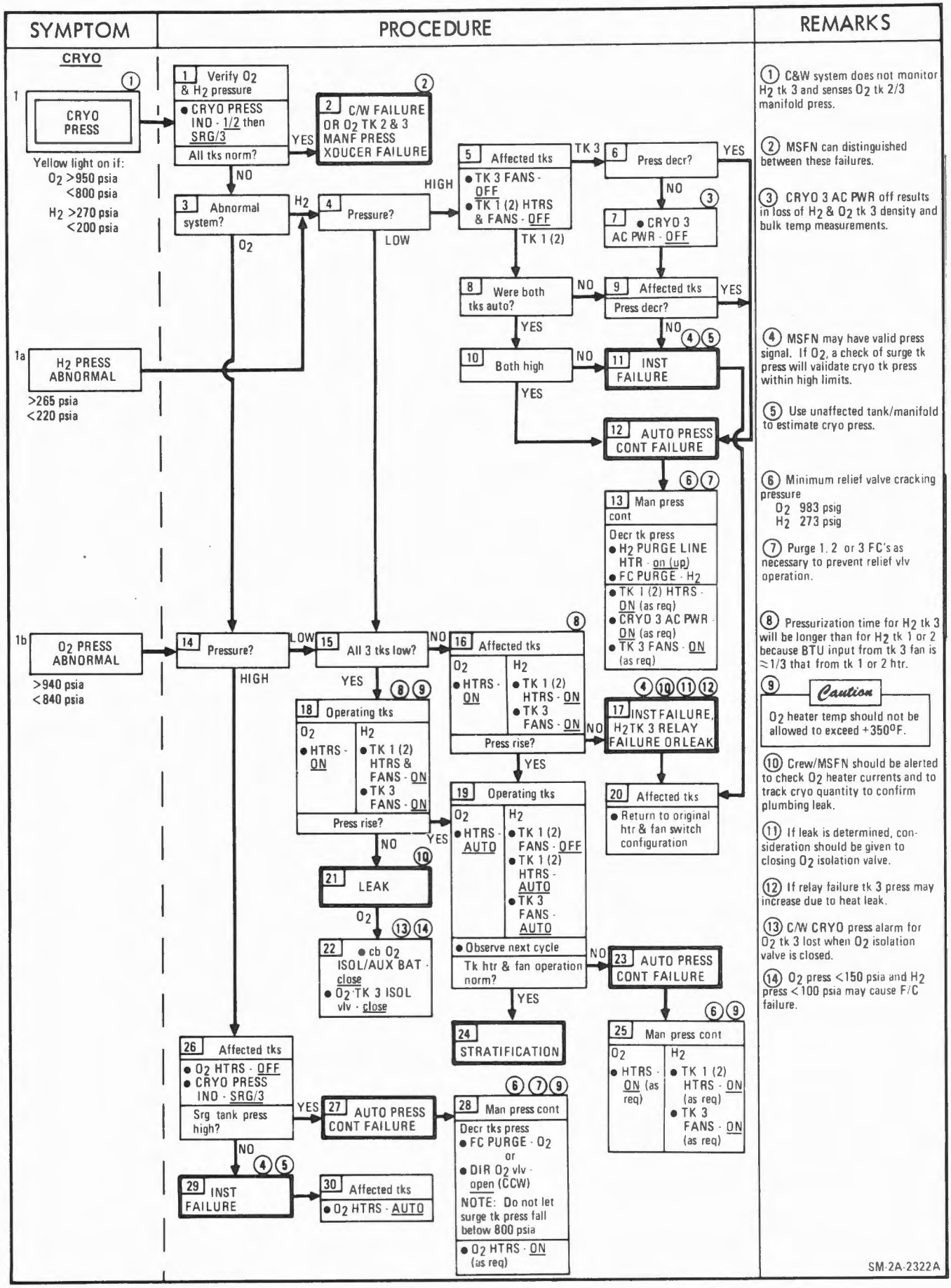
CRYO MALFUNCTION INDEX

1 CRYO PRESS

YELLOW

1a H_2 PRESS ABNORMAL

1b O_2 PRESS ABNORMAL


SYMPTOM
PROCEDURE
REMARKS
CRYO
1
CRYO PRESS
Yellow light on if:
O2 >950 psia
<800 psia
H2 >270 psia
<200 psia
1a
H2 PRESS ABNORMAL
>265 psia
<220 psia
1b
O2 PRESS ABNORMAL
>940 psia
<840 psia
1 Verify O2 & H2 pressure
• CRYO PRESS IND - 1/2 then SRG/3
All tks norm?
YES
NO
2 C/W FAILURE OR O2 TK 2 & 3 MANF PRESS XDUCER FAILURE
3 Abnormal system?
H2
O2
4 Pressure?
HIGH
LOW
5 Affected tks
• TK 3 FANS - OFF
• TK 1 (2) HTRS & FANS - OFF
TK 3
TK 1 (2)
6 Press decr?
YES
NO
7 • CRYO 3 AC PWR - OFF
8 Were both tks auto?
NO
YES
9 Affected tks
Press decr?
YES
NO
10 Both high
NO
YES
11 INST FAILURE
12 AUTO PRESS CONT FAILURE
13 Man press cont
Decr tk press
• H2 PURGE LINE HTR - on (up)
• FC PURGE - H2
• TK 1 (2) HTRS - ON (as req)
• CRYO 3 AC PWR - ON (as req)
• TK 3 FANS - ON (as req)
14 Pressure?
LOW
HIGH
15 All 3 tks low?
NO
YES
16 Affected tks
O2
• HTRS - ON
H2
• TK 1 (2) HTRS - ON
• TK 3 FANS - ON
Press rise?
NO
YES
17 INST FAILURE, H2TK 3 RELAY FAILURE OR LEAK
18 Operating tks
O2
• HTRS - ON
H2
• TK 1 (2) HTRS & FANS - ON
• TK 3 FANS - ON
Press rise?
YES
NO
19 Operating tks
O2
• HTRS - AUTO
H2
• TK 1 (2) FANS - OFF
• TK 1 (2) HTRS - AUTO
• TK 3 FANS - AUTO
• Observe next cycle
Tk htr & fan operation norm?
NO
YES
20 Affected tks
• Return to original htr & fan switch configuration
21 LEAK
O2
22 • cb O2 ISOL/AUX BAT - close
• O2 TK 3 ISOL vlv - close
23 AUTO PRESS CONT FAILURE
24 STRATIFICATION
25 Man press cont
O2
• HTRS - ON (as req)
H2
• TK 1 (2) HTRS - ON (as req)
• TK 3 FANS - ON (as req)
26 Affected tks
• O2 HTRS - OFF
• CRYO PRESS IND - SRG/3
Srg tank press high?
YES
NO
27 AUTO PRESS CONT FAILURE
28 Man press cont
Decr tks press
• FC PURGE - O2 or
• DIR O2 vlv - open (CCW)
NOTE: Do not let surge tk press fall below 800 psia
• O2 HTRS - ON (as req)
29 INST FAILURE
30 Affected tks
• O2 HTRS - AUTO
(1) C&W system does not monitor H2 tk 3 and senses O2 tk 2/3 manifold press.
(2) MSFN can distinguished between these failures.
(3) CRYO 3 AC PWR off results in loss of H2 & O2 tk 3 density and bulk temp measurements.
(4) MSFN may have valid press signal. If O2, a check of surge tk press will validate cryo tk press within high limits.
(5) Use unaffected tank/manifold to estimate cryo press.
(6) Minimum relief valve cracking pressure
O2 983 psig
H2 273 psig
(7) Purge 1, 2 or 3 FC's as necessary to prevent relief vlv operation.
(8) Pressurization time for H2 tk 3 will be longer than for H2 tk 1 or 2 because BTU input from tk 3 fan is ≈1/3 that from tk 1 or 2 htr.
(9) Caution
O2 heater temp should not be allowed to exceed +350°F.
(10) Crew/MSFN should be alerted to check O2 heater currents and to track cryo quantity to confirm plumbing leak.
(11) If leak is determined, consideration should be given to closing O2 isolation valve.
(12) If relay failure tk 3 press may increase due to heat leak.
(13) C/W CRYO press alarm for O2 tk 3 lost when O2 isolation valve is closed.
(14) O2 press <150 psia and H2 press <100 psia may cause F/C failure.
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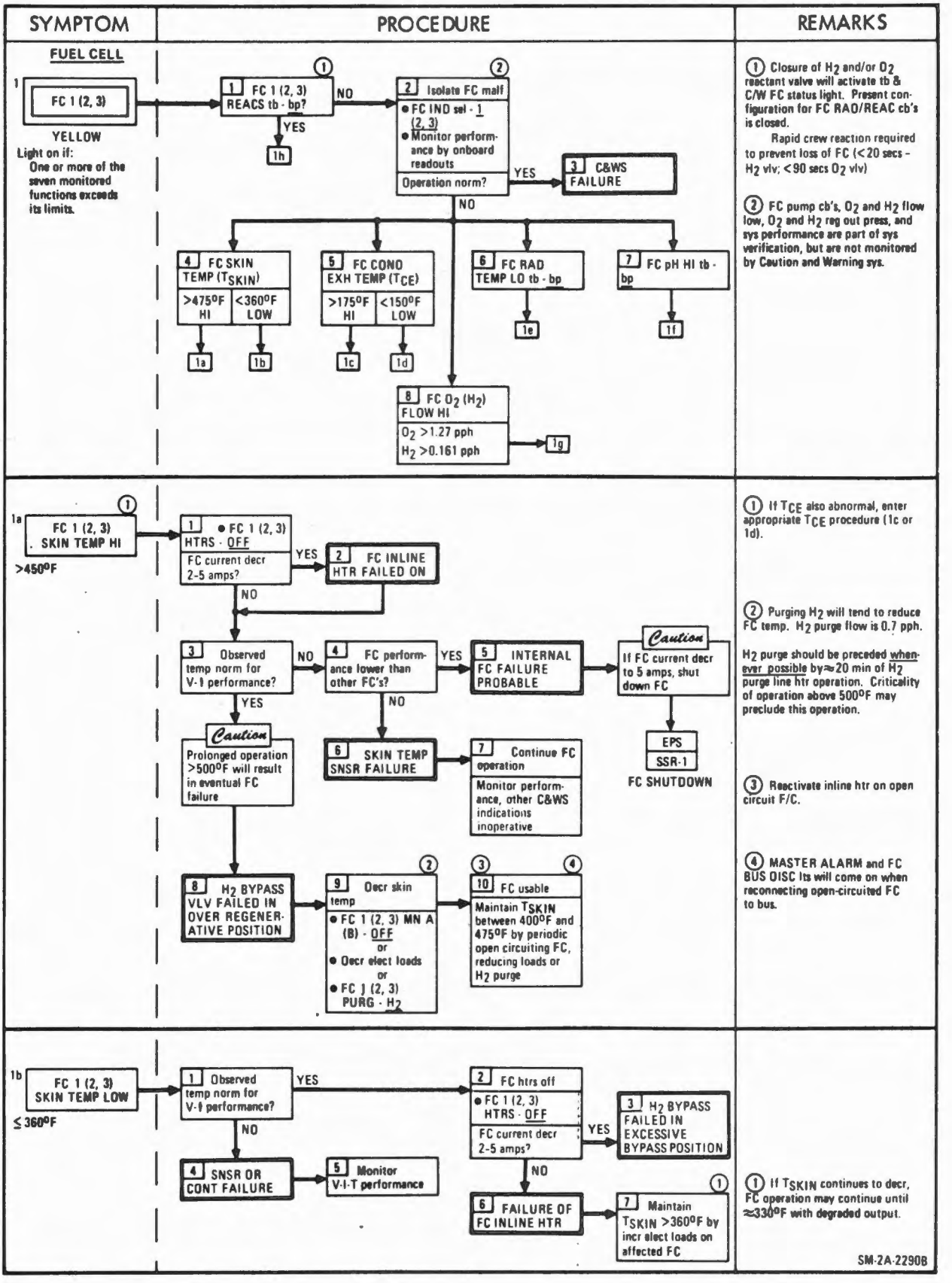
FUEL CELL MALFUNCTION INDEX

1 FC 1 (2,3)

YELLOW

1a FC 1 (2,3) SKIN TEMP HI
1b FC 1 (2,3) SKIN TEMP LOW
1c FC 1 (2,3) MOD COND EXH TEMP HI
1d FC 1 (2,3) COND EXH TEMP LOW
1e FC 1 (2,3) RAD TEMP LOW tb - bp
1f FC 1 (2,3) ph HI tb - bp
1g FC 1 (2,3) $O_2(H_2)$ FLOW HI
1h FC 1 (2,3) REACS tb - bp
2 FC 1 (2,3) $O_2(H_2)$ FLOW LOW
3 FC REG $O_2(H_2)$ OUT PRESS HI
4 cb FC 1 (2,3) PUMPS AC - OPEN
5 FC 1 (2,3) V-I-T PERFORMANCE LOW


SYMPTOM
PROCEDURE
REMARKS
FUEL CELL
1
FC 1 (2, 3)
YELLOW
Light on if:
One or more of the seven monitored functions exceeds its limits.
1 FC 1 (2, 3) REACS tb - bp?
NO
YES
1h
2 Isolate FC malf
• FC IND sel - 1 (2, 3)
• Monitor performance by onboard readouts
Operation norm?
YES
3 C&WS FAILURE
NO
4 FC SKIN TEMP (T_{SKIN})
>475°F HI
<360°F LOW
1a
1b
5 FC COND EXH TEMP (T_{CE})
>175°F HI
<150°F LOW
1c
1d
6 FC RAD TEMP LO tb - bp
1e
7 FC pH HI tb - bp
1f
8 FC O_2 (H_2) FLOW HI
O_2 >1.27 pph
H_2 >0.161 pph
1g
(1) Closure of H_2 and/or O_2 reactant valve will activate tb & C/W FC status light. Present configuration for FC RAD/REAC cb's is closed.
Rapid crew reaction required to prevent loss of FC (<20 secs - H_2 vlv; <90 secs O_2 vlv)
(2) FC pump cb's, O_2 and H_2 flow low, O_2 and H_2 reg out press, and sys performance are part of sys verification, but are not monitored by Caution and Warning sys.
1a
FC 1 (2, 3) SKIN TEMP HI
>450°F
1 • FC 1 (2, 3) HTRS - OFF
FC current decr 2-5 amps?
YES
2 FC INLINE HTR FAILED ON
NO
3 Observed temp norm for V-I performance?
NO
4 FC performance lower than other FC's?
YES
5 INTERNAL FC FAILURE PROBABLE
Caution
If FC current decr to 5 amps, shut down FC
EPS SSR-1
FC SHUTDOWN
YES
Caution
Prolonged operation >500°F will result in eventual FC failure
NO
6 SKIN TEMP SNSR FAILURE
7 Continue FC operation
Monitor performance, other C&WS indications inoperative
8 H_2 BYPASS VLV FAILED IN OVER REGENERATIVE POSITION
9 Decr skin temp
• FC 1 (2, 3) MN A (B) - OFF
or
• Decr elect loads
or
• FC 1 (2, 3) PURG - H_2
10 FC usable
Maintain T_{SKIN} between 400°F and 475°F by periodic open circuiting FC, reducing loads or H_2 purge
(1) If T_{CE} also abnormal, enter appropriate T_{CE} procedure (1c or 1d).
(2) Purging H_2 will tend to reduce FC temp. H_2 purge flow is 0.7 pph.
H_2 purge should be preceded whenever possible by≈20 min of H_2 purge line htr operation. Criticality of operation above 500°F may preclude this operation.
(3) Reactivate inline htr on open circuit F/C.
(4) MASTER ALARM and FC BUS OISC lts will come on when reconnecting open-circuited FC to bus.
1b
FC 1 (2, 3) SKIN TEMP LOW
≤360°F
1 Observed temp norm for V-I performance?
YES
NO
4 SNSR OR CONT FAILURE
5 Monitor V-I-T performance
2 FC htrs off
• FC 1 (2, 3) HTRS - OFF
FC current decr 2-5 amps?
YES
3 H_2 BYPASS FAILED IN EXCESSIVE BYPASS POSITION
NO
6 FAILURE OF FC INLINE HTR
7 Maintain T_{SKIN} >360°F by incr elect loads on affected FC
(1) If T_{SKIN} continues to decr, FC operation may continue until ≈330°F with degraded output.
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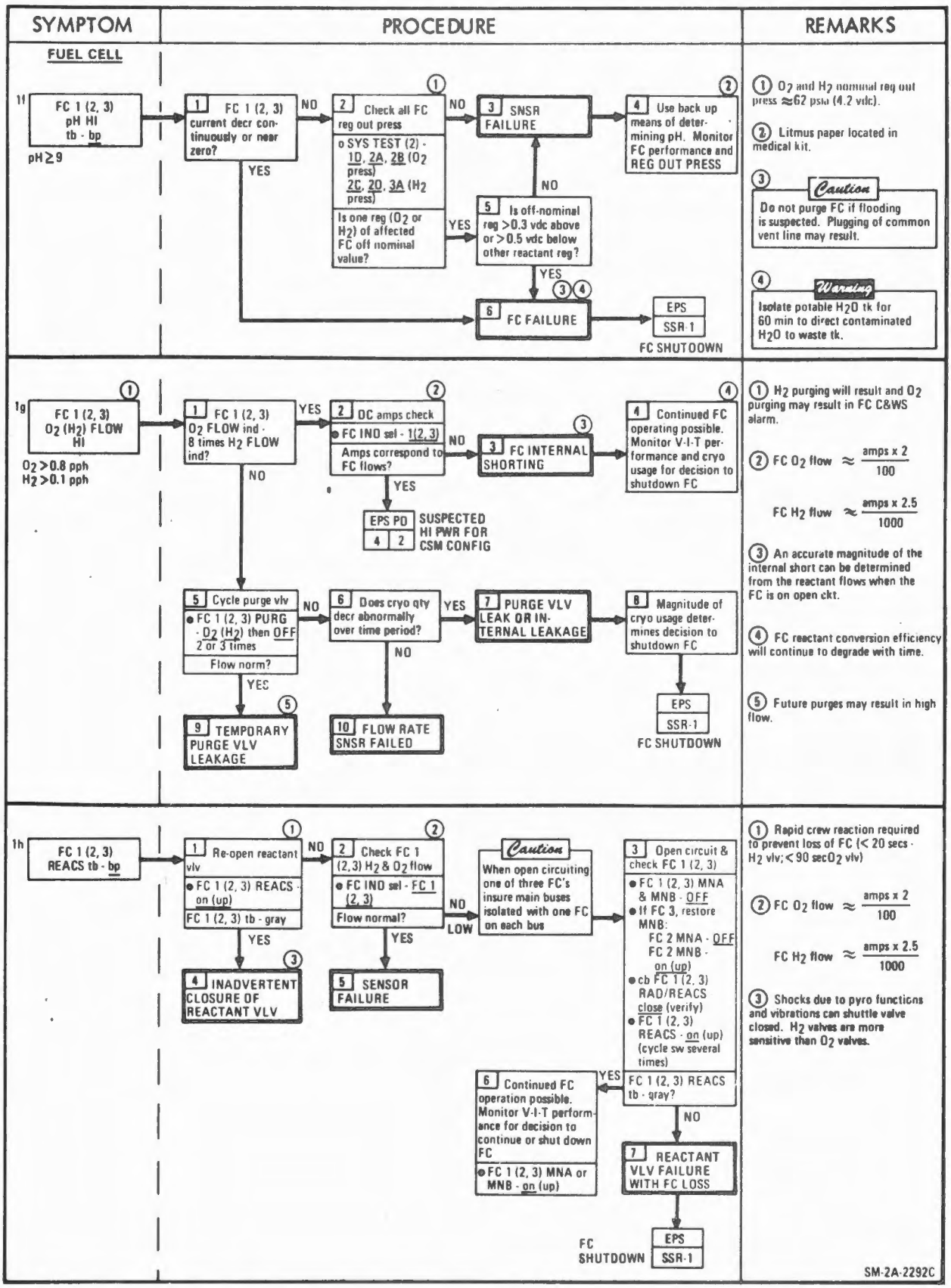
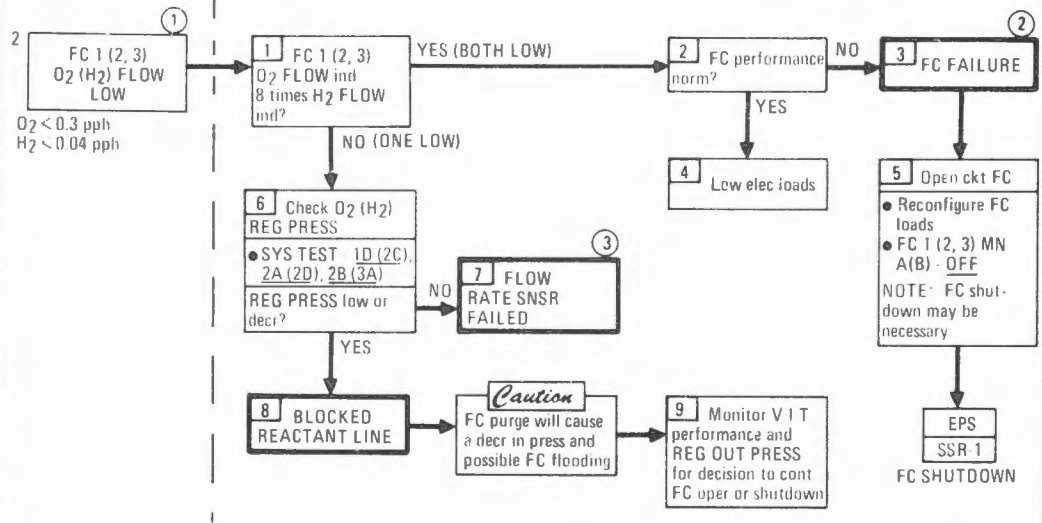
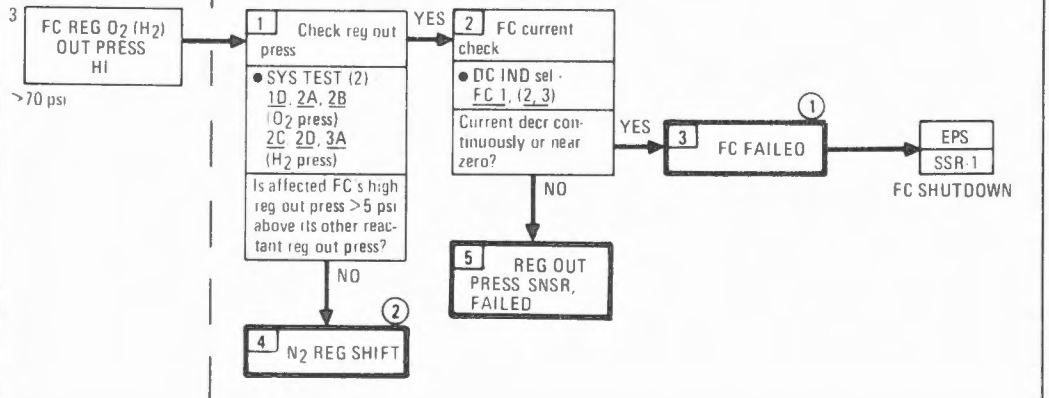
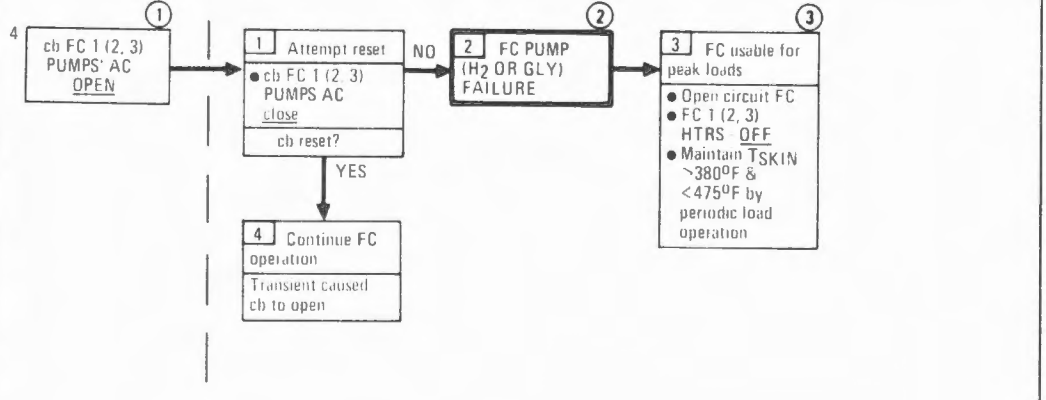
e

SYMPTOM	PROCEDURE	REMARKS
FUEL CELL 1c FC 1 (2, 3) CONO EXH TEMP HI >175°F	1 Rate of incr >10°F per minute? (1) YES → 2 Initiate 5 min H_2 purge; T_{CE} decr? (2) NO → 3 T_{SKIN} incr in <30 min? (3) YES → 4 GLYCOL PUMP FAILURE (4) 1 NO → 5 T_{CE} stabilizes <215°F? NO → 1; YES → 8 T_{SKIN} incr relative to other FC's? (3) YES → 9 COOLANT B/P VALVE FAILED IN OVER REGENERATIVE POSITION OR FLOW RESTRICTION (7) → 10 FC usable maintain T_{CE} <225°F & T_{SKIN} >380°F & <475°F by H_2 purging for cooling, water removal and open ckt if reqd. (6) 8 NO → 11 SENSOR OR SIG COND FAILURE 3 NO → 6 SENSOR OR SIG COND FAILURE 4 (5) (6) → 7 FC usable for peak loads: • Open circuit FC 1 (2, 3) • FC 1 (2,3) PUMPS - OFF • FC 1 (2, 3) HTRS - OFF • Maintain T_{SKIN} >380°F & <475°F by periodic load operation	(1) Cyclic overheats to 250°F may be tolerated. Use H_2 purge to prevent steady state T_{CE} from exceeding 225°F at 25 amps. (2) If possible, H_2 PURGE LINE HTR should be ON (up) 20 min prior to purge. (3) FC load changes may affect rates of temperature change. (4) If coolant pump failure is confirmed by MSFN reporting rad in and rad out temps converging, turn FC PUMPS - OFF for affected FC. (5) Loss of glycol pump will result in loss of H_2 pump due to overheating. H_2 pump loss will result in in-line htr burn out if used. (6) MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus. (7) MSFN can determine if reduced flow condition exists.
1d FC 1 (2, 3) COND EXH TEMP LOW (1) <150°F	1 cb's FC 1 (2,3) PUMPS AC? CLOSE → 2 T_{SKIN} hi and/or rising? (≃ 40°/hr) YES → 3 FC H_2 PUMP OPEN CKT FAILURE (2) (3) → 4 FC usable for peak loads: • Open ckt FC 1 (2, 3) • FC 1 (2, 3) HTRS - OFF • Maintain T_{SKIN} >380°F & <475°F by periodic load operation 1 OPEN → FC 4 1 cb FC 1 (2, 3) PUMPS AC - OPEN 2 NO → 5 V-I-T performance normal and compatible with other FC's? NO → FC 5 1 V-I-T PERFORMANCE LOW 5 YES → 6 SYS TEST - 3B, (3C, 3D) rad temp out; Temp <-30°F? NO → 7 T_{CE} cycles greater than other FC's following load changes or T_{SKIN} decr in 30 min? NO → 8 FC CONO EXH SNSR FAILURE 6 YES → 9 Incr elect loads and/or orient CSM (4) 7 YES → (1) 10 COOLANT BYPASS VLV FAILED IN EXCESSIVE B/P POSITION (5)	(1) Low T_{CE} is no restriction to FC operation if rad out and T_{SKIN} are maintained within limits. (2) If H_2 pump is not running, inline htr will burn out if used. (3) MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus (4) Since continuous operation with rad out temp <-30°F may result in rad freezing or high pressure drop and pump stall, consideration may be given to rad bypass. However, this procedure may be an irreversible action. (5) Performance may be improved due to electrolyte dehydration. Voltage should be maintained within limits.
1e FC 1 (2, 3) RAD TEMP LOW th · bp <-30°F	1 T_{CE} normal? NO → 2 T_{CE} >175°F → FC 1c 1 T_{CE} HI 2 NO → 3 T_{CE} <150°F → FC 1d 1 T_{CE} LOW 1 YES → 4 Compare rad out temps • SYS TEST - 3B, 3C, 3D All temps low? YES → Warning: Uncorrected condition could result in loss of all FC's → 5 Rad heat rejection excessive for elect loads → (1) 6 • Orient rad pnl 8 (+Z axis) toward sun • Incr elect loads 4 NO → (2) 7 RAD TEMP SNSR FAILURE	(1) Since continuous operation with rad out temp <-30°F may result in rad freezing or high pressure drop and pump stall, consideration may be given to rad bypass. However, this procedure may be an irreversible action. (2) Use other FC rad out temp's for confirmation or MSFN can confirm snsr failure from FC rad inlet temp's.

SM-2A-2291


SYMPTOM
PROCEDURE
REMARKS
FUEL CELL
1f
FC 1 (2, 3) pH HI tb - bp
pH ≥ 9
1 FC 1 (2, 3) current decr continuously or near zero?
NO
YES
2 Check all FC reg out press
o SYS TEST (2) - 1D, 2A, 2B (O2 press) 2C, 2D, 3A (H2 press)
Is one reg (O2 or H2) of affected FC off nominal value?
NO
YES
3 SNSR FAILURE
4 Use back up means of determining pH. Monitor FC performance and REG OUT PRESS
5 Is off-nominal reg >0.3 vdc above or >0.5 vdc below other reactant reg?
NO
YES
6 FC FAILURE
EPS
SSR-1
FC SHUTDOWN
1g
FC 1 (2, 3) O2 (H2) FLOW HI
O2 >0.8 pph
H2 >0.1 pph
1 FC 1 (2, 3) O2 FLOW ind - 8 times H2 FLOW ind?
YES
NO
2 DC amps check
• FC IND sel - 1(2, 3)
Amps correspond to FC flows?
NO
YES
3 FC INTERNAL SHORTING
4 Continued FC operating possible. Monitor V-I-T performance and cryo usage for decision to shutdown FC
EPS PD 4 2 SUSPECTED HI PWR FOR CSM CONFIG
5 Cycle purge vlv
• FC 1 (2, 3) PURG - O2 (H2) then OFF 2 or 3 times
Flow norm?
NO
YES
6 Does cryo qty decr abnormally over time period?
YES
NO
7 PURGE VLV LEAK OR INTERNAL LEAKAGE
8 Magnitude of cryo usage determines decision to shutdown FC
EPS
SSR-1
FC SHUTDOWN
9 TEMPORARY PURGE VLV LEAKAGE
10 FLOW RATE SNSR FAILED
1h
FC 1 (2, 3) REACS tb - bp
1 Re-open reactant vlv
• FC 1 (2, 3) REACS - on (up)
FC 1 (2, 3) tb - gray
NO
YES
2 Check FC 1 (2, 3) H2 & O2 flow
• FC IND sel - FC 1 (2, 3)
Flow normal?
NO
LOW
YES
Caution
When open circuiting one of three FC's insure main buses isolated with one FC on each bus
3 Open circuit & check FC 1 (2, 3)
• FC 1 (2, 3) MNA & MNB - OFF
• If FC 3, restore MNB: FC 2 MNA - OFF FC 2 MNB - on (up)
• cb FC 1 (2, 3) RAD/REACS close (verify)
• FC 1 (2, 3) REACS - on (up) (cycle sw several times)
FC 1 (2, 3) REACS tb - gray?
YES
NO
4 INADVERTENT CLOSURE OF REACTANT VLV
5 SENSOR FAILURE
6 Continued FC operation possible. Monitor V-I-T performance for decision to continue or shut down FC
• FC 1 (2, 3) MNA or MNB - on (up)
7 REACTANT VLV FAILURE WITH FC LOSS
FC SHUTDOWN
EPS
SSR-1
SM-2A-2292C
1 O2 and H2 nominal reg out press ≈62 psia (4.2 vdc).
2 Litmus paper located in medical kit.
3 Caution
Do not purge FC if flooding is suspected. Plugging of common vent line may result.
4 Warning
Isolate potable H2O tk for 60 min to direct contaminated H2O to waste tk.
1 H2 purging will result and O2 purging may result in FC C&WS alarm.
2 FC O2 flow ≈ amps x 2 / 100
FC H2 flow ≈ amps x 2.5 / 1000
3 An accurate magnitude of the internal short can be determined from the reactant flows when the FC is on open ckt.
4 FC reactant conversion efficiency will continue to degrade with time.
5 Future purges may result in high flow.
1 Rapid crew reaction required to prevent loss of FC (< 20 secs - H2 vlv; < 90 sec O2 vlv)
2 FC O2 flow ≈ amps x 2 / 100
FC H2 flow ≈ amps x 2.5 / 1000
3 Shocks due to pyro functions and vibrations can shuttle valve closed. H2 valves are more sensitive than O2 valves.

2 HRU 4

SYMPTOM	PROCEDURE	REMARKS
FUEL CELL		(1) FC flow and press instrumentation powered by INST PWR CONT cb's (pnl 276). (2) Flood ing is most probable cause. Isolate potable tank to direct possible contaminated H_2O to waste tank until FC condition is postively determined. (3) Other reactant indicator may be used for affected flow indication.
		(1) pH HI tb may indicate bp. If so, isolate potable H_2O tank for 60 min. to direct contaminated H_2O to waste tank. (2) Failure of N_2 regulator will raise H_2, O_2, and N_2 press but not dangerously. FC should continue to operate at new press with slight performance change. Heat transfer will not be affected by incr in accumulator press.
		(1) This condition will result in low T_{CE} and or high T_{SKIN}. (2) pH snsr lost since power is common to pumps (3) MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus.

SM-2A-2293

SYMPTOM	PROCEDURE	REMARKS

FUEL CELL

5 FC 1 (2, 3) V-I-T PERFORMANCE LOW

1 Compare V-I-T performance of all FC's
- Record V-I-T for each FC
- Compare with V-I-T curves

Performance low on all FC's?

YES → 2 Potable & waste tanks full? (1)

NO (1 FC LOW) → 6 Purge 1 FC (2)

2 Potable & waste tanks full? (1)

YES → ECS 31a 9 → WASTE H_2O OVERBOARD DUMP NOT DRAINING

NO → 3 Purge all FC (2)
- H_2 PURG LINE HTR - on (up), 20 min prior to purge
- FC 1, 2, 3 PURG - O_2 for 2 min then - OFF
- FC 1, 2, 3 PURG - H_2 for 1 min 20 sec then OFF

Performance improved on all FC's?

YES → 4 CONTAMINATION IN REACTANTS OR PURGE INEFFICIENCY → 5 Repeat purge: Continue purging as long as improved performance results

NO → 8 OC volt check (3)
- DC IND sel - BAT C

Voltage 34-38V?

YES → 9 DC AMPS IND FAILURE (3)

NO → 11 OC VOLTS IND FAILURE

6 Purge 1 FC (2)
- H_2 PURG LINE HTR - on (up) 20 min prior to purge
- FC 1, (2, 3) PURG - O_2 for 2 min then - OFF
- FC 1, (2, 3) PURG - H_2 for 1 min 20 sec, then OFF

Performance improved?

YES → 7 TEMPORARY DEGRADATION IN FC PERFORMANCE → 10 Repeat purge: Continue purging as long as improved performance results

NO → 13 Affected FC current output much lower than other FC's and T_{SKIN} ≃ or lower? (4)

YES → 14 Currents correspond to FC flow? (3)

YES → 15 INTERNAL FC FAILURE → Caution: If FC current decr to 5 amps, shut down FC → EPS SSR 1 → FC SHUTDOWN

NO → 16 T_{SKIN} SNSR FAILURE

NO → 17 Open ckt affected FC (5)
- FC 1, (2, 3) HTR - OFF
- DC IND sel - FC 1 (2, 3)
- Open ckt affected FC (momentarily)

FC flow > 0?

NO → 18 AMMETER CIRCUITRY SHIFT (6)

YES → 19 INTERNAL FC SHORT (≃FC FLOW)

(1) If both potable & waste H_2O tanks are full, possible freezing of waste H_2O dump line may be cause.

(2) Verify purge flow by incr in reactant flow.

(3) Ammeter accuracy can be verified by FC reactant flow

$$FC\ O_2\ flow \simeq \frac{amps \times 2}{100}$$

$$FC\ H_2\ flow \simeq \frac{amps \times 2.5}{1000}$$

(4) If only 2 FC's are in operation, both FC's should be tied to both buses for this check. Time must be allowed for T_{SKIN} to stabilize.

(5) MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus.

(6) Use reactant flow rates to estimate current.

SM 2A-2294A

5

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PWR DISTR MALFUNCTION INDEX

1 [MN BUS A(B) UNDERVOLT] YELLOW

1a [AS BUS 1(2)] YELLOW

1b [AC BUS 1(2) OVERLOAD] YELLOW

1c MN BUS A(B) INDICATES < 26 VDC

1d AC BUS 1(2) VOLTAGE LOW

1e AC BUS 1(2) VOLTAGE HIGH

2 [INV 1(2,3) TEMP HI] YELLOW

3 [FC BUS DISCONNECT] YELLOW

4 SUSPECTED HI CURRENT FOR CSM CONFIG

5 BAT CHGR CURRENT ZERO

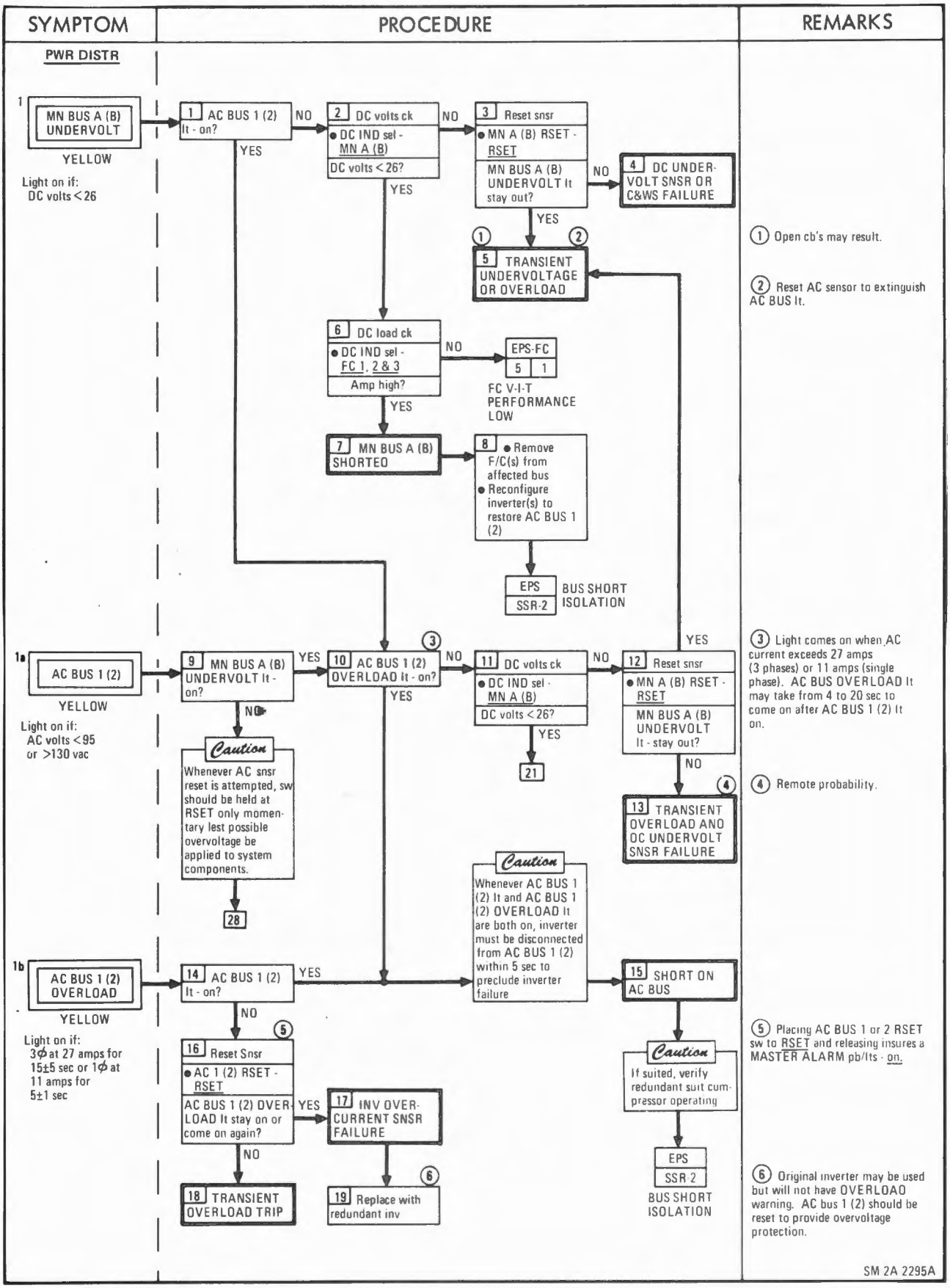
6 BAT BUS A(B) CURRENT > 1.0 WITH MN BUS TIE(2) - OFF

6a FC tb's ALL GRAY

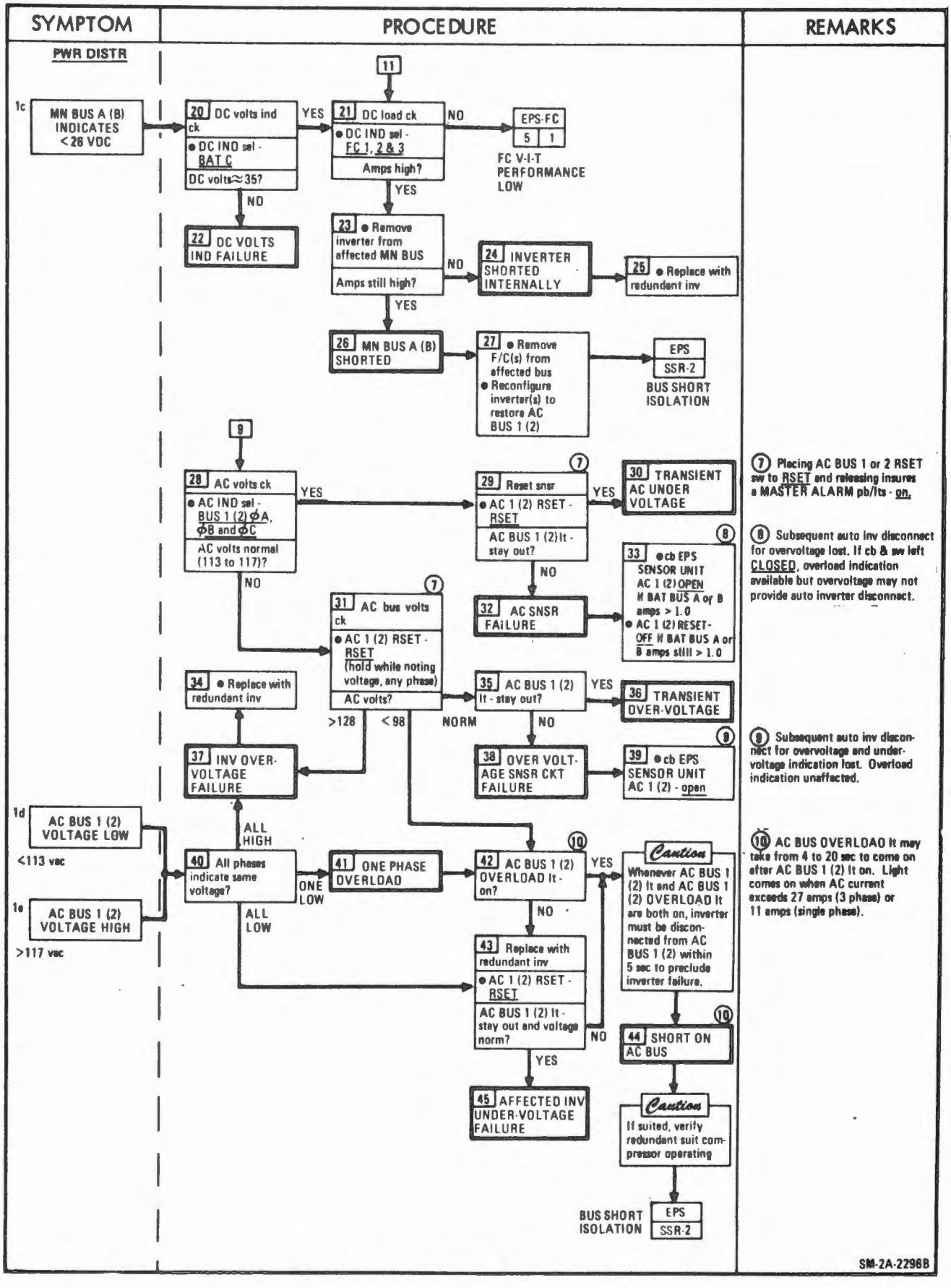
7 PYRO BAT VOLTAGE < 35 VDC

SSR-1 FUEL CELL SHUTDOWN

SSR-2 BUS SHORT ISOLATION


SYMPTOM
PROCEDURE
REMARKS
PWR DISTR
1
MN BUS A (B) UNDERVOLT
YELLOW
Light on if:
DC volts < 26
1 AC BUS 1 (2) lt - on?
NO
YES
2 DC volts ck
• DC IND sel - MN A (B)
DC volts < 26?
NO
YES
3 Reset snsr
• MN A (B) RSET - RSET
MN BUS A (B) UNDERVOLT lt stay out?
NO
YES
4 DC UNDERVOLT SNSR OR C&WS FAILURE
(1) (2)
5 TRANSIENT UNDERVOLTAGE OR OVERLOAD
6 DC load ck
• DC IND sel - FC 1, 2 & 3
Amp high?
NO
YES
EPS-FC 5 1
FC V-I-T PERFORMANCE LOW
7 MN BUS A (B) SHORTED
8 • Remove F/C(s) from affected bus
• Reconfigure inverter(s) to restore AC BUS 1 (2)
EPS SSR-2
BUS SHORT ISOLATION
1a
AC BUS 1 (2)
YELLOW
Light on if:
AC volts < 95 or > 130 vac
9 MN BUS A (B) UNDERVOLT lt - on?
YES
NO
Caution
Whenever AC snsr reset is attempted, sw should be held at RSET only momentary lest possible overvoltage be applied to system components.
28
(3)
10 AC BUS 1 (2) OVERLOAD lt - on?
NO
YES
11 DC volts ck
• DC IND sel - MN A (B)
DC volts < 26?
NO
YES
21
12 Reset snsr
• MN A (B) RSET - RSET
MN BUS A (B) UNDERVOLT lt - stay out?
YES
NO
(4)
13 TRANSIENT OVERLOAD AND DC UNDERVOLT SNSR FAILURE
1b
AC BUS 1 (2) OVERLOAD
YELLOW
Light on if:
3φ at 27 amps for 15±5 sec or 1φ at 11 amps for 5±1 sec
14 AC BUS 1 (2) lt - on?
YES
NO
Caution
Whenever AC BUS 1 (2) lt and AC BUS 1 (2) OVERLOAD lt are both on, inverter must be disconnected from AC BUS 1 (2) within 5 sec to preclude inverter failure
15 SHORT ON AC BUS
Caution
If suited, verify redundant suit compressor operating
EPS SSR-2
BUS SHORT ISOLATION
(5)
16 Reset Snsr
• AC 1 (2) RSET - RSET
AC BUS 1 (2) OVERLOAD lt stay on or come on again?
YES
NO
17 INV OVERCURRENT SNSR FAILURE
(6)
19 Replace with redundant inv
18 TRANSIENT OVERLOAD TRIP
(1) Open cb's may result.
(2) Reset AC sensor to extinguish AC BUS lt.
(3) Light comes on when AC current exceeds 27 amps (3 phases) or 11 amps (single phase). AC BUS OVERLOAD lt may take from 4 to 20 sec to come on after AC BUS 1 (2) lt on.
(4) Remote probability.
(5) Placing AC BUS 1 or 2 RSET sw to RSET and releasing insures a MASTER ALARM pb/lts - on.
(6) Original inverter may be used but will not have OVERLOAD warning. AC bus 1 (2) should be reset to provide overvoltage protection.
SM 2A 2295A

1c THRU 1e


SYMPTOM
PROCEDURE
REMARKS
PWR DISTR
1c MN BUS A (B) INDICATES <26 VDC
20 DC volts ind ck
• DC IND sel - BAT C
DC volts≈35?
YES
NO
21 DC load ck
• DC IND sel - FC 1, 2 & 3
Amps high?
NO
EPS-FC 5 1
FC V-I-T PERFORMANCE LOW
YES
22 DC VOLTS IND FAILURE
11
23 • Remove inverter from affected MN BUS
Amps still high?
NO
24 INVERTER SHORTED INTERNALLY
25 • Replace with redundant inv
YES
26 MN BUS A (B) SHORTED
27 • Remove F/C(s) from affected bus
• Reconfigure inverter(s) to restore AC BUS 1 (2)
EPS SSR-2
BUS SHORT ISOLATION
9
28 AC volts ck
• AC IND sel - BUS 1 (2) ΦA, ΦB and ΦC
AC volts normal (113 to 117)?
YES
NO
7
29 Reset snsr
• AC 1 (2) RSET - RSET
AC BUS 1 (2) lt - stay out?
YES
30 TRANSIENT AC UNDER VOLTAGE
NO
8
33 • cb EPS SENSOR UNIT AC 1 (2) OPEN
If BAT BUS A or B amps > 1.0
• AC 1 (2) RESET - OFF If BAT BUS A or B amps still > 1.0
32 AC SNSR FAILURE
7
31 AC bus volts ck
• AC 1 (2) RSET - RSET (hold while noting voltage, any phase)
AC volts?
>128
<98
NORM
34 • Replace with redundant inv
35 AC BUS 1 (2) lt - stay out?
YES
36 TRANSIENT OVER-VOLTAGE
NO
9
38 OVER VOLTAGE SNSR CKT FAILURE
39 • cb EPS SENSOR UNIT AC 1 (2) - open
37 INV OVER-VOLTAGE FAILURE
1d AC BUS 1 (2) VOLTAGE LOW
<113 vac
1e AC BUS 1 (2) VOLTAGE HIGH
>117 vac
ALL HIGH
40 All phases indicate same voltage?
ONE LOW
ALL LOW
41 ONE PHASE OVERLOAD
10
42 AC BUS 1 (2) OVERLOAD lt - on?
YES
NO
Caution
Whenever AC BUS 1 (2) lt and AC BUS 1 (2) OVERLOAD lt are both on, inverter must be disconnected from AC BUS 1 (2) within 5 sec to preclude inverter failure.
43 Replace with redundant inv
• AC 1 (2) RSET - RSET
AC BUS 1 (2) lt - stay out and voltage norm?
NO
YES
10
44 SHORT ON AC BUS
Caution
If suited, verify redundant suit compressor operating
45 AFFECTED INV UNDER-VOLTAGE FAILURE
BUS SHORT ISOLATION
EPS SSR-2
(7) Placing AC BUS 1 or 2 RSET sw to RSET and releasing insures a MASTER ALARM pb/lts - on.
(8) Subsequent auto inv disconnect for overvoltage lost. If cb & sw left CLOSED, overload indication available but overvoltage may not provide auto inverter disconnect.
(9) Subsequent auto inv disconnect for overvoltage and under-voltage indication lost. Overload indication unaffected.
(10) AC BUS OVERLOAD lt may take from 4 to 20 sec to come on after AC BUS 1 (2) lt on. Light comes on when AC current exceeds 27 amps (3 phase) or 11 amps (single phase).
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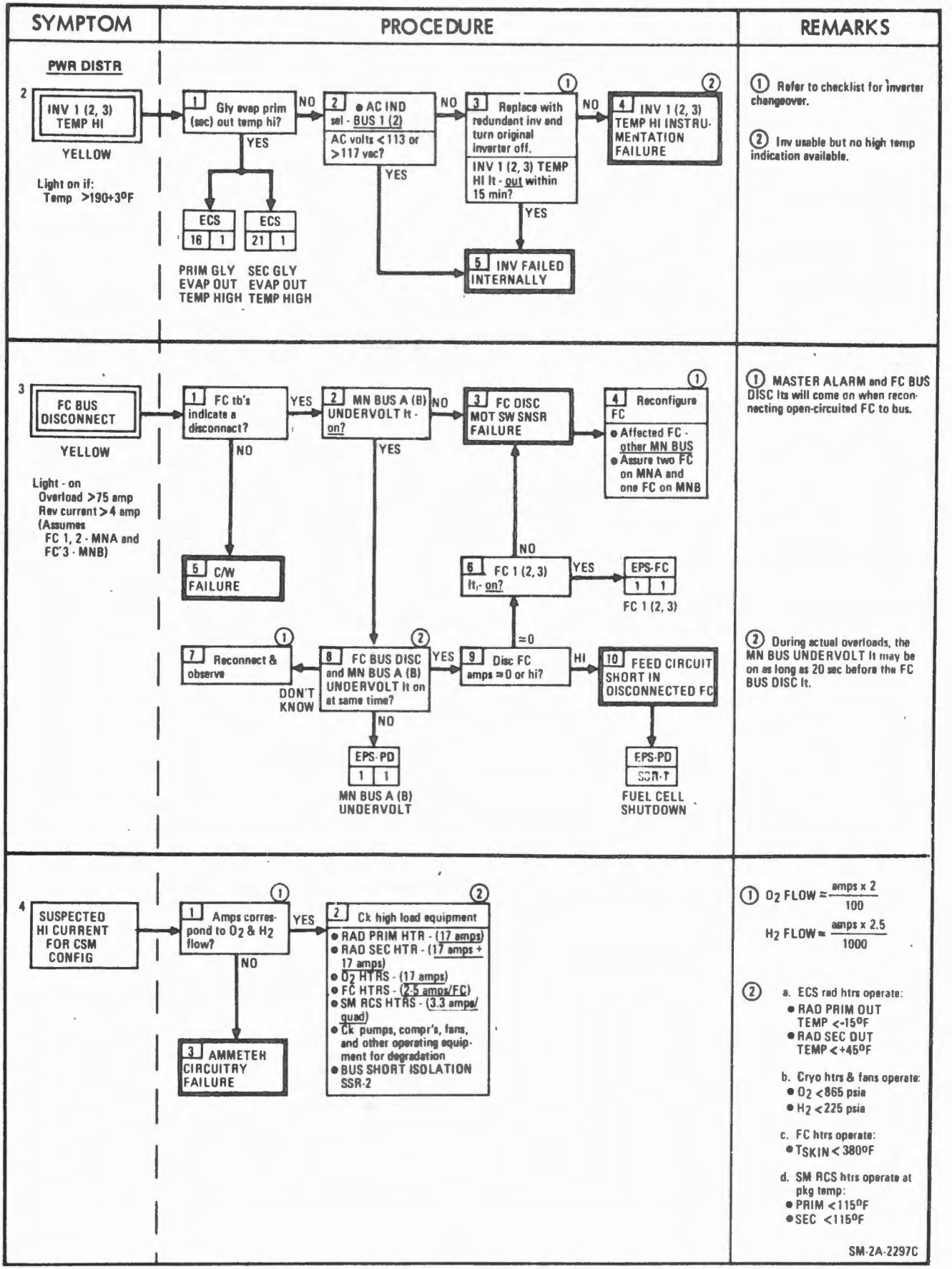
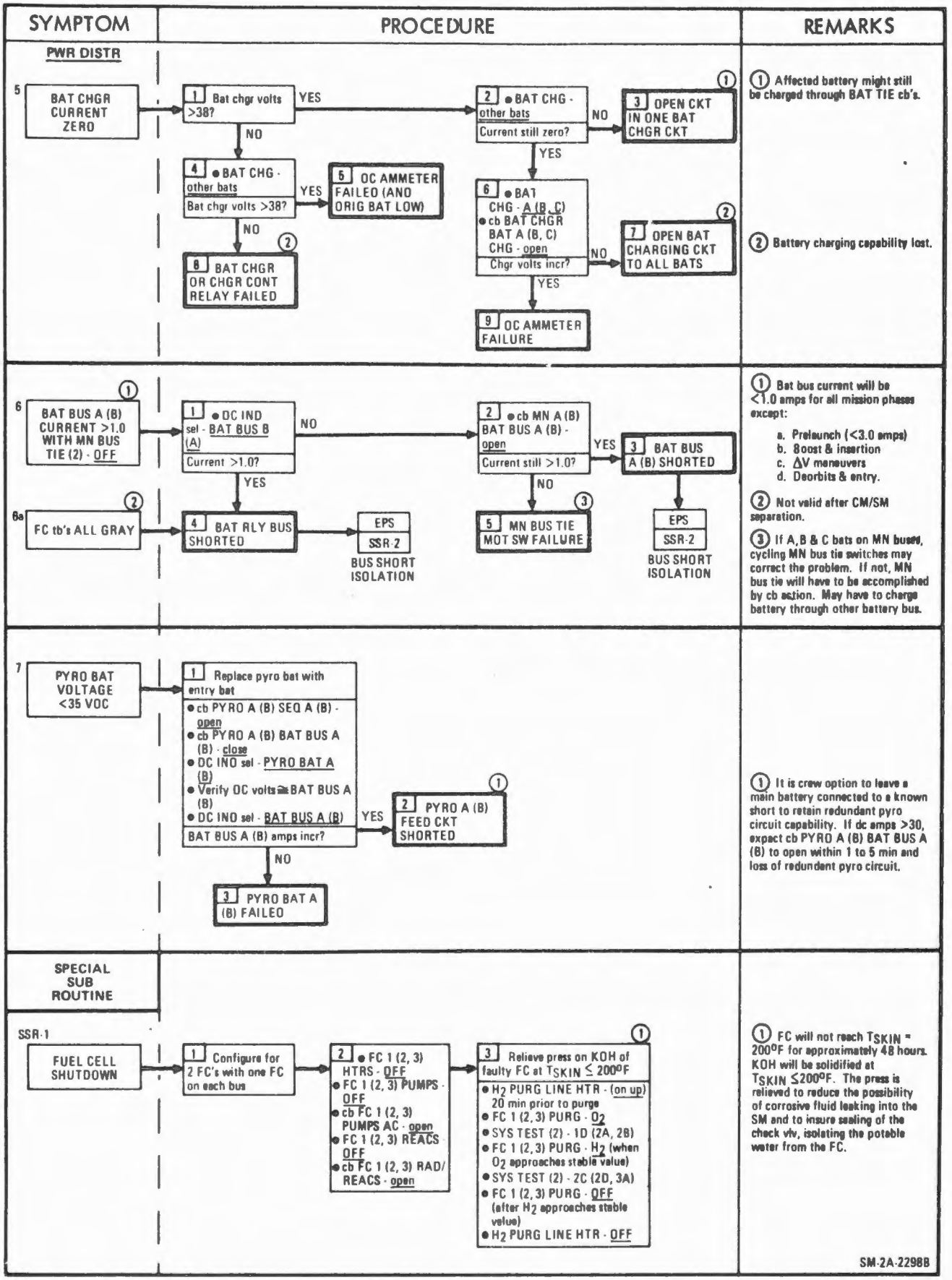

SYMPTOM
PROCEDURE
REMARKS
PWR DISTR
2
INV 1 (2, 3) TEMP HI
YELLOW
Light on if:
Temp >190+3°F
1 Gly evap prim (sec) out temp hi?
NO
YES
2 • AC IND sel - BUS 1 (2)
AC volts < 113 or >117 vac?
NO
YES
3 Replace with redundant inv and turn original inverter off.
INV 1 (2, 3) TEMP HI lt - out within 15 min?
NO
YES
4 INV 1 (2, 3) TEMP HI INSTRU-MENTATION FAILURE
5 INV FAILED INTERNALLY
ECS 16 1
PRIM GLY EVAP OUT TEMP HIGH
ECS 21 1
SEC GLY EVAP OUT TEMP HIGH
1 Refer to checklist for inverter changeover.
2 Inv usable but no high temp indication available.
2 TH 4
3
FC BUS DISCONNECT
YELLOW
Light - on
Overload >75 amp
Rev current >4 amp
(Assumes FC 1, 2 - MNA and FC 3 - MNB)
1 FC tb's indicate a disconnect?
YES
NO
2 MN BUS A (B) UNDERVOLT lt - on?
NO
YES
3 FC DISC MOT SW SNSR FAILURE
4 Reconfigure FC
• Affected FC - other MN BUS
• Assure two FC on MNA and one FC on MNB
5 C/W FAILURE
6 FC 1 (2, 3) lt - on?
NO
YES
EPS-FC 1 1
FC 1 (2, 3)
7 Reconnect & observe
DON'T KNOW
8 FC BUS DISC and MN BUS A (B) UNDERVOLT lt on at same time?
YES
NO
9 Disc FC amps ≈0 or hi?
≈0
HI
10 FEED CIRCUIT SHORT IN DISCONNECTED FC
EPS-PD 1 1
MN BUS A (B) UNDERVOLT
EPS-PD SSR-T
FUEL CELL SHUTDOWN
1 MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus.
2 During actual overloads, the MN BUS UNDERVOLT lt may be on as long as 20 sec before the FC BUS DISC lt.
4
SUSPECTED HI CURRENT FOR CSM CONFIG
1 Amps correspond to O2 & H2 flow?
YES
NO
2 Ck high load equipment
• RAD PRIM HTR - (17 amps)
• RAD SEC HTR - (17 amps + 17 amps)
• O2 HTRS - (17 amps)
• FC HTRS - (2.5 amps/FC)
• SM RCS HTRS - (3.3 amps/quad)
• Ck pumps, compr's, fans, and other operating equipment for degradation
• BUS SHORT ISOLATION SSR-2
3 AMMETER CIRCUITRY FAILURE
1 O2 FLOW ≈ amps x 2 / 100
H2 FLOW ≈ amps x 2.5 / 1000
2 a. ECS rad htrs operate:
• RAD PRIM OUT TEMP <-15°F
• RAD SEC OUT TEMP <+45°F
b. Cryo htrs & fans operate:
• O2 <865 psia
• H2 <225 psia
c. FC htrs operate:
• TSKIN < 380°F
d. SM RCS htrs operate at pkg temp:
• PRIM <115°F
• SEC <115°F
SM-2A-2297C

5
HRU
SR-1


SYMPTOM
PROCEDURE
REMARKS
PWR DISTR
5
BAT CHGR CURRENT ZERO
1 Bat chgr volts >38?
YES
NO
2 • BAT CHG - other bats
Current still zero?
NO
YES
3 OPEN CKT IN ONE BAT CHGR CKT
4 • BAT CHG - other bats
Bat chgr volts >38?
YES
NO
5 OC AMMETER FAILED (AND ORIG BAT LOW)
6 • BAT CHG - A (B, C)
• cb BAT CHGR BAT A (B, C) CHG - open
Chgr volts incr?
NO
YES
7 OPEN BAT CHARGING CKT TO ALL BATS
8 BAT CHGR OR CHGR CONT RELAY FAILED
9 OC AMMETER FAILURE
(1) Affected battery might still be charged through BAT TIE cb's.
(2) Battery charging capability lost.
6
BAT BUS A (B) CURRENT >1.0 WITH MN BUS TIE (2) - OFF
1 • DC IND sel - BAT BUS B (A)
Current >1.0?
NO
YES
2 • cb MN A (B) BAT BUS A (B) - open
Current still >1.0?
YES
NO
3 BAT BUS A (B) SHORTED
6a
FC tb's ALL GRAY
4 BAT RLY BUS SHORTED
EPS SSR-2
BUS SHORT ISOLATION
5 MN BUS TIE MOT SW FAILURE
EPS SSR-2
BUS SHORT ISOLATION
(1) Bat bus current will be <1.0 amps for all mission phases except:
a. Prelaunch (<3.0 amps)
b. Boost & insertion
c. ΔV maneuvers
d. Deorbits & entry.
(2) Not valid after CM/SM separation.
(3) If A,B & C bats on MN buses, cycling MN bus tie switches may correct the problem. If not, MN bus tie will have to be accomplished by cb action. May have to charge battery through other battery bus.
7
PYRO BAT VOLTAGE <35 VDC
1 Replace pyro bat with entry bat
• cb PYRO A (B) SEQ A (B) - open
• cb PYRO A (B) BAT BUS A (B) - close
• DC IND sel - PYRO BAT A (B)
• Verify DC volts ≅ BAT BUS A (B)
• DC IND sel - BAT BUS A (B)
BAT BUS A (B) amps incr?
YES
NO
2 PYRO A (B) FEED CKT SHORTED
3 PYRO BAT A (B) FAILED
(1) It is crew option to leave a main battery connected to a known short to retain redundant pyro circuit capability. If dc amps >30, expect cb PYRO A (B) BAT BUS A (B) to open within 1 to 5 min and loss of redundant pyro circuit.
SPECIAL SUB ROUTINE
SSR-1
FUEL CELL SHUTDOWN
1 Configure for 2 FC's with one FC on each bus
2 • FC 1 (2, 3) HTRS - OFF
• FC 1 (2, 3) PUMPS - OFF
• cb FC 1 (2, 3) PUMPS AC - open
• FC 1 (2, 3) REACS - OFF
• cb FC 1 (2, 3) RAD/REACS - open
3 Relieve press on KOH of faulty FC at TSKIN ≤ 200°F
• H2 PURG LINE HTR - (on up) 20 min prior to purge
• FC 1 (2, 3) PURG - O2
• SYS TEST (2) - 1D (2A, 2B)
• FC 1 (2, 3) PURG - H2 (when O2 approaches stable value)
• SYS TEST (2) - 2C (2D, 3A)
• FC 1 (2, 3) PURG - OFF (after H2 approaches stable value)
• H2 PURG LINE HTR - OFF
(1) FC will not reach TSKIN = 200°F for approximately 48 hours. KOH will be solidified at TSKIN ≤200°F. The press is relieved to reduce the possibility of corrosive fluid leaking into the SM and to insure sealing of the check vlv, isolating the potable water from the FC.
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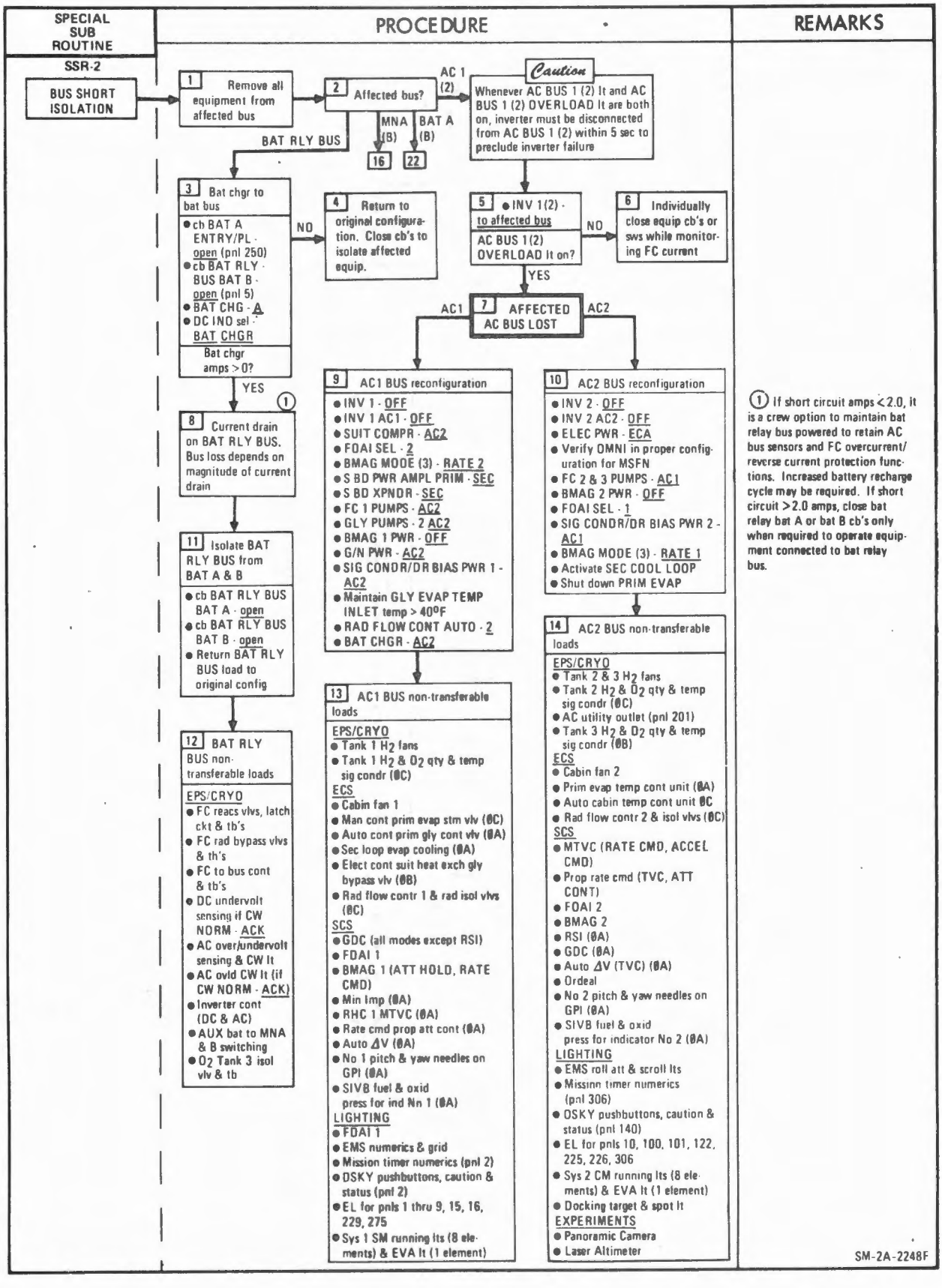

SPECIAL SUB ROUTINE
PROCEDURE
REMARKS
SSR-2
BUS SHORT ISOLATION
1 Remove all equipment from affected bus
2 Affected bus?
AC 1 (2)
MNA (B)
BAT A (B)
16
22
Caution
Whenever AC BUS 1 (2) It and AC BUS 1 (2) OVERLOAD It are both on, inverter must be disconnected from AC BUS 1 (2) within 5 sec to preclude inverter failure
BAT RLY BUS
3 Bat chgr to bat bus
• cb BAT A ENTRY/PL - open (pnl 250)
• cb BAT RLY - BUS BAT B - open (pnl 5)
• BAT CHG - A
• DC IND sel - BAT CHGR
Bat chgr amps > 0?
NO
4 Return to original configuration. Close cb's to isolate affected equip.
5 • INV 1(2) - to affected bus
AC BUS 1(2) OVERLOAD It on?
NO
6 Individually close equip cb's or sws while monitoring FC current
YES
AC1
7 AFFECTED AC BUS LOST
AC2
YES
1
8 Current drain on BAT RLY BUS. Bus loss depends on magnitude of current drain
9 AC1 BUS reconfiguration
• INV 1 - OFF
• INV 1 AC1 - OFF
• SUIT COMPR - AC2
• FOAI SEL - 2
• BMAG MODE (3) - RATE 2
• S BD PWR AMPL PRIM - SEC
• S BD XPNDR - SEC
• FC 1 PUMPS - AC2
• GLY PUMPS - 2 AC2
• BMAG 1 PWR - OFF
• G/N PWR - AC2
• SIG CONDR/DR BIAS PWR 1 - AC2
• Maintain GLY EVAP TEMP INLET temp > 40°F
• RAD FLOW CONT AUTO - 2
• BAT CHGR - AC2
10 AC2 BUS reconfiguration
• INV 2 - OFF
• INV 2 AC2 - OFF
• ELEC PWR - ECA
• Verify OMNI in proper configuration for MSFN
• FC 2 & 3 PUMPS - AC1
• BMAG 2 PWR - OFF
• FOAI SEL - 1
• SIG CONDR/DR BIAS PWR 2 - AC1
• BMAG MODE (3) - RATE 1
• Activate SEC COOL LOOP
• Shut down PRIM EVAP
11 Isolate BAT RLY BUS from BAT A & B
• cb BAT RLY BUS BAT A - open
• cb BAT RLY BUS BAT B - open
• Return BAT RLY BUS load to original config
12 BAT RLY BUS non-transferable loads
EPS/CRYO
• FC reacs vlvs, latch ckt & tb's
• FC rad bypass vlvs & th's
• FC to bus cont & tb's
• DC undervolt sensing if CW NORM - ACK
• AC over/undervolt sensing & CW It
• AC ovld CW It (if CW NORM - ACK)
• Inverter cont (DC & AC)
• AUX bat to MNA & B switching
• O2 Tank 3 isol vlv & tb
13 AC1 BUS non-transferable loads
EPS/CRYO
• Tank 1 H2 fans
• Tank 1 H2 & O2 qty & temp sig condr (ØC)
ECS
• Cabin fan 1
• Man cont prim evap stm vlv (ØC)
• Auto cont prim gly cont vlv (ØA)
• Sec loop evap cooling (ØA)
• Elect cont suit heat exch gly bypass vlv (ØB)
• Rad flow contr 1 & rad isol vlvs (ØC)
SCS
• GDC (all modes except RSI)
• FDAI 1
• BMAG 1 (ATT HOLD, RATE CMD)
• Min Imp (ØA)
• RHC 1 MTVC (ØA)
• Rate cmd prop att cont (ØA)
• Auto ΔV (ØA)
• No 1 pitch & yaw needles on GPI (ØA)
• SIVB fuel & oxid press for ind No 1 (ØA)
LIGHTING
• FDAI 1
• EMS numerics & grid
• Mission timer numerics (pnl 2)
• DSKY pushbuttons, caution & status (pnl 2)
• EL for pnls 1 thru 9, 15, 16, 229, 275
• Sys 1 SM running lts (8 elements) & EVA lt (1 element)
14 AC2 BUS non-transferable loads
EPS/CRYO
• Tank 2 & 3 H2 fans
• Tank 2 H2 & O2 qty & temp sig condr (ØC)
• AC utility outlet (pnl 201)
• Tank 3 H2 & O2 qty & temp sig condr (ØB)
ECS
• Cabin fan 2
• Prim evap temp cont unit (ØA)
• Auto cabin temp cont unit ØC
• Rad flow contr 2 & isol vlvs (ØC)
SCS
• MTVC (RATE CMD, ACCEL CMD)
• Prop rate cmd (TVC, ATT CONT)
• FOAI 2
• BMAG 2
• RSI (ØA)
• GDC (ØA)
• Auto ΔV (TVC) (ØA)
• Ordeal
• No 2 pitch & yaw needles on GPI (ØA)
• SIVB fuel & oxid press for indicator No 2 (ØA)
LIGHTING
• EMS roll att & scroll lts
• Missinn timer numerics (pnl 306)
• OSKY pushbuttons, caution & status (pnl 140)
• EL for pnls 10, 100, 101, 122, 225, 226, 306
• Sys 2 CM running lts (8 elements) & EVA lt (1 element)
• Docking target & spot lt
EXPERIMENTS
• Panoramic Camera
• Laser Altimeter
1 If short circuit amps < 2.0, it is a crew option to maintain bat relay bus powered to retain AC bus sensors and FC overcurrent/reverse current protection functions. Increased battery recharge cycle may be required. If short circuit > 2.0 amps, close bat relay bat A or bat B cb's only when required to operate equipment connected to bat relay bus.
SM-2A-2248F

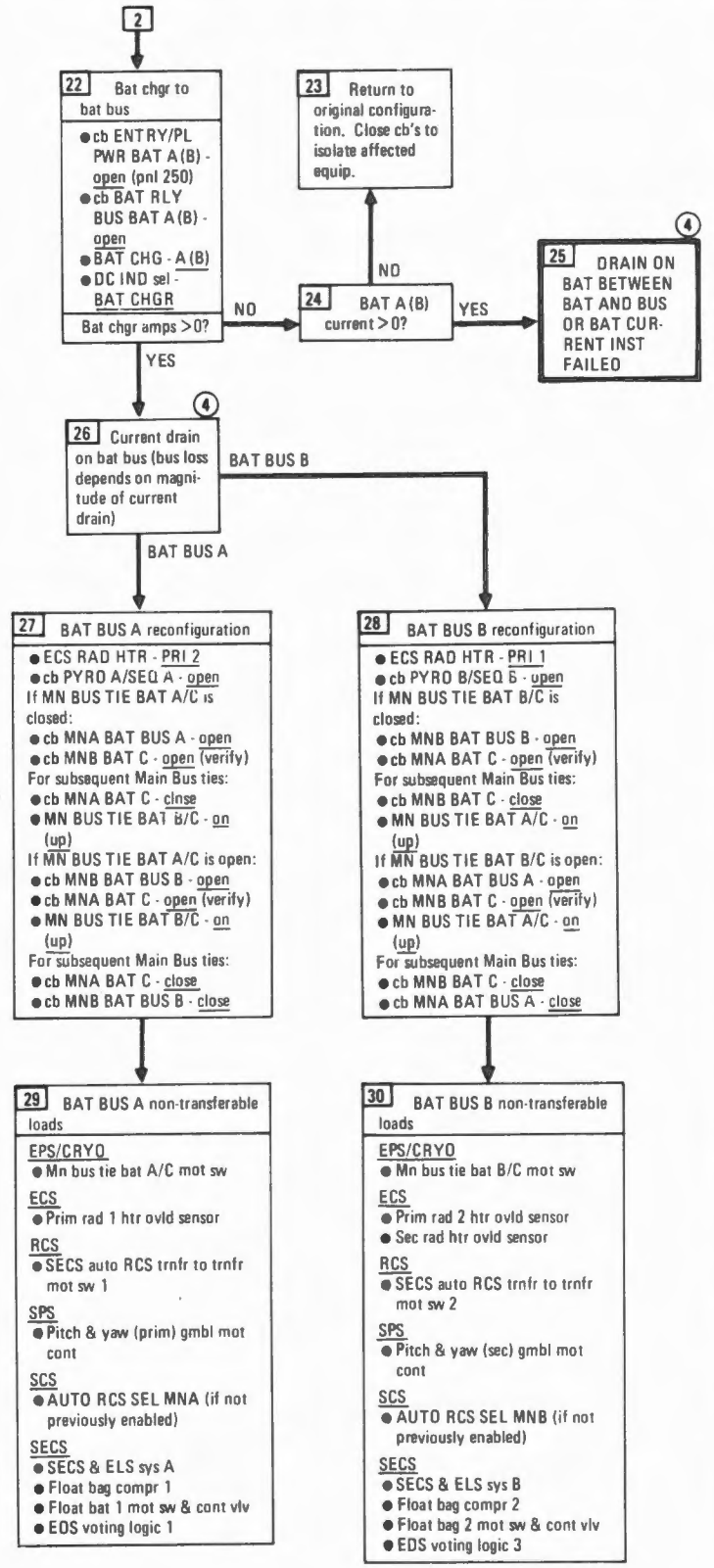
SSR-

SSR-2 (Cont)

SYMPTOM	PROCEDURE	REMARKS
SSR-2 (CONT)		(2) MASTER ALARM and FC BUS DISC lts will come on when reconnecting open-circuited FC to bus. (3) Place two batteries on remaining bus for SPS maneuvers.

SYMPTOM	PROCEDURE	REMARKS

SSR-2 (CONT)



(4) If cb RAD HTRS OVLO BAT A and/or BAT B are opened to reduce battery drain, they should not be closed unless batteries are tied to main buses. This prevents possible disconnect of ECS radiator heaters by a false overload signal.

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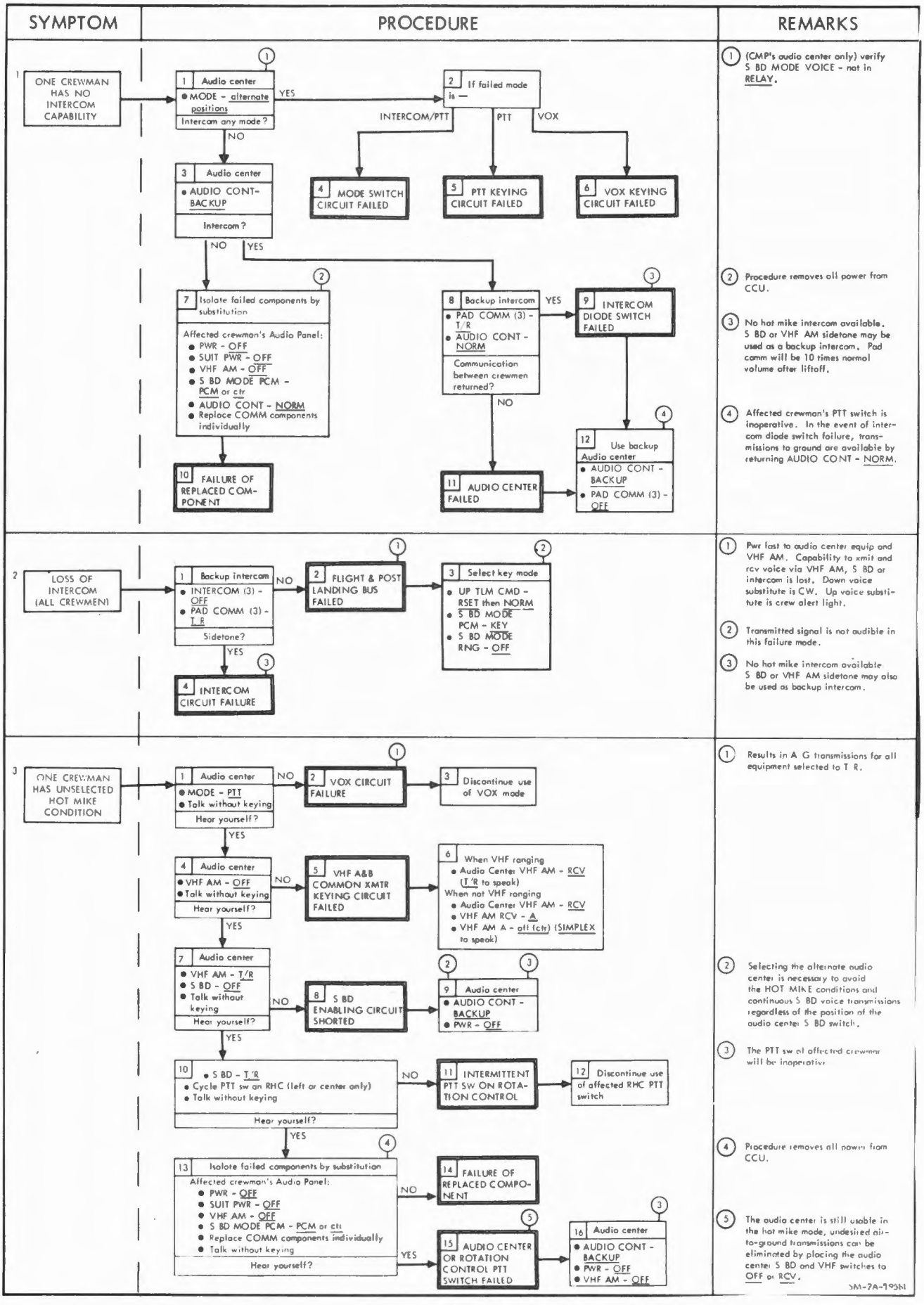
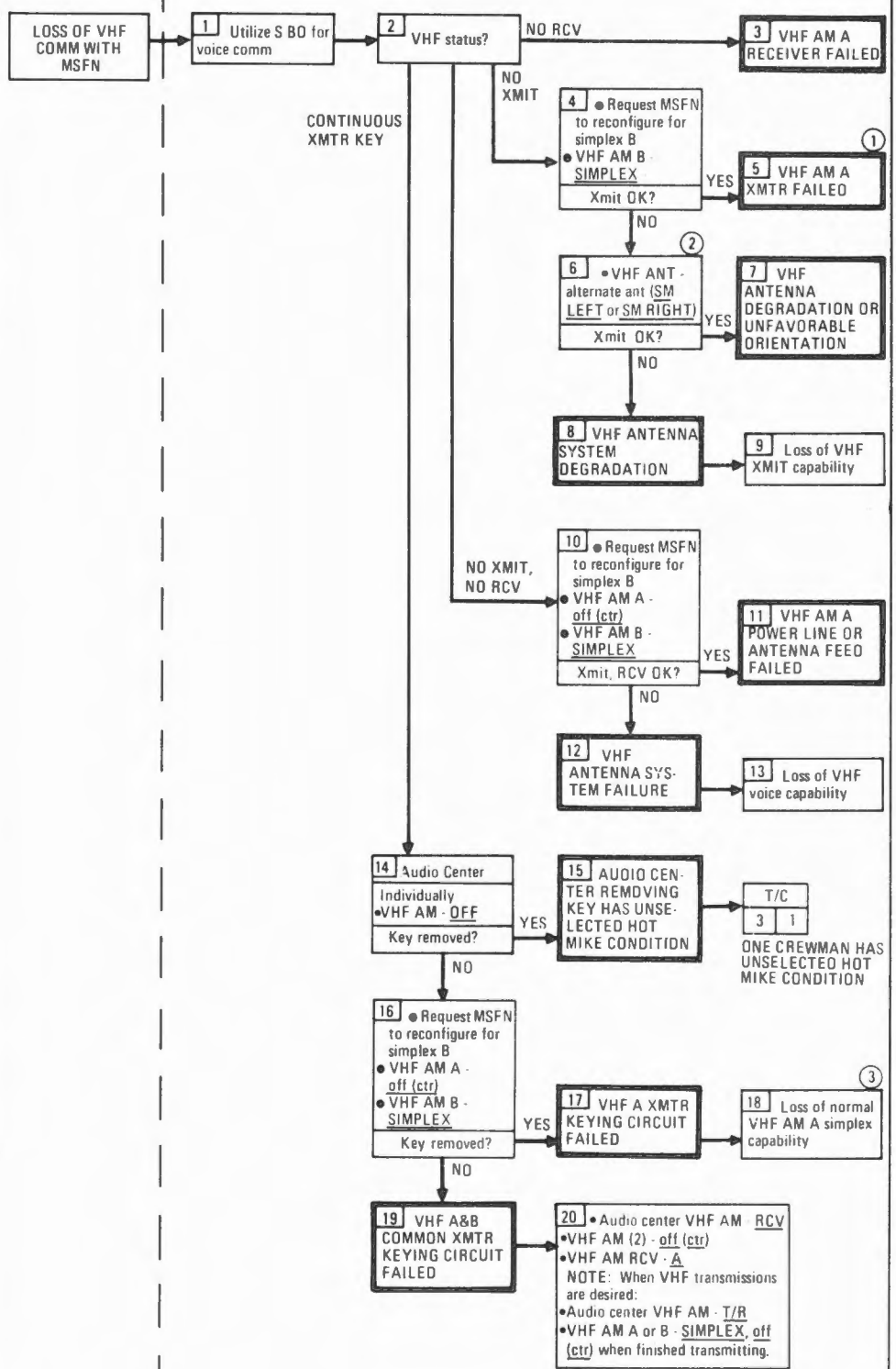
TELECOMM MALFUNCTION INDEX


SYMPTOM
PROCEDURE
REMARKS
1 ONE CREWMAN HAS NO INTERCOM CAPABILITY
1 Audio center
• MODE - alternate positions
Intercom any mode?
YES
NO
2 If failed mode is —
INTERCOM/PTT
PTT
VOX
4 MODE SWITCH CIRCUIT FAILED
5 PTT KEYING CIRCUIT FAILED
6 VOX KEYING CIRCUIT FAILED
3 Audio center
• AUDIO CONT - BACKUP
Intercom?
NO
YES
7 Isolate failed components by substitution
Affected crewman's Audio Panel:
• PWR - OFF
• SUIT PWR - OFF
• VHF AM - OFF
• S BD MODE PCM - PCM or ctr
• AUDIO CONT - NORM
• Replace COMM components individually
10 FAILURE OF REPLACED COMPONENT
8 Backup intercom
• PAD COMM (3) - T/R
• AUDIO CONT - NORM
Communication between crewmen returned?
YES
NO
9 INTERCOM DIODE SWITCH FAILED
11 AUDIO CENTER FAILED
12 Use backup Audio center
• AUDIO CONT - BACKUP
• PAD COMM (3) - OFF
1 (CMP's audio center only) verify S BD MODE VOICE - not in RELAY.
2 Procedure removes all power from CCU.
3 No hot mike intercom available. S BD or VHF AM sidetone may be used as a backup intercom. Pad comm will be 10 times normal volume after liftoff.
4 Affected crewman's PTT switch is inoperative. In the event of intercom diode switch failure, transmissions to ground are available by returning AUDIO CONT - NORM.
2 LOSS OF INTERCOM (ALL CREWMEN)
1 Backup intercom
• INTERCOM (3) - OFF
• PAD COMM (3) - T/R
Sidetone?
NO
YES
2 FLIGHT & POST LANDING BUS FAILED
3 Select key mode
• UP TLM CMD - RSET then NORM
• S BD MODE PCM - KEY
• S BD MODE RNG - OFF
4 INTERCOM CIRCUIT FAILURE
1 Pwr fail to audio center equip and VHF AM. Capability to xmit and rcv voice via VHF AM, S BD or intercom is lost. Down voice substitute is C.W. Up voice substitute is crew alert light.
2 Transmitted signal is not audible in this failure mode.
3 No hot mike intercom available S BD or VHF AM sidetone may also be used as backup intercom.
3 ONE CREWMAN HAS UNSELECTED HOT MIKE CONDITION
1 Audio center
• MODE - PTT
• Talk without keying
Hear yourself?
NO
YES
2 VOX CIRCUIT FAILURE
3 Discontinue use of VOX mode
4 Audio center
• VHF AM - OFF
• Talk without keying
Hear yourself?
NO
YES
5 VHF A&B COMMON XMTR KEYING CIRCUIT FAILED
6 When VHF ranging
• Audio Center VHF AM - RCV (T/R to speak)
When not VHF ranging
• Audio Center VHF AM - RCV
• VHF AM RCV - A
• VHF AM A - off (ctr) (SIMPLEX to speak)
7 Audio center
• VHF AM - T/R
• S BD - OFF
• Talk without keying
Hear yourself?
NO
YES
8 S BD ENABLING CIRCUIT SHORTED
9 Audio center
• AUDIO CONT - BACKUP
• PWR - OFF
10 • S BD - T/R
• Cycle PTT sw on RHC (left or center only)
• Talk without keying
Hear yourself?
NO
YES
11 INTERMITTENT PTT SW ON ROTATION CONTROL
12 Discontinue use of affected RHC PTT switch
13 Isolate failed components by substitution
Affected crewman's Audio Panel:
• PWR - OFF
• SUIT PWR - OFF
• VHF AM - OFF
• S BD MODE PCM - PCM or ctr
• Replace COMM components individually
• Talk without keying
Hear yourself?
NO
YES
14 FAILURE OF REPLACED COMPONENT
15 AUDIO CENTER OR ROTATION CONTROL PTT SWITCH FAILED
16 Audio center
• AUDIO CONT - BACKUP
• PWR - OFF
• VHF AM - OFF
1 Results in A G transmissions for all equipment selected to T R.
2 Selecting the alternate audio center is necessary to avoid the HOT MIKE conditions and continuous S BD voice transmissions regardless of the position of the audio center S BD switch.
3 The PTT sw of affected crewman will be inoperative.
4 Procedure removes all power from CCU.
5 The audio center is still usable in the hot mike mode, undesired air-to-ground transmissions can be eliminated by placing the audio center S BD and VHF switches to OFF or RCV.
SM-7A-19561

4

SYMPTOM	PROCEDURE	REMARKS

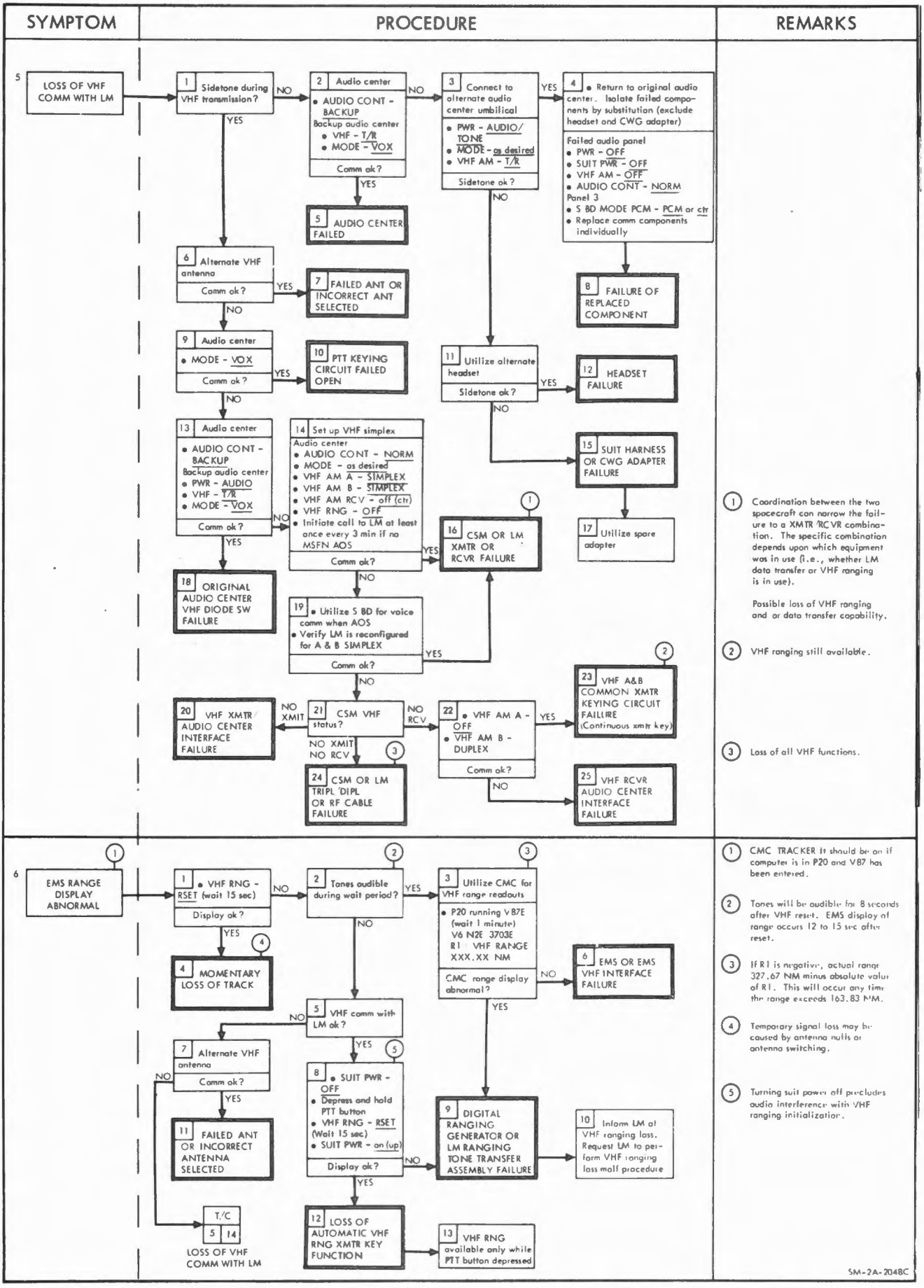


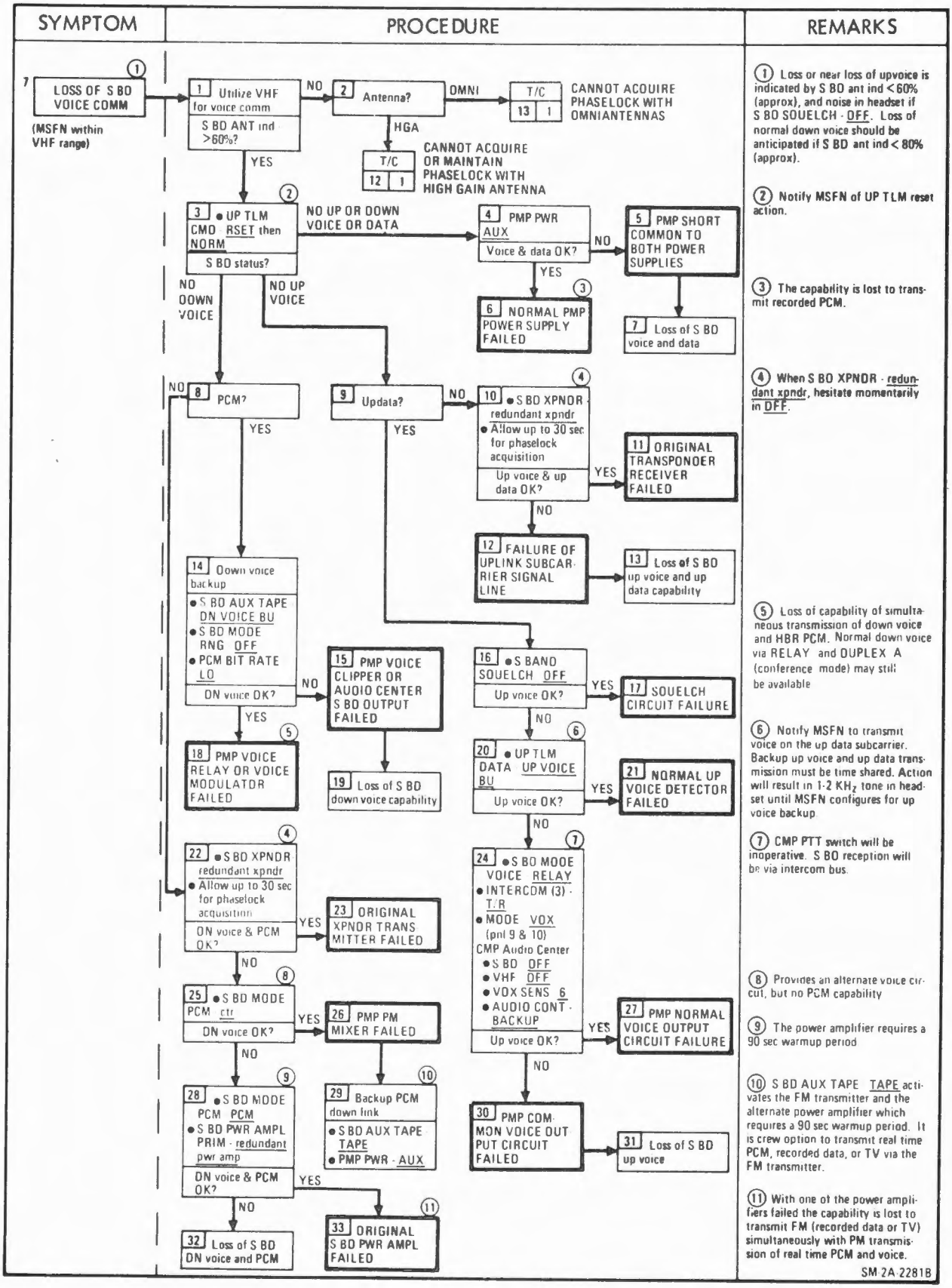
(1) Duplex B is available.

(2) When operating with MSFN, uplink circuit margin is greater than down-link circuit margin. Antenna system degradation can therefore disable transmission while allowing reception.

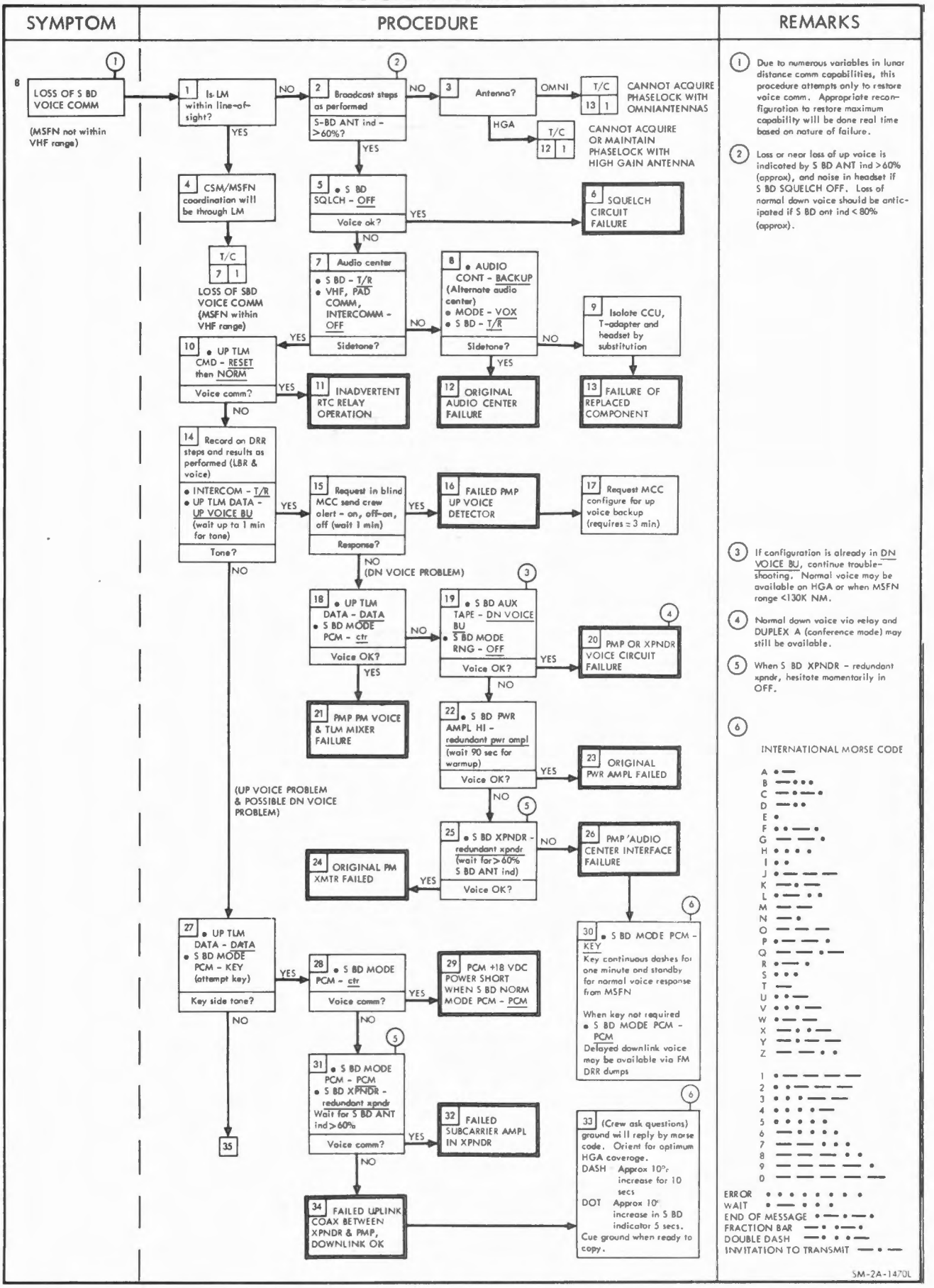
(3) Simplex operation of VHF AM A may be restored by placing VHF AM A - off (ctr) and VHF AM - T/R. Transmission is accomplished by placing VHF AM A - SIMPLEX then off (ctr) when finished transmitting.

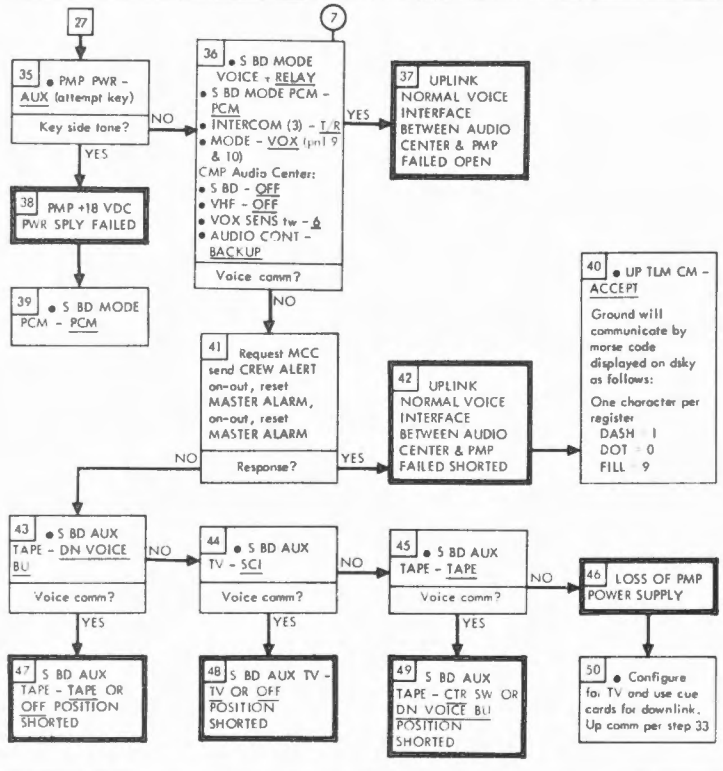
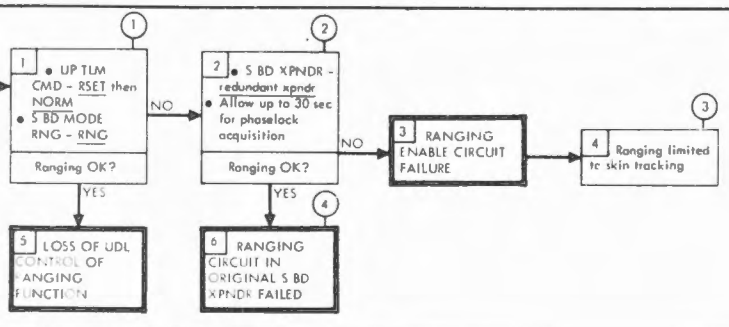
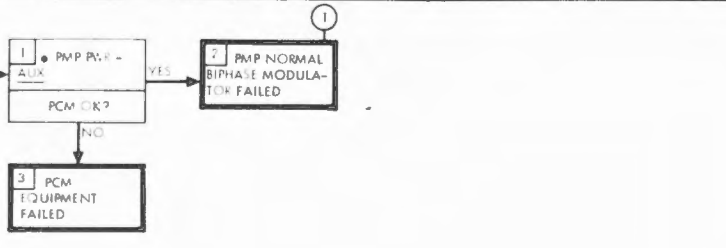
SM-2A-2279


SYMPTOM
PROCEDURE
REMARKS
5
LOSS OF VHF COMM WITH LM
1 Sidetone during VHF transmission?
NO
YES
2 Audio center
• AUDIO CONT - BACKUP
Backup audio center
• VHF - T/R
• MODE - VOX
Comm ok?
YES
5 AUDIO CENTER FAILED
NO
3 Connect to alternate audio center umbilical
• PWR - AUDIO/TONE
• MODE - as desired
• VHF AM - T/R
Sidetone ok?
YES
4 • Return to original audio center. Isolate failed components by substitution (exclude headset and CWG adapter)
Failed audio panel
• PWR - OFF
• SUIT PWR - OFF
• VHF AM - OFF
• AUDIO CONT - NORM
Panel 3
• S BD MODE PCM - PCM or ctr
• Replace comm components individually
8 FAILURE OF REPLACED COMPONENT
6 Alternate VHF antenna
Comm ok?
YES
7 FAILED ANT OR INCORRECT ANT SELECTED
NO
9 Audio center
• MODE - VOX
Comm ok?
YES
10 PTT KEYING CIRCUIT FAILED OPEN
NO
11 Utilize alternate headset
Sidetone ok?
YES
12 HEADSET FAILURE
NO
13 Audio center
• AUDIO CONT - BACKUP
Backup audio center
• PWR - AUDIO
• VHF - T/R
• MODE - VOX
Comm ok?
NO
14 Set up VHF simplex
Audio center
• AUDIO CONT - NORM
• MODE - as desired
• VHF AM A - SIMPLEX
• VHF AM B - SIMPLEX
• VHF AM RCV - off (ctr)
• VHF RNG - OFF
• Initiate call to LM at least once every 3 min if no MSFN AOS
Comm ok?
YES
16 CSM OR LM XMTR OR RCVR FAILURE
15 SUIT HARNESS OR CWG ADAPTER FAILURE
17 Utilize spare adapter
YES
18 ORIGINAL AUDIO CENTER VHF DIODE SW FAILURE
NO
19 • Utilize S BD for voice comm when AOS
• Verify LM is reconfigured for A & B SIMPLEX
Comm ok?
YES
NO
20 VHF XMTR/AUDIO CENTER INTERFACE FAILURE
NO XMIT
21 CSM VHF status?
NO RCV
NO XMIT
NO RCV
24 CSM OR LM TRIPL DIPL OR RF CABLE FAILURE
22 • VHF AM A - OFF
• VHF AM B - DUPLEX
Comm ok?
YES
23 VHF A&B COMMON XMTR KEYING CIRCUIT FAILURE (Continuous xmtr key)
NO
25 VHF RCVR AUDIO CENTER INTERFACE FAILURE
1 Coordination between the two spacecraft can narrow the failure to a XMTR/RCVR combination. The specific combination depends upon which equipment was in use (i.e., whether LM data transfer or VHF ranging is in use).
Possible loss of VHF ranging and or data transfer capability.
2 VHF ranging still available.
3 Loss of all VHF functions.
5 THR 6
6
EMS RANGE DISPLAY ABNORMAL
1 • VHF RNG - RSET (wait 15 sec)
Display ok?
NO
YES
4 MOMENTARY LOSS OF TRACK
2 Tones audible during wait period?
YES
NO
3 Utilize CMC for VHF range readouts
• P20 running V87E (wait 1 minute)
V6 N2E 3703E
R1 VHF RANGE XXX.XX NM
CMC range display abnormal?
NO
6 EMS OR EMS VHF INTERFACE FAILURE
YES
5 VHF comm with LM ok?
NO
YES
7 Alternate VHF antenna
Comm ok?
NO
YES
11 FAILED ANT OR INCORRECT ANTENNA SELECTED
T/C 5 14
LOSS OF VHF COMM WITH LM
8 • SUIT PWR - OFF
• Depress and hold PTT button
• VHF RNG - RSET (Wait 15 sec)
• SUIT PWR - on (up)
Display ok?
NO
YES
9 DIGITAL RANGING GENERATOR OR LM RANGING TONE TRANSFER ASSEMBLY FAILURE
10 Inform LM of VHF ranging loss. Request LM to perform VHF ranging loss malf procedure
12 LOSS OF AUTOMATIC VHF RNG XMTR KEY FUNCTION
13 VHF RNG available only while PTT button depressed
1 CMC TRACKER It should be on if computer is in P20 and V87 has been entered.
2 Tones will be audible for 8 seconds after VHF reset. EMS display of range occurs 12 to 15 sec after reset.
3 If R1 is negative, actual range 327.67 NM minus absolute value of R1. This will occur any time the range exceeds 163.83 NM.
4 Temporary signal loss may be caused by antenna nulls or antenna switching.
5 Turning suit power off precludes audio interference with VHF ranging initialization.
SM-2A-2048C


SYMPTOM
PROCEDURE
REMARKS
7
(1)
LOSS OF S BD VOICE COMM
(MSFN within VHF range)
1 Utilize VHF for voice comm
S BD ANT ind >60%?
NO
YES
2 Antenna?
OMNI
T/C 13 1
CANNOT ACQUIRE PHASELOCK WITH OMNIANTENNAS
HGA
T/C 12 1
CANNOT ACQUIRE OR MAINTAIN PHASELOCK WITH HIGH GAIN ANTENNA
(2)
3 • UP TLM CMD RSET then NORM
S BD status?
NO UP OR DOWN VOICE OR DATA
NO DOWN VOICE
NO UP VOICE
4 PMP PWR AUX
Voice & data OK?
NO
YES
5 PMP SHORT COMMON TO BOTH POWER SUPPLIES
7 Loss of S BD voice and data
(3)
6 NORMAL PMP POWER SUPPLY FAILED
NO
8 PCM?
YES
9 Updata?
NO
YES
(4)
10 • S BD XPNDR redundant xpndr
• Allow up to 30 sec for phaselock acquisition
Up voice & up data OK?
YES
11 ORIGINAL TRANSPONDER RECEIVER FAILED
NO
12 FAILURE OF UPLINK SUBCARRIER SIGNAL LINE
13 Loss of S BD up voice and up data capability
14 Down voice backup
• S BD AUX TAPE DN VOICE BU
• S BD MODE RNG OFF
• PCM BIT RATE LO
DN voice OK?
NO
YES
15 PMP VOICE CLIPPER OR AUDIO CENTER S BD OUTPUT FAILED
19 Loss of S BD down voice capability
(5)
18 PMP VOICE RELAY OR VOICE MODULATOR FAILED
16 • S BAND SQUELCH OFF
Up voice OK?
YES
17 SQUELCH CIRCUIT FAILURE
NO
(6)
20 • UP TLM DATA UP VOICE BU
Up voice OK?
YES
21 NORMAL UP VOICE DETECTOR FAILED
NO
(4)
22 • S BD XPNDR redundant xpndr
• Allow up to 30 sec for phaselock acquisition
DN voice & PCM OK?
YES
23 ORIGINAL XPNDR TRANSMITTER FAILED
NO
(8)
25 • S BD MODE PCM ctr
DN voice OK?
YES
26 PMP PM MIXER FAILED
NO
(9)
28 • S BD MODE PCM PCM
• S BD PWR AMPL PRIM - redundant pwr amp
DN voice & PCM OK?
YES
NO
32 Loss of S BD DN voice and PCM
(10)
29 Backup PCM down link
• S BD AUX TAPE TAPE
• PMP PWR AUX
(11)
33 ORIGINAL S BD PWR AMPL FAILED
(7)
24 • S BD MODE VOICE RELAY
• INTERCOM (3) T/R
• MODE VOX (pnl 9 & 10)
CMP Audio Center
• S BD OFF
• VHF OFF
• VOX SENS 6
• AUDIO CONT BACKUP
Up voice OK?
YES
27 PMP NORMAL VOICE OUTPUT CIRCUIT FAILURE
NO
30 PMP COMMON VOICE OUTPUT CIRCUIT FAILED
31 Loss of S BD up voice
(1) Loss or near loss of upvoice is indicated by S BD ant ind < 60% (approx), and noise in headset if S BD SQUELCH - OFF. Loss of normal down voice should be anticipated if S BD ant ind < 80% (approx).
(2) Notify MSFN of UP TLM reset action.
(3) The capability is lost to transmit recorded PCM.
(4) When S BD XPNDR - redundant xpndr, hesitate momentarily in OFF.
(5) Loss of capability of simultaneous transmission of down voice and HBR PCM. Normal down voice via RELAY and DUPLEX A (conference mode) may still be available
(6) Notify MSFN to transmit voice on the up data subcarrier. Backup up voice and up data transmission must be time shared. Action will result in 1-2 KHz tone in headset until MSFN configures for up voice backup
(7) CMP PTT switch will be inoperative. S BD reception will be via intercom bus.
(8) Provides an alternate voice circuit, but no PCM capability
(9) The power amplifier requires a 90 sec warmup period
(10) S BD AUX TAPE TAPE activates the FM transmitter and the alternate power amplifier which requires a 90 sec warmup period. It is crew option to transmit real time PCM, recorded data, or TV via the FM transmitter.
(11) With one of the power amplifiers failed the capability is lost to transmit FM (recorded data or TV) simultaneously with PM transmission of real time PCM and voice.
SM 2A-2281B

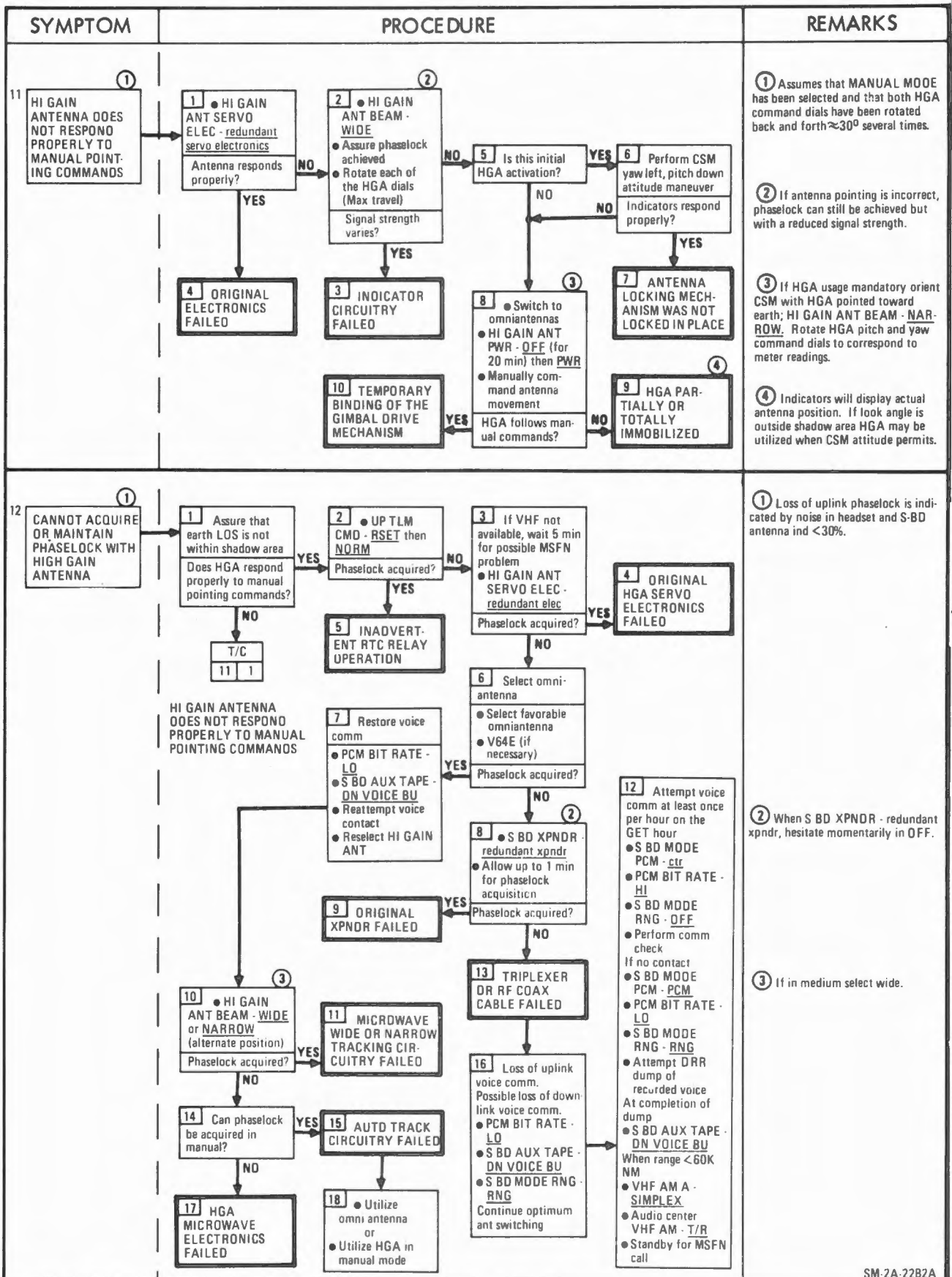
SM2A-03-BLOCK II-(2)
APOLLO OPERATIONS HANDBOOK



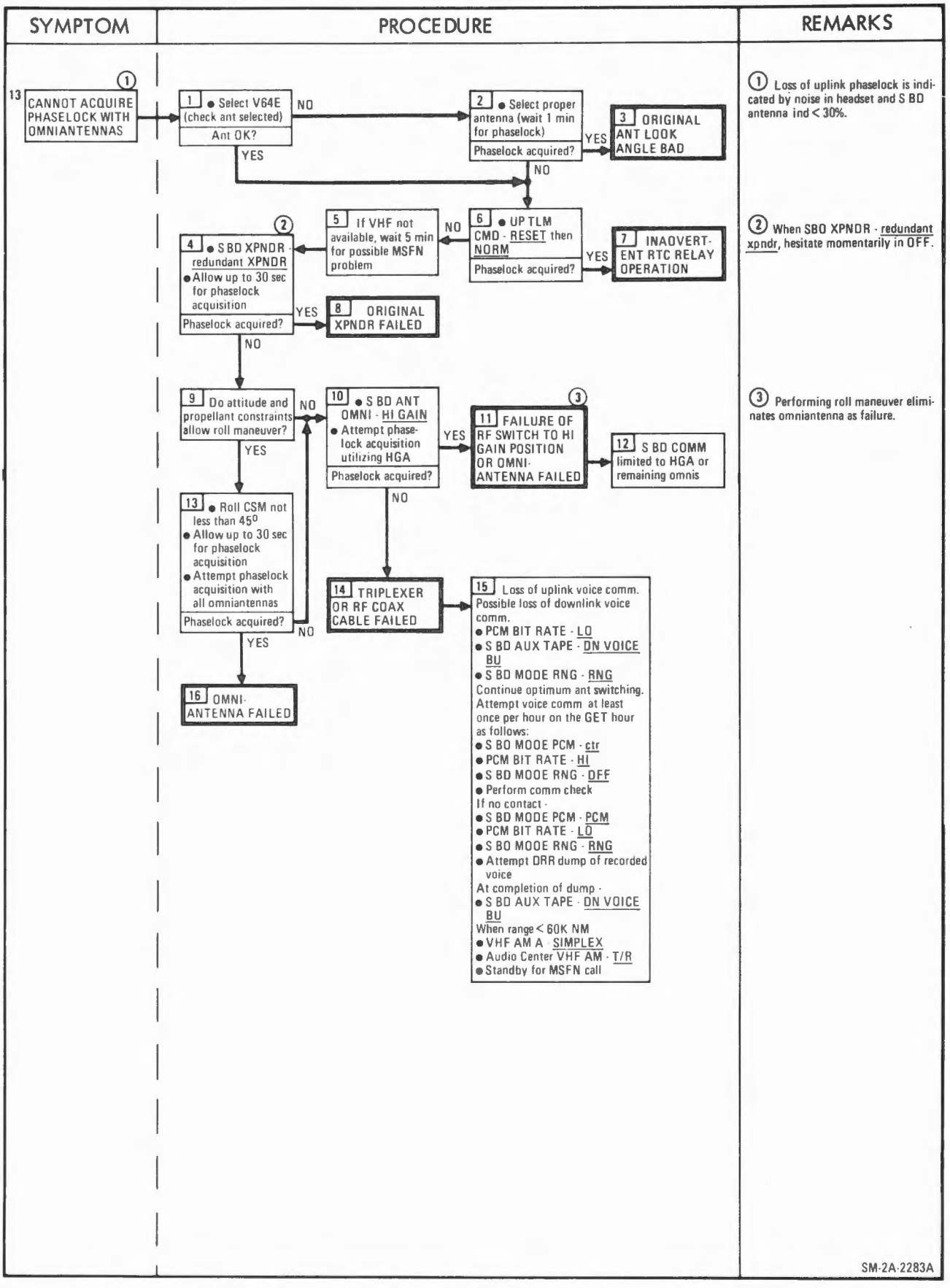
SYMPTOM	PROCEDURE	REMARKS
8 (Cont) 8 HRU 10		(7) CMP PTT switch will be inoperative. S BD reception will be via intercom bus.
9 MSFN REPORTS LOSS OF RANGING		(1) Coordinate with MSFN (2) When SBD XPNDR–redundant xpndr, hesitate momentarily in OFF. (3) Skin tracking performed by ground radar; no crew action required. (4) Original XPNDR is usable for all functions except ranging.
10 MSFN REPORTS LOSS OF REAL TIME PCM		(1) The capability is lost to transmit recorded PCM simultaneously with real time PCM.

SM2A-03-BLOCK II-(2)

APOLLO OPERATIONS HANDBOOK



11 THRU 12


SYMPTOM
PROCEDURE
REMARKS
13 CANNOT ACQUIRE PHASELOCK WITH OMNIANTENNAS (1)
1 • Select V64E (check ant selected)
Ant OK?
NO
YES
2 • Select proper antenna (wait 1 min for phaselock)
Phaselock acquired?
YES
3 ORIGINAL ANT LOOK ANGLE BAD
NO
6 • UP TLM CMD - RESET then NORM
Phaselock acquired?
NO
YES
7 INADVERTENT RTC RELAY OPERATION
5 If VHF not available, wait 5 min for possible MSFN problem
NO
(2)
4 • S BD XPNDR - redundant XPNDR
• Allow up to 30 sec for phaselock acquisition
Phaselock acquired?
YES
8 ORIGINAL XPNDR FAILED
NO
9 Do attitude and propellant constraints allow roll maneuver?
NO
YES
10 • S BD ANT OMNI - HI GAIN
• Attempt phaselock acquisition utilizing HGA
Phaselock acquired?
YES
(3)
11 FAILURE OF RF SWITCH TO HI GAIN POSITION OR OMNI-ANTENNA FAILED
12 S BD COMM limited to HGA or remaining omnis
NO
13 • Roll CSM not less than 45°
• Allow up to 30 sec for phaselock acquisition
• Attempt phaselock acquisition with all omniantennas
Phaselock acquired?
NO
YES
14 TRIPLEXER OR RF COAX CABLE FAILED
15 Loss of uplink voice comm. Possible loss of downlink voice comm.
• PCM BIT RATE - LO
• S BD AUX TAPE - DN VOICE BU
• S BD MODE RNG - RNG
Continue optimum ant switching. Attempt voice comm at least once per hour on the GET hour as follows:
• S BD MODE PCM - ctr
• PCM BIT RATE - HI
• S BD MODE RNG - OFF
• Perform comm check
If no contact -
• S BD MODE PCM - PCM
• PCM BIT RATE - LO
• S BD MODE RNG - RNG
• Attempt DRR dump of recorded voice
At completion of dump -
• S BD AUX TAPE - DN VOICE BU
When range < 60K NM
• VHF AM A - SIMPLEX
• Audio Center VHF AM - T/R
• Standby for MSFN call
16 OMNI-ANTENNA FAILED
(1) Loss of uplink phaselock is indicated by noise in headset and S BD antenna ind < 30%.
(2) When SBD XPNDR - redundant xpndr, hesitate momentarily in OFF.
(3) Performing roll maneuver eliminates omniantenna as failure.
SM-2A-2283A

3

ECS

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ECS

ECS MALFUNCTION INDEX

O_2 FLOW HI

RED

1a O_2 FLOW HIGH

2 O_2 FLOW LOW

3 SURGE TANK PRESS HIGH

4 CABIN PRESS HIGH OR INCREASING

5 SURGE TANK PRESS LOW

6 CABIN PRESS LOW OR DECREASING

7 CREW UNCOMFORTABLE IN CABIN

7a CABIN HUMIDITY HIGH

8 CLINGING SUIT

8a NO O_2 FLOW THRU PGA

9 SUIT COMPRESSOR

RED

9a SUIT COMPR ΔP LOW

10 BALLOONED PGA'S

11 CREW UNCOMFORTABLE IN SUIT LOOP

11a SUIT CKT HUMIDITY HIGH

12 CO_2 PP HI

YELLOW

12a CO_2 PART PRESS HIGH

12b CO_2 PRESS LOW

13 CO_2 FILTER SEIZURE WITHIN CANISTER

14 GLYCOL TEMP LOW

YELLOW

14a PRIM ECS RAD OUT TEMP LOW

15 PRIM ECS RAD OUT TEMP HIGH

16 PRIM GLY EVAP OUT TEMP HIGH

16a PRIM STEAM PRESS LOW

17 PRIM GLY EVAP OUT TEMP LOW

18 PRIM GLY ACCUM QTY HIGH

18a PRIM GLY DISCH PRESS HIGH

19 PRIM GLY ACCUM QTY LOW OR DECREASING

20 PRIM GLY DISCH PRESS LOW

21 SEC GLY EVAP OUT TEMP HIGH

21a SEC STEAM PRESS LOW

22 SEC GLY EVAP OUT TEMP LOW

23 SEC ECS RAD OUT TEMP HIGH

24 SEC ECS RAD OUT TEMP LOW

25 SEC GLY ACCUM QTY HIGH

26 SEC GLY ACCUM QTY DECREASING

27 SEC GLY DISCH PRESS LOW

28 H_2O DUMPING OVERBOARD

28a POTABLE H_2O QUANTITY DECREASING RAPIDLY

28b WASTE H_2O QUANTITY DECREASING RAPIDLY

29 FOOD PREP WATER TEMP LOW

30 ENTRAPPED GAS IN POTABLE H_2O

31 URINE OVERBOARD DUMP NOT DRAINING

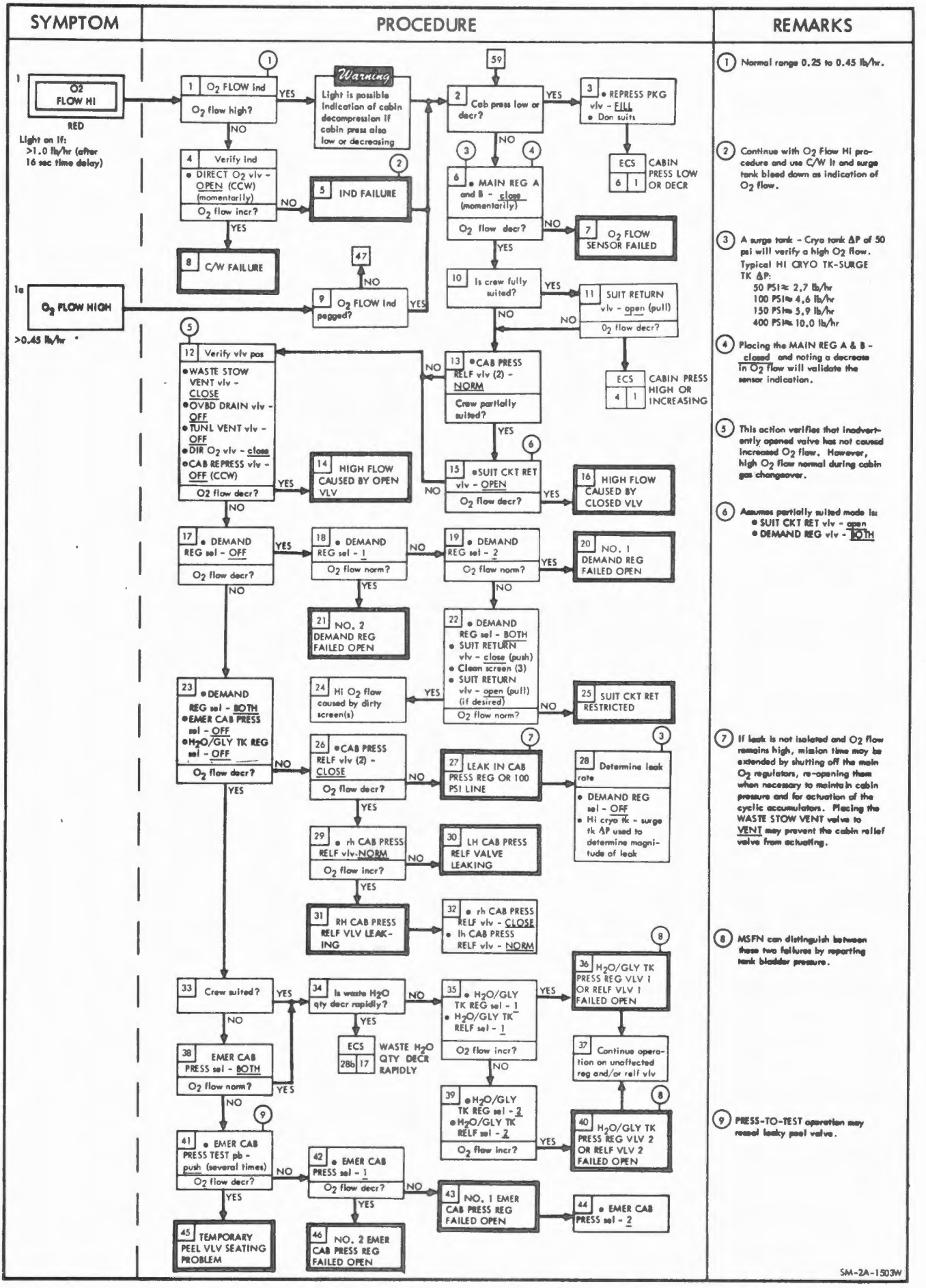
31a WASTE H_2O OVERBOARD DUMP NOT DRAINING

32 INADEQUATE VENTILATION AFTER LANDING

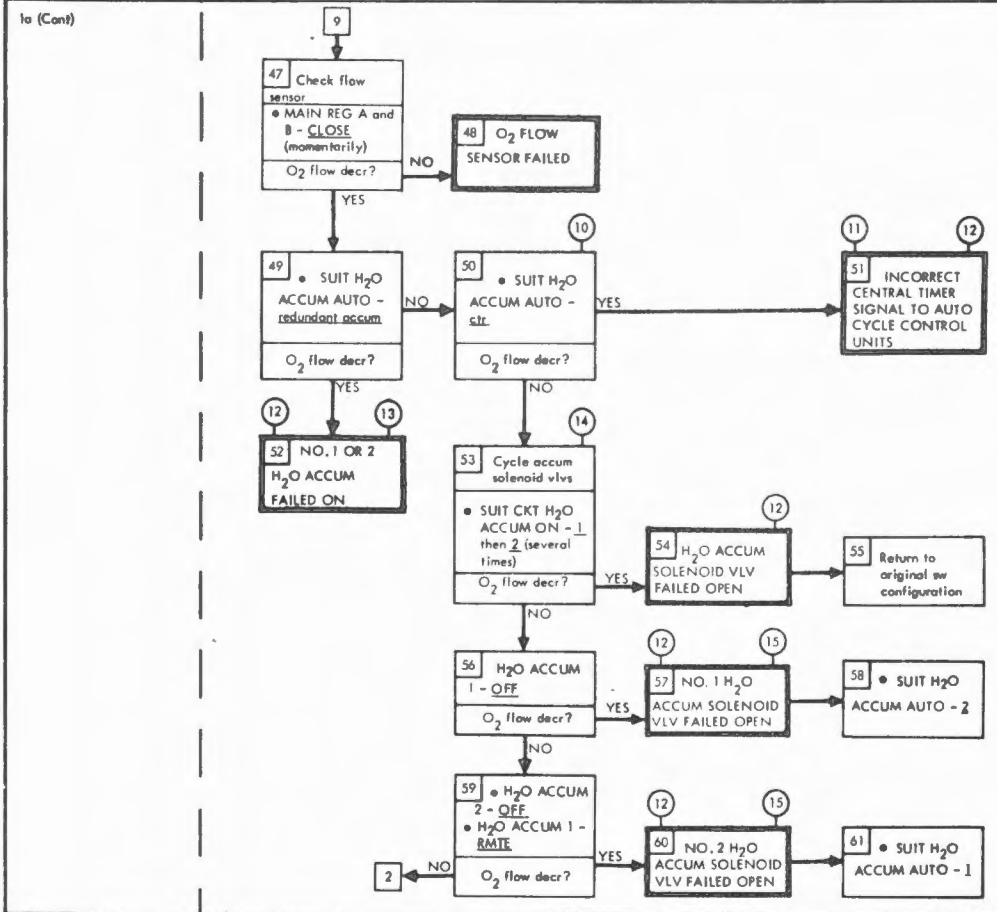
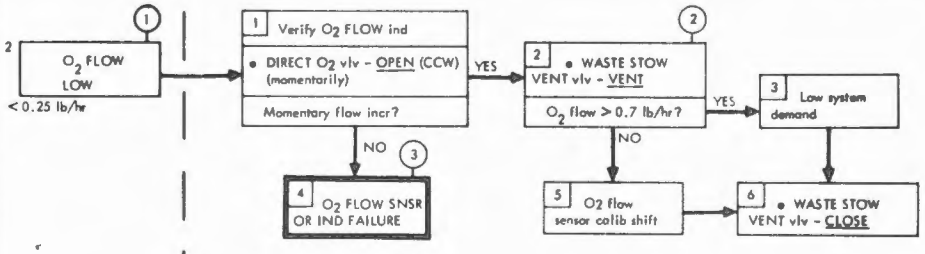
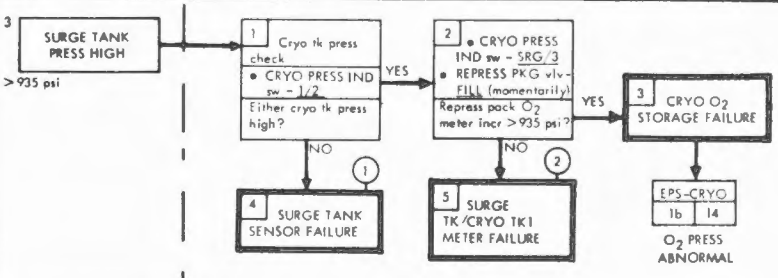
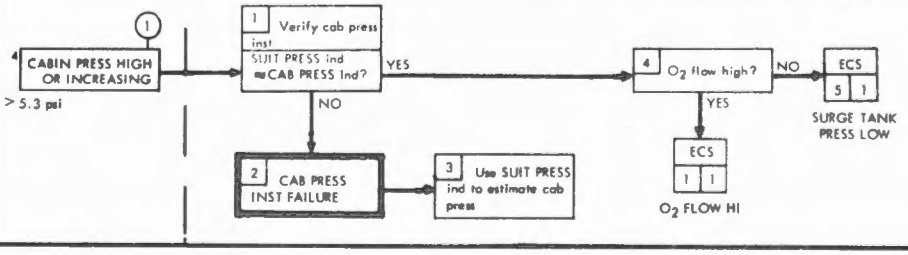
33 WATER INFLOW AFTER LANDING

SSR-1 SECONDARY LOOP ACTIVATION

SSR-2 FROZEN STEAM DUCT


SYMPTOM
PROCEDURE
REMARKS
1 O2 FLOW HI
RED
Light on if: >1.0 lb/hr (after 16 sec time delay)
1a O2 FLOW HIGH
>0.45 lb/hr
1 O2 FLOW ind
O2 flow high?
YES
NO
Warning
Light is possible indication of cabin decompression if cabin press also low or decreasing
4 Verify ind
• DIRECT O2 vlv - OPEN (CCW) (momentarily)
O2 flow incr?
NO
5 IND FAILURE
YES
8 C/W FAILURE
9 O2 FLOW ind pegged?
YES
NO
47
59
2 Cab press low or decr?
YES
3 • REPRESS PKG vlv - FILL
• Don suits
ECS 6 1 CABIN PRESS LOW OR DECR
NO
6 • MAIN REG A and B - close (momentarily)
O2 flow decr?
NO
7 O2 FLOW SENSOR FAILED
YES
10 Is crew fully suited?
YES
11 SUIT RETURN vlv - open (pull)
O2 flow decr?
NO
ECS 4 1 CABIN PRESS HIGH OR INCREASING
NO
12 Verify vlv pos
•WASTE STOW VENT vlv - CLOSE
•OVBD DRAIN vlv - OFF
•TUNL VENT vlv - OFF
•DIR O2 vlv - close
•CAB REPRESS vlv - OFF (CCW)
O2 flow decr?
YES
14 HIGH FLOW CAUSED BY OPEN VLV
NO
13 •CAB PRESS RELF vlv (2) - NORM
Crew partially suited?
YES
15 •SUIT CKT RET vlv - OPEN
O2 flow decr?
NO
YES
16 HIGH FLOW CAUSED BY CLOSED VLV
17 • DEMAND REG sel - OFF
O2 flow decr?
YES
NO
18 • DEMAND REG sel - 1
O2 flow norm?
YES
NO
19 • DEMAND REG sel - 2
O2 flow norm?
YES
NO
20 NO. 1 DEMAND REG FAILED OPEN
21 NO. 2 DEMAND REG FAILED OPEN
22 • DEMAND REG sel - BOTH
• SUIT RETURN vlv - close (push)
• Clean screen (3)
• SUIT RETURN vlv - open (pull) (if desired)
O2 flow norm?
YES
NO
24 Hi O2 flow caused by dirty screen(s)
25 SUIT CKT RET RESTRICTED
23 • DEMAND REG sel - BOTH
• EMER CAB PRESS sel - OFF
• H2O/GLY TK REG sel - OFF
O2 flow decr?
NO
YES
26 •CAB PRESS RELF vlv (2) - CLOSE
O2 flow decr?
NO
YES
27 LEAK IN CAB PRESS REG OR 100 PSI LINE
28 Determine leak rate
• DEMAND REG sel - OFF
• Hi cryo tk - surge tk ΔP used to determine magnitude of leak
29 • rh CAB PRESS RELF vlv-NORM
O2 flow incr?
NO
YES
30 LH CAB PRESS RELF VALVE LEAKING
31 RH CAB PRESS RELF VLV LEAKING
32 • rh CAB PRESS RELF vlv - CLOSE
• lh CAB PRESS RELF vlv - NORM
33 Crew suited?
YES
NO
34 Is waste H2O qty decr rapidly?
NO
YES
35 • H2O/GLY TK REG sel - 1
• H2O/GLY TK RELF sel - 1
O2 flow incr?
YES
NO
36 H2O/GLY TK PRESS REG VLV 1 OR RELF VLV 1 FAILED OPEN
37 Continue operation on unaffected reg and/or relf vlv
ECS 28b 17 WASTE H2O QTY DECR RAPIDLY
38 EMER CAB PRESS sel - BOTH
O2 flow norm?
YES
NO
39 • H2O/GLY TK REG sel - 2
• H2O/GLY TK RELF sel - 2
O2 flow incr?
YES
NO
40 H2O/GLY TK PRESS REG VLV 2 OR RELF VLV 2 FAILED OPEN
41 • EMER CAB PRESS TEST pb - push (several times)
O2 flow decr?
NO
YES
42 • EMER CAB PRESS sel - 1
O2 flow decr?
NO
YES
43 NO. 1 EMER CAB PRESS REG FAILED OPEN
44 • EMER CAB PRESS sel - 2
45 TEMPORARY PEEL VLV SEATING PROBLEM
46 NO. 2 EMER CAB PRESS REG FAILED OPEN
1 Normal range 0.25 to 0.45 lb/hr.
2 Continue with O2 Flow Hi procedure and use C/W if and surge tank bleed down as indication of O2 flow.
3 A surge tank - Cryo tank ΔP of 50 psi will verify a high O2 flow. Typical HI CRYO TK-SURGE TK ΔP:
50 PSI≈ 2,7 lb/hr
100 PSI≈ 4,6 lb/hr
150 PSI≈ 5,9 lb/hr
400 PSI≈ 10.0 lb/hr
4 Placing the MAIN REG A & B - closed and noting a decrease in O2 flow will validate the sensor indication.
5 This action verifies that inadvertently opened valve has not caused increased O2 flow. However, high O2 flow normal during cabin gas changeover.
6 Assumes partially suited mode is:
• SUIT CKT RET vlv - open
• DEMAND REG vlv - BOTH
7 If leak is not isolated and O2 flow remains high, mission time may be extended by shutting off the main O2 regulators, re-opening them when necessary to maintain cabin pressure and for actuation of the cyclic accumulators. Placing the WASTE STOW VENT valve to VENT may prevent the cabin relief valve from actuating.
8 MSFN can distinguish between these two failures by reporting tank bladder pressure.
9 PRESS-TO-TEST operation may reseal leaky pool valve.
SM-2A-1503W

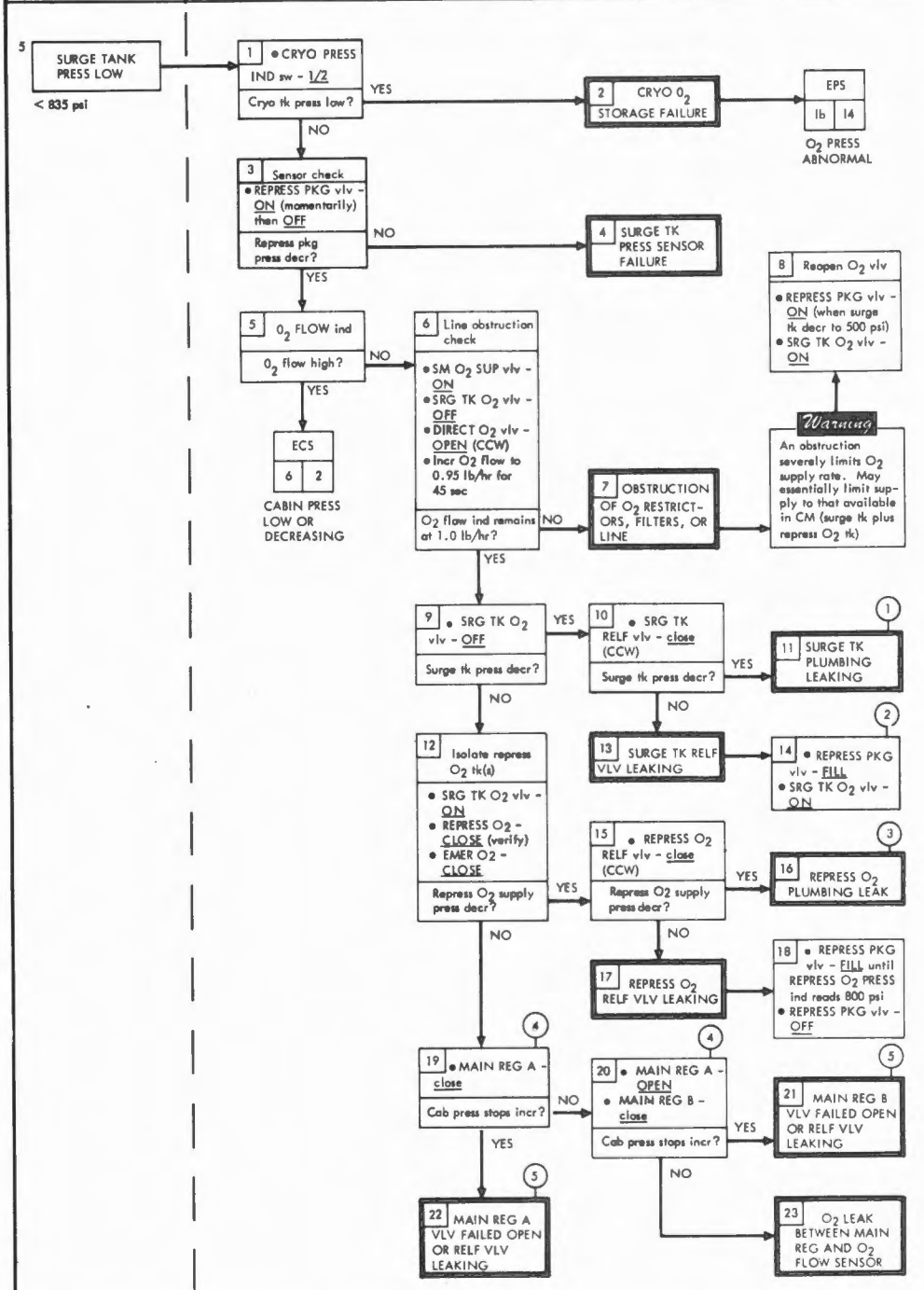
1a
ONT)
HRU
4r

SYMPTOM	PROCEDURE	REMARKS
1a (Cont)		(10) Removes power from H_2O accumulator. (11) H_2O accumulator can be manually operated. (12) Max O_2 bleed into suit loop will be 0.55 lb/hr (from which metabolic use and cabin leakage will be taken). (13) This failure does not necessarily preclude manual operation of the affected H_2O accumulator. (14) Cycling operation may free sticking valve. (15) Loss of electrical cyclic control of affected H_2O accumulator. Periodic manual valve operation the only means of actuating H_2O accumulator.
2 O_2 FLOW LOW < 0.25 lb/hr		(1) Normal range 0.25 - 0.45 lb/hr. (2) May take up to 45 minutes max. (3) MSFN can distinguish between these two failures.
3 SURGE TANK PRESS HIGH > 935 psi		(1) Use highest cryo tank indication to estimate surge tank pressure. (2) Surge tank pressure may be determined by momentarily positioning REPRESS PKG vlv - FILL and read repress pack press meter after stabilization.
4 CABIN PRESS HIGH OR INCREASING > 5.3 psi		(1) Cabin pressure > 5.3 psi is normal after insertion. Normal range is 4.7 to 5.3 psi.

SM-2A-1504V

5 THRU 6

SYMPTOM	PROCEDURE	REMARKS



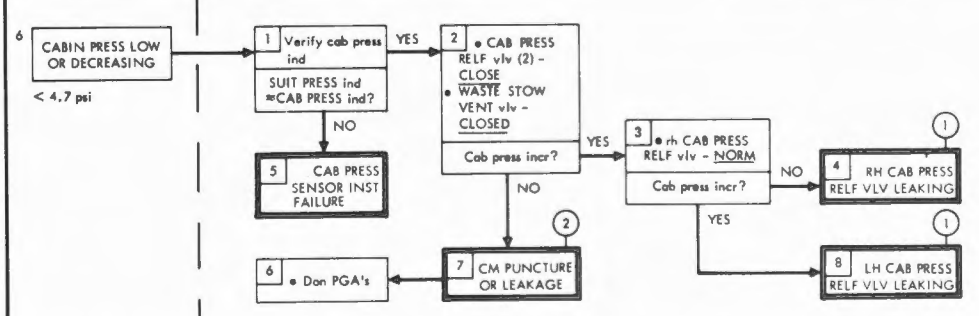
(1) REPRESS PKG vlv - FILL; repress O_2 supply to perform surge tank function.

(2) Use REPRESS O_2 RELF vlv for surge tank pressure relief.

(3) If subsequent O_2 mask use is necessary, position REPRESS PKG vlv to FILL. Excessive O_2 consumption results.

(4) This step may require considerable time.

(5) MSFN can distinguish between these two failures by reporting O_2 system pressure.



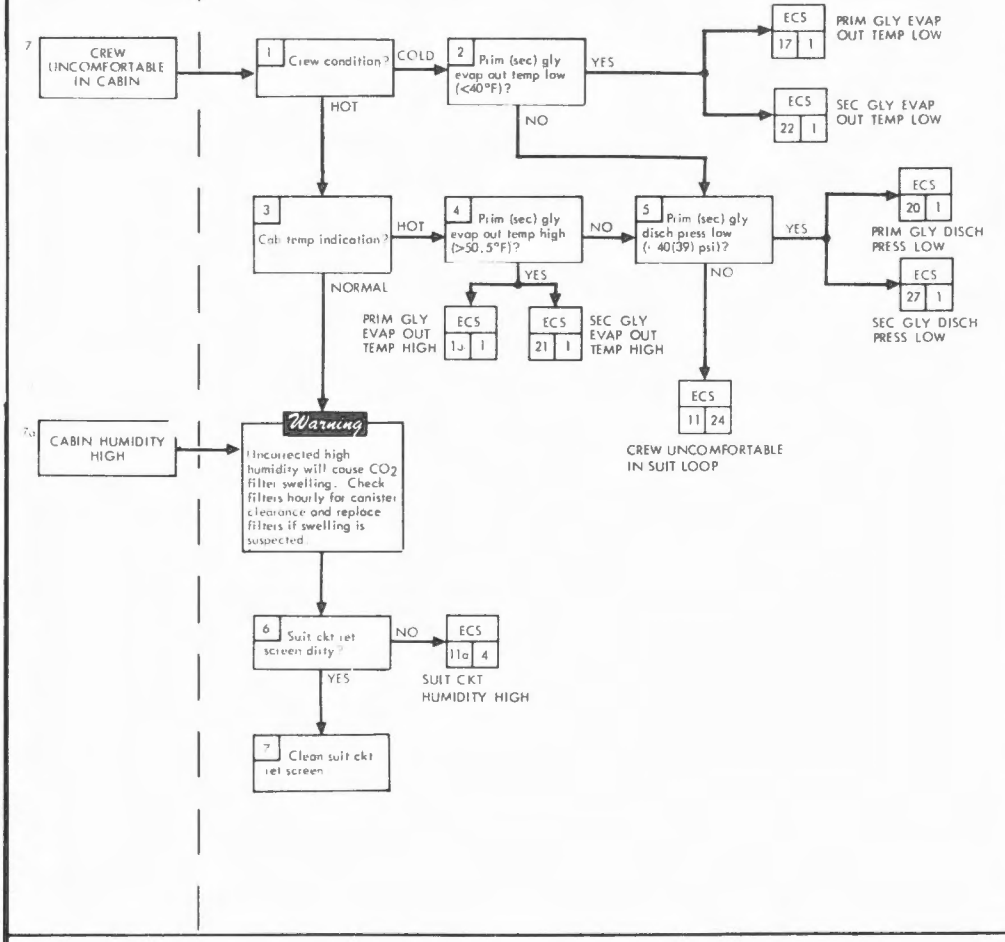
(1) Maintain close position on leaking valve. Cabin pressure relief valve redundancy lost.

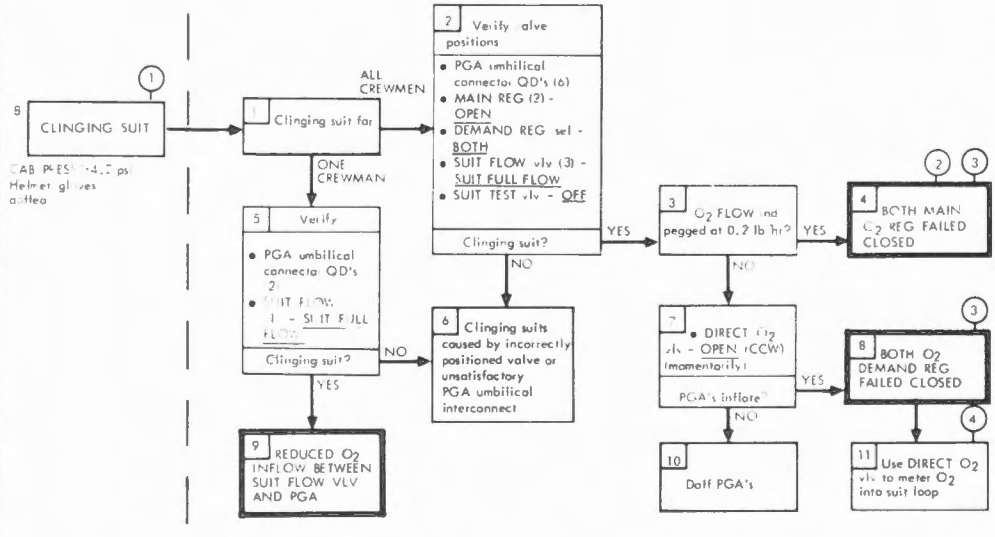
(2) Maintain fully suited mode. Excessive O_2 consumption if cabin pressure is maintained. The suit circuit should be purged to eliminate accumulated H_2 as follows:
a. Periodic purge (every 6 hours) - DIRECT O_2 vlv - OPEN (fully) for one minute then closed.
b. After use of water gun for drinking, provided O_2 supply permits DIRECT O_2 vlv - OPEN (fully) for 8 seconds then closed.

SM-2A-1505V

7 HRU 8

SYMPTOM	PROCEDURE	REMARKS





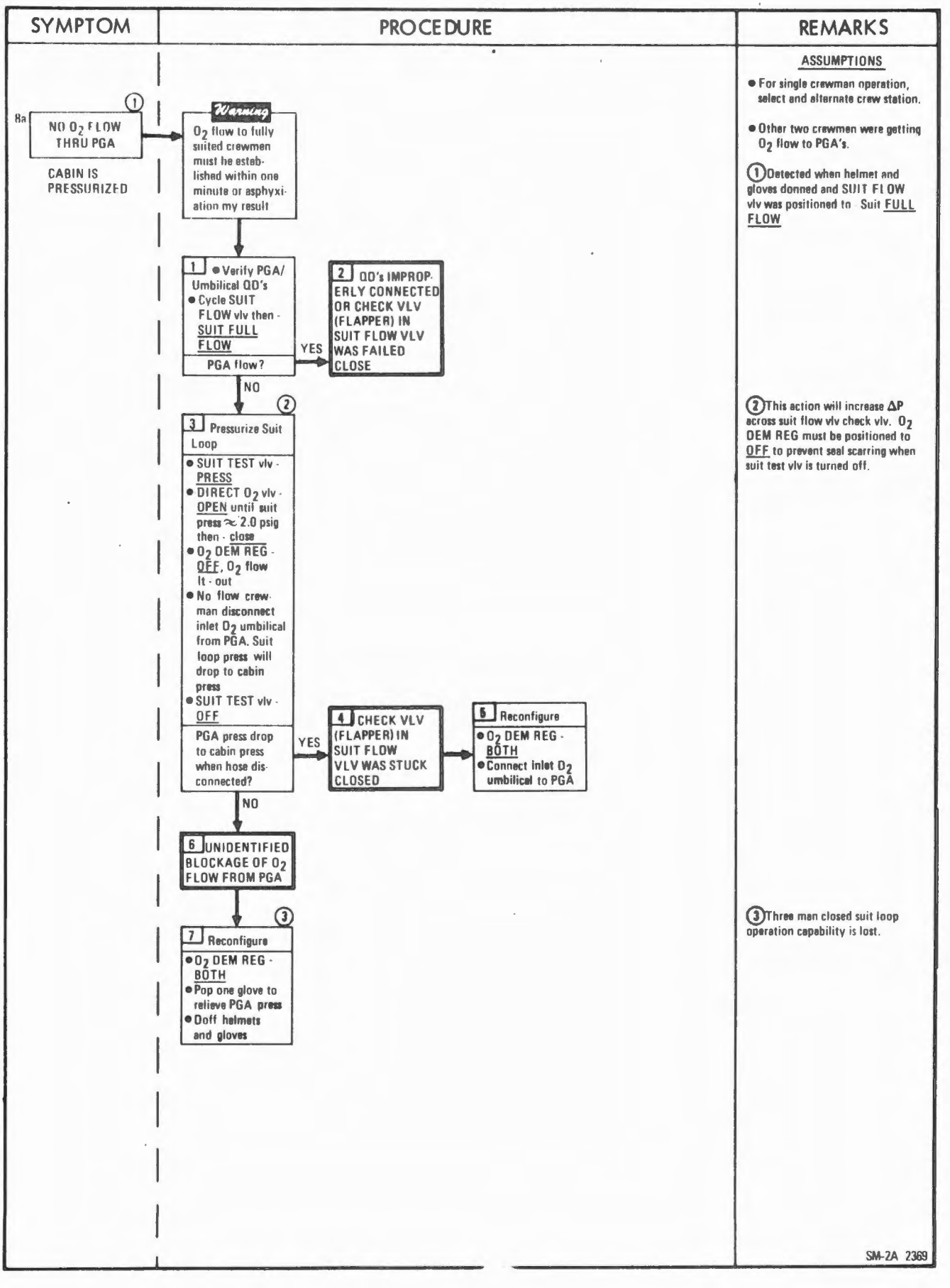
(1) Valid only for non-reversed hose configuration.

(2) MSFN can verify loss of 100 psi circuit. Open close REPRESS vlv to maintain 5 psia cabin press.

(3) Doff PGA's closed suit operations are lost.

(4) Metabolic requirement per crewman is approximately 0.1 lb/hr.

SM-2A-1506J

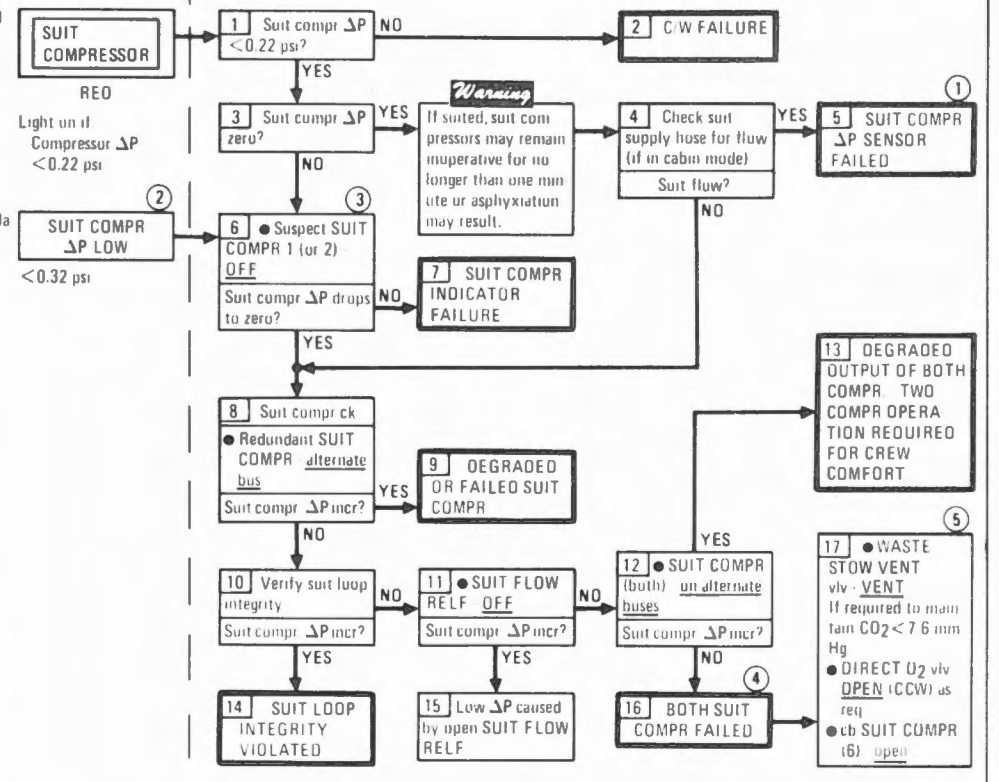

SYMPTOM
PROCEDURE
REMARKS
8a
NO O_2 FLOW THRU PGA
CABIN IS PRESSURIZED
Warning
O_2 flow to fully suited crewmen must be established within one minute or asphyxiation may result
1 • Verify PGA/ Umbilical QD's • Cycle SUIT FLOW vlv then - SUIT FULL FLOW
PGA flow?
YES
2 QD's IMPROPERLY CONNECTED OR CHECK VLV (FLAPPER) IN SUIT FLOW VLV WAS FAILED CLOSE
NO
3 Pressurize Suit Loop
• SUIT TEST vlv - PRESS
• DIRECT O_2 vlv - OPEN until suit press ≈ 2.0 psig then - close
• O_2 DEM REG - OFF, O_2 flow lt - out
• No flow crewman disconnect inlet O_2 umbilical from PGA. Suit loop press will drop to cabin press
• SUIT TEST vlv - OFF
PGA press drop to cabin press when hose disconnected?
YES
4 CHECK VLV (FLAPPER) IN SUIT FLOW VLV WAS STUCK CLOSED
5 Reconfigure
• O_2 DEM REG - BOTH
• Connect inlet O_2 umbilical to PGA
NO
6 UNIDENTIFIED BLOCKAGE OF O_2 FLOW FROM PGA
7 Reconfigure
• O_2 DEM REG - BOTH
• Pop one glove to relieve PGA press
• Doff helmets and gloves
ASSUMPTIONS
• For single crewman operation, select and alternate crew station.
• Other two crewmen were getting O_2 flow to PGA's.
(1) Detected when helmet and gloves donned and SUIT FLOW vlv was positioned to Suit FULL FLOW
(2) This action will increase ΔP across suit flow vlv check vlv. O_2 DEM REG must be positioned to OFF to prevent seal scarring when suit test vlv is turned off.
(3) Three man closed suit loop operation capability is lost.
SM-2A 2369

9 THRU 10

SYMPTOM

PROCEDURE

REMARKS



① Subsequent compressor operation verified by monitoring supply hose flow and humidity level.

② Unsuited compressor ΔP of approximately 0.275 psid is normal with SUIT FLOW valve in SUIT FULL FLOW position.

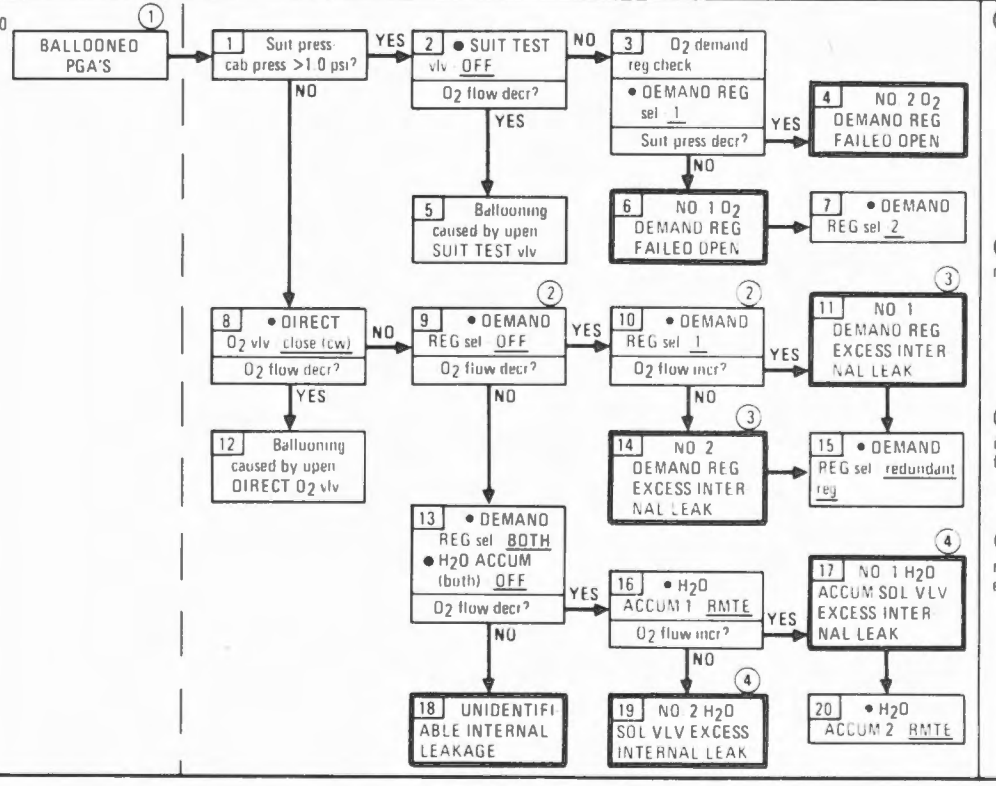
③ Pressure rise across suit compressor is 0.36 psi in cabin mode (5.0 psi) and 0.26 psi at emergency suit pressure (3.75 psi). Suit compr ΔP of 0.1 psi will adequately scrub cabin air for unsuited operation.

④ Humidity and CO_2 control lost. Inadequate suit ventilation obtained by opening DIRECT O_2 vlv. PGAs will balloon up to 0.32 psi above cabin if in suited mode. Use emergency O_2 masks if in cabin mode since CO_2 indicator inoperative. Some consideration may be given to taping a CO_2 absorber element to the cabin fan inlet.

Metabolic Load BTU/HR/Man	O_2 Flow - 3 men masked LB/HR at 5 psia cab press
1500	6.6
750	3.4
500	2.2
400	1.6

⑤ With CO_2 level at 0.1 mm Hg at time of suit compr failure, CO_2 will remain < 7.6 mm Hg for times shown at following WASTE STOWAGE VENT vlv positions.

VLV Position	Minutes
CLOSE	74
VENT	77
VENT plus side hatch dump venting	80



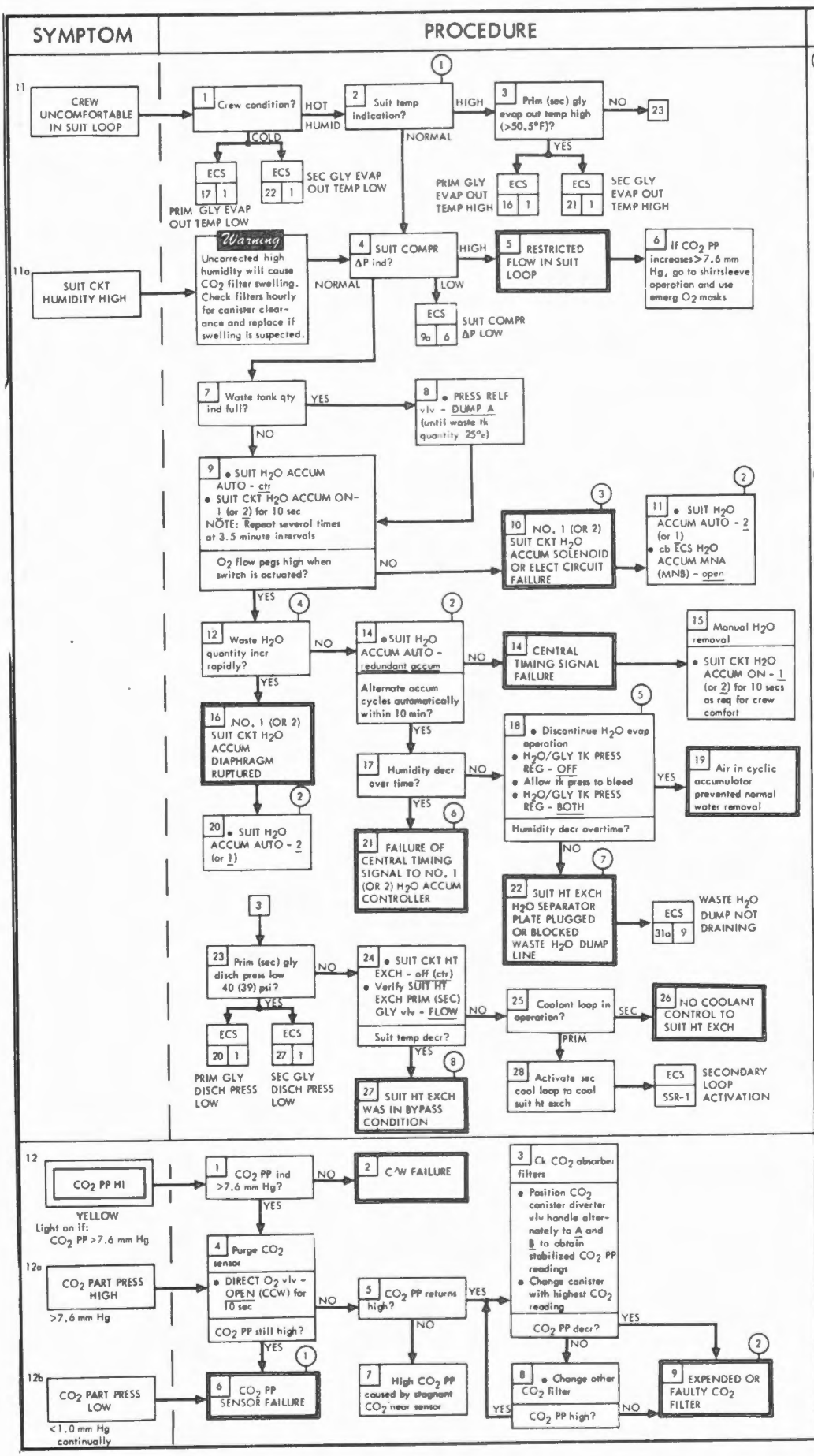
① Slightly ballooned can be verified by the suit-to-cabin ΔP indicator >zero. Cabin to suit ΔP maintained at 2.5 to 3.5 in H_2O.

② Recycling valve serveral times may correct excessive O_2 flow.

③ Leaking O_2 demand regulator is still operational and may be used for depressurized cabin mode.

④ H_2O accumulators may be used manually for H_2O removal with excessive O_2 usage.

SM 2A 2255B



(1) Assumes SUIT FLOW RELF valve is OFF.

(2) Operation is verified by O_2 FLOW indicator pegging high within a ten minute period. Accum cycle occurs at CTE - even 10 min marks (i.e. 0, 10, 20, etc.) and CTE clocks GET.

(3) Operation of No. 1 (or 2) H_2O accumulator may still be possible. This can be verified by placing H_2O ACCUM 1 (or 2) valve to MAN for 10 sec and then OFF noting a high O_2 flow while valve is in MAN position.

(4) If a rapid increase in waste water quantity is noted, release SUIT CKT H_2O ACCUM ON switch.

(5) Humidity and water coming out of suit supply hose should be greater than that caused by condensation from cold structure before proceeding to this step. This removes air from suit ckt H_2O accum. However, time for tank bleed-down is dependent upon the following waste H_2O tk quantities:
80°c 1 hr
50°c 3 hrs
20°c 5 hrs
(MSFN reads H_2O gly tank press)

(6) Operation of No. 1 (or 2) H_2O accumulator can be maintained by manual actuation of solenoid switch or manual operation of selector valve.

(7) A blocked waste H_2O dump line can be concluded if the waste H_2O tank qty were verified full in step 7.

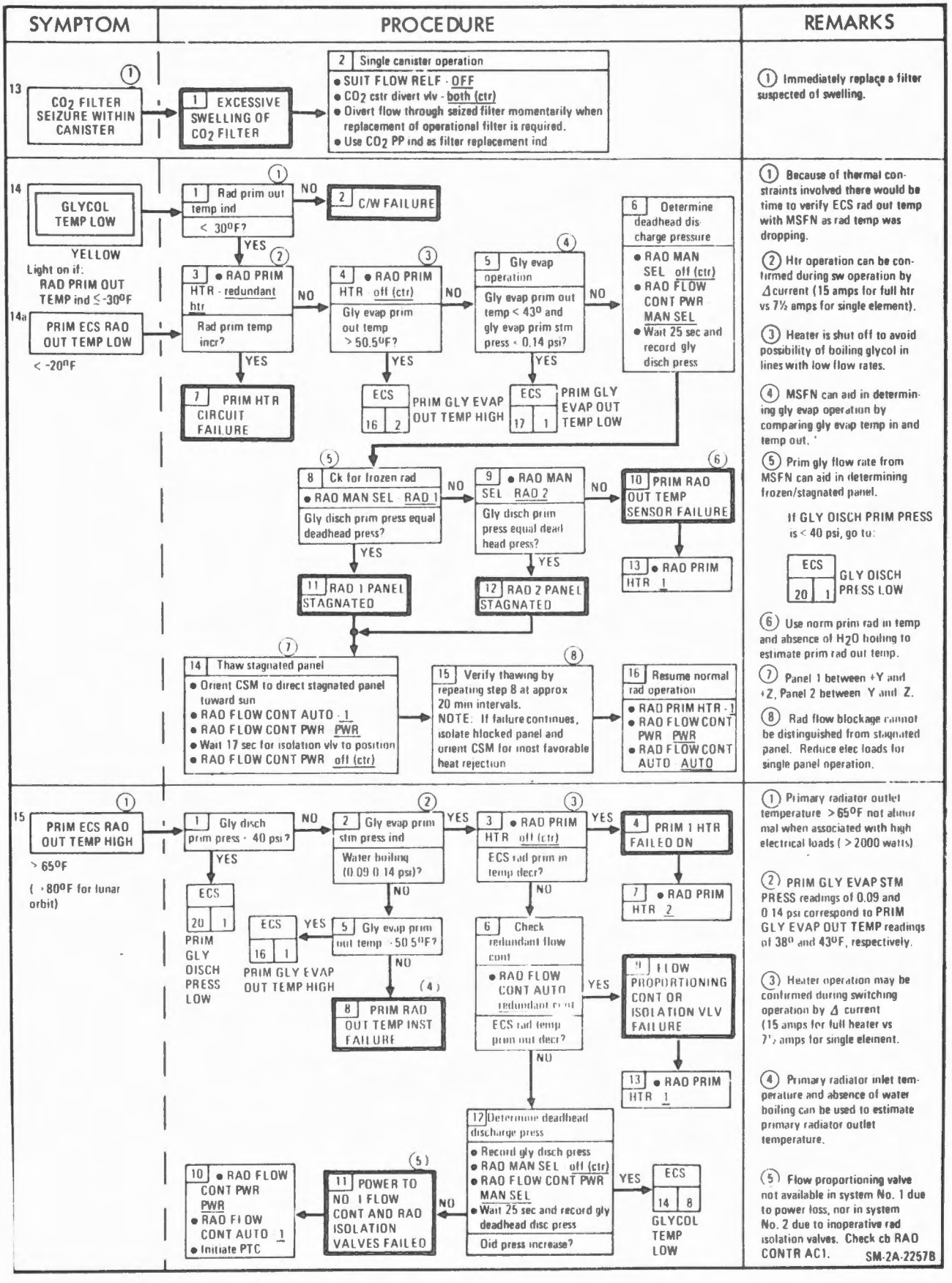
(8) Suit heat exchanger must be bypassed manually for future use. In the primary ht exchanger mode, this failure could be caused by a motor or control switch failure.

(1) The CO_2 PP HI warning light may be extinguished by pulling cb ECS PRESS XDUCER 2 MNA. However, this eliminates redundant MN bus pwr sources to the following sensors:
- Cabin press ind
- O_2 flow ind
- Gly stm press ind (Pri)
- O_2 manifold press (MSFN).

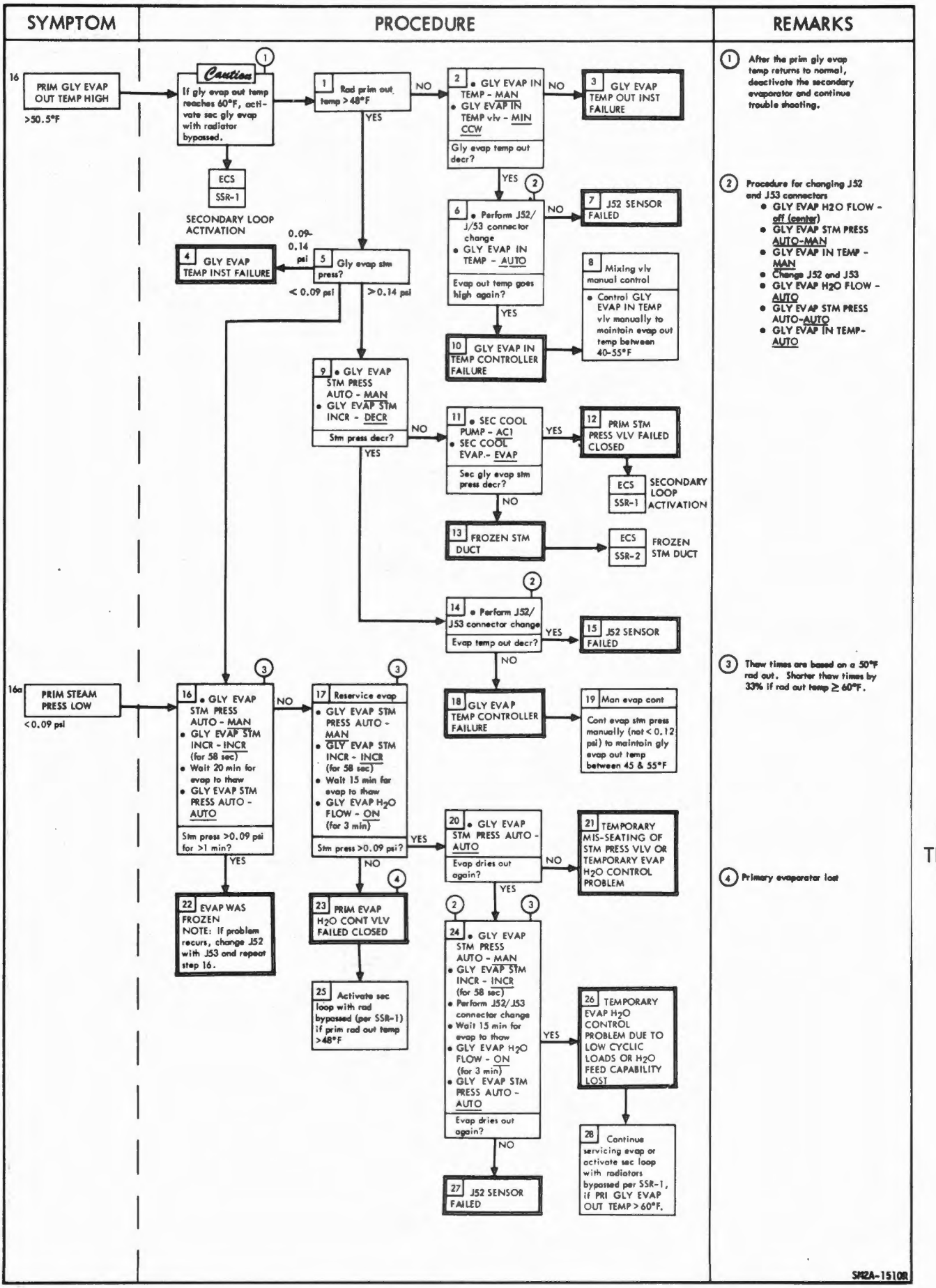
(2) Manual CO_2 partial pressure control can be accomplished by use of DIRECT O_2 vlv operation, or emergency O_2 masks can be used.

SM-2A-1508M

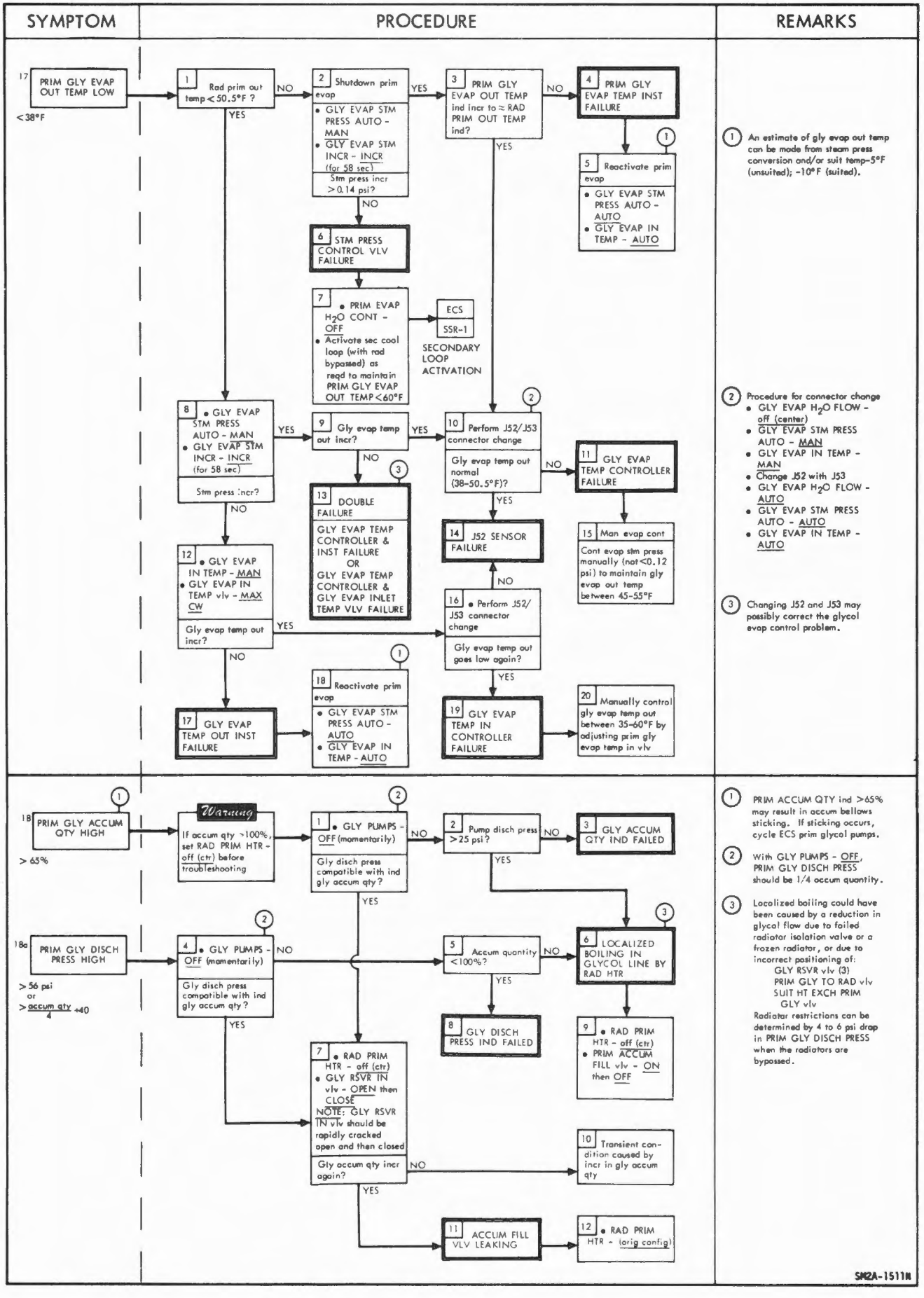
11 THR 12

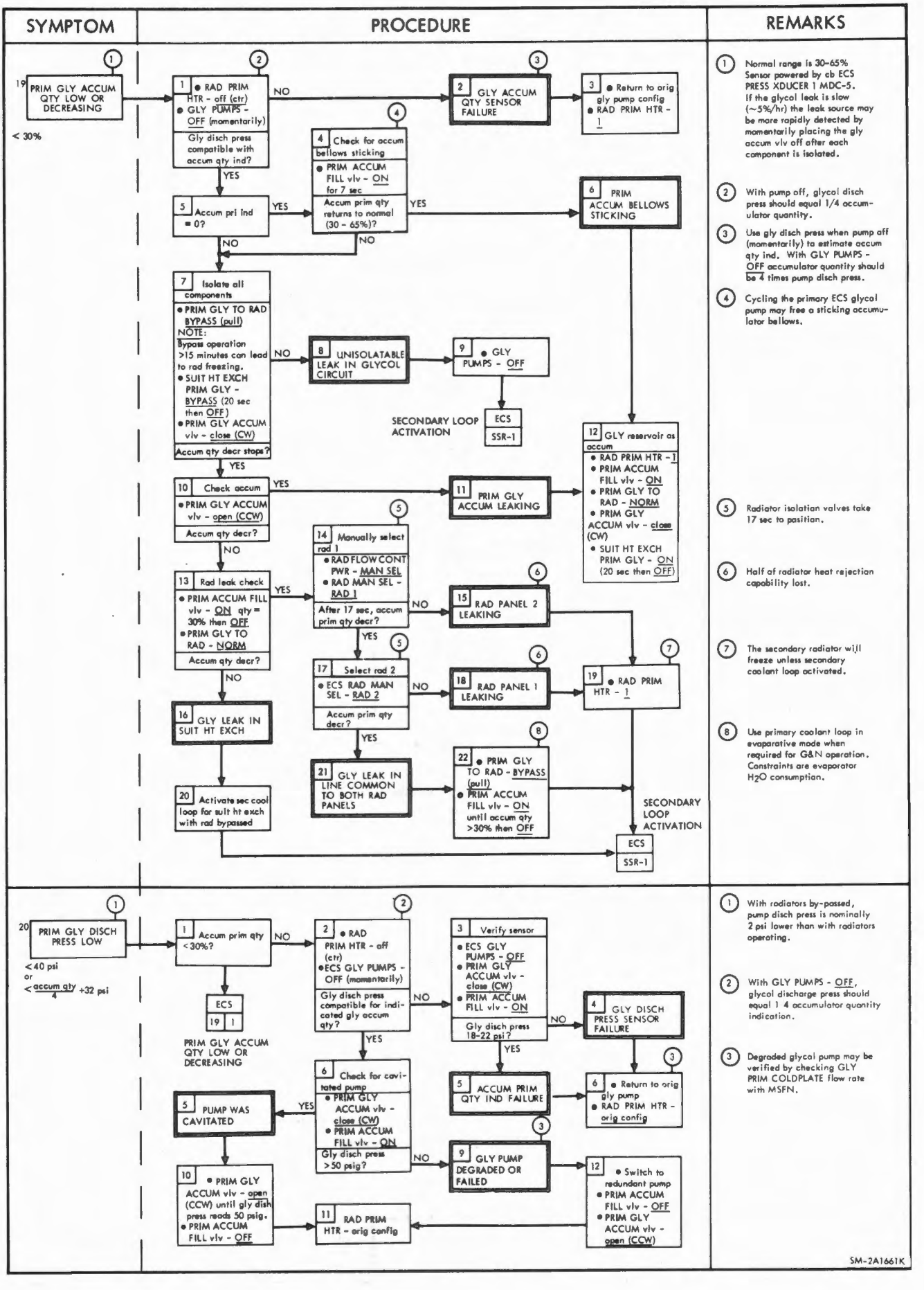

SYMPTOM
PROCEDURE
REMARKS
13
CO2 FILTER SEIZURE WITHIN CANISTER
1 EXCESSIVE SWELLING OF CO2 FILTER
2 Single canister operation
• SUIT FLOW RELF - OFF
• CO2 cstr divert vlv - both (ctr)
• Divert flow through seized filter momentarily when replacement of operational filter is required.
• Use CO2 PP ind as filter replacement ind
(1) Immediately replace a filter suspected of swelling.
14
GLYCOL TEMP LOW
YELLOW
Light on if:
RAD PRIM OUT TEMP ind ≤ -30°F
14a
PRIM ECS RAD OUT TEMP LOW
< -20°F
1 Rad prim out temp ind < 30°F?
NO
2 C/W FAILURE
YES
3 • RAD PRIM HTR - redundant htr
Rad prim temp incr?
NO
4 • RAD PRIM HTR off (ctr)
Gly evap prim out temp > 50.5°F?
NO
5 Gly evap operation
Gly evap prim out temp < 43° and gly evap prim stm press < 0.14 psi?
NO
6 Determine deadhead discharge pressure
• RAD MAN SEL off (ctr)
• RAD FLOW CONT PWR MAN SEL
• Wait 25 sec and record gly disch press
YES
7 PRIM HTR CIRCUIT FAILURE
ECS 16 2 PRIM GLY EVAP OUT TEMP HIGH
ECS 17 1 PRIM GLY EVAP OUT TEMP LOW
8 Ck for frozen rad
• RAD MAN SEL RAD 1
Gly disch prim press equal deadhead press?
NO
9 • RAD MAN SEL RAD 2
Gly disch prim press equal dead head press?
NO
10 PRIM RAD OUT TEMP SENSOR FAILURE
13 • RAD PRIM HTR 1
YES
11 RAD 1 PANEL STAGNATED
YES
12 RAD 2 PANEL STAGNATED
14 Thaw stagnated panel
• Orient CSM to direct stagnated panel toward sun
• RAD FLOW CONT AUTO 1
• RAD FLOW CONT PWR PWR
• Wait 17 sec for isolation vlv to position
• RAD FLOW CONT PWR off (ctr)
15 Verify thawing by repeating step 8 at approx 20 min intervals.
NOTE: If failure continues, isolate blocked panel and orient CSM for most favorable heat rejection
16 Resume normal rad operation
• RAD PRIM HTR 1
• RAD FLOW CONT PWR PWR
• RAD FLOW CONT AUTO AUTO
(1) Because of thermal constraints involved there would be time to verify ECS rad out temp with MSFN as rad temp was dropping.
(2) Htr operation can be confirmed during sw operation by Δ current (15 amps for full htr vs 7½ amps for single element).
(3) Heater is shut off to avoid possibility of boiling glycol in lines with low flow rates.
(4) MSFN can aid in determining gly evap operation by comparing gly evap temp in and temp out.
(5) Prim gly flow rate from MSFN can aid in determining frozen/stagnated panel.
If GLY DISCH PRIM PRESS is < 40 psi, go to:
ECS 20 1 GLY DISCH PRESS LOW
(6) Use norm prim rad in temp and absence of H2O boiling to estimate prim rad out temp.
(7) Panel 1 between +Y and +Z, Panel 2 between -Y and -Z.
(8) Rad flow blockage cannot be distinguished from stagnated panel. Reduce elec loads for single panel operation.
15
PRIM ECS RAD OUT TEMP HIGH
> 65°F
(> 80°F for lunar orbit)
1 Gly disch prim press < 40 psi?
YES
ECS 20 1 PRIM GLY DISCH PRESS LOW
NO
2 Gly evap prim stm press ind
Water boiling (0.09 0.14 psi)?
YES
ECS 16 1 PRIM GLY EVAP OUT TEMP HIGH
NO
5 Gly evap prim out temp < 50.5°F?
NO
8 PRIM RAD OUT TEMP INST FAILURE
(4)
3 • RAD PRIM HTR off (ctr)
ECS rad prim in temp decr?
YES
4 PRIM 1 HTR FAILED ON
7 • RAD PRIM HTR 2
NO
6 Check redundant flow cont
• RAD FLOW CONT AUTO redundant cont
ECS rad temp prim out decr?
YES
9 FLOW PROPORTIONING CONT OR ISOLATION VLV FAILURE
13 • RAD PRIM HTR 1
NO
12 Determine deadhead discharge press
• Record gly disch press
• RAD MAN SEL off (ctr)
• RAD FLOW CONT PWR MAN SEL
• Wait 25 sec and record gly deadhead disc press
Did press increase?
YES
ECS 14 8 GLYCOL TEMP LOW
NO
(5)
11 POWER TO NO 1 FLOW CONT AND RAD ISOLATION VALVES FAILED
10 • RAD FLOW CONT PWR PWR
• RAD FLOW CONT AUTO 1
• Initiate PTC
(1) Primary radiator outlet temperature > 65°F not abnormal when associated with high electrical loads (> 2000 watts)
(2) PRIM GLY EVAP STM PRESS readings of 0.09 and 0.14 psi correspond to PRIM GLY EVAP OUT TEMP readings of 38° and 43°F, respectively.
(3) Heater operation may be confirmed during switching operation by Δ current (15 amps for full heater vs 7½ amps for single element.
(4) Primary radiator inlet temperature and absence of water boiling can be used to estimate primary radiator outlet temperature.
(5) Flow proportioning valve not available in system No. 1 due to power loss, nor in system No. 2 due to inoperative rad isolation valves. Check cb RAD CONTR AC1.
SM-2A-2257B

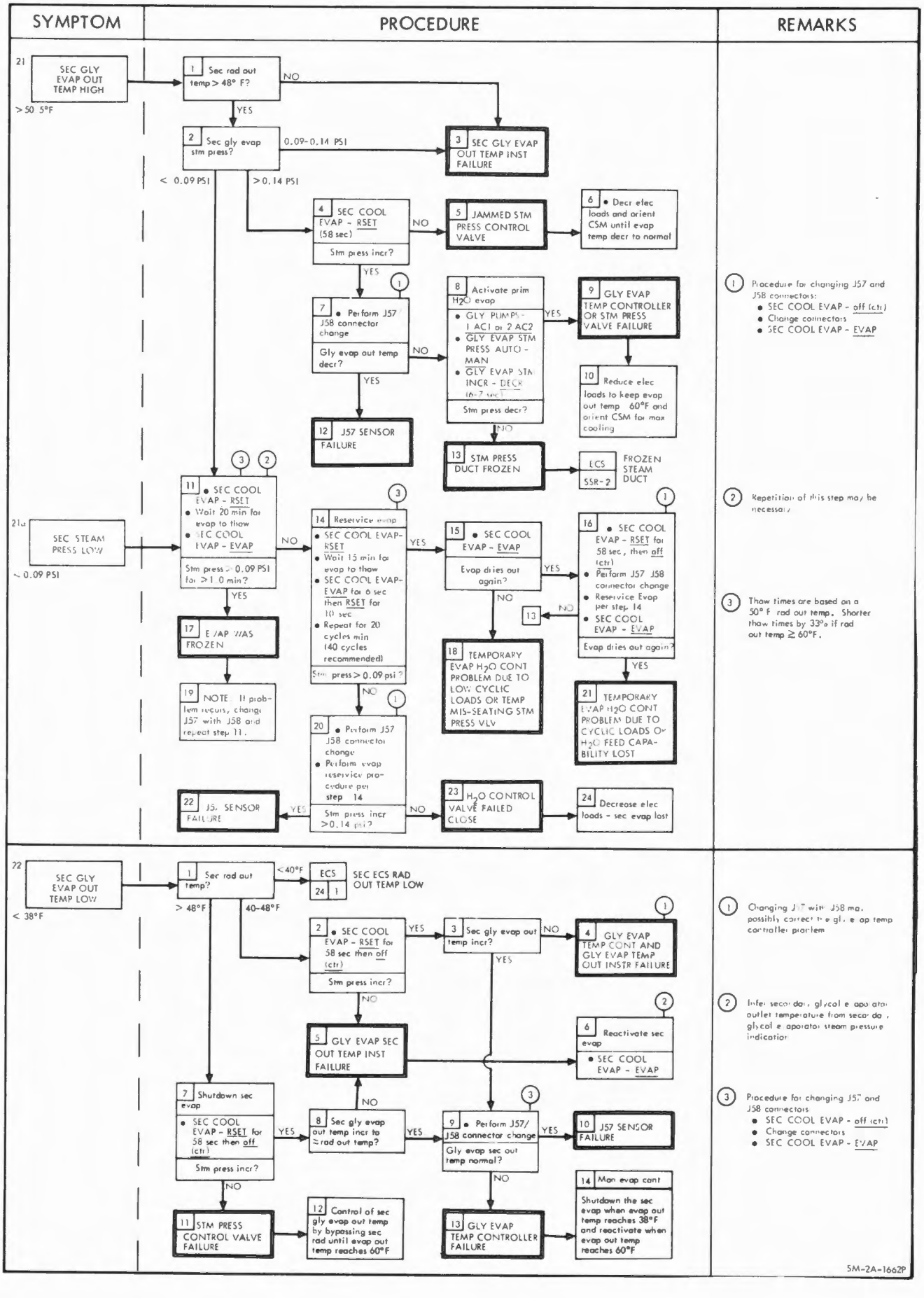
13
HRU
15


SYMPTOM
PROCEDURE
REMARKS
16 PRIM GLY EVAP OUT TEMP HIGH
>50.5°F
Caution
If gly evap out temp reaches 60°F, activate sec gly evap with radiator bypassed.
ECS SSR-1
SECONDARY LOOP ACTIVATION
1 Rad prim out temp > 48°F
NO
YES
2 • GLY EVAP IN TEMP - MAN • GLY EVAP IN TEMP vlv - MIN CCW
Gly evap temp out decr?
NO
3 GLY EVAP TEMP OUT INST FAILURE
YES
6 • Perform J52/J53 connector change • GLY EVAP IN TEMP - AUTO
Evap out temp goes high again?
NO
7 J52 SENSOR FAILED
YES
8 Mixing vlv manual control
• Control GLY EVAP IN TEMP vlv manually to maintain evap out temp between 40-55°F
10 GLY EVAP IN TEMP CONTROLLER FAILURE
0.09-0.14 psi
5 Gly evap stm press?
< 0.09 psi
>0.14 psi
4 GLY EVAP TEMP INST FAILURE
9 • GLY EVAP STM PRESS AUTO - MAN • GLY EVAP STM INCR - DECR
Stm press decr?
NO
YES
11 • SEC COOL PUMP - AC1 • SEC COOL EVAP.- EVAP
Sec gly evap stm press decr?
NO
12 PRIM STM PRESS VLV FAILED CLOSED
ECS SSR-1 SECONDARY LOOP ACTIVATION
13 FROZEN STM DUCT
ECS SSR-2 FROZEN STM DUCT
14 • Perform J52/J53 connector change
Evap temp out decr?
YES
15 J52 SENSOR FAILED
NO
18 GLY EVAP TEMP CONTROLLER FAILURE
19 Man evap cont
Cont evap stm press manually (not < 0.12 psi) to maintain gly evap out temp between 45 & 55°F
16a PRIM STEAM PRESS LOW
<0.09 psi
16 • GLY EVAP STM PRESS AUTO - MAN • GLY EVAP STM INCR - INCR (for 58 sec) • Wait 20 min for evap to thaw • GLY EVAP STM PRESS AUTO - AUTO
Stm press >0.09 psi for >1 min?
NO
YES
17 Reservice evap
• GLY EVAP STM PRESS AUTO - MAN • GLY EVAP STM INCR - INCR (for 58 sec) • Wait 15 min for evap to thaw • GLY EVAP H2O FLOW - ON (for 3 min)
Stm press >0.09 psi?
YES
NO
20 • GLY EVAP STM PRESS AUTO - AUTO
Evap dries out again?
NO
21 TEMPORARY MIS-SEATING OF STM PRESS VLV OR TEMPORARY EVAP H2O CONTROL PROBLEM
YES
22 EVAP WAS FROZEN NOTE: If problem recurs, change J52 with J53 and repeat step 16.
23 PRIM EVAP H2O CONT VLV FAILED CLOSED
25 Activate sec loop with rad bypassed (per SSR-1) if prim rad out temp >48°F
24 • GLY EVAP STM PRESS AUTO - MAN • GLY EVAP STM INCR - INCR (for 58 sec) • Perform J52/J53 connector change • Wait 15 min for evap to thaw • GLY EVAP H2O FLOW - ON (for 3 min) • GLY EVAP STM PRESS AUTO - AUTO
Evap dries out again?
NO
YES
26 TEMPORARY EVAP H2O CONTROL PROBLEM DUE TO LOW CYCLIC LOADS OR H2O FEED CAPABILITY LOST
28 Continue servicing evap or activate sec loop with radiators bypassed per SSR-1, if PRI GLY EVAP OUT TEMP > 60°F.
27 J52 SENSOR FAILED
1 After the prim gly evap temp returns to normal, deactivate the secondary evaporator and continue trouble shooting.
2 Procedure for changing J52 and J53 connectors
• GLY EVAP H2O FLOW - off (center)
• GLY EVAP STM PRESS AUTO-MAN
• GLY EVAP IN TEMP - MAN
• Change J52 and J53
• GLY EVAP H2O FLOW - AUTO
• GLY EVAP STM PRESS AUTO-AUTO
• GLY EVAP IN TEMP- AUTO
3 Thaw times are based on a 50°F rad out. Shorter thaw times by 33% if rad out temp ≥ 60°F.
4 Primary evaporator lost
SMZA-1510R

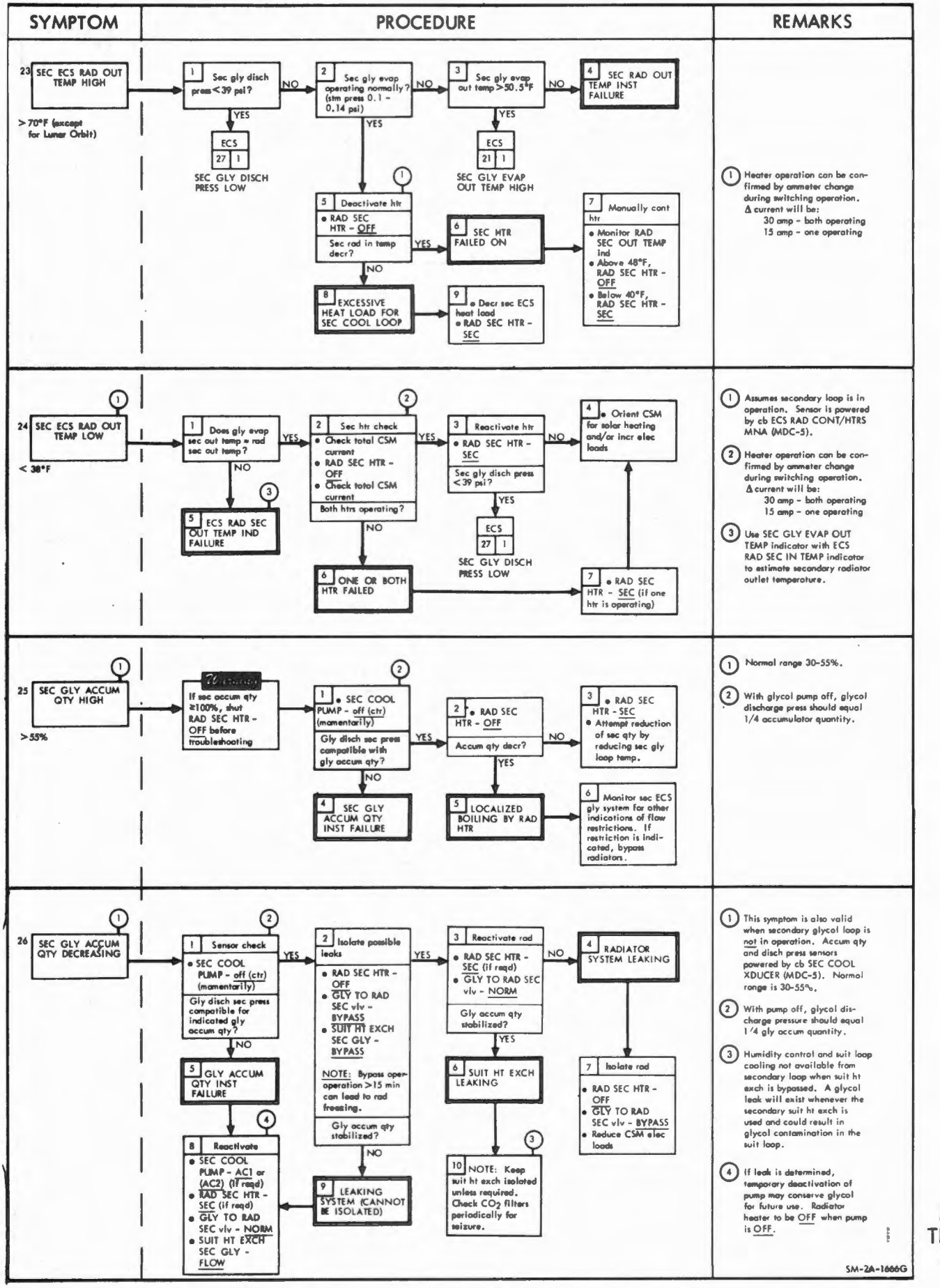
16 THRU 16a


SYMPTOM
PROCEDURE
REMARKS
17 PRIM GLY EVAP OUT TEMP LOW
<38°F
1 Rad prim out temp < 50.5°F ?
NO
YES
2 Shutdown prim evap
• GLY EVAP STM PRESS AUTO - MAN
• GLY EVAP STM INCR - INCR (for 58 sec)
Stm press incr >0.14 psi?
YES
NO
3 PRIM GLY EVAP OUT TEMP ind incr to ≈ RAD PRIM OUT TEMP ind?
NO
YES
4 PRIM GLY EVAP TEMP INST FAILURE
5 Reactivate prim evap
• GLY EVAP STM PRESS AUTO - AUTO
• GLY EVAP IN TEMP - AUTO
6 STM PRESS CONTROL VLV FAILURE
7 • PRIM EVAP H2O CONT - OFF
• Activate sec cool loop (with rad bypassed) as reqd to maintain PRIM GLY EVAP OUT TEMP <60°F
ECS SSR-1
SECONDARY LOOP ACTIVATION
8 • GLY EVAP STM PRESS AUTO - MAN
• GLY EVAP STM INCR - INCR (for 58 sec)
Stm press incr?
YES
NO
9 Gly evap temp out incr?
YES
NO
10 Perform J52/J53 connector change
Gly evap temp out normal (38-50.5°F)?
NO
YES
11 GLY EVAP TEMP CONTROLLER FAILURE
13 DOUBLE FAILURE
GLY EVAP TEMP CONTROLLER & INST FAILURE
OR
GLY EVAP TEMP CONTROLLER & GLY EVAP INLET TEMP VLV FAILURE
14 J52 SENSOR FAILURE
15 Man evap cont
Cont evap stm press manually (not <0.12 psi) to maintain gly evap out temp between 45-55°F
12 • GLY EVAP IN TEMP - MAN
• GLY EVAP IN TEMP vlv - MAX CW
Gly evap temp out incr?
YES
NO
16 • Perform J52/J53 connector change
Gly evap temp out goes low again?
YES
NO
17 GLY EVAP TEMP OUT INST FAILURE
18 Reactivate prim evap
• GLY EVAP STM PRESS AUTO - AUTO
• GLY EVAP IN TEMP - AUTO
19 GLY EVAP TEMP IN CONTROLLER FAILURE
20 Manually control gly evap temp out between 35-60°F by adjusting prim gly evap temp in vlv
1 An estimate of gly evap out temp can be made from steam press conversion and/or suit temp-5°F (unsuited); -10°F (suited).
2 Procedure for connector change
• GLY EVAP H2O FLOW - off (center)
• GLY EVAP STM PRESS AUTO - MAN
• GLY EVAP IN TEMP - MAN
• Change J52 with J53
• GLY EVAP H2O FLOW - AUTO
• GLY EVAP STM PRESS AUTO - AUTO
• GLY EVAP IN TEMP - AUTO
3 Changing J52 and J53 may possibly correct the glycol evap control problem.
17 THRU 8a
18 PRIM GLY ACCUM QTY HIGH
>65%
Warning
If accum qty >100%, set RAD PRIM HTR - off (ctr) before troubleshooting
1 • GLY PUMPS - OFF (momentarily)
Gly disch press compatible with ind gly accum qty?
YES
NO
2 Pump disch press >25 psi?
NO
YES
3 GLY ACCUM QTY IND FAILED
18a PRIM GLY DISCH PRESS HIGH
>56 psi or > accum qty/4 +40
4 • GLY PUMPS - OFF (momentarily)
Gly disch press compatible with ind gly accum qty?
NO
YES
5 Accum quantity <100%?
NO
YES
6 LOCALIZED BOILING IN GLYCOL LINE BY RAD HTR
8 GLY DISCH PRESS IND FAILED
9 • RAD PRIM HTR - off (ctr)
• PRIM ACCUM FILL vlv - ON then OFF
7 • RAD PRIM HTR - off (ctr)
• GLY RSVR IN vlv - OPEN then CLOSE
NOTE: GLY RSVR IN vlv should be rapidly cracked open and then closed
Gly accum qty incr again?
NO
YES
10 Transient condition caused by incr in gly accum qty
11 ACCUM FILL VLV LEAKING
12 • RAD PRIM HTR - (orig config)
1 PRIM ACCUM QTY ind >65% may result in accum bellows sticking. If sticking occurs, cycle ECS prim glycol pumps.
2 With GLY PUMPS - OFF, PRIM GLY DISCH PRESS should be 1/4 accum quantity.
3 Localized boiling could have been caused by a reduction in glycol flow due to failed radiator isolation valve or a frozen radiator, or due to incorrect positioning of:
GLY RSVR vlv (3)
PRIM GLY TO RAD vlv
SUIT HT EXCH PRIM GLY vlv
Radiator restrictions can be determined by 4 to 6 psi drop in PRIM GLY DISCH PRESS when the radiators are bypassed.
SM2A-1511N


SYMPTOM
PROCEDURE
REMARKS
19 PRIM GLY ACCUM QTY LOW OR DECREASING
< 30%
1 • RAD PRIM HTR - off (ctr) • GLY PUMPS - OFF (momentarily) Gly disch press compatible with accum qty ind?
NO
2 GLY ACCUM QTY SENSOR FAILURE
3 • Return to orig gly pump config • RAD PRIM HTR - 1
YES
4 Check for accum bellows sticking • PRIM ACCUM FILL vlv - ON for 7 sec Accum prim qty returns to normal (30 - 65%)?
YES
NO
5 Accum pri ind = 0?
YES
NO
6 PRIM ACCUM BELLOWS STICKING
7 Isolate all components • PRIM GLY TO RAD BYPASS (pull) NOTE: Bypass operation >15 minutes can lead to rad freezing. • SUIT HT EXCH PRIM GLY - BYPASS (20 sec then OFF) • PRIM GLY ACCUM vlv - close (CW) Accum qty decr stops?
NO
8 UNISOLATABLE LEAK IN GLYCOL CIRCUIT
9 • GLY PUMPS - OFF
SECONDARY LOOP ACTIVATION
ECS SSR-1
YES
10 Check accum • PRIM GLY ACCUM vlv - open (CCW) Accum qty decr?
YES
11 PRIM GLY ACCUM LEAKING
12 GLY reservoir as accum • RAD PRIM HTR - 1 • PRIM ACCUM FILL vlv - ON • PRIM GLY TO RAD - NORM • PRIM GLY ACCUM vlv - close (CW) • SUIT HT EXCH PRIM GLY - ON (20 sec then OFF)
NO
13 Rad leak check • PRIM ACCUM FILL vlv - ON qty = 30% then OFF • PRIM GLY TO RAD - NORM Accum qty decr?
YES
14 Manually select rad 1 • RAD FLOW CONT PWR - MAN SEL • RAD MAN SEL - RAD 1 After 17 sec, accum prim qty decr?
NO
15 RAD PANEL 2 LEAKING
YES
NO
16 GLY LEAK IN SUIT HT EXCH
17 Select rad 2 • ECS RAD MAN SEL - RAD 2 Accum prim qty decr?
NO
18 RAD PANEL 1 LEAKING
19 • RAD PRIM HTR - 1
YES
20 Activate sec cool loop for suit ht exch with rad bypassed
21 GLY LEAK IN LINE COMMON TO BOTH RAD PANELS
22 • PRIM GLY TO RAD - BYPASS (pull) • PRIM ACCUM FILL vlv - ON until accum qty >30% then OFF
SECONDARY LOOP ACTIVATION
ECS SSR-1
1 Normal range is 30-65% Sensor powered by cb ECS PRESS XDUCER 1 MDC-5. If the glycol leak is slow (~5%/hr) the leak source may be more rapidly detected by momentarily placing the gly accum vlv off after each component is isolated.
2 With pump off, glycol disch press should equal 1/4 accumulator quantity.
3 Use gly disch press when pump off (momentarily) to estimate accum qty ind. With GLY PUMPS - OFF accumulator quantity should be 4 times pump disch press.
4 Cycling the primary ECS glycol pump may free a sticking accumulator bellows.
5 Radiator isolation valves take 17 sec to position.
6 Half of radiator heat rejection capability lost.
7 The secondary radiator will freeze unless secondary coolant loop activated.
8 Use primary coolant loop in evaporative mode when required for G&N operation. Constraints are evaporator H_2O consumption.
20 PRIM GLY DISCH PRESS LOW
< 40 psi or < accum qty / 4 + 32 psi
1 Accum prim qty < 30%?
NO
2 • RAD PRIM HTR - off (ctr) • ECS GLY PUMPS - OFF (momentarily) Gly disch press compatible for indicated gly accum qty?
NO
3 Verify sensor • ECS GLY PUMPS - OFF • PRIM GLY ACCUM vlv - close (CW) • PRIM ACCUM FILL vlv - ON Gly disch press 18-22 psi?
NO
4 GLY DISCH PRESS SENSOR FAILURE
YES
5 ACCUM PRIM QTY IND FAILURE
6 • Return to orig gly pump • RAD PRIM HTR - orig config
ECS 19 1
PRIM GLY ACCUM QTY LOW OR DECREASING
YES
6 Check for cavitated pump • PRIM GLY ACCUM vlv - close (CW) • PRIM ACCUM FILL vlv - ON Gly disch press >50 psig?
YES
5 PUMP WAS CAVITATED
NO
9 GLY PUMP DEGRADED OR FAILED
12 • Switch to redundant pump • PRIM ACCUM FILL vlv - OFF • PRIM GLY ACCUM vlv - open (CCW)
10 • PRIM GLY ACCUM vlv - open (CCW) until gly disch press reads 50 psig. • PRIM ACCUM FILL vlv - OFF
11 RAD PRIM HTR - orig config
1 With radiators by-passed, pump disch press is nominally 2 psi lower than with radiators operating.
2 With GLY PUMPS - OFF, glycol discharge press should equal 1 4 accumulator quantity indication.
3 Degraded glycol pump may be verified by checking GLY PRIM COLDPLATE flow rate with MSFN.
SM-2A1661K


SYMPTOM
PROCEDURE
REMARKS
21 SEC GLY EVAP OUT TEMP HIGH
> 50.5°F
1 Sec rad out temp > 48° F?
NO
YES
2 Sec gly evap stm press?
0.09-0.14 PSI
3 SEC GLY EVAP OUT TEMP INST FAILURE
< 0.09 PSI
> 0.14 PSI
4 SEC COOL EVAP - RSET (58 sec)
Stm press incr?
5 JAMMED STM PRESS CONTROL VALVE
6 • Decr elec loads and orient CSM until evap temp decr to normal
7 • Perform J57/J58 connector change
Gly evap out temp decr?
8 Activate prim H2O evap
• GLY PUMPS - 1 AC1 or 2 AC2
• GLY EVAP STM PRESS AUTO - MAN
• GLY EVAP STM INCR - DECR (6-7 sec)
Stm press decr?
9 GLY EVAP TEMP CONTROLLER OR STM PRESS VALVE FAILURE
10 Reduce elec loads to keep evap out temp 60°F and orient CSM for max cooling
12 J57 SENSOR FAILURE
13 STM PRESS DUCT FROZEN
ECS SSR-2 FROZEN STEAM DUCT
11 • SEC COOL EVAP - RSET
• Wait 20 min for evap to thaw
• SEC COOL EVAP - EVAP
Stm press ≥ 0.09 PSI for ≥ 1.0 min?
21a SEC STEAM PRESS LOW
~ 0.09 PSI
14 Reservice evap
• SEC COOL EVAP - RSET
• Wait 15 min for evap to thaw
• SEC COOL EVAP - EVAP for 6 sec then RSET for 10 sec
• Repeat for 20 cycles min (40 cycles recommended)
Stm press > 0.09 psi?
15 • SEC COOL EVAP - EVAP
Evap dries out again?
16 • SEC COOL EVAP - RSET for 58 sec, then off (ctr)
• Perform J57/J58 connector change
• Reservice Evap per step 14
• SEC COOL EVAP - EVAP
Evap dries out again?
17 EVAP WAS FROZEN
18 TEMPORARY EVAP H2O CONT PROBLEM DUE TO LOW CYCLIC LOADS OR TEMP MIS-SEATING STM PRESS VLV
21 TEMPORARY EVAP H2O CONT PROBLEM DUE TO CYCLIC LOADS OR H2O FEED CAPABILITY LOST
19 NOTE: If problem recurs, change J57 with J58 and repeat step 11.
20 • Perform J57/J58 connector change
• Perform evap reservice procedure per step 14
Stm press incr > 0.14 psi?
22 J57 SENSOR FAILURE
23 H2O CONTROL VALVE FAILED CLOSE
24 Decrease elec loads - sec evap lost
1 Procedure for changing J57 and J58 connectors:
• SEC COOL EVAP - off (ctr)
• Change connectors
• SEC COOL EVAP - EVAP
2 Repetition of this step may be necessary
3 Thaw times are based on a 50° F rad out temp. Shorter thaw times by 33% if rad out temp ≥ 60°F.
22 SEC GLY EVAP OUT TEMP LOW
< 38°F
1 Sec rad out temp?
< 40°F
ECS 24 1 SEC ECS RAD OUT TEMP LOW
> 48°F
40-48°F
2 • SEC COOL EVAP - RSET for 58 sec then off (ctr)
Stm press incr?
3 Sec gly evap out temp incr?
4 GLY EVAP TEMP CONT AND GLY EVAP TEMP OUT INSTR FAILURE
5 GLY EVAP SEC OUT TEMP INST FAILURE
6 Reactivate sec evap
• SEC COOL EVAP - EVAP
7 Shutdown sec evap
• SEC COOL EVAP - RSET for 58 sec then off (ctr)
Stm press incr?
8 Sec gly evap out temp incr to ≈ rad out temp?
9 • Perform J57/J58 connector change
Gly evap sec out temp normal?
10 J57 SENSOR FAILURE
11 STM PRESS CONTROL VALVE FAILURE
12 Control of sec gly evap out temp by bypassing sec rad until evap out temp reaches 60°F
13 GLY EVAP TEMP CONTROLLER FAILURE
14 Man evap cont
Shutdown the sec evap when evap out temp reaches 38°F and reactivate when evap out temp reaches 60°F
1 Changing J57 with J58 may possibly correct the gly evap temp controller problem
2 Infer secondary glycol evaporator outlet temperature from secondary glycol evaporator steam pressure indication
3 Procedure for changing J57 and J58 connectors
• SEC COOL EVAP - off (ctr)
• Change connectors
• SEC COOL EVAP - EVAP
5M-2A-1662P

21 HRU 22


SYMPTOM
PROCEDURE
REMARKS
23 SEC ECS RAD OUT TEMP HIGH
>70°F (except for Lunar Orbit)
1 Sec gly disch press < 39 psi?
NO
2 Sec gly evap operating normally? (stm press 0.1 - 0.14 psi)
NO
3 Sec gly evap out temp > 50.5°F
NO
4 SEC RAD OUT TEMP INST FAILURE
YES
ECS 27 1
SEC GLY DISCH PRESS LOW
YES
ECS 21 1
SEC GLY EVAP OUT TEMP HIGH
1
5 Deactivate htr
• RAD SEC HTR - OFF
Sec rad in temp decr?
YES
6 SEC HTR FAILED ON
7 Manually cont htr
• Monitor RAD SEC OUT TEMP ind
• Above 48°F, RAD SEC HTR - OFF
• Below 40°F, RAD SEC HTR - SEC
NO
8 EXCESSIVE HEAT LOAD FOR SEC COOL LOOP
9 • Decr sec ECS heat load
• RAD SEC HTR - SEC
(1) Heater operation can be confirmed by ammeter change during switching operation. Δ current will be: 30 amp - both operating 15 amp - one operating
24 SEC ECS RAD OUT TEMP LOW
< 38°F
1
1 Does gly evap sec out temp = rad sec out temp?
YES
2 Sec htr check
• Check total CSM current
• RAD SEC HTR - OFF
• Check total CSM current
Both htrs operating?
2
NO
3 Reactivate htr
• RAD SEC HTR - SEC
Sec gly disch press < 39 psi?
YES
4 • Orient CSM for solar heating and/or incr elec loads
NO
3
5 ECS RAD SEC OUT TEMP IND FAILURE
ECS 27 1
SEC GLY DISCH PRESS LOW
6 ONE OR BOTH HTR FAILED
7 • RAD SEC HTR - SEC (if one htr is operating)
(1) Assumes secondary loop is in operation. Sensor is powered by cb ECS RAD CONT/HTRS MNA (MDC-5).
(2) Heater operation can be confirmed by ammeter change during switching operation. Δ current will be: 30 amp - both operating 15 amp - one operating
(3) Use SEC GLY EVAP OUT TEMP indicator with ECS RAD SEC IN TEMP indicator to estimate secondary radiator outlet temperature.
25 SEC GLY ACCUM QTY HIGH
>55%
1
Warning
If sec accum qty ≥100%, shut RAD SEC HTR - OFF before troubleshooting
1 • SEC COOL PUMP - off (ctr) (momentarily)
Gly disch sec press compatible with gly accum qty?
2
YES
2 • RAD SEC HTR - OFF
Accum qty decr?
NO
3 • RAD SEC HTR - SEC
• Attempt reduction of sec qty by reducing sec gly loop temp.
NO
YES
4 SEC GLY ACCUM QTY INST FAILURE
5 LOCALIZED BOILING BY RAD HTR
6 Monitor sec ECS gly system for other indications of flow restrictions. If restriction is indicated, bypass radiators.
(1) Normal range 30-55%.
(2) With glycol pump off, glycol discharge press should equal 1/4 accumulator quantity.
26 SEC GLY ACCUM QTY DECREASING
1
1 Sensor check
• SEC COOL PUMP - off (ctr) (momentarily)
Gly disch sec press compatible for indicated gly accum qty?
2
YES
2 Isolate possible leaks
• RAD SEC HTR - OFF
• GLY TO RAD SEC vlv - BYPASS
• SUIT HT EXCH SEC GLY - BYPASS
NOTE: Bypass operation >15 min can lead to rad freezing.
Gly accum qty stabilized?
YES
3 Reactivate rad
• RAD SEC HTR - SEC (if reqd)
• GLY TO RAD SEC vlv - NORM
Gly accum qty stabilized?
NO
4 RADIATOR SYSTEM LEAKING
NO
YES
5 GLY ACCUM QTY INST FAILURE
6 SUIT HT EXCH LEAKING
7 Isolate rad
• RAD SEC HTR - OFF
• GLY TO RAD SEC vlv - BYPASS
• Reduce CSM elec loads
4
3
8 Reactivate
• SEC COOL PUMP - AC1 or (AC2) (if reqd)
• RAD SEC HTR - SEC (if reqd)
• GLY TO RAD SEC vlv - NORM
• SUIT HT EXCH SEC GLY - FLOW
9 LEAKING SYSTEM (CANNOT BE ISOLATED)
10 NOTE: Keep suit ht exch isolated unless required. Check CO_2 filters periodically for seizure.
(1) This symptom is also valid when secondary glycol loop is not in operation. Accum qty and disch press sensors powered by cb SEC COOL XDUCER (MDC-5). Normal range is 30-55%.
(2) With pump off, glycol discharge pressure should equal 1/4 gly accum quantity.
(3) Humidity control and suit loop cooling not available from secondary loop when suit ht exch is bypassed. A glycol leak will exist whenever the secondary suit ht exch is used and could result in glycol contamination in the suit loop.
(4) If leak is determined, temporary deactivation of pump may conserve glycol for future use. Radiator heater to be OFF when pump is OFF.
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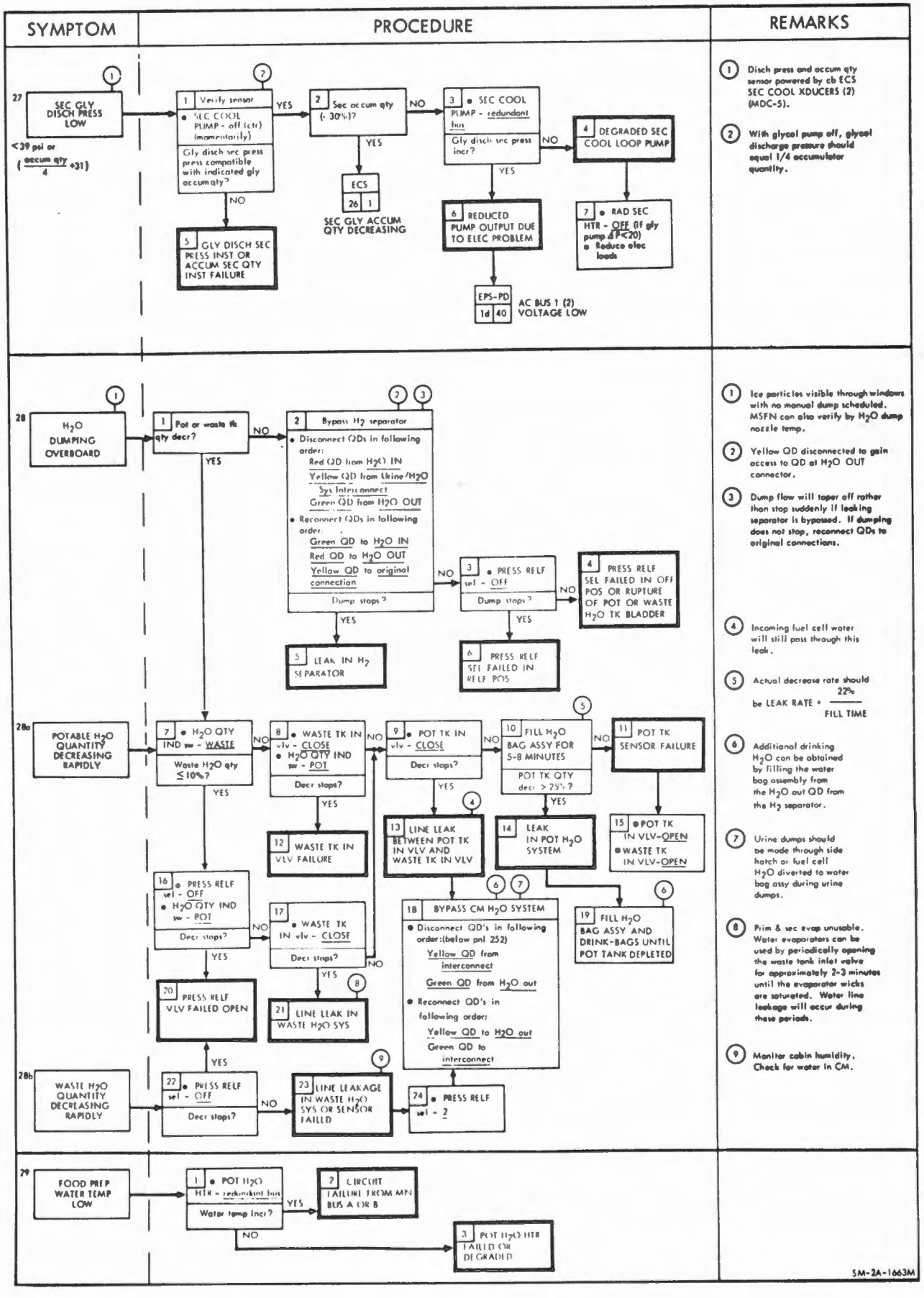
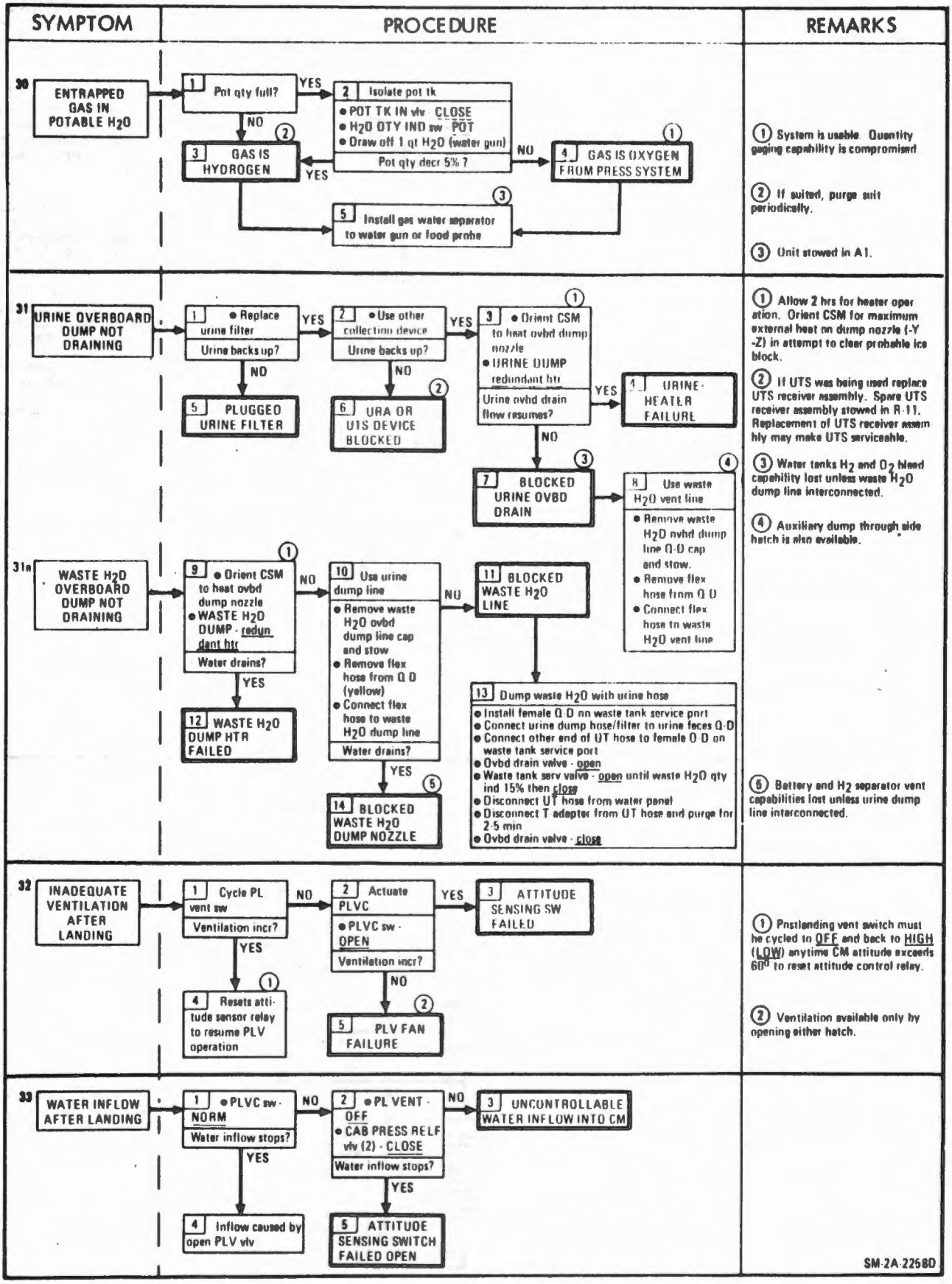
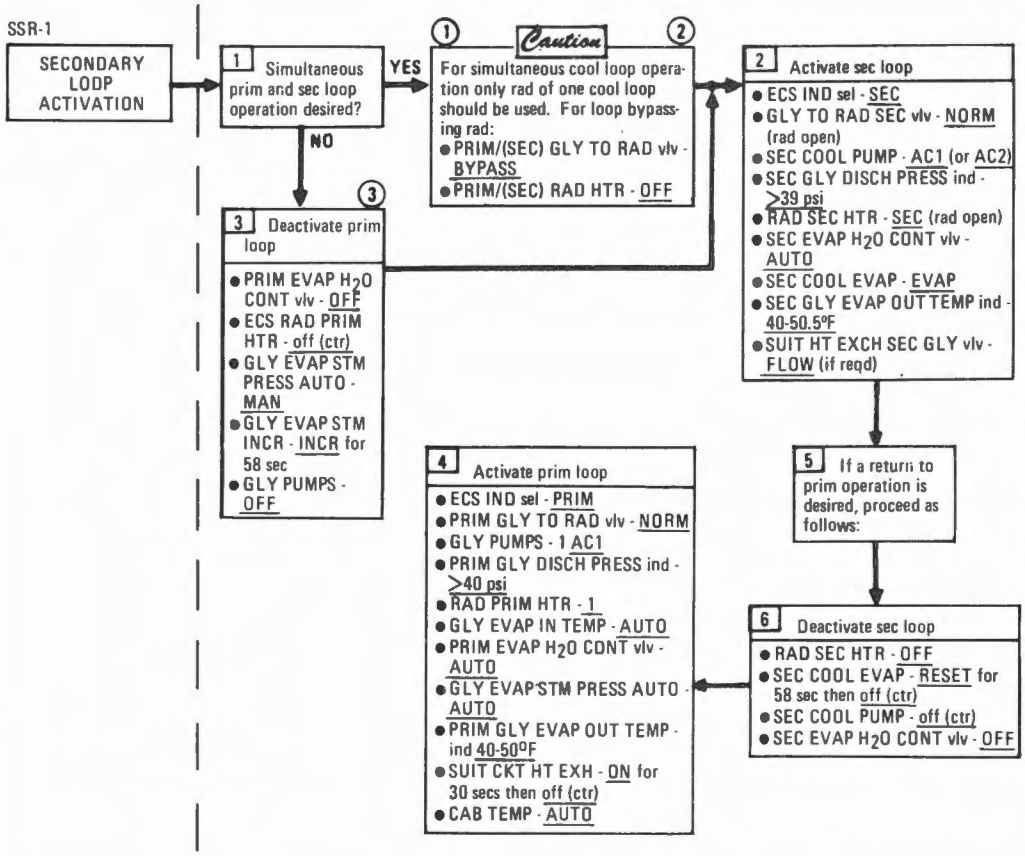

SYMPTOM
PROCEDURE
REMARKS
27
SEC GLY DISCH PRESS LOW
< 39 psi or (accum qty / 4 + 31)
1 Verify sensor
• SEC COOL PUMP - off (momentarily)
Gly disch sec press compatible with indicated gly accum qty?
YES
NO
2 Sec accum qty (- 30%)?
YES
NO
ECS 26 1
SEC GLY ACCUM QTY DECREASING
3 • SEC COOL PUMP - redundant bus
Gly disch sec press incr?
YES
NO
4 DEGRADED SEC COOL LOOP PUMP
5 GLY DISCH SEC PRESS INST OR ACCUM SEC QTY INST FAILURE
6 REDUCED PUMP OUTPUT DUE TO ELEC PROBLEM
7 • RAD SEC HTR - OFF (if gly pump ΔP<20)
• Reduce elec loads
EPS-PD 1d 40 AC BUS 1 (2) VOLTAGE LOW
1 Disch press and accum qty sensor powered by cb ECS SEC COOL XDUCERS (2) (MDC-5).
2 With glycol pump off, glycol discharge pressure should equal 1/4 accumulator quantity.
28
H2O DUMPING OVERBOARD
1 Pot or waste tk qty decr?
YES
NO
2 Bypass H2 separator
• Disconnect QDs in following order:
Red QD from H2O IN
Yellow QD from Urine/H2O Sys Interconnect
Green QD from H2O OUT
• Reconnect QDs in following order:
Green QD to H2O IN
Red QD to H2O OUT
Yellow QD to original connection
Dump stops?
YES
NO
5 LEAK IN H2 SEPARATOR
3 • PRESS RELF sel - OFF
Dump stops?
YES
NO
6 PRESS RELF SEL FAILED IN RELF POS
4 PRESS RELF SEL FAILED IN OFF POS OR RUPTURE OF POT OR WASTE H2O TK BLADDER
1 Ice particles visible through windows with no manual dump scheduled. MSFN can also verify by H2O dump nozzle temp.
2 Yellow QD disconnected to gain access to QD at H2O OUT connector.
3 Dump flow will taper off rather than stop suddenly if leaking separator is bypassed. If dumping does not stop, reconnect QDs to original connections.
28a
POTABLE H2O QUANTITY DECREASING RAPIDLY
7 • H2O QTY IND sw - WASTE
Waste H2O qty ≤ 10%?
YES
NO
8 • WASTE TK IN vlv - CLOSE
• H2O QTY IND sw - POT
Decr stops?
YES
NO
9 • POT TK IN vlv - CLOSE
Decr stops?
YES
NO
10 FILL H2O BAG ASSY FOR 5-8 MINUTES
POT TK QTY decr > 25%?
YES
NO
11 POT TK SENSOR FAILURE
12 WASTE TK IN VLV FAILURE
13 LINE LEAK BETWEEN POT TK IN VLV AND WASTE TK IN VLV
14 LEAK IN POT H2O SYSTEM
15 • POT TK IN VLV-OPEN
• WASTE TK IN VLV-OPEN
16 • PRESS RELF sel - OFF
• H2O QTY IND sw - POT
Decr stops?
YES
NO
17 • WASTE TK IN vlv - CLOSE
Decr stops?
YES
NO
18 BYPASS CM H2O SYSTEM
• Disconnect QD's in following order:(below pnl 252)
Yellow QD from interconnect
Green QD from H2O out
• Reconnect QD's in following order:
Yellow QD to H2O out
Green QD to interconnect
19 FILL H2O BAG ASSY AND DRINK-BAGS UNTIL POT TANK DEPLETED
20 PRESS RELF VLV FAILED OPEN
21 LINE LEAK IN WASTE H2O SYS
4 Incoming fuel cell water will still pass through this leak.
5 Actual decrease rate should be LEAK RATE + 22% / FILL TIME
6 Additional drinking H2O can be obtained by filling the water bag assembly from the H2O out QD from the H2 separator.
7 Urine dumps should be made through side hatch or fuel cell H2O diverted to water bag assy during urine dumps.
8 Prim & sec evap unusable. Water evaporators can be used by periodically opening the waste tank inlet valve for approximately 2-3 minutes until the evaporator wicks are saturated. Water line leakage will occur during these periods.
9 Monitor cabin humidity. Check for water in CM.
28b
WASTE H2O QUANTITY DECREASING RAPIDLY
22 • PRESS RELF sel - OFF
Decr stops?
YES
NO
23 LINE LEAKAGE IN WASTE H2O SYS OR SENSOR FAILED
74 • PRESS RELF sel - ?
29
FOOD PREP WATER TEMP LOW
1 • POT H2O HTR - redundant bus
Water temp incr?
YES
NO
7 CIRCUIT FAILURE FROM MN BUS A OR B
3 POT H2O HTR FAILED OR DEGRADED
SM-2A-1663M

27 thru 29


SYMPTOM
PROCEDURE
REMARKS
30 ENTRAPPED GAS IN POTABLE H2O
1 Pot qty full?
YES
NO
2 Isolate pot tk
• POT TK IN vlv - CLOSE
• H2O QTY IND sw - POT
• Draw off 1 qt H2O (water gun)
Pot qty decr 5%?
NO
YES
3 GAS IS HYDROGEN
4 GAS IS OXYGEN FROM PRESS SYSTEM
5 Install gas water separator to water gun or food probe
(1) System is usable. Quantity gaging capability is compromised
(2) If suited, purge suit periodically.
(3) Unit stowed in A1.
31 URINE OVERBOARD DUMP NOT DRAINING
1 • Replace urine filter
Urine backs up?
YES
NO
2 • Use other collection device
Urine backs up?
YES
NO
3 • Orient CSM to heat ovbd dump nozzle
• URINE DUMP redundant htr
Urine ovbd drain flow resumes?
YES
NO
4 URINE HEATER FAILURE
5 PLUGGED URINE FILTER
6 URA OR UTS DEVICE BLOCKED
7 BLOCKED URINE OVBD DRAIN
8 Use waste H2O vent line
• Remove waste H2O ovbd dump line O-D cap and stow.
• Remove flex hose from O D
• Connect flex hose to waste H2O vent line
(1) Allow 2 hrs for heater operation. Orient CSM for maximum external heat on dump nozzle (-Y -Z) in attempt to clear probable ice block.
(2) If UTS was being used replace UTS receiver assembly. Spare UTS receiver assembly stowed in R-11. Replacement of UTS receiver assembly may make UTS serviceable.
(3) Water tanks H2 and O2 bleed capability lost unless waste H2O dump line interconnected.
(4) Auxiliary dump through side hatch is also available.
31a WASTE H2O OVERBOARD DUMP NOT DRAINING
9 • Orient CSM to heat ovbd dump nozzle
• WASTE H2O DUMP - redundant htr
Water drains?
NO
YES
10 Use urine dump line
• Remove waste H2O ovbd dump line cap and stow
• Remove flex hose from O D (yellow)
• Connect flex hose to waste H2O dump line
Water drains?
NO
YES
11 BLOCKED WASTE H2O LINE
12 WASTE H2O DUMP HTR FAILED
13 Dump waste H2O with urine hose
• Install female O D on waste tank service port
• Connect urine dump hose/filter to urine feces O-D
• Connect other end of UT hose to female O D on waste tank service port
• Ovbd drain valve - open
• Waste tank serv valve - open until waste H2O qty ind 15% then close
• Disconnect UT hose from water panel
• Disconnect T adapter from UT hose and purge for 2-5 min
• Ovbd drain valve - close
14 BLOCKED WASTE H2O DUMP NOZZLE
(5) Battery and H2 separator vent capabilities lost unless urine dump line interconnected.
32 INADEQUATE VENTILATION AFTER LANDING
1 Cycle PL vent sw
Ventilation incr?
NO
YES
2 Actuate PLVC
• PLVC sw - OPEN
Ventilation incr?
YES
NO
3 ATTITUDE SENSING SW FAILED
4 Resets attitude sensor relay to resume PLV operation
5 PLV FAN FAILURE
(1) Prestanding vent switch must be cycled to OFF and back to HIGH (LOW) anytime CM attitude exceeds 60° to reset attitude control relay.
(2) Ventilation available only by opening either hatch.
33 WATER INFLOW AFTER LANDING
1 • PLVC sw - NORM
Water inflow stops?
NO
YES
2 • PL VENT - OFF
• CAB PRESS RELF vlv (2) - CLOSE
Water inflow stops?
NO
YES
3 UNCONTROLLABLE WATER INFLOW INTO CM
4 Inflow caused by open PLV vlv
5 ATTITUDE SENSING SWITCH FAILED OPEN
SM-2A-2258D

SR-1
HRU
SR-2

SECONDARY SUB ROUTINES	PROCEDURE	REMARKS



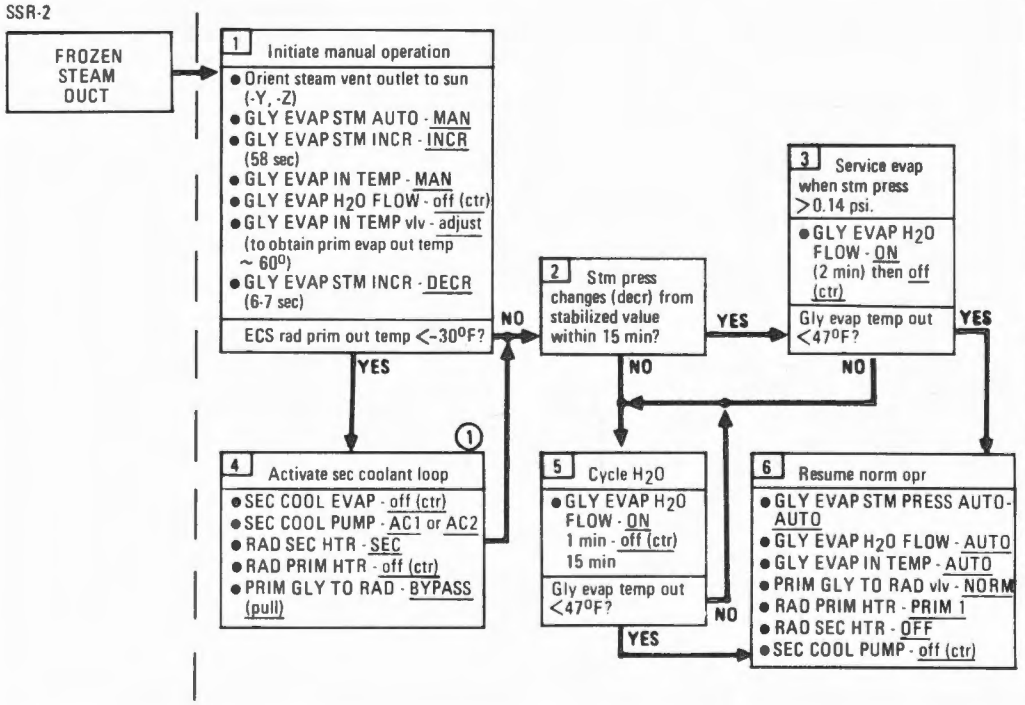
(1) If one panel of the primary radiator is lost, the secondary radiator should be used, otherwise the secondary radiator will be lost due to freezing.

(2) Operation of both coolant loops simultaneously may result in low rad out temp. To preclude rad freezing, terminate evap operation if possible.

(3) G&N, OSE, and signal conditioners are not coldplated on secondary loop. Usage limits for this equipment are as follows:

G&N 17% duty cycle with max on time of 1 hr 55 min.

DSE 66% duty cycle with max on time of 2 hrs.



(1) Primary glycol evaporator temperature inlet can be approximated by secondary radiator inlet temperature.

SM-2A-2271

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EMS MALFUNCTION INDEX

1 .05G LT ON (TEST 1)

2 G/V SCROLL ASSY DOES NOT SLEW (TEST 1)

3 .5G LT OUT (TEST 2)

4 LIFT VECTOR DN LT WILL NOT COME ON (TEST 3)

4a RNG IND WILL NOT SLEW (TEST 3)

5 V-AXIS ONLY OR MULTIPLE DISPLAYS ABNORMAL (TEST 4)

6 RNG IND ONLY ABNORMAL (TEST 4)

7 G-AXIS ONLY ABNORMAL (TEST 4)

8 LIFT VECTOR UP LT NOT ON (TEST 5)

8a G-AXIS DOES NOT DRIVE (TEST 5)

9 RNG IND DOES NOT SLEW IN RNG SET

9a G-AXIS DOES NOT ZERO IN RNG SET

10 V-AXIS DOES NOT SLEW IN Vo SET

11 ΔV-RNG IND ABNORMAL IN ΔV TEST

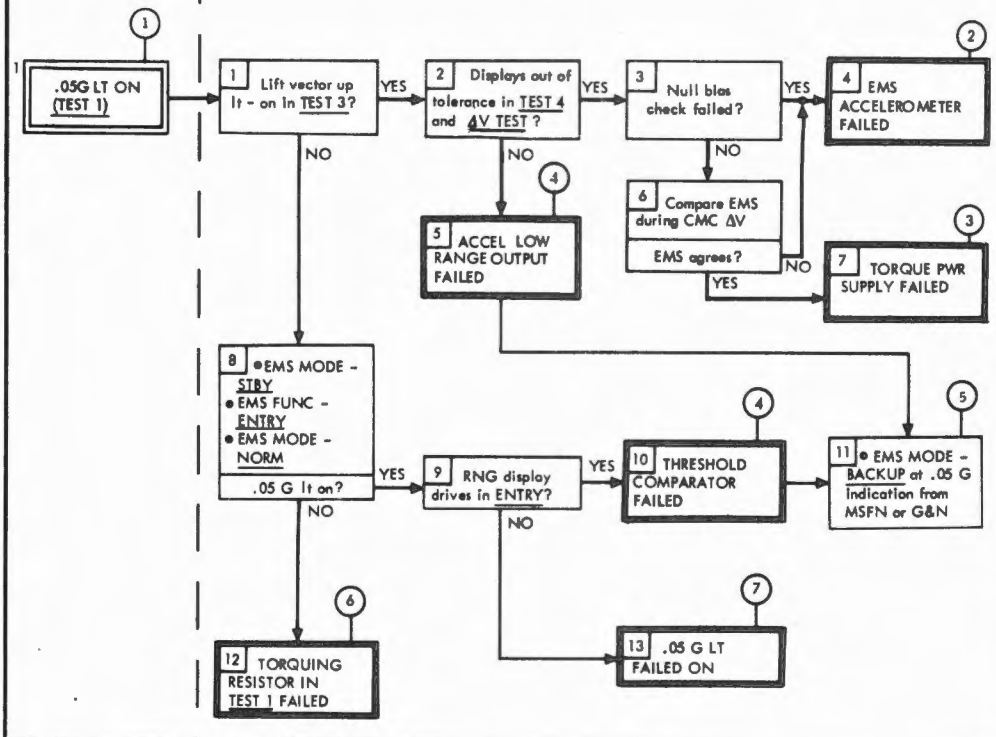
12 SPS THRUST LT NOT ON IN ΔV TEST

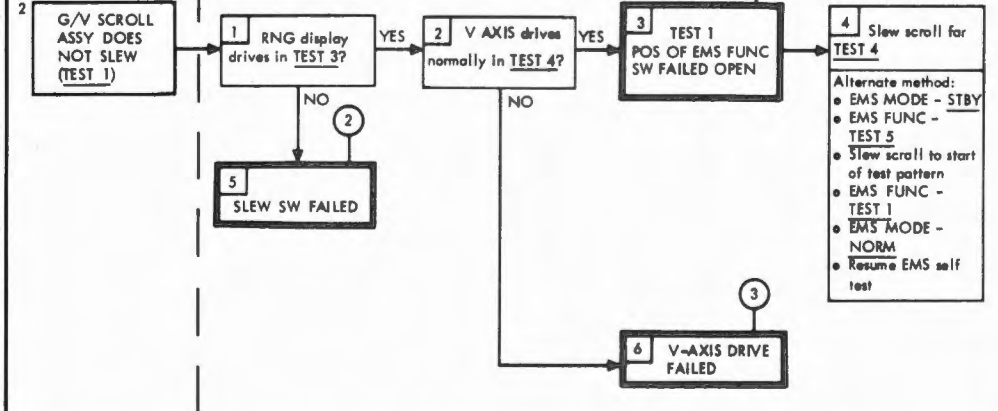
13 ΔV IND DOES NOT SLEW IN ΔV SET

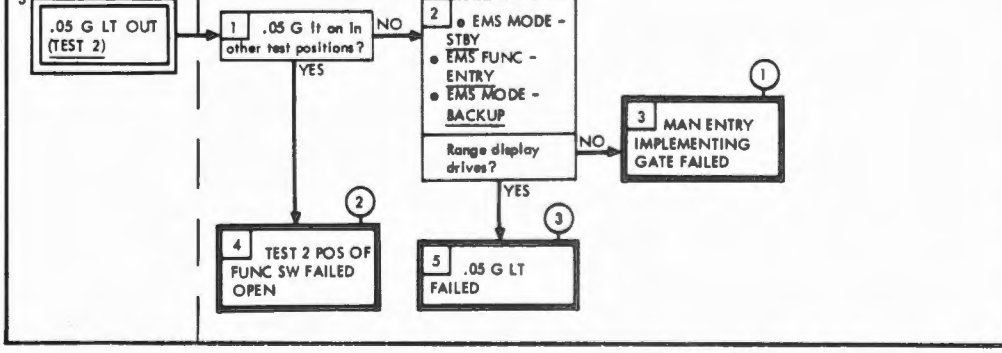
14 ΔV/RNG IND FAILS TO COUNT DURING ΔV's

15 EITHER LIFT VECTOR LT ON AFTER 2G

SYMPTOM	PROCEDURE	REMARKS







(1) The EMS MODE sw assumed to be in STBY for at least 5 sec before self-test started.

(2) EMS lost except EMS RSI.

(3) All self test capability lost. For entry, G-Drive, and corridor verification will be erroneous. ΔV/RNG ind, V AXIS and EMS RSI unaffected.

(4) AUTO position functions of EMS MODE sw lost for entry only.

(5) Corridor verification inoperative with EMS MODE sw - BACKUP.

(6) EMS FUNC - TEST 1 lost only.

(7) Loss of threshold cue only (.05 G lt). RNG ind operation is indication of .05 G.

(1) EMS FUNC - TEST 1 capability lost only.

(2) RNG SET capability lost. SCS ΔV possible only if ΔV display is driven positive by placing the GTA sw - on (up), then - off (down) at the desired value. G&N or ΔV maneuver with the SPS THRUST - DIR ON can be monitored by the change in the ΔV display (down to -9999 fps). Vo can be set by using EMS FUNC - TEST 4 (repeatedly if necessary), stopping the V drive at the desired value by EMS FUNC - TEST 5. No backup capability available.

(3) EMS lost for ENTRY except threshold, corridor, and EMS RSI. ΔV functions unaffected.

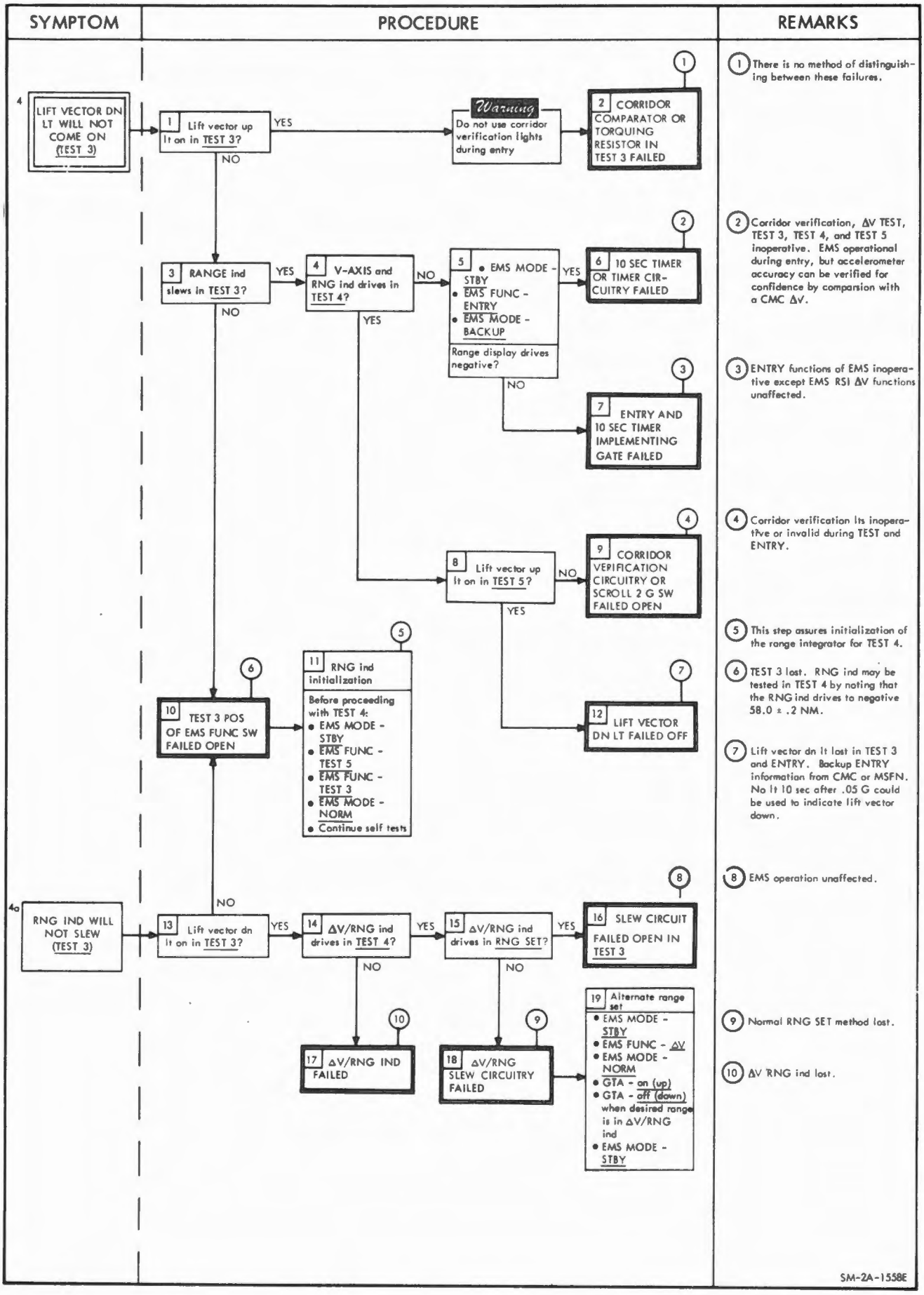
(1) ENTRY functions of EMS inoperative except EMS RSI. ΔV functions unaffected.

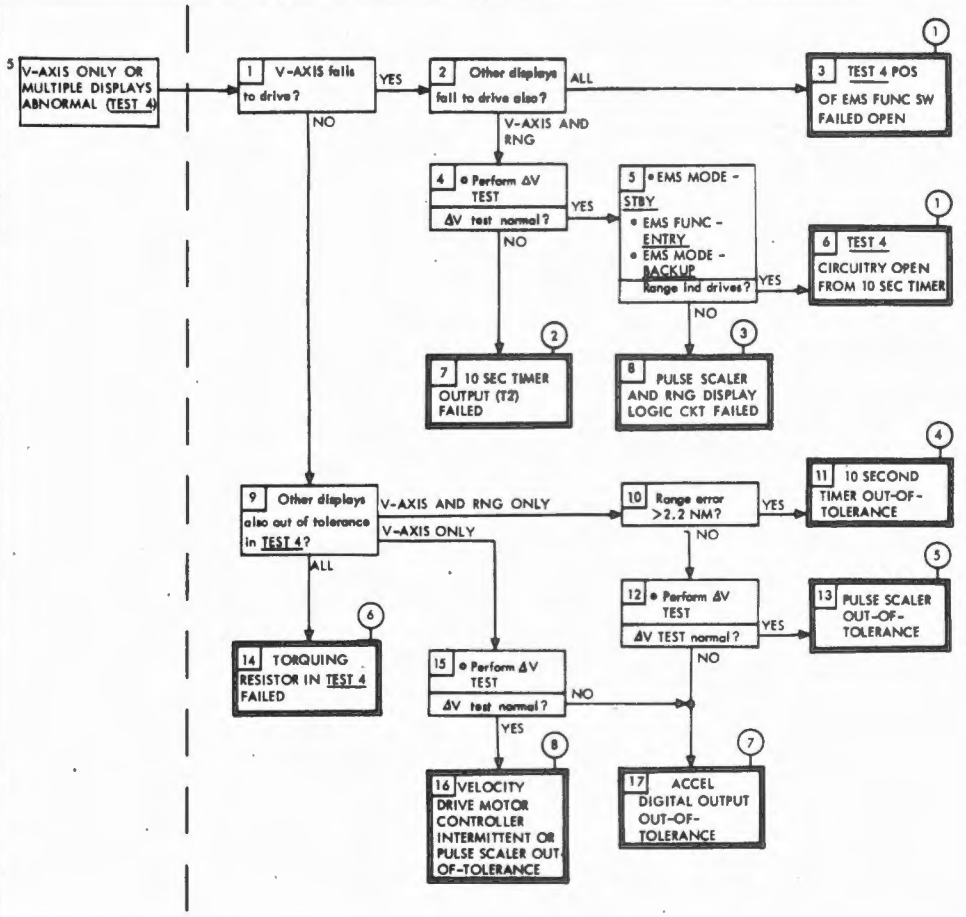
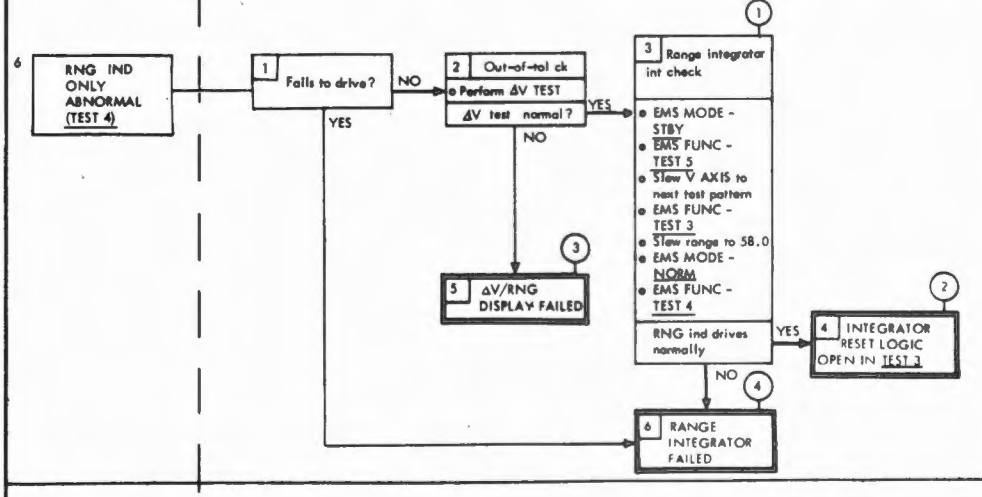
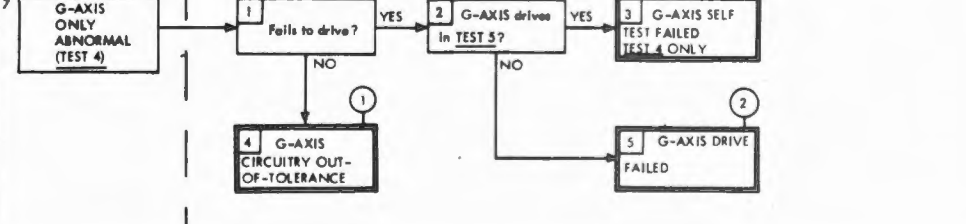
(2) EMS FUNC - TEST 2 inoperative.

(3) EMS operation unaffected. RNG ind operation is indication of .05 G.

SM-2A-1557E

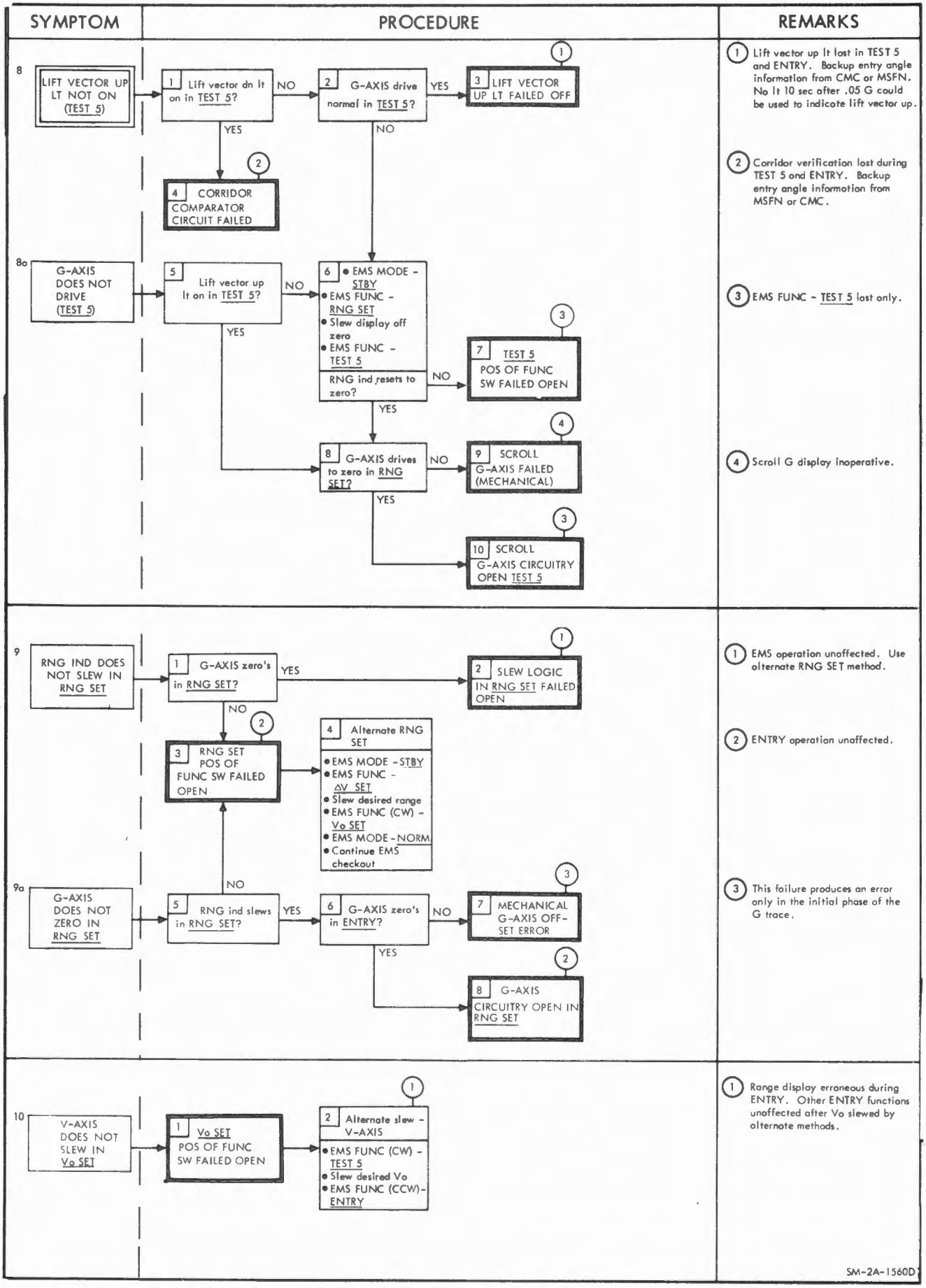
4 THRU 4a

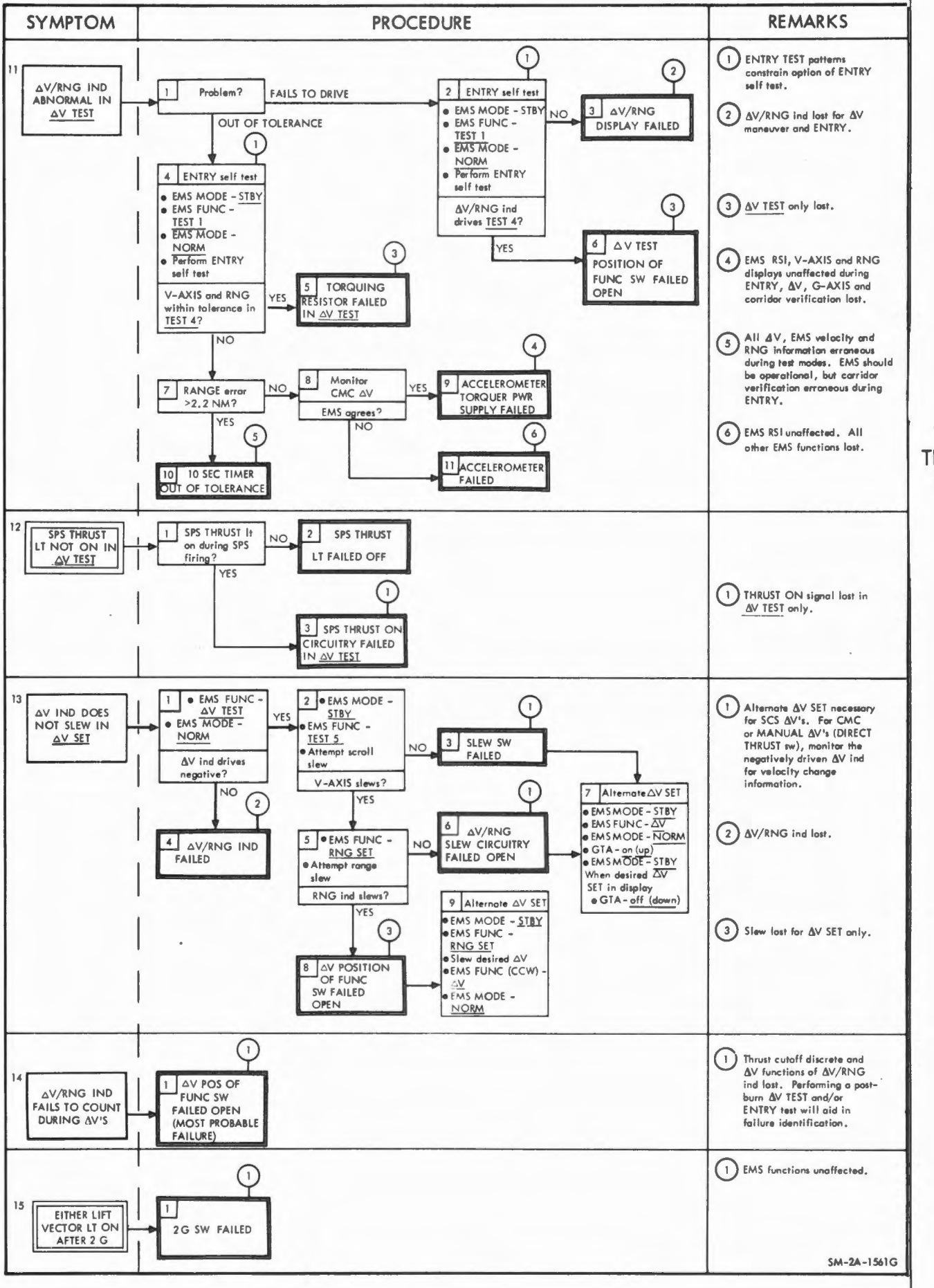

SYMPTOM
PROCEDURE
REMARKS
4 LIFT VECTOR DN LT WILL NOT COME ON (TEST 3)
1 Lift vector up lt on in TEST 3?
YES
NO
Warning
Do not use corridor verification lights during entry
2 CORRIDOR COMPARATOR OR TORQUING RESISTOR IN TEST 3 FAILED
3 RANGE ind slews in TEST 3?
YES
NO
4 V-AXIS and RNG ind drives in TEST 4?
NO
YES
5 • EMS MODE - STBY
• EMS FUNC - ENTRY
• EMS MODE - BACKUP
Range display drives negative?
YES
NO
6 10 SEC TIMER OR TIMER CIRCUITRY FAILED
7 ENTRY AND 10 SEC TIMER IMPLEMENTING GATE FAILED
8 Lift vector up lt on in TEST 5?
NO
YES
9 CORRIDOR VERIFICATION CIRCUITRY OR SCROLL 2 G SW FAILED OPEN
10 TEST 3 POS OF EMS FUNC SW FAILED OPEN
11 RNG ind initialization
Before proceeding with TEST 4:
• EMS MODE - STBY
• EMS FUNC - TEST 5
• EMS FUNC - TEST 3
• EMS MODE - NORM
• Continue self tests
12 LIFT VECTOR DN LT FAILED OFF
4a RNG IND WILL NOT SLEW (TEST 3)
13 Lift vector dn lt on in TEST 3?
YES
NO
14 ΔV/RNG ind drives in TEST 4?
YES
NO
15 ΔV/RNG ind drives in RNG SET?
YES
NO
16 SLEW CIRCUIT FAILED OPEN IN TEST 3
17 ΔV/RNG IND FAILED
18 ΔV/RNG SLEW CIRCUITRY FAILED
19 Alternate range set
• EMS MODE - STBY
• EMS FUNC - ΔV
• EMS MODE - NORM
• GTA - on (up)
• GTA - off (down) when desired range is in ΔV/RNG ind
• EMS MODE - STBY
1 There is no method of distinguishing between these failures.
2 Corridor verification, ΔV TEST, TEST 3, TEST 4, and TEST 5 inoperative. EMS operational during entry, but accelerometer accuracy can be verified for confidence by comparsion with a CMC ΔV.
3 ENTRY functions of EMS inoperative except EMS RSI ΔV functions unaffected.
4 Corridor verification lts inoperative or invalid during TEST and ENTRY.
5 This step assures initialization of the range integrator for TEST 4.
6 TEST 3 lost. RNG ind may be tested in TEST 4 by noting that the RNG ind drives to negative 58.0 ± .2 NM.
7 Lift vector dn lt lost in TEST 3 and ENTRY. Backup ENTRY information from CMC or MSFN. No lt 10 sec after .05 G could be used to indicate lift vector down.
8 EMS operation unaffected.
9 Normal RNG SET method lost.
10 ΔV RNG ind lost.
SM-2A-1558E

SYMPTOM	PROCEDURE	REMARKS
5 V-AXIS ONLY OR MULTIPLE DISPLAYS ABNORMAL (TEST 4)		(1) EMS FUNC - TEST 4 capability lost. EMS operational but accelerometer accuracy can be verified only by performing a ΔV TEST. (2) TEST 4 and ΔV TEST only lost. (3) V-axis and range display lost. (4) This failure will invalidate the ΔV TEST and TEST 4, except the G-axis display. EMS should be operational but corridor verification erroneous during entry. (5) V AXIS and RNG information erroneous only. (6) EMS FUNC - TEST 4 lost but EMS operation during entry should be normal. (7) V AXIS, ΔV and RNG information erroneous. Other EMS information unaffected. MSFN may be able to supply a correction factor for this error. (8) There is no method of distinguishing between these two failures. Scroll velocity information will be erroneous. Range readout of uncertain validity.
6 RNG IND ONLY ABNORMAL (TEST 4)		(1) This check constrained by test pattern availability. (2) EMS ENTRY and ΔV functions unaffected. (3) RNG and ΔV displays lost. (4) RNG display lost.
7 G-AXIS ONLY ABNORMAL (TEST 4)		(1) Scroll G display erroneous. (2) Scroll G display lost. Backup G information from CMC or G meter.

5 THR 7

8 HRU 10


SYMPTOM
PROCEDURE
REMARKS
8
LIFT VECTOR UP LT NOT ON (TEST 5)
1 Lift vector dn lt on in TEST 5?
NO
2 G-AXIS drive normal in TEST 5?
YES
1
3 LIFT VECTOR UP LT FAILED OFF
YES
NO
2
4 CORRIDOR COMPARATOR CIRCUIT FAILED
8a
G-AXIS DOES NOT DRIVE (TEST 5)
5 Lift vector up lt on in TEST 5?
NO
6 • EMS MODE - STBY
• EMS FUNC - RNG SET
• Slew display off zero
• EMS FUNC - TEST 5
RNG ind resets to zero?
NO
3
7 TEST 5 POS OF FUNC SW FAILED OPEN
YES
YES
4
8 G-AXIS drives to zero in RNG SET?
NO
9 SCROLL G-AXIS FAILED (MECHANICAL)
YES
3
10 SCROLL G-AXIS CIRCUITRY OPEN TEST 5
1 Lift vector up lt lost in TEST 5 and ENTRY. Backup entry angle information from CMC or MSFN. No lt 10 sec after .05 G could be used to indicote lift vector up.
2 Corridor verification lost during TEST 5 ond ENTRY. Backup entry angle informotion from MSFN or CMC.
3 EMS FUNC - TEST 5 lost only.
4 Scroll G display inoperative.
9
RNG IND DOES NOT SLEW IN RNG SET
1 G-AXIS zero's in RNG SET?
YES
1
2 SLEW LOGIC IN RNG SET FAILED OPEN
NO
2
3 RNG SET POS OF FUNC SW FAILED OPEN
4 Alternate RNG SET
• EMS MODE - STBY
• EMS FUNC - ΔV SET
• Slew desired range
• EMS FUNC (CW) - Vo SET
• EMS MODE - NORM
• Continue EMS checkout
NO
9a
G-AXIS DOES NOT ZERO IN RNG SET
5 RNG ind slews in RNG SET?
YES
6 G-AXIS zero's in ENTRY?
NO
3
7 MECHANICAL G-AXIS OFF-SET ERROR
YES
2
8 G-AXIS CIRCUITRY OPEN IN RNG SET
1 EMS operation unaffected. Use alternate RNG SET method.
2 ENTRY operation unaffected.
3 This failure produces an error only in the initial phase of the G trace.
10
V-AXIS DOES NOT SLEW IN Vo SET
1 Vo SET POS OF FUNC SW FAILED OPEN
1
2 Alternate slew - V-AXIS
• EMS FUNC (CW) - TEST 5
• Slew desired Vo
• EMS FUNC (CCW) - ENTRY
1 Range display erraneous during ENTRY. Other ENTRY functions unoffected after Vo slewed by alternate methods.
SM-2A-1560D


SYMPTOM
PROCEDURE
REMARKS
11
ΔV/RNG IND ABNORMAL IN ΔV TEST
1 Problem?
FAILS TO DRIVE
OUT OF TOLERANCE
2 ENTRY self test
• EMS MODE - STBY
• EMS FUNC - TEST 1
• EMS MODE - NORM
• Perform ENTRY self test
ΔV/RNG ind drives TEST 4?
NO
3 ΔV/RNG DISPLAY FAILED
YES
6 ΔV TEST POSITION OF FUNC SW FAILED OPEN
4 ENTRY self test
• EMS MODE - STBY
• EMS FUNC - TEST 1
• EMS MODE - NORM
• Perform ENTRY self test
V-AXIS and RNG within tolerance in TEST 4?
YES
5 TORQUING RESISTOR FAILED IN ΔV TEST
NO
7 RANGE error >2.2 NM?
NO
8 Monitor CMC ΔV
EMS agrees?
YES
9 ACCELEROMETER TORQUER PWR SUPPLY FAILED
NO
11 ACCELEROMETER FAILED
YES
10 10 SEC TIMER OUT OF TOLERANCE
1 ENTRY TEST patterns constrain option of ENTRY self test.
2 ΔV/RNG ind lost for ΔV maneuver and ENTRY.
3 ΔV TEST only lost.
4 EMS RSI, V-AXIS and RNG displays unaffected during ENTRY, ΔV, G-AXIS and corridor verification lost.
5 All ΔV, EMS velocity and RNG information erraneous during test modes. EMS should be operational, but corridor verification erraneous during ENTRY.
6 EMS RSI unaffected. All other EMS functions lost.
12
SPS THRUST LT NOT ON IN ΔV TEST
1 SPS THRUST lt on during SPS firing?
NO
2 SPS THRUST LT FAILED OFF
YES
3 SPS THRUST ON CIRCUITRY FAILED IN ΔV TEST
1 THRUST ON signal lost in ΔV TEST only.
13
ΔV IND DOES NOT SLEW IN ΔV SET
1 • EMS FUNC - ΔV TEST
• EMS MODE - NORM
ΔV ind drives negative?
YES
2 • EMS MODE - STBY
• EMS FUNC - TEST 5
• Attempt scroll slew
V-AXIS slews?
NO
3 SLEW SW FAILED
YES
5 • EMS FUNC - RNG SET
• Attempt range slew
RNG ind slews?
NO
6 ΔV/RNG SLEW CIRCUITRY FAILED OPEN
YES
8 ΔV POSITION OF FUNC SW FAILED OPEN
NO
4 ΔV/RNG IND FAILED
7 Alternate ΔV SET
• EMS MODE - STBY
• EMS FUNC - ΔV
• EMS MODE - NORM
• GTA - on (up)
• EMS MODE - STBY
When desired ΔV SET in display
• GTA - off (down)
9 Alternate ΔV SET
• EMS MODE - STBY
• EMS FUNC - RNG SET
• Slew desired ΔV
• EMS FUNC (CCW) - ΔV
• EMS MODE - NORM
1 Alternate ΔV SET necessary for SCS ΔV's. For CMC or MANUAL ΔV's (DIRECT THRUST sw), monitor the negatively driven ΔV ind for velocity change information.
2 ΔV/RNG ind lost.
3 Slew lost for ΔV SET only.
14
ΔV/RNG IND FAILS TO COUNT DURING ΔV'S
1 ΔV POS OF FUNC SW FAILED OPEN (MOST PROBABLE FAILURE)
1 Thrust cutoff discrete and ΔV functions of ΔV/RNG ind lost. Performing a post-burn ΔV TEST and/or ENTRY test will aid in failure identification.
15
EITHER LIFT VECTOR LT ON AFTER 2 G
1 2G SW FAILED
1 EMS functions unaffected.
SM-2A-1561G

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DOCK AND HATCH MALFUNCTION INDEX

DOCKING

1 DOCK PROBE WILL NOT FOLD

2 DOCK PROBE EXTD/REL tb A (B) REMAINS GRAY AFTER CAPTURE (TLD ONLY)

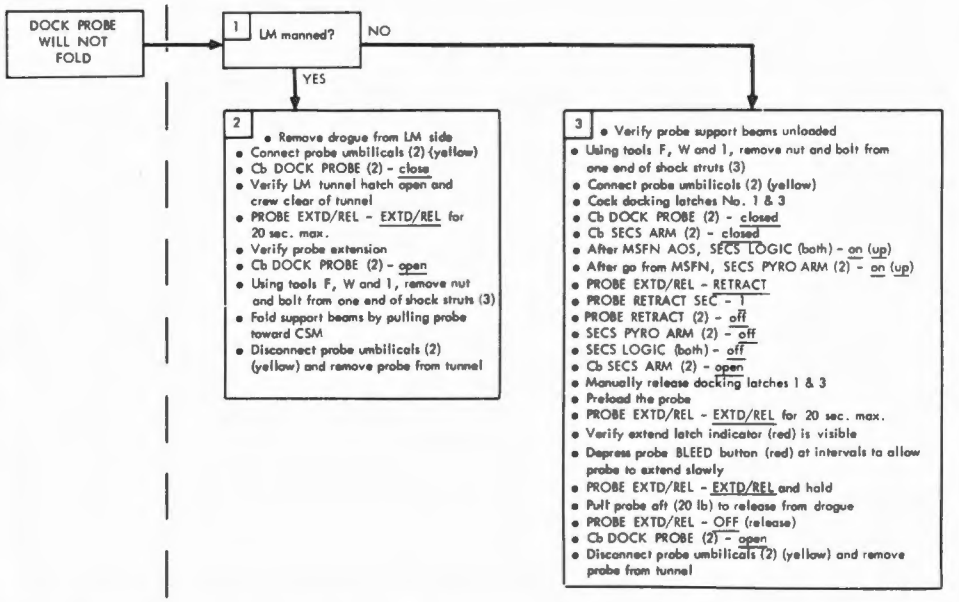
HATCH

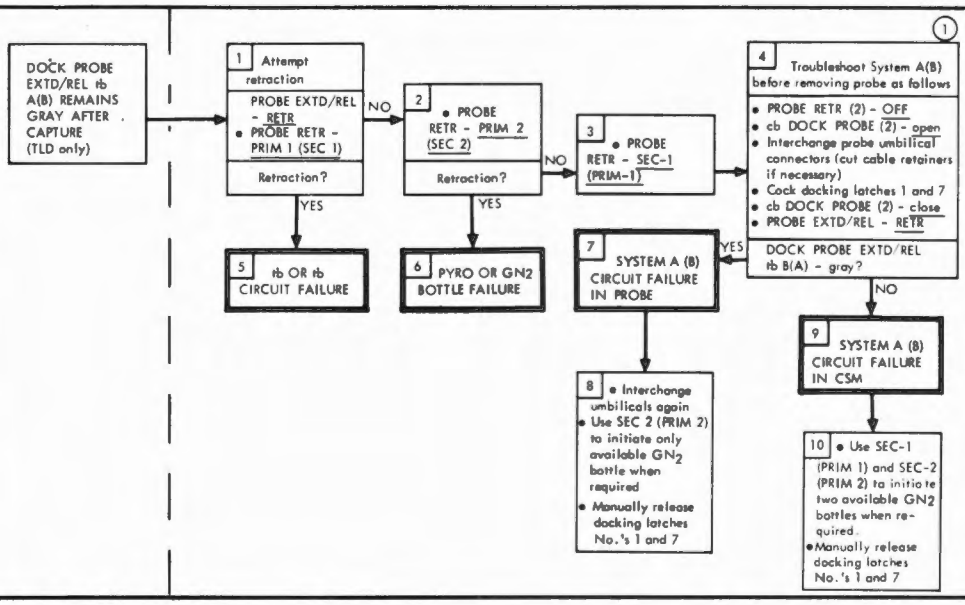
1 FWD HATCH WILL NOT UNLATCH

2 FWD HATCH WILL NOT LATCH

SYMPTOM	PROCEDURE	REMARKS

DOCKING





(1) Probe telemetry will be lost when probe umbilicals are interchanged.

SM-2A-1746J

SYMPTOM	PROCEDURE	REMARKS

HATCH

1 FWD HATCH WILL NOT UNLATCH

1 Does actr handle drive clutch engage gearbox? — NO → 2 Assume failure of actr handle to engage and drive gearbox

YES → 3 Assume failure is frozen gearbox.

2 Assume failure of actr handle to engage and drive gearbox → 4
- Unstow actr handle and push to stop to unlock gearbox
- AUX LATCH DRIVE - rotate 113° (use tool B)
- Remove tool B and verify hatch unlatch

3 Assume failure is frozen gearbox. → 5
- Remove gearbox mounting screws (3) and spacers (use tools Wand 4)
- Unstow actr handle and rotate away from hatch approx 30°
- Push actr handle outboard rotating gearbox approx 40° CCW to release latches
- Remove hatch from tunnel

5 → 6 To reinstall hatch
- Align hatch in tunnel
- Rotate gearbox approx 40° CW and reinstall gearbox mounting screws (3)

2 FWD HATCH WILL NOT LATCH

1
- Remove hatch to CM cabin
- Attempt to latch mechanism

Does actr handle drive gearbox? — NO → 2 Gearbox frozen
- Gearbox disconnect - 180° CCW (tool B)
- Position hatch in tunnel
- AUX LATCH DRIVE - LATCH (113° CW - tool B)
- Verify hatch latched, remove tool B (cannot remove hatch from LM side)

YES → 3 Frozen latch
- Inspect to identify frozen latch(es)
- Remove dome nuts from long pivot screws of frozen latch. (Use tools F, W, 2 and 4)
- Remove long pivot screws and rotate latch dog to clear striker plate
- Unlatch mechanism
- Install hatch

SM-2A-20538

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EVA MALFUNCTION INDEX

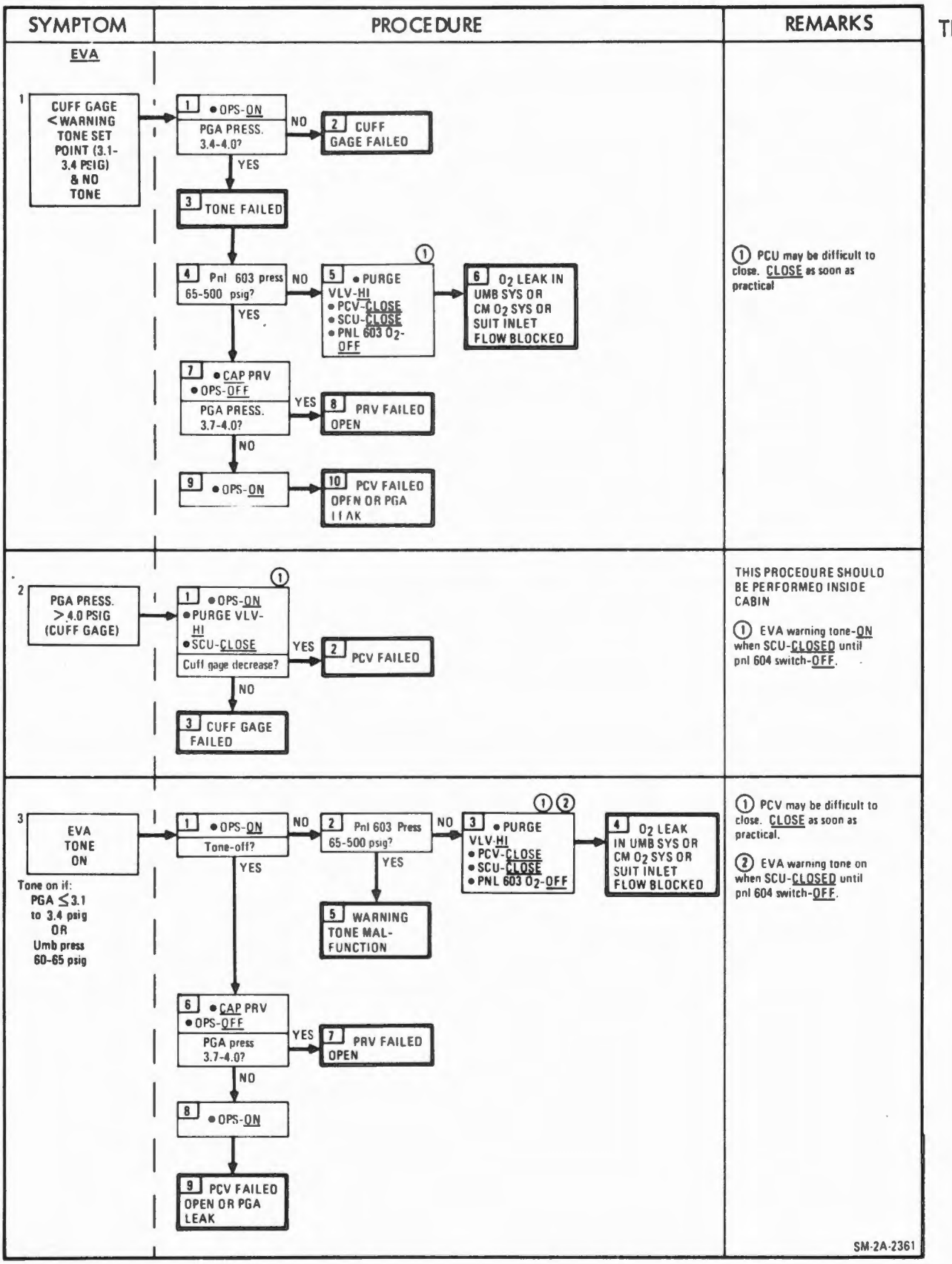
1 CUFF GAGE < WARNING TONE SET POINT (3.1 - 3.4 PSIG) & NO TONE

2 PGA PRESS. > 4.0 PSIG (CUFF GAGE)

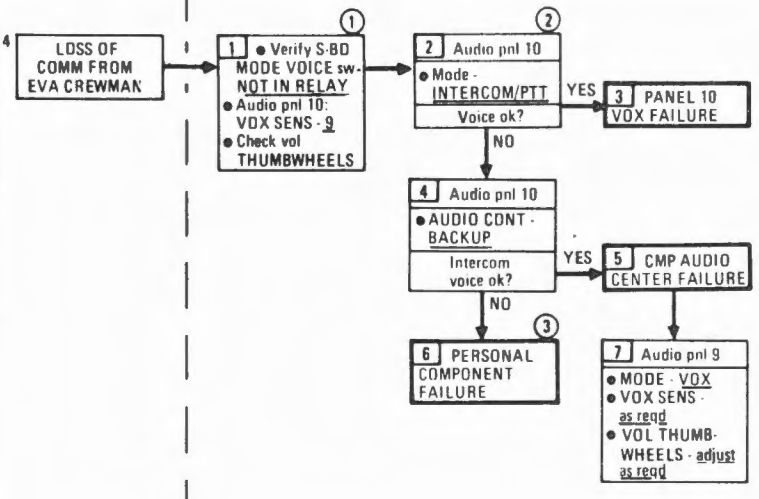
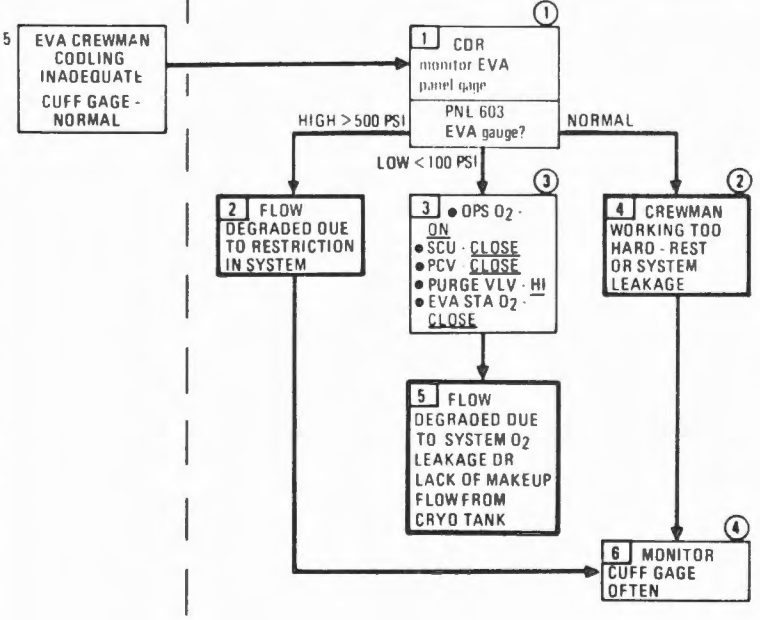
3 EVA TONE ON

4 LOSS OF COMM FROM EVA CREWMAN

5 EVA CREWMAN COOLING INADEQUATE CUFF GAGE - NORMAL


SYMPTOM
PROCEDURE
REMARKS
EVA
1
CUFF GAGE <WARNING TONE SET POINT (3.1-3.4 PSIG) & NO TONE
1 • OPS-ON
PGA PRESS. 3.4-4.0?
NO
2 CUFF GAGE FAILED
YES
3 TONE FAILED
4 Pnl 603 press 65-500 psig?
NO
5 • PURGE VLV-HI • PCV-CLOSE • SCU-CLOSE • PNL 603 O2-OFF
(1)
6 O2 LEAK IN UMB SYS OR CM O2 SYS OR SUIT INLET FLOW BLOCKED
YES
7 • CAP PRV • OPS-OFF
PGA PRESS. 3.7-4.0?
YES
8 PRV FAILED OPEN
NO
9 • OPS-ON
10 PCV FAILED OPEN OR PGA LEAK
(1) PCU may be difficult to close. CLOSE as soon as practical
2
PGA PRESS. >4.0 PSIG (CUFF GAGE)
1 • OPS-ON • PURGE VLV-HI • SCU-CLOSE
Cuff gage decrease?
(1)
YES
2 PCV FAILED
NO
3 CUFF GAGE FAILED
THIS PROCEDURE SHOULD BE PERFORMED INSIDE CABIN
(1) EVA warning tone-ON when SCU-CLOSED until pnl 604 switch-OFF.
3
EVA TONE ON
Tone on if: PGA ≤3.1 to 3.4 psig OR Umb press 60-65 psig
1 • OPS-ON
Tone-off?
NO
2 Pnl 603 Press 65-500 psig?
NO
3 • PURGE VLV-HI • PCV-CLOSE • SCU-CLOSE • PNL 603 O2-OFF
(1) (2)
4 O2 LEAK IN UMB SYS OR CM O2 SYS OR SUIT INLET FLOW BLOCKED
YES
5 WARNING TONE MAL-FUNCTION
YES
6 • CAP PRV • OPS-OFF
PGA press 3.7-4.0?
YES
7 PRV FAILED OPEN
NO
8 • OPS-ON
9 PCV FAILED OPEN OR PGA LEAK
(1) PCV may be difficult to close. CLOSE as soon as practical.
(2) EVA warning tone on when SCU-CLOSED until pnl 604 switch-OFF.
SM-2A-2361

4 HRU 5

SYMPTOM	PROCEDURE	REMARKS
4 LOSS OF COMM FROM EVA CREWMAN		(1) If EVA crewman has egressed cabin, CDR or LMP will perform switching functions. (2) Continuous (hot mike) intercom will be available from EVA. CDR or LMP must depress CMP PTT switch for EVA to transmit to MSFN. (3) SUIT PRESS alarm tone may not be operational.
5 EVA CREWMAN COOLING INADEQUATE CUFF GAGE - NORMAL		(1) Normal range 500-100 psid. (2) CMP metabolic rate exceeding purge flow cooling capability. (3) EVA warning tone-ON when SCU-CLOSED until pnl 604 switch-OFF (4) If additional cooling is required • OPS-ON • PURGE VLV-HI

SM-2A-2362

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CAMERA MALFUNCTION INDEX

16mm

A CAN NOT START CAMERA
B CAN NOT STOP CAMERA
C CAMERA STOPS IMMEDIATELY AFTER START
D CAMERA RUNS 24FPS IN ALL MODES SELECTED
E CAMERA RUNS BUT FILM NOT TRANSPORTING
F CAMERA RUNS BUT NO OPERATE LIGHT

70mm

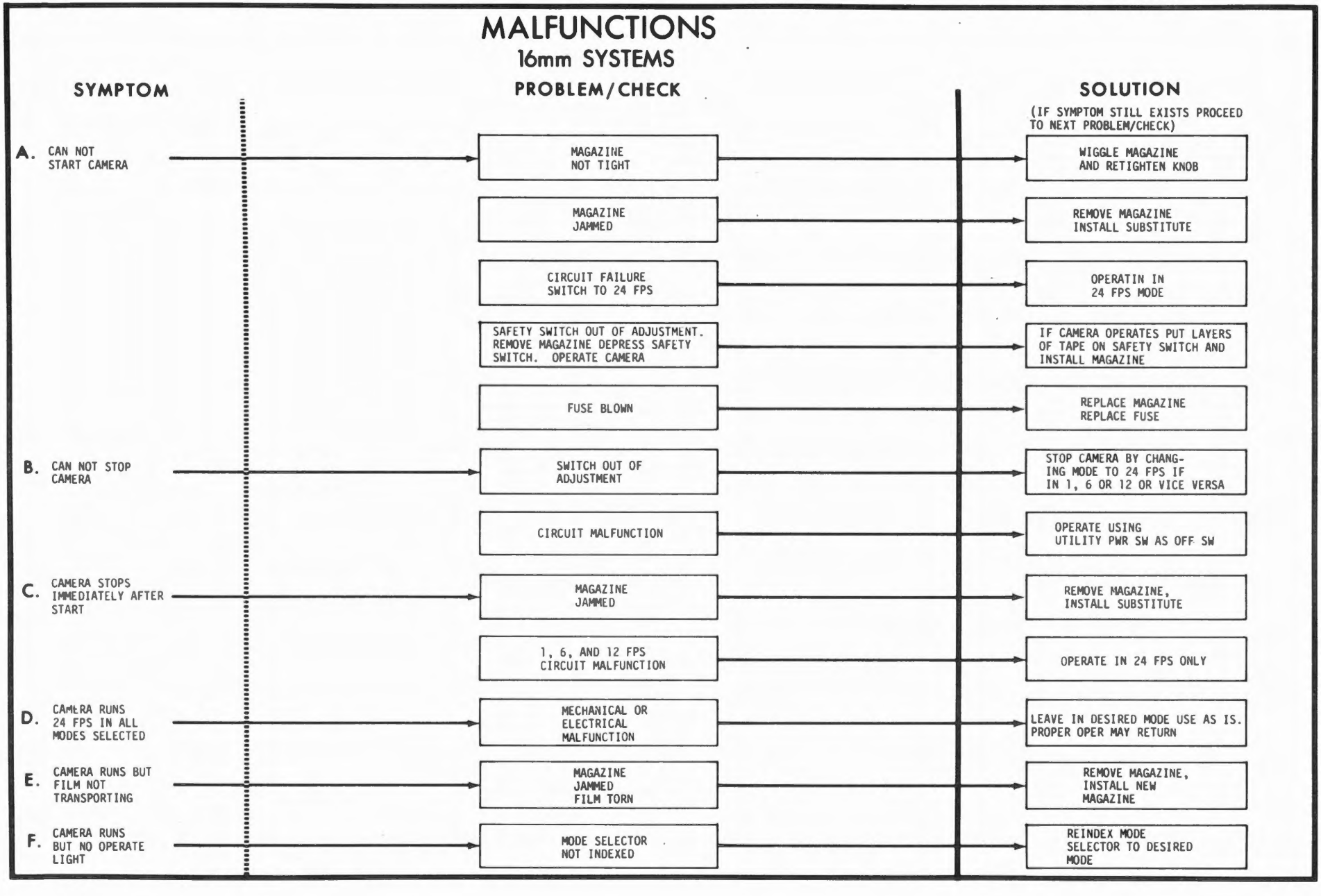
I CAMERA WITH MAGAZINE
  A SHUTTER FIRES/NO FILM ADVANCE
  B NO CAMERA ACTION/BUTTON CYCLED
  C SHUTTER FIRES/PARTIAL FILM ADVANCE
  D CANNOT ATTACH LENS
II CAMERA ONLY
  A NO CAMERA ACTION/BUTTON CYCLED
III INTERVALOMETER WITH CAMERA AND MAGAZINE
  A CAMERA DOES NOT CYCLE

35mm

SHUTTER WILL NOT OPERATE
FILM WILL NOT REWIND
BACK WILL NOT REMOVE
LENS FAILS TO REOPEN TO MAXIMUM AFTER EXPOSURE
LIGHT METERING SYSTEM INOPERATIVE

MALFUNCTIONS

16mm SYSTEMS



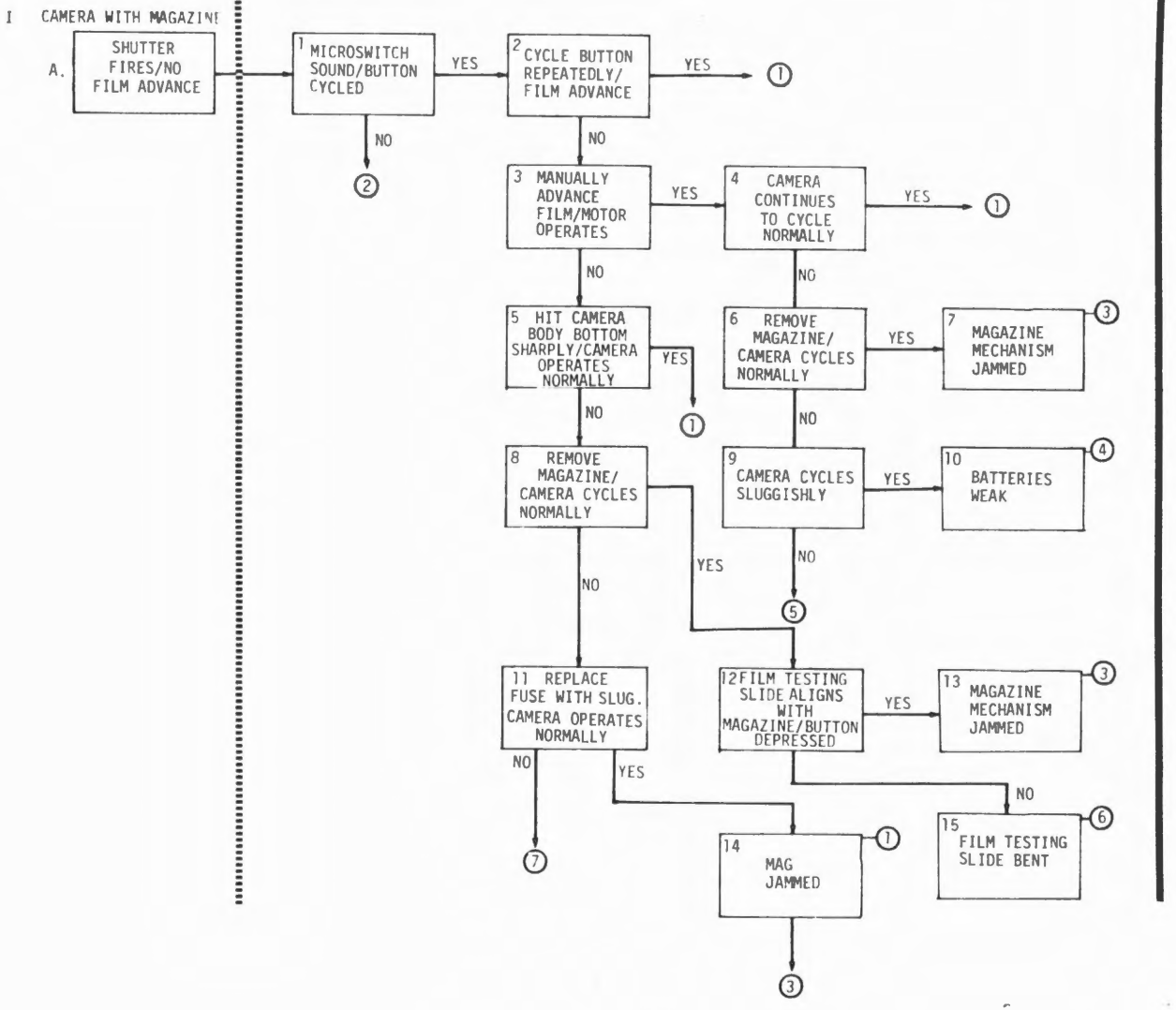
70mm CAMERA MALFUNCTIONS

PROCEDURES

SYMPTOM

I CAMERA WITH MAGAZINE

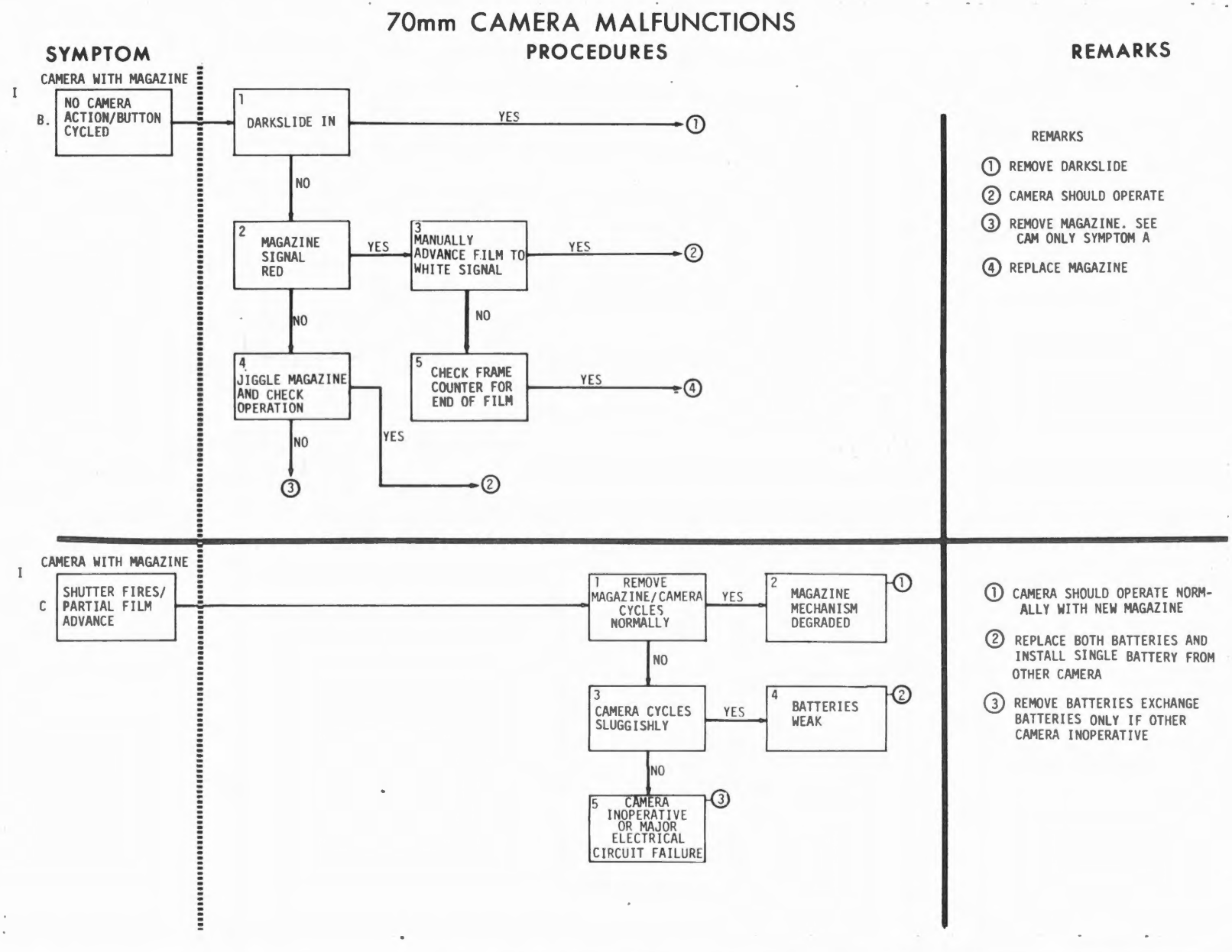
A. SHUTTER FIRES/NO FILM ADVANCE



REMARKS

1. CAM SHOULD CONTINUE TO OPERATE BUT MONITOR OPERATION CLOSELY AS FAILURE CAN REOCCUR
2. REMOVE MAGAZINE AND SEE SYMPTOM A UNDER "CAMERA ONLY" SECTION
3. CAMERA SHOULD OPERATE NORMALLY WITH NEW MAGAZINE
4. REPLACE BOTH BATTERIES
5. IMPROBABLE FAILURE MODE
6. ATTEMPT TO STRAIGHTEN FILM TESTING SLIDE AND CYCLE CAMERA/MAGAZINE
7. CAMERA INOPERATIVE

70mm CAMERA MALFUNCTIONS



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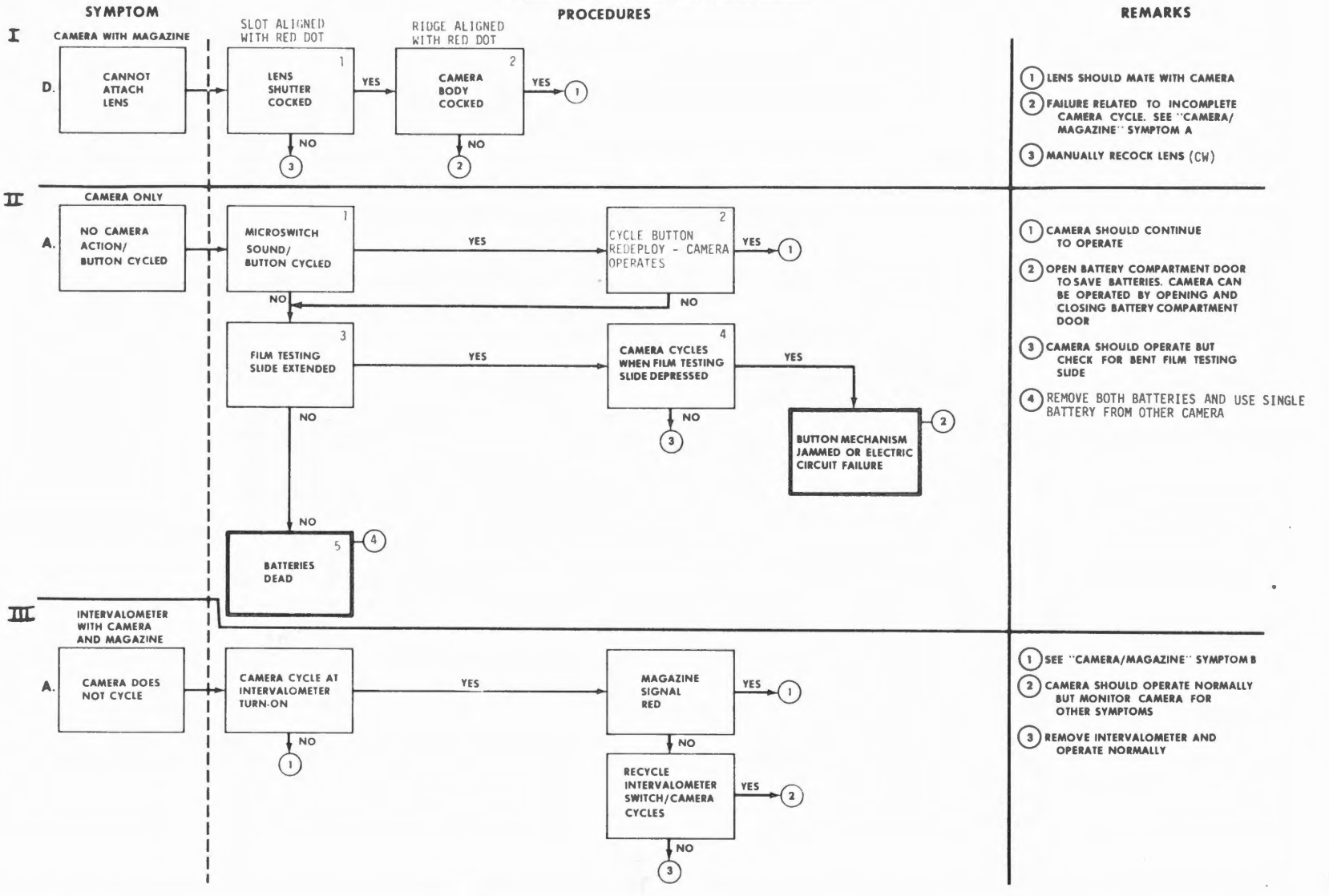
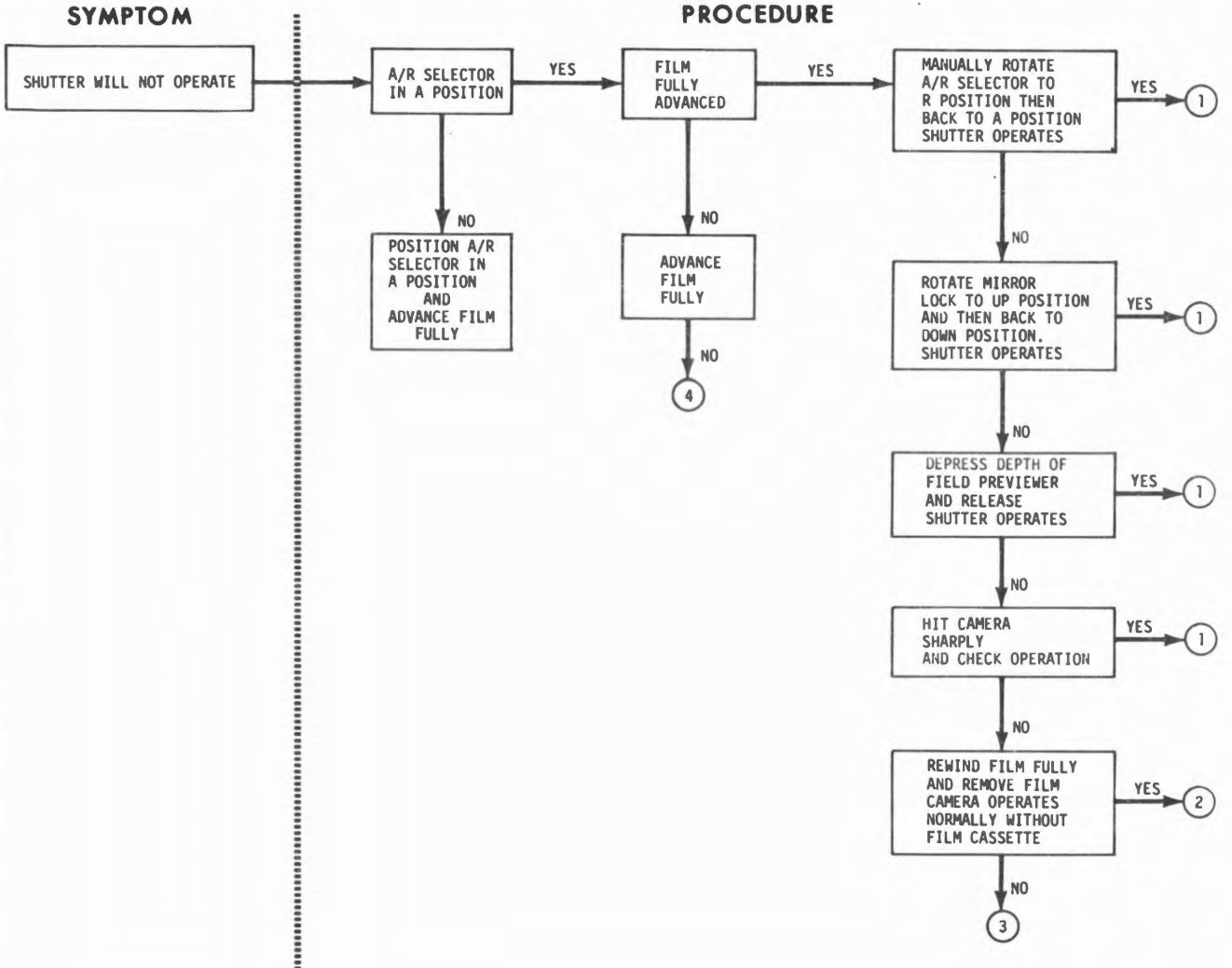


35mm CAMERA MALFUNCTIONS



REMARKS

(1) CAMERA SHOULD CONTINUE TO OPERATE NORMALLY BUT MONITOR OPERATION CLOSELY AS FAILURE COULD REOCCUR.

(2) CAMERA SHOULD OPERATE NORMALLY WITH A NEW FILM CASSETTE.

(3) CAMERA INOPERATIVE.

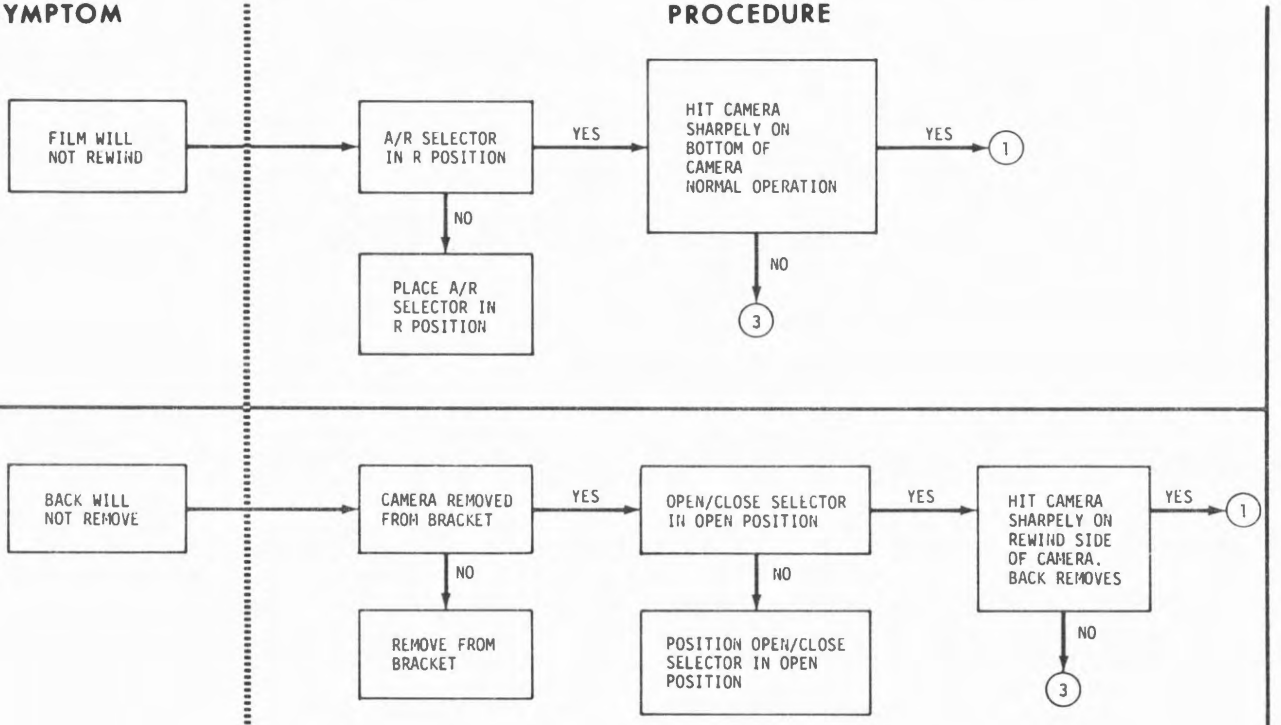
(4) IF FILM WILL NOT ADVANCE FULLY, REWIND FILM AND INSTALL A NEW FILM CASSETTE.

(5) CAMERA WILL OPERATE NORMALLY, HOWEVER LIGHT METER SYSTEM WILL BE INACCURATE. USE SPOTMETER FOR LIGHT MEASUREMENT.

(6) LIGHT METER INOPERATIVE. USE SPOTMETER TO OBTAIN LIGHT MEASUREMENT.

(7) USE STOP DOWN SYSTEM FOR LIGHT METERING.

35mm CAMERA MALFUNCTIONS



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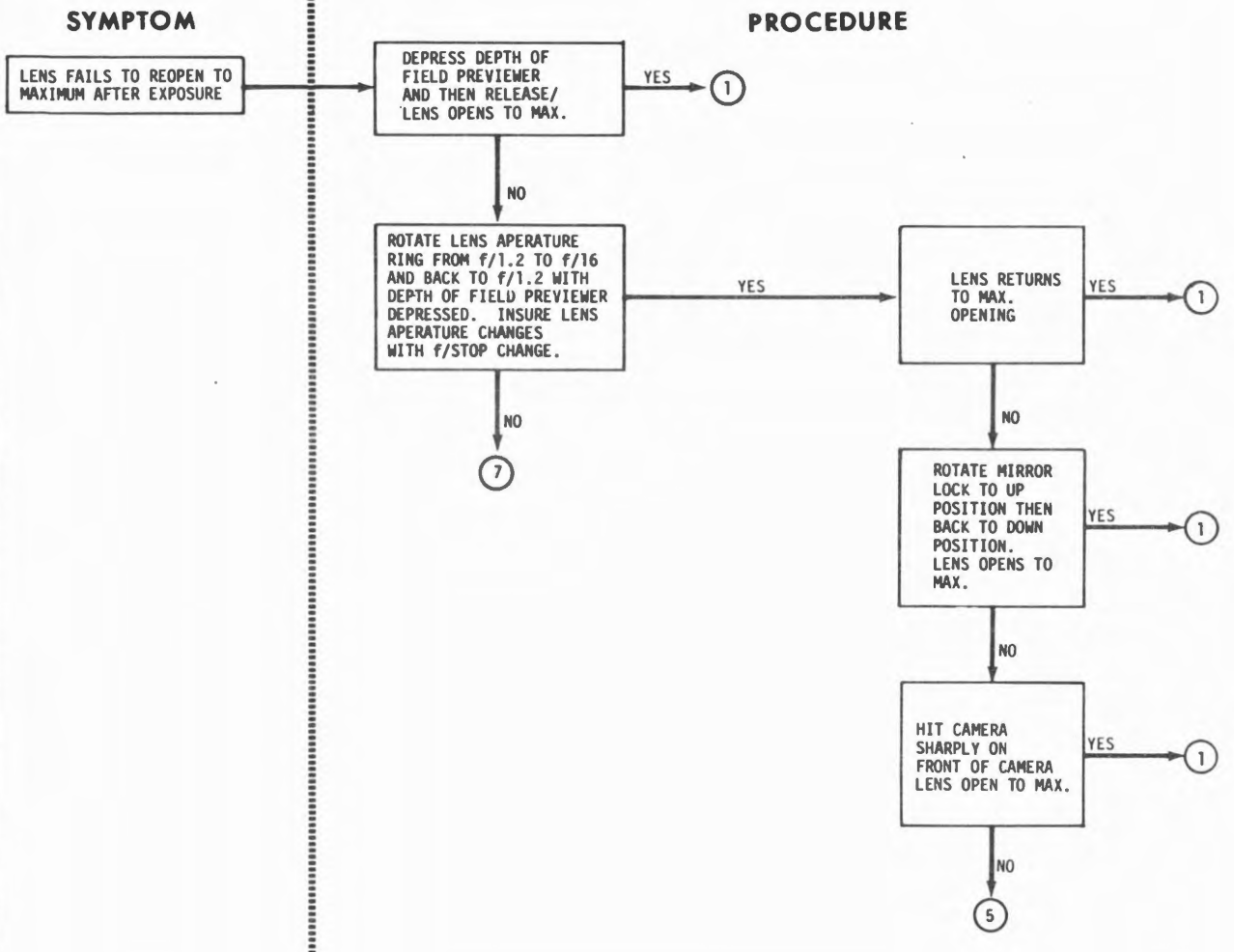

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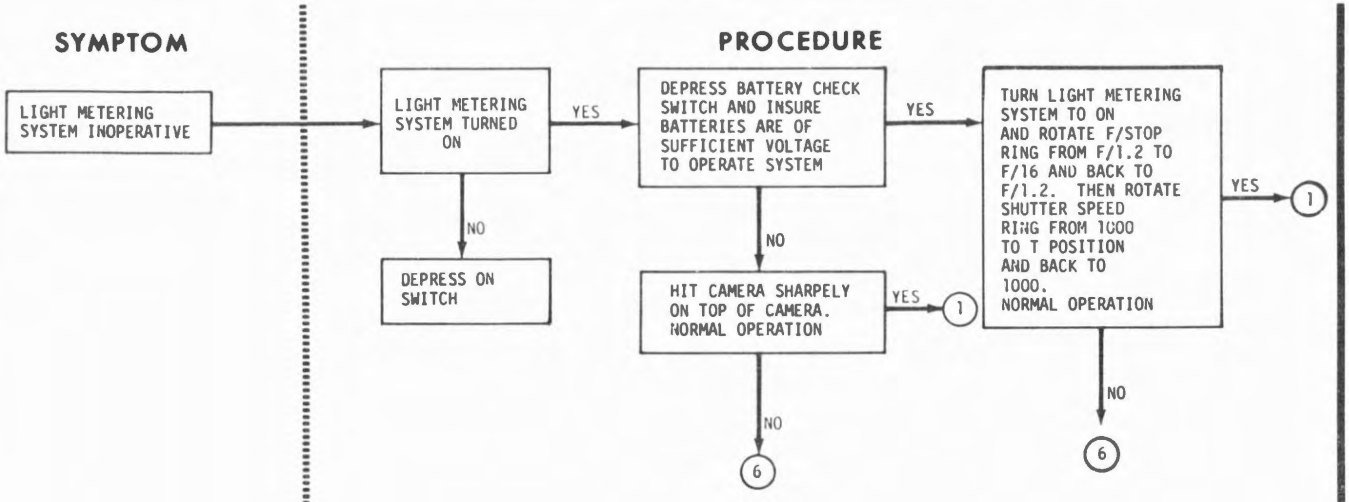

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NO.	ITEM ⇨	ACTION	BACKOUT

NO.	ITEM ⇨	ACTION	BACKOUT

DATE 8/7/72

NO.	ITEM ⇨	ACTION	BACKGROUND

DATE 8/7/72

NO.	ITEM ⇨	ACTION	BACKGROUND

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NO.	ITEM ⇨	ACTION	BACKGROUND

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NO.	ITEM ⇨	ACTION	BACKGROUND

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