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### Environmental Control System (ECS) Malfunction Procedures Symptom 1 to 37 - SSR1 + Notes - Feb. 16, 1968 Group

National Aeronautics and Space Administration (NASA)

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## Fuel Cells

Order of Malfunctions changed.  
is this significant

1(f) Step 6.07 Remarks - what  
ECS Procedure?

Step 609 Is there a B/S proced  
that calls out how to  
remove F/C from bus & Shut  
down. Is this step is done so  
it could be referenced - from  
other procedures - later

1(g) Step Missing - should check  
O<sub>2</sub> Reg pressure by function  
select A Positions 4, 5, 6 - before  
check N<sub>2</sub> reg pressure to determine  
if O<sub>2</sub> reg failed open dumping  
O<sub>2</sub> supply press in line.

7.026 Don't see how you can definitely  
establish O<sub>2</sub> Reg failure unless  
you check O<sub>2</sub> Supply Press with  
Function select. Then isolate F/C



1(h) Step 8.04 a) & b Believe  
"regular" should mean  
"regulator"

However, shouldn't this  
procedure essentially follow  
1(g). Check  $N_2$  &  $H_2$  reg  
pressures. both.

1(i) Before shutting down fuel cell  
shouldn't we also check  
 $O_2$  &  $H_2$  reg pressures by  
the Function select. It  
takes little time and doesn't  
hurt to measure. The Voltages  
corresponding to pressures  
should be available to the  
crew as an aid.



j) 10.00 Why were steps 10.01 put before 10.02, 10.03, 10.04

d) Calibrated values of  $H_2$  <sup>for s/corr</sup> and  $O_2$  are missing

e) Calibrated values of  $H_2$  and  $O_2$  low limits are missing

Step 5.04 Remarks. Typo error

$O_2$  60.5 psi (4.03V) should read

$H_2$  60.5 psi (4.03V)

h) 11.01a Heater failed to come on

i) what do initials FCPP stand for

Errors?

1201a Failure — Didn't we have  $H_2$  or coolant pump failure here in earlier proof

1201b Sensor Failure



1(a); 1.050) Bmark mistake  
90°F vs 900V

1(c) 3.03 object to "open cycle"  
prefer continuous purge

1(b) - C/W failure not  
mentioned

Step 202 (c)  
Rad Out temp =  $-30^{\circ}$   
on all 3 fuel cells

Power Dist

Proc 2 Step 6.  
would add

Voltage

normal  $> 34V$  Fail.  
low  $< 34V$  Loss of pyro bus  
Short on pyro bus

# AVOID VERBAL ORDERS

TO:

John L. SWIGERT

DATE

3/11/68

FROM:

ROGER BURKE

SUBJECT:

ECS MALFUNCTION PROCEDURES

As a matter of clarification, the following effort is to be included in Action Memo \_\_\_\_\_:

ATTACHED IS A RED LINED COPY of the ECS MALFUNCTION procedures. I would be happy to attend the review of these procedures. Please contact me as to the time and place of this meeting. My extension is 3421

SIGNATURE

Roger Burke



UNITED STATES GOVERNMENT

# Memorandum

TO : See distribution list below

FROM : CB/John L. Swigert, Jr.

SUBJECT: ECS Malfunction Procedures

Attached is a copy of the preliminary ECS Malfunction Procedures for Spacecraft 101. It is anticipated that a meeting will be held in about 4 weeks to update these procedures.

Flight crew inputs are the most valued since sometimes those of us writing procedures can't see the forest for the trees.

Your comments and suggestions as to accuracy, clarity and coverage of the possible malfunctions would be appreciated.

*Jack*

John L. Swigert, Jr.

cc:

CB/A. B. Shepard  
W. R. Cunningham  
E. Cernan  
J. Young  
D. Scott  
R. Gordon  
A. Worden  
M. Collins  
J. Lovell  
K. Mattingly  
J. Kerwin  
CF3/C. H. Woodling ✓  
J. Mitchell,  
Cape Kennedy, AMS

CB:JLSwigert:ps 2-16-68

~~FASSER~~ SNYDER  
DICK - WOULD YOU PLEASE ASSIGN  
REVIEW OF THIS TO YOUR ECS MAN -  
WE SHOULD GIVE THIS A GOOD  
REVIEW SINCE IN THE FINAL  
ANALYSIS TRAINING AND FLIGHT  
DATE: February 16, 1968  
WILL DEPEND ON THESE DATA  
BEING ACCURATE

CTHW  
2/17

Dick, A written  
response is required.  
CR





UNITED STATES GOVERNMENT

# Memorandum

See distribution list below

TO : Mr. John I. Swigart, Jr.

SUBJECT: FOS Malfunction Procedures

Attached is a copy of the preliminary FOS Malfunction Procedures for Specimens 101. It is anticipated that a meeting will be held in about 4 weeks to update these procedures.

Flight crew inputs are the most valued since sometimes those of us writing procedures can't see the forest for the trees.

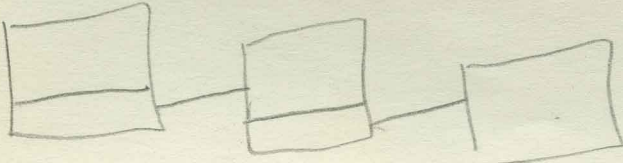
Your comments and suggestions as to accuracy, clarity and coverage of the possible malfunctions would be appreciated.

John I. Swigart, Jr.

cc: Mr. J. B. Grogan  
Mr. T. Grogan  
Mr. Grogan  
Mr. Young  
Mr. Scott  
Mr. Gordon  
Mr. Warden  
Mr. Collins  
Mr. J. J. J.  
Mr. J. J. J.  
Mr. J. J. J.  
Mr. J. J. J.

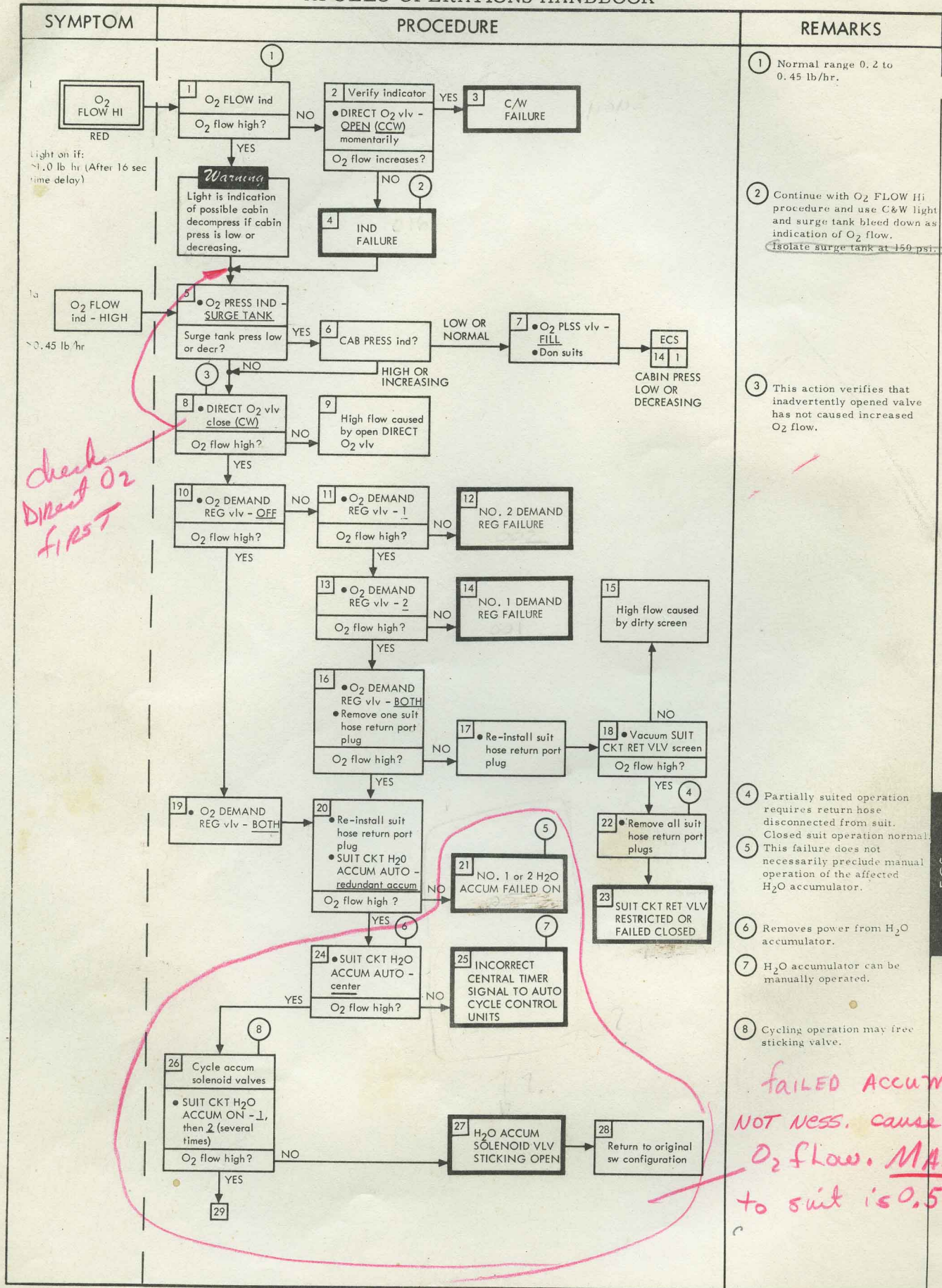
Mr. C. H. Woodling  
Mr. Mitchell  
Cape Kennedy, MS

CS:Jswigart:ps 2-10-68





SM2A-03-SC101-(2)  
APOLLO OPERATIONS HANDBOOK





SM2A-03-SC101-(2)  
APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
1 (Cont)	<p>26</p> <p>29 • H<sub>2</sub>O ACCUM 1 vlv - OFF O<sub>2</sub> flow high?</p> <p>NO → 30 NO. 1 H<sub>2</sub>O ACCUM SOLENOID VLV FAILED OPEN → 31 • SUIT CKT H<sub>2</sub>O ACCUM AUTO - 2</p> <p>YES → 32 • H<sub>2</sub>O ACCUM 2 vlv - OFF • H<sub>2</sub>O ACCUM 1 vlv - RMTE O<sub>2</sub> flow high?</p> <p>NO → 33 NO. 2 H<sub>2</sub>O ACCUM SOLENOID VLV FAILED OPEN → 34 • SUIT CKT H<sub>2</sub>O ACCUM AUTO - 1</p> <p>YES → 35 • H<sub>2</sub>O ACCUM 2 vlv - RMTE • SUIT CKT H<sub>2</sub>O ACCUM AUTO - 1 • CAB REPRESS vlv close (CW) O<sub>2</sub> flow high?</p> <p>NO → 36 High flow caused by open CAB REPRESS vlv</p> <p>YES → 11</p> <p>37 Close emer cabin press vlv • EMER CAB PRESS vlv - OFF O<sub>2</sub> flow high?</p> <p>NO → 38 "BARDAHL" procedure • EMER CAB PRESS vlv - BOTH • EMER CAB PRESS TO TEST pb - push O<sub>2</sub> flow high?</p> <p>NO → 39 TEMPORARY PEEL VLV SEATING PROBLEM</p> <p>YES → 40 • EMER CAB PRESS vlv - 1 O<sub>2</sub> flow high?</p> <p>NO → 41 NO. 2 EMER CAB PRESS REG FAILURE</p> <p>YES → 42 NO. 1 EMER CAB PRESS REG FAILURE → 43 • EMER CAB PRESS vlv - 2</p> <p>44 • EMER CAB PRESS vlv - BOTH • H<sub>2</sub>O/GLY TK PRESS REG vlv - OFF O<sub>2</sub> flow high?</p> <p>NO → 45 • H<sub>2</sub>O/GLY TK PRESS REG vlv - 1 • H<sub>2</sub>O/GLY TK PRESS RELF vlv - 1 O<sub>2</sub> flow high?</p> <p>NO → 46 H<sub>2</sub>O/GLY TK PRESS REG NO. 2 FAILED HIGH OR RELIEF VLV NO. 2 FAILED OPEN → 47 Continue operations on No. 1 reg &amp; relief vlv</p> <p>YES → 12 13</p> <p>48 LEAK IN CABIN PRESS REG OR IN 100 PSI LINE DOWNSTREAM OF FLOW SENSOR</p> <p>52 Determine leak rate • O<sub>2</sub> DEMAND REG vlv - OFF • Surge tank press decay rate used to determine magnitude of leak in cabin press reg or 100 psi line</p> <p>49 • H<sub>2</sub>O/GLY TK PRESS REG vlv - 2 • H<sub>2</sub>O/GLY TK PRESS RELF vlv - 2 O<sub>2</sub> flow high?</p> <p>NO → 50 H<sub>2</sub>O/GLY TK PRESS REG NO. 1 FAILED HIGH OR RELF vlv NO. 1 FAILED OPEN → 51 Continue operations on No. 2 reg &amp; relief vlv</p> <p>YES → 53 LEAK DOWNSTREAM OF H<sub>2</sub>O/GLY TK PRESS RELF VLV → 54 • H<sub>2</sub>O/GLY TK PRESS REG vlv - OFF • H<sub>2</sub>O/GLY TK PRESS RELF vlv - OFF</p>	<p>9 <sup>this</sup> Loss of electrical cyclic control of H<sub>2</sub>O accumulators. Periodic manual valve operation the only means of actuating H<sub>2</sub>O accumulator.</p> <p><sup>this</sup> see page 1</p> <p>10 PRESS-TO-TEST operation may reveal leaky peel valve.</p> <p>11 Steps 37, 38, 40 and 43 to be omitted if all crewmen are suited as valve is already off.</p> <p>12 If leak is not isolated and O<sub>2</sub> flow remains high, mission time may be extended by shutting off the main O<sub>2</sub> regulators, re-opening them when necessary to maintain cabin pressure and CO<sub>2</sub> level.</p> <p>13 As required repressurize H<sub>2</sub>O tanks by placing H<sub>2</sub>O/GLY TK PRESS REG &amp; RELF valves in the BOTH position, then OFF.</p>

ECS  
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SM-2A-1504



SM2A-03-SC101-(2)  
APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
<p>2</p> <p>O<sub>2</sub> FLOW ind - LOW</p> <p>Normal range 0.2 to 0.45 lbs/hr 0.25</p>	<p>1 Surge tk press</p> <ul style="list-style-type: none"> <li>• O<sub>2</sub> PRESS IND sw - <u>SURGE TANK</u></li> </ul> <p>Surge tank press low?</p> <p>YES</p> <p>ECS 4 1</p> <p>SURGE TANK PRESS LOW</p> <p>NO</p> <p>2 Verify O<sub>2</sub> flow ind</p> <ul style="list-style-type: none"> <li>• DIRECT O<sub>2</sub> vlv - <u>OPEN (CW)</u> momentarily</li> </ul> <p>Momentary flow incr?</p> <p>YES</p> <p>4 Low system demand</p> <p>NO</p> <p>3 O<sub>2</sub> FLOW SENSOR OR IND FAILURE</p> <p>1</p>	<p>1 MSFN can distinguish between these two failures.</p>
<p>3</p> <p>SURGE TANK PRESS HIGH</p> <p>&gt;935 psi</p>	<p>1 Cryo tk press check</p> <ul style="list-style-type: none"> <li>• O<sub>2</sub> PRESS IND sw - <u>TANK 1</u></li> </ul> <p>Either cryo tank press high?</p> <p>YES</p> <p>3 CRYO O<sub>2</sub> STORAGE FAILURE</p> <p>EPS-CYRO 1a 7</p> <p>O<sub>2</sub> CRYO PRESS HI</p> <p>NO</p> <p>2 SURGE TANK PRESS SENSOR FAILURE</p> <p>1</p>	<p>1 Use highest cryo tank indication to estimate surge tank pressure.</p>
<p>4</p> <p>SURGE TANK PRESS LOW</p> <p>&lt;865 psi</p>	<p>1 Cab press high?</p> <p>YES</p> <p>ECS 13 1</p> <p>CABIN PRESS HIGH OR INCREASING</p> <p>NO</p> <p>2 O<sub>2</sub> FLOW ind</p> <p>O<sub>2</sub> flow?</p> <p>LOW</p> <p>ECS 1 2</p> <p>O<sub>2</sub> FLOW HI</p> <p>NO</p> <p>7 • O<sub>2</sub> SM SUPPLY vlv - <u>ON</u></p> <p>Surge tank press incr?</p> <p>YES</p> <p>9 Low press caused by closed O<sub>2</sub> SM SUPPLY vlv</p> <p>NO</p> <p>5 Check for O<sub>2</sub> line obstruction</p> <ul style="list-style-type: none"> <li>• O<sub>2</sub> PLSS vlv - <u>OFF</u></li> <li>• O<sub>2</sub> SURGE TK vlv - <u>OFF</u></li> <li>• DIRECT O<sub>2</sub> vlv - <u>OPEN (CCW)</u></li> <li>• Increase O<sub>2</sub> flow 0.95 lb/hr for TBD sec</li> <li>• Monitor O<sub>2</sub> FLOW ind</li> </ul> <p>O<sub>2</sub> flow ind remains at 1.0 lb/hr?</p> <p>YES</p> <p>6 SURGE TK PRESS SENSOR FAILURE</p> <p>NO</p> <p>8 OBSTRUCTION OF O<sub>2</sub> RESTRICTORS, FILTERS OR LINE</p> <p>An obstruction severely limits O<sub>2</sub> supply rate. May essentially limit supply to that available in CM (surge tk plus repress O<sub>2</sub> tk).</p> <p>10 Reopen O<sub>2</sub> vlv</p> <ul style="list-style-type: none"> <li>• O<sub>2</sub> PLSS vlv - <u>ON</u></li> <li>• O<sub>2</sub> SURGE TK vlv - <u>ON</u></li> </ul> <p>3 • O<sub>2</sub> PRESS IND sw - <u>TANK 1</u></p> <p>Cryo tk press low?</p> <p>YES</p> <p>4 CRYO O<sub>2</sub> STORAGE FAILURE</p> <p>EPS-CYRO 1b 1</p> <p>CRYO PRESS LOW</p> <p>NO</p> <p>1</p>	<p>Can have Normal O<sub>2</sub> flow even with SM supply "OFF"</p>

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MALFUNCTION

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SM2A-03-SC101-(2)  
APOLLO OPERATIONS HANDBOOK

4

SYMPTOM	PROCEDURE	REMARKS
<p>MSFN reports O<sub>2</sub> SYS PRESS HIGH (CF0036P)</p> <p>&gt;110 psi</p>	<p>1 CAB PRESS ind</p> <p>Cab press high?</p> <p>YES → 2 MAIN REG B vlv - close</p> <p>MSFN reports O<sub>2</sub> sys press decr?</p> <p>YES → 3 MAIN O<sub>2</sub> REG B FAILURE</p> <p>NO → 4 O<sub>2</sub> SYS PRESS SENSOR FAILURE OR MAIN REG CALIBRATION SHIFT</p> <p>5 Check second reg</p> <p>• MAIN REG B vlv - OPEN</p> <p>• MAIN REG A vlv - close</p> <p>MSFN reports O<sub>2</sub> sys press decr?</p> <p>YES → 6 MAIN O<sub>2</sub> REG A FAILURE</p> <p>NO → 8 FAILURE OF BOTH MAIN REG</p> <p>7 Use redundant main reg</p>	<p>① If O<sub>2</sub> flow rate does not decrease when regulators are isolated, calibration has shifted but not up to relief pressure. Regulator is still usable.</p>
<p>MSFN reports O<sub>2</sub> SYS PRESS LOW (CF 0036P)</p> <p>&gt;90 psi</p>	<p>1 Check surge tk press</p> <p>• O<sub>2</sub> PRESS IND sw - SURGE TANK</p> <p>Surge tk press low?</p> <p>YES → ECS 4 1</p> <p>SURGE TANK PRESS LOW</p> <p>NO → 2 O<sub>2</sub> PRESS SENSOR FAILURE</p> <p>3 • Direct O<sub>2</sub> vlv - OPEN (CCW)</p> <p>O<sub>2</sub> FLOW HI?</p> <p>YES → O<sub>2</sub> SYS PRESS SENSOR FAILED (CF0036P)</p> <p>NO → 4 • SURGE TANK PRESS DECR?</p> <p>YES → DOUBLE IND FAILED (O<sub>2</sub> FLOW ↑ O<sub>2</sub> SYS PRESS)</p> <p>NO → BOTH MAIN REGS FAILED CLOSED</p> <p>Surge TNK "ON" Check</p>	<p>① Suit circuit</p>
<p>CO<sub>2</sub> PP HI</p> <p>YELLOW</p> <p>Light on if: CO<sub>2</sub> PP &gt;7.6mm Hg</p> <p>7a CO<sub>2</sub> PART PRESS ind - HIGH</p> <p>&gt;7.6mm Hg</p> <p>7b CO<sub>2</sub> PART PRESS ind - LOW</p>	<p>1 CO<sub>2</sub> PART PRESS ind</p> <p>&gt;7.6mm Hg?</p> <p>NO → 2 C/W FAILURE</p> <p>YES → 3 Purge CO<sub>2</sub> sensor</p> <p>• DIRECT O<sub>2</sub> vlv - OPEN (CCW) for 10 sec</p> <p>CO<sub>2</sub> PP high?</p> <p>YES → 4 Check cabin gas analyzer</p> <p>CO<sub>2</sub> PP high?</p> <p>YES → 5 Check CO<sub>2</sub> absorber filters</p> <p>• Position CO<sub>2</sub> canister divert vlv handle alternately to A and B and obtain stabilized CO<sub>2</sub> PP readings</p> <p>• Change canister with highest CO<sub>2</sub> reading</p> <p>CO<sub>2</sub> PP High?</p> <p>NO → 3</p> <p>YES → 8 • Change other CO<sub>2</sub> filter</p> <p>CO<sub>2</sub> PP high?</p> <p>NO → 9 EXPENDED OR FAULTY CO<sub>2</sub> FILTER</p> <p>YES → 7 CO<sub>2</sub> PP SENSOR FAILURE</p> <p>6 High CO<sub>2</sub> PP caused by stagnant CO<sub>2</sub> near sensor</p>	<p>① Cabin Gas Analyzer is battery operated and time limited.</p> <p>② Loss of CO<sub>2</sub> partial pressure indicator. Use Cabin Gas Analyzer.</p> <p>③ Manual CO<sub>2</sub> partial pressure control can be accomplished by use of DIRECT O<sub>2</sub> valve operation or emergency O<sub>2</sub> masks can be used.</p>

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SM2A-03-SC101-(2)  
APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
<p>1</p> <p>CO<sub>2</sub> FILTER SEIZURE WITHIN CANISTER</p>	<p>1</p> <p>EXCESSIVE SWELLING OF CO<sub>2</sub> FILTER</p> <p>2 Single canister operation</p> <ul style="list-style-type: none"> <li>SUIT FLOW RELF vlv - OFF</li> <li>CO<sub>2</sub> canister divert vlv - both (center)</li> <li>Divert flow through seized filter momentarily when replacement of operational filter is required</li> <li>Use of CO<sub>2</sub> PART PRESS ind as filter replacement indicator</li> </ul>	<p>1</p> <p>Immediately replace a filter suspected of swelling.</p>
<p>1</p> <p>BALLOONED PGA'S</p>	<p>1</p> <ul style="list-style-type: none"> <li>DIRECT O<sub>2</sub> vlv - close (CW)</li> <li>O<sub>2</sub> flow decr?</li> </ul> <p>YES</p> <p>2</p> <p>Ballooning caused by open DIRECT O<sub>2</sub> vlv</p> <p>NO</p> <p>3</p> <ul style="list-style-type: none"> <li>SUIT TEST vlv - OFF</li> <li>O<sub>2</sub> flow decr?</li> </ul> <p>YES</p> <p>7</p> <p>Ballooning caused by open SUIT TEST vlv</p> <p>NO</p> <p>4</p> <ul style="list-style-type: none"> <li>O<sub>2</sub> DEMAND REG vlv - OFF</li> <li>O<sub>2</sub> flow decr?</li> </ul> <p>YES</p> <p>5</p> <ul style="list-style-type: none"> <li>O<sub>2</sub> DEMAND REG vlv - 1</li> <li>O<sub>2</sub> flow decr?</li> </ul> <p>YES</p> <p>6</p> <p>NO. 2 DEMAND REG EXCESSIVE INTERNAL LEAKAGE</p> <p>NO</p> <p>8</p> <ul style="list-style-type: none"> <li>O<sub>2</sub> DEMAND REG vlv - 2</li> <li>O<sub>2</sub> flow decr?</li> </ul> <p>YES</p> <p>9</p> <p>NO. 1 DEMAND REG EXCESSIVE INTERNAL LEAKAGE</p> <p>NO</p> <p>10</p> <p>BOTH DEMAND REG EXCESSIVE INTERNAL LEAKAGE</p> <p>NO</p> <p>11</p> <ul style="list-style-type: none"> <li>O<sub>2</sub> DEMAND REG vlv - BOTH</li> <li>H<sub>2</sub>O ACCUM vlv (2) - OFF</li> <li>O<sub>2</sub> flow decr?</li> </ul> <p>YES</p> <p>12</p> <ul style="list-style-type: none"> <li>H<sub>2</sub>O ACCUM 1 vlv - RMTE</li> <li>O<sub>2</sub> flow incr?</li> </ul> <p>YES</p> <p>13</p> <p>NO. 1 H<sub>2</sub>O ACCUM SOLENOID VLV EXCESSIVE INTERNAL LEAKAGE</p> <p>NO</p> <p>15</p> <p>NO. 2 H<sub>2</sub>O ACCUM SOLENOID VLV EXCESSIVE INTERNAL LEAKAGE</p> <p>NO</p> <p>14</p> <p>UNIDENTIFIABLE INTERNAL LEAKAGE</p>	<p>1</p> <p>Ballooned means slightly overinflated and can be verified by the suit to cabin ΔP indicator &gt; zero. Cabin to suit ΔP maintained at 0.09 to 0.13 psi. Suit pressure maintained at 3.75 ± 0.25 psi when cabin pressure ≤ 3.5 psi.</p> <p>2</p> <p>"BARDAHL" procedure may correct excessive O<sub>2</sub> flow.</p> <p>3</p> <p>Leaking O<sub>2</sub> demand regulator is still operational and may be used for depressurized cabin mode.</p> <p>4</p> <p>H<sub>2</sub>O accumulators may be used manually for H<sub>2</sub>O removal with excessive O<sub>2</sub> usage.</p>
<p>10</p> <p>CLINGING SUIT</p> <p>CABIN PRESS &gt; 4.0 psi</p>	<p>1</p> <p>Clinging suit for ?</p> <p>ALL CREWMEN</p> <p>2</p> <p>Verify valve positions</p> <ul style="list-style-type: none"> <li>O<sub>2</sub> DEMAND REG vlv - BOTH</li> <li>Suit flow vlv (3) - SUIT FULL FLOW</li> <li>SUIT TEST vlv - OFF</li> </ul> <p>Clinging suit ?</p> <p>YES</p> <p>3</p> <ul style="list-style-type: none"> <li>Perform suit circuit and PGA check</li> <li>Suit maintains pressure ?</li> </ul> <p>NO</p> <p>4</p> <p>SUIT LOOP PLUMBING LEAK</p> <p>YES</p> <p>7</p> <ul style="list-style-type: none"> <li>Verify O<sub>2</sub> system press with MSFN</li> <li>System press low ?</li> </ul> <p>NO</p> <p>8</p> <p>BOTH O<sub>2</sub> DEMAND REG FAILED CLOSED</p> <p>YES</p> <p>ECS</p> <p>6 1</p> <p>MSFN reports O<sub>2</sub> SYS PRESS LOW</p> <p>11</p> <ul style="list-style-type: none"> <li>Use DIRECT O<sub>2</sub> vlv to meter O<sub>2</sub> into suit loop</li> </ul> <p>5</p> <ul style="list-style-type: none"> <li>Suit flow vlv - SUIT FULL FLOW</li> <li>Clinging suit ?</li> </ul> <p>NO</p> <p>6</p> <p>Clinging suits caused by incorrectly positioned valve</p> <p>YES</p> <p>9</p> <p>REDUCED O<sub>2</sub> INFLOW BETWEEN SUIT FLOW VLV AND PGA</p> <p>10</p> <ul style="list-style-type: none"> <li>Switch to spare umbilical hose</li> </ul>	<p>1</p> <p>Metabolic requirement per crewman is approximately 0.2 lb/hr.</p>

ECS  
MALFUNCTION

SM-2A-1507

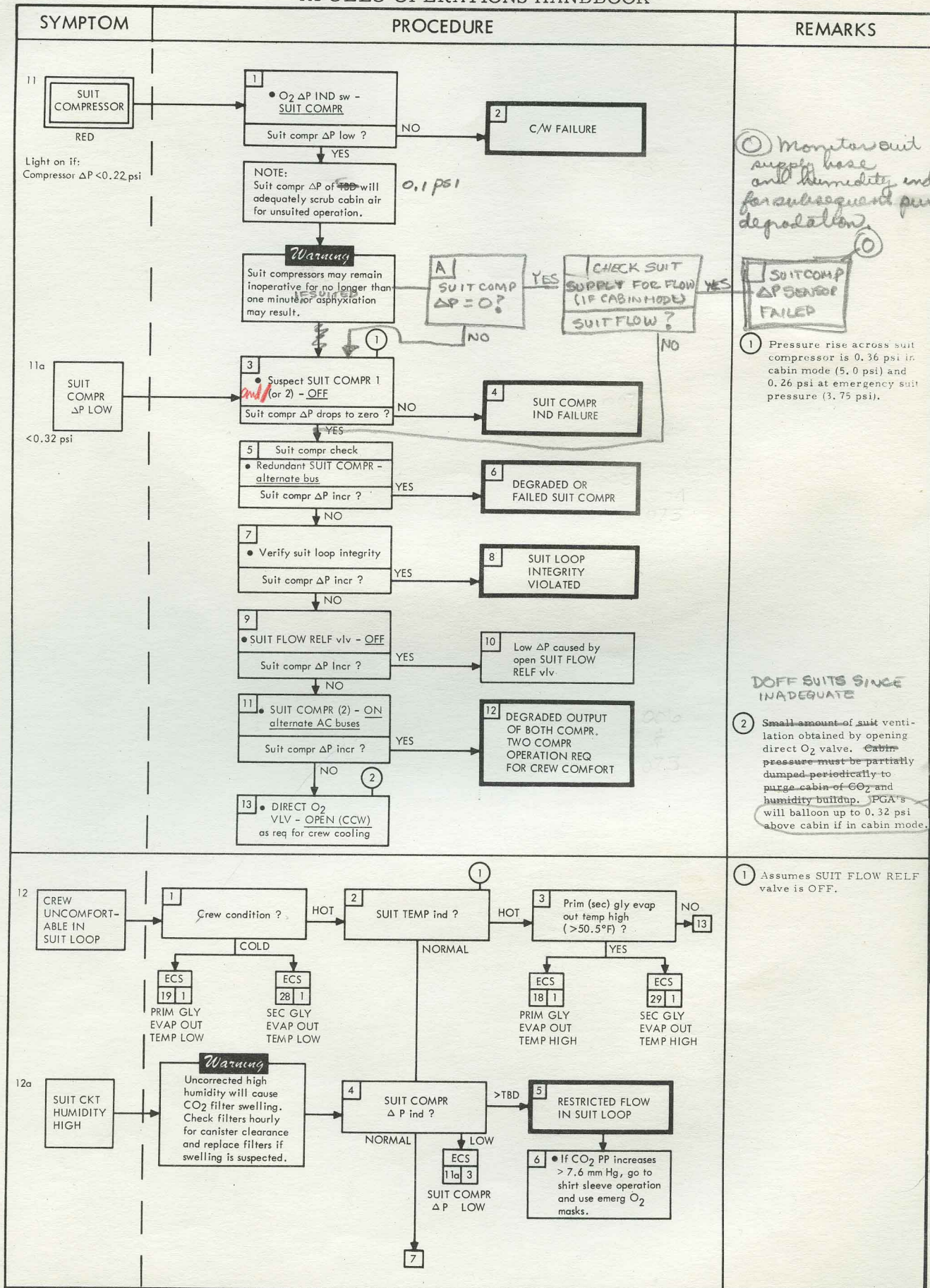
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SM2A-03-SC101-(2)  
APOLLO OPERATIONS HANDBOOK



ECS  
MALFUNCTION



SM2A-03-SC101-(2)  
APOLLO OPERATIONS HANDBOOK

SYMPTOM	PROCEDURE	REMARKS
Waste tank qty ind full ?	<div>4</div> <div>7</div> <div>Waste tank qty ind full ?</div> <div>YES</div> <div>2</div> <div>9</div> <div>Verify waste tk qty</div> <div>• SUIT CKT H<sub>2</sub>O ACCUM AUTO - center</div> <div>• SUIT CKT H<sub>2</sub>O ACCUM ON - 1 (or 2) for 20 sec</div> <div>NOTE: O<sub>2</sub> FLOW HI light may come on</div> <div>O<sub>2</sub> flow decr &lt;1.0 lb/hr after max of 15 sec ?</div> <div>NO</div> <div>11</div> <div>NO. 1 (or 2) SUIT CKT H<sub>2</sub>O ACCUM DIAPHRAM RUPTURED</div> <div>YES</div> <div>8</div> <div>SUIT CKT H<sub>2</sub>O ACCUM AUTO - center</div> <div>SUIT CKT H<sub>2</sub>O ACCUM ON - 1 (or 2) for 10 sec</div> <div>NOTE: Repeat several times at 1 minute intervals</div> <div>O<sub>2</sub> flow pegs high when switch is actuated?</div> <div>YES</div> <div>20</div> <div>NO</div> <div>3</div> <div>10</div> <div>NO. 1 (or 2) SUIT CKT H<sub>2</sub>O ACCUM SOLENOID OR ELECT CIRCUIT FAILURE</div> <div>651</div> <div>4</div> <div>12</div> <div>SUIT CKT H<sub>2</sub>O ACCUM AUTO - 2 (or 1)</div>	<div>2</div> <div>Quantity verification test is valid only if O<sub>2</sub> flow rate is &lt; 0.45 lb/hr before test.</div> <div>3</div> <div>Operation of No. 1 (or 2) H<sub>2</sub>O accumulator may still be possible. This can be verified by placing H<sub>2</sub>O ACCUM 1 (or 2) valve to MAN for 10 sec and then off, noting a high O<sub>2</sub> flow while valve is in MAN position.</div> <div>4</div> <div>Operation is verified by O<sub>2</sub> FLOW indicator pegging high within a ten minute period.</div>
Prim (sec) gly disch press low (< 40 psi) ?	<div>3</div> <div>13</div> <div>Prim (sec) gly disch press low (&lt; 40 psi) ?</div> <div>YES</div> <div>ECS</div> <div>20 1</div> <div>PRIM GLY DISCH PRESS LOW</div> <div>NO</div> <div>14</div> <div>SUIT CKT HT EXCH - off (center)</div> <div>• Verify SUIT HT EXCH PRIM (SEC) GLY vlv - FLOW</div> <div>Suit temp decr ?</div> <div>YES</div> <div>15</div> <div>SUIT HT EXCH WAS IN BYPASS CONDITION</div> <div>5</div> <div>16</div> <div>Suit ht exch must be bypassed manually for future use</div> <div>NO</div> <div>17</div> <div>Cool loop in operation ?</div> <div>SEC</div> <div>18</div> <div>NO COOL CONTROL TO SUIT HT EXCH</div> <div>PRIM</div> <div>19</div> <div>• Activate sec cool loop to cool suit ht exch</div> <div>ECS</div> <div>SSR-1</div> <div>SECONDARY LOOP ACTIVATION</div> <div>7</div>	<div>5</div> <div>In the primary heat exchanger mode, this failure could be caused by a motor / motor switch failure.</div>
Waste water qty incr rapidly ?	<div>8</div> <div>6</div> <div>20</div> <div>Waste water qty incr rapidly ?</div> <div>YES</div> <div>21</div> <div>NO. 1 (or 2) SUIT CKT H<sub>2</sub>O ACCUM DIAPHRAM RUPTURED</div> <div>• SUIT CKT H<sub>2</sub>O ACCUM AUTO - 2 (or 1)</div> <div>7</div> <div>23</div> <div>• SUIT CKT H<sub>2</sub>O ACCUM AUTO - 2 (or 1)</div> <div>No. 2 (or 1) accum cycles automatically within 10 min?</div> <div>YES</div> <div>24</div> <div>Humidity decr over time?</div> <div>NO</div> <div>25</div> <div>SUIT HT EXCH H<sub>2</sub>O SEPARATOR PLATE PLUGGED OR BLOCKED URINE DUMP LINE</div> <div>8</div> <div>27</div> <div>FAILURE OF CENTRAL TIMING SIGNAL TO NO. 1 (or 2) H<sub>2</sub>O ACCUM CONTROLLER</div> <div>28</div> <div>NOTE: A blocked urine dump line can be concluded only if the waste H<sub>2</sub>O tank qty has been verified full. See step 9.</div> <div>26</div> <div>CENTRAL TIMING SIGNAL FAILURE</div> <div>29</div> <div>Manual H<sub>2</sub>O removal</div> <div>• SUIT CKT H<sub>2</sub>O ACCUM ON - 1 (or 2) for 10 sec as req for crew comfort</div> <div>URINE OVBD DUMP NOT DRAINING</div> <div>ECS</div> <div>34 1</div>	<div>6</div> <div>If a rapid increase in waste water quantity is noted, release SUIT CKT H<sub>2</sub>O ACCUM ON switch.</div> <div>7</div> <div>Operation is verified by O<sub>2</sub> FLOW indicator pegging high within a ten minute period.</div> <div>8</div> <div>Operation of No. 1 (or 2) H<sub>2</sub>O accumulator still operable by manual actuation of solenoid switch.</div>

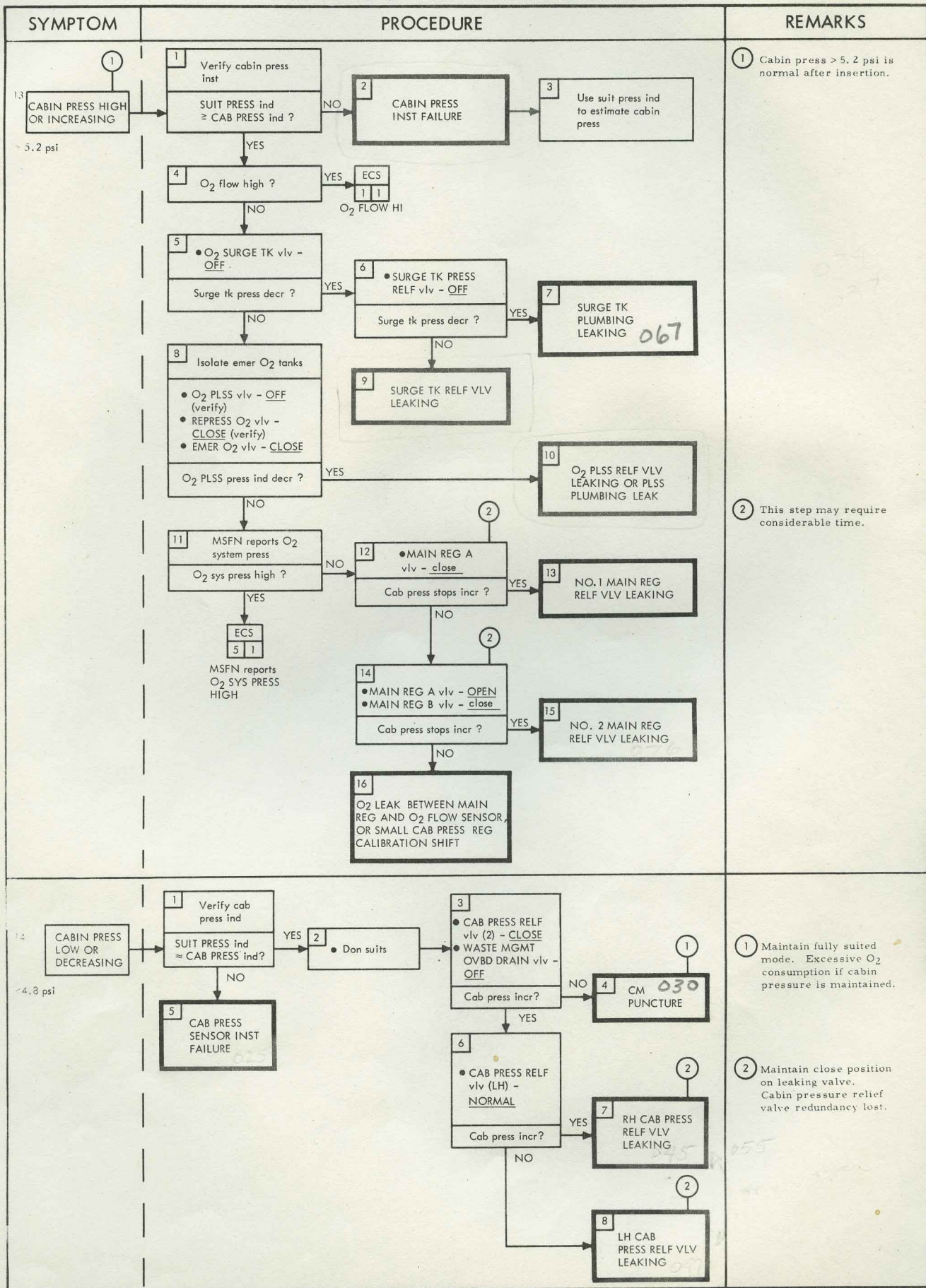
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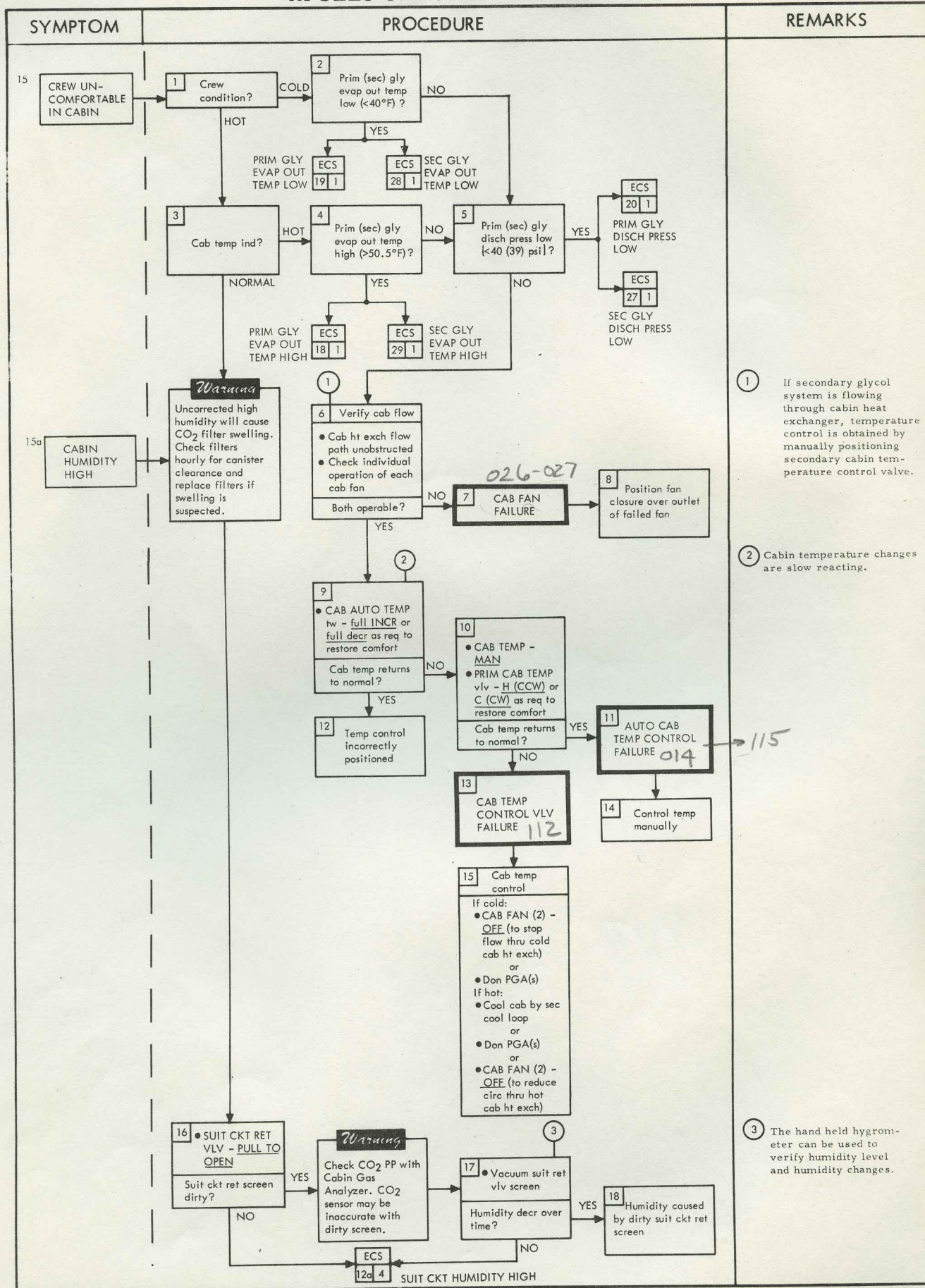
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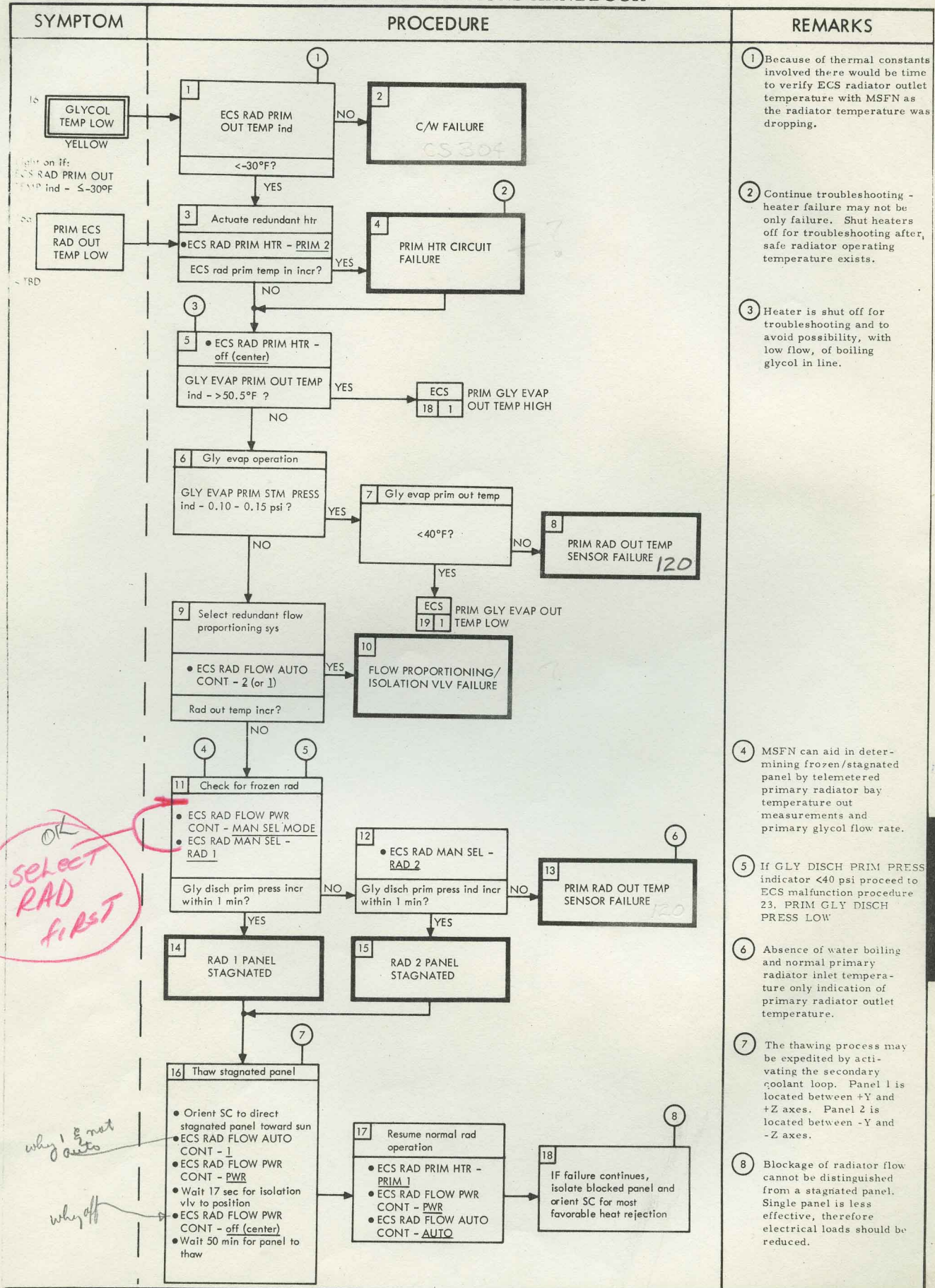




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*OK*  
*SELECT RAD FIRST*

*why 1 & not auto*

*why off*



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SYMPTOM	PROCEDURE	REMARKS
<p>17 PRIM ECS RAD OUT TEMP HIGH &gt;55°F</p>	<p>1 Gly disch prim press &lt; 40 psi? YES ECS 20 1 PRIM GLY DISCH PRESS LOW</p> <p>NO 2 GLY EVAP PRIM STM PRESS ind Water boiling (0.10 - 0.15 psi)? YES 5 • ECS RAD PRIM HTR - off (center) ECS rad prim in temp decr? YES 6 HEATER NO.1 FAILED ON NO 7 Check redundant flow control • ECS RAD AUTO FLOW CONT - redundant controller ECS rad temp prim out decr? YES 9 FLOW PROPORTIONING CONTROLLER FAILURE 10 • ECS RAD PRIM HTR - PRIM 1 NO 8 UNISOLATABLE DOUBLE FAILURE</p> <p>3 Gly evap prim out temp &gt;50.5°F? YES ECS 18 1 PRIM GLY EVAP OUT TEMP HIGH 4 PRIM RAD OUT TEMP INST FAILURE</p>	<p>1 Primary radiator outlet temperature &gt; 55°F not abnormal when associated with high electrical loads (&gt;2000 watts).</p> <p>2 Primary radiator inlet temperature and absence of water boiling can be used to estimate primary radiator outlet temperature.</p>
<p>18 PRIM GLY EVAP OUT TEMP HIGH &gt;50.5°F</p>	<p><b>Caution</b> If gly evap outlet temp reaches 60° activate secondary gly evap with radiator bypassed.</p> <p>1 Rad prim out temp &gt;48°F? YES 2 Gly evap steam press? &gt;0.15 psi 3 • GLY EVAP STM PRESS AUTO - MAN • GLY EVAP STM PRESS INCR - DECR Stm press decr? NO 4 FROZEN STM DUCT OR STM PRESS VLV FAILED CLOSED YES 6 GLY EVAP TEMP CONTROLLER FAILURE 7 Control evap stm press manually to lower gly evap out temp</p> <p>NO 5 • GLY EVAP STM PRESS AUTO - MAN • GLY EVAP STM PRESS INCR - INCR (for 45 sec) • After 15 min, GLY EVAP STM PRESS AUTO - AUTO Stm press still &lt; 0.1 psi? YES 8 • GLY EVAP IN TEMP - MAN • GLY EVAP H<sub>2</sub>O FLOW - off (center) • GLY EVAP STM PRESS AUTO - MAN • Change J52 with J53 • Perform evap re-service procedure TBD Does evap dry out again? YES 11 H<sub>2</sub>O CONTROL SECTION OF GLY EVAP TEMP CONTROLLER FAILED NO 13 J52 SENSOR FAILURE 14 Manually control water boiling • TMU - NULL • GLY EVAP H<sub>2</sub>O FLOW - ON as req</p> <p>NO 9 • GLY EVAP IN TEMP - MAN • PRIM GLY EVAP IN TEMP vlv - MIN Gly evap temp out decr? YES 12 GLY EVAP IN TEMP CONTROLLER FAILURE 16 • GLY EVAP IN TEMP vlv - adjust to maintain prim evap out temp 35°-60°F NO 15 GLY EVAP TEMP OUT INST FAILURE</p> <p>10 EVAP WAS FROZEN NOTE: If problem recurs, change J52 with J53 and repeat step 5.</p>	<p>1 Repetition of this step may be necessary.</p> <p>2 Reduction of electrical loads may reduce evaporator inlet temperature so that water boiling is not required.</p>

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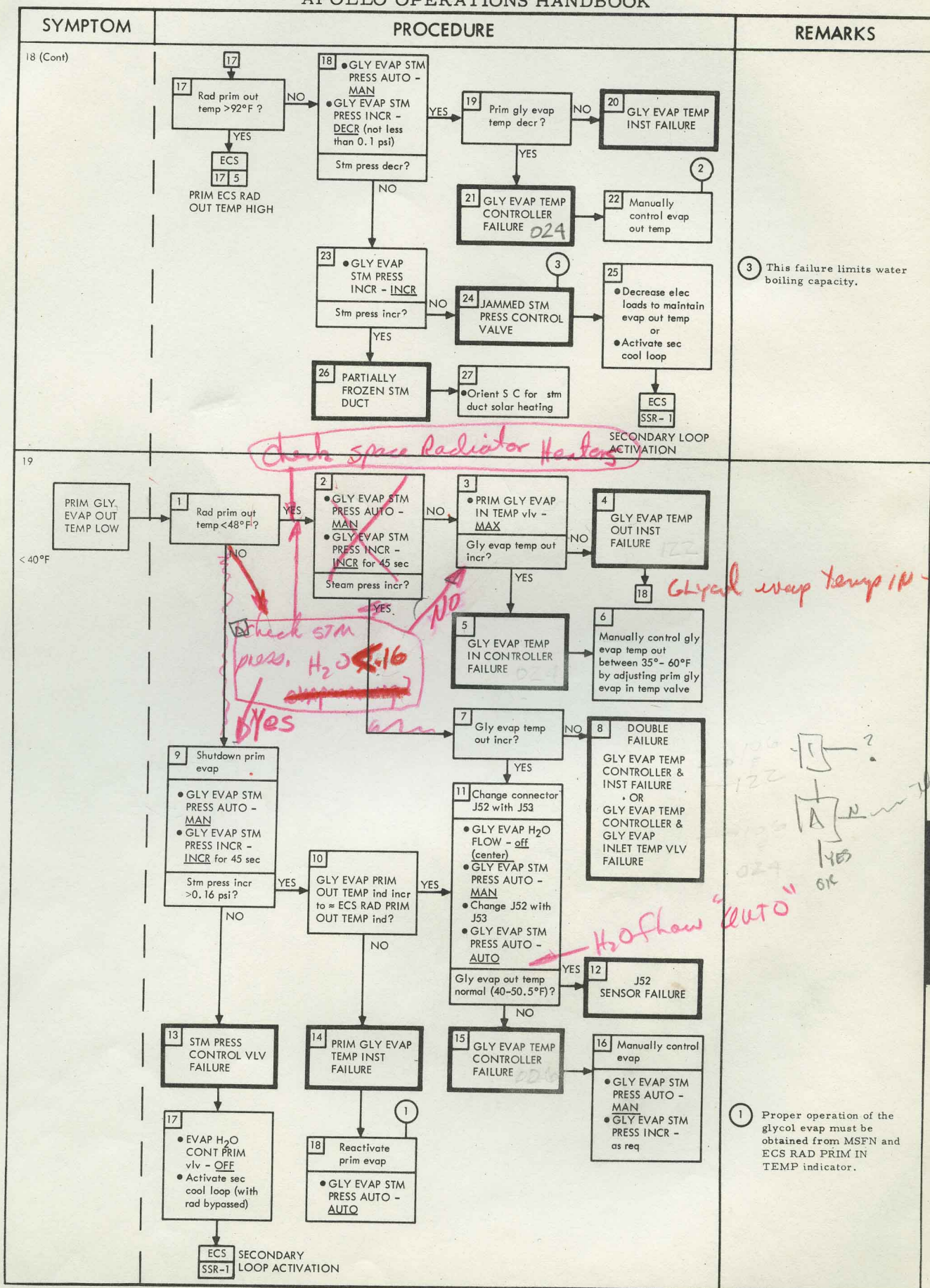
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SYMPTOM	PROCEDURE	REMARKS
<p>20 PRIM GLY DISCH PRESS LOW ~40 psi</p>	<pre> graph TD     1[1 ACCUM PRIM QTY ind low (&lt;30%)?] -- YES --&gt; 21[21 1 ECS PRIM GLY ACCUM QTY LOW OR DECREASING]     1 -- NO --&gt; 2[2 • Switch operating ECS gly pump to redundant bus Gly disch press incr?]     2 -- YES --&gt; 3[3 REDUCED PUMP OUTPUT DUE TO ELEC PROBLEM EPS TBD]     2 -- NO --&gt; 4[4 • ECS GLY PUMPS - OFF (momentarily) Gly disch press decr?]     4 -- YES --&gt; 5[5 GLY DISCH PRESS IND FAILURE 6 • Return to original gly pump]     4 -- NO --&gt; 7[7 • Switch to redundant gly pump Gly disch press incr?]     7 -- YES --&gt; 8[8 GLY PUMP DEGRADED OR FAILED]     7 -- NO --&gt; 9[9 Verify sensor • ECS GLY PUMPS - OFF • PRIM GLY ACCUM vlv - OFF (CW) • PRIM ACCUM FILL vlv - ON Gly disch press 18-27 psi?]     9 -- YES --&gt; 12[12 • PRIM ACCUM FILL vlv - OFF • PRIM GLY ACCUM vlv - ON (CW) Gly disch press compatible for indicated gly accum qty?]     9 -- NO --&gt; 10[10 GLY DISCH PRESS SENSOR FAILURE 11 • Return to original gly pump]     12 -- YES --&gt; 13[13 DEGRADED OUTPUT OF BOTH GLY PUMPS]     12 -- NO --&gt; 14[14 ACCUM PRIM QTY IND FAILURE 15 • Return to original gly pump]     </pre> <p><i>Handwritten notes in procedure:</i>          123 126 064</p>	<p>① Degraded glycol pump must now be verified by checking GLY PRIM COLDPLATE flow rate with MSFN.</p> <p>② With ECS GLY PUMPS - OFF, glycol discharge pressure should equal 1/4 accumulator quantity indication.</p>

*Handwritten note:*  
 YES what has this to do with Low Disch press? Have not found problem!

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SYMPTOM	PROCEDURE	REMARKS
21 PRIM GLY ACCUM QTY LOW OR DECREASING	<div>1 Bypass rad • ECS RAD PRIM HTR - OFF (center) • PRIM GLY TO RAD vlv - PULL TO BYPASS NOTE: Bypass operation &gt;15 min can lead to rad freezing Decr stops?</div> <div>2 Manually select rad 1 • GLY TO RAD PRIM vlv - NORMAL • ECS RAD FLOW PWR CONT - MAN SEL MODE • ECS RAD MAN SELECT - RAD 1 Accum prim qty decr?</div> <div>3 RAD PANEL 2 LEAKING • ECS RAD PRIM HTR - PRIM 1</div> <div>4 ECS RAD PRIM HTR - PRIM 1</div> <div>5 Manually select rad 2 • ECS RAD MAN SEL - RAD 2 Accum prim qty decr?</div> <div>6 RAD PANEL 1 LEAKING • ECS RAD PRIM HTR - PRIM 1</div> <div>7 ECS RAD PRIM HTR - PRIM 1</div> <div>8 Isolate accum • PRIM GLY TO RAD vlv - NORMAL • PRIM GLY ACCUM vlv - OFF (CW) Decr stops?</div> <div>9 GLY LEAK IN LINE COMMON TO BOTH RAD PANELS ECS SSR-1 SECONDARY LOOP ACTIVATION</div> <div>10 PRIM GLY ACCUM LEAKING 11 Gly rsrv as accum • PRIM ACCUM FILL vlv - ON • ECS RAD HTR - PRIM 1</div> <div>12 Isolate suit ht exch • PRIM GLY ACCUM vlv - ON (CCW) • SUIT CKT HT EXCH - BYPASS Decr stops?</div> <div>13 GLY LEAK IN SUIT HT EXCH 14 Activate sec cool loop for suit ht exch operation with rad bypassed ECS SSR-1 SECONDARY LOOP ACTIVATION</div> <div>15 GLY ACCUM QTY IND FAILURE 16 • Return to original gly pump • ECS RAD PRIM HTR - PRIM 1</div> <div>17 • SUIT CKT HT EXCH - ON • ECS GLY PUMPS - OFF Gly disch press compatible with indicated gly accum qty?</div> <div>18 UNISOLATABLE LEAK IN GLYCOL CIRCUIT ECS SSR-1 SECONDARY LOOP ACTIVATION</div>	<div>1 Normal range 30-70%.</div> <div>2 Half of radiator heat rejection capability lost.</div> <div>3 All indications of glycol quantity are lost.</div> <div>4 With pump off glycol discharge pressure should equal 1/4 accumulator quantity.</div>
22 PRIM GLY ACCUM QTY HIGH > 70%: normal range is 30 - 70%	<div>1 Transfer gly to rsrv • PRIM ACCUM FILL vlv - OFF • GLY RSVR IN vlv - OPEN then CLOSE NOTE: GLY RSVR IN vlv should be rapidly cracked open and then closed. Qty decr to normal?</div> <div>2 Gly accum qty incr again?</div> <div>3 Transient condition caused incr in accum qty</div> <div>4 PRIM ACCUM FILL VLV LEAKING 5 Status OK • Repeat step 1 as req if leak rate is high • PRIM ACCUM FILL vlv - ON</div> <div>6 GLY ACCUM QTY IND FAILURE</div>	
23 SEC ECS RAD OUT TEMP LOW 40°F	<div>1 Sec htr check • Check total SC current • ECS RAD SEC HTR - OFF • Check total SC current Both htr operating?</div> <div>2 Reactivate htr • ECS RAD SEC HTR - SEC Sec gly disch press &lt; 39 psi?</div> <div>3 Does gly evap sec out temp ≈ ECS rad sec out temp?</div> <div>4 ECS RAD TEMP SEC OUT IND FAILURE</div> <div>5 ONE OR BOTH HTR FAILED 6 • ECS RAD SEC HTR - SEC (if one htr is operating) • Orient SC for solar heating and/or incr elec loads</div>	<div>1 Assumes secondary loop is in operation.</div> <div>2 When heaters are switched off, delta current will be approximately 30 amps if both heaters are operating, and 15 amps if one heater is operating.</div> <div>3 Use GLY EVAP SEC OUT TEMP indicator with ECS RAD SEC IN TEMP indicator to estimate secondary radiator outlet temperature.</div>

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SYMPTOM	PROCEDURE	REMARKS
24 SEC ECS RAD OUT TEMP HIGH ~60°F	<pre>graph TD     1_24["1 Sec gly disch press &lt; 39 psi?"] -- YES --&gt; ECS271["ECS 27 1 SEC GLY DISCH PRESS LOW"]     1_24 -- NO --&gt; 2_24["2 Sec gly evap boiling H2O (Strm press 0.1-0.15 psi)?"]     2_24 -- YES --&gt; 5_24["5 Deactivate htr • ECS RAD SEC HTR - OFF Sec rad in temp decr?"]     2_24 -- NO --&gt; 3_24["3 Sec gly evap out temp &gt; 50.5°F?"]     3_24 -- YES --&gt; ECS291["ECS 29 1 SEC GLY EVAP OUT TEMP HIGH"]     3_24 -- NO --&gt; 4_24["4 SEC RAD OUT TEMP INST FAILURE"]     5_24 -- YES --&gt; 6_24["6 SEC HTR FAILED ON"]     5_24 -- NO --&gt; 8_24["8 EXCESSIVE HT LOAD FOR SEC COOL LOOP"]     6_24 --&gt; 7_24["7 Manually control htr • Monitor ECS RAD SEC OUT TEMP ind • Above 48°F, ECS RAD SEC HTR - OFF • Below 40°F, ECS RAD SEC HTR - SEC"]     7_24 --&gt; 9_24["9 • Decr sec ECS heat load • ECS RAD SEC HTR - SEC"]     8_24 --&gt; 9_24</pre>	<p>① Heater operation can be confirmed by ammeter change during switching operation.</p>
25 SEC GLY ACCUM QTY DECREASING Normal range is 30 - 70%	<pre>graph TD     1_25["1 Isolate possible leaks • ECS RAD SEC HTR - OFF • GLY TO RAD SEC vlv - BYPASS • SUIT HT EXCH SEC GLY vlv - BYPASS NOTE: Bypass operation &gt;15 min can lead to rad freezing."] -- YES --&gt; 6_25["6 Reactivate rad • ECS RAD SEC HTR - SEC (if req) • GLY TO RAD SEC vlv - NORMAL Gly accum qty stabilized?"]     1_25 -- NO --&gt; 2_25["2 • SEC COOL LOOP PUMP - off (center) Is gly disch sec press compatible for indicated gly accum qty?"]     2_25 -- YES --&gt; 4_25["4 LEAKING SYSTEM (CANNOT BE ISOLATED)"]     2_25 -- NO --&gt; 3_25["3 GLY ACCUM QTY INST FAILURE"]     3_25 --&gt; 5_25["5 Reactivate • SEC COOL LOOP PUMP - AC 1 (AC 2) (if req) • ECS RAD SEC HTR - SEC (if req) • GLY TO RAD SEC vlv - NORMAL • SUIT HT EXCH SEC GLY vlv - FLOW"]     5_25 --&gt; 8_25["8 Isolate rad • ECS RAD SEC HTR - OFF • GLY TO RAD SEC vlv - BYPASS • Reduce S C elec loads"]     8_25 --&gt; 9_25["9 SUIT HT EXCH LEAKING"]     9_25 --&gt; 10_25["10 NOTE: Keep suit ht exch sec gly vlv isolated except just prior to, and during entry to conserve coolant."]     6_25 -- YES --&gt; 9_25     6_25 -- NO --&gt; 7_25["7 RADIATOR SYSTEM LEAKING"]     7_25 --&gt; 8_25</pre>	<p>① This symptom is also valid when secondary glycol loop is <u>not</u> in operation.</p> <p>② With pump off glycol discharge pressure should equal 1/4 glycol accumulator quantity.</p> <p>③ Humidity control and suit loop cooling not available from secondary loop when suit heat exchanger is bypassed.</p>

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26 SEC GLY ACCUM QTY HIGH  > 70%, normal range is 30 - 70%	<div>1 ● SEC COOL LOOP PUMP - off (center)</div> <div>Is gly disch sec press compatible with indicated gly accum qty?</div> <div>YES 2 High sec accum qty 3 ● Attempt reduction of sec qty by reducing sec gly loop temp</div> <div>NO 4 SEC GLY ACCUM QTY INST FAILURE</div>	1 With glycol pump off glycol discharge pressure should equal 1/4 accumulator quantity.
27 SEC GLY DISCH PRESS LOW  < 39 psi	<div>1 ACCUM SEC QTY ind low (&lt;30%)?</div> <div>YES ECS 25 1 SEC GLY ACCUM QTY DECREASING</div> <div>NO 2 ● SEC COOL LOOP PUMP - redundant bus Gly disch sec press incr?</div> <div>YES 4 Reduced pump output due to elec problem EPS TBD</div> <div>NO 3 1 Verify sensor ● SEC COOL LOOP PUMP - off (center) Gly disch sec press compatible with indicated gly accum qty?</div> <div>NO 5 GLY DISCH SEC PRESS INST FAILURE</div> <div>YES 6 DEGRADED SEC COOL LOOP PUMP 7 ● ECS RAD SEC HTR - OFF ● Reduce elec loads</div>	1 With glycol pump off glycol discharge pressure should equal 1/4 accumulator quantity.
28 SEC GLY EVAP OUT TEMP LOW  < 40°F	<div>1 Sec rad out temp?</div> <div>40-48°F 2 ● SEC COOL LOOP EVAP - RESET for 45 sec then OFF Stm press incr?</div> <div>NO 3 GLY EVAP SEC OUT TEMP INST FAILURE</div> <div>YES 4 Sec gly evap out temp incr?</div> <div>NO 5 DOUBLE FAILURE</div> <div>YES 8 CHANGE SENSORS ● SEC COOL LOOP EVAP - OFF ● Change J57 with J58 ● SEC COOL LOOP EVAP - EVAP Gly evap sec out temp normal?</div> <div>YES 9 J57 SENSOR FAILURE</div> <div>NO 12 GLY EVAP TEMP CONTROLLER FAILURE 15 Some manual control of sec evap may be possible by use of SEC COOL LOOP EVAP switch</div> <div>&lt; 40°F 6 Shutdown sec evap ● SEC COOL LOOP EVAP - RESET for 45 sec then OFF Stm press incr?</div> <div>YES 7 Sec gly evap out temp incr to ≈ rad out temp?</div> <div>YES 11 INST FAILURE 14 Reactivate sec evap ● SEC COOL LOOP EVAP - EVAP</div> <div>NO 10 STM PRESS CONTROL VLV FAILURE 13 Control of sec gly out temp by bypassing sec rad until evap out temp reaches 60°F</div> <div>ECS 23 1 SEC ECS RAD OUT TEMP LOW</div>	1 Infer secondary glycol evap- orator outlet temperature from ECS RAD SEC IN TEMP indicator.

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29 SEC GLY EVAP OUT TEMP HIGH  >50.5°F	<div>1 Sec rad out temp &gt;48°F?</div> <div>2 SEC GLY EVAP OUT TEMP INST FAILURE</div> <div>3 Sec gly evap stm press?</div> <div>4 • SEC COOL LOOP EVAP - off (center) • Change J57 with J58 • SEC COOL LOOP EVAP - EVAP</div> <div>5 • Orient SC to heat stm duct Stm press decr to normal?</div> <div>6 SEC EVAP TEMP CONTROLLER FAILURE OR STM PRESS CONTROL VLV FAILED CLOSED, OR FROZEN STM DUCT</div> <div>7 J57 SENSOR FAILURE</div> <div>8 Sec rad out temp &gt;92°F?</div> <div>9 STM PRESS DUCT TEMPORARILY FROZEN</div> <div>10 Sec evap lost unless stm press decr &lt;0.15 psi</div> <div>11 • SEC COOL LOOP EVAP - RESET Stm press incr?</div> <div>12 JAMMED STM PRESS CONTROL VALVE</div> <div>13 • Decrease elec loads and orient SC until evap temp decr to normal</div> <div>14 • SEC COOL LOOP EVAP - off (center) • Change J57 with J58 • SEC COOL LOOP EVAP - EVAP</div> <div>15 • Orient SC to heat stm duct Stm press decr to normal?</div> <div>16 GLY EVAP TEMP CONTROLLER FAILURE OR FROZEN STM DUCT</div> <div>17 • Reduce elec loads to keep evap out temp &lt;60°F and orient SC for max cooling</div> <div>18 J57 SENSOR FAILURE</div> <div>19 STM PRESS DUCT TEMPORARILY FROZEN</div> <div>20 • SEC COOL LOOP EVAP - RESET • After 15 min, SEC COOL LOOP EVAP - EVAP Stm press still &lt;0.1 psi?</div> <div>21 • SEC COOL LOOP EVAP - off (center) • Change J57 with J58 • SEC COOL LOOP EVAP - EVAP Stm press still &lt;0.1 psi?</div> <div>22 GLY EVAP TEMP CONTROLLER FAILURE</div> <div>23 EVAP WAS FROZEN</div> <div>24 NOTE: If problem recurs, change J57 with J58 and repeat step 20.</div> <div>25 J57 SENSOR FAILURE</div> <div>26 • Decr elec loads - sec evap lost</div> <div>27 • Repetition of this step may be necessary.</div>	<div>1 This may require considerable time.</div>
30 FOOD PREP WATER TEMP LOW	<div>1 • POT H<sub>2</sub>O HTR - redundant bus</div> <div>Water temp incr?</div> <div>2 CIRCUIT FAILURE FROM MN BUS A OR B</div> <div>3 POT H<sub>2</sub>O HTR FAILED OR DEGRADED</div>	
31 ENTRAPPED GAS IN FOOD RECON- STITUTION OR DRINKING H <sub>2</sub> O	<div>TBD</div>	

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SYMPTOM	PROCEDURE	REMARKS
32 POTABLE H <sub>2</sub> O QUANTITY DECREASING RAPIDLY	<pre>graph TD     S32[POTABLE H2O QUANTITY DECREASING RAPIDLY] --&gt; 1[1. H2O QTY IND sw - WASTE]     1 --&gt; 2[Waste H2O qty zero?]     2 -- NO --&gt; 3[2. WASTE TK IN vlv - CLOSE]     2 -- YES --&gt; 7[7. PRESS RELF vlv - OFF H2O QTY IND sw - POT]     3 --&gt; 4[Decr stops?]     4 -- YES --&gt; 5[5. WASTE TK IN VLV FAILURE]     4 -- NO --&gt; 6[3. POT TK IN vlv - CLOSE]     6 --&gt; 7[Decr stops?]     7 -- YES --&gt; 8[4. LINE LEAK BETWEEN POT TK IN VLV AND WASTE TK IN VLV]     7 -- NO --&gt; 9[6. LEAK IN POT H2O SYS OR SENSOR FAILURE]     9 --&gt; 10[10. PRESS RELF vlv - 2]     10 --&gt; 11[11. LINE LEAK IN WASTE H2O SYS]     11 --&gt; 12[12. WASTE TK IN vlv - CLOSE]     12 --&gt; 13[13. NO. 2 PRESS RELF VLV FAILED OPEN]     12 --&gt; 14[NOTE: Prim and sec H2O evap unusable.]     13 --&gt; 15[NO. 1 PRESS RELF VLV FAILED OPEN]     15 --&gt; 16[9. PRESS RELF vlv - 1]     16 --&gt; 17[Decr stops?]     17 -- YES --&gt; 18[8. PRESS RELF vlv - 1]     18 --&gt; 19[Decr stops?]     19 -- YES --&gt; 20[7. PRESS RELF vlv - OFF H2O QTY IND sw - POT]     19 -- NO --&gt; 21[4. LINE LEAK IN WASTE H2O SYS]</pre>	<p>1 Incoming fuel cell water will still pass through this leak.</p> <p>2 This failure is not serious and will result in approximately equal quantities being maintained in potable and waste water tanks.</p> <p>3 Remaining water in potable tank may be saved by turning the H<sub>2</sub>O/GLY TK PRESS REG vlv - <u>OFF</u>.</p> <p>4 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.</p>
33 WASTE H <sub>2</sub> O QUANTITY DECREASING RAPIDLY	<pre>graph TD     S33[WASTE H2O QUANTITY DECREASING RAPIDLY] --&gt; 1[1. PRESS RELF vlv - OFF]     1 --&gt; 2[Decr stops?]     2 -- YES --&gt; 3[2. PRESS RELF vlv - 1]     2 -- NO --&gt; 4[4. LINE LEAKAGE IN WASTE H2O SYS OR SENSOR FAILURE]     3 --&gt; 5[Decr stops?]     5 -- YES --&gt; 6[3. NO. 2 PRESS RELF VLV FAILED OPEN]     5 -- NO --&gt; 7[5. NO. 1 PRESS RELF VLV FAILED OPEN]     7 --&gt; 8[6. PRESS RELF vlv - 2]</pre>	<p>1 Monitor cabin humidity. Check for water in command module.</p>
34 URINE OVBD DUMP NOT DRAINING	<pre>graph TD     S34[URINE OVBD DUMP NOT DRAINING] --&gt; 1[1. Urine backs up?]     1 -- YES --&gt; 2[2. Replace urine filter]     2 --&gt; 3[3. Urine backs up?]     3 -- NO --&gt; 4[4. PLUGGED URINE FILTER]     3 -- YES --&gt; 5[5. Orient SC to heat ovbd urine dump port URINE DUMP - redundant htr]     5 --&gt; 6[6. Urine ovbd drain flow resumes?]     6 -- YES --&gt; 7[7. URINE HEATER FAILURE]     6 -- NO --&gt; 8[8. FROZEN URINE OVBD DRAIN]     8 --&gt; 9[9. Intentional water boiling]     9 --&gt; 10[10. PRIM GLY EVAP IN TEMP vlv - MAX]     10 --&gt; 11[NOTE: This is an attempt to maintain waste tank quantity &lt; 90%.]</pre>	<p>1 Use filter associated with either vacuum cleaner or fecal canister.</p> <p>2 Allow time for urine tip heater operation. Orient SC for maximum external heat on urine dump nozzle in attempt to clear probable ice block. Probability of success very low.</p> <p>3 Battery vents, fecal canister, vacuum cleaner, fecal storage vent, water tanks H<sub>2</sub> and O<sub>2</sub> bleed, and water dump capability lost.</p> <p>4 Loss of water dump capability will result in over pressurization of water system if waste tank is full, and loss of fuel cells if waste and potable tanks are full. Excessive manual control in maximum heat (CCW) might result in partial radiator freezing.</p>

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SYMPTOM	PROCEDURE	REMARKS
<div>35</div> <div>VACUUM CLEANER SUCTION LOW</div> <div>1</div>	<div>1</div> <div>• Change vacuum cleaner debris bag</div> <div>Suction normal ?</div> <div>YES</div> <div>2</div> <div>DEBRIS BAG CLOGGED OR EXPENDED</div> <div>NO</div> <div>35a</div> <div>FECAL CANISTER VACUUM LOW</div> <div>1</div> <div>3</div> <div>• Replace WMS filters</div> <div>Suction normal ?</div> <div>YES</div> <div>4</div> <div>CLOGGED FILTER</div> <div>NO</div> <div>ECS</div> <div>34 1</div> <div>URINE OVBD DUMP NOT DRAINING</div>	<div>1</div> <div>Assumes second WMS hose is disengaged.</div>
<div>36</div> <div>INADEQUATE VENTILATION AFTER LANDING</div>	<div>1</div> <div>Cycle PL vent sw</div> <div>Ventilation incr ?</div> <div>NO</div> <div>2</div> <div>Actuate PLVC</div> <div>• PLVC - OPEN</div> <div>Ventilation incr ?</div> <div>YES</div> <div>3</div> <div>ATTITUDE SENSING SW FAILED CLOSED</div> <div>NO</div> <div>5</div> <div>PLV FAN FAILURE</div> <div>YES</div> <div>4</div> <div>Resets attitude sensor relay to resume PLV operation</div>	<div>1</div> <div>Postlanding vent switch must be cycled to off and back to high (low) anytime SC attitude exceeds 60° to reset the attitude control relay.</div>
<div>37</div> <div>WATER INFLOW AFTER LANDING</div>	<div>1</div> <div>• PLVC - NORMAL</div> <div>Water inflow stops ?</div> <div>YES</div> <div>4</div> <div>Inflow caused by open PLV vlv</div> <div>NO</div> <div>2</div> <div>• PL VENT - OFF • CAB PRESS RELF vlv (2) - CLOSE</div> <div>Water inflow stops ?</div> <div>YES</div> <div>5</div> <div>ATTITUDE SENSING SWITCH FAILED OPEN</div> <div>NO</div> <div>3</div> <div>UNCONTROLLABLE WATER INFLOW INTO SC</div>	

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SPECIAL SUB ROUTINE	PROCEDURE	REMARKS
SSR-1 SECONDARY LOOP ACTIVATION	<div>1 Simultaneous prim and sec loop operation?</div> <div>YES <div>Caution For simultaneous cool loop operation only rad of one cool loop should be used. For loop bypassing rad: • PRIM/SEC GLY TO RAD vlv - <u>BYPASS</u> • PRIM/SEC ECS RAD HTR - <u>OFF</u></div></div> <div>NO 3 Deactivate prim loop • EVAP H<sub>2</sub>O CONT PRIM vlv - <u>OFF</u> • ECS RAD PRIM HTR - off (center) • GLY EVAP STM PRESS AUTO - <u>MAN</u> • GLY EVAP STM PRESS INCR - <u>INCR</u> for 45 sec • ECS GLY PUMPS - <u>OFF</u></div> <div>2 Activate sec loop • ECS IND sel - <u>SEC</u> • GLY TO RAD SEC vlv - <u>NORMAL</u> (rad opn) • SEC COOL LOOP PUMP - <u>AC1</u> (or AC2) • GLY DISCH SEC PRESS ind - &gt;39 psi • ECS RAD SEC HTR - <u>SEC</u> (rad opn) • EVAP H<sub>2</sub>O CONT SEC vlv - <u>AUTO</u> • SEC COOL LOOP EVAP - <u>EVAP</u> • GLY EVAP SEC OUT TEMP ind - 40-50.5°F • SUIT HT EXCH SEC GLY vlv - <u>FLOW</u> (if req)</div> <div>4 If a return to prim operation is desired proceed as follows:</div> <div>5 Deactivate sec loop • ECS RAD SEC HTR - <u>OFF</u> • SEC COOL LOOP EVAP - <u>RESET</u> for 45 sec then to off (center) • SEC COOL LOOP PUMP - off (center) • EVAP H<sub>2</sub>O CONT SEC vlv - <u>OFF</u></div> <div>6 Activate prim loop • ECS IND sel - <u>PRIM</u> • GLY TO RAD PRIM vlv - <u>NORMAL</u> • ECS GLY PUMPS - <u>AC1</u> • GLY DISCH PRIM PRESS ind - &gt;40 psi • ECS RAD PRIM HTR - <u>PRIM 1</u> • GLY EVAP IN TEMP - <u>AUTO</u> • ECS H<sub>2</sub>O CONT PRIM vlv - <u>AUTO</u> • GLY EVAP PRIM OUT TEMP ind - 40-50.5°F • SUIT CKT HT EXCH - <u>ON</u> • CAB TEMP - <u>AUTO</u></div>	<div>1 G&amp;N, DSE, and signal conditioners are not cold-plated on secondary loop. Usage limits for this equipment is as follows:  G&amp;N 1.9 hours ON 11.1 hours OFF (PSA is the critical G&amp;N unit)  DSE 20 minutes ON 30 minutes OFF  SC 20 minutes ON 40 minutes OFF</div>

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