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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

# APOLLO OPERATIONS HANDBOOK, EXTRAVEHICULAR MOBILITY UNIT

## VOLUME II, OPERATIONAL PROCEDURES, CSD-A-789-(2), MISSIONS 12 through 15

CREW SYSTEMS DIVISION

Original Issue May 1969

Revision 1

October 1969

MANNED SPACECRAFT CENTER  
HOUSTON, TEXAS



INDEXING DATA

DATE	OPR	#	T	PGM	SUBJECT	SIGNATOR	LOC
10-00-69	MSC		R	EXT	(with)	MSC	072-11

Manned Spacecraft Center  
Crew Systems Division

PROJECT DOCUMENT COVER SHEET

APOLLO OPERATIONS HANDBOOK EXTRAVEHICULAR MOBILITY UNIT  VOLUME II — OPERATIONAL PROCEDURES	
CSD CSD-A-789-(2) I	DATE May 1969

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NO. OF PAGES 109

		REVISIONS			
DATE	PREPARED BY	APPROVALS			REV. LETTER
		BRANCH	DIVISION	PROGRAM OFFICE	

CSD  
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PREFACE

This document is the first revised issue of Volume II of the AOH. This revision incorporates Crew Procedures Change Requests 1 through 53. Change requests released subsequent to the publication of this revision will be numbered sequentially with the next change number (i.e., 54 and on).

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FOREWORD

This handbook, sections 4 and 5, of the Apollo Operations Handbook (AOH) series, is bound separately as Volume II and pertains only to the Extravehicular Mobility Unit (EMU). Volume I of the AOH contains sections 1, 2, and 3, and pertains to the description of the EMU.

The operational procedures are written specifically for Missions 12 through 15 EMU hardware and will be superseded by a mission oriented checklist which is reviewed by CSD for unique hardware procedures. Both the operational procedures and the malfunction procedures will be updated for the mission.

This handbook is composed of two major sections:

- a. Section 4 provides a step-by-step operational procedure for activation and deactivation of EMU subsystems.
- b. Section 5 provides emergency procedures for critical EMU symptoms and continuing diagnosis during EVA and post-EVA to determine the EMU malfunction.

Inquiries concerning this handbook should be addressed to Crew Systems Division, Apollo Support Branch, MSC, mail code EC9 or to Flight Crew Support Division, EVA Branch, Office Code CF25.

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ABBREVIATIONS

acfm	actual cubic feet per minute
AOH	Apollo Operations Handbook
CDR	Commander
cfm	cubic feet per minute
CM	command module
CMP	command module pilot
CSM	command/service module
CWG	constant wear garment
"DES" H <sub>2</sub> O	descent water
ECG	electrocardiogram
ECS	environmental control system
EMU	extravehicular mobility unit
EV	extravehicular
LEVA	lunar extravehicular visor assembly
FCS	fecal containment system
ITMG	integrated thermal micrometeoroid garment
IV	intravehicular
IVA	intravehicular activity
kHz	kilohertz (thousand cycles per second)
LCG	liquid cooling garment
LiOH	lithium hydroxide
LM	lunar module
MSFN	Manned Space Flight Network
OPS	oxygen purge system
PGA	pressure garment assembly

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PHA	pressure helmet assembly
PLSS	portable life support system
pos.	position
POS	primary oxygen system of PLSS
press.	pressure
psia	pounds per square inch absolute
psid	pounds per square inch differential
psig	pounds per square inch gage
RCU	remote control unit
SC	spacecraft
SSC	space suit communication
SW.	switch
TLSA	torso limb suit assembly
TM	telemetry
UCTA	urine collection and transfer assembly
UTS	urine transfer system
vlv	valve
WMS	waste management system
ZPN	impedance pneumograph
$\Delta T$	change in temperature
$\Delta P$	change in pressure



SECTION 4

OPERATIONAL PROCEDURES

This section describes the procedures for activation and deactivation of EMU equipment.

The order of appearance of groups of steps required to activate or deactivate components is not necessarily the order of performance of activation and deactivation of components.

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STEP	PROCEDURE	REMARKS
4.1 PGA DONNING AND DOFFING  4.1.1 PGA IV CONFIGURATION DONNING PROCEDURES  1 Donning FCS  a. Don FCS as conventional underwear and place genitals through front opening.  b. Position FCS around waist and thighs to insure a seal. Insure a snug fit with no sag in the crotch portion of the FCS.  2 Donning CWG  a. Open front buttons.  b. Don CWG as conventional long underwear.  c. Adjust feet into socks.	Techniques in donning and doffing may vary within an individual step but the sequence of steps outline in each donning and doffing task shall be followed. "Normal" will be with assist from another crewman.  CMP only.	

4.1 PGA DONNING AND DOFFING

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STEP	PROCEDURE	REMARKS
	<p>d. Insert bioinstrumentation leads through slots on chest area of CWG.</p> <p>e. Button front opening.</p>	<p>Step 4.1.1-3 must be performed before Steps 4.1.1-2d and e. When transferring bioinstrumentation between CWG or LCG, or when reinstalling after removal, the signal conditioners should not be removed from the pockets in the biobelt. Only the nine-pin airlock connector, the sternal electrode harness (Blue Code), and the axillary harness (Yellow Code) should be disconnected. The color code of the harness to signal conditioner should be observed when reinstalling the biobelt. The electrodes are <u>not</u> removed from skin to change garments.</p>

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STEP	PROCEDURE	REMARKS
3	<p>Donning bioinstrumentation system (prelaunch)</p> <ol style="list-style-type: none"> <li>a. Shave electrode sites where necessary. Shower after shaving.</li> <li>b. During PGA suiting procedure prior to launch, clean electrode sites with alcohol and let dry. Attach electrodes under medical direction.</li> <li>c. Assemble signal conditioners, biomedical harness with biomedical belt, and test as a system.</li> <li>d. Don top half of CWG, insert harness connectors (blue and yellow) through holes in CWG. Snap biomedical belt to CWG.</li> <li>e. Connect electrode harness to proper color-coded signal conditioner. Dot on electrode harness is facing out.</li> <li>f. Perform functional check.</li> <li>g. Adjust ECG gain for normal signal to 40 percent of full scale.</li> <li>h. Adjust ZPN gain to allow maximum inhalation to be at or near full scale.</li> </ol>	<p>CWG is donned to waist.</p> <p>Use caution in mating biomedical connector to signal conditioners. Connectors are keyed for proper fit.</p> <p>See remarks page 4-3, Step 4.1.1-2d.</p>

## 4.1 PGA DONNING AND DOFFING

STEP	PROCEDURE	REMARKS
i.	Don lower half of PGA (Step 4.1-5) and connect nine-pin biomedical connector.	See remarks page 4-3, Step 4.1.1-2d.
j.	Perform functional check prior to donning PGA helmet and gloves.	
4	Donning UCTA	
a.	Obtain proper size cuff and roll down to cuff flange after removing flange from UCTA.	
b.	Place penis in flange and roll cuff on.	If the UCTA has been worn, it will be stowed in the PGA with a UCTA clamp on the cuff. Remove and stow the UCTA clamp.
c.	Attach cuff half of the UCTA flange to the UCTA by depressing the flange release lever and twisting the two halves together.	
d.	Aline the colored waistband patches to the corresponding colors on the UCTA.	Place waistband of harness across "small of the back."
e.	Attach the crotch strap to the UCTA.	Strap length can be adjusted at mating point. Verify all straps attached.
f.	Connect hand pump to drain hose and evacuate all gas from the UCTA through the drain hose.	This step is required for donning at 14.7 psia ambient pressure only — not required for 5 psia donning.
g.	Don leg part of the PGA.	

## 4.1 PGA DONNING AND DOFFING

STEP	PROCEDURE	REMARKS
	<p>h. Connect the UCTA drain hose to the UCTA transfer hose assembly on the suit.</p> <p>i. Finish donning PGA.</p> <p>5 Donning PGA</p> <p>a. Remove protective cover from PGA electrical connector and two protective plugs from gas connectors and stow.</p> <p>b. Loosen torso tiedown strap.</p> <p>c. Fully open both the restraint and pressure-sealing zippers.</p> <p>d. Grasp PGA at sides. Do NOT pick up PGA at pressure-sealing zipper location. Place both feet into PGA and work feet into the boots.</p> <p>e. Pull excess liner material up around leg. Grab PGA at knee convolutes and pull boots onto feet.</p> <p style="text-align: center;"><u>CAUTION</u></p> <p style="text-align: center;">Do not sit on zippers.</p> <p>f. Pull PGA to knee position.</p>	<p>Do not coil or loop the drain hose. Do not put hose near the PGA biomedical injection patch.</p> <p>Remove donning lanyards from UCTA/biomedical injection access flap.</p> <p>If unassisted, insert the red suit-donning lanyard through the pull tab of restraint zipper slider and the blue suit-donning lanyard through the pull tab of pressure-sealing zipper slider.</p> <p>Point toes toward boots to avoid pickup of excess liner material.</p>

## 4.1 PGA DONNING AND DOFFING

STEP	PROCEDURE	REMARKS
<p>g. With front of PGA hanging forward, go to squatting position placing PGA front in lap.</p> <p>h. Reach inside of right leg and connect UCTA quick-disconnect to PGA-UCTA hose assembly.</p> <p>i. Aline index marks and connect biomedical harness electrical branch to suit electrical harness.</p> <p>j. Verify communications carrier connection from electrical harness is pushed through neckring.</p> <p>k. Insert one arm completely into PGA arm while simultaneously inserting head into neckring with assistance from free arm. Insert free arm into other PGA arm.</p> <p>l. Stand erect to permit PGA to settle over torso and limbs.</p> <p>m. Close restraint and pressure-sealing zipper closures.</p>		<p>Alternate methods such as full insertion of arms into suit sleeves, then insertion of head through neckring, or insertion of one arm, then the combined insertion of second arm and head are acceptable, provided the load on the PGA, and/or the zippers is not increased.</p> <p>If unassisted, grasp back of neckring and top of CWG with one hand. With other hand, grasp red donning lanyard, pull out and down to position restraint zipper slider toward middle of the back. Pull red donning lanyard over buttocks while running fingers ahead of slider to prevent snagging of CWG.</p>

STEP	PROCEDURE	REMARKS
	<p>n. Engage snap fastener of slider tab to receptacle on PGA.</p> <p>Position lock assembly over slider and push lock button to LOCK.</p> <p>Close cover flap over zipper and engage snap fasteners.</p> <p>o. Don communication carrier by spreading the ear cups and then make fine adjustments to the mike boom by bending it from the center.</p> <p>Adjust the chinstrap for proper fit.</p> <p>p. Connect electrical lead to upper branch of electrical harness.</p>	<p>Grasp cloth tab of restraint slider and fully close.</p> <p>Remove suit-donning lanyard, tuck slider tab up into PGA, and stow lanyard in pocket.</p> <p>Grasp back of neckring with one hand and with other hand grasp blue donning lanyard; pull lanyard out and down to fully close pressure-sealing zipper.</p> <p>Remove and stow blue suit donning lanyard.</p> <p>Do not bend mike boom more than 80° from center. Bend mike boom from the middle section only. Do not straighten or bend the mike boom unless necessary.</p>

## 4.1 PGA DONNING AND DOFFING



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STEP	PROCEDURE	REMARKS
	<p>q. Connect gas umbilical to PGA.</p> <p>r. Provide ventilation flow.</p> <p>6 Donning pressure helmet</p> <p>a. Place helmet-attaching ring lock subassembly in ENGAGE.</p> <p>b. Place pressure helmet on helmet-attaching ring, insure proper alinement by alining dual white lines and press down on helmet.</p> <p>c. Position lock subassembly to LOCK.</p> <p style="text-align: center;"><u>CAUTION</u></p> <p>PGA neckring alinement marks must be alined with the helmet "locked" alinement marks to insure proper helmet ventilation.</p> <p>7 Donning PGA gloves</p> <p>a. Gloves or helmet may be difficult to don. If so, stop gas flow momentarily.</p> <p>b. Place suit wrist disconnects in ENGAGE.</p> <p>c. Insure that glove palm restraint is loosened, then place hand into glove.</p>	<p>Steps 4.1.1-6 and -7 can be reversed provided the second step is accomplished with decreased gas flow.</p>

4.1 PGA DONNING AND DOFFING

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STEP	PROCEDURE	REMARKS
	<p>d. Aline glove wrist disconnect with suit wrist disconnect and engage both units.</p> <p>e. Insure that glove can be easily rotated and place the wrist disconnect to LOCK.</p> <p>f. Adjust glove palm restraint.</p> <p>g. Don other glove in the same way.</p>	
8	<p><u>Donning Neckdam</u></p> <p>1 Place helmet-attaching ring lock assembly in ENGAGE position.</p> <p>2 Slip neckdam over head so that eyelet tab is forward.</p> <p>3 Aline neckdam ring eyelet tab with index marks on helmet-attaching ring and snap tab in place.</p> <p>4 Continue pushing other tabs down into place until all tabs of neckdam are latched.</p> <p>5 Place the lock assembly into LOCK.</p>	<p>The neckdam is donned before water egress to prevent water from entering the open neck area of the TLSA.</p>

4.1 PGA DONNING AND DOFFING

STEP	PROCEDURE	REMARKS
4.1.2	<p>PGA IV CONFIGURATION DOFFING PROCEDURE</p> <ol style="list-style-type: none"> <li>1 Doffing PGA gloves               <ol style="list-style-type: none"> <li>a. Decrease suit pressure to less than 0.75 psig.</li> <li>b. Loosen palm restraint.</li> <li>c. Place wrist disconnect in open position and remove glove.</li> <li>d. Doff other glove.</li> </ol> </li> <li>2 Doffing pressure helmet               <ol style="list-style-type: none"> <li>a. Place helmet attaching ring latching mechanism to the open position.</li> <li>b. Lift the helmet up and out of helmet attaching ring.</li> </ol> </li> <li>3 Doffing PGA               <ol style="list-style-type: none"> <li>a. Empty UCTA. (See AOH-IM and - CSM procedures.)</li> <li>b. Open slide zipper cover flap.</li> </ol> </li> </ol>	<p>Unlock pressure sealing zipper lock and release slider tab snap fastener.</p>

STEP	PROCEDURE	REMARKS
c.	<p>Fully open pressure and sealing zippers.</p> <p style="text-align: center;"><u>CAUTION</u></p> <p style="text-align: center;">Do not sit on zippers.</p>	<p>If unassisted, remove blue donning lanyard from lanyard pocket and insert into pressure sealing zipper tab. Grasp blue suit-donning lanyard and pull until the pressure-sealing zipper tab is full OPEN and remove suit-donning lanyard.</p> <p>Remove red suit-donning lanyard from lanyard pocket; release restraint zipper tab from stowed position; and insert lanyard in zipper tab.</p> <p>Grasp red suit-donning lanyard; pull until restraint zipper is full OPEN; and remove lanyard. Restow red and blue lanyards.</p>
d.	<p>Disconnect gas inlet and outlet hoses.</p>	
e.	<p>Disconnect communications carrier electrical lead and undo chinstrap to remove communication carrier. Remove communications carrier carefully. Do NOT bend mike boom.</p>	
f.	<p>Grasp PGA at rear-entry area and separate slide fasteners; then slip PGA from around back and buttocks.</p>	
g.	<p>Grasp helmet-attaching ring, slip head out, and pull both arms away from PGA.</p>	
h.	<p>Disconnect biomedical connector.</p>	
i.	<p>Disconnect UCTA drain hose quick-disconnect. (See Step 4.1.2-4.)</p>	

## 4.1 PGA DONNING AND DOFFING

STEP	PROCEDURE	REMARKS
	<p>j. Remove legs from TLSA.</p> <p>k. Replace protective covers and caps on PGA electrical connector and two gas connectors.</p>	

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STEP	PROCEDURE	REMARKS
4	<p>Doffing UCTA</p> <ul style="list-style-type: none"><li>a. Drain UCTA before doffing. (See AOH-LM and -CSM procedures.)</li><li>b. Partially doff PGA to disconnect the UCTA drain hose disconnect.</li><li>c. Disconnect UCTA drain hose from suit-mounted UCTA transfer hose assembly.</li><li>d. Complete doffing of PGA.</li><li>e. Remove UCTA elastic harness by detaching waistband Velcro patches while holding UCTA in place.</li><li>f. Remove cuff half of UCTA flange by using release button and twisting motion.</li><li>g. Roll cuff from penis.</li><li>h. Fold cuff and use UCTA clamp to close.</li><li>i. Stow UCTA in PGA.</li></ul>	
5	<p>Doffing biomedical harness and belt</p> <ul style="list-style-type: none"><li>a. Disconnect electrical leads of biomedical electrode harness from signal conditioners in biomedical belt.</li><li>b. Disengage snaps securing biomedical belt.</li></ul>	<p>See page 4-3, Step 4.1.1-2d.</p> <p>See Step 4.8.2-3 for permanent removal procedures, if necessary.</p>

## 4.1 PGA DONNING AND DOFFING

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STEP	PROCEDURE	REMARKS
6	Doffing CWG (if applicable)  a. Unbutton front opening.  b. Pass bioinstrumentation electrode harness leads through slot on chest area of CWG.  c. Remove CWG in the same manner as conventional long underwear.	The CWG without the FCS is normally worn throughout the flight. See remarks page 4-3, Step 4.1.1-2d.
7	Doffing FCS  Doff FCS in the same manner as conventional underwear shorts.	
8	Doffing neckdam  a. Unlock helmet-attaching ring and separate neckdam.  b. Pull neckdam over head.	The neckdam is used only for water egress.

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STEP	PROCEDURE	REMARKS
4.1.3	<p>PGA EV CONFIGURATION DONNING PROCEDURE</p> <p>1 Donning FCS (see Step 4.1.1-1)</p> <p>2 Donning LCG</p> <p style="text-align: center;"><u>CAUTION</u></p> <p style="text-align: center;">Take care to avoid damaging LCG H<sub>2</sub>O lines.</p> <p>a. Unstow LCG from bag.</p> <p>b. Open front entry fastener of LCG.</p> <p>c. Don the LCG like conventional long underwear and adjust feet into socks.</p> <p>d. Insert bioinstrumentation leads through holes on front of LCG.</p> <p>e. Close front entry of LCG.</p> <p>3 Donning bioinstrumentation systems (see Step 4.1.1-5)</p> <p>4 Donning UCTA (see Step 4.1.1-4)</p> <p>5 Donning PGA</p> <p>a. Remove one PGA electrical connector cover and four PGA gas connector caps.</p>	<p>The LCG replaces the CWG for EVA. The LCG may be worn during periods of IVA.</p> <p>See remarks page 4-3, Step 4.1.1-2d.</p> <p>Verify that LCG manifold is outside of biobelt.</p>

## 4.1 PGA DONNING AND DOFFING



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STEP	PROCEDURE	REMARKS
b. Loosen torso tiedown strap.  c. Fully open the restraint, pressure sealing, and ITMG zippers.          d. Grasp PGA at sides.  <p style="text-align: center;"><u>CAUTION</u></p> <p style="text-align: center;">Do NOT pick up PGA at pressure-sealing zipper location.</p> <p>Place both feet into PGA and work feet into the boots. Pull excess liner material up around legs.</p> <p>Grab PGA at knee convolutes and pull boots onto feet.</p> <p style="text-align: center;"><u>CAUTION</u></p> <p style="text-align: center;">Do not sit on zippers.</p> <p>Pull PGA tight to knee position. Stand up. Grasp side of coverlayer and pull to waist position with zipper below buttocks.</p>	<p>If alternate method of donning is to be used, unstow donning lanyards and attach after opening zippers. Insert red suit-donning lanyard through pull tab of restraint zipper slider and blue suit-donning lanyard through pull tab of pressure-sealing zipper slider.</p> <p>Point toes toward boots to avoid pickup of excess liner material.</p>	

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STEP	PROCEDURE	REMARKS
	<p>e. With front of PGA hanging forward, go to squatting position putting PGA front in lap.</p> <p>f. Connect the UCTA quick-disconnect to PGA-UCTA hose assembly.</p> <p>g. Aline index marks and connect biomedical harness electrical branch to suit electrical harness.</p> <p>h. Remove water connector plug and connect LCG water connector to PGA multiple water connector receptacle.</p> <p>i. Verify communications carrier connection from electrical harness is pushed through neckring.</p> <p>j. Insert one arm completely into PGA arm while simultaneously inserting head into neckring with assistance from free arm. Insert free arm into other PGA arm.</p>	<p>If LCG is not used, do not remove water connector plug.</p> <p>Alternate methods such as full insertion of arms into suit sleeves, then insertion of head through neckring; or insertion of one arm, then the combined insertion of second arm and head is acceptable provided the load on the PGA, and/or the zippers is not increased.</p>

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STEP	PROCEDURE	REMARKS
k.	<p>Stand erect and settle PGA over torso and limbs.</p> <p>1. Close restraint and pressure-sealing zipper closures.</p> <p>m. Engage snap fastener of slider tab to receptacle on PGA.</p> <p>Position lock assembly over slider and push lock button to LOCK.</p> <p>Close cover flap over zipper and engage fasteners.</p>	<p>If unassisted, grasp back of neckring and top of CWG with one hand. With other hand, grasp red donning lanyard, pull out and down to position restraint zipper slider toward middle of the back. Pull red donning lanyard over buttocks while running fingers ahead of slider to prevent snagging of CWG. Repeat with blue lanyard and sealing zipper.</p>

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STEP	PROCEDURE	REMARKS
	<p>n. Don communication carrier by spreading the ear cups and then make fine adjustments to the mike boom by bending the boom from the center.</p> <p>Adjust the chinstrap for proper fit.</p> <p>o. Connect communications carrier electrical lead to upper branch of electrical harness.</p> <p>p. Connect gas umbilical to PGA.</p> <p>q. Provide ventilation flow.</p>	<p>Do not bend mike boom more than 80° from center. Bend mike boom from the middle section only. Do not straighten or bend unless necessary.</p>
6	<p>Donning lunar boots.</p> <p>a. Insert PGA boots into lunar boots and position with attached donning straps.</p> <p>b. Engage snap fasteners on tongue of boot.</p> <p>c. Latch adjustment strap and buckle.</p>	
7	<p>Donning PLSS/OPS (Step 4.3.1)</p>	

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4.1 PGA DONNING AND DOFFING

STEP	PROCEDURE	REMARKS
8	<p>Donning pressure helmet</p> <p>a. Apply antifog solution.</p> <p>b. Helmet may be difficult to don. Is so, stop gas flow momentarily.</p> <p style="text-align: center;"><u>CAUTION</u></p> <p>Prior to donning helmet, PGA diverter valves must be EV (vertical) position if O<sub>2</sub> flow is to be provided by PLSS/OPS.</p> <p>c. Place helmet-attaching ring lock subassembly in ENGAGE.</p> <p>d. Place pressure helmet on helmet-attaching ring; insure proper alinement by alining dual white lines and press down on helmet.</p> <p>e. Position lock subassembly to LOCK.</p> <p style="text-align: center;"><u>CAUTION</u></p> <p>PGA neckring alinement marks must be alined with the helmet "locked" alinement marks to insure proper helmet ventilation.</p>	See Step 4.8.1-2a.
9	Donning EV gloves	
	a. Don comfort gloves and wristlets.	
	b. Roll glove gauntlet back to provide access to wrist disconnect.	

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STEP	PROCEDURE	REMARKS
	<ul style="list-style-type: none"> <li>c. Place suit wrist disconnect in ENGAGE</li> <li>d. Gloves may be difficult to don. If so, stop gas flow momentarily.</li> <li>e. Insure glove palm restraint is loosened; place hand into glove.</li> <li>f. Aline glove wrist disconnect with suit wrist disconnect and engage both units.</li> <li>g. Insure glove rotates easily and place suit wrist disconnect to LOCK.</li> <li>h. Roll glove gauntlet back over PGA arm.</li> <li>i. Adjust palm restraint as desired. Close cover flap and engage fasteners.</li> <li>j. Similarly don other glove.</li> </ul>	
10	Donning LEVA <ul style="list-style-type: none"> <li>a. Verify that both visors are open or open the visors.</li> <li>b. Disengage latching mechanism through access on LEVA collar.</li> <li>c. Place LEVA over pressure helmet and lower onto helmet-attaching ring.</li> <li>d. Aline separation of plastic collar with helmet "Engaged" alinement marks.</li> </ul>	Aline LEVA by using the projecting PGA feedport as a guide.

## 4.1 PGA DONNING AND DOFFING

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STEP	PROCEDURE	REMARKS
e.	Insure LEVA is properly located on attaching ring and lock.	
f.	Lower collar and fasten to PGA.	
	<p style="text-align: center;"><u>CAUTION</u></p> <p style="text-align: center;">Collar must conceal helmet-attaching ring area for lunar surface activity only.</p>	
11	Donning helmet protective shield	
a.	Expand shield, slip hole over helmet feedport, rotate opposite side over helmet, and allow to contract in place.	

4.1 PGA DONNING AND DOFFING

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STEP	PROCEDURE	REMARKS
4.1.4	<p>PGA EV CONFIGURATION DOFFING PROCEDURES</p> <ol style="list-style-type: none"><li>1 Doffing EV glove<ol style="list-style-type: none"><li>a. Decrease PGA pressure flow to &lt;0.75 psig.</li><li>b. Roll glove gauntlet back and put wrist disconnect to OPEN position.</li><li>c. Doff glove.</li><li>d. Similarly doff other glove.</li></ol></li><li>2 Doffing LEVA<ol style="list-style-type: none"><li>a. Verify both visors in full OPEN position.</li><li>b. Disengage fastener tapes of LEVA collar.</li><li>c. Disengage locking mechanism.</li><li>d. Ease LEVA up and off pressure helmet.</li></ol></li><li>3 Doffing pressure helmet<ol style="list-style-type: none"><li>a. Place helmet-attaching ring in OPEN.</li><li>b. Ease pressure helmet up and out of helmet-attaching ring.</li></ol></li></ol>	<p>The EMU is assumed to be in the same configuration as at end of extravehicular configuration donning procedures.</p>

## 4.1 PGA DONNING AND DOFFING



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STEP	PROCEDURE	REMARKS
4	Doffing ITMG connector cover Unsnap cover and remove.	
5	Doffing PLSS (Step 4.3.2)	
6	Doffing lunar boots a. Unbuckle adjusting strap and unsnap fasteners. b. Slip boots off	
7	Doffing PGA a. Empty UCTA. (See AOH-IM and -CSM procedures.) b. Open slide fastener cover flap. c. Unlock pressure-sealing zipper lock and release slider tab snap fastener. d. Fully OPEN pressure and sealing zippers.	<p>If unassisted, remove donning lanyards from stowage and attach to zipper slider tabs. Grasp blue suit-donning lanyard and pull until the pressure-sealing slider tab is full OPEN and remove suit-donning lanyard.</p> <p>Remove red suit-donning lanyard from lanyard pocket; release restraint slider tab from its stowed position and insert lanyard into slider tab.</p> <p>Grasp the red suit-donning lanyard; pull until the restraint slider is full OPEN and remove the suit-donning lanyard.</p>

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STEP	PROCEDURE	REMARKS
	e. Disconnect gas inlet and outlet umbilicals and replace protective covers and caps.	
	f. Grasp PGA at rear-entry area and separate zippers then slip PGA from around back and buttocks.	
	g. Disconnect communications carrier electrical lead. Power off from electrical umbilical.	
	h. Grasp helmet attaching ring, slip head out, and pull both arms away from PGA.	
	i. Disconnect LCG multiple water connector. If LCG is to be doffed, reinstall PGA protective plug.	
	j. Disconnect biomedical electrical connector.	
	k. Disconnect urine connector.	
	l. Remove legs from PGA.	
8	Doffing UCTA (Step 4.1.2-4)	
9	Doffing biomedical harness and belt (Step 4.1.2-5)	See remarks page 4-3, Step 4.1.1-2d.
10	Doffing LCG	
	a. Open front entry.	
	b. Pull bioinstrumentation leads out of LCG front.	
	c. Slip out of LCG.	
11	Doffing FCS (Step 4.1.2-7)	

4.1 PGA DONNING AND DOFFING

STEP	PROCEDURE	REMARKS
12	Doffing helmet protective shield  a. Expand shield, rotate about helmet feedport, and disengage from feedport.	

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STEP	PROCEDURE	REMARKS
4.2 OPS OPERATIONS		
4.2.1 OPS CHECKOUT		
1	Open access flaps and verify OPS bottle pressure gage reads 5880 ± 500 psia.	
2	Verify OPS O <sub>2</sub> connector locked in stowage plate.	
3	OPS actuation lever — ON.	
4	Verify OPS regulator checkout gage reads 3.70 ± 0.30 psid.	
5	DEPRESS heater test button.	Note the heater test light status.
6	OPS O <sub>2</sub> actuation lever is OFF.	The OPS regulator checkout gage will continue to read 3.7 ± 0.3 psid for approximately 3 minutes after OPS actuation lever is OFF.
7	Secure all access flaps.	
8	Verify OPS regulator checkout gage less than 2.5 psi.	
4.2.2 OPS DONNING PRIOR TO CONTINGENCY TRANSFER		
1	Pull out tear-tack stitches on the PLSS adjustable harness by yanking on endtab until strap is free.	
2	Open thermal cover over strap buckle adjustment; remove retaining spring clip.	

STEP	PROCEDURE	REMARKS
3	Join the fixed waist harness to the adjustable waist harness of the PLSS using the D-buckle under the thermal cover of the adjustable harness (PLSS attachment end) and the hook under the thermal cover on the fixed length strap (PLSS attachment end). The hook on the free end of the straps should be faced inward.	
4	Loop harnesses around the back of PGA and thread through LM tether restraints.	
5	Remove OPS O <sub>2</sub> connector from stowage plate.	
6	Hook harnesses to OPS.	
7	Install OPS oxygen connector (blue) into the top (blue) PGA oxygen connector.	
8	Install purge valve into bottom (red) PGA O <sub>2</sub> connector and verify locked.	
9	Open OPS actuator access flap.	
10	Adjust harnesses to secure OPS. Allow for the expansion of the PGA when pressurized.	
4.2.3	<p>OPS ACTIVATION</p> <p>Move OPS actuation lever from OFF to ON position and allow it to lock.</p>	
4.2.4	<p>OPS DEACTIVATION</p> <p>Move OPS actuation lever from ON to OFF position and allow it to lock.</p>	

## 4.2 OPS OPERATIONS

STEP	PROCEDURE	REMARKS
4.3	PLSS/OPS DONNING AND DOFFING	
4.3.1	PLSS/OPS DONNING	PGA helmet and gloves off. PGA diverter valves (2) — Horizontal
1	Open access flap, unstow antenna connector, OPS half, secure access flaps.	
2	Lift OPS locking pin.	
3	Slide OPS onto PLSS from left to right while facing PLSS conformal side.	Conformal side of PLSS is the side that conforms to the crewman's back when PLSS is donned.
4	Push locking pin down.	
5	Remove EVCS antenna connector (J5) dust cap.	
6	Connect antenna connector, OPS half to antenna connector, PLSS half. Screw on CW.	
7	Verify sublimator exhaust is clear.	Visual inspection.
8	Unstow PLSS shoulder and waist harnesses.	
9	Unstow PLSS PGA electrical umbilical, inlet and outlet O <sub>2</sub> , and multiple water connectors.	
10	Remove battery cable from stowage plate. Rotate battery cable handle CCW (90° to alignment marks).	
11	Remove battery connector (J6) dust cap and stow on battery cable stowage plate.	

4.3 PLSS/OPS DONNING AND DOFFING

STEP	PROCEDURE	REMARKS
12	Connect battery cable to battery.  a. Aline marks on battery cable body and handle.  b. Aline marks on battery cable handle and battery.  c. Connect battery cable to battery connector and rotate handle CW (90°).	
13	Remove dust cap RCU connector (J3), PLSS half. Twist CCW.	
14	Verify OPS actuation lever is OFF and OPS regulator checkout gage reads less than 2.5 psi.	
15	Unstow OPS connector. Pull stowage plate tabs and rotate CCW.	Do not unstow OPS oxygen hose at this time.
16	Secure PLSS/OPS access flaps.	
17	Don PLSS/OPS by securing shoulder and waist harnesses to the PGA upper and lower PLSS brackets.	
18	Connect PLSS inlet and outlet O <sub>2</sub> (red to red, blue to blue) and multiple water connectors to PGA left side and lock. Connect PLSS PGA electrical umbilical and lock.	
19	Before connecting RCU, verify: PLSS pump switch — OFF, PLSS fan switch — OFF, and PLSS mode selector switch — Position 0 (OFF).	

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STEP	PROCEDURE	REMARKS
20	Connect RCU electrical connector to the PLSS.  a. Aline marks on RCU connector body and handle.  b. Aline marks on RCU connector and PLSS, insert, and rotate CW 90°.	
21	Attach RCU to PLSS straps and PGA as follows:  a. Pull Velcro strap away from front of RCU.  b. Using strap as a grip, pull directly forward of RCU and then down. Release strap to lock in open position.  c. Insert lower clip to PGA upper PLSS bracket.  d. Raise RCU and insert the left shoulder clip into left RCU clip, then clip the right side.  e. To lock clips, pull strap handle forward and up to a horizontal position and release. Verify hooks are locked in closed position.  f. Restow Velcro strap handle on front of RCU.	
22	Unstow OPS hose.	
23	Depress OPS actuation lever bracket tab and unstow actuation lever cable.	

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4.3 PLSS/OPS DONNING AND DOFFING



STEP	PROCEDURE	REMARKS
24	Attach OPS actuation lever to the RCU.  a. Insert lower pins on the OPS actuation lever into the RCU actuation lever bracket slots.  b. Push upper portion of the OPS actuation lever toward the bracket until the upper pins engage the bracket and snap locked.	
25	Install OPS connector to the PGA (blue to blue) and lock.	
26	Install purge valve in PGA O <sub>2</sub> connector (red to red).	
27	Secure all PLSS/OPS access flaps and verify gas connector lock locks (4).	
28	Unstow antenna.	
4.3.2	PLSS/OPS DOFFING IN PRESSURIZED ENVIRONMENT	1. Helmet and gloves - Off 2. PLSS feedwater valve - CLOSED (up) 3. PLSS O <sub>2</sub> shutoff valve - OFF (up) 4. IM is at 5 psia. 5. OPS actuation lever is OFF.
1	Remove OPS actuation lever from RCU.	
2	Disconnect RCU from PGA upper PLSS bracket and PLSS shoulder harnesses.	
a.	Pull Velcro strap away from front of RCU.	
b.	Using strap as a grip, pull directly forward of RCU and then down. Release strap to lock in open position.	

STEP	PROCEDURE	REMARKS
c.	Lift RCU from left shoulder strap, then right.	
d.	Lower RCU from PGA upper PLSS bracket.	
	<p style="text-align: center;"><u>CAUTION</u></p> <p>Before disconnecting RCU, all electrical PLSS controls must be OFF.</p> <p>PLSS pump switch — OFF</p> <p>PLSS fan switch — OFF</p> <p>PLSS mode selector switch — Position 0 (OFF)</p>	
3	Disconnect RCU electrical umbilical from PLSS by rotating RCU connector handle CCW (90°).	
4	Disconnect inlet and outlet O <sub>2</sub> and multiple water connectors, electrical umbilical connector, and OPS O <sub>2</sub> connector. The electrical umbilical connector is pulled away from the PGA and rotated CCW to remove.	
5	Remove the purge valve and stow.	
6	Remove PLSS shoulder and waist harnesses from the PGA.	
7	Temporarily stow PLSS.	
8	Stow OPS antenna.	

## 4.3 PLSS/OPS DONNING AND DOFFING

STEP	PROCEDURE	REMARKS
9	Stow OPS actuation lever.  a. Insert lower pins on the OPS actuation lever into the OPS actuation lever bracket slots.  b. Push upper portion of the OPS actuation lever down until the upper pins engage the bracket and snap locked.	
10	Verify OPS actuation lever is OFF and locked.	
11	Stow OPS O <sub>2</sub> hose and connector; secure OPS access covers.  a. Route the hose around the back of the OPS over the actuation lever cable.  b. Verify the OPS connector stowage plate is in the open position (CCW).  c. Insert the OPS connector and lock the OPS stowage plate connector (twist CW).  d. Secure access flaps over OPS hose.	
12	Stow PLSS inlet and outlet O <sub>2</sub> and multiple water hoses and connectors and PLSS PGA electrical umbilical and connector.	

STEP	PROCEDURE	REMARKS
	<p>a. Confirm O<sub>2</sub> water and electrical connector stowage plates are in the open position (CCW).</p> <p>b. Perform stowage routing according to the decal on the PLSS O<sub>2</sub> bottle shield.</p> <p>c. Lock all stowage connectors (twist CW).</p>	
13	Disconnect OPS antenna connector from EVCS by unscrewing CCW.	
14	Replace antenna connector dust cap by pushing straight on.	
15	Lift OPS locking pin to release.	
16	Slide OPS off PLSS from right to left while facing PLSS conformal side.	Conformal side of the PLSS is the side that conforms to the crewman's back when PLSS is donned.
17	Stow antenna connector inside OPS by screwing antenna connector CW on the stowage plate.	
18	Secure OPS access covers.	
19	Replace RCU connector (J3) dust cap by alining marks, inserting, and twisting CW	
20	Restow PLSS shoulder and waist harnesses.	

STEP	PROCEDURE	REMARKS
4.3.3	PLSS/OPS DOFFING IN UNPRESSURIZED ENVIRONMENT	
1	Verify OPS actuation lever OFF.	
2	Disconnect purge valve and stow.	
3	Disconnect OPS O <sub>2</sub> connector.	
4	Connect ECS O <sub>2</sub> umbilicals to PGA (red to red, blue to blue), lock and actuate ECS.	
5	PLSS fan switch — OFF.	
6	PLSS O <sub>2</sub> shutoff valve — OFF (up).	
7	Verify PGA pressure gage reads 3.6 to 4.3 psi.	
	a. PGA diverter valves (2) — horizontal.	
8	PLSS mode selector switch — Position 0 (OFF).	
9	Disconnect PLSS PGA electrical umbilical. The electrical umbilical connector is pulled away from the PGA and rotated CCW to remove. Connect IM communication umbilical.	
10	PLSS feedwater valve — CLOSED (up).	
11	PLSS pump switch — OFF.	
12	Remove OPS actuation lever from the RCU. Depress release lever to free actuation lever upper pins and remove.	O <sub>2</sub> shutoff handle safety must be depressed as handle is pulled forward.

STEP	PROCEDURE	REMARKS
13	<p>Disconnect RCU from PGA upper PLSS bracket and PLSS shoulder harnesses.</p> <p>a. Pull Velcro strap away from front of RCU.</p> <p>b. Using strap as a grip, pull directly forward of RCU and then down. Release strap to lock in open position.</p> <p>c. Lift RCU from left shoulder strap, then right.</p> <p>d. Lower RCU from PGA upper PLSS bracket.</p> <p style="text-align: center;"><u>CAUTION</u></p> <p>Before electrically disconnecting RCU, all PLSS electrical controls must be in OFF position.</p> <p>PLSS pump switch — OFF</p> <p>PLSS fan switch — OFF</p> <p>PLSS mode selector switch — Position 0 (OFF)</p>	
14	<p>Disconnect RCU electrical connector from the PLSS. Rotate RCU electrical connector handle CCW to disconnect.</p>	
15	<p>Disconnect PLSS inlet and outlet O<sub>2</sub> and multiple water connectors. Disconnect red O<sub>2</sub> connector first.</p>	

STEP	PROCEDURE	REMARKS
16	<p>Remove waist harnesses from the PGA.</p> <ul style="list-style-type: none"> <li>a. Grasp outside loop of right-hand strap between adjustment buckle and PGA hook and tear tack-stitches adjacent to buckle.</li> <li>b. Unsnap harness keeper between adjustment buckle and PLSS hook.</li> <li>c. Grasp exposed end of strap between PLSS hook and adjustment buckle and tear tack-stitches.</li> <li>d. Unsnap adjustment-buckle thermal insulation to expose buckle.</li> <li>e. Grasp buckle roller release tab and rotate outward to release grip on harness. Lengthen the harness by use of the adjustment buckle.</li> <li>f. Unhook right-hand harness from PGA.</li> <li>g. Unhook left-hand harness from PGA.</li> </ul>	<p>Crewman will require assistance.</p>
17	<p>Remove shoulder harnesses from the PGA.</p>	
18	<p>Temporarily stow the PLSS.</p>	
19	<p>Stow antenna.</p>	
20	<p>Disconnect OPS antenna connector from EVCS. Unscrew CCW.</p>	

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STEP	PROCEDURE	REMARKS
21	Stow OPS actuation lever.  a. Insert lower pins on the OPS actuation lever into the OPS actuation lever bracket slots.  b. Push upper portion of the OPS actuation lever down until the upper pins engage the bracket and snap locked.	
22	Verify OPS actuation lever is OFF and locked.	
23	Stow OPS hose and connector and secure OPS access flaps.	The hose is routed around the back of the OPS over the actuation lever cable and is held in place by the thermal cover. The OPS hose connector stowage plate must be in the open position (full CCW) when the connector is inserted and twisted CW to close.

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4.3 PLSS/OPS DONNING AND DOFFING



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STEP	PROCEDURE	REMARKS
4.4	<p>PLSS COMMUNICATION CHECK</p> <ol style="list-style-type: none"> <li>1 PLSS mode selector switch to Position B.</li> <li>2 Verify 1.5 kHz warble tone on for 10 seconds. Low vent flow warning flag shows P, low PGA pressure warning flag shows 0.</li> <li>3 Read PLSS O<sub>2</sub> gage (percent of full scale).</li> <li>4 Verify voice communications. Adjust volume.</li> <li>5 PLSS mode selector switch to Position A.</li> <li>6 Verify 1.5 kHz warble tone on for 10 seconds. Low vent flow warning flag continues to show P. Low PGA pressure warning flag continues to show 0.</li> <li>7 Read PLSS O<sub>2</sub> gage (percent of full scale).</li> <li>8 Verify voice communications and TM, adjust volume.</li> <li>9 PLSS mode selector switch to position AR.</li> <li>10 Verify 1.5 kHz warble tone on for 10 seconds. Low vent flow warning flag shows P. Low PGA pressure warning flag shows 0.</li> </ol>	<p>OPS, RCU, PLSS, and PGA systems are properly connected. PLSS/EVCS modes interface with LM and CM communications subsystems. Spacecraft switch positions for various communications modes (PLSS, SC, MSFN) are found in the AOH for CSM and LM. PLSS switches and valves off.</p> <p>Increase volume by rotating blade CCW.</p> <p>Increase volume by rotating wheel CCW.</p>

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4.4 PLSS COMMUNICATION CHECK

STEP	PROCEDURE	REMARKS
11	Read PLSS O <sub>2</sub> gage (percent of full scale).	
12	Verify voice communication and TM, adjust volume as required.	

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4.4 PLSS COMMUNICATION CHECK

STEP	PROCEDURE	REMARKS
4.5	PRESSURE INTEGRITY CHECK	
4.5.1	PLSS/OPS/PGA PRESSURE INTEGRITY CHECK	EMU donned. Ambient pressure 5.0 psia. PLSS fan in ON. ECS O <sub>2</sub> — OFF. PLSS feedwater valve — CLOSED.
1	PLSS O <sub>2</sub> shutoff valve — ON (down)	
2	Verify PLSS 1.5 kHz warble tone on for 10 seconds. High O <sub>2</sub> flow warning flag shows 0. Low PGA pressure warning flag shows 0 and clears when PGA pressure reaches 3.1 to 3.4 psid.	
3	Verify high O <sub>2</sub> flow warning flag clears as PGA gage reaches 3.85 ± 0.15 psig.	
4	PLSS O <sub>2</sub> shutoff valve — OFF (up).	
5	Read PGA pressure gage and monitor pressure decay for 1 minute. Exercise suit joints during decay period.	
6	EMU circuit decay is not to exceed 0.3 psid.	
7	PLSS O <sub>2</sub> shutoff valve — ON (down).	
8	Verify PGA pressure is 3.85 ± 0.15 psi and all warning flags are clear.	

4.5 PRESSURE INTEGRITY CHECK

STEP	PROCEDURE	REMARKS
4.6	PLSS NORMAL OPERATING MODES	
4.6.1	PLSS ACTIVATION	PLSS/OPS donned, helmet and gloves off.
1	PLSS mode selector switch to position AR.	1.5 kHz warble tone on for 10 seconds. Low vent flow warning flag shows P. Low PGA pressure warning flag shows 0. Verify communication and TM.
2	PLSS fan switch — ON.	Verify low vent flow warning flag clear. If fan is activated for more than 30 minutes without PGA cooling, visor fogging may occur.
3	Don helmet and gloves.	
4	PLSS O <sub>2</sub> shutoff valve — ON (down). a. Verify low PGA pressure warning flag clear. b. Verify 1.5 kHz tone for 10 seconds and high O <sub>2</sub> flow warning flag shows 0 and then clear when PGA reaches 3.85 ± 0.15 psig.	
5	PLSS pump switch — ON.	Low feedwater pressure warning tone on and warning flag shows A at 1.3 to 1.6 psia cabin.
6	Verify diverter valve in the MINIMUM position.	
7	PLSS feedwater valve — OPEN (down).	Ambient pressure must be below 1000μ before opening valve.
8	Position PLSS H <sub>2</sub> O diverter valve for comfort after low feedwater pressure warning flag clears.	

4.6 PLSS NORMAL OPERATING MODES

STEP	PROCEDURE	REMARKS
4.6.2 WET SUBLIMATOR RESTART  1 PLSS feedwater valve is CLOSED (up). 2 PLSS H <sub>2</sub> O diverter valve is at MAXIMUM (down). 3 Maintain workload to deplete feedwater rapidly. 4 1.5 kHz warble tone for 10 seconds. Low feedwater pressure warning flag shows A. 5 After 5 minutes, PLSS H <sub>2</sub> O diverter valve is at MINIMUM (up). 6 PLSS feedwater valve — OPEN (down). Select desired diverter position after low feedwater pressure warning flag clears.	PLSS operating. Ambient pressure at vacuum.	
4.6.3 PLSS DEACTIVATION  1 PLSS water feedwater valve — CLOSED (up).  2 PLSS O <sub>2</sub> shutoff valve — OFF (up). 3 Pump switch — OFF. PGA pressure is equalized with ambient. Helmet and gloves are doffed. 4 Fan switch — OFF. 5 PLSS mode selector switch — Position 0 (OFF).	EMU donned, PLSS operating. Ambient pressure at vacuum.  This is performed prior to repressurization to prevent loss of feedwater when pressure is reestablished. The remaining steps are conducted after the cabin is pressurized.	

## 4.6 PLSS NORMAL OPERATING MODES

STEP	PROCEDURE	REMARKS
4.7	<p>PLSS RECHARGE AND FEEDWATER REMOVAL PROCEDURES</p> <p>4.7.1 BATTERY REPLACEMENT</p> <ol style="list-style-type: none"> <li>1 If RCU is connected electrically to the PLSS, all electrical controls must be in OFF position before connecting or disconnecting battery cable. <ul style="list-style-type: none"> <li>PLSS pump switch — OFF</li> <li>PLSS fan switch — OFF</li> <li>PLSS mode selector switch — Position 0 (OFF)</li> </ul> </li> <li>2 Rotate PLSS main battery cable 90° CCW and remove from battery. Remove protective cover from main battery cable stowage connector and stow on battery. Depress and rotate battery locking device CCW 90° to unlock battery.</li> <li>3 Remove old battery from PLSS and stow.</li> <li>4 Obtain replacement battery, remove dust cap, and align battery on battery foot and slide into place in PLSS.</li> <li>5 Depress and rotate battery locking device CW 90° to lock battery in PLSS.</li> <li>6 Connect PLSS main battery cable to battery.</li> </ol>	<p>The PLSS recharge procedures consist of battery replacement, LiOH cartridge change, oxygen system recharge, and feedwater reservoir recharge. Oxygen- and feedwater-recharge procedures are given in the LM-AOH.</p>

4.7 PLSS RECHARGE AND FEEDWATER REMOVAL PROCEDURES

STEP	PROCEDURE	REMARKS
7	Verify battery lift strap snapped in a loop.	
8	Insert PLSS hose stowage strap through lift strap loop and stow.	
4.7.2	LiOH CARTRIDGE CHANGE	
1	Verify PLSS O <sub>2</sub> shutoff valve — OFF.	
2	Remove thermal insulation from the canister cover.	
3	Depress cover lock.	
4	Rotate canister cover CCW until alinement mark on cover is alined with the open mark on canister.	
5	Remove cover by pulling from canister.	
6	Grasp drop handle and rotate contaminant control cartridge CCW until alinement marks on cartridge and canister assembly are alined.	
7	Pull spent contaminant cartridge out of canister.	
8	Obtain replacement cartridge, grasp drop handle, and aline marks, and insert replacement cartridge into canister until it bottoms.	
9	Rotate cartridge CW approximately 90° until marks are alined to lock into position.	

STEP	PROCEDURE	REMARKS
10	Ascertain that alinement marks on both parts of the cover are alined. Grasp cover by handle and depress cover lock.	
11	Aline the alinement marks on canister cover with the "open" mark on cover.	
12	Insert cover in canister.	
13	Rotate cover CW until alinement mark on cover is alined with "closed" mark on canister.	
14	Resnap insulation flap over canister cover.	
4.7.3 PLSS FEEDWATER REMOVAL AND WEIGHING PROCEDURES		
1	Unstow PLSS feedwater collection bag.	
2	Unfold the bag.	
3	Remove the spring scale from the bag side pocket.	
4	Flatten the bag by hand to remove any trapped oxygen.	
5	Remove the H <sub>2</sub> O fill connector from the feedwater collection bag connector.	
6	Zero the spring scale with the adjustment knob.	
7	Weigh RCU and record weight in pounds.	

4.7 PLSS RECHARGE AND FEEDWATER REMOVAL PROCEDURES



STEP	PROCEDURE	REMARKS
8	Lay the spring scale aside.	
9	Open the PLSS recharge access door to expose the PLSS H <sub>2</sub> O fill connector.	
10	Remove the protective cap from the PLSS H <sub>2</sub> O fill connector.	
11	Mate the feedwater collection bag to the PLSS H <sub>2</sub> O fill connector.	
12	Turn the PLSS O <sub>2</sub> shutoff valve to the ON (down) position.	
13	Allow the O <sub>2</sub> loop to pressurize for 30 seconds.	
14	Turn the PLSS H <sub>2</sub> O shutoff and relief valve to the OPEN (down) position.	
15	Allow 1-1/2 minutes minimum for the feedwater bladder to drain.	
16	Turn the PLSS H <sub>2</sub> O shutoff and relief valve to the CLOSED (up) position.	
17	Turn the PLSS O <sub>2</sub> shutoff valve to the OFF (up) position.	
18	Disconnect the feedwater collection bag from the PLSS H <sub>2</sub> O fill connector.	

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STEP	PROCEDURE	REMARKS
19	Attach the protective cap to the PLSS H <sub>2</sub> O fill connector.	
20	Close the PLSS recharge access door.	
21	Weigh the feedwater collection bag and contents. Record weight in pounds.	
22	Stow the bag, H <sub>2</sub> O fill connector, and scale for jettison.	

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4.7 PLSS RECHARGE AND FEEDWATER REMOVAL PROCEDURES

STEP	PROCEDURE	REMARKS
4.8	<p>EMU INFLIGHT MAINTENANCE</p> <p>4.8.1 PGA AND LEVA INFLIGHT EXAMINATION AND MAINTENANCE</p> <p>This section contains procedures for examining, cleaning, lubricating, and repairing of PGA and LEVA components during flight.</p> <p>1 PGA and LEVA inflight examination</p> <p>At a prescribed interval during the mission, each item shall be examined for the conditions outlined in the inflight examination and maintenance schedule. Tasks may be performed earlier than the scheduled intervals at the discretion of the crewman. A detailed examination is not feasible and shall not be attempted. If damage to a component is suspected, a more detailed examination and analysis of the malfunction should be performed.</p> <p>The term "general condition" implies that the item will be inspected for the following:</p> <ol style="list-style-type: none"> <li>a. Loose or broken stitches</li> <li>b. Rips, snags, and abraded areas</li> <li>c. Sharp edges and scratches</li> <li>d. Damaged seals or O-rings</li> <li>e. Proper position and security of components</li> </ol>	

4.8 EMU INFLIGHT MAINTENANCE

STEP	PROCEDURE	REMARKS
	<p>f. Lack of lubrication</p> <p>g. Cleanliness</p> <p>Inflight repairs on items found to be discrepant in general condition are possible in certain instances, dependent upon the provisions of the EMU maintenance kit.</p> <p>2 PGA inflight maintenance</p> <p>a. Cleaning and antifog treatment of pressure helmet and helmet shield viewing areas</p> <p style="text-align: center;"><u>CAUTION</u></p> <p>Do not clean LEVA because coatings may become damaged.</p> <ol style="list-style-type: none"> <li>1. Cut antifog containers to open and extract pad.</li> <li>2. Apply film of solution on all viewing areas, using a continuous straight line motion.</li> <li>3. Allow to remain a few minutes</li> <li>4. Wipe clean and dry with towel.</li> <li>5. Apply second coat on inner surface of pressure helmet, using clean side of pad.</li> <li>6. Allow to remain a few minutes, wipe dry, and buff with dry towel.</li> </ol>	<p>Do not allow film to dry before removing or buffing.</p>

## 4.8 EMU INFLIGHT MAINTENANCE

STEP	PROCEDURE	REMARKS
	<p>b. Lubrication of pressure-sealing zippers</p> <p style="text-align: center;"><u>CAUTION</u></p> <p>Avoid excessive use of lubricant and wipe away excess. Insure lubricant does not extend beyond specified lubricating area.</p> <ol style="list-style-type: none"><li>1. Position zipper in full open position.</li><li>2. Remove lubricant pad from maintenance kit and spread lubricant thinly and evenly over the exposed outer side and underside of both closures.</li></ol> <p>c. Maintenance of seals and O-rings</p> <ol style="list-style-type: none"><li>1. Removal of seal or O-ring</li></ol> <p>Fit the contoured end of the seal removal tool between the seal O-ring and seat.</p> <p>Rotate the tool circumferentially around until the seal O-ring is free of the recess and remove tool and O-ring.</p>	<p>All accessible seals and O-rings may be lubricated in flight.</p>

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STEP	PROCEDURE	REMARKS
	<p>2. Inspection of removed seal or O-ring</p> <p>Inspect removed seal and O-ring for cuts, abrasions, or breaks in surface as well as irregularities in shape.</p> <p>If seal and O-ring are not faulty, lubricate and install. Replace if O-ring is faulty.</p> <p>3. Lubrication of seal and O-ring</p> <p>Obtain lubrication pad from maintenance kit.</p> <p>Wipe seal and O-ring with pad, being careful not to get lubricant on any other part of PGA.</p> <p>4. Installation of seal and O-ring</p>	

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STEP	PROCEDURE	REMARKS
	<p>Cut the pouch in the maintenance kit to remove replacement seal and O-ring.</p> <p style="text-align: center;"><u>CAUTION</u> Use care to avoid cutting the seal and O-ring.</p> <p>Remove replacement and lubricate.</p> <p>Install seal and O-ring into opening.</p> <p>d. Bladder Repair</p> <p>Small punctures in the bladder portion of the PGA may be repaired in flight provided the structural integrity of the PGA is not greatly impaired.</p> <p>Determine location of leakage and obtain a repair patch from maintenance kit.</p> <p>Cut repair patch to desired size. The repair patch shall not extend more than one-fourth inch beyond the damaged area.</p> <p>Remove backing from patch and place adhesive side of patch over damaged area. The patch shall be applied to inside of PGA.</p> <p>Apply pressure to insure positive bond.</p>	<p>The seal removal tool can be used to facilitate installation of seals.</p> <p>Punctures of sufficient magnitude to degrade the restraint quality of the glove bladder may be repaired by a patch. However, the glove will not be used but retained for emergency use.</p>

STEP	PROCEDURE	REMARKS
4.8.2	<p>BIOINSTRUMENTATION INFLIGHT REPAIR</p> <p>1 Replacement of loose electrode</p> <p>a. Remove all trace of old electrode paste from electrode site.</p> <p>b. Replace existing electrode using paste P/N SEB42100014 and electrode attachment assembly P/N SEB42150035.</p> <p>c. Cover electrode with micropore covering P/N SB-AE-005408.</p> <p>2 Replacement of electrode harness</p> <p>a. Obtain spare electrode harness and attached each electrode as described in Step 4.8.2-1.</p> <p>b. Attach electrode harness to signal conditioners. The connectors should be finger-tight.</p> <p style="text-align: center;"><u>CAUTION</u> Do not overtighten connectors.</p> <p>3 Permanent removal of bioinstrumentation system</p> <p>Remove bioinstrumentation system and cover exposed end of the PGA electrical umbilical and/or T-adapter cable with tape P/N SEB12100050-201 (on board).</p>	<p>Located in medical accessories kit</p> <p>Located in medical accessories kit</p>



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STEP	PROCEDURE	REMARKS
4.9	PURGE VALVE OPERATION	
4.9.1	ACTIVATION PROCEDURES FOR PURGE VALVE  1 Remove pull pin by grasping the red apple and pulling with about 20 pound of force.  2 Squeeze the two locktabs on the purge valve barrel simultaneously. The valve will now pop open.	
4.9.2	SHUTOFF PROCEDURES  1 Squeeze the two locktabs simultaneously and push in the purge valve barrel.  2 Release the locktabs while still pushing on the barrel until the locktabs are engaged.  3 Confirm purge valve closing, either by flow changes or by visually confirming the barrel is no longer extended.	
4.9.3	PURGE VALVE REMOVAL PROCEDURES  1 Release gas connector lock-lock.  2 Lift gas connector locktabs and rotate to release position.  3 Remove purge valve from gas connector.	

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4.9 PURGE VALVE OPERATION

STEP	PROCEDURE	REMARKS
4.10	MISCELLANEOUS PROCEDURES	
4.10.1	PLSS GAS TRAP ACTIVATION	
1	EV activation (by other crewman)	
a.	Shift PLSS to extreme left.	
b.	Open gas trap guard.	
c.	Depress gas trap button for 5 seconds then release.	Cooling should be improved in 3 minutes.
d.	Close guard.	
e.	Realign PLSS.	
2	Pressurized cabin activation — PLSS doffed	
a.	Connect PLSS multiple water connector to suit connector.	
b.	Switch pump to ON.	
c.	Cycle diverter valve slowly (three times).	
d.	Switch pump to OFF.	
e.	Disconnect multiple water connector from suit.	
f.	Connect LM water supply hose to PLSS fill connector and open supply valve.	
g.	Open gas trap guard.	

4.10 MISCELLANEOUS PROCEDURES

STEP	PROCEDURE	REMARKS
	<ul style="list-style-type: none"> <li>h. Depress gas trap button until water is observed at the vent on top of the gas trap then release.</li> <li>i. Close guard.</li> <li>j. Close LM water supply valve and disconnect supply hose.</li> <li>k. Close PLSS fill cover.</li> </ul>	
	<p>4.10.2 CAMERA MOUNTING/RCU</p> <p>1 Outside LM beginning of EVA</p> <ul style="list-style-type: none"> <li>a. Crewman receives camera with mounting bracket attached.</li> <li>b. Crewman will place the camera bracket (female) and center the base directly center of the RCU and mate the two brackets (camera and RCU halves).</li> <li>c. Push camera and bracket down until lock is in place.</li> </ul> <p>2 Release of camera and bracket (assumes crewman unassisted)</p> <ul style="list-style-type: none"> <li>a. Place right hand under camera and bracket and apply a small force upward.</li> <li>b. Place left thumb or forefinger on tab release lever on front of RCU.</li> <li>c. Push release lever to the right while applying upward force from base of camera and lift camera from RCU mounting.</li> </ul>	

4.10 MISCELLANEOUS PROCEDURES

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SECTION 5

EMU

MALFUNCTION PROCEDURES

5.1 INTRODUCTION

- 5.1.1 The malfunction procedures encompass the recognition, diagnosis and corrective action for system malfunctions. In most cases, the crew is alerted to a malfunction condition by indicators and gages. The malfunction analyses do not contain solutions; such solutions are found in Mission Rules. The procedures in this section cover significant single failures, and are not intended to replace the detailed Failure Modes-Effects Analyses published in other documents.
- 5.1.2 The malfunction procedures are for use during Apollo missions where an EMU having an SV 706100-6 PLSS (without a CO<sub>2</sub> sensor) will be worn. The procedures have been classified as (1) emergency, (2) EVA, and (3) post-EVA.
- 5.1.3 For maximum safety, all emergency procedures should be memorized so action can be taken immediately when the malfunction occurs. The EVA procedures do not need to be memorized since they are provided through voice communications, except for steps which cover EVA procedures for loss of voice communications.
- 5.1.4 The post-EVA procedures are designed to extract a maximum amount of information on any observed anomaly, since the PLSS/OPS and associated hardware would not normally be returned to earth for postflight analysis.
- 5.1.5 The procedures and remarks are representative of a nominal EMU. Values and quantities which are characteristic of an individual EMU, and which can be established only by testing the actual EMU to be used in the flight, are underlined in each case.

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5.2      **FORMAT OF PROCEDURES**

The malfunction procedures are presented in a three-column, logic flow diagram format. A description and use of each of these columns is as follows:

- |                  |  |
|------------------|--|
| <b>SYMPTOM</b>   | The primary purpose of the symptom column is to give "First Indication" of the malfunction as received by either the crew or telemetry. The possible causes of the malfunction are indicated in this column.   |
| <b>PROCEDURE</b> | The procedures column presents a step-by-step logic flow diagram of actions and decisions used to isolate or correct a malfunction symptom. The remote-event number symbols are used to reference items to the "Remarks" column or to refer to other procedural steps.   |
| <b>REMARKS</b>   | This column will include the following information:<br><br><ul style="list-style-type: none"><li>a. Amplifying additional remarks related to the symptom, such as relief valve vents at _____ psid.</li><li>b. Amplifying remarks which relate to a decision and/or action items.</li><li>c. Explaining resultant system status or operational capability after a failure has been identified.</li><li>d. Cautions or warnings, as necessary, to cover conditions that may exist because of a failure.</li></ul> |

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**5.3 MALFUNCTION SYMPTOMS FOR EMU USING PLSS SV 706100-6**

Symptom	Page
EMU 1 - Warning tone and low vent flow flag "P" . . . . .	5-4
EMU 2 - Warning tone and low PGA pressure flag "O". . . . .	5-6
EMU 3 - Warning tone and high O <sub>2</sub> flow flag "O". . . . .	5-10
EMU 4 - Warning tone and low feedwater pressure flag "A". . . . .	5-12
EMU 5 - Warning tone with no warning flags . . . . .	5-14
EMU 6 - PGA pressure gage <3.7 psid and apparently stable (no warning tone) . . . . .	5-16
EMU 7 - PLSS O <sub>2</sub> quantity indicator abnormal reading . . . . .	5-17
EMU 8 - PGA pressure gage >4.0 psid . . . . .	5-19
EMU 9 - Loss of pump noise . . . . .	5-20
EMU 10 - Inadequate cooling of crewman (diverter valve - MAX. cooling) . . . . .	5-21
EMU 11 - EVA-1 loses voice from MSFN (EVA-1 has voice from EVA-2) . . . . .	5-23
EMU 12 - EVA-1 loses voice from MSFN (EVA-1 does not have voice from EVA-2) . . . . .	5-24
EMU 13 - EVA-1 loses voice from EVA-2 (EVA-1 has voice from MSFN) . . . . .	5-26
EMU 14 - EVA-2 loses voice from MSFN (EVA-2 receives voice from EVA-1) . . . . .	5-28
EMU 15 - EVA-2 loses voice from MSFN (EVA-2 does not have voice from EVA-1) . . . . .	5-29
EMU 16 - EVA-2 loses voice from EVA-1 (EVA-2 has comm. with MSFN) . . . . .	5-31
EMU 17 - Loss of voice comm. with EVA-1, EVA-2, or MSFN (two-man EVA) (comm. restoration procedure) . . .	5-33
EMU 18 - EVA loses voice from LM . . . . .	5-34

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Symptom	Page
EMU 19 - LM loses voice from EVA . . . . .	5-36
EMU 20 - GT8168P/GT8268P PGA pressure <3.7 psid and apparently stable (no warning tone) . . . . .	5-38
EMU 21 - GT8168P/GT8268P PGA pressure >4.0 psid . . . . .	5-40
EMU 22 - GT8182P/GT8282P PLSS O <sub>2</sub> pressure abnormal . . . . .	5-41
EMU 23 - GT8182P/GT8282P PLSS O <sub>2</sub> pressure <800 psia (pre-EVA) . . . . .	5-43
EMU 24 - GT8182P/GT8282P PLSS O <sub>2</sub> pressure <350 psia (post-EVA) . . . . .	5-44
EMU 25 - GT8110P/GT8210P feedwater pressure <1.8 psid (no warning tone) . . . . .	5-45
EMU 26 - GT8154T/GT8254T LCG H <sub>2</sub> O temperature >68° F with diverter valve in MAX. cooling . . . . .	5-47
EMU 27 - GT8196T/GT8296T LCG H <sub>2</sub> O ΔT >11° F (MAX. diverter valve position) . . . . .	5-48
EMU 28 - GT8140C/GT8240C PLSS battery current >3.0 amps . . . . .	5-50
EMU 29 - GT8140C/GT8240C PLSS battery current <2.3 amps (no warning tone) . . . . .	5-52
EMU 30 - GT8141V/GT8241V PLSS battery voltage ≤16.0 Vdc (no warning tone) . . . . .	5-54
EMU 31 - GT8170T/GT8270T O <sub>2</sub> temperature <38° F (no warning tone) . . . . .	5-56
EMU 32 - GT8170T/GT8270T O <sub>2</sub> temperature >52° F (no warning tone) . . . . .	5-57

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SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 11</b></p> <p>Warning tone ON and low vent flow flag "P"</p> <p>Actuating parameter: Vent flow &lt;4.0 to 5.3 acfm for &gt;5 sec</p> <p>Possible causes: a. Fan OFF or degraded b. Battery degraded c. High PGA ΔP d. Low vent flow sensor failed on or shifted set point e. Flow restriction in PLSS vent loop</p>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <div style="text-align: center;"> <p>1</p> <p>● Cycle Fan OFF/ON Low vent flow flag CLEAR after 10 sec</p> <p>YES</p> <p>NO</p> </div> <div style="text-align: center;"> <p>2</p> <p>FAN SWITCHED OFF INADVERTENTLY</p> </div> <div style="text-align: center;"> <p>3</p> <p>● Actuate OPS ● Open purge valve</p> </div> <hr/> <p style="text-align: center;"><b>EVA PROCEDURE</b></p> <div style="text-align: center;"> <p>4</p> <p>GT8140C/ GT8240C PLSS battery current &lt;1.1 amps</p> <p>YES</p> <p>NO</p> </div> <div style="text-align: center;"> <p>5</p> <p>FAN CIRCUIT FAILED</p> </div> <hr/> <p style="text-align: center;"><b>POST EVA PROCEDURE</b></p> <div style="text-align: center;"> <p>6</p> <p>GT8140C/ GT8240C PLSS Batt. Curr. &gt;3.0 amps</p> <p>YES</p> <p>NO</p> </div> <div style="text-align: center;"> <p>7</p> <p>● Fan OFF/ON GT8140C/ GT8240C PLSS Batt. Curr. &lt;1.1 amps while fan OFF</p> <p>NO</p> <p>YES</p> </div> <div style="text-align: center;"> <p>8</p> <p>FAN DEGRADED</p> </div> <div style="text-align: center;"> <p>9</p> <p>GT8141V/ GT8241V PLSS Batt. Volt &lt;16.0 Vdc</p> <p>YES</p> <p>NO</p> </div> <div style="text-align: center;"> <p>10</p> <p>FAILING BATTERY CAUSED FAN DEGRADATION</p> </div> <p style="text-align: center;">To Step 11 Next page</p>	<p style="text-align: center;">1</p> <p>The OPS regulates at <math>3.7 \pm 0.3</math> psid. A full OPS will provide a minimum of 30 min operation at 8 lb/hr flow at 50° to 80° F inlet temperature with purge valve open.</p>



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SYMPTOM	PROCEDURE	REMARKS
	<p style="text-align: center;">POST EVA PROCEDURE (continued)</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>11</p> <p>● Low Vent Flow Sensor Check</p> <hr/> <ul style="list-style-type: none"> <li>● Repress LM</li> <li>● PLSS O<sub>2</sub> - OFF</li> <li>● OPS O<sub>2</sub> - OFF</li> <li>● Doff Helmet and gloves</li> <li>● Disconnect OPS and purge valve</li> <li>● Connect blue LM ECS and red PGA Gas Connectors</li> <li>● Connect red LM ECS and blue PGA Gas Connectors</li> <li>● Activate ECS &lt;30 sec</li> </ul> <hr/> <p>Low vent flow flag "p"</p> </div> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>NO</p> <p>↓</p> </div> <div style="text-align: center;"> <p>YES</p> <p>→</p> </div> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px; width: fit-content;"> <p>12</p> <p>LOW VENT FLOW SENSOR SHIFTED SET POINT OR FAILED CLOSED</p> </div> <div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>13</p> <p>HIGH PGA ΔP, OR FAN PERFORMANCE DEGRADED, OR SHIFT IN LOW VENT FLOW SENSOR SET POINT</p> </div>	

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SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 2</b></p> <p>Warning tone ON and low PGA pressure flag "0"</p> <p>Actuating parameter: PGA Pressure &lt;math&gt;&lt; 3.25 \pm 0.15 \text{ psid}&lt;/math&gt;</p> <p>Possible causes: a. EMU leak b. Low PGA Pressure sensor failed ON c. PLSS O<sub>2</sub> regulator shifted set point or failed closed</p>	<p align="center"><b>EMERGENCY PROCEDURE</b></p> <p>①</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>1</p> <ul style="list-style-type: none"> <li>Actuate OPS</li> </ul> <p>Low PGA pressure flag CLEAR</p> </div> <p>YES →</p> <p>NO →</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>2</p> <p>LOW PGA PRESS. SENSOR FAILED ON</p> </div> <p align="center"><b>EVA PROCEDURE</b></p> <div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>3</p> <ul style="list-style-type: none"> <li>Verify PGA pressure gage and GT8168P/GT8268P</li> <li>PGA pressure &gt;3.4 psia and shut off OPS</li> </ul> </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>4</p> <ul style="list-style-type: none"> <li>Verify PGA pressure gage and GT8168P/GT8268P</li> <li>PGA pressure &gt;3.10 psia</li> </ul> </div> </div> <p align="center"><b>POST EVA PROCEDURE</b></p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>5</p> <ul style="list-style-type: none"> <li>Bladder Leak Check</li> <li>H<sub>2</sub>O shutoff and relief valve - CLOSED</li> <li>OPS - OFF, then ON</li> </ul> <p>Low PGA pressure flag CLEAR while OPS is OFF</p> </div> <p>YES →</p> <div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>6</p> <p>FEEDWATER BLADDER LEAK, OR DRAIN CONNECTOR LEAK</p> </div> <p>NO →</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>7</p> <ul style="list-style-type: none"> <li>EMU Press. Integrity Check</li> <li>Repress LM</li> <li>OPS O<sub>2</sub> - OFF</li> <li>PLSS O<sub>2</sub> Supply - OFF</li> </ul> <p>Integrity OK</p> </div> <p>NO → To Step 8 Next page</p> <p>YES → To Step 9 Next page</p>	<p>① OPS regulates at <math>3.7 \pm 0.3 \text{ psid}</math>.</p>

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SYMPTOM	PROCEDURE	REMARKS
POST EVA PROCEDURE (continued)		
	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; justify-content: space-between; width: 100%;"> <div style="width: 45%;"> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p><b>8</b></p> <ul style="list-style-type: none"> <li>● PGA/PLSS Press. Integrity Check</li> <li>● Disconnect OPS</li> <li>● Purge valve - CLOSED</li> <li>● PLSS O<sub>2</sub> - ON, then OFF</li> </ul> <p>Integrity OK</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p><b>11</b></p> <ul style="list-style-type: none"> <li>● PGA Press. Integrity Check</li> <li>● Connect ECS to PGA</li> <li>● Disconnect PLSS Hoses</li> </ul> <p>Integrity OK</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p><b>14</b></p> <p style="text-align: center;">PGA LEAK</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p><b>16</b></p> <ul style="list-style-type: none"> <li>● DEGRADED PRESS. REGUL.</li> <li>● RECORD GT8168P/ GT8268P PGA PRESSURE OR ● CONNECT BLUE PLSS GAS CONNECTOR TO OPS PRESSURE REGULATOR CHECKOUT STOWAGE PLATE</li> <li>● PLSS O<sub>2</sub> - ON</li> <li>● RECORD GAGE PRESSURE</li> </ul> </div> </div> <div style="width: 45%;"> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p><b>9</b></p> <p style="text-align: center;">Doff PLSS</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p><b>10</b></p> <p style="text-align: center;">PLSS O<sub>2</sub> Quantity Indicator &lt;gauge zero</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p><b>12</b></p> <p style="text-align: center;">LEAK BETWEEN OPS SHUTOFF VL.V. AND PGA</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p><b>13</b></p> <ul style="list-style-type: none"> <li>● Recharge PLSS O<sub>2</sub></li> </ul> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p><b>15</b></p> <p style="text-align: center;">LEAK BETWEEN PLSS O<sub>2</sub> SHUTOFF VL.V. AND PGA</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p><b>17</b></p> <ul style="list-style-type: none"> <li>● Pressurize O<sub>2</sub> Vent Loop</li> <li>● Depress blue PLSS gas connector to vent PLSS</li> <li>● Release blue PLSS gas connector</li> <li>● PLSS O<sub>2</sub> - ON, then OFF after 5 m n</li> <li>● Depress blue PLSS gas connector</li> </ul> <p style="text-align: center;">Verify PLSS O<sub>2</sub> flow</p> </div> </div> </div> <div style="display: flex; justify-content: space-between; width: 100%; margin-top: 10px;"> <div style="width: 45%; text-align: center;"> <p>To Step 18 Next page</p> </div> <div style="width: 45%; text-align: center;"> <p>To Step 24 Next page</p> </div> </div> </div>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
POST EVA PROCEDURE (continued)		
	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>18</p> <ul style="list-style-type: none"> <li>Connect PLSS O<sub>2</sub> Bottle to LM ECS</li> </ul> <p>GF3589P PLSS Recharge Press. &lt; 111 psi</p> </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>NO</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>22</p> <p>PLSS O<sub>2</sub> PRESS. REFUL. FAILED CLOSED</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>25</p> <ul style="list-style-type: none"> <li>Pressurize O<sub>2</sub> Vent Loop</li> <li>PLSS Gas Connectors to be stowed in stowage plates</li> <li>PLSS O<sub>2</sub> - ON</li> </ul> <p>GT8182P/GT8282P PLSS O<sub>2</sub> Press. or GF3589P PLSS Recharge Press. decay after 5 min</p> </div> <p style="text-align: center;">NO</p> <p style="text-align: center;">To Step 27 Next page</p> </div> <div style="width: 45%;"> <p>YES</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>20</p> <p>Do PLSS O<sub>2</sub> Quantity Indicator and GT8182P/GT8282P PLSS O<sub>2</sub> Press. agree</p> </div> <p>NO</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>23</p> <p>PLSS O<sub>2</sub> QUANT. INDIC. FAILED</p> </div> <p>YES</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>24</p> <p>GT8182P/GT8282P PLSS O<sub>2</sub> Press. or GF3589P PLSS Recharge Press. stable 50 min after recharge</p> </div> <p>NO</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>26</p> <p>LEAK ABOVE PLSS O<sub>2</sub> SHUTOFF VALVE</p> </div> <p>YES</p> <p style="text-align: center;">To Step 28 Next page</p> </div> </div> <div style="width: 45%; margin-left: 10px;"> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>21</p> <p>PRIMARY O<sub>2</sub> PRESS. SENSOR FAILED (COMMON XDUCCER)</p> </div> <p>YES</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>24</p> <p>GT8182P/GT8282P PLSS O<sub>2</sub> Press. or GF3589P PLSS Recharge Press. stable 50 min after recharge</p> </div> <p>NO</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>26</p> <p>LEAK ABOVE PLSS O<sub>2</sub> SHUTOFF VALVE</p> </div> </div>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
	<p style="text-align: center;">POST EVA PROCEDURE (continued)</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>27</p> <ul style="list-style-type: none"> <li>● PLSS/PGA Press. Verification</li> <li>● PLSS O<sub>2</sub> - OFF</li> <li>● Connect blue PLSS Gas Connector to OPS Regulator Press. Checkout Storage Plate</li> <li>● PLSS O<sub>2</sub> - ON</li> </ul> <p>Checkout Gage Press. &lt;4.2 psid</p> </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>28</p> <p>LEAK BETWEEN PLSS O<sub>2</sub> SHUTOFF VLV. AND PLSS O<sub>2</sub> PRESS. REGULATOR</p> </div> </div> <div style="margin-top: 20px; display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>29</p> <p>PRIMARY O<sub>2</sub> PRESS. REGULATOR REGULATING HIGHER THAN PRV CRACKING PRESS.</p> </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>30</p> <p>HIGH O<sub>2</sub> USAGE</p> </div> </div> <p style="margin-top: 10px;">Flow: 27 (NO) → 29; 27 (YES) → 30</p>	

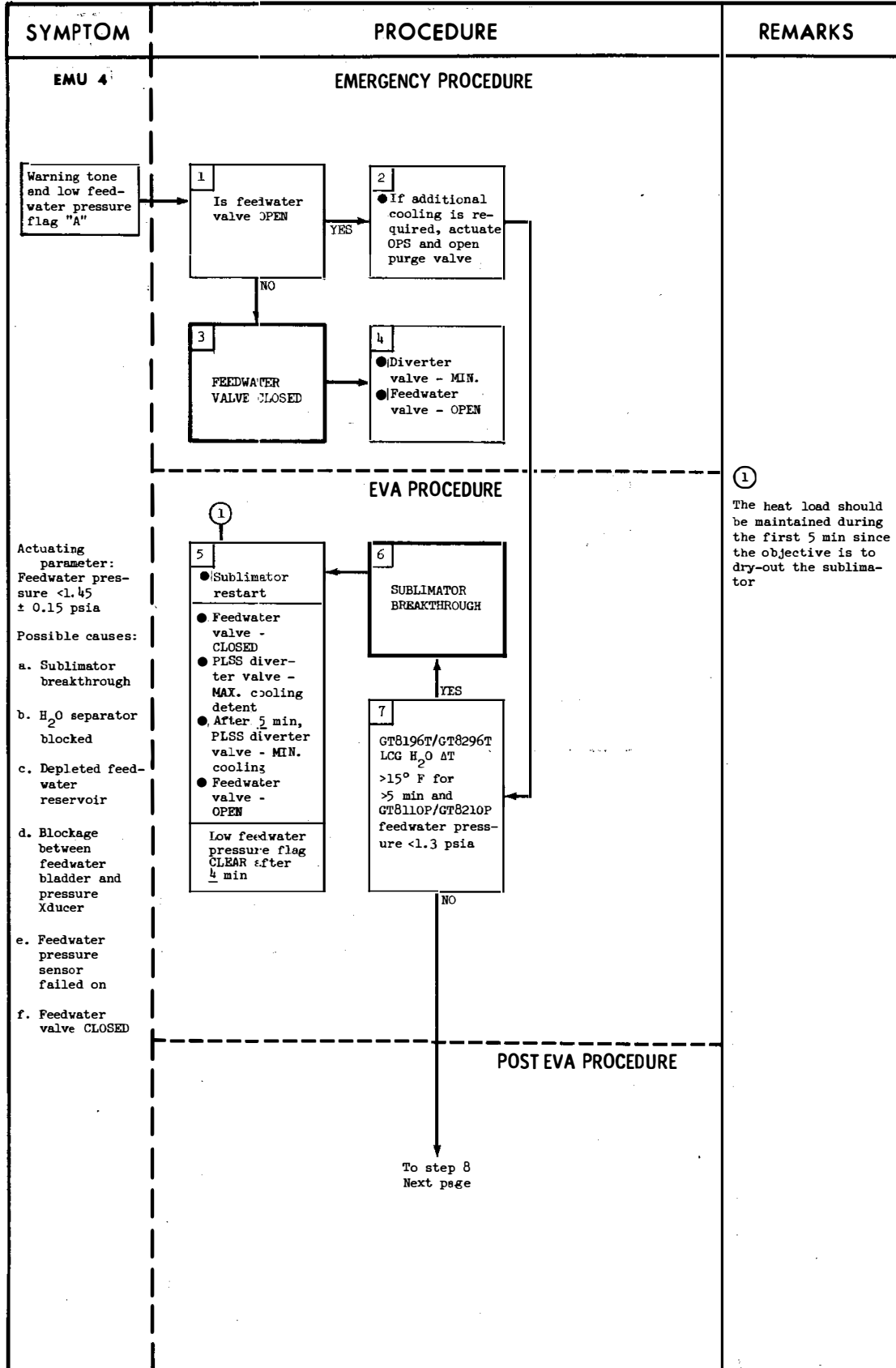
APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 3</b></p> <p>Warning tone ON and high O<sub>2</sub> flow flag "0"</p> <p>Actuating parameter: PLSS O<sub>2</sub> flow &gt;0.50 to 0.65 lb/hr for &gt;5 sec</p> <p>Possible causes:</p> <ul style="list-style-type: none"> <li>a. EMU leak</li> <li>b. Primary O<sub>2</sub> pressure regulator regulating higher than PRV cracking pressure</li> <li>c. High O<sub>2</sub> flow sensor failed on</li> </ul>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>1 Low PGH pressure flag "0"</p> <p>YES →</p> <p>NO →</p> </div> <div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>2 PLSS C<sub>2</sub> Quant. Indic. decreasing</p> <p>YES →</p> <p>NO →</p> </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>3 Actuate OPS</p> </div> </div> <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;"><b>EVA PROCEDURE</b></p> <div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>4 HIGH O<sub>2</sub> FLOW SENSOR FAILED ON</p> </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>5</p> <ul style="list-style-type: none"> <li>● Bladder Leak Check</li> <li>● H<sub>2</sub>O shutoff and relief valve - CLOSED</li> <li>● OPS - OFF, then ON</li> </ul> <p>High O<sub>2</sub> flow flag CLEAR while OPS is OFF</p> <p>YES →</p> <p>NO →</p> </div> </div> <div style="border: 1px solid black; padding: 5px; margin-top: 10px; width: 15%; text-align: center;"> <p>6 FEEDWATER BLADDER LEAK, OR DRAIN CONNECTOR LEAK</p> </div> <div style="border: 1px solid black; padding: 5px; margin-top: 10px; width: 45%;"> <p>7</p> <ul style="list-style-type: none"> <li>● EMU Press. Integrity Check</li> <li>● Repress LM</li> <li>● OPS O<sub>2</sub> - OFF</li> <li>● PLSS C<sub>2</sub> supply - OFF</li> </ul> <p>Integrity O.K.</p> <p>YES →</p> <p>NO →</p> </div> <p style="text-align: center;">To Step 8 Next page      To Step 13 Next page</p>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
	<p style="text-align: center;">POST EVA PROCEDURE (continued)</p> <pre>             graph TD               8["8 ● PGA/PLSS Press. Integrity Check ● Disconnect OPS ● Purge valve - CLOSED ● PLSS O<sub>2</sub> - ON, then OFF Integrity OK"]               9["9 LEAK BETWEEN OPS SHUTOFF VALVE AND PGA"]               10["10 ● PGA Press. Integrity Check ● Connect ECS to PGA ● Disconnect PLSS Hoses Integrity OK"]               11["11 LEAK BETWEEN HIGH O<sub>2</sub> FLOW SENSOR AND PGA"]               12["12 PGA LEAK"]               13["13 Was GT6168P/ GT6268P PGA Press. &lt;4.5 psia"]               14["14 PRIMARY O<sub>2</sub> PRESS. REGULATOR REGULATING HIGHER THAN PRV CRACKING PRESS."]               15["15 HIGH O<sub>2</sub> USAGE"]                8 -- YES --&gt; 9               8 -- NO --&gt; 10               10 -- YES --&gt; 11               10 -- NO --&gt; 12               13 -- YES --&gt; 15               13 -- NO --&gt; 14           </pre>	

APOLLO OPERATIONS HANDBOOK-EMU





APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<b>POST EVA PROCEDURE</b>		
	<pre> graph TD     8["8 ● Repress LM Flag CLEAR before cabin press. &gt;1.6 psia"] -- YES --&gt; 9["9 ● Pressurize backside of Feedwater Bladder from O2 Vent Loop ● Connect LM Waste Mgmt. Bag to PLSS Vent Connector ● PLSS O2 - ON ● Hoses disconnected from PGA Feedwater expelled through Vent Connector"]     8 -- NO --&gt; 10["10 FEEDWATER PRESS. TRANSDUCER FAILED ON"]     9 -- YES --&gt; 11["11 BLOCKAGE BETWEEN BLADDER AND FEEDWATER PRESS. TRANSDUCER"]     9 -- NO --&gt; 13["13 ● Connect LM Waste Mgmt. Bag to Drain Connector Drain H2O or O2 expelled from H2O Drain Connector"]     11 -- YES --&gt; 12["12 FEEDWATER RESERVOIR DEPLETED"]     13 -- YES --&gt; 12     13 -- NO --&gt; 14["14 WATER SEPARATOR BLOCKED"]     </pre>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 5</b></p> <p>Warning tone with all warning flags CLEAR</p> <p>Actuating parameters:</p> <p>Vent flow &gt;4.0 to 5.3 acfm for &gt;5 sec</p> <p>PGA pressure &gt;3.10 to 3.40 psia</p> <p>PLSS O<sub>2</sub> flow &gt;0.50 to 0.65 lb/hr for &gt;5 sec</p> <p>Feedwater pressure &gt;1.30 to 1.60 psia</p> <p>Possible causes:</p> <p>a. Tone failure</p> <p>b. Low vent flow</p> <p>c. Low PGA pressure</p> <p>d. High PLSS O<sub>2</sub> flow</p> <p>e. Low feedwater pressure</p>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p>	<p>① TM and voice communications should be used to aid in this determination.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
	<p style="text-align: center;"><b>EVA PROCEDURE</b></p> <pre> graph TD     17["17 GT8196T/ GT8296T LCG H<sub>2</sub>O AT &gt;15° for &gt;5 min and GT8110P/ GT8210P feed- water pressure &lt;1.3 psia"] -- YES --&gt; 18["18  LOW FEEDWATER PRESSURE FLAG FAILED CLEAR"]     18 --&gt; 19["19  Go to Step 6 Page 5-12"]     17 -- NO --&gt; 20["20 ● H<sub>2</sub>O shutoff and relief valve - CLOSED for 5 min with diverter valve in MAX.  Low feedwater pressure flag "A""]     20 -- YES --&gt; 21["21  WARNING TONE FAILED (CAME ON WHEN THERE WAS NO CAUSE)"]     20 -- NO --&gt; 22["22  LOW FEEDWATER PRESSURE FLAG FAILED CLEAR"]     22 --&gt; 23["23  Go to Step 9 Page 5-13"]                     </pre> <p style="text-align: center;"><b>POST EVA PROCEDURE</b></p>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 6</b></p> <p>① PGA pressure gage &lt;3.7 psid and apparently stable (with no warning tone and warning flags clear)</p> <p>Possible causes;                      a. Gage shift or failure                      b. PLSS O<sub>2</sub> regulator shift/degraded                      c. EMU leak</p>	<p><b>EMERGENCY PROCEDURE</b></p> <p>①                      1 Actuate the OPS                      Does PGA press. gage respond</p> <p>YES</p> <p>NO</p> <p>2                      PGA PRESSURE GAGE FAILED</p> <hr/> <p><b>EVA PROCEDURE</b></p> <p>3                      GT8168P/GT8268P                      PGA pressure &gt;3.7 psia</p> <p>4                      Turn off OPS</p> <p>YES</p> <p>NO</p> <p>5                      Go to Step 5 on Page 5-6</p>	<p>①                      PLSS O<sub>2</sub> pressure regulator regulates the PGA to 3.7 psid minimum if flow is 0.07 to 0.7 lb/hr.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 7:</b></p> <p>PLSS O<sub>2</sub> QUANTITY INDICATOR abnormal reading</p> <p>Possible causes:</p> <ol style="list-style-type: none"> <li>PLSS O<sub>2</sub> quantity indicator failed</li> <li>EMU leak</li> <li>PLSS O<sub>2</sub> pressure Xducer failed</li> <li>PLSS O<sub>2</sub> regulator regulating out of spec.</li> <li>High O<sub>2</sub> usage</li> </ol>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <p style="text-align: center;">①</p> <p>1 Low PGA pressure flag "0", or PGA pressure gage reads &lt;3.7 psia and decreasing</p> <p>YES → 2 ● Actuate OPS</p> <p>NO → 3 High O<sub>2</sub> flow flag "0"</p> <p style="text-align: center;">②</p> <p>2 ● Actuate OPS</p> <p>YES → 3 High O<sub>2</sub> flow flag "0"</p> <p>NO → 5 Go to Step 5 Page 5-6</p> <p style="text-align: center;">EVA PROCEDURE</p> <p>4 GT8182P/GT8282P PLSS O<sub>2</sub> pressure abnormal reading</p> <p>YES → 5 Go to Step 5 Page 5-6</p> <p>NO → POST EVA PROCEDURE</p> <p style="text-align: center;">POST EVA PROCEDURE</p> <p>6 ● Recharge PLSS O<sub>2</sub></p> <p>7 ● Connect PLSS O<sub>2</sub> Bottle to LM ECS Does GF3589P PLSS Recharge Press. agree with GT8182P/GT8282P</p> <p>YES → 10 ● PLSS O<sub>2</sub> shutoff valve - OFF</p> <p>NO → 9 GT8182P/GT8282P PLSS O<sub>2</sub> PRESS FAILED</p> <p>8 PLSS O<sub>2</sub> Quantity Indicator shows re-charge</p> <p>YES → 9 GT8182P/GT8282P PLSS O<sub>2</sub> PRESS FAILED</p> <p>NO → To Step 12 Next page</p> <p>9 GT8182P/GT8282P PLSS O<sub>2</sub> PRESS FAILED</p> <p>10 ● PLSS O<sub>2</sub> shutoff valve - OFF</p> <p>11 PLSS O<sub>2</sub> PRESSURE XDUCER FAILED (COMMON XDUCER)</p> <p>To Step 13 Next page</p>	<p>① 1600 Btu/hr metabolic load plus allowable EMU leakage consumes approximately 0.25 lb/hr O<sub>2</sub>. Without makeup O<sub>2</sub>, this will reduce PGA pressure to 3 psia in approximately 3 min.</p> <p>② OPS regulates at 3.7 ± 0.3 psid.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
	<p style="text-align: center;">POST EVA PROCEDURE (continued)</p> <pre> graph TD     12["12 PLSS O<sub>2</sub> QUANTITY INDIC. FAILED"] --&gt; 13["13 ● Recharge PLSS O<sub>2</sub>"]     13 --&gt; 14["14 GF3589F PLSS Recharge Press. stable after 50 min"]     14 -- YES --&gt; 15["15 LEAK BETWEEN PLSS O<sub>2</sub> SHUT- OFF VLV. AND HIGH O<sub>2</sub> FLOW SENSOR"]     14 -- NO --&gt; 16["16 LEAK UPSTREAM OF PLSS O<sub>2</sub> SHUTOFF VLV."]                     </pre>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 8</b></p> <p>① PGA pressure gage &gt;4.0 psid</p> <p>Possible causes: a. Regulator fails open or shifts set point b. PGA pressure gage fails</p>	<p align="center"><b>EMERGENCY PROCEDURE</b></p> <p>②</p> <pre> graph TD     1[1] --&gt; 1_1[1 High O2 flow flag "0" (after 5 sec)]     1_1 -- YES --&gt; 2[2 Actuate OPS]     1_1 -- NO --&gt; 4[4 Does GT8168P/GT8268P PGA Press. agree with PGA Press. Gage]     2 --&gt; 3[3 PLS5 O2 PRESS. REGUL. FAILED OPEN OR SHIFTED SET POINT]     4 -- YES --&gt; 5[5 SHIFT IN PLS5 O2 REGULATED PRESSURE]     4 -- NO --&gt; 6[6 Connect blue PLS5 Gas Connector to OPS Regul. Check-out Storage Plate. Does OPS gage agree with PGA gage]     6 -- YES --&gt; 7[7 GT8168P/GT8268P PGA PRESS. FAILED]     6 -- NO --&gt; 8[8 PGA PRESS. GAGE FAILED]     5 --&gt; 7                     </pre>	<p>① PLSS O<sub>2</sub> pressure regulator regulates to 4.0 psid maximum to PGA. PGA pressure relief valve cracks at 4.5 to 5.5 psid.</p> <p>② The PLS5 O<sub>2</sub> shutoff valve should be closed if possible. If additional mobility is needed, open purge valve to reduce PGA pressure to &gt;3.4 psid.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 9</b></p> <p>Loss of pump noise</p> <p>Possible causes:</p> <ul style="list-style-type: none"> <li>a. Pump switch OFF</li> <li>b. Power failure</li> <li>c. Open RCU connection</li> <li>d. Pump failure</li> </ul>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <pre> graph TD     Start[Loss of pump noise] --&gt; 1[1 Receiving Sidetone]     1 -- YES --&gt; 3[3 Pump switch ON]     1 -- NO --&gt; 2[2 Actuate OPS and open purge valve]     2 --&gt; 3     3 -- YES --&gt; 5[5 GT8140C/ GT8240C PLSS Batt. Current &lt;1.2 amp]     3 -- NO --&gt; 4[4 PUMP SWITCHED OFF]     5 -- YES --&gt; 6[6 PUMP MOTOR FAILED (OPEN CIRCUIT)]     5 -- NO --&gt; 7[7 PUMP SEIZED OR SLOWED]     4 --&gt; 8[8 Is RCU Connection properly mated]     6 --&gt; 8     7 --&gt; 8     8 -- YES --&gt; 9[9 MAIN POWER FAILED]     8 -- NO --&gt; 10[10 OPEN RCU CONNECTION]                     </pre> <p style="text-align: center;"><b>EVA PROCEDURE</b></p> <p style="text-align: center;"><b>POST EVA PROCEDURE</b></p>	



APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 10</b></p> <p>Inadequate cooling of crewman (diverter valve - MAX. cooling)</p> <p>Possible causes:</p> <ul style="list-style-type: none"> <li>a. Thermal leak</li> <li>b. Pump degradation or flow restriction</li> <li>c. Gas in transport water line</li> <li>d. Sublimator degraded</li> </ul>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <p>1 ● Actuate gas trap for 5 sec Cooling improved within 3 min</p> <p>2 GAS IN WATER TRANSPORT LINE</p> <p>3 ● If additional cooling is needed, actuate OPS and open purge valve</p> <hr/> <p style="text-align: center;"><b>EVA PROCEDURE</b></p> <p>4 GT8196T/GT8296T LCG H<sub>2</sub>O ΔT &gt;11° F GT8154T LCG H<sub>2</sub>O temp. &lt;45° F</p> <p>5 COOLANT FLOW RATE &lt;3.5 LB./MIN. DUE TO DEGRADED PUMP OR FLOW RESTRICTION</p> <p>6 Go to Step 3 Page 5-21</p> <p>7 GT8154T/GT8254T LCG H<sub>2</sub>O temp. &gt;68° F and GT8196T/GT8296T LCG H<sub>2</sub>O ΔT &lt;5° F</p> <p>8 LEVA HEAT LEAK</p> <p>9 EXCESSIVE THERMAL LEAK INTO EMU</p> <p>10 ● Check LEVA position, latch, and Interface Collar and adjust as required Feel cooler</p> <p>11 INSULATION HEAT LEAK</p> <p>To Step 12 Next page</p>	<p>① Actuation of the gas trap must be performed by another EV crewman. It cannot be self-accomplished.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
	<p style="text-align: center;">EVA PROCEDURE (continued)</p> <div style="text-align: center;"> <p>①</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> <p>12</p> <ul style="list-style-type: none"> <li>● Sublimator restart</li> <li>● Feedwater valve - CLOSED</li> <li>● PLS diverter - MAX. cooling</li> <li>● After 2 min, PLS diverter in MIN. cooling position</li> <li>● Feedwater valve - OPEN</li> </ul> <p>GT8154T/GT8254T LCG H<sub>2</sub>O temp. &lt;68° F after 2 min</p> </div> <div style="display: flex; justify-content: center; align-items: center; margin: 5px 0;"> <div style="margin-right: 10px;">YES →</div> <div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>13</p> <p>SUBLIMATOR BREAKTHROUGH</p> </div> </div> <div style="display: flex; justify-content: center; align-items: center; margin: 5px 0;"> <div style="margin-right: 10px;">NO</div> <div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>14</p> <p>SUBLIMATOR DEGRAD D OR FEEDWATER FLOW REST ICT</p> </div> </div> </div>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 11</b></p> <p>EVA-1 loses voice from MSFN (see "Additional conditions" below)</p> <p>Additional conditions:                      1. Dual EVA                      2. EVA-1 has voice from EVA-2</p> <p>Possible causes:                      a. IM or MSFN failed                      b. EVA-1 "A" volume control turned too low                      c. EVA-1 R/T Relay K-1 failed closed in backup mode                      d. Triplexer "A" section failed                      e. EVA-1 "A" Receiver RF section failed                      f. EVA-1 Triplexer "A" section, "A" Receiver, or R/T Relay K-1 failed open in both modes                      g. EVA-1 "A" Receiver audio section failed                      h. Receiver "A" RCU volume control failed</p>	<p><b>EVA PROCEDURE</b></p> <pre>                     graph TD                         Start[EVA-1 loses voice from MSFN] --&gt; B1{1 Does EVA-2 receive voice from MSFN}                         B1 -- YES --&gt; B2{2 Does EVA-1 have side-tone}                         B1 -- NO --&gt; B4{4 IM OR MSFN FAILED}                         B2 -- YES --&gt; B3{3 Set EVA-1 Mode Sel. Sw. at "B" Set EVA-2 Mode Sel. Sw. at "A"}                         B2 -- NO --&gt; B5{5 EVA-1 set RCU "A" volume control to max. Comm. restored}                         B3 --&gt; B6{6 Does EVA-2 receive voice from EVA-1}                         B5 -- YES --&gt; B6                         B5 -- NO --&gt; B7{7 EVA-1 "A" VOLUME CONTROL TURNED TOO LOW}                         B6 -- YES --&gt; B3                         B6 -- NO --&gt; B8{8 EVA-1 R/T RELAY K-1 FAILED OPEN IN BOTH MODES, OR TRIPLEXER "A" SECTION FAILED}                         B8 --&gt; B9{9 EVA-1 R/T RELAY K-1 FAILED CLOSED IN MODE "B", OR "A" RECEIVER RF SECTION FAILED}                     </pre> <p><b>POST EVA PROCEDURE</b></p> <pre>                     graph TD                         B5 --&gt; B10{10 Swap EVA-1 RCU with EVA-2 EVA-1 receive on "A" Receiver}                         B10 -- YES --&gt; B11{11 RCVR "A" RCU VOLUME CONTROL FAILED}                         B10 -- NO --&gt; B12{12 EVA-1 "A" RCVR FAILED}                     </pre>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 12.</b></p> <p>EVA-1 loses voice from MSPFN (see "Additional conditions" below)</p> <p><b>Additional conditions:</b></p> <ol style="list-style-type: none"> <li>Dual EVA</li> <li>EVA-1 does not receive voice from EVA-2</li> </ol> <p><b>Possible causes:</b></p> <ol style="list-style-type: none"> <li>Comm. carrier failed</li> <li>RCU mode selector "A" section failed</li> <li>RCU cable failed</li> <li>Primary dual comm. regulator failed</li> <li>PLSS electrical umbilical failed</li> <li>Antenna or triplexer common port failed</li> <li>J-3 Pin 8 failed</li> </ol>	<p align="center"><b>EVA PROCEDURE</b></p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>1</p> <p>Does EVA-1 have sidetone</p> <p>YES → [To Step 13 Next Page]</p> <p>NO ↓</p> </div> <div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>2</p> <ul style="list-style-type: none"> <li>EVA-1 set Mode Sel. Sw. in "A" position</li> </ul> <p>Comm. restored with MSPFN</p> <p>YES → [To Step 13 Next Page]</p> <p>NO ↓</p> </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>3</p> <p>RCU MODE SELECTOR DUAL CONTACT "A" WAFER FAILED</p> </div> </div> <div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>4</p> <ul style="list-style-type: none"> <li>EVA-1 set Mode Sel. Sw. in position "B"</li> </ul> <p>Does EVA-1 hear sidetone</p> <p>YES → [To Step 13 Next Page]</p> <p>NO ↓</p> </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>5</p> <ul style="list-style-type: none"> <li>EVA-1 Mode Sel. Sw. in Pos. "B"</li> <li>EVA-2 Mode Sel. Sw. in Pos. "A"</li> </ul> </div> </div> <div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>6</p> <ul style="list-style-type: none"> <li>EVA-1 PLSS fan - OFF &gt;5 sec</li> </ul> <p>EVA-1 hear warning tone</p> <p>YES → [To Step 13 Next Page]</p> <p>NO ↓</p> </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>7</p> <p>RCU MODE SELECTOR "A" WAFER FAILED</p> </div> </div> <div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>8</p> <ul style="list-style-type: none"> <li>EVA-1 low vent flow flag "F" while fan is OFF</li> </ul> <p>YES → [To Step 16 Next Page]</p> <p>NO → [To Step 18 Next page]</p> </div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>9</p> <p>RCU J-3 PIN 8 FAILED</p> </div> </div>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
POST EVA PR CEDURE		
	<pre> graph TD     Start(( )) --&gt; 10     10["10 ● Swap EVA-1 Comm. Carrier with EVA-2 Comm. restored"] -- Yes --&gt; 11["11 EVA-1 COMM. CARRIER FAILED"]     10 -- No --&gt; 12["12 SUIT ELECTRICAL HARNESSE FAILED"]     12 --&gt; 13     13["13 ● Swap EVA-1 RCU with EVA-2 Comm. re- stored in Mode Sel. Sw. Pos. 'A', 'AR', and 'B'"] -- Yes --&gt; 14["14 RCU MODE SE- LECTOR DUAL CONTACT 'A' WAFER FAILED"]     13 -- No --&gt; 15["15 PRI/DUAL COMM. REGUL. FAILED"]     14 --&gt; 16     15 --&gt; 16     16["16 ● EVA-1 connect to IM electrical umbilical Comm. restored"] -- YES --&gt; 17["17 PLSS ELEC- TRICAL UMBILICAL FAILED"]     16 -- NO --&gt; 18     17 --&gt; 18     18["18 ● Swap EVA-1 OPS with EVA-2 Comm. restored"] -- Yes --&gt; 19["19 EVA-1 ANTENNA OR CABLE FAILED"]     18 -- No --&gt; 20["20 EVA-1 TRIPLEX- ER COMMON PORT FAILED"]                     </pre>	

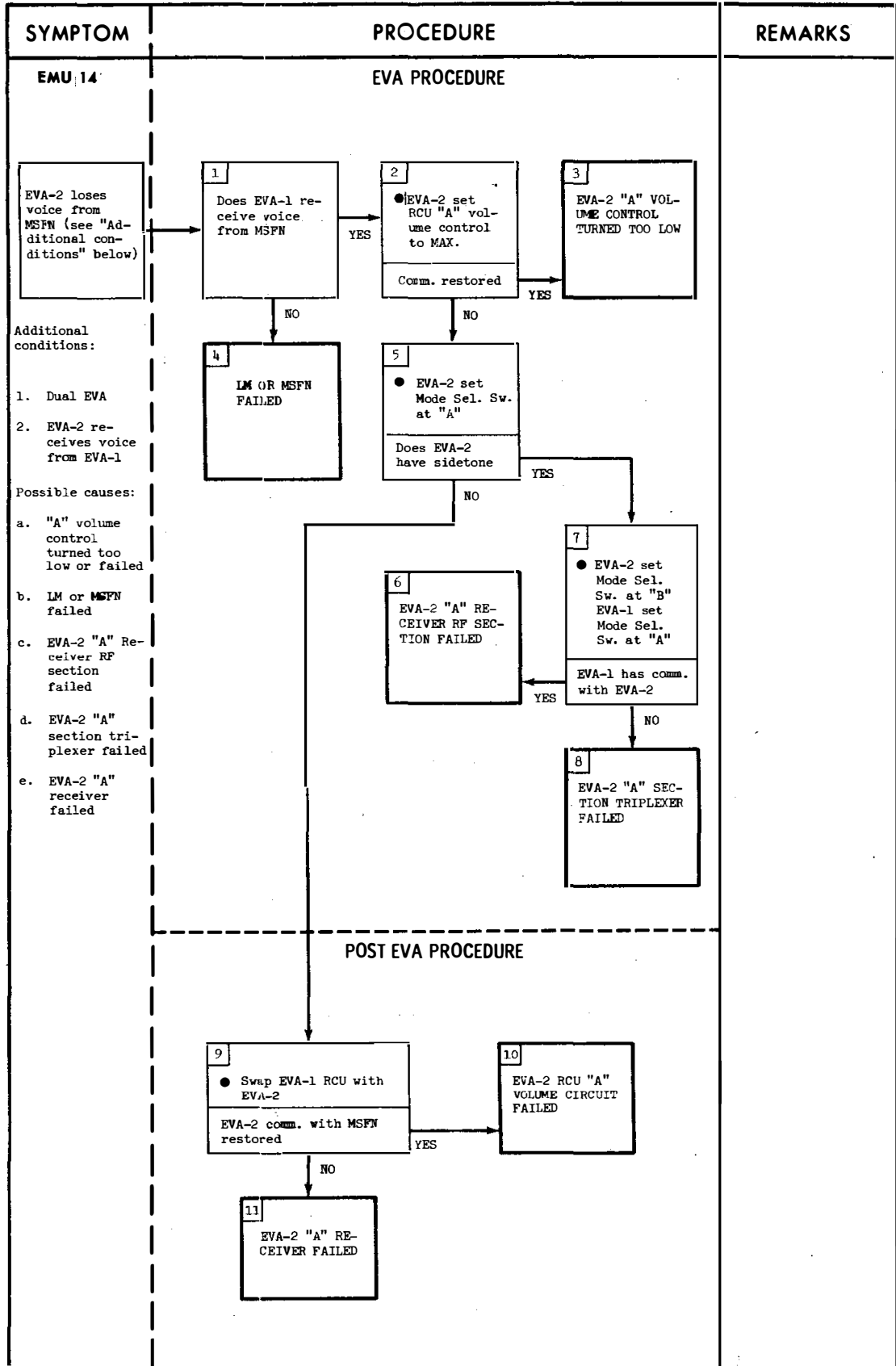
APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 13<sup>1</sup></b></p> <p>EVA-1 loses voice from EVA-2 (See "Additional conditions" below)</p> <p>Additional conditions:</p> <ol style="list-style-type: none"> <li>1. EVA-1 has voice from MSFM</li> <li>2. Dual EVA</li> </ol> <p>Possible causes:</p> <ol style="list-style-type: none"> <li>a. EVA-1 B/C volume control set too low</li> <li>b. EVA-1 "B" receiver audio section failed</li> <li>c. EVA-2 PTT switch was OFF</li> <li>d. EVA-2 R/T Relay K-2 failed closed in "A" position</li> <li>e. FM link failed</li> <li>f. Audio section of signal processor failed</li> </ol> <p>(continued on next page)</p>	<p style="text-align: center;"><b>EVA PROCEDURE</b></p> <pre> graph TD     S1["1 ● EVA-1 set RCU B/C volume to MAX. Comm. restored"] -- YES --&gt; S2["2 VOLUME CONTROL WAS TURNED TOO LOW"]     S1 -- NO --&gt; S3["3 Does MSFM hear EVA-2 and receive 'IM from EVA-2"]     S3 -- YES --&gt; S4["4 EVA-1 'B' RCVR. AUDIO SECTION FAILED"]     S3 -- NO --&gt; S5["5 Does MSFM receive 'IM but no voice from EVA-2"]     S5 -- YES --&gt; S6["6 ● EVA-2 switch PTT OFF/MAIN Comm. restored"]     S5 -- NO --&gt; S8["8 ● EVA-2 Mode Sel. Sw. - Pos. 'B' Comm. restored"]     S6 -- YES --&gt; S7["7 EVA-2 PTT SWITCH WAS OFF"]     S6 -- NO --&gt; S9["9 ● EVA-2 go to MOM. from MAIN. Comm. restored"]     S8 -- YES --&gt; S9     S8 -- NO --&gt; S10["10 EVA-2 R/T RE- LAY K-2 FAILED CLOSED IN 'A' POSITION"]     S9 -- YES --&gt; S11["11 FM LINK FAILED"]     S9 -- NO --&gt; S12["To Step 12 Next page"]     S10 --&gt; S11     S11 --&gt; S12                     </pre>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p>Possible causes: (continued)</p> <p>g. PTT circuit in EVA-2 RCU failed</p> <p>h. PTT circuit in EVA-2 PLSS failed</p> <p>i. EVA-2 comm. carrier failed</p>	<p style="text-align: center;">POST EVA PROCEDURE</p> <pre> graph TD     12["12 ● Swap EVA-2 RCU with EVA-1 Comm. restored"] -- YES --&gt; 13["13 MAIN CONTACTS OF PTT SWITCH IN EVA-2 RCU FAILED"]     12 -- NO --&gt; 14["14 PRIMARY VOX CIRCUIT IN EVA-2 PLSS FAILED"]     14 --&gt; 15["15 ● Swap EVA-1 Comm. Carrier with EVA-2 Comm. restored"]     15 -- YES --&gt; 16["16 EVA-2 COMM. CARRIER FAILED"]     15 -- NO --&gt; 17["17 AUDIO SECTION OF SIGNAL PROCESSOR FAILED"]                     </pre>	

APOLLO OPERATIONS HANDBOOK-EMU





APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 15</b></p> <p>EVA-2 loses voice from MSFPN (See "Additional conditions" below)</p> <p>Additional conditions:</p> <ol style="list-style-type: none"> <li>1. Dual EVA</li> <li>2. EVA-2 does not receive voice from EVA-1</li> </ol> <p>Possible causes:</p> <ol style="list-style-type: none"> <li>a. RCU mode selector dual contact failed</li> <li>b. RCU mode selector switch "A" wafer failed</li> <li>c. RCU P-3 Pin 8 failed</li> </ol> <p>(continued on next page)</p>	<p style="text-align: center;"><b>EVA PROCEDURE</b></p> <pre> graph TD     Start[EVA-2 loses voice from MSFPN] --&gt; Step1{1 Does EVA-1 have sidetone}     Step1 -- YES --&gt; End1[To Step 12 Next page]     Step1 -- NO --&gt; Step2{2 • EVA-2 set mode sel. sw. in "A" position MSFPN comm. restored}     Step2 -- YES --&gt; Step3{3 RCU MODE SEL. DUAL CONTACT "A" WAFER FAILED}     Step2 -- NO --&gt; Step4{4 • EVA-2 set mode sel. sw. to "B" Does EVA-2 hear sidetone}     Step3 --&gt; End2[To Step 17 Next page]     Step4 -- YES --&gt; Step5{5 • EVA-2 mode sel. sw. to "B" • EVA-1 mode sel. sw. to "A"}     Step4 -- NO --&gt; Step6{6 • EVA-2 Fan OFF/ON EVA-2 hear warning tone}     Step5 --&gt; End3[To Step 17 Next page]     Step6 -- YES --&gt; Step7{7 RCU MODE SEL. SW. "A" WAFER FAILED}     Step6 -- NO --&gt; Step8{8 EVA-2 low vent flow warning flag "p"}     Step7 --&gt; End4[To Step 17 Next page]     Step8 -- YES --&gt; End5[To Step 10 Next page]     Step8 -- NO --&gt; Step9{9 RCU P-3 PIN 8 FAILED}     Step9 --&gt; End6[To Step 17 Next page]                     </pre>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 15</b></p>	<p>POST EVA PROCEDURE</p>	
<p>d. PISS electrical umbilical failed</p>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>10</p> <p>●EVA-2 connect to LM umbilical</p> <hr/> <p>MSFN comm. all right</p> </div> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>11</p> <p>PISS ELECTRICAL UMBILICAL FAILED</p> </div> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>12</p> <p>●EVA-2 swap OPS with EVA-1</p> <hr/> <p>Comm. restored</p> </div> </div>	
<p>e. EVA-2 comm. carrier failed</p>	<p style="text-align: center;">NO</p>	
<p>f. EVA-2 triplexer failed</p>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>13</p> <p>●EVA-2 swap comm. carrier with EVA-1</p> <hr/> <p>MSFN comm. all right</p> </div> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>14</p> <p>EVA-2 COMM. CARRIER FAILED</p> </div> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>15</p> <p>EVA-2 TRI- PLEXER FAILED</p> </div> </div>	
<p>g. EVA-2 suit electrical harness failed</p>	<p style="text-align: center;">NO</p>	
<p>h. RCU mode selector switch dual and primary contact "A" wafer failed</p>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>16</p> <p>EVA-2 SUIT ELECTRICAL HARNESS FAILED</p> </div> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>17</p> <p>●EVA-2 swap RCU with EVA-1</p> <hr/> <p>Comm. all right in "A" and "AR"</p> </div> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>18</p> <p>RCU MODE SEL. SW. DUAL AND PRIMARY CONTACT "A" WAFER FAILED</p> </div> </div>	
<p>i. Primary/dual comm. regulator failed</p>	<p style="text-align: center;">NO</p>	
<p>j. EVA-2 antenna or cable failed</p>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>19</p> <p>PRIMARY/DUAL COMM. REG. FAILED</p> </div> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>20</p> <p>EVA-2 ANTENNA OR CABLE FAILED</p> </div> </div>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 16</b></p> <p>EVA-2 loses voice from EVA-1 (See "Additional conditions" below)</p> <p>Additional conditions:</p> <ol style="list-style-type: none"> <li>Dual EVA</li> <li>EVA-2 has comm. with MSFN</li> </ol> <p>Possible causes:</p> <ol style="list-style-type: none"> <li>EVA-2 B/C volume control turned too low</li> <li>EVA-2 "B" receiver failed</li> <li>EVA-1 RCU PTT switch turned OFF</li> <li>EVA-2 "B" section triplexer or K-2 relay antenna section failed</li> </ol> <p>(Continued next page)</p>	<p align="center"><b>EVA PROCEDURE</b></p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><b>1</b></p> <p>● EVA-2 set RCU B/C volume to MAX.</p> <p>Comm. restored</p> </div> <div style="width: 45%;"> <p><b>2</b></p> <p>VOLUME CONTROL WAS TURNED TOO LOW</p> </div> </div> <p>NO →</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><b>3</b></p> <p>Does MSFN have comm. from EVA-1</p> </div> <div style="width: 45%;"> <p><b>4</b></p> <p>● EVA-2 set Mode Sel. Sw. to "A"</p> <p>● EVA-1 set Mode Sel. Sw. to "B"</p> <p>EVA-2/EVA-1 comm. all right</p> </div> </div> <p>NO →</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><b>6</b></p> <p>● EVA-1 insure that RCU PTT switch is in MAIN position</p> <p>EVA-2/EVA-1 comm. restored</p> </div> <div style="width: 45%;"> <p><b>7</b></p> <p>EVA-1 RCU PTT SW. ACCIDENTLY SET TO OFF POSITION</p> </div> </div> <p>NO →</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><b>9</b></p> <p>● EVA-1 set RCU PTT switch to MOM. position</p> <p>EVA-2/EVA-1 comm. restored</p> </div> <div style="width: 45%;"> <p><b>10</b></p> <p>EVA-1 VOX CIRCUIT OR RCU PTT SWITCH VOX SECTION FAILED</p> </div> </div> <p>NO →</p> <p align="center"><b>POST EVA PROCEDURE</b></p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><b>11</b></p> <p>● EVA-1 swap RCU with EVA-2</p> <p>EVA-2/EVA-1 comm. restored</p> </div> <div style="width: 45%;"> <p><b>12</b></p> <p>EVA-1 RCU PTT SWITCH CIRCUIT FAILED</p> </div> </div> <p>NO →</p> <p>To Step 13 Next page</p>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
POST EVA PROCEDURE (continued)		
<p>Possible causes: (continued)</p> <p>e. EVA-1 VOX circuit or RCU PTT switch VOX section failed</p> <p>f. EVA-1 RCU PTT switch circuit failed</p> <p>g. EVA-1 primary/dual signal processor failed</p> <p>h. EVA-1 VOX/PTT circuit failed</p> <p>i. EVA-1 comm. carrier failed</p> <p>j. EVA-1 suit electrical harness failed</p>	<pre> graph TD     13["13 ● EVA-1 connect to LM umbilical EVA-1/EVA-2 comm. restored"]     14["14 ● EVA-1 reconnect to PLSS ● RCU mode sel. switch to 'B' ● LM set for backup mode EVA-1/MSFN comm. restored"]     15["15 EVA-1 PRIMARY/DUAL SIGNAL PROCESSOR FAILED"]     16["16 EVA-1 VOX/PTT CIRCUIT FAILED"]     17["17 ● EVA-1 swap comm. carrier with EVA-2 EVA-1/MSFN comm. restored"]     18["18 EVA-1 COMM. CARRIER FAILED"]     19["19 ● EVA-1 SUIT ELECTRICAL HARNESS FAILED"]      13 -- YES --&gt; 14     13 -- NO --&gt; 17     14 -- YES --&gt; 15     14 -- NO --&gt; 16     17 -- YES --&gt; 18     17 -- NO --&gt; 19     </pre>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 17</b></p> <p>Loss of voice comm. with EVA-1, EVA-2, or MSPFN (two-man EVA) (comm. restoration procedure)</p> <p>Possible causes:</p> <ol style="list-style-type: none"> <li>EVCS receiver "A" squelch failure</li> <li>LM VHF "A" failure</li> <li>Volume control to low</li> <li>PTT switch OFF or intermittent</li> <li>VOX circuit failure</li> <li>EVA-1 XMTR "B", EVA-1 RCVR "C", EVA-2 RCVR "B", or EVA-2 XMTR "C" failed.</li> <li>EVA-1 RCVR "B"/RCVR "C" summed output failure</li> <li>EVA-1 or EVA-2 total comm. failure</li> </ol>	<p><b>EVA PROCEDURE</b></p> <pre> graph TD     1[1 Excessive noise present in headset] -- YES --&gt; 2[2 Outer volume control - DECREASE EVA-1/EVA-2 comm. OK]     1 -- NO --&gt; 5[5 Increase appropriate volume control Comm. OK]     2 -- YES --&gt; 3[3 EVCS RCVR A SQUELCH FAIL OR LM PROBLEM ON VHF A]     2 -- NO --&gt; 4[4 Outer volume control INCREASE periodically to see if noise present]     3 --&gt; 4     5 -- YES --&gt; 6[6 VOLUME CONTROL TOO LOW]     5 -- NO --&gt; 8[8 PTT - OFF then MAIN Comm. OK]     6 --&gt; 4     7[7 Outer volume control - INCREASE] --&gt; 4     8 -- YES --&gt; 12[12 PTT SWITCH OFF OR INTERMITTENT]     8 -- NO --&gt; 9[9 T MOM Comm. OK]     12 --&gt; 9     9 -- YES --&gt; 13[13 VOX CIRCUIT FAILURE]     9 -- NO --&gt; 10[10 EVA 1 mode - pos. "B" EVA 2 mode - pos. "A" Comm. OK]     10 --&gt; 2     10 --&gt; 11[11 EVA-1 XMTR B OR EVA-1 RCVR C OR EVA-2 RCVR B OR EVA-2 XMTR C FAILED]     11 -- YES --&gt; 11     11 -- NO --&gt; 14[14 EVA 1 mode - pos A EVA 2 mode - pos B Comm. OK]     14 --&gt; 10     14 -- YES --&gt; 15[15 EVA-1 RCVR B/RCVR C SUMMED OUTPUT FAILURE]     14 -- NO --&gt; 16[16 EVA-1 OR EVA-2 TOTAL COMM. FAILURE (TRIPLEXER, POWER SUPPLY, ETC.) OR LM FAILURE]     </pre>	<p>① Reception of MSPFN is disabled while outer volume is in full DECREASE.</p> <p>② EMU data not available from EVA-1. EVA-1 cannot hear MSPFN.</p> <p>③ EMU data not available from EVA-2. EVA-2 cannot hear MSPFN.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 18:</b></p> <p>EVA loses voice from LM (see "Additional conditions" below)</p> <p><b>Additional conditions:</b></p> <p>1. Single EVA</p> <p><b>Possible causes:</b></p> <p>a. EVA "A" volume control turned too low</p> <p>b. EVA "A" receiver RF section failed</p> <p>c. R/T Relay K-1 failed</p> <p>d. EVA antenna failed</p> <p>e. EVA comm. carrier failed</p> <p>f. Triplexer common port failed</p> <p>g. LM electrical umbilical failed</p> <p>(Continued next page)</p>	<p align="center"><b>EVA PROCEDURE</b></p> <pre> graph TD     Start[EVA loses voice from LM] --&gt; Step1{1 Does VA receive voice from MSFN}     Step1 -- YES --&gt; Next12[To Step 12 Next page]     Step1 -- NO --&gt; Step2{2 VA set RCU "A" volume control to MAX. Comm. restored}     Step2 -- YES --&gt; Step3{3 EVA "A" VOL. CONTROL TURNED TOO LOW}     Step2 -- NO --&gt; Step4{4 Does VA hear sidetone}     Step4 -- YES --&gt; Step5{5 EVA and LM configure for "B" mode Comm. restored}     Step4 -- NO --&gt; Step7{7 VA connect to LM Umbil. Comm. restored}     Step5 -- YES --&gt; Step6{6 EVA "A" RCVR. RF SECTION, OR R/T RELAY K-1, OR LM FAILED}     Step5 -- NO --&gt; Step8{8 EVA swap OPS with other crewman Comm. restored}     Step7 -- YES --&gt; Step8     Step7 -- NO --&gt; Step10{10 EVA COMM. CARRIER FAILED}     Step8 -- YES --&gt; Step9{9 EVA ANTENNA FAILED}     Step8 -- NO --&gt; Step11{11 EVA R/T RELAY K-1, K-2, OR TRIPLEXER COMMON PORT FAILED}     </pre> <p align="center"><b>POST EVA PROCEDURE</b></p>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
POST EVA PROCEDURE (continued)		
<p>Possible causes: (continued from preceding page)</p> <p>h. EVA RCU "A" volume circuit failed</p> <p>i. LM failed</p> <p>j. EVA "A" receiver RF section failed</p> <p>k. PLSS electrical umbilical failed</p> <p>l. Primary dual comm. regulator failed</p> <p>m. EVA "A" receiver failed</p>	<pre> graph TD     12["12 ● LM Crewman transfer to Pilot's Elect. Umbilical Comm. with MSFN O.K."] -- YES --&gt; 13["13 LM ELECT. UMBIL. FAILED"]     12 -- NO --&gt; 14["14 LM CREWMAN COMM. CARRIER FAILED"]     14 --&gt; 15["15 ● EVA connect to other PLSS Comm. restored"]     15 -- YES --&gt; 16["16 ● EVA reconnect to original PLSS, swap RCU with other crewman Comm. restored"]     15 -- NO --&gt; 18["18 LM FAILED"]     16 -- YES --&gt; 17["17 EVA RCU 'A' VOLUME CIRCUIT FAILED"]     16 -- NO --&gt; 19["19 Does EVA hear sidetone"]     19 -- YES --&gt; 20["20 EVA 'A' RCVR. RF SECTION OR R/T RELAY K-1 FAILED"]     19 -- NO --&gt; 22["22 Did LM receive voice from EVA"]     22 -- YES --&gt; 23["23 EVA 'A' RCVR. OR R/T RELAY K-1 FAILED"]     22 -- NO --&gt; 21["21 PRI./DUAL COMM. REGUL. FAILED"]     </pre>	

AFOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 19</b></p> <p>LM loses voice from EVA (see "Additional conditions" below)</p> <p>Additional conditions:</p> <ol style="list-style-type: none"> <li>1. Single EVA</li> </ol> <p>Possible causes:</p> <ol style="list-style-type: none"> <li>a. LM failed</li> <li>b. EVA RCU PTT switch turned OFF</li> <li>c. EVA VOX circuit failed</li> <li>d. EVA "A" mode failed</li> <li>e. EVA comm. carrier failed</li> <li>f. EVA RCU VOX circuit failed</li> </ol> <p>(continued next page)</p>	<p style="text-align: center;"><b>EVA PROCEDURE</b></p> <pre> graph TD     Start[LM loses voice from EVA] --&gt; Step1{1 Does LM receive voice from MSFN}     Step1 -- YES --&gt; Step2{2 Does MSFN have voice from EVA}     Step1 -- NO --&gt; Step4{4 LM FAILED}     Step2 -- YES --&gt; Step3{3 LM FAILED}     Step2 -- NO --&gt; Step5{5 EVA insure RCU PTT Switch in MAIN position Comm. restored}     Step5 -- YES --&gt; Step6{6 EVA RCU PTT SWITCH ACCIDENTLY SET TO OFF}     Step5 -- NO --&gt; Step7{7 EVA set RCU to PTT Comm. restored}     Step7 -- YES --&gt; Step15[To Step 15 Next page]     Step7 -- NO --&gt; Step8{8 EVA set Mode Sel. Sw. to "B" mode Comm. restored}     Step8 -- YES --&gt; Step9{9 EVA "A" MODE FAILED OR LM FAILED CONFIG. IM FOR "B" MODE}     Step8 -- NO --&gt; Step10{10 EVA check comm. using other PLSS/OPS Comm. with LM}     Step9 --&gt; Step15     Step10 -- YES --&gt; Step16[To Step 16 Next page]     Step10 -- NO --&gt; Step11[To Step 11 Next page]                     </pre> <p style="text-align: center;"><b>POST EVA PROCEDURE</b></p>	



APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p>Possible causes: (Continued from preceding page)</p> <p>g. EVA RCU mode select "A" wafer failed</p> <p>h. EVA antenna failed</p> <p>i. EVA triplexer common port failed</p> <p>j. Suit electrical harness failed</p>	<p style="text-align: center;"><b>POST EVA PROCEDURE (continued)</b></p> <pre> graph TD     11["11 ● EVA swap comm. carrier Comm. restored"] -- YES --&gt; 12["12 EVA COMM. CARRIER FAILED"]     11 -- NO --&gt; 13["13 ● LM OR SUIT ELECTRICAL HARNESS FAILED"]     13 --&gt; 14["14 EVA RCU VOX CIRCUIT FAILED"]     14 --&gt; 15["15 ● Swap RCU ● EVA operates in MAIN Comm. all right"]     15 -- YES --&gt; 14     15 -- NO --&gt; 18["18 EVA VOX CIRCUIT FAILED"]     16["16 ● EVA swap back to original RCU Comm. restored"] -- YES --&gt; 17["17 ● EVA swap back to original OPS Comm. all right"]     16 -- NO --&gt; 19["19 EVA RCU 'A' WAFER MODE SELECTOR FAILED"]     17 -- YES --&gt; 21["21 EVA TRIPLEXER FAILED"]     17 -- NO --&gt; 20["20 EVA ANTENNA FAILED"]     18 --&gt; 21                 </pre>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 20</b></p> <p>①</p> <p>GT8168P/ GT8268P PGA pressure &lt;3.7 psid and apparently stable (no warning tone)</p> <p>Possible causes:</p> <p>a. GT8168P/ GT8268P failed</p> <p>b. PLSS O<sub>2</sub> regulator shift/de- graded</p> <p>c. EMU leak</p>	<p><b>EMERGENCY PROCEDURE</b></p> <p>①</p> <p>1 ● Low PGA pressure flag "0"</p> <p>1A WARNING TONE FAILED</p> <p>2 Go to Step 1 Page 5-6</p> <p>3 PGA Press. Gage &lt;3.7 psia</p> <p>4 ● Monitor PGA Press. for 1 min Is there a decay</p> <p>5 ● Actuate OPS</p> <p>6 ● Flex arms Does GT8168P/ GT8268P PGA Press. respond</p> <p>7 GT8168P/ GT8268P PGA PRESS. FAILED</p> <p><b>EVA PROCEDURE</b></p> <p><b>POST EVA PROCEDURE</b></p> <p>9 ● Doff P SS/ OPS</p> <p>8 Go to Step 5 Page 5-6</p> <p>To Step 10 Next page</p>	<p>①</p> <p>PLSS O<sub>2</sub> pressure regulator regu- lates the PGA to 3.7 psid minimum if flow is 0.07 to 0.7 lb/hr.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
POST EVA PROCEDURE (continued)		
	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>10</p> <ul style="list-style-type: none"> <li>● PLSS O<sub>2</sub> Regul. Verification</li> <li>● Connect blue PLSS Gas Connector to OPS Regul. Checkout Storage Plate</li> </ul> <p>Press. &gt; 3.7 psid</p> </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p style="text-align: center;">NO</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>12</p> <p>SHIFT IN PLSS O<sub>2</sub> REGULATED PRESSURE</p> </div> </div> <div style="width: 45%;"> <p style="text-align: center;">YES</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>11</p> <ul style="list-style-type: none"> <li>● PGA Press. Readout Check</li> <li>● Connect PGA to ECS Hoses</li> <li>● Don Helmet and Gloves</li> </ul> <p>GT8168P/GT8268P PGA Press. &lt; 3.7 psia and constant</p> </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p style="text-align: center;">NO</p> <div style="border: 1px solid black; padding: 5px;"> <p>14</p> <p>TRANSIENT ERROR IN GT8168P/GT8268P PGA PRESS. READING</p> </div> </div> <div style="width: 45%;"> <p style="text-align: center;">YES</p> <div style="border: 1px solid black; padding: 5px;"> <p>13</p> <p>SHIFT IN GT8168P/GT8268P PGA PRESS. CALIBRATION</p> </div> </div> </div> </div> </div>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 21</b></p> <p>① GT8168P/ GT8268P PGA Press. &gt;4.0 psid</p> <p>Possible causes: a. Regulator fails open or shifts set point b. GT8168P/ GT8268P fails</p>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <p>① High O<sub>2</sub> flow flag "0" (after 5 sec); or GT8182P/ GT8282P PLSS O<sub>2</sub> pressure or PLSS O<sub>2</sub> quant. indic. decreas- ing rapidly</p> <p>YES → ② ● Actuate OPS</p> <p>③ PLSS O<sub>2</sub> PRESS. REG. FAILED OPEN OR SHIFTED SET POINT</p> <hr/> <p style="text-align: center;"><b>EVA PROCEDURE</b></p> <p>④ Does PGA Press. Gage agree with GT8168P/GT8268P PGA Press.</p> <p>YES → ⑤ SHIFT IN PLSS O<sub>2</sub> REGULATED PRESS.</p> <p>NO → ⑥ Reduced mobility or hear relief Vlv. relieving</p> <p>YES → ⑦ PGA PRESS. GAGE FAILED</p> <p>NO → ③ ⑧ GT8168P/GT8268P PGA PRESS. FAILED</p>	<p>① PLSS O<sub>2</sub> pressure regulator regulates to 4.0 psid maximum to PGA. PGA pressure relief valve cracks at 4.5 to 5.5 psid.</p> <p>② The PLSS O<sub>2</sub> shutoff valve should be CLOSED if possible. If additional mobility is needed, open purge valve to reduce PGA pressure to &gt;3.4 psid.</p> <p>③ Upon returning to the LM, Steps 7 and 8 can be verified by con- necting the blue PLSS gas con- nector to the OPS pressure regulator checkout stowage plate.</p>

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SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 22</b></p> <div style="border: 1px solid black; padding: 2px;">                     GT8182P/ GT8282P PLSS O<sub>2</sub> pressure abnormal                 </div> <p>Possible causes:</p> <ul style="list-style-type: none"> <li>a. GT8182P/ GT8282P failed</li> <li>b. EMU leak</li> <li>c. Common PLSS O<sub>2</sub> pressure sensor failed</li> <li>d. PLSS O<sub>2</sub> pressure regulator out of spec.</li> <li>e. High O<sub>2</sub> usage</li> </ul>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <div style="text-align: center;"> <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">1</span> <span style="margin-left: 200px; border: 1px solid black; border-radius: 50%; padding: 2px;">2</span> </div> <div style="border: 1px solid black; padding: 2px;">                     1 Low PGA pressure flag "0", or PGA pressure gage reads &lt;3.7 psia or GT8168P/ GT8268P PGA pressure &lt;3.7 psia and decreasing                 </div> <div style="border: 1px solid black; padding: 2px;">                     2 ● Actuate OPS                 </div> <div style="border: 1px solid black; padding: 2px;">                     3 High O<sub>2</sub> flow flag "0"                 </div> <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;"><b>EVA PROCEDURE</b></p> <div style="border: 1px solid black; padding: 2px;">                     4 PLSS O<sub>2</sub> Quantity Indicator abnormal reading                 </div> <div style="border: 1px solid black; padding: 2px;">                     5 Go to Step 5 Page 5-6                 </div> <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;"><b>POST EVA PROCEDURE</b></p> <div style="border: 1px solid black; padding: 2px;">                     6 ● Recharge PLSS O<sub>2</sub> </div> <div style="border: 1px solid black; padding: 2px;">                     7 ● Connect PLSS O<sub>2</sub> Bottle to LM ECS  Does GF3589P PLSS Recharge Press. agree with GT8182P/GT8282P                 </div> <div style="border: 1px solid black; padding: 2px;">                     8 GT8182P/GT8282P PLSS O<sub>2</sub> Press. shows recharge                 </div> <div style="border: 1px solid black; padding: 2px;">                     9 PLSS O<sub>2</sub> QUANTITY INDICATOR FAILED                 </div> <div style="border: 1px solid black; padding: 2px;">                     10 PLSS O<sub>2</sub> PRESS. REDUCER FAILED (COMMON REDUCER)                 </div> <div style="border: 1px solid black; padding: 2px;">                     11 ● PLSS O<sub>2</sub> shutoff valve - OFF                 </div> <p style="text-align: center;">To Step 12 Next page</p> <p style="text-align: center;">To Step 13 Next page</p>	<div style="text-align: center;"> <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">1</span> </div> <p>1600 Btu/hr metabolic load plus allowable EMU leakage consumes approximately 0.25 lb/ hr O<sub>2</sub>. Without makeup O<sub>2</sub>, this will reduce PGA pressure to 3 psia in approximately 3 min.</p> <div style="text-align: center;"> <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">2</span> </div> <p>OPS regulates at 3.4 to 4.0 psia.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
	<p style="text-align: center;">POST EVA PROCEDURE (continued)</p> <pre> graph TD     12["12 GT/8182P/GT8282P PLSS O<sub>2</sub> PRESS. FAILED."] --&gt; 13["13 ● Recharge PLSS O<sub>2</sub>"]     13 --&gt; 15["15 GF3589P PLSS Recharge Press. stable after 50 minutes"]     15 -- YES --&gt; 14["14 LEAK BETWEEN PLSS O<sub>2</sub> SHUTOFF VLV. AND HIGH O<sub>2</sub> FLOW SENSOR"]     15 -- NO --&gt; 16["16 LEAK UPSTREAM OF PLSS O<sub>2</sub> SHUTOFF VLV."]                     </pre>	

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SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 23</b></p> <p>①</p> <p>GT8182P/ GT8282P PLSS O<sub>2</sub> pressure &lt;800 psia (pre-EVA)</p> <p>Possible causes:</p> <p>a. GT8182P/ GT8282P failed</p> <p>b. Inadequate PLSS O<sub>2</sub> charge for EVA</p> <p>c. Common PLSS O<sub>2</sub> pressure sensor failed</p>	<p><b>PRE-EVA PROCEDURE</b></p> <pre> graph TD     Start[1: GT8182P/GT8282P PLSS O2 pressure &lt;800 psia (pre-EVA)] --&gt; Step1[1: PLSS O2 Quantity Indicator &gt;3/4]     Step1 -- YES --&gt; Step2[2: Connect PLSS O2 Bottle to LM ECS GF3589P PLSS Recharge Press. &lt;800 psia]     Step1 -- NO --&gt; Step4[4: Connect PLSS O2 bottle to LM ECS GF3589P PLSS Recharge Press. &lt;800 psia]     Step2 -- YES --&gt; Step3[3: PLSS O2 QUANTITY INDICATOR FAILED]     Step2 -- NO --&gt; Step5[5: GT8182P/GT8282P PLSS O2 PRESS. FAILED]     Step4 -- YES --&gt; Step6[6: INSUFFICIENT O2 SUPPLY TO SUPPORT PLANNED EVA]     Step4 -- NO --&gt; Step7[7: Pressurize LM PLSS Manifold from LM ECS GF3589P PLSS recharge pressure &lt;800 psia]     Step5 --&gt; Step6     Step7 -- YES --&gt; Step8[8: GF3589P PLSS RECHARGE PRESSURE FAILED]     Step7 -- NO --&gt; Step9[9: COMMON PLSS O2 PRESSURE SENSOR FAILED]     Step3 --&gt; Step6     Step8 --&gt; Step6     </pre>	<p>①</p> <p>Provides enough O<sub>2</sub> for:</p> <p>a) PLSS checkout b) &gt;3 hours normal operation at 1200 Btu/hr metabolic load, plus allowable EMU leakage.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 24</b></p> <p>①</p> <p>GT8182P/GT8282P PLSS O<sub>2</sub> pressure &lt;350 psia (post-EVA)</p> <p>Possible causes:</p> <p>a. GT8182P/ GT8282P failed</p> <p>b. Common PLSS O<sub>2</sub> pressure sensor failed</p> <p>c. Inadequate PLSS O<sub>2</sub> charge for contingency transfer to CM</p>	<p><b>POST EVA PROCEDURE</b></p> <pre> graph TD     Start[GT8182P/GT8282P PLSS O2 pressure &lt;350 psia (post-EVA)] --&gt; Step1[1 PLSS O2 Quantity Indicator &lt;1/4 full]     Step1 -- YES --&gt; Step2[2 ● Connect PLSS O2 Bottle to LM ECS GF3589P PLSS Recharge Press.&lt;350 psia]     Step1 -- NO --&gt; Step7[7 ● Connect PLSS O2 Bottle to LM ECS GF3589P PLSS Recharge Press.&lt;350 psia]     Step2 -- YES --&gt; Step3[3 INSUFFICIENT PLSS O2 SUPPLY TO SUPPORT A CONTINGENCY TRANSFER TO CM]     Step2 -- NO --&gt; Step4[4 ● Pressurize LM PLSS Manifold from LM ECS Does GF3589P read &gt;800 psia]     Step4 -- YES --&gt; Step5[5 COMMON PLSS O2 PRESSURE SENSOR FAILED]     Step4 -- NO --&gt; Step6[6 GF3589P PLSS RECHARGE PRESSURE FAILED]     Step5 --&gt; Step3     Step6 --&gt; Step3     Step7 -- YES --&gt; Step8[8 PLSS O2 QUANTITY INDICATOR FAILED]     Step7 -- NO --&gt; Step9[9 GT8182P/GT8282P PLSS O2 PRESS. FAILED]     Step8 --&gt; Step3     </pre>	<p>①</p> <p>Provides enough O<sub>2</sub> for:</p> <p>a. PLSS checkout</p> <p>b. 30-min contingency transfer at 2000 Btu/hr.</p>



APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 25</b></p> <p>GT8110P/GT8210P feedwater pressure &lt;1.8 psid (no warning tone)</p> <p>Possible causes:</p> <ol style="list-style-type: none"> <li>GT8110P/GT8210P failed</li> <li>Sublimator breakthrough</li> <li>H<sub>2</sub>O separator blocked</li> <li>Depleted feedwater reservoir</li> <li>Blockage between feedwater bladder and pressure Xducer</li> <li>Feedwater pressure Xducer failed</li> <li>High feedwater usage rate</li> <li>Low PGA pressure</li> <li>Feedwater valve CLOSED</li> </ol>	<p align="center"><b>EMERGENCY PROCEDURE</b></p> <pre> graph TD     S1[1] -- YES --&gt; S2[2]     S1 -- NO --&gt; S4[4]     S2 --&gt; S3[3]     S4 -- YES --&gt; S5[5]     S4 -- NO --&gt; S7[7]     S5 --&gt; S6[6]     S7 --&gt; S8[8]     S8 -- YES --&gt; S9[9]     S8 -- NO --&gt; S12[12]     S9 --&gt; S10[10]     S10 --&gt; S11[11]     S11 --&gt; S12                     </pre> <p><b>EVA PROCEDURE</b></p> <p>11 ● Sublimator restart</p> <ul style="list-style-type: none"> <li>● Feedwater valve - CLOSED</li> <li>● PLSS diverter - MAX. cooling</li> <li>● After 5 min, PLSS diverter - MIN. cooling</li> <li>● Feedwater valve - OPEN</li> </ul> <p>To Step 12 Next page</p>	<p>① Low feedwater pressure warning actuates at 1.45 ± 0.15 psid.</p> <p>② The heat load should be maintained during the first 5 min since the objective is to dry-out the sublimator.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 24:</b></p> <p>①</p> <p>GT8182P/GT8282P PLSS O<sub>2</sub> pressure &lt;350 psia (post-EVA)</p> <p>Possible causes:</p> <p>a. GT8182P/ GT8282P failed</p> <p>b. Common PLSS O<sub>2</sub> pressure sensor failed</p> <p>c. Inadequate PLSS O<sub>2</sub> charge for contingency transfer to CM</p>	<p><b>POST EVA PROCEDURE</b></p> <pre> graph TD     Start[1: PLSS O2 Quantity Indicator &lt;1/4 full] -- YES --&gt; Step2[2: Connect PLSS O2 Bottle to LM ECS; GF3589P PLSS Recharge Press. &lt;350 psia]     Start -- NO --&gt; Step7[7: Connect PLSS O2 Bottle to LM ECS; GF3589P PLSS Recharge Press. &lt;350 psia]     Step2 -- YES --&gt; Step3[3: INSUFFICIENT PLSS O2 SUPPLY TO SUPPORT A CONTINGENCY TRANSFER TO CM]     Step2 -- NO --&gt; Step4[4: Pressurize LM PLSS Manifold from LM ECS; Does GF3589P read &gt;800 psia?]     Step4 -- YES --&gt; Step5[5: COMMON PLSS O2 PRESSURE SENSOR FAILED]     Step4 -- NO --&gt; Step6[6: GF3589P PLSS RECHARGE PRESSURE FAILED]     Step7 -- YES --&gt; Step8[8: PLSS O2 QUANTITY INDICATOR FAILED]     Step7 -- NO --&gt; Step9[9: GT8182P/GT8282P PLSS O2 PRESS. FAILED]     Step3 --&gt; Remarks[1: Provides enough O2 for: a. PLSS checkout b. 30-min contingency transfer at 2000 Btu/hr.]     Step5 --&gt; Remarks     Step6 --&gt; Remarks     Step8 --&gt; Remarks     Step9 --&gt; Remarks                     </pre>	<p>①</p> <p>Provides enough O<sub>2</sub> for:</p> <p>a. PLSS checkout</p> <p>b. 30-min contingency transfer at 2000 Btu/hr.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 25</b></p> <p>GT8110P/GT8210P feedwater pressure &lt;1.8 psid (no warning tone)</p> <p>Possible causes:</p> <ol style="list-style-type: none"> <li>GT8110P/GT8210P failed</li> <li>Sublimator breakthrough</li> <li>H<sub>2</sub>O separator blocked</li> <li>Depleted feedwater reservoir</li> <li>Blockage between feedwater bladder and pressure Xducer</li> <li>Feedwater pressure Xducer failed</li> <li>High feedwater usage rate</li> <li>Low PGA pressure</li> <li>Feedwater valve CLOSED</li> </ol>	<p align="center"><b>EMERGENCY PROCEDURE</b></p> <pre> graph TD     S1[1] --&gt; S2[2]     S1 -- NO --&gt; S4[4]     S2 -- YES --&gt; S3[3]     S4 -- YES --&gt; S5[5]     S4 -- NO --&gt; S7[7]     S5 -- YES --&gt; S6[6]     S7 --&gt; S8[8]     S8 -- YES --&gt; S9[9]     S8 -- NO --&gt; S12[To Step 12 Next page]     S9 --&gt; S10[10]     S10 --&gt; S11[11]                     </pre> <p><b>EMERGENCY PROCEDURE</b></p> <p>1 Low PGA pressure flag "0", or PGA pressure gage &lt;3.1 psia</p> <p>2 WARNING TONE FAILED</p> <p>3 Go to Step 1 Page 5-6</p> <p>4 Low feedwater pressure flag "A"</p> <p>5 WARNING TONE FAILED</p> <p>6 Go to Step 1 Page 5-12</p> <p>7 ● If additional cooling is required, actuate OPS and open purge valve.</p> <p align="center"><b>EVA PROCEDURE</b></p> <p>8 GT8196T/GT8296T LOG H<sub>2</sub>O ΔT &gt;15° F for &gt;5 min and GT8110P/GT8210P feedwater pressure &lt;1.3 psia</p> <p>9 PLSS ALARM CONTROL MODULE FAILED (LOW FEEDWATER PRESSURE FLAG AND TONE)</p> <p>10 SUBLIMATOR BREAKTHROUGH</p> <p>11 ● Sublimator restart          ● Feedwater valve - CLOSED          ● PLSS diverter - MAX. cooling          ● After 2 min, PLSS diverter - MIN. cooling          ● Feedwater valve - OPEN</p>	<p>① Low feedwater pressure warning actuates at 1.45 ± 0.15 psid.</p> <p>② The heat load should be maintained during the first 2 min since the objective is to dry-out the sublimator.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
POST EVA PROCEDURE		
	<div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>12</p> <ul style="list-style-type: none"> <li>● Close PLSS Feedwater Vlv.</li> </ul> <p>Warning tone and low feedwater pressure flag "A" within 5 min</p> </div> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>13</p> <ul style="list-style-type: none"> <li>● Open PLSS Feedwater Vlv.</li> <li>● Repress LM</li> </ul> <p>GT8110P/GT8210P Feedwater Press. increase with LM Press.</p> </div> <div style="border: 1px solid black; padding: 5px; width: 30%;"> <p>14</p> <p>HIGH FEEDWATER USAGE RATE</p> </div> </div> <div style="margin-top: 20px; margin-left: 100px;"> <p>15</p> <p>GT8110P/GT8210P FEEDWATER PRESSURE FAILED</p> </div> <div style="margin-top: 40px; margin-left: 100px;"> <p>16</p> <p>COMMON FEEDWATER PRESS. XDUCKER FAILED</p> </div> <pre> graph TD     12 -- YES --&gt; 13     12 -- NO --&gt; 16     13 -- YES --&gt; 14     13 -- NO --&gt; 15                     </pre>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 26</b></p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;">                     GT815T/ GT8154T GT8254T LCG H<sub>2</sub>O temperature &gt; 68° F with diverter valve in MAX. cooling                 </div> <p>Possible causes:</p> <ol style="list-style-type: none"> <li>GT8154T/ GT8254T failed</li> <li>Sublimator degraded</li> <li>Feedwater flow re- stricted</li> <li>Sublimator breakthrough</li> </ol>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;"><b>EVA PROCEDURE</b></p> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; width: 100%; justify-content: space-between;"> <div style="width: 45%; border: 1px solid black; padding: 5px;"> <p style="text-align: center;">1</p> <ul style="list-style-type: none"> <li>● Actuate gas trap for <math>\sum</math> sec</li> </ul> <p>GT8154T/ GT8254T &lt;68° F within <math>\sum</math> min</p> </div> <div style="width: 45%; border: 1px solid black; padding: 5px;"> <p style="text-align: center;">2</p> <p style="text-align: center;">GAS IN TRANSPORT WATER LINE</p> </div> </div> <div style="display: flex; width: 100%; justify-content: space-between; margin-top: 10px;"> <div style="width: 45%; border: 1px solid black; padding: 5px;"> <p style="text-align: center;">3</p> <p>GT8196T/ GT8296T LCG H<sub>2</sub>O <math>\Delta T</math> &gt;15° F &gt;5 min and GT8110P/ GT8210P feed- water pres- sure &lt;1.3 psia</p> </div> <div style="width: 45%; border: 1px solid black; padding: 5px;"> <p style="text-align: center;">4</p> <p style="text-align: center;">SUBLIMATOR BREAKTHROUGH</p> </div> </div> <div style="display: flex; width: 100%; justify-content: space-between; margin-top: 10px;"> <div style="width: 45%; border: 1px solid black; padding: 5px;"> <p style="text-align: center;">6</p> <p>GT8196T/ GT8296T LCG H<sub>2</sub>O <math>\Delta T</math> &lt;5° F AND/OR GT8170T/ GT8270T O<sub>2</sub> TEMPERA- TURE &gt;50° F</p> </div> <div style="width: 45%; border: 1px solid black; padding: 5px;"> <p style="text-align: center;">5</p> <ul style="list-style-type: none"> <li>● Sublimator re- start</li> <li>● Feedwater valve - CLOSED</li> <li>● PLSS diverter - MAX. cooling</li> <li>● After <math>\sum</math> min, PLSS diverter valve - MIN. cooling</li> <li>● Feedwater valve - OPEN</li> </ul> </div> </div> <div style="display: flex; width: 100%; justify-content: space-between; margin-top: 10px;"> <div style="width: 45%; border: 1px solid black; padding: 5px;"> <p style="text-align: center;">8</p> <p>GT8154T/ GT8254T LCG H<sub>2</sub>O TEMP- ERATURE FAILED</p> </div> <div style="width: 45%; border: 1px solid black; padding: 5px;"> <p style="text-align: center;">7</p> <p style="text-align: center;">SUBLIMATOR DEGRADED OR FEEDWATER FLOW RE- STRICTED</p> </div> </div> </div>	

①

The heat load should be maintained during the first  $\sum$  min since the objective is to dry-out the sublimator.

②

Actuation of the gas trap must be performed by another EV crewman. It cannot be self-accomplished.

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SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 27</b></p> <div style="border: 1px solid black; padding: 2px;">                     GT8196T/GT8296T                      LCG H<sub>2</sub>O AT                      &gt;11° F                      (MAX. diverter                      valve position)                 </div> <p>Possible causes:</p> <ul style="list-style-type: none"> <li>a. GT8196T/ GT8296T failed</li> <li>b. Pump de- gradation</li> <li>c. Gas in trans- port water line</li> <li>d. Sublimator breakthrough</li> </ul>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;"><b>EVA PROCEDURE</b></p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <div style="border: 1px solid black; padding: 2px;"> <p>1 GT8154T/ GT8254T LCG H<sub>2</sub>O Temp. &lt;45° F</p> </div> <div style="border: 1px solid black; padding: 2px;"> <p>3 GT8140C/ GT8240C PLSS Batt. Current &gt;3.0 amps</p> </div> <div style="border: 1px solid black; padding: 2px;"> <p>5 ● Actuate gas trap for 5 sec  Cooling improved in 3 min</p> </div> </div> <div style="width: 45%;"> <div style="border: 1px solid black; padding: 2px;"> <p>2 PUMP DEGRADATION (COOLANT FLOW RATE &lt;3.5 LB/MIN.)</p> </div> <div style="border: 1px solid black; padding: 2px;"> <p>4 GT8154T/ GT8254T LCG H<sub>2</sub>O TEMP. FAILED</p> </div> <div style="border: 1px solid black; padding: 2px;"> <p>6 GAS IN TRANSPORT WATER LINE</p> </div> </div> </div> <p style="text-align: center;">To Step 7 Next page</p>	<p>① During EVA operations, actuation of the gas trap can be performed by an assisting crewman only.</p>

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
	<p style="text-align: center;"><b>EVA PROCEDURE (continued)</b></p> <pre> graph TD     7["7 GT8196T/ GT8296T LCG H<sub>2</sub>O ΔT &gt; 15° F &gt; 5 min and GT8110F/ GT8210F feed- water pressure &lt;1.3 psia"] -- YES --&gt; 8["8 SUBLIMATOR BREAKTHROUGH"]     7 -- NO --&gt; 9["9 GT8196T/ GT8296T LCG H<sub>2</sub>O ΔT FAILED OR SHIFTED CALI- BRATION"]     8 -- 1 --&gt; 10["10 ● Sublimator restart ● Feedwater valve-CLOSED ● PLSS diverter valve - MAX. cooling ● After 5 min, PLSS diverter valve - MIN. cooling ● Feedwater valve - OPEN"]                     </pre>	<p>① The heat load should be maintained during the first 5 min since the objective is to dry-out the sublimator.</p>

APOLLO OPERATIONS HANDBOOK-EMU

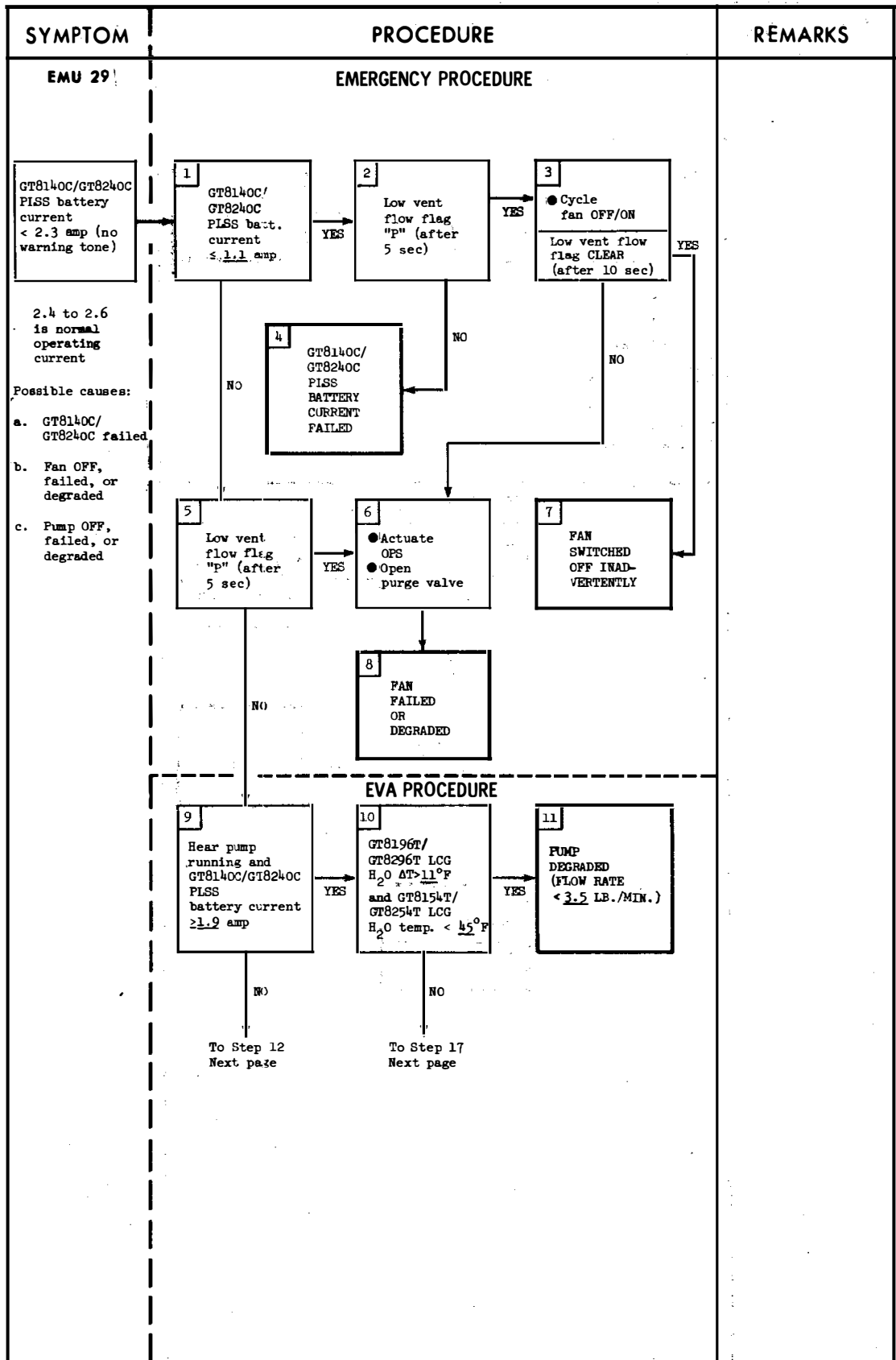
SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 28</b></p> <p>①</p> <p>GT8140C/GT8240C PLSS battery current &gt; <u>3.0</u> amps</p> <p>2.4 to 2.6 is normal operating current</p> <p>Possible causes:</p> <p>a. GT8140C/ GT8240C failed</p> <p>b. Fan degraded</p> <p>c. Current sensor failed</p> <p>d. Pump degraded</p>	<p><b>EMERGENCY PROCEDURE</b></p> <p>1</p> <p>GT8140C/GT8240C double normal current reading</p> <p>YES</p> <p>2</p> <p>ONE OF TWO CURRENT SENSOR ELEMENTS FAILED OPEN</p> <p>3</p> <p>Low vent flow flag "p"</p> <p>YES</p> <p>4</p> <p>● Actuate OPS, open purge valve</p> <hr/> <p><b>EVA PROCEDURE</b></p> <p>5</p> <p>GT8170T/GT8270T O<sub>2</sub> Temp. &lt; <u>38</u>°F</p> <p>YES</p> <p>6</p> <p>FAN DEGRADED</p> <p>7</p> <p>● Fan - CFF/ON</p> <p>GT8140C/GT8240C PLSS battery current <u>≤ 1.1</u> amp. while fan is OFF</p> <p>YES</p> <p>NO</p> <p>To Step 8 Next page</p>	<p>①</p> <p>Nominal PLSS power loads with EVCS operating in the primary mode:</p> <p>a. EVCS - <u>0.6</u> amp</p> <p>b. Fan - <u>1.3</u> amp</p> <p>c. Pump - <u>0.5</u> amp</p> <p>Total <u>2.4</u> amp</p>



APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
	<p style="text-align: center;"><b>EVA PROCEDURE (continued)</b></p> <pre> graph TD     8["8 GT8196T/GT8296T LCG H<sub>2</sub>O ΔT &gt;11 °F and/or GT8154T/GT8254T LCG H<sub>2</sub>O Temp. &lt;45 °F"] -- YES --&gt; 9["9 ● If required for cooling, actuate OPS and open purge valve"]     8 -- NO --&gt; 11["11 ● Turn pump OFF/ON  GT8140C/GT8240C PLSS battery current &lt;1.9 amp when pump is OFF"]     9 --&gt; 10["10 PUMP DEGRADED (FLOW RATE &lt;3.5 lb./min.)"]     10 --&gt; 11     11 -- YES --&gt; 10     11 -- NO --&gt; 12["12 Record GT8141V/ GT8241V Battery Voltage"]             </pre> <p style="text-align: center;"><b>POST EVA PROCEDURE</b></p>	<p>① Normal PLSS battery voltage = 16.8 ± 0.8 Vdc and GT8141V/GT8241V inaccuracy is ±0.19 Vdc.</p>

APOLLO OPERATIONS HANDBOOK-EMU



CSD-A-789-(2)  
**APOLLO OPERATIONS HANDBOOK-EMU**

SYMPTOM	PROCEDURE	REMARKS
	<p><b>EVA PROCEDURE (continued)</b></p> <pre> graph TD     12["12 Pump switch ON"] -- YES --&gt; 13["13 ● If additional cooling re- quired, actuate OPS and open purge valve"]     12 -- NO --&gt; 15["15 PUMP SWITCHED OFF INADVERTENTLY"]     13 --&gt; 14["14 PUMP FAILED"]                     </pre>	
	<p><b>POST EVA PROCEDURE</b></p> <pre> graph TD     17["17 ● Record GT8141V/GT8241V Battery Voltage"] --&gt; 16["16 ● Replace Battery (from other PLSS)"]     16 --&gt; 18["18 GT8141V/GT8241V PLSS Batt. Volt. &gt;16.0 Vdc"]     18 -- YES --&gt; 19["19 DEGRADED BATTERY"]     18 -- NO --&gt; 20["20 GT8141V/GT8241V PLSS BATT. VOLT. FAILED"]                     </pre>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 30</b></p> <div style="border: 1px solid black; padding: 5px;">                     GT8141V/ GT8241V PLSS battery voltage <math>\leq 16.0</math> Vac (no warn- ing tone)                 </div> <div style="border: none; padding: 5px;">                     Possible causes:                      a. GT8141V/ GT8241V failed                      b. Battery failed or degraded                 </div>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <div style="border: 1px solid black; padding: 5px;">                     1                      Low vent flow flag "p" (after 5 sec)                 </div> <div style="border: 1px solid black; padding: 5px;">                     2                      ● Actuate OPS                      ● Open purge valve                 </div> <div style="border: 1px solid black; padding: 5px;">                     3                      BATTERY FAILED                 </div> <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;"><b>EVA PROCEDURE</b></p> <div style="border: 1px solid black; padding: 5px;">                     4                      GT8170T/GT8270T                      O<sub>2</sub> Temp. <math>&lt; 38^{\circ}\text{F.}</math>,                      or GT8196T/ GT8296T LCG                      H<sub>2</sub>O Temp. <math>&gt; 11^{\circ}\text{F.}</math>                      and GT8154T/ GT8254T LCG                      H<sub>2</sub>O Temp. <math>&lt; 45^{\circ}\text{F}</math>                      or, sense                      any indication                      of degraded                      fan or pump                 </div> <div style="border: 1px solid black; padding: 5px;">                     5                      BATTERY FAILING                 </div> <div style="border: none; padding: 5px;">                     To Step 6                      Next page                 </div>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
	<p style="text-align: center;"><b>POST EVA PROCEDURE</b></p> <pre> graph TD     6["6 • Replace Battery (from other PLSS)"] --&gt; 7["7 GT8141V/GT8241V PLSS Batt. Volt. &gt;16.0 Vdc"]     7 -- YES --&gt; 8["8 DEGRADED BATTERY"]     7 -- NO --&gt; 9["9 GT8141V/GT8241V PLSS Batt. Voltage failed"]                     </pre>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p><b>EMU 31</b></p> <p>GT8170T/ GT8270T O<sub>2</sub> temperature ≤38° F (no warning tone)</p> <p>Possible causes:</p> <ul style="list-style-type: none"> <li>a. GT8170T/ GT8270T failed</li> <li>b. Fan OFF or degraded</li> <li>c. High PGA AP</li> <li>d. Flow restriction in vent loop</li> </ul>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>1 Low vent flow flag "P" YES → 2 Go to Step 1 Page 5-4</p> <p>NC ↓</p> </div> <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;"><b>EVA PROCEDURE</b></p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>3 GT8140C/GT8240C PLSS Batt. Curr. &gt;3.0 amp YES → 4</p> <p>NC ↓</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>4 ● Fan OFF/ON GT8140C/GT8240C PLSS Battery Current ≤1.1 amp while fan OFF YES → 5 FAN DEGRADED</p> <p>NO ↓</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>6 GT8141V/GT8241V PLSS Batt. Volt ≤16.0 Vdc YES → 7 FAILING BATTERY CAUSED FAN DEGRADATION</p> <p>NO ↓</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p>8 GT8170T/GT8270T O<sub>2</sub> TEMPERATURE FAILED, OR HIGH PGA AP, OR FLOW RESTRICTION IN VENT LOOP</p> </div>	

APOLLO OPERATIONS HANDBOOK-EMU

SYMPTOM	PROCEDURE	REMARKS
<p>EMU 32</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">                     GT8170T/ GT8270T O<sub>2</sub> temperature &gt;52° F (no warning tone)                 </div> <p>Possible causes:</p> <ul style="list-style-type: none"> <li>a. GT8170T/ GT8270T failed</li> <li>b. Sublimator breakthrough or degradation</li> <li>c. Feedwater depleted</li> <li>d. Blocked water separator</li> </ul>	<p style="text-align: center;"><b>EMERGENCY PROCEDURE</b></p> <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;"><b>EVA PROCEDURE</b></p> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; justify-content: space-between; width: 100%;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>1 Low feedwater pressure flag "A"</p> </div> <div style="width: 10%; text-align: center;">YES</div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>2 Go to Step 1 Page 5-12</p> </div> </div> <div style="margin: 5px 0;">NO</div> <div style="display: flex; justify-content: space-between; width: 100%;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>3 GT8154T/GT8254T LCG H<sub>2</sub>O temper- ature &gt;68° F (Diverter valve- MAX. cooling)</p> </div> <div style="width: 10%; text-align: center;">YES</div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>4 SUBLIMATOR DEGRADED</p> </div> </div> <div style="margin: 5px 0;">NO</div> <div style="display: flex; justify-content: space-between; width: 100%;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>5 GT8196T/ GT8296T LCG H<sub>2</sub>O ΔT &gt;11° F</p> </div> <div style="width: 10%; text-align: center;">YES</div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>6 EXCESSIVE HEAT LOAD</p> </div> </div> <div style="margin: 5px 0;">NO</div> <div style="display: flex; justify-content: space-between; width: 100%;"> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>7 Crewman feels hot, sweats</p> </div> <div style="width: 10%; text-align: center;">YES</div> <div style="border: 1px solid black; padding: 5px; width: 45%;"> <p>6 EXCESSIVE HEAT LOAD</p> </div> </div> <div style="margin: 5px 0;">NO</div> <div style="border: 1px solid black; padding: 5px; width: 100%;"> <p>8 GT8170T/ GT8270T O<sub>2</sub> TEMP. FAILED</p> </div> </div>	