

## **Space Flight Operations Contract**

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# **Crew Escape Systems 2102**

October 1996

Contract NAS9-20000



**Crew Escape Systems  
2102**

October 1996

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## Preface

This document was prepared by the United Space Alliance under contract to the Mechanical, Booster, Maintenance, and Crew Systems Branch, Systems Division, NASA, Lyndon B. Johnson Space Center, Houston, Texas. Documentation support was provided by Hernandez Engineering, Inc., Space Flight Operations Contract (HEI-SFOC).

Information contained in this document is provided for the use and training of crewmembers and for use by escape instructors and others who need to know about equipment, systems, and procedures relating to orbiter emergency egress and crew rescue.

The document describes and explains the use of crew-worn equipment and orbiter hardware. It also identifies the escape modes and the orbiter crew response in each mode. It is intended to be a workbook to which notes and additional information presented in classroom sessions can be added.

Mission-specific data will sometimes differ from the material contained in this document. In that case, flight supplements, Crew Compartment Configuration Drawings (CCCDs), and escape instructors should be consulted.

Additions and revisions to the document will be issued as required. Periodic changes will be distributed per the distribution list. Those not on distribution, may call for updates. For copies of the document, call the Mission Operations Library at (713) 244-7060, or pick up copies in person at the library, B-4S, room 1303.

Comments, questions, or changes to this document should be directed to DF52, Crew Systems Section, (713) 483-2583 or 244-0092.

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# Chapter 1

## Introduction

### Overview

---

**Introduction** The crew escape systems facilitate safe and expeditious crew egress and escape from the orbiter in an emergency during the following mission phases:

- Prelaunch
- In flight (bailout)
- Postlanding

The crew escape systems include:

- Equipment worn by the crew; for example:
  - Launch and entry suit and helmet
  - Parachute harness and parachute assembly
  - Rescue and survival equipment
- Hardware built into the orbiter; for example:
  - Side hatch jettisoning system
  - Window 8 escape panel
  - Descent control devices (sky genies)
  - Escape pole (for bailout)
  - Egress slide

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**Purpose** This document describes the crew escape systems, the operation of these systems, and their use during specific emergency or contingency situations. It also discusses systems associated with crew emergency egress, including orbiter nominal seating, the Recumbent Seating System (RSS), seat ingress/egress, and the side hatch.

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## Overview, Continued

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### Objectives

On completing this document, you will be able to

1. Identify the components of:
    - Crew-worn escape equipment
    - Built-in escape hardware
    - Associated equipment and hardware
  2. Identify the functional features of this equipment and hardware.
  3. Identify the various emergency escape modes and crew action in each mode.
  4. Distinguish between the egress slide configuration for hatch on deployment and for hatch jettison deployment.
  5. Know the correct sequence in bailout.
  6. Identify Search and Rescue (SAR) resources for crew bailout.
- 

### In this document

Chapters describe the crew escape systems and their use as follows:

Chapter	Page
Crew-Worn Equipment	2.1-1
Orbiter Hardware	3.1-1
Emergency Egress and Escape	4.1-1

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## Chapter 2

# Crew-Worn Equipment

### Overview

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**Introduction**      The orbiter crewmembers wear equipment and gear that facilitate quick and safe egress/escape in an emergency occurring prelaunch, in flight, or post-landing. The crew-worn equipment and gear include the pressure suit and helmet, the parachute and harness, and rescue and survival aids.

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**Purpose**              This chapter describes the components, functional features, and operation and use of crew-worn emergency egress/escape equipment and associated hardware.

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**Objectives**        On completing this chapter, you will be able to identify:

1. The components and functional features of:
    - Launch and entry suits (older and upgraded versions)
    - Helmet, comm carrier assembly, headset interface unit
    - Suit cooling systems (older and upgraded versions)
    - Parachute harness and parachute assembly
    - Rescue and survival equipment
  2. The operation and use of this equipment and gear
- 

**In this chapter**    Sections describe the crew-worn escape gear as follows:

Section	Page
Launch and Entry Suits	2.2-1
Helmet, Comm Carrier Assembly, Headset Interface Unit	2.3-1
Personal Suit Cooling Systems	2.4-1
Parachute Harness, Personal Parachute Assembly	2.5-1
Rescue/Survival Gear	2.6-1

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## Notes

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# Launch and Entry Suits

## Introduction

All orbiter crewmembers wear a protective suit during launch and entry. The crewmembers don and doff their suits as follows:

Prelaunch	Launch	Postinsertion	On Orbit	Deorbit Prep	Entry	Postlanding
↑		↑		↑		↑
Don suit (in suit room, Operations and Checkout Building) before orbiter ingress		Doff suit and stow after seat egress		Don suit before seat ingress		Doff suit after orbiter egress

## *Suit use in transition*

Two types of suits are currently in use:

- The older type, commonly called the Launch/Entry Suit (LES)
- The newer, advanced type, presently referred to as the Advanced Crew Escape Suit (ACES)

Which type an individual crewmember wears depends on availability.

## *Suit functions*

The LES and the ACES have the same functions:

- Both protect the crewmembers from
  - Loss of cabin pressure and/or orbiter oxygen at altitudes to 100,000 ft.
  - Pooling of blood in the lower body after prolonged exposure to zero g.
  - Cold atmospheric and/or water temperatures after bailing out.
  - Contaminated atmosphere during flight or postlanding egress.
- Both deliver O<sub>2</sub> at the proper pressure and in the proper quantity for breathing and pressurization.

Note: For both suits, a “hard pressure” is experienced when cabin pressure equals an altitude of ~60,000 ft. (In an in-flight emergency, this would be a good indication to the crew that bailout is not yet safe.)

At ~40,000 ft, both suits are unpressurized. (Bailout is possible at this altitude without thermal injury to the crew or parachute failure.)

*Continued on next page*

## Launch and Entry Suits, Continued

**Suit differences** The table below summarizes the differences between the two suit types:

LES	ACES
<ul style="list-style-type: none"> <li>• Partial pressure suit with mechanical pressure exerted by pressure bladders.</li> <li>• Protection up to 100,000 ft for 30 min.</li> <li>• Full pressurization at 3.2 psi (relief valve operates at 5 psi).</li> <li>• Pressure bladders made of two layers of polyurethane-coated nylon fabric.</li> <li>• Two neck dams, the opening of each adjustable by a neck tab:             <ul style="list-style-type: none"> <li>– Upper neck dam required for regulator to work properly (maintain 1.5 in. of H<sub>2</sub>O in breathing cavity).</li> <li>– Lower neck dam is required for suit to maintain pressure integrity.</li> </ul> </li> <li>• Two pressure seals:             <ol style="list-style-type: none"> <li>1. Helmet visor</li> <li>2. Neck dam</li> </ol> </li> <li>• Integrated antigravity suit (g-suit).</li> <li>• Gloves connected to suit by valve and tube.</li> </ul>	<ul style="list-style-type: none"> <li>• Full pressure vessel providing an “atmosphere of protection.”</li> <li>• Protection up to 100,000 ft indefinitely.</li> <li>• Full pressurization at 3.5 psi (relief valve operates at 5 psi).</li> <li>• A single bladder made of a single layer of nylon fabric laminated to Gore-Tex (which stays cooler).</li> <li>• Single neck dam, its opening adjustable by a neck tab. A “vent tree” distributes O<sub>2</sub> to torso and limbs.</li> <li>• Six pressure seals:             <ol style="list-style-type: none"> <li>1. Helmet visor</li> <li>2. Neck dam</li> <li>3. Main suit zipper</li> <li>4. Bioinstrumentation Passthrough (BIP) plug</li> <li>5. Right glove</li> <li>6. Left glove</li> </ol> </li> <li>• Nonintegrated g-suit.</li> <li>• Gloves connected by wrist disconnects attached to suit.</li> </ul>

*Continued on next page*

## Launch and Entry Suits, Continued

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**Suit differences  
(cont)**

The table summarizing the differences between the two suit types continues below:

LES	ACES
<ul style="list-style-type: none"><li>• Tight fit to body; mobility constrained.</li><li>• LES has wrist dams to keep water out.</li></ul>	<ul style="list-style-type: none"><li>• Loose fit; adequate mobility.</li><li>• ACES gloves must be worn to keep water out.</li></ul>

Each type of suit is discussed in subsequent sections:

- LES - Section 2.2a
  - ACES - Section 2.2b
-

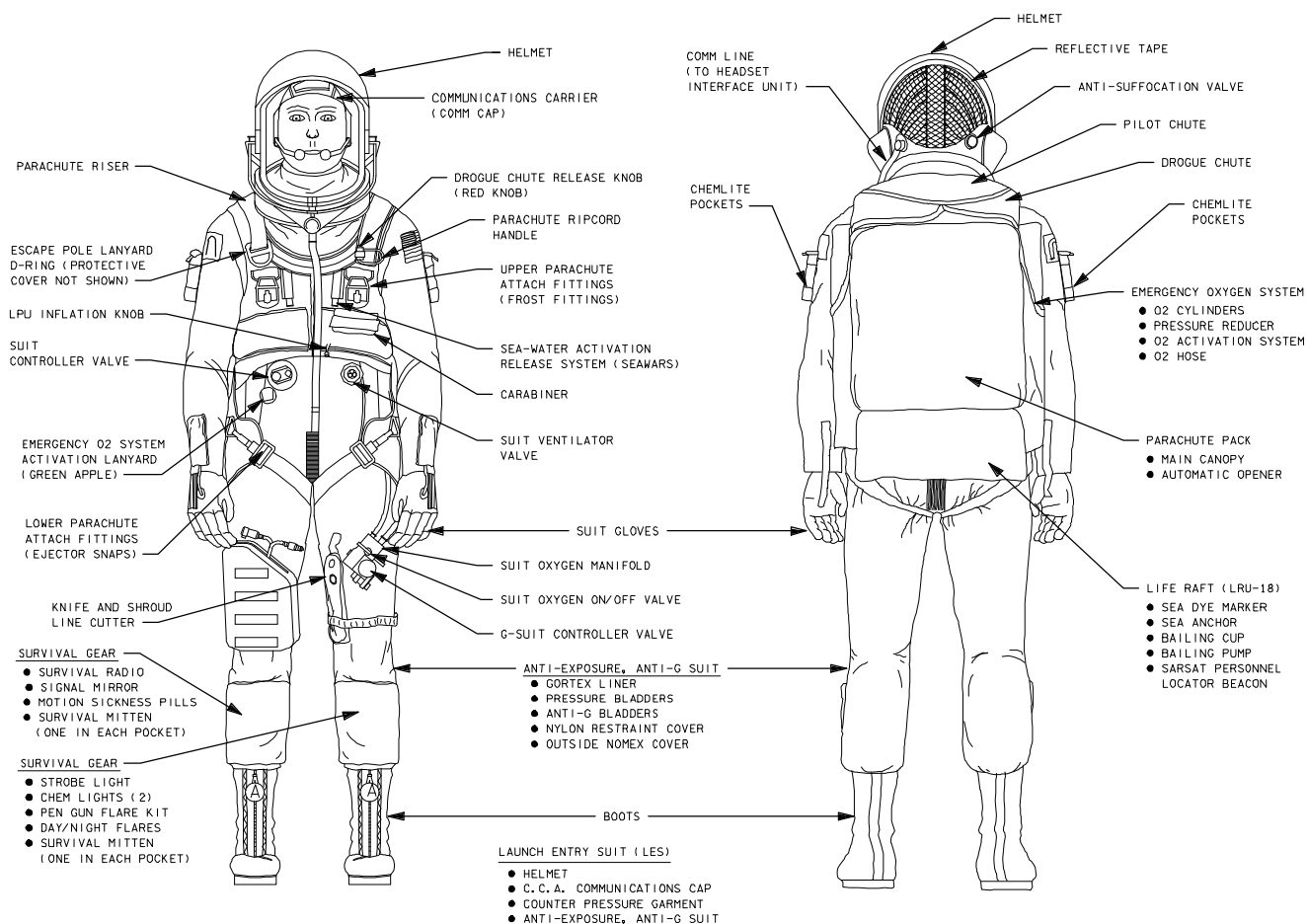
## Notes

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# Launch/Entry Suit (LES)

## Introduction

The LES currently still in use is shown with the parachute assembly in figure 2.2a-1 and with the assembly removed in figure 2.2a-2.



2698422A1, ART# 1

**Figure 2.2a-1. LES with parachute assembly, front and back views**

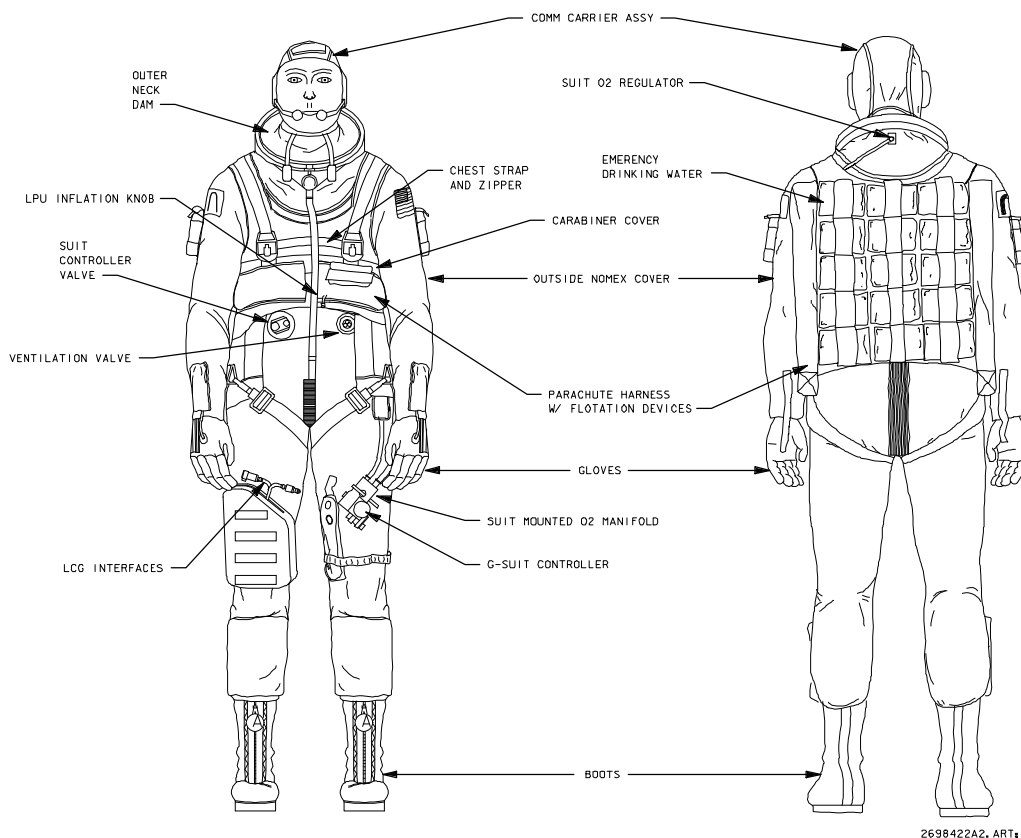
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## Launch/Entry Suit (LES), Continued

### Introduction (cont)

The LES currently still in use and the parachute harness are shown in figure 2.2a-2 below without the parachute assembly.



**Figure 2.2a-2. LES and parachute harness, front and back views**

### LES features

The LES, which weighs 21.4 lb, has the following features:

- Orange-colored Nomex outer garment covers integrated urethane-coated nylon pressure bladders.
- Waterproof zipper seals out water.
- Vent connection has flapper valve to prevent water from entering.
- Dual neck dams prevent water from entering through neck cavity.
- Neck ring tiedown used to adjust position of neck ring.
- Separate gloves inflated via needle valve.

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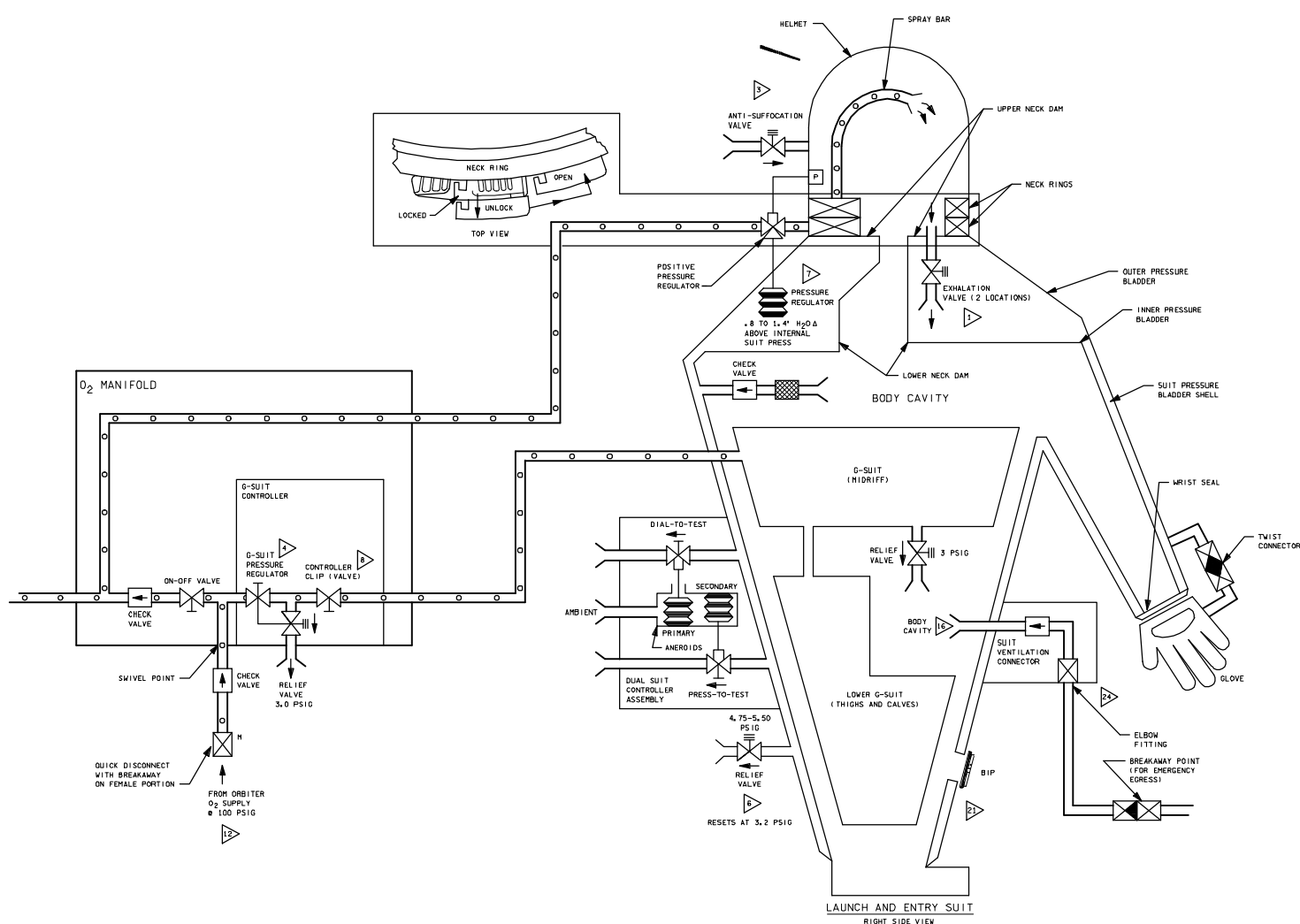
## Launch/Entry Suit (LES), Continued

### LES features (cont)

The next subsection describes LES O<sub>2</sub> flow and the system of pressure bladders. Subsequent subsections discuss the other LES components. The personal suit cooling systems are presented in section 2.4.

### O<sub>2</sub> flow, pressure bladders

LES O<sub>2</sub> flow and the LES system of pressure bladders are schematized in figure 2.2a-3 below.



2898422A3, ART# 3

**Figure 2.2a-3. LES oxygen flow and pressure system**

*Continued on next page*

## Launch/Entry Suit (LES), Continued

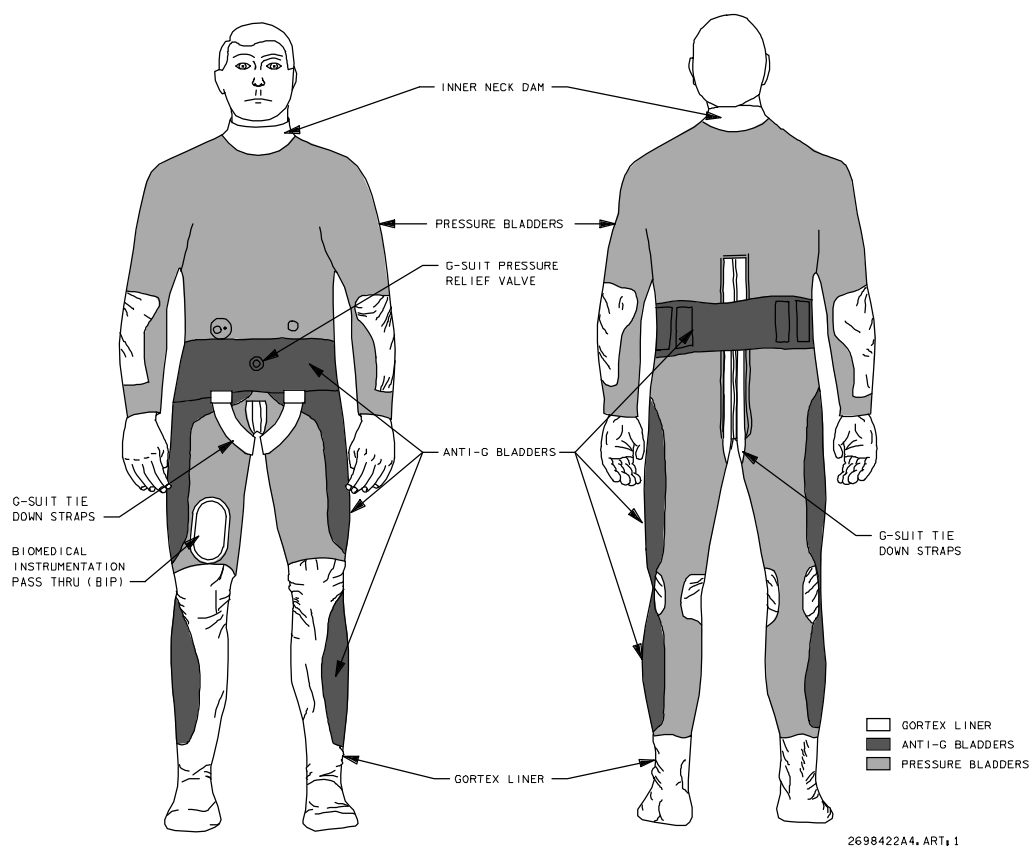
### LES system of pressure bladders

The LES is a partial pressure suit, not a pressure vessel. The pressure on the crewmember's body is mechanical, rather than atmospheric, and is exerted by built-in bladders pressurized by trapping the exhaled air of the crewmembers in the bladders.

The bladders cover most, but not all, of the crewmember's body. Parts of the body not covered by the bladders are covered by Gore-Tex.

Separate bladders, depicted in figure 2.2a-4, provide:

- Partial pressure protection.
- Anti-g protection.

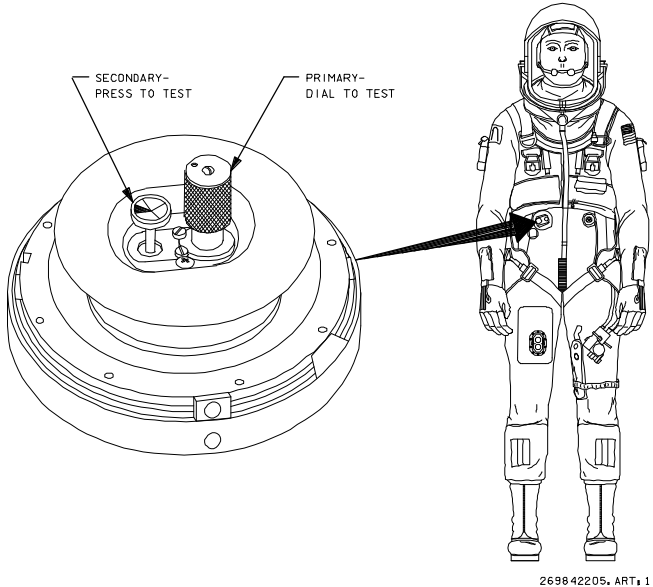


**Figure 2.2a-4. LES bladder system**

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## Launch/Entry Suit (LES), Continued

**Partial pressure system** The inflated bladders of the LES partial pressure system protect the crewmembers from loss of cabin pressure at altitudes to 100,000 ft. This system includes the following components:

Component	Characteristics/Function		
Suit controller	<p>Located on right side of suit chest (depicted below, with the manual controls detailed). Opens and closes to regulate suit pressure.</p>  <p>2698 42205, ART 1</p> <p>The controller includes dual (redundant) aneroids and valve assemblies that operate in <i>auto</i> and <i>test</i> modes:</p> <p style="text-align: center;"><b>Auto Mode</b></p> <p>In auto mode, the suit controller operates as follows:</p> <ul style="list-style-type: none"> <li>• The valve assembly opens and closes as necessary to maintain pressure in the bladders (and thus on the body).</li> <li>• The suit controller valve assembly opens to allow exhaled air to flow through the bladders and the suit controller.</li> <li>• Valve assembly <i>closes</i> when ambient cabin pressure is:</li> </ul> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">For <i>primary</i> assembly, 3.38 to 2.95 psia (= alt. 35,500 to 38,200 ft).</td><td style="padding: 5px;">For <i>secondary</i> assembly, 3.0 to 2.75 psia (= alt. 38,000 to 40,000 ft).</td></tr> </table>	For <i>primary</i> assembly, 3.38 to 2.95 psia (= alt. 35,500 to 38,200 ft).	For <i>secondary</i> assembly, 3.0 to 2.75 psia (= alt. 38,000 to 40,000 ft).
For <i>primary</i> assembly, 3.38 to 2.95 psia (= alt. 35,500 to 38,200 ft).	For <i>secondary</i> assembly, 3.0 to 2.75 psia (= alt. 38,000 to 40,000 ft).		

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## Launch/Entry Suit (LES), Continued

### Partial pressure system (cont)

Component	Characteristics/Function
Suit controller (cont)	<p style="text-align: center;"><b><i>Auto Mode (cont)</i></b></p> <p>When the suit controller valve assembly <i>closes</i>, the bladders are inflated by crewmember respiration until the total of suit pressure and cabin pressure equals 2.95 to 3.38 psia (primary) or 2.75 to 3.0 psia (secondary).</p> <p>Note: Even with the valve assembly closed, the pressure in the bladders varies with altitude. The suit is designed to protect against total loss of pressure up to 100,000 ft (ambient pressure 0.16 psi).</p>
	<p style="text-align: center;"><b><i>Test Mode</i></b></p> <p>The suit controller has the two following means of testing LES inflation:</p> <ol style="list-style-type: none"> <li>1. <u>Dial-to-Test feature</u> - When the knurled knob in the center of the controller is turned clockwise (CW) approximately one rotation, it closes the <i>primary</i> valve assembly regardless of altitude. If the helmet visor is closed and locked, crewmember exhalation inflates the bladders ~3 psi. Once inflated this way, the bladders remain inflated (even if the visor is later opened) until the knob is turned one full turn counterclockwise (CCW).</li> <li>2. <u>Press-to-Test button</u> - Also located near the center of the suit controller. If the helmet visor is closed and locked, depressing the button partially closes the <i>secondary</i> valve assembly and allows the pressure bladders to inflate to 2.1 psi <i>as long as the button remains depressed</i>.</li> </ol>

*Continued on next page*

## Launch/Entry Suit (LES), Continued

### Partial pressure system (cont)

Component	Characteristics/Function
Suit controller (cont)	<p><b><i>Test Mode (cont)</i></b></p> <p>Note: <u>If you find your suit inflating unexpectedly:</u></p> <ul style="list-style-type: none"> <li>You may have inadvertently closed the Dial-to-Test knob (primary valve assembly)</li> </ul> <p style="text-align: center;"><i>or</i></p> <ul style="list-style-type: none"> <li>You may be pressing in on the Press-to-Test button (secondary valve assembly)</li> </ul>
Suit bladders	Normally unpressurized, the bladders will not retain pressure unless the controller valve assembly is <i>closed</i> .
Suit O <sub>2</sub> regulator	During normal use, pressurized O <sub>2</sub> from the orbiter supply enters the helmet through the regulator.
Exhalation valves	During exhalation, the two exhalation valves between the helmet cavity and the bladders <i>open</i> ; exhaled air passes into the partial pressure bladders and out the suit controller on the right side of the chest.
Relief valve	Located in the right hip area. The valve opens when the bladder pressure reaches $5.5 \pm 0.2$ psi. Once open, the valve stays open until the pressure in the bladders is reduced to $3.5 \pm 0.2$ psi.

### Anti-g protection

As shown in figure 2.2a-4, the LES also has several bladders (distinct from the partial pressure bladders) that can be inflated to apply pressure on a crew-member's lower body.

The applied pressure prevents blood from pooling in the lower extremities when *g* forces are imposed on the body, as may happen during entry after a crew-member has experienced 2 or more days of zero *g*. (Preventing the pooling of blood in the lower extremities helps maintain the circulating blood volume.)

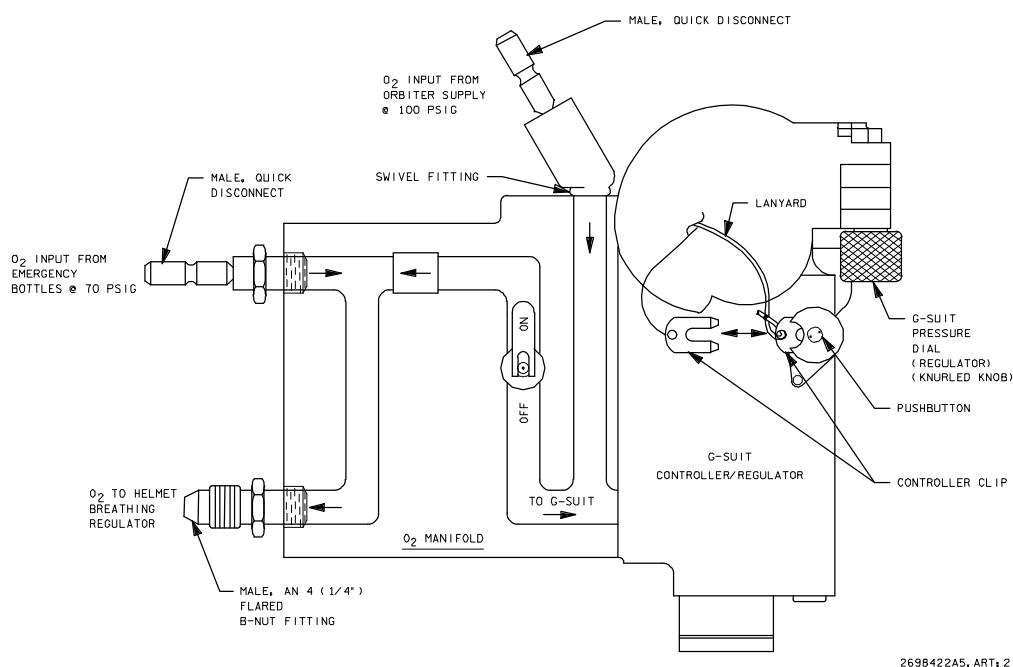
Note: The *g*-suit is used with the LES and the ACES. The *g*-suit can be demated from the ACES but not from the LES.

*Continued on the next page*

## Launch/Entry Suit (LES), Continued

### O<sub>2</sub> manifold/g-suit controller assembly

Inflation of the g-suit is controlled at the O<sub>2</sub> manifold/g-suit controller (figure 2.2a-5), a one-piece assembly located on the LES upper left leg (figure 2.2a-2).



**Figure 2.2a-5. O<sub>2</sub> manifold/g-suit controller**

The functional features of the O<sub>2</sub> manifold/g-suit controller assembly are as follows:

Component	Characteristics/Function
O <sub>2</sub> hose fittings	Three O <sub>2</sub> hose fittings are on the assembly: 1. A male fitting connects to the orbiter O <sub>2</sub> supply hose. This fitting is provided with a quick disconnect.

*Continued on next page*

## Launch/Entry Suit (LES), Continued

### O<sub>2</sub> manifold/g-suit controller assembly (cont)

Component	Characteristics/Function
O <sub>2</sub> hose fittings (cont)	<p>2. A second male fitting, also a quick disconnect, connects the manifold with emergency O<sub>2</sub> bottles in the parachute harness.</p> <p>Note: The <i>emergency</i> O<sub>2</sub> system does not provide anti-g protection.</p> <p>3. A third (threaded) male fitting connects the manifold with the suit O<sub>2</sub> regulator for crew respiration.</p>
g-suit controller	<p>The controller inflates the g-suit bladders when</p> <ul style="list-style-type: none"> <li>• The manifold is connected to orbiter O<sub>2</sub>.</li> <li>• The manifold g-suit pressure dial (knurled knob) is turned CW (in the direction of the arrow).</li> </ul> <p>The controller inflates the bladders 0.5 psi each complete turn (indicated by a slight detent) to 2.5 psi max.</p> <p>Note: <i>Entry Checklist</i> calls for 1.5 psi, or three complete turns.</p> <p>Note: <u>If you find the g-suit inflating unexpectedly</u>, check that the g-suit pressure dial (knurled knob) is completely CCW.</p> <p>A one-way valve inside the manifold keeps the suit from inflating with emergency O<sub>2</sub>, which is reserved for breathing.</p>

*Continued on next page*



## Launch/Entry Suit (LES), Continued

### O<sub>2</sub> manifold/g-suit controller assembly (cont)

Component	Feature/Function
g-suit controller clip	<p>When the controller clip is pulled free, it:</p> <ul style="list-style-type: none"> <li>• Traps the current volume of O<sub>2</sub> inside the g-suit bladders and prevents any deflation, even when the manifold is disconnected from orbiter O<sub>2</sub>.</li> <li>• Prevents the g-suit from being inflated.</li> </ul> <p>Reinstalling the clip allows the g-suit bladders to deflate or inflate.</p>
Relief valve	<p>Located on the abdominal bladder of the g-suit. The valve operates as follows:</p> <ul style="list-style-type: none"> <li>• It vents pressure in excess of 3.0 psi out of the anti-g bladders.</li> <li>• Once open, the valve stays open until bladder pressure has been reduced to 2.5 psi.</li> </ul>

### LES boots, gloves

On the back of each LES glove is a pressure bladder. The bladder connects to the pressure bladder in the suit sleeve by a short neoprene rubber hose with a bayonet fitting. The gloves are made of leather and Nomex.

The boots, made of leather, Nomex, and rubber, are equipped with a zipper for quick donning and with lacing for fit adjustment.

The boot zipper tang has a colored Velcro patch with a letter for crewmember identification during SAR operations (see next paragraph).

*Continued on next page*

## Launch/Entry Suit (LES), Continued

### Crewmember identification patches

Colored Velcro patches with a letter (see table below) help identify each crewmember during SAR operations. The helmet, parachute harness, and boots have this patch.

Crew-member	Color	Letter	
CDR	Red	A	<i>Alpha</i>
PLT	Yellow	B	<i>Bravo</i>
MS1	Blue	C	<i>Charlie</i>
MS2	Green	D	<i>Delta</i>
MS3	Orange	E	<i>Echo</i>
MS4/PS1	Brown	F	<i>Foxtrot</i>
MS5/PS2	Purple	G	<i>Golf</i>
MS6/PS3	Beige	H	<i>Hotel</i>
MS7/PS4	Black	I	<i>India</i>
MS8/PS5	Light gray	J	<i>Juliet</i>

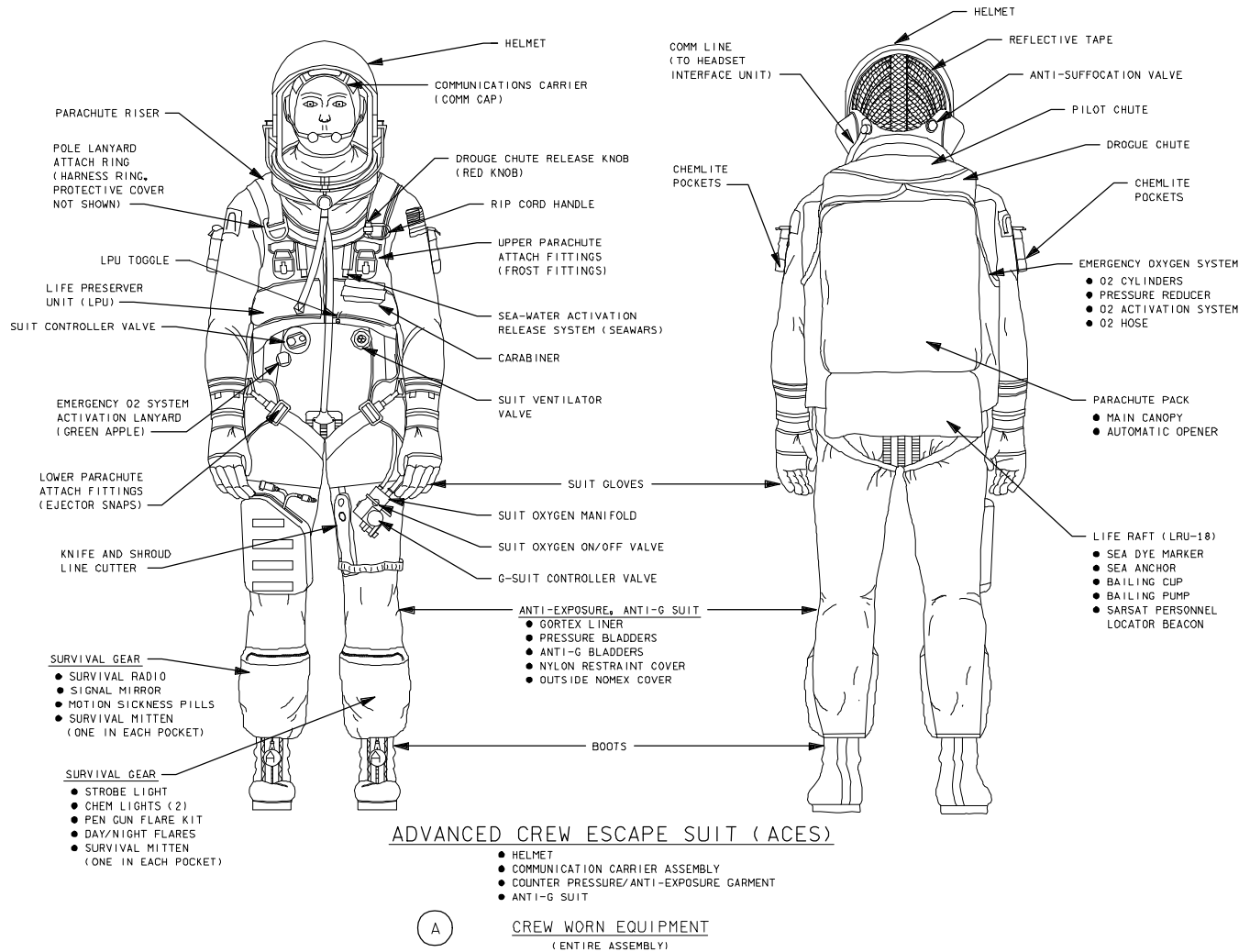
## Notes

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# Advanced Crew Escape Suit (ACES)

## Introduction

The newer, upgraded launch and entry suit, referred to as the Advanced Crew Escape Suit (ACES), is shown in figure 2.2b-1 below.



2698422B1, ART. 2

**Figure 2.2b-1. ACES, front and back views**

*Continued on next page*

## Advanced Crew Escape Suit (ACES), Continued

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**ACES features**    The ACES has the following features:

- A full pressure suit, the air pressure exerts direct pressure on the body. The orange-colored outer garment of flame-retardant Nomex covers the single nonintegrated pressure bladder.
- The detachable anti-g suit can be demated before launch and remated before entry.
- The gloves are attached to the suit by disconnects and pressurize when the suit is pressurized.
- The waterproof main zipper seals out water.
- The vent connection has a flapper valve to prevent water from entering.
- The single neck dam prevents water from entering through neck cavity.
- The neck ring tiedown is used to adjust the position of the neck ring.

Subsequent subsections describe the following ACES features in more detail:

- O<sub>2</sub> flow and pressure system
- Pressure system components
- Anti-g protection
- O<sub>2</sub> manifold/g-suit controller assembly
- Cooling
- Gloves, boots

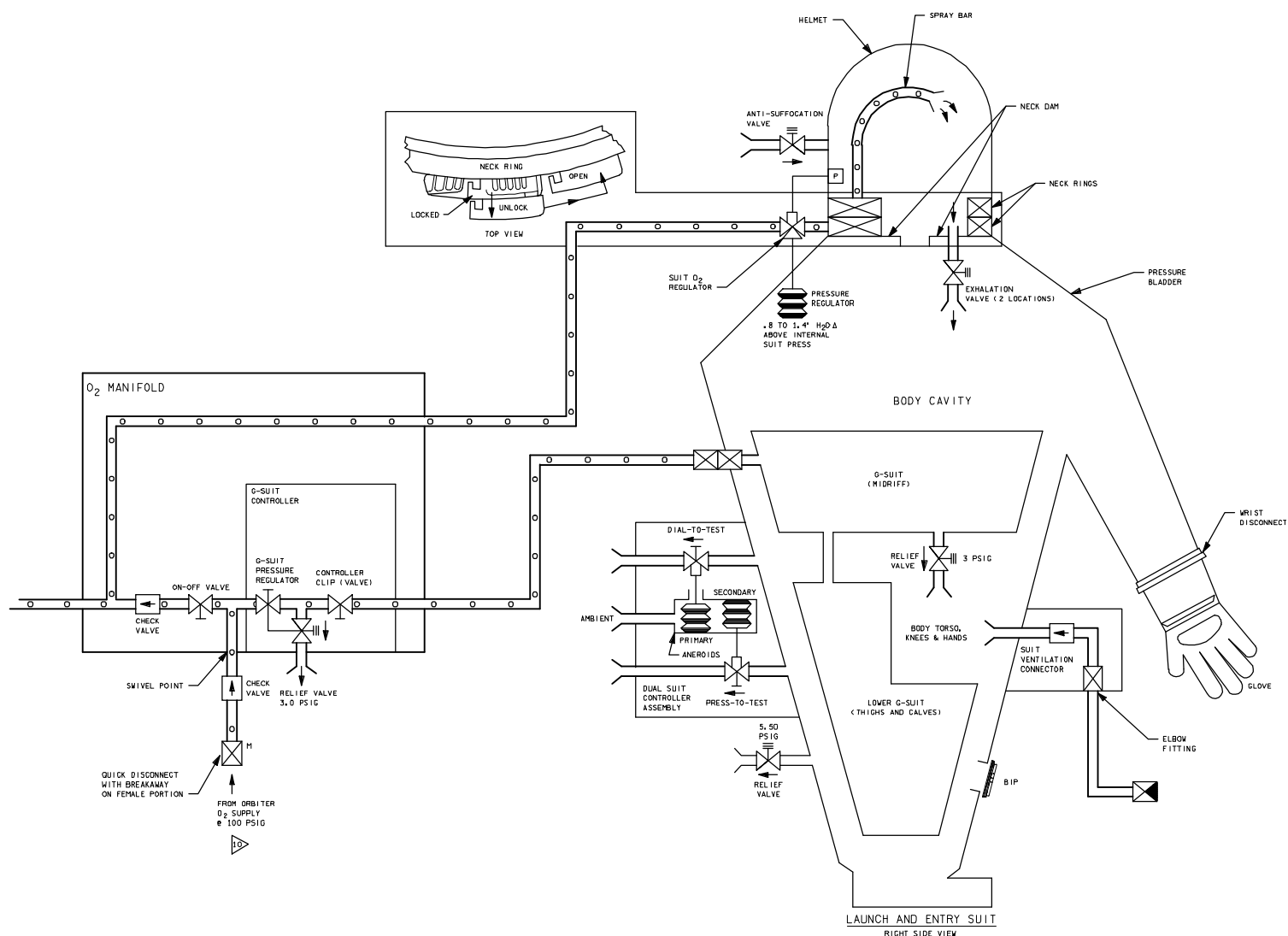
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## Advanced Crew Escape Suit (ACES), Continued

ACES O<sub>2</sub> flow, pressure system

ACES O<sub>2</sub> flow and pressure system are shown in figure 2.2b-2 below.



2698422B2, ART. 4

**Figure 2.2b-2. ACES oxygen flow and pressure system**

*Continued on next page*

## Advanced Crew Escape Suit (ACES), Continued

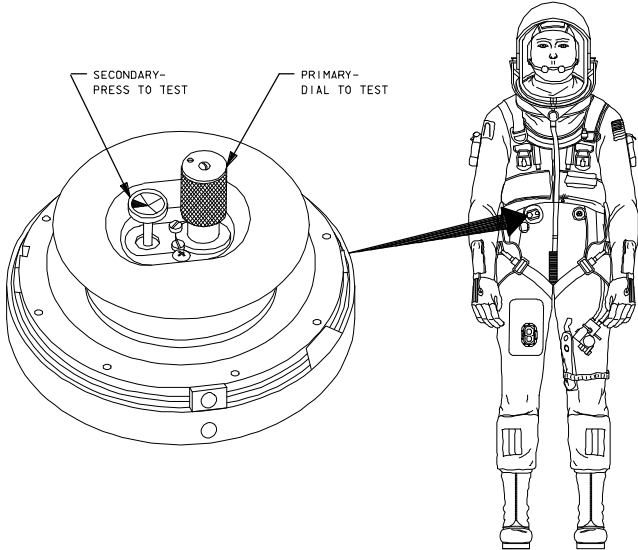
**Pressure system components** The ACES, a full pressure suit, is a pressure vessel. The single pressure bladder covers all but a crewmember's head and hands.

The pressure on the crewmember's body is atmospheric, the pressure being exerted directly and providing "an atmosphere of protection" *indefinitely* from a loss of cabin pressure to 100,000 ft.

The pressure bladder is constructed of a single nylon layer laminated to Gore-Tex and has the following advantages over the LES system:

- The single layer makes the ACES looser fitting, giving the crewmember greater freedom of movement and comfort.
- The Gore-Tex is porous and "breathes" (helping the crewmember stay cooler), but seals when air pressure is applied.

Besides the pressure bladder, the ACES pressure system includes the following components:

Component	Characteristics/Function
Suit controller	<p>Located on right side of suit chest (depicted below, with manual controls detailed).</p> <p>Opens and closes to regulate suit pressure.</p>  <p>269842205, ART 1</p>

*Continued on next page*

## Advanced Crew Escape Suit (ACES), Continued

### Pressure system components (cont)

Component	Characteristics/Function		
Suit controller (cont)	The controller includes dual (redundant) aneroids and valve assemblies that operate in <i>auto</i> and <i>test</i> modes:		
	<p style="text-align: center;"><b><i>Auto Mode</i></b></p> <p>In auto mode, the suit controller operates as follows:</p> <ul style="list-style-type: none"><li>• The valve assembly opens and closes as necessary to maintain pressure in the suit bladder (and thus directly on the body).</li><li>• The suit controller valve assembly opens to allow exhaled air to flow through the suit bladder and the suit controller.</li><li>• The valve assembly <i>closes</i> when ambient cabin pressure is:<table><tr><td>For <i>primary</i> assembly, 3.67 to 3.24 psia (= alt. 34,000 to 36,500 ft).</td><td>For <i>secondary</i> assembly, 3.48 to 3.05 psia (= alt. 35,000 to 38,000 ft).</td></tr></table></li><li>• Only when the suit controller valve assembly <i>closes</i> is the suit bladder inflated by crewmember respiration until total suit pressure and cabin pressure equal 3.24 to 3.67 psia (primary) or 3.05 to 3.48 psia (secondary).</li></ul> <p>Note: Even with the valve assembly closed, suit bladder pressure varies with altitude. The ACES is designed to protect against total loss of pressure <i>indefinitely</i> up to 100,000 ft (ambient pressure 0.16 psi).</p>	For <i>primary</i> assembly, 3.67 to 3.24 psia (= alt. 34,000 to 36,500 ft).	For <i>secondary</i> assembly, 3.48 to 3.05 psia (= alt. 35,000 to 38,000 ft).
	For <i>primary</i> assembly, 3.67 to 3.24 psia (= alt. 34,000 to 36,500 ft).	For <i>secondary</i> assembly, 3.48 to 3.05 psia (= alt. 35,000 to 38,000 ft).	
<p style="text-align: center;"><b><i>Test Mode</i></b></p> <p>The suit controller has the two following means of testing ACES inflation:</p>			

*Continued on next page*



## Advanced Crew Escape Suit (ACES), Continued

### Pressure system components (cont)

Component	Characteristics/Function
Suit controller (cont)	<p style="text-align: center;"><b><i>Test Mode (cont)</i></b></p> <ol style="list-style-type: none"> <li>1. <u>Dial-to-Test feature</u> - When the knurled knob in the center of the controller is turned CW approximately one rotation, it closes the <i>primary</i> valve assembly regardless of altitude.  If the helmet visor is closed and locked, crewmember exhalation inflates the suit bladder ~3.5 psi. Once inflated this way, the suit bladder remains inflated (even if the visor is later opened) until the knob is turned one full turn CCW.</li> <li>2. <u>Press-to-Test button</u> - Also located near the center of the suit controller. If the helmet visor is closed and locked, depressing the button partially closes the <i>secondary</i> valve assembly and allows the suit bladder to inflate to 2.3 psi <i>as long as the button remains depressed</i>.</li> </ol> <p>Note: <u>If you find your suit inflating unexpectedly:</u></p> <ul style="list-style-type: none"> <li>• You may have inadvertently closed the Dial-to-Test knob (primary valve assembly)</li> </ul> <p style="text-align: center;"><i>or</i></p> <ul style="list-style-type: none"> <li>• You may be pressing in on the Press-to-Test button (secondary valve assembly)</li> </ul>
Suit O <sub>2</sub> regulator	During normal use, pressurized O <sub>2</sub> from the orbiter supply enters the helmet through the regulator when the crewmember inhales.
Exhalation valves	During exhalation, the two exhalation valves between the helmet cavity and the suit bladder <i>open</i> ; exhaled air passes into the suit bladder and out the suit controller on the right side of the chest.
Relief valve	Located in the right hip area. The valve opens when suit bladder pressure reaches $5.5 \pm 0.02$ psi. Once open, the valve stays open until pressure in the suit bladder is reduced to $3.5 \pm 0.02$ psi.

*Continued on next page*

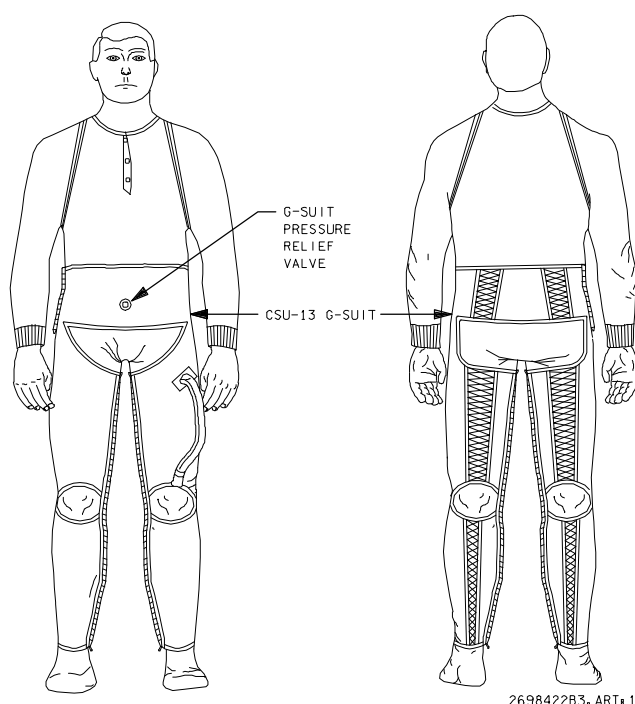
## Advanced Crew Escape Suit (ACES), Continued

### Anti-g protection

Crewmembers wear a *g*-suit that applies pressure on the body to protect against *g* forces. The applied pressure prevents blood from pooling in the lower extremities when *g* forces are imposed on the body, as may happen during entry after a crewmember has experienced 2 or more days of zero *g*. (Preventing the pooling of blood in the lower extremities helps maintain the circulating blood volume.)

Crewmembers wearing the ACES suit do not wear a *g*-suit for launch. The *g*-suit is stowed prelaunch, then unstowed and mated for entry.

- The CSU-13 (figure 2.2b-3) is the same *g*-suit that is integrated into the LES. This *g*-suit has an abdominal bladder and leg bladders that do not cover the entire leg.



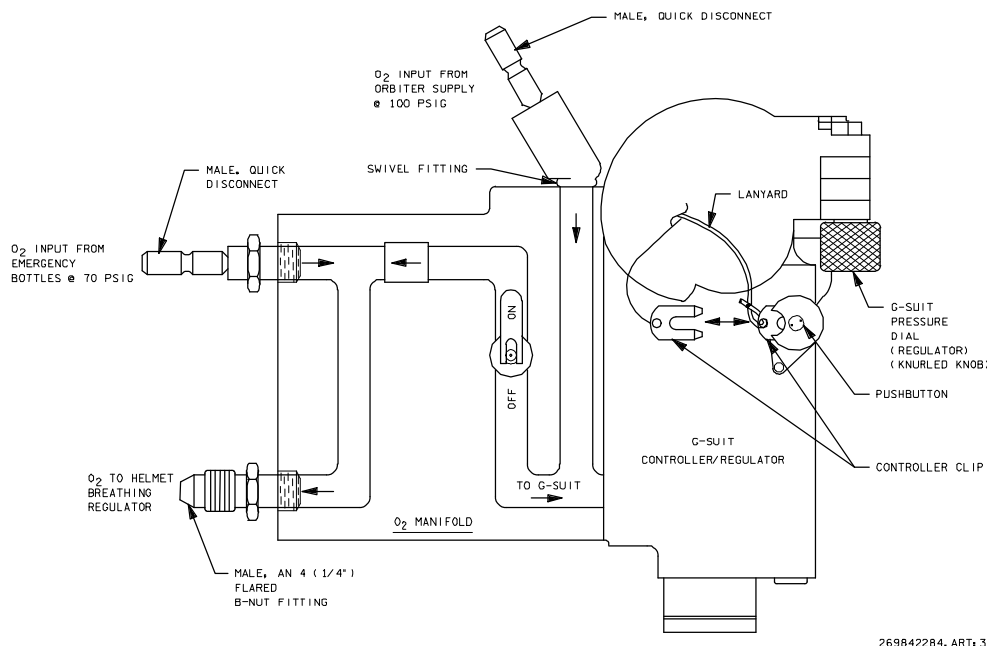
**Figure 2.2b-3. CSU-13**

*Continued on next page*

## Advanced Crew Escape Suit (ACES), Continued

### O<sub>2</sub> manifold/g-suit controller assembly

Inflation of the g-suit is controlled at the O<sub>2</sub> manifold/g-suit controller (figure 2.2b-4), a one-piece assembly located on the ACES upper left leg (figure 2.2b-1).



269842284, ART. 3

**Figure 2.2b-4. O<sub>2</sub> manifold/g-suit controller**

The functional features of the O<sub>2</sub> manifold/g-suit controller assembly are as follows:

Component	Characteristics/Function
O <sub>2</sub> hose fittings	There are three O <sub>2</sub> hose fittings on the assembly: <ol style="list-style-type: none"> <li>1. A male fitting connects to the orbiter O<sub>2</sub> supply hose. This fitting is provided with a quick disconnect.</li> </ol>

*Continued on next page*

## Advanced Crew Escape Suit (ACES), Continued

### O<sub>2</sub> manifold/g-suit controller assembly (cont)

Component	Characteristics/Function
O <sub>2</sub> hose fittings (cont)	<p>2. A second male fitting, also a quick disconnect, connects the manifold with the emergency O<sub>2</sub> bottles in the parachute harness.</p> <p>Note: The <i>emergency</i> O<sub>2</sub> system does not provide anti-g suit protection.</p> <p>3. A third (threaded) male fitting connects the manifold with the suit O<sub>2</sub> regulator for crew respiration.</p>
g-suit controller	<p>The controller inflates the g-suit bladders when:</p> <ul style="list-style-type: none"> <li>• The manifold is connected to orbiter O<sub>2</sub>.</li> <li>• The manifold g-suit pressure dial (knurled knob) is turned CW (in the direction of the arrow).</li> </ul> <p>The controller inflates the suit bladder 0.5 psi each complete turn (indicated by a slight detent) to 2.5 psi max.</p> <p>Note: <i>Entry Checklist</i> calls for 1.5 psi, or three complete turns.</p> <p>Note: <u>If you find the g-suit inflating unexpectedly</u>, check that the g-suit pressure dial (knurled knob) is completely CCW.</p> <p>A one-way valve inside the manifold keeps the suit from inflating with emergency O<sub>2</sub>, which is reserved for breathing.</p>

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## Advanced Crew Escape System (ACES), Continued

O<sub>2</sub> manifold/g-suit controller assembly (cont)

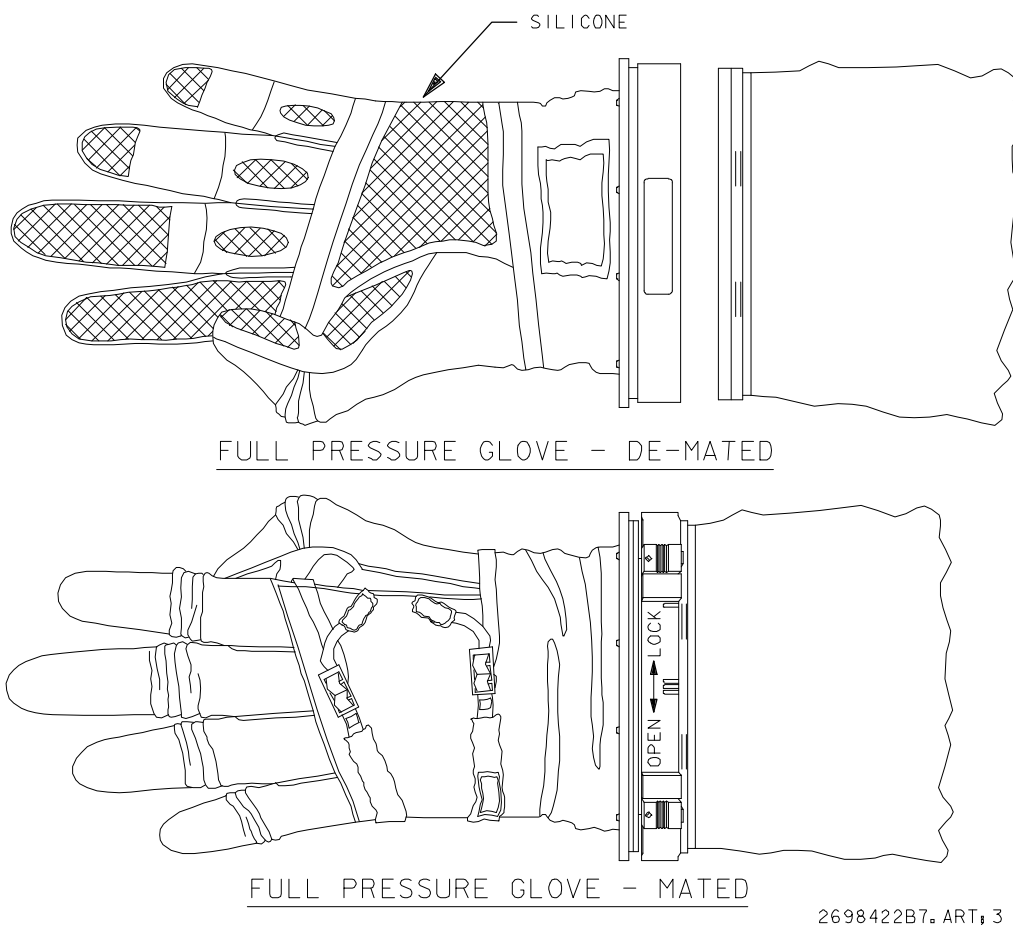
Component	Feature/Function
g-suit controller clip	<p>When the controller clip is pulled free, it:</p> <ul style="list-style-type: none"><li>• Traps the current volume of O<sub>2</sub> inside the g-suit bladders and prevents any deflation, even when the manifold is disconnected from orbiter O<sub>2</sub>.</li><li>• Prevents the g-suit from being inflated.</li></ul> <p>Reinstalling the clip allows the g-suit bladders to deflate or inflate.</p>
Relief valve	<p>Located on the abdominal bladder of the g-suit. The valve operates as follows:</p> <ul style="list-style-type: none"><li>• It vents pressure in excess of 3.0 psi out of the anti-g bladders.</li><li>• Once open, the valve stays open until bladder pressure has been reduced to 2.5 psi.</li></ul>

*Continued on next page*

## Advanced Crew Escape Suit (ACES), Continued

### ACES gloves

The ACES gloves are shown in figure 2.2b-5 both in de-mated and mated configuration.



**Figure 2.2b-5. ACES gloves**

The gloves, made of Nomex and silicone have the following features:

- Have adjustable straps that serve as pressure bars to reduce the rigidity of the gloves when the suit is pressurized.
- Mate to the suit sleeve at the sleeve ring.
- Have a locking ring with a directional arrow labeled “OPEN” and another arrow labeled “LOCK.”

*Continued on next page*

## Advanced Crew Escape Suit (ACES), Continued

### ACES gloves (cont)

- Alignment marks on the glove ring and on the sleeve ring show the proper alignment for *mating* the glove to the sleeve.

To mate glove to suit sleeve:

Step	Action
1	Align mark on glove ring with mark on sleeve ring.
2	Twist glove until glove lock tabs snap into locking position.

To demate glove from suit sleeve:

Step	Action
1	Release and hold two locking tabs while twisting glove fully to mechanical stop.
2	Remove glove.

Each glove has a colored Velcro patch with a letter that helps identify individual crewmembers (see last paragraph).

### Boots

The boots, made of leather, Nomex, and rubber, are equipped with a zipper for quick donning and with lacing for fit adjustment. Each boot zipper tang has a colored Velcro patch with a letter for crewmember identification during SAR operations (see next paragraph).

*Continued on next page*

## Advanced Crew Escape Suit (ACES), Continued

### Crewmember identification patches

Colored Velcro patches with a letter help identify individual crewmembers during SAR operations (see table below). The helmet, parachute harness, and boots have this patch.

Crew-member	Color	Letter	
CDR	Red	A	<i>Alpha</i>
PLT	Yellow	B	<i>Bravo</i>
MS1	Blue	C	<i>Charlie</i>
MS2	Green	D	<i>Delta</i>
MS3	Orange	E	<i>Echo</i>
MS4/PS1	Brown	F	<i>Foxtrot</i>
MS5/PS2	Purple	G	<i>Golf</i>
MS6/PS3	Beige	H	<i>Hotel</i>
MS7/PS4	Black	I	<i>India</i>
MS8/PSS	Light gray	J	<i>Juliet</i>



## Notes

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# Helmet, Comm Carrier Assembly, Headset Interface Unit

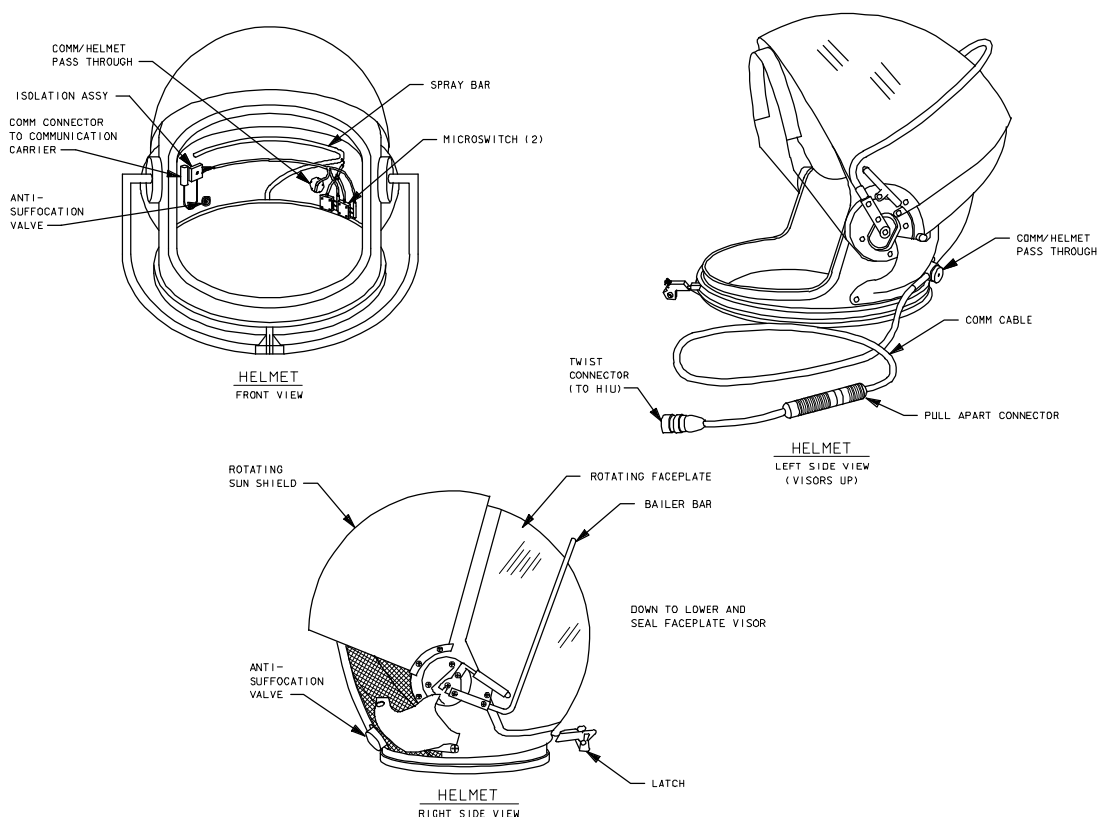
## Introduction

The main purpose of the helmet, shown in figure 2.3-1, is to provide protection during bailout/egress. Figure 2.3-2 shows how the helmet attaches to the suit at the neck ring. The helmet also provides a conduit between the Communications Carrier Assembly (CCA) and the Headset Interface Unit (HIU).

The CCA, or “comm cap,” contains all the equipment necessary for voice communication. The assembly is shown in figure 2.3-3.

The HIU, depicted in figure 2.3-4, provides volume control and Push-to-Talk (PTT) capability for both comm and intercom and preamplifies the microphone signal.

**Helmet features** The helmet features are shown in figure 2.3-1 below.



269840231, ART 1

**Figure 2.3-1. Helmet**

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## Helmet, Comm Carrier Assembly, Headset Interface Unit, Continued

### Helmet features (cont)

The helmet, which weighs 7.5 lb, includes the following components:

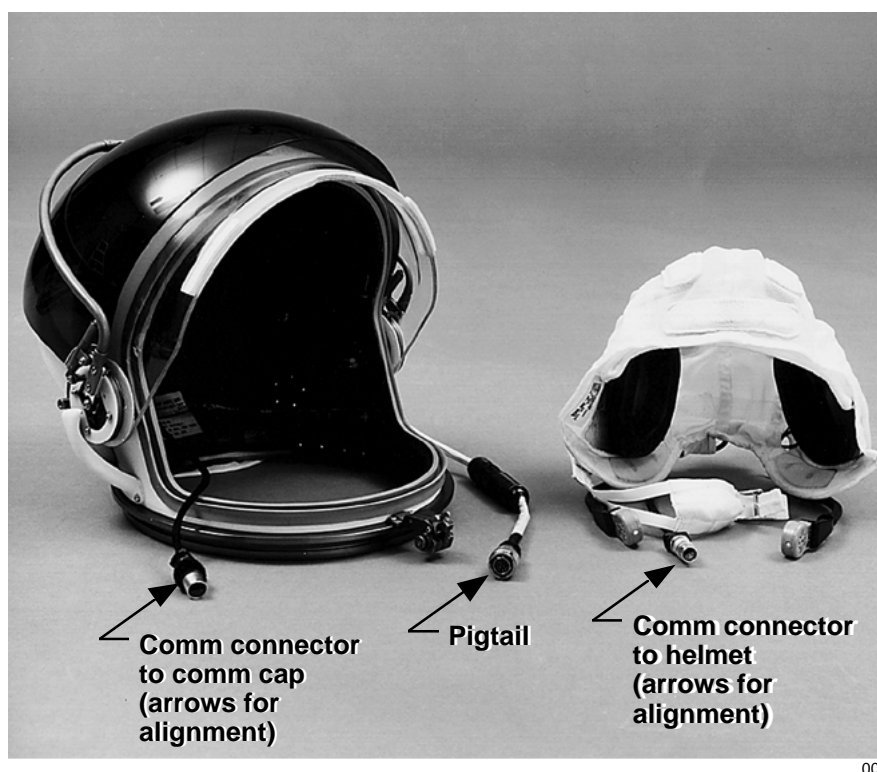
Component	Description
Rotating faceplate	<p>A pressure visor that operates as follows:</p> <ul style="list-style-type: none"> <li>• To CLOSE, release neck dam tabs, grasp rim of <i>clear</i> visor, and pull down.</li> <li>• To LOCK, pull bailer bar down into double lock.</li> <li>• To UNLOCK/RAISE <ul style="list-style-type: none"> <li>– Push ribbed locking lever down.</li> <li>– Squeeze together two buttons on either side of lock.</li> <li>– Raise visor by manually pulling up on bailer bar.</li> </ul> </li> </ul> <p>Note: Do not <i>close</i> visor by pulling down on bailer bar. Doing so will jam mechanism.</p>
Rotating sunshield	<p>A tinted sunshade is mounted to the outside of the helmet with a continuous friction hinge.</p> <p>Can be lowered/raised independently of the <i>clear</i> visor.</p>
Comm cable/comm pigtail	<p>The comm cable that comes out of the helmet at the back is equipped with a quick disconnect for egress/bailout. It connects to the <i>comm pigtail</i>, which in turn connects to the HIU.</p> <p>An extra pigtail (connected to an extra HIU) is carried in either the MS1 or the MS2 Fight Data File (FDF) bag.</p>
Antisuffoca- tion valve	<p>Located at the lower right rear of the helmet.</p> <p>Allows ambient air outside the helmet to enter when:</p> <ul style="list-style-type: none"> <li>• Visor is closed.</li> <li>• Breathing O<sub>2</sub> is not available.</li> </ul> <p>The antisuffocation valve opens when pressure inside the helmet is 1.5 in. H<sub>2</sub>O (0.054 psi) <i>less than</i> the pressure outside the helmet (as happens when a crewmember inhales with the visor closed and no O<sub>2</sub> is being supplied).</p> <p>Note: The antisuffocation valve will let water into the helmet if submerged.</p>

*Continued on next page*

## Helmet, Comm Carrier Assembly, Headset Interface Unit, Continued

### CCA

The CCA contains all equipment necessary for voice communication. It is shown in figure 2.3-3, alongside the helmet, with the comm connectors identified.



*Figure 2.3-3. The CCA*

### CCA components

CCA components include the following:

Component	Characteristics/Function
Microphones	<p>The CCA has two independent (redundant) microphones. The microphones are noise-canceling. When O<sub>2</sub> flows into the helmet, microswitches deactivate the microphones, automuting them.</p> <p>Note: If the helmet does not have a good seal, O<sub>2</sub> will flow continuously, causing continuous auto-muting.</p>

*Continued on next page*

## Helmet, Comm Carrier Assembly, Headset Interface Unit, Continued

### CCA components (cont)

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Component	Characteristics/Function
Earphones	The CCA has two independent (redundant) padded, earmuff-type earphones.
Connector	The connector is located on the back of the cap.

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### HIU

The HIU (figure 2.3-4) provides volume control and PTT capability and preamplifies the microphone signal.

An extra HIU (with an extra comm pigtail connected to it) is carried in either the MS1 or MS2 FDF bag.



*Figure 2.3-4. HIU*

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*Continued on next page*

## Helmet, Comm Carrier Assembly, Headset Interface Unit, Continued

### HIU (cont)

The HIU includes the following components:

Component	Description
Volume control	Provides volume control from “0” (min.) to “9” (max.) for earphones.  Fine-tunes the volume level selected by the crewmember at the Audio Terminal Unit (ATU).
“XMIT” PTT button	Provides push-to-talk capability for transmitting on the Air-to-Air (A/A) and Air-to-Ground (A/G) loops.  The top surface of the button has a ridge (or “rib”) across the diameter for easy identification by touch.
“ICOM” PTT button	Provides push-to-talk capability for transmitting on the intercomm loops.  The top surface of the button is concave (“like a corpuscle”) for easy identification by touch.
Retainer clip	Allows unit to be attached to crew clothing during on-orbit operations.  Note: The retainer clip must be attached to the shoulder harness <i>before</i> launch and entry for the proper operation of the comm pigtail quick disconnect (see “Helmet features”) in case of emergency egress.
Preamplifier	Preamplifies signal from comm cap microphone. Without preamp, the signal is too weak to pick up.

## Personal Suit Cooling Systems

**Introduction** Each crewmember is provided with a personal suit cooling system for personal comfort.

The type of system used is in transition and may be either of two types:

- The Personal Suit Ventilation System (PSVS)
- The Thermal Electric Liquid Cooling Unit (TELCU)

**PSVS features** Figure 2.4-1 below shows the PSVS.

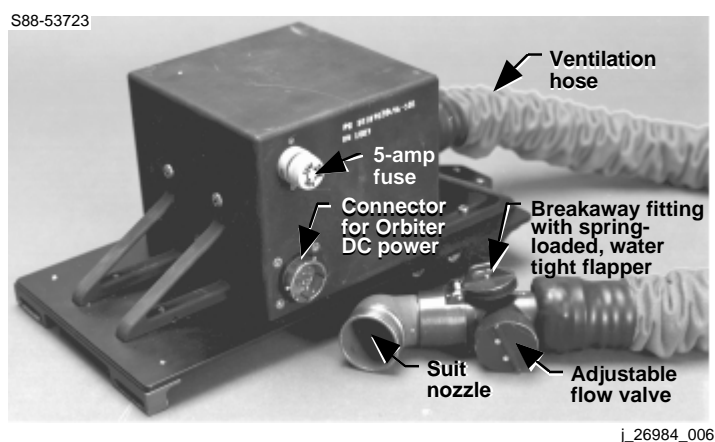


Figure 2.4-1. PSVS

PSVS features include the following:

- An on/off switch.
- A 5-amp fuse.
- A 28-V dc motor running off orbiter power.

**PSVS panel connections** Crewmembers connect the PSVS units to orbiter utility power outlets according to the mission-specific utility outlet plug-in plan in the *Reference Data* book.

*Continued on next page*



## Personal Suit Cooling Systems, Continued

### PSVS functional overview

Airflow and hose connections are as described below.

Step	Description
1	The fan blows air into the ventilation hose.
2	The ventilation hose attaches to the suit nozzle via a breakaway fitting. The hose has a flow adjustment knob. Note: Always use the breakaway fitting to disconnect from the fan.
3	The suit nozzle connects to the suit vent (left chest area of suit). <ul style="list-style-type: none"> <li>The nozzle has a spring-loaded flapper at the breakaway fitting. When the fitting is disconnected, the flapper closes to keep water out.</li> <li>The suit vent has an in-only valve, which prevents loss of pressure.</li> </ul>
4	The internal hose routes air through the pressure bladders and out three ports, one in front and two in back.
5	The neck dam lets air into the helmet unless the helmet visor is closed.

**TELCU cooling** The two main components of the TELCU cooling system are:

- The TELCU that cools the water flowing through the network of vinyl tubing in the Liquid Cooling Garment (LCG).
- The two-piece LCG worn by crewmembers as an undergarment.

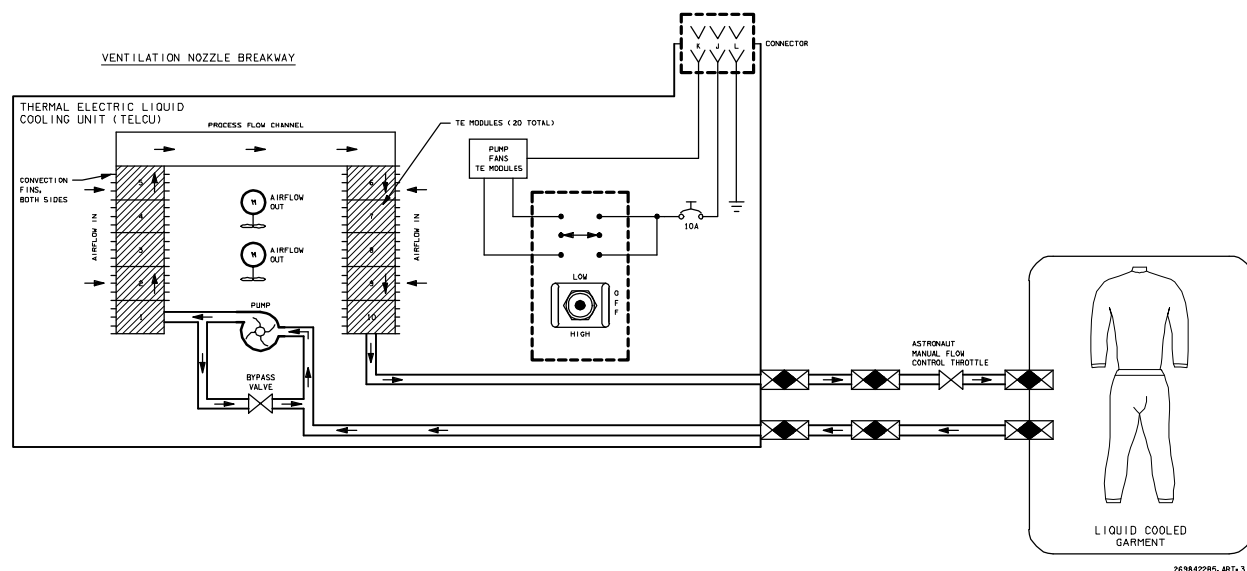
Note: The older cooling system, the PSVS, which does not require the LCG, can still be used with the ACES. Likewise, the TELCU can be worn with the older LES.

*Continued on next page*

## Personal Suit Cooling Systems, Continued

### TELCU

The TELCU cooling process is shown in figure 2.4-2.



**Figure 2.4-2. TELCU cooling process**

The stages in the TELCU cooling process are as follows:

Stage	Action
1	Water from the liquid cooling garment enters the cooling side of the TELCU cooling core.
2	The water travels through a channel in the cooling core, where the heat exchange process occurs. A pair of cooling fans aids the process.
3	The TELCU pump delivers the cooled water through the TELCU lines to the LCG lines via quick disconnects at the BIP.

*Continued on next page*

## Personal Suit Cooling Systems, Continued

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### TELCU (cont)

Stage	Action
4	The cooled water circulates through the vinyl tubing network of the LCG worn by the crewmember.
5	The water becomes warmer during the heat exchange and returns to the TELCU, where the process starts over.

---

### *Temperature Control*

The crew can control suit cooling in two ways:

1. By using the control switch located on top of each TELCU. The switch is a three-position toggle with the following positions:
  - OFF.
  - LOW - Delivers 70° F water to LCG (based on 75° F cabin).
  - HIGH - Delivers 80° F water to LCG (based on 90° F cabin).

(The low and high temperatures are achieved by changing the voltage to the thermocouples in the thermoelectric module.)
2. By using a clamp on the LCG inlet line to control the water flow and thus the cooling.

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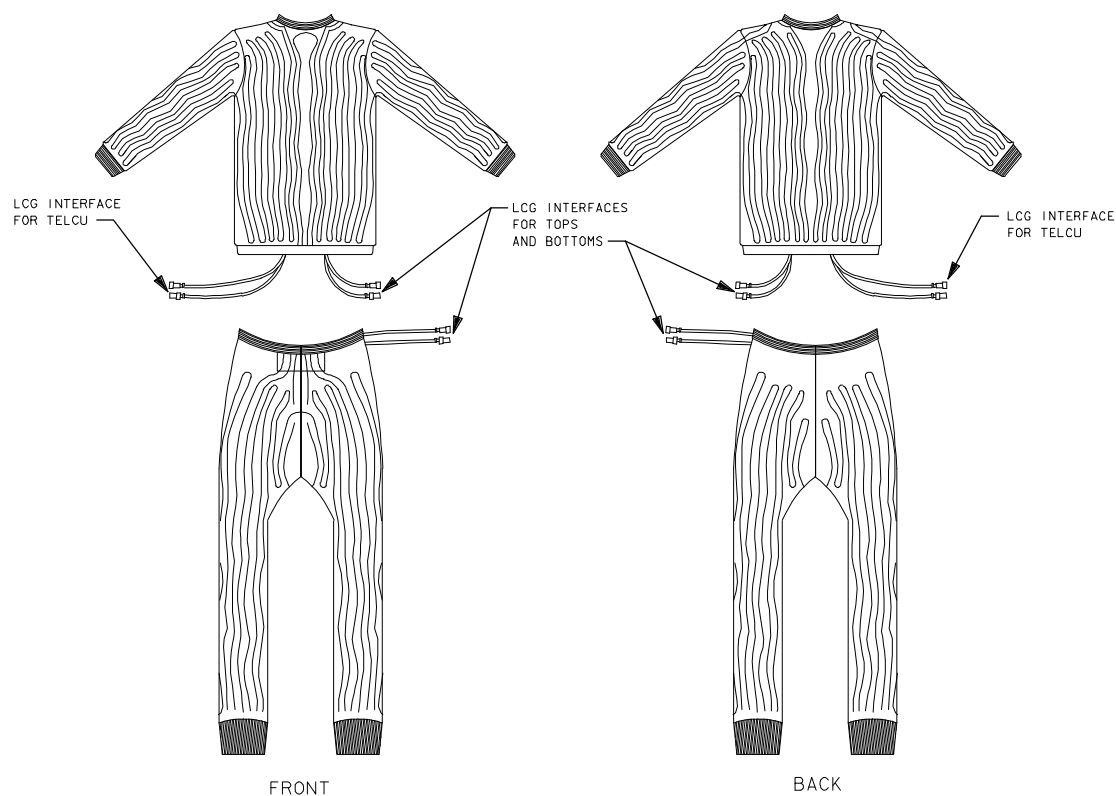
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## Personal Suit Cooling Systems, Continued

### LCG

Crewmembers wear the two-piece LCG under the LES or ACES. The LCG is used with the TELCU (previous subsection), which cools and pumps water through the LCG network of vinyl tubing to cool the wearer.

Both the LCG top and bottom have water hoses with quick disconnects at the BIP. Either garment part can be used with the TELCU. The two parts and the water hoses and fittings are shown in figure 2.4-3 below.



2698422B6, ART. 1

**Figure 2.4-3. LCG**

## Notes

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# Parachute Harness, Personal Parachute Assembly

## Introduction

The parachute harness, which supports the crewmember's body weight, attaches to the Personal Parachute Assembly (PPA) containing the parachute system. Both the harness and the PPA include survival and rescue gear.

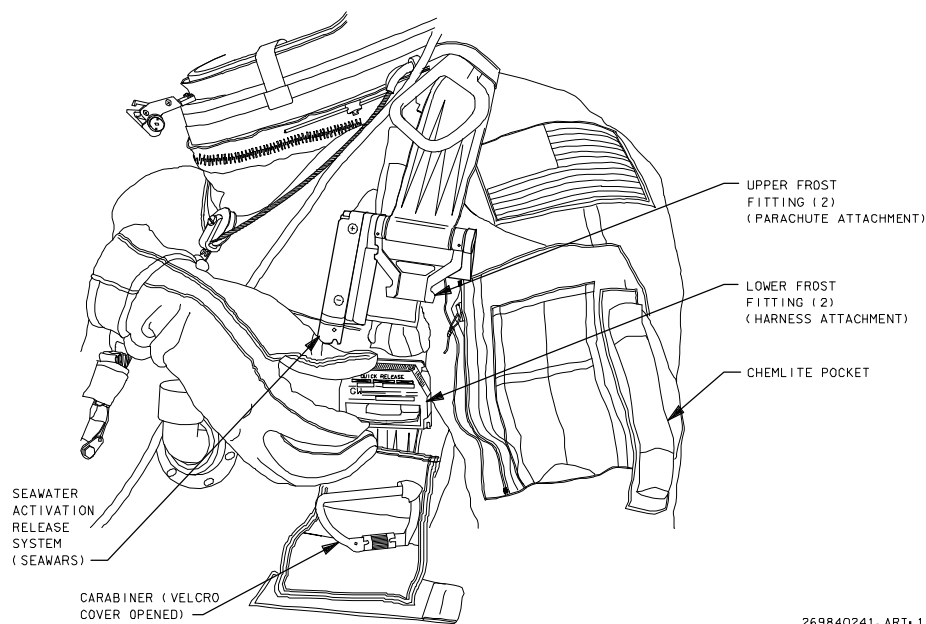
The harness and the PPA are discussed in separate subsections that follow. The rescue and survival gear associated with each system is described in section 2.6.

## Parachute harness

The parachute harness has:

- Straps that support the crewmember.
- Fittings/snaps that attach the harness to the parachute.
- Items that may be needed in an emergency:
  - Emergency Oxygen System (EOS)
  - Carabiner
  - Life Preserver Unit (LPU)
  - Emergency drinking water

These elements are shown in figure 2.5-1 and on the next page. Harness elements are described in the table that follows (for the rescue and survival gear, refer to section 2.6).



269840241, ART1 1

**Figure 2.5-1. Parachute harness (upper part)**

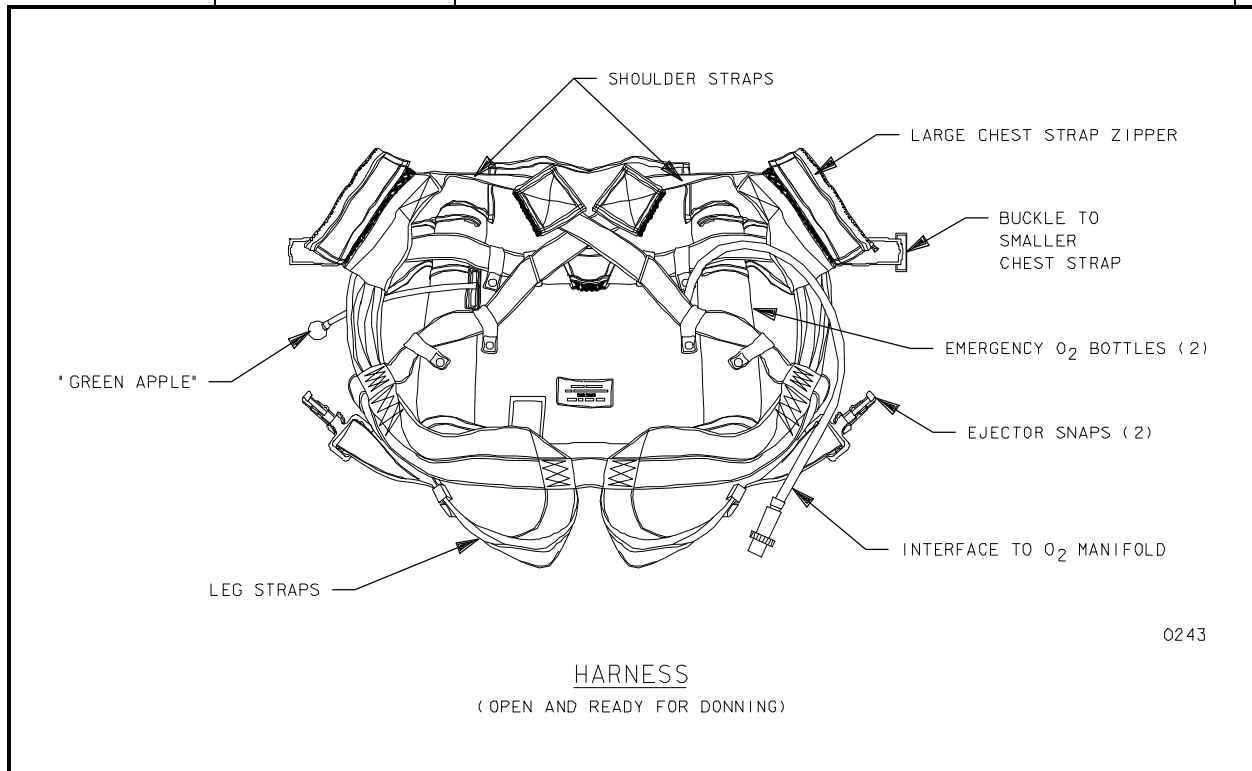
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## Parachute Harness, Personal Parachute Assembly, Continued

### Parachute harness (cont)

The parachute harness elements include the following:

Component	Description
Support straps	The system of nylon straps, depicted below, completely supports a crewmember's body weight during emergency egress, bailout, and rescue operations.

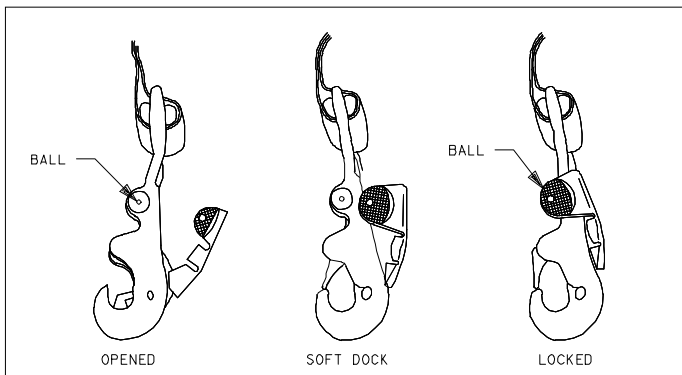


To don the harness:	
Step	Procedure
1	Step through both leg loops.
2	Place arms through both sleeve openings.
3	Zip the vest zipper (under neck ring tiedown strap).
4	Connect and tighten the chest strap (under neck ring tiedown strap).

*Continued on next page*

## Parachute Harness, Personal Parachute Assembly, Continued

### Parachute harness (cont)

Component	Description								
Parachute attach points	The parachute attach points include: <u>Two Frost fittings</u> (figure 2.5-1) <ul style="list-style-type: none"><li>• Are the <i>upper</i> parachute attach points on the harness.</li><li>• Allow the parachute risers to attach to the harness.</li></ul> To attach:								
	<table><tr><th>Step</th><th>Procedure</th></tr><tr><td>1</td><td>Squeeze the top and bottom together on the <i>lower</i> attach fitting (female portion).</td></tr><tr><td>2</td><td>Insert <i>upper</i> (male) fitting and snap into place.</td></tr><tr><td>3</td><td>Verify proper connection (no red mark seen in “mirror”).</td></tr></table>	Step	Procedure	1	Squeeze the top and bottom together on the <i>lower</i> attach fitting (female portion).	2	Insert <i>upper</i> (male) fitting and snap into place.	3	Verify proper connection (no red mark seen in “mirror”).
	Step	Procedure							
	1	Squeeze the top and bottom together on the <i>lower</i> attach fitting (female portion).							
	2	Insert <i>upper</i> (male) fitting and snap into place.							
3	Verify proper connection (no red mark seen in “mirror”).								
<u>Two ejector snaps</u> (see illustration below) <ul style="list-style-type: none"><li>• Are the <i>lower</i> parachute attach points on the harness.</li><li>• Connect to the lower parachute attach fittings.</li><li>• Have soft dock position and locked position (see below).</li></ul>									
<div></div> <p style="text-align: center;"><u>EJECTOR SNAP POSITIONS</u> (LOWER PARACHUTE ATTACH FITTINGS)</p>									

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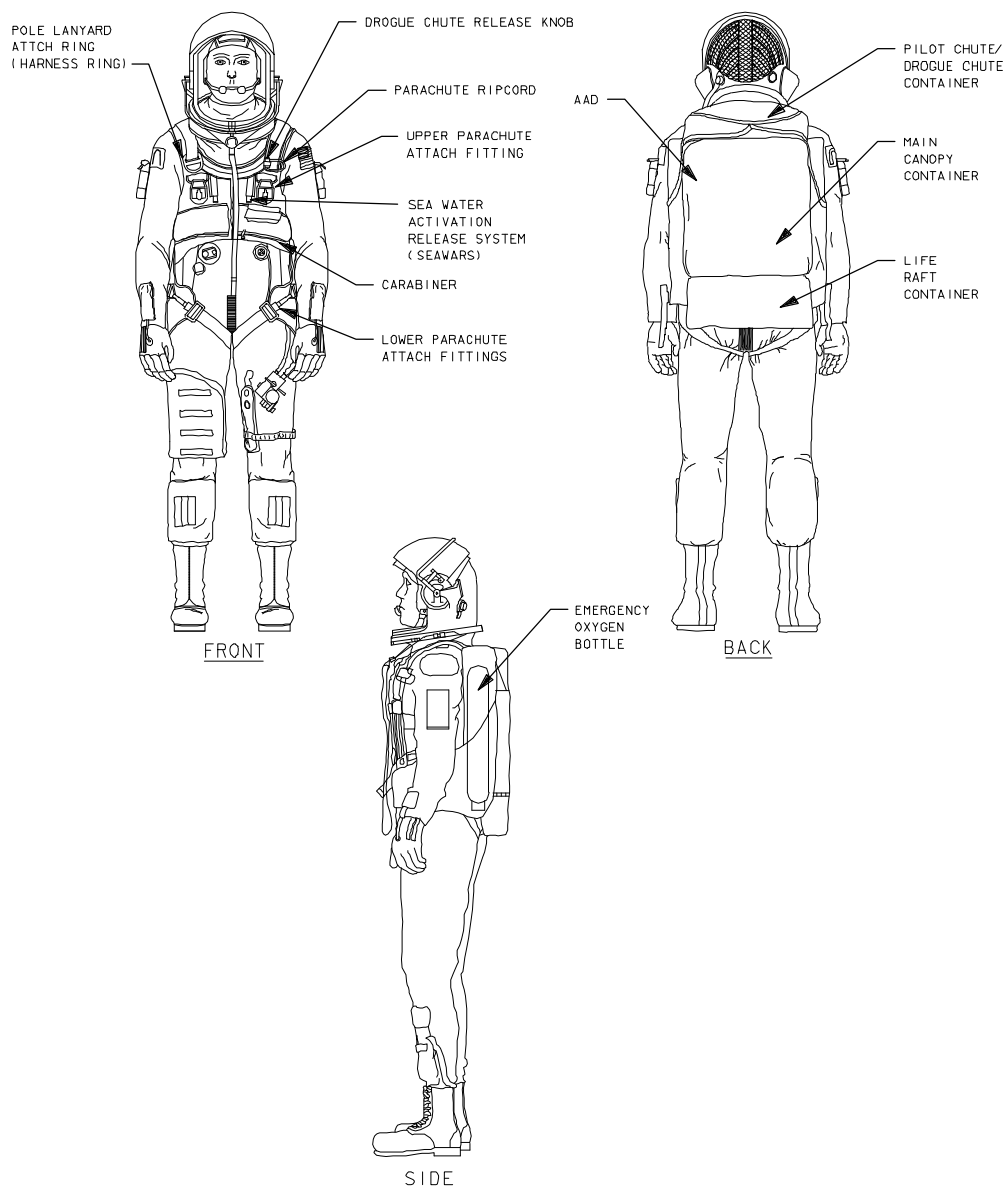


## Parachute Harness, Personal Parachute Assembly, Continued

### Parachute assembly

The PPA, figure 2.5-2, includes:

- The parachutes, risers, and associated items.
- The Search and Rescue Satellite-Aided Tracking (SARSAT) radio beacon.
- A small, one-person life raft.



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**Figure 2.5-2. Personal parachute assembly**

*Continued on next page*

## Parachute Harness, Personal Parachute Assembly, Continued

### Parachute assembly (cont)

The PPA is:

- Used as a seat back cushion.
- Placed on the crew seats before ingress.
- Connected during prelaunch to the parachute harness at four attach points.

The table below describes the PPA components (for the rescue/survival gear, refer to section 2.6).

Component	Description
Lanyard attach D-ring and bridle	The D-ring serves as the attachment point for the bailout lanyard located on the lanyard pole.
Pyrotechnic deployment system for the parachutes	Consists of: <ul style="list-style-type: none"> <li>• Three light-duty cutters for deployment of the pilot chute.</li> <li>• Two heavy-duty cutters for bridle/lanyard separation.</li> <li>• An Automatic Actuation Device (AAD) for the main canopy.</li> </ul>
Parachute ripcord	The manual backup method of activating automatic deployment sequence. Located on left parachute riser.
Drogue chute release knob	Used only as a manual override to the AAD to deploy main canopy (if drogue chute already deployed).
Pilot chute	Has an 18-in. diameter canopy; pulls drogue chute from parachute pack.
Drogue chute	Has a 4.5-foot-diameter canopy; stabilizes crewmember before main canopy deploys.
Main canopy	A modified 26-foot-diameter circular military canopy with: <ul style="list-style-type: none"> <li>• Four antioscillation windows.</li> <li>• A pyrotechnic reefing system to reduce the opening shock of the parachute on the crewmember.</li> </ul>
SARSAT radio beacon	See section 2.6
One-person life raft	

*Continued on next page*

## Parachute Harness, Personal Parachute Assembly, Continued

---

### Parachute assembly (cont)

Component	Description
Pair of standard military Seawater-Activated Release Systems (SEAWARS)	One is attached to the front of each parachute riser.  When immersed in salt water, the two SEAWARS automatically release the risers, separating the crewmember from the canopy.  Note: In the highly unlikely event that the SEAWARS fails, squeeze top and bottom of Frost fittings to disconnect.
Raft inflation lanyard	Used to manually inflate and deploy the life raft.

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### Parachute deployment

Figures 2.5-3 and 2.5-4 on pages that follow illustrate respectively:

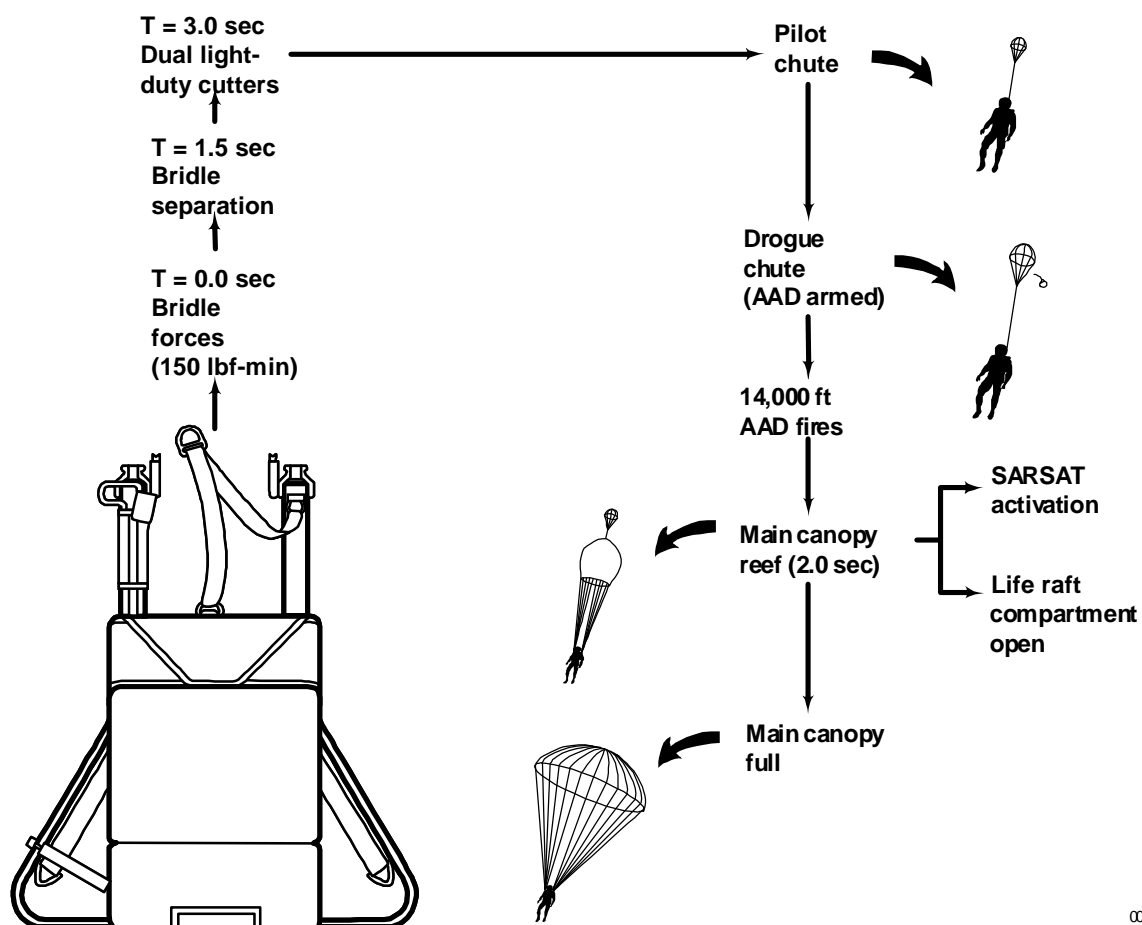
- The automatic parachute deploy sequence.
- The manual parachute deploy sequence.

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## Parachute Harness, Personal Parachute Assembly, Continued

### Parachute deployment (cont)



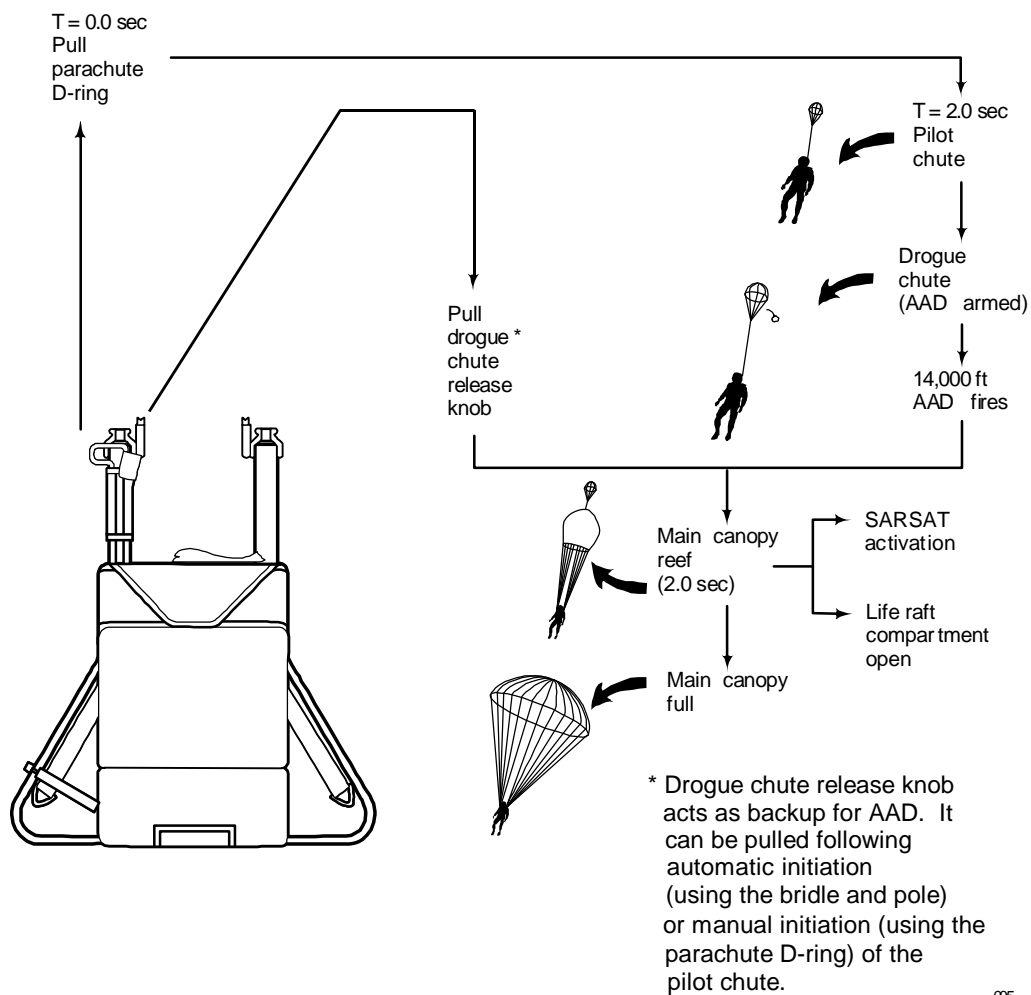
004

*Figure 2.5-3. Automatic parachute deploy sequence*

*Continued on next page*

## Parachute Harness, Personal Parachute Assembly, Continued

### Parachute deployment (cont)



006

*Figure 2.5-4. Manual parachute deploy sequence*

## Rescue/Survival Gear

### Introduction

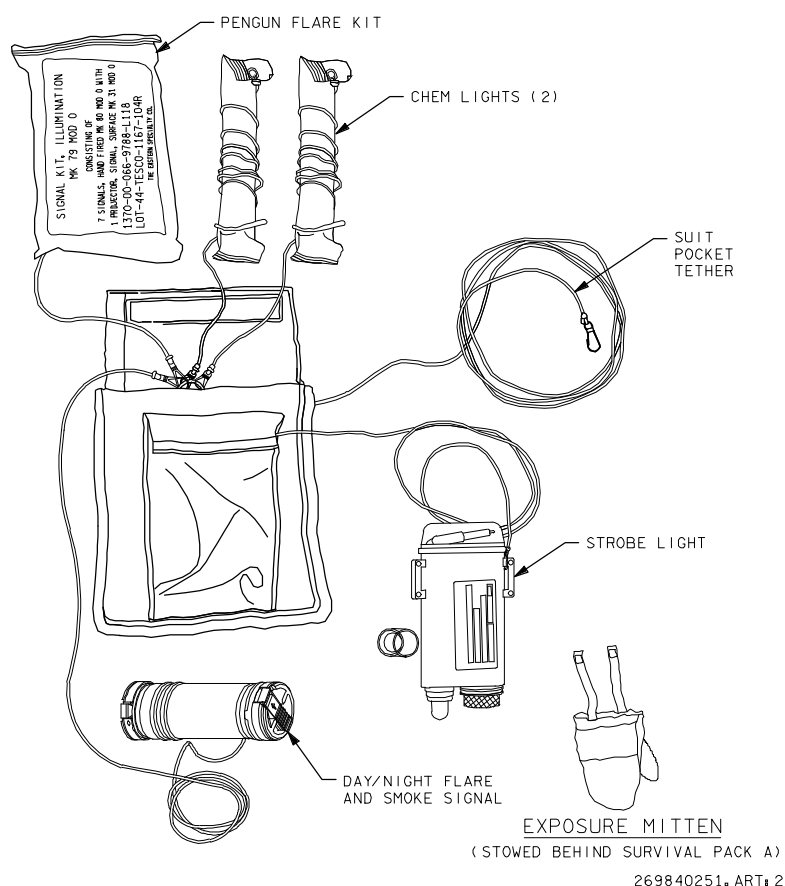
Crewmembers are provided an array of emergency rescue/survival gear. This gear is stowed in the following places:

- Right and left suit leg pockets (there is also a shroudline cutter/knife located in a small pocket on the upper left suit leg).
- Parachute harness.
- Personal parachute assembly.

Subsections below depict and describe the gear by stowage location.

### Gear in suit left leg pocket

The rescue/survival gear stowed in a packet (packet A) in the suit left leg pocket is illustrated in figure 2.6-1 and described in the table that follows.



**Figure 2.6-1. Rescue/survival gear, suit left leg pocket (packet A)**

*Continued on next page*

## Rescue/Survival Gear, Continued

### Gear in suit left leg pocket (cont)

The table below describes the rescue/survival gear stowed in a packet (packet A) in the suit *left leg pocket*.

Item	Description	
Penguin flare kit (MK-70)	Functional features:	
	<ul style="list-style-type: none"> <li>• Seven cartridges supplied.</li> <li>• Duration of each cartridge 4.5 sec.</li> <li>• Visible 50 mi.</li> </ul>	
	Note: Use recommended only when visual contact made with SAR forces or SAR forces request use.	
	To operate:	
	Step	Procedure
	1	With gun in “cocked” position, screw in cartridge.
	2	Aiming away from raft and self at 45° angle, pull trigger knob and release (firing produces “kick”).
Two chem lights	12-hr, high-intensity Cyalume lightsticks.	
	To activate, bend to break glass bead and shake stick (decal).	
Day/night flare and smoke signal (MK-124)	Functional features:	
	<ul style="list-style-type: none"> <li>• Orange smoke day; red flare night.</li> <li>• Duration 16 sec day; 20 sec night.</li> <li>• Visible 7 mi day; 30 mi night.</li> <li>• Use gloves if handheld (flare and smoke generate heat).</li> </ul>	
	Note: Use recommended only when visual contact made with SAR forces or SAR forces request use.	
	To operate:	
	Step	Procedure
	1	Remove end cover.
	2	Holding away from raft, pull trigger out, then down to fire.
		Note: If smoke signal begins to flare, quickly dip in water.

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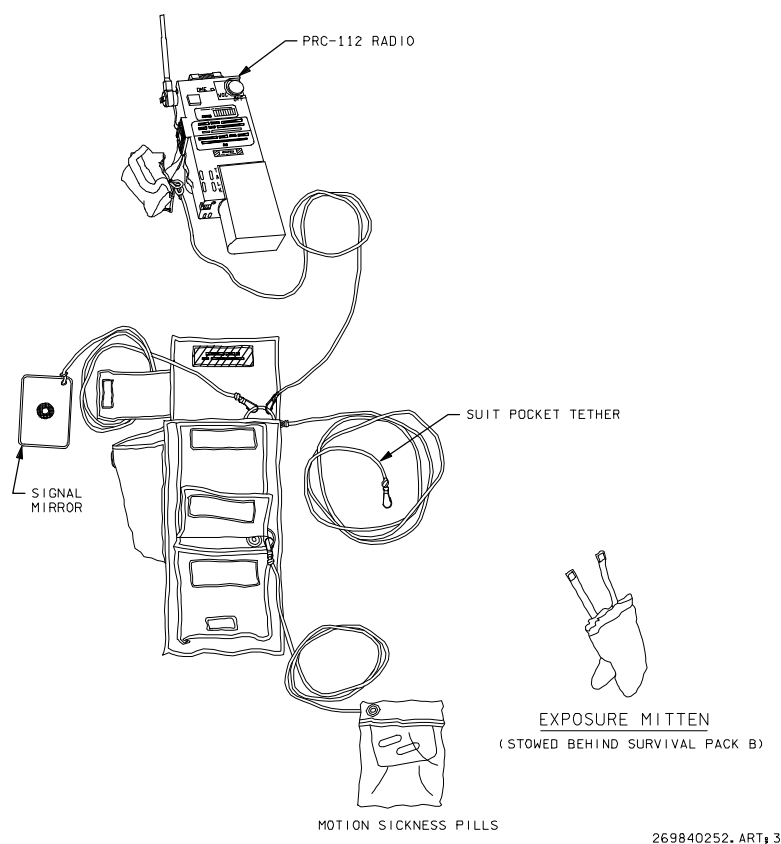
## Rescue/Survival Gear, Continued

### Gear in suit *left* leg pocket (cont)

Item	Description
Strobe light	<ul style="list-style-type: none"> <li>• On/off switch.</li> <li>• Battery life 6 to 9 hr continuous operation; 18 hr intermittent.</li> <li>• Visible 50 mi.</li> </ul>
Survival mitten	(Other mitten is in right leg pocket.)

### Gear in suit *right* leg pocket

The rescue/survival gear stowed in a packet (packet B) in the suit *right* leg pocket is illustrated in figure 2.6-2 below and described in the table that follows.



**Figure 2.6-2. Rescue/survival gear, suit *right* leg pocket (packet B)**

*Continued on next page*



## Rescue/Survival Gear, Continued

**Gear in suit  
right leg pocket  
(cont)**

The table below describes the rescue/survival gear stowed in a packet (packet B) in the suit *right* leg pocket:

Item	Description																														
Survival radio and earphone	<p>The radio, a PRC-112, has:</p> <ul style="list-style-type: none"> <li>• Transmit/receive capability.</li> <li>• Continuous beacon capability.</li> </ul> <p>Battery life is 24 hr (90 percent receive, 10 percent transmit).</p> <p>An earphone and spare antenna are in a packet attached to the radio.</p> <p>To operate the radio, follow the decal on the radio back. The decal procedures are iterated below:</p> <table border="1"> <thead> <tr> <th colspan="2">PRC-112 RADIO INSTRUCTIONS</th></tr> </thead> <tbody> <tr> <td>•</td><td>EXTEND SARSAT TELESCOPING ANTENNA, THEN DISCONNECT WIRE ANTENNA</td></tr> <tr> <td>•</td><td>CONTINUE SARSAT BEACONING</td></tr> <tr> <td>•</td><td>STANDBY FOR RADIO CONTACT WITH SAR FORCES</td></tr> <tr> <td>•</td><td>FOLLOW INSTRUCTIONS FROM SAR FORCES</td></tr> <tr> <td>•</td><td>RETURN TO 282.8 IF CONTACT WITH SAR FORCES LOST</td></tr> <tr> <td>•</td><td>VERIFY SARSAT BEACON TONES WITH PRC-112 BY MOMENTARILY LISTENING TO 243.0 (VOICE) AND 121.5 (VOICE)</td></tr> </tbody> </table> <table border="1"> <thead> <tr> <th colspan="2">ADDITIONAL INFORMATION</th></tr> </thead> <tbody> <tr> <td>121.5 BCN</td><td>INTERNATIONAL EMERGENCY FREQUENCY (VHF/BEACON)</td></tr> <tr> <td>121.5</td><td>INTERNATIONAL EMERGENCY FREQUENCY (VHF/VOICE)</td></tr> <tr> <td>243.0 BCN</td><td>MILITARY EMERGENCY FREQUENCY (UHF/BEACON)</td></tr> <tr> <td>243.0</td><td>MILITARY EMERGENCY FREQUENCY (UHF/VOICE) DME</td></tr> <tr> <td>282.8</td><td>PRIMARY SAR OPERATIONS FREQUENCY (UHF/VOICE)</td></tr> <tr> <td>A.</td><td>SECONDARY SAR OPERATIONS (259.7) FREQUENCY (SHUTTLE A/G) (UHF/VOICE) DME</td></tr> <tr> <td>B.</td><td>BACKUP SAR OPERATIONS (236.0) FREQUENCY (UHF/VOICE) DME</td></tr> </tbody> </table>	PRC-112 RADIO INSTRUCTIONS		•	EXTEND SARSAT TELESCOPING ANTENNA, THEN DISCONNECT WIRE ANTENNA	•	CONTINUE SARSAT BEACONING	•	STANDBY FOR RADIO CONTACT WITH SAR FORCES	•	FOLLOW INSTRUCTIONS FROM SAR FORCES	•	RETURN TO 282.8 IF CONTACT WITH SAR FORCES LOST	•	VERIFY SARSAT BEACON TONES WITH PRC-112 BY MOMENTARILY LISTENING TO 243.0 (VOICE) AND 121.5 (VOICE)	ADDITIONAL INFORMATION		121.5 BCN	INTERNATIONAL EMERGENCY FREQUENCY (VHF/BEACON)	121.5	INTERNATIONAL EMERGENCY FREQUENCY (VHF/VOICE)	243.0 BCN	MILITARY EMERGENCY FREQUENCY (UHF/BEACON)	243.0	MILITARY EMERGENCY FREQUENCY (UHF/VOICE) DME	282.8	PRIMARY SAR OPERATIONS FREQUENCY (UHF/VOICE)	A.	SECONDARY SAR OPERATIONS (259.7) FREQUENCY (SHUTTLE A/G) (UHF/VOICE) DME	B.	BACKUP SAR OPERATIONS (236.0) FREQUENCY (UHF/VOICE) DME
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## Rescue/Survival Gear, Continued

### Gear in suit right leg pocket (cont)

Item	Description
Signal mirror	Visible 40 mi.
Two motion sickness pills	0.4 mg Scopolamine, 5 mg Dexedrine in each pill.
Exposure mitten	(Other mitten is in left leg pocket.)

### Shroudline cutter/knife

A shroudline cutter/knife is located in a small pocket on the upper left leg of the suit.

### Gear, para-chute harness

The parachute harness (figure 2.5-1) includes the following emergency gear:

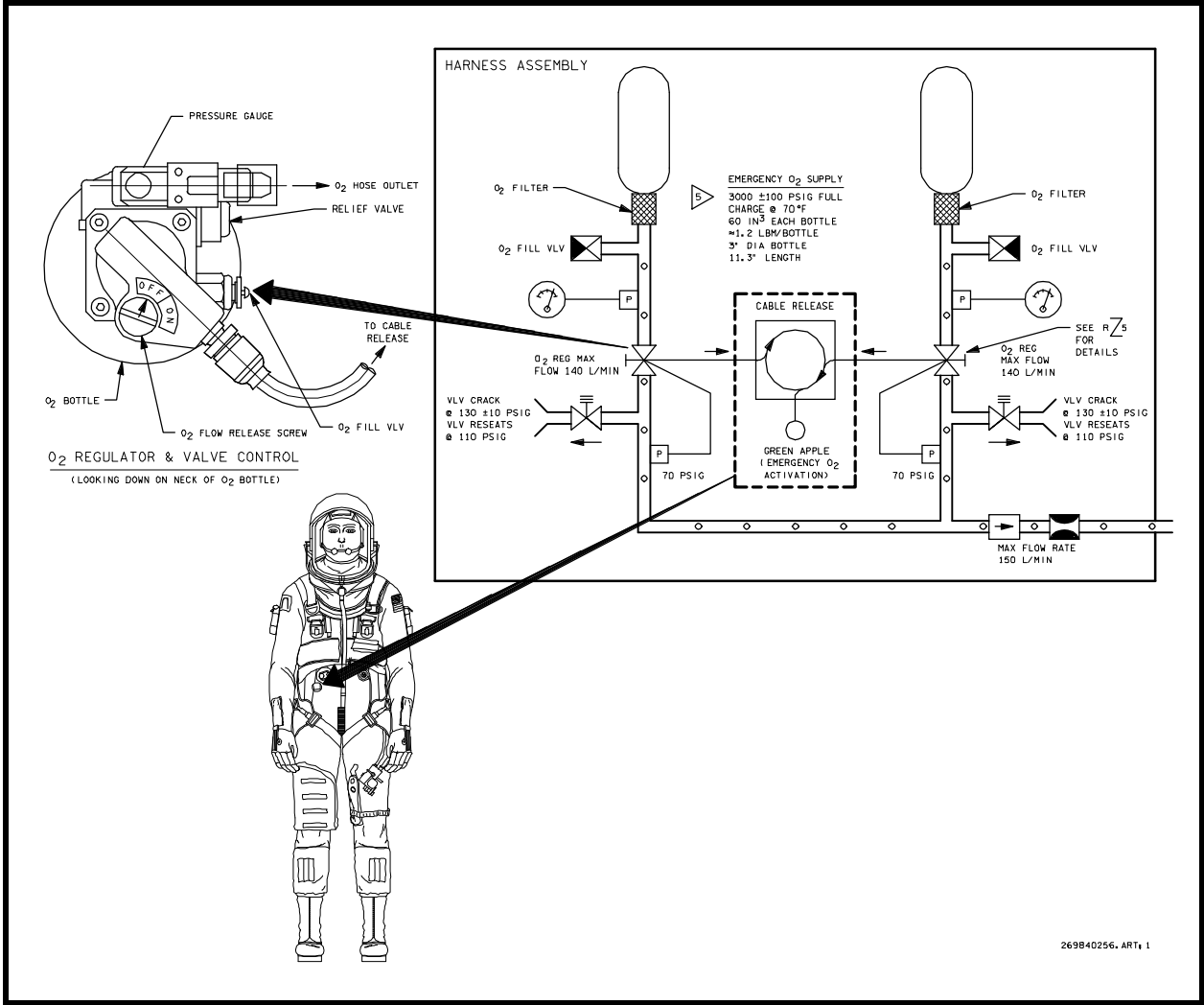
Item	Description
Life preserver unit	<p>The LPU, attached to the harness, has the following features:</p> <ul style="list-style-type: none"> <li>• Horseshoe-shaped, fits under the crewmember's arms and around back.</li> <li>• Designed to keep an unconscious crewmember's head out of the water.</li> <li>• Inflates <i>automatically</i> from CO<sub>2</sub> bottle (new design has two bottles) when immersed in any type of water, <i>or</i> may be inflated <i>manually</i>.</li> </ul>
Emergency oxygen system	<p>Consists of two bottles of oxygen for emergency breathing, which:</p> <ul style="list-style-type: none"> <li>• Are woven into the back of the harness.</li> <li>• Contain 120 in<sup>3</sup> O<sub>2</sub> at 3000 psi (381 liters usable O<sub>2</sub>).</li> <li>• Deliver O<sub>2</sub>, via reducer valves, at 70 psia.</li> <li>• At moderate level of exertion (38 liters/min of use), EOS will last 10 min at sea level and longer at high altitudes.</li> </ul> <p>The figure on the next page gives a schematic overview of the EOS.</p>

*Continued on next page*

Rescue/Survival Gear, Continued

Gear, para-  
chute harness  
(cont)

Item	Description
Emergency oxygen system (cont)	The figure below gives an overview of the EOS and the detail of the O <sub>2</sub> regulator/valve:



To activate the EOS:	
Step	Procedure
1	Lower and lock helmet visor.

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## Rescue/Survival Gear, Continued

### Gear, para- chute harness (Cont)

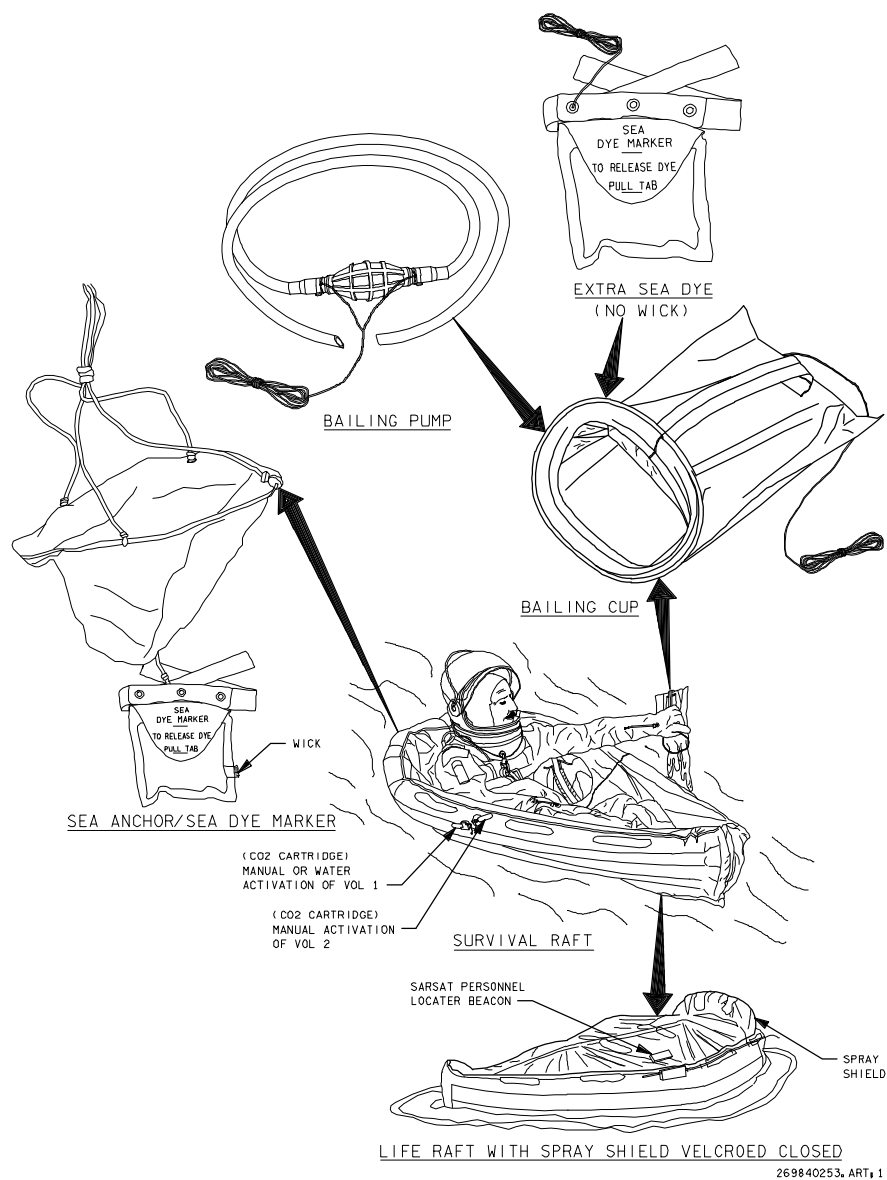
Item	Description	
Emergency oxygen system (cont)	To activate the EOS (cont):	
	<b>1 (cont)</b>	Note: <i>When helmet visor is closed and locked, the regulator in suit causes O<sub>2</sub> to flow only when crewmember inhales.</i>  <i>If helmet visor is opened while EOS is activated, O<sub>2</sub> will flow continuously into helmet until O<sub>2</sub> bottles are empty (right bottle is connected to left bottle by a hose within harness; another hose connects left bottle to O<sub>2</sub> distribution manifold on crewmember's left leg).</i>
	<b>2</b>	Pull EOS activation lanyard ("green apple") on lower right front of harness.  Note: There are two positions:  1. The first disconnects from the keeper. 2. The second initiates O <sub>2</sub> flow.
Carabiner	The carabiner (figure 2.5-1), attached to right side of harness above the LPU, can be used to hoist a crewmember.	
Emergency drinking water	The water pack containing emergency drinking water: <ul style="list-style-type: none"><li>• Is Velcroed to the rear of the harness between the EOS bottles.</li><li>• Is also attached to the harness by a 2-foot tether.</li><li>• Has 2 liters of water contained in 16 packets Velcroed inside.</li></ul>	

*Continued on next page*

## Rescue/Survival Gear, Continued

### Gear in PPA/life raft

The rescue/survival gear stowed in the life raft, which is contained in the PPA, is illustrated in figure 2.6-3 below and described in the table that follows.



**Figure 2.6-3. Rescue/survival gear, PPA/life raft**

*Continued on next page*

## Rescue/Survival Gear, Continued

### Gear in PPA/life raft (cont)

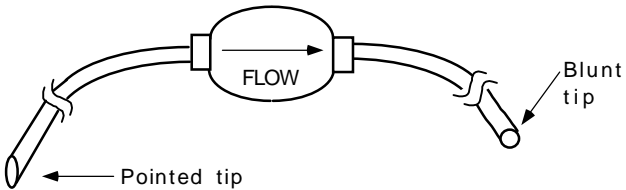
The life raft, which is stowed in the lower portion of the PPA, and the rescue/survival gear contained in the life raft are described in the table below.

Item	Description						
One-person survival raft	<p>The raft has the following features:</p> <ul style="list-style-type: none"> <li>• Has eight rows of inflatable tubes that are inflated in the following manner: <ul style="list-style-type: none"> <li>- <u>Normally</u>, the tubes are inflated by two CO<sub>2</sub> cartridges (FLU-9) as follows: <p>On entering the water, one of the CO<sub>2</sub> cartridges automatically inflates the second, third, and fourth rows, thus giving the raft some shape and flotation. (The CO<sub>2</sub> cartridge can also be activated manually.)</p> <p>After climbing in the raft, the crewmember manually fires the other CO<sub>2</sub> cartridge to inflate the remaining five raft tubes.</p> </li> <li>- <u>If necessary</u>, the tubes can be inflated by using the two oral inflation tubes provided inside the raft.</li> </ul> </li> <li>• Is equipped with two spray shields. These shields are orange winglike structures that can be Velcroed closed.</li> <li>• Has reflective tape on sides.</li> <li>• Is tethered to PPA (to part that remains on crewmember) by 12-foot Kevlar tether.</li> <li>• Has bailing cup, siphon tube, and additional sea dye marker tethered to the right side.</li> </ul>						
SARSAT personal locator beacon	<p>Tethered to a small pocket on the left side of spray shield.</p> <p>Antenna loops around the back of the spray shield.</p> <p>Beacon automatically activates upon parachute deployment, transmitting on the following frequencies:</p> <table> <tr> <td>121.5</td><td>International distress</td></tr> <tr> <td>243.0</td><td>Military distress</td></tr> <tr> <td>406.0</td><td>Satellite SAR</td></tr> </table>	121.5	International distress	243.0	Military distress	406.0	Satellite SAR
121.5	International distress						
243.0	Military distress						
406.0	Satellite SAR						

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## Rescue/Survival Gear, Continued

Gear in  
PPA/life raft  
(cont)

Item	Description
Sea anchor/sea dye marker	<p>Tethered to outside of raft.</p> <p>The anchor is usually allowed to be untied by wave action.</p> <p>The sea dye marker is fitted with a wick and will “wick” upon contact with water.</p> <p>Note: The dye dissipates quickly in rough water. The extra sea dye will not “wick.” Open packet when requested by SAR forces.</p>
Bailing pump, bailing cup, packet of extra sea dye	<p>The pump has directional flow; the flow is as follows:</p> 

## Chapter 3

# Orbiter Hardware

### Overview

---

#### Introduction

Crew escape hardware has been built into the orbiter that facilitates quick and safe crew egress/escape in an emergency. This hardware includes:

- The escape pole, which makes it possible for the crew to bail out safely in flight.
- The escape slide, which makes it possible for the crew to egress quickly from the orbiter postlanding.
- The window 8 escape panel used postlanding in the event of total side hatch failure.
- The descent control devices used postlanding in the event of complete slide failure.
- The orbiter side hatch.

---

#### Purpose

This chapter describes the components, operational features, and operation of orbiter built-in crew escape hardware.

---

#### Objectives

After completing this chapter, you will be able to identify:

1. Components of the orbiter side hatch and the steps in opening the hatch normally and by jettisoning.
2. Components of the window 8 escape panel and the steps in opening it.
3. Components of the descent control device (sky genie) and the steps in using it postlanding to descend from the orbiter through:
  - The side hatch (primary route).
  - The window 8 escape panel (secondary route).
4. Components of the escape pole and the steps in deploying and using the pole for bailout.
5. Components of the emergency egress slide system and the steps in using the system with:
  - The side hatch *on* (hatch opened normally).
  - The side hatch *off* (hatch jettisoned).

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*Continued on next page*



## Overview, Continued

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**In this chapter**    Sections describe crew escape orbiter hardware as follows:

Section	Page
Nominal Seat Ingress/Egress	3.2-1
Side Hatch	3.3-1
Window 8 Escape Panel	3.4-1
Descent Control Device (Sky Genie)	3.5-1
Escape Pole	3.6-1
Emergency Egress Slide System	3.7-1

---

## Nominal Seat Ingress/Egress

---

**Introduction** Nominal seat ingress and egress procedures are defined by the mission phase during which the ingress or the egress occurs.

Ingress and egress during each mission phase are discussed below. For seat/orbiter egress because of a mission scrub, see “Nominal seat/orbiter egress” at the end of the section.

---

**Prelaunch seat ingress** The sequence of events is as follows immediately before and during prelaunch ingress (T - 2:25:00 to T - 1:10:00):

Pre-ingress:

Step	Action
1	After donning flight suits (and bioinstrumentation if manifested) in the suit room in the Operations and Checkout (O&C) building, the crew arrives at the 195-foot level of the Fixed Service Structure (FSS).
2	In the white room on the Orbiter Access Arm (OAA), the closeout crew and the suit technician assist the crew in donning a parachute harness and a CCA (comm cap).

Ingress:

Step	Action										
1	<p>Crewmembers ingress through the orbiter side hatch into the flight deck and middeck to assigned seats in the following order (ingress into the two areas can be at the same time):</p> <table> <tr> <th><u>Flight Deck</u></th><th><u>Middeck</u></th></tr> <tr> <td>CDR (Seat 1)</td><td>MS5/PS2 (Seat 7)</td></tr> <tr> <td>PLT (Seat 2)</td><td>MS3 (Seat 5)</td></tr> <tr> <td>MS1 (Seat 3)</td><td>MS4/PS1 (Seat 6)</td></tr> <tr> <td>MS2 (Seat 4)</td><td></td></tr> </table>	<u>Flight Deck</u>	<u>Middeck</u>	CDR (Seat 1)	MS5/PS2 (Seat 7)	PLT (Seat 2)	MS3 (Seat 5)	MS1 (Seat 3)	MS4/PS1 (Seat 6)	MS2 (Seat 4)	
<u>Flight Deck</u>	<u>Middeck</u>										
CDR (Seat 1)	MS5/PS2 (Seat 7)										
PLT (Seat 2)	MS3 (Seat 5)										
MS1 (Seat 3)	MS4/PS1 (Seat 6)										
MS2 (Seat 4)											

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## Nominal Seat Ingress/Egress, Continued

### Prelaunch seat ingress (cont)

Step	Action
2	<p>A suit technician, aided by Astronaut Support Personnel (ASP), assists each crewmember into assigned seat.</p> <ul style="list-style-type: none"> <li>• The seat has a parachute pack on it (pack acts as seat back cushion).</li> <li>• Crewmembers lie on back on the parachute.</li> </ul>
3	<p>The suit technician and the ASP help the crewmembers with strap-in (flight deck crew and middeck crew at same time).</p> <p>The Commander (CDR) and the Pilot (PLT) have additional procedures for adjusting the headrest, rudder pedal, and Rotational Hand Controller (RHC); otherwise, the strap-in procedures are basically the same for all crewmembers.</p> <p>These strap-in procedures are outlined below:</p> <ol style="list-style-type: none"> <li>a. Normally, parachute connections are made first, and in the following order:             <ol style="list-style-type: none"> <li>(1) Two upper Frost fittings first.</li> <li>(2) Lower ejector snaps next.</li> </ol> </li> <li>b. The cooling may be attached and turned on to cool the crewmember.</li> <li>c. The shoulder harness/lapbelt assembly is connected in the following sequence:             <ol style="list-style-type: none"> <li>(1) Lapbelt is connected to the buckle on the crotch strap.</li> <li>(2) Shoulder harness is attached.</li> </ol> <p>When connections are completed, the shoulder harness and lapbelt are adjusted.</p> </li> <li>d. The helmet is placed on the neck ring and securely fastened.</li> <li>e. The orbiter O<sub>2</sub> hose is attached.</li> <li>f. The helmet comm leads and the HIU are connected.</li> <li>g. If bioinstrumentation is manifested, some additional connections may need to be made.</li> </ol>

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## Nominal Seat Ingress/Egress, Continued

### Prelaunch seat ingress (cont)

Step	Action
<b>3</b> (cont)	<p>The ASP conducts suit pressurization and comm tests (flight deck crew first, middeck crew second):</p> <ol style="list-style-type: none"> <li>The ASP asks each crewmember to perform a suit pressurization test consisting of the following steps: <ol style="list-style-type: none"> <li>Close and lock helmet visor.</li> <li>Turn suit O<sub>2</sub> switch ON.</li> <li>Push the push-to-test button on suit dual suit controller.</li> </ol> <p>The test checks the operation of the secondary pressurization system of the dual suit controller and confirms the suit pressurization function.</p> </li> <li>Crewmember communications are checked both with the helmet visor up and with the visor down.</li> </ol>
<b>4</b>	Once the strap-in and tests are completed, the ASP and suit technicians leave the vehicle and the orbiter hatch is closed.

### Postinsertion seat egress

Postinsertion procedures for seat egress follow the activities outlined in the *Post Insertion Checklist*.

Generally, the procedural sequence is as follows:

Time	Step	Procedure
~ Launch + 55 min	<b>1</b>	The mission specialists egress seats first (to begin configuring the aft flight deck and the middeck for orbital operations).
	<b>2</b>	MS3 installs the side hatch locking device and the pyro box safing pin.
~ Launch + 1:35 (go for orbit ops)	<b>3</b>	PLT and CDR egress seats.
	<b>4</b>	All crewmembers doff suits.

*Continued on next page*

## Nominal Seat Ingress/Egress, Continued

### Postinsertion seat egress (cont)

Crewmembers perform the following steps for seat egress:

Step	Procedure
1	Disconnect seat harness, orbiter O <sub>2</sub> , cooling, and comm.
2	Remove parachute, helmet, and comm cap.
3	Configure Very Lightweight Headset (VLHS) for orbit operations.
4	Stow the removed equipment.

### Deorbit prep seat ingress

In preparing for deorbit, crewmembers suit up and strap themselves into their assigned seats.

The strap-in procedures are the same as those for prelaunch (see “Prelaunch seat ingress”), except that the crewmembers help each other in ensuring proper configuration and checking that all connections are made.

The procedural sequence is as follows:

Step	Procedure
1	If bioinstrumentation manifested, connect leads, cuffs, etc., as necessary, before donning suit.
2	Place parachute on seat.
3	Don suit and harness.
4	Sit in assigned seat and attach parachute (placed on the seat back in step 2).
5	Connect harness/lapbelt.
6	If suit needs cooling, connect cooling.
7	Don comm cap, then helmet.
8	Connect comm leads and orbiter O <sub>2</sub> hose.
9	Don gloves, kneeboard, etc.
10	If bioinstrumentation manifested, make additional connections if necessary.

*Continued on next page*

## Nominal Seat Ingress/Egress, Continued

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### Nominal seat/orbiter egress

Nominal seat/orbiter egress occurs in two instances:

- At the *planned* end of the mission.
- Prelaunch, if the mission is scrubbed.

#### Postlanding

Nominal egress at the planned end of the mission is as follows:

Step	Action
1	At wheel stop, crewmembers unstrap from seats and prepare to egress the orbiter.
2	Convoy crew moves into position, opens side hatch, and assists crewmembers in doffing suit and/or egressing the orbiter.

#### Prelaunch

In the event that the mission is scrubbed, nominal egress is similar to that for the planned end of the mission. The difference is that prelaunch, the flightcrew is assisted by the closeout crew, the ASP, and the suit technicians.

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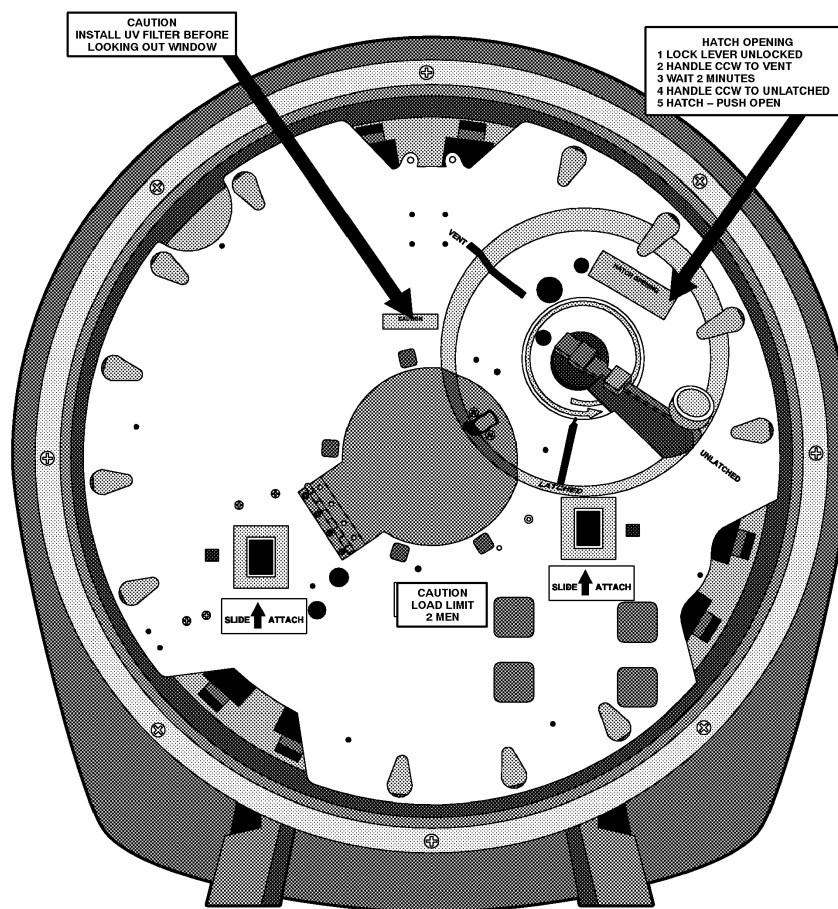
## Notes

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## Side Hatch

### Introduction

The side hatch, shown in figure 3.3-1 from the interior, is the primary means of entering and exiting the orbiter.



j\_48013\_60\_QC4\_9

**Figure 3.3-1. Orbiter side hatch, interior view**

### Physical features

The physical features of the side hatch are as follows:

- Weighs ~300 lb.
- Has 40-in. diameter.
- Has a clear-view window in center with a 10-in. diameter.
- Is attached to crew cabin tunnel by hinges, torque tube, and support fittings.
- Has a pressure seal that is compressed by the hatch latch mechanisms when the hatch is *locked* closed.

*Continued on next page*



## Side Hatch, Continued

### Functional features

The functional features of side hatch mechanisms are as follows:

- Force required to operate the hatch mechanisms:
  - Lock lever: 6 to 13 lbf to unlock.
  - Hatch handle: ~16 lbf to rotate, 25 lbf to overcome vent position detent.
- A hydraulic attenuator controls the rate of hatch opening.
- Hatch opens outwardly 90° (90° down with orbiter horizontal, 90° sideways with orbiter vertical).

### Normal side hatch opening

During normal operations, the flightcrew does not need to operate the side hatch because:

- Prelaunch, the closeout crew closes and seals the hatch.
- Postflight, the convoy crew opens the hatch.

However, because crewmembers may need to open the side hatch for a prelaunch or postlanding emergency, they need to be familiar with the nominal hatch opening procedure. The procedure is supplied on a decal affixed to the side hatch (figure 3.5-1) and is iterated below.

Step	Action
1	Ensure that the side hatch locking device is removed.
2	Flip lock lever to UNLOCKED position.
3	Rotate hatch handle CCW to VENT position. <div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: fit-content;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Stop at VENT position for 2 minutes to avoid rapid hatch opening.</p> </div>
4	Rotate hatch handle CCW to UNLATCHED position (hard stop).
5	Push hatch open.

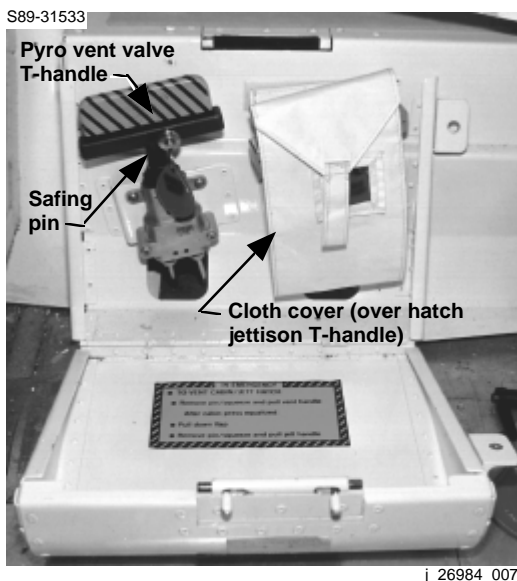
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## Side Hatch, Continued

### Depress, hatch jettison

Both the depressurization and hatch jettison are accomplished through a pyrotechnic system that includes the following components:

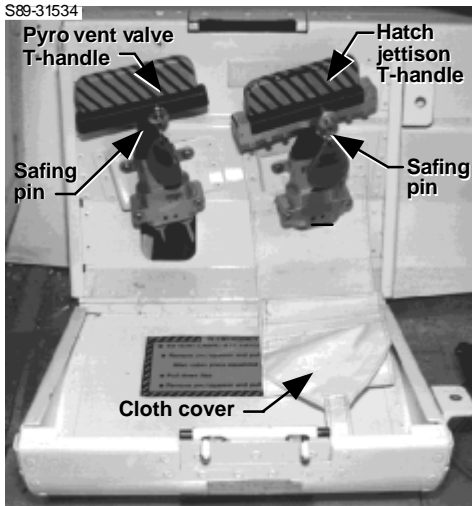
Component	Feature/Function
T-handle box	<p>Located on port forward middeck floor.</p> <p>Equipped with safing pin.</p> <p>Has two T-shaped handles:</p> <ol style="list-style-type: none"> <li>1. <u>Vent valve T-handle</u>, which: <ul style="list-style-type: none"> <li>• Is aft, “smooth” handle.</li> <li>• Has <i>no</i> cloth cover.</li> <li>• Activates pyro vent valve <i>to depressurize cabin</i> (in-flight bailout only).</li> </ul> </li> </ol>



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## Side Hatch, Continued

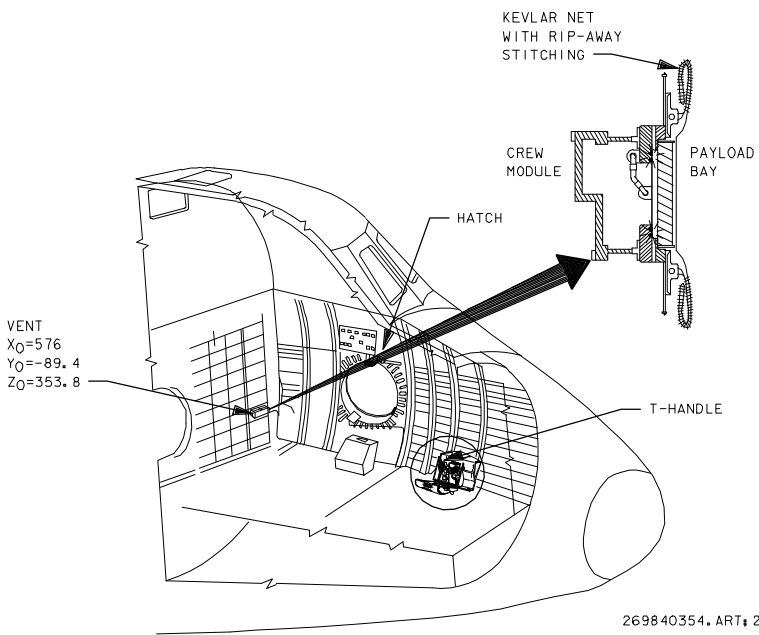
Depress, hatch  
jettison (cont)

Component	Feature/Function
T-handle box (cont)	<p>1. <u>Vent valve T-handle</u> (cont)</p> <div style="border: 1px solid black; padding: 10px; text-align: center;"> <p><b>WARNING</b></p> <p>Initiating cabin vent on ground could be an ignition source in payload bay.</p> </div> <p>2. <u>Hatch jettison T-handle</u>, which:</p> <ul style="list-style-type: none"> <li>• Is <i>forward</i>, “ribbed” handle.</li> <li>• Has white cloth cover.</li> <li>• Sets off hatch pyrotechnics <i>to jettison hatch</i>.</li> </ul> <div style="text-align: center;">  <p style="font-size: small;">S89-31534</p> <p style="font-size: small;">j_26984_007b</p> </div> <div style="border: 1px solid black; padding: 10px; text-align: center;"> <p><b>Caution</b></p> <p>During in-flight bailout only, cabin pressure must be equalized before hatch is jettisoned. Otherwise, middeck structural damage will likely result.</p> </div> <p>Each T-handle has a safing pin (see illustration above) that must be removed before handle can be moved and squeezed.</p>

*Continued on next page*

## Side Hatch, Continued

### Depress, hatch jettison (cont)

Component	Feature/Function
T-handle box (cont)	The handles are connected to respective pyro components by dual lengths of shielded detonating cord (that require no orbiter power).
Pyro vent valve	<p data-bbox="621 594 1427 667">Located behind waste management compartment (port side of middeck aft bulkhead):</p> <div data-bbox="638 724 1393 1354">  </div> <p data-bbox="621 1417 1427 1528">The vent valve depresses the cabin at a controlled rate by opening a 15 in<sup>2</sup> hole between the crew compartment and the payload bay (otherwise, middeck floor could buckle).</p> <div data-bbox="727 1554 1321 1738" style="border: 1px solid black; padding: 10px;"> <p data-bbox="938 1579 1107 1612" style="text-align: center;"><b>WARNING</b></p> <p data-bbox="738 1621 1291 1730">The cabin vent pyros are an ignition source in the payload bay and should not be used for postlanding egress.</p> </div>

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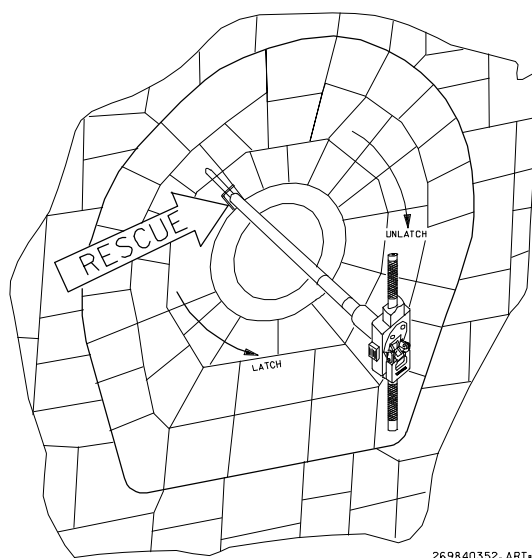
## Side Hatch, Continued

### Depress, hatch jettison (cont)

Component	Feature/Function
Hatch pyrotechnics (cont)	<p>The pyrotechnics associated with the hatch include:</p> <ul style="list-style-type: none"> <li>• Four linear-shaped charges (two per hinge for redundancy) to sever the hinges.</li> <li>• Two (redundant) expanding tube assemblies to sever the 70 frangible bolts holding the hatch adapter ring to the orbiter.</li> <li>• Three (partially redundant) thruster packs to separate the hatch from the orbiter at a velocity of approx. 45 ft/sec.</li> </ul> <p>Note: The hatch jettison features could be used in a bailout or landing emergency.</p>

### Side hatch opening by rescue personnel

In an emergency prelaunch or postlanding, rescue personnel can open the side hatch from the outside by using the external side hatch opening/closing tool shown in figure 3.3-2 (or by using a 1/2-in. or 5/8-in. square drive with a 12-in. extension).



**Figure 3.3-2. External side hatch  
opening/closing device**

*Continued on next page*

## Side Hatch, Continued

### Side hatch opening by rescue personnel

Rescue personnel follow the procedures below, presented here for general awareness, to open the orbiter side hatch from the outside:

Step	Procedure
1	<div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Following a nominal entry, hatch window temps can exceed 200° F 4 min after touchdown and 130° F 30 min after touchdown.</p> </div> <p>On side hatch, punch through the small red tile to expose the latch mechanism receptacle.</p>
2	Insert the hatch release tool into the latching mechanism receptacle.
3	Strike the end of tool with enough force to disengage the lock lever on the internal release mechanism.
4	<p>Rotate the latch release mechanism CW in two stages:</p> <p><i>Stage 1</i>      Rotate to the VENT detent; wait for pressure equalization.</p> <p style="padding-left: 150px;">Note: Nominal wait is 2 min. <i>Worst case</i> wait is 30 sec at sea level and up to 1 min at higher altitudes).</p> <p><i>Stage 2</i>      Rotate to hard stop (UNLATCH position).</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Stand clear when opening the hatch. The side hatch weighs 136 kg (300 lb). Positive cabin pressure can cause the hatch to open quite rapidly initially.</p> </div>
5	If necessary, pull or pry the hatch open from the top (hatch opening is attenuated).

## Notes

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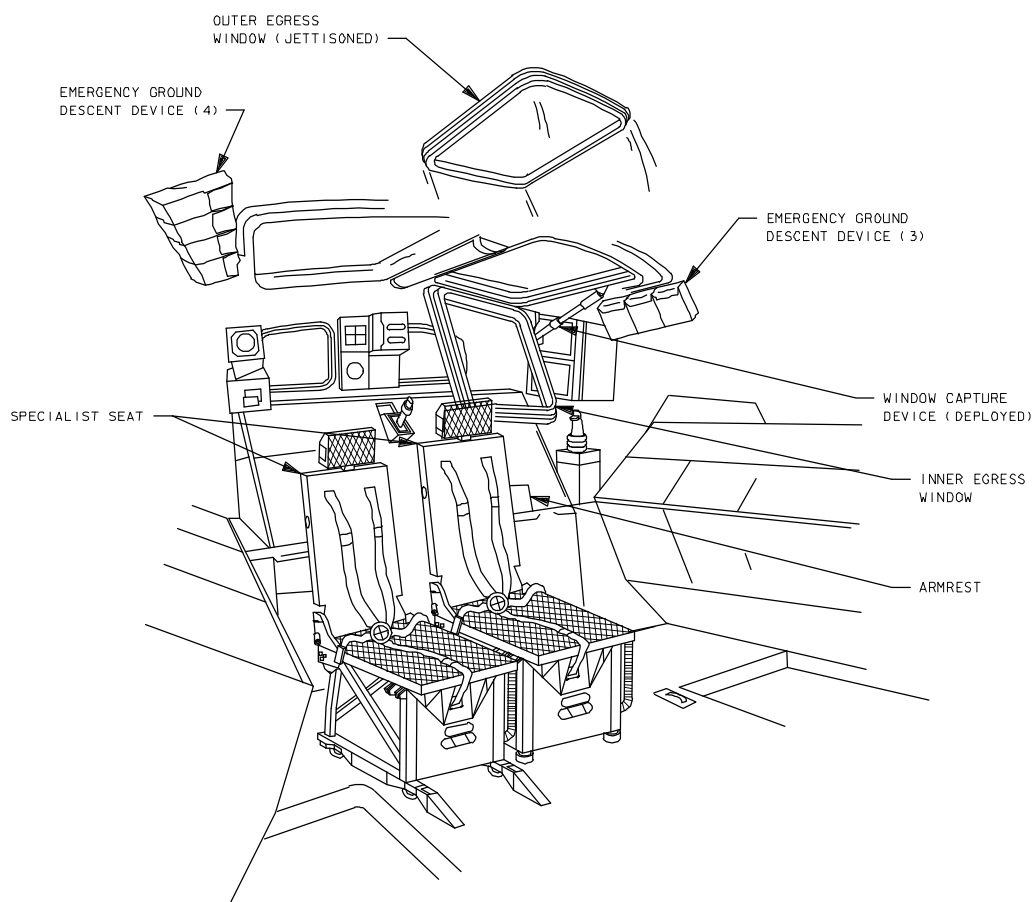
## Window 8 Escape Panel

### Introduction

Postlanding, if emergency egress through the side hatch is impossible, the crew uses the *secondary* route, which is via the escape panel at window 8 (figure 3.4-1).

To use this secondary route, crewmembers

- Jettison the escape panel using the panel pyrotechnic system as described in subsection “Escape panel jettison.”
- Attach to a sky genie (see next section).
- Climb out window 8 using MS2’s seat.
- Descend the starboard side of the orbiter.



269840341, ART. 1

**Figure 3.4-1. Window 8 escape panel**

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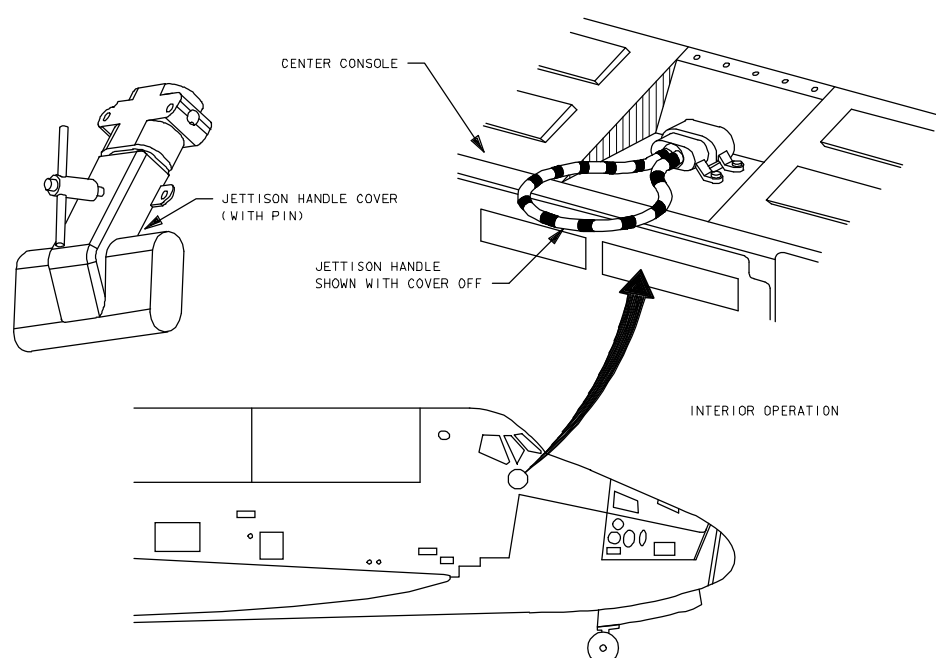
## Window 8 Escape Panel, Continued

### Panel pyrotechnics

The pyrotechnic system for jettisoning the escape panel is:

- A mechanical system requiring no orbiter power to operate.
- Initiated by the jettison handle (figure 3.4-2) located on top of flight deck panel C2 (center console).

Pyro components include expanding tube assemblies, mild detonating fuses, frangible bolts, and associated initiators.



269840342, ART: 3

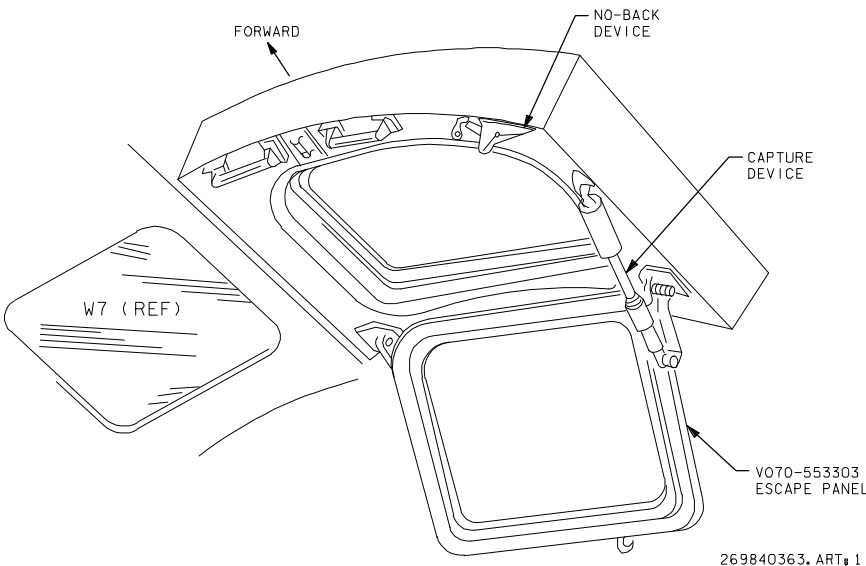
**Figure 3.4-2. Escape panel jettison handle, panel C2**

*Continued on next page*

## Window 8 Escape Panel, Continued

### Escape panel jettison

The operational detail of opening the escape panel is as follows:

Step	Action
1	<p>As the handle initiator is pulled, the <i>outer</i> thermal window pane and frame are ejected upward and overboard as a unit.</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;"><b>Caution</b></p> <p>The thermal pane window shatters. Take care to avoid injury from glass fragments.</p> </div>
2	<p>At 0.3 sec after the <i>outer</i> pane is jettisoned, the two <i>inner</i> pressure panes hinge down and aft and rest on the aft flight deck panel as illustrated below:</p>  <p style="text-align: right; font-size: small;">269840363, ART. 1</p> <ul style="list-style-type: none"> <li>• A <u>capture device</u> prevents the <i>inner</i> window pane from opening with too much force and holds the panel open.</li> <li>• A <u>no-back device</u> keeps the <i>inner</i> window from closing when the pressure across it is too great (as can happen at a landing field with a high elevation).</li> </ul> <p>This no-back device is spring loaded to:</p> <ul style="list-style-type: none"> <li>– Follow the window during the initial opening.</li> <li>– Engage a ratchet to prevent subsequent closing.</li> </ul>

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## Window 8 Escape Panel, Continued

### Escape panel jettison (cont)

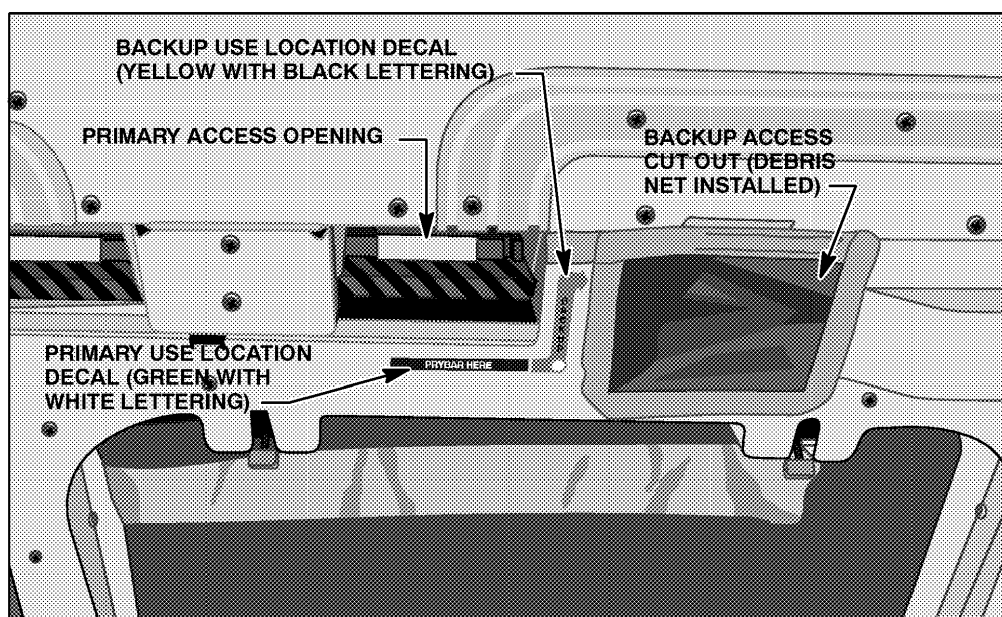
Step	Action
3	Should the inner window fail to open sufficiently because of delta pressure, a prybar is used when necessary to force the window open (see next subsection).

### Manual opening with prybar

If the pyro system fails to open the escape panel sufficiently against delta pressure, the crew can open the panel manually with a prybar (locker A17).

As shown in figure 3.4-3 below, there are two pry locations on the escape panel, each location color-coded for the end of the prybar to use:

Primary pry location	Backup pry location
Marked <i>green</i> .	Marked <i>yellow</i> .
Use if panel opens slightly.	Use if panel does not open at all.
Use <i>green</i> end of prybar.	Use <i>yellow</i> end of prybar.



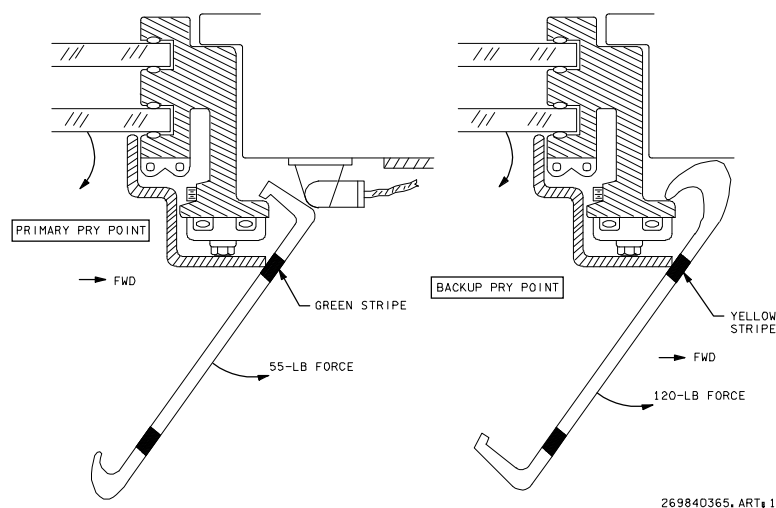
*Figure 3.4-3. Escape panel pry locations*

*Continued on next page*

## Window 8 Escape Panel, Continued

### Manual opening with prybar (cont)

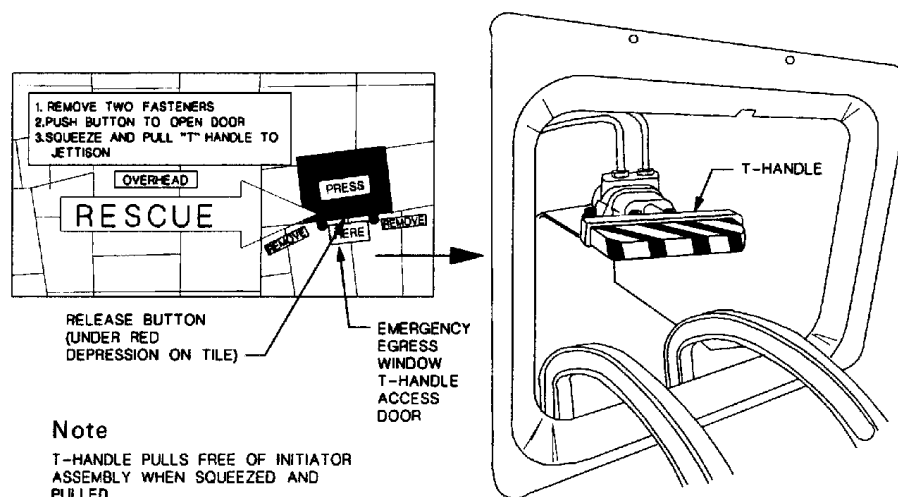
Figure 3.4-4 below shows prybar positioning in the primary and backup locations:



**Figure 3.4-4. Prybar positioning**

### Opening by rescue personnel

In a postlanding emergency when entry through the side hatch is impossible, rescue personnel can open the window 8 escape panel from the outside to enter the orbiter and aid the orbiter crew. The external T-handle initiator, located on the starboard side of the orbiter forward of the wing, is depicted in figure 3.4-5.



**Figure 3.4-5. External T-handle initiator**

*Continued on next page*

## Window 8 Escape Panel, Continued

Opening by  
rescue  
personnel  
(cont)

Rescue personnel follow the procedures below, given here for general awareness, to open the escape panel from the outside to rescue the orbiter crew.

Step	Procedure						
1	<div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <ul style="list-style-type: none"> <li>• Advise flightcrew and crash/rescue personnel of intent to jettison the emergency escape panel and to stay clear of inner egress window opening path (ground comm).</li> <li>• Before jettisoning the escape panel, fire fighting personnel should direct a water fog across the top of the orbiter to dissipate any explosive/flammable atmosphere that may have accumulated in the panel area.</li> </ul> </div> <p>On the lower right side of the forward fuselage:</p> <ol style="list-style-type: none"> <li>Remove two fasteners.</li> <li>Punch through small red tile.</li> <li>Depress door release button and open.</li> </ol>						
2	Squeeze and pull egress window jettison T-handle (handle pulls free of initiator assembly when squeezed and pulled).						
3	<p>Using a ladder or other suitable means, gain access to top of orbiter.</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Following a nominal entry, the thermal protection system in the overhead window area can be 120° F 4 min after touchdown, and the overhead window glass can be 190° F.</p> </div> <p>Note:</p> <table> <tr> <th>If outer window ...</th><th>Then ...</th></tr> <tr> <td>a. Broke loose from the orbiter but failed to jettison overboard</td><td>Pry window loose at its forward edge with a prybar; lift window and toss overboard.</td></tr> <tr> <td>b. Has pyro failure</td><td>Break thermal pane with prybar or heavy hammer.</td></tr> </table>	If outer window ...	Then ...	a. Broke loose from the orbiter but failed to jettison overboard	Pry window loose at its forward edge with a prybar; lift window and toss overboard.	b. Has pyro failure	Break thermal pane with prybar or heavy hammer.
If outer window ...	Then ...						
a. Broke loose from the orbiter but failed to jettison overboard	Pry window loose at its forward edge with a prybar; lift window and toss overboard.						
b. Has pyro failure	Break thermal pane with prybar or heavy hammer.						

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## Window 8 Escape Panel, Continued

Opening by  
rescue  
personnel  
(cont)

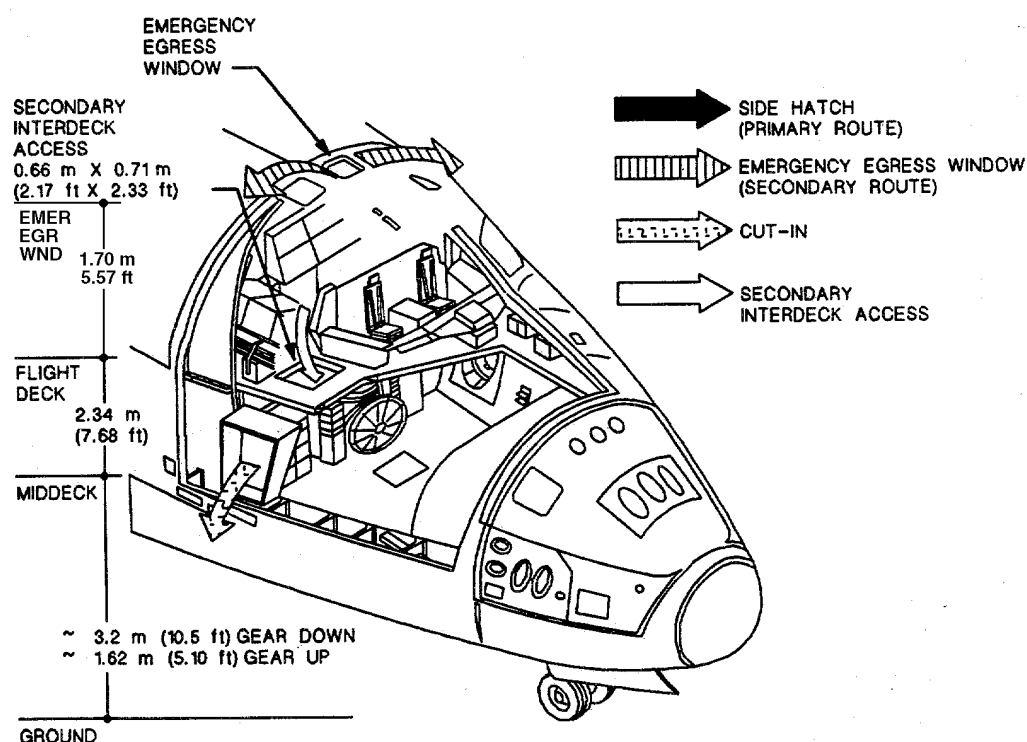
Step	Procedure	
<b>3</b> (cont)	<b>If <i>inner</i> window ...</b>	<b>Then ...</b>
	a. Closed after jettison operation	<ul style="list-style-type: none"> <li>• First, apply pressure with prybar at forward end of window to open and allow internal/external pressures to equalize.</li> <li>• Next, manually push window down to fully open position.</li> </ul>
	b. Has pyro failure	Proceed to break both panes of the window.
<b>4</b>	Enter aft flight deck through window opening.	
<b>5</b>	Immediately verify that all crewmembers have: <ol style="list-style-type: none"> <li>Released their neck dam tabs.</li> <li>Closed helmet faceplates.</li> <li>Turned on emergency O<sub>2</sub> bottles.</li> </ol>	
<b>6</b>	Assess conditions (fire, debris) in cabin. If fire or smoke evident, activate fire suppression system and/or use portable fire extinguishers as required.  Note: Orbiter power must be available to activate the fire suppression system.	
<b>7</b>	Power down orbiter electrical systems.	
<b>8</b>	Aid or rescue each crewmember, beginning with MS directly beneath window 8: <ol style="list-style-type: none"> <li>Crewmembers requiring little or no assistance use descent devices.</li> <li>Incapacitated crewmembers will be lifted up through window opening and lowered to ground by rescue personnel by means available.</li> </ol>	

*Continued on next page*

## Window 8 Escape Panel, Continued

### Cut-in area

If in extreme circumstances it is not possible or advisable to open either the side hatch or the window 8 escape panel, rescue personnel can remove a specially designed section of the orbiter wall (figure 3.4-6) to gain access to the middeck. Removal of the specially designed section, called the “cut-in” (or “cut-out”), requires 45 min or more. (Figure 3.4-6 also shows the secondary interdeck access.)



Note: Overall, from top to ground is ~7.24 meters, or ~23.75 ft.

*Figure 3.4-6. Cut-in area*

## Descent Control Device (Sky Genie)

### Introduction

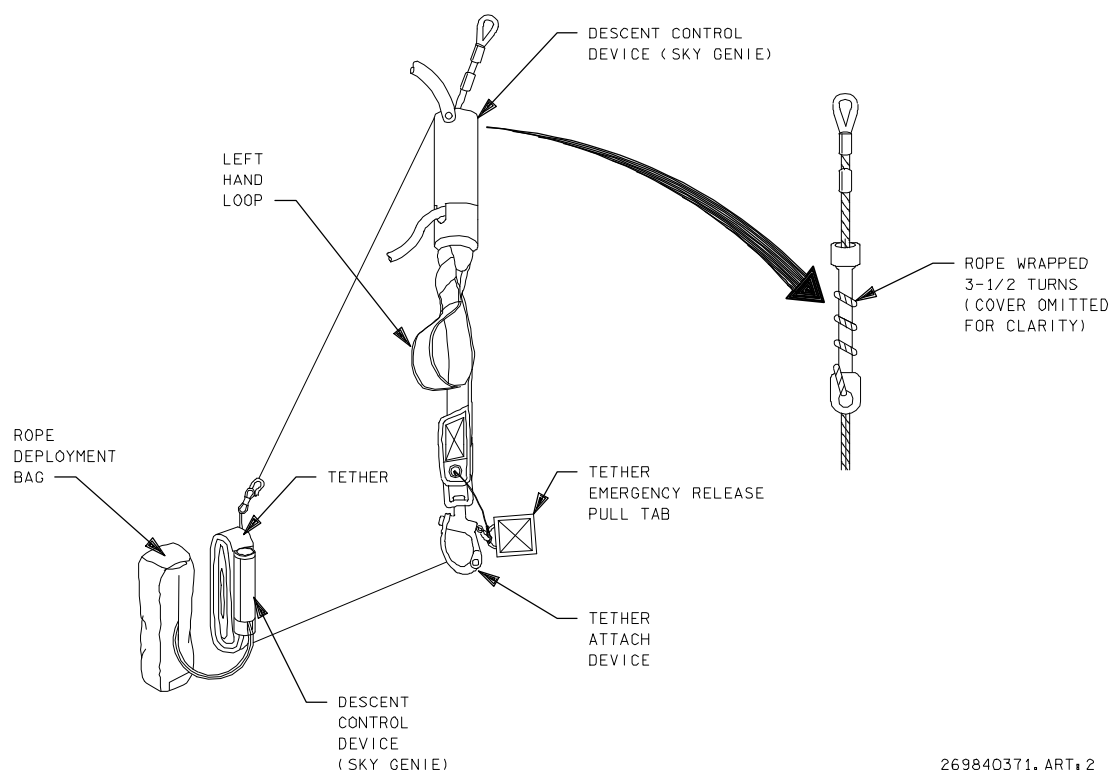
Crewmembers can use the descent control device, or “sky genie,” in an emergency postlanding situation to lower themselves from the orbiter to the ground quickly and safely in either of two ways:

1. If the egress slide fails, through the side hatch (either opened normally or jettisoned).
2. If the side hatch fails altogether, through the window 8 escape panel.

### Functional Features

Each sky genie, depicted in figure 3.5-1, includes the following components:

- A descent device
- 50 ft of nylon rope
- Rope bag
- Crewmember tether and hand loop
- Swivel snap shackle
- Emergency release tab



269840371. ART, 2

**Figure 3.5-1. Sky genie components**

*Continued on next page*



## Descent Control Device (Sky Genie), Continued

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**Sky genie use** Sky genie use is depicted in figure 3.5-2.



*Figure 3.5-2. Sky genie use*

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*Continued on next page*

## Descent Control Device (Sky Genie), Continued

### Sky genie use (cont)

The detail of sky genie use is as follows:

Step	Feature/Operation
1	The nylon rope is attached to a support bracket forward of the escape panel by a 30-in. metal cable.
2	The rope is fed through an opening at the top of the descent device and wrapped 3 1/2 times around the central shaft (the friction of the rope passing around the shaft allows the crewmember to control the descent rate). Refer to figure 3.5-1.
3	The rope exits the device on the same side as the crewmember's tether and hand loop. (A metal cover over this end of the device keeps debris out and provides a smooth sliding surface).
4	The free length of the rope is stowed in a bag.
5	Crewmembers throw the bag containing the free length of rope out the egress opening. The rope's weight helps unfurl the rope when the bag is thrown.
6	Crewmembers attach sky genie snap shackle to carabiner on their harness. At this point, the crewmembers can let go of the sky genie and use two hands to egress.

### Sky genie use, side hatch

Since the side hatch is the *primary* egress route from the orbiter, the crew uses the sky genie through the side hatch in case of egress slide failure. The procedure is as follows for using the sky genie through the side hatch:

Step	Action
1	A crewmember on the flight deck passes down a sky genie rope.
2	The rope is thrown out the hatch opening (aft of the hatch).
3	A sky genie must be manually pulled down from the flight deck and attached to a carabiner.
4	The crewmember crawls out on the side hatch, places his feet on the side of the orbiter, and rappels to the ground.

*Continued on next page*

## Descent Control Device (Sky Genie), Continued

### Sky genie use, window 8 escape panel

The procedure for using the sky genie in egressing through the window 8 escape panel is as follows:

Step	Procedure
1	Pull window jettison handle.
2	Remove sky genie from stowage bag and free cable from cable track. <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;"><b>Caution</b></p> <p>Take care not to drop the rope in the cabin. Dropping it could put knots in the rope or cause shattered glass and debris to stick to it, making descent difficult or impossible.</p> </div>
3	Throw sky genie rope out window 8 over <i>starboard</i> side of orbiter (rope is thrown out this side in case the side hatch unexpectedly jettisons).
4	Uncover and open harness carabiner and attach sky <i>genie snap shackle to carabiner</i> .
5	<div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;"><b>Caution</b></p> <p>Exercise caution in egressing the window 8 opening to avoid entanglement and injury from metal cables and ropes.</p> </div> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Following a nominal entry, the thermal protection system in the overhead window area can be 120° F 4 min. after touchdown, and the overhead window glass can be 190° F.</p> </div> <p>Climb onto MS2's seat and through window.</p> <p>Note: Make sure that sky genie cable is <i>over left shoulder</i> when climbing through the window area. Positioning the cable thus keeps cable from wrapping around you.</p>
6	While sitting on window sill, check that the rope and cable are not tangled or caught on any part of suit or around arm or leg.
7	Hold onto the sky genie hand loop with the <i>left</i> hand and onto the loose end of the rope with the <i>right</i> hand.

*Continued on next page*

## Descent Control Device (Sky Genie), Continued

Sky genie use,  
window 8  
escape panel  
(cont)

Step	Procedure
<b>8</b>	While lying on <i>left</i> side, slowly slide down the <i>starboard</i> side of the orbiter until the sky genie cable and rope are taut.  Note: The starboard side should always be used, thus staying clear of potential hatch jettison on the port side. Of course, if a fire or hazard is present on the starboard side, the port side must be used.
<b>9</b>	Proceed to lower self down the starboard side of the orbiter while controlling the rate of descent by applying tension on the sky genie rope.
<b>10</b>	Upon reaching the ground, disconnect the snap shackle from the carabiner and assist the next person in descending.
<b>11</b>	Proceed crosswind to the edge of the runway and then upwind (in this direction to best avoid contaminants and to remain visible to support crew).

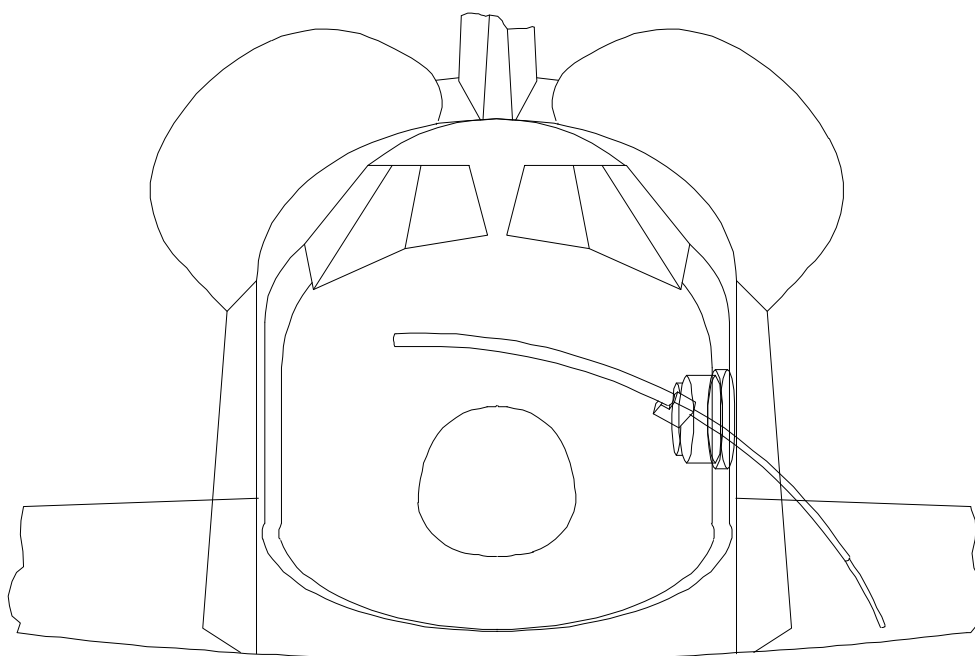
## Notes

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# Escape Pole

## Introduction

The crew escape system orbiter-based hardware includes the escape pole, depicted in figure 3.6-1. The pole is designed to guide crewmembers during bailout on a trajectory that clears the orbiter's left wing.



269840381. ART; 1

**Figure 3.6-1. Deployed escape pole (looking aft)**

## Functional features

The functional features of the escape pole are as follows:

- Has a curved steel and aluminum pole with spring-activated, telescoping deployment.
- Extends outward from side hatch 9.2 ft when fully deployed.
- Is contained within an aluminum housing that attaches to the middeck ceiling and the side wall by the hatch.
- Can be removed from the ceiling and stowed on orbit.
- Has a magazine holding eight lanyards attached to port (hatch) end. The lanyards guide the crewmembers down the pole.
- Weighs ~275 lb (the entire assembly, including pole and lanyards).

*Continued on next page*

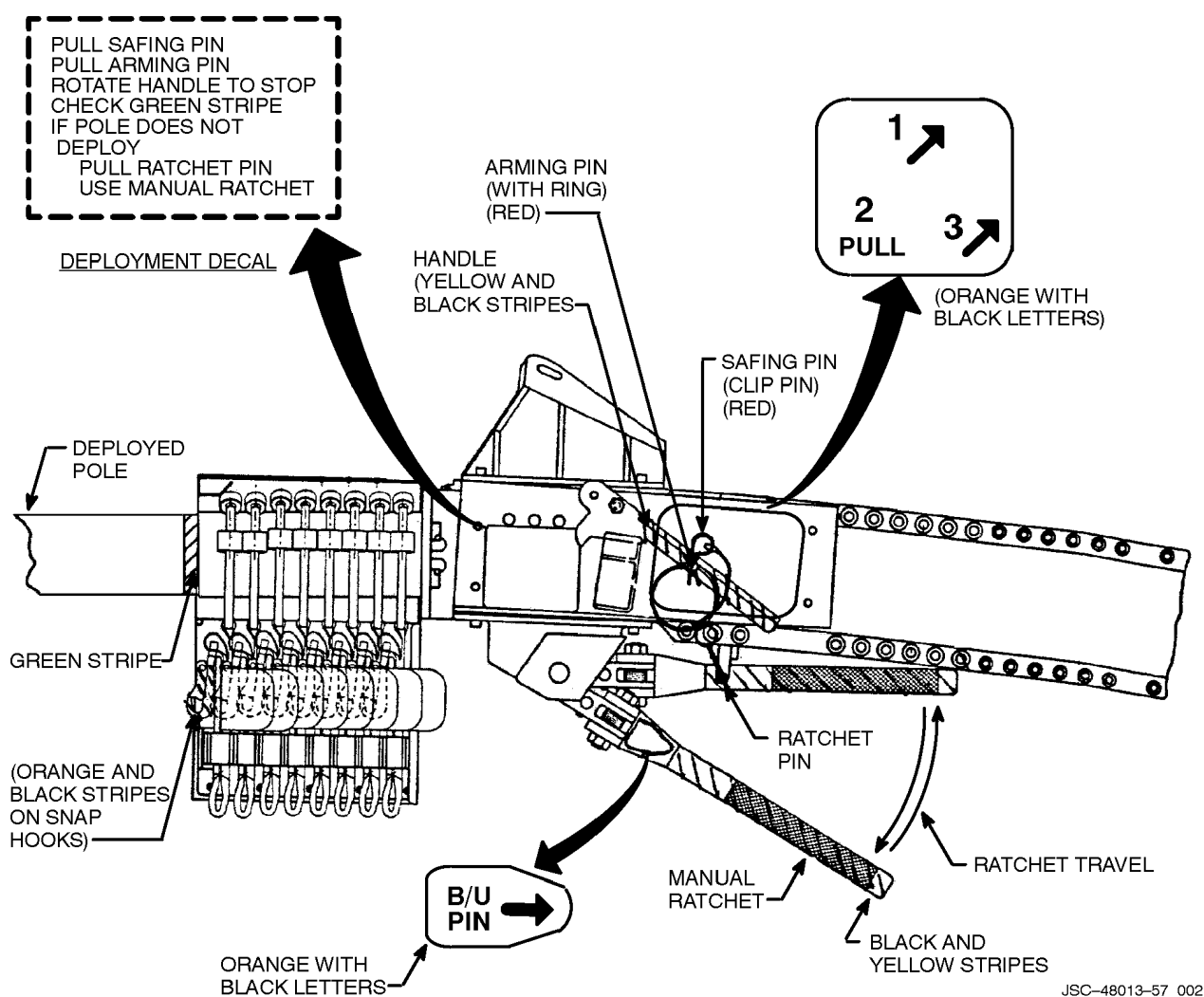
## Escape Pole, Continued

### Escape pole deployment

The escape pole is normally deployed as described in the next paragraph. If the pole fails to extend properly, it can be deployed manually, as described in the succeeding paragraph.

### Normal escape pole deployment

The instructions for normal pole deployment are supplied on a decal next to the pole deploy handle (yellow and black strips), as shown in figure 3.6-2.



**Figure 3.6-2. Escape pole deployment**

*Continued on next page*

## Escape Pole, Continued

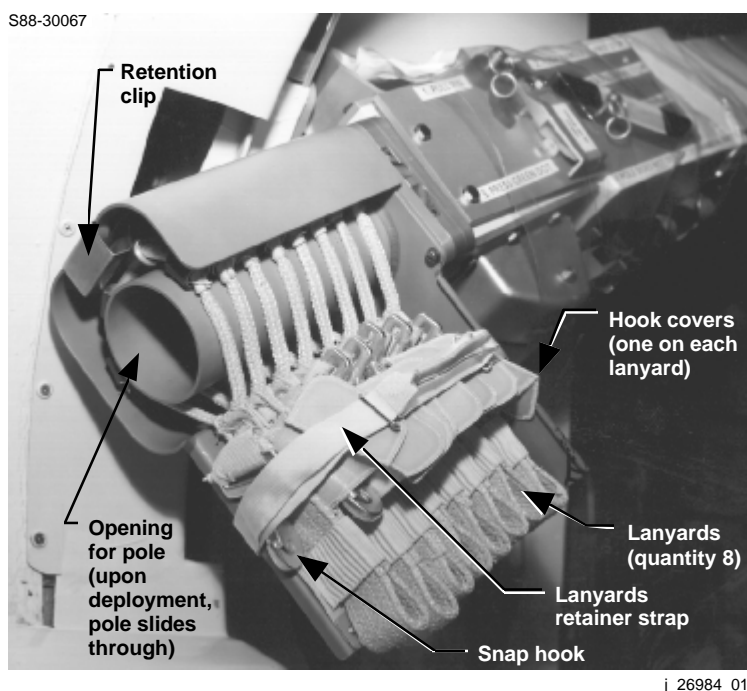
### Manual escape pole deployment

Should the pole fail to extend fully in normal deployment (green strip not visible, see figure 3.6-2), the ratcheting device shown in figure 3.6-2 is used to extend the pole manually.

Step	Action
1	Remove pin from ratchet handle.
2	Cycle handle up and down to extend pole. (Each upstroke of the ratchet handle extends the pole ~4 in., taking ~30 sec to deploy fully.)

### Magazine and lanyards

The magazine containing a total eight lanyard assemblies (regardless of crew size) is shown in figure 3.6-3 below:



*Figure 3.6-3. Magazine and lanyards*

*Continued on next page*



## Escape Pole, Continued

### Magazine and lanyards (cont)

Features to be noted (figure 3.6-3):

- Each lanyard assembly consists of a hook attached to a Kevlar strap that has five roller bearings surrounding the pole.
- A spring-loaded retention clip at the top of the magazine and an elastic strap at the bottom retain the lanyards.
- The small fabric tab on each lanyard (called a hook cover) prevents crewmembers from accidentally attaching to any of the lanyards except the *outermost* one in the magazine.
- The lanyard retainer strap is held in place with Velcro and is easily removed.

### Lanyard use

Once the pole is deployed, either normally or manually, lanyard use is as follows:

Step	Action
1	Note: The crewmembers should perform the tasks below <i>before</i> leaving seat.  Each crewmember: <ul style="list-style-type: none"> <li>• Uncovers the lanyard attach ring on <i>right</i> riser of the parachute.</li> <li>• Pulls the ring out to extend to the attach bridle.</li> </ul>
2	The first crewmember to bail out removes the lanyard retainer strap by simply pulling on the cloth loop.
3	Each crewmember in sequence: <ul style="list-style-type: none"> <li>• Leans forward into the hatch area.</li> <li>• Attaches the metal ring to the snap hook on the <i>outermost</i> lanyard before bailout.</li> </ul>

## Emergency Egress Slide System

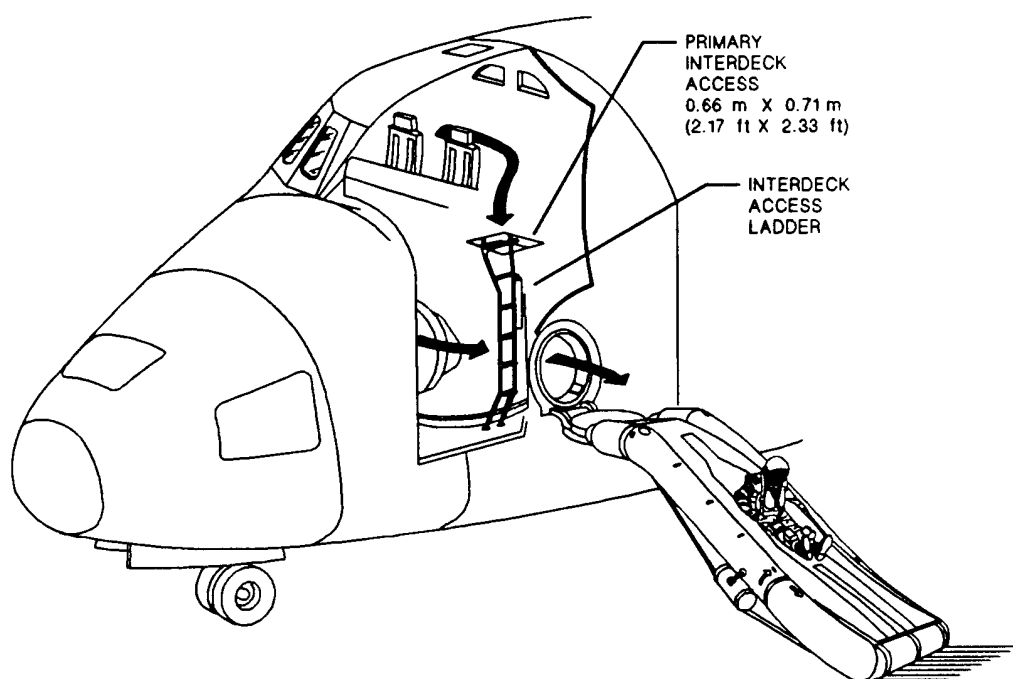
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### Introduction

The Emergency Egress Slide System (EESS) provides rapid and safe orbiter egress during postlanding contingency or emergency situations. The slide system accommodates:

- Egress to the ground within 60 sec after the side hatch is fully opened (or jettisoned).
- Removal of incapacitated crewmembers.

Figure 3.7-1 shows the Emergency Egress Slide (EES) deployed.



*Figure 3.7-1. Emergency egress slide deployed  
(side hatch opened normally)*

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*Continued on next page*

## Emergency Egress Slide System, Continued

### Physical characteristics

The slide system consists of the following components:

Component	Characteristics
Inflatable slide	<p>Constructed of neoprene-coated nylon fabric with a sliding surface of urethane-coated nylon fabric.</p> <p>Inflated by an argon bottle (see next item) to ~2.75 psig. A vent valve, with adjustment screw, bleeds off pressures greater than 3.0 psig.</p> <p>Remains functional for at least 6 min after inflation.</p>
Pressurized argon bottle	<p>Pressurized to 3000 psig; equipped with pressure gauge.</p> <p>When actuated by pulling the firing lanyard, argon flows at 400 psi through a hose to an aspirator. The aspirator entrains about four times the stored gas with air, inflating the slide in ~3 sec.</p>
Slide support assembly	<p>Consists of two aluminum plates and brackets attached to wall below side hatch.</p> <p>Inflatable part of the slide system is attached to the support assembly by a fabric girt that loops around the removable girt bar portion of the support assembly.</p> <p>Support assembly (with slide attached) easily removed and attached to hatch.</p>
Valise	<p>Holds entire slide system.</p> <p>Equipped with window for argon bottle pressure gauge.</p>
Stowage cover	<p>Made of aluminum; equipped with handle for easy removal.</p> <p>Attached to valise by floor pins and a bracket mechanism.</p> <p>Packed valise/cover attached to wall below side hatch.</p>
Chem lights	<p>Two lightsticks are located on top of slide girt bracket beneath side cover.</p>

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## Emergency Egress Slide System, Continued

### Slide deployment

The egress slide can be deployed in two ways:

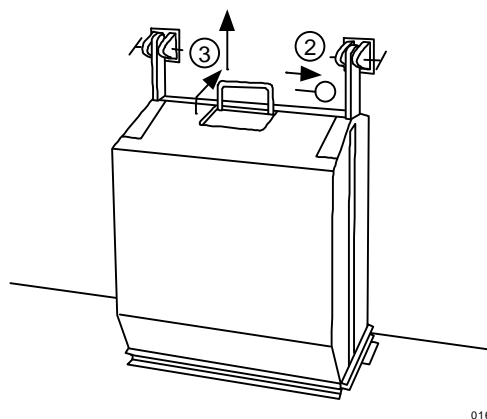
- With the hatch opened normally.
- If necessary, with the hatch jettisoned.

Subsections that follow give the procedures for slide deployment in each situation.

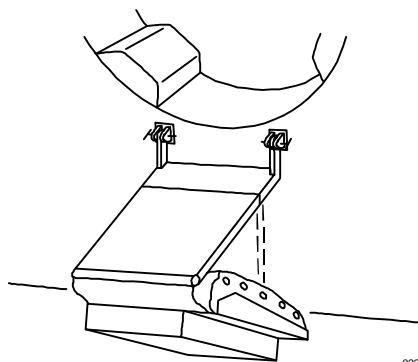
### Slide deploy, hatch *on*

Slide deployment with the hatch *on* (hatch opened normally) is as follows:

Step	Procedure
1	Rotate hatch handle CCW to VENT.
2	Pull pin to release cover handle (plastic tie wraps hold pin in place).
3	Lift handle and remove slide cover (pass cover back to crewmember behind, or toss out of the way).
4	Lift girt bracket and lock into 90° position.



016

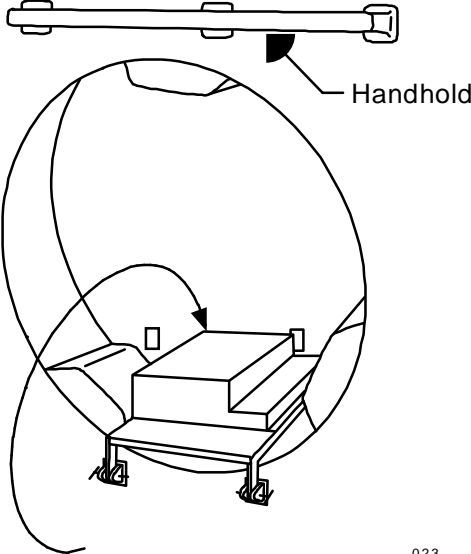
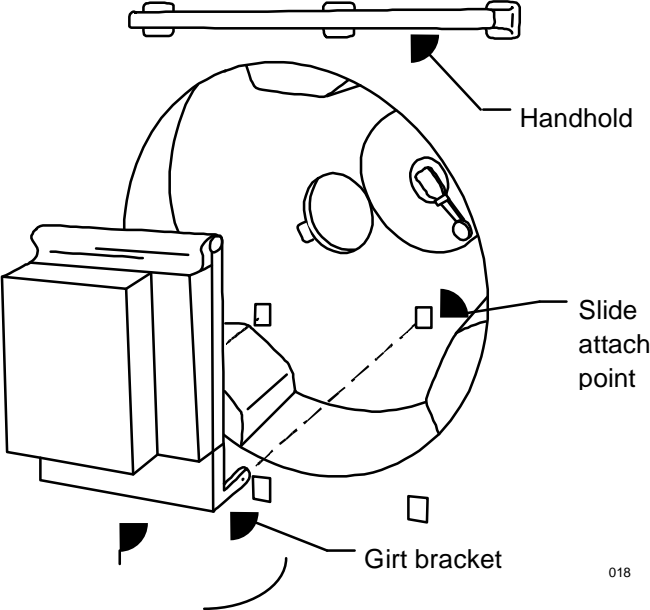


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## Emergency Egress Slide System, Continued

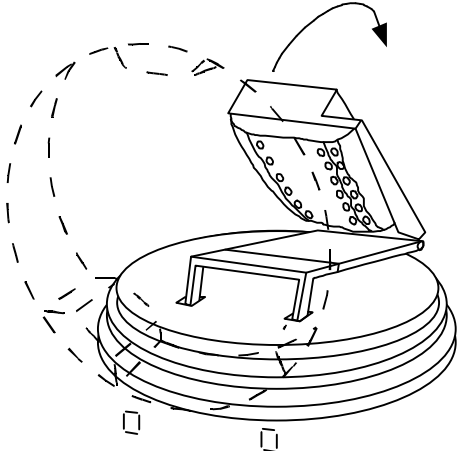
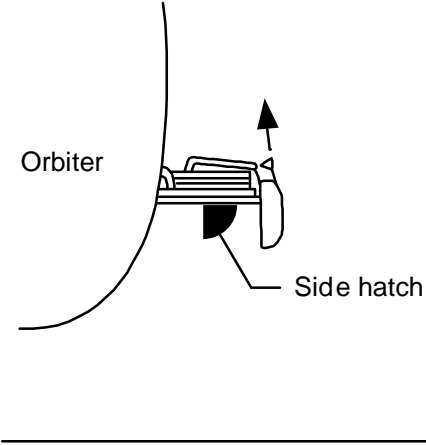
Slide deploy,  
hatch *on*  
(cont)

Step	Procedure
5	<p data-bbox="532 474 1192 506">Rotate girt bracket and slide 180° into hatch tunnel.</p>  <p data-bbox="1143 1052 1170 1066">023</p>
6	<p data-bbox="532 1113 1386 1186">Remove the two hinge pip pins; lift entire slide assembly and rotate 90° to insert brackets into the slide attach points on the hatch.</p>  <p data-bbox="1247 1749 1274 1764">018</p>

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## Emergency Egress Slide System, Continued

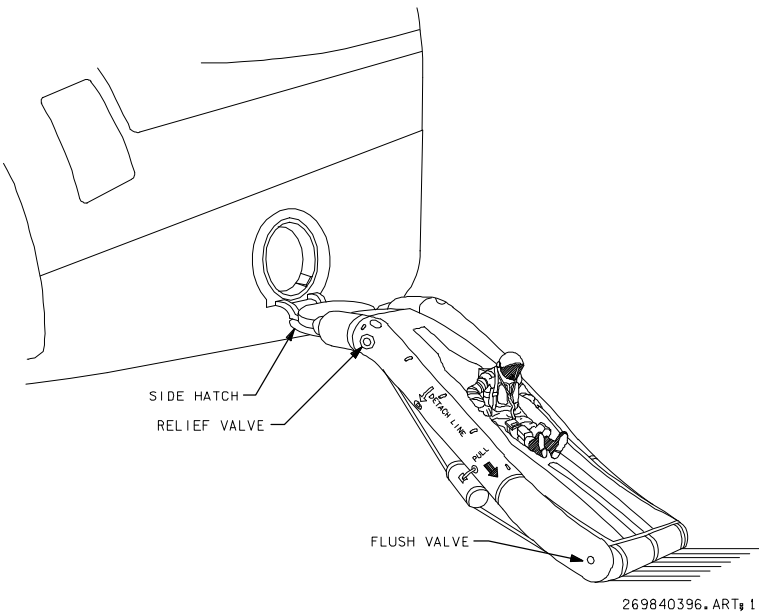
Slide deploy,  
hatch *on*  
(cont)

Step	Procedure
7	Rotate hatch handle CCW to the UNLATCHED position and push hatch open.
8	<p data-bbox="532 554 1159 590">Push the slide off the <i>outboard</i> edge of the hatch.</p> <div data-bbox="760 604 1154 741" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p style="text-align: center;"><b>Caution</b></p> <p>Side hatch is approximately 10 ft above the ground.</p> </div>  <p style="text-align: right; font-size: small;">019</p>
9	<p data-bbox="532 1257 1333 1293">Pull the inflation lanyard all the way out <i>without releasing grip</i>.</p>  <p style="text-align: right; font-size: small;">020</p>

*Continued on next page*

## Emergency Egress Slide System, Continued

Slide deploy,  
hatch *on*  
(cont)

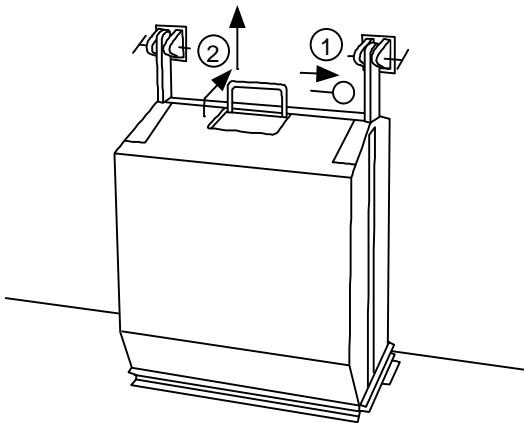
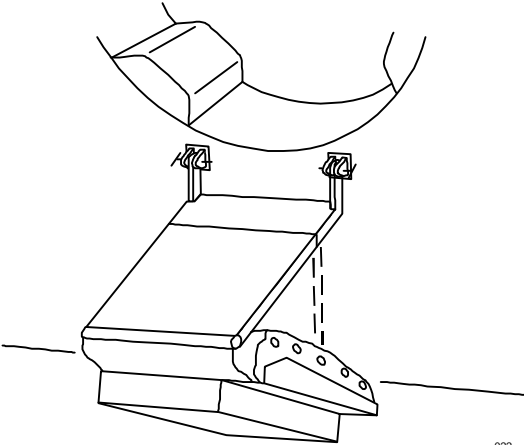
Step	Procedure
10	<p>Crawl onto the side hatch; descend slide feet first.</p> <p>Note: Before descending:</p> <ul style="list-style-type: none"> <li>• Have legs and feet <i>slightly apart</i>.</li> <li>• Put hands at side of body to aid balance.</li> <li>• Lean back with weight off heels.</li> <li>• Prepare to stand when reaching bottom.</li> </ul> <p>There is a two-person load limit on the side hatch (includes person on slide).</p>  <p>269840396, ART. 1</p>

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## Emergency Egress Slide System, Continued

**Slide deploy,  
hatch off**

Slide deployment with the hatch *off* (hatch jettisoned) is as follows:

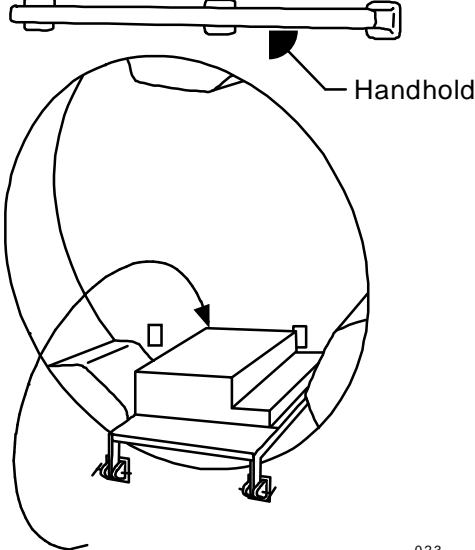
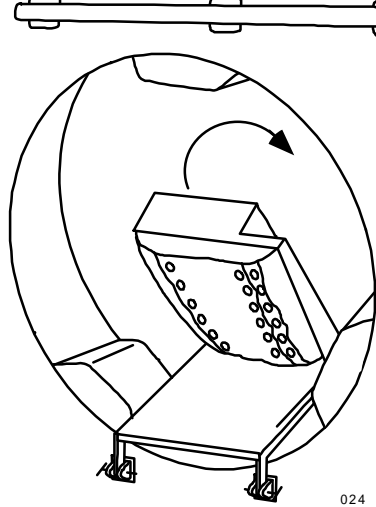
Step	Action
<b>1</b> <b>2</b>	<p>Pull pin to release cover handle (plastic tie wraps hold pin in place).</p> <p>Lift handle and remove slide cover (pass cover back to crewmember behind, or toss out of the way).</p>  <p>021</p>
<b>3</b>	<p>Lift girt bracket and lock into 90° position.</p>  <p>022</p>

*Continued on next page*



## Emergency Egress Slide System, Continued

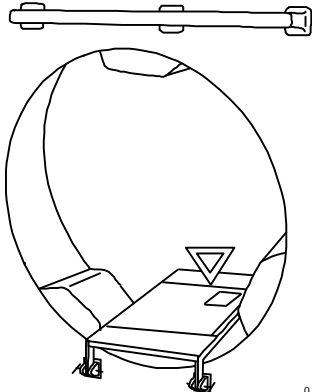
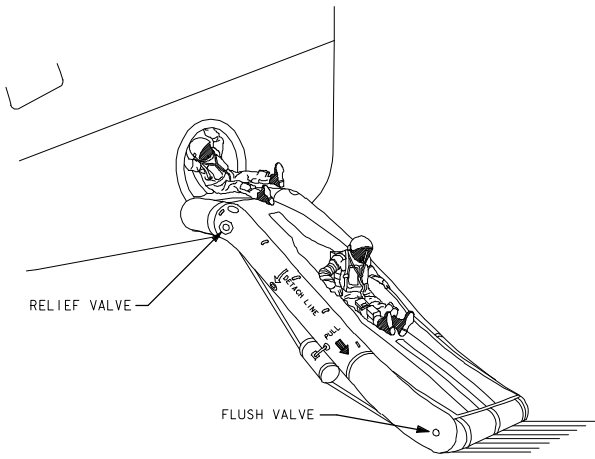
Slide deploy,  
hatch off  
(cont)

Step	Action
4	<p data-bbox="527 472 1193 504">Rotate girt bracket and slide 180° into hatch tunnel.</p>  <p data-bbox="1144 1050 1177 1071">023</p>
5	<p data-bbox="527 1123 917 1155">Push the slide pack overboard.</p>  <p data-bbox="1104 1648 1136 1669">024</p>

*Continued on next page*

## Emergency Egress Slide System, Continued

Slide deploy,  
hatch off  
(cont)

Step	Action
6	<p>Pull the inflation lanyard all the way out <i>without releasing grip</i>.</p>  <p>025</p>
7	<p>Grab the handhold above the hatch tunnel; swing legs out and descend the slide feet first.</p> <p>Note: Before descending:</p> <ul style="list-style-type: none"> <li>• Have legs and feet <i>slightly</i> apart and toes pointed up.</li> <li>• Put hands at side of body to aid balance.</li> <li>• Lean back with weight off heels.</li> <li>• Prepare to stand when reaching bottom.</li> </ul>  <p>RELIEF VALVE</p> <p>FLUSH VALVE</p> <p>269840399, ART. 1</p>

## Notes

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# Chapter 4

## Emergency Egress and Escape

### Overview

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**Introduction** There are eight crew emergency egress/escape modes. These modes are differentiated by:

- The mission phase during which the emergency situation arises.
  - The nature of the emergency situation.
  - Whether support personnel assist the orbiter crew.
- 

**Purpose** This chapter describes the different emergency crew egress/escape modes, the common guidelines, and the orbiter crew response in each mode.

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**Objectives** After completing this chapter, you will be able to identify:

1. The eight crew egress/escape modes.
  2. The guidelines common to several or all modes.
  3. The sequence of crew action in each mode.
  4. SAR resources available for bailout.
- 

**In this chapter** Sections describe the emergency egress/escape modes as follows:

Section	Page
Emergency Egress/Escape Modes	4.2-1
Mode 1 - Unassisted Pad Egress/Escape	4.3-1
Modes 2, 3, 4 - Assisted Pad Egress/Escape	4.4-1
Mode 5 - Unassisted Postlanding Egress/Escape	4.5-1
Modes 6, 7 - Assisted Postlanding Egress/Escape	4.6-1
Mode 8 - Bailout	4.7-1

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## Notes

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## Emergency Egress/Escapes Modes

### Introduction

The table below summarizes the eight orbiter crew emergency egress modes by mission phase: four modes occurring prelaunch, three postlanding, and one in flight (bailout).

In modes 1, 5, and 8, indicated by a checkmark (✓) in the table, the orbiter crew egresses unassisted by support personnel. These three unassisted modes are emphasized in training since the crew is expected to egress unassisted, as much as physical conditions allow, regardless of mode (see “Assumptions,” item 1).

In the other five modes (2, 3, 4, 6, 7), the crew is assisted by the support personnel indicated in the table.

<b>Mission Phase</b>	<b>Type</b>	<b>Mode</b>	<b>Description</b>
Prelaunch	Pad egress and escape	✓ 1	Orbiter crew unassisted.
		2	Orbiter crew assisted by closeout crew.
		3	Orbiter crew assisted by fire rescue crew.
		4	Orbiter crew and closeout crew assisted by fire rescue crew.
Postlanding	Orbiter egress and escape	✓ 5	Orbiter crew unassisted. Egress may be any of three types: <ul style="list-style-type: none"> <li>• Hatch on</li> <li>• Hatch jettison</li> <li>• Window 8</li> </ul>
		6	Landing on or near runway. Orbiter crew assisted by pre-positioned convoy crew.
		7	Landing in a remote area. Orbiter crew assisted by rescue and medical personnel arriving by helicopter.
Ascent, entry	Bailout	✓ 8	Bailout from orbiter in following circumstances: <ul style="list-style-type: none"> <li>• During ascent or entry</li> <li>• Over land or water</li> </ul>

*Continued on next page*

## Emergency Egress/Escapes Modes, Continued

### Assumptions

The following assumptions apply for emergency egress:

1. Regardless of mode, the orbiter crew is expected to egress *unassisted* by support personnel as much as physical conditions allow.
2. Crewmembers on the short-duration mission will assist returning deconditioned crewmembers in every way possible.

The deconditioned crewmembers will receive all the training and equipment possible to ensure their safety.

3. Persons authorized to call for emergency crew egress are:
  - Crew CDR
  - NASA Test Director (NTD)
  - Flight Director (FD)
  - Convoy CDR
4. All crewmembers must be able to perform all egress tasks (e.g., hatch jettison, cabin vent, escape pole deploy, and escape slide deploy). Thus, if a crewmember assigned to a task is incapacitated, any other crewmember can perform the task without delaying the escape operation.
5. Persons in charge of egress activity for the four prelaunch egress modes are the following:

Mode	Fixed Service Structure	Bunker	Triage	Evacuation
1	CDR	NTD	Triage doctor	Flight doctor
2	Closeout leader			
3, 4	Rescue leader			

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## Emergency Egress/Escape Modes, Continued

### Emergency egress cue card

The emergency egress cue card has one version for all crewmembers. Subsequent sections detail the procedures for each of these three unassisted egress modes.

PRELAUNCH MODE 1	BAILOUT MODE 8
TABS - RELEASE VISOR - CLOSE/LOCK LES O2 - ON GREEN APPLE - PULL KNEEBOARDS - REMOVE COOLING - DISCONNECT RESTRAINT - RELEASE RESTRAINT (four) - RELEASE COMM - DISCONNECT LES O2 - DISCONNECT EGRESS SEAT SLIDEWIRE BASKETS	REPORT POSITION MACH <.95, OPS 305/603 SB - AUTO; BF - AUTO FLY 185-195 KEAS, $\Phi = 0^\circ$ ABORT MODE - ATO ABORT PBI - PUSH P,R/Y - AUTO FLT CNTLR PWR (two) - OFF <u>~50K FT</u> TABS - RELEASE VISOR - CLOSE/LOCK LES O2 - ON GREEN APPLE - PULL
POST LANDING MODE 5	
TABS - RELEASE VISOR - CLOSE/LOCK LES O2 - ON GREEN APPLE - PULL KNEEBOARDS - REMOVE COOLING - DISCONNECT RESTRAINT - RELEASE PARACHUTE (four) - RELEASE COMM - DISCONNECT G-SUIT CLIP - PULL LES O2 - DISCONNECT PLT - PWR DOWN EGRESS SEAT SLIDE/ESCAPE PANEL	<u>~40K FT</u> MS3 - VENT CABIN CDR,PLT SEATS - LOWER KNEEBOARDS - REMOVE COOLING - DISCONNECT RESTRAINT - RELEASE D-RING - UNCOVER <u>~30K FT</u> MS3 - JETTISON HATCH COMM - DISCONNECT (G-SUIT CLIP - PULL) LES O2 - DISCONNECT EGRESS SEAT POLE - DEPLOY D-RING - HOOK UP BAILOUT

*Figure 4.2-1. Emergency egress cue card*

*Continued on next page*



## Emergency Egress/Escapes Modes, Continued

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**Emergency  
egress cue card**

A copy of the emergency egress cue card is accessible to individual crewmembers in the following locations:

Crewmember	Cue card location
CDR, PLT	First page of <i>Ascent Flipbook</i> .
MS1, MS2	On back of CDR and PLT seats.
All middeck MSs/PSs	On lockers immediately in front of all MSs/PSs.

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## Mode 1 - Unassisted Pad Egress/Escape

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<b>Introduction</b>	<p>Mode 1 is <i>unassisted</i> pad egress and escape to a safe place. The orbiter crew must on their own:</p> <ul style="list-style-type: none"><li>• Unstrap themselves and egress their seats.</li><li>• Open the side hatch.</li><li>• Proceed to the emergency slidewire baskets (figures 4.3-1 and 4.3-2).</li><li>• Descend in the baskets.</li><li>• Proceed to a protective concrete bunker (then, if directed, evacuate in an M-113 armored personnel carrier).</li></ul>
<b>Conditions</b>	<p>The conditions attending mode 1 egress/escape are the following:</p> <ol style="list-style-type: none"><li>1. The NTD or the CDR calls for mode egress.</li><li>2. The closeout crew and the ASP have left the launch platform.</li><li>3. The situation is too critical to dispatch fire/rescue personnel to the pad.</li><li>4. The orbiter is in vertical position, making it difficult for the orbiter crew to move around quickly in the crew cabin. Moreover, the crew must be careful where they step to avoid tripping on hardware.</li><li>5. The OAA (retracted at T - 7:00) can be repositioned in ~30 sec.</li></ol>
<b>Slidewire basket system</b>	<p>As depicted in figures 4.3-1 and 4.3-2, the slidewire basket system uses seven separate slidewires and seven multiperson basket assemblies to effect rapid escape from the 195-foot level of the FSS to a landing zone 1168 ft away.</p>

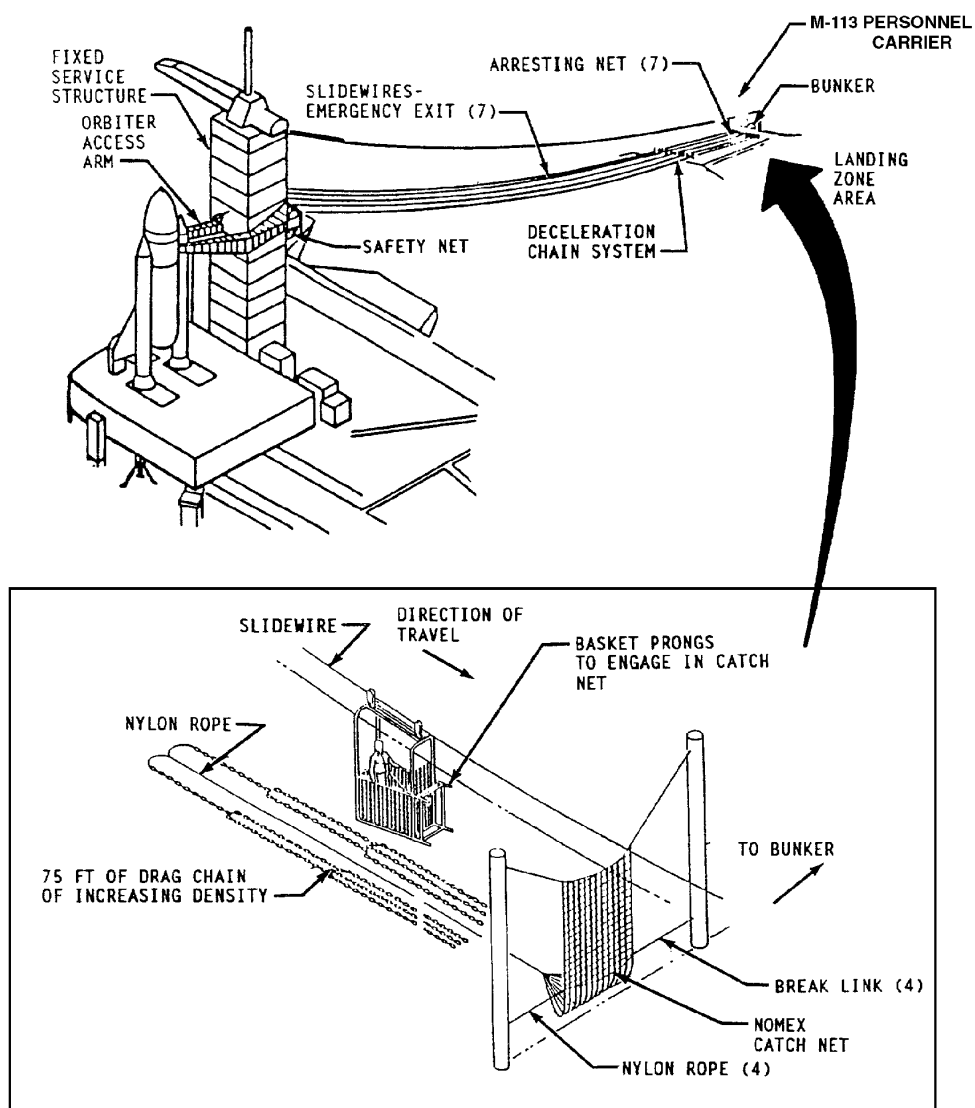
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## Mode 1 - Unassisted Pad Egress/Escape, Continued

### Slidewire basket system (cont)

Figure 4.3-1 below gives an overall view of the slidewire basket system.



*Figure 4.3-1. Overall view of slidewire basket system*

*Continued on next page*

## Mode 1 - Unassisted Pad Egress/Escape, Continued

### Slidewire basket system (cont)

The seven slidewire baskets have the following characteristics:

- Are each designed to hold three persons (with suits on).
- Hang in recessed cutouts on the west side of the FSS.
- Are secured in place with Kevlar rope. (A manually operated guillotine-type device is used to sever the rope.)
- Have fire-resistant material around them to protect passengers from heat and fire below.
- Are suspended from a 3/4-in. stainless steel cable by two trolleys, one of which is equipped with an antirollback brake.
- Are slowed by a catch net that is attached to increasingly denser links of chain buried in sand.

The basket south wall releases for exit when a D-ring is pulled.

### Sequence of action

The table on the next page details the sequence of action in mode 1 pad egress. The following guidelines apply:

1. All crewmembers follow a buddy system, arranged before flight, and maintain visual or physical contact with the partner at all times (to make sure no one is left behind).
2. If a crewmember has difficulty in performing an assigned task, another crewmember is expected to step in and perform the task. For example, if MS3 has difficulty opening the side hatch, another crewmember should immediately step in to open it.
3. All crewmembers exit headfirst on hands and knees, proceeding carefully to ensure that no one is hurt.
4. The CDR is in command until the orbiter crew reaches the bunker, where the NTD is in command.

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## Mode 1 - Unassisted Pad Egress/Escape, Continued

Sequence of  
action (cont)

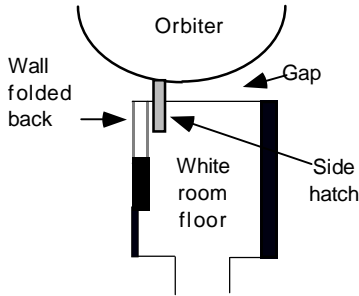
The table below details the mode 1 sequence of action.

Step	Crew-member	Action
1	All	<p><b><i>Prep for egress</i></b></p> <p>Upon call by CDR or NTD for emergency egress, immediately prepare for egress as follows (refer to emergency egress cue card):</p> <ol style="list-style-type: none"> <li>Check that neck dam tabs are released.</li> <li>Close and lock helmet visor.</li> <li>Turn on orbiter oxygen (to conserve EOS oxygen until quick disconnect from orbiter oxygen in substep e).</li> <li>Activate EOS by pulling green apple.</li> <li>Release seat restraints by turning rotary buckle.</li> <li>Release chute ejector snaps and Frost fittings</li> <li>Release quick disconnects for: <ul style="list-style-type: none"> <li>Comm</li> <li>Suit cooling</li> <li>Orbiter oxygen</li> </ul> </li> </ol> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b><i>Caution</i></b></p> <p>Crewmembers must be careful where they step to prevent loss of footing or tripping on hardware.</p> </div>
2	MS3	<p><b><i>Side hatch opening</i></b></p> <div style="border: 3px double black; padding: 10px; margin-top: 10px;"> <p><b>WARNING</b></p> <p>Under no circumstances should the side hatch be jettisoned. If jettisoned, the side hatch would contact the launch tower and possibly destroy the OAA.</p> </div>

*Continued on next page*

## Mode 1 - Unassisted Pad Egress/Escape, Continued

Sequence of  
action (cont)

Step	Crew-member	Action
<b>2</b> (cont)	MS3	<p><b><i>Side hatch opening (cont)</i></b></p> <ol style="list-style-type: none"> <li>Egress seat (seat 5) carefully, using handhold strap on forward locker.</li> <li>Climb “down” to egress platform; duck under egress pole and proceed to hatch.</li> </ol> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p><b><i>Caution</i></b></p> <p>Exercise care in pushing the hatch open. There is a 1-foot drop to the floor of the white room and a 12-in. gap (18-in. gap on pad B) between the orbiter and the edge of the white room.</p> </div> <ol style="list-style-type: none"> <li>Hatch - VENT, then OPEN (decal).</li> </ol>
<b>3</b>	<i>All</i>	<p><b><i>Evacuate orbiter</i></b></p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p><b><i>Caution</i></b></p> <p>A portion of the <i>right side</i> of the white room folds back so that the OAA can move into position.</p> <p>This creates an unprotected area on that side:</p>  <p>You can fall from this unprotected area if you veer too far right.</p> </div>

*Continued on next page*

## Mode 1 - Unassisted Pad Egress/Escape, Continued

Sequence of  
action (cont)

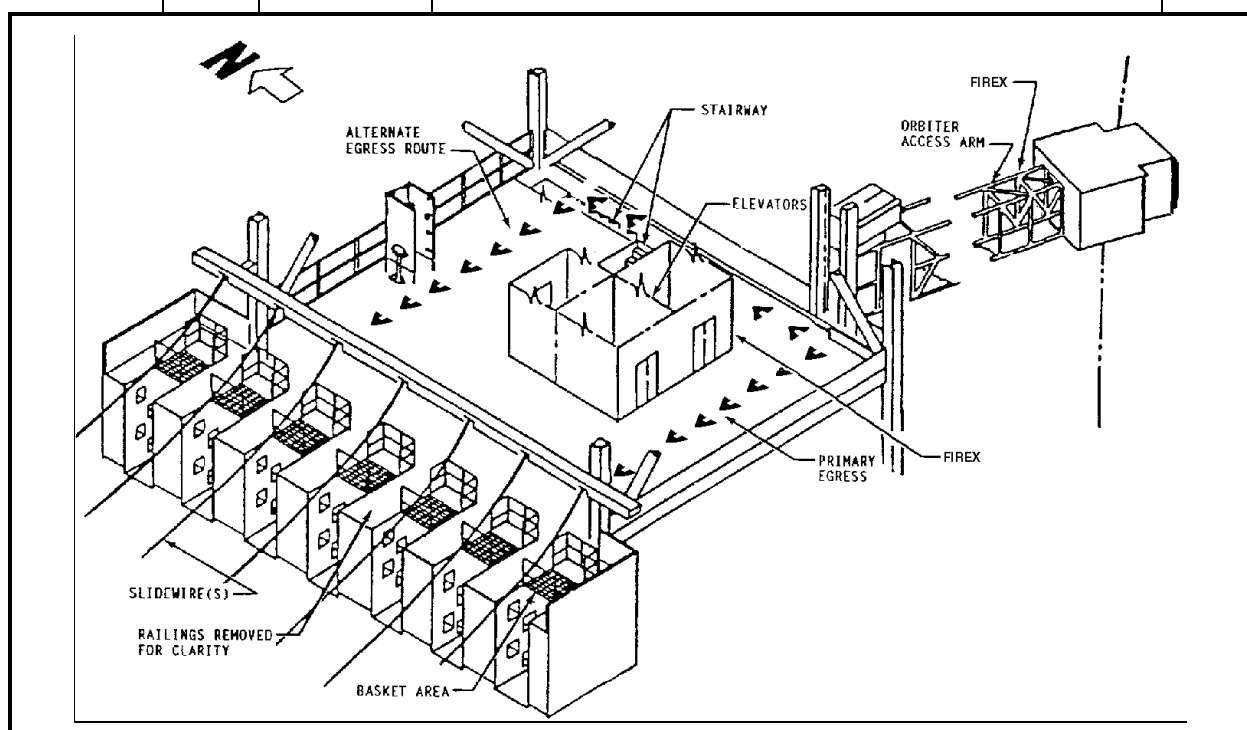
Step	Crew-member	Action
<b>3</b> (cont)	MS3	<b><i>Evacuate orbiter (cont)</i></b> Crawl out side hatch headfirst.
	MS/PS in seats 6, 7	Roll off seats and follow MS3, crawling out the side hatch headfirst.
	MS2	Egress seat as soon as possible and crawl out the side hatch headfirst.
	MS1	Travel over MS2's seat to exit flight deck and crawl out the side hatch headfirst.
	CDR, PLT	Perform the following actions in egressing: <ol style="list-style-type: none"> <li>Remove <i>Ascent Flipbook</i> to access glareshield handhold.</li> <li>Using glareshield handhold, lift self from seat.</li> <li>"Walk" down panel C3 to stand on MS2's seat.</li> <li>Sit down on MS2's seat, then crawl headfirst to middeck and out the side hatch.</li> </ol>
<b>4</b>	<i>All</i>	<b><i>Proceed to baskets</i></b> Follow marked route (shown on next page) through the white room and across the OAA and the FSS to the baskets (which are located in recesses on the <i>west</i> side of the FSS).

*Continued on next page*

## Mode 1 - Unassisted Pad Egress/Escape, Continued

Sequence of  
action (cont)

Step	Crew-member	Action
<b>4</b> (cont)	<i>All</i>	<i>Proceed to baskets (cont)</i> The primary and alternate routes are as shown below:



**Figure 4.3-2. Primary and alternate routes to baskets**

- Primary route is painted yellow with black chevrons pointing the direction. The primary route runs along the OAA, straight-ahead past the elevator doors, and on to the baskets.
- Alternate route is used if primary route is blocked. The secondary route also is painted yellow with black chevrons. It turns right, then proceeds around the back of the elevators and on to the baskets.

*Continued on next page*



## Mode 1 - Unassisted Pad Egress/Escape, Continued

Sequence of  
action (cont)

Step	Crew-member	Action
4 (cont)	All	<p><b><i>Proceed to baskets (cont)</i></b></p> <p>Note: Visibility enroute will be very poor because of water spray from the Firex fire extinguishing system and possibly because of smoke or vapor.</p> <div style="border: 1px solid black; padding: 10px;"> <p><b><i>Firex system activation</i></b></p> <p>Upon leaving the white room, crewmembers can activate the Firex fire extinguishing system.</p> <p>The system sprays 287 gal of water per minute along the OAA and at the 195-foot level of the launch platform.</p> <p>Crewmembers activate the system by hitting two paddles just outside the white room on the right side of the OAA. The paddles, labeled “ARM” and “FLOW” (or “ACTUATE”) can be pushed in any sequence.</p> <p>Crewmembers also can activate the Firex system immediately upon leaving the OAA. Additional activation paddles are located on the elevator shaft in front of the access arm.</p> </div>

*Continued on next page*

## Mode 1 - Unassisted Pad Egress/Escape, Continued

Sequence of  
action (cont)

Step	Crew-member	Action
5	All	<p><b><i>Descend in baskets</i></b></p> <p>Descend as follows:</p> <ol style="list-style-type: none"> <li>Two to max. three persons enter each basket.</li> <li>Using the manually operated guillotine-type device (attached to the platform handrail), the <i>crewmember nearest the guillotine</i> in each group severs the rope securing the basket (a backup knife is stowed in the basket).</li> <li>All ride baskets to landing zone (takes 22 sec).</li> <li>After basket stops in landing zone, a crewmember in each group pulls a D-ring to release the <i>south</i> side of the basket for easier egress.</li> </ol> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p style="text-align: center;"><b><i>Caution</i></b></p> <p>The baskets tend to ascend as each crewmember exits. Exercise care in jumping out.</p> </div> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p style="text-align: center;"><b><i>Caution</i></b></p> <p>To avoid being hit by descending baskets, stay on the cement walkways enroute to the bunker.</p> </div> <ol style="list-style-type: none"> <li>Exit basket and, staying on cement walkways, go directly to the bunker.</li> </ol>

*Continued on next page*

## Mode 1 - Unassisted Pad Egress/Escape, Continued

Sequence of  
action (cont)

Step	Crew-member	Action
6	All	<p><b><i>In bunker</i></b></p> <p>Follow NTD's directions whether to:</p> <ol style="list-style-type: none"> <li><u>Stay in bunker</u> until rescuers arrive. The bunker has breathing air, water, phone line communications, and medical supplies.</li> <li><u>Evacuate</u> in M-113 armored personnel carrier (see below) to a designated helicopter landing site.</li> </ol>

Armored  
personnel  
carrier

Figure 4.3-3 below shows the M-113 armored personnel carrier used to evacuate the orbiter crew and fire rescue personnel from the pad area.

The M-113 is located at the bunker and driven to helipad sites considered safe for helicopters to land.



***Figure 4.3-3. M-113 armored personnel carrier***

*Continued on next page*

## Mode 1 - Unassisted Pad Egress/Escape, Continued

### Mode 1 egress cue card procedures

The CDR/PLT and MS versions of the emergency egress cue card are shown in figure 4.3-4 below with the mode 1 pad egress procedures highlighted.

PRELAUNCH MODE 1	BAILOUT MODE 8
TABS - RELEASE	REPORT POSITION
VISOR - CLOSE/LOCK	MACH <.95, OPS 305/603
LES 02 - ON	SB - AUTO; BF - AUTO
GREEN APPLE - PULL	FLY 185-195 KEAS, $\Phi = 0^\circ$
KNEEBOARDS - REMOVE	ABORT MODE - ATO
COOLING - DISCONNECT	ABORT PBI - PUSH
RESTRAINT - RELEASE	P,R/Y - AUTO
PARACHUTE (four) - RELEASE	FLT CNTLR PWR (two) - OFF
COMM - DISCONNECT	<u>~50K FT</u>
LES 02 - DISCONNECT	TABS - RELEASE
EGRESS SEAT	VISOR - CLOSE/LOCK
SLIDEWIRE BASKETS	LES 02 - ON
	GREEN APPLE - PULL
POST LANDING MODE 5	<u>~40K FT</u>
TABS - RELEASE	MS3 - VENT CABIN
VISOR - CLOSE/LOCK	CDR,PLT SEATS - LOWER
LES 02 - ON	KNEEBOARDS - REMOVE
GREEN APPLE - PULL	COOLING - DISCONNECT
KNEEBOARDS - REMOVE	RESTRAINT - RELEASE
COOLING - DISCONNECT	D-RING - UNCOVER
RESTRAINT - RELEASE	<u>~30K FT</u>
PARACHUTE (four) - RELEASE	MS3 - JETTISON HATCH
COMM - DISCONNECT	COMM - DISCONNECT
(G-SUIT CLIP - PULL)	(G-SUIT CLIP - PULL)
LES 02 - DISCONNECT	LES 02 - DISCONNECT
PLT - PWR DOWN	EGRESS SEAT
EGRESS SEAT	POLE - DEPLOY
SLIDE/ESCAPE PANEL	D-RING - HOOK UP
	BAILOUT

*Figure 4.3-4. Mode 1 pad egress cue card procedures*

*Continued on next page*

## Mode 1 - Unassisted Pad Egress/Escape, Continued

### Mode 1 egress procedures (cont)

The table below iterates the mode 1 pad egress procedures in the left column as they appear in both the CDR/PLT and MS versions of the mode 1 pad egress cue card (previous page) and gives an expanded version in the right column.

### “MODE 1” PAD EGRESS

Cue Card Version	Expanded Version
<b>TABS - RELEASE</b> <b>VISOR - CLOSE/LOCK</b> <b>LES O2 - ON</b> <b>GREEN APPLE - PULL</b>	Release neck dam tabs. Close and lock helmet visor. Turn orbiter oxygen on. Activate emergency oxygen by pulling “green apple.” Note: Ensure green apple pulled full travel.
<b>KNEEBOARDS - REMOVE</b> <b>COOLING - DISCONNECT</b> <b>RESTRAINT - RELEASE</b>  <b>PARACHUTE (four) - RELEASE</b>  <b>COMM - DISCONNECT</b> <b>LES O2 - DISCONNECT</b>	Remove kneeboards if worn. Release suit cooling quick disconnect. Release seat restraints by turning rotary buckle. Release parachute from harness at shoulders and hips (four attachment points). Release communications quick disconnect. Release orbiter oxygen quick disconnect.
<b>EGRESS SEAT</b>	1. All crewmembers egress seats and move to side hatch. 2. All crewmembers evacuate orbiter. <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> <p style="text-align: center;"><b>Caution</b></p> <p>Watch for gap between orbiter and white room and open wall.</p> </div> 3. Go through white room and across OAA. <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> <p style="text-align: center;"><b>Caution</b></p> <p>Water spray will reduce visibility and make footing slippery. Use buddy system.</p> </div>
<b>SLIDEWIRE BASKETS</b>	1. Get into slidewire baskets (three persons max. per basket, total seven baskets). 2. Activate release mechanism. 3. Ride basket down to landing area. <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> <p style="text-align: center;"><b>Caution</b></p> <p>Stay on walkways after exiting baskets.</p> </div> 4. Enter bunker and wait for instructions (may be instructed to leave area in M-113 armored personnel vehicle).

## Modes 2, 3, 4 - Assisted Pad Egress/Escape

### Introduction

In modes 2, 3, and 4, the three *assisted* pad egress and escape modes, support personnel assist the flightcrew in egressing from the orbiter and escaping to a safe place. Differences among these modes are discussed below. Egress following shutdown of the Space Shuttle Main Engine (SSME) also is discussed.

### Egress conditions

The conditions attending each of the *assisted* pad egress modes are as follows:

Mode 2	Mode 3	Mode 4
Seven-person closeout crew is still assisting flightcrew with ingress (time from when flightcrew enters the 195-foot level until closeout crew leaves).	Seven-person closeout crew has left the launch pad.	Seven-person closeout crew is still assisting flightcrew with ingress.
Side hatch is still open.	Side hatch is already closed.	Side hatch may still be open.
The emergency is such that the fire/rescue crew cannot be sent to the pad.	The emergency is such that members of the seven-person fire/rescue team can be sent to the 195-foot level to rescue the flightcrew.	The emergency is such that members of the seven-person fire/rescue team can be sent to the 195-foot level <i>to rescue the flightcrew and the closeout crew.</i>
Person in charge is the closeout leader until reaching the bunker, where the NTD is in charge.	Person in charge is the rescue team leader until reaching the bunker, where the NTD is in charge.	

### Sequence of action

The action taken by the flightcrew and support personnel in the *assisted* pad egress modes is as follows:

Modes 2, 3, and 4	
At call for <i>mode egress</i> , crewmembers immediately perform the following steps:	
Step	Procedure
1	Close and lock visor.
2	Activate EOS.
3	Pull following three quick disconnects: <ul style="list-style-type: none"> <li>• Orbiter oxygen hose</li> <li>• Suit cooling hose</li> <li>• Comm cable</li> </ul>

*Continued on next page*

## Modes 2, 3, 4 - Assisted Pad Egress/Escape, Continued

### Sequence of action (cont)

The action taken by the orbiter crew and support personnel in each of the assisted pad egress modes continues below:

Mode 2	Mode 3	Mode 4
<p>Crewmembers egress on own assisted by the closeout crew.</p> <p>The closeout crew assists the flightcrew as follows:</p> <ul style="list-style-type: none"> <li>Assists crewmembers out of seats if necessary.</li> <li>Ensures that crewmembers without helmets have oxygen.</li> <li>Evacuates everyone to the slidewire baskets.</li> </ul>	<p><u>If some crewmembers can egress on own</u>, they:</p> <ul style="list-style-type: none"> <li>Open the side hatch.</li> <li>Assist others to the slidewire baskets.</li> </ul> <p><u>If no crewmember can egress on own</u>, the fire/rescue crew:</p> <ul style="list-style-type: none"> <li>Opens the side hatch.</li> <li>Enters the orbiter.</li> <li>First checks: <ul style="list-style-type: none"> <li>Each crewmember's helmet closed.</li> <li>EOS activated.</li> </ul> </li> <li>Assists flightcrew in escaping as follows: <ul style="list-style-type: none"> <li><u>If safe enough</u>, brings crew down elevator.</li> <li><u>If not safe enough</u>, takes crew to slidewire baskets.</li> </ul> </li> </ul>	<p>The actions in mode 4 are the same as those in mode 3, except:</p> <ul style="list-style-type: none"> <li>The side hatch may still be open.</li> <li>Members of closeout crew can also assist others to slidewire baskets.</li> <li>There will be more persons needing assistance (flightcrew and closeout crew).</li> </ul>
Modes 2, 3, and 4		
<p>The rest of the action taken is the same as that for mode 1:</p> <ul style="list-style-type: none"> <li>Descend in baskets.</li> <li>Go to bunker.</li> <li>Follow NTD's direction whether to stay or evacuate in M-113.</li> </ul>		

### SSME shutdown

For as long as 5 min following a shutdown of the SSME, the NTD receives information from Launch Control Center (LCC) console operators about the status of the system and whether the system has shut down safely.

Once it is determined that the system has shut down safely, the orbiter crew is told that there is a launch scrub and to begin safing the orbiter systems from the flight deck.

*Continued on next page*

## Modes 2, 3, 4 - Assisted Pad Egress/Escape, Continued

### SSME shutdown (cont)

During the 5 min following SSME shutdown, the flightcrew situation is as follows:

- The flightcrew does not know immediately whether there is an emergency, and the possibility exists during the 5 min that an emergency with subsequent *mode egress* could be declared at any time.
- The flightcrew is aware that SSME shutdown has occurred and that the crew will egress.

Prudence in this situation dictates that crewmembers immediately prepare to egress the orbiter as follows:

Note: Use the egress cue card as a guideline.

- Keep visor down and locked with Orbiter O<sub>2</sub> - ON.
- Remove all kneeboards.
- Release seat restraint.
- Release four parachute attachments.

The flightcrew will be then ready in either of the two following cases:

1. If an emergency is declared and a *mode egress* called, the flightcrew will be ready to perform the following steps immediately:

Step	Procedure
1	Note: Visor should already be closed and locked with Orbiter O <sub>2</sub> - ON.  Activate EOS by pulling "green apple."
2	Pull the following three quick disconnects: <ul style="list-style-type: none"> <li>• Suit cooling</li> <li>• Comm cable</li> <li>• Orbiter oxygen hose</li> </ul>
3	Egress.

2. Even if no emergency is declared and the launch is scrubbed, the flightcrew will be that much closer to egressing once the closeout crew arrives. The flightcrew should wait for clearance from NTD to turn off O<sub>2</sub> and raise visors.



## Notes

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## Mode 5 - Unassisted Postlanding Egress/Escape

### Introduction

Orbiter crewmembers perform mode 5 egress any time they have to leave the orbiter postlanding without assistance from convoy crew personnel (who assist the orbiter crew in escaping to a safe area from a fallback position). Refer to figure 4.5-1 for mode 5 postlanding egress cue card procedures and figure 4.5-2 for convoy positioning.

There are three types of mode 5 egress:

- *Hatch jettison* mode 5 egress, made when there is imminent danger to the orbiter or the crew; e.g., fire or collapsed landing gear.
- *Hatch on* mode 5 egress, made when egress has to be expedited because of a hazardous condition or when the landing occurs at a landing site that has no convoy crew support.
- *Window 8* mode 5 egress made when side hatch path cannot be used.

### Egress routes, means

The egress routes and means for mode 5 are as follows:

#### Primary Route - Side Hatch

The *primary* egress route is through the side hatch. Orbiter crewmembers use the escape slide to descend or, in case of slide failure, crewmembers use descent control devices (“sky genies”) to lower themselves to the ground.

Egress through the side hatch is faster, easier, and less hazardous. It is the egress route used unless:

- The side hatch cannot be opened or jettisoned.
- Hazardous conditions exist outside the side hatch.

#### Secondary Route - Escape Panel

The *secondary* egress route is through the window 8 escape panel with the orbiter crew using sky genies to descend to the ground.

Since the side hatch can be jettisoned, there are only a few scenarios that would require using the window 8 escape panel.

The table that follows summarizes these egress routes and the means used.

*Continued on the next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

### Egress routes, means (cont)

The table below summarizes the egress routes and the means used.

When egress is through ...	Use ...	
	As <i>primary</i> means:	As <i>secondary</i> means:
<b>Side hatch</b> (primary route) <ul style="list-style-type: none"> <li>Opened <u>normally</u></li> <li>Opened <u>by jettisoning</u></li> </ul>	<b>Slide</b>	<b>Sky genie</b> (If slide fails)
<b>Window 8 escape panel</b> (secondary route) <ul style="list-style-type: none"> <li>Opened <u>by jettisoning</u></li> </ul>	<b>Sky genie</b>	

### Hatch-on mode 5 slide egress

Hatch-on mode 5 slide egress procedures are as follows:

Step	Crew-member	Procedure
<b>1</b>	CDR	<b>Call for mode 5 egress</b> Call for mode 5 egress.
<b>2</b>	All	<b>Seat egress</b> At CDR call for mode 5 egress, egress seat per cue card (for cue card, see “Mode 5 cue card procedures” in this section).
<b>3</b>	MS3* (MS2)	<b>Slide deploy</b> <ol style="list-style-type: none"> <li>Rotate hatch handle CCW to VENT position per hatch decal.</li> <li>Pull pin to release slide cover handle.</li> </ol>

\*On “recumbent” mission, MS2 deploys slide while MS3 assists long-duration crewmembers.

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

*Hatch-on  
mode 5 slide  
egress (cont)*

Step	Crew-member	Procedure
<b>3</b> (cont)	MS3* (MS2)	<p><b><i>Slide deploy (cont)</i></b></p> <ul style="list-style-type: none"> <li>c. Lift handle and remove slide cover.</li> <li>d. Lift girt bracket with the slide pack; lock bracket in place and rotate slide assembly 180° into side hatch tunnel.</li> <li>e. Remove forward and aft hinge pip pins.</li> <li>f. Lift and rotate entire slide pack 90° and insert girt bracket into slide attach points (decals) on the hatch.</li> <li>g. Make sure slide is fully locked in place.</li> <li>h. Rotate hatch handle to the UNLATCHED position and push hatch open.</li> <li>i. Push the slide off the outboard edge of the hatch.</li> </ul> <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p><b><i>Caution</i></b> Side hatch is approximately 10 ft above the ground.</p> </div> <ul style="list-style-type: none"> <li>j. Pull the inflation lanyard all the way out <i>without releasing grip</i>.</li> </ul>
<b>4</b>	<i>All</i>	<p><b><i>Hatch egress, slide descent</i></b></p> <p>All crewmembers egress through the side hatch as follows:</p> <p>Note: There is a two-person load limit on the side hatch (including person on the slide).</p>

\*On “recumbent” mission, MS2 deploys slide while MS3 assists long-duration crewmembers.

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

*Hatch-on  
mode 5 slide  
egress (cont)*

Step	Crew-member	Procedure
<b>4</b> (cont)	<i>All</i>	<p><b><i>Hatch egress, slide descent (cont)</i></b></p> <p>a. Crawl onto the side hatch and descend slide <i>feet first</i>, making sure to:</p> <ul style="list-style-type: none"> <li>• Keep legs and feet <i>slightly</i> apart and toes pointed up.</li> <li>• Keep hands at side of body to aid balance.</li> <li>• Lean back with weight off heels.</li> <li>• Be prepared to stand and move away on reaching bottom of slide.</li> </ul> <p>b. Upon reaching bottom of slide:</p> <ul style="list-style-type: none"> <li>• Use forward momentum to assist in standing.</li> <li>• Move to one side.</li> <li>• Assist next person.</li> </ul>
<b>5</b>	<i>All</i>	<p><b><i>Escape to safe area</i></b></p> <p>Move <i>crosswind</i> to edge of runway, then move <i>upwind</i> along edge of hardtop.</p> <p>Note: Convoy crew personnel positioned in the fallback area (figure 4.5-2) assist crewmembers as needed in escaping to a safe area.</p>

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

### *Hatch-jettison mode 5 slide egress*

The hatch-jettisoned mode 5 slide egress procedures are as follows:

Step	Crew-member	Procedure
1	CDR	<p><b><i>Call for mode 5 egress</i></b></p> <p>Call for mode 5 egress.</p>
2	All	<p><b><i>Seat egress</i></b></p> <p>At CDR call for mode 5 egress, egress seat per cue card (for cue card, see “Mode 5 cue card procedures” in this section).</p>
3	MS3	<p><b><i>Hatch jettison</i></b></p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>The <i>cabin vent pyros</i> are an ignition source in the payload bay and should never be activated postlanding.</p> </div> <p>Note: MS3 removes T-handle door safing pin before launch and entry.</p> <ol style="list-style-type: none"> <li>a. Open T-handle door by squeezing latch knobs together and pulling door down.</li> <li>b. Remove: <ul style="list-style-type: none"> <li>• T-handle pip pin (marked “hatch jettison”).</li> <li>• Cloth cover (white).</li> </ul> </li> <li>c. Squeeze and pull hatch jettison T-handle (ribbed).</li> </ol> <p>Note: To move hatch jettison T-handle requires 30 lb of force.</p>
4	MS3* (MS2)	<p><b><i>Slide deploy</i></b></p> <ol style="list-style-type: none"> <li>a. Pull pin to release slide cover handle.</li> <li>b. Lift handle and remove slide cover.</li> <li>c. Lift girt bracket and lock into 90° position.</li> </ol>

\*On “recumbent” mission, MS2 deploys slide while MS3 assists long-duration crewmembers.

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

*Hatch-jettison  
mode 5 slide  
egress (cont)*

Step	Crew-member	Procedure
<b>4</b> (cont)	MS3* (MS2)	<p><b><i>Slide deploy (cont)</i></b></p> <p>d. Flip slide pack overboard.</p> <p>e. Pull inflation lanyard all the way out <i>without releasing grip</i>.</p>
<b>5</b>	<i>All</i>	<p><b><i>Hatch egress, slide descent</i></b></p> <p>a. Grab handhold above hatch tunnel; swing legs out and descend slide feet first, making sure to:</p> <ul style="list-style-type: none"> <li>• Keep legs and feet <i>slightly</i> apart and toes pointed up.</li> <li>• Keep hands at side of body to aid balance.</li> <li>• Lean back with weight off heels.</li> <li>• Be prepared to stand and move away on reaching bottom of slide.</li> </ul> <p>b. Upon reaching bottom of slide:</p> <ul style="list-style-type: none"> <li>• Use forward momentum to assist in standing.</li> <li>• Move to one side.</li> <li>• Assist next person.</li> </ul>
<b>6</b>	<i>All</i>	<p><b><i>Escape to safe area</i></b></p> <p>Move <i>crosswind</i> to edge of runway, then move <i>upwind</i> along edge of hardtop.</p> <p>Note: Convoy crew personnel positioned in the fallback area (figure 4.5-2) assist crewmembers as needed in escaping to a safe area.</p>

\*On "recumbent" mission, MS2 deploys slide while MS3 assists long-duration crewmembers.

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## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

### Side hatch egress with sky genie

Since the side hatch is the *primary* egress route, it is preferable in the event of egress slide failure to use the sky genies through the side hatch rather than through the window 8 escape panel.

The procedures for sky genie use through the side hatch (hatch on or hatch off) are as follows:

Step	Crew-member	Procedure
1	Flight deck crewmember  <i>All</i>	<p><b><i>Sky genie deploy</i></b></p> <ol style="list-style-type: none"> <li>Remove sky genie and rope bag from stowage bag; free cable from cable track.</li> <li>Pass sky genie rope bag down to middeck.</li> <li>Manually pull down sky genie from flight deck for just enough slack to sit on hatch or in the side hatch tunnel if hatch jettisoned.</li> <li>Throw bag containing rope out hatch opening <i>aft of hatch</i>.</li> <li>Uncover and open carabiner and attach sky genie snap shackle to carabiner <i>before exiting</i>.</li> </ol>
2	<i>All</i>	<p><b><i>Hatch egress, sky genie descent</i></b></p> <p>Note: Distance to ground may be 10 ft or more.</p> <ol style="list-style-type: none"> <li>Crawl out on side hatch or sit in side hatch tunnel.</li> <li>While sitting, make sure rope and cable are not tangled or caught on any part of suit or around arm or leg.</li> <li>Place feet on wing root, which is aft of side hatch.</li> </ol>

*Continued on next page*



## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

Side hatch  
egress with sky  
genie (cont)

The procedures for sky genie use through the side hatch continue below:

Step	Crew-member	Procedure
<b>2</b> (cont)	<i>All</i>	<p><b><i>Hatch egress, sky genie descent (cont)</i></b></p> <p>d. Lower down side of orbiter to ground; control descent rate by applying tension on rope.</p> <p>Note: Rescue team personnel also can control the descent rate by applying tension on the rope from the ground.</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p style="text-align: center;"><b><i>Caution</i></b></p> <p>The orbiter fuselage curves under. Take care not to get too far out from the fuselage at the curvature. You could swing in and be injured.</p> </div> <p>e. Upon reaching ground, disconnect snap shackle from carabiner (can open carabiner if snap shackle fails to release).</p> <p>f. Assist next person descending.</p>
<b>3</b>	<i>All</i>	<p><b><i>Escape to safe area</i></b></p> <p>Move <i>crosswind</i> to edge of runway, then move <i>upwind</i> along edge of hardtop.</p> <p>Note: Convoy crew personnel positioned in the fallback area (figure 4.5-2) assist crewmembers as needed in escaping to a safe area.</p>

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

Escape panel  
egress with sky  
genie

The procedures for egressing through the window 8 escape panel using sky genies are as follows:

Step	Crew-member	Procedure
1	All	<p><i>Seat egress</i></p> <p>Egress seat per cue card:</p> <div style="border: 1px dashed black; padding: 10px; text-align: center;"> <p><b>ESCAPE PANEL EGRESS</b></p> <p>CLEAR WINDOW</p> <p>✓ TABS / VISOR / GREEN APPLE</p> <p>PULL PANEL JETT HANDLE</p> <p>PRY BAR / VENT IF REQD</p> <p>DEPLOY AND ATTACH SKY GENIE</p> <p>EGRESS CUE-1a/A,E/E</p> </div>
2	<p>CDR</p> <p>CDR/PLT</p>	<p><i>Panel jettison</i></p> <p>Advise ground personnel of intent to jettison panel.</p> <p>Note: Fire personnel will direct a water fog across the top of the orbiter before panel jettison to dissipate any explosive/inflammable atmosphere in the panel area.</p> <p>a. Remove jettison handle pip pin.</p> <p>b. Pull jettison handle.</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Do not jettison window until all flight deck crewmembers are breathing emergency O<sub>2</sub>.</p> </div> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Inner window severs and rotates inboard to aft console. Ensure that all crewmembers are clear of opening path.</p> </div>

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

### Escape panel egress with sky genie (cont)

The procedures continue below for egressing through the window 8 escape panel using sky genies :

Step	Crew-member	Procedure
<b>2</b> (cont)	MS3	<p><b><i>Panel jettison (cont)</i></b></p> <p>b. (cont)</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Window glass will shatter. Beware of falling glass around entire window area and down to middeck.</p> </div> <p>If escape panel does not open, use prybar (stowed in locker A17).</p>
<b>3</b>	<i>All</i>	<p><b><i>Sky genie deploy</i></b></p> <p>a. Remove sky genie and rope bag from stowage bag; free cable from cable track.</p> <p>b. Throw sky genie rope bag out window 8 over <i>starboard</i> side of the orbiter (starboard side because hatch could still jettison unexpectedly).</p> <p>c. Uncover and open harness carabiner and attach sky genie snap shackle to carabiner <i>before exiting</i>.</p>

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

### Escape panel egress with sky genie (cont)

The procedures continue below for egressing through the window 8 escape panel using sky genies :

Step	Crew-member	Procedure
4	All	<p><b><i>Escape panel egress, sky genie descent</i></b></p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p style="text-align: center;"><b>Caution</b></p> <p>Take care not to drop the rope in the cabin. Dropping it could put knots in the rope or cause shattered glass and debris to stick to it, making descent difficult or impossible.</p> </div> <p>Note: You do not need to hold on to sky genie when climbing up seat and out of opening. This allows use of both hands.</p> <p>Keep sky genie cable/rope over <i>left shoulder</i> when climbing through window area. Doing so prevents cable from wrapping around you.</p> <p>a. Climb onto MS2's seat, arm rest, and headrest, and then through window.</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Crewmembers should stay clear of previous member's descent cable/rope until rope is slack, signaling that the previous crewmember is on the ground.</p> </div> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Following a nominal entry, the thermal protection system around the overhead window area can be 120° F 4 min after touchdown, and the overhead glass can be 190° F.</p> </div>

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

### Escape panel egress with sky genie (cont)

The procedures continue below for egressing through the window 8 escape panel using sky genies :

Step	Crew-member	Procedure
<b>4</b> (cont)	<i>All</i>	<p><b><i>Escape panel egress, sky genie descent (cont)</i></b></p> <ul style="list-style-type: none"> <li>b. While sitting on window sill, make sure rope and cable are not tangled or caught on any part of suit or around arm or leg.</li> <li>c. Hold onto sky genie hand loop with left hand and onto loose end of rope with right hand.</li> <li>d. On your <i>left side</i>, slide down <i>starboard</i> side of orbiter until sky genie cable and rope are taut.</li> <li>e. Proceed to lower down starboard side of orbiter, controlling descent rate by applying tension on the rope.</li> </ul> <p>Note: Rescue team personnel also can control the descent rate by applying tension on the rope from the ground.</p> <ul style="list-style-type: none"> <li>f. Upon reaching ground, disconnect snap shackle from carabiner (can open carabiner if snap shackle fails to release).</li> <li>g. Assist next person descending.</li> </ul>
<b>5</b>	<i>All</i>	<p><b><i>Escape to safe area</i></b></p> <p>Move <i>crosswind</i> to edge of runway, then move <i>upwind</i> along edge of hardtop.</p> <p>Note: Convoy crew personnel positioned in the fallback area (figure 4.5-2) assist crewmembers as needed in escaping to a safe area.</p>

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

### Mode 5 cue card procedures

Figure 4.5-1 below shows the CDR/PLT and MS versions of the emergency egress cue card with the mode 5 postlanding egress procedures highlighted:

PRELAUNCH MODE 1	BAILOUT MODE 8
TABS - RELEASE	REPORT POSITION
VISOR - CLOSE/LOCK	MACH <.95, OPS 305/603
LES O2 - ON	SB - AUTO; BF - AUTO
GREEN APPLE - PULL	FLY 185-195 KEAS, $\Phi = 0^\circ$
KNEEBOARDS - REMOVE	ABORT MODE - ATO
COOLING - DISCONNECT	ABORT PBI - PUSH
RESTRAINT - RELEASE	P,R/Y - AUTO
PARACHUTE (four) - RELEASE	FLT CNTLR PWR (two) - OFF
COMM - DISCONNECT	<u>~50K FT</u>
LES O2 - DISCONNECT	TABS - RELEASE
EGRESS SEAT	VISOR - CLOSE/LOCK
SLIDEWIRE BASKETS	LES O2 - ON
POST LANDING MODE 5	GREEN APPLE - PULL
TABS - RELEASE	<u>~40K FT</u>
VISOR - CLOSE/LOCK	MS3 - VENT CABIN
LES O2 - ON	CDR,PLT SEATS - LOWER
GREEN APPLE - PULL	KNEEBOARDS - REMOVE
KNEEBOARDS - REMOVE	COOLING - DISCONNECT
COOLING - DISCONNECT	RESTRAINT - RELEASE
RESTRAINT - RELEASE	D-RING - UNCOVER
PARACHUTE (four) - RELEASE	<u>~30K FT</u>
COMM - DISCONNECT	MS3 - JETTISON HATCH
(G-SUIT CLIP - PULL)	COMM - DISCONNECT
LES O2 - DISCONNECT	(G-SUIT CLIP - PULL)
PLT - PWR DOWN	LES O2 - DISCONNECT
EGRESS SEAT	EGRESS SEAT
SLIDE/ESCAPE PANEL	POLE - DEPLOY
	D-RING - HOOK UP
	BAILOUT

*Figure 4.5-1. Mode 5 postlanding egress cue card procedures*

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

### Mode 5 cue card procedures (cont)

The table below iterates the mode 5 postlanding egress procedures in the left column as they appear in both the CDR/PLT and MS versions of the mode 5 cue card (previous pages) and gives an expanded version of them in the right column.

#### “MODE 5” POSTLANDING EGRESS

Cue Card Version	Expanded Version
TABS - RELEASE VISOR - CLOSE/LOCK LES O2 - ON GREEN APPLE - PULL	Release neck dam tabs. Close and lock helmet visor. Turn orbiter oxygen on. Activate emergency oxygen by pulling “green apple.” Note: Ensure green apple pulled full travel.
KNEEBOARDS - REMOVE COOLING - DISCONNECT RESTRAINT - RELEASE PARACHUTE (four) - RELEASE (G-SUIT CLIP - PULL) LES O2 - DISCONNECT	Remove kneeboards if worn. Release suit cooling quick-disconnect. Release seat restraints by turning rotary buckle. Release parachute from harness at shoulders and hips (four attachment points). Pull g-suit clip (only if returning from orbit after 2 or more days). Release orbiter oxygen quick disconnect.
PLT - PWR DOWN	Pilot powers down per Emergency Pwrdsn cue card.
EGRESS SEAT	All crewmembers egress seats and move to side hatch (unless escape panel used).
SLIDE/ESCAPE PANEL	<p><u>If slide used:</u></p> <ol style="list-style-type: none"> <li>Slide down slide. <ul style="list-style-type: none"> <li>Keep toes pointed up.</li> <li>Hands to side to balance.</li> <li>Lean back to keep heels from “digging in” on slide.</li> </ul> </li> <li>Move upwind of orbiter.</li> </ol> <p><u>If escape panel used:</u></p> <ol style="list-style-type: none"> <li>Attach sky genie rope to carabiner.</li> </ol> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p style="text-align: center;"><b>Caution</b></p> <p>Take care not to drop rope in cabin. This could put knots in rope or cause shattered glass and debris to stick to it, making descent difficult or impossible.</p> </div>

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

### Mode 5 cue card procedures (cont)

Cue Card Version	Expanded Version
SLIDE/ESCAPE PANEL (Cont)	<p>If escape panel used (cont):</p> <p>2. Climb out window 8 escape panel.</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Crewmembers should stay clear of the previous member's descent cable/rope until rope is slack, signaling that previous crewmember is on ground</p> </div> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p style="text-align: center;"><b>WARNING</b></p> <p>Following a nominal entry, the thermal protection system around the overhead window area can be 120° F 4 min after touchdown, and overhead glass can be 190° F.</p> </div> <p>3. Lower self down starboard side of orbiter.</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p style="text-align: center;"><b>Caution</b></p> <p>The orbiter fuselage curves under. Take care not to get too far out from the fuselage at the curvature. You could swing in and be injured.</p> </div> <p>4. Move upwind of orbiter.</p>

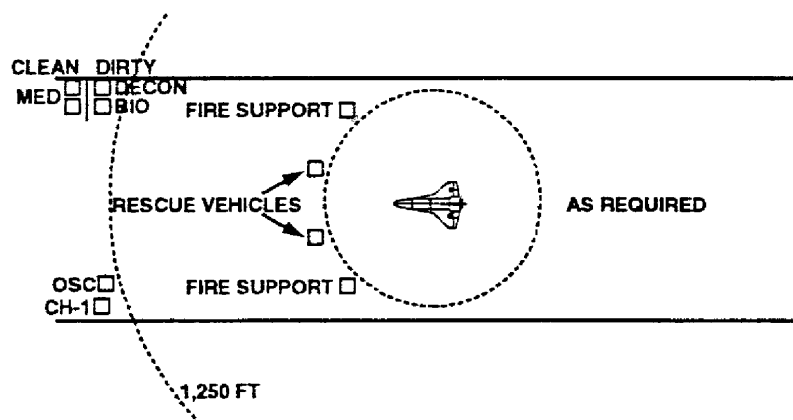
*Continued on next page*



## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

### Mode 5 convoy crew positioning

Figure 4.5-2 below shows convoy crew positioning for mode 5 (and mode 6) postlanding crew egress.



*Figure 4.5-2. Convoy positioning, mode 5 (and mode 6)*

### Postlanding loss of orbiter comm

In the event of orbiter comm loss postlanding, the crew can communicate with the convoy crew:

- By using the PRC-112 survival radio.
- If no radio contact, by using light signals.

The “Postlanding Procedures” section of the *Entry Checklist* contains information on each method. These two methods also are discussed below.

### Using PRC-112 survival radio

If orbiter communication with the convoy crew and/or Mission Control Center (MCC) is lost, the CDR or PLT uses the PRC-112 survival radio (stowed in suit leg pocket) as follows:

Step	Action
1	Select PRC-112 channel A (shuttle A/G channel programmed to 259.7 MHz) to establish voice comm with the convoy crew.
2	When comm has been established, the CDR informs the convoy crew of his/her intentions (mode 5, vehicle safing, powerdown, etc.).

*Continued on next page*

## Mode 5 - Unassisted Postlanding Egress/Escape, Continued

### Using PRC-112 survival radio (cont)

The procedures for using the PRC-112 survival radio continue below:

Step	Action
3	If contact is not possible on channel A, select 243.0 MHz (UHF military emergency frequency).
4	Once contact is made, convoy commander changes to a nonemergency frequency.

### Using light signals

If reestablishing comm with the PRC-112 is not successful, the flightcrew can make its intentions known to the convoy crew by light signals made with a flashlight (usually stowed at location A16).

The flightcrew continues signaling until the convoy crew acknowledges the signals by flashing the headlights on the convoy vehicle.

The table below defines the light signals used for specific actions.

<i>Signals from flightcrew to convoy crew</i>	
Action	Signal
Crew OK	Circular motion
OMS/RCS and hatch safed	
Auxiliary Power Unit (APU) hutdown	
Crew needs assistance; will open/jettison hatch	Vertical motion
Crew needs assistance; will not open/jettison hatch	Horizontal motion
<i>Signals from convoy crew to flightcrew:</i>	
The convoy crew acknowledges flightcrew signals with a sequence of three flashes of the headlights on the convoy vehicle.	
Continuous flashes signal emergency powerdown and egress.	

## Notes

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## Modes 6, 7 - Assisted Postlanding Egress/Escape

### Introduction

In a mode 5 postlanding situation, crewmembers egress from the orbiter and escape to a safe place on their own (convoy personnel assist from the convoy fallback position).

In a mode 6 or 7 postlanding situation, support personnel assist the crew both in egressing from the orbiter and in escaping to a safe place.

These last two modes are differentiated as follows:

- Mode 6 - Assisted crew egress/escape *on or near the runway*.
- Mode 7 - Assisted crew egress/escape *in a remote area*.

### Description

The table below gives a brief description of modes 6 and 7.

Mode 6	Mode 7
The mishap occurs on or near a runway that is readily accessible to pre-positioned convoy ground personnel.	The mishap occurs off the runway within 25 n. mi. of the landing site.
Crash and rescue personnel help the crew egress and escape.	Rescue and medical personnel are transported to the crash site by helicopter.

### Mode 6 convoy positioning

Mode 6 convoy positioning is the same as that for mode 5 (figure 4.5-2).

## Notes

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## Mode 8 - Bailout

### Introduction

Mode 8 emergency egress makes it possible for the orbiter crew to bail out safely from the orbiter during controlled gliding flight at an altitude of 30,000 ft or less.

Bailout could occur during:

- Return-to-Launch-Site (RTLS) abort.
- Transatlantic Abort Landing (TAL).
- Abort Once Around (AOA).
- Emergency deorbit that must be made regardless of landing site.

### Bailout sequence of action

The table below details the bailout sequence:

Alt. (ft)	Step	Crew-member	Action
50k	1	CDR	<p><b><i>Call for bailout</i></b></p> <p>If range to go exceeds ~ 55 n. mi. at alt. 50k ft:</p> <ol style="list-style-type: none"> <li>Call for bailout.</li> <li>Place orbiter in minimum sink rate attitude.</li> <li>Engage autopilot.</li> </ol>
		All	<p>At CDR call for bailout:</p> <ol style="list-style-type: none"> <li>Lower and lock helmet visor.</li> <li>Suit O<sub>2</sub> - ON (to breathe orbiter O<sub>2</sub> until quick disconnect, when emergency O<sub>2</sub> starts flowing).</li> <li>Pull green apple.</li> <li>If bailout during <i>entry</i> and after 2 or more days in space, pull g-suit clip.</li> </ol>

*Continued on next page*

## Mode 8 - Bailout, Continued

Bailout  
sequence of  
action (cont)

Alt. (ft)	Step	Crew- member	Action
40k	2	CDR	<p><b><i>Cabin venting</i></b></p> <p>Request MS3 to vent cabin.</p> <p>At CDR request to vent cabin:</p> <p>a. Vent cabin as follows:</p> <ul style="list-style-type: none"> <li>• Open T-handle box.</li> <li>• Pull pyro vent pin.</li> <li>• Squeeze and pull pyro vent (smooth) T-handle.</li> </ul> <p>b. During cabin vent, monitor altimeter on middeck locker; communicate reading to CDR.</p>
31k		MS3	
		CDR	<p>During cabin vent, monitor altimeter reading (pnl F8); communicate reading to MS3.</p> <p><b><i>Cabin pressure equalization</i></b></p> <p>Note: Altimeter reading rises as cabin pressure decreases. In ~75 sec (31k ft) altimeter peaks.</p>
	3	All	<p><b><i>Seat egress prep</i></b></p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p><b>WARNING</b></p> <p>Take care not to undo parachute inadvertently during egress prep.</p> </div> <p>During cabin vent:</p> <p>a. Remove kneeboards.</p> <p>b. Break cooling, any biomed connections.</p> <p>c. Release seat restraints by turning rotary buckle.</p> <p>d. Remove cover to parachute D-ring on right riser; extend D-ring.</p>

*Continued on next page*

## Mode 8 - Bailout, Continued

Bailout  
sequence of  
action (cont)

Alt. (ft)	Step	Crew- member	Action
30k	4	CDR  MS3  <i>All</i>	<p><b><i>Side hatch jettison</i></b></p> <p>When pressure equalized, request MS3 to jettison side hatch.</p> <p>At CDR request to jettison side hatch:</p> <ol style="list-style-type: none"> <li>Pull hatch jettison pin.</li> <li>Squeeze and pull hatch jettison (ribbed) T-handle.</li> <li>Disconnect comm and orbiter O<sub>2</sub>.</li> </ol>
~ 25k	5	MS3* (MS2)  <i>All</i>	<p><b><i>Escape pole deploy</i></b></p> <ol style="list-style-type: none"> <li>Egress seat and fold down seat back.</li> <li>Follow decal to deploy escape pole.</li> </ol> <p>If pole does not deploy fully (green stripe not visible), deploy pole <i>manually</i>:</p> <ol style="list-style-type: none"> <li>Pull manual backup pip pin.</li> <li>Pump ratchet handle in direction of pole (power stroke is upward) until green stripe visible.</li> </ol> <p>Egress seat and move to side hatch.</p>

\*On “recumbent” mission, MS2 deploys escape pole while MS3 assists long-duration crewmembers.

*Continued on next page*



## Mode 8 - Bailout, Continued

**Bailout  
sequence of  
action (cont)**

Alt. (ft)	Step	Crew- member	Action																													
~ 25k	6	All	<b>Bailout</b>																													
			a. The prescribed order of bailout will be:																													
			<table><tr><td rowspan="2">Bailout Order</td><td colspan="2">Seat Number</td></tr><tr><td>Nominal Mission</td><td>“Recumbent” Mission</td></tr><tr><td>1st</td><td>Seat 5</td><td>Seat 6</td></tr><tr><td>2nd</td><td>Seat 6</td><td>Seat 3</td></tr><tr><td>3rd</td><td>Seat 7</td><td>Seat 7</td></tr><tr><td>4th</td><td>Seat 4</td><td>Seat 2</td></tr><tr><td>5th</td><td>Seat 3</td><td>Seat 8</td></tr><tr><td>6th</td><td>Seat 2</td><td>Seat 4</td></tr><tr><td>7th</td><td>Seat 1</td><td>Seat 5</td></tr><tr><td>8th</td><td>--</td><td>Seat 1</td></tr></table>	Bailout Order	Seat Number		Nominal Mission	“Recumbent” Mission	1st	Seat 5	Seat 6	2nd	Seat 6	Seat 3	3rd	Seat 7	Seat 7	4th	Seat 4	Seat 2	5th	Seat 3	Seat 8	6th	Seat 2	Seat 4	7th	Seat 1	Seat 5	8th	--	Seat 1
			Bailout Order		Seat Number																											
				Nominal Mission	“Recumbent” Mission																											
			1st	Seat 5	Seat 6																											
			2nd	Seat 6	Seat 3																											
			3rd	Seat 7	Seat 7																											
			4th	Seat 4	Seat 2																											
			5th	Seat 3	Seat 8																											
6th	Seat 2	Seat 4																														
7th	Seat 1	Seat 5																														
8th	--	Seat 1																														
b. At side hatch:																																
(1) Attach D-ring on parachute riser to snap hook on lanyard (before releasing snap hook from magazine).																																
(2) Release lanyard from magazine.																																
(3) Kneel into hatch.																																
(4) Bail out, forcibly rolling out of hatch remaining tucked.																																

*Continued on next page*

## Mode 8 - Bailout, Continued

### Mode 8 bailout cue card procedures

Figure 4.7-1 shows the CDR/PLT and MS versions of the Mode 8 bailout cue card.

PRELAUNCH MODE 1	BAILOUT MODE 8
TABS - RELEASE	REPORT POSITION
VISOR - CLOSE/LOCK	MACH <.95, OPS 305/603
LES 02 - ON	SB - AUTO; BF - AUTO
GREEN APPLE - PULL	FLY 185-195 KEAS, $\Phi = 0^\circ$
KNEEBOARDS - REMOVE	ABORT MODE - ATO
COOLING - DISCONNECT	ABORT PBI - PUSH
RESTRAINT - RELEASE	P,R/Y - AUTO
PARACHUTE (four) - RELEASE	FLT CNTLR PWR (two) - OFF
COMM - DISCONNECT	<u>-50K FT</u>
LES 02 - DISCONNECT	TABS - RELEASE
EGRESS SEAT	VISOR - CLOSE/LOCK
SLIDEWIRE BASKETS	LES 02 - ON
POST LANDING MODE 5	GREEN APPLE - PULL
TABS - RELEASE	<u>-40K FT</u>
VISOR - CLOSE/LOCK	MS3 - VENT CABIN
LES 02 - ON	CDR,PLT SEATS - LOWER
GREEN APPLE - PULL	KNEEBOARDS - REMOVE
KNEEBOARDS - REMOVE	COOLING - DISCONNECT
COOLING - DISCONNECT	RESTRAINT - RELEASE
RESTRAINT - RELEASE	D-RING - UNCOVER
PARACHUTE (four) - RELEASE	<u>-30K FT</u>
COMM - DISCONNECT	MS3 - JETTISON HATCH
(G-SUIT CLIP - PULL)	COMM - DISCONNECT
LES 02 - DISCONNECT	(G-SUIT CLIP - PULL)
PLT - PWR DOWN	LES 02 - DISCONNECT
EGRESS SEAT	EGRESS SEAT
SLIDE/ESCAPE PANEL	POLE - DEPLOY
	D-RING - HOOK UP
	BAILOUT

*Figure 4.7-1. Mode 8 bailout cue card procedures*

*Continued on next page*

## Mode 8 - Bailout, Continued

### Mode 8 bailout cue card procedures (cont)

The table below iterates mode 8 bailout procedures in the left column as they appear in the cue card (previous page) and gives an expanded version in the right column.

### BAILOUT (CDR/PLT)

Cue Card Version	Expanded Version
<b>REPORT POSITION</b>  <b>MACH &lt;.95, OPS 305/603</b>  <b>SB - AUTO; BF - AUTO</b>  <b>FLY 185-195 KEAS, <math>\Phi = 0^\circ</math></b>  <b>ABORT MODE - ATO</b>  <b>ABORT PBI - PUSH</b> <b>P, R/Y - AUTO</b>  <b>FLT CNTLR PWR (two) - OFF</b>	Contact Houston with TACAN radial and DME, altitude, heading, and indicated airspeed.  When M <.95, using PASS keyboard: <u>If end of mission or TAL:</u> Type "OPS 305 PRO" <u>If RTLS:</u> Type "OPS 603 PRO"  Press AUTO pushbutton indicators for both speed brake and body flap.  Stabilize airspeed between 185 and 195 with bank of angle at 0 (zero).  Turn rotary ABORT MODE dial to ATO (abort to orbit).  Press ABORT pushbutton indicator.  Press pitch, roll, and yaw pushbutton indicators (to hold attitude and airspeed).  Flip both FLT CNTLR PWR toggle switches to OFF (disables rotational hand controllers to prevent accidental inputs when egressing seat).
<u><b>~50K FT</b></u>  <b>TABS - RELEASE</b> <b>VISOR - CLOSE/LOCK</b>  <b>LES O2 - ON</b> <b>GREEN APPLE - PULL</b>	Release neck dam tabs. Close and lock helmet visor. Turn orbiter oxygen on. Activate emergency oxygen by pulling "green apple."  Note: Ensure green apple pulled full travel.
<u><b>~40K FT</b></u>  <b>MS3 - VENT CABIN</b>  <b>CDR, PLT SEATS - LOWER</b>	CDR gives command to MS3 to vent cabin by pulling cabin vent T-handle. CDR and PLT lower seats.

*Continued on next page*

## Mode 8 - Bailout, Continued

Mode 8 bailout  
cue card  
procedures  
(cont)

### BAILOUT (CDR/PLT) - Cont

Cue Card Version	Expanded Version
<u>~40K FT (cont)</u>  <b>KNEEBOARDS - REMOVE</b> <b>COOLING DISCONNECT</b> <b>RESTRAINT - RELEASE</b>  <b>D-RING - UNCOVER</b>	Remove kneeboards if worn. Release cooling quick disconnect. Release seat restraints by turning rotary buckle. Expose and extend D-ring and bridle for pole hookup on right parachute riser.
<u>~30K FT</u>  <b>MS3 - JETTISON HATCH</b>  <b>COMM - DISCONNECT</b> <b>(G-SUIT CLIP - PULL)</b>  <b>LES O2 - DISCONNECT</b> <b>EGRESS SEAT</b>  <b>POLE - DEPLOY</b> <b>D-RING - HOOK UP</b> <b>BAILOUT</b>	CDR gives command to MS3 to jettison side hatch by pulling hatch jettison T-handle. Release communications quick disconnect. Pull g-suit clip (only if returning from orbit after 2 or more days). Release orbiter oxygen quick disconnect. All crewmembers leave seats and move to side hatch. MS3 deploys pole per decal. Hook D-ring to snap hook on pole. At hatch: 1. Pull snap hook from pole magazine. 2. Kneel into hatch. 3. Bail out.

*Continued on next page*

## Mode 8 - Bailout, Continued

### Parachute deploy sequence

The table below gives the time/altitude and action during the parachute deployment sequence.

Time/ alt	Step	Crew- member	Action
~ 25k	1	All	<p><b><i>Parachute deploy activation</i></b></p> <p>Normally, the parachute deployment sequence is activated automatically, but should auto activation fail, activate sequence manually.</p> <p>a. <u>Auto activation</u>:</p> <ul style="list-style-type: none"> <li>As each crewmember exits the orbiter, the windstream exerts a 150-lb force on the crewmember and consequently on the bridle.</li> <li>A pyrotechnic cutter separates the bridle and the lanyard (by this time crewmember is off the escape pole and away from the orbiter).</li> <li>The 18-in. pilot chute deploys. As it deploys, it: <ul style="list-style-type: none"> <li>- Deploys the 4.5-foot drogue chute (stabilizing the crewmember down to 14,000 ft).</li> <li>- Arms the AAD, which allows main canopy deployment.</li> </ul> </li> </ul> <p>b. <u>Manual activation</u> (if auto activation fails):</p> <ul style="list-style-type: none"> <li>Pull the ripcord on the left parachute riser (to activate a single pyrotechnic cutter that deploys the pilot chute after a 2-sec delay).</li> <li>The sequence of events is now the same as for the auto opening sequence.</li> </ul>
T = 0.0 sec			
T = 1.5 sec			
T = 3.0 sec			

*Continued on next page*

## Mode 8 - Bailout, Continued

Parachute  
deploy  
sequence (cont)

Time/ alt	Step	Crew- member	Action
14k ft	2	All	<p><b><i>Main canopy deployment</i></b></p> <p>Normally, main canopy deployment is activated automatically, but should the AAD fail, activate deployment manually.</p> <p>a. <u>Auto deploy:</u></p> <ul style="list-style-type: none"> <li>• When the AAD senses a pressure altitude of 14,000 ± 1000 ft, a pyrotechnic charge releases the drogue chute, which pulls the 26-foot main canopy out of the pack.</li> <li>• The main canopy stays reefed for 2 sec, thus slowing descent from ~120 ft/sec (freefall) to 80 ft/sec.</li> <li>• After 2-sec reef: <ul style="list-style-type: none"> <li>- Redundant cutters cut the reefing line, allowing the main canopy to open fully.</li> <li>- SARSAT is activated.</li> <li>- Life raft compartment is opened.</li> </ul> </li> </ul> <p>b. <u>Manual deploy</u> (if AAD fails):</p> <ul style="list-style-type: none"> <li>• Pull the <i>drogue chute release knob</i> on the left parachute riser (this releases the drogue chute from the parachute pack and allows it to pull the main canopy).</li> </ul> <p>Note: The drogue chute release knob will not function <i>if the drogue chute has not been deployed.</i></p>

*Continued on next page*

## Mode 8 - Bailout, Continued

### Parachute deploy sequence (cont)

Time/ alt	Step	Crew- member	Action
	3	All	<p><b><i>LPU activation (if water landing)</i></b></p> <p>Prior to a water landing:</p> <ul style="list-style-type: none"> <li>• Pull the <i>manual inflation toggles</i> for the LPU (an additional safeguard, since the LPUs are designed to inflate automatically upon immersion in water).</li> </ul>
	4	All	<p><b><i>Landing</i></b></p> <p><i>See next section.</i></p>

### Sequence of action, water landing

The table below describes the sequence of action when landing in water:

Step	Action
1	<p>When immersed in water:</p> <ul style="list-style-type: none"> <li>• SEAWARS automatically releases the crewmember from the parachute risers.</li> <li>• Life raft automatically deploys and partially inflates.</li> </ul>
2	<p>Before ingressing raft:</p> <ol style="list-style-type: none"> <li>Locate sea anchor/wicking sea dye and throw out of raft (dye begins wicking green).</li> <li>Locate and throw out of raft: <ul style="list-style-type: none"> <li>• Bailing cup/nonwicking sea dye (save dye until asked by SAR forces to deploy).</li> <li>• Bailing pump.</li> </ul> </li> </ol>
3	Move to foot of raft and float survival water packet in front.
4	Release one parachute ejector snap and bring remainder of parachute pack to front of self.

*Continued on next page*

## Mode 8 - Bailout, Continued

Sequence of  
action, water  
landing (cont)

Step	Action
<b>4</b> (cont)	Note: Since the raft is tethered to the parachute pack, release only one ejector snap to ensure that you stay connected to the raft at all times.
<b>5</b>	Ingress raft as follows: <ol style="list-style-type: none"> <li>Grasp and roll back spray shield.</li> <li>Sink foot of raft behind self.</li> <li>Flood raft underneath self while lying back.</li> <li>Kick feet slowly to remain upright in water; be careful not to get tangled in tethers.</li> </ol>
<b>6</b>	After entering raft, proceed as follows: <ol style="list-style-type: none"> <li>Inflate second volume of the raft by pulling the lanyard on the upper CO<sub>2</sub> cylinder on the right side of raft (inflating the second volume raises the raft higher in the water and makes it more stable).</li> <li>Pull spray shield up and over shoulders.</li> <li>Bail water from raft using these methods:               <ol style="list-style-type: none"> <li>Hold both sides of the spray shield below the water level in the raft, then “scoop” the water over the sides.</li> <li>Use bailing cup (stowed in raft).</li> <li>Use bailing pump (stowed in raft).</li> </ol> <p>If the sea is not too rough, the recommended bailing method is the following:</p> <ol style="list-style-type: none"> <li>Remove most of the water with the spray shield and the bailing cup.</li> <li>Seal the spray shield over body (take care to seal the Velcro in such a way that water will not leak in).</li> <li>Pump out the remaining water with the bailing pump.</li> </ol> </li> </ol>

*Continued on next page*



## Mode 8 - Bailout, Continued

Sequence of  
action, water  
landing (cont)

Step	Action
<b>6</b> (cont)	<p>Getting the raft dry and keeping it dry are important for survival in cold conditions, when staying as dry as possible aids physical well-being and increases survival time.</p> <p>d. Do not remove the harness at any time. The raft, survival water, and the LPU are connected to the harness. Should you be dumped from the raft, you will not be separated from the raft, and the LPU will provide buoyancy.</p> <p>e. The helmet protects the head during rescue operations.</p>
<b>7</b>	<p>Unpack and configure SARSAT signaling equipment stowed in pocket on left spray shield (beacon can remain in pocket unless foul weather dictates that it be brought inside):</p> <p>a. Extend <i>rigid</i> antenna fully (otherwise, signal strength will be diminished).</p> <p>Note: If rigid antenna does not extend, leave flexible antenna in place.</p> <p>b. After extending <i>rigid</i> antenna, disconnect <i>flexible</i> antenna.</p> <p>Note: If flexible antenna cannot be removed with gloved hands, use the shroudline cutter to cut the antenna as close to the fitting as possible.</p>
<b>8</b>	<p>When an aircraft or a ship is seen or heard, try to make contact via <i>voice</i> on the PRC survival radio (stowed in suit right lower leg pocket).</p> <div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: fit-content;"> <p style="text-align: center;"><b>Caution</b></p> <p>Do not deplete smoke/flare if no visual or aural contact is made with SAR/Fire Rescue.</p> </div>

*Continued on next page*

## Mode 8 - Bailout, Continued

Sequence of  
action, water  
landing (cont)

Step	Action
<b>8</b> (cont)	<p>Depending upon how far bailout was from land, it could take 8 hours or more before rescue forces arrive.</p> <p>The first rescue force to arrive will probably be personnel in a C-130 transport aircraft specially equipped for search and rescue:</p> <ul style="list-style-type: none"> <li>• Two teams, each consisting of three rescue jumpers with a motorized rescue boat, will drop from the C-130 and pick up individual crewmembers as they work toward the middle of the “string.”</li> <li>• The C-130 will also drop two 20-person life rafts for the assembled crewmembers and rescue personnel to wait in until rescue helicopters arrive.</li> <li>• The helicopters will pick up the waiting crewmembers and personnel and transport the crewmembers to a local hospital for evaluation.</li> </ul>

Launch contin-  
gency bailout  
area rescue

The Kennedy Space Center (KSC) contingency bailout area is the region within 50 n. mi. of the launch area and downrange along the launch groundtrack from the coastline to the TAL site. This bailout area is divided into two probability areas:

- Higher probability area
- Lower probability area

Department of Defense (DOD) SAR forces are postured to respond immediately in the launch contingency bailout area. Depending on the probability area, the weather and sea conditions, and the reliability of the bailout location, the SAR forces can locate, assist, and recover the orbiter crew within the time indicated in the table on the next page.

*Continued on next page*

## Mode 8 - Bailout, Continued

### Launch contingency bailout area rescue (cont)

The table below outlines SAR response in the launch contingency bailout area by probability area. The recovery posture for the bailout area is illustrated in figures 4.7-2, 4.7-3, and 4.7-4 following the table.

Probability Area	Resources	Response Time
<b><i>Higher probability</i></b> <ol style="list-style-type: none"> <li>Within 50 n. mi. of launch site</li> <li>From coastline along ground-track to point 200 n. mi. downrange</li> </ol>	<u>Launch and RTLS (KSC)</u> <ul style="list-style-type: none"> <li>Helicopters (one for every two crew-members plus a spare) at KSC Shuttle Landing Facility (SLF) configured for SAR and Medical Evacuation (MEDEVAC).</li> </ul> <u>Launch and RTLS (downrange)</u> <ul style="list-style-type: none"> <li>The helicopters above refueled by H/KC-130 tanker aircraft for downrange up to 200 n. mi.</li> <li>One each HC-130 and KC-130 aircraft at Patrick AFB (one spare) with two 3-man teams of Pararescue Jumpers (PJs) and survival equipment; three rescue packages on helicopters; one HC-130 aircraft 175 - 200 n. mi. downrange L - 10 min with PJs and rescue package.</li> <li>One E-2C aircraft on alert at Patrick AFB and one on alert as backup at Naval Air Station (NAS) Norfolk to assist in aircraft control and communications relay.</li> <li>U.S. Navy ship with helo at 150 n. mi.</li> <li>Coast Guard cutter with helo at 100 n. mi.</li> <li>Assistance from Solid Rocket Booster (SRB) recovery ships.</li> </ul>	SAR forces can: <ul style="list-style-type: none"> <li>Locate and assist orbiter crew within 3 hours of notification.</li> <li>Recover orbiter crew within 6 hours.</li> </ul>
<b><i>Lower probability</i></b> <ol style="list-style-type: none"> <li>From point 200 n. mi. from launch site to TAL sites</li> <li>Within 50 n. mi. of AOA and End-of-Mission (EOM) sites</li> </ol>	<ul style="list-style-type: none"> <li>HC-130 aircraft, CONUS.</li> <li>P-3C aircraft on <i>ready 1</i> alert to launch within 30 min from selected locations, drop SAR kits, provide surveillance.</li> <li>C-130 aircraft from KSC with two 3-man PJ teams or from primary and secondary TAL sites with three 3-man PJ teams (C-130 MEDEVAC aircraft on alert at Moron AB, Spain).</li> <li>U.S. Navy vessels, USCG cutters, ships of opportunity used for recovery.</li> </ul>	SAR forces can: <ul style="list-style-type: none"> <li>Locate and assist orbiter crew within 24 hours of notification.</li> <li>Recover orbiter crew as soon as possible.</li> </ul>

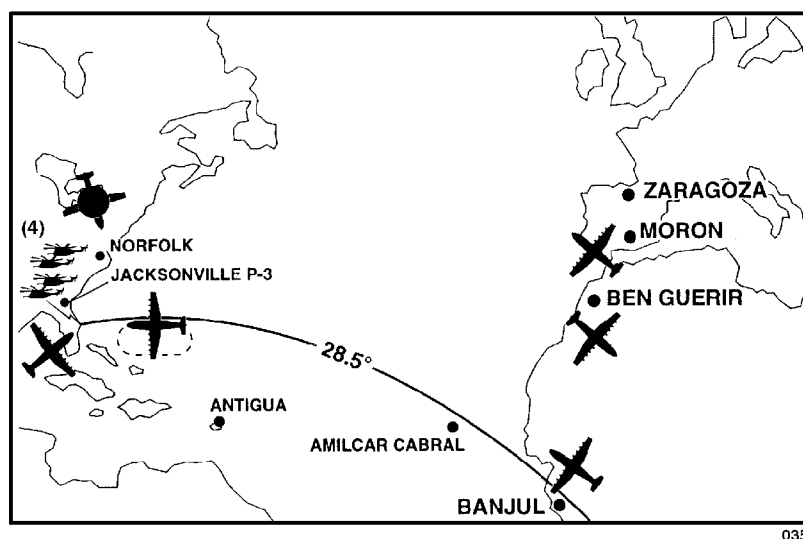
All night rescue operations will be “best effort” by SAR forces.

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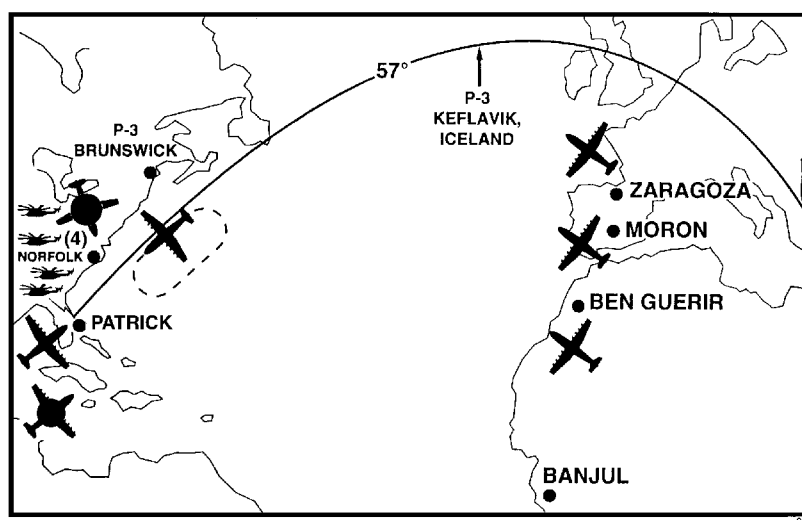
## Mode 8 - Bailout, Continued

### Launch contingency bailout area rescue (cont)

Figures 4.7-2, 4.7-3, and 4.7-4 below illustrate the recovery posture for the launch contingency bailout area.



*Figure 4.7-2. Launch contingency bailout area recovery posture, low inclination*



*Figure 4.7-3. Launch contingency bailout area recovery posture, high inclination*

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Mode 8 - Bailout, Continued

Launch contingency bailout area rescue (cont)

Figure 4.7-4 below illustrates the SAR recovery posture for the launch contingency bailout area.

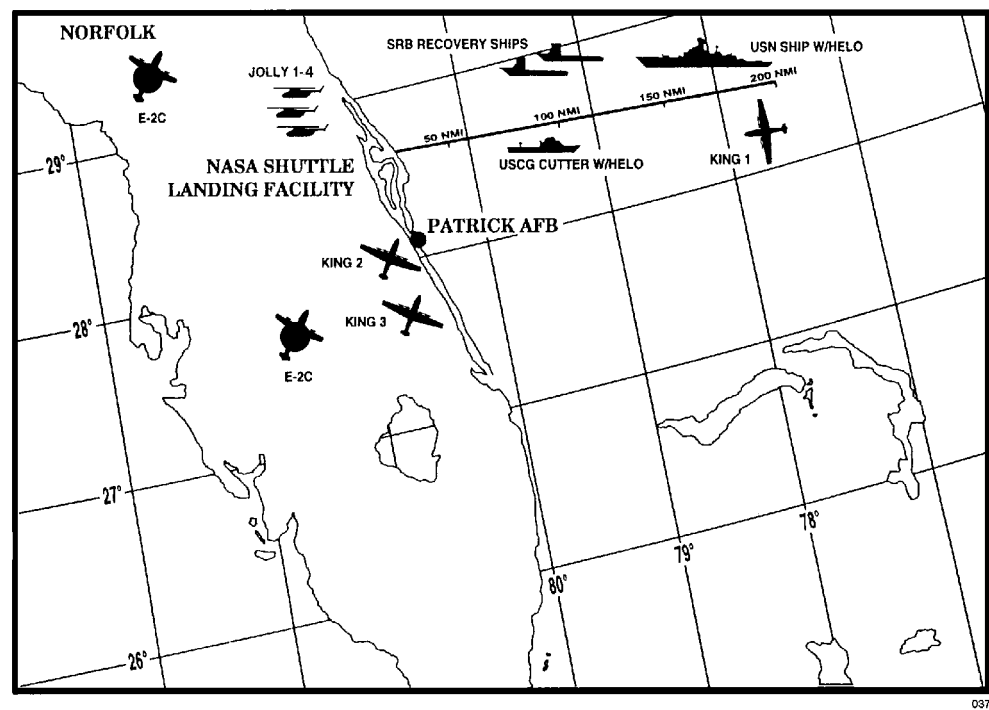


Figure 4.7-4. Launch contingency bailout area SAR recovery posture

Contingency landing site resources

The table below describes the resources available at each contingency landing site.

Site	Resources
East coast abort landing sites	Designated east coast DOD bases dedicate a runway to serve as an abort landing site (as an alternative to bailout if two or three shuttle main engines fail during ascent prior to TAL abort capability).

Continued on next page

## Mode 8 - Bailout, Continued

Contingency  
landing site  
resources  
(cont)

Site	Resources
TAL	<p>The TAL primary site and secondary site both have a C-130 in place at L - 24 hr, each with three 3-member PJ teams and survival equipment for SAR/MEDEVAC support. A MEDEVAC C-130 is on alert at Moron AB, Spain.</p> <p>The C-130 crews are on cockpit alert from L - 30 min until the TAL opportunity passes.</p>
AOA	Helicopter support forces are at the AOA runway at landing (Ld) - 30 min.
Early termination landing	<p>Helicopter support forces are at the runway at Ld-30 min for:</p> <ul style="list-style-type: none"> <li>• Scheduled daily Primary Landing Site (PLS) opportunities when landing is declared.</li> <li>• Unscheduled PLS landing (notification time permitting).</li> <li>• Emergency Landing Site (ELS) (notification time permitting).</li> </ul>

## Notes

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# Appendix A

## Acronyms

<b>A</b>		<b>F</b>	
A/A	Air to Air	FD	Fight Director
A/G	Air to Ground	FDF	Fight Data File
AAD	Automatic Actuation Device	FSS	Fixed Service Structure
ACES	Advanced Crew Escape Suit		
AFB	Air Force Base		
AOA	Abort Once Around		
APU	Auxiliary Power Unit		
ASP	Astronaut Support Personnel		
ATU	Audio Terminal Unit		
<b>B</b>		<b>G</b>	
B/U	Backup	<i>g</i>	gravity
BIP	Bioinstrumentation Passthrough		
<b>C</b>		<b>H</b>	
CCA	Communications Carrier Assembly	HIU	Headset Interface Unit
CCCD	Crew Compartment Configuration Drawing		
CCW	counterclockwise		
CDR	Commander		
CO <sub>2</sub>	carbon dioxide		
CONUS	Continental United States		
CW	clockwise		
<b>D</b>		<b>I</b>	
dc	direct current	icom	intercom
DME	Distance Measuring Equipment		
DOD	Department of Defense		
<b>E</b>		<b>K</b>	
EES	Emergency Egress Slide	KSC	Kennedy Space Center
EESS	Emergency Egress Slide System		
ELS	Emergency Landing Site		
EOM	End of Mission		
EOS	Emergency Oxygen System		
		<b>L</b>	
		LCC	Launch Control Center
		LCG	Liquid Cooling Garment
		Ld	landing
		LES	Launch/Entry Suit
		LPU	Life Preserver Unit
		LWS	Lightweight Seat
		<b>M</b>	
		MAR	Middeck Accommodations Rack
		MCC	Mission Control Center
		MEDEVAC	Medical Evacuation
		MS	Mission Specialist
		<b>N</b>	
		n. mi.	nautical mile
		NAS	Naval Air Station
		NASA	National Aeronautics and Space Administration
		NTD	NASA Test Director



# Appendix A

## Acronyms

<b>O</b>		<b>T</b>	
O <sub>2</sub>	oxygen	T	time
O&C	Operations and Checkout	TACAN	Tactical Air Navigation
OAA	Orbiter Access Arm	TAL	Transatlantic Abort Landing
		TELCU	Thermal Electric Liquid Cooling Unit
<b>P</b>		<b>U</b>	
PJ	Pararescue Jumper		
PLS	Primary Landing Site		
PLT	Pilot	UHF	Ultrahigh Frequency
PPA	Personal Parachute Assembly	USCG	United States Coast Guard
PS	Payload Specialist	USN	United States Navy
PSCS	Personal Suit Cooling System		
psi	pounds per square inch		
psia	pounds per square inch absolute		
psig	pounds per square inch gauge	V dc	volts dc
PSVS	Personal Suit Ventilation System	VLHS	Very Lightweight Headset
PTT	Push to Talk		
<b>Q</b>		<b>W</b>	
QD	Quick Disconnect	w/helo	with helicopter
<b>R</b>		<b>X</b>	
RHC	Rotational Hand Controller		
RSS	Recumbent Seating System		
RTLS	Return to Launch Site		
<b>S</b>			
S	seat		
SAR	Search and Rescue		
SARSAT	Search and Rescue Satellite-Aided Tracking		
SEAWARS	Seawater-Activated Release System		
SLF	Shuttle Landing Facility		
SRB	Solid Rocket Booster		
SSME	Space Shuttle Main Engine		
		xmit	transmit