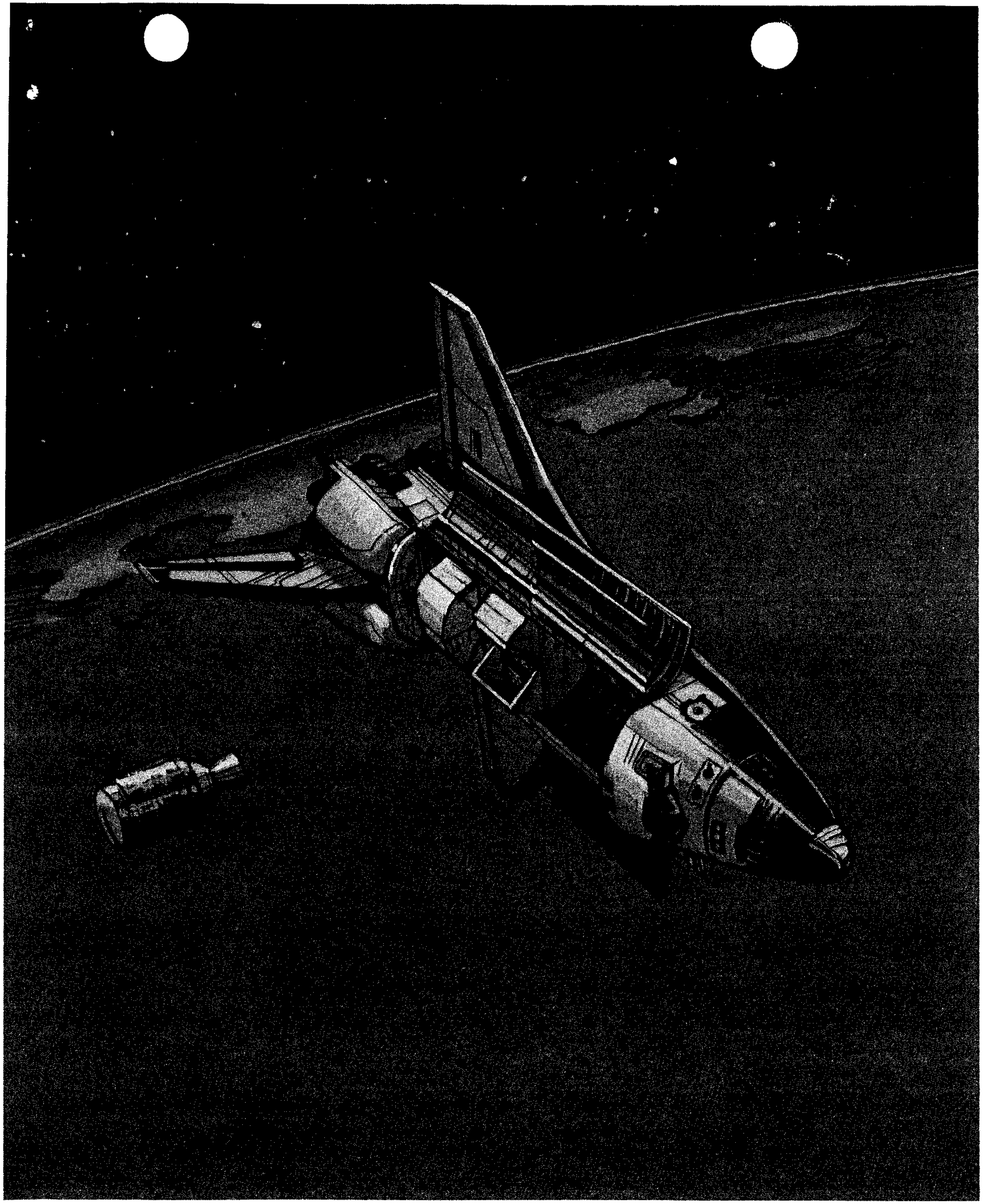

STS-5
November 1982

Press Information

Rockwell International

Space Transportation &
Systems Group

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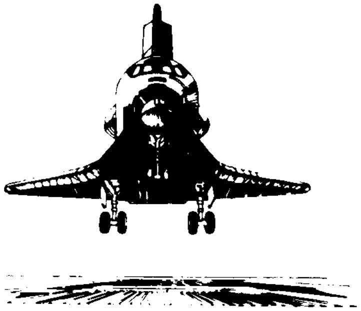


NEWS ABOUT AMERICA'S SPACE SHUTTLE

...it comes from Rockwell International

STS-5 MISSION STATISTICS

Launch: Thursday, November 11, 1982 7:19 A.M. E.S.T.
6:19 A.M. C.S.T.
4:19 A.M. P.S.T.

Duration: 5 days, 2 hr, 6 min., 16 sec.
(122 hr, 6 min., 16 sec.)

Landing: Tuesday, November 16, 1982 9:25:16 AM E.S.T.
8:25:16 AM C.S.T.
6:25:16 AM P.S.T.

Inclination: 28.45 degrees

SSME throttling: 68 to 100 percent

Altitude: 160 nautical miles (184 statute miles)

Payload weight up: Approximately 14,557 kilograms (32,093 pounds)

Payload weight down: Approximately 7,882 kilograms (17,377 pounds)

Payload: Development flight instrumentation (DFI) pallet, Telesat-E/PAM (Payload Assist Module)-D, SBS (Satellite Business Systems)-C/PAM-D, ACIP (Aerodynamic Coefficient Package), Orbiter Experiments (OEX), Task Simulation Device (TSD), Getaway Special (GAS)

Entry angle of attack: 40 degrees

Maximum Q (Aerodynamic Pressure): 785 pounds per square foot

Crew Members:
- Commander (CDR) Vance Brand
- Pilot (PLT) Bob Overmyer
- Mission Specialist (MS) William Lenoir
- Mission Specialist (MS) Joe Allen

MS William Lenoir will be seated on the flight deck for launch and mid-deck for entry.

MS Joe Allen will be seated in the mid-deck for launch and flight deck for entry.

Crew attire: Blue intravehicular activity (IVA) flight suits. Helmets will be worn for launch and entry. Anti-"G" (gravity) suit worn for entry (lower extremity) over IVA flight suit.

Crew stations: During satellite deploy CDR at aft (starboard) maneuver flight station. PLT in forward right seat. A MS in forward left seat. A MS at aft (port) payload flight station. CDR and MS in forward left seat will exchange positions in preparation for OMS engine maneuver.

Extravehicular activity in payload bay: MS William Lenoir, MS Joe Allen.

Crossrange: Less than 600 nautical miles (690 statute miles).

Autoland control mode: Autoland to a predetermined altitude, then control stick steering.

Runway: Lakebed runway 17 at Edwards AFB, California.

STS-5 MISSION OBJECTIVES

- Cold OMS (Orbital Maneuvering System) engine restart, scheduled as recircularization thrusting period
- Ascent performance data collection
- Entry/approach and landing verification
- Payload bay door centerline latch performance
- Nonsymmetrical/cold OMS/RCS (Reaction Control System) pods TCS (Thermal Conditioning System) test
  - 47 hours of starboard (right) sun inertial attitude hold (+Y solar inertial)
  - 19 hours of nose sun inertial attitude hold (+X solar inertial with a 10-degree pitch up – tail to sun)

It is noted, the spacecraft can be at any attitude in orbit, nose first (which "looks right," like an airplane), tail first, broadside and the bottom or top may face the earth. The spacecraft will be positioned according to the needs of the payload on orbit.

In the flight of the *Columbia,* a thermal test will register the reactions of the spacecraft and its payload at temperature differentials. Temperatures may range from plus 82 to 93 degrees Celsius (180 to 200°F) on surfaces irradiated by sunlight to minus 82 to 93 degrees Celsius (minus 180 to 200°F) on any surface out of direct sunlight or shaded by another object.

With relatively small satellites, the resulting thermal strain can be checked in advance, in test chambers on earth. But such tests are not possible with the large orbiter.

When the spacecraft has its bottom towards the sun, its attitude fixed with respect to the sun, the payload bay remains entirely in the shade and extreme cold.

With the spacecraft payload bay facing the sun, the payload bay is exposed to the heat of the sun.

The Passive Thermal Control (PTC) mode, when the spacecraft rolls to equalize temperatures on all surfaces at any time required, especially before reentry, is referred to as a "barbecue mode."

- ARCS (Aft Reaction Control System) Three Engine Soakback Test

  All port (left) pod PRCS (Primary Reaction Control System) engines inhibited for five hours before the test and for five hours after the test. The test is a 30-second thrusting duration of engines L1U, L2U, and L4U accomplished using a high Z translation maneuver in a retrograde thrusting attitude to adjust the orbit for entry and is in attitude hold rather than free drift.

- ARCS Single-Engine Duty Cycle Soakback Test

  All port (left) pod PRCS inhibited for five hours before the test and five hours after the test. The test is a series of five 30-second thrusting of engine L2U, each separated by 30 minutes, accomplished by using a plus Z translation maneuver in a retrograde thrusting attitude to adjust the orbit for entry.

- VRCS (Vernier Reaction Control System) Engine Soak-back Test

  All RCS in port (left) pod inhibited for five hours before the test and for five hours after the test. This test is a single 125 second thrusting duration of L5D accomplished as a pitch maneuver.

- Entry Aerodynamic Test

- Payload Bay Unsymmetrical Distortion Test

- PRSD (Power Reactant Storage Distribution) Stratification Test

  Test scheduled at more than 85 percent cryo level. Two hours with no maneuvers or OMS thrusting periods prior to the pitch maneuvers.

- EMU (Extravehicular Mobility Unit)/EVA (Extravehicular Activity) Evaluation

- DAP (Digital Autopilot) Performance in LVLH (Local Vertical/Local Horizontal) Mode

- Air Data Subsystem Performance

- Left air data probe deployed at Mach 5.0 during entry.

- Orbiter/Detached Payload Communications

  Accomplished as part of nominal SBS (Satellite Business System) satellite checkout/deployment.

- Autoland Performance

  Autoland in effect to a predetermined altitude, then control stick steering.

- S-Band/UHF (Ultra High Frequency) Antenna Tests With Upper Antennas

- Maximum braking test after nose wheel touchdown from 140 to 80 knots

- Crosswind Landing Performance

- Glow Experiment

- Oxygen Interaction With Materials Experiment

- Vestibular Study Experiment

- Student Experiments

- Getaway Special Experiment

MODIFICATIONS – STS-4 TO STS-5

- Payload Modular Auxiliary Data System (MADS) for technology flight instrumentation for payload
- Removal of Power Reactant Storage Distribution System cryogenic liquid oxygen and liquid hydrogen tank set No. 4
- Mission specialist seat installation at aft flight station with quick disconnect-type attach fittings to permit easy removal and stowage for on-orbit operations
- Mission specialist seat installation in mid-deck with quick disconnect-type attach fittings to permit easy removal and stowage for on-orbit operations.
- Deactivation of pyrotechnics in commander's and pilot's ejection seats (safety pins and hose disconnections, did not remove catapult pyrotechnics as would have to remove seats). Overhead ejection panel jettison system still active for emergency ground egress
    - Safing devices installed or removals from commander's and pilot's ejection seats:

        Secondary ejection T-handle pin
        Scramble handle maintenance cover
        Catapult valve key
        Ballistic hose section removal
        Parachute hose section removal
        Parachute drogue gun removal
        Parachute beacon removal
        No foot spurs on commander's and pilot's boots
- Removal of survival equipment and oxygen system in commander's and pilot's ejection seat, seat cushion
- Addition of four emergency ground egress descent devices on commander's seat support structure
- Removal of portable oxygen system (POS) and installation of personal egress air packs (PEAP's) for each flight crew member. PEAP is utilized with the launch/entry helmet for each crew member
- Removed ablators on elevons. Replaced ablators on right elevons with new ablators. Replaced ablators on left hand elevons with high-temperature reusable surface insulation tiles
- Removal of remote manipulator system, arm, and manipulator positioning system including two control and display panels at aft flight station (one Rockwell International panel and one Canadian panel)
- Install operational (upgraded) black boxes
    - Ground Control Interface Logic (GCIL) Unit
    - Pulse Code Modulation Master Unit (PCMMC)
    - Reaction Jet Driver Assemblies (RJDA's)
    - Engine Cutoff (ECO) Point Sensor Electronics
- Removal of spare general purpose computer (GPC) No. 6
- Removal of continuous flow electrophoresis system (CFES) experiment from mid-deck
- Removal of induced environment contamination monitor (IECM) experiment from DFI
- Addition of payload related hardware
    - S-band coaxial switch
    - Payload signal processor
    - Payload data interleaver and switch
    - Payload interrogator
    - Payload support hardware

  - Aft flight deck custom payload harness and controls and displays
  - S-band payload antenna

- Reconfigured structural attachments, electrical, instrumentation and support installations

- Extravehicular (EVA) tether in payload bay

- Extravehicular mobility unit (EMU) television on Mission Specialist Joe Allen's EMU helmet

- Extravehicular mobility units (EMU's), two, in airlock

- Addition of mid-deck egress platform on ladder, flight deck to mid-deck, to provide capability for upper to mid-deck assisted egress down ladder

- Removal of monodisperse latex reactor (MLR) experiment, mid-deck

- Removal and replacement of getaway special (GAS) experiment

- Oxygen, biomedical and communications cables routing for mission specialists stations, two

- Installation of Telesat-E/PAM-D payload in payload bay at Launch Complex 39A

- Installation of SBS-C/PAM-D payload in payload bay at Launch Complex 39A

- Mid-deck floor beef-up

- Relocation of DFI pressure transducers from base heat shield to wing

- Removed unused DFI signal conditioners

- Relocated treadmill (crew exercise) in mid-deck

- Installation of EVA task simulation device (TSD) in payload bay

- Thermal protection system
  - Removed and replaced 273 tiles

    This includes tiles damaged in flight (nicks, dings, etc.), tile modifications for orbiter experiments, tiles damaged on ground, tiles for engineering evaluation and for densification.
  - Rewaterproofed tiles

- Survival kit addition at aft flight station panel A17
  - Provides land and sea survival capability for seven crewmembers for 48 hours. The kit is packaged in a single container sized to be deployed through the side hatch (or the overhead ejection ground egress panels on Orbiter 102) by a single crewmember.
  - Life raft (8 person) consists of:

    CO_2 (carbon dioxide) inflation assembly, inflation time less than 30 seconds

    Mooring lanyard assembly, 15.25 meters (50 feet)

    Oral inflation tube – two

    Bellows pump

    Bailing bucket

    Sea anchor

    CO_2 valve cover
  - Signaling equipment consisting of:

    Personal distress signal kit (launcher and seven flares), altitude above ground 213 to 427 meters (700 to 1,400 feet), signal duration 9 seconds and range of 33 to 37 kilometers (18 to 20 nmi)

    Smoke/illumination flare – two, day-smoke, night-flare, duration 18 seconds, range 13 kilometers (7 nmi)

Sun mirror, 50 x 76 millimeters (2 x 3 inch), range 33 kilometers (18 nmi) under ideal conditions

Radio/beacon with two spare batteries

Sea dye marker – two, produce yellow-green slick, range 3.7 to 5.5 kilometers (2 to 3 (nmi)

– Other survival equipment

Individual survival kits

Survival glasses

Survival knife assembly (pocket knife)

Desalter bag and chemical packets

– Size

304 x 406 x 762 millimeters (12 x 16 x 30 inches)

– Weight

19 kilograms (42 pounds)

– The commander, pilot and mission specialists each have integrated life vests.

LINE REPLACEABLE UNITS (LRU'S)

- Remove and replace forward reaction control system (FRCS) engine F1L due to oxidizer seepage.
- Remove and replace auxiliary power unit (APU) No. 3, lube oil filter clogged in STS-4 flight, operated satisfactorily in bypass mode.
- Remove and replace water spray boiler (WSB) No. 3, froze up during ascent in STS-4 flight, operated normally for entry phase of flight.
- Remove and replace fuel cell (FC) No. 1, was drifting toward low temperature limits in coolant portion of system. The replacement fuel cell is the one from the STS-2 flight which was refurbished and installed for STS-5.
- Remove and replace TACAN (tactical air navigation) No. 2.
- Remove and replace multiplexer/demultiplexer (MDM), flight aft No. 4.
- Remove and replace MDM, flight forward No. 4.
- Remove and replace Space Shuttle main engine (SSME) No. 2 ignitor sensor.
- Remove and replace SSME No. 3 high pressure fuel turbopump (HPFTP) due to high torque readings.
- Remove and replace SSME No. 1 high pressure oxidizer turbopump (HPOTP) turbine blades for routine 3,000 second maintenance.
- Remove and replace SSME No. 3 main fuel valve.
- Remove waste collection system, modify slinger and motor, and increase wiring and circuit breaker to 5 amps.
- Remove and replace left-hand and right-hand inboard brakes.
- Remove and replace right-hand side main landing gear tires.
- Remove and replace power reactant and storage distribution cryogenic control box fuses.
- Remove and replace two floodlight electronic assemblies and forward bulkhead floodlight lamps.

- Remove and replace video tape recorder.
- Remove and replace DFI tape recorder.
- Remove and replace vernier RCS engines, L5L, R5R, L5D, R5D, F5L and F5R due to pitted coatings in chamber.
- Remove and replace inertial measurement unit (IMU) No. 3; azimuth unit failed to cage properly when commanded to operate.
- Remove and replace aft load controller (ALC) No. 1.
- Remove and replace keyboard unit No. 1 (left-hand), CDR's.
- Remove and replace display electronics unit (DEU) No. 2.

PAYLOAD ASSIST MODULE (PAM)

The Payload Assist Module (formerly called the Spinning Solid Upper Stage – SSUS) is designed as a higher altitude booster of satellites deployed in near Earth orbit but operationally destined for higher altitudes.

Both payloads carried in STS-5 – the SBS-C and Telesat E – will be boosted to geosynchronous orbits (35,887 kilometers – 22,300 miles) by PAM-D's.

There are two versions of the PAM – the "D" which is utilized to launch lighter weight satellites and the "A" which is capable of launching satellites weighing up to 1,995 kilograms (4,400 pounds) into a 27-degree geosynchronous transfer orbit after being deployed from the Shuttle spacecraft's cargo bay.

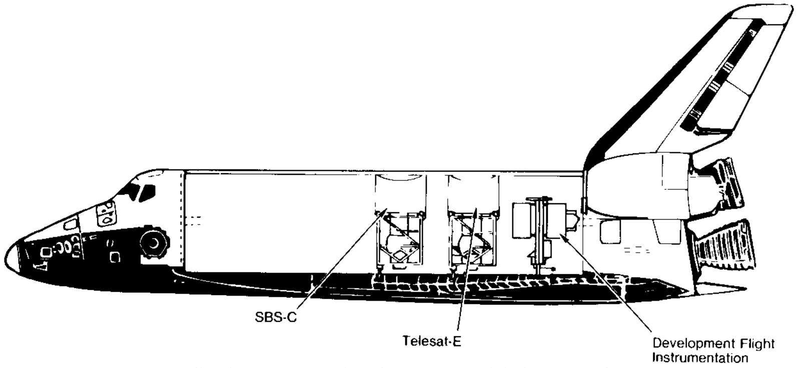
The PAM-D is capable of launching satellite weights up to 1,247 kilograms (2,750 pounds) into a 27 degree geosynchronous orbit following deployment. A requirement for a 1,361 kilogram (3,000 pound) transfer orbit capability requires about a 10 percent increase in the PAM-D motor performance, which can be accomplished by adding more length to the motor case, but reducing the nozzle length the same amount to retain the overall stage length. The motor case extension is about 137 millimeters (5.4 inches). This uprating will require other changes, namely the strengthening and addition of cradle members so that the system structural dynamic frequency will avoid the Space Shuttle forcing frequencies.

The PAM-A and PAM-D have a deployable (expendable) stage consisting of a spin stabilized solid rocket fueled motor (SRM), a payload attach fitting (PAF) to mate with the unmanned spacecraft, and the necessary timing, sequencing, power and control assemblies.

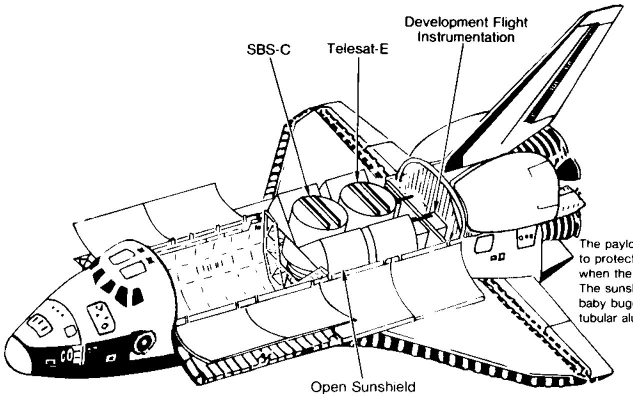
The reusable airborne support equipment (ASE) consists of the cradle structure for mounting the deployable system in the Space Shuttle orbiter payload bay, a spin system to provide the stabilizing rotation, a separation system to release and deploy the stage and unmanned spacecraft, and the necessary avionics to control, monitor, and power the system.

The PAM-A and PAM-D stages are supported through the spin table at the base of the motor and through restraints at the PAF. The forward restraints are retracted before deployment.

The PAM-D also provides a sunshield for thermal protection of the satellite when the Space Shuttle orbiter payload bay doors are open.



STS-Payload Configuration (Side View)



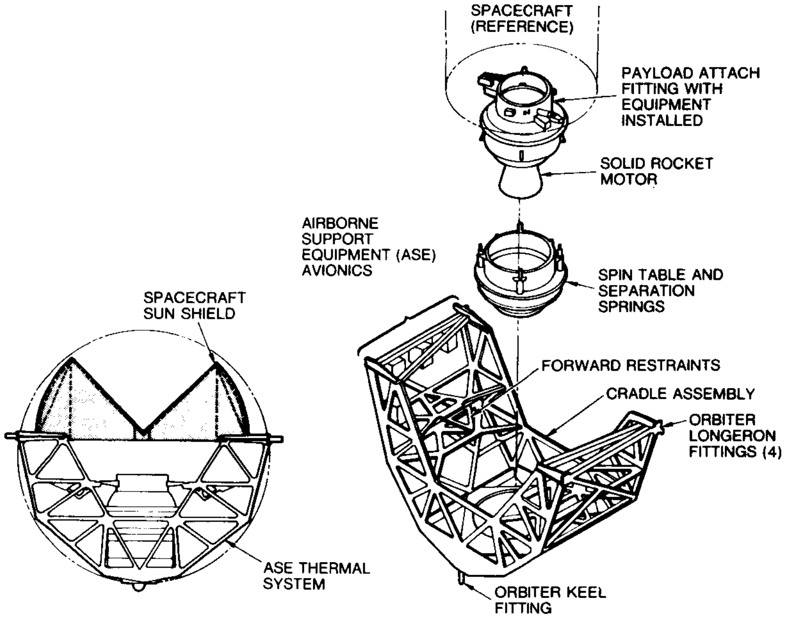
The payload is covered by a sunshield to protect against thermal extremes when the orbiter bay doors are open. The sunshield, resembling a two-piece baby buggy canopy, is constructed of tubular aluminum and mylar sheeting.

STS-Payload Configuration (Top View)

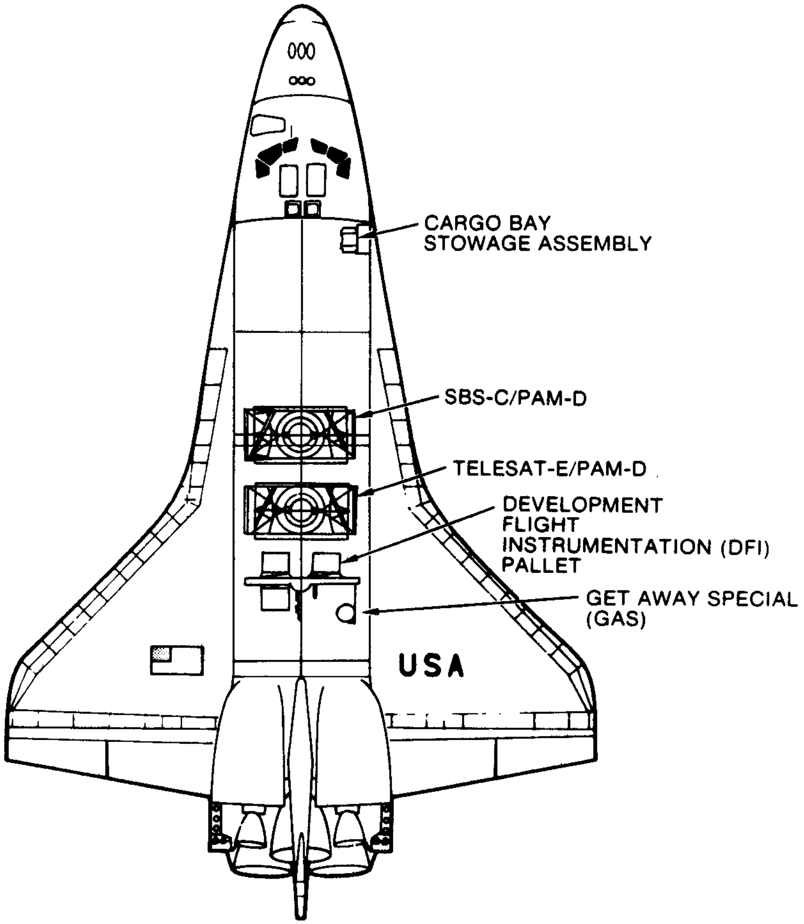
PAM-D AIRBORNE SUPPORT EQUIPMENT AND ORBITER INSTALLATION

The PAM-D Airborne Support Equipment (ASE) consists of all the reusable hardware elements that are required to mount, support, control, monitor, protect, and operate the PAM-D expendable hardware and unmanned spacecraft from liftoff to deployment from the Space Shuttle. It will also provide the same functions for the safing and return of the stage and spacecraft in case of an aborted mission. The ASE is designed to be as self-contained as possible, thereby minimizing dependence on orbiter or flight crew functions for its operation. The major ASE elements include the cradle for structural mounting and support, the spin table and drive system, the avionics system to control and monitor the ASE and the PAM-D vehicle and the thermal control system.

The cradle assembly provides a vertical structural mounting support for the PAM-D/unmanned spacecraft assembly in the orbiter payload bay. The nominal envelope for the PAM-D vertical installation provides a cylindrical volume 2,562 millimeters (100.88 inches) in height on the centerline and a diameter of 2,184 millimeters (86 inches). The diameter limitation applies to all early unmanned spacecraft that require the capability to use the Delta launch vehicle as a backup to the Space Shuttle. After full transition to the Space Shuttle is



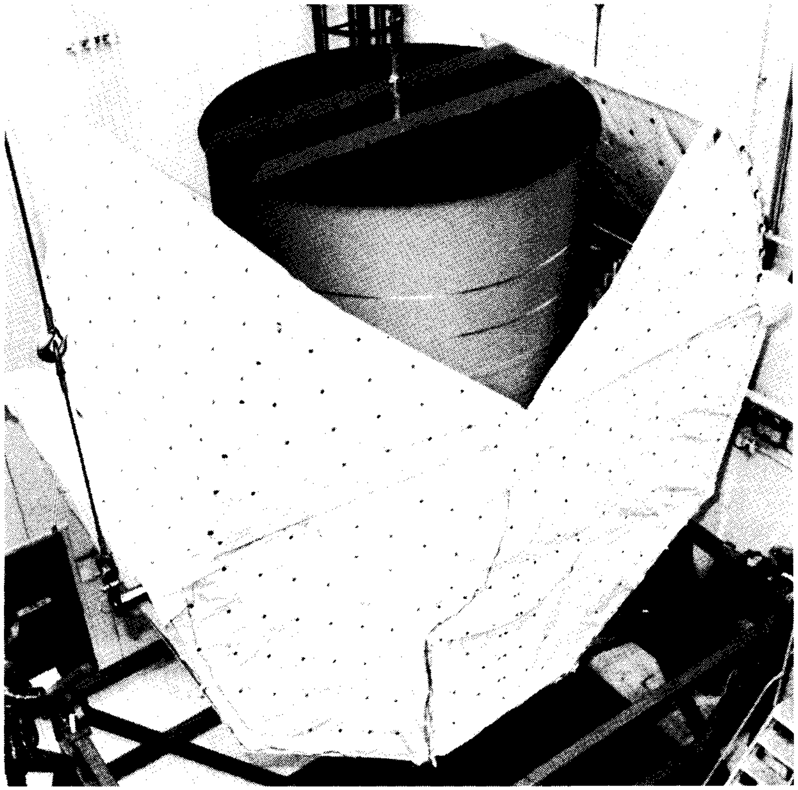
PAM-D System



STS-Payload Configuration (Top View)

complete, the unmanned spacecraft configuration may use the extra volume available within the Space Shuttle payload bay, a maximum diameter of 2,743 millimeters (108 inches) inside the cradle, 3,048 millimeters (120 inches) above the cradle. The cradle is 4.5 meters (15 feet) wide. The length of the cradle is 2,362 millimeters (93 inches) static and 2,438 millimeters (96 inches) dynamic. The open truss structure cradle is constructed of machined aluminum frame sections and chrome plated steel longeron and keel trunnions.

The spacecraft-to-cradle lateral loads are reacted by forward retractable retraction fittings between the payload attach fitting and cradle, which are driven by redundant dc electrical motors.

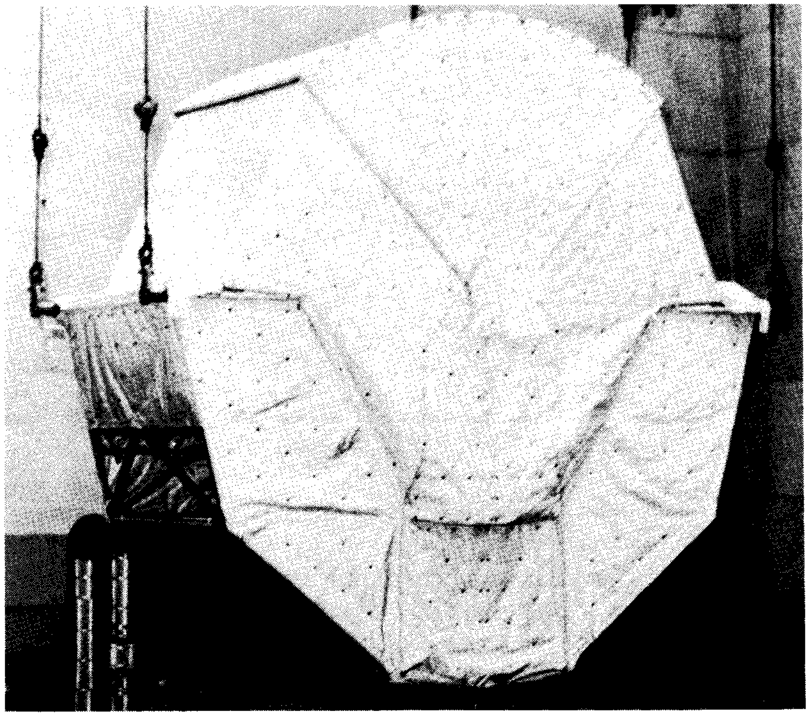


PAM-D/Telesat-E Sunshield Open

After the reaction fittings are retracted, the spin table is free to spin the PAM unmanned spacecraft when commanded.

The spin table consists of three subsystems, spin, separation, and electrical interface. The spin subsystem consists of the spin table, the spin bearing, the rotating portion of the spin table, a gear and gear support ring, two redundant drive motors, a despin braking device, and a rotational index and locking mechanism. The separation subsystem includes four compression springs mounted on the outside of the rotating spin table, each with an installed preload of 635 kilograms (1,400 pounds) and a Marman-type clamp band assembly.

The electrical interface subsystem is composed of a slip-ring assembly to carry electrical circuits for PAM-D and spacecraft across the rotating spin bearing. The electrical wiring from the



PAM-D/Telesat-E Sunshield Closed

slip ring terminates at electrical disconnects at the spin-cable separation point. The slip-ring assembly is used to carry safety-critical command and monitor functions and those commands required before separation from the spin table.

The system provides a capability for spin rates between 45 and 100 rpm. In this flight, the spin rate is approximately 50 rpm. Upon command, the spin table will be spun up to the nominal rpm by two electric motors, either of which can produce the required torque. When the spin table rpm has been verified and the proper point is reached in the parking orbit, redundant debris-free explosive bolt cutters are fired upon command from the electrical ASE to separate the band clamp (which is mechanically retained on the spin table) and the springs provide the thrust to attain a separation velocity of approximately 0.9 meters per second (3 feet per second).

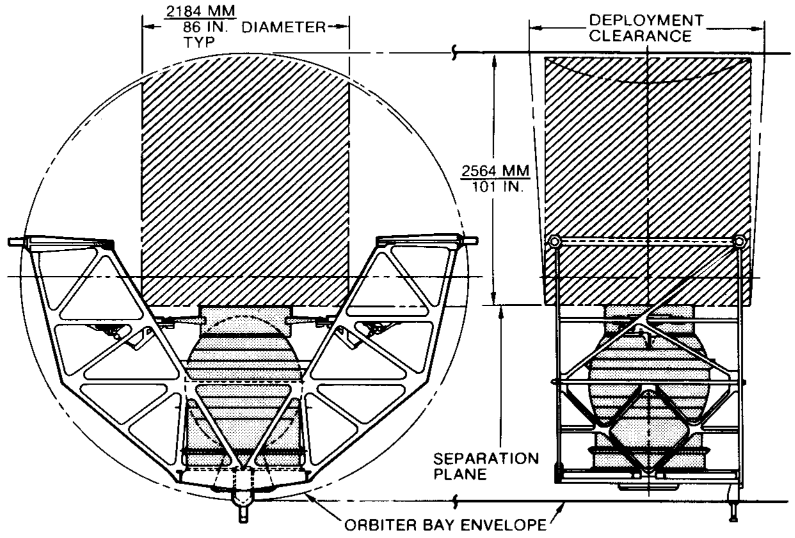
In case of an abort mode after spinup, the multiple-disc-stack friction-type braking device will despin the PAM-D unmanned spacecraft assembly and the spin drive motor will slowly rotate the assembly until the solenoid-operated indexing and locking device is engaged. Upon confirmation by the ASE that the spin table is properly aligned and locked, the restraint pins will be re-engaged.

PAM-D MOUNTED THERMAL CONTROL SYSTEM

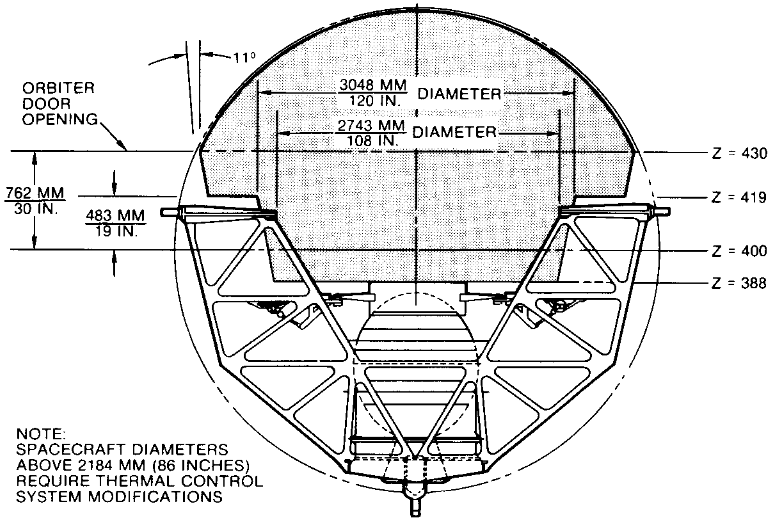
The PAM-D thermal control system is provided to alleviate severe thermal stresses on both the unmanned spacecraft and the PAM-D system.

The system consists of thermal blankets mounted on the cradle to provide thermal protection for the PAM-D system, and a passive sunshield mounted on the cradle to control the solar input to and heat loss from the payload when the orbiter payload bay doors are open.

Thermal blankets consisting of multilayered insulation mounted to the forward and aft sides of the cradle protect the PAM-D from thermal extremes. On the sides and the bottom,



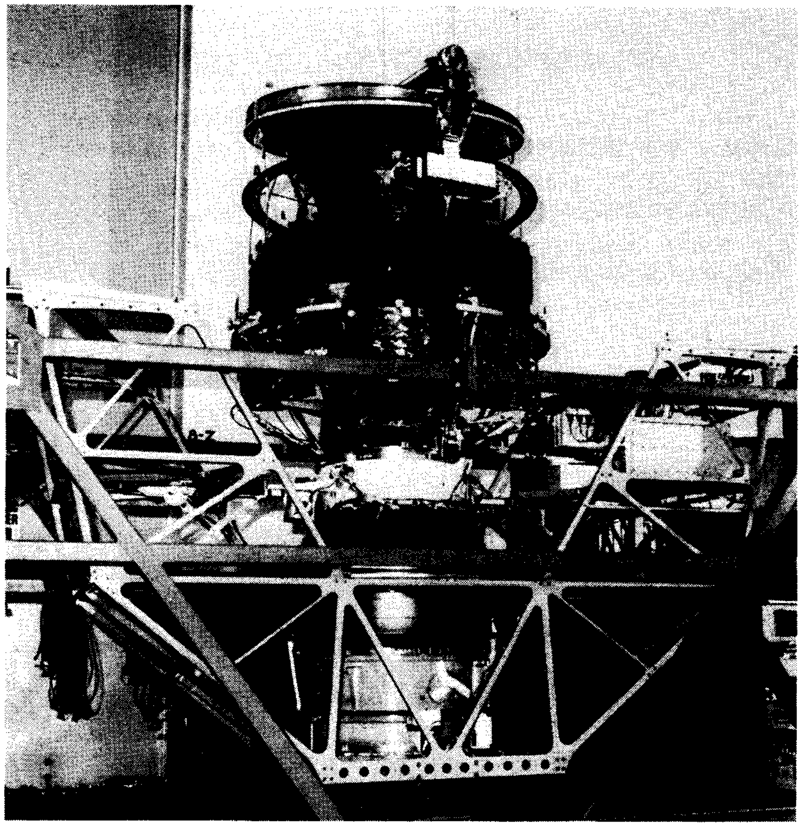
PAM-D Orbiter Vertical Installation



NOTE:
SPACECRAFT DIAMETERS ABOVE 2184 MM (86 INCHES) REQUIRE THERMAL CONTROL SYSTEM MODIFICATIONS

Maximum Spacecraft Envelope With STS PAM-D the orbiter payload bay liner protects the PAM-D from the environmental extremes.

A sunshield, consisting of multilayered, Mylar lightweight insulation supported on a tubular frame, mounts to the cradle and protects the unmanned spacecraft from environmental extremes. The sunshield panels on the sides are fixed and stationary. The portion of the shield covering the top of the unmanned spacecraft is a clamshell structure that remains closed to protect against thermal extremes when the orbiter payload bay doors are open. The sunshield resembles a two-piece baby buggy canopy. The clamshell is opened by redundant electric rotary actuators operating a control-cable system.



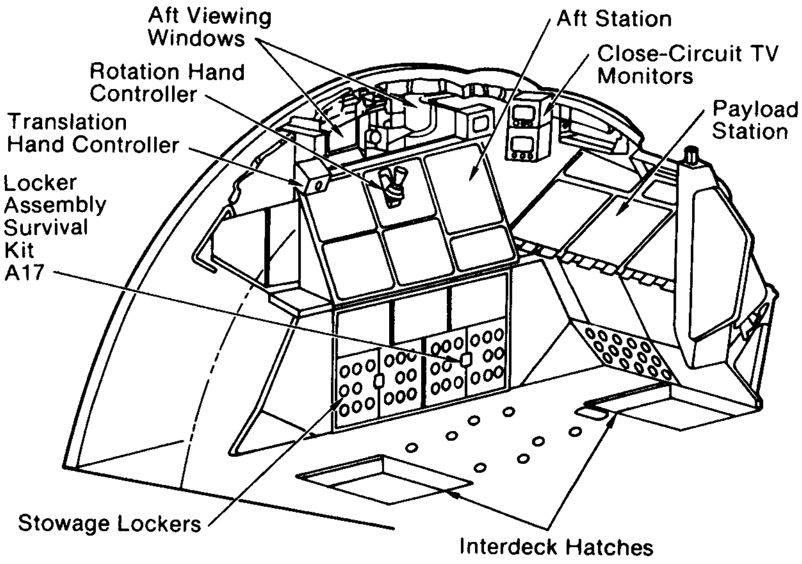
PAM-D/Telesat-E

The sunshield required for the PAM-D growth will have a width adjustment capability to accommodate spacecraft up to 2,901 millimeters (115 inches) in diameter.

PAM-D VEHICLE CONFIGURATION

The PAM-D expendable vehicle hardware consists of a Thiokol Star-48 solid-fueled rocket motor, the payload attach fitting and its functional system. The Star-48 motor features a titanium case, an 89-percent solid propellant, a carbon-carbon throat insert, and a carbon-carbon exit cone. Maximum loading of propellant is 1,998 kilograms (4,405 pounds) with a nominal of 1,738 kilograms (3,833 pounds). The motor is 1,239 millimeters (48.8 inches) in diameter and is 1,828 millimeters (72 inches) long.

The payload attach fitting (PAF) structure is a machined

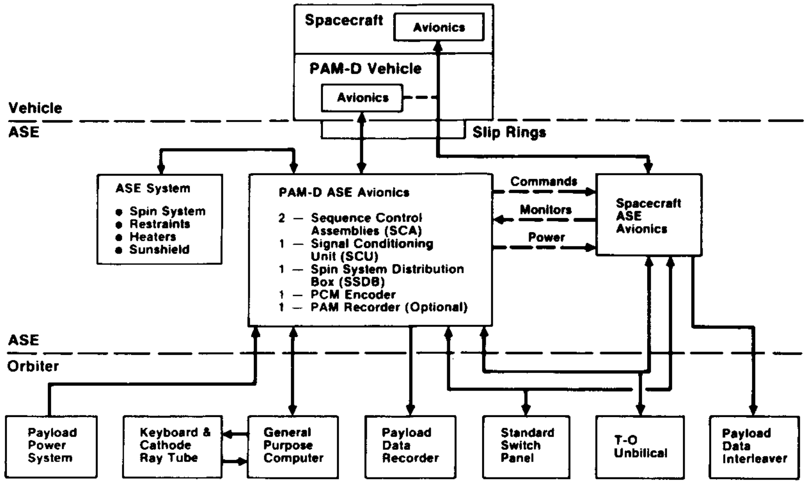


Orbiter-102–STS-5 Aft Flight Deck Station forging and provides the subsystem mounting installations and mounts on the forward ring of the motor case. The two cradle reaction fittings provide structural support to the forward end of the PAM-D stage and unmanned spacecraft, and transmit loads to the ASE cradle structure. The forward interface of the PAF provides the spacecraft mounting and separation system. One steel band is preloaded to approximately 2,585 kilograms (5,700 pounds) and separation is achieved by redundant bolt cutters. Four separation springs, mounted inside the PAF provide the impetus for clear separation. The installed preload for each spring is approximately 90 kilograms (200 pounds) with a spring stroke of 133 millimeters (5.25 inches), providing a spacecraft separation velocity of about 0.9 meters per second (3 feet per second). The electrical interface connectors between the PAM-D and the spacecraft are mounted on brackets on opposite sides of the PAF. Other subsystems mounted on the PAF include the redundant safe-and-arm device for motor ignition, and telemetry components (if desired) and the S-band transmitter.

PAM-D AVIONICS

The electrical ASE minimizes the number of operations to be performed by the flight crew so that greater attention can be paid to monitoring functions that are critical to safety and reliability.

Flight crew control functions include system power on, SRM arming, deployment ordnance arming, emergency deployment and sequence control assembly (SCA) control.



PAM-D Interfaces

The electrical ASE performs control and monitoring of restraint withdrawal, spin-table spin and deployment functions; arms (and disarms, if necessary) the SRM; controls and monitors the PAM-D vehicle electrical sequencing system (and telemetry system, when used); generates system status information for display to the flight crew (cathode ray tube) via the data lens and from the orbiter keyboard panel; and provides wiring to carry required spacecraft functions. And, as a mission option, it provides control and monitoring of spacecraft systems.

The Payload Assist Modules are designed and built by McDonnell Douglas Astronautics, Co., Huntington Beach, California.

SBS-C SATELLITE

SBS (Satellite Business Systems) is a private communications company owned by subsidiaries of Aetna Life and Casualty, COMSAT General Corporation, and IBM. It has established a nationwide advanced communications satellite system to serve both business and government customers. SBS headquarters is in McLean, Virginia. As a communications common carrier, SBS does not manufacture or sell equipment, but does provide a range of communication services.

SBS-C is planned for commercial operations beginning in early 1983. It will augment SBS's two operational satellites, providing additional transmission capability for expanding customer services as well as in-orbit backup capability.

The SBS spacecraft is manufactured by Hughes Aircraft Company, El Segundo, California.

SBS will pay approximately $8 million for the launch under a launch services agreement with NASA. The SBS-C payload occupies one-seventh of the Space Shuttle payload bay. The spacecraft is insured by SBS.

The SBS system began operations in March 1981 after more than five years of development work.

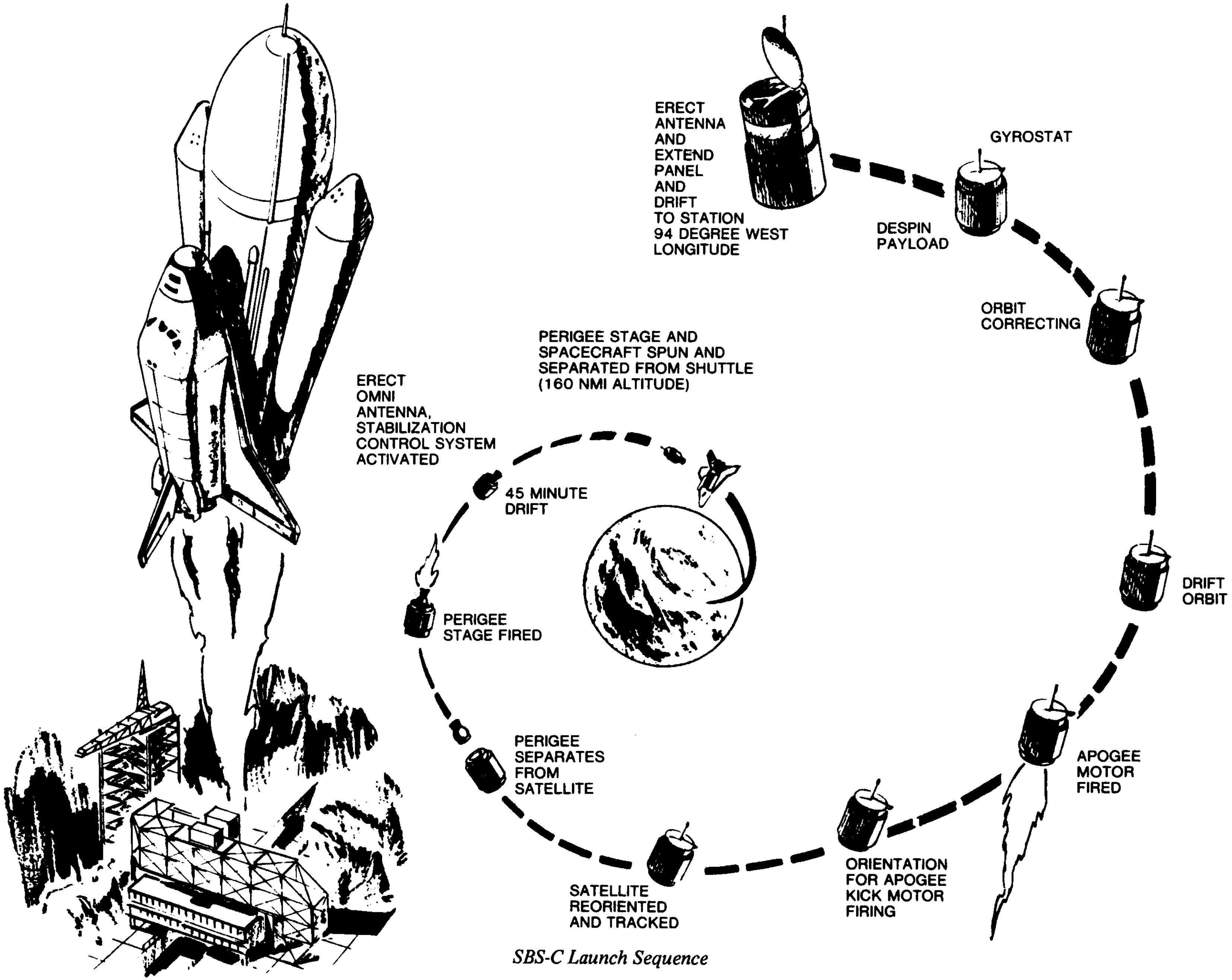
Two SBS satellites launched in November 1980 and September 1981, respectively, are in full time use along with 65 SBS communications earth stations in the United States. The number of earth stations will double by 1983. SBS-1 is in geosynchronous orbit over the equator, positioned at 100 degrees west longitude; and SBS-2 is positioned at 97 degrees west longitude. SBS-C will be positioned at 94 degrees west longitude. SBS has asked the Federal Communications Commission for authority to launch a fourth satellite in mid-1984, and a fifth in mid-1985. In conjunction with this request, SBS proposed to adopt two-degree orbital spacing for the five in-orbit satellites at 92 degrees, 94 degrees, 96 degrees, and 100 degrees west longitude. SBS is the first satellite operator to seek to expand orbital resources through two-degree spacing.

The system operates in the 14- and 12-gigahertz bands (Ku-band) of the frequency spectrum. These higher frequencies are relatively unused today, thereby averting radio frequency interference problems. This enables SBS to use relatively small earth stations and to position them in metropolitan areas where business communications needs are greatest, rather than at distant sites remote from radio frequency congestion. Each satellite incorporates 10 operational transponder channels. The system is all digital. It features time-division, multiple-access (TDMA) techniques for efficient use of satellite transmission capability.

For management of its satellites in orbit, SBS operates a Beacon Station at Castle Rock, Colo., and a Satellite Control Station at Clarksburg, Md. These facilities perform tracking, telemetry, and control that are essential for stationkeeping, monitoring of satellite operation and other "housekeeping" functions. Each provides full redundancy in case of an emergency. A network control center at McLean, Va., performs capacity allocation, monitoring, and diagnostic functions for the entire system.

SBS has realized several firsts in the telecommunications industry: the first all-digital system for integrated, switched business communications; the first system to offer a nationwide low-cost long-distance telephone service using satellite transmission entirely for the long-distance links; and the first system to operate at higher frequencies (Ku-band), permitting smaller dish antennas and freedom from most radio frequency interference. SBS-C will add 50 percent more capacity to the space segment of SBS's nationwide system.

In addition to satellites in orbit, the SBS system includes a growing number (90 at present) of communications earth stations throughout the 48 contiguous states. These high-capacity



SBS-C Launch Sequence

facilities perform communications processing, switching, and transmission functions for customer traffic.

SBS provides three different kinds of customer services:

1. Communications Network Service (CNS) for large business organizations. It provides to each customer an advanced, high-capacity private network that is capable of handling the entire range of intraorganization communications for that customer – telephone, computer data, electronic mail, and video teleconferencing.

2. Message Service I (long-distance, interstate telephone service) for business customers.

3. Transponder capacity services, which offer the communications and broadcasting industries and others Ku-band transponder service to meet their transmission needs.

Thirteen of the large CNS networks have been implemented by SBS since the first commercial service began in March 1981. At least 11 more will be implemented later this year and in 1983.

At the present, CNS service is provided only among customer facilities in the 48 contiguous states. To interconnect domestic customers with their facilities overseas, SBS applied to the Federal Communications Commission for international carrier status and has so far been authorized to serve the United Kingdom and Canada. SBS plans to use the transmission facilities of INTELSAT for overseas service extensions and will negotiate operating agreements with a number of foreign governments.

Earlier this year, SBS concluded an agreement with British Telecom International (BTI) for the joint provision of a wide range of transatlantic services, with particular emphasis on video teleconferencing, high-speed data, and facsimile. SBS also is currently negotiating required arrangements with the Canadian government and Canadian carriers.

The new interstate, long-distance telephone service for residences and small businesses is called Message Service II. It will be provided via a nationwide network of SBS earth stations and switching centers in 20 large cities. SBS operational satellites in orbit and terrestrial facilities also are essential elements of the network.

Message Service II usage charges will be as low as 10 cents a minute for calls into adjacent states and as low as 14 cents to any other interstate point in the contiguous 48 states, Washington, D.C., Puerto Rico, and the U.S. Virgin Islands during the late night weekend period.

Calls will pass through SBS earth stations and high capacity switches in 20 of the nation's largest cities. The calls are relayed via an SBS satellite to an earth station near the call's destination. They are then routed over telephone company terrestrial lines for the remainder of the call's trip.

SBS plans to begin service in late December in Washington followed by Minneapolis and Philadelphia in January 1983. The service will be available later in 1983 on a phased basis in these 17 other cities: Atlanta, Boston, Chicago, Cincinnati, Dallas, Denver, Detroit, Houston, Los Angeles, Miami, New Orleans, New York, Phoenix, Pittsburgh, St. Louis, San Francisco, and Seattle. Service originating through cities beyond the initial 20 will be implemented later.

For launch, the SBS spacecraft is compressed to a height of about 2.7 meters (9 feet) and positioned on a cradle in the orbiter cargo bay. With the PAM, the payload stack is 4.2 meters (14 feet) tall.

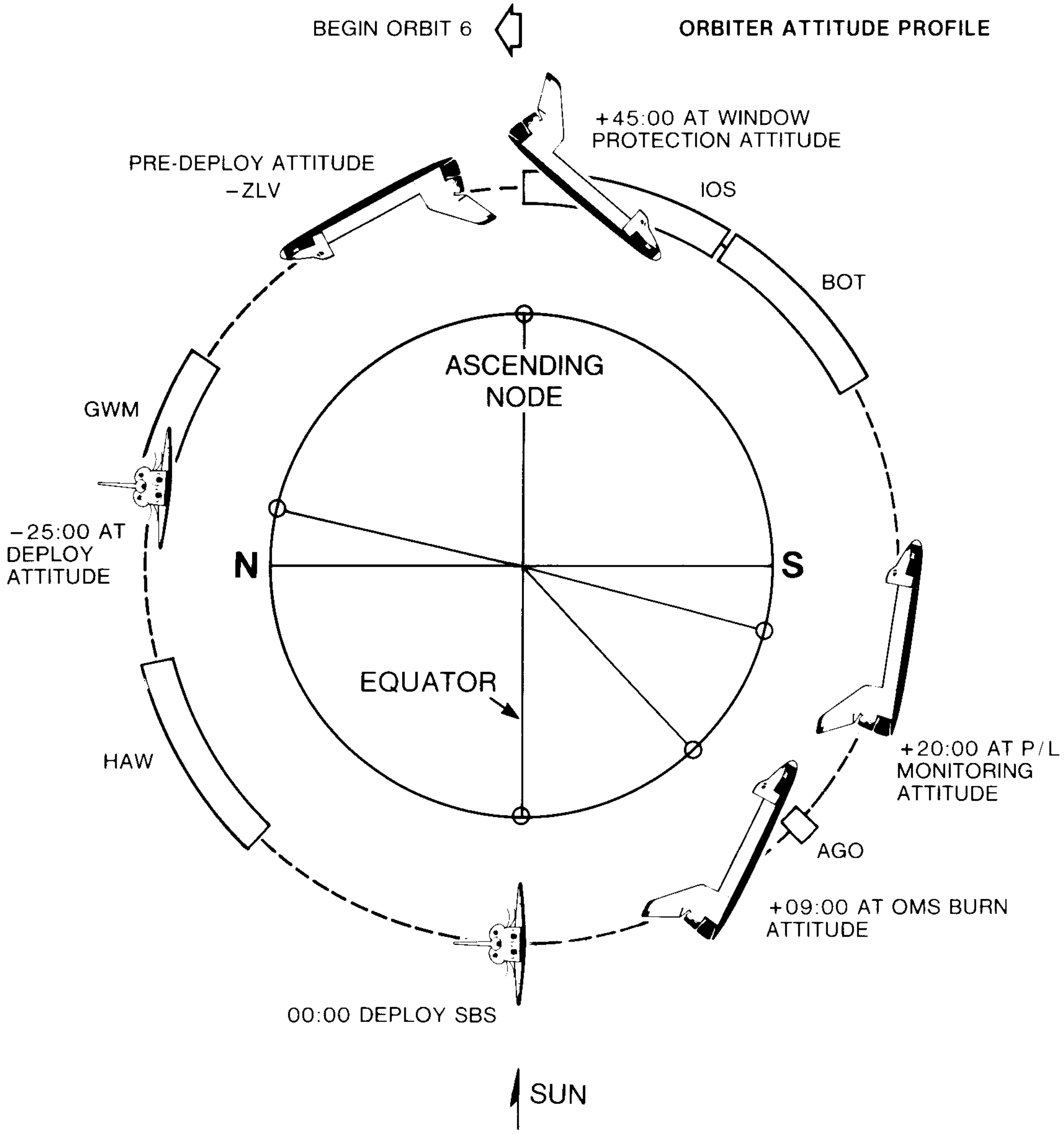
The SBS satellites are 2 meters (7 feet) in diameter and 6.4 meters (21 feet) tall when deployed in orbit. The exterior surface of each is covered by approximately 14,000 solar cells that generate 1,000 watts of dc power. An on-board power subsystem, including rechargeable nickel-cadmium batteries, powers the satellite's communications subsystem, including ten operational transponder channels. Redundant traveling-wave-

SBS-C DEPLOYMENT

ORBIT 6 EVENTS

−45:00	BEGIN ORBIT 6
−40:00	INITIATE MNVR TO DEPLOY ATTITUDE
−30:00	TO −26:00 GWM CONTACT
−29:00	SUNRISE
−25:00	AT DEPLOY ATTITUDE
−20:00	MECHANICAL SEQUENCE START
−19:00	TO −10:00 HAW CONTACT
−03:00	TERMINAL SEQUENCE START
00:00	DEPLOY SBS
00:00	TO +35:00 RECORD PAM DATA
+03:00	INITIATE MNVR TO OMS BURN ATTITUDE
+09:00	AT OMS BURN ATTITUDE
+11:00	TO 12:00 AGO CONTACT
+15:00	OMS SEP BURN
+18:00	INITIATE MNVR TO PAYLOAD MONITORING ATTITUDE
+25:00	SUNSET
+31:00	INITIATE MNVR TO WINDOW PROTECTION ATTITUDE
+31:00	TO +39:00 BOT CONTACT
+39:00	TO +48:00 IOS CONTACT
+45:00	PAM PERIGEE MOTOR FIRING INITIATE INERTIAL ATTITUDE HOLD

ORBITER ATTITUDE PROFILE



tube amplifiers (TWTA's) provide a transmit power of 20 watts for each channel.

The payload ejected from the bay weighs about 3,270 kilograms (7,211 pounds). This includes the payload assist module (PAM-D) which weighs 190 kilograms (421 pounds) with 1,963 kilograms (4,328 pounds) of solid propellant for thrusting the satellite from parking orbit to transfer orbit; an apogee motor with 493 kilograms (1,089 pounds) gross weight of solid propellant for injecting the satellite into synchronous orbit; and the satellite itself–622 kilograms (1,373 pounds) including about 148 kilograms (327 pounds) of hydrazine fuel for 8 to 9 years of stationkeeping operation.

Before ejection, the deployable payload is supported by its cradle and electronics system.

SBS-C/PAM-D EJECTION

To prepare for cargo ejection, the orbiter flight crew verifies the spacecraft through a series of checks and configures the payload for deployment. The orbiter is at approximately 160 nautical miles (184 statute miles) altitude for spacecraft deployment. The satellite is spun up (to 50 rpm) on the cradle's spin table, communications and other subsystems are checked by means of an electrical and communications harness to the flight crew cabin, and the payload ordnance items are armed. All the checks are performed remotely from the flight crew cabin, and payload data are transmitted from the orbiter to the Mission Control Center in Houston (MCC-H) for analysis.

During a final pre-ejection sequence lasting approximately 30 minutes, the orbiter is maneuvered into a deployment attitude with the open cargo bay facing the direction desired for firing the PAM motor.

Ejection will occur, nominally, about eight hours after liftoff when the orbiter is over the Atlantic Ocean on the sixth descending node (heading south toward the Equator on its sixth orbit). A Marman clamp is released by explosive bolts, and the spinning payload pops out of the cradle and cargo bay at 0.9 meters per second (3 feet per second).

At ejection from the orbiter cargo bay, the SBS-C spacecraft has completed only the first of several critical launch events. At this point it is in an orbit similar to the orbiter's with an altitude of about 160 nautical miles (185 statute miles), a velocity of about 27,835 kilometers (17,300 mph), an inclination to the equator of 28.5 degrees, and a period of 90 minutes.

To perform its intended communications service, the spacecraft must be raised to an altitude of about 33,800 kilometers (22,250 statute miles), with a velocity of about 10,941 kilometers per hour (6,800 mph), at a zero-degree inclination to the equator and a period of 24 hours.

The first in a series of major in-orbit events is the firing of the solid-propellant motor aboard the payload's PAM. At ejection, this motor is armed to automatically fire in 45 minutes. Spacecraft sensors and thrusters automatically maintain the payload's correct attitude (longitudinal axis inclined 9 degrees to the Equator) for firing. At the time of firing, the spacecraft is over the Indian Ocean.

The PAM motor firing raises the apogee (high point) of the orbit to about 36,202 kilometers (22,500 statute miles). Now the spacecraft is in a highly elliptical transfer orbit with a perigee of about 158 nautical miles (182 statute miles), an orbital period of 11 hours, and an inclination to the Equator of 23.8 degrees. The PAM motor casing is jettisoned after firing.

Nominally, on the third apogee of the transfer orbit, an on-board solid-fuel motor (or apogee motor) is fired to raise the perigee of the orbit. This puts the spacecraft into a near-circular orbit at near-geosynchronous altitude. The apogee motor will be fired on command of SBS engineers at the COMSAT Launch Control Center in Washington, D.C.

Next comes a series of spacecraft thruster firings by SBS engineers to refine the orbit and adjust spacecraft velocity so that a controlled drift will bring it to its 94 degrees West longitude destination in two to three weeks.

Three other critical maneuvers, in sequence, are the despin of the communications platform, the raising of the spacecraft's antenna reflector, and the lowering of its solar-panel skirt, all by means of on-board electric motors activated on command.

When the maneuvers are completed, SBS conducts a series of in-orbit tests and verifications of all spacecraft subsystems, lasting several weeks, before commercial service is begun.

NASA's responsibility for the launch mission is completed upon the satellite's ejection from the orbiter, except for tracking of the payload until the PAM is fired. During transfer orbit, responsibility is then assumed by SBS, which also contracts with Communications Satellite Corporation (COMSAT) for transfer orbit assistance and with the International Telecommunications Satellite Organization (INTELSAT) for global tracking services.

TELESAT (ANIK) – E

Telesat Canada is a federally regulated shareholder-owned commercial Canadian telecommunications common carrier engaged in the transmission and distribution of all forms of telecommunications in Canada by satellite.

Telesat is neither a Crown Corporation nor an agent of Her Majesty. Although the government of Canada is a major but not a majority shareholder, Telesat Canada does not have access to government grants or other funding. It is dependent for its financing on the revenues it generates through its operations and from banks and other commercial sources of debt financing.

It was the intention of the Government of Canada in establishing the company in 1969 that its services would be complementary to and not competitive with the telecommunications services offered by other Canadian carriers.

The company has the statutory mandate to establish satellite communications systems providing, on a commercial basis, telecommunications services between locations in Canada and subject to the appropriate intergovernmental arrangements, to and between other locations.

The Telesat-E, also called Anik-C (Eskimo for "brother") when on orbit, series satellites will be the most powerful domestic satellites in commercial service until the latter half of the decade.

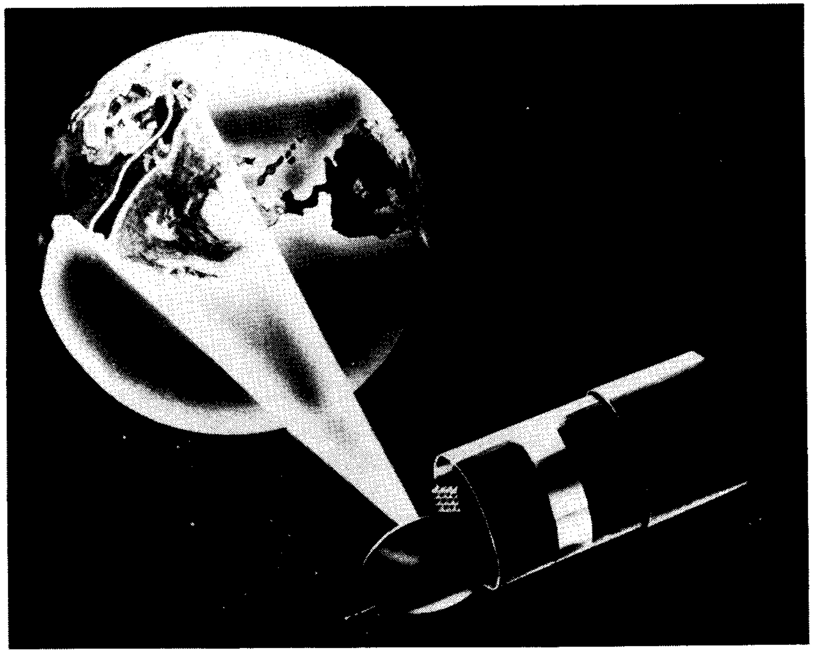
In addition to the satellites which make up the space segment of the system, several hundred earth stations, more than 100 of which are owned and operated by Telesat, compose the earth segment.

Telesat employs more than 400 people, most of whom work in the company's Ottawa, Ontario headquarters. The majority of the remaining employees staff the company's main heavy route earth station at Allan Park, north of Toronto.

The satellite will be worth close to $160 million (Canadian dollars) and will cost in the vicinity of $9 to $10 million (U.S. dollars) to launch on the Space Shuttle. The satellite weighs 1,140 kilograms (2,513 pounds) in the transfer orbit. Its solar cells are capable of producing 800 watts of electricity to power the satellite.

Telesat communication satellites are cylindrical in shape and will operate exclusively in the high frequency 14 and 12 gigahertz radio bands, with 16 radio frequency channels. Each of these 16 channels will be capable of carrying two full color television signals, together with their associated audio and cue and control circuits, for a total television signal capacity of 32 programs.

The combination of higher transmit power from 15-watt

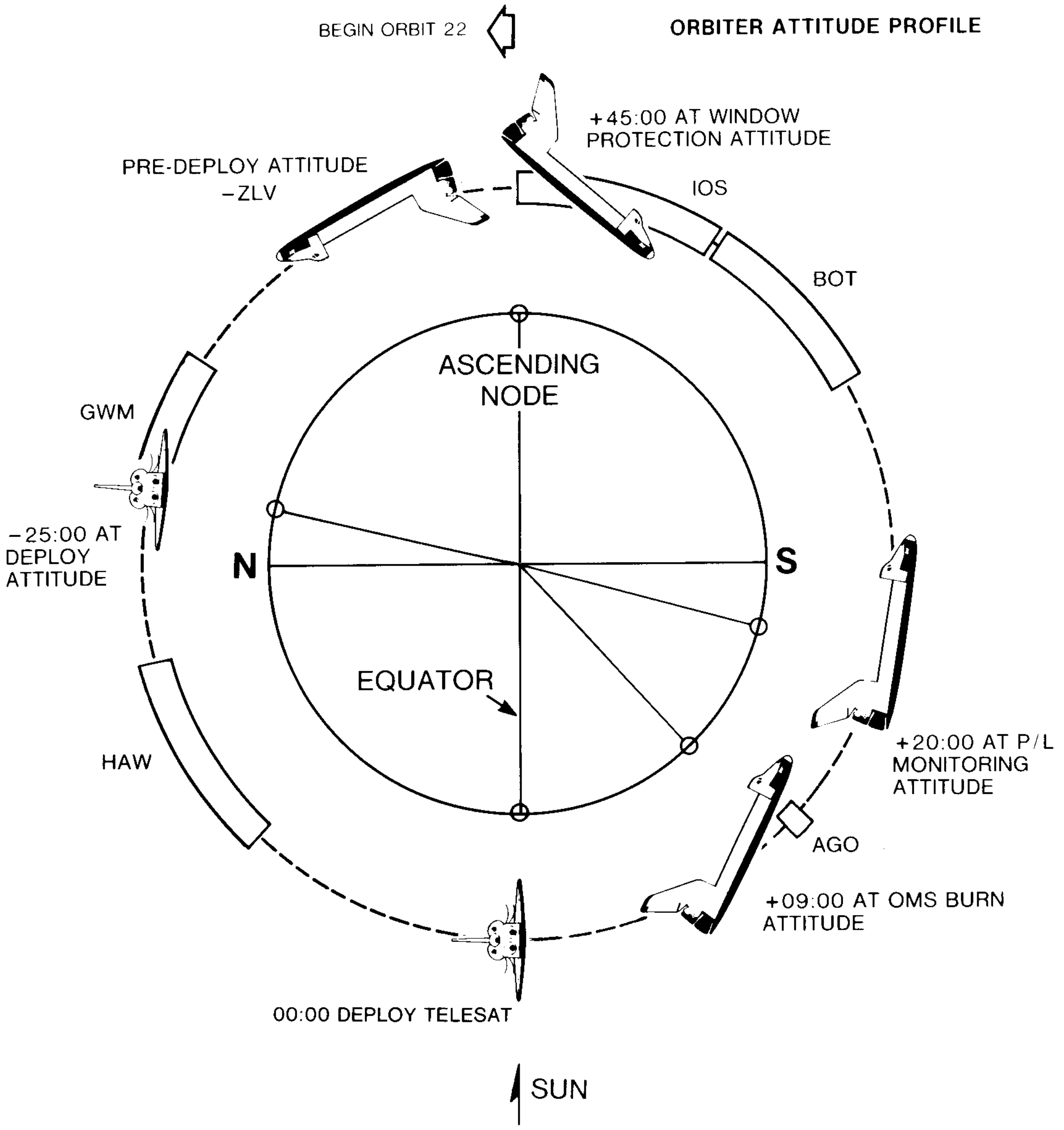


Telesat-E

TELESAT-E DEPLOYMENT

ORBIT 22 EVENTS

−45:00	BEGIN ORBIT 22
−40:00	INITIATE MNVR TO DEPLOY ATTITUDE
−29:00	SUNRISE
−28:00	TO 24:00 GWM CONTACT
−25:00	AT DEPLOY ATTITUDE
−20:00	MECHANICAL SEQUENCE START
−16:00	TO 08:00 HAW CONTACT
−03:00	TERMINAL SEQUENCE START
00:00	DEPLOY TELESAT
+03:00	INITIATE MNVR TO OMS BURN ATTITUDE
+12:00	TO 17:00 AGO CONTACT
+15:00	OMS SEP BURN
+18:00	INITIATE MNVR TO PAYLOAD MONITORING ATTITUDE
+25:00	SUNSET
+31:00	INITIATE MNVR TO WINDOW PROTECTION ATTITUDE
+33:00	TO 35:00 BOT CONTACT
+41:00	TO +50:00 IOS CONTACT
+45:00	PAM PERIGEE MOTOR FIRING INITIATE INERTIAL ATTITUDE HOLD



ORBITER ATTITUDE PROFILE

output tubes with use of the 14 and 12 gigahertz bands means that the satellite will be able to work with much smaller earth stations than those in use today.

Because of the smaller size, and the fact the higher frequencies in use won't interfere (or be interfered with by) existing terrestrial microwave communications that share the lower frequencies used by older satellites, the Telesat-E earth terminals can be located easily in relatively crowded spaces. They can be placed in city centers or mounted on rooftops of individual homes. Telesat-E will be able to deliver a high quality television picture to a private earth terminal equipped with a dish antenna as small as 1.2 meters (3.93 feet) in diameter, making it ideal for direct broadcast satellite services.

Telesat-E will provide rooftop to rooftop transmission of integrated voice, video and data communications for Canadian businesses, carry newly-licensed Canadian pay-television and other broadcasting services as well as point-to-point voice, video and data links, private business networks and a host of other specialized telecommunications services that will generally help to meet Canada's growing needs for efficient, flexible and reliable satellite communications of many kinds. Telesat satellites will be the backbone of Canada's satellite communications systems until the 1990's.

The antenna coverage of Telesat-E will include virtually all of populated Canada, with four contiguous spot beams serving the West, Western-Central, Eastern-Central, and Eastern regions of the country. Telesat's customers will be able to choose regional half- or whole-country coverage, depending on their needs.

The three identical Telesat-E satellites that will eventually be positioned at geosynchronous orbit are due to be stationed at 112.5, 116 and 109 degrees West longitude.

Designed to last 10 years, the satellites are expected to have minimum mission lives of around eight years.

The three Telesat-E satellites are built for Telesat Canada by Hughes Aircraft Company, Los Angeles, Calif., with considerable work performed by Spar Aerospace Limited and other Canadian companies.

For launch the Telesat-E spacecraft is compressed to a height of about 2.7 meters (9 feet) and positioned in its cradle in the orbiter cargo bay. With the PAM, the payload is 4.2 meters (14 feet) tall.

The prior to ejection sequences and ejection sequences of the Telesat-E/PAM-D are similar to those of the SBS-C/PAM-D. Telesat-E ejection occurs about 30 hours after liftoff on orbit 22.

The Telesat Satellite Control Center, Analysis Center and Computer Center are located at Telesat Headquarters in Ottawa.

Each Telesat–E satellite measures more than 6.4 meters (21 feet) tall with concentric solar skirts and antennas fully deployed.

The STS-5 extravehicular activity (EVA) scheduled for both mission specialists requires the use of the airlock in the spacecraft and two extravehicular mobility units (EMU's).

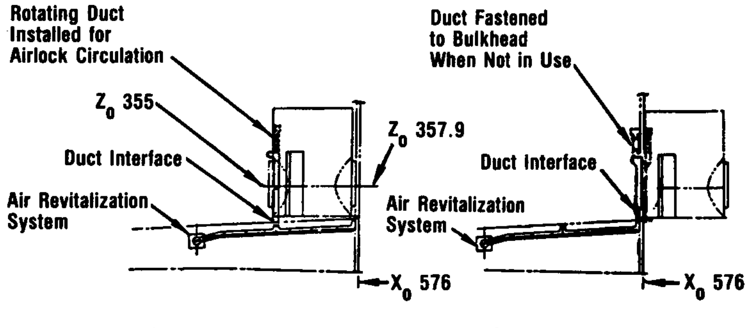
The airlock and airlock hatches permit the EVA flight crew members to transfer from the mid-deck crew compartment into the payload bay without depressurizing the orbiter crew cabin.

The EMU's are an integrated space suit assembly and life support system which provides the capability for the flight crew to leave the orbiter pressurized crew cabin and work outside the cabin in space.

The airlock in this flight is located inside the mid-deck of the spacecraft's pressurized crew cabin. It has an inside diameter of 1,600 millimeters (63 inches), is 2,108 millimeters (83 inches) long, and has two 1,016 millimeter (40 inch) diameter D-shaped openings, 914 millimeters (36 inches) across, plus two pressure sealing hatches and a complement of airlock support systems. The airlock volume is 4.24 cubic meters (150 cubic feet).

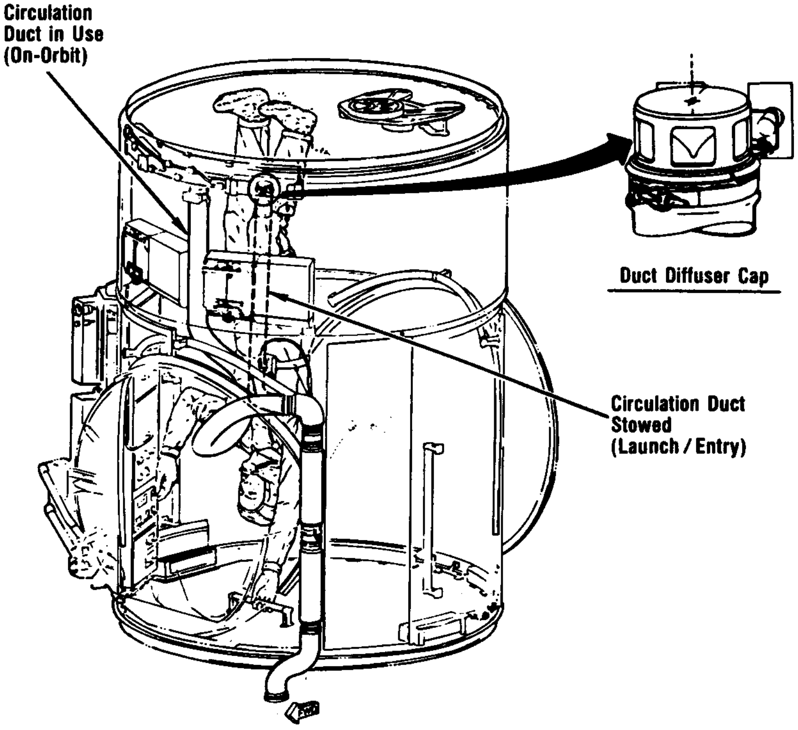
The airlock is sized to accommodate two fully suited flight crew members simultaneously. The airlock support provides airlock depressurization and repressurization, EVA equipment recharge, liquid cooled garment water cooling, EVA equipment checkout, donning and communications. All EVA gear, checkout panel, and recharge stations are located against the internal walls of the airlock.

The airlock hatches are mounted on the airlock. The inner hatch is mounted on the exterior of the airlock (orbiter crew cabin mid-deck side) and opens in the mid-deck. The inner hatch isolates the airlock from the orbiter crew cabin. The outer hatch is mounted in the interior of the airlock and opens in the airlock. The outer hatch isolates the airlock from the unpressurized payload bay when closed and permits the EVA crew members to exit from the airlock to the payload bay when open.



Airlock — in Cabin

Airlock — in Payload Bay



Airlock

Airlock repressurization is controllable from inside the orbiter crew cabin mid-deck and from inside the airlock. It is performed by equalizing the airlock and cabin pressure with airlock hatch-mounted equalization valves mounted on the inner hatch. Depressurization of the airlock is controlled from inside the airlock. The airlock is depressurized by venting the airlock pressure overboard. The two D-shaped airlock hatches are installed to open toward the primary pressure source, the orbiter crew cabin, to achieve pressure assist sealing when closed.

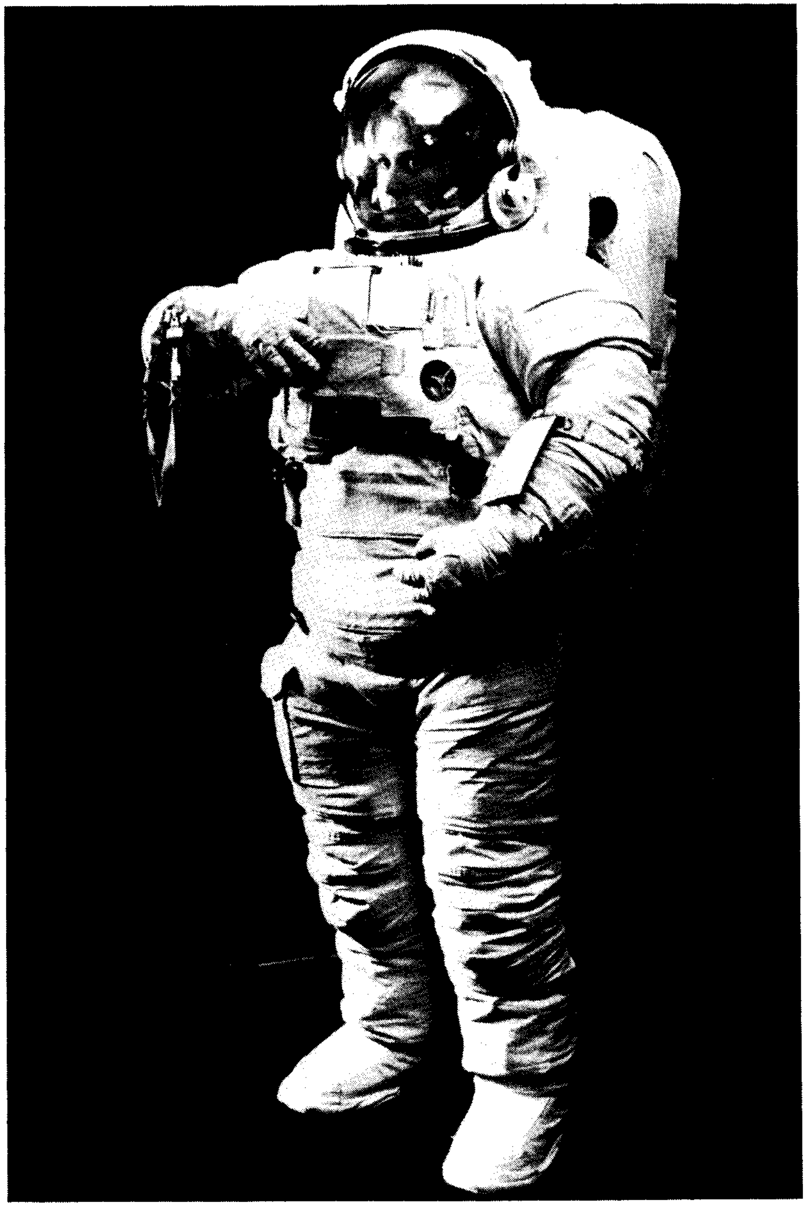
Each hatch has six interconnected latches with a gearbox/actuator, a window, a hinge mechanism and hold-open device, a differential pressure gage on each side, and two equalization valves.

The window in each airlock hatch is 101 millimeters (4 inches) in diameter. The window is used for crew observation from the cabin/airlock and the airlock/payload bay. The dual window panes are made of polycarbonate plastic and mounted directly to the hatch using bolts fastened through the panes. Each hatch window has dual pressure seals with seal grooves located in the hatch.

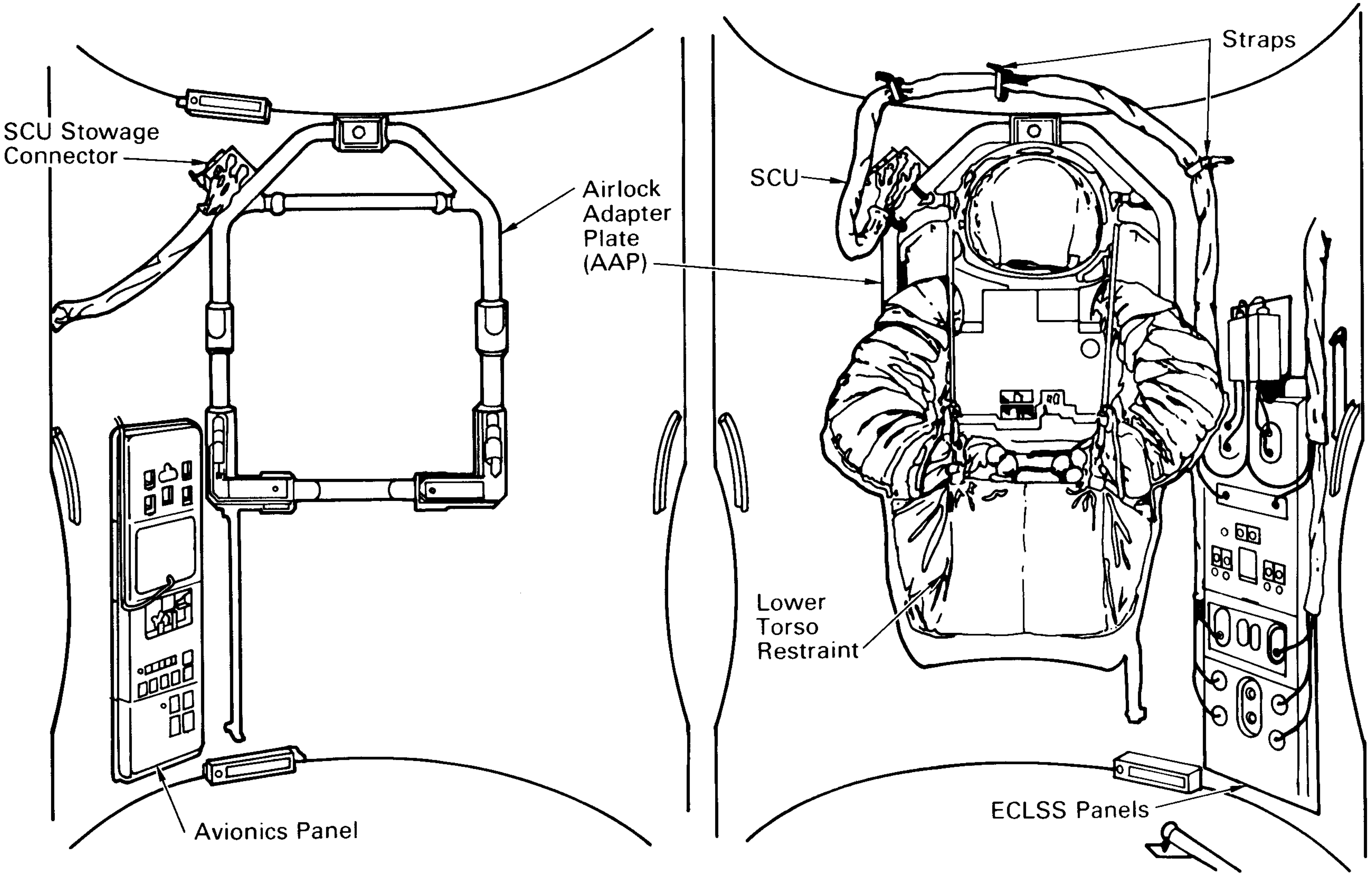
Each airlock hatch has dual pressure seals to maintain pressure integrity for the airlock. One seal is mounted on the airlock hatch and the other on the airlock structure. A leak check quick disconnect is installed between the hatch and the airlock pressure seals to verify hatch pressure integrity prior to the flight.

The gearbox with latch mechanisms on each hatch allows the flight crew to open and/or close the hatch during transfers and EVA operation. The gearbox and the latches are mounted on the low pressure side of each hatch, with a gearbox handle installed on both sides to permit operation from either side of the hatch.

Three of the six latches on each hatch are double acting. They have cam surfaces which force the sealing surfaces apart

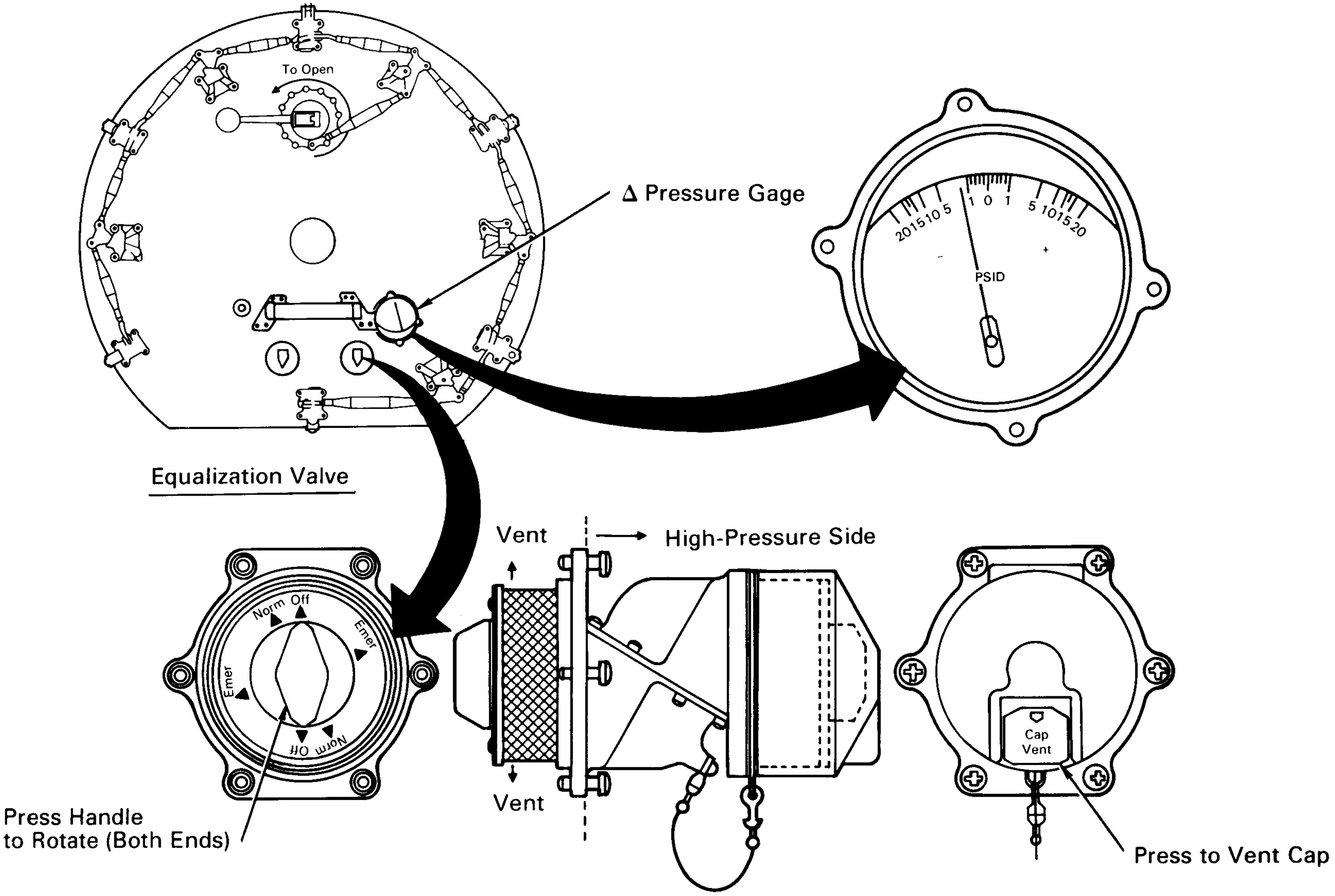


Extravehicular Mobility Unit (EMU)

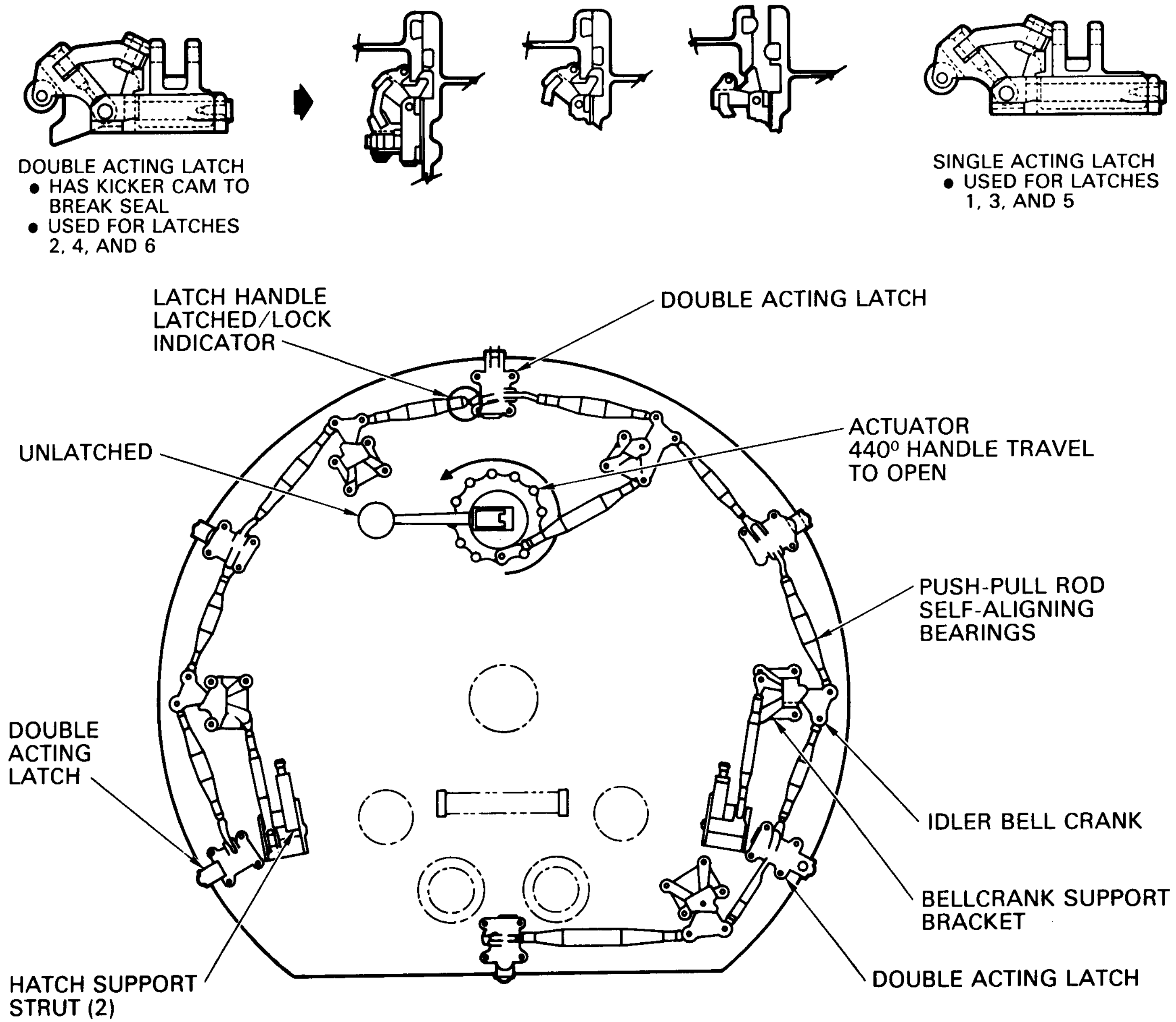


Extravehicular Mobility Unit (EMU)
Service and Cooling Umbilical (SCU)

Airlock Stowage Provisions



Airlock Repressurization



Airlock Hatch Latches

when the latches are opened, thereby acting as crew assist devices. The latches are interconnected with "push-pull" rods and an idler bellcrank installed between the rods for pivoting the rods. Self-aligning dual rotating bearings are used on the rods for attachment to the bellcranks and the latches. The gearbox and hatch open support struts are also connected to the latching system, using the same rod/bellcrank and bearing system. To latch or unlatch the hatch, a rotation of 440 degrees on the gearbox handle is required.

The hatch actuator/gearbox is used to provide the mechanical advantage to open/close the latches. The hatch actuator lock lever requires a force of 35 to 44 Newtons (8 to 10 pounds) through an angle of 180 degrees to unlatch the actuator. A rotation of 440 degrees minimum with a force of 133 Newtons (30 pounds) maximum applied to the actuator handle is required to operate the latches to their fully unlatched positions.

The hinge mechanism for each hatch permits a minimum opening sweep into the airlock or the crew cabin mid-deck. The inner hatch (airlock to crew cabin) is pulled/pushed forward to the crew cabin approximately 152 millimeters (6 inches). The hatch pivots up and to the starboard (right) side. Positive locks are provided to hold the hatch in both an intermediate and a full open position. To release the lock, a spring-loaded handle is provided on the latch hold-open bracket. Friction is also provided in the linkage to prevent the hatch from moving if released during any part of the swing.

The outer hatch (in airlock to payload bay) opens and closes to the contour of the airlock wall. The hatch is hinged to be first pulled into the airlock and then pulled forward at the bottom and rotated down until it rests with the low pressure (outer) side facing the airlock ceiling (mid-deck floor). The linkage mechanism guides the hatch from the closed/open, open/closed position with friction restraint throughout the stroke. The hatch has a hold-open hook which snaps into place over a flange when the hatch is fully open. The hook is released by depressing the spring-loaded hook handle and by pushing the hatch toward the closed position. To support and protect the hatch against the airlock sealing, the hatch incorporates two deployable struts. The struts are connected to the hatch linkage mechanism and are deployed when the hatch linkage is rotated open. When the hatch latches are rotated closed, the struts are retracted against the hatch.

The airlock hatches can be removed in-flight from the hinge mechanism via pip pins, if required.

Airlock air circulation system provides conditioned air to the airlock during non-EVA operation periods. The airlock revitalization system duct is attached to the outside airlock wall at launch. Upon airlock hatch opening in-flight, the duct is rotated by the flight crew through the cabin/airlock hatch and installed into the airlock and held in place by a strap holder. The duct has a removable air diffuser cap installed on the end of the flexible duct which can adjust the airflow from 0 to 97 kilograms per hour (216 pounds per hour). The duct must be rotated out of the airlock prior to closing the cabin/airlock hatch for airlock depressurization. During the EVA preparation period, the duct is rotated out of the airlock and can be used as supplemental air circulation in the mid-deck.

To assist the crew member in pre- and post-EVA operations, the airlock incorporates handrails and foot restraints. Handrails are located alongside the avionics and ECLSS panels. A handhold is mounted on each side of the hatches. They are aluminum alloy and oval configurations 19.05 by 33.52 millimeters (0.75 by 1.32 inches) and are painted yellow. The handrails are bonded to the airlock walls with an epoxyphenolic adhesive. Each handrail provides a handgrip clearance of 57 millimeters (2.25 inches) from the airlock wall to the handrail to allow gripping operations in a pressurized glove. Foot restraints are installed on the airlock floor nearer the payload bay side and the ceiling handhold installed nearer the cabin side of the airlock. The foot restraints can be rotated 360 degrees by releasing a spring-loaded latch and will lock in every 90 degrees. A rotation release knob on the foot restraint is designed for shirt sleeve operation, and therefore must be positioned before the suit is donned. The foot restraint is bolted to the floor and cannot be removed in flight and is sized for the EMU boot. The crew member ingresses by first inserting the foot under the toe bar and then the heel is pressed down by rotating the heel from inboard to outboard until the heel of the boot is captured.

There are four floodlights in the airlock The lights are controlled by switches in the airlock on panel AW18A; light 2 can also be controlled by a switch on mid-deck panel M013Q, allowing illumination of the airlock prior to entry. Lights 1, 3, and 4 are powered by buses MNA, B, and C respectively and light 2 is powered by ESS1BC. The circuit breakers are on panel ML86B.

In preparation for an EVA, the mission specialists will first don a liquid cooled and ventilation garment (LCVG). It is similar to "long-john" underwear into which have been woven many feet of flexible tubing that circulates cooling water. The liquid cooled and ventilation garment is worn under the pressure and gas garment to maintain desired body temperature.

A urine collection device (UCD) is worn for collection of urine in the suit. It stores approximately 0.9 liter (approximately one quart) of urine. It consists of adapter tubing, storage bag and disconnect hardware for emptying after an EVA into the orbiter waste water system.

The airlock provides stowage for two Extravehicular Mobility Units (EMU's) and two service and cooling umbilicals (SCU's) and various miscellaneous support equipment.

Both EMU's are mounted on the airlock walls by means of an airlock adapter plate (AAP).

The prime contractor to NASA for the space suit/life support system is United Technologies' Hamilton Standard Division in Windsor Locks, Conn. Hamilton Standard is program systems manager for the space suit/life support system in addition to designer and builder. Hamilton Standard's major subcontractor is ILC Dover of Frederica, Del., which fabricates the space suit.

The EMU's provide the necessities for life support, such as oxygen, carbon dioxide removal, a pressurized enclosure, temperature control and meteoroid protection during EVA.

The EMU space suit comes in various sizes so that prior to launch, flight crew members can pick their suits "off the rack." Components are designed to fit male and female from the 5th to the 95th percentiles of body size.

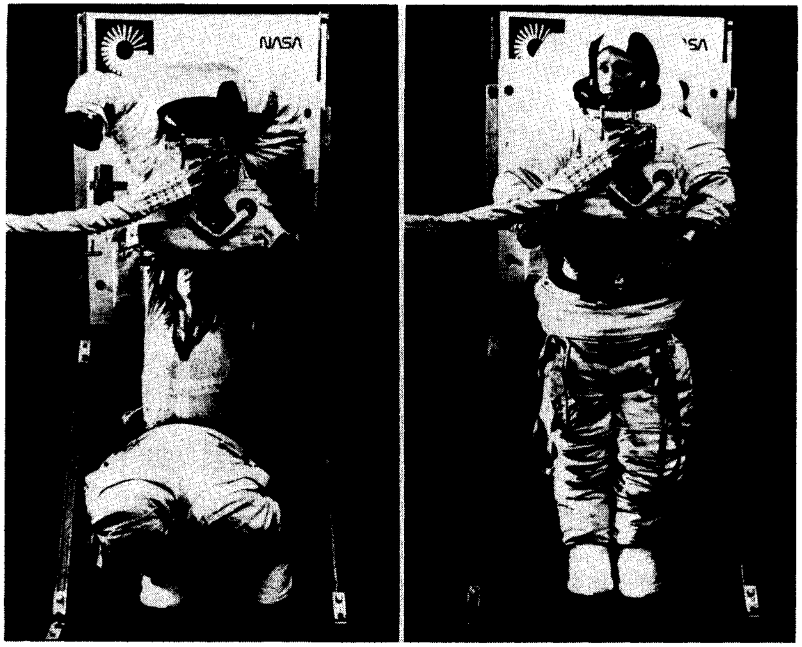
The life support system is self contained and contains seven hours of expendables such as oxygen, battery power for electrical power, water for cooling, and lithium hydroxide for carbon dioxide removal and a 30 minute emergency life support system during an EVA.

The airlock adapter plate in the airlock also provides a fixed position for the EMU's to assist the crew member during donning, doffing, checkout and servicing. Each EMU weighs approximately 102 kilograms (225 pounds) and the overall storage envelope is 660 by 711 by 1,016 millimeters (26 by 28 by 40 inches). For launch and entry, the lower torso restraint, a cloth bag attached to the airlock adapter plate (AAP) with straps, is used to hold the lower torso and arms securely in place.

To don the EMU, the crew member enters the airlock and dons the lower torso assembly which has boots attached. The lower torso consists of the pants, boots and the hip, knee and ankle joints. The hard, upper torso assembly includes the life support backpack and provides the structural mounting interface for most of the EMU including helmet, arms, lower torso, portable life support system, display and control module and electrical harness. The arm assembly contains the shoulder joint and upper arm bearings that permit shoulder mobility as well as the elbow joint and wrist bearing. The gloves contain the wrist disconnect, wrist joint and insulation padding for palms and fingers. The helmet consists of a clear polycarbonate bubble neck disconnect and ventilation pad. An EVA visor assembly is attached externally to the helmet which contains visors which are manually adjusted to shield the crew member's eyes. The upper and lower torsos are connected with a waist ring.

In addition, the portable life support system consists of an EMU electrical harness that provides bioinstrumentation and communications connections; a display and control module that is chest mounted which contains all external fluid and electrical interfaces and controls and displays; the portable life support subsystem referred to as the "backpack" which contains the life support subsystem expendables and machinery; a secondary oxygen pack mounted on the base of the portable life support subsystem which contains a 30 minute emergency oxygen supply and a valve and a regulator assembly, and an in-suit drink bag that stores liquid in the hard upper torso which has a tube projecting up into the helmet to permit the crew member to drink while suited.

The orbiter provides electrical power, oxygen, liquid cooled ventilation garment cooling and water to the EMU's in the airlock via the SCU for EVA prep and post-EVA operations.



Extravehicular Mobility Unit (EMU)

The service and cooling umbilical (SCU) is launched with the orbiter end fittings permanently connected to the appropriate ECLSS panels and the EMU connected to the airlock adapter plate stowage connector. The SCU contains communication lines, electrical power, water and oxygen, recharge lines and drain lines. It allows all supplies (oxygen, water, electrical, and communication) to be transported from the airlock control panels to the EMU before and after EVA without using the EMU expendable supplies of water, oxygen and battery power that are scheduled for use in the EVA. The SCU also provides EMU recharge. The SCU umbilical is disconnected just before the crew member leaves the airlock on an EVA and upon return to the airlock after an EVA. Each SCU is 3,657 millimeters (144 inches) long and 88 millimeters (3.5 inches) in diameter and weighs 9.1 kilograms (20 pounds). Actual usable length after attachment to the control panel is approximately 2 meters (7 feet).

The airlock has two display and control panels. The airlock control panels are basically split to provide either ECLSS or avionics operations. The ECLSS panel provides the interface for the SCU waste and potable water, liquid cooled ventilation garment cooling water, EMU hardline communication, EMU power and oxygen supply. The avionics panel includes the airlock lighting, the airlock audio system, and the EMU power and battery recharge controls. The avionics panel is located on the starboard (right) side of the cabin airlock hatch and the ECLSS panel on the port (left) side. The airlock panels are designated AW18H, AW18D, and AW18A on the port side and AW82H, AW82D, and AW82B on the starboard side. The ECLSS panel is divided into EMU1 functions on the starboard side and EMU2 functions on the port side.

Airlock communications are provided with the orbiter audio system at airlock panel AW82D where connectors for the headset interface units (HIU's) and the EMU's are located at airlock panel AW18D which is the airlock audio terminal (ATU). The HIU's are inserted in the crew-member communications carrier unit (CCU1 and CCU2) connectors on airlock panel AW82D. The CCU's are also known as the "Snoopy Cap" which fits over the crew member's head and snaps into place with a chin guard. It contains a microphone and headphones for two-way communications and receiving caution and warning tone. The adjacent two-position switches labeled CCU1 and CCU2 POWER enable transmit functions only, as reception is normal as soon as the HIU's are plugged in. The EMU1 and EMU2 connectors on the same panel to which the service and cooling umbilical (SCU) is connected include contacts for EMU hard-line communications with the orbiter prior to EVA. Panel AW18D contains displays and controls used to select access to and control volume of various audio signals. Control of the airlock audio functions can be transferred to the mid-deck ATU's panel M042F, by placing the CONTROL knob to MIDDECK position.

During EVA, the Extravehicular Communicator (EVC) is part of the same UHF system which is used for air-to-air and air-to-ground voice communications between the orbiter and landing site control tower and the orbiter and chase aircraft. The EVC provides full duplex (simultaneous transmission and reception) communications between the orbiter and the two EVA crew members and continuous data reception of electrocardiogram signals from each crew member by the orbiter and orbiter processing and relay of electrocardiogram signals to the ground. The UHF airlock antenna in the forward portion of the payload bay provides the UHF-EVA capability.

Panel AW18H in the airlock provides 17 plus or minus 0.5 vdc at five amperes at both EMU electrical connector panels, panel AW82D, in EVA prep. Bus MNA or B can be selected on the BUS SELECT switch and then the MODE switch is positioned to POWER. The BUS SELECT switch provides a signal to a remote power controller (RPC) which applies 28 vdc from the selected bus to the power/battery recharger. The MODE switch in the POWER position makes the power available at the SCU connector and also closes a circuit that provides a battery feedback voltage charger control which inhibits EMU power when any discontinuity is sensed in the SCU/EMU circuitry. The MODE switch in the POWER position also applies power through the SCU for the EMU microphone amplifiers for hard-line communication. When the SCU umbilical is disconnected for EVA, the EMU operates on its self contained battery power. For post-EVA, when the SCU is reconnected to the EMU, selecting a bus and the CHARGE position on the MODE switch charges the portable life support system battery at 1.55 plus or minus 0.05 amps. When the battery reaches 21.8 plus or minus 0.1 vdc and/or the charging circuit exceeds 1.55 plus or minus 0.05 amps, a solenoid controlled switch internal to the battery charger removes power to the charging circuitry. The EMU silver zinc battery provides all electrical power used by the portable life support system during EVA and is filled with electrolyte and charged prior to flight.

Cooling for the flight crew members before and after the EVA is provided by the liquid cooled garment circulation system via the SCU and LCG (liquid cooled garment) SUPPLY AND RETURN connections on panel AW82B. These connections are routed to the orbiter liquid cooled garment heat exchanger which transfers the collected heat to the orbiter Freon-21 coolant loops. The nominal loop flow of 113 kilograms per hour (250 pounds per hour) is provided by the EMU/portable life support system water loop pump. The system circulates chilled water at 10 degrees Celsius (50°F) maximum to the liquid cooled ventilation garment inlet and provides a heat removal capability of 2,000 Btu (British Thermal Units) per hour per crew member. When the SCU is disconnected the portable life support system provides the cooling. Upon return from the EVA, the portable life support system is reconnected to the SCU and the crew member cooling is provided as it was in the EVA prep.

With the suit connected to the SCU, oxygen at 46,575 mmhg (900 psia) plus or minus 2,587 mmhg (500 psia) is supplied through airlock panel AW82B from the orbiter oxygen system when the OXYGEN valve is in the OPEN position on the airlock panel. This provides the suited crew member with breathing oxygen, preventing depletion of the portable life support system oxygen tanks prior to the EVA. Prior to the crew member sealing the helmet, an oxygen purge adapter hose is connected to the airlock panel to flush nitrogen out of the suit.

The crew member will prebreathe pure oxygen in the EMU for approximately 3 and one-half hours prior to the EVA. This is necessary to remove nitrogen from their blood before working in the pure oxygen environment of the EMU due to the orbiter pressurized crew cabin mixed gas atmosphere of 20 percent oxygen and 80 percent nitrogen at a pressure of 750 plus or minus 10 mmhg (14.5 plus or minus 0.2 psia). Without prebreathing, bends occur when an individual fails to reduce nitrogen levels in the blood prior to working in a pressure condition that can result in nitrogen coming out of solution in the form of bubbles in the bloodstream. This condition results in pain in the body joints, possibly because of restricted blood flow to connective tissues or the extra pressure caused by bubbles in the blood at joint area. During prebreathe, the suit is at 2.5 mmhg (1/2 psia).

When the SCU is disconnected, the portable life support system provides oxygen for the suit. When the EVA is completed and the SCU is reconnected, the orbiter oxygen supply begins recharging the portable life support system, providing the OXYGEN valve on panel AW82B is OPEN. Full oxygen recharge takes approximately one hour (allowing for thermal expansion during recharge) and the tank pressure is monitored on the EMU display and control panel as well as on the airlock oxygen pressure readout.

Each EMU is pressurized to 207 mmhg (4.0 psid) differential. They are designed for a 15 year life with cleaning and drying between flights.

The EMU WATER SUPPLY and WASTE valves are opened during the EVA prep by switches on panel AW82D. This provides the EMU, via the SCU, access to both the orbiter potable water and waste water systems. The support provided to the EMU portable life support system is further controlled by the EMU display and control panel. Potable water–supplied from the orbiter at 828 plus or minus 25 mmhg (16 plus or minus 0.5 psi), 45 to 58 kilograms per hour (100 to 300 pounds per hour), and 4 to 37 degrees C (40 to 100°F)–allowed to flow to the feedwater reservoir in the EMU which provides pressure which would "top-off" any tank not completely filled. Waste water, condensate, developed in the portable life support system is allowed to flow to the orbiter waste water system via the SCU whenever the regulator connected at the bacteria filters (airlock end of the SCU) detects upstream pressure in excess of 828 plus or minus 25 mmhg (16 plus or minus 0.5 psi).

When the SCU is disconnected from the EMU, the portable life support system assumes this function. When the SCU is reconnected to the EMU upon completion of the EVA, the same functions as in pre-EVA are performed except that the water supply is allowed to continue until the portable life support system water tanks are filled, which takes approximately 30 minutes.

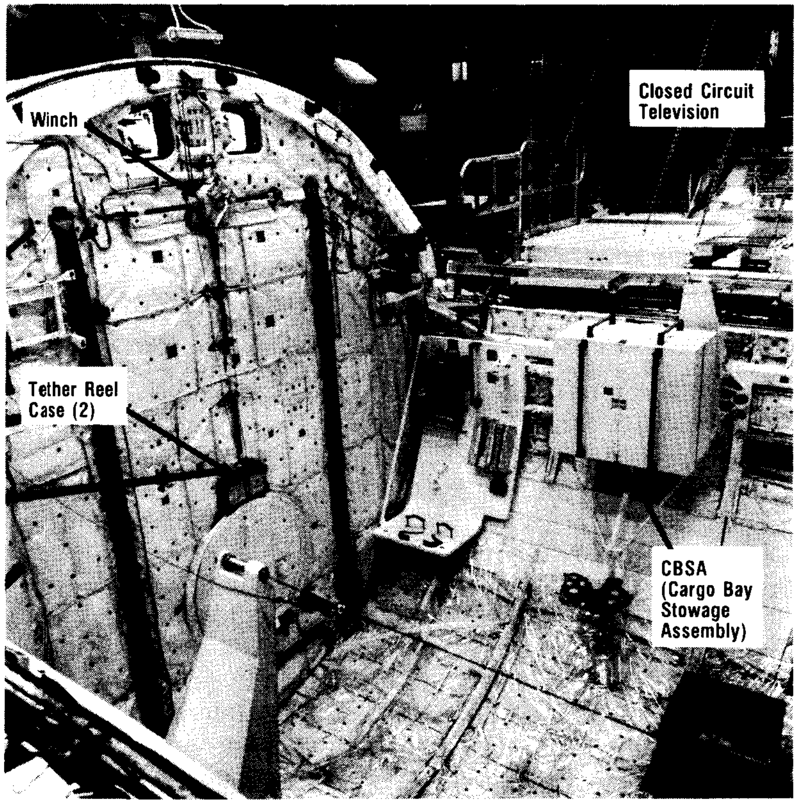
In preparation for the EVA from the airlock, the airlock hatch to the orbiter crew cabin is closed and depressurization of the airlock begins.

Airlock depressurization is accomplished by a three position valve located on the ECLSS (Environmental Control Life Support System) panel AW82A in the airlock. The airlock depressurization valve is covered with a pressure/dust cap. Prior to removing the cap from the valve, it is necessary to vent the area between the cap and valve by pushing the vent valve on the cap. In-flight storage of the pressure/dust cap is adjacent to the valve. The airlock depressurization valve is connected to a 50 millimeter (2 inch) inside diameter stainless steel overboard vacuum line. The AIRLOCK DEPRESS valve controls the rate of depressurization by varying the valve diameter size. Depressurization is accomplished in two stages. The CLOSED position prevents any airflow from escaping to the overboard vent system.

When the crew members have completed the prebreathe in the EMU's for 3.5 hours, the airlock is depressurized from 750 mmhg (14.5 psia) to 258 mmhg (5 psia) by position labeled "5" on the AIRLOCK DEPRESS valve which opens the depressurization valve and allows the pressure in the airlock to decrease. Pressure during depressurization can be monitored by the delta pressure gage on either airlock hatch. A delta pressure gage is installed on each side of both airlock hatches. The depressurization from 750 mmhg (14.5 psia) to 258 mmhg (5 psia) takes approximately 200 seconds.

At this time the flight crew performs an EMU suit leak check, electrical power is transferred from the umbilicals to the EMU batteries, the umbilicals are disconnected and the suit oxygen packs are brought on line.

The second stage of airlock depressurization is accomplished by positioning the AIRLOCK DEPRESS valve to "0" which increases the valve diameter and allows the pressure in the airlock to decrease from 258 mmhg (5 psia) to 0 mmhg (0 psia) in approximately 13 seconds. The suit sublimators are activated for cooling, EMU system checks are performed and the airlock/payload bay hatch can be opened. The hatch is capable of opening against a 10 mmhg (0.2 psia) differential maximum.



Orbiter Forward Payload Bay

Hardware provisions are installed in the orbiter payload bay for use by the crew member during the EVA.

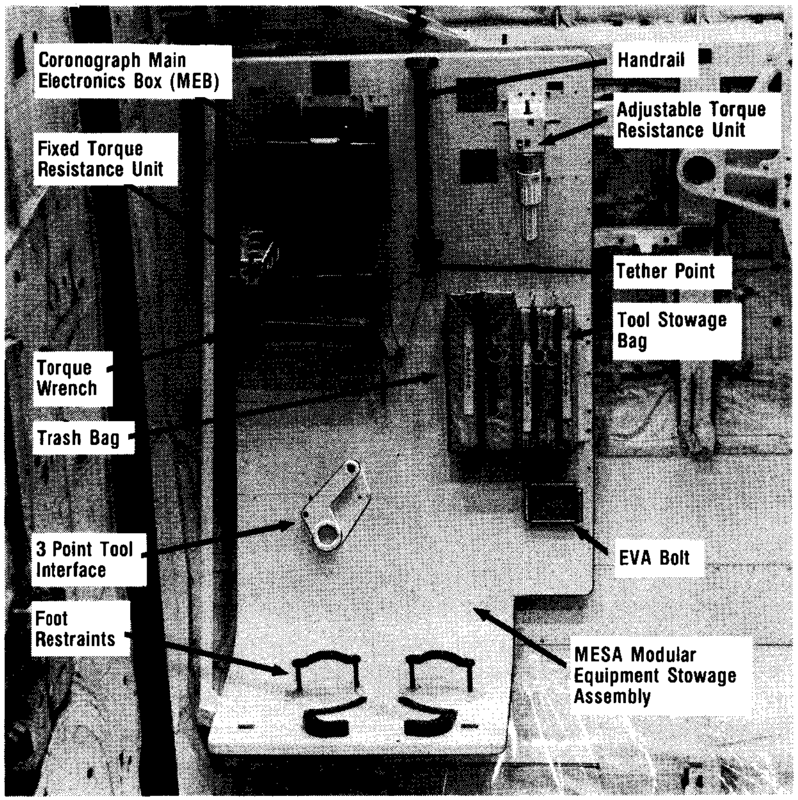
Handrails and tether points are located on the payload bulkheads, forward bulkhead station X_O 576 and aft bulkhead station X_O 1307, and along the sill longeron on both sides of the bay to provide translation and stabilization capability for the EVA crew member. The handrails are designed to withstand a load of 90.72 kilograms (200 pounds), 127.01 kilograms (280 pounds) maximum in any direction. Tether attach points are designed to sustain a load of 260.37 kilograms (574 pounds), 364.69 kilograms (804 pounds) maximum, in any direction.

The handrails have a cross section of 33 by 19 millimeters (1.32 by 0.75 inches). They are made of aluminum alloy tubing and are painted yellow. The end braces and side struts of the handrails are constructed of titanium. An aluminum alloy end support standoff functions as the terminal of the handrail. Each end support standoff incorporates a 25.4 millimeter (one inch) diameter tether point.

A 7.62 meter (25 foot) crew member safety tether is attached to each crew member at all times during an EVA.

The tether consists of a reel case with an integral "D" ring, a reel with a light takeup spring, a cable and a locking hook. The safety tether hook is locked onto the slidewire before launch and the cable is routed and clipped along the port (left) and starboard (right) handrails to a position just above the airlock/payload bay hatch. After opening the airlock hatch and before egress, the crew member attaches a waist tether to the "D" ring of the safety tether to be used. The other end of the waist tether is hooked to a ring on the EMU waist bearing. The crew member may select either the port or the starboard safety tether. With the selector on the tether in the locked position, the cable will not retract or reel out. Moving the selector to the unlocked position allows the cable to reel out and the retract feature to take up slack. The cable is designed for a maximum load of 398 kilograms (878 pounds). The routing of the tethers follows the handrails, allowing the crew member to deploy and restow his tether during translation.

The two slidewires, approximately 14.11 meters (46.3 feet) long, are located in the longeron sill area on each side of the payload bay. They start approximately 2.83 meters (9.3 feet) aft of the forward bulkhead and extend approximately 14.11 meters (46.3 feet) down the payload bay. The slidewires withstand a tether load of 260.37 kilograms (574 pounds) with a safety factor of 1.4 or 364.49 kilograms (804 pounds) maximum.



MESA (Modular Equipment Stowage Assembly)

In this flight the EVA demonstration is to verify the operational adequacy of the end-to-end EVA system, including the EMU, airlock, payload bay provisions, procedures, timelines, and training.

The work station consists of the STS-1 Modular Equipment Stowage Assembly (MESA) as the base with several devices mounted on it for EVA evaluation. These devices include a representation of the Solar Maximum Mission (SMM) coronograph main electronics box (MEB) (Solar Maximum Mission satellite was launched Feb. 2, 1980), an adjustable torque measuring device, a bolt cluster for static torque measurements, an interface for a bulkhead latch tool, an EVA bolt, and stowage bags for tools utilized at the work station. The work station provides an integral foot restraint and handhold for crew member restraint and is located adjacent to the Cargo Bay Stowage Assembly (CBSA) on the starboard forward section of the payload bay.

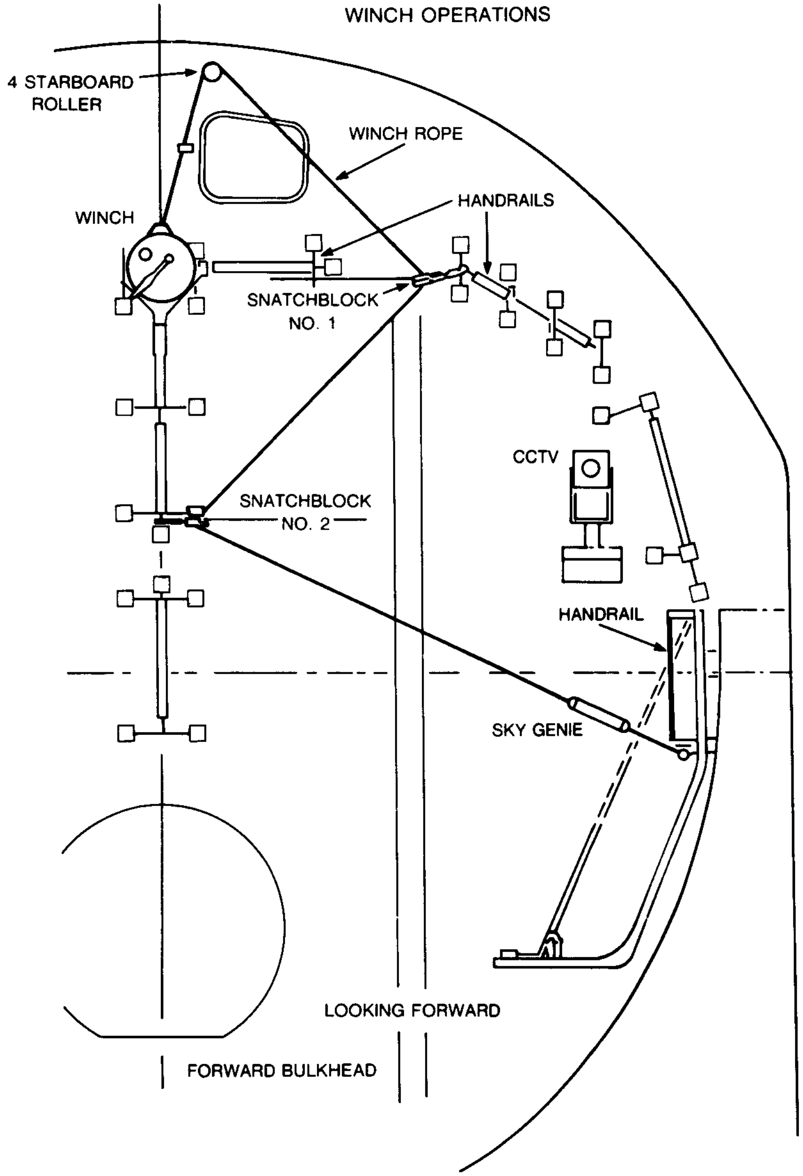
The EVA crew members will be designated as EV1 and EV2. The first task is for EV1 to translate to the tool box to don a restraint device known as a mini-work station. Both crew members will translate to the aft bulkhead in series so that one can monitor the other during translation. EV1 will translate down the starboard side and EV2 will translate down the port side. They will evaluate translation rates, safety tethers, handholds and miscellaneous restraints/tethers, EMU communications and TV performance from various locations in the payload bay; payload bay and EMU lighting provisions; and work sites for possible contingency EVA.

After translating back to the forward bulkhead, EV1 and EV2 will perform torque measurements at the work station. The work station has two torque measurement devices which are located on the outer perimeter of the reach envelope and both provide bolt clusters for the application of torque from different locations. One of the devices provides only fixed bolts, but the other provides bolts with adjustable torque. The adjustable torsional resistance is provided by multiple sets of moving and stationary clutches. By manually adjusting a control on the bottom of the device, spring force on the clutches can be varied, and, therefore, the desired level of resistance. Both devices will provide static torque measurements and one will provide dynamic or moving torque measurements. The tool for measuring the static torque is a beam wrench which will measure 0 to 600 inch pounds. The data from this activity will be recorded by the pilot. This task will determine design requirements for EVA equipment and compare crew member one "g" and water emergence tank facility data with on-orbit force capability to determine a "correction factor" for ground simulations.

The most complex of four repair tasks being considered for the SMM repair mission is the replacement of the coronograph MEB. The work station contains a mockup of the MEB for demonstrating the feasibility of the task. The task includes removing a thermal blanket, removing mounting fasteners, demating connectors, cutting a ground strap and remating the connectors. Special tools are flown for this task, including a tool proposed for the Space Telescope EVA operations. This activity will demonstrate the ability of an EVA crew member to perform manipulative tasks with small fasteners and connectors on payloads which are not designed specifically for EVA.

The winches on the forward and aft bulkheads in the payload bay are aboard for closing the payload bay doors in contingency situations. The winch can also be utilized to manually restow the IUS (Interim Upper Stage)/spacecraft and ASE (Airborne Support Equipment) aft frame should the primary and secondary tilt actuators fail. In this operation, the aft bulkhead winch rope is routed through a pulley on the bulkhead to attain the proper rope orientation and then to the ASE tube assembly. This is simulated on STS-5 by using the forward bulkhead winch. The winch rope will be routed through pulleys on the forward payload bay bulkhead handrails and then to the work station where it will be attached to a

WINCH OPERATIONS



variable friction device (sky-genie) attached to the work station handrail. The sky-genie friction is adjusted by varying the number of turns of rope around a center spindle and will be set at prelaunch to less than 45 kilograms (100 pounds). This activity will demonstrate the capability of the EVA crew members to manage rope in 0 "g" and their ability to apply a load at the winch without foot restraints.

Time permitting, one EVA crew member will translate across the forward payload bay bulkhead and down the payload bay door hingeline with a bag of payload bay door latch tools which weigh approximately 27 kilograms (60 pounds). The techniques required to translate with the tools will be evaluated.

The EVA on STS-5 will allow for TV and photography coverage. The EV2 crew member will have a television camera. There will be a shopping list of activities which could be accomplished, time permitting, such as evaluate miscellaneous items in the tool box (e.g., tape, Velcro, and thermal gloves), install the payload retention device between a bulkhead handrail and the work station; remove an EVA bolt at the work station (the bolt is representative of bolts in the payload bay door drive linkage); and install a bulkhead latch tool at the work station.

The EVA will be terminated by stowing the equipment in the payload bay. Upon completion of the EVA, the flight crew will enter the airlock and close the airlock/payload bay hatch.

The airlock/cabin hatch has two pressure equalization valves which can be operated from both sides of the hatch for repressurizing the airlock volume. Each valve has three positions, CLOSED, NORM (Normal), and EMERG (Emergency) and is protected by a debris pressure cap on the intake (high-pressure) side of the valve, which on the outer hatch must be vented for removal. The caps are tethered to the valves and also have small Velcro spots which allow temporary stowage on the hatch. The exit side of the valve contains an air diffuser to provide uniform flow out of the valve.

Through the use of the equalization valve/valves in the various positions, the airlock can be repressurized in a normal mode to 745 mmhg (14.4 psia) in 325 seconds, then equalized to the crew cabin pressure of 750 mmhg (14.5 psia) in 110 seconds. If both equalization valves are positioned to EMERG, the airlock can be repressurized to 754 mmhg (14.4 psia) in 28 seconds, then equalized to the crew cabin pressure of 750 mmhg (14.5 psia) in 200 seconds. The hatch is capable of opening against a 10 mmhg (0.2 psia) differential maximum.

The airlock is initially pressurized to 258 mmhg (5 psia) and the umbilicals are connected and electrical power is transferred back to umbilical power. The airlock is then pressurized to equalize with the cabin pressure, followed by EMU doffing and the crew members' recharge of the EMU's.

The orbiter provides accommodations for three two-flight-crew member EVA's of six-hour duration per flight at no weight or volume cost to the payload. Two of the EVA's are for payload support and the third is reserved for orbiter contingency. Additional EVA's can be considered with consumables charged to payloads.

CARGO BAY STOWAGE ASSEMBLY (CBSA)

The Cargo Bay Stowage Assembly contains miscellaneous tools for use in the payload bay. It is located on the starboard (right) side of the payload bay forward, between Orbiter Station $X_O = 589$ and $X_O = 636$.

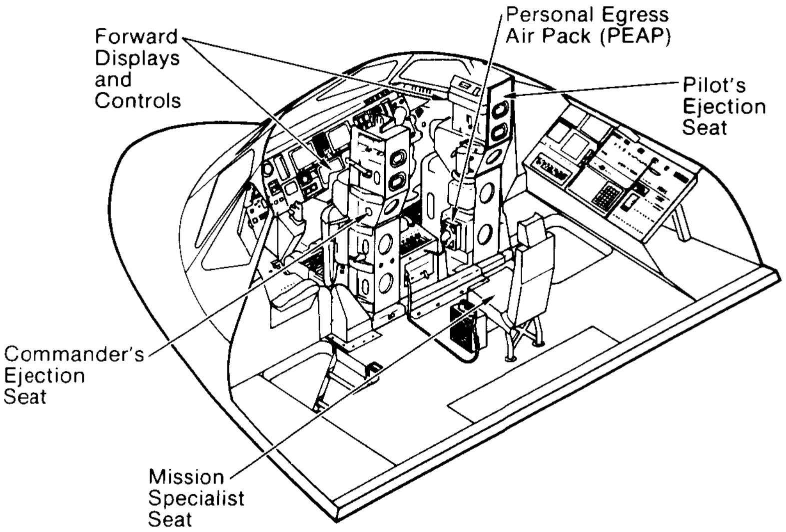
The CBSA is approximately 1,066 millimeters (42 inches) wide, 609 millimeters (24 inches) in depth and 914 millimeters (36 inches) in height. The CBSA weight is approximately 259 kilograms (573 pounds).

PERSONAL EGRESS AIR PACKS

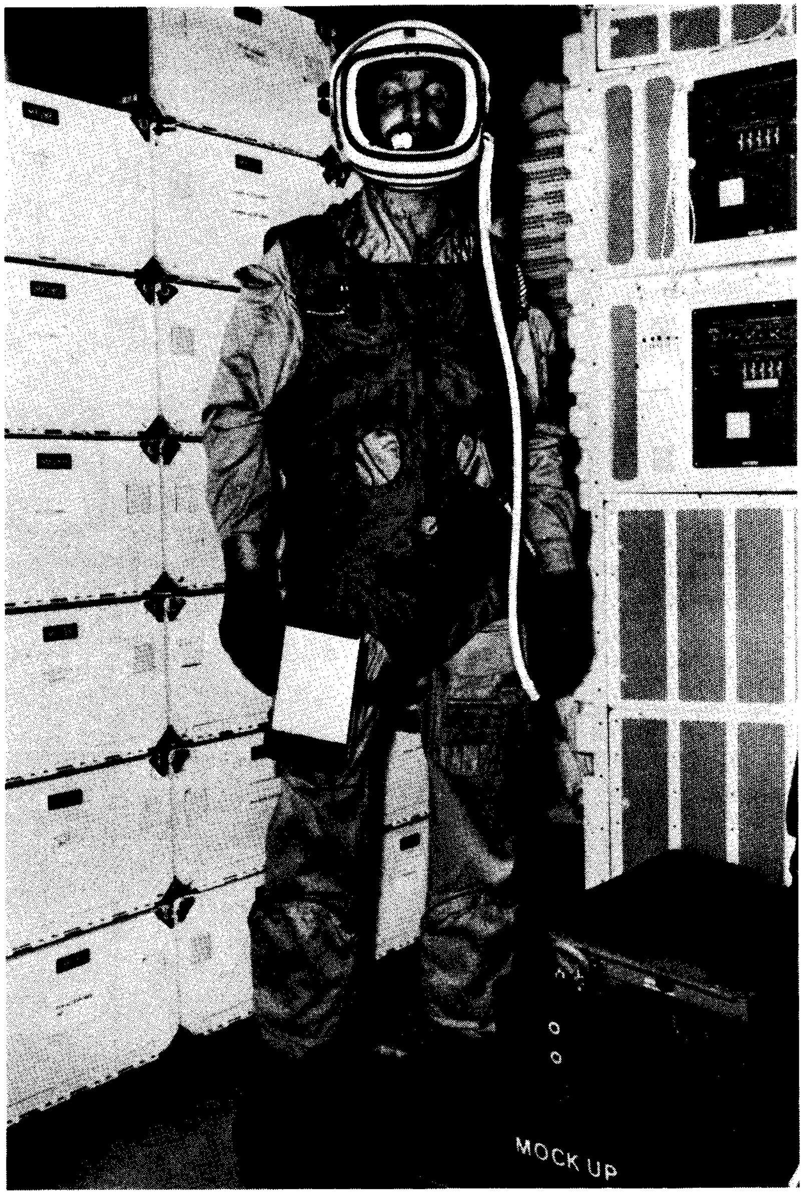
The portable oxygen system used in the *Columbia* in the STS-1 through STS-4 flights is being replaced for the STS-5 flight with Personal Egress Air Packs (PEAP's). The reason for this change is that the flight crew will wear a coverall type flight suit and not emergency ejection suits.

The PEAP's are designed to be used with the Launch Entry Helmet (LEH) that will be worn by each flight crew member beginning with the STS-5 flight. The LEH's are used during launch and entry and may be used for EVA prebreathing to denitrogenize the flight crew member's circulatory system.

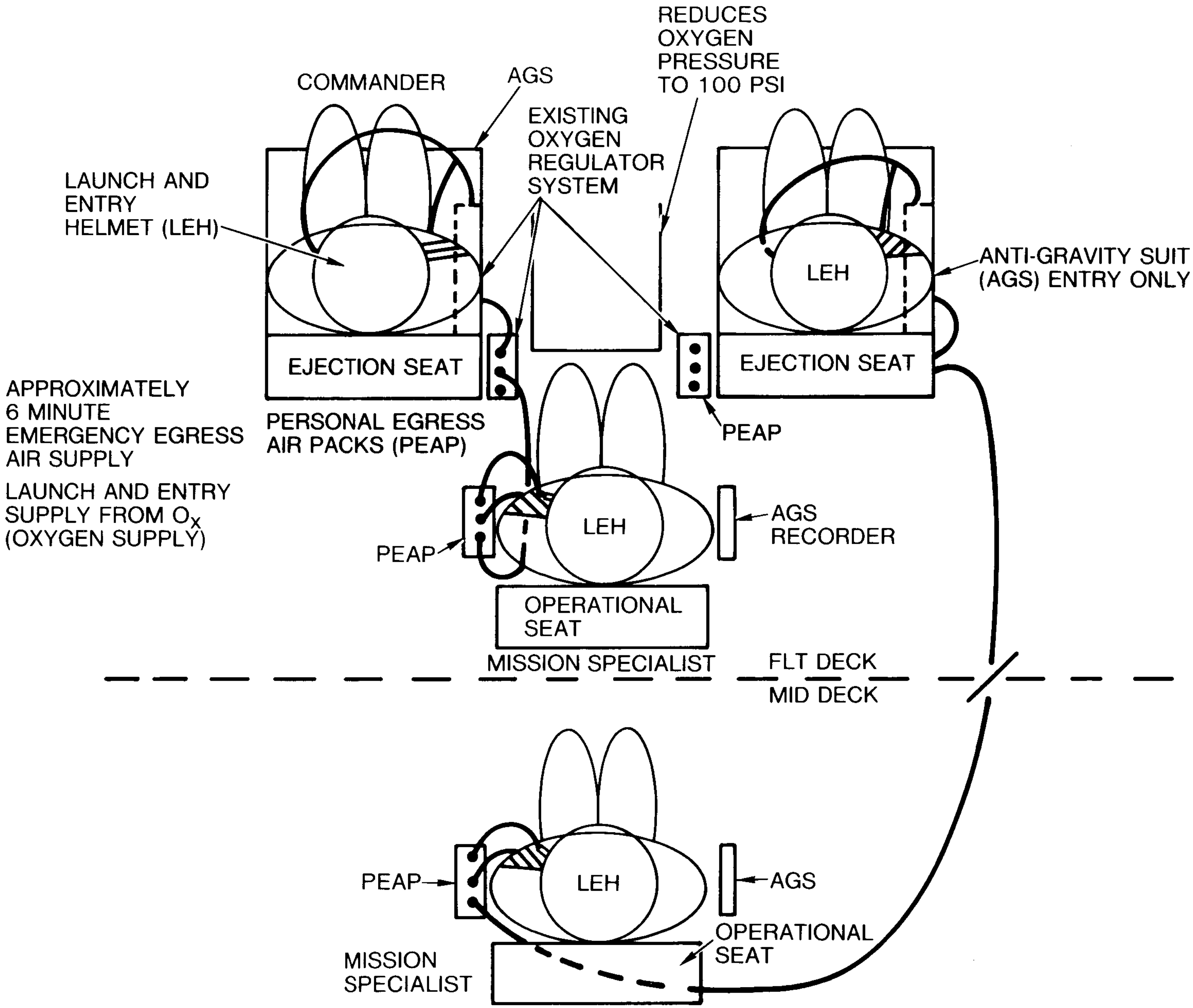
The PEAP located at each flight crew member's seat is supplied with oxygen from the atmospheric revitalization system (ARS). In STS-5, a regulator is installed to reduce the oxygen pressure to 5,175 millimeters of mercury (mmhg) (100 psi) for each PEAP. Oxygen is supplied from the regulator to each PEAP through quick disconnect flexible hoses. Each PEAP will supply that crew member with an approximate six



Orbiter 102 – STS-5 Crew Compartment Flight Deck

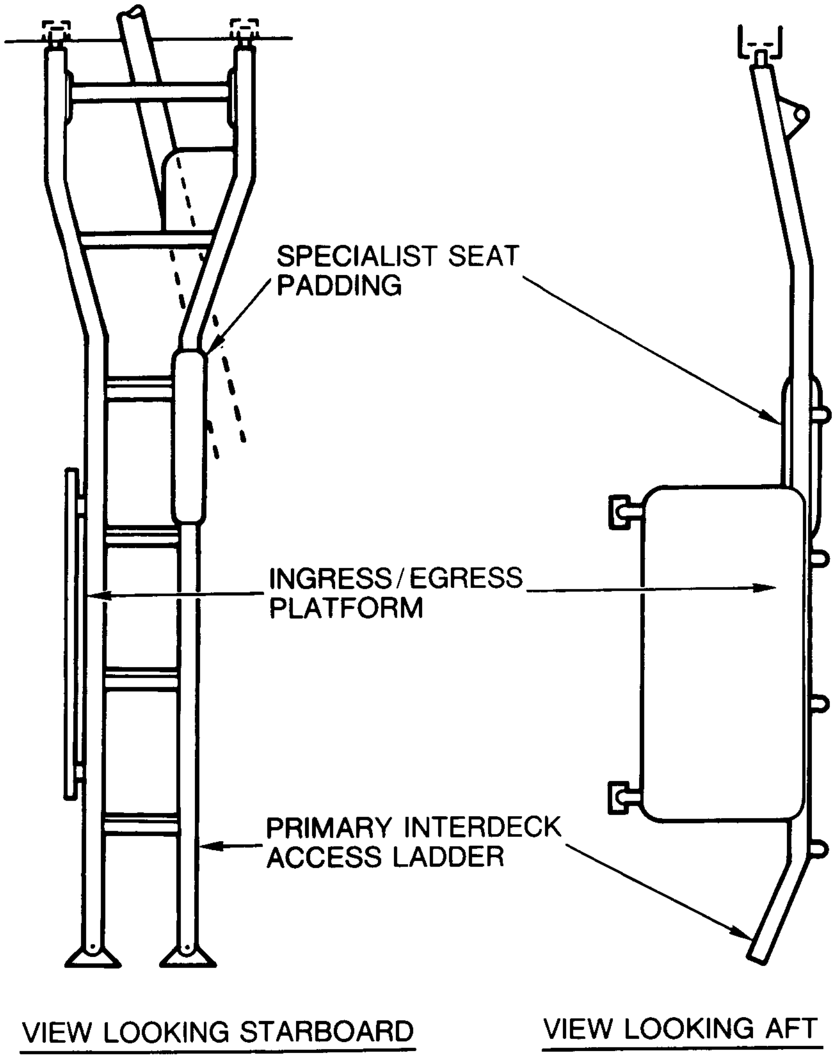


Personal Egress Air Pack, Launch Entry Helmet, Anti-"G" Suit for Entry



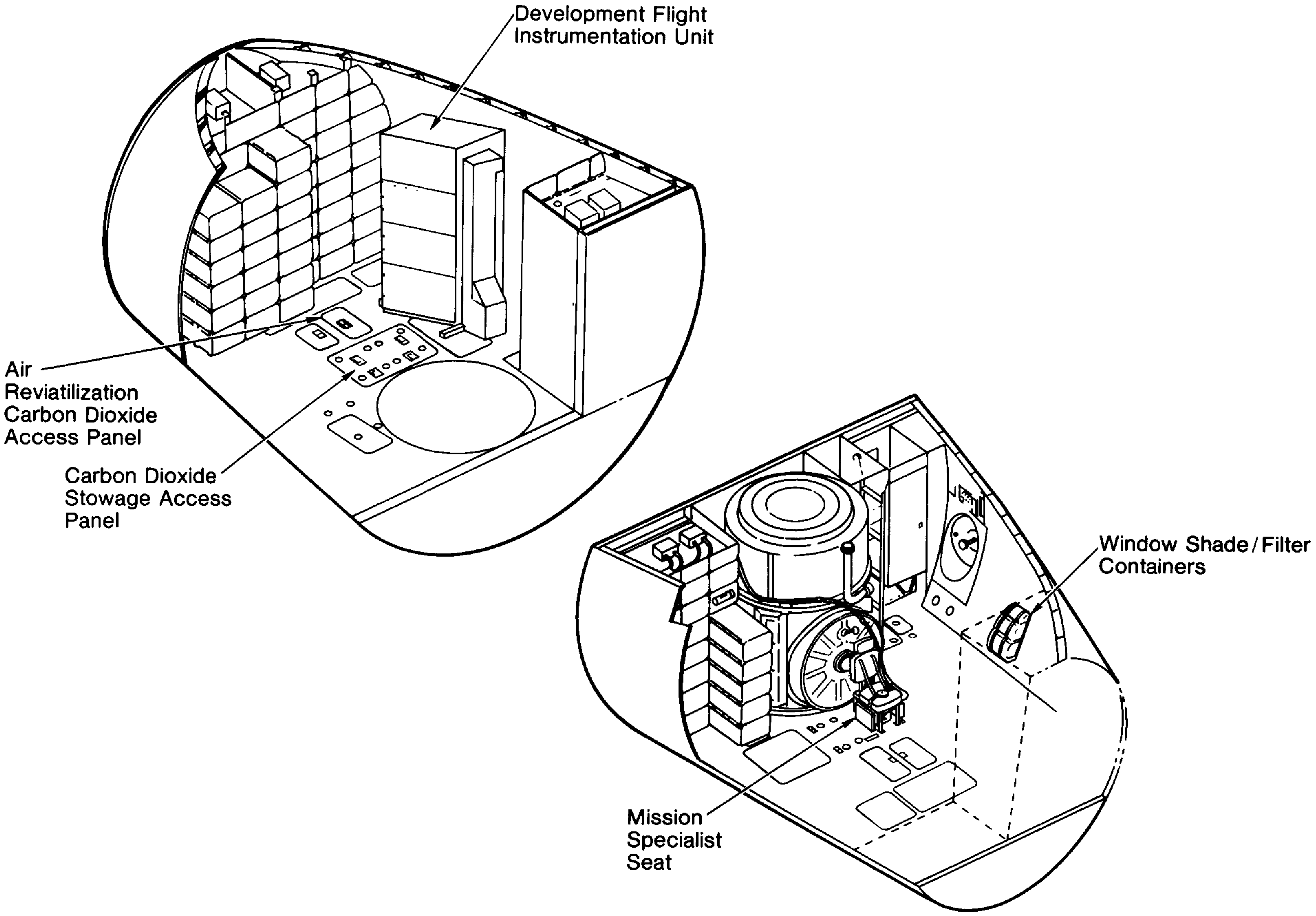
Orbiter 102 – STS-5 Personal Egress Air Packs minute walk-around capability when disconnected from the oxygen supply system.

After STS-5 the *Columbia* will have two oxygen regulators (redundant) as the *Challenger* does.



Mid-Deck Ladder Ingress/Egress Platform

Personal Egress Air Pack Launch Entry Helmet Anti-"G" Suit for Entry



Orbiter 102 – STS-5 Crew Compartment Mid Deck

GLOW EXPERIMENT

In the STS-3 flight, the flight crew attempted to photograph an electron beam with extremely fast film and long exposures. They inadvertently photographed a glow in the dark, on the edge of the orbiter OMS/RCS pods and vertical stabilizer, which was unrelated to the vehicle charging experiment. This was an unexpected phenomenon that could have implications for Space Shuttle optical payloads to be operated on the night side of each orbit.

It is believed this phenomenon is a chemoluminescent effect resulting from atomic oxygen impacting the spacecraft and building to the point that the atomic oxygen atoms combine to form molecules of oxygen. As the oxygen molecules are shed, it is believed they give off photons of light as they slow down when separating from the spacecraft. It is thought that all parts of the spacecraft covered with tile and facing into the velocity vector glow as atomic oxygen builds on the spacecraft.

In this flight, cameras will be utilized for filming this phenomenon out the aft flight windows to provide additional data for understanding of the glow.

OXYGEN INTERACTION WITH MATERIALS EXPERIMENT

The oxygen interaction with materials in the space environment flown on this flight consists of two plates approximately 331 millimeters (15 inches) by 914 millimeters (36 inches) bolted to the DFI. Each plate contains 27 strips of material with three heated zones of 23, 65, 121 degrees C (75, 150, 250°F). The heaters are thermostatically controlled and have an ON/OFF switch in the cabin. The heaters will not be operated when the EVA crew members are in the payload bay and the EVA sharp-edge criteria are being observed; therefore, no problem is anticipated with the EVA operations. Also, the payload is positioned not to interfere with the planned EVA translations in that area.

VESTIBULAR STUDY EXPERIMENT

A vestibular study and hardware evaluation during launch and entry will be accomplished on this flight. The hardware consists of five electrodes placed on the crew member's face and connected to an instrumentation box attached to the PEAP bracket. Two biomedical cables will connect the box to panel MO62M for data flow to the ground and/or recording. The test will examine eye movements and their relationship to motion sickness.

STUDENT EXPERIMENTS

Three student experiments, selected by NASA and the National Science Teacher's Association among ten winners in the 1981 nation-wide contest, will be flown aboard *Columbia* in STS-5. Three other student experiments were completed in prior Shuttle flights.

Formation of Crystals in a Weightlessness Environment. Michelle Issel, a freshman at American University in Washington, D.C., is one of the youths selected. Michelle has prepared the experiment to evaluate the growth of triglycine sulfate crystals in the weightlessness environment of space, free from the effect of gravity.

Such crystals are used on satellites to detect light waves in the infrared or invisible spectrum, allowing the detection of heat-emitting sources such as stars or microrganisms that may not be visible.

The experiment involves cooling a triglycine sulfate seed while heating the solution in which it is saturated. The solution is composed of triglycine sulfate and distilled water. In space, the seed will remain suspended in the solution and grow freely, whereas on earth the seed's growth is effected by gravity. Michelle predicts that in space, surface growth of the seed should be uniform and a geometrically perfect crystal may grow. If successful, the results will prove beneficial to the electronics and computer industries as the crystals would last longer and be more efficient. The experiment is located in the crew cabin.

The experiment contains its own electrical power battery supply and power-on switch. The experiment is turned on by the flight crew 23 hours after launch and is left on until its electrical power battery supply is expended.

United Technologies, Hamilton Standard Division of Windsor Locks, Conn., is the industry sponsor for Michelle's experiment. Hamilton Standard engineer Charles Flugel has provided technical support and the company funds travel, experiment development and related costs. Lee Sarsfield of NASA's Lewis Research Center, Cleveland, Ohio, has consulted on the development and integration of Michelle's experiment.

Michelle is 18 years old and is the daughter of Carl and Janet Issel of Wallingford, Conn. Michelle's experiment was selected in 1981 from among 1,500 proposals submitted to NASA. At that time, she was a student at the Mark T. Sheehan High School in Wallingford, Conn.

Effect of Near Weightlessness on the Formation of Sponges. Aaron K. Gillette, a freshman at Western Carolina University in Cullowhee, N.C., is one of the youths selected. Aaron's experiment will examine the effect of near weightlessness on the formation of sponges. He hypothesizes that the cells which form sponges will have difficulty doing so if gravity is not present to enable them to properly join together.

Here on earth, sponges regenerate to create new sponges. This experiment is a simple model for other life organisms such as human beings.

Martin Marietta Aerospace, Orlando, Fla., is the industry sponsor for Aaron's experiment. Aaron was a junior at Winter Haven Senior High School when he proposed his experiment. He is 18 years old and is from Winter Haven, Fla. Toni Hogan of Martin Marietta Aerospace, Orlando, Fla., is the coordinator.

A similar experiment will be performed at Martin Marietta Aerospace, Orlando, Fla., to provide ground control data.

The experiment is located in the orbiter crew cabin.

Liquid Surface Tension Convection in Microgravity. D. Scott Thomas, a freshman at Utah State University, is one of the youths selected. Scott's experiment is to study liquid surface tension convection in microgravity. Surface tension is what allows a spider to "skate" on water. It induces flow patterns (convection) in liquids that are heated. Since gravity also affects convection on earth, it is better to study surface tension induced convection in space where gravity effects can be minimized.

Thiokol Corporation, Wasatch (Utah) Division, is the industry sponsor for Scott's experiment. Scott was a junior at Richland Senior High School when he proposed his experiment. He is 18 years old and is from Johnstown, Pa.

The experiment is stowed in the aft flight deck and will require about one hour of time by Joe Allen on the day before landing.

GETAWAY SPECIAL

The getaway special (GAS), officially titled small self contained payloads (SSCP's), is offered by NASA to provide anyone who wishes the opportunity to fly a small experiment aboard the Space Shuttle.

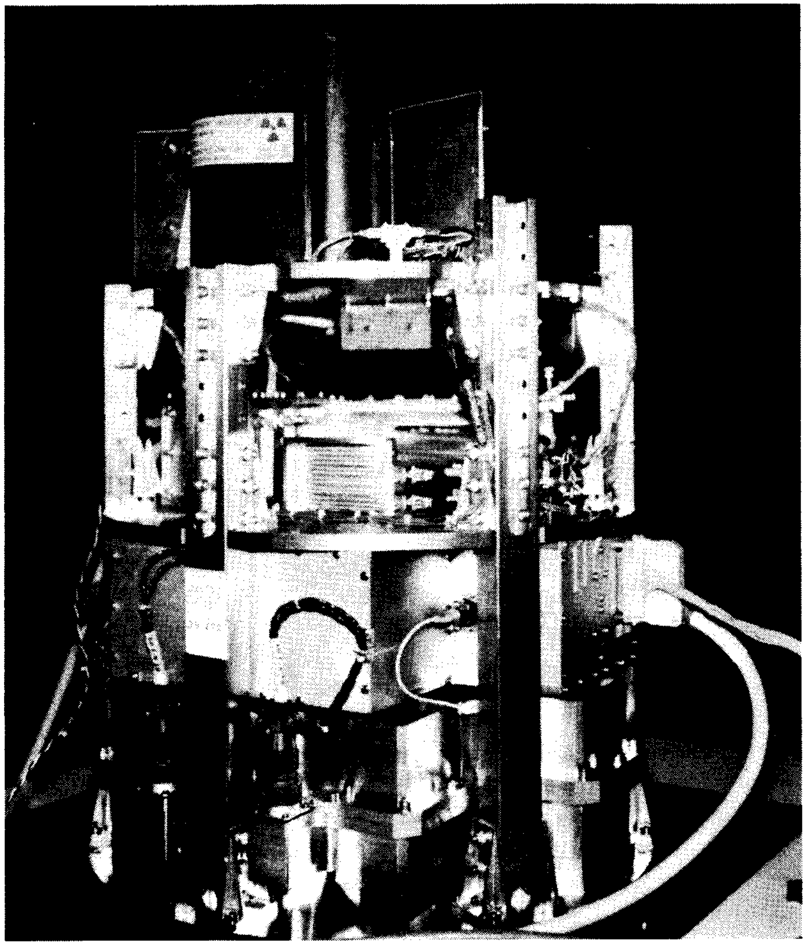
Since the offer was first announced in the fall of 1976, more than 326 GAS reservations have been made by over 197 individuals and groups. Payload spares have been reserved by several foreign governments and individuals: United States industrialists, foundations, high schools, colleges and universities, professional societies, service clubs and many others. Although many reservations have been obtained by persons and groups having an obvious interest in space research, a large number of spaces have been reserved by persons and organizations entirely outside the space community.

There are no stringent requirements to qualify for space flight, but the payload must meet safety criteria and must have a scientific or technological objective. A person who wishes to fly items of a commemorative nature, such as medallions for later resale as "objects that have flown in space," would be refused.

GAS requests must first be approved at NASA Headquarters, Washington D.C., by the Director, Space Transportation Systems Utilization Office, Code OT6. It is at this point that requests for Space Shuttle space are screened for propriety, and scientific or technical aim. These requests must be accompanied or preceded by the payment of $500 earnest money.

Requests approved by the Space Transportation Systems Utilization Office are given a payload identification number and referred to the GAS Team at the Goddard Space Flight Center, Greenbelt, Maryland. The center has been designated the lead center or direct manager for the project.

The GAS Team screens the proposal for safety and provides advice and consultation for payload design. The GAS Team certifies that the proposed payload is safe, that it will not harm or interfere with the operations of the Space Shuttle, its crew, or other experiments on the flight. If any physical testing must be done on the payload to answer safety questions prior to the launch, the expense of these tests must be borne by the customer.



Getaway Special Experiment

In flight, the flight crew will turn on and off up to three payload switches, but there will be no opportunity for flight crew monitoring of GAS experiments or any form of in-flight servicing.

The cost of this unique service will depend on the size and weight of the experiment; Getaway Specials of 90 kilograms (200 pounds) and 0.14 cubic meter (5 cubic feet) may be flown at a cost of $10,000; 45 kilograms (100 pounds) and 0.07 cubic meter (2.5 cubic feet) for $5,000, and 27 kilograms (60 pounds) and 0.07 cubic meter (2.5 cubic feet) at $3,000. These prices remain fixed for the first three years of Space Shuttle operations.

The GAS container provides for internal pressure which can be varied from near vacuum to about one atmosphere. The bottom and sides of the container are always thermally insulated and the top may be insulated or not depending on the specific experiment; an opening lid or one with a window may be required. These may be offered as additional cost options.

The weight of the GAS container, experiment mounting plate and its attachment screws, and all hardware regularly supplied by NASA is not charged to the experimenter's weight allowance.

The GAS container is made of aluminum and the circular end plates are 15 millimeters (5/8 inch) thick aluminum. The bottom 76 millimeters (3 inches) of the container are reserved for NASA interface equipment such as command decoders and pressure regulating systems. The container is a pressure vessel capable of evacuation prior to launch, or evacuation during launch and repressurization during reentry, or maintaining about one atmosphere pressure at all times, evacuation and repressurization during orbit as provided by the experimenter. The experimenters' payload envelopes in the 0.14 cubic meter (5 cubic feet) container are 501 millimeters (19.95 inches) in diameter and 717 millimeters (28.25 inches) in length. The payload envelope in the 0.07 cubic meter (2.5 cubic feet) container is 501 millimeters (19.95 inches) in diameter and 358 millimeters (14.13 inches) in length.

The GAS program is managed by the Goddard Space Flight Center. Project manager is James S. Barrowman. Clarke Prouty, also of Goddard, is technical liaison officer, and queries can be addressed to him at Code 741, Goddard Space Flight Center, Greenbelt, MD, 20771. Program manager at NASA Headquarters, Washington, D.C., is Donna S. Miller.

The GAS payload on STS-5 will be contained in the one 0.14 cubic meter (5 cubic foot) container.

The Getaway Special (GAS) payload assigned to STS-5 is part of a material science program of the German Minister of Research and Technology. Known as Project MAUS (Materialwissenschaftliche Autonome Experimente unter Schwerelasigkeit), the project is managed by Deutsche Forchungs-und Versuchsanstalt fuer Luft und Raumfahrt (DFVLR), a German Aerospace Research establishment. The experiment is the first foreign project to be flown in the GAS program on the Shuttle and the second payload from the private sector.

The STS-5 experiment for the first time makes use of x-ray recording to investigate the behavior of metallic dispersions. The experiment will use x-rays to radiate through the metallic sample and record its appearance in the liquid state periodically on photographic film during processing in near weightlessness, or microgravity. The sample will consist of two metals – gallium and mercury – which, under normal conditions, do not dissolve in the liquid state. Gallium is a rare, hard and brittle metallic element usually obtained as a by-product in the extraction of aluminum from bauxite or zinc from zinc ores.

Under normal conditions (room temperature) these metals do not mix or permit one to dissolve into the other. Under elevated temperatures (above 200 degrees C), the mercury will dissolve into the gallium, both on Earth and in space, under a process known as diffusion. This diffusion process will be recorded by x-ray, as will the cooling down period. During the cooling, the mercury will be separated again from the gallium.

This process is known as dispersion. Both the diffusion and dispersion take longer in space, and the scientists want to record the activities under those conditions because they provide more opportunity for analysis.

The understanding of physical processes occurring in liquid metals shortly before or during solidification is hampered by the lack of direct observation. Metallic samples which were processed and solidified in earlier space missions had to be analyzed after their return to Earth on polished cross-sections. The interpretation of the results was often made difficult by the missing intermediate steps in sample development.

The following metallurgical effects will be investigated with the experiment: diffusion, convection, residual Stoke's sedimentation, Marangoni convection caused by temperature and concentration gradients, Ostwald ripening and particle growth by supersaturation.

Besides obtaining scientific results, an additional objective of Project MAUS is to verify the Standard Service System – the mounting structure, power supply, experiment control, data acquisition, and housekeeping sensors which can be reused for a number of different experiments. The experiments on a given flight ride on the upper section of the payload package, on a separate shelf, and can be easily tailored and interchanged between flights.

West Germany has reserved a total of 25 Getaway Special payloads, and about 10 of these will be devoted to materials processing experiments.

The next five payloads of the MAUS project are already integrated and tested in West Germany and will be flown on STS-7 as part of SPAS-01 (German Shuttle Pallet Satellite) pallet and OSTA-2 (Office of Space and Terrestrial Applications) pallet. They were completed in mid-1982 by ERNO, a West Germany aerospace consortium.

Principal investigator on the STS-5 project MAUS experiment is Dr. Guenther Otto, DFVLR, Institute of Space Simulation, Cologne. MAUS Project Manager is Dieter Baum.

ORBITER EXPERIMENT (OEX) SUPPORT SYSTEMS

The support system for the orbiter experiments was developed to record the data obtained by such experiments and to provide time correlation for the recorded data. The information obtained through the sensors of the OEX instruments must be recorded during the orbiter mission because there will be no real-time or delayed downlink of OEX data. In addition, the analog data produced by certain instruments must be digitized for recording.

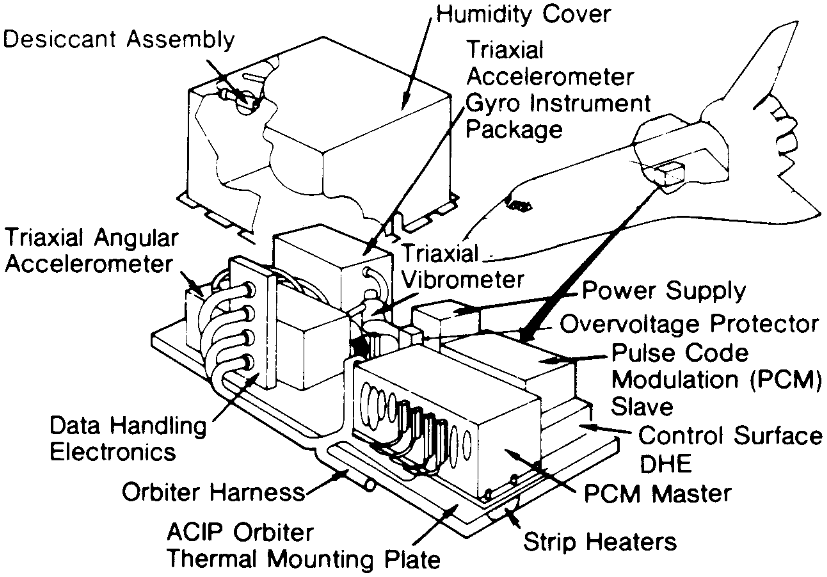
The support system for the OEX consists of five packages: the OEX recorder, the interface control module (ICM), and the pulse code modulation (PCM) master, PCM slave, and data hand handling electronics (DHE) package. The ICM is the primary interface between the OEX recorder and the experiment instruments and between the recorder and the orbiter subsystems. The ICM transmits operating commands from the orbiter MDM to the instruments and controls the operation of the recorder to correspond to the instrument operation. Time signals will be received by the ICM from the orbiter timing buffer, converted to a frequency-modulated signal, and transmitted to the recorder to provide the time information needed. The recorder will carry 2804 meters (9200 feet) of magnetic tape that will permit up to two hours of recording time at the rate of 38 millimeters (15 inches) per second. After the return of the spacecraft, the data tape will be played back for recording on a ground system. The tape will not usually be removed from the spacecraft.

AERODYNAMIC COEFFICIENT IDENTIFICATION PACKAGE (ACIP)

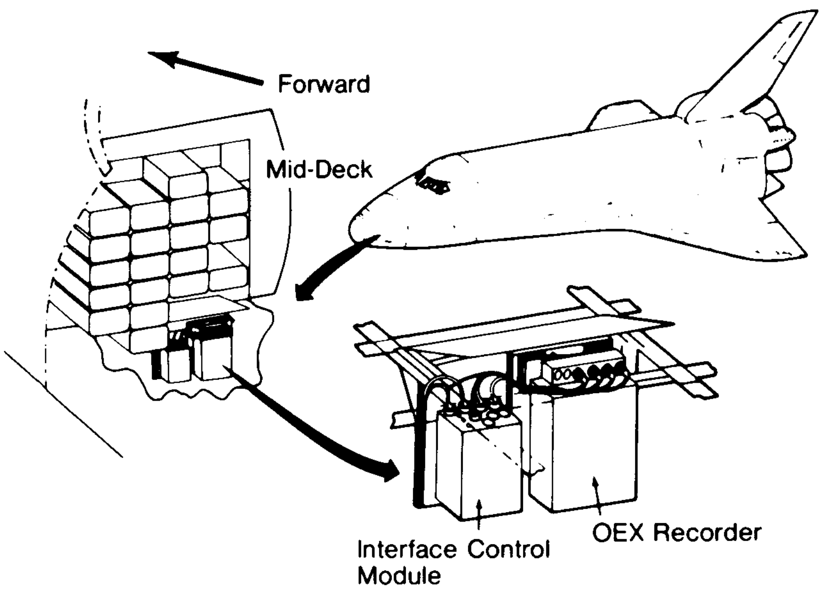
The ACIP is a sensor package installed below the payload bay area in the aft area of the mid-fuselage at station $X_0$1069. It contains a rate gyro package, a linear accelerometer package, an angular accelerometer package, and associated electronics.

The ACIP will collect aerodynamic data in the hypersonic, supersonic, and transonic flight regimes, regions in which there has been little opportunity for gathering and accumulating practical data, to establish an extensive aerodynamic data base for verification of and correlation with ground-based test data including assessments of the uncertainties in such data. In addition, it will provide flight dynamics state and variable data in support of other technology areas, such as aerothermal and structural dynamics.

The implementation of the ACIP will benefit the Space Shuttle because the more precise data obtainable through the ACIP will enable earlier attainment of the full operational capability of the Space Shuttle. Currently installed instrumentation provides data that is sufficiently precise for spacecraft operations but not for research. The result is that constraint removal would either be based on less substantive data or would require a long-term program of gathering less accurate data.



Aerodynamic Coefficient Identification Package (ACIP) Experiment



ACIP Experiment

Although all of the generic types of data required for aerodynamic parameter identification are available from the baseline spacecraft systems, the data is not suitable for experimentation due to such factors as sample rate deficiencies, sensor ranges too large for bit resolutions, or computer cycle time/core size interactions. In addition, the baseline data compromises operational measurements and is not subject to the desired changes required for experiments. The ACIP places a sensor package on the spacecraft to obtain experiment measurements that are not available through the baseline system.

The ACIP incorporates three triaxial instruments: one of dual-range linear accelerometers, one of angular accelerometers, and one of rate gyros. Also included are the power conditioner for the gyros, the power control system, and the housekeeping components for the instruments. The ACIP is aligned to the orbiter axes to a very high order of accuracy. Mounted on the ACIP base is a triaxial vibrometer which will provide the structural vibration characteristics of the orbiter affecting the ACIP experiment necessary for baseline filtration of accelerometer data. The output signals of the instruments are recorded on the OEX tape recorder. The ACIP operates through launch and through the entry and descent phases. The internal instruments continuously sense the dynamic and performance characteristics of the orbiter through these critical flight phases. In addition, the ACIP receives indications of position of the control surfaces and converts them into higher orders of precision before recording them with the attitude data. Power is supplied from the mid-power control assembly 3 main bus C. Heaters are employed on the package and controlled by a switch on panel R11.

Weight of the ACIP is 119 kilograms (262 pounds). The principal technologist for the experiment is David Howes of NASA's Johnson Space Center.

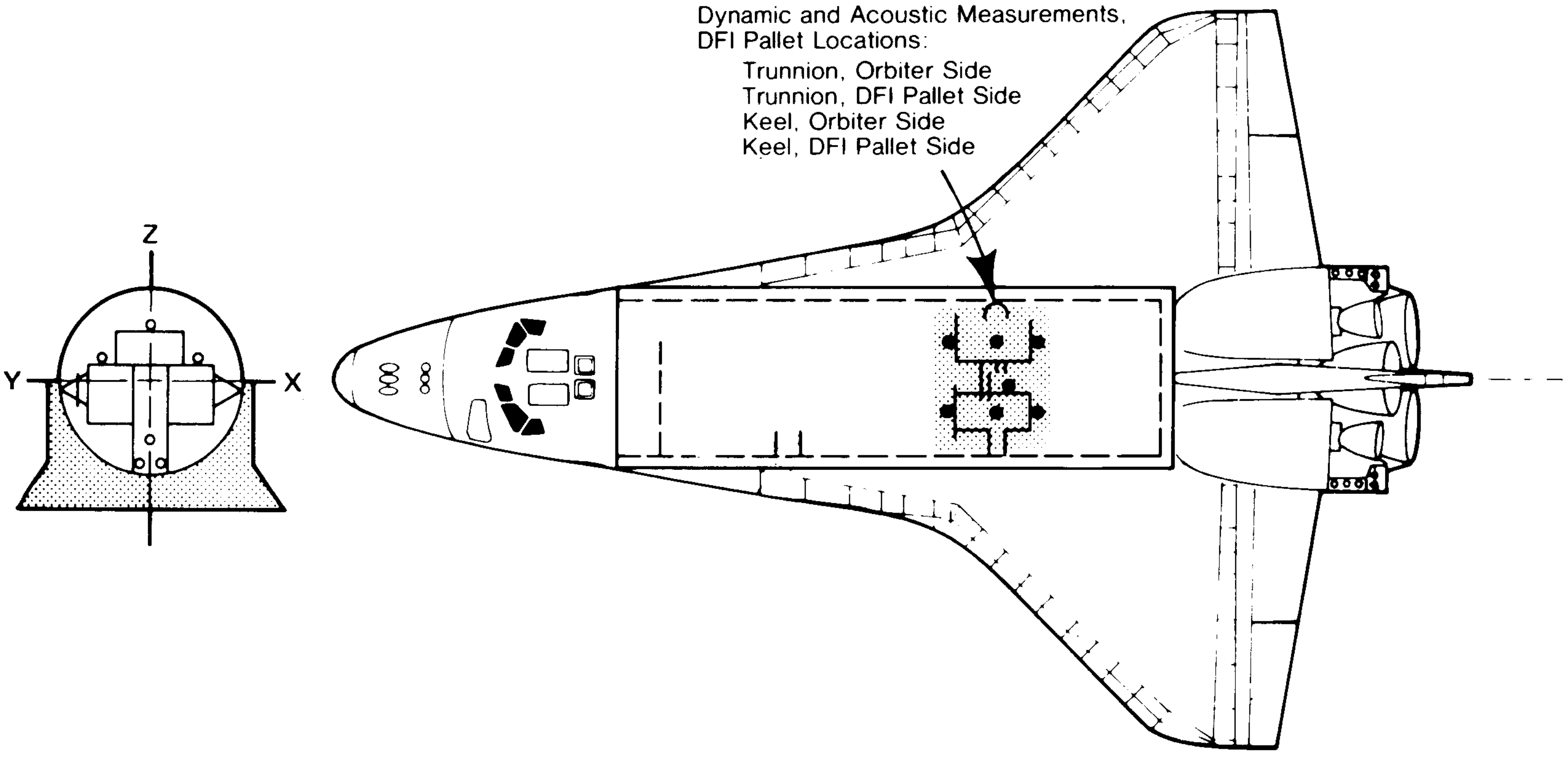
DYNAMICS, ACOUSTIC, AND THERMAL ENVIRONMENT (DATE)

The DATE experiment is to acquire environmental response and input data for prediction of environments for future payloads. The environments are neither constant nor consistent throughout the payload bay and are influenced by interactions among cargo elements.

The DATE experiment consists of accelerometers and force gauges (for dynamic influences), microphones (for vibra-acoustic effects), and thermal sensors. These devices will be installed on both payload components and carrying structure (pallet, shelf, etc.). DATE has no commands or telemetry interfaces. This data is recorded on the OEX recorder whenever the recorder is on.

THERMAL PROTECTION SYSTEM (TPS)

The TPS experiment is subdivided into two groups: scorched filler bar data acquisition and catalytic surface effects. These experiments will provide a better understanding of TPS heating phenomena which could lead to a TPS with greater reusability.



Dynamics, Acoustic, and Thermal Environment (DATE) Experiment

Scorched Filler Bar Data Acquisition: This experiment will evaluate the effects of the tile gap and step height geometry on the spacecraft TPS inter-tile gap convective heating. This panel will fly in place of the tile gap heating effects experiment.

This experiment will provide basic thermal data on the effects of varying step heights and gaps on gap heating during entry. The experiment consists of a removable carrier panel with 11 TPS tiles of baseline material located on the underside of the spacecraft fuselage. Measurements through the tiles and in the gaps will provide temperature data during entry. This experiment will provide flight data on the effects of gap and step height variances on entry heating.

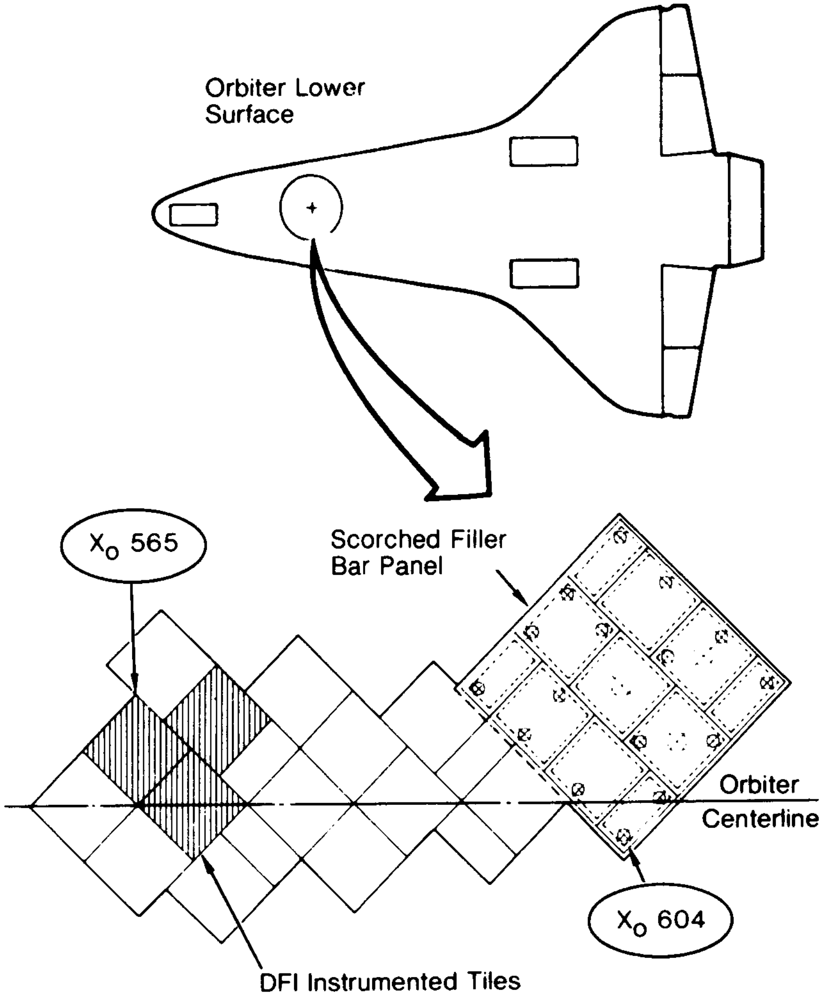
The scorched filler bar panel of the tile gap heating experiment will be conducted jointly by William Pitts of NASA Ames Research Center and Robert Dotts of NASA Johnson Space Center.

Catalytic Surface Effects. This experiment will verify predictions of the effects of surface catalytic efficiency on convective heating rates. Indications from analyses and ground test are that the design criteria for the spacecraft TPS may be overly conservative because surface catalytic efficiency was not included. To obtain flight data for comparison, this experiment was proposed.

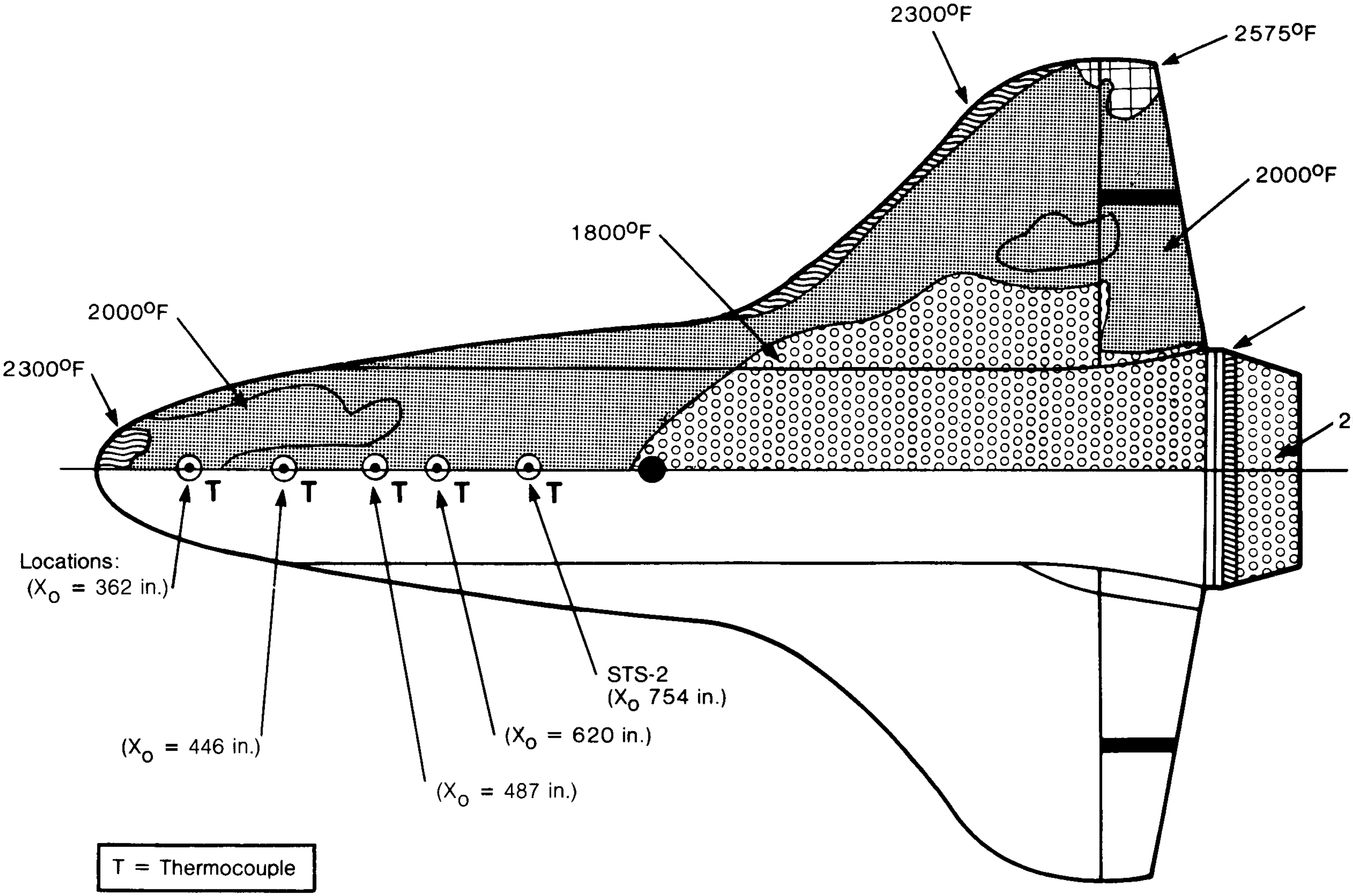
The experiment will use ten baseline tiles, having DFI thermocouples, located along the lower mid fuselage of the spacecraft. Five of these tiles will be sprayed with an overcoat consisting of iron-cobalt-chromia spinel (a highly efficient catalytic material) in a polyvinyl acetate binder. The overcoat is compatible with the existing baseline tile coating. During ascent the polyvinyl acetate will burn out of the overcoat, leaving the high emittance iron cobalt chromia spinel exposed.

During entry, beginning at 121,920 meters (400,000 feet) and continuing through landing, the thermocouple measurements will be recorded by the PCM recorder. As an aid in evaluating this data, comparisons will be made using DFI measurements recorded on baseline tiles adjacent to the tiles with the overcoat.

This experiment is conducted by principal investigator David Stewart of NASA Ames Research Center.



Scorched Filler Bar panel of the Tile Gap Heating Experiment



Lower Surface View

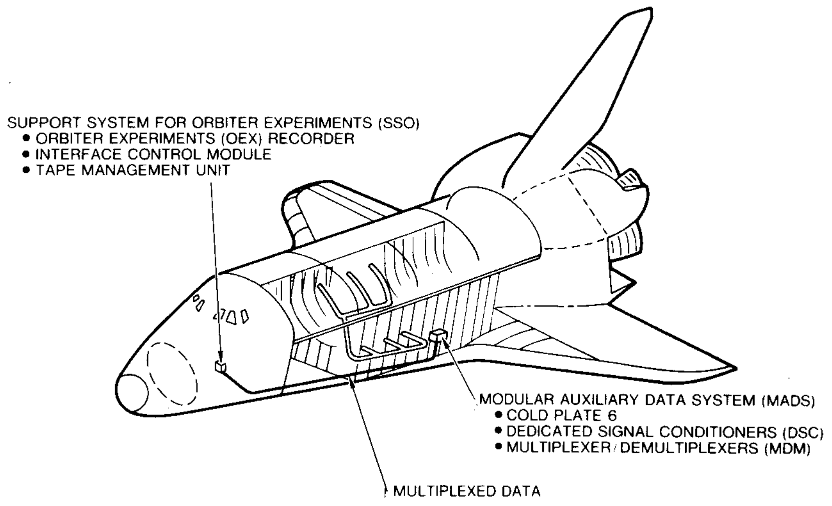
Catalytic Surface Effects Experiment

TECHNOLOGY FLIGHT INSTRUMENTATION (TFI)

To supplement the data obtained through the orbiter experiments (OEX) program and continue the flight research program, the technology flight instrumentation (TFI) provides an onboard source of information about orbiter environments, conditions, and reactions.

The sensing devices will primarily measure the temperatures, pressures, and strains of the payloads in the STS-5 flight.

In contrast to the development flight instrumentation which is in a payload carrier mounted in the cargo bay and accommodates the major components of the system except for the actual sensing devices, the Modular Auxiliary Data System (MADS) will process the technology flight measurements and is mounted within the orbiter to minimize interference with other payloads. The MADS data are stored by the support system for the orbiter experiments. An overlay wire harness will connect the desired (up to 600) measurements to MADS.



Technology Flight Instrumentation (TFI)

The flexibility afforded by the use of patch cables will greatly facilitate the rearrangement and expansion of the data collection capabilities so that the evolving needs of the flight research program can be met with only minor impacts.

The configuration of the instrumentation will remain fixed, although the installation of new OEX instruments may occasionally require the addition of specific new sensors which will become a permanent part of the system and will not be removed even though the experiment that created the need for them is removed. Not all sensors will be used on all flights. The test requirements will determine the types of data needed.

DEVELOPMENT FLIGHT INSTRUMENTATION (DFI)

In STS-5, the development flight instrumentation pallet in the cargo bay is retained as well as the development flight instrumentation unit in the mid-deck of the crew compartment.

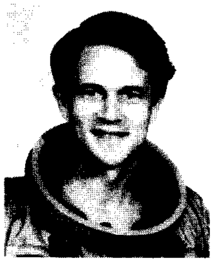
This provides a continuance of data gathering by the development flight instrumentation, principally in the disciplines of aerodynamics, aerothermodynamics, and flight control in the STS-5 flight.

STS-5 FLIGHT CREW

VANCE D. BRAND is the spacecraft commander for the STS-5 flight. He has logged 217 hours and 28 minutes in space flight as command module pilot of the Apollo-Soyuz Test Project. A graduate of the University of Colorado with a bachelor of science degree in business (1953) and a bachelor of science degree in aeronautical engineering (1960), and a masters degree in business administration from UCLA in 1964, Brand was commissioned a naval aviator and served as a Marine Corps fighter pilot until 1957. He was with the Marine Reserve and Air National Guard until 1964. He joined Lockheed Aircraft as a flight test engineer in 1960, and following completion of the Navy's Test Pilot School was assigned to Palmdale, Calif., as an experimental test pilot on the F-104. He was selected as an astronaut in 1966, and was a crew member of the prototype command module in thermal-vacuum chamber program. He was a support crewman on Apollo 8 and 13, and was backup pilot for Apollo 15 and the Skylab 3 and 4 missions. Brand is a Fellow, American Astronautical Society, Associate Fellow of AIAA, and a member of SETP. He has the NASA Distinguished and Exceptional Service Medals, the JSC Certificate of Commendation, the Richard Gottheil Medal, the Wright Brothers International Manned Space Flight Award, the VFW National Space Award, the FAI Yuri Gagarin Gold Medal, the AIAA Special Presidental Citation and the Haley Astronautics Award, the AAS's Flight Achievement Award, and the University of Colorado's Alumnus of the Century award. Brand was born in Longmont, Colo., May 9, 1931, is married and has five children. He is 5'11" in height, and weighs 175 pounds. He has blond hair and gray eyes.

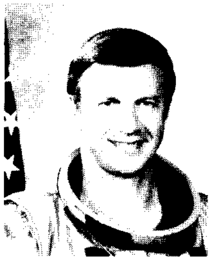
ROBERT F. OVERMYER is the pilot for the STS-5 flight. He was previously assigned engineering development duties on the Space Shuttle program and the Development Flight Test missions group of the astronaut office. His first assignment with NASA was engineering development duties on Skylab. Overmyer then served on the support crews for the Apollo 17 and Apollo-Soyuz Test Project. In 1976 he was the prime T-38 chase pilot for the Approach and Landing Test program on orbiter free flights 1 and 3. Overmyer was selected as a NASA astronaut when the U.S. Air Force Manned Orbiting Laboratory program was canceled in 1969. Colonel Overmyer entered active duty with the Marine Corps in January 1958. After flight training, several squadron tours, and graduate school, he attended the Air Force Test Pilots school in 1965. He was selected as an astronaut for the U.S. Air Force Manned Orbiting Laboratory program in 1966. He is a member of the Society of Experimental Test Pilots. He has the USAF Meritorious Service Medal and the USMC Meritorious Award. Overmyer was born in Lorain, Ohio, July 14, 1936, but considers Westlake, Ohio his hometown. He is married and has three children. He is 5'11-3/4" and weighs 180 pounds. He has brown hair and blue eyes.

WILLIAM B. LENOIR is one of the mission specialists on the STS-5 flight. He is a graduate of the Massachusetts Institute of Technology where he received a bachelor of science degree in Electrical Engineering, and a doctor of science degree. From 1964 to 1965, he was an instructor at MIT, and in 1965 he was named assistant professor of Electrical Engineering until he was selected as a NASA scientist astronaut in 1967. He was backup science pilot for the Skylab 3 and 4 missions. From 1974 to 1976, Lenoir spent approximately one-half of his time as leader of the NASA satellite power team. Since 1976, he has supported the Space Shuttle program in the areas of payload deployment and retrieval. He has received the NASA Exceptional Service Medal and is a senior member of the Institute of Electrical and Electronics Engineers and a member of the American Geophysical Union. He has logged over 2,900 hours of flying time in jet aircraft. He is married, has two children. Lenoir was born in Miami, Fla., March 14, 1939. He is 5'10" in height and weighs 150 pounds. He has brown hair and eyes.

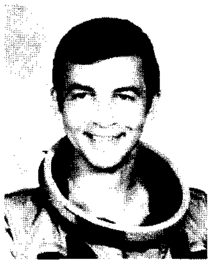


JOSEPH P. ALLEN is one ot the mission specialists on the STS-5 flight. He received a bachelor of arts degree in math-physics from DePauw University and a master of science degree and doctorate in physics from Yale University. He was a staff physicist at the Nuclear Structure Lab at Yale from 1965 to 1966 and served as a guest research associate at Brookhaven National Laboratory from 1963 to 1967 and was a research associate in the Nuclear Physics Laboratory at the University of Washington from 1967 until he was selected as a scientist astronaut in 1967. He was a mission scientist while a member of the astronaut support crew for Apollo 15 and served as a staff consultant on science and technology for the President's Council on International Economic Policy. From 1975 to 1978, Allen served as NASA Assistant Administrator for Legislative Affairs in Washington, D.C. Allen has received two NASA Group Achievement Awards, the Yale Science and Engineering Association Award, the DePauw University Distinguished Alumnus Award, the NASA Exceptional Scientific Achievement Medal, and a NASA Exceptional Service Medal. He is a member of the American Physical Society, the American Astronomical Society, the AIAA, the American Association for the Advancement of Science, and the AAS. He has logged more than 2,800 hours of flying time in jet aircraft. Allen is married and has two children. He was born in Crawfordsville, Ind., June 27, 1937. He is 5'6" and weighs 125 pounds. He has brown hair and blue eyes.

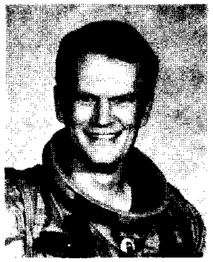
STS-6 FLIGHT CREW



PAUL J. WEITZ is the commander for the STS-6 flight. He was the pilot in the Skylab 2 mission, logging 672 hours and 49 minutes aboard the Skylab workshop in addition to 2 hours and 11 minutes in extravehicular activities. Weitz retired from the Navy in 1976 with 22 years of service and remains with NASA as a civilian astronaut. Weitz received his commission as an Ensign through the ROTC program at Pennsylvania State University in 1954 and received his wings in 1956. He was an A-4 Tactics Instructor at the Naval Air Station in Jacksonville, Fla. from 1956 to 1960, a project officer at China Lake, Calif. in various air-to-ground delivery tactic projects from 1960 to 1962, completed the U.S. Naval Postgraduate School in 1964, was assigned to the Naval Air Station at Widbey Island, Washington in 1964 and was selected as a NASA astronaut in 1966. He received a bachelor of science degre in Aeronautical Engineering from Pennsylvania State University in 1954 and a masters degree in Aeronautical Engineering from the U.S. Naval Postgraduate School in Monterey, Calif., in 1964. Weitz was awarded the NASA Distinguished Service Medal, the Navy Distinguished Service Medal, the Federal Aviation Agency's Space Mechanic Technician Award, the Los Angeles Chamber of Commerce Kitty Hawk Award, the Robert J. Collier Trophy, the AAS Flight Achievement Award, the AIAA Haley Astronautics Award, the FAI V. M. Komarov Diploma, the Dr. Robert H. Goddard MemorialTrophy and the Harman International Trophy. He has logged more than 6,200 flying hours time, 5,100 hours in jet aircraft. Weitz is married and has two children. He was born in Erie, Pa., July 25, 1932. He is 5'10" in height and weighs 180 pounds. He has blond hair and blue eyes.



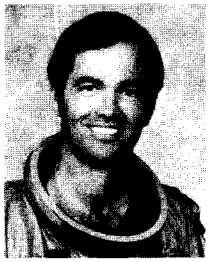
DONALD H. PETERSON is a mission specialist on the STS-6 flight. He served on the astronaut support crew for Apollo 16. He received a bachelor of science degree from the United States Military Academy at West Point in 1955 and a masters degree in Nuclear Engineering from the Air Force Institute of Technology, Wright-Patterson AFB, Ohio in 1962. His USAF assignments included 4 years as a flight instructor and military training officer with the Air Training Command and 3 years as a nuclear systems analyst with the Air Force Systems Command. He is a graduate of the Aerospace Research Pilot School and was assigned to the USAF Manned Orbiting Laboratory Program. He became a NASA astronaut in 1969. He has retired from the USAF after 24 years of active service but continues his assignment as a NASA astronaut in civilian capacity. He has logged over 4,900 hours of flying time including more than 4,180 hours in jet aircraft. He has received the Air Force Commendation Medal and the Meritorious Service Medal, and the JSC Group Achievement Award. He is married and has three children. He was born in Winona, Miss., October 22, 1933. He is 5'8" in height and weighs 147 pounds. He has blond hair and green eyes.



KAROL J. BOBKO is the pilot for the STS-6 flight. He was a member of the Skylab Medical Experiments Altitude Test (SMEAT) – a 56 day simulation of the Skylab mission – and a member of the astronaut support crew for the ASTP mission and a member of the support crew for the Space Shuttle Approach and Landing Test program. He was then involved with the ground test and checkout of the *Columbia*. He received a bachelor of science degree from the Air Force Academy in 1959 and a master of science degree in Aerospace Engineering from the University of Southern California in 1970. Bobko received his wings in 1960 and flew F-100 and F-105 aircraft from 1961 to 1965, then attended the Aerospace Research Pilots school and was assigned as an astronaut in the USAF Manned Orbiting Laboratory Program in 1966 and became a NASA astronaut in 1969. He has logged over 4,800 hours of flying time in the F-100, F-104, F-105, T-33 and T-38. Bobko was awarded the NASA Exceptional Service Medal, three JSC Group Achievement Awards and two USAF Meritorious Service Medals. He is married and has two children. He was born in New York, New York December 23, 1937. He is 5'11" in height and weighs 190 pounds. He has blond hair and blue eyes.

STORY MUSGRAVE is a mission specialist on the STS-6 flight. Dr. Musgrave was selected as a scientist astronaut in 1967. He worked on the design and development of the Skylab program, as a back-up science pilot for the first Skylab mission and has been participating in the design and development of all Space Shuttle extravehicular activity equipment. He received a bachelor of science degree in mathematics and statistics from Syracuse University in 1958, a master of business adminstration degree in Operations Analysis and Computer Programming from the University of California at Los Angeles in 1959, a bachelor of arts degree in chemistry from Marietta College in 1960, a doctorate in Medicine from Columbia University in 1964. He served his surgical internship at the University of Kentucky Medical Center in Lexington from 1964 to 1965 and continued there as a USAF post-doctoral fellow working in aerospace medicine and physiology from 1965 to 1966 and received his master of science in Physiology and Biophysics from the University of Kentucky in 1966. From 1966 to 1967, as a National Heart Institute post-doctoral fellow, Dr. Musgrave was teaching and doing research in cardiovascular and exercise physiology. He is continuing clinical and scientific training as a part-time surgeon at the Denver General Hospital and as a part-time professor of physiology and biophysics at the University of Kentucky Medical Center. He has flown 90 different types of civilian and military aircraft, logging over 13,200 flying hours, including 5,500 in jet aircraft, and holds instructor, instrument instructor, glider instructor and airline transport ratings. He has received the National Defense Service Medal, USAF Post-doctoral Fellowship, National Heart Fellowship, American College of Surgeons I. S. Ravdin Lecture, NASA Exceptional Service Medal and Flying Physicians Association Airmen of the Year Award. He has five children. He was born in Boston, Mass., August 19, 1935 but considers Lexington, Ky. his hometown. He is 5'10" in height and weighs 149 pounds. He has blond hair and blue eyes.

STS-7 FLIGHT CREW



ROBERT L. CRIPPEN is the commander for the STS-7 flight. He was the pilot in the 54-1/2 hour STS-1 flight. He has logged more than 4,980 hours of flying time—most of it in jet-powered aircraft—as a U.S. Navy pilot and astronaut. A graduate of the University of Texas in aerospace engineering, Crippen entered naval service and was a carrier pilot. He completed the U.S. Air Force's Aerospace Research Pilot School at Edwards AFB and remained as an instructor until he was selected for the Manned Orbiting Laboratory program in 1966. He transferred to the NASA Astronaut Office in 1969 and was a crew member of the Skylab Medical Experiments Altitude Test—a 56-day simulation of the Skylab mission. He was a member of the support crew for Skylab 2, 3, and 4, and the ASTP mission. He has been awarded the NASA Distinguished Service Medal and Exceptional Service Medal and the JSC Group Achievement Award. Crippen was born in Beaumont, Tex., September 11, 1937, is married and has three children. He is 5'10" in height, weighs 160 pounds, and has brown hair and eyes.

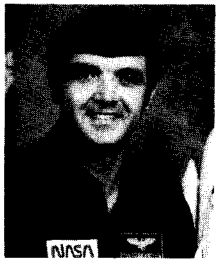
FREDERICK H. HAUCK is the pilot for the STS-7 flight. He was a member of the support crew for STS-1 and capsule communicator during reentry for the STS-2 flight. He was selected as an astronaut candidate by NASA in 1978. Hauck received a bachelor of science degree in Physics from Tufts University in 1962 and a master of science degree in Nuclear Engineering from MIT in 1966. He was a Navy ROTC student at Tufts University and was commissioned upon graduation and served as communications officer and CIC officer on the USS Warrington. In 1964 he attended the U.S. Naval Postgraduate School, Monterey, Calif., in math and physics and studied Russian at the Defense Language Institute in Monterey. He was then selected for the Navy's Advanced Science Program. He received his wings in 1968. He flew 114 combat and combat support missions in the Western Pacific aboard the USS Coral Sea. He graduated from the U.S. Naval Test Pilot School in 1971. Hauck then served as a project test pilot for automatic carrier landing systems in the A-6, A-7, F-4 and F-14 aircraft. In 1974 he was assigned to the USS Enterprise flying A-6, A-7 and F-14 aircraft. He was an executive officer in February 1977 until he was selected as an astronaut. He was born in Long Beach, Calif., April 11, 1941 but considers Winchester, Mass., and Washington, D.C. as his hometown. He is married and has two children. He is 5'9" in height and weighs 175 pounds. He has blond hair and blue eyes.

SALLY K. RIDE is a mission specialist for the STS-7 flight. She was selected as an astronaut candidate by NASA in 1978. Dr. Ride received a bachelor of arts in English from Stanford University in 1973, a bachelor of science, a master of science, and doctorate degrees in Physics in 1973, 1975, and 1978, respectively from Stanford University. Dr. Ride has held teaching assistant and research assignments while a graduate student in the Physics Department at Stanford University. Her research includes one summer with the low-temperature group working in experimental general relativity and three years in X-ray astrophysics. She was born in Los Angeles, Calif., May 26, 1951 and considers Encino, Calif. her hometown. Dr. Ride is 5'5" in height and weighs 115 pounds. She has brown hair and blue eyes. She married Astronaut Steve Hawley on July 24, 1982.

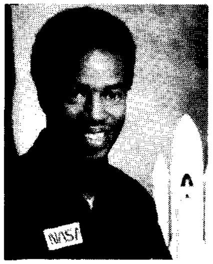
JOHN M. FABIAN is a mission specialist for the STS-7 flight. He was selected as an astronaut candidate in 1978. He received a bachelor of science degree in Mechanical Engineering from Washington State University in 1962, a master of science in Aerospace Engineering from the Air Force Institute of Technology in 1964 and a doctorate in Aeronautics and Astronautics from the University of Washington in 1974. Fabian was an Air Force ROTC student at Washington State University and was commissioned in 1962. He had various assignments in the Air Force Institute of Technology at Wright-Patterson Air Force Base, Ohio, aeronautical engineer at San Antonio Air Material Area, Kelly AFB, Tex., then attended flight training at Williams AFB, Ariz., and spent five years as a KC-135 pilot at Wurtsmith AFB, Mich., and flew 90 combat missions in Southeast Asia. Following additional graduate work at the University of Washington, he served four years on the faculty of the Aeronautics Department at the USAF Academy in Colo. He has logged 3,400 hours flying time, including 2,900 hours in jet aircraft. He is a member of AIAA. He is married and has two children. He was born in Goosecreek, Tex., January 28, 1939, but considers Pullman, Wash., his hometown. He is 6' 1" in height and weighs 175 pounds. He has brown hair and green eyes.

STS-8 FLIGHT CREW

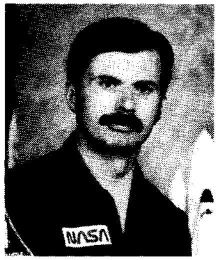
RICHARD H. TRULY is the commander for the STS-8 flight. He was the spacecraft pilot for the 54 hour, 24 minute STS-2 flight. He was an orbiter pilot during the successful Approach and Landing Test program, and as a naval pilot and astronaut has logged nearly 6,000 hours in jet aircraft. He graduated from the Georgia Institute of Technology in aeronautical engineering and entered naval flight training. Following service as a carrier pilot, Truly completed the USAF Aerospace Research Pilot School at Edwards and was subsequently assigned there as an instructor. In 1965 he was assigned to the Manned Orbiting Laboratory program and in 1969 was assigned to the NASA Astronaut Office. Truly was a member of the Skylab support crew and served in a similar capacity for the ASTP flight. He has been awarded two NASA Exceptional Service Medals, the JSC Superior Achievement Award and Special Achievement Award, the SETP Iven C. Kincheloe Award, the AFA's David C. Schilling Award, the American Astronomical Society's Flight Achievement Award, the Navy Distinguished Flying Cross, and the AIAA's Haley Space Flight Award. Truly was born in Fayette, Miss., Nov. 12, 1937, is married and has three children. He is 5'8" in height, weighs 150 pounds, and has brown hair and eyes.



DANIEL C. BRANDENSTEIN is the pilot for the STS-8 flight. Brandenstein was selected as an astronaut candidate in 1978. He was a member of the STS-1 and STS-2 astronaut support crew and served as ascent capcom. He received a bachelor of science degree in Mathematics and Physics from the University of Wisconsin in 1965. He entered the Navy in 1965 and was designated a naval aviator in 1967. He flew 192 combat missions in Southeast Asia from the USS Constellation and Ranger. He graduated from the U.S. Naval Test Pilot School. He then served aboard the USS Ranger in the Western Pacific and Indian Ocean flying A-6 aircraft. He has logged 3,600 hours flying time in 19 different types of aircraft and has 400 carrier landings. Brandenstein is married and has one child. He was born in Watertown, Wisc., January 17, 1943. He is 5'11" in height and weighs 185 pounds. He has brown hair and blue eyes.



GUION S. BLUFORD JR. is a mission specialist for the STS-8 flight. He was selected as an astronaut candidate in 1978. He received a bachelor of science degree in Aerospace Engineering from Pennsylvania State University in 1964, a master of science degree with distinction in Aerospace Engineering from the Air Force Institute of Technology in 1974, and a doctor of philosophy in Aerospace Engineering with a minor in Laser Physics from the Air Force Institute in 1978. Bluford was an Air Force ROTC graduate at Penn. State University and attended pilot training at Williams AFB, Ariz., and received his wings in 1965. He was assigned to F-4C combat crew training and subsequently flew 144 combat missions. He was assigned then as a T-38A instructor pilot at Sheppard AFB, Tx., and served as a standardization/evaluation officer and as an assistant flight commander. In 1972 he entered the Air Force Institute of Technology at Wright-Patterson AFB, Ohio, and upon graduating in 1974, he was assigned to the Air Force Flight Dynamics Laboratory at Wright-Patterson AFB as a staff development engineer. He then served as Deputy for Advanced Concepts for the Aeromechanics Division and as Branch Chief of the Aerodynamics and Airframe Branch in the Laboratory. He has logged over 3,000 hours jet flight time in the T-33, T-37, T-38, F-4C, C-135, and F-5A/B, including 1,300 hours as a T-38 instructor pilot. Bluford also has an FAA commercial license. He is married and has two children. He was born in Philadelphia, Pa., November 22, 1942. He is 6' in height and weighs 180 pounds. He has black hair and brown eyes.



DALE A. GARDNER is a mission specialist for the STS-8 flight. He was selected as an astronaut candidate in 1978. He received a bachelor of science degree in Engineering Physics from the University of Illinois in 1970. Gardner entered the U.S. Navy in 1970 upon graduation from college and was assigned to Aviation Officer Candidate School. In 1970 he attended basic naval officer training and was graduated with the highest academic average ever achieved in the 10-year history of the squadron. He proceeded to the Naval Aviation Technical Training Center for advanced naval flight officer training and received his wings in 1971. From 1971 to 1973 he was assigned to weapons system test division at the Naval Test Center in F-14A development test and evaluation as project officer for testing inertial navigation system. He then flew F-14A aircraft and participated in two WESTEC cruises while deployed aboard the USS Enterprise. From 1976 until reporting to NASA, Gardner was with the Air Test and Evaluation Squadron in the operational test and evaluation of fighter aircraft. Gardner is married and has one child. He was born in Fairmont, Minn., November 8, 1948, but considers Clinton, Iowa, his hometown. He is 6' in height and weighs 160 pounds. He has brown hair and eyes.

STS-9 FLIGHT CREW

JOHN W. YOUNG, veteran of five space flights, is the commander of the STS-9 flight and was commander for the 54-1/2 hour STS-1 flight. He has logged 642 hours, 30 minutes in space flight on the Gemini 3 and 10 missions, the Apollo 10 and 16 flights to the moon, and the STS-1 flight. A graduate of Georgia Institute of Technology in aeronautical engineering, Young entered U.S. Naval service and after a year of destroyer duty he was accepted and completed flight training. He is a graduate of the Navy's Test Pilot School and was stationed at the Naval Air Test Center for three years prior to entering the Astronaut Corps in 1962. He retired from the Navy in 1976. Young was assigned responsibility for the Space Shuttle Branch of the Astronaut Office in 1973, and in 1975 was named as chief of the Astronaut Office. Young is a Fellow of the American Astronautical Society (AAS), and the Society of Experimental Test Pilots (SETP) and associate fellow of the American Institute of Aeronautics and Astronautics (AIAA). He was awarded the Congressional Medal of Honor, the Department of Defense Distinguished Service Medal, three NASA Distinguished Service Medals, two NASA Exceptional Service Medals, the JSC Certificate of Commendation, two Special Achievement Awards, the Navy Astronaut Wings, two Navy Distinguished Service Medals, three Navy Distinguished Flying Crosses, the Georgia Tech Distinguished Alumni Award (1965) and the Distinguished Service Alumni Award (1972), the SETP Iven C. Kincheloe Award, the AAS Flight Achievement Award, the FAI Yuri Gagarin Gold Medal, and the AIAA Haley Astronautics Award. Young was born in San Francisco, Calif., Sept. 24, 1930, is married and has two children. He is 5'9" in height, weighs 165 pounds, and has green eyes and brown hair.

BREWSTER A. SHAW is the pilot for the STS-9 flight. Shaw was selected as an astronaut candidate in 1978. He received a bachelor and master of science degrees in Engineering Mechanics from the University of Wisconsin in 1968 and 1969 respectively. Shaw entered the Air Force in 1968 and after completing Officer Training School, attended undergraduate pilot training, receiving his wings in 1970 and was assigned to the F-100 at Luke AFB, Ariz., and was subsequently assigned to the Republic of Vietnam. He returned to the U.S. in 1971 and was assigned to the F-4 and subsequently reported to Thailand, where he flew the F-4. In 1973 he returned to George AFB, Calif., for F-4 instructor duties. In 1976, he attended the USAF Test Pilot School and remained at Edwards AFB, Calif., as an operational test pilot. He then served as an instructor at the USAF Test Pilot School from 1977 until selected as an astronaut candidate. Shaw is married and has three children. He was born in Cass City, Mich., May 16, 1945. He is 5'8" in height and weighs 135 pounds. He has brown hair and blue eyes.

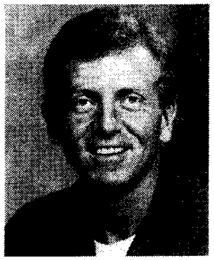
ROBERT ALLAN RIDLEY PARKER is a mission specialist for the STS-9 flight. Parker was a member of the astronaut support crews for the Apollo 15 and 17 missions and served as program scientist for the Skylab Program Director's Office during the three manned Skylab flights. He received a bachelor of arts degree in Astronomy and Physics from Amherst College in 1958 and a doctorate in Astronomy from the California Institute of Technology in 1962. Parker was an associate professor of astronomy at the University of Wisconsin prior to his selection as an astronaut. Dr. Parker was selected as a scientist-astronaut in 1967. He has logged over 2,225 hours flying time in jet aircraft. He was awarded the NASA Exceptional Scientific Achievement Medal and the NASA Outstanding Leadership Medal. He is married and has two children. He was born in New York City, December 14, 1936, but grew up in Shrewsburg, Mass. Parker is 5'10" in height and weighs 160 pounds. He has brown hair and blue eyes.

OWEN K. GARRIOTT is a mission specialist for the STS-9 flight. Dr. Garriott was the science pilot for the Skylab 3, 59-1/2 day mission. He logged 1,427 hours and 9 minutes in space in the Skylab 3 mission and also spent 13 hours and 43 minutes in three separate extravehicular activities outside the Skylab workshop. Since the Skylab 3 flight, Garriott has served as Deputy and then Director of Science and Applications and as the Assistant Director for Space Science at JSC. Dr. Garriott was selected as a scientist astronaut in 1965. Prior to his selection as an astronaut, he taught electronics, electromagnetic theory, and ionospheric physics as an associate professor in the Department of Electrical Engineering at Stanford University. He has performed research in ionospheric physics since obtaining his doctorate. Garriott remains a consulting professor at Stanford University. He has logged over 3,900 flying hours—including over 2,100 hours in jet aircraft and the remainder in spacecraft, light aircraft, and helicopters. In addition he holds FAA commercial pilot and flight instructor certification for instrument and multi-engine aircraft. He has received the NASA Distinguished Service Medal, the City of Chicago Gold Medal, the Robert J. Collier Trophy, the FAI V. M. Komarov Diploma, and was elected to the International Academy of Astronautics. He is a Fellow of the AAS and a member of the IEEE. He is married and has four children. Garriott was born in Enid, Okla., November 22, 1930. He is 5'9" in height and weighs 140 pounds. He has brown hair and blue eyes.

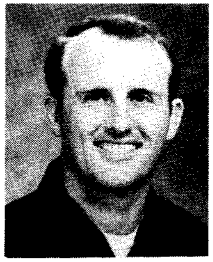
STS-10 FLIGHT CREW

THOMAS K. MATTINGLY, II is the commander for the STS-10 mission. He was also the commander in the STS-4 flight. He was the backup commander for the STS-3 flight and STS-2 flight. From 1979 to 1981 he headed the astronaut ascent/entry group. Mattingly was previously assigned as technical assistant for flight test to the manager of the Development Flight Test program. He was the head of the astronaut office support to the STS program from 1973 to 1978. Mattingly was the designated command module pilot for the Apollo 13 flight, but was removed from flight status 72 hours prior to the scheduled launch due to exposure to the German measles. He subsequently served as command module pilot of Apollo 16, April 16 through April 27, 1972. With the completion of his first space flight Mattingly has logged 435 hours and 1 minute in space—1 hour and 13 minutes of which were spent in extravehicular activity (EVA). He has logged 6,300 hours of flight time—4,130 hours in jet aircraft. Mattingly is one of the 19 astronauts selected by NASA in April 1966. Prior to reporting for duty as an astronaut, he was a student at the Air Force Aerospace Research Pilot school. Mattingly began his naval career as an ensign in 1958 and received his wings in 1960. He was then assigned to the USS Saratoga from 1960 to 1963 flying AIH aircraft and then served aboard the USS Franklin D. Roosevelt where he flew A3B aircraft for two years. He served as a member of the astronaut support crews for the Apollo 8 and 11 missions. Mattingly is an Associate Fellow, American Institute of Aeronautics and Astronautics; Fellow, American Astronautical Society; and Member, Society of Experimental Test Pilots, and the U.S. Naval Institute. He has the NASA Distinguished Service Medal, the JSC Group Achievement Award, the Navy Distinguished Service Medal and Navy Astronauts Wings, the SETP Ivan C. Kincheleo Award, the Delta Tau Delta Achievement Award, the Auburn Alumni Engineers Council Outstanding Achievement Award, the AAS Flight Achievement Award, the AIAA Haley Astronautics Award, and the Federation Aeronautique Internationale V.M. Komarov Diploma. Mattingly was born in Chicago, Illinois, March 17, 1936, and has one child. He is 5' 10" and weighs 140 pounds. He has brown hair and blue eyes.

ELLISON S. ONIZUKA is a mission specialist on the STS-10 mission. He received bachelor and master of science degrees in Aerospace Engineering in June and December 1969, respectively, from the University of Colorado. Onizuka entered active duty with the United States Air Force in January 1970 after receiving his commission at the University of Colorado through the four year ROTC program as a distinguished military graduate. As an aerospace flight test engineer with the Sacramento Air Logistics Center at McClellan Air Force Base, California, he participated in flight test programs and systems safety engineering for the F-84, F-100, F-105, F-111, EC-121T, T-33, T-39, T-28 and A-1 aircraft. He attended the USAF Test Pilot School and in July 1975 he was assigned to the Air Force Flight Test Center at Edwards Air Force Base, California, serving on the USAF Test Pilot School staff initially as squadron flight test engineer and later as chief of the engineering support section in the training resources branch. He has logged more than 900 hours flying time. Onizuka was selected as an astronaut candidate in January 1978 and in August 1979, he completed a one year training and evaluation period making him eligible for assignment as a mission specialist. He is a recipient of the Air Force Commendation Medal, Air Force Meritorious Service Medal, Air Force Outstanding Unit Award, Air Force Organizational Excellence Award, and National Defense Service Medal. He is a member of the Society of Flight Test Engineers, the Air Force Association and AIAA. He was born in Kealakekua, Kona, Hawaii, June 24, 1946. He is married and has two children. He is 5'9" in height and weighs 162 pounds. He has black hair and brown eyes.



LOREN J. SHRIVER is the pilot for the STS-10 mission. He received a bachelor of science in Aeronautical Engineering from the United States Air Force Academy in 1967 and a master of science degree in Astronautical Engineering from Purdue University in 1968. Shriver was commissioned in 1967 upon graduation from the USAF Academy and from 1969 to 1973 he served as a T-38 academic instructor pilot at Vance Air Force Base, Oklahoma. He completed F-4 combat crew training at Homestead Air Force Base, Florida, in 1973, and was assigned to Thailand until 1974. He attended the USAF Test Pilot School in 1975 and was assigned to the 6512th Test Squadron at Edwards Air Force Base. In 1976, Shriver served as a test pilot for the F-15 joint Test Force at Edwards. He was selected as an astronaut candidate in January 1978, and in August 1979, he completed a one year training and evaluation period making him eligible for assignment as a pilot. He has flown in 30 different types of single and multi-engine civilian and military fixed wing and helicopter aircraft and has logged over 2,950 hours in jet aircraft, and holds commercial pilot and private glider ratings. He has received the Air Force Meritorious Service Medal, Air Force Commendation Medal, two Air Force Outstanding Unit Awards, and the National Defense Service Medal. Shriver is a member of SETP, Air Force Association and AIAA. He was born in Jefferson, Iowa but considers Paton, Iowa his hometown. He is married and has four children. He is 5'10" in height and weighs 160 pounds. He has blond hair and blue eyes.



JAMES F. BUCHLI is a mission specialist on the STS-10 mission. He received a bachelor of science degree in Aeronautical Engineering from the United States Naval Academy in 1967 and a master of science degree in Aeronautical Engineering Systems from the University of West Florida in 1975. He received his commission in the United States Marine Corps following graduation from the United States Naval Academy at Annapolis in 1967. He served a one year tour of duty in the Republic of Vietnam and upon his return to the United States in 1969, he reported to naval flight officer training at Pensacola, Florida. Buchli spent the next three years assigned to the Marine Fighter/Attack Squadron at Kaneohe Bay, Hawaii and Iwakuni, Japan and in 1973 he proceeded to duty with Marine Fighter/Attack Squadron at Namphong, Thailand, and Iwakuni, Japan. At completion of this tour of duty he returned to the United States and participated in the Marine Advanced Degree Program at the University of West Florida. He was assigned subsequently to Marine Fighter/Attack Squadron at the Marine Corps Air Station, Beaufort, S. C., and in 1977, to the U.S. Test Pilot School, Patuxent River, Maryland. He was selected as an astronaut candidate by NASA in January 1978 and in August 1979, he completed a one-year training and evaluation period making him eligible for assignment as a mission specialist. He has logged 1,900 hours flying time, 1,780 hours in jet aircraft. Buchli is the recipient of an Air Medal, Navy Commendation Medal, Purple Heart, Combat Action Ribbon, Presidential Unit Citation, Navy Unit Citation, a Meritorious Unit Citation, and a Vietnamese Cross of Gallantry with the Silver Star. He was born in New Rockford, North Dakota, June 20, 1945, but considers Fargo, North Dakota his hometown. He is married and has two children. He has brown hair and hazel eyes. He is 5'7" in height and weighs 160 pounds.