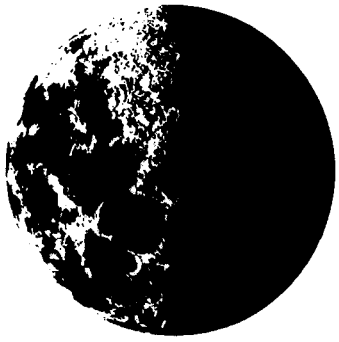
SID 62-319

# APOLLO SPACE SUIT INTERFACE

# SPECIFICATION
(U)

18 April 1962



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## SPECIFICATION
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Approved by

J. W. Paup
Vice President and Apollo Program Manager



[redacted]

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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# 1. SCOPE

1.1 Scope. - This specification provides preliminary design interface requirements between the Space Suit and the Apollo Spacecraft including the mission environments and program requirements. The design requirements shall be incorporated into the Space Suit Performance Specification.

# 2. APPLICABLE DOCUMENTS

2.1 General. - The following documents shall form a part of this specification. Where the requirements of this specification differ from those of the following documents, the requirements of this specification shall have precedence.

2.1.1 Government Documents. -

Military

| | |
|---|---|
| MIL-R-27542(1) | Reliability Program Requirements for Aerospace Systems, Subsystems, and Equipment, dated 31 October 1961 |

Non-Military

| | |
|---|---|
| NASA | Project Apollo Spacecraft Development Statement of Work, Parts I, II, III, IV, dated 18 December 1961 |
| NASA-NCP 200-2 | Quality Assurance Provisions for Space System Contractors |

2.1.2 Non-Government Documents. -

Space and Information Systems Division (S&ID)

| | |
|---|---|
| SID 62-51 | Apollo Spacecraft Specification, dated 28 February 1962 |
| SID 62-52 | Command Module Interface Specification, dated 28 February 1962 |
| SID 62-57 | GSE Performance and Interface Specification, dated 28 February 1962 |

| | |
|---|---|
| SID 62-65 | Apollo Design Criteria Specification, dated 28 February 1962 |
| SID 62-109 | Apollo Spacecraft Preliminary Test Plan, dated 13 February 1962 |
| SID 62-167 | Human Engineering Criteria for Space Systems, dated 1 April 1962 |

## 3. REQUIREMENTS

3.1 General. - The anticipated routine user requirements based on optimization of the suit-mission interface implies consideration of the constant wear undergarment, a radiation and micrometeorite intermittant wear overgarment, and a typical fourteen-day lunar space trip with multiple environments under which the suit will be worn. The most prominent use will be that in the command module, while the most extreme use is envisioned to be that on the lunar surface. The pressure suit is required for extra-vehicular activities, lunar exploration, as a back-up for environmental control system failure, and as an exposure suit for post landing survival. All requirements shall be consistent with the philosophy that man is the prime design entity in the total system. Integration with all aspects of the crew mission should be considered in selecting the suit configuration. NAA/S&ID Specifications SID 62-51, SID 62-52, SID 62-57, SID 62-65 and the NASA-Project Apollo Spacecraft Development Statement of Work will be used as design guides in the development of the space suit.

3.1.1 Environment. - The space suit shall be designed to perform satisfactorily when exposed to hostile environments of space as described in SID 62-65.

3.1.2 Nonconforming Materials. - NASA Specification NCP 200-2 shall be applicable to this specification with the exception of Section 8, Nonconforming Materials.

3.2 Interface Design Requirements. - The design of the space suit will require compatibility with the following criteria:

3.2.1 Constant Wear Garment. - The suit will be designed to be worn over an undergarment, i.e., constant wear garment, resembling a summer flying suit, which will be worn by the crewmen at all times. The one-piece garment will be the primary clothing for the crewmen and shall integrate functions of comfort, minor impact protection, hygiene, bio-monitoring, and possible electrical heating elements in the event a thermal source is needed for overall pressure suit operations. An air distribution system may be incorporated within the constant wear garment. The undergarment will be free of protruding pockets or attachment hardware and will include an energy-absorbing fitted hood and headset-microphone communications equipment suited for use in both the pressure suit and vehicle. Appropriate openings will be allowed for urination and defecation, with throw-away pads in the apocrine sweat gland regions. The pads will serve as odor and bacterial control without affecting the pressure suit as a whole. The entire undergarment assembly will be worn under the pressure suit and will serve as a carrier for communications, heating, bio-monitoring, etc.

3.2.1.1 Electrical Interface Connections. - Electrical connections between the constant wear garment and the pressure suit system will be grouped in such a manner as to be compatible with quick donning and doffing, and with the connector and plug located for comfort and easy mating in both garments.

3.2.2 Life Support System (LSS). - A bio-pack (LSS) will be a part of the pressure suit. When the crew member is in the command module, an umbilical line from the module's environmental control system to the pressure suit will replace the bio-pack (the system is shown in Figure 1).

3.2.3 Helmet Assembly. - The helmet will be joined to the suit by means of a positive, single-motion locking action adapter ring. Restraint will be compatible with the Apollo seat and crash loads of 55 G for 0.01 seconds (facing aft). Nutritional, defogging, visor heating, regurgitation trap, and shielding provisions will be necessary. The helmet will provide protection of the face from direct space sunlight while producing a minimum of distortion for television viewing of the face of the crewman. Provisions for a common inlet disconnect point to a 70 psi connector will be integral. The helmet will have shielding properties for protection against UV and Beta radiation, and be appropriately coated with low emissivity reflective material to enhance infra-red and visual attenuation.

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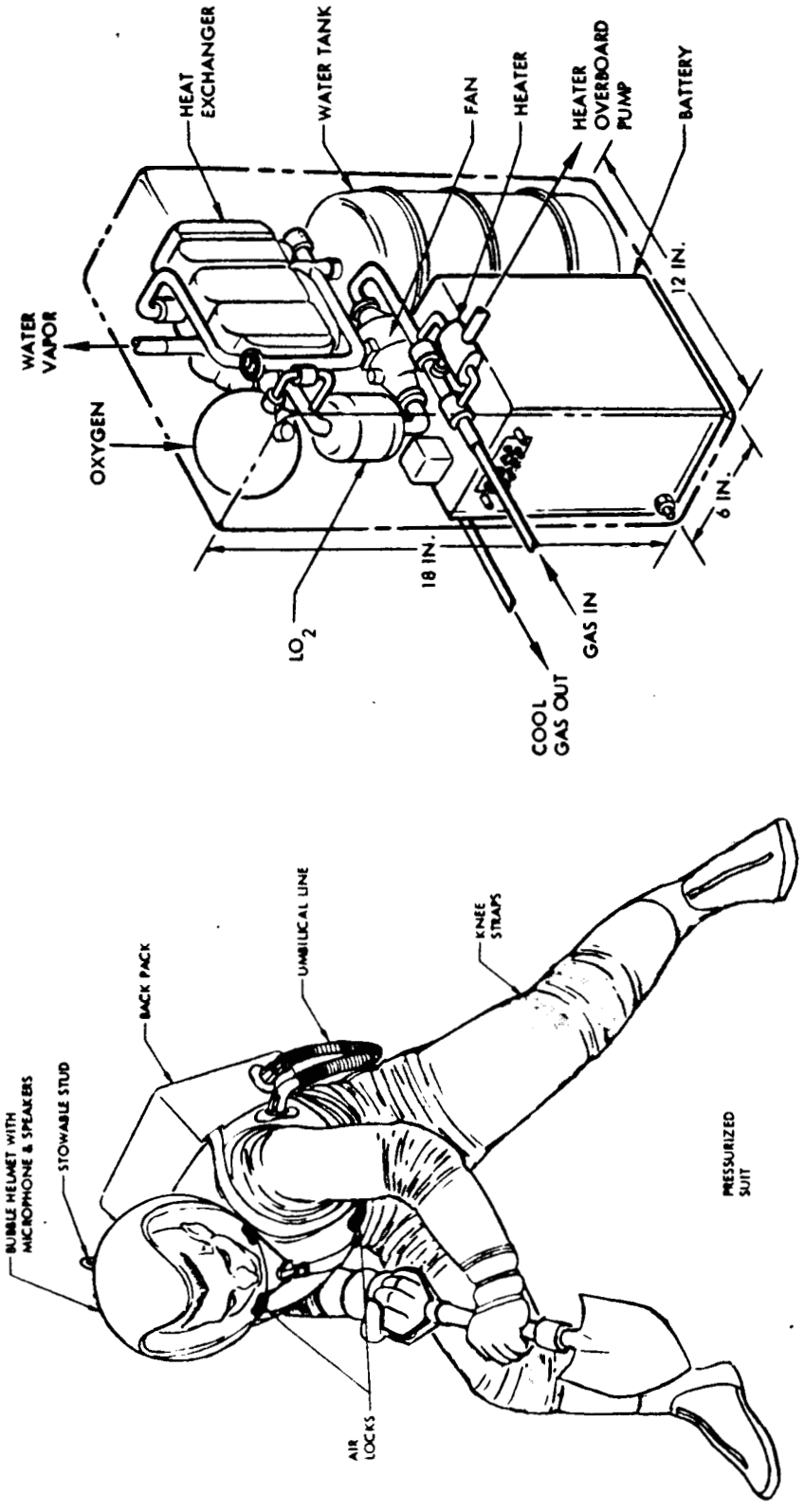


FIGURE 1

Typical Pressure Suit and Portable Life Support System



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3.2.3.1 Vision and Visual Control. - Vision requirements to facilitate visual control in the command module will be integral with the helmet development. Unrestricted vision in the horizontal of 190 degrees plus 75 degrees up and 75 degrees down from straight line of sight will be required.

3.2.4 Suit Donning. - The suit will be designed to allow the crewman to don or doff the suit, complete with helmet, within five minutes without any assistance from other crewmen.

3.2.5 Command Module Ingress and Egress. - The suit shall allow direct unassisted ingress and egress to the Apollo Command Module while inflated or uninflated.

3.2.5.1 Additional Egress Considerations. - Consideration will be given within the early stages of the Command Module development to provide for the use of personal parachutes.

3.2.6 Suit Mobility. - The suit shall permit reasonably unrestricted mobility while performing all required tasks within the design limits of the Apollo vehicle. When pressurized to 5 psig, the suit will allow a crewman to open and enter the Apollo airlock and to enter the crew compartment from the airlock. The inflated suit will allow the occupant easy ingress/egress to the seat. Hand dexterity will allow apposition of the thumb with each finger. Wrist articulation will be sufficient to operate a side arm controller throughout its entire range. Mobility requirements to satisfy the anticipated intra/extravehicular crew activities shall be met. See Figure 2 for anthropometric considerations.

3.2.6.1 Donning - LSS. - The suit LSS will be designed so that a crewman can don or doff the equipment without assistance from another crewman.

3.2.6.2 Walk-Around Capability - LSS. - The suit LSS will provide not less than a four (4) hour walk-around capability for lunar exploration or for unscheduled inflight maintenance on exterior of the spacecraft during lunar transit whether in the direct sunlight or shadow.

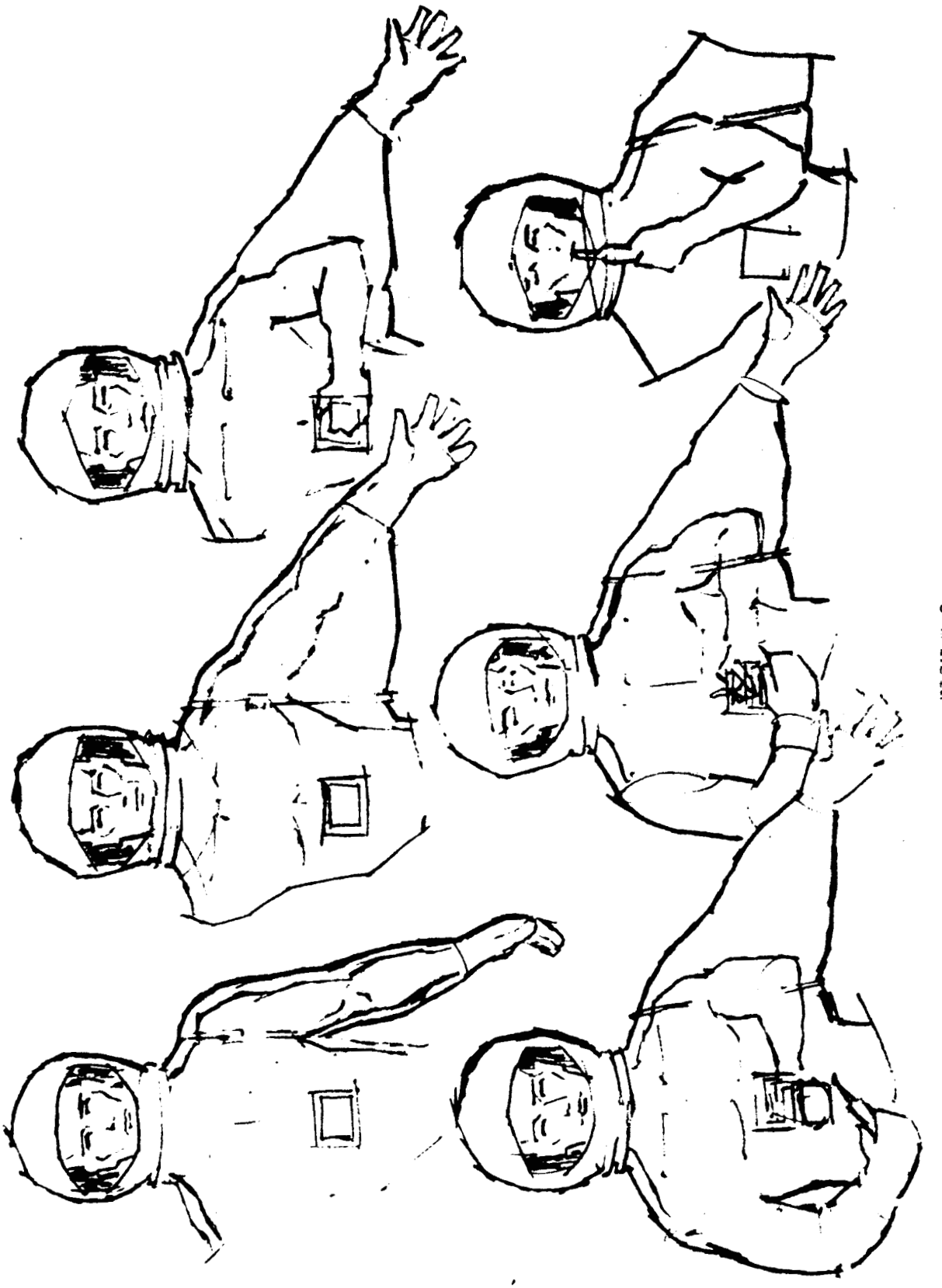

FIGURE 2
Some Pressure Suit Anthropometric Considerations

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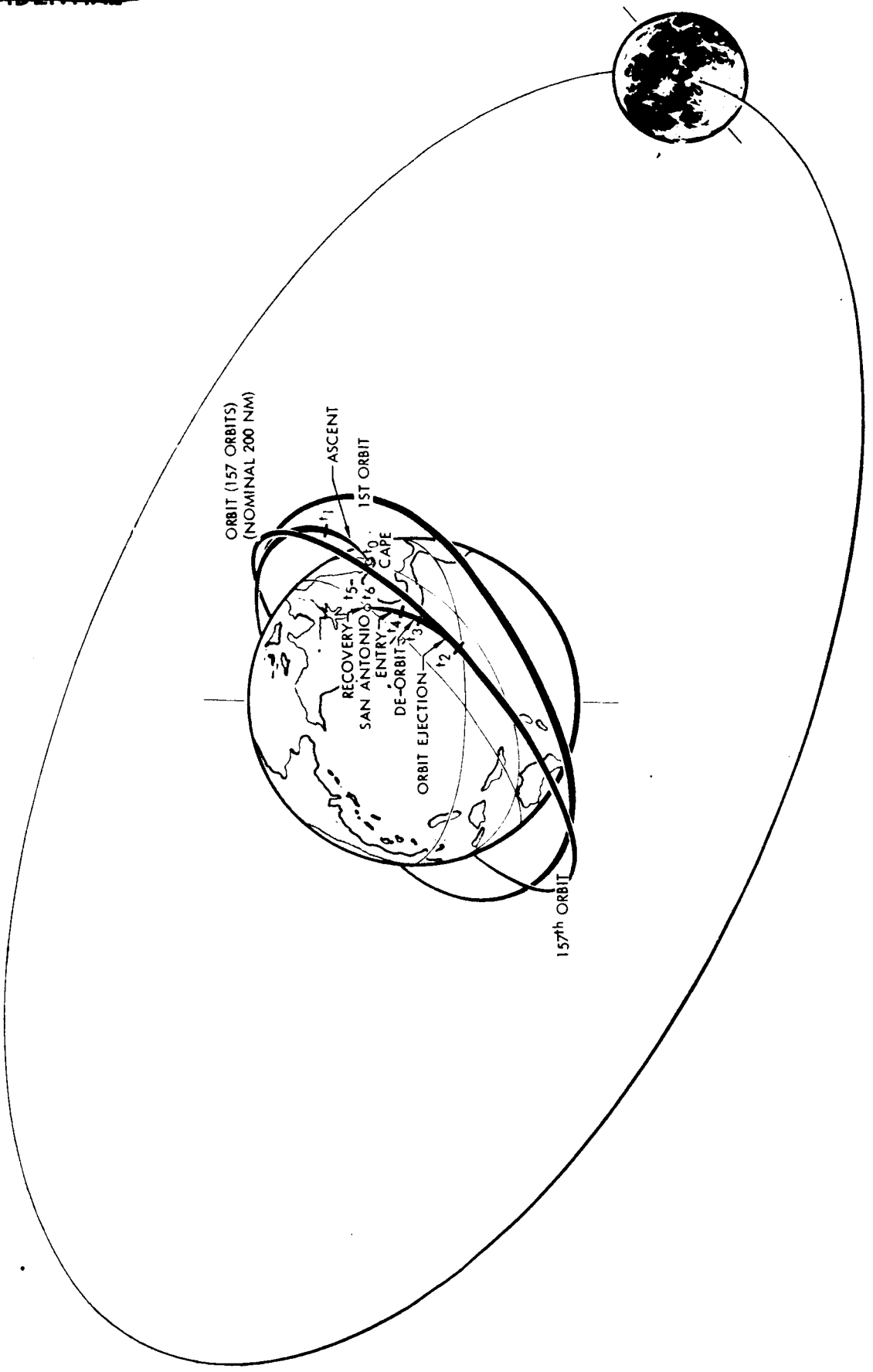


Figure 2. Flight Trajectory—Earth Orbital Mission



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3.2.6.3 Suit Attachments. - The suit LSS will be equipped with attachments for attaching two (2) pressure suits to one (1) LSS under emergency conditions.

3.2.6.4 Emergency Use of LSS. - Emergency use of one suit LSS by two crewmen shall not unduly compromise suit mobility. The emergency attach hardware shall allow one crewman to carry another on his back, or allow two crewmen to walk single-file or side-by-side.

3.2.6.5 LSS Recharge. - The suit LSS will be designed to be recharged to approximately 900 psi from the Apollo Environmental Control System. The suit connectors will be quick-disconnect, self-sealing type fittings.

3.2.6.6 Anticipated Duty Cycles. - The anticipated duty cycles that the pressure suit will be compatible with are:

(a) Non-pressurized scheduled periods up to 8 hours for pre-launch and through translunar injection, or at any time the vehicle undergoes acceleration

(b) Pressurized scheduled periods for extra-vehicular activities of up to 8 hours (non-acceleration segments of the mission). The majority of the time that the suit will be used in the space environment, between 100 nautical mile earth orbit and the lunar surface, it will be in direct rays of the sun. The suit will also be worn by the crewman while working in the vehicle's shadow

(c) The suit will be "tolerable" for periods up to 96 hours of continuous wear in a normal pressurized condition (3.5 psi).

3.2.7 Airlock Egress. - The Apollo airlock dimensions will require that the pressure suit and life support system or back-pack (LSS) be designed so that egress can be achieved through an elliptical hatch opening with greatest dimensions of 25 inches x 27 inches. Airlock egress and ingress is shown in Figure 3.

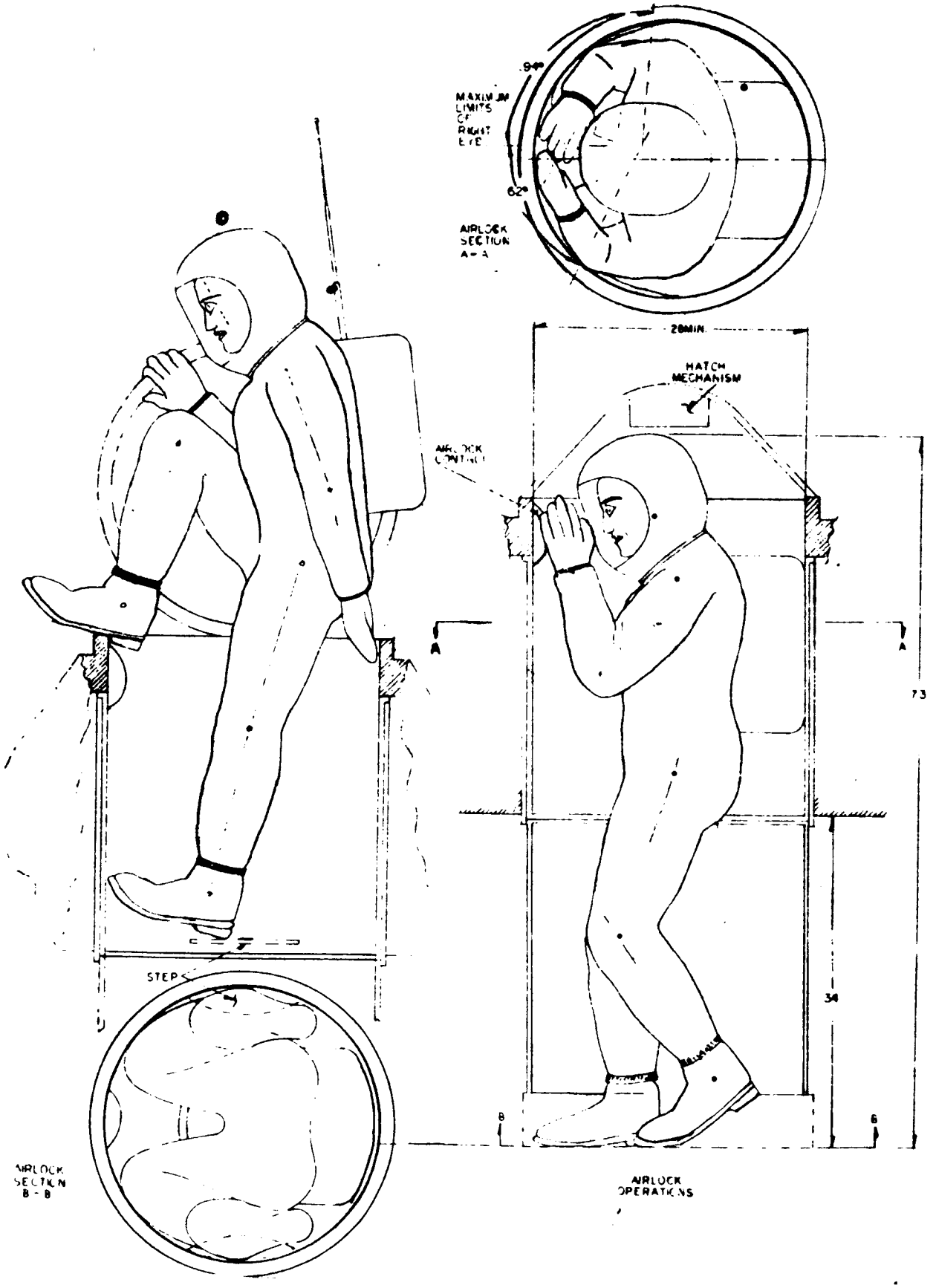


Figure 3 - Airlock Ingress-Egress

3.2.8 Thermal Resistance. - An integrated Clo value of 4.0 which would include the constant wear garment, will be required to allow sufficient thermal inertia to offset rapid temperature transients and will allow the environment control system or bio-pack to compensate. Low Clo to weight ratio will be of major consideration in development.

3.2.9 Portable Light. - A portable light source will be required and will be hand held or attached to the wrist of the pressure suit. The color of the light will be white, will resemble visual solar radiation, and will demonstrate no stroboscopic effects. The light will satisfactorily operate for a minimum of 4 hours, will operate in a vacuum with temperatures from minus 240 to plus 210 degrees F, and will provide a controlled beam of 500 lumens. The light source shall not expose the crew member to a heat radiation of greater than 120 degrees F.

3.2.10 Suit Provisions. - The suit shall allow for:

(a) Eating
(b) Drinking
(c) Defecation
(d) Urination
(e) Regurgitation.

3.2.11 Restraint Harness. - The suit may contain an integrated restraint harness with attach points at shoulders and hips which will be compatible with the restraint attach points of the couch. The attach points and fittings will be designed in such a way that the backpack may be attached to the suit by utilizing the fittings of the restraint harness.

3.2.12 Ventilation. - Ventilation will be provided to all portions of the suit extremities and will accomplish thermal equilibrium through convection methods. The suit inlet valve will be guarded against functional failure during post landing immersion. A neck-seal will prevent suit-helmet exchange of gas and will assist the water immersion requirement of post landing.

3.2.13 Vehicle Storage. - The pressure suit will be designed to be stored in the smallest possible space. Considerations for folded storage or flat storage will be examined early in development to ensure coordination with the vehicle development.

3.2.14 Suit Life. - The suit shall be designed to perform satisfactorily without major overhaul after being donned, worn and removed as many times as required for preflight checkout and for three lunar missions.

3.3 Spacecraft Mission Requirements. - The anticipated optimization of the suit-mission interface requirements implies consideration of the lunar mission, the pressure suit subsystem, and the multiple environments in which the suit will be worn. The following data provides interface parameters for the spacecraft-mission suit design requirements:

3.3.1 Lunar Mission Modes. -

(a) Pre-Launch. -

Time: Four to eight hours.
Temperature: Ambient 40°F - 120°F.
Suit Use: The crew will enter the Command Module through the air-lock, lie on couches, fasten restraint system, connect suits to ECS, await "Launch" command, and monitor the instruments.

(b) Boost. -

Time: 10 minutes.
Temperature: Command Module +165°F to -75°F.
Suit Use: The Command Module will depressurize automatically to 7 psia. Crew will monitor instruments. Suit design shall allow operation of "Abort" controls during boost.

(c) Parking Orbit. -

Time: 2 hours to two days.
Temperature: Command Module: +165°F to -165°F.
Exterior +308°F to -200°F.
Suit Pressure: 3.5 psia to 5 psia.
Other Parameters - See Specification SID 62-65.
Suit Use: The crew will remove suits, the man on duty will remain in suit. The suits will be donned for exit from Command Module to perform inflight maintenance or assembly of units at orbital rendezvous. Suits will be donned in preparation for lunar injection. Suit will be required if capsule pressurization fails.

(d) Lunar Injection-Transit. -

Time: 56-85 hours.
Temperature: Same as c.
Suit Use: Suit worn by man on duty at the controls. "Shirtsleeve" environment for rest of the crew. Suit donned for in-flight maintenance on exterior of the vehicle. Suit worn by the crew in preparation for, and during, midcourse correction motor firings. The suit will be required in case of Command Module pressurization failure, up to 96 hours continuous wear.

(e) Lunar Orbit Insertion. -

Time: Minutes.
Other Parameters: See Specification SID 62-65.
Suit Use: Suit will be worn during orbit establishment. Suit will be required for any exterior in-flight maintenance. Suit will be required in case of Command Module pressurization failure.

(f) Lunar Landing. -

Time: Minutes.
Other Parameters: See Specification SID 62-65.
Suit Use: Suits worn by all crewmen for lunar landing. Suit will be worn by man on-duty after landing.

(g) Lunar Exploration. -

Time: Up to 7 days.
Other Parameters: See Specification SID 62-65.
Suit Use: Suit worn by man on-duty in Command Module. Two-man exploration crew will wear suits on lunar surface for at least 4-hours continuous wear up to 8-hours wear. Suit will be worn up to 96-hours if Command Module decompresses. "Buddy" use of the suit LSS will be required in case of another crewman's suit failure.

(h) Lunar Launch. -

Time: 1 minute.
Other Parameters: See Specification SID 62-65.
Suit Use: Suits will be worn during launch.

(i) Earth Injection-Transit. -

Time: 56-85 hours, maximum.
Other Parameters: See Specification SID 62-65.
Suit Use: Suits will be worn by all crewmen during rocket firing to enter earth transit phase. Suit will be worn by man on-duty at controls. Suits will be worn for external in-flight maintenance. Suits will be worn continuously for a Command Module decompression.

(j) Earth Entry. -

Time: Minutes to hours.
Other Parameters: See Specification SID 62-65.
Suit Use: Suits will be worn by all crewmen during final approach to entry.

(k) Landing. -

Time: Minutes.
Other Parameters: See Specification SID 62-65.
Suit Use: Suits will be worn by all crewmen. If the crew is required to bail out the suit shall not interfere with exit through the emergency escape hatch, with the parachute. The suit shall be capable of supplying air during the descent and landing following bail out.

(l) Post-Landing. -

Time: Minutes to 23 hours.
Other Parameters: Any earth terrain, (e.g., Desert, Mountain, Ocean ).
Suit Use: Suits are worn until after crew has left the Command Module.

3.4 Operation and Storage. - The suit shall be capable of operating satisfactorily throughout all modes after being subjected to permanent storage for a minimum of one year with the necessary required periodic maintenance.

3.5 Reliability Program. - The suit supplier shall have or establish a reliability program that conforms to the requirements of Specification MIL-R-27542, except that SID 62-167 will replace MIL-STD-803 as an applicable document. Reliability requirements will be apportioned to each suit as outlined in Test Plan SID 62-107.

## 4. SUIT TEST PROGRAMS

4.1 Test Program Integration. - Performance and compatibility testing of the space suit will be developed and conducted by S&ID. Confinement, environmental, and flight simulation tests will be developed and conducted with the space suit and spacecraft as a participating effort of the suit contractor and S&ID, and will conform to applicable portions of Test Plan SID 62-109.

4.2 Space Suit Contractor Test Program. - The Space Suit Contractor will be responsible for the preparation of the plans and procedures, and performance of the Qualification Test Program. Test data and reports will be reviewed by NASA and S&ID.

## 5. TECHNICAL COORDINATION

5.1 Representation. - The space suit contractor will provide technical representation at S&ID on a full-time basis or as required to ensure full coordination of interfaces with S&ID Apollo engineering. S&ID will provide similar representation as required at the space suit contractor's plant.

5.2 Technical Data. - S&ID and the space suit contractor will exchange appropriate technical information, schedules, configuration control drawings, progress reports, and other documents to ensure interface compatibility and conformance with all applicable specifications and other contractual requirements.

## 6. DELIVERY REQUIREMENTS

6.1 Quantities and Schedules. - The S&ID Spacecraft Test Program schedule requires that the prototype suit be delivered in quantities and schedules as shown below. The suit contractor will coordinate with S&ID to determine size characteristics (10 to 90 percentile) and the degree of qualification of each of the suits listed: The following schedule is based on ready-to-wear suits delivered to S&ID, Downey, California, on or before the corresponding dates.

| | | |
|---|---|---|
| 14 | prototype astronaut (manned) suits | Nov. 1, 1962 |
| 7 | prototype dummy suits | Jan.2, 1963 |
| 3 | astronaut suits | March 1, 1963 |
| 7 | dummy suits | March 1, 1963 |