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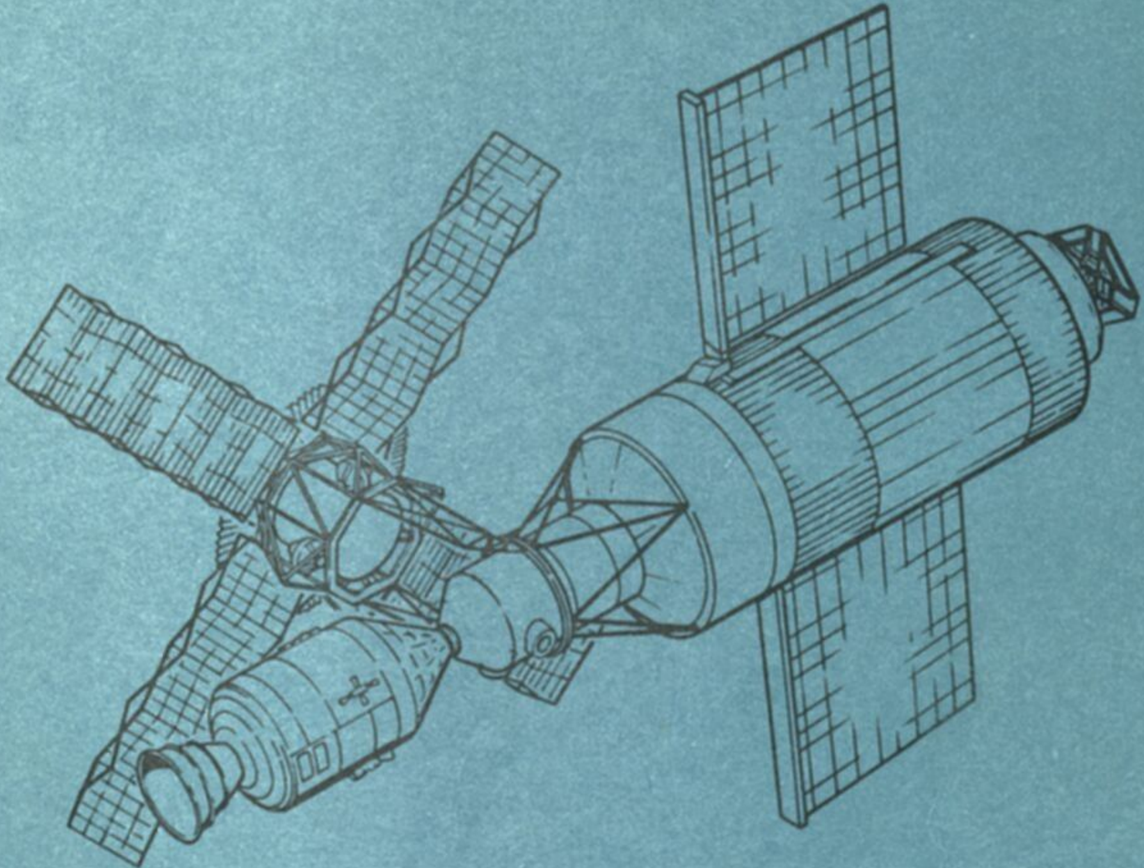

SKYLAB SYSTEMS HANDBOOK

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

MCDONNELL DOUGLAS

CORPORATION

SKYLAB SYSTEMS HANDBOOK

AN INTRODUCTION TO

SKYLAB AND ORBITAL WORKSHOP SYSTEMS

This handbook was prepared by MDAC-W Logistics Engineering, Orbital Workshop Training, as a reference document for Skylab/Orbital Workshop Systems orientation and familiarization briefings.

Use of this document in whole or in part for other than general information or training reference is not authorized.

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SKYLAB ORIENTATION

CONFIGURATION

The Skylab consists of the Apollo Telescope Mount (ATM), which is also referred to as the Solar Astronomy Array, and the Orbital Assembly Module. The Orbital Assembly Module (OAM) consists of the Multiple Docking Adapter (MDA), the Airlock Module (AM) including the Fixed Airlock Shroud (FAS), the Instrument Unit (IU), and the Orbital Workshop (OWS). The Instrument Unit is normally considered as part of the launch vehicle, but because of its function in preparing the Skylab, it is here considered as part of the Orbital Assembly Module.

The Apollo Applications Command and Service Modules (CSM) are not considered part of the Skylab, but when docked with the Skylab, the entire cluster is referred to as the Orbital Assembly (OA).

The launch configuration for the Skylab (SL-1) mission consists of the following:

- o Saturn 1C Stage
- o Saturn II Stage
- o Skylab
- o Payload Shroud

The launch configuration for the SL-2, SL-3, and the SL-4 missions consist of the following:

- o Saturn 1B Stage
- o Saturn SIV-B Stage
- o Instrument Unit
- o Spacecraft Lunar Module Adapter (SLA)
- o Command and Service Modules
- o Launch Escape Assembly (LEA)

MISSION DESCRIPTION

The Skylab Program consists of three earth orbit missions: SL-1/2, SL-3, and SL-4, and extends over a period of about eight months.

SL-1/2 Mission

The first mission, SL-1/2, consists of two launches approximately one day apart. This mission is 28 days in duration.

The SL-1 vehicle uses a Saturn V Launch Vehicle to place the Skylab in orbit about the earth at approximately 250 miles. After insertion, the S-II Stage is separated by retrorockets, and the Skylab is pitched downward by instrument unit command to the Thruster Attitude Control System (TACS). As the Skylab passes through nose-down attitude, the payload shroud is jettisoned. When the Skylab achieves retrograde attitude, the instrument unit commands the deployment of the Apollo Telescope Mount (ATM), and the orientation of the Skylab to a solar inertial attitude using the TACS. The solar inertial attitude, with the Skylab axially aligned in the orbital plane, and the ATM solar cannister pointing directly at the sun, is the primary attitude for all Skylab missions except for CSM docking and earth resources passes.

After solar inertial attitude has been acquired, the instrument unit commands deployment of the ATM and OWS solar arrays, and the OWS meteoroid shield. The ATM Control Moment Gyros (CMG) are activated at this time.

The SL-2 vehicle uses a Saturn 1B Launch Vehicle to orbit the Apollo CSM and the Skylab crew. The Skylab is oriented to a rendezvous/earth resources attitude, in which the ATM solar cannister continuously points to the earth, and the CSM docks at the MDA axial docking port. The crew then transfers to the Skylab and activates the OA systems for on-orbit activities.

SL-3 Mission

The second Skylab mission consists of one launch, using a Saturn 1B Launch Vehicle, approximately 80 days after the SL-2 launch. The CSM rendezvous and docking is identical to SL-2. This mission has a planned duration of 56 days.

SL-4 Mission

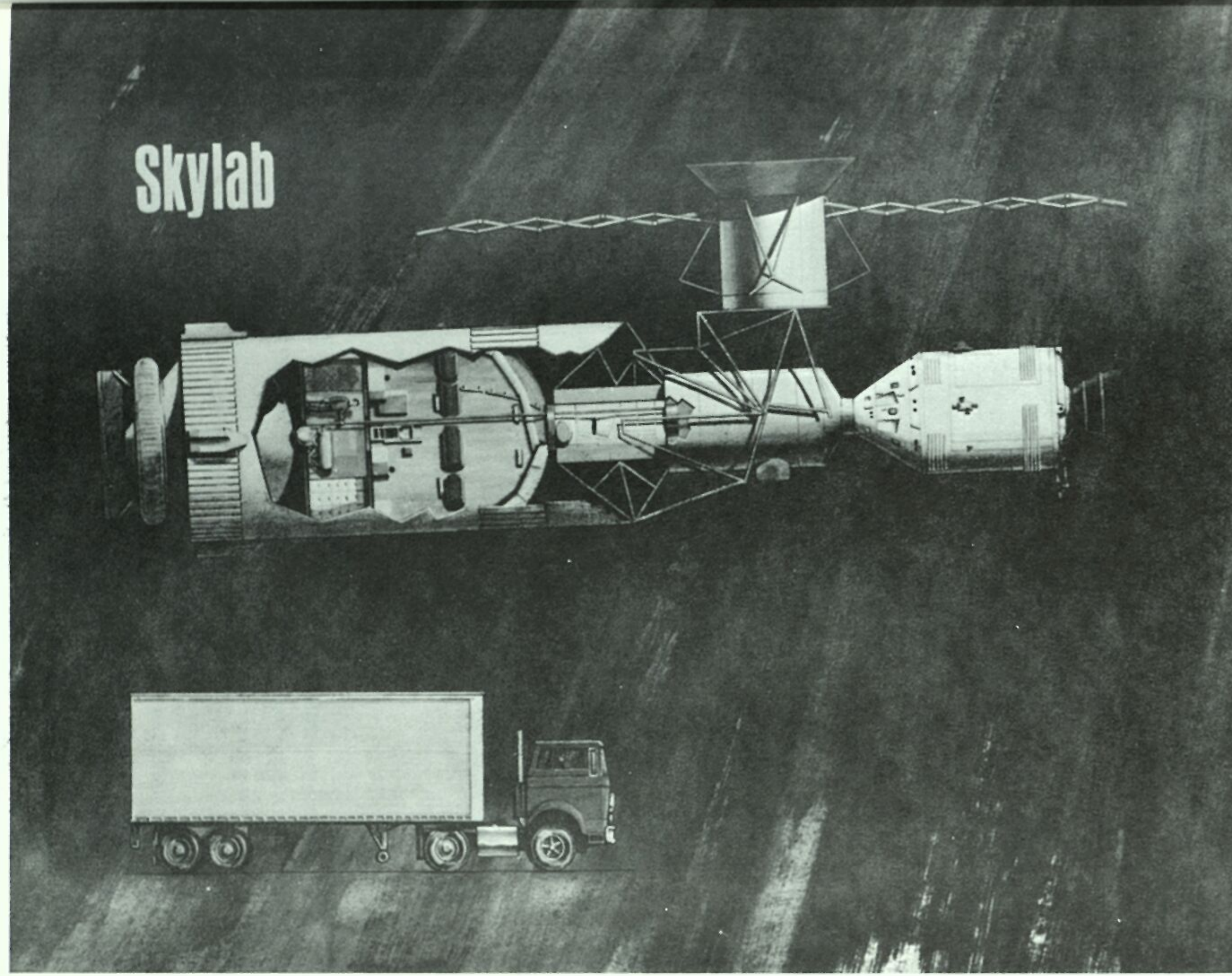
The final mission, SL-4, uses a Saturn 1B Launch Vehicle. The launch occurs approximately 103 days after the SL-3 launch. The duration of this mission is also scheduled for 56 days.

MISSION OBJECTIVES

Mission objectives for the three Skylab missions are as follows:

- O Establish an experimental space station in orbit
  - o Operate the OA as a habitable space structure for long duration missions of 28 to 56 days.
  - o Obtain data for evaluating OA performance.
  - o Obtain data for evaluation of astronaut mobility and work capability for intra- and extravehicular activities.
- O Extend the duration of manned spaceflight.
  - o Obtain biomedical data for evaluating the effects of zero-g missions of 28 to 56 days on crew members.
  - o Determine the feasibility and advisability of manned zero-g spaceflights with durations greater than 56 days.
- O Perform inflight experiments.
  - o Obtain solar astronomy and stellar astronomy data in several wavelengths to continue and extend studies beyond the limits of terrestrial observations.

- Obtain data for the evaluation of extended weightlessness on man.
- Obtain data for the development of operational procedures for extended manned orbital operation.
- Obtain engineering and technological data for development of advanced space vehicles and equipment.


Skylab

ORBITAL WORKSHOP

SKYLAB ORBITAL ASSEMBLY CONFIGURATION

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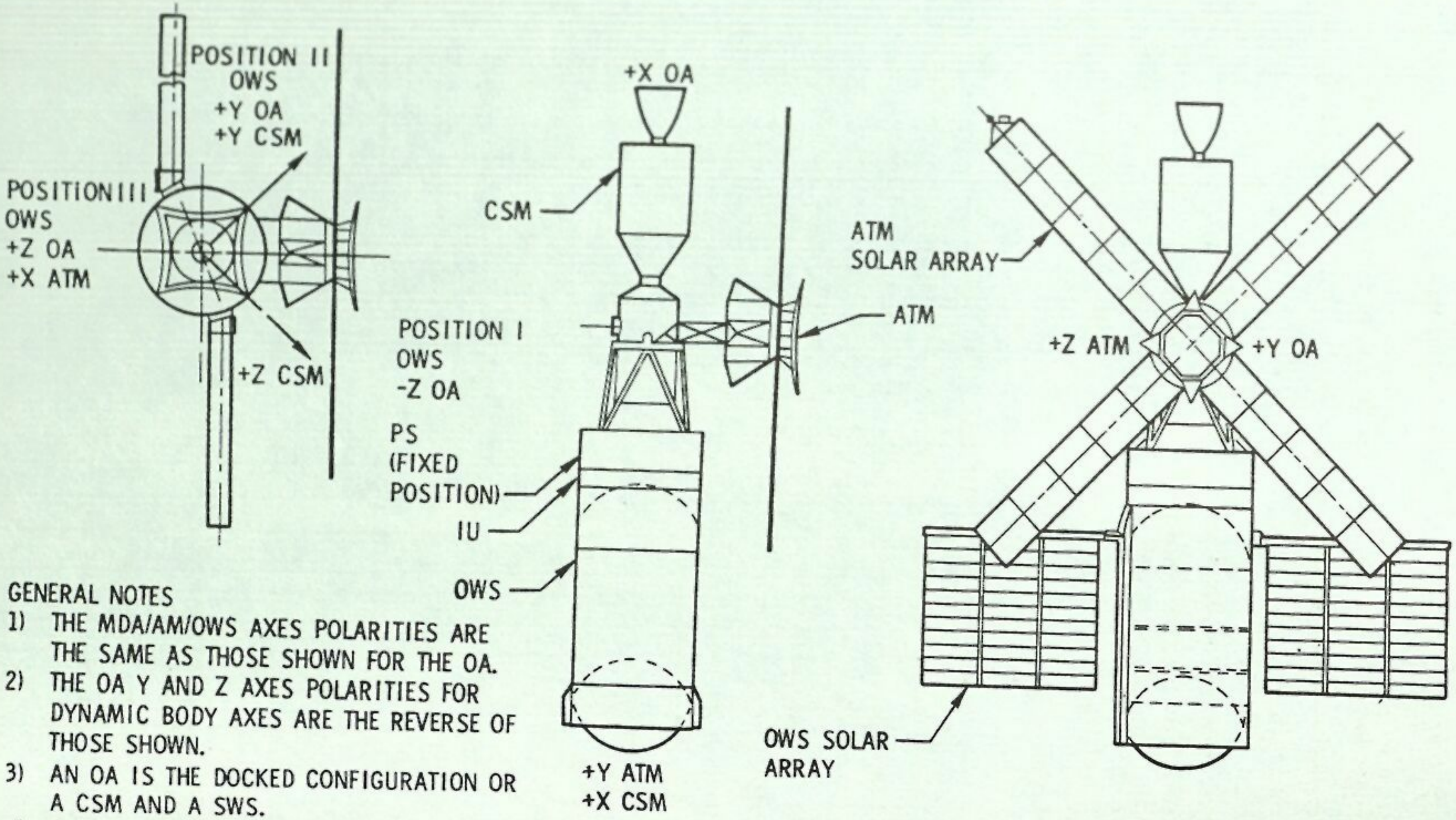


GENERAL NOTES

1) THE MDA/AM/OWS AXES POLARITIES ARE THE SAME AS THOSE SHOWN FOR THE OA.
2) THE OA Y AND Z AXES POLARITIES FOR DYNAMIC BODY AXES ARE THE REVERSE OF THOSE SHOWN.
3) AN OA IS THE DOCKED CONFIGURATION OR A CSM AND A SWS.
4) A SWS IS THE OWS/AM/MDA/ATM/PS/IU.

APOLLO APPLICATIONS COMMAND AND SERVICE MODULE

The Apollo Command and Service Module, while not part of the Skylab, is considered along with the other modules as part of the Orbital Assembly (OA) when docked in orbit.

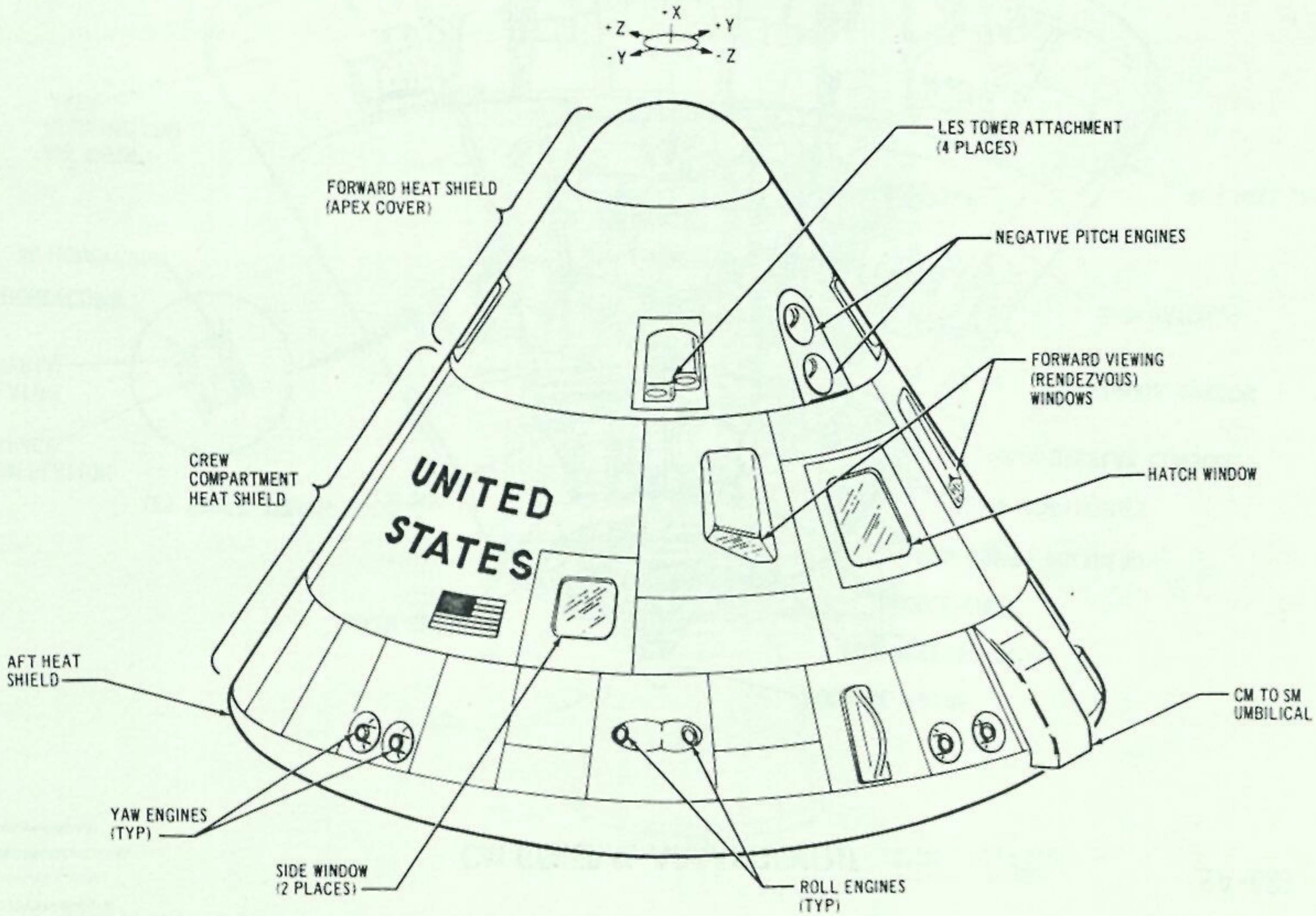
The Command Module is the control center of the Apollo spacecraft, and contains necessary automatic and manual equipment to control and monitor the spacecraft systems. It also contains the required equipment for the safety and comfort of the three-man crew. The module is an irregular-shaped primary structure encompassed by three heat shields, forming a truncated conic structure. The CM consists of a forward compartment, a crew compartment, and an aft compartment for equipment stowage. The module is approximately 12 feet long and 13 feet in diameter at the base. The forward compartment surrounds the forward access tunnel which interfaces the Skylab MDA, and most of the equipment stored in the forward compartment is earth landing (recovery) system (ELS) equipment. The crew compartment or inner structure is a sealed cabin with pressurization maintained by the Environmental Control System (ECS). The compartment, protected by a heat shield, contains controls and displays for operation of the spacecraft and spacecraft systems, crew couches and restraint harness assemblies, window, crew equipment such as food and water, waste management, and survival provisions. The aft area compartment is encompassed by the aft portion of the crew compartment heat shield, aft heat shield, and aft portion of the primary structure. This compartment provides reaction control engines, the impact attenuation structure, instrumentation, and storage tanks for water, fuel, oxidizer (RCS), and gaseous helium.

The service module is a cylindrical structure about 13 feet long and 13 feet in diameter. The Service Module (SM) contains service and reaction control propulsion systems including their respective propellants, descent battery pack, fuel cells, for power generation (and contingency water production), and storage tanks for oxygen and hydrogen.

Both the command and service modules have been modified from previous Apollo configurations to better meet the mission requirements of the Skylab series.

The command and service modules are attached to the launch vehicle via a Spacecraft Lunar Module Adapter (SLA) which is empty except for a stabilizing device which provides structural support to the outer skin of the adapter. The adapter is a truncated cone structure.

APOLLO COMMAND MODULE (CM) EXTERIOR



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CM GENERAL ARRANGEMENT

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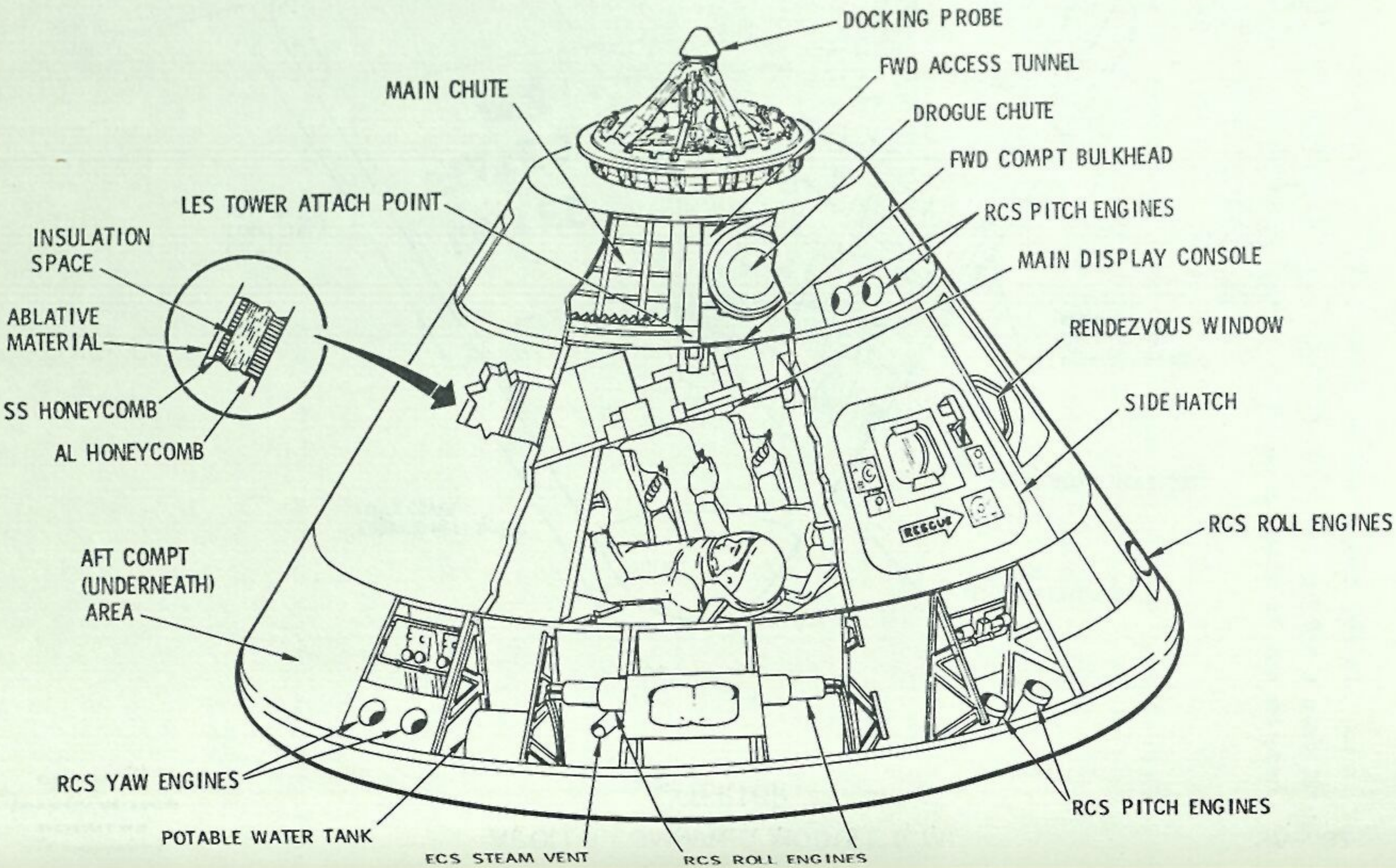
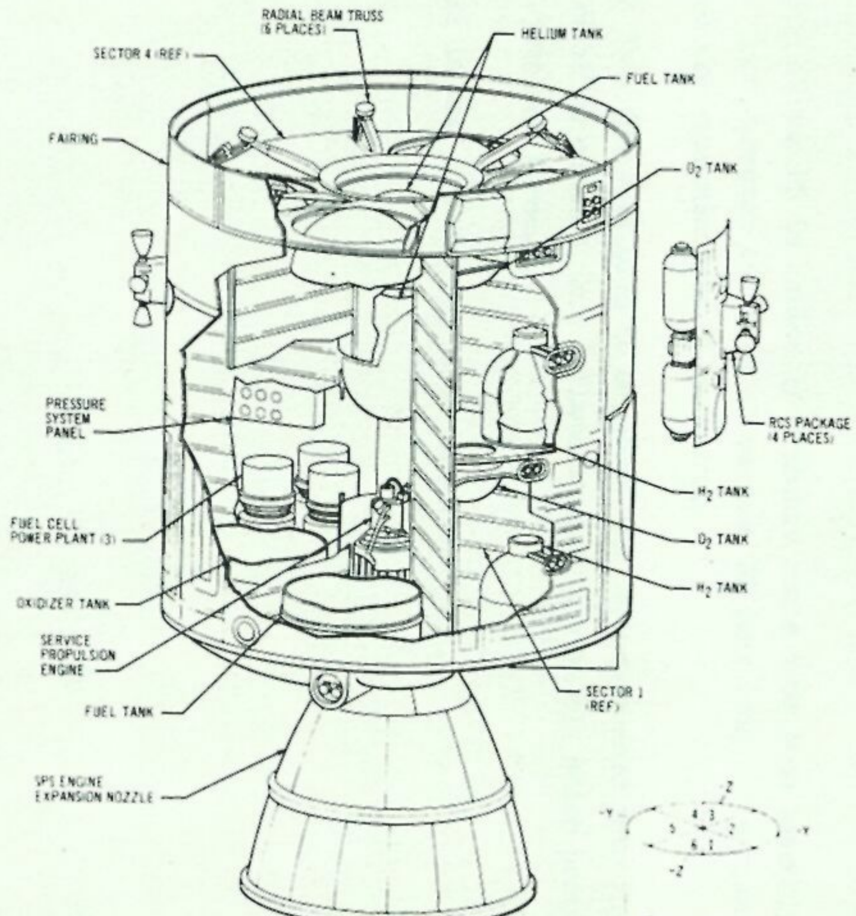


APOLLO SERVICE MODULE (SM)



SECTORS (TOP VIEW)

1 AND 4 ARE 50-DEGREE SECTORS
2 AND 5 ARE 70-DEGREE SECTORS
3 AND 6 ARE 60-DEGREE SECTORS

PAYLOAD SHROUD (PS)

The payload shroud provides an aerodynamic envelope for the ATM, MDA, and part of the AM during boost phase of the mission. It also provides support for ATM loads during prelaunch, launch, and boost. These loads are transmitted to the PS/FAS interface. After orbital insertion, during the retrograde maneuver, the payload shroud is separated into four quarter segments and jettisoned.

The configuration of the PS is basically a double angle nose cone assembly mounted on a 22 foot diameter cylindrical section 30 feet long. The nose cap and forward cone are approximately 15 feet long.

Mild Detonation Fuse (MDF) is used to separate the payload shroud into four quarter segments at IU command, and inflate a bellows assembly which provides separation and jettison force.

Primary material in the payload shroud is aluminum.

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SKYLAB
LAUNCH CONFIGURATION

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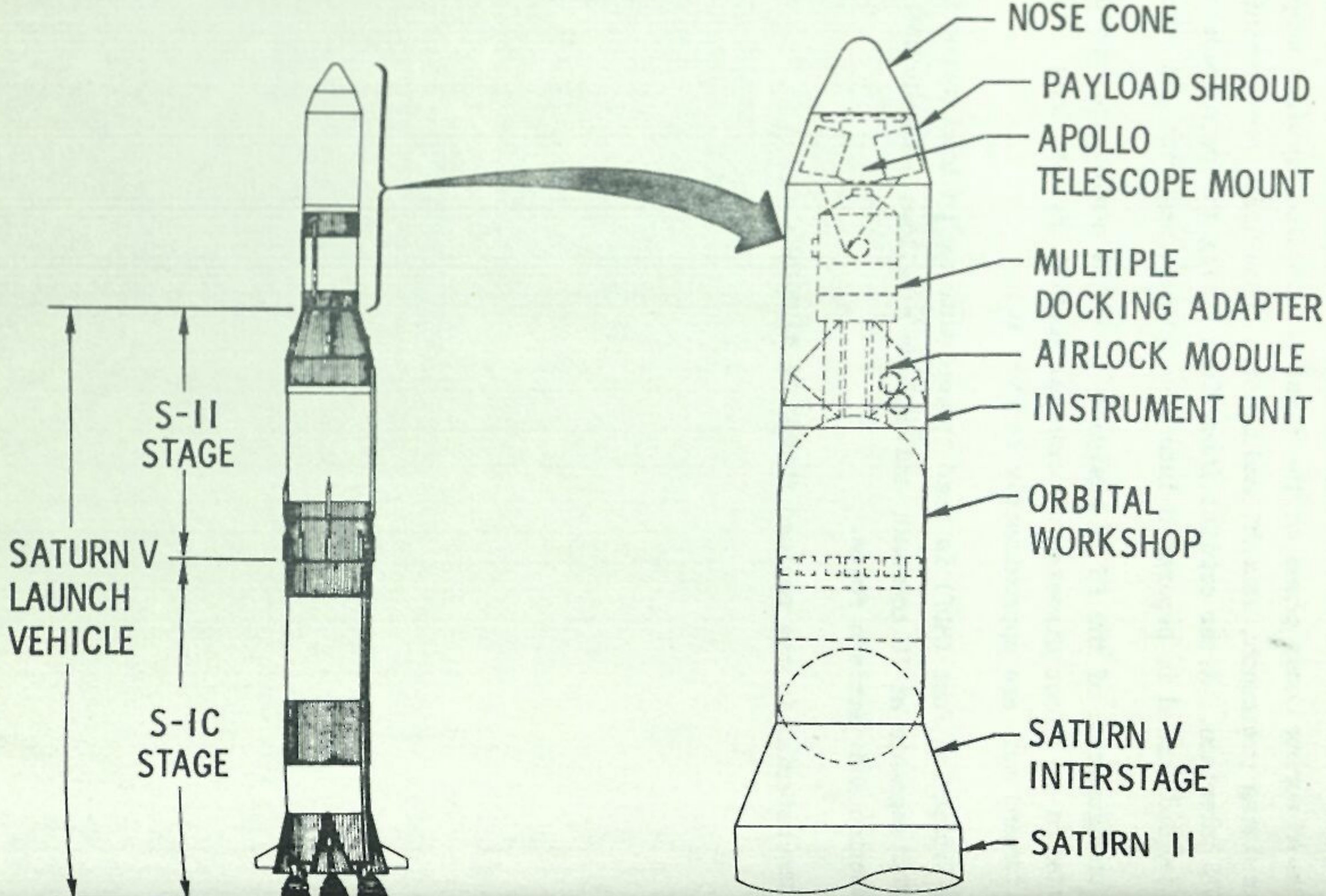
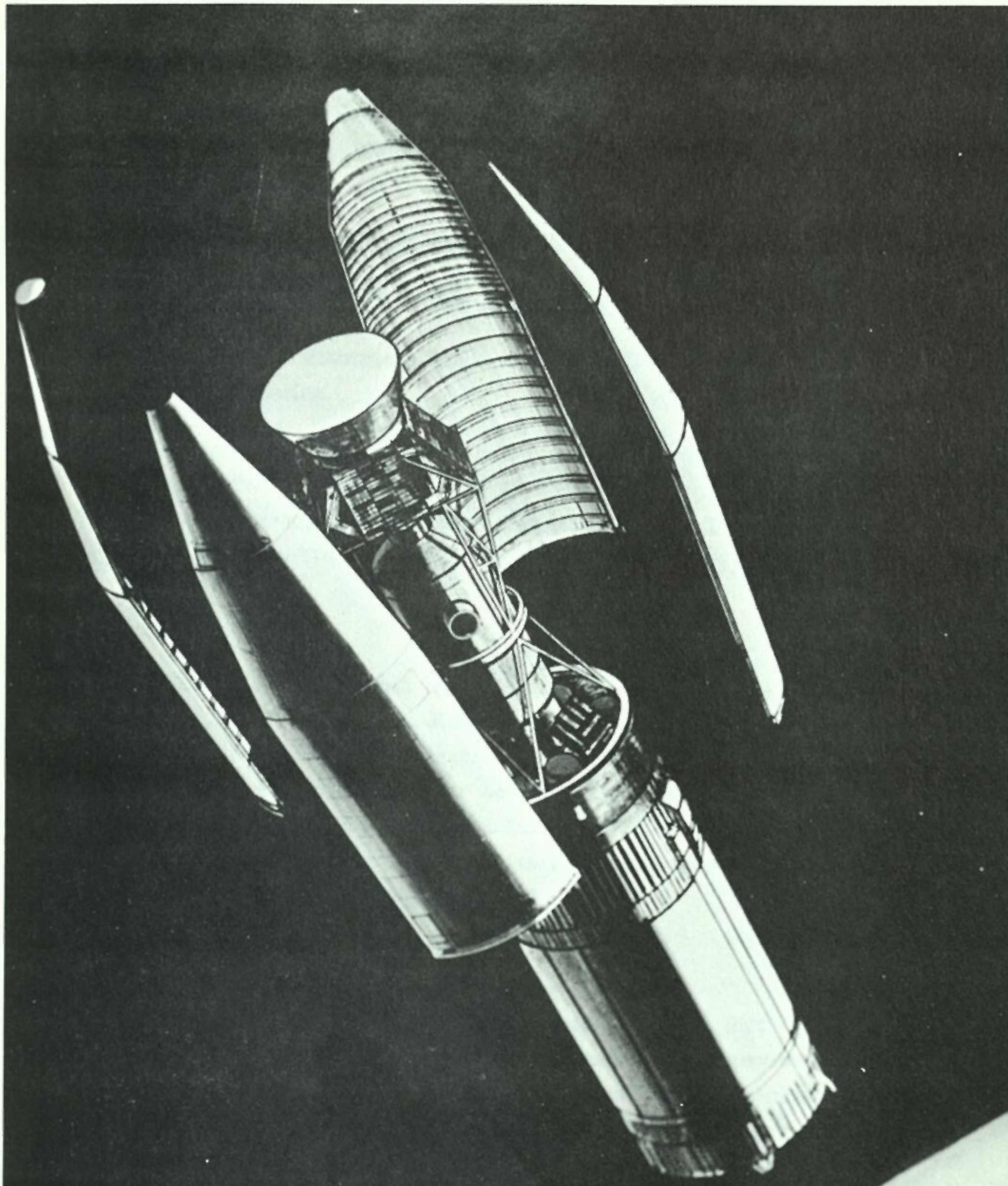




APOLLO TELESCOPE MOUNT (ATM)

The Apollo telescope mount consists of a rack, experiment cannister, solar array, Control and Display (C&D) console, and various support subsystems. The ATM provides the OA with:

- Attitude control via the Control Moment Gyro (CMG) subsystem
- Electrical power for the ATM experiments via the solar array
- Sharing of OA electrical loads with the OWS solar array system and the AM batteries.

The ATM is launched in a stowed position forward of the MDA axial port (#5), and is deployed after orbital insertion by a motorized deployment mechanism at IU command. After the ATM is locked into place, the solar arrays are deployed at a subsequent command from the IU.

ATM Rack

The ATM rack is an octagonal structure approximately 11 feet across and 12 feet high, with a 14 foot diameter solar shield at one end, and four truss type structural members extending from four of the eight sides. The rack is open in the center to accommodate the experiment cannister and has attachment points for the solar array and most of the ATM subsystem equipment on the exterior of its sides and one end. It is mounted to the ATM deployment assembly (ATM-DA).

Experiment Cannister

The experiment cannister is a cylinder approximately 7 feet in diameter, 10 feet in length, and closed at both ends except for experiment viewing doors. It has a cruciform spar inside, to provide for experiment mounting. The cannister is attached to the rack by means of a two-degree-of-freedom gimbal and roll mechanism called the Experiment Pointing Control System (EPCS) which allows more accurate pointing control than the OA attitude control provides. Some subsystem equipment is mounted on the MDA end of the cannister.

Solar Array

The ATM solar array is the electrical power source for the ATM. The array consists of four wings covered with solar cells, and the means to deploy them on-orbit. The wings are attached to the experiment end of the rack perpendicular to the long axis of the OA, and their span is approximately 100 feet. The four wings comprise 1200 square feet of generating area, and have an average power capability of approximately 3500 watts.

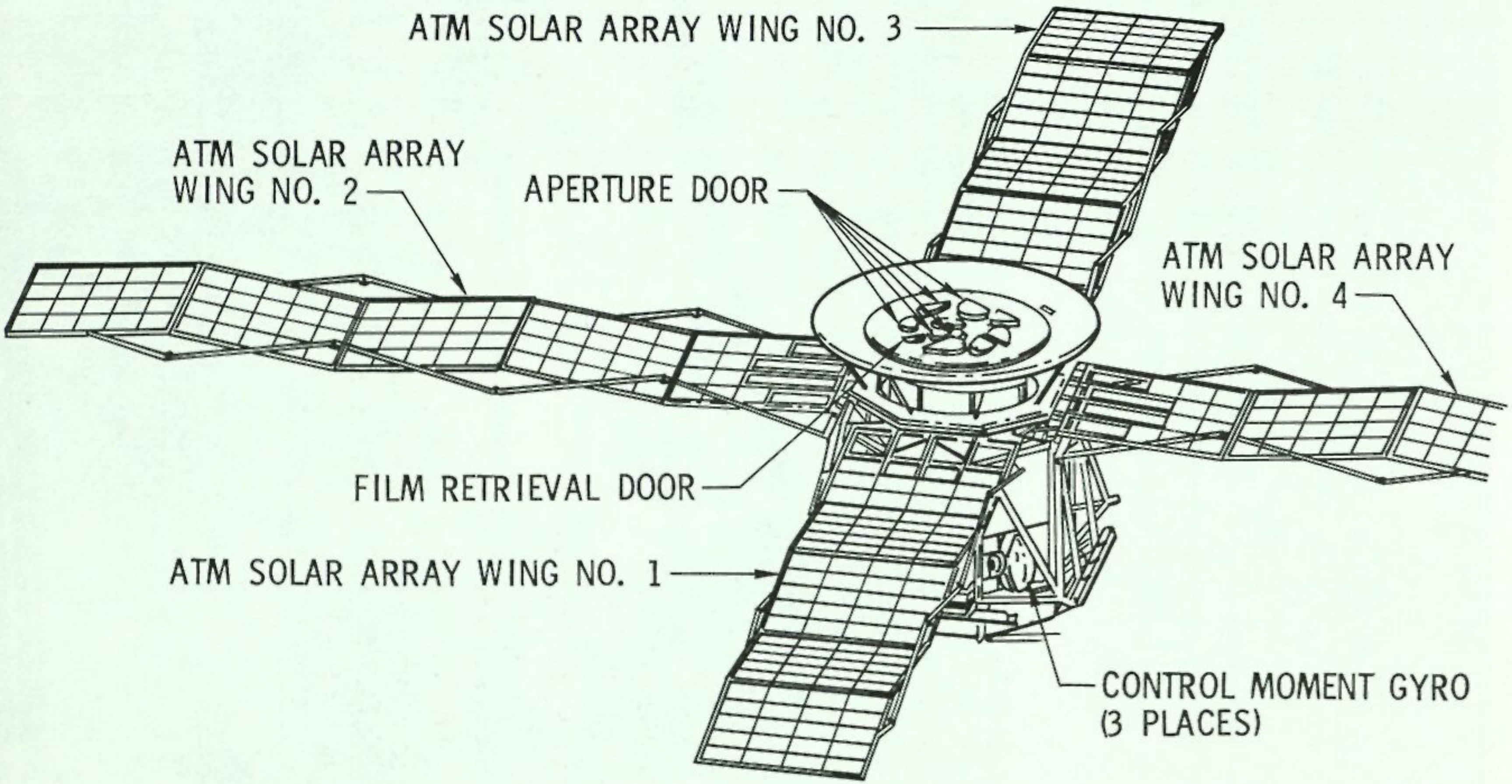
ATM Control and Display Console (C&D)

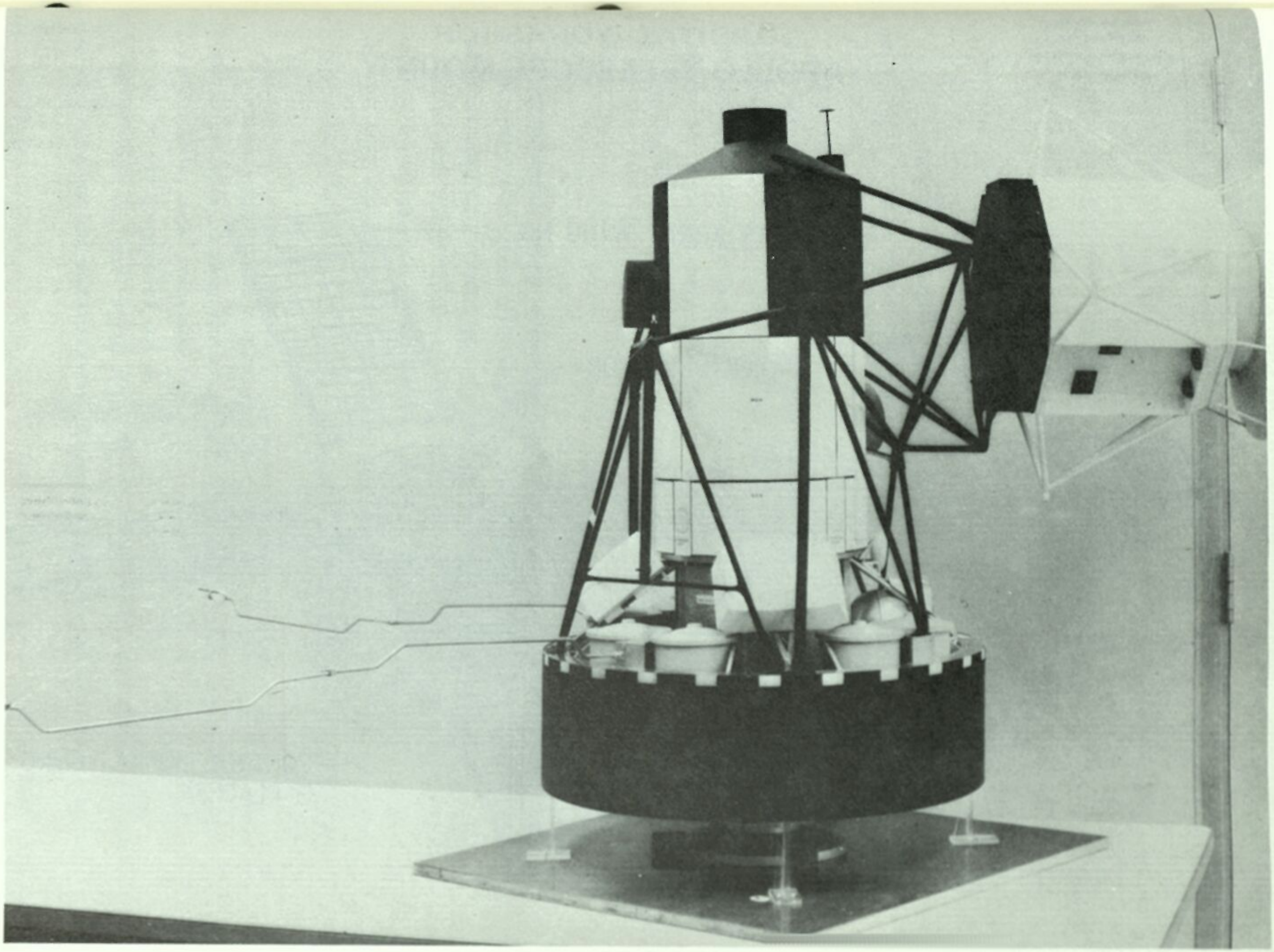
The ATM C&D console is located in the MDA and provides the crew interface with the ATM experiments, attitude control and ATM subsystems. A water cooling system which consists of a water reservoir, three pump modules and a heat exchanger, provides cooling to the C&D panel. The heat exchanger interfaces with an AM coolant system. The water cooling system also supports the Earth Resources Experiment Package (EREP) experiments.

ATM Deployment Assembly (ATM-DA)

The ATM-DA provides structural support for the ATM during launch and deployment capabilities on-orbit. It also provides mounting facilities for rendezvous lighting and antennas for the earth resources experiment package (EREP) and burst noise monitor experiments. The ATM-DA consists of upper and lower tubular truss assemblies, and a rotation system. The truss assemblies are attached to the FAS on the airlock module, and provide support for the ATM. The deployment is accomplished by means of the rotation system which consists of springs, reels, cable, gear trains, and motors. The entire system is redundant in case of failure.

ORBITAL WORKSHOP
APOLLO TELESCOPE MOUNT





MULTIPLE DOCKING ADAPTER (MDA)

The MDA is basically a double walled pressure vessel of cylindrical configuration, approximately 17 feet in length, and 10 feet in diameter.

The MDA provides the OA with the following:

- o Two docking interfaces (port 5 axial; and port 3, radial) for the CSM. Port 3 provides physical interface only. Cluster systems interface capabilities are provided at port 5 to allow integration of the docked CSM with the Skylab.
- o Interface between the CSM and the rest of the cluster for transfer of personnel, equipment, power, and other electrical signals.
- o Internal storage and operation of hardware and experiments launched in the MDA.
- o Control and display capabilities for the ATM and TACS.
- o Vent control for the AM/MDA.
- o Storage vaults for ATM cameras and film.
- o Thermal control of the MDA interior.
- o Crew systems: lighting, communication, mobility aids and restraints.
- o A viewing window with cover.

MDA Configuration

The MDA consists of a conical forward bulkhead assembly with an axial docking port, an upper cylindrical section with a radial docking port, and a lower cylindrical section. The MDA is structurally cantilevered from the AM and is designed to withstand launch loads, docking loads, on-orbit stabilization maneuvers, and internal pressure loads.

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ORBITAL WORKSHOP
MDA EXTERNAL STRUCTURE

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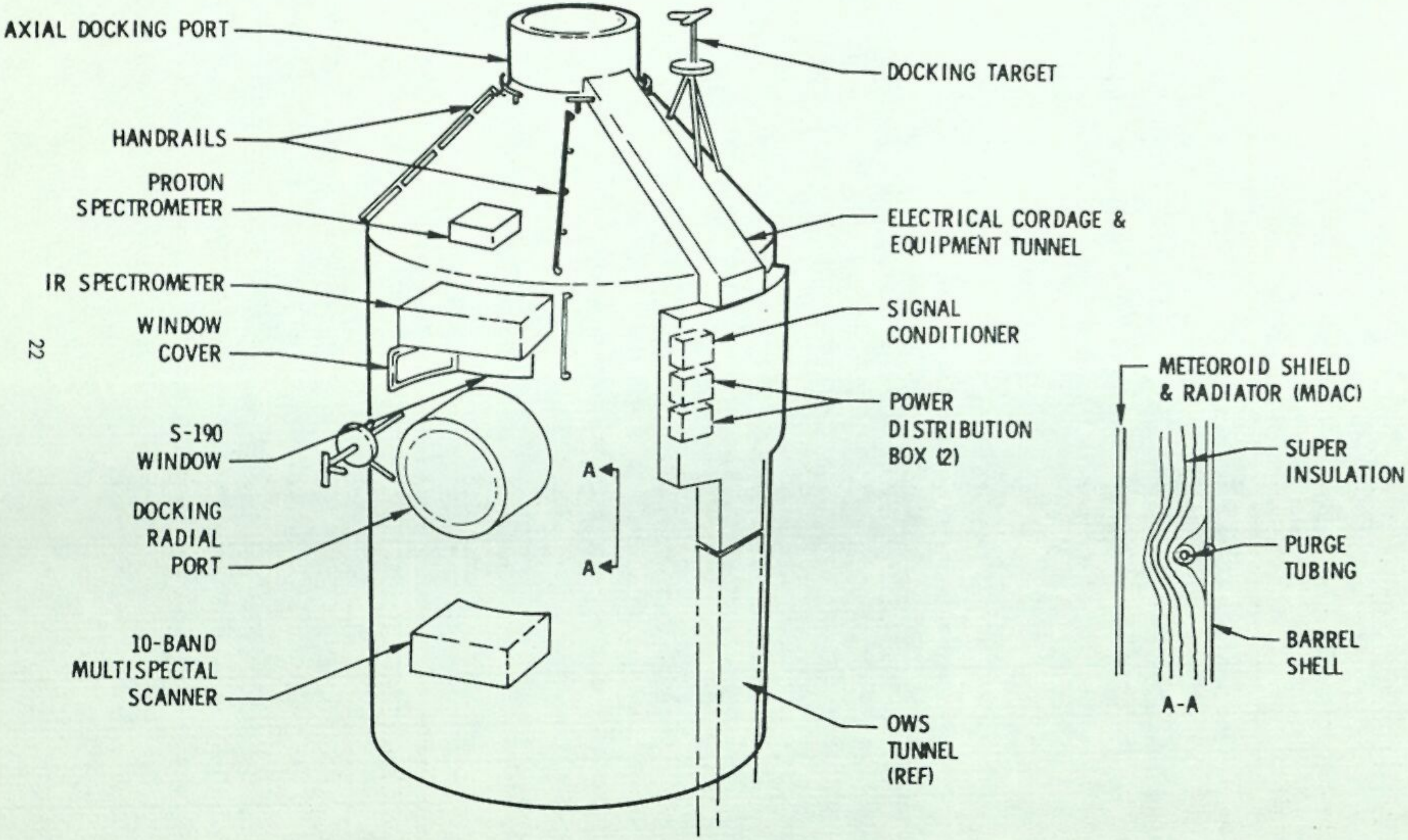

A single window with cover is located above the radial docking port. The MDA has external handrails, docking targets, cable tunnels, running lights, and provisions for mounting the radiators, meteoroid shield, proton spectrometer, and Earth Resources Experiment Package (EREP).

Thermal Control System

The MDA employs double-walled construction, with standoffs and stiffeners between the walls, and insulation mounted on the exterior of the inner wall for passive thermal control. The aft position of the MDA exterior is shielded against meteoroids by a standoff radiator, and the forward portion has a meteoroid shield. A multilayer High-Performance Insulation (HPI) blanket is placed between the MDA pressure skin and the radiator/meteoroid shields and extends into the docking ports.

The external surface thermal coating is white paint. The radiator is coated with a white zinc oxide paint with a low ratio of solar absorptivity to surface emissivity to provide additional passive thermal control.

Active thermal control is provided by 16 strip heaters mounted at 45 degree intervals around the interior wall. Eight 40 watt heaters are located in the aft section and eight 20 watt heaters in the forward section. A 15 watt heater is located on each of the two docking ports.

Venting System

The MDA venting system provides the capability of venting the AM and MDA during ascent and orbital storage. It consists of two vent valves, an overboard vent line, and vent plugs for sealing the vent valve ducts. The two vent valves are located on a vent valve panel in the forward section of the MDA. These valves are motor driven, and are remotely operated by the Digital Command System (DCS).

Crew Systems

Internal lighting is provided by eight 10-watt fluorescent lamps, four of which are located in the dome, and four of which are in the cylindrical section.

Three Speaker Intercom Assemblies (SIA) are provided in the MDA, one on the dome above the MDA window, one on the cylinder wall near Experiment M512, and one on the cylinder aft wall, opposite the window.

Crewman restraints and mobility aids include handrails, attach points for tether devices, and an ATM Control and Display Panel (C&D)(which provides operational control and monitoring of the ATM and TACS) work platform.

Docking Provisions

The MDA provides docking capabilities at two locations. The primary docking location is the axial port, which is located at the forward end of the MDA and centered in the dome. The radial port is located on the forward portion of the cylindrical section opposite the deployed ATM.

Both docking ports have standard Apollo drogues, docking rings, and utilize 15-watt heaters, pressure hatches, and docking targets. The axial docking port, however, is the only one which has provisions for the transfer of electrical power, communications, and conditioned air.

The drogue assembly is a conical structure with provisions for mounting in the docking tunnel forward of the pressure hatch. It is designed to accept the docking probe on the CSM. The drogue can be removed from either end of the docking tunnel.

Docking Port Hatch

The docking port hatch is a circular machined member which is hinged on one side and incorporates the following provisions:

- o A pressure equalization valve which can be operated from either side.

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ORBITAL WORKSHOP
MDA INTERNAL VIEW (LEFT SIDE)

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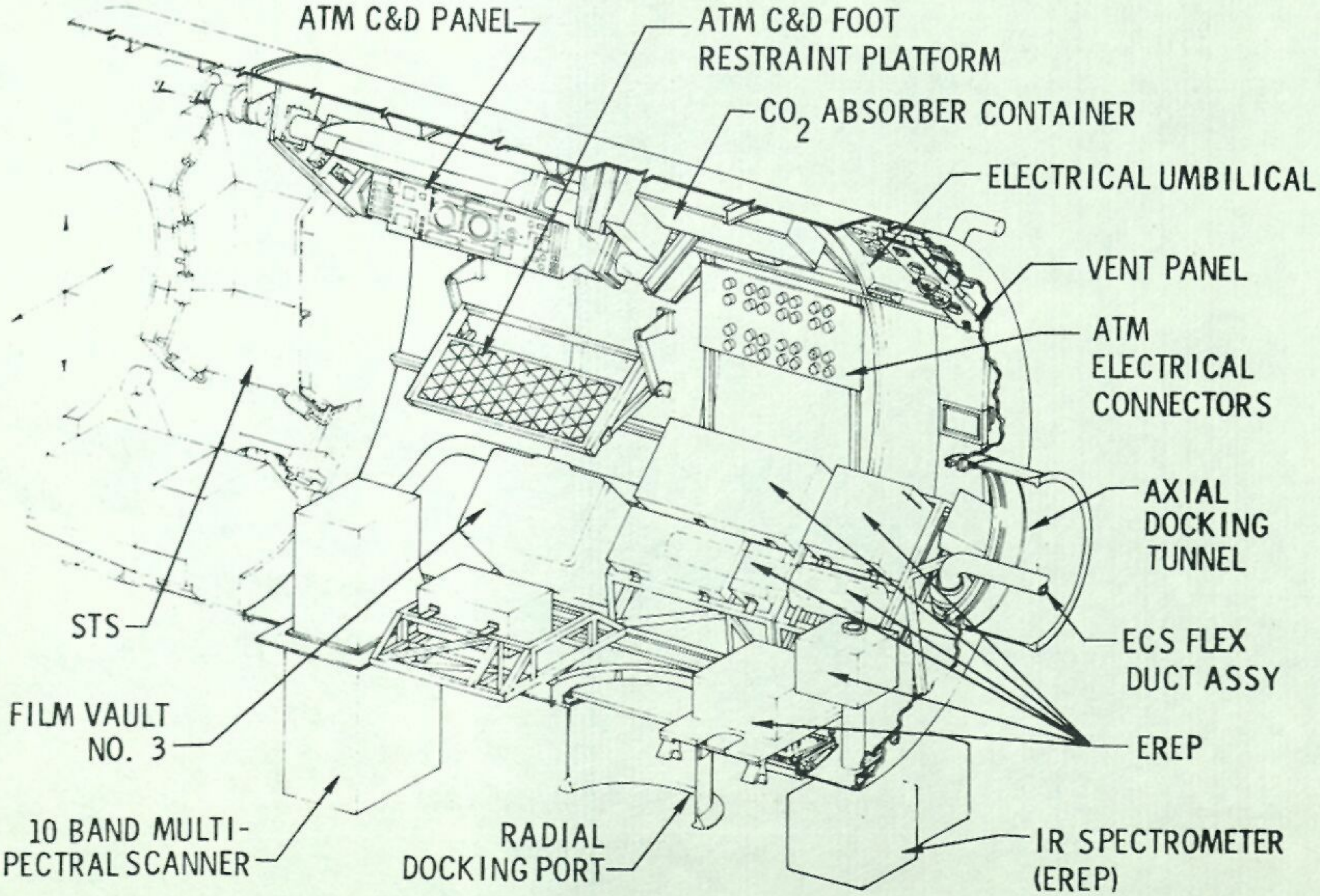

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ORBITAL WORKSHOP
MDA INTERNAL VIEW (RIGHT SIDE)

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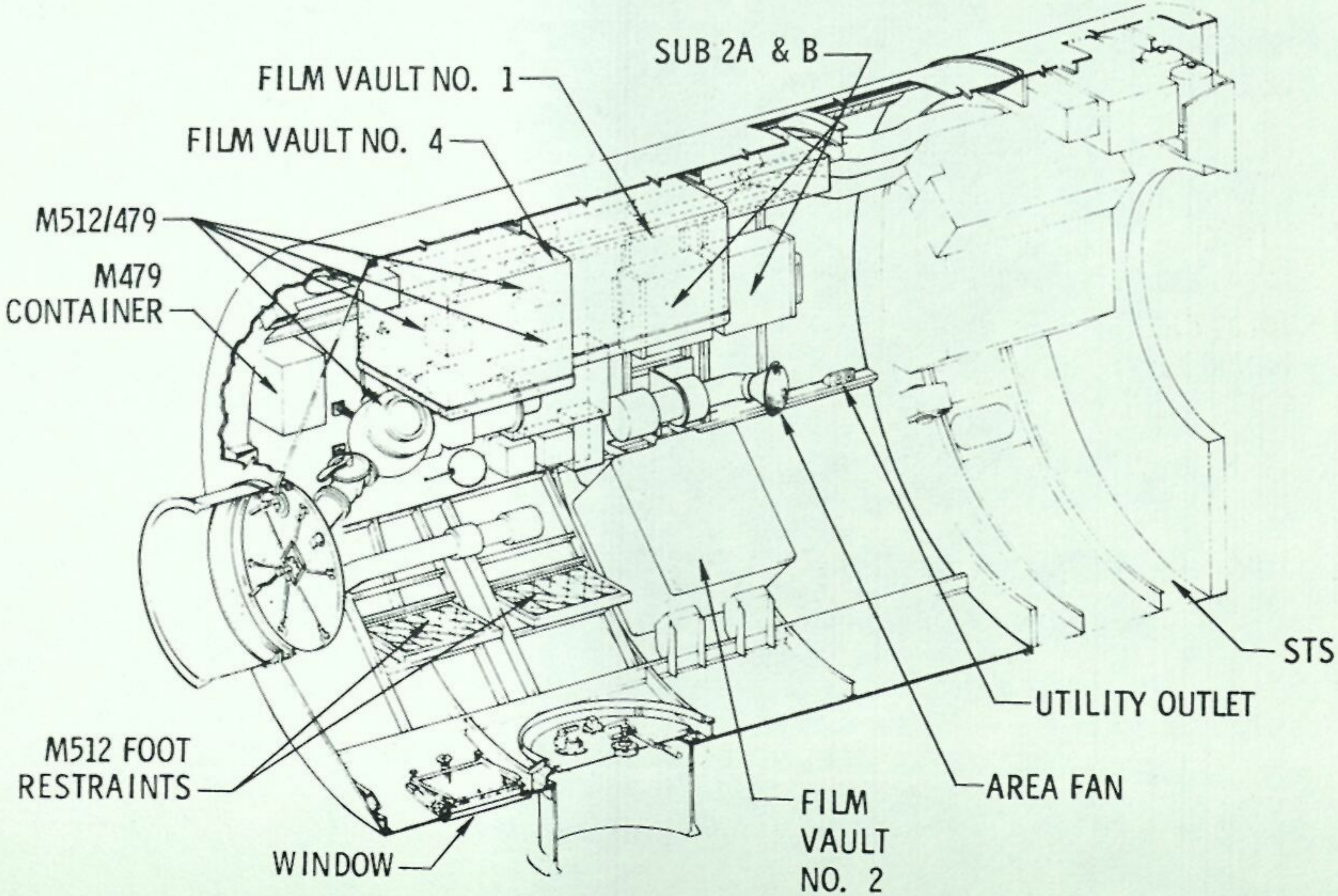

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- A differential pressure indicator on both sides of the hatch.
- A latching handle on both sides of the hatch permitting opening and closing from either side of the hatch.
- Six, over center, positive locking, latching mechanisms.

Docking Aids

Docking aids are provided to facilitate final rendezvous maneuvers and docking of the CSM to the Skylab.

A set of docking lights located about the periphery of the dome area provide visual orientation for rendezvous maneuvers. These lights are controlled by DCS command. A docking target, consisting of a circular field and a standoff cross, illuminated by fluorescent paint and electroluminescent disks, is provided for alignment of the probe and drogue during docking.

AIRLOCK MODULE (AM)

The Airlock Module (AM) is basically two double walled cylindrical pressure vessels stacked together. The overall length of the airlock module is approximately 17 feet, the diameter of the large cylindrical section is about 10 feet, and that of the smaller section is about 5 feet.

Included here is the Fixed Airlock Shroud (FAS) which interfaces the OWS, and provides structural support for the MDA, ATM, and AM. It is a cylinder, approximately 22 feet in diameter, and 7 feet long.

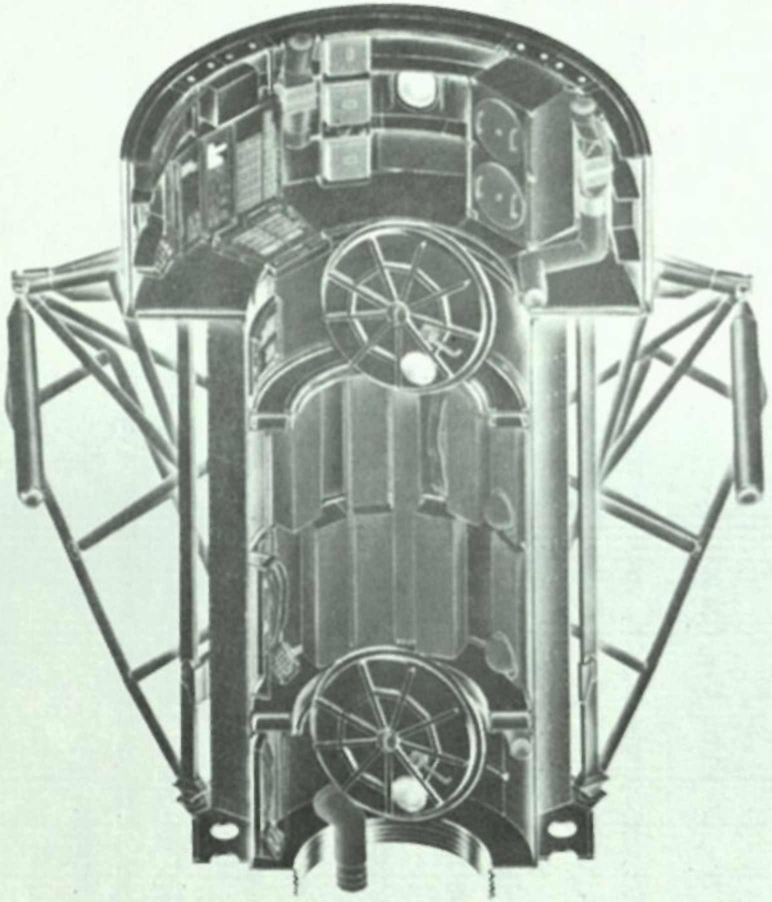
The AM is situated between the MDA and OWS, and contains systems for environmental control, instrumentation, electrical power, communications, and operational management for the OA. It also provides a lock compartment, hatch, and support systems for extravehicular activities (EVA).

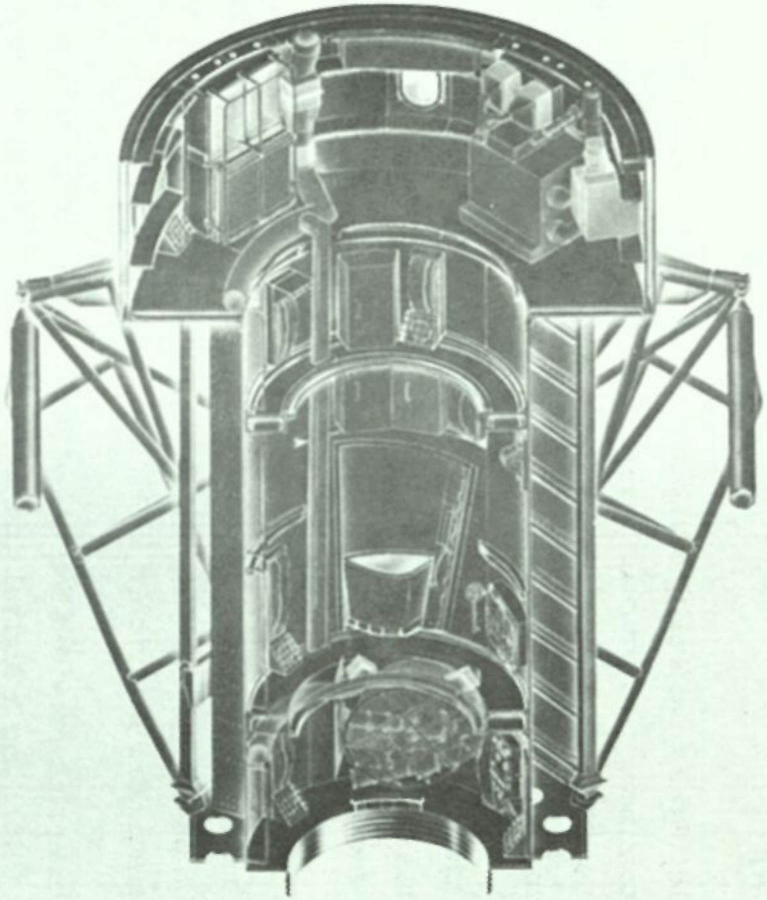
Operational management is provided for OA systems by means of control and display consoles (C&D), and a Digital Command System (DCS) for ground control of Skylab systems.

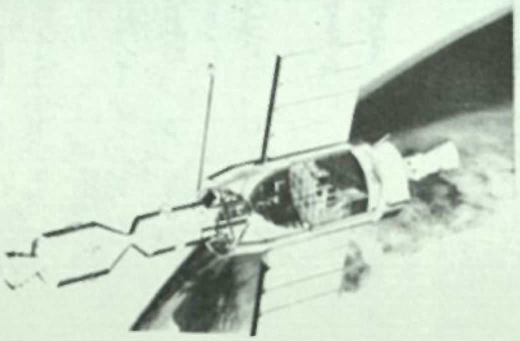
The AM provides the OA with the following:

- Conditioning, management, and distribution of electrical power for the MDA, OWS, and CSM.
- Management and control for paralleling the AM and ATM electrical power systems.
- Environmental control of the OA atmosphere.
- Nitrogen storage and controls for the OA atmospheric supplies (Nitrogen--N_2, and Oxygen--O_2).
- Accumulation and conditioning of OAM housekeeping, vehicle status, and experiment data for real-time transmission to the Manned Spaceflight Network (MSFN).

Airlock Module







LEGEND

- Water
- Coolant System
- ECS
- Instrumentation
- Electrical Power
- Stowage
- Lights
- EVA/IVA
- Communication

- Tape recording and storage of data for delayed transmission to the MSFN.
- OAM DCS link with the MSFN for system control from the ground.
- Transmitters, receivers, and controls for the OAM data link with the MSFN.
- Transport equipment for traversing ATM film magazines from the EVA hatch area to the ATM work stations.
- Audio-visual alert system for OAM caution and warning indications.
- Cluster intercommunications via the CSM for voice transmission to the MSFN.
- Hard copy message reception from the MSFN via teleprinter.
- Life supporting oxygen, cooling, and communications for crew EVA.
- Experiment installations and controls.

Equipment installation for systems performing listed functions is accomplished by mounting modules on the AM tunnel and its trusses, and within the AM.

The lock compartment allows EVA without interrupting crew or systems operations in the pressurized sections on either side of the lock.

Airlock Configuration

The AM consists of four major structural components, and the fixed airlock shroud. The major components are:

- The Structural Transition Section (STS)
- The tunnel assembly
- The flexible tunnel extension
- The airlock truss assemblies (4)

The AM is attached to the MDA at the forward end of the STS, and to the OWS via the flexible tunnel extension and the fixed airlock shroud. The truss assemblies attach to the FAS at each axis.

Structural Transition Section (STS)

The STS provides structural transition from the 10 foot diameter MDA to the 5 foot diameter AM tunnel assembly. The STS is a welded aluminum pressurized cylinder approximately 46 inches long and 120 inches in diameter, of stressed skin, semi-monocoque construction.

The STS bulkhead provides the transition from 120 inch diameter to 65 inch diameter to mate with the tunnel assembly. The bulkhead, along with the tunnel shear webs, provides shear continuity of the AM and redistributes loads to the AM support truss assemblies.

Four double pane glass viewing ports are provided for visibility. Each window is protected when not in use by an external movable cover assembly which is actuated from inside the STS by the crew. The covers serve to minimize meteoroid impacts on the glass and heat losses from the cabin area.

AM Radiator Assembly

The AM radiator serves as a meteoroid shield for the MDA and STS in addition to its primary function as a heat radiator to space.

The radiator consists of panels containing fluid paths which are supported three inches outside the vehicle pressure skin. The coolant paths are connected to the AM coolant loop. The radiator is constructed mostly of magnesium alloy, and extends virtually the entire length of the AM.

AM Tunnel Assembly

The tunnel assembly is a 65 inch diameter, 153 inch long cylinder of aluminum, semi-monocoque construction. The tunnel is internally divided into three sections by two bulkheads equipped with hatches. These are the forward compartment, the center or lock compartment, and the aft compartment.

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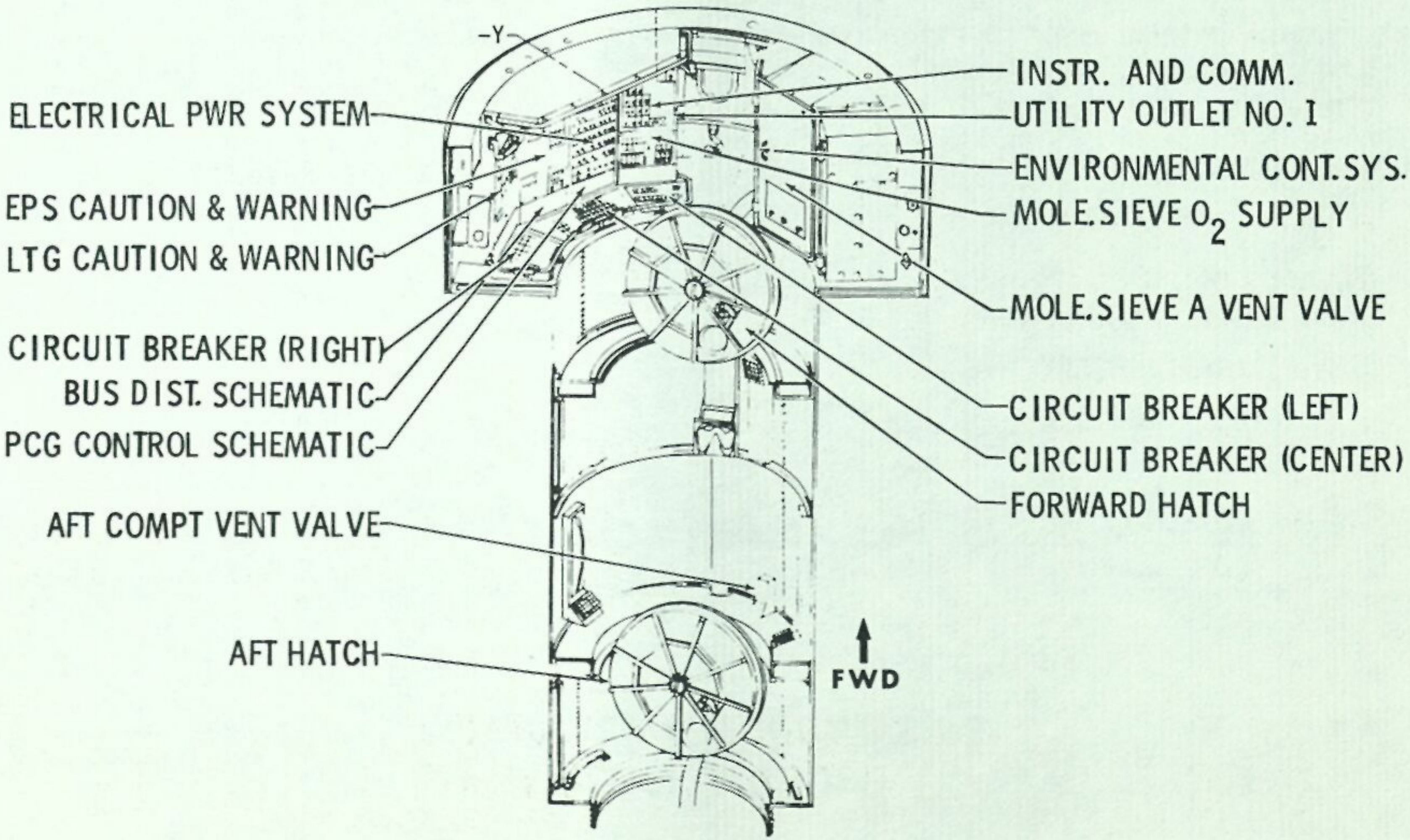
AIRLOCK MODULE
INTERNAL VIEW LEFT SIDE

SA-418A



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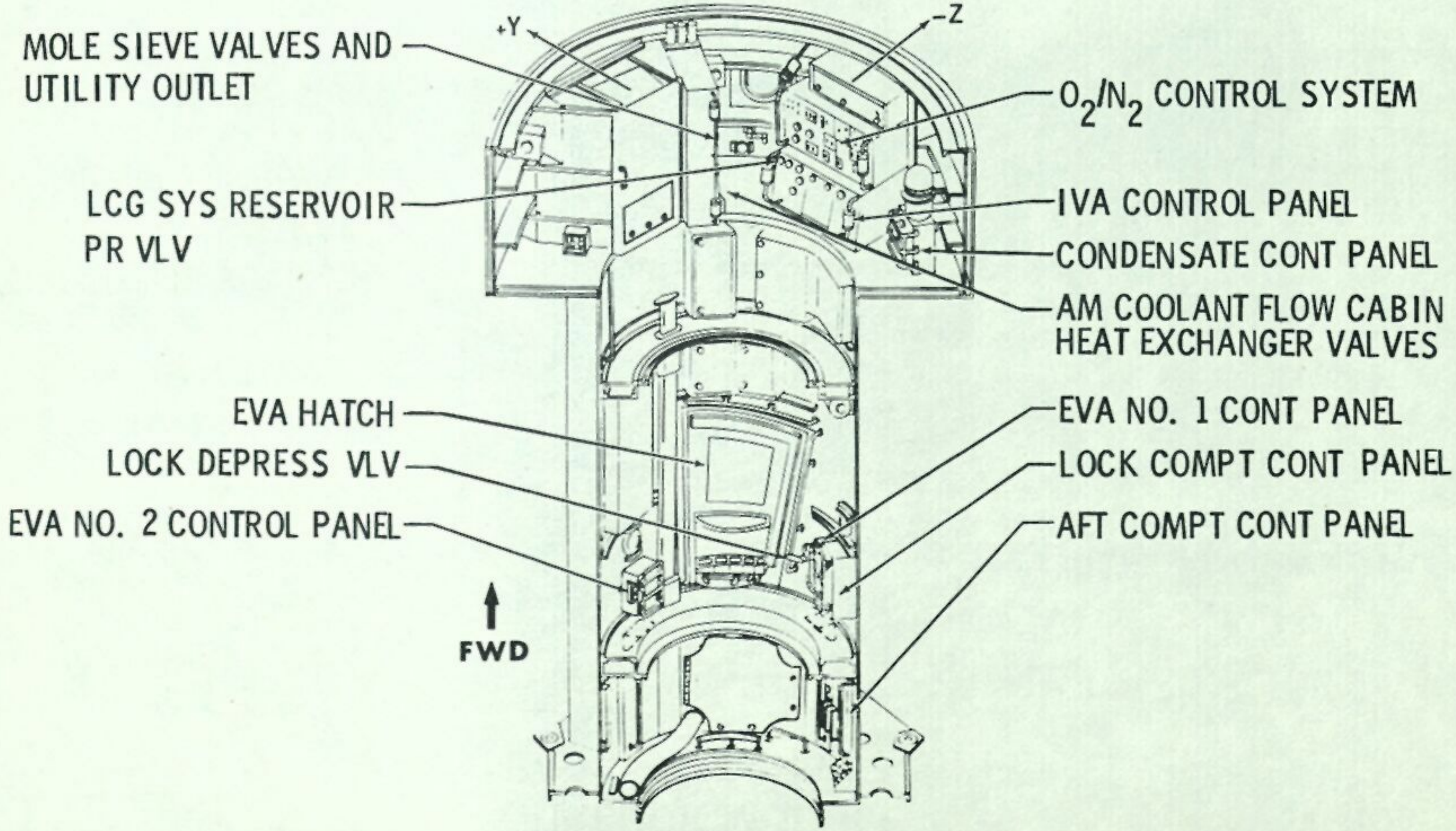
AIRLOCK MODULE
INTERNAL VIEW RIGHT SIDE

SA-419A



Forward Compartment

The forward compartment mates to the STS and includes a cabin relief valve and provisions for stowage containers, tape recorders, and miscellaneous equipment. It is approximately 65 inches in diameter, and 31 inches in length.

Lock Compartment

The center or lock compartment is approximately 80 inches long, and includes a Gemini type crew hatch for ingress/egress during EVA.

The lock compartment is sealed from the rest of the Skylab during EVA by two internal hatches. These are circular machinings with radial stiffeners and each has a dual pane window which permits viewing the lock compartment from both forward and aft compartments. Each hatch is equipped with a latching mechanism which is actuated by rotating a handle. The aft hatch can be detached from its hinge by removing two quick release pins, and then be re-installed at the flexible tunnel extension to isolate the OWS from the rest of the Skylab during "contingency mode" operations.

The EVA hatch is a titanium structure of conical section configuration like those used in the Gemini missions. The hatch is latched or unlatched by the rotation of a handle on the interior of the hatch.

The EVA hatch is equipped with a dual pane viewing window which enables viewing of the aft portion of the EVA quadrant.

Aft Compartment

The aft compartment is approximately 42 inches long and provides a recessed housing to support OAM thermal control system heat exchanger fans. The aft compartment also houses the controls for the OAM Thermal Control System (TCS), and the N_2 recharge station which is associated with one of the experiments.

Flexible Tunnel Extension Assembly (Bellows)

A metallic convolute flexible bellows approximately a foot long, and having an internal diameter of about three and one-half feet, joins the AM to the OWS forward dome. The tunnel extension provides continuity of the pressurized passageway from the AM to the OWS. It is attached to the AM and OWS prior to launch and allows relative deflection between the AM and OWS with minimum load transfer. A fiberglas laminate shield mounted inside the bellows protects it from damage during equipment and crew transfer through the bellows.

AM Support Truss Assemblies

Four truss assemblies are used to attach the AM to the FAS. These are located at ninety degree intervals around the AM, and are indexed to the reference axes.

The trusses are constructed of fusion welded aluminum tubes. Machined fittings are used at the attach points to the tunnel and FAS.

In addition to their primary function of attaching the AM to the FAS, and strengthening the assembly, the truss assemblies support battery modules (2), and gaseous nitrogen (GN2) spheres (4).

Fixed Airlock Shroud

The Fixed Airlock Shroud (FAS) is a cylindrical structure approximately 7 feet long and 22 feet in diameter. It provides structural support for the ATM, AM, MDA, and PS during the launch phase of the mission. It also supports six cylindrical gaseous oxygen (GO_2) tanks and provides attachment points for two discone antennas for OAM DCS and data communication. Five spherical GN_2 tanks mounted in the FAS provide pressurization gas for the OWS water tanks, and atmospheric supply.

INSTRUMENT UNIT

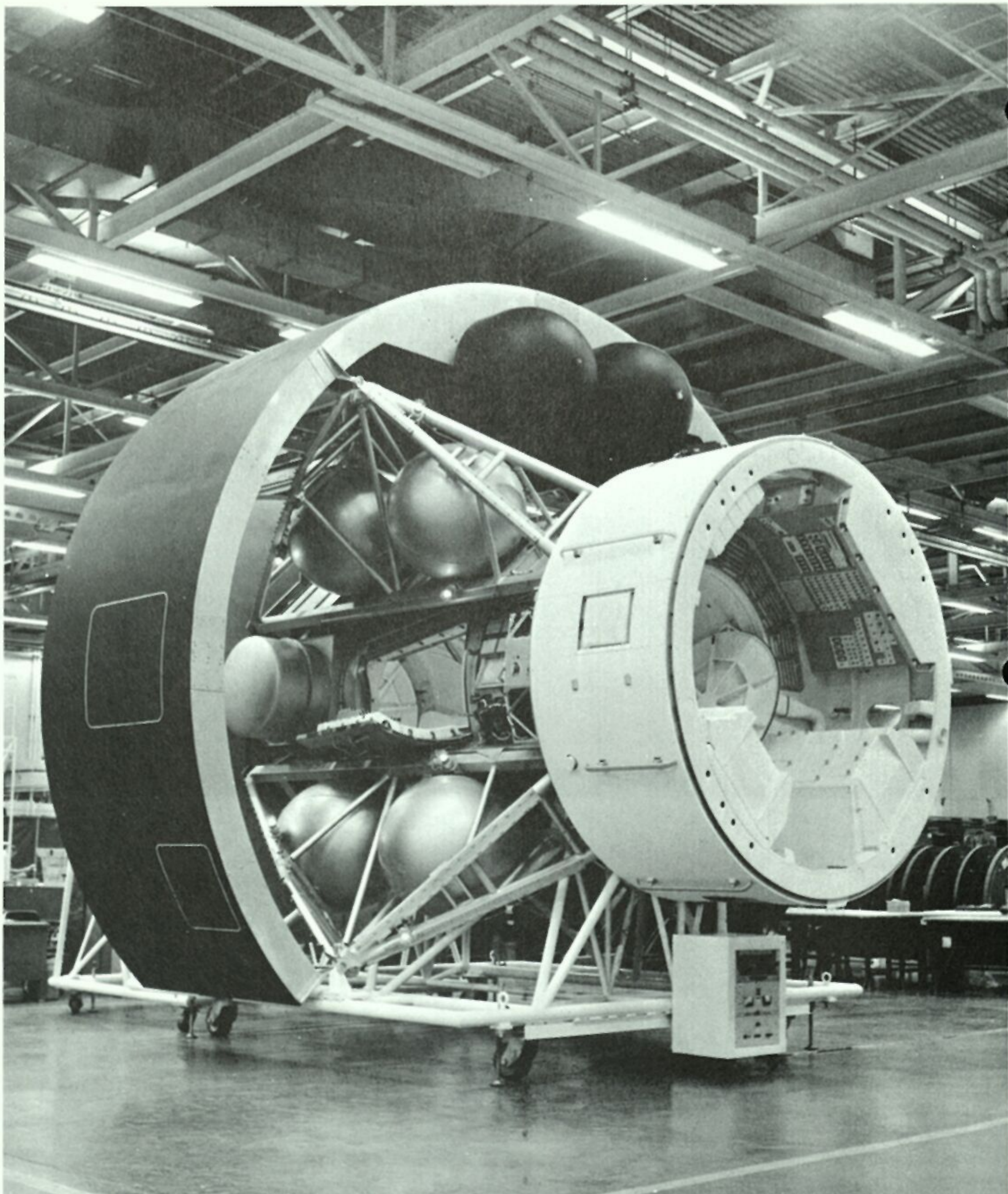
The instrument unit is an unpressurized, cylindrical load-supporting structure of honeycomb sandwich construction. It is approximately 22 feet in diameter, and 3 feet long, and it is located between the Fixed Airlock Shroud (FAS) and the OWS forward skirt.

The instrument unit is normally considered to be part of the launch vehicle, but because of its location, and the role it plays in the orbital preparation of the Skylab, it is considered here as part of the OAM.

Mounted on the internal wall of the instrument unit are items of equipment which comprise electrical and mechanical systems which guide, control, and monitor vehicle performance from liftoff for approximately 7 hours. Included among these systems are guidance and control, measurement and telemetry, tracking, IU command, and electrical systems. The IU commands the following orbital functions of the OAM:

- Skylab maneuver to retrograde following S-II separation.
- Payload Shroud (PS) jettison during retrograde maneuver.
- Apollo Telescope Mount (ATM) deployment.
- Acquisition of solar inertial attitude.
- OWS and ATM solar array deployment.
- OWS meteoroid shield deployment.
- ATM Control Moment Gyro (CMG) activation.
- OAM systems activation.
- OAM venting and pressurizing.
- TACS command transfer to DCS.

After accomplishing the listed functions, the IU batteries expire, and the IU has no further function during the Skylab mission.



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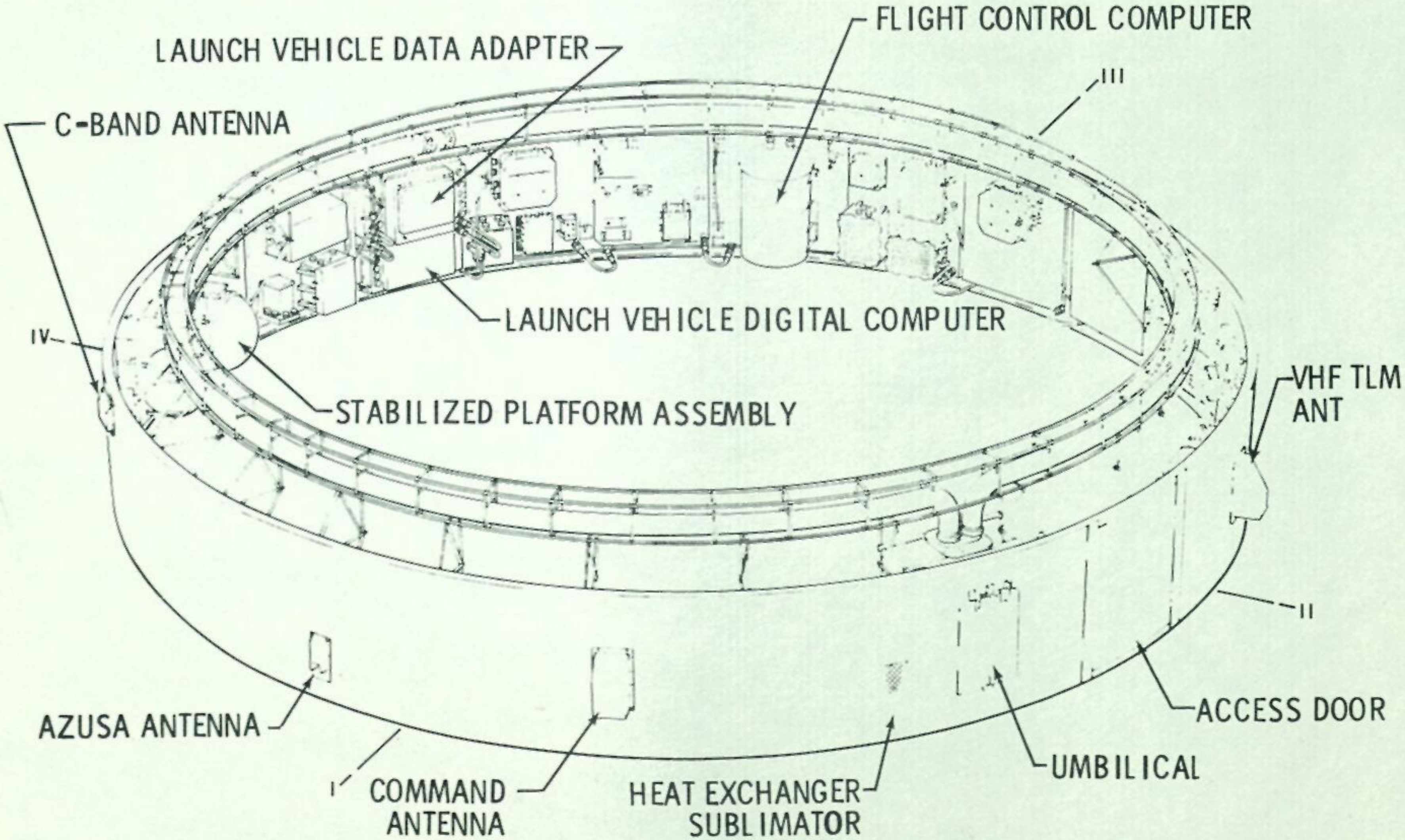
ORBITAL WORKSHOP
INSTRUMENT UNIT

SA-502
1-11-71



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ORBITAL WORKSHOP (OWS)

The OWS is a modified third stage of the Saturn V Launch Vehicle (SIV-B Stage). The Liquid Hydrogen (LH_2) fuel tank has been converted into crew living and working quarters, and the Liquid Oxygen (LO_2) oxidizer tank has been utilized as a plenum area for waste matter. The propulsion and propellant feed systems, auxiliary propulsion system, and supporting hardware have been removed, and certain structural modifications accomplished for the conversion.

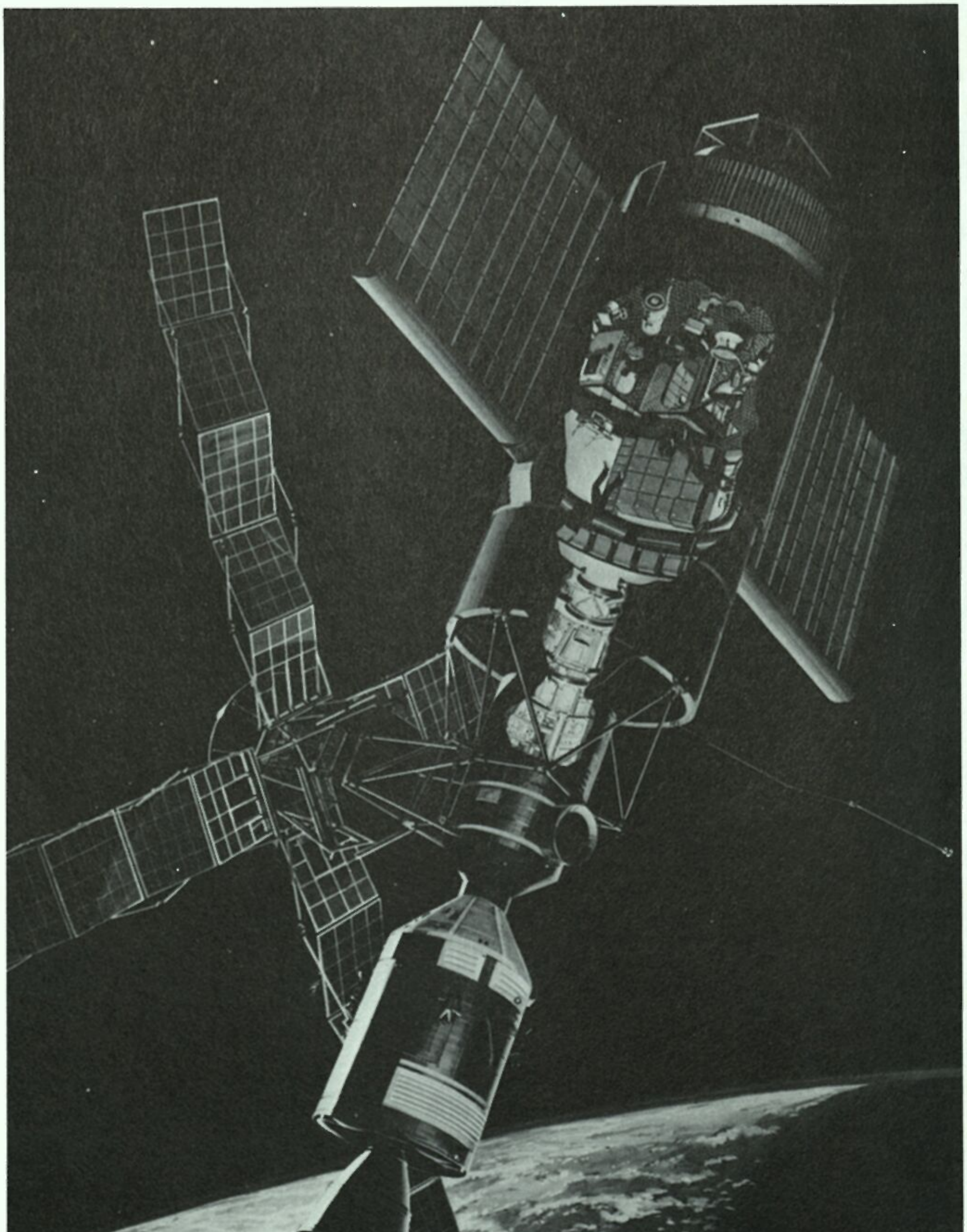
The exterior of the OWS is fitted with a deployable meteoroid shield, a solar power array system (SAS), a radiator for the refrigeration system, two rings of gaseous nitrogen (GN_2) spheres for the thruster attitude control system, and two thruster modules. The meteoroid shield is deployed on-orbit and protects the OWS against meteoroid penetrations. The SAS wing assemblies are also deployed on-orbit, and provide a source of electrical power to the OAM. The refrigeration system radiator is mounted in a fixed position to the thrust structure on the aft end of the OWS and is used to radiate heat absorbed by the OWS refrigeration system. The GN_2 bottles store gas for use in the TACS which maintains attitude control of the Skylab prior to CMG activation, and supplements the CMG system after it has assumed primary control.

The OWS is divided into two major areas, the habitation area, and the waste tank. These areas are separated by the common bulkhead that separates the fuel from the oxidizer portions of the SIV-B propellant tank.

During the Skylab mission, the crew will inhabit the living and working quarters of the OWS, and perform many of the experiments required to meet the established mission objectives.

The OWS provides the OA with the following:

- OWS crew quarters in which the crew can live, and perform experiments requisite to mission success.
- Habitability support system, which includes the capabilities of food, water, and waste management, personal hygiene, sleep accommodations, and trash management.



- Stowage provisions for all equipment and consumables which are part of the OWS.
- Electrical power from the SAS, distribution, and control, and illumination of both interior habitable areas, and exterior (running lights).
- Atmosphere control of the OWS interior for pressure, ventilation, and heating.
- Refrigeration of food, water, and experimental samples.
- Thruster attitude control of the cluster prior to activation of the CMG system, and as backup to the CMG system.
- Data acquisition for housekeeping, experiment data and vehicle/systems status, for telemetry and on-board display.
- Communications facilities among the various elements of the cluster, television, telecommunications, and on-board caution and warning indications.
- A crew viewing window for observation and experiment support.
- Scientific airlocks to support extravehicular experiment requirements.
- On-board accommodations and support systems for experiment packages.

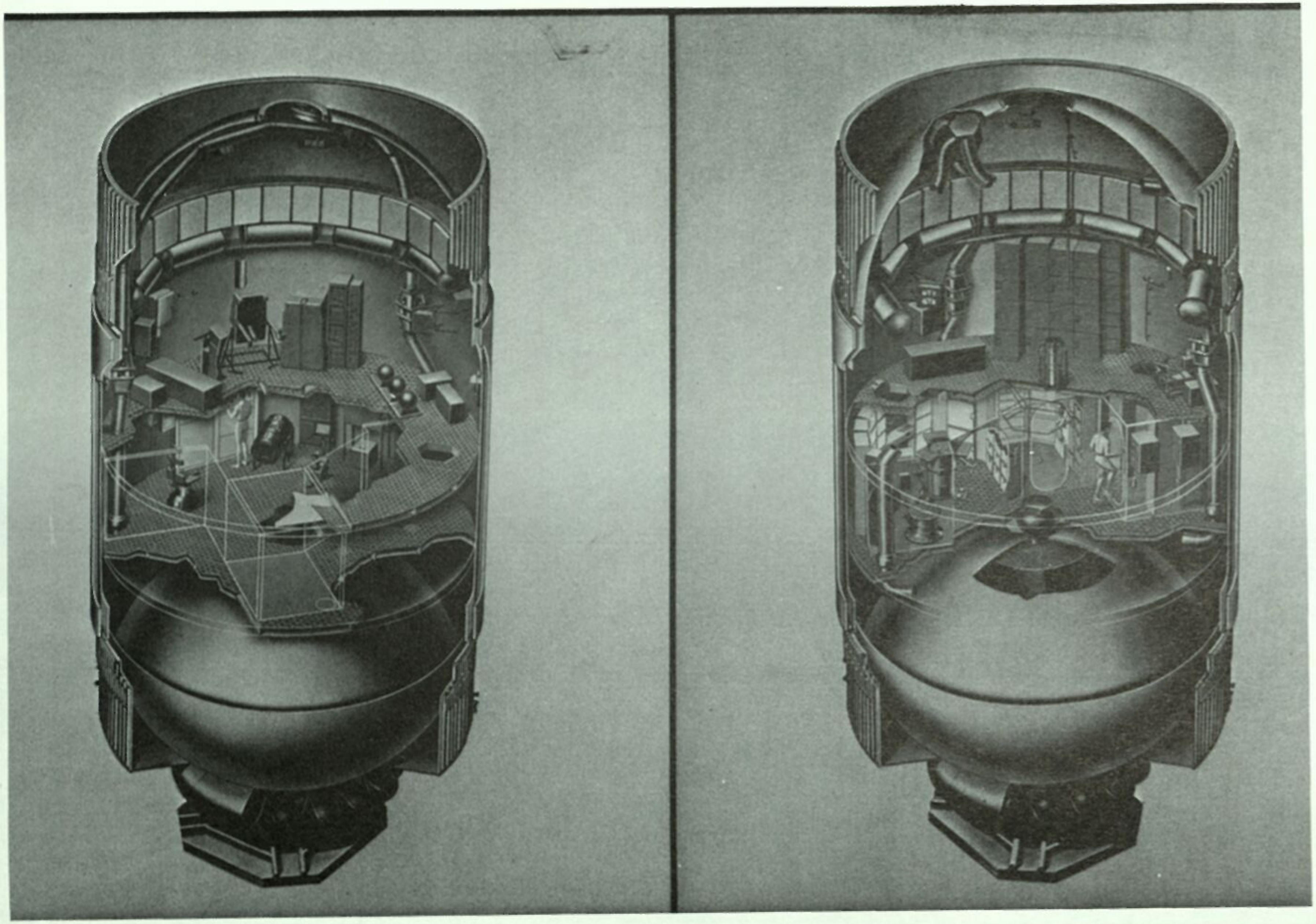
OWS Configuration

The Skylab OWS consists of a Saturn V SIV-B propellant tank assembly, forward and aft skirts, thrust structure, and aft interstage. The aft interstage separates with the S-II stage, and is not considered to be part of the OWS after launch.

Habitation Area

The habitation area is divided into the forward compartment, which is used primarily as a storage and work area, and the crew quarters, which are the living and operating areas for the crew on-orbit. A third area, located between

ORBITAL WORKSHOP



the crew quarters and the waste tank is used as a plenum for the ventilation control system, and is accessible to the crew.

The forward compartment floor consists of an eight inch beam structure sandwiched between triangular grid sections. The grid pattern is typical of that used throughout the OWS, and facilitates crew mobility. The beam structure is attached to the wall, and includes a large hexagonal opening in its center to allow crew and equipment movement between the forward compartment and the crew quarters. Two smaller openings are provided in the floor above the sleep compartment to allow emergency egress of the crew quarters.

The crew quarters floor is similar to the forward compartment floor but has an aluminum sheet on the underside, toward the plenum area, and waste tank. The floor has three openings similar to those in the floor of the forward compartment. The large opening provides access to the trash airlock, and the smaller openings provide access to the plenum area. The trash airlock is used for the disposal of waste matter.

Forward Compartment

Initial entry to the OWS from the AM is made through a hatch located at the apex of the dome in the forward compartment. The hatch is a reusable circular machining curved to conform to the radius of the forward dome. It contains a pressure equalization valve, and redundant check valves and operating handles which are used to open the hatch from either side.

Ten water tanks are installed around the wall of the forward compartment. Each tank has a capacity of approximately 50 gallons. Located just above the water tanks are 25 stowage containers. Stowed in these 25 containers are waste management, personal hygiene, photographic, and maintenance equipment. Various stowage lockers and experiment equipment are also installed on the floor. The two scientific airlocks are located in the wall of the forward compartment 180 degrees apart. These airlocks are used in the performance of various experiments which involve exposure to space.

Crew Quarters

The OWS crew quarters contain the sleep compartment, waste management compartment, wardroom, and experiment compartment. These compartments provide areas in which the crew can conduct their normal daily activities, as well as special experiment tasks. The sleep compartment furnishes sleeping and communication equipment for each of the three crewmen. The waste management compartment provides toilet and personal hygiene facilities. The wardroom provides storage and preparation facilities for food, recreational facilities such as games and television, communications, and a viewing window for observation and experimental photography. The wardroom also includes provisions for temporary stowage of trash.

Waste Tank

The waste tank is the LO_2 portion of the SIV-B propellant tank assembly from which the propellant utilization probes, chilldown pumps, and other support hardware have been removed. It is located immediately aft of the crew quarters floor/plenum area, and shares the common bulkhead with the habitation area. The trash airlock provides access to the waste tank from the crew quarters. A large mesh screen installed in the tank prevents trash from clogging the liquid dump probe inlets and prevents trash and liquids from clogging or escaping through the vent ducts.

Saturn V Skirts

The forward skirt is a cylindrical structure of the same diameter as the OWS (approximately 22 feet), and approximately 10 feet in length. It is located between the Instrument Unit (IU) and the OWS habitation area wall.

Equipment mounted on the interior wall of the forward skirt is used during launch and for telemetry throughout the mission. The Solar Array System (SAS) is attached to the forward skirt from which it hinges and deploys. The meteoroid shield forward torsion arms are also supported by the forward skirt.

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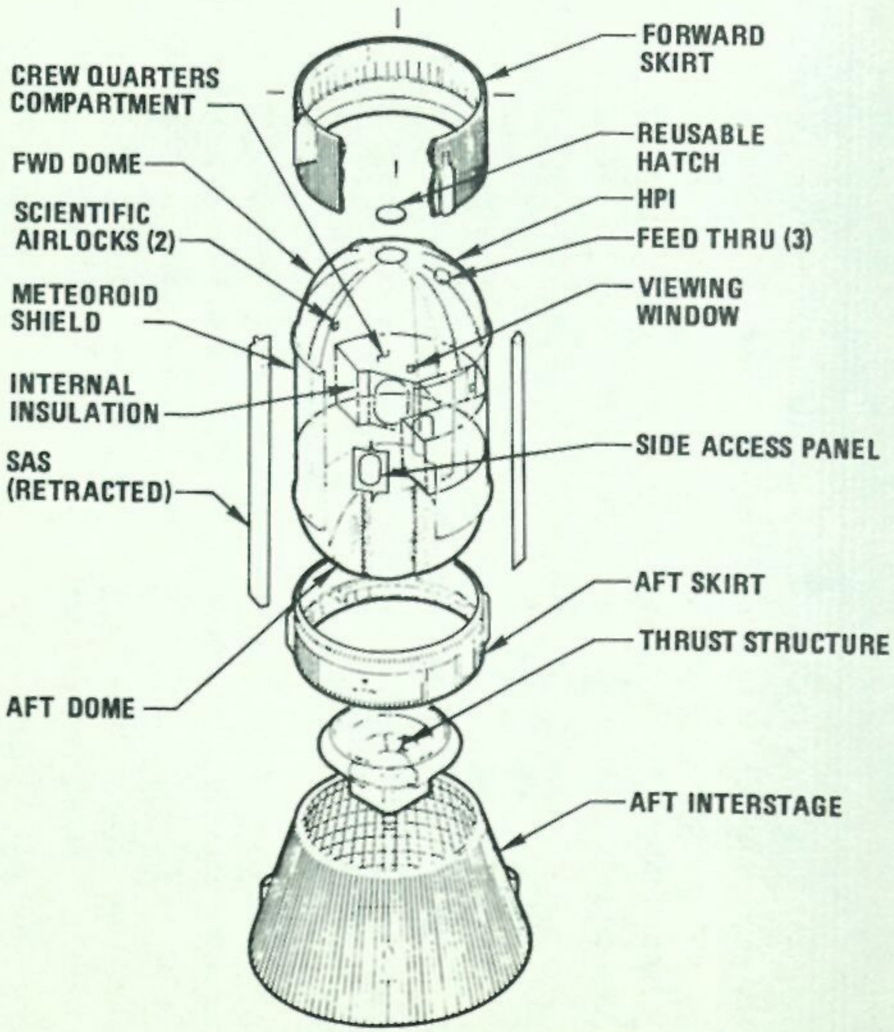
ORBITAL WORKSHOP
TANK ASSEMBLY, SKIRTS AND INTERSTAGE

SA-282
12-2-70



OWS REQUIREMENTS

STRUCTURE ASSEMBLY WILL WITHSTAND ALL PRESSURE, PRIMARY BODY, THERMAL, AND DYNAMIC LOADS

LEAKAGE (WHEN PRESSURIZED TO OWS ENVIRONMENT PRESSURE): LESS THAN 5 LBS MASS PER DAY

METEOROID PROTECTIVE SHIELDING (INCLUDING TANK STRUCTURE) TO BE EQUIVALENT OF 1.43 CM OF 2024-T6 ALUMINUM

REUSABLE HATCH – 40" IN DIAMETER

SIDE ACCESS PANEL – 35 X 52 INCHES

VIEWING WINDOW – APPROX 18" DIAM
25^{0} 55' FROM POS III TOWARD POS II

The aft skirt is a cylindrical structure approximately 22 feet in diameter, and approximately 7 feet long. It is located between the OWS habitation area wall and the aft interstage. It supports the TACS thrusters and provides support for the aft portion of the SAS, and the rear torsion arms of the meteoroid shield.

Solar Array System (SAS)

The SAS consists of two wing assemblies which are attached to the OWS forward skirt and deployed on-orbit out of beam fairings on opposite sides of the OWS. Each wing assembly consists of:

- o Forward fairing assembly
- o Beam fairing assembly
- o Three wing section assemblies
- o SAS deployment system

The wing assemblies are permanently attached to the forward skirt through the forward fairing assembly. The beam fairing assemblies are attached to the forward fairing assemblies by machined hinge fittings. The hinges are oriented in such a way that the wing sections can be deployed in planes parallel to the plane of the ATM experiment cannister. The forward fairing assembly is a box beam type structure which extends the length of the forward skirt, and houses the deployment mechanism and hinge which interfaces the beam fairing.

The beam fairing is also basically a box beam structure which extends the length of the OWS habitation area. It is approximately 37 feet in length, and 4 feet wide by 1 foot deep. The beam fairing houses the stowed SAS wing sections during the launch phase of the mission.

The wing assembly has three wing sections that are deployed out of the beam fairing on-orbit. Each wing section contains ten solar cell panels, a dummy solar cell panel, a truss type panel, and two parallel stabilizing beams. The truss type panel is fastened to the beam fairing and to the dummy panel. The dummy panel is in turn fastened to the first of the ten active solar cell panels. All the panels are hinged together and folded accordion style into the beam fairing until deployment. Each panel is approximately 10 feet by 2 feet, and is connected by swivel fittings to the stabilizing beams.

The parallel stabilizing beams each consist of seven truss type structures. These beam sections contain the swivel fittings to which the solar cell panels attach, and spring lock mechanisms which engage when the wing sections are fully deployed to hold the wing sections in that position.

The solar array system is capable of being completely deployed from a stowed position within 4 minutes. Deployment of the SAS is automatic and completed within the IU lifetime and prior to excessive discharging of the OAM batteries. Primary control is from the IU programmer, with backup capability from the OAM DCS. The SAS is deployed in two stages which are initiated by Exploding Bridge-Wire (EBW) firing units. The first stage is the deployment of the beam fairing. An interlock assures that the beam fairing is completely deployed before the command is given to deploy the wing sections. If the IU fails to deploy either the beam fairing or the wing sections, the OAM DCS would be used to deploy the SAS by ground command.

Meteoroid Shield

The meteoroid shield protects the OWS against penetration by meteoroids during a typical mission. The shield is an aluminum sheet which encompasses the exterior of the habitation area over the length of the cylindrical section of the OWS. It forms a cylinder that is concentric to the tank and when deployed is spaced approximately 5 inches from the tank wall. During ground handling and launch the shield is held retracted against the tank wall. The excess shield material is retained in hinged panels which fold on themselves permitting proper retraction to the smaller diameter. The interior of the shield is coated with teflon to allow even distribution of preload forces around the tank circumference.

The meteoroid shield is deployed on-orbit subsequent to SAS deployment. The shield is deployed at IU command when the SAS has been fully deployed. Ordnance trains initiated by EBW firing units release tension straps, and preload torsion arms complete the deployment. Meteoroid shield boots of preformed metal fingers close the forward and aft portions of the shield after deployment.

Thrust Structure

The OWS thrust structure is cone shaped, and mounted aft of the waste tank. On Saturn flights, it is used to support the J-2 engine and to transmit engine thrust to the fuel tank wall. On the OWS, the thrust structure is used to support the Thruster Attitude Control System (TACS) nitrogen spheres, the pneumatic control sphere, the sphere meteoroid shield, and the refrigeration system radiator. The sphere meteoroid shield performs the same task as the OWS meteoroid shield, protecting the TACS and pneumatic control spheres from penetration by meteoroids on-orbit.

Refrigeration System Radiator

The refrigeration system radiator is an irregular octagon shaped aluminum structure attached to the OWS thrust structure at the engine mount. The radiator surface is slightly inclined from the OWS centerline to prevent the sun's rays from striking the radiator surface while the Skylab is in the solar inertial attitude. The surface is coated with zinc oxide.

The radiator contains cooling loops containing a refrigerant to cool the ward-room and food storage freezers, refrigerator, urine freezer, urine chiller, and water chiller.

ORBITAL WORKSHOP SYSTEMS

Ten major functional and structural systems are provided in the OWS vehicle to establish a safe and habitable astronaut living area and facilitate planned experimental operations while the OWS is on-orbit. These systems are:

- o Crew accommodations
- o Habitability support
- o Experiment accommodations
- o Stowage
- o Electrical
- o Atmosphere control
- o Refrigeration
- o Thruster attitude control
- o Data acquisition
- o Communication.

Crew Accommodations

The OWS crew accommodations system consists of equipment which:

- o Provides compartments for crew habitation and operational activites.
- o Aids crew mobility and restraint.
- o Supports crew safety.

Compartmentization

The crew quarters are divided into four compartments: sleep compartment, waste management compartment, wardroom, and experiment compartment.

Access to each compartment is provided by openings to the experiment compartment. A door is installed for the waste management compartment only. A folded curtain is provided at the wardroom entrance. The curtain is constructed of aluminum coated mylar, sandwiched between two layers of Armalon fabric.

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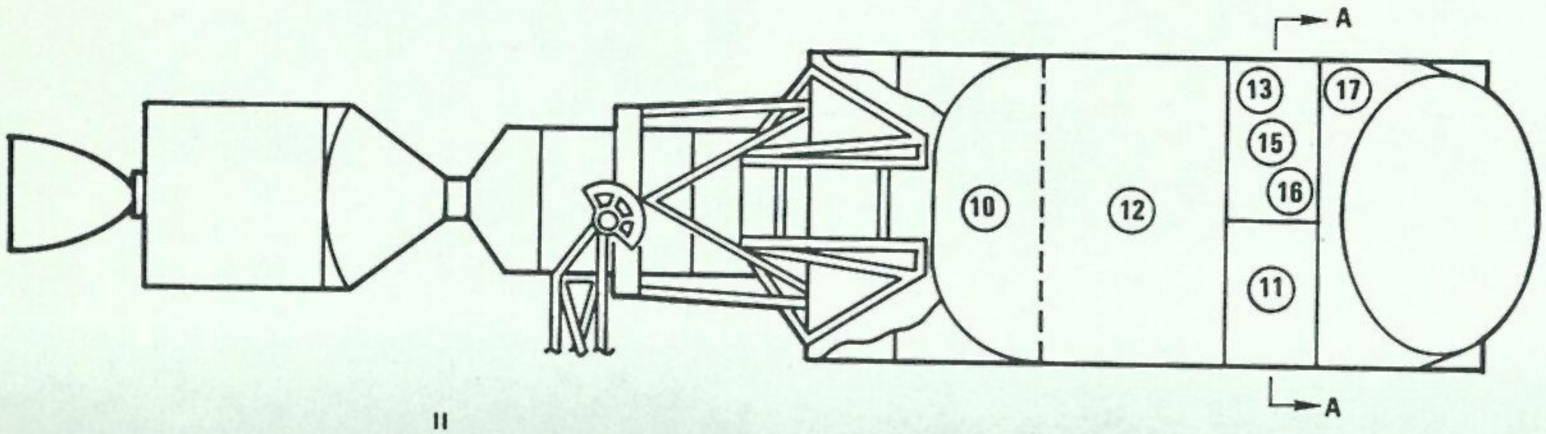
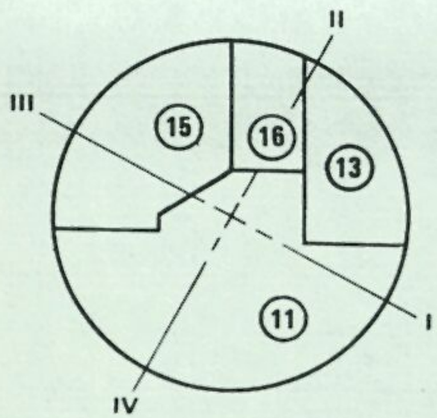
ORBITAL WORKSHOP
ORBITAL ASSEMBLY CREW STATION LOCATIONS

O/W-5278
4–14–70





A – A

(10) FORWARD DOME
(11) EXPERIMENT COMPARTMENT
(12) FORWARD COMPARTMENT
(13) SLEEP COMPARTMENT
(15) WARD ROOM
(16) WASTE MANAGEMENT COMPARTMENT
(17) AFT COMPARTMENT

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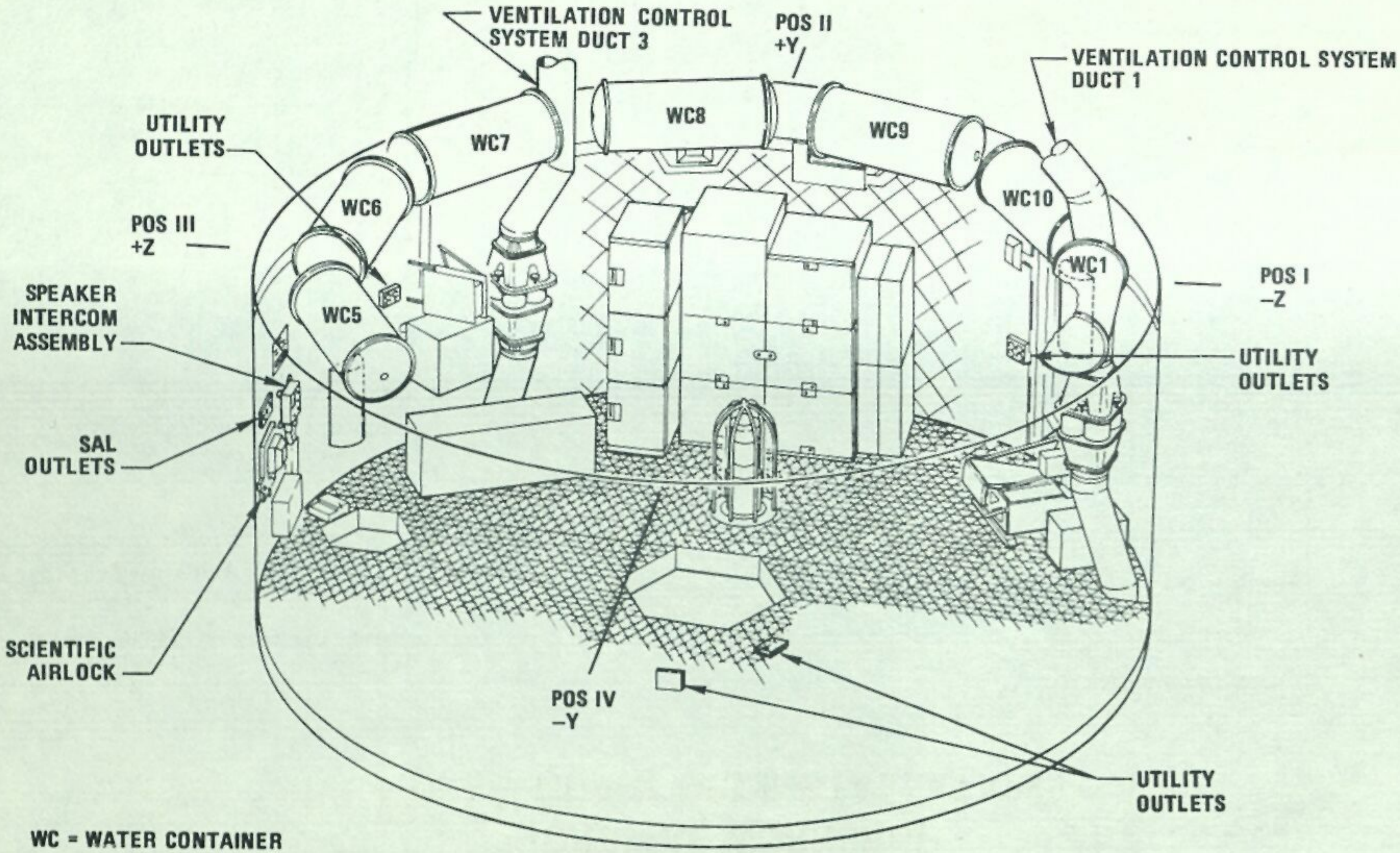
ORBITAL WORKSHOP FORWARD COMPARTMENT

O/W-7835
6–16–70



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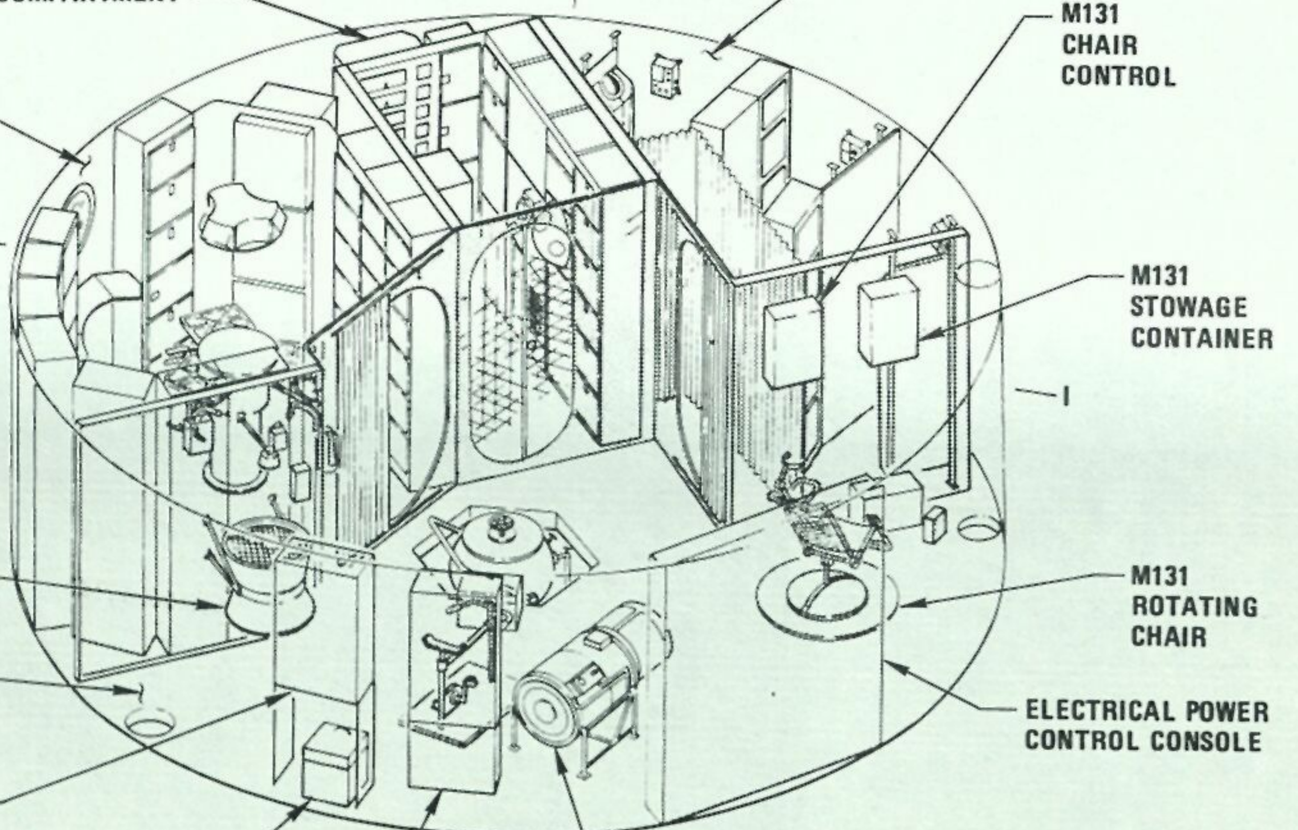
ORBITAL WORKSHOP
CREW QUARTERS INSTALLATIONS

O/W-802D
5–26–70



Fixed Astronaut Aids

Fixed astronaut aids consist of handrails, handholds, and the central handrail.

The waste management compartment ceiling handrail extends from the doorway to the outboard wall of the compartment. The forward compartment handrails consist of a series of six handrails of various lengths which extend vertically in the forward compartment, and a series of three handrails which extend circumferentially around the floor of the forward compartment about five feet from the floor. The forward dome handrails consist of a series of five handrails of various lengths which extend circumferentially around the forward dome interior, and a series of three segmented vertical handrails which extend from the vicinity of the access hatch handrail, to the forward circumferential wire cover above the water tank support structure. The access handrail consists of two circular segments which are concentric with the access hatch. The aft compartment (plenum) handrail is a straight handrail located on the aft side of the crew quarters floor. The central handrail is of irregular hexagonal cross-section, and extends from the access hatch to the crew quarters ceiling. It can be removed and stowed during experimental operations in the forward compartment.

Portable Astronaut Aids

Portable astronaut aids consist of portable handholds, portable foot restraints, portable pressure suit foot restraints, and detachable tethers. The portable astronaut aids attach to the standard triangular grid pattern and can be used wherever open grid is available.

Crew Safety Provisions

Crew safety provisions include the meteoroid shield which is deployed around the circumference of the OWS habitation area, fire protection from three Apollo extinguishers, and utilization of stringent design requirements regarding flammability of materials used in the OWS, and contamination control which is furnished by utilization of stringent toxicity and outgassing requirements in the design of OWS equipment.

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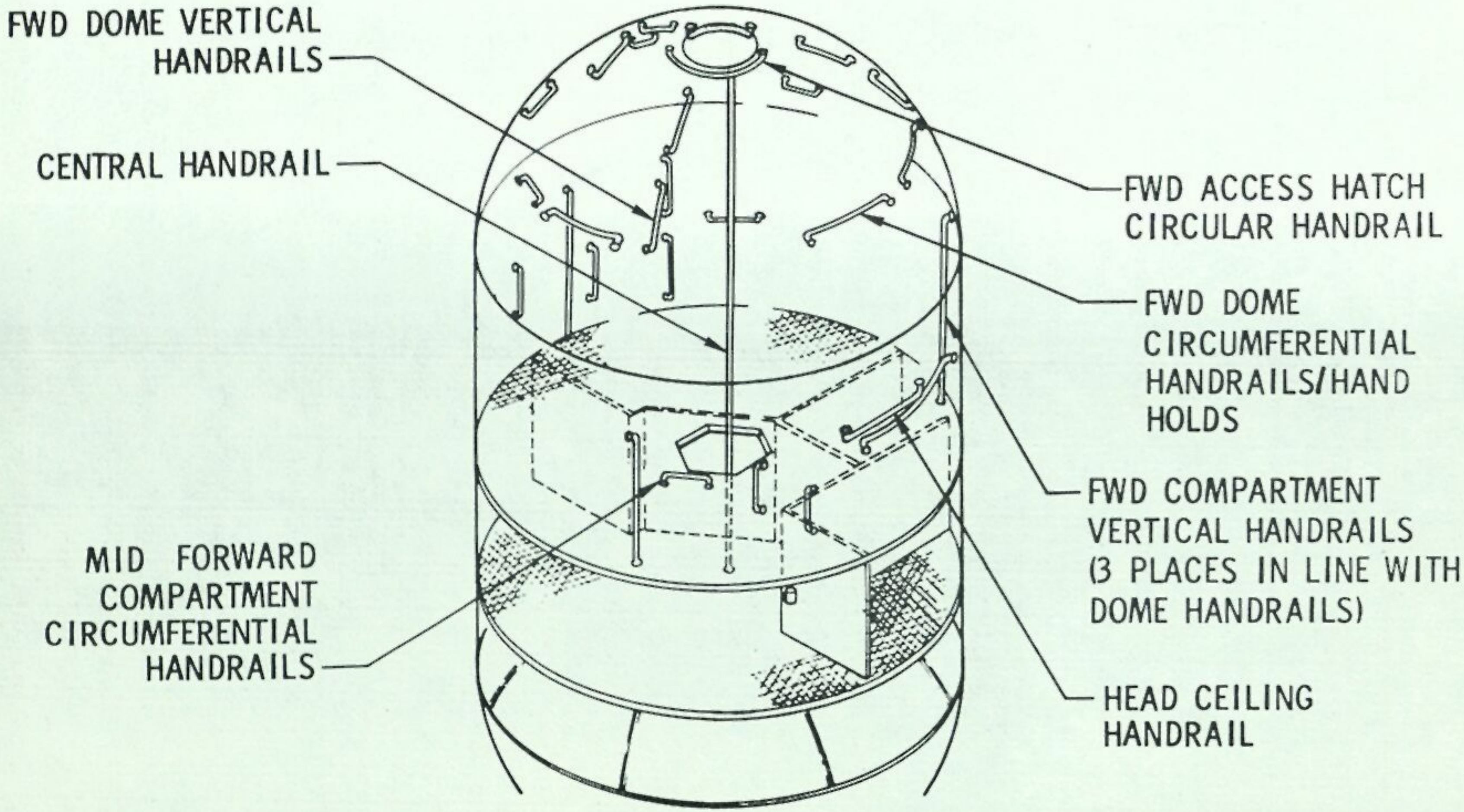
ORBITAL WORKSHOP ASTRONAUT AIDS

O/W-104
9–2–70



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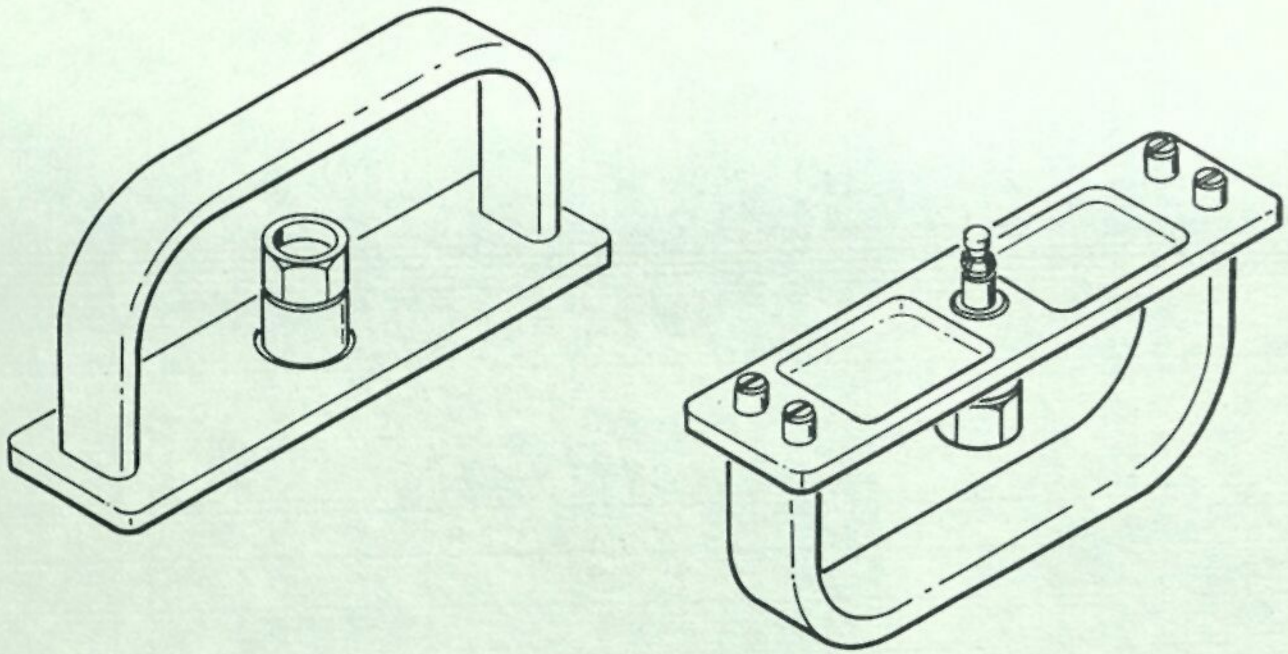
ORBITAL WORKSHOP
ASTRONAUT AIDS
PORTABLE HANDHOLD

O/W-75
9-10-70

57



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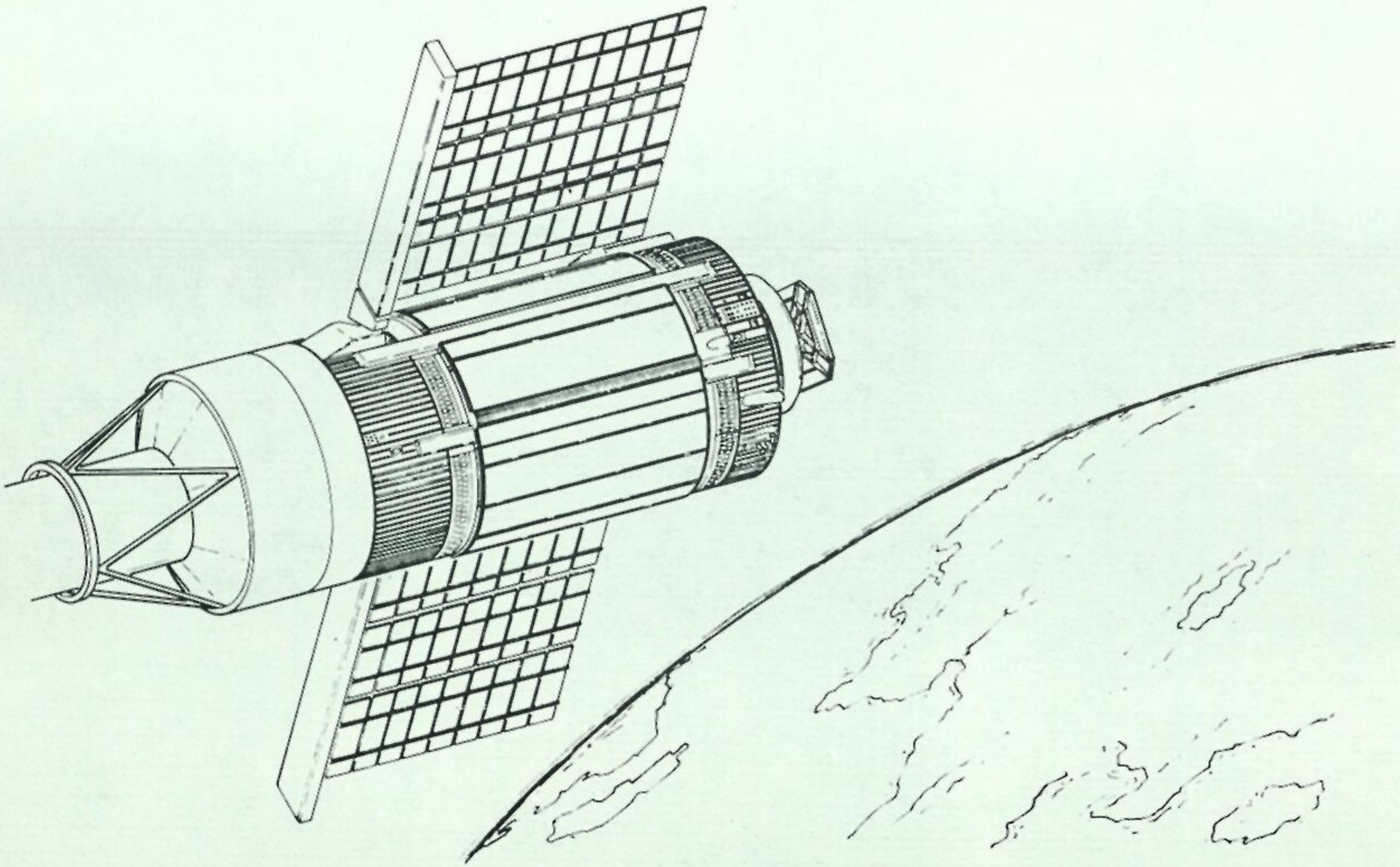
ORBITAL WORKSHOP METEOROID SHIELD

O/W–282
5–19–70



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Orbital Maintenance Provisions

Orbital maintenance provisions consist of orbital spares, an orbital tool kit, and an OWS repair kit.

The orbital spares list defines those items of replaceable equipment deemed pertinent to orbital maintenance activities, such as switches, lamps, filter elements, and seals.

The orbital tool kit contains common hand tools which will be useful to the crew in the performance of orbital maintenance and spares replacement. All tools are equipped with tether rings, and bits are furnished with velcro patches so they may be applied to velcro pile during use.

The OWS repair kit is provided for the orbital repair of air ducts, curtains, filters, and tank wall punctures.

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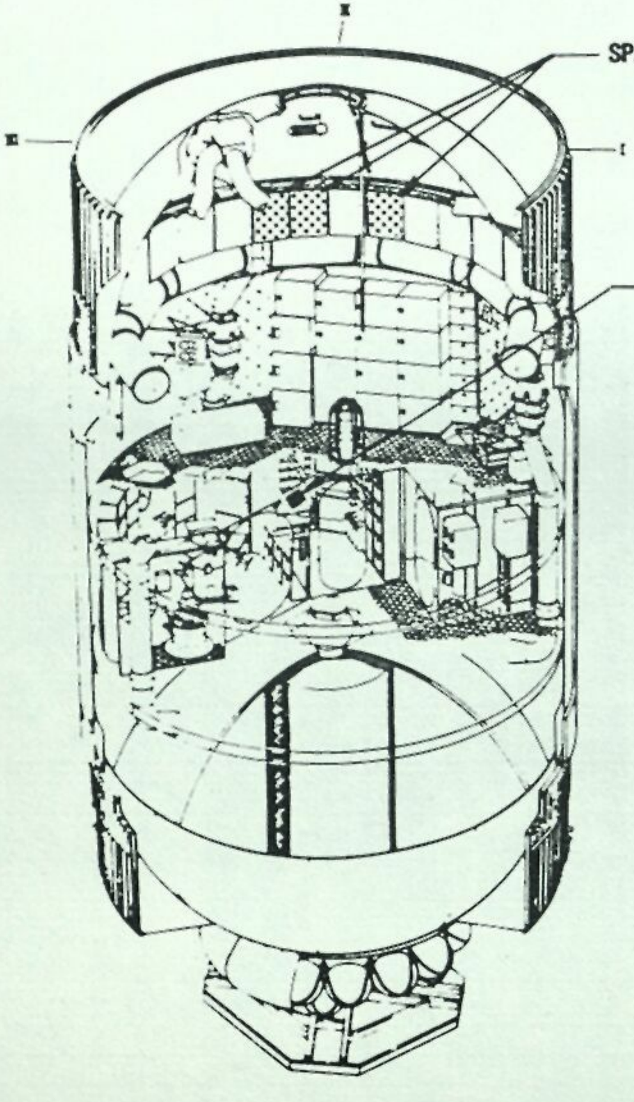
ORBITAL WORKSHOP MAINTENANCE

SA-290
12-2-70



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REQUIREMENTS

TOOL KIT
- SOCKETS, DRIVERS & RATCHETS
- DRIVER HANDLES & ADAPTERS
- TOOL TETHERS
- LOOSE HAND TOOLS

REPAIR KIT
- METEOROID REPAIR EQUIPMENT
- VELCRO (ON ORBIT APPLICATION
- SCISSORS

SPARES
- O'RING & SEALS
- LIGHTS, FANS & FILTERS
- COMM BOX'S
- HEATERS
- ELECTRONIC COMPONENTS
- LIQUID DUMP PROBE & HEATER
- WATER DISPENSER & VALVE

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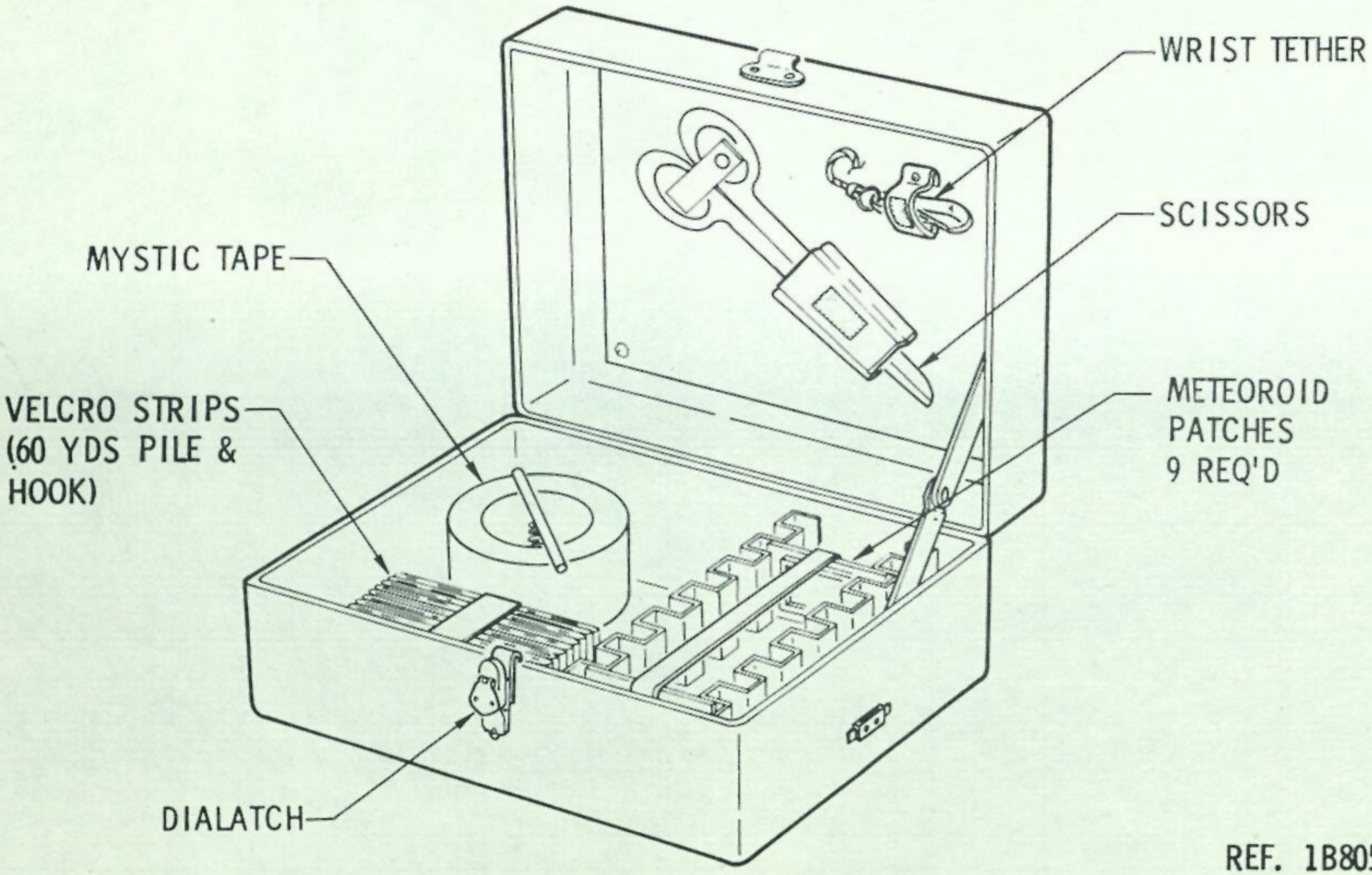
ORBITAL WORKSHOP REPAIR KIT

O/W-5836
10–14–70



REF. 1B80508

Habitability Support System

The Habitability Support System (HSS) consists of subsystems and equipment which manage metabolic waste, and accommodate the crew for sustenance, health, personal hygiene, and comfort.

The habitability support system includes:

- o Waste management subsystem
- o Water management subsystem
- o Food management subsystem
- o Personal hygiene subsystem
- o Sleep compartment equipment
- o Trash disposal subsystem

Waste Management Subsystem (WMS)

The waste management subsystem provides the equipment necessary for safe, effective and hygienic collection, processing, storage, return and or disposal of feces, urine, and vomitus waste products for three OWS crewmen. The WMS also provides for the collection and disposal of debris and free water from the OWS atmosphere.

Waste product samples are processed for return by mass determination and either freezing, or vacuum drying, and stored in special containers for transfer to the command module at the end of the mission.

A portable vacuum cleaner is used to collect and retain particulate matter and free water from any area within the OWS.

Water Management Subsystem

The OWS water management subsystem provides potable water to the OWS crew quarters (WMC and wardroom) for consumption, personal hygiene, and housekeeping.

The water management subsystem consists of water storage, distribution, microbiological control, and dispensing equipment.

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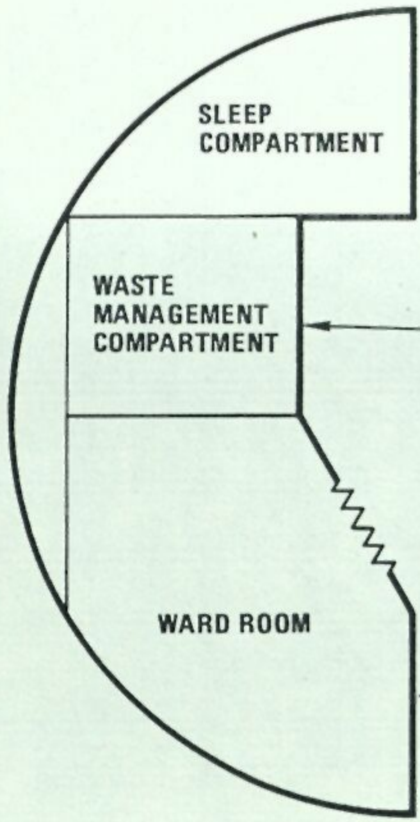
ORBITAL WORKSHOP HABITABILITY SUPPORT SYSTEM EQUIPMENT LOCATION

O/W-1714
8–8–70



Sleep Compartment

- SLEEP RESTRAINTS
- PRIVACY PARTITION & CURTAINS
- GENERAL PURPOSE TISSUE/UTILITY WIPE DISPENSER
- STOWAGE LOCKERS & EQUIPMENT
- TRASH CONTAINERS

Waste Management Compartment

- FECAL/URINE COLLECTION MODULES
- WASTE PROCESSOR
- URINE FREEZER
- COLLECTION BAG DISPENSERS
- STOWAGE LOCKERS & EQUIPMENT
- COLLECTION BAGS
- GENERAL PURPOSE TISSUE/UTILITY WIPE DISPENSER
- SPONGE SQUEEZER
- VACUUM CLEANER
- TRASH BAG CONTAINER
- TOWEL AND WASHCLOTH DRYING
- WMC WATER MODULE
- PERSONAL HYGIENE EQUIPMENT
- PROCESSED COLLECTION BAG CONTAINER
- TOWEL & WASH CLOTH DISPENSERS

Ward Room

- FOOD FREEZERS/REFRIGERATOR
- GALLEY
- FOOD PREPARATION TABLE
- FOOD MANAGEMENT RESTRAINTS
- FOOD TRAYS
- WATER CHILLER & HEATER
- WARD ROOM WATER MODULE
- GENERAL PURPOSE TISSUE/UTILITY WIPE DISPENSER
- TRASH BAG CONTAINER
- STOWAGE LOCKERS & EQUIPMENT
- WRITING DESK

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ORBITAL WORKSHOP
WASTE MANAGEMENT SUBSYSTEM

SA-307
12-2-70

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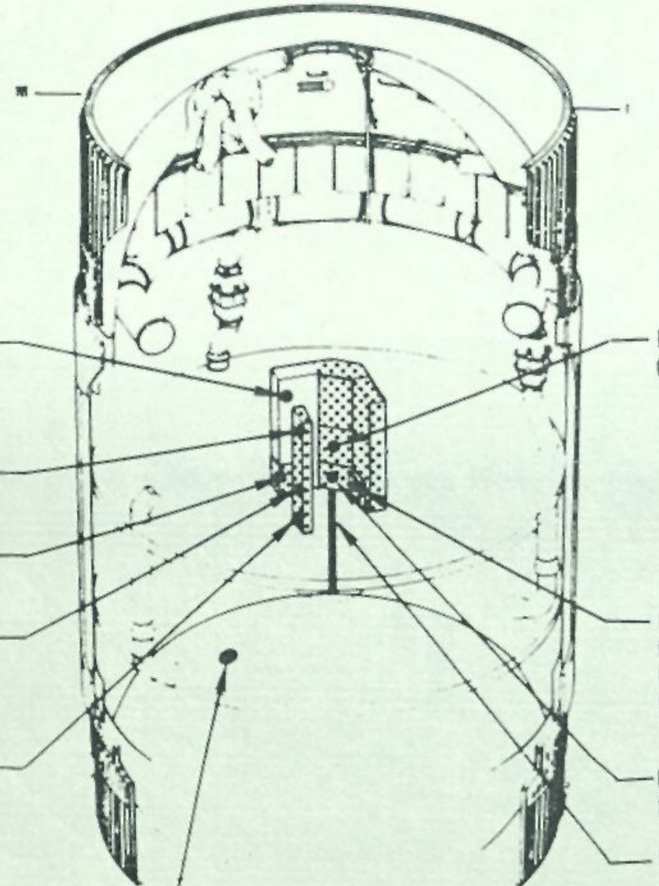

REQUIREMENTS

PROVIDE FOR COLLECTION, MASS DETERMINATION, PROCESSING, AND STORAGE OF FECES AND VOMIT

PROVIDE FOR COLLECTION, MASS AND/OR SAMPLE DETERMINATION, DISPOSAL AND/OR PROCESSING, AND STORAGE OF URINE SAMPLES

PROVIDE FOR COLLECTION, DEACTIVATION AND/OR PROCESSING, STORAGE AND/OR DISPOSAL OF DEBRIS AND FREE WATER

PRECLUDE MIXING AND CROSS CONTAMINATION BETWEEN CREW MEMBERS

PROVIDE FOR TRANSFERRING OF PROCESSED AND IDENTIFIED SAMPLES TO THE CM FOR RETURN TO EARTH FOR ANALYSIS

SYSTEM OPERATION

PROCESSOR	
HEATER TEMP	140°F
POWER	
AVERAGE	30 WATTS
PEAK	60 WATTS
ATMOSPHERE LOSS	.33 LB/DAY
FECAL/URINE COLLECTOR	
3 URINE CHILLER DRAWERS	
BLOWER MOTOR	
AIR FLOW	11.4 CFM
POWER (AVE)	84 WATTS

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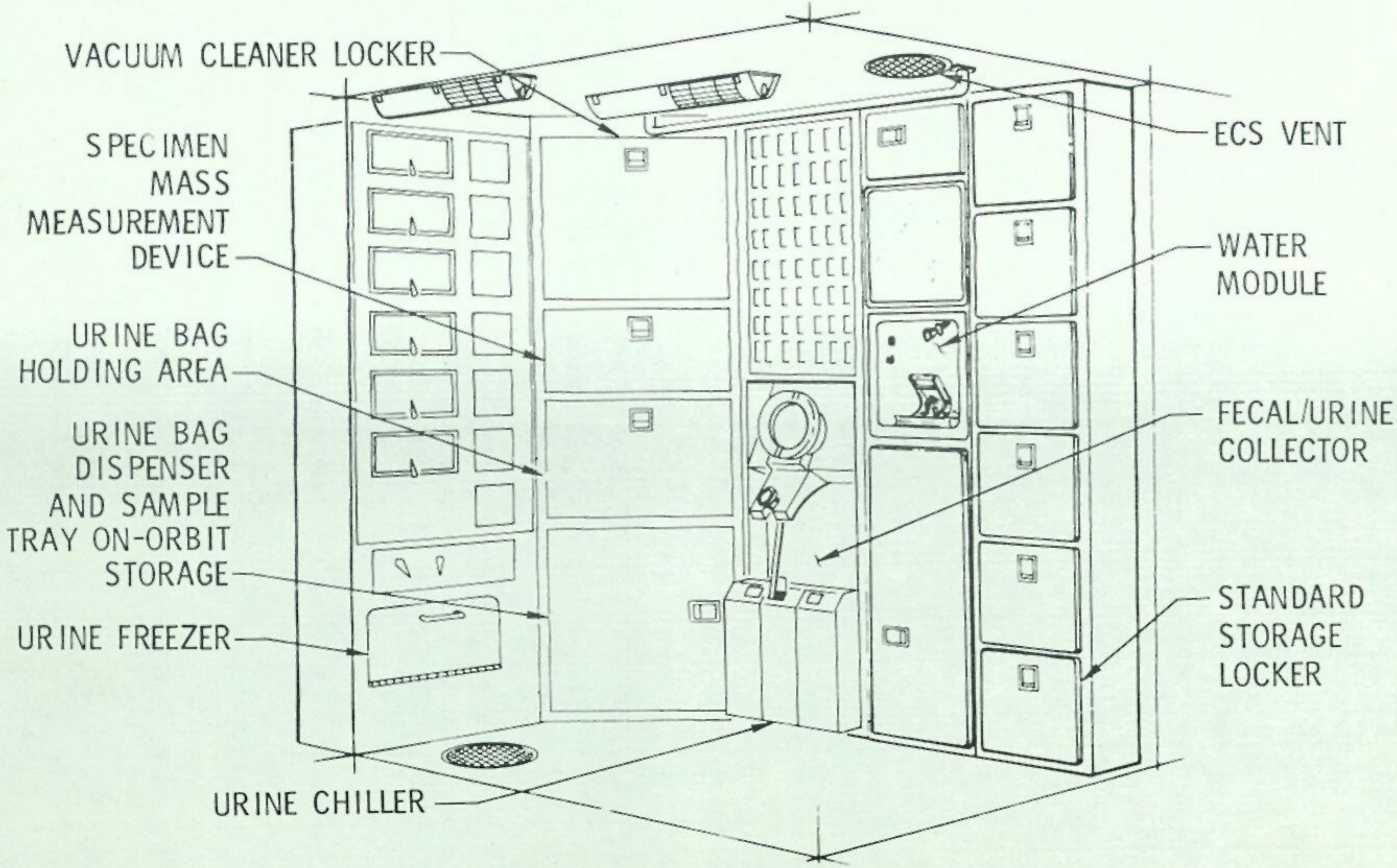
ORBITAL WORKSHOP
HSS WASTE MANAGEMENT COMPARTMENT

O/W-2183B-1
8–28–70



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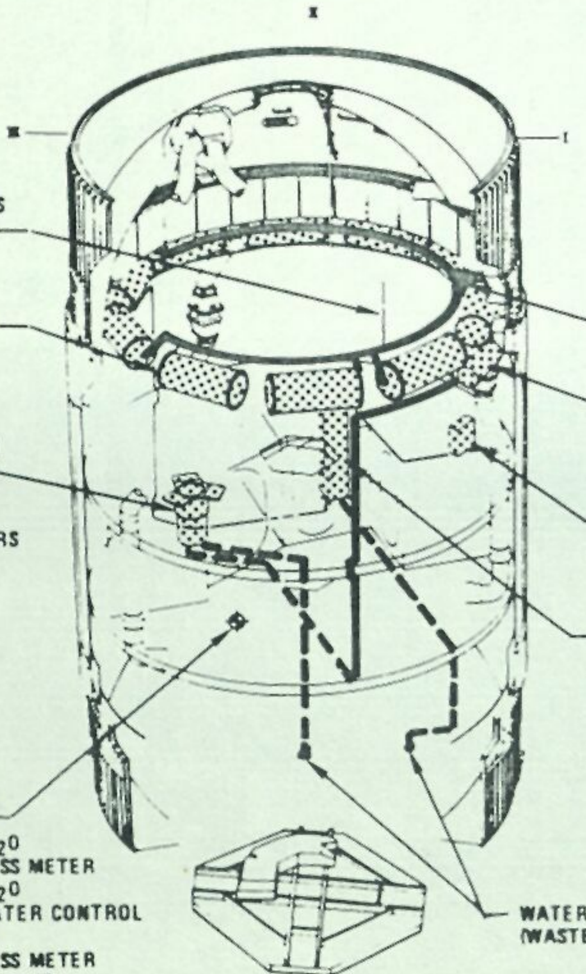
ASTRONAUTICS
COMPANY

ORBITAL WORKSHOP WATER SYSTEM

SA-296
12-2-70



REQUIREMENTS

WATER WEIGHT	6,000 LBS MAXIMUM
MEASUREMENT OF WATER	
DRINKING	½ OZ ±1% INCREMENTS
FOOD RECONSTITUTION	½ OZ (FROM 1 TO 6 OZ) ±1% INCREMENTS
DRINK DISPENSERS (3)	40±5°F
FOOD RECONSTITUTION DISPENSER (1)	40±5°F
FOOD RECONSTITUTION DISPENSER (1)	150±5°F
PERSONAL HYGIENE DISPENSER (1)	125±5°F
PORTABLE WATER TANK	28 LBS MINIMUM
IODINE USED AS BIOCIDE	2 TO 12 MG/L STORAGE 2 TO 6 MG/L CONSUMPTION
IODINE MONITORING	2 TO 18 MG/L

SYSTEM OPERATION

WATER TANKS (10)	600 LBS MINIMUM
FLEX METAL BELLOWS	
GN_2 PRESSURE SYSTEM	35±2 PSIG
WATER HEATER VOLUME (2)	4.0 LBS NOMINAL
WATER CHILLER VOLUME	5.9 LBS NOMINAL
WATER PRESSURE	$35^{+5}_{-3.5}$ PSIG
PORTABLE TANK VOLUME	24 LBS WATER
PORTABLE TANK PRESSURE	18 TO 40 PSIG
IODINE STORAGE/INJECTION	I_2 + KI
WATER SAMPLE/ IODINE MONITOR	STARCH REAGENT/ VISUAL COMPARISON

Water is stored in ten stainless steel water tanks located around the forward section of the forward compartment. Total storage capacity is approximately 500 gallons. Each water tank has a stainless steel bellows enclosed in the shell which is used to pressurize the contents from a common manifold connected to all of the ten tanks, and an agitator pump which aids in the distribution of biocide throughout the tank.

In addition to the ten tanks mounted in the forward compartment, the OWS is equipped with a portable water tank of approximately 3 gallons capacity.

Water conditioning and dispensing equipment is located in the wardroom and in the waste management compartment. The wardroom equipment consists of a water heater and a water chiller which condition the water for reconstitution of foods and drinking. The waste management equipment consists of a heater which conditions the water for body cleansing and general housekeeping. Appropriate dispensing equipment is located in each of the two compartments for the controlled dispensation of water for these purposes.

Microbiological control of the OWS water supply begins with prelaunch installation of processed water that meets stringent purity specifications, and is continued on-orbit by periodic monitoring and addition of iodine solution.

Food Management Subsystem

The OWS food management subsystem provides the equipment and supplies required for storage, preparation, and consumption of the food supply for three men for 140 days. Among this equipment are food freezers, refrigerator, stowage containers, a galley, heaters, table, and restraints.

One of the food freezers is located in the wardroom, and the other is located in the forward compartment. They contain five freezer compartments of 100 pounds capacity each.

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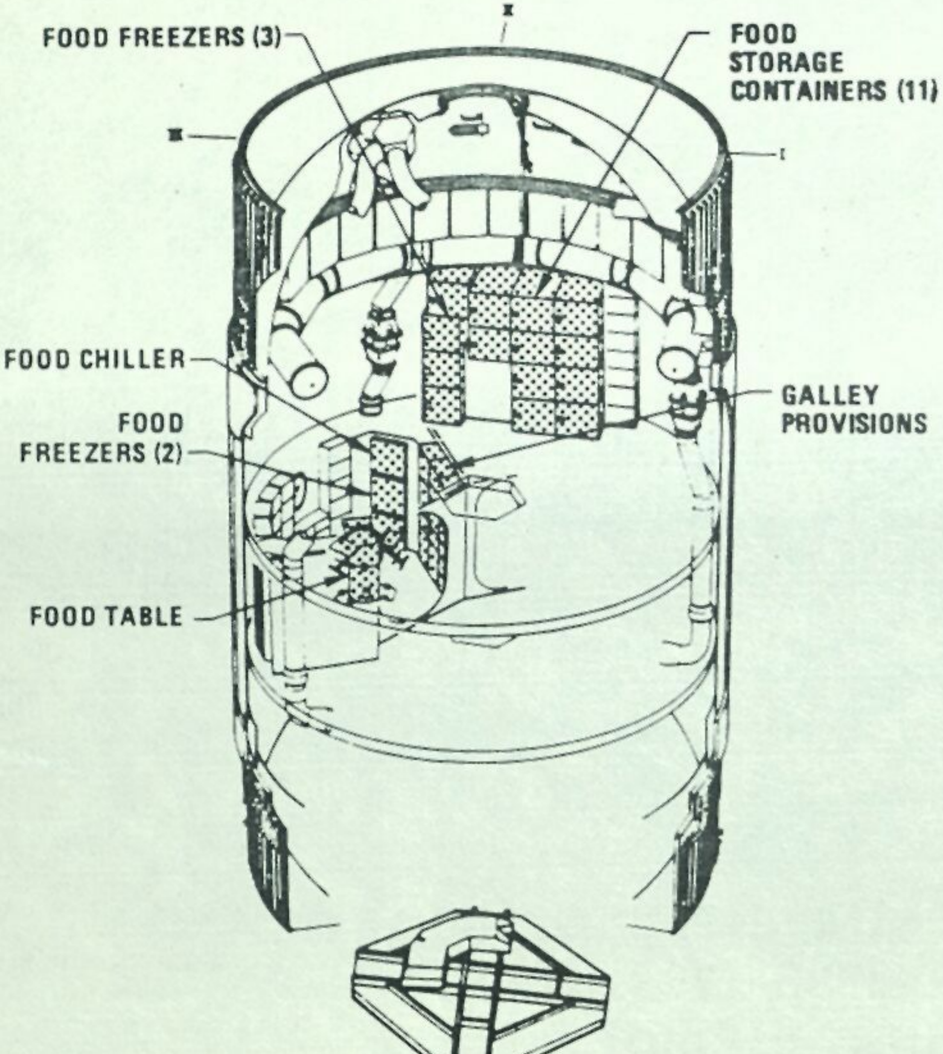
ORBITAL WORKSHOP
FOOD MANAGEMENT SYSTEM

SA-304
12-2-70



REQUIREMENTS

11 FOOD STOWAGE CONTAINERS (CANNED)
- 2,200 LB
- 88 FT^3 (20 X 22 X 30 EACH)
- OWS ENVIRONMENTAL PRESSURE
- OWS ENVIRONMENTAL TEMP 40° – 80°F

5 FOOD FREEZERS
- (3) FORWARD COMPARTMENT, (2) WARD ROOM
- 23 DAY/EACH FREEZER
- 17 X 13 X 16.5
- 1.75 FT^3 EACH/8.75 FT^3 TOTAL
- 50.4 POUNDS EACH/252 POUNDS TOTAL
- TEMPERATURE – 10 ± 10°F
- OWS ENVIRONMENTAL PRESSURE
- INTERNAL COOLANT LOOP

1 FOOD CHILLER
- (1) WARDROOM
- 56 DAY CAPACITY
- 17 X 13 X 16.5
- 1.75 FT^3 REQUIRED/54.4 LB
- OWS ENVIRONMENTAL PRESSURE
- 45 + 0° – 12°F

GALLEY PROVISIONS
- STORAGE FOR FOOD STORAGE OVERCANS
- STORAGE FOR AVERAGE PACKAGES
- STORAGE OF FOOD TRAYS
- CAN OPENER, TRASH CONTAINER

FOOD TABLE
- FOOD TRAYS – OPERATION & HEATING
- FOOD MGMT RESTRAINTS

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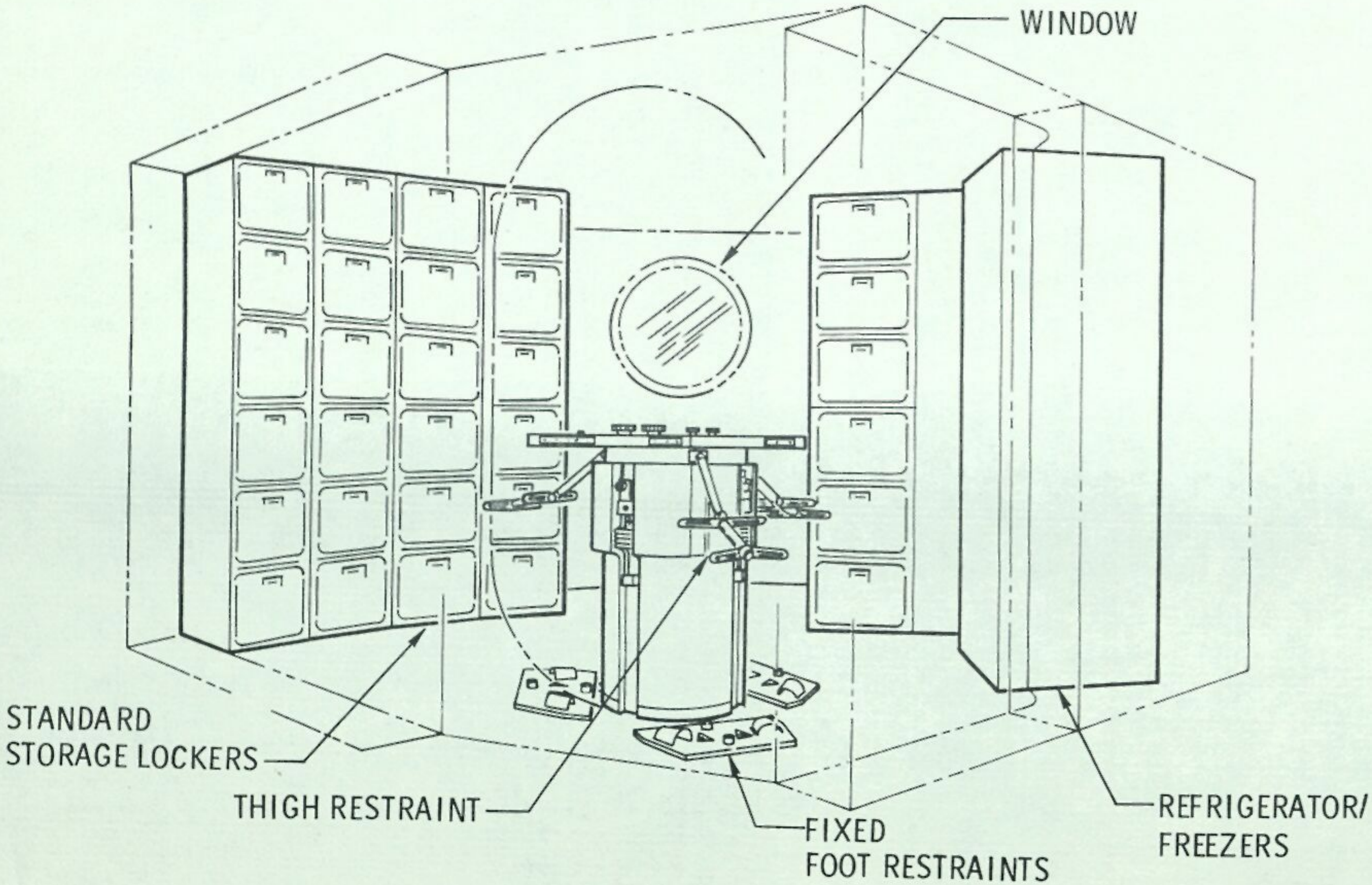
ORBITAL WORKSHOP
UTILIZE FOOD PREPARATION TABLE, FOOD MGT RESTRAINTS & FOOD HEATERS

O/W-4280 A
4-20-70



The food chiller, colocated with the wardroom freezer, stores 100 pounds of refrigerated food and beverage.

The food stowage containers provide space for unrefrigerated food. There are eleven of these stowage containers, which are located in the forward compartment.

The galley provides for stowage of a seven day supply of food cannisters, stowage for empty cannisters, a can opener, general purpose restraints, food trays, covers, and utensils. General purpose tissue-utilitv wipe dispensers are also provided in the OWS galley.

The food table and restraints provide the means for three crewmen to simultaneously consume food in an efficient and comfortable manner. The table also contains elements of the water management subsystem. The table base contains the water heater, water chiller, water dispensers, and personal dental hygiene equipment. The table top is convertible to a game table, or writing desk. The thigh restraints are adjustable for various sizes, and can be folded against the table base when not in use.

Personal Hygiene Subsystem

The personal hygiene subsystem, in conjunction with the WMC water equipment, provides for maintenance of skin health, personal cleanliness, and grooming, including total body cleansing, dental hygiene, shaving, nail and hair clipping.

Included in the personal hygiene subsystem are towel and washcloth dispensers, holders, general purpose tissue and utility wipe dispensers, a mirror, a sponge/washcloth squeezer, and toothbrush stowage containers. Personal hygiene kits for each crewman are included as government furnished equipment. These kits contain hairbrush, nail clippers, tooth brush, and such individually-used items of equipment.

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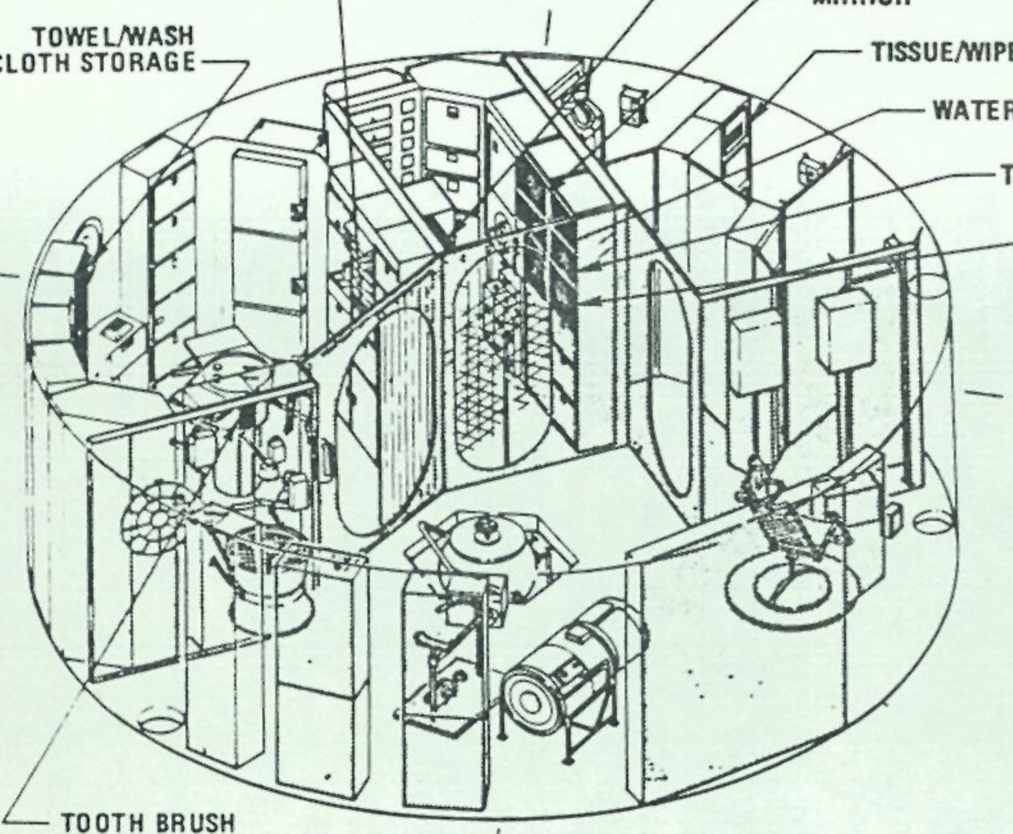
ORBITAL WORKSHOP
PERSONAL HYGIENE EQUIPMENT

SA-288
12-2-70



PERSONAL HYGIENE EQUIPMENT

INDIVIDUAL PERSONAL HYGIENE EQUIPMENT
- GFE KITS–(15) 28 DAYKITS
- 12 FT^3 EACH–TOTAL 1.80 FT^3

COMMON PERSONAL HYGIENE EQUIPMENT
- TOWELS (120) & DISPENSER
- WASH CLOTHS (840) & DISPENSER
- TOOTH BRUSH STOWAGE CONTAINERS (3)
- TOWEL & WASH CLOTH DRYING EQUIPMENT (3 EACH)
- SOAP (55 BARS) & SOAP DISPENSERS
- MIRROR (1)
- GENERAL PURPOSE TISSUES (4200) & WIPES (3500) AND DISPENSERS
- WASH WATER BAGS (22)
- HYGIENE WATER MODULE

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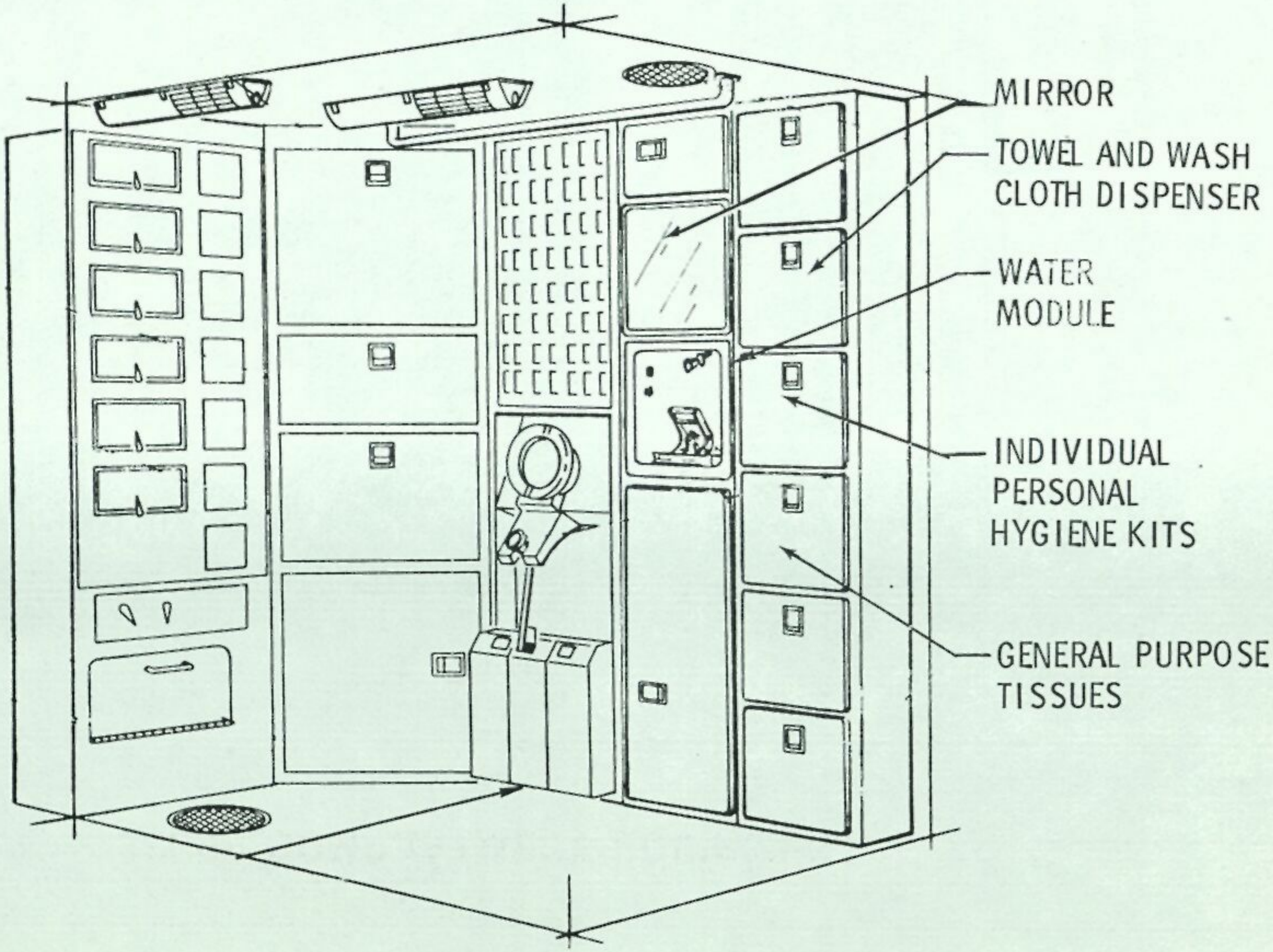
ORBITAL WORKSHOP

PERSONAL HYGIENE EQUIPMENT

O/W-9754-1
9-12-70



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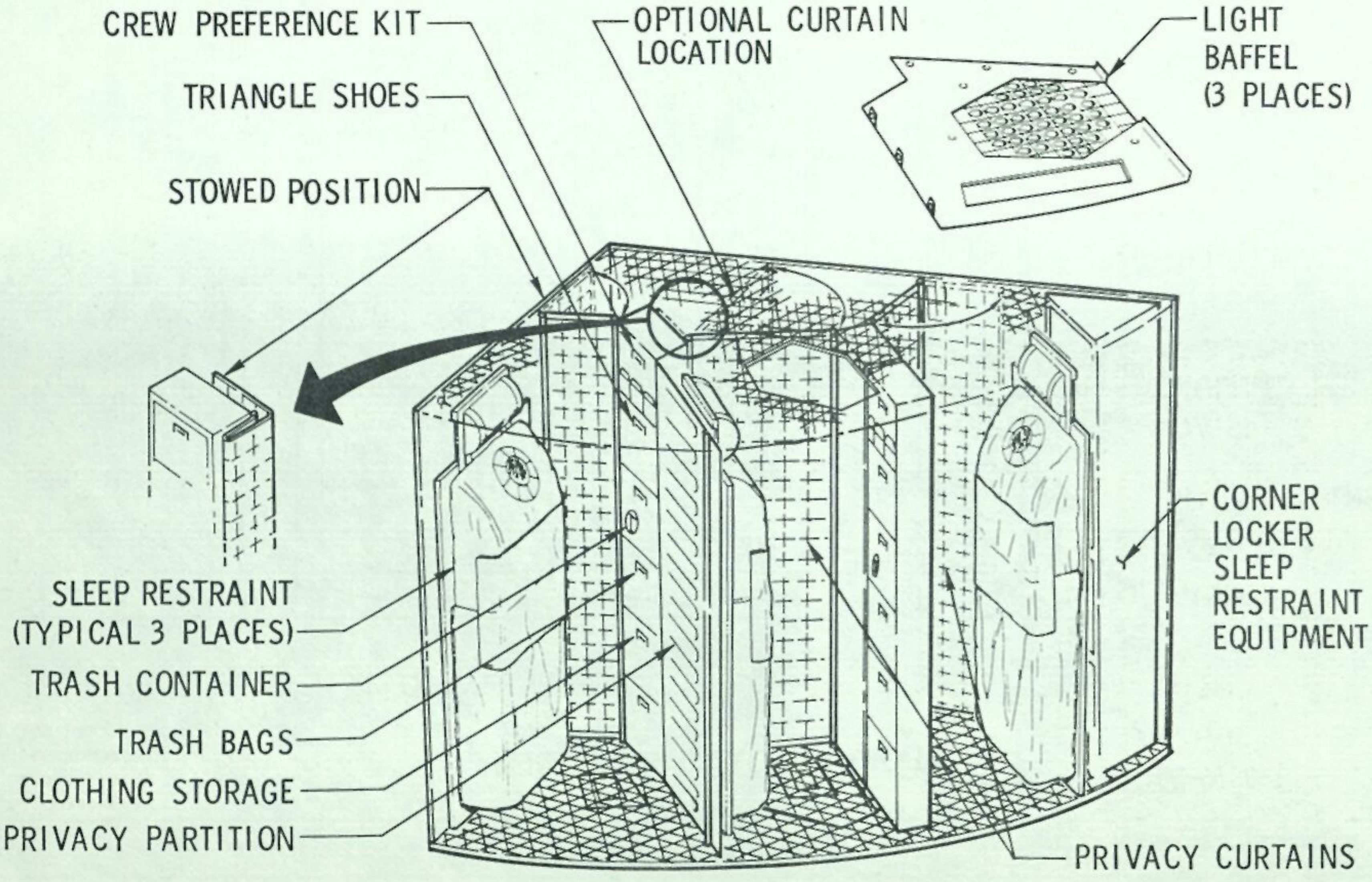
SLEEP COMPARTMENT EQUIPMENT

SA-299A
5–19–71



Sleep Compartment Equipment

The sleep compartment equipment consists of crew sleep restraints, a privacy partition, and three privacy curtains.

Thirty sleep restraints will be supplied for the entire mission, to provide positive restraint of the crewmen during sleep. One privacy curtain is provided for each of the three individual sleep areas, to provide visual separation and light control. The privacy partition separates two sleep areas in the sleep compartment, two lockers separate the third. The privacy partition provides visual separation and acts as a light barrier.

Trash Disposal Subsystem

The OWS trash disposal subsystem consists of the equipment and supplies required to manage the trash generated by three crewmen during the 140 days of programmed mission duration. This equipment includes trash bags, a trash airlock and stowage provisions for trash in the waste tank.

The trash bags are vented teflon containers of approximately cylindrical configuration. The trash bags are equipped with self closures which seal the bags when full.

The trash airlock, located in the hexagonal opening in the center of the crew quarters floor, provides for the expulsion of packaged trash into the waste tank area for stowage. It consists of a chamber, inboard and outboard hatches, and a trash ejector which expels the trash into the waste tank.

Experiment Accommodations

The OWS experiment accommodations include the necessary mounting, electrical, gas, vacuum, and data collection requirements for the operation of experiments which are installed and operated in the OWS. The experiments are divided into three categories:

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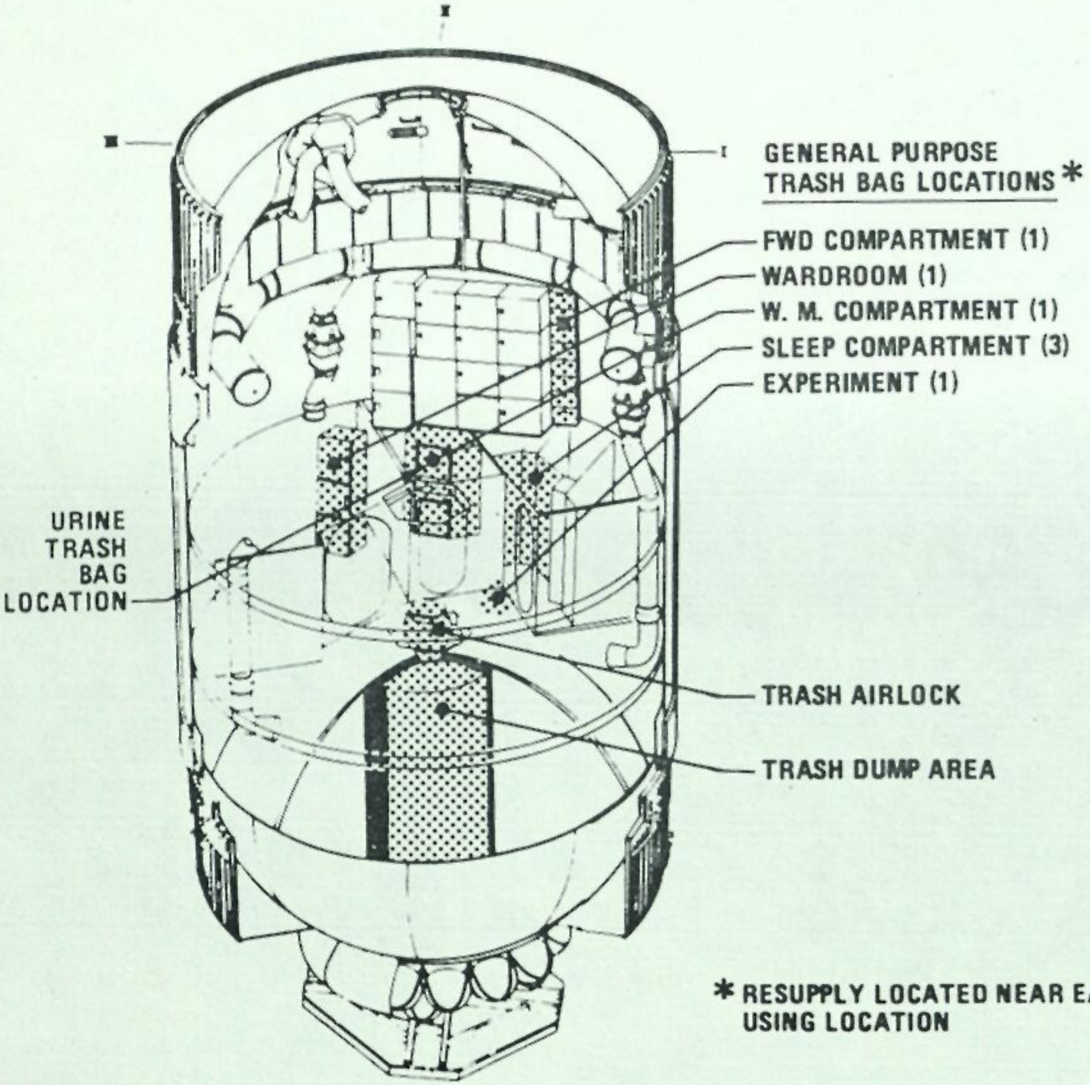
ORBITAL WORKSHOP
TRASH DISPOSAL SUBSYSTEM

SA-295
12-2-70



* RESUPPLY LOCATED NEAR EACH USING LOCATION

REQUIREMENTS

DISPOSAL OF WET MATERIAL

DISPOSAL OF DRY MATERIAL

DISPOSAL FROM ORBITAL ASSY

DISPOSAL SHALL BE MADE IN WASTE TANK

HABITABILITY AREA TO BE KEPT FREE OF AGENTS THAT COULD PROMOTE BACTERIAL GROWTH AND UNDESIRABLE ODORS

TRASH BAG USAGE (140 DAYS)

GENERAL PURPOSE BAG	
SLEEP COMPARTMENT	60
WMC	140
WARDROOM	140
EXPERIMENT	10
FWD COMPARTMENT	10
MISC	22
	382
CONTINGENCY	38
TOTAL	420
URINE TRASH BAG (WMC)	
URINE POOLING	140
FOOD OVER CANS	140
SLEEP RESTRAINT	9
MISC	28
	317
CONTINGENCY	32
TOTAL	349

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ORBITAL WORKSHOP
EXPERIMENT PROVISIONS

O/W-3974
6-7-71

EXP. NO.	EXPERIMENT TITLE
M071	MINERAL BALANCE (HSS)
M073	BIOASSAY OF BODY FLUIDS (HSS)
M074	SPECIMEN MASS MEASUREMENT
M092	INFLIGHT LOWER BODY NEGATIVE PRESSURE
M093	VECTORCARDIOGRAM
M131	HUMAN VESTIBULAR FUNCTION
M133	SLEEP MONITORING
M151	TIME AND MOTION STUDY
M171	METABOLIC ACTIVITY
M172	BODY MASS MEASUREMENT
ESS	EXPERIMENT SUPPORT SYSTEM

EXP. NO.	EXPERIMENT TITLE
M509	ASTRONAUT MANEUVERING EQUIPMENT
S019	UV STELLAR ASTRONOMY
S020	UV/X-RAY SOLAR PHOTOGRAPHY
S063	UV AIRGLOW HORIZON PHOTOGRAPHY
S073	GEGENSCHEIN / ZODIACAL LIGHT
S149	PARTICLE COLLECTION
S183	UV PANORAMA
T003	INFLIGHT AEROSOL ANALYSIS
T013	CREW / VEHICLE DISTURBANCE
T020	FOOT CONTROLLED MANEUVERING UNIT
T025	CORONAGRAPH CONTAMINATION MEASUREMENT
T027	ATM CONTAMINATION MEASUREMENT

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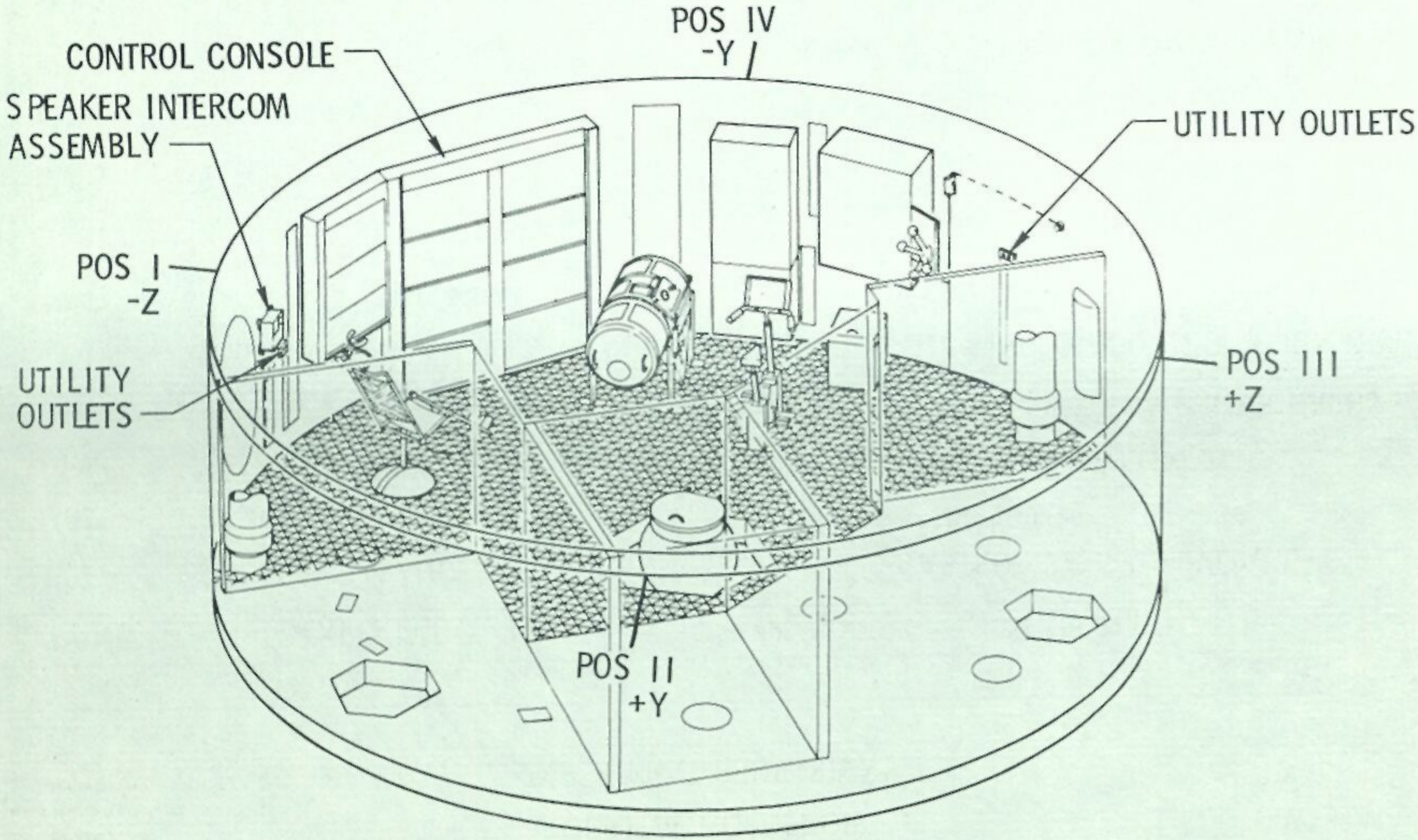
ORBITAL WORKSHOP
EXPERIMENT COMPARTMENT

O/W-5394
6–2–70



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- Biomedical
- Scientific
- Technological and operational

Biomedical Experiments

The biomedical experiments to be performed in the OWS have a general objective to determine the effects of extended weightlessness and confinement in space on the three crewmen associated with each mission.

Among these experiments are:

Experiment Support System (ESS)

The experiment support system is basically a console which contains a power panel and an experiment control panel, and provides support to several of the detailed biomedical experiments by switching and distributing power, and providing control, display, signal conditioning, and data management.

Inflight Lower Body Negative Pressure (LBNP) M092

The LBNP experiment reduces pressure to the lower portion of the crewman's body to evaluate the cardiovascular deconditioning as a function of time in a zero-g environment. The device is basically a tank into which the crewman is inserted to the waist, which has an overboard vent system which can be controlled to reduce pressure in the tank. The crewman's temperature, blood pressure, leg volume, and pulse are measured while the crewman is in the LBNP, and these data are displayed on the ESS console and/or recorded for telemetry. Power is from the ESS console.

Vectorcardiogram (VCG) M093

The vectorcardiogram experiment measures changes in the electrical activity of the heart to determine the relationship of these changes to prolonged exposure of the crew to weightless environment

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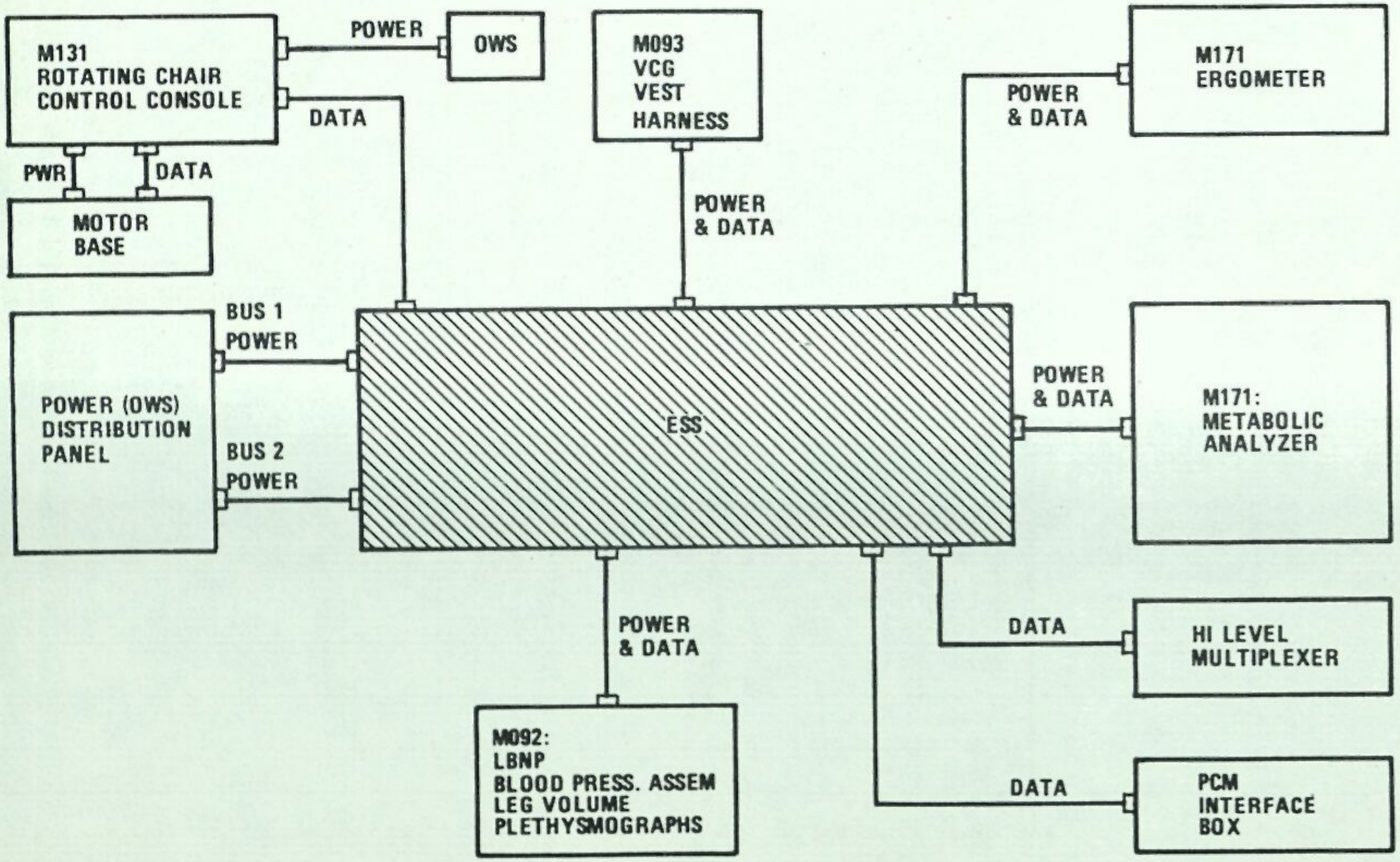
ORBITAL WORKSHOP
EXPERIMENT ACCOMMODATIONS CDR
EXPERIMENT SUPPORT SYSTEM (ESS)

O/W-7075A
9-8-70



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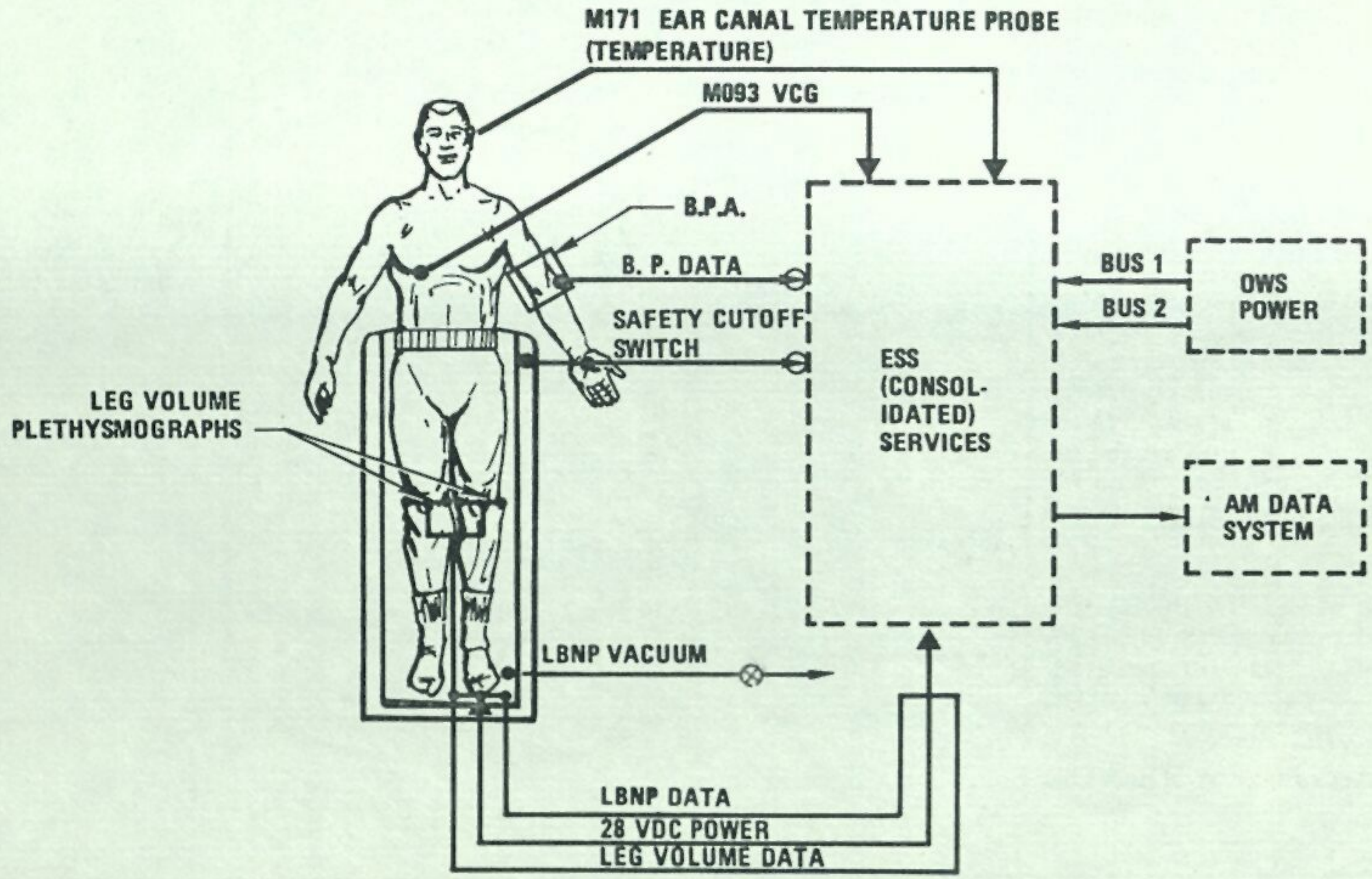
ORBITAL WORKSHOP
EXPERIMENT ACCOMMODATIONS CDR
EXPERIMENT - M092
INFLIGHT LOWER BODY NEGATIVE PRESSURE

O/W-7050
9-2-70



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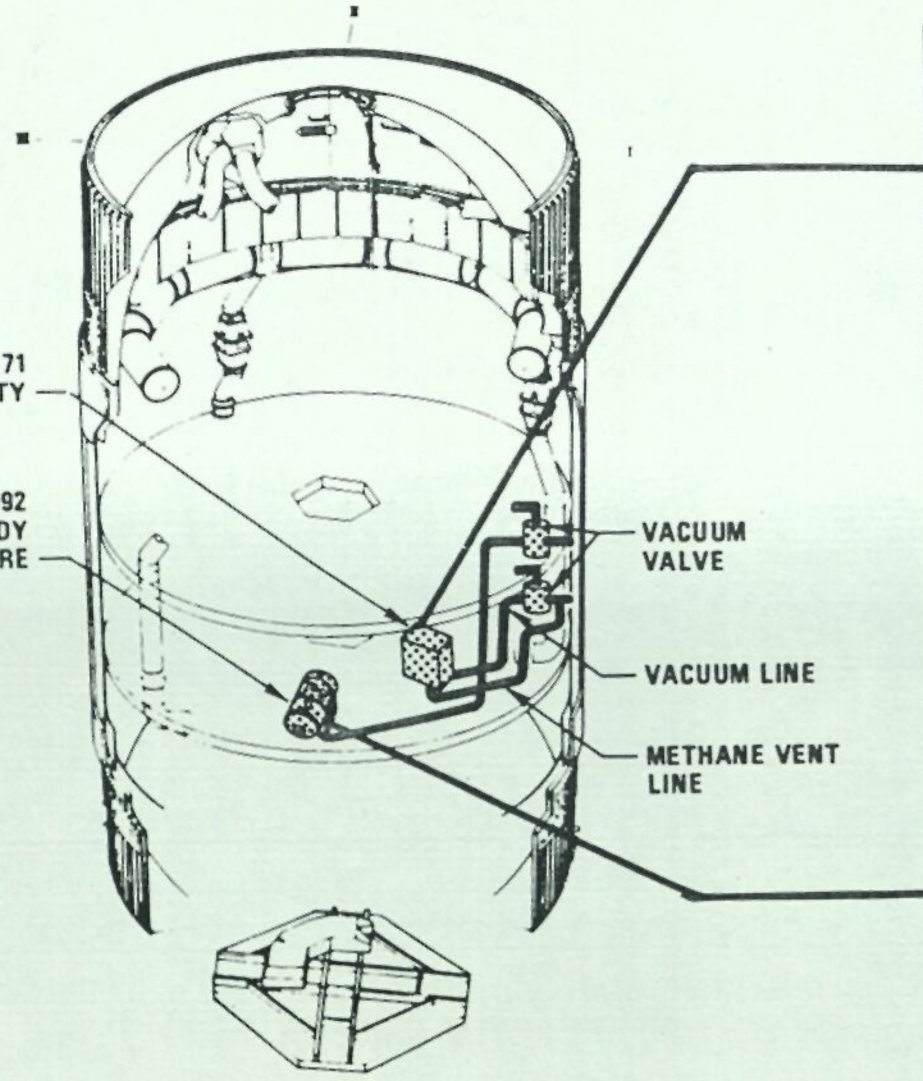
ORBITAL WORKSHOP
VACUUM SYSTEM-EXPERIMENTS

SA-302
12-2-70



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METABOLIC ACTIVITY EXPERIMENT

REQUIREMENTS

PROVIDE VACUUM FOR STARTING ION PUMP

VENT FOR GAS SAMPLE

OVERBOARD RELIEF FOR METHANE (CALIBRATION GAS)

SYSTEM OPERATION

VENTED DIRECTLY OVERBOARD

1" VACUUM LINE WITH ISOLATION VALVE

1/4" METHANE RELIEF LINE

INFLIGHT LOWER BODY NEGATIVE PRESSURE

REQUIREMENTS

PROVIDE VACUUM FOR EXPERIMENT

VENT 0.141 POUNDS PER MINUTE WITH INTERFACE PRESSURE 2.8 PSIA

SYSTEM OPERATION

VENTS DIRECTLY OVERBOARD

1" VACUUM LINE WITH ISOLATION VALVE

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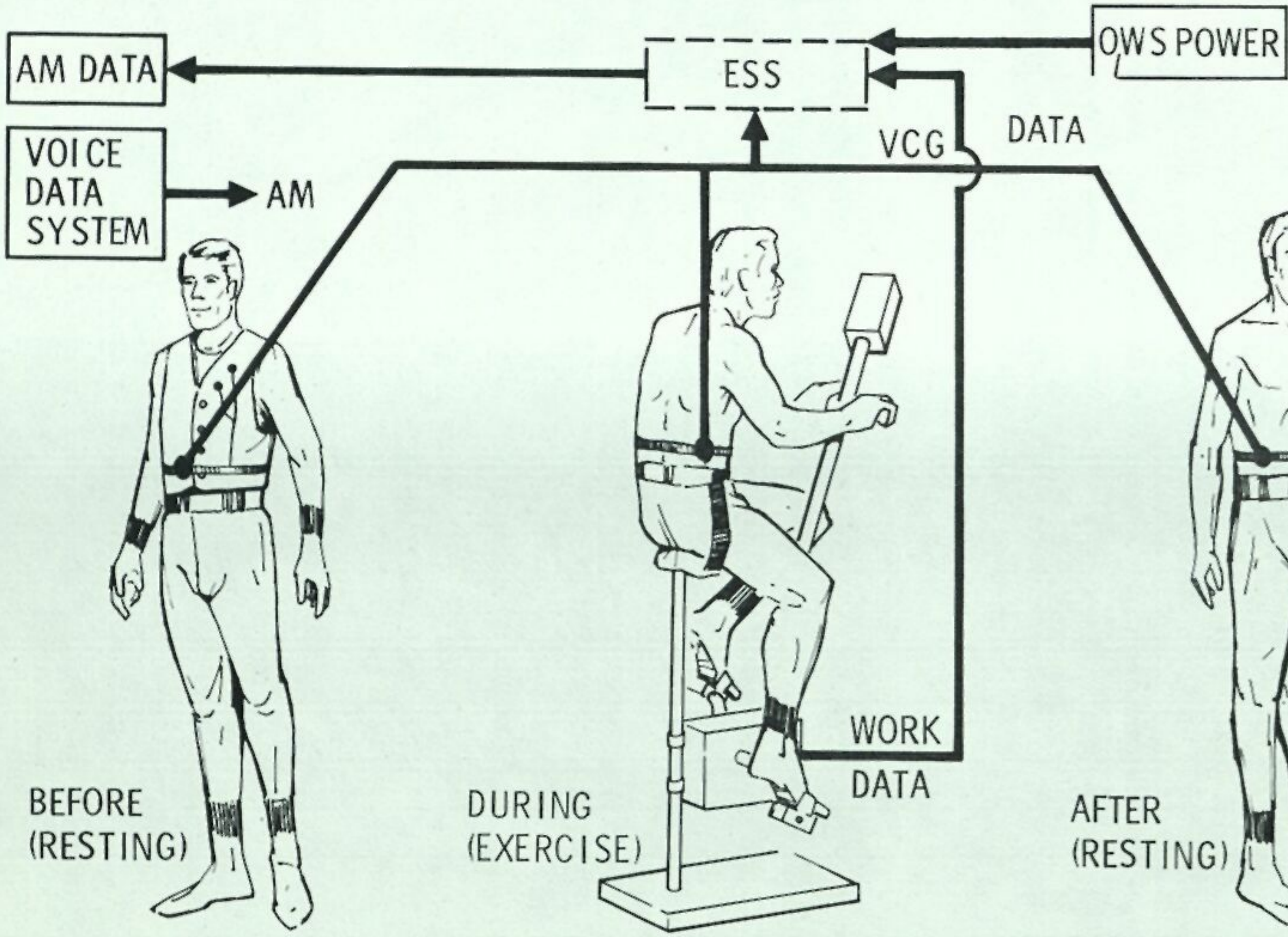
ORBITAL WORKSHOP
EXPERIMENT ACCOMMODATIONS CDR
EXPERIMENT - M093
VECTORCARDIOGRAM

O/W-7052
9–8–70



OPERATIONAL CONFIGURATION

and other stress conditions associated with spaceflight. The vectorcardiogram experiment is supported for power, control, and data management by the ESS console. The ergometer from Experiment M171 (metabolic activity) is used during the vectorcardiogram experiment. Experiment data will be recorded for telemetry, and/or displayed on the VCG panel.

Human Vestibular Function M131

The human vestibular function experiment is conducted to determine man's susceptibility to motion sickness, and his ability to adapt to disorientation as a result of subgravity and other effects which could be encountered during spaceflight.

The subject is seated in a rotating litter chair and required to make verbal reports and perform head movements, to determine symptoms and display judgment ability of spatial coordinates based upon gravity receptor and visual clues. Data is recorded and telemetered, for both static and rotating cases. The ESS provides telemetry interface for this experiment, which has its own control and display panel.

Sleep Monitoring M133

The sleep monitoring experiment is designed to evaluate sleep quantity and quality by using automatic on-board analysis of the Electro-Encephalographic (EEG), Electro-Oculographic (EOG) and head movement activities of one crewman subject.

It has been demonstrated that disrupted patterns of sleep are associated with modified performance. It has also been demonstrated that changes in waveforms of brain activity are associated with the transition from wakefulness to deep sleep. Seven stages of sleep activity have been defined, and individual requirements for each stage have been established.

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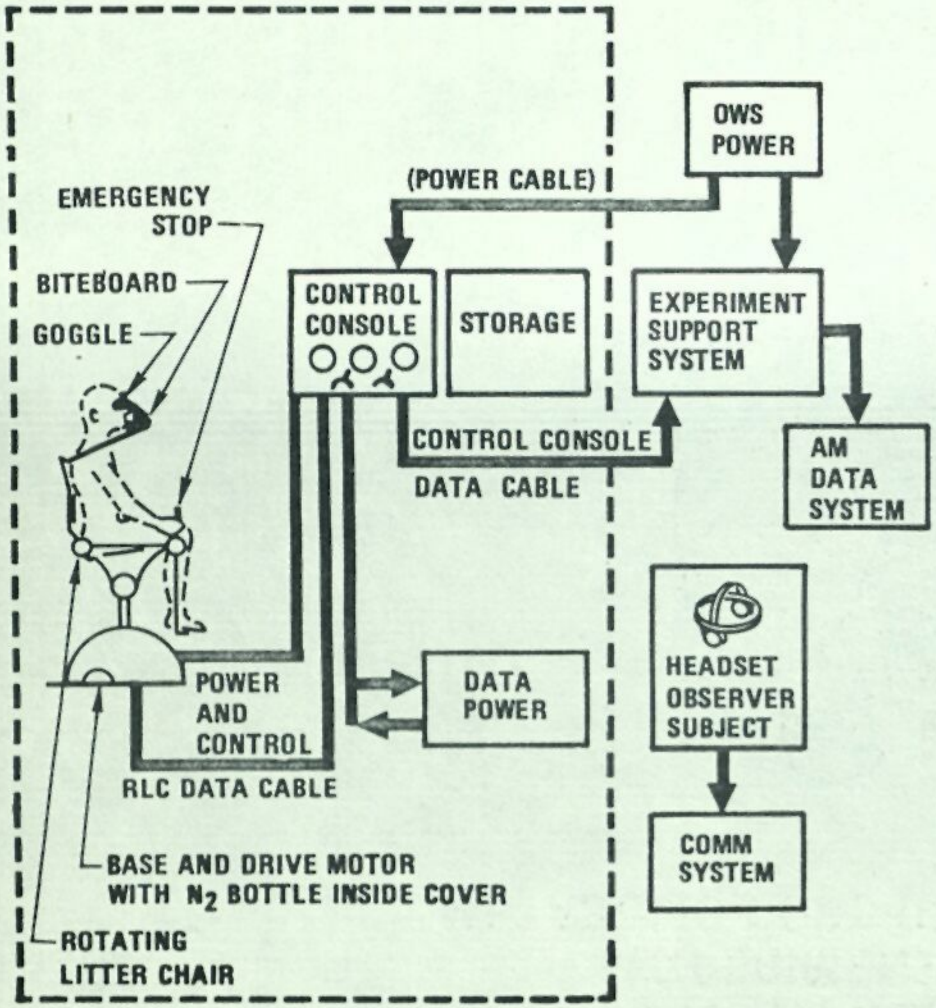
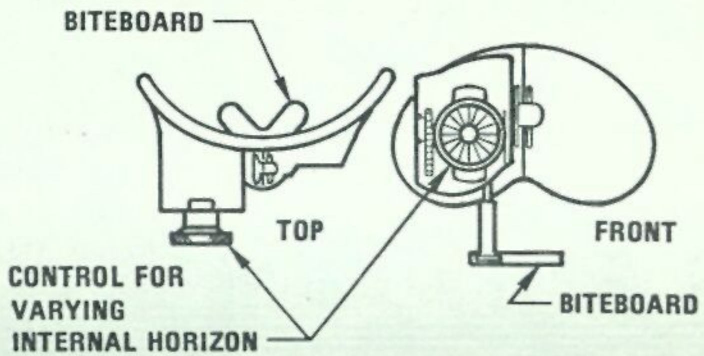
ORBITAL WORKSHOP
EXPERIMENT ACCOMMODATIONS CDR
EXPERIMENT - M131
HUMAN VESTIBULAR FUNCTION

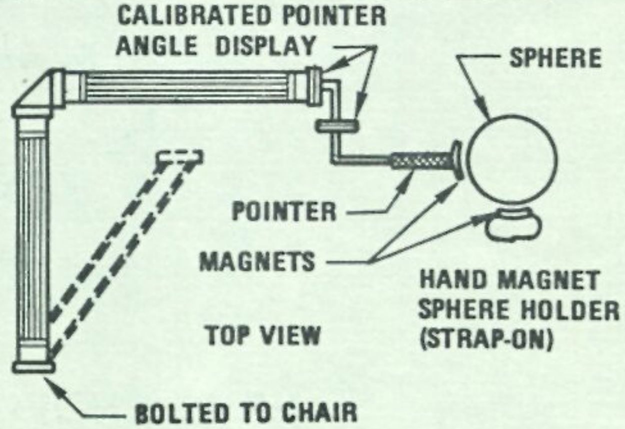
O/W-7054
9–8–70



OTOLITH TEST GOGGLES



POINTER AND SPHERE READOUT DEVICE



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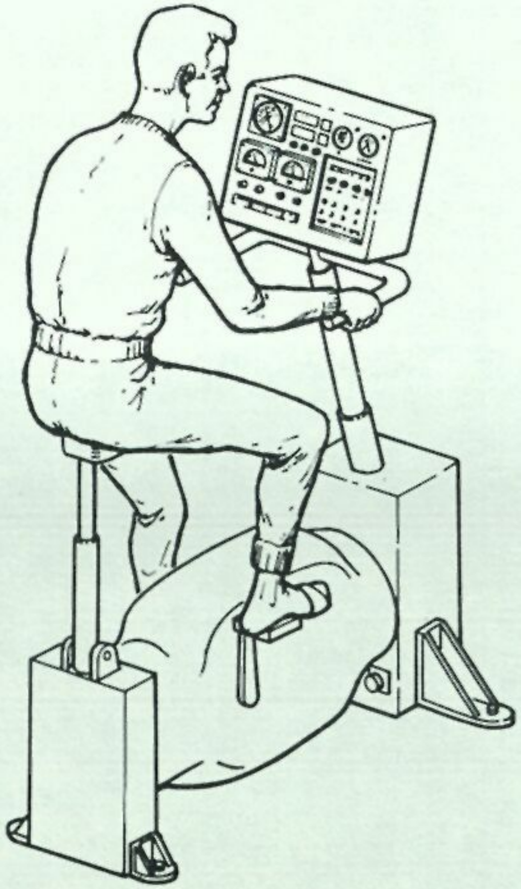
ORBITAL WORKSHOP
EXPERIMENT - M171
METABOLIC COST OF INFLIGHT TASK

O/W-7056A
9–10–70



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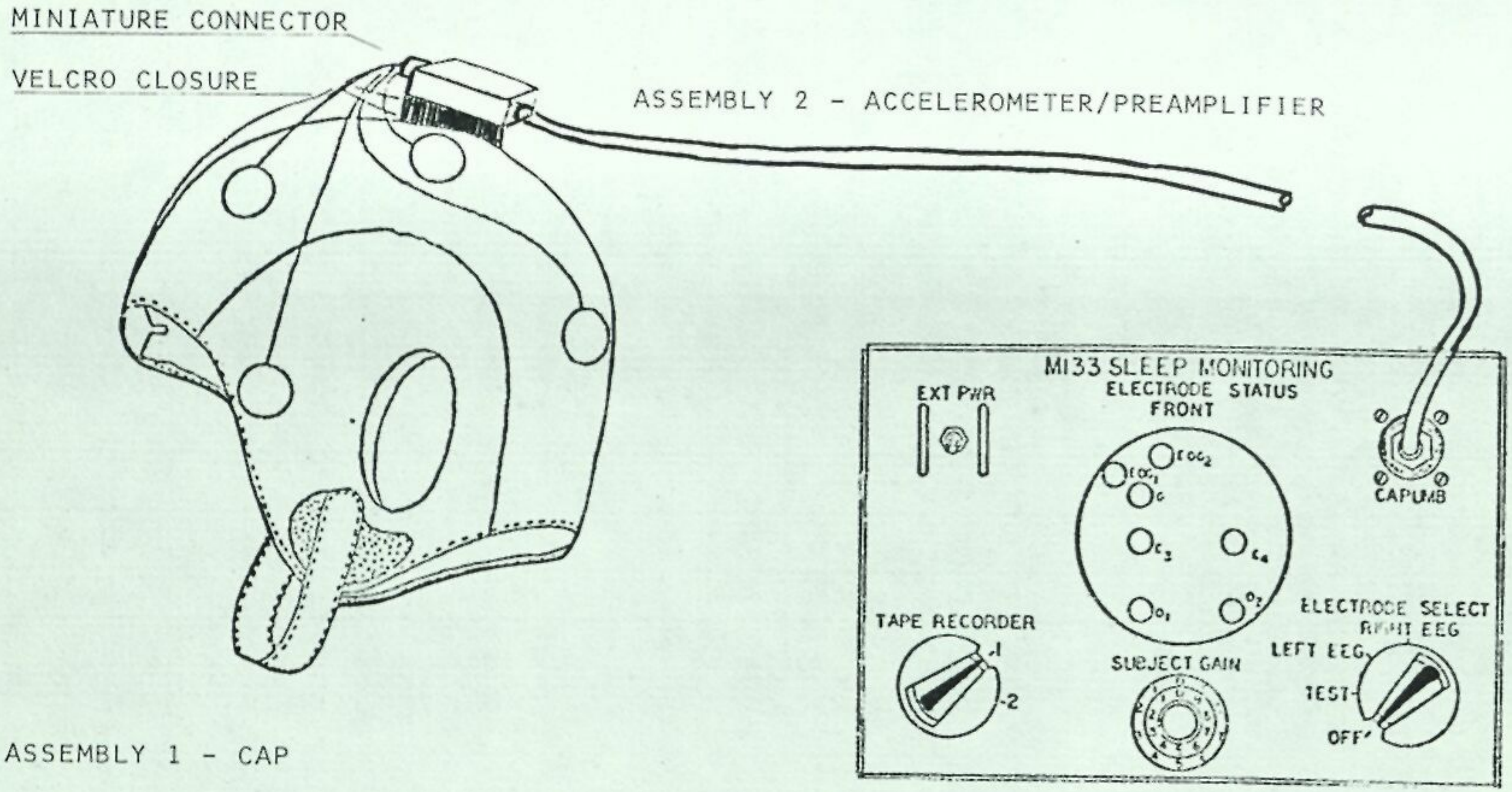
ORBITAL WORKSHOP
EXPERIMENT M133
SLEEP MONITORING



ASSEMBLY 1 - CAP

ASSEMBLY 3 - PANEL ASSEMBLY

A cap assembly will be utilized to gain EEG and EOG data, and an accelerometer/preamplifier assembly mounted on the top of the cap will obtain head movement data.

Changes in the frequency and amplitude of EEG waveforms, occurrence of bursts of rapid eye movements (REM's) associated with dreaming, and head movement activity will be monitored and recorded on the data tape recorders for subsequent transmission to the MSFN, to provide investigators with essential information for planning the work/sleep cycle for extended space missions.

Time and Motion Study M151

Experiment M151 will determine through analysis of film, the effectiveness with which crewmen perform inflight tasks compared with their effectiveness in performing the same tasks during preflight zero-g and neutral buoyancy training.

The GFE provided to accomplish this experiment includes 16mm Maurer data acquisition cameras (DAC's), Skylab Universal camera mount, high intensity photo lamps, power cable, auxiliary lenses, film vault and film.

Tasks which will be filmed as part of the time and motion study will include translation activities, the ingress and egress of confined enclosures in the OWS, mounting and operation of the bicycle ergometer, operation of the SAL, donning and doffing of the pressure garment assembly, periodic maintenance activities, food preparation, consumption and measurement of residue, and experimental activities related to M092, M509, T027, M171 and M074.

Metabolic Activity M171

The primary objective of the metabolic activity experiment is to determine if man's metabolic effectiveness in doing mechanical work is progressively altered by exposure to the space environment; and to determine the metabolic cost of identical activities when man is deprived of the benefits of earth gravity as compared to the cost on earth. Secondary objectives of the experiment are to evaluate ground-based reduced gravity simulators, and to evaluate the bicycle ergometer as an exerciser for long duration spaceflight missions. Elements of other experiments are used in conjunction with the M171 equipment to measure the subject crewman's temperature, vectorcardiogram, blood pressure, food consumption, and body mass. The metabolic analyzer which forms part of the M171 equipment determines oxygen consumption, carbon dioxide (CO_2) production, and respiration volume during the experimental activity. Data related to this experiment will be recorded for telemetry, and the activity will be photographed as part of another experiment (M151--Time and Motion). The ESS provides power control, visual displays, and telemetry interfaces for this experiment.

Mass Measurement (BMMD and SMMD) M074 and M172

Two inertial pendulum measuring devices consisting of platforms mounted on springs, with counting devices are furnished as means of on-orbit mass determinations of waste and food samples, and crew members' body masses in zero-g environment. The sample/body is placed on a platform, released, and the oscillations about an equilibrium point are counted. These oscillations can be related to the mass of the object by calibration of the measurement devices. These experiments are self contained except for power requirements. Data is hand logged, and no telemetry is required.

Scientific Experiments

The scientific experiments to be performed in the OWS have a general objective of providing researchers with multispectral photographic data of stellar fields, micrometeoroid distribution data, contamination data on the induced atmosphere about the orbiting Skylab, and the contamination on exposed optical elements.

These experiments consist of packages which are exposed to space via the two scientific airlocks mounted in the wall of the OWS in the forward compartment. Among the scientific experiments performed in the OWS are the following:

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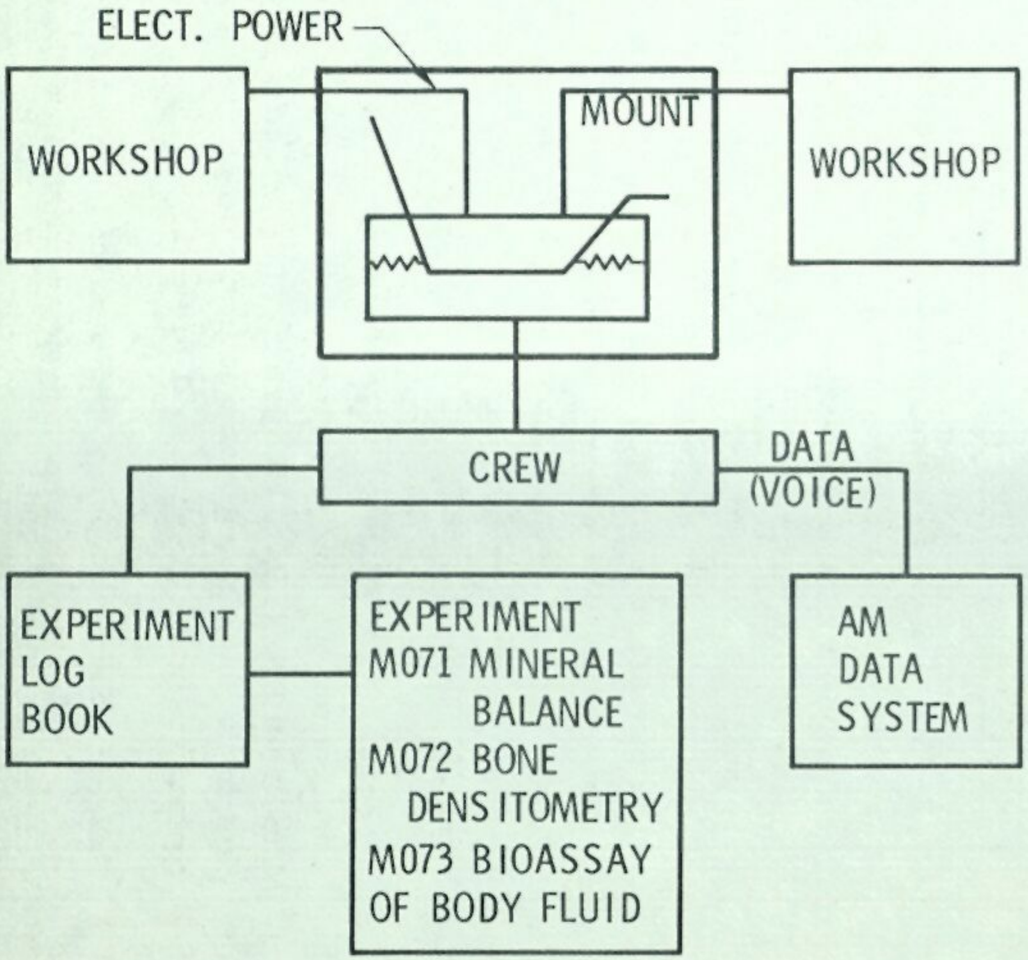
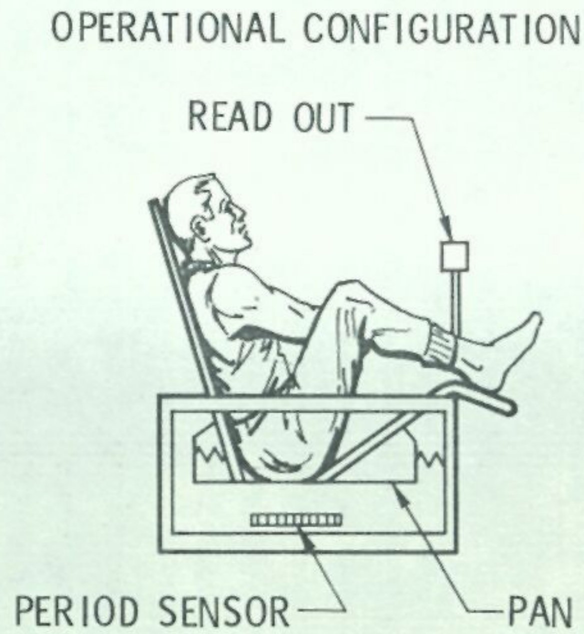
ORBITAL WORKSHOP
EXPERIMENT - M172
BODY MASS MEASUREMENT DEVICE

O/W-7058A
5–20–70





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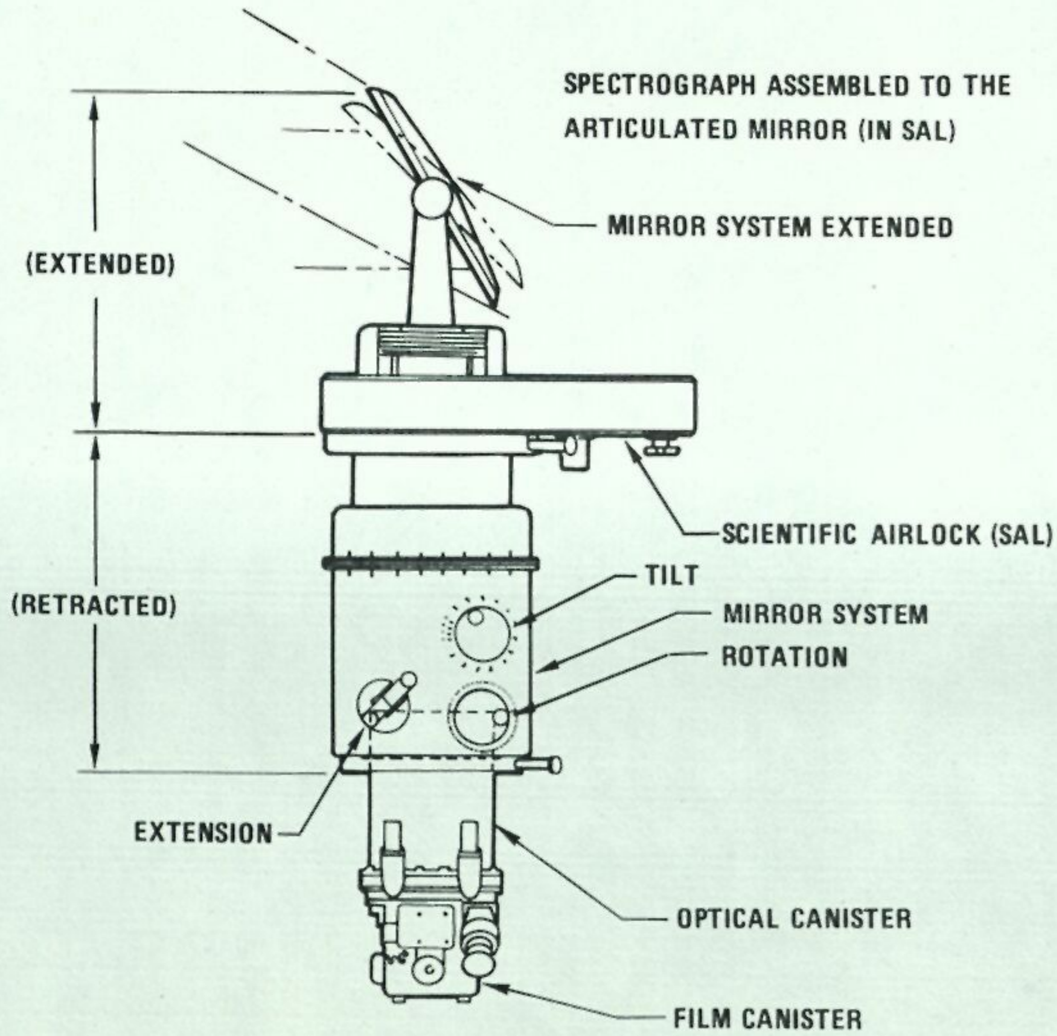
ORBITAL WORKSHOP
EXPERIMENT ACCOMMODATIONS CDR
EXPERIMENT - S019
UV STELLAR ASTRONOMY

O/W-7087A
9-2-70



Ultraviolet (UV) Stellar Astronomy S019

This package consists basically of a spectrograph with a telescope sight, and an articulated mirror system with controls for extension, retraction, tilt, and rotation of the mirror. This equipment will be used to photograph approximately 50 star fields for studies of the UV line spectra and spectra energy distributions of early type stars, and to obtain UV spectra for a number of stars in the Milky Way.

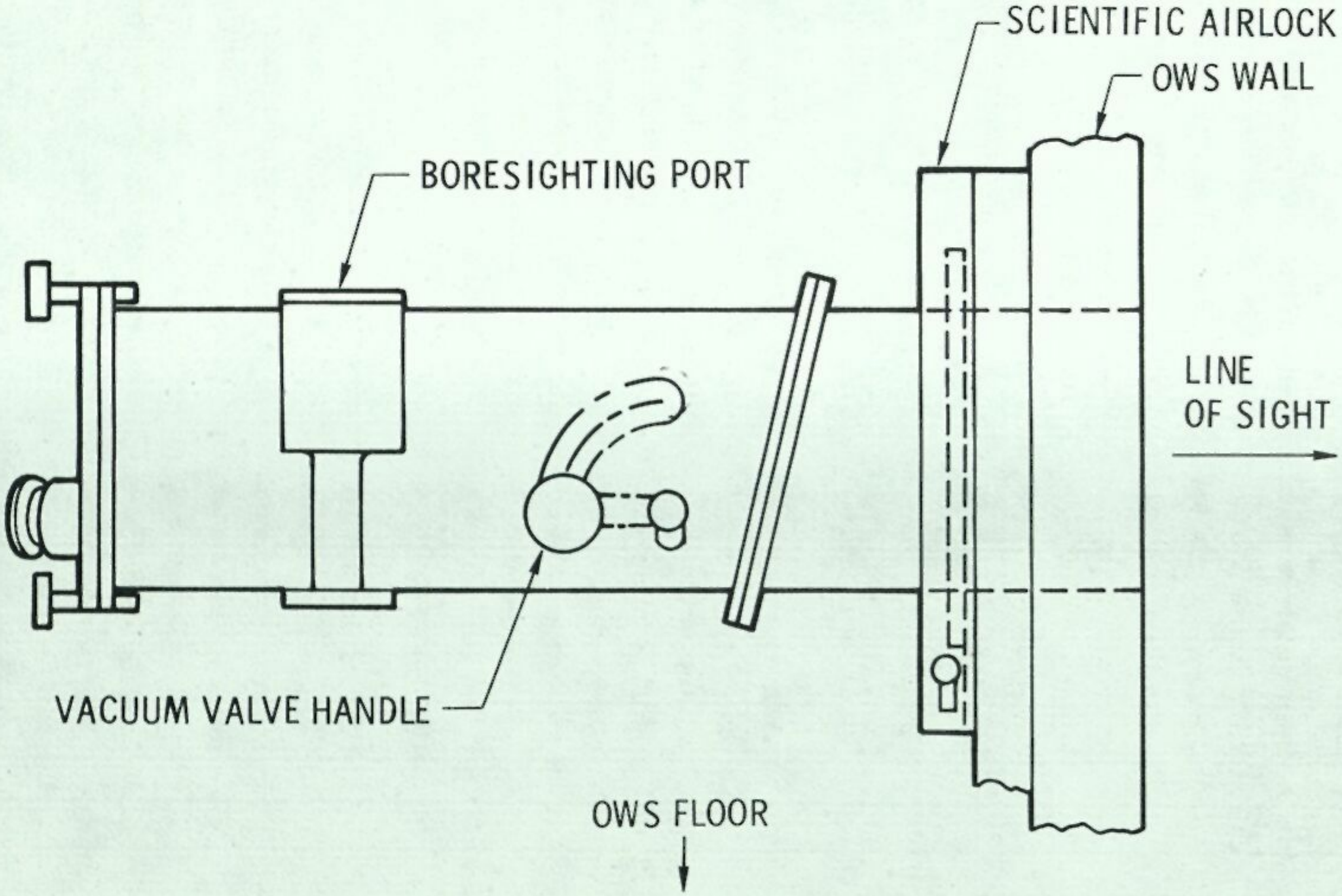
X-Ray/UV Solar Photography S020

This experiment also consists of a spectrograph camera, and a sighting device, and will be used to photograph the sun during quiescent and flare periods. A flare notification device which will signal crew members of solar flare activity will be provided. The spectrograph camera will be mounted in the Sunside Scientific Airlock (SAL). During the performance of this experiment, the vehicle must be held stationary, and no dumping will be accomplished. After the completion of this experiment, the film cannister will be stored in the film vault. Telemetry of housekeeping data is required along with hand logging for this experiment.

UV Airglow Horizon Photography S063

This package consists of two cameras, and supporting equipment which will be employed to photograph the earth's ozone layers, and twilight airglow at UV and visible wavelengths. The ozone layer photography will be accomplished during Earth Resources Experiment Passes (EREP) when the sunside SAL will be pointing at the earth. For horizon airglow photography, the vehicle will be in the solar inertial attitude, and on the dark side of the orbit. Exposure data and time of performance will be voice recorded for telemetry.

ORBITAL WORKSHOP
EXPERIMENT ACCOMMODATIONS
EXPERIMENT - S020



Gegenschein/Zodiacal Light S073

This experiment utilizes the photometer system from Experiment T027 (contamination measurement) and a film cannister, together with one of the SAL's to measure the surface brightness and polarization of the nightglow over as large a portion of the celestial sphere as possible at several wavelengths in the visible light spectrum, and to determine the extent and nature of spacecraft corona while the vehicle is in sunlight. Telemetry requirements include photometer system data, housekeeping data, and voice annotations.

Particle Collection S149

This experiment also utilizes portions of the T027 equipment, together with a collection cassette which consists of two impact plates which can be deployed at ground command or manually to collect micrometeoroid particles in the vicinity of the earth. The exposed cassettes will be returned in the command module. Telemetry data on cassette status and voice annotation of significant events is required for this experiment.

UV Panorama S183

The mirror system described for S019 will be used for this experiment together with a wide-angle spectrograph to obtain luminosity distributions of selected star fields, improve the classification of hot, young stars of up to 10th magnitude, and provide a general survey of the sky in the UV range. Three analog data signals and voice comments are the data requirements for this experiment.

Technological Experiments and Operational Experiments

The operational and technological experiments have a general objective of obtaining data to further the development of advanced space vehicles and equipment, and to aid in the development of operational

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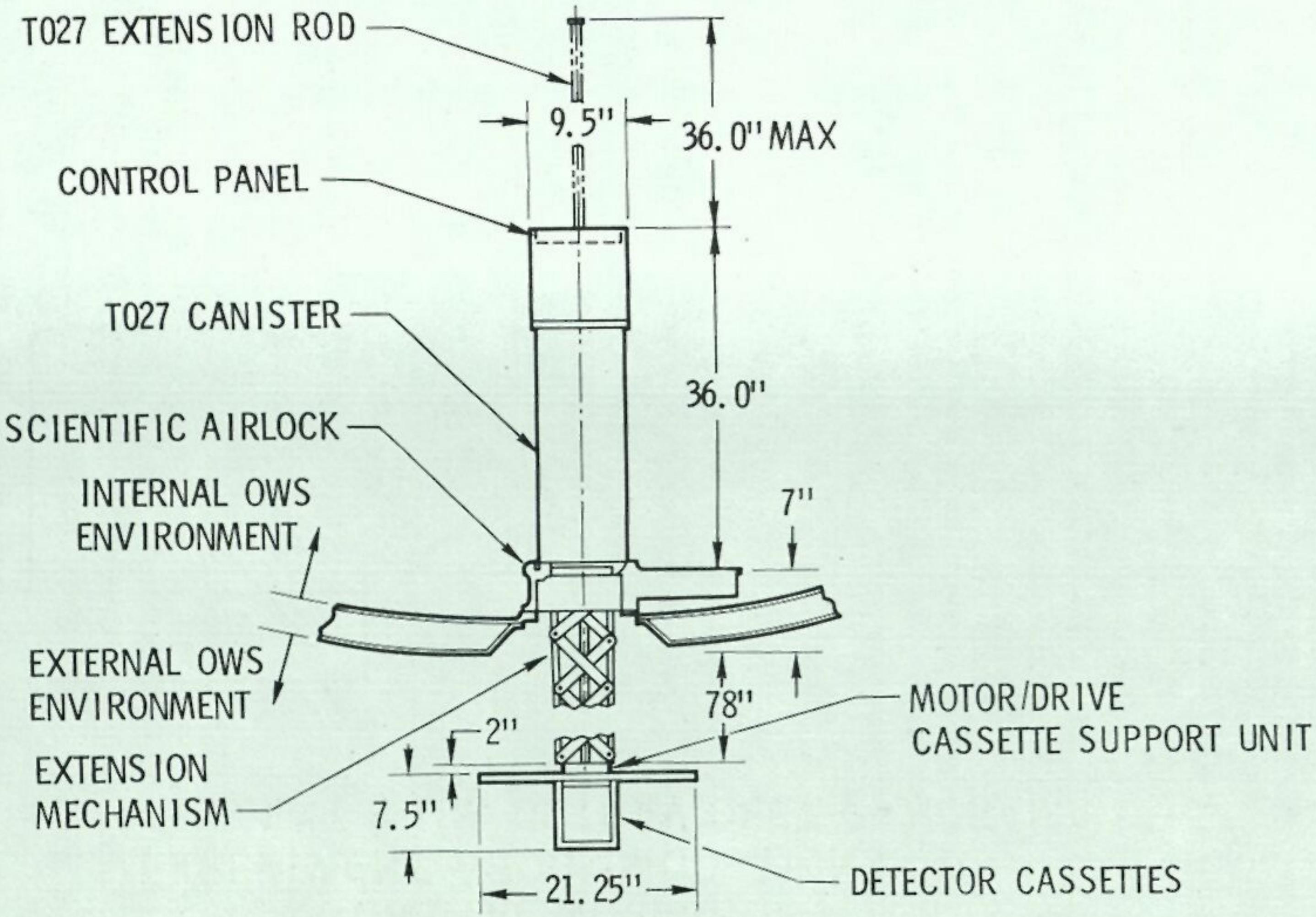
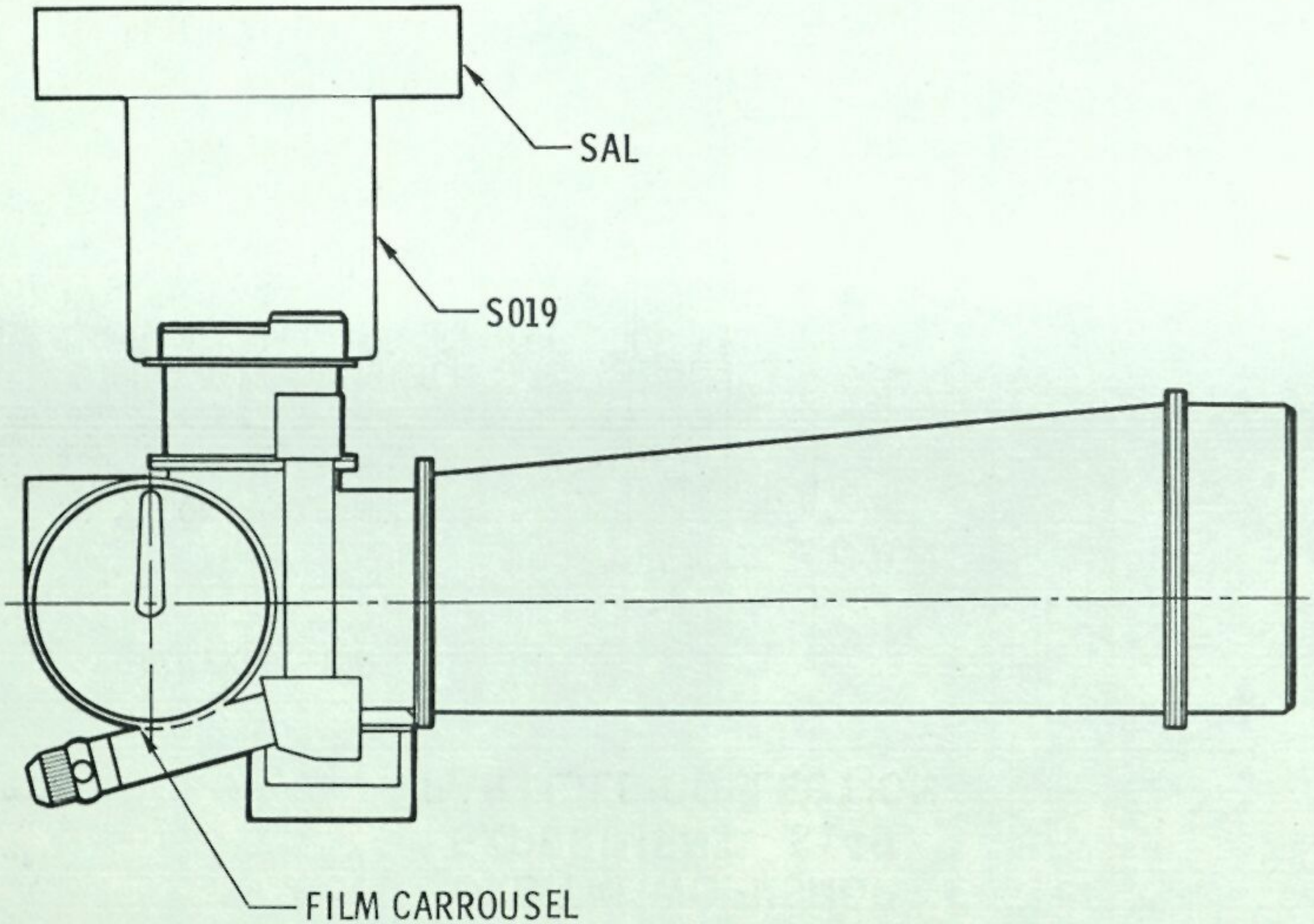
ORBITAL WORKSHOP
EXPERIMENT - S149
PARTICLE COLLECTION



ORBITAL WORKSHOP
EXPERIMENT ACCOMMODATIONS CDR
EXPERIMENT S 183 ULTRAVIOLET PANORAMA



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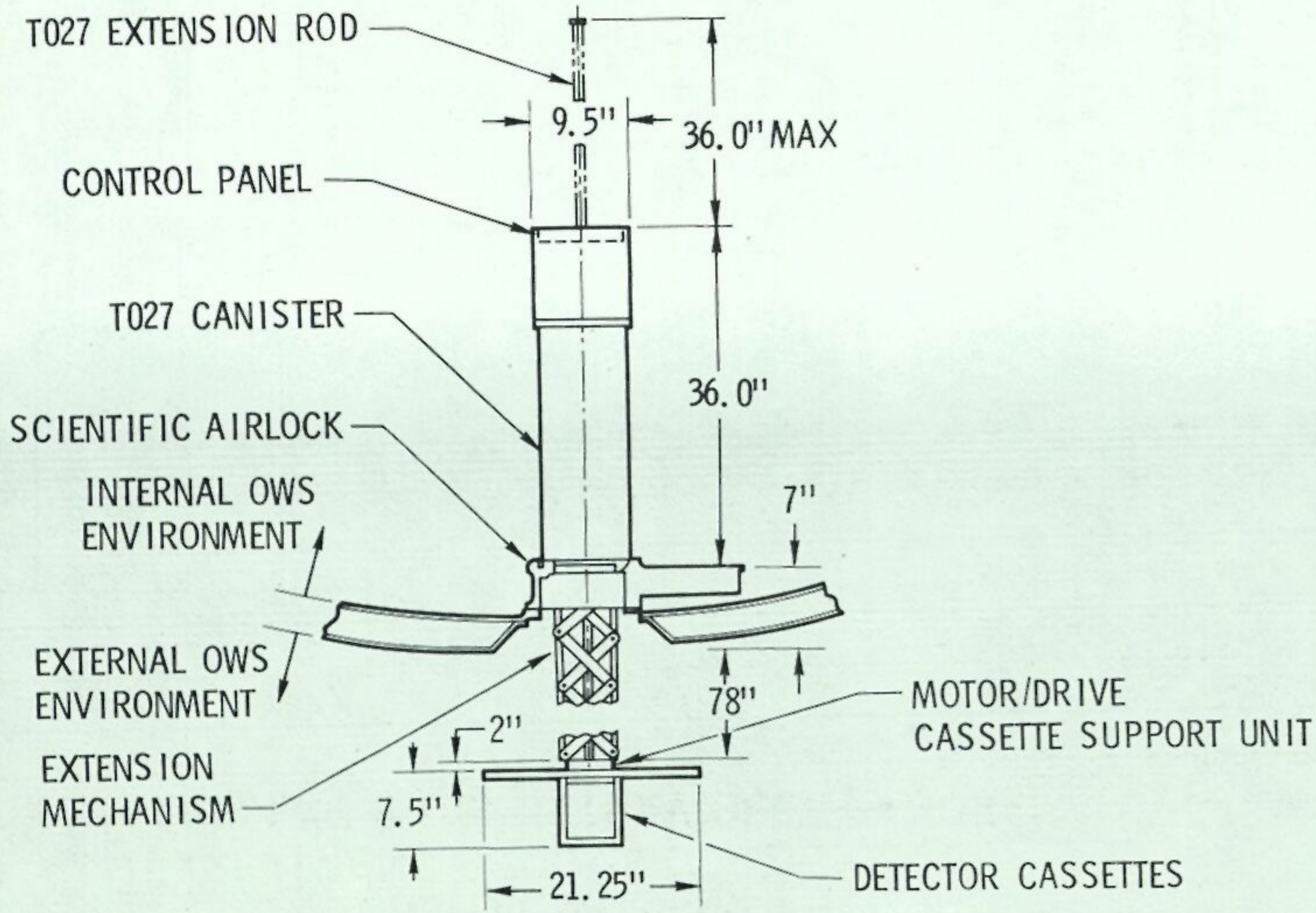
ORBITAL WORKSHOP
EXPERIMENT - S149
PARTICLE COLLECTION

O/W-7093A
4–27–70



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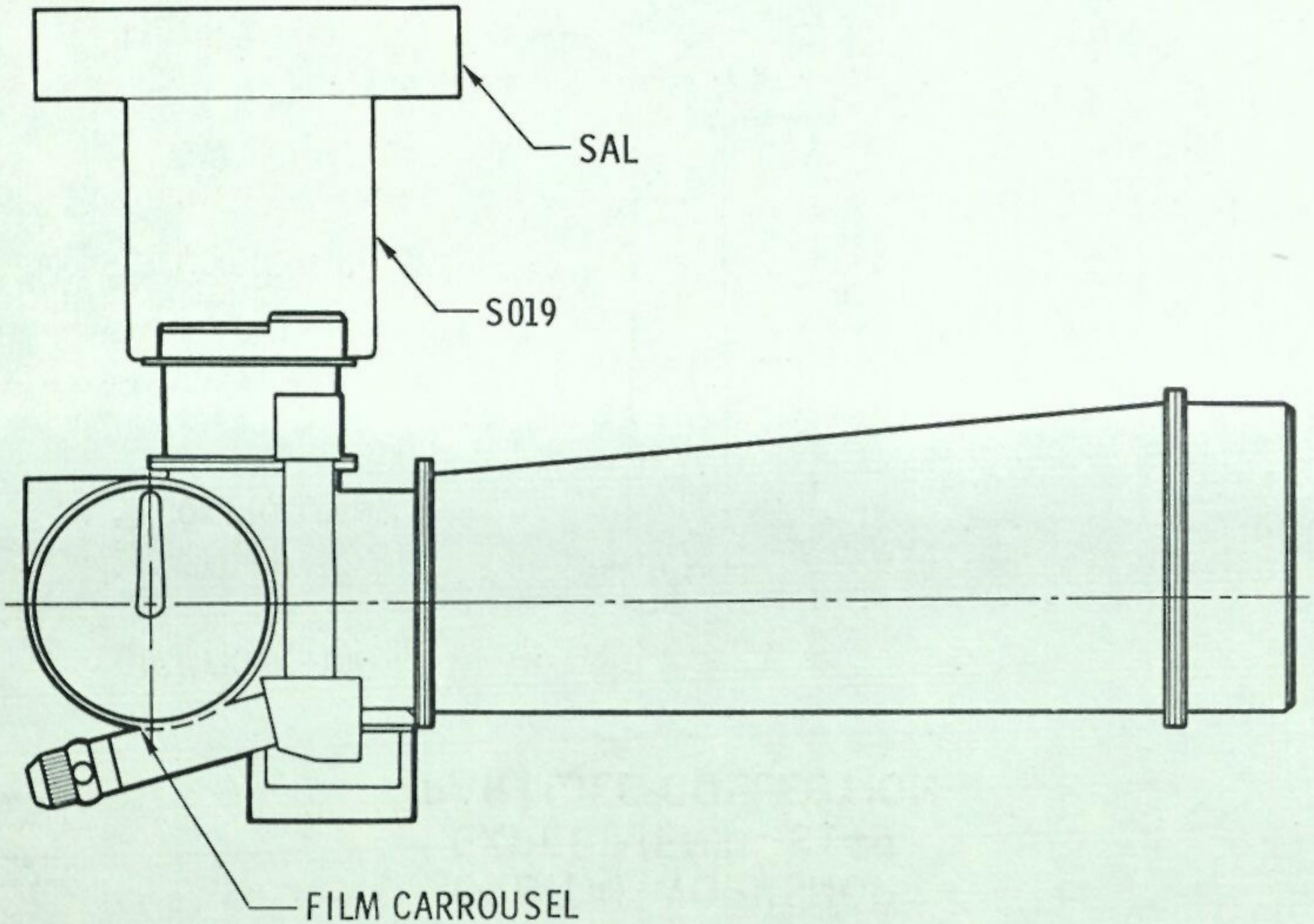
ORBITAL WORKSHOP
EXPERIMENT ACCOMMODATIONS CDR
EXPERIMENT S 183 ULTRAVIOLET PANORAMA

O/W-9410-1
9–8–70



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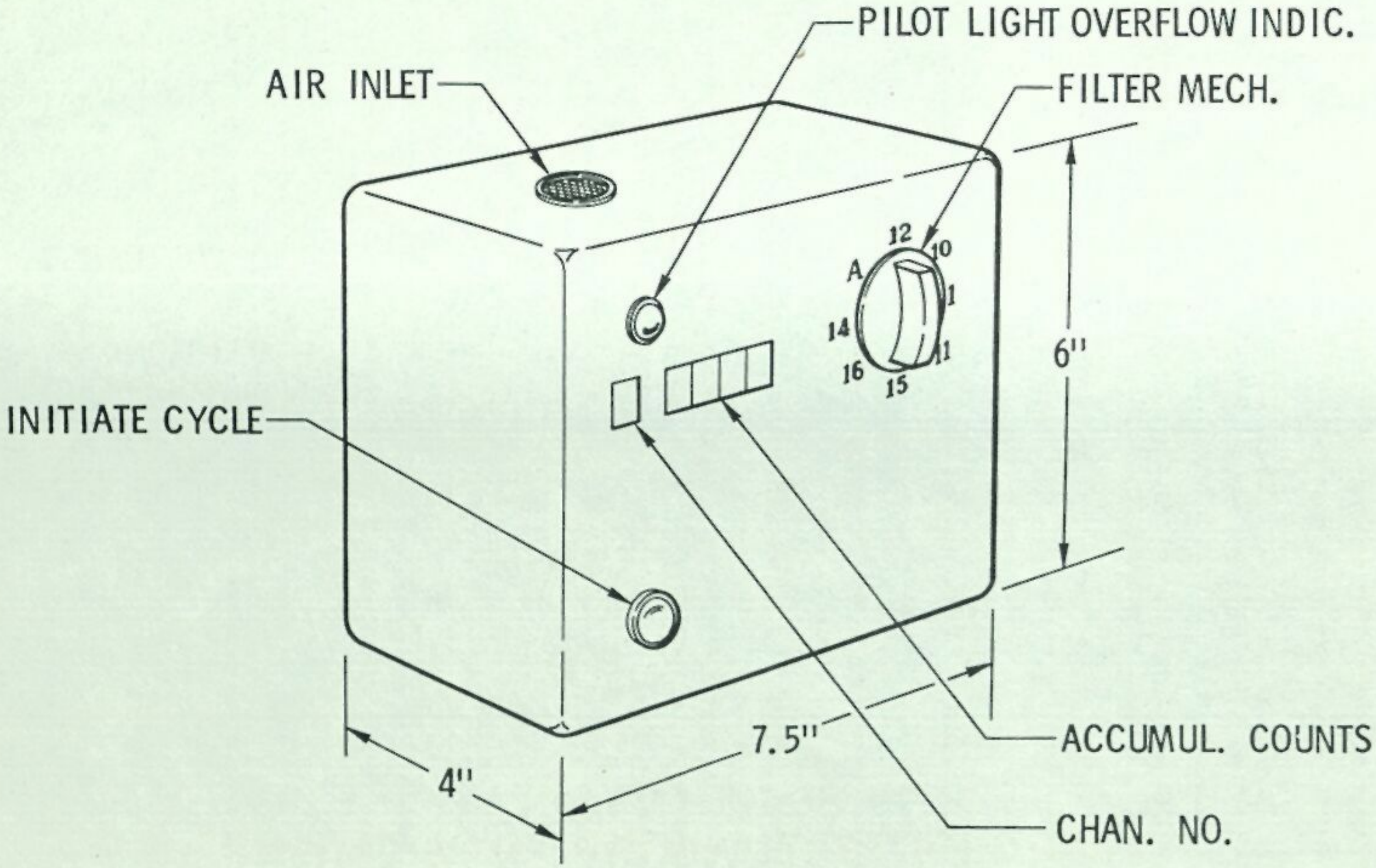
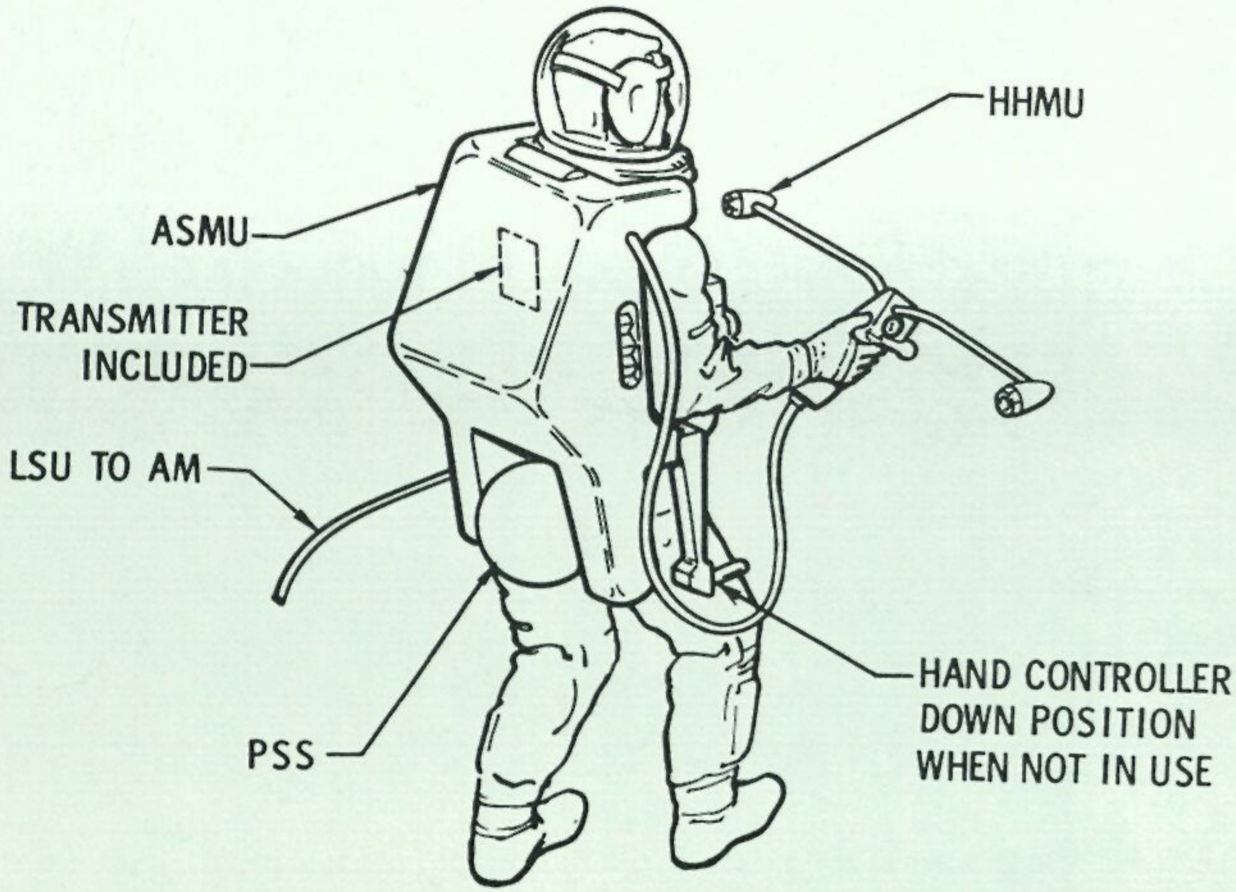
ORBITAL WORKSHOP
EXPERIMENT - T003
INFLIGHT AEROSOL PARTICLE ANALYZER

O/W-7071A
4–27–70



ORBITAL WORKSHOP
EXPERIMENT ACCOMMODATIONS CDR
EXPERIMENT M509 AME



procedures for extended manned orbital operation. Among the operational and technological experiments planned for the OWS are the following:

Astronaut Maneuvering Equipment (AME) M509

This experiment consists of two items of maneuvering equipment which will be evaluated by crewmen in the forward compartment of the OWS.

The Automamatically Stabilized Maneuvering Unit (ASMU) is a back-mounted device that provides the astronaut with six-degree-of-freedom flight, utilizing compressed nitrogen gas thrusters in conjunction with a control moment and rate gyro stabilizing system. The Hand Held Maneuvering Unit (HHMU) consists of a hand held manifold with two tractor and one pusher thruster, and is connected to the ASMU.

Inflight Aerosol Analysis T003

This experiment consists of an aerosol analyzer (nephelometer) which will be used to make concentration and size distribution determinations at various locations throughout the OWS. The device is self-contained, battery-operated, and capable of either hand-held or mounted operation.

The analyzer draws air samples into a chamber, and uses reflected light from the sample to provide amplitude and time related pulses that are counted and displayed for logging by the using crewmen. The sample air is discharged through a filter and the particulate matter is retained for return and postflight analysis.

Crew Vehicle Disturbance T013

This package consists of equipment which will be utilized by crewmen to determine the effects of various crew activities on the dynamics of a manned spacecraft. The equipment consists of a limb motion sensor assembly, which will be worn by the crewman to measure his arm and leg motions, a force measuring system, which consists of load cells, and load bearing platforms, and a central data system which gathers the experimental data and transmits it to the airlock module data system for recording and subsequent telemetering. Photographic coverage, and recorded voice comments are also required for this experiment.

Foot Controlled Maneuvering Unit T020

This experiment package consists of a gas propulsion device that is straddled by a crewman and controlled by his foot movements. The experiment is performed in the OWS forward compartment and will provide data for use in determining the feasibility of the FCMU concept for EVA, and the design of subsequent operational systems of this type.

FCMU maneuvers will be photographed and voice comments will be recorded for telemetry.

Coronagraph Contamination Measurements T025

This experiment will be performed to determine the presence of an induced particulate atmosphere surrounding the OA; to determine changes in this atmosphere as a result of thruster pulsing, waste dumps, and vehicle orientation; and to determine the nature and extent of the solar F-corona viewed by the coronagraph.

The equipment for this experiment consists of a coronagraph cannister which will be mounted in a scientific airlock, and an extensible boom-mounted occulting disk assembly which will block the solar disk. Exposed film will be stored in film vaults and returned in the command module.

Housekeeping data and recorded voice comments are required for this experiment.

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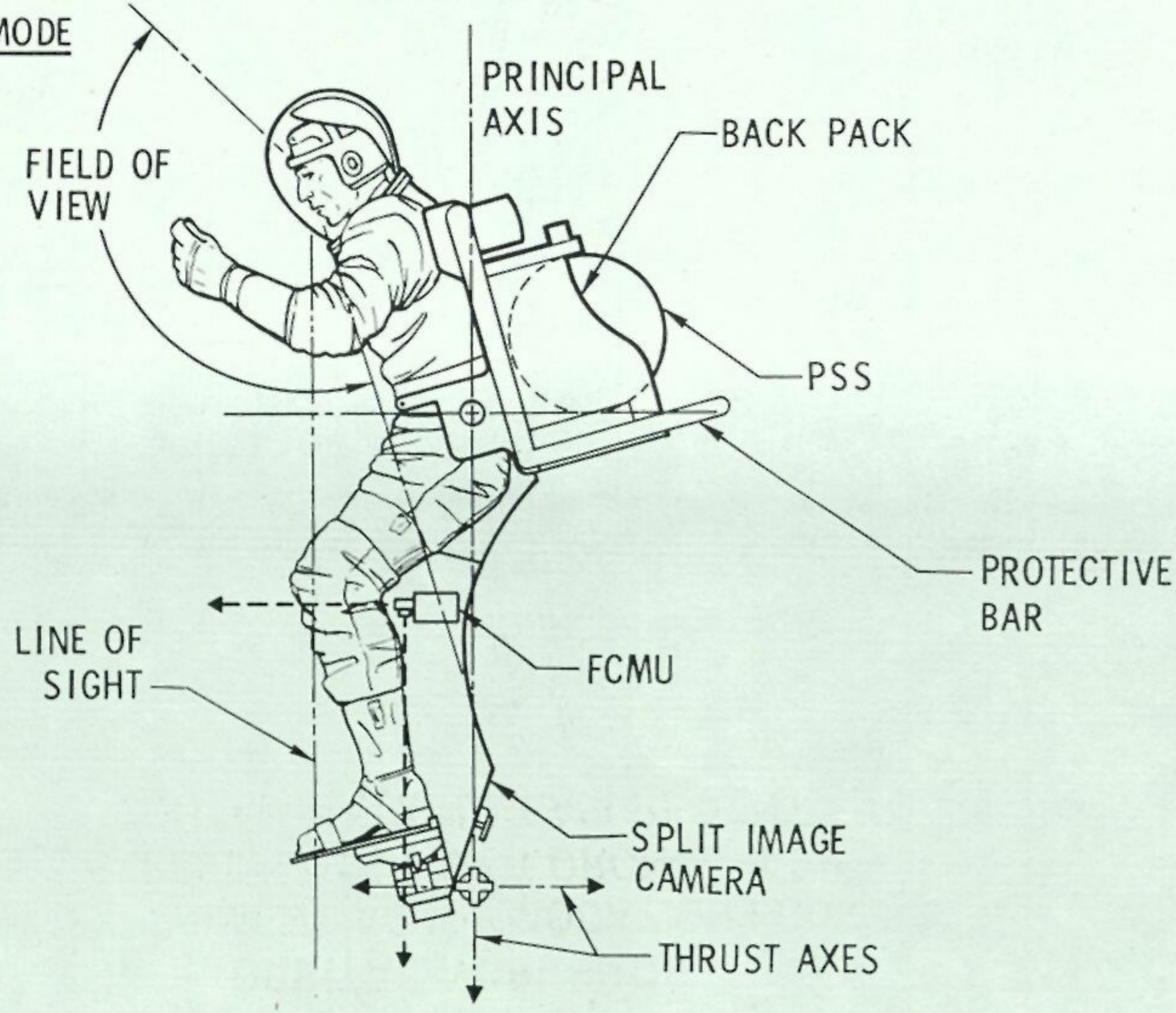
ORBITAL WORKSHOP
EXPERIMENT ACCOMMODATIONS CDR
EXPERIMENT - T020
FOOT CONTROLLED MANEUVERING UNIT

PRESSURE SUITED MODE



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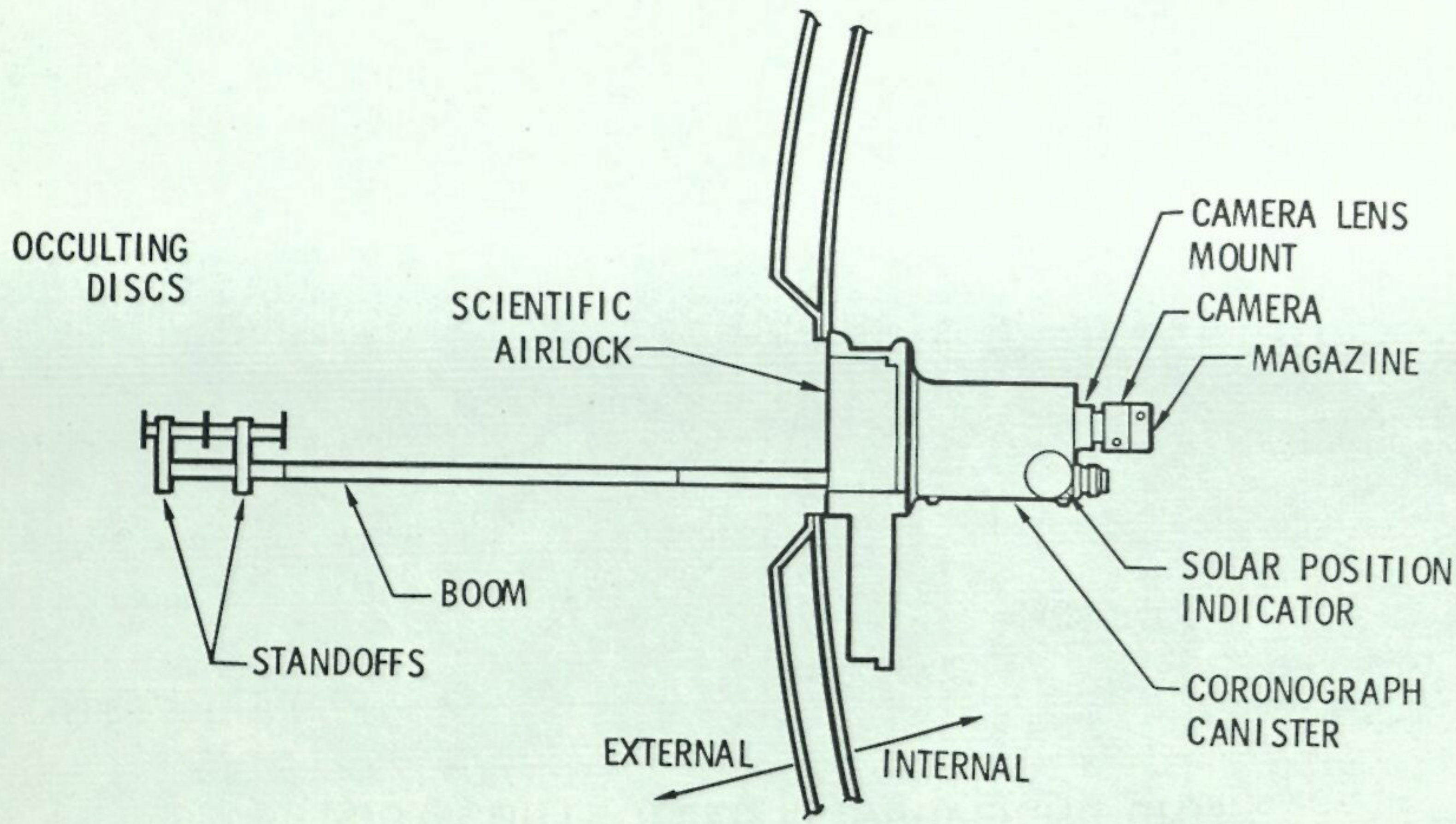
ORBITAL WORKSHOP
EXPERIMENT ACCOMMODATIONS CDR
EXPERIMENT - T025 CORONOGRAPH CONTAMINATION MEASUREMENT

O/W-7098A
9-2-70

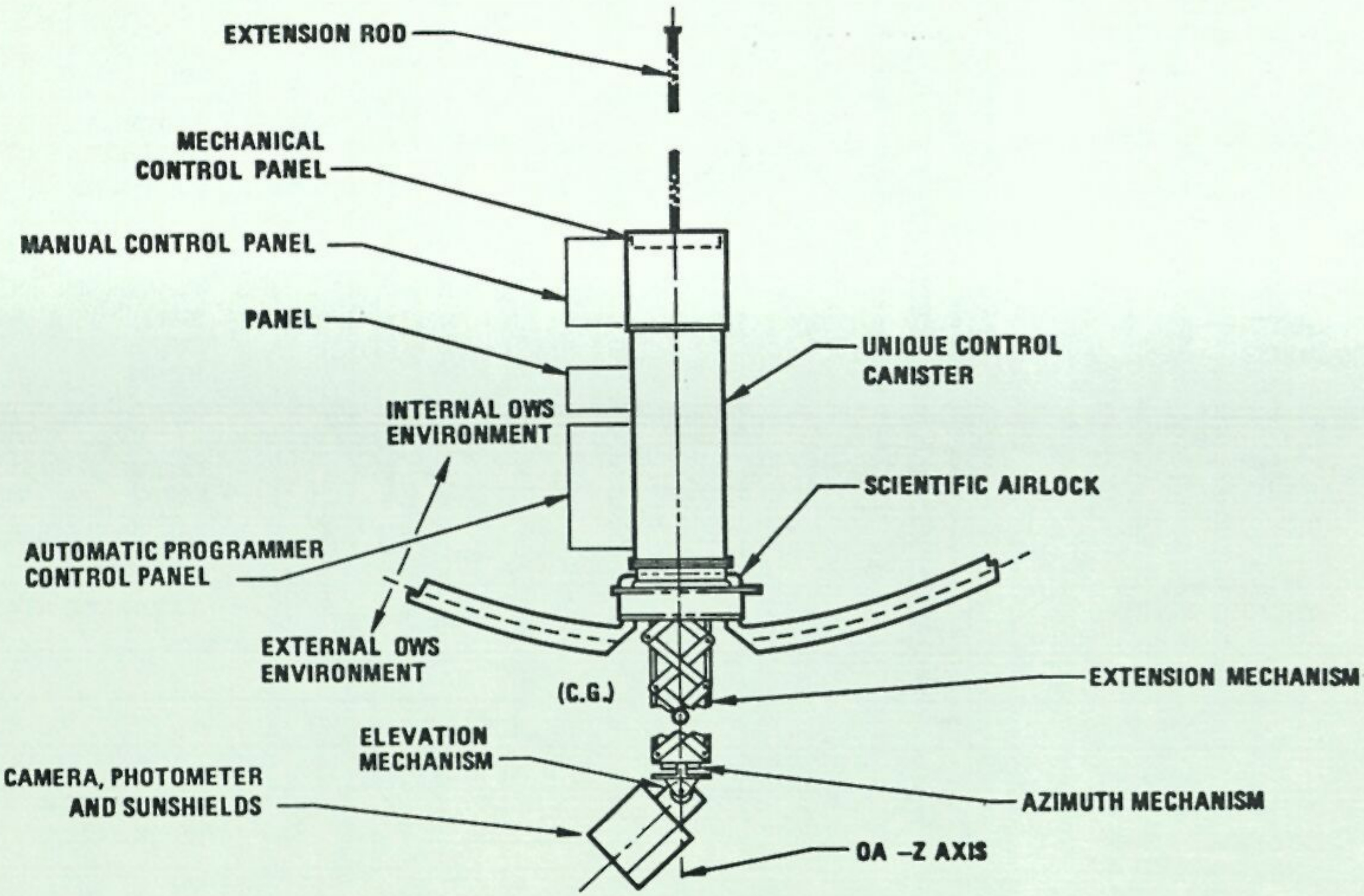


Contamination Measurement T027

This experiment will provide data to determine the effects of the induced OA particulate atmosphere on exposed optical elements such as windows, lenses, mirrors, and diffraction gratings by exposing a cannister containing various samples (sample array system) to space via a scientific airlock, and making photometric measurements of the particulate atmosphere.

Telemetry from the photometer system, the sample array system, and voice comments, as well as logged data are required for this experiment,

ORBITAL WORKSHOP
EXPERIMENT ACCOMMONATIONS CDR
EXPERIMENT - T027
ATM CONTAMINATION MEASUREMENT



Scientific Airlock (SAL)

Two government furnished scientific airlocks will be provided and installed in the forward compartment of the OWS. One SAL will be located facing sunward, and the other 180 degrees opposite the first. The two SAL will provide space exposure capabilities for various experiment package components which are activated and function in a space environment to achieve the experimental objectives.

The SAL consists of a chamber, installed in the OWS wall, inner and outer doors, vacuum/pressure gage, door control, and pressurization control. SAL operating instructions are included on decals mounted on each SAL faceplate.

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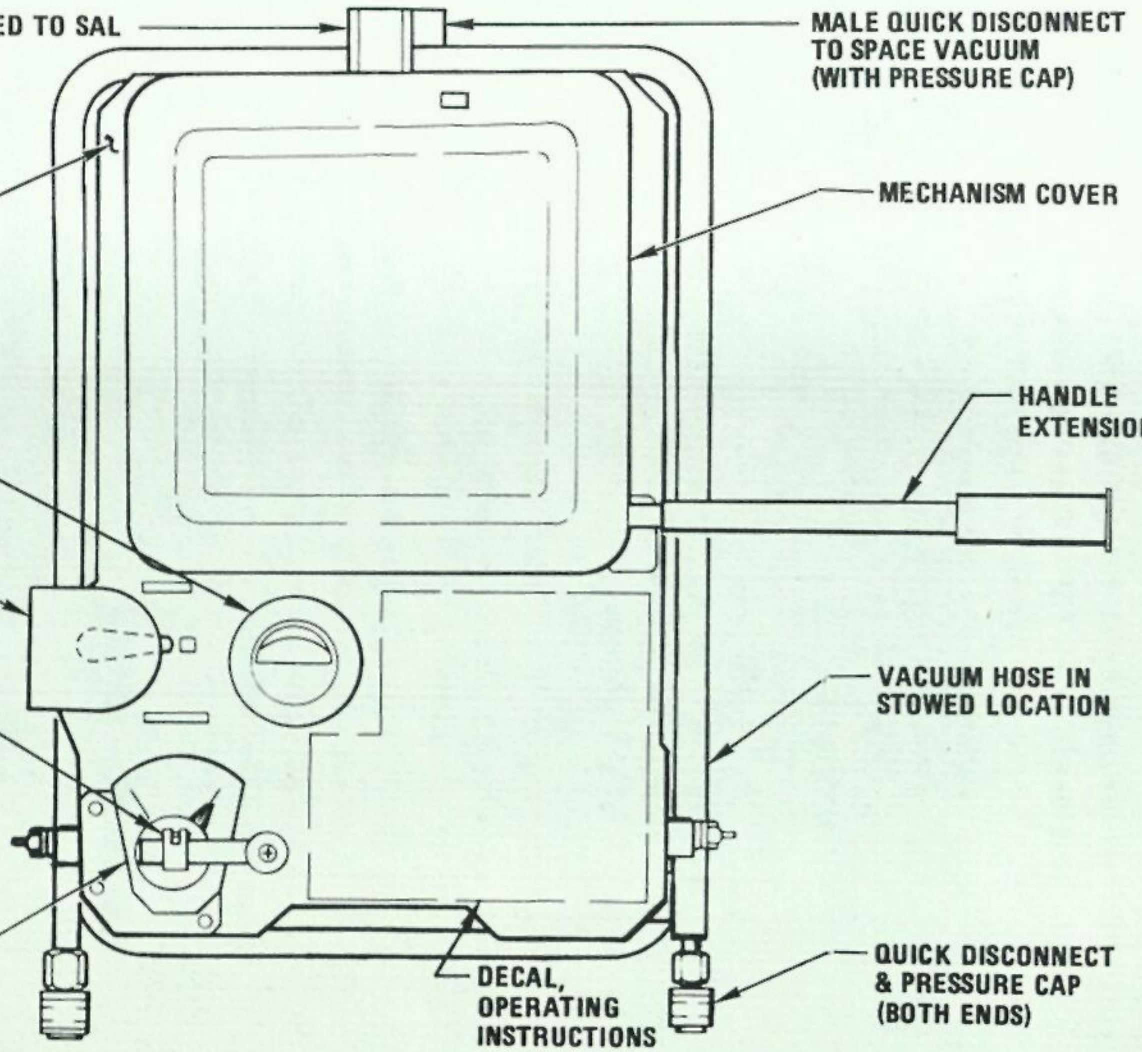
ORBITAL WORKSHOP
REVISED SCIENTIFIC AIRLOCK

O/W-7812
8–28–70



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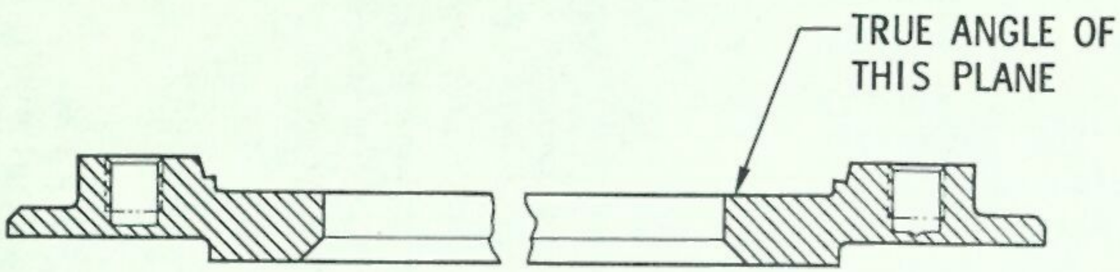
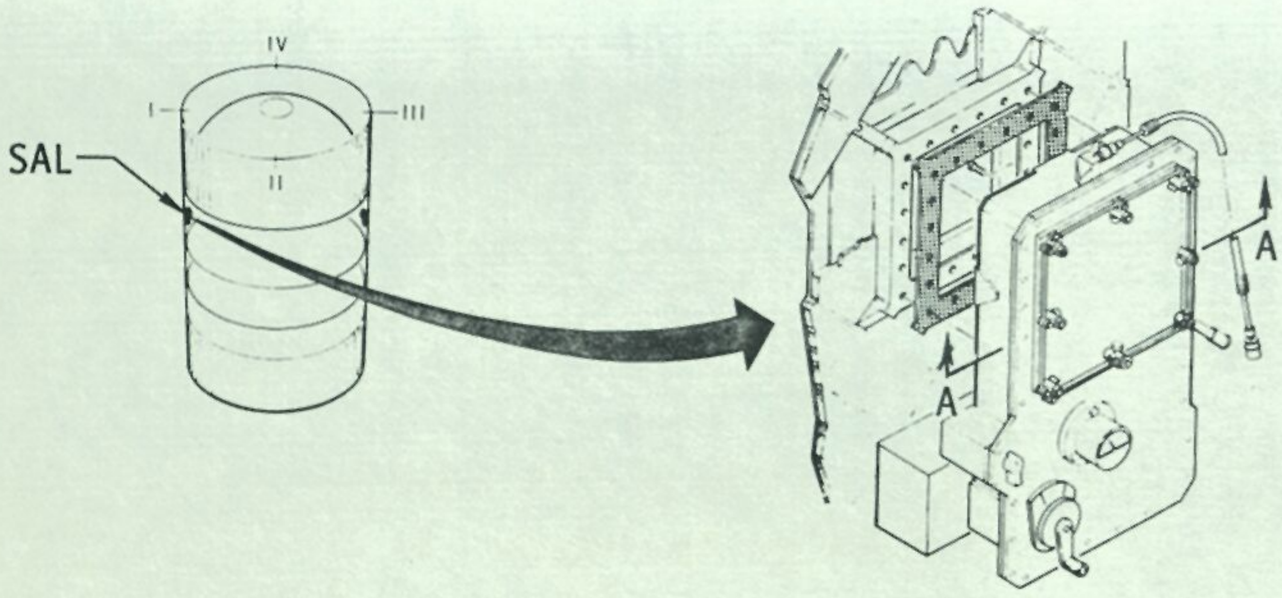
ORBITAL WORKSHOP
SCIENTIFIC AIRLOCK INSTALLATION

O/W-5866A
8–12–70



SECTION A-A



Stowage System

The OWS stowage system consists of provisions for the containment/restraint, and accessibility of loose equipment within the OWS. These provisions consist of the following stowage system equipment:

- o Stowage lockers
- o Stowage cabinets
- o Containers
- o Miscellaneous provisions
- o Film Vault
- o Food chiller and freezers

Stowage Lockers

Sixteen stowage lockers containing a total of 95 compartments are located throughout the OWS. The lockers contain six stowage compartments which have approximate dimensions of 10 inches by 11 inches by 16 inches. One locker in the forward compartment contains two compartments which are oversize, and have approximate dimensions of 10 inches by 11 inches by 20 inches. One locker in the waste management compartment has only four compartments. The distribution of lockers and compartments is as follows:

Compartment	Lockers	Compartments
Forward compartment	2	13
Experiment compartment	1	6
Sleep compartment	3	18
Waste management compartment	2	10
Wardroom	8	48
Totals	16	95

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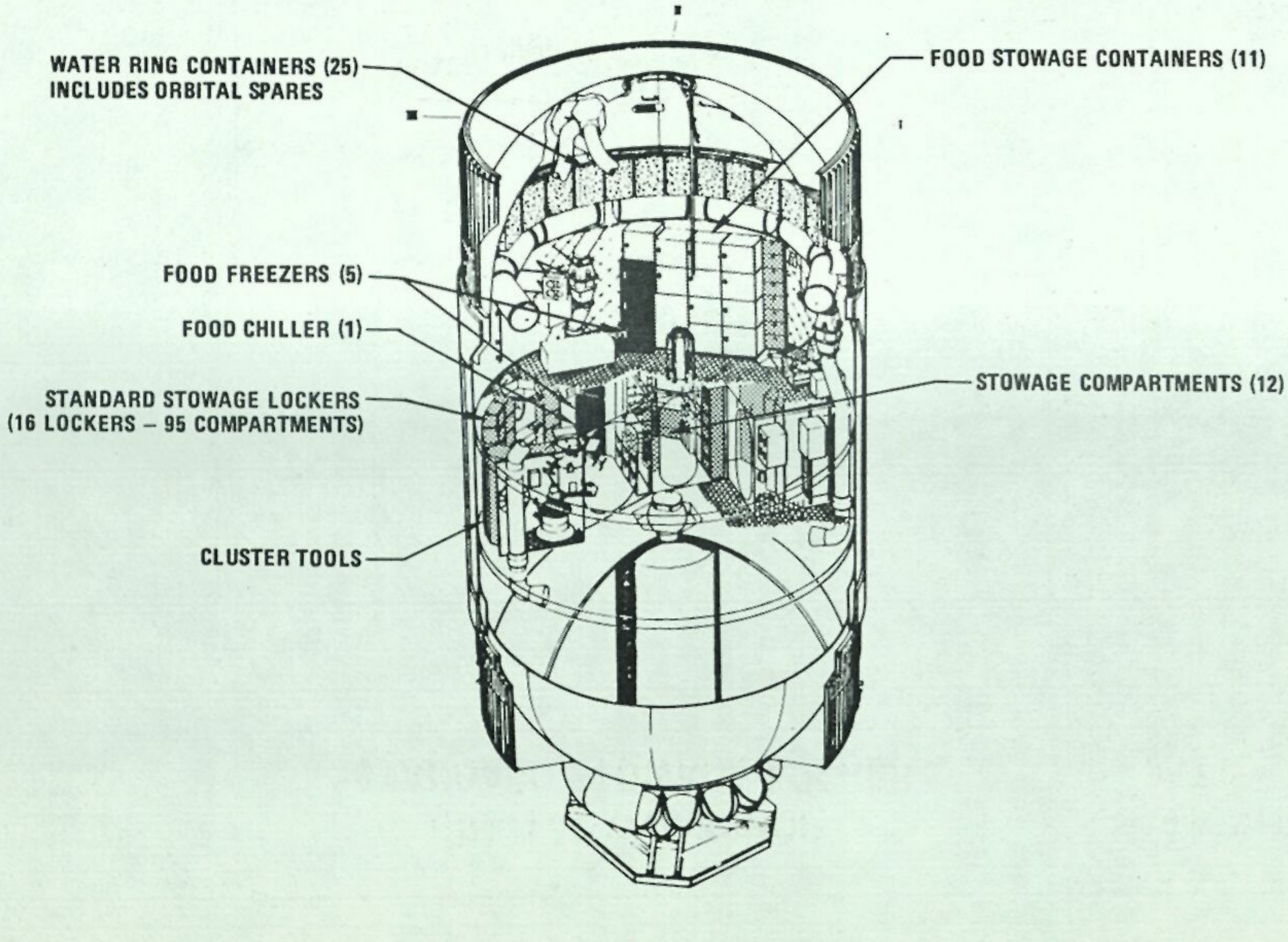
SA-286A
5–19–71

STOWAGE SYSTEM



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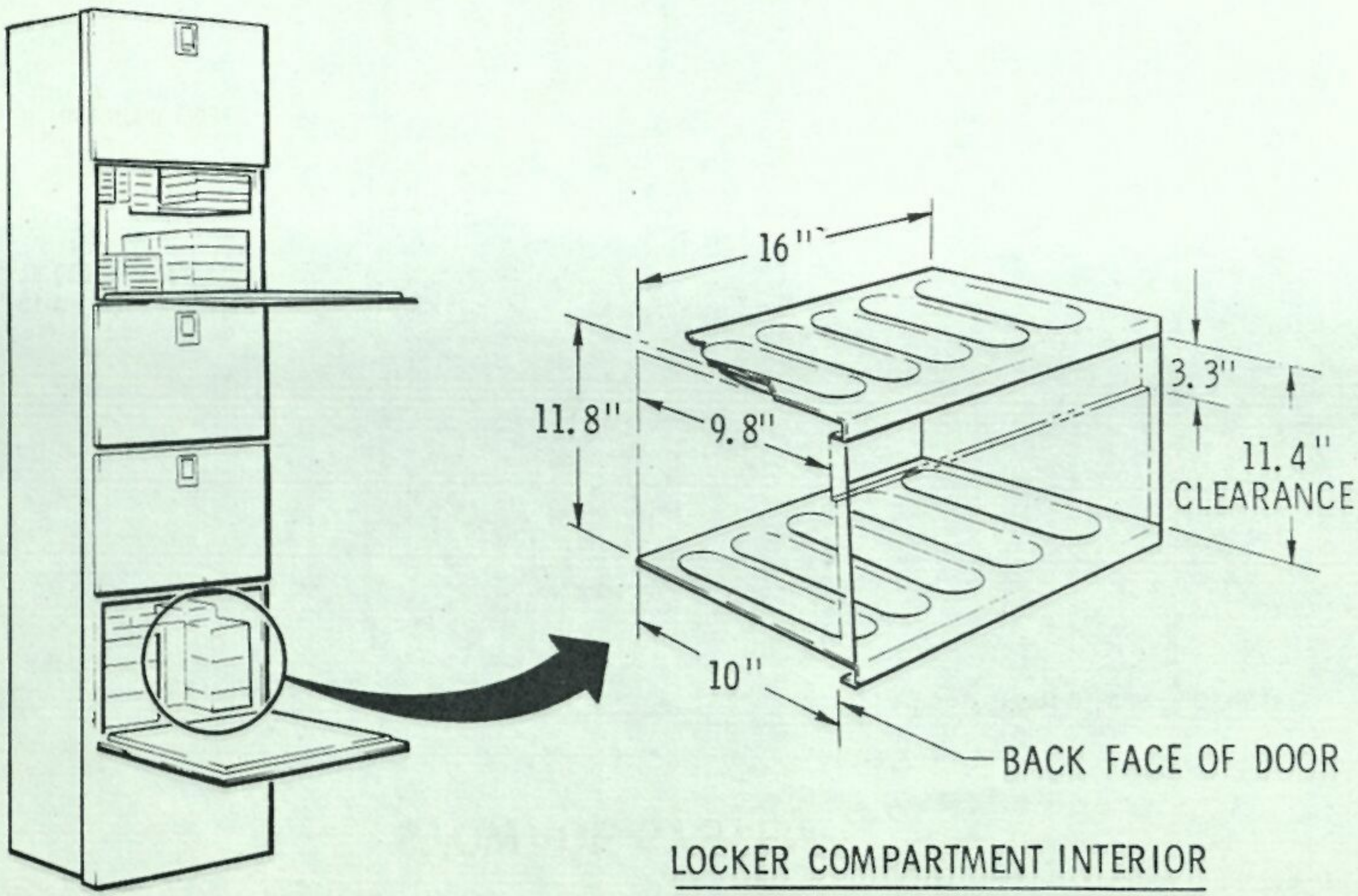
ORBITAL WORKSHOP STANDARD STOWAGE LOCKER

O/W-3759
4-2-70



LOCKER COMPARTMENT INTERIOR

The stowage lockers are of beaded aluminum construction with piano-hinged and latched access doors. The lockers are attached to the OWS floor by means of a mounting pallet at the locker base and a pivoting linkage at the forward end of the locker. The pallet and linkage provide load restraint and stability.

The stowage compartments contain such items as O_2 mask, lights, camera equipment, trash and waste collection bags, clothing, orbital spares, tape recorders, medical supplies, personal hygiene equipment, and crew personal preference items.

Stowage Cabinets

Five stowage cabinets are located throughout the OWS and contain a total of 16 stowage compartments of various sizes. The stowage cabinets are distributed in the OWS as follows:

Compartments	Cabinets	Compartments
Forward compartment	1	3
Wardroom	2	5
Waste management compartment	1	4
Sleep compartment	1	4
Total	5	16

The stowage cabinets are constructed of sheet metal, and have piano-hinged, latched access doors. Attachment provisions for the stowage cabinets are similar to those for the stowage lockers.

Items stowed in the cabinet compartments include tool kit, repair kit, shoes, sleep restraints, entertainment kit, data file, vacuum cleaner, and waste collection bags.

Containers

Stowage containers are loaded, prior to their installation in the OWS. There are provisions for 25 containers forward of the water storage tanks in the forward compartment. Eleven food containers are provided for the storage of dehydrated, intermediate moisture, and wet-pack foods, and these are installed in the forward compartment. Three containers are provided for the storage and return of urine samples. These are configured to fit the command module, and are located in the forward compartment.

Miscellaneous Stowage Provisions

Miscellaneous stowage provisions consist of the mounting and restraint hardware provisions for those items of equipment which are stowed individually in the OWS, rather than in lockers or cabinets. These items include fire extinguishers, spare mole sieve, portable astronaut aids, portable fans, and the IVA umbilicals. These provisions are mainly in the forward and experiment compartments.

Film Vault

The film vault provides the photographic film utilized to record experimental data from the expected radiation environment in the OWS. The 12 drawers of the vault will have different thicknesses of aluminum for radiation protection. The film vault will be bolted to the OWS floor in the forward compartment.

Food Chiller and Freezers

The food chiller and freezers are provided for the storage of foods which are perishable or frozen The freezers are located in the forward compartment (3 compartments) and in the wardroom (2 compartments). The chiller is the top compartment in the wardroom freezer assembly. The freezer maintains a temperature of -10 ± 10 degrees Fahrenheit, and the chiller a temperature of 39 ± 6 degrees Fahrenheit. These items of equipment utilize heat rejection capabilities of the OWS refrigeration system to achieve the required temperatures.

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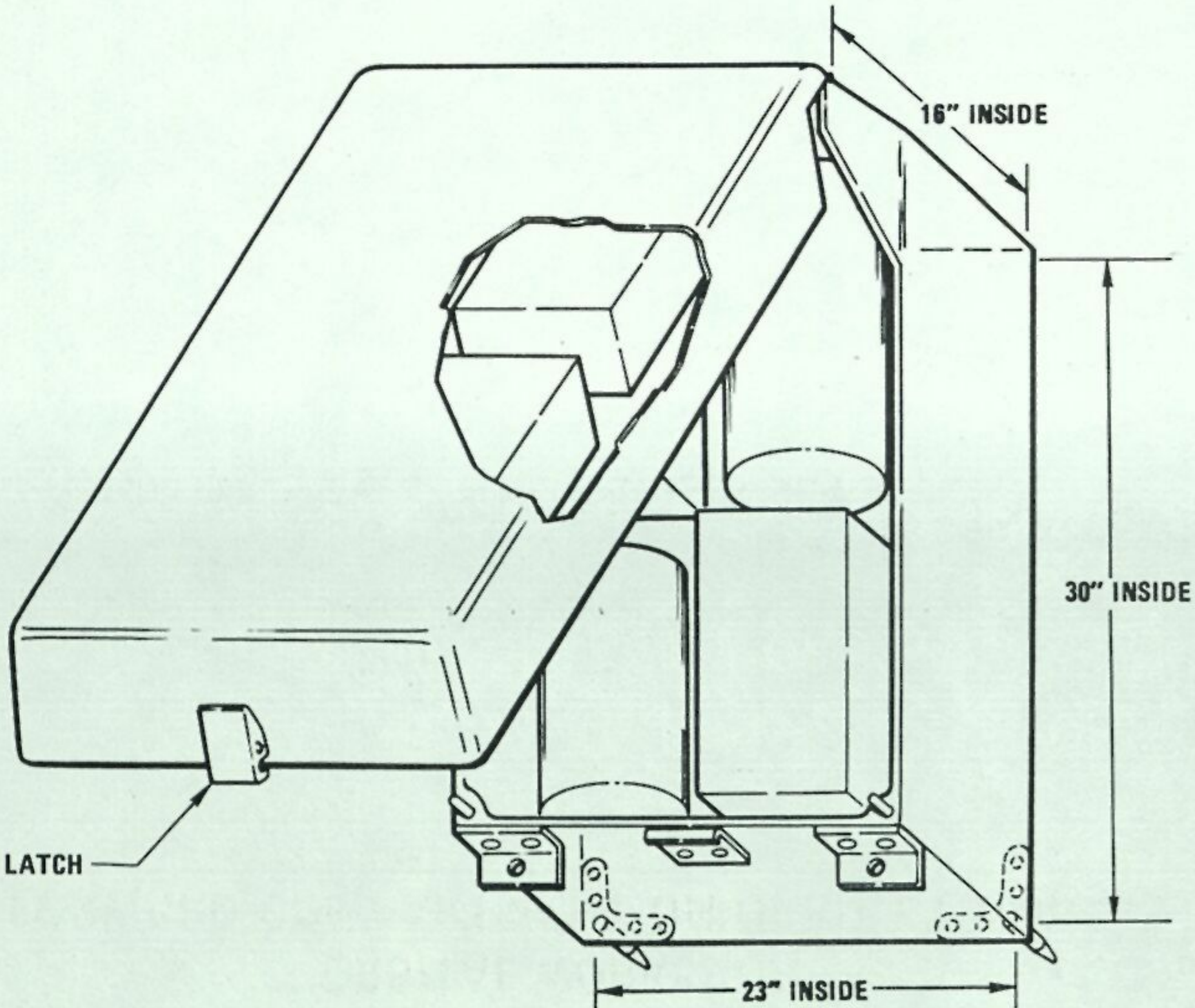
O/W-8258
8–7–70

ORBITAL WORKSHOP
STOWAGE RING CONTAINER



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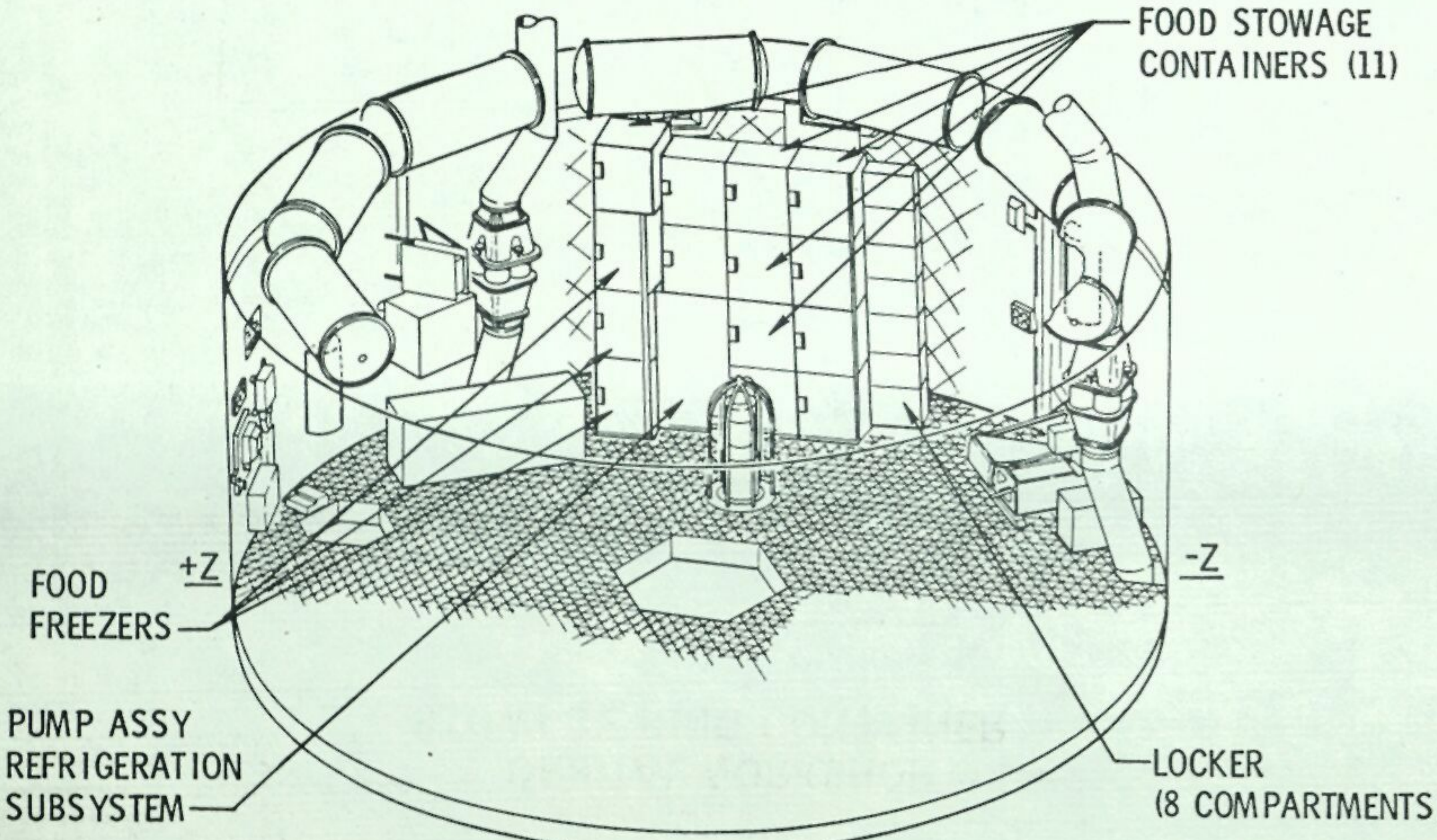
ORBITAL WORKSHOP
FORWARD COMPARTMENT ON-ORBIT STOWAGE

O/W-5393B
8-27-70



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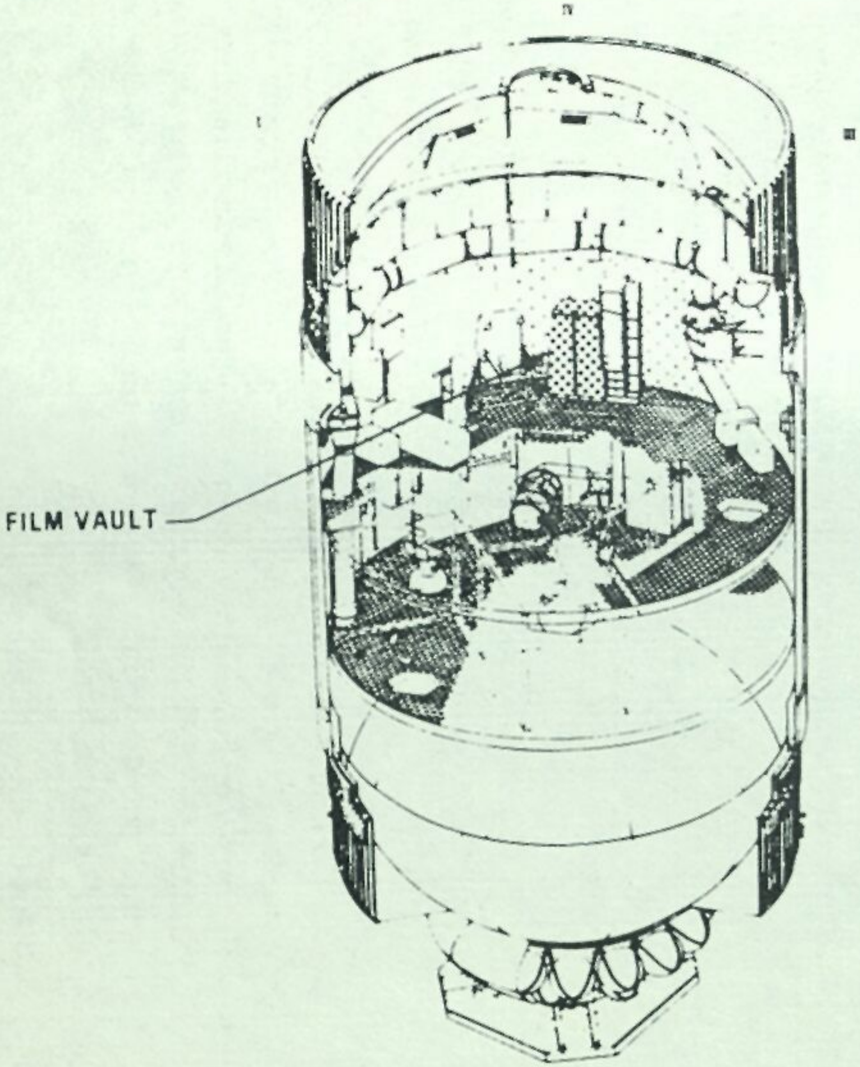
ORBITAL WORKSHOP
FILM VAULT

SA-303
12-2-70



REQUIREMENTS

ALUMINUM CASTING 54 X 40 X 22
APPROX 3,000 LB

0.25 TO 3.40 IN RADIATION PROTECTION

FOUR VAULT COMPARTMENTS

REMOVABLE FILM DRAWERS (12)

TOTAL DRAWER AREA 270.0 IN^2
APPROX

60,000 FT (APPROX) 16 MM
MOVIE FILM

27,000 (APPROX) FRAMES 70 MM
CAMERA FILM + MSCL SPECIAL FILM

OWS AMBIENT PRESSURE

45 ±15 RELATIVE HUMIDITY –
PASSIVE SALT PAD SYSTEM

Electrical System

The electrical system provides the primary OWS electrical power source and the distribution and control of IU/AM power and commands to OWS equipment and experiments. The OWS illumination system is also considered as part of the electrical system.

IU/OWS Power Distribution and Control

This system provides power and control of OWS functions interfacing the Instrument Unit (IU). These functions are as follows:

- TACS control
- Atmosphere control system
- Refrigeration system
- Solar array deployment
- Meteoroid shield deployment

This system is peculiar to the launch phase of the mission, ascent, and preliminary orbital phase, and has no function after IU power depletion, approximately seven and one-half hours after liftoff. This system is electrically isolated from the AM/OWS system.

AM/OWS Power Distribution and Control

The electrical power distribution and control system receives control and instrumentation power to support the OWS systems and experiments via the airlock module. Power is furnished at DCS command or by actuation of switches on either the STS instrumentation panel or the OWS control and display panel. The main power control and display console in the OWS is located in the experiment compartment. This console contains all necessary switches, circuit breakers, and indicators to allow the crew to control electrical power throughout the OWS. There is no OWS crew interface with the instrumentation power system.

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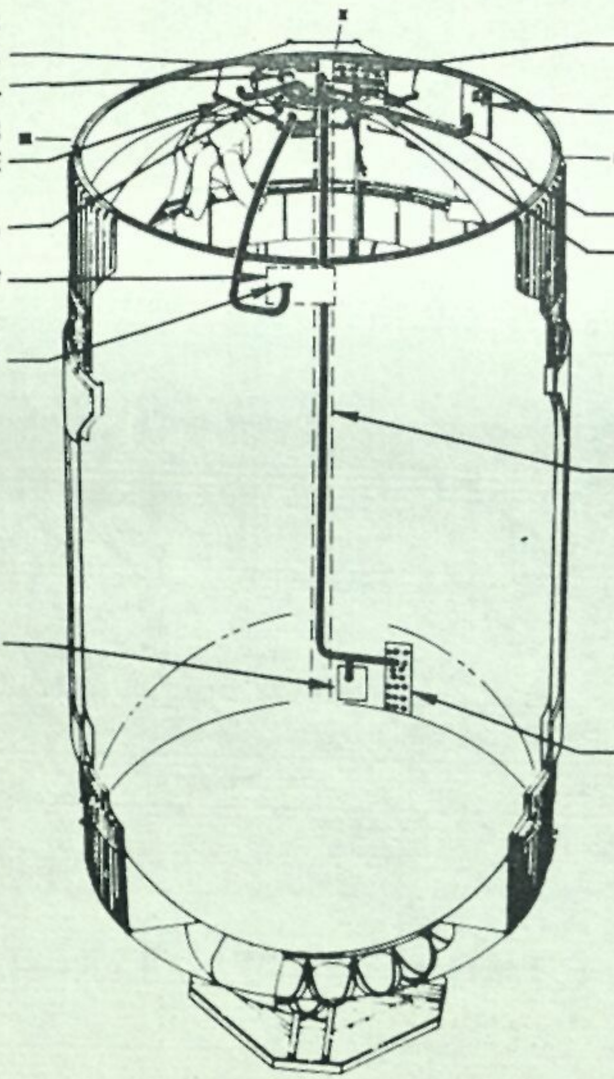
ORBITAL WORKSHOP
ELECTRICAL COMMAND SUBSYSTEM

SA-287
12-2-70



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OWS ELECTRICAL COMMAND SUBSYSTEM

REQUIREMENTS

PROVIDE AUTOMATIC GROUND COMMAND CAPABILITY FOR INITIAL 7.5 HOURS OF MISSION FOR THE FOLLOWING SYSTEMS:

(1) PRESSURE CONTROL
(2) THRUSTER ATTITUDE CONTROL
(3) SOLAR ARRAY DEPLOYMENT
(4) METEOROID SHIELD DEPLOYMENT
(5) REFRIGERATION
(6) AM/ATM/MDA FUNCTIONS - INCLUDING CONTROL OF AM BUSSES, ATM DEPLOYMENT, PAYLOAD SHROUD JETTISON AND MDA VENT VALVE CONTROL

SYSTEM OPERATION

ORDER OF EVENTS IS DETERMINED BY THE SL-1 PROGRAM FLIGHT SEQUENCE

SEQUENCE IS STORED IN A PREPROGRAMED IU COMPUTER

OWS SWITCH SELECTOR DECODES COMMANDS RECEIVED FROM IU

EACH SYSTEM AFFECTED RECEIVES COMMANDS FROM THE OWS SWITCH SELECTOR

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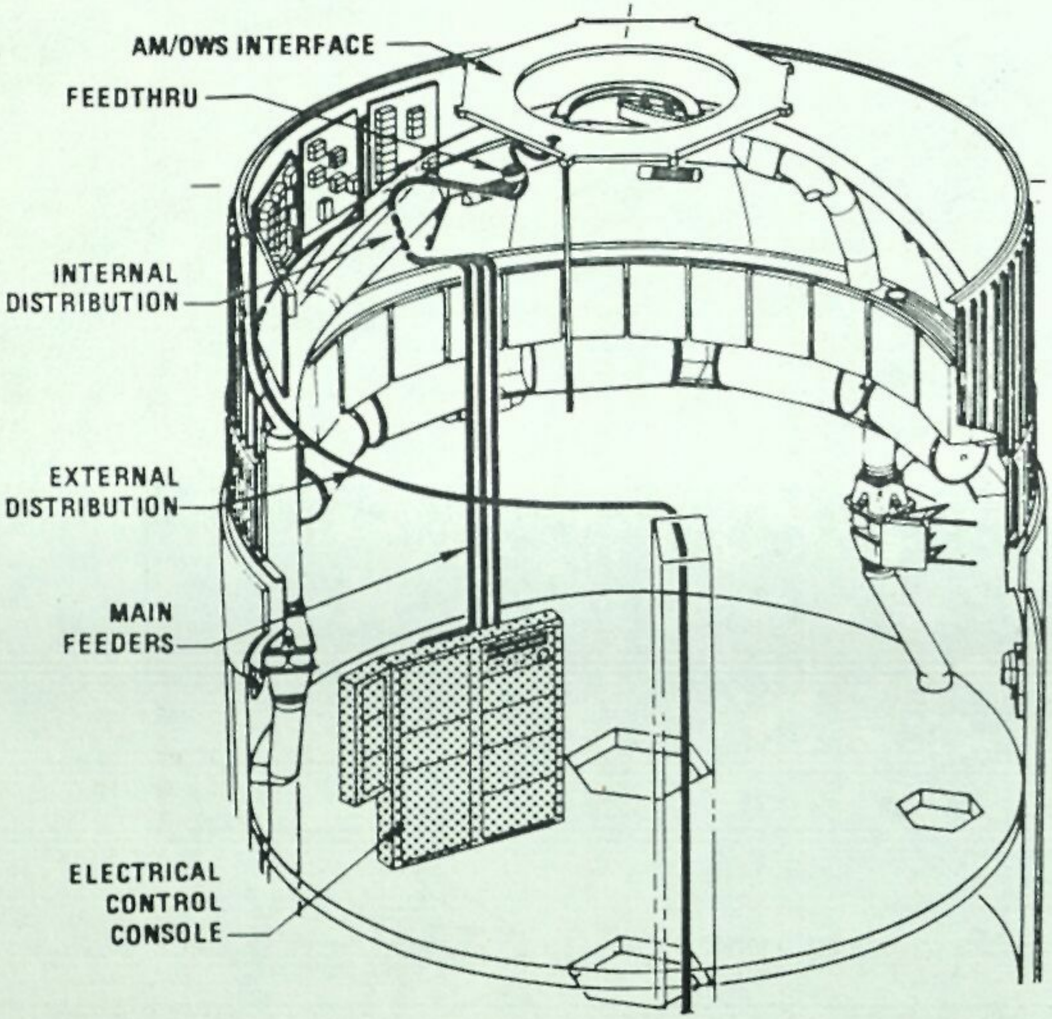
ORBITAL WORKSHOP
ELECTRICAL POWER DISTRIBUTION SYSTEM

SA-306
12-2-70



REQUIREMENTS

PROVIDE 24-30 VDC TO OWS END ITEMS

PROTECT WIRING FROM DAMAGE AND FIRE

PROVIDE CREW INTERFACE TO CONTROL AND MONITOR POWER ALLOCATION

SYSTEM OPERATION

RECEIVES 25.5 TO 30 VDC FROM AM

PROVIDES REDUNDANT BUSSES IN CONSOLE

SUPPLIES 24-30 VDC TO END ITEMS

PROTECTS WIRING TO END ITEMS WITH CIRCUIT BREAKERS

CAPABILITY OF 118 AMP LOADING

NOMINAL POWER USAGE AT 26 VDC IS 2200 WATTS

Remote control panels for illumination, habitability support systems, and tape recorders are provided at convenient locations. All power wiring is protected with circuit breakers. Some of the design characteristics of the distribution system are:

- o Two wire circuits are employed with a single point ground which is isolated from the OWS structure ground.
- o Utility outlets with common receptacles are provided for fans, lights, heaters, cameras, or experiments. The receptacles and connectors are designed to preclude arcing when the crew mates or demates electrical equipment.
- o Internal OWS wiring is protected from physical damage, and fire.
- o Procedural means of removing power from the OWS receptacles is available.
- o Main power feeders are physically and electrically isolated from each other.
- o Explosion-proof zero-g connectors, utilizing a bail handle rather than twist-lock or screw engagement to facilitate one handed operation are utilized on OWS equipment which derives electrical power from the utility outlets.

Solar Array System (SAS)

The solar array system converts solar energy into direct current (DC) electrical power and supplies it to the airlock module where it is conditioned and distributed to the rest of the OA (OWS, MDA, ATM, DSM).

The SAS consists of two deployable wing assemblies externally mounted on the OWS, and their associated electronics, instrumentation, and deployment equipment.

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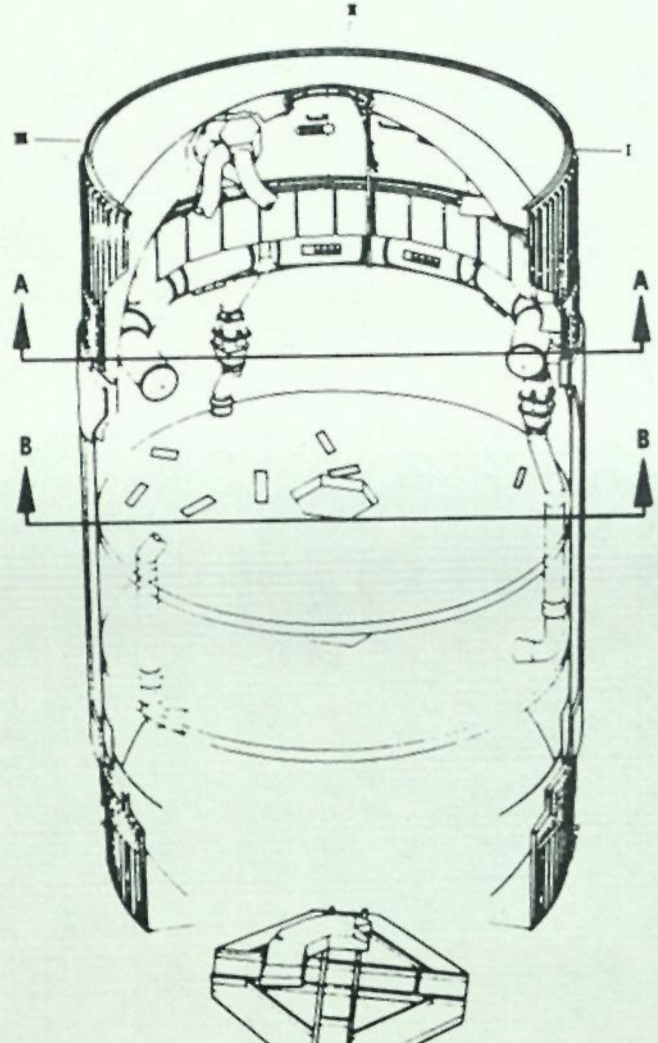
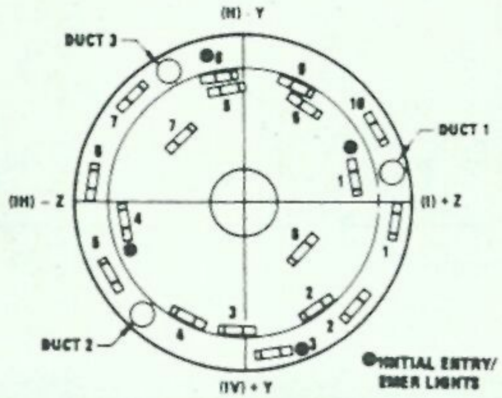
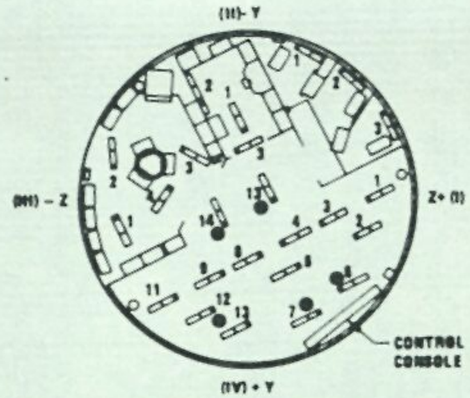
ORBITAL WORKSHOP
GENERAL ILLUMINATION SYSTEM

SA-300
12-2-70





SECTION A-A FWD COMPT.



SECTION B-B CREW QUARTERS

REQUIREMENTS

GENERAL ILLUMINATION LIGHTS SHALL PROVIDE THE FOLLOWING AVERAGE ILLUMINATION LEVELS.

AREA	FOOTCANDLE (MIN)
NASA SLEEP COMPARTMENT	4.5
WARD ROOM	5.0
HEAD	9.0
WORK EXPERIMENT COMPARTMENT	5.5
FORWARD COMPARTMENT	1.0

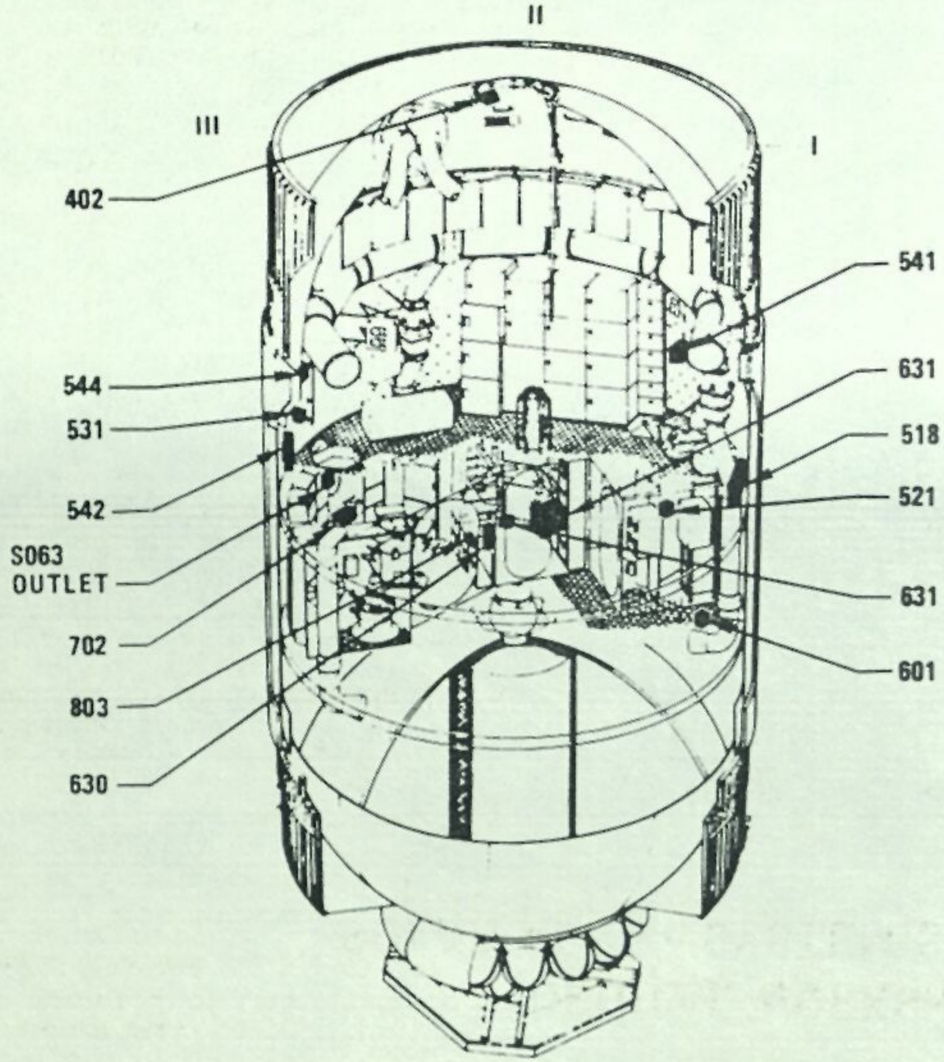
DURING INITIAL ENTRY AND EMERGENCY MODE THE LIGHTING SYSTEM SHALL PROVIDE AN AVERAGE ILLUMINATION OF 0.5 FOOT CANDLES (MIN) IN THE CREW QUARTERS AND FORWARD COMPARTMENT.

SYSTEM OPERATION

42 SYLVANIA FLOODLIGHTS (1869364) WITH 3 POSITION SWITCH, (OFF, LO, AND HI).

ORBITAL WORKSHOP
ELECTRICAL CONTROLS AND DISPLAYS

SA-291
12-2-70



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SYSTEM OPERATION

PANEL-542
DATA RECORDERS FROM THE FORWARD COMPARTMENT

PANEL-630
LIGHTS IN THE WMC AND WARDROOM

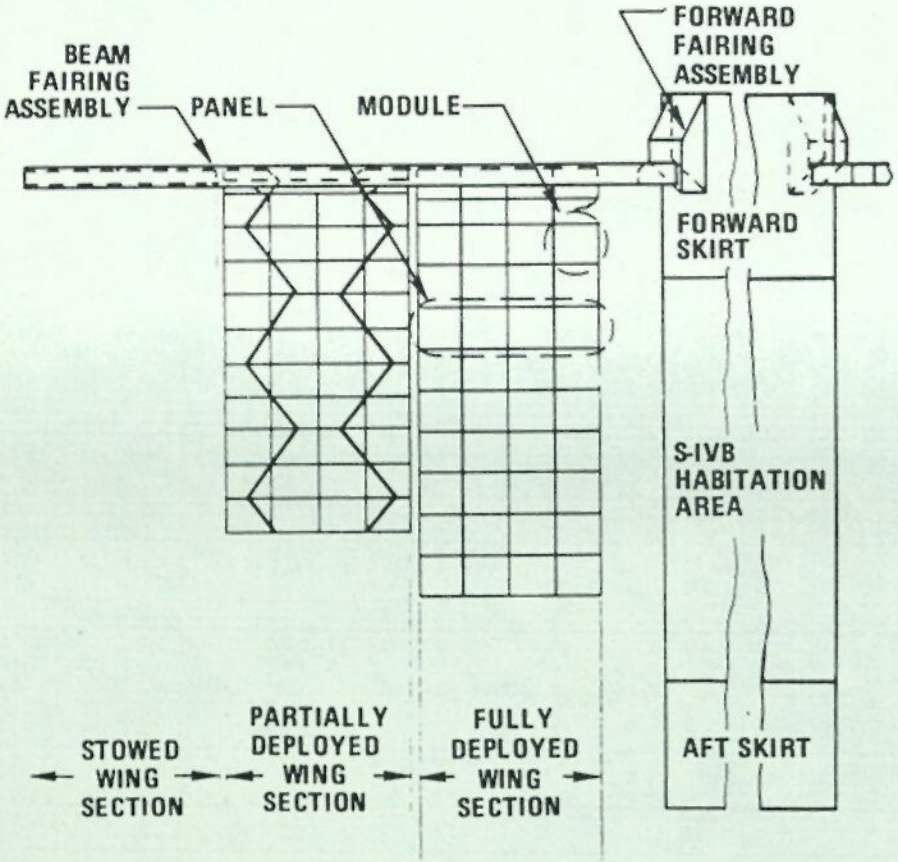
PANEL-700
WATER SYSTEM AND WINDOW HEATER IN WARDROOM

PANEL-800
WATER, URINE, AND FAN IN WMC

OUTLETS -402, -521, -531, -541, -601, -631, -803
CREW CONVENIENCE, PORTABLE, LIGHTS, FANS, CAMERAS AND VACUUM CLEANER

OUTLETS -518, -544,
EXPERIMENTS UTILIZING THE SAL'S

ORBITAL WORKSHOP
SOLAR ARRAY SYSTEM-STRUCTURE



<u>SAS REQUIREMENTS</u>

FULLY DEPLOYED IN 4 MINUTES

DEPLOYED PANELS FACE DIRECTION OF POS I

NO CONTAMINATION OF PANELS BY EXPLOSIVE DEVICES

OUTPUT OF 11,200 WATTS AT FAIRING INTERFACE AT:

a. 130°F
b. INTENSITY OF 140 NM/CM^2
c. BEGINNING OF MISSION

OPERATING TEMPERATURE OF −85° TO +212°F

WITHSTAND VIBRATION AND SHOCK LOADS OF DOCKING OPERATIONS AND SWS MANEUVERS

During the Skylab orbital mission, when the OA is maintained in a solar inertial attitude, the SAS active faces point toward the sun.

Each of the wing assemblies consist of:

- o Fairing assemblies which house the wings and their actuating mechanisms during the launch and ascent phases of the mission.
- o Three wing sections which contain the solar cells and are stored within the fairing assembly.
- o Mechanical and ordnance systems for SAS orbital deployment.
- o Stabilizing beams which restrain the wing sections in the deployed position.

Electrical support equipment for the solar array system consists of the following:

- o Cabling from the SAS modules to the SAS power unit located in the OWS forward skirt.
- o The SAS power unit which contains isolation and bussing devices, and GSE connectors.
- o The SAS instrumentation signal conditioning unit in the OWS forward skirt.
- o Cabling from the SAS power unit to the AM.
- o Fairing release and SAS deployment electronics.

The solar array wing sections are made up of 240 modules (120 per wing), divided into eight electrically isolated power groups of 30 parallel-connected cells each. This arrangement minimizes power output differences among the groups as a result of expected shadowing conditions.

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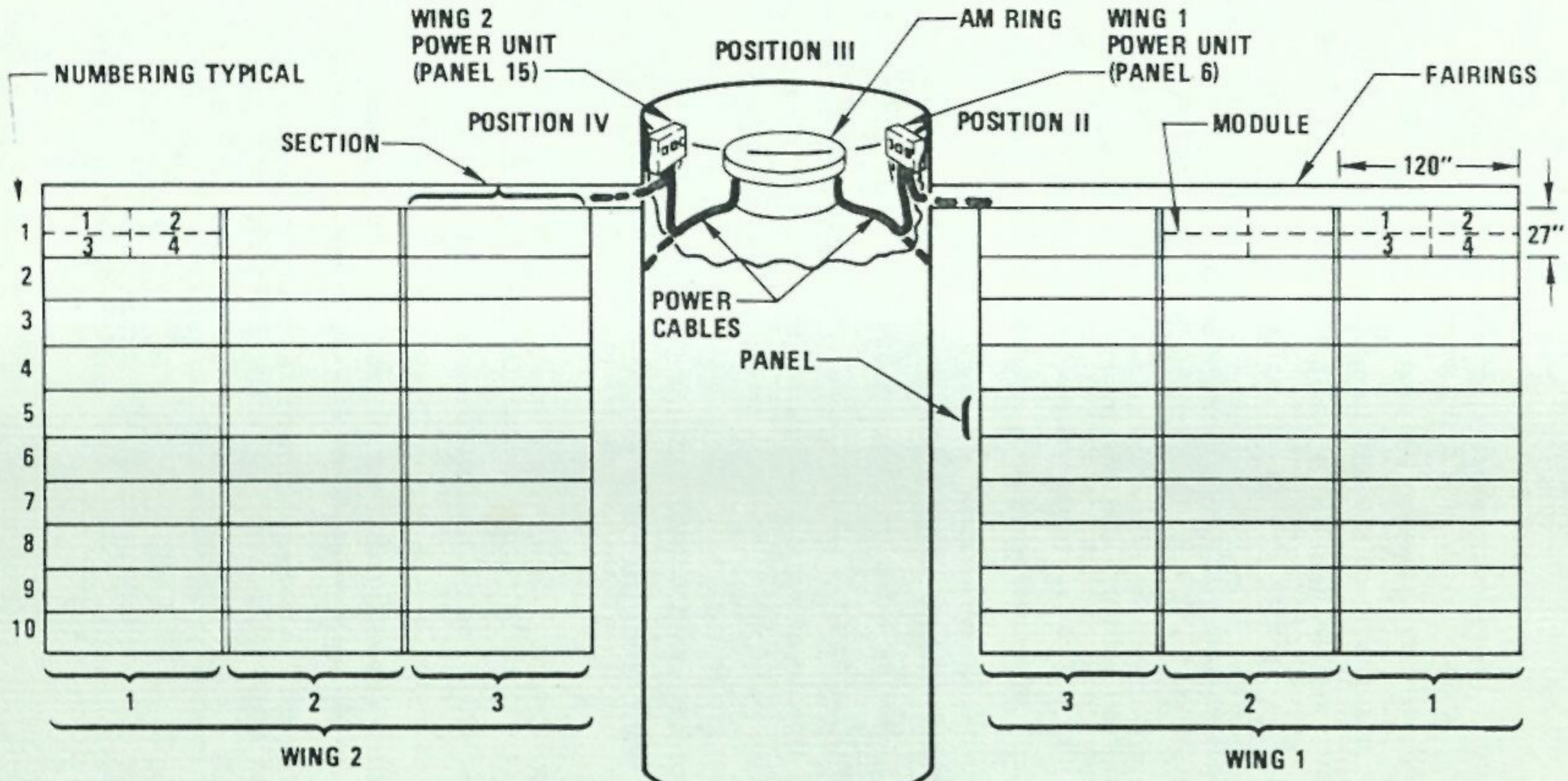
ORBITAL WORKSHOP
SOLAR ARRAY SYSTEM-ELECTRICAL

SA-298
12-2-70



NOTES:
1. (616) SOLAR CELLS MAKE UP A MODULE
2. (4) MODULES MAKE UP A PANEL
3. (10) PANELS MAKE UP A WING SECTION
4. (3) WING SECTIONS PLUS BEAM FAIRING MAKE UP A WING

The solar array is deployed at IU command by means of preloaded mechanical energy storage systems which are released by initiation of redundant EBW firing unit/EBW/CDF ordnance trains. Ground command backup is provided via the DCS should the IU fail to command the deployment. After the wings' beam fairing assemblies are deployed, the solar panel wing sections are released and driven into extension, where they are locked by means of devices in the stabilizing beams.

The deployed SAS provides approximately 10,000 watts of electrical power for operation of OA systems, and recharging of AM batteries, which provide OA power during the night side of the orbit.

Atmosphere Control System (ACS)

The OWS atmosphere control system provides for habitation area and waste tank pressurization prior to launch and pressure control during boost phase; remote pressurization and venting of the OWS on-orbit; active and passive control of atmospheric temperatures within human comfort limits; and controlled atmospheric circulation.

Pressure Control System (PCS)

The pressure control function of the ACS provides for prelaunch pressurization and inflight venting control for the habitation area and waste tank. The habitation area pressure control capability includes the use of two sets of valves: a pair of pneumatically operated valves which are used for orbital blowdown immediately after orbital insertion; and a set of solenoid valves utilized for venting the habitation area for storage. Both sets of valves exhaust into ducts which terminate in orifice plates so oriented as to render the venting non-propulsive.

The waste tank has similar pneumatic vent valves, and both the habitation area and waste tank pneumatic valves include pressure relieving functions.

The pressurization of the habitation system after orbital insertion is accomplished by an airlock-controlled system. The habitation area is pressurized and maintained at 5.0 psia total pressure (3.7 psia O_2 partial pressure, and 1.3 psia N_2 partial pressure) throughout the manned portions of the mission. This pressurization is accomplished after the launch pressure has been blown-down. This pressure is required to provide structural integrity during launch loads. The waste tank is also pressurized to avoid high differential pressure across the common propellant tank bulkhead which separates the habitation area from the waste tank.

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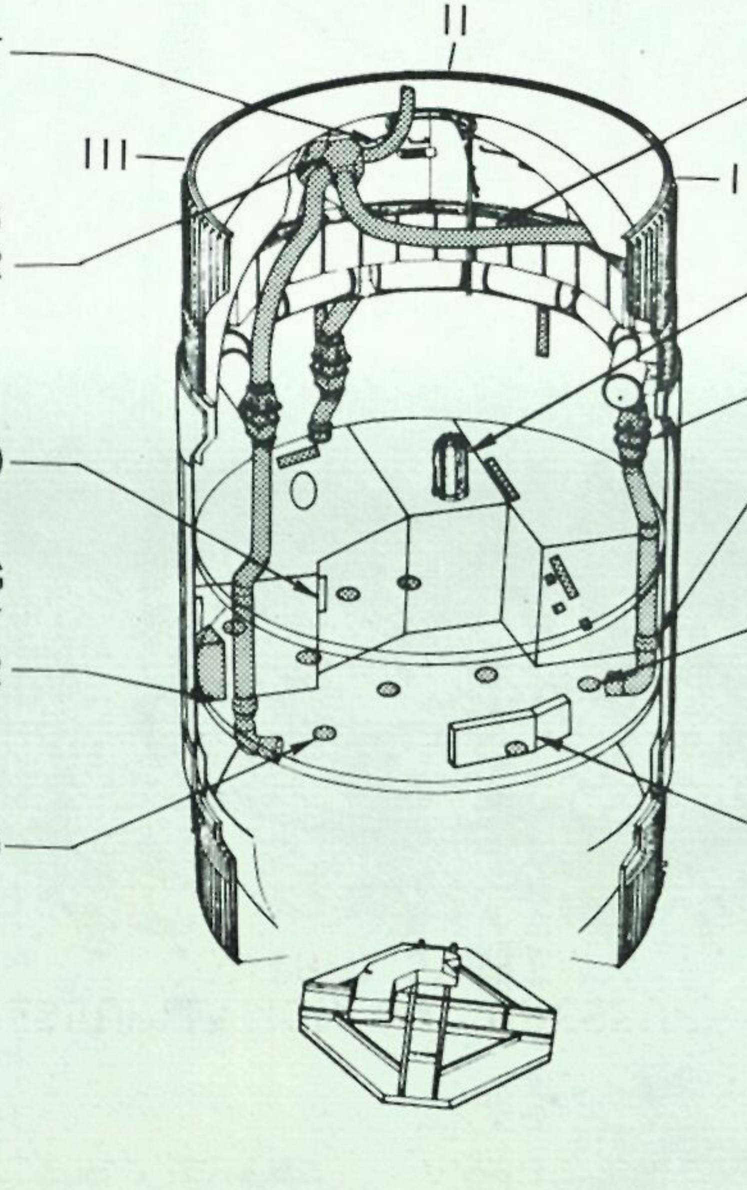
SA-294A
5-19-71

ACTIVE THERMAL CONTROL



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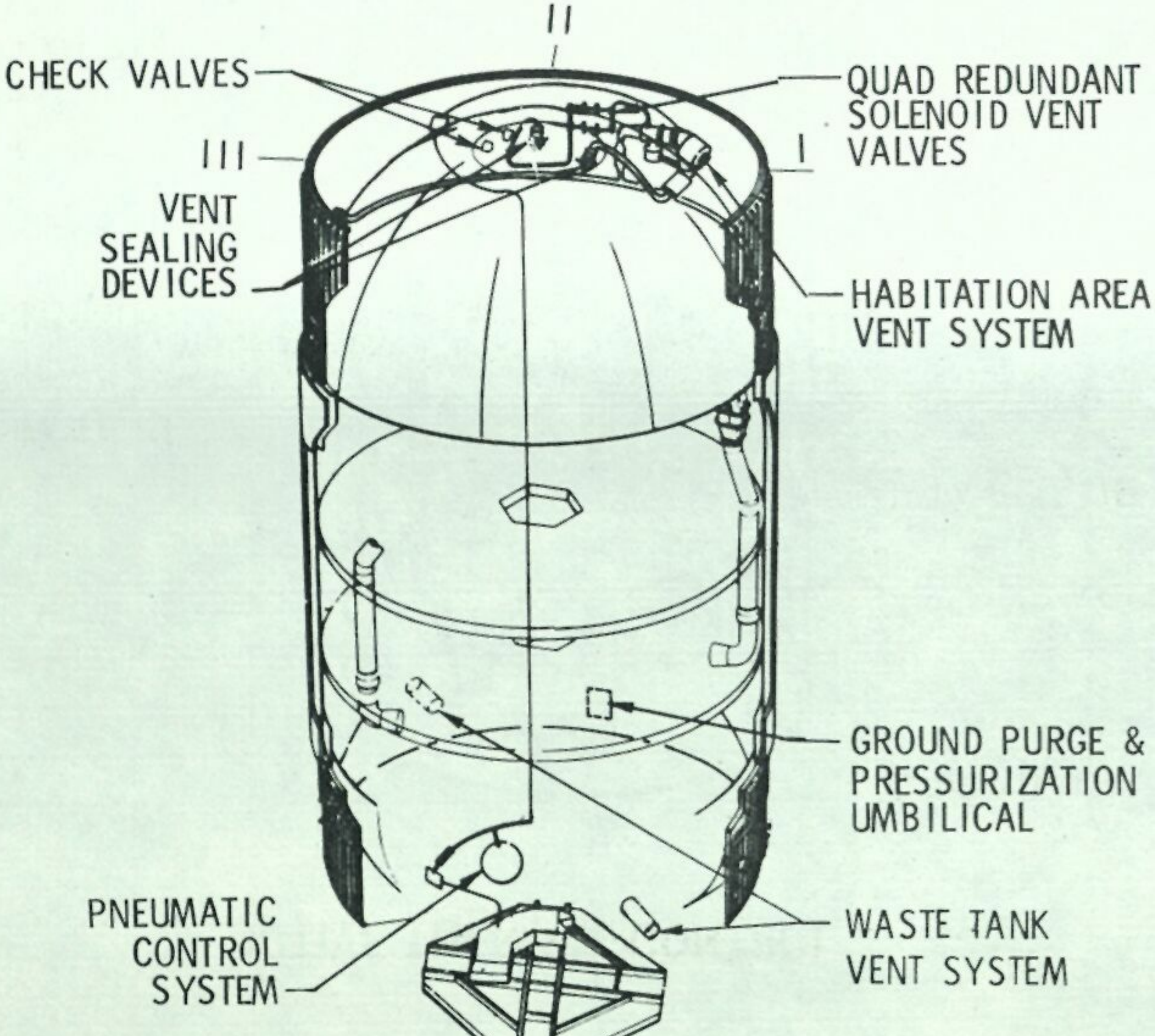
PRESSURIZATION AND PRESSURE CONTROL SYSTEM

SA-284A
5-19-71



A pneumatic system consisting of a GN_2 sphere containing approximately five cubic feet of nitrogen at 750 psia, and an actuation control module containing solenoid valves, is utilized in the operation of the OWS pneumatic vent valves.

Thermal Control System (TCS)

The OWS thermal control system is designed to meet the OWS thermal requirements from ground-hold conditions through orbital activation, habitation, and storage. During ground-hold, and orbital storage, the OWS is thermally conditioned to satisfy the temperature requirements of the food and film stored in the OWS. During orbital activation and habitation, the OWS must be conditioned to within astronaut entry limits (activation), and "shirtsleeve" environment (habitation). The ground thermal control portion of the system employs OWS heat exchangers which are serviced with a mixture of water and ethylene glycol and circulation fans along with ground thermal conditioning units (TCU). The orbital thermal control portion consists of active and passive provisions for maintaining orbital thermal requirements. Cabin gas temperature is maintained by heat exchangers located in the airlock module, as well as convective heaters mounted in the ventilation ducts. Passive thermal control provisions include optical property control of exterior and interior surfaces, and application of insulating material on the insides of habitation area pressure walls.

Ventilation Control System (VCS)

The ventilation control system transports revitalized air which has been purified and dehumidified from the airlock module and mixes it with the OWS atmosphere, and circulates the mixture throughout the habitable area. The system also provides for particulate and odor filtration of the waste management air.

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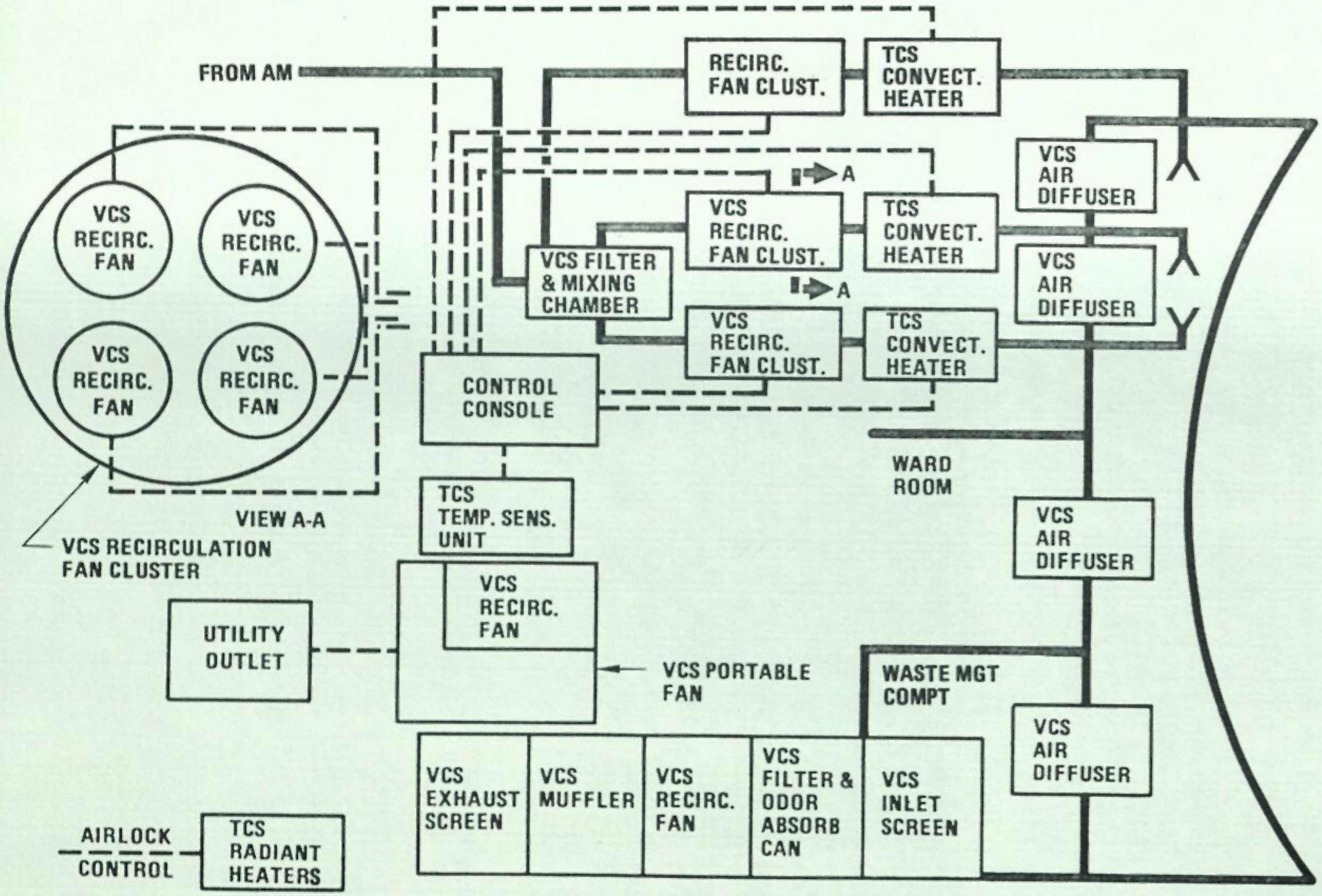
ORBITAL WORKSHOP
VCS/TCS SCHEMATIC

O/W-4759
8-25-70



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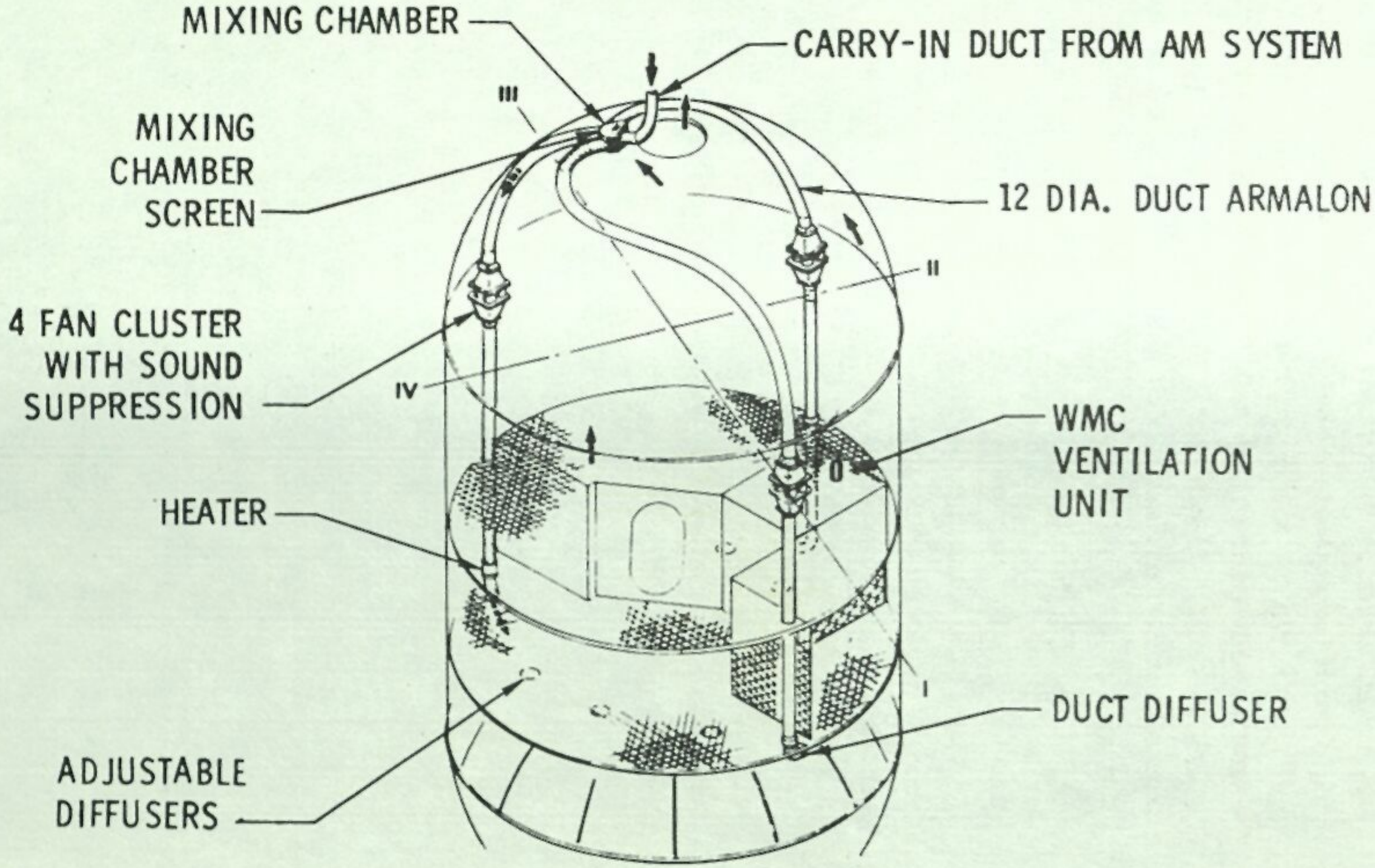
COMPANY

ORBITAL WORKSHOP VENTILATION

O/W-3961
8–5–70



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Revitalized atmosphere is brought from the AM to the dome of the OWS via a duct, which is fed into a mixing chamber (plenum) located in the forward compartment on the OWS dome. Three OWS ventilation ducts are routed from the mixing chamber to the plenum chamber between the crew quarters and the waste tank. The ventilation is produced by fan clusters mounted in each duct. The crew quarters floor is equipped with adjustable diffusers which allow the ducted air to circulate through the crew quarters and back to the forward compartment, thence to the airlock module for revitalization.

Each ventilation duct contains four Apollo post landing ventilation (PLV) fans, mounted in a baffled cluster assembly. A filter/odor removal cannister is mounted on the forward compartment floor, and contains activated charcoal filters to remove odors and particles suspended in the atmosphere. A portable fan complement is included in the OWS consisting of three of the PLV fans mounted in central fixtures which can be located anywhere on the OWS grid, on handrails, or the central fireman's pole, and can be connected to utility outlets for electrical power.

Refrigeration System

The Refrigeration System (RS) provides cooling and freezing capabilities for food, potable water, and urine samples in the OWS. Redundant cooling loops are provided, one for the normal operational requirements, and one backup system in case of primary system failure.

Each system utilizes liquid refrigerant which is circulated through the temperature-controlled storage units absorbing heat. The coolant is then routed either to a ground cooling heat exchanger, while the OWS is in a ground hold status, or to the OWS external radiator, or, during phases of the mission where the radiator cannot provide sufficient heat rejection, to a thermal capacitor.

Recirculation

Four positive displacement gear pumps are utilized in each refrigerant loop for circulating the Coolanol-15 refrigerant. The pumping and thermal control assemblies contain approximately 80 percent of the potential leak paths for the refrigerant aboard the OWS. To minimize the possibility of inboard coolant leakage, the pumping and chiller thermal control assemblies are combined in a pressure tight container which is vented directly to the waste tank and overboard, in the event of leakage. A hand shutoff valve is provided for on-orbit access to these assemblies. The pumps are automatically shut off during launch to prevent exceeding the radiator working pressure, and are sequenced on at IU command following S-II separation. The pumps are also shut off manually prior to exceeding their guaranteed life cycle of 2,200 hours.

Controls and Displays

The refrigeration system is provided with the following major electrical components for control and display of its operation:

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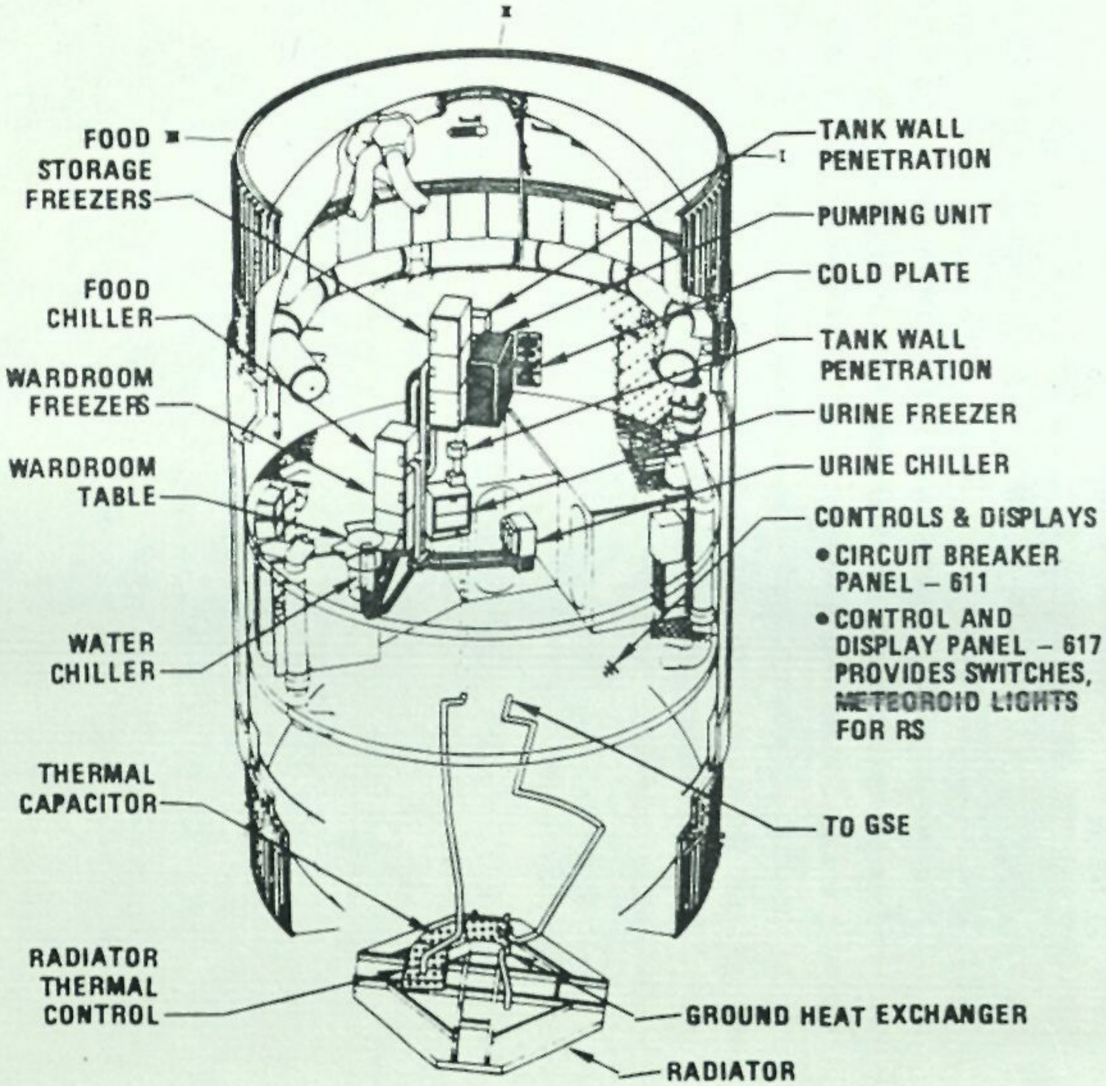
ORBITAL WORKSHOP REFRIGERATION SYSTEM

SA-277
12-2-70



REQUIREMENTS

FROZEN FOOD	-20° TO $+0^{\circ}$F
CHILLERS	$+33^{\circ}$ TO $+45^{\circ}$F
CHILLED WATER	$+33^{\circ}$ TO $+45^{\circ}$F
FROZEN URINE	-2.5°F MAX
CHILLED URINE	$+59^{\circ}$F MAX

SYSTEM OPERATION

THERMAL CAPACITOR	-14°F
RADIATOR TEMP CYCLE	-50° TO $+10^{\circ}$F
PUMPS	
VOLUMETRIC FLOW	.0365 CFM
PRESSURE DROP	55 PSID
PUMP POWER	50 WATTS
RADIATOR CAPACITY	1,680 BTU/HR
PUMP OPERATING LIFE	2250 HRS EA

EARTH RESOURCES CAPABILITY
2 PASSES PER 6 ORBITS
4 PASSES PER 16 ORBITS

MAX OPERATING PRESSURE 140 PSIA (DESIGN)

COOLANT VOLUME PER LOOP 1016 IN.^{3}

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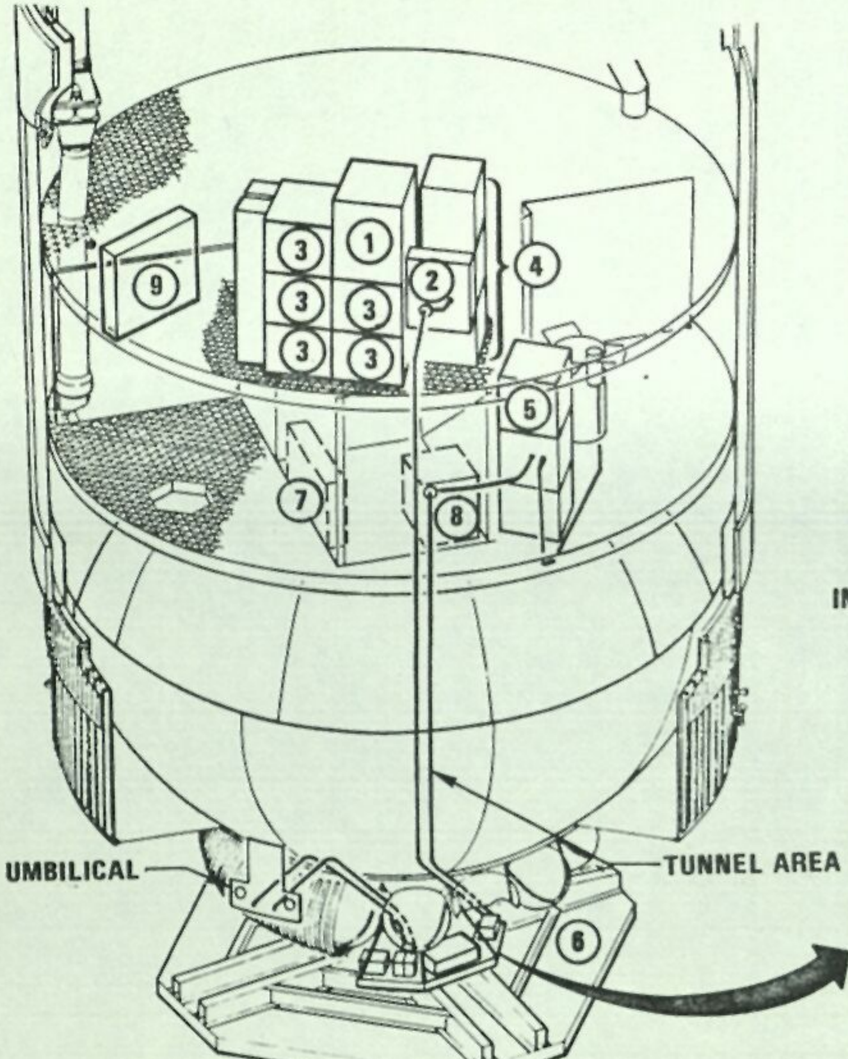
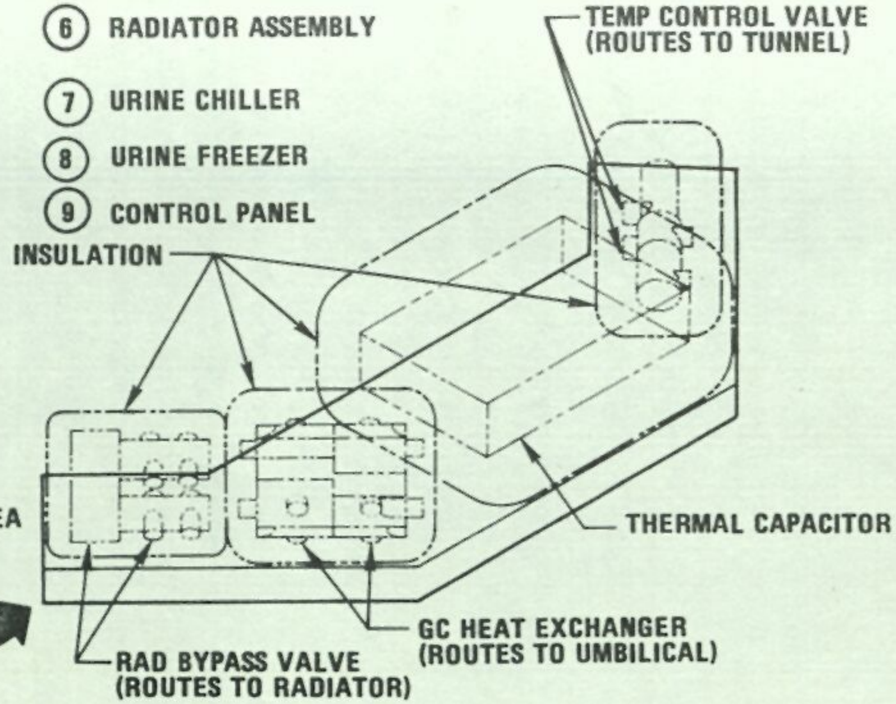
ORBITAL WORKSHOP
REFRIGERATION SUBSYSTEM
EQUIPMENT LOCATION

O/W-6027
8–12–70

1. PUMPING ASSEMBLY, REFRIGERATION SUBSYSTEM
2. THERMAL CONTROL ASSY, CHILLER, REFRIGERATION SUBSYSTEM
3. CONTAINER – STORAGE, FOOD
4. FREEZER, FOOD STORAGE
5. FREEZER, WARDROOM
6. RADIATOR ASSEMBLY
7. URINE CHILLER
8. URINE FREEZER
9. CONTROL PANEL





- o Two coolant pump inverters
- o Two control logic units
- o Two radiator bypass valves
- o Two regenerator heater controllers
- o One display and control panel (part of power console)
- o Instrumentation and control sensors

The coolant pump inverters convert the 28 VDC electrical power to ~~8.5~~ 7.5 VRMS to drive the pump. The control logic units provide operation of the pumps, radiator bypass valves, and regenerator heaters for the two loops. System parameters requiring display are also derived from the control logic units. Radiator bypass valve controllers are provided in each coolant loop to control refrigerant bypass from the radiator to the thermal capacitor when abnormal radiator temperatures are sensed. Flow throughout the radiator is restored when normal radiator temperatures are sensed. Electrical heater blankets are provided in each loop to maintain the temperature of the refrigerant in each loop within a selected control range. These regenerator heaters have their own controllers which are operated by the control logic units to provide on-off power to the heaters. The RS control and display panel is part of the electrical control and display console located in the experiment compartment and provides for crew monitoring and manual system control.

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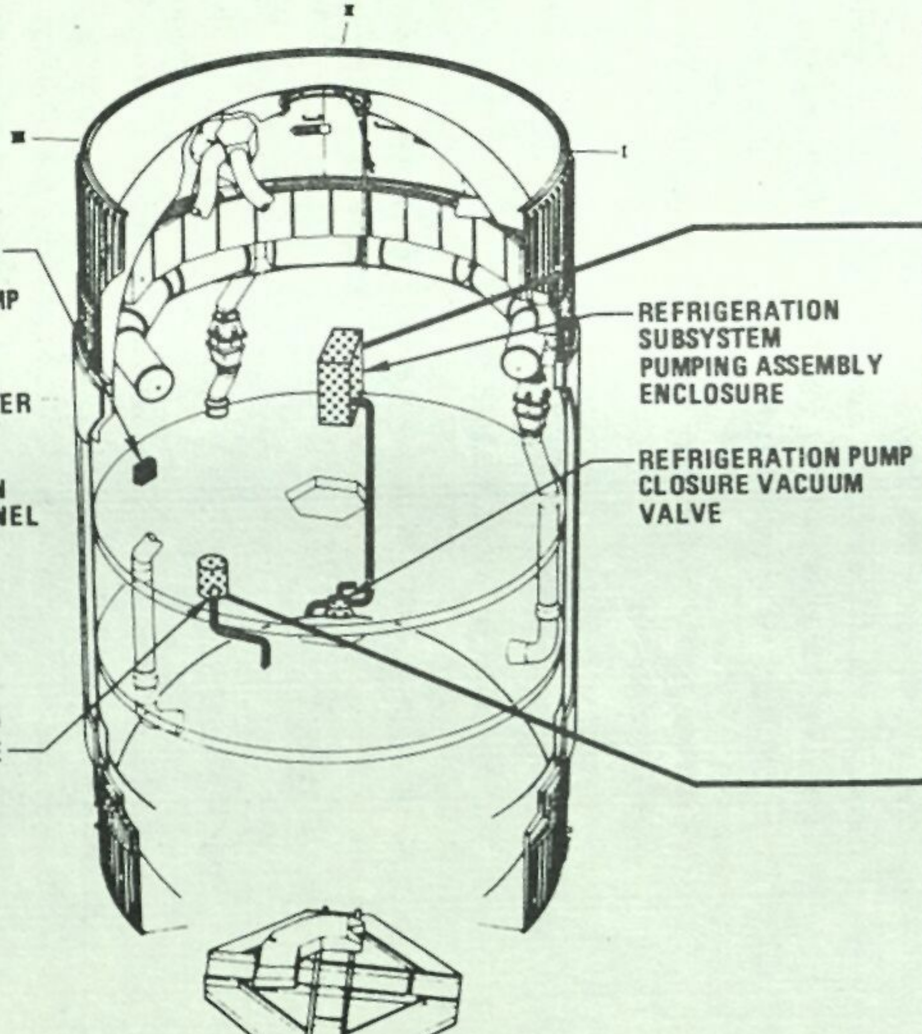
ORBITAL WORKSHOP
VACUUM SYSTEMS
WARD ROOM & REFRIGERATION SYSTEM

SA-285
12-2-70



REFRIGERATION PUMP ENCLOSURE

REQUIREMENT

VENTS REFRIGERATION PUMP ENCLOSURE IN EVENT OF COOLANT LEAKAGE

SYSTEM OPERATION

VENTS INTO WASTE TANK

1/4" LINE WITH ISOLATION VALVE

WARDROOM WATER DUMP

REQUIREMENTS

EVACUATE WATER LINES FOR SYSTEM ACTIVATION AND FOR STORAGE

SYSTEM OPERATION

1/4" LINE WITH ISOLATION VALVE

HEATED PROBE FOR DUMP INTO WASTE TANK

LINE DISCONNECTED WHEN NOT IN USE

Thruster Attitude Control System (TACS)

The Thruster Attitude Control System consists of 22 GN_2 spheres manifolded together on the OWS thrust structure, two thruster modules, and control valves and plumbing to operate the system. The TACS provides primary OA attitude control following separation of the S-II, until the ATM control moment gyros are brought up to operating speed. The TACS can be controlled by the IU, or the DCS, and operates on command during the following mission phases and conditions:

- During CMG spinup the TACS is the primary OA attitude control system. The IU provides control of the TACS for approximately the first 7.5 hours of the mission, and then transfers control to the Digital Command System (DCS).
- Whenever the TACS deadband is exceeded, or the CMG momentum build-up is excessive.
- Whenever "TACS ONLY" mode of OA control is selected by the crew.
- In the event of a CMG failure.

TACS thrusters are pulsed gas nozzles which provide approximately 20 to 50 pounds of thrust each. They are located on the aft skirt of the OWS in two clusters of three nozzles each.

Propellant Supply/Distribution

The Gaseous Nitrogen (GN_2) propellant is stored in 22 spheres which have a volume of 4.5 cubic feet each, at 3100 $\pm$ 100 psia, and distributed via a common manifold connecting the thruster modules. The propellant supply and distribution system is completely brazed to avoid gas leakage.

Meteoroid shielding is included to prevent penetration of the spheres or pressure lines by meteoroid particles, and to provide passive thermal protection. The spheres are fabricated of Titanium, and are the same as currently used on the S-IV-B stage. Two filters are used in the propellant supply/distribution system, and these are brazed into the lines to the thruster modules.

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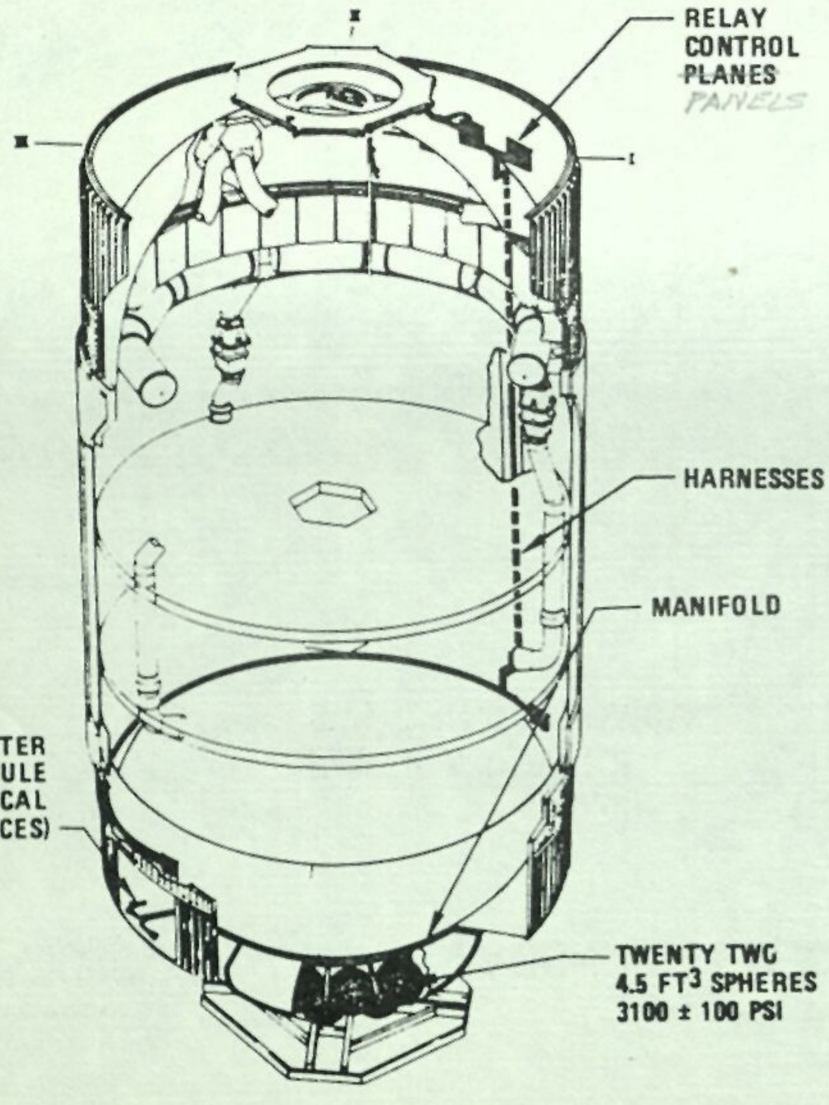
ORBITAL WORKSHOP
THRUSTER ATTITUDE CONTROL SYSTEM

SA-292
12-2-70



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REQUIREMENTS

PROVIDE PRIMARY ATTITUDE CONTROL THRU CMG SPIN-UP

PROVIDE BACKUP & SUPPLEMENTAL ATTITUDE CONTROL FOR CMG DESATURATION, FOR MANEUVERS & DOCKING TRANSIENTS

SYSTEM OPERATION

GASEOUS NITROGEN PROPELLANT BLOW-DOWN SYSTEM
TWO MODULES – THREE THRUSTERS EACH
QUAD REDUNDANT VALVES – EACH THRUSTER
ALL BRAZED SYSTEM

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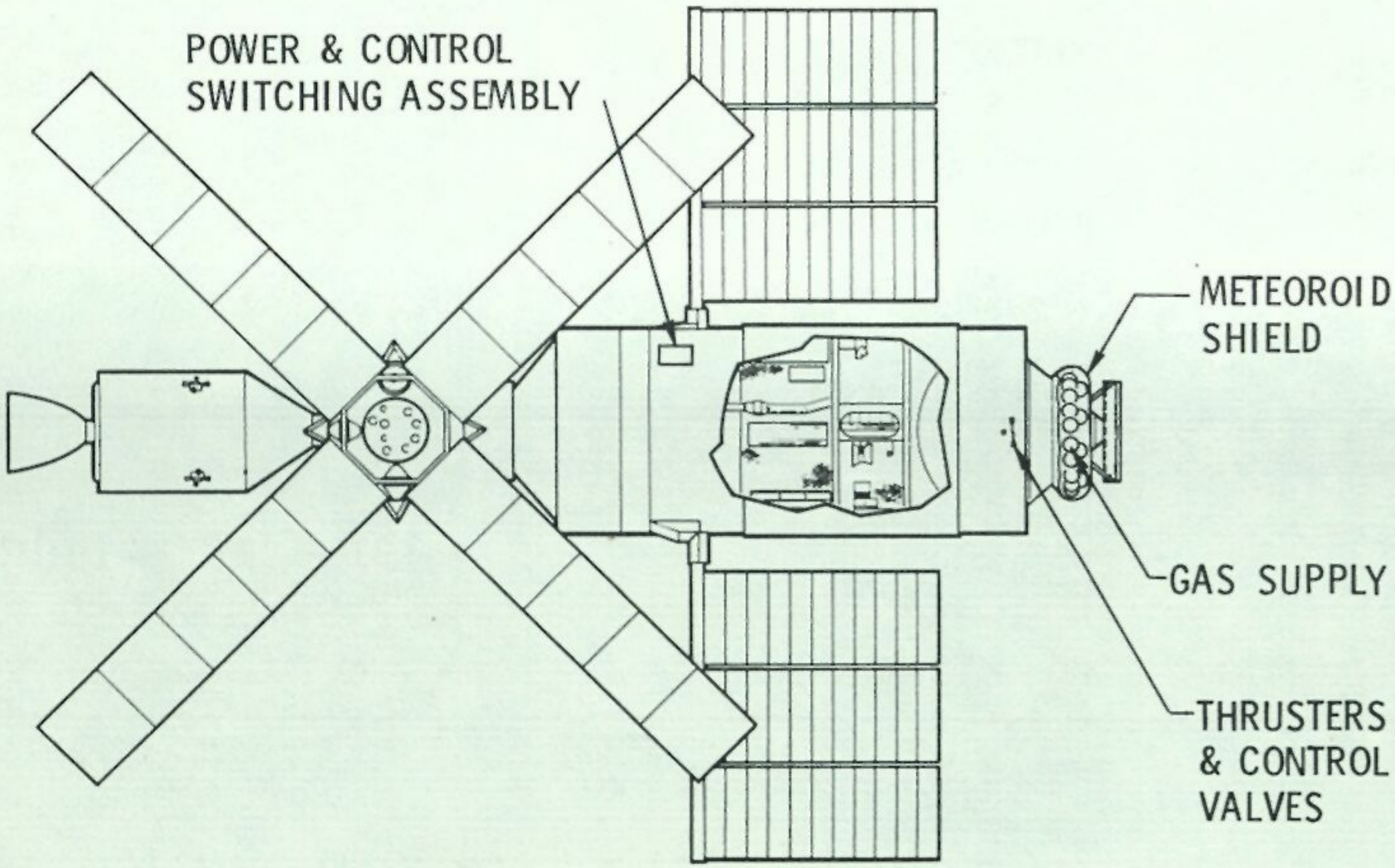
ORBITAL WORKSHOP
TACS-SYSTEM CONFIGURATION

O/W-3982B
8–25–70



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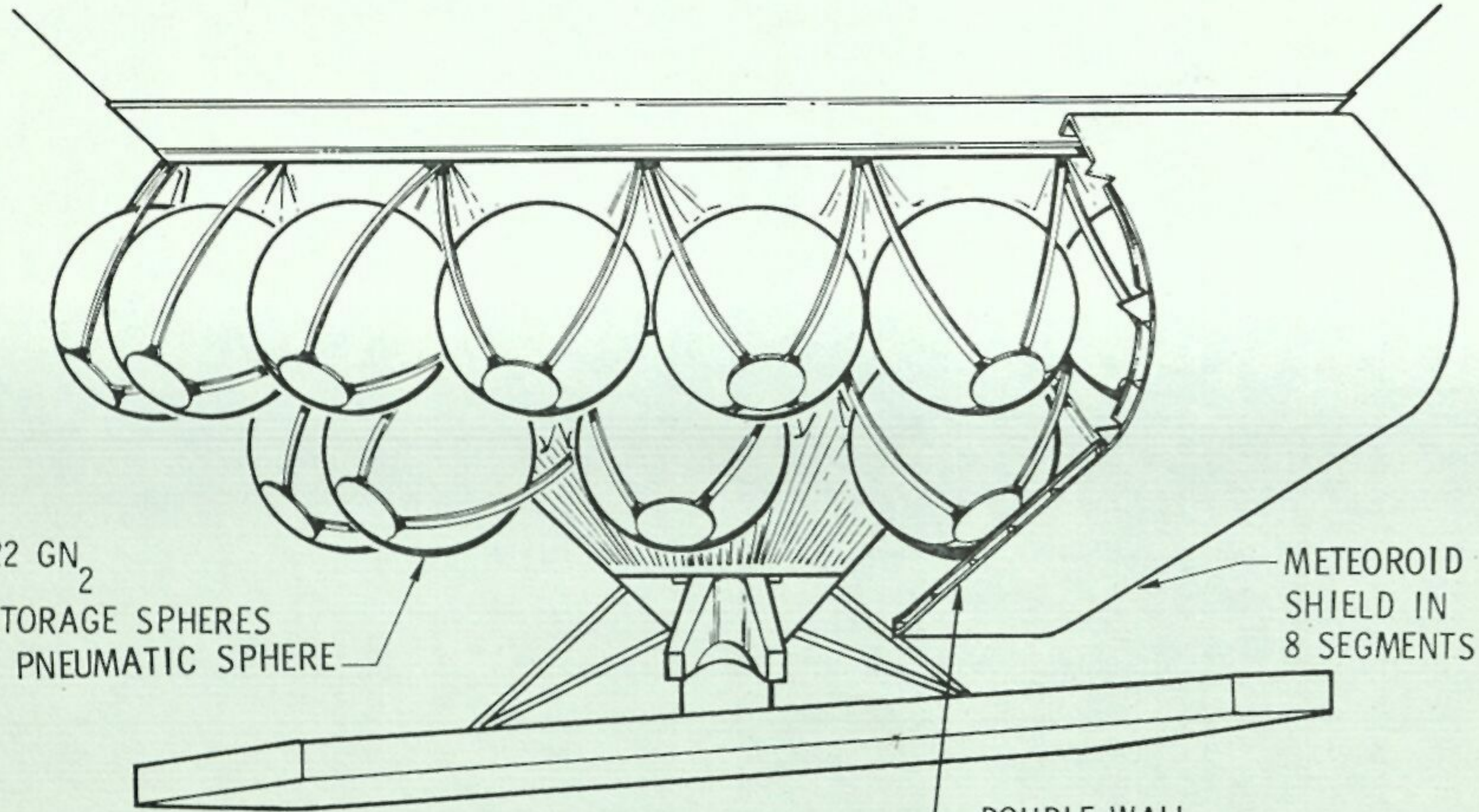
TACS SPHERES AND METEOROID SHIELD INSTALLATION

O/W-5730
9–11–70



Thruster Control

Propellant is supplied to each of the six nozzles in the two thruster modules by quad redundant solenoid control valves. A control switching assembly provides for valve actuation on command from either the IU, or DCS. The Control Switching Assembly (CSA) is located in the OWS forward skirt, and provides isolation from other on-board electrical and electronic systems to minimize detrimental influence of these systems on the reliability of the TACS.

Thrusters

Six stainless steel nozzles, with their associated control valve packages, are mounted in two thruster modules of three thrusters each. The modules are located 180 degrees from each other on the OWS aft skirt, and provide 20 to 50 pounds of thrust from each nozzle. The nozzles point directly out and 90 degrees to either side of a plane dividing the OWS longitudinally.

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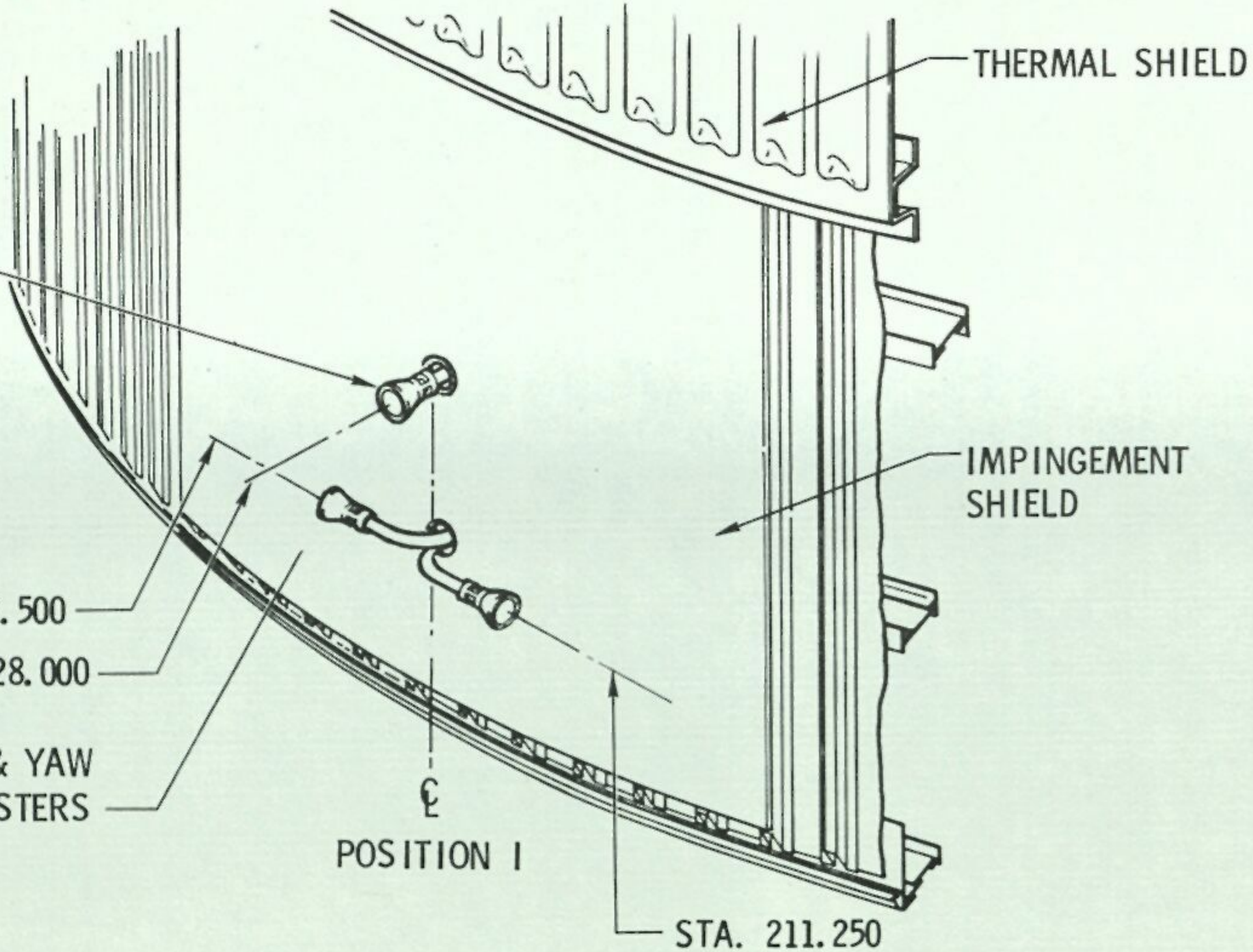
ORBITAL WORKSHOP
TACS-AFT SKIRT-EXTERNAL VIEW

O/W-3986
9–2–70



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.01°/sec man rate CMG capability

Data Acquisition System (DAS)

The OWS data acquisition system provides for the collection of experimental, housekeeping, crew and OWS systems status data for transmission to the ground.

The OWS data acquisition system is divided into telemetry, on-board display, and manual data sections.

Telemetry

OWS telemetry consists of transducers, signal conditioning modules, and transducer power supplies, as well as high and low-level multiplexers. A Remote Automatic Calibration System (RACS) is provided for ground checkout of the OWS telemetry system.

The transducers convert physical phenomena into electrical signals that are routed to signal conditioners or multiplexers. Transducer power is derived from the airlock module, as is power for the multiplexers. The control signals, which are sent to the multiplexers for gating are also from the airlock module. The transmitters, receivers, and controls for the data link with the Manned Spaceflight Network (MSFN) are located in the airlock module, and it is to these items of equipment that the various data gathered in the OWS are routed.

Multiplexers accept analog and bilevel signals for a total of 450 channels of data. The Remote Automatic Calibration System (RACS) is designed to allow ground checkout of the OWS signal conditioning modules by supplying stimuli to the electronics which results in 0, 20, or 80 percent of full scale output, for the selected channel. No provisions exist for inflight calibration.

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ORBITAL WORKSHOP
DATA ACQUISITION SUBSYSTEM

SA-289
12-2-70

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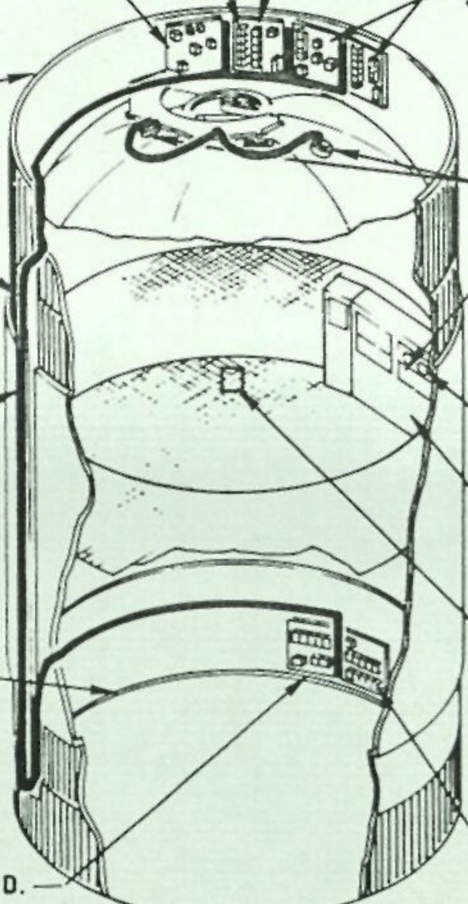

REQUIREMENTS

GEMINI TYPE MULTIPLEXERS
- LOW LEVEL (7 REQ'D)
- HIGH LEVEL (5 REQ'D)

SIGNAL CONDITIONING MODULES
- TEMPERATURE BRIDGES
- 5 VDC EXCITATION MODULES (9 REQ'D)
- DC AMPLIFIERS

TRANSDUCERS

REMOTE CALIBRATION
- CENTRAL DECODER (1 REQ'D)
- CHANNEL DECODERS (15 REQ'D)

THERMAL CONDITIONING - MULTIPLEXERS
- HEATERS
- THERMOSTATS

SYSTEM OPERATION

LOW LEVEL MULTIPLEXERS
- SAMPLE RATE 1.25 SPS, 0.416 SPS
- INPUT 0-20 MVDC, OUTPUT 0-5 VDC

HIGH LEVEL MULTIPLEXERS
- SAMPLE RATE - 1.25 SPS (ANALOG), 10 SPS (BI-LEVEL, BI-LEVEL PULSE)
- INPUT - BI-LEVEL $<$ 5 VDC OFF, $>$ 15 VDC ON

On-Board Display

The OWS data acquisition system includes on-board displays which provide crew members with selected system status and caution and warning information. These data are displayed to the crew on various panels and consoles located in the forward compartment, experiment compartment, wardroom, and waste management compartment. The OWS on-board instrumentation for meters and annunciators located in these panels is separate from that used for telemetry.

Manual Data

In addition to the data gathered automatically by Electronics, there is a requirement for additional data which can be met only by crew action. The manual data section of the OWS data acquisition system provides for the gathering of these data. Log books, and use of recorders, television, and photography equipment furnished with experiment and other systems constitute the manual data gathering activities which meet the additional data requirement.

Communication System

The OWS communication system consists of the telecommunications subsystem, the intercommunications subsystem, the caution and warning subsystem, and television. The communication system provides the following capabilities:

- o Interface with the OA audio system providing the OWS with a direct voice link with the MSFN. (Voice communication is via the CSM.)
- o Interface the astronauts with the airlock module telemetry system for biomedical data transmission to the MSFN.
- o Intercommunication provisions throughout the orbital assembly.
- o Provision of a video link from the OWS to the CSM for television transmissions originating in the OWS.

Telecommunication Subsystem

The telecommunication subsystem is an extension of the cluster communications system provided by the Speaker Intercom Assemblies (SIA) located throughout the OWS. The CSM S-band communications system provides the voice link with the MSFN.

Intercommunication Subsystem

The OWS intercommunication subsystem comprises 10 Speaker Intercom Assemblies (SIA) and their associated wiring, and provides dual channel communications. The dual channel capability allows simultaneous transmission of voice and/or biomedical data from two astronauts to the MSFN. Conversation can be carried on via headsets, or the speaker/microphone at any SIA.

The SIA are located aboard the OWS as follows:

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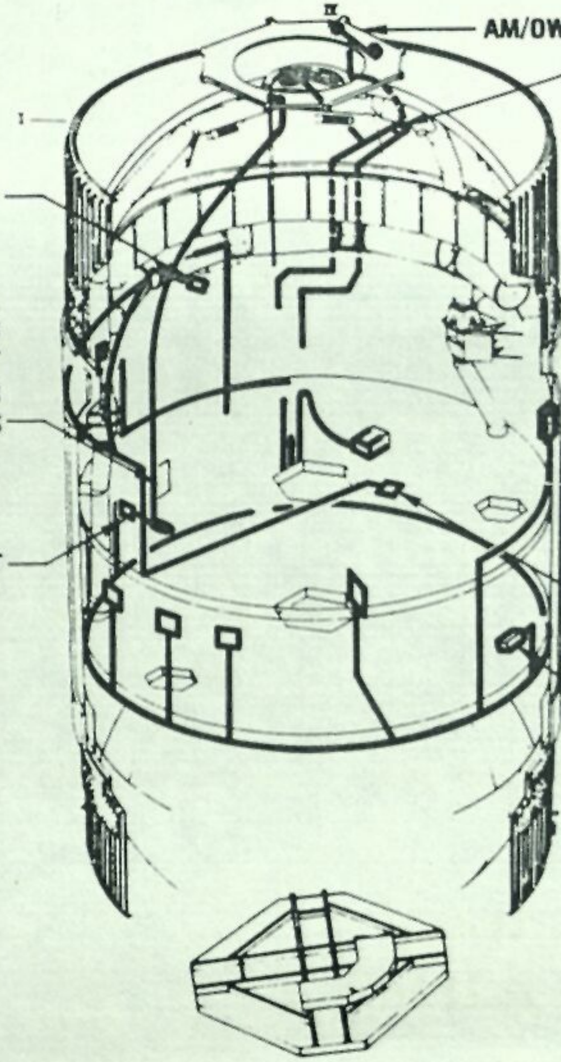
ORBITAL WORKSHOP COMMUNICATION SYSTEM

SA-297
12-2-70



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REQUIREMENTS

PROVIDE ASTRONAUT COMMUNICATIONS WITHIN CLUSTER

PROVIDE COMMUNICATIONS BETWEEN FLIGHT CREW AND GROUND CONTROL

UTILIZE DUAL CHANNEL SYSTEM

PROVIDE DATA INTERFACE FOR BIO-MED FUNCTIONS

PROVIDE AUDIO DEVICE FOR CAUTION AND WARNING TONES

PROVIDE ACCOMMODATIONS FOR TV CAMERA

SYSTEM OPERATION

CREWMANS COMMUNICATIONS UMBILICAL MAY BE CONNECTED TO CHANNEL A OR B

PUSH-TO-TALK OR PUSH-TO-TRANSMIT IS SELECTED

VOICE TAPE RECORDER MAY BE SELECTED

DISPLAY ON SPEAKER INTERCOM ASSEMBLY INFORMS ASTRONAUT OF VOICE RECORDER OPERATION

BIO-MED DATA IS AVAILABLE THROUGH THE CCU CABLE

TV CAMERA CAN BE OPERATED IN CREW QUARTERS OR IN FORWARD COMPARTMENT

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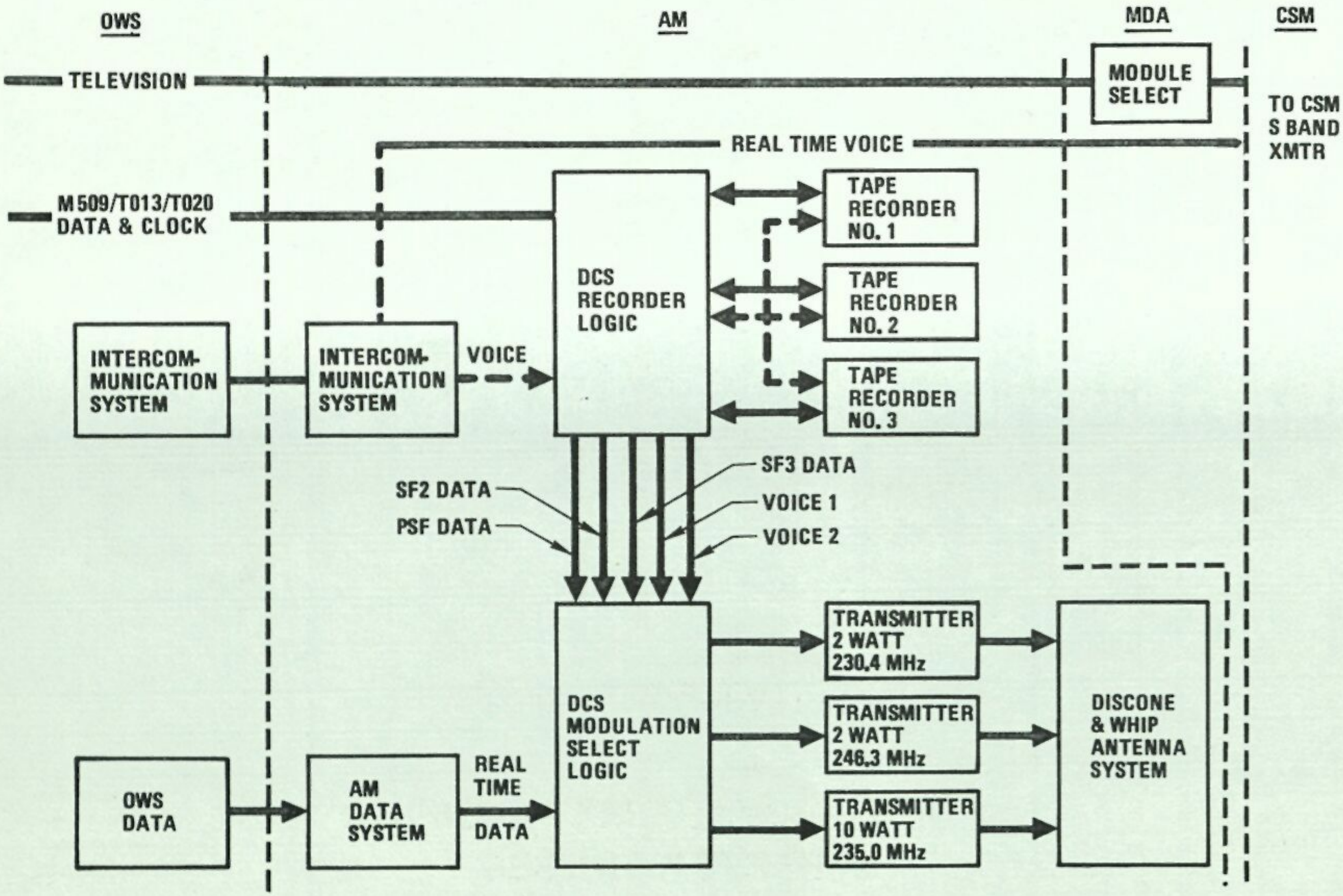
ORBITAL WORKSHOP COMMUNICATION

O/W-4347
5–26–70



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ORBITAL WORKSHOP
INTERCOMMUNICATIONS STATIONS

O/W-1375B
9–8–70

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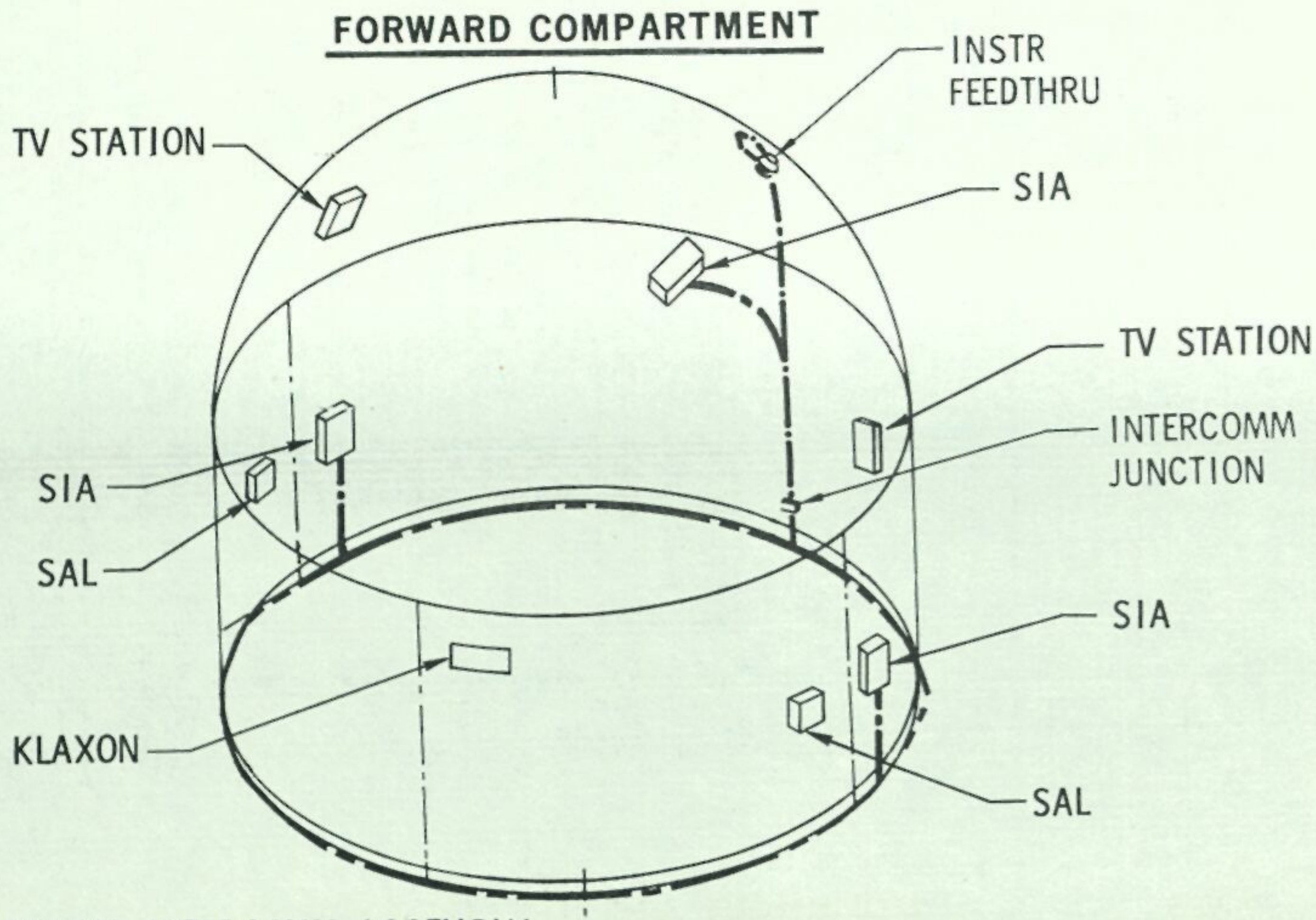

SIA SPEAKER INTERCOMM ASSEMBLY

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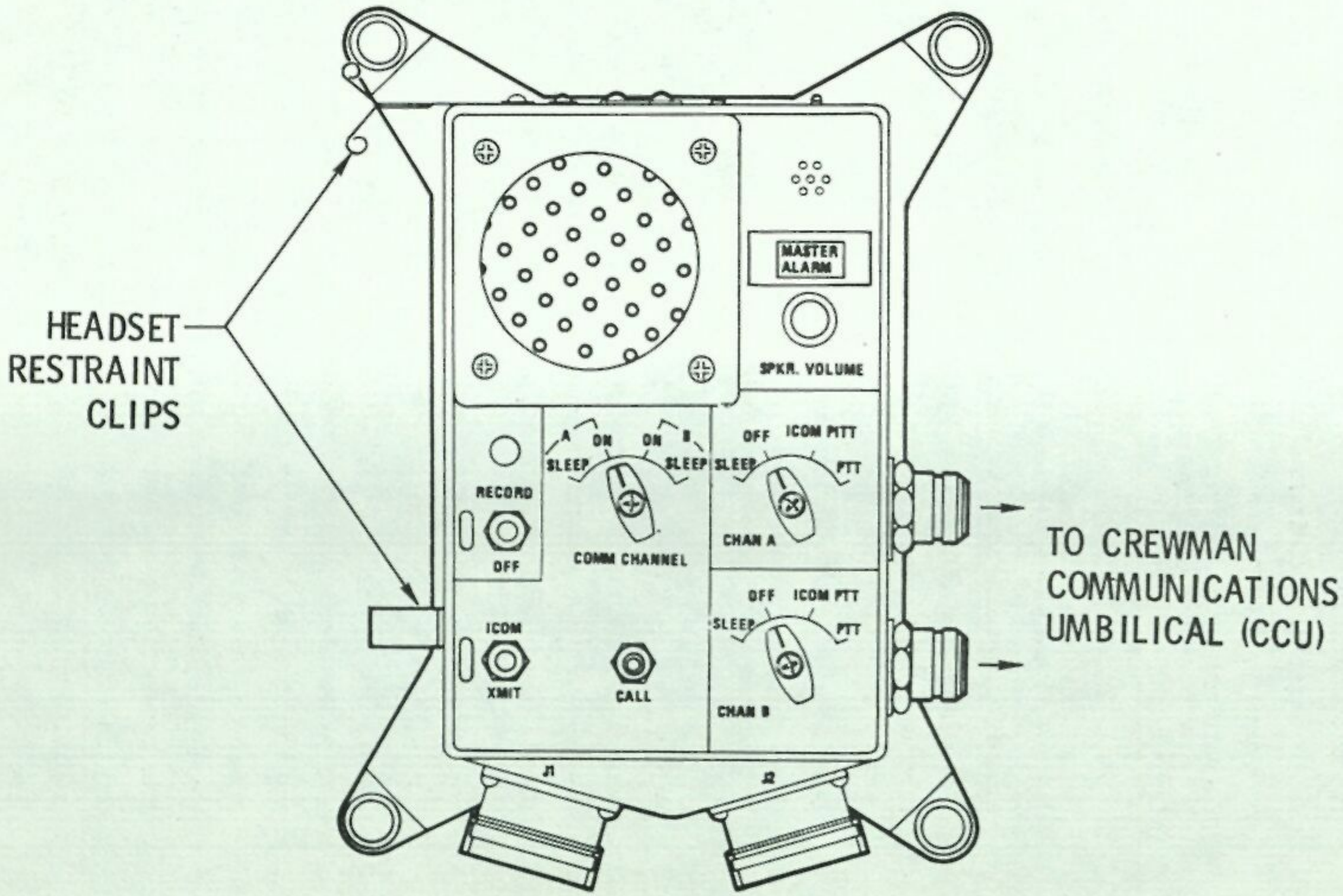
ORBITAL WORKSHOP
SPEAKER INTERCOM ASSEMBLY

O/W-1151A
9–9–70



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SIA LOCATION	QUANTITY
Sleep compartment	3
Waste management compartment	1
Experiment compartment	2
Forward compartment	3
Wardroom	1
Total	10

The Crew Communication Umbilicals (CCU) interface with the SIA, allowing crew communication capabilities while suited for IVA. The master alarm light, as well as caution and warning tones are provided for by the SIA.

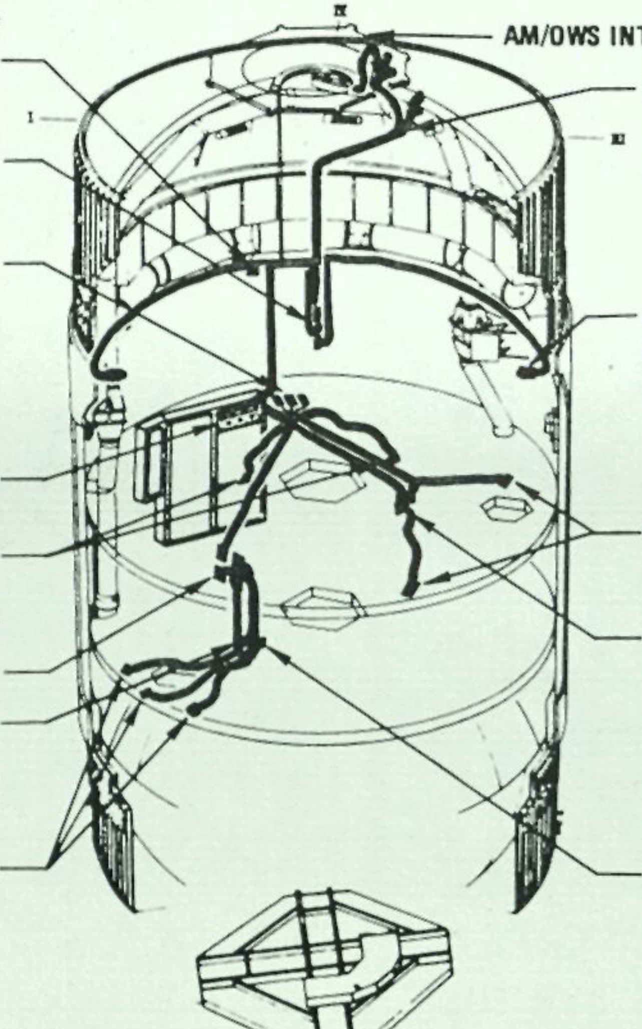
Caution and Warning Subsystem

The caution and warning subsystem provides for the alerting of crewmen to impending or existing conditions that are hazardous to crew safety or completion of mission requirements. The OWS caution and warning subsystem is an extension of the AM Caution and Warning System (CWS), and consists of the repeater CWS control and display panel, alarm devices (Klaxons and SIA), and associated wiring.

The repeater control and display panel provides the annunciators for emergency, caution, and warning parameters with redundant panel lamps. Red lamps are provided for emergency and warning indications, and yellow lamps for caution indications. Emergencies consist mainly of fire, or rapid pressure fall. Warnings indicate low bus power or crew alert, and caution indications include low cluster pressure. Malfunction indicators are included on the panel to show the cause of the malfunction which caused the alarm. These indicators remain lighted even when the alarm light and tone has been reset. The audible tones indicating emergency, warning, or caution conditions are routed to the SIA and crew headsets while in the "ON" mode of operation. A "crew alert" ground command will override "off" or "sleep" modes.

ORBITAL WORKSHOP
CAUTION AND WARNING SYSTEM

SA-293
12-2-70



REQUIREMENTS

REDUNDANT SYSTEM

CONTROL AND DISPLAY PANEL

EMERGENCY ALARM

CAUTION AND WARNING SIGNALS TO AM

EMERGENCY SIGNALS TO AM

FIRE DETECTION SYSTEM

MASTER RESET

SYSTEM OPERATION

CAUTION, WARNING AND EMERGENCY PARAMETERS MONITORED IN OWS

PARAMETERS ARE ROUTED TO AM

AM LOGIC RECOGNIZES ALARM CONDITIONS

AM TRANSMITS CAUTION, WARNING AND EMERGENCY INDICATIONS TO OWS

AUDIO AND VISUAL DISPLAYS INDICATE CAUTION, WARNING AND EMERGENCY CONDITIONS

EMERGENCY INDICATORS ARE EXTINGUISHED WHEN CONDITION IS CORRECTED

MASTER RESET TURNS OFF ALL CAUTION AND WARNING INDICATORS

FIRE DETECTION SYSTEM UTILIZES INDIVIDUAL CONTROL PANELS

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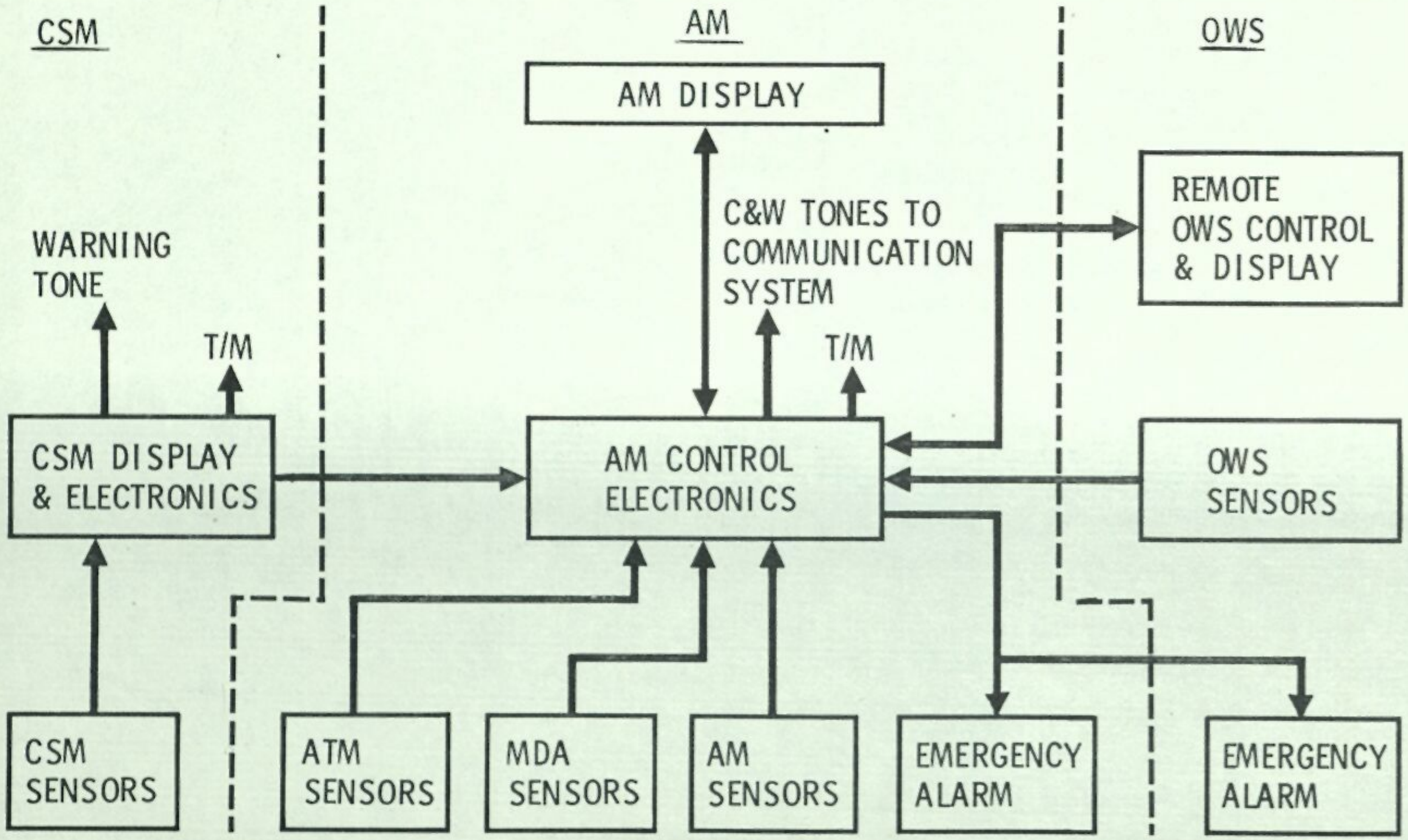
ORBITAL WORKSHOP CAUTION AND WARNING SYSTEM

O/W-7363
8-25-70



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Television

The television subsystem is an extension of the cluster television system for coverage of crew activities, equipment operation, and experimental activity in the OWS. The OWS television provisions allow the operation of an Apollo color television camera and monitor unit. Mounting and power provisions are included in the OWS as well as provisions for routing the coaxial cable which interfaces with the CSM video system for S-band transmission to the MSFN.

SKYLAB NOMENCLATURE

ACS	- Atmosphere control system
AM	- Airlock module
AME	- Astronaut maneuvering equipment
APCS	- Attitude and pointing control system
ASMU	- Automatically stabilized maneuvering unit
ATM	- Apollo telescope mount
biomed	- Biomedical
BL	- Bilevel
BLP	- Bilevel pulse
BMMD	- Body mass measurement device
CCU	- Crewman communications umbilical
C&D	- Control and display
CDF	- Confined detonating fuse
CM	- Command module
CMG	- Control moment gyros
Comm	- Communication
CSM	- Command and service module
dc	- Direct current
DCS	- Digital command system
EBW	- Exploding bridge wire
ECS	- Environmental control system
EPS	- Electrical power system
ER	- Earth resources
EREP	- Earth resources experiment package
ESS	- Experiment support system
EVA	- Extravehicular activity
FAS	- Fixed airlock shroud
FCMU	- Foot controlled maneuvering unit
FM	- Frequency modulation
GN_2	- Gaseous nitrogen
GO_2	- Gaseous oxygen
hpi	- High performance insulation
HSS	- Habitability support system

Hz	- Hertz
icom	- Intercom
IOP	- In orbit plane
IU	- Instrument unit
IVA	- Intravehicular activity
KSC	- Kennedy Space Center
LBNP	- Lower body negative pressure
LiOH	- Lithium hydroxide
LV	- Launch vehicle
LVDC	- Launch vehicle digital computer
MDA	- Multiple docking adapter
MDF	- Mild detonating fuse
mHz	- Mega-Hertz
mol	- Molecular
MSC	- Manned Spacecraft Center
MSFC	- George C. Marshall Space Flight Center
MSFN	- Manned spaceflight network
N_2	- Nitrogen
NASA	- National Aeronautics and Space Administration
NI-CD	- Nickel-cadmium
NPV	- Non-propulsive vent
O_2	- Oxygen
OA	- Orbital assembly (CSM/OAM/ATM)-(CSM/SWS)(CSM/ATM/MDA/AM/OWS)
OAM	- Orbital assembly module (OWS/AM/MDA)
OWS	- Orbital workshop
PCM	- Pulse code modulation
PCS	- Pressure control system
PS	- Payload shroud
psia	- Pounds per square inch absolute
ptt	- Press to transmit
RS	- Refrigeration system
SAL	- Scientific airlock
SAS	- Solar array system
SIA	- Speaker intercom assembly
S-IVB	- Saturn IVB "stage"
Skylab	- To be used synonymously with "SWS"

SL	- Skylab (program designation)
SL-1	- Skylab (mission designation)
SL-I	- Skylab (ATM/MDA/AM/OWS) (Spacecraft designation)
SLA	- Spacecraft launch adapter
SMMD	- Specimen mass measurement device
STS	- Structural transition section
SWS	- Saturn workship (ATM/MDA/AM/OWS) = (ATM/OAM)
TACS	- Thruster attitude control system
TCS	- Thermal control system
tlm	- Telemetry
TV	- Television
VCG	- Vectrocardiogram
VCS	- Ventilation control system
vdc	- Volts direct current
WMC	- Waste management compartment
WMS	- Waste management system
xducer	- Transducer
xfer	- Transfer

REFERENCES

For more detailed information concerning the Skylab Mission, Skylab and Orbital Workshop Systems, the reader is referred to the following documents:

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