

— ROBINSON —



APOLLO TRAINING

APOLLO SPACECRAFT & SYSTEMS  
FAMILIARIZATION

COURSE NUMBER  
APC-118

AUGUST 15, 1967

FOR TRAINING PURPOSES ONLY





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QUESTIONS RELATIVE TO THE CONTENTS OF THIS  
DOCUMENT SHOULD BE DIRECTED TO:

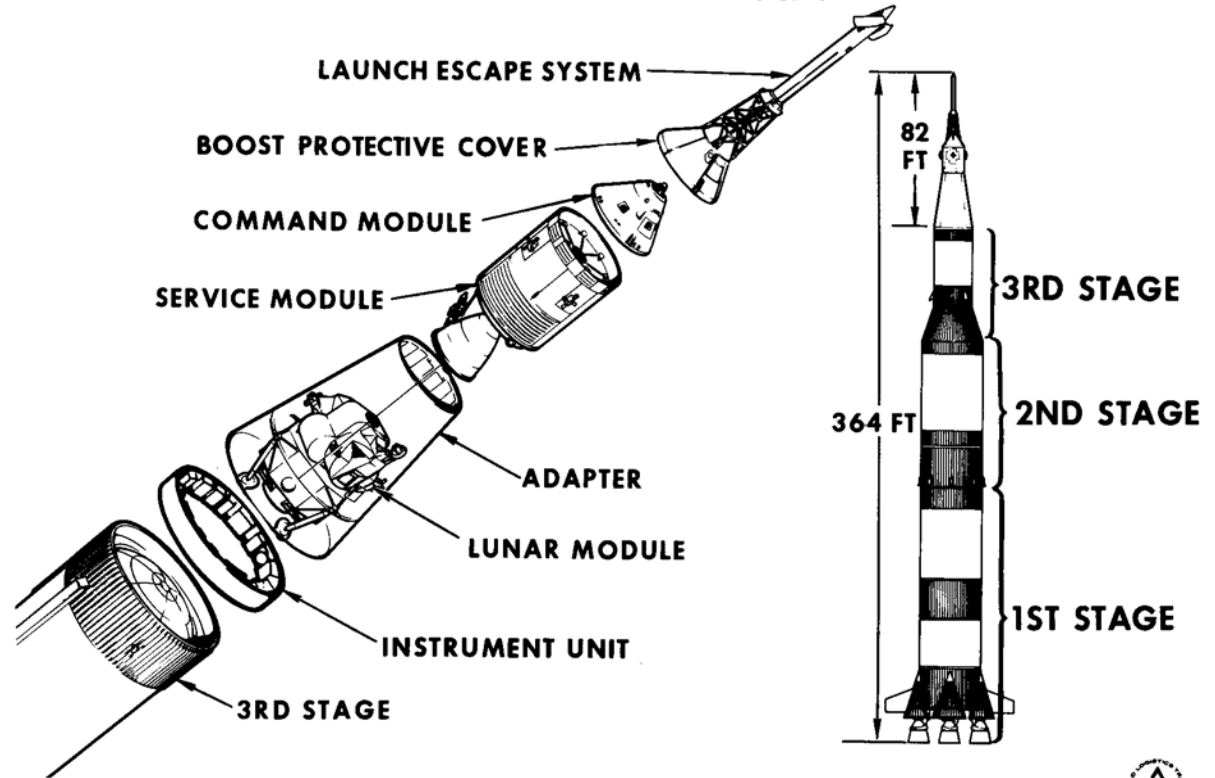
S.I. JIMENEZ  
B.C. GROVER  
NAA, SPACE DIVISION  
DOWNEY, CALIFORNIA  
EXTENSION 4325,6 OR 7

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# APOLLO SPACECRAFT



## NAA APOLLO SUBCONTRACTORS (CONT)

SYSTEM/COMPONENTS

CONTRACTOR

PROPULSION

CM REACTION CONTROL ENGINES.....ROCKETDYNE DIV OF NAA - CANOGA PARK, CALIF.  
 SM REACTION CONTROL ENGINES..... MARQUARDT CORP - VAN NUYS, CALIF.  
 POSITIVE EXPULSION TANKS (RCS).....BELL AEROSYSTEMS - BUFFALO, N.Y.  
 HELIUM TANKS.....AIRITE PRODUCTS - LOS ANGELES, CALIF.  
 FUEL & OXIDIZER TANKS (SPS)..... ALLISON DIV OF GMC - INDIANAPOLIS, IND.  
 PROPELLANT GAGING & MIXTURE RATIO CONTROL..... SIMMONDS PRECISION PROD - TARRYTOWN, N.Y.  
 SERVICE PROPULSION ENGINE..... AEROJET GENERAL - SACRAMENTO, CALIF.

COMMUNICATIONS & DATA.....COLLINS RADIO CO.-CEDAR RAPIDS, IOWA

BEACON ANTENNA (R&D).....MELPAR - FALLS CHURCH, VA.  
 C-BAND ANTENNA.....RADCOM - COLLEGE PARK, MD.  
 CENTRAL TIMING SYSTEM.....GENERAL TIME - ROLLING MEADOWS, ILL.  
 HF ANTENNAS (RECOVERY & ORBITAL).....DEHAVILLAND - ONTARIO, CANADA  
 DIGITAL UP-DATA LINK.....MOTOROLA, INC. - SCOTTSDALE, ARIZ.  
 VHF ANTENNA..... LOS ANGELES DIV OF NAA - INGLEWOOD, CALIF.  
 TV CAMERA.....RCA - PRINCETON, N.J.  
 2 KMC HI GAIN ANTENNA.....DALMO - VICTOR - BELMONT, CALIF.

MISSION SIMULATOR TRAINER..... GIP - LINK DIV - BINGHAMTON, N.Y.

SYSTEMS INTEGRATED TEST EQUIPMENT..... AUTONETICS DIV OF NAA - ANAHEIM, CALIF.

# NAA APOLLO SUBCONTRACTORS

## SYSTEM/COMPONENTS

## CONTRACTOR

### STRUCTURES

ABLATIVE MATERIAL FOR HEAT SHIELD.....AVCO CORP-WILMINGTON, MASS.  
BOOST COVER, LES TOWER, DOCKING PROBE, CANARDS  
RADIAL BEAMS, FWD HEAT SHIELD & CREW COUCHES ..... LOS ANGELES DIV OF NAA - INGLEWOOD, CALIF.  
STAINLESS STEEL HONEY COMB PANELS ..... AERONCA MFG CO - MIDDLETOWN, OHIO

### ELECTRICAL POWER

BATTERIES ("A", "B" & "C").....EAGLE PICHER - JOPLIN, MO.  
BATTERY CHARGER.....ITT - INDUSTRIAL PRODUCTS DIV - SAN FERNANDO, CALIF.  
FUEL CELL MODULES.....PRATT & WHITNEY - EAST HARTFORD, CONN.  
STATIC INVERTERS .....WESTINGHOUSE ELECTRIC CORP - LIMA, OHIO  
CRYOGENIC GAS STORAGE.....BEECH AIRCRAFT - BOULDER, COLO.

ENVIRONMENTAL CONTROL ..... AIRESEARCH MFG CO - LOS ANGELES, CALIF.

### SEQUENTIAL EVENTS CONTROL

MASTER EVENT SEQUENCE CONTROLLER..... AUTONETICS DIV OF NAA - ANAHIEM, CALIF.  
LAUNCH ESCAPE & PITCH CONTROL MOTORS ..... LOCKHEED PROPULSION CO - REDLANDS, CALIF.  
TOWER JETTISON MOTOR ..... THIOKOL CHEMICAL CORP - ELKTON, MD.  
EARTH LANDING PARACHUTE SUBSYSTEM ..... NORTHROP - VENTURA - NEWBERRY PARK, CALIF.

STABILIZATION & CONTROL.....HONEYWELL CORP - MINNEAPOLIS, MINN.

## NAA APOLLO SUBCONTRACTORS (CONT)

SYSTEM/COMPONENTS

CONTRACTOR

PROPULSION

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 SERVICE PROPULSION ENGINE.....AEROJET GENERAL - SACRAMENTO, CALIF.

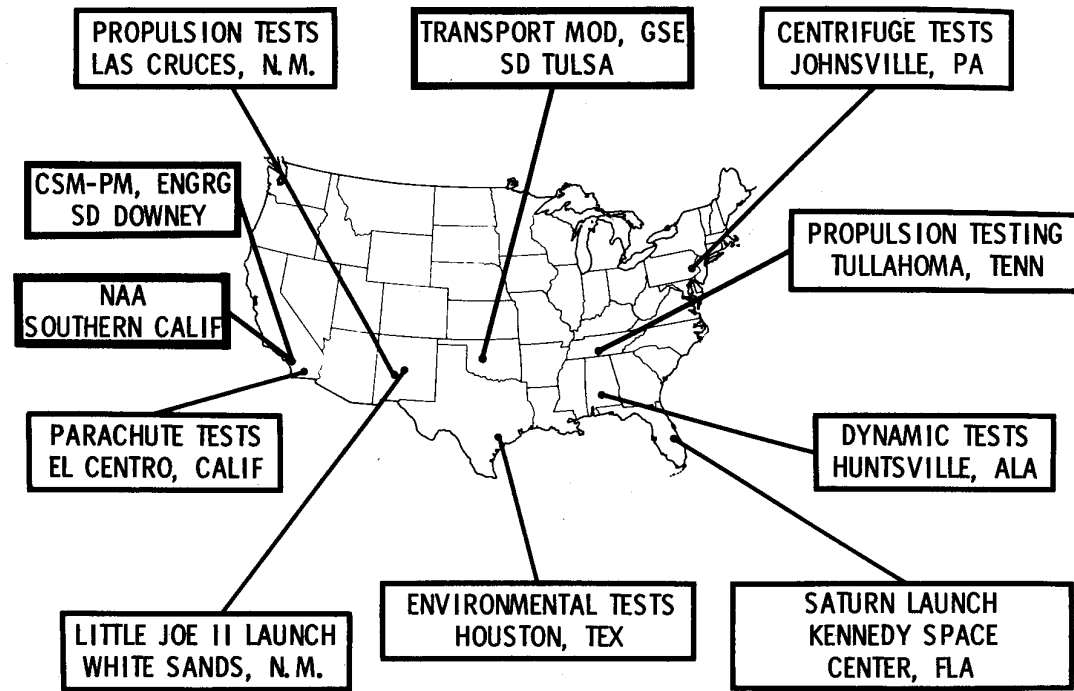
COMMUNICATIONS & DATA.....COLLINS RADIO CO.-CEDAR RAPIDS, IOWA

BEACON ANTENNA (R&D).....MELPAR - FALLS CHURCH, VA.  
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MISSION SIMULATOR TRAINER..... GIP - LINK DIV - BINGHAMTON, N.Y.

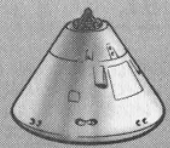
SYSTEMS INTEGRATED TEST EQUIPMENT..... AUTONETICS DIV OF NAA - ANAHEIM, CALIF.

# FACILITIES-NATIONWIDE



# APOLLO SPACECRAFT SPACE DIVISION RESPONSIBILITIES

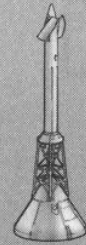
337 AP83067E



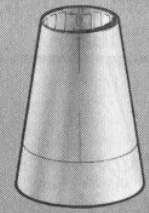
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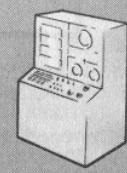
SM



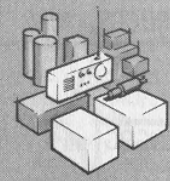
LEM



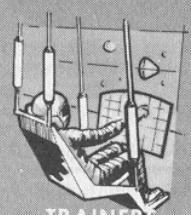
SLA



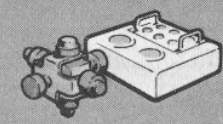
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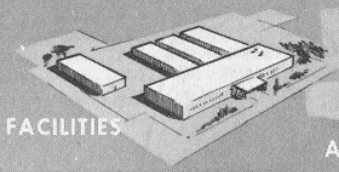
SPARES



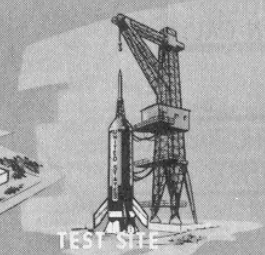
TRAINERS



MAJOR SUBS



FACILITIES



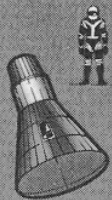
TEST SITE  
ACTIVATION

(NAA ALSO INTERFACES WITH ASSOCIATE CONTRACTORS FOR GUIDANCE & NAVIGATION, ACCEPTANCE CHECKOUT EQUIPMENT, LUNAR MODULE, ETC.)

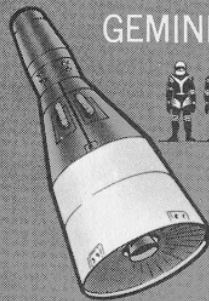
# MANNED SPACECRAFT

S47ASD10175D

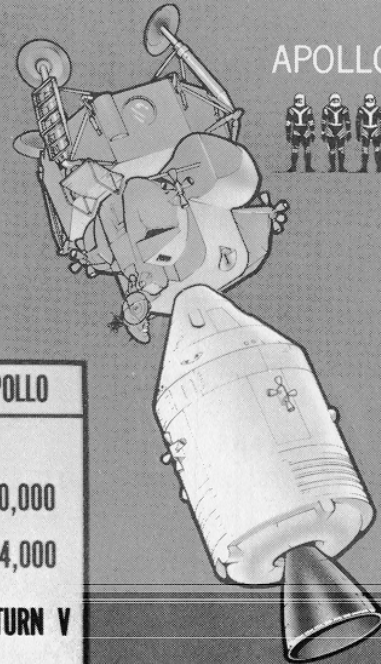
MERCURY



GEMINI

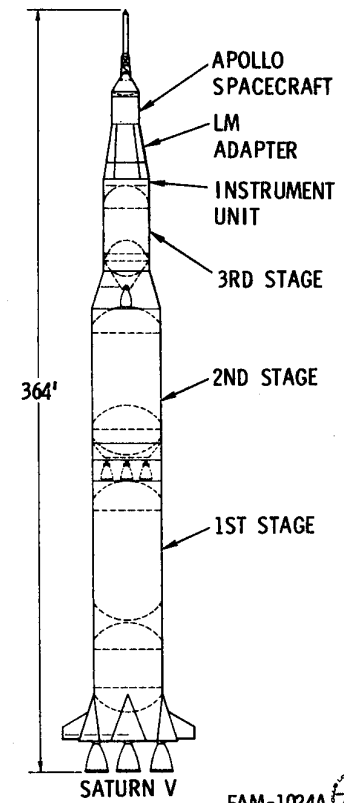
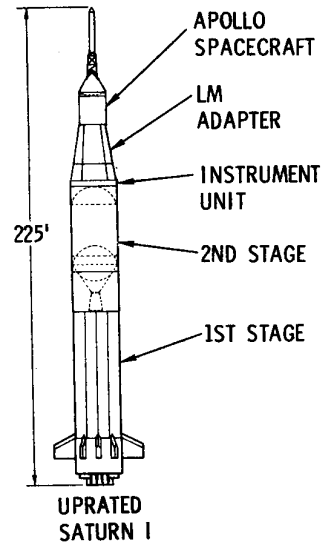



APOLLO



	MERCURY	GEMINI	APOLLO
<b>PAYLOAD, LBS</b>			
EARTH ORBITAL	3,500	7,000	250,000
TRANSLUNAR	—	—	94,000
<b>BOOSTER</b>	<b>ATLAS</b>	<b>TITAN II</b>	<b>SATURN V</b>
<b>THRUST, LBS</b>	360,000	430,000	7,500,000

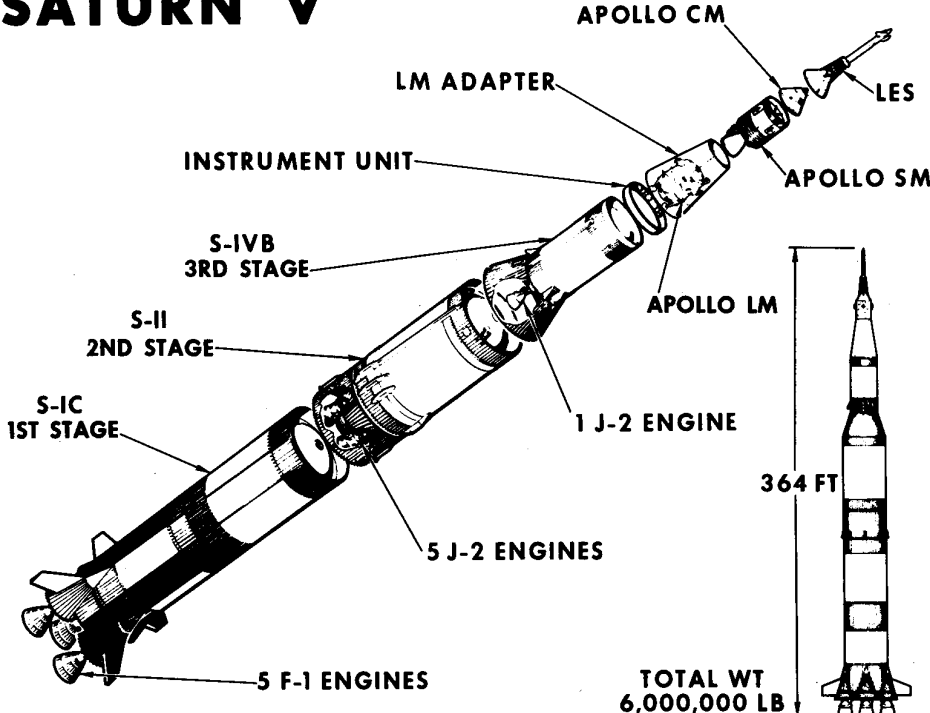
# APOLLO LAUNCH VEHICLES



FAM-1024A 



# SATURN V



APOLLO CM

LM ADAPTER

LES

INSTRUMENT UNIT

APOLLO SM

S-IVB  
3RD STAGE

APOLLO LM

S-II  
2ND STAGE

1 J-2 ENGINE

S-IC  
1ST STAGE

5 J-2 ENGINES

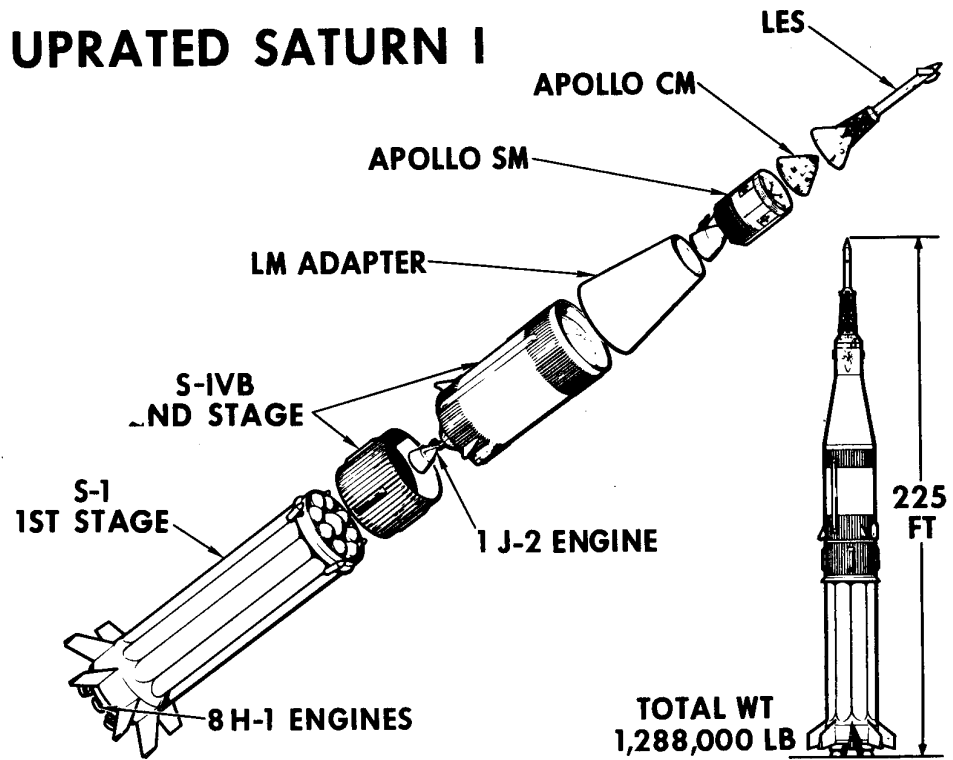
364 FT

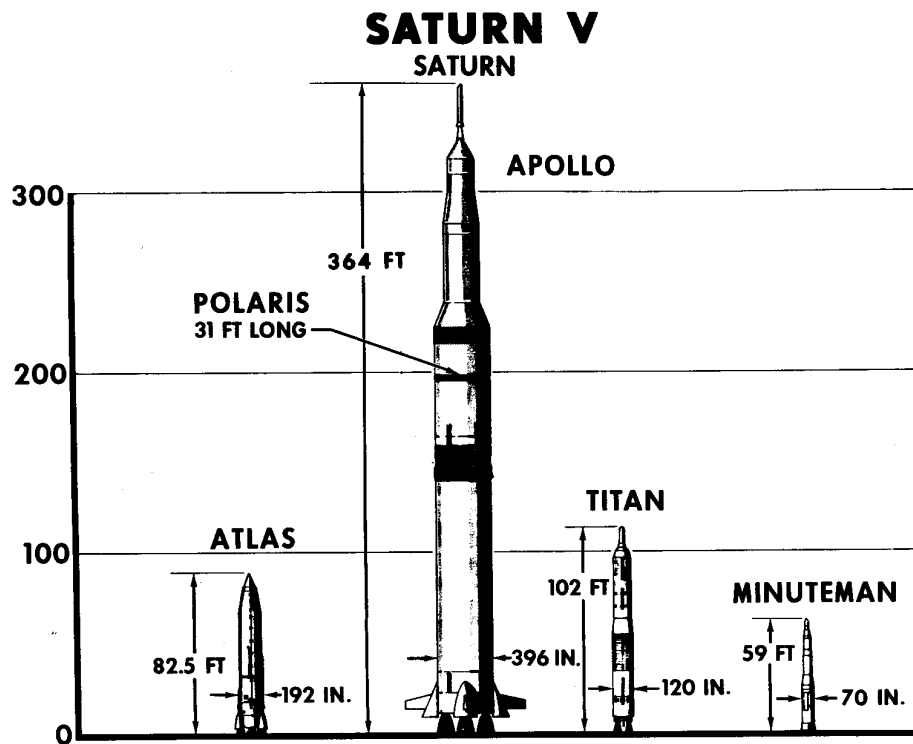
5 F-1 ENGINES

TOTAL WT  
6,000,000 LB

FAM-1026

# UPDATED SATURN I

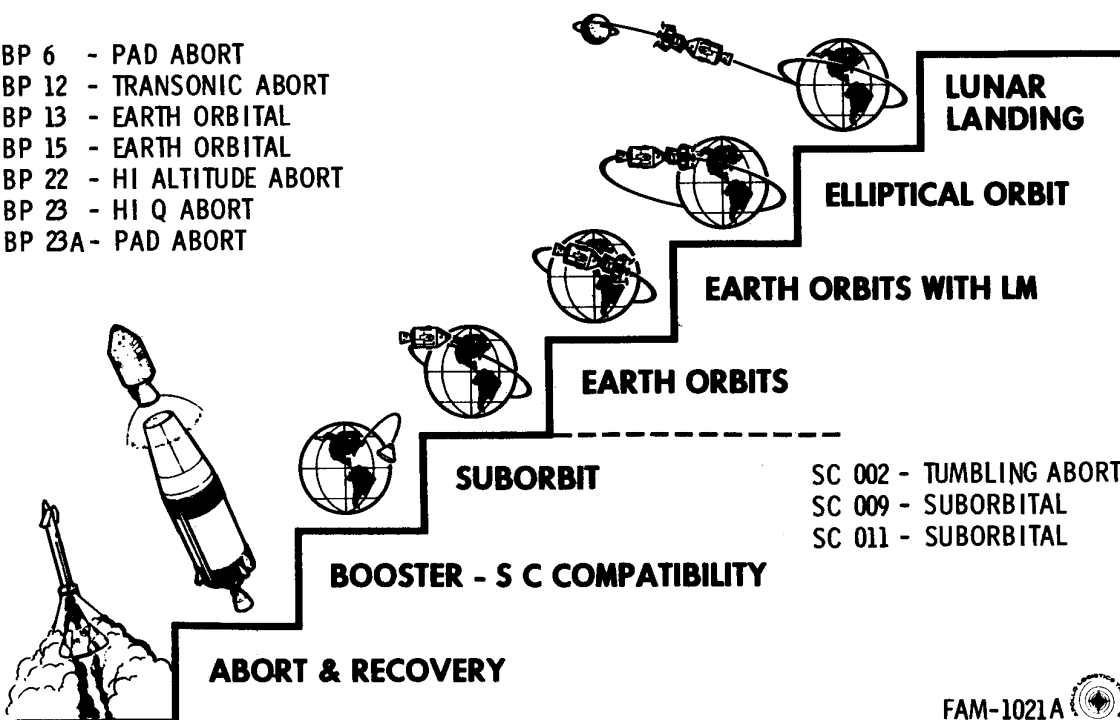




# SPACECRAFT DEVELOPMENT FLIGHT CATEGORIES

## MAJOR STEPS TO ULTIMATE MISSION

- BP 6 - PAD ABORT
- BP 12 - TRANSONIC ABORT
- BP 13 - EARTH ORBITAL
- BP 15 - EARTH ORBITAL
- BP 22 - HI ALTITUDE ABORT
- BP 23 - HI Q ABORT
- BP 23A - PAD ABORT

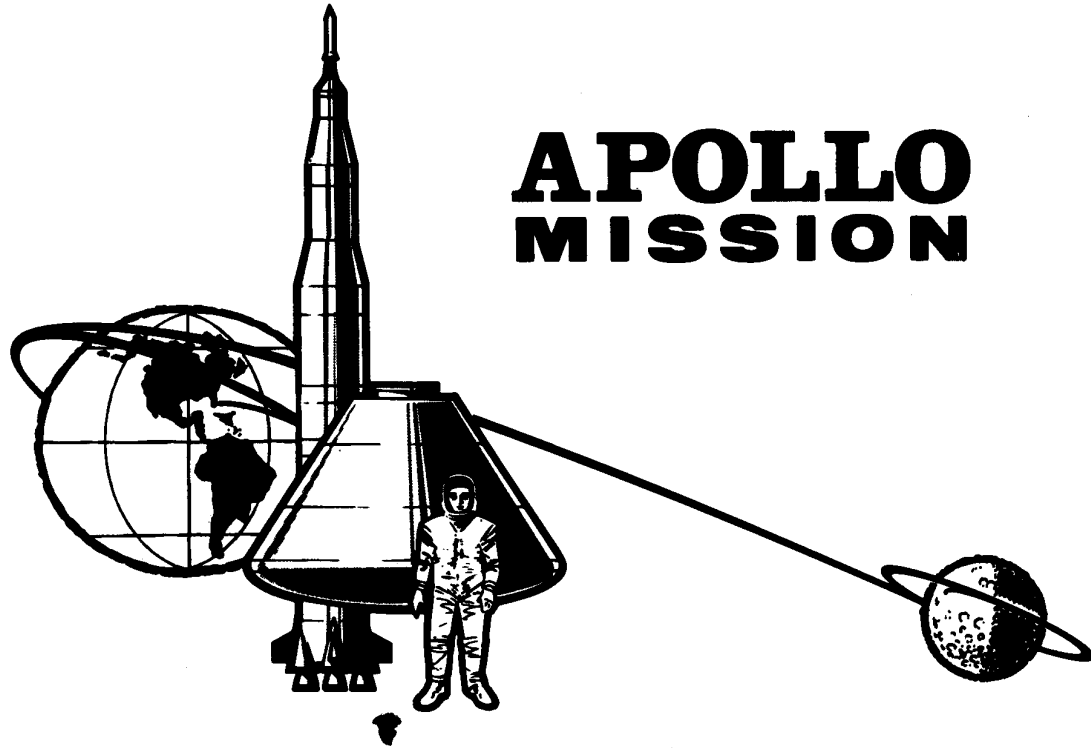


- SC 002 - TUMBLING ABORT
- SC 009 - SUBORBITAL
- SC 011 - SUBORBITAL

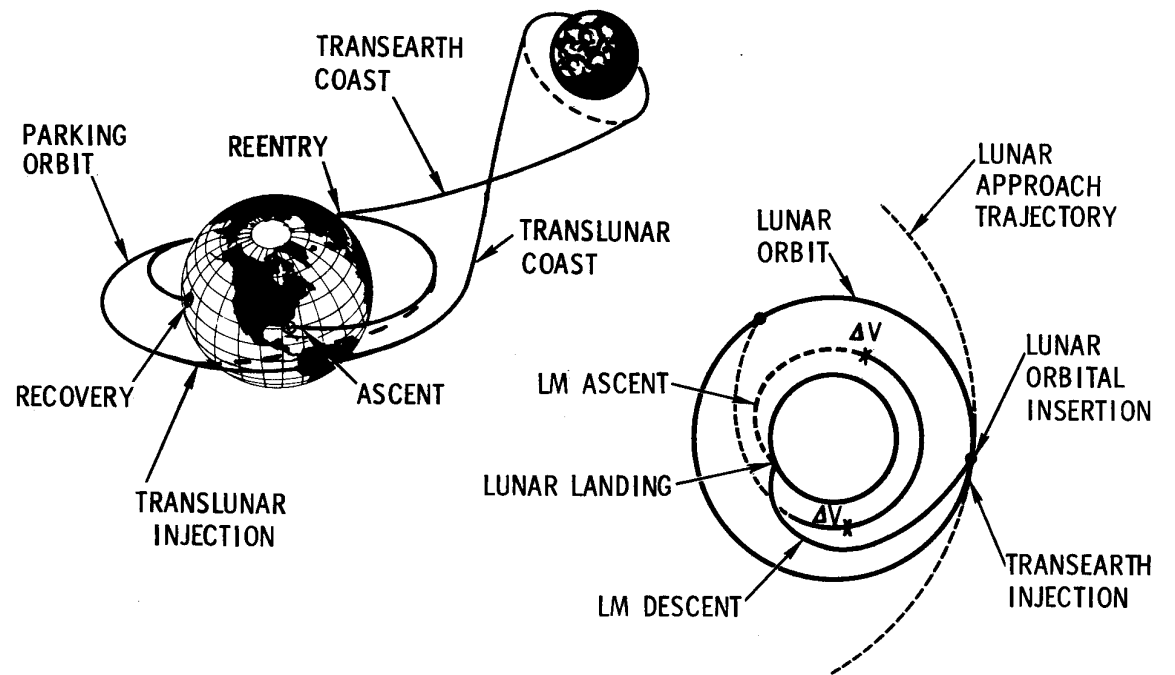
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1

# APOLLO MISSION

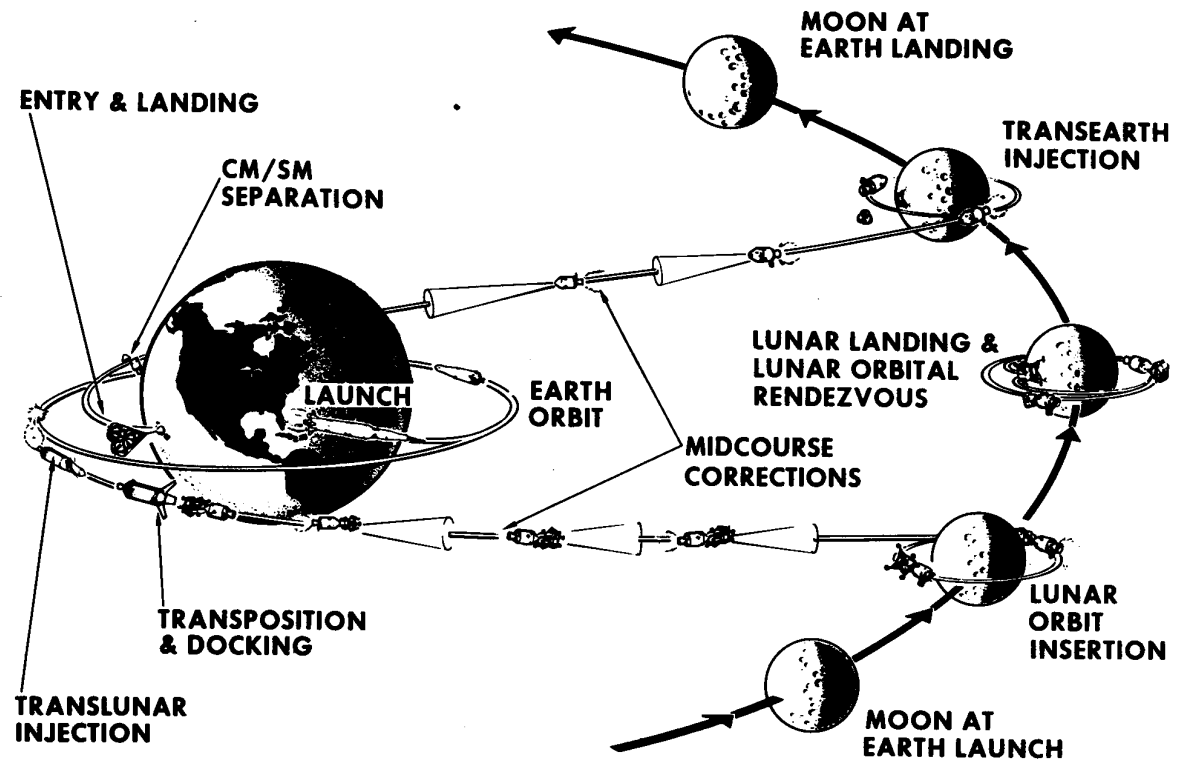


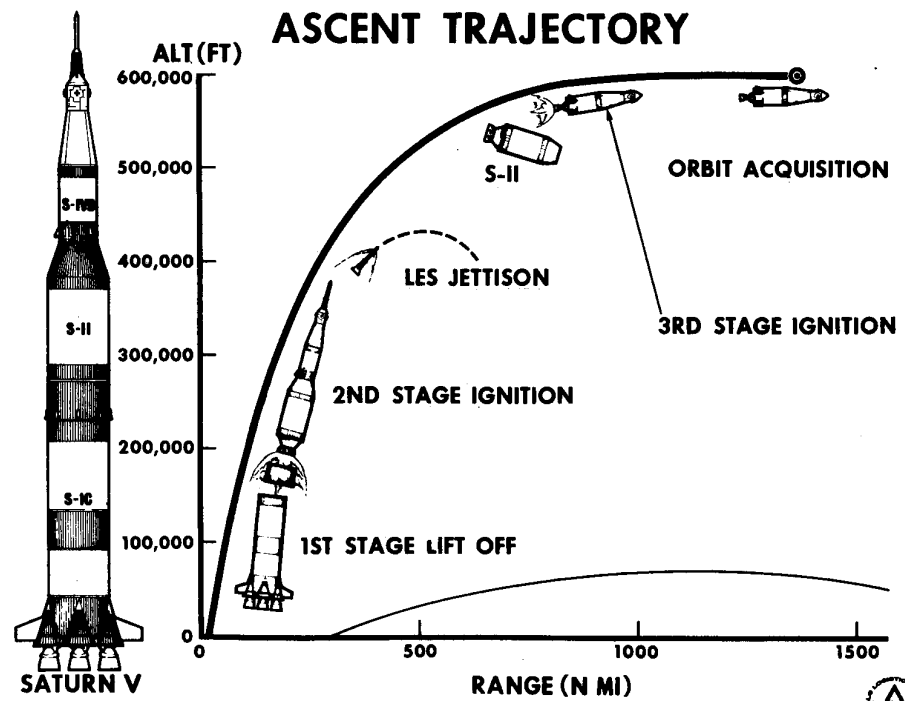
# LUNAR MISSION



# APOLLO MISSION PLAN

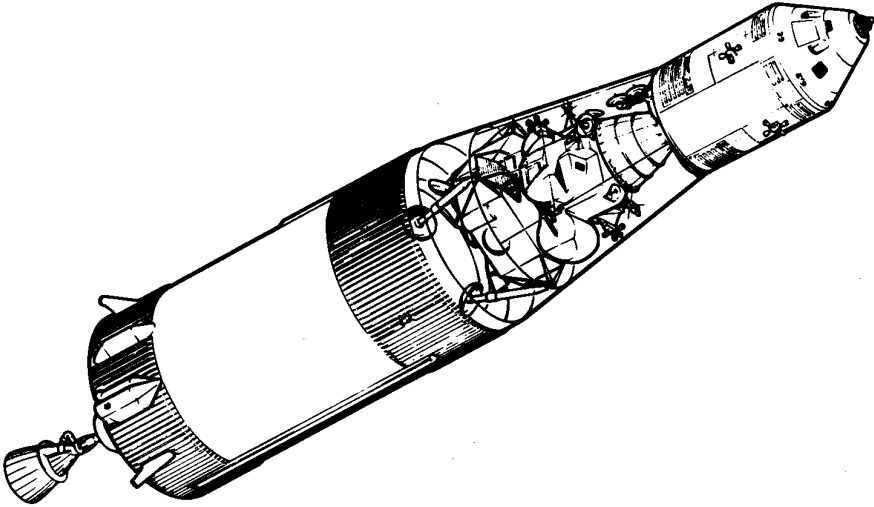
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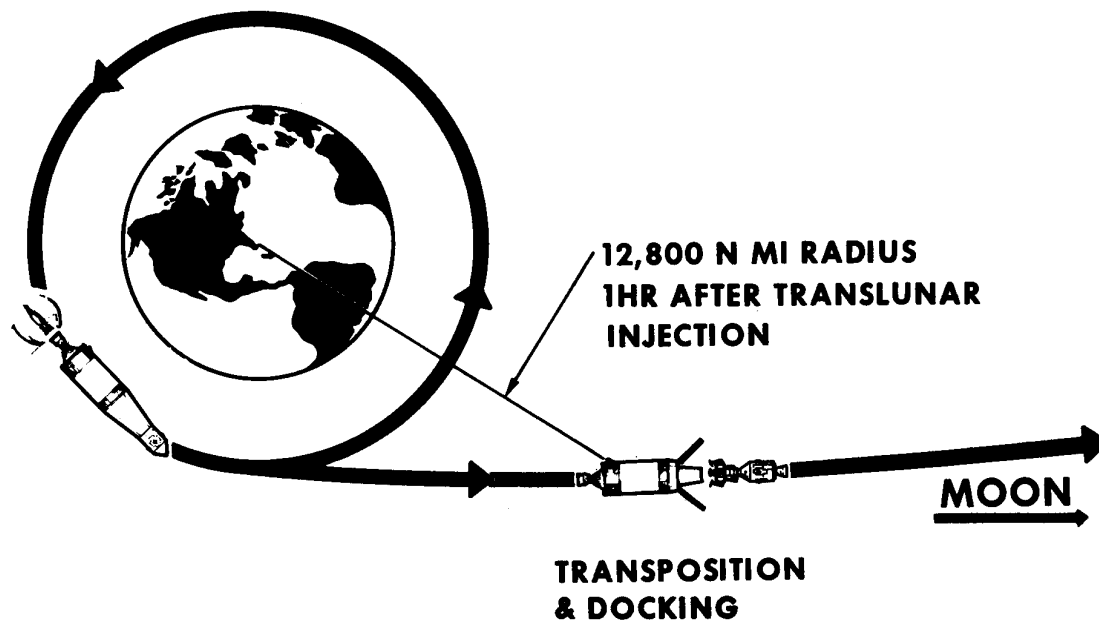




**APOLLO SPACECRAFT/3RD STAGE  
EARTH ORBITAL CONFIGURATION**

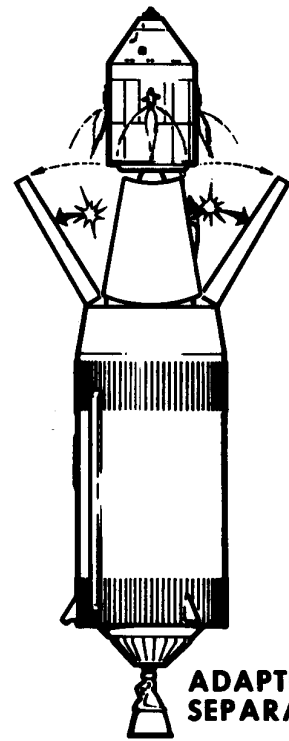


# TRANSLUNAR INJECTION & COAST

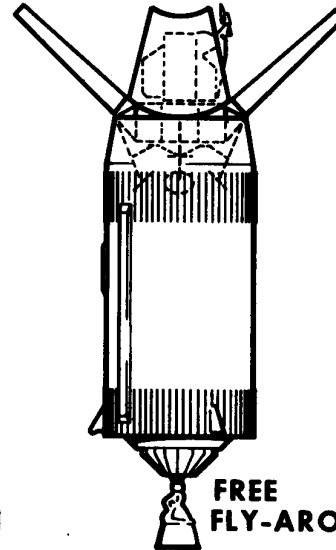
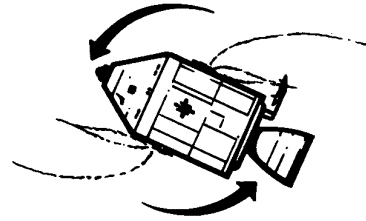


# TRANSPOSITION & DOCKING

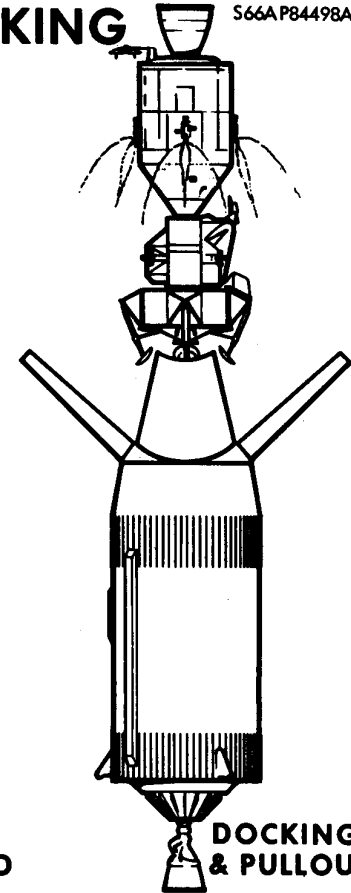
S66AP84498A



**ADAPTER  
SEPARATION**



**FREE  
FLY-AROUND**

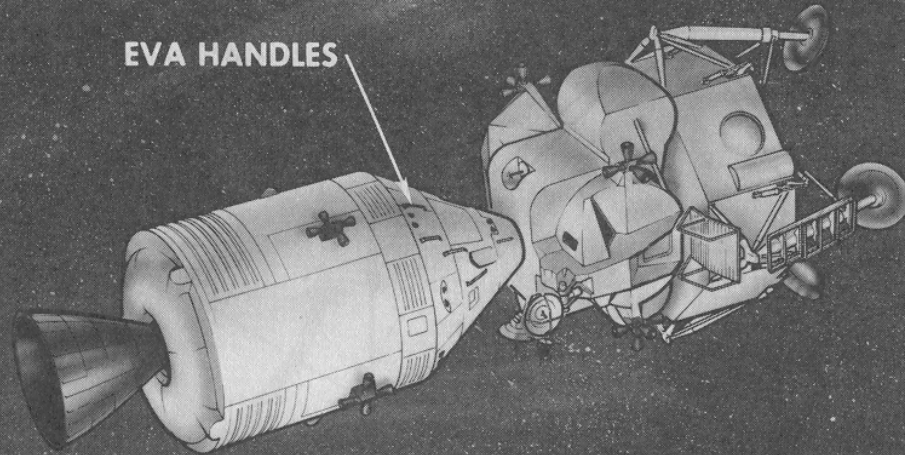


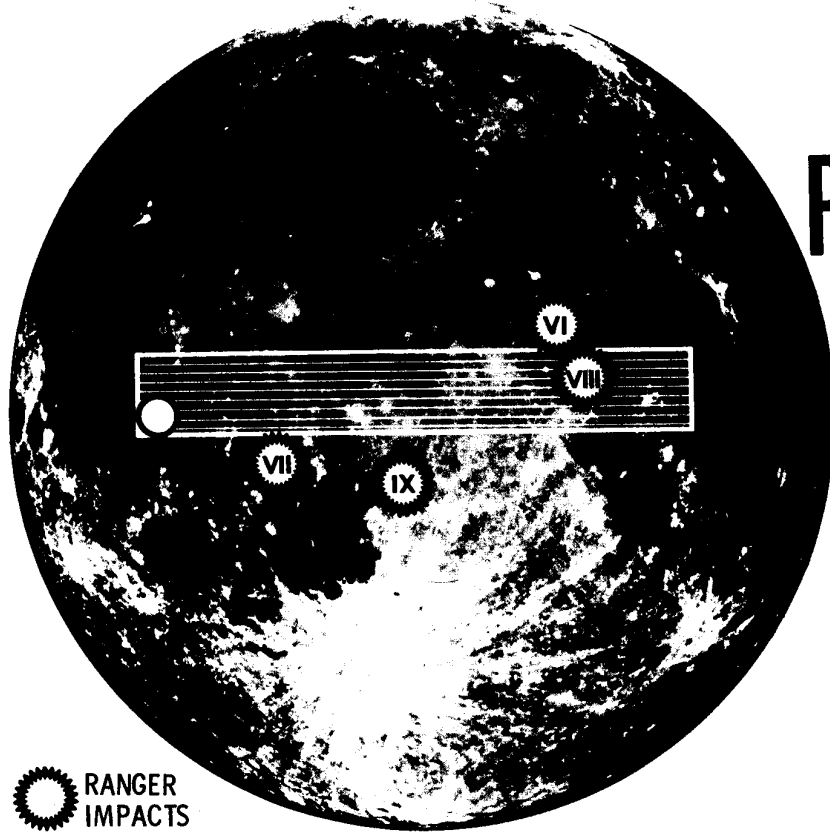
**DOCKING  
& PULLOUT**

# APOLLO SPACECRAFT TRANSLUNAR CONFIGURATION

S47AP84497B


EVA HANDLES





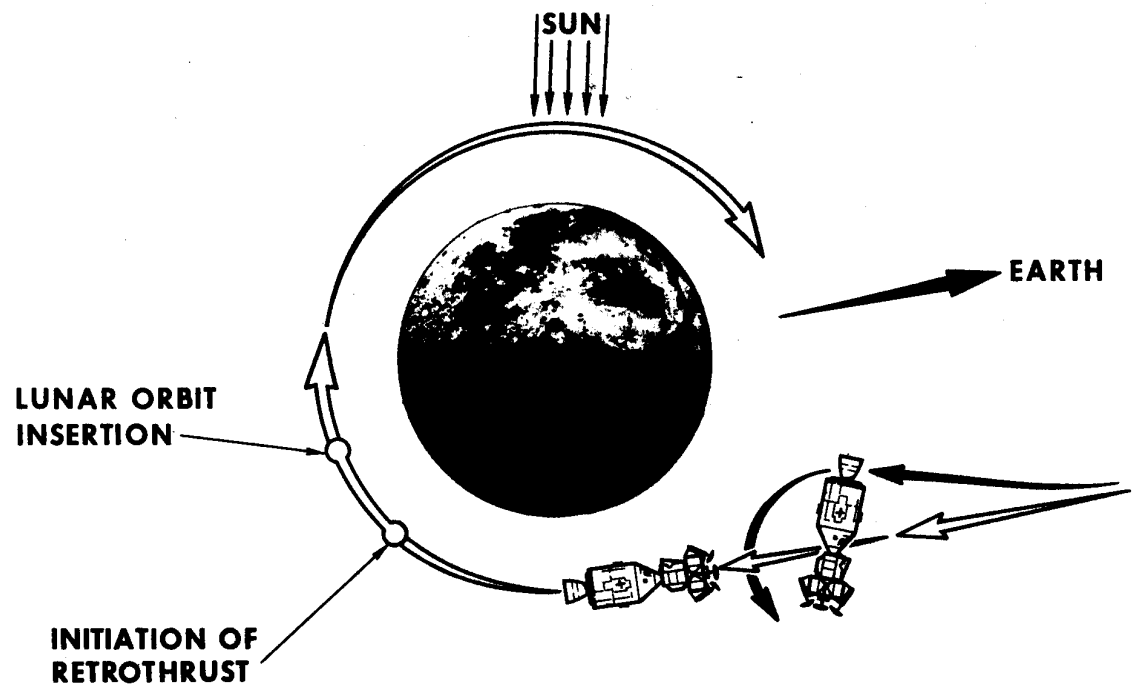
# PROPOSED LUNAR LANDING

 RANGER  
IMPACTS  
 SURVEYOR

FAM-1022 

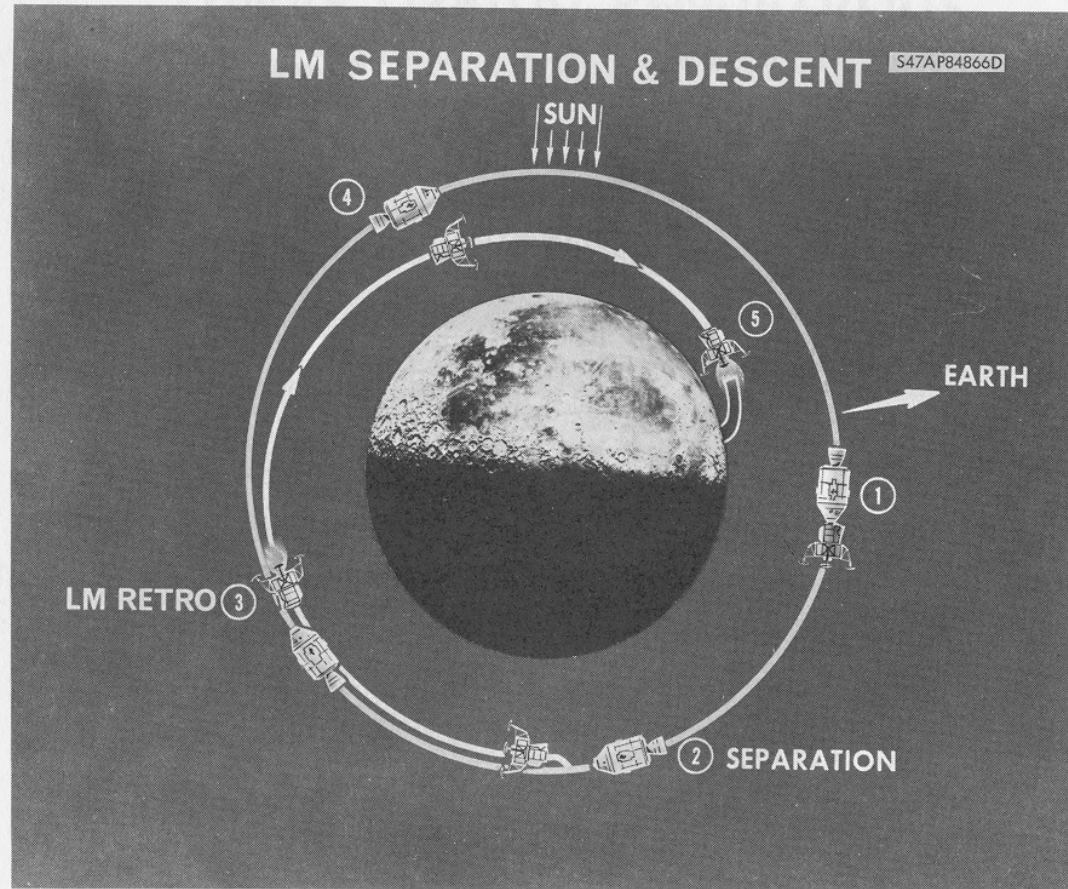
# LUNAR ORBIT INSERTION

S56AP85005C



# LM SEPARATION & DESCENT

S47AP84866D



# LM DESCENT AND LANDING

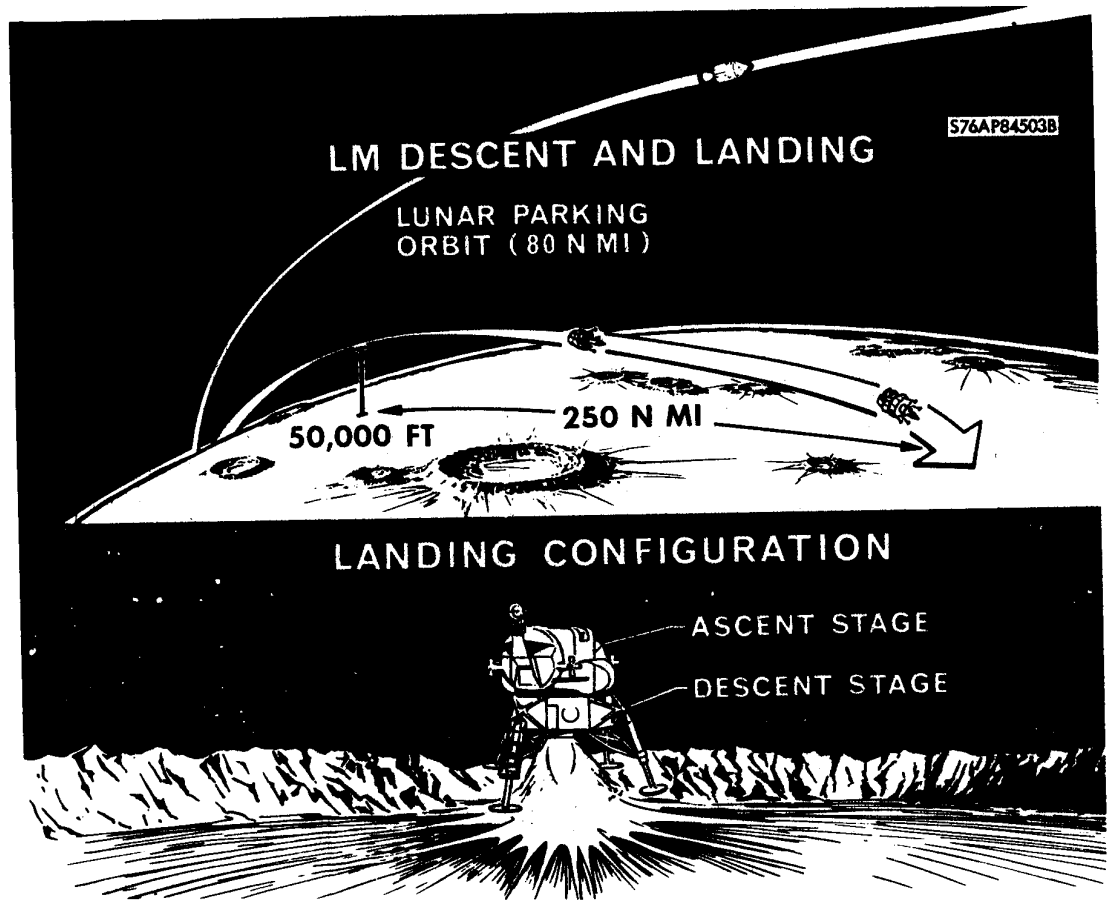
576AP84503B

LUNAR PARKING  
ORBIT (80 N MI)

50,000 FT      250 N MI

# LANDING CONFIGURATION

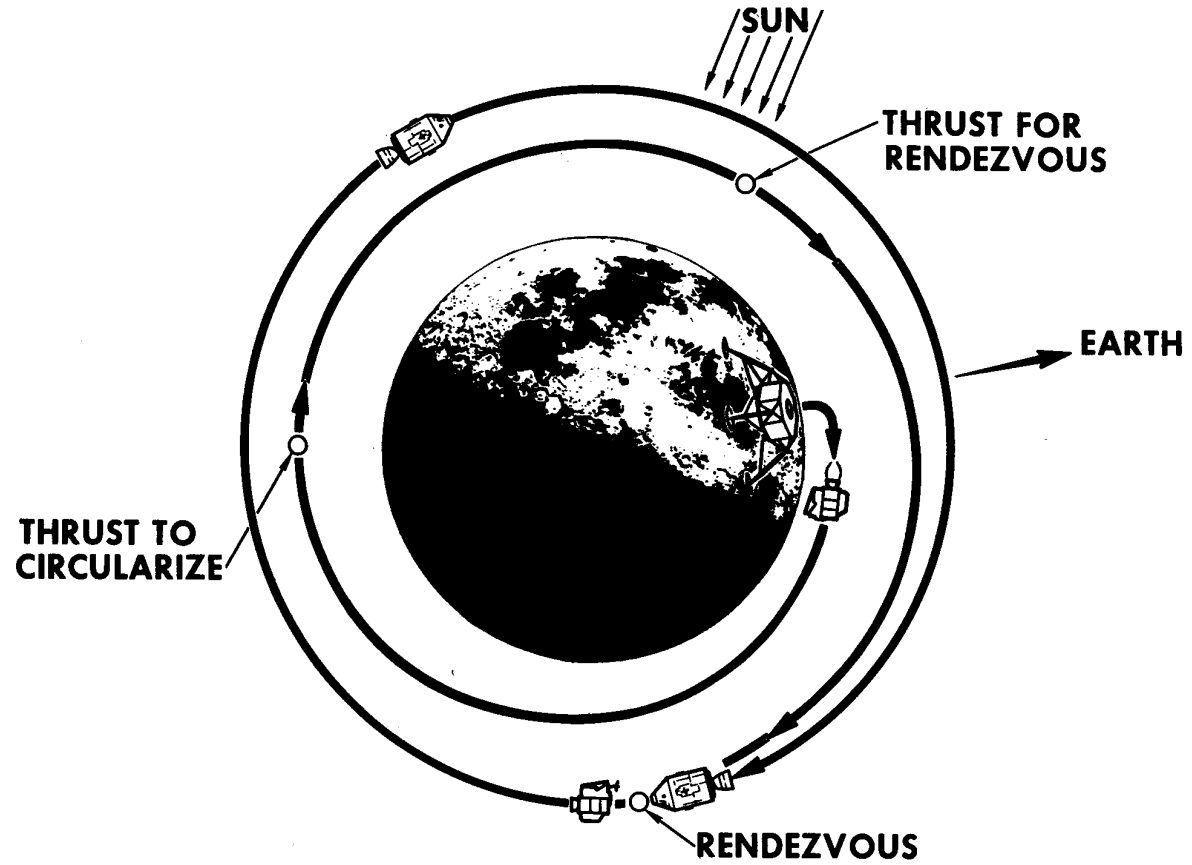
ASCENT STAGE  
DESCENT STAGE

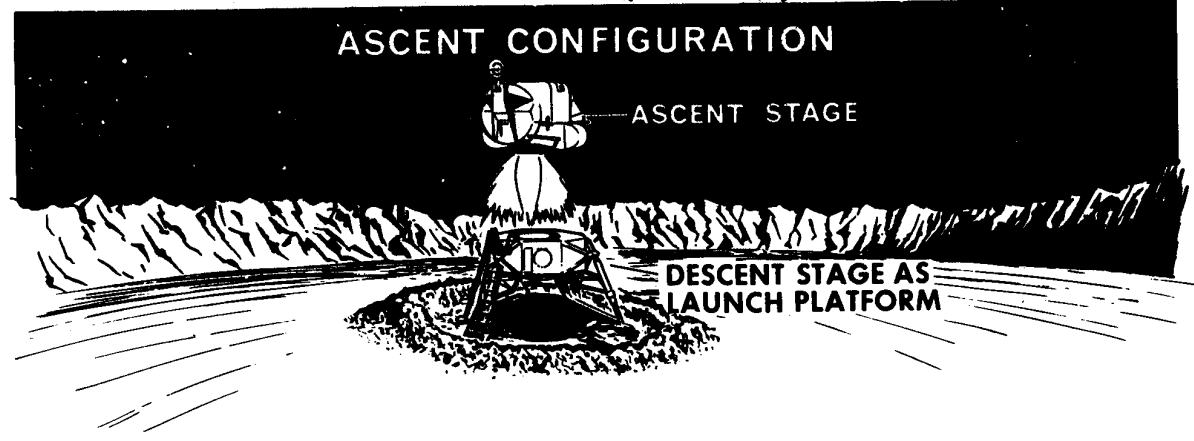
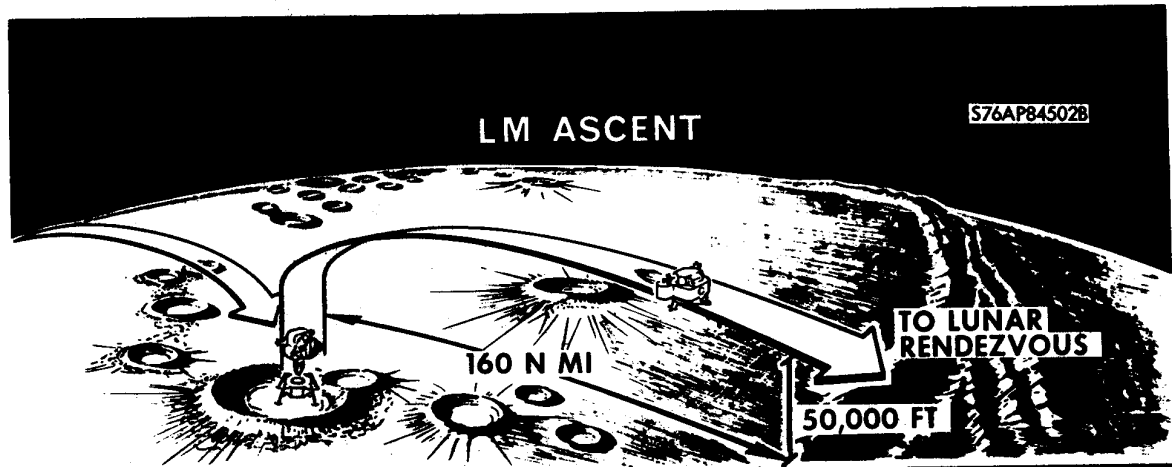




# LUNAR ORBITAL RENDEZVOUS

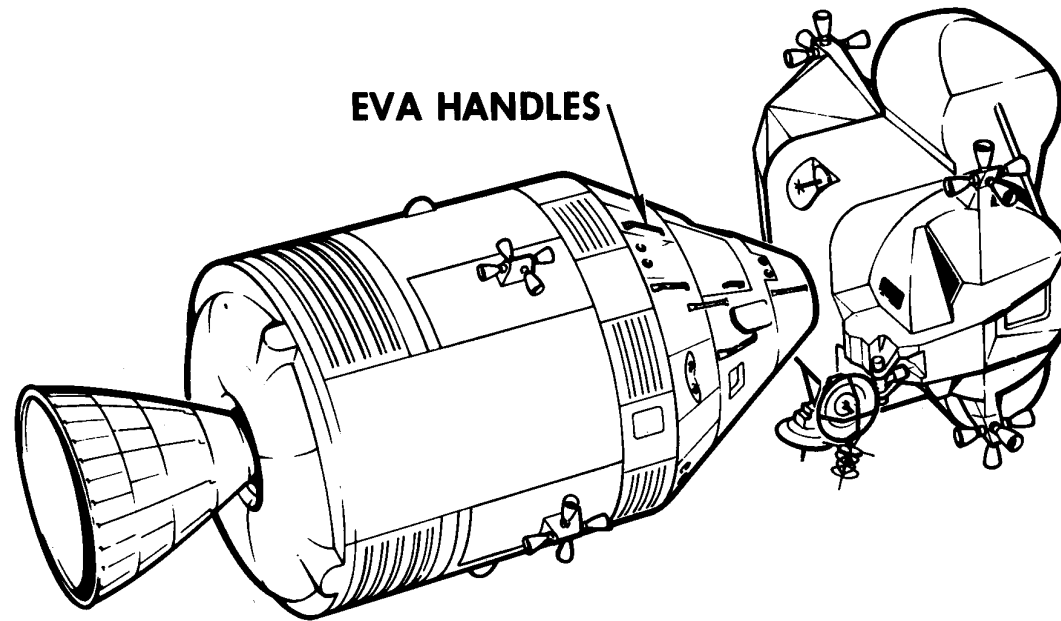
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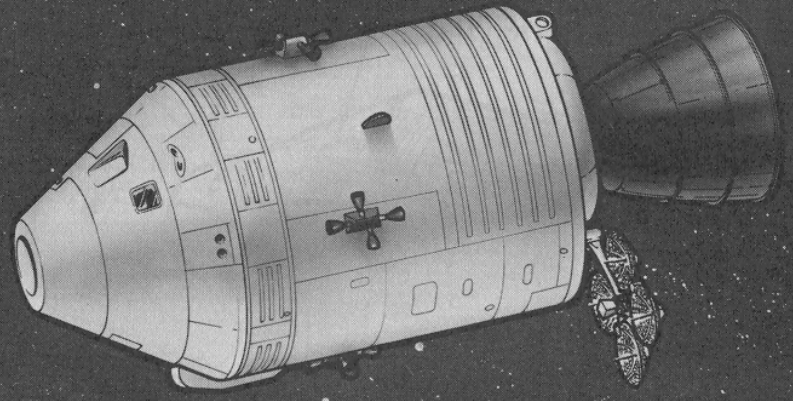
S47AP84507B

# APOLLO SPACECRAFT LOR CONFIGURATION

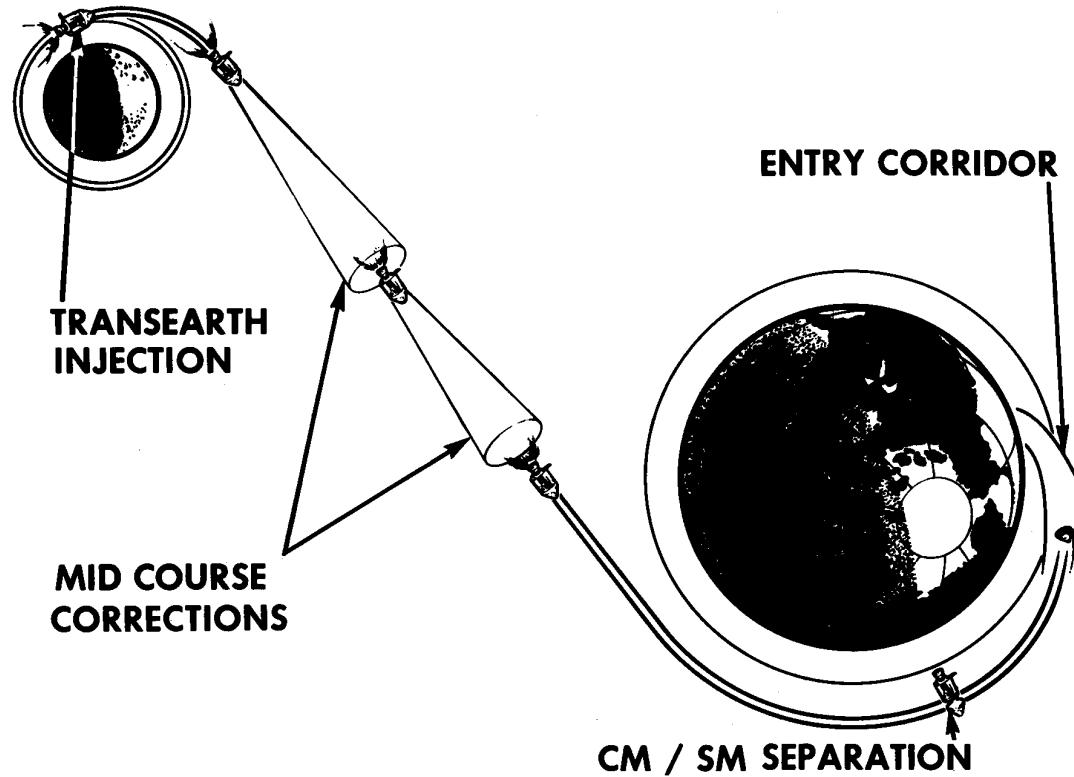



S47AP83078B

# APOLLO TRANSEARTH CONFIGURATION

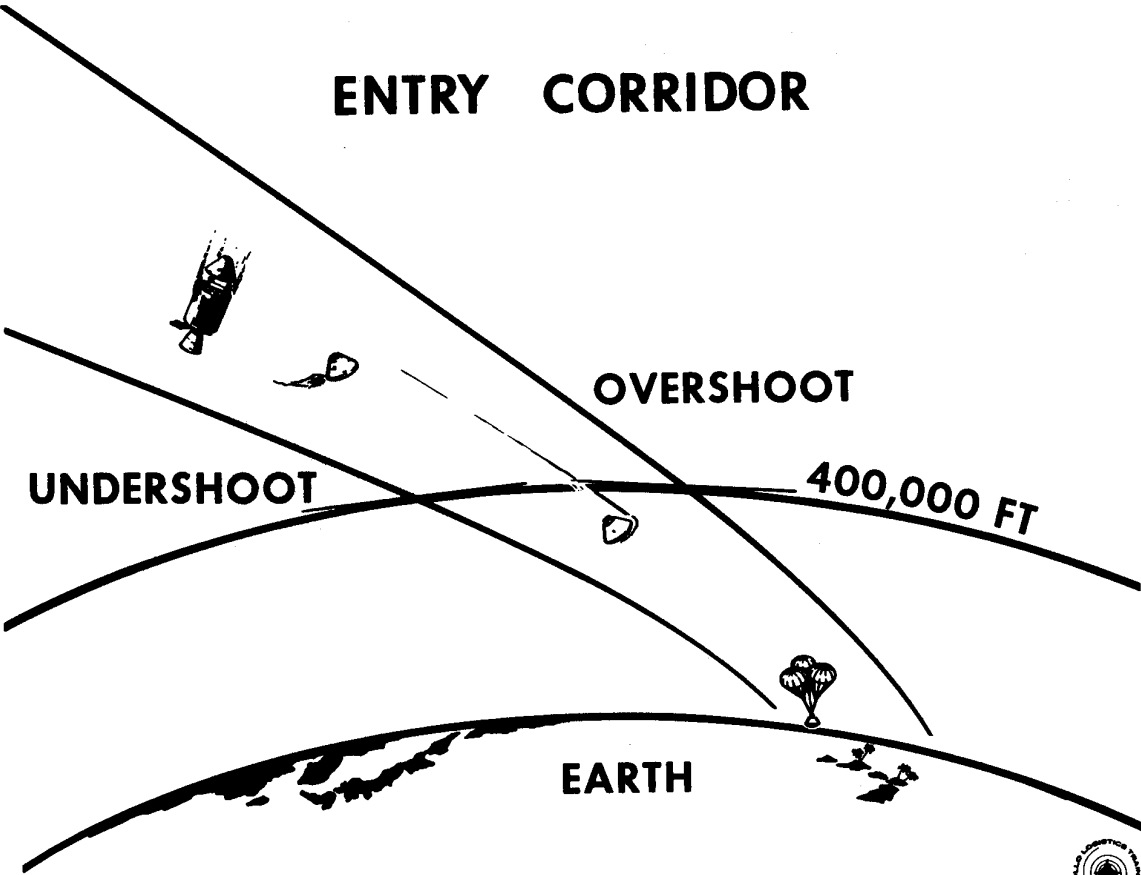


# TRANSEARTH & ENTRY

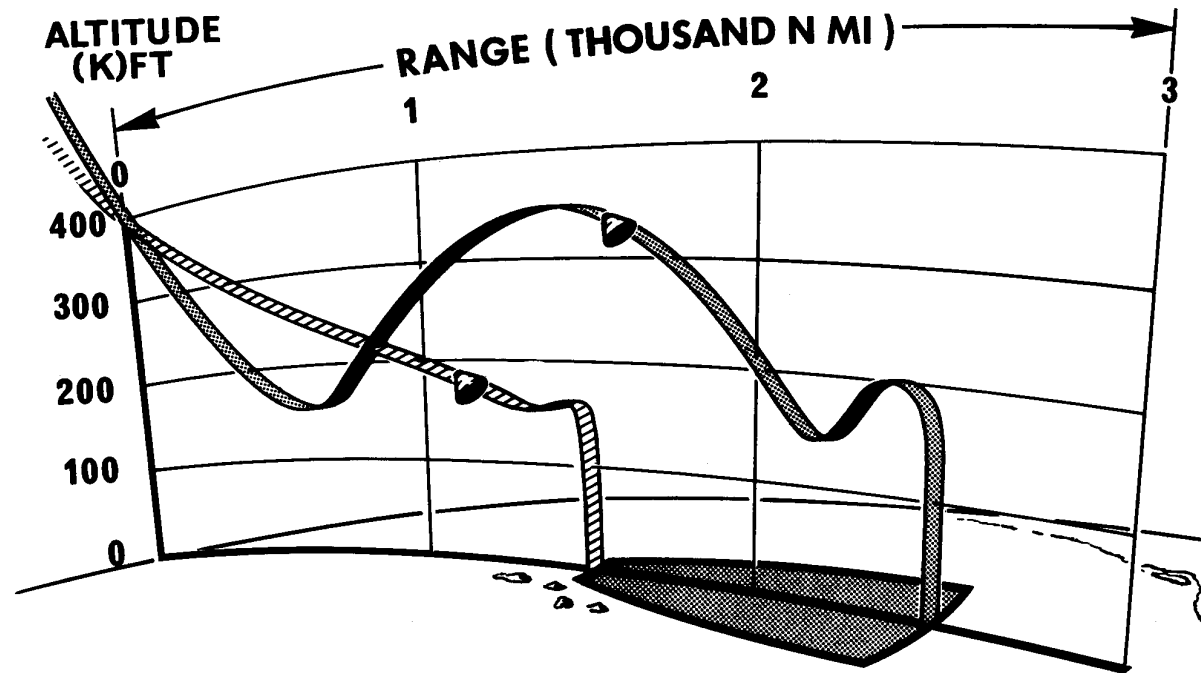


FAM-1018A 

# ENTRY CORRIDOR

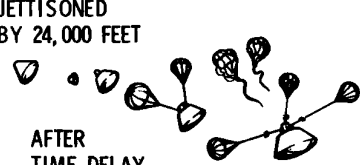


# TYPICAL RE-ENTRY RANGES



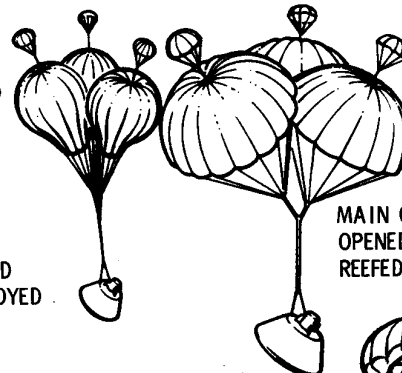
# RECOVERY

HEAT SHIELD  
JETTISONED  
BY 24,000 FEET



AFTER  
TIME DELAY  
DROGUE CHUTES  
DEPLOYED - REEFED

DROGUE CHUTES RELEASED  
AND MAIN CHUTES DEPLOYED  
REEFED BY 10,000 FT



MAIN CHUTES FULLY  
OPENED AFTER BEING  
REEFED

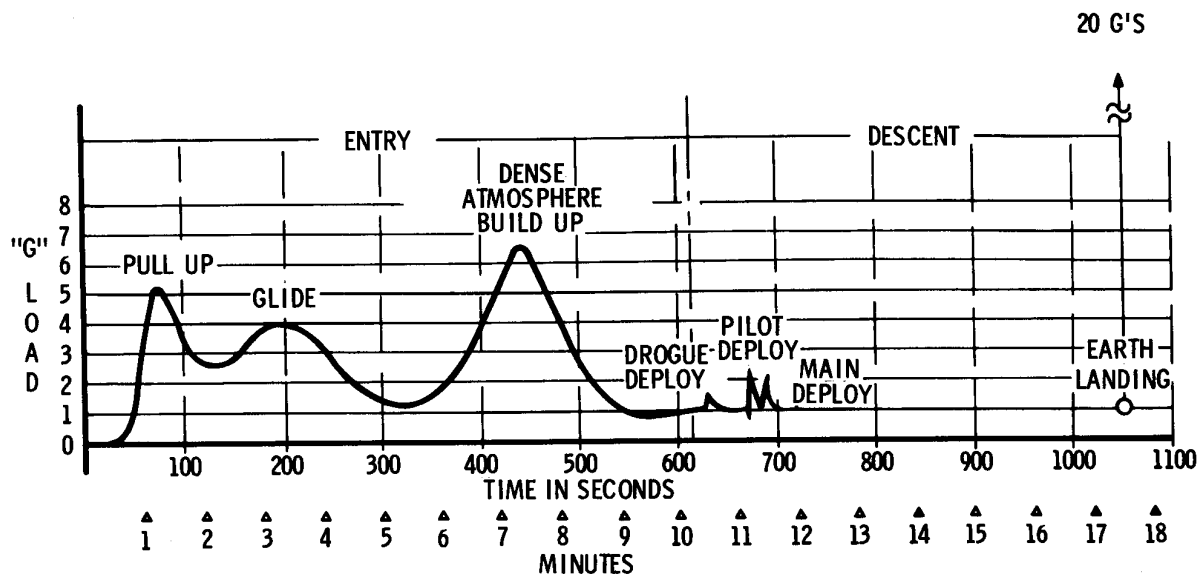


MAIN CHUTES RELEASED AFTER SPLASHDOWN



# "G" FORCES, LUNAR MISSION, BLOCK II

## ASTRONAUT SENSED

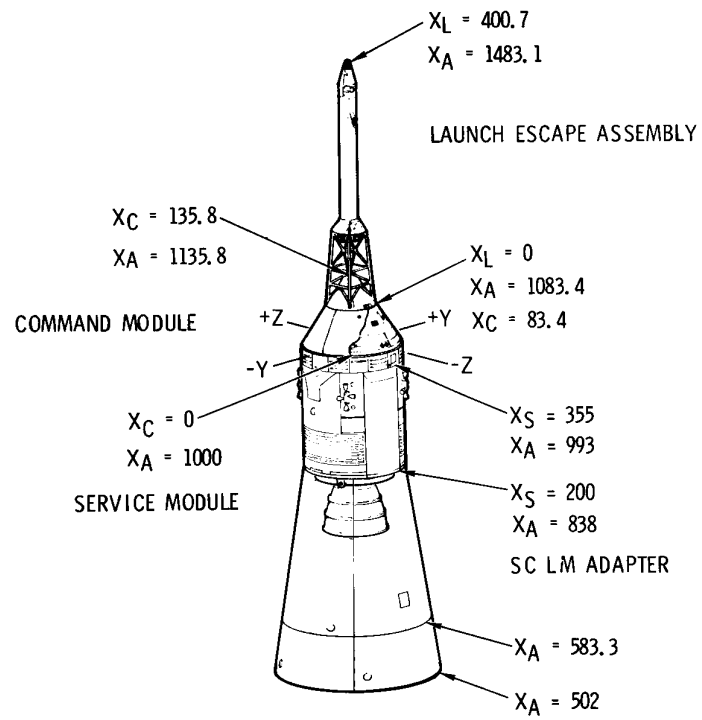



REF DESIGN REFERENCE MISSION, LED-540-12 dtd OCT 64

# STRUCTURES

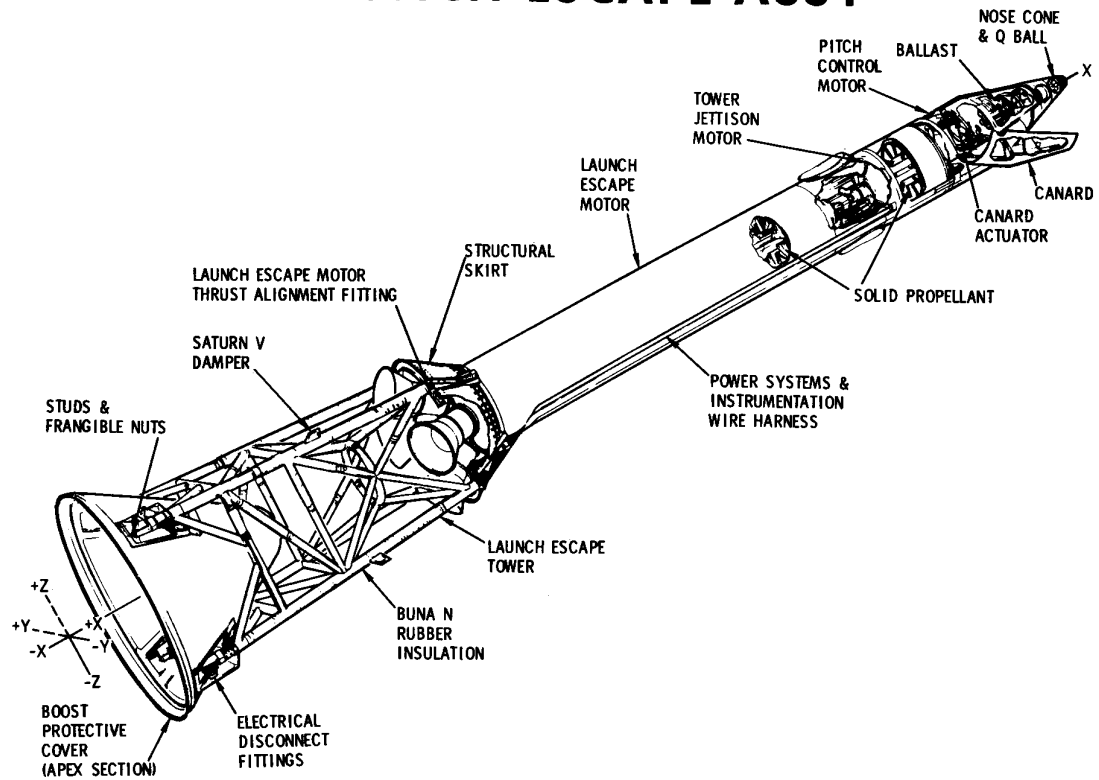
# APOLLO INTEGRATED STATION & CSM AXIS

## BLOCK II



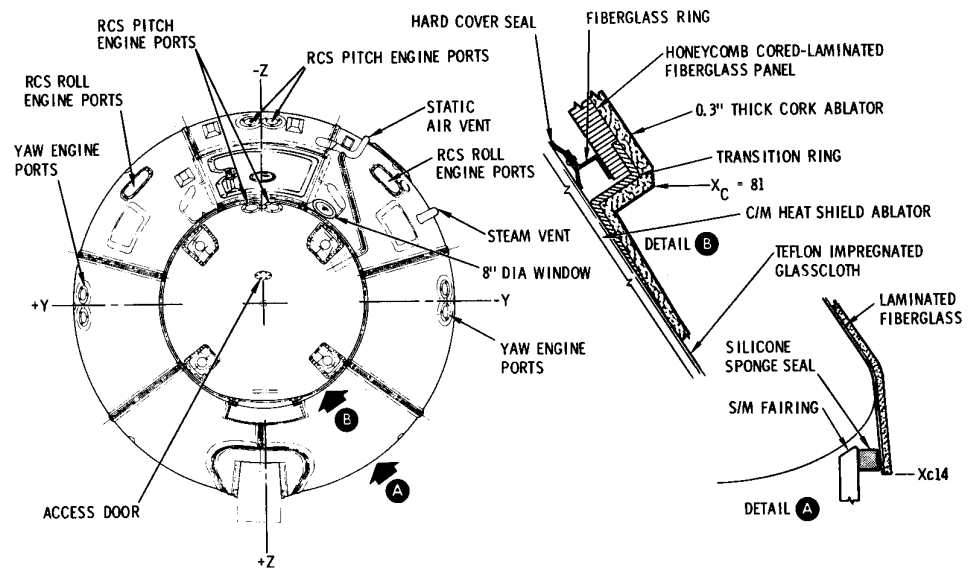
ST-107A 

# LAUNCH ESCAPE ASSY



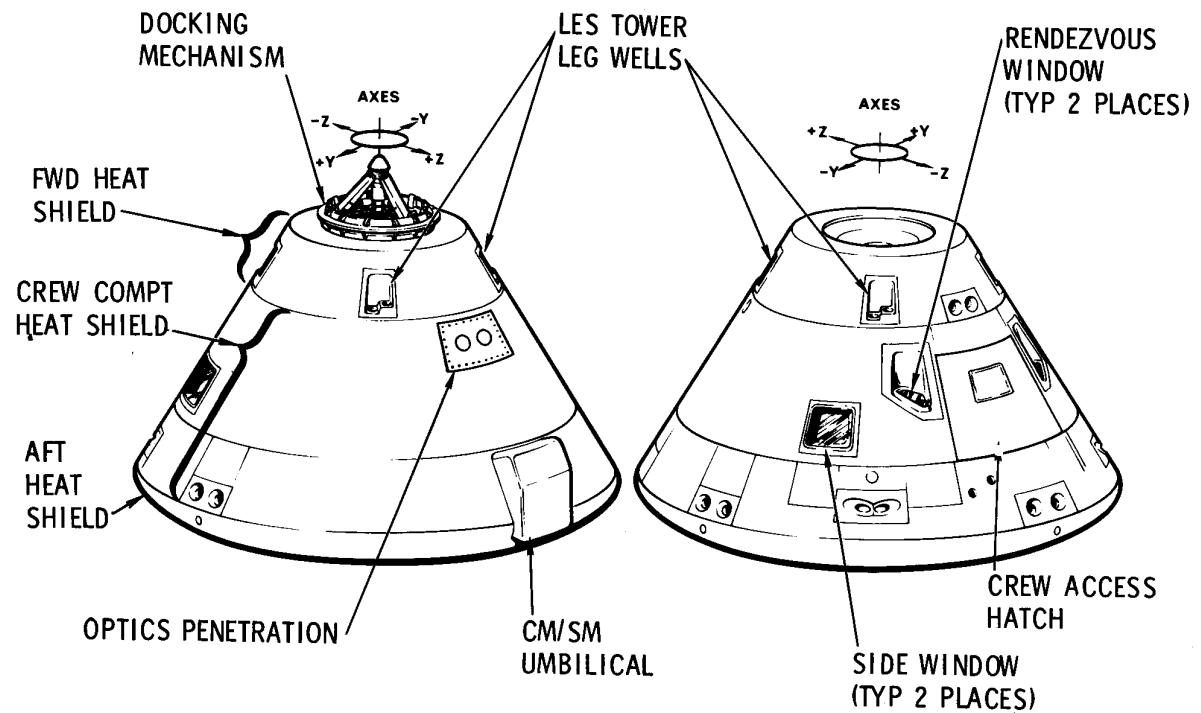
# BOOST PROTECTIVE COVER

BLOCK II CSM



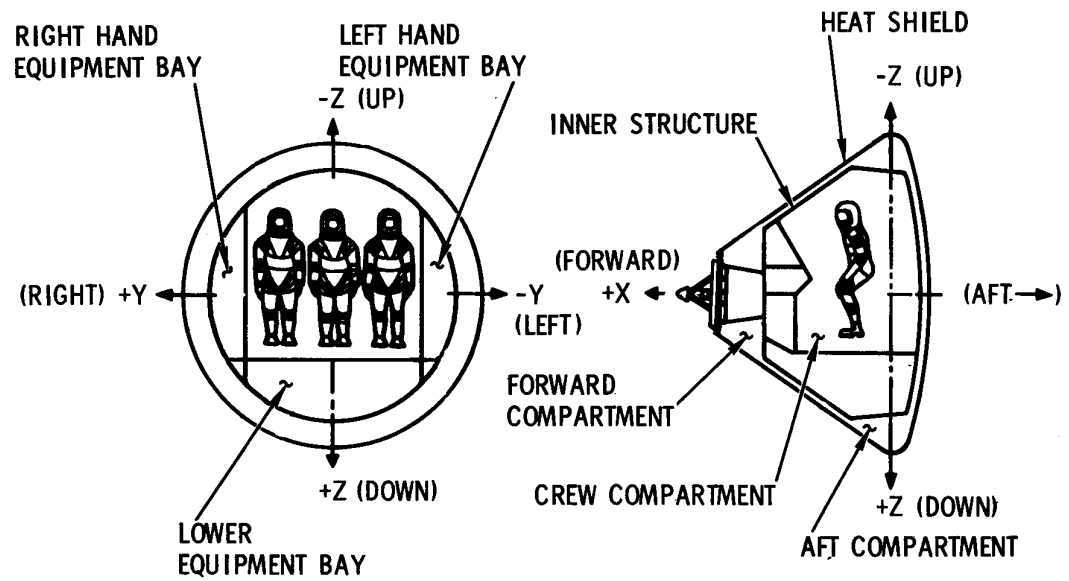
# COMMAND MODULE EXTERIOR

## BLOCK II

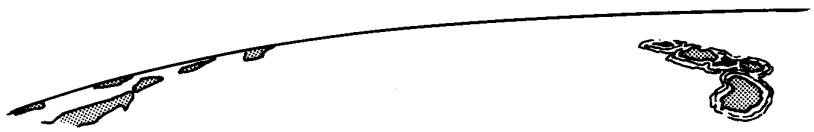
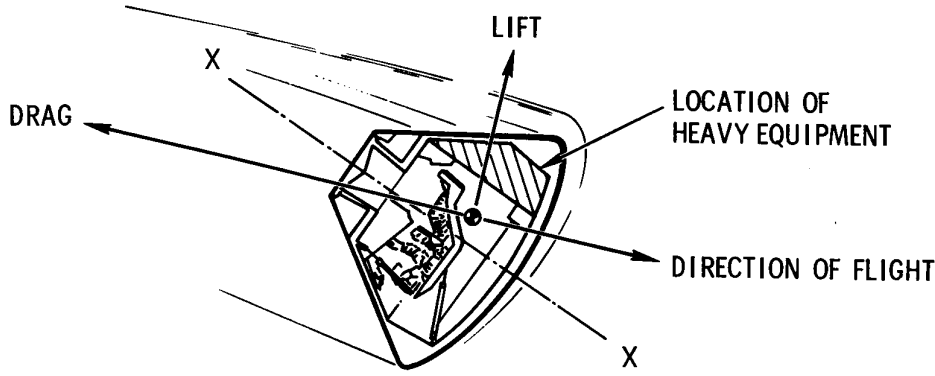


# COMMAND MODULE COMPARTMENT ORIENTATION

## BLOCK II



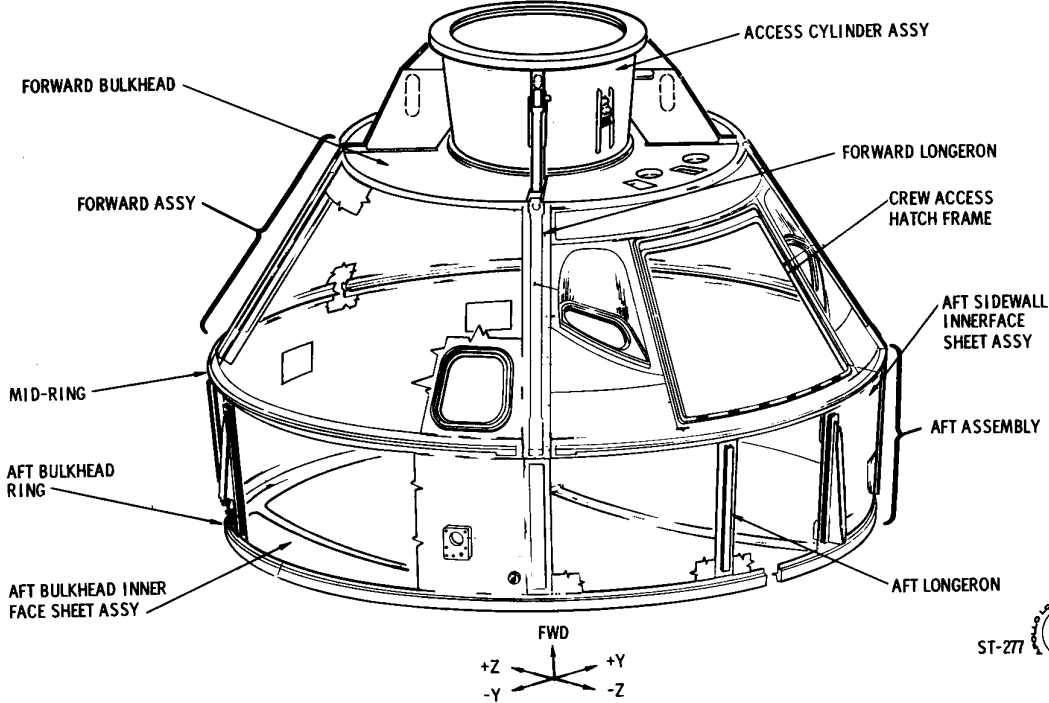
# COMMAND MODULE AERODYNAMICS





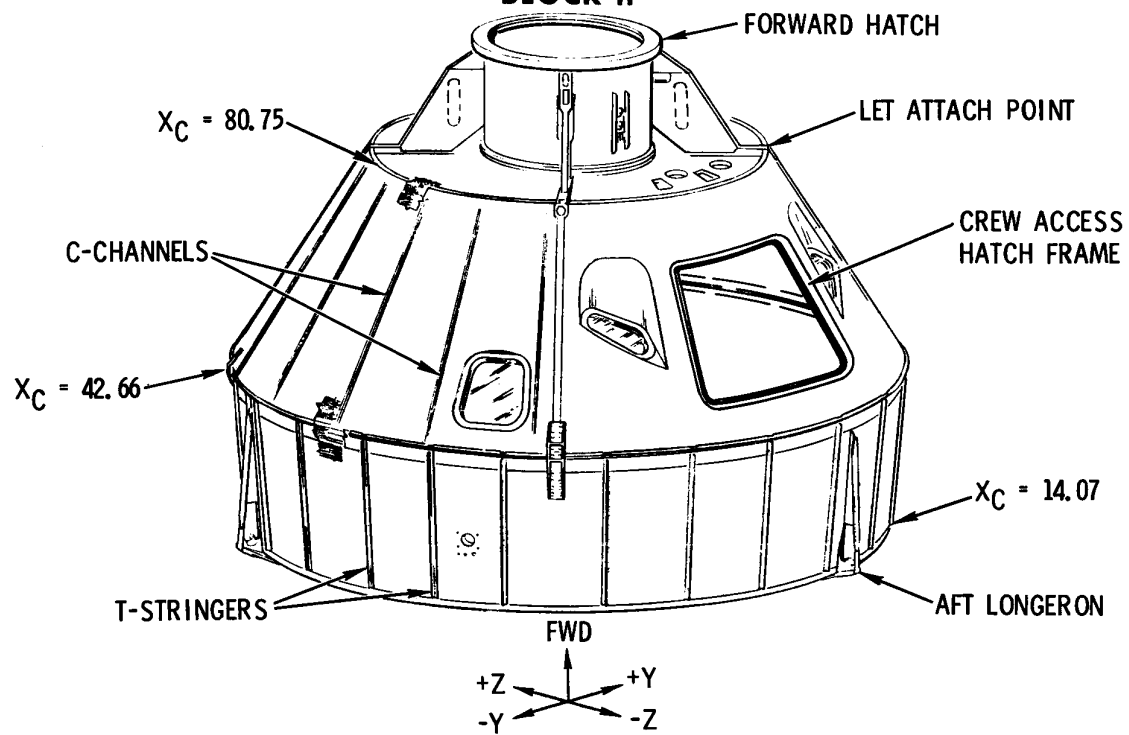
# INNER STRUCTURE

INNER SHELL (BLOCK II)



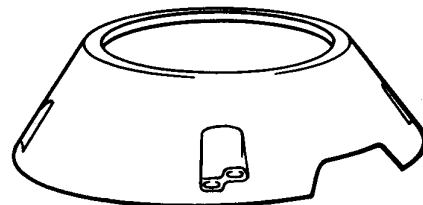
# CM INNER STRUCTURE

## BLOCK II

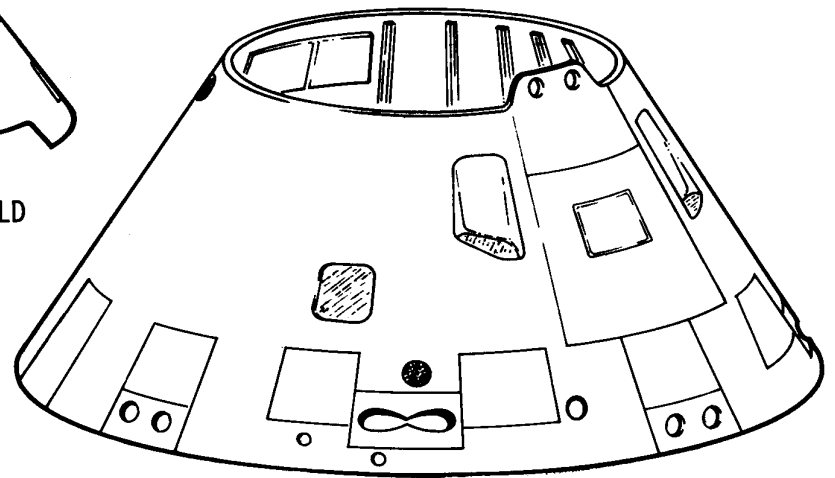


# COMMAND MODULE HEAT SHIELDS

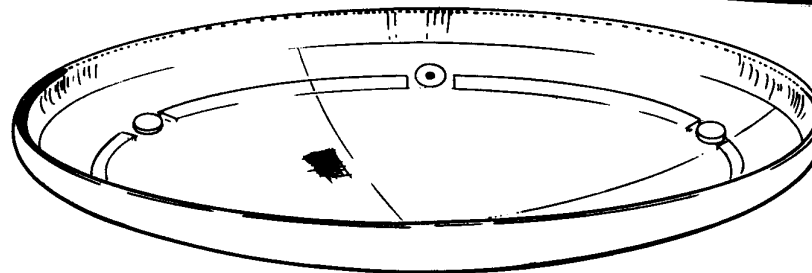
## BLOCK II



FORWARD HEAT SHIELD

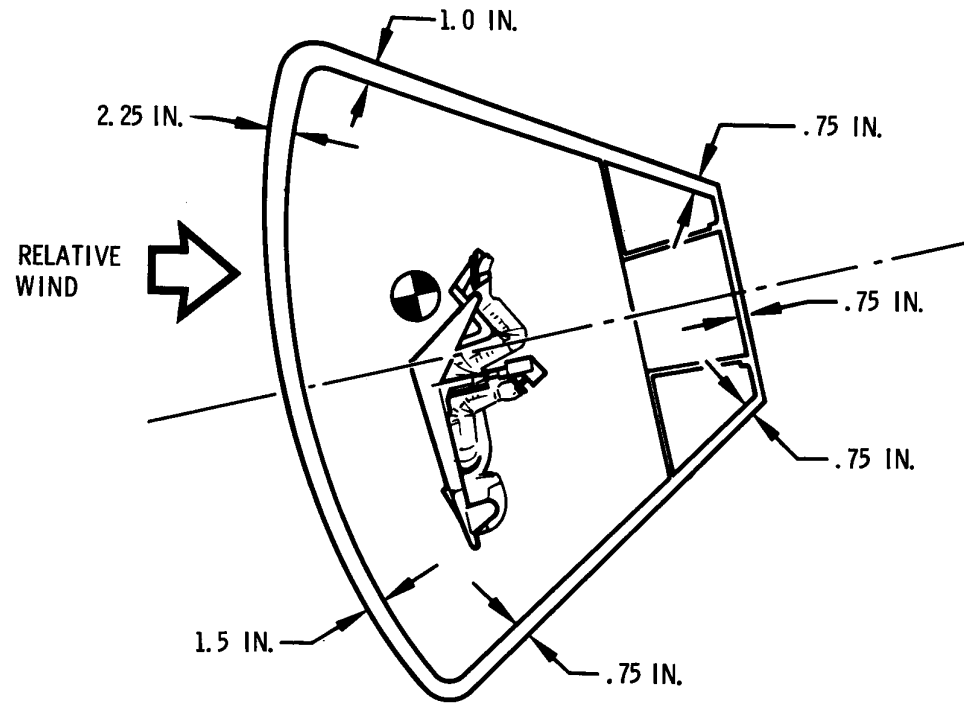


CREW COMPARTMENT  
HEAT SHIELD

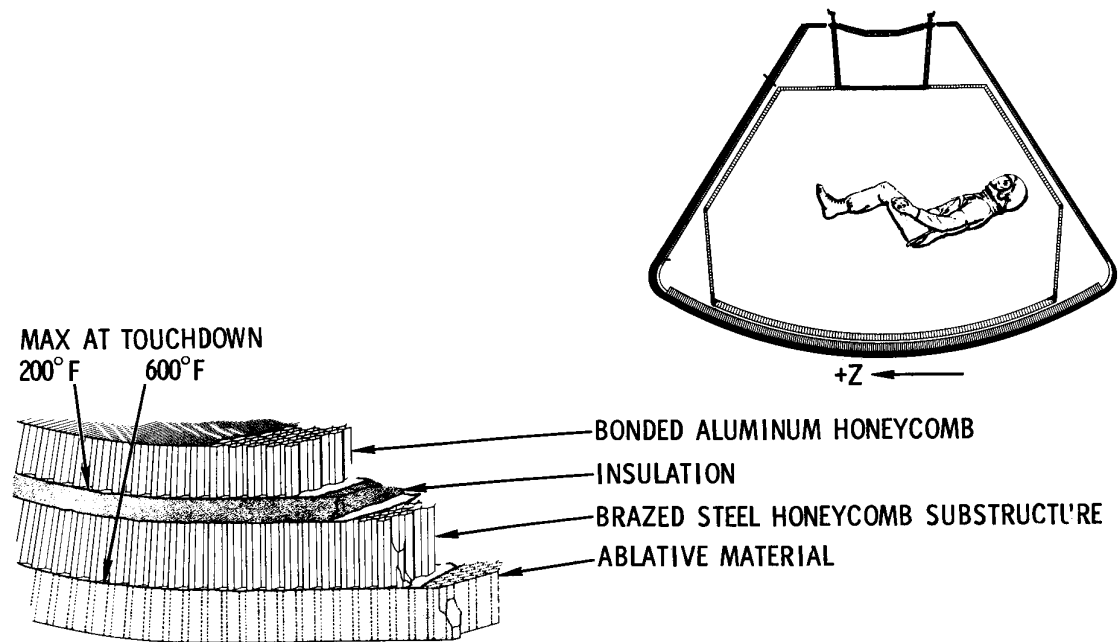


AFT HEAT SHIELD

# COMMAND MODULE ABLATIVE MATERIAL THICKNESS BLOCK II

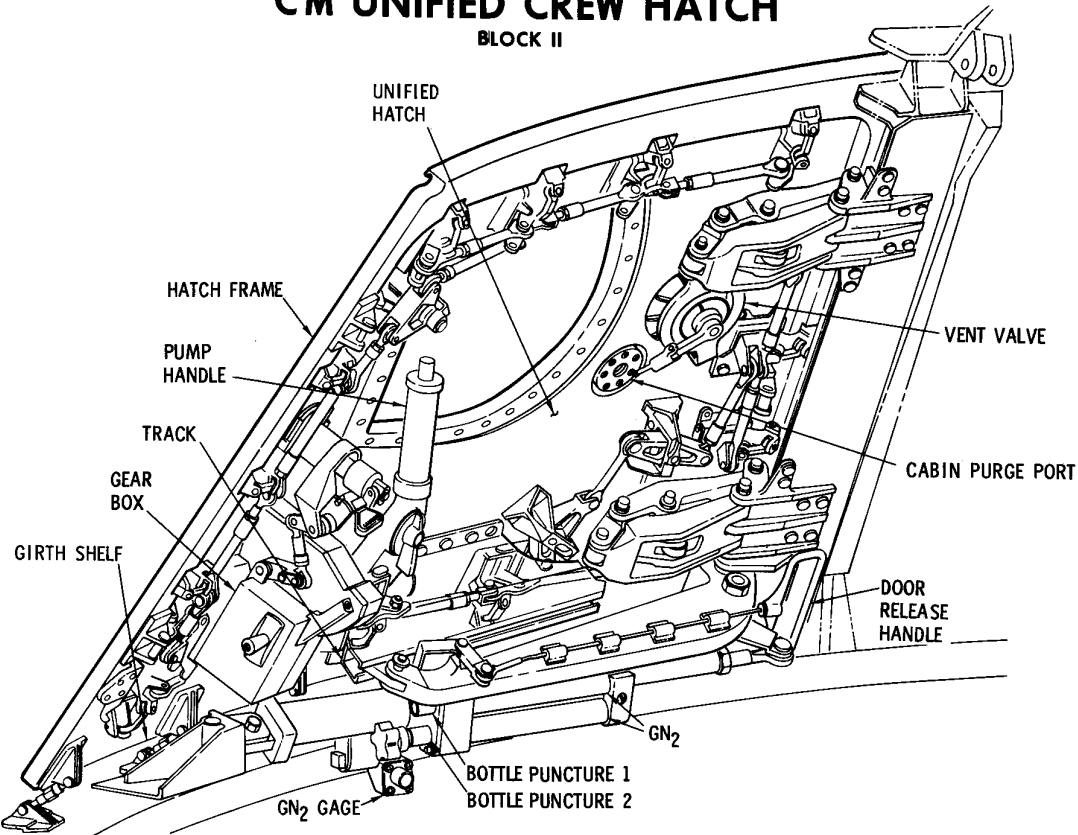


# COMMAND MODULE SKIN CONFIGURATION



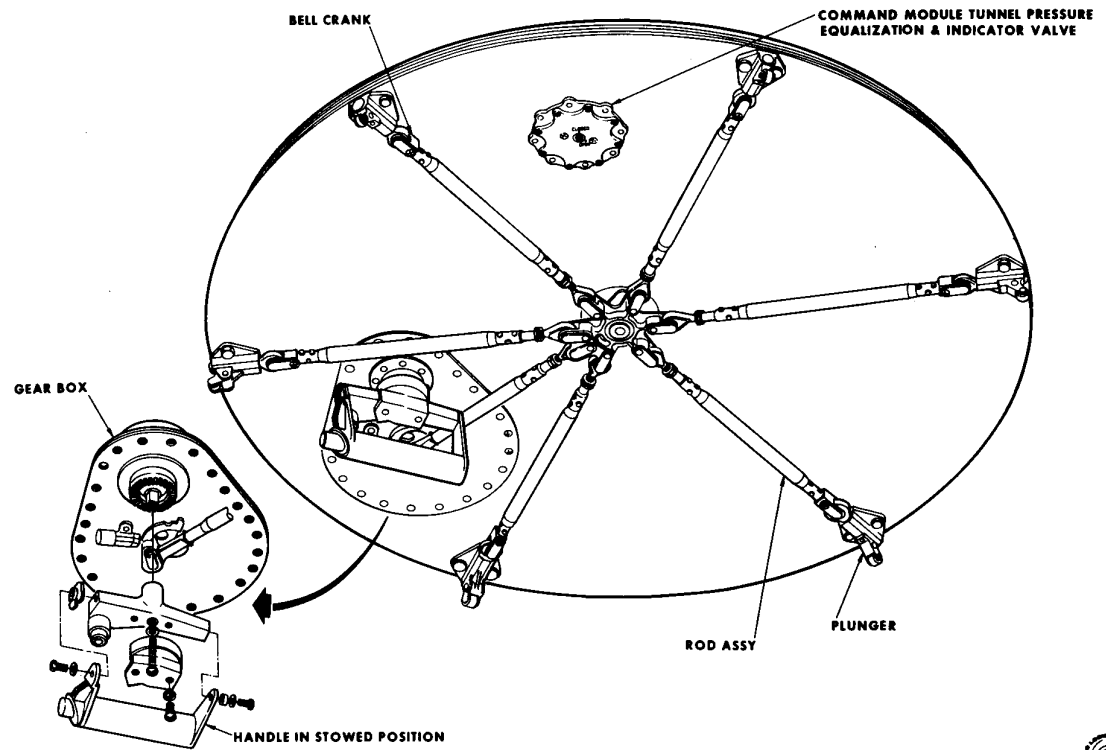
# CM UNIFIED CREW HATCH

BLOCK II

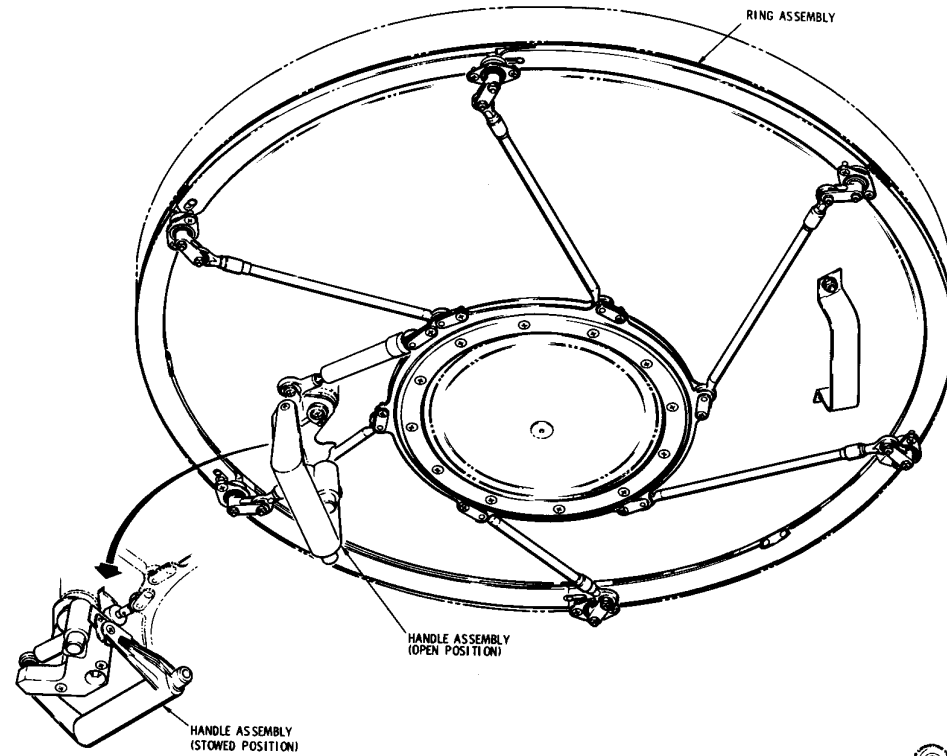


# FORWARD PRESSURE HATCH

## BLOCK II



# ABLATIVE HATCH

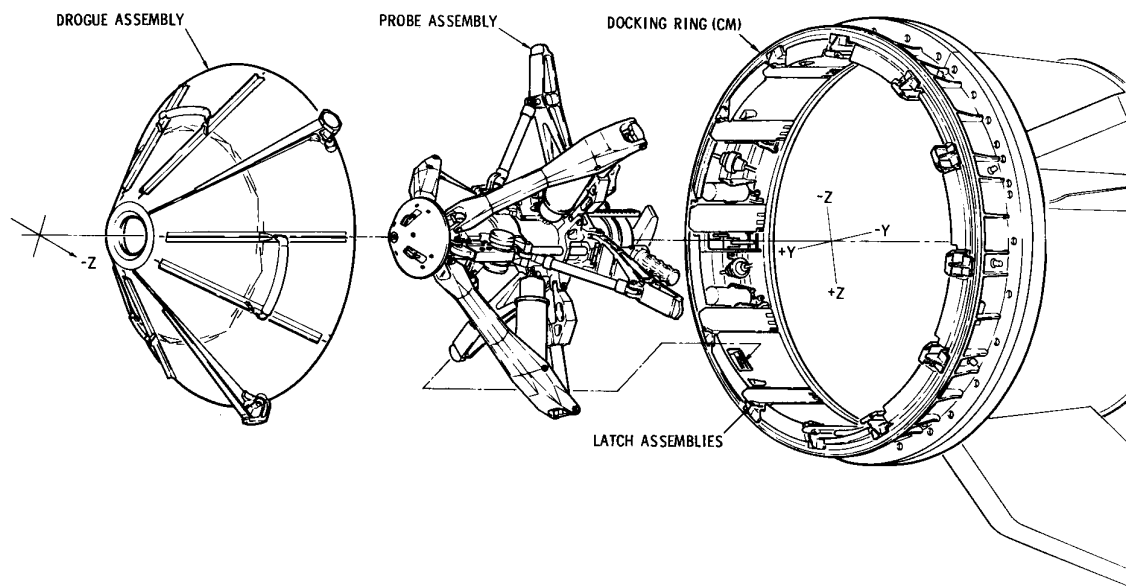


ST-901 

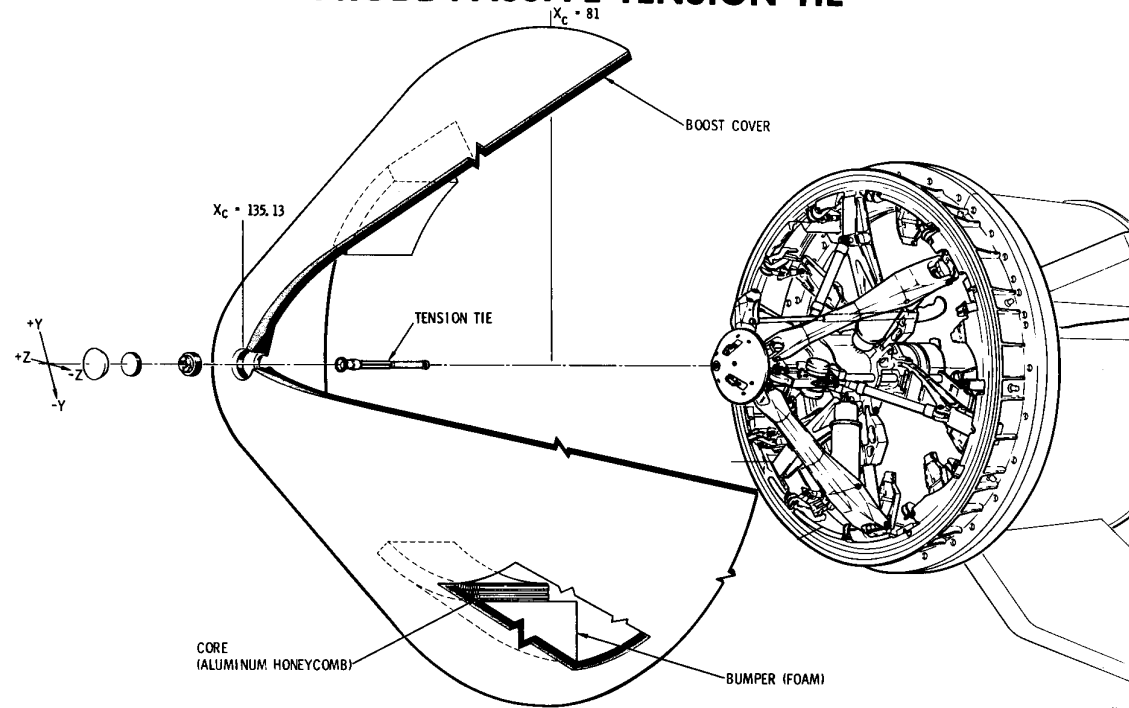


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# PROBE INSTALLATION-DOCKING SYSTEM



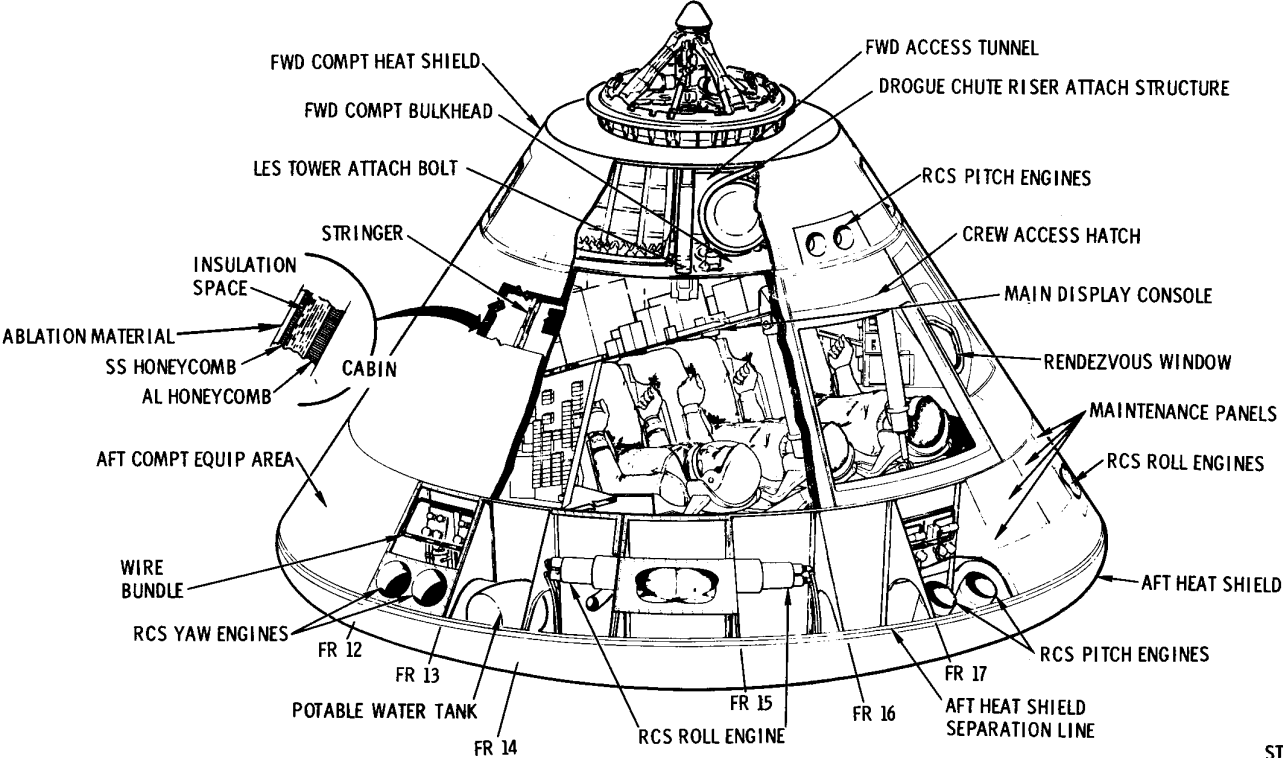
# PROBE PASSIVE TENSION TIE



DKG-013A

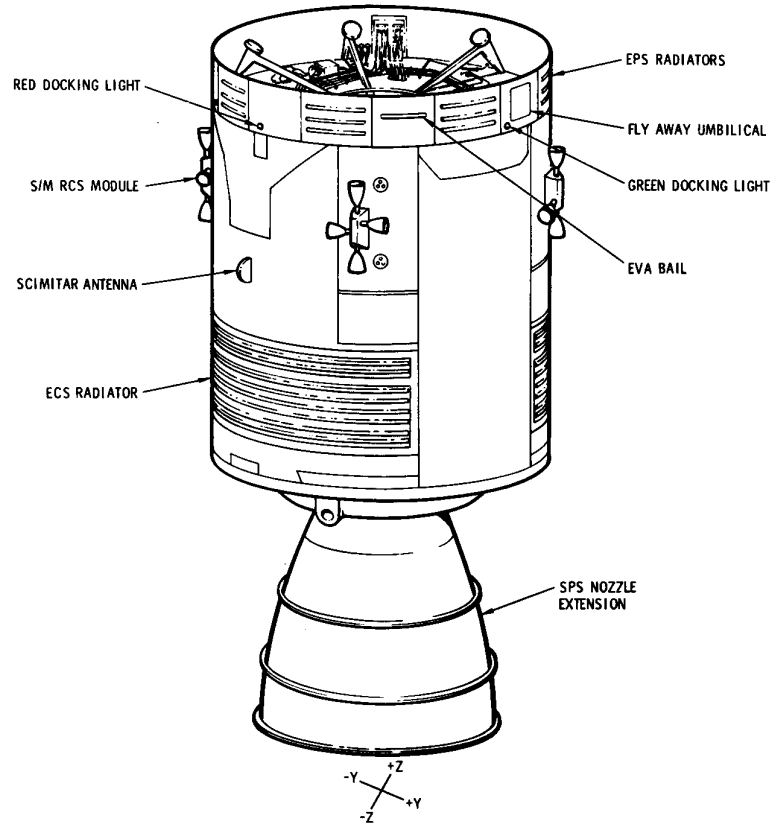


# GENERAL ARRANGEMENT COMMAND MODULE (BLOCK II)



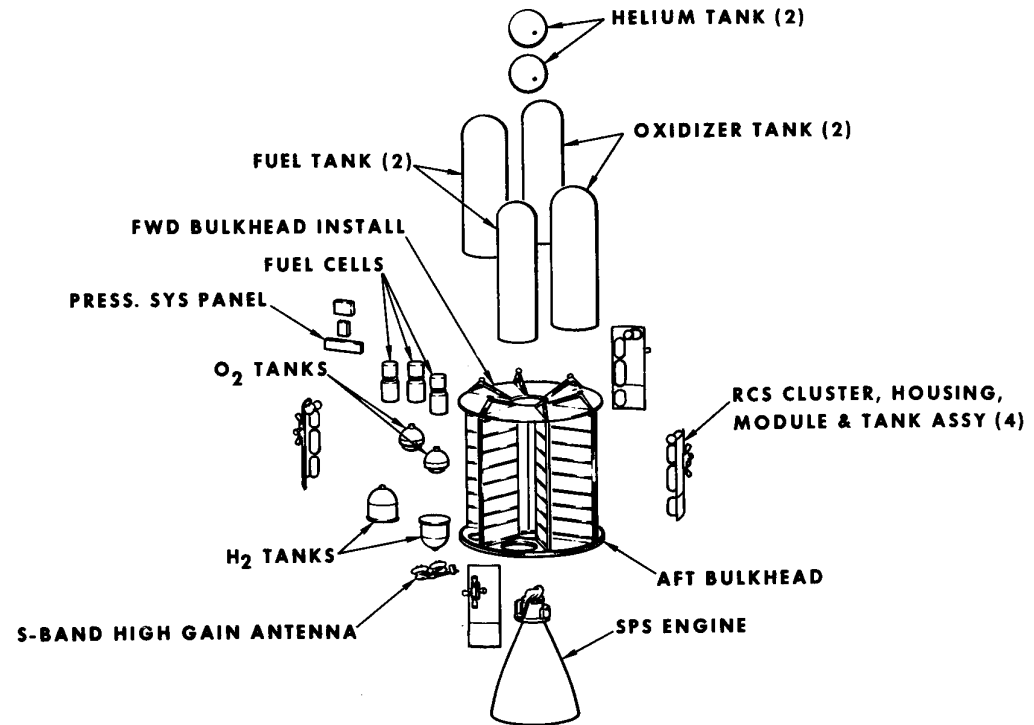
# SERVICE MODULE

## BLOCK II

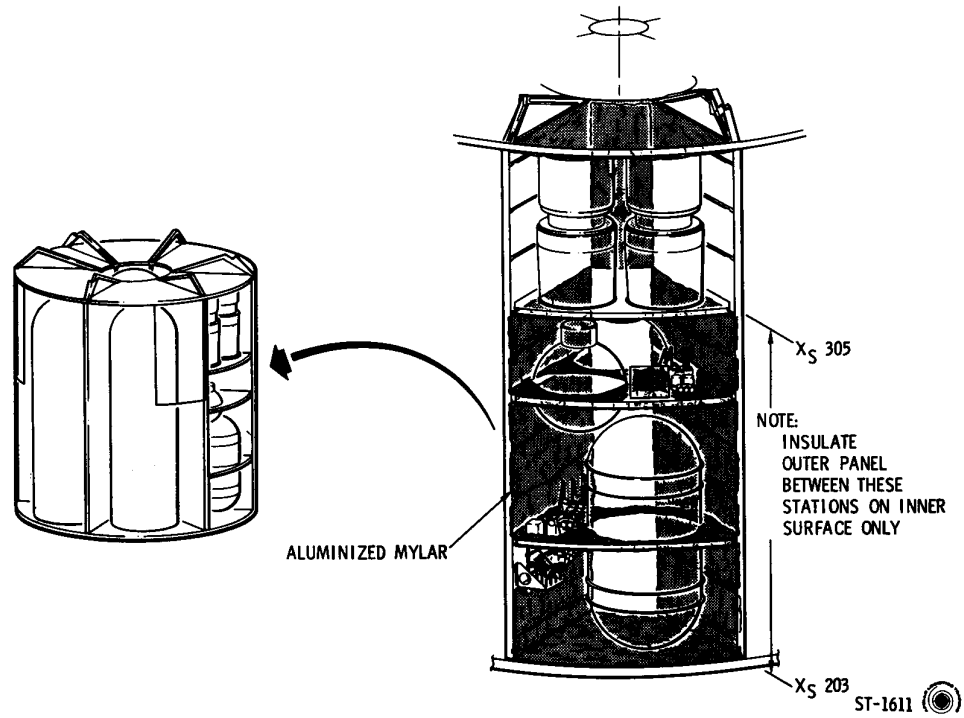


# APOLLO SM SYSTEMS EQUIPMENT

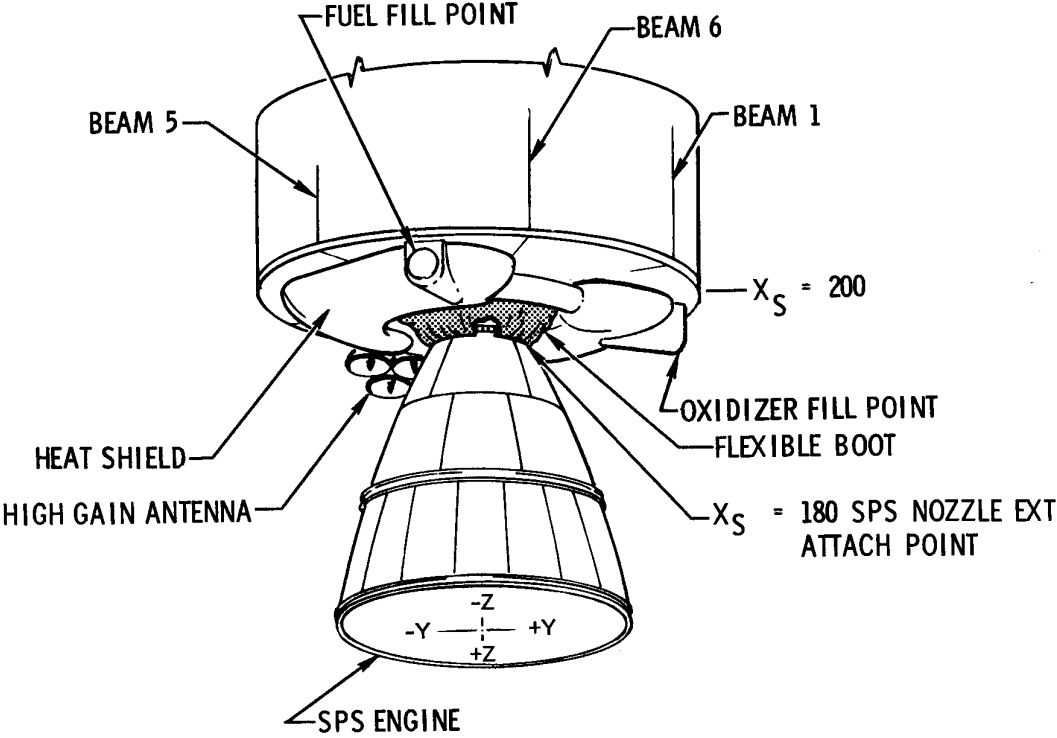
## BLOCK II



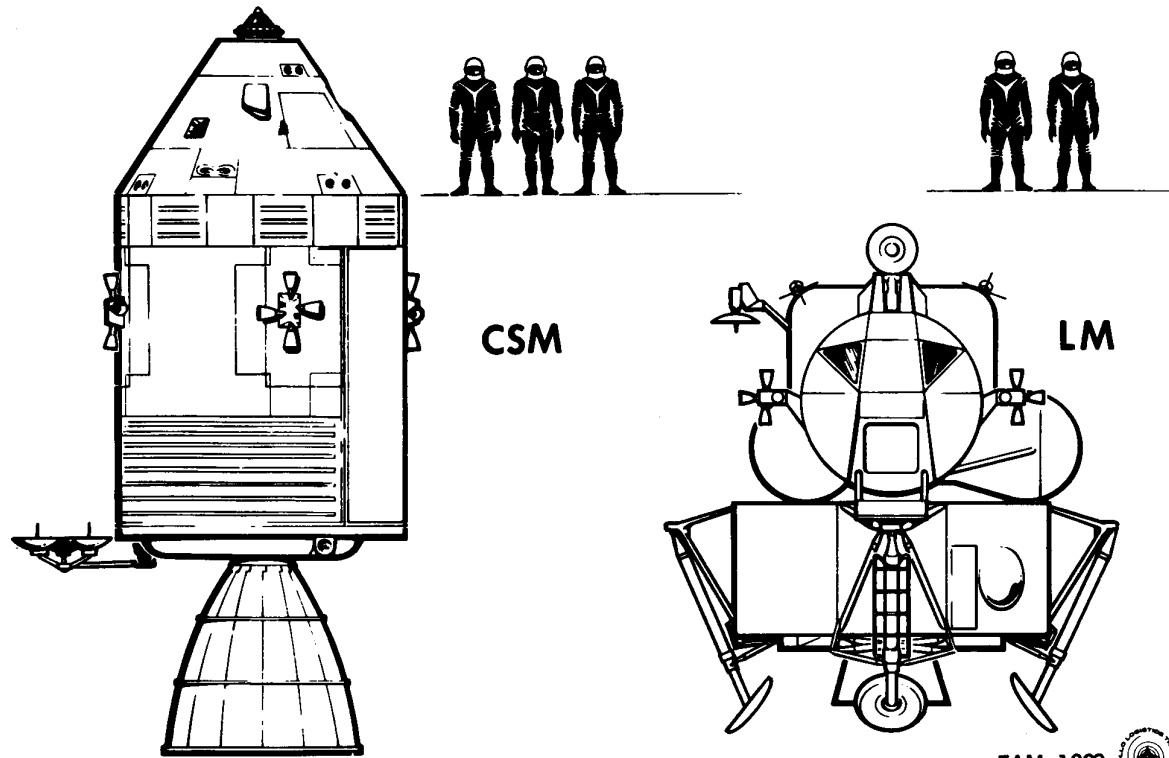
# SM INSULATION TYPICAL FOR SECTOR IV




# S/M SPS NOZZLE AND HEAT SHIELD



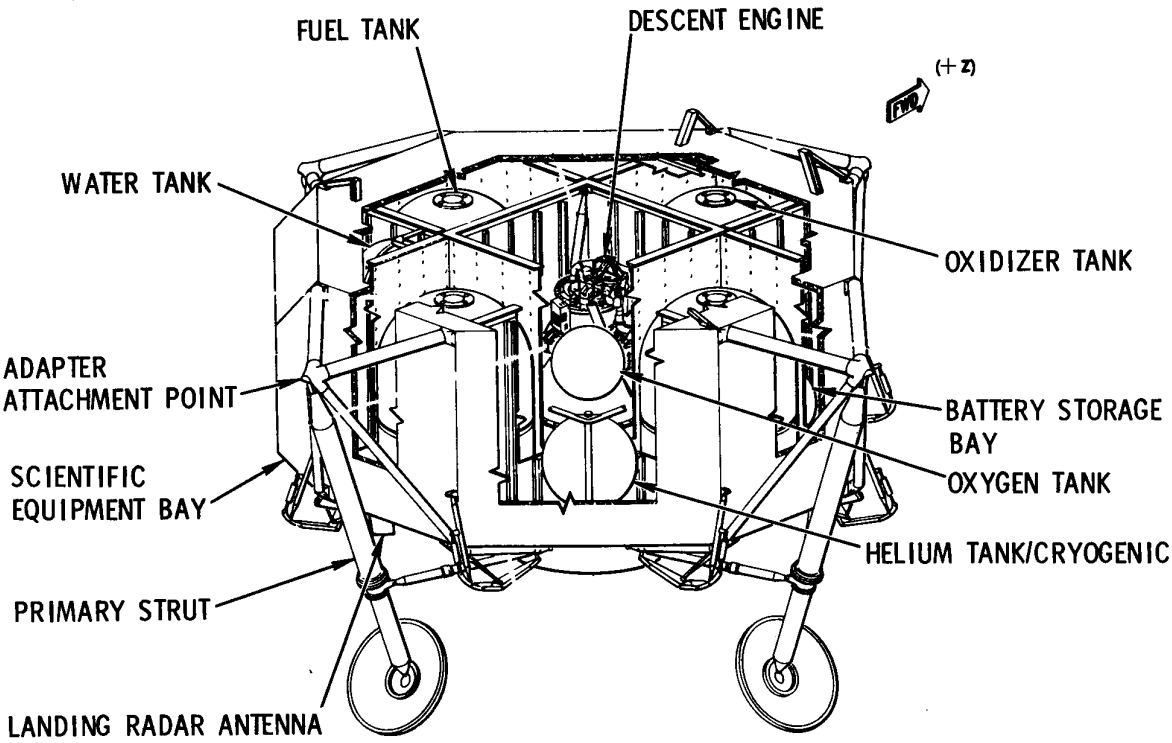
# CSM & LM COMPARISON




FAM-1023 



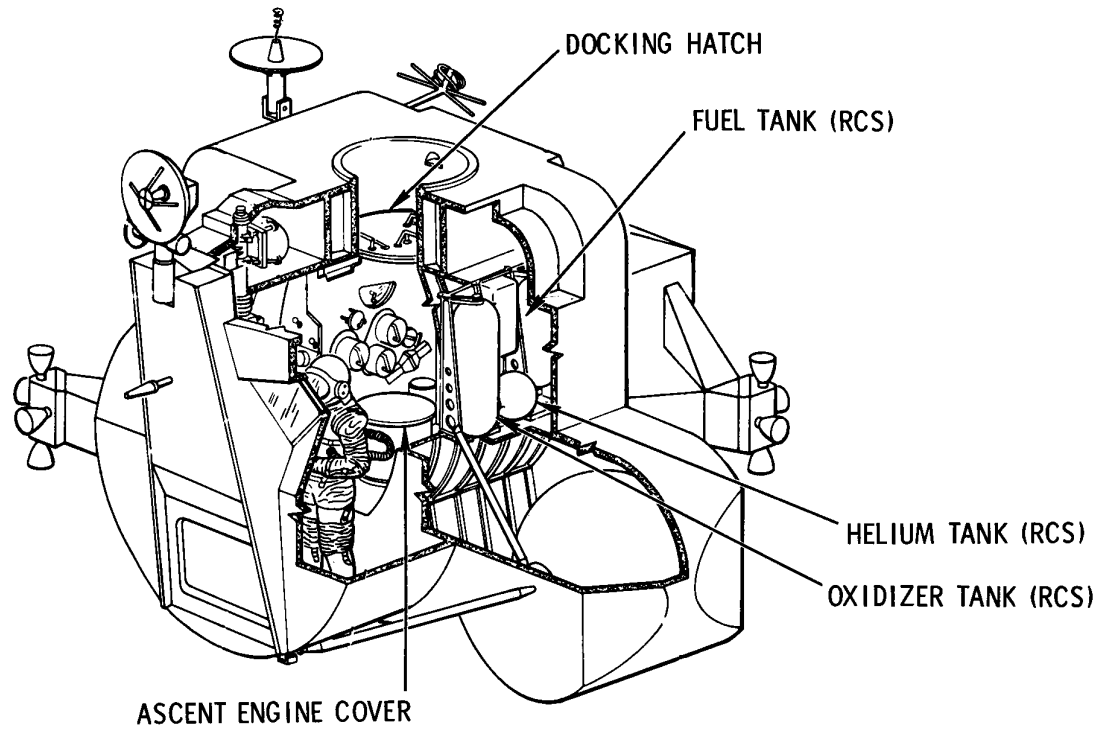
# LM DESCENT STAGE



FAM-1512 A 

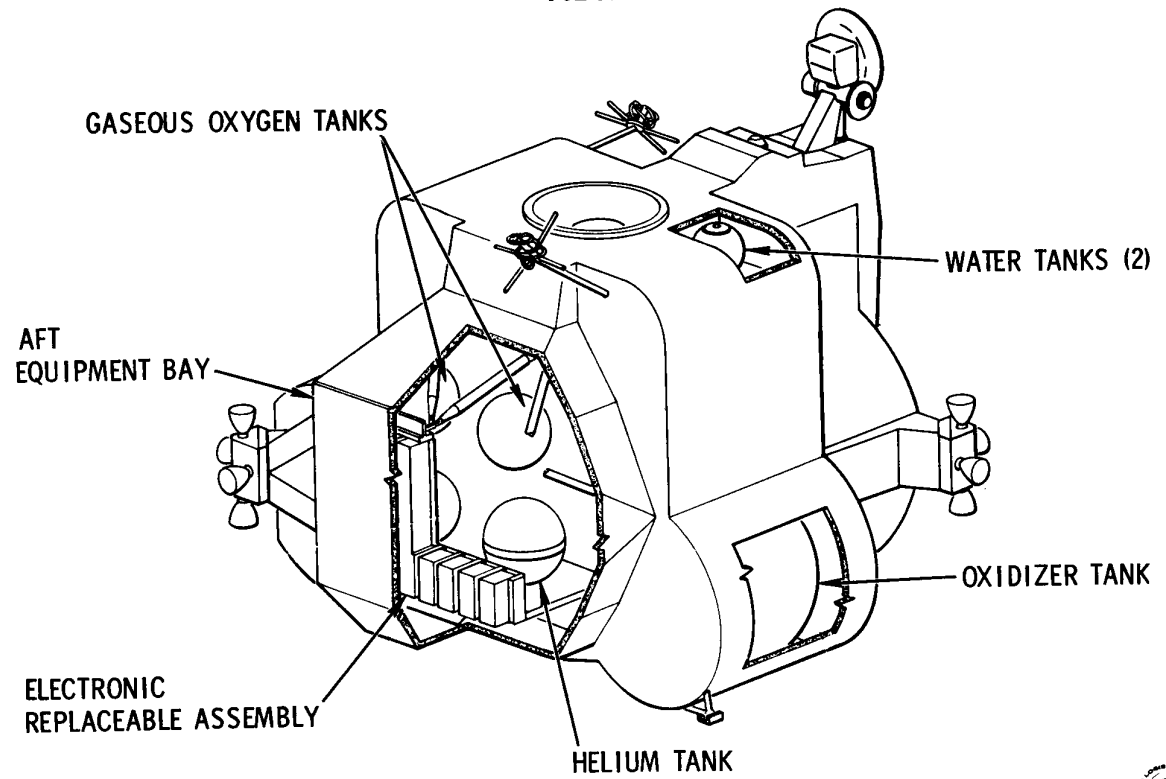
# LM ASCENT STAGE

VIEW A



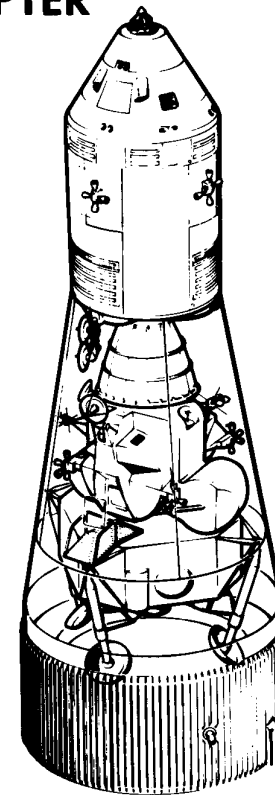
# LM ASCENT STAGE


VIEW B



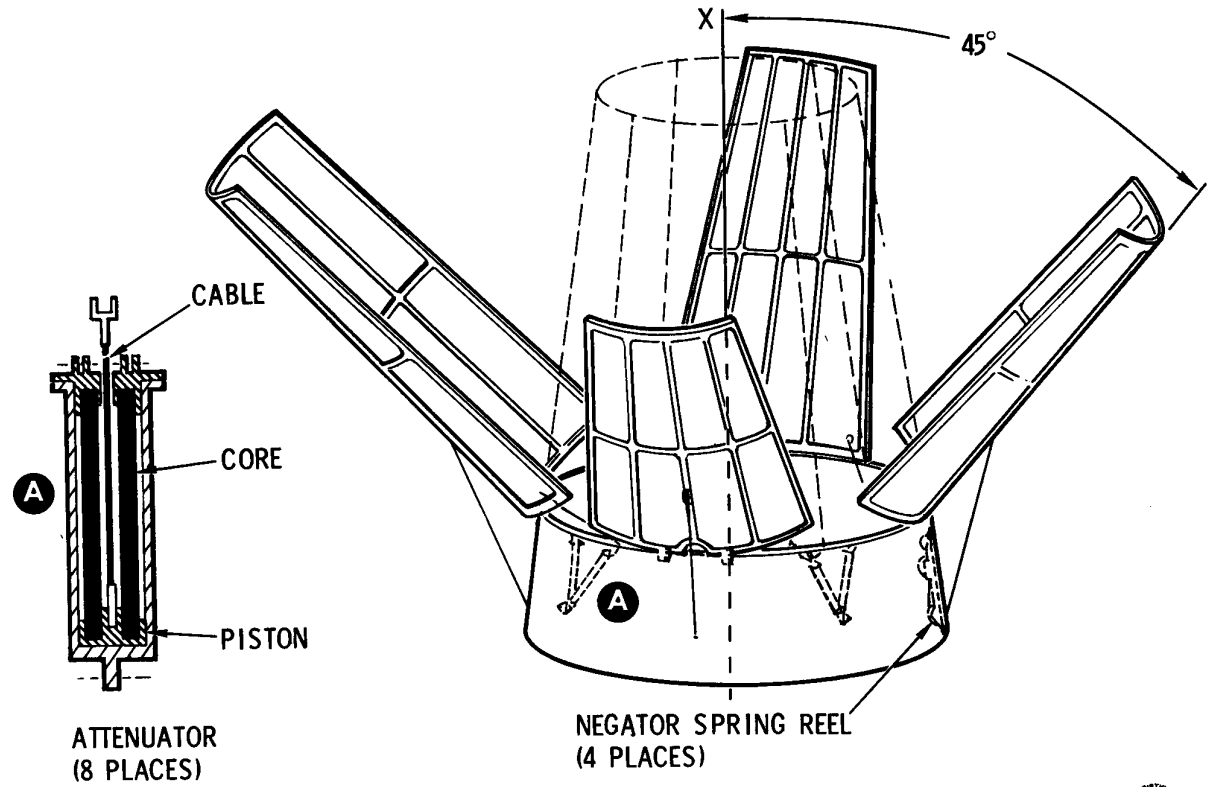
# SPACECRAFT/LM ADAPTER

PANEL SEPARATION BY  
EXPLOSIVE CHARGES  
(MDF)

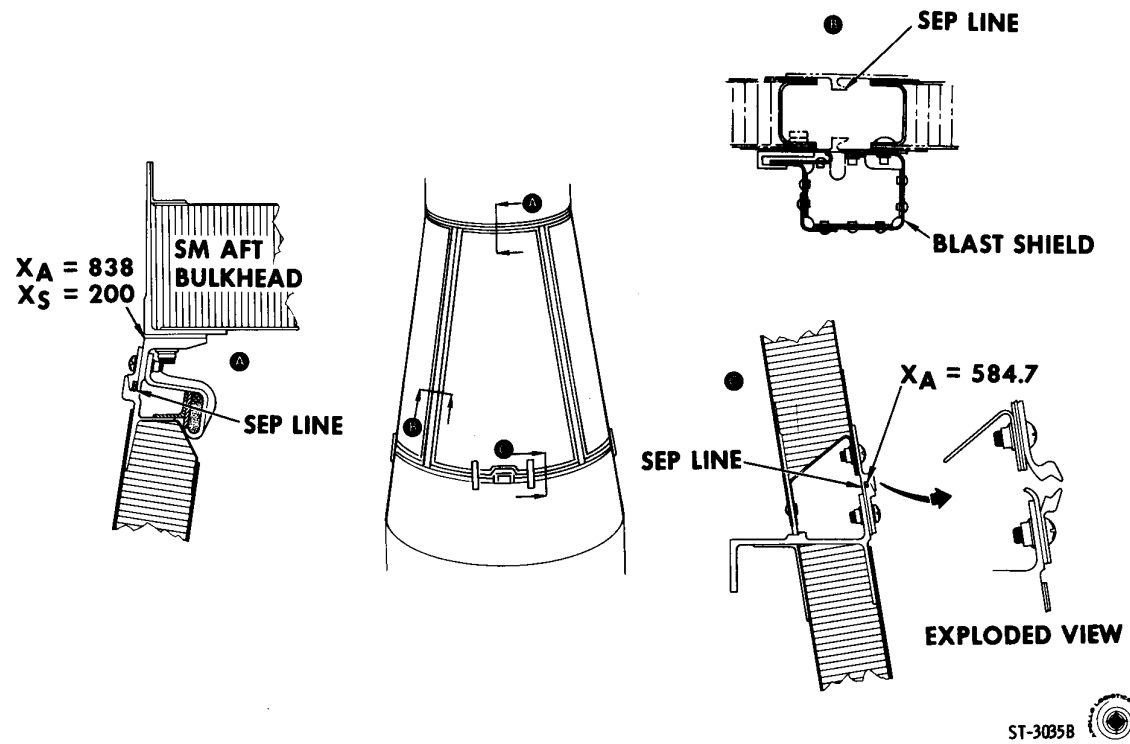


FAM-1503D 

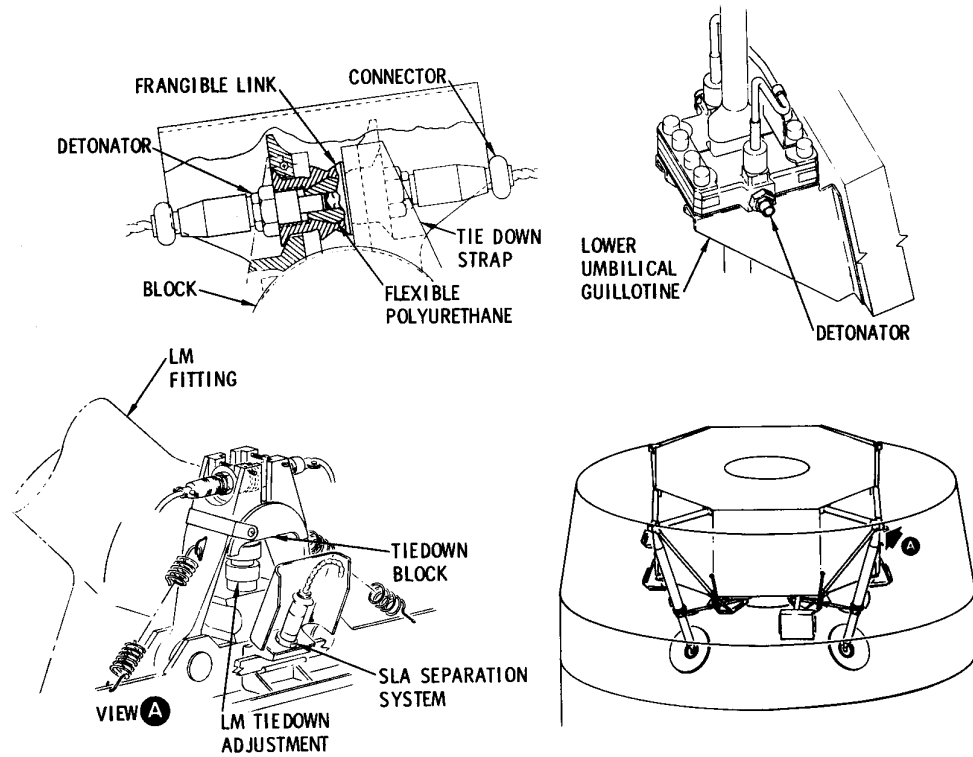
# SLA PANEL DEPLOYMENT



# ADAPTER PANEL SEPARATION LINE



# LM SEPARATION SYSTEM BLOCK II

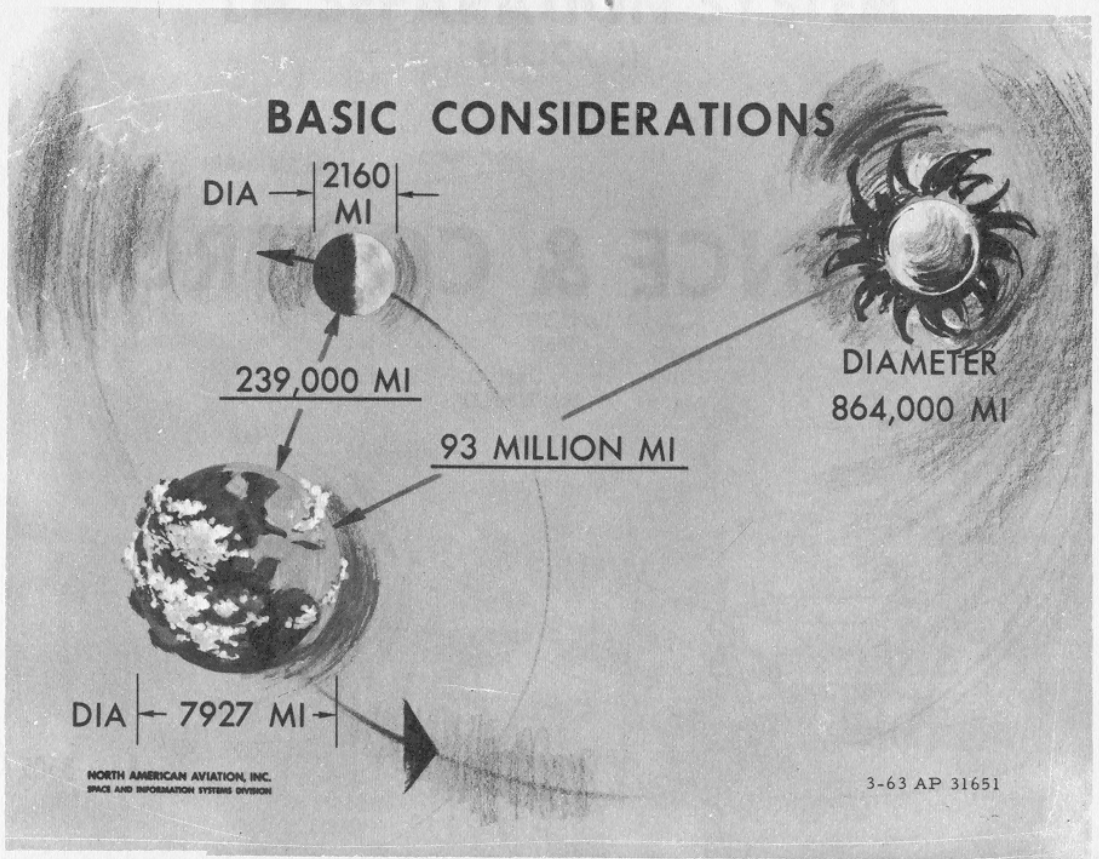


# GUIDANCE & CONTROL



IN SEPARATION SYSTEM

### BASIC CONSIDERATIONS



NORTH AMERICAN AVIATION, INC.  
SPACE AND INFORMATION SYSTEMS DIVISION

3-63 AP 31651

# VELOCITY REQUIREMENTS

## ESCAPE VELOCITY

36,700 FT/SEC



8,400 FT/SEC

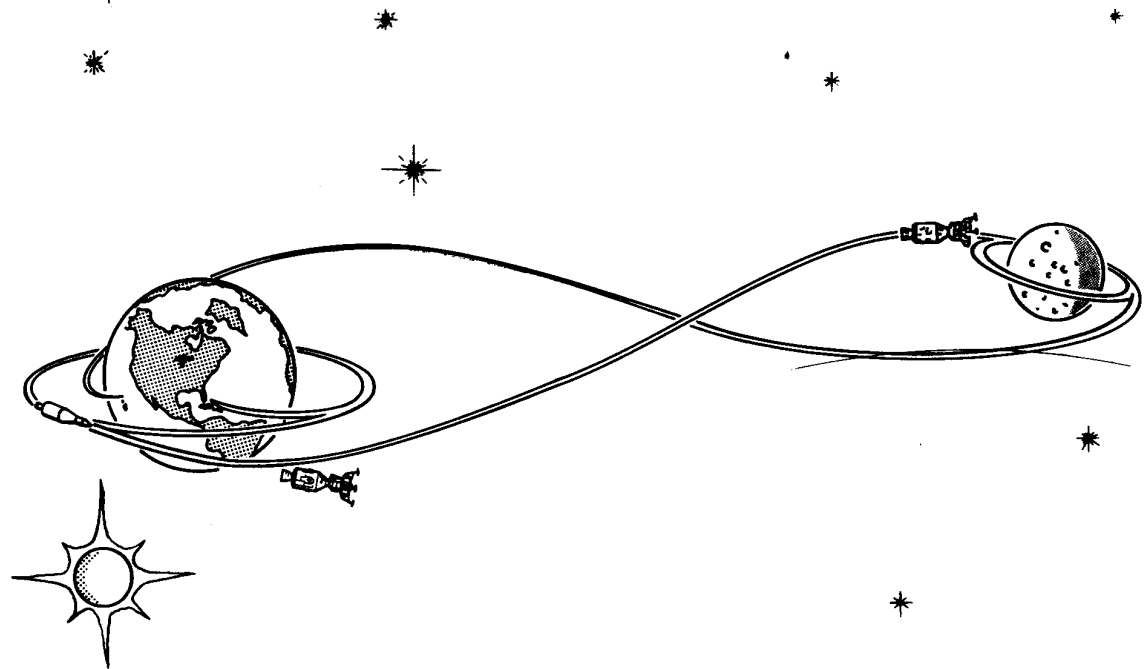
25,000 FT/SEC - ORBIT - 5280 FT/SEC

6 - RELATIVE GRAVITY - 1

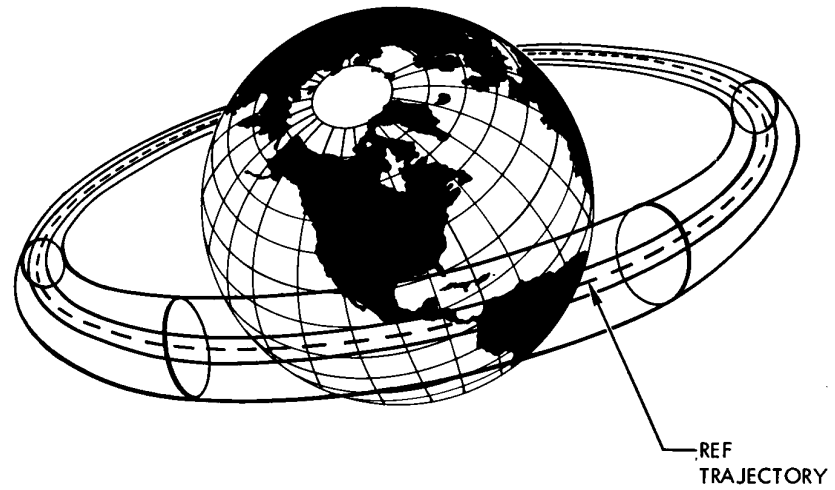
NORTH AMERICAN AVIATION, INC.  
SPACE AND INFORMATION SYSTEMS DIVISION

3-63 AP 31653

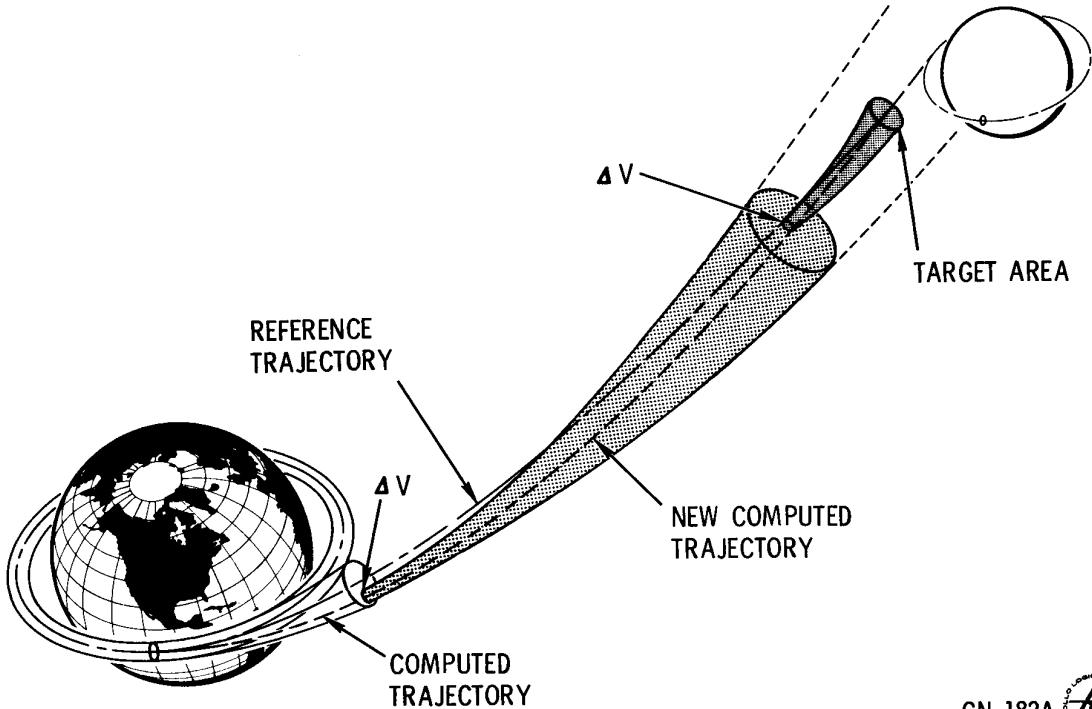
# GUIDANCE & NAVIGATION REFERENCE TRAJECTORIES



# EARTH ORBIT POSITION & TRAJECTORY DETERMINATION



# MIDCOURSE POSITION & TRAJECTORY DETERMINATION



# GUIDANCE & CONTROL FUNCTIONS

## GNCS

- POSITION
- TRAJECTORY
- VELOCITY
- ATTITUDE

## SCS

- RATE CONTROL
- ATTITUDE CONTROL
- DISPLAY
- MANUAL CONTROLS

## RCS

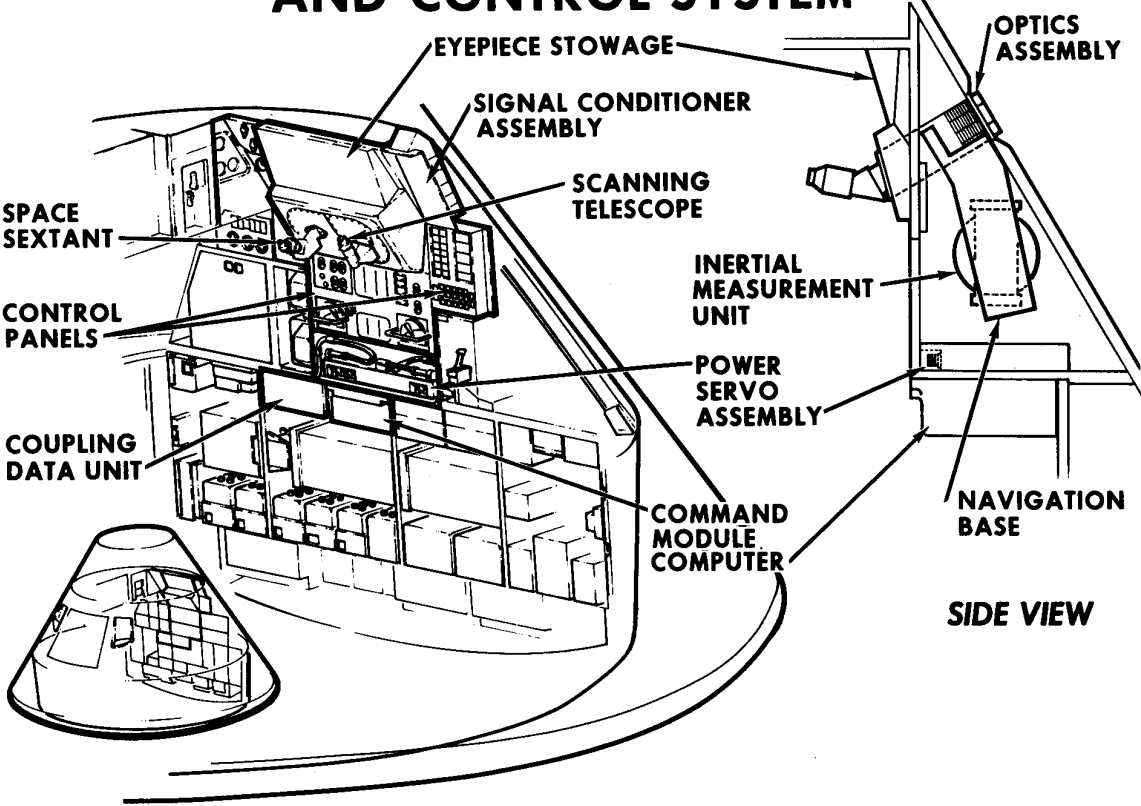
- ROTATION  
ROLL  
PITCH  
YAW
- TRANSLATION  
X, Y, Z  
ACCELERATIONS

## SPS

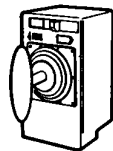
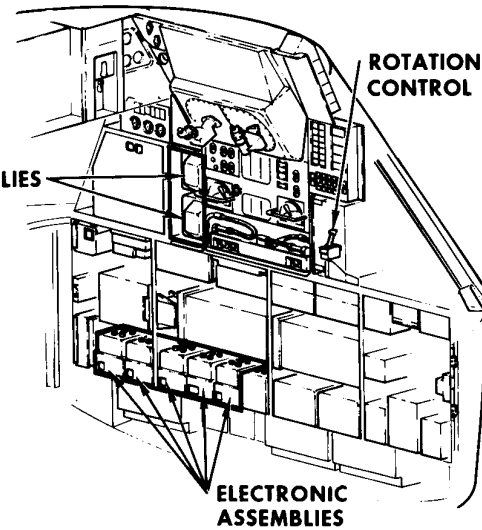
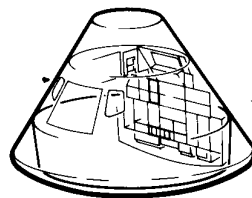
- MID-COURSE  
CORRECTIONS
- PLANE  
CHANGES
- LUNAR ORBIT  
INSERTION
- TRANS-EARTH  
INJECTION

# GUIDANCE, NAVIGATION, AND CONTROL SYSTEM

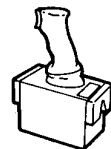
S865D10793B



# STABILIZATION AND CONTROL SYSTEM



TRANSLATION CONTROL

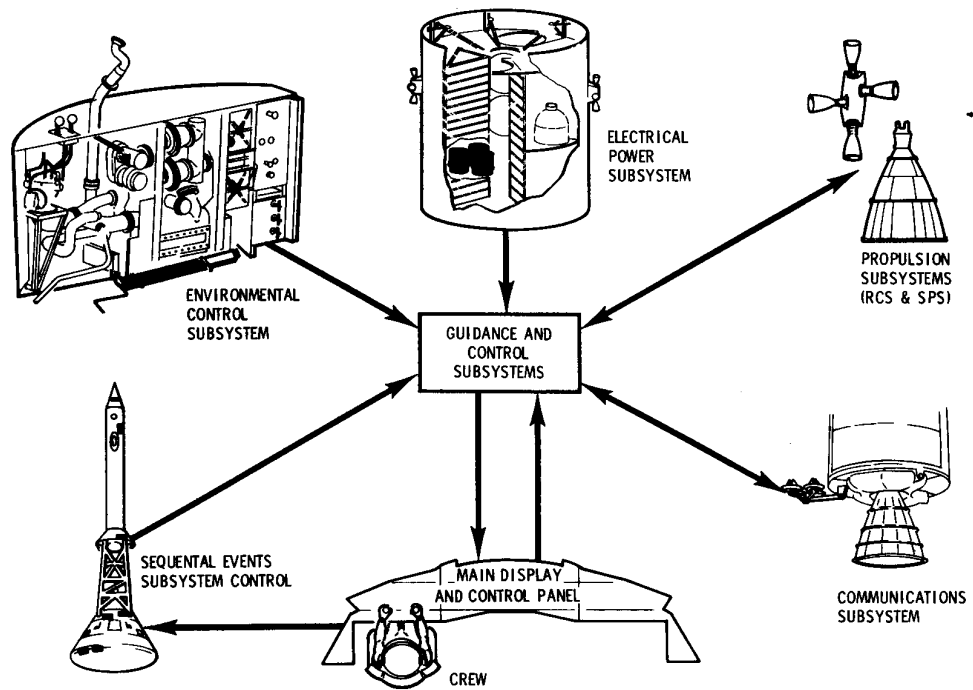


ROTATION CONTROL

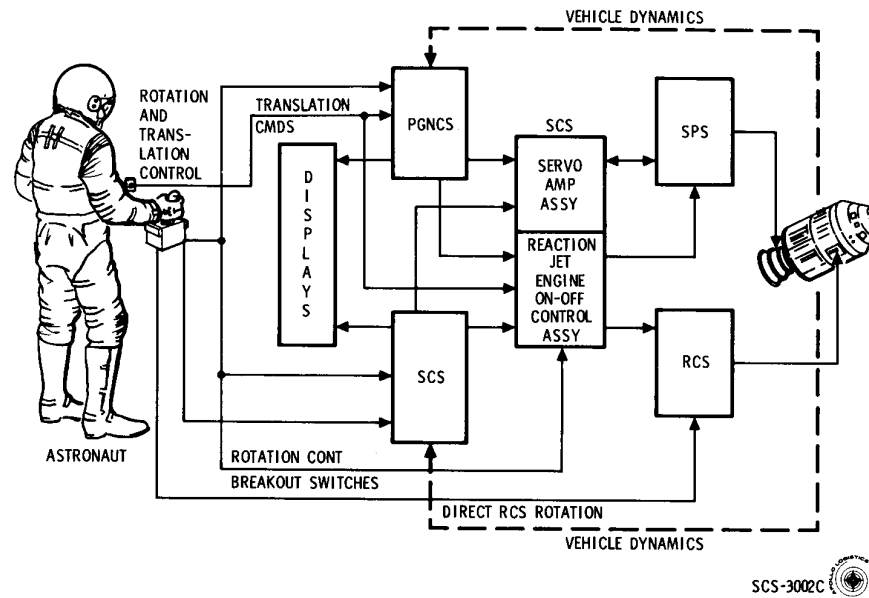
MANUAL CONTROLS



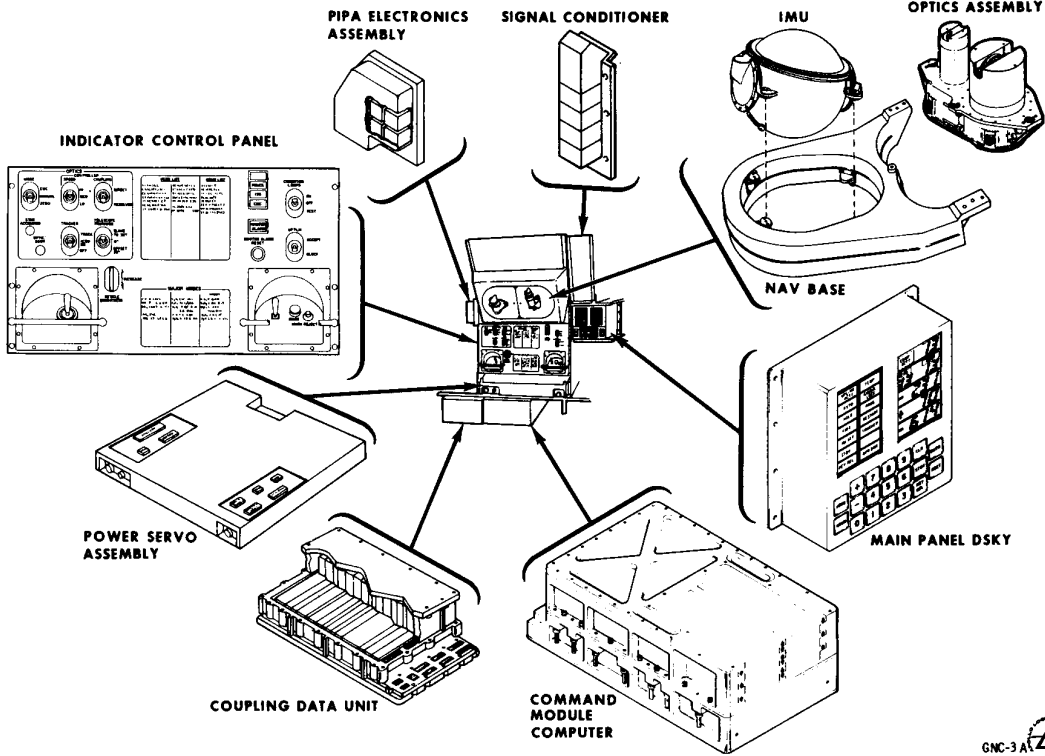
# G&C AND APOLLO SUBSYSTEMS INTERFACE



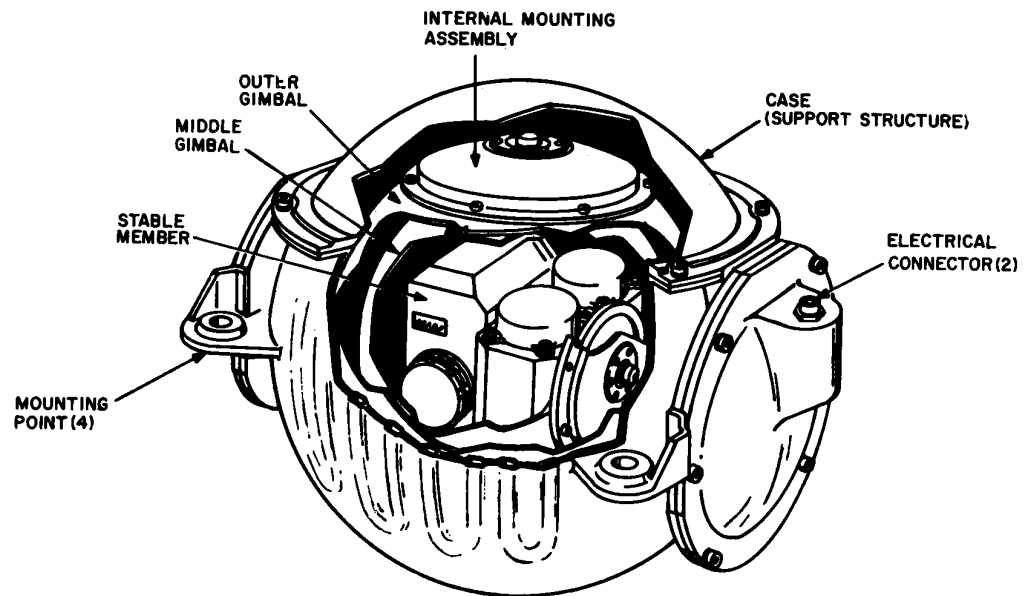
# CSM GUIDANCE & CONTROL



# PGNCS EQUIPMENT

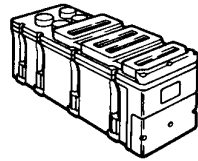


# INERTIAL MEASUREMENT UNIT

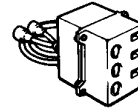


# SCS FLIGHT HARDWARE

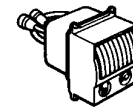
## BLOCK II



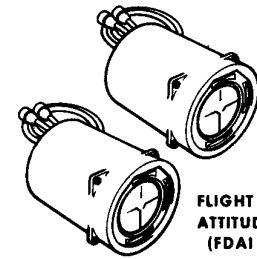
**ELECTRONIC CONTROL ASSEMBLY  
(ECA)**



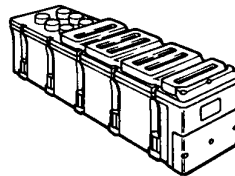
**ATTITUDE SET CONTROL PANEL  
(ASCP)**



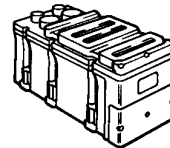
**GIMBAL POSITION/  
FUEL PRESSURE INDICATOR  
(GP/FPI)**



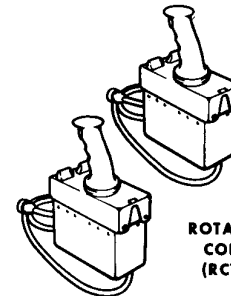
**FLIGHT DIRECTOR  
ATTITUDE INDICATOR  
(FDAI 1, FDAI 2)**



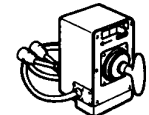
**REACTION JET AND ENGINE  
ON-OFF CONTROL  
(RJ/EC)**



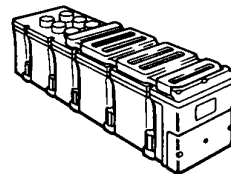
**THRUST VECTOR POSITION  
SERVO AMPLIFIER  
(TVSA)**



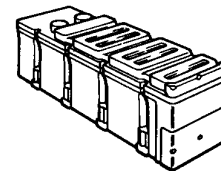
**ROTATION  
CONTROL  
(RC1, RC2)**



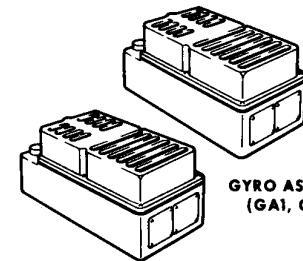
**TRANSLATION CONTROL  
(TC)**



**ELECTRONIC DISPLAY ASSEMBLY  
(EDA)**

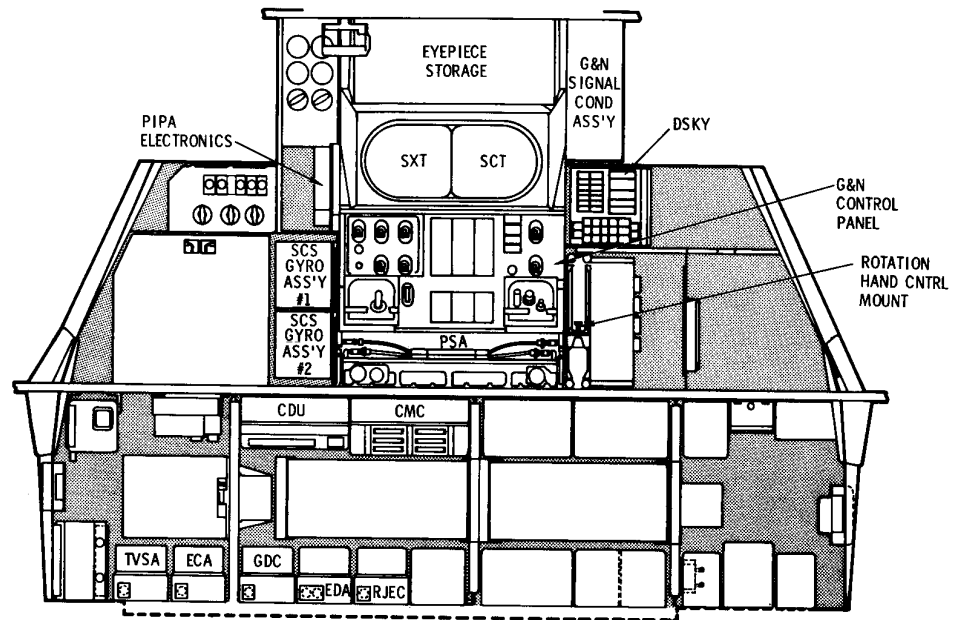


**GYRO DISPLAY COUPLER  
(GDC)**



**GYRO ASSEMBLY  
(GA1, GA2)**

# G&C EQUIPMENT LOCATION



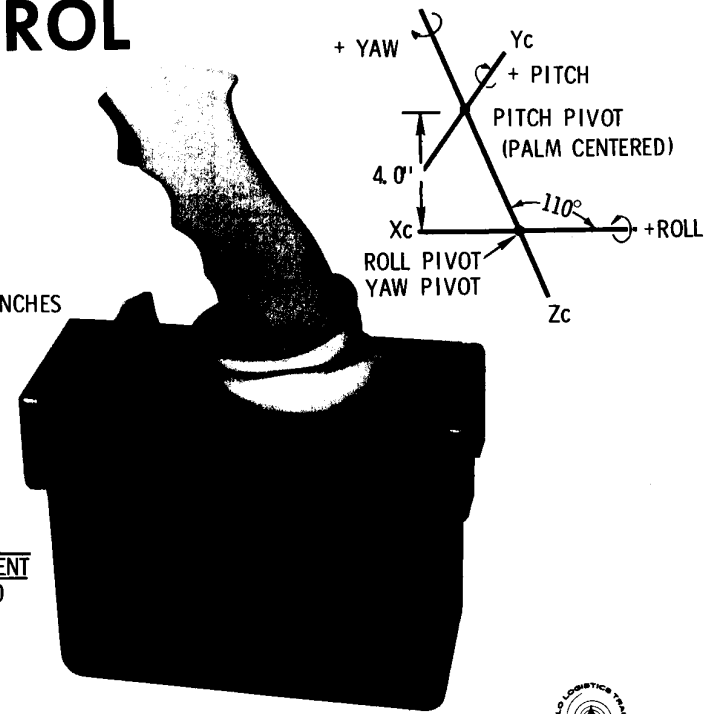
# ROTATION CONTROL

## PUSH TO TALK SWITCH PARAMETERS

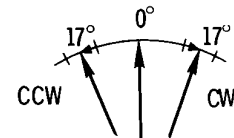
TRAVEL PRIOR TO SWITCH ACTUATION	8.0° MIN
TRAVEL TO HARDSTOP	25.0° MAX
MAXIMUM TORQUE	1.0 POUND INCHES

## ROTATION CONTROL PARAMETERS

	<u>DISPLACEMENT</u>
HARD STOP	11.5±0.50
DIRECT SWITCH ACTUATION	≈11.0°
SOFT STOP	10±1°
BREAKOUT SWITCH ACTUATION	1.5± 0.5°
CONTROLLER LOCK TO ARM	50.0°



# TRANSLATION CONTROL

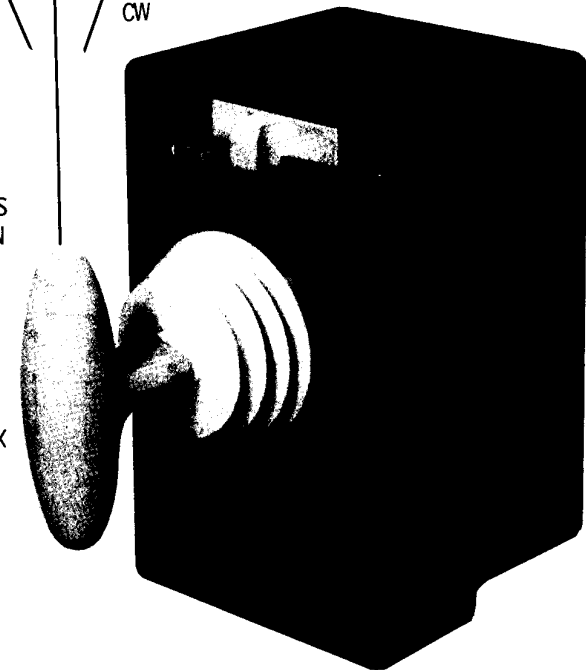
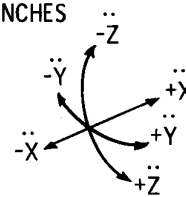


## CW & CCW CONTROL MOTION LIMITS

HARD STOP, DETENT & SWITCH CLOSURE	$17^{\circ} \pm 2^{\circ}$
FORCE INTO DETENT	$15 \pm 5.0$ LB INCHES
OUT OF DETENT	6 LB INCHES MIN

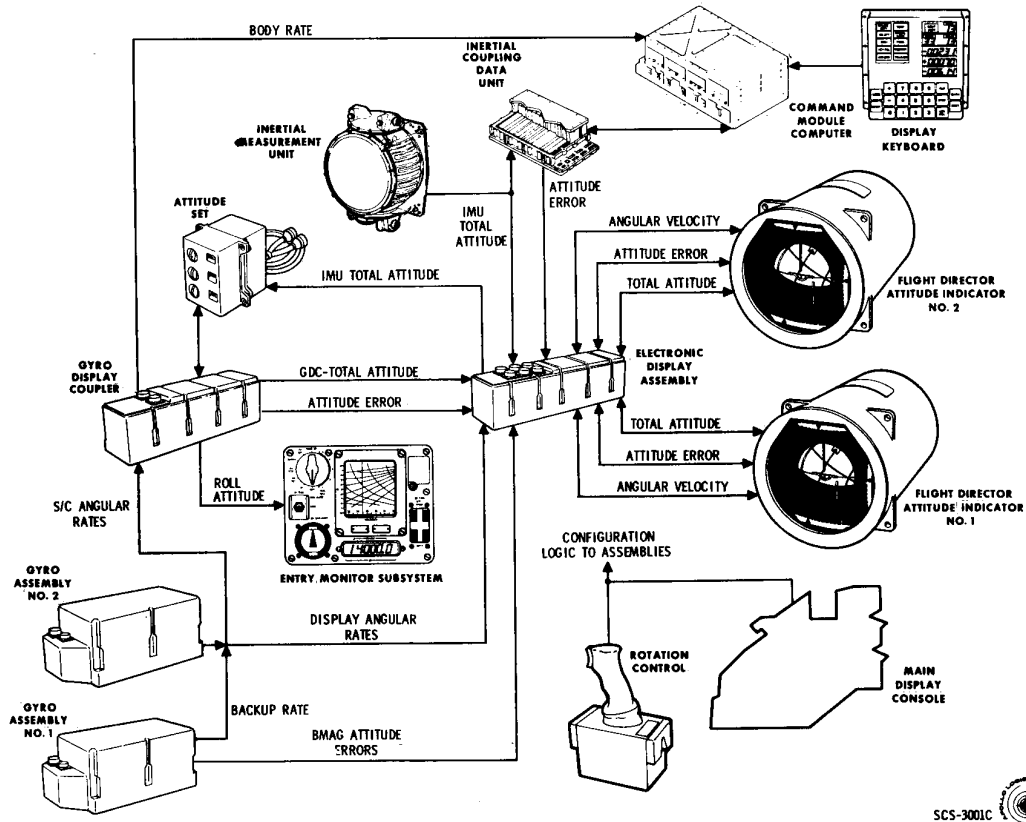
## TRANSLATION CONTROL MOTION LIMITS (+ OR - COMMANDS)

MECHANICAL STOP	-	$0.5 \pm 0.075$ ARC INCHES
SWITCH CLOSURE	-	$0.375 \begin{matrix} +0.025 \\ -0.075 \end{matrix}$ ARC INCHES
FORCE	-	$1.5 \pm 0.33$ POUNDS

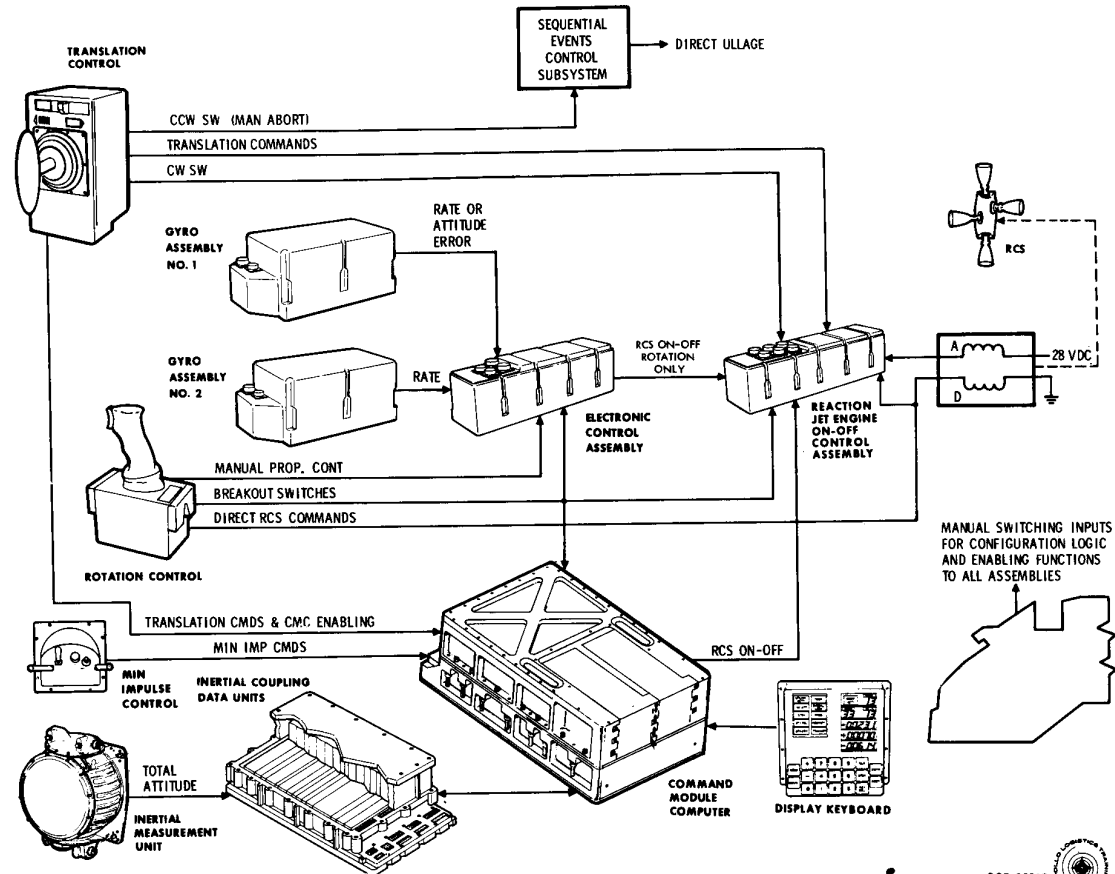




# G & C ATTITUDE REFERENCE

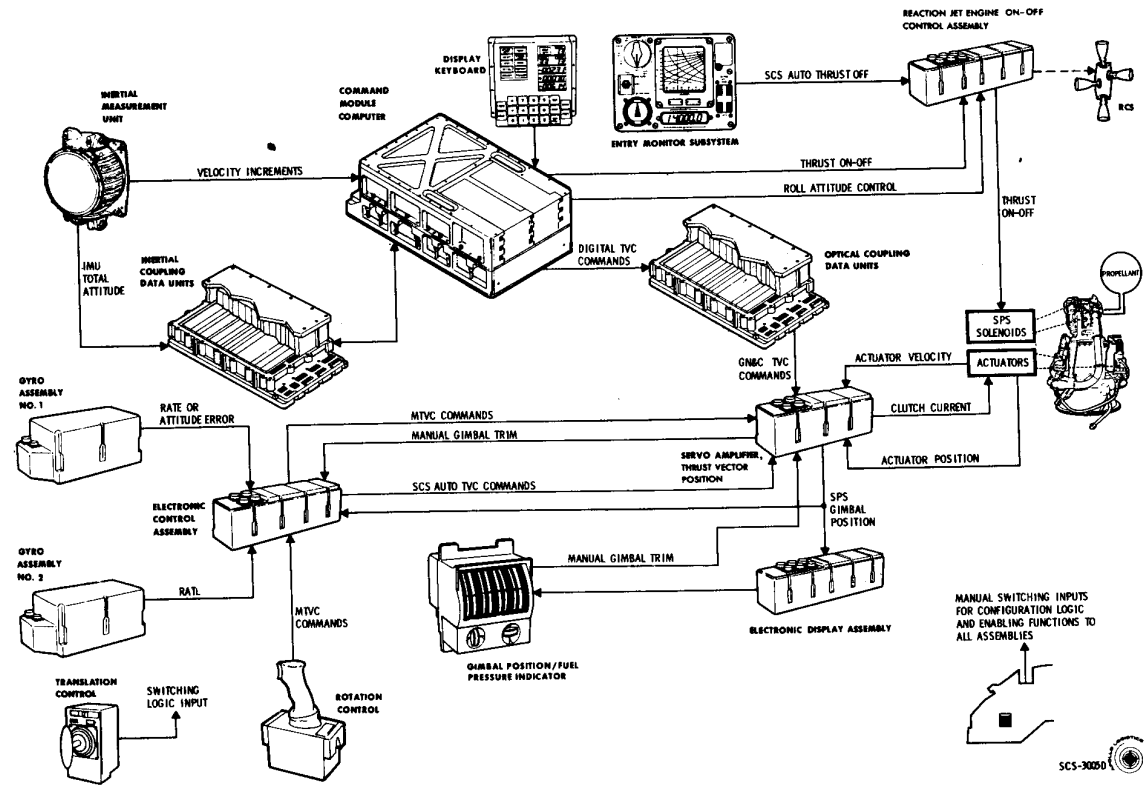


# G&C ATTITUDE CONTROL



SCS-3006E 

# G & C THRUST VECTOR CONTROL

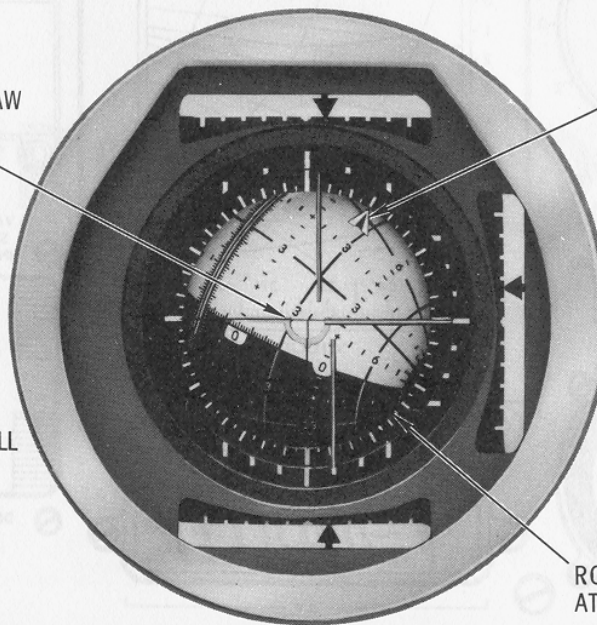


# FLIGHT DIRECTOR ATTITUDE INDICATOR

ROLL  
 +ANGULAR VELOCITY-  
 +ATTITUDE ERROR-

PITCH & YAW  
 INDEX

ROLL INDEX



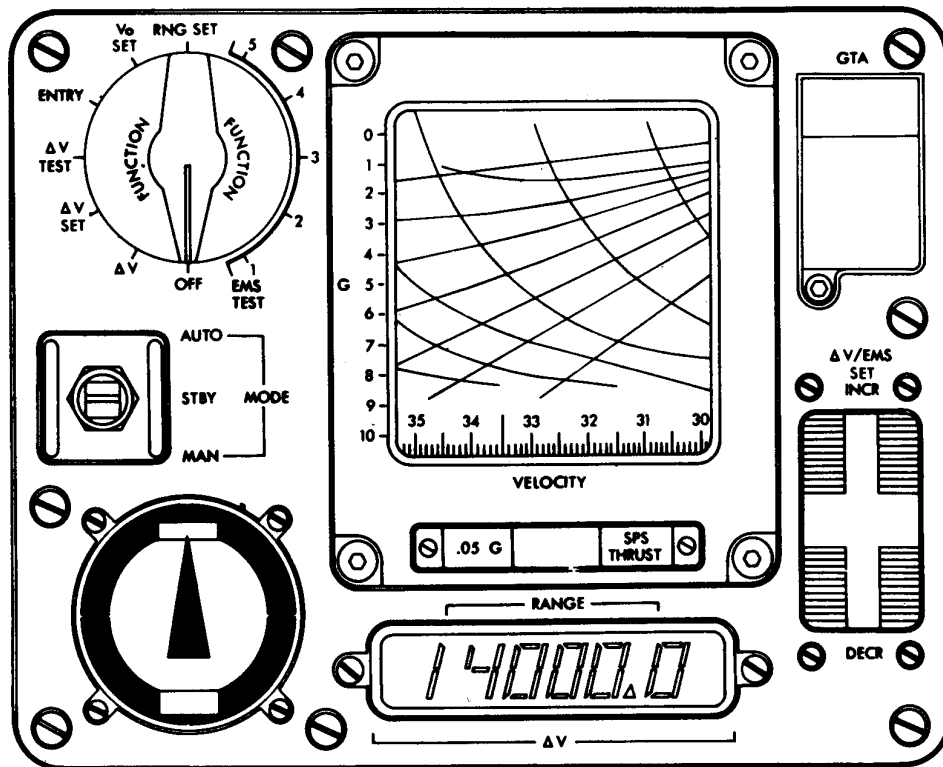
-	P	-
ATTITUDE	I	ANGULAR
ERROR	T	VELOCITY
	C	
+	H	+


EULER ATTITUDE ON BALL  
 PITCH -  $\theta = 014^\circ$   
 YAW -  $\psi = 034^\circ$   
 ROLL -  $\phi = 330^\circ$

NOTE:  
 ALL POLARITIES INDICATE  
 VEHICLE DYNAMICS

YAW  
 +ATTITUDE ERROR-  
 +ANGULAR VELOCITY-

ROLL TOTAL  
 ATTITUDE SCALE



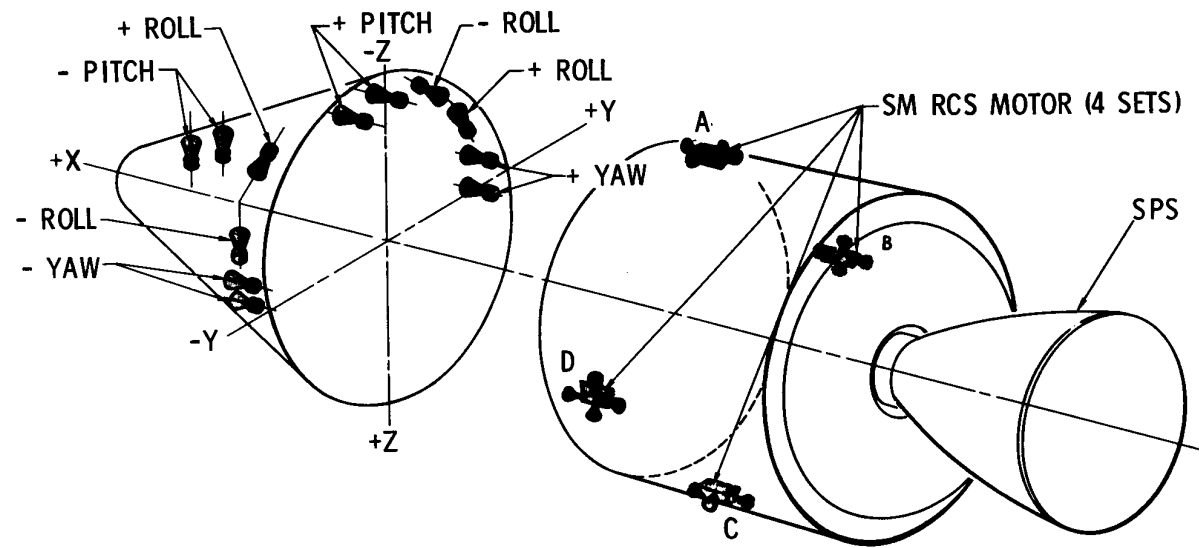
FAM-6400 

# PROPULSION

FAM-4000A



# ENGINE LOCATION



## S/M REACTION CONTROL SYSTEM

PURPOSE: PROVIDE POWER FOR ATTITUDE AND/OR TRANSLATION

CONTROL AFTER BOOSTER SEPARATION UNTIL C/M AND S/M SEPARATION

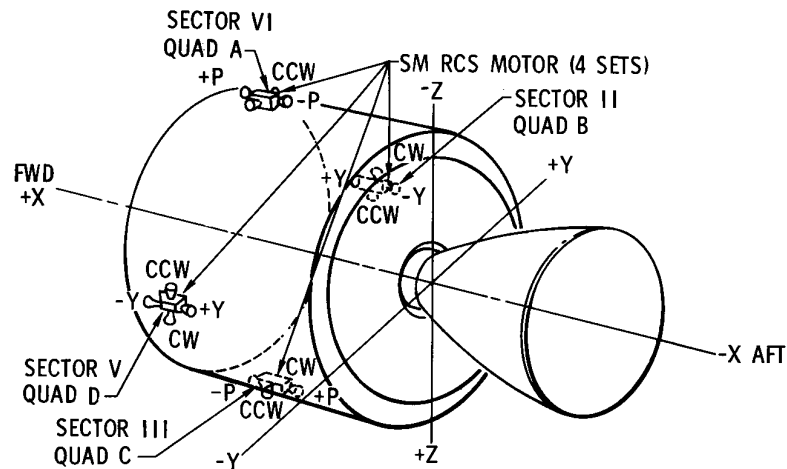
TYPE OF SYSTEM: NON THROTTLEABLE, PRESSURE FEED SYSTEM, HYPERGOLIC PROPELLANTS AND RADIANT COOLED THRUST CHAMBERS.

SYSTEM DESCRIPTION: FOUR INDIVIDUAL SUB-SYSTEMS

EACH SUBSYSTEM CONSISTS OF A SEPARATE PROPELLANT FEED SYSTEM AND FOUR THRUST CHAMBERS

PROPELLANTS - INHIBITED NITROGEN TETROXIDE AND MONOMETHYL HYDRAZINE

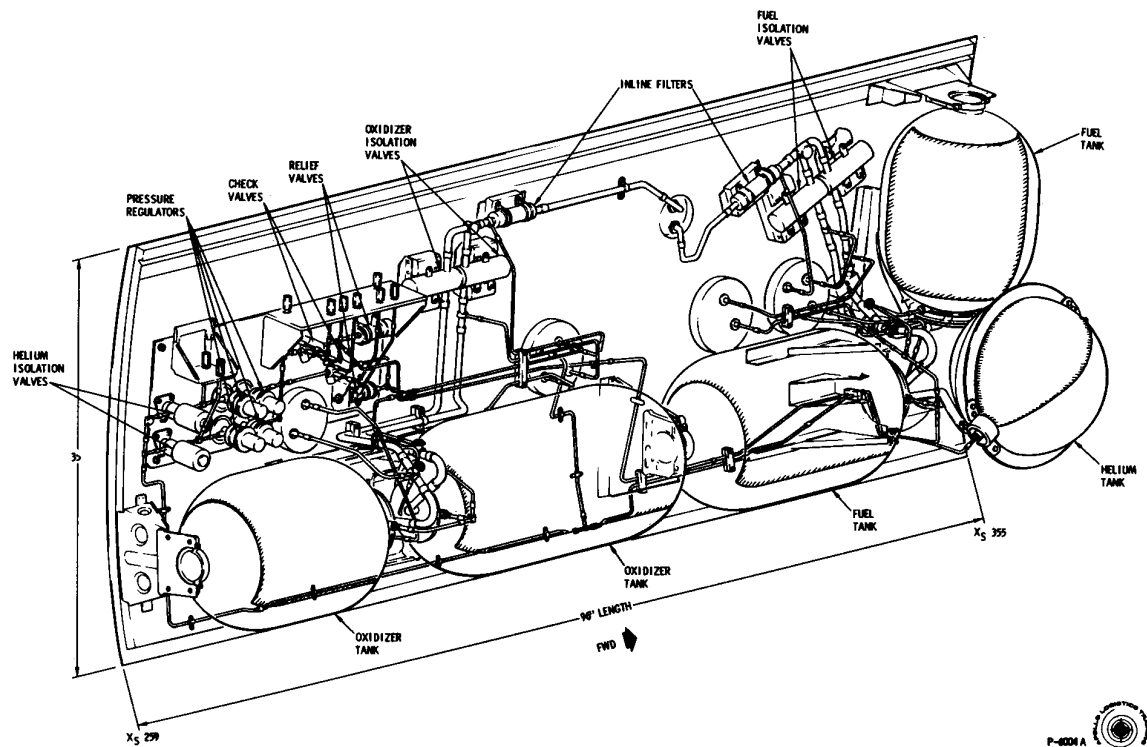
SYSTEM CONTROLLED BY CMC OR SCS WITH A MANUAL BACK-UP CAPABILITY



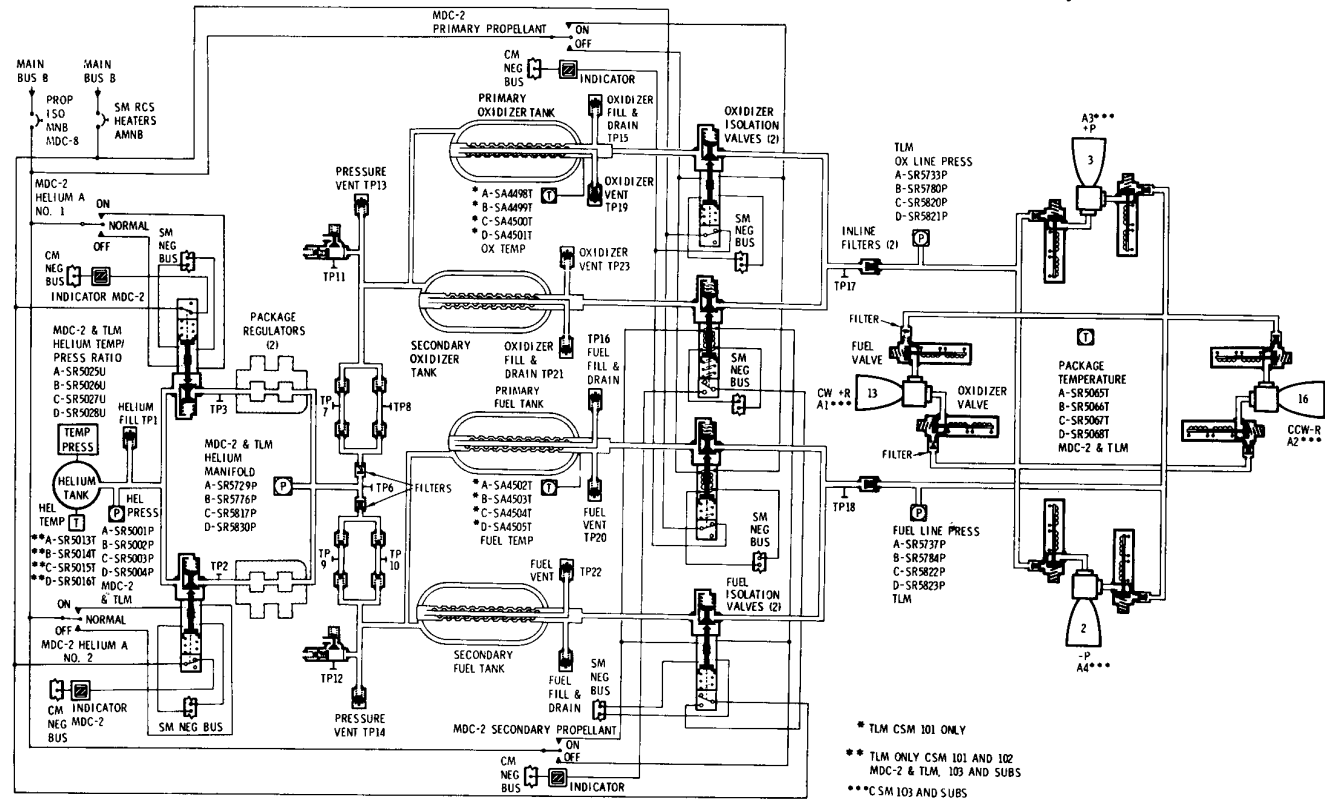
P-6000A 



# SM RCS PANEL ASSEMBLY QUAD B & D

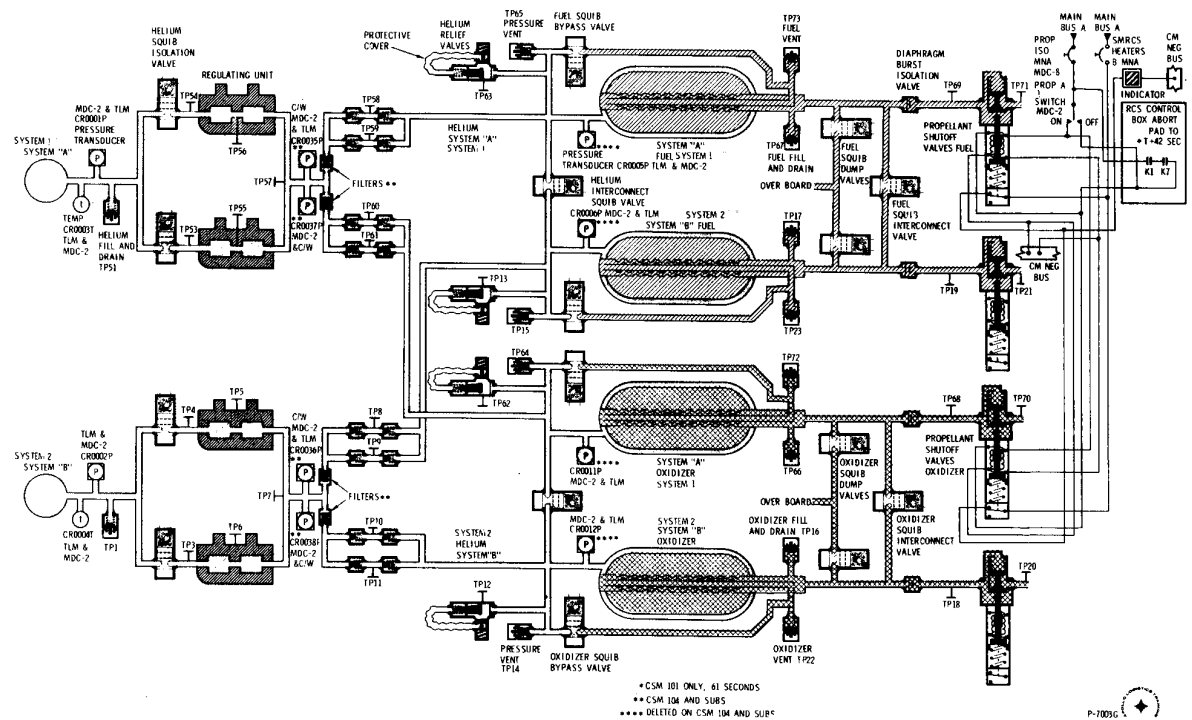


# SM REACTION CONTROL SUBSYSTEM (QUAD A)

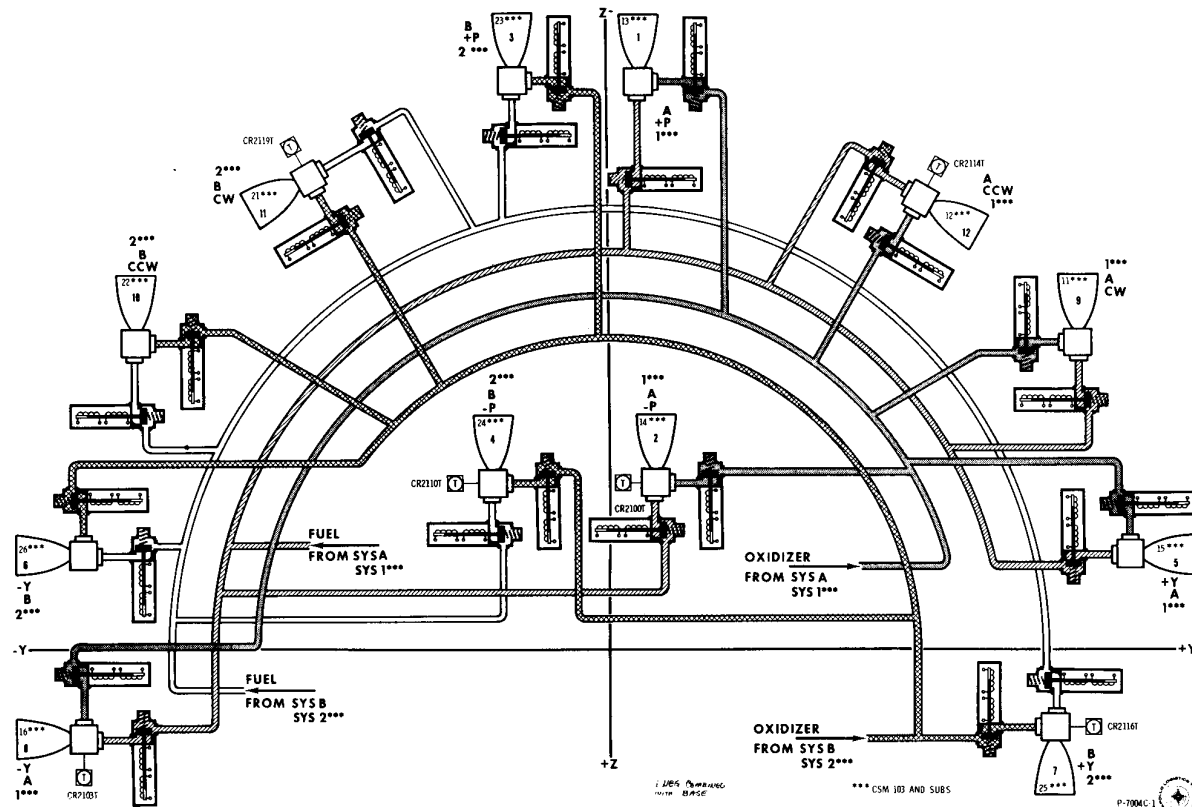


# CM REACTION CONTROL SUBSYSTEM

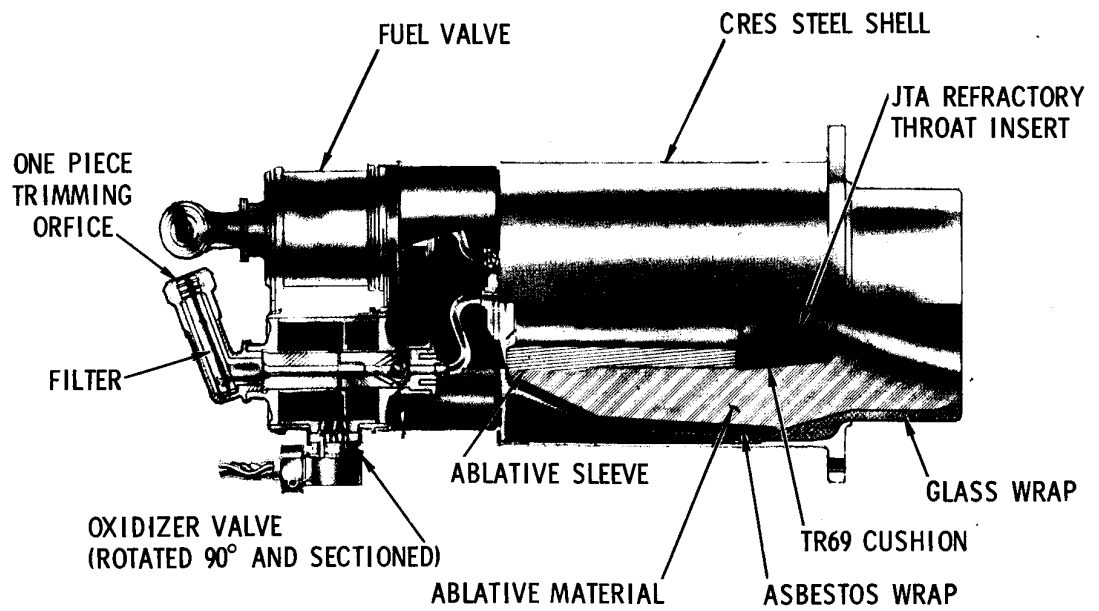
## PROPELLANT FEED SUBSYSTEM A&B



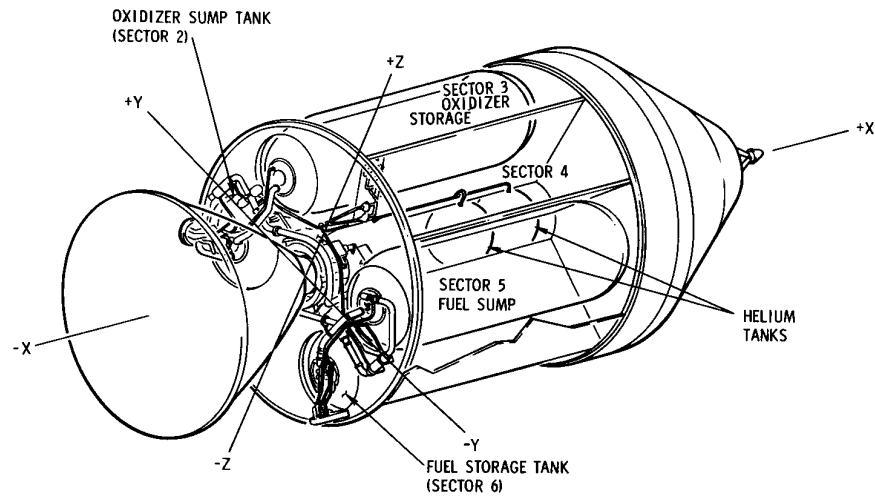
# CM REACTION CONTROL ENGINES



# CM RCS ENGINE



# SERVICE PROPULSION SYSTEM




**TYPE OF SYSTEM:** NON-THROTTLEABLE, PRESSURE FEED SYSTEM, HYPERGOLIC PROPELLANTS AND ABLATIVE CHAMBER WITH RADIANT COOLED NOZZLE EXTENSION.

**SYSTEM DESCRIPTION:** ONE SYSTEM CONSISTING OF A PROPELLANT FEED SYSTEM AND ONE ENGINE

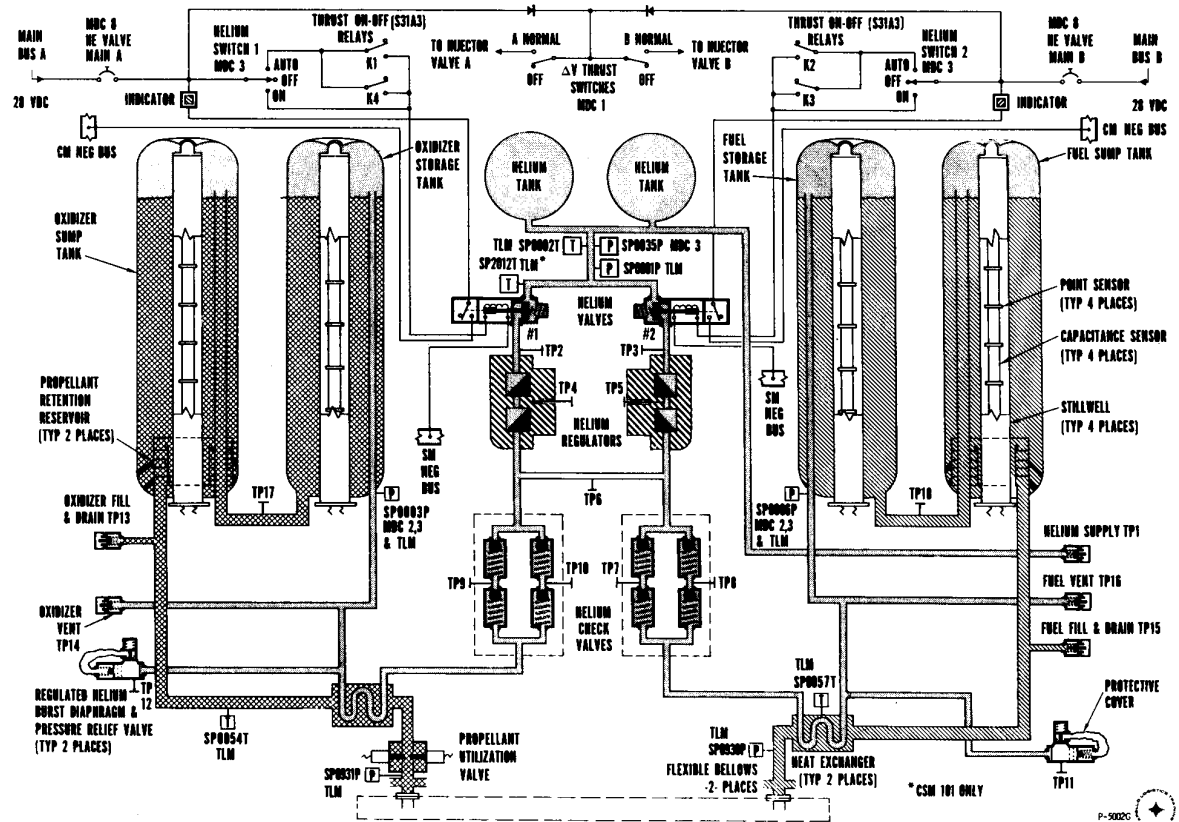
**PROPELLANTS -** INHIBITED NITROGEN TETROXIDE AND BLENDED HYDRAZINE (50% UDMH & 50% HYDRAZINE)

**SYSTEM CONTROLLED BY** CMC OR SCS WITH A MANUAL BACK-UP CAPABILITY

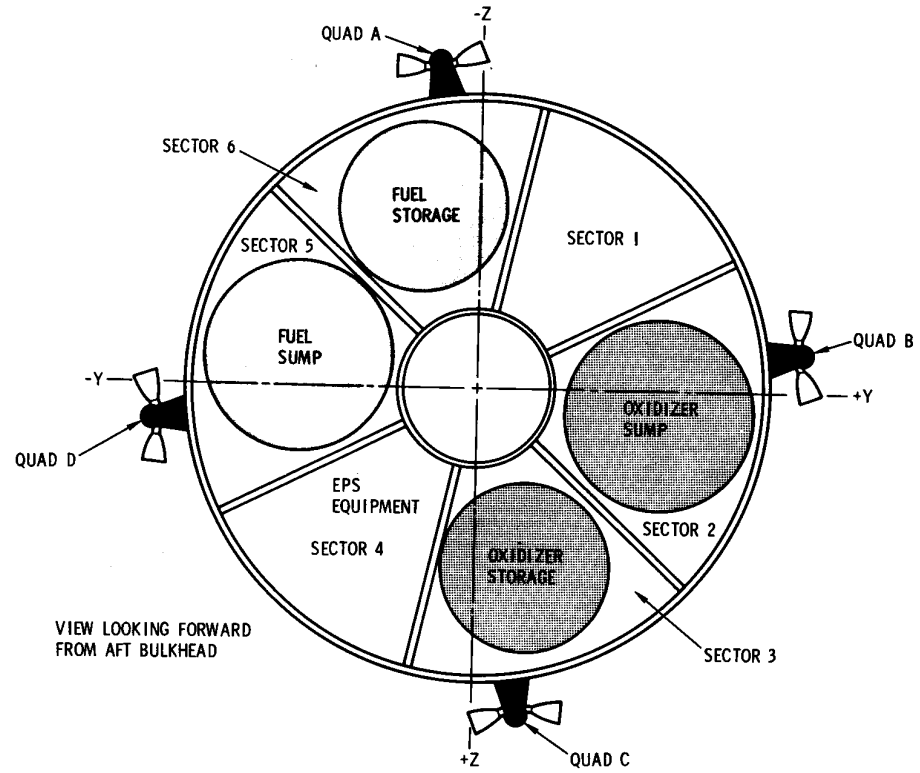
**PURPOSE:** PROVIDE THRUST FOR MAJOR VELOCITY CHANGES AFTER BOOSTER SEPARATION UNTIL C/M S/M SEPARATION. IN ADDITION SUPPORTS S/M ABORT AFTER THE LAUNCH ESCAPE TOWER HAS BEEN JETTISONED.

P-5078A 

# SERVICE PROPULSION SYSTEM PROPELLANT FEED

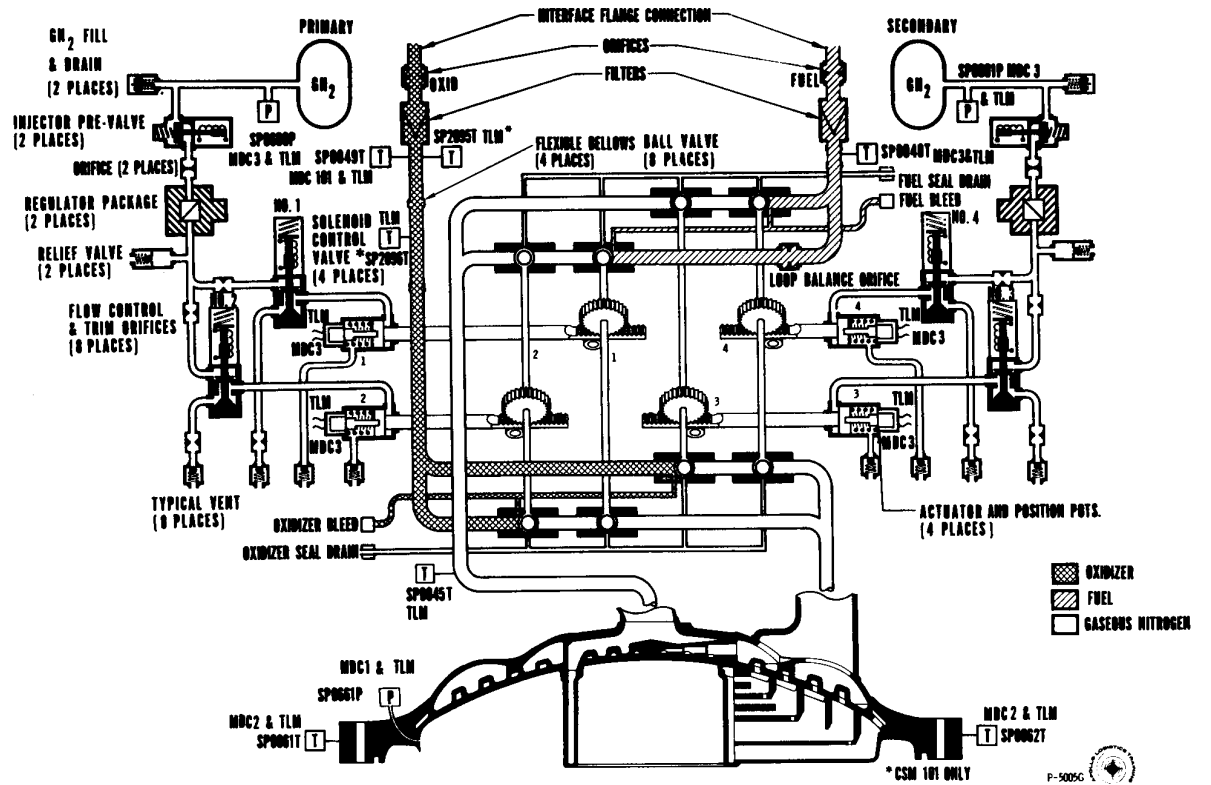


# SERVICE MODULE SECTORS



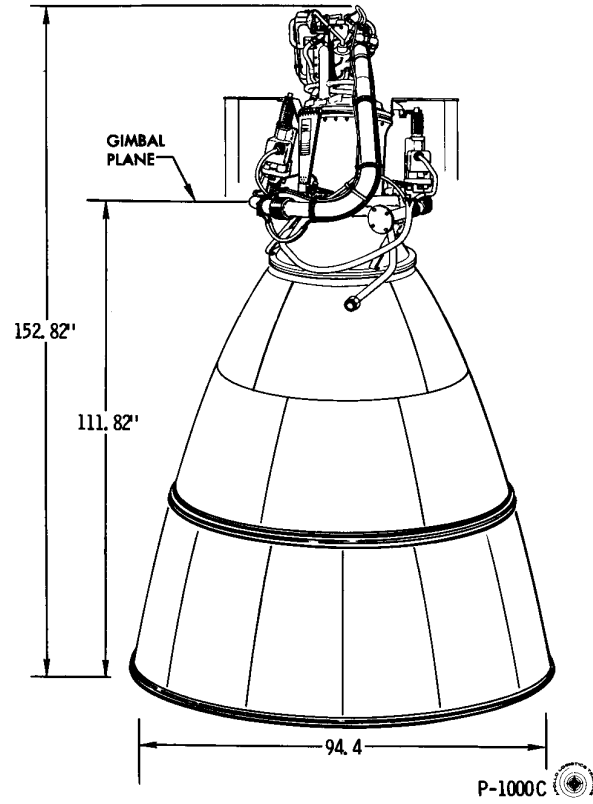


# SPS ENGINE PROPELLANT FEED

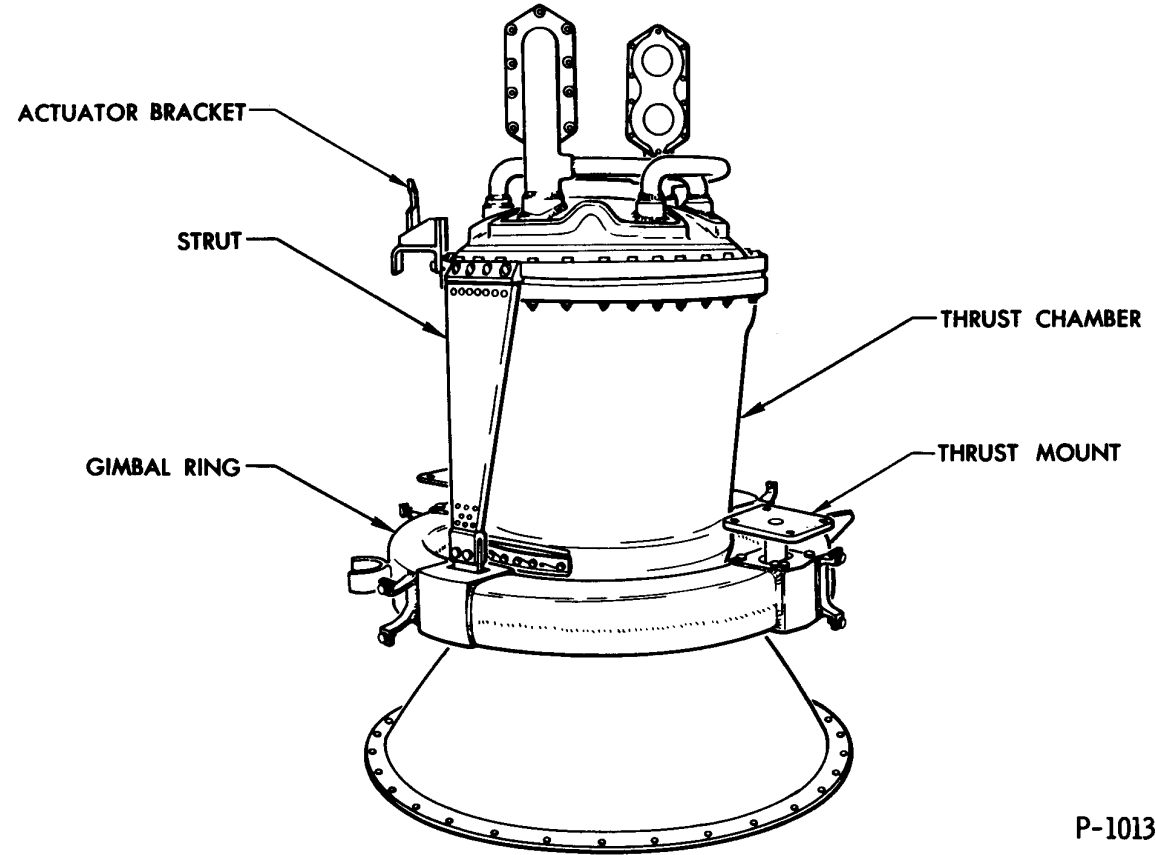


# SPS ROCKET ENGINE

AJ10-137



# SPS RING, STRUT & THRUST CHAMBER ASSEMBLY



# TELECOMMUNICATIONS

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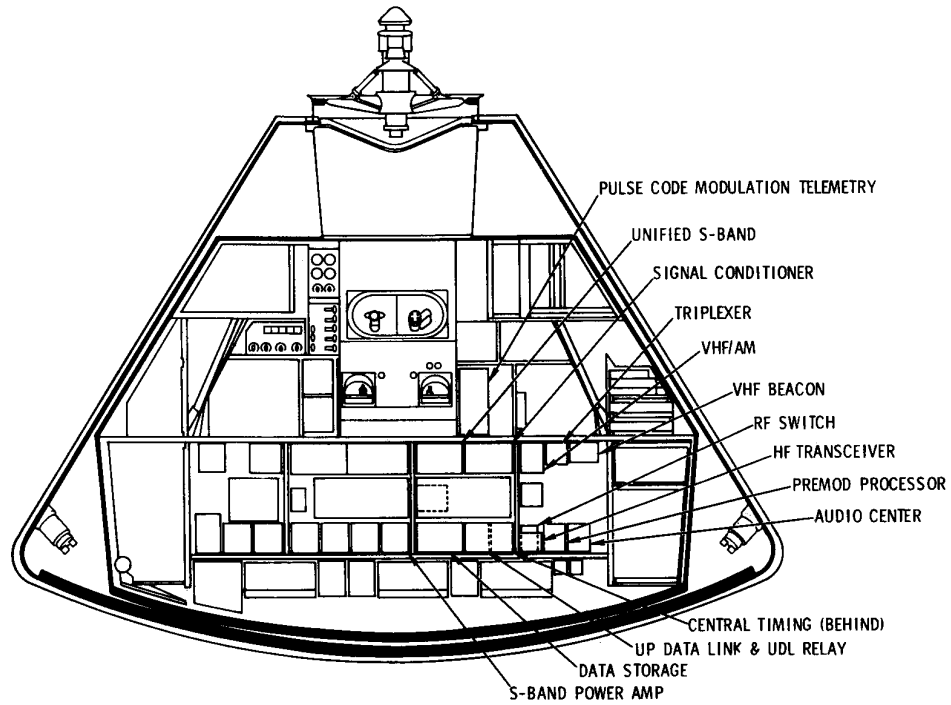
# COMMUNICATIONS SYSTEM

## MISSION REQUIREMENTS

- DATA COLLECTION
  - CREW STATUS
  - SYSTEM STATUS
- VOICE
- TV
- TRACKING
- RECOVERY BEACON
- UP DATA
- TAPE RECORDER

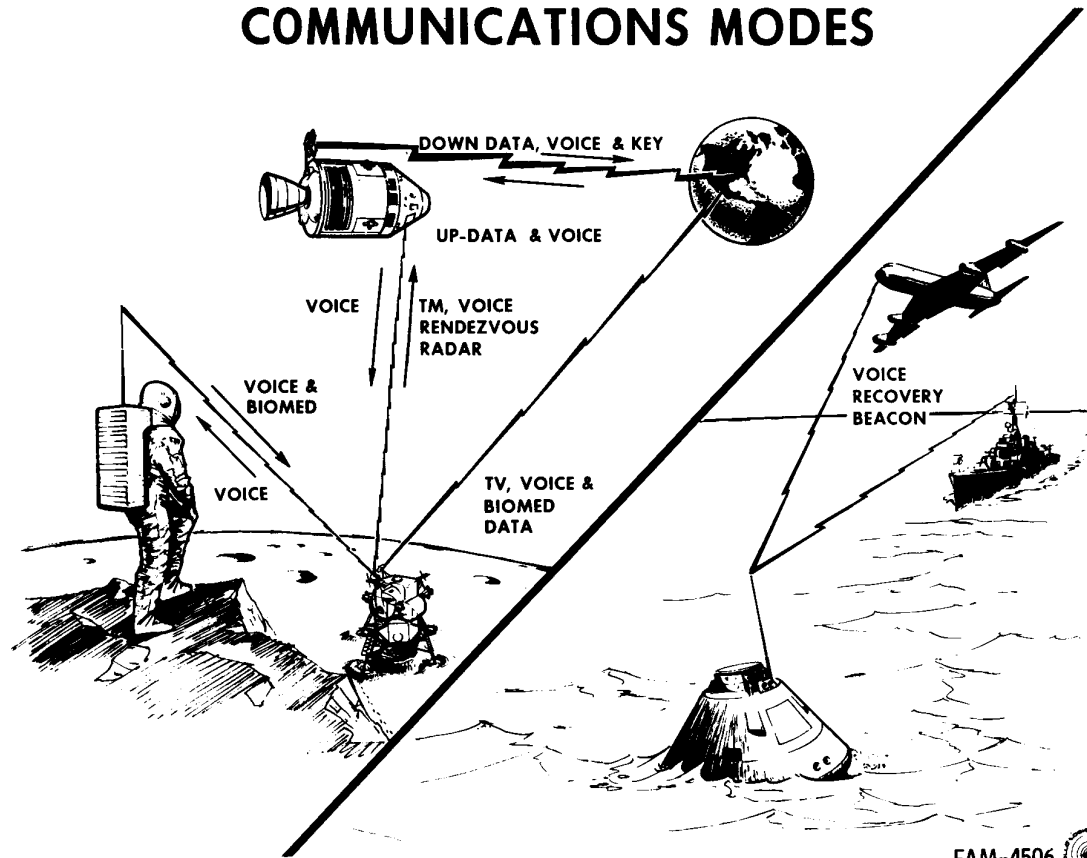
# TELECOMMUNICATIONS EQUIPMENT

LOWER EQUIPMENT BAY BLOCK II

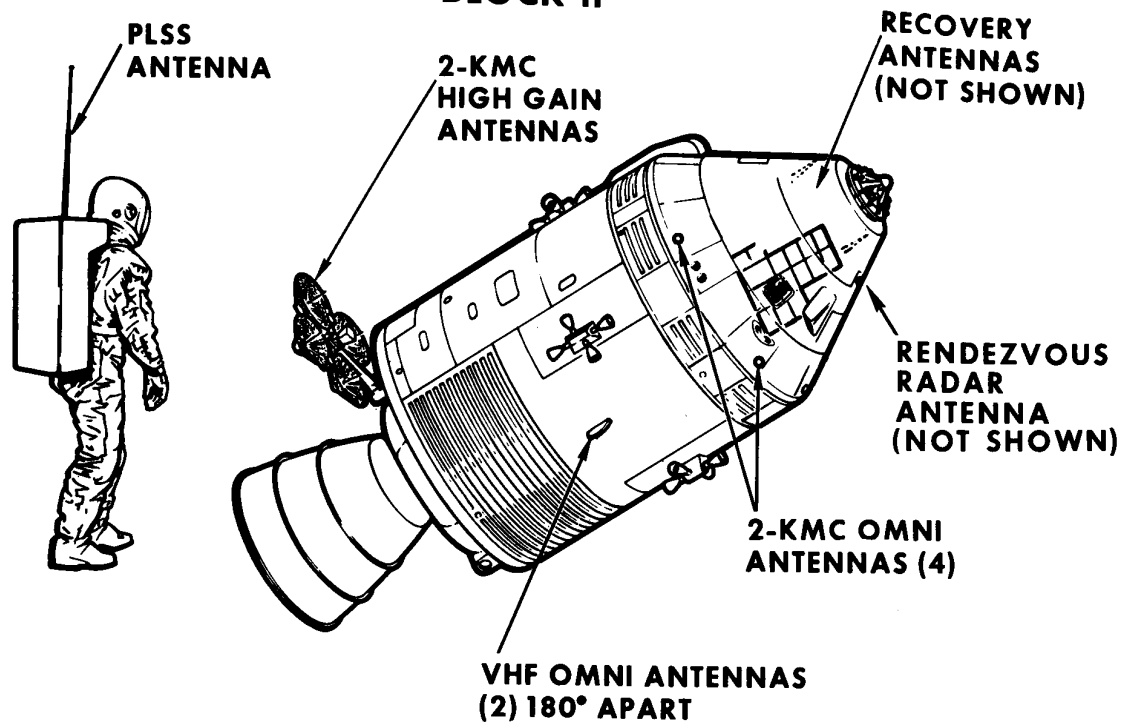



CD-2006 

# COMMUNICATIONS MODES



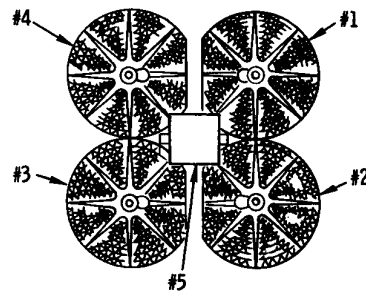
# COMMUNICATIONS SYSTEM BLOCK II



FAM-4507A 



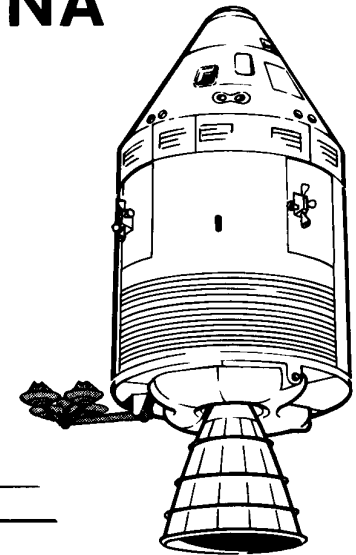
# BLOCK II S-BAND HI GAIN ANTENNA



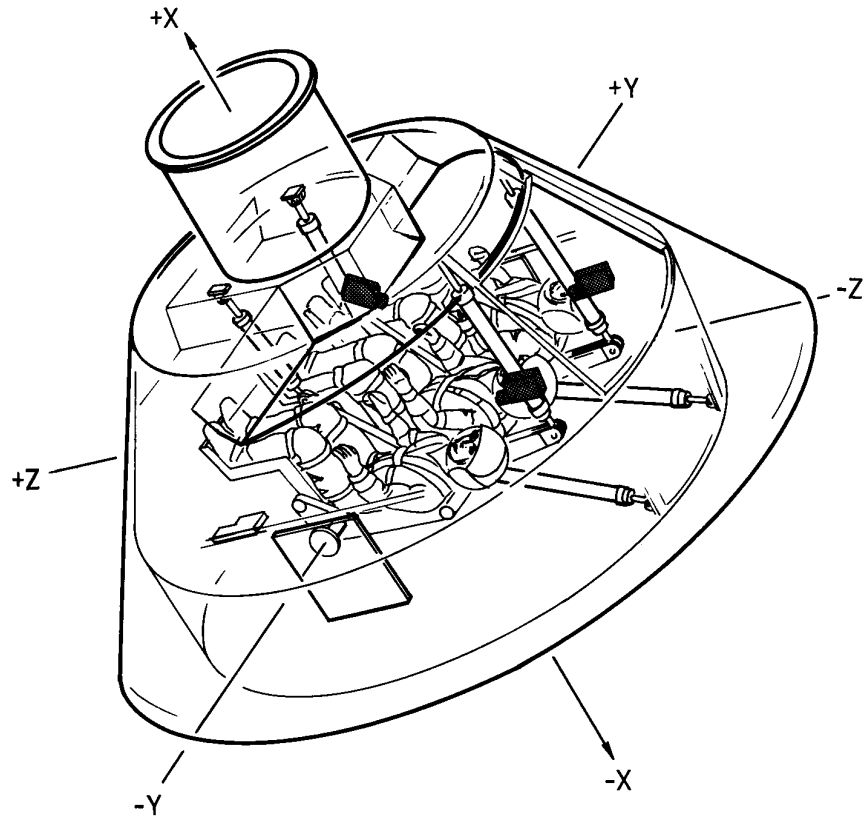
SOLAR RIB  
REFLECTORS  
≈ 31" DIA

FEEDHORNS  
10° OFFSET

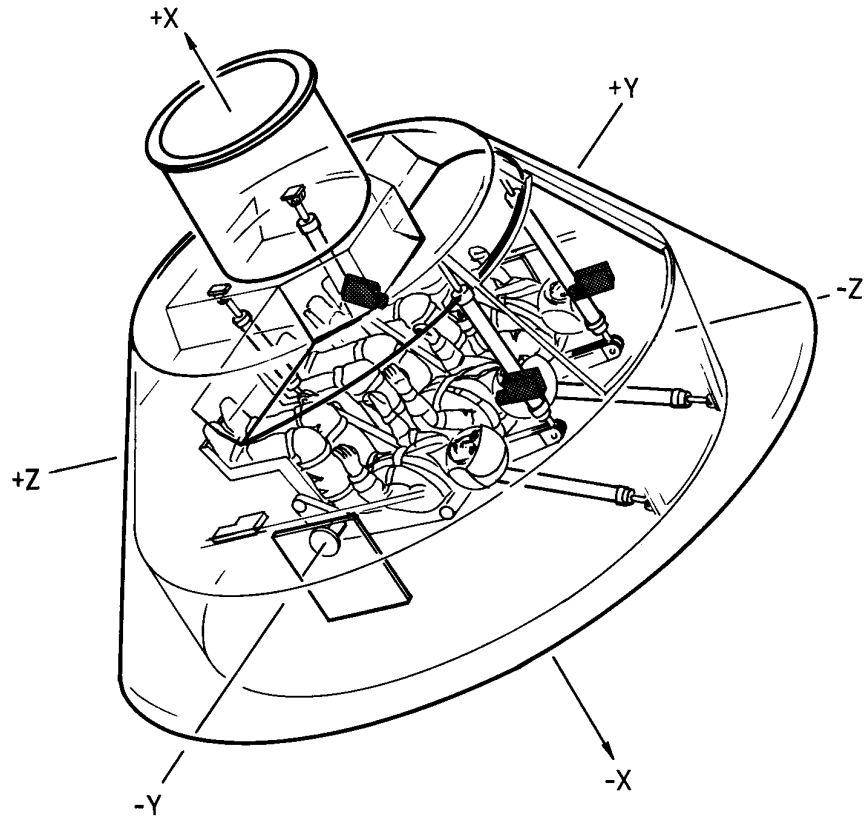
FRONTVIEW



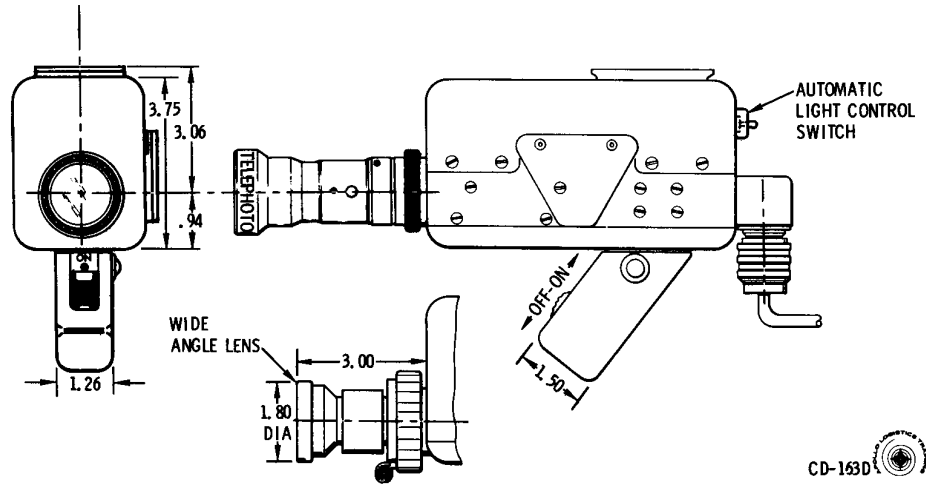
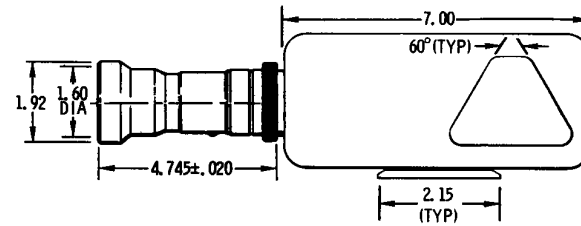
# TV CAMERA LOCATIONS



# TV CAMERA LOCATIONS

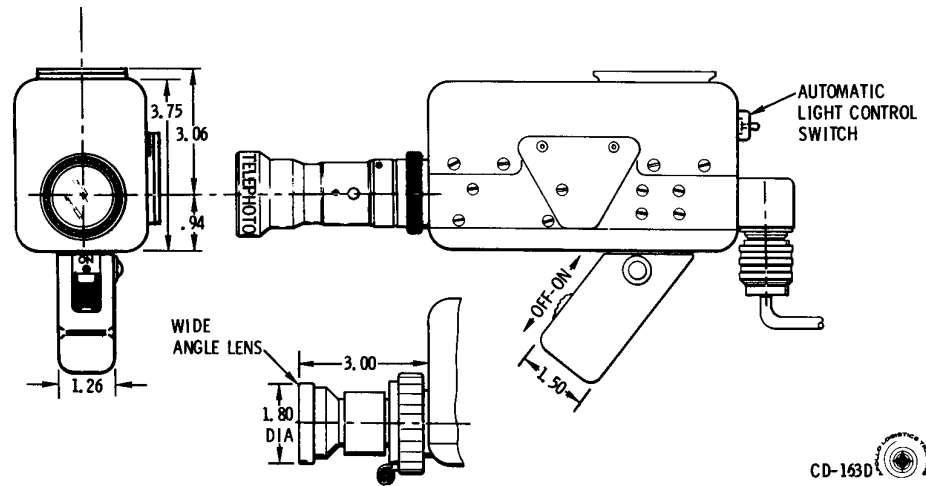
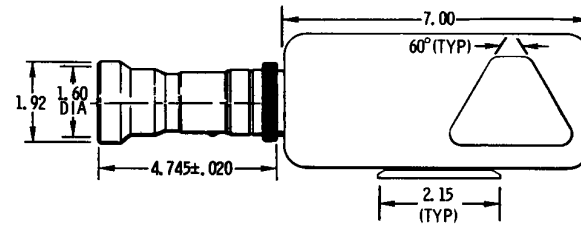


# APOLLO TV CAMERA



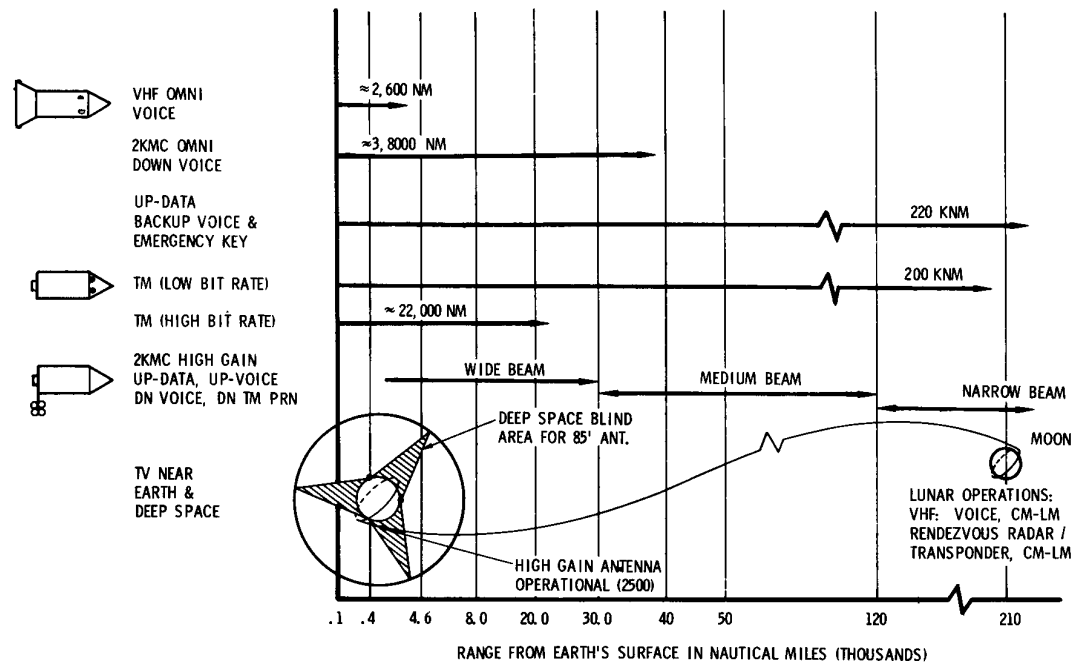
CD-163D 

# APOLLO TV CAMERA

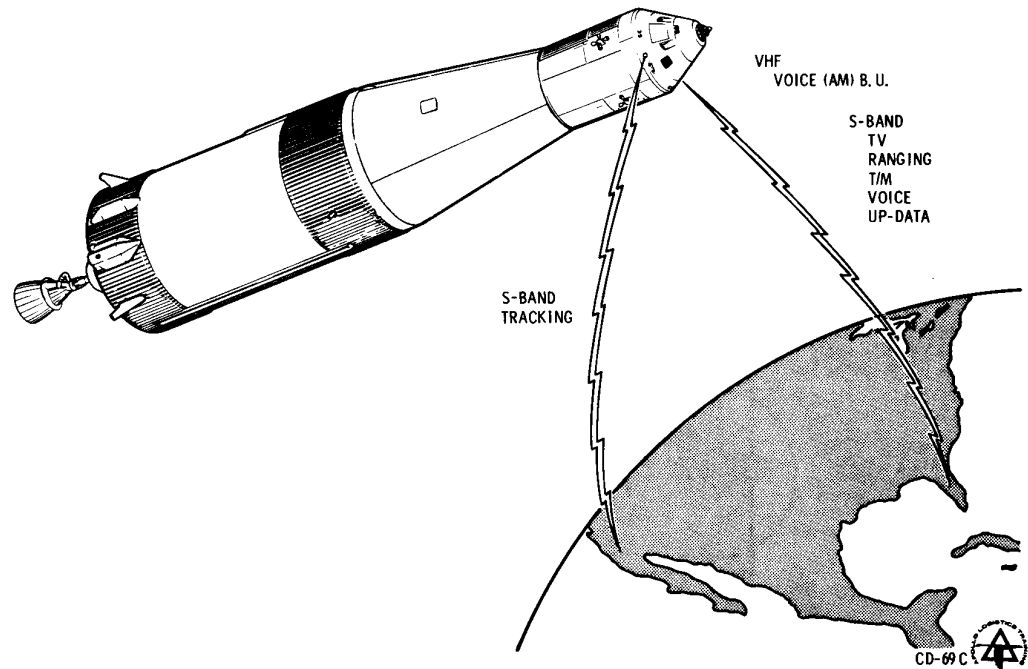


CD-163D 

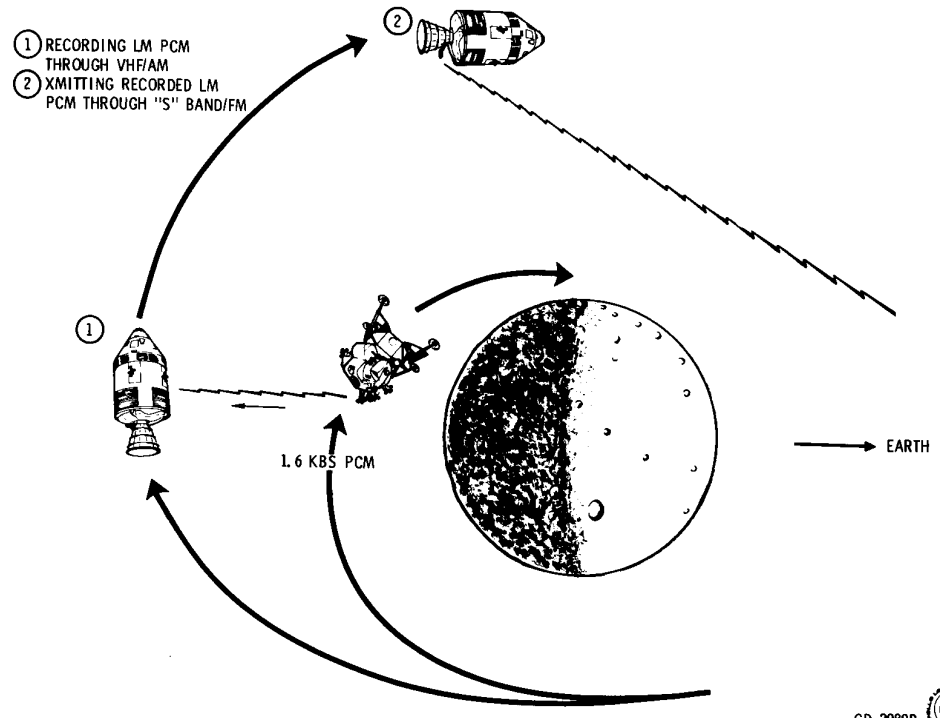
# CSM COMMUNICATIONS RANGES BLOCK II



# NEAR EARTH COMMUNICATION MODES

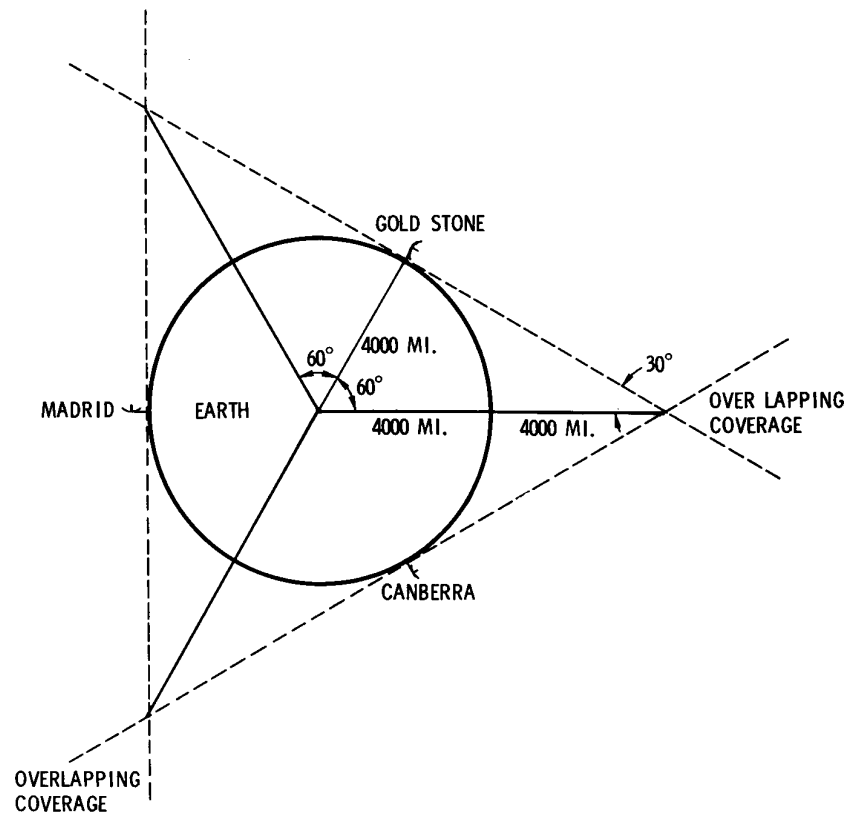


# LEM-CSM VHF/AM DATA REC

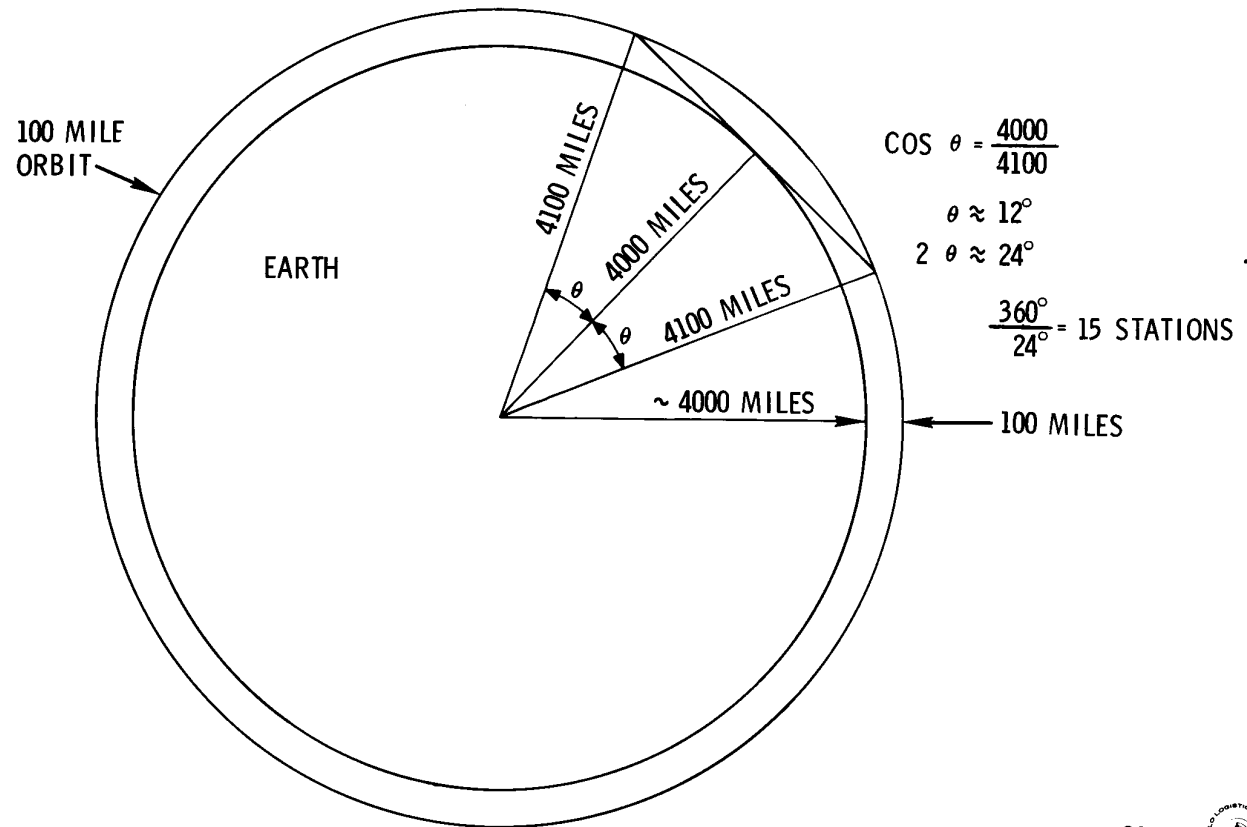




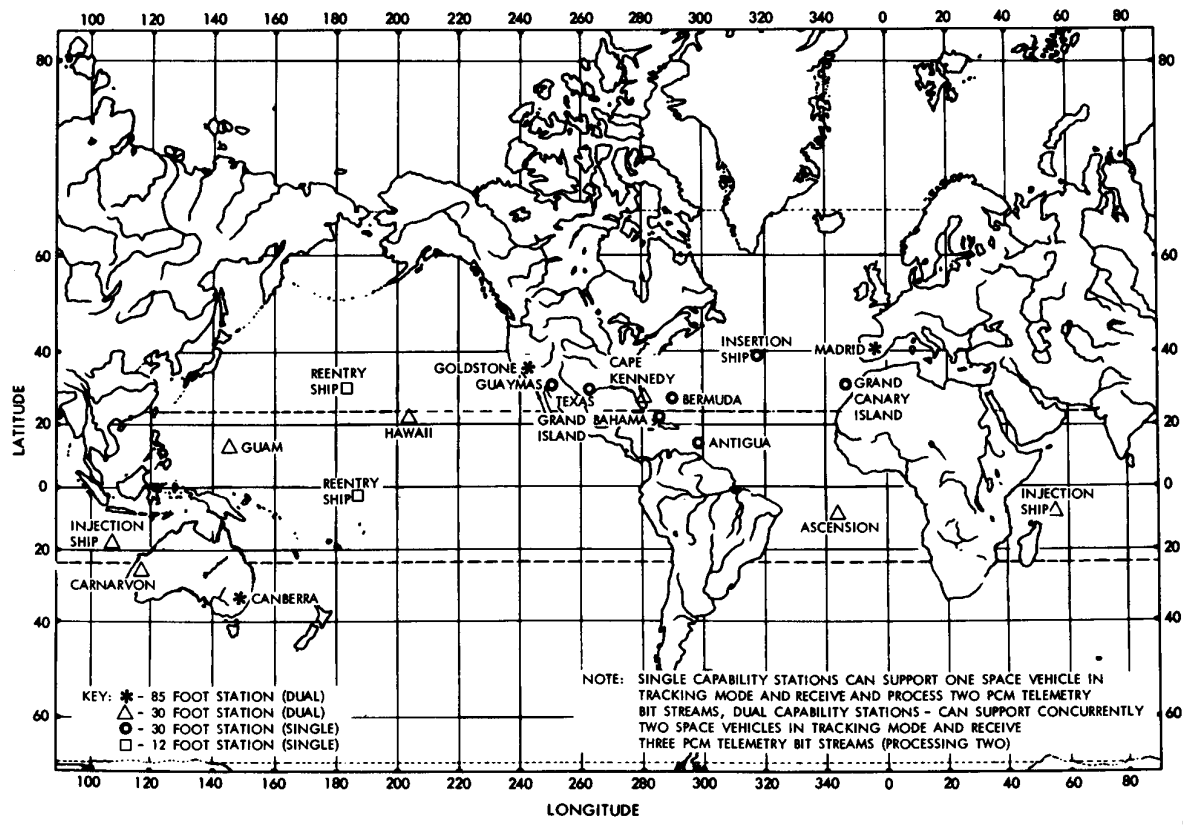
# S-BAND GROUND STATION GEOMETRY



# S-BAND GROUND STATION REQ



# BLOCK I & II MSFN S-BAND STATION LOCATIONS



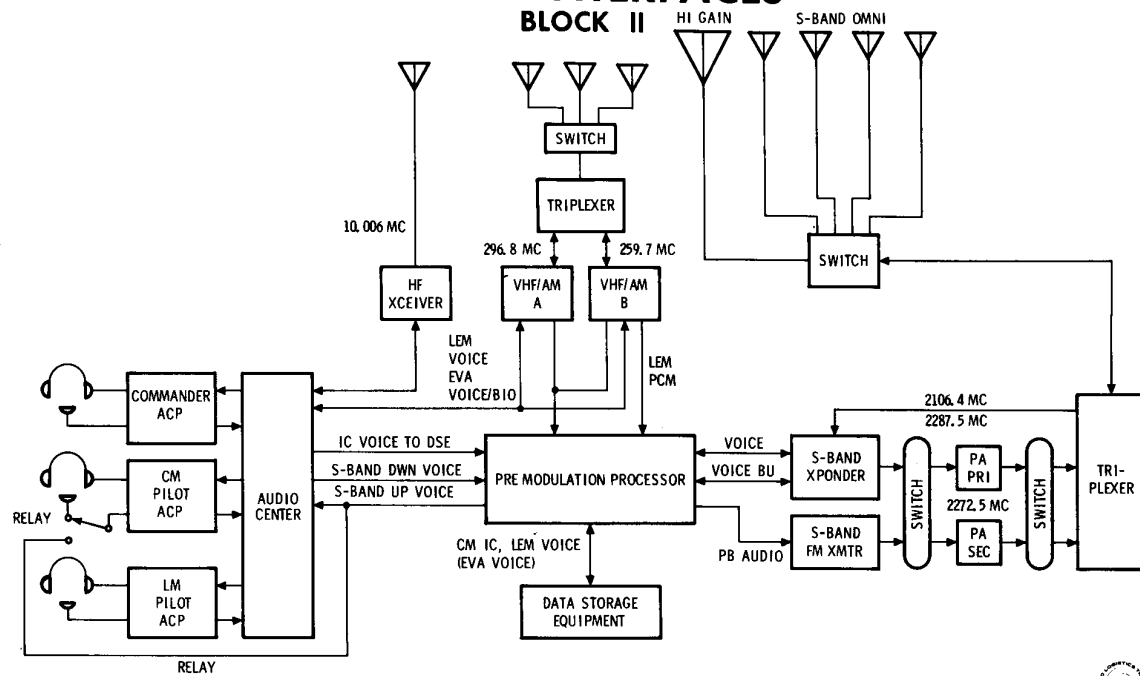


# COMM EQUIPMENT/MISSION PHASE

	PRE-LAUNCH	LAUNCH EARTH ORBIT TRANS-LUNAR INJECT.	TRANS-LUNAR FLIGHT 4000 MI	LUNAR ORBIT	LEM DESCENT LUNAR EXPLORE LEM ASCENT	TRANS-EARTH INJECT TRANS EARTH FLIGHT	DESCENT LANDING RECOVERY
VOICE	HARDLINE S-BAND	S-BAND VHF/AM*	S-BAND	S-BAND	S-BAND VHF/AM+	S-BAND	S-BAND VHF/AM
TV	HARDLINE	S-BAND	S-BAND	S-BAND	S-BAND	S-BAND	
BIO MED	HARDLINE S-BAND*	S-BAND	S-BAND VHF/AM+	S-BAND	S-BAND VHF/AM+	S-BAND	
UP-DATA	HARDLINE S-BAND*	S-BAND	S-BAND	S-BAND	S-BAND	S-BAND	
DWN-DATA	HARDLINE S-BAND*	S-BAND	S-BAND	S-BAND	S-BAND	S-BAND	
RANGING		S-BAND	S-BAND	S-BAND	S-BAND	S-BAND	
BEACON							VHF-BCN

\* BACKUP MODE  
 + LM-E. V. A. COMMUNICATIONS

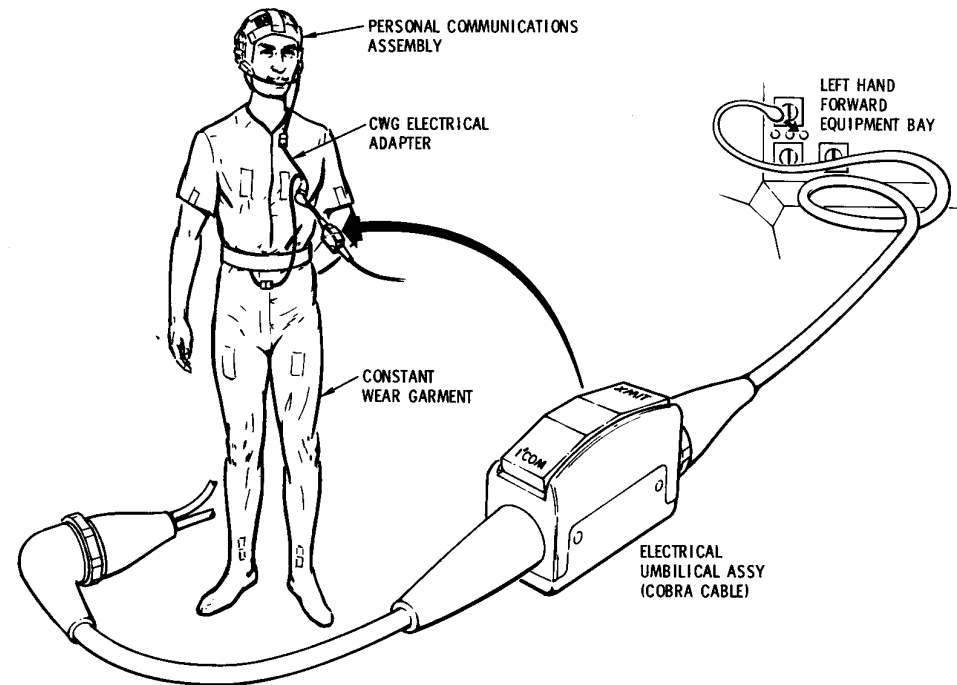
# AUDIO INTERFACES



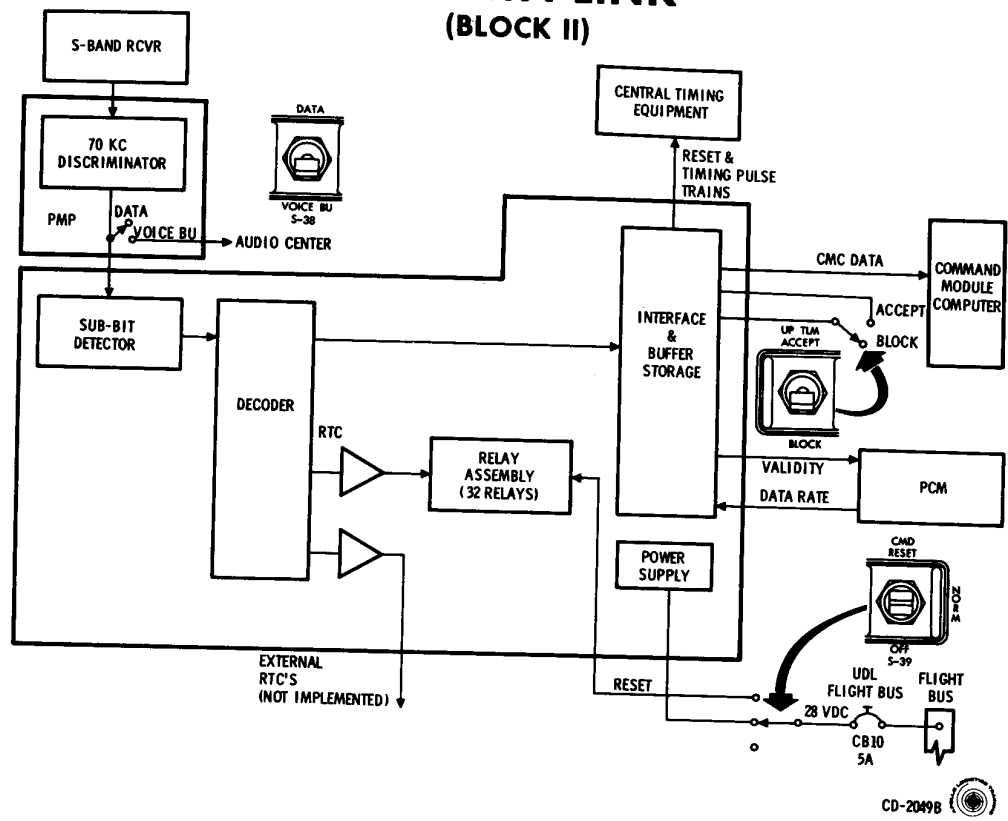
CD-2040-1B 

# ELECTRICAL UMBILICAL (COMM CABLE)

## BLOCK II



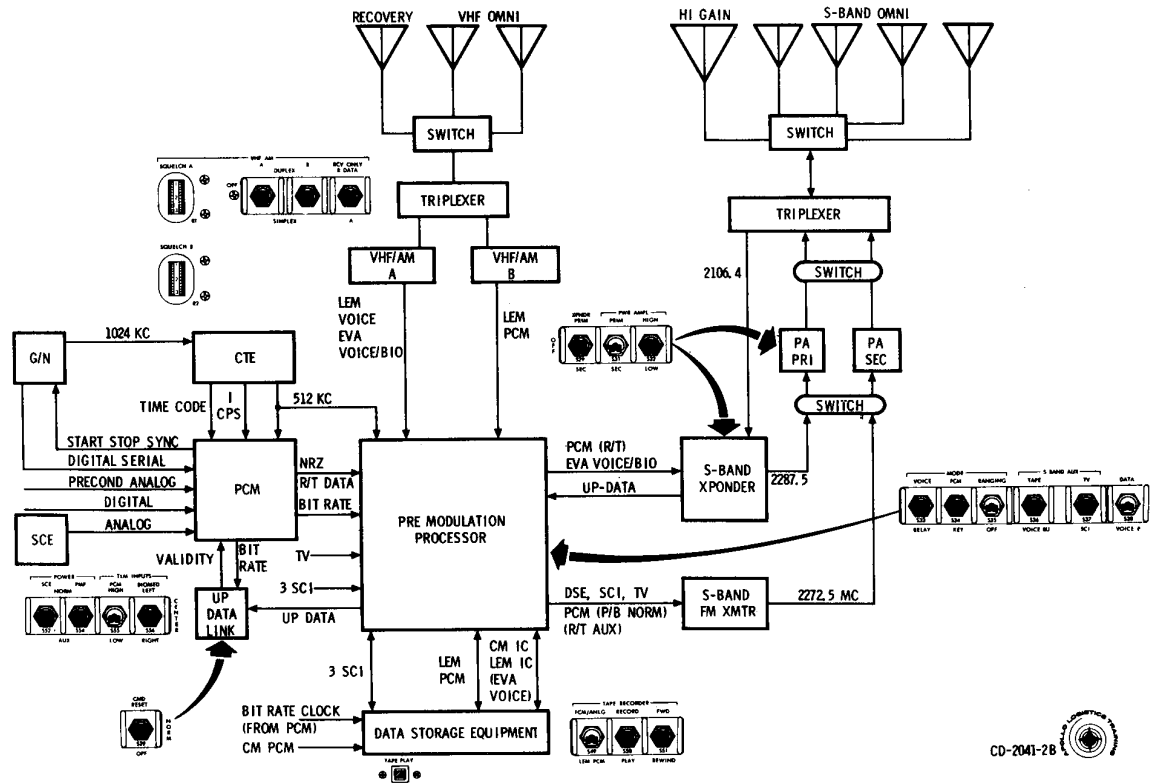
# UP-DATA LINK (BLOCK II)



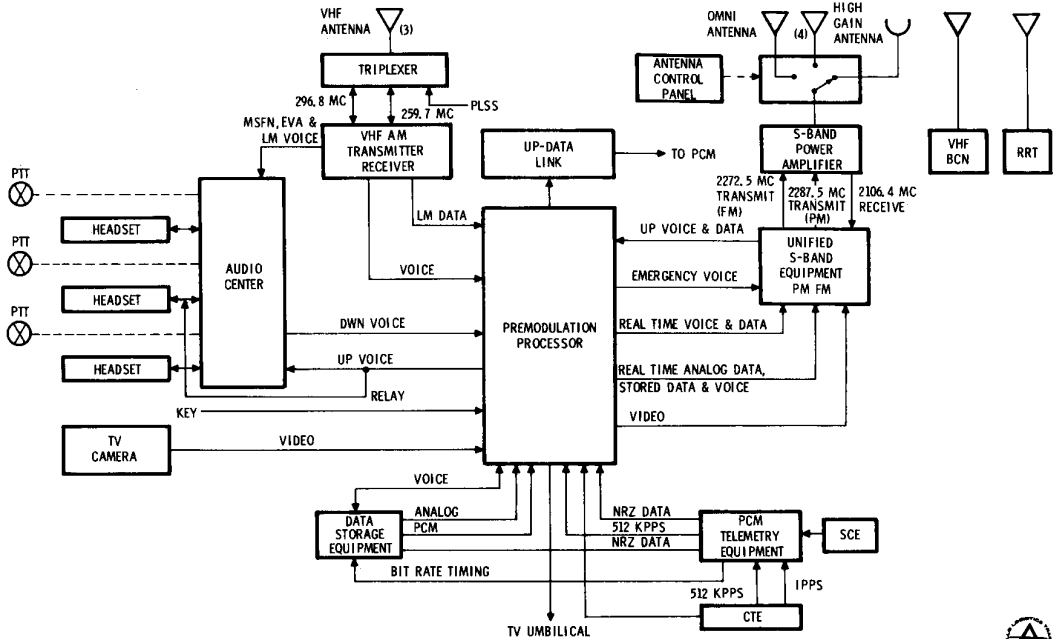


# DATA INTERFACES

## BLOCK II



# TELECOMMUNICATIONS SYSTEM BLOCK II



FAM-4508C

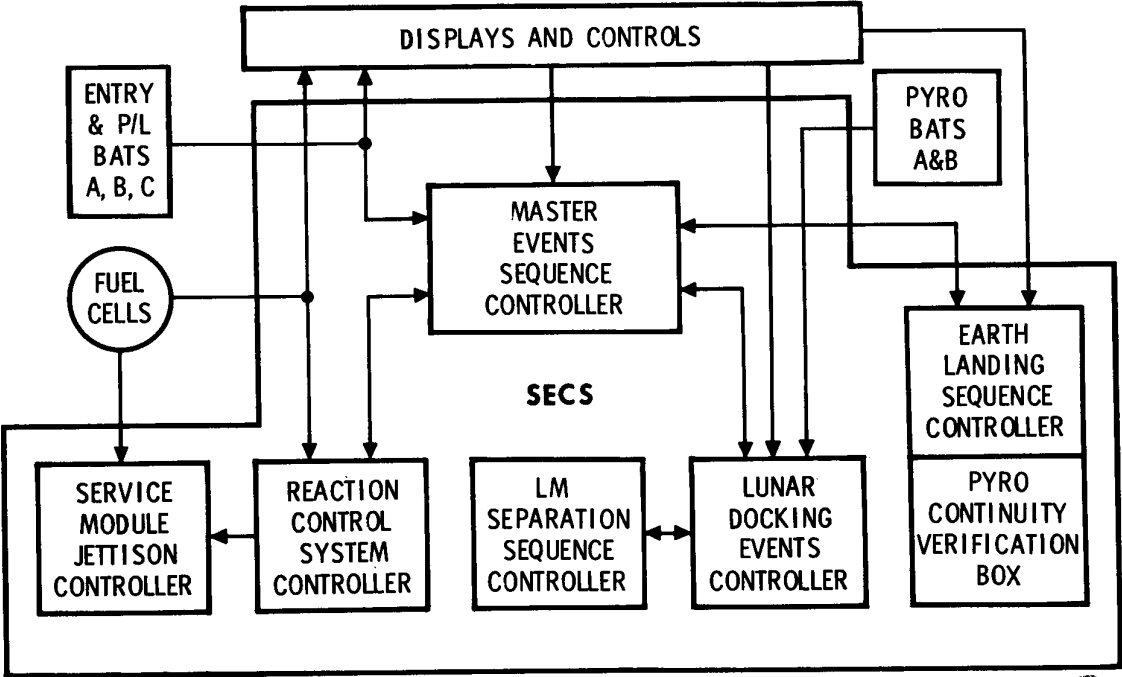
# SEQUENCING

FAM-3005B

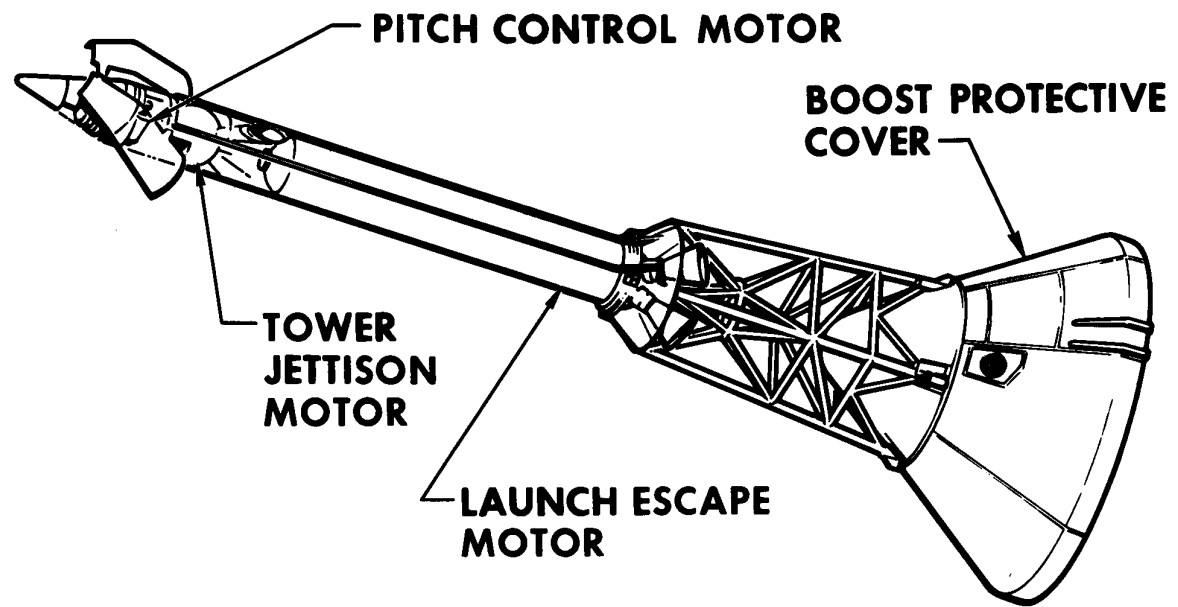


# SECS

## MAJOR COMPONENTS (BLOCK II)

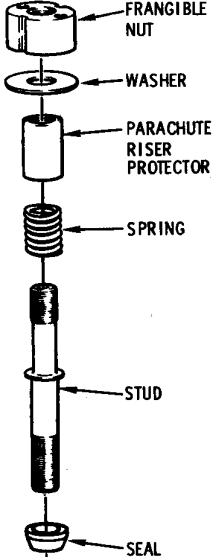
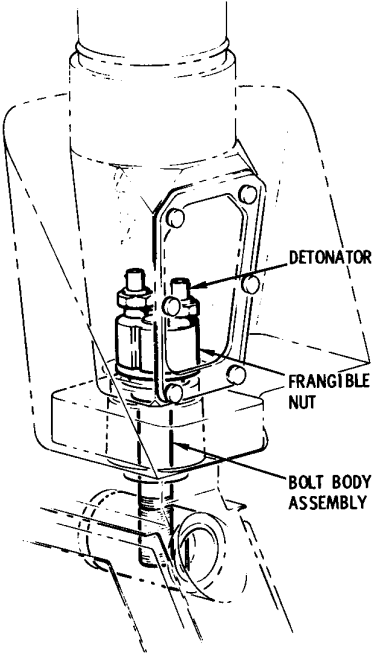
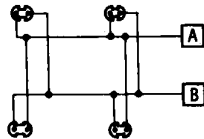
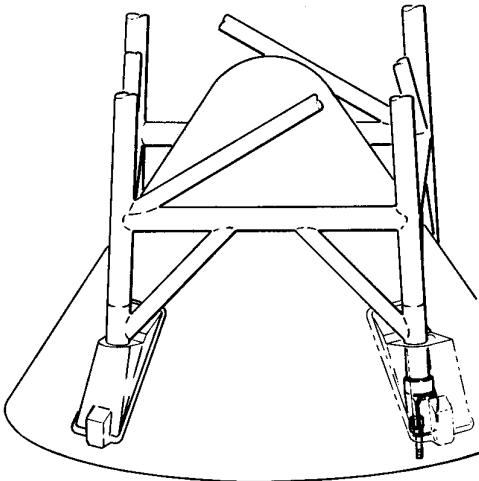


# LAUNCH ESCAPE SYSTEM & BOOST PROTECTIVE COVER

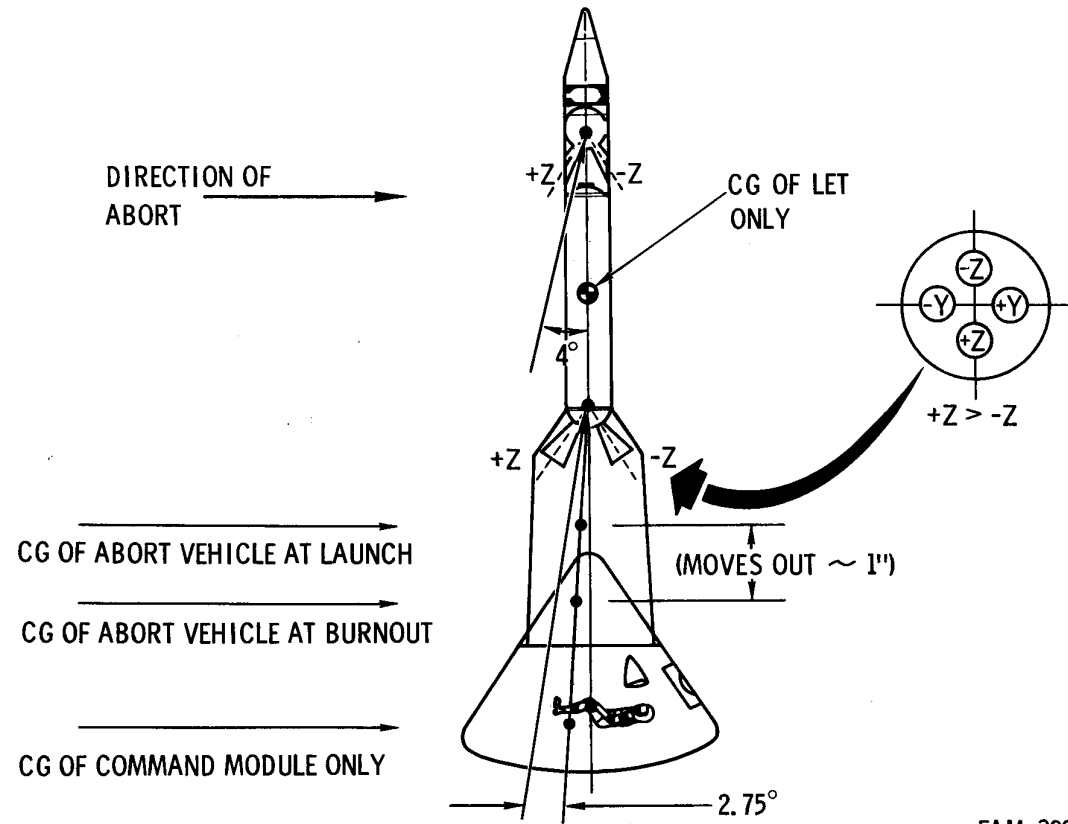


FAM-3017 

# TOWER SEPARATION SYSTEM

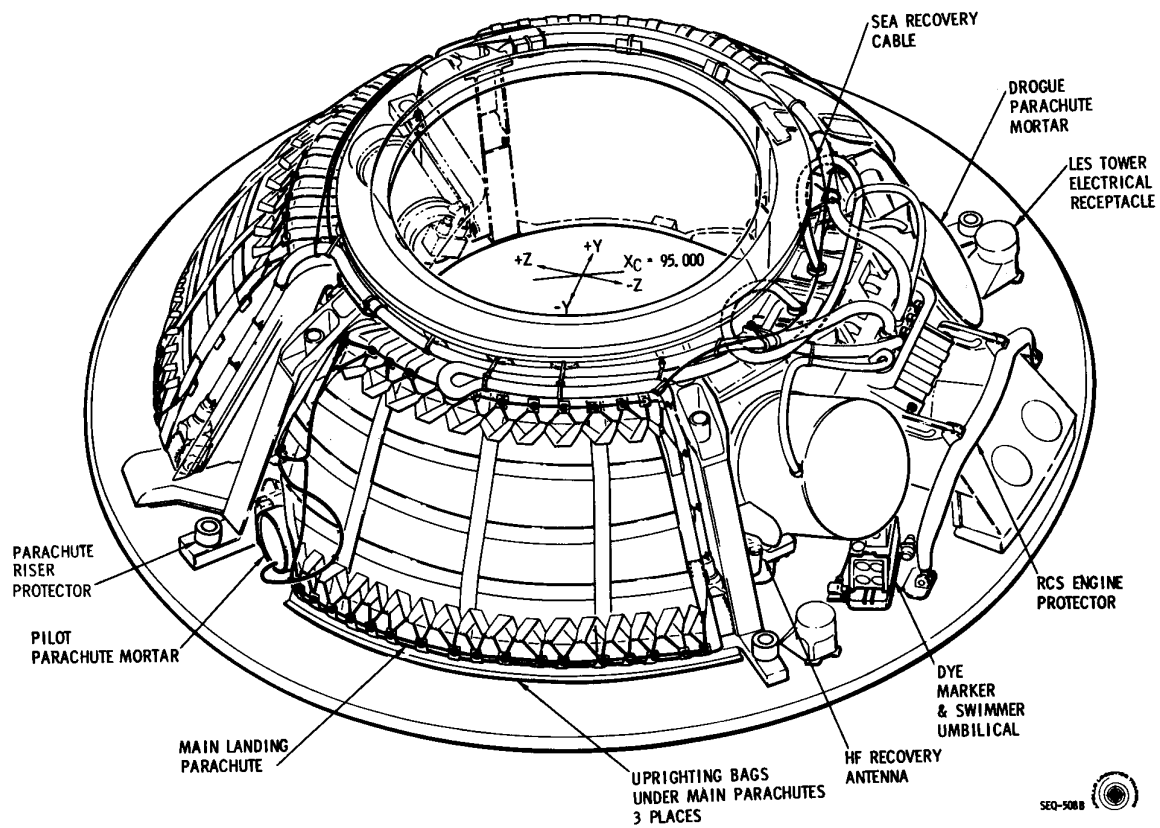


# ABORT VEHICLE MECHANICS



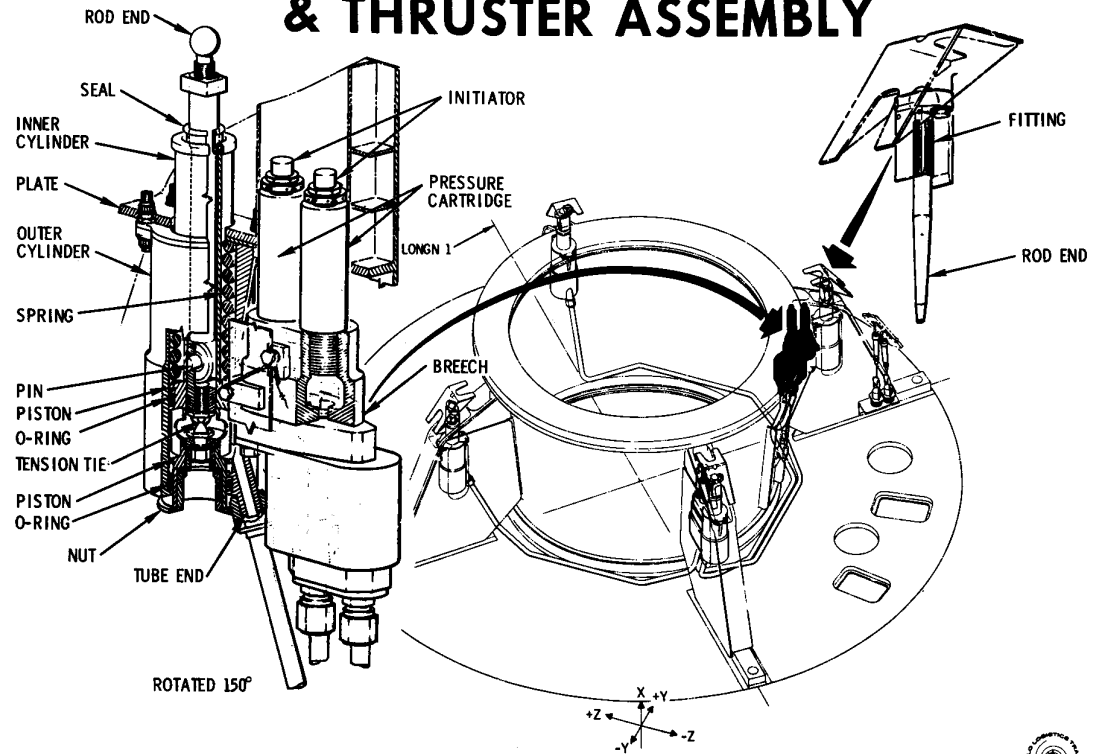
FAM-3009A 

# ELS EQUIPMENT (BLOCK II)

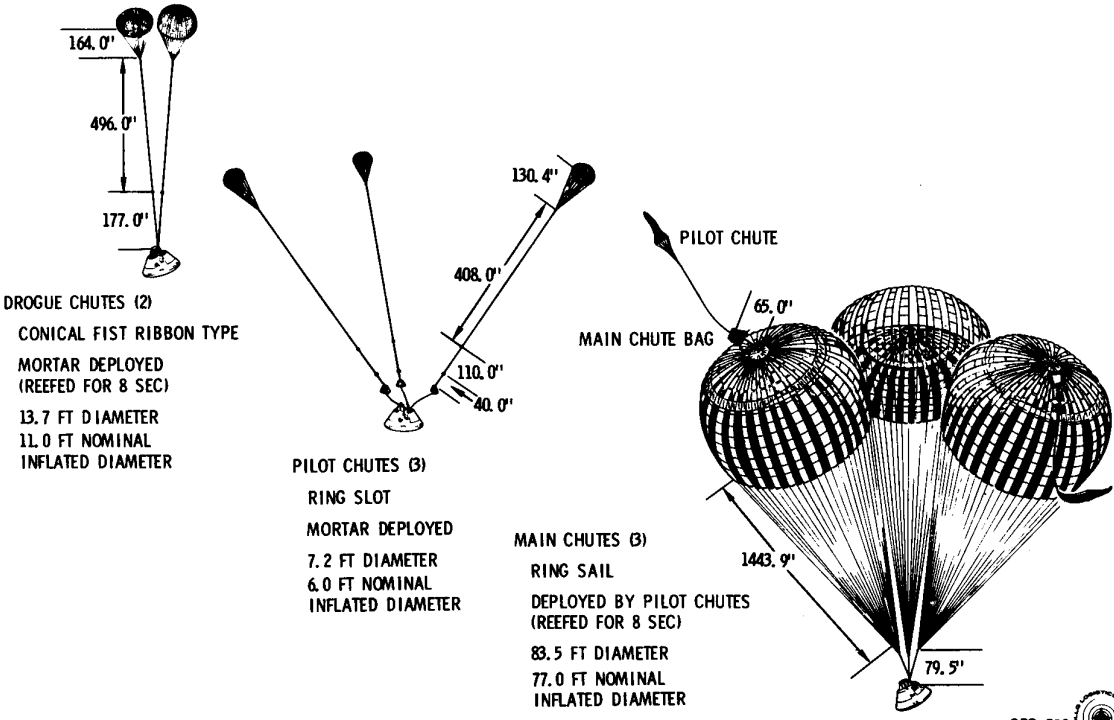




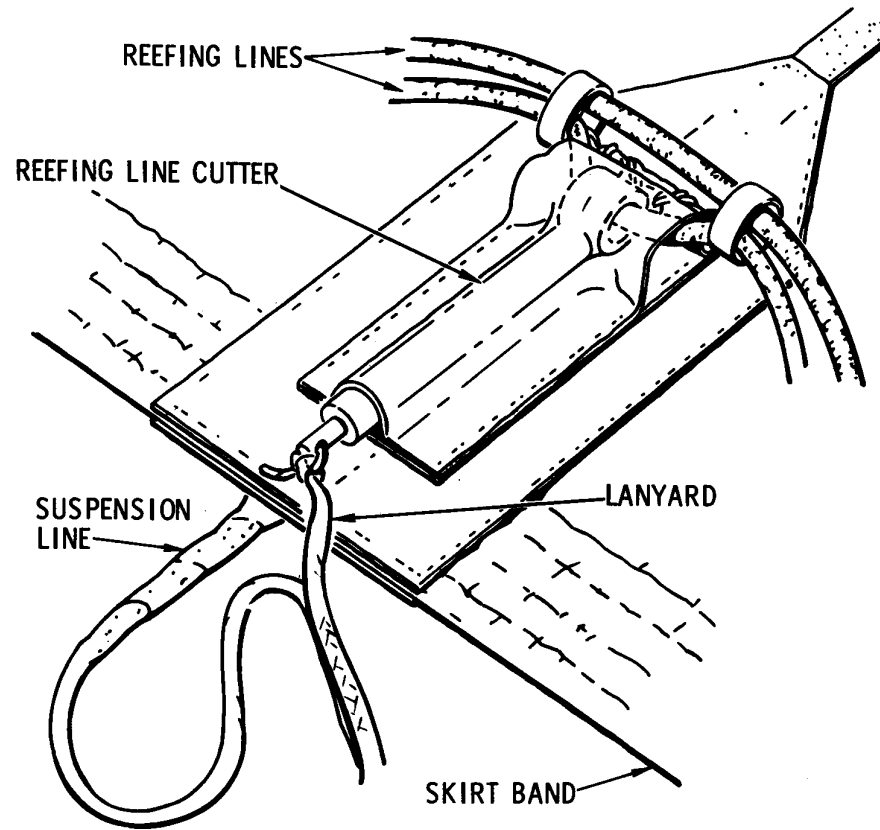
# FORWARD HEATSHIELD ATTACHMENT & THRUSTER ASSEMBLY



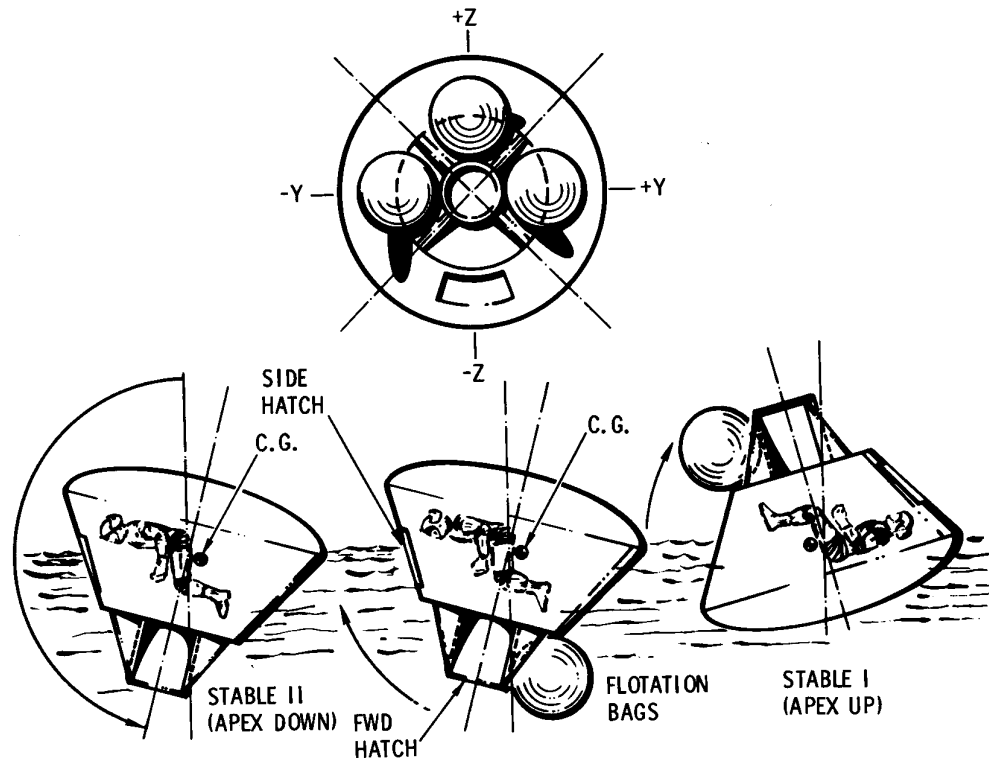
# EARTH LANDING SYSTEM PARACHUTES




# REEFING LINE CUTTER INSTALLATION

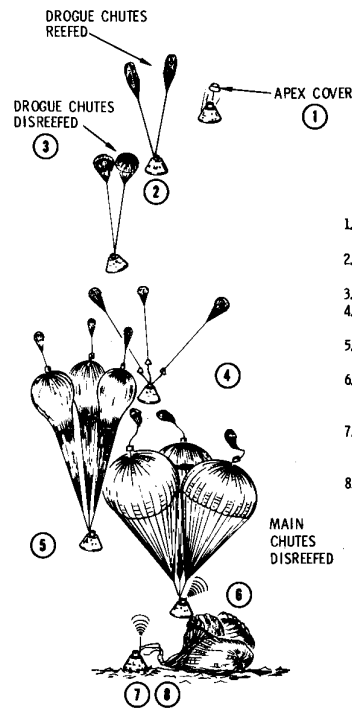


# UPRIGHTING SYSTEM 3 BAG SYSTEM



ST-650C 

## EARTH LANDING SYSTEM NORMAL SEQUENCE

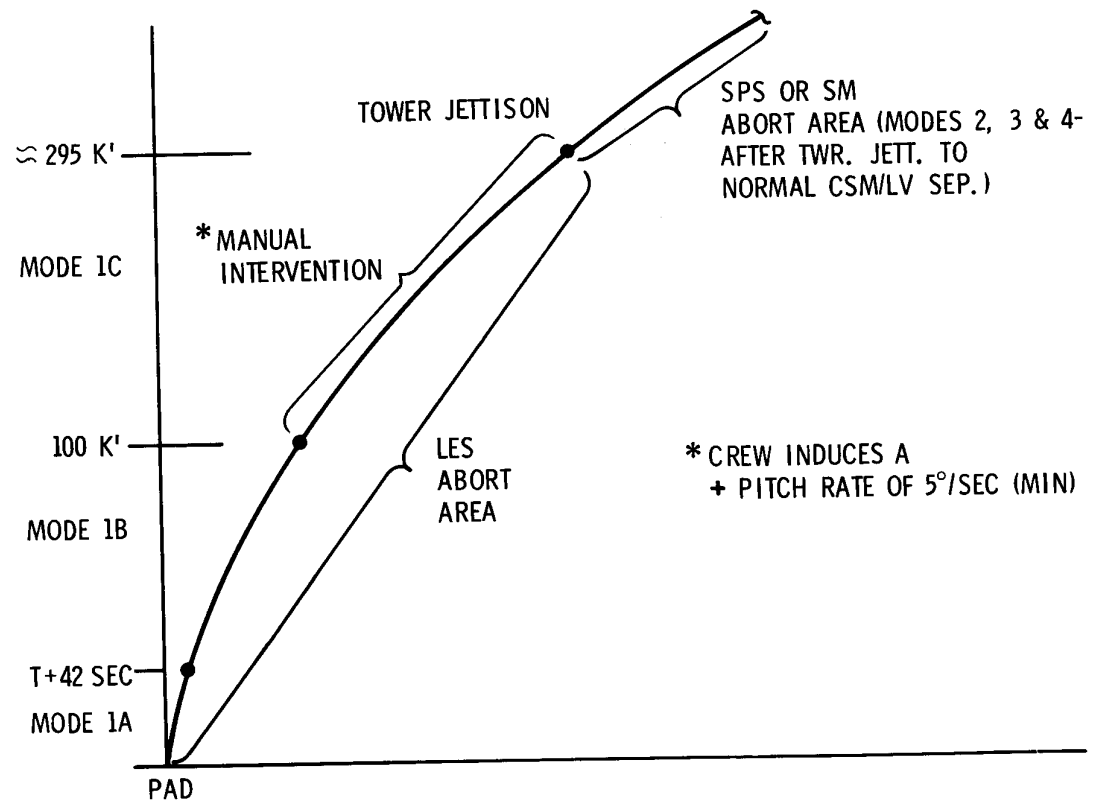


1. APEX COVER JETTISONED AT 24,000 FT + .4 SEC (TLM)
2. DROGUE CHUTES DEPLOYED AT 24,000 FT + 2 SEC (REEFED FOR 8 SEC) (TLM)
3. DROGUE CHUTES DISREEFED
4. PILOT CHUTES DEPLOYED & DROGUE CHUTES RELEASED AT 10,000 FT (TLM)
5. MAIN CHUTES DEPLOYED AT 10,000 FT (REEFED FOR 8 SEC)
6. MAIN CHUTES DISREEFED, VHF RECOVERY ANTENNAS, & FLASHING BEACON DEPLOYED
7. MAIN CHUTES RELEASED & LM PRESS. PYRO VALVE CLOSED AFTER TOUCH-DOWN (TLM)
8. HF ANTENNA DEPLOYED (TLM)

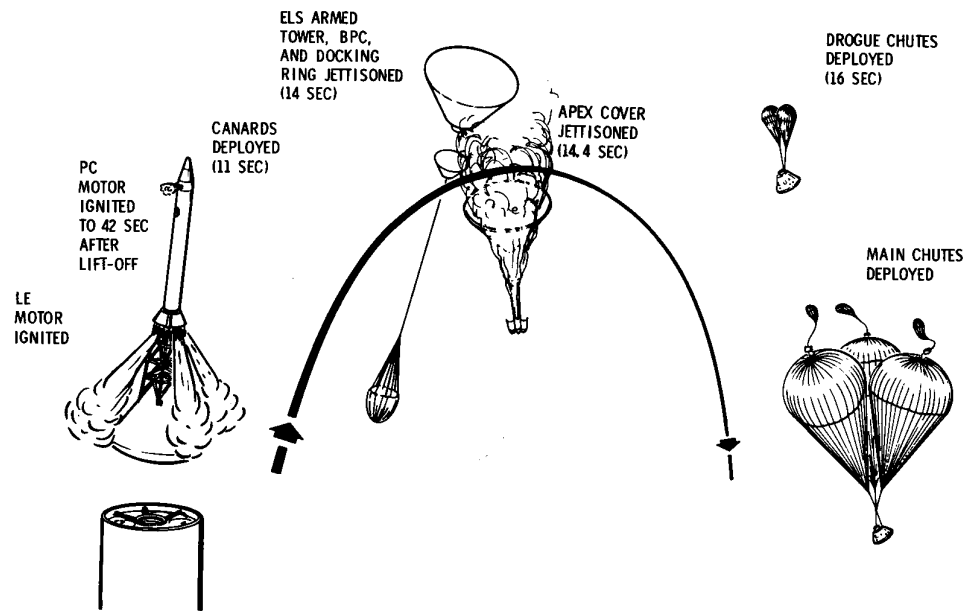
TOUCHDOWN VELOCITIES:  
3 CHUTES - 30.5 FT/SEC


# ABORT DESIGNATIONS

## BLOCK II - MODE 1

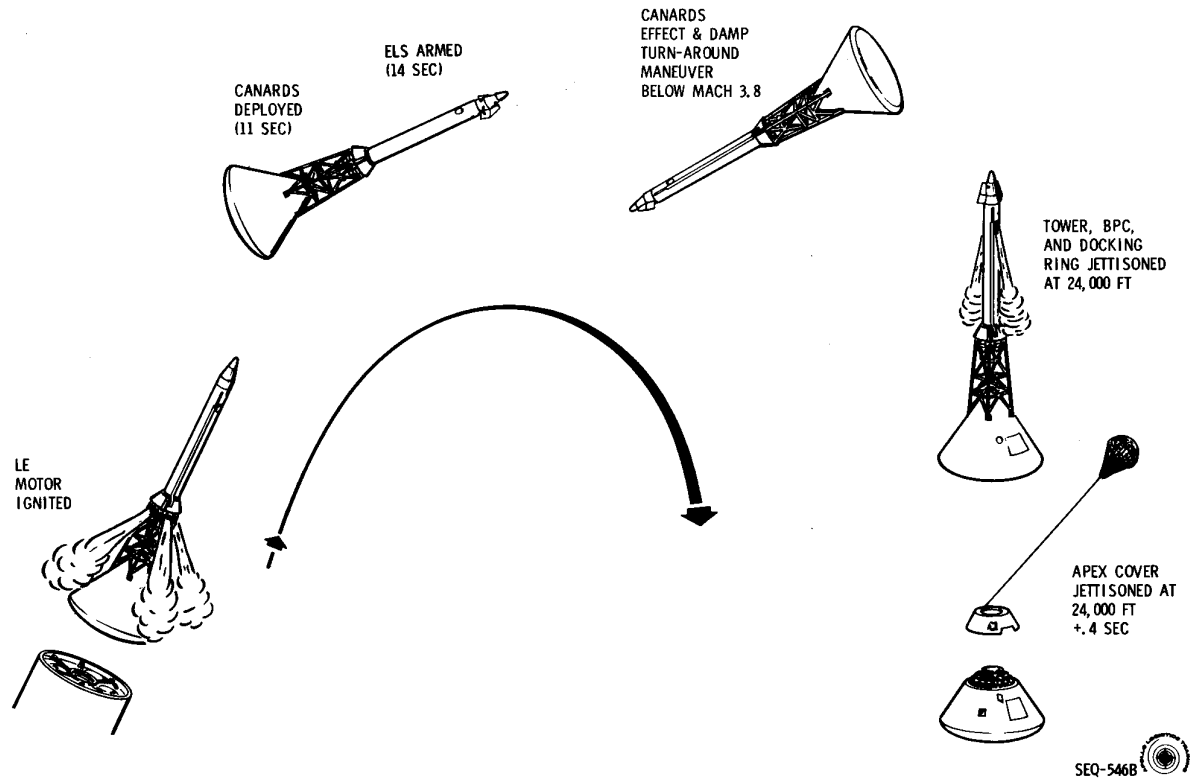


# PAD TO $\approx$ 30,000 FT LES ABORT



SEQ-544B 

# ≈ 30,000 FT TO TWR JETT LES ABORT

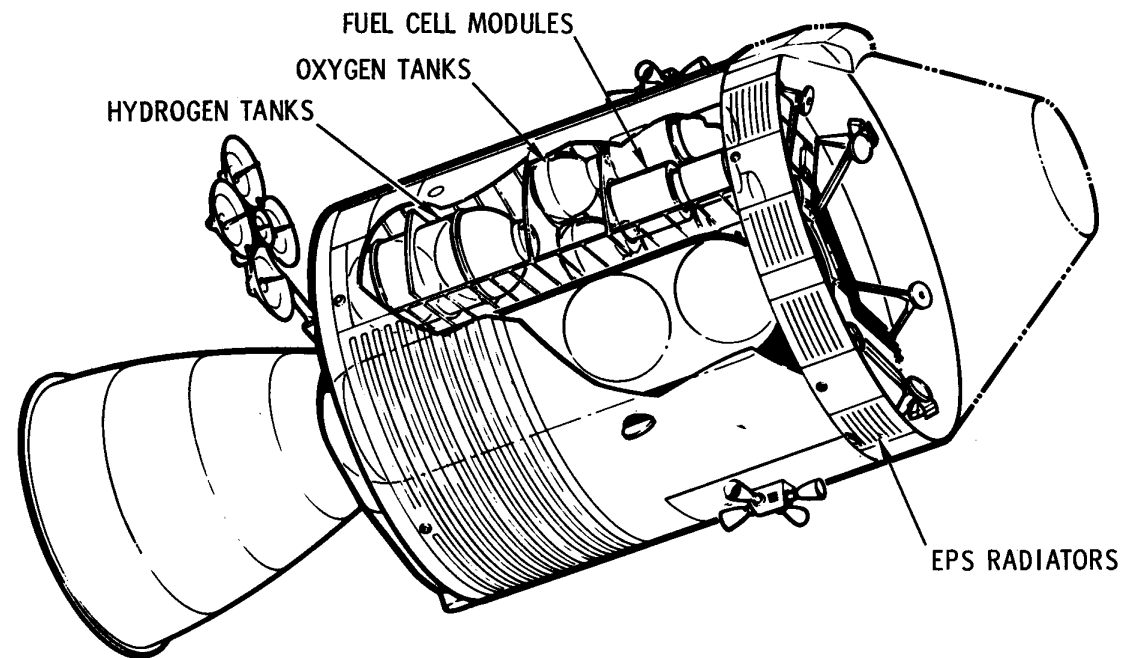




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# ELECTRICAL POWER

# ELECTRICAL POWER SYSTEM BLOCK II



# **ELECTRICAL POWER SYSTEM**

## **FUNCTIONAL DIVISION**

### **POWER SOURCES**

- **D.C. SYSTEM**
  - FUEL CELL MODULES (3)**
  - BATTERIES (3)**
- **A.C. SYSTEM**
  - INVERTERS (3)**

### **POWER DISTRIBUTION**

- **D.C. BUSSES**
- **A.C. BUSSES**

### **SPECIAL CIRCUITS**

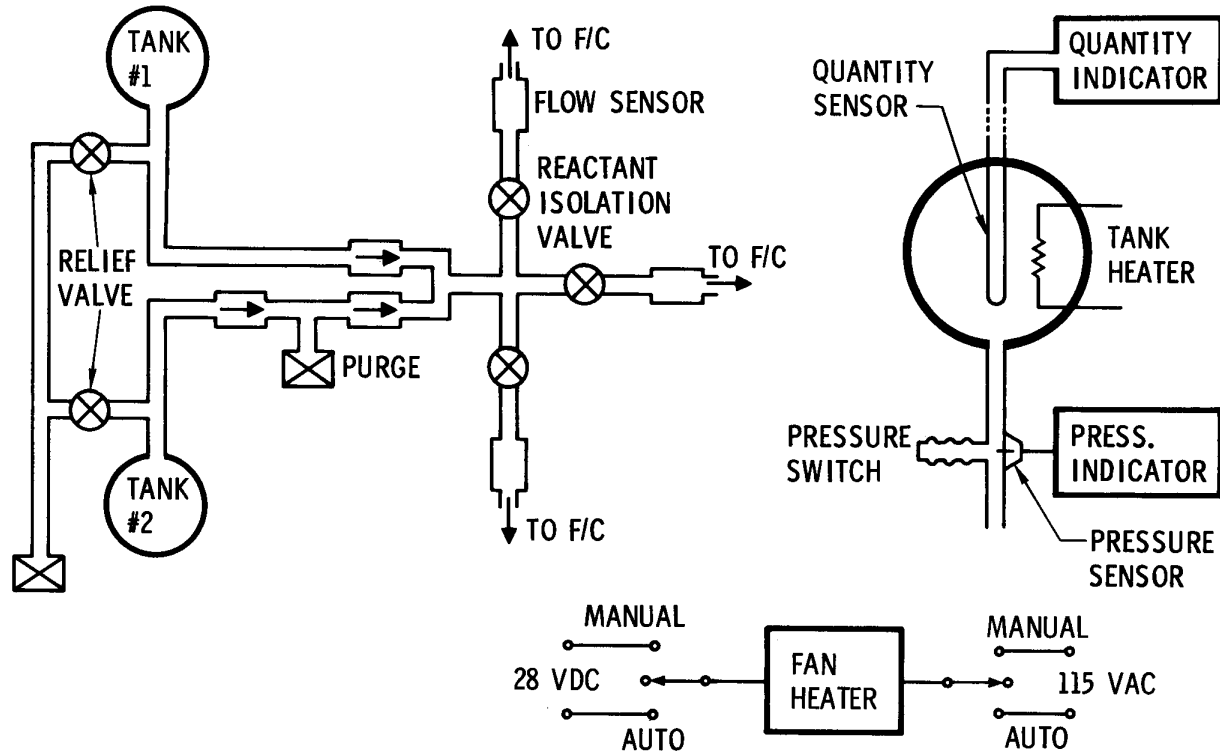
- **BATTERY CHARGER**
- **PYROTECHNIC BATTERIES (2)**
- **S/M JETTISON CONTROL**

## CRYOGENIC STORAGE SYSTEM

GAS	CONTAINER	USEABLE	TOTAL USEABLE
O <sub>2</sub>	INCONEL (2)	320 LBS (EA)	640 LBS
H <sub>2</sub>	TITANIUM (2)	28 LBS (EA)	56 LBS

GAS	INPUT TEMP.	SETTLED TEMP.	STORED PRESSURE	SYSTEM ALLOCATION
O <sub>2</sub>	-297° F	-284° F	900 ± 35 PSIA	EPS - 410 #
				ECS - 230 #
H <sub>2</sub>	-423° F	-417° F	245 ± 15 PSIA	FUEL CELLS ONLY

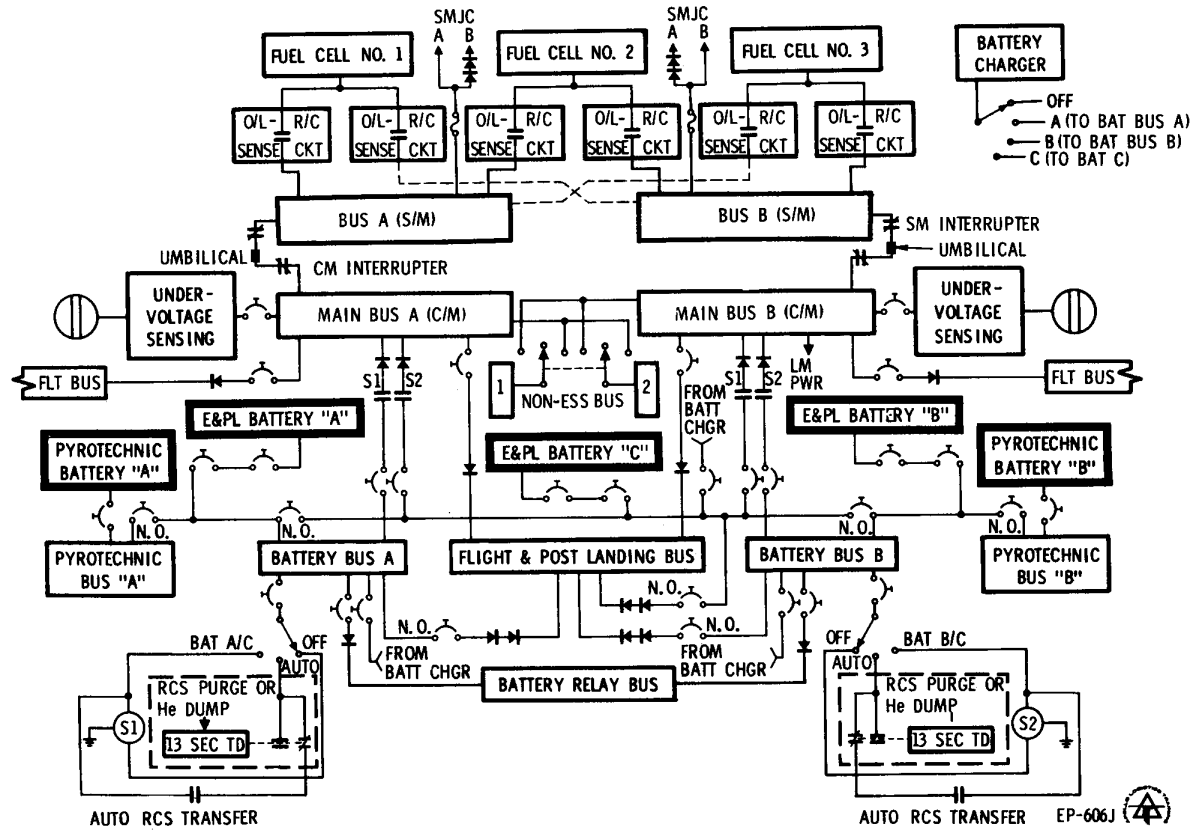
# CRYOGENIC STORAGE SYSTEM



EP-008B 

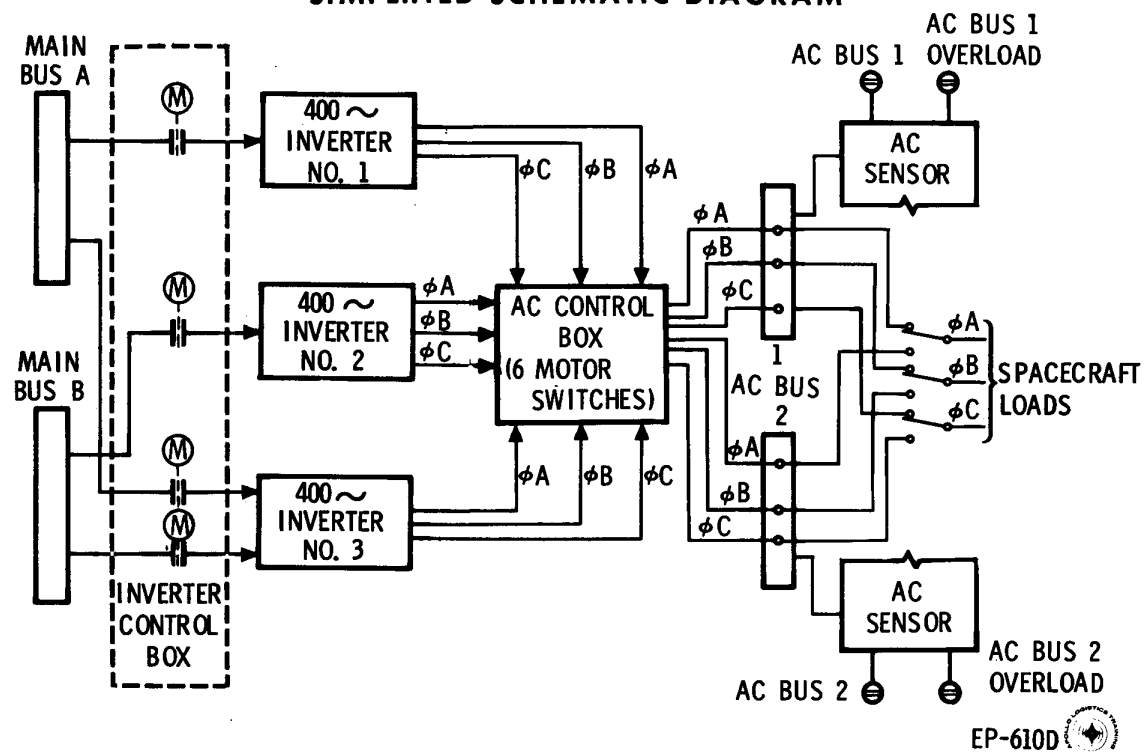
# DC POWER DISTRIBUTION

## SIMPLIFIED SCHEMATIC DIAGRAM

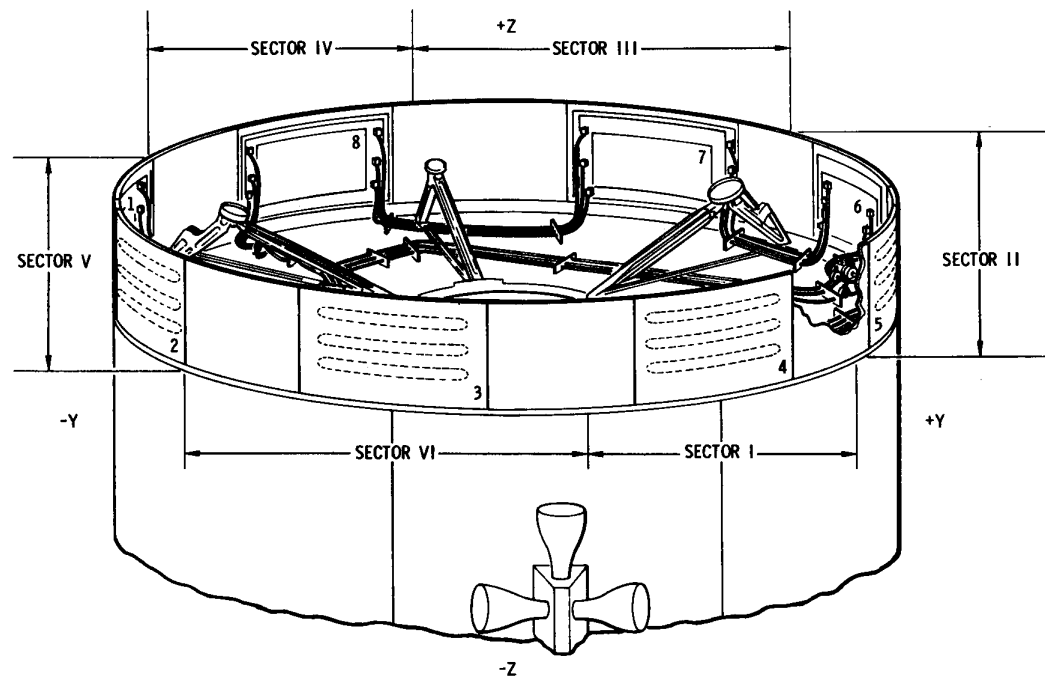


# AC POWER DISTRIBUTION

## SIMPLIFIED SCHEMATIC DIAGRAM

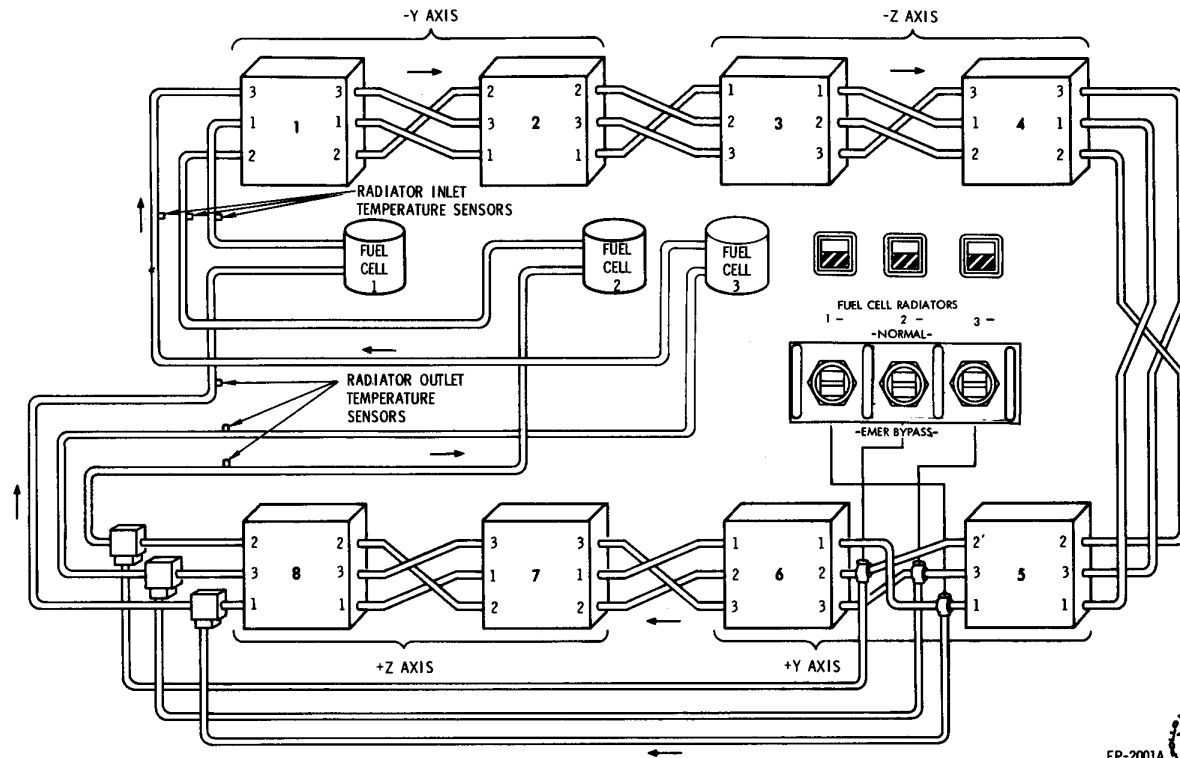


# EPS RADIATOR LOCATION BLOCK II

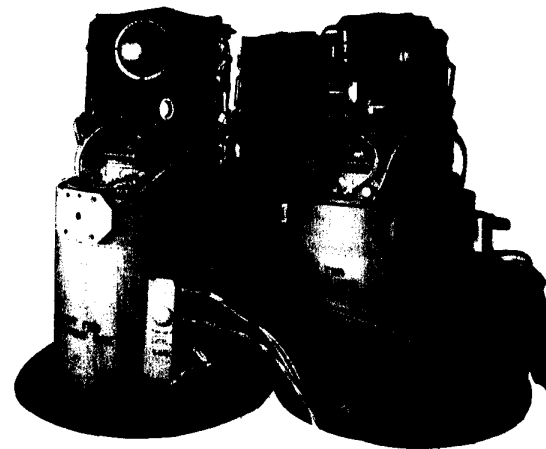




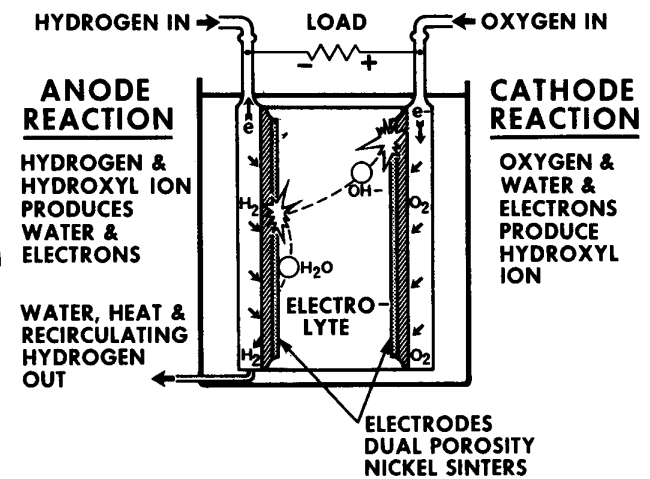
# EPS RADIATOR CONTROL BLOCK II



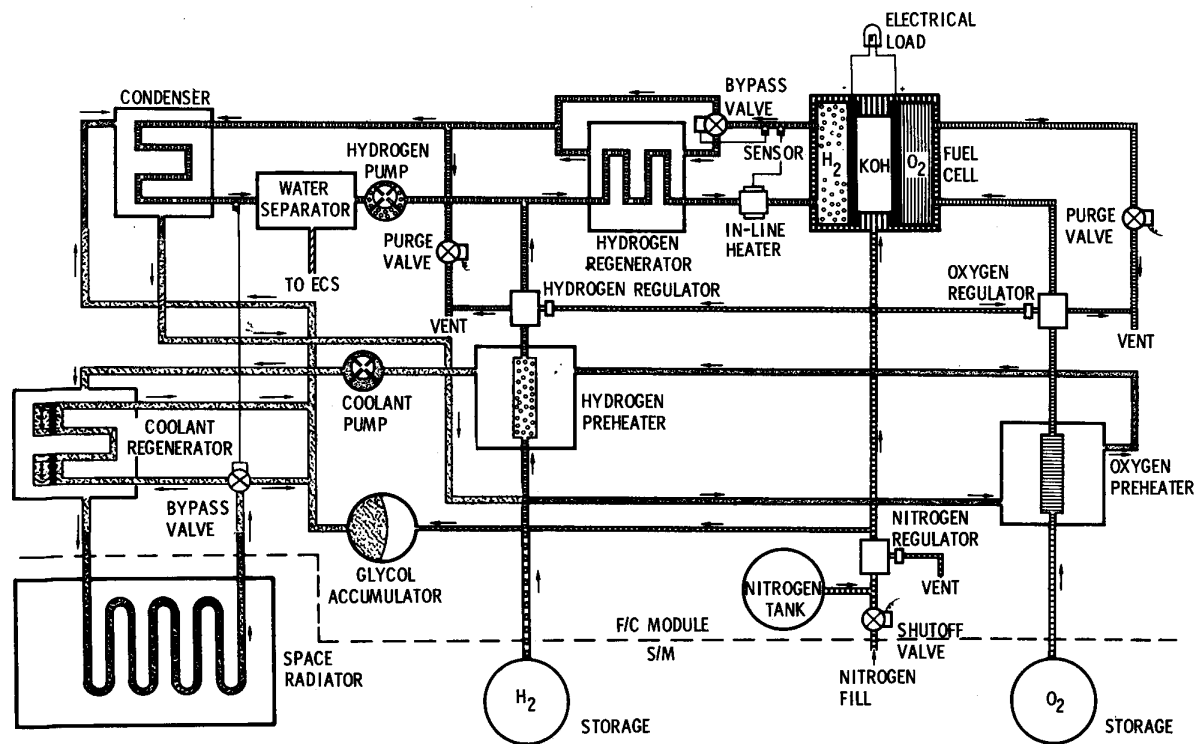
# APOLLO FUEL CELL POWERPLANT




HEIGHT = 44 IN.  
DIAM = 22 IN.  
WEIGHT = 245 LB EACH



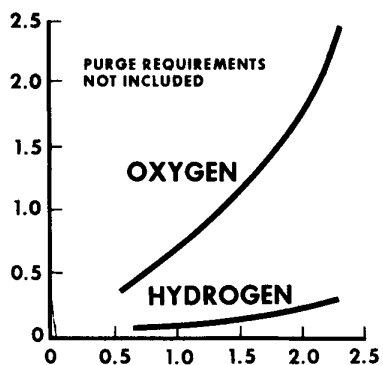
# EPS FUEL CELL DIAGRAM



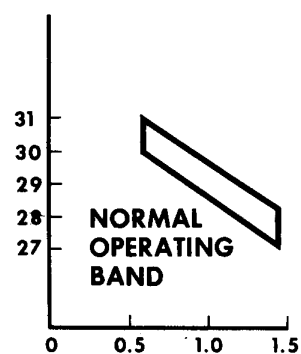
FAM-2000C 

## FUEL CELL REACTION

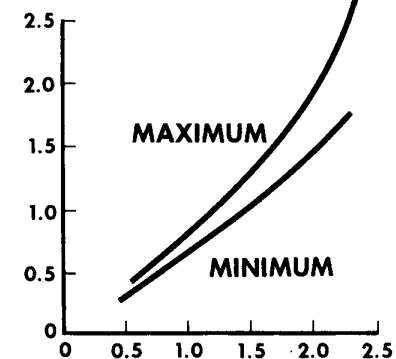
MAXIMUM REACTANT  
CONSUMPTION-  
POUNDS PER HOUR



VOLTAGE

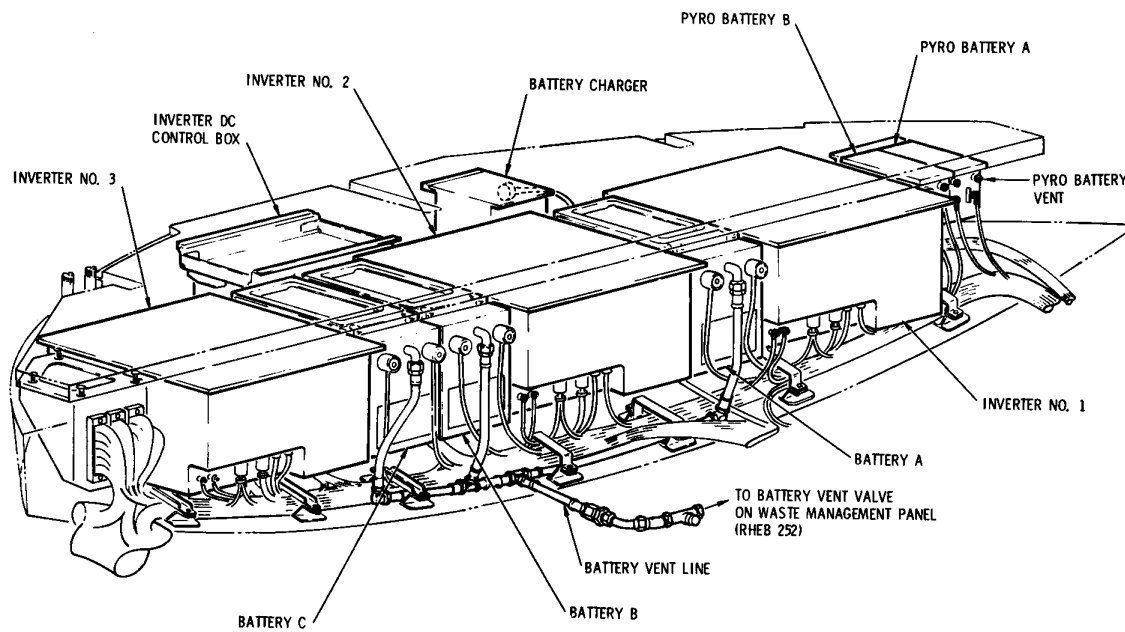


WATER GENERATION RATE-  
POUNDS PER HOUR-  
PURGING NOT INCLUDED



GROSS POWER PER POWERPLANT - KILOWATTS

# EPS COMPONENTS LOWER EQUIPMENT BAY (BLOCK II)



# ENVIRONMENTAL CONTROL

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# **ECS FUNCTIONAL REQUIREMENTS**

## **CONTROL SPACECRAFT ATMOSPHERE**

- **PRESSURE-TEMPERATURE-HUMIDITY-CONTAMINATION**

## **PROVIDE COOLING FOR SPACECRAFT EQUIPMENT**

- **GUIDANCE & NAVIGATION-STABILIZATION & CONTROL**
- **COMMUNICATIONS-AC POWER SUPPLY-OTHER**

## **CONTROL COLLECTION, STORAGE & DISTRIBUTION OF WATER**

- **POTABLE WATER FOR CREW USE**
- **WASTE WATER FOR SUPPLEMENTAL COOLING**

---

# ENVIRONMENTAL CONTROL

## SUBSYSTEM FUNCTIONS

### OXYGEN SUPPLY SUBSYSTEM

- NORMAL OXYGEN SUPPLY
- ENTRY OXYGEN SUPPLY
- CABIN PRESSURE CONTROL
- FLUID TANK PRESSURIZATION

### PRESSURE SUIT SUBSYSTEM

- WATER & CONTAMINANT REMOVAL FROM SUIT & CABIN
- SUIT PRESSURE & TEMPERATURE CONTROL

### WATER SUBSYSTEM

- STORES & DISTRIBUTES  
POTABLE WATER (DRINKING & FOOD RECONSTITUTION)  
WASTE WATER (SUPPLEMENTAL COOLING)

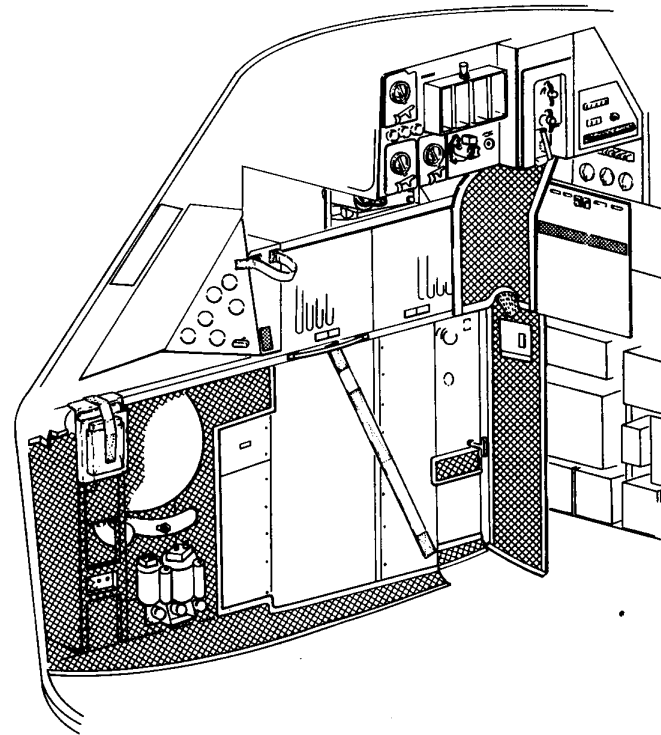
### WATER GLYCOL SUBSYSTEM

- PRIMARY HEAT TRANSFER
- COOLING FOR SUIT & ELECTRONICS
- HEATING OR COOLING FOR CABIN
- REJECTS EXCESS HEAT TO SPACE



# APOLLO CM INTERIOR LHEB & LHFE

## BLOCK II



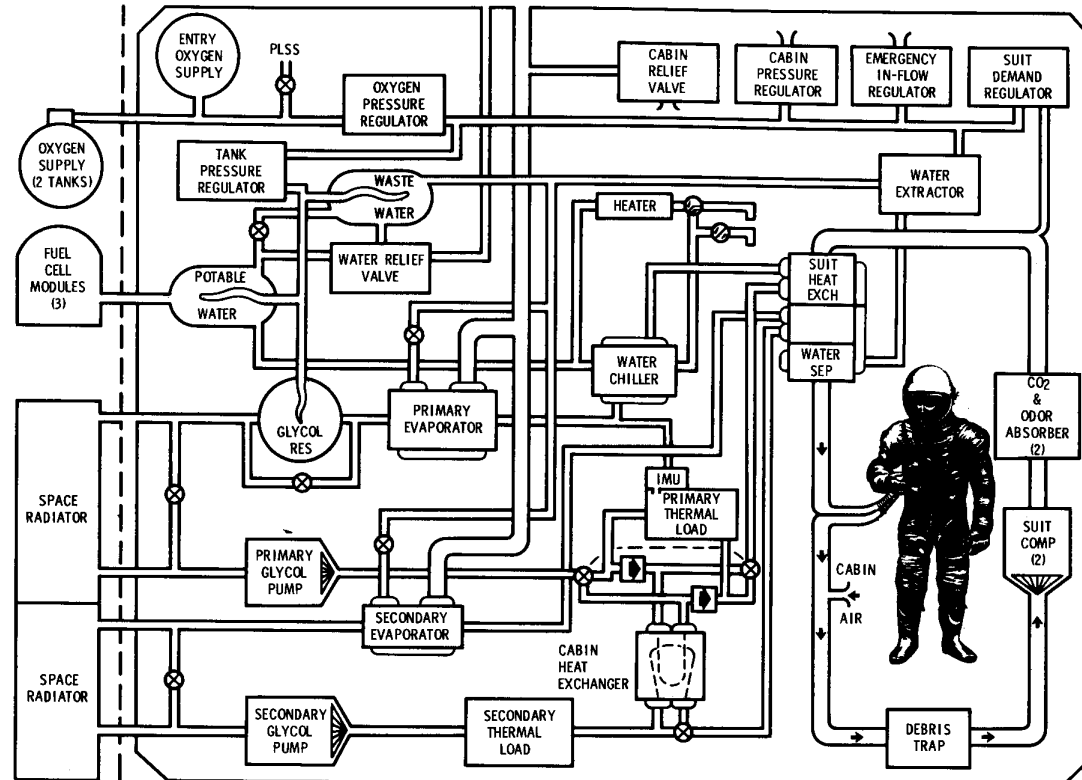
■ VELCRO

FEB 67

CS-0014 

# ENVIRONMENTAL CONTROL

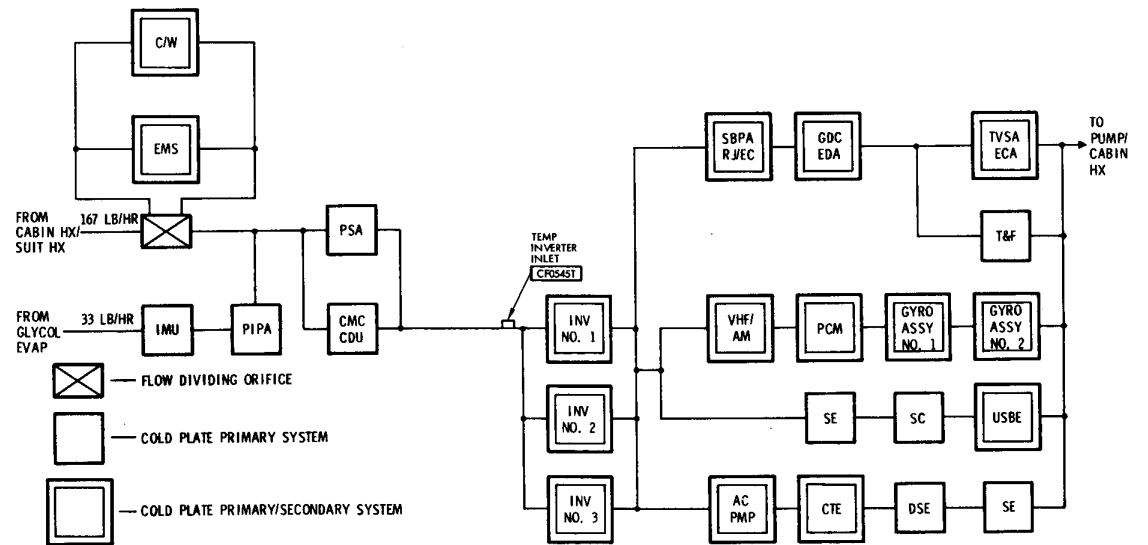
BLOCK II



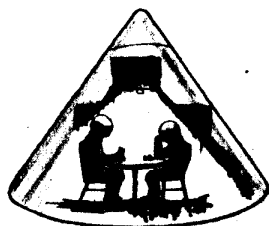
FAM-2507D

# COLD PLATE NETWORK

## PRIMARY SYSTEM - BLOCK II



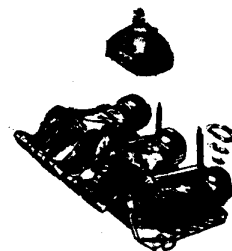
# CREW EQUIPMENT



LIGHT AND SIGHT <sup>A10</sup>



SPACE SUIT ASSY



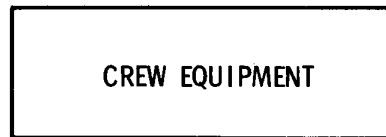
CREW COUCHES



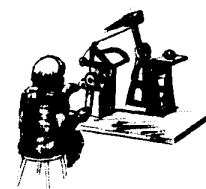
RESTRAINTS



SURVIVAL



CREW EQUIPMENT



INFLIGHT TOOLSET



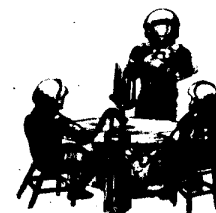
MISSION EXPERIMENTS



MEDICAL



WASTE CONTROL

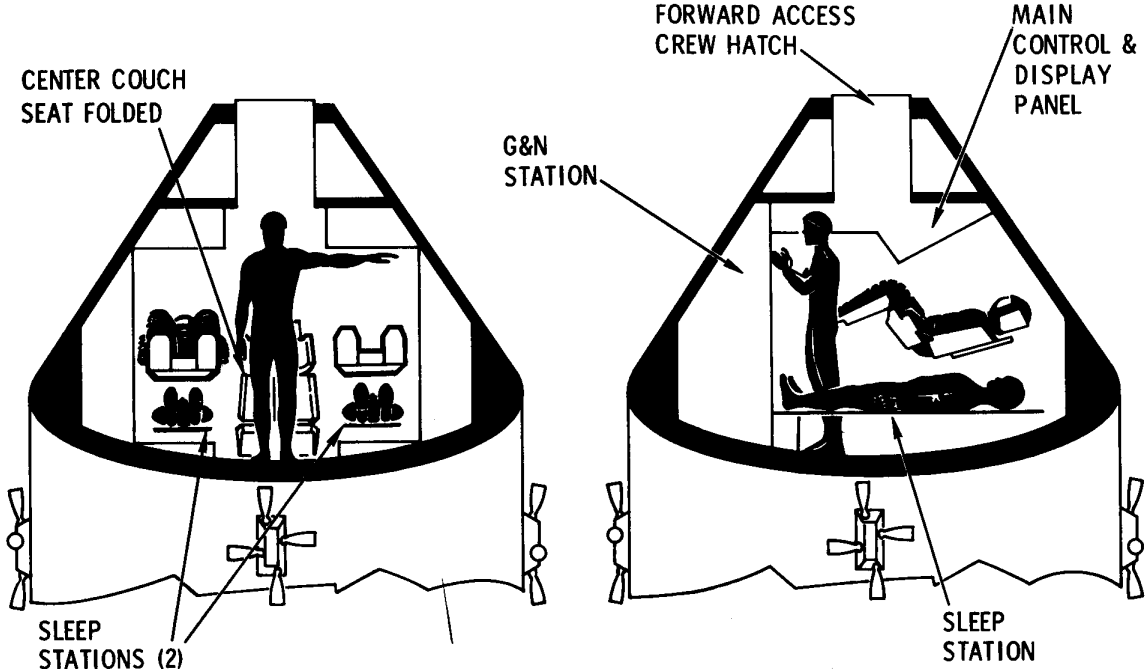


WATER AND FOOD <sup>A11</sup>

MAR 66

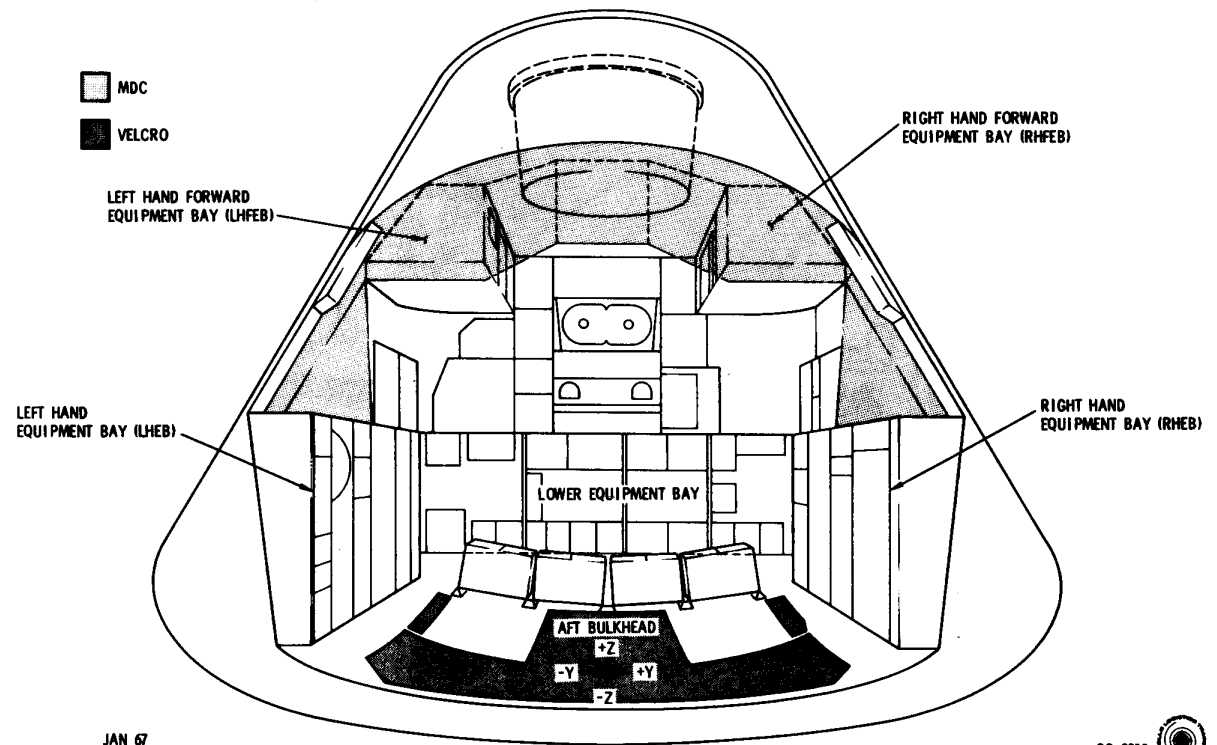
FAM-5402 A 

# APOLLO CREW STATIONS

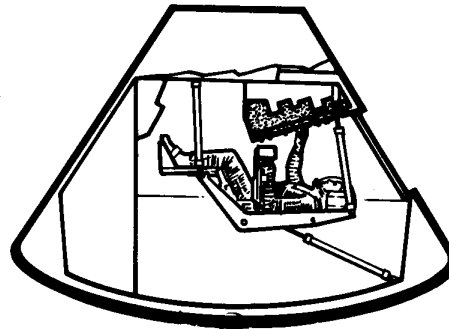
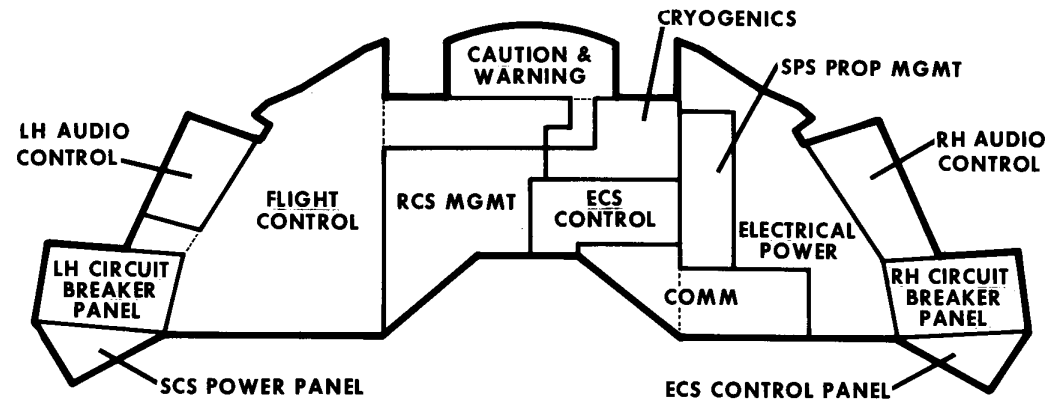


# APOLLO CREW COMPARTMENT

BLOCK II



# COMMAND MODULE MAIN PANEL



S66SD1081B-1B

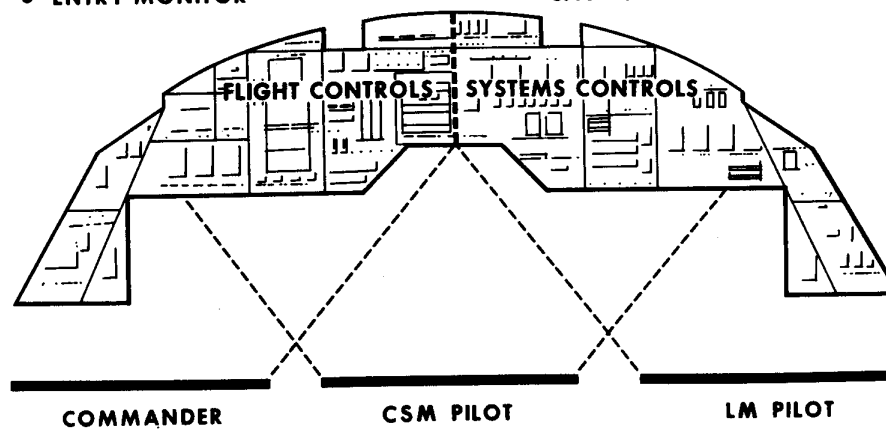


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## MAIN PANEL FUNCTIONS

- LV EMERGENCY DETECTION
- FLIGHT ATTITUDE
- MISSION SEQUENCE
- $\Delta V$  MONITOR
- ENTRY MONITOR

- PROPELLANT GAGING
- ENVIRONMENT CONTROL
- COMMUNICATIONS CONTROL
- POWER DISTRIBUTION
- CAUTION & WARNING



# CM INTEGRAL/NUMERICS ILLUMINATION SYSTEM

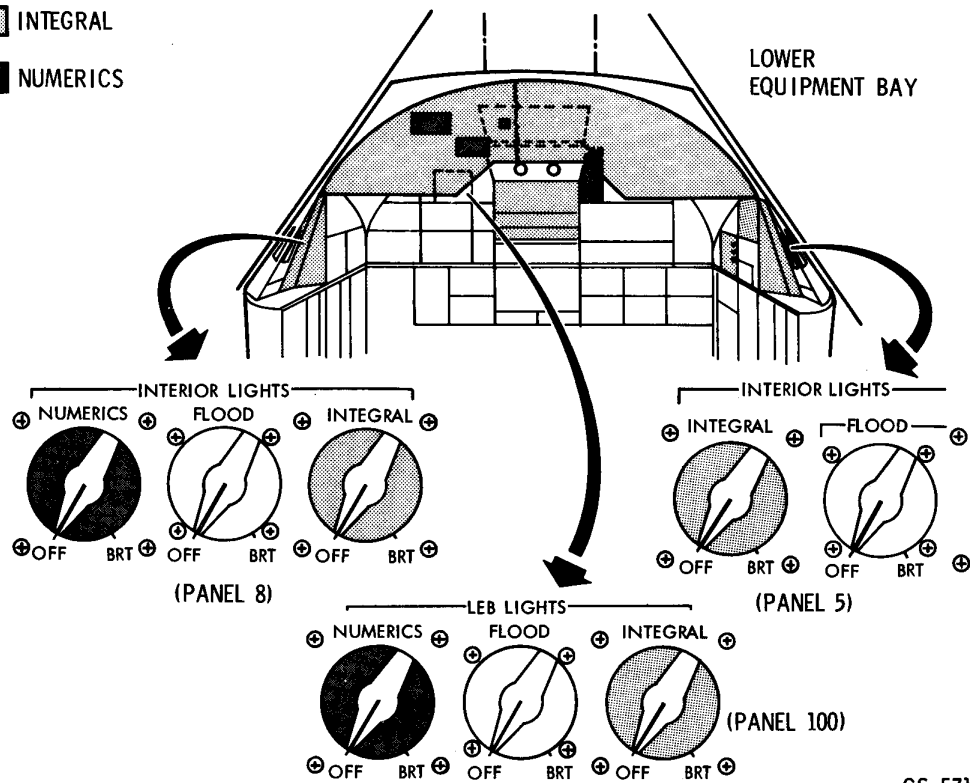
## BLOCK II

☐ INTEGRAL

■ NUMERICS

LOWER  
EQUIPMENT BAY

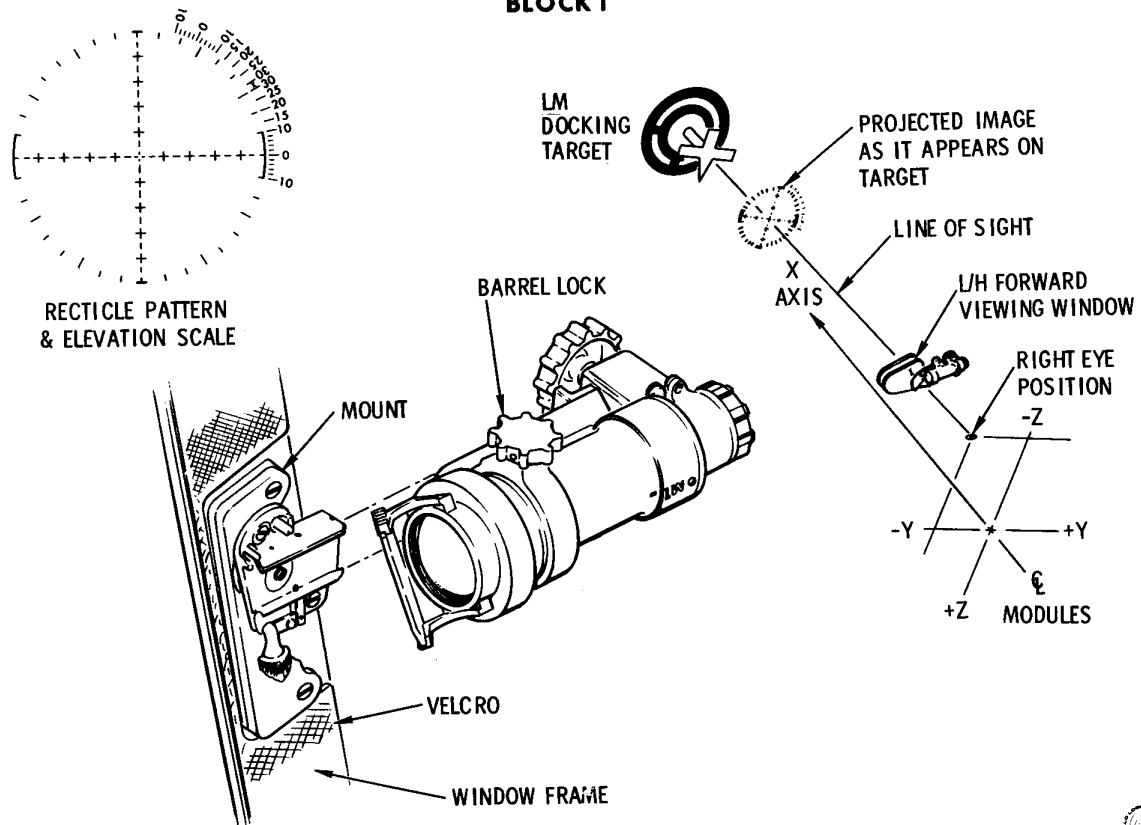
9



JAN 67

CS-571A

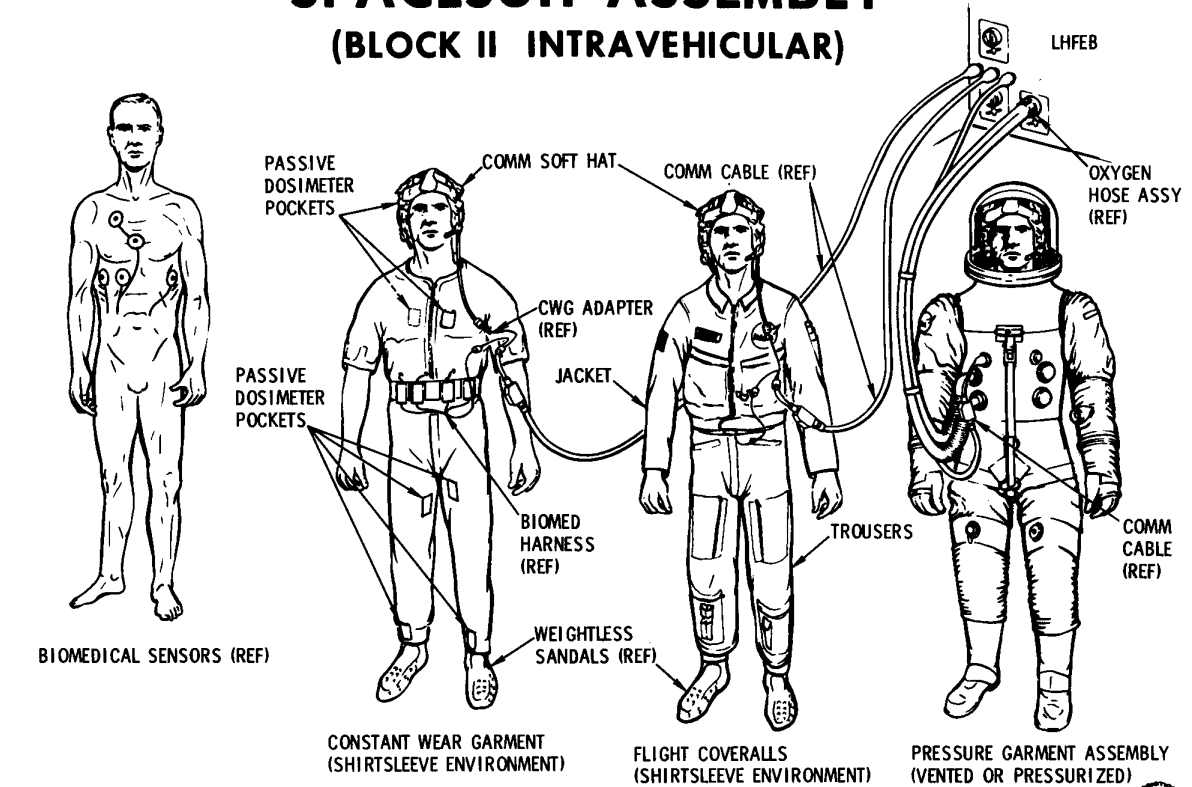
# APOLLO CREWMAN ALIGNMENT SIGHT SYSTEM CONFIGURATION BLOCK I



FEB 67


CS-531C

# SPACESUIT ASSEMBLY (BLOCK II INTRAVEHICULAR)

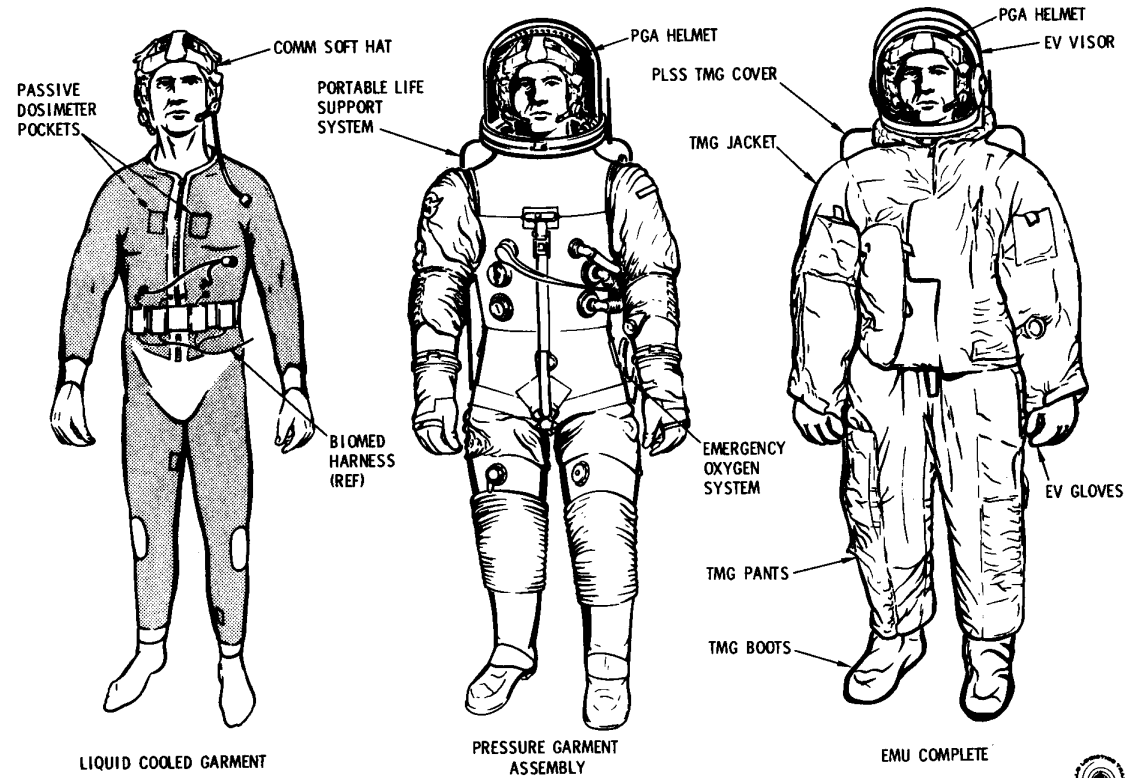


(REF) NOT PART OF SPACESUIT ASSEMBLY


MAY 67

CS-1001 B 

# EXTRAVEHICULAR MOBILITY UNIT (EMU)

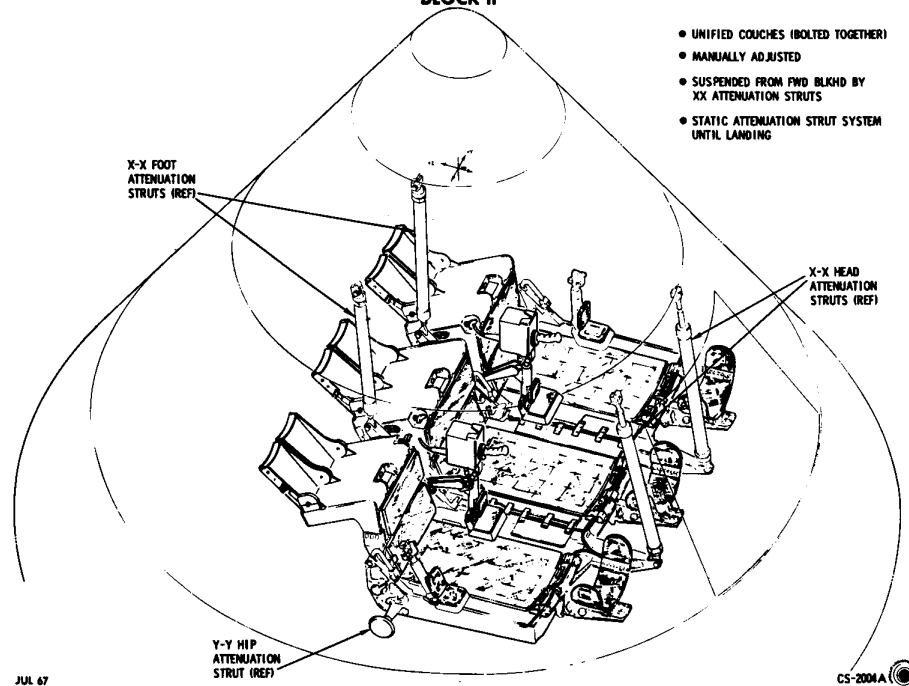


JAN 67

CS-1002A 

# CREW COUCH STRUCTURE BLOCK II

- UNIFIED COUCHES (BOLTED TOGETHER)
- MANUALLY ADJUSTED
- SUSPENDED FROM FWD BULKHD BY XX ATTENUATION STRUTS
- STATIC ATTENUATION STRUT SYSTEM UNTIL LANDING



X-X FOOT  
ATTENUATION  
STRUTS (REF)

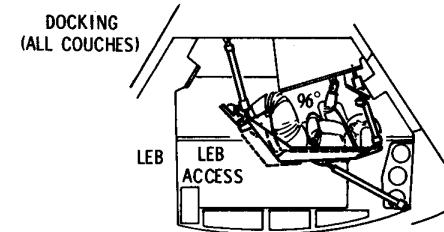
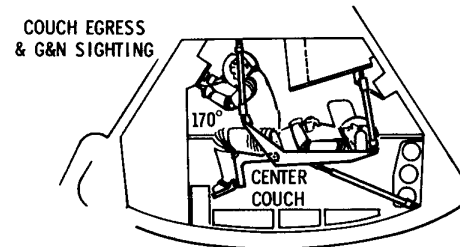
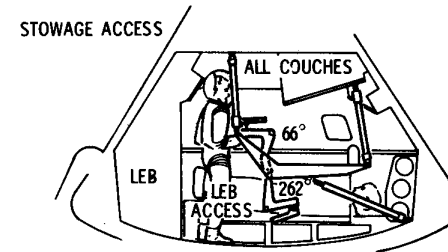
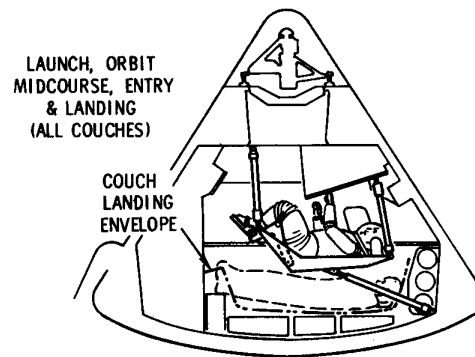
X-X HEAD  
ATTENUATION  
STRUTS (REF)

Y-Y HIP  
ATTENUATION  
STRUT (REF)

JUL 67

CS-200A

## MISSION PHASES WITH COUCH POSITIONS & SEAT ANGLE SC 2TV-1 & 101

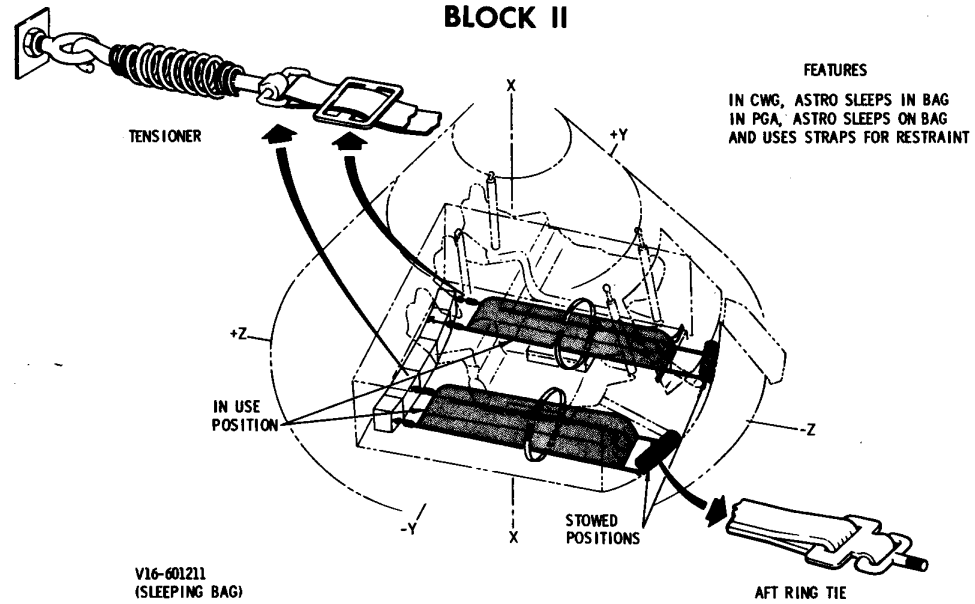


JUN 67

CS-2025C (↻)


# SLEEPING POSITION RESTRAINT CONFIGURATION

## BLOCK II



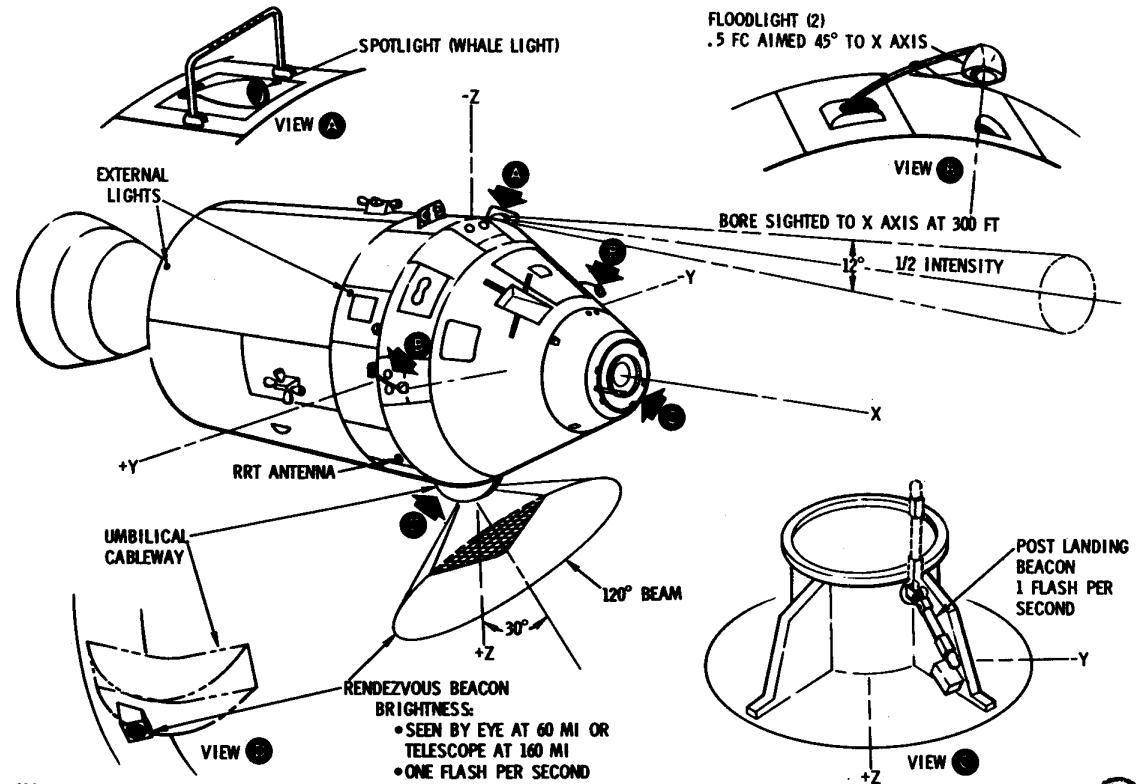
V16-601211  
(SLEEPING BAG)

MAR 67


CS-2331 



# CSM DOCKING, EVA, & EXTERNAL LIGHTS

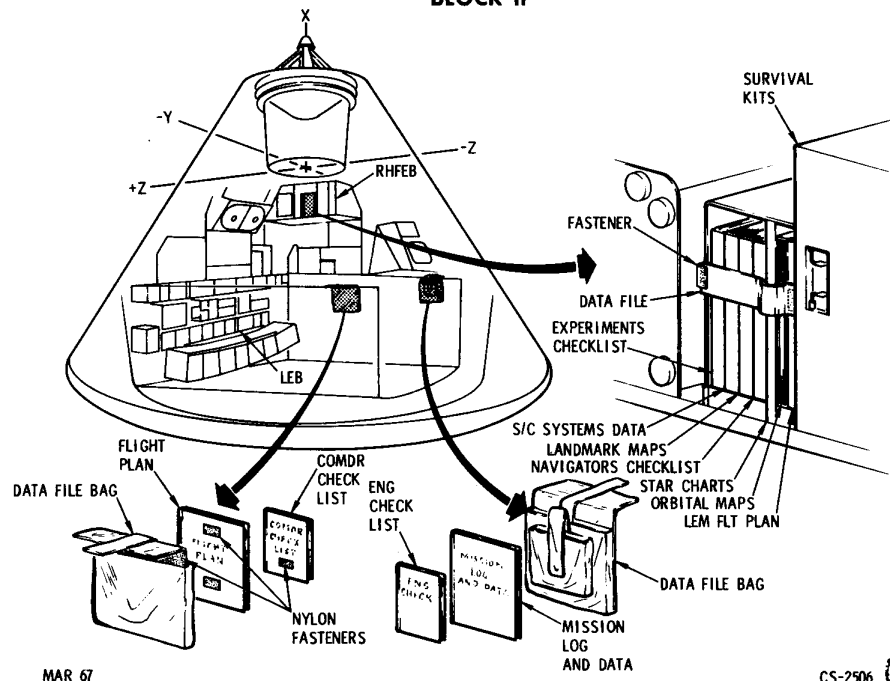


MAY 67


CS-755 

# FLIGHT DATA FILE

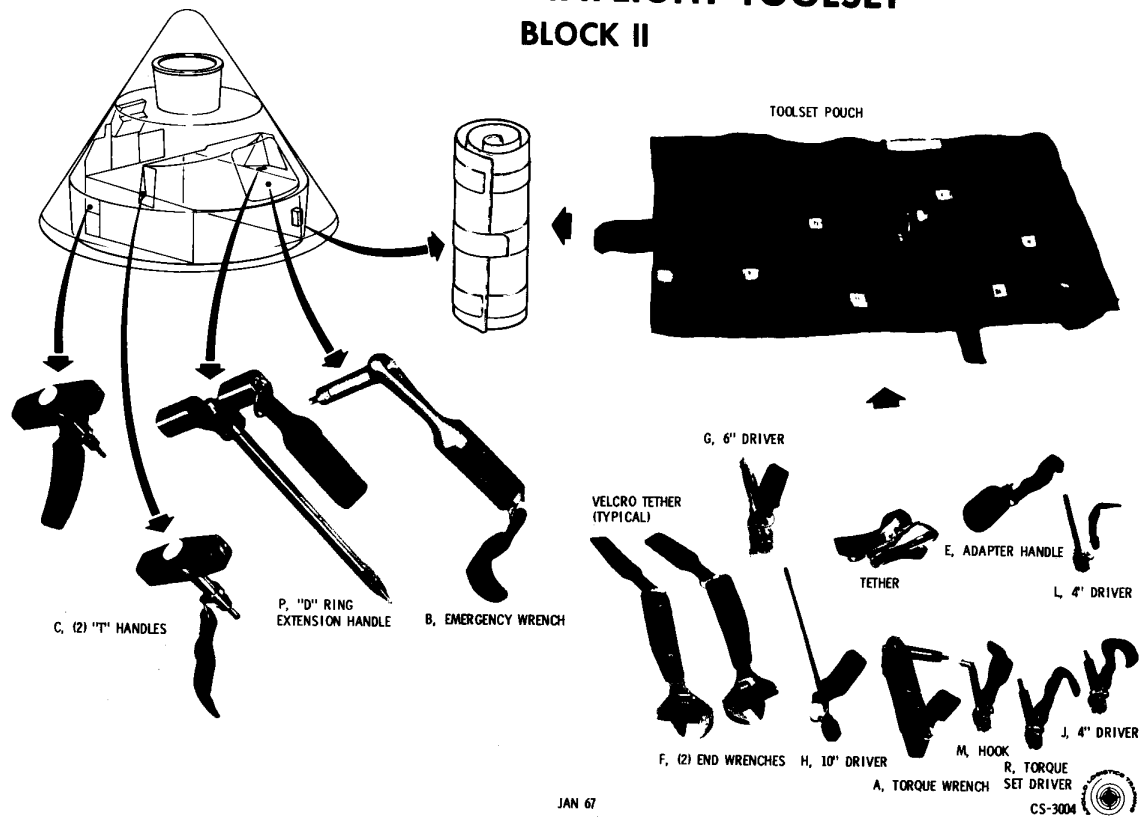
## BLOCK II



MAR 67

CS-2506 

# CM CREWMAN INFLIGHT TOOLSET BLOCK II

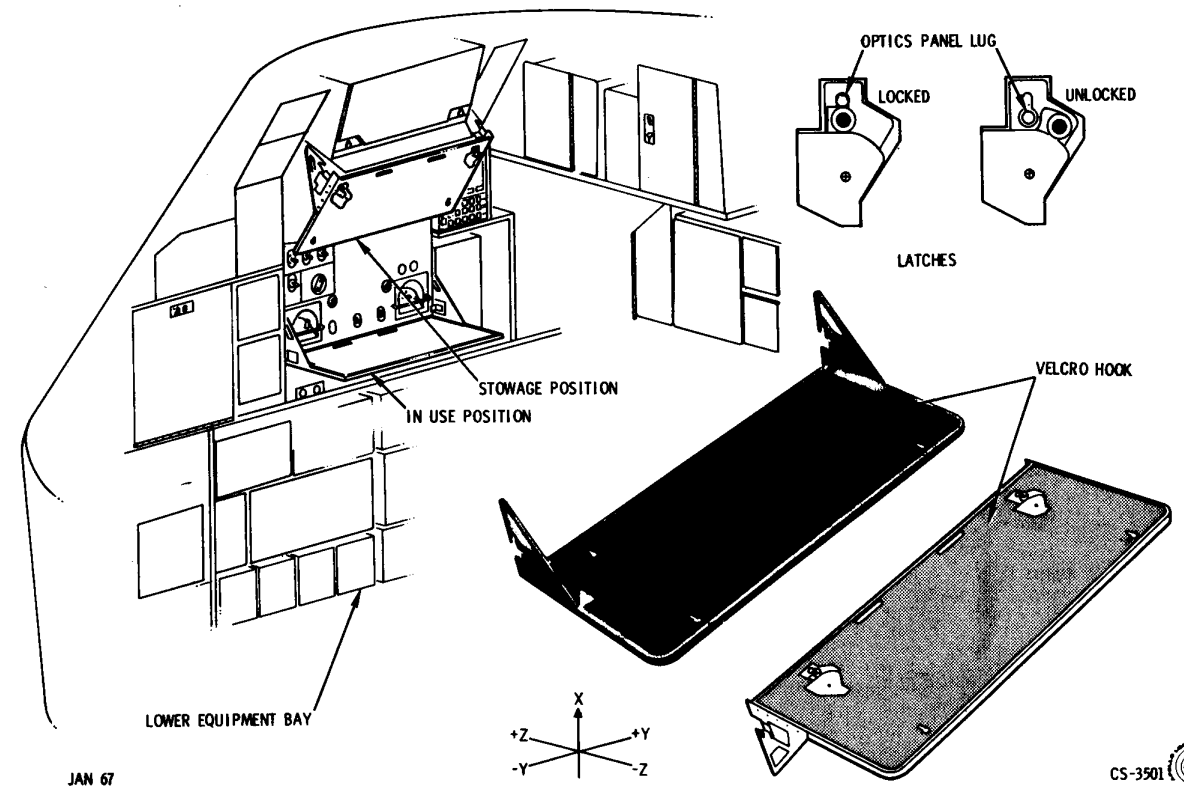


JAN 67

CS-3004



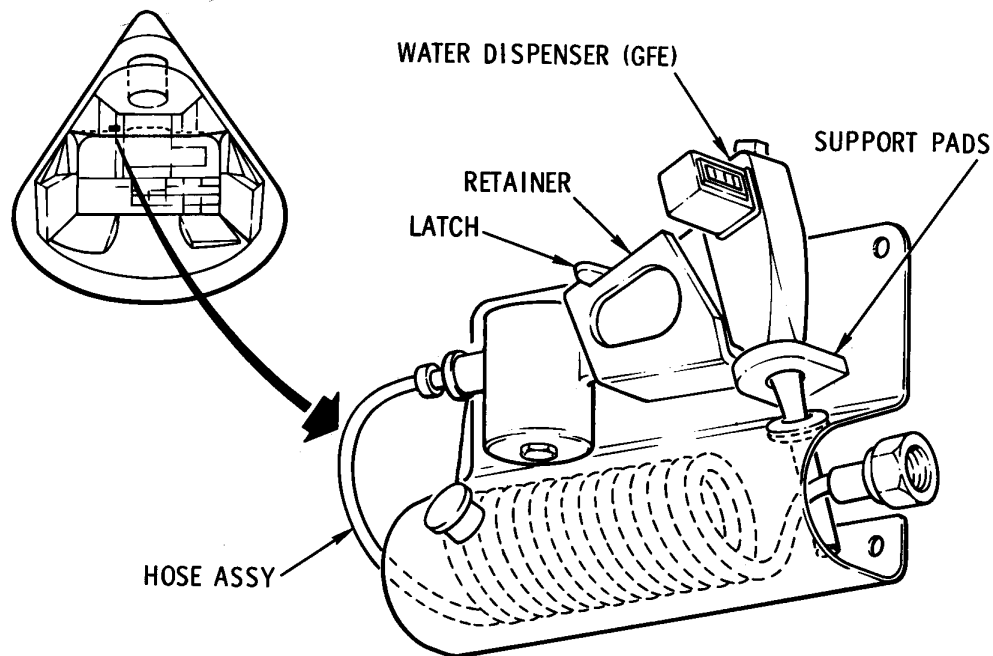
# WORK SHELF/OPTICS PANEL COVER BLOCK II



JAN 67

CS-3501

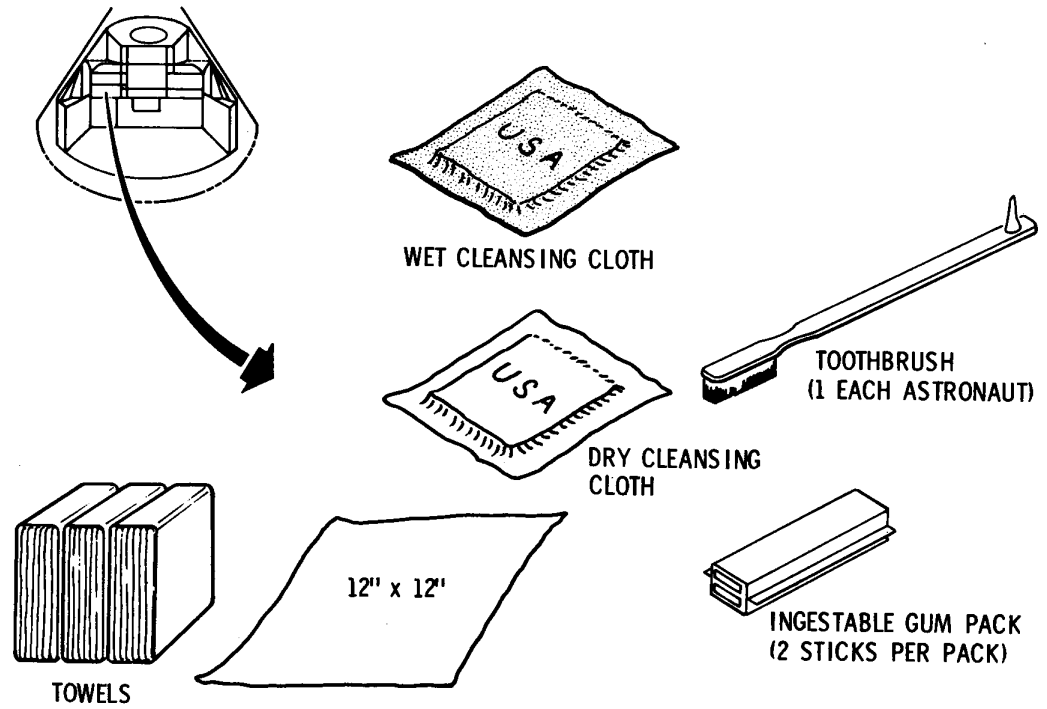
# WATER METERING DISPENSER ASSEMBLY




JAN 67

CS-4101D 

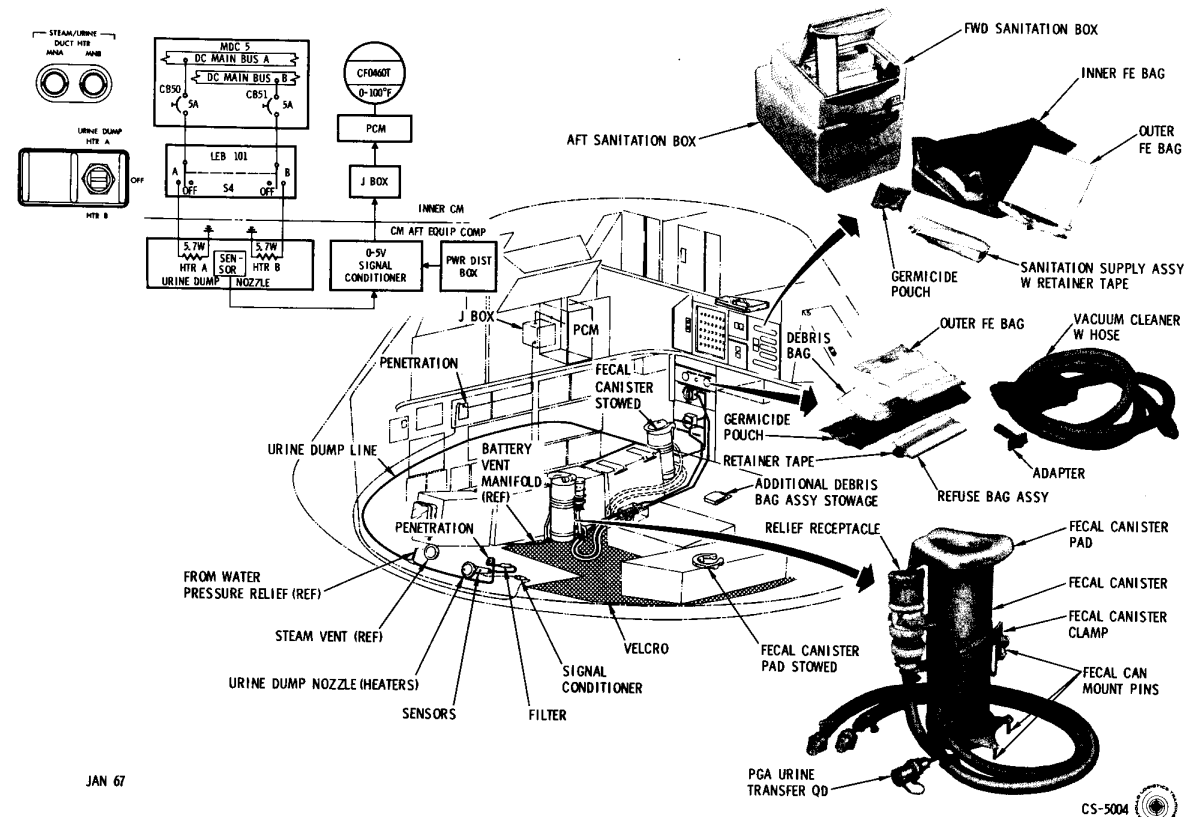
## PERSONAL HYGIENE ITEMS



CS-5501D 

# WASTE MANAGEMENT SYSTEM

## BLOCK II

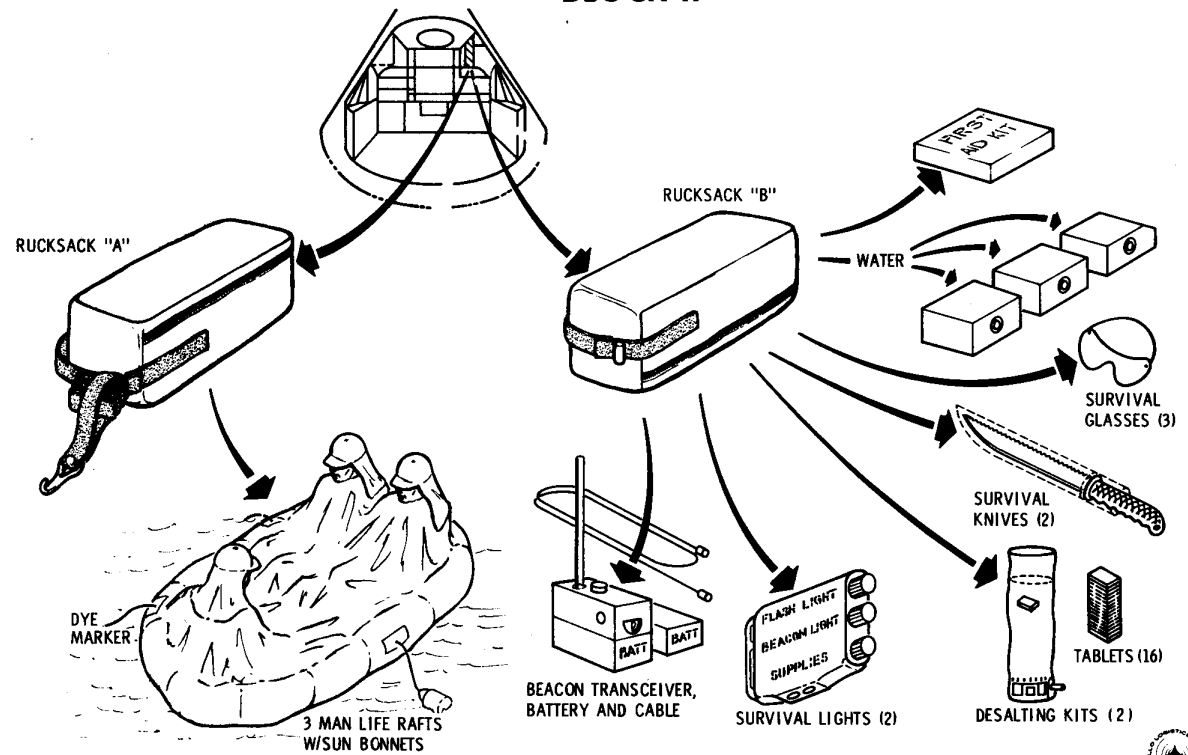


JAN 67


CS-5004

# APOLLO SURVIVAL KIT AND COMPONENTS

## BLOCK II

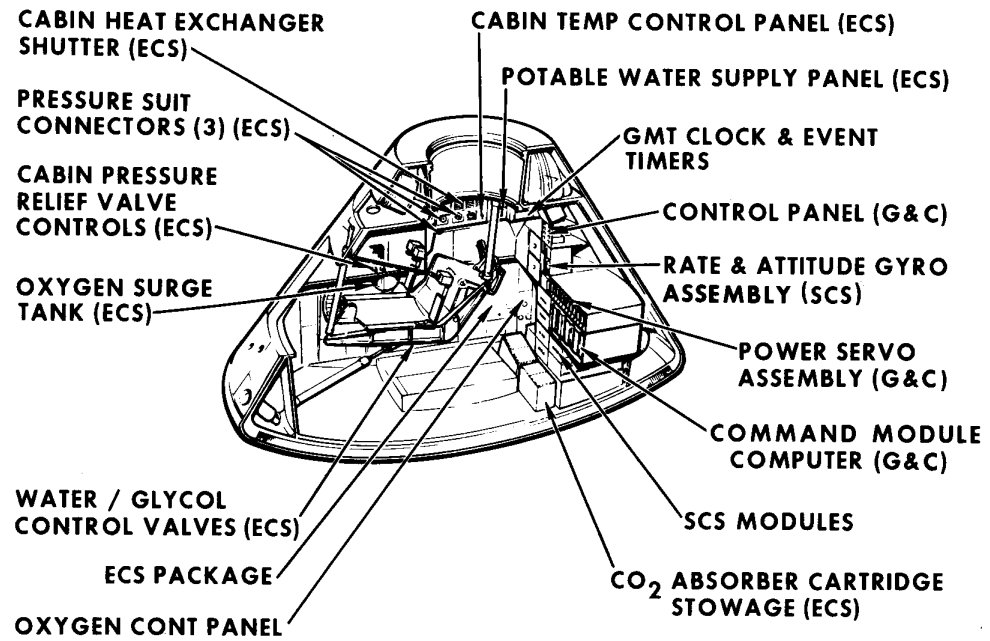


JAN 67

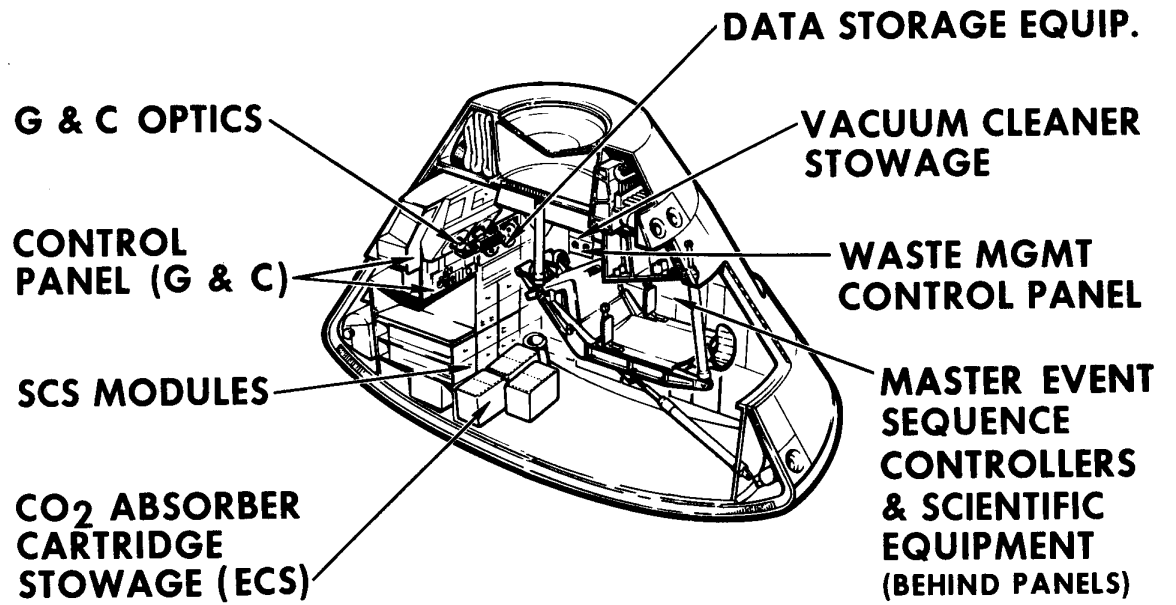
CS-7000D 



# COMMAND MODULE INTERIOR (LEFT SIDE)



# COMMAND MODULE INTERIOR (RIGHT SIDE)



**COMMUNICATIONS MODULES**

# APOLLO ABBREVIATIONS

A/C	AUDIO CENTER (COMM)	L/O	LIFT-OFF
ACE	ACCEPTANCE CHECKOUT EQUIP.	LOI	LUNAR ORBIT INSERTION (G&C)
ACS	ATTITUDE CONTROL SUBSYSTEM (SCS)	LOR	LUNAR ORBITAL RENDEZVOUS
A/D	ANALOG TO DIGITAL (COMM)	LOS	LINE OF SIGHT (G&N)
AGAA	ATTITUDE GYRO ACCELEROMETER ASSEMBLY (SCS)	LSC	LINEAR SHAPE CHARGE (SECS)
ARS	ATTITUDE REFERENCE SUBSYSTEM (SCS)	LV	LAUNCH VEHICLE
BMAG	BODY MOUNTED ATTITUDE GYRO (SCS)	MAX Q	MAXIMUM DYNAMIC PRESSURE
BPC	BOOST PROTECTIVE COVER (SECS)	MC	MEGACYCLES
B/P	BOILERPLATE	MDC	MAIN DISPLAY CONSOLE
CDU	COUPLING DATA UNIT (G&C)	MDF	MILD DETONATING FUSE (STRUCT)
CM	COMMAND MODULE	MESC	MASTER EVENTS SEQUENCE CONTROLLER (SECS)
CMC	COMMAND MODULE COMPUTER	MNA	MAIN BUS A (EPS)
COAS	CREWMAN OPTICAL ALIGNMENT SIGHT (CREW)	MNB	MAIN BUS B (EPS)
COMM	COMMUNICATIONS SUBSYSTEM	MSFN	MANNED SPACE FLIGHT NETWORK (COMM)
CSM	COMMAND SERVICE MODULE	MTVC	MANUAL THRUST VECTOR CONTROL (SCS)
CTE	CENTRAL TIMING EQUIP. (COMM)	PCM	PULSE CODE MODULATION (COMM)
C/W	CAUTION & WARNING	PGA	PRESSURE GARMENT ASSEMBLY (CREW)
DWG	CONSTANT WEAR GARMENT (CREW)	PONCS	PRIMARY GUIDANCE, NAVIGATION & CONTROL SYS
D/A	DIGITAL TO ANALOG (COMM)	PIPA	PULSED INTEGRATING PENDULOUS ACCELEROMETER (G&C)
DSE	DOCKING SYSTEM	PLSS	PORTABLE LIFE SUPPORT SYSTEM (CREW)
DSE	DATA STORAGE EQUIP. (COMM)	PM	PHASE MODULATION (COMM)
DSIF	DEEP SPACE INSTRUMENTATION FACILITY (COMM)	PMP	PREMODULATION PROCESSOR (COMM)
DSKY	DISPLAY & KEYBOARD (G&C)	PRN	PSEUDO-RANDOM NOISE (COMM)
AV	DIFFERENTIAL VELOCITY (G&C)	PROP	PROPULSION
ECA	ELECTRONIC CONTROL ASSEMBLY (SCS)	PSA	POWER SERVO ASSEMBLY (G&C)
ECS	ENVIRONMENTAL CONTROL SUBSYSTEM	PTT	PUSH TO TALK (COMM)
ECU	ENVIRONMENTAL CONTROL UNIT (ECS)	RCS	REACTION CONTROL SUBSYSTEM
EDA	ELECTRONIC DISPLAY ASSEMBLY (G&C)	RGA	RATE GYRO ASSEMBLY (SCS)
EDS	EMERGENCY DETECTION SUBSYSTEM (SECS)	RJEC	REACTION JET AND ENGINE ON-OFF CONTROL (G&C)
ELS	EARTH LANDING SUBSYSTEM (SECS)	RRT	RENDEZVOUS RADAR TRANSPONDER (COMM)
EHS	ENTRY MONITOR SYSTEM	RTC	REAL TIME COMMAND (COMM)
EMU	EXTRA-VEHICULAR MOBILITY UNIT (CREW)	SBPA	S-BAND POWER AMPLIFIER (COMM)
EPI	EARTH ORBIT INSERTION (G&C)	SC	SPACECRAFT
EPS	ELECTRICAL POWER SUBSYSTEM	SCE	SIGNAL CONDITIONING EQUIPMENT (TLM)
EVA	EXTRA-VEHICULAR ACTIVITY (CREW)	SCS	STABILIZATION & CONTROL SUBSYSTEM
FC	FUEL CELL (EPS)	SCT	SCANNING TELESCOPE (G&N)
FDAI	FLIGHT DIRECTOR ATTITUDE INDICATOR (SCS)	SECS	SEQUENTIAL EVENTS CONTROL SUBSYSTEM
FHS	FORWARD HEAT SHIELD	SLA	SPACECRAFT LM ADAPTER
G&C	GUIDANCE & CONTROL	SM	SERVICE MODULE
GDC	GYRO DISPLAY COUPLER (SCS)	SPS	SERVICE PROPULSION SUBSYSTEM
GHZ	GIGAHERTZ (COMM)	SSA	SPACE SUIT ASSEMBLY (CREW)
G&N	GUIDANCE & NAVIGATION	SXT	SEXTANT (G&N)
GNC/S	GUIDANCE NAVIGATION & CONTROL SYSTEM	TCA	THRUST CHAMBER ASSEMBLY (PROP)
GSE	GROUND SUPPORT EQUIP.	TEI	TRANSEARTH INJECTION (G&C)
HF	HIGH FREQUENCY (3-30MC)	TLI	TRANSLUNAR INJECTION (G&C)
IMU	INERTIAL MEASUREMENT UNIT (G&N)	TLM	TELEMETRY (COMM)
INV	INVERTER (EPS)	TMG	THERMAL METEOROID GARMENT (CREW)
IU	INSTRUMENT UNIT (LV)	TVC	THRUST VECTOR CONTROL (SPS)
KMC	KILOMEGA CYCLES	TVSA	THRUST VECTOR POSITION SERVO AMPLIFIER (G&C)
KOH	POTASSIUM HYDROXIDE (EPS)	UDL	UP DATA LINK (COMM)
LCC	LIQUID COOLED GARMENT (CREW)	UDMH	UNSYMMETRICAL DIMETHYL HYDRAZINE (PROP)
LDEC	LUNAR DOCKING EVENTS CONTROLLER (DS)	UHF	ULTRA HIGH FREQUENCY (300-3000 MC)
LEB	LOWER EQUIPMENT BAY	USBE	UNIFIED S-BAND EQUIP. (COMM)
LES	LAUNCH ESCAPE SUBSYSTEM (SECS)	VHF	VERY HIGH FREQUENCY (30-300 MC)
LET	LAUNCH ESCAPE TOWER (SECS)	WMS	WASTE MANAGEMENT SUBSYSTEM (CREW)
LM	LUNAR MODULE		