

APOLLO

REVISED APRIL 20, 1965



RD-1000

APOLLO SUBCONTRACTORS

SUBSYSTEM

CM REACTION CONTROL ENGINES
DIGITAL TEST COMMAND SYSTEM
MISSION SIMULATOR TRAINER
SS HONEYCOMB PANELS
TV CAMERAS BLOCK I
REACTION CONTROL S/M
EARTH LANDING SYSTEM
ENVIRONMENTAL CONTROL
SERVICE MODULE PROPULSION MOTOR
LAUNCH ESCAPE PITCH CONTROL MOTORS
COMMUNICATION & DATA
STABILIZATION & CONTROL
ABLATIVE HEAT SHIELD
FUEL CELL MODULES
ESCAPE TOWER JETTISON MOTOR
R & D TELEMETRY ANTENNA
BATTERY CHARGER

SUBCONTRACTOR

ROCKETDYNE - CANOGA PARK, CALIF
CONTROL & DATA CORP - MINNEAPOLIS, MINN
GPI LINK DIVISION - BINGHAMTON, NY
AERONCA MFG CO - MIDDLETOWN, OHIO
RCA - PRINCETON, NJ
MARQUARDT CORP - VAN NUYS, CALIF
NORTHROP-VENTURA-NEWBERRY PK, CALIF
AIRSEARCH MFG CO - LOS ANGELES, CALIF
AEROJET-GENERAL - SACRAMENTO, CALIF
LOCKHEED PROPULSION CO - REDLANDS, CALIF
COLLINS RADIO CO - CEDAR RAPIDS, IOWA
HONEYWELL - MINNEAPOLIS, MINN
AVCO CORP - WILMINGTON, MASS
PRATT & WHITNEY - EAST HARTFORD, CONN
THIOKOL CHEMICAL CORP - ELKTON, MD
TRANSCO - VENICE, CALIF
ITT-INDUSTRIAL PROD DIV - SAN FERNANDO, CALIF



APOLLO SUBCONTRACTORS (CONT)

SUBSYSTEM

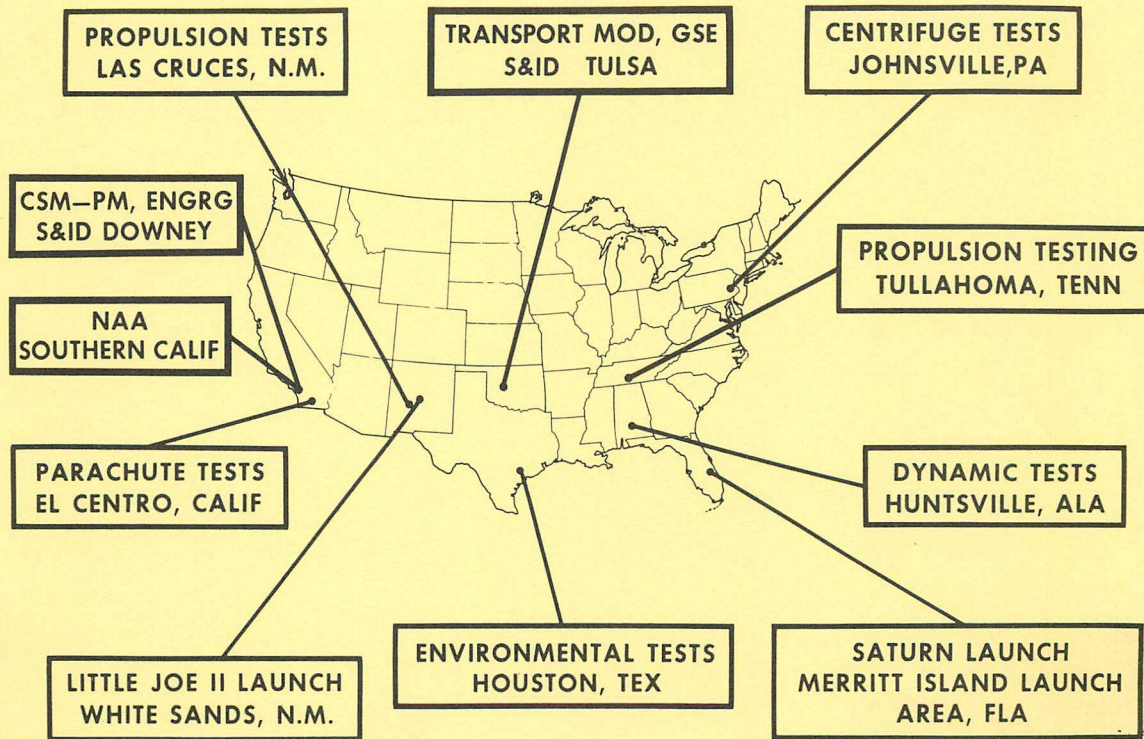
SUPERCritical GAS STORAGE
ENTRY & POST LANDING BATTERY
STATIC INVERTER
RECOVERY ANTENNA
R&D BEACON ANTENNA
CENTRAL TIMING SYSTEM
POSITIVE EXPULSION TANKS RCS
ANTHROPOMORPHIC DUMMIES
PROPELLENT GAGING SYSTEM S/M RCS
HELIUM TANKS
DIGITAL UP-DATA LINK
2 KMC HI GAIN ANTENNA
FUEL & OXIDIZER TANKS
PROP GAGING MIXTURE & RATIO CONTROL
C-BAND ANTENNA
TV CAMERAS BLOCK II
HF RECOVERY ANTENNA
HF ORBITAL ANTENNA

SUBCONTRACTOR

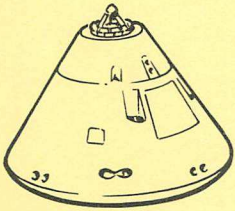
BEECH AIRCRAFT - BOULDER, COLO
EAGLE PICHER - JOPLIN, MO
WESTINGHOUSE-ELECTRIC CORP - LIMA, OHIO
AIRBORNE INSTRUMENTS LAB, LONG ISLAND, NY
MELPAR - FALLS CHURCH, VA
ELGIN - ROLLING MEADOWS, ILL
BELL AEROSYSTEM - BUFFALO, NY
ALDERSON LABS - LONG ISLAND, NY
GIANNINI CONTROL CORP - DUARTE, CALIF
AIRITE PRODUCTS - LOS ANGELES, CALIF
MOTOROLA INCORPORATION - SCOTTSDALE, ARIZ
DALMO-VICTOR - BELMONT, CALIF
ALLISON DIV GMC - INDIANAPOLIS, IND
SIMMONS PRECISION PROD - TARRYTOWN, NY
RADCOM - COLLEGE PARK, MD
WESTINGHOUSE - BALTIMORE MD
DEHAVILLAND ONTARIO, CANADA
DEHAVILLAND ONTARIO, CANADA



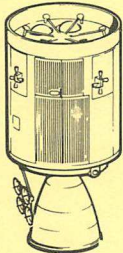
FACILITIES-NATIONWIDE



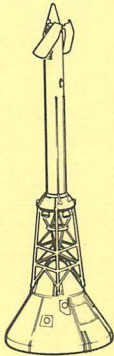
APOLLO SPACECRAFT S&ID RESPONSIBILITIES



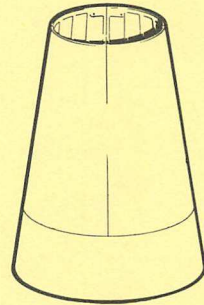
CM



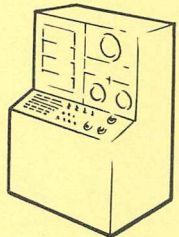
SM



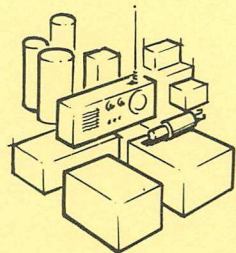
LES



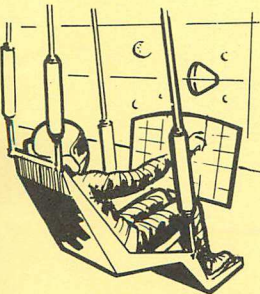
SLA



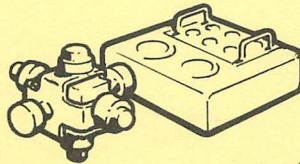
GSE



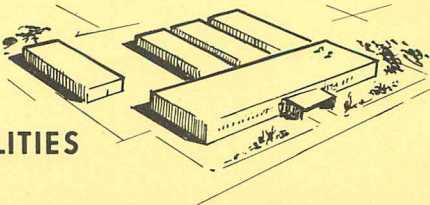
SPARES



TRAINERS



MAJOR SUBS



FACILITIES

INTERFACE WITH
ASSOCIATE
CONTRACTORS
G&N
ACE
LEM
ETC

MANNED SPACECRAFT



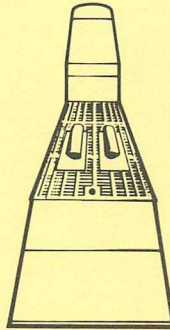
1 MAN

MERCURY

PAYLOAD , LBS 3,500

BOOSTER ATLAS

THRUST , LBS 360,000



2 MAN

GEMINI

7,000

TITAN II

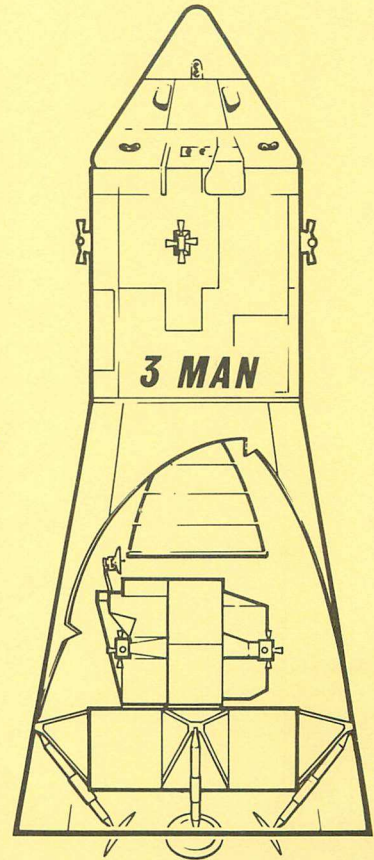
430,000

APOLLO

250,000

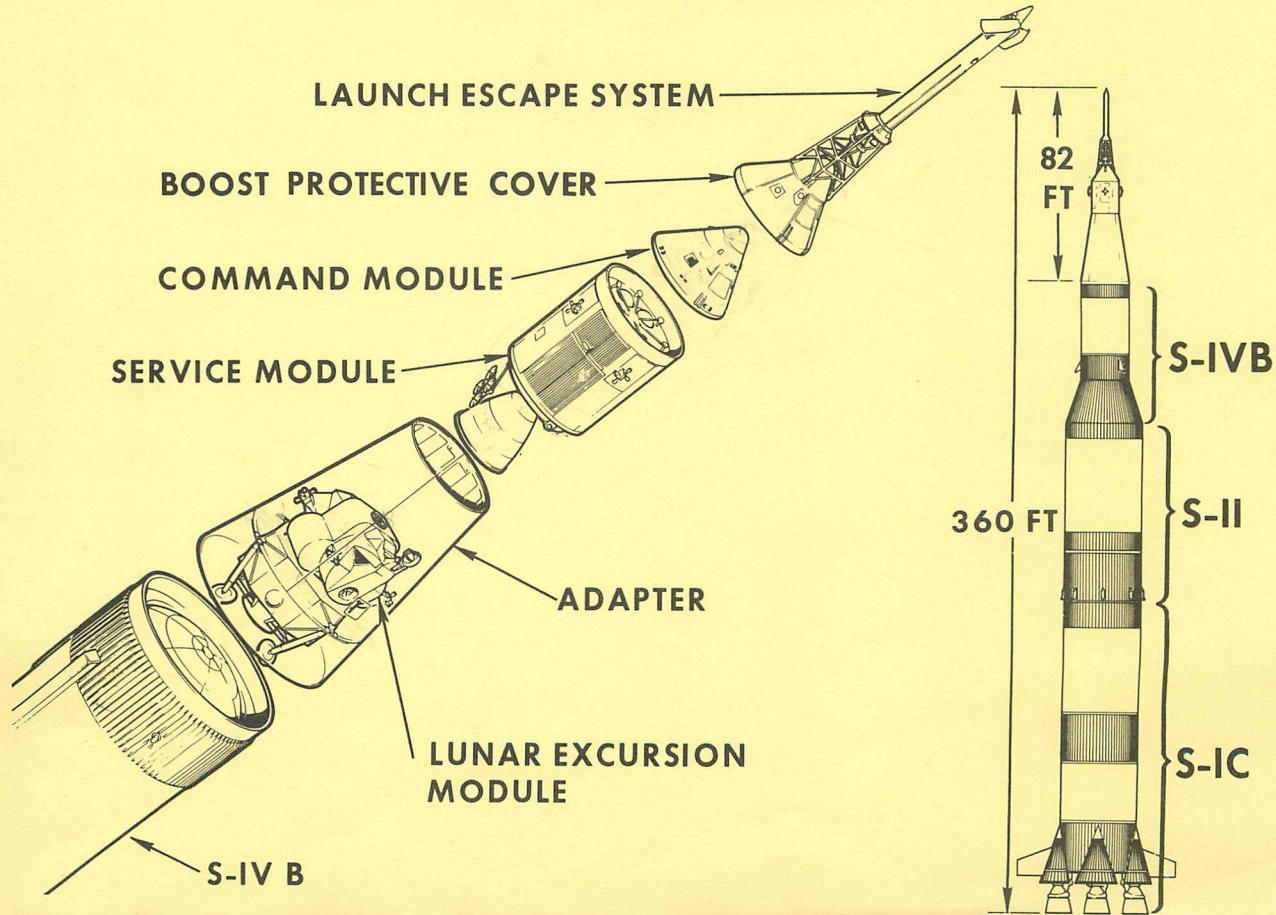
SATURN

7,500,000

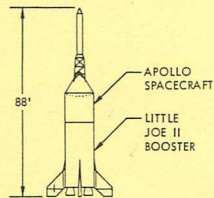


3 MAN

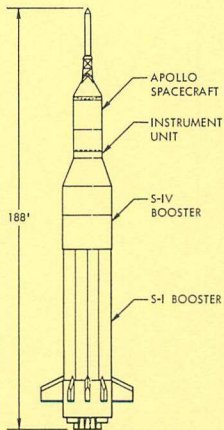
APOLLO SPACECRAFT



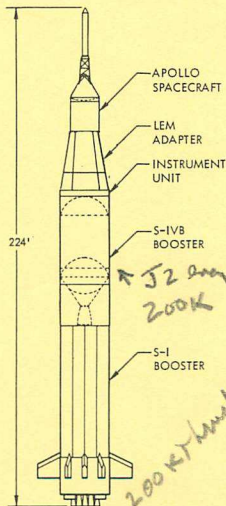
SPACE VEHICLES



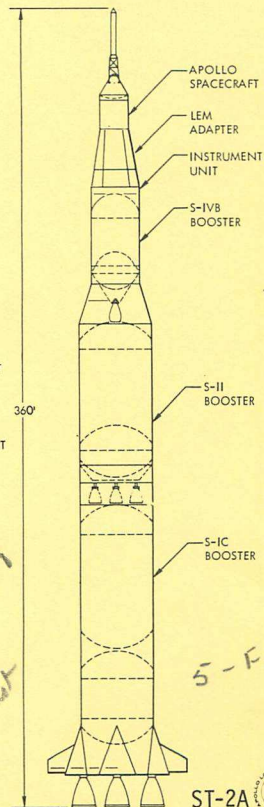
LITTLE JOE II




SATURN I



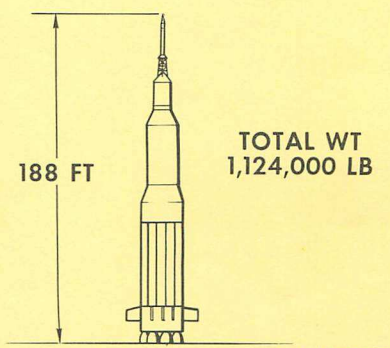
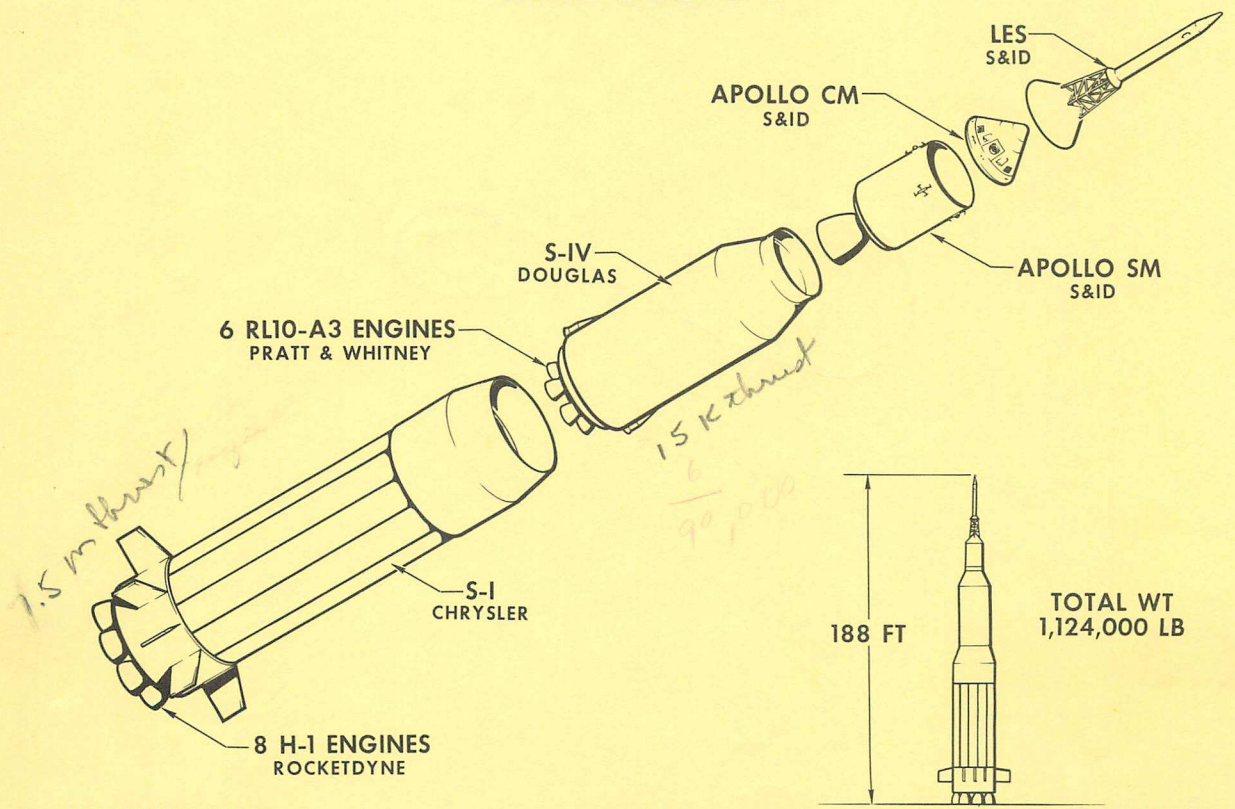
SATURN IB



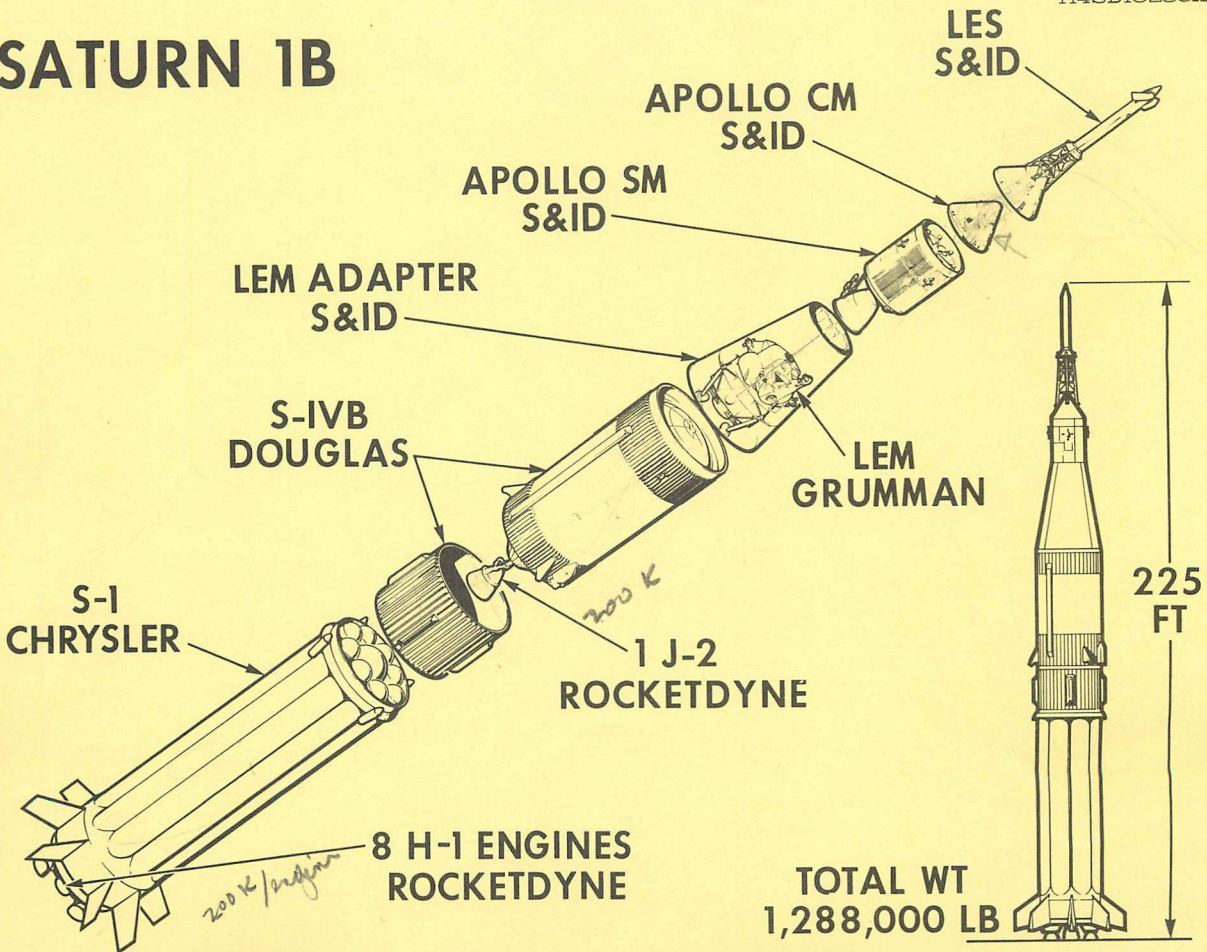
SATURN V

ST-2A 

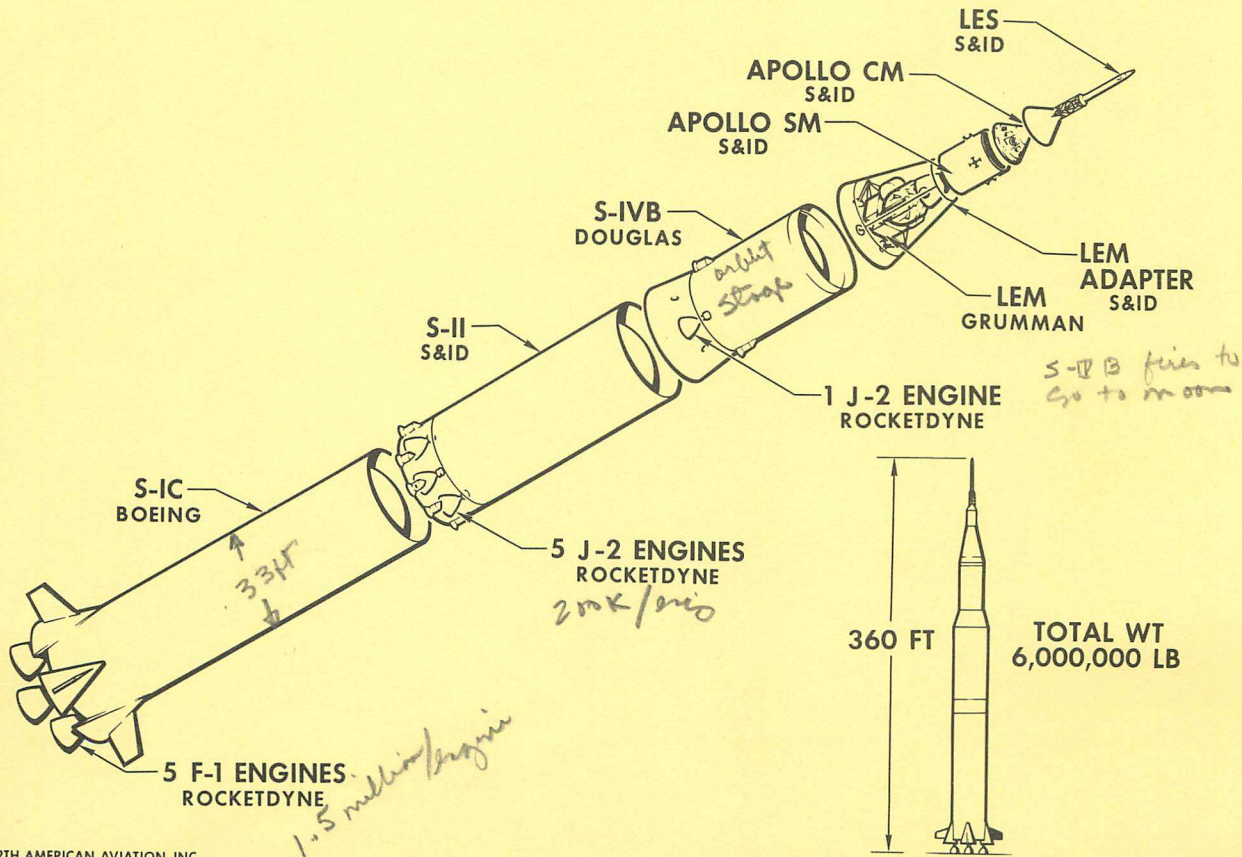
SATURN I



SATURN 1B

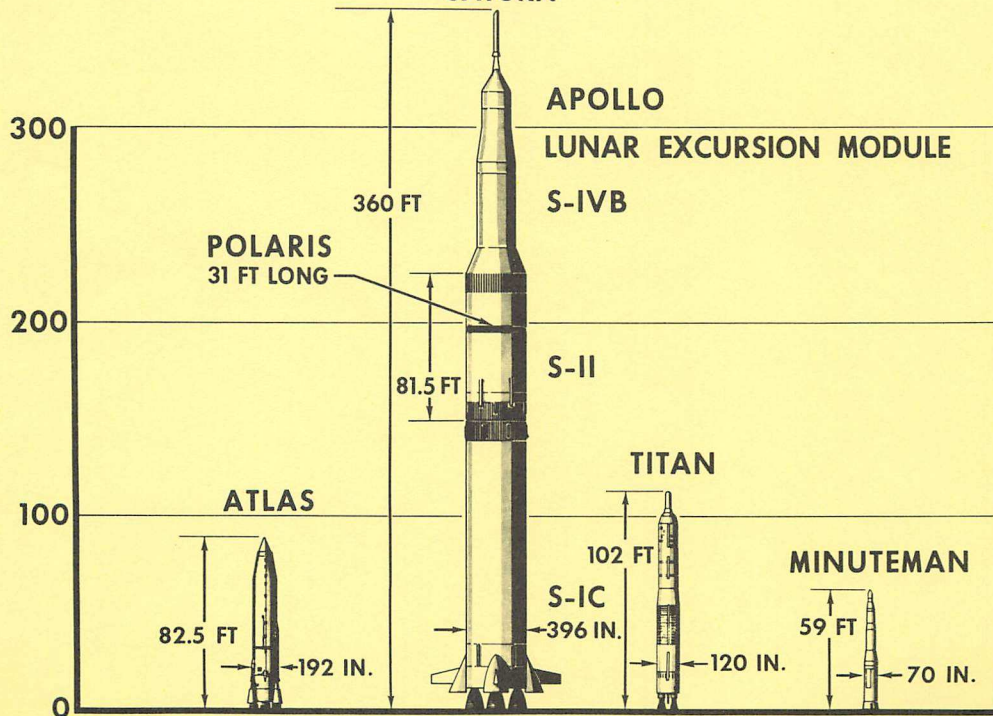


SATURN V

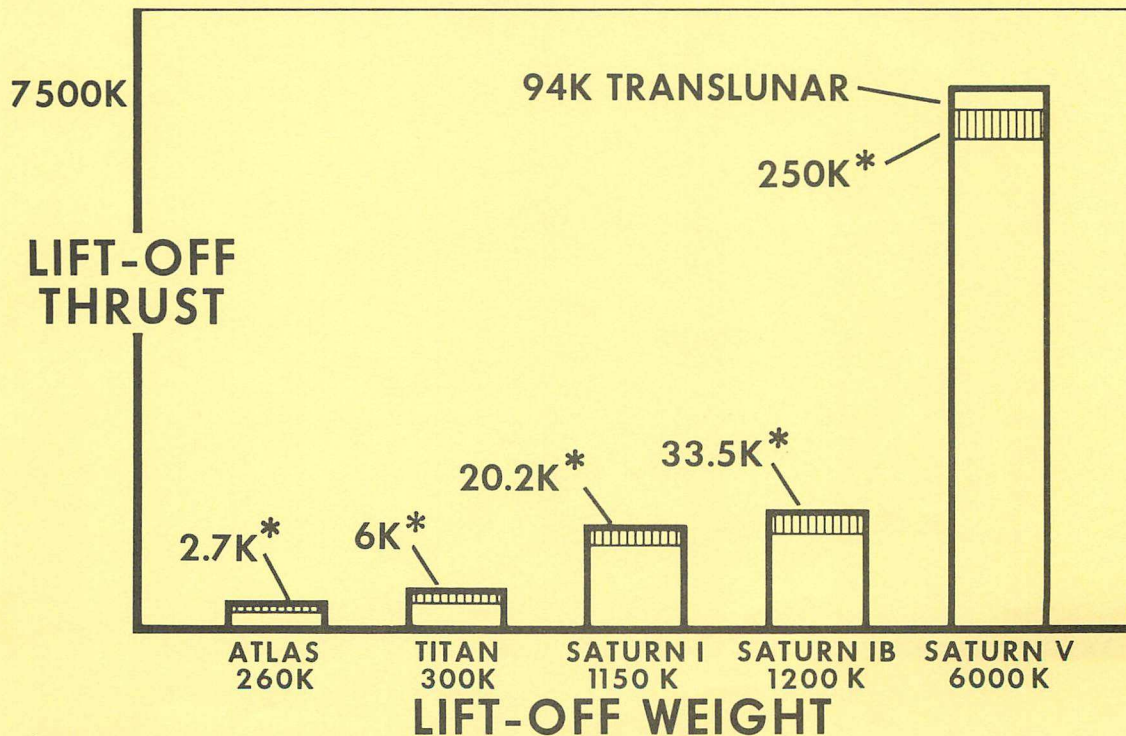


SATURN V

SATURN



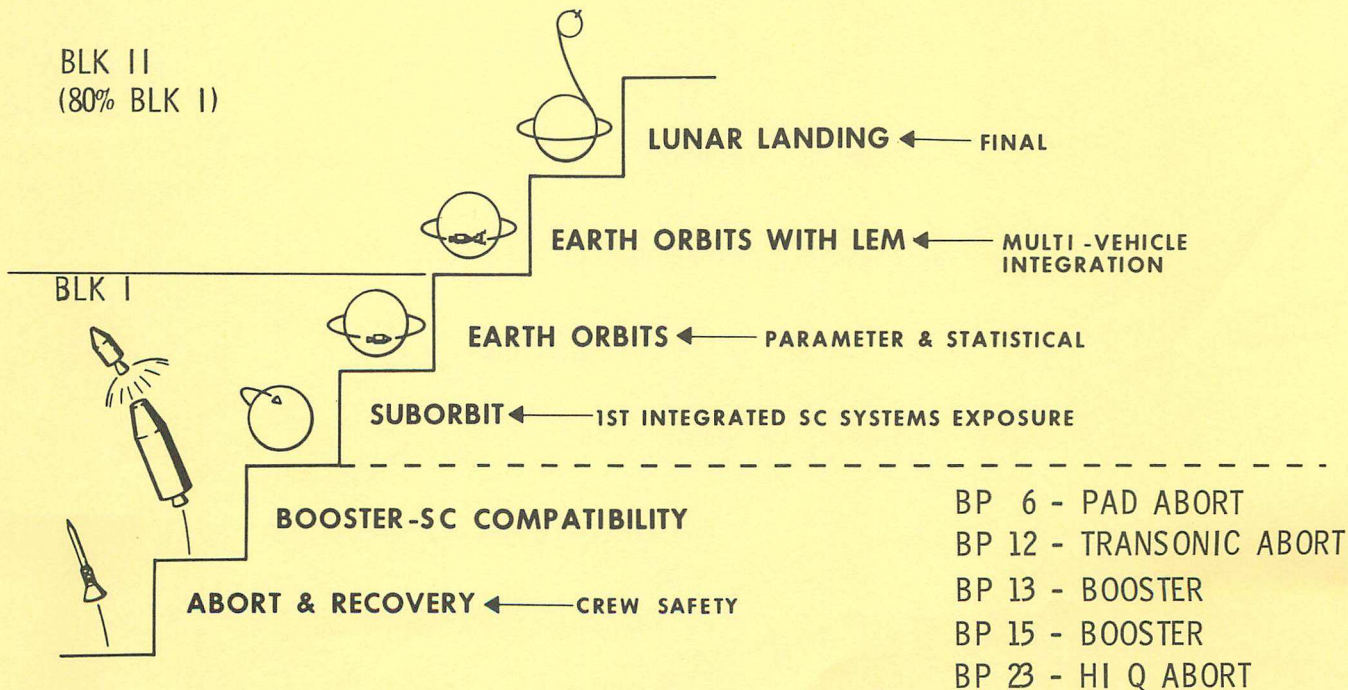
LAUNCH VEHICLES WEIGHT / PAYLOAD / THRUST

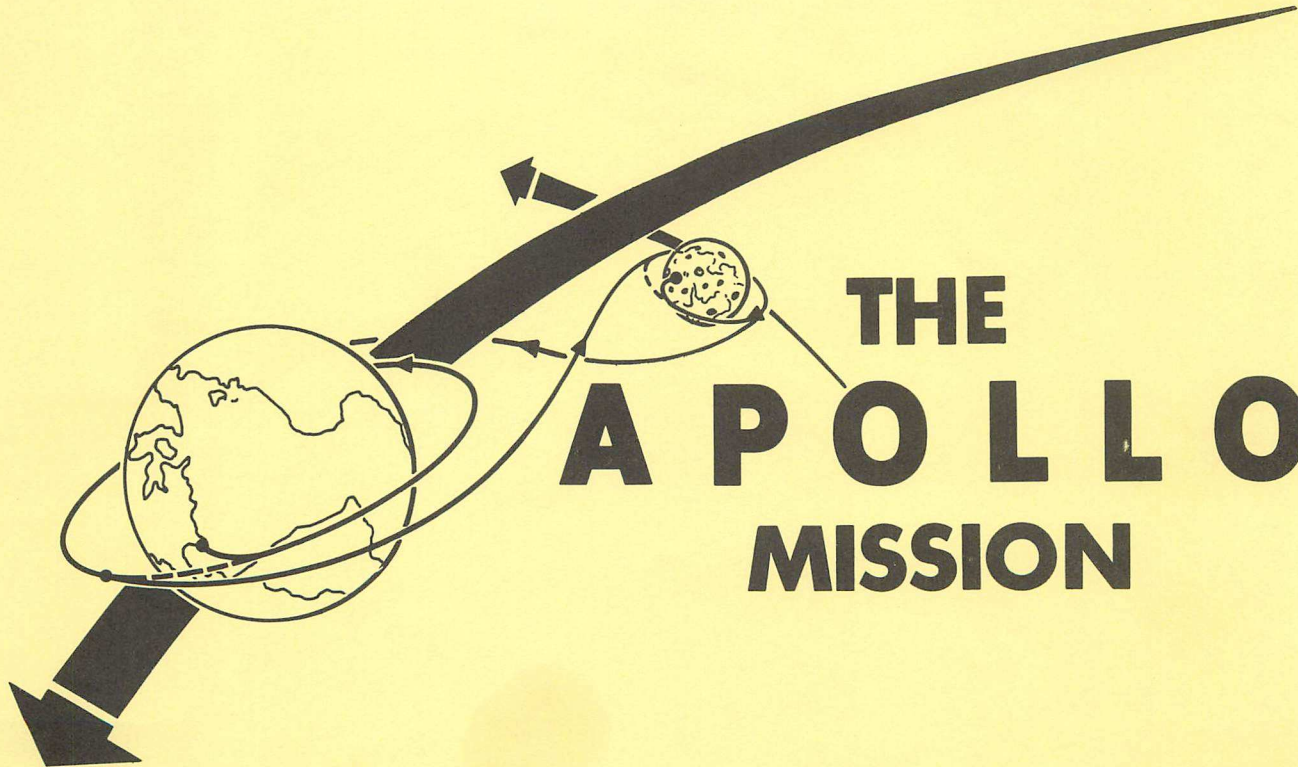


* INTO 100 N MI CIRCULAR ORBIT

SPACECRAFT DEVELOPMENT FLIGHT CATEGORIES

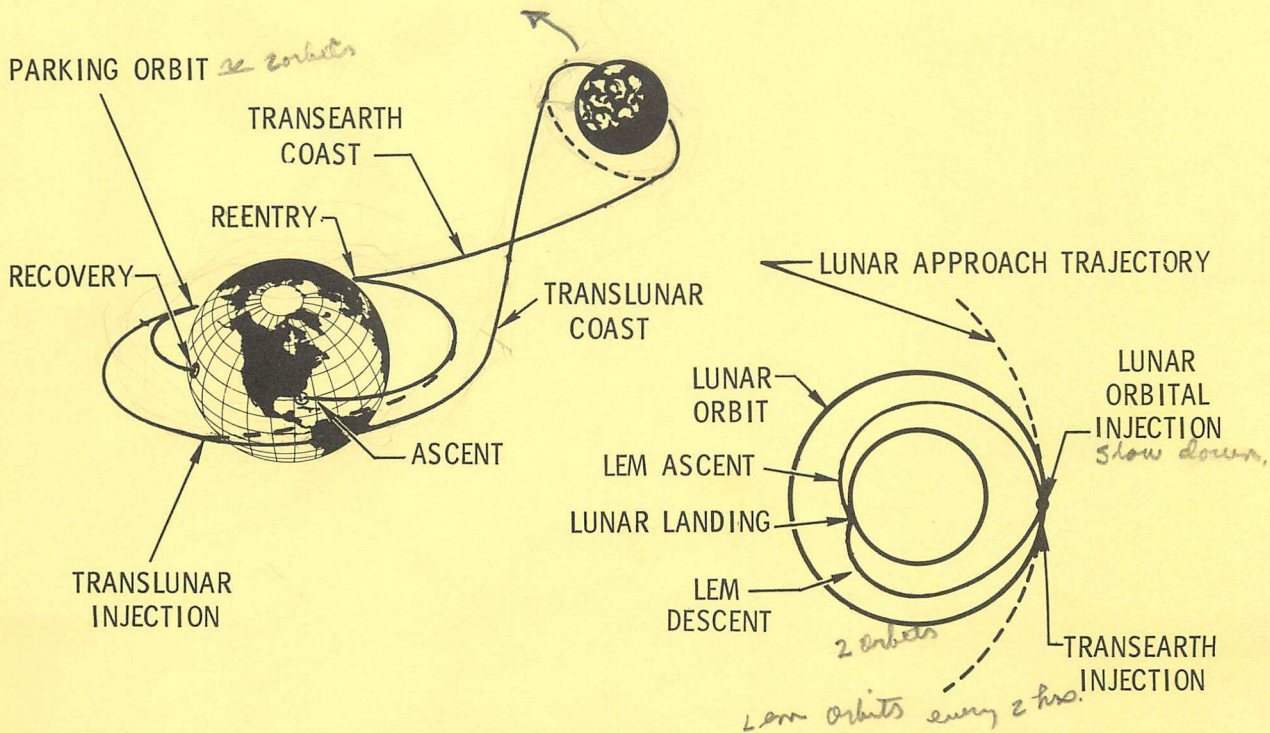
MAJOR STEPS TO ULTIMATE MISSION



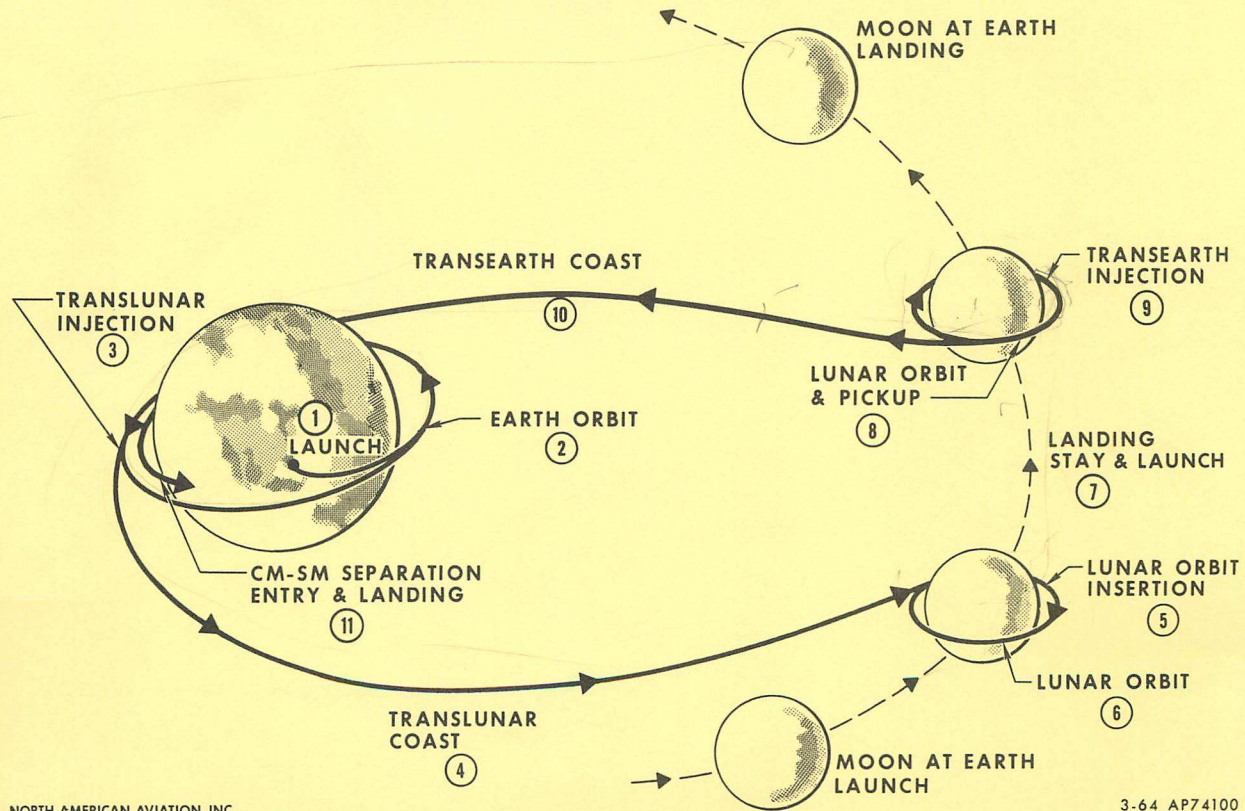


THE A P O L L O MISSION

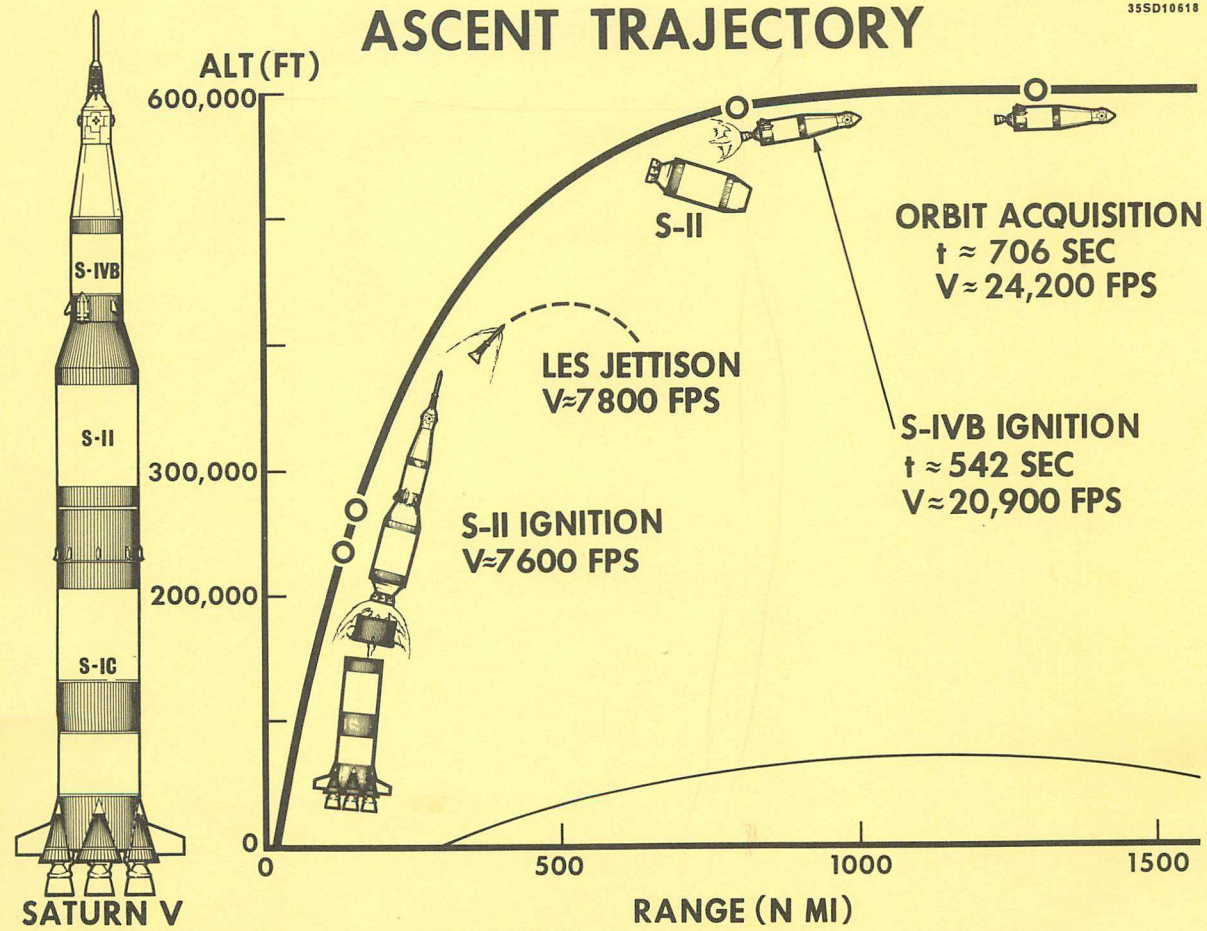
LUNAR MISSION



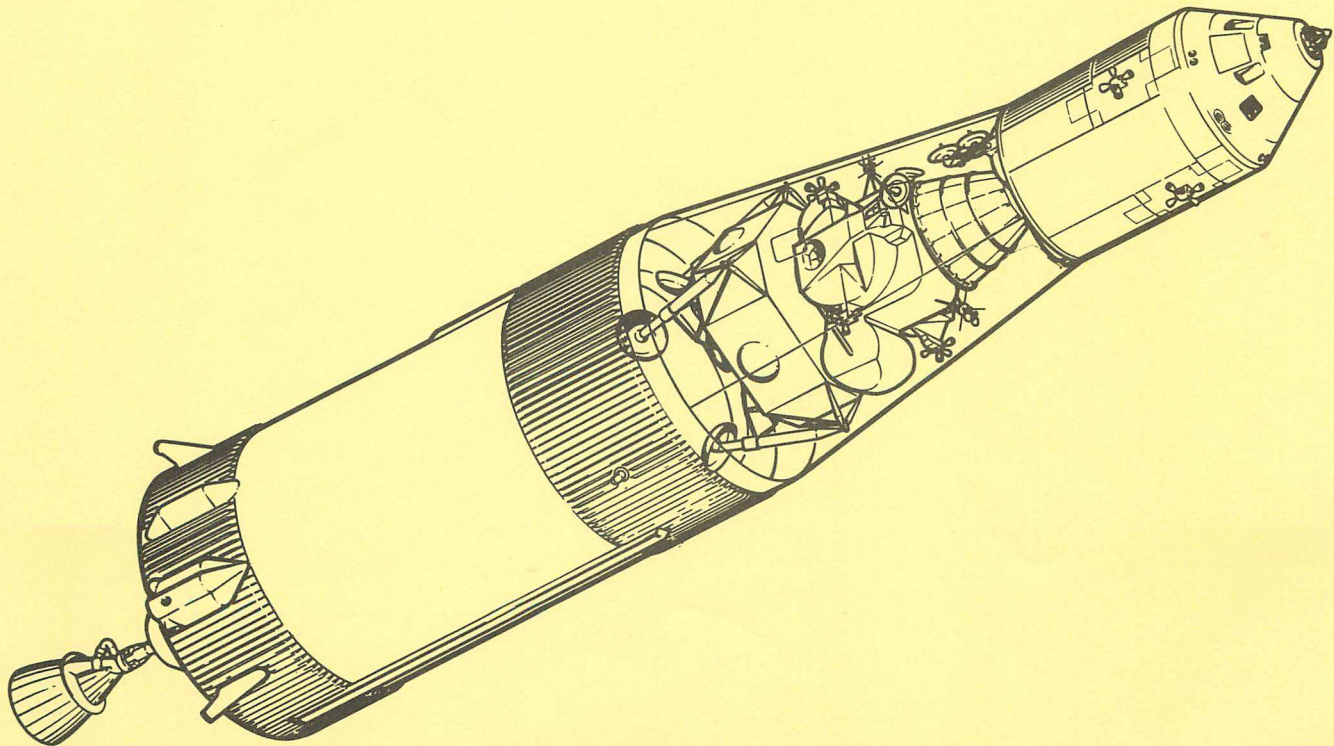
MISSION PLAN - LUNAR ORBITAL RENDEZVOUS MODE



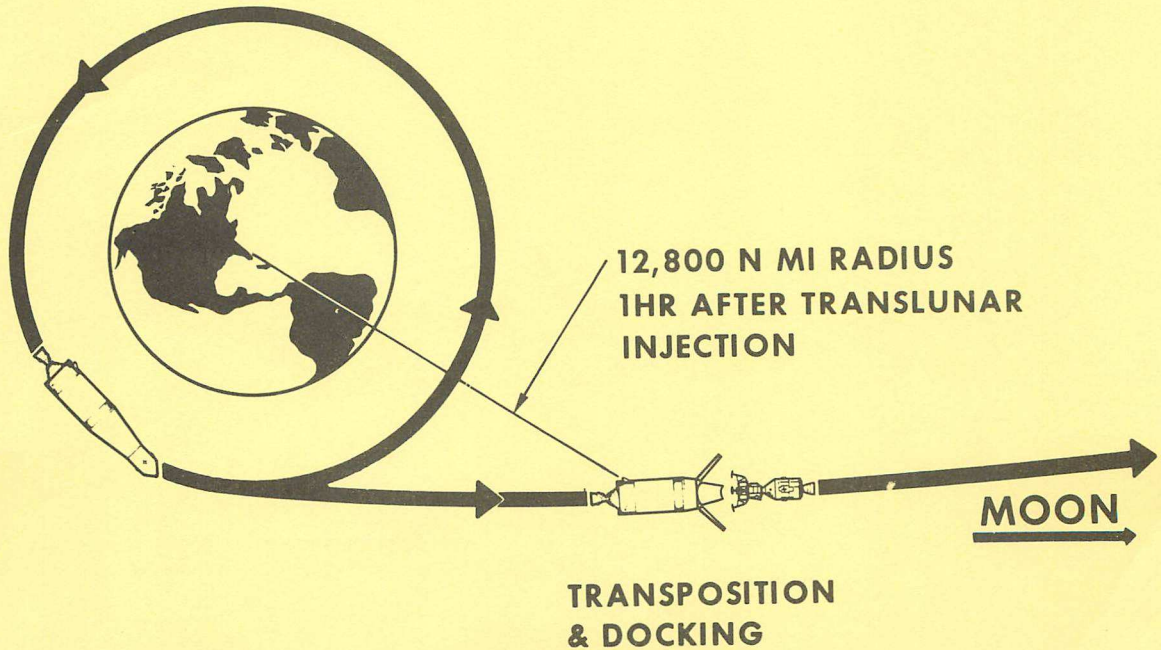
ASCENT TRAJECTORY



APOLLO SPACECRAFT/S-IVB EARTH ORBITAL CONFIGURATION

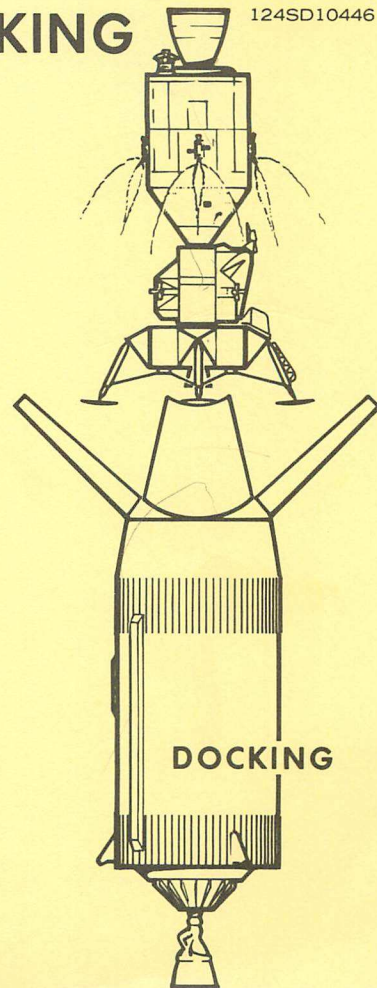
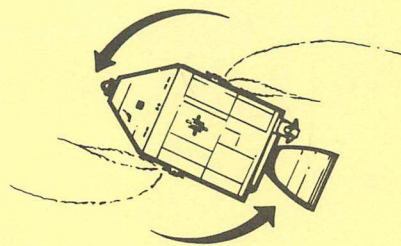
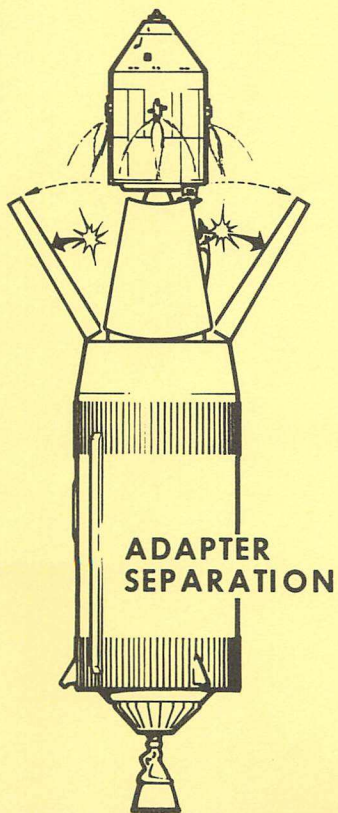


TRANSLUNAR INJECTION & COAST

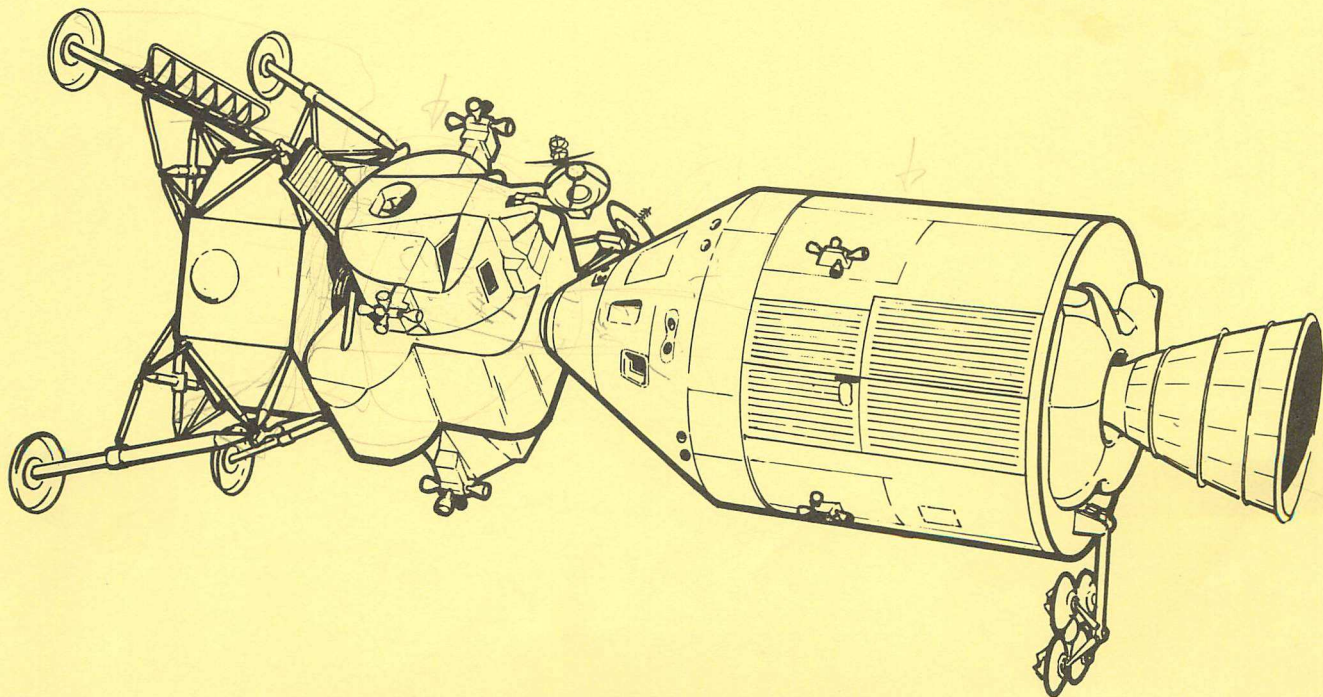


TRANSPOSITION & DOCKING

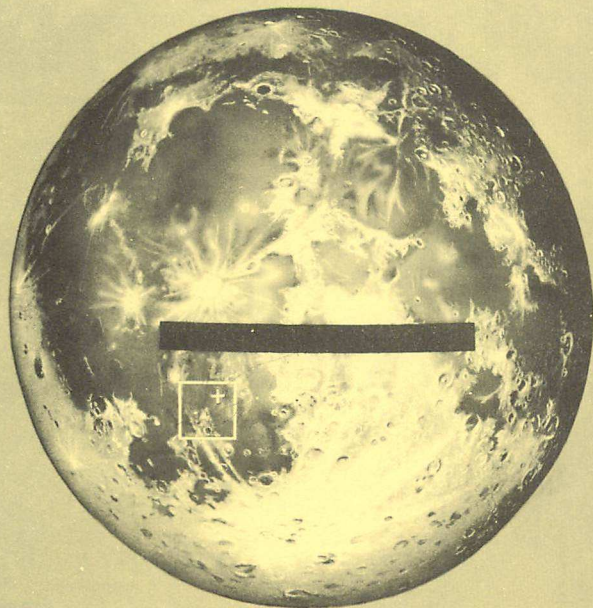
124SD10446



APOLLO SPACECRAFT TRANSLUNAR CONFIGURATION



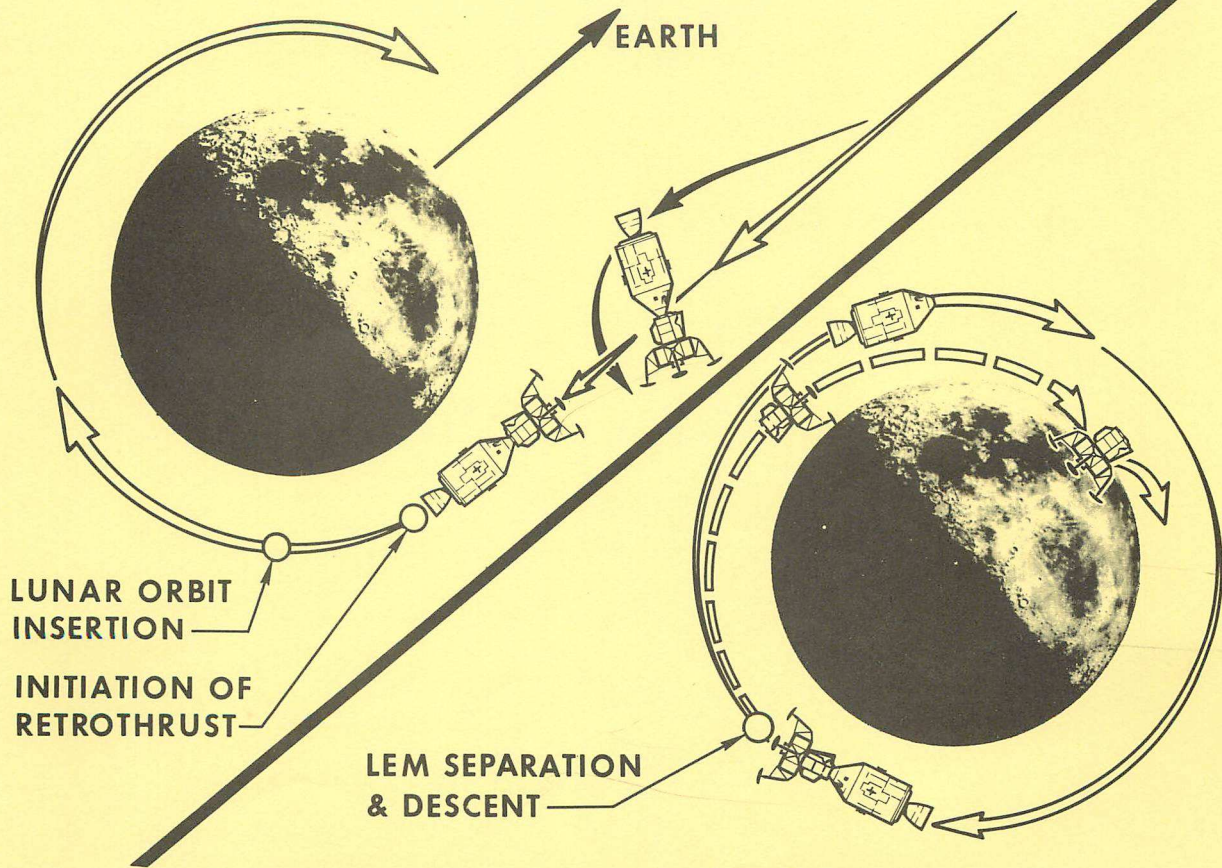
84AP77520



**PROPOSED
LUNAR
LANDING
AREA**

LUNAR ORBIT & LEM DESCENT

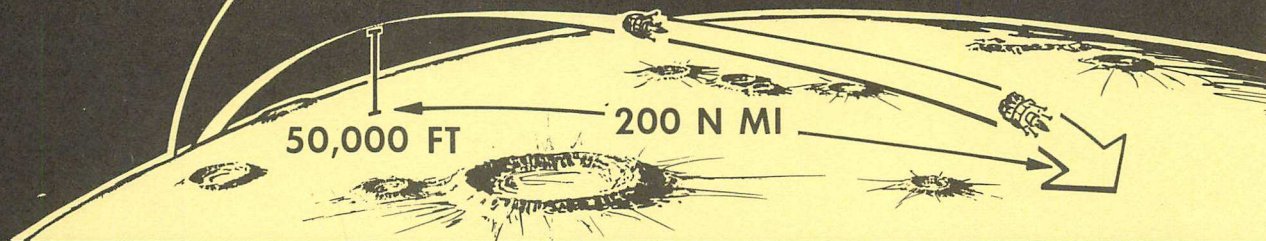
124SD10439



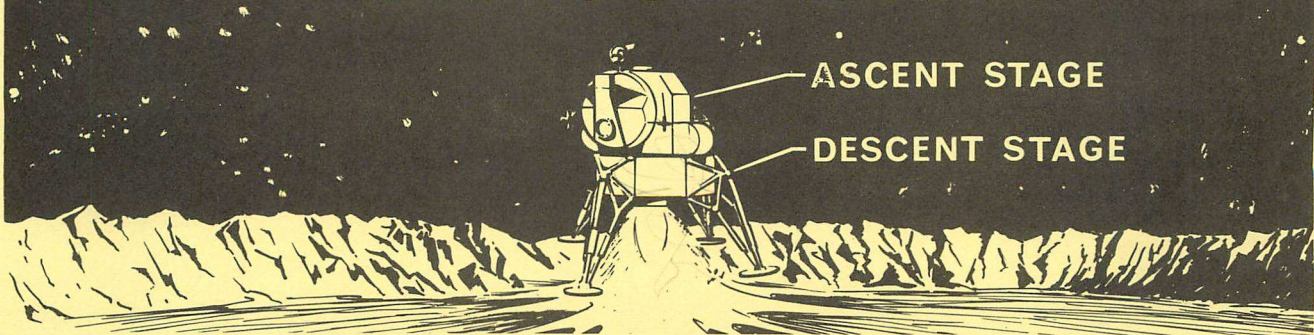
84AP 77521

LEM DESCENT AND LANDING

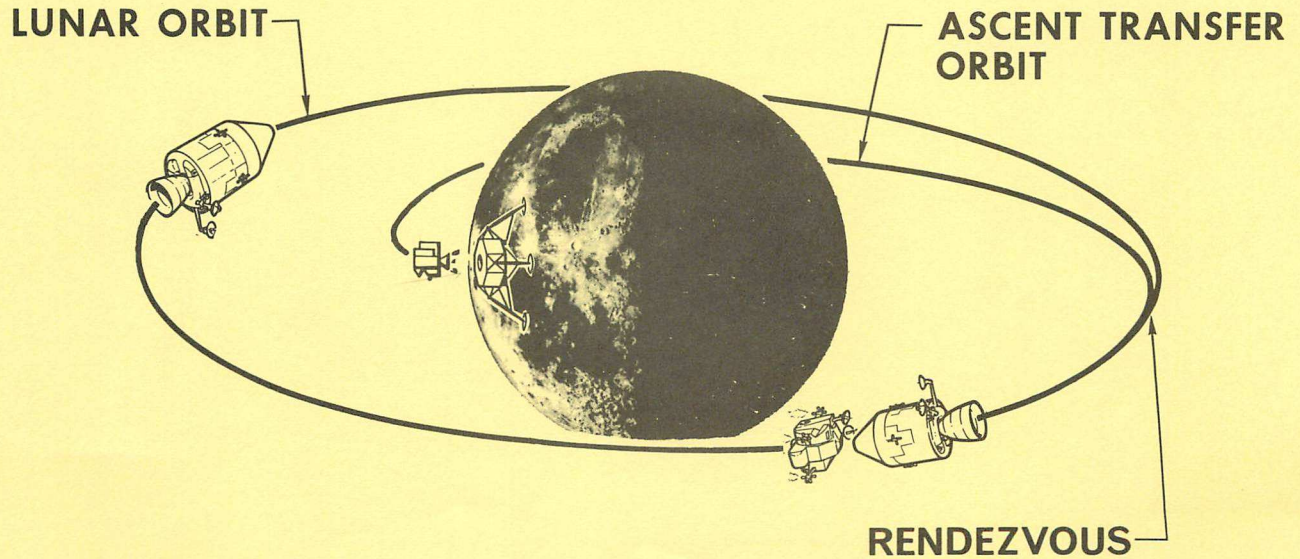
LUNAR PARKING
ORBIT (80 N MI)



LANDING CONFIGURATION

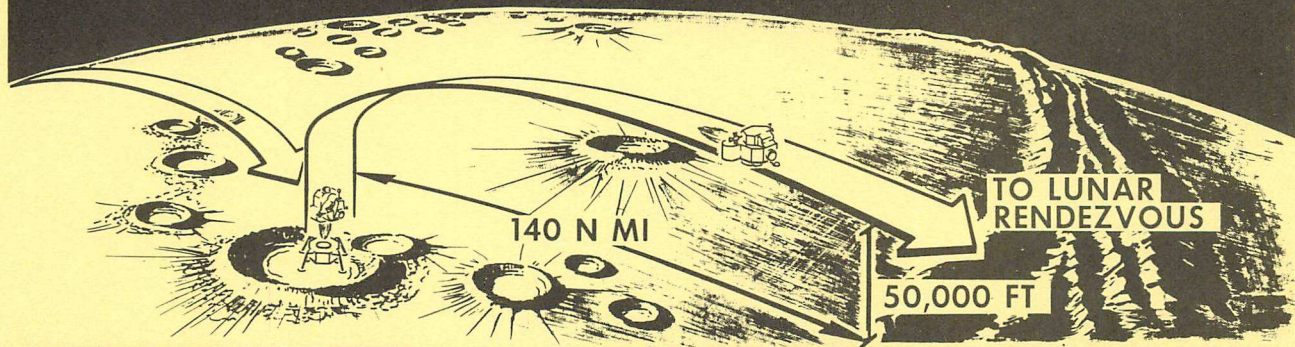


LEM ASCENT & LUNAR ORBITAL RENDEZVOUS

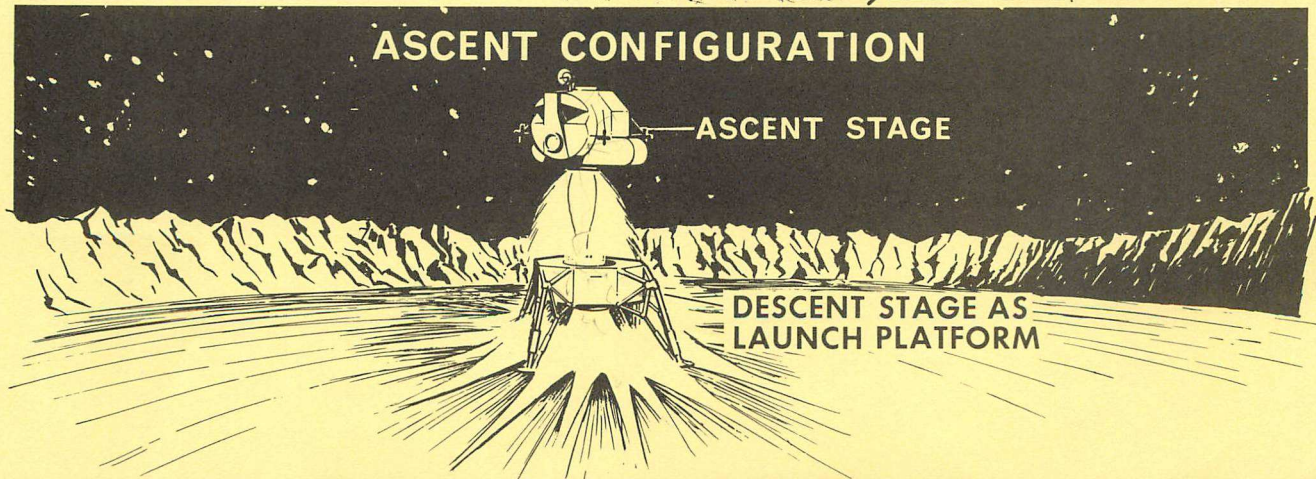


LEM ASCENT

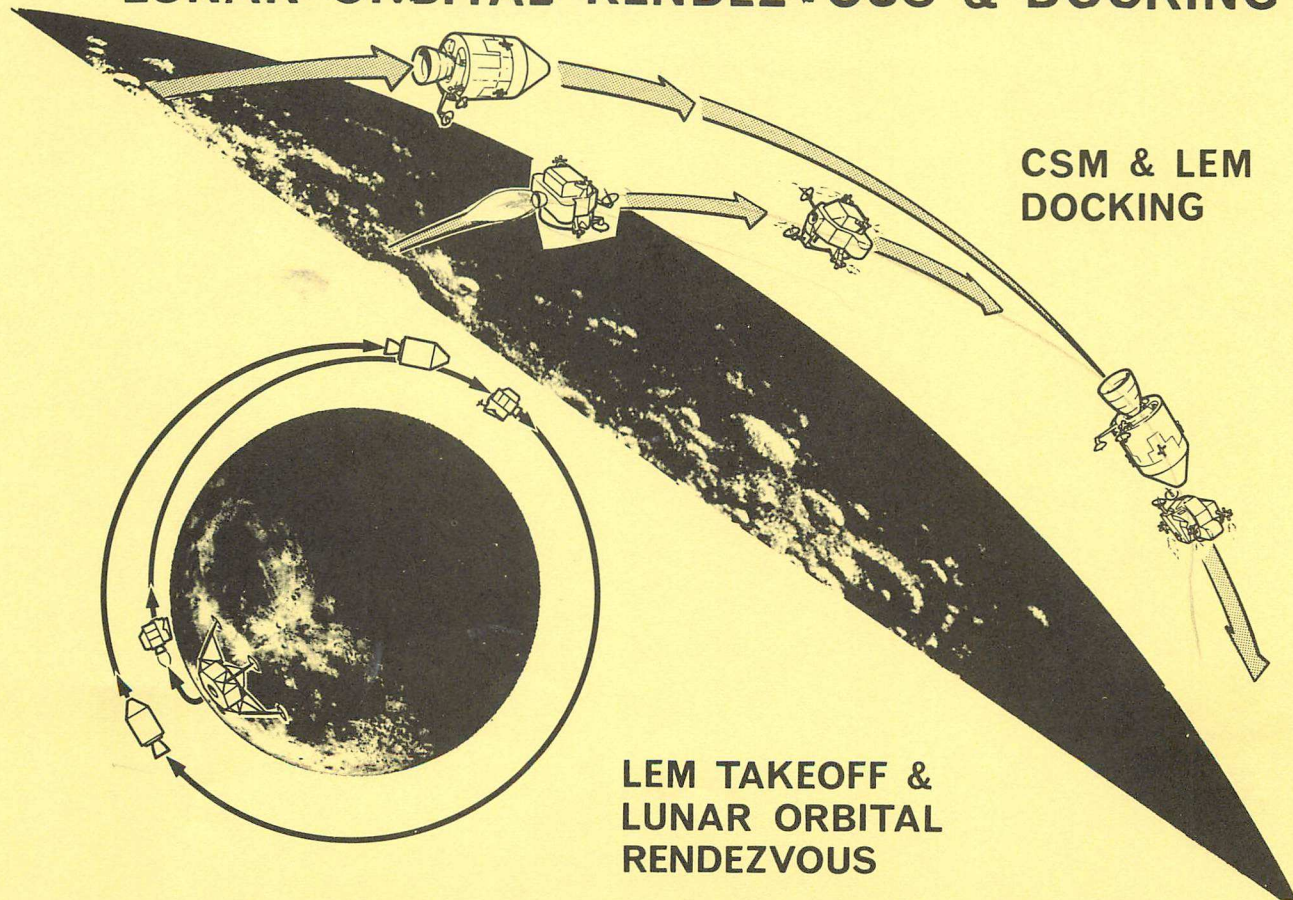
84AP77535



ASCENT CONFIGURATION



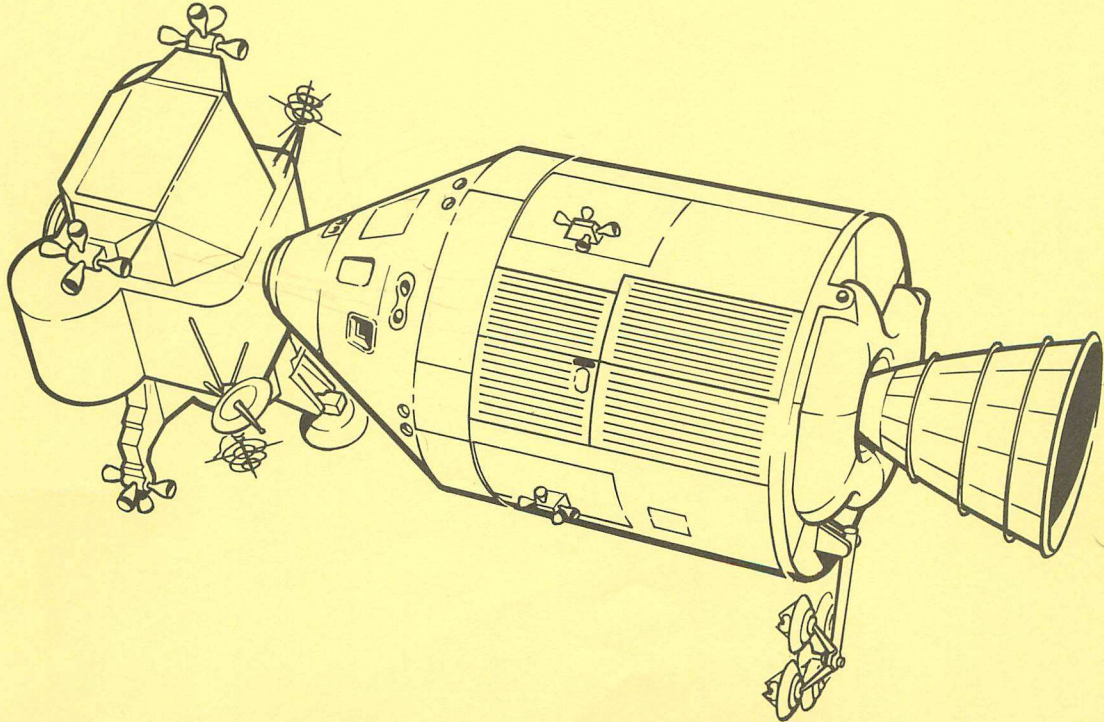
LUNAR ORBITAL RENDEZVOUS & DOCKING



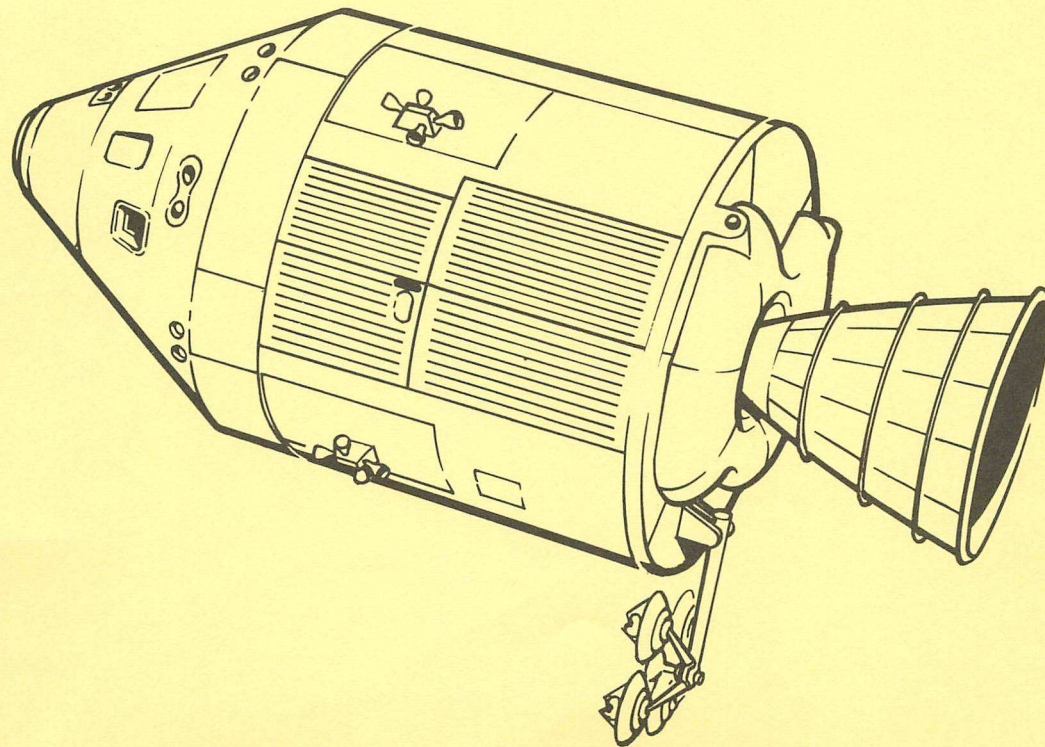
**CSM & LEM
DOCKING**

**LEM TAKEOFF &
LUNAR ORBITAL
RENDEZVOUS**

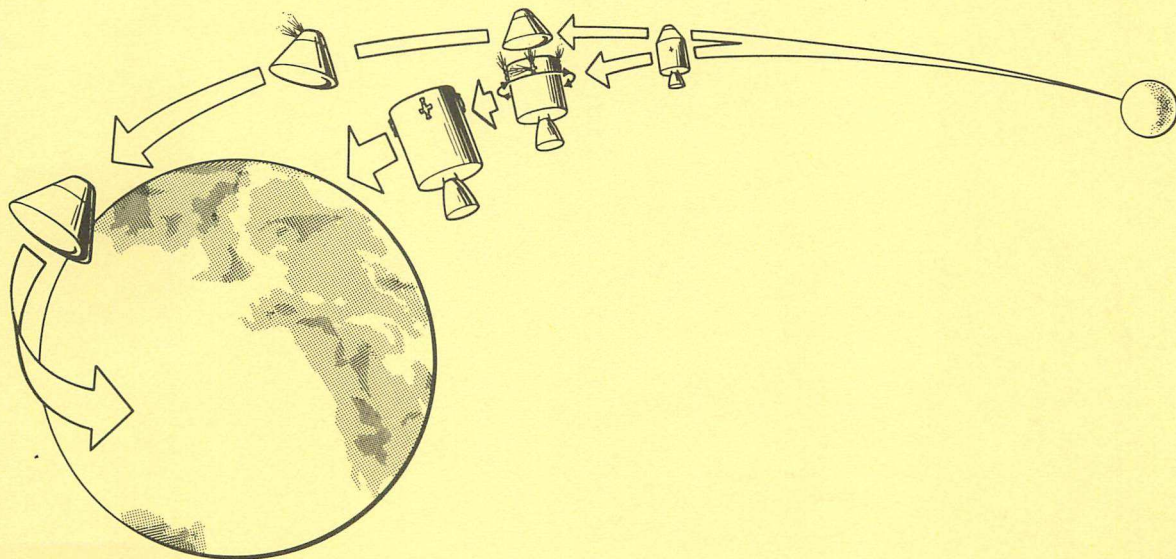
APOLLO SPACECRAFT LOR CONFIGURATION



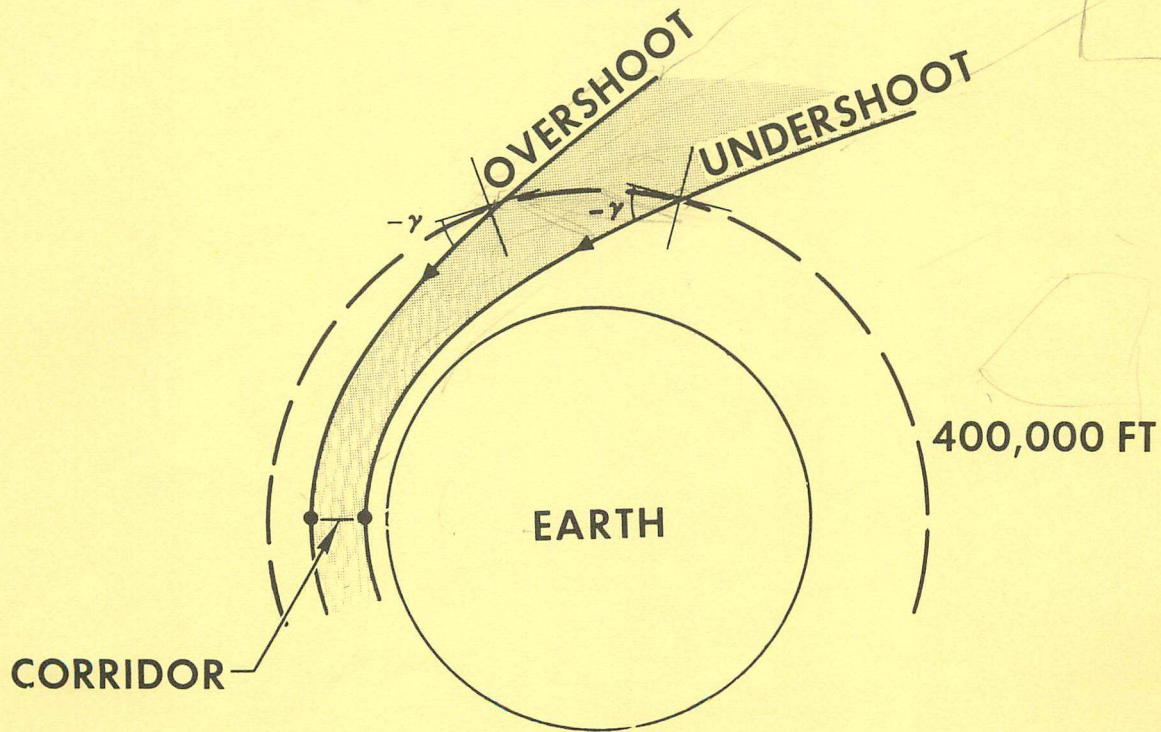
APOLLO TRANSEARTH CONFIGURATION



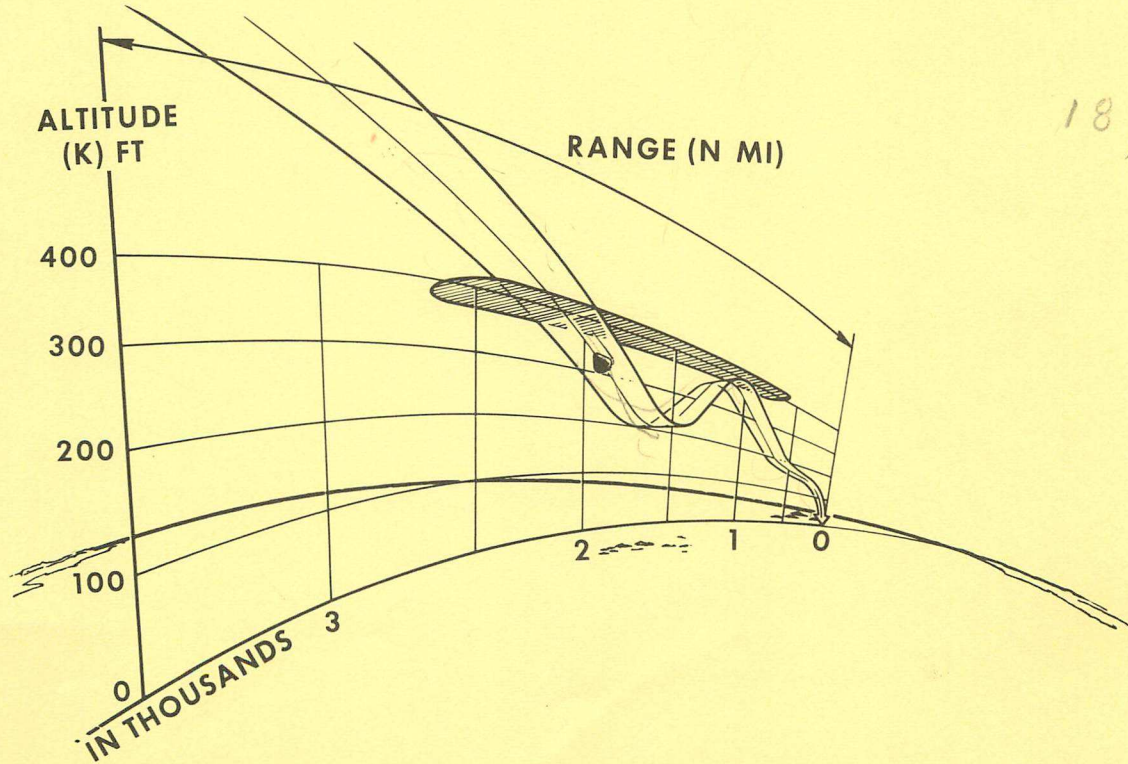
TRANSEARTH & SM SEPARATION



ENTRY CORRIDORS

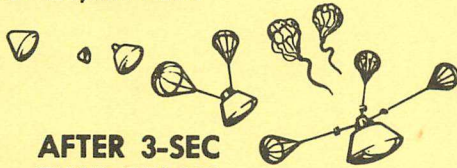


TYPICAL RE-ENTRY RANGE

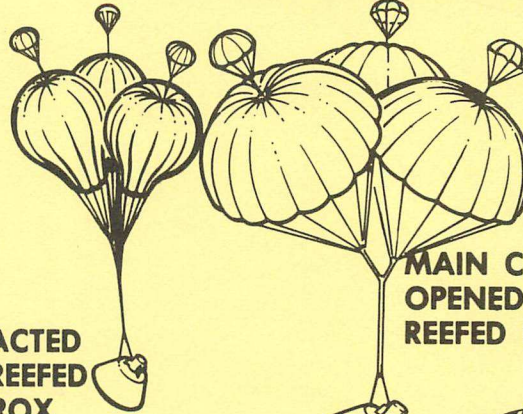


RECOVERY MODES

**HEAT SHIELD
JETTISONED
AT 25,000 FEET**



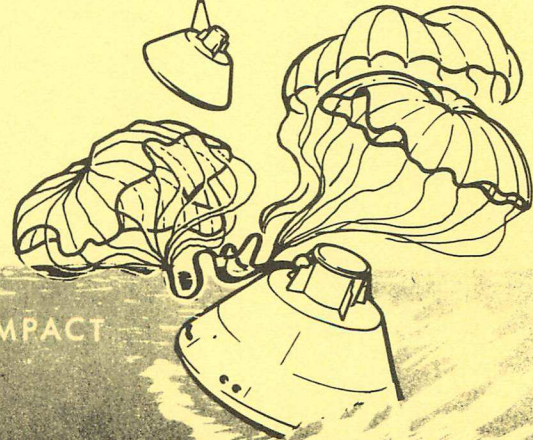
**AFTER 3-SEC
TIME DELAY
DROGUE CHUTES
DEPLOYED**



**MAIN CHUTES EXTRACTED
& DEPLOYED TO A REEFED
CONDITION AT APPROX
13,500 FT**

**DROGUE CHUTES RELEASED & PILOT
CHUTES DEPLOYED AT 15,000 FEET**

**MAIN CHUTES FULLY
OPENED AFTER BEING
REEFED FOR 6 SEC**

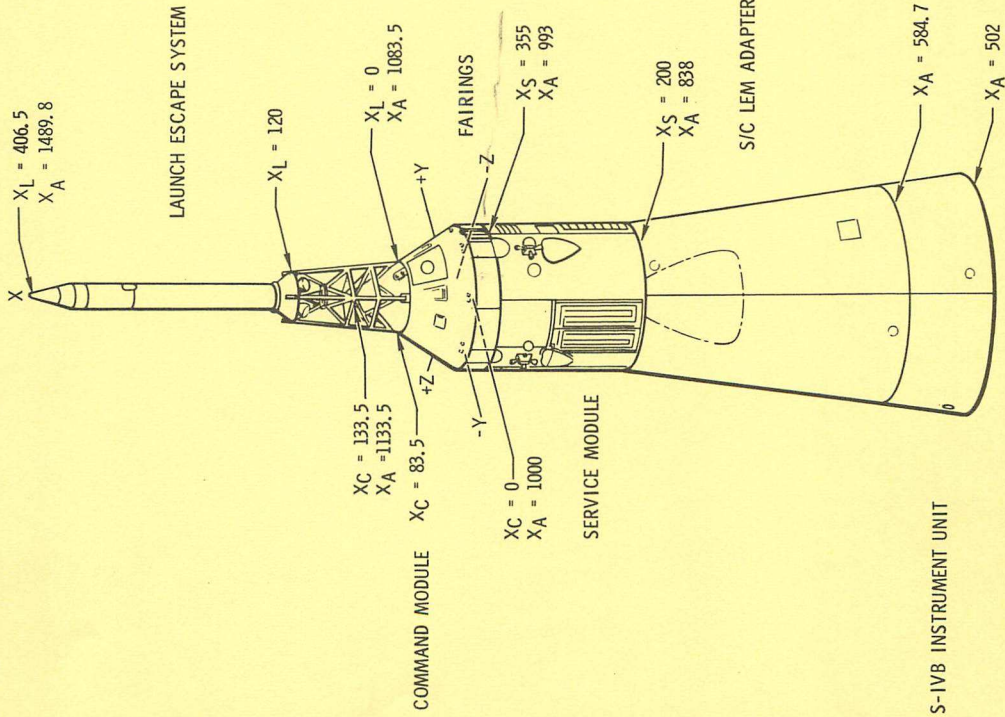


MAIN CHUTES RELEASED AT IMPACT



STRUCTURES

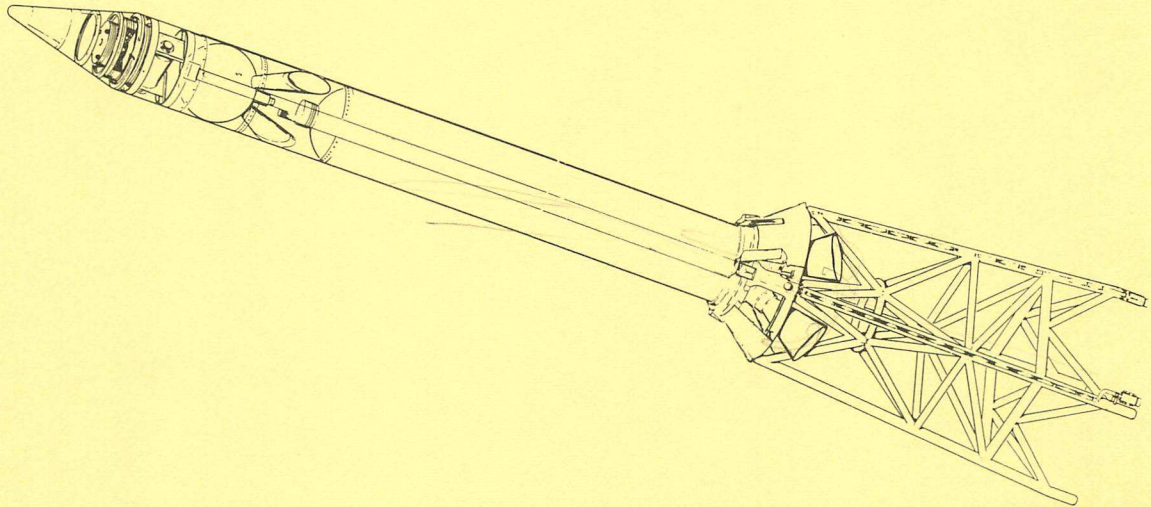
APOLLO INTEGRATED STATIONS & AXIS



ST-106B

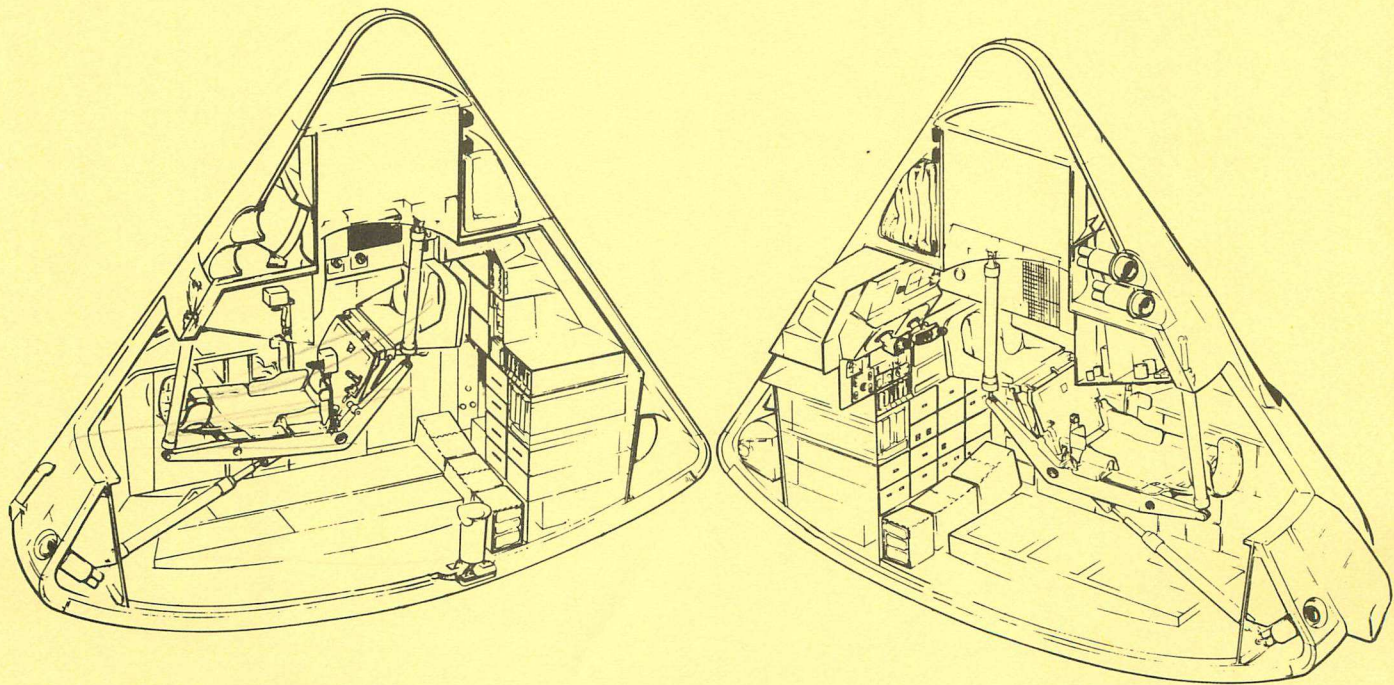
0261N

LAUNCH ESCAPE TOWER

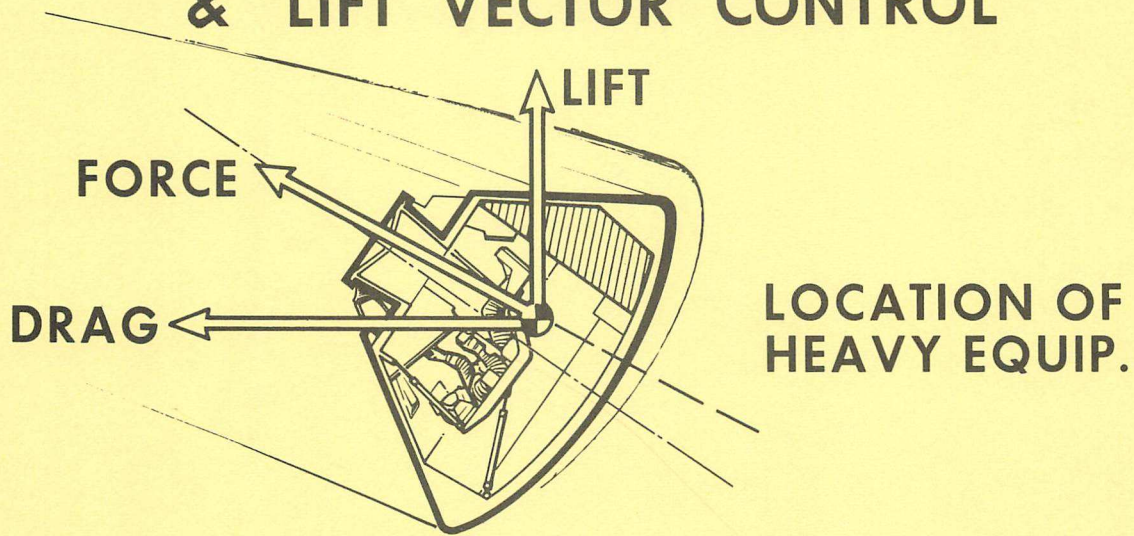


COMMAND MODULE

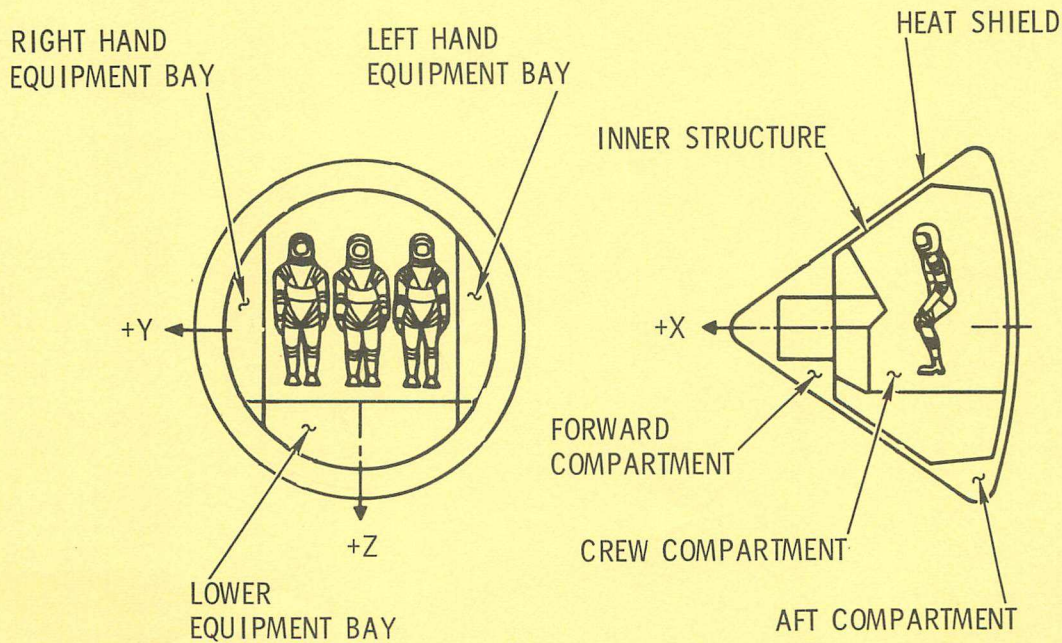
COMPARTMENTS



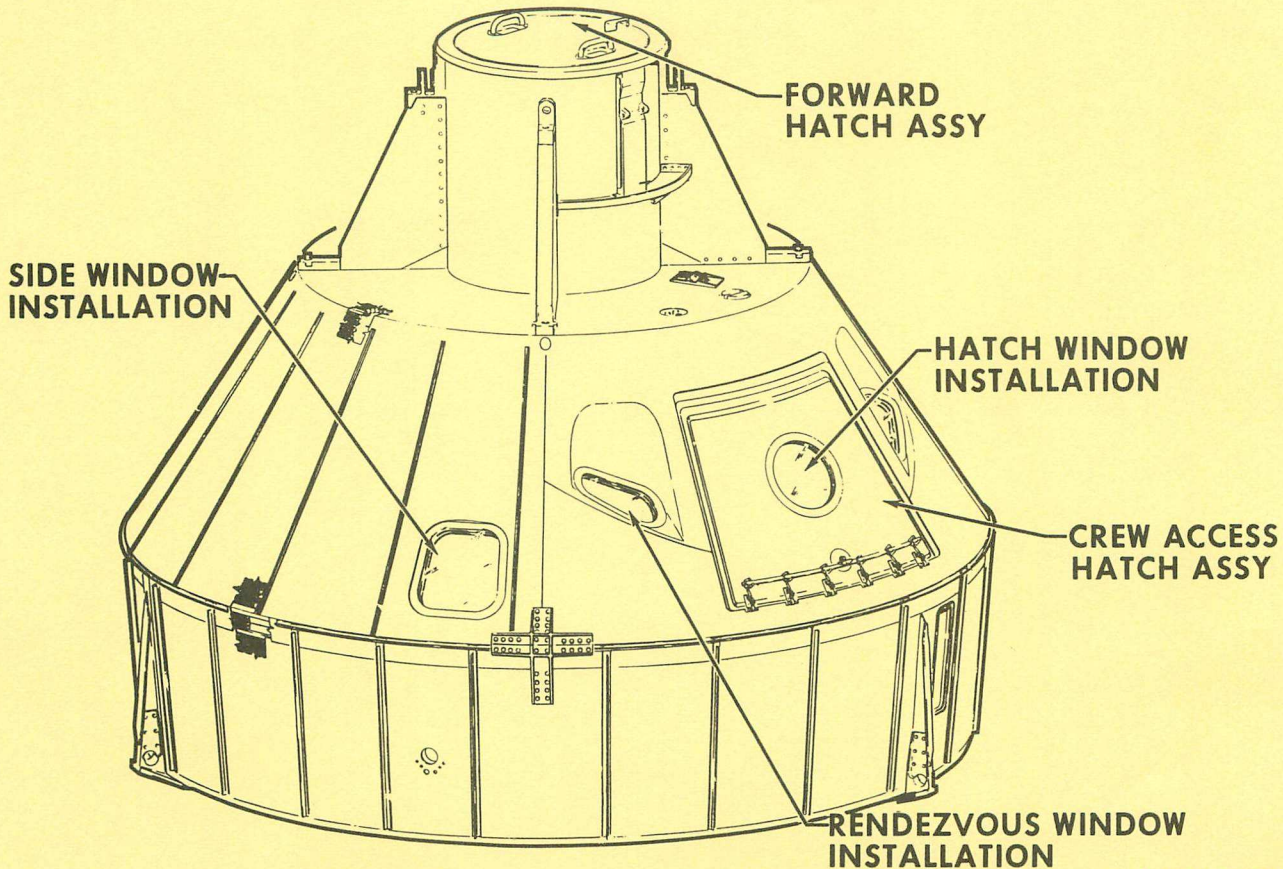
COMMAND MODULE AERODYNAMICS & LIFT VECTOR CONTROL



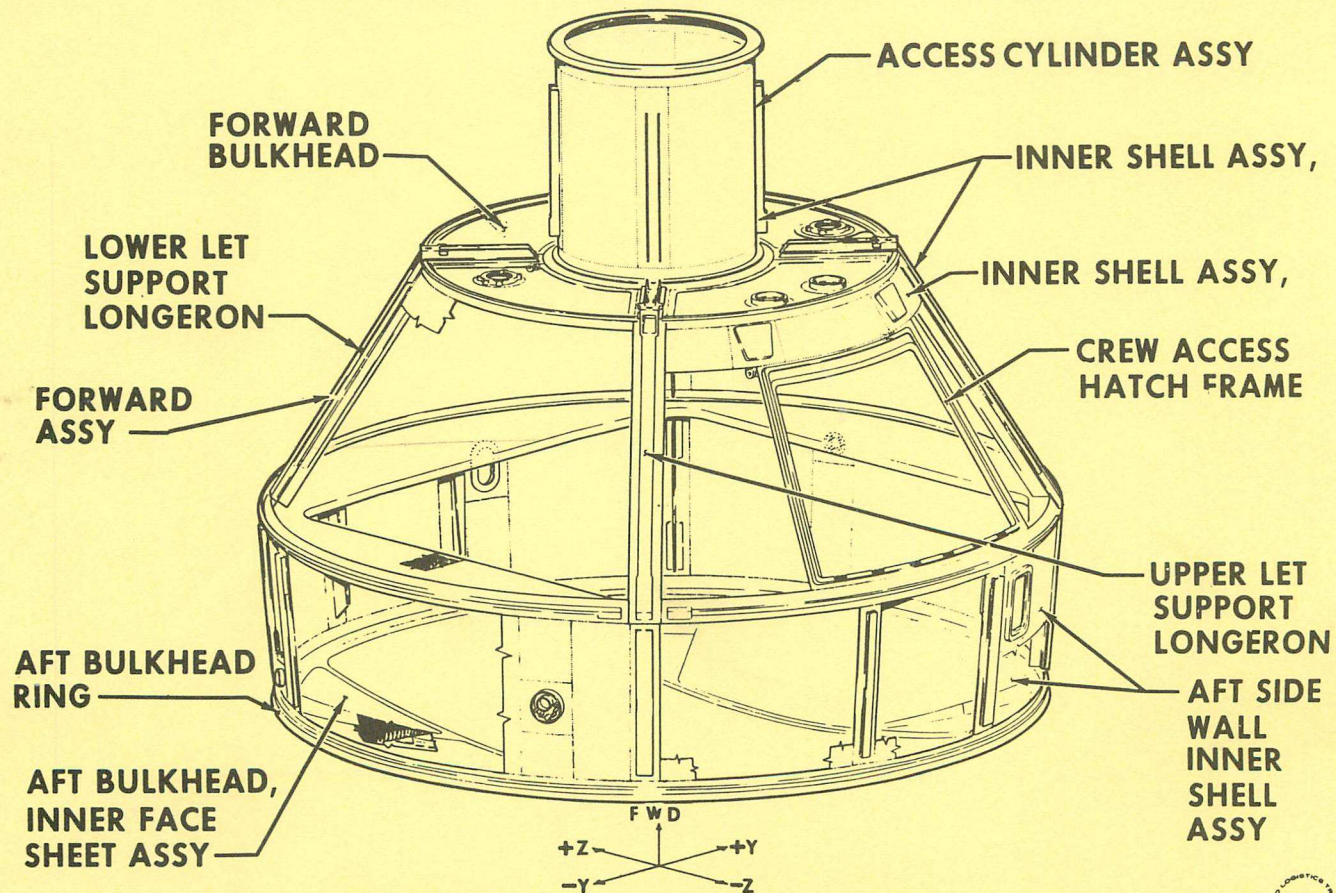
COMMAND MODULE COMPARTMENT CONFIGURATION



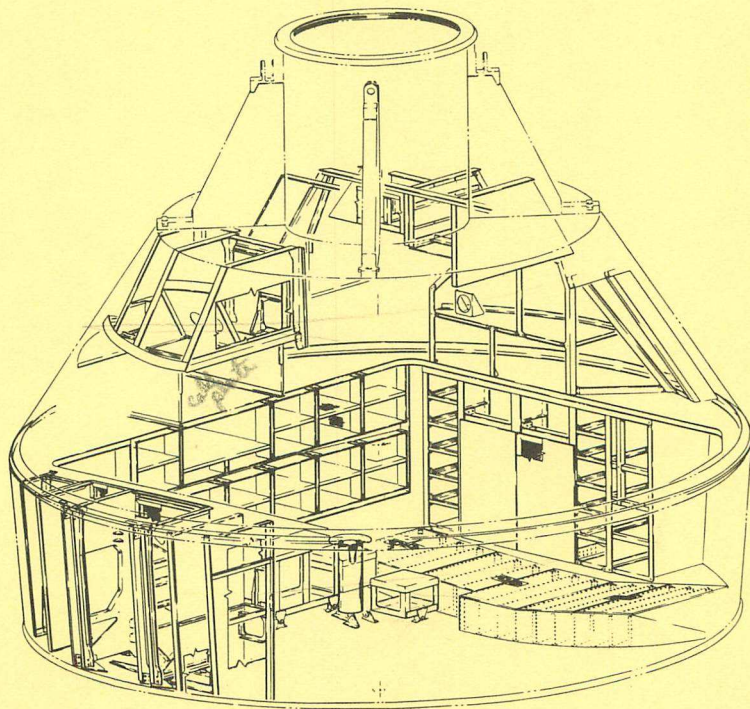
COMMAND MODULE INNER STRUCTURE



INNER STRUCTURE-INNER SHELL



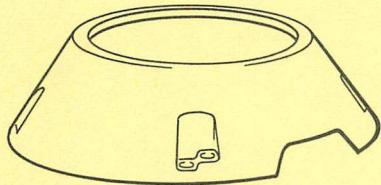
C/M SECONDARY STRUCTURE



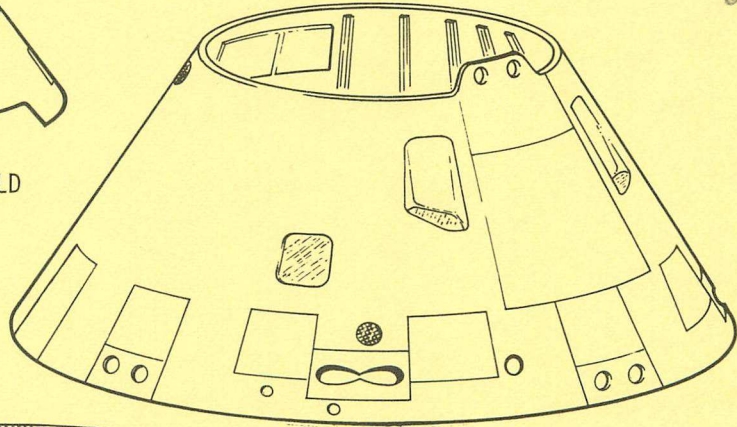
COMMAND MODULE HEAT SHIELDS

BLOCK II

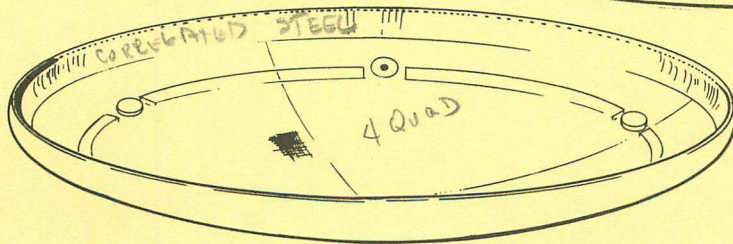
*Rough steel
Honeycomb
Sandwich*



FORWARD HEAT SHIELD

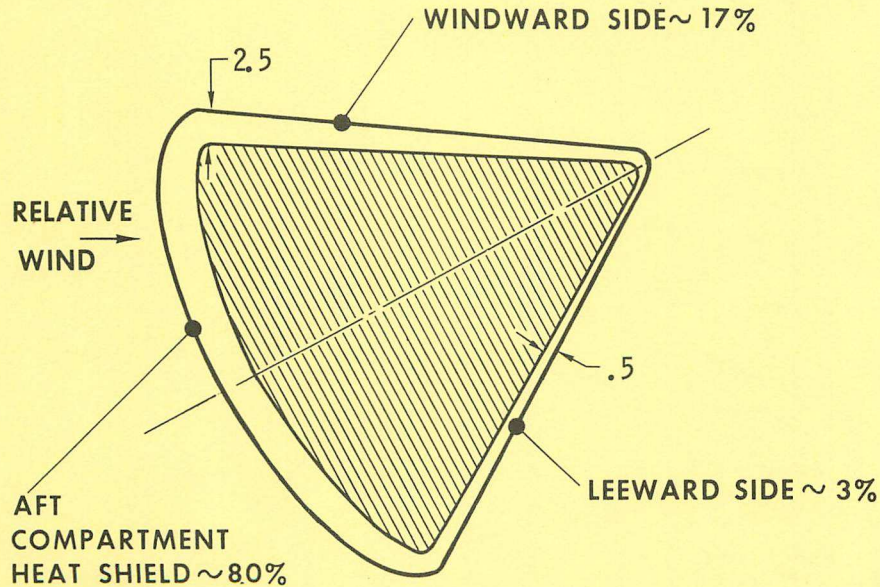


CREW COMPARTMENT
HEAT SHIELD



AFT HEAT SHIELD

ENTRY HEAT LOAD DISTRIBUTION & ABLATOR THICKNESS

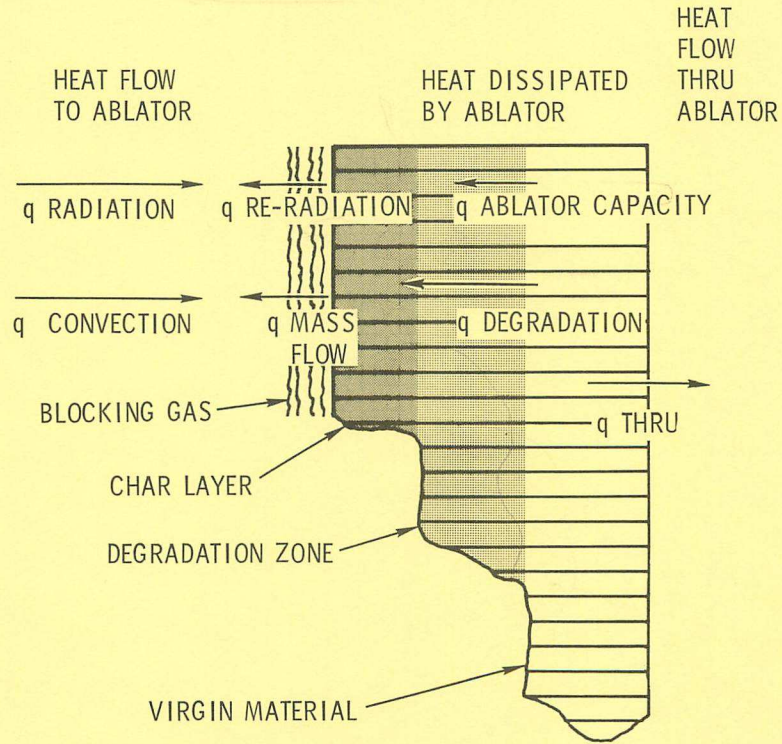


AVCOAT 5026-39

- 35 LB/FT³
- EPOXY RESIN
- GLASS FIBERS
- SILICA FIBERS
- PHENOLIC MICROBALLOON
Hydro Carbon

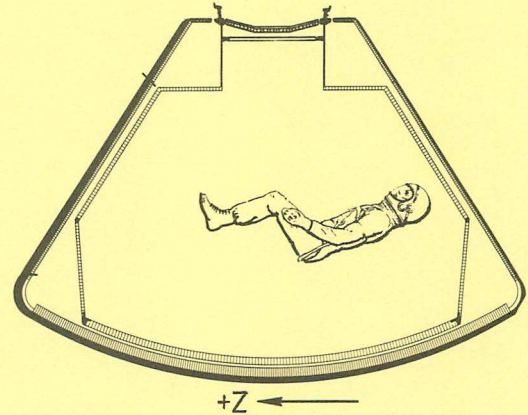
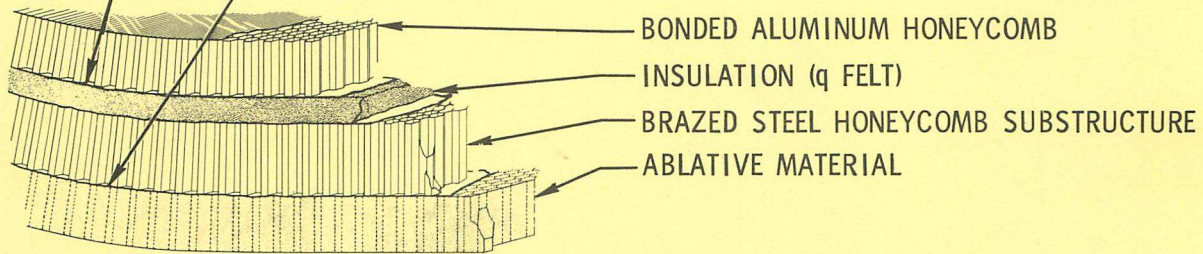
AVCO 5026-39

ABLATION PROCESS



APOLLO SKIN CONFIGURATION

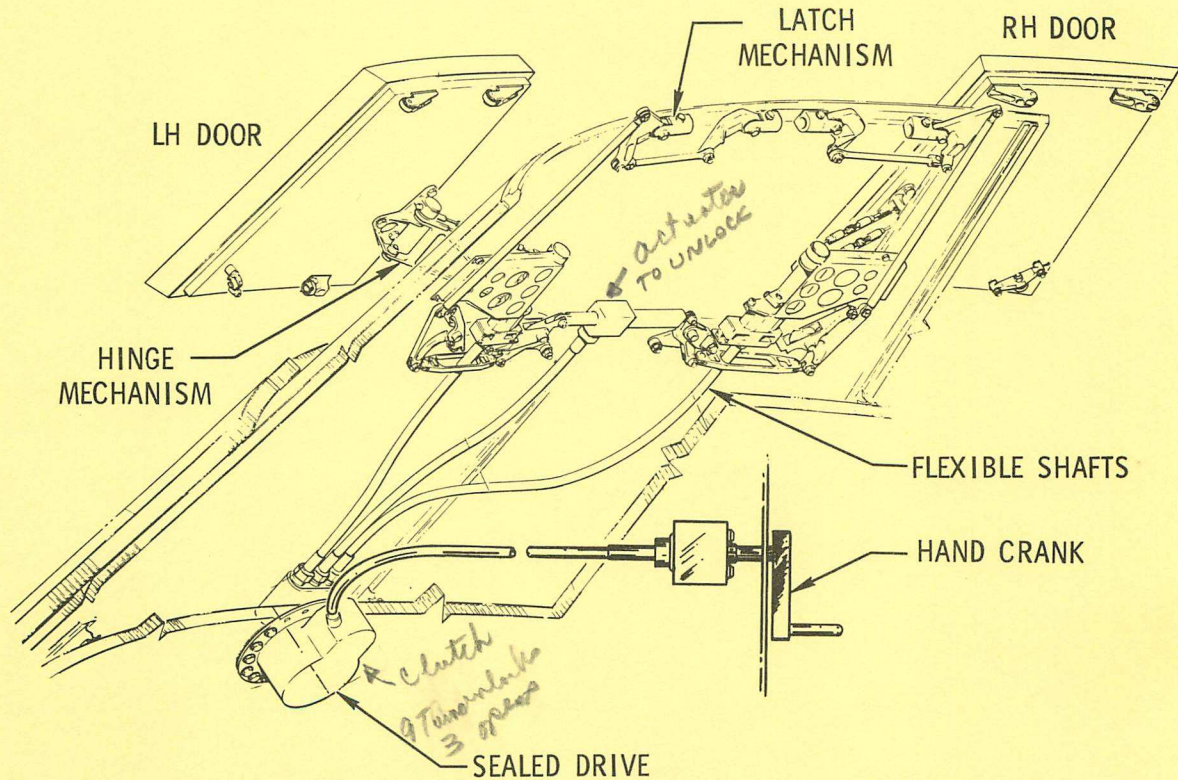
MAX AT MAIN CHUTE DEPLOYMENT
200°F 600°F



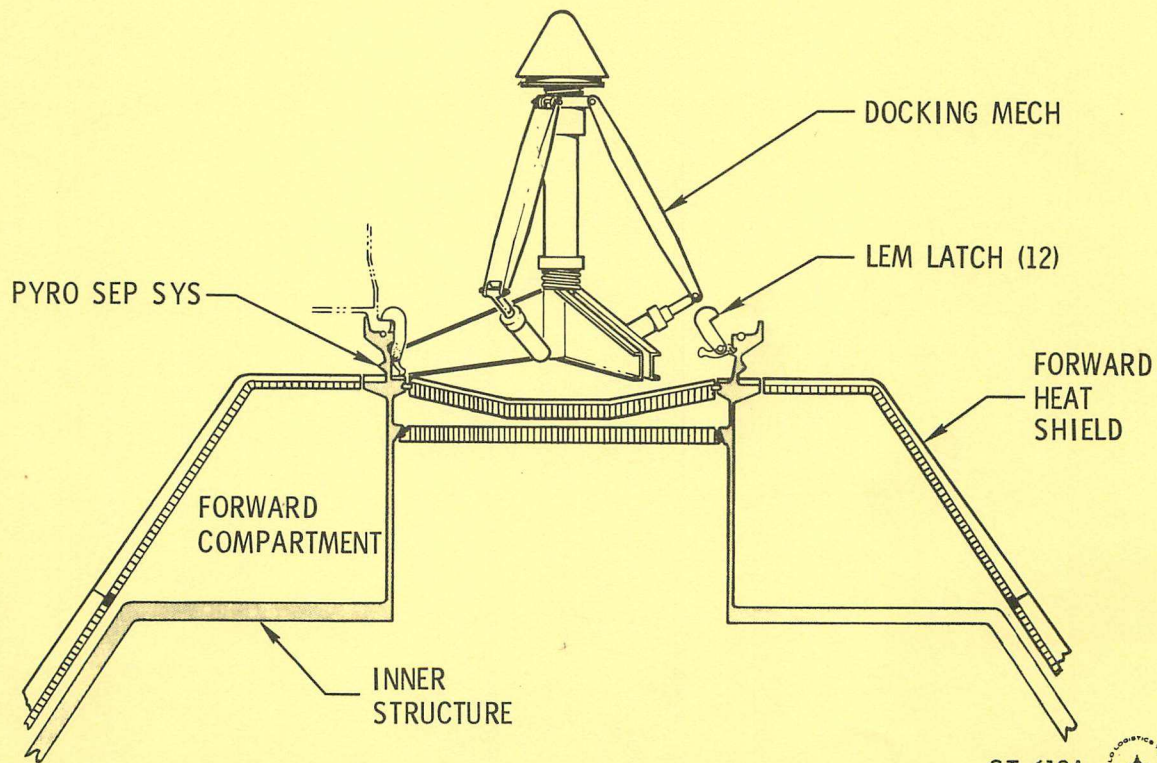
ST-206D



ASTRO-SEXTANT DOORS



CM FORWARD SECTION



ST-618A

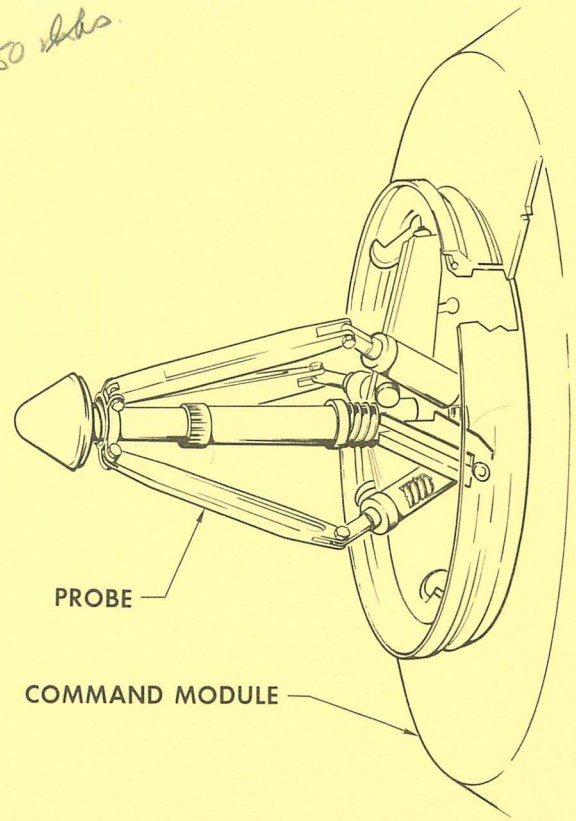
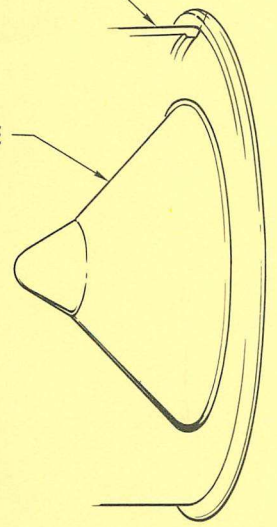


LEM DOCKING MECHANISM

LUNAR EXCURSION
MODULE

150 lbs.

DROGUE

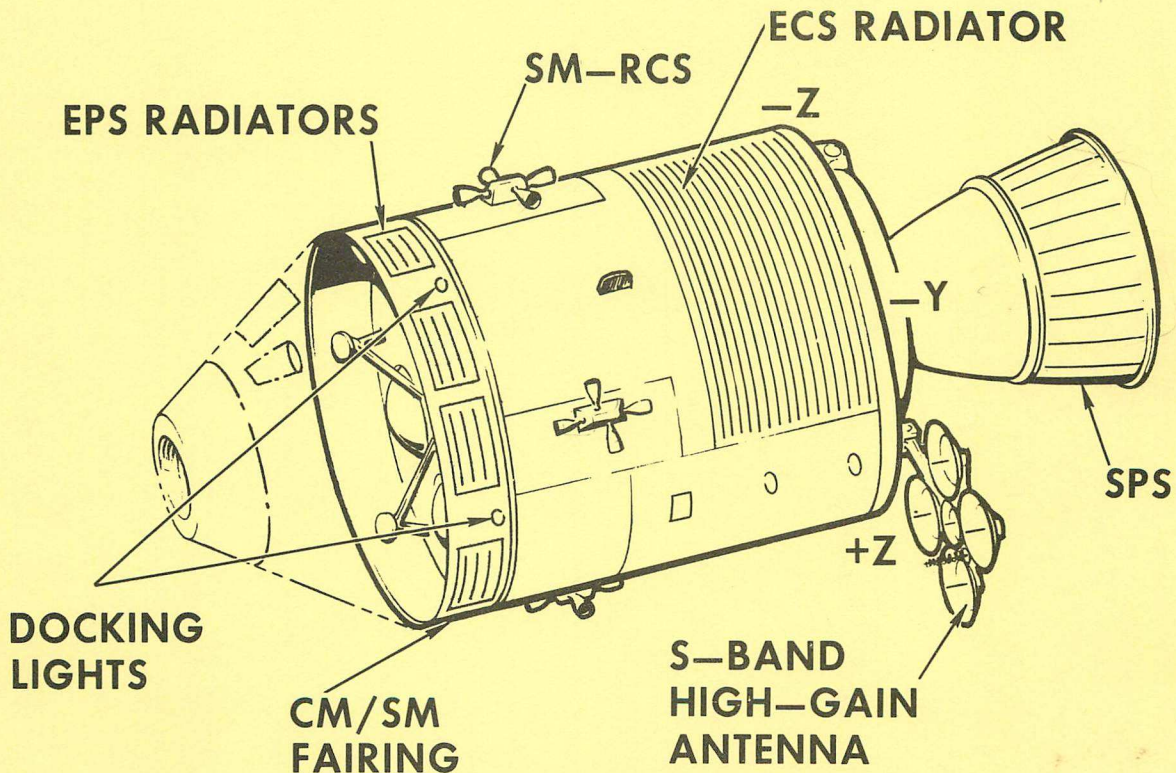


PROBE

COMMAND MODULE

SERVICE MODULE

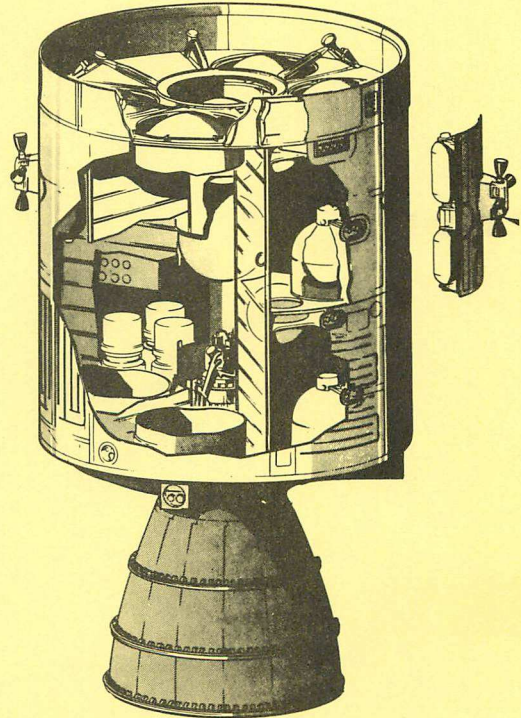
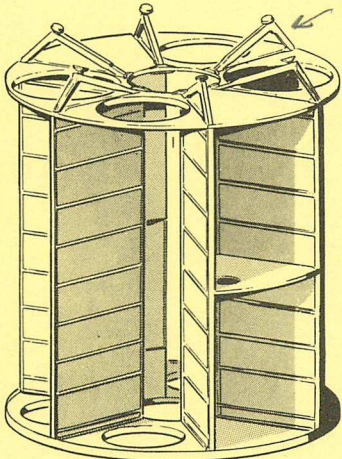
*Block II
WT-50K
101K w/o fuel*



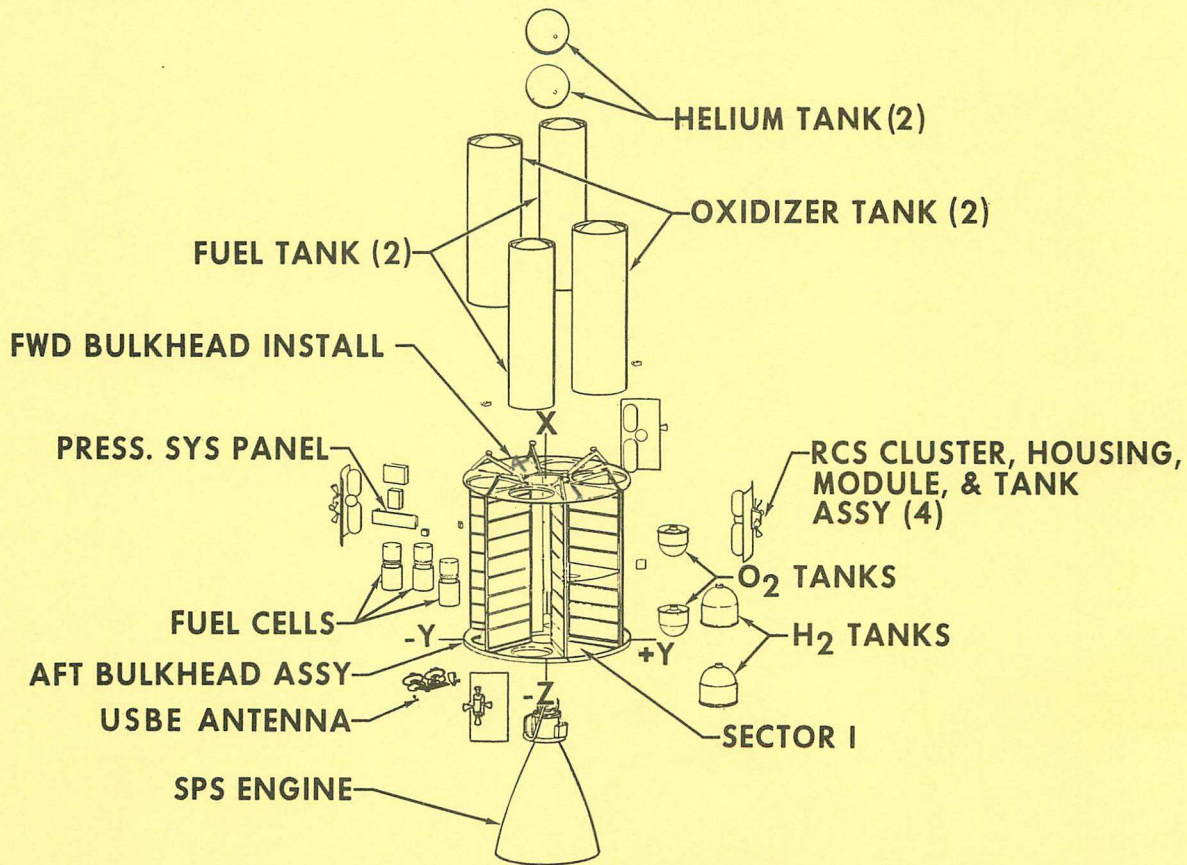
B-1005

SERVICE MODULE

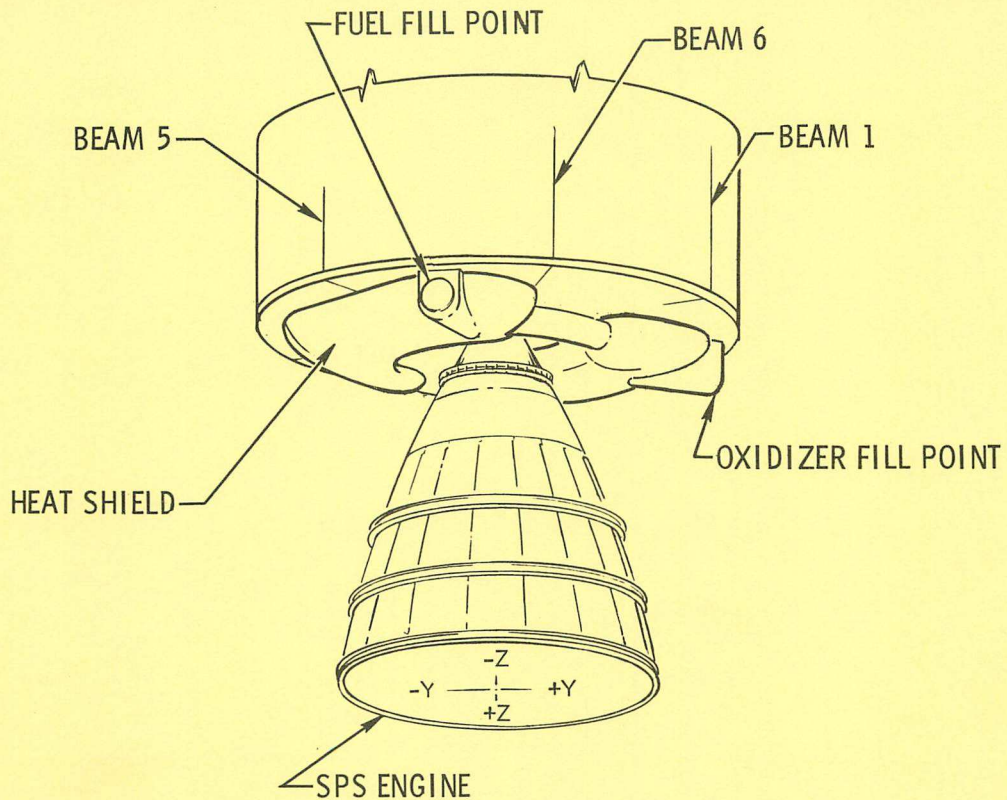
6 Compression
3 tension
Radial Shear and Peen



APOLLO S/M STRUCTURE & SYSTEMS EQUIPMENT

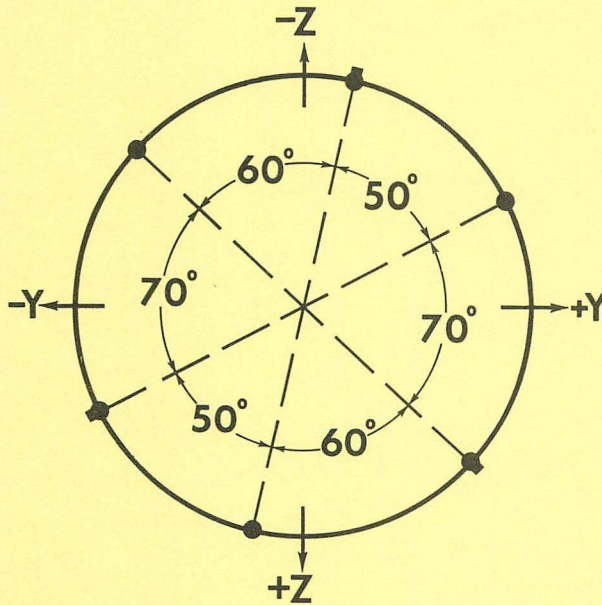


S/M SPS NOZZLE AND HEAT SHIELD



CM/SM STRUCTURAL INTERFACE

Between service & command



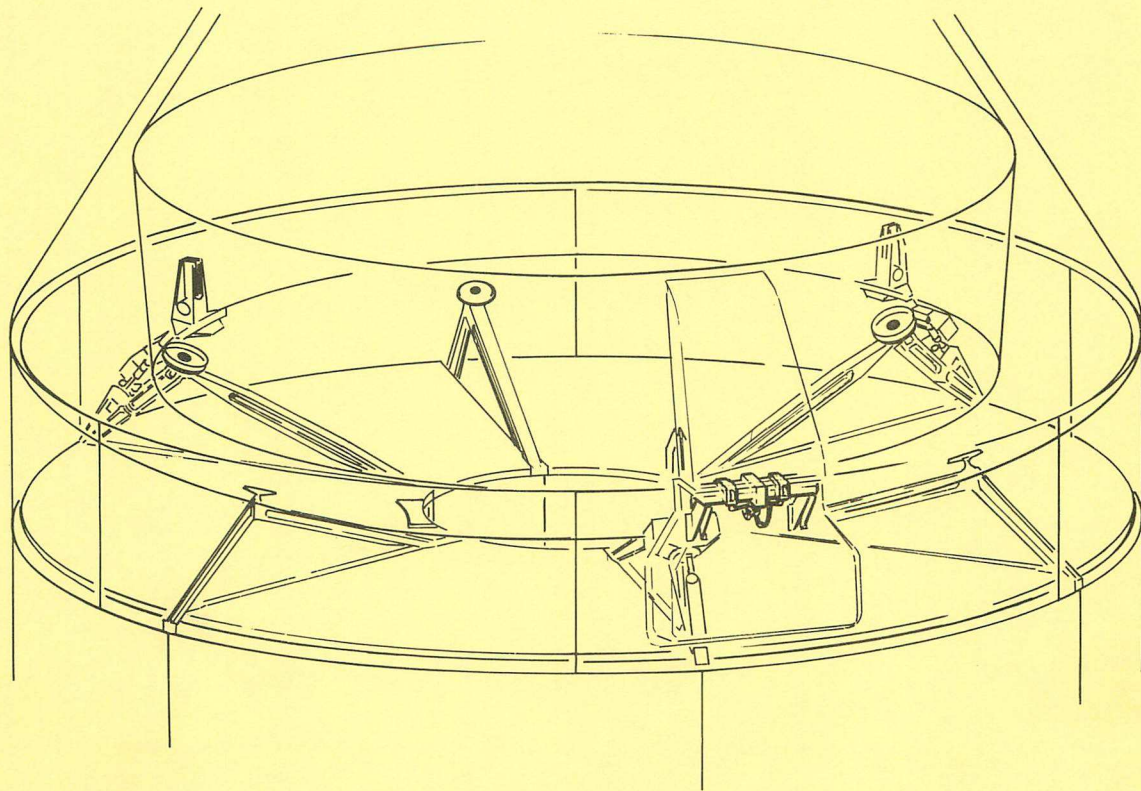
● COMPRESSION PAD

■ COMPRESSION PAD/TENSION TIE COMBINATION

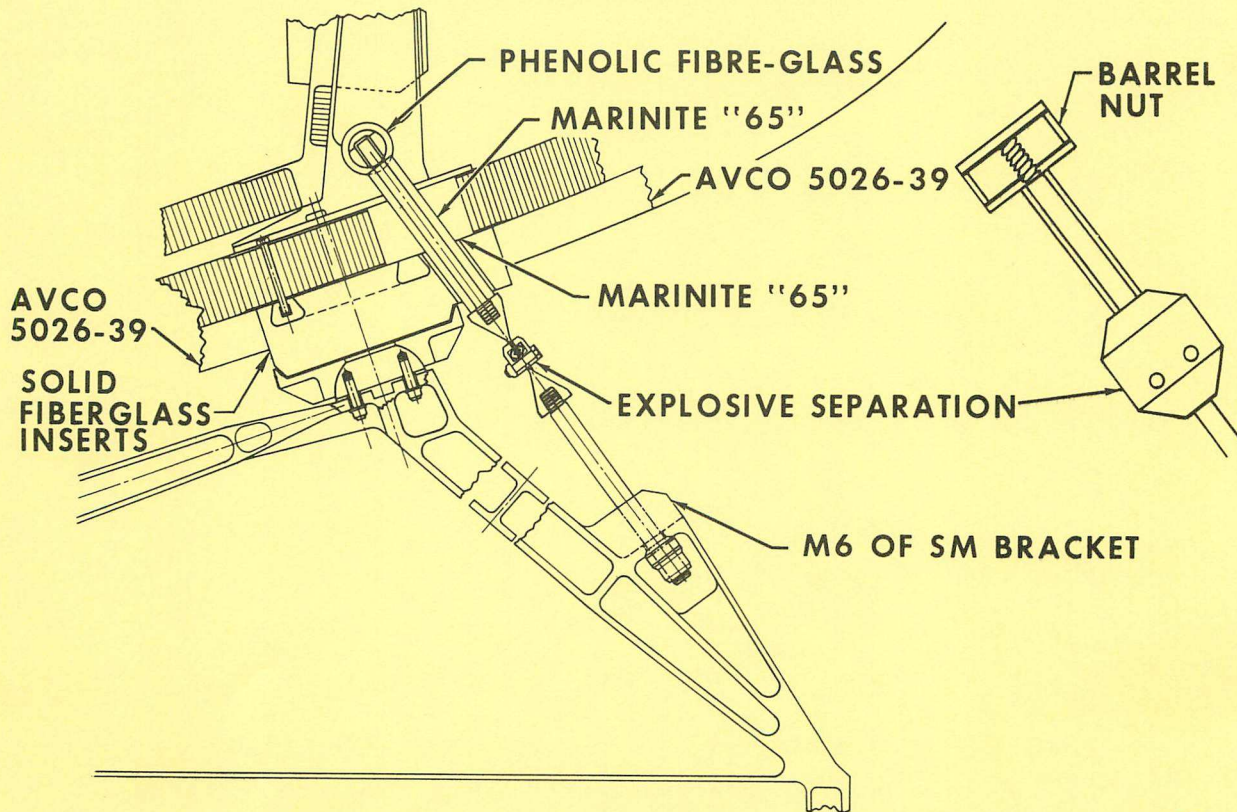
VIEW
LOOKING FORWARD



C/M - S/M SEPARATION SYSTEM



AFT TENSION-TIE

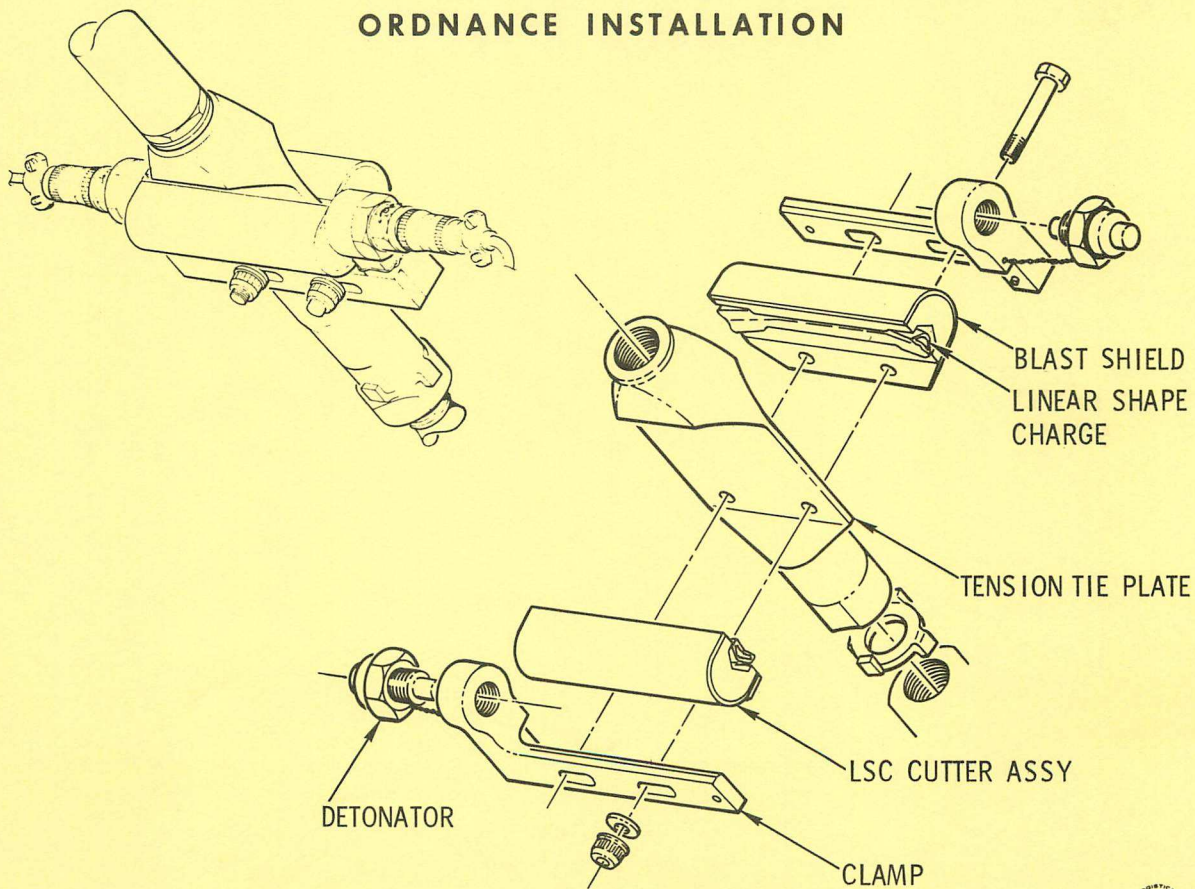


ST-616A



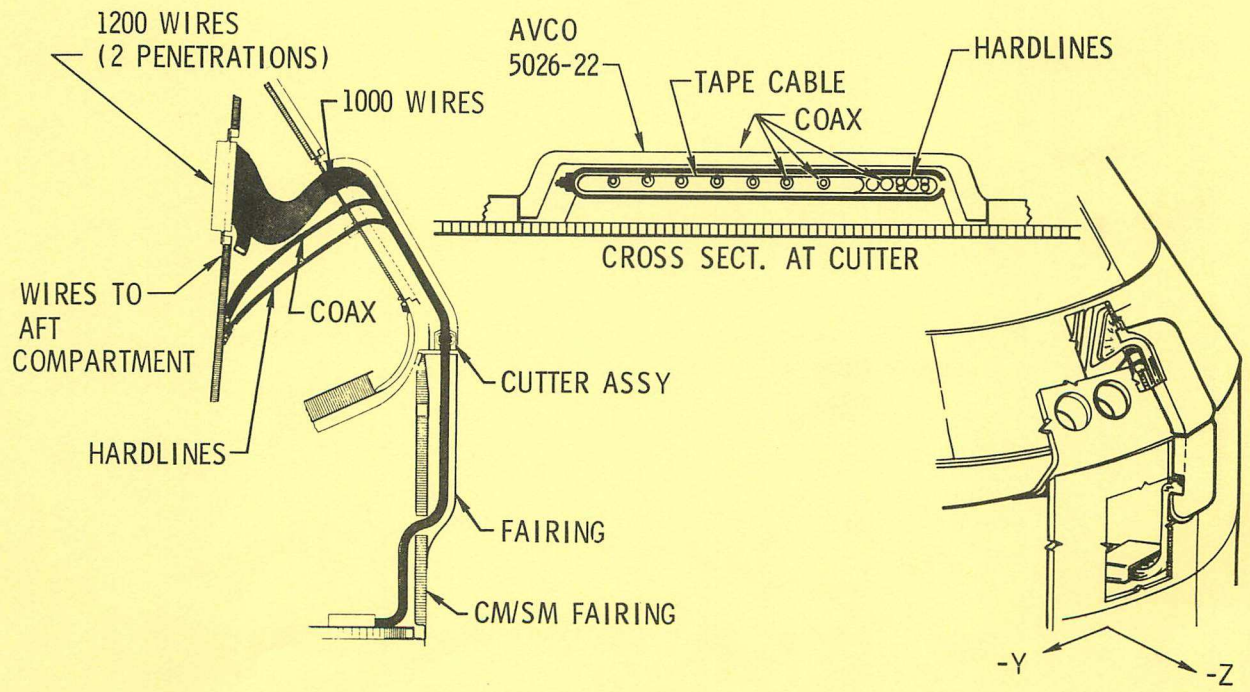
C/M-S/M SEPARATION SYSTEM

ORDNANCE INSTALLATION

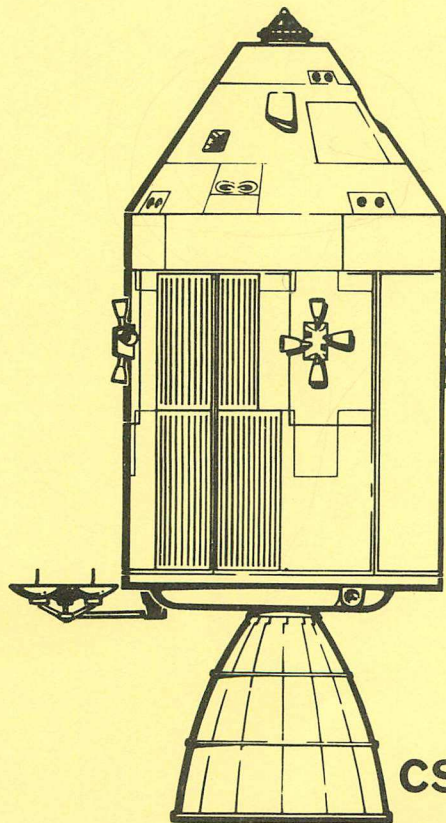


UMBILICAL

C/M TO S/M ELECTRICAL CABLE & HARD LINE ASSY

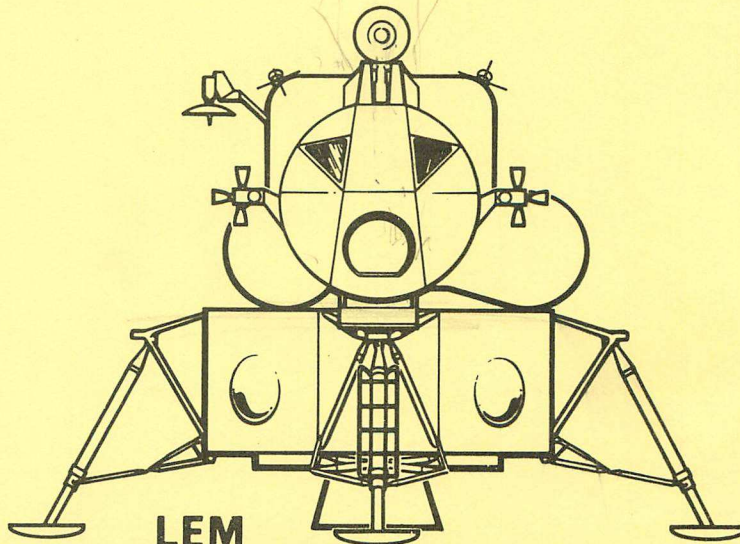
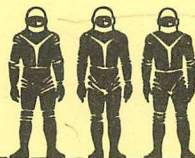


CSM & LEM COMPARISON



CSM

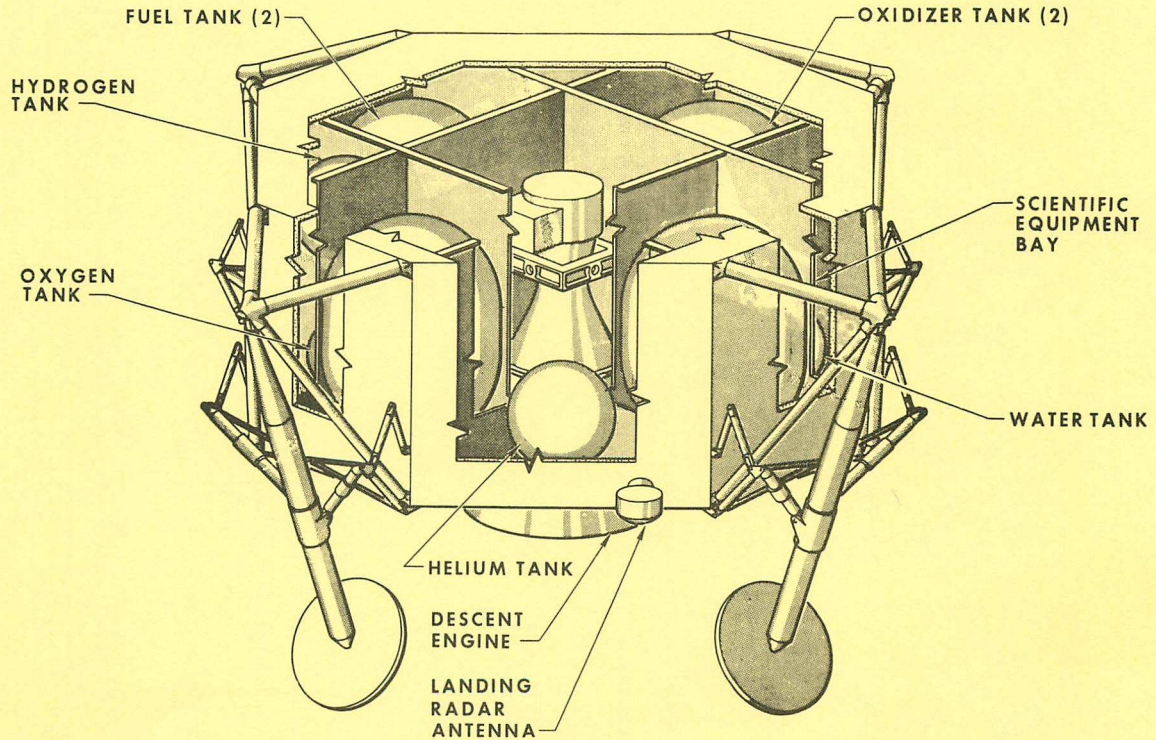
Command Service Module



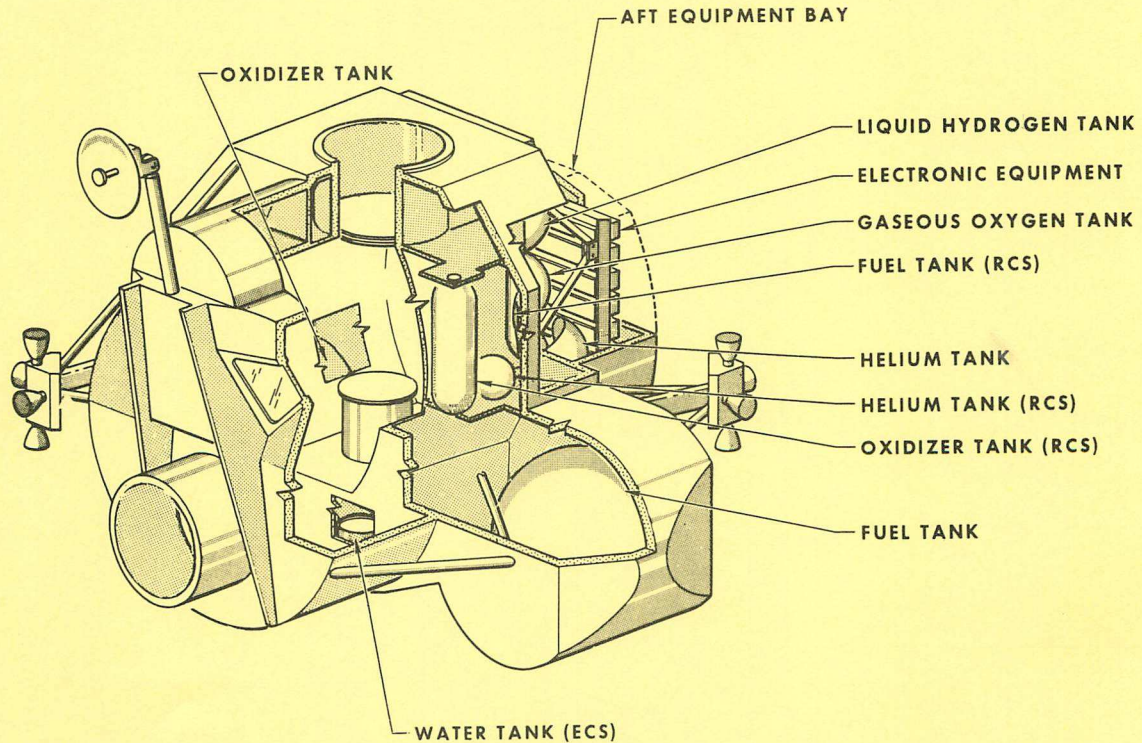
LEM

= 32K lbs

LEM DESCENT STAGE

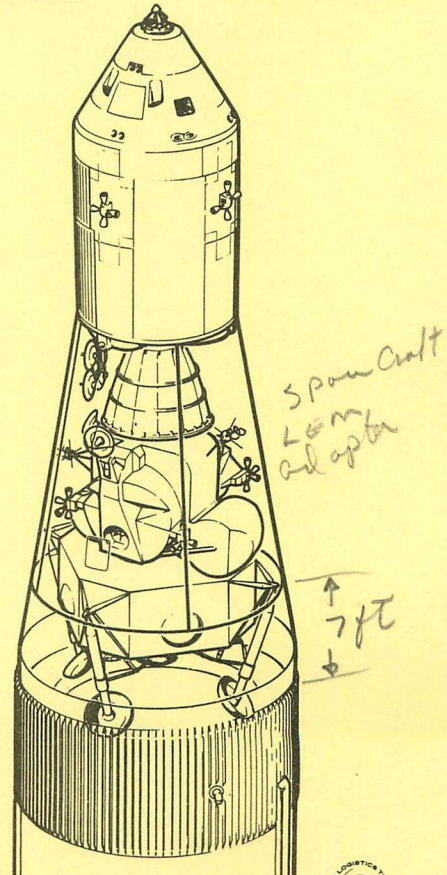
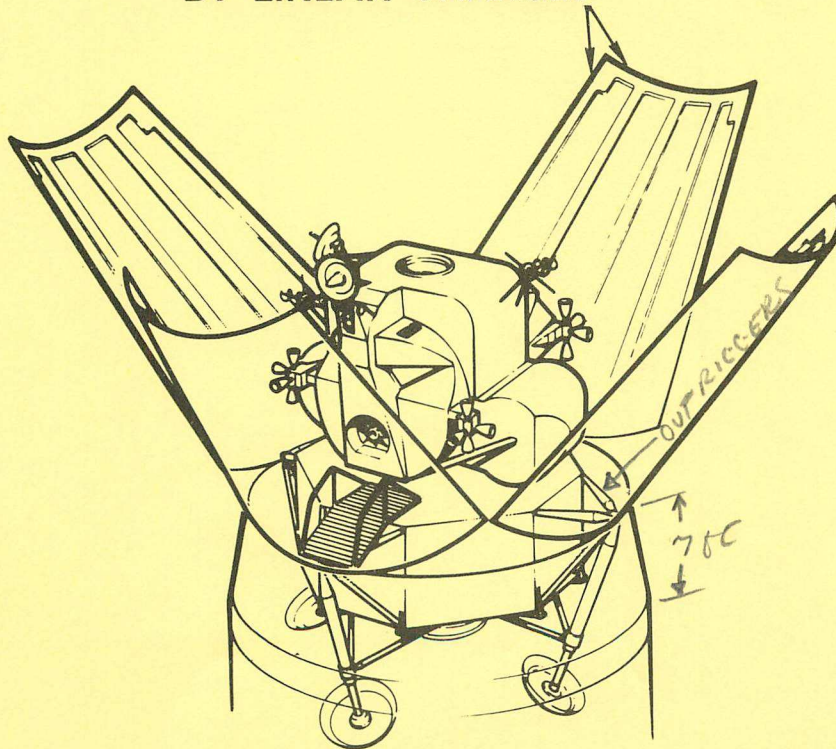


LEM ASCENT STAGE



LEM/S-IVB ADAPTER

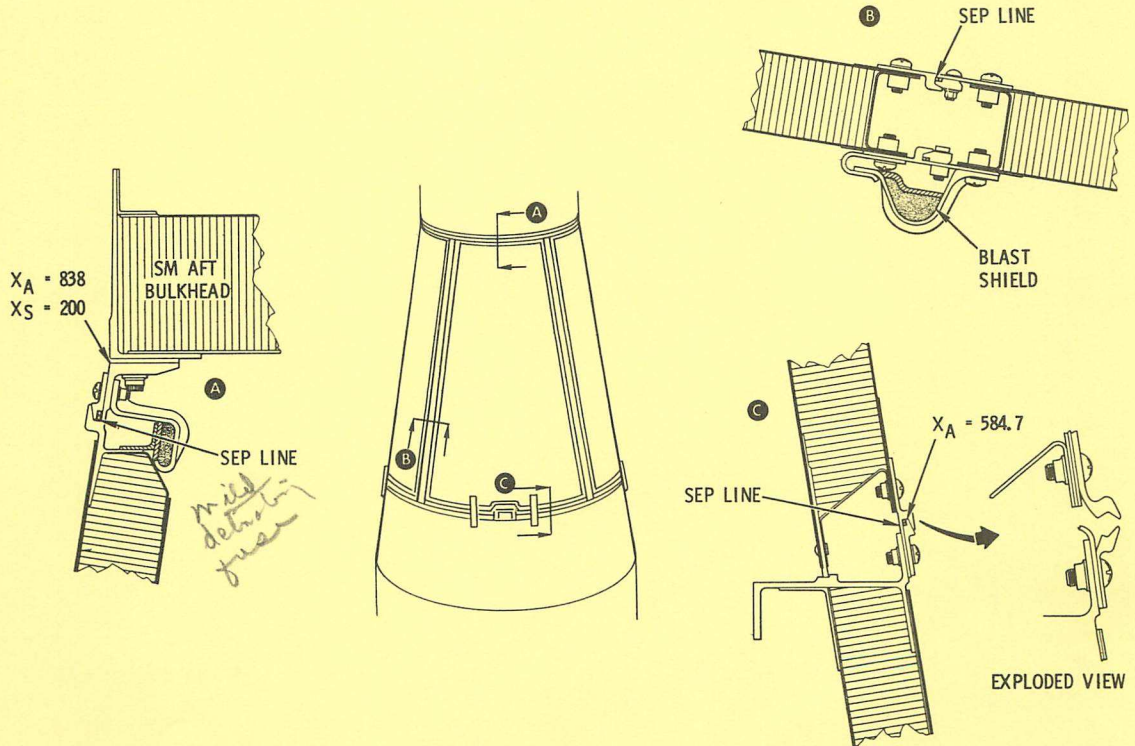
PANEL SEPARATION
BY LINEAR CHARGES



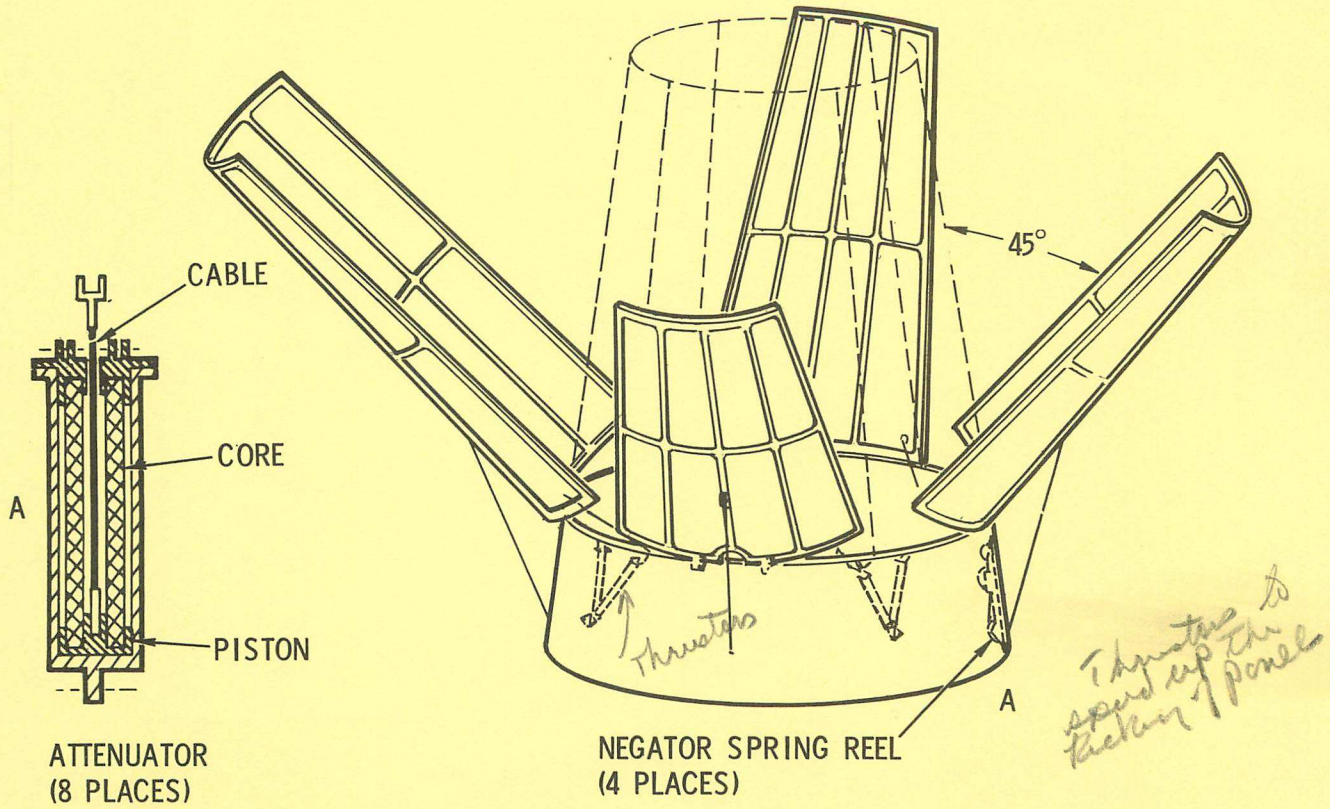
FAM-1503A



ADAPTER PANEL SEPARATION LINE



SLA PANEL DEPLOYMENT



Thrustors to speed up the backing of panels



ELECTRICAL POWER SYSTEM



H₂ & O₂ CRYOGENIC STORAGE

Compressed gases

- STORAGE VESSELS
- CONTROL VALVES
- PRESSURE
- TEMPERATURE

CRYOGENIC STORAGE SYSTEM

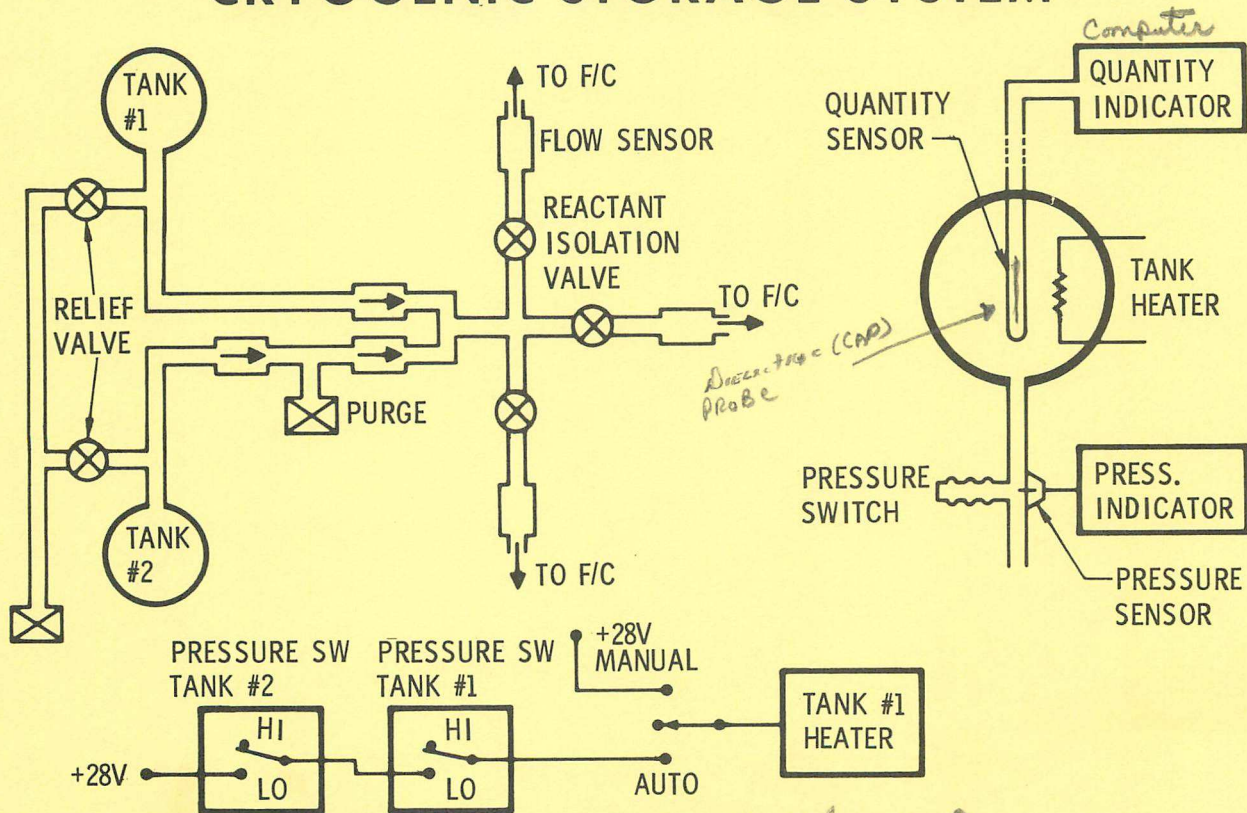
GAS	CONTAINER	CAPACITY	TOTAL CAPACITY
O ₂	INCONEL (2)	320 LBS (EA)	640 LBS
H ₂	TITANIUM (2)	28 LBS (EA)	56 LBS

*Down
log. state*

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



CRYOGENIC STORAGE SYSTEM

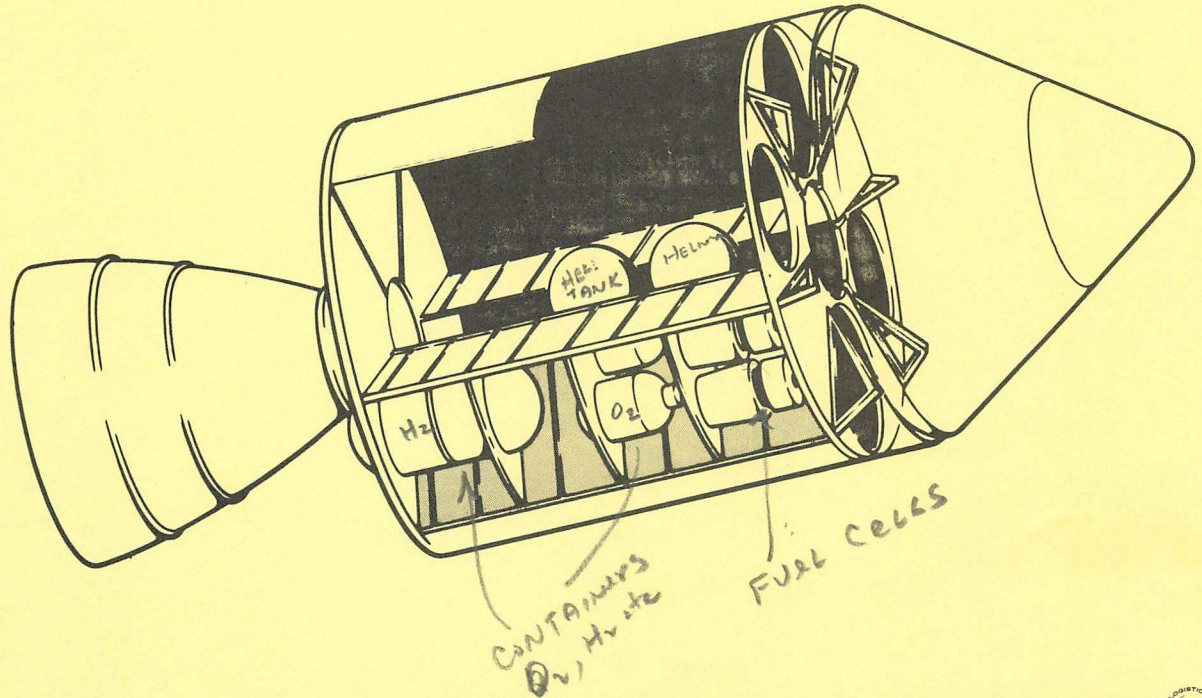


when pressure drops the pressure switch closes and the Tank Heater will come on which will repressurize.

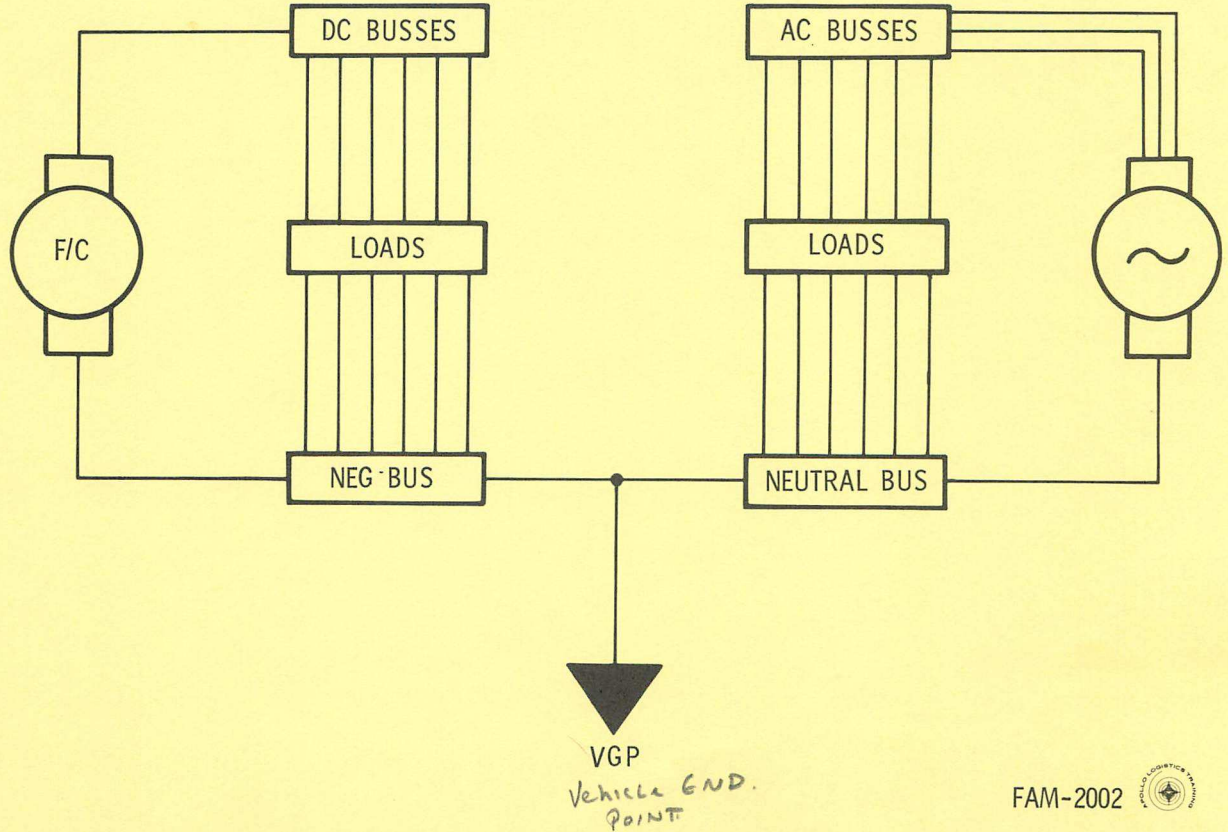


ELECTRICAL POWER SYSTEM

BLOCK II



EPS GROUND LOOPS



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 BATTERIES (2)

used to designate the pyrotechnic devices

Power LCS engines



EPS POWER SOURCES

FUEL CELL MODULES

29V \pm 2 VDC
1500 WATTS EA

HYDROGEN-OXYGEN-POTASSIUM HYDROXIDE
BY-PRODUCT IS POTABLE WATER

3 BATTERIES

29V \pm 2VDC
40 AH

SILVER-OXIDE-ZINC (KOH)

AC INVERTERS

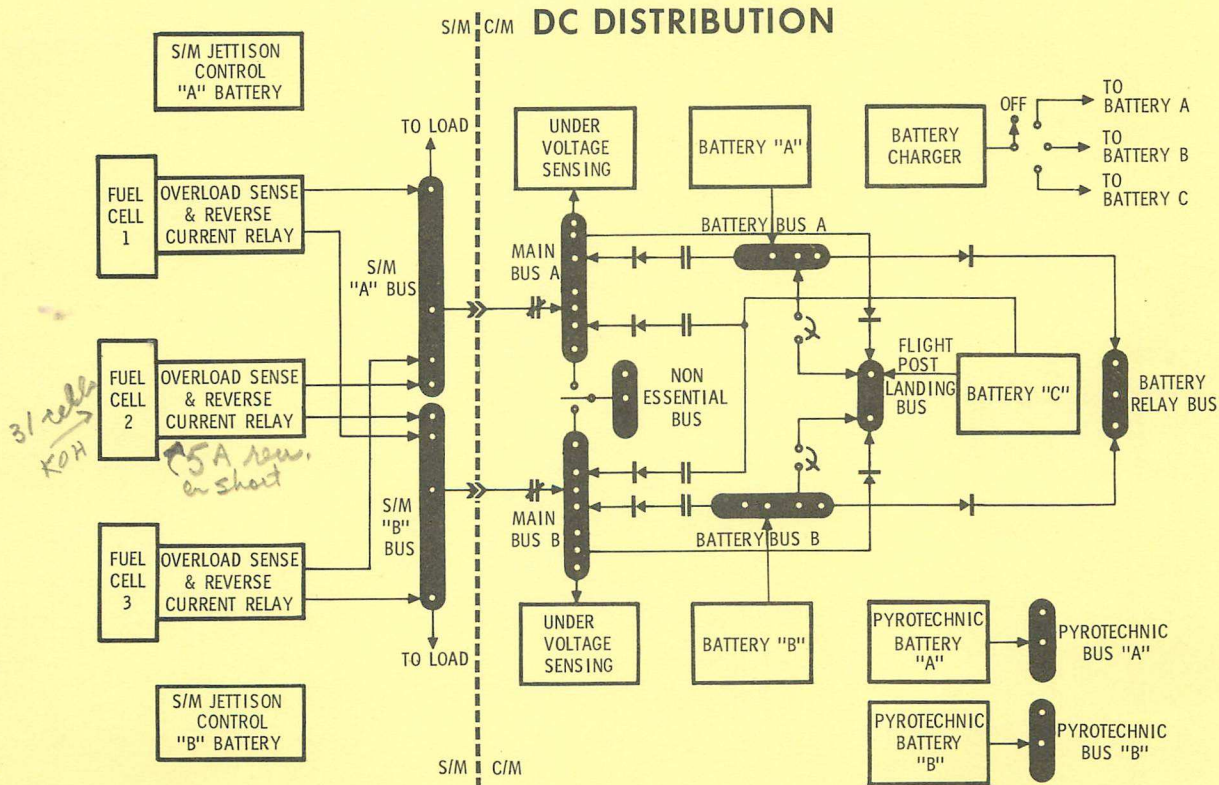
115/200 VAC
3 PHASE
400 CYCLES
1250 VA

SOLID STATE (TRANSISTORIZED)

cell plate water 30% glycol 70%

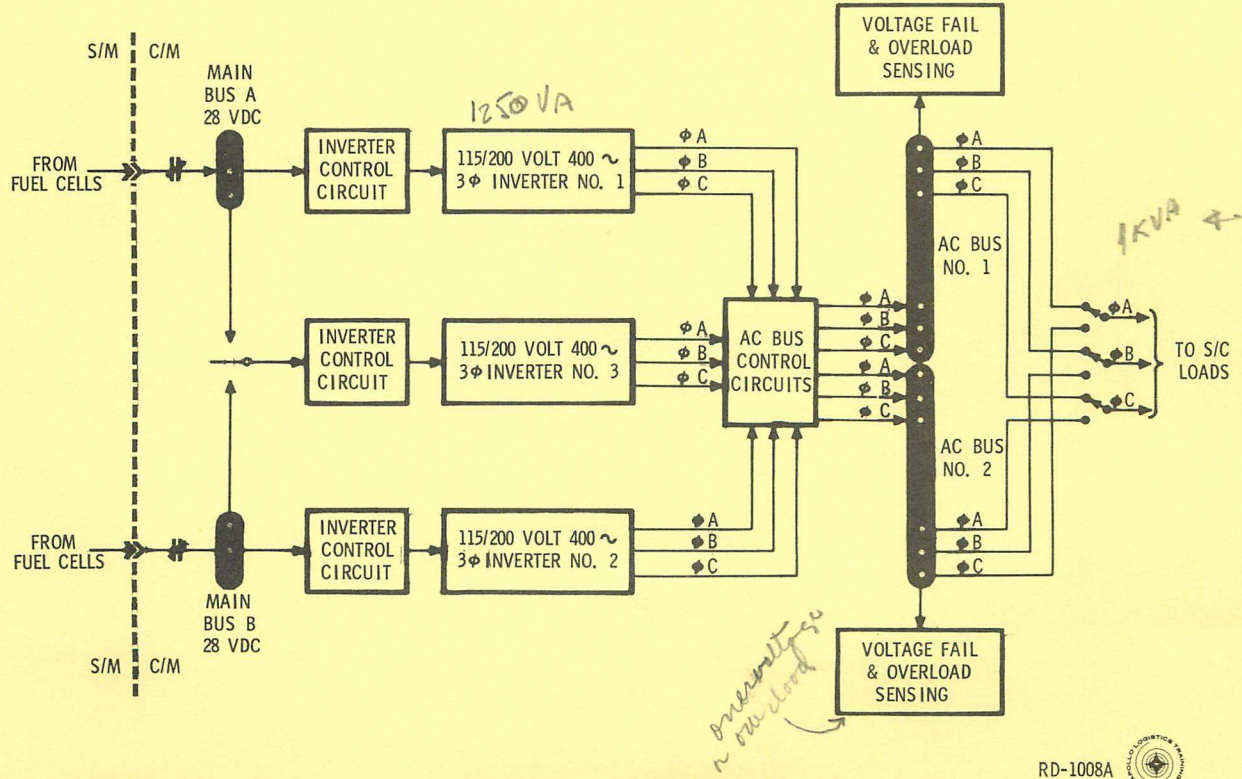


ELECTRICAL POWER SYSTEM

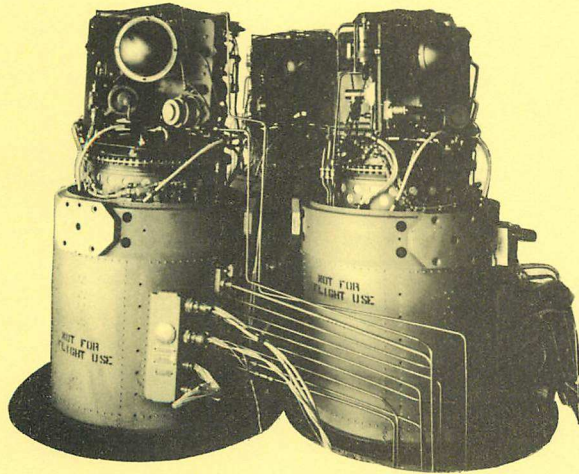


ELECTRICAL POWER SYSTEM

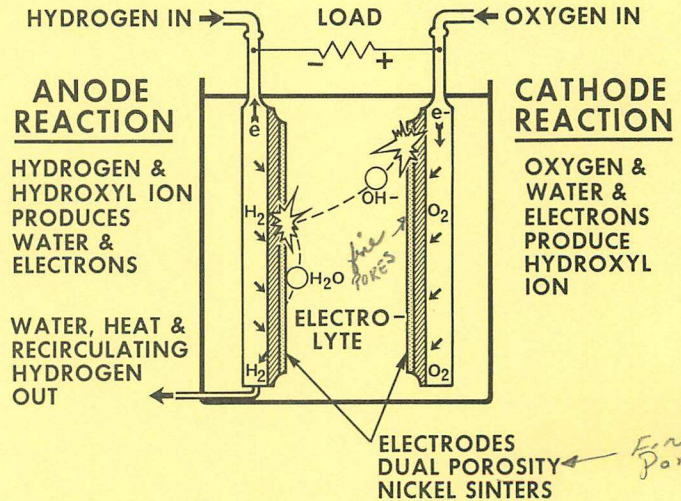
AC DISTRIBUTION



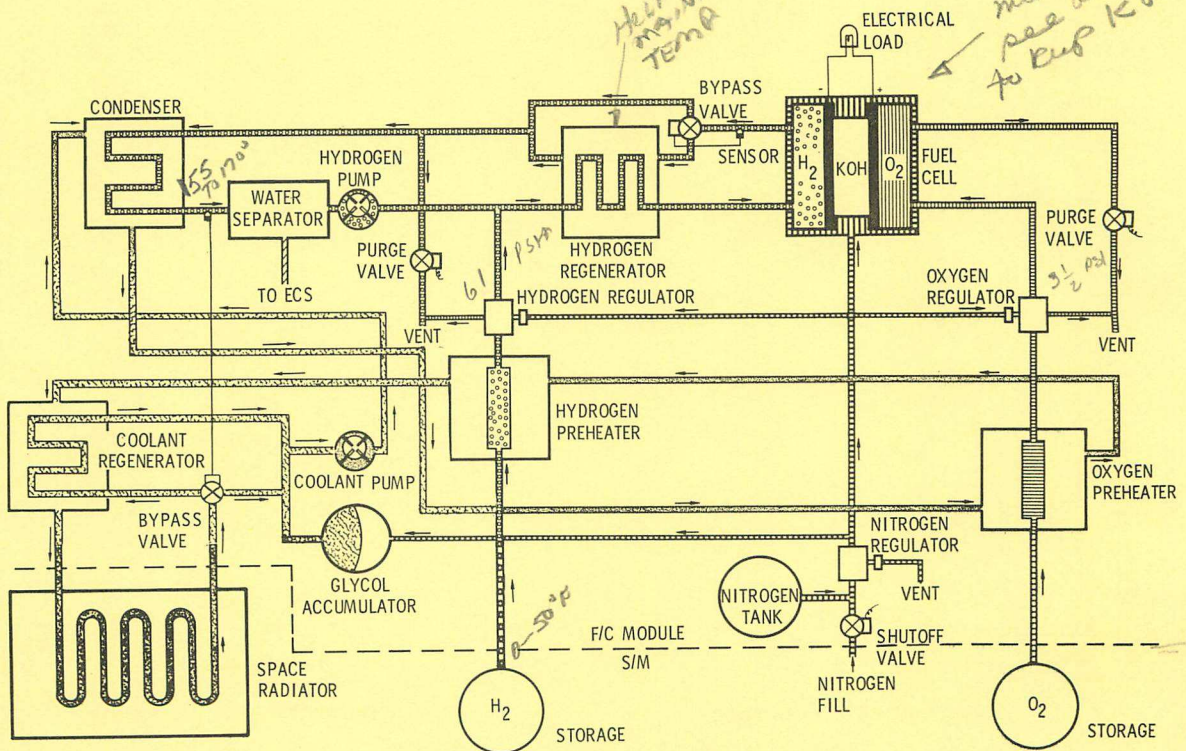
APOLLO FUEL CELL POWERPLANT



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

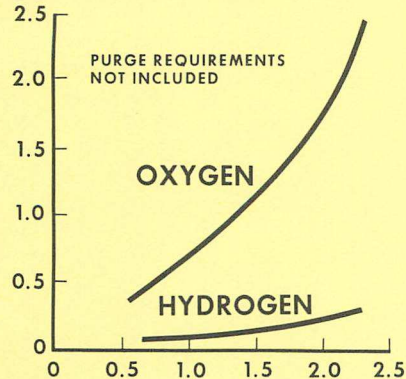


EPS FUEL CELL DIAGRAM

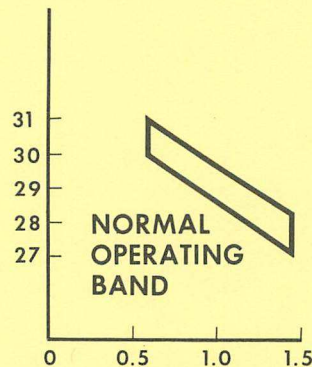


FUEL CELL REACTION

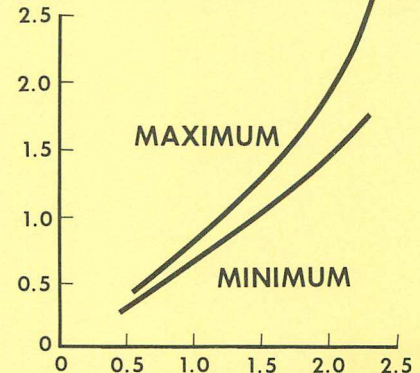
MAXIMUM REACTANT
CONSUMPTION-
POUNDS PER HOUR



VOLTAGE



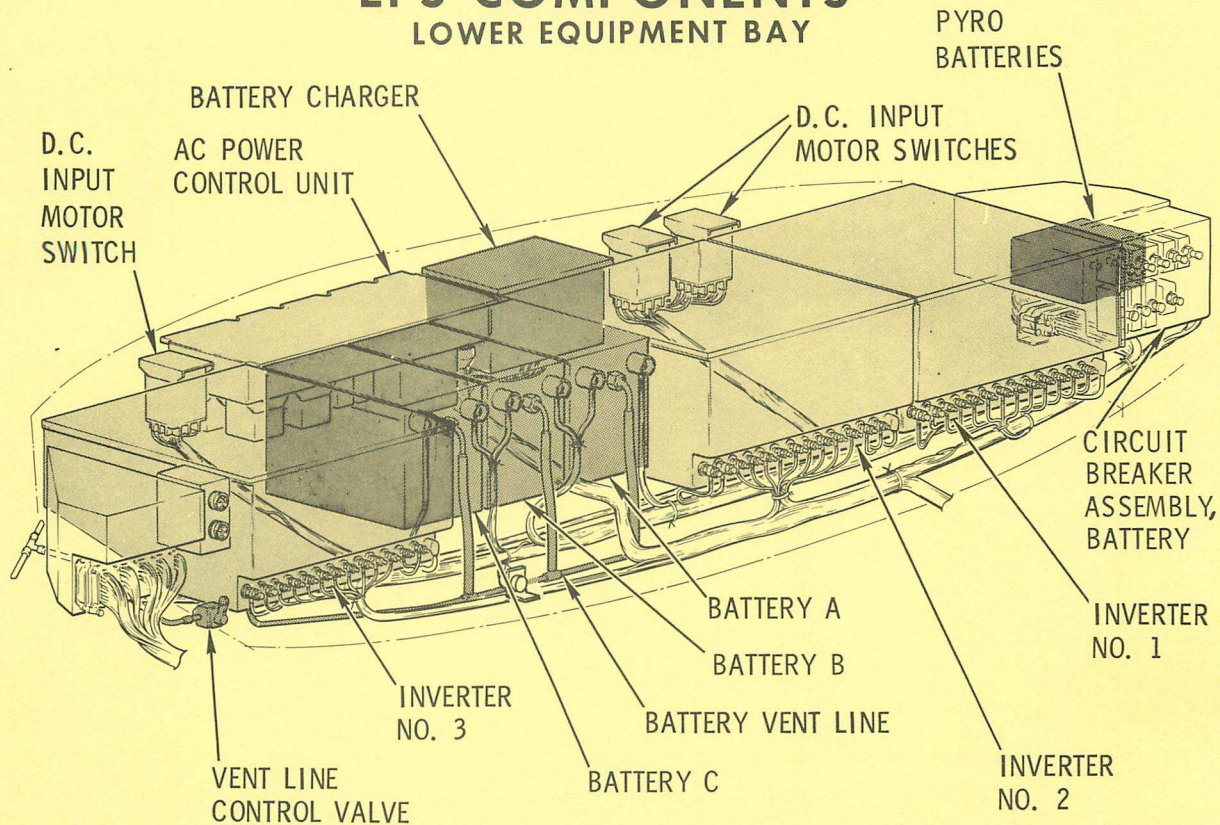
WATER GENERATION RATE-
POUNDS PER HOUR-
PURGING NOT INCLUDED



GROSS POWER PER POWERPLANT - KILOWATTS

EPS COMPONENTS

LOWER EQUIPMENT BAY



SEQUENTIAL EVENTS CONTROL SYSTEM

FAM-3005



SEQUENTIAL EVENTS CONTROL SYSTEM

MAJOR FUNCTIONS

- LAUNCH ESCAPE
- VOTES EDS AUTO ABORT
- L. E. TOWER JETTISON
- Deserts* • ADAPTER SEPARATION
- CM - SM SEPARATION
- SM JETTISON
- EARTH LANDING

Sequential

COMPOSED OF:

- SEQUENCE CONTROLLERS
 - MASTER EVENT SEQUENCE CONTROLLER
 - EARTH LANDING SEQUENCE CONTROLLER *inside CM*
 - SM JETTISON CONTROLLER
 - CM - RCS CONTROLLER *Relay*
- INTERFACING HARDWARE
 - LAUNCH ESCAPE SYSTEM
 - EARTH LANDING SYSTEM
 - EMERGENCY DETECTION SYSTEM
 - MECHANICAL SEPARATION DEVICES



LAUNCH ESCAPE SYSTEM

MAJOR COMPONENTS

- TOWER STRUCTURE

welded tubular titanium

- ROCKET MOTORS

LAUNCH ESCAPE MOTOR

PITCH CONTROL MOTOR

TOWER JETTISON MOTOR

Star burner - soft propellant

- BALLAST

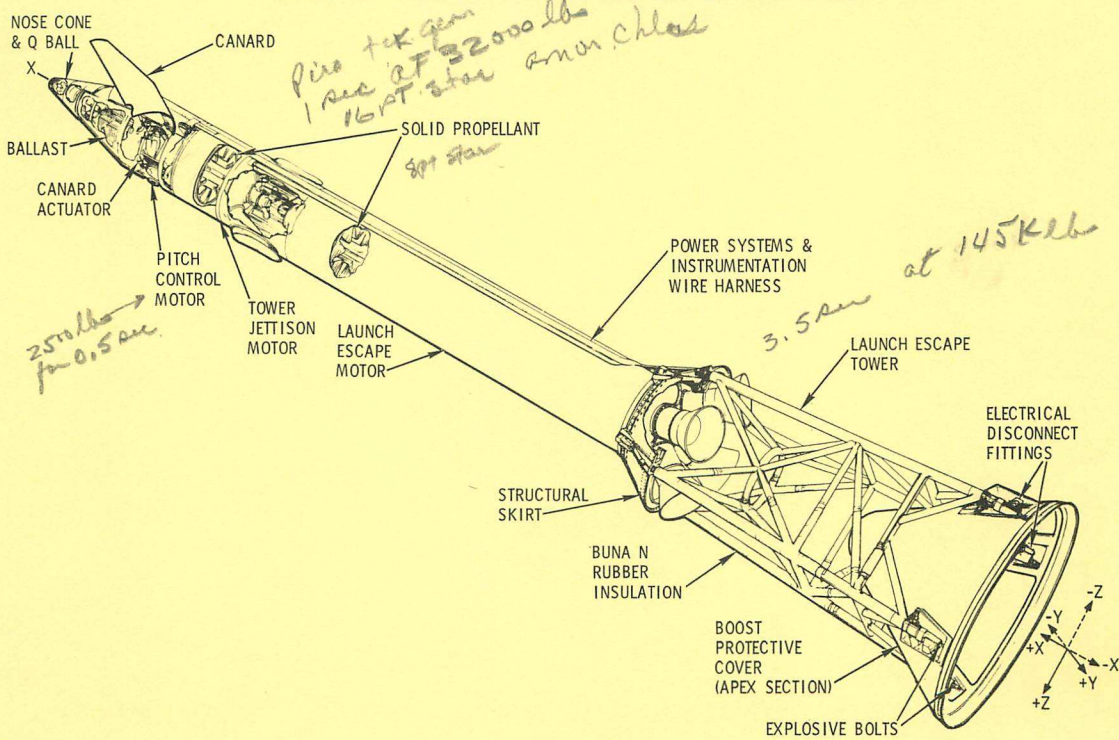
- CANARDS

- TOWER SEPARATION MECHANISM

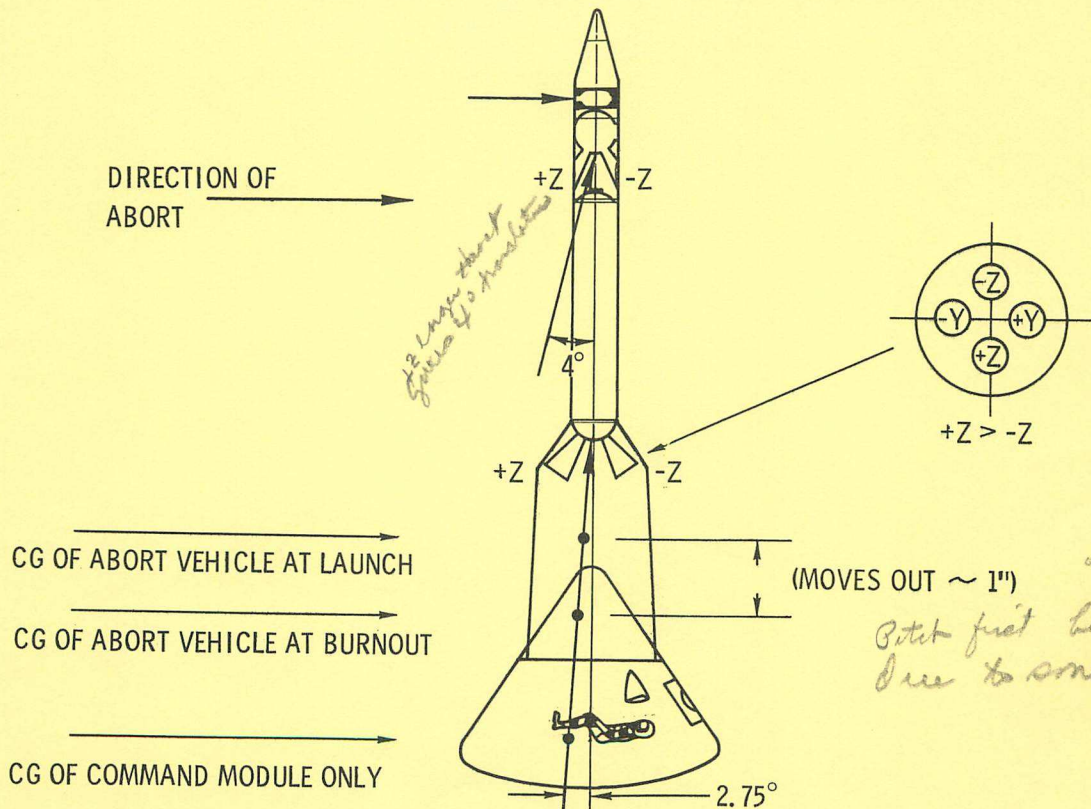
- BOOST PROTECTIVE COVER



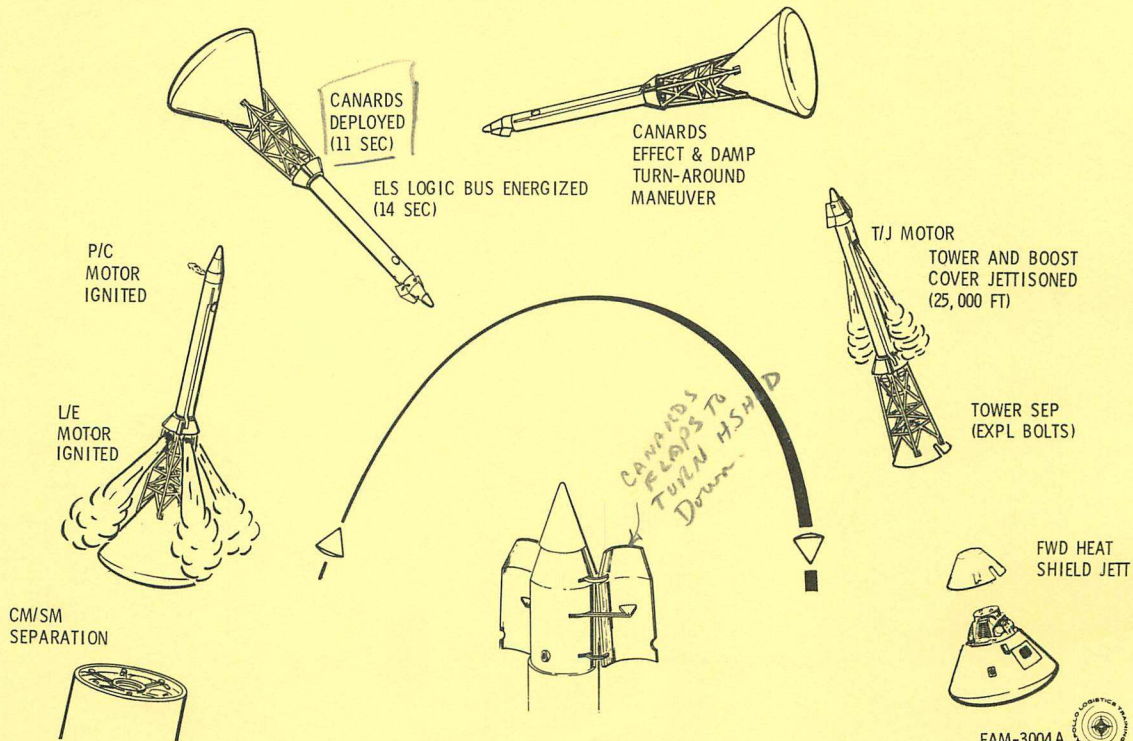
LAUNCH ESCAPE SYSTEM



ABORT VEHICLE MECHANICS



CANARD OPERATION



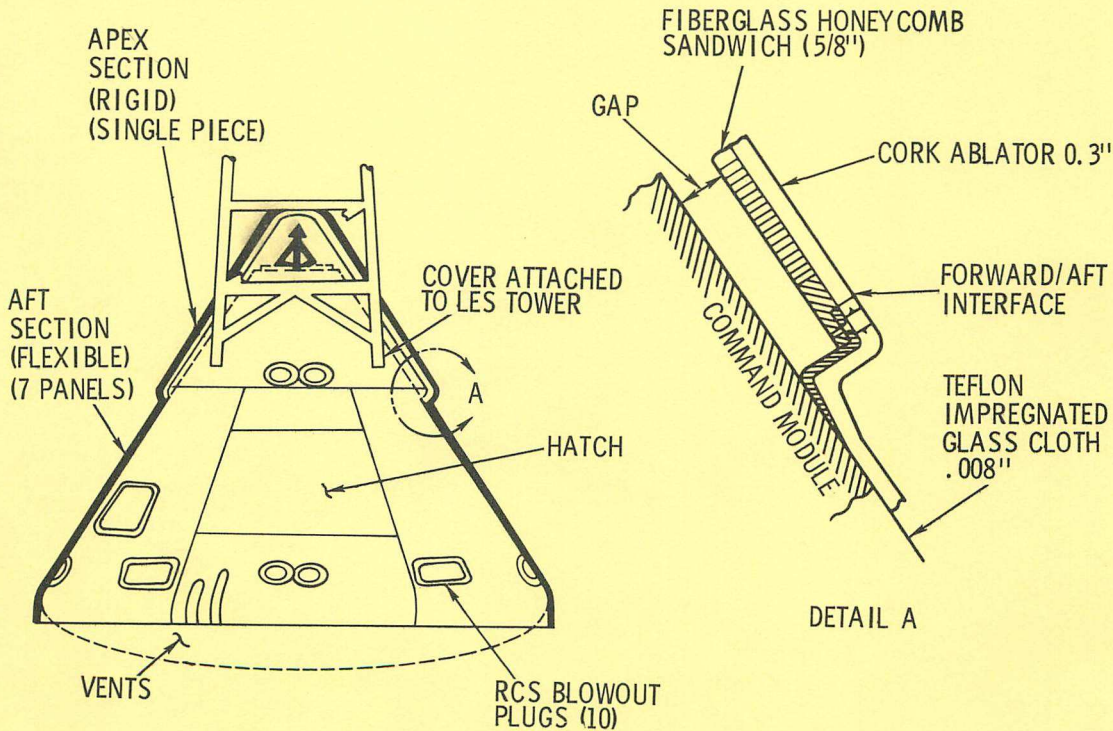
FAM-3004A



BOOST PROTECTIVE COVER

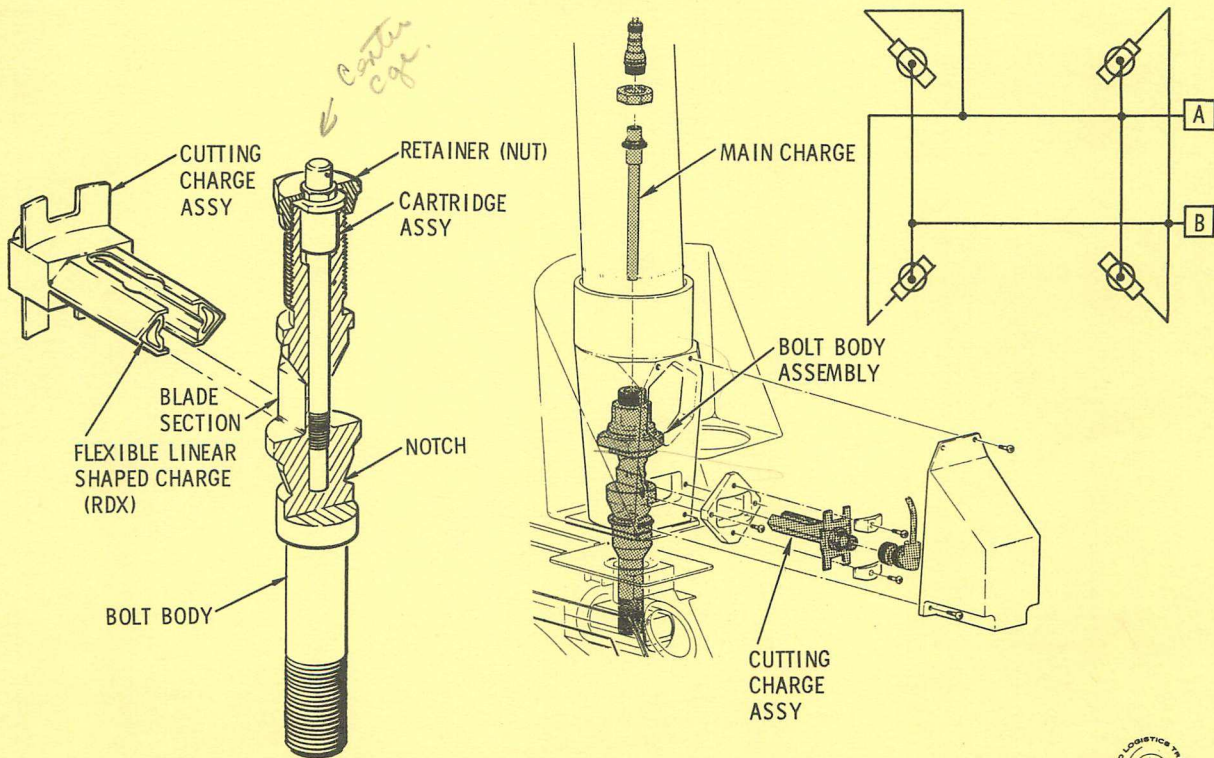
= 500 lbs.

Protects on way up
Protects from Tond



TOWER SEPARATION MECHANISM

EXPLODED VIEW



ST-615D



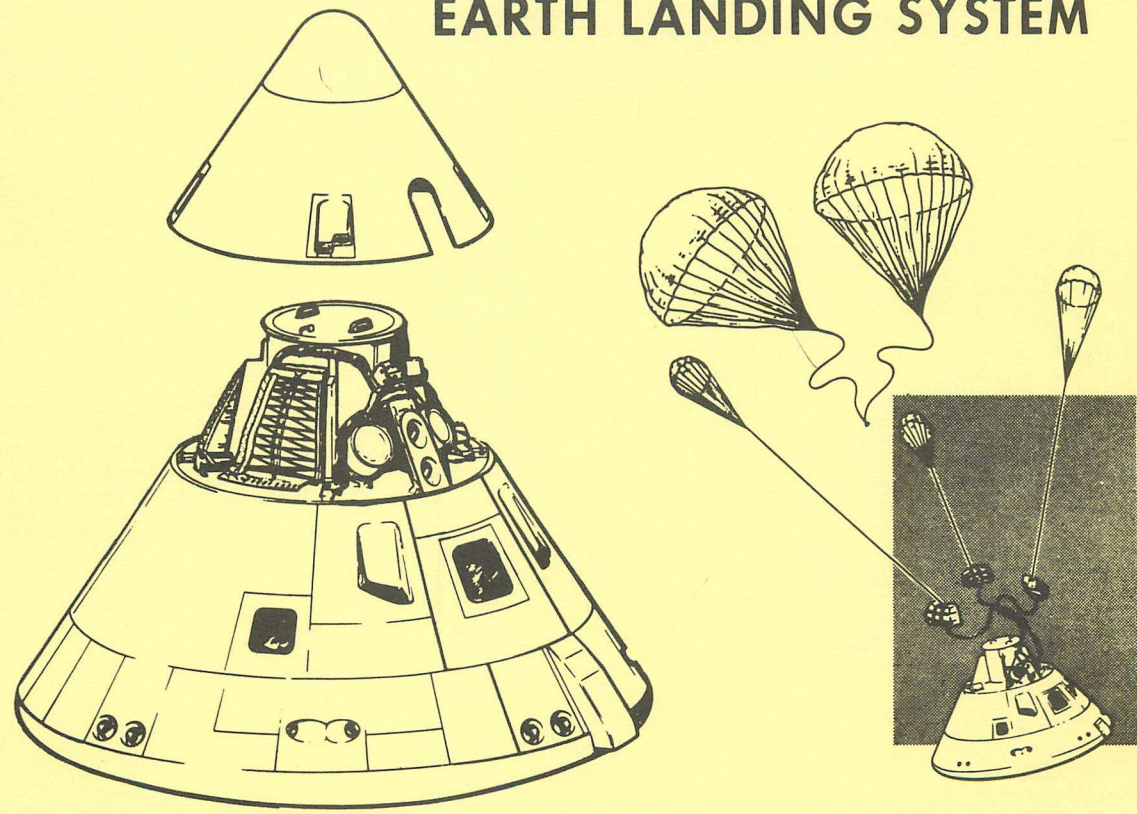
EARTH RECOVERY SYSTEM

MAJOR COMPONENTS

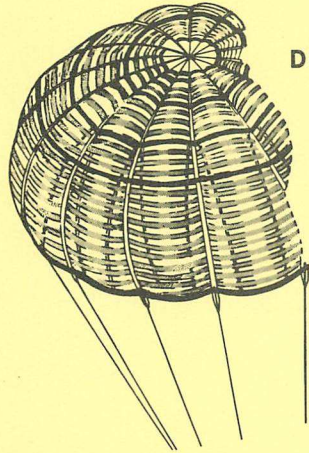
- ELS {
- FWD HEAT SHIELD SEPARATION MECHANISM
 - PARACHUTE SUBSYSTEM
 - DROGUE PARACHUTES
 - PILOT PARACHUTES
 - MAIN LANDING PARACHUTES
 - RECOVERY AIDS
 - POST LANDING VENTILATION SYSTEM
 - FLOTATION BAGS
 - SEA PICKUP SLING
 - SEA MARKER
 - SWIMMER UMBILICAL
 - RECOVERY ANTENNAS (HF & VHF)



EARTH LANDING SYSTEM



EARTH LANDING SYSTEM PARACHUTES

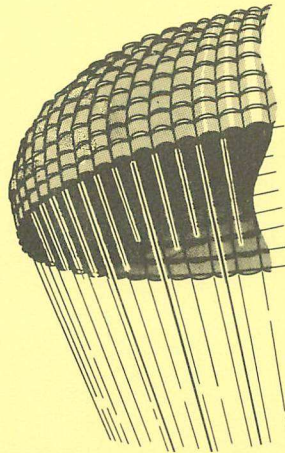
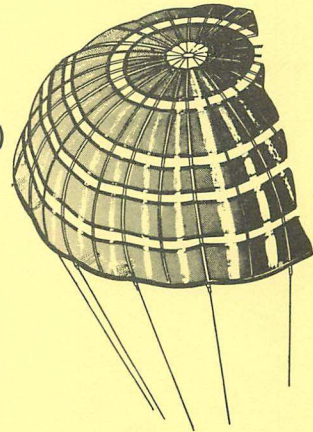


DROGUE CHUTE (2)

FIST RIBBON TYPE
DIA = 13.7 FT

PILOT CHUTE (3)

RING SLOT TYPE
DIA = 7.2 FT



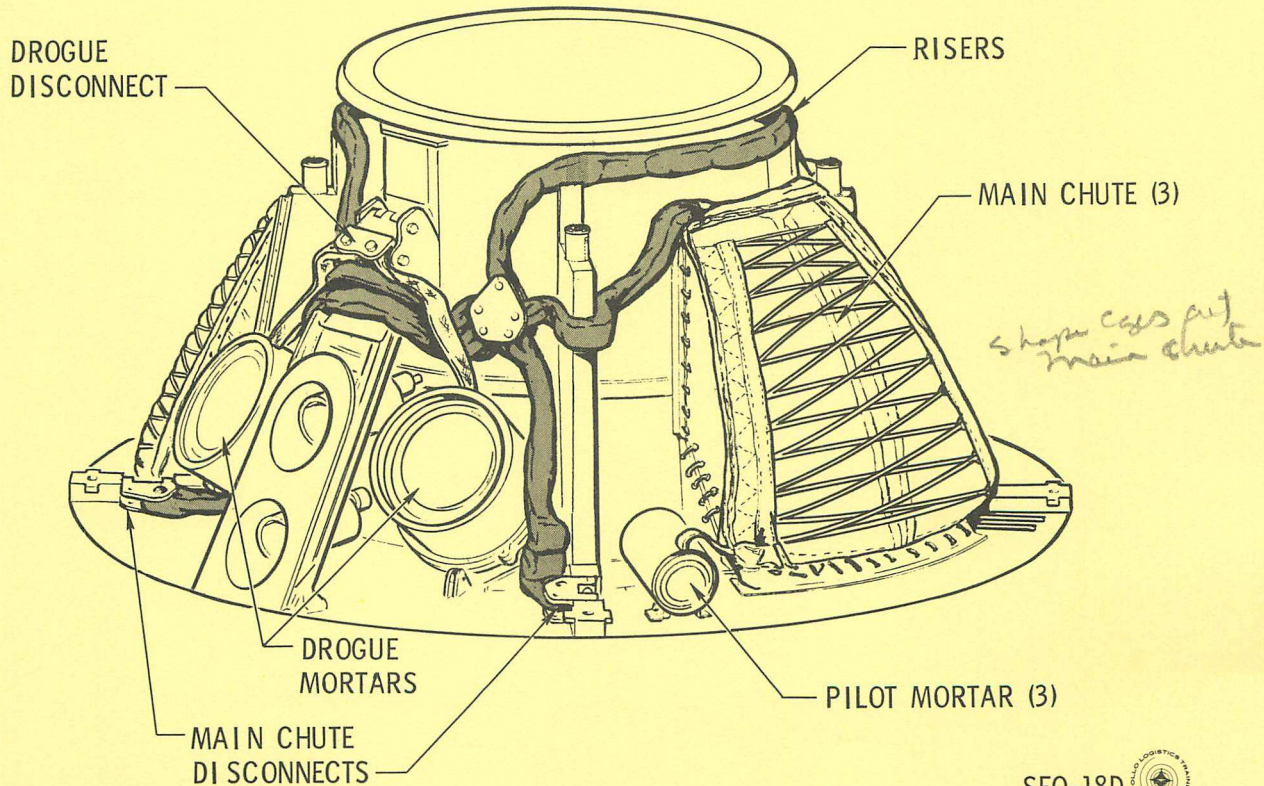
MAIN CHUTE (3)

RING SAIL TYPE
DIA = 88.1 FT

*6700m
stun lift of solid*

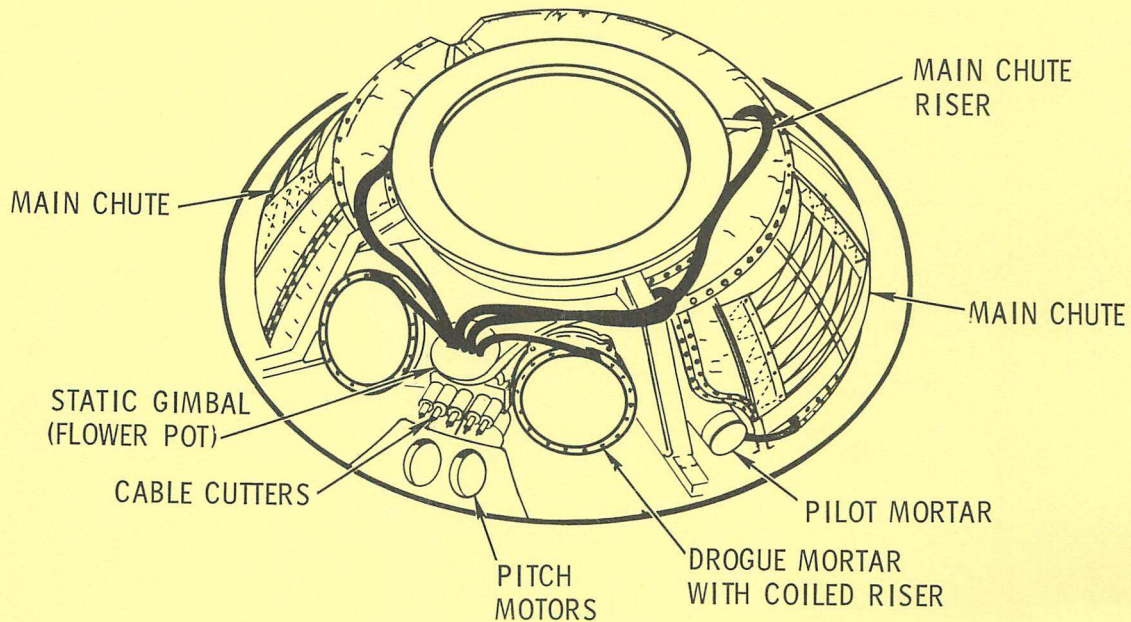


ELS EQUIPMENT BLOCK I



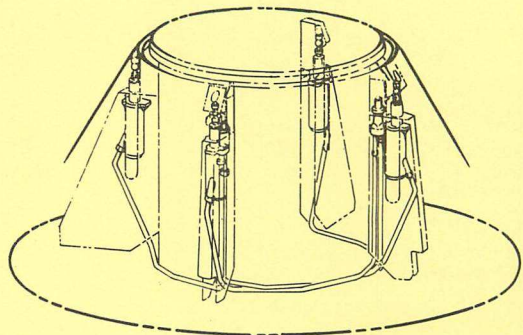
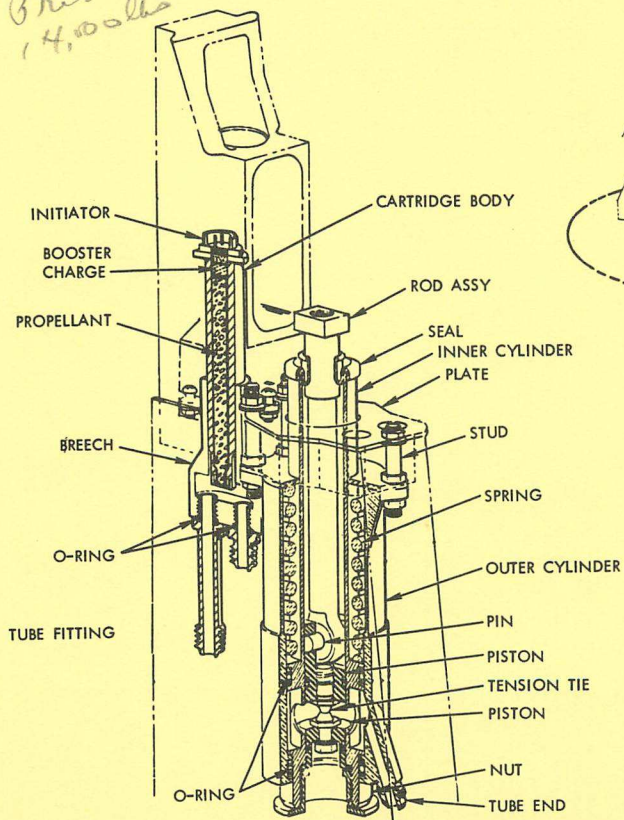
ELS EQUIPMENT

BLOCK II



FORWARD HEAT SHIELD SEPARATION SYSTEM

*Breech cut
(4,000 lbs)*

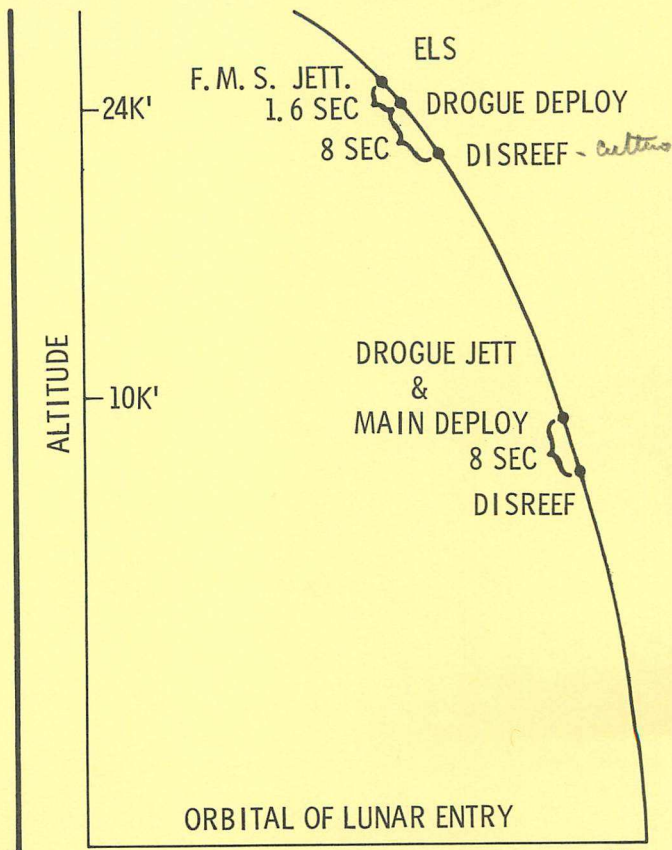
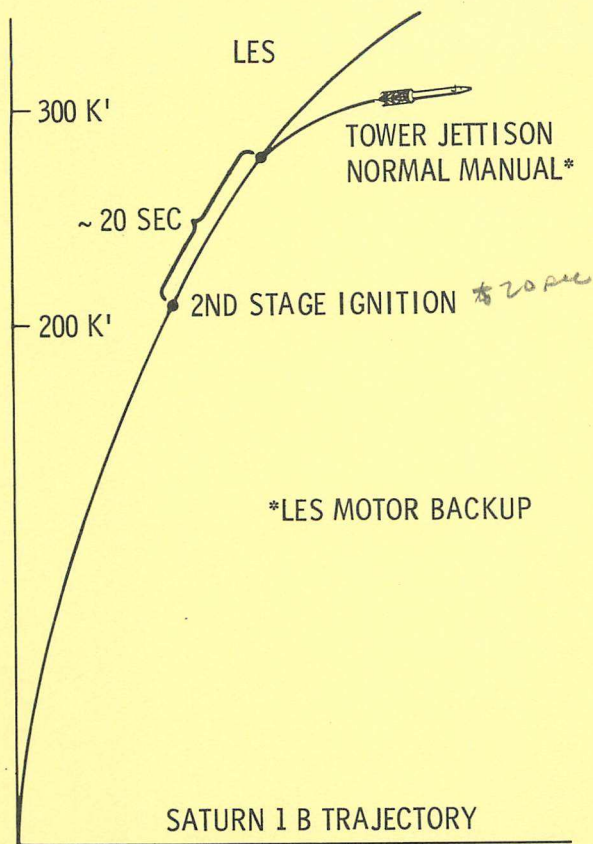


j Hat 25 FPS

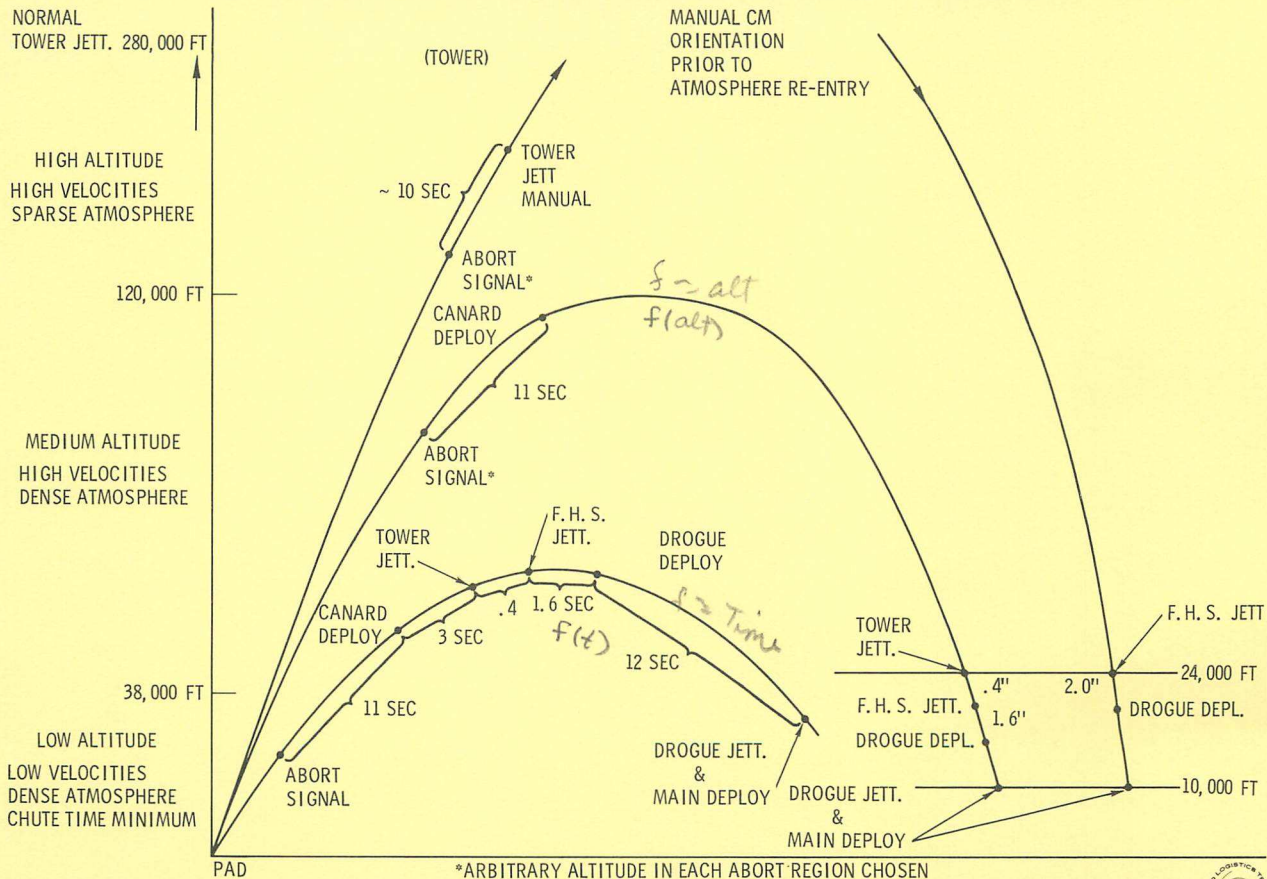
only need 2 to fire



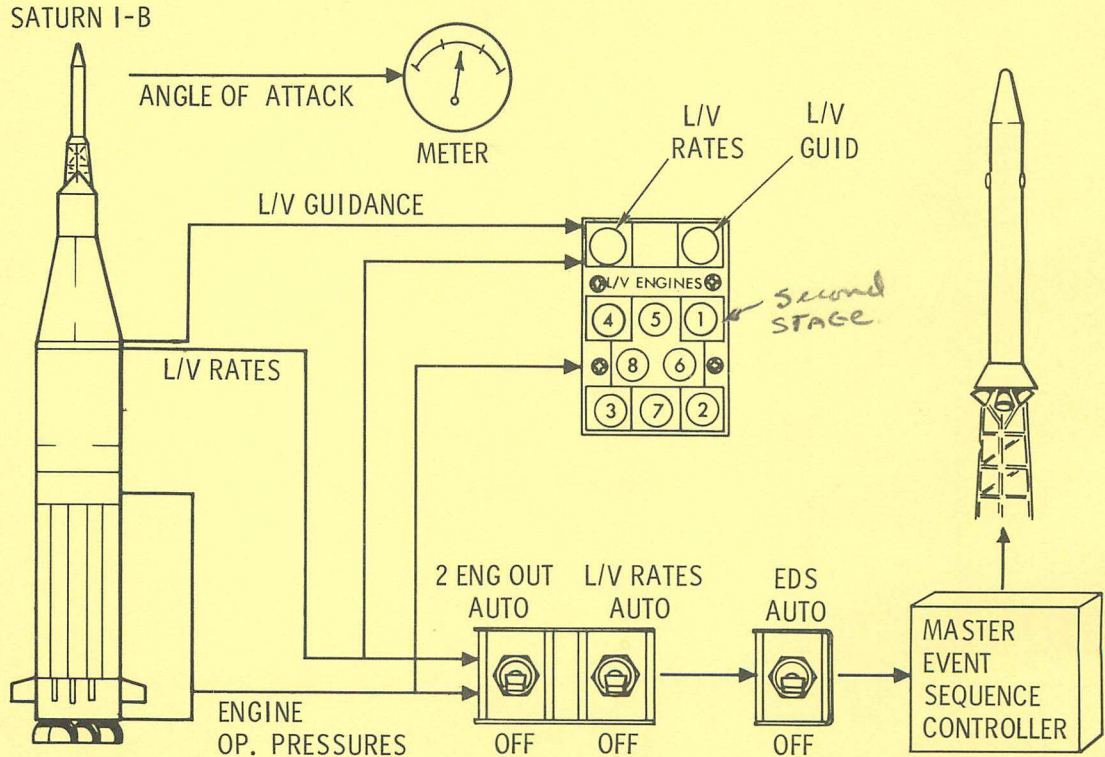
NORMAL MODES OF OPERATION



ATMOSPHERIC ABORT MODES



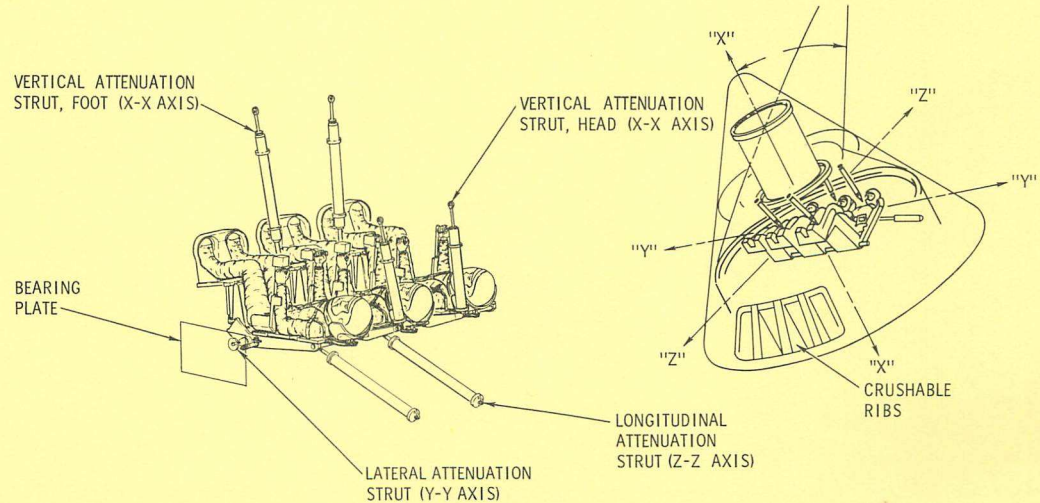
EMERGENCY DETECTION SYSTEM



IMPACT ATTENUATION

METHODS OF ABSORBING KENETIC ENERGY:

1. WATER DEFLECTION
2. CM STRUCTURE DEFLECTION
3. CRUSHABLE RIBS
4. ATTENUATION STRUTS (CRUSHABLE ALUM. MATL.)

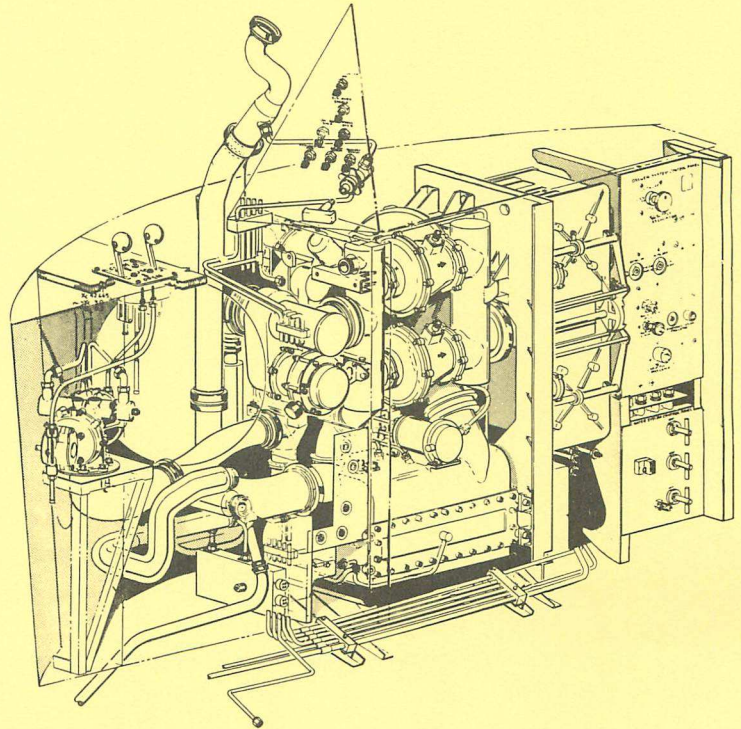
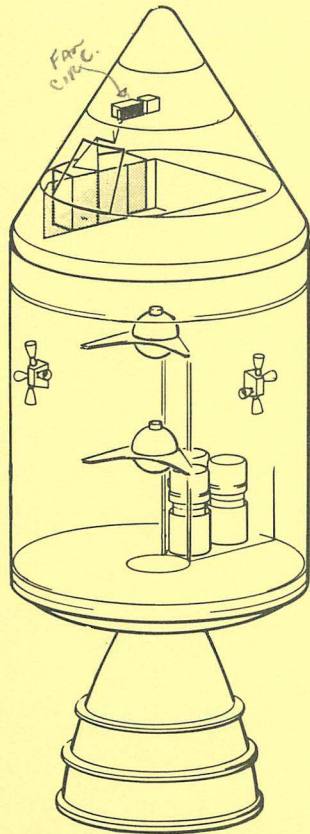


ENVIRONMENTAL CONTROL SYSTEM

FAM-2505



ENVIRONMENTAL CONTROL SYSTEM



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**

ECS OPERATIONAL REQUIREMENTS

PRESSURIZATION & TEMPERATURE CONTROL-CABIN/SUIT

- PRE-LAUNCH
- ASCENT
- ENTRY
- ABORT

- SPACE OPERATIONS
SHIRT SLEEVE
PRESSURE SUIT (NO FACE MASK)
EMERGENCY

CONTAMINANT REMOVAL

WATER MANAGEMENT

HUMIDITY CONTROL

EQUIPMENT COOLING

ENVIRONMENTAL CONTROL SYSTEM

SUBSYSTEM FUNCTIONS

OXYGEN SUPPLY SUBSYSTEM

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

PRESSURE SUIT SUBSYSTEM

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

WATER SUBSYSTEM

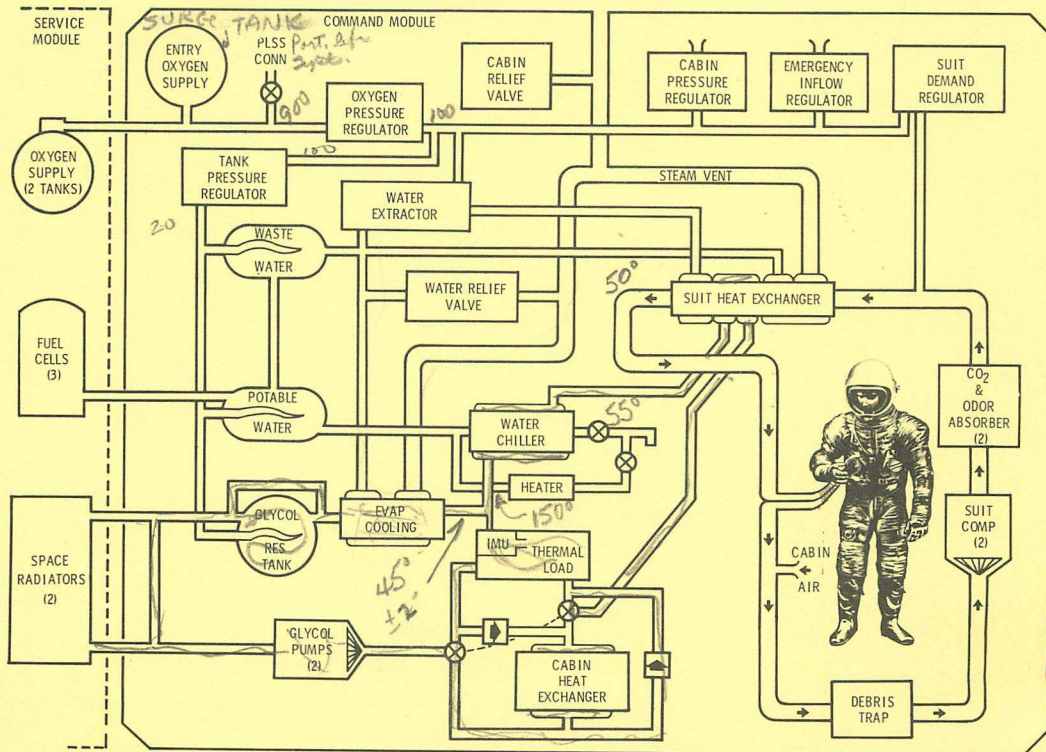
- STORES & DISTRIBUTES
POTABLE WATER (DRINKING & FOOD RECONSTITUTION)
WASTE WATER (SUPPLEMENTAL COOLING)

WATER GLYCOL SUBSYSTEM

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

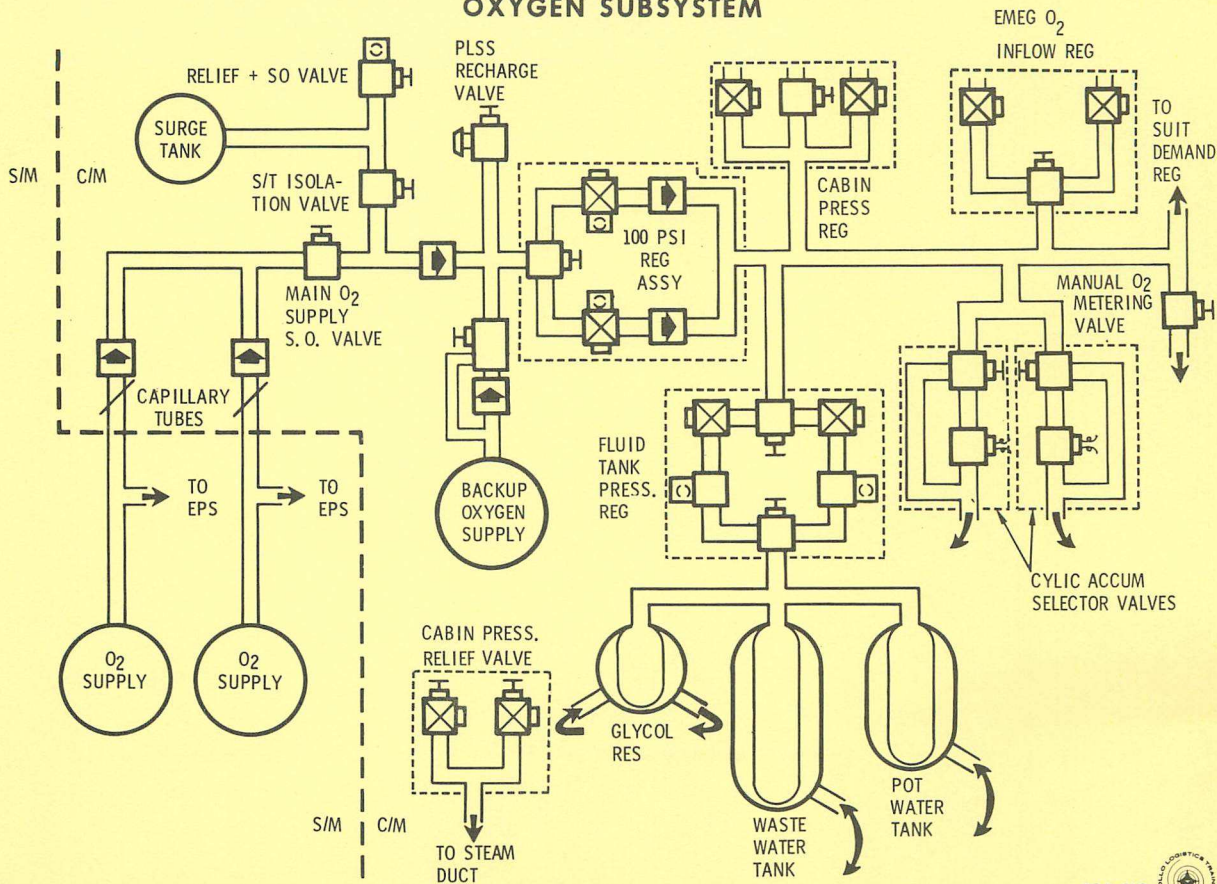
ENVIRONMENTAL CONTROL SYSTEM

FUNCTIONAL BLOCK DIAGRAM

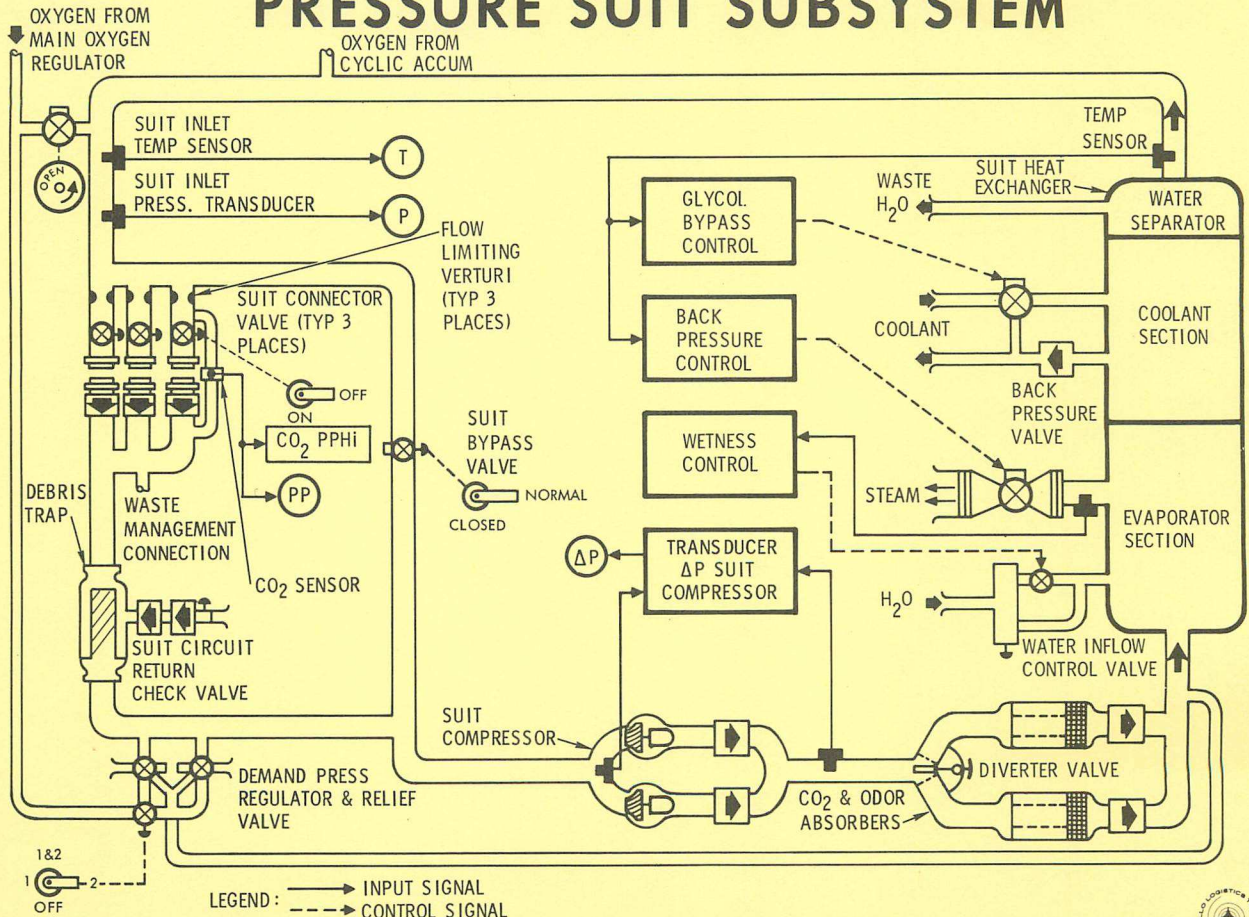


ENVIRONMENTAL CONTROL SYSTEM

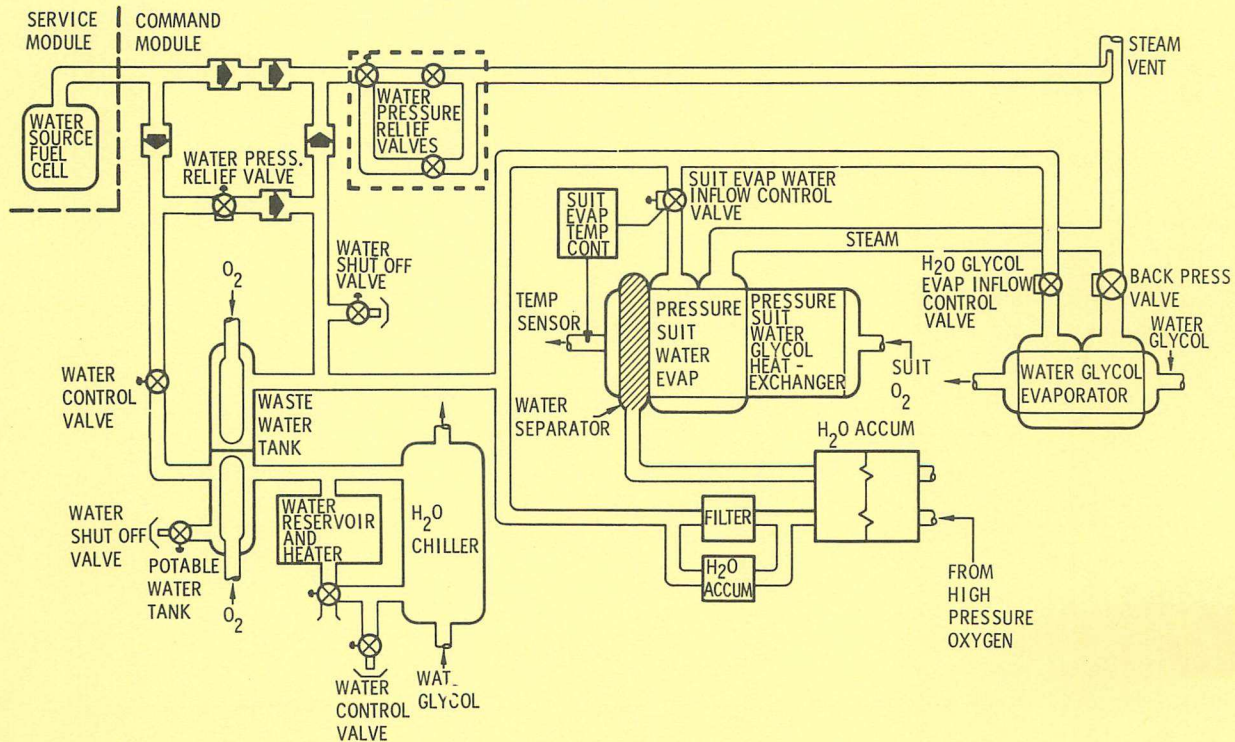
OXYGEN SUBSYSTEM



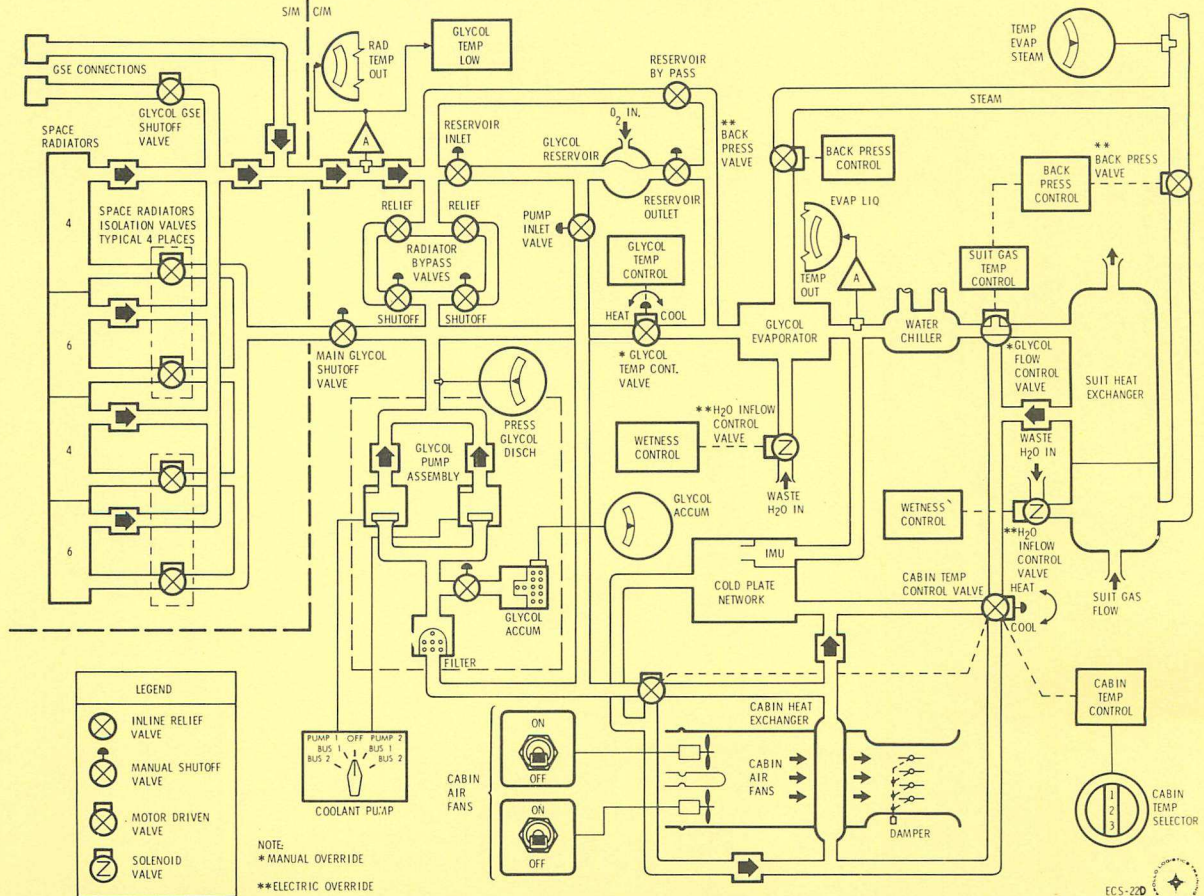
PRESSURE SUIT SUBSYSTEM



ENVIRONMENTAL CONTROL SYSTEM WATER SUBSYSTEM

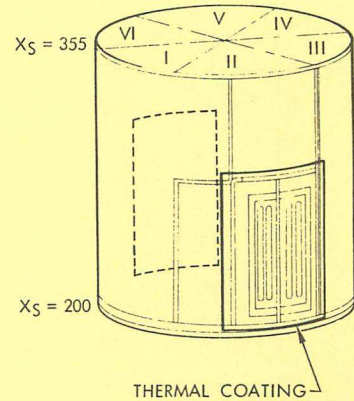
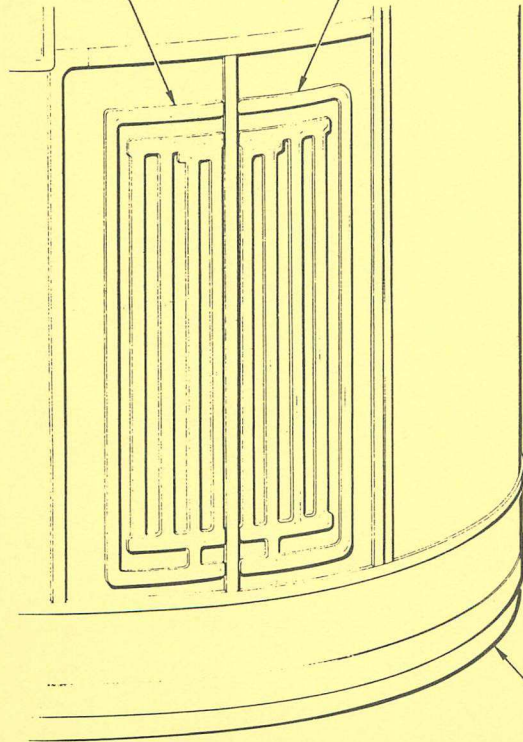


WATER GLYCOL SYSTEM



RADIATOR INSTALLATION

RADIATOR-L.H. RADIATOR-R.H.



RADIATOR - SECTION 2

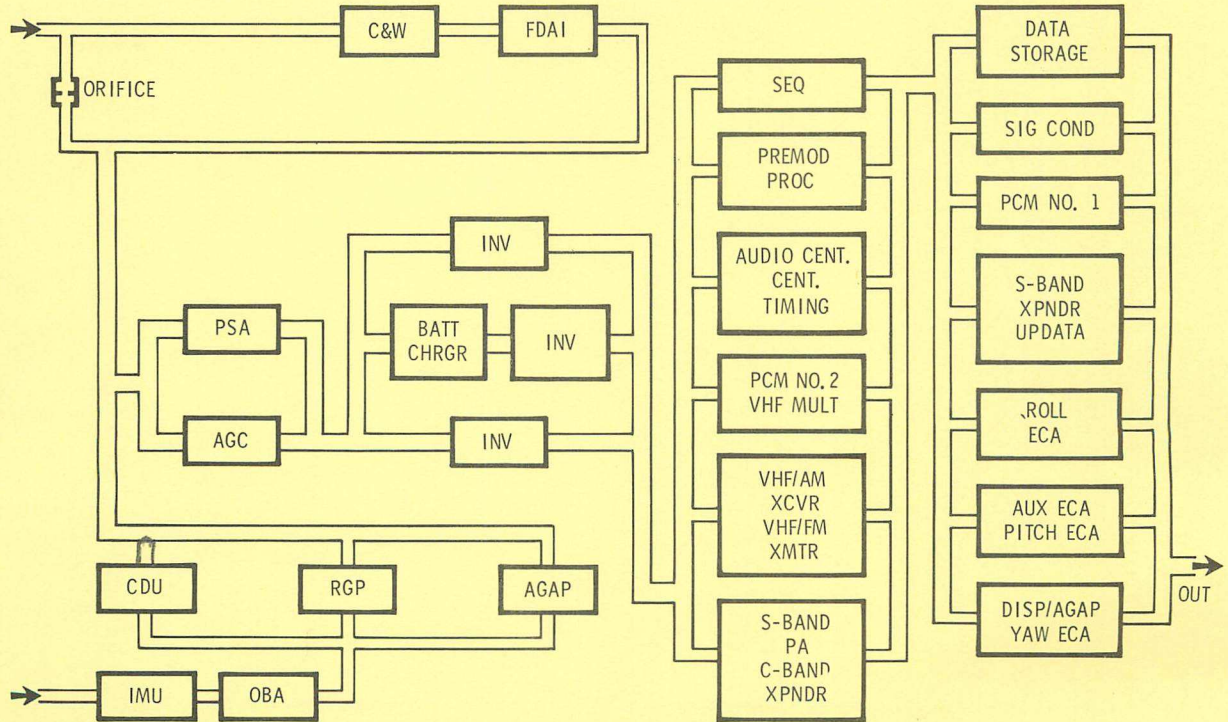
AFT
BULKHEAD

RADIATORS 60 SQ FT LUNAR MISSION

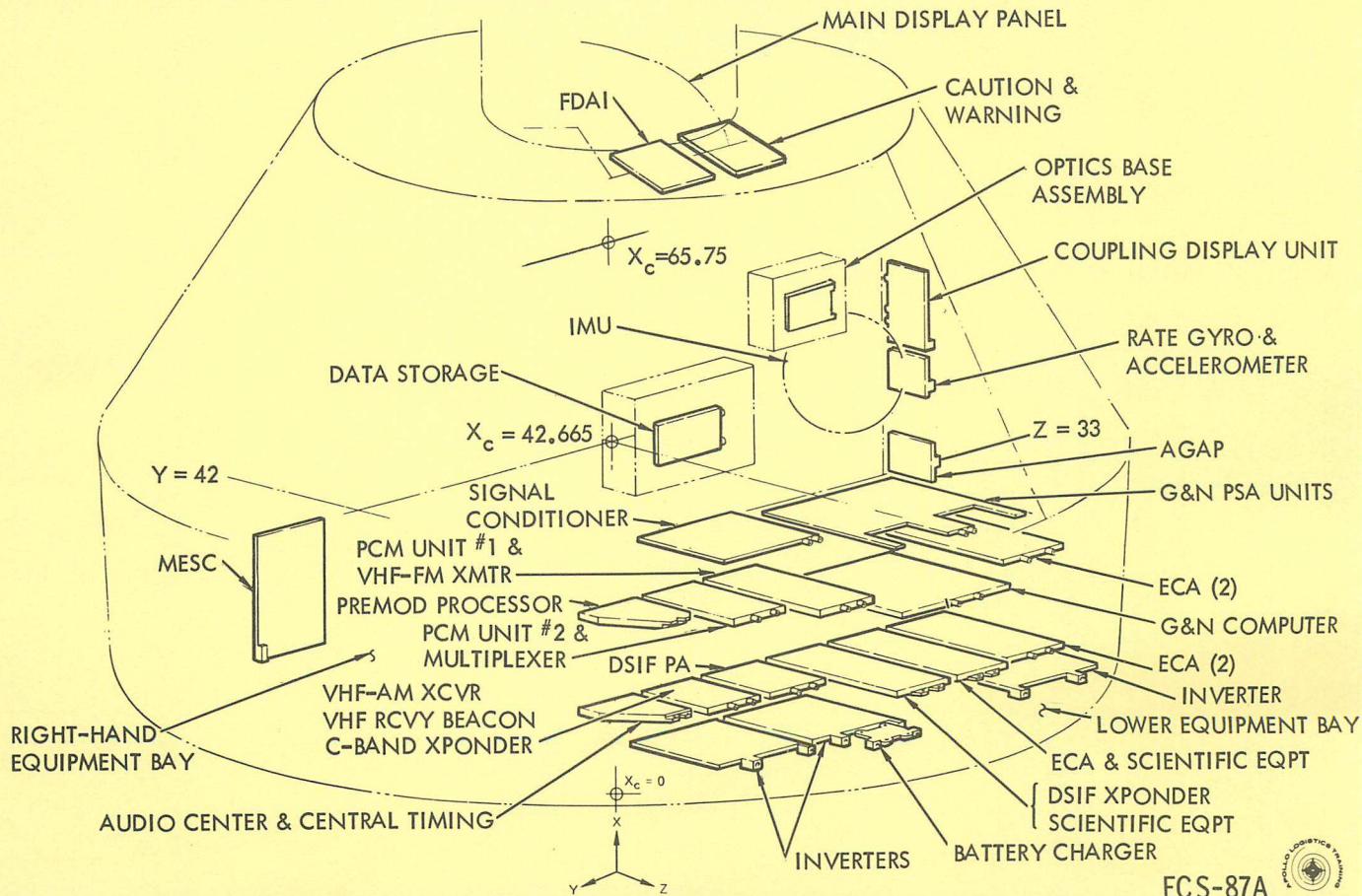
ECS-88



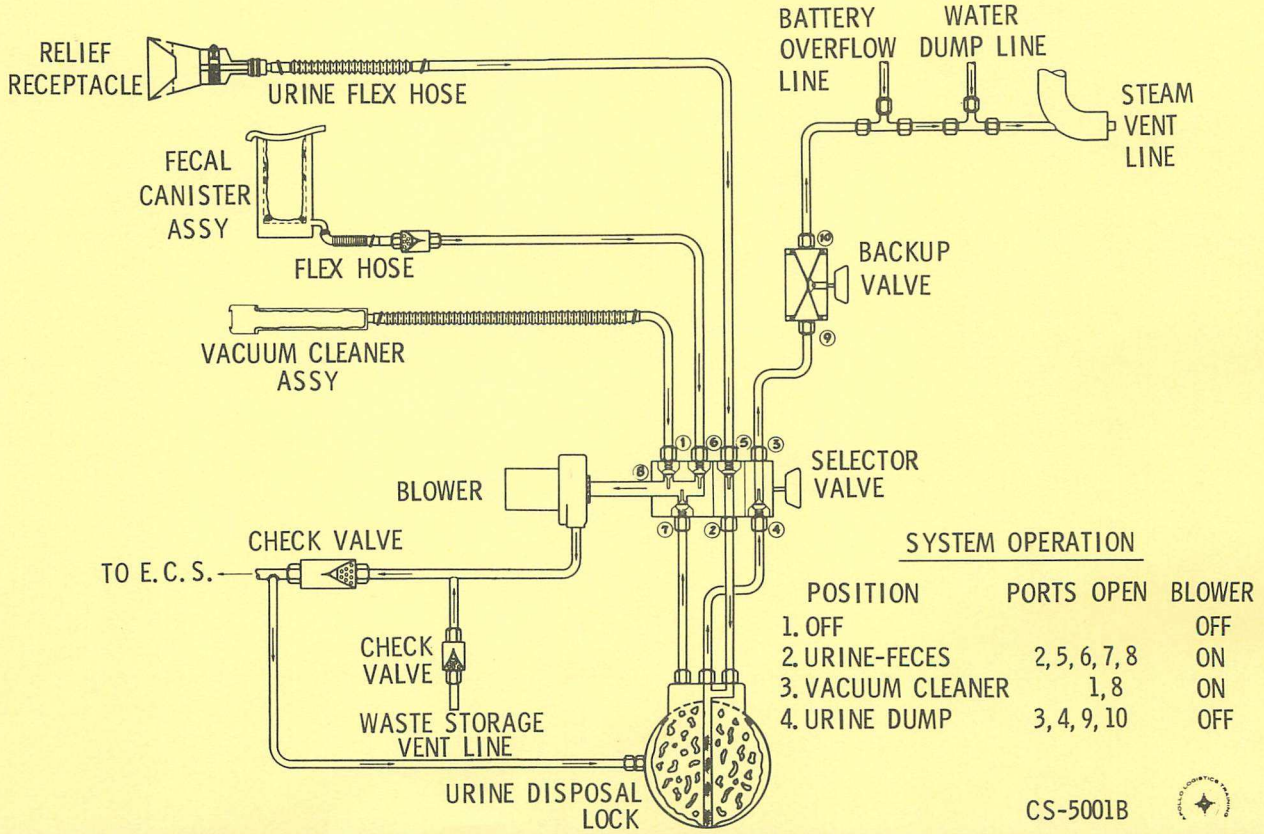
COLDPLATE NETWORK



COMMAND MODULE COLDPLATE PROVISIONS



WASTE MANAGEMENT SYSTEM



SYSTEM OPERATION

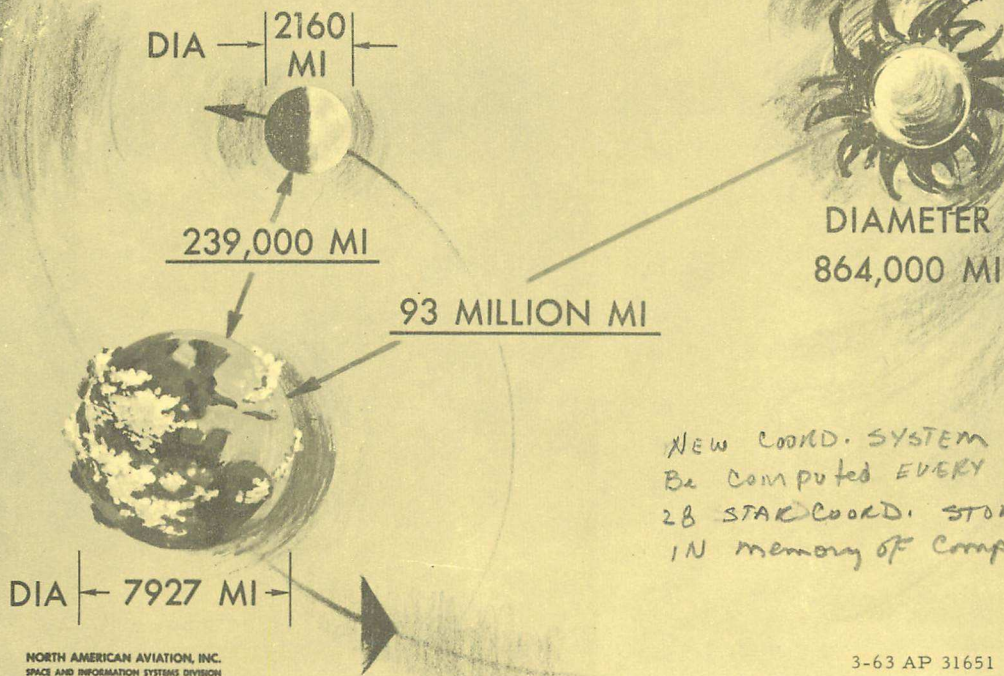
POSITION	PORTS OPEN	BLOWER
1. OFF		OFF
2. URINE-FECES	2, 5, 6, 7, 8	ON
3. VACUUM CLEANER	1, 8	ON
4. URINE DUMP	3, 4, 9, 10	OFF

CS-5001B



GUIDANCE & CONTROL SYSTEM

BASIC CONSIDERATIONS



VELOCITY REQUIREMENTS

ESCAPE VELOCITY

36,700 FT/SEC

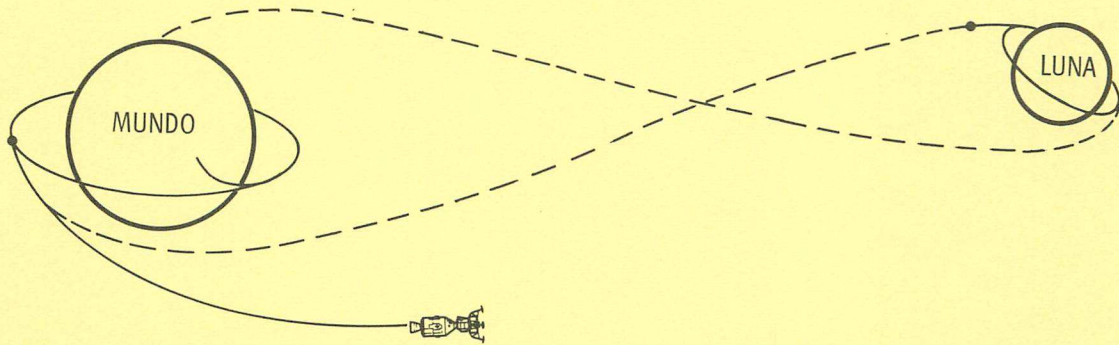


8,400 FT/SEC

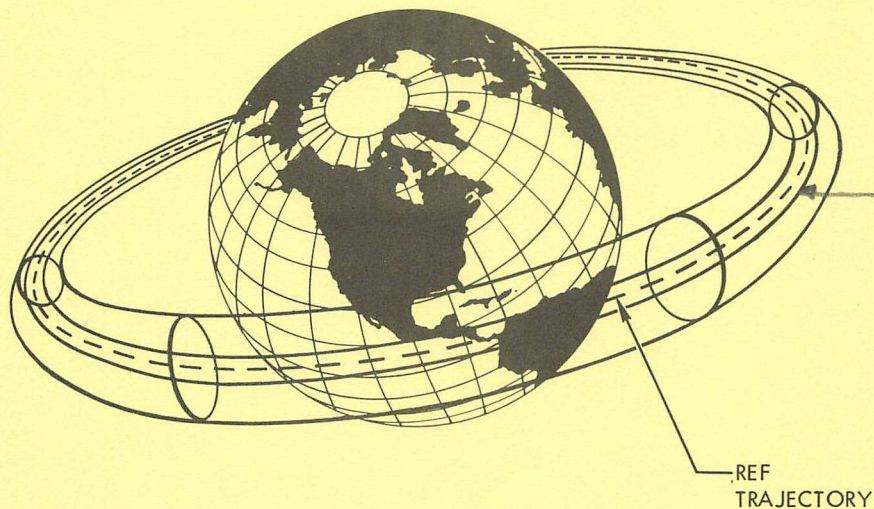
25,000 FT/SEC - ORBIT - 5280 FT/SEC

6 - RELATIVE GRAVITY - 1

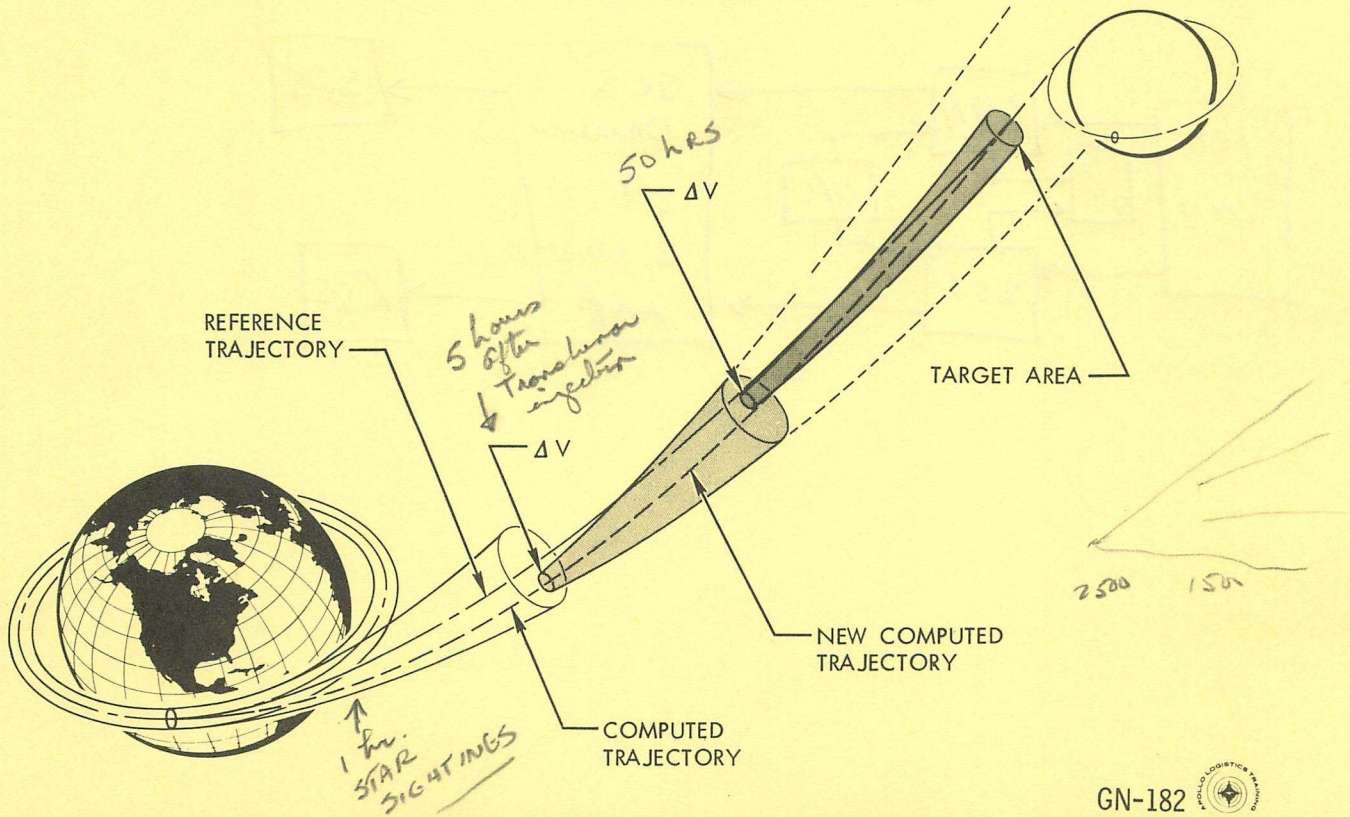
GUIDANCE & NAVIGATION REFERENCE TRAJECTORIES



EARTH ORBIT POSITION & TRAJECTORY DETERMINATION



MIDCOURSE POSITION & TRAJECTORY DETERMINATION



GUIDANCE & CONTROL FUNCTIONS

G&N

- POSITION
- TRAJECTORY
- VELOCITY
- ATTITUDE

SCS

- STABILIZATION
- ROTATION
- TRANSLATION
- THRUST VECTOR

SPS

- MAJOR ΔV 'S

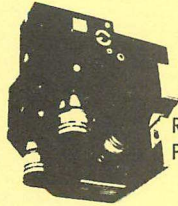
RCS

- ROTATION
- TRANSLATION

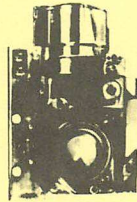


SCS HARDWARE

SENSORS



RATE GYRO
PACKAGE

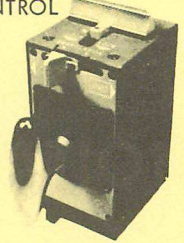
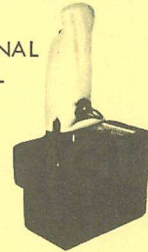


ATTITUDE
GYRO
ACCELEROMETER
PACKAGE

HAND CONTROLLERS

TRANSLATIONAL CONTROL

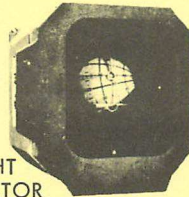
3 AXIS
ROTATIONAL
CONTROL



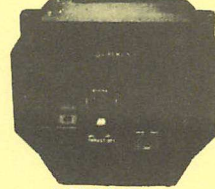
CONTROLS & DISPLAYS



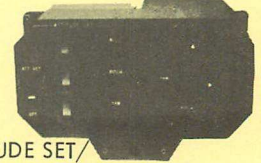
SCS CONTROL PANEL



FLIGHT
DIRECTOR
ATTITUDE INDICATOR

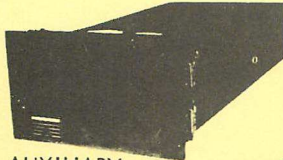


DELTA V
INDICATOR

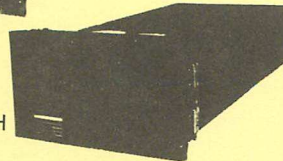


ATTITUDE SET/
GIMBAL POSITION
INDICATOR

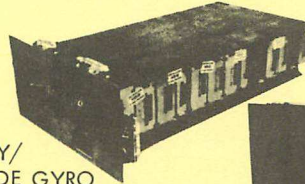
ELECTRONIC CONTROL ASSEMBLIES



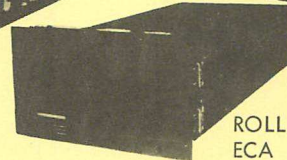
AUXILIARY
ECA



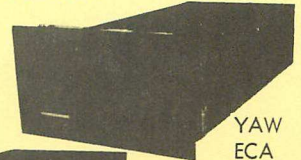
PITCH
ECA



DISPLAY/
ATTITUDE GYRO
ACCELEROMETER
PACKAGE ECA



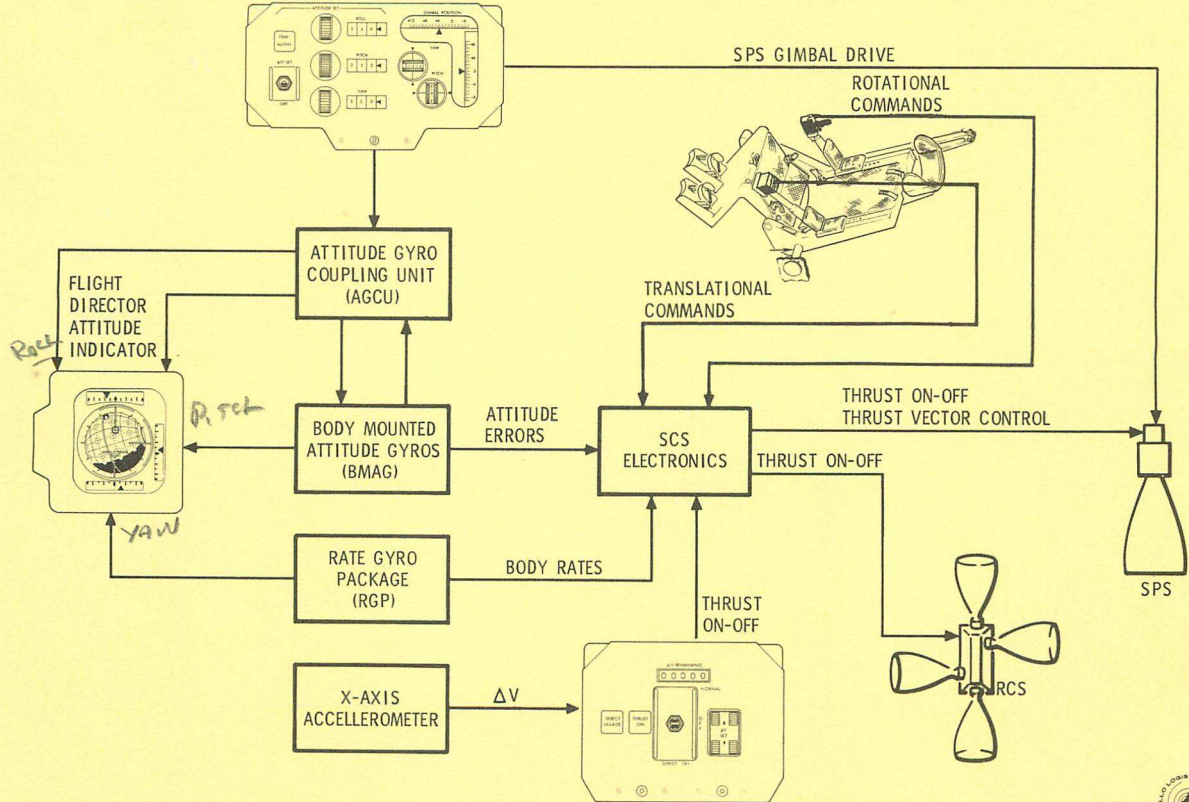
ROLL
ECA



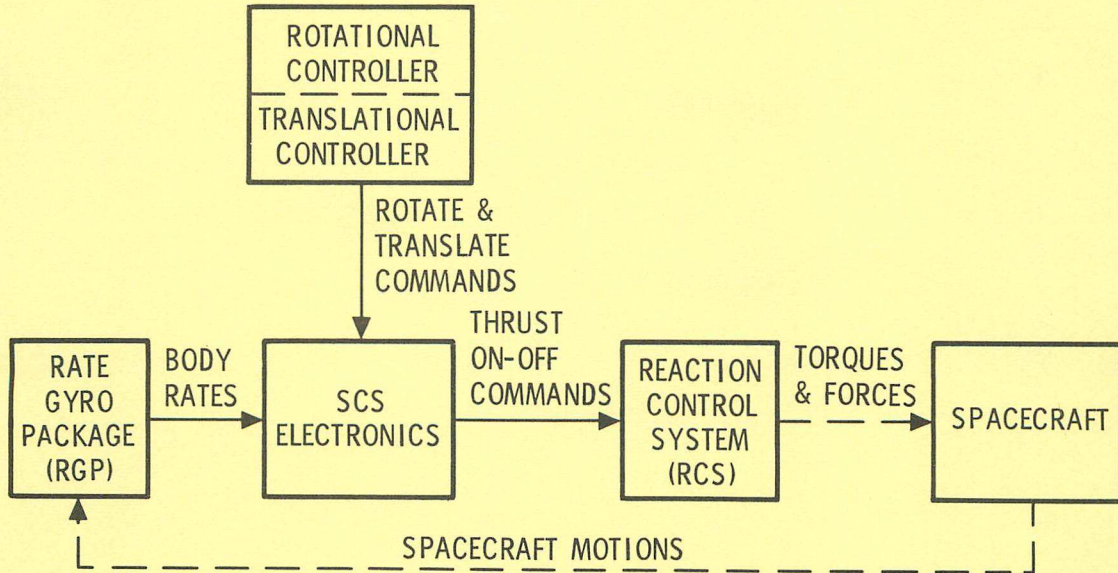
YAW
ECA



STABILIZATION & CONTROL SYSTEM

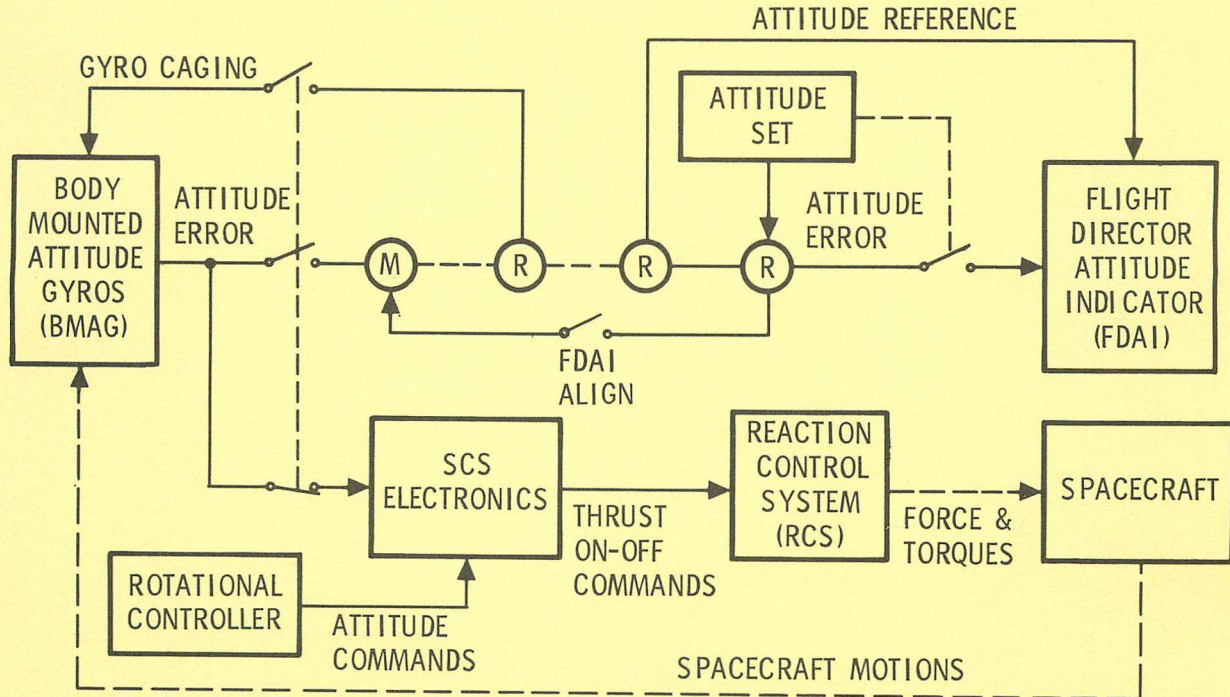


RATE STABILIZATION

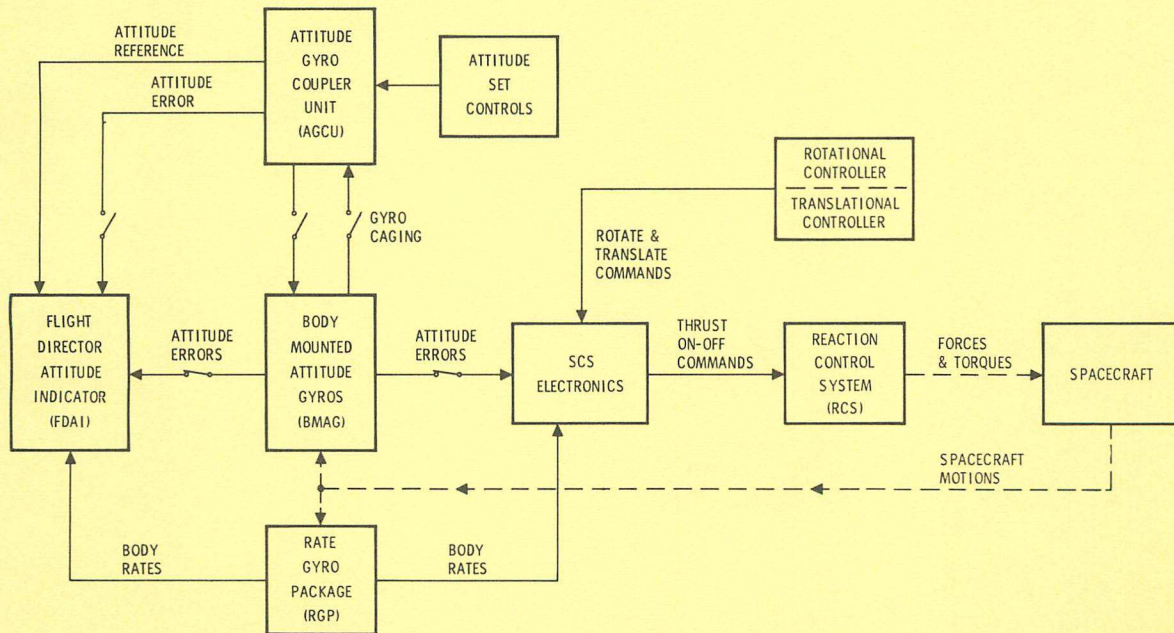


ATTITUDE REFERENCE (SCS)

MANEUVER FUNCTION (AGCU)



ATTITUDE REFERENCE (SCS)



ATTITUDE CONTROL (SCS)

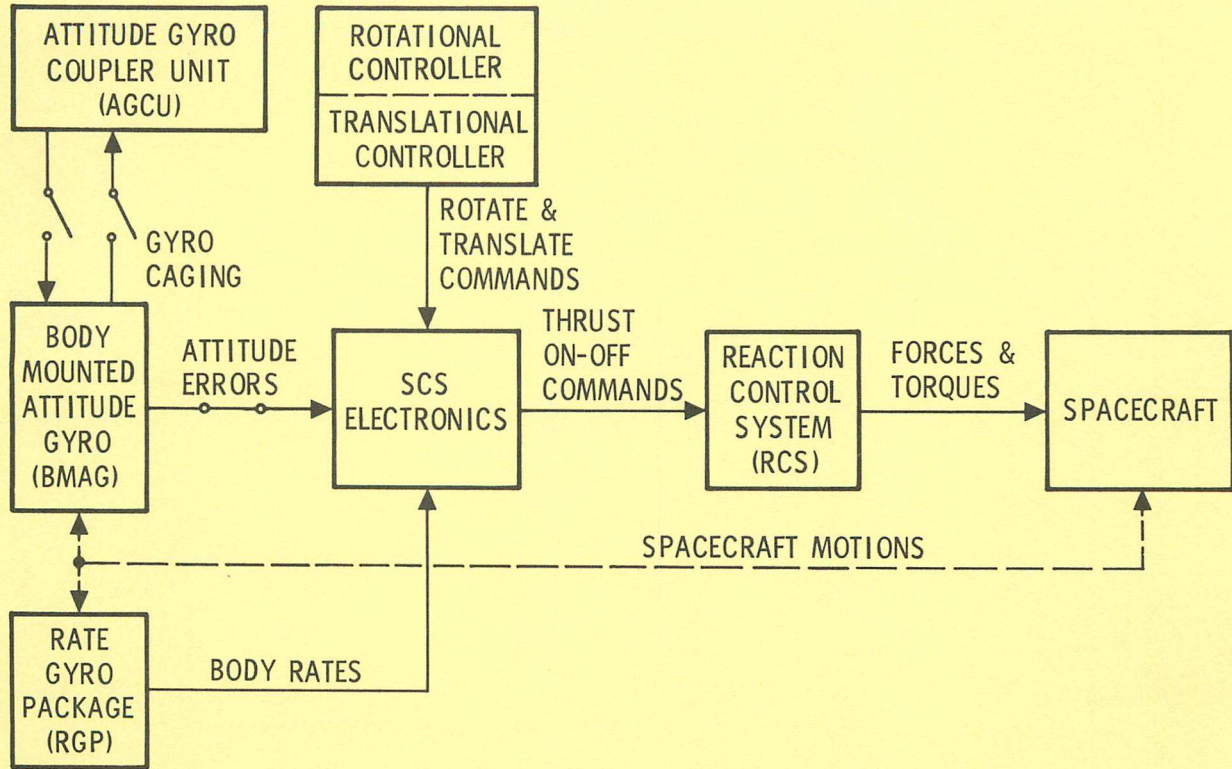
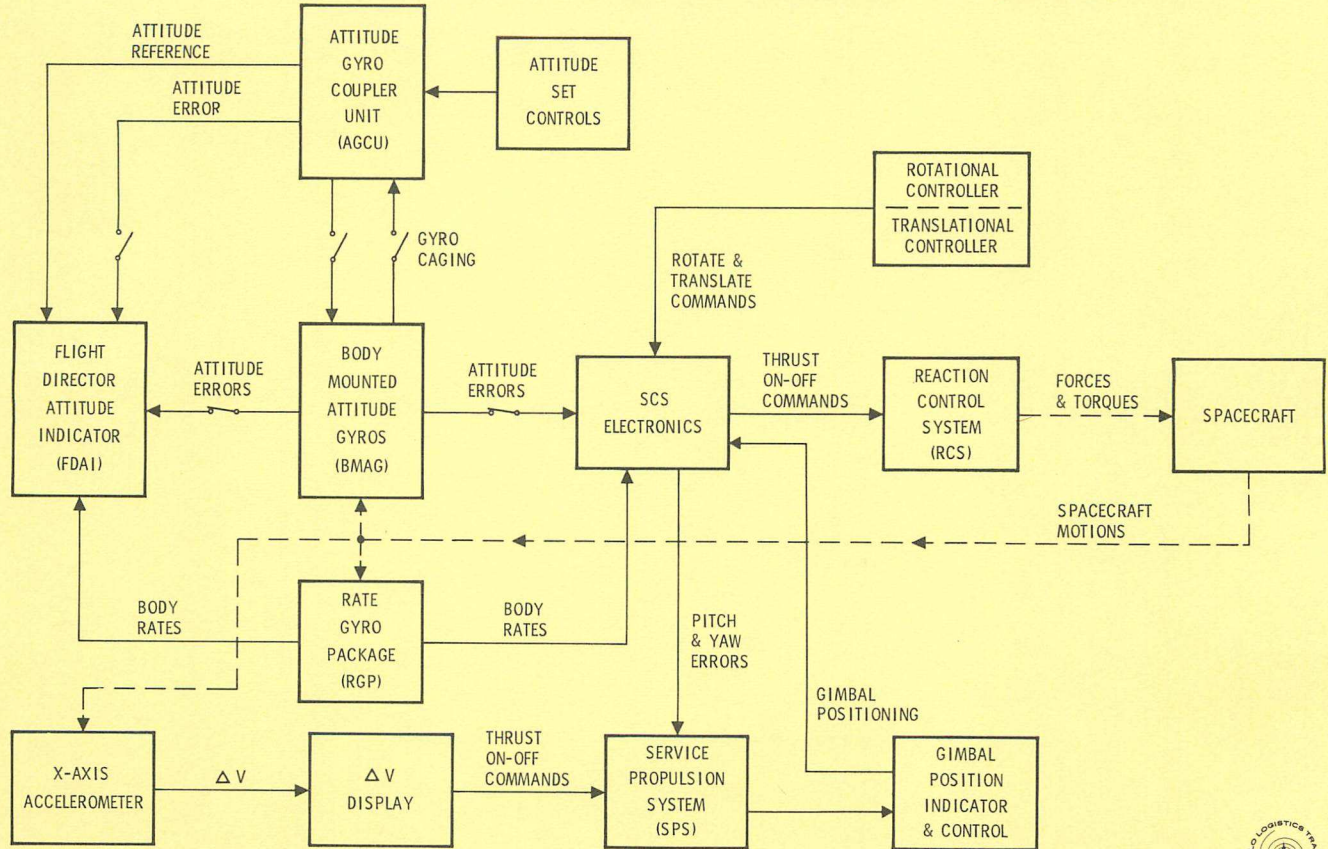


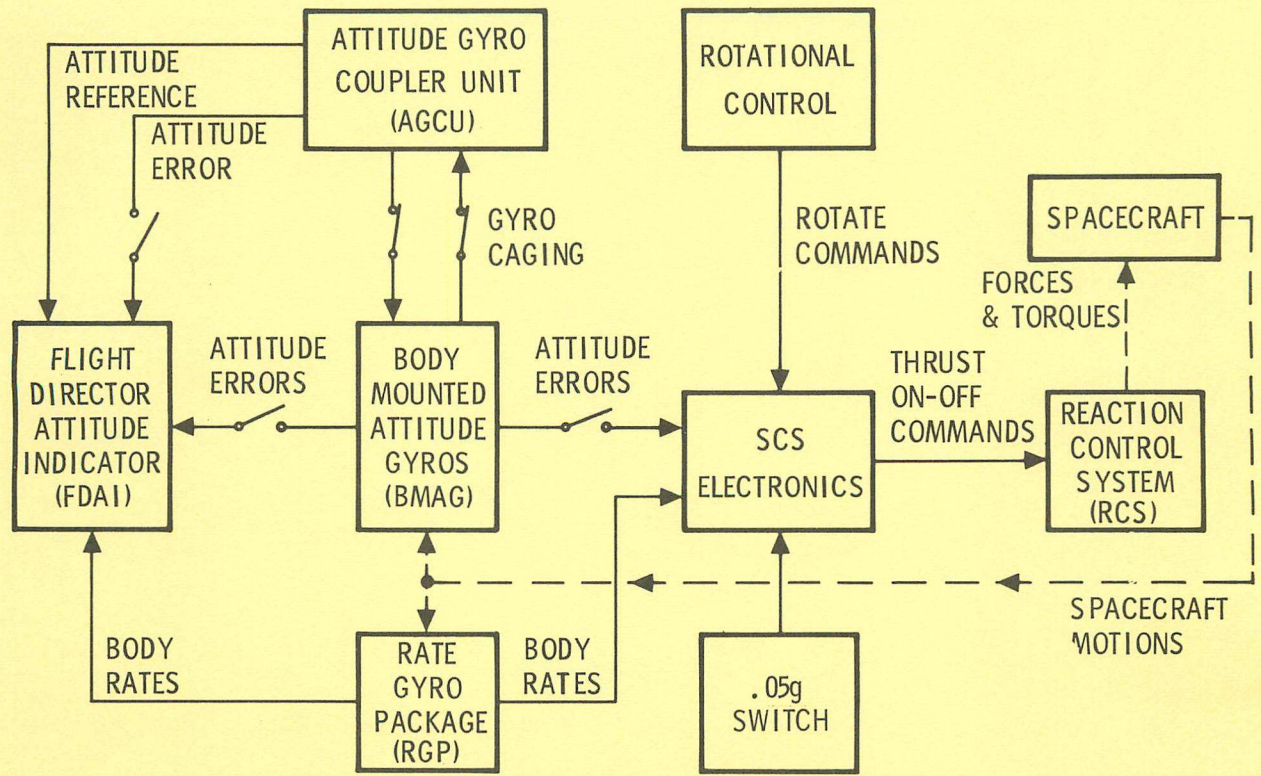
Figure 4-2



THRUST VECTOR CONTROL (SCS)

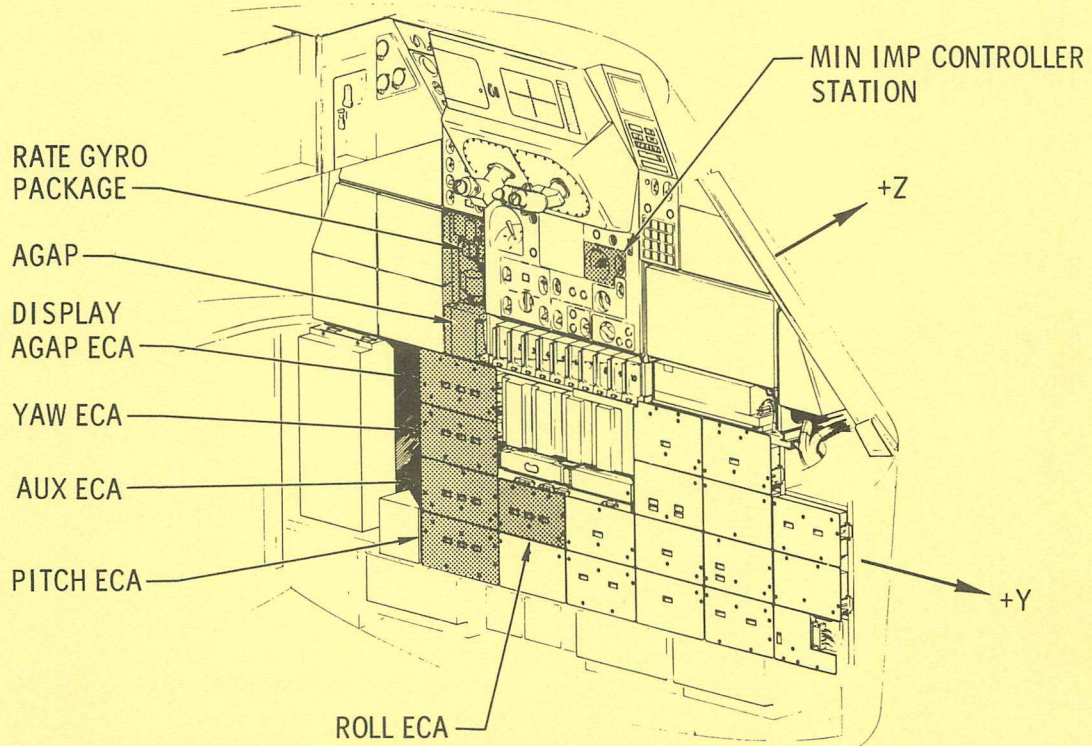


ENTRY (SCS)

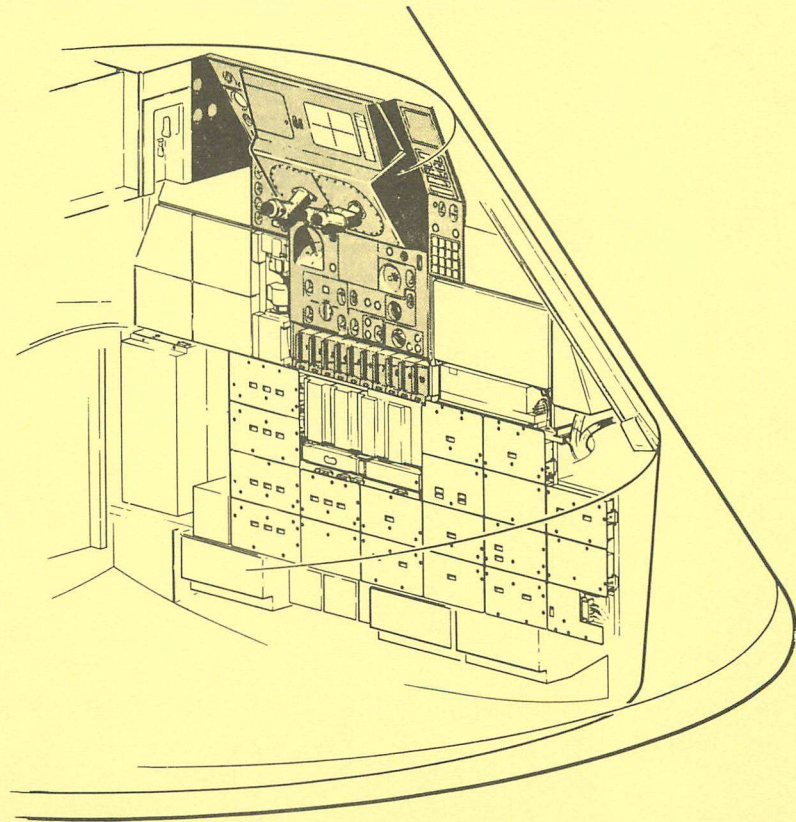


LOWER EQUIPMENT BAY

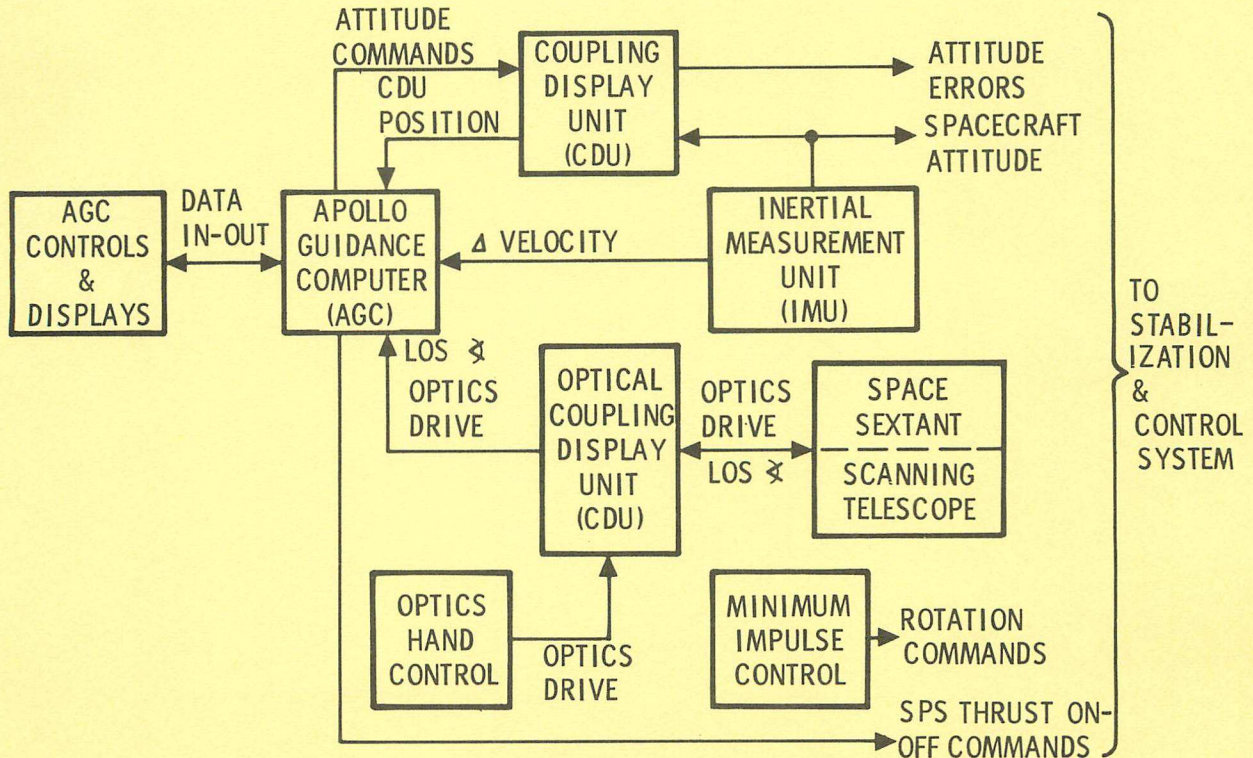
SCS FUNCTIONS



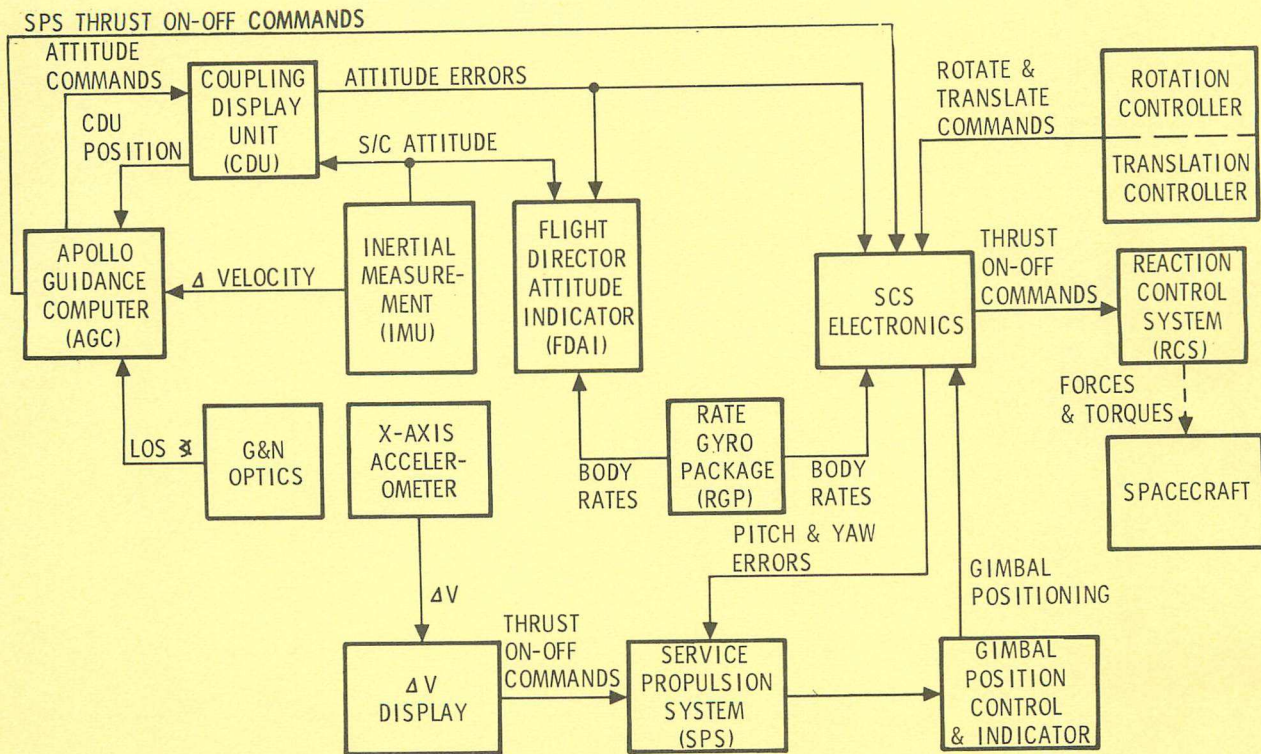
GUIDANCE & NAVIGATION SYSTEM



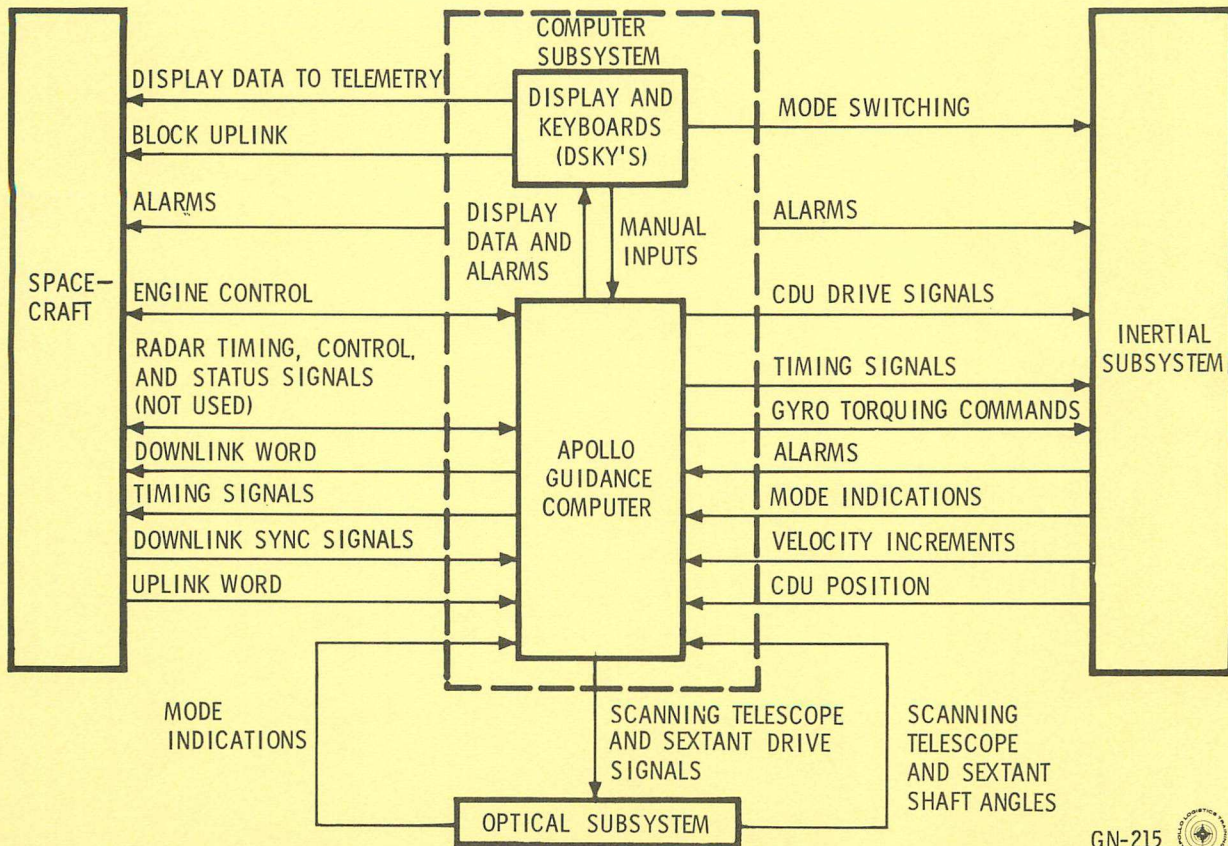
GUIDANCE & NAVIGATION SYSTEM



G&N-SCS INTERFACE



COMPUTER SUBSYSTEM, GENERAL INTERFACE

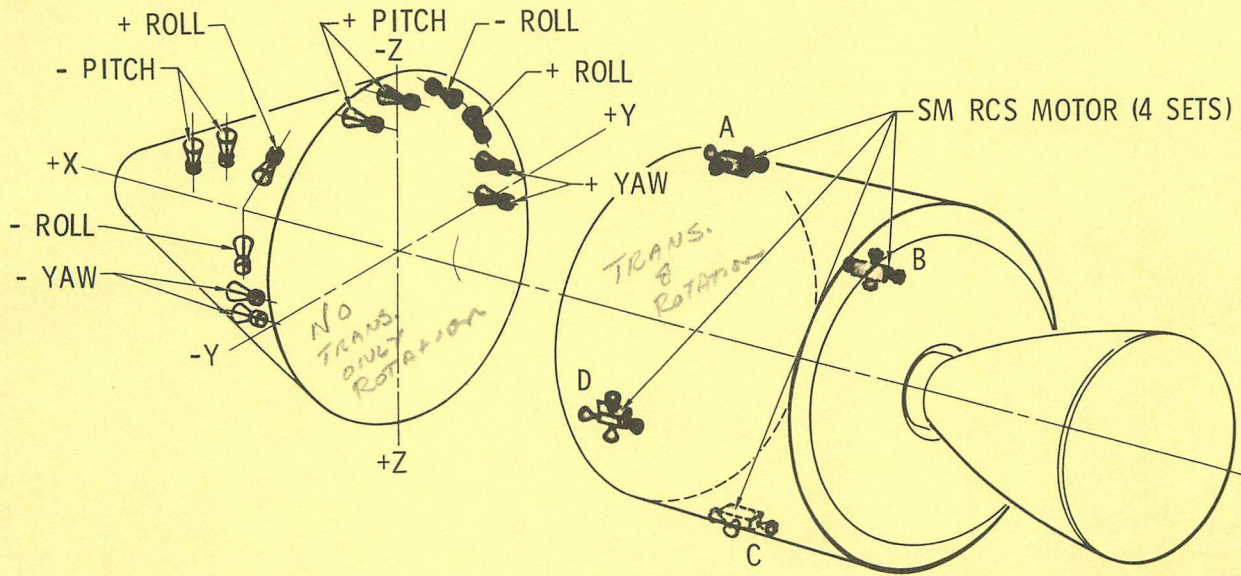


PROPULSION SYSTEMS

FAM-4000



ENGINE LOCATION



REACTION CONTROL SYSTEM

S/M REACTION CONTROL

- 4 INDEPENDENT SUBSYSTEMS
- 16 ENGINES TOTAL
- ENGINE THRUST: 100 LB
- PROPELLANT: HYPERGOLIC
 - FUEL: 50/50 UDMH/HYDRAZINE
 - OXIDIZER: NITROGEN TETROXIDE (N_2O_4)

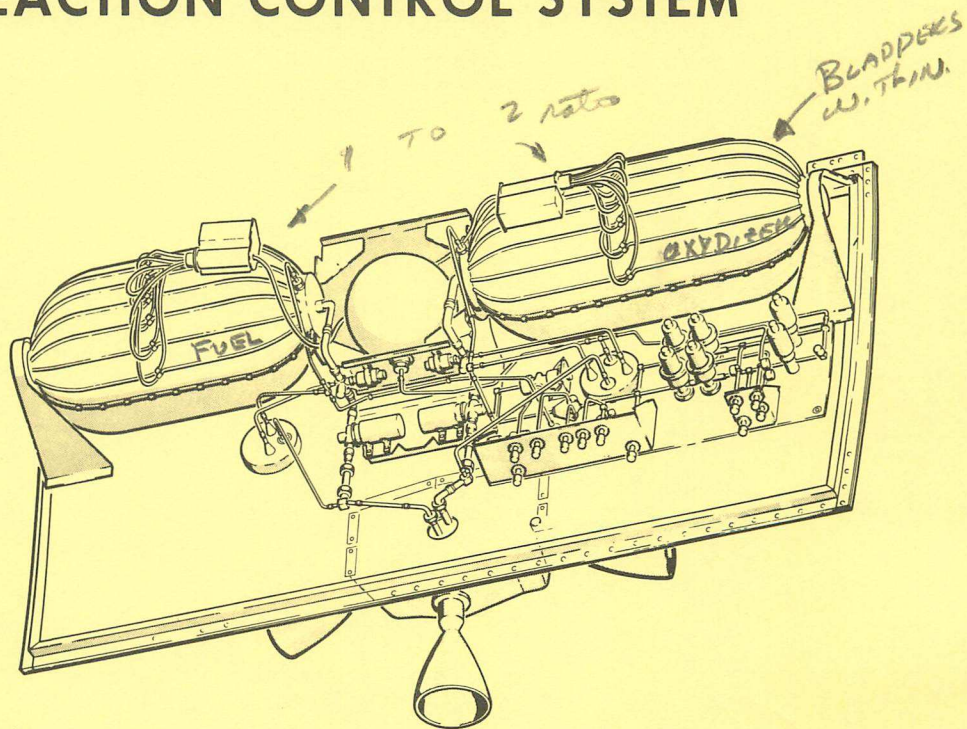
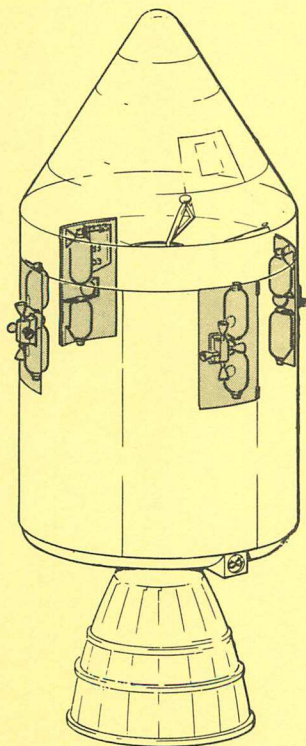
C/M REACTION CONTROL

- 2 INDEPENDENT SUBSYSTEMS
- 12 ENGINES TOTAL
- ENGINE THRUST: 93 LB
- PROPELLANT: HYPERGOLIC
 - FUEL: MONOMETHYL-HYDRAZINE (MMH)
 - OXIDIZER: NITROGEN TETROXIDE (N_2O_4)

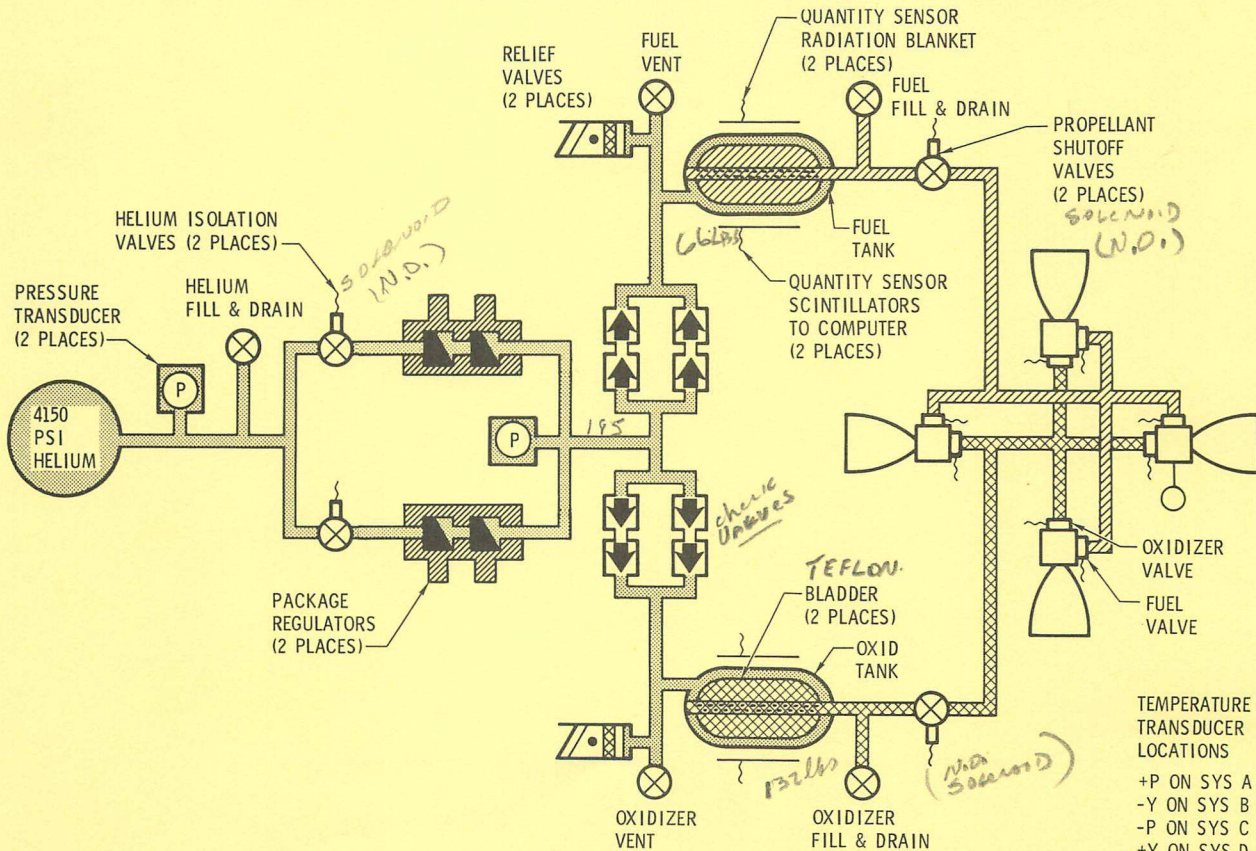
} Less Temp. Control
than S/M.



S/M REACTION CONTROL SYSTEM



S/M REACTION CONTROL SYSTEM

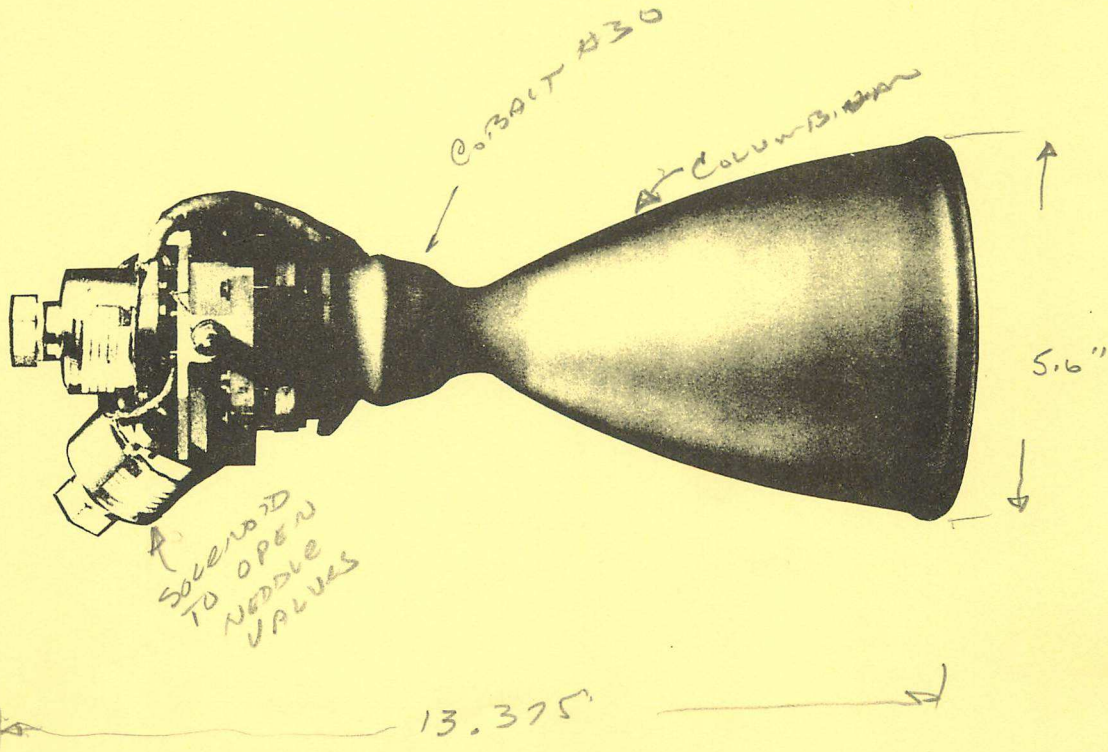


TEMPERATURE
TRANSDUCER
LOCATIONS

- +P ON SYS A
- Y ON SYS B
- P ON SYS C
- +Y ON SYS D



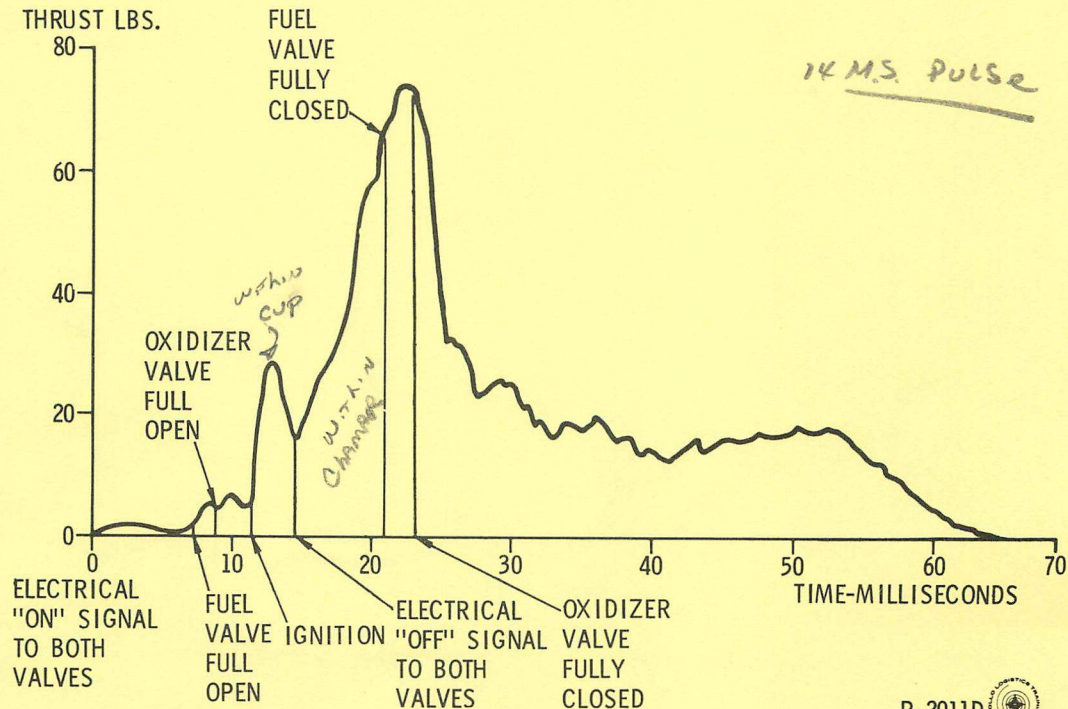
MA-109XAA ROCKET ENGINE



S/M RCS ENGINE-MINIMUM TOTAL IMPULSE

(14 MILLISECOND MINIMUM ELECTRICAL ON SIGNAL)

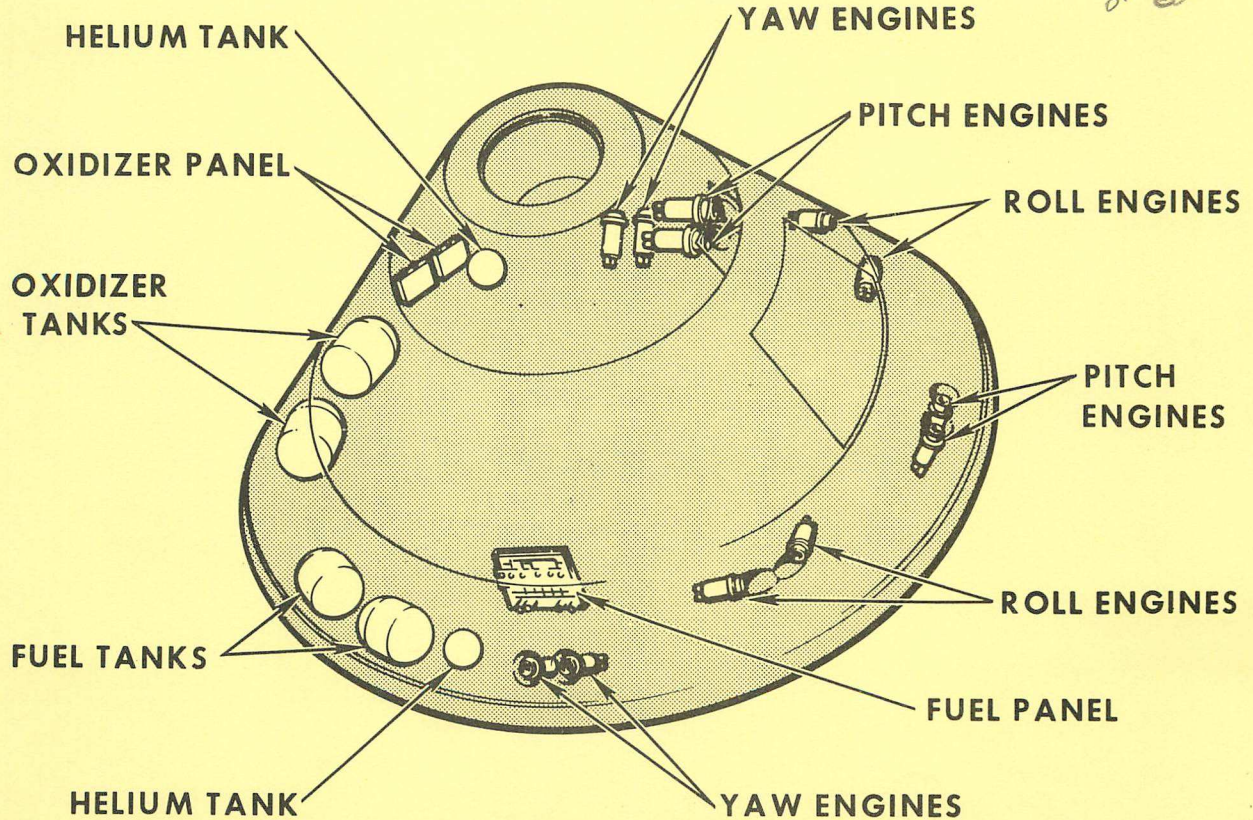
(SCS 18 + - 4 MILLISECOND)



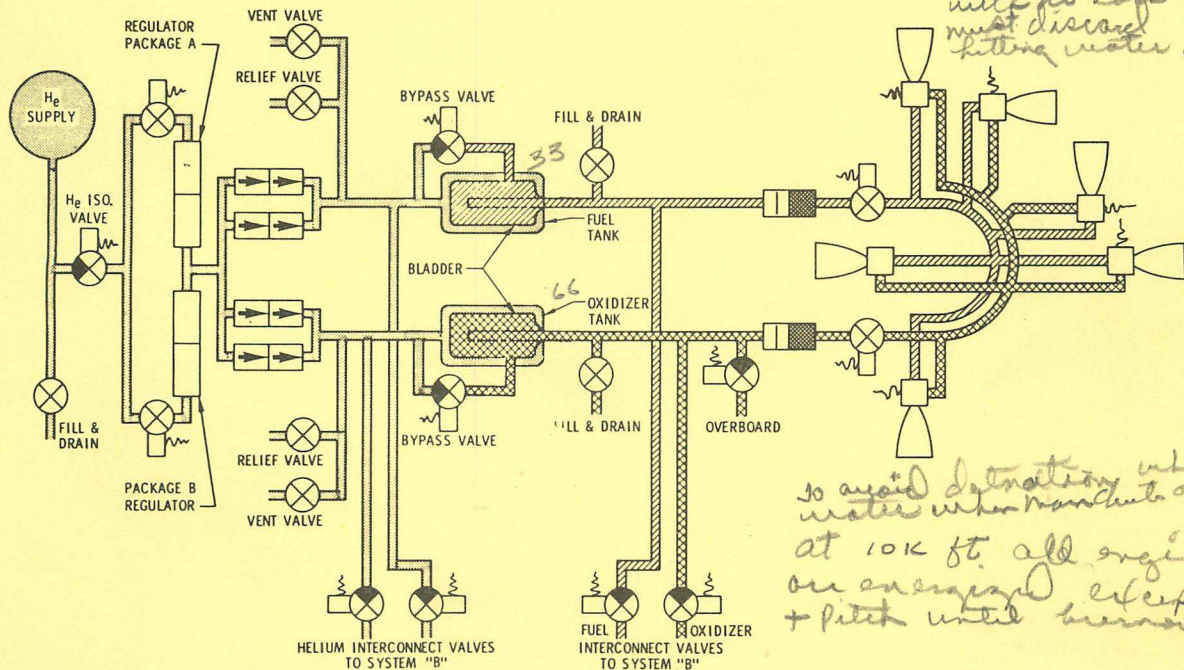
C/M REACTION CONTROL SYSTEM

35SD10792

oblique cooled



C/M REACTION CONTROL SYSTEM



must maintain system throughout mission with no leaks then must discard before hitting water.

to avoid detonation when hitting water when manifold opens at 10K ft. all engines on overboard except + pitch until burnout.

If abort takes place in first 42 sec the abort signal opens overboard valve dumping oxidizer then when chute opens the pilot lets fuel out through engines.



SERVICE PROPULSION SYSTEM

ENGINE THRUST: 21,900 LB

PROPELLANT FEED

2 FUEL TANKS

2 OXIDIZER TANKS

2 HELIUM STORAGE TANKS

PROPELLANTS: HYPERGOLIC

FUEL: 50/50 UDMH/HYDRAZINE

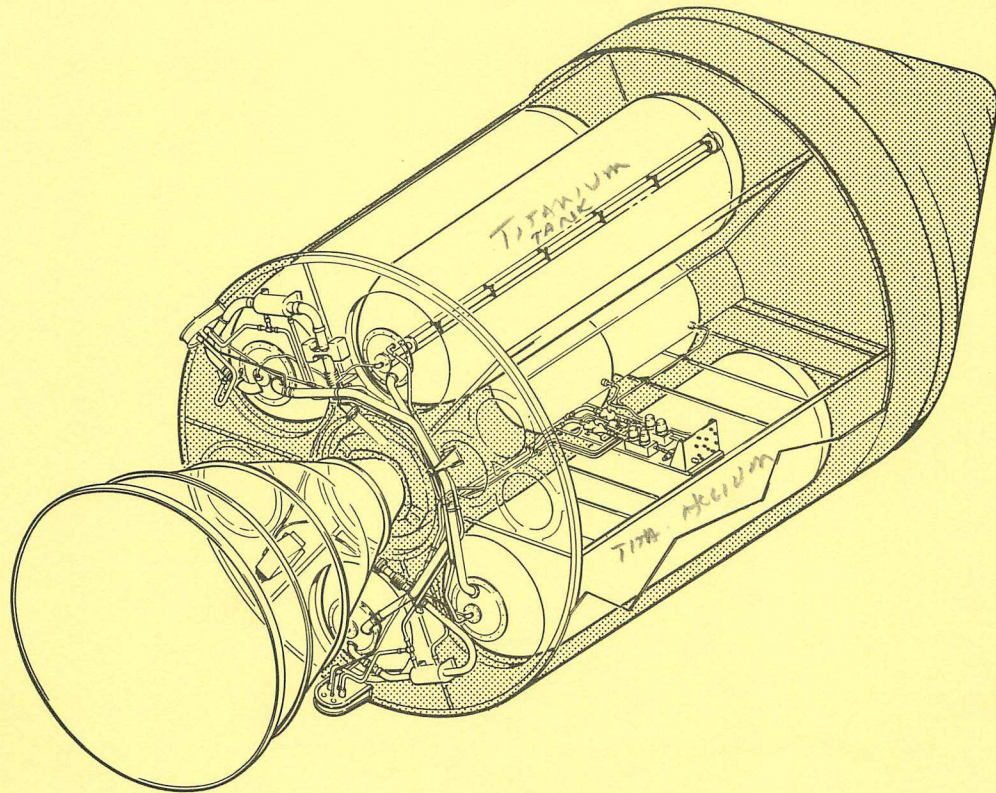
OXIDIZER: NITROGEN TETROXIDE (N₂ O₄)

ENGINE GIMBALED

PROPELLANT UTILIZATION



SERVICE PROPULSION SYSTEM

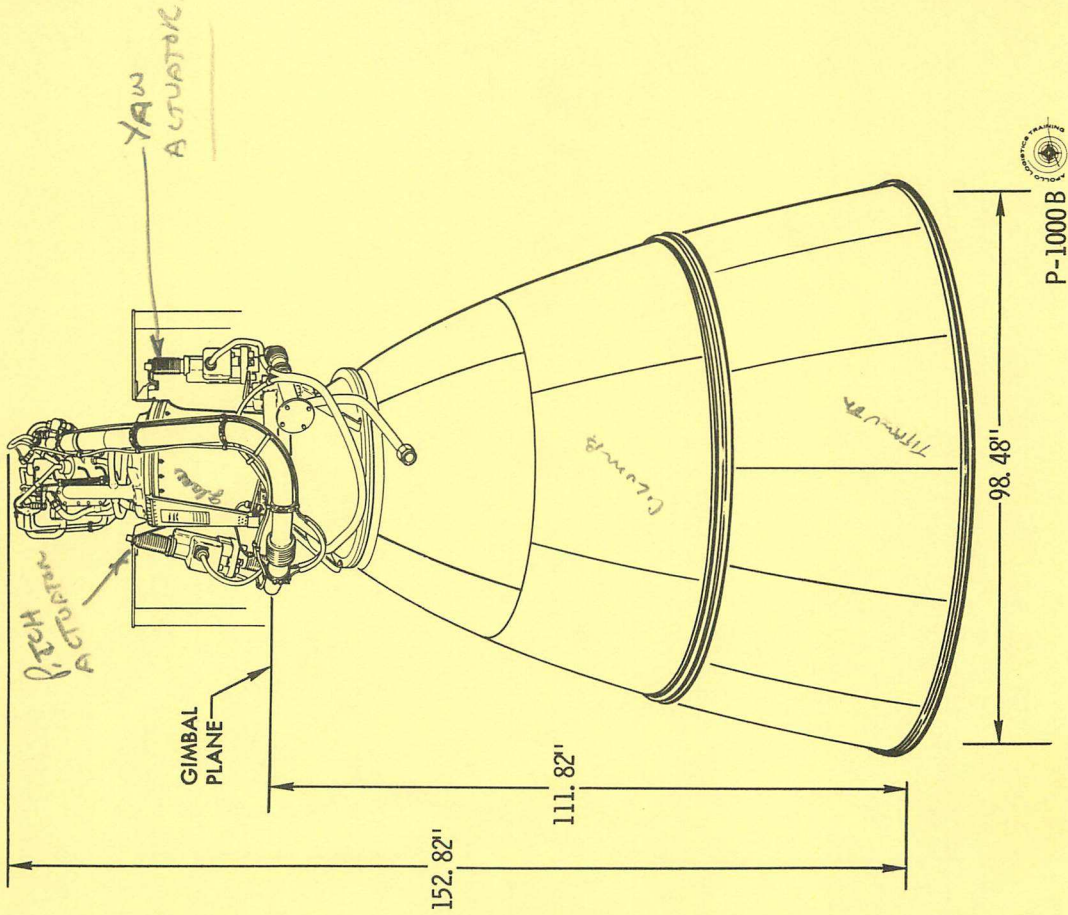


RD-1020

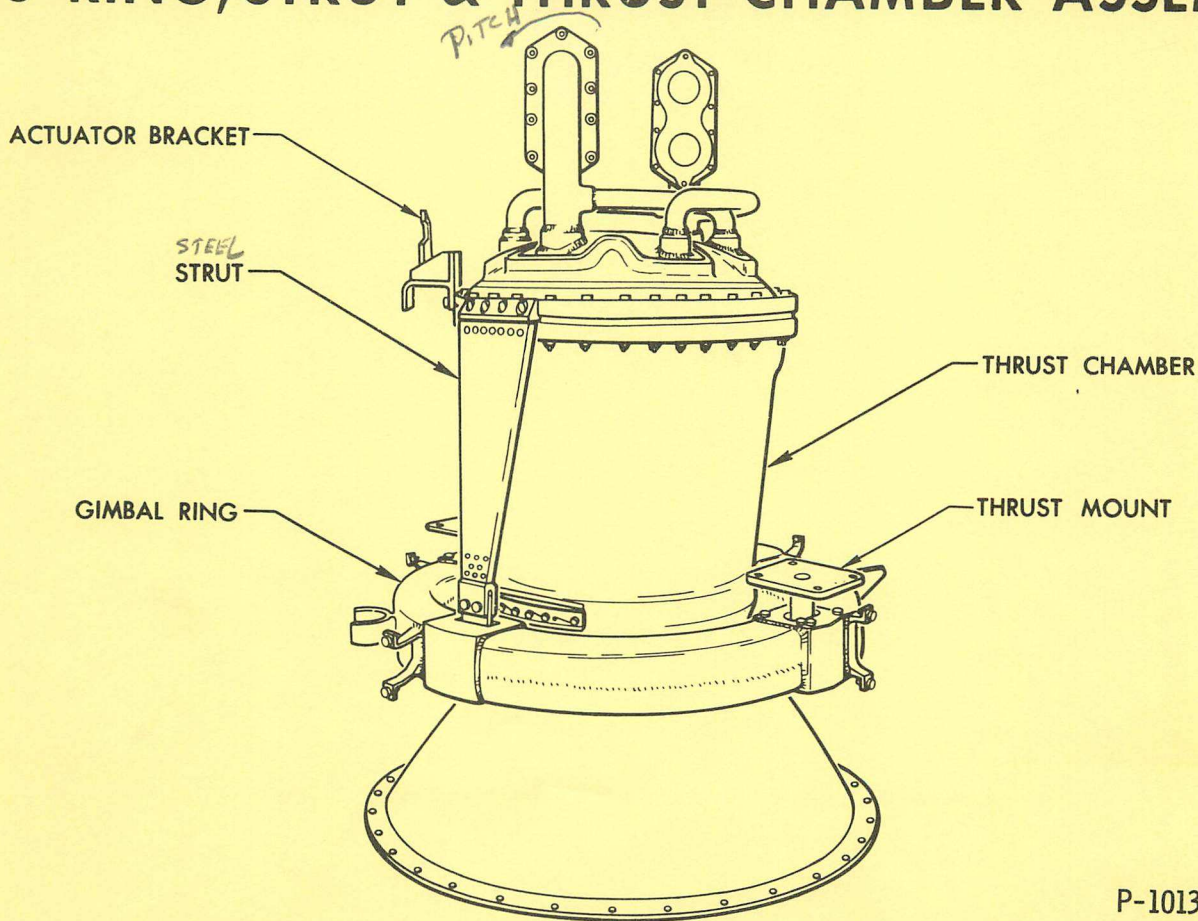


SPS ROCKET ENGINE

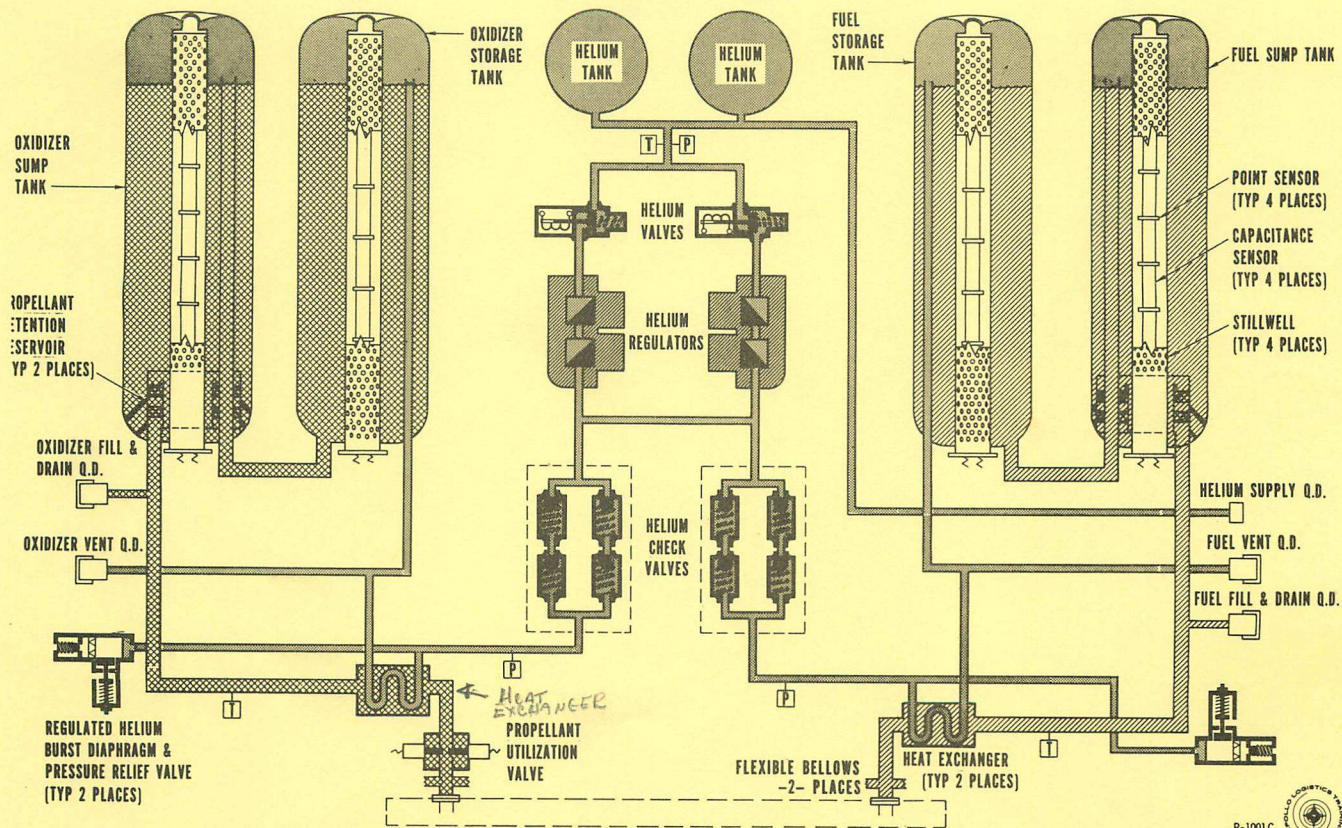
AJ10-137



SPS RING, STRUT & THRUST CHAMBER ASSEMBLY

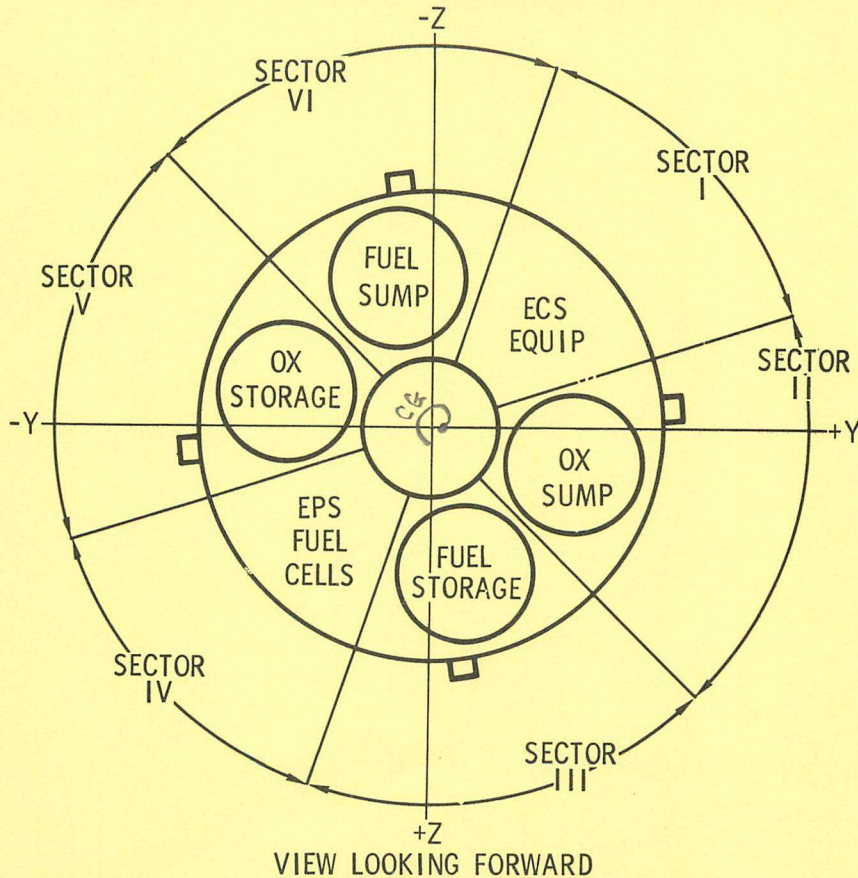


SERVICE PROPULSION SYSTEM PROPELLANT FEED



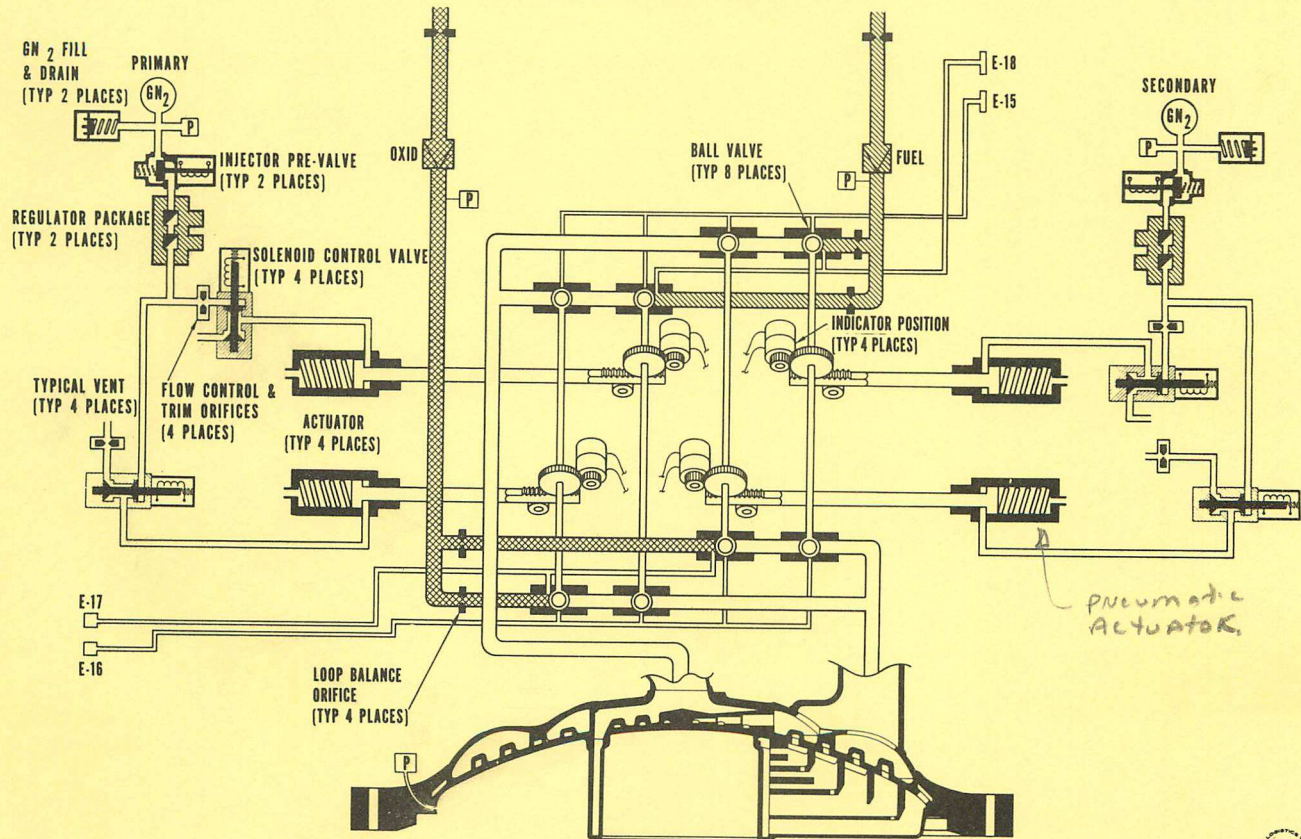
SERVICE MODULE SECTORS

NOTE: CG CASE ON
FUEL IS USED




PROPELLANT FLOW SCHEMATIC

SERVICE PROPULSION SYSTEM



TELECOMMUNICATIONS SYSTEM

NORTH AMERICAN AVIATION, INC.
SPACE AND INFORMATION SYSTEMS DIVISION

CD-1B 

COMMUNICATIONS SYSTEM

FUNCTIONAL EQUIPMENT GROUPS

RF EQUIPMENT GROUP

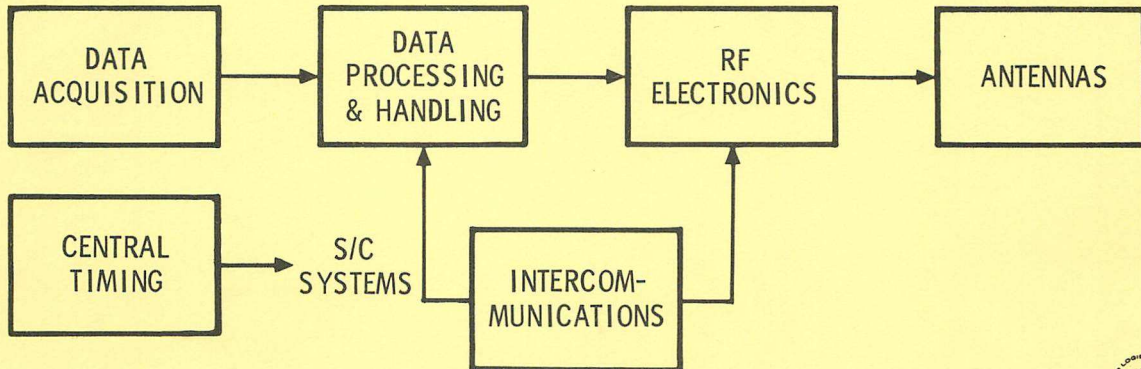
ANTENNA EQUIPMENT GROUP

INTERCOMMUNICATIONS EQUIPMENT GROUP

DATA EQUIPMENT GROUP

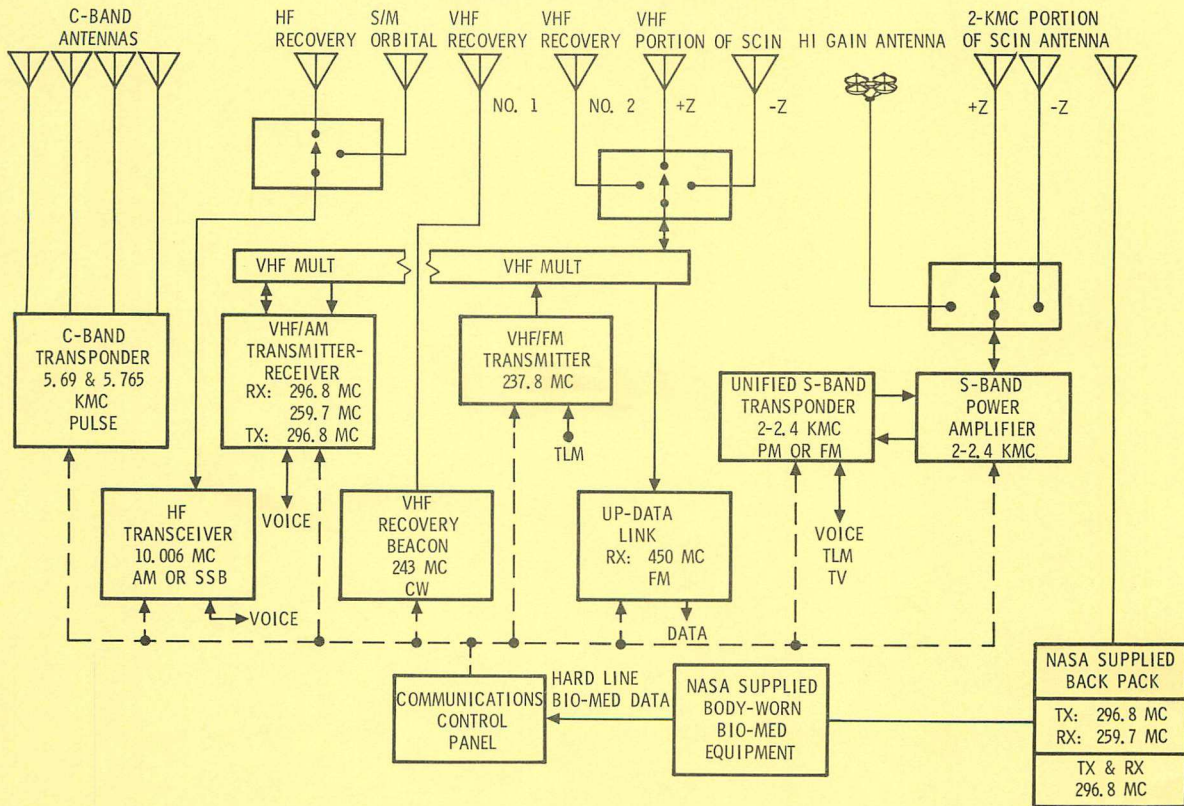
DATA ACQUISITION EQUIPMENT GROUP

CENTRAL TIMING EQUIPMENT GROUP

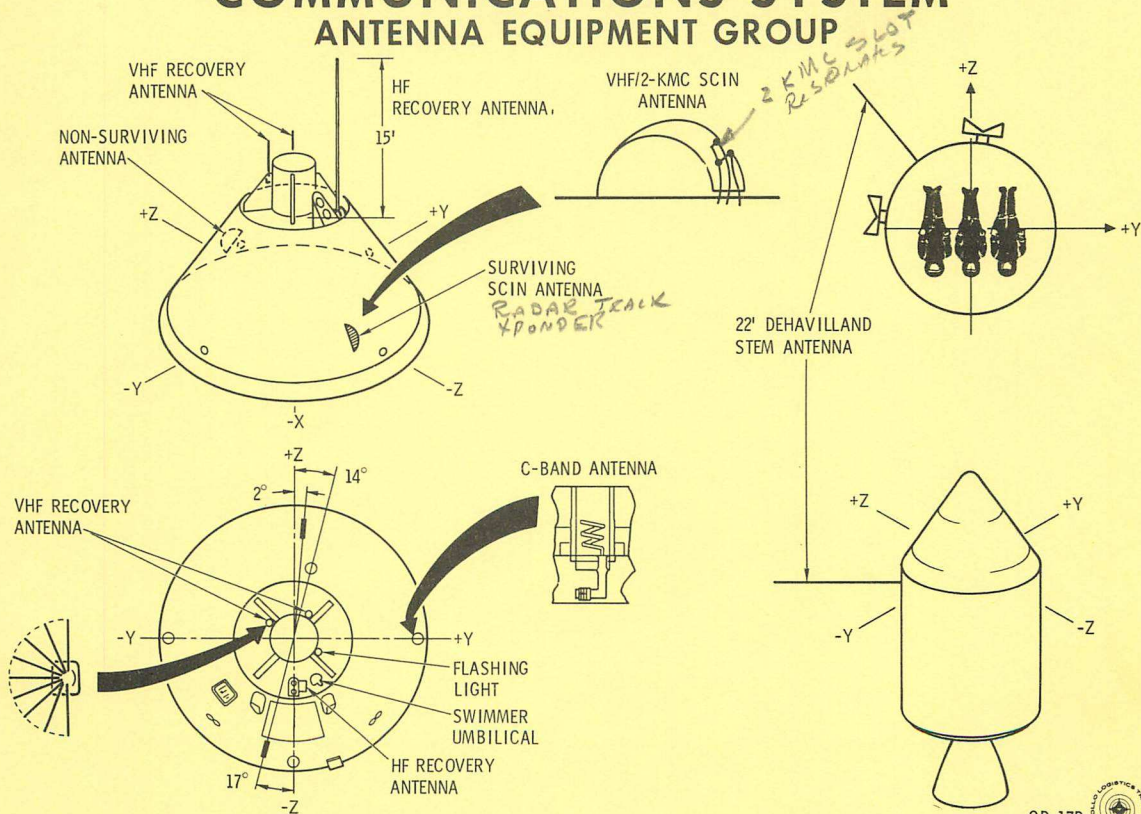


COMMUNICATIONS SYSTEM

RF EQUIPMENT GROUP

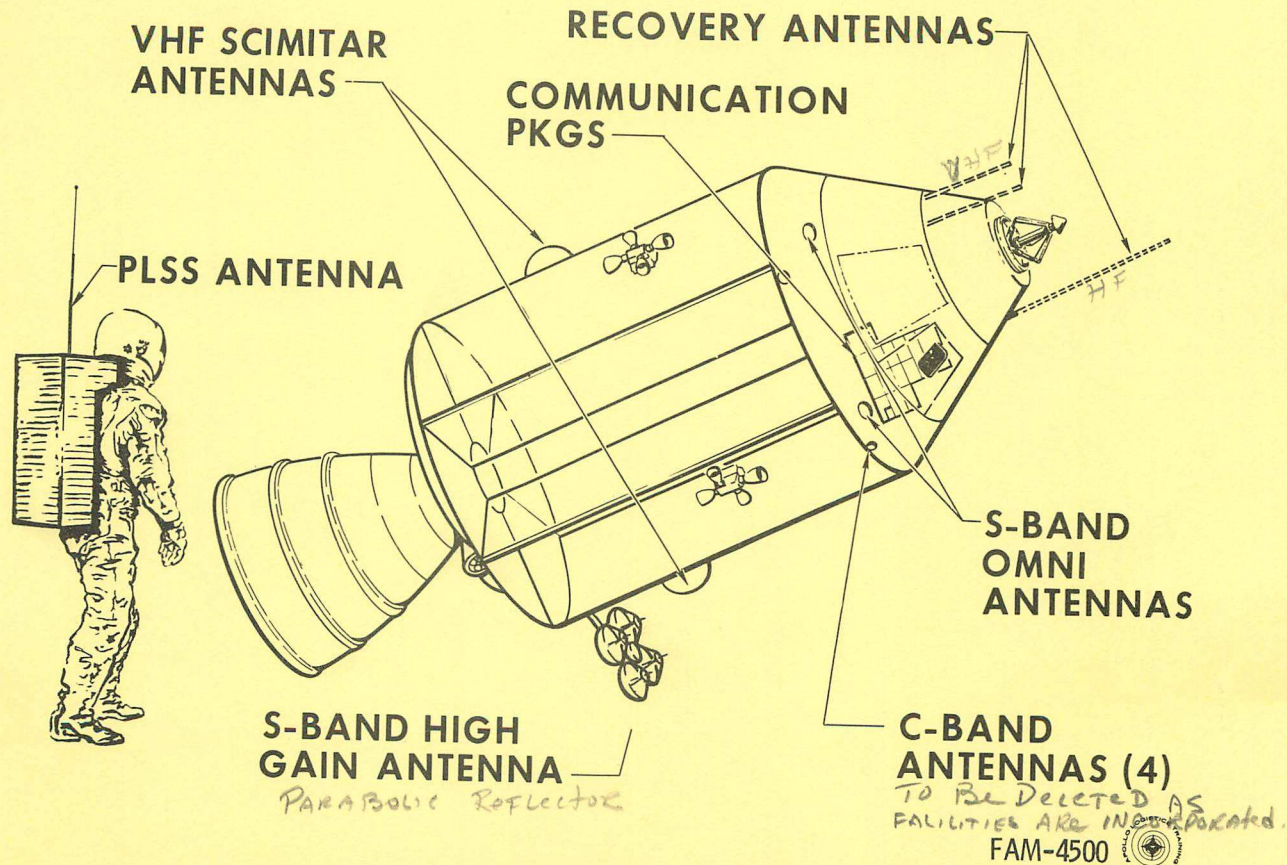


COMMUNICATIONS SYSTEM ANTENNA EQUIPMENT GROUP



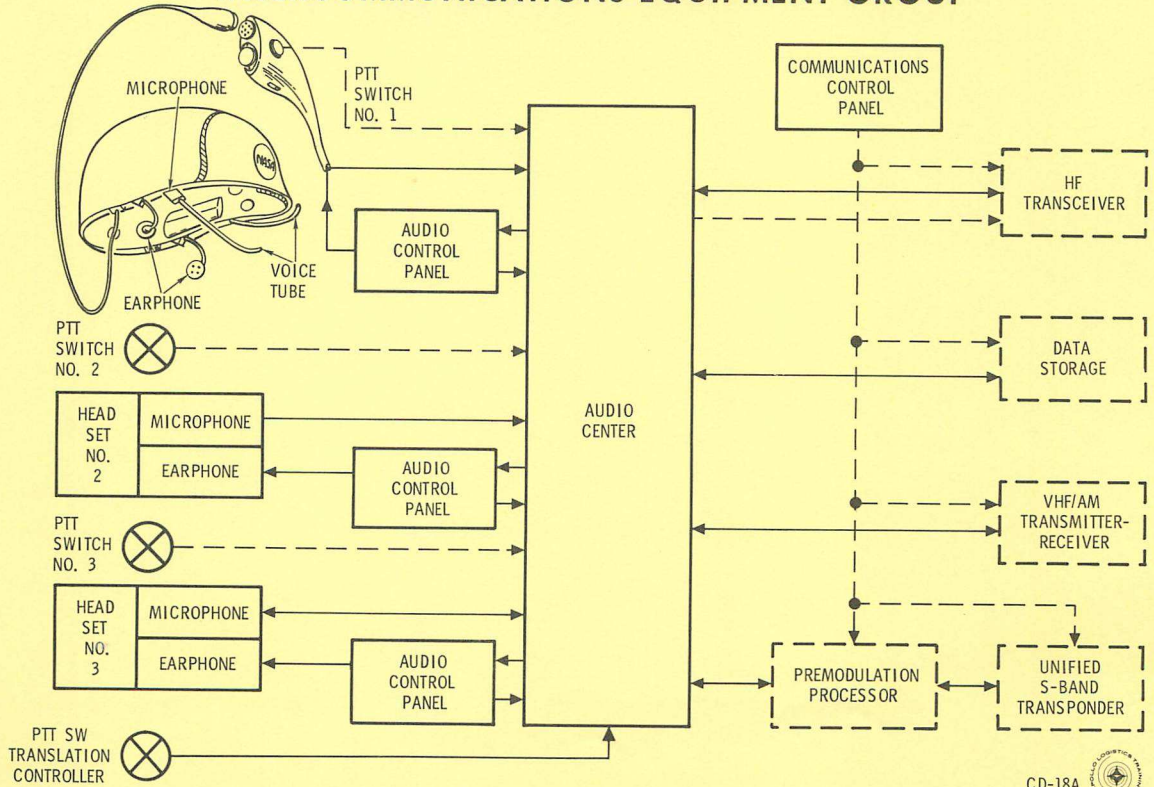
COMMUNICATIONS INSTALLATION

BLOCK II



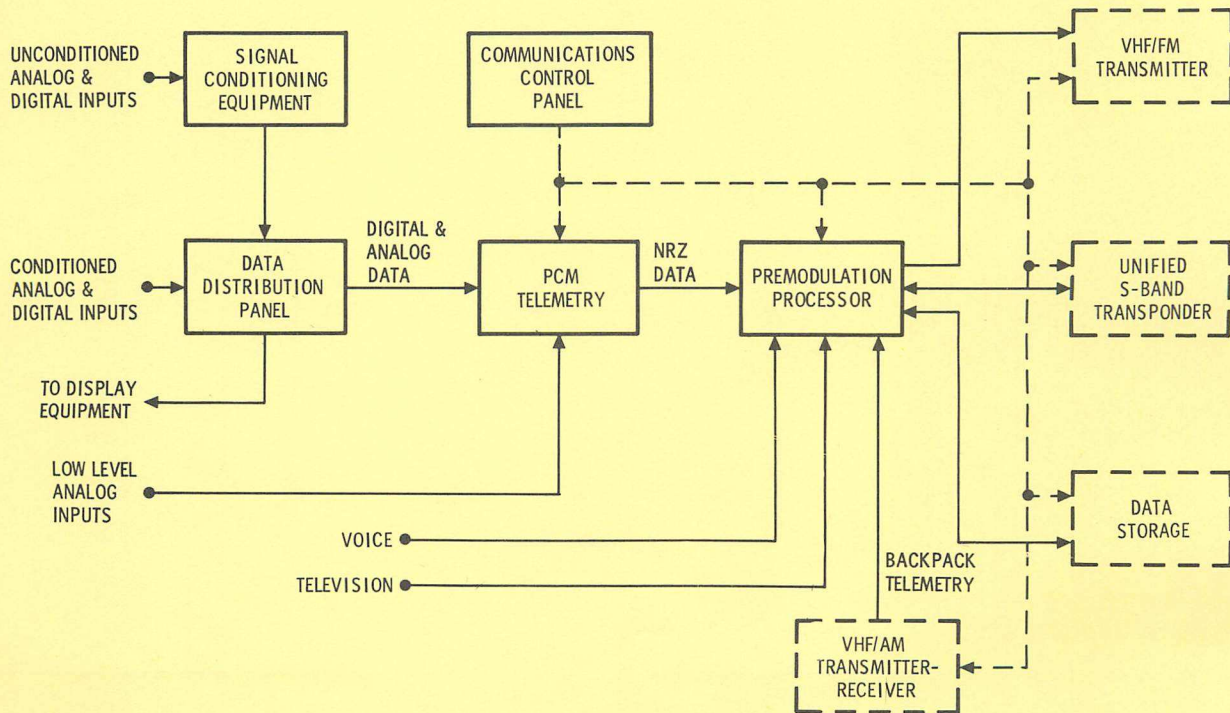
COMMUNICATIONS SYSTEM

INTERCOMMUNICATIONS EQUIPMENT GROUP



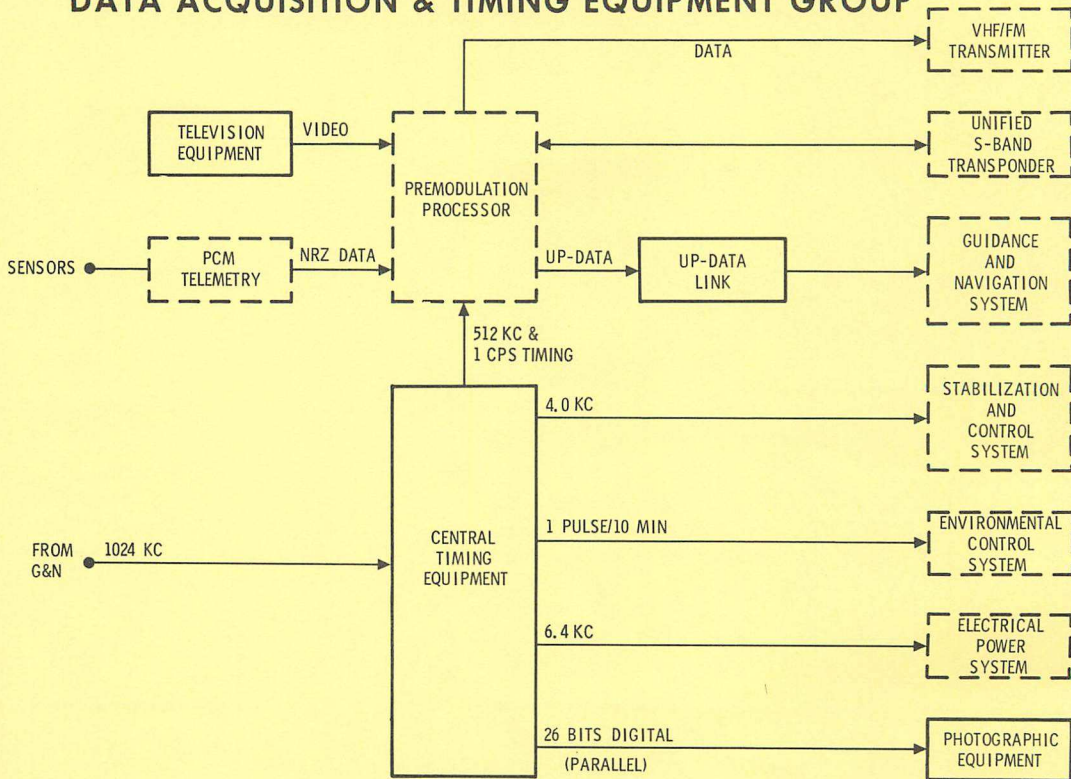
COMMUNICATIONS SYSTEM

DATA EQUIPMENT GROUP



COMMUNICATIONS

DATA ACQUISITION & TIMING EQUIPMENT GROUP



TYPES OF MSFN STATIONS

NAME	FUNCTION
• MISSION CONTROL CENTER (MCC)	NETWORK CONTROL <i>Jonathan</i>
• LAUNCH CONTROL CENTER (LCC)	LAUNCH CHECKOUT & CONTROL <i>Cape</i>
• REMOTE STATION NETWORK	NEAR-EARTH TELECOMMUNICATIONS
• DEEP-SPACE INSTRUMENTATION FACILITIES (DSIF)	DEEP-SPACE TELECOMMUNICATIONS
• RECOVERY CENTERS	CREW RETRIEVAL

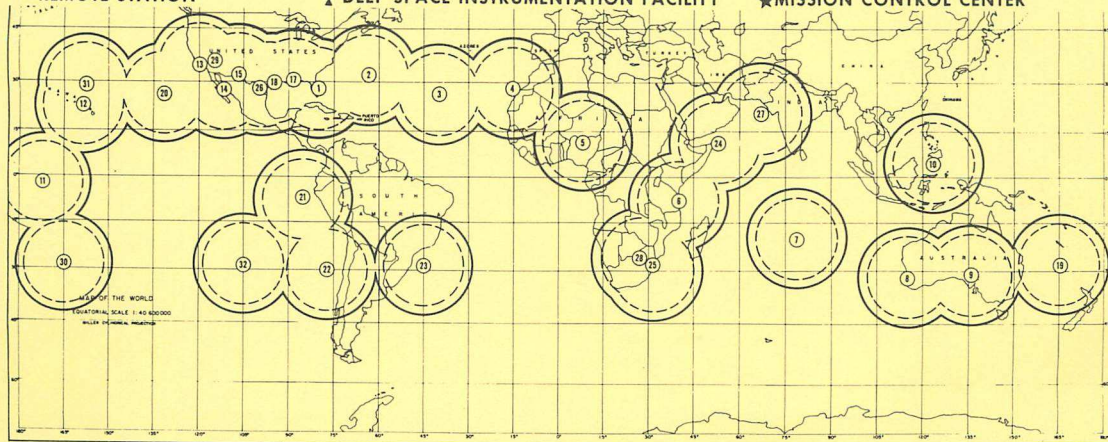
MSFN STATION LOCATIONS

NO.	LOCATION	TYPE	NO.	LOCATION	TYPE	NO.	LOCATION	TYPE
1	CAPE CANAVERAL, FLA	⦿	12	KAUAI, HI	⦿	23	SOUTH ATLANTIC SHIP	⦿
2	BERMUDA	⦿	13	POINT ARGUELLO, CALIF	⦿	24	INDIAN OCEAN SHIP NO. 2	⦿
3	ATLANTIC SHIP	⦿	14	GUAYMAS, MEX	⦿	25	DURBAN S. AFR	⦿
4	GRAND CANARY IS.	⦿	15	WHITE SANDS MISSILE RANGE, NM	⦿	26	SAN ANTONIO, TEXAS	⦿
5	KANO, NIGERIA	⦿	16		⦿	27	PERSIAN GULF SHIP	⦿
6	ZANZIBAR, AFR	⦿	17	ELGIN AFB, FLA	⦿	28	JOHANNESBURG, SO. AFR ?	⦿
7	INDIAN O. SHIP NO. 1	⦿	18	HOUSTON, TEXAS	★	29	GOLDSTONE, CALIF	⦿
8	MUCHEA, AUSTRALIA	⦿	19	NOUMEA, NEW CALEDONIA	⦿	30	KERMADEC IS.	⦿
9	WOOMERA, AUSTRALIA	⦿	20	PACIFIC O. SHIP NO. 1	⦿	31	HAWAIIAN SHIP	⦿
10	MINDANAO, PI.	⦿	21	PACIFIC O. SHIP NO. 2	⦿	32	EASTER IS.	⦿
11	CANTON IS.	⦿	22	PACIFIC O. SHIP NO. 3	⦿			

CAIRNARVO
CANBERKA
GUAM

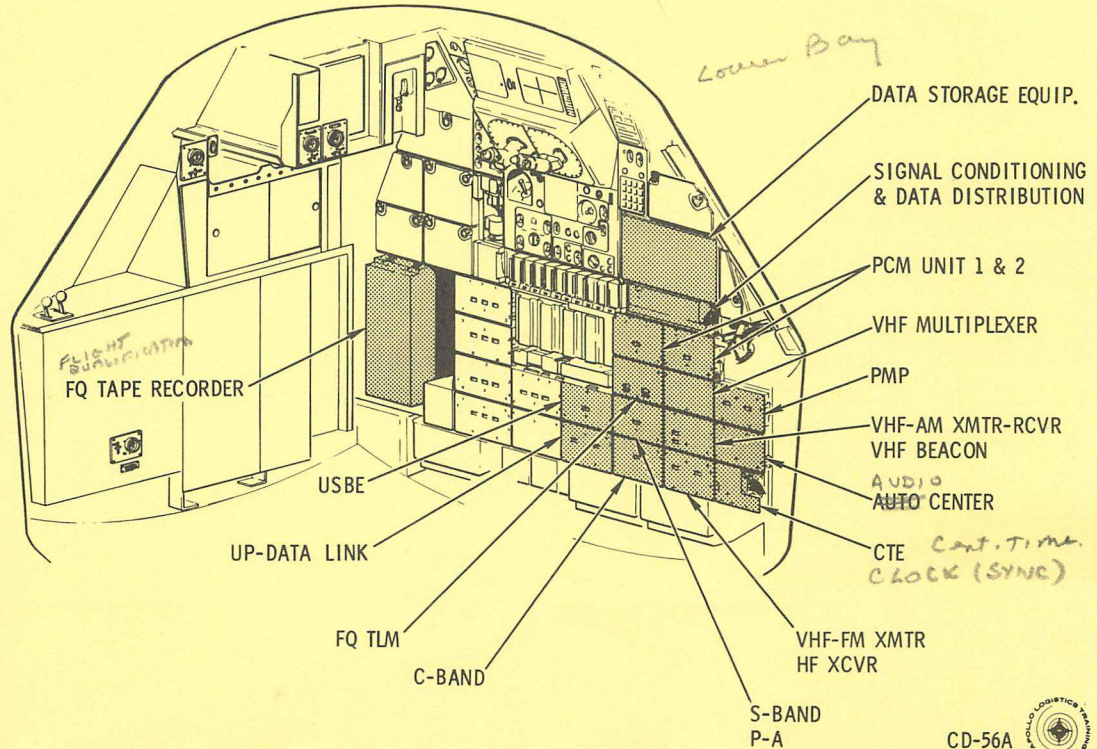
MADRID ?

- ⦿ LAUNCH CONTROL CENTER
- ⦿ REMOTE STATION
- ⦿ RECOVERY
- ⦿ DEEP SPACE INSTRUMENTATION FACILITY
- ★ MISSION CONTROL CENTER




LOWER EQUIPMENT BAY

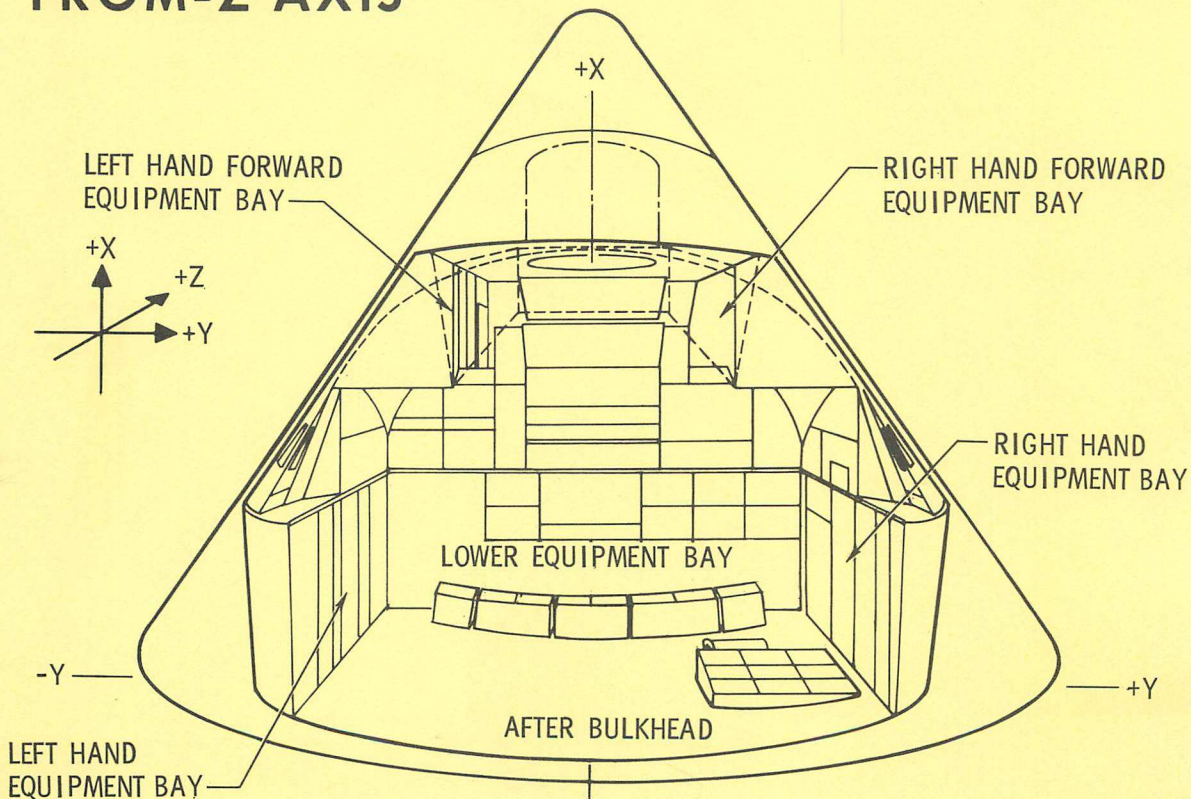
COMMUNICATIONS



CREW SYSTEMS AND CABIN

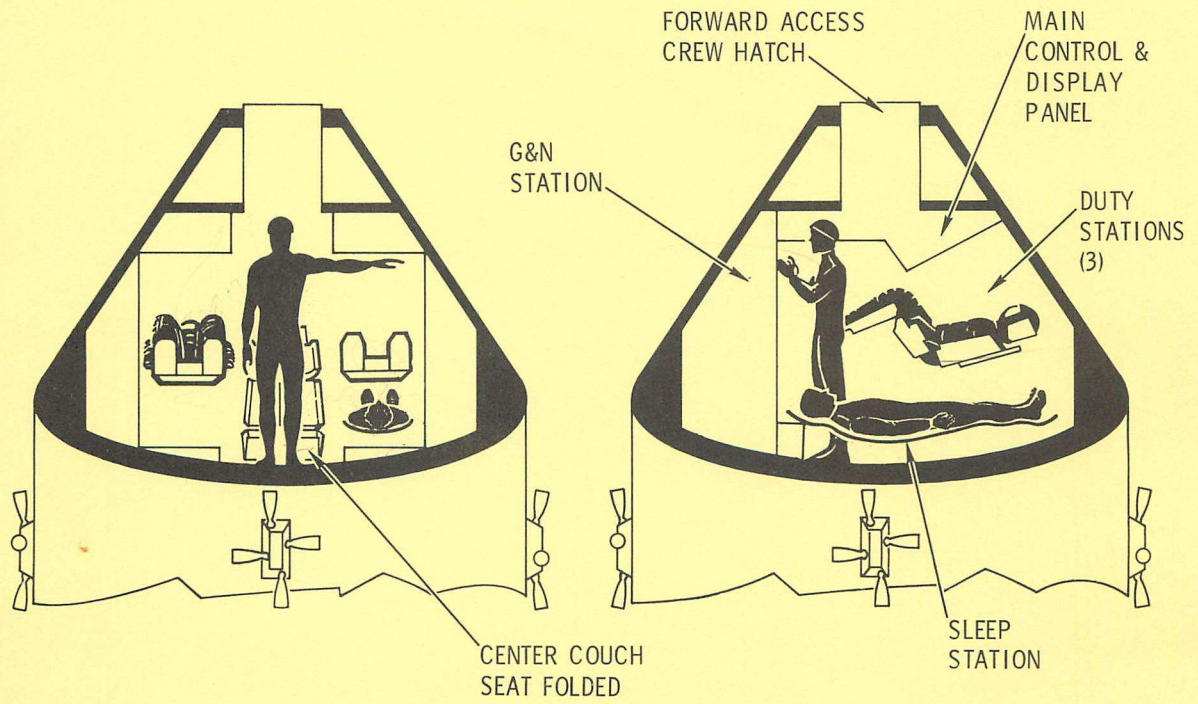
ST-700A 

APOLLO CREW COMPARTMENT, INT VIEW, FROM-Z AXIS



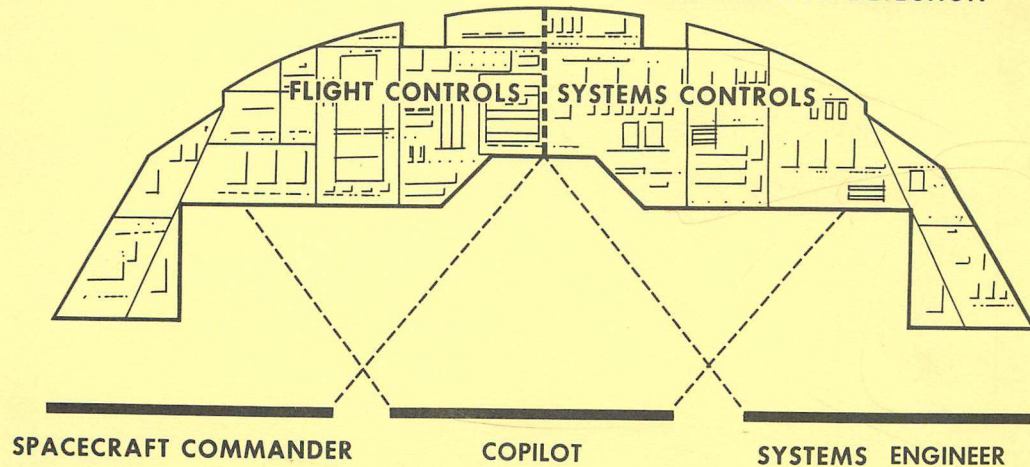
now - Copilot

APOLLO CREW STATIONS

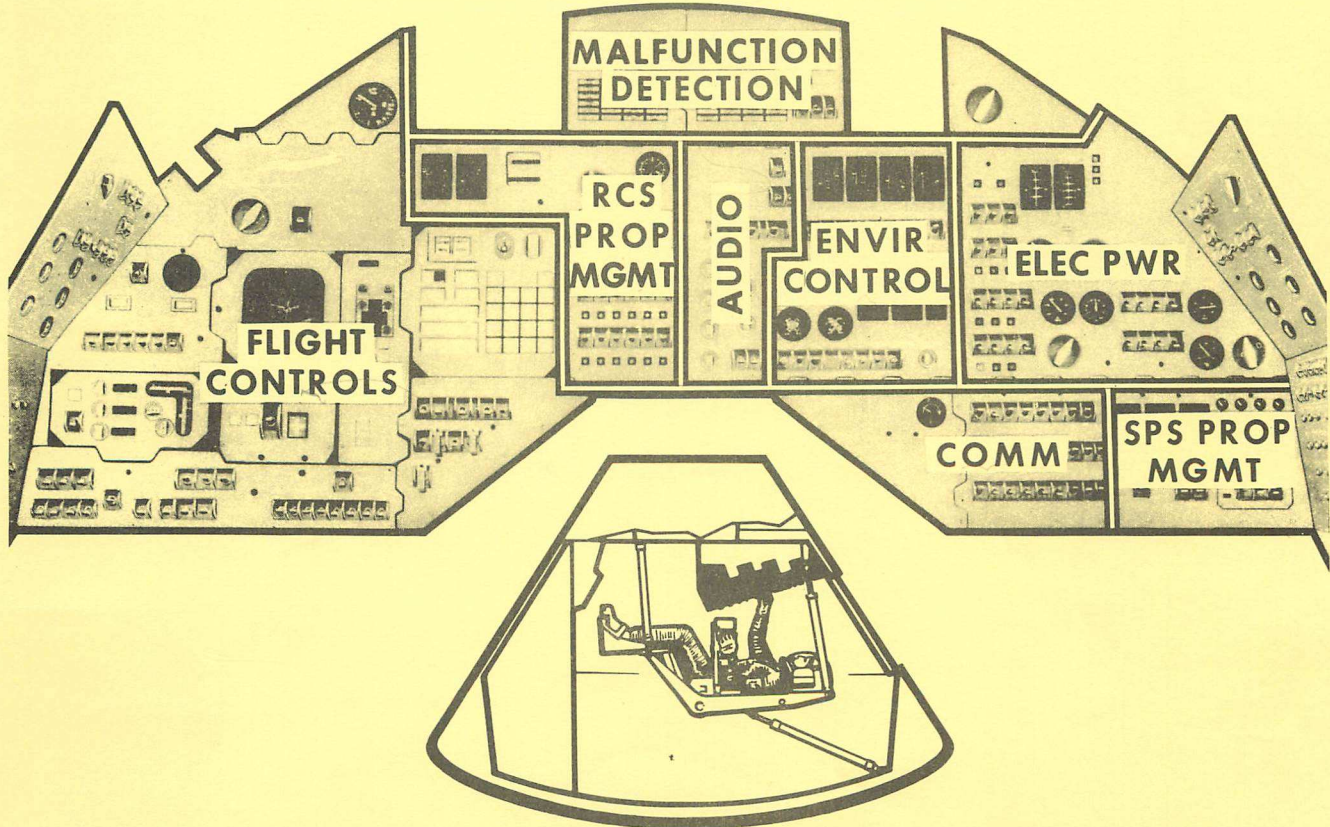


MAIN PANEL FUNCTIONS

- LV EMERGENCY DETECTION
- FLIGHT ATTITUDE
- MISSION SEQUENCE
- ΔV MONITOR
- ENTRY MONITOR
- PROPELLANT GAGING
- ENVIRONMENT CONTROL
- COMMUNICATIONS CONTROL
- POWER DISTRIBUTION
- MALFUNCTION DETECTION



MAIN PANEL

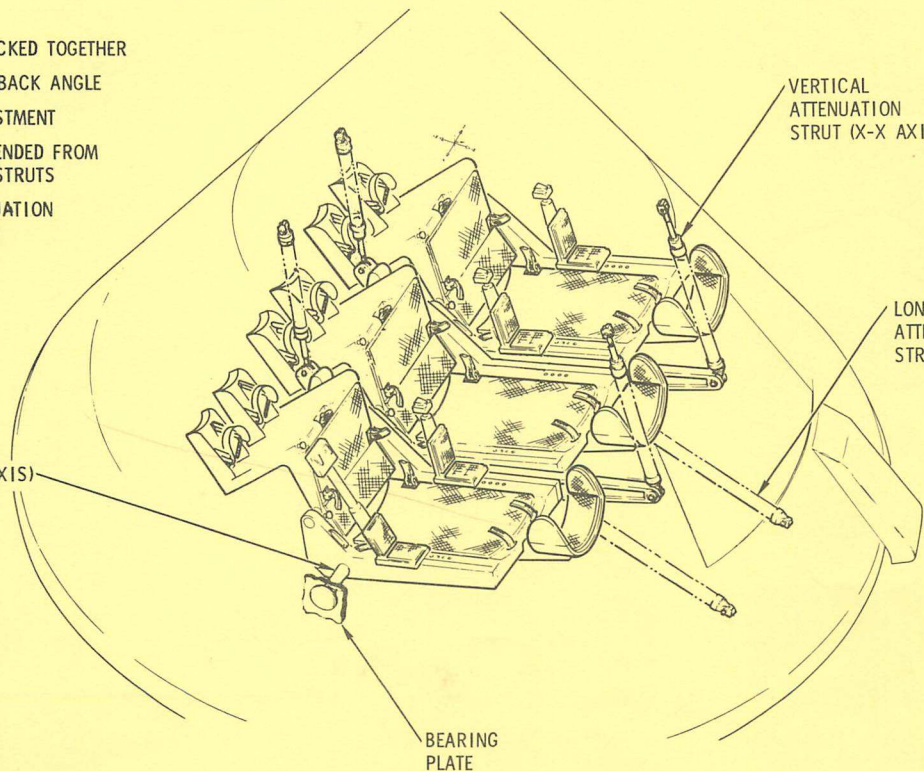


CREW COUCH

SUPPORT STRUCTURE

- 3 COUCHES LOCKED TOGETHER
- FIXED COUCH BACK ANGLE
- MANUAL ADJUSTMENT
- SYSTEM SUSPENDED FROM ATTENUATION STRUTS
- STATIC ATTENUATION STRUT SYSTEM UNTIL IMPACT

LATERAL
ATTENUATION
STRUT (Y-Y AXIS)

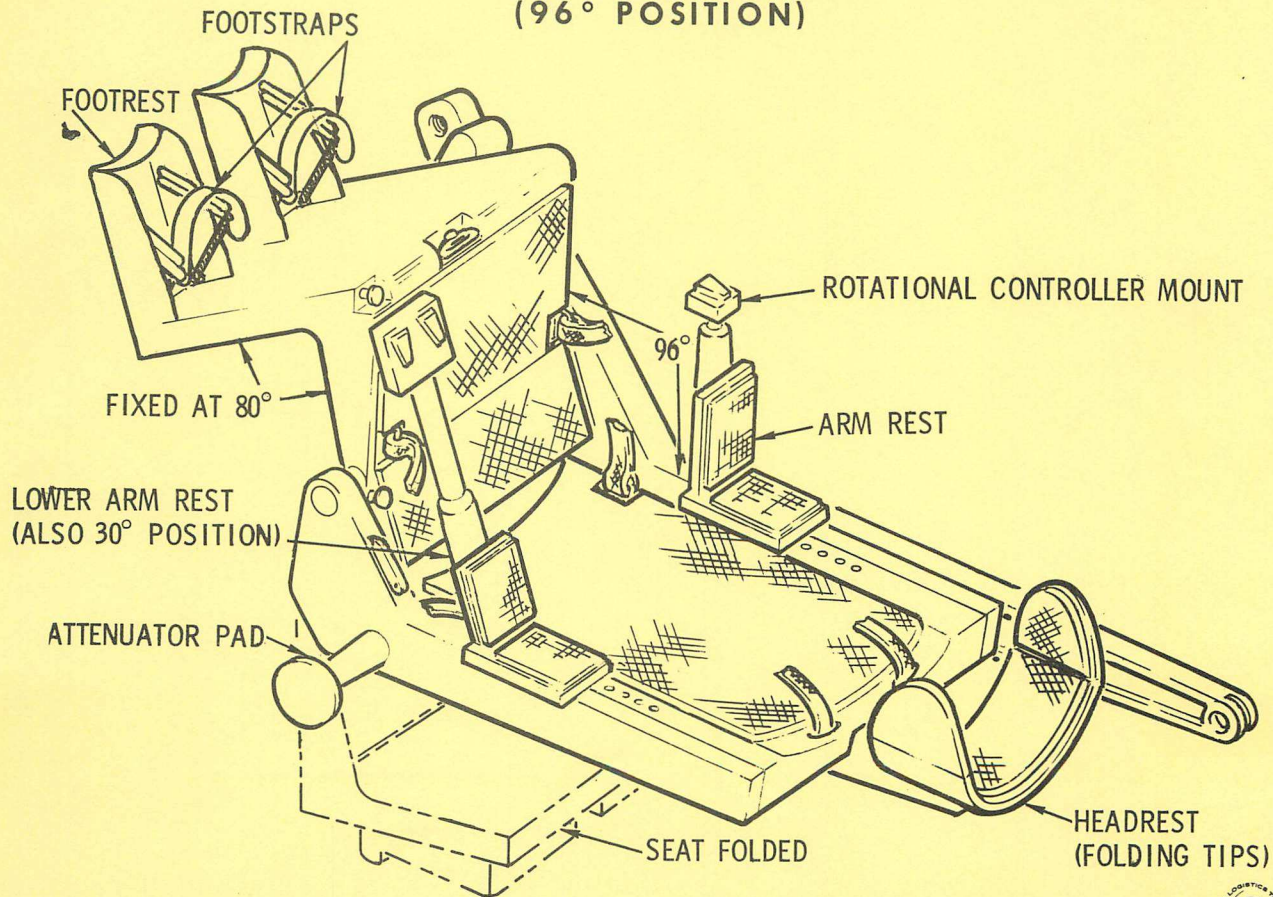


VERTICAL
ATTENUATION
STRUT (X-X AXIS)

LONGITUDINAL
ATTENUATION
STRUT (Z-Z AXIS)

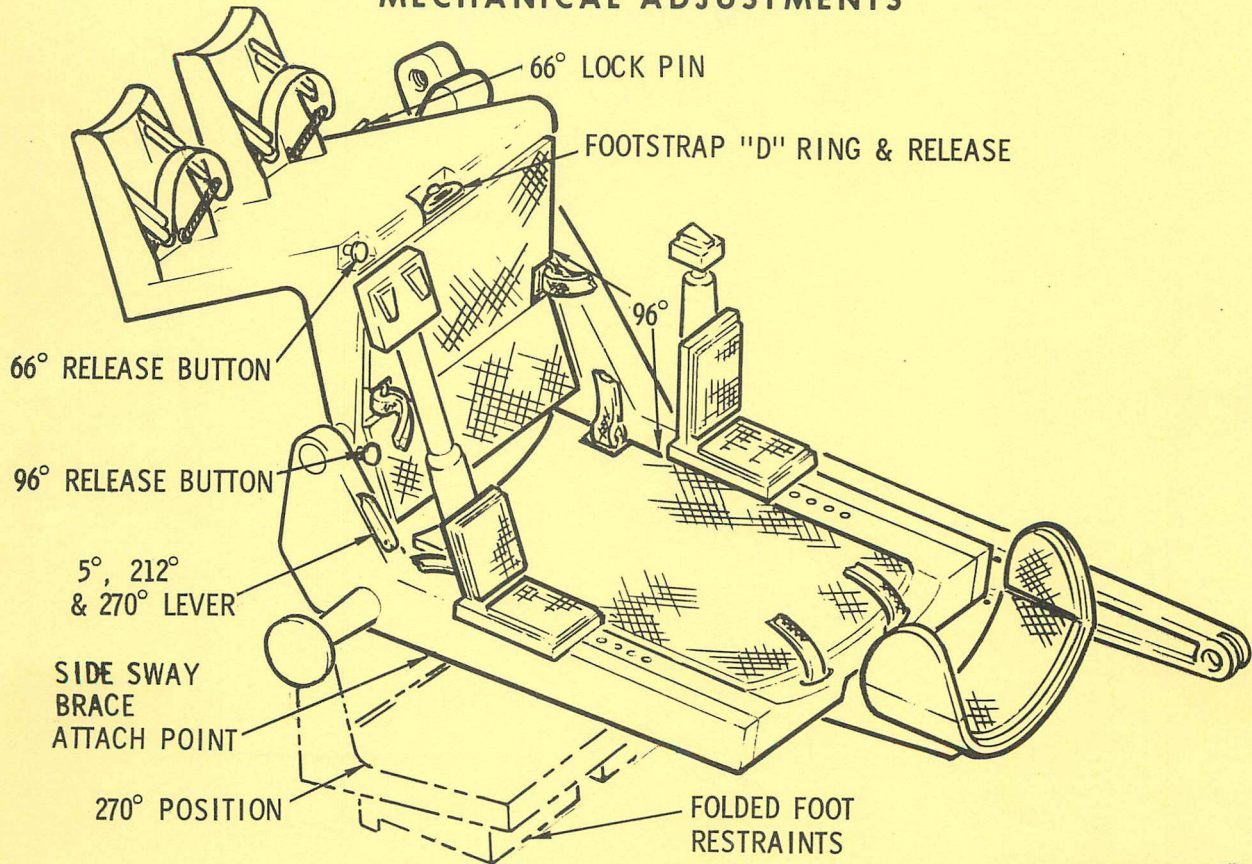
BEARING
PLATE

L.H. COUCH (96° POSITION)



L.H. COUCH

MECHANICAL ADJUSTMENTS

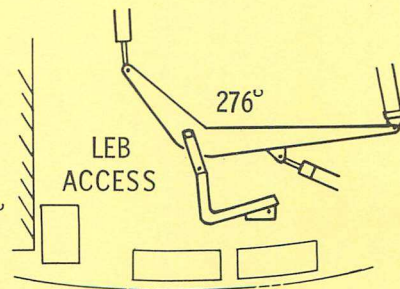
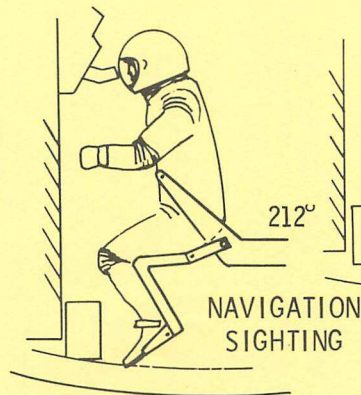
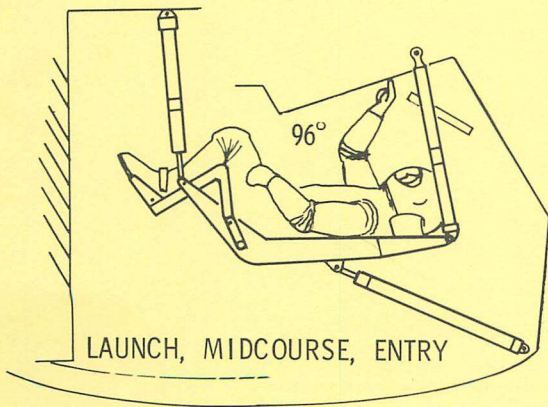
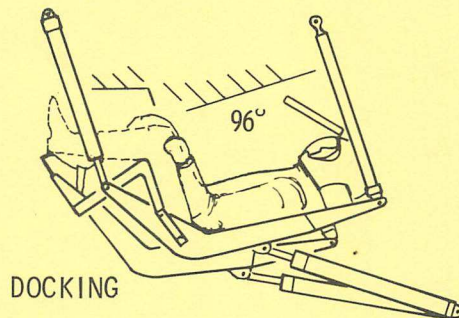
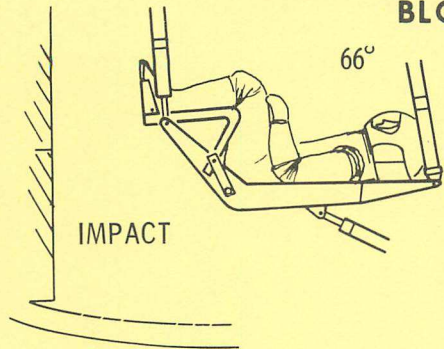


CS-2101A

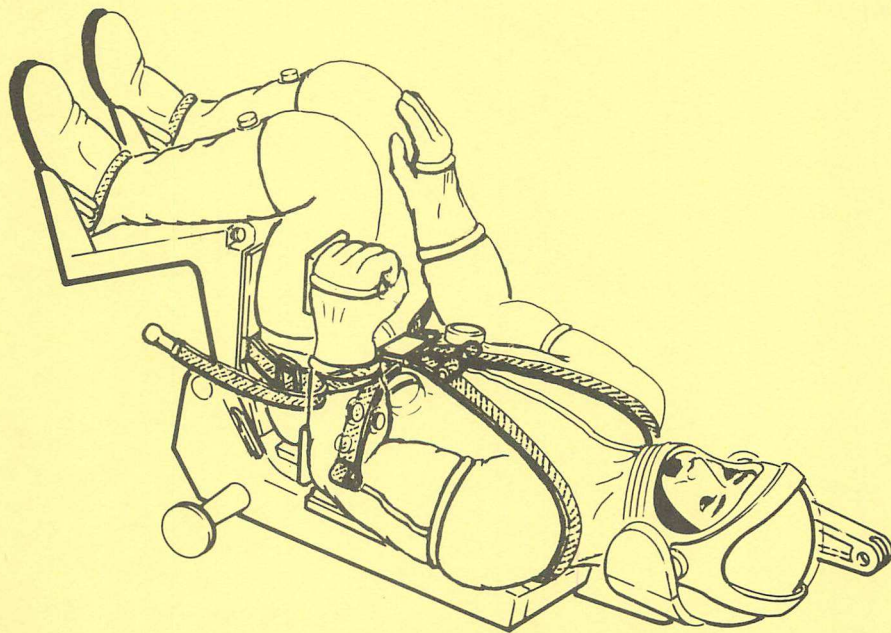


CREW COUCH POSITIONS

BLOCK I & BLOCK II

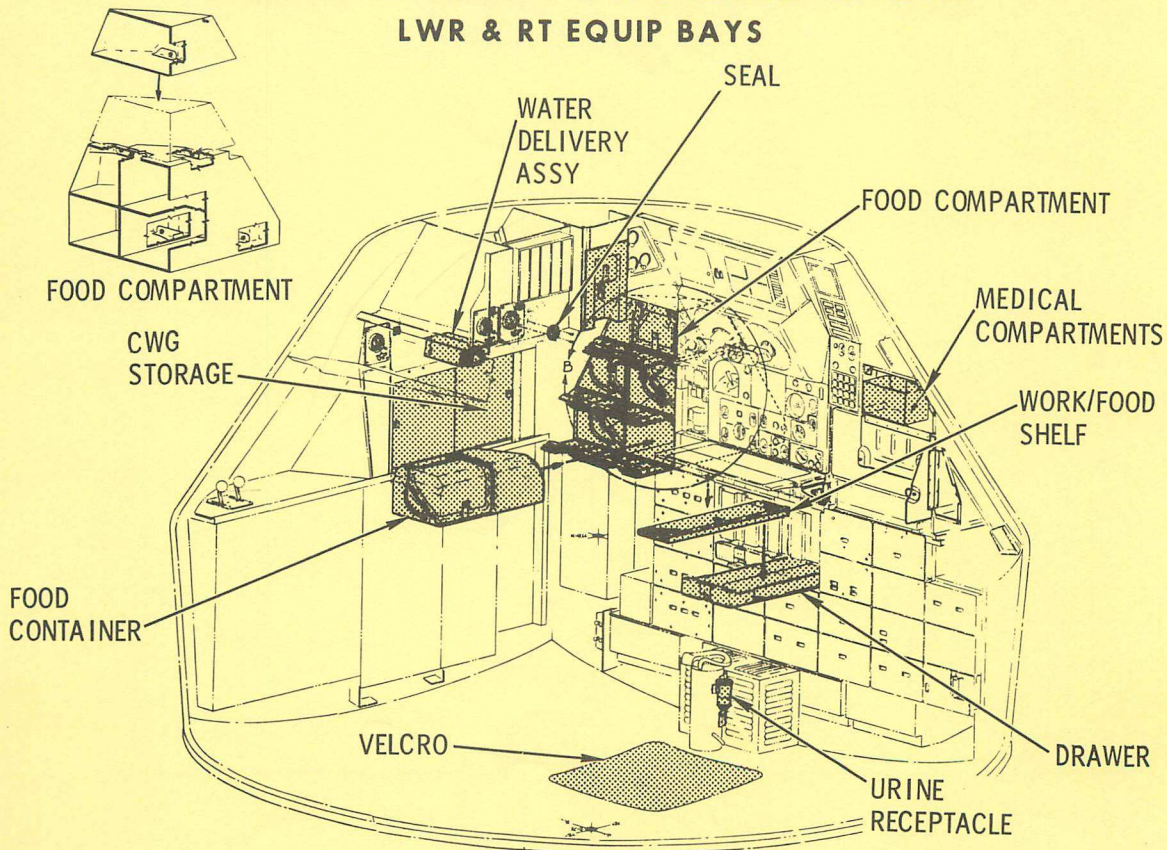


APOLLO CREWMAN RESTRAINT HARNESS ASSEMBLY



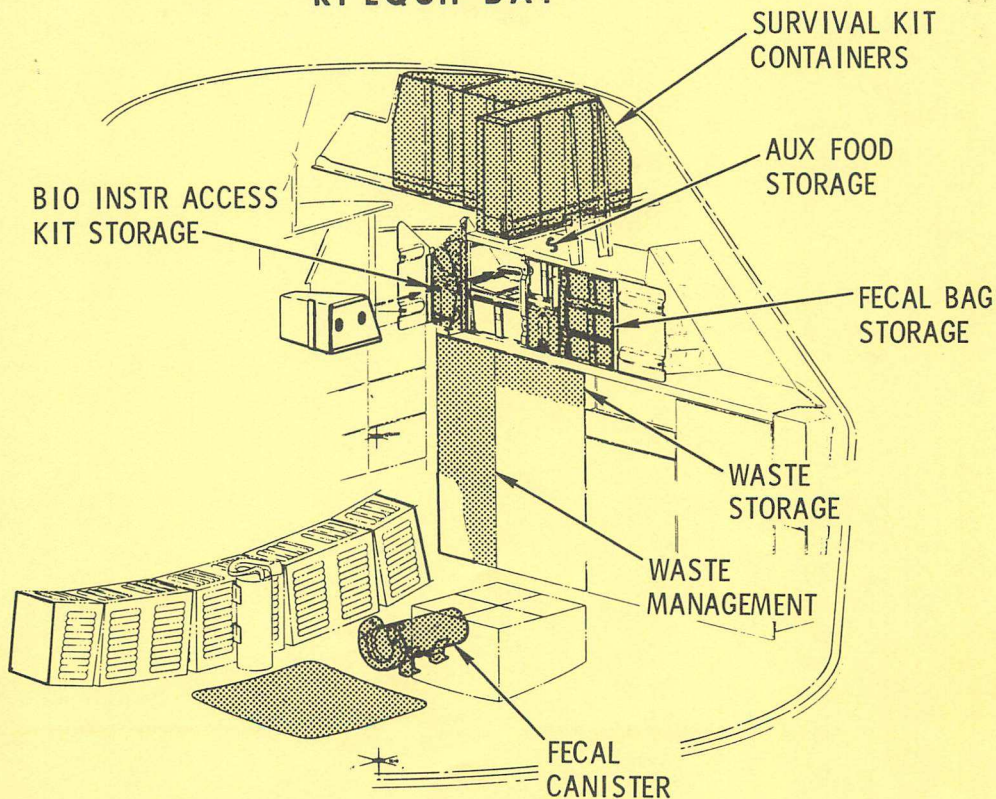
APOLLO CREW SYSTEMS INSTL

LWR & RT EQUIP BAYS



APOLLO CREW SYSTEMS INSTL

RT EQUIP BAY

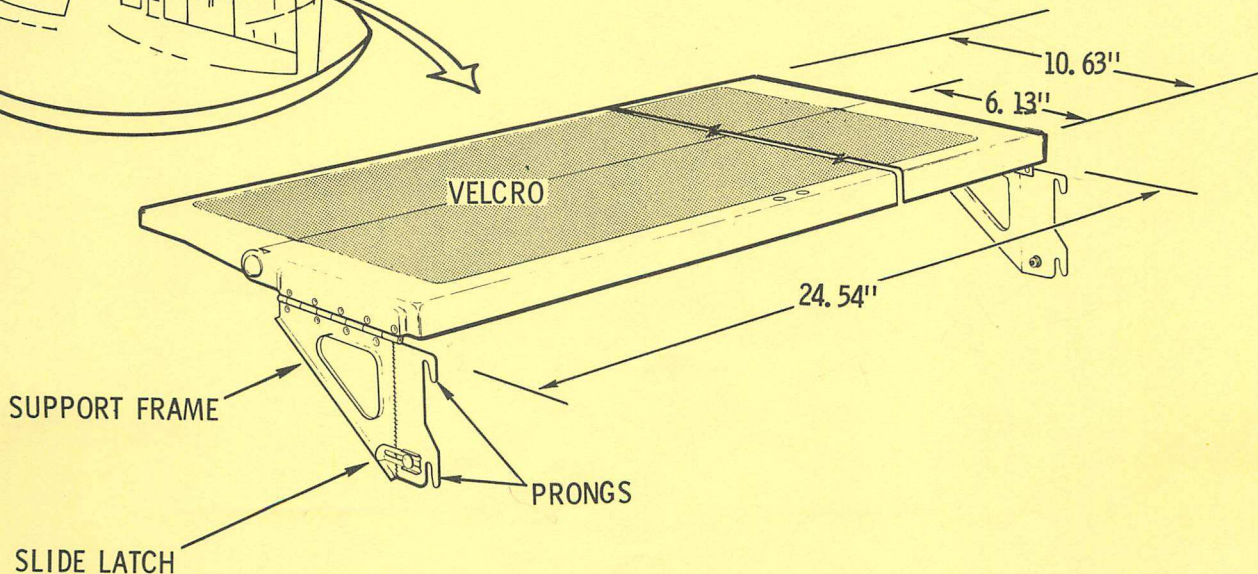
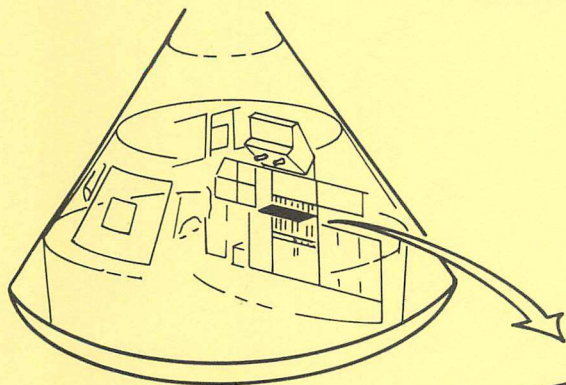


CS-0004A



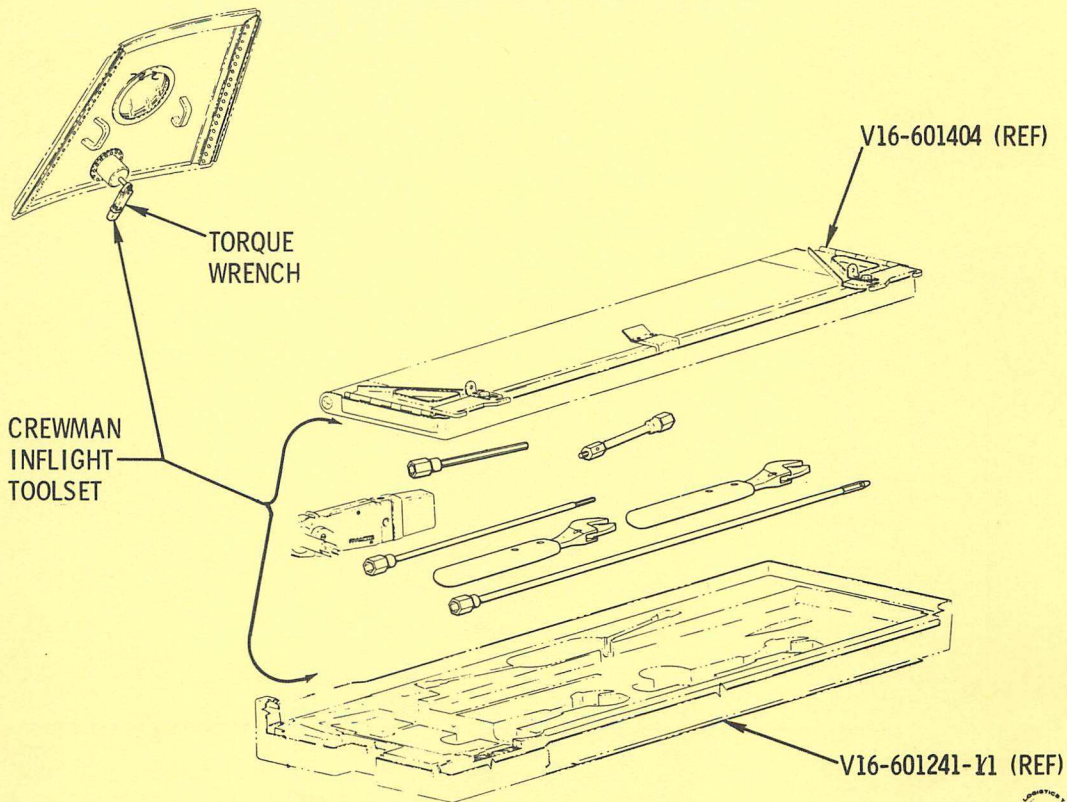
WORK/FOOD SHELF

(BLOCK I)

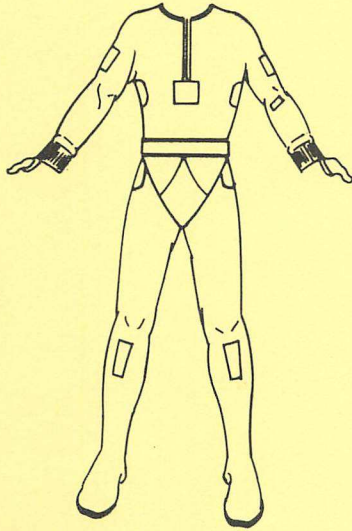


FIELD INSTALLATIONS

CREWMAN INFLIGHT TOOLSET



CREWMAN CLOTHING



CONSTANT
WEAR
GARMENT

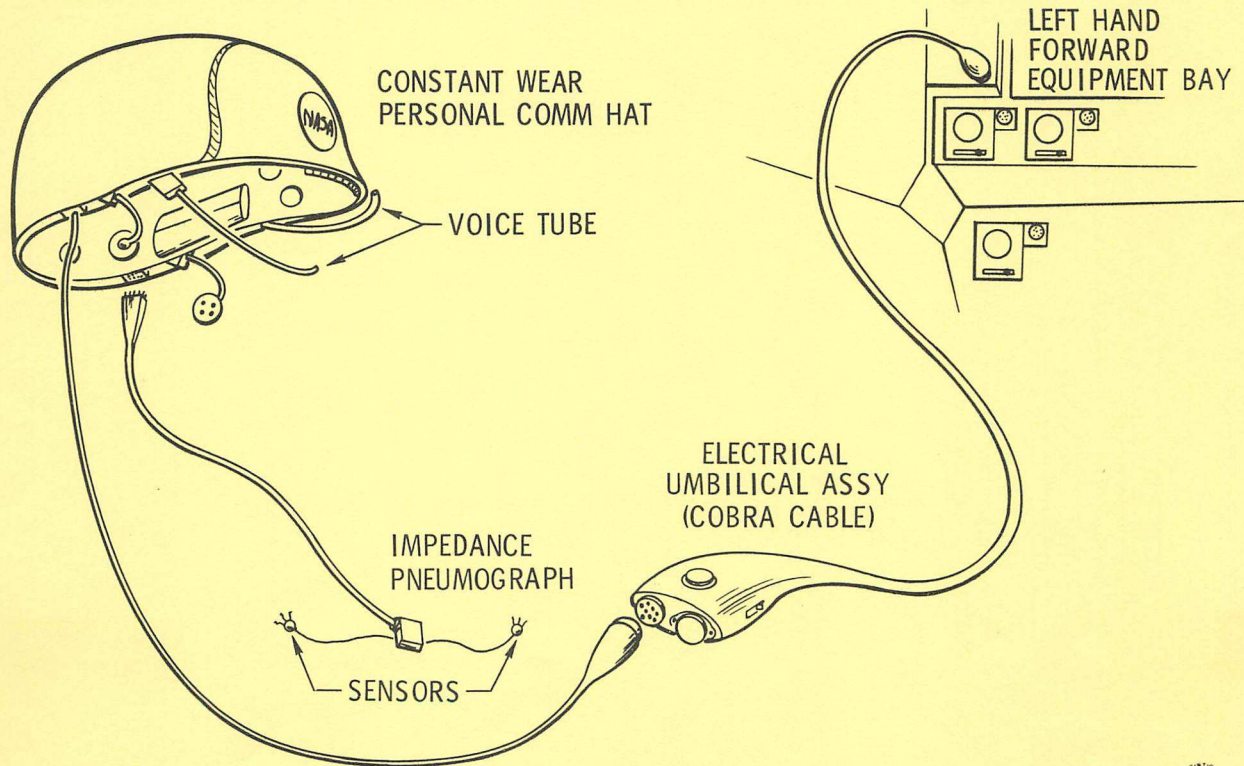


APOLLO PRESSURE SUIT &
PORTABLE LIFE SUPPORT SYSTEM

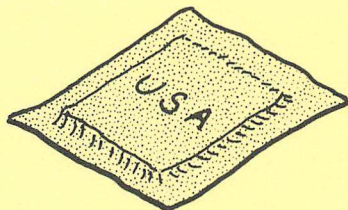
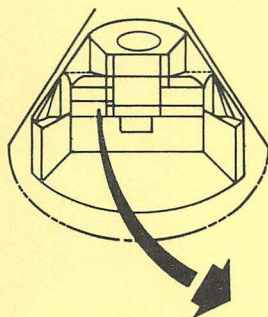


THERMAL
GARMENT

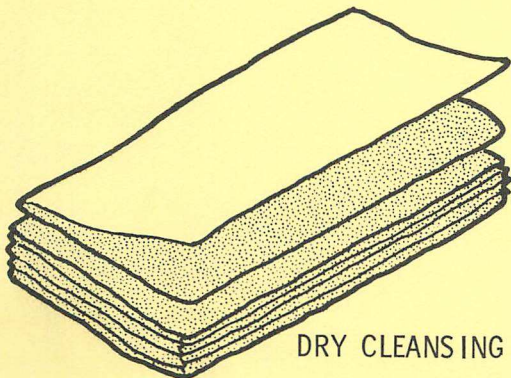
PERSONAL COMMUNICATIONS EQUIPMENT CONNECTIONS (SHIRTSLEEVE ENVIRONMENT)



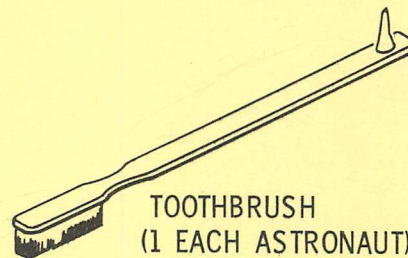
PERSONAL HYGIENE ITEMS



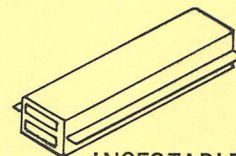
WET CLEANSING CLOTH



DRY CLEANSING CLOTH



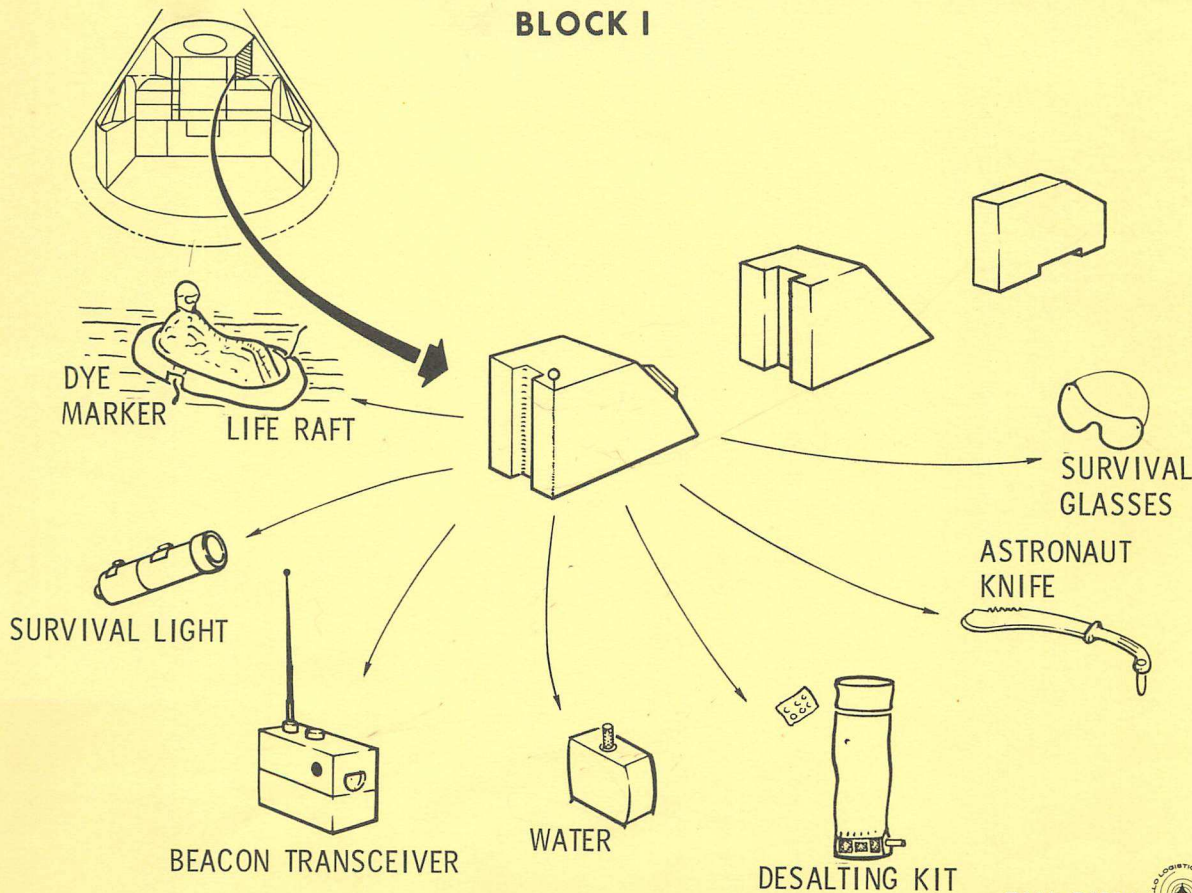
TOOTHBRUSH
(1 EACH ASTRONAUT)



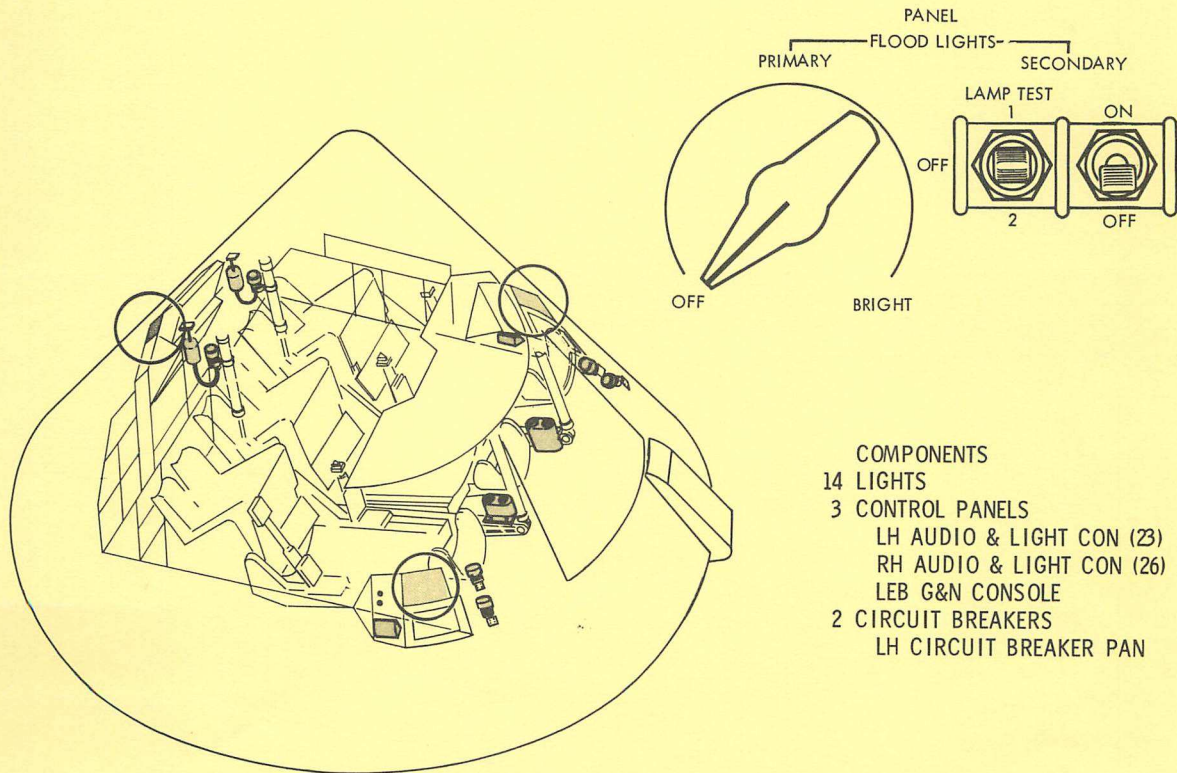
INGESTABLE GUM PACK
(2 STICKS PER PACK)

APOLLO SURVIVAL KIT AND COMPONENTS

BLOCK I



CM FLOODLIGHT SYSTEM CONFIGURATION (BLOCK I)



APOLLO ABBREVIATIONS

AGAP	ATTITUDE GYRO ACCELEROMETER PACKAGE	LOR	LUNAR ORBITAL RENDEZVOUS
AGC	APOLLO GUIDANCE COMPUTER	LOS	LINE OF SIGHT
AM	AMPLITUDE MODULATION	LV	LAUNCH VEHICLE
BMAG	BODY MOUNTED ATTITUDE GYRO	MDV	MAP & DATA VIEWER
CDU	COUPLING DISPLAY UNIT	MESC	MASTER EVENTS SEQUENCE CONTROLLER
CM	COMMAND MODULE	MSFN	MANNED SPACE FLIGHT NETWORK
CO ₂	CARBON DIOXIDE	N ₂	NITROGEN
COMM	COMMUNICATIONS SYSTEM	N ₂ O ₄	NITROGEN TETROXIDE
CTE	CENTRAL TIMING EQUIPMENT	N ₂ H ₄	HYDRAZINE
CW	CONTINUOUS WAVE	O ₂	OXYGEN
DSE	DATA STORAGE EQUIPMENT	PCM	PULSE CODE MODULATION
DSIF	DEEP SPACE INSTRUMENTATION FACILITY	PM	PHASE MODULATION
ECS	ENVIRONMENTAL CONTROL SYSTEM	PMP	PREMODULATION PROCESSOR
EDS	EMERGENCY DETECTION SYSTEM	PRN	PSEUDO-RANDOM NOISE
ELS	EARTH LANDING SYSTEM	Q	DYNAMIC PRESSURE
EPS	ELECTRICAL POWER SYSTEM	RCS	REACTION CONTROL SYSTEM
FDAI	FLIGHT DIRECTOR ATTITUDE INDICATOR	RGP	RATE GYRO PACKAGE
FM	FREQUENCY MODULATION	SCS	STABILIZATION & CONTROL SYSTEM
G & C	GUIDANCE & CONTROL	SCT	SCANNING TELESCOPE
G & N	GUIDANCE & NAVIGATION SYSTEM	SECS	SEQUENTIAL EVENTS CONTROL SYSTEM
H ₂	HYDROGEN	SM	SERVICE MODULE
He	HELIUM	SPS	SERVICE PROPULSION SYSTEM
HF	HIGH FREQUENCY (3 - 30 MC)	SSB	SINGLE SIDE-BAND
H ₂ O	WATER	SXT	SPACE SEXTANT
IMU	INERTIAL MEASUREMENT UNIT	TCA	THRUST CHAMBER ASSEMBLY
I _S ^P	INSTANTANEOUS SPECIFIC IMPULSE	TLM	TELEMETRY
IU	INSTRUMENT UNIT	TVC	THRUST VECTOR CONTROL
KOH	POTASSIUM HYDROXIDE	UDL	UP DATA LINK
LEM	LUNAR EXCURSION MODULE	UDMH	UNSYMMETRICAL DIMETHYL HYDRAZINE
LES	LAUNCH ESCAPE SYSTEM	UHF	ULTRA HIGH FREQUENCY (300-3000 MC)
		USBE	UNIFIED S-BAND EQUIPMENT
		VHF	VERY HIGH FREQUENCY (30-300 MC)

