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AX68-22

AAP
ELECTRICAL POWER SYSTEM
BCR BRIEFING

October 1968

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION

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108AX 16444

AAP ELECTRICAL POWER SYSTEM BCR BRIEFING

ELECTRICAL POWER SYSTEM SUMMARY

AAP REQUIREMENTSPOWER TRANSFER AND CONTROL
UMBILICALS

1. PROVIDE CAPABILITY OF TRANSFERRING AND CONTROLLING UP TO 2000 WATTS EITHER DIRECTION BETWEEN CM MAIN BUSES AND OA OR LM-ATM BUSES.
2. PROVIDE STOWAGE FOR POWER AND CONTROL UMBILICALS IN CM.
3. PROVIDE ADDITIONAL CONTROL UMBILICAL CAPACITY

ENTRY AND PYRO BATTERY SYSTEM

1. PROVIDE BATTERY CHARGED STAND LIFE OF: 45 DAY, AAP-1
73 DAY, AAP-3A, -3
2. "BATTERY REDUNDANCY REQUIRED TO PRECLUDE MISSION TERMINATION IN FLIGHT DUE TO LOSS OF SINGLE BATTERY." 128.4 A.H. REQUIRED AFTER LOSS OF SINGLE BATTERY.

BLOCK II CAPABILITY

1. PROVIDES 180 W PEAK POWER TO LM.
 2. PROVIDES STOWAGE FOR CONTROL UMBILICALS IN LM.
 3. PROVIDES CONTROL UMBILICALS WITH TOTAL CAPACITY OF 74 WIRES. THROUGH FWD FEED THROUGH AND THERMAL RING
-
1. ENTRY BATTERY CHARGED STAND LIFE: 90 DAYS
PYRO BATTERY CHARGED STAND LIFE: 36 DAYS
 2. PROVIDES 80 A.H. AFTER LOSS OF ONE ENTRY BATTERY.

AAP DELTA

1. ADD NEW 2000 W TUNNEL POWER UMBILICAL.
 2. ADD STOWAGE FOR POWER AND CONTROL UMBILICALS IN CM.
 3. ADD TUNNEL CONTROL UMBILICAL HARNESS WIRING AND CHANGE TO LARGER THERMAL RING CONNECTORS FOR LL@ FUNCTIONS
-
1. REMOVE PYRO BATTERIES, ADD FOURTH ENTRY BATTERY USE TWO ENTRY BATTERIES FOR PYRO BUS POWER AND 2 ENTRY BATTERIES FOR BATTERY BUS POWER.
 2. ADD FOURTH ENTRY BATTERY.

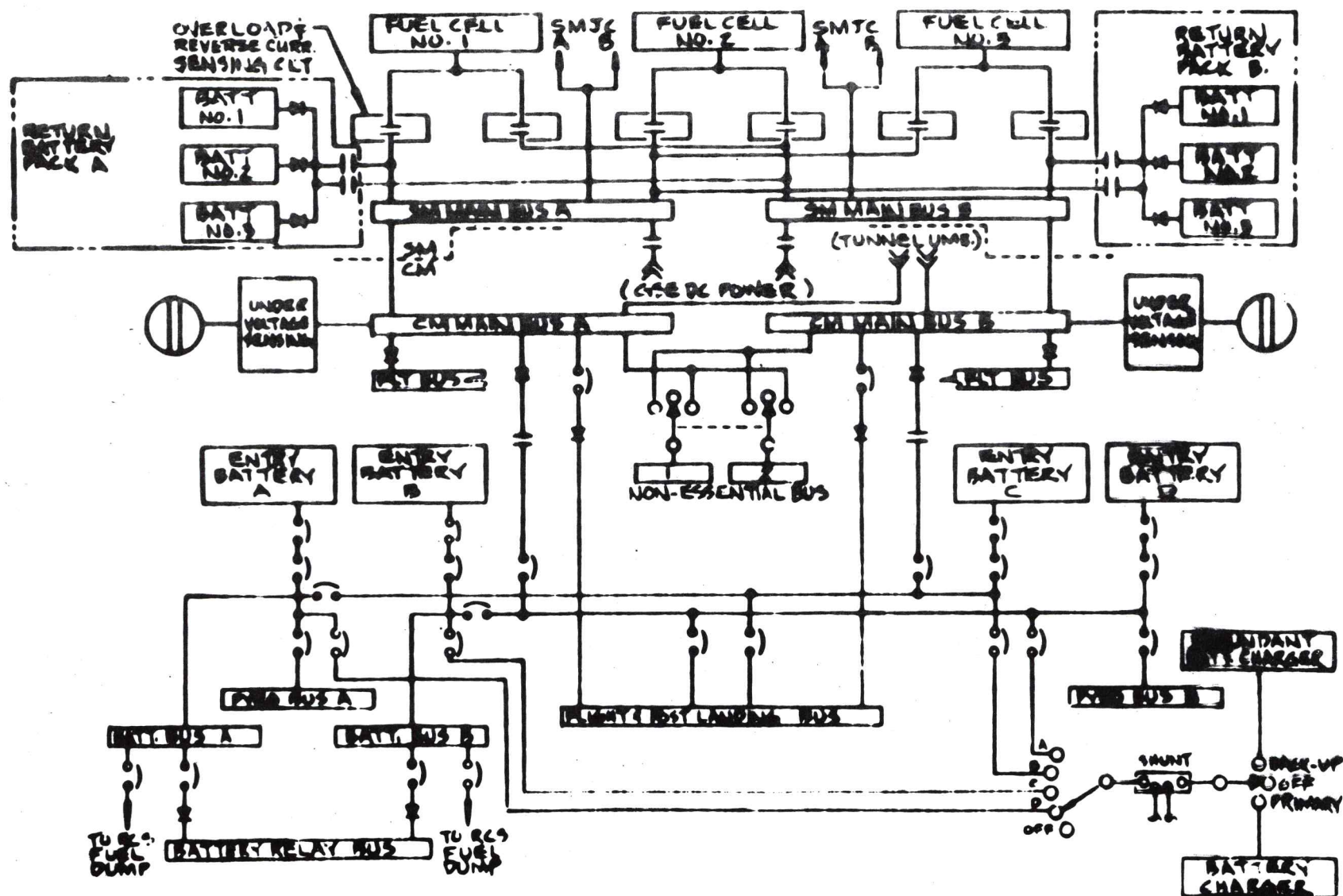
ELECTRICAL POWER SYSTEM SUMMARY (CONTINUED)

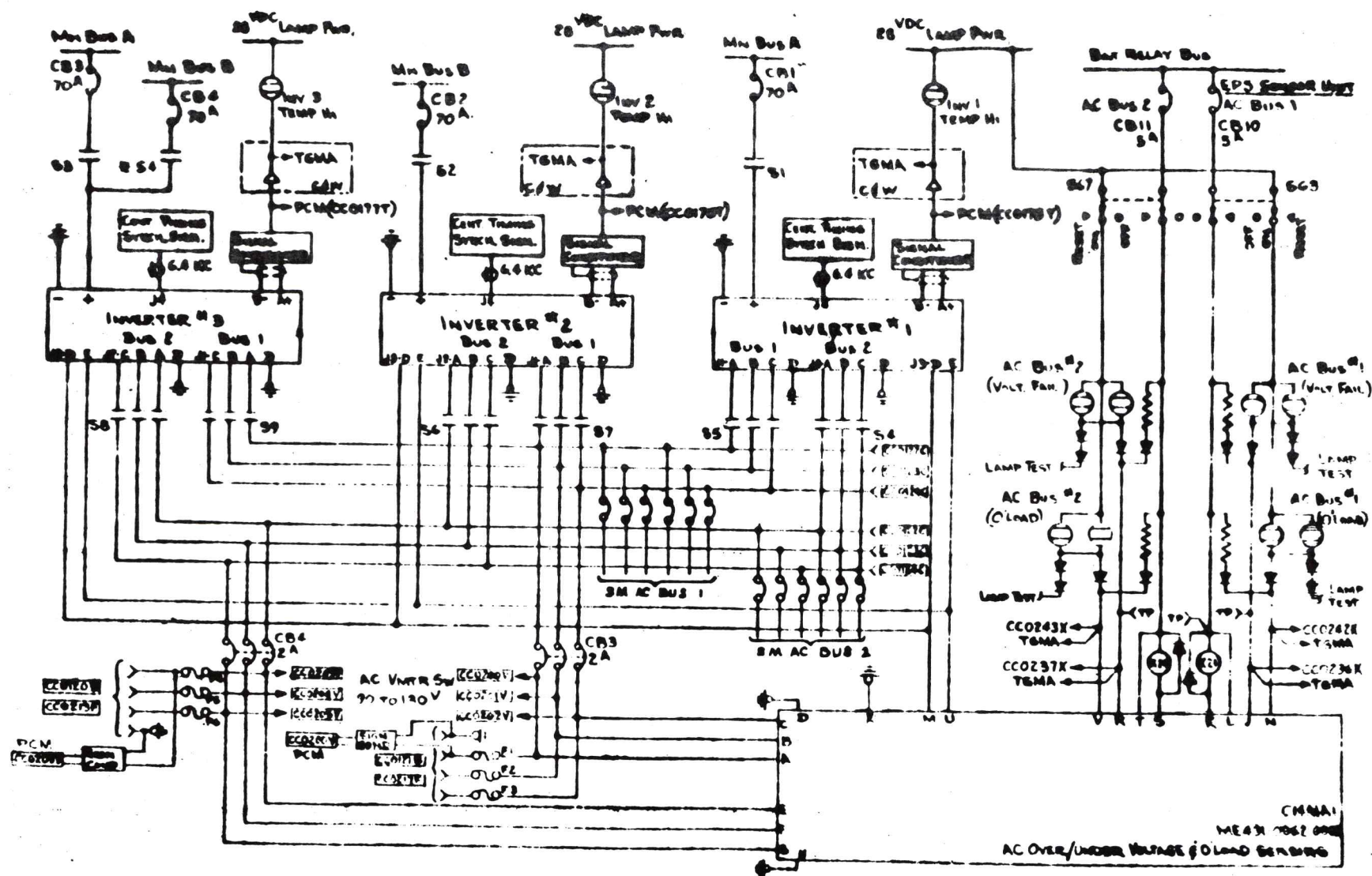
<u>AAP REQUIREMENTS</u>	<u>BLOCK II CAPABILITY</u>	<u>AAP DELTA</u>
BATTERY CHARGER SYSTEM		
PRECLUDE EARLY MISSION TERMINATION DUE TO LOSS OF SINGLE BATTERY CHARGER	LOSS OF SINGLE BATTERY CHARGER EARLY IN MISSION WOULD REQUIRE MISSION TERMINATION	ADD SECOND IDENTICAL AND REDUNDANT BATTERY CHARGER
POWER GENERATION		
THREE FUEL CELLS	THREE P&W PC3A-2	THREE AC FCA
P MIN 400 W/FCA	563 WATTS/FC	400 WATTS/FCA
P MAX (EVA) 1700 W/FCA	1420 WATTS/FC	1900 WATTS/FCA
P MAX (REPRESS) 1350 W/FCA	1420 WATTS/FC	1900 WATTS/FCA
H ₂ O PRODUCTION 27.5 LB/DAY	MEETS REQUIREMENT	MEETS REQUIREMENT AT 1800 WATTS AVERAGE
SOLAR ARRAY LOAD SHARING	N/A (WOULD REQUIRE VOLTAGE REGULATORS)	VOLTAGE REGULATORS NOT REQUIRED
MISSION LIFE 1344 HR (56 DAY)	336 HR (14 DAY)	QUALIFY ACFCA TO 1500 HR
NO H ₂ O VENTING 3000 WATTS	NOT APPLICABLE	
INSPACE SHUTDOWN AND RESTART	HOT STANDBY ONLY	MEETS REQUIREMENT, MINOR EPS RADIATOR MODIFICATION

ELECTRICAL POWER SYSTEM SUMMARY (CONTINUED)

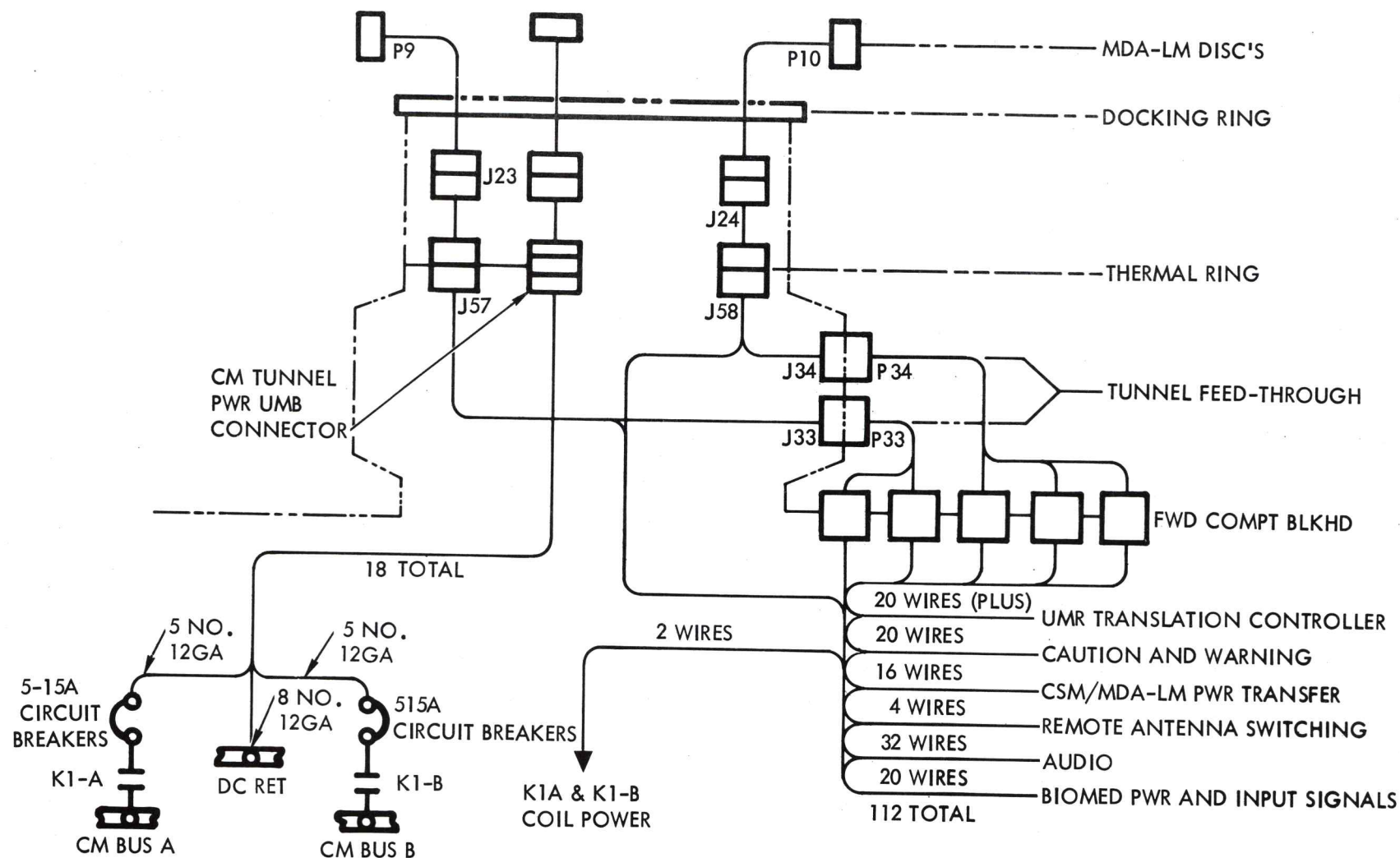
<u>AAP REQUIREMENTS</u>	<u>BLOCK II CAPABILITY</u>	<u>AAP DELTA</u>
RETURN BATTERY PACK	N/A	
MAINTAIN DEORBIT CAPABILITY AFTER LOSS OF ALL THREE F/C	DEORBIT AFTER LOSS OF TWO FLPs	ADD RETURN BATTERY PACK
DEORBIT TIME (RCS, ΔV) = 3.6 HRS.		OPERATING LIFE OF 4.25 HRS.
WET STAND LIFE = 60 DAYS		DESIGN LIFE = 120 DAYS
ENERGY = 8.5 KWH AFTER 60 DAY WET STAND LIFE		9.95 KWH AFTER 60 DAYS

D-C POWER DISTRIBUTION, SCHEMATIC DIAGRAM

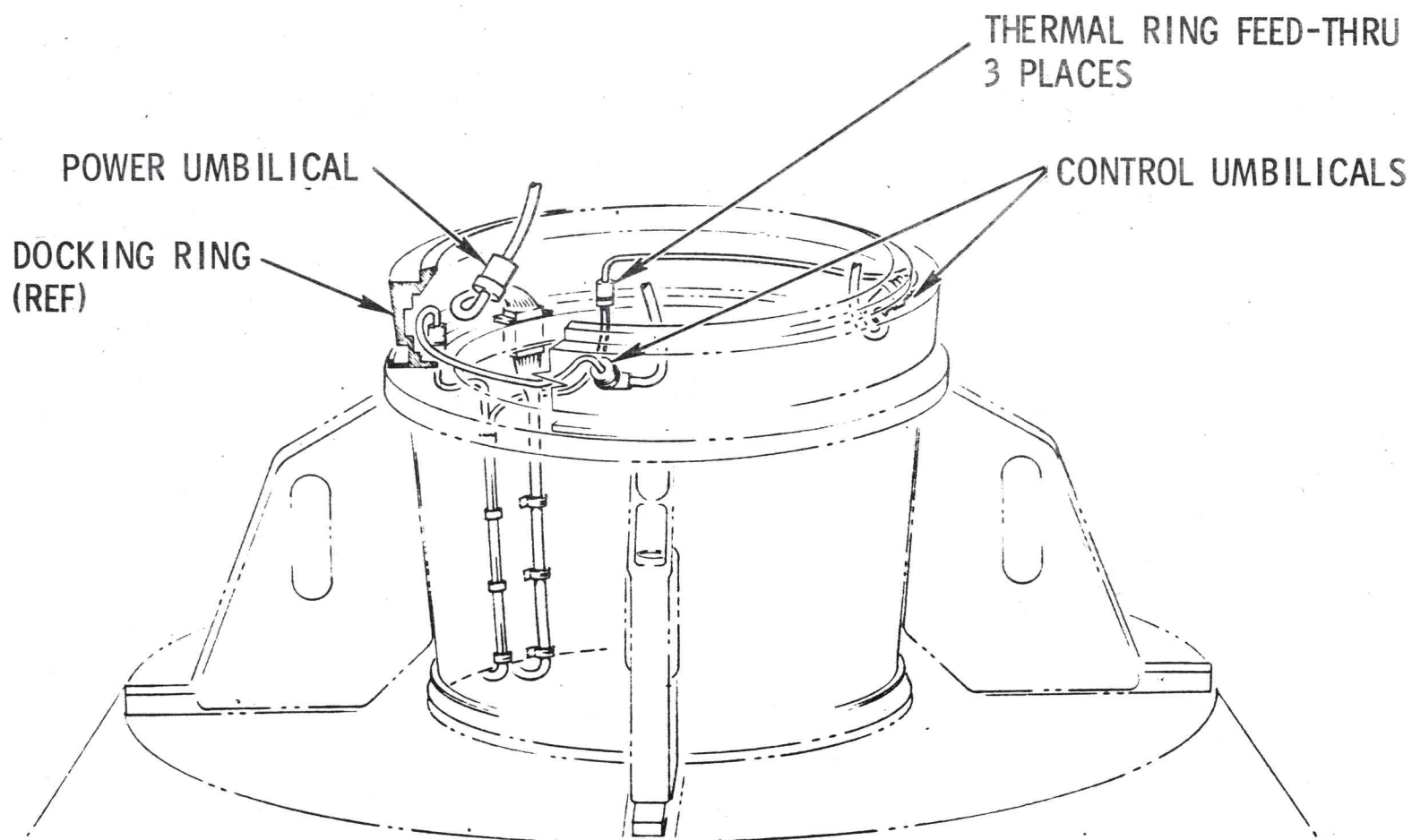




CSM/MDA - LM POWER & CONTROL HARNESS ROUTING

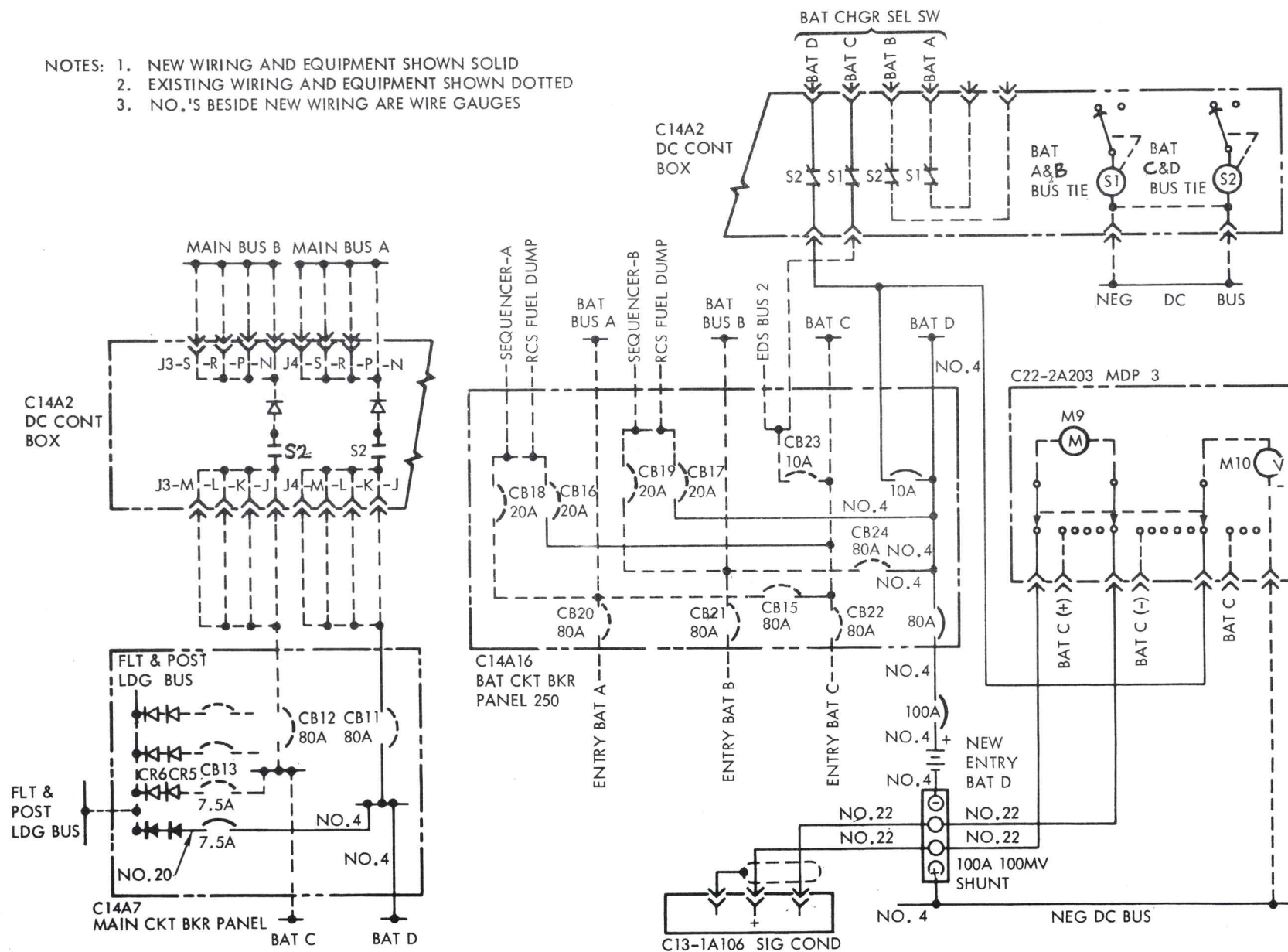


TUNNEL WIRE HARNESSSES

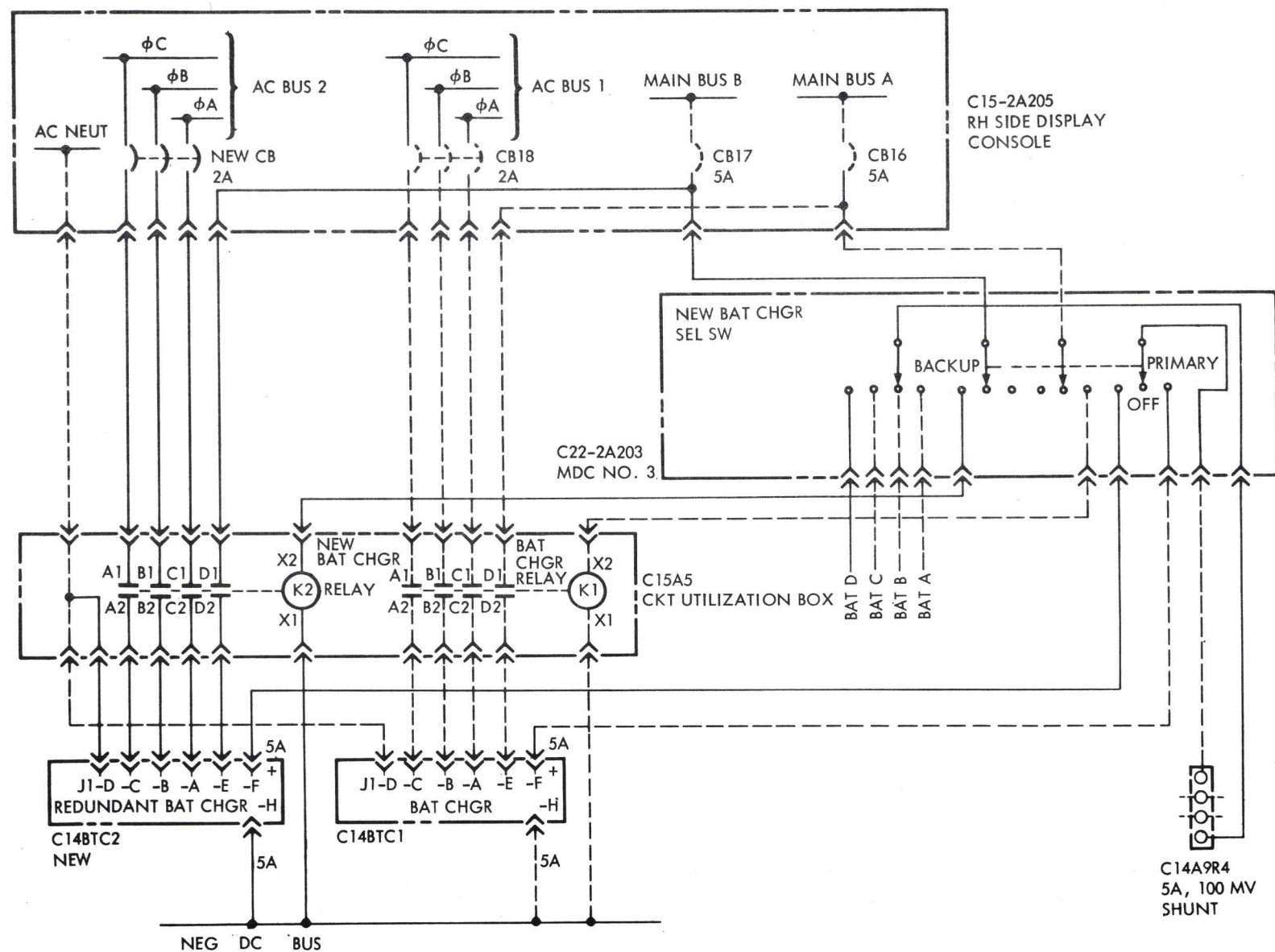


FOURTH ENTRY BATTERY INSTALLATION, SCHEMATIC

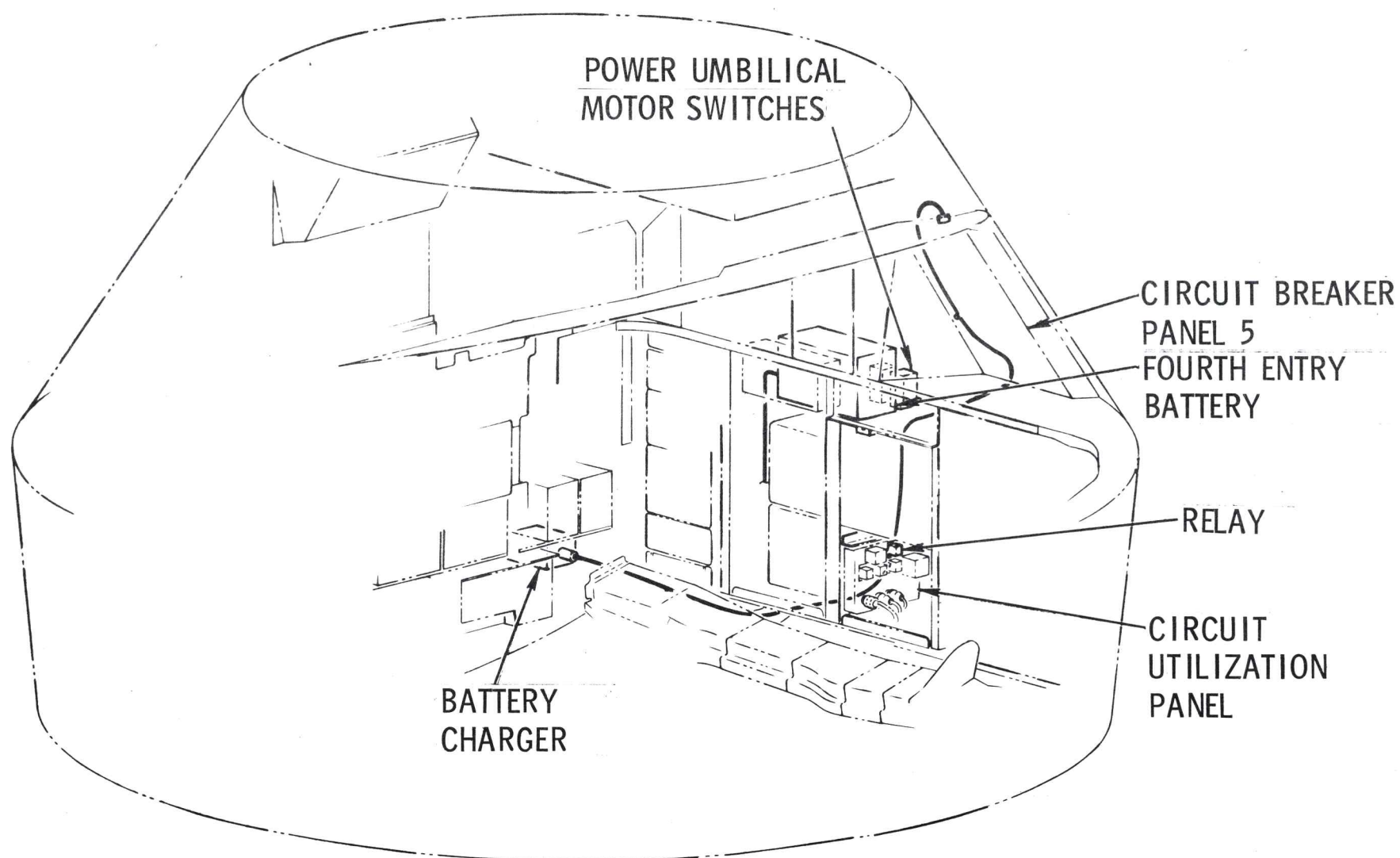
- NOTES: 1. NEW WIRING AND EQUIPMENT SHOWN SOLID
 2. EXISTING WIRING AND EQUIPMENT SHOWN DOTTED
 3. NO.'S BESIDE NEW WIRING ARE WIRE GAUGES



REDUNDANT BATTERY CHARGER INSTALLATION, SCHEMATIC



ELECTRICAL POWER SYSTEM



+Z +Y
-Y -Z

PGS BASELINE CONFIGURATION

FUEL CELL ASSEMBLY SUBSYSTEM

THREE ALLIS-CHALMERS FCAs

SECTOR IV SM INSTALLATION

HEAT REJECTION VIA BLOCK II EPS RADIATOR ASSEMBLY

NO FCA VOLTAGE REGULATORS

CLEAN INTERFACE OPERATION AAP 1-2 AND AAP 3 BACKUP

FCAS/SAB LOAD SHARING AAP 3A AND AAP 3-4

1800 WATTS AVERAGE (CSM) 56 DAYS

RETURN BATTERY PACK

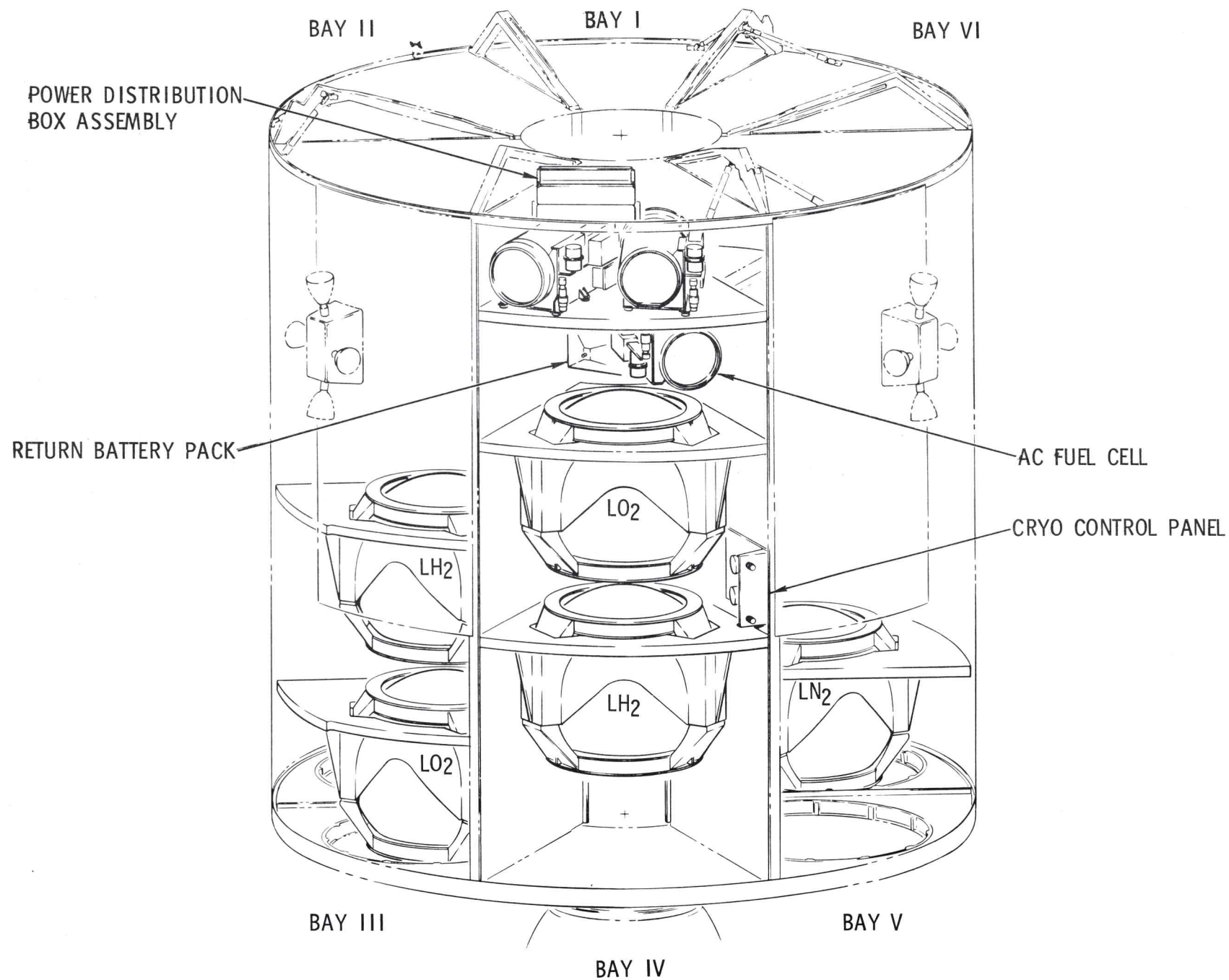
SIX SILVER ZINC BATTERIES

SECTOR I SM INSTALLATION

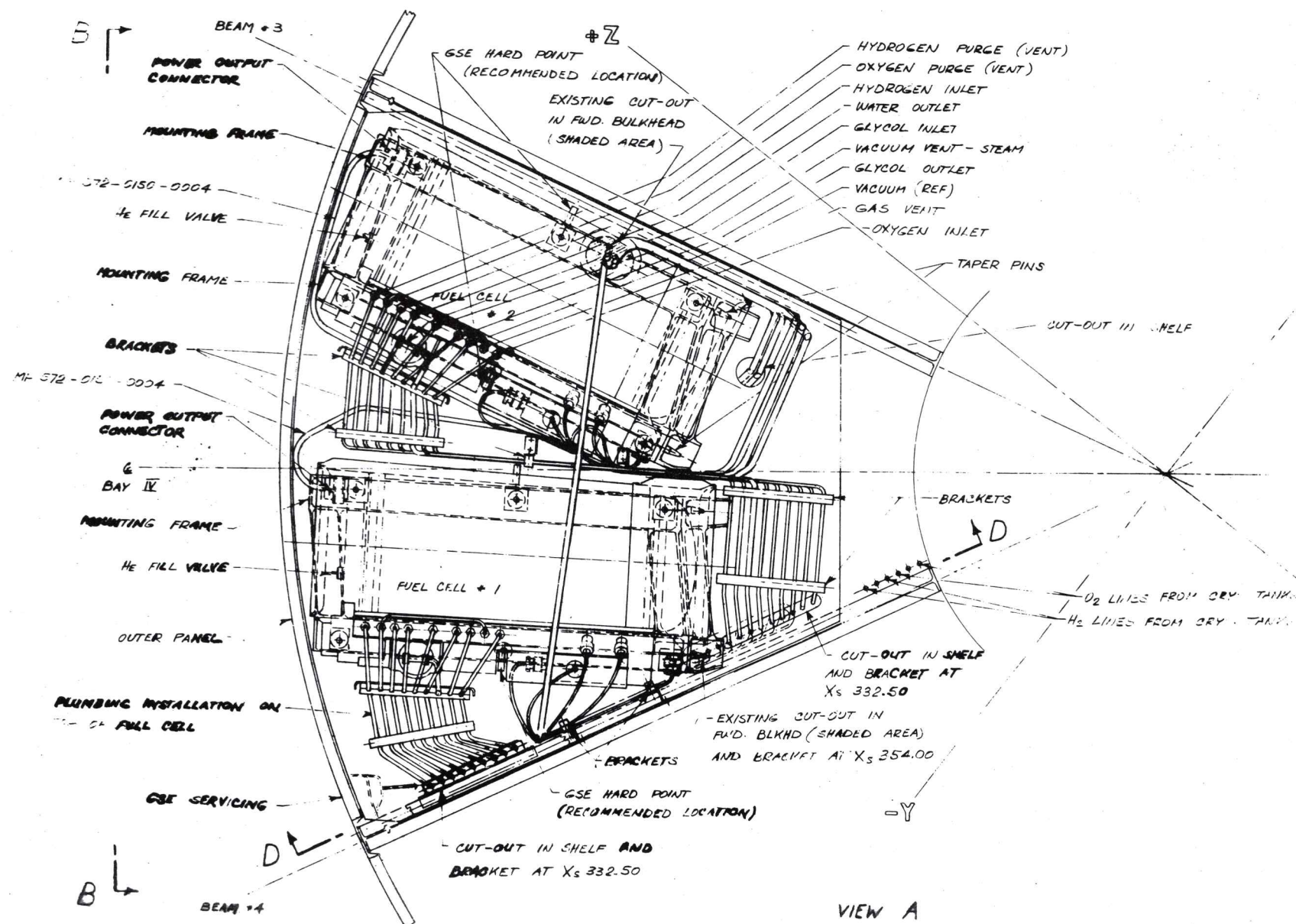
120 DAY WET STAND LIFE

2300 WATTS FOR 3.60 HOURS AT END OF 60 DAYS

EPS & CSS



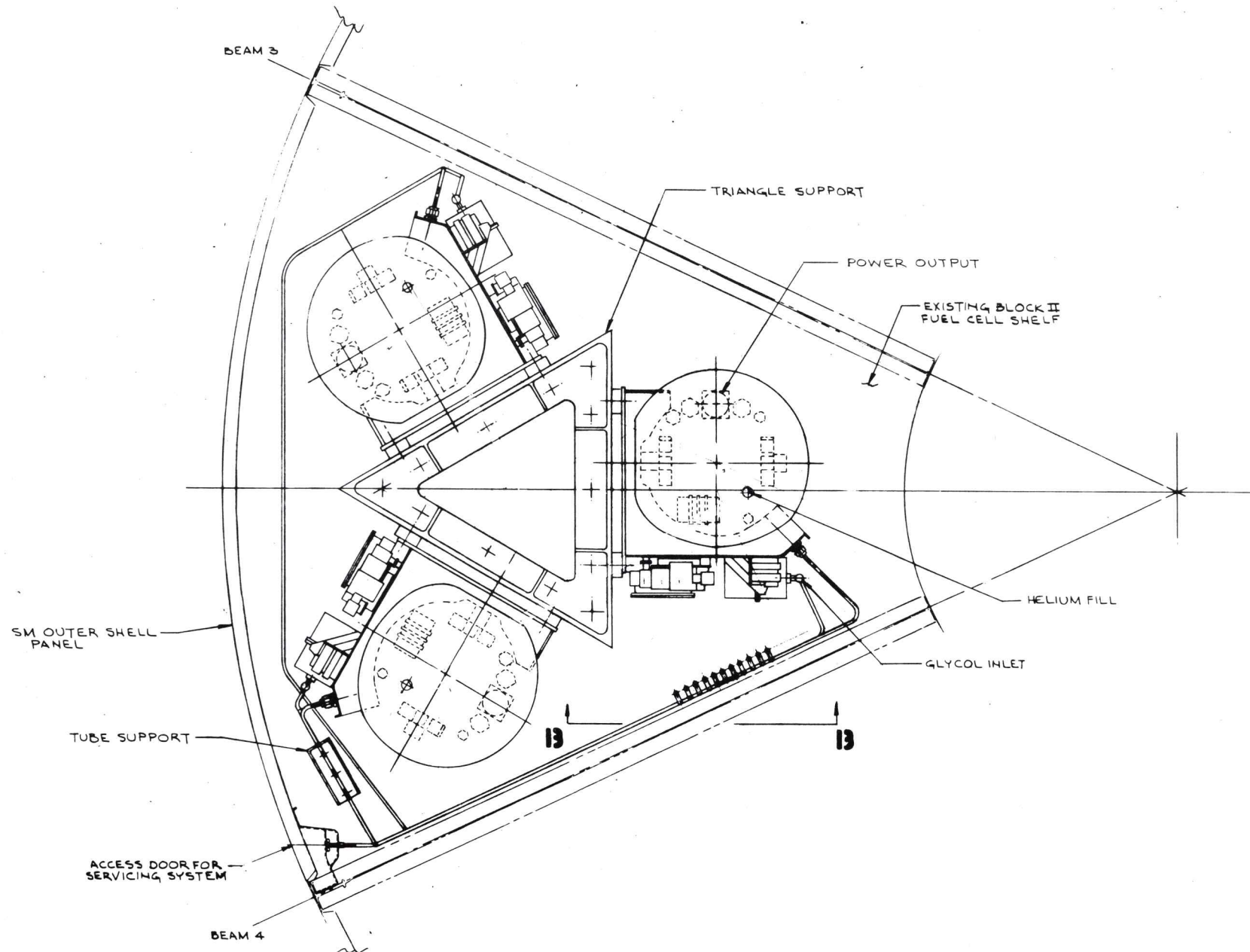
AC FCP INSTALLATION VIEW 1



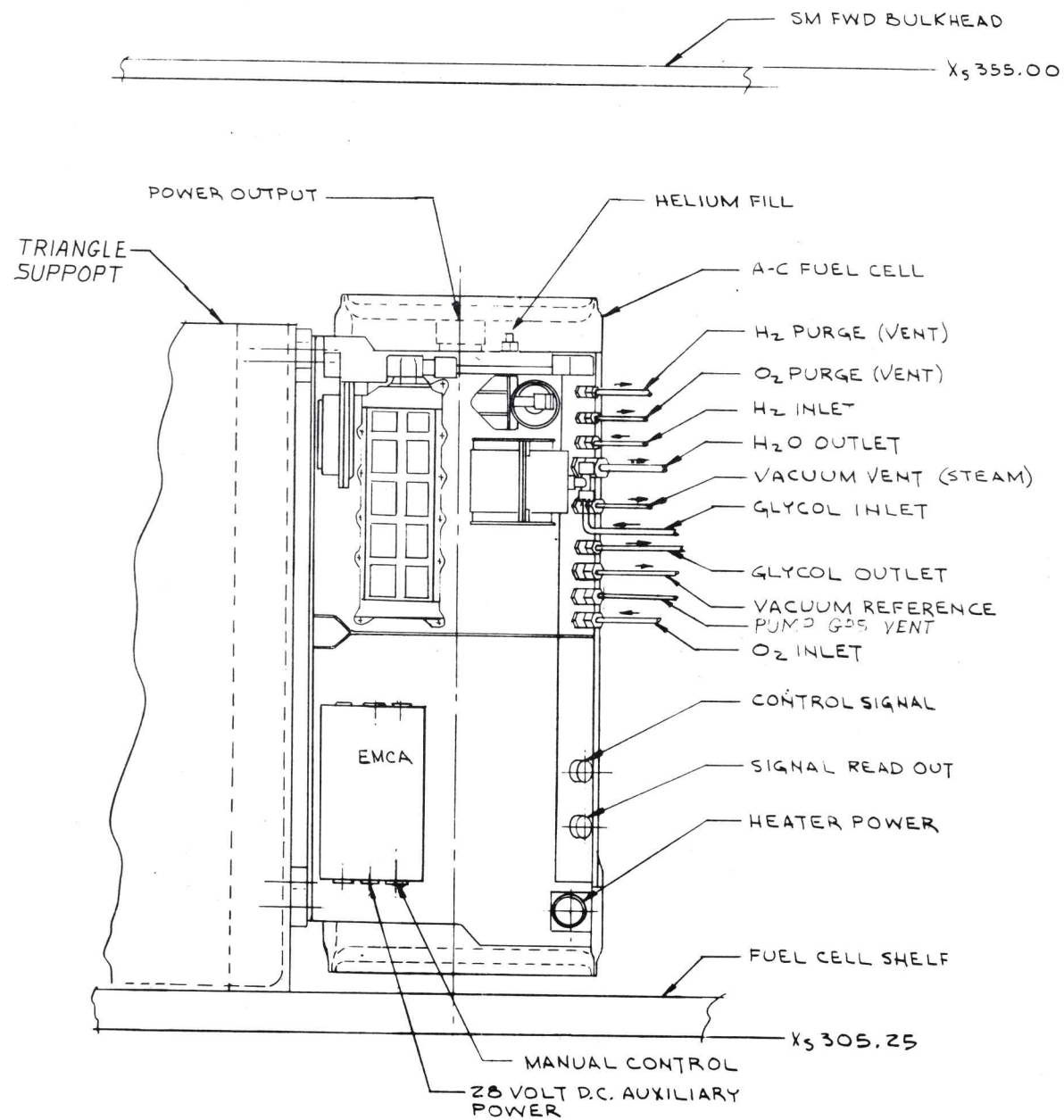
VIEW A
VIEW LOOKING AFT
ROTATED 90° - FWD. BLKHD. OMITTED FOR CLARITY

108AX16453X

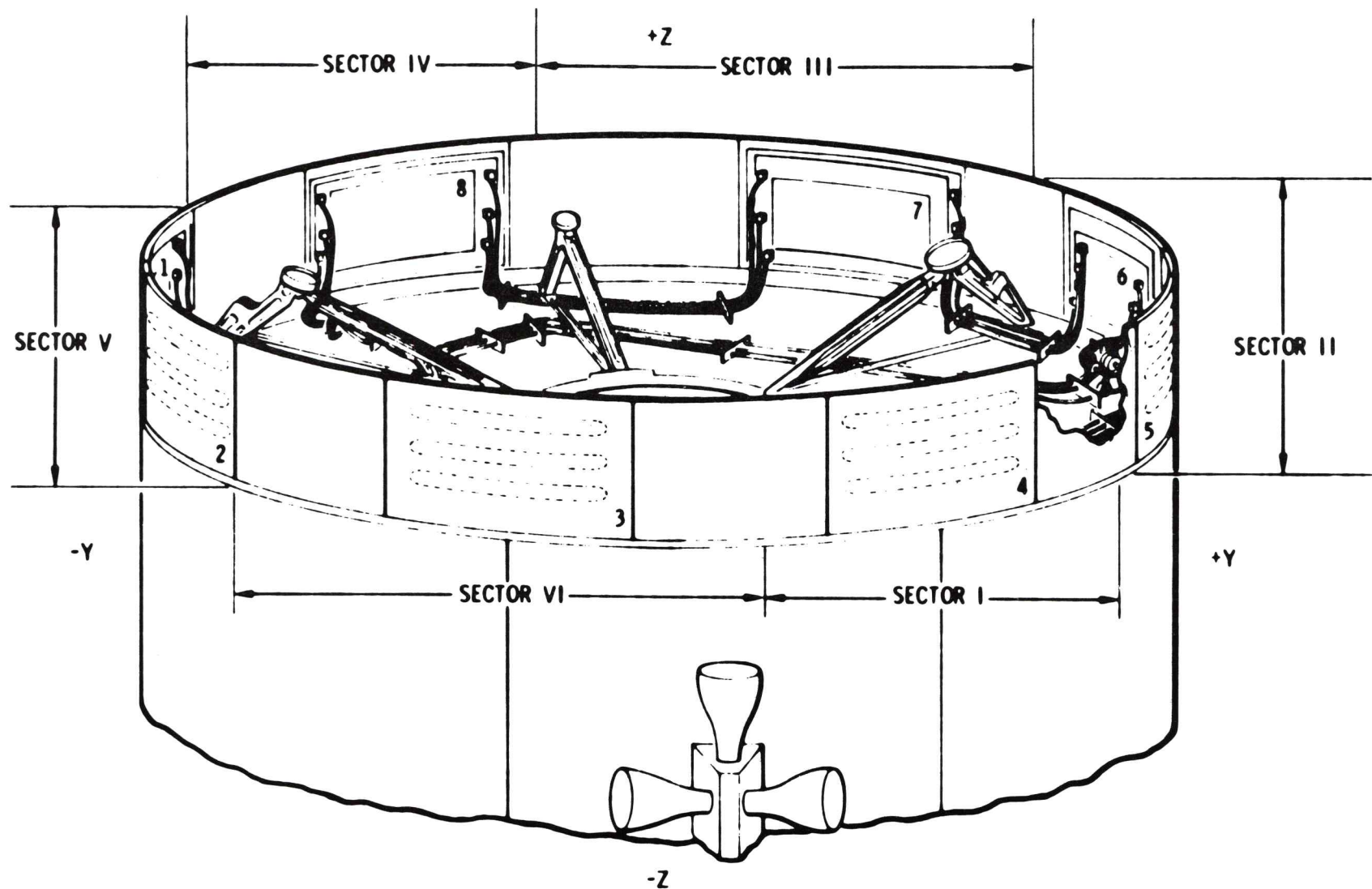
VERTICAL INSTALLATION - BLOCK II SHELF LOCATION



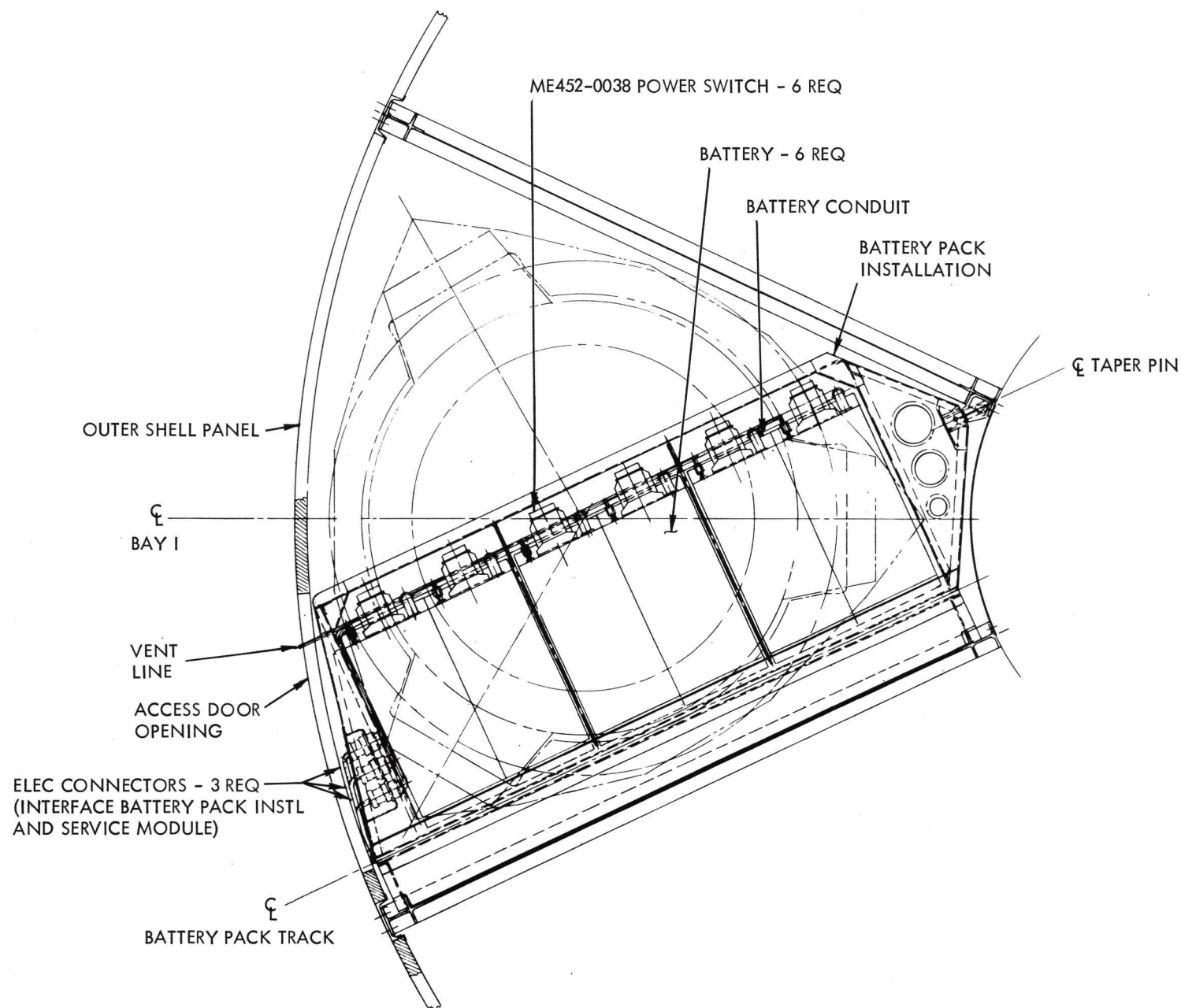
VIEW B-B TYPICAL 3 PLACES



EPS RADIATOR LOCATION BLOCK II



RETURN BATTERY PACK



ELECTRICAL POWER SYSTEM HISTORICAL SUMMARY

POWER AND CONTROL CM TUNNEL UMBILICALS

EXTERNAL UMBILICAL FROM AIRLOCK TO SM

RECTANGULAR POWER UMBILICAL PLUG AT TUNNEL THERMAL RING, WITH ENGAGING MECHANISM

CM CONTROL OF POWER TRANSFER BY CIRCUIT BREAKERS ONLY.

SMALLER NUMBER OF POWER UMBILICAL WIRES AND CIRCUIT BREAKERS

ENTRY AND PYRO BATTERY

PYRO BATTERY REDESIGN FOR LONGER LIFE

REMOVE PYRO BATTERIES, USE THREE OR FIVE ENTRY BATTERIES

REDUNDANT BATTERY CHARGER

BATTERY BUS LOAD REDUCTION

FIFTH ENTRY BATTERY

FUEL CELL

ANALYZED BLOCK II FCP MOD FOR AES MISSIONS

ANALYZED ALLIS-CHALMERS FCP FOR AES MISSIONS

ANALYZED 2 BLOCK II FCP SYSTEM FOR EARTH ORBITAL MISSIONS

STUDY TO DEFINE BLOCK II UPRATED FCP CONFIGURATION FOR AAP

EPS SIMULATION AND EPS RADIATOR ANALYSIS

AAP MODIFICATIONS KIT E-4 UPRATED FCP

ELECTRICAL POWER SYSTEM HISTORICAL SUMMARY (CONTINUED)

FUEL CELL (CONTINUED)

TRADE-OFF ANALYSIS OF CSM FUEL CELLS/SOLAR ARRAY BATTERY SYSTEMS
FOR AAP MISSIONS

EPS RADIATOR AND FCP/ECS THERMAL MANAGEMENT SYSTEM HEAT TRANSFER
ANALYSIS

CSM POWER PROFILES AAP 1-2 AND 3-4

CSM EPS COMPUTER SIMULATION REPORTS

PROBLEM AREAS REQUIRING ACTION

COMMAND MODULE TUNNEL UMBILICAL

CM/LM-ATM INTERFACE - ATM INTERCONNECTS

CM MAIN BUSES A AND B AT ATM RELAY K_Z

NR POSITION IS THAT CM BUSES A AND B MUST BE KEPT ISOLATED
AND REDUNDANT IN ATM

PROGRAM CONSIDERATION

EMC VERIFICATION

NASA PRR RID 8-10 REQUIRES THAT THE CMTU INTERFACE BE VERIFIED DURING THE FRT AT THE LAUNCH PAD. THIS WILL REQUIRE EITHER:

- A. GSE TO REMOVE HATCH
- B. ACCESS OPENINGS THROUGH BOOST PROTECTIVE COVER, OR
- C. TEST CONNECTIONS FROM CMTU TO GSE ACCESS CONNECTOR, AND THE
THE SIMULATOR DESIGNED FOR AND LOCATED ON THE LAUNCH TOWER
PLATFORM

NASA TWX DATED 9/24/68, REQUESTED NR STUDY USE OF MDA SIMULATOR FOR EMC VERIFICATION OF CMTU INTERFACE - NR REPLY STATES THIS APPROACH IS FEASIBLE PROVIDING AN ACTUAL SIMULATOR CAN BE BUILT.

NASA REQUESTED TO COORDINATE THIS METHOD OF EMC VERIFICATION WITH MDA AND LM/ATM CONTRACTORS.

PROGRAM CONSIDERATIONS (CONTINUED)

FUEL CELL/SAB INCOMPATIBILITIES

NASA SHOULD ESTABLISH SAB POWER AVAILABILITY TO CSM FOR CRITICAL
MISSION PHASES

PRESENT SIMULATION RUN - EVA PEAK POWER 5100 WATTS

- EVA AVERAGE POWER 4000 WATTS

PRESENT FCAS REQUIREMENT - 2500 WATTS (2 FCAs) NO VENTING

SAB MUST PROVIDE DELTA POWER - UP TO 2600 WATTS

SAB BUDGETED FOR 700 WATTS AVERAGE - PEAK POWER NOT ESTABLISHED

IS NO VENTING A REAL REQUIREMENT, ALLIS CHALMERS REDESIGN TO
MEET NO VENTING REQUIREMENT SERIOUS PROBLEM

ALTERNATE OF INCREASING RADIATOR AREA RESULTS IN SM MODIFICATIONS

SEQUENTIAL EVENTS CONTROL SUBSYSTEM (SECS) AND LAUNCH
VEHICLE-EMERGENCY DETECTION SUBSYSTEM (LV-EDS)AAP SYSTEM
CONFIGURATIONBLOCK II CONFIGURATIONAAP DELTA

SECS

TWO MESC

TWO MESC

TWO SMJC

TWO SMJC

ONE RCSC

ONE RCSC

TWO DEC

TWO LDEC

TWO ELSC

TWO ELSC

ONE PCVB

ONE PCVB

NO CM CIRCUIT PROVISIONS
FOR LSSC OR SM CIRCUIT
PROVISIONS FOR HI-GAIN ANTENNA
DEPLOYMENTWITH CM CIRCUIT PROVISIONS
FOR LSSC, AND SM CIRCUIT
PROVISIONS FOR HI-GAIN
ANTENNA DEPLOYMENTREMOVE CM CIRCUIT PRO-
VISIONS FOR LSSC, AND SM
CIRCUIT PROVISIONS FOR HI-
GAIN ANTENNA DEPLOYMENT

NO LSSC IN SLA

LSSC IN SLA

REMOVE LSSC FROM SLA

LV-EDS

8-ENGINE OUT LIGHT DISPLAY
PANEL5-ENGINE OUT LIGHT DISPLAY
PANELREPLACE 5-LIGHT PANEL
BY 8-LIGHT PANEL

AAP SUMMARY CHART

AAP REQUIREMENTS	BLOCK II CAPABILITY	AAP DESIGN
FUNCTIONAL SAME AS BLOCK II	ADEQUATE	NONE
MISSION DURATION 56 DAYS IN ORBITAL ENVIRONMENT	DEMONSTRATED ONLY TO BLOCK II REQUIREMENTS	UNKNOWN FURTHER TESTING REQUIRED

- SYSTEM ALTERNATES

NONE

- SYSTEM USES APOLLO COMPONENTS AS DESIGNED

- BLOCK II SYSTEMS

BLOCK II ORDNANCE CONSISTS OF

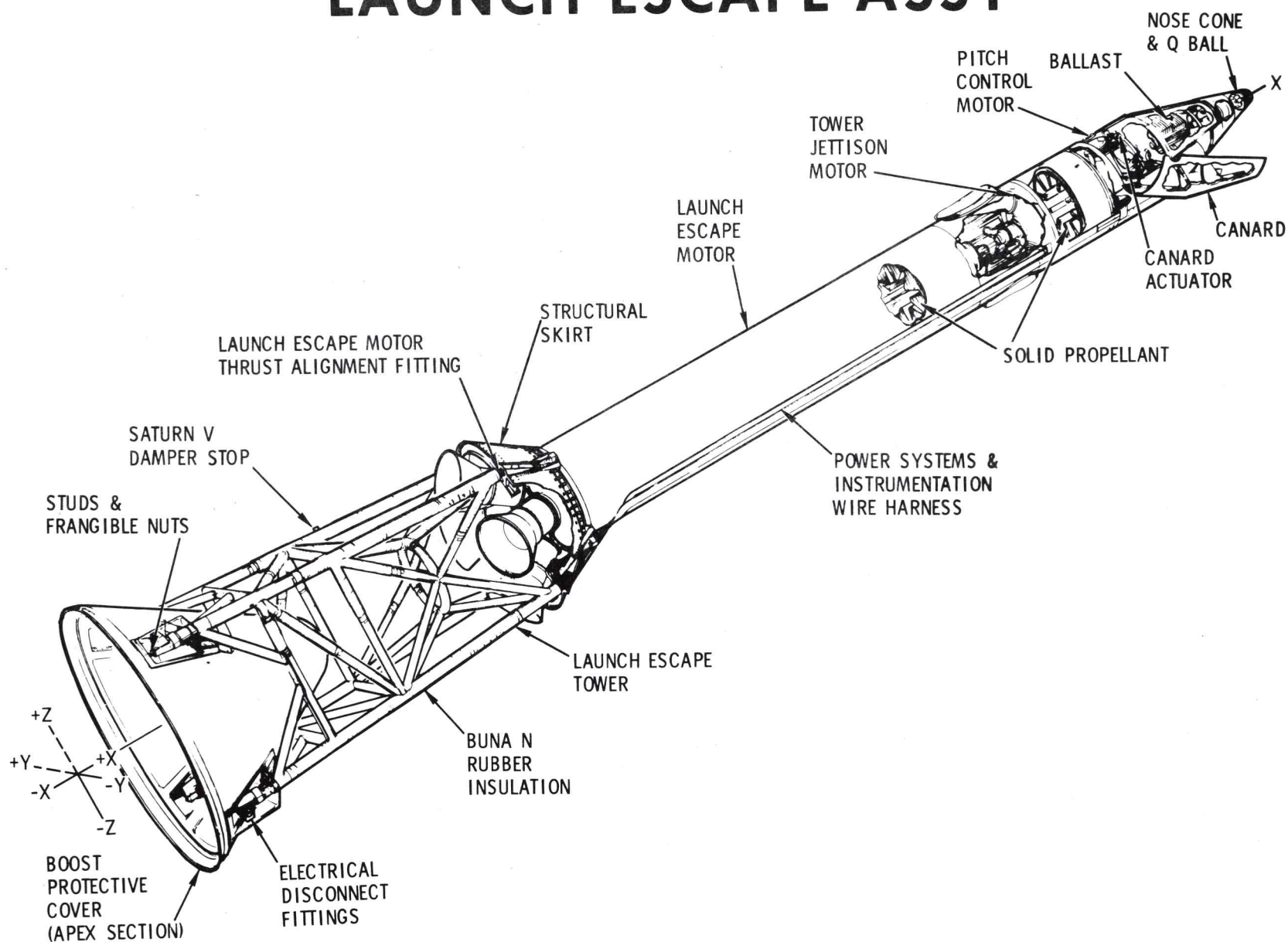
SYSTEM

- LES SEPARATION SYSTEM
- SLA SEPARATION SYSTEM
- SLA LEM SEPARATION SYSTEM
- SM CM SEPARATION SYSTEM
- CM RCS SYSTEM
- FWD HEATSHIELD EJECTION SYSTEM
- ELS SYSTEM
- LOCATION AIDS RELEASE SYSTEM
- CM LM SEPARATION

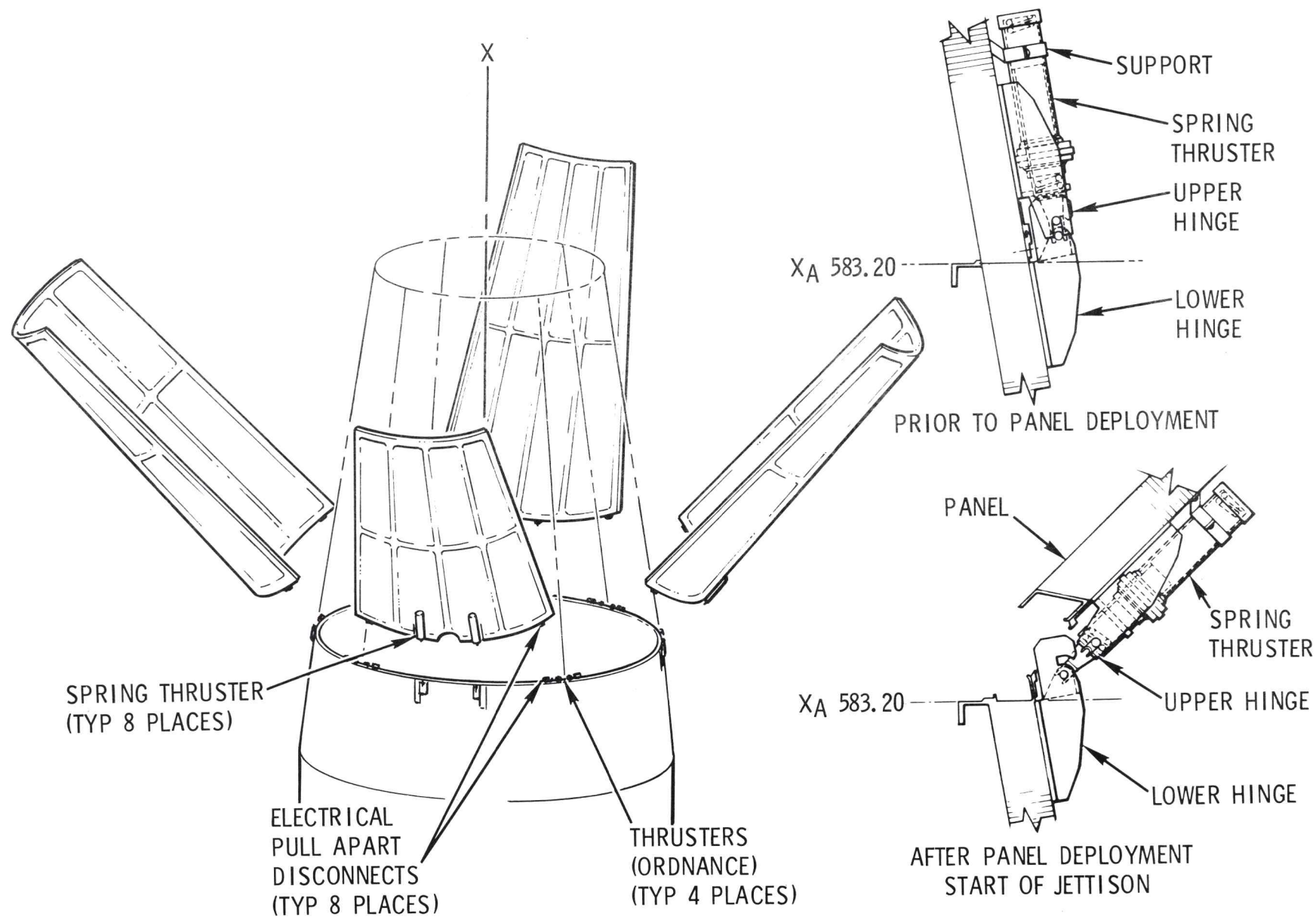
LOCATED

- EXTERNAL TO CM FWD OF FWD HEATSHIELD
- BETWEEN SM AND S-IVB
- IN LOWER SLA AREA
- EXTERNAL TO CM AND BETWEEN CM AFT HEATSHIELD AND SM FWD BULKHEAD
- EXTERNAL TO CM INNER STRUCTURES AND INTERNAL TO CM OUTER STRUCTURAL SHELL
- BENEATH FWD HEATSHIELD IN ELS AREA
- EXTERNAL TO CM AND BENEATH FWD CM HEATSHIELD
- BENEATH FWD HEATSHIELD
- BENEATH FWD HEATSHIELD APEX

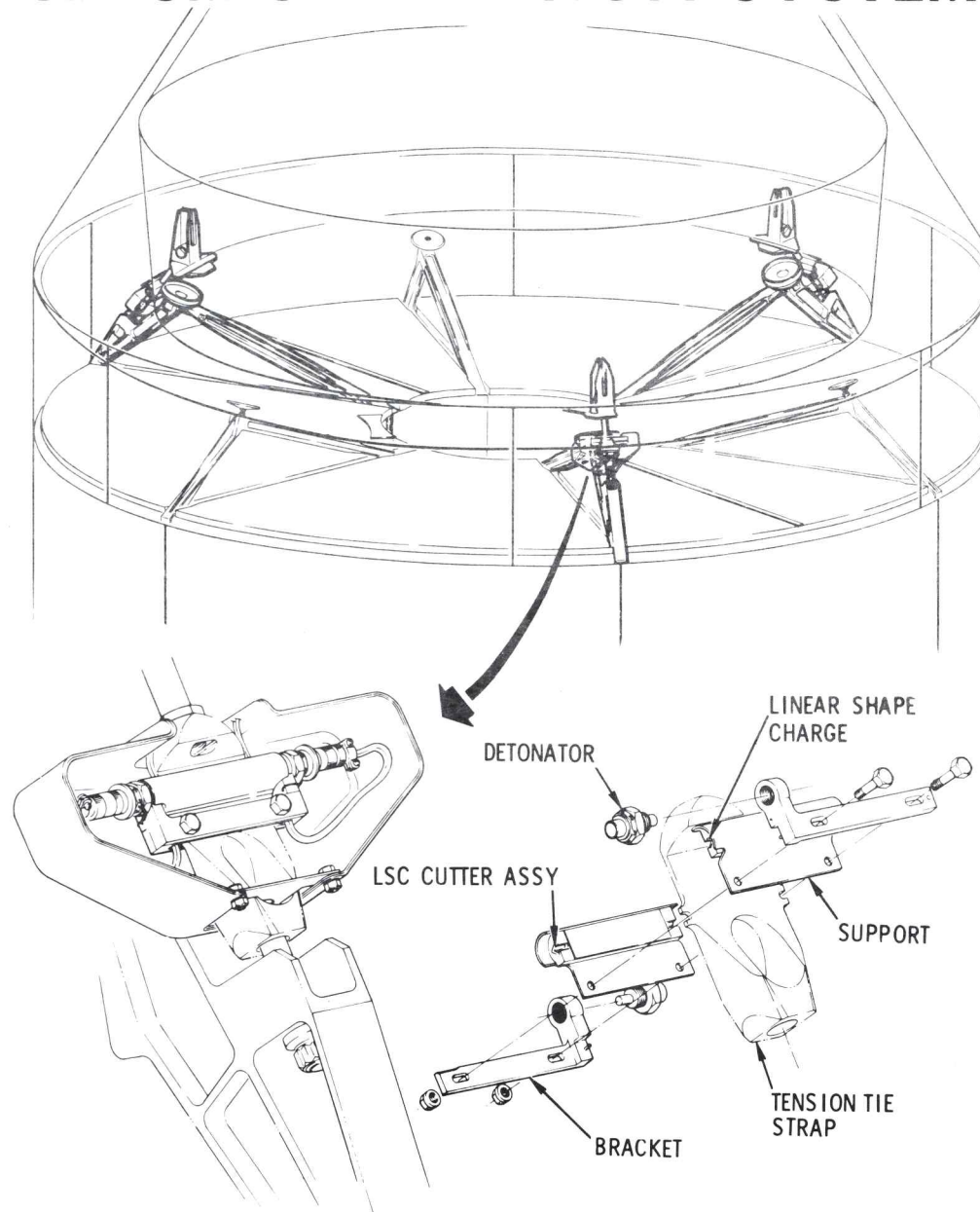
LAUNCH ESCAPE ASSY



SLA PANEL JETTISON SYSTEM

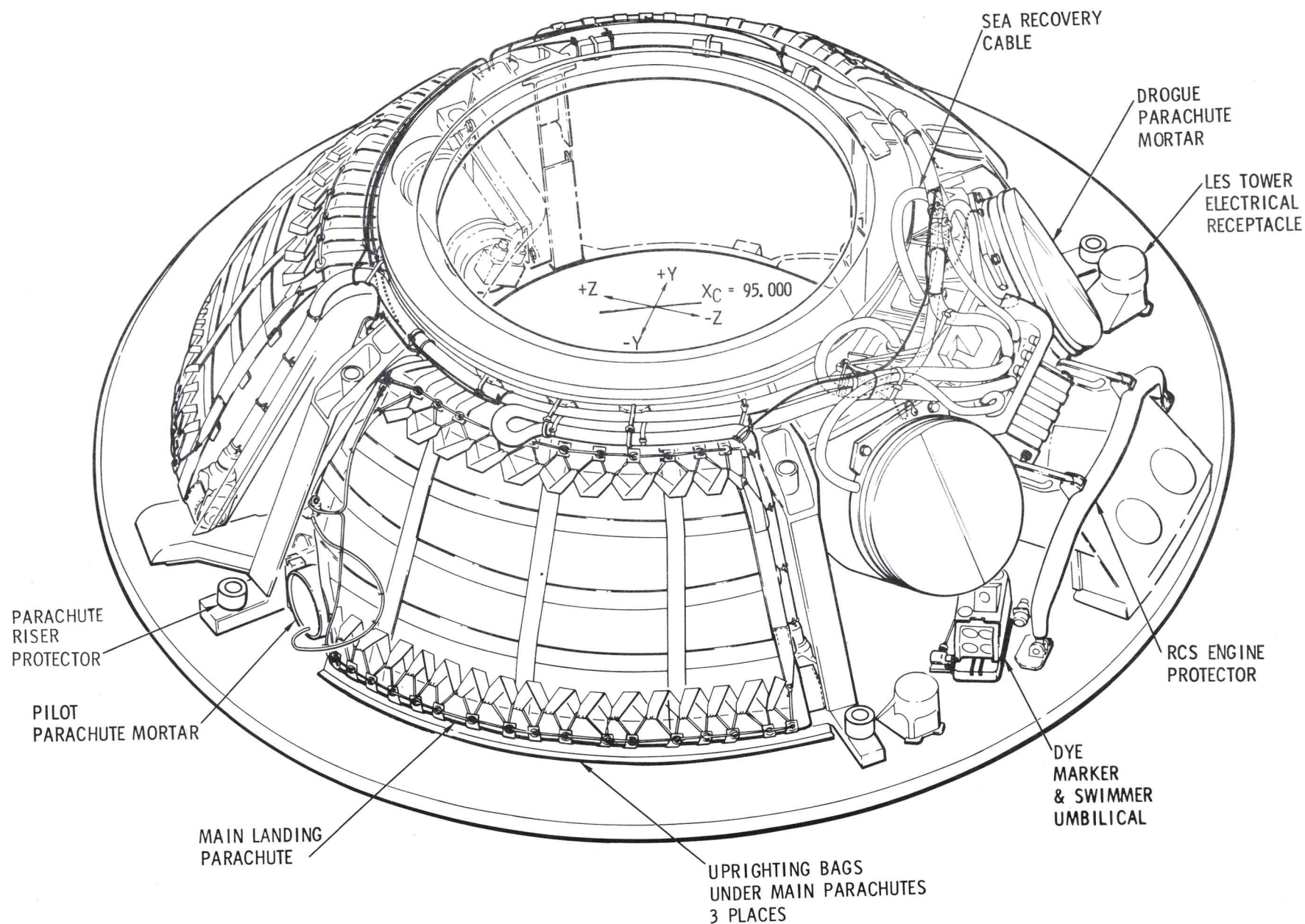


CM-SM SEPARATION SYSTEM



ELS EQUIPMENT

(BLOCK II)



PROBLEMS NEEDING FURTHER STUDIES

- MISSION CAPABILITY OF BLOCK II ORDNANCE COMPONENT BASE EXPLOSIVE
- BLOCK II BASE EXPLOSIVE AND BOOSTER CHARGE INTERFACE