



APOLLO TRAINING

SEQUENTIAL SYSTEMS
(EDS, SECS, LES, ELS)

COURSE NO. A-318
HANDOUT NO. 1

15 FEB. 1969

FOR TRAINING PURPOSES ONLY



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

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A NOTE TO THE STUDENT

The following pages contained within this handout have been revised since the 1 November 1968 release: 4, 14, 17, 26, 39, 54, 70, 71, 84, 85, 86, 88, & 90.

These pages have been added to the handout since the 1 November 1968 issue: 45, 46, 77, 78, 87, & 89.

The following pages of the 1 November 1968 handout have been deleted from this publication: 62, 65, 66, 67, 71, 73, 74, 87, & 88.

Due to the above listed revisions, additions, and deletions the pages in this handout, beginning with page 45, have been completely renumbered. The schematics, power distribution, and system data sections have been rearranged to make the handout more convenient for you to use. For the location of all the displays and controls associated with Sequential Systems, please refer to the latest Displays and Controls drawings for CSM 106 and subs.

SEQUENTIAL SYSTEMS

WHAT ARE THEY?

- THE INTEGRATION OF THE LAUNCH VEHICLE (LV) EMERGENCY DETECTION SYSTEM (EDS) WITH A NUMBER OF APOLLO SUBSYSTEMS

FOR THE PURPOSE OF:

1. PROVIDING A FLIGHT CREW WITH IMMEDIATE ABORT AND CERTAIN EARLY MISSION TERMINATION CAPABILITIES (PRIME CONCERN: CREW SAFETY)
2. PERFORMING MANY NORMAL MISSION FUNCTIONS

DEFINITION OF TERMS

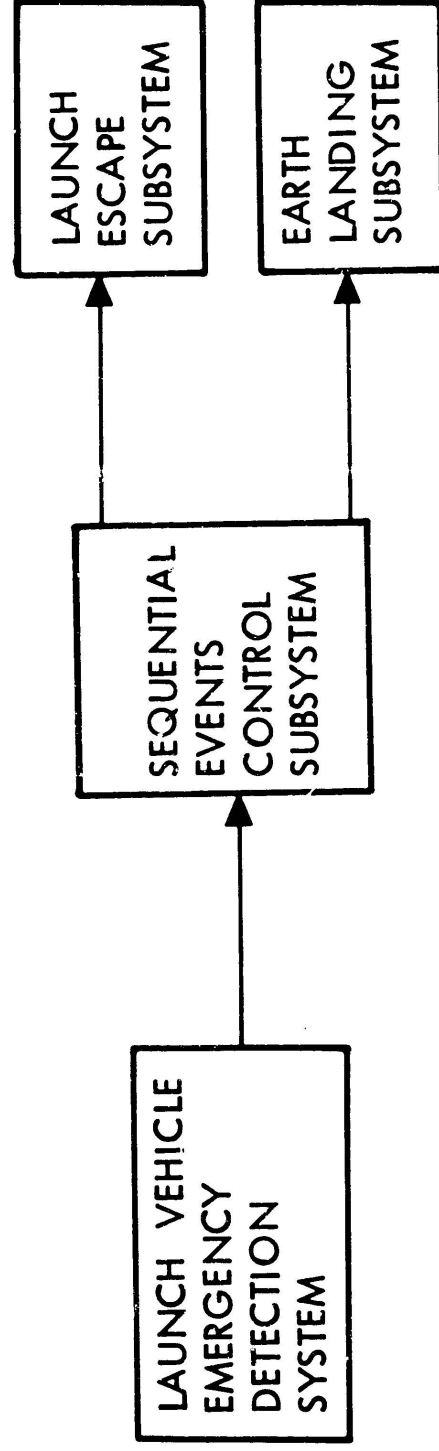
- ABORT

A MISSION TERMINATION BY UNSCHEDULED INTENTIONAL SEPARATION OF
THE SPACECRAFT FROM THE LAUNCH VEHICLE PRIOR TO ORBIT INSERTION

- EARLY MISSION TERMINATION

AN UNSCHEDULED INTENTIONAL MISSION TERMINATION AT OR AFTER
ORBIT INSERTION

SEQUENTIAL SYSTEMS MAJOR SUBSYSTEMS

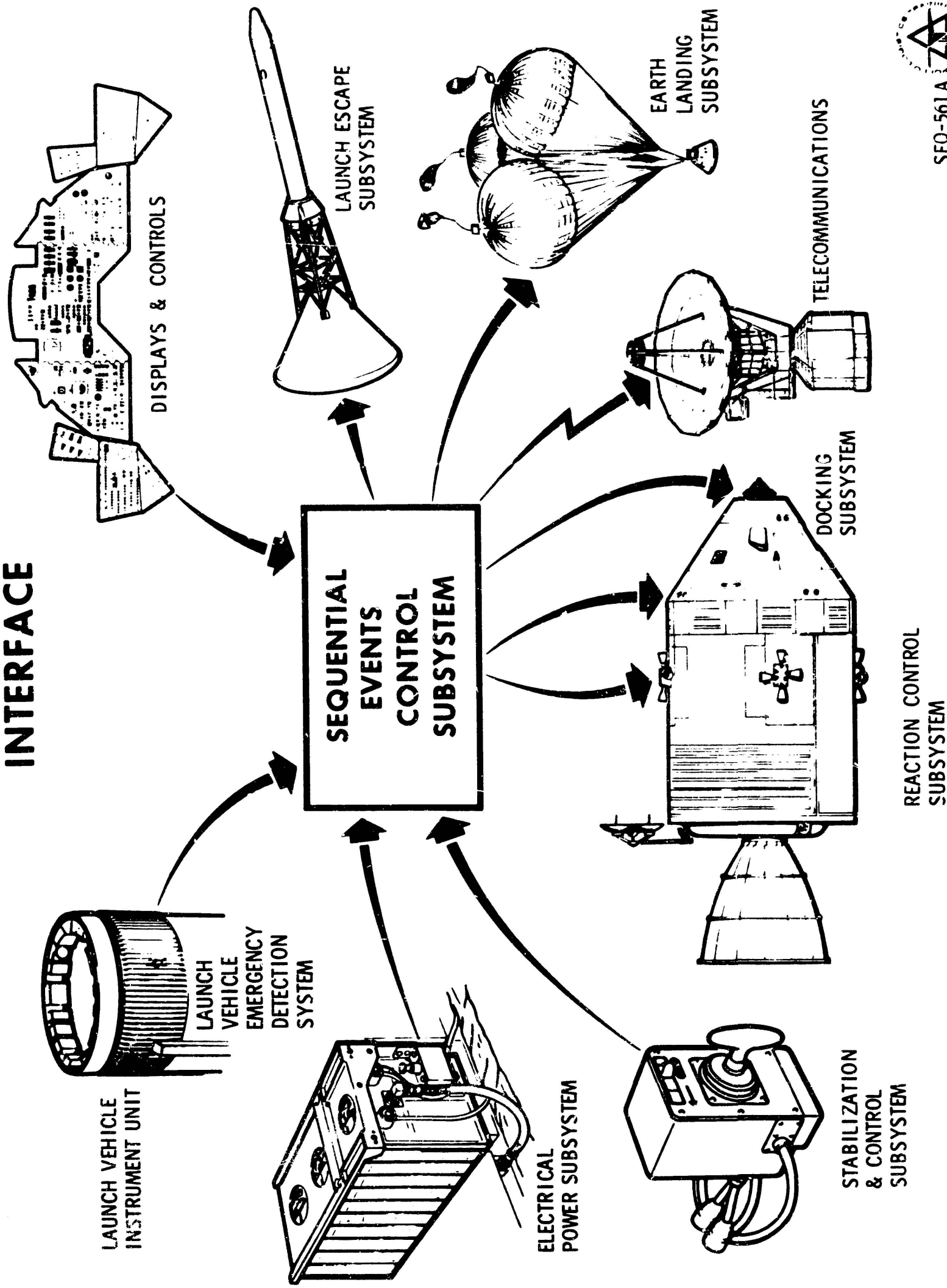


GENERAL PURPOSES

- 3
- | | |
|------|--|
| EDS | <ol style="list-style-type: none"> 1. MONITOR THE CRITICAL PARAMETERS OF THE LV & PROVIDE THIS STATUS TO THE ASTRONAUTS 2. PROVIDE AN AUTOMATIC ABORT CAPABILITY TO THE ASTRONAUTS WITH ANY 2 FIRST STAGE ENGINES FAILING AFTER LIFTOFF OR EXCESSIVE LV ANGULAR RATES |
| SECS | <ol style="list-style-type: none"> 1. PROVIDE AUTOMATIC SEQUENCING OF THE NUMEROUS EVENTS (GENERALLY THE ACTIVATION OF PYROTECHNIC DEVICES) REQUIRED TO SAFELY RESCUE THE CREW IF A SERIOUS EMERGENCY ARISES WHILE THE CSM IS ATTACHED TO THE LV 2. PROVIDE CONTROL OF THE PYROTECHNIC DEVICES REQUIRED TO PERFORM CERTAIN NORMAL MISSION EVENTS |
| LES | <ol style="list-style-type: none"> 1. PROVIDE A MEANS FOR THE ASTRONAUTS TO IMMEDIATELY ESCAPE FROM A DANGEROUS SITUATION EITHER FROM THE LAUNCH PAD OR UP UNTIL THE LAUNCH ESCAPE TOWER (LET) IS JETTISONED |
| ELS | <ol style="list-style-type: none"> 1. RECOVER THE ASTRONAUTS AND CM SAFELY EITHER SUBSEQUENT TO AN UNSCHEDULED INTENTIONAL MISSION TERMINATION OR A NORMAL MISSION |

SEQUENTIAL SYSTEMS

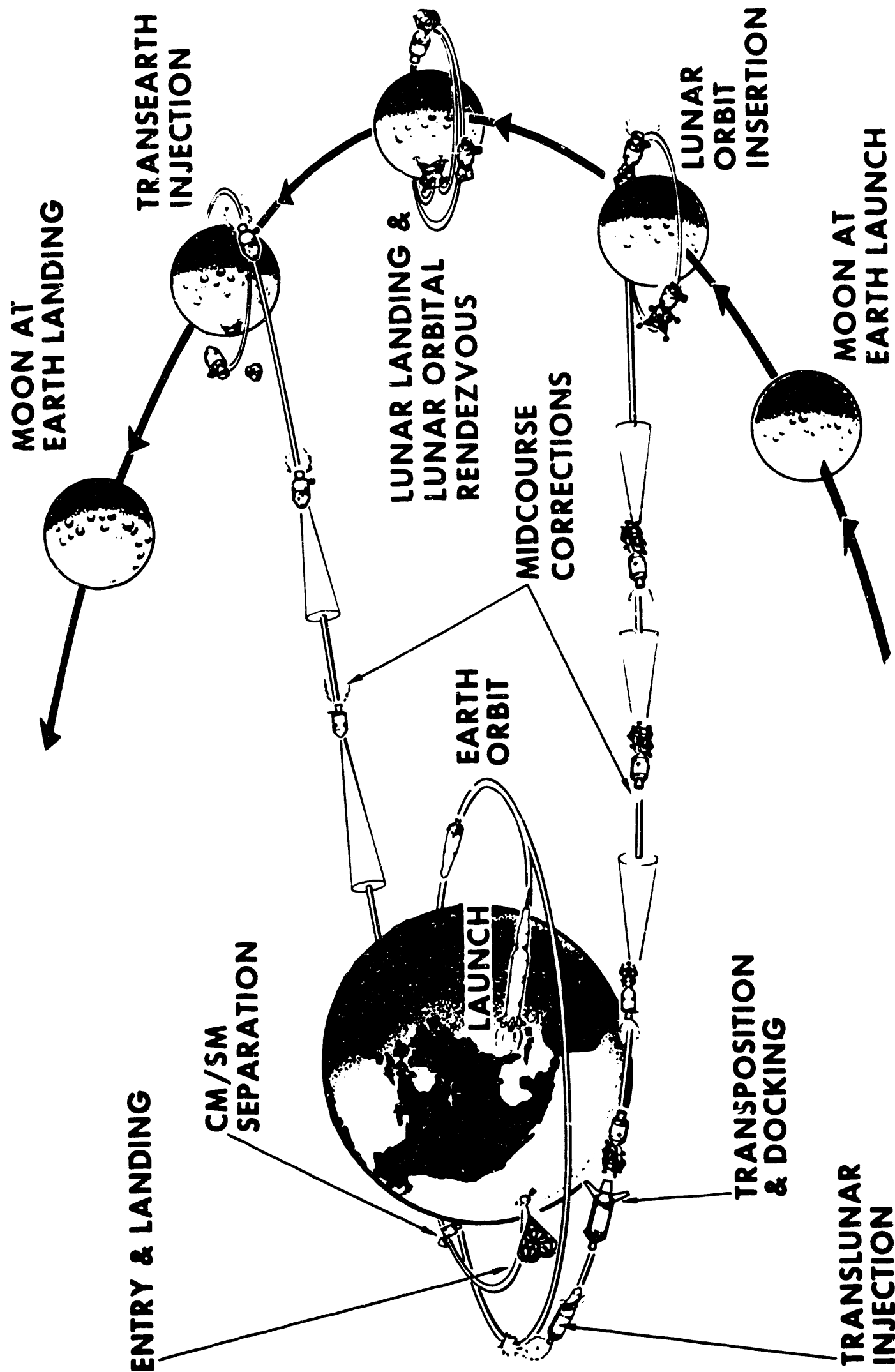
INTERFACE



MISSION PHASES
WHERE SEQUENTIAL SYSTEMS
ARE UTILIZED

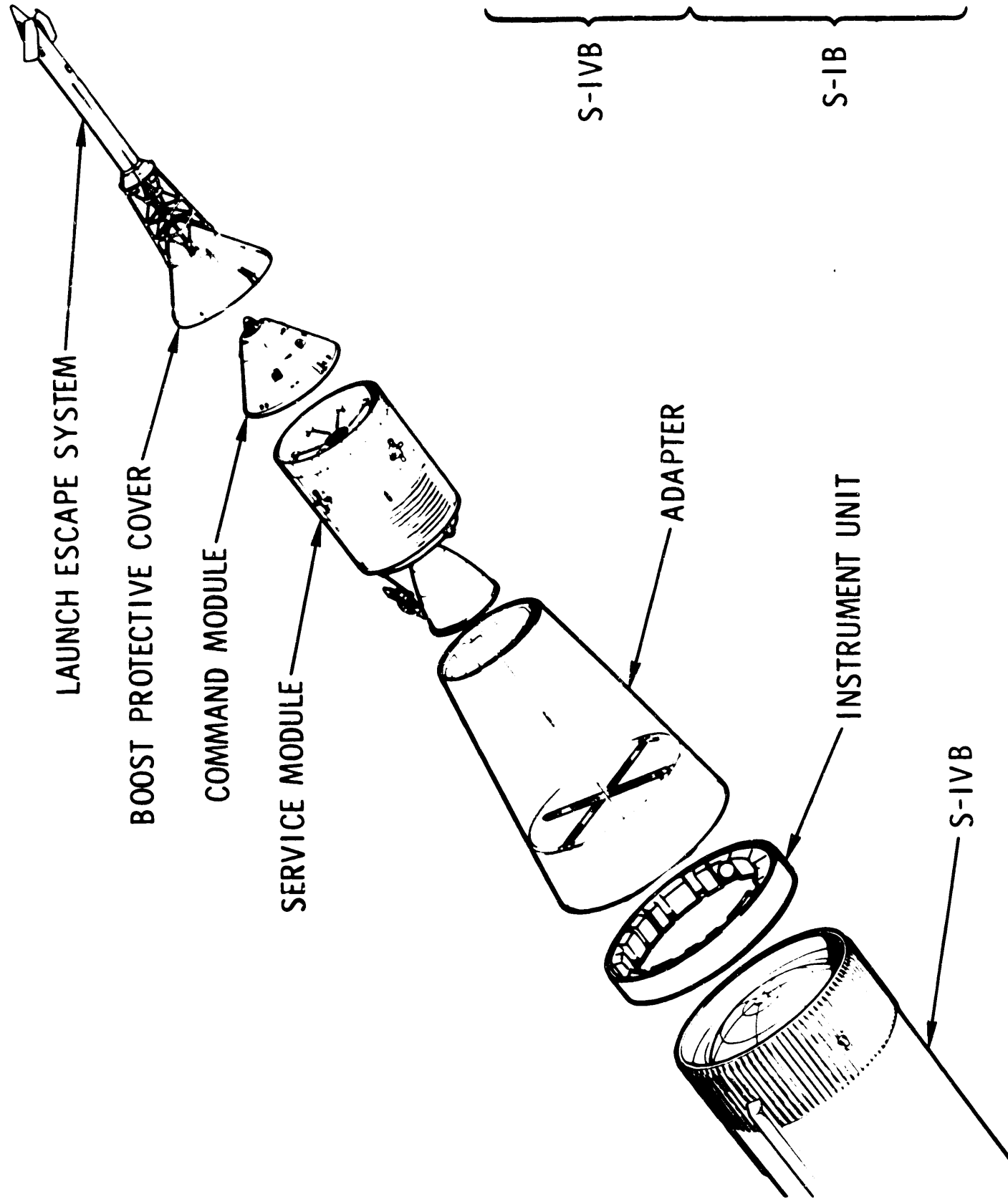
- LAUNCH AND EARTH ASCENT
 - EARTH ORBIT
 - TRANSLUNAR INJECTION
 - TRANSLUNAR COAST
 - LUNAR ORBIT COAST
 - PRE - ENTRY
 - ENTRY
 - PARACHUTE DESCENT
 - POSTLANDING

APOLLO MISSION PLAN



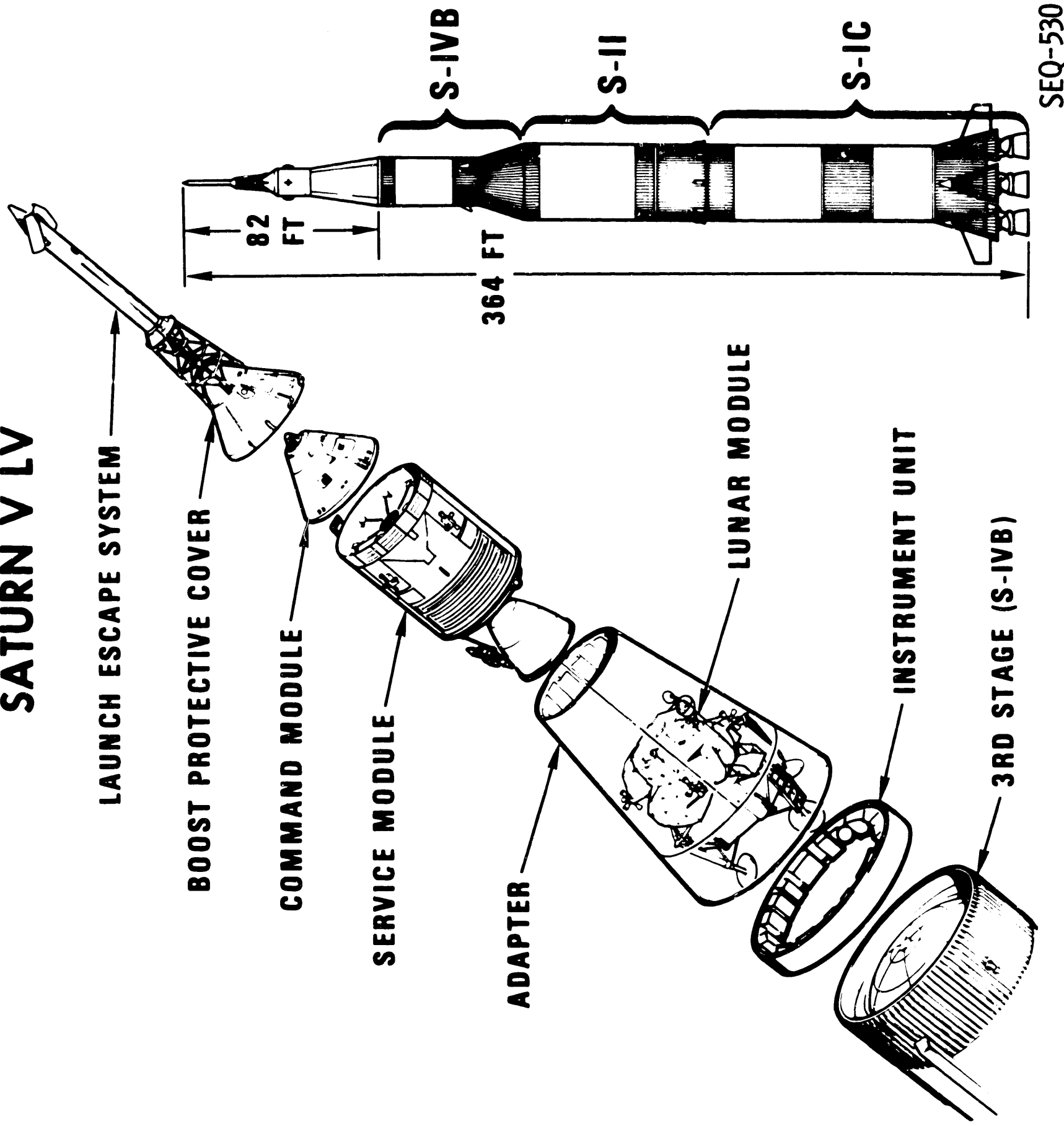
APOLLO SPACECRAFT

SA-IB LV



APOLLO SPACECRAFT

SATURN V LV



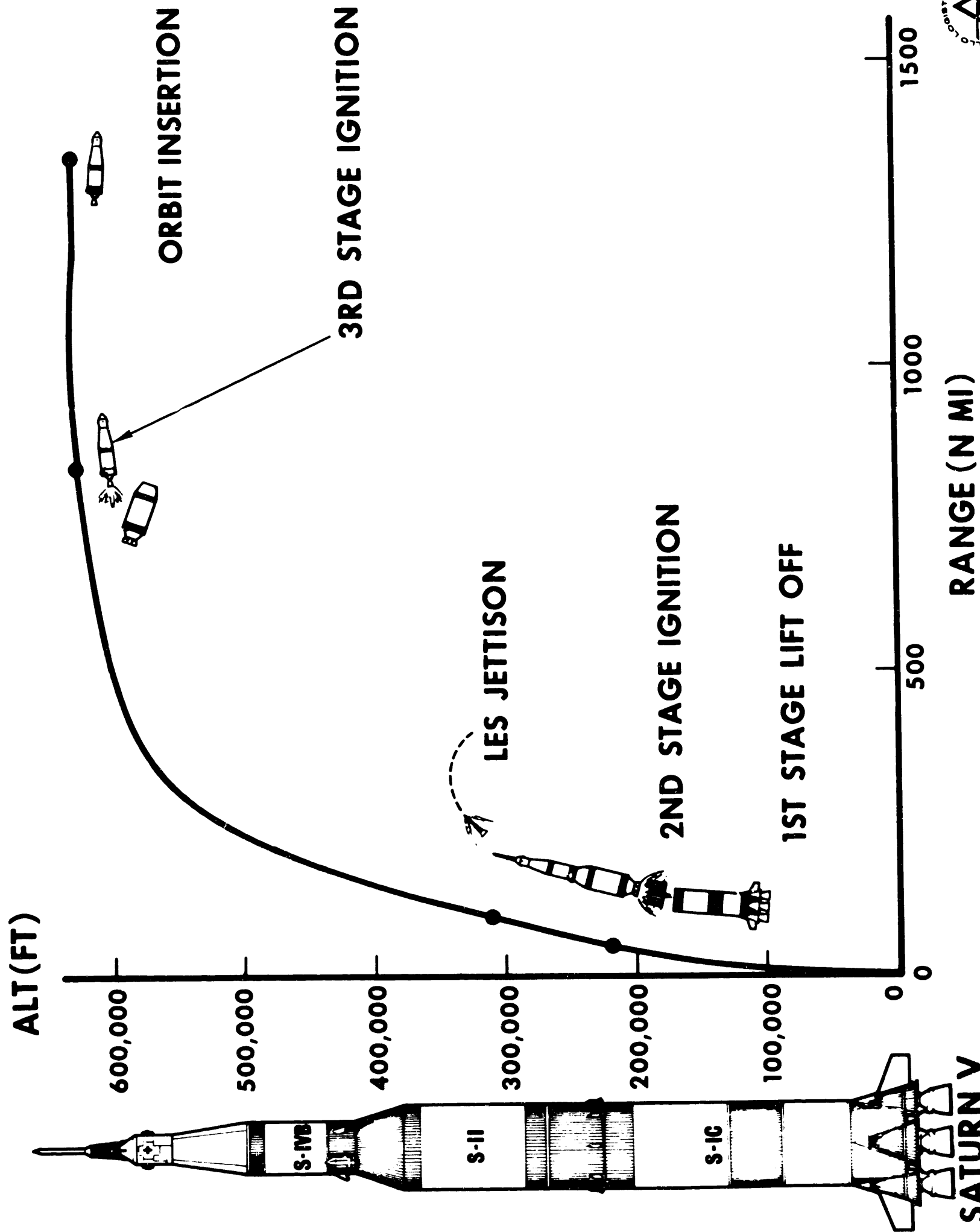
SEQ-530

SEQUENTIAL SYSTEMS FUNCTIONS

LAUNCH AND EARTH ASCENT

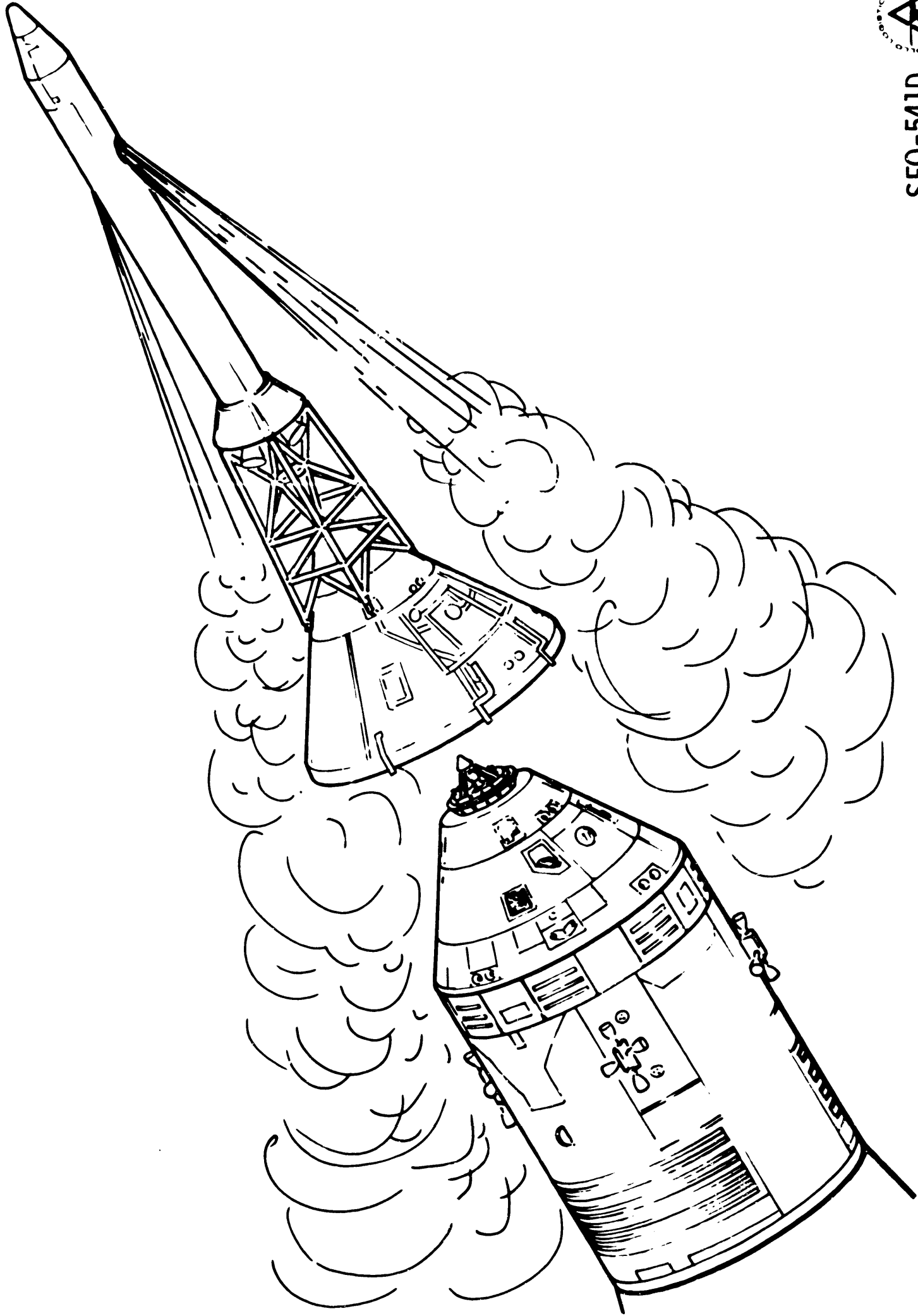
- RESET & START EVENT & MISSION TIMERS AT LIFTOFF
- ENABLE EDS AUTO. ABORT CAPABILITY AT LIFTOFF
- ENABLE AUTO. CM RCS PROPELLANT & PRESSURANT DUMP CAPABILITY AT LIFTOFF & DISABLE AT T + 42 SEC.
- MONITOR LV STATUS
- JETTISON LAUNCH ESCAPE TOWER (LET)
- PROVIDE IMMEDIATE ABORT CAPABILITY THROUGHOUT

ASCENT TRAJECTORY



FAM-1028B

NORMAL TOWER JETTISON



SEQ-541D

SEQUENTIAL SYSTEMS FUNCTIONS

EARTH ORBIT AND TRANSLUNAR INJECTION

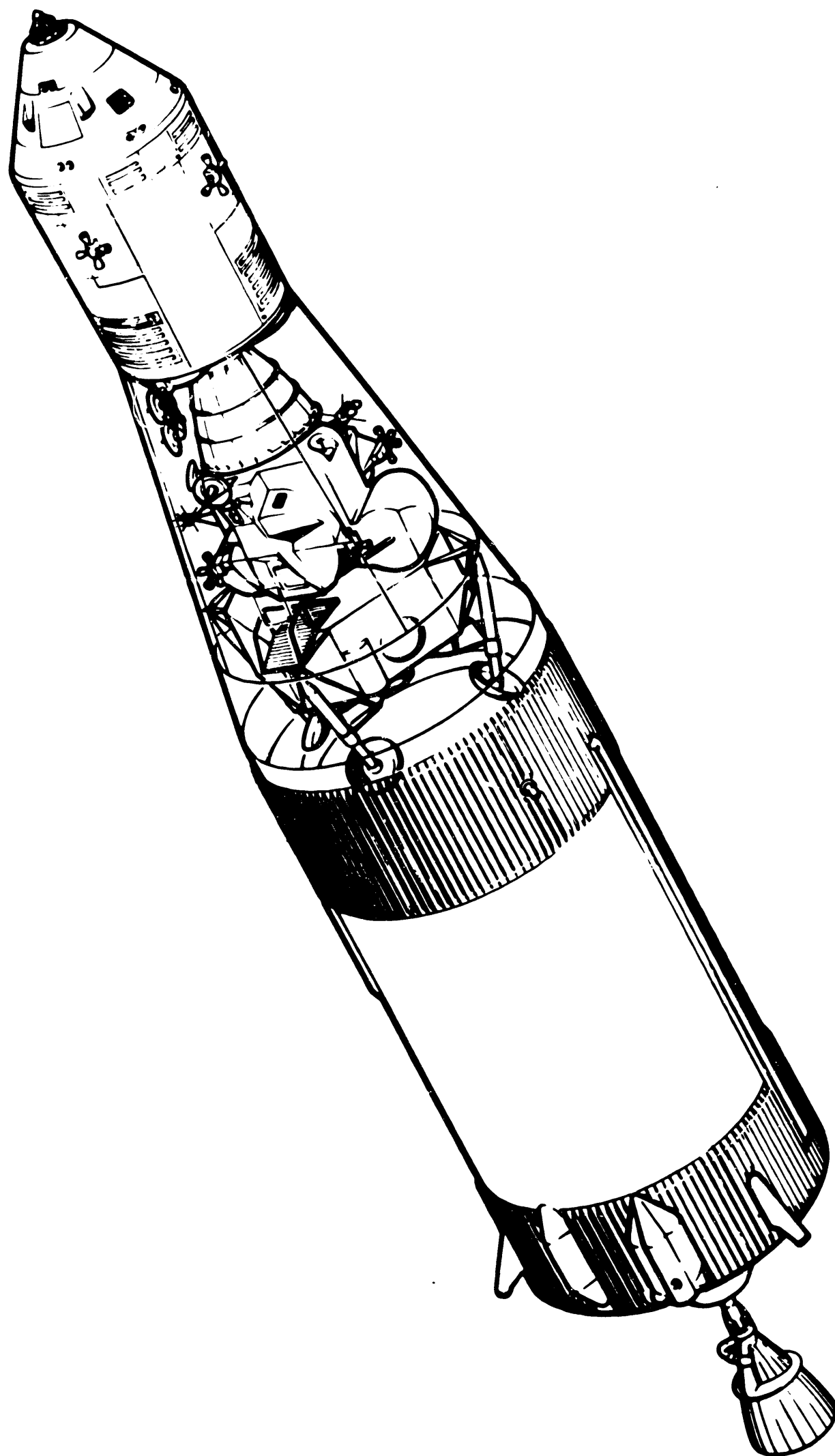
- MONITOR LV STATUS
- PROVIDE IMMEDIATE EARLY MISSION TERMINATION CAPABILITY

TRANSLUNAR COAST

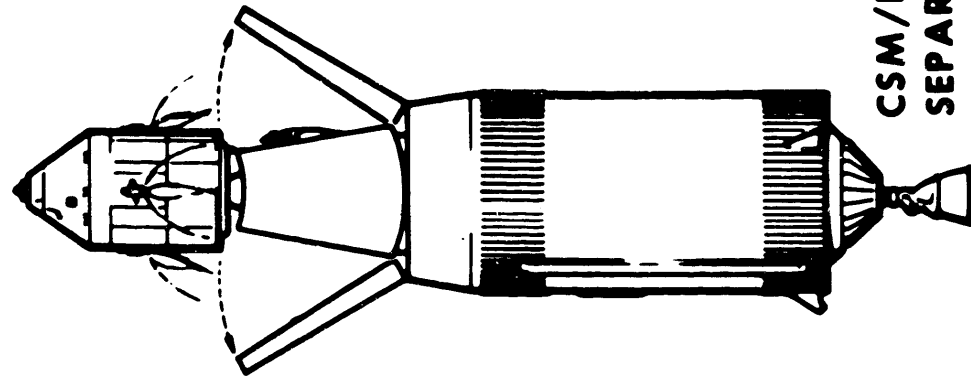
- ENABLE SM RCS/SCS
 - SEPARATE CSM FROM LV
 - RETRACT DOCKING PROBE
 - SEPARATE LM FROM LV
- TRANSPOSITION & DOCKING

S125AP84510

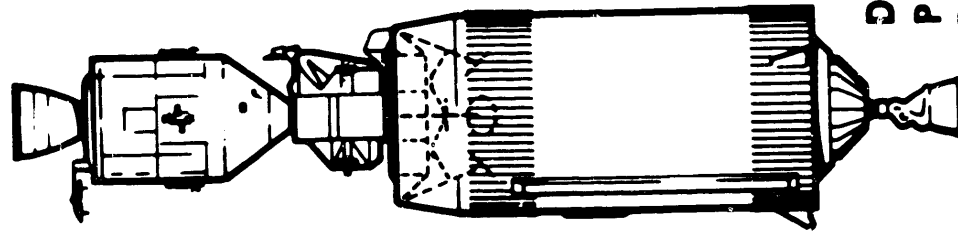
APOLLO SPACECRAFT/S-IVB EARTH ORBITAL CONFIGURATION



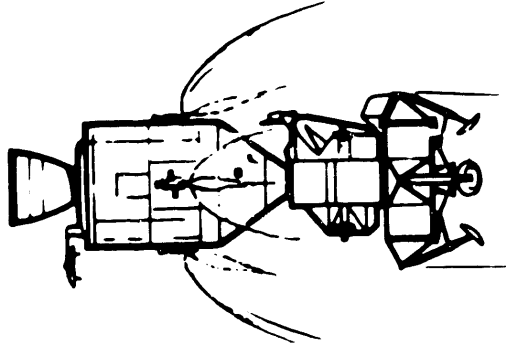
TRANSPPOSITION & DOCKING FUNCTIONS



CSM/LV
SEPARATION



DOCKING
PROBE
RETRACTION



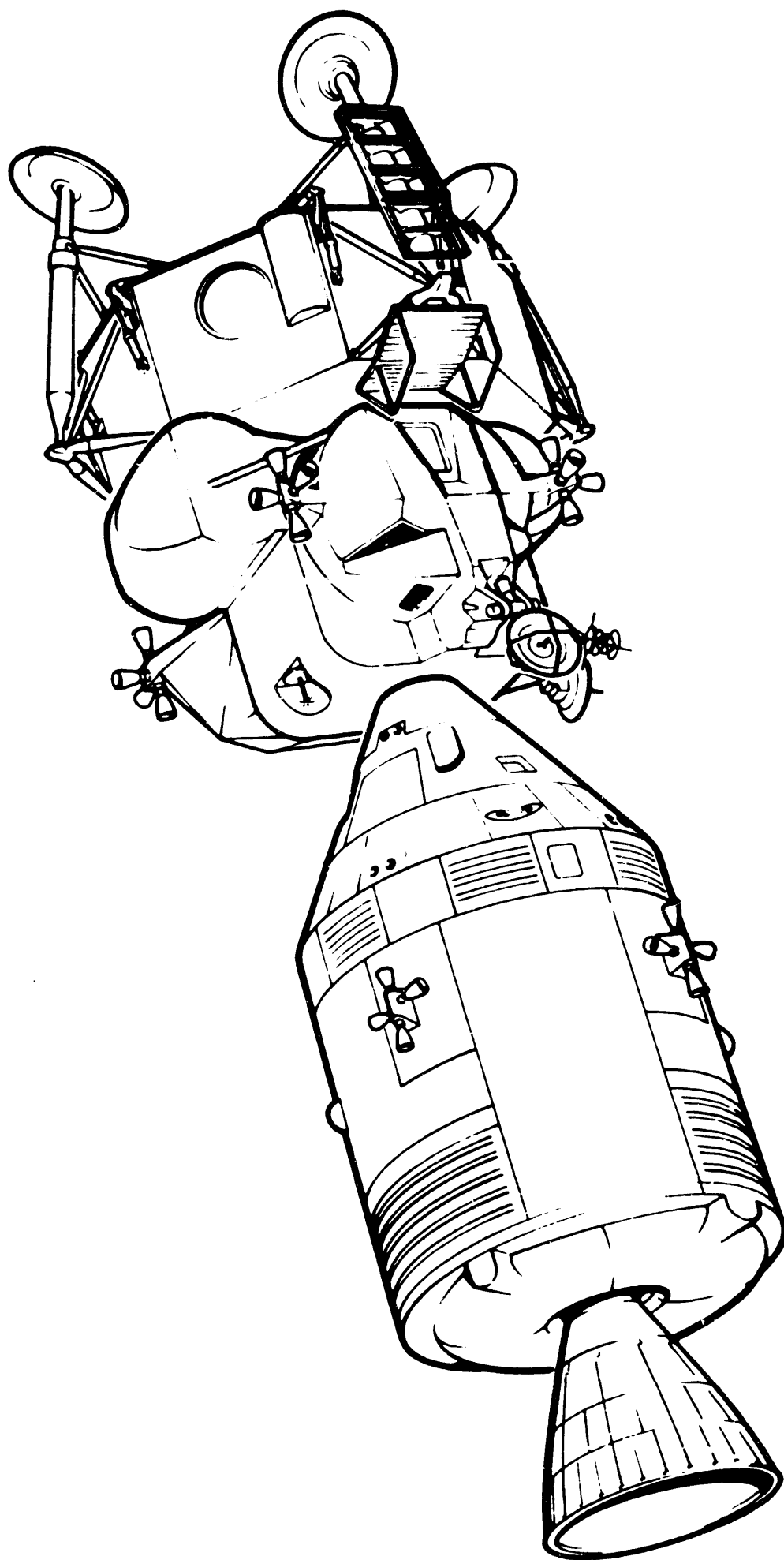
S-IV B/LM
SEPARATION



SEQ-565 A

S-25AP84497

APOLLO SPACECRAFT TRANSLUNAR CONFIGURATION



SEQUENTIAL SYSTEMS FUNCTIONS

LUNAR ORBIT COAST

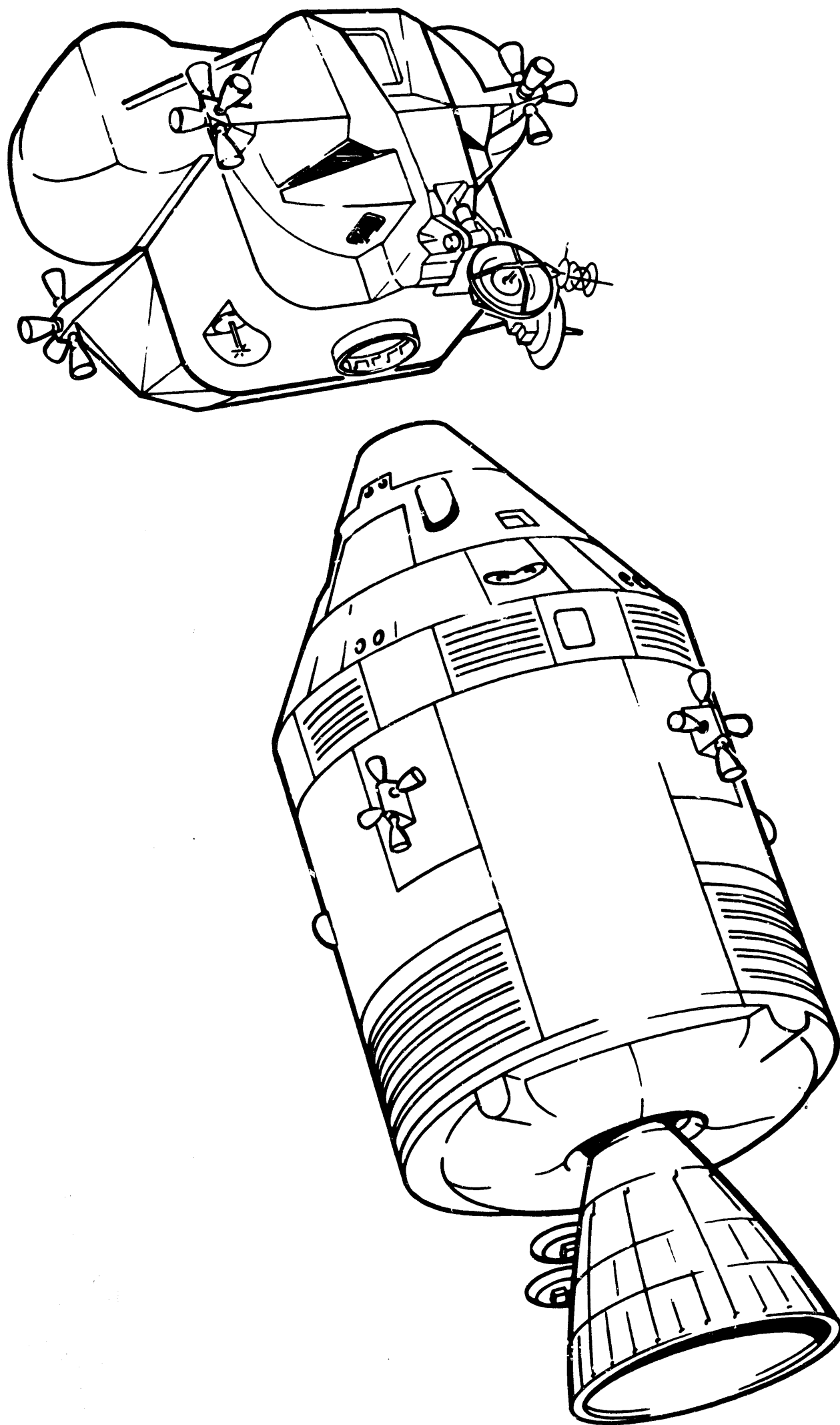
- RETRACT DOCKING PROBE
- SEPARATE LM FROM CSM

PRE - ENTRY AND ENTRY

- SEPARATE SM FROM CM
- MANEUVER SM AWAY FROM ENTERING CM
- PRESSURIZE CM
- TRANSFER RCS CONTROL TO CM
- PROVIDE AUTO. TRANSFER OF BATTERY POWER TO MAIN DC BUSES
- ARM & ACTIVATE ELS

SEQ - 566

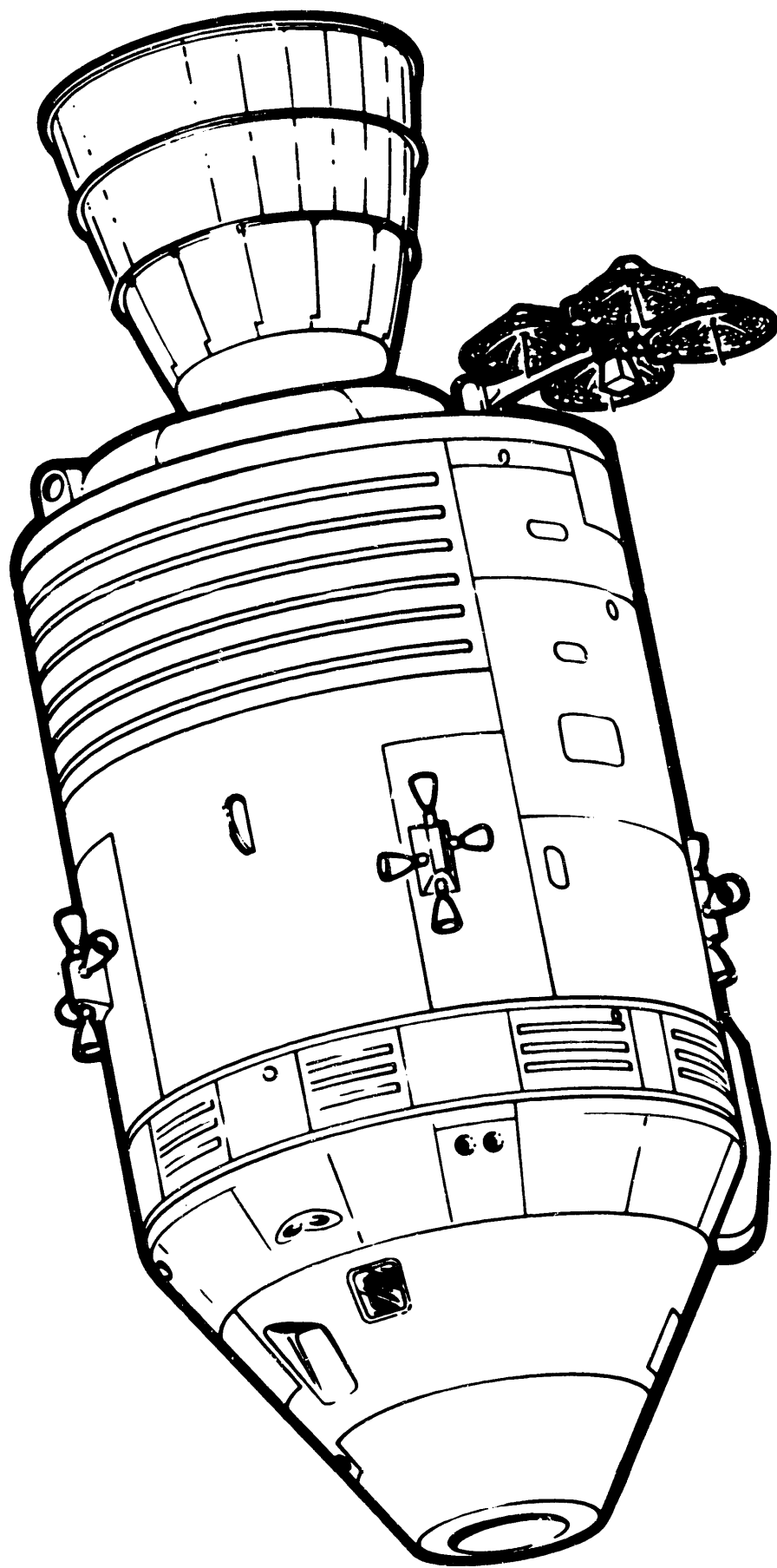
NORMAL CSM/LM SEPARATION



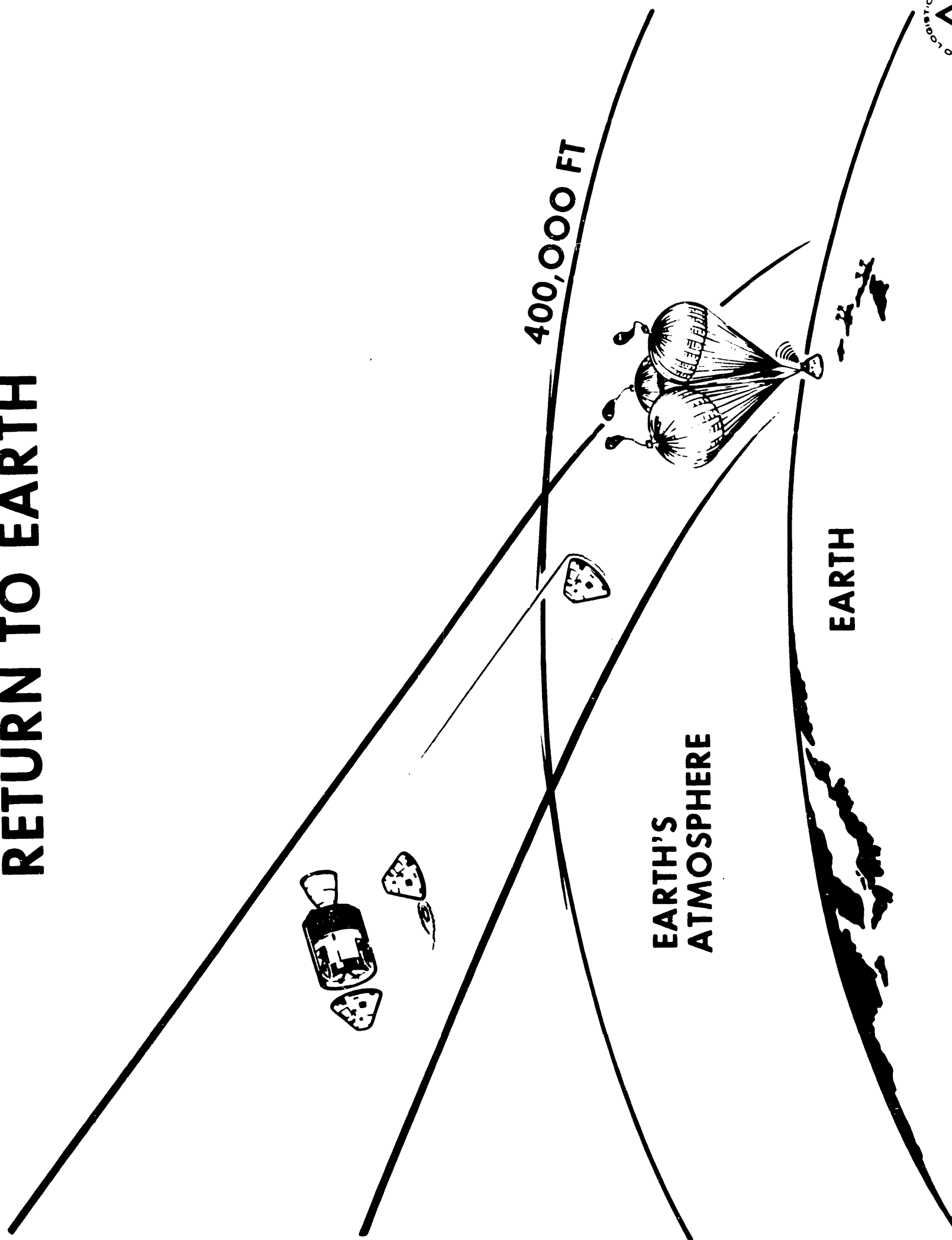
SEQ-577 

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APOLLO TRANSEARTH CONFIGURATION

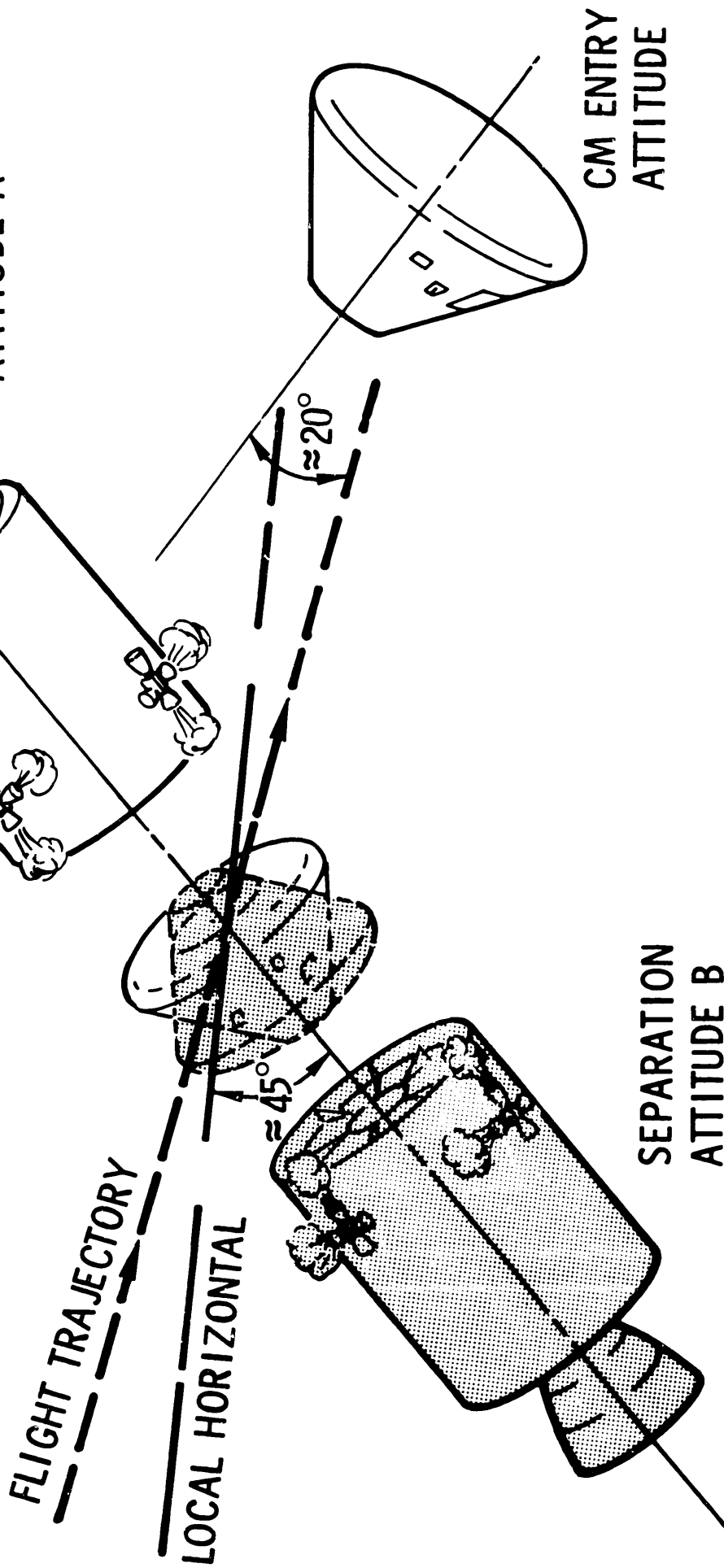


RETURN TO EARTH



NORMAL CM-SM SEPARATION AND SM JETTISON

SMJC RCS FUNCTIONS
-X TRANSLATION
5.5 SEC + ROLL AFTER
2 SEC



SEQ-543B

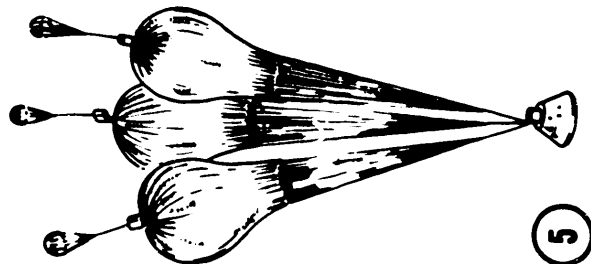
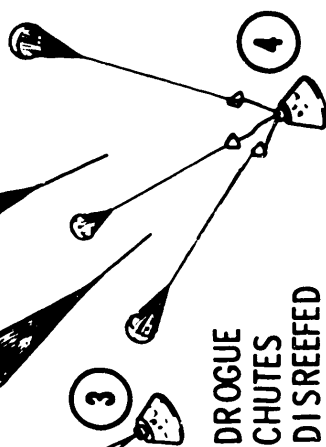
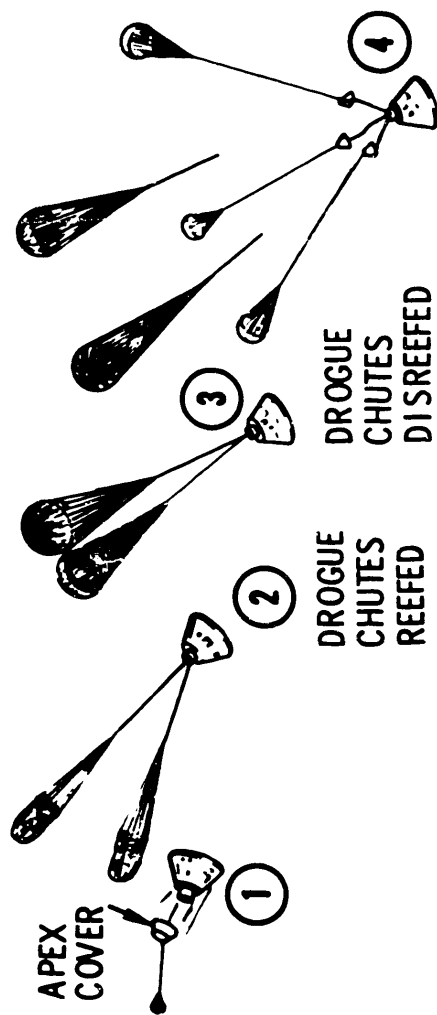
SEQUENTIAL SYSTEMS FUNCTIONS

PARACHUTE DESCENT AND POSTLANDING

- DISABLE CM RCS/SCS
- JETTISON APEX COVER
- DEPLOY DROGUE PARACHUTES
- RELEASE DROGUE PARACHUTES & DEPLOY MAIN PARACHUTES
- EXTEND VHF RECOVERY ANTENNAS & FLASHING BEACON LIGHT
- DISPOSE OF REMAINING RCS PROPELLANTS & PRESSURANT
- RELEASE MAIN PARACHUTES AFTER SPLASHDOWN

EARTH LANDING SYSTEM

NORMAL SEQUENCE



1. APEX COVER JETTISONED AT 24,000 FT
+.4 SEC

2. DROGUE CHUTES DEPLOYED REEFED
AT 24,000 FT +2 SEC

3. DROGUE CHUTE SINGLE STAGE DISREEF
10 SEC

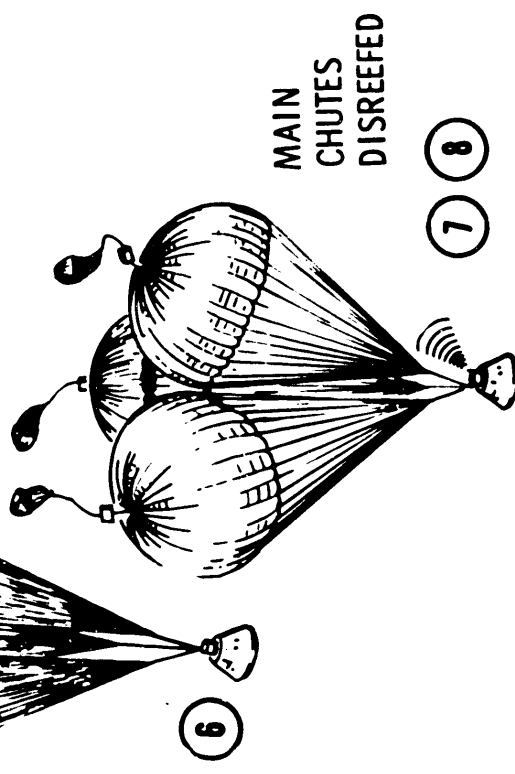
4. MAIN CHUTE DEPLOYED REEFED VIA
PILOT CHUTES AND DROGUE CHUTES
RELEASED AT 10,000 FT

5. MAIN CHUTE INITIAL INFLATION
6. MAIN CHUTE FIRST STAGE DISREEF
6 SEC

7. VHF RECOVERY ANTENNAS AND FLASHING
BEACON DEPLOYED 8 SEC

8. MAIN CHUTE SECOND STAGE DISREEF
10 SEC

9. MAIN CHUTES RELEASED



MAIN CHUTES DISREEFED

7

8



SPLASH DOWN VELOCITIES:
3 CHUTES - 32 FT/SEC
2 CHUTES - 36 FT/SEC

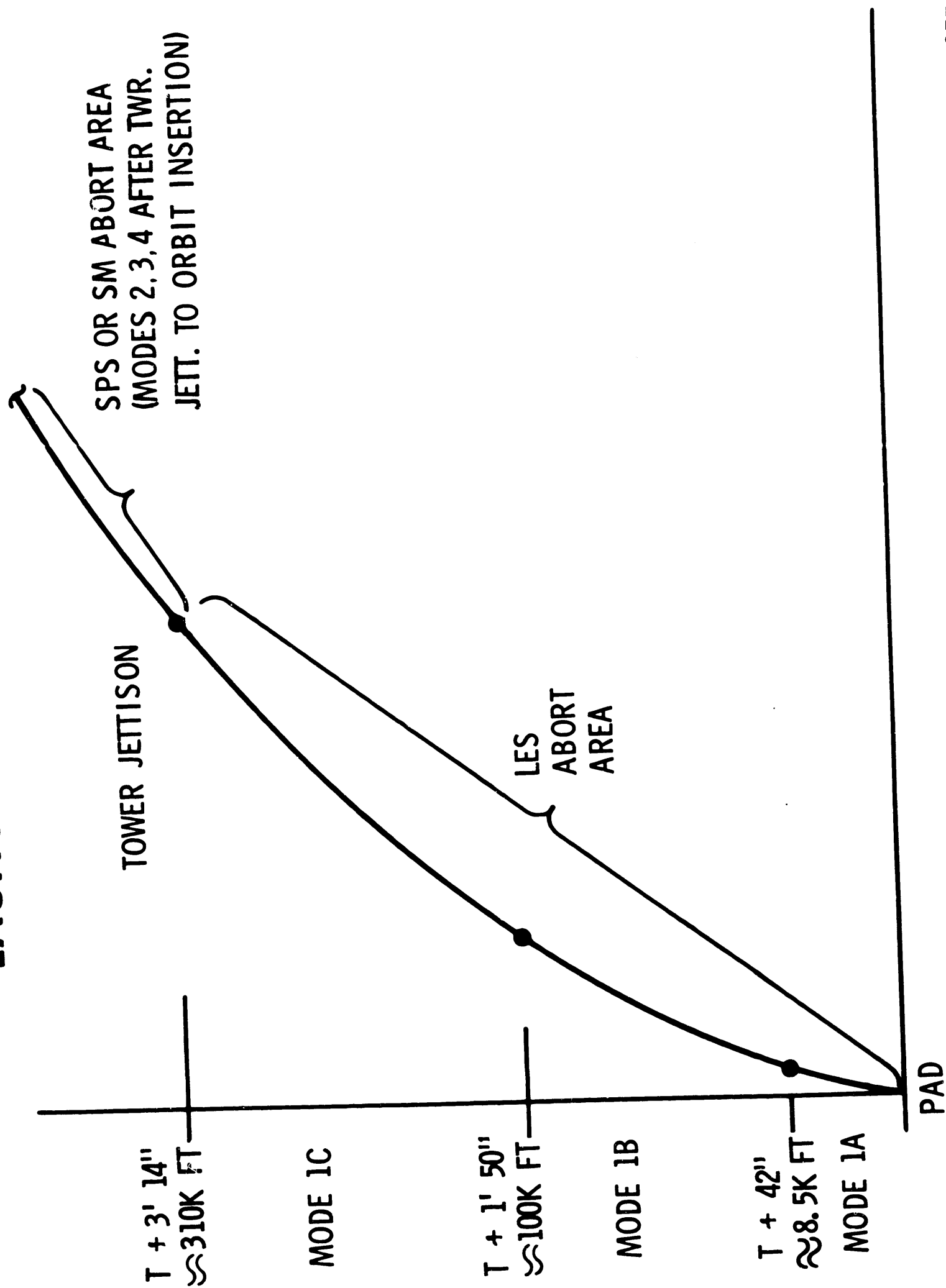
(TLM)

(TLM)

(TLM)

(TLM)

ABORT DESIGNATIONS LAUNCH & EARTH ASCENT PHASE

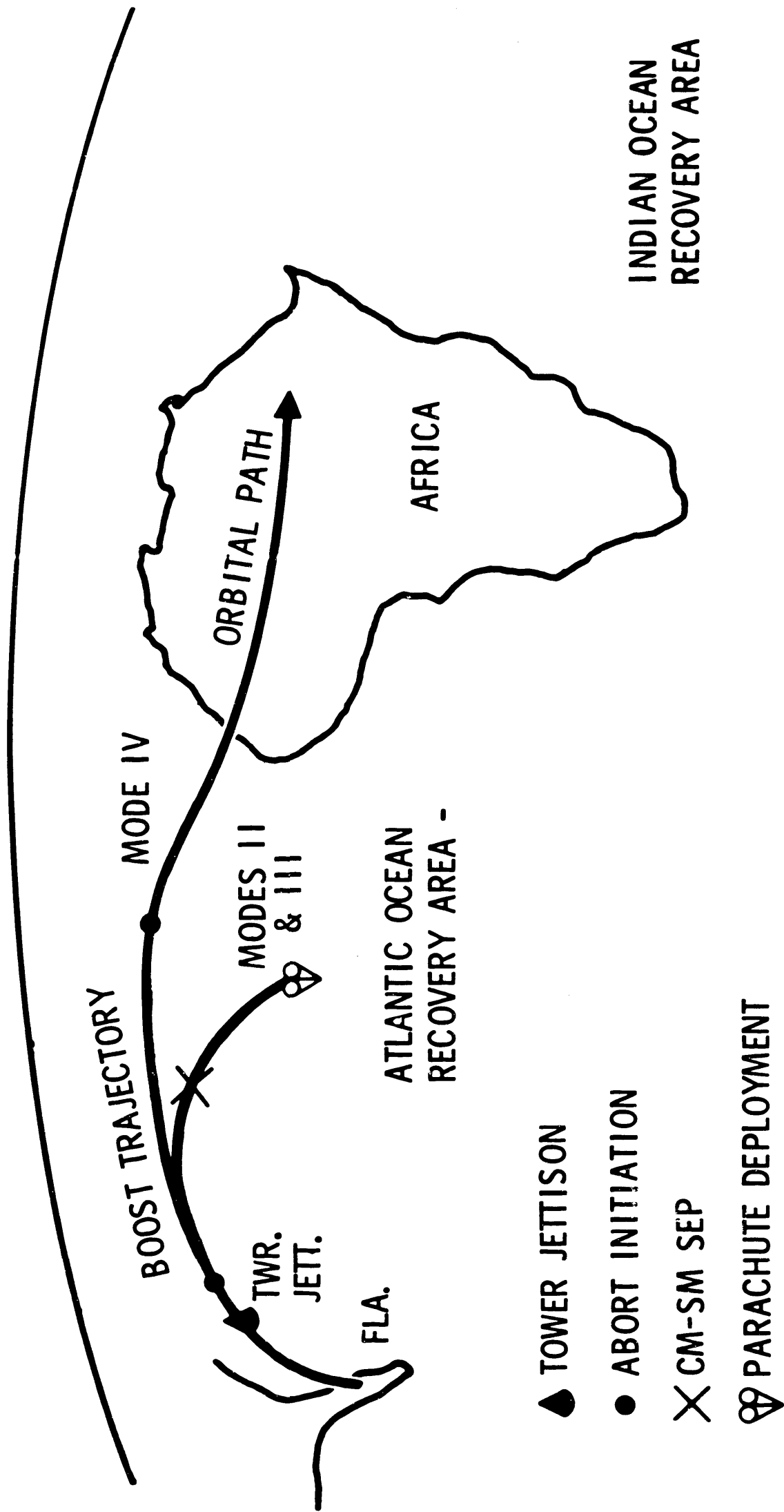


SEQ-95E

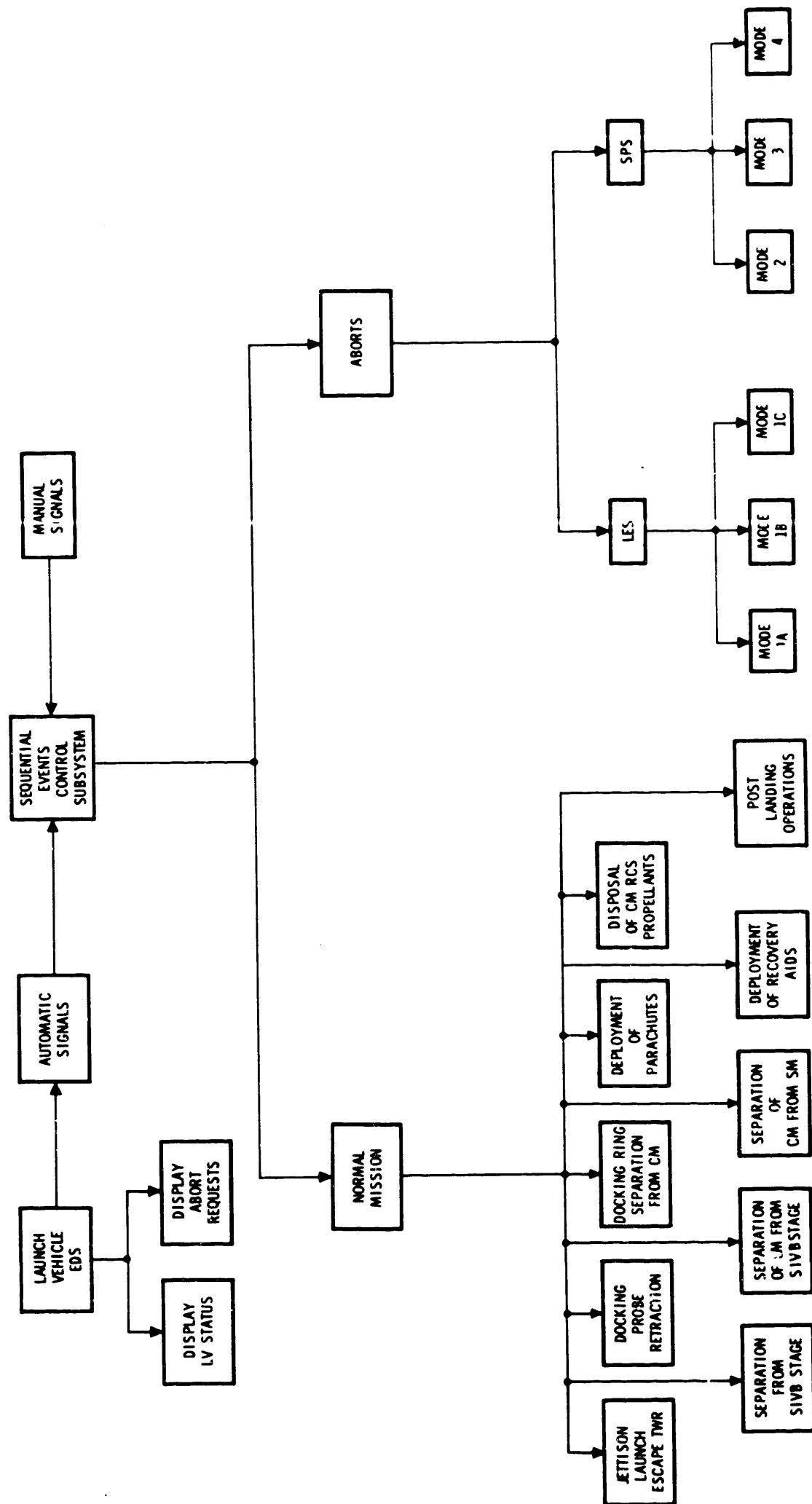


SPS ABORTS

EARTH ASCENT PHASE



FUNCTIONAL BLOCK DIAGRAM SEQUENTIAL SYSTEMS

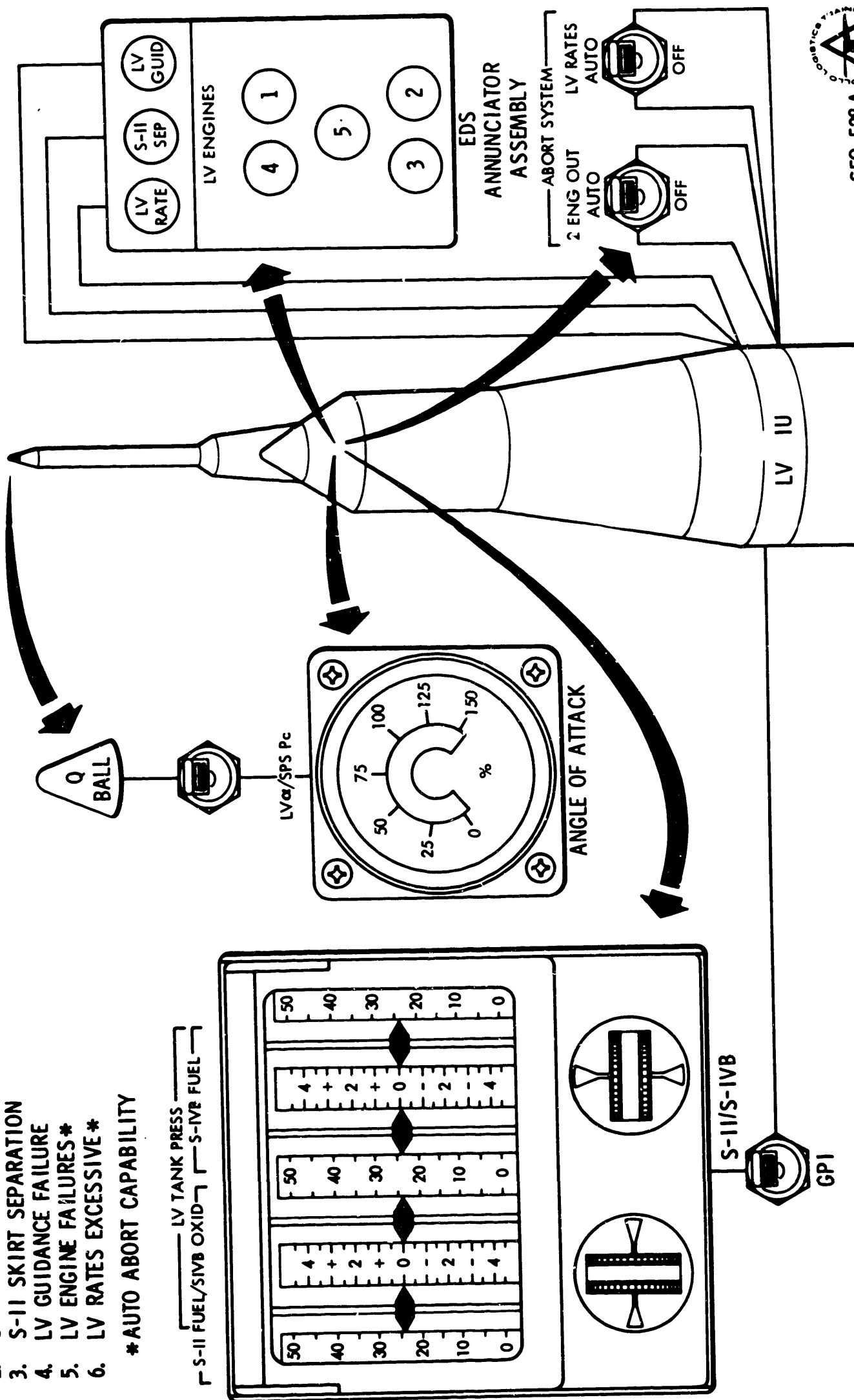


APOLLO EDS COMPONENTS FOR LV STATUS

LV PARAMETERS MONITORED

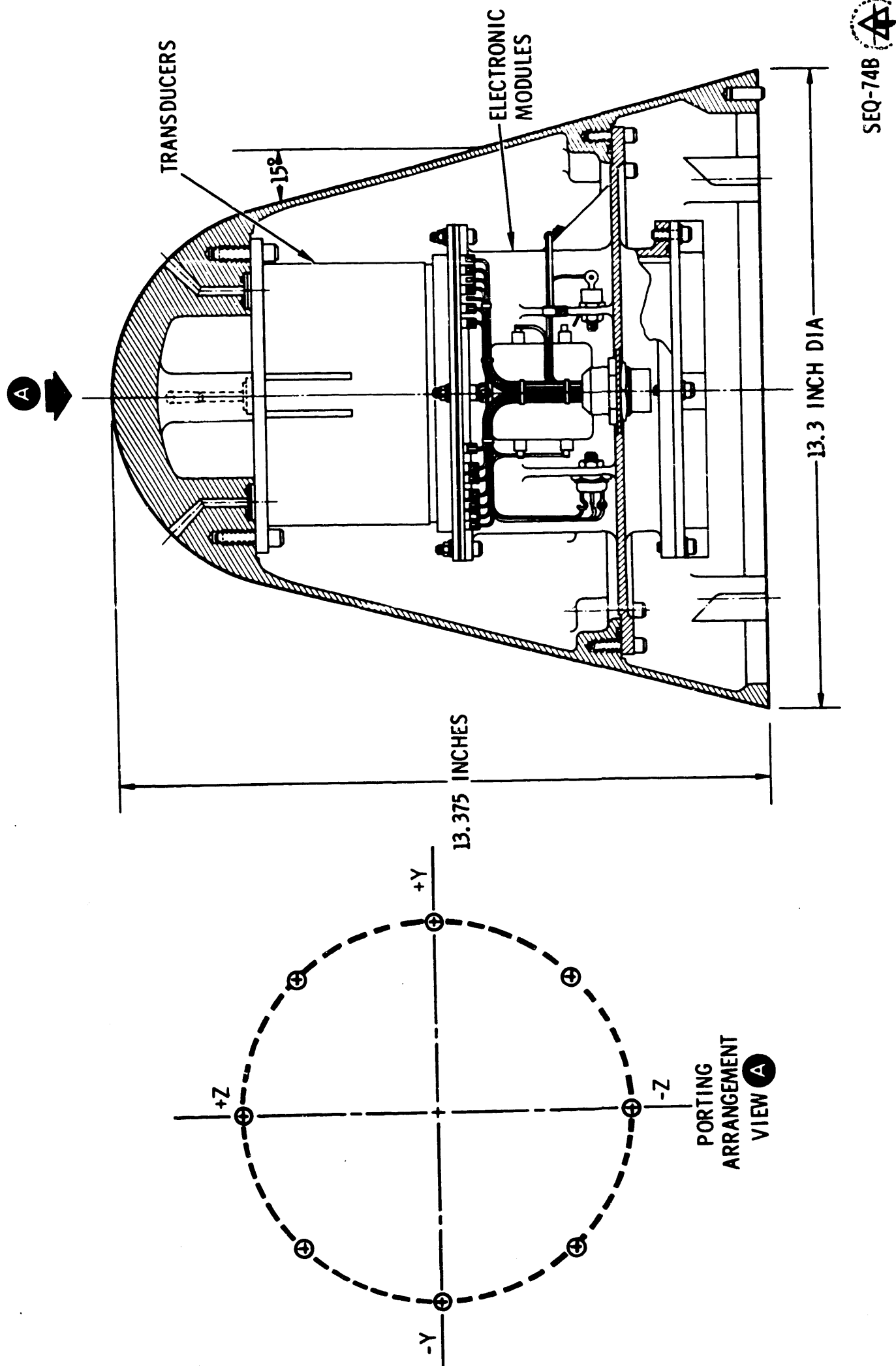
1. LV ANGLE OF ATTACK
2. S-11/S-IVB TANK PRESSURES
3. S-11 SKIRT SEPARATION
4. LV GUIDANCE FAILURE
5. LV ENGINE FAILURES*
6. LV RATES EXCESSIVE*

*AUTO ABORT CAPABILITY



SEQ-528 A

EDS Q-BALL



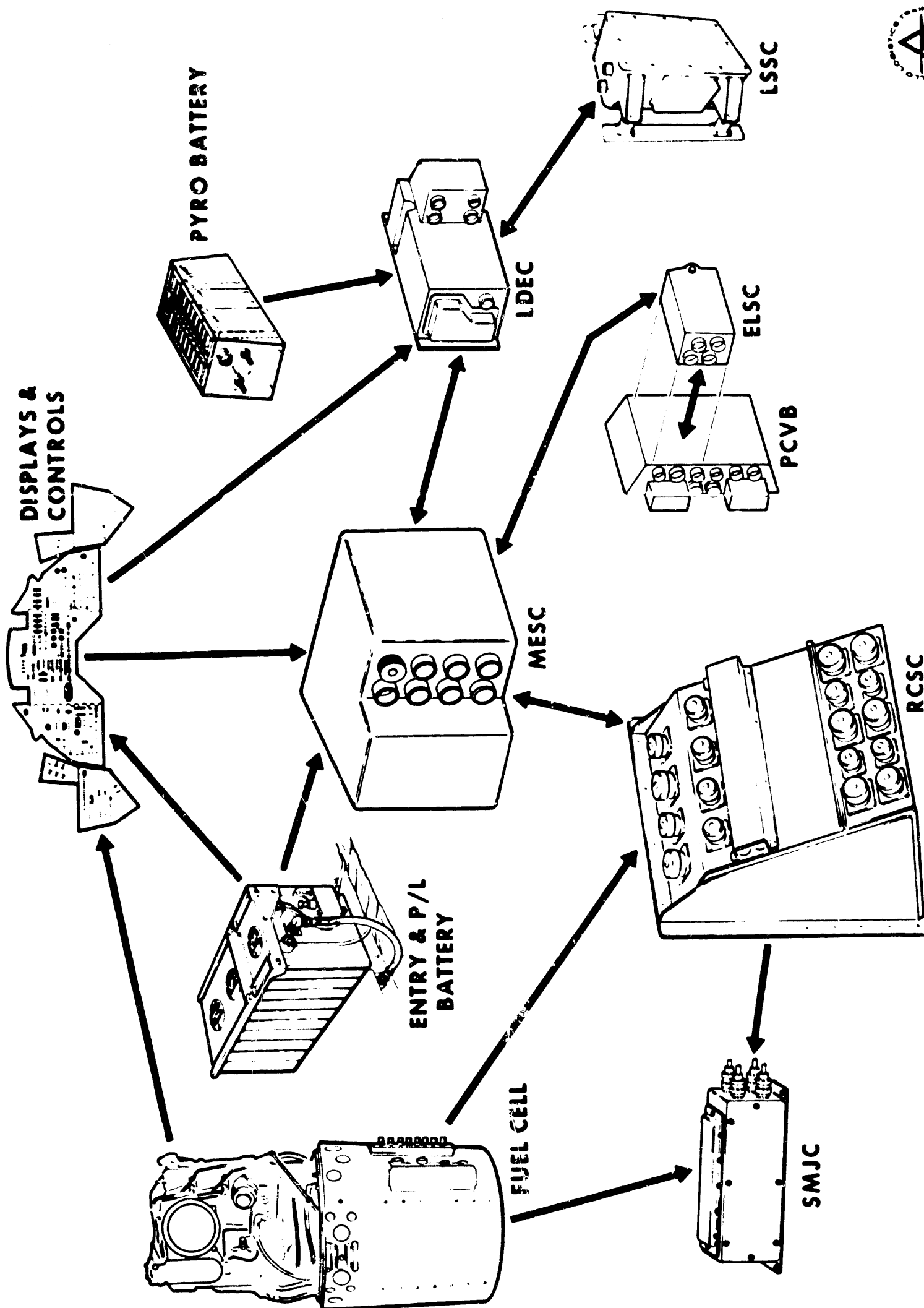
EDS FUNCTIONS

- INDICATE ABORT REQUESTS TO THE FLIGHT CREW
- PROVIDE A LIFTOFF SIGNAL TO THE CREW AND TO CSM SUBSYSTEMS
- PROVIDE AN EMERGENCY LV ENGINE CUTOFF CAPABILITY TO THE CREW
- MONITOR S-II INTERSTAGE SKIRT SEPARATION

MONITOR FOR AND WARN CREW OF:

- EXCESSIVE LV ANGLE OF ATTACK
- LOSS OF ATTITUDE REFERENCE IN THE LV GUIDANCE SYSTEM
- OUT-OF-TOLERANCE S-I/S-IVB TANK PRESSURES
- OUT-OF-TOLERANCE LV ENGINE THRUSTS
- EXCESSIVE ROLL, PITCH, OR YAW ANGULAR RATES ON THE LV
- INITIATE AN AUTO. ABORT WITH A 2 OUT OF 3 VOTE LOGIC WHENEVER ANY 2 FIRST STAGE ENGINE THRUSTS DROP TO 89% RATED OR LV ANGULAR RATES BECOME EQUAL TO OR GREATER THAN 20 DEGREES PER SEC. IN ROLL OR 4 DEGREES PER SEC. IN PITCH OR YAW
- S-IVB RESTART SEQUENCE FOR TLI

SECS MAJOR COMPONENTS



SECS CONTROLLERS IN CM RHEB

- 2 MASTER EVENTS SEQUENCE CONTROLLERS (MESC)

PURPOSES: PROVIDES FOR ARMING THE LOGIC BUSES OF THE SECS
PROVIDES MASTER CONTROL OF ALL SEQUENCED EVENTS REQUIRED
FOR LAUNCH ESCAPES & OF CERTAIN NORMAL MISSION EVENTS
- 2 LUNAR DOCKING EVENTS CONTROLLERS (LDEC)

PURPOSES: PROVIDES FOR ARMING THE PYRO BUSES OF THE SECS
CONTROLS ALL DOCKING PROBE RETRACTIONS, DOCKING RING
SEPARATION, & ASSISTS IN S-IVB/LM SEPARATION
- 2 EARTH LANDING SEQUENCE CONTROLLERS (ELSC)

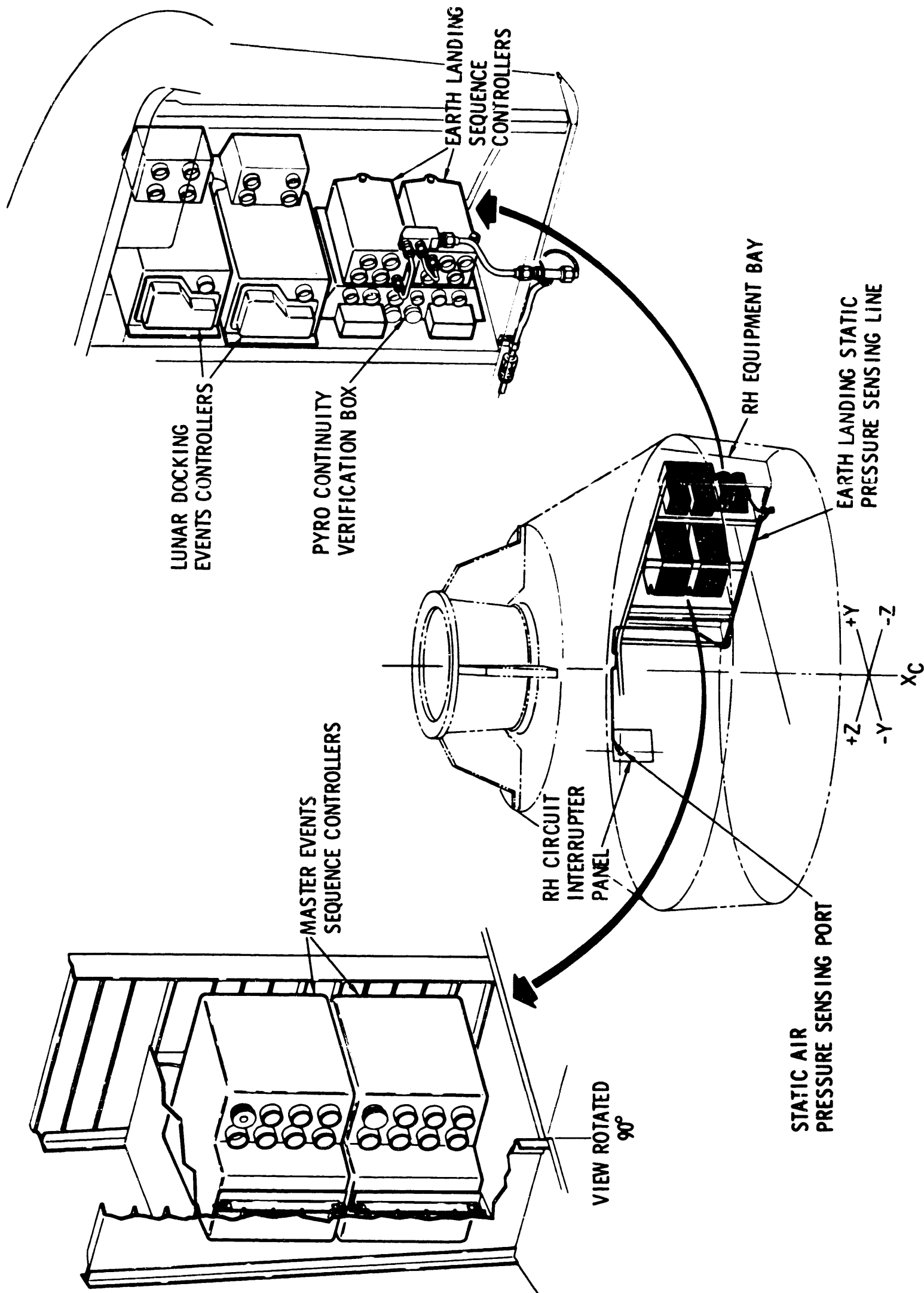
PURPOSE: SEQUENCE THE DEPLOYMENT & RELEASE OF THE ELS PARACHUTES
- 1 PYRO CONTINUITY VERIFICATION BOX (PCVB)

PURPOSES: PROVIDE AN ACCESSIBLE POINT IN THE CM TO VERIFY THE
CONTINUITY OF THE PYRO FIRING CIRCUITS IN THE FWD.
COMPT. OF THE CM
ELIMINATE SINGLE POINTS OF FAILURE IN THE ELSC PYRO
FIRING CIRCUITS

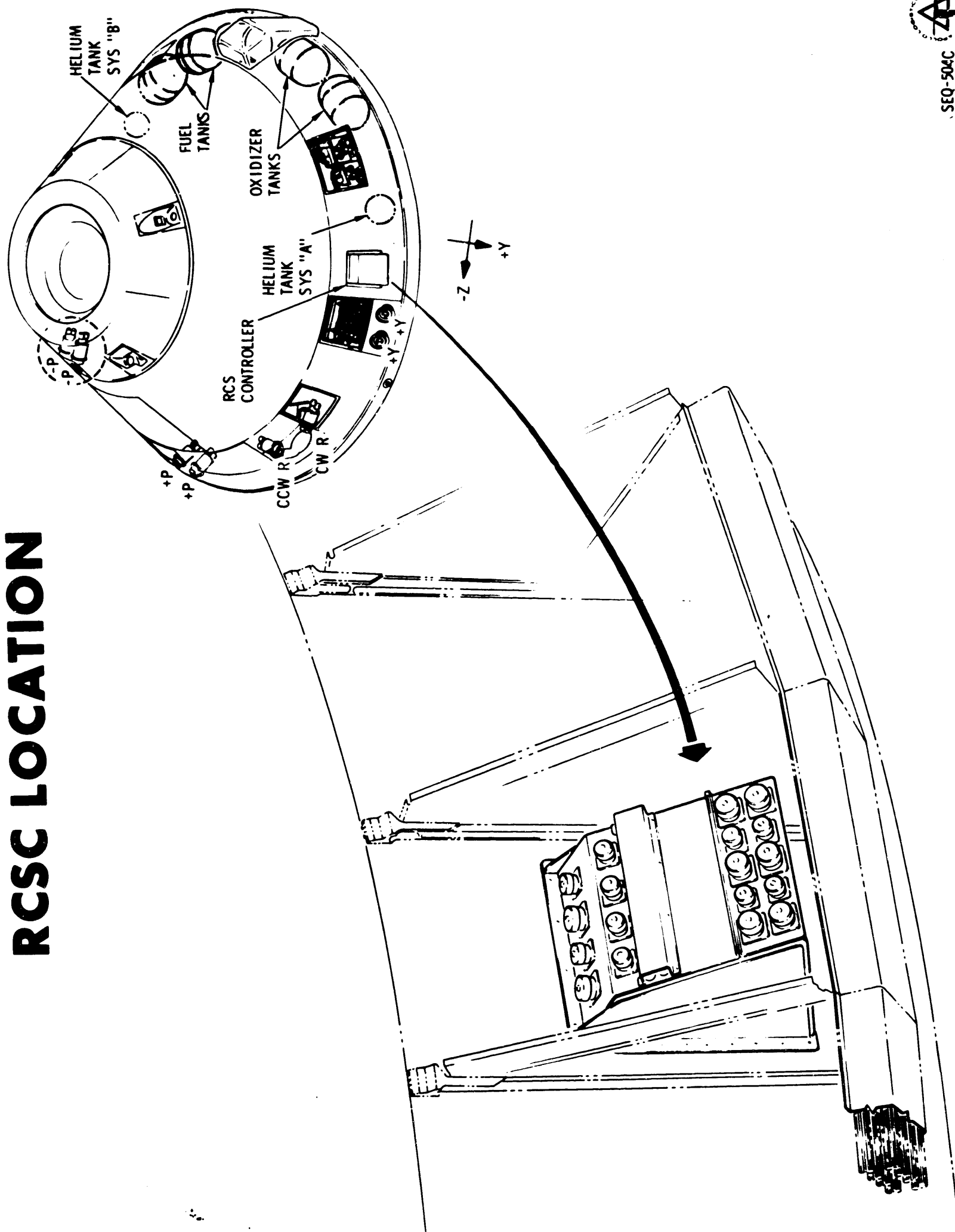
SECS CONTROLLERS
IN CM AFT COMPT., SM, & SLA

- 1 REACTION CONTROL SYSTEM CONTROLLER (RCSC)
PURPOSE: CONTROLS THE PROPELLANT & PRESSURANT DISPOSAL OF THE
CM RCS BEFORE ANY SPLASHDOWN
- * 2 SERVICE MODULE JETTISON CONTROLLERS (SMJC)
PURPOSE: MANEUVERS THE SM AWAY FROM THE CM BEFORE ENTRY
TO PREVENT A COLLISION WITH THE CM
- 2 LM SEPARATION SEQUENCE CONTROLLERS (LSSC)
PURPOSE: SEPARATES THE LM FROM THE S-IVB STAGE

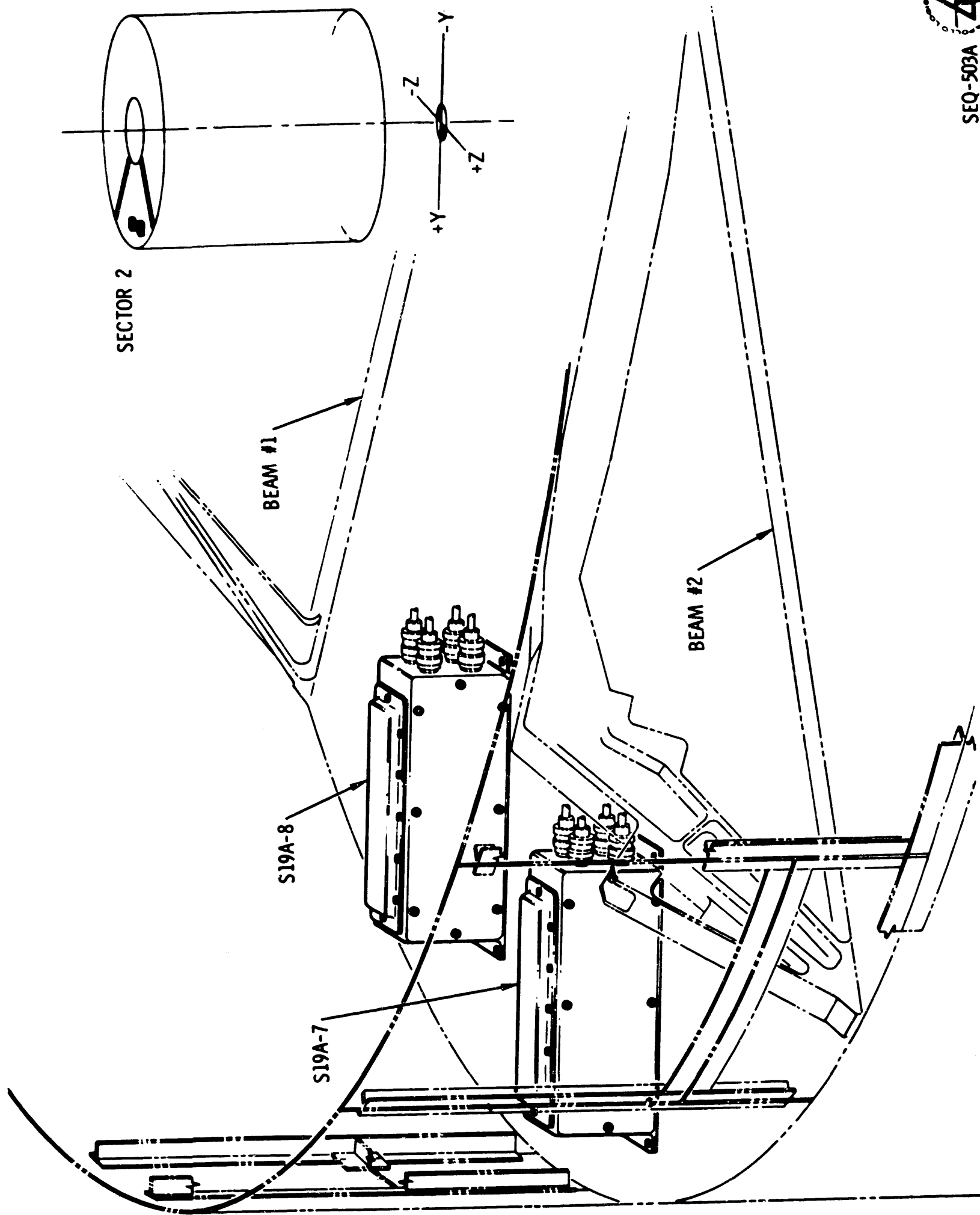
MESC, ELSC, LDEC, PCVB LOCATION



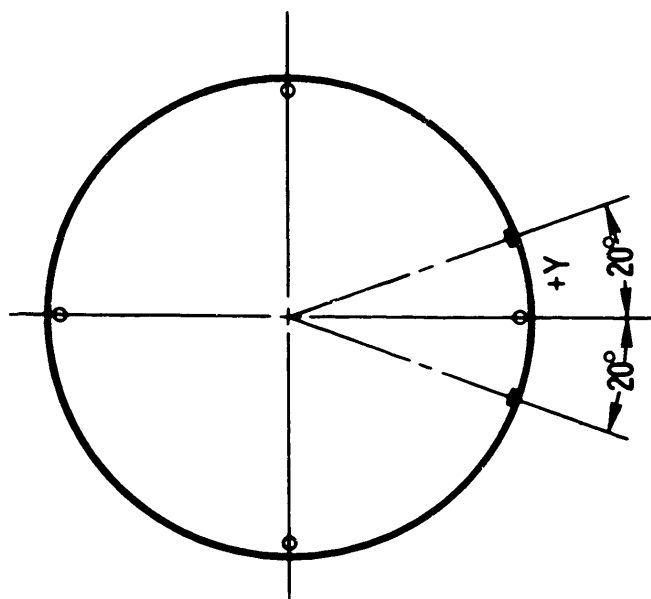
RCSC LOCATION



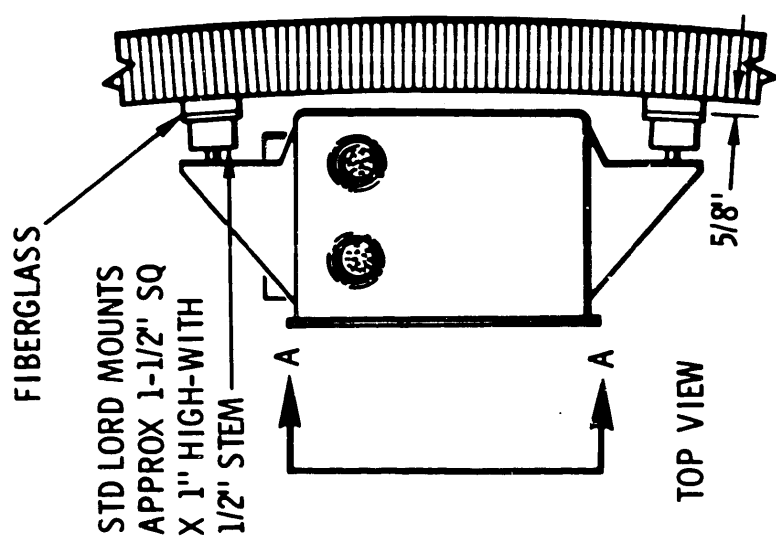
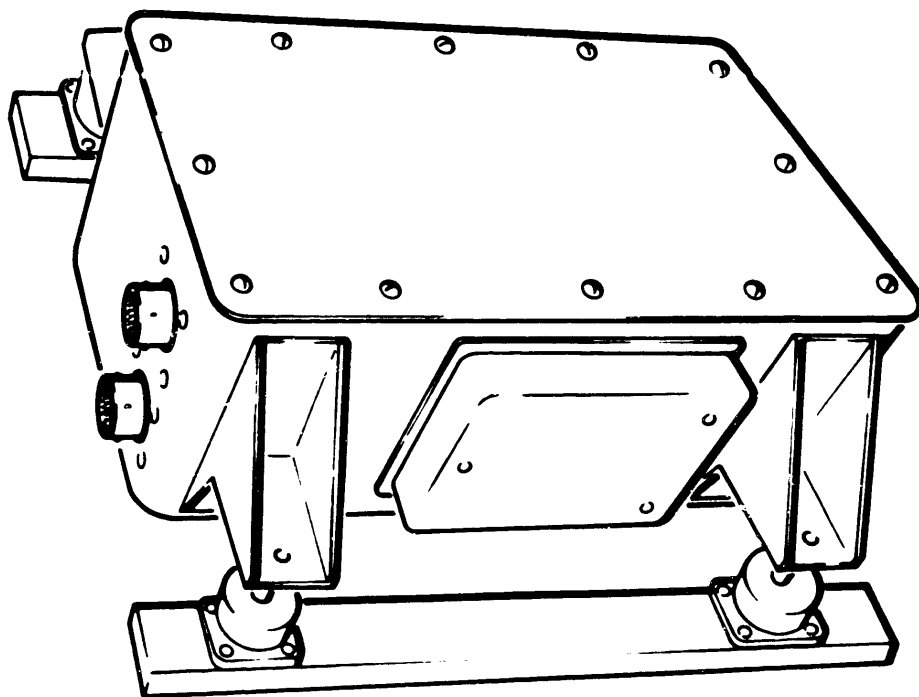
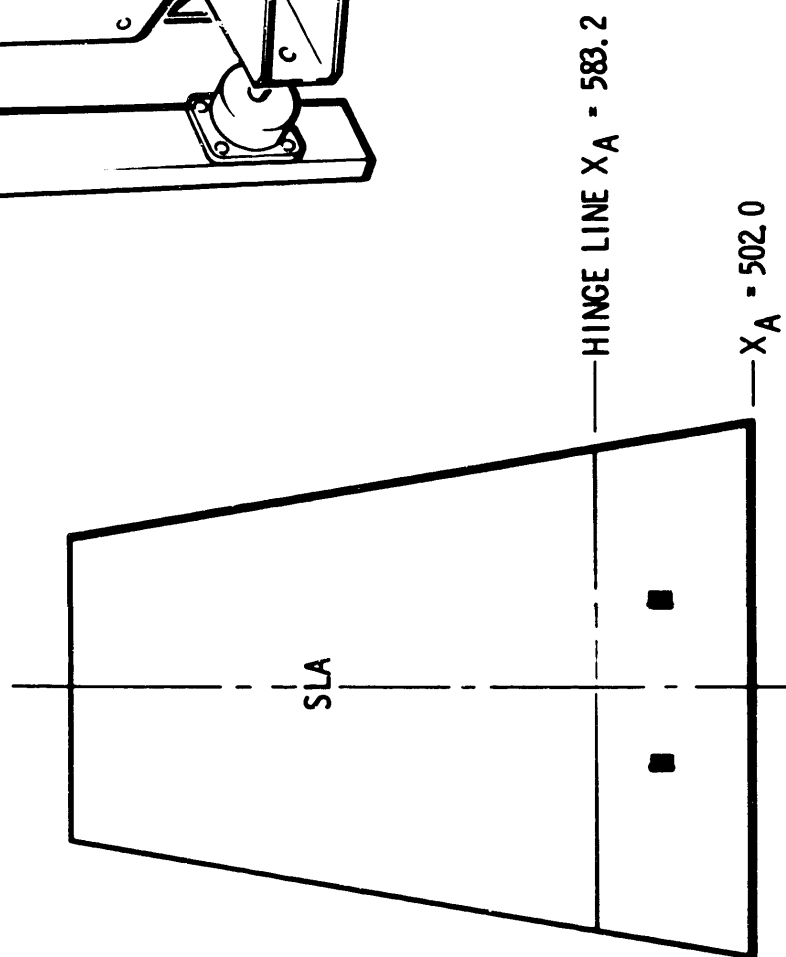
SMJC LOCATION



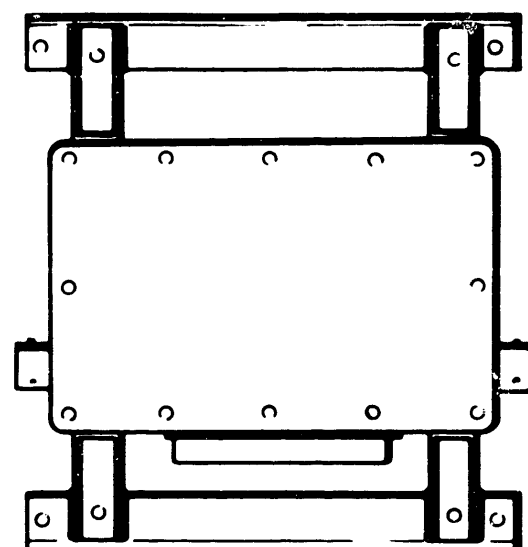
LSSC LOCATION



35

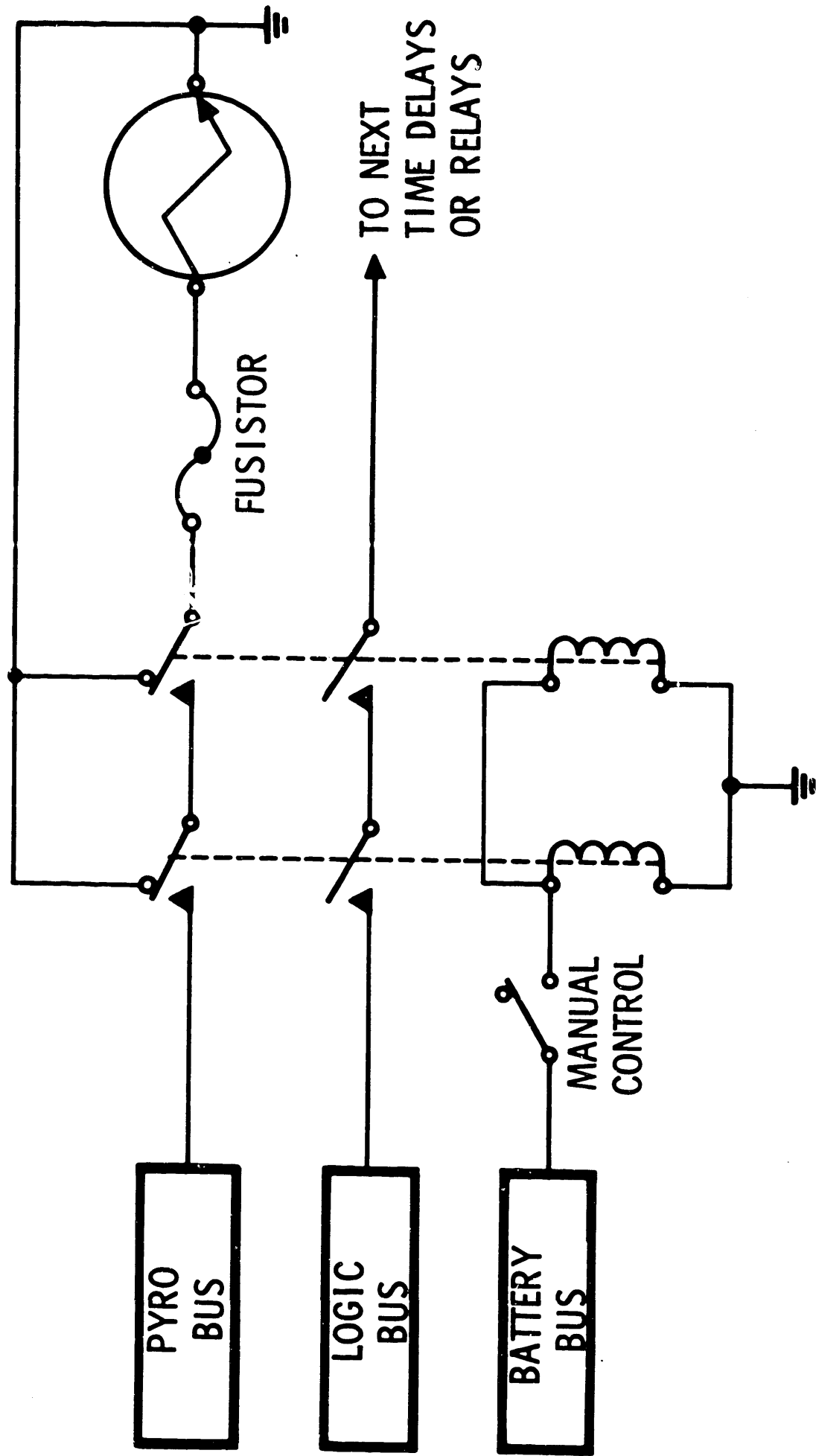


VIEW A



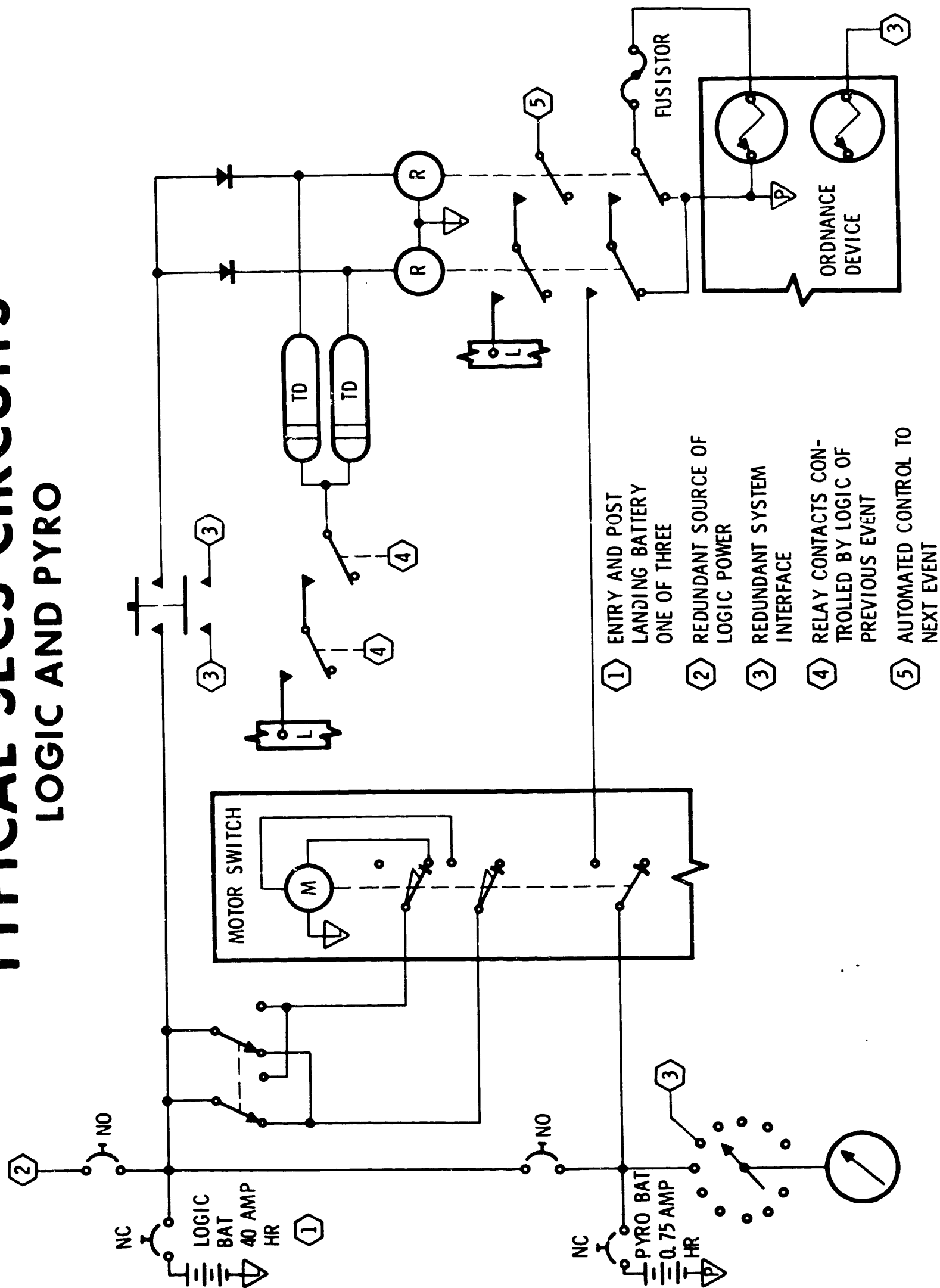
SEQ-505A

CIRCUIT CONCEPT

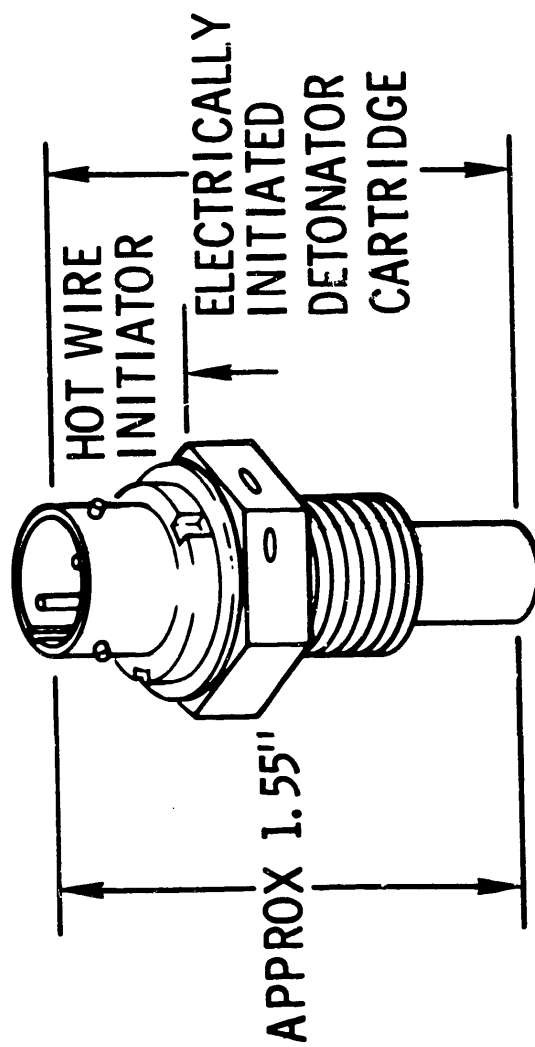
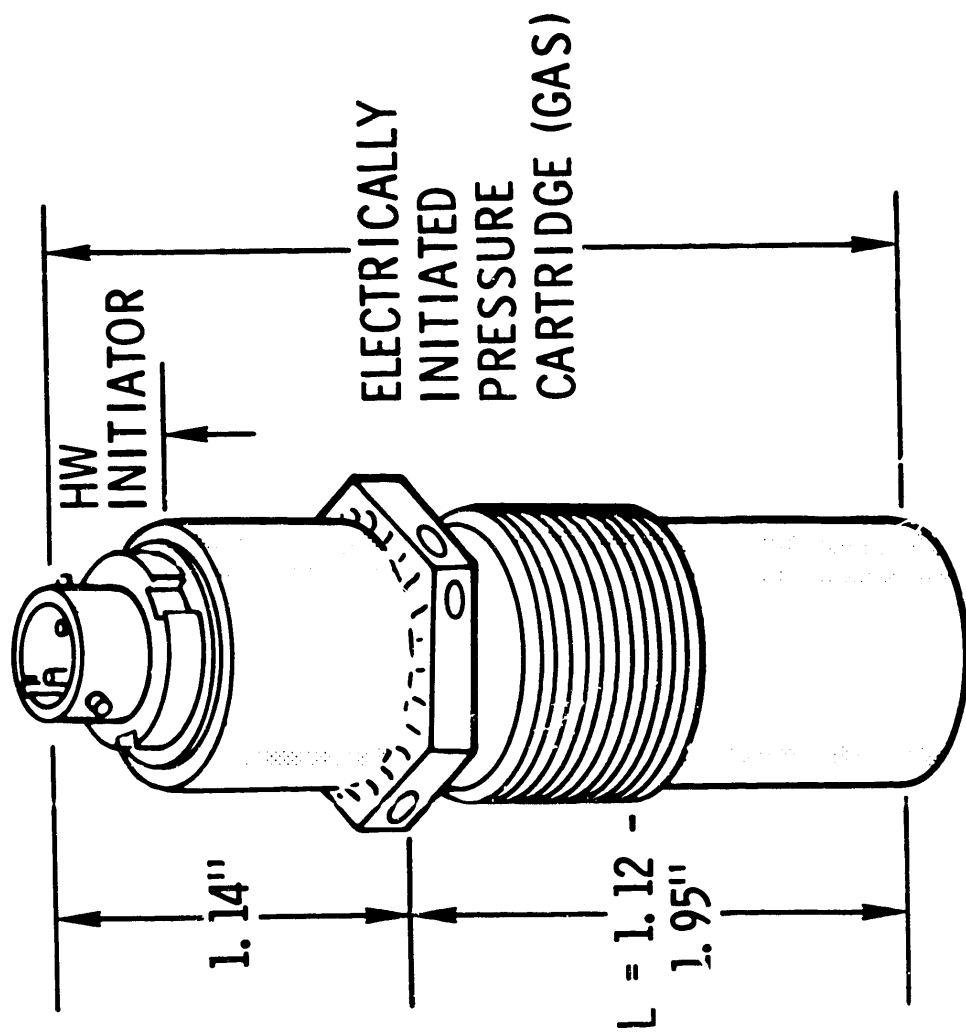
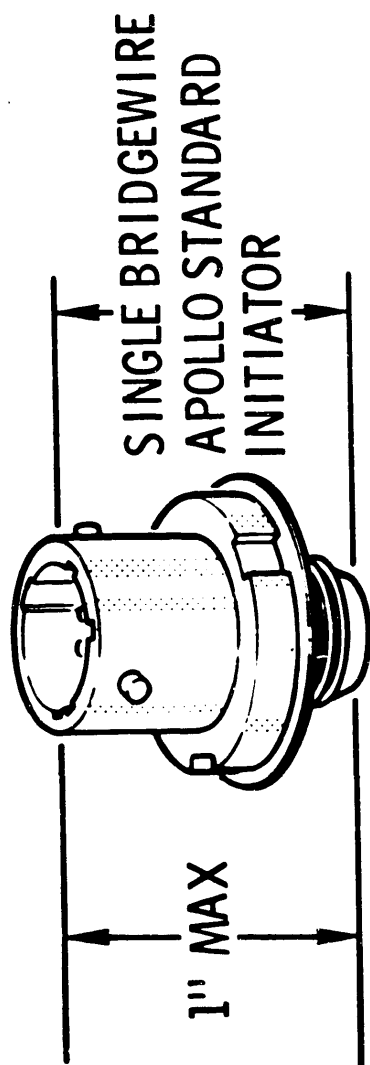


TYPICAL SECS CIRCUITS

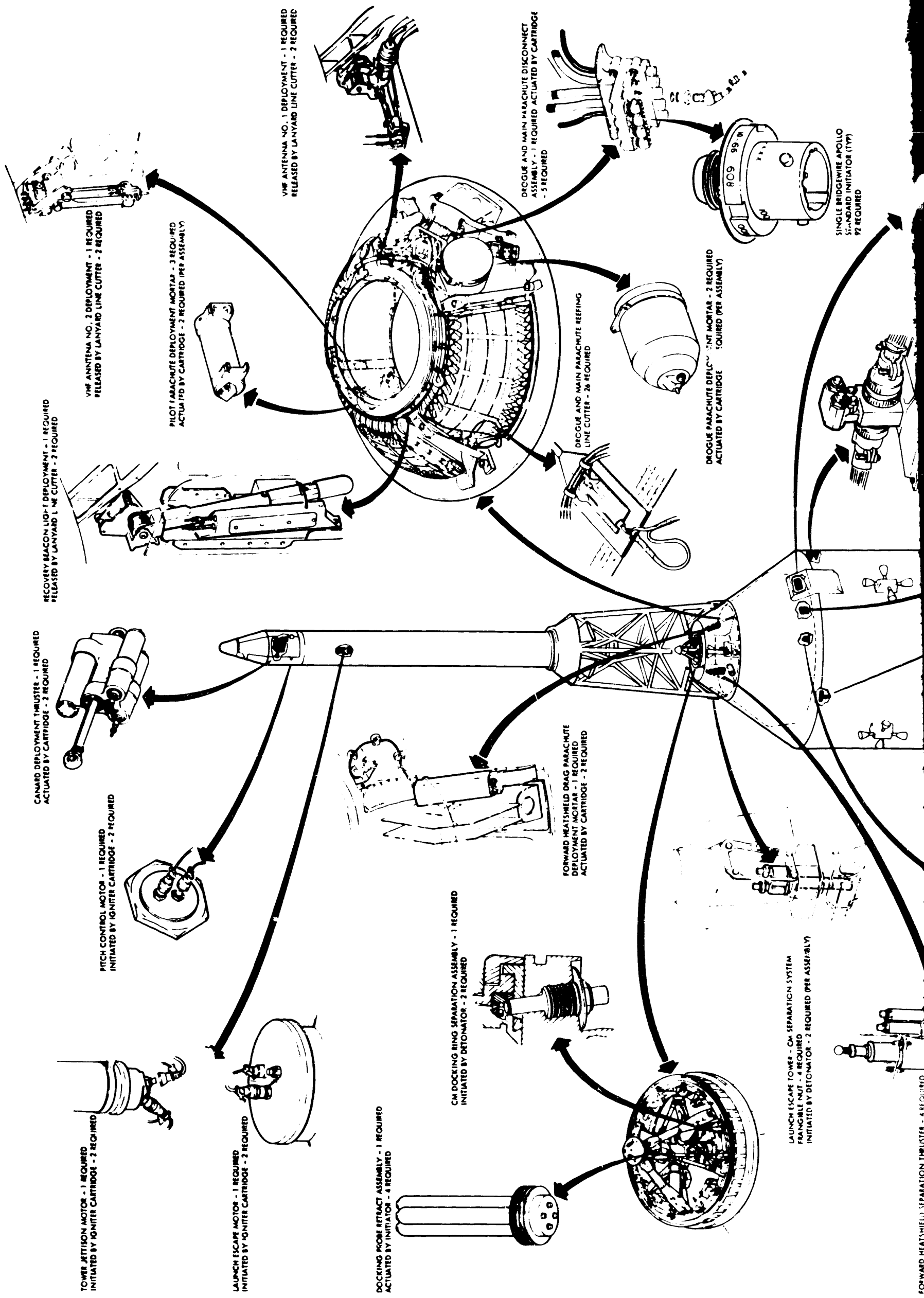
LOGIC AND PYRO

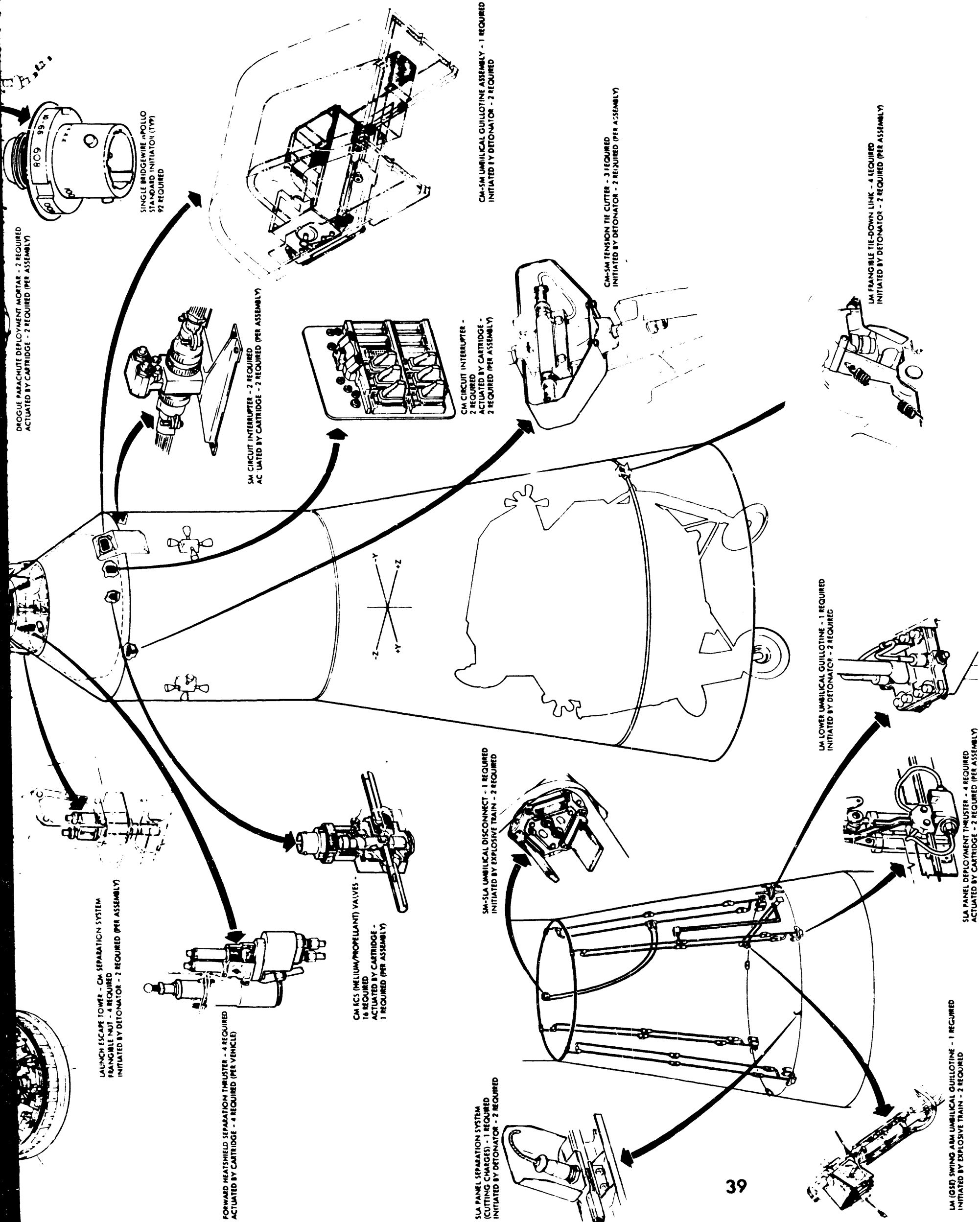


PYROTECHNIC DEVICES

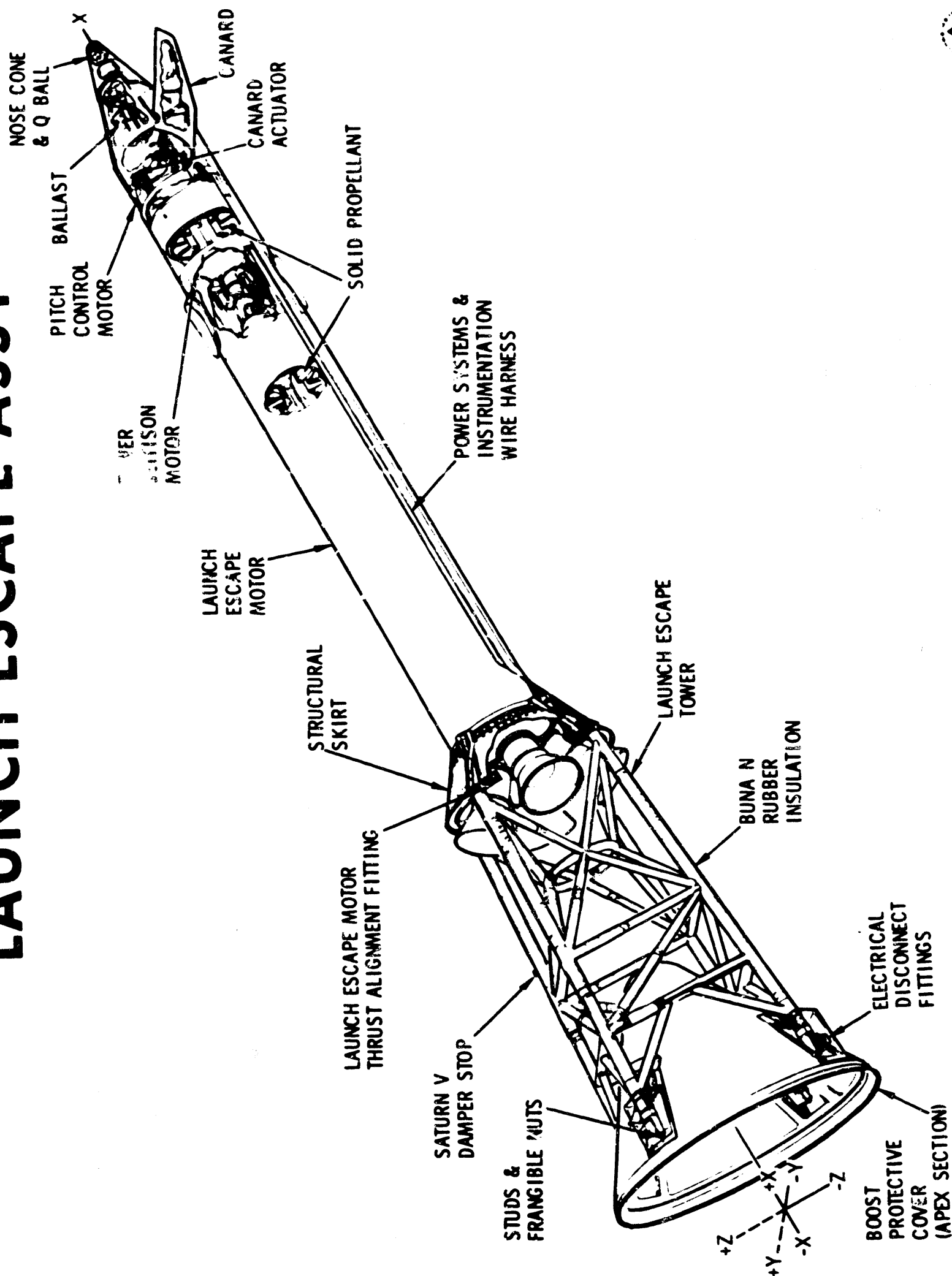


APOLLO SPACECRAFT PYROTECHNICS





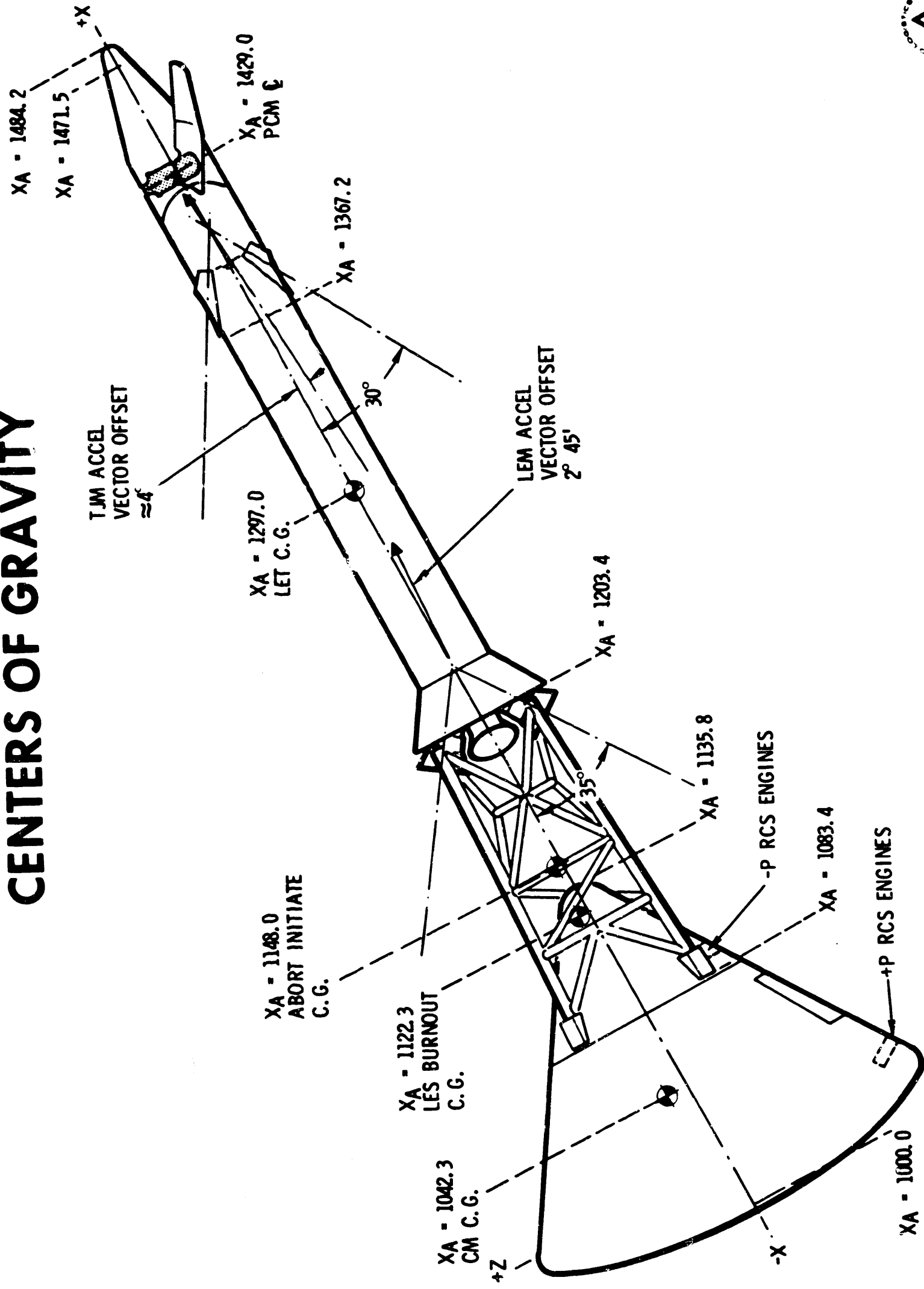
LAUNCH ESCAPE ASSY



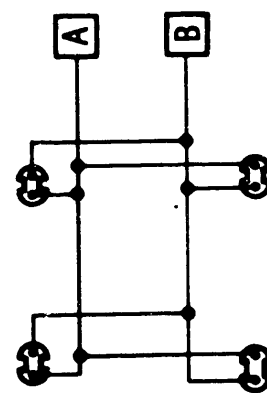
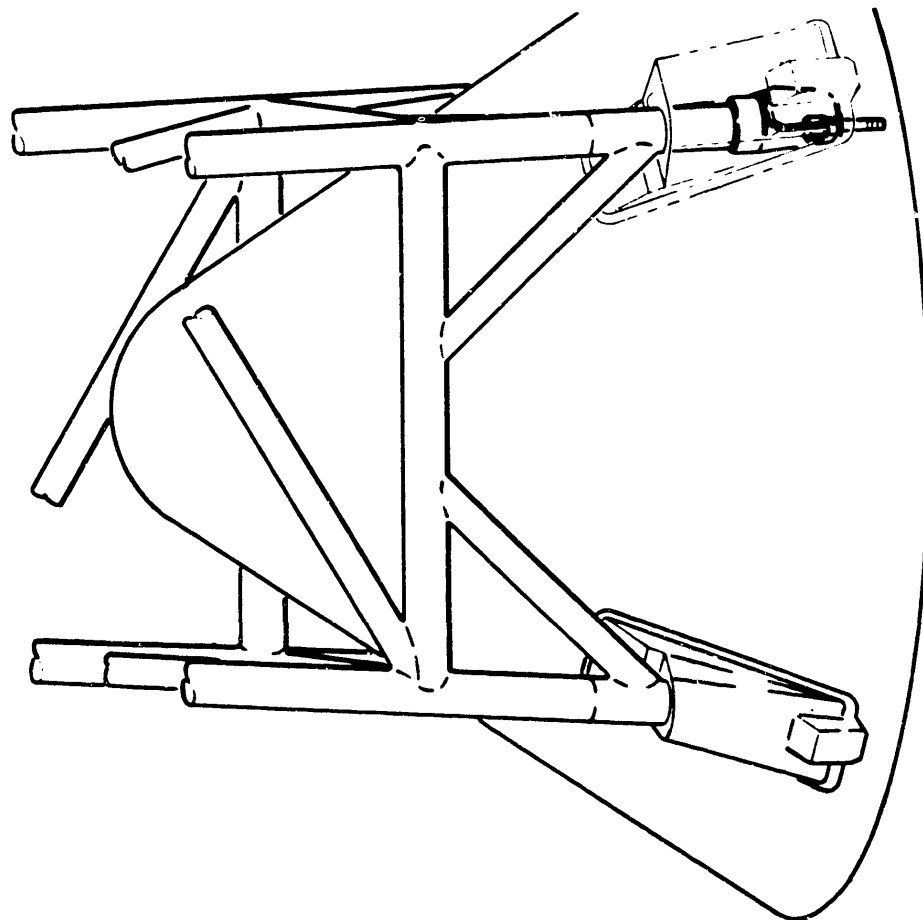
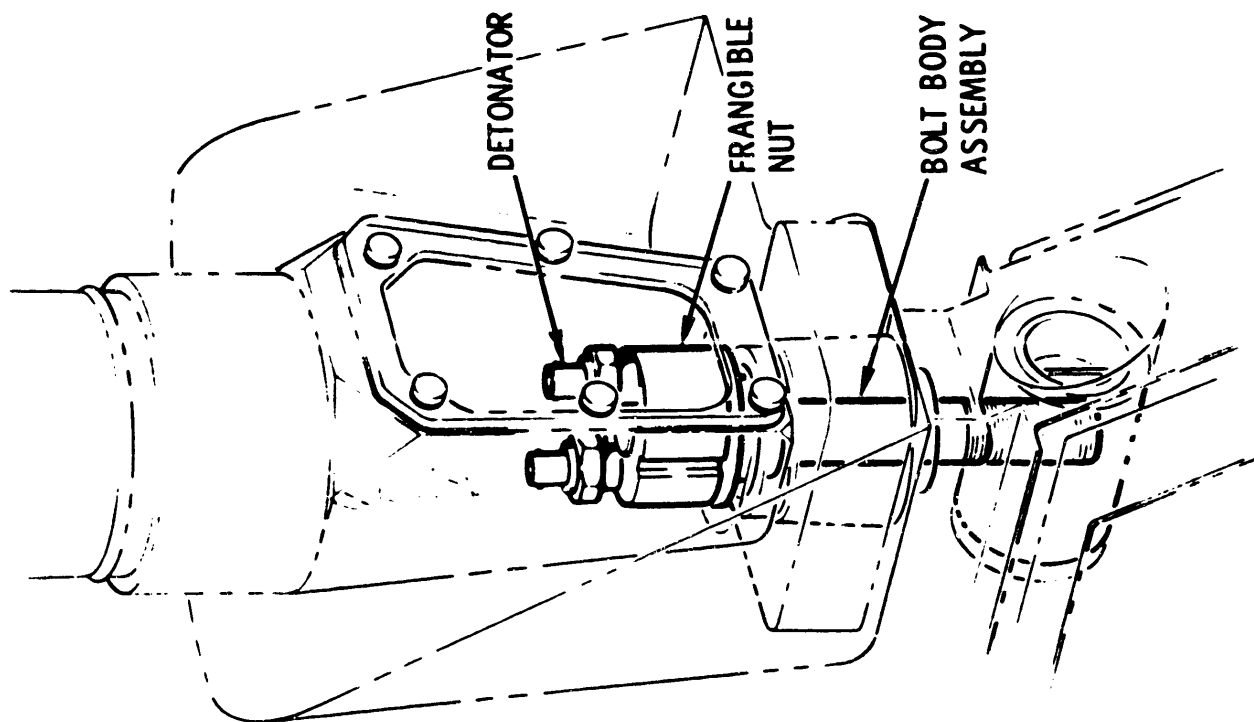
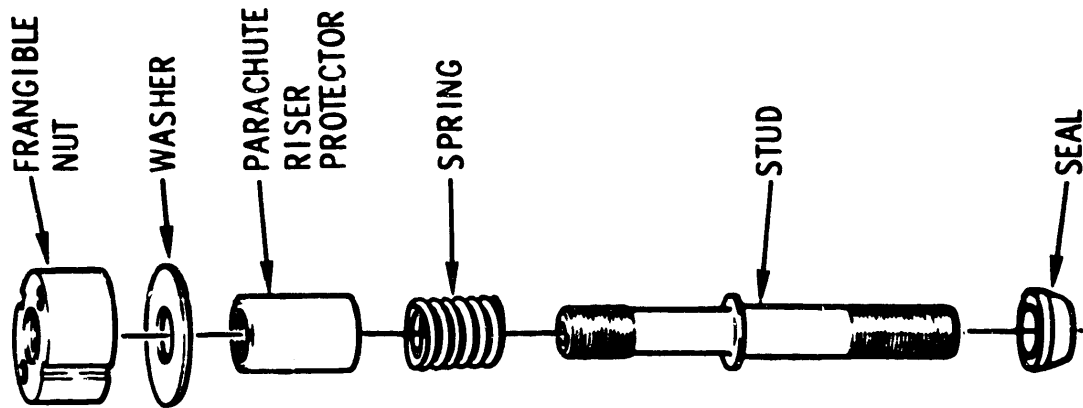
SEQ-65E (A)

LAUNCH ESCAPE VEHICLE

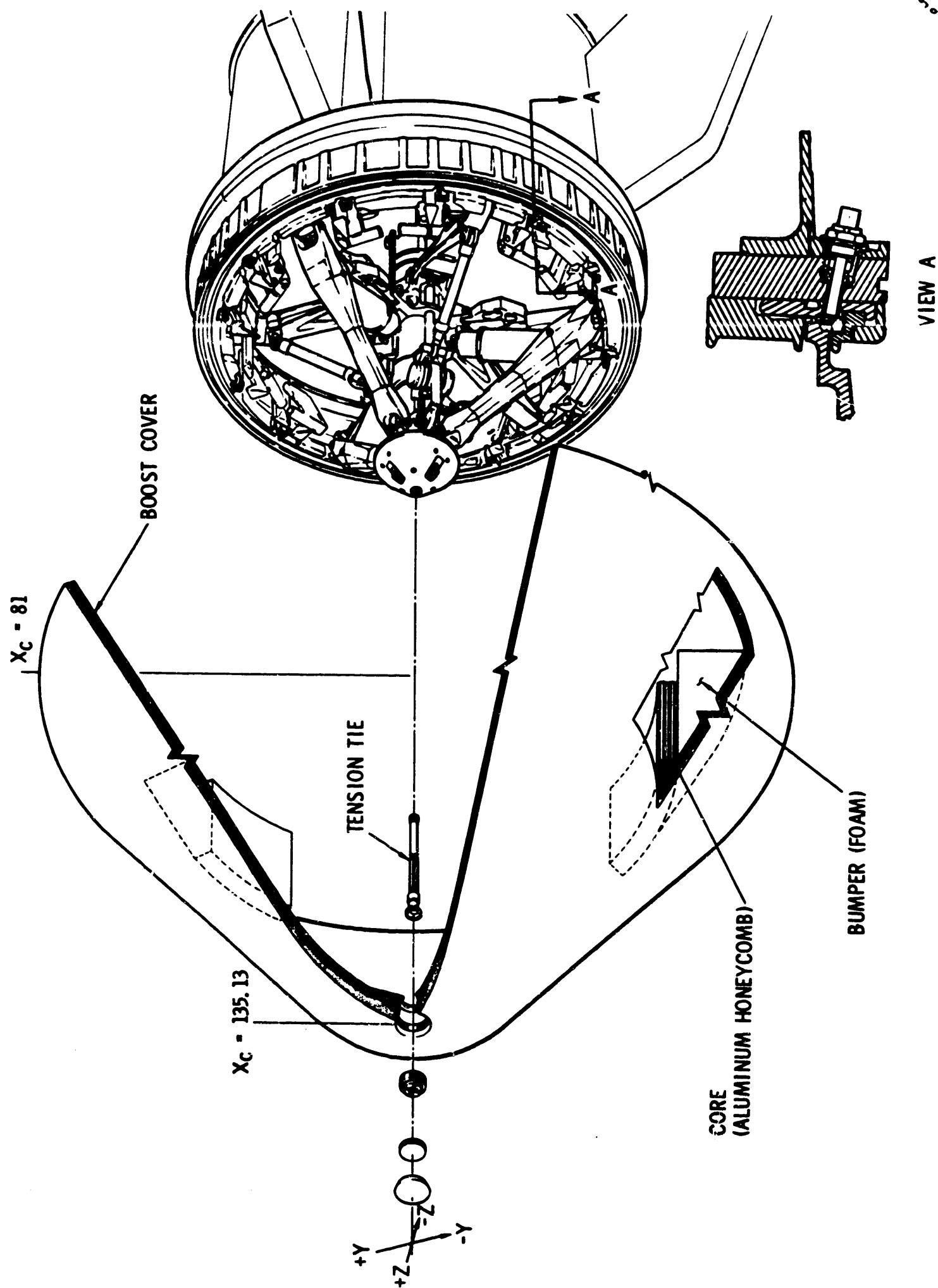
CENTERS OF GRAVITY



TOWER SEPARATION SYSTEM

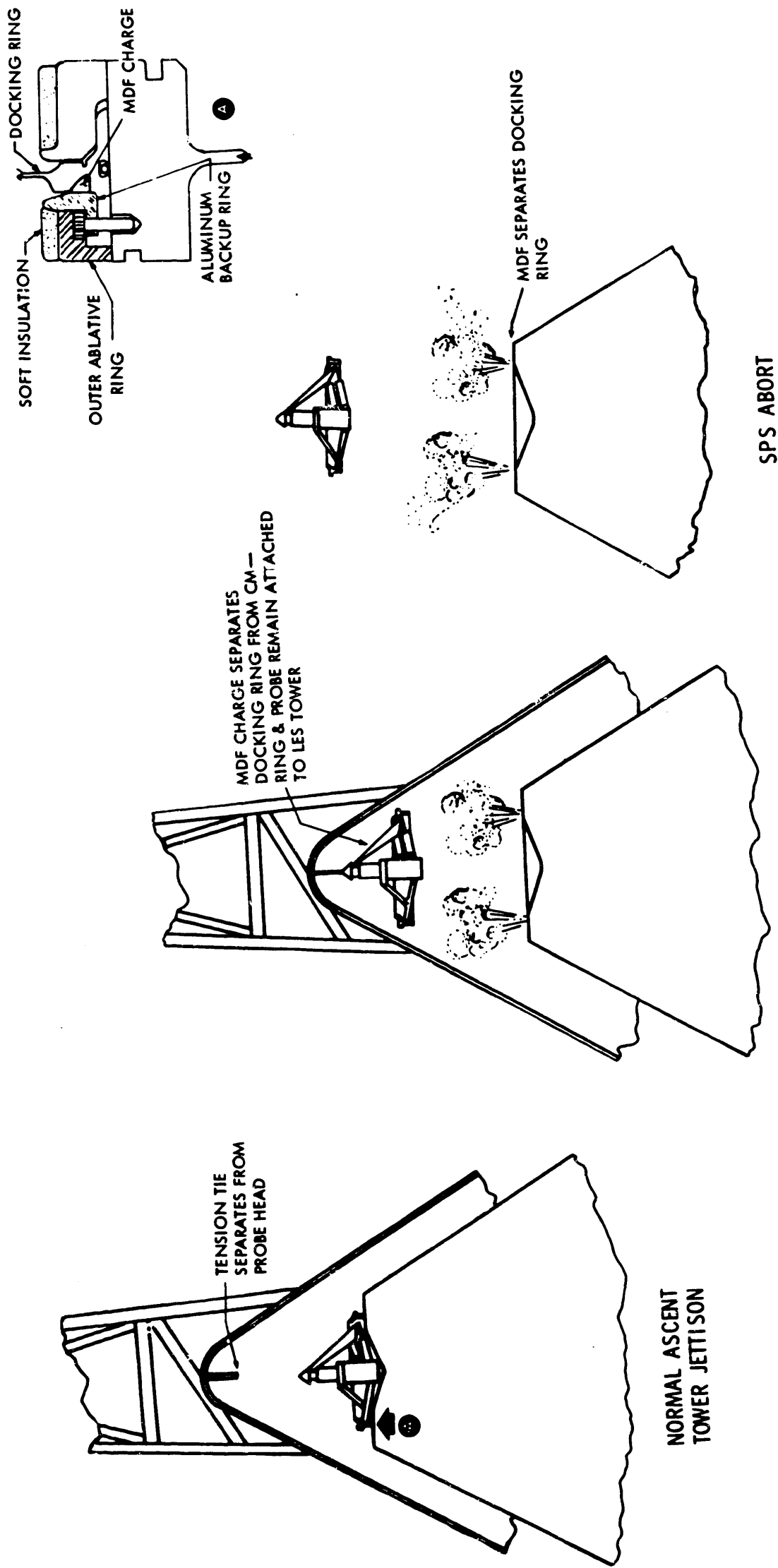


DOCKING RING SEPARATION SYSTEM



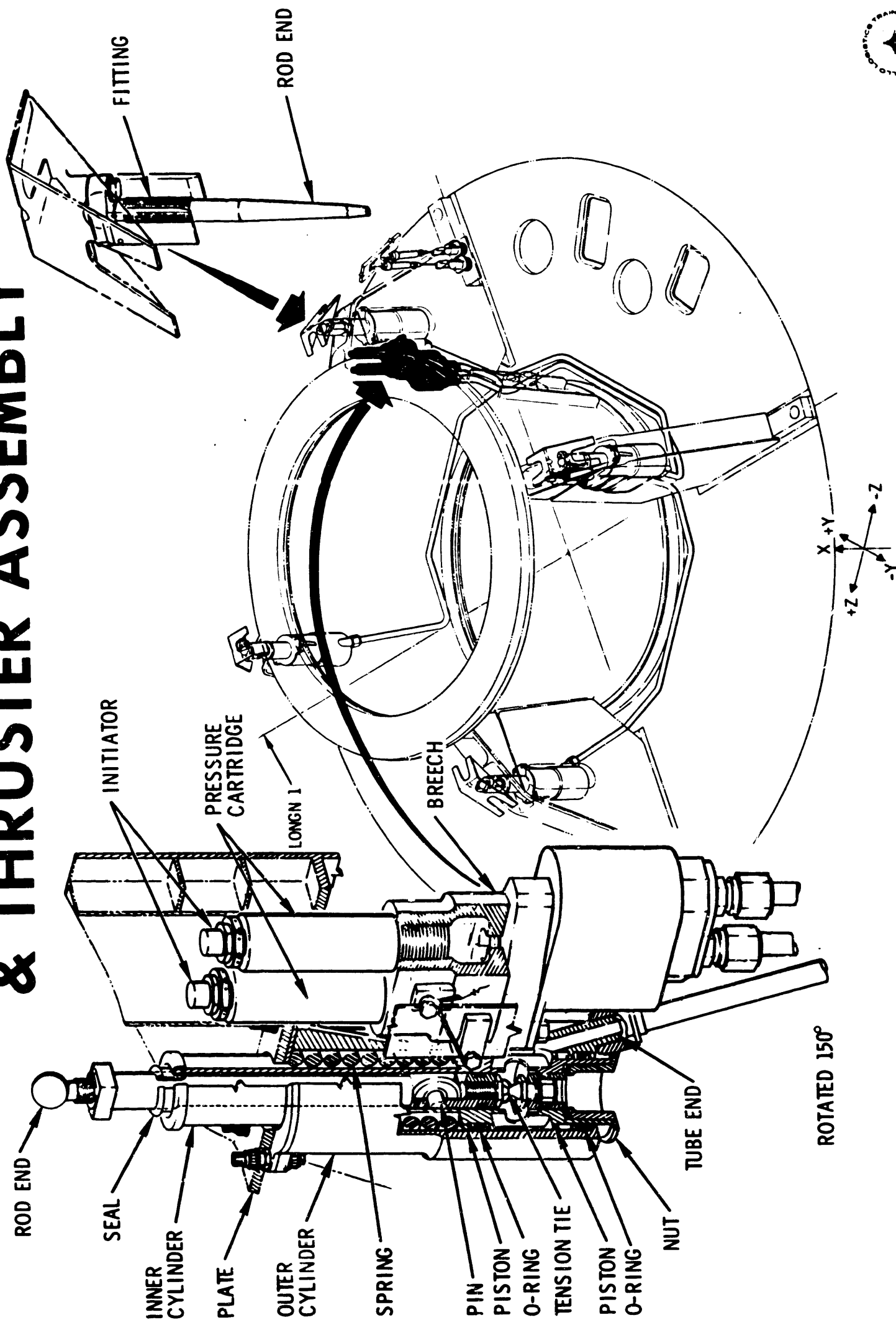
SEQ-548

DOCKING PROBE SEPARATION MODES



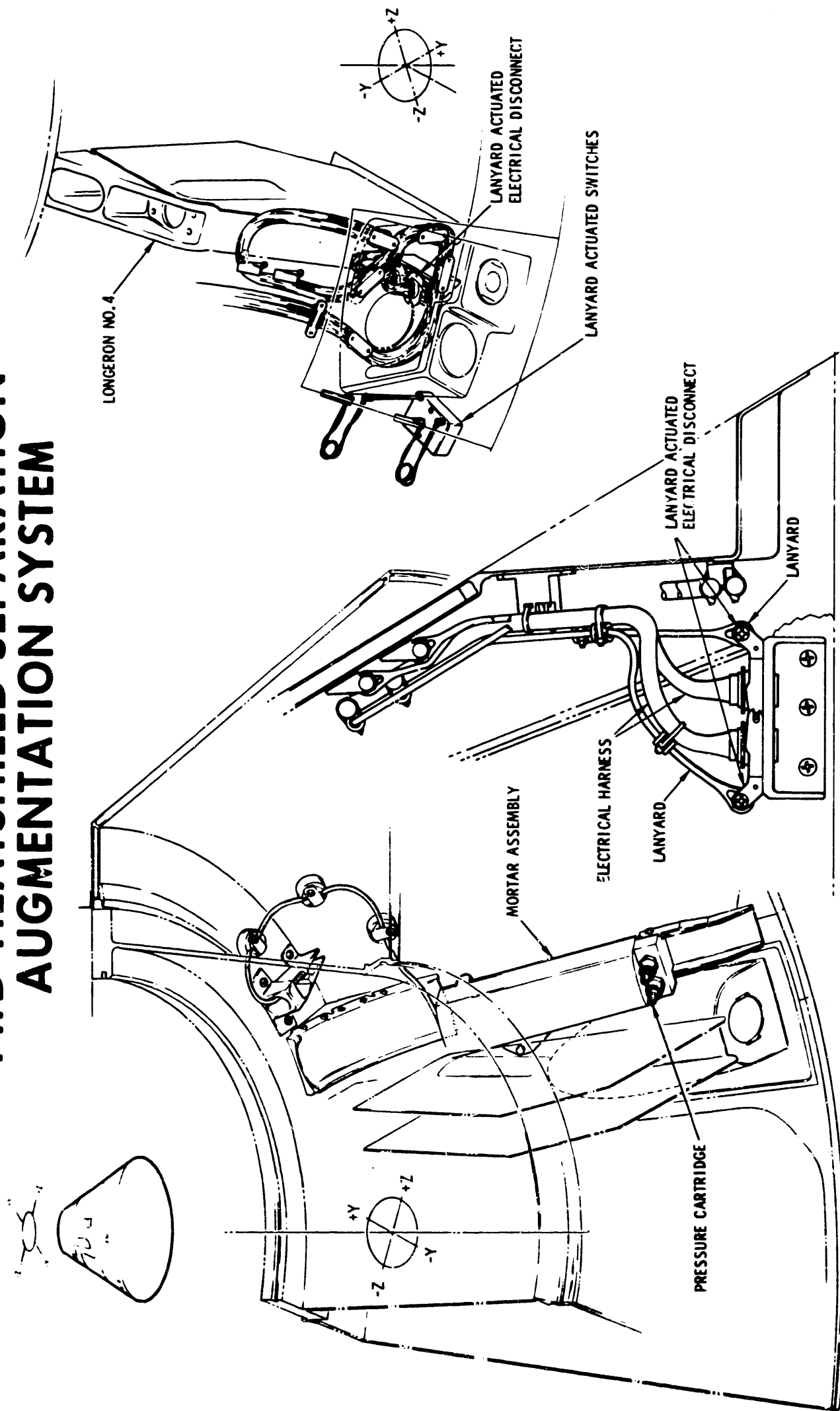
DKG-025

FORWARD HEATSHIELD ATTACHMENT & THRUSTER ASSEMBLY

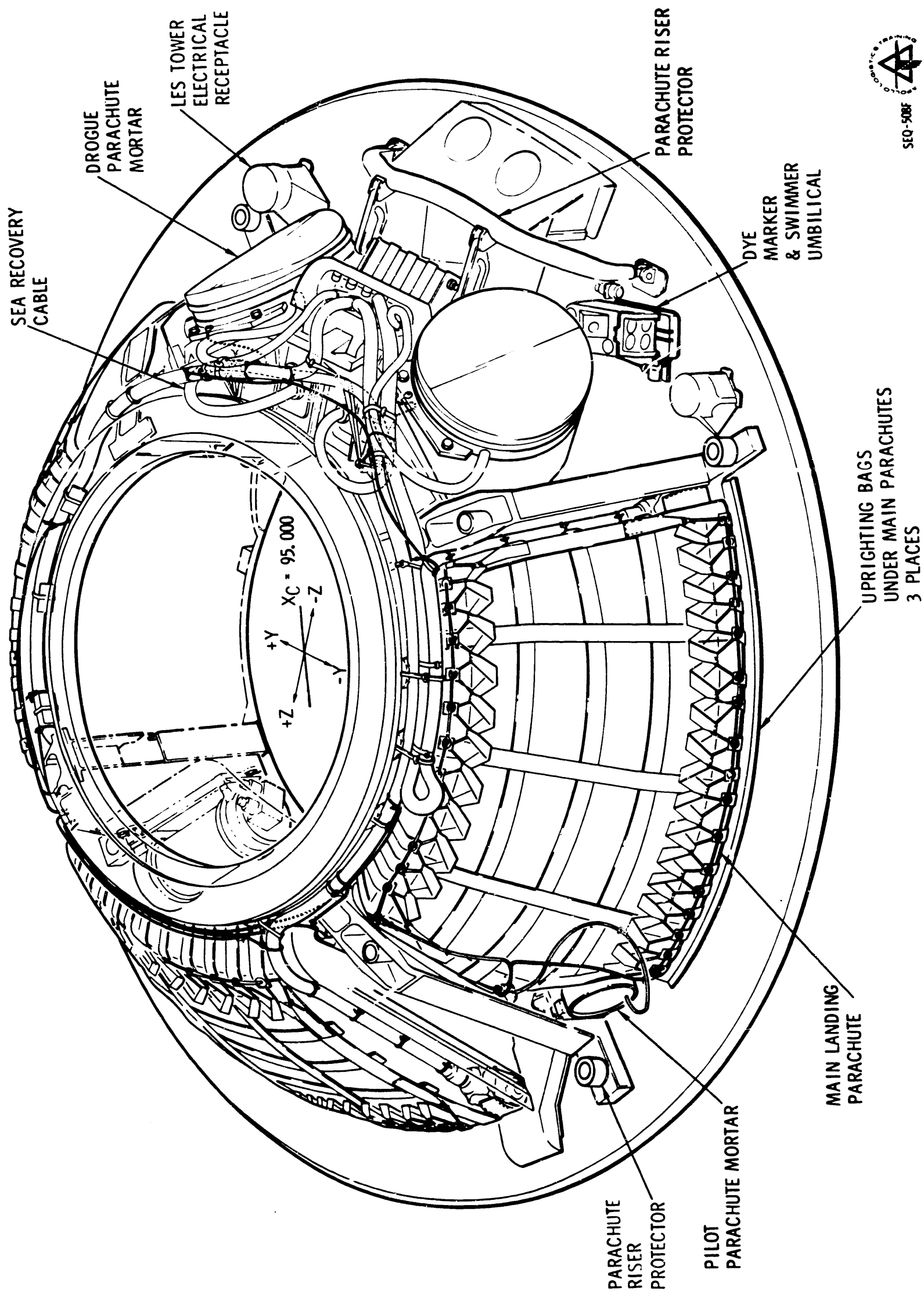


ST-590A
POLYGRAPHIC TRAINING

FWD HEATSHIELD SEPARATION AUGMENTATION SYSTEM

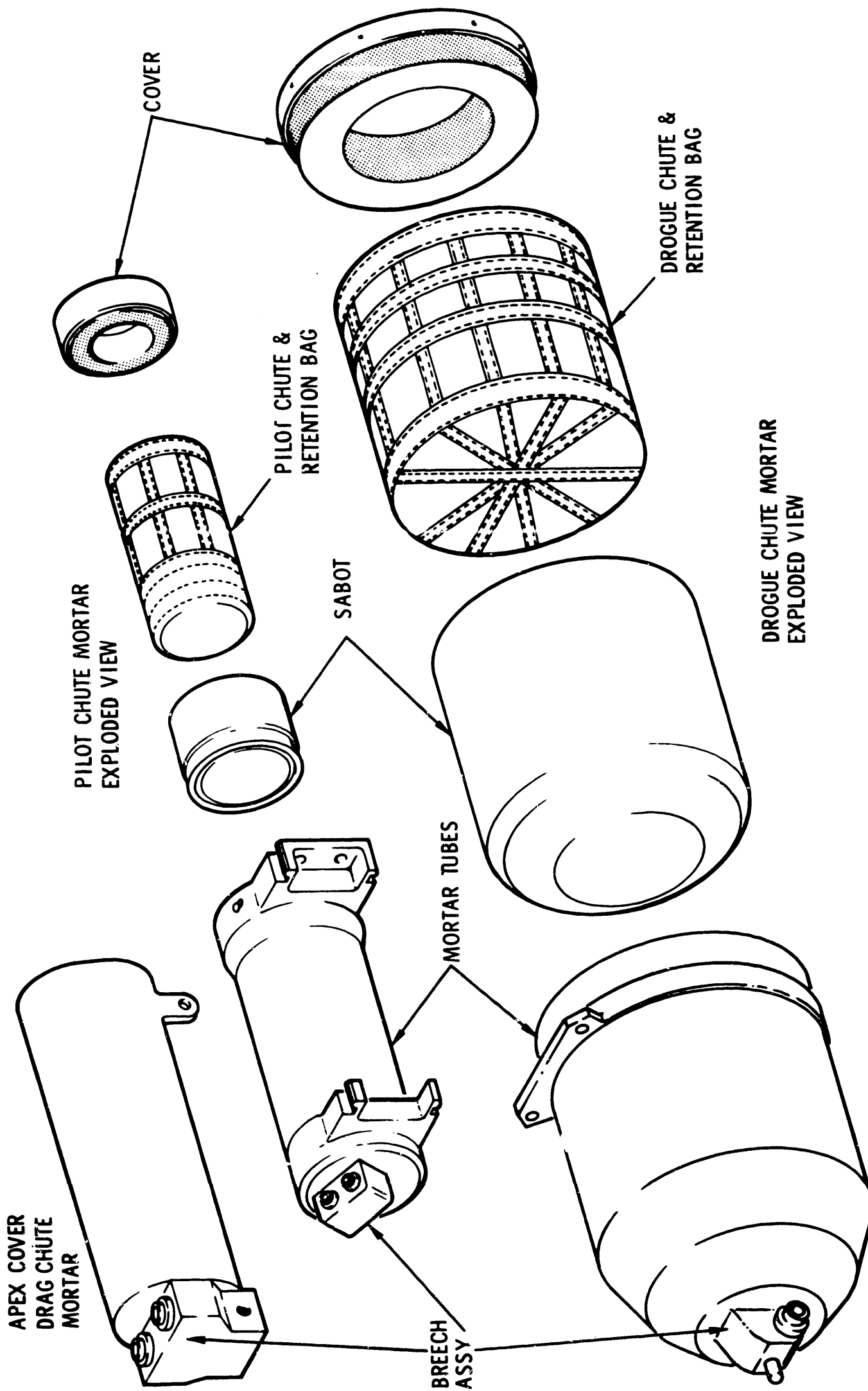


ELS EQUIPMENT

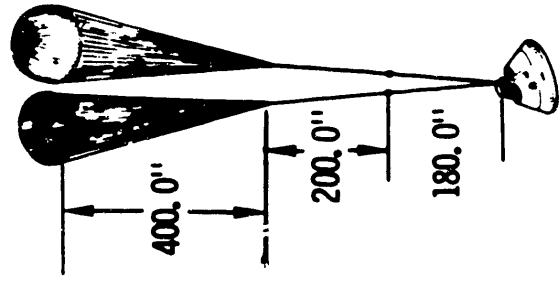


SEQ-508F


MORTAR ASSEMBLIES



EARTH LANDING SYSTEM PARACHUTES



DROGUE CHUTES (2)

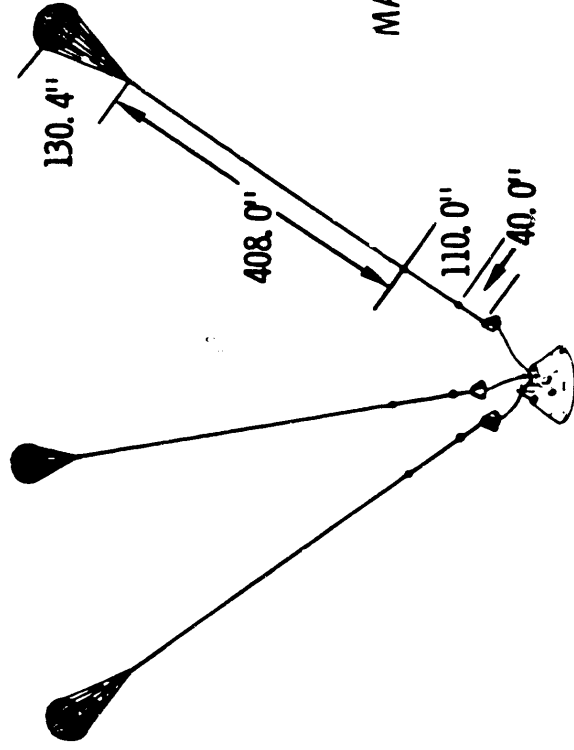
CONICAL RIBBON TYPE

MORTAR DEPLOYED
(REEFED FOR 10 SEC)

16.5 FT DIAMETER

13.0 FT NOMINAL

INFLATED DIAMETER



PILOT CHUTES (3)

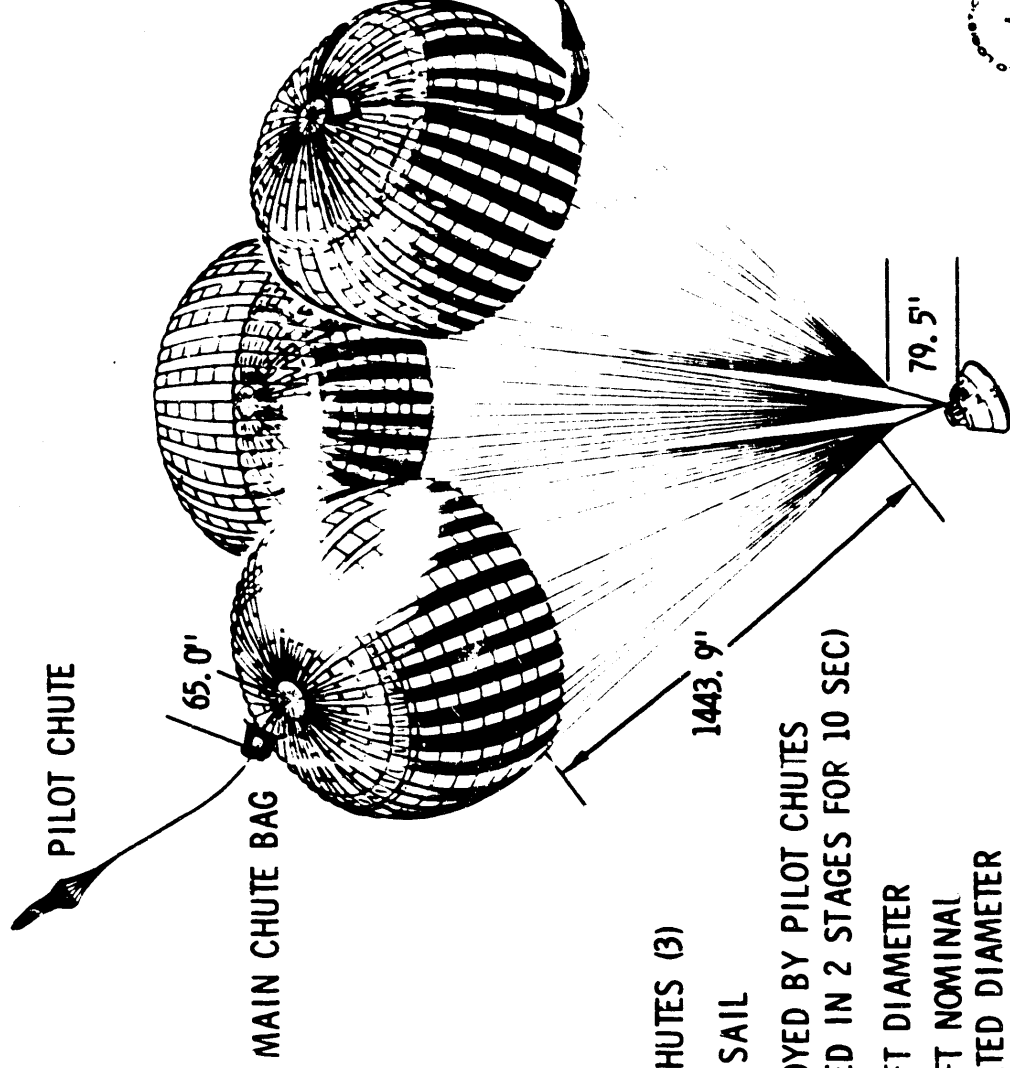
RING SLOT

MORTAR DEPLOYED

7.2 FT DIAMETER

6.0 FT NOMINAL

INFLATED DIAMETER



PILOT CHUTE

MAIN CHUTE BAG

65.0"

MAIN CHUTES (3)

RING SAIL

DEPLOYED BY PILOT CHUTES

(REEFED IN 2 STAGES FOR 10 SEC)

83.5 FT DIAMETER

77.0 FT NOMINAL

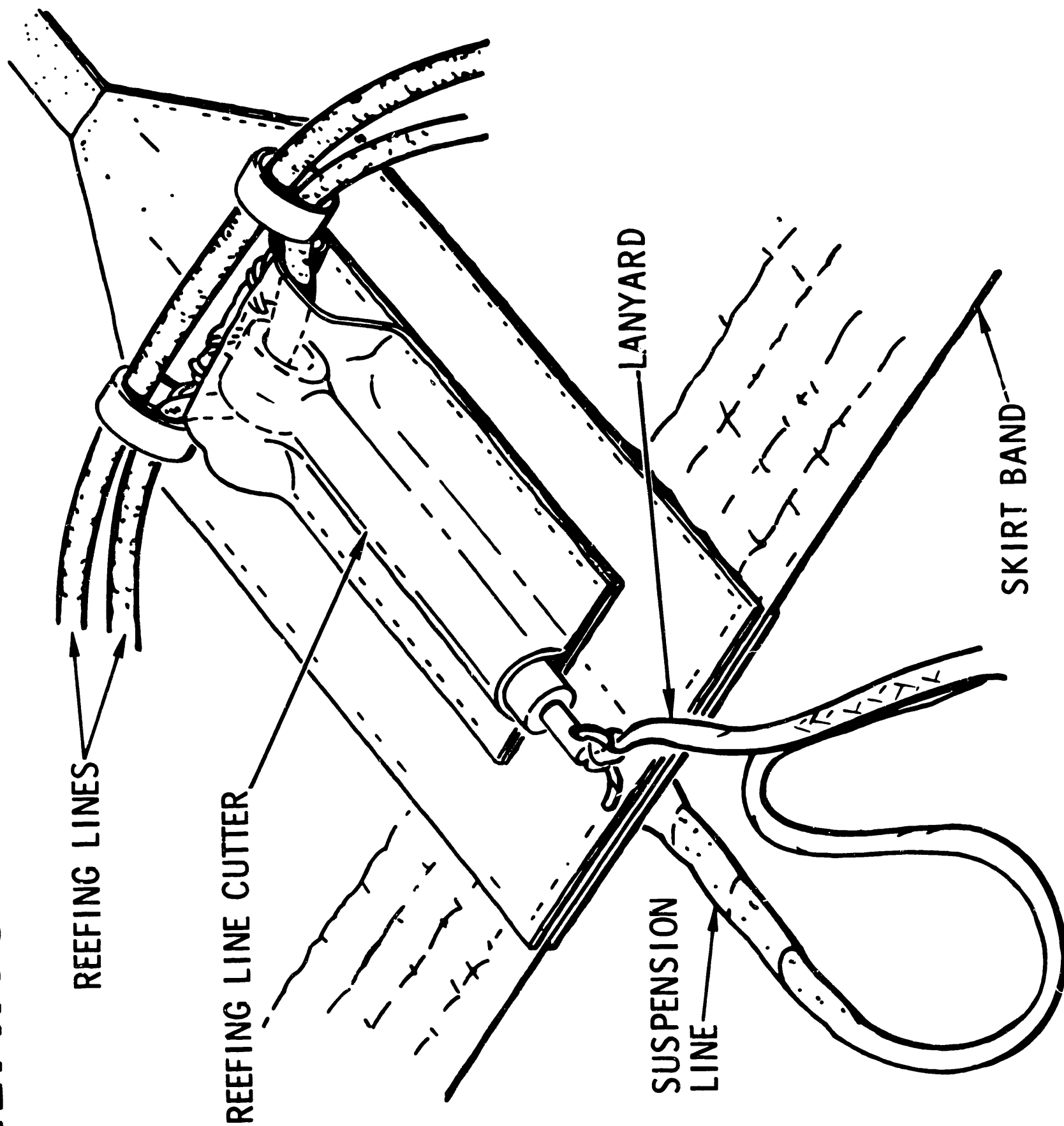
INFLATED DIAMETER

1443.9"

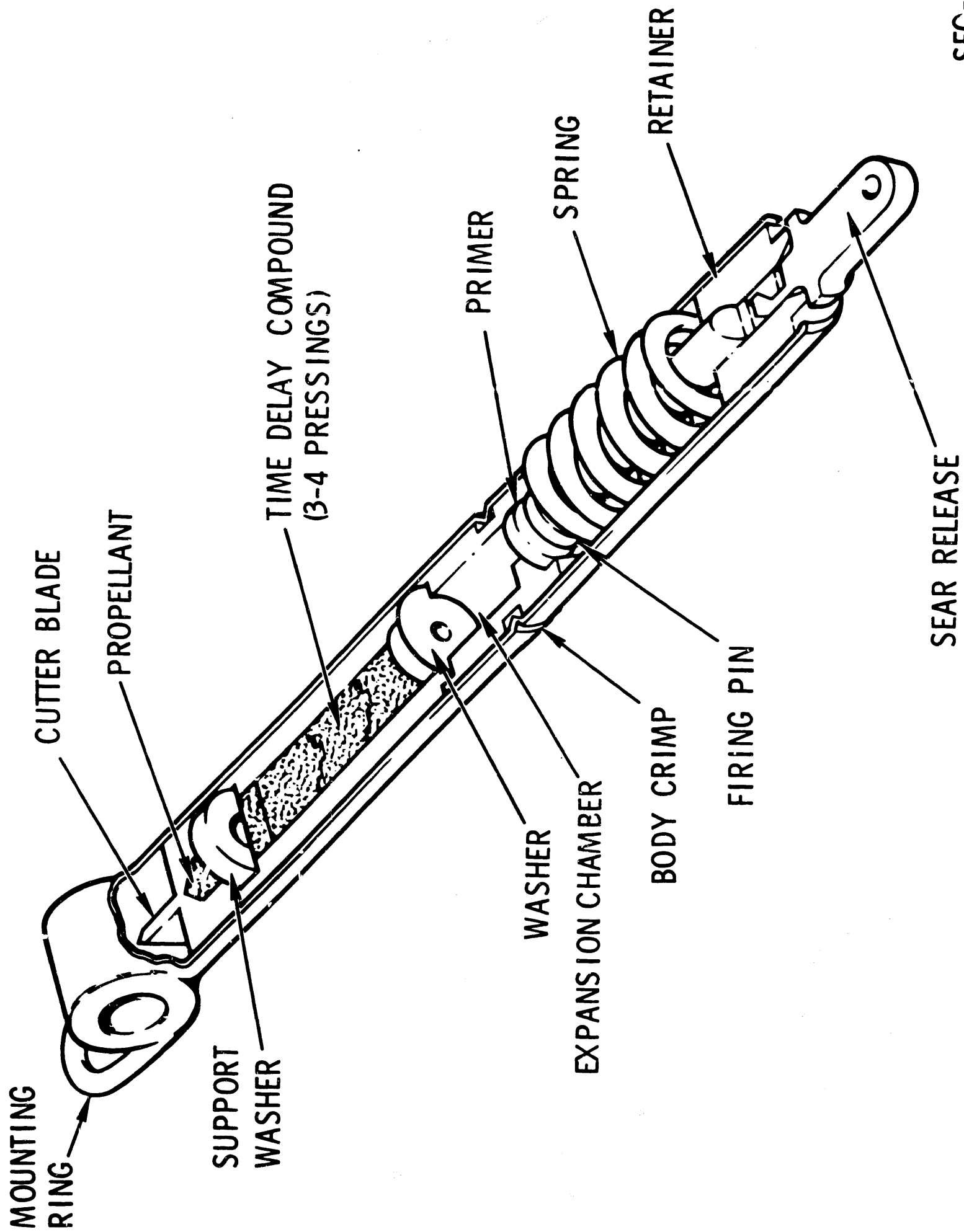
79.5"

SEQ-520C

REEFING LINE CUTTER INSTALLATION



REEFING LINE CUTTER

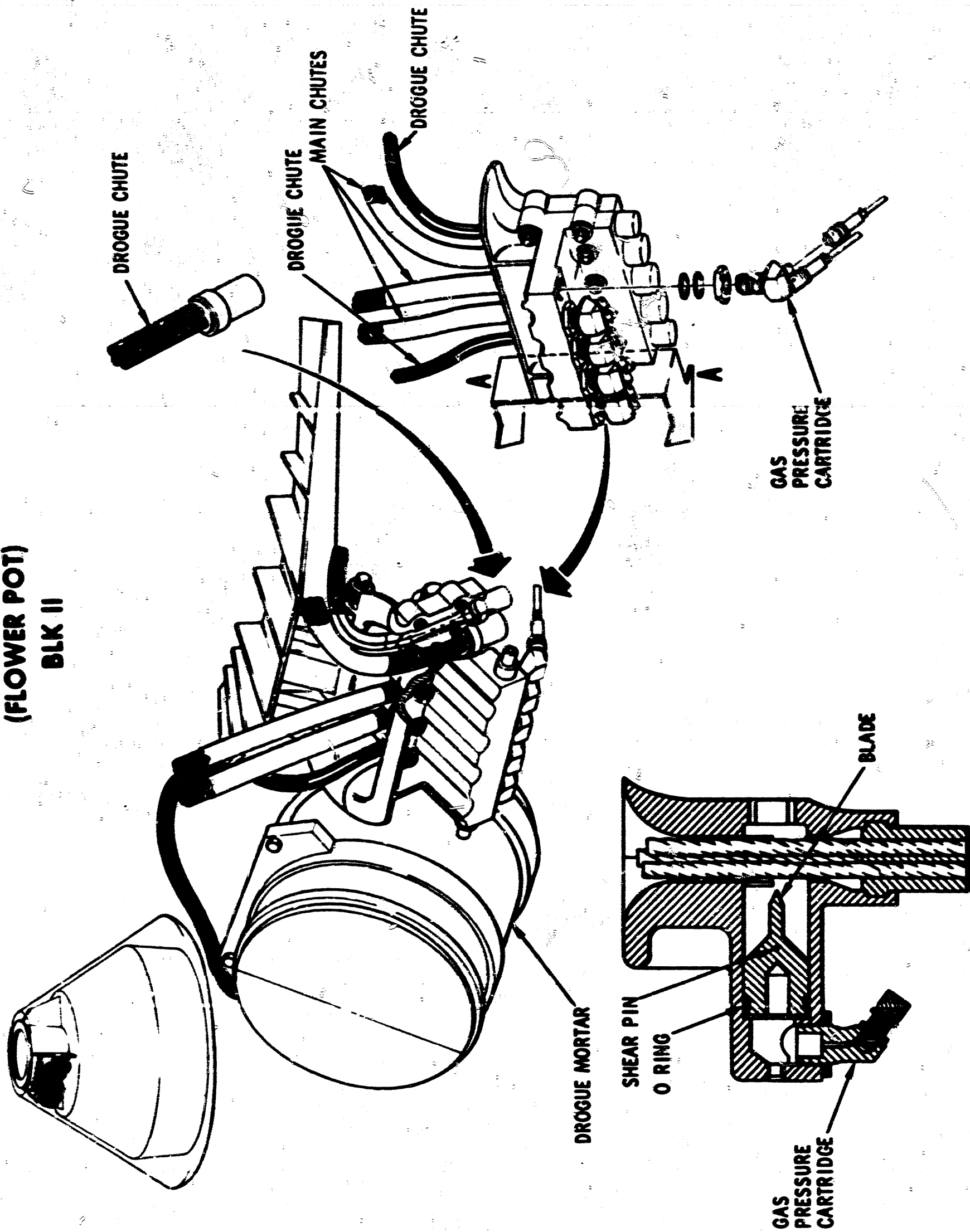


SEQ-8E

PARACHUTE DISCONNECT

(FLOWER POT)

BLK II



EVENT PROFILE

NORMAL ASCENT

SA-IB LV

ORBIT
INSERTION

11

T - $\approx$ 9'53"

1. LIFT-OFF/EDS ENABLE
2. AUTO PRPLNT DUMP "OFF", PC MOTOR INHIBITED, AND ARM AUTO. RCS ENABLE
3. MAX. Q REGION
4. INHIBIT AUTO. ABORT
5. S-IB INB'D ENG "OFF"
6. S-IB OUTB'D ENG "OFF"
7. S-IB JETTISON
8. S-IVB IGNITION
9. S-IVB THRUST COMMITMENT
10. JETTISON TOWER
11. S-IVB ECO

NOTE: THE SECS AND EDS POWER WILL BE TURNED OFF FOLLOWING ORBITAL S-IVB STABILIZATION

T - 2' 46" 10 - $\approx$ 265K'

T - +2'32" 9 - $\approx$ 222K'

T - +2'29" 8

T - +2'27" 7 - $\approx$ 206K'

T - +2'26" 6

T - +2'23" 5 - $\approx$ 190K'

T - +1'40" 4 - $\approx$ 75K'

T - +1'18" 3 - $\approx$ 40K'

T - +61" 2 - $\approx$ 22K'

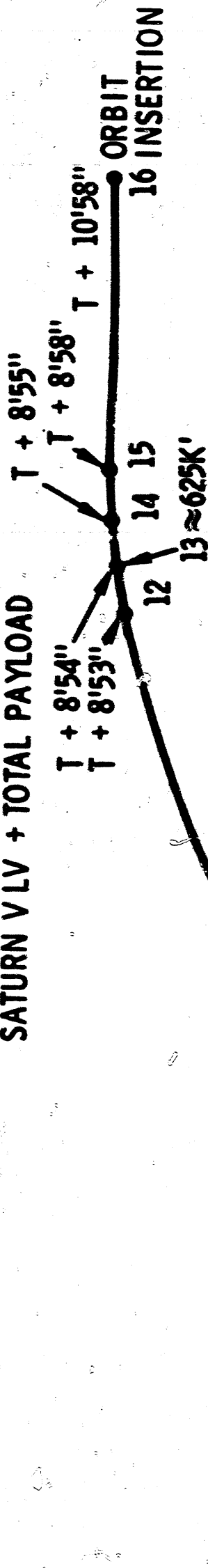
T = 0 1

SEQ-531D (A)

EVENT PROFILE

NORMAL ASCENT

SATURN V LV + TOTAL PAYLOAD



1. LIFTOFF/EDS AUTO. ABORT ENABLED
2. ARM AUTO. RCS ENABLE, AUTO. PRPLNT DUMP AND PC MOTOR INHIBITED
3. MAX Q REGION
4. INHIBIT AUTO. ABORT
5. S-IC INB'D ENG CUTOFF
6. S-IC OUTB'D ENG CUTOFF
7. S-IC SEPARATION
8. S-II IGNITION
9. S-II THRUSTING
10. S-II SECOND PLANE SEP
11. JETTISON TOWER
12. S-II ENGINE CUTOFF
13. S-II SEPARATION
14. S-IVB IGNITION
15. S-IVB THRUSTING
16. S-IVB ENGINE CUTOFF

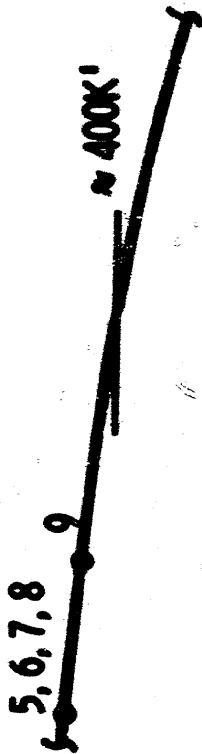
NOTE: THE SECS AND EDS POWER WILL BE TURNED OFF FOLLOWING ORBITAL S-IVB STABILIZATION

SEQ-538E

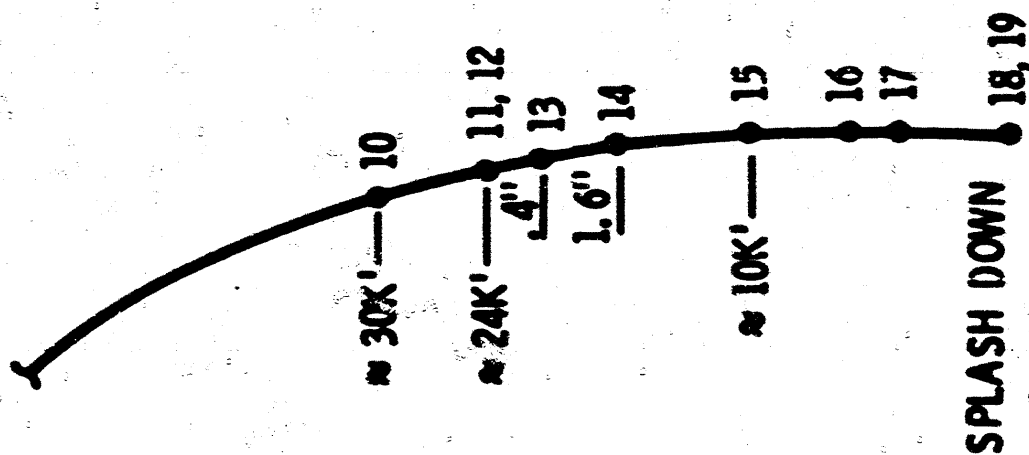


EVENT PROFILE

NORMAL PRE-ENTRY, ENTRY & DESCENT



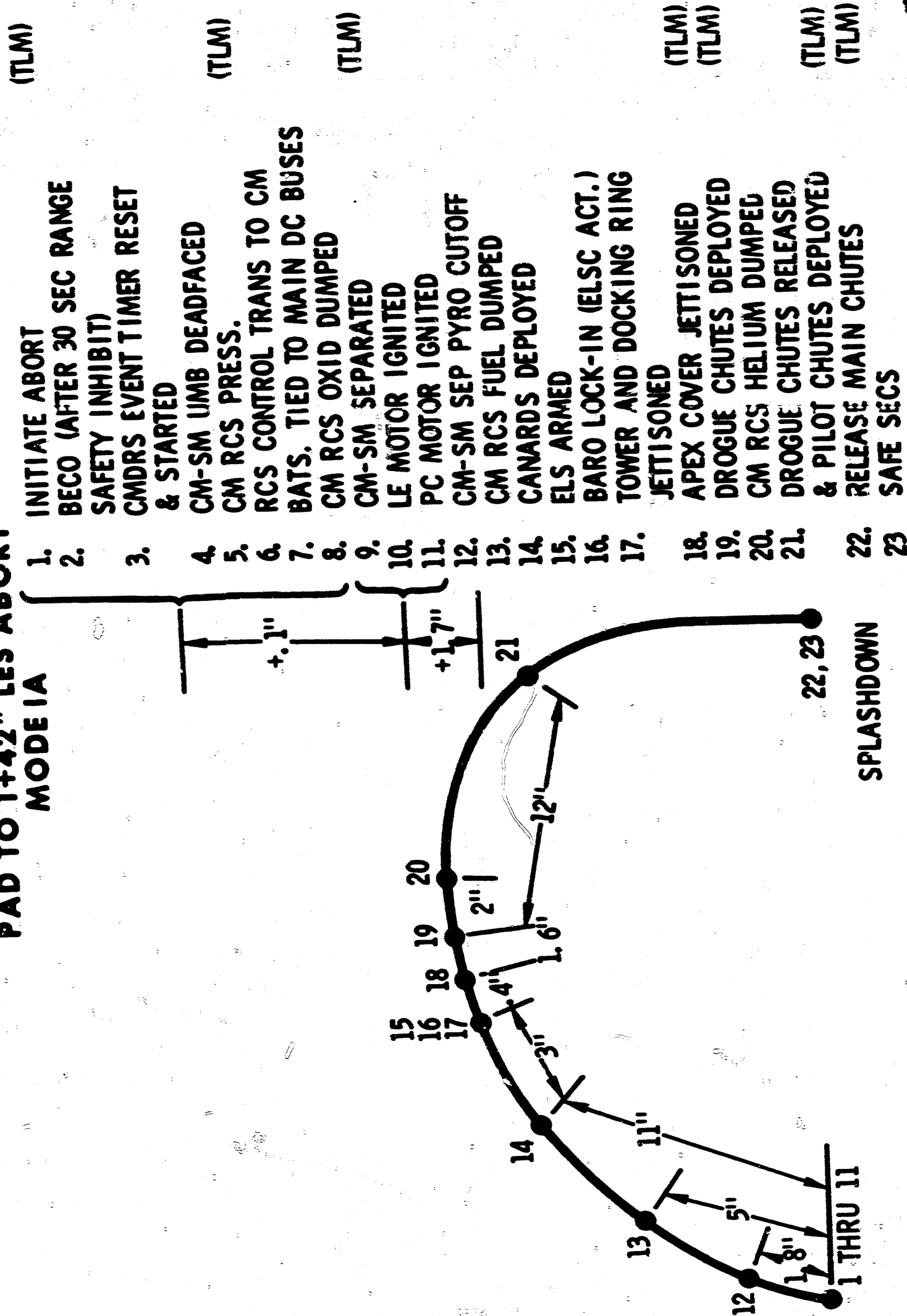
1. ARM SECS
2. TRANS RCS CONTROL TO CM
3. PRESS. CM RCS
4. TRANS RCS CONTROL TO SM
5. INITIATE CM-SM SEP
6. CM-SM UMB DEADFACED
7. RCS CONTROL TRANS TO CM
8. CM-SM SEPARATED
9. CM-SM SEP PYRO CUTOFF
10. ARM ELS
11. BARO LOCK-IN (ELSC ACT.)
12. CM RCS/SCS DISABLED
13. APEX COVER JETTISONED
14. DROGUE CHUTES DEPLOYED
15. DROGUE CHUTES RELEASED & PILOT CHUTES DEPLOYED
16. BURN RCS PROPELLANTS
17. PURGE CM RCS
18. RELEASE MAIN CHUTES
19. SAFE SECS



SEQ-532H (A)

EVENT PROFILE

PAD TO T+42" LES ABORT
MODE 1A

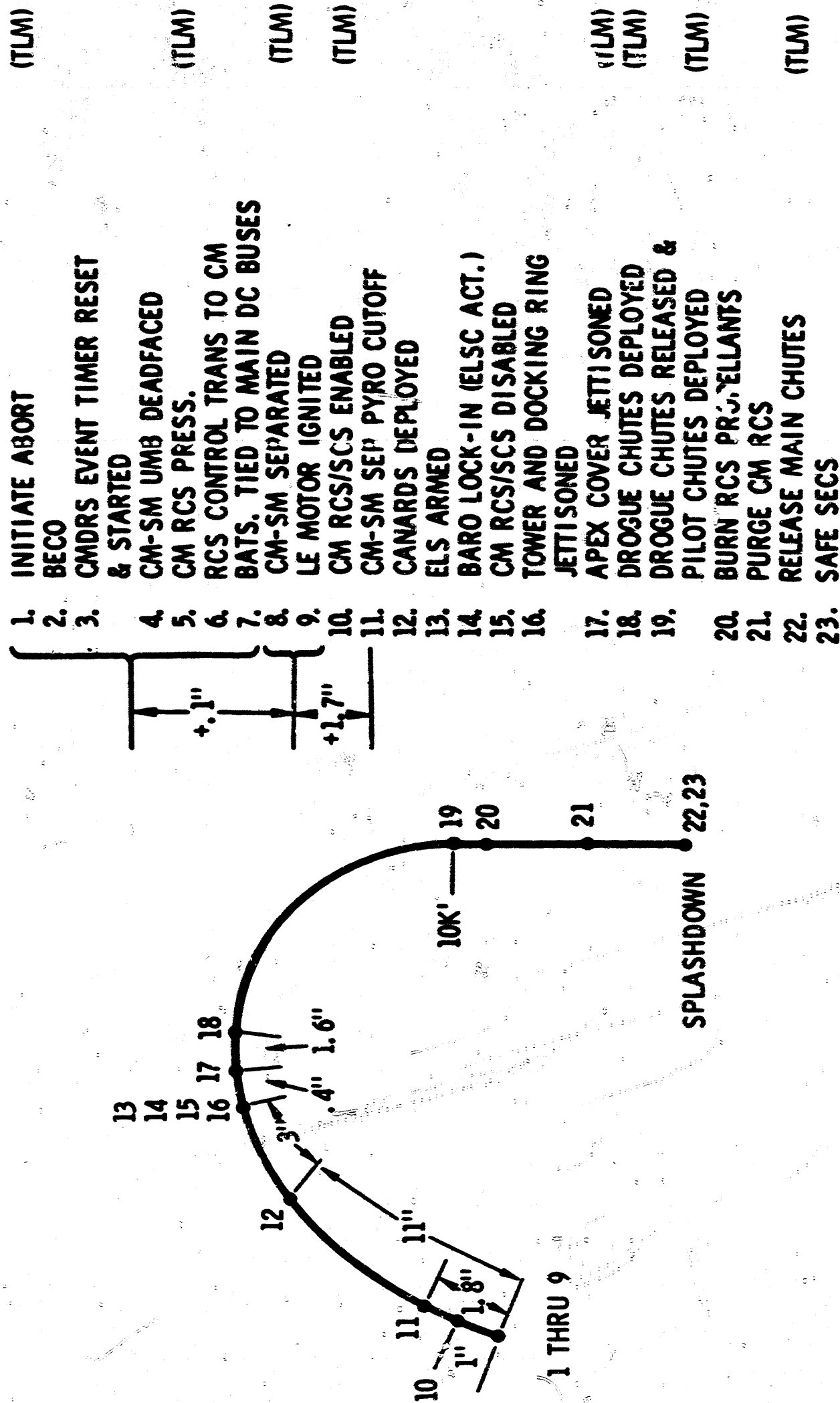


SEQ-533 E (A)

EVENT PROFILE

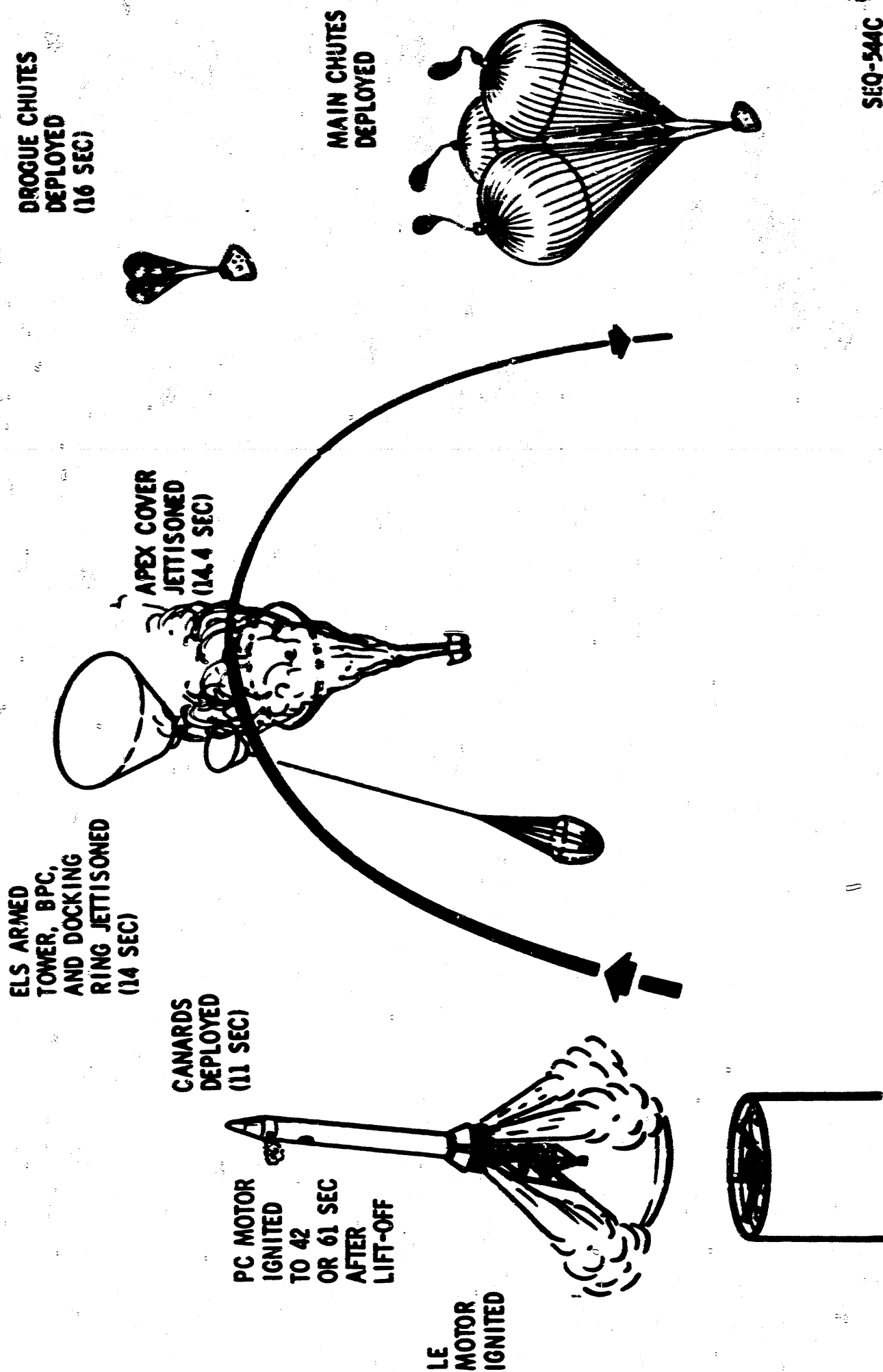
T+42" TO ≈30,000 FT LES ABORT

MODE 1B



SEQ-534F (A)

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



SEQ-544C

≈30,000 FT TO T+1'50" LES ABORT

(TLM)

INITIATE ABORT

BECC

3. CMDRS EVENT TIMER RESET & STARTED

4. CM-3M UMB DEADFACED

CW RCS PRESS.

**RCS CONTROL TRANS TO CM
BATS. TIED TO MAIN DC BUSES**

CM-SM SEPARATED

LE MOTOR IGNITED

CM RCS/SCS ENABLED

CM-SM SEP PYRO CUTOFF

CANARDS DEPLOYED

ELS ARMED

BARO LOCK-IN (ELSC ACT.)

CM RCS/SCS DISABLED

TOWER AND DOCKING RING

JETTISONED

APEX COVER JETTISONED

DROGUE CHUTES DEPLOYED

DROGUE CHUTES RELEASED

PILOT CHUTES DEPLOYED

BURN RCS PROPELLANTS

PURGE CM RCS

RELEASE MAIN CHUTES

SAFE SECS

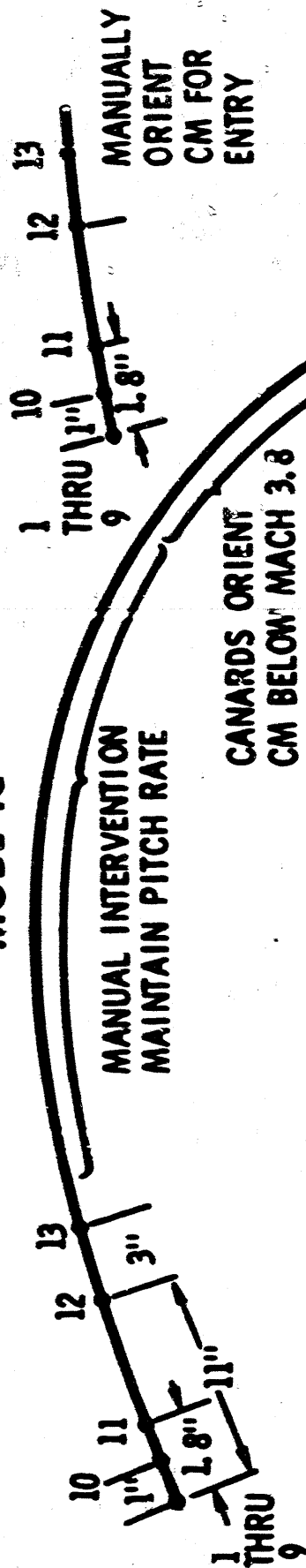
SPLASHDOWN

SEQ-535E



EVENT PROFILE

T+1'50" TO TWR. JETT. LES ABORT
MODE IC



1. INITIATE ABORT
2. BECO
3. CMDRS EVENT TIMER RESET & STARTED
4. CM-SM UMB DEADFACED
5. CM RCS PRESS.
6. RCS CONTROL TRANS TO CM
7. BATS. TIED TO MAIN DC BUSES
8. CM-SM SEPARATED
9. LE MOTOR IGNITED
10. CM RCS/SCS ENABLED
11. CM-SM SEP PYRO CUTOFF
12. CANARDS DEPLOYED
13. ELS ARMED-JETT TOWER (OPTION)
14. BARO LOCK-IN (ELSC ACT.)
15. CM RCS/SCS DISABLED
16. TOWER AND DOCKING RING JETTISONED
17. APEX COVER JETTISONED
18. DROGUE CHUTES DEPLOYED
19. DROGUE CHUTES RELEASED & PILOT CHUTES DEPLOYED
20. BURN RCS PROPELLANTS
21. PURGE CM RCS
22. RELEASE MAIN CHUTES
23. SAFE SECS

(TLM)

(TLM)

(TLM)

(TLM)

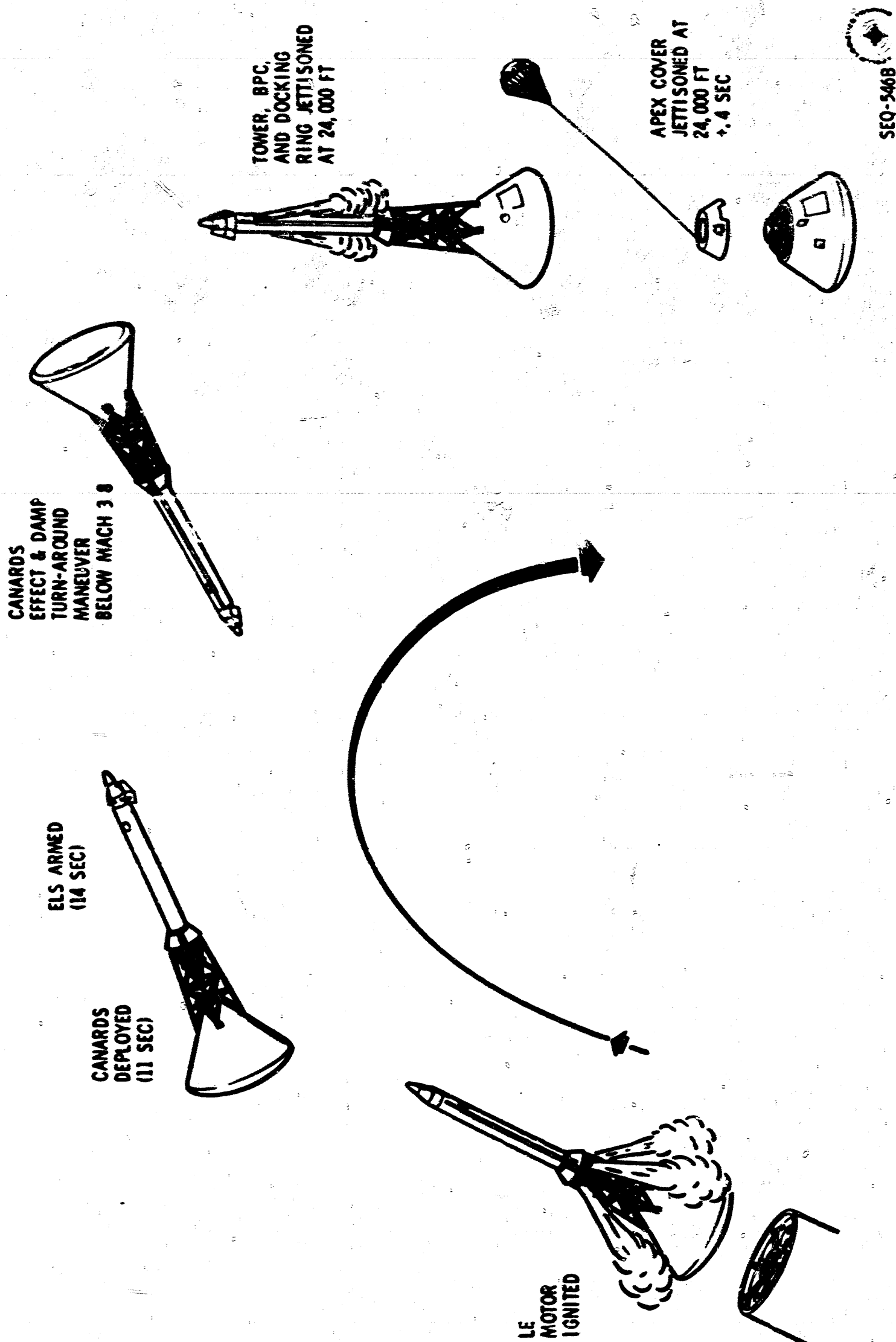
(TLM)

(TLM)

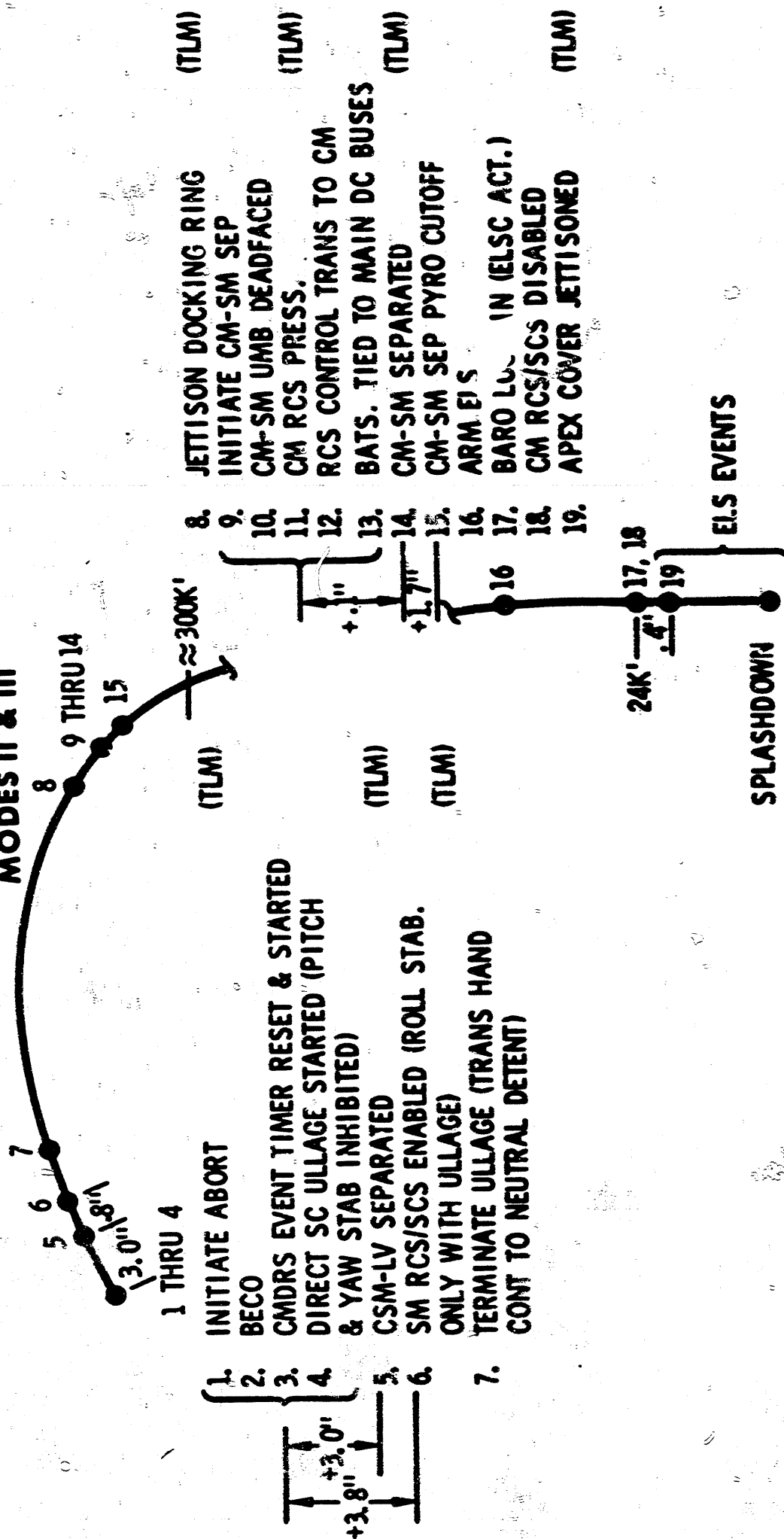
(TLM)

(TLM)

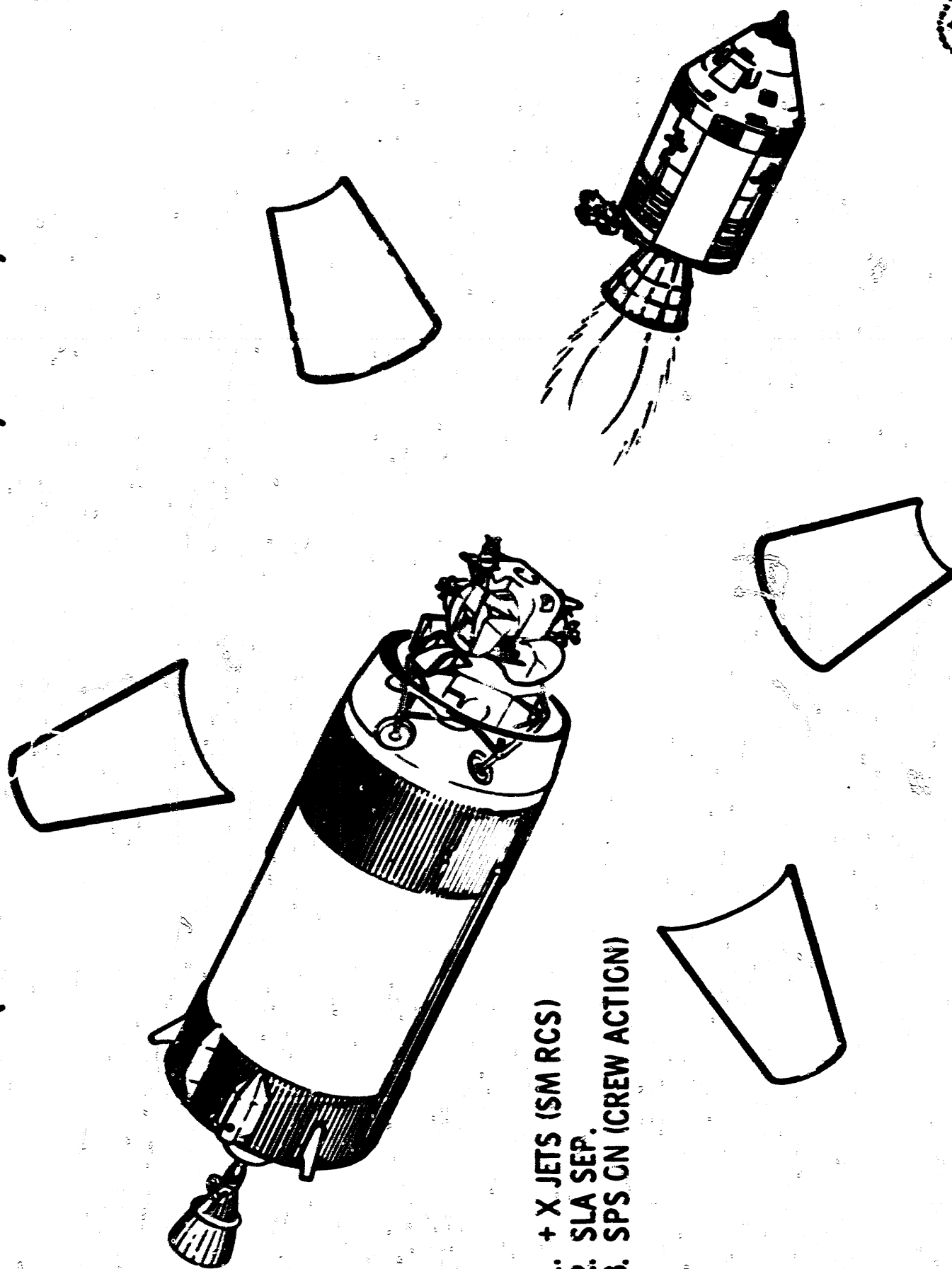
≈ 30,000 FT TO TWR JETT LES ABORT



EVENT PROFILE **SPS ABORT AND RETURN TO EARTH** **MODES II & III**



SPS ABORT (TWR JETT TO NORMAL CSM/LV SEP)

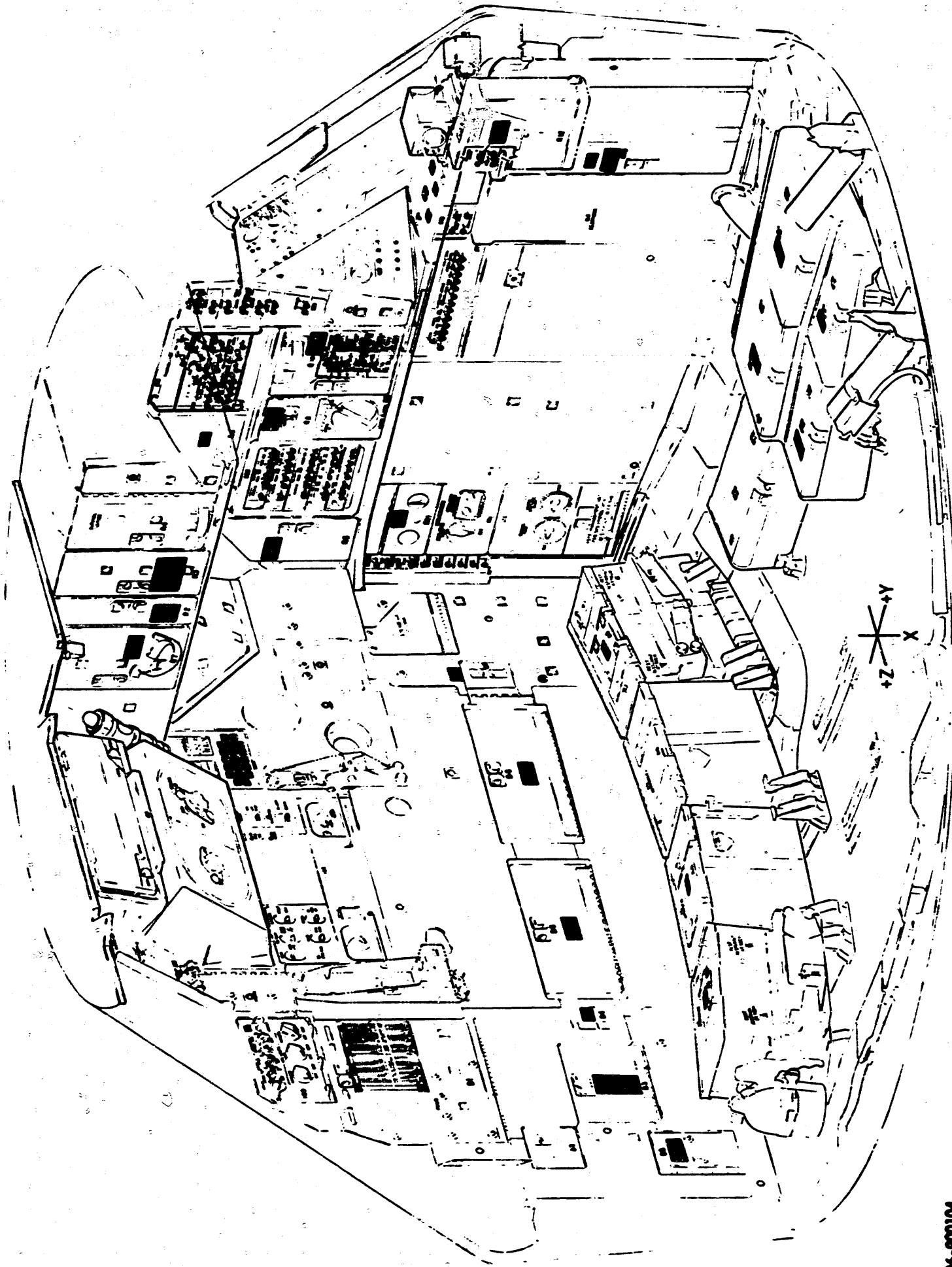


1. + X JETS (SM RCS)
2. SLA SEP.
3. SPS ON (CREW ACTION)

SEQ-540A (A)

CM 104 INTERIOR CONFIGURATION

LEB, RHEB, RHIEB, RHFEB, & RIGHT AB

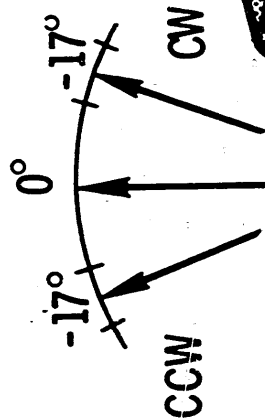


VIEW LOOKING DOWN & OUTBOARD

REF: V36-900104
OCT 68

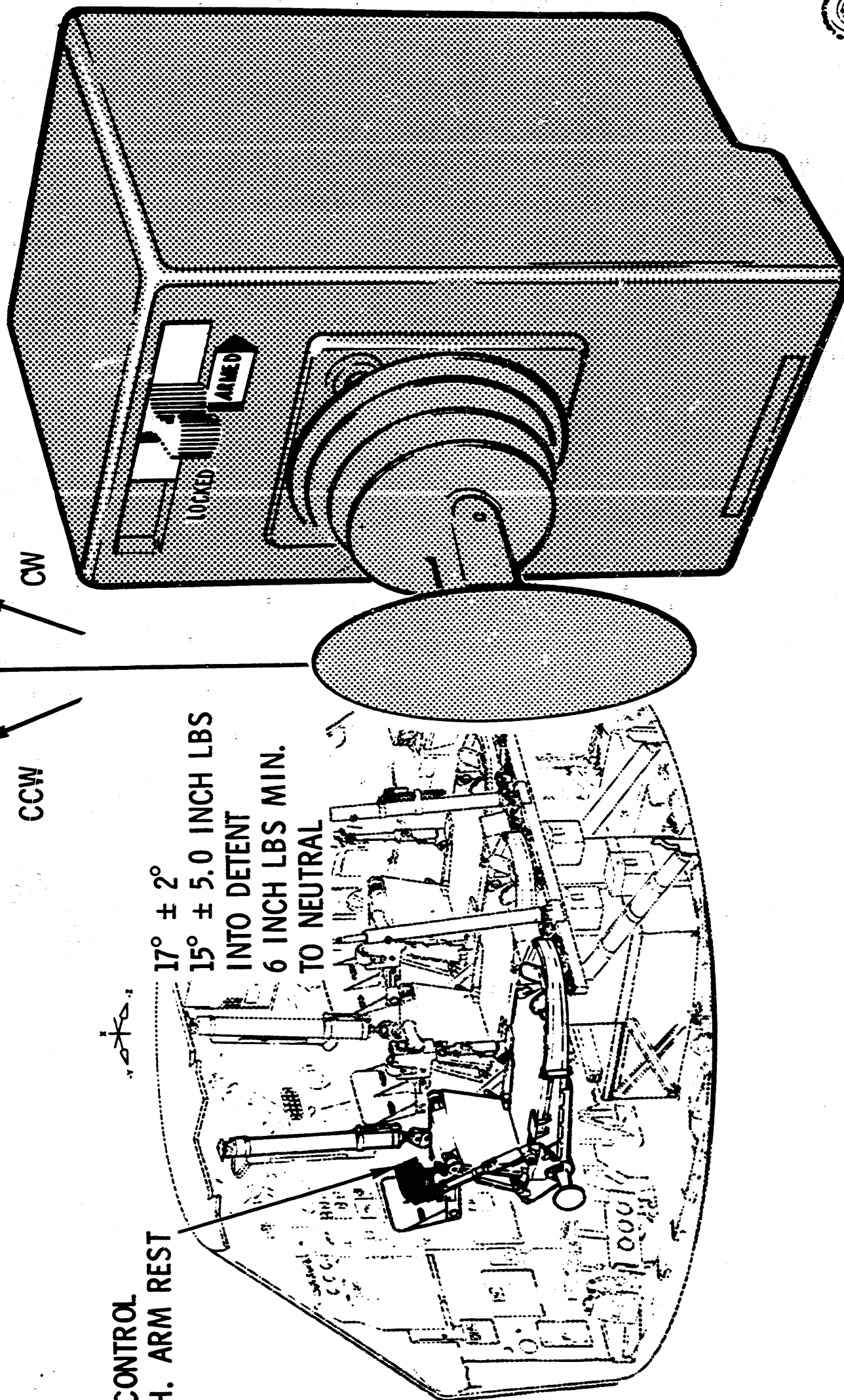
CS-0025 (A)

TRANSLATION HAND CONTROL



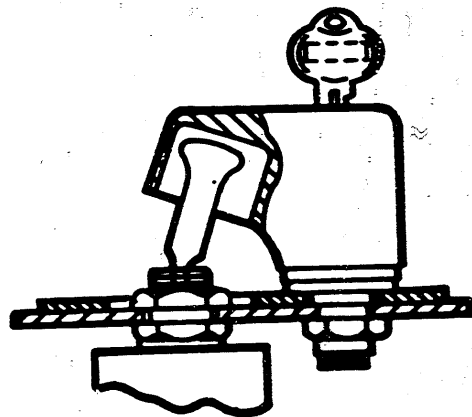
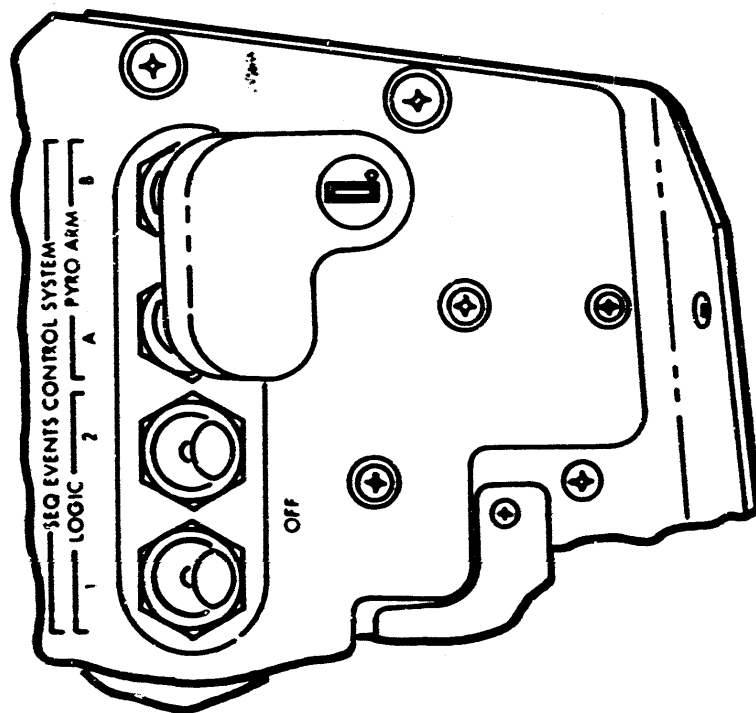
$17^\circ \pm 2^\circ$
 $15^\circ \pm 5.0$ INCH LBS
 INTO DETENT
 6 INCH LBS MIN.
 TO NEUTRAL

1 CONTROL
 L.H. ARM REST



SEQ-506C

PYRO ARM SWITCH GUARD



SEQ-556 

SECS DATA

Master Events Sequence Controller (MESC)

2 ea.

Part No.:

ME901-0567

Mfr'd. by:

Autonetics, Anaheim, Calif.

Dimensions:

14" x 14" x 8"

Weight:

38 lbs.

No. of electrical receptacles:

8 ea.

Relays:

Babcock, 4 pole

42 non-latching & 2 latching

10 amps. continuous current rating

Z1K1, Z1K2, & Z2K1

EDS Auto. Abort Voting

Z2K2

EDS Bus Changeover

Z3K1 & 2

Escape Tower Physical Separation

Z4K1 & 2

EDS Auto. Abort Enable

Z5K1 & 2

Booster Cutoff & Abort Initiate

Z6K1 & 2

LES Abort Lockup

Z7K1 & 2

CM RCS Pressurize

Z8K1 & 2

CM-SM Umbilical Deadface

Z9K1 & 2

CM-SM Separation

Z10K1 & 2

Launch Escape Motor Fire

Z11K1 & 2

Canard Deploy

Z12K1 & 2

ELS Activate

Z13K1 & 2

Tower Jettison

Z14K1 & 2

Apex Cover Jettison

Z16K1 & 2

Direct Ullage

Z17K1 & 2

SLA Separation

Z18K1 & 2

RCS Enable Arm

Z19K1 & 2 (latching)

RCS Enable/Disable (latching)

Z20K1 & 2

SECS Logic Bus Arming

Z23K1 & 2

CM-SM Sep. Pyro Cutoff

Z24K1 & 2

Pitch Control Motor Fire

Z25K1 & 2

Apex Cover Drag Parachute

Time Delays:

Parko, resistance-capacitance-transistor type, 18 ea.

TD1 & 2

0.03 sec. Booster Cutoff

TD3 & 4

0.1 sec. CM-SM Separation

TD5 & 6

11.0 sec. Canard Deploy

TD7 & 8

3.0 sec. ELS Activate

TD11 & 12

3.0 sec. SLA Separate

TD13 & 14

0.8 sec. RCS Enable Arm

TD15 & 16

1.0 sec. RCS Enable/Disable

SECS DATA

TD17 & 18
TD23 & 24

0.4 sec. Apex Cover Jettison
1.7 sec. CM-SM Sep. Pyro Cutoff

Lunar Docking Events Controller (LDEC)

2 ea.

Part No.:
Mfr'd. by:
Dimensions:
Weight:
No. of electrical receptacles:
Motorswitch:

ME476-0035
Autonetics, Anaheim, Calif.
11.5" x 6" x 8.5"
12 lbs.
5 ea.
Kinetics, 9 pole
1 ea. powered during transfer only
15 amps. continuous current rating

K1

SECS Pyro Bus Arming

Relays:

Babcock, 4 pole
7 non-latching & 1 latching
10 amps. continuous current rating

Z1K1 (latching) & Z1K2
Z2K1 & 2
Z3K1 & 2
Z4K1 & 2

LM-SLA Separation Initiate
Docking Probe Retract No. 2
Docking Probe Retract No. 1
Docking Ring Final Separation

Time Delays:

Parko, resistance-capacitance-
transistor type, 2 ea.

TD1 & 2

0.03 sec. LM-SLA Sep. Initiate

Earth Landing Sequence Controller (ELSC)

2 ea.

Part No.:
Mfr'd. by:
Dimensions:
Weight:
No. of electrical receptacles:
Relays:

ME901-0001
Northrop-Ventura, Newbury Park, Calif.
7" x 4.5" x 3"
5 lbs.
4 ea.
Filtors, 4 pole
4 non-latching
5 amps. continuous current rating

K1

Baroswitch Lock-in

SECS DATA

K2
K3

Drogue Parachute Deploy
Drogue Parachute Release & Pilot Parachute Deploy
Not Used

K4

Time Delays:

General Time, resistance-capacitance-transistor type, 4 ea.

TD1 & 2
TD3 & 4

2.0 sec. Drogue Parachute Deploy
14.0 sec. Pilot Parachute Deploy

Pyro Continuity Verification Box (PCVB)

1 ea.

Part No.:
Mfr'd. by:

V16-540130
Space Div., North American Rockwell Corp., McAlester, Okla.

Dimensions:

10.5" x 7" x 3"

Weight:

10 lbs.

No. of electrical receptacles:

8 ea.

Relays:

Babcock, 4 pole

10 non-latching (2 modules - 5 ea.)

10 amps. continuous current rating

Z2K1

Sys. A Drogue Parachute Deploy

Z2K2

Sys. A Drogue Parachute Release & Pilot Parachute Deploy Lockup

Z2K3

Sys. A Main Parachute Release

Z2K4

Sys. A Drogue Parachute Release & Pilot Parachute Deploy

Z2K5

Sys. A Main Parachute Release

Z1K1

Sys. B Drogue Parachute Deploy

Z1K2

Sys. B Drogue Parachute Release & Pilot Parachute Deploy Lockup

Z1K3

Sys. B Main Parachute Release

Z1K4

Sys. B Drogue Parachute Release & Pilot Parachute Deploy

Z1K5

Sys. B Main Parachute Release

Reaction Control System Controller (RCSC)

1 ea.

Part No.:
Mfr'd. by:

V36-447520
Space Div., North American Rockwell Corp., McAlester, Okla.

SECS DATA

Dimensions:	15" x 13" x 9"
Weight:	35 lbs.
No. of electrical receptacles:	18 ea.
Motorswitches:	Kinetics, 22 pole
	2 ea. powered during transfer only
	5 amps. continuous current rating
S1 & 2	Sys. 1 & 2 CM-SM RCS Transfer
Relays:	Babcock, 4 pole
	18 non-latching
	10 amps. continuous current rating
K1 & 7	Sys. 1 Oxidizer Dump Valves
K2 & 8	Sys. 2 Oxidizer Dump Valves
K3 & 9	Sys. 1 Helium & Oxidizer Inter-connect Valves
K4 & 10	Sys. 2 Helium & Oxidizer Inter-connect Valves
K5 & 11	Sys. 1 Fuel & Oxidizer By-pass Valves
K6 & 12	Sys. 2 Fuel & Oxidizer By-pass Valves
K13 & 14	Sys. 1 & 2 CM-SM RCS Transfer
K15 & 17	Sys. 1 CM RCS Heaters
K16 & 18	Sys. 2 CM RCS Heaters
Time Delays:	Eagle-Signal, resistance-capacitance-transistor type, 14 ea.
TD1 & 8	42.0 sec. Sys. 1 & 2 Propellant Dump Inhibit
TD3 & 9	5.0 sec. Sys. 1 Fuel Dump
TD2 & 10	5.0 sec. Sys. 2 Fuel Dump
TD5 & 11	13.0 sec. Sys. 1 Helium Dump
TD4 & 12	13.0 sec. Sys. 2 Helium Dump
TD7 & 13	13.0 sec. Sys. 1 Main DC Bus OFF
TD6 & 14	13.0 sec. Sys. 2 Main DC Bus OFF
Service Module Jettison Controller (SMJC)	2 ea.
Part No.:	ME901-0569
Mfr'd. by:	Autonetics, Anaheim, Calif.
Dimensions:	13.5" x 5.25" x 5.75"

SECS DATA

Weight:	8 lbs.
No. of electrical receptacles:	4 ea.
Relays:	Babcock, 4 pole
	4 non-latching & 2 latching
	10 amps. continuous current rating
Z1K1 & 2 (latching)	SMJC Activate/ -X Translation
Z2K1 & 2	Positive Roll Initiate
Z3K1 & 2	Positive Roll Deactivate

Time Delays:	Parko, resistance-capacitance-transistor type, 4 ea.
--------------	--

Z2 TD1 & 2	2.0 sec. Roll Initiate
Z3 TD1 & 2	5.5 sec. Roll Deactivate

LM Separation Sequence Controller (LSSC)	2 ea.
--	-------

Part No.:	ME450-0007
Mfr'd. by:	Autonetics, Anaheim, Calif.
Dimensions:	10" x 8.5" x 4"
Weight:	5 lbs.
No. of electrical receptacles:	4 ea.
Relays:	Babcock, 4 pole
	4 non-latching
	10 amps. continuous current rating

Z1K1 & 2	LM-SLA Separation (LM legs)
Z2K1 & 2	LM-SLA Separation (Guillotine)

Time Delays:	Parko, resistance-capacitance-transistor type, 2 ea.
--------------	--

TD1 & 2	0.03 sec. LM-SLA Sep. (guillotine)
---------	------------------------------------

NOTE: All of the above controllers are fully qualified for any spacecraft environment.

LES DATA

Launch Escape Motor

Mfr'd. by:	Lockheed Propulsion, Redlands, Calif.
Dimensions:	26 inch diameter, 15.5 ft. long, incl. nozzles & igniter
Propellant:	8 point star grained solid using a polysulphide ammonium perchlorate formulation
Resultant Thrust:	147,000 pounds force (lbf.) nominal at 70 degrees F. & sea level barometric pressure
Burn Time:	Total of 8 sec. of which the greatest portion of the total impulse is delivered in the first 3.5 to 4.0 sec.
Nozzle Cant Angle:	4 nozzles each canted 35 degrees off the motor centerline
Nozzle Insert I. D.:	-Y & +Y = 5.2 inches, -Z = 4.8 inches, & +Z = 5.6 inches
Resultant Thrust Vector:	2.75 degrees offset of motor centerline

Pitch Control Motor

Mfr'd. by:	Lockheed Propulsion, Redlands, Calif.
Dimensions:	9 inch dia., 22 inches long incl. nozzle & igniter
Propellant:	14 point star grained solid using a polysulphide ammonium perchlorate formulation
Resultant Thrust:	2,850 pounds force (lbf.) nominal at 70 degrees F. & sea level barometric pressure
Burn Time:	0.6 plus or minus 0.1 sec.
Resultant Thrust Vector:	Coincidental with motor centerline

Tower Jettison Motor

Mfr'd. by:	Thiokol Chemical, Elkton, Md.
Dimensions:	26 inch dia., 55.5 inches long
Propellant:	10 point star grained solid using a polysulphide ammonium perchlorate formulation

LES DATA

Resultant Thrust:

32,000 pounds force (lbf.) nominal
at 70 degrees F. & sea level baro-
metric pressure

Burn Time:

1.1 plus or minus 0.06 sec.

Nozzle Cant Angle:

2 nozzles each canted 30 degrees
off the motor centerline

Nozzle Insert I. D.:

-Z = 3.5 inches & +Z = 3.2 inches

Resultant Thrust Vector:

4.0 degrees offset of motor center-
line

ELS DATA

Apex Cover Drag Parachute

1 ea.

Mfr'd. by:
How Deployed:
Type:
No. of Rings:
No. of Gores:
No. of Suspension Lines:
Dimensions:
Weight:

Northrop-Ventura, Newbury Park, Calif.
Mortar
Ring Slot
9
12
12
7.2 ft. dia.
10 lbs. incl. mortar

Drogue Parachutes

2 ea.

Mfr'd. by:
How Deployed:
Type:
No. of Ribbons:
No. of Gores:
No. of Suspension Lines:
Dimensions:
Weight:
Reefing:

Northrop-Ventura, Newbury Park, Calif.
Mortar
Conical Ribbon
36
20
20
16.5 ft. dia.
50 lbs. incl. mortar
Single stage, 10 sec. from line stretch
plus a permanent skirt band

Pilot Parachutes

3 ea.

Mfr'd. by:
How Deployed:
Type:
No. of Rings:
No. of Gores:
No. of Suspension Lines:
Dimensions:
Weight:

Northrop-Ventura, Newbury Park, Calif.
Mortar
Ring Slot
9
12
12
7.2 ft. dia.
9 lbs. incl. mortar

Main Landing Parachutes

3 ea.

Mfr'd. by:
How Deployed:
Type:
No. of Rings:
No. of Gores:
No. of Suspension Lines:
Dimensions:

Northrop-Ventura, Newbury Park, Calif.
Pilot parachutes
Ring Sail
12
68
68
83.5 ft. dia.

ELS DATA

Weight:
Reefing:

136 lbs.

**Two stage, 6 & 10 sec. from line
stretch**

**NOTE: All weights quoted which include a mortar do not include the weight
of the dual gas pressure cartridges in the breech.**

QUANTITIES OF SECS CONTROLLED PYROTECHNIC DEVICES ON THE APOLLO SPACECRAFT

Launch Escape Tower

Canard Thruster	2
Pitch Control Motor	2
Tower Jettison Motor	2
Launch Escape Motor	2
Tower Separation System	8

CM Fwd. Compt. & Docking Subsystem

Docking Probe Retraction Bottles	4
* Docking Ring Separation System	2
* Apex Cover Separation System (thrusters)	4
Apex Cover Separation System (drag chute)	2
* Drogue Parachute Deployment Mortars	4
* Pilot Parachute Deployment Mortars	6
* Parachute Disconnect Mechanism	10

CM Aft Compt.

* Helium Isolation Valves	4
* Oxidizer & Fuel Dump Valves	4
* Oxidizer, Fuel, & Helium Interconn. Valves	4
* Oxidizer & Fuel By-pass Valves	4
* Circuit Interrupters	4
* CM-SM Umbilical Guillotine	2

SM Fwd. Compt.

Circuit Interrupters	4
CM-SM Separation System	6

Spacecraft LM Adapter

SLA Separation System	2
S-IVB/LM Separation System	10
Total	<u>92</u>

* Denotes live or expended pyrotechnic devices recovered on CM.

Reefing Line Cutters

Drogue Parachutes, 8 ea; Main Landing Parachutes, 18 ea; VHF Recovery Antennas, 4 ea; and Recovery Flashing Beacon, 2 ea. Total - 32.

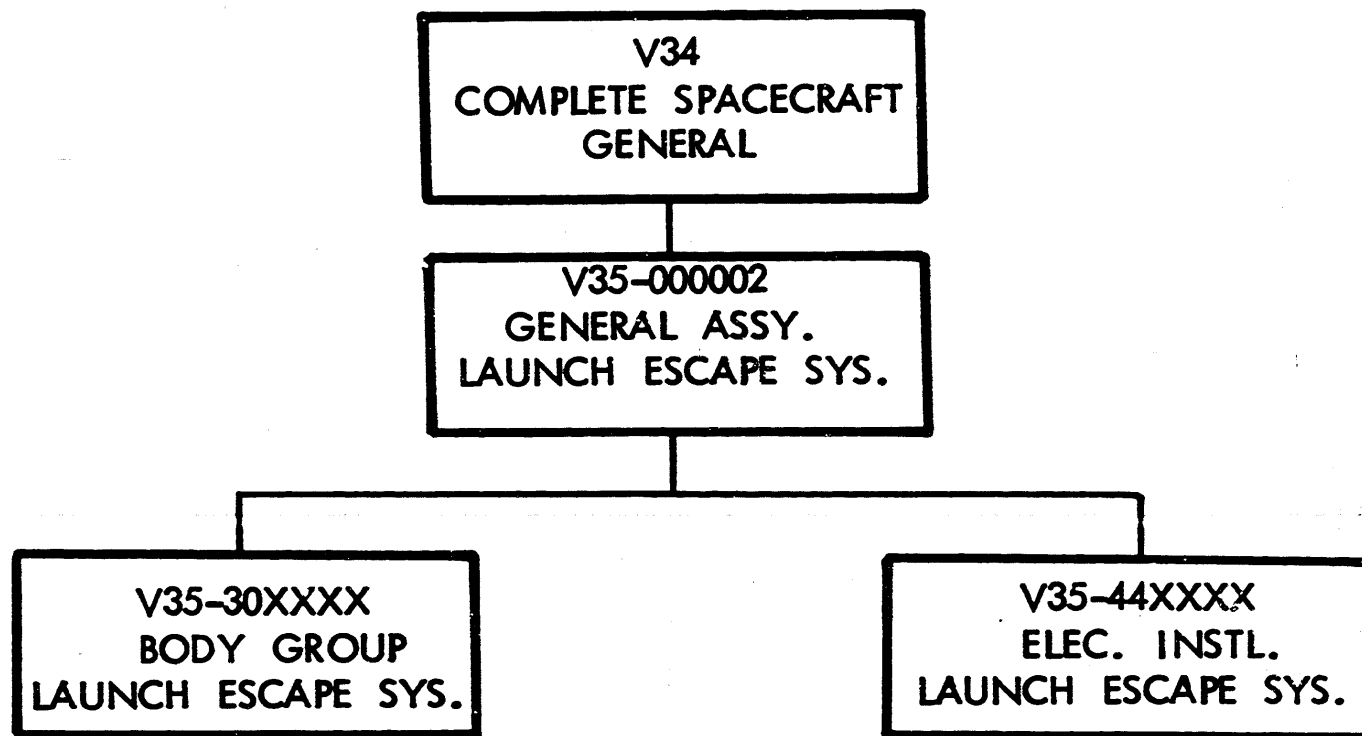
SC-104, -106 & SUBS.
TELEMETRY MEASUREMENT ID

<u>MEAS. ID</u>	<u>DESCRIPTION</u>	<u>SWITCH OR RELAY NO.</u>	<u>CHANNEL CODE</u>
LAUNCH ESCAPE SYSTEM			
CD0005V	DC Voltage Pyro Bus A	K1	11A9
CD0006V	DC Voltage Pyro Bus B	K1	11A5
CD0023X	CM-SM Sep. Relay Close A	Z9	11E22-1
CD0024X	CM-SM Sep. Relay Close B	Z9	11E23-1
CD0123X	SLA Separation Relay A	Z17	11E22-5
CD0124X	SLA Separation Relay B	Z17	11E23-7
CD0130X	Hand Controller Input A	Manual Abort	11E13-3
CD0131X	Hand Controller Input B	Manual Abort	11E13-6
CD0132X	EDS Abort Logic Input No. 1	EDS POWER	11E14-1
CD0133X	EDS Abort Logic Input No. 2	EDS POWER	11E14-2
CD0134X	EDS Abort Logic Input No. 3	EDS POWER	11E14-4
CD0135X	EDS Abort Logic Output A	Z1K1, Z1K2, & Z2K1	11E13-7
CD0136X	EDS Abort Logic Output B	Z1K1, Z1K2, & Z2K1	11E13-4
CD0170X	RCS Activate Signal A	Z19 (latched)	11E22-3
CD0171X	RCS Activate Signal B	Z19 (latched)	11E23-3
CD0173X	CM RCS Pressurize Signal A	Z7	11E22-7
CD0174X	CM RCS Pressurize Signal B	Z7	11E23-5
CD0200V	DC Voltage Logic Bus A	Z20	11A8
CD0201V	DC Voltage Logic Bus B	Z20	11A6
CD0230X	Forward Heatshield Jettison A	Z14	11E24-1
CD0231X	Forward Heatshield Jettison B	Z14	11E26-5
CD1154X	CSM-LEM Lock Ring Sep. Relay A	Z4	11E15-6
CD1155X	CSM-LEM Lock Ring Sep. Relay B	Z4	11E15-7

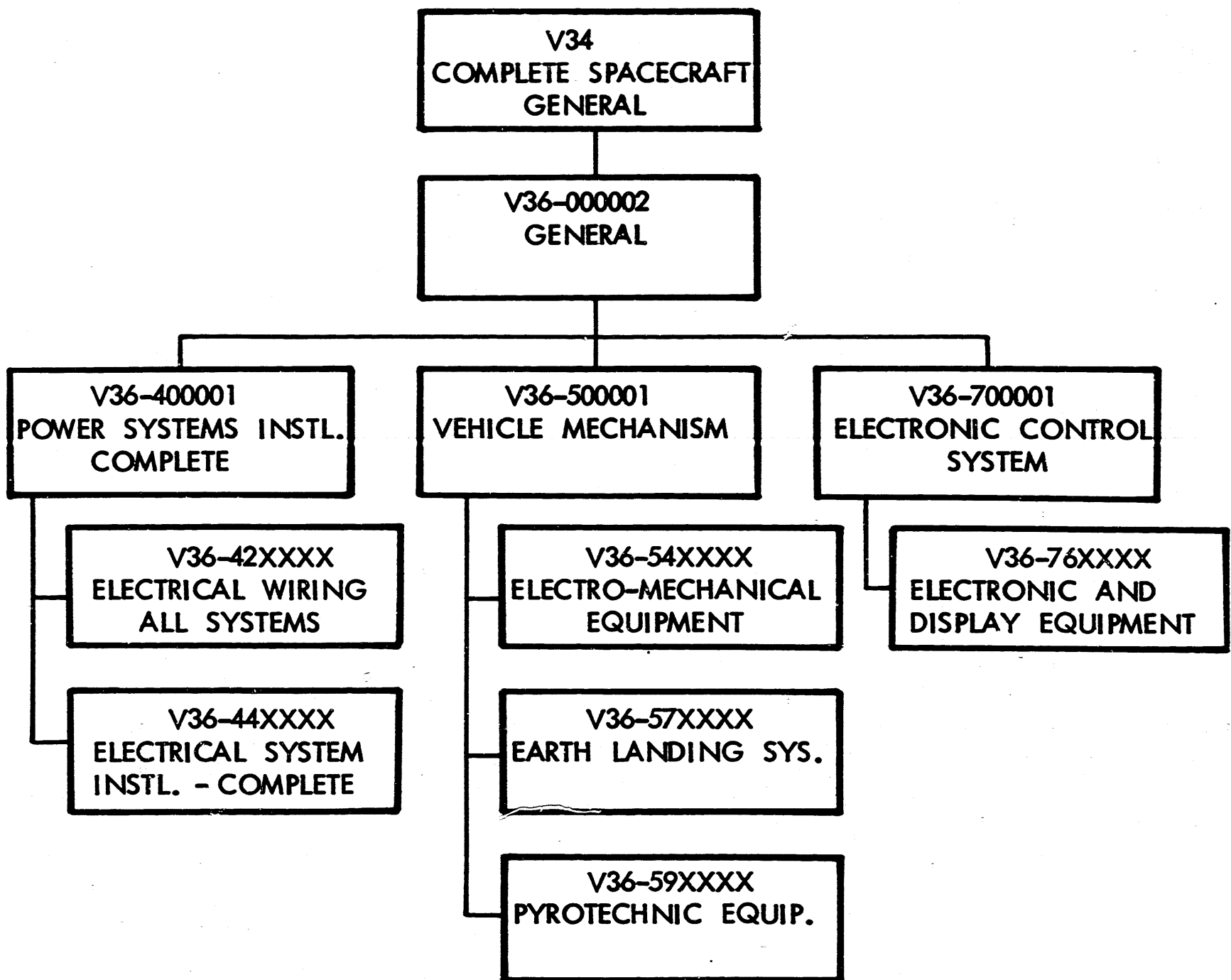
SC-104, -106 & SUBS.
TELEMETRY MEASUREMENT ID

<u>MEAS. ID</u>	<u>DESCRIPTION</u>	<u>SWITCH OR RELAY NO.</u>	<u>CHANNEL CODE</u>
CREW SAFETY SYSTEM			
BS0080X	EDS Abort Request A	UDL	11E4-5
BS0081X	EDS Abort Request B	UDL	11E4-3
CS0150X	Master Caution Warning ON		11E4-6
LS0200H	Angle of Attack (Vector Sum Output)		11A51
CS0220T	Temp. Docking Probe		10A22
EARTH LANDING SEQUENCE CONTROLLER			
CE0001X	Drogue Deploy Relay Close A	K2 & Z2K1	11E29-1
CE0002X	Drogue Deploy Relay Close B	K2 & Z1K1	11E30-6
CE0003X	Main Chute Deploy-Drogue Rel. Relay A	K3 & Z2K4	11E29-8
CE0004X	Main Chute Deploy-Drogue Rel. Relay B	K3 & Z1K4	11E30-3
CE0321X	Main Chute Disconnect Relay A	Z2K3 & Z2K5	11E29-5
CE0322X	Main Chute Disconnect Relay B	Z1K3 & Z1K5	11E30-8

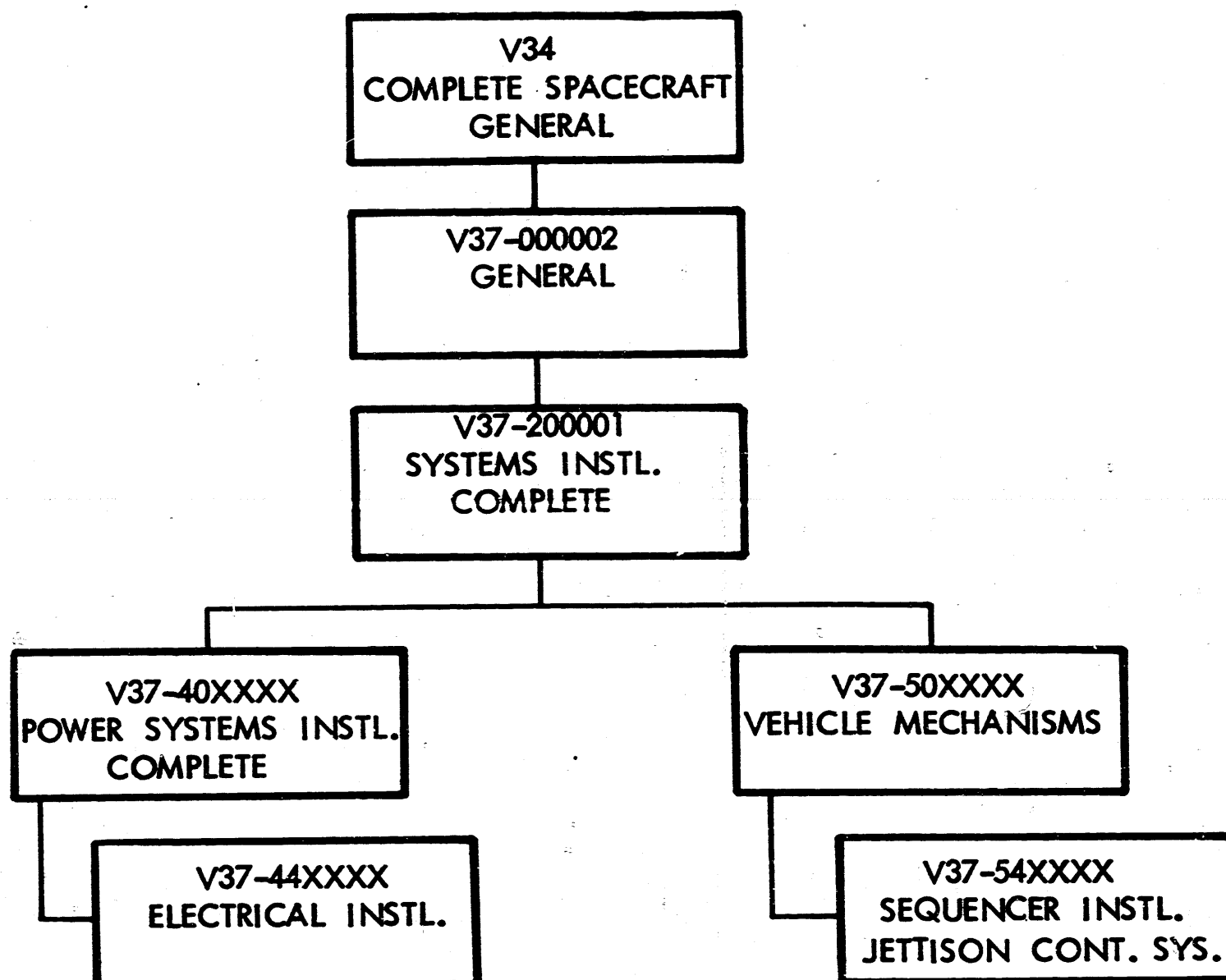
APOLLO LAUNCH ESCAPE SYSTEM
DRAWING NUMBERING SYSTEM (V35-)



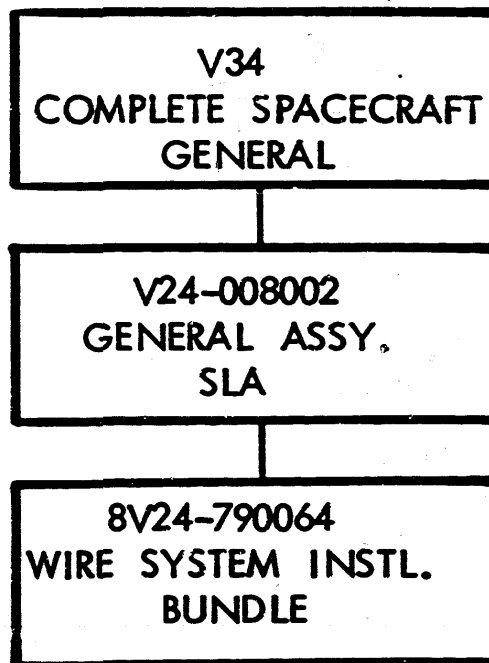
APOLLO COMMAND MODULE
DRAWING NUMBERING SYSTEM (V36-)



APOLLO SERVICE MODULE
DRAWING NUMBERING SYSTEM (V37-)

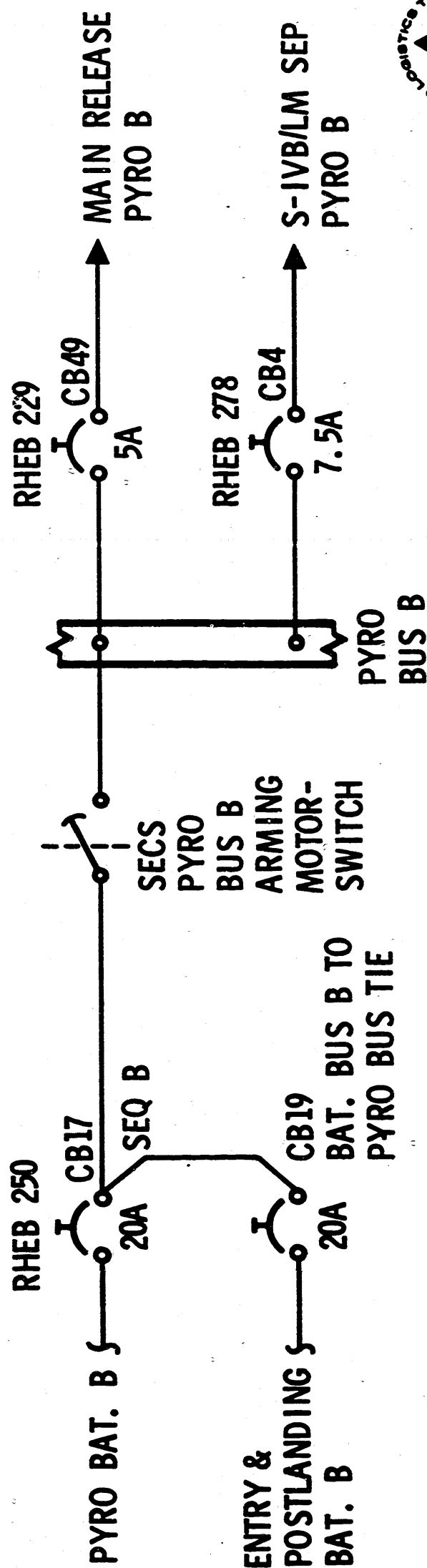
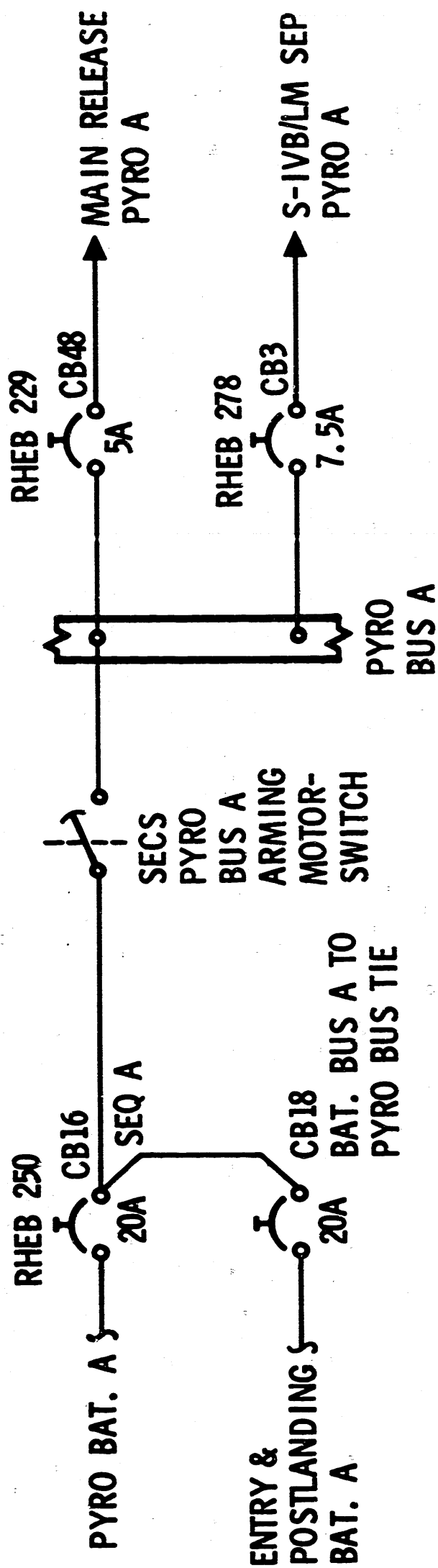


APOLLO SPACECRAFT LUNAR MODULE ADAPTER
DRAWING NUMBERING SYSTEM (V24-)



PYRO BATTERY A & B POWER

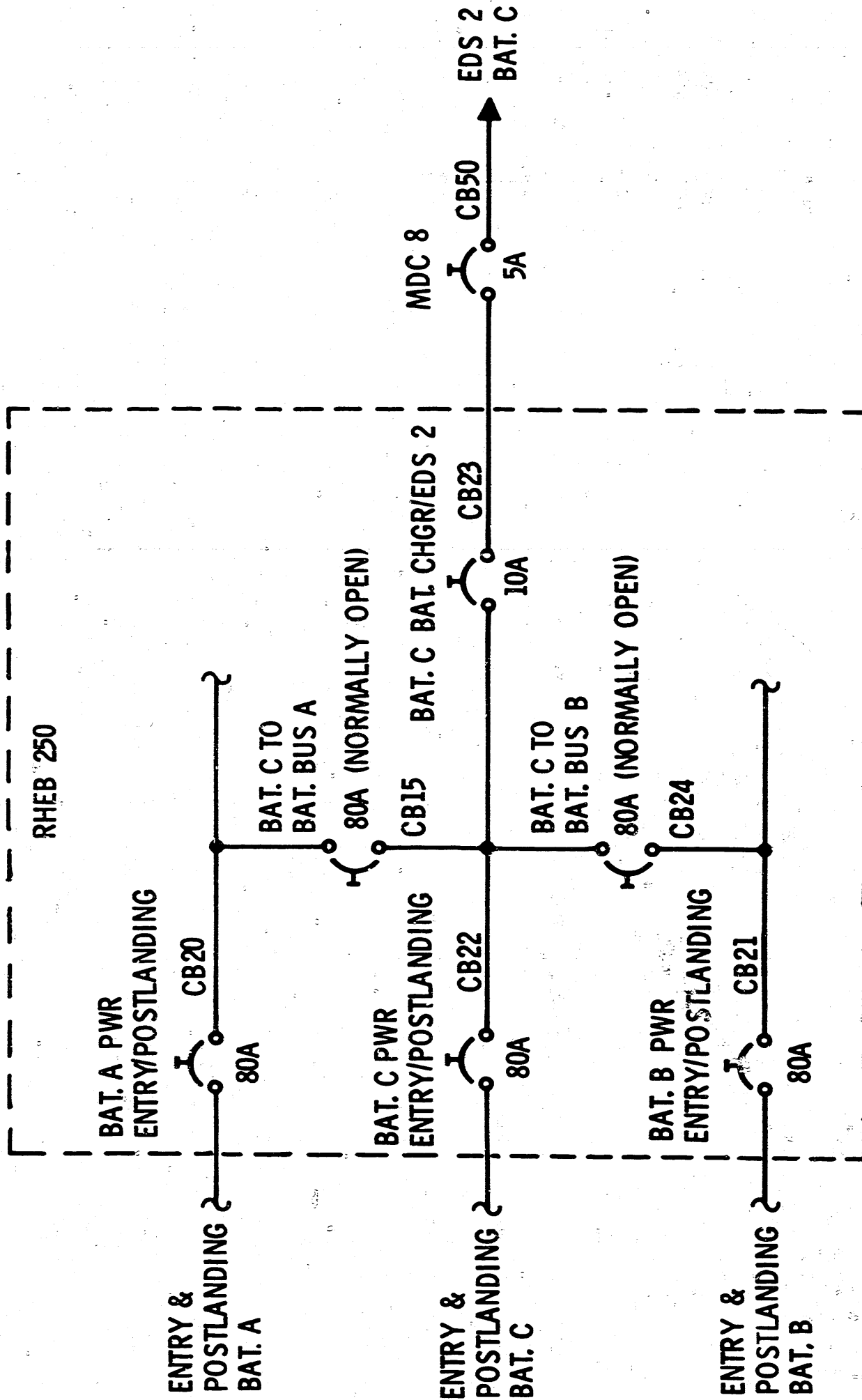
CSM 103 & SUBS



SEQ-575

BATTERY C EDS POWER

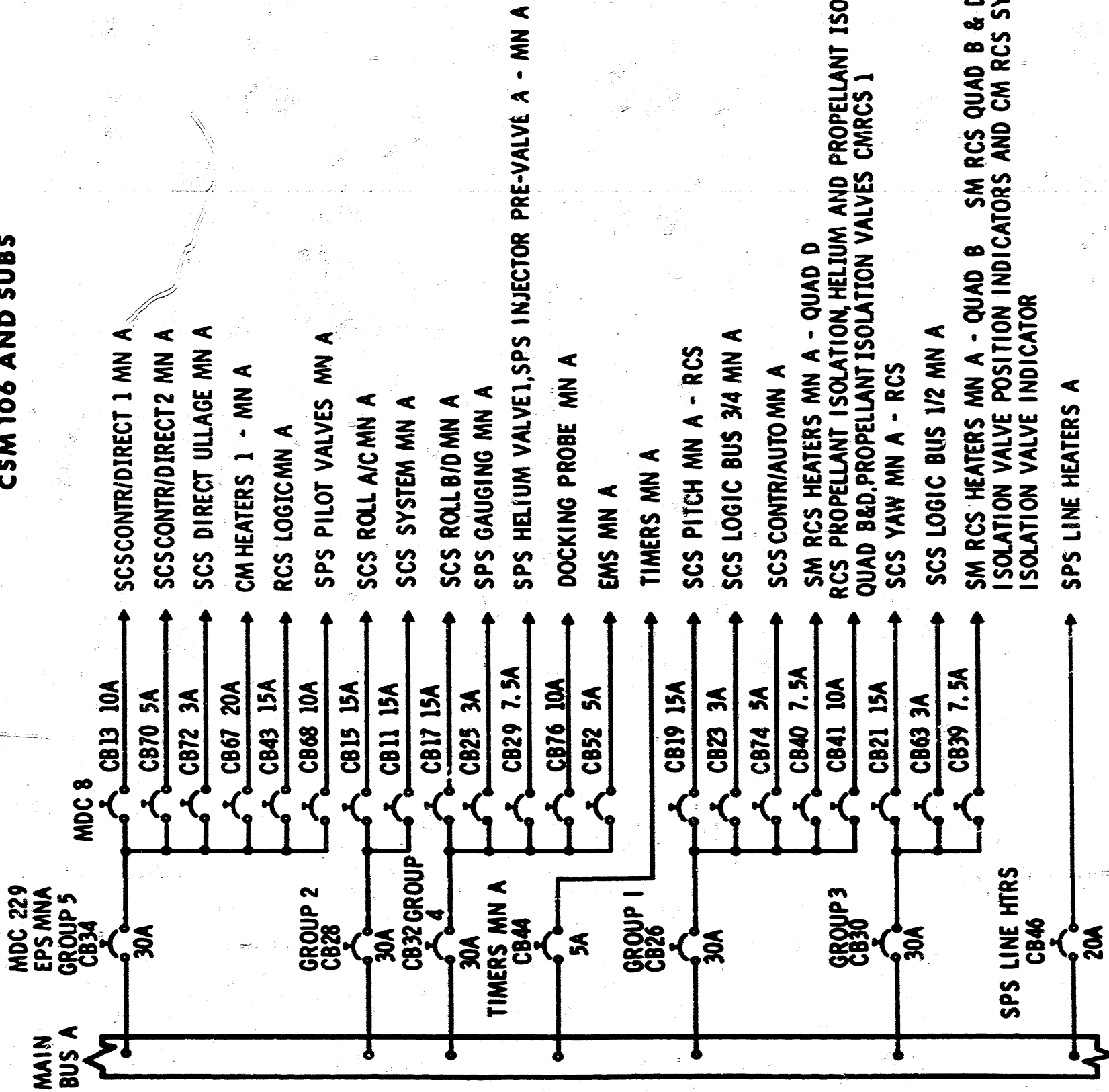
CSM 103 & SUBS



SEQ-576A (A)

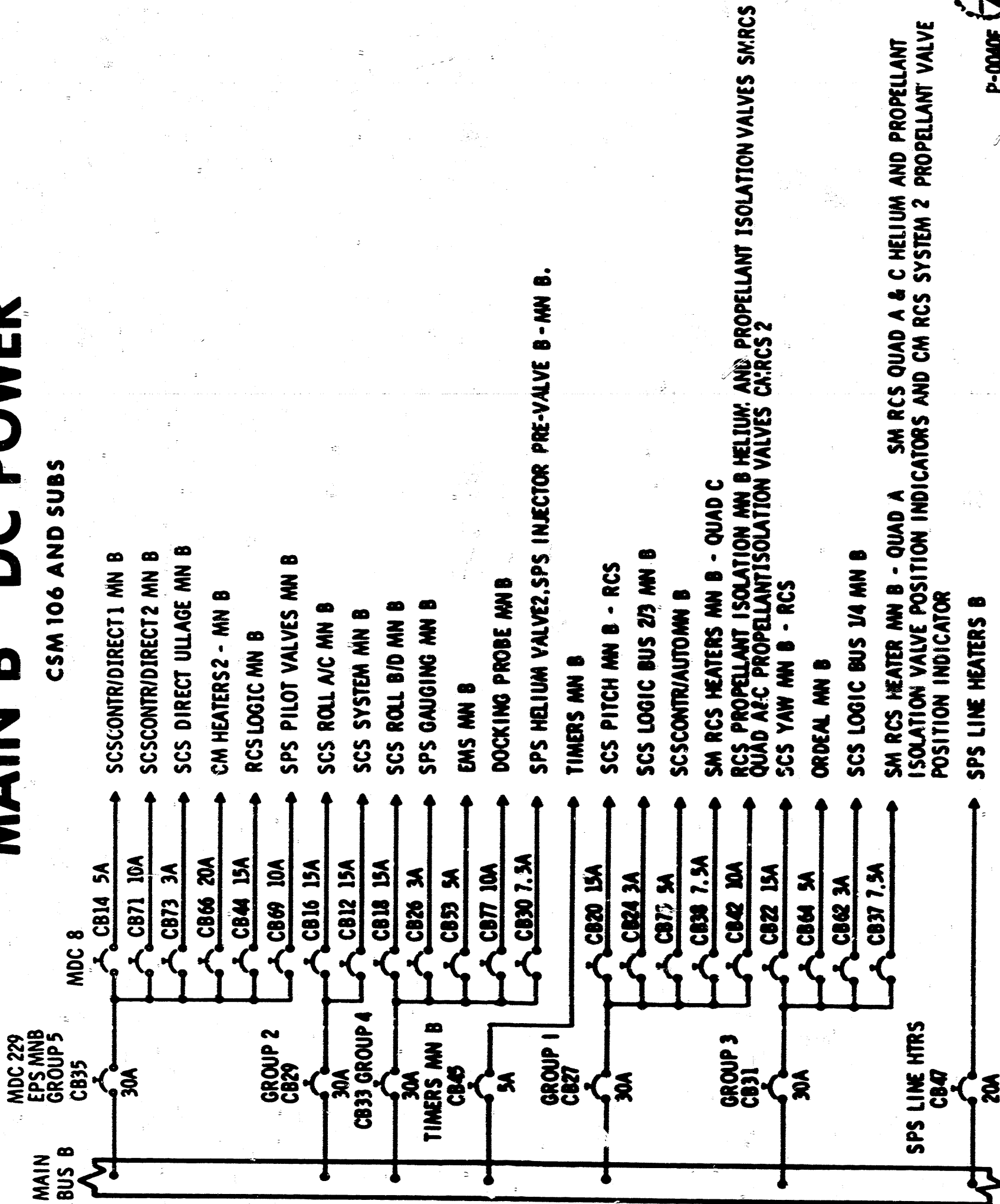
MAIN A DC POWER

CSM 106 AND SUBS

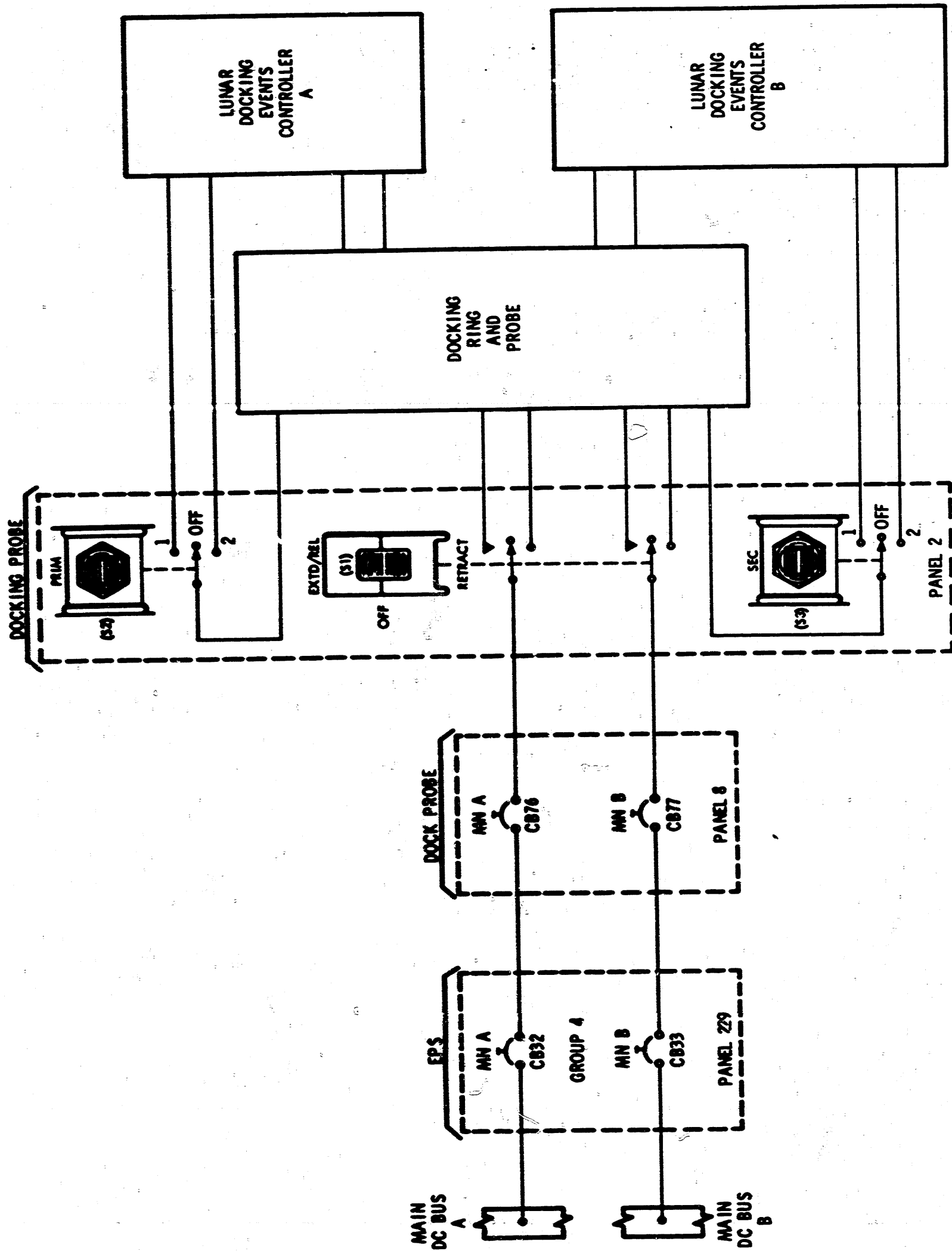


MAIN B DC POWER

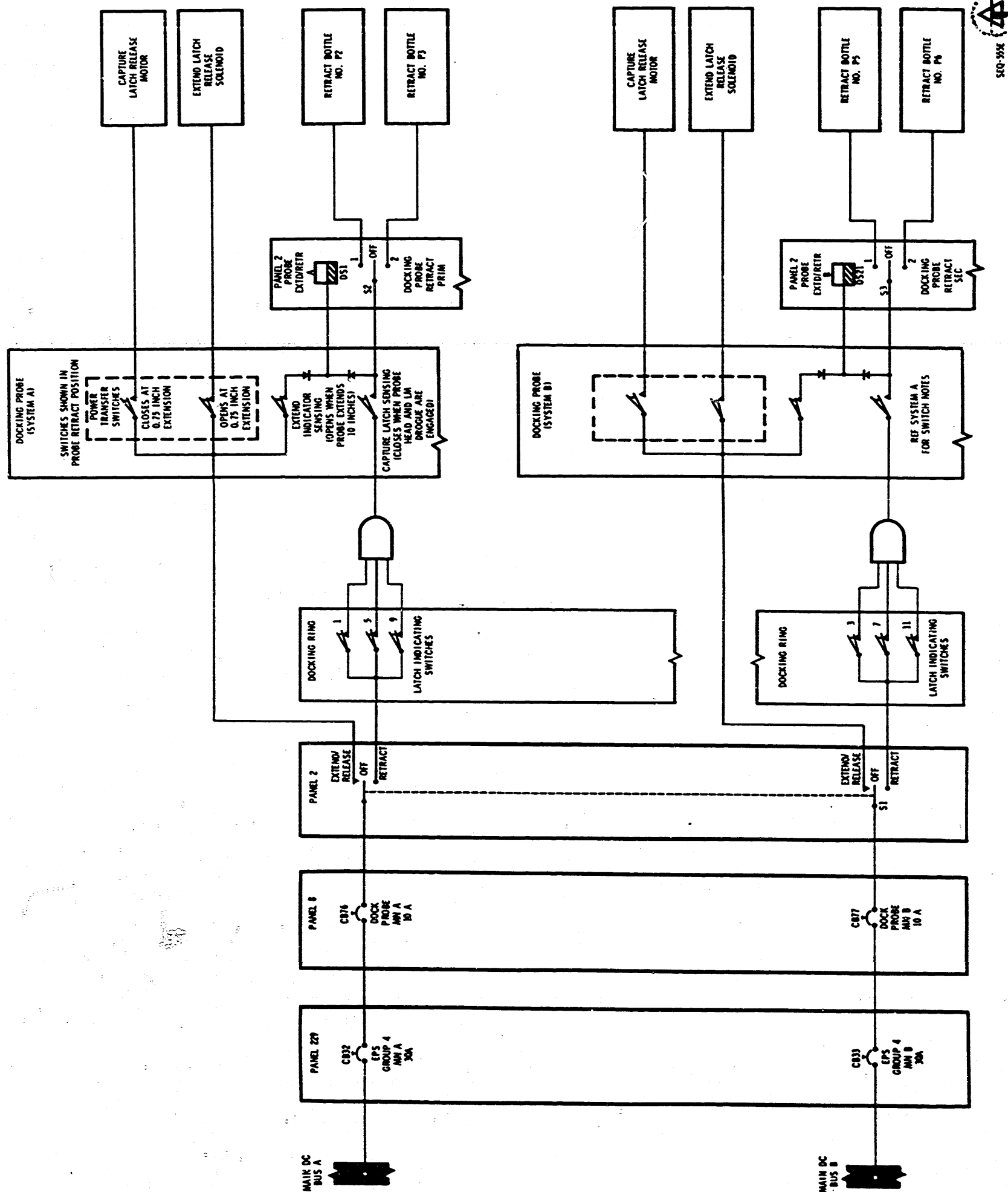
CSM 106 AND SUBS



DOCKING SUBSYSTEM POWER DISTRIBUTION



DOCKING OPERATIONAL LOGIC

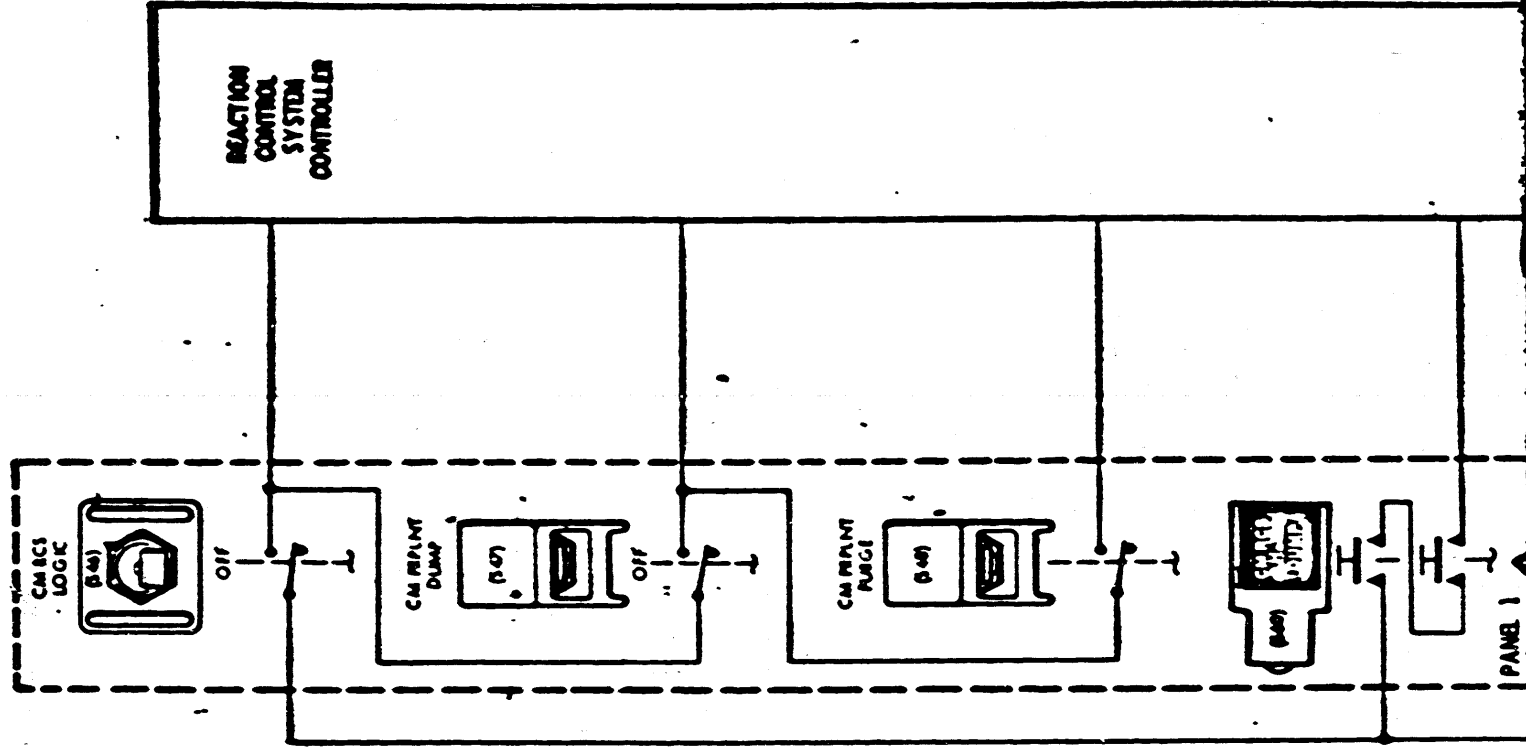


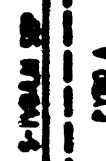
SEQUENTIAL SYSTEMS

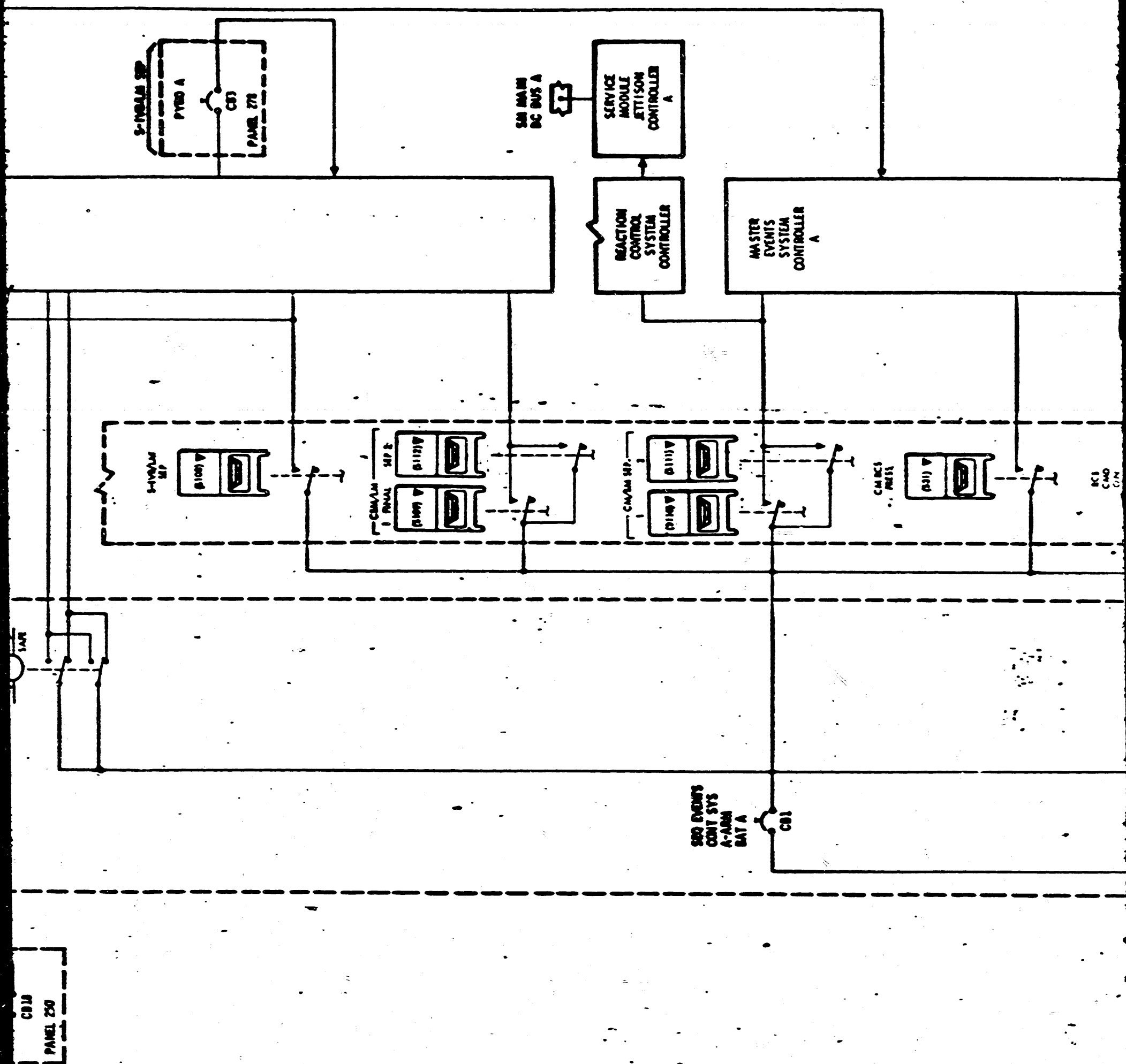
POWER DISTRIBUTION

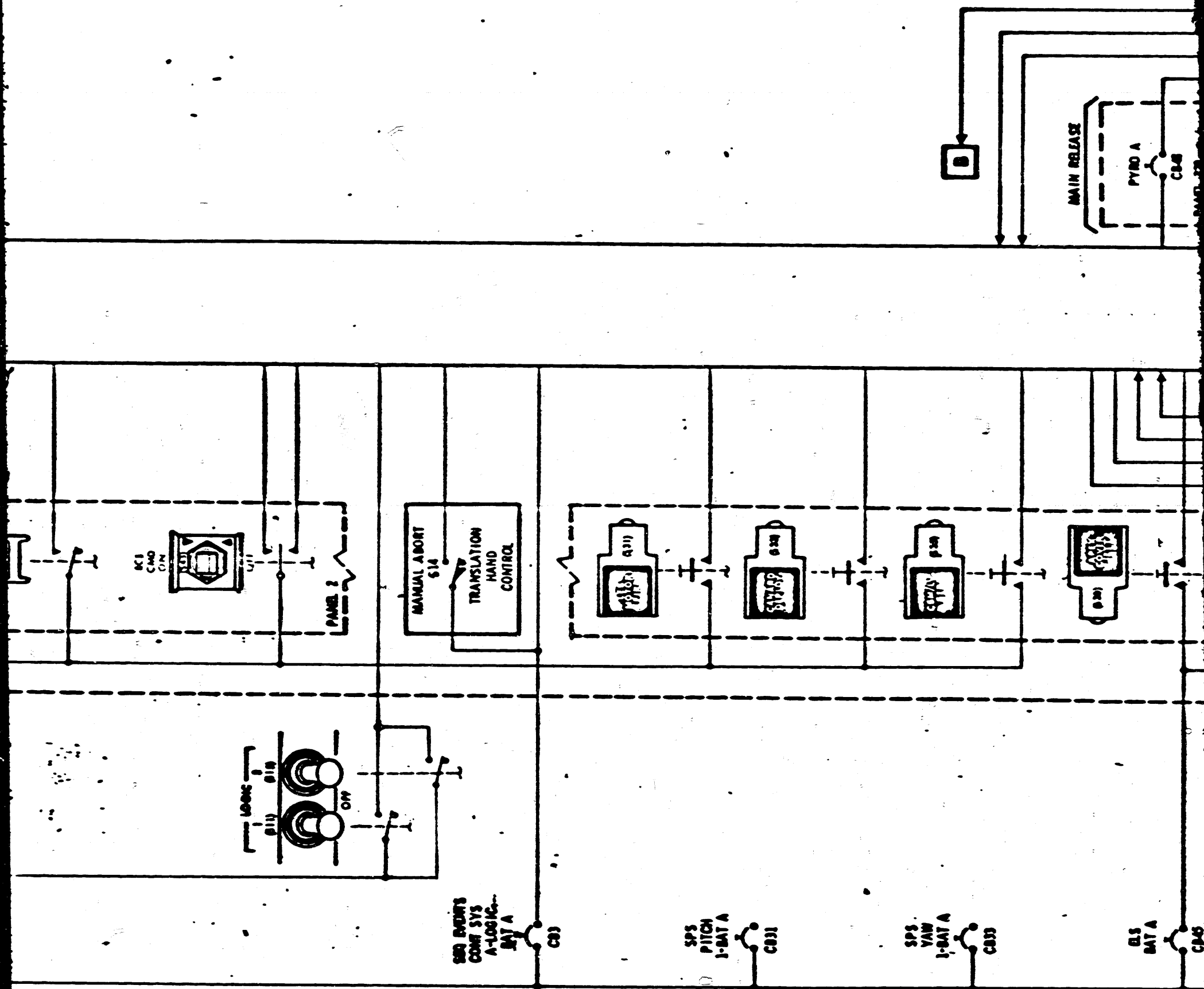
SYSTEM A SHOWN; SYSTEM B IDENTICAL

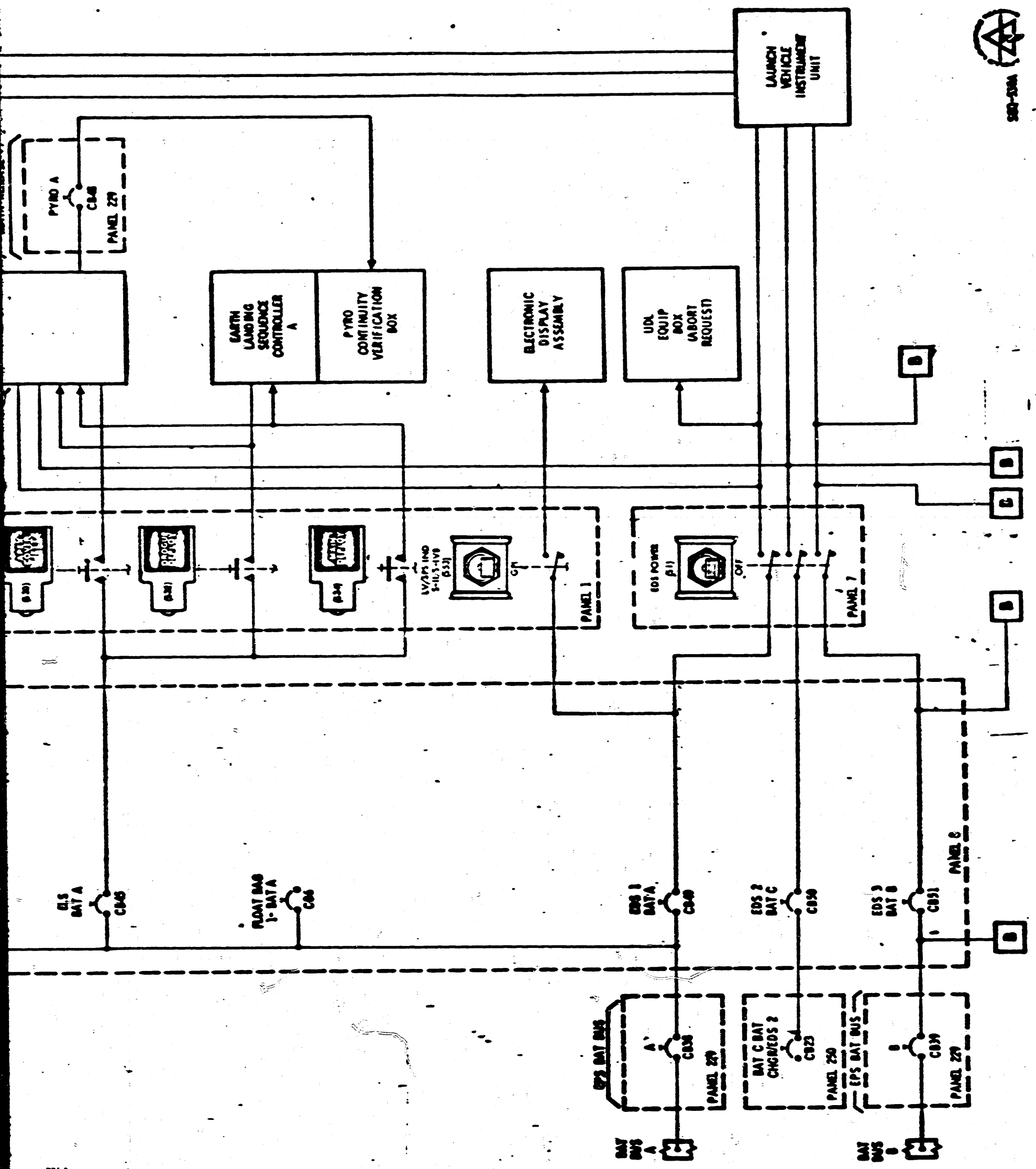
 = REFERENCE TO REDUNDANT SYSTEM B

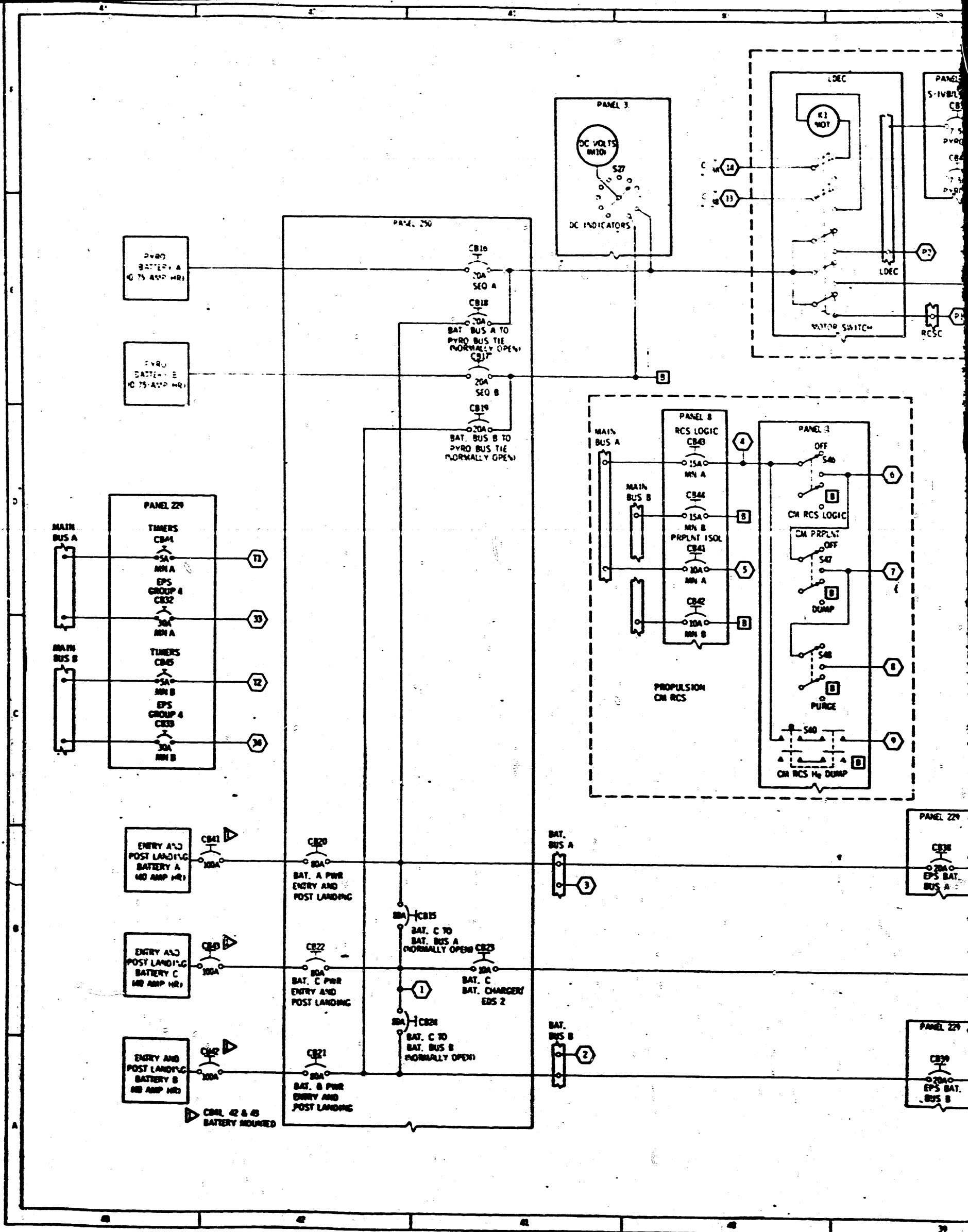


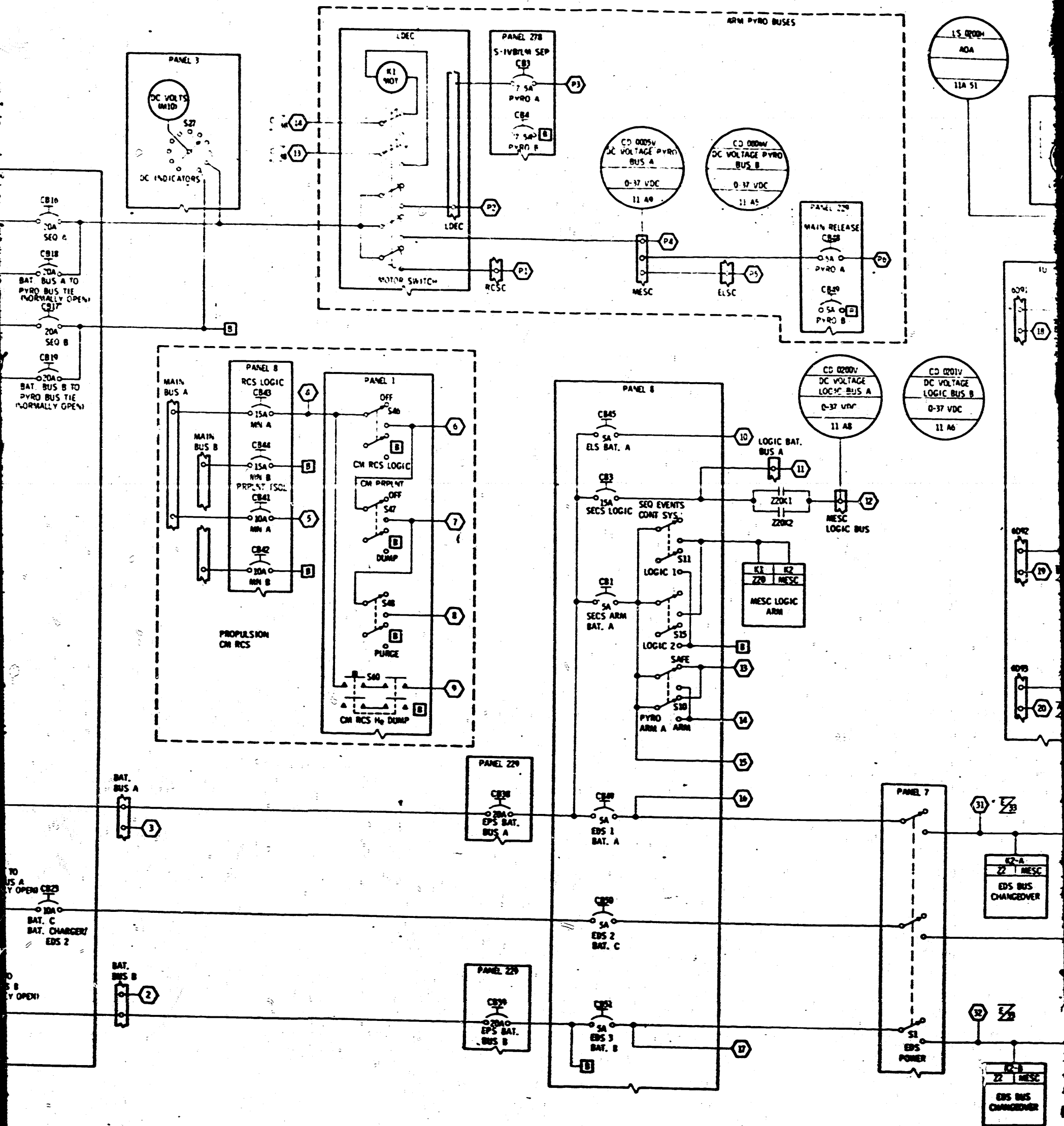


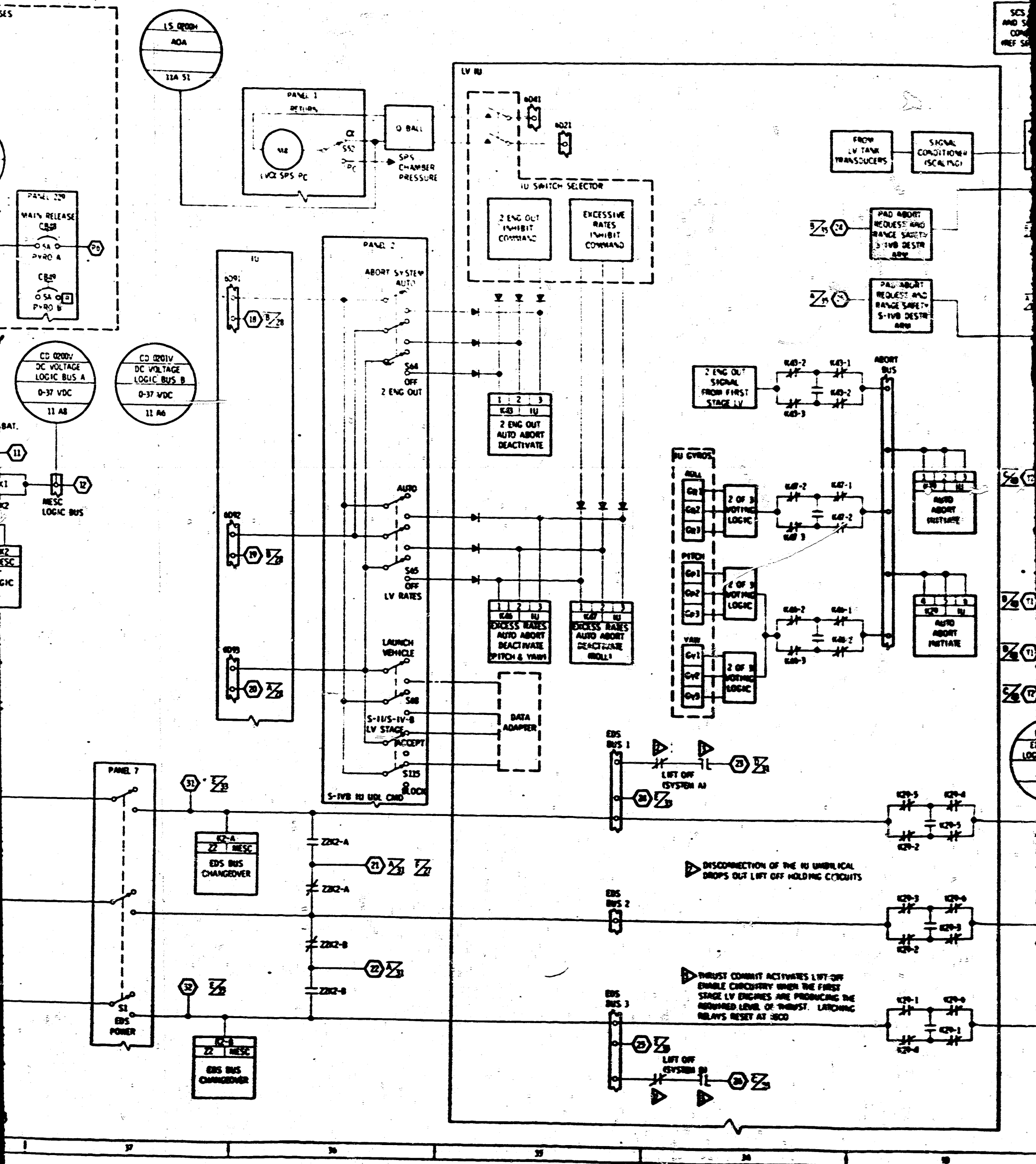


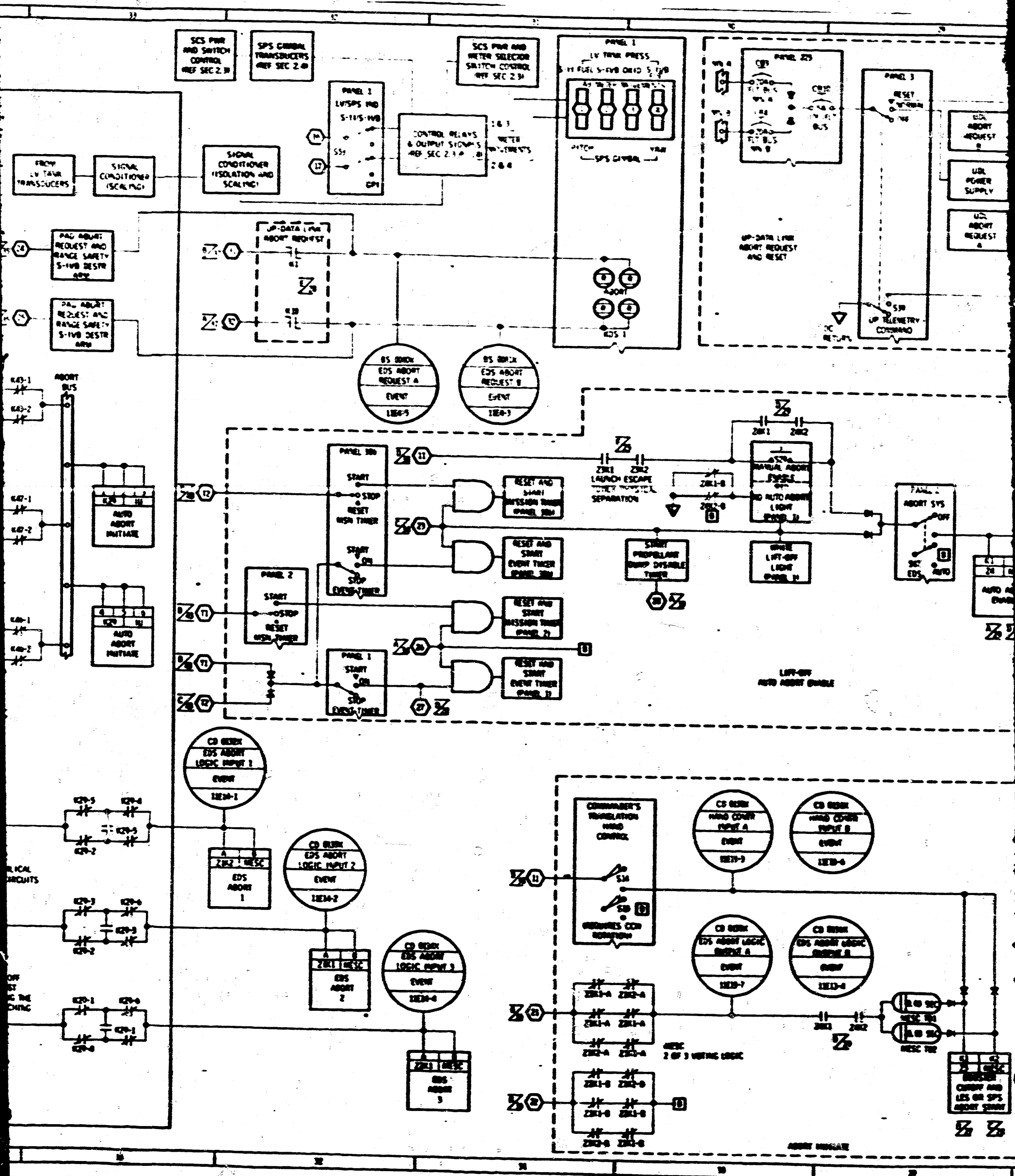


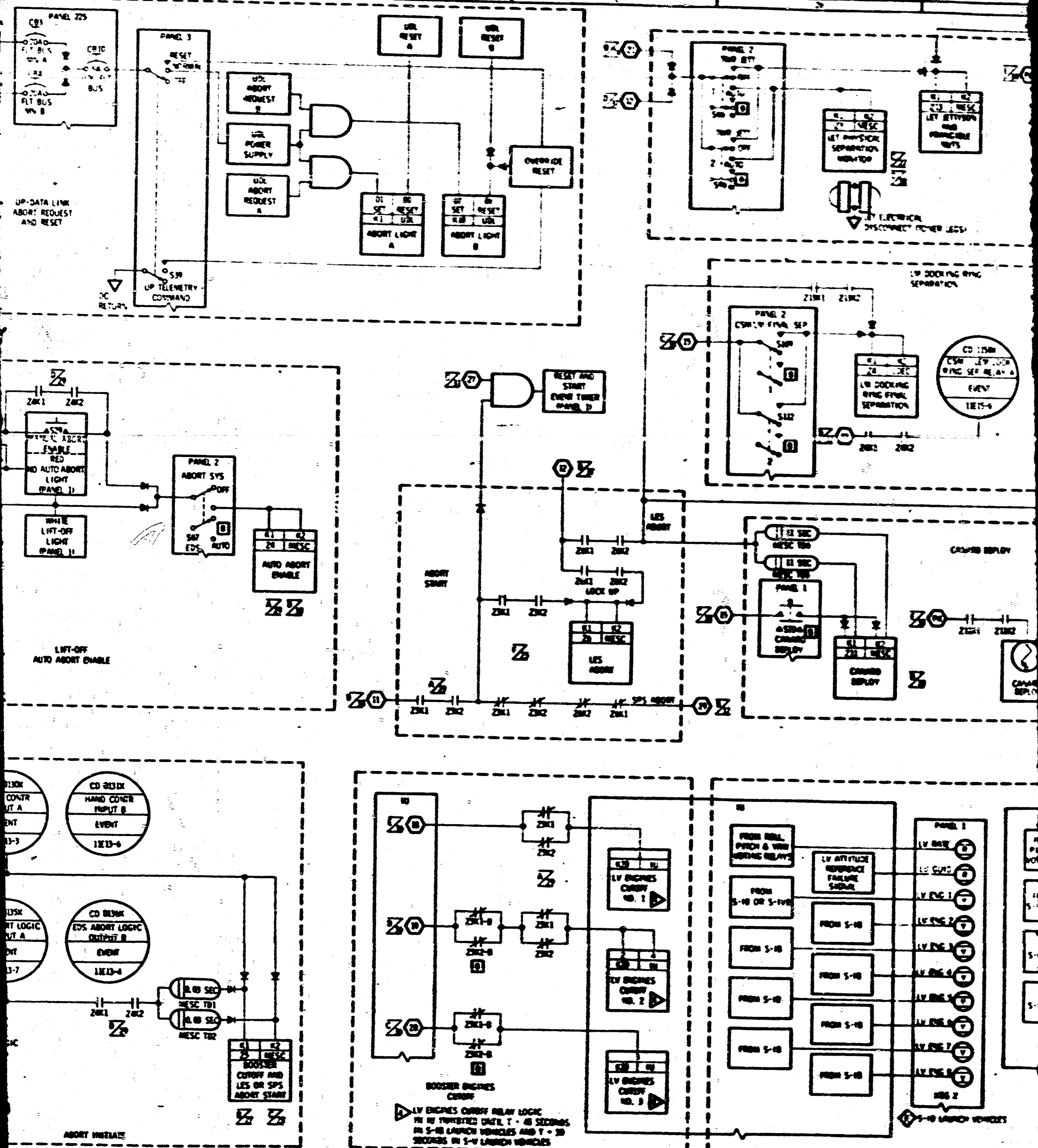


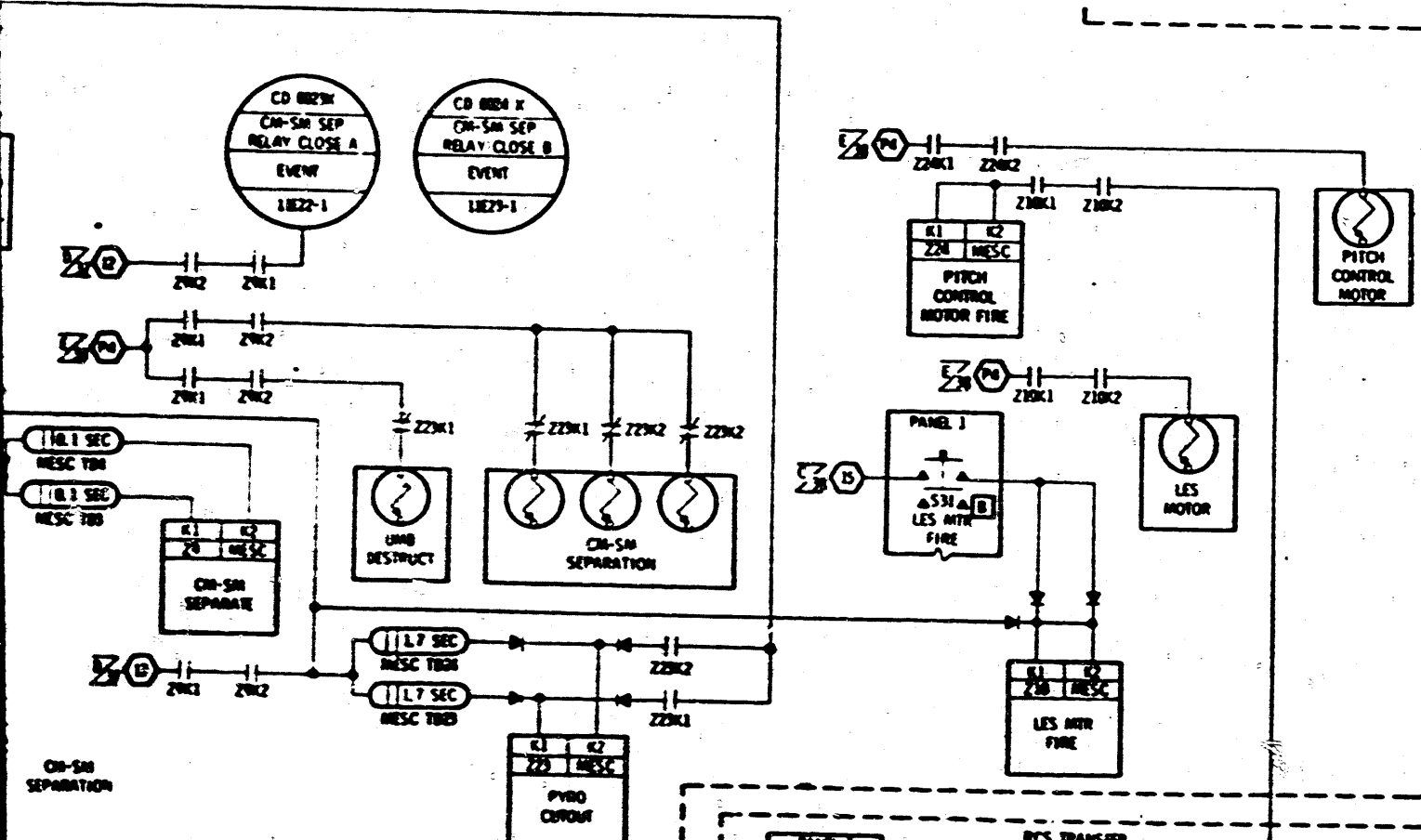
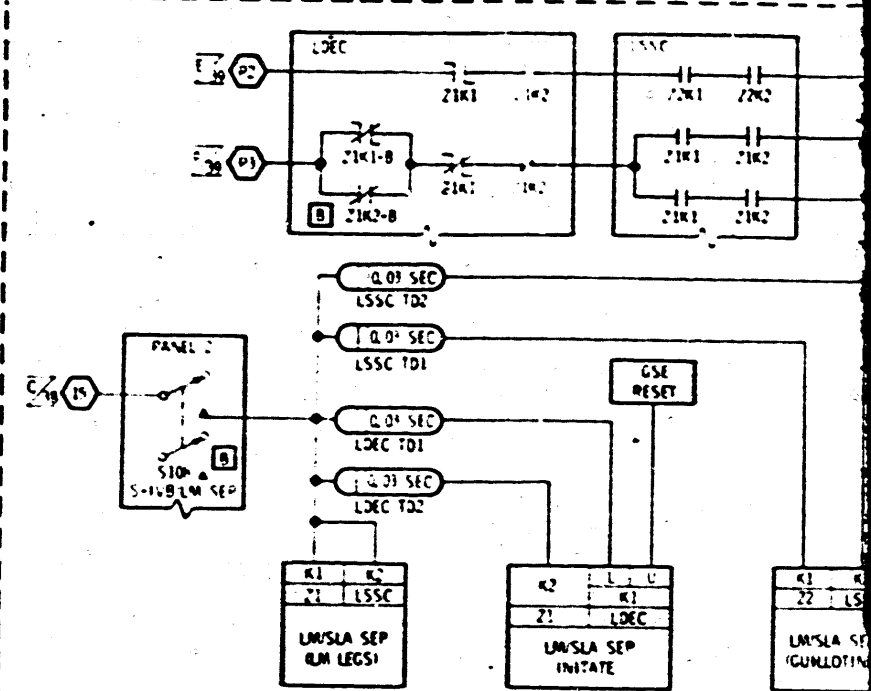
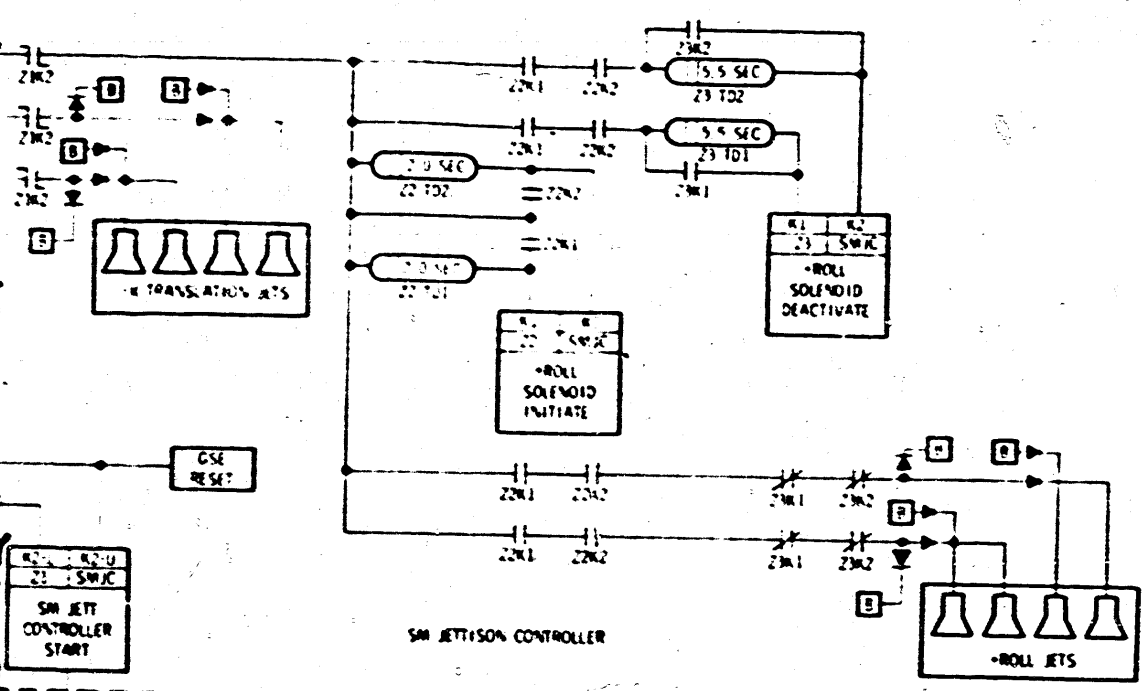




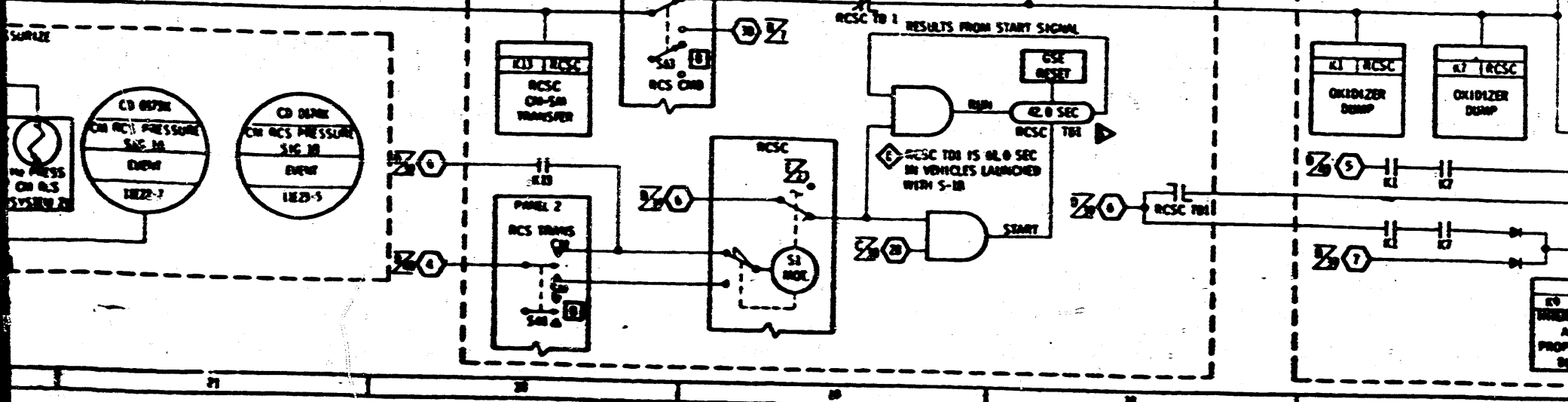


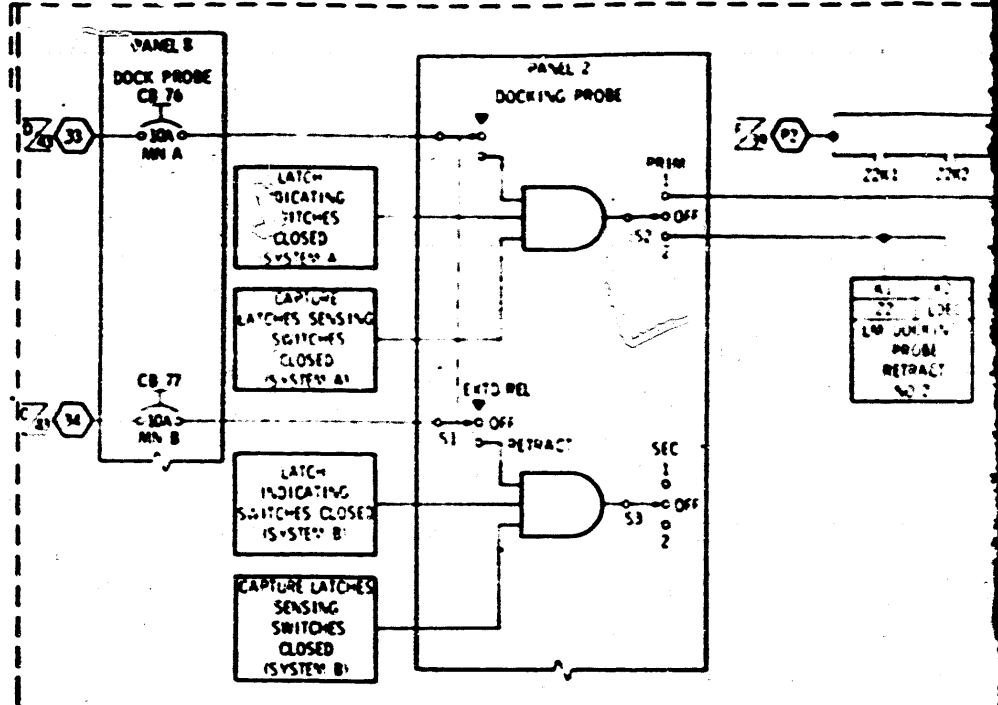
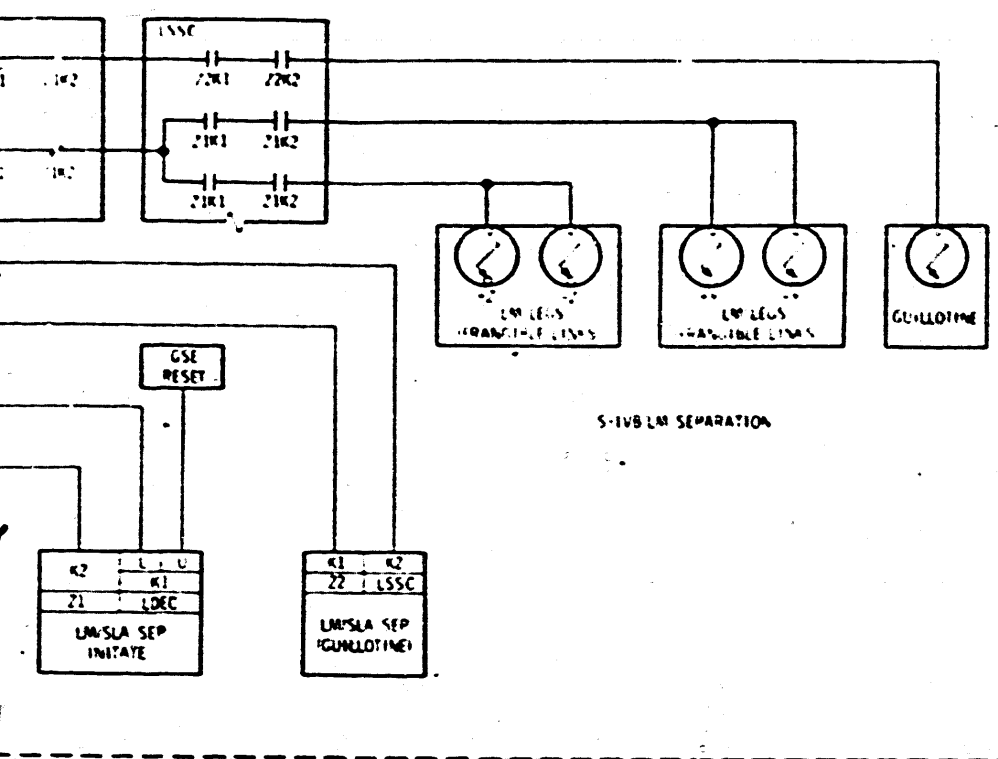




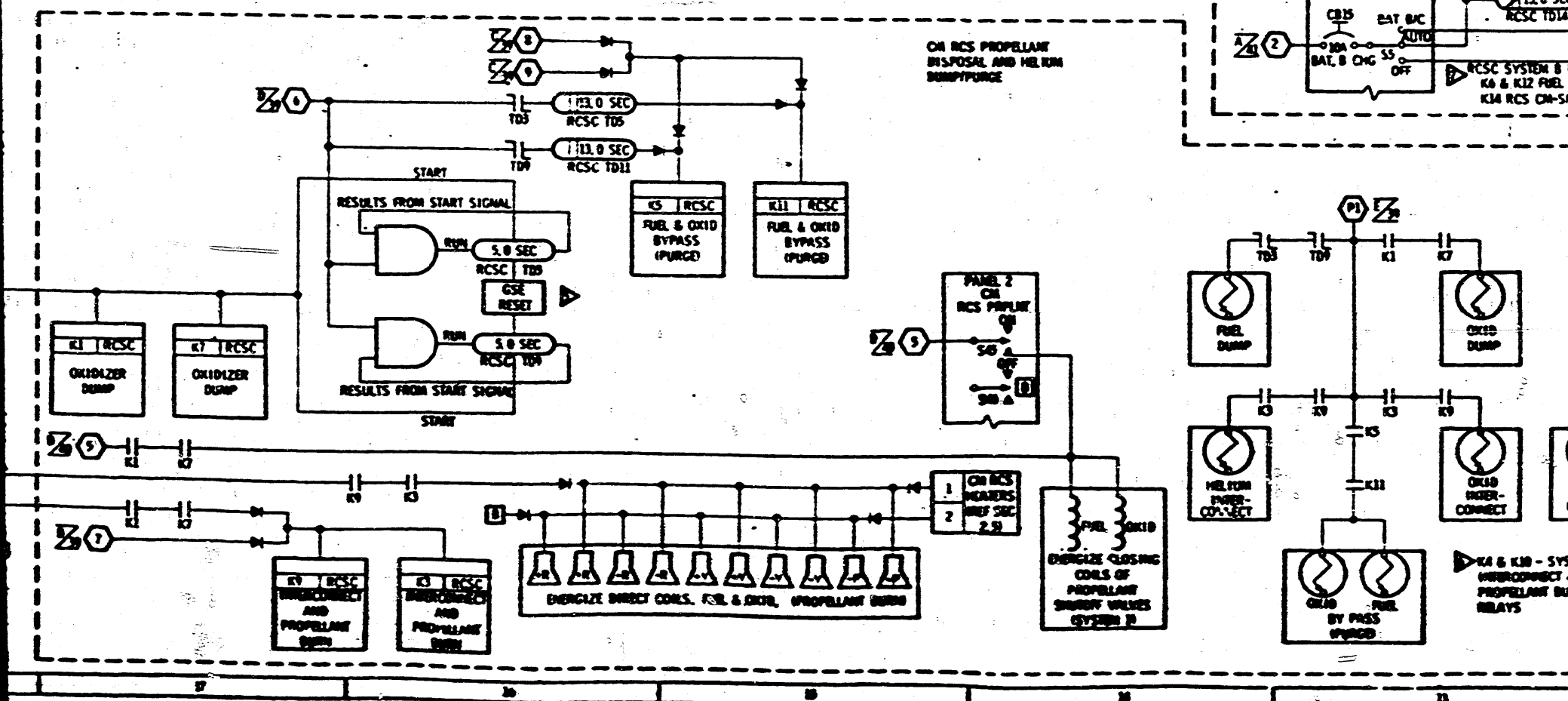
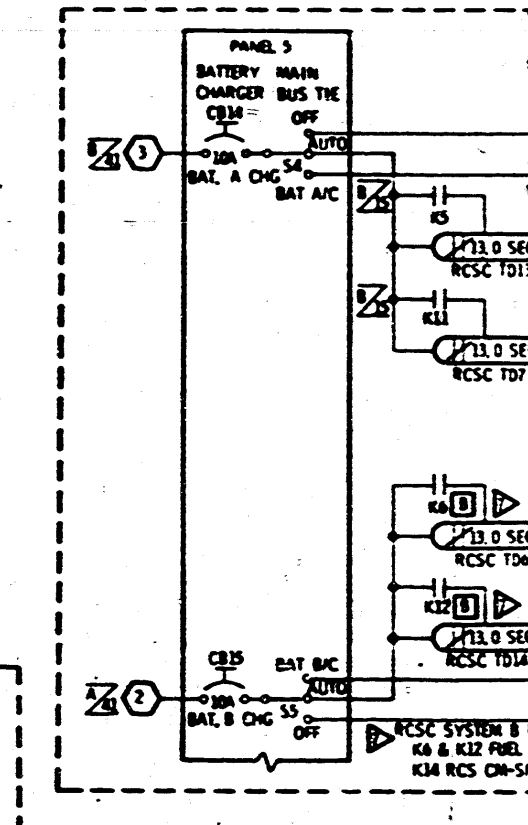


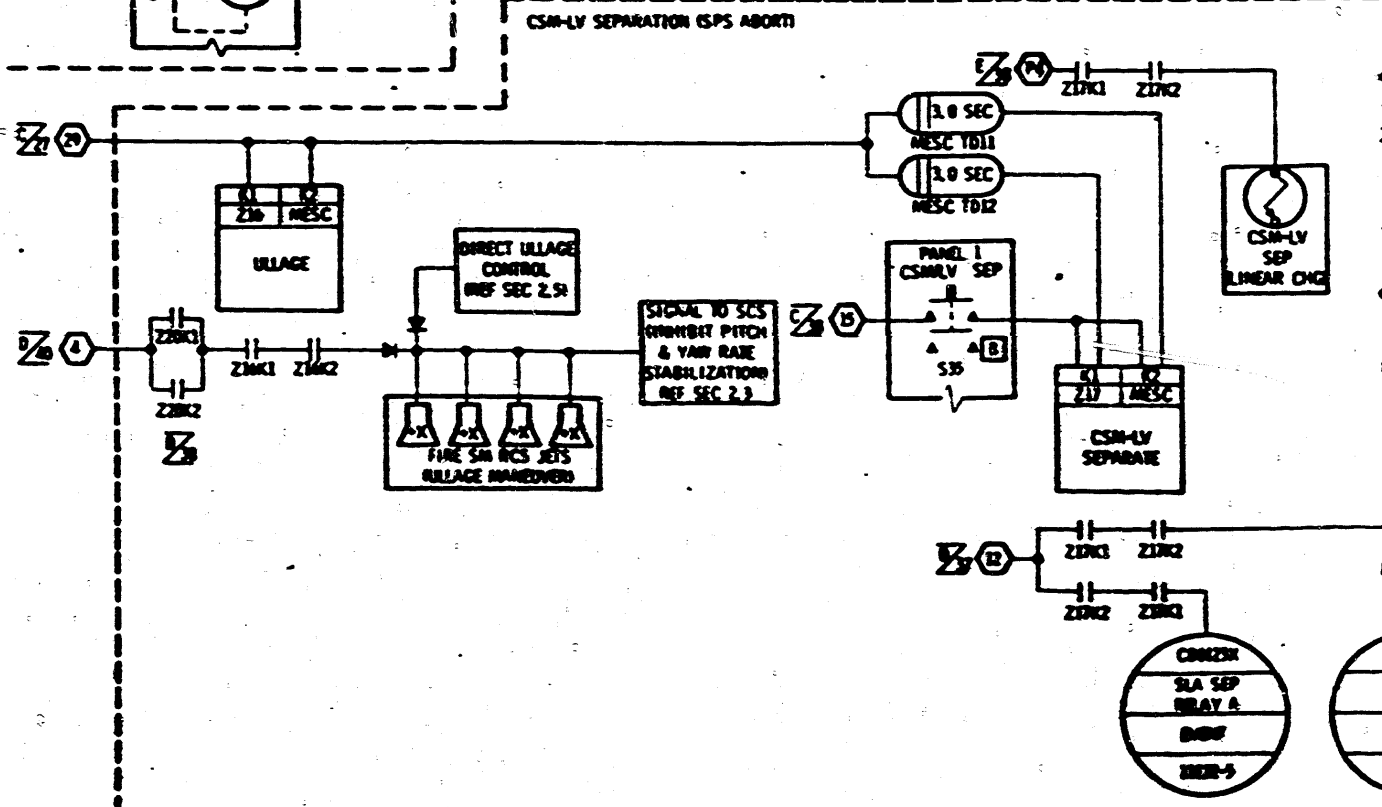
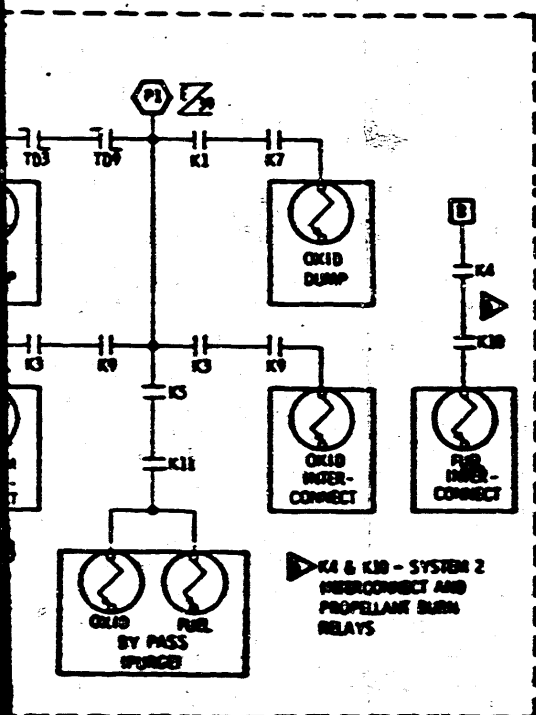
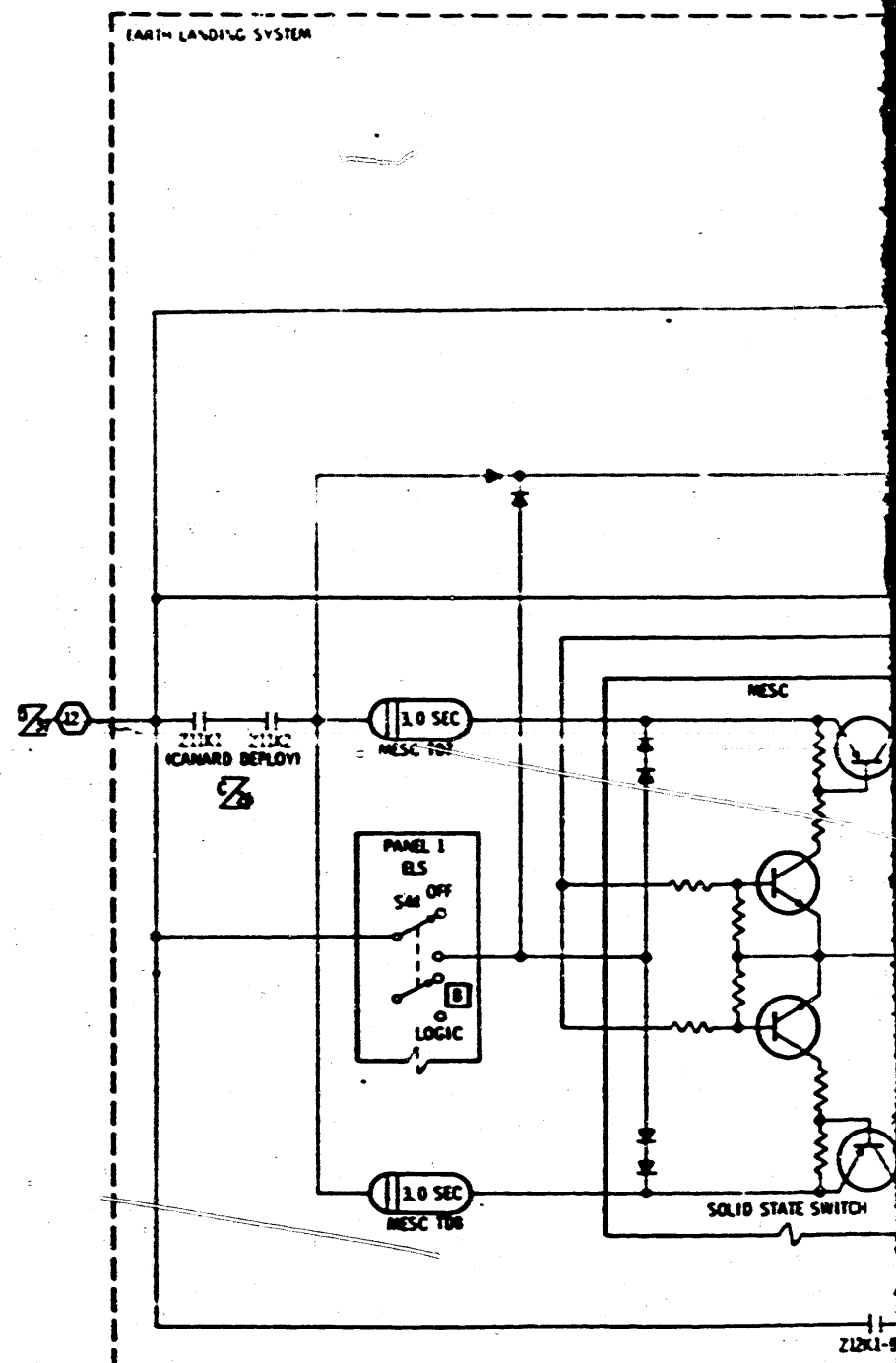
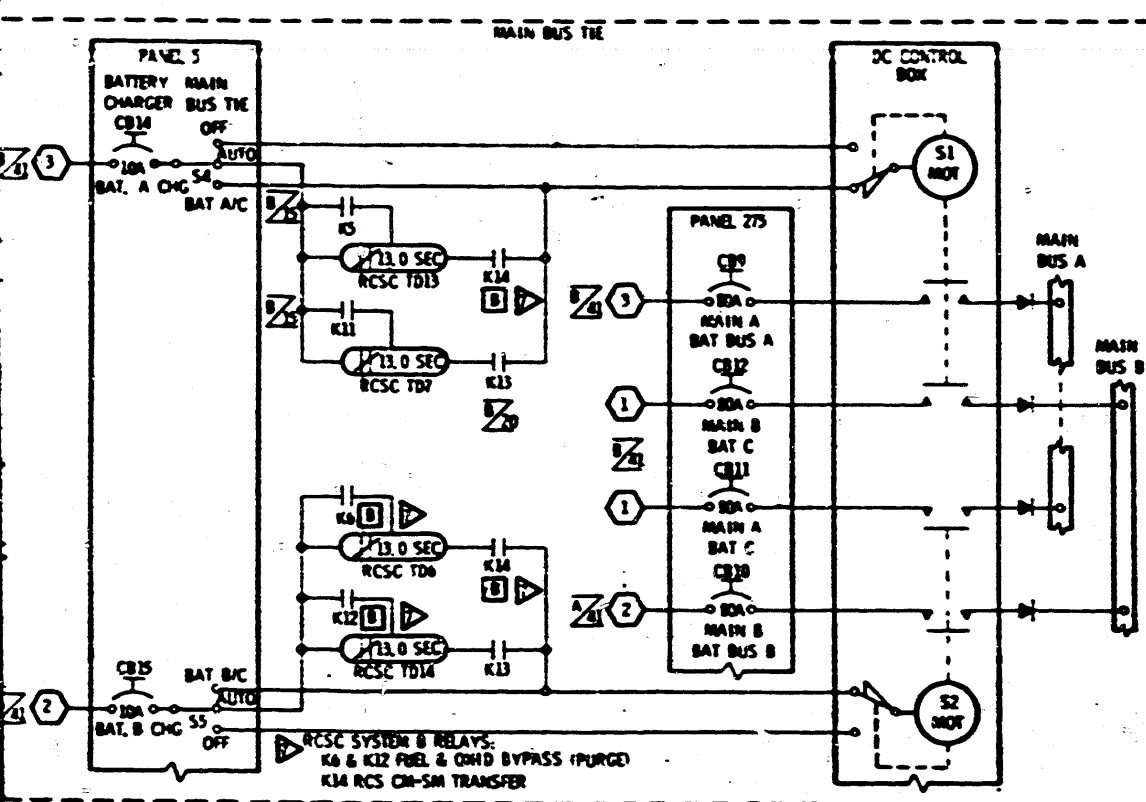
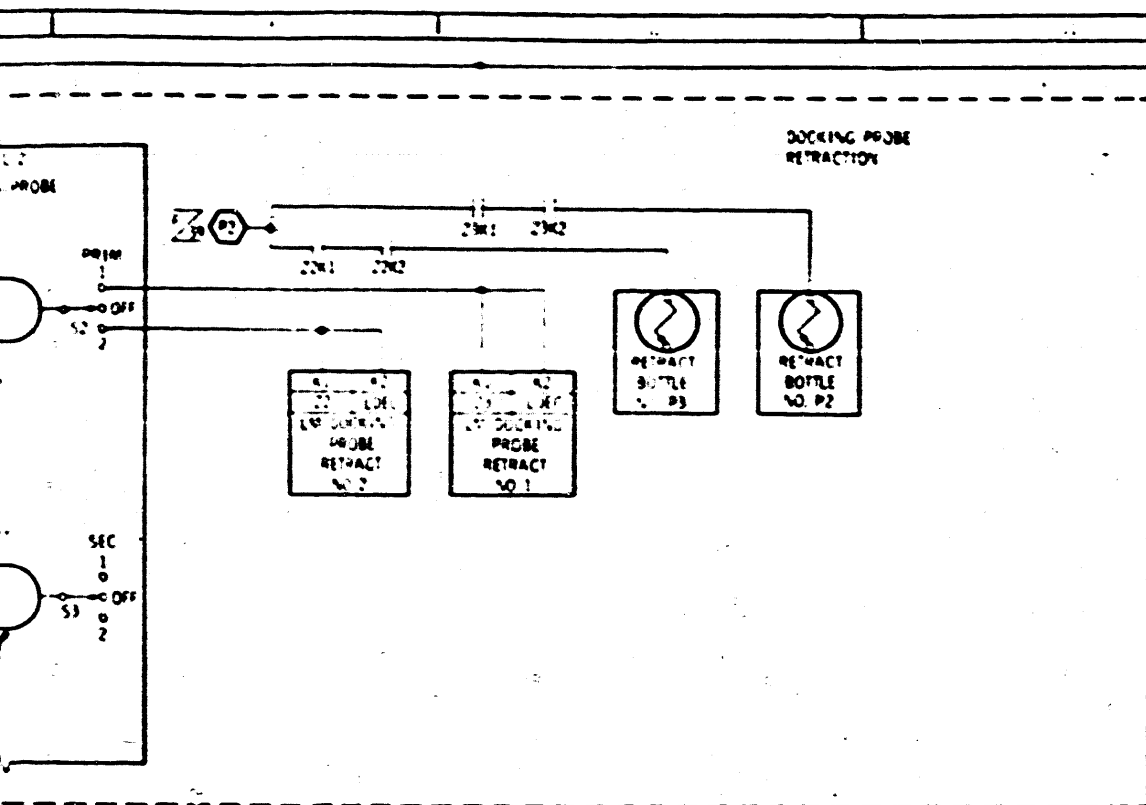
RCSC T01, T03 & T09 START SIGNAL MAY BE INTERRUPTED AFTER HAVING BEEN STARTED AND TIMERS WILL STOP TIMERS TO ZERO. TIMERS MAY BE STARTED AGAIN WITH

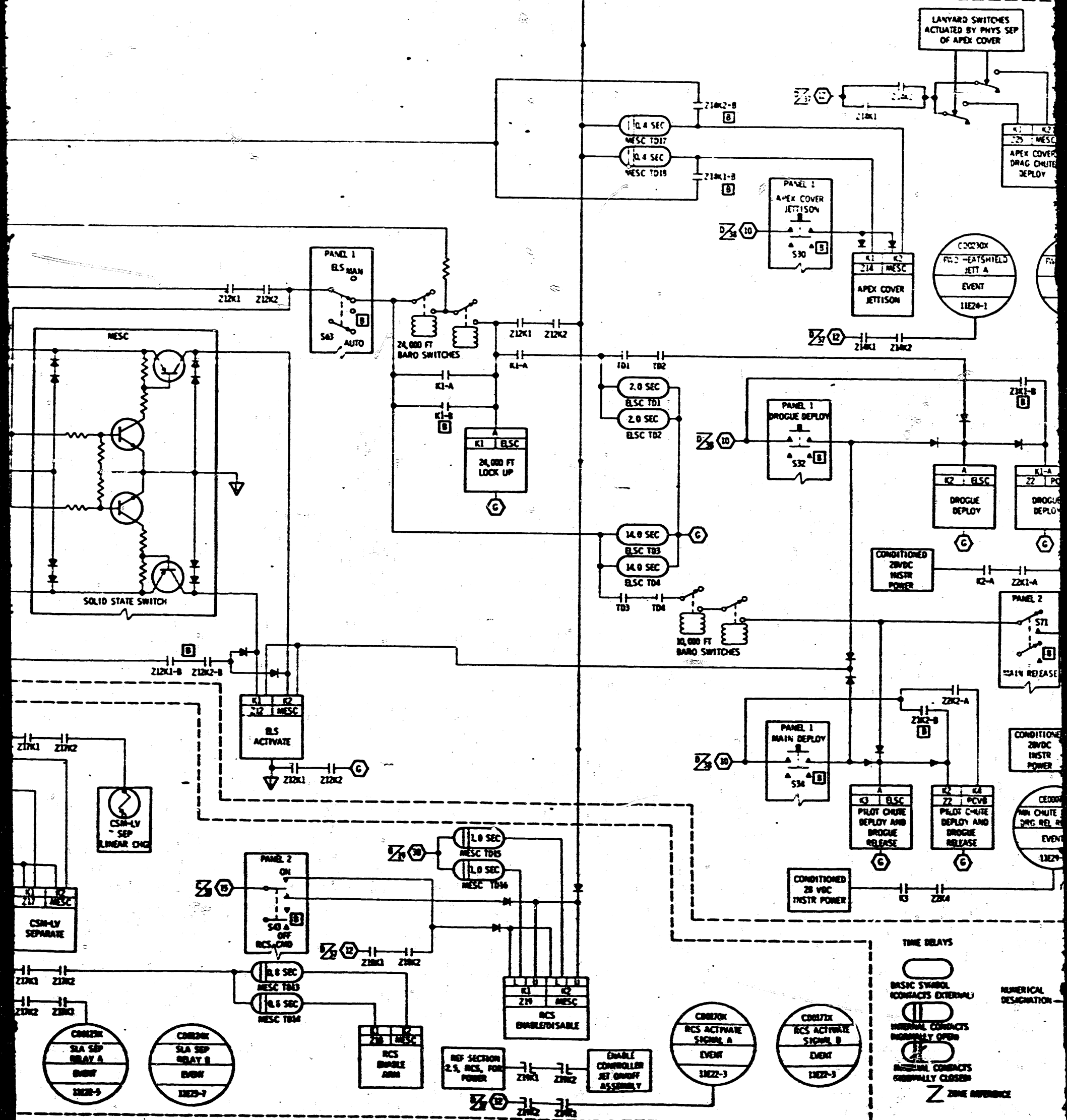


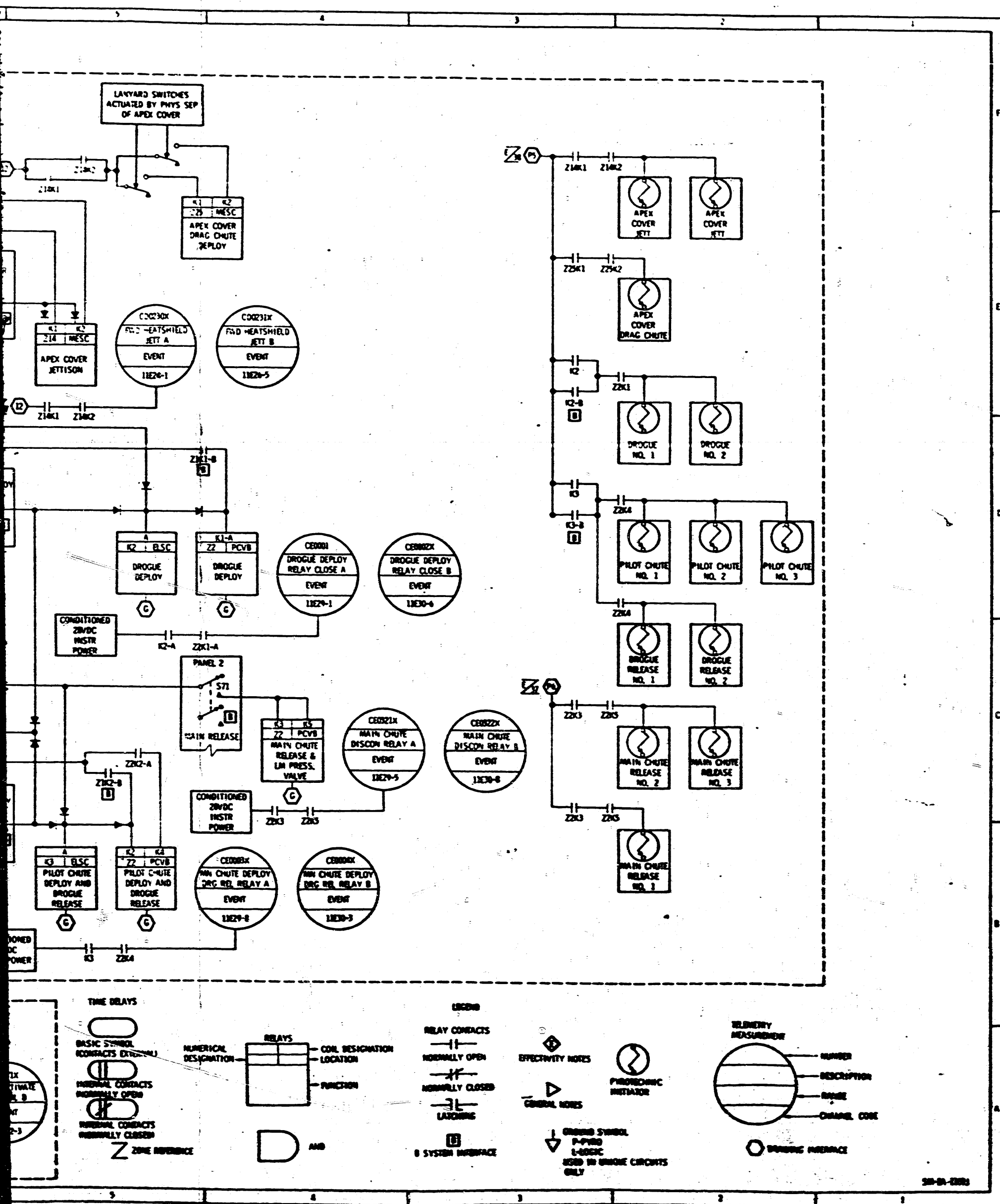


RCSC TDL, TD3 & TD9 START SIGNAL MAY BE INTERRUPTED AFTER HAVING BEEN STARTED AND TIMERS WILL CONTINUE TO OPERATE. INTERRUPTION OF RUN SIGNAL WILL STOP TIMERS BUT WILL NOT RESET THEM TO ZERO. TIMERS MAY BE STARTED AGAIN WITH RUN SIGNAL.









ABBREVIATIONS

ACE	Acceptance Checkout Equipment	MSC	Manned Spacecraft Center
AOA	Angle of Attack	MCC	Mission Control Center
AOH	Apollo Operations Handout	MSFC	Marshall Space Flight Center
BECO	Booster Engine Cutoff	MSFN	Manned Space Flight Network
BPC	Boost Protective Cover	MT	Mission Timer
CB	Circuit Breaker	NR	North American Rockwell Corp.
CDF	Confined Detonating Fuse	OECO	Outboard Engine Cutoff
CECO	Center Engine Cutoff	OI	Orbit Insertion
CM	Command Module	PCM	Pitch Control Motor
COI	Contingency Orbital Insertion	PCVB	Pyro Continuity Verification Box
CSM	Command Service Module	PGNCS	Primary Guidance, Navigation and Control System
D & C	Displays & Controls	PSO	Pad Safety Officer
DET	Digital Event Timer	RCS	Reaction Control Subsystem
DS	Docking Subsystem	RCSC	Reaction Control System Controller
ECS	Environmental Control Subsystem	RHC	Rotation Hand Control
EDS	Emergency Detection System	RHEB	Right Hand Equipment Bay
ELS	Earth Landing Subsystem	RHFEB	Right Hand Fwd. Equip. Bay
ELSC	Earth Landing Sequence Controller	RSO	Range Safety Officer
EPS	Electrical Power Subsystem	SBASI	Single Bridgewire Apollo Standard Initiator
ET	Event Timer	SECO	S-IVB Engine Cutoff
FDAI	Flight Director Attitude Indicator	SECS	Sequential Events Control Subsystem
FLSC	Flexible Linear Shaped Charge	SC	Spacecraft
GPI	Gimbal Position Indicator	SCS	Stabilization and Control Subsystem
GSE	Ground Support Equipment	SLA	Spacecraft LM Adapter
IECO	Inboard Engine Cutoff	SM	Service Module
IPB	Illuminated Push Button	SMJC	Service Module Jettison Controller
IU	Instrument Unit	SPS	Service Propulsion Subsystem
LCC	Launch Control Center	TB	Talkback
LDEC	Lunar Docking Events Controller	T/C	Telecommunications Subsystem
LEB	Lower Equipment Bay	TEC	Transearth Coast
LEM	Launch Escape Motor	TEI	Transearth Injection
LHEB	Left Hand Equipment Bay	THC	Translation Hand Control
LHFEB	Left Hand Fwd. Equip. Bay	TJM	Tower Jettison Motor
LM	Lunar Module	TLC	Translunar Coast
LES	Launch Escape Subsystem	TLI	Translunar Injection
LET	Launch Escape Tower	TLM	Telemetered or Telemetry
LEV	Launch Escape Vehicle	UDL	Up-Data Link
LOC	Lunar Orbit Coast		
LOI	Lunar Orbit Insertion		
LSSC	LM Separation Sequence Controller		
LV	Launch Vehicle		
MDC	Main Display Console		
MDF	Mild Detonating Fuse		
MESC	Master Events Sequence Controller		