TABLE IV

SHUTTLE PROGRAM CONTRACTS

- Orbiter/System Integration - R.I. Space Division
  - Flight control systems----------Honeywell
  - Data processing & software requirements--------IBM
  - Orbital maneuvering system pods----------MDAC
  - Vertical stabilizer----------Republic
  - Wing----------Grumman
  - Mid-fuselage----------General Dynamics
  - Ground maintenance & operations support--------American Airlines
- Main Engine - R.I. Rocketdyne Division
  - Controller----------Honeywell
  - Hydraulic actuator----------Hydraulic Research Inc.
- External Tank----------Martin Marietta Corporation
- Solid Rocket Booster----------Thiokol Chemical Corporation
  (Solid rocket motor; the total SRB to be defined later)

APOLLO SOYUZ TEST PROJECT MAJOR MILESTONES

1. USA/USSR Approval of Project
2. Joint Testing of Docking System (Scale Models)
3. Joint Testing of Full Scale Docking Systems
4. Joint Testing of Communications Systems
5. Preflight Check of Compatible Systems
6. Familiarization of Crews
7. Training of Soyuz Crew in USA
8. Training of Apollo Crew in USSR
9. Training of Flight Controllers
10. Control Center Tests
11. Flight Readiness Review
12. Launch

Figure 1

APOLLO/SOYUZ TEST PROJECT
MASTER PROGRAM SCHEDULE

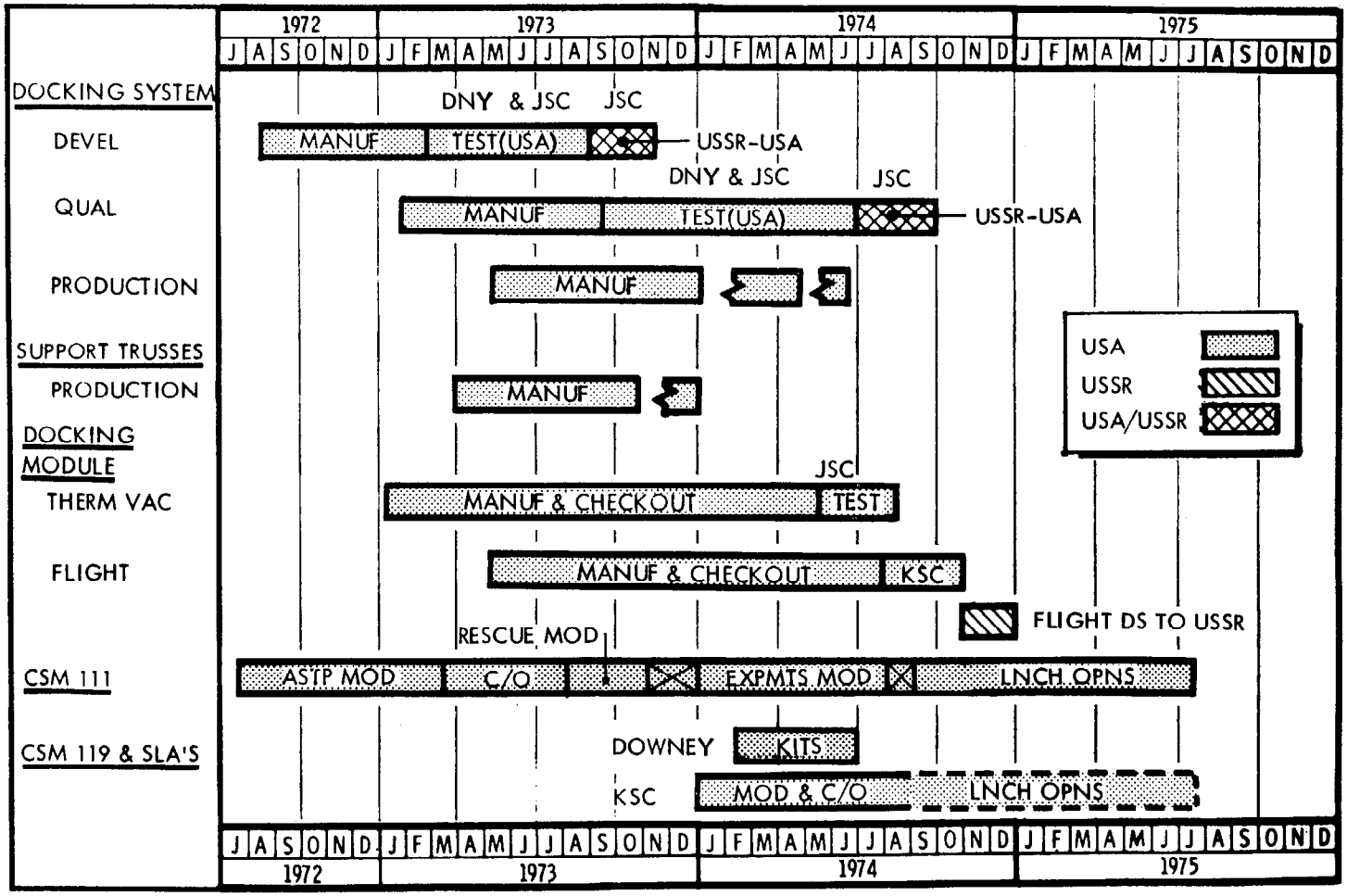


Figure 2

GROUND TESTS, MOCKUPS, TRAINERS AND SIMULATORS

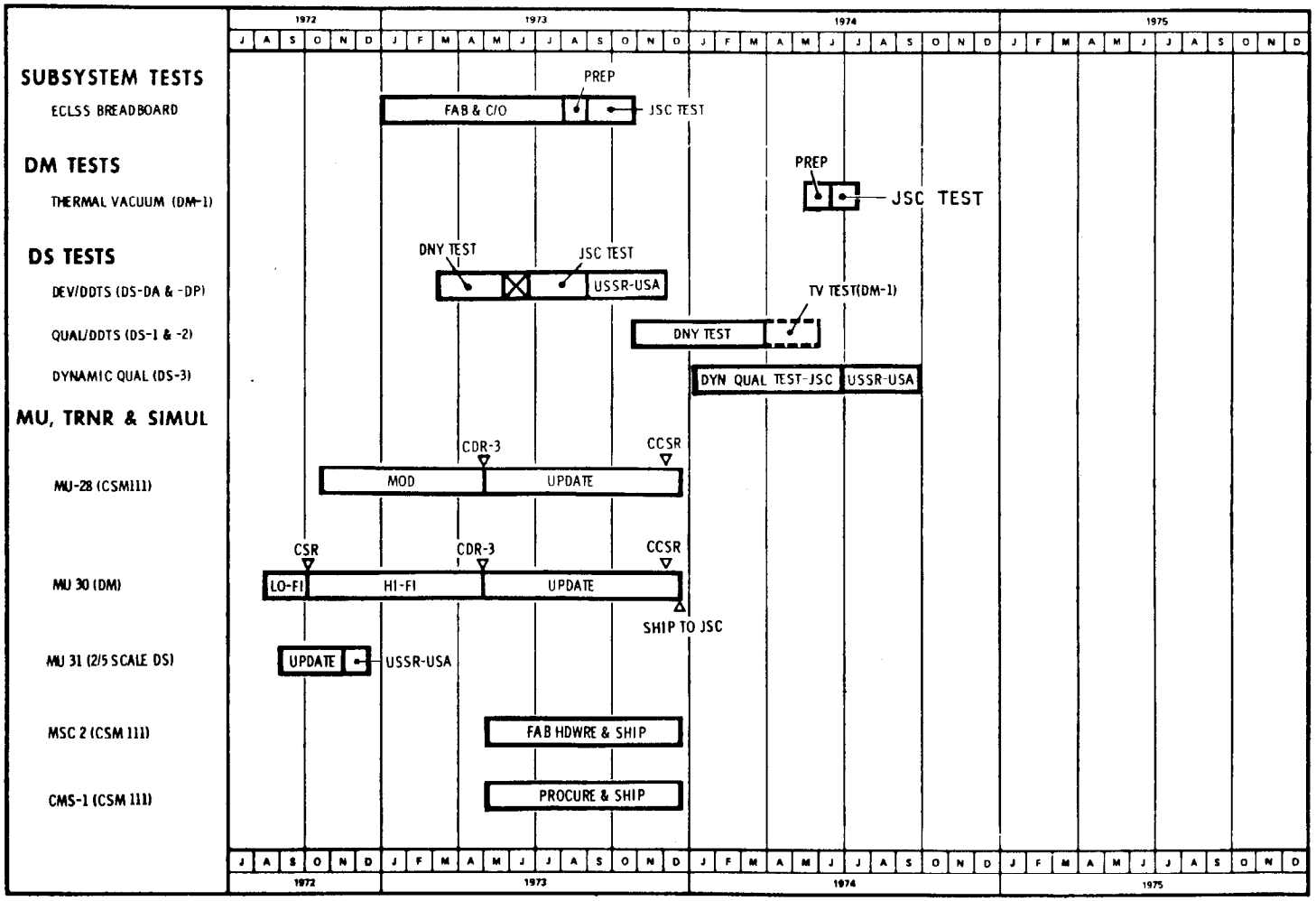
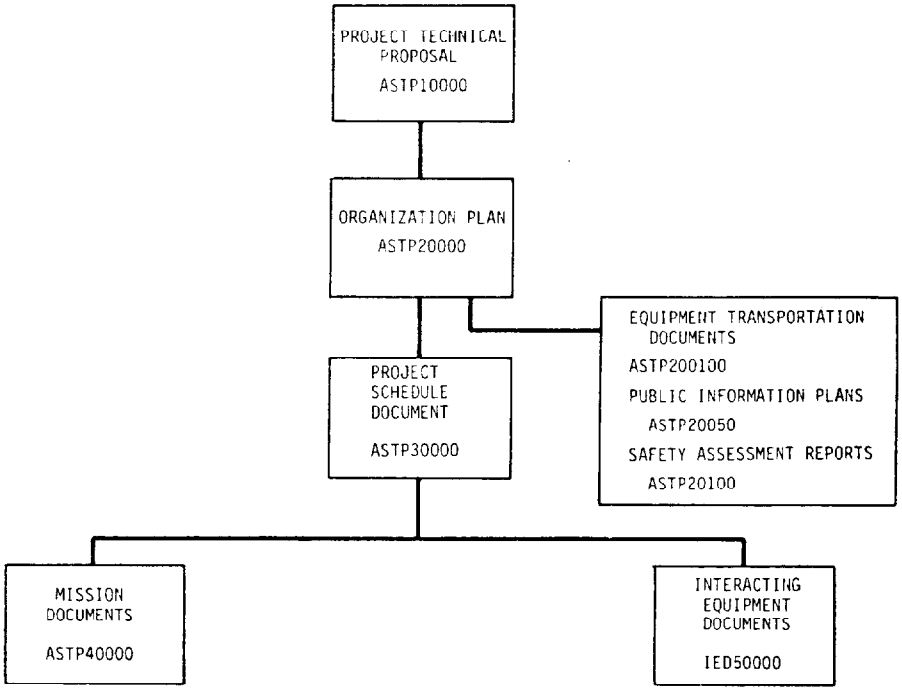


Figure 3

ASTP
PROJECT DOCUMENTATION



MISSION REQUIREMENTS
ASTP40000

LAUNCH WINDOW PLAN
ASTP40100

TRAJECTORY PLAN
ASTP40200

FLIGHT PLAN GUIDELINES
ASTP40300

MISSION OPERATIONS PLAN
ASTP40400

CONTINGENCY PLAN
ASTP40500

ON-BOARD JOINT OPERATIONS INSTRUCTIONS
ASTP40600

CREW AND GROUND PERSONNEL TRAINING PLAN
ASTP40700

POST-MISSION REPORT
ASTP40800

DOCKING MECHANISM
IED50000

COMMUNICATIONS AND TRACKING EQUIPMENT
IED50100

DOCKING AIDS
IED50200

OPTICS AND ORIENTATION
IED50300

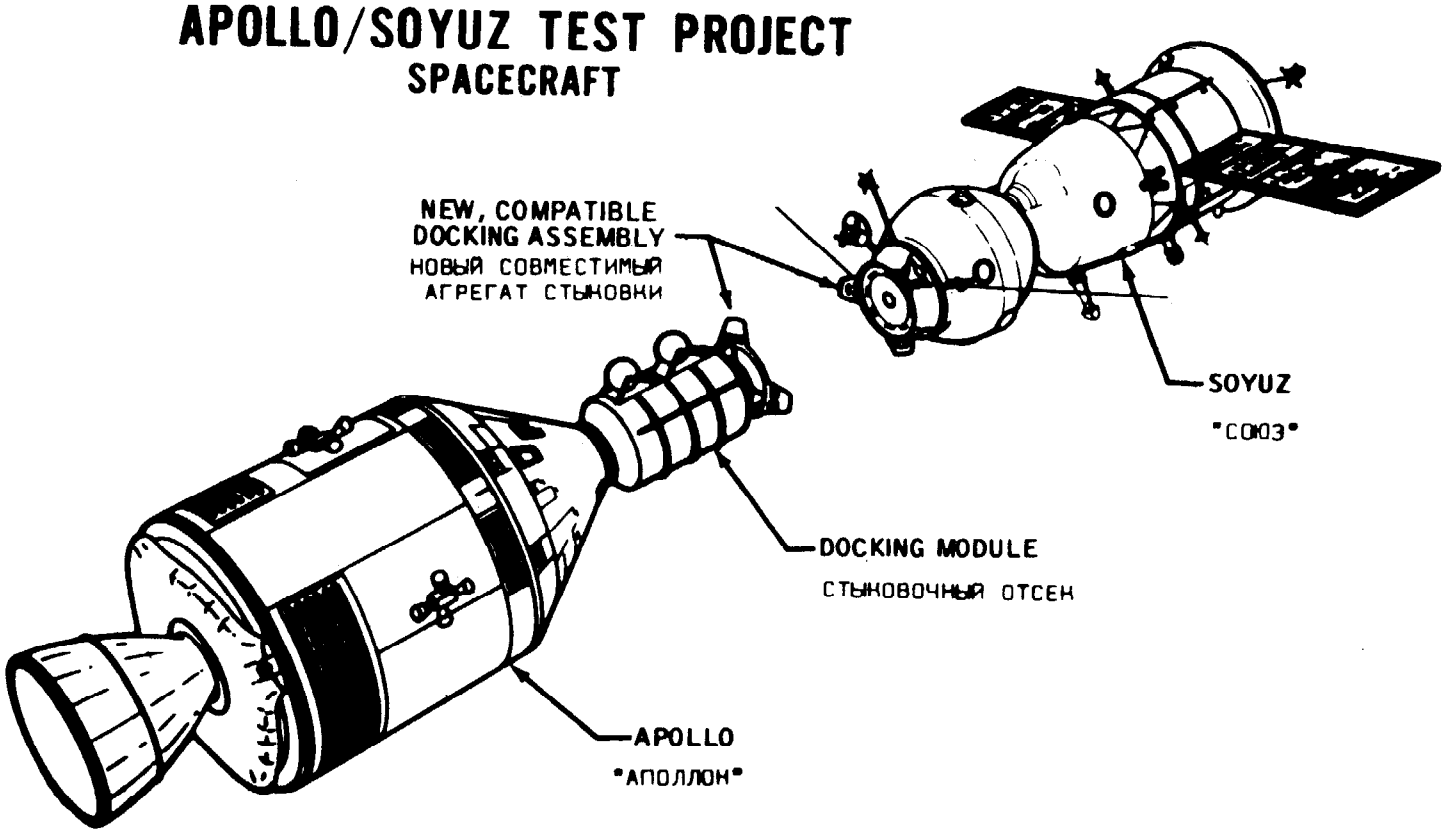
CONTROL SYSTEMS
IED50400

INTER-CONTROL CENTER COMMUNICATIONS
IED50500

CABLE COMMUNICATIONS AND TELEVISION
IED50600

CONDITIONS AND EQUIPMENT IN CREW TRANSFER
IED50700

Figure 4



APOLLO-SOYUZ RENDEZVOUS AND DOCKING TEST PROJECT

ЭКСПЕРИМЕНТАЛЬНЫЙ ПРОЕКТ СБЛИЖЕНИЯ И СТЫКОВКИ "АПОЛЛОН/СОЮЗ"

Figure 5

ASTP LAUNCH CONFIGURATION

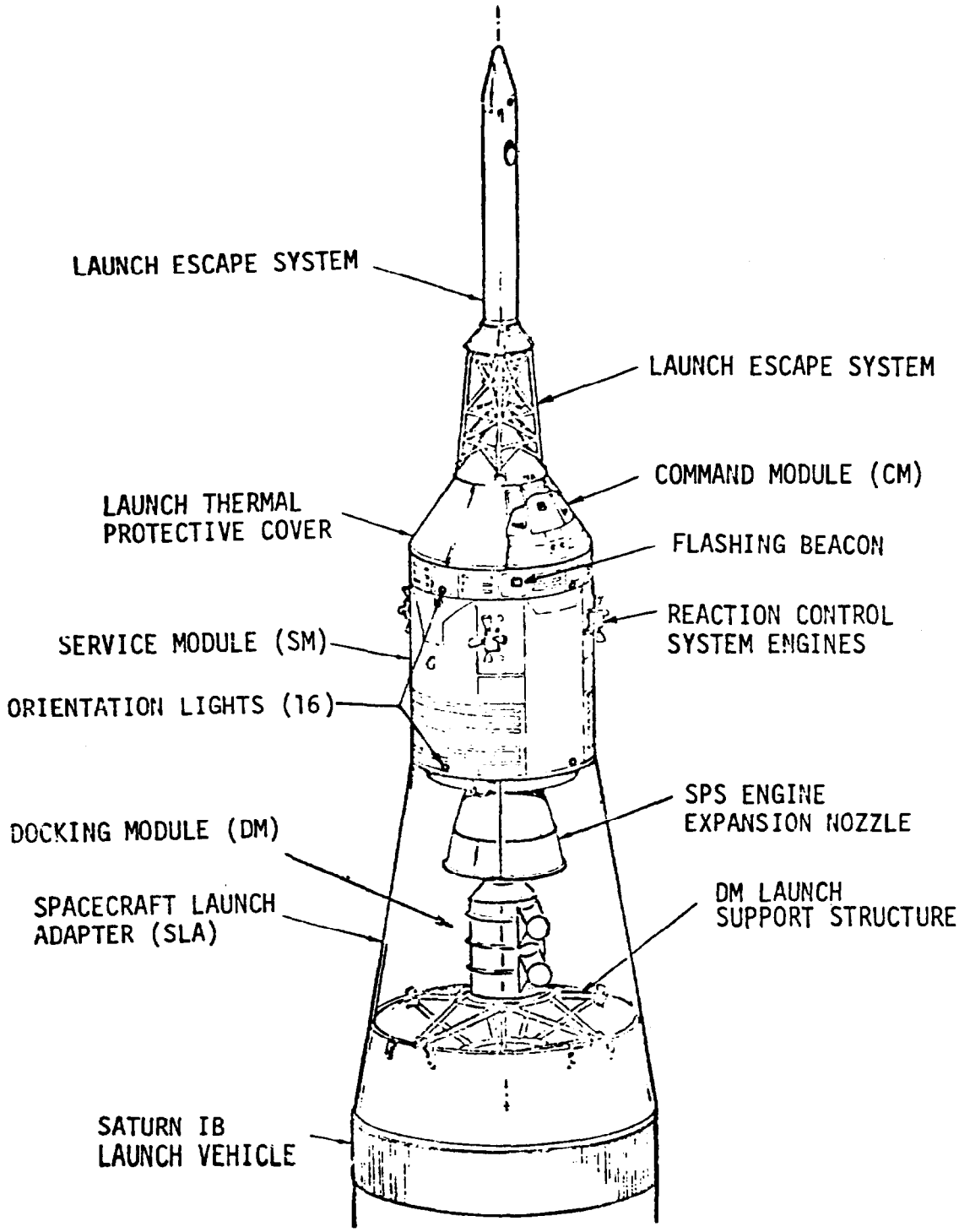


Figure 6

APOLLO/SOYUZ - TEST MISSION RADIO COMMUNICATIONS LINKS

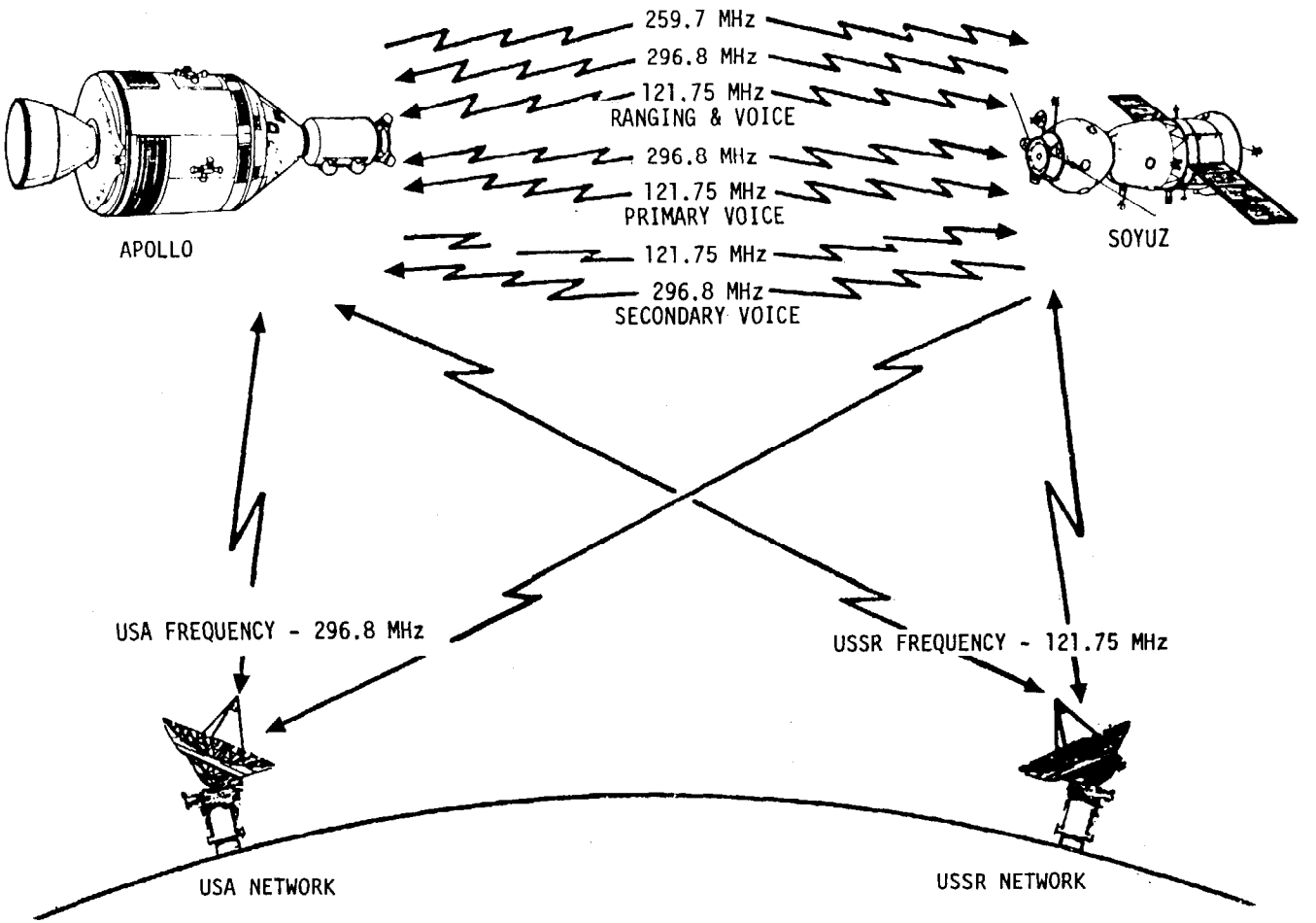


Figure 7

DOCKING MODULE - SOYUZ END

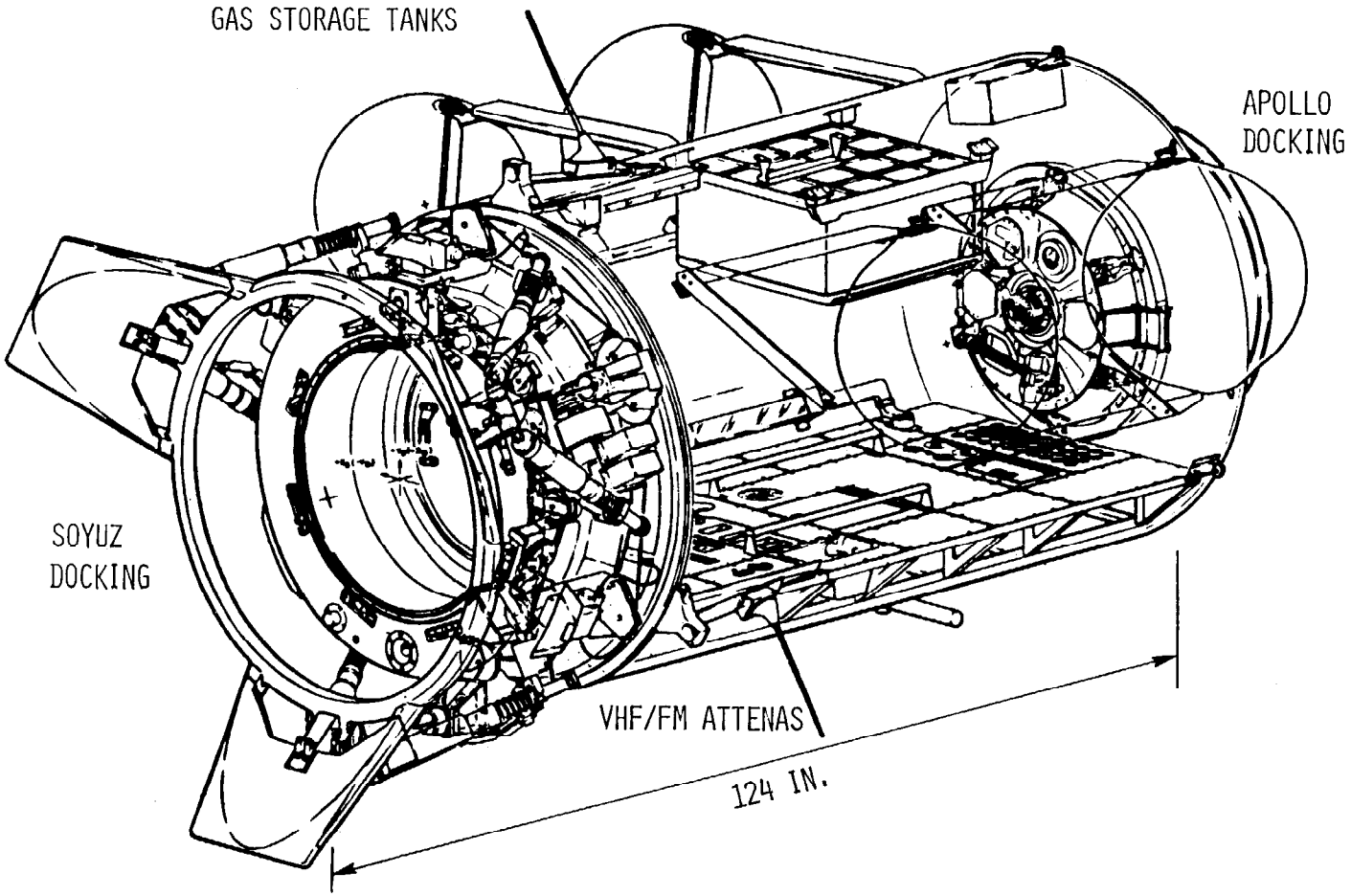


Figure 8

ASTP CABLE COMMUNICATIONS SYSTEM

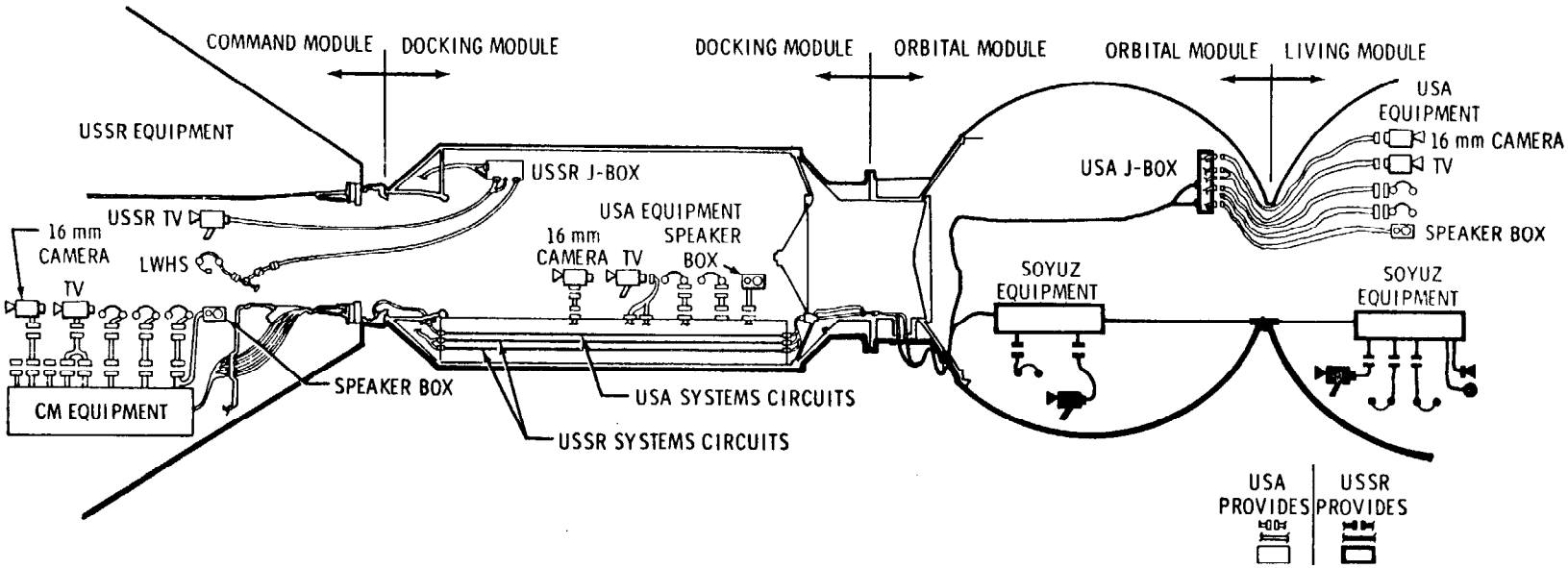


Figure 8A

U.S. AND USSR COMPATIBLE DOCKING SYSTEMS

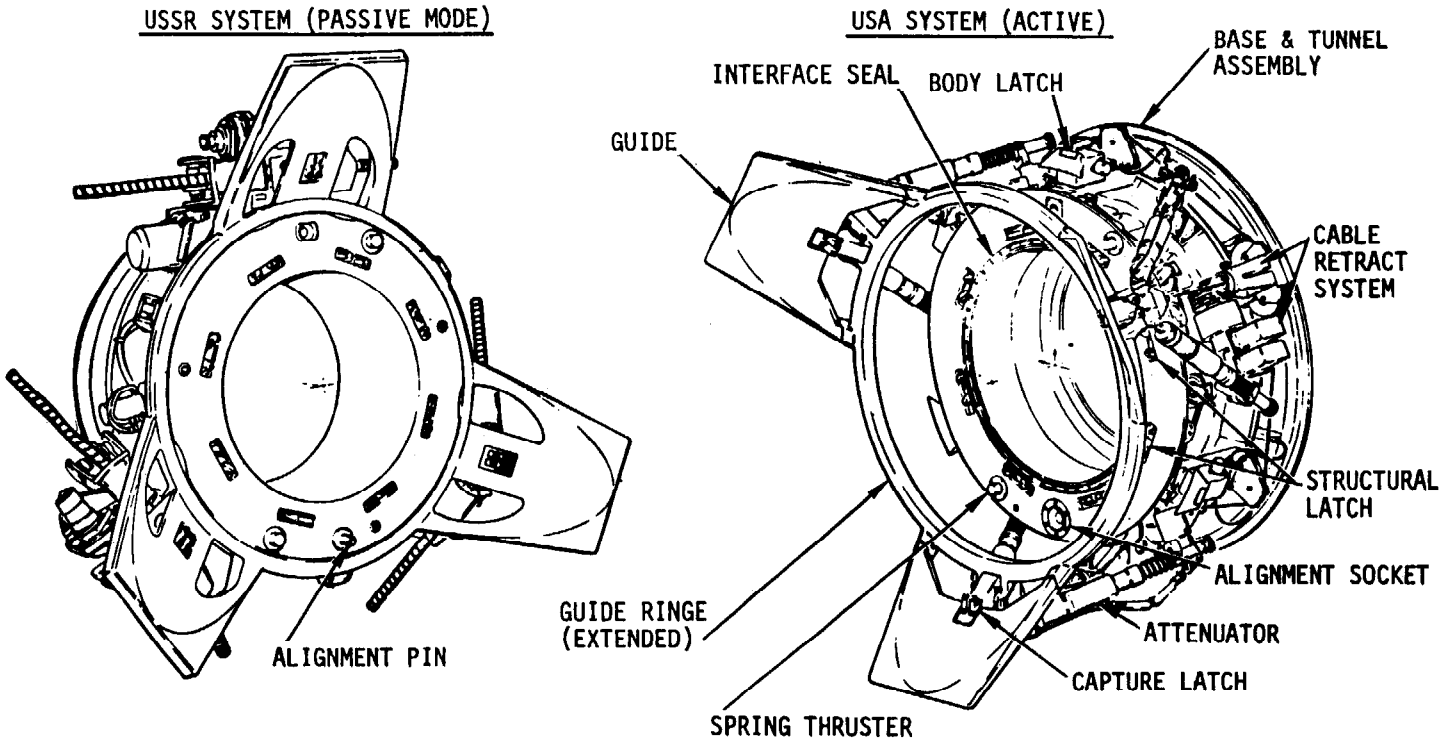
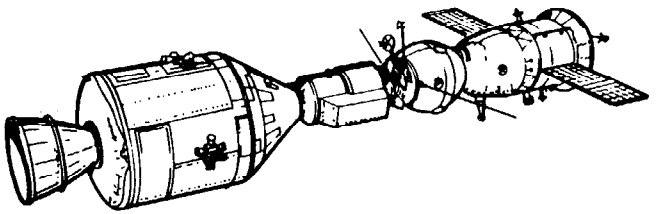


Figure 9

APOLLO SOYUZ TEST PROJECT
MISSION PROFILE



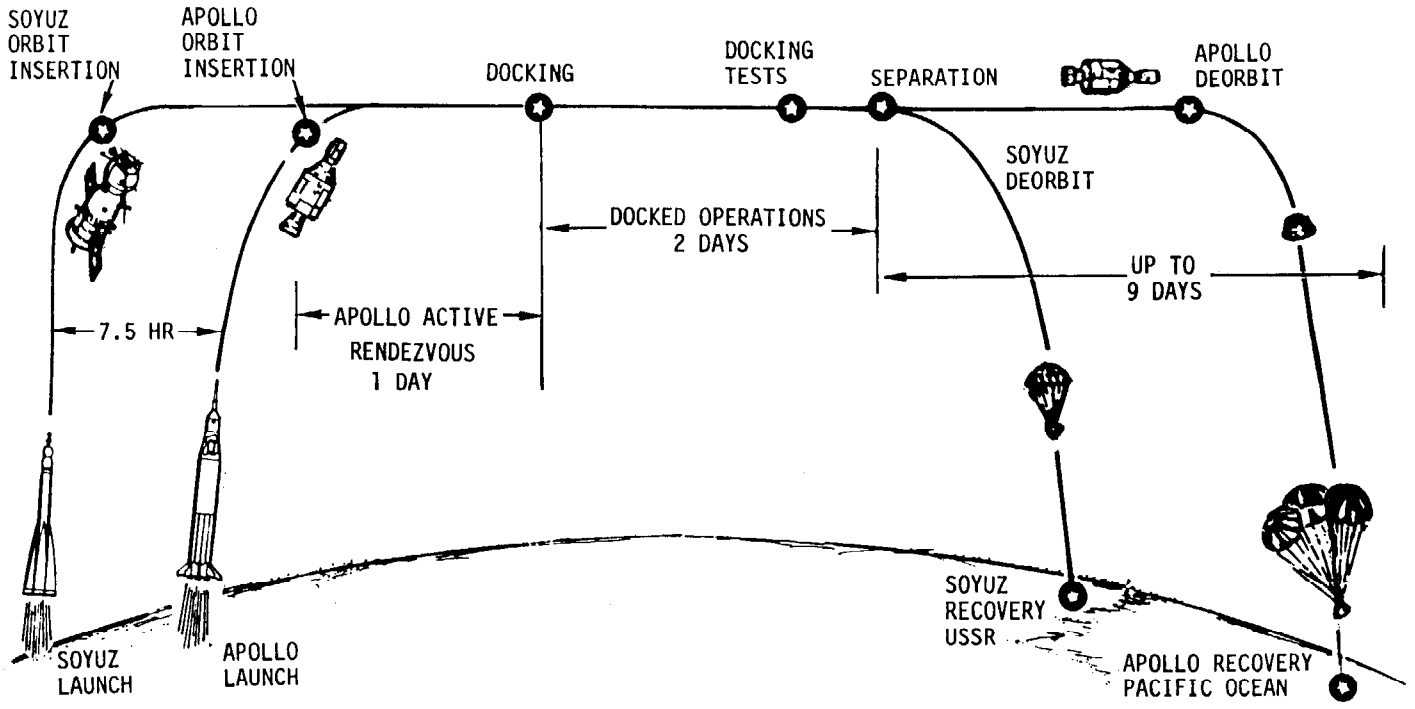
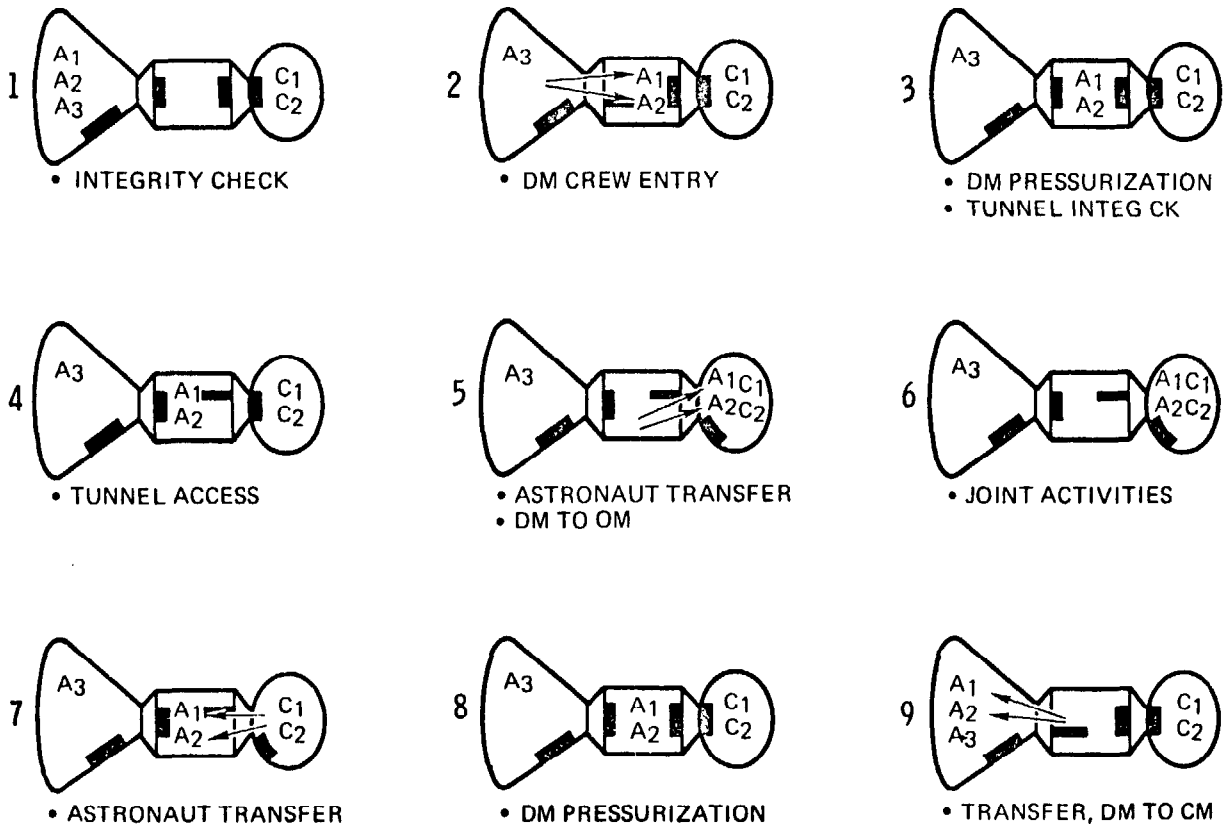


Figure 10

FIRST TRANSFER OPERATIONS



CM - COMMAND MODULE
DM - DOCKING MODULE
OM - ORBITAL MODULE

Figure 11

SPACE SHUTTLE MANAGEMENT RELATIONSHIPS

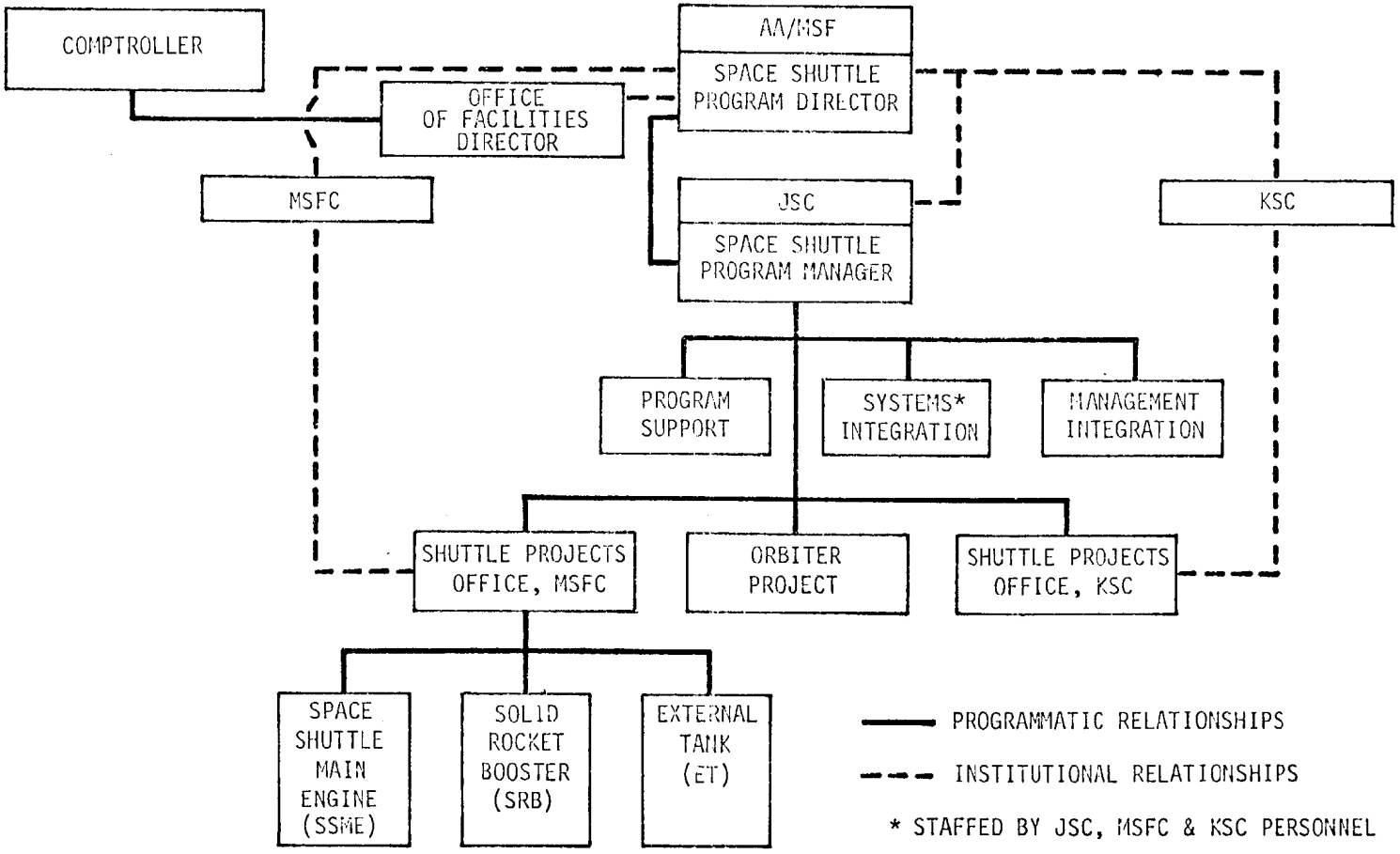


Figure 12

NASA SPACE SHUTTLE PROGRAM ORGANIZATION

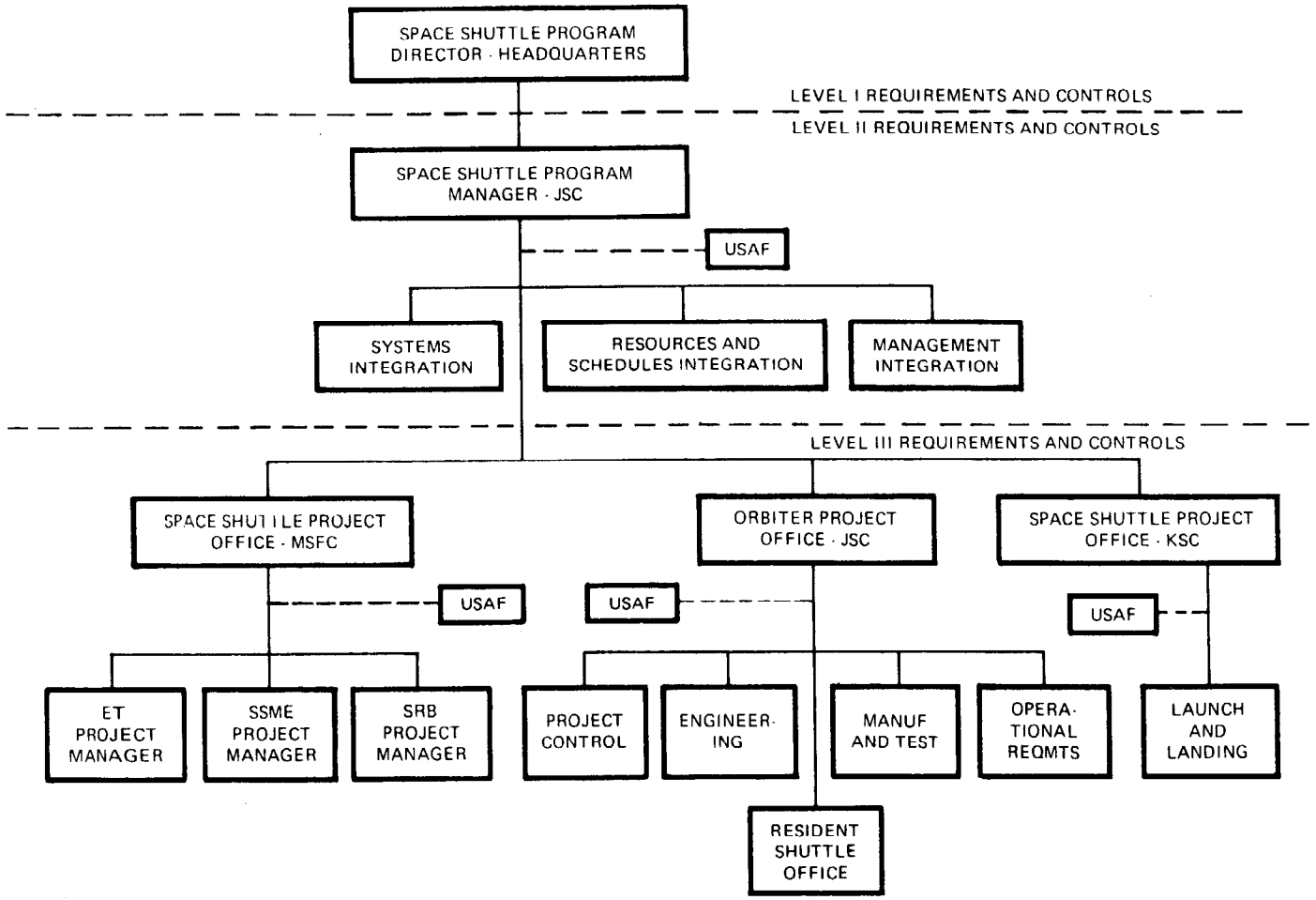


Figure 13

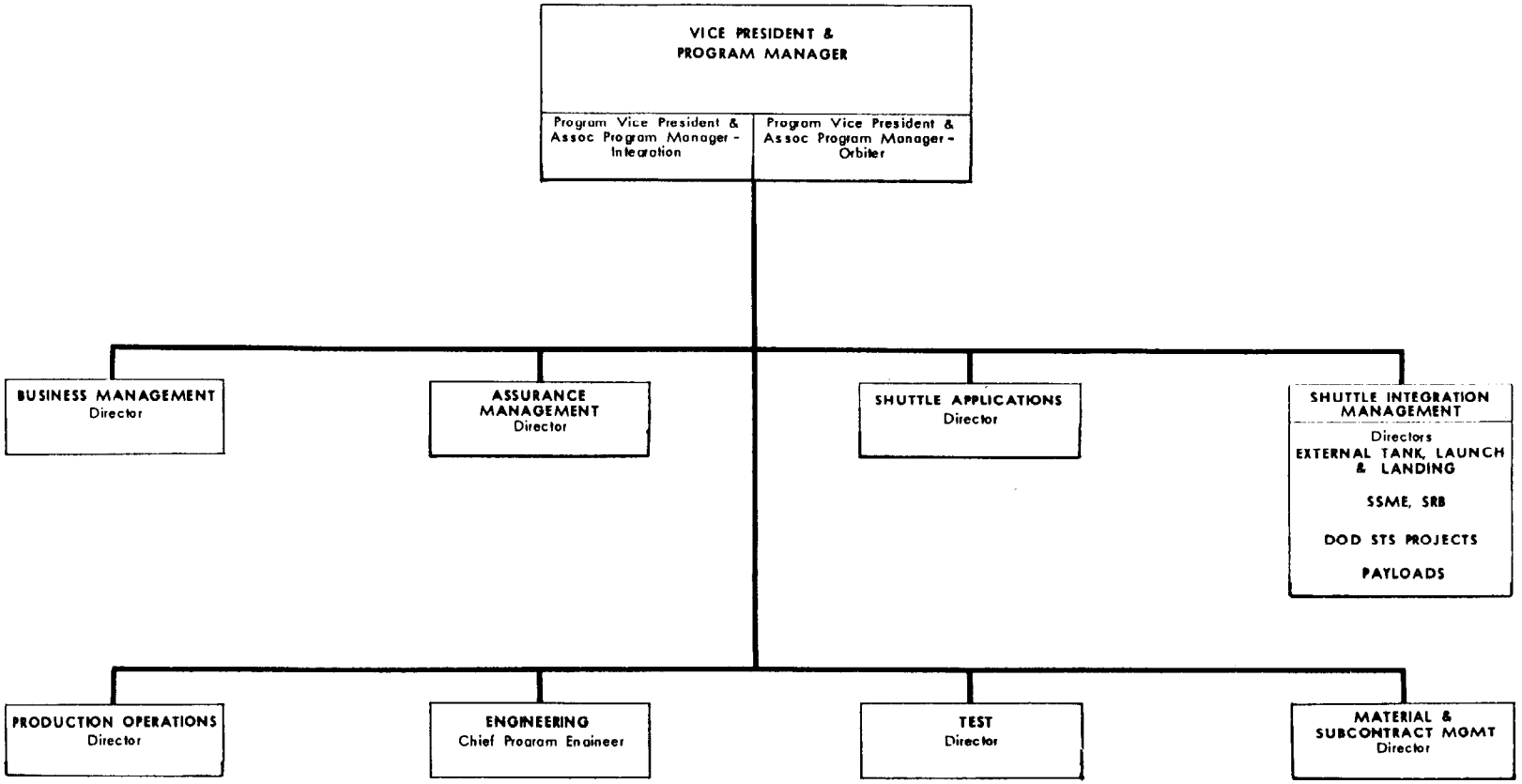

VICE PRESIDENT &
PROGRAM MANAGER
Program Vice President & Assoc Program Manager - Integration
Program Vice President & Assoc Program Manager - Orbiter
BUSINESS MANAGEMENT
Director
ASSURANCE MANAGEMENT
Director
SHUTTLE APPLICATIONS
Director
SHUTTLE INTEGRATION MANAGEMENT
Directors
EXTERNAL TANK, LAUNCH & LANDING
SSME, SRB
DOD STS PROJECTS
PAYLOADS
PRODUCTION OPERATIONS
Director
ENGINEERING
Chief Program Engineer
TEST
Director
MATERIAL & SUBCONTRACT MGMT
Director

Figure 14

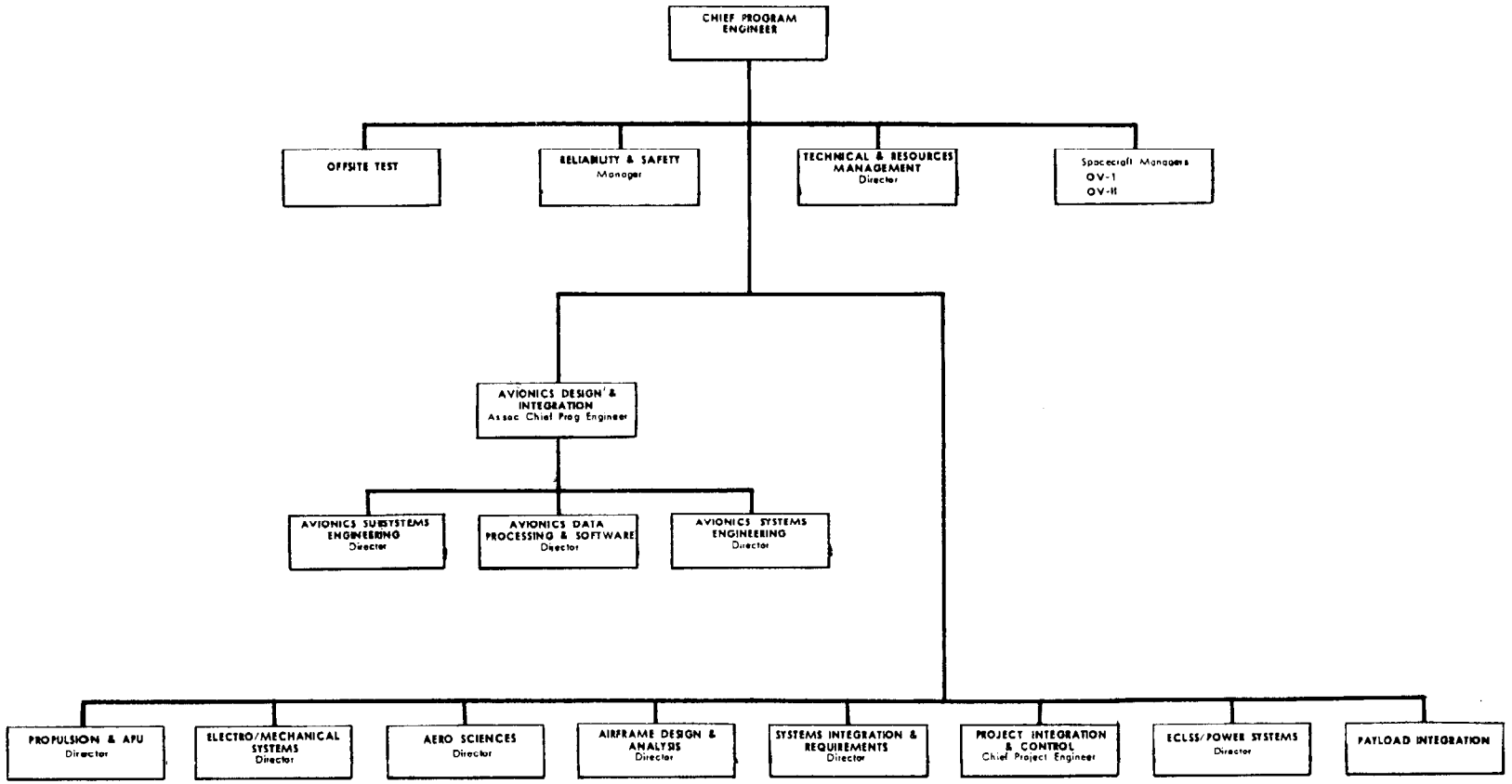

CHIEF PROGRAM ENGINEER
OFFSITE TEST
RELIABILITY & SAFETY
Manager
TECHNICAL & RESOURCES MANAGEMENT
Director
Spacecraft Managers
OV-1
OV-II
AVIONICS DESIGN & INTEGRATION
Assoc Chief Prog Engineer
AVIONICS SUBSYSTEMS ENGINEERING
Director
AVIONICS DATA PROCESSING & SOFTWARE
Director
AVIONICS SYSTEMS ENGINEERING
Director
PROPULSION & APU
Director
ELECTRO/MECHANICAL SYSTEMS
Director
AERO SCIENCES
Director
AIRFRAME DESIGN & ANALYSIS
Director
SYSTEMS INTEGRATION & REQUIREMENTS
Director
PROJECT INTEGRATION & CONTROL
Chief Project Engineer
ECLSS/POWER SYSTEMS
Director
PAYLOAD INTEGRATION

Figure 15

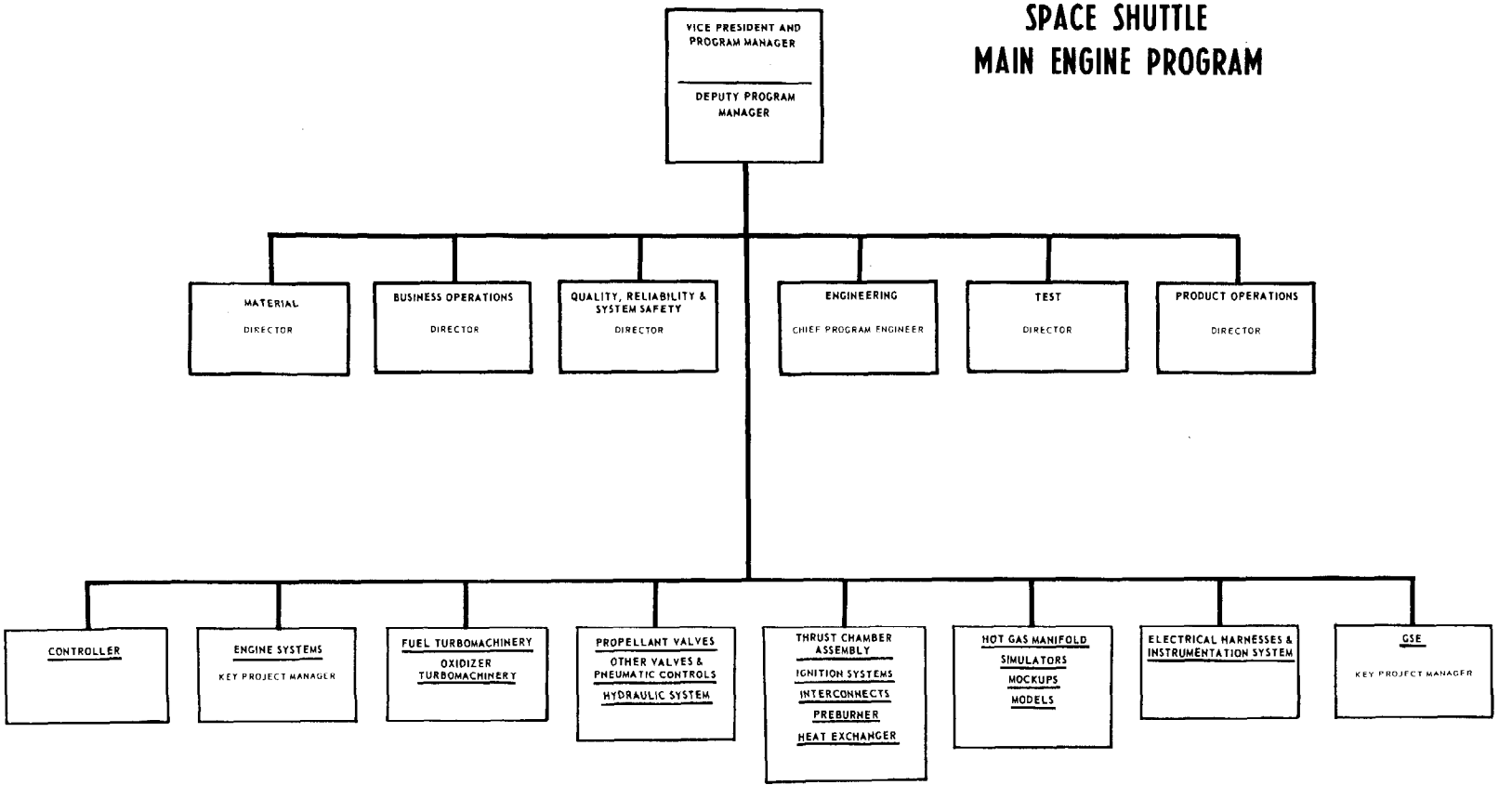
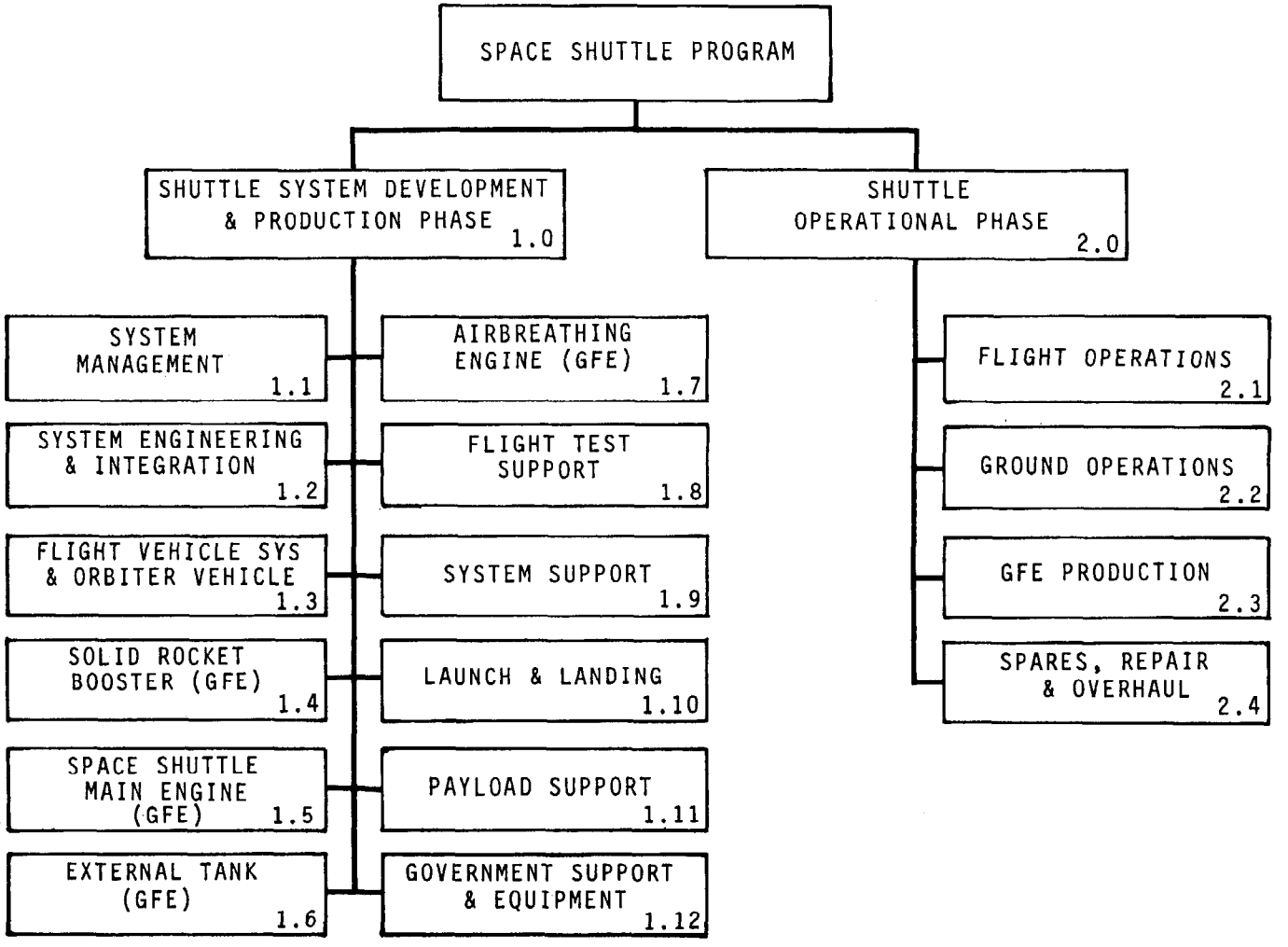

SPACE SHUTTLE
MAIN ENGINE PROGRAM
VICE PRESIDENT AND PROGRAM MANAGER
DEPUTY PROGRAM MANAGER
MATERIAL
DIRECTOR
BUSINESS OPERATIONS
DIRECTOR
QUALITY, RELIABILITY & SYSTEM SAFETY
DIRECTOR
ENGINEERING
CHIEF PROGRAM ENGINEER
TEST
DIRECTOR
PRODUCT OPERATIONS
DIRECTOR
CONTROLLER
ENGINE SYSTEMS
KEY PROJECT MANAGER
FUEL TURBOMACHINERY
OXIDIZER TURBOMACHINERY
PROPELLANT VALVES
OTHER VALVES & PNEUMATIC CONTROLS
HYDRAULIC SYSTEM
THRUST CHAMBER ASSEMBLY
IGNITION SYSTEMS
INTERCONNECTS
PREBURNER
HEAT EXCHANGER
HOT GAS MANIFOLD
SIMULATORS
MOCKUPS
MODELS
ELECTRICAL HARNESSES & INSTRUMENTATION SYSTEM
GSE
KEY PROJECT MANAGER

Figure 16



PROGRAM WORK BREAKDOWN STRUCTURE

Figure 17

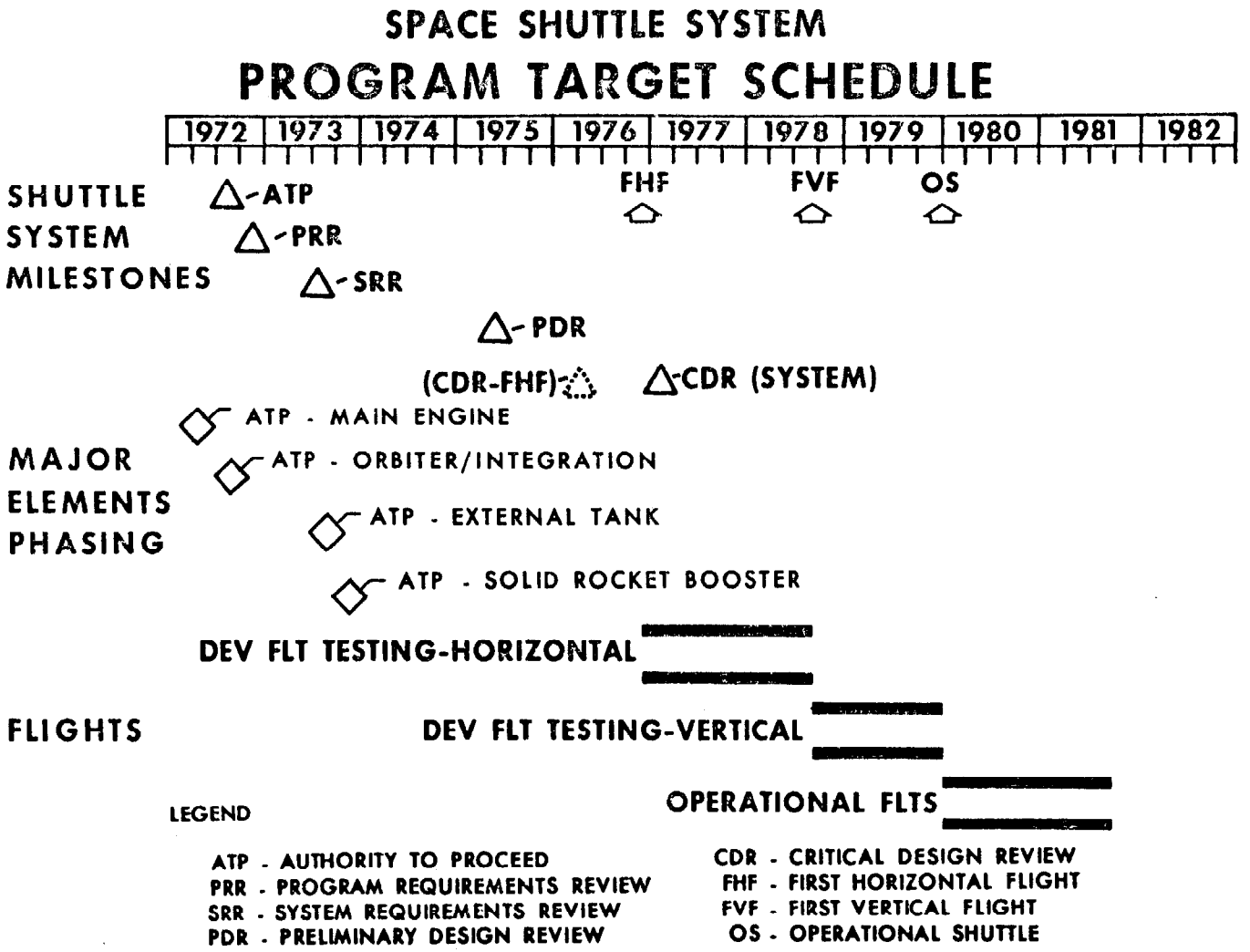

SPACE SHUTTLE SYSTEM
PROGRAM TARGET SCHEDULE
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
SHUTTLE SYSTEM MILESTONES
ATP
PRR
SRR
PDR
(CDR-FHF)
CDR (SYSTEM)
FHF
FVF
OS
MAJOR ELEMENTS PHASING
ATP - MAIN ENGINE
ATP - ORBITER/INTEGRATION
ATP - EXTERNAL TANK
ATP - SOLID ROCKET BOOSTER
FLIGHTS
DEV FLT TESTING-HORIZONTAL
DEV FLT TESTING-VERTICAL
OPERATIONAL FLTS
LEGEND
ATP - AUTHORITY TO PROCEED
PRR - PROGRAM REQUIREMENTS REVIEW
SRR - SYSTEM REQUIREMENTS REVIEW
PDR - PRELIMINARY DESIGN REVIEW
CDR - CRITICAL DESIGN REVIEW
FHF - FIRST HORIZONTAL FLIGHT
FVF - FIRST VERTICAL FLIGHT
OS - OPERATIONAL SHUTTLE

Figure 18

SPACE SHUTTLE PROGRAM SCHEDULE

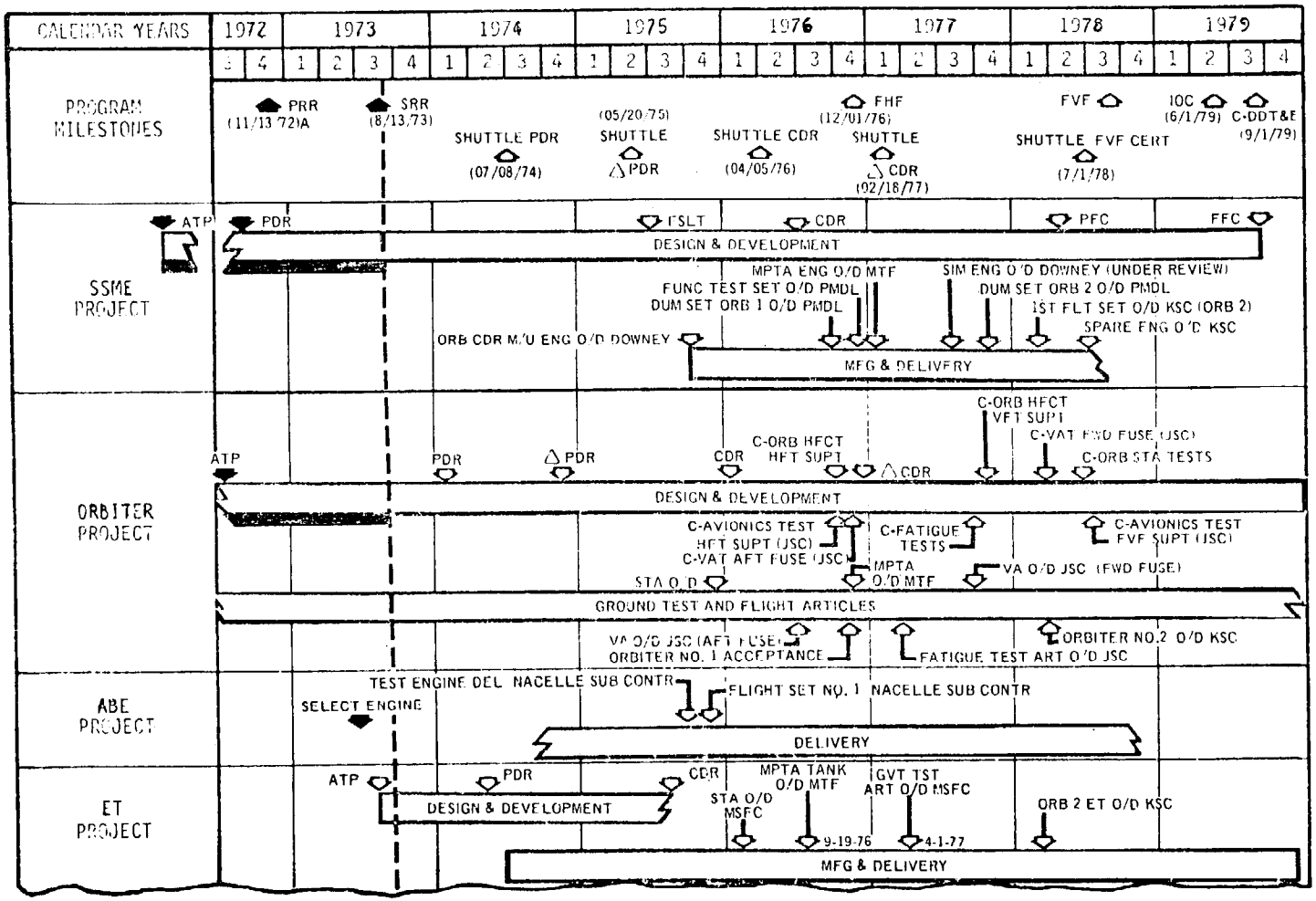


Figure 19A

SPACE SHUTTLE PROGRAM SCHEDULE (CONT)

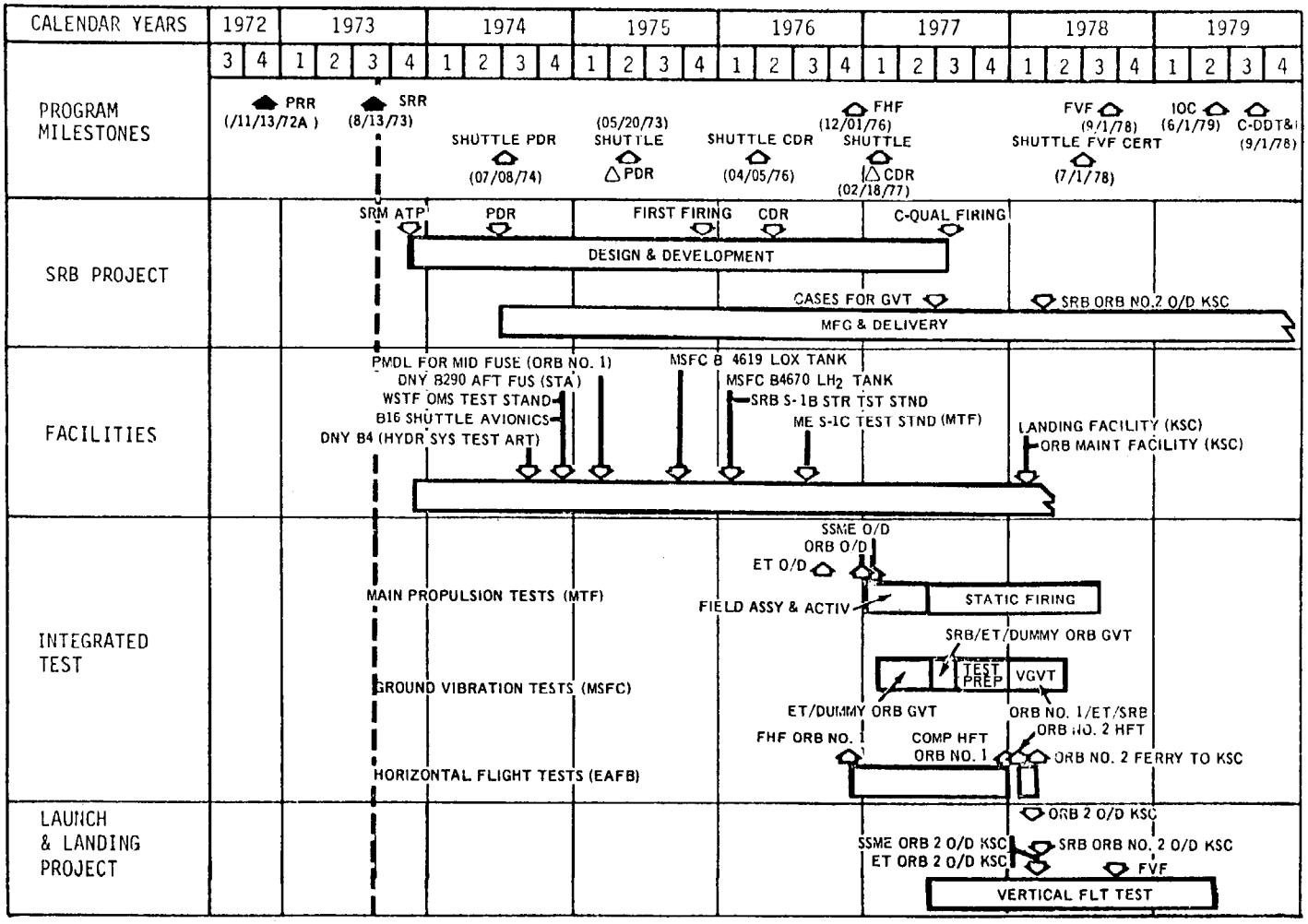


Figure 19B

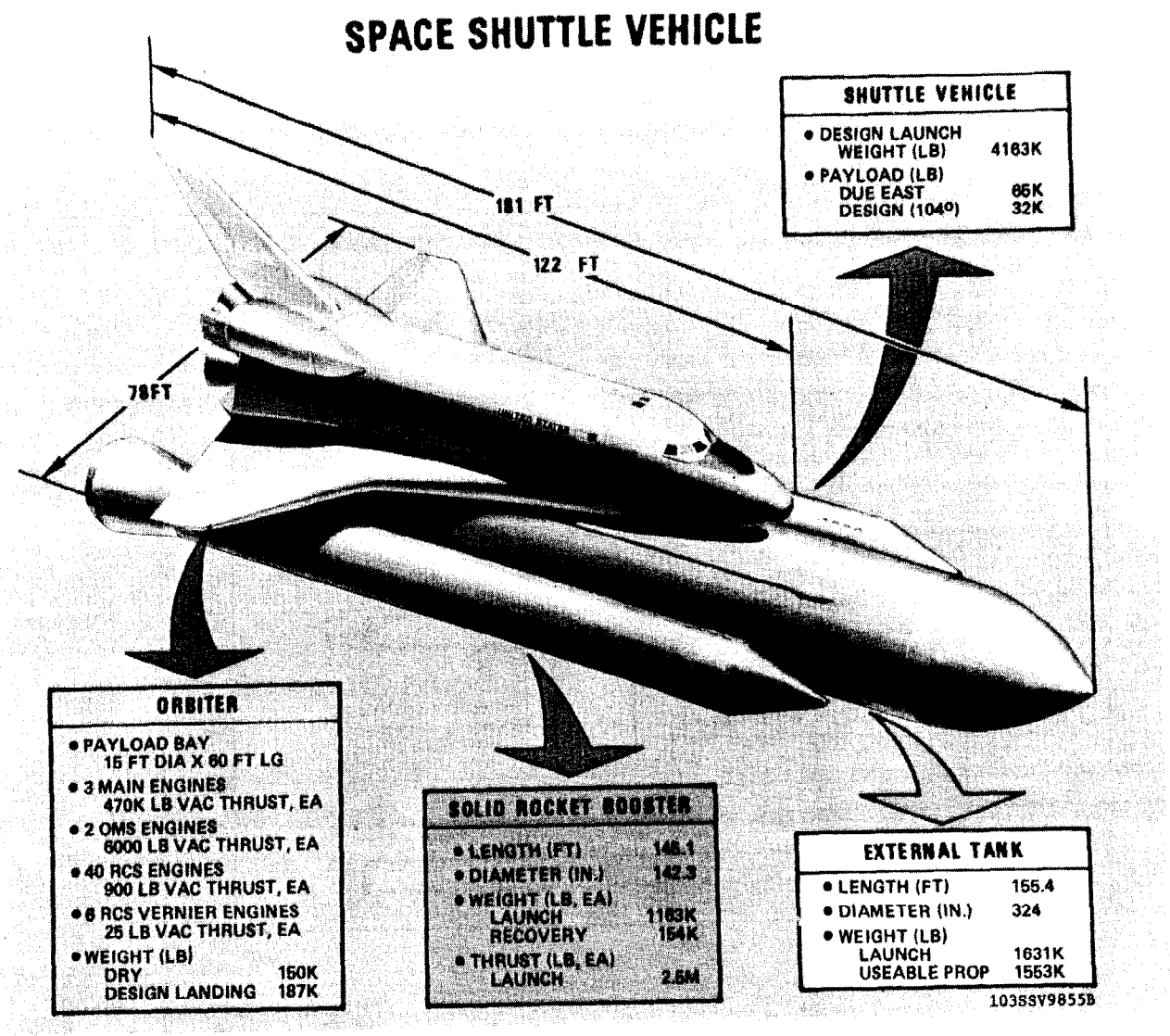
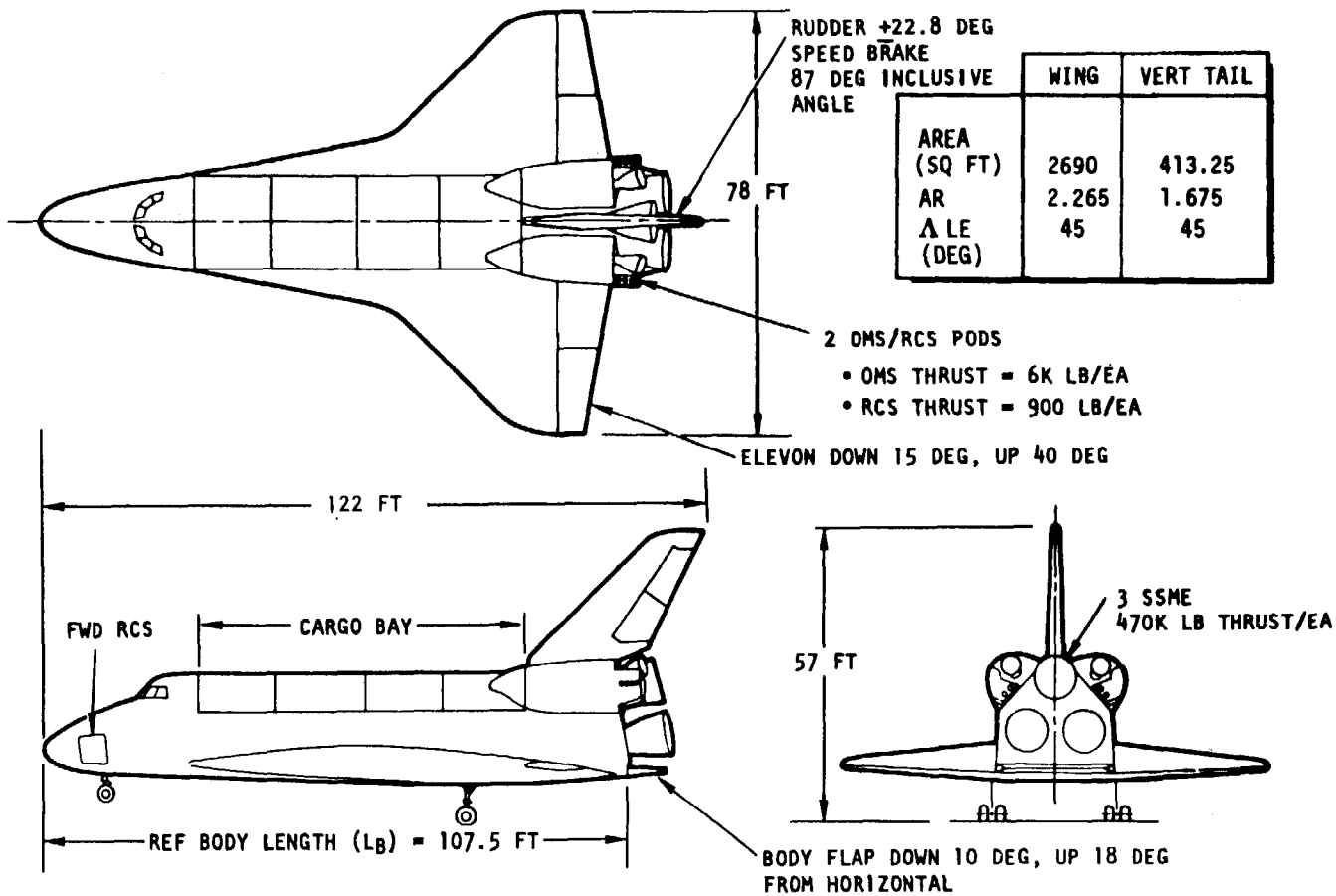

SPACE SHUTTLE VEHICLE
SHUTTLE VEHICLE
• DESIGN LAUNCH WEIGHT (LB) 4163K
• PAYLOAD (LB)
DUE EAST 65K
DESIGN (104°) 32K
181 FT
122 FT
78FT
ORBITER
• PAYLOAD BAY 15 FT DIA X 60 FT LG
• 3 MAIN ENGINES 470K LB VAC THRUST, EA
• 2 OMS ENGINES 6000 LB VAC THRUST, EA
• 40 RCS ENGINES 900 LB VAC THRUST, EA
• 6 RCS VERNIER ENGINES 25 LB VAC THRUST, EA
• WEIGHT (LB)
DRY 150K
DESIGN LANDING 187K
SOLID ROCKET BOOSTER
• LENGTH (FT) 146.1
• DIAMETER (IN.) 142.3
• WEIGHT (LB, EA)
LAUNCH 1163K
RECOVERY 154K
• THRUST (LB, EA)
LAUNCH 2.6M
EXTERNAL TANK
• LENGTH (FT) 155.4
• DIAMETER (IN.) 324
• WEIGHT (LB)
LAUNCH 1631K
USEABLE PROP 1553K
1035SV9855B

Figure 20

ORBITER VEHICLE



	WING	VERT TAIL
AREA (SQ FT)	2690	413.25
AR	2.265	1.675
Λ LE (DEG)	45	45

Figure 21

FORWARD FUSELAGE WINDOW SUBSYSTEM

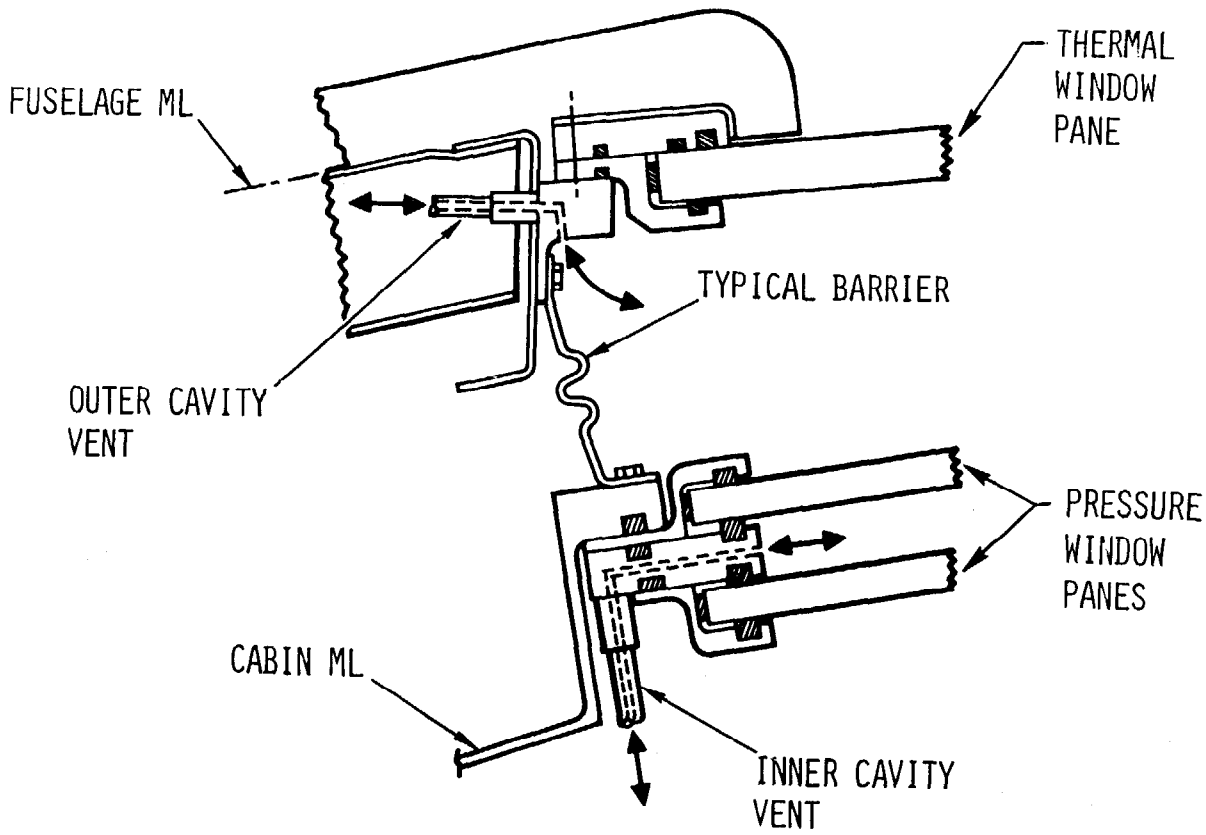


Figure 22

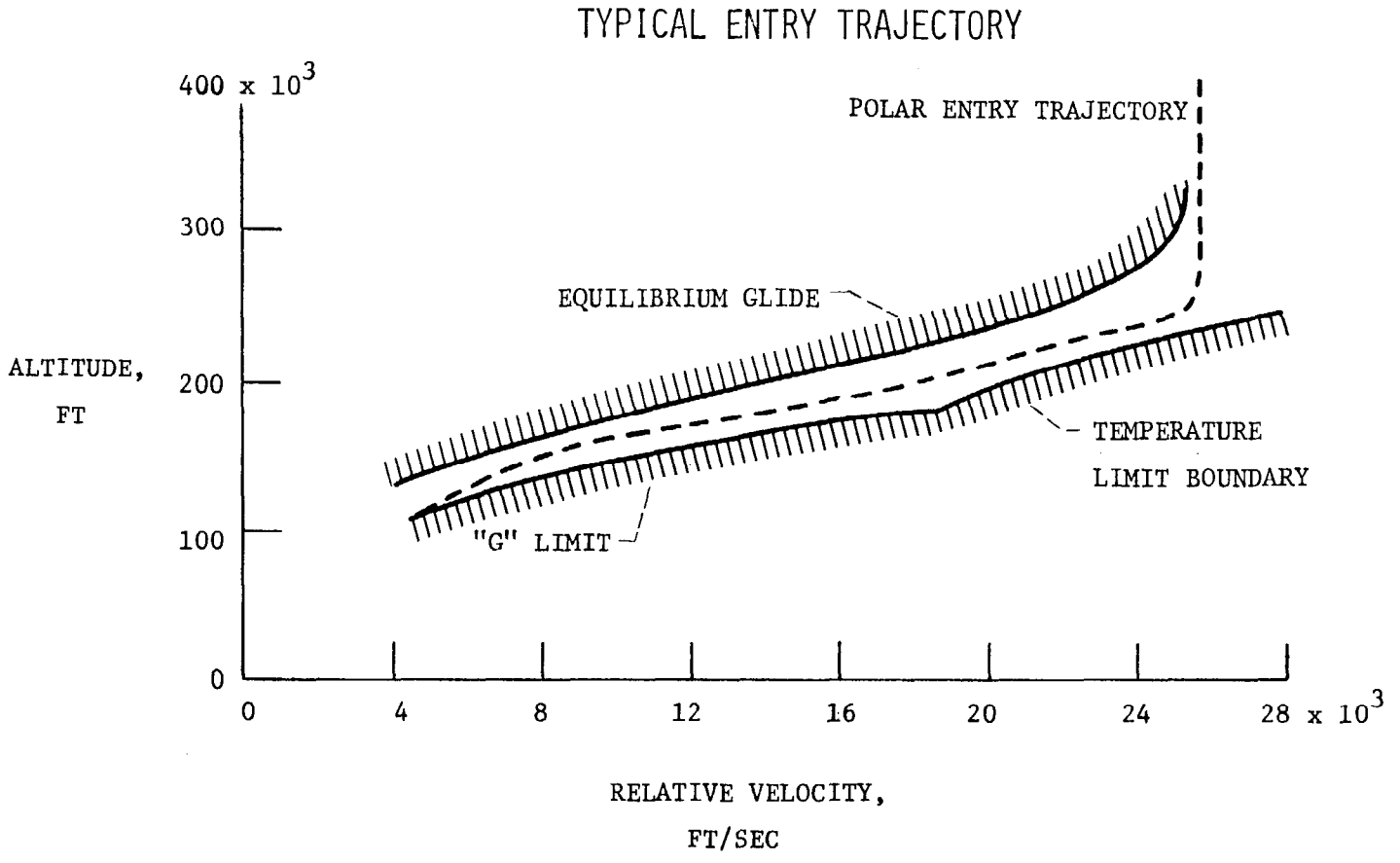

TYPICAL ENTRY TRAJECTORY
400 x 10^3
300
200
100
0
ALTITUDE,
FT
POLAR ENTRY TRAJECTORY
EQUILIBRIUM GLIDE
TEMPERATURE
LIMIT BOUNDARY
"G" LIMIT
0
4
8
12
16
20
24
28 x 10^3
RELATIVE VELOCITY,
FT/SEC

Figure 23

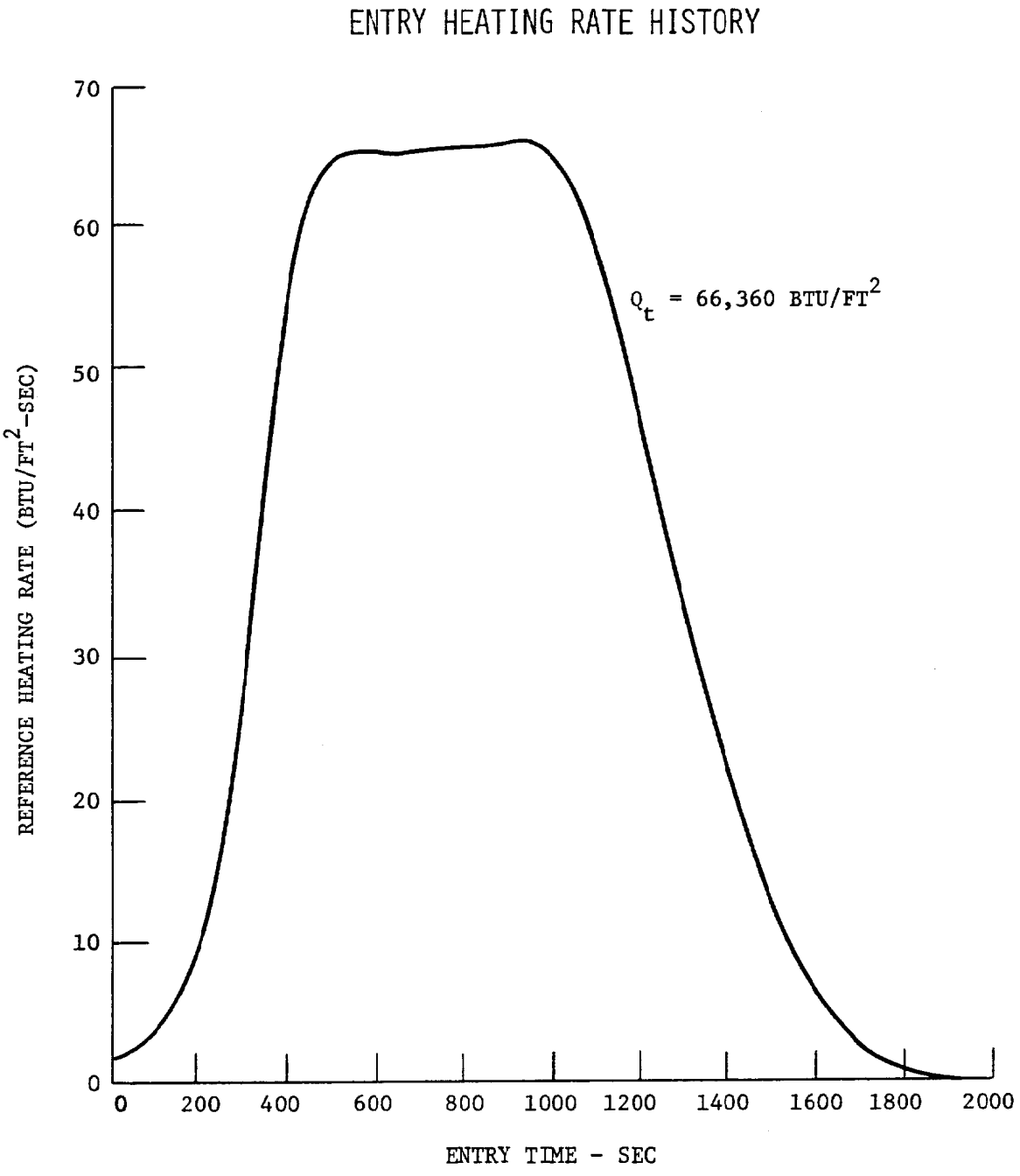

ENTRY HEATING RATE HISTORY
70
60
50
40
30
20
10
0
REFERENCE HEATING RATE (BTU/FT^2-SEC)
Q_t = 66,360 BTU/FT^2
0
200
400
600
800
1000
1200
1400
1600
1800
2000
ENTRY TIME - SEC

Figure 24

ORBITER ISOTHERMS
&
TPS THICKNESS REQMT

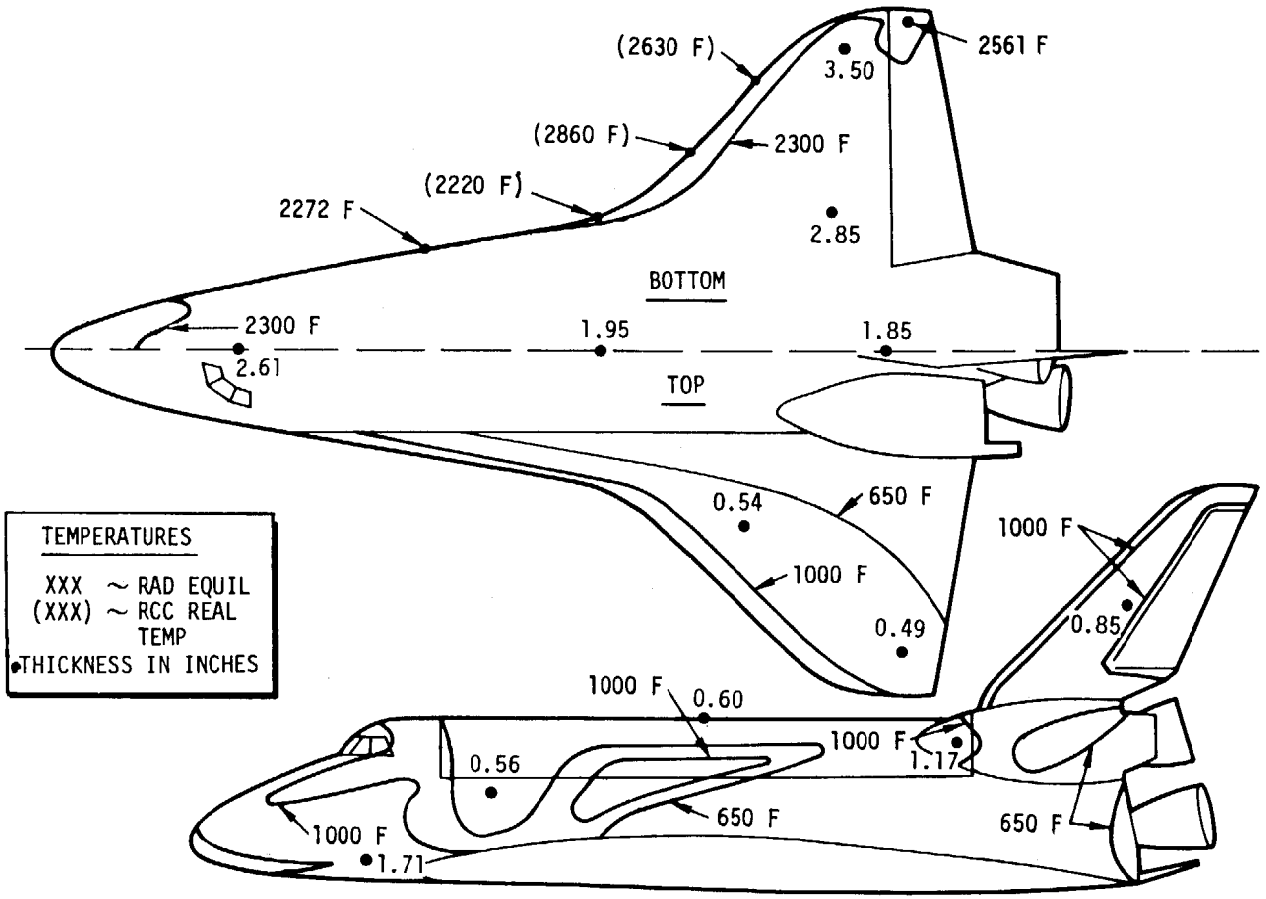


Figure 25

ORBITER THERMAL PROTECTION SYSTEM

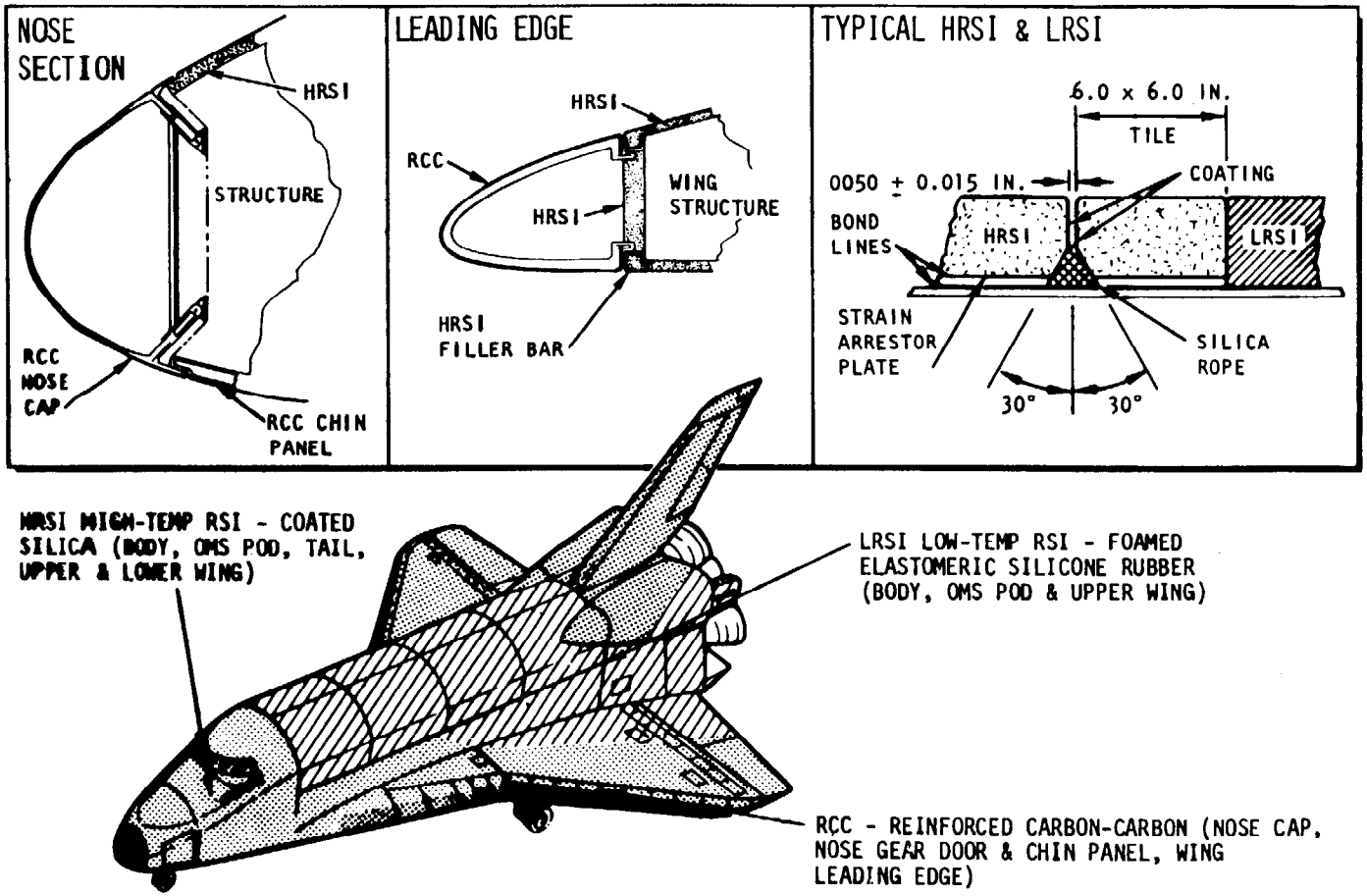


Figure 26

RCS AND OMS LOCATION ON ORBITER

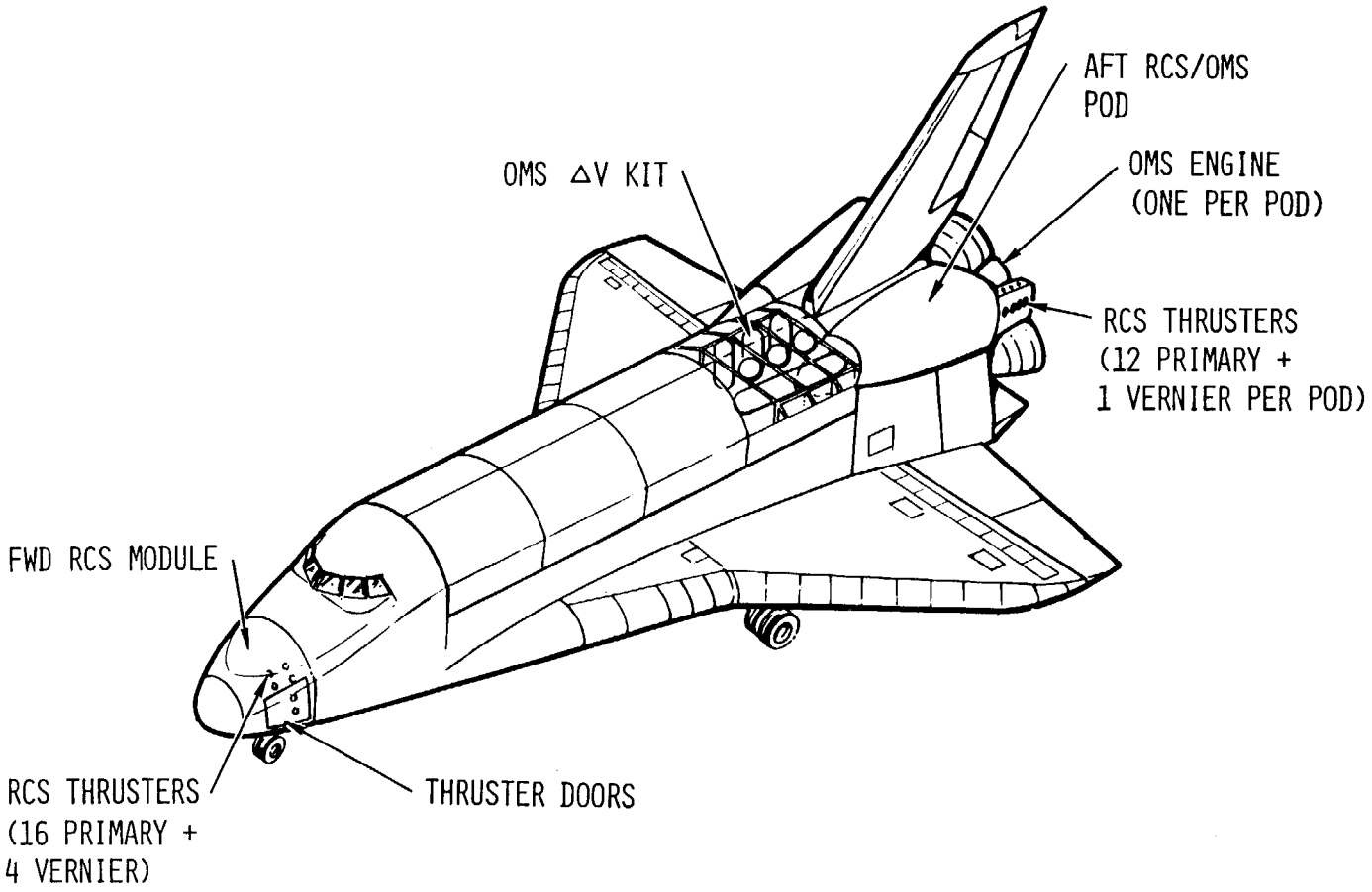


Figure 27

ORBITER REACTION CONTROL SUBSYSTEM

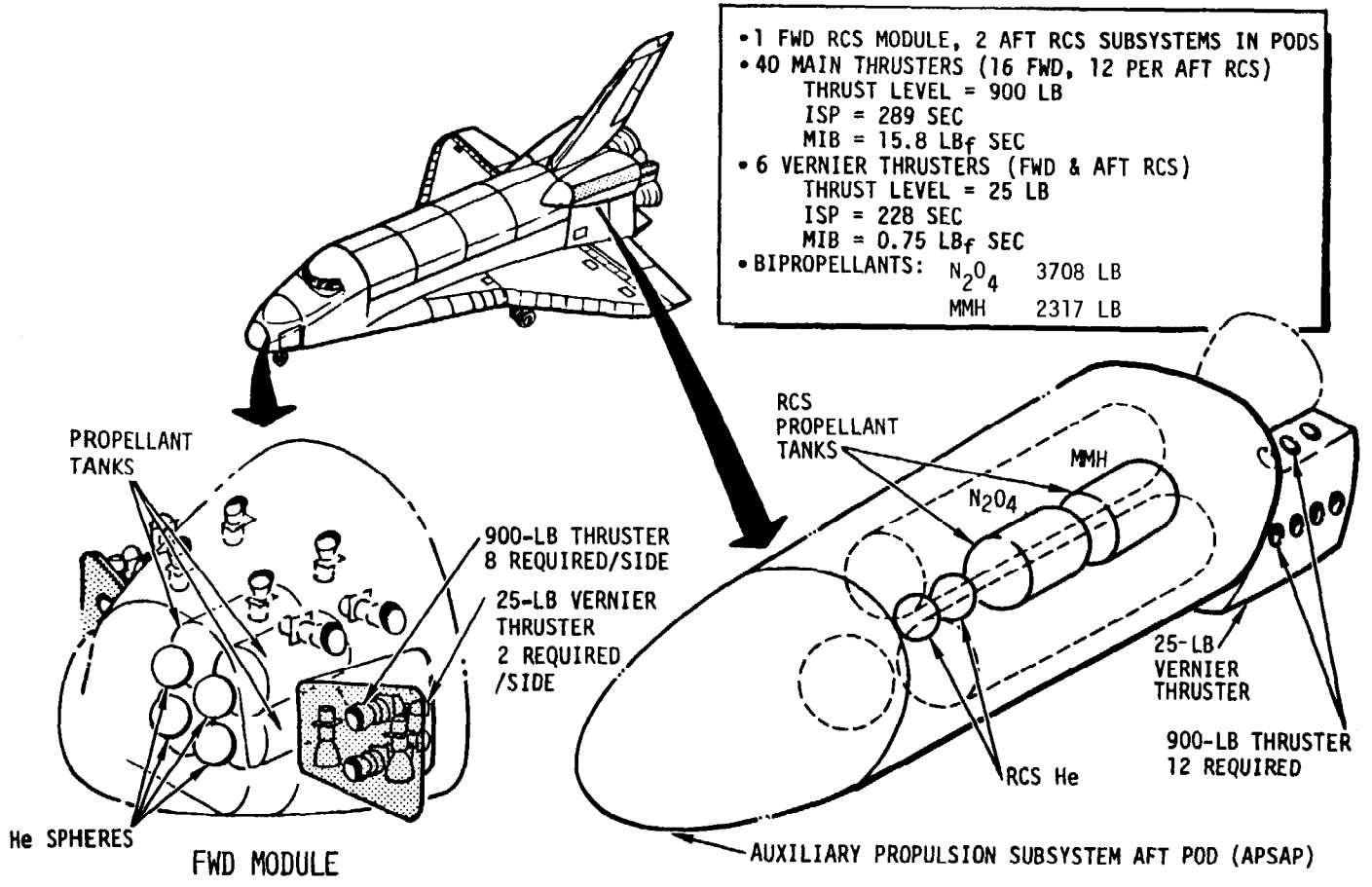


Figure 28

OMS/RCS SCHEMATIC

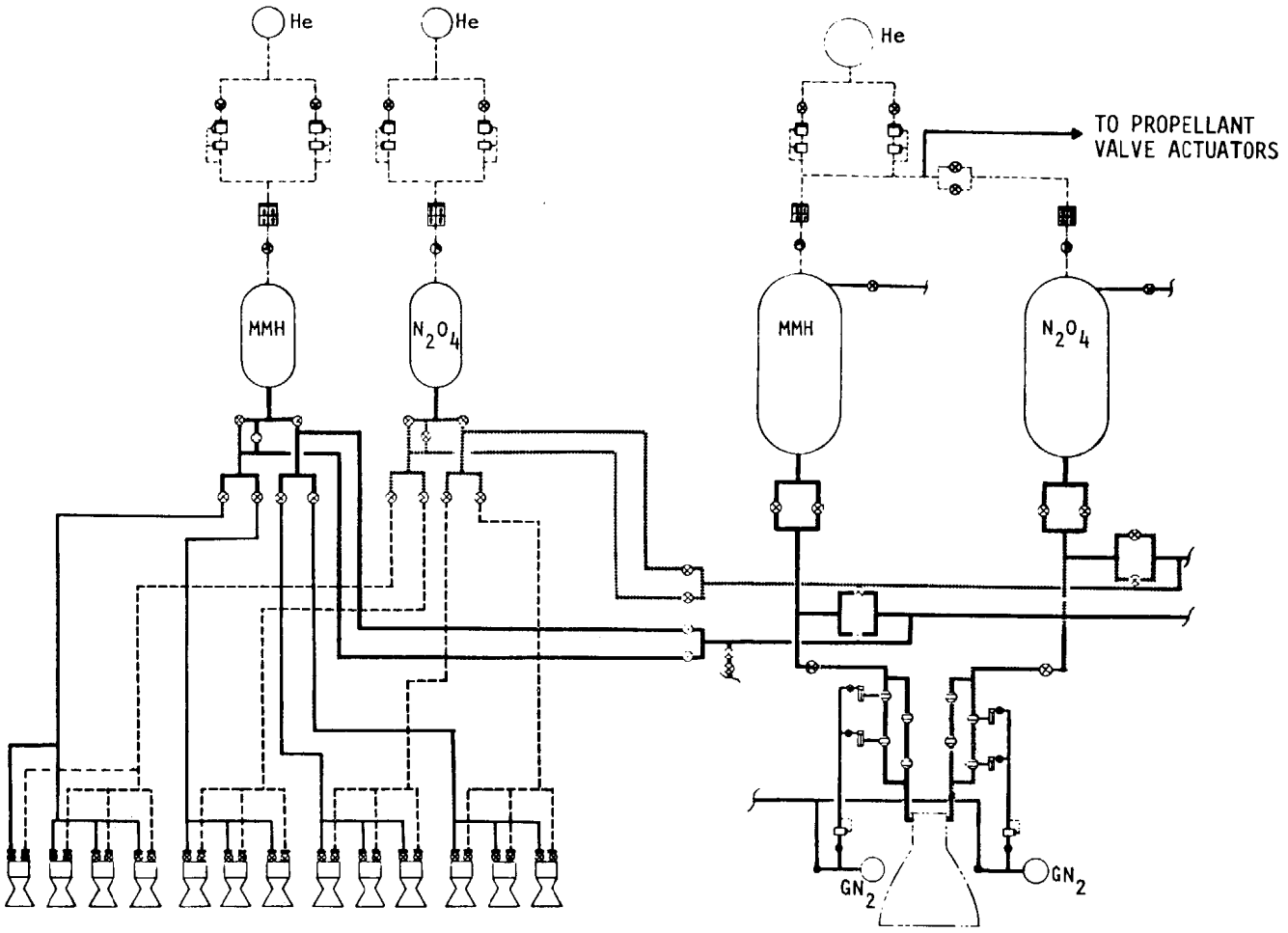


Figure 29

OMS POD PRESSURE BUDGET

PRESSURIZATION		
4300		HELIUM BOTTLE
220 (235)		REGULATOR OUTLET-PRI (SEC)
265 ± 8		BURST DISK/RELIEF VALVE
PROPELLANT FEED		
OXIDIZER	**FUEL**	
215	215	PROPELLANT TANK (ULLAGE)
214	214	TANK OUTLET
9	5.8	ΔP_{FEED}
ENGINE		
OXIDIZER	**FUEL**	
205	208.2	ENGINE INLET
125		CHAMBER

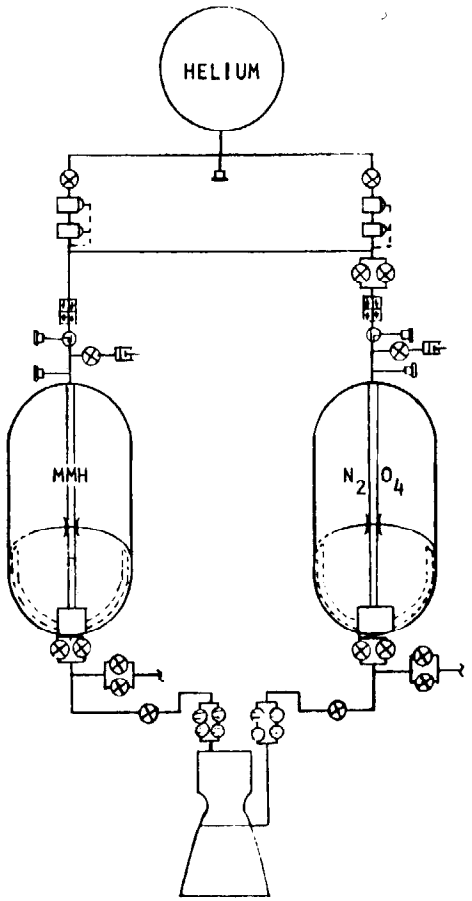


Figure 30

RCS PRESSURE BUDGET

PRESSURIZATION		
4000		HELIUM BOTTLE
295 (300)		REGULATOR LOCKUP—PRI (SEC)
425 ± 10		BURST DISC/RELIEF VALVE
PROPELLANT FEED		
OXIDIZER	**FUEL**	
280	280	PROPELLANT TANK (ULLAGE)
279	279	TANK OUTLET
13	13	ΔP_{FEED}
ENGINE		
OXIDIZER	**FUEL**	
266	266	ENGINE INLET
158		CHAMBER

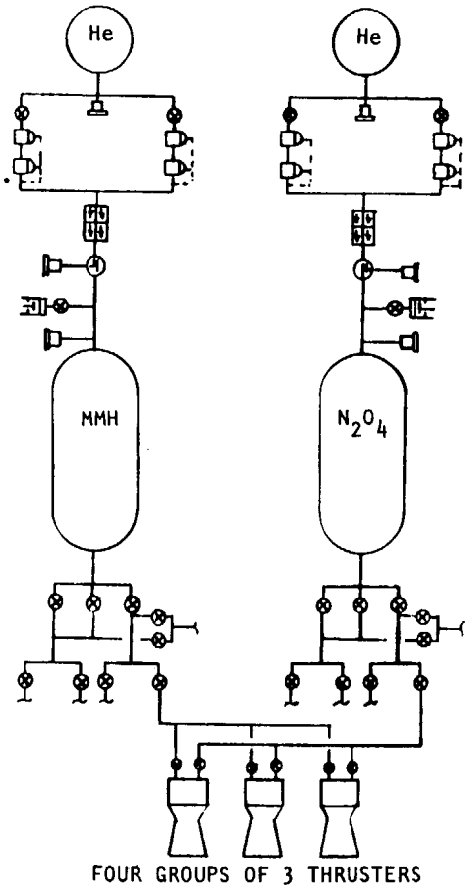
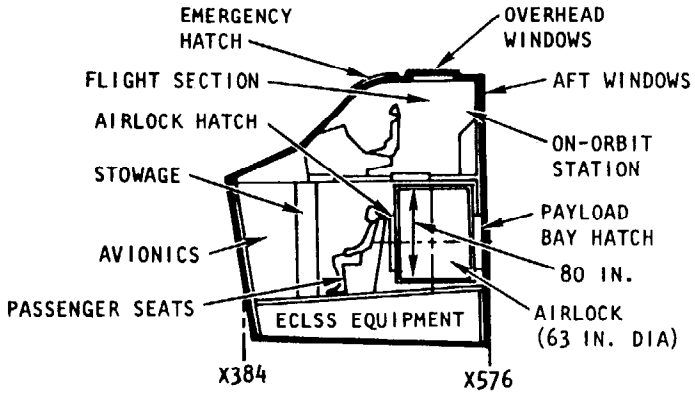
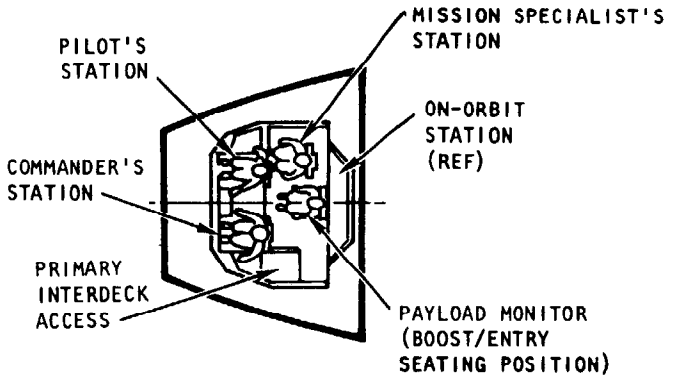


Figure 31

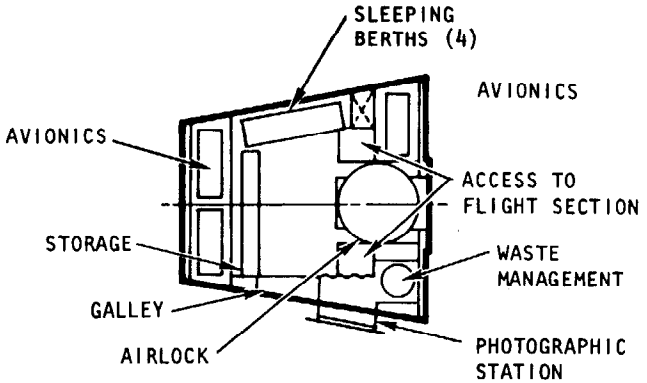
ORBITER CABIN ARRANGEMENT



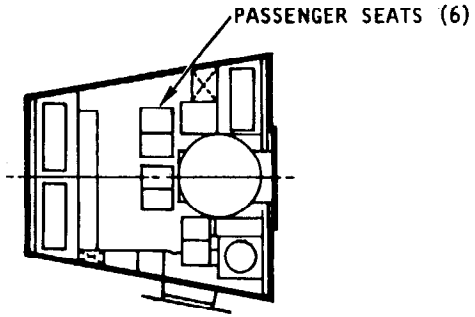
CREW CABIN



FLIGHT SECTION



MIDSECTION
ON-ORBIT CONFIGURATION



MIDSECTION
LAUNCH/LANDING
CONFIGURATION

Figure 32

ORBITER MECHANICAL SUBSYSTEMS

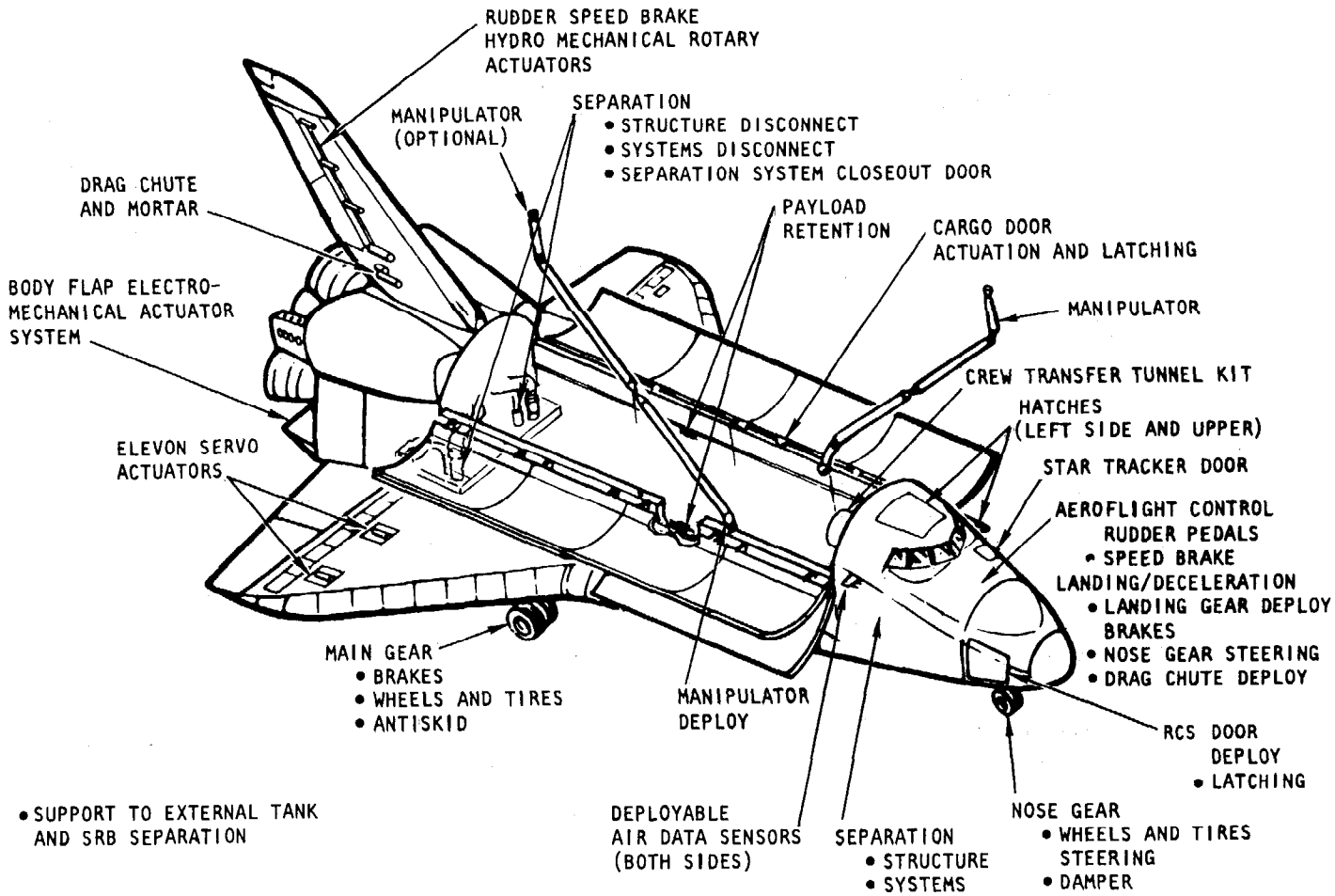


Figure 33

TYPICAL DEWAR DESIGN

TYPE I (O_2)

SPHERICAL
38.6 OD
34.6 ID
INCONEL 718 PV
2219 AL SHELL

TYPE II (H_2)

SPHERICAL
46 OD
43.2 ID
2219 AL PV
2219 AL SHELL

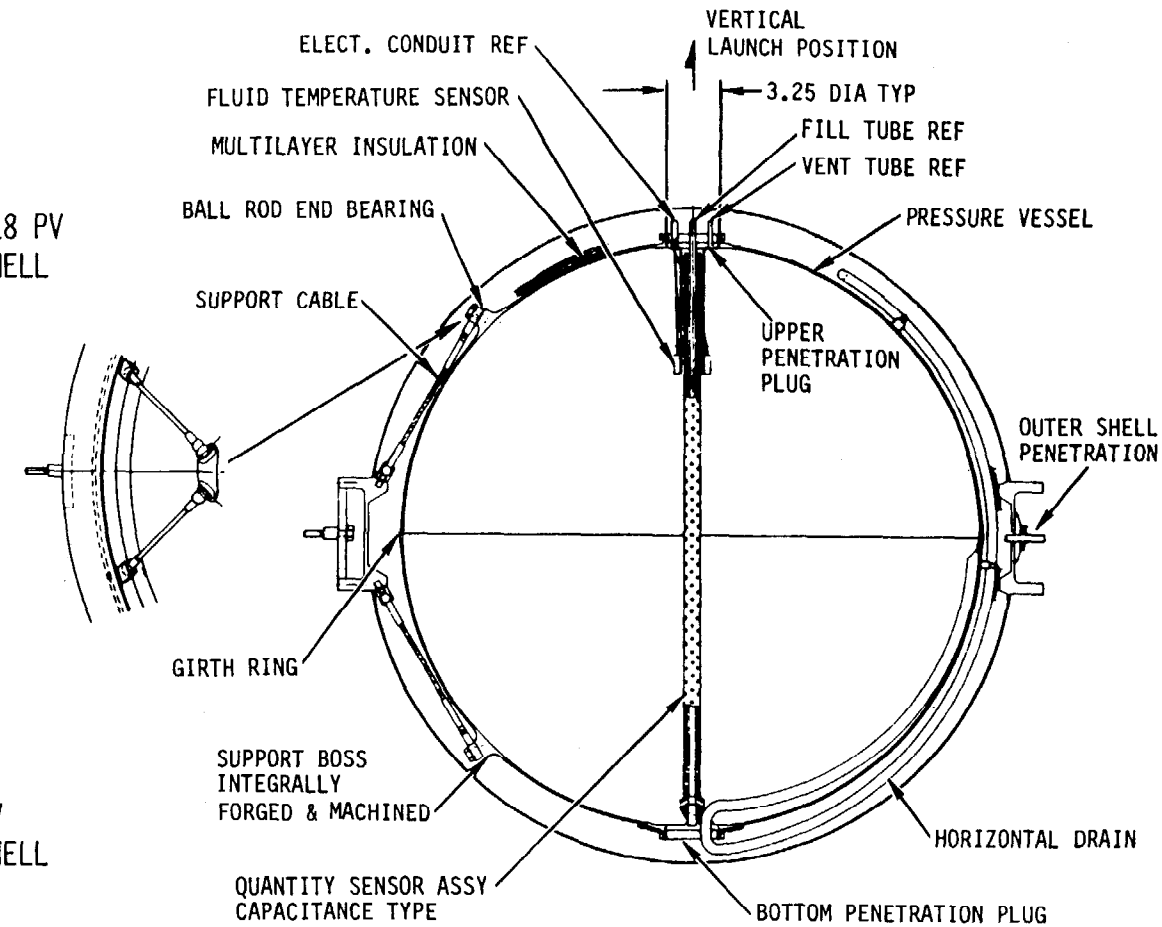


Figure 34

ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM

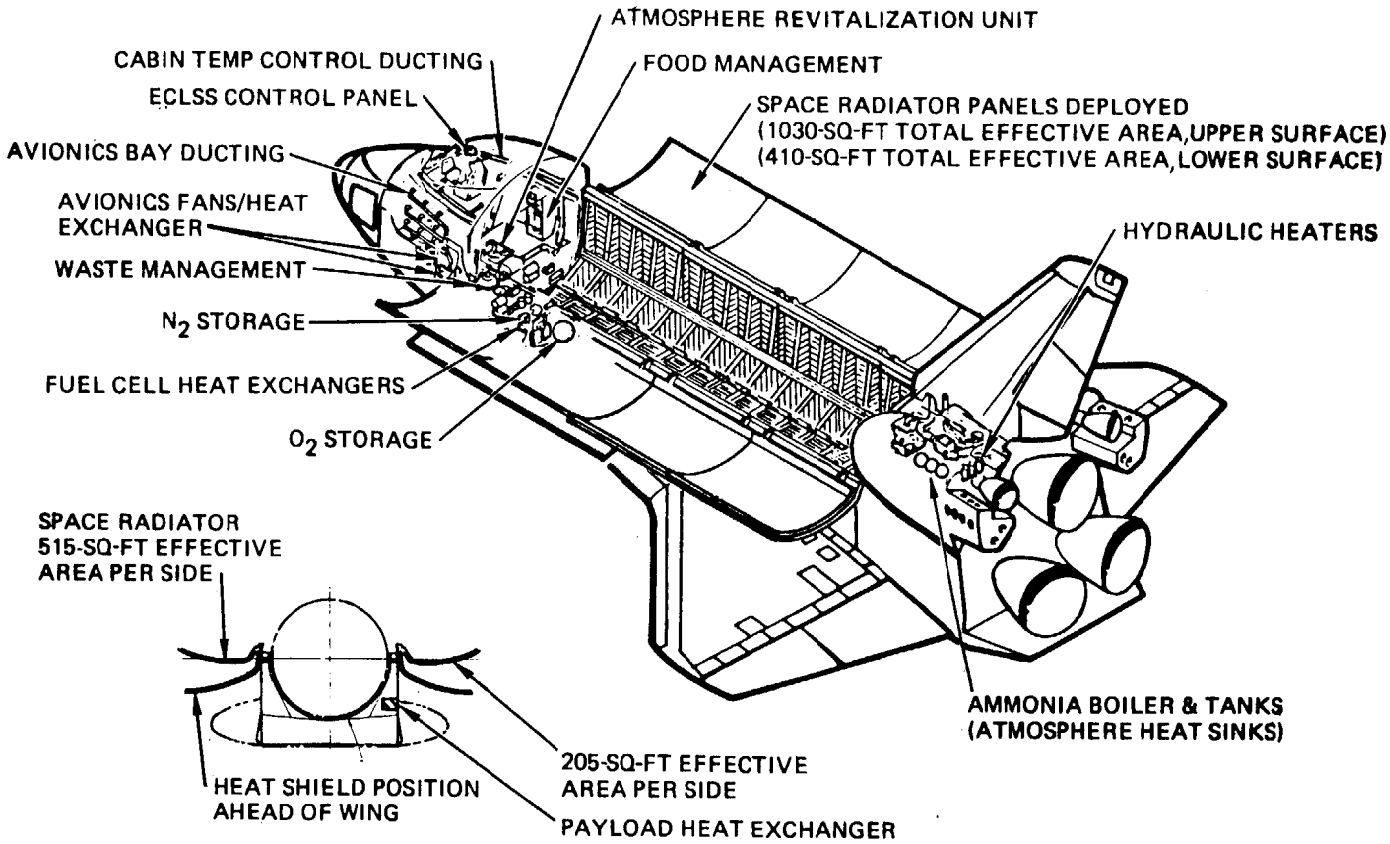


Figure 35

ENVIRONMENTAL CONTROL AND LIFE SUPPORT

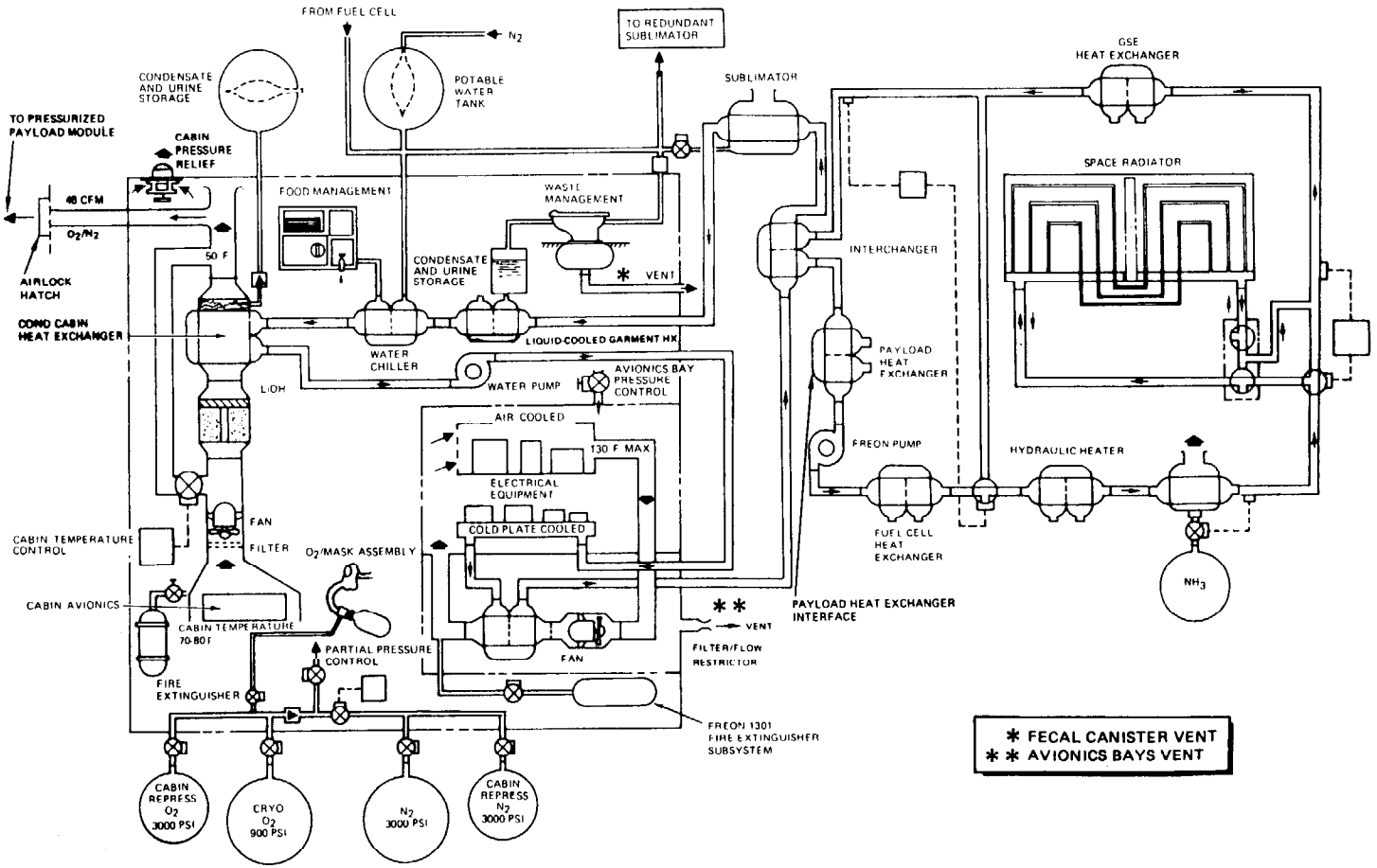


Figure 36

ORBITER THERMAL CONTROL SUBSYSTEM

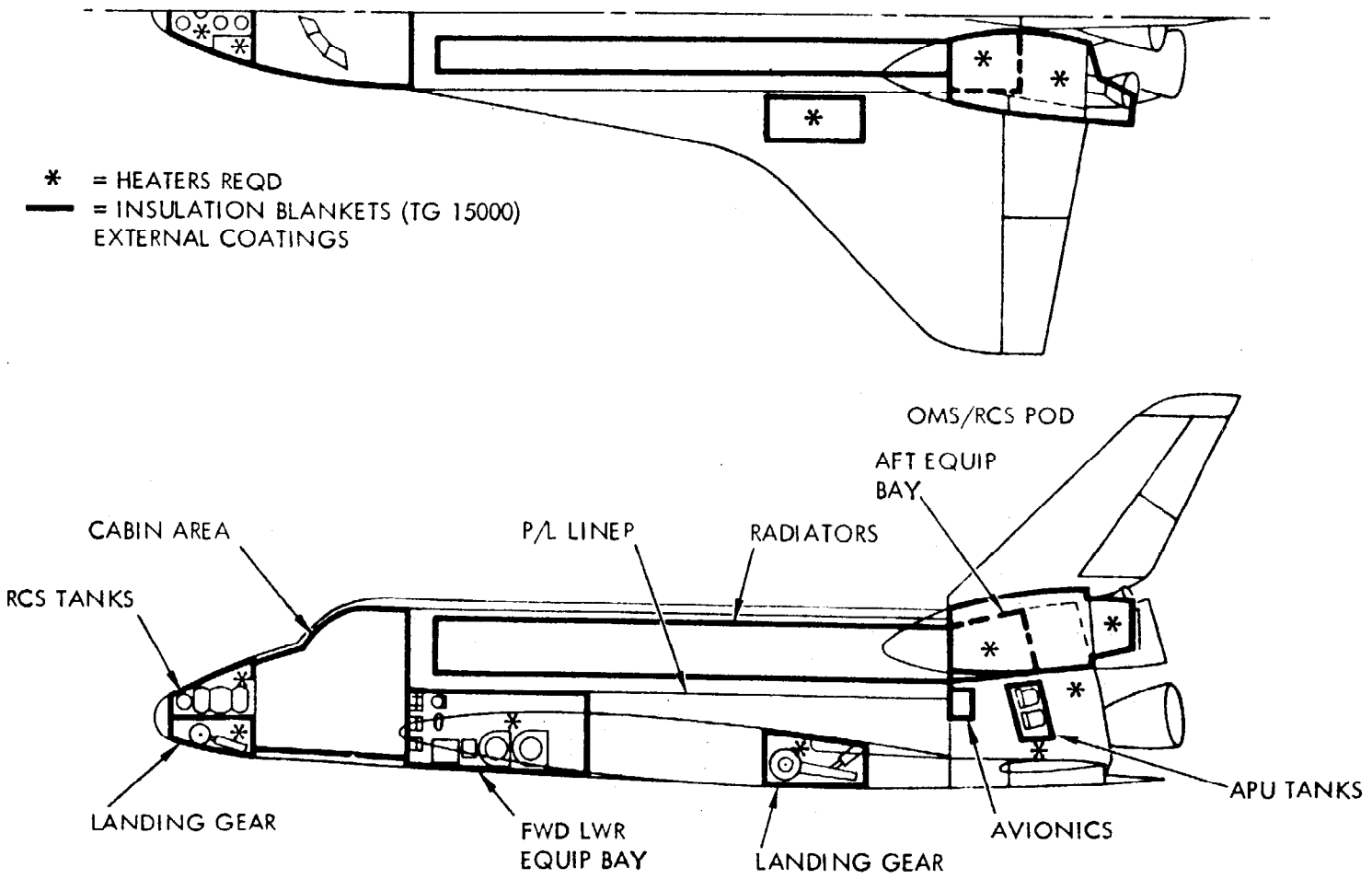


Figure 37

ORBITER AVIONICS SUBSYSTEM

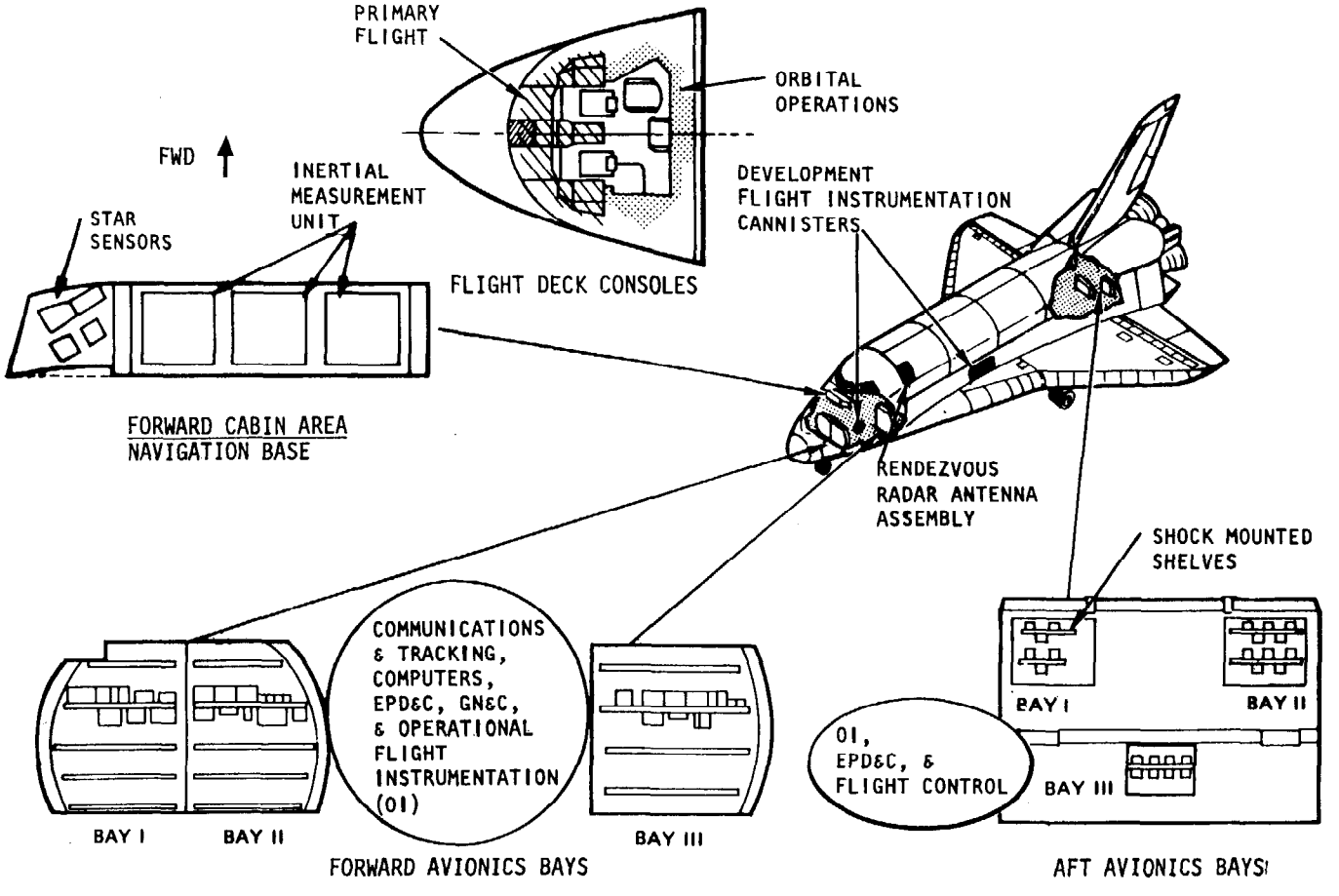


Figure 38

ORBITER COMMUNICATIONS & TRACKING

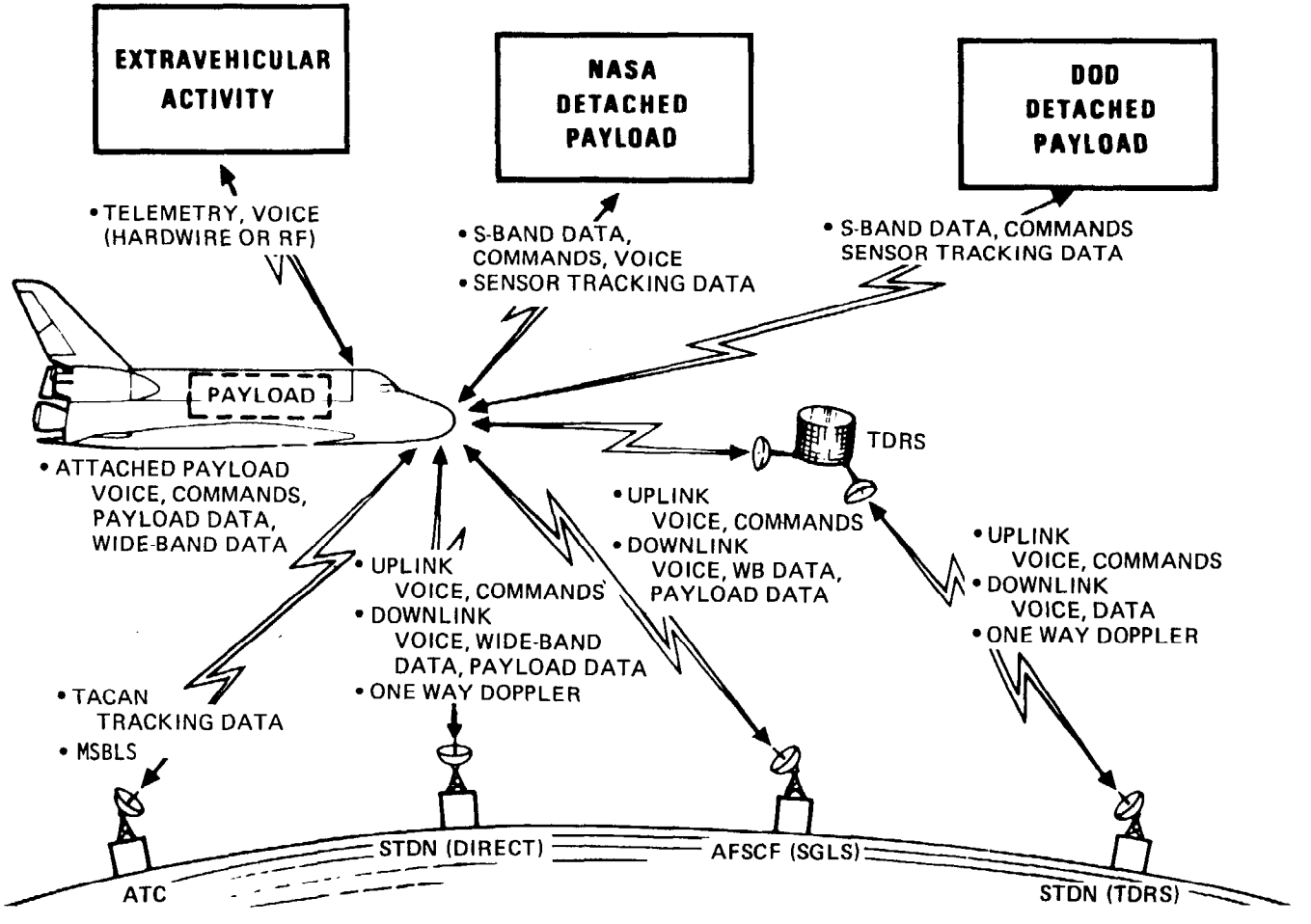
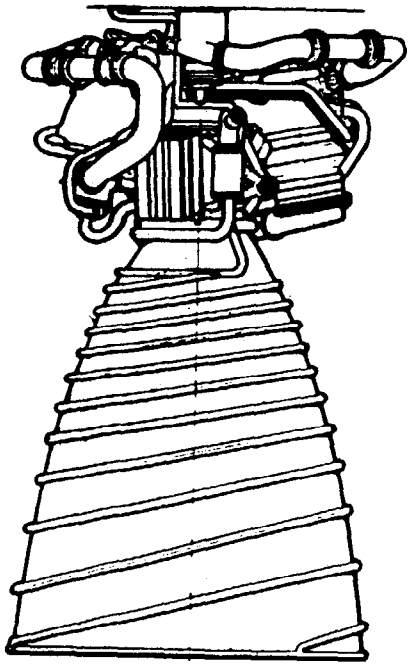


Figure 39

SPACE SHUTTLE MAIN ENGINE



- IMPROVED EFFICIENCY - HIGH-PRESSURE LIQUID OXYGEN/LIQUID HYDROGEN ENGINE SYSTEM
- THRUST, VACUUM 470,000 POUNDS/ENGINE
- THROTTLEABLE 50% TO 109%
- COMBUSTION CHAMBER PRESSURE - 3000 PSIA
- TURBOPUMP CHARACTERISTICS

	FUEL	OXIDIZER
DISCHARGE PRESSURE (PSIA)		
MAIN	6,200	4,620
BOOST	-	7,630
SPEED, RPM	35,100	29,225
POWER, BHP	62,240	21,300
FLOW RATE, LB/SEC	147	884
FLOW RATE, GPM	15,000	5,570

- ENGINE WEIGHT 6300 POUNDS
- EQUIVALENT HORSEPOWER, EA ENGINE - 6,500,000 (2,500 HP/CU IN. ≈4X PWR DENSITY OF J-2)
- 100 STARTS /55 MISSION REUSE
- DEVELOPMENT PROGRAM OBJECTIVES:
  MEET SPECIFIED PERFORMANCE & WEIGHT

Figure 40

SSME MAJOR COMPONENTS

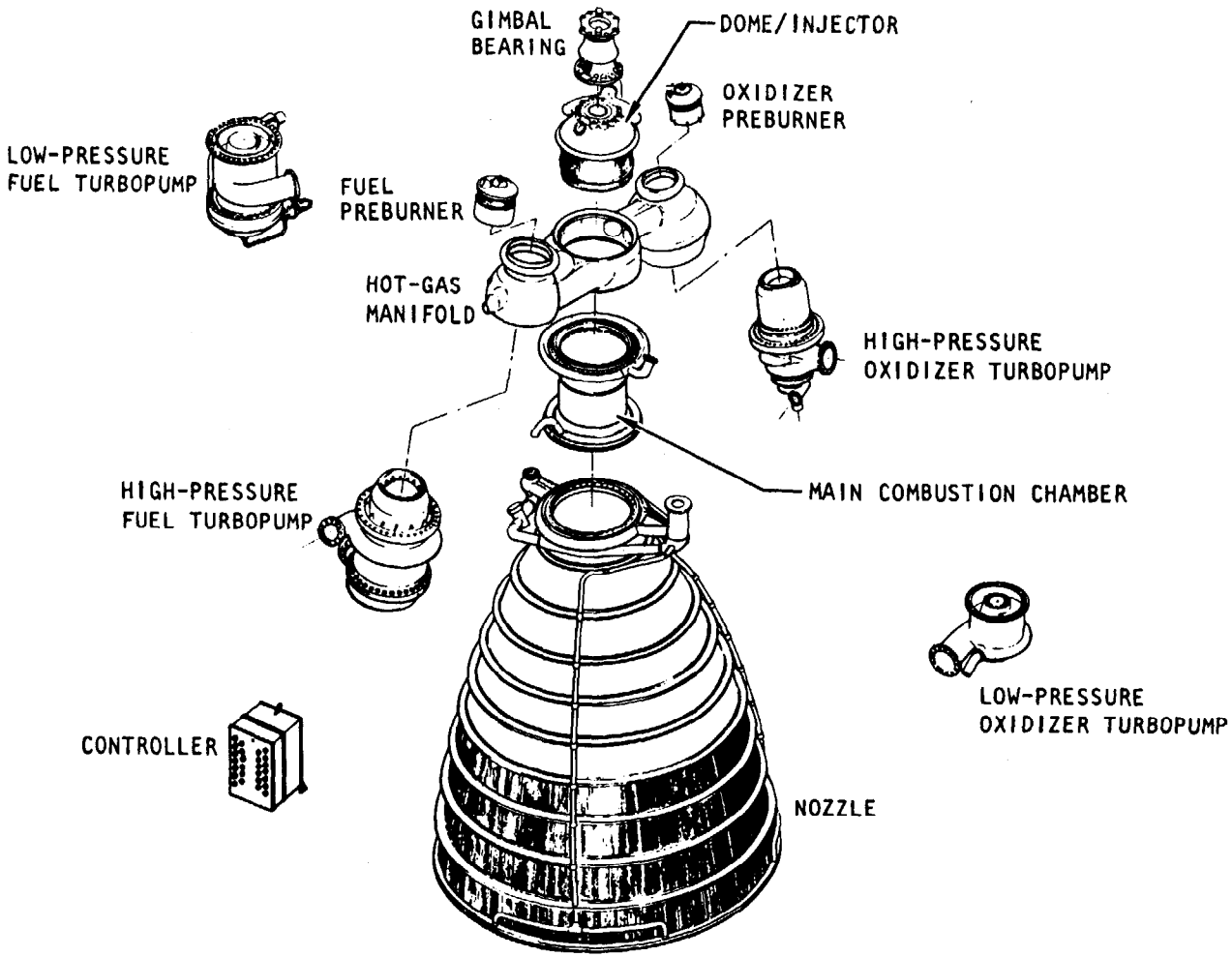


Figure 41

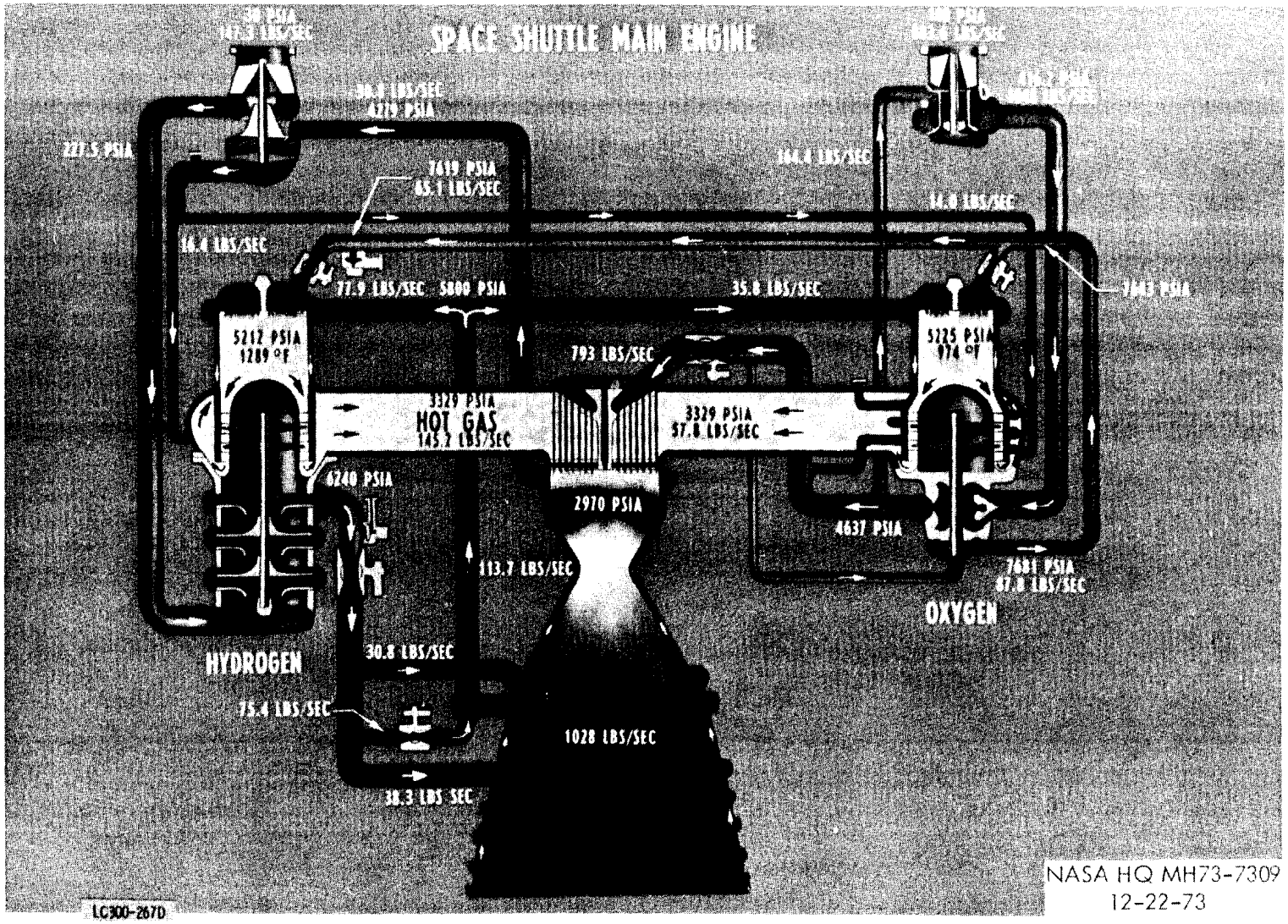
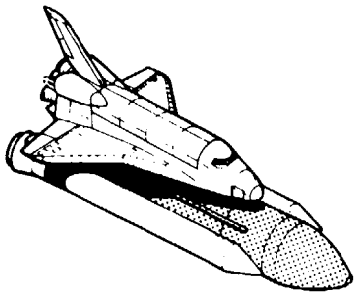
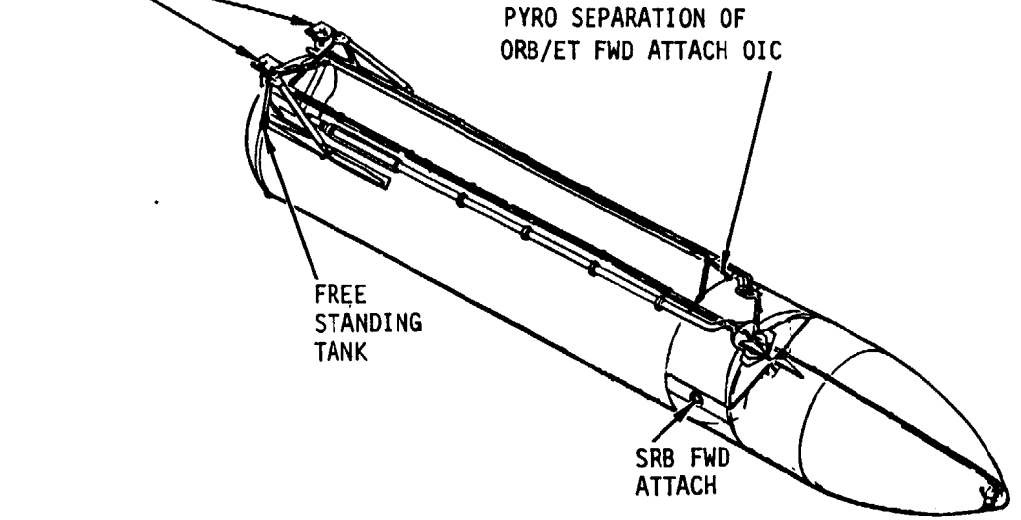

SPACE SHUTTLE MAIN ENGINE
227.5 PSIA
4279 PSIA
7619 PSIA
65.1 LBS/SEC
16.4 LBS/SEC
77.9 LBS/SEC
5800 PSIA
5212 PSIA
1289 °F
793 LBS/SEC
3329 PSIA
HOT GAS
145.2 LBS/SEC
6240 PSIA
2970 PSIA
113.7 LBS/SEC
30.8 LBS/SEC
75.4 LBS/SEC
1028 LBS/SEC
38.3 LBS SEC
HYDROGEN
384.4 LBS/SEC
14.8 LBS/SEC
35.8 LBS/SEC
5225 PSIA
974 °F
3329 PSIA
57.8 LBS/SEC
4637 PSIA
7681 PSIA
87.8 LBS/SEC
OXYGEN
LC900-267D
NASA HQ MH73-7309
12-22-73

Figure 42

EXTERNAL TANK





DIMENSIONS	
LENGTH	155.4 FT
DIAMETER	324 IN.

GROSS WT 1,630,700 LB
PROPELLANT (USABLE)

LOX (LB)	1,329K
LH_2 (LB)	221K
TOTAL (LB)	1,550K

Figure 43

SOLID ROCKET BOOSTER

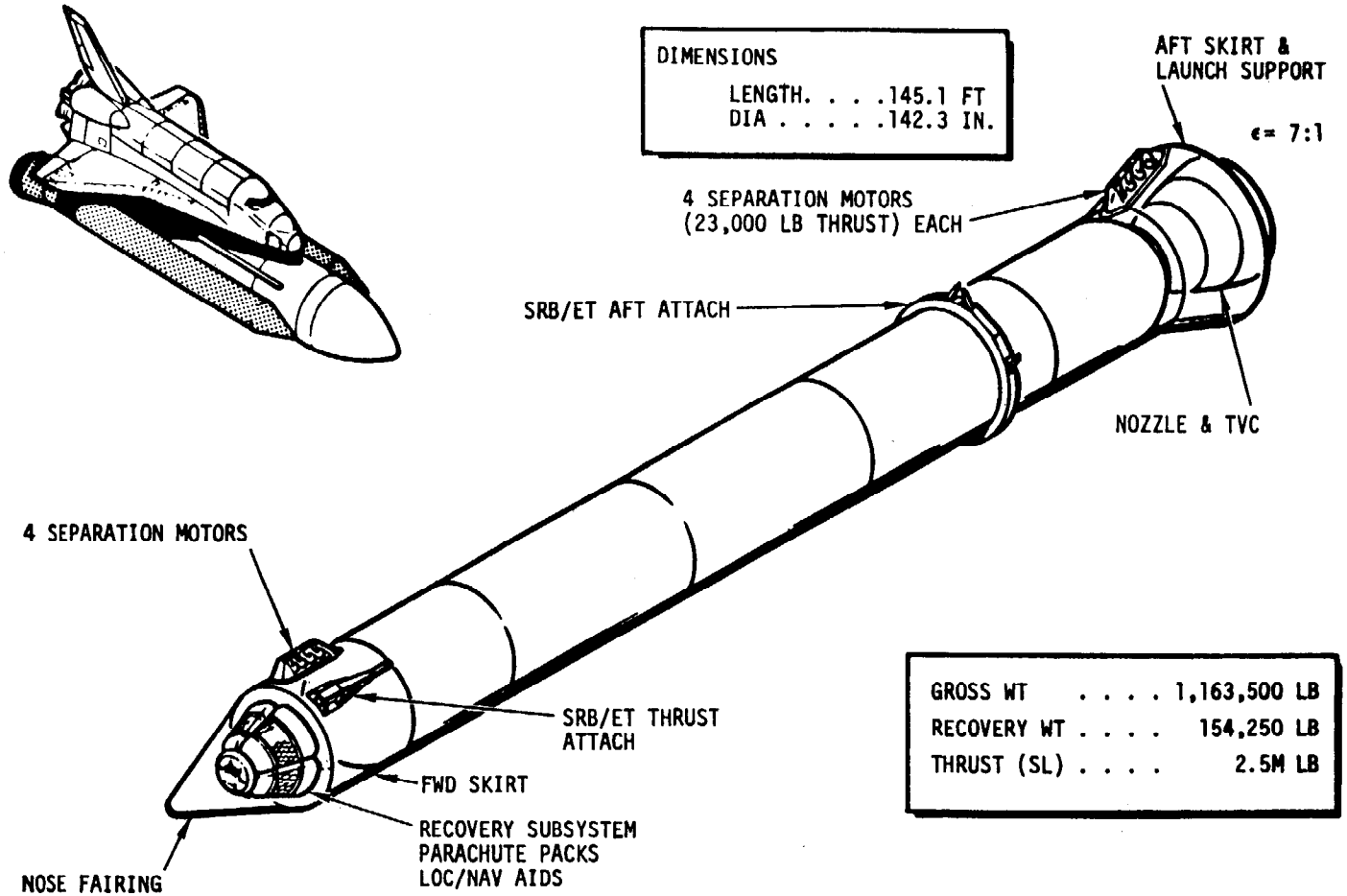


Figure 44

SCOPE OF P/L ACCOMMODATIONS

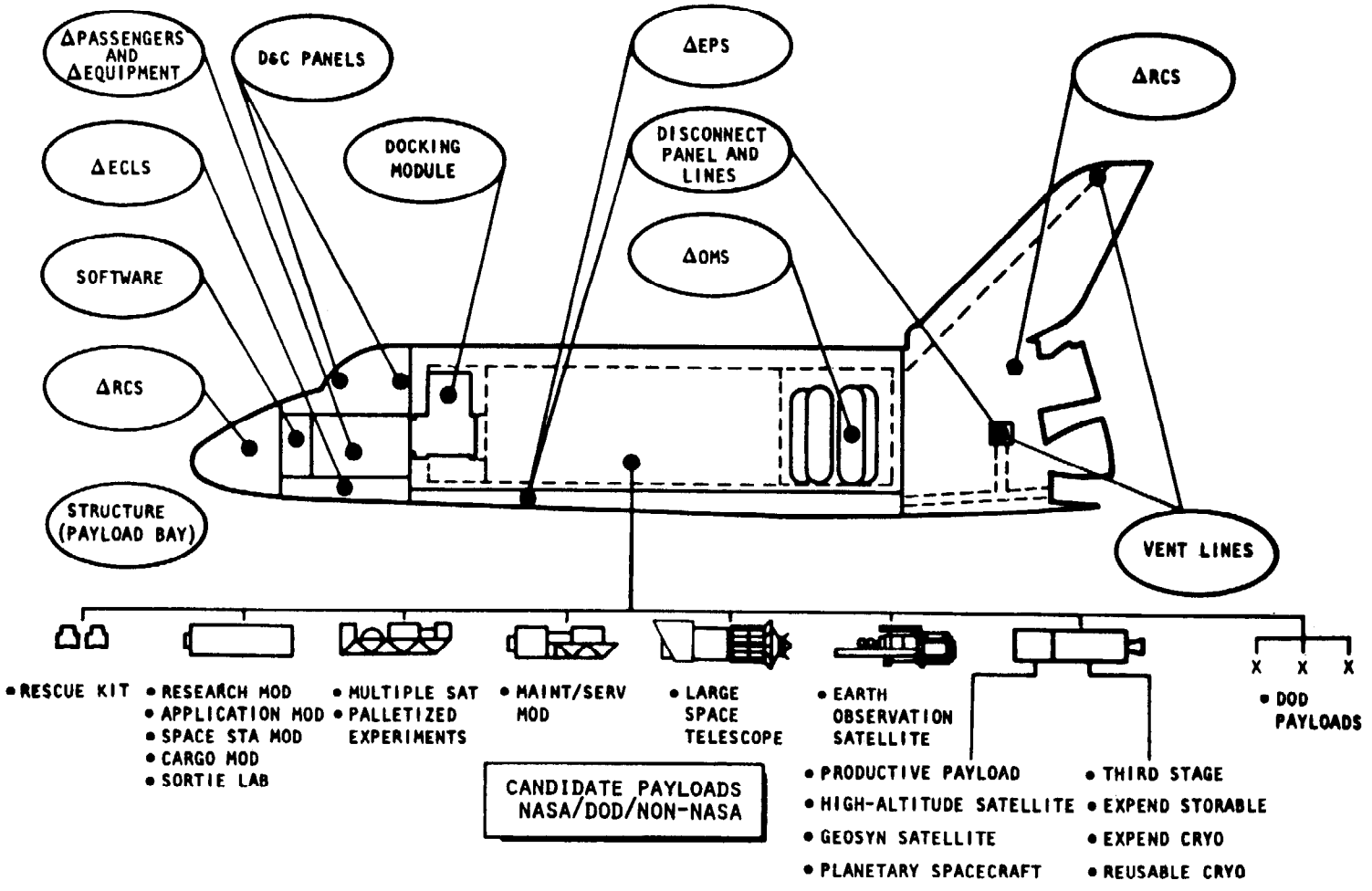


Figure 45

PAYLOAD RETENTION

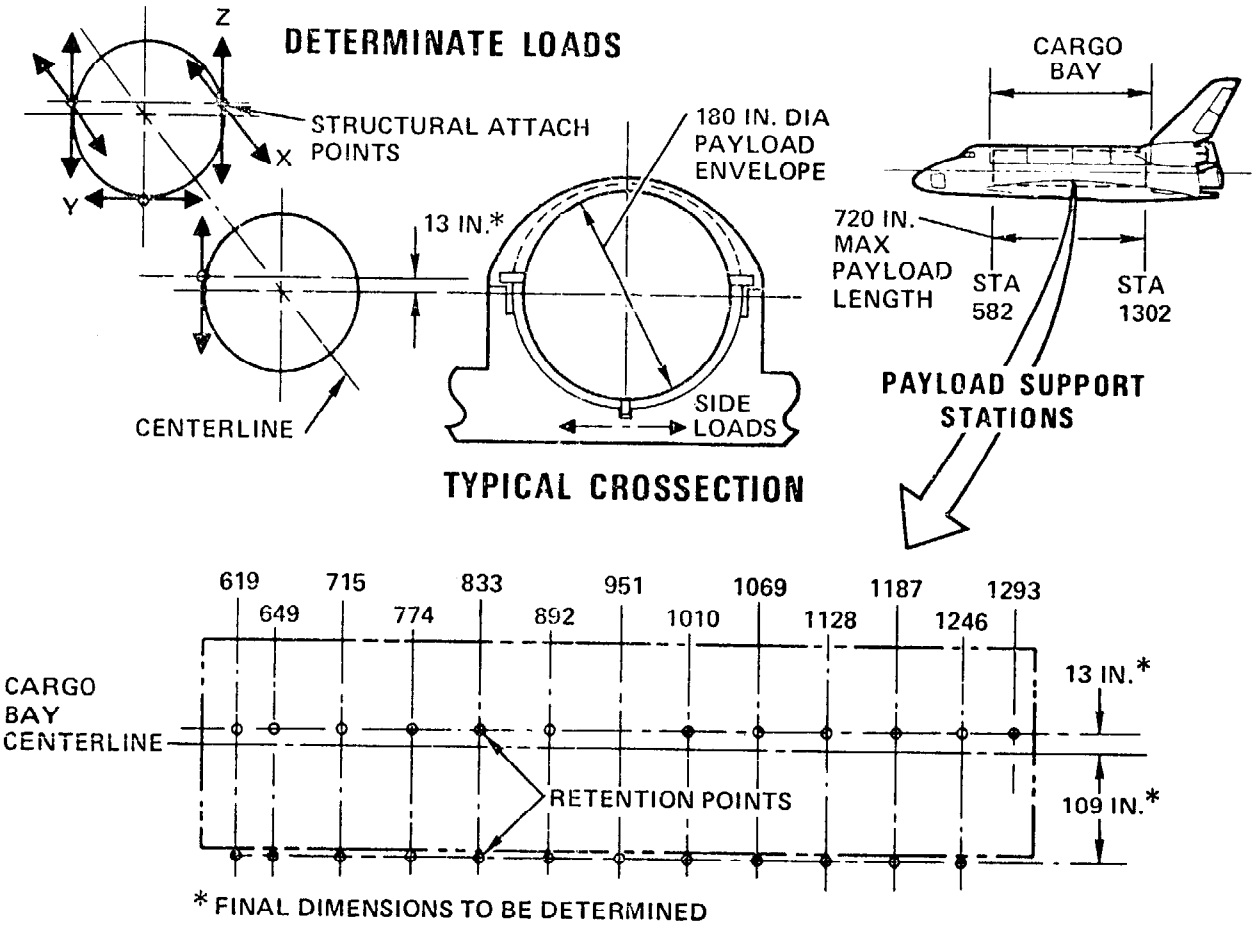


Figure 46

PRACTICAL LAUNCH AZIMUTH AND INCLINATION LIMITS FROM VAFB AND KSC

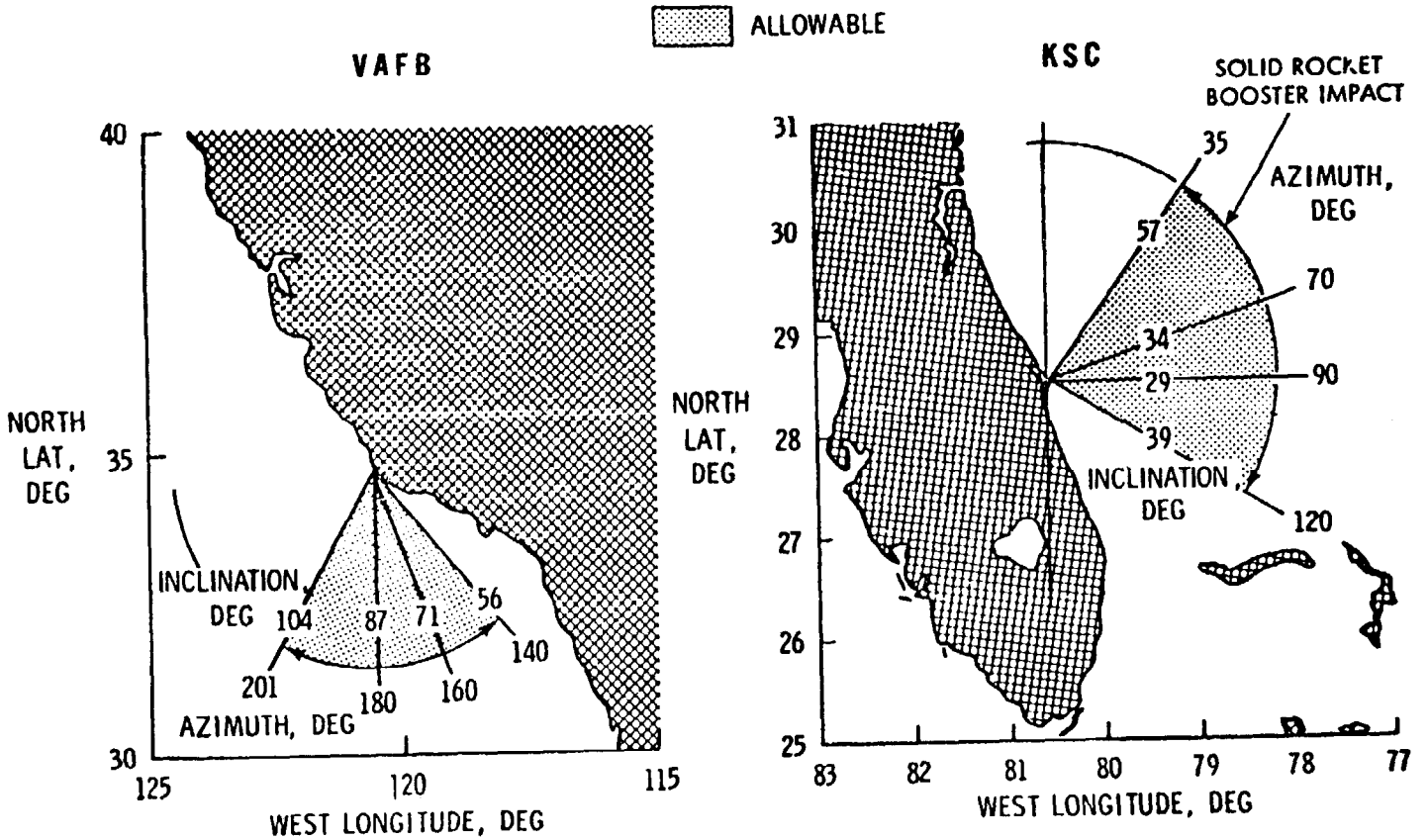


Figure 47

ORBITER ENTRY AND RETURN FLIGHT PROFILE

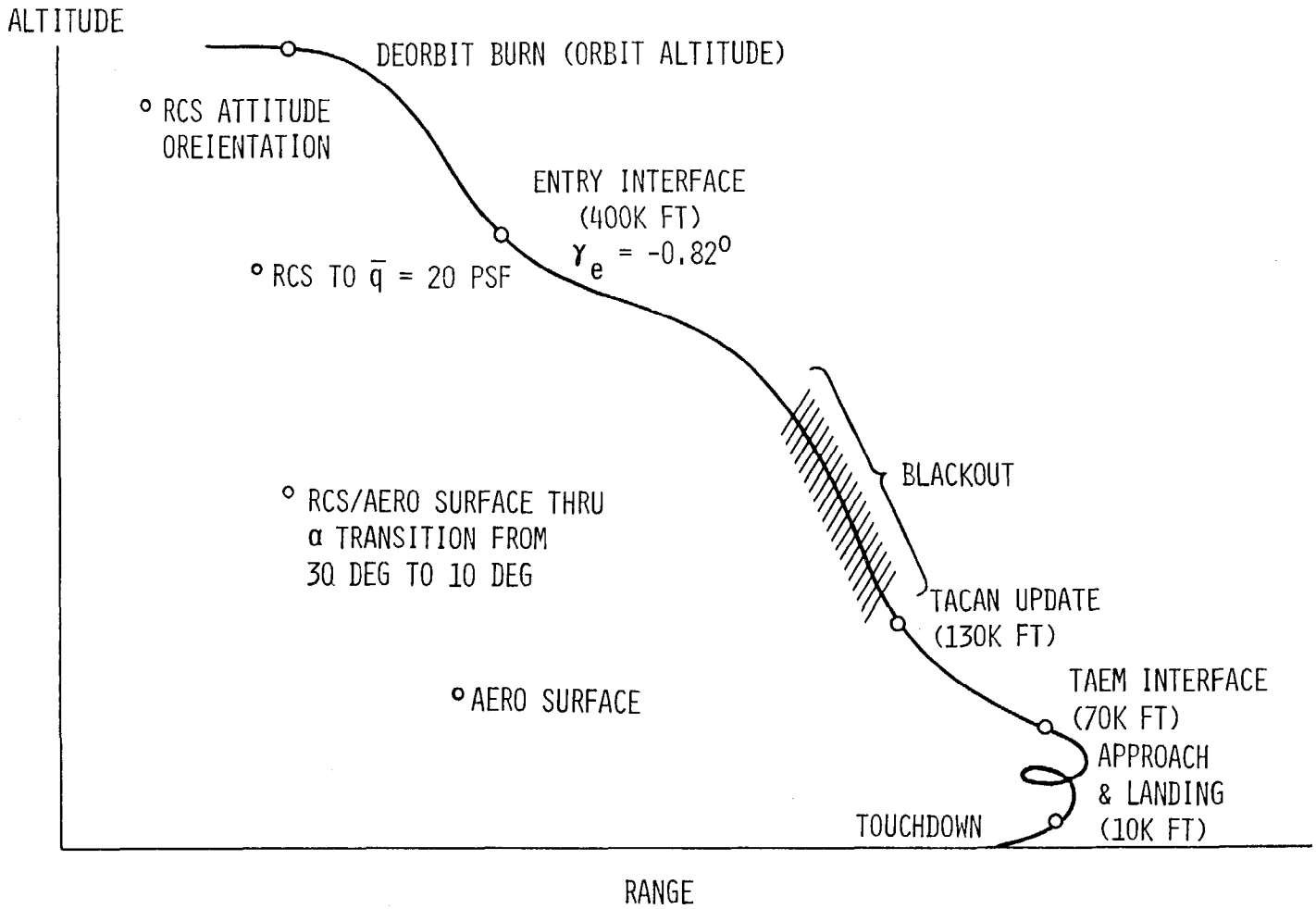


Figure 48

AEROSURFACE CONFIGURATION

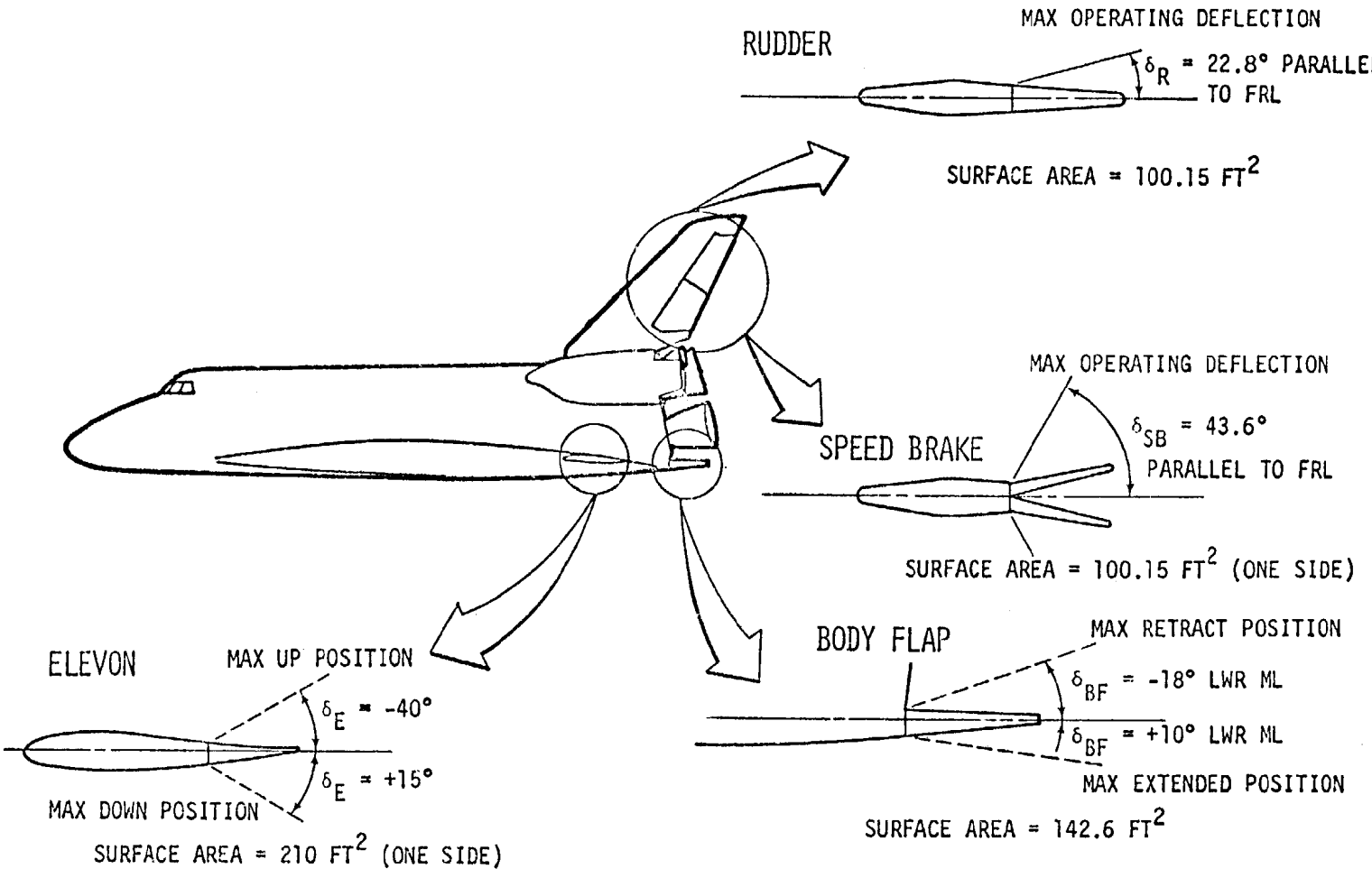


Figure 49

BASELINE REFERENCE TRAJECTORY

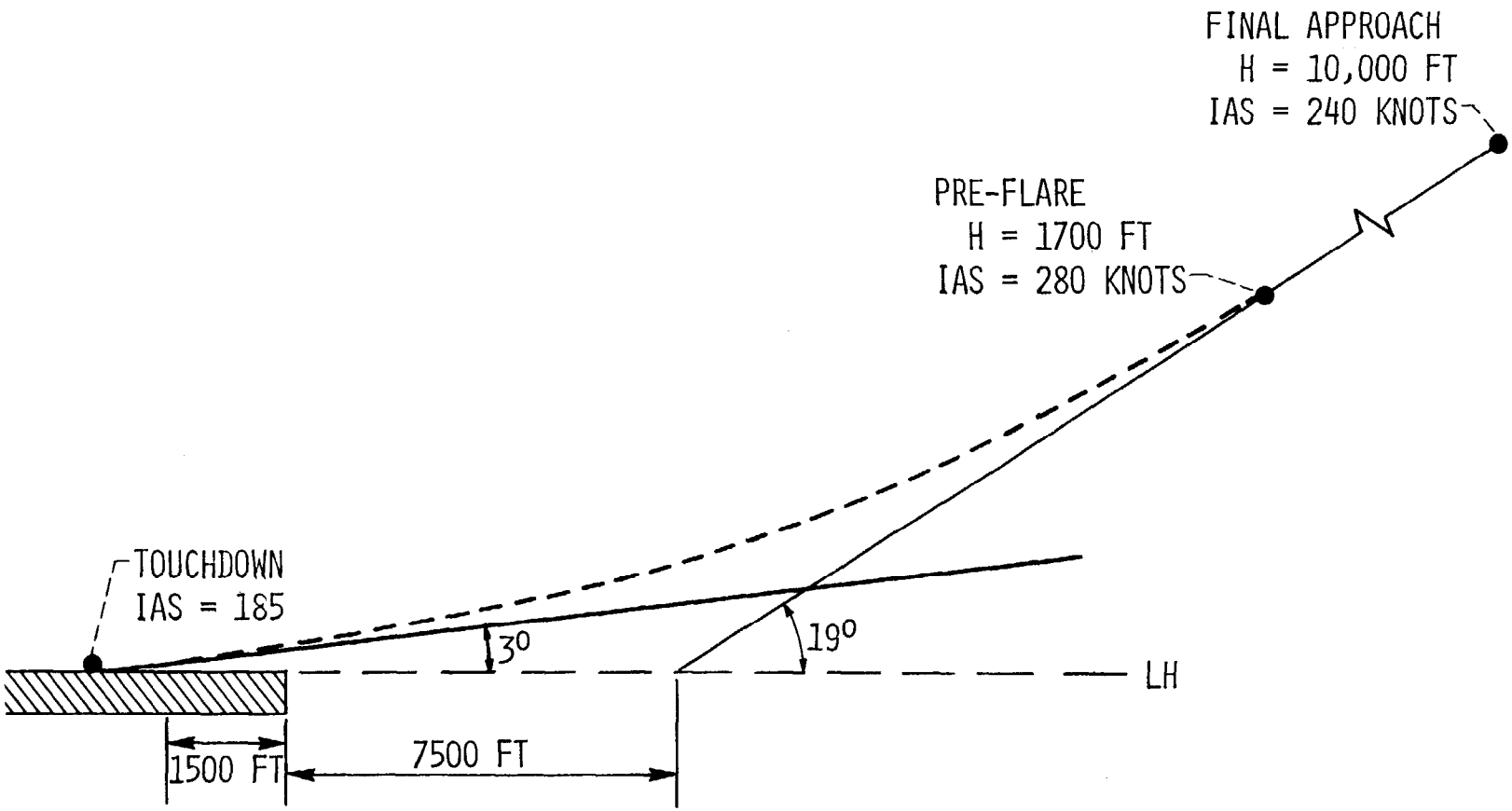


Figure 50

ENTRY FOOTPRINT CAPABILITY

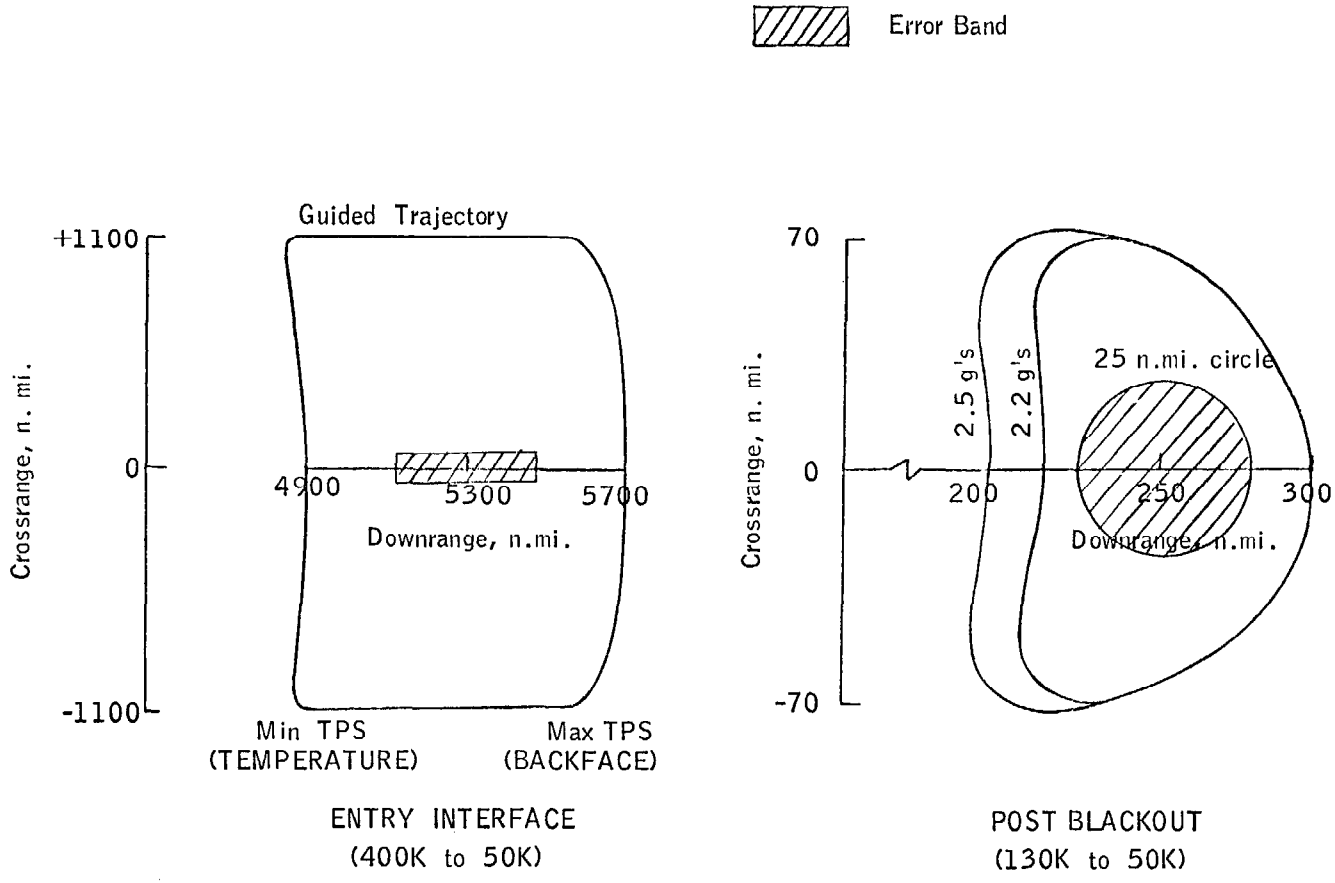


Figure 51

TURNAROUND CYCLE

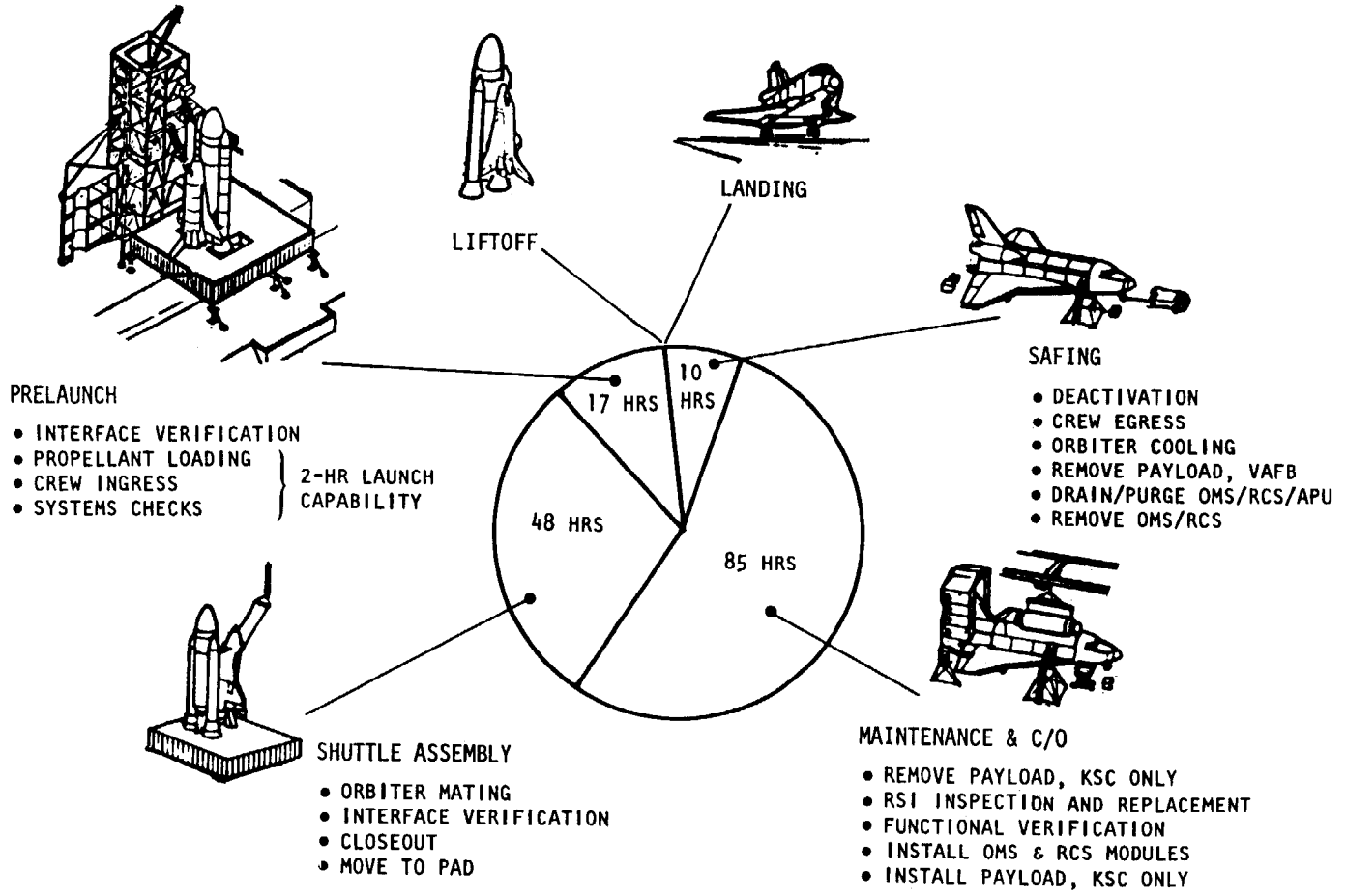


Figure 52

CONFIGURATION MANAGEMENT
RESPONSIBILITY LEVELS

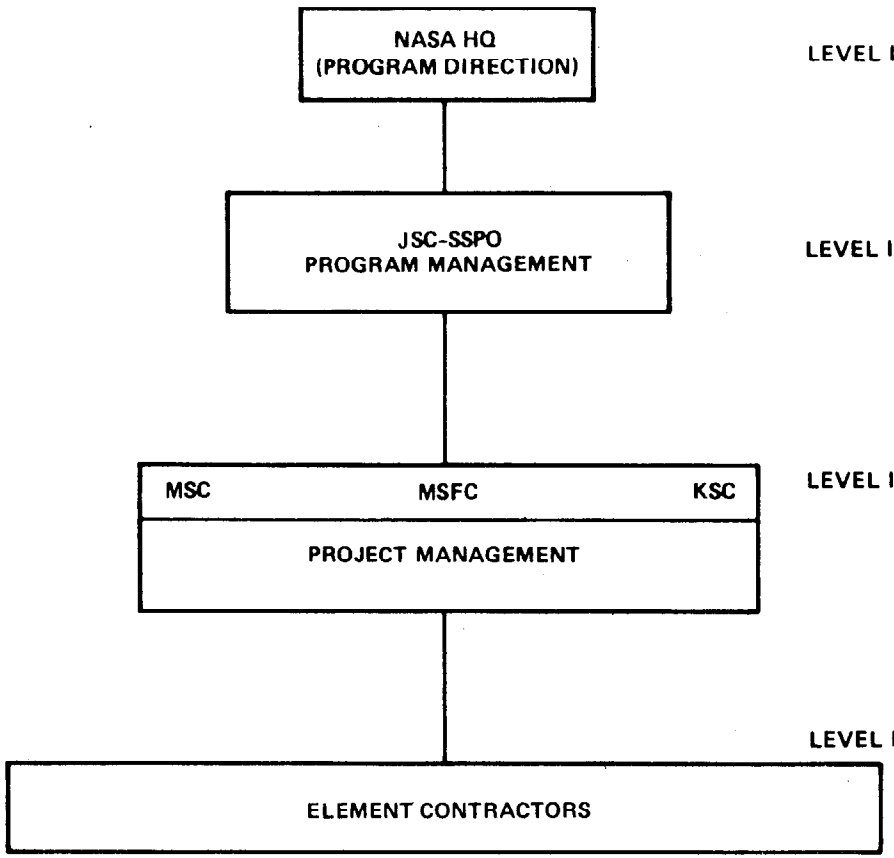


Figure 53

SPACE SHUTTLE TEST PROGRAM FACILITIES

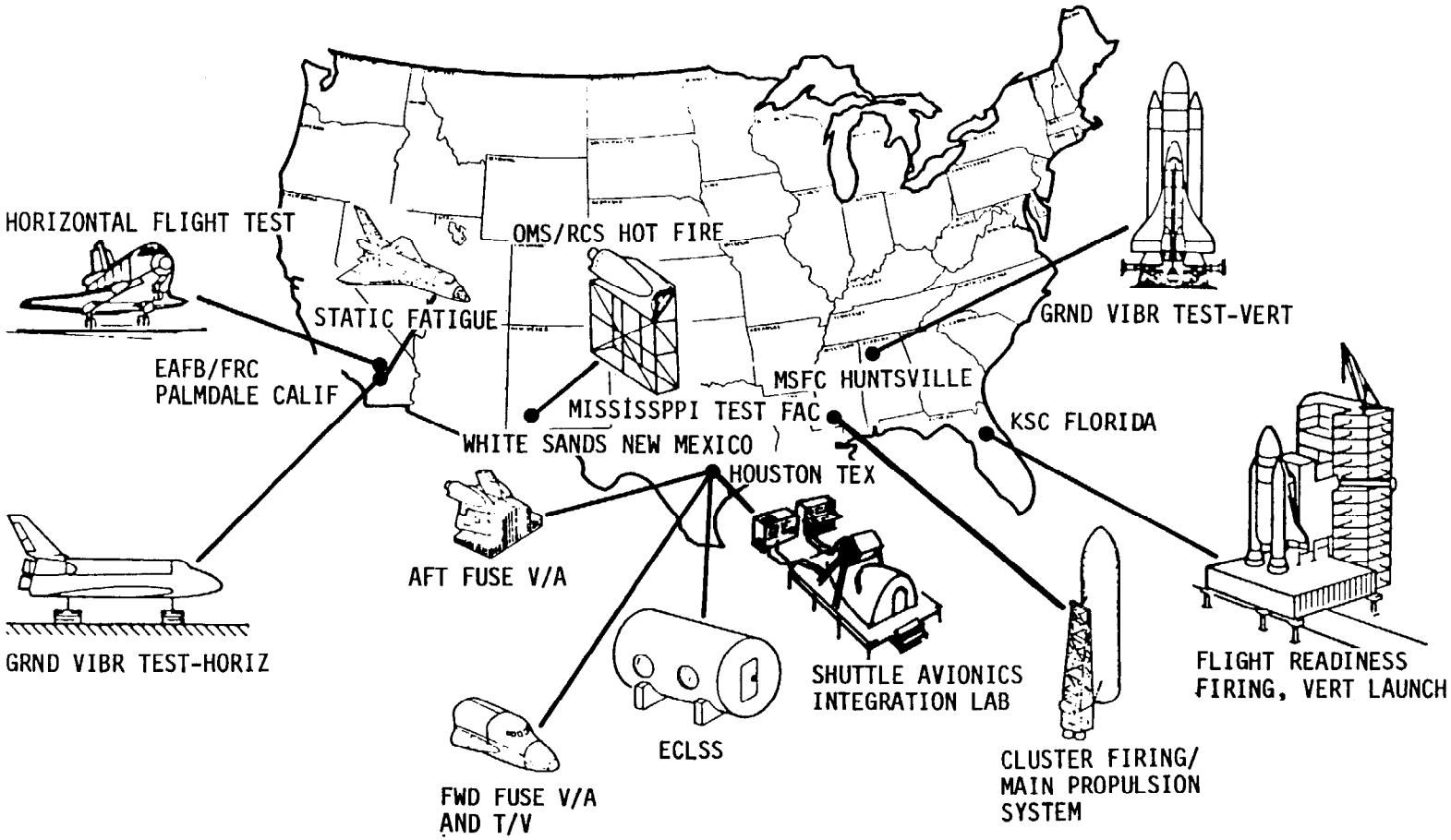
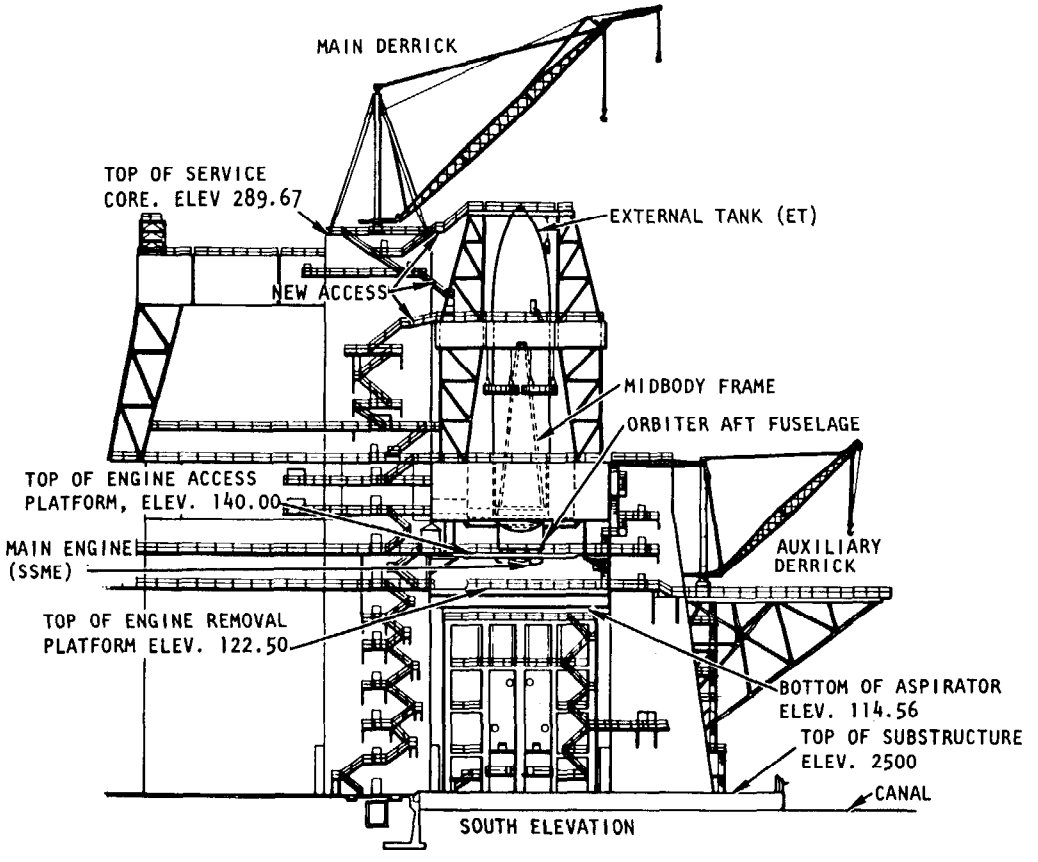


Figure 54

MAIN PROPULSION TEST STATION SET 42
PICTORIAL



STATIC FIRING READINESS CHECKOUT GSE

- ELECTRICAL CHECKOUT
- PNEUMATIC CHECKOUT
- ACCESS EQUIPMENT
- HYDRAULIC SERVICING
- AUXILIARY EQUIPMENT
- DATE RECORDING

PREPARATION FOR STATIC FIRING COUNTDOWN GSE

- TEST ARTICLE PURGING
- TANK CONDITIONING

PROPELLANT LOADING SUPPORT GSE

- LO_2 & LH_2 LOADING
- ELECTRONICS CONTROL
- PNEUMATIC SERVICING
- SYSTEM PURGING
- DATA RECORDING

STATIC FIRING COUNTDOWN GSE

- PROPELLANT TOPPING CONTROL
- STATIC FIRING ELECTRONICS
- PNEUMATIC SERVICING & CONTROL
- HYDRAULIC POWER
- EMERGENCY PURGING
- ENGINE AREA FIREX
- FRAG & HEAT SHIELD
- EMERGENCY DRAIN CAPABILITY
- DATA RECORDING

HANDLING GSE

- ET INSTALLATION EQUIP.
- MIDBODY INSTALLATION EQUIP.
- AFT FUSELAGE INSTALLATION EQUIP.
- MAIN ENGINE INSTALLATION EQUIP.
- SUB ASSY & COMPONENT REMOVAL EQUIP. AS REQUIRED

Figure 55

TPS TEST PROGRAM
REPRESENTATIVE VEHICLE AREAS TO BE TESTED

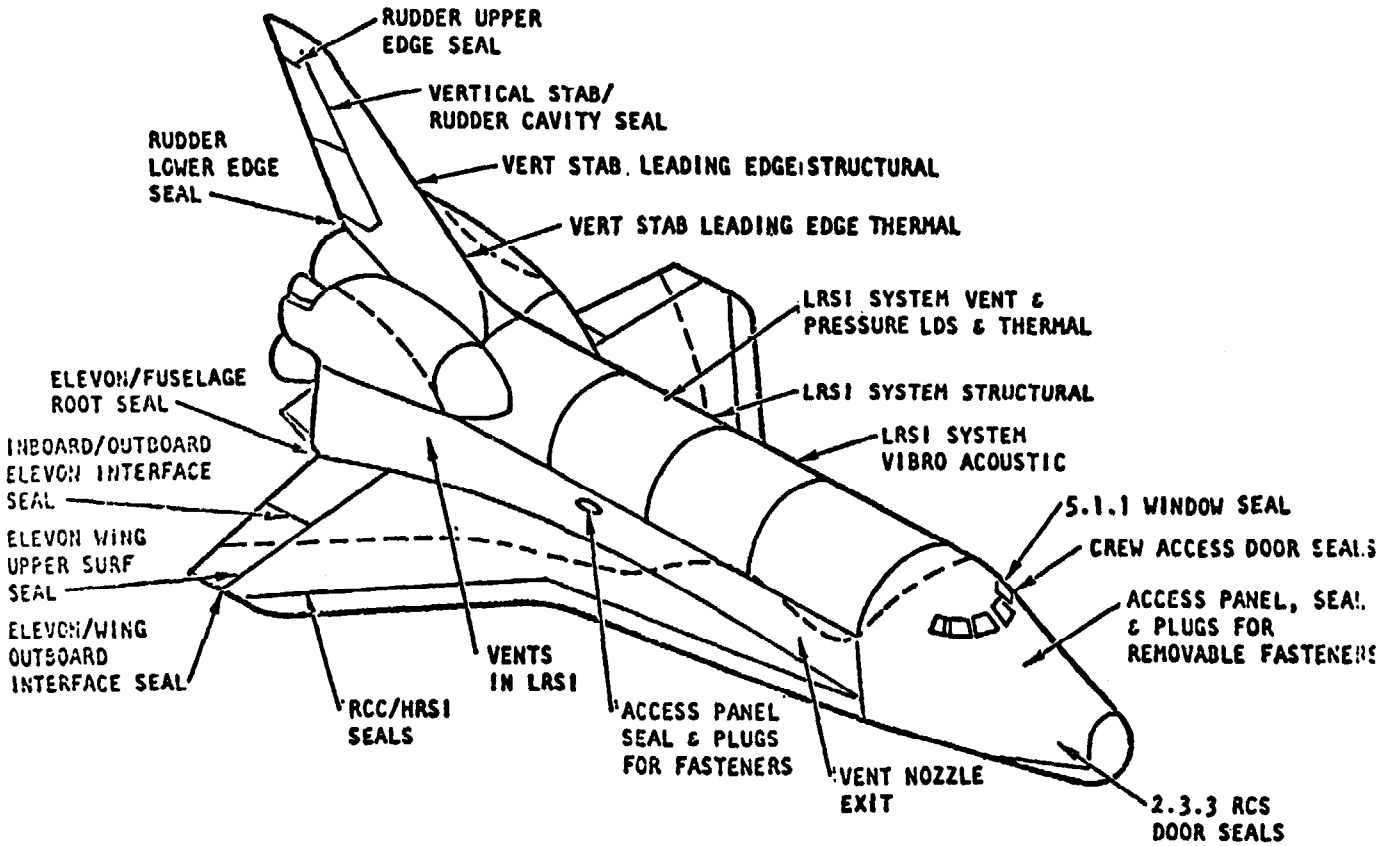


Figure 56

TPS TEST PROGRAM
REPRESENTATIVE VEHICLE AREAS TO BE TESTED (CONT)

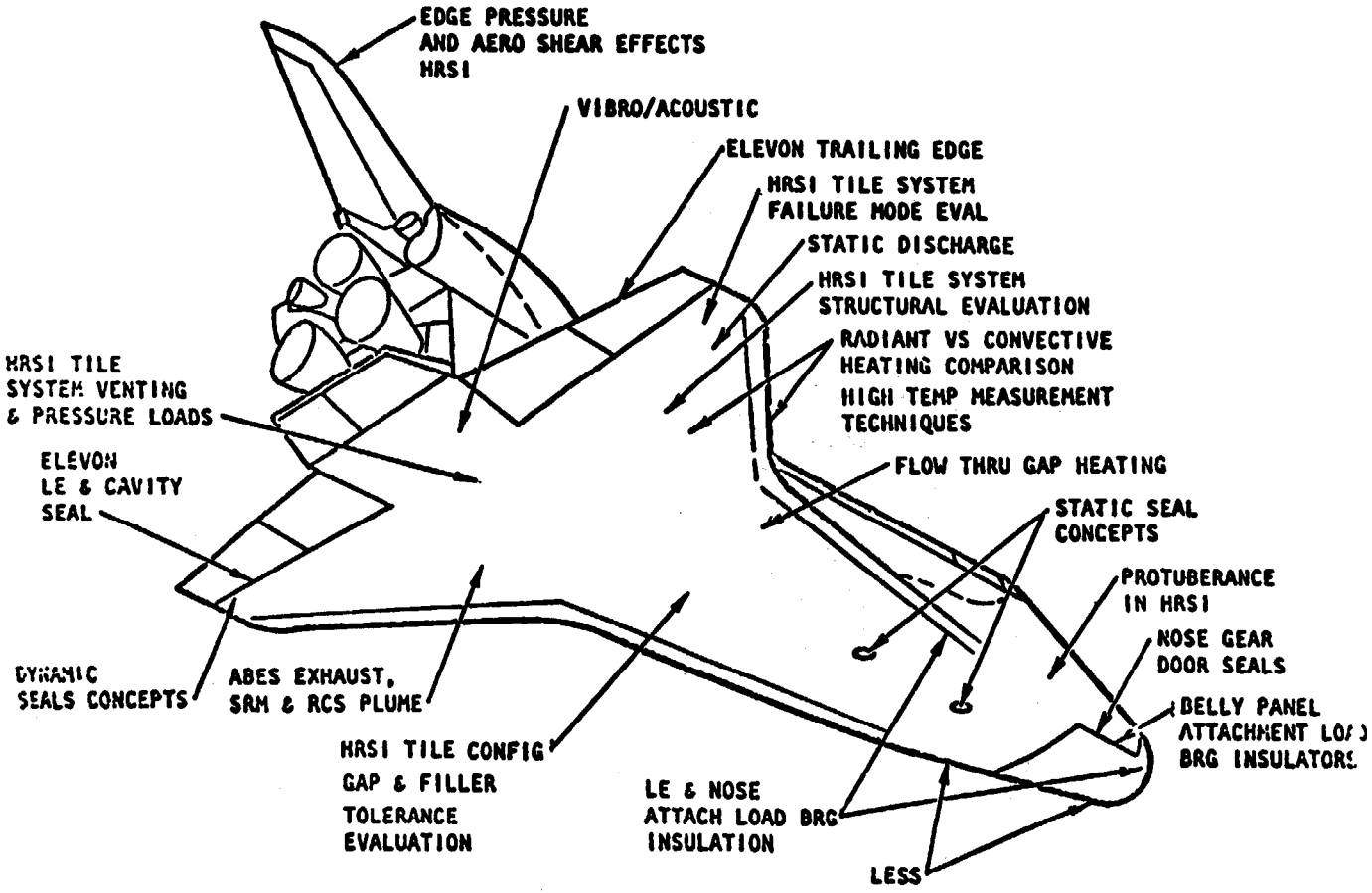


Figure 57

KSC OPERATIONAL SITE

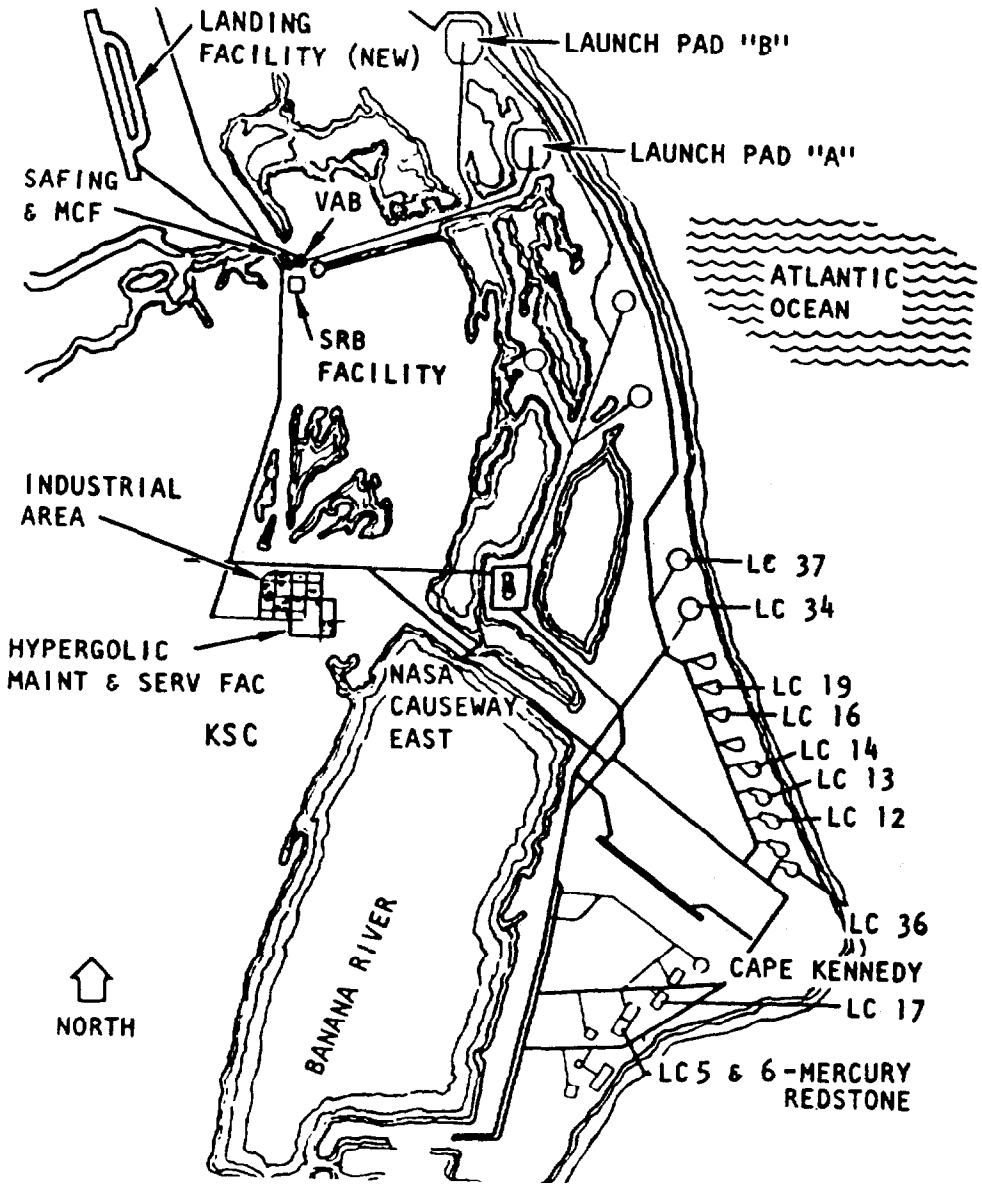


Figure 58