Total Pages 108

SSV 73-39

# SPACE SHUTTLE SYSTEM PAYLOAD ACCOMMODATIONS

NOORDWIJK, HOLLAND
19-21 JUNE 1973

NAS9-14000

(NASA-CR-150931) SPACE SHUTTLE SYSTEM PAYLOAD ACCOMMODATIONS (North American Rockwell Corp.) 110 p

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Space Division
Rockwell International

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# SPACE SHUTTLE SYSTEM
# PAYLOAD ACCOMMODATIONS

NOORDWIJK, HOLLAND
19-21 JUNE 1973

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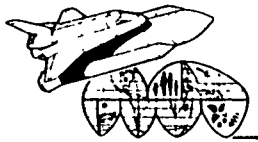
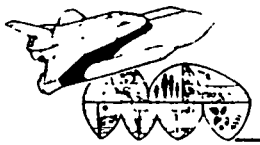
Geo. Fraser of RI presented this on June 19 to the European Spacelab team at ESTEC.
J C Haberling

Space Division
Rockwell International



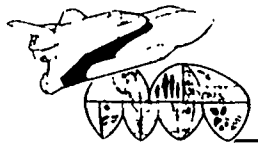
# SPACE SHUTTLE SYSTEM PAYLOAD ACCOMMODATIONS



# BRIEFING OUTLINE

PRESENT CONFIGURATION OVERVIEW

- ORBITER SUBSYSTEMS
- PAYLOAD ACCOMMODATIONS
- TRADE STUDIES





SHUTTLE VEHICLE MISSION REQUIREMENTS

MISSION PROFILE

SHUTTLE VEHICLE CONFIGURATION - ET & SRB

- SHUTTLE VEHICLE WEIGHTS

SHUTTLE VEHICLE PERFORMANCE

ORBITER VEHICLE CONFIGURATION

- ORBITER VEHICLE WEIGHTS

ORBITER VEHICLE SUBSYSTEM SUMMARY

PAYLOAD ACCOMMODATIONS SUMMARY



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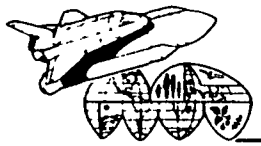


# SHUTTLE VEHICLE MISSION REQUIREMENTS

- MISSION REQUIREMENTS

| MISSION | INCL (DEG) | ASCENT PL (K LB) | LAUNCH SITE | OMS ΔV (FPS) | RCS ΔV (FPS) |
|---|---|---|---|---|---|
| 1. DUE EAST | 28.5 | 65 | KSC | 650 | 100 |
| 2. RESUPPLY | 55 | 25 | KSC | 1250 | 120 |
| ✓ 3A. DEPLOY | 104 | 32 | WTR | 250 | 100 |
| 3B. RETRIEVE | 104 | 0 | WTR | 500 | 150 |

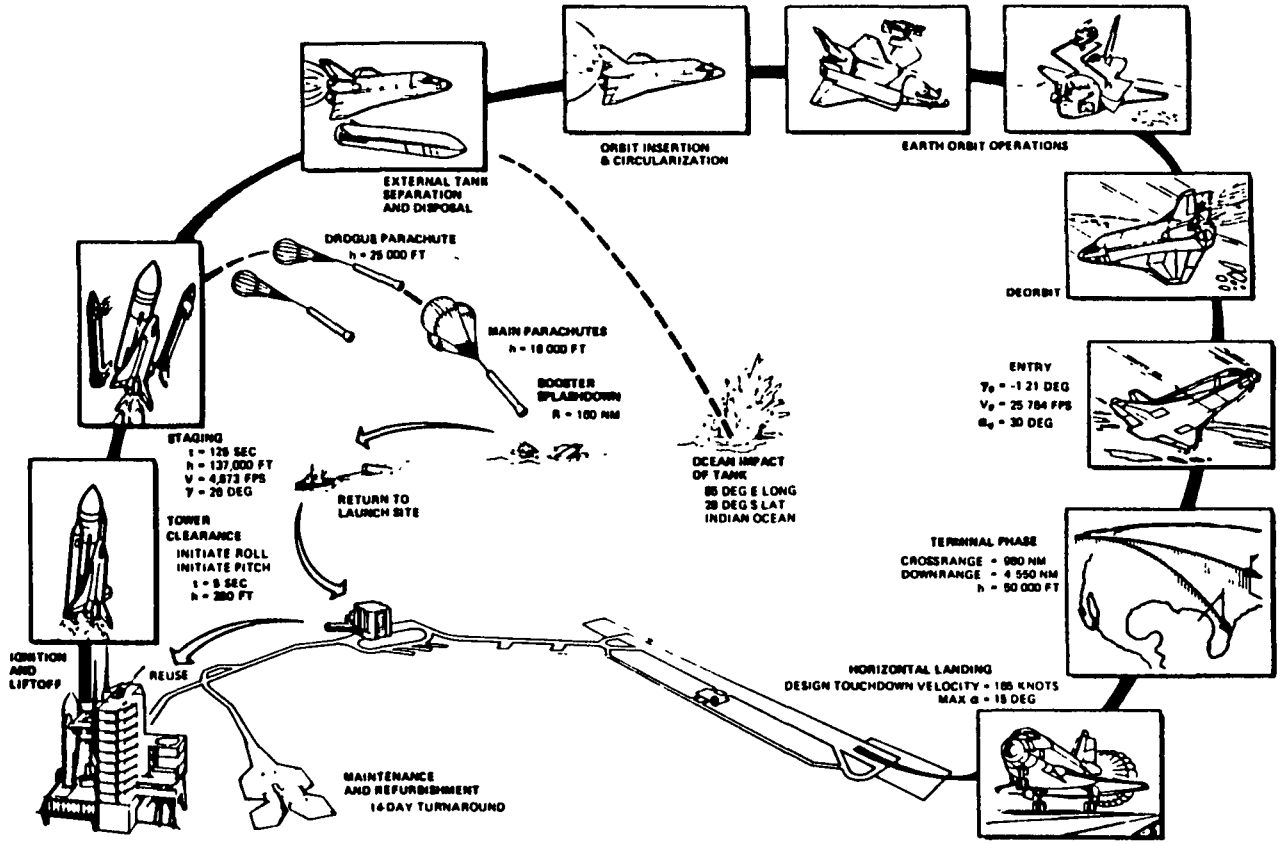
NOTES:

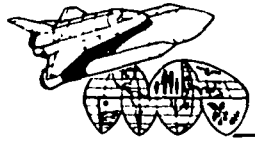
1. OMS ΔV REMAINING IN EXCESS OF REFERENCE ENERGY ORBIT, 50 X 100 N MI
2. ACTUAL INSERTION CONDITION OPTIMIZED FOR MISSION (50 X 100 N MI NOT REQUIRED)
3. RCS ΔV FOR ORBITAL TRANSLATION MANEUVERS. ADDITIONAL RCS FOR ATTITUDE CONTROL ON-ORBIT & ENTRY TBD

- PROVIDE ONCE-AROUND ABORT CAPABILITY FROM LAST RTLS POINT

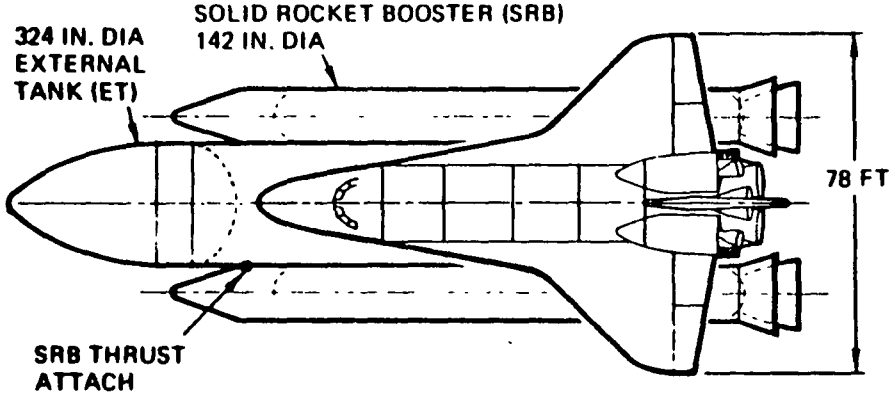
# SPACE SHUTTLE MISSION PROFILE
# DUE EAST LAUNCH FROM KSC

## SUBORBITAL ET DISPOSAL



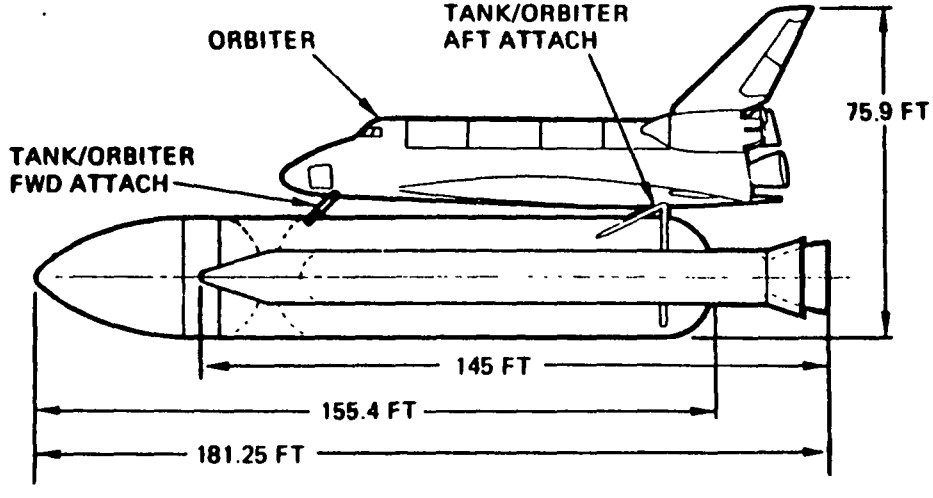


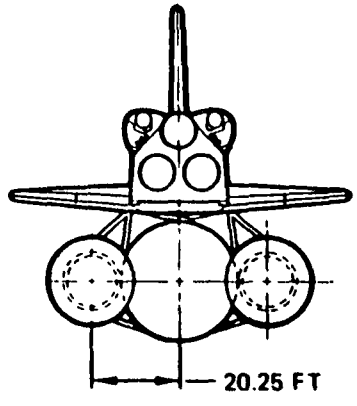
# SHUTTLE VEHICLE

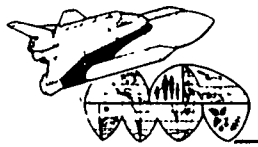



**GROSS LIFT-OFF WEIGHT – 4167K LB**
**(50 X 100 N MI BY 104 DEG)**

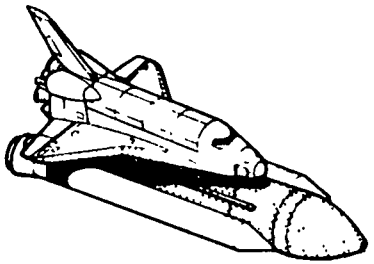
| | |
|---|---|
| ORBITER . . . | 150K LB DRY |
| SRB . . . . . | 2327K LB |
| ET . . . . . | 1633K LB |
| PAYLOAD . . . | 32K LB |





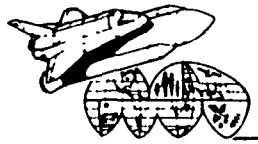
# EXTERNAL TANK SYSTEM



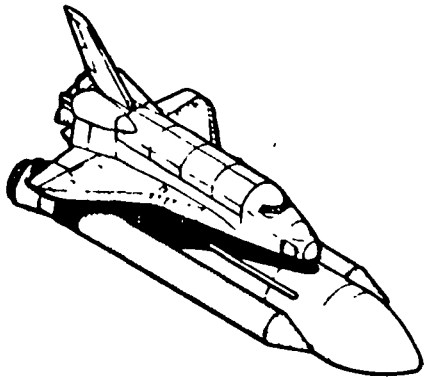
| DIMENSIONS | |
|---|---|
| LENGTH | 155.4 FT |
| DIA | 324 IN. |




| | |
|---|---|
| GROSS WT | 1,633,000 LB |
| ASCENT PROP WT | 1,550,000 LB |



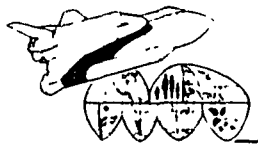
# SOLID ROCKET BOOSTER



**DIMENSIONS**
LENGTH . . . . . 145.1 FT
DIA . . . . . 142.3 IN.




| | |
|---|---|
| GROSS WT . . . . . | 1,163,500 LB |
| RECOVERY WT . . . | 154,250 LB |
| THRUST (SL) . . . . | 2.5M LB |



# SPACE SHUTTLE WEIGHT SUMMARY

## PAYLOAD CAPABILITY - MISSION 32 UP/25 DOWN 104° INCL

| SYSTEM | SRB | ORBITER | EXT TANK |
|---|---|---|---|
| GROSS WT (4167) | 2327 | 207 | 1633 |
| ASCENT PROPELLANT | 2018 | | 1555 |
| DRY WEIGHT | 309 | 150 | 70 |
| LANDING WEIGHT | | 180 | |
| INERT WEIGHT | 309 | 186 | 78 |
| OMS PROPELLANT ($N_2O_4$/MMH) (USABLE) | | 11.7 | |
| RCS PROPELLANT (USABLE) | | 4.5 | |

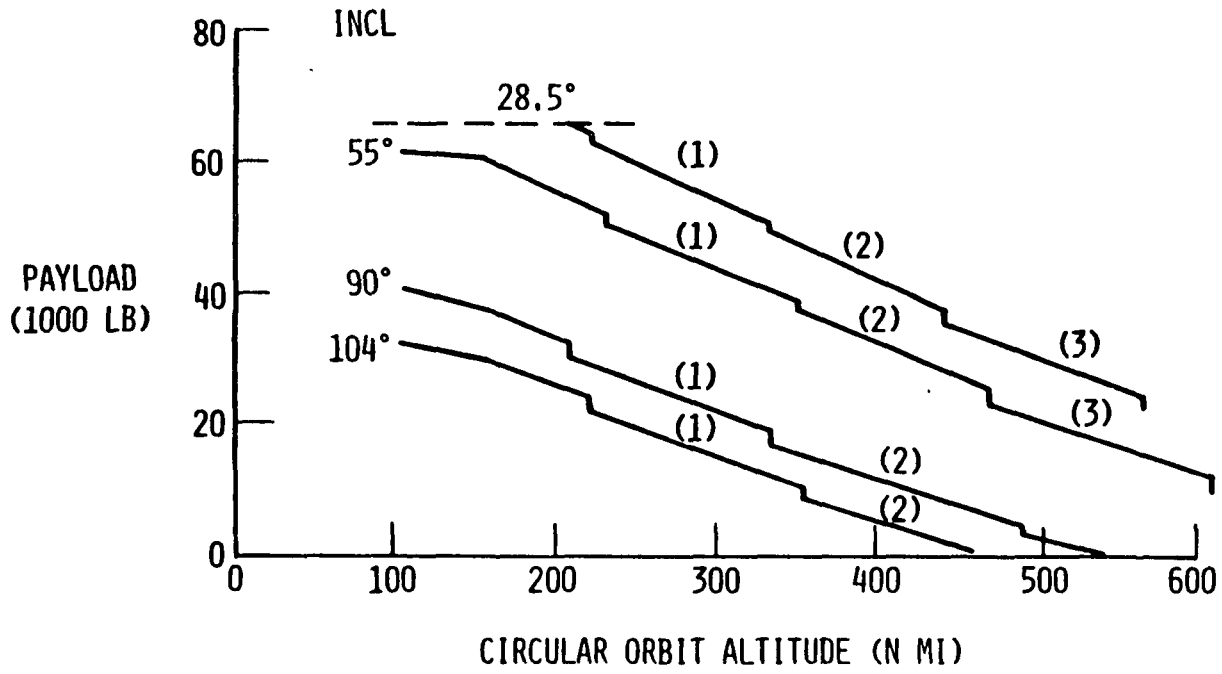
WEIGHT IN KLB

# PAYLOAD/CIRCULAR ORBIT ALTITUDE CAPABILITY

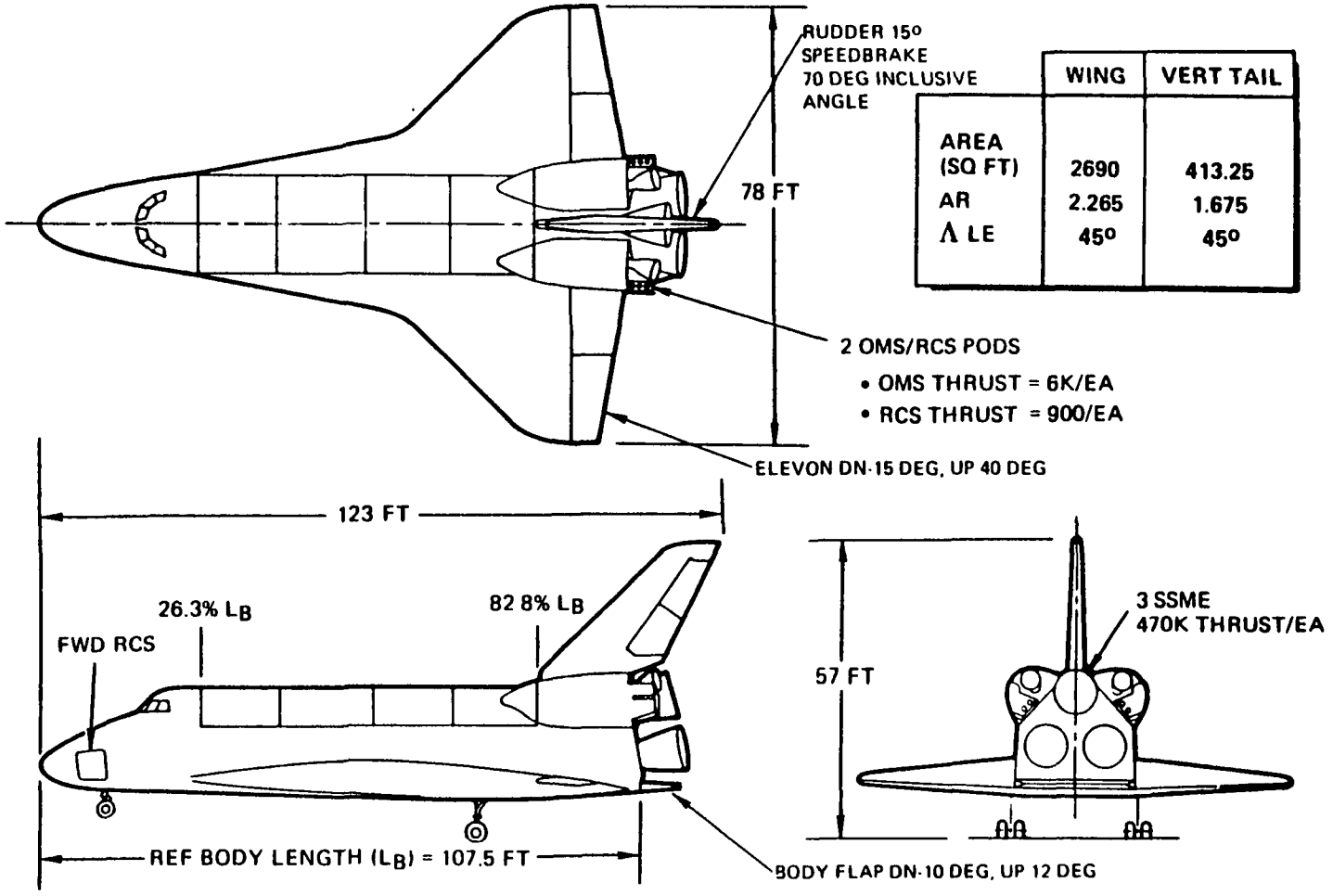
PRELIMINARY

- DELIVERY WITHOUT RENDEZVOUS
- DIRECT DEORBIT
- 50 FPS OMS ΔV RESERVE
- SUB ORBITAL ET DISPOSAL

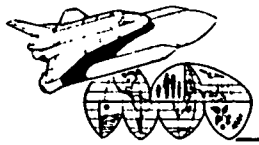
( ) - NUMBER OF OMS KITS



# ORBITER VEHICLE




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



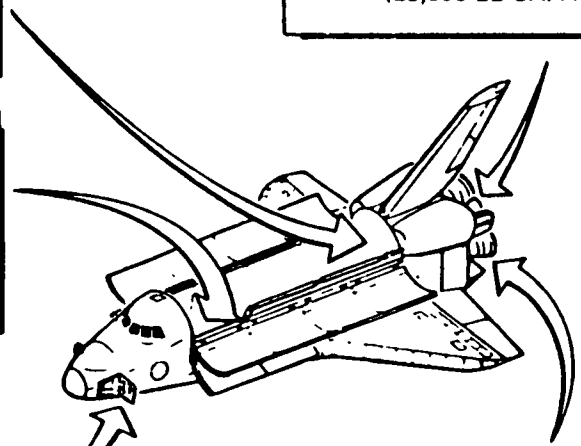
# ORBITER SUBSYSTEM SUMMARY
## PROPULSION & POWER

### AUXILIARY POWER
- 4 HYDRAZINE APU'S (150 HP EACH)
  5 KVA GENERATOR
  3000 PSI HYDRAULIC PUMPS

### ELECTRICAL POWER
- 3 X 7 KW FUEL CELLS ($H_2$, $O_2$)
  1677 KWH ENERGY
  27.5 TO 32.5 VDC
- 3 X 10 AMP-HOUR BATTERIES

### RCS
- FWD MODULE & 2 AFT MODULES
  40 THRUSTERS (900 LB)
  & 6 VERNIERS (25 LB)
  $N_2O_4$/MMH PROPELLANT
  (6244 LB)

### OMS
- TWO ENGINES (6000 LB VAC THRUST EACH)
  $N_2O_4$/MMH PROPELLANT
  (23,800-LB CAPACITY)



### MAIN PROPULSION
- 3 ENGINES (470,000 LB VAC THRUST EACH)
  $H_2$, $O_2$ PROPELLANT

# ORBITER SUBSYSTEM SUMMARY
## MECHANICAL, STRUCTURE & ENVIRONMENT

### MECHANICAL SUBSYSTEM

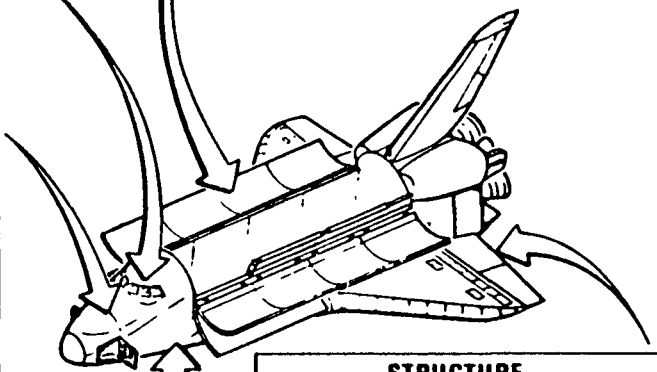
- 1 PAYLOAD MANIPULATOR (50 FT REACH)
- PAYLOAD RETENTION
- LANDING GEAR
  - TIRES
  - ANTISKID BRAKES
  - DRAG CHUTE
- MECHANICAL CONTROLS & ACTUATORS

### ECLSS

- SPACE RADIATORS
  - FREON 21 FLUID
  - 1440 SQ FT
- COOLANT LOOPS
  - WATER IN CABIN
  - FREON FOR OTHERS
- $O_2$, $N_2$ ATMOSPHERE
- WASTE DRIED & STORED
- FOOD, GALLEY

### THERMAL PROTECTION SUBSYSTEM

- RCC LEADING EDGES (NOSE/CHIN CAP > 2300 F)
- HRSI AREAS TEMP RANGE 650 TO 2300 F
- LRSI ON AREAS LESS THAN 650 F



### THERMAL CONTROL SUBSYSTEM

- PASSIVE
- INSULATION & MAKEUP HEATERS
- GROUND PURGE, PRELAUNCH, & POSTLANDING

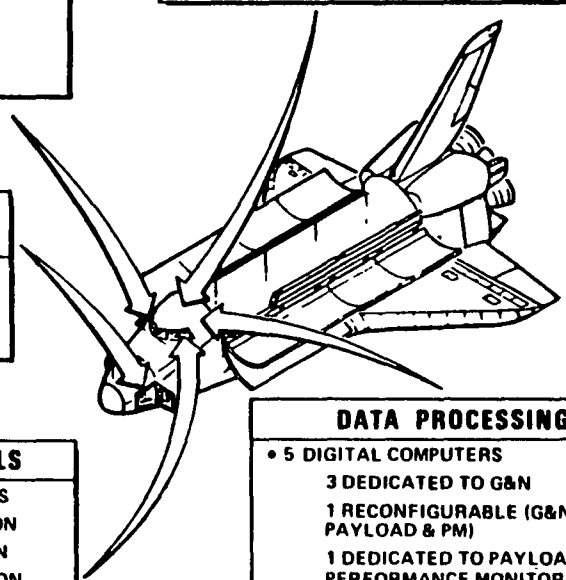
### STRUCTURE

- MOSTLY ALUMINUM
- SKIN STRINGER BODY
- COMPOSITE MAIN ENGINE THRUST STRUCTURE
- INCONEL 718 SANDWICH BASE HEAT SHIELD
- HONEYCOMB RUDDER/ELEVON COVERS

# ORBITER SUBSYSTEM SUMMARY
## AVIONICS

### COMMUNICATION & TRACKING
- SGLS-COMPATIBLE (S BAND) TRANSCEIVER
- STDN COMPATIBLE TRANSCEIVERS
- TDRS TRANSCEIVER
- PAYLOAD S-BAND INTERROGATOR
- TACAN INTERROGATOR
- RADAR ALTIMETER & ILS
- RENDEZVOUS RADAR
- BLACK & WHITE AND COLOR TV
- AUDIO CENTER

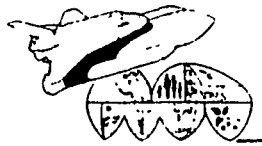
### GN&C
- STAR SENSORS
- INERTIAL MEASUREMENT UNITS
- RATE GYROS
- ACCELEROMETERS
- AIR-DATA SENSORS
- DOPPLER



### OPERATIONAL FLIGHT INSTRUMENTATION
- PCM DATA ACQUISITION & DISTRIBUTION
- RECORDERS
- MASTER TIMING UNIT

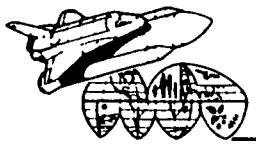
### DISPLAYS & CONTROLS
- 2 PRIMARY FLIGHT STATIONS
- PAYLOAD-HANDLING STATION
- MISSION SPECIALIST STATION
- PAYLOAD SPECIALIST STATION
- SUBSYS MGMT & POWER DISTRIB PANELS

### DATA PROCESSING
- 5 DIGITAL COMPUTERS
  - 3 DEDICATED TO G&N
  - 1 RECONFIGURABLE (G&N OR PAYLOAD & PM)
  - 1 DEDICATED TO PAYLOAD & PERFORMANCE MONITORING
- MASS MEMORY
- KEYBOARDS & CRT DISPLAYS



# ORBITER WEIGHT SUMMARY
## REFERENCE MISSIONS

| | | MISSION | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3a | 3b |
| WING GROUP | 11,208 | | | | |
| TAIL GROUP | 2,669 | | | | |
| BODY GROUP | 35,552 | | | | |
| INDUCED ENVIRONMENTAL PROTECTION | 25,164 | | | | |
| LANDING DOCKING | 9,501 | | | | |
| PROPULSION ASCENT | 26,441 | | | | |
| PROPULSION, AUXILIARY | 5,223 | | | | |
| PRIME POWER | 3,432 | | | | |
| ELECTRICAL CONVERSION & DISTRIBUTION | 4,604 | | | | |
| HYDRAULIC CONVERSION & DISTRIBUTION | 1,576 | | | | |
| SURFACE CONTROLS | 1,837 | | | | |
| AVIONICS | 4,522 | | | | |
| ENVIRONMENTAL CONTROL | 4,231 | | | | |
| PERSONNEL PROVISION | 1,317 | | | | |
| PAYLOAD ACCOMMODATION | 48 | | | | |
| GROWTH | 12,675 | | | | |
| SUBTOTAL (DRY WT) | 150,000 | 150,000 | 150,000 | 150,000 | 150,000 |
| PERSONNEL | | 1,104 | 1,104 | 1,104 | 1,104 |
| CARGO | | 65,000 | 25,000 | 32,000 | 2,500 |
| RESIDUAL FLUIDS | | 2,421 | 2,421 | 2,421 | 2,421 |
| SUBTOTAL (INERT WT) | | 218,525 | 178,525 | 185,525 | 156,025 |
| RESERVE FLUIDS | | 1,083 | 1,083 | 1,083 | 1,083 |
| INFLIGHT LOSSES | | 4,037 | 4,037 | 4,037 | 4,037 |
| PROPELLANT - MANEUVER/RCS | | 20,648 | 30,047 | 9,285 | 15,928 |
| TOTAL WEIGHT | | 244,293 | 213,692 | 199,930 | 177,073 |



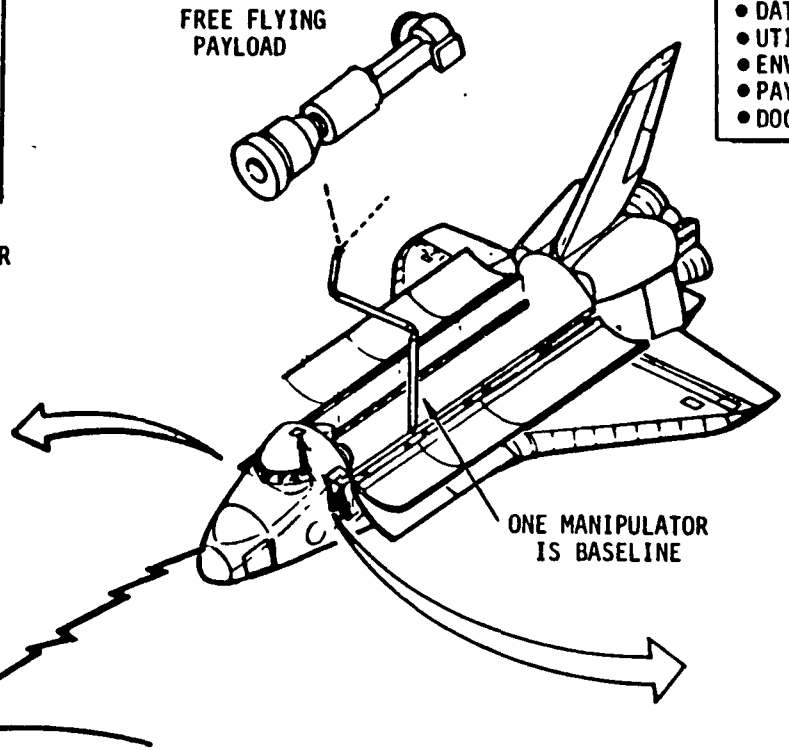
# ORBITER PAYLOAD ACCOMMODATIONS

PAYLOAD MANIPULATOR STATION

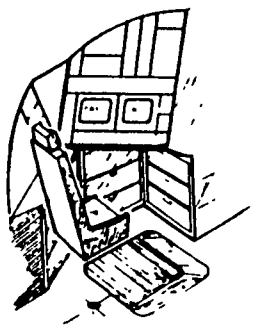
FREE FLYING PAYLOAD

**SUPPORTING SUBSYSTEMS**

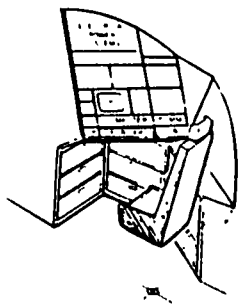
- GUIDANCE & NAVIGATION
- COMMUNICATIONS & TRACKING
- DISPLAYS & CONTROL
- DATA PROCESSING
- UTILITIES PWR/FLUID/GAS
- ENVIRONMENTAL
- PAYLOAD ATTACHMENTS
- DOCKING MODULE



ONE MANIPULATOR IS BASELINE

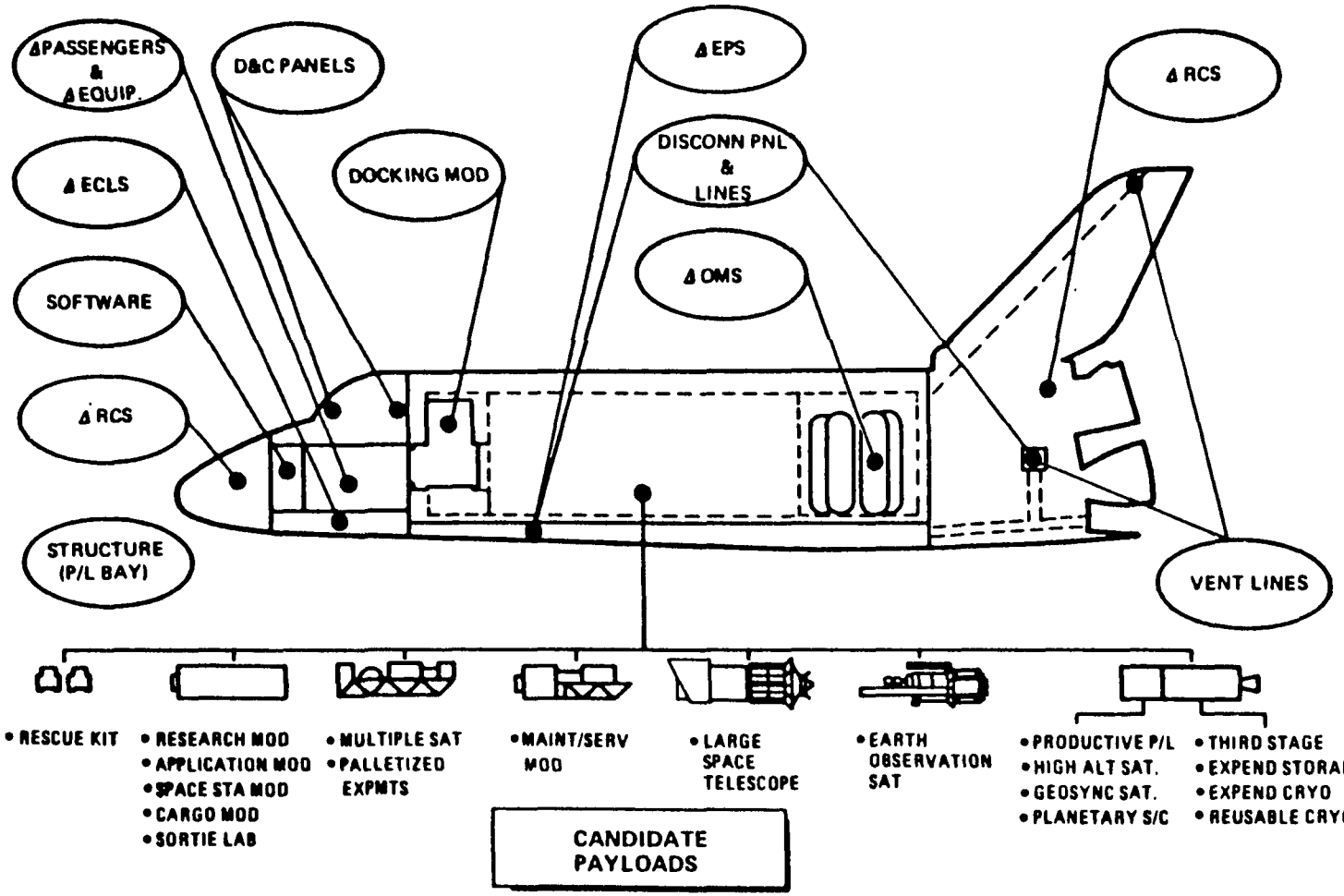


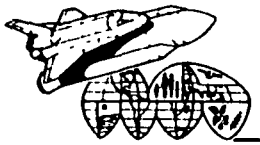
PAYLOAD SPECIALIST STATION



MISSION SPECIALIST STATION

# SCOPE OF P/L ACCOMMODATIONS





# BRIEFING OUTLINE

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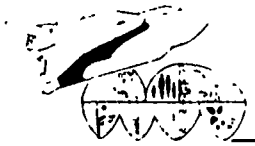
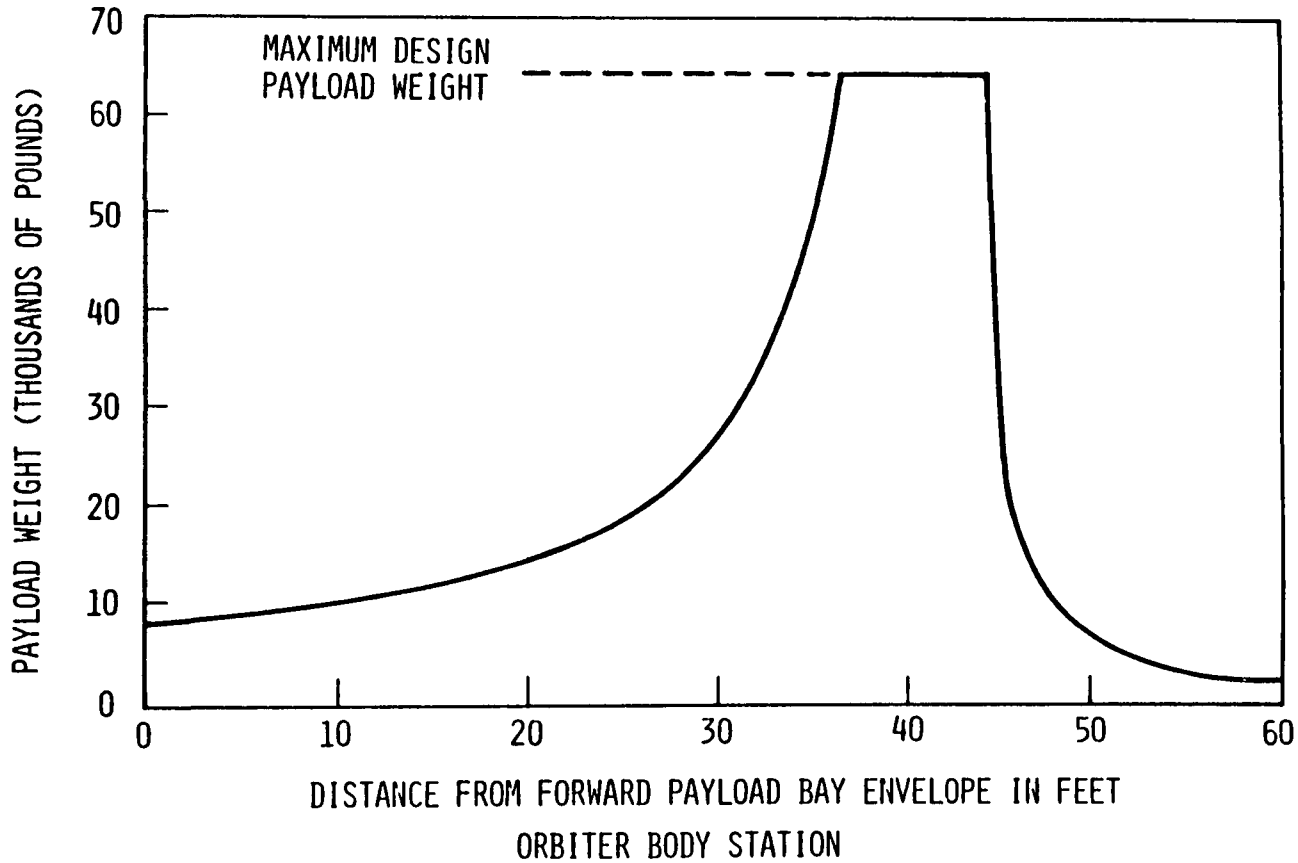
- PAYLOAD ACCOMMODATIONS
- TRADE STUDIES

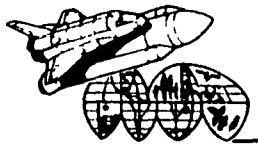




- PAYLOAD C.G.
- STRUCTURE
- MAIN PROPULSION SUBSYSTEM
- ORBITAL MANEUVERING SUBSYSTEM
- REACTION CONTROL SUBSYSTEMS
- ELECTRICAL POWER SUBSYSTEM
- AUXILIARY POWER UNIT
- ENVIRONMENTAL CONTROL & LIFE SUPPORT SUBSYSTEM
- AVIONICS
- MECHANICAL SUBSYSTEMS
- CREW SUBSYSTEM
- PAYLOAD CHECKOUT
- PAYLOAD ENVIRONMENT
- PAYLOAD INTERFACES

# PAYLOAD CENTER-OF-GRAVITY ENVELOPE REQUIREMENT

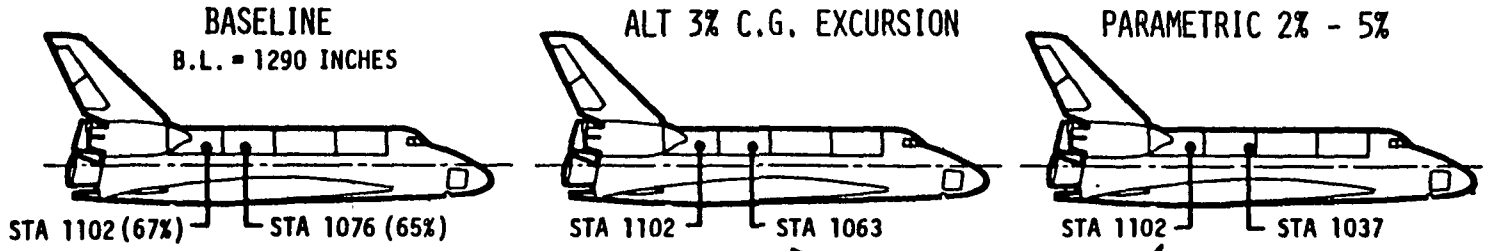


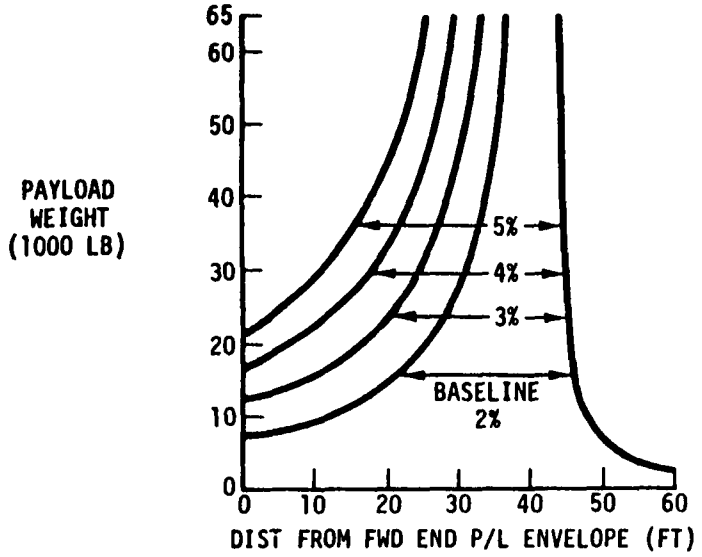


# DOWN PAYLOAD & C.G. TRADE

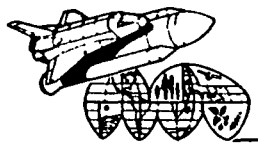
OBJECTIVE: ESTABLISH ORBITER IMPACT OF:

- 32K LB DOWN P/L
- INCREASED ALLOWABLE P/L C.G. RANGE
  - ORBITER/PL C.G.: 64%-67%
  - PARAMETRIC STUDY



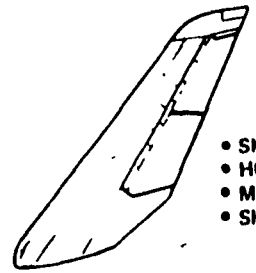

- REVISED AERO CONFIGURATION
- INCREASED CONTROL REQUIREMENTS
- INCREASED WEIGHT



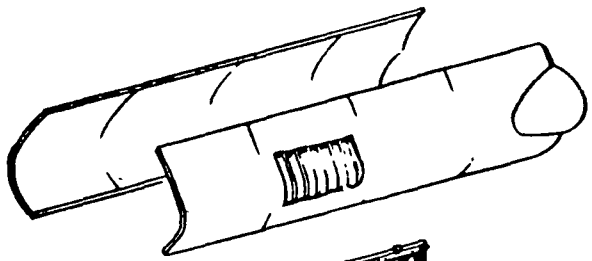
# STRUCTURES SUBSYSTEM

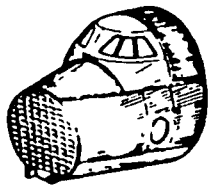
**FWD FUSELAGE**
- SKIN & STRINGER

**PAYLOAD BAY DOOR**
- 2 DOORS SPLIT AT VERTICAL
- 4 SEGMENTS PER DOOR
- SKIN & STRINGER

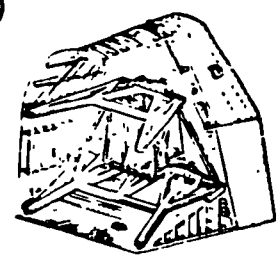


**VERTICAL**
- SKIN & STRINGER FIN COVERS
- HONEYCOMB RUDDER COVER
- MACHINED SPARS
- SHEET METAL RIBS

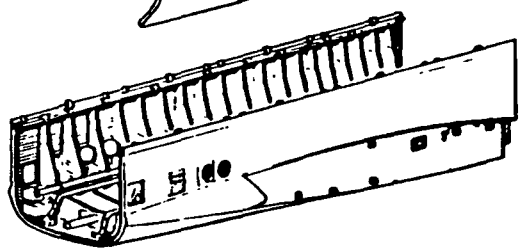




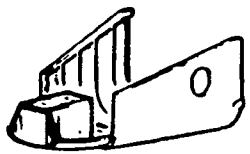
**CABIN**
- FLOATING



**AFT FUSELAGE**
- SKIN & STRINGER SHELL
- TITANIUM/BORON EPOXY THRUST STRUCT
- INCONNEL 718 BASE HEAT SHIELD



**MID FUSELAGE**
- SKIN & STRINGER



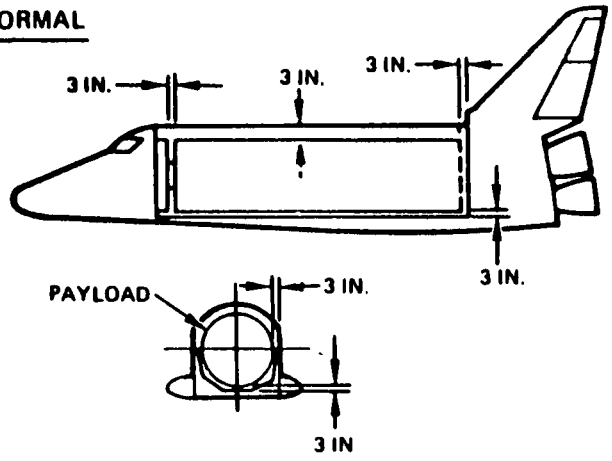
**FWD FUSELAGE**
- SKIN & STRINGER

**WING**
- SKIN & STRINGER COVERS
- WEB & TRUSS SPARS
- ELEVON HONEYCOMB COVERS

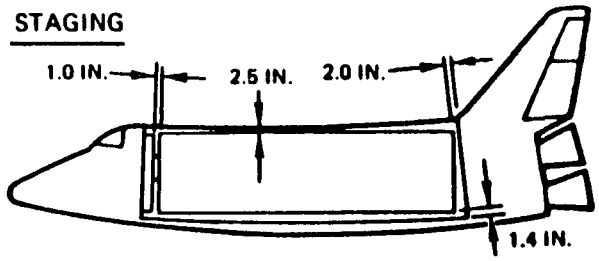
- CONVENTIONAL ALUMINUM STRUCTURE
- 350° MAX TEMPERATURE
- PROTECTED BY REUSABLE SURFACE INSULATION

# PAYLOAD CLEARANCES

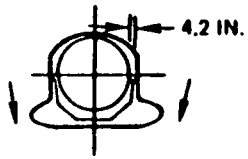
**NORMAL**



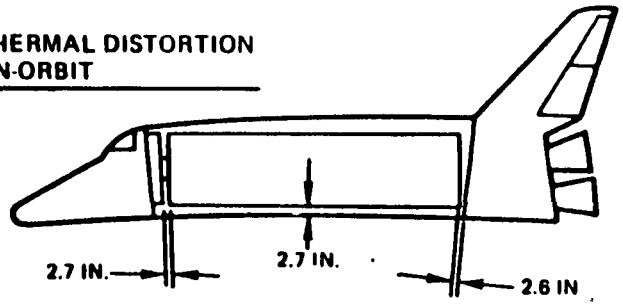

**STAGING**




**HiQ-BOOST HEADWIND**

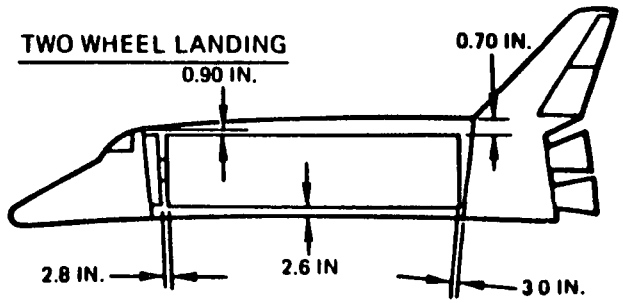



**THERMAL DISTORTION ON-ORBIT**

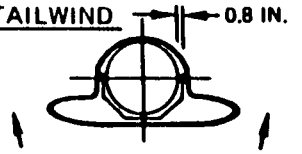



$\Delta T = 150\ F$

**TWO WHEEL LANDING**



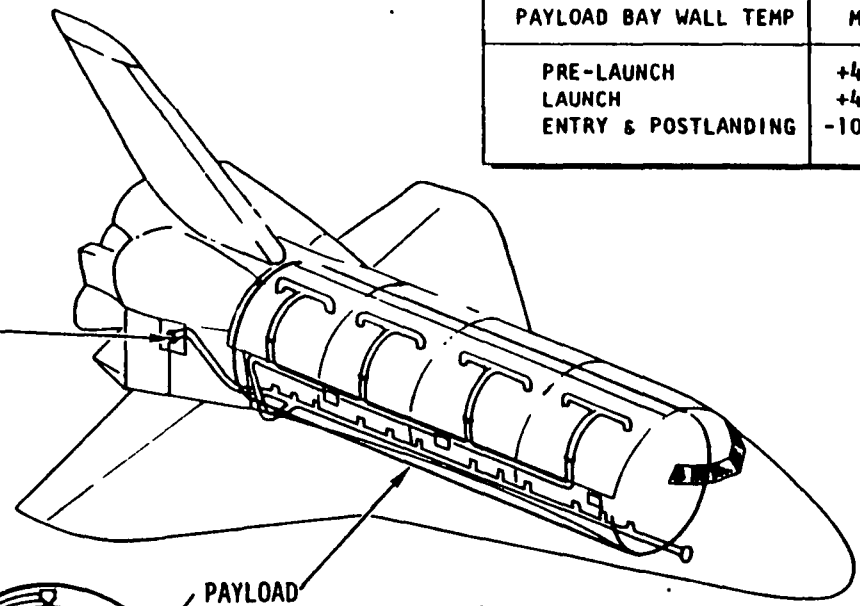

**HiQ BOOST TAILWIND**



# PAYLOAD BAY PURGE VENTING

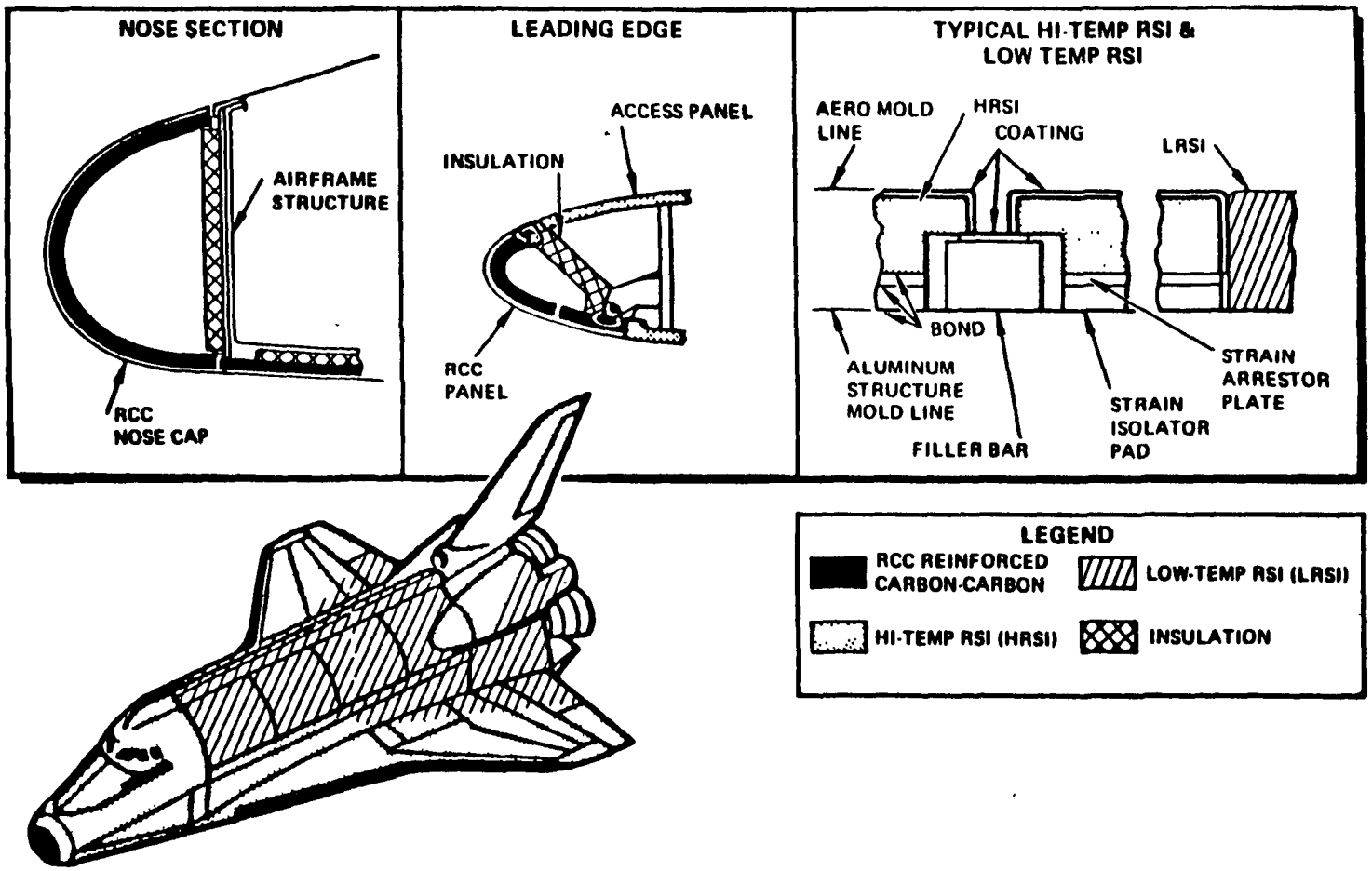
| PAYLOAD BAY WALL TEMP | MIN | MAX |
|---|---|---|
| PRE-LAUNCH | +40F | +120F |
| LAUNCH | +40F | +150F |
| ENTRY & POSTLANDING | -100F | +200F |

- PAD PAYLOAD BAY THERMO CONTROL
- SEPARATE & DEDICATED PURGE & VENT NETWORK

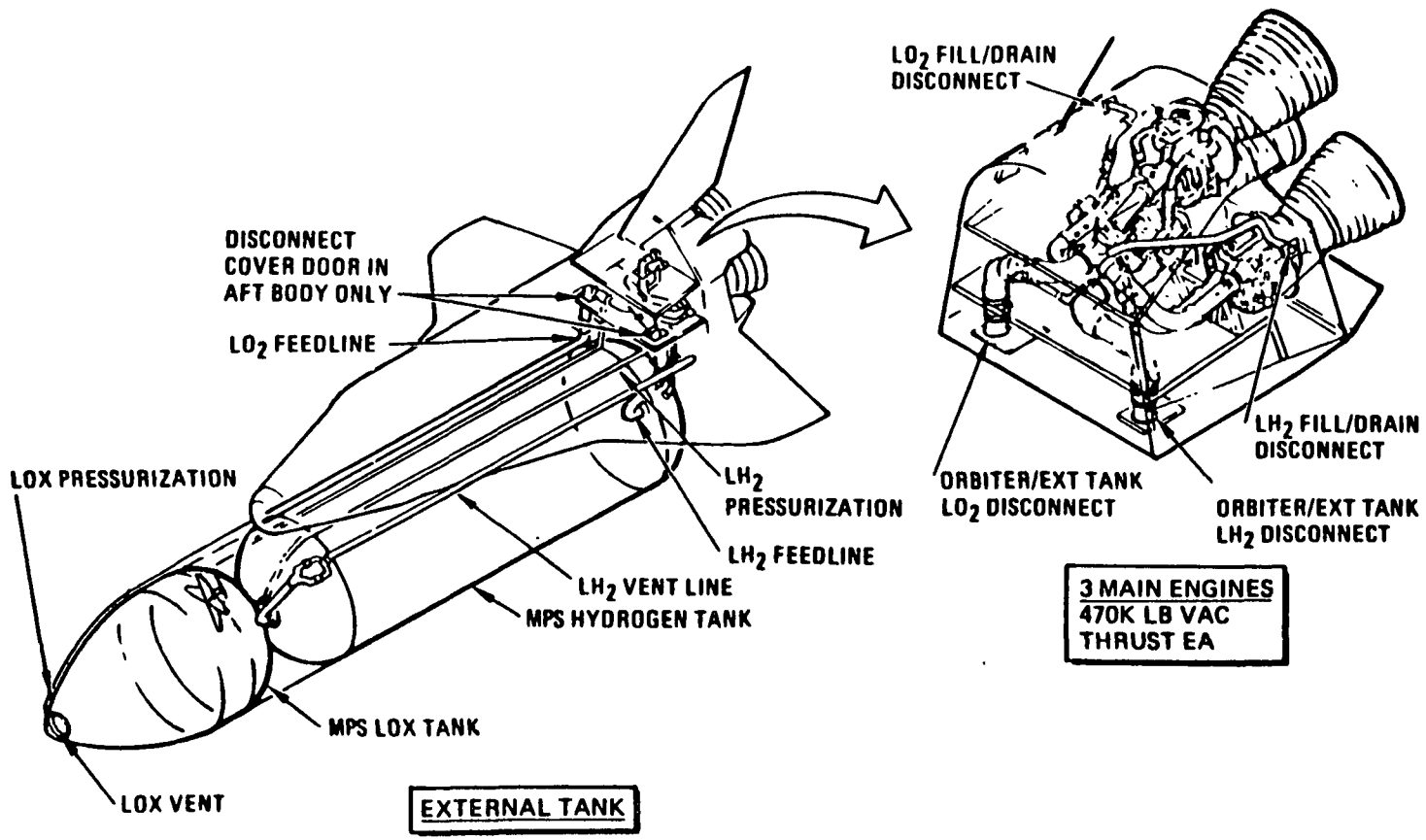



NO ENVIRONMENTAL PROTECTION
- RADIATORS OPEN
- EXCESS POTABLE WATER DUMP

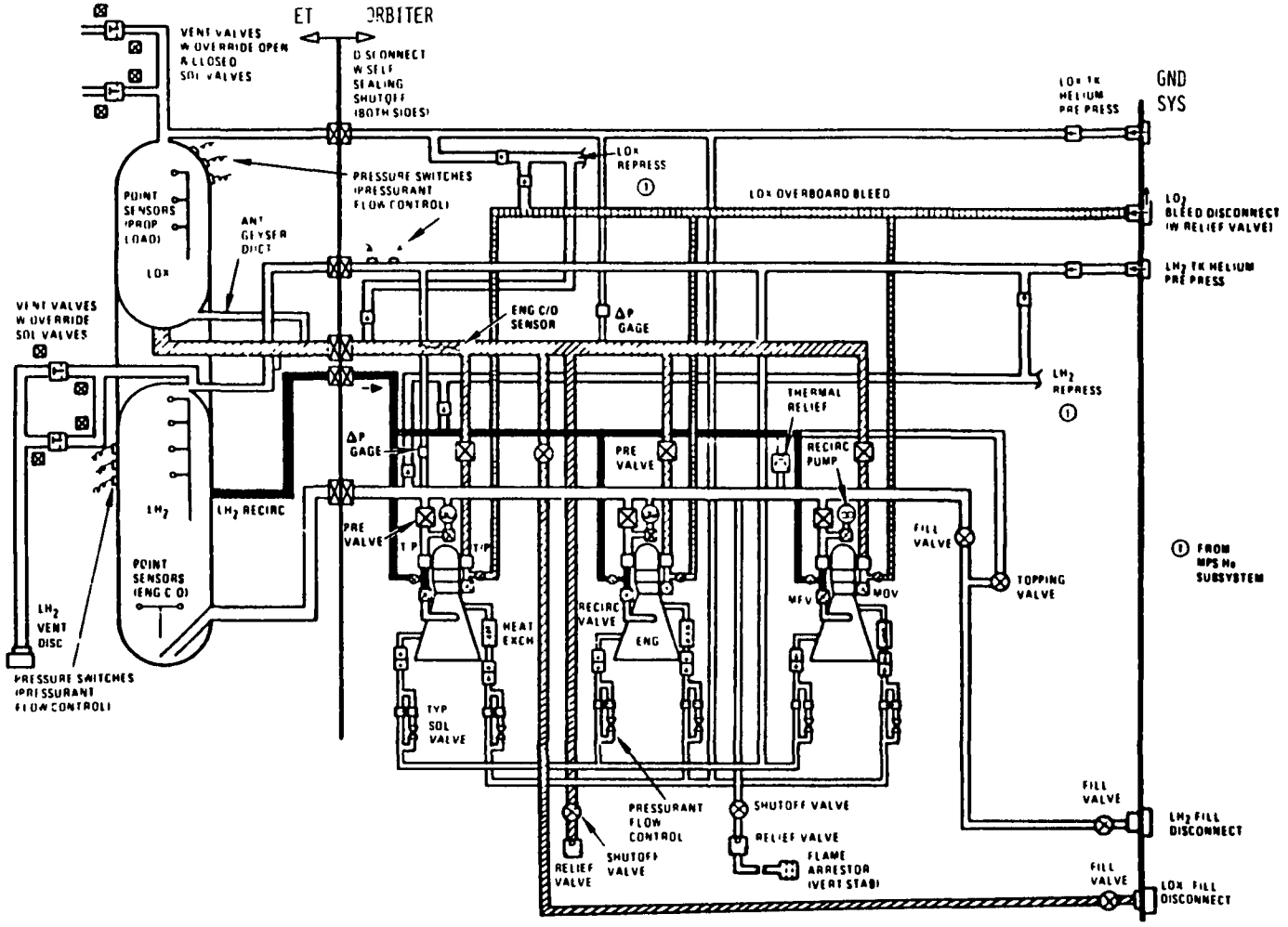
# ORBITER THERMAL PROTECTION SYSTEM

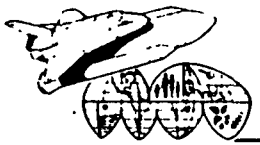


# ORBITER MAIN PROPULSION SUBSYSTEM

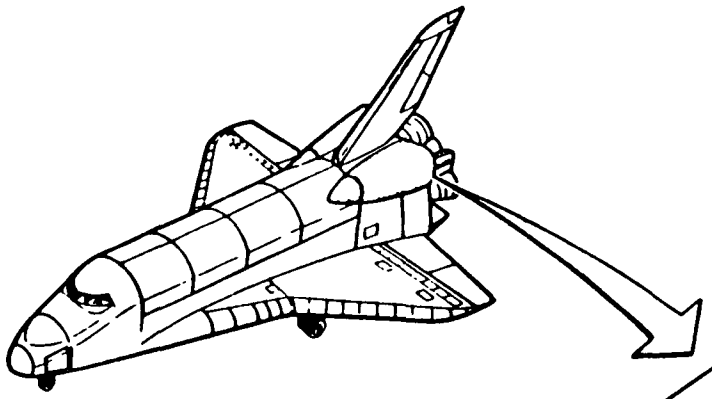


# MAIN PROPULSION SUBSYSTEM SCHEMATIC

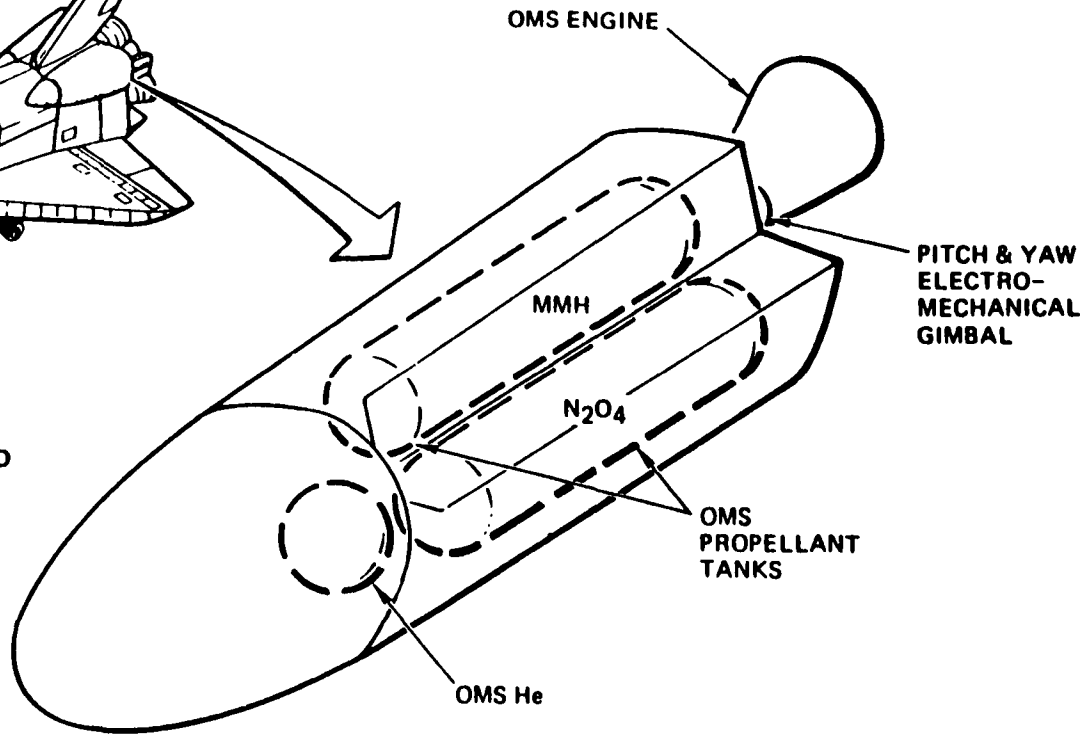


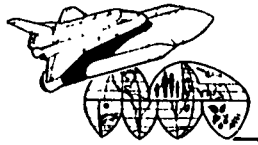


# ORBITAL MANEUVERING SUBSYSTEM



- TWO PODS, $\Delta V$ = 1000 FPS
- $F_{VAC}$ = 6000 LB/POD
- $N_2O_4$/MMH
- $W_P$ = 11,940 LB USABLE/POD
- CROSS-OVER LINES BETWEEN PODS
- PAYLOAD BAY KIT FOR $\Delta V$ >1000 FPS

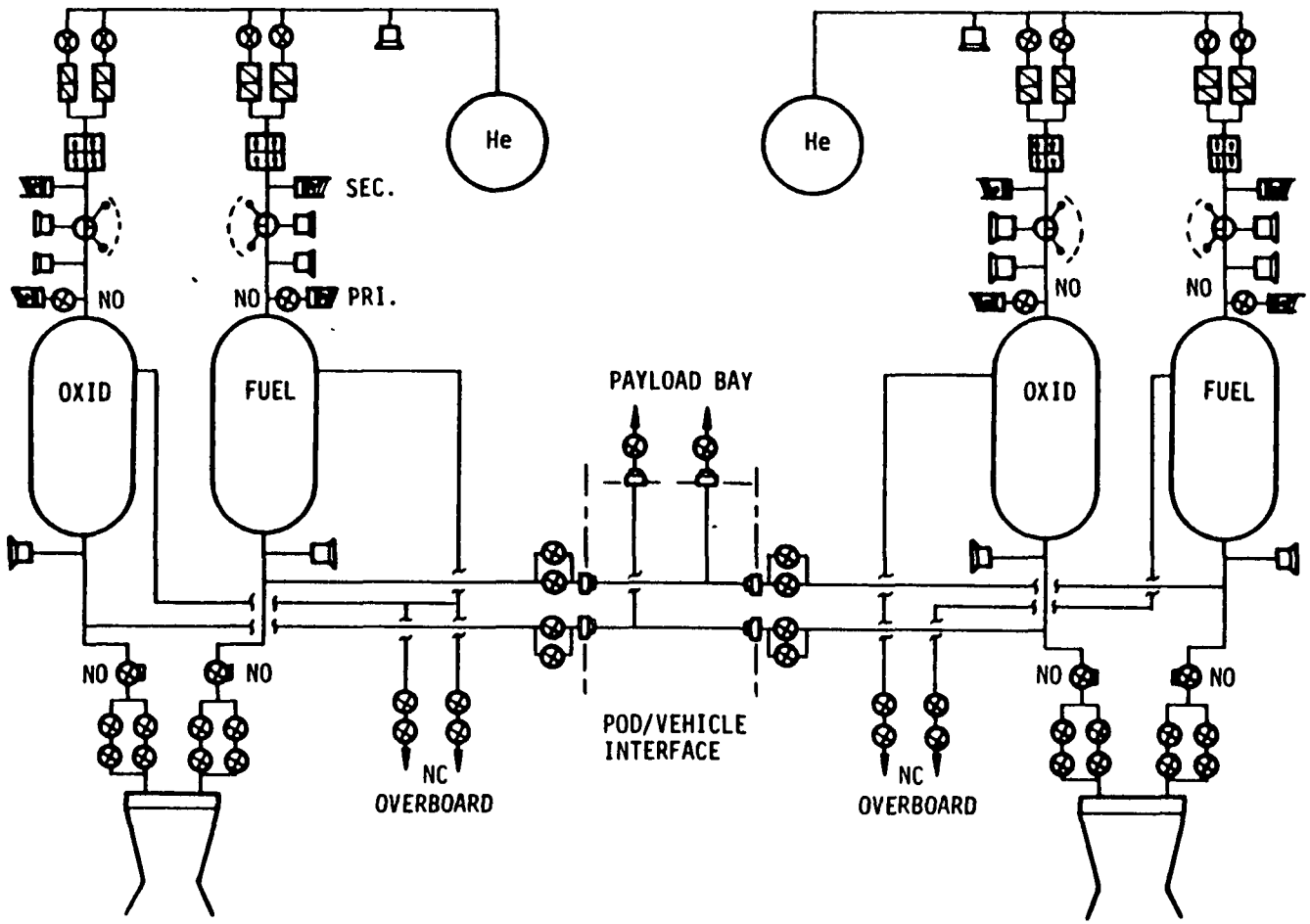




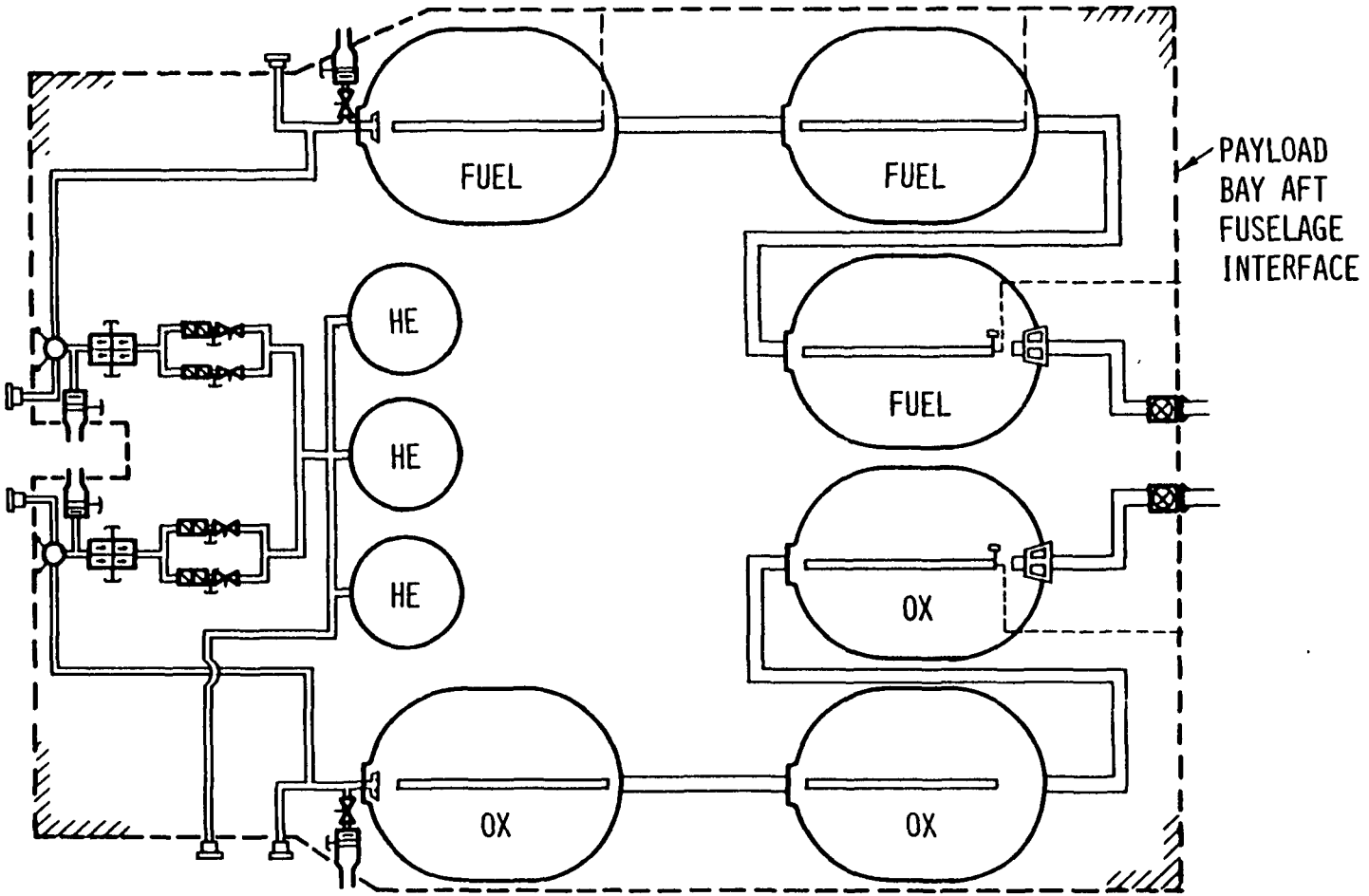
# ORBITAL MANEUVER SUBSYSTEM CAPABILITY

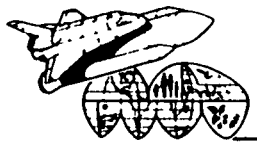
- PROPULSIVE THRUST FOR:
  - ORBIT INSERTION
  - ORBIT CIRCULARIZATION
  - ORBIT TRANSFER
  - RENDEZVOUS
  - DEORBIT
- $\Delta V$ (BASIC) = 1000 FT/SEC WITH 65,000 LB PAYLOAD
- AUXILIARY PROPELLANT IN PAYLOAD BAY PROVIDES ADDITIONAL $\Delta V$ CAPABILITY OF 1500 FT/SEC

# ORBITAL MANEUVER SUBSYSTEM (BASELINE)



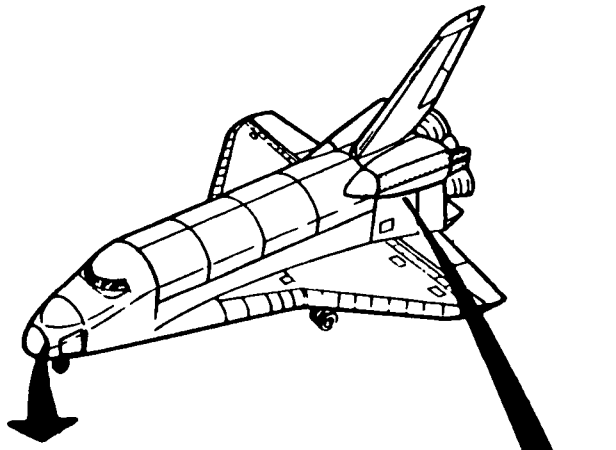
# OMS PAYLOAD BAY KIT

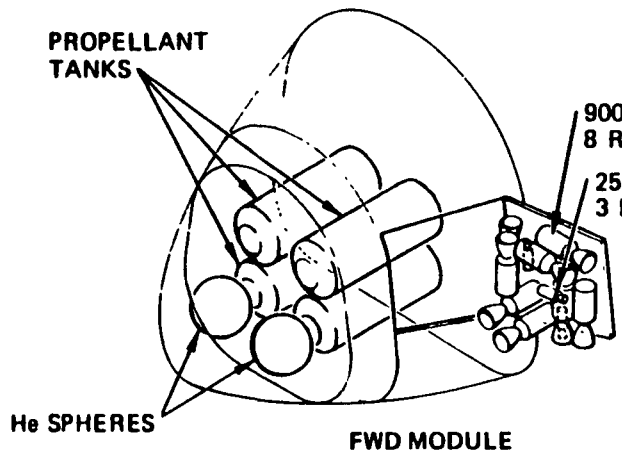


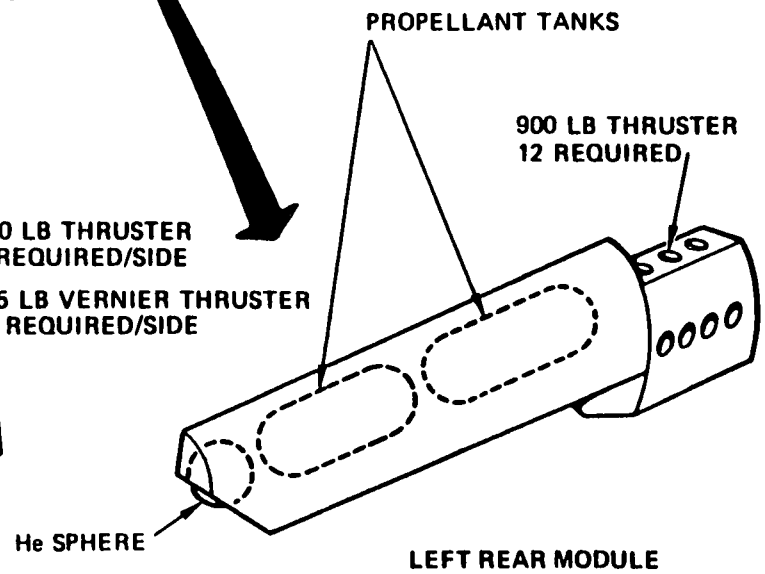


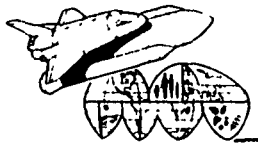
# ORBITER REACTION CONTROL SUBSYSTEM

- 1 FWD MODULE, 2 AFT MODULES
- $F_{VAC}$ = 900 LB
- 40 THRUSTERS & 6 VERNIERS
- $N_2O_4$/MMH







# RCS PERFORMANCE & CAPABILITY SUMMARY

- MAIN THRUSTER

  THRUST LEVEL = 900 LB  $I_{SP}$ = 289 SEC  MIB = 15.8 $LB_F$ SEC  $\epsilon$ = 20:1
  FORWARD MODULES = 16  AFT MODULES = 24  TOTAL = 40

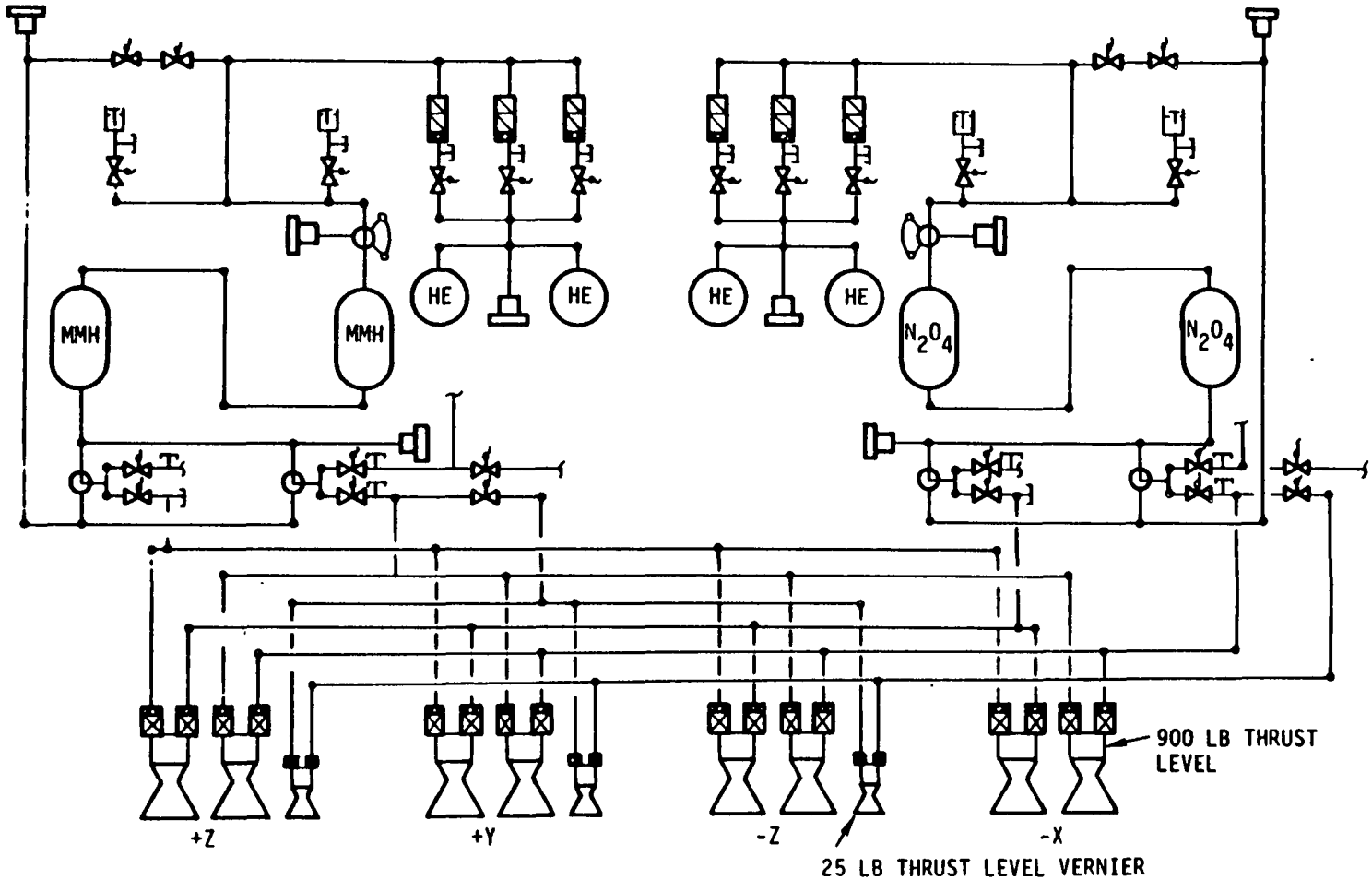
- VERNIER THRUSTER

  THRUST LEVEL = 25 LB  $I_{SP}$ = 228 SEC  MIB = 0.75 $LB_F$ SEC  $\epsilon$ = 40:1
  FORWARD MODULES = 6  AFT MODULES = 0  TOTAL = 6

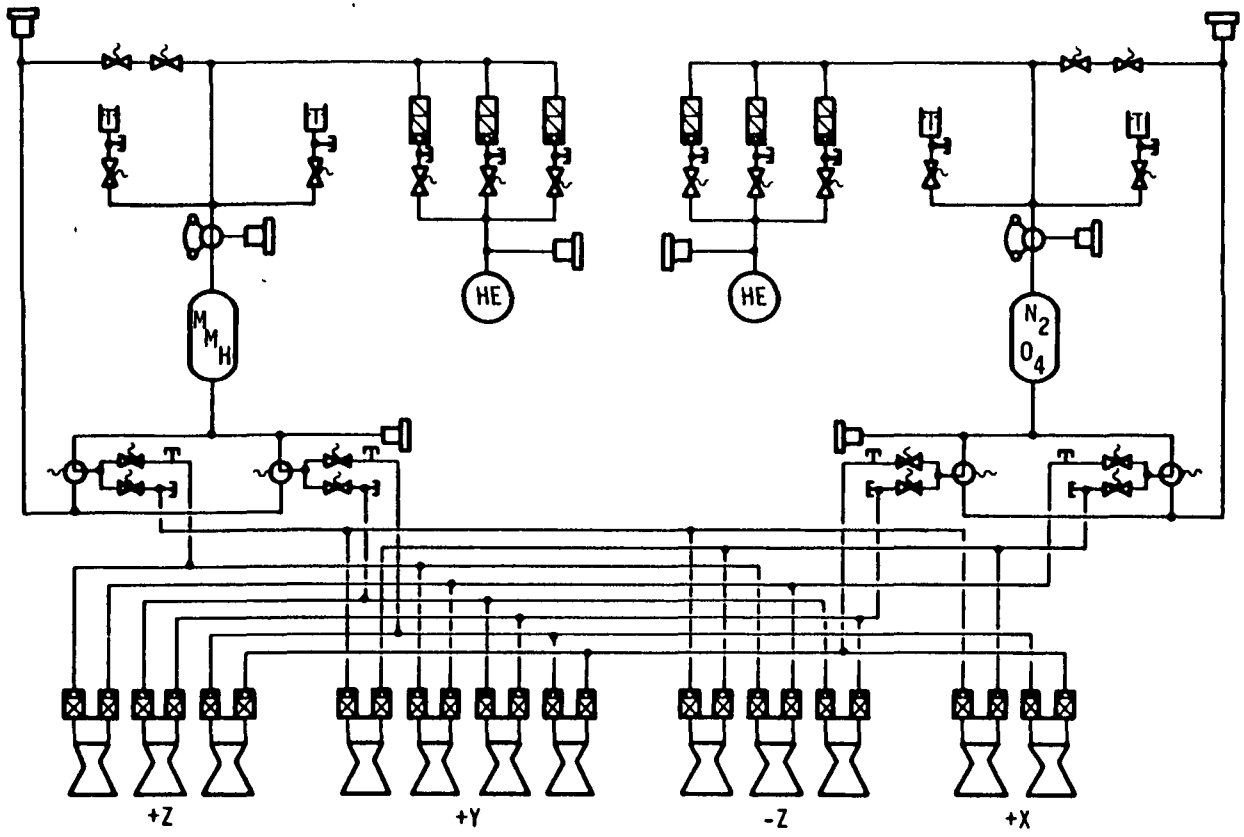
- PROPELLANT: $N_2O_4$/MMH

| | | FORWARD MODULES | AFT MODULES (TOTAL) |
|---|---|---|---|
| MAX CAPACITY | MISSION REQMT, LB | 2576 | 2702 |
| MISSION NO. 4 | TOTAL LOADED, LB | 3003 | 3241 |
| VEHICLE SIZING MISSION | MISSION REQMT, LB | 1245 | 2297 |
| MISSION NO. 3A | TOTAL LOADED, LB | 1566 | 2806 |

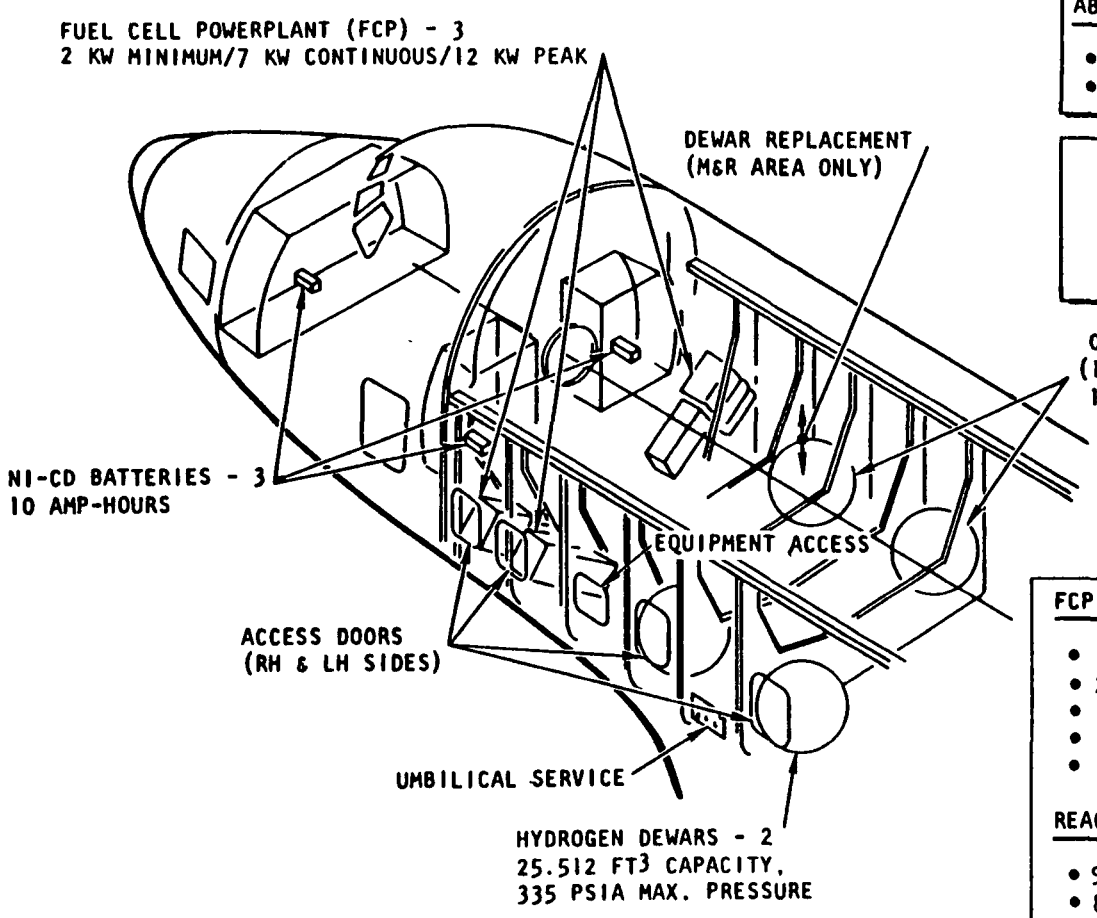
# ORBITER RCS SUBSYSTEM SCHEMATIC
## FORWARD MODULE LEFT DOOR THRUSTERS ONLY SHOWN



# ORBITER RCS SUBSYSTEM SCHEMATIC AFT MODULE



# ORBITER ELECTRICAL POWER SUBSYSTEM




**ABE DRIVEN AC GENERATORS - 3**

- FERRY ONLY
- 75/90 KVA, 120/208 VAC, 400 HZ

**DFI BATTERY ASSEMBLY**

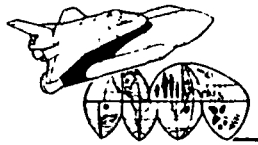
- 1726 WH; 982 WATTS
- 3 APOLLO ENTRY & POST-LANDING BATTERIES

**FCP SUBSYSTEM**

- 14 KW CONTINUOUS/24 KW PEAK
- 27.5 TO 32.5 VDC
- 1677 KWH MISSION ENERGY
- 282 KWH ABORT/SURVIVAL ENERGY
- 100 LB $O_2$ ALLOTTED TO ECLSS

**REACTANT STORAGE**

- 98 LB $H_2$/TANK
- 834 LB $O_2$/TANK



# ORBITER ELECTRICAL POWER SUBSYSTEM (EPS)
## SUBSYSTEM CAPABILITY

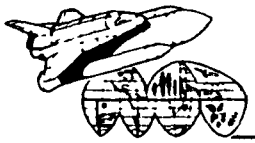
- PRIME POWER - 3 FUEL CELLS
  - FAIL OPERATIONAL/FAIL SAFE
  - OPERATIONAL POWER CAPABILITY
    - 14 KW CONTINUOUS/24 KW PEAK (2 OR 3 FUEL CELLS)
    - CONTINUOUS POWER CAPABILITY HEAT REJECTION LIMITED BY RADIATORS
  - FAIL SAFE POWER CAPABILITY
    - 7 KW CONTINUOUS/12 KW PEAK (1 FUEL CELL)

- EMERGENCY POWER - 3 NI-CD BATTERIES (10 AH EACH)
  - EMERGENCY PRIME POWER RESET
  - CRITICAL CREW DISPLAYS & LIGHTING

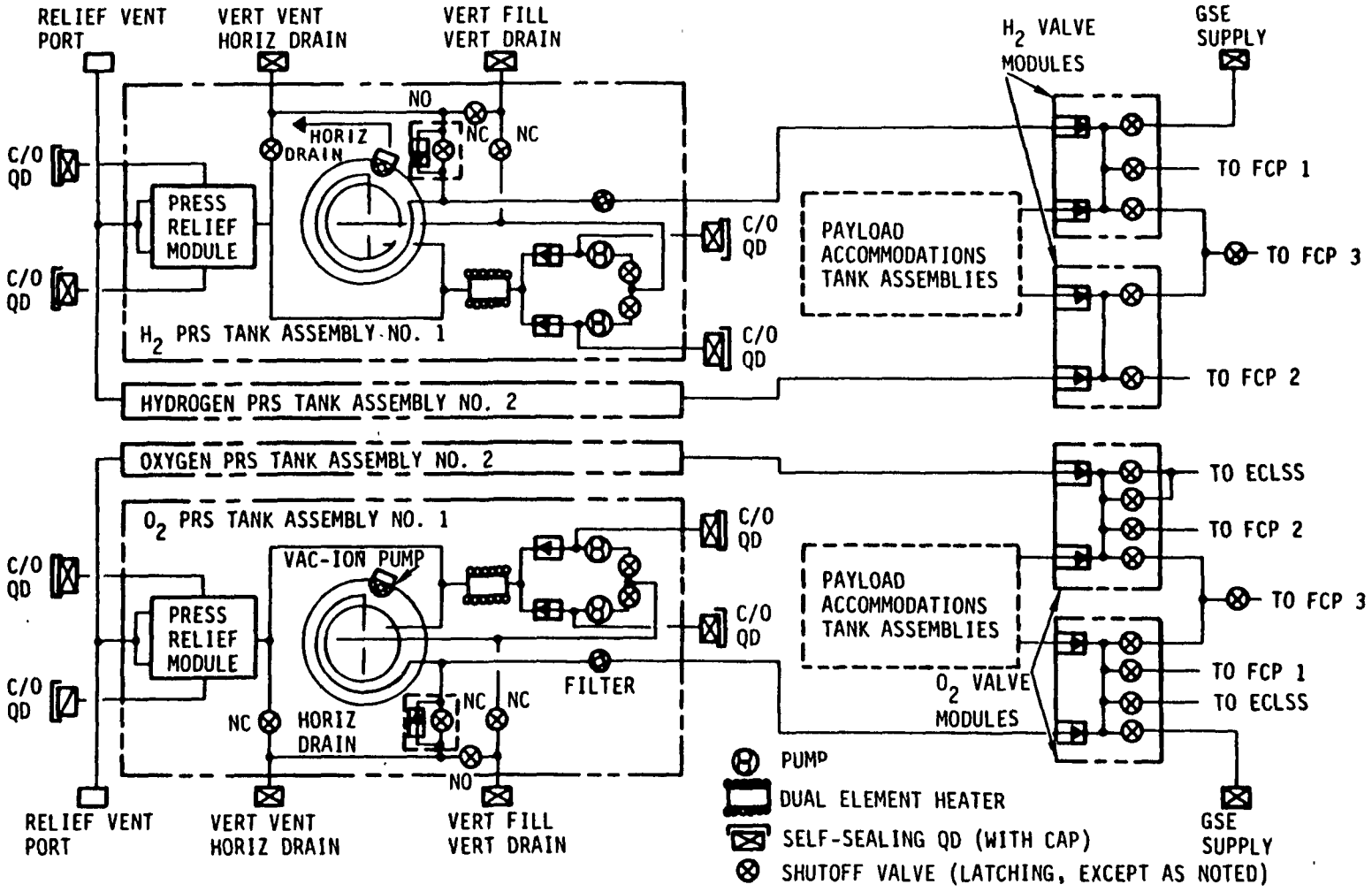
- FERRY FLIGHTS - 3 AC GENERATORS (75 KVA EACH)
  - FAIL OPERATIONAL/FAIL SAFE

- DEVELOPMENT FLIGHT INSTRUMENTATION (DFI) - 1 BATTERY PACKAGE (3 BATTERIES)
  - CONTINGENCY POWER SOURCE FOR DFI
  - UP TO 982 WATTS/1726 WATT-HOURS

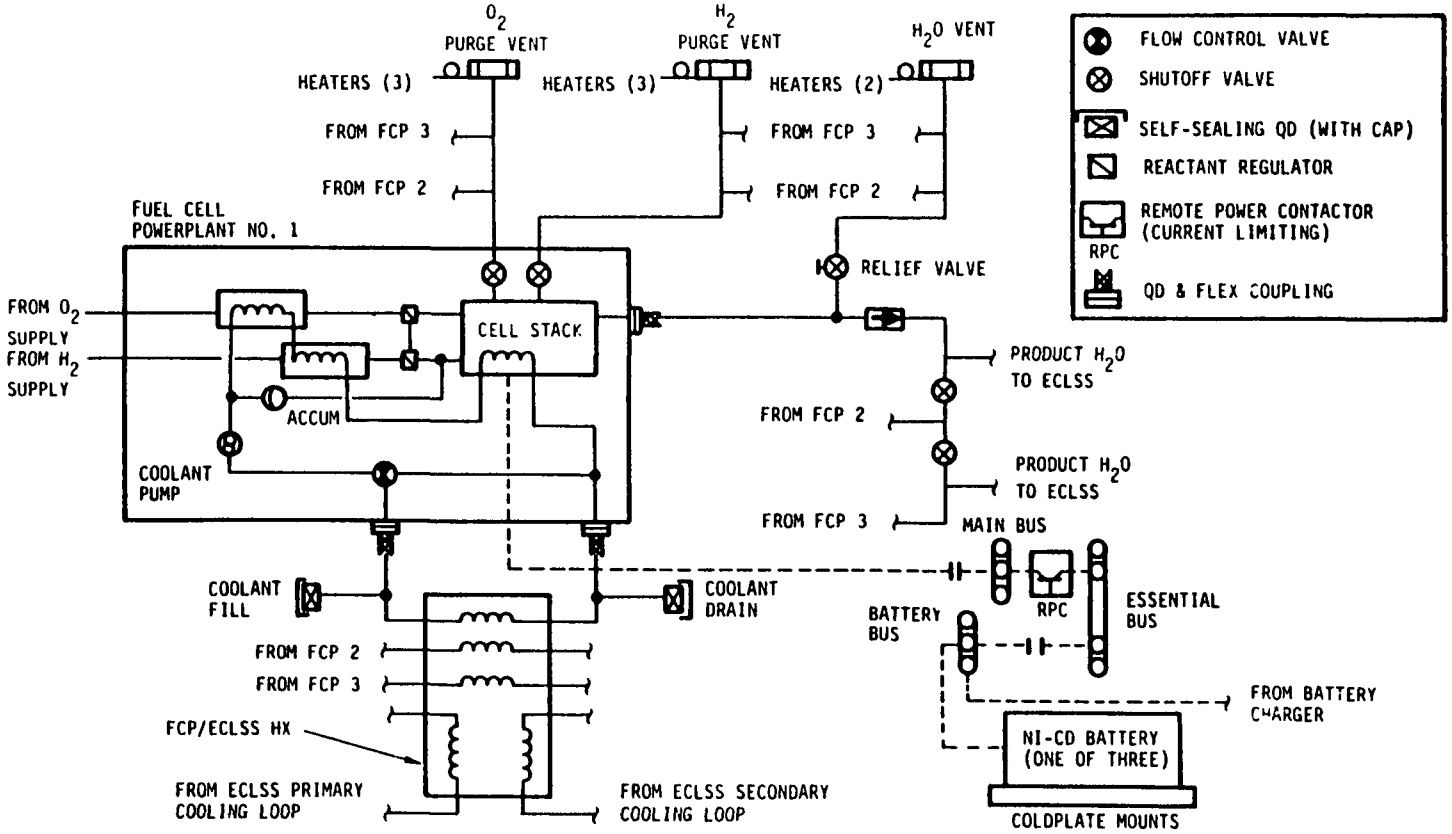
- REACTANT STORAGE
  - SUPERCRITICAL STORAGE DEWARS (OXYGEN & HYDROGEN)
  - FAIL SAFE
  - SELECTED COMPONENTS - FAIL OPERATIONAL/FAIL SAFE
  - SIZING
    - 7 DAY ORBITER OPERATION (1677 KWH)
    - PAYLOAD ALLOTMENT (50 KWH) - INCLUDED ABOVE
    - 96 HOUR SURVIVAL (282 KWH) - BOTH TANKS OPERATIONAL
    - 7 DAY ECLSS SUPPLY (100 LB $O_2$)

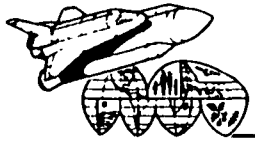


# ELECTRICAL POWER SUBSYSTEM SCHEMATIC
## POWER REACTANT STORAGE & DISTRIBUTION (PRSD)



# ELECTRICAL POWER SUBSYSTEM FUEL CELL POWERPLANT (FCP)



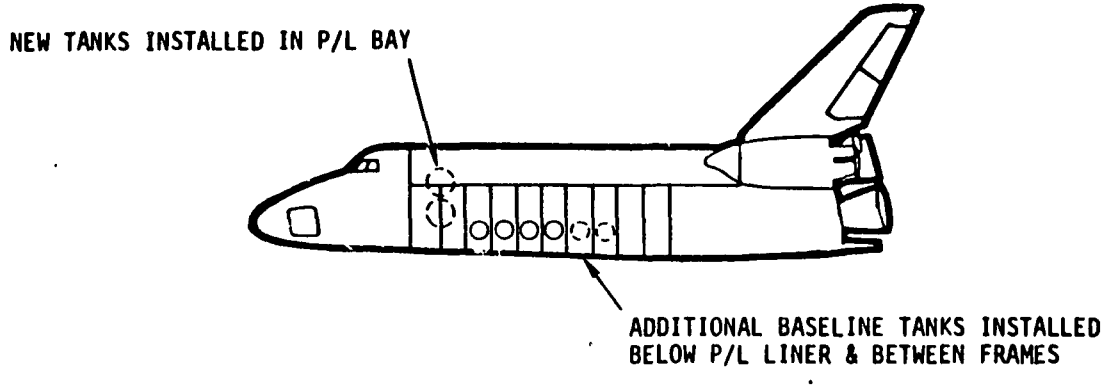


# ORBITER ELECTRICAL POWER SUBSYSTEM (EPS)
## PAYLOAD POWER & ENERGY

### BASELINE CAPABILITY

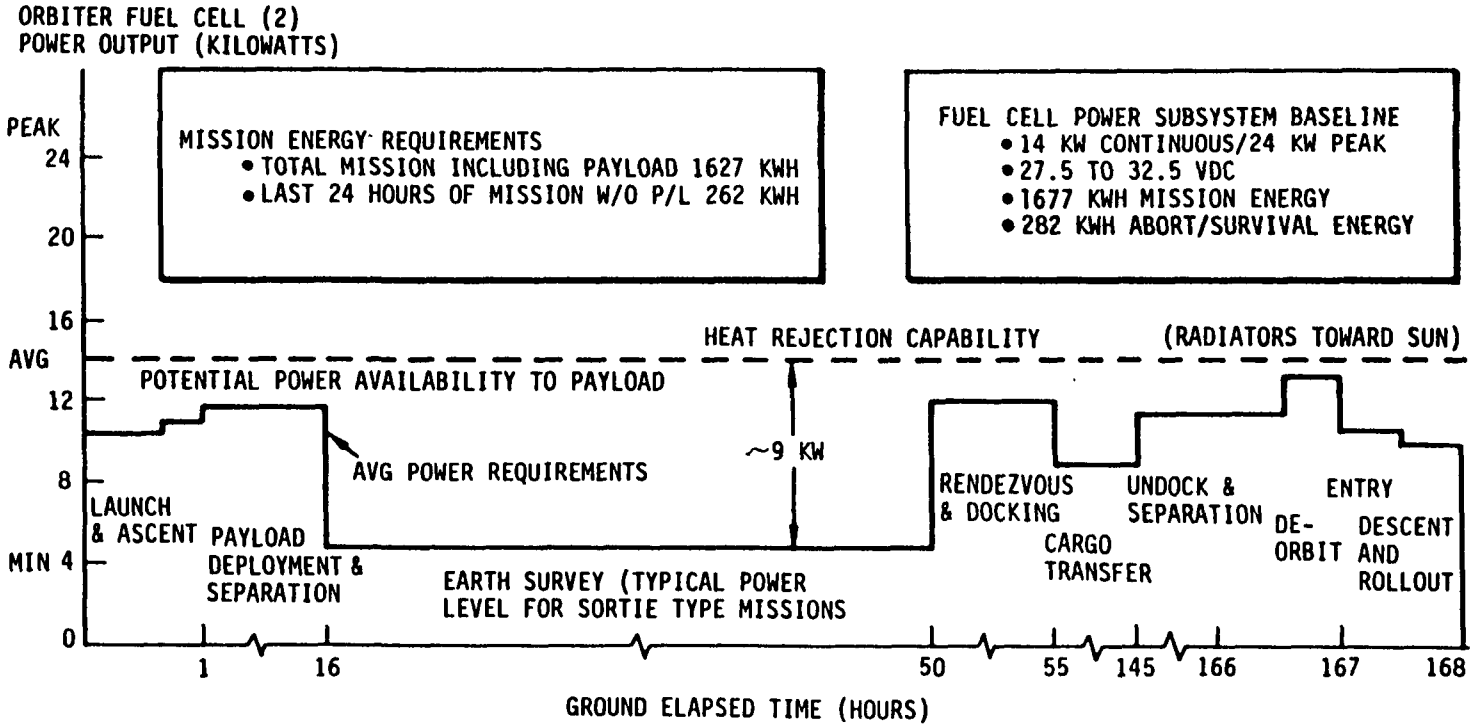
- ENERGY - 50 KWH
- POWER - 1 KW AVERAGE/1.5 KW PEAK (AVAILABLE ALL MISSION PHASES)
  3 KW AVERAGE/6 KW PEAK (AVAILABLE ON ORBIT - MOST MISSION PHASES)

### OPTIONAL EXTENSION CAPABILITY

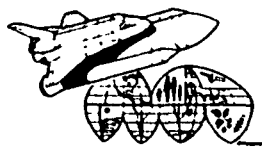


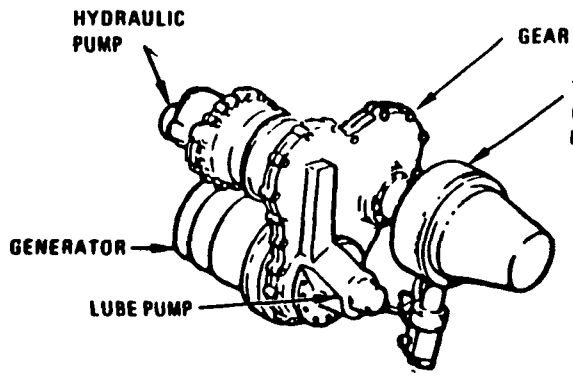
# ELECTRICAL POWER PROFILE
## EXAMPLE OF A COMPOSITE OF ALL KNOWN ORBITAL ACTIVITIES IN A 7-DAY POLAR MISSION

- BASELINE ENERGY TO PAYLOAD - 50 KWH
- BASELINE POWER TO PAYLOAD
  - 1.0 KW (AVG) | DURING CRITICAL ORBITER PHASES
  - 1.5 KW (PEAK) | DURING CRITICAL ORBITER PHASES
  - 3.0 KW (AVG) | DURING NON-CRITICAL (ON-ORBIT) ORBITER PHASES
  - 6.0 KW (PEAK) | DURING NON-CRITICAL (ON-ORBIT) ORBITER PHASES



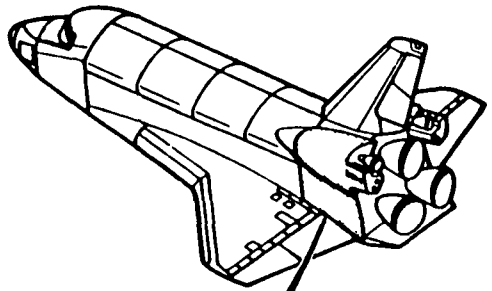
# ORBITER AUXILIARY POWER UNIT SUBSYSTEM

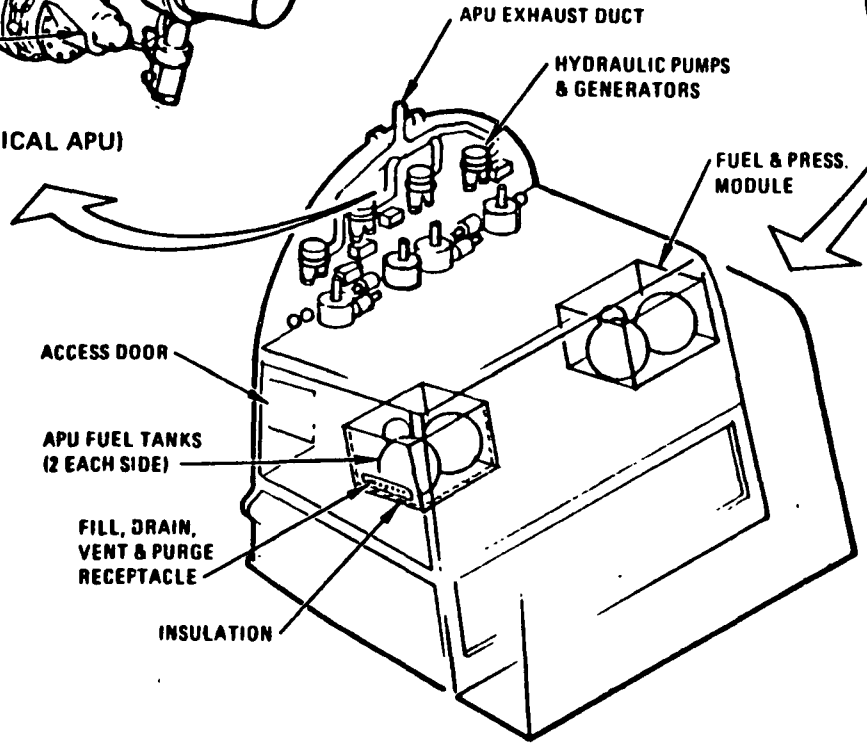





(TYPICAL APU)

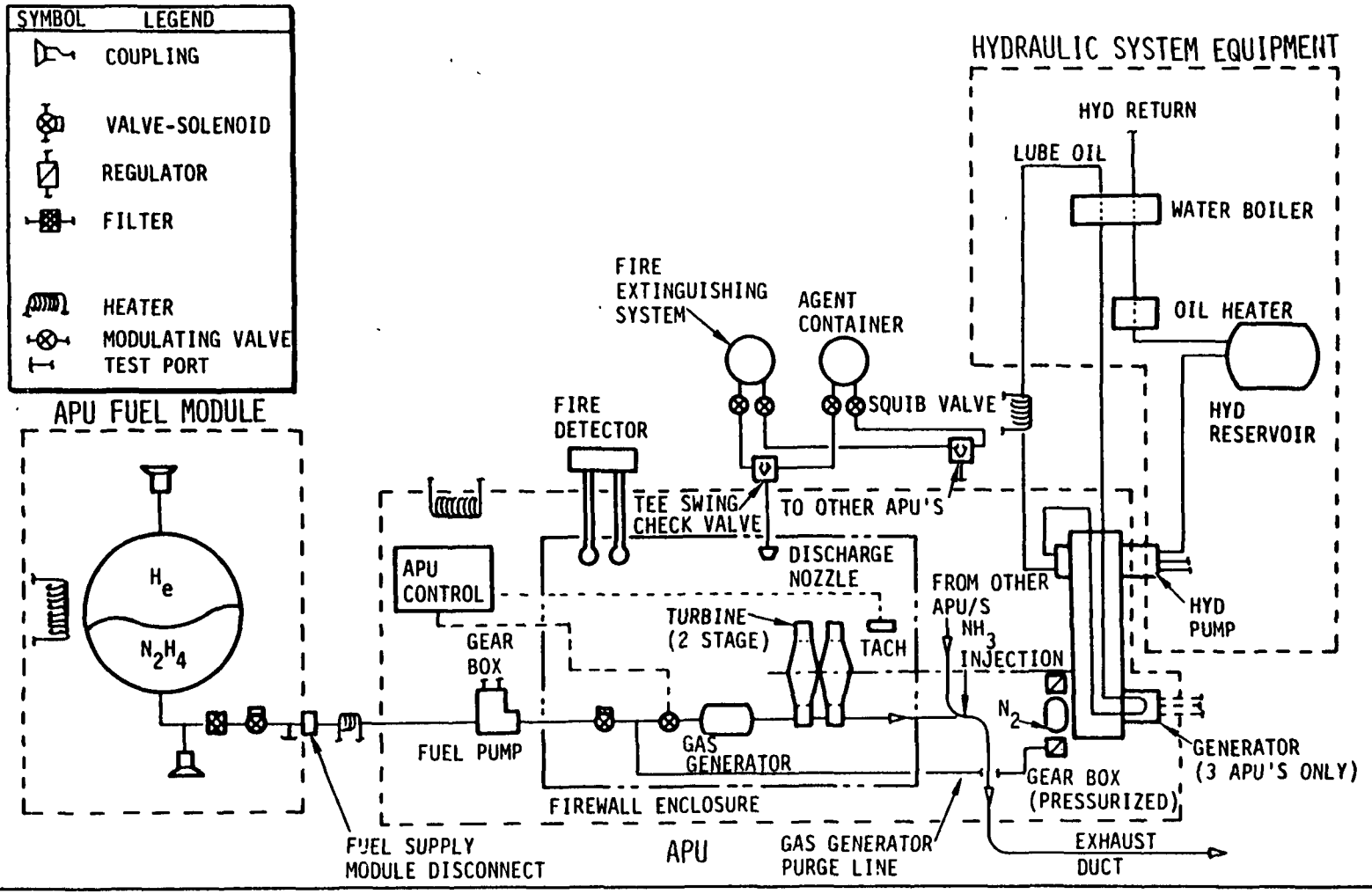
- 10 YEAR LIFE
- 100 REUSES

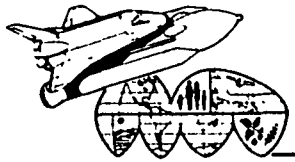




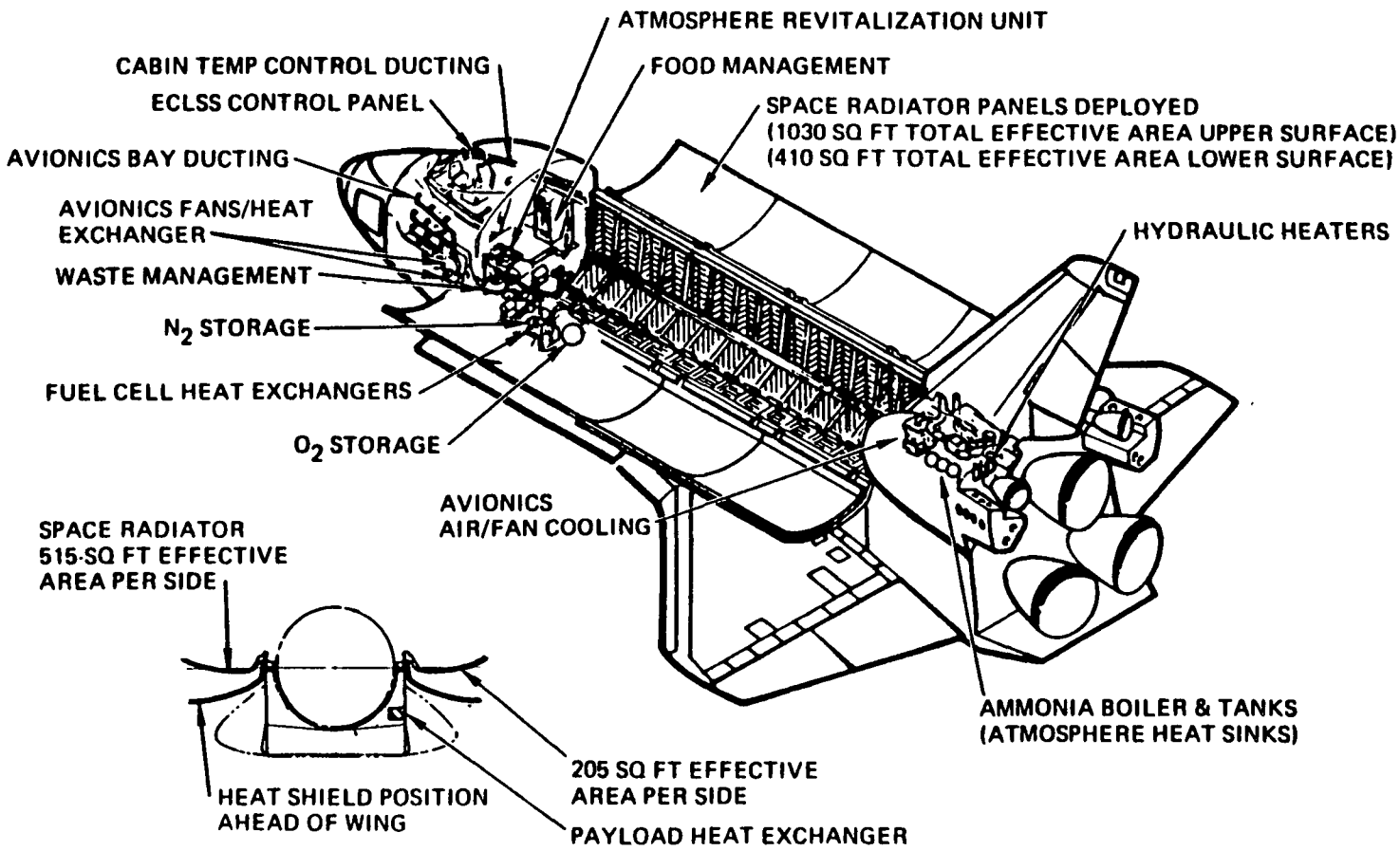

- 4 INDEPENDENT SYSTEMS
- 150 HP/APU
  - ONE 60 GPM, 3000 PSI HYD PUMP
  - 5 KVA GENERATOR
- MONOPROPELLANT
  - HYDRAZINE ($N_2H_4$)

# AUXILIARY POWER UNIT SUBSYSTEM

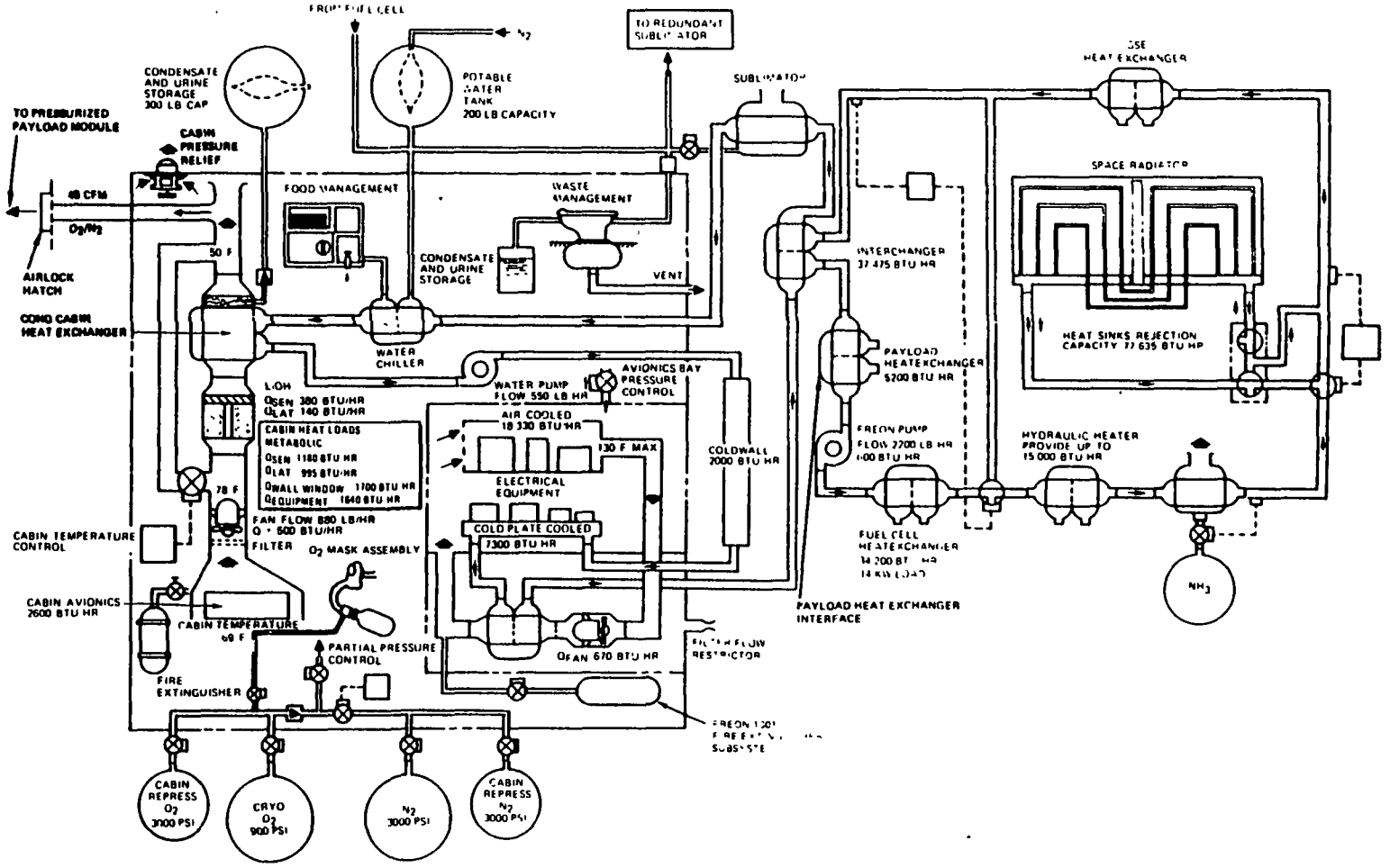


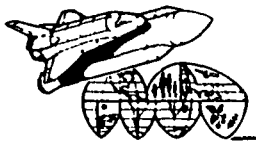


# ENVIRONMENTAL CONTROL & LIFE SUPPORT SYSTEM

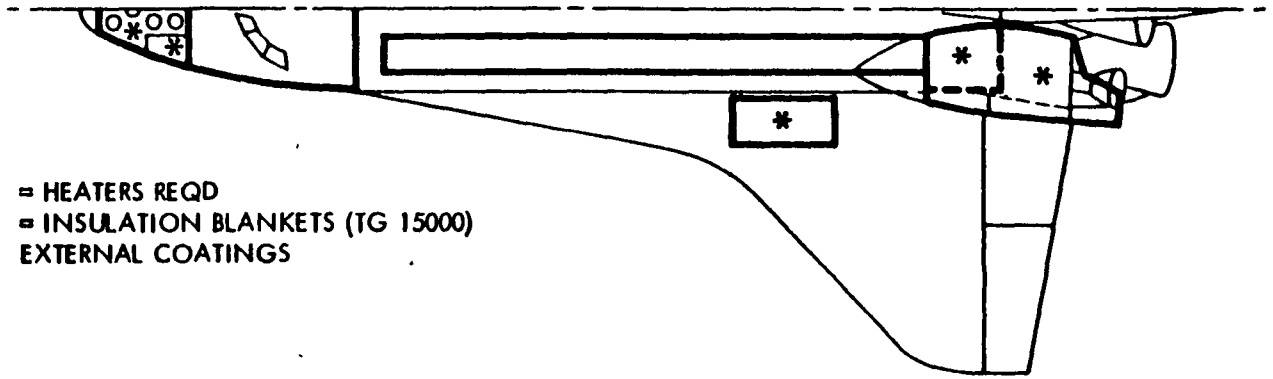


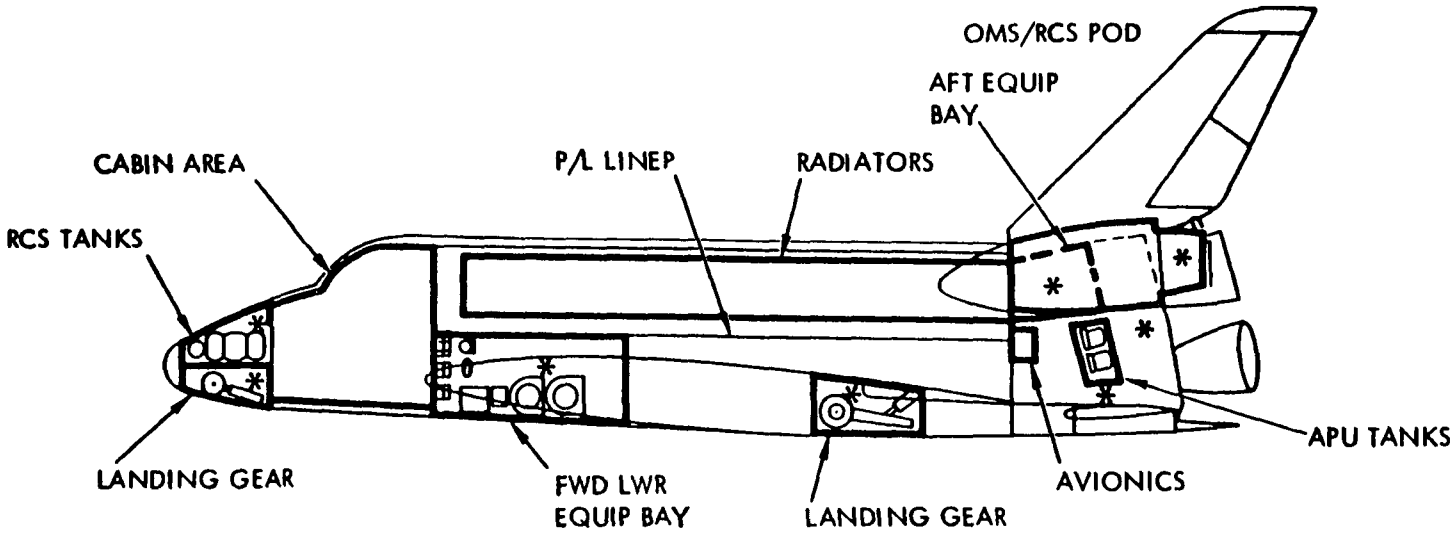
# ENVIRONMENTAL CONTROL & LIFE SUPPORT



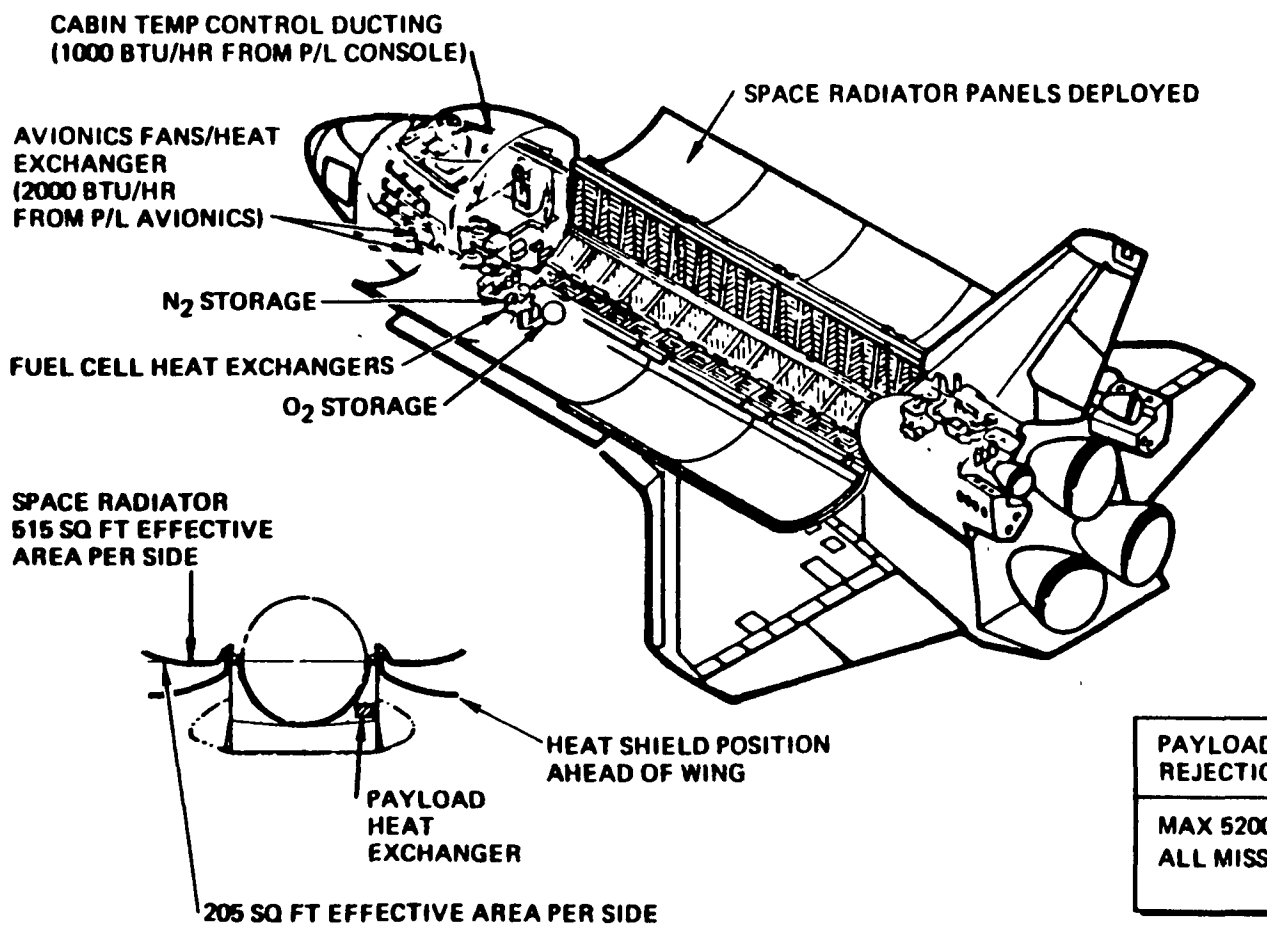


# ORBITER THERMAL CONTROL SUBSYSTEM



# PAYLOAD HEAT REJECTION



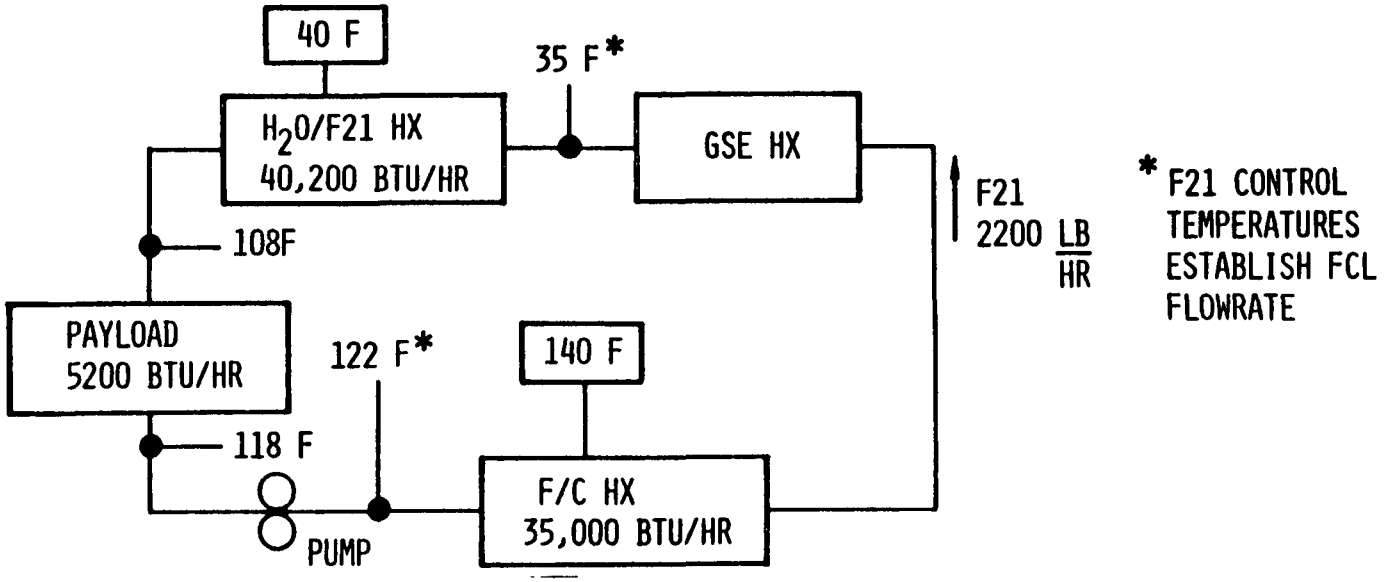

| PAYLOAD HEAT LOAD REJECTION CAPABILITY: |
| --- |
| MAX 5200 BTU/HR<br>ALL MISSION PHASES |

# PAYLOAD HEAT REJECTION REQMTS TRADE

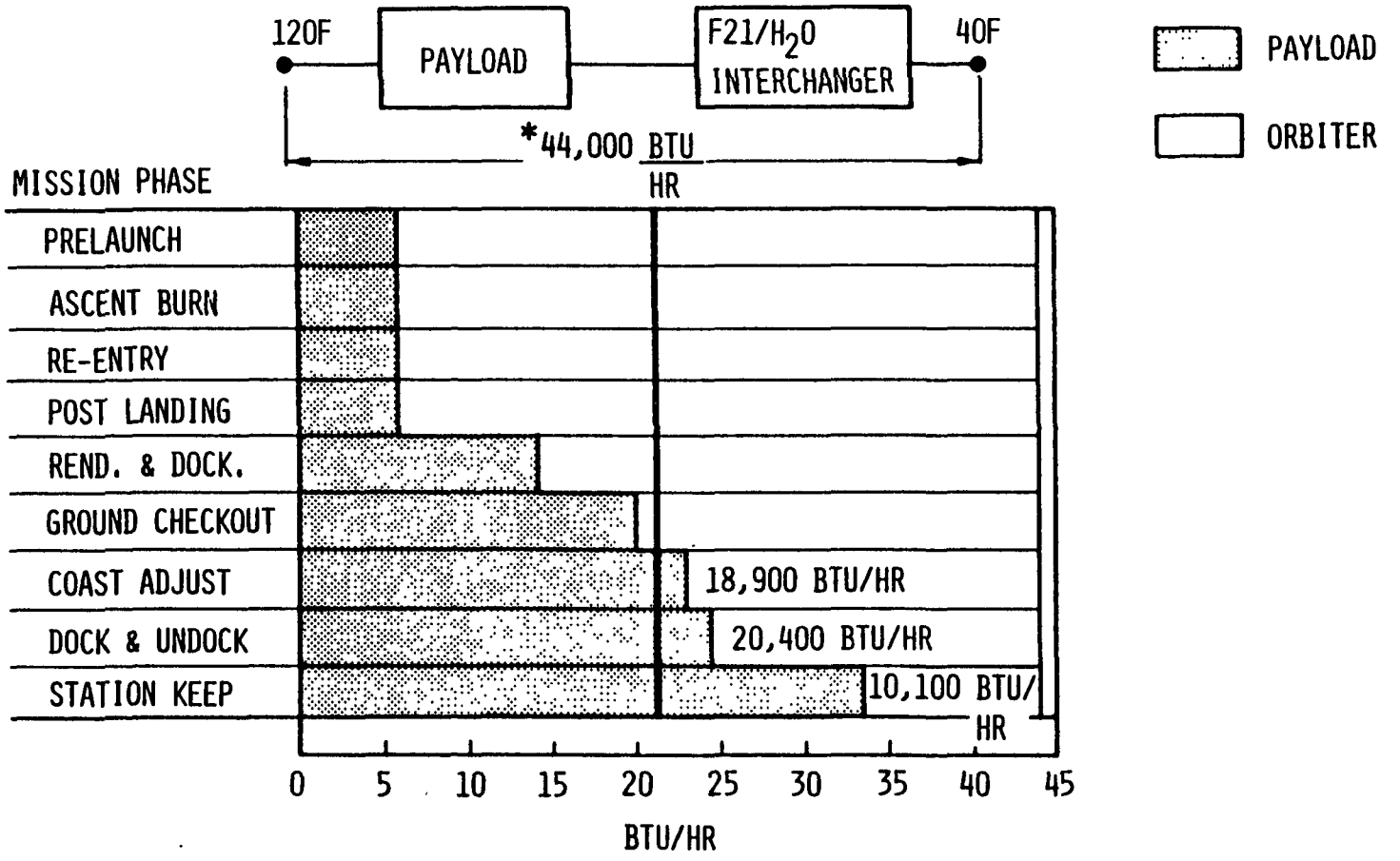
- OBJECTIVE: DETERMINE BASELINE HEAT REJECTION SUBSYSTEM CAPABILITY TO HANDLE 21,500 BTU/HR FROM PAYLOAD

- FCL DESIGN CONDITIONS

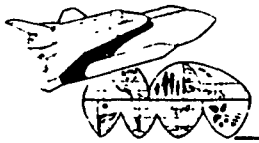
  PRELAUNCH WITH 10 MAN CREW



# TYPICAL MISSION PHASES




*FUEL CELLS NOT INCLUDED



# CONCLUSIONS

21,500 BTU/HR OF PAYLOAD HEAT REJECTION CAN BE PROVIDED

- ASSUMING PAYLOAD HX DESIGN CONDITIONS OF COOLANT (WATER) & FLOW (550 LB/HR)

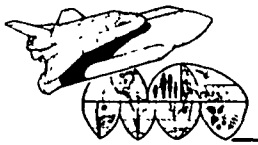
CONDITIONS RESULT IN

- 70 - 90 F PAYLOAD COOLANT TEMPERATURE TO THE HEAT LOAD
- APPROXIMATE WEIGHT INCREASE OF 10 LB FOR A 12 F APPROACH TEMPERATURE HX

FACTORS EFFECTING RECOMMENDATION

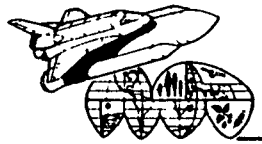
- COOLANT OTHER THAN WATER CAN RESULT IN LARGER HEAT EXCHANGER WEIGHTS
  FREON 21 HAS BEEN CONSIDERED
- LOWER PAYLOAD COOLANT TEMPERATURES DURING NON-CRITICAL PHASE CAN CAUSE ADDED COMPLEXITY TO BOTH ARS & ATCS
- HEAT LOAD ON ARS/ATCS DURING PAYLOAD SUPPORT
  (COAST ADJUST COULD BE TYPICAL)

STUDIES TO CONTINUE

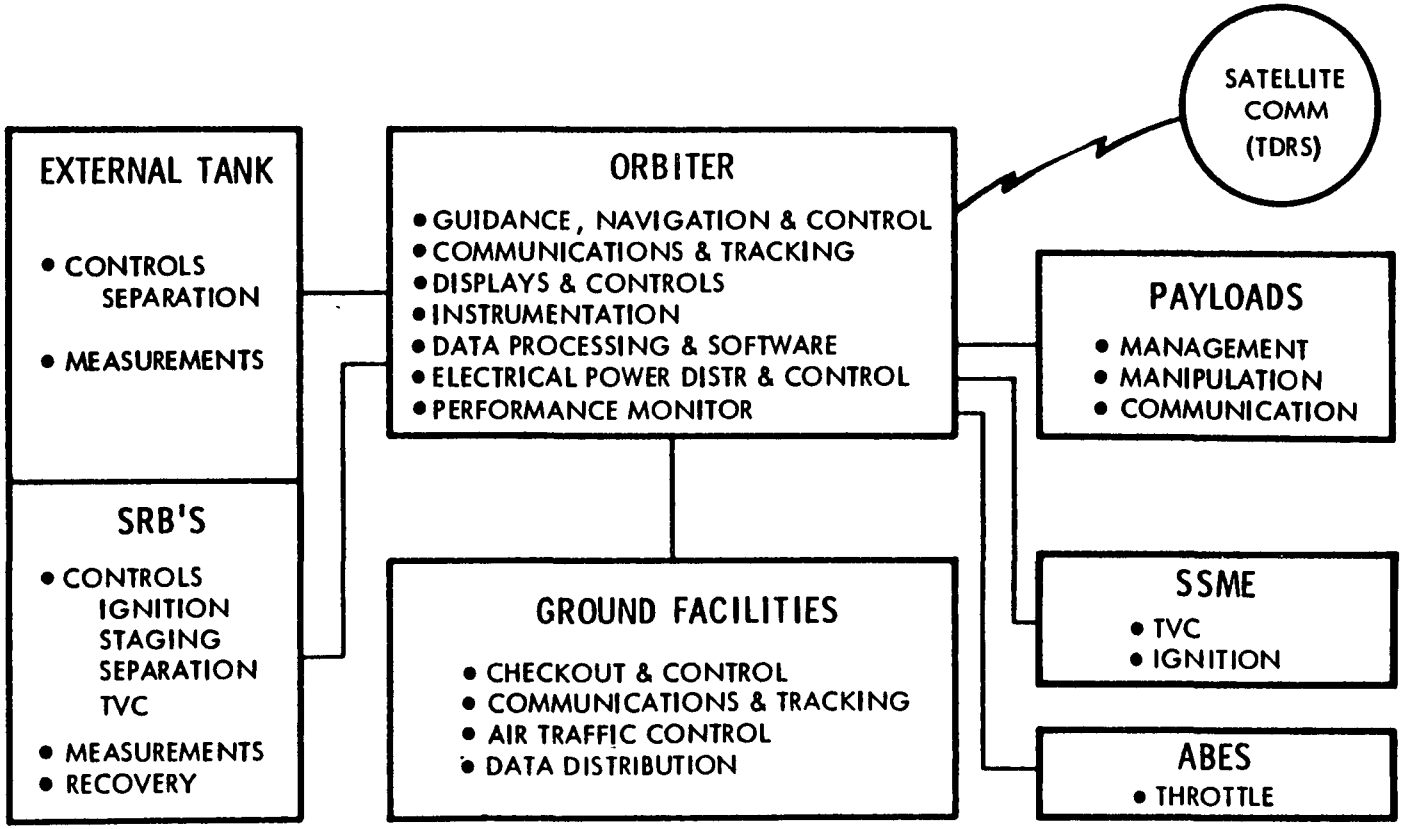


# SPACE SHUTTLE AVIONICS
## AVIONICS SYSTEM FUNCTIONS

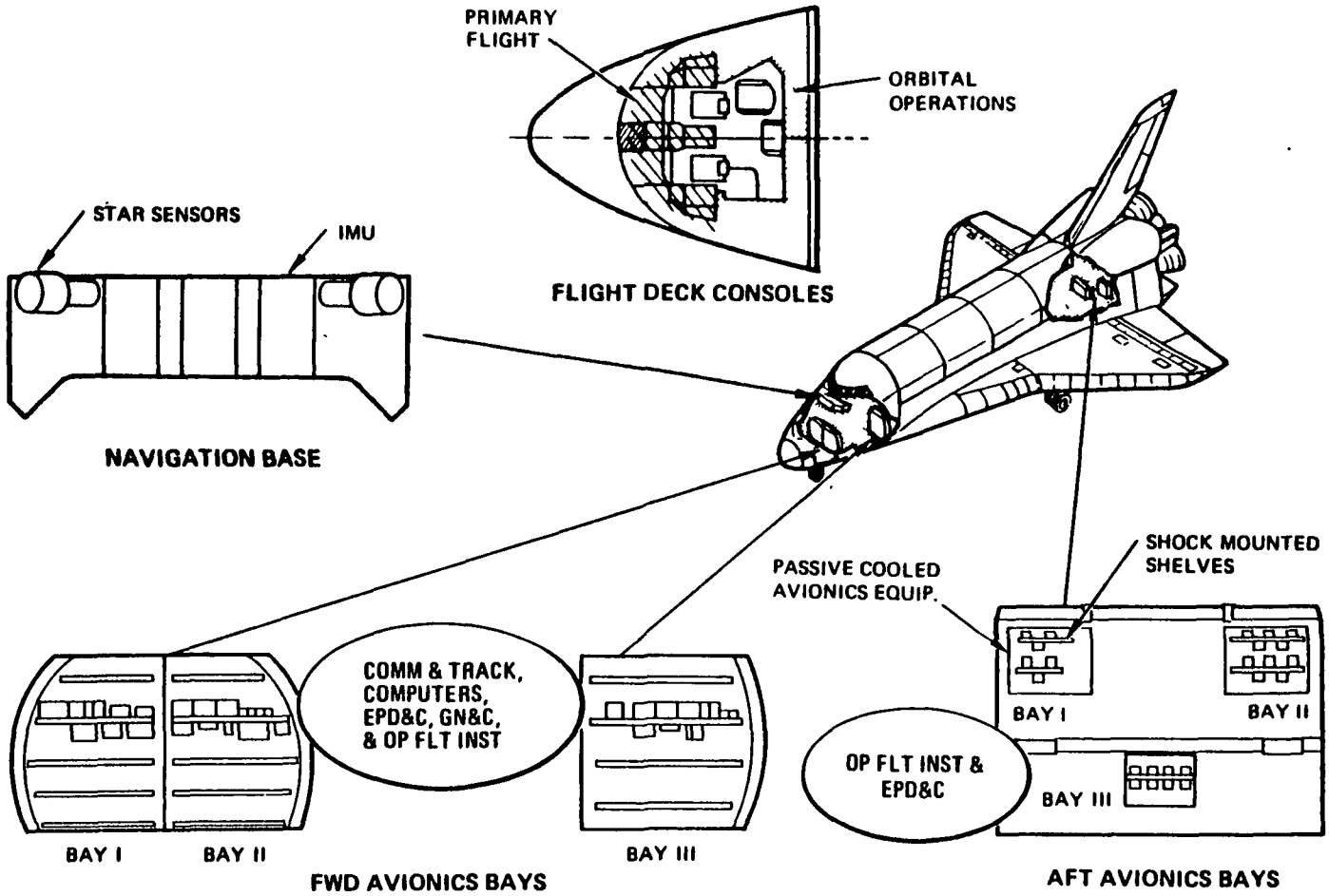
- GUIDANCE NAVIGATION & CONTROL
- COMMUNICATIONS & TRACKING
- DISPLAYS & CONTROLS
- ELECTRICAL POWER DISTRIBUTION & CONTROL
- DATA PROCESSING & SOFTWARE
- INSTRUMENTATION
  - OPERATIONAL & DEVELOPMENT



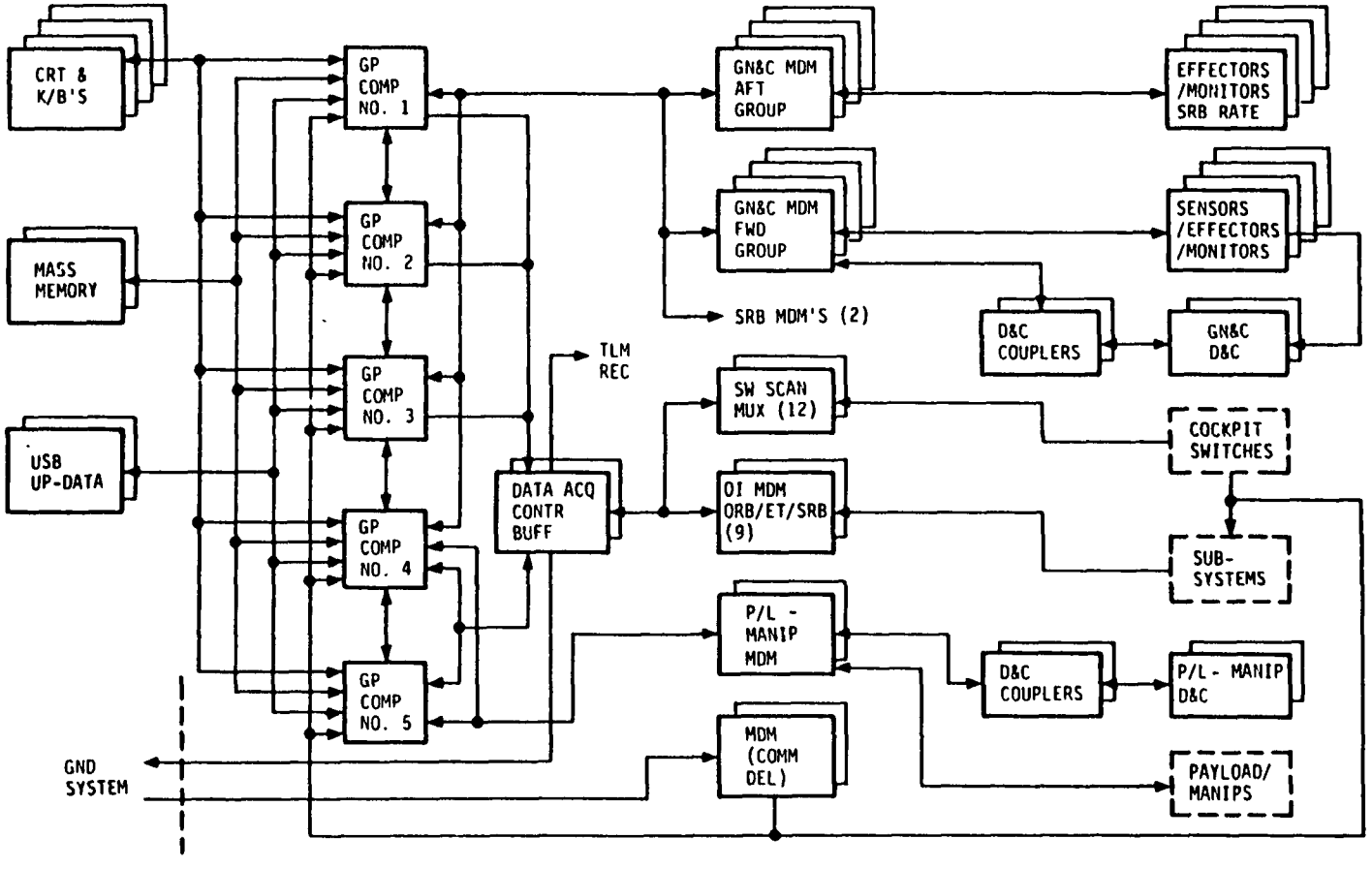
# SHUTTLE SYSTEM AVIONICS



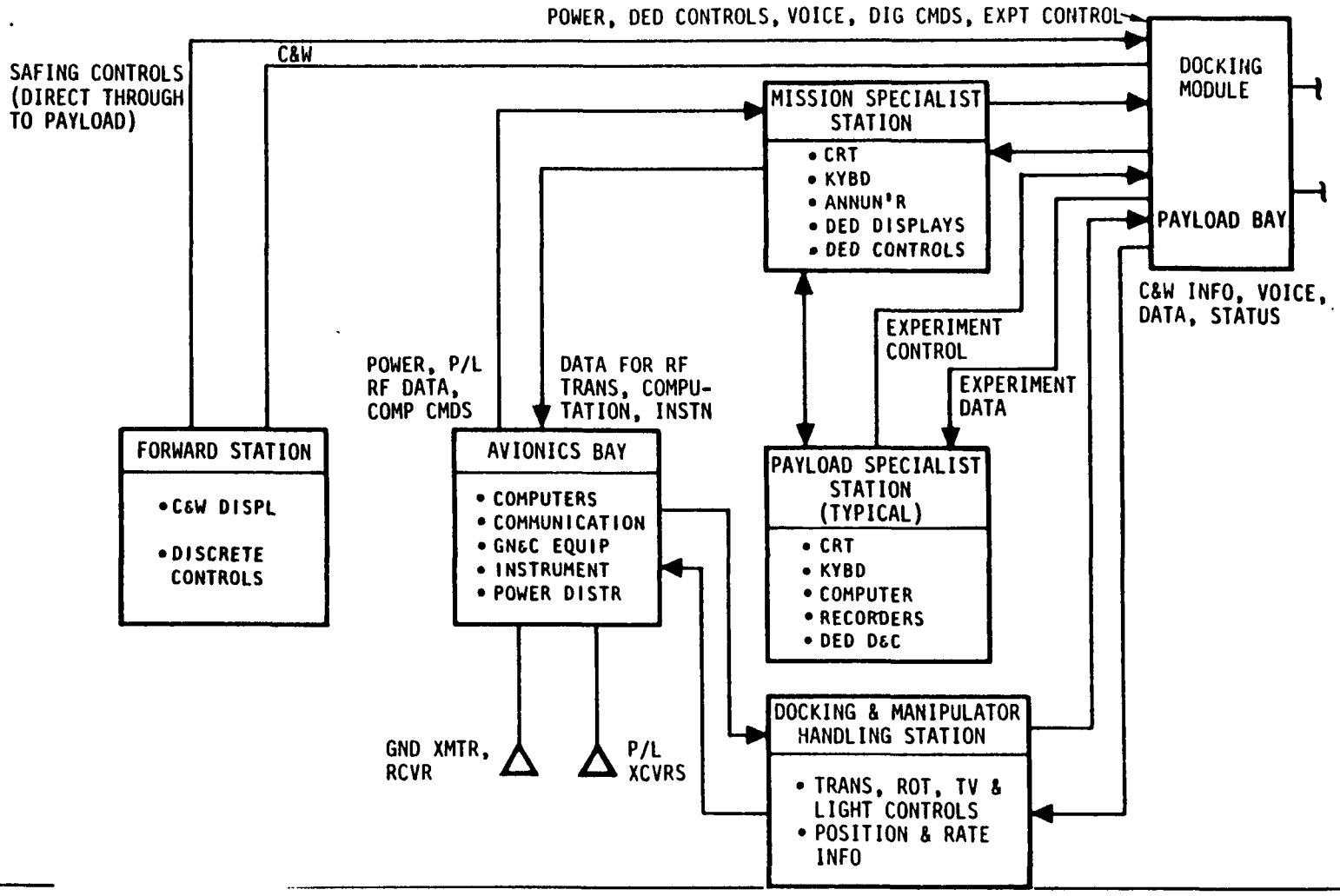
# ORBITER AVIONICS INSTALLATION

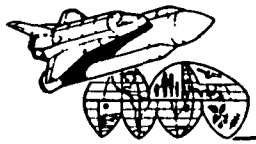


# SPACE SHUTTLE AVIONICS
## AVIONICS SYSTEM BLOCK DIAGRAM

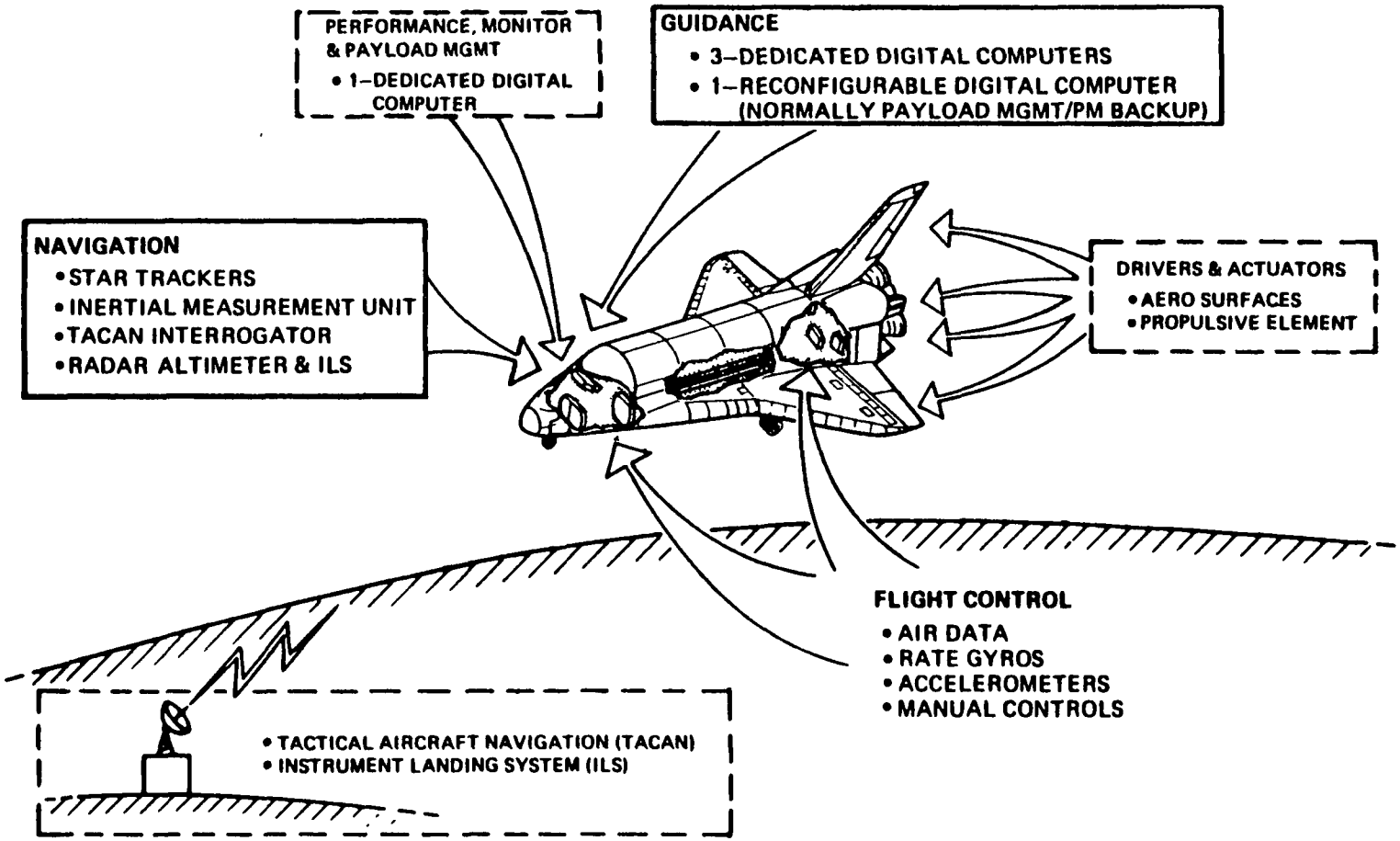


# SPACE SHUTTLE AVIONICS
## PAYLOAD SIGNAL INTERFACES BASELINE

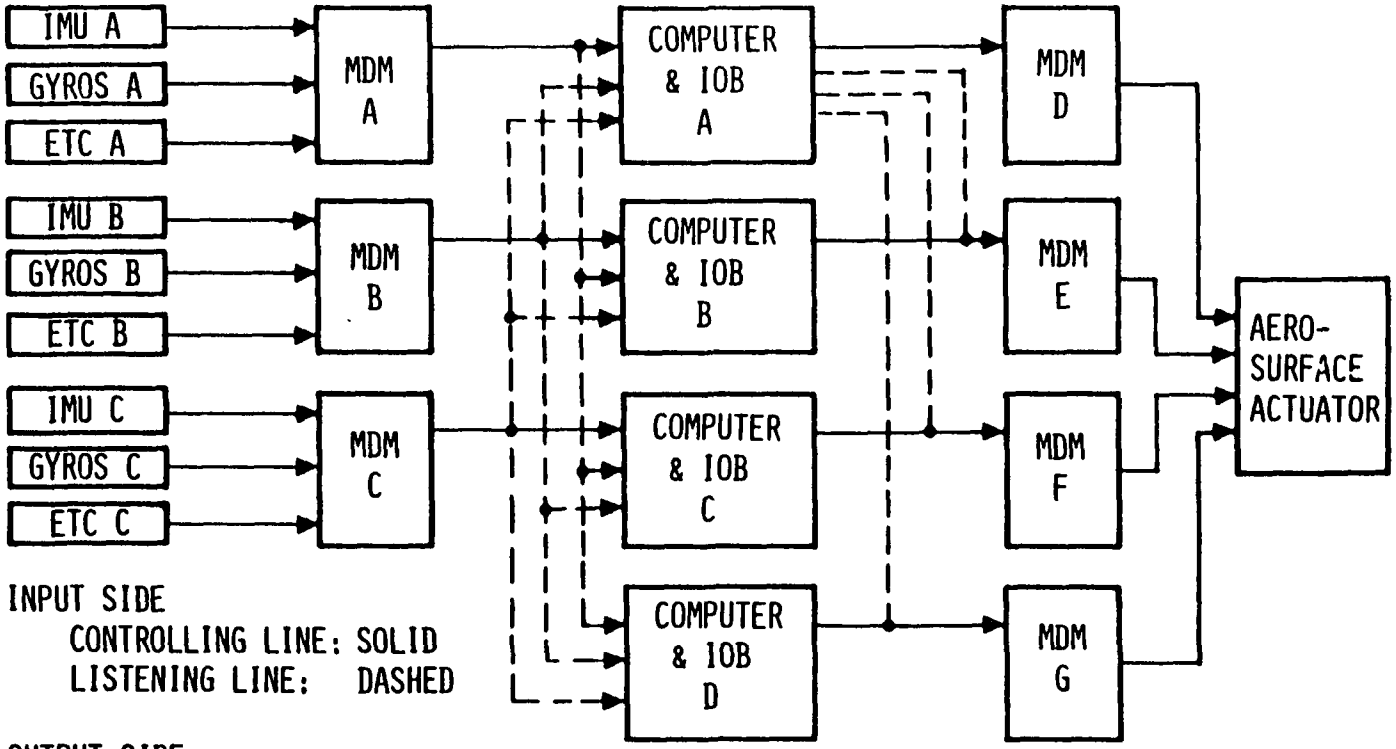




# ORBITER GUIDANCE NAVIGATION & CONTROL



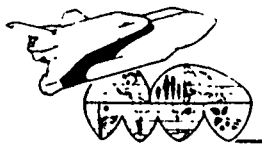
# GN&C BLOCK DIAGRAM




INPUT SIDE
CONTROLLING LINE: SOLID
LISTENING LINE: DASHED

OUTPUT SIDE
CONTROLLING LINE: SOLID
ALTERNATE LINE: DASHED

ALTERNATE LINES NOT SHOWN
SHOWN FOR COMPUTER B,C, & D



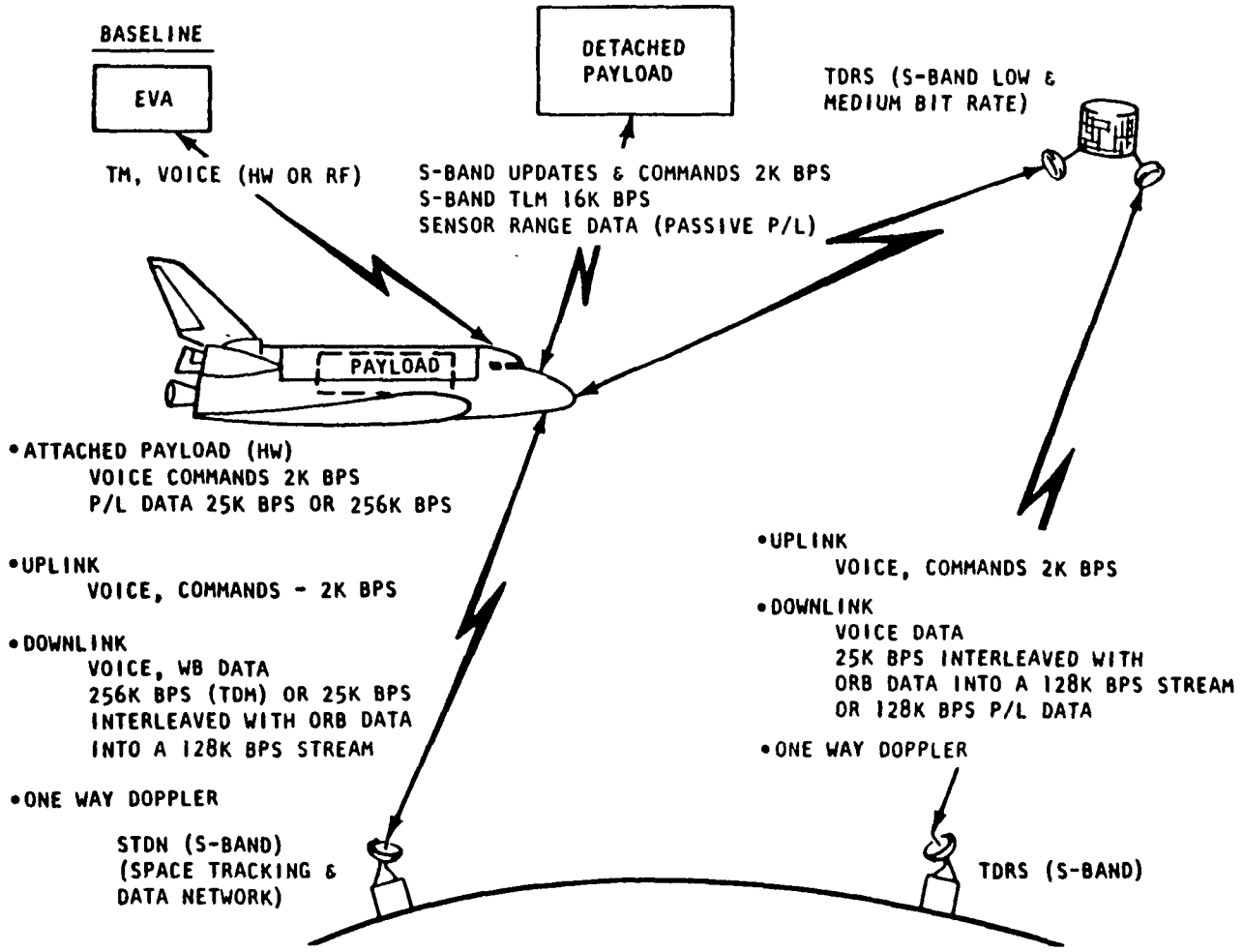
# ORBITER AVIONICS SUPPORT TO PAYLOADS
## GN&C

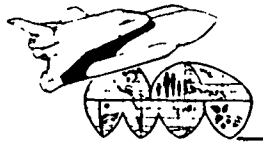
REQUIREMENT

- THE CAPACITY TO TRANSFER ORBITER STATE VECTOR, ATTITUDE, GREENWICH MEAN TIME, & MISSION ELAPSED TIME TO THE PAYLOAD SHALL BE PROVIDED

- SUPPORT THE ACCOMPLISHMENT OF THE POINTING & STABILITY REQUIREMENTS OF ±0.5 DEGREES WITH ±0.1 DEGREE PER SEC, INCLUDING INTERFACING WITH A P/L PROVIDED ATTITUDE SENSOR

# SPACE SHUTTLE AVIONICS
## ORBITAL COMMUNICATIONS & TRACKING





# ORBITER AVIONICS SUPPORT TO PAYLOADS
## COMMUNICATIONS & TRACKING

2-WAY VOICE COMMUNICATIONS AT MSS TO ATTACHED NASA PAYLOADS VIA HARDWIRE & TO RELEASED NASA PAYLOADS VIA RF WITH CONFERENCE CAPABILITY WITH GROUND

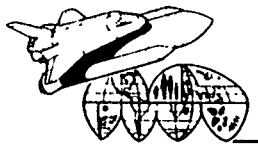
CAPABILITY TO INITIATE, TRANSMIT, & RELAY FROM GROUND UP TO 2K BPS (INFORMATION RATE) OF COMMANDS OR UPDATES TO ATTACHED OR RELEASED PAYLOADS

MEDIUM BANDWIDTH TDRS LINK (S-BANDS, TDM)

- 2 INDEPENDENT DUPLEX DIGITAL VOICE CHANNELS
- UPLINK DATA – REALTIME COMMANDS & COMPUTER UPDATES
- DOWNLINK DATA – TLM, P/L DATA & COMMAND VERIFICATION
- ONE WAY DOPPLER

DIGITAL DATA RATES:

- ATTACHED P/L
  - TO ORBITER
    - 25K BPS P/L DATA (PM)
    - 256K BPS P/L DATA & WIDEBAND DATA (FM)
  - FROM ORBITER
    - 2K BPS (INFORMATION RATE) COMMANDS & UPDATES



# ORBITER AVIONICS SUPPORT TO PAYLOADS (CONT)
## COMMUNICATIONS & TRACKING

- RELEASED P/L'S
  - TO ORBITER
    16K BPS TLM UNMANNED
  - FROM ORBITER
    2K BPS (INFORMATION RATE) UNMANNED

RENDEZVOUS SENSORS

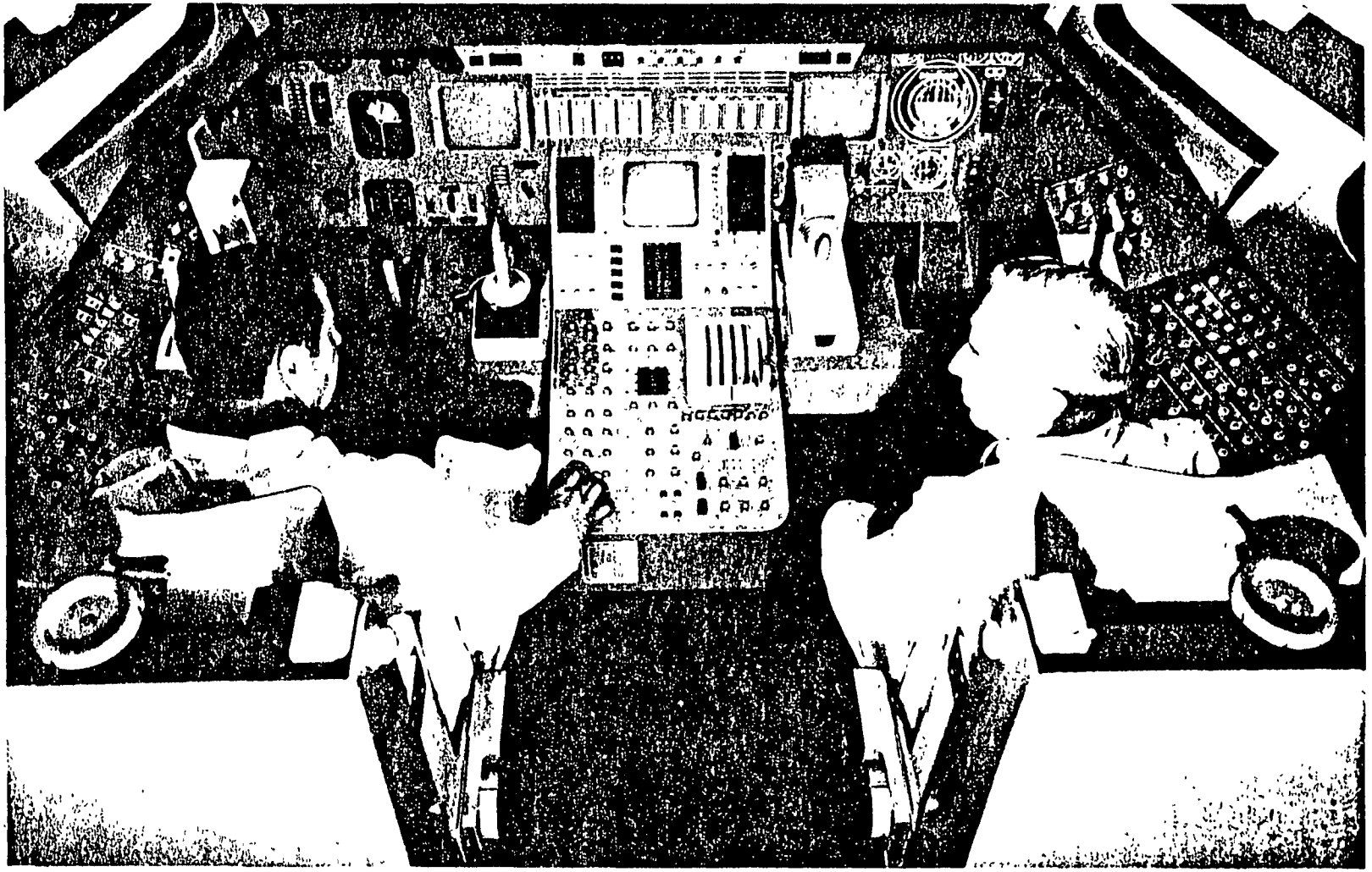
PROVIDE ON-BOARD CAPABILITY TO RENDEZVOUS WITH PASSIVE & COOPERATIVE TARGETS FROM 300 N MI TO 100 FEET FOR ALL DESIGNATED MISSIONS

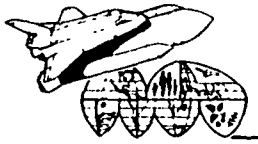
RENDEZVOUS IS ACCOMPLISHED WITH MICROWAVE RADAR & STAR TRACKER

# SPACE SHUTTLE AVIONICS
# DISPLAY & CONTROL REQUIREMENTS

- PROVIDE THE CREW WITH THE MEANS TO:
  - MONITOR & COMMAND VEHICLE ROTATION, TRANSLATION & FLIGHT PATH
  - MONITOR & COMMAND ONBOARD SUBSYSTEMS
  - MONITOR & COMMAND CRITICAL ATTACHED PAYLOAD FUNCTIONS
  - ANNUNCIATE & COMMAND SAFING OF HAZARDOUS CONDITIONS
- PROVIDE CREW OVERRIDE OF AUTOMATED CRITICAL COMMAND FUNCTIONS
- PROVIDE CREW SELECTION OF AUTOMATIC OR MANUAL FLIGHT GUIDANCE & CONTROL
- EXERCISE MANUAL CONTROL OF FLIGHT MODES
- PROVIDE AUTONOMOUS ONBOARD SYSTEM MANAGEMENT, CONFIGURATION CONTROL, FAULT ISOLATION TO LEVEL REQUIRED IN FLIGHT

# DISPLAYS & CONTROLS SUBSYSTEM

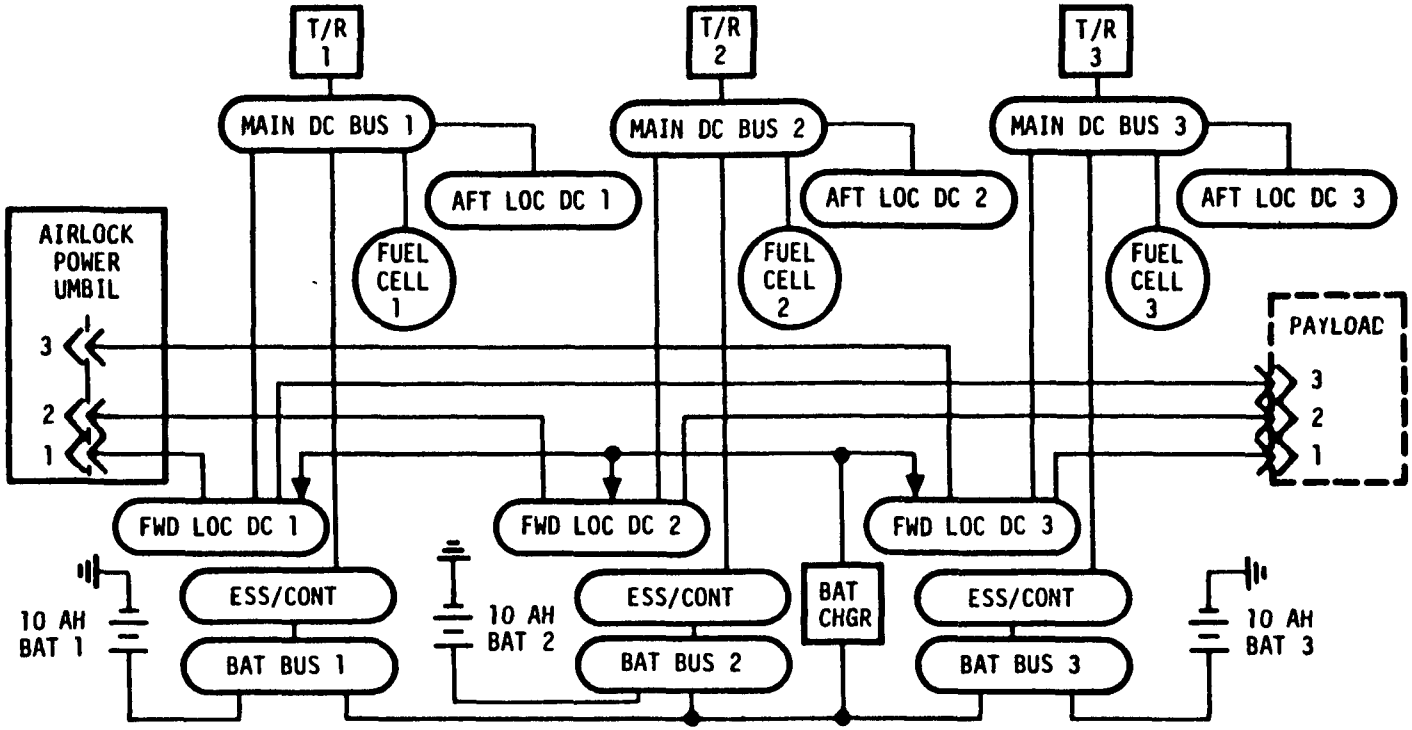




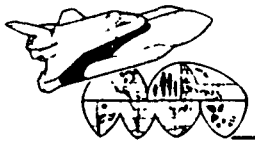
# SPACE SHUTTLE AVIONICS
## ORBITER AVIONICS BASELINE SUPPORT TO PAYLOADS DISPLAYS & CONTROLS

- MISSION SPECIALIST STATION WITHIN THE FLIGHT SECTION FOR DISPLAYS & CONTROLS REQUIRED TO MANAGE THE ORBITER/PAYLOAD INTERFACES
- PAYLOAD HANDLING STATION SHALL PROVIDE THE FLIGHT CREW WITH THE CONTROLS/ VISIBILITY, & DISPLAYS REQUIRED TO DEPLOY & RETRIEVE PAYLOADS
- PAYLOAD SPECIALIST STATION SHALL PROVIDE PANEL SPACE FOR MONITORING & CONTROLLING OPERATION OF ATTACHED OR DETACHED PAYLOADS EXPERIMENTS
- PAYLOAD C&W SIGNALS SHALL BE DISPLAYED TO THE FLIGHT CREW & AT THE MSS
- CAPABILITY TO DISPLAY PAYLOAD PARAMETERS IN REALTIME AT THE MSS
- PAYLOAD HANDLING STATION TV DISPLAYS CAPABLE OF DISPLAYING COMPATIBLE PAYLOAD TV

# SPACE SHUTTLE AVIONICS
## ORBITER 28V DC POWER DISTRIBUTION

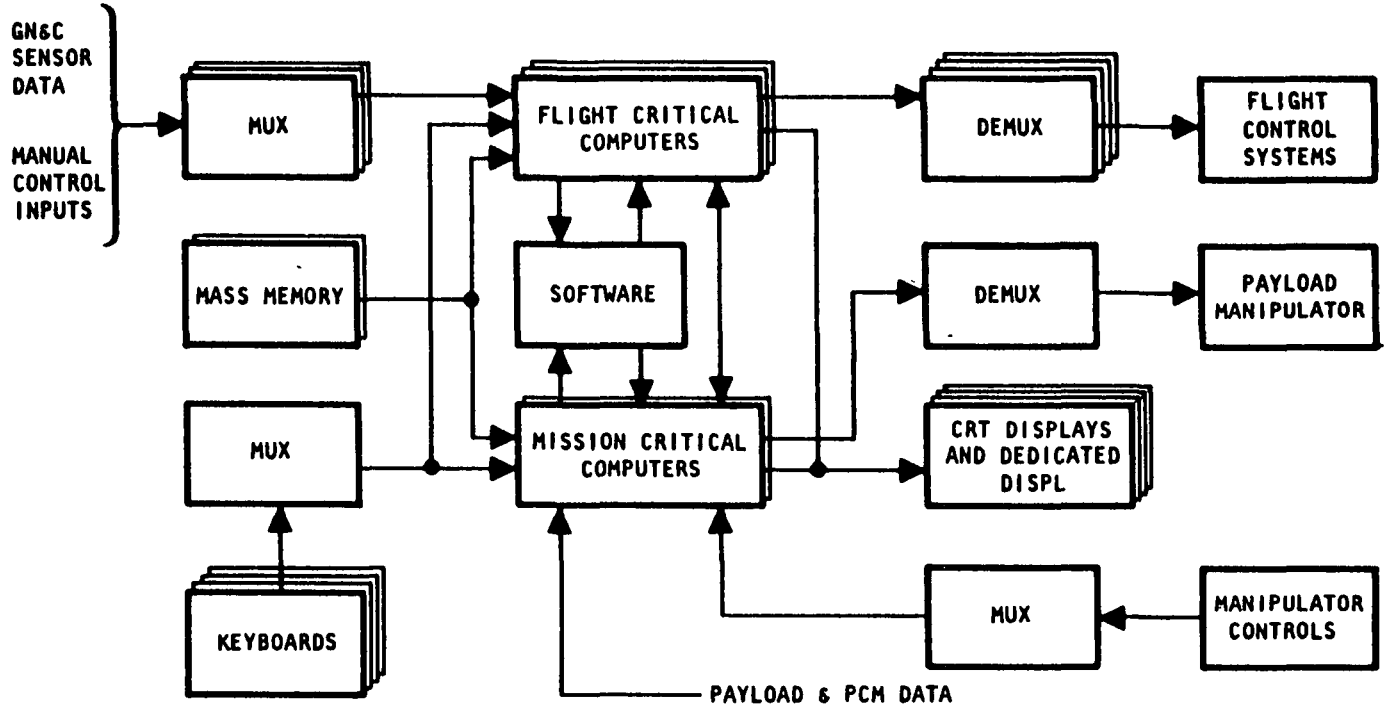



MAIN DC POWER: 28 V DC NOMINAL, TWO WIRE SYSTEMS, STRUCTURE CURRENT RETURN

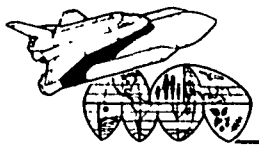


# ORBITER AVIONICS SUPPORT TO PAYLOADS
# ELECTRICAL POWER DISTRIBUTION & CONTROL

- 50 KWH OF REDUNDANT DC POWER CONSUMPTION
- RESTRICTED TO 1 KW AVERAGE & 1.5 KW PEAK (ASCENT & DESCENT)
- POWER AVAILABLE AT OTHER TIMES SHALL BE 3 KW AVERAGE & 6 KW PEAK




MISSION CRITICAL COMPUTER RECONFIGURABLE FOR FLIGHT CRITICAL FUNCTIONS

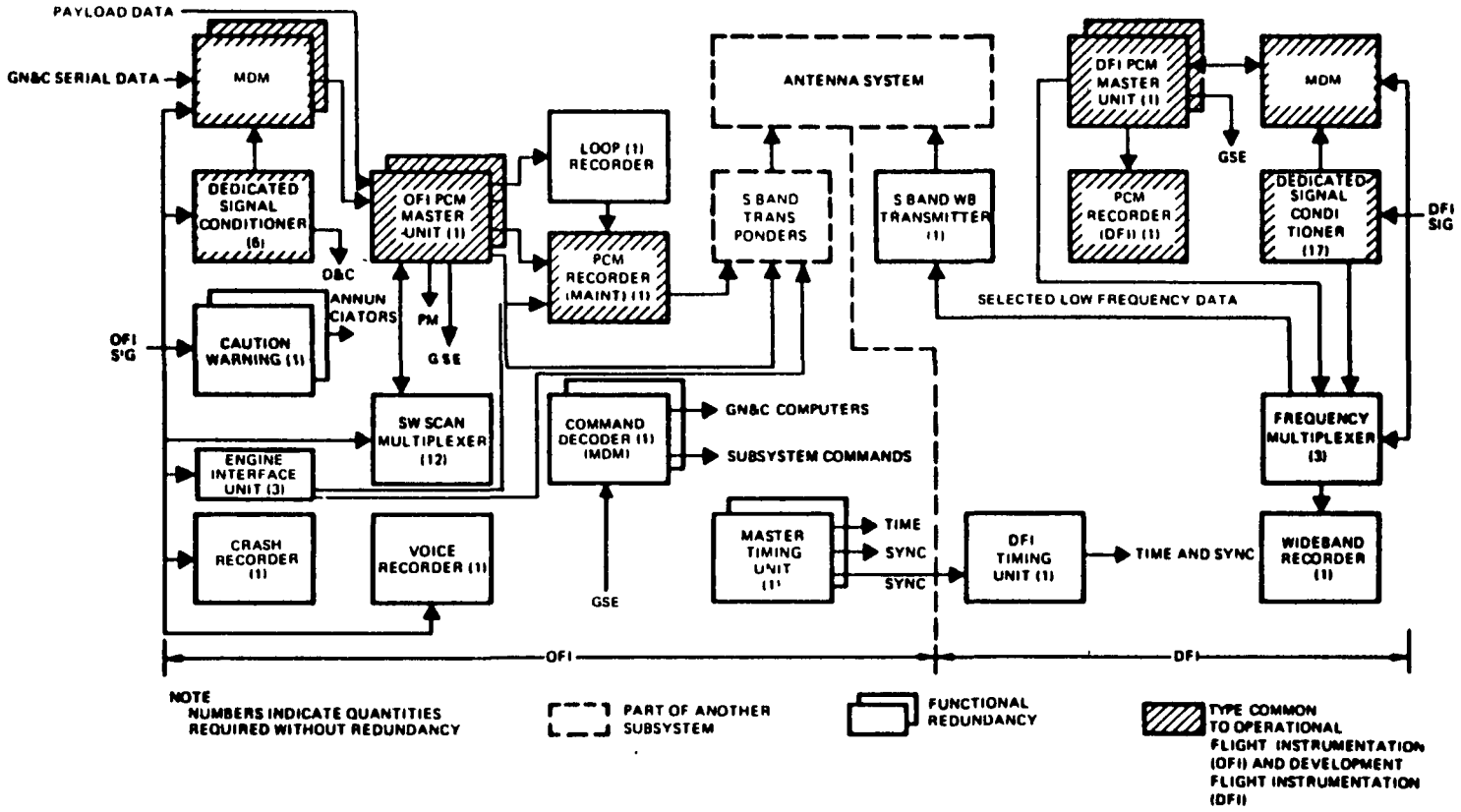


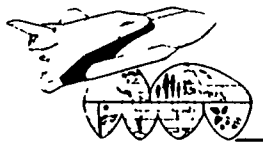
# SPACE SHUTTLE AVIONICS
# ORBITER AVIONICS SUPPORT TO PAYLOAD DATA PROCESSING & SOFTWARE

- COMPUTATIONAL CAPABILITIES ARE PROVIDED FOR PAYLOAD HANDLING & PAYLOAD DATA MANAGEMENT & FOR CHECKOUT OF THE ELECTRONIC INTERFACE WITH THE PAYLOAD

- TWO COMPUTERS, EACH WITH A MEMORY CAPACITY OF 48K 32 BIT DATA WORDS – ONE DEDICATED TO PAYLOAD ON ORBIT

# ORBITER DEVELOPMENT & OPERATIONAL FLIGHT INSTRUMENTATION





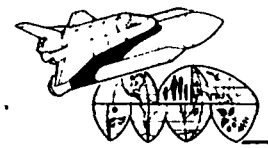
# INSTRUMENTATION CAPABILITY

## OPERATIONAL INSTRUMENTATION

- ACQUIRES & CONDITIONS SUBSYSTEMS DATA
- DIGITIZES & FORMATS DATA TO SERIAL DIGITAL PCM STREAM
- ACQUIRES PAYLOAD DATA
- INTERLEAVES P/L DATA WITH PCM DATA STREAM
- RECORDS DATA & CREW VOICE
- PROVIDES HARDWIRED DATA FOR DISPLAY & CAUTION/WARNING
- PROVIDES DATA FOR PERFORMANCE MONITOR
- PROVIDES MASTER TIMING FOR ONBOARD SYSTEMS
- DECODES GROUND COMMANDS FOR GROUND C/O
- PROVIDES INTERFACE BETWEEN ORBITER & MAIN ENGINE CONTROLLERS

## DEVELOPMENT FLIGHT INSTRUMENTATION

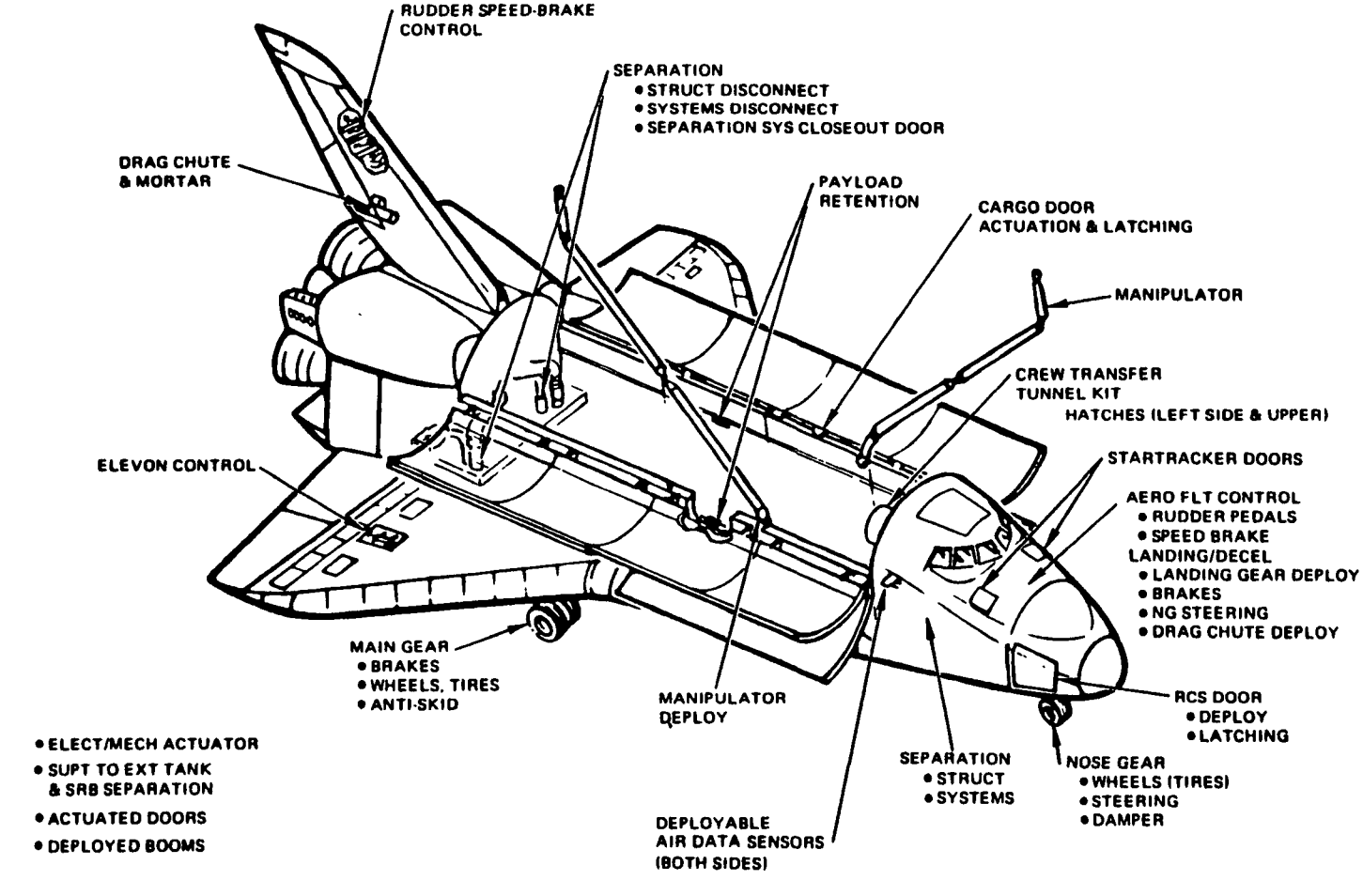
- ADDITIONAL INSTRUMENTATION CAPACITY FOR DEVELOPMENT FLIGHTS
- ACQUIRES & CONDITIONS DATA
- DIGITIZES & FORMATS QUASI-STATIC DATA TO SERIAL DIGITAL PCM STREAM
- FREQUENCY MULTIPLEXES WIDEBAND DATA (VIBRATION & ACOUSTIC)
- RECORDS DATA
- PROVIDES TIMING, SYNCED TO MASTER TIMING FOR DATA CORRELATION

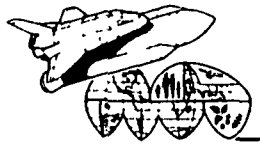


# SPACE SHUTTLE AVIONICS
## SUMMARY

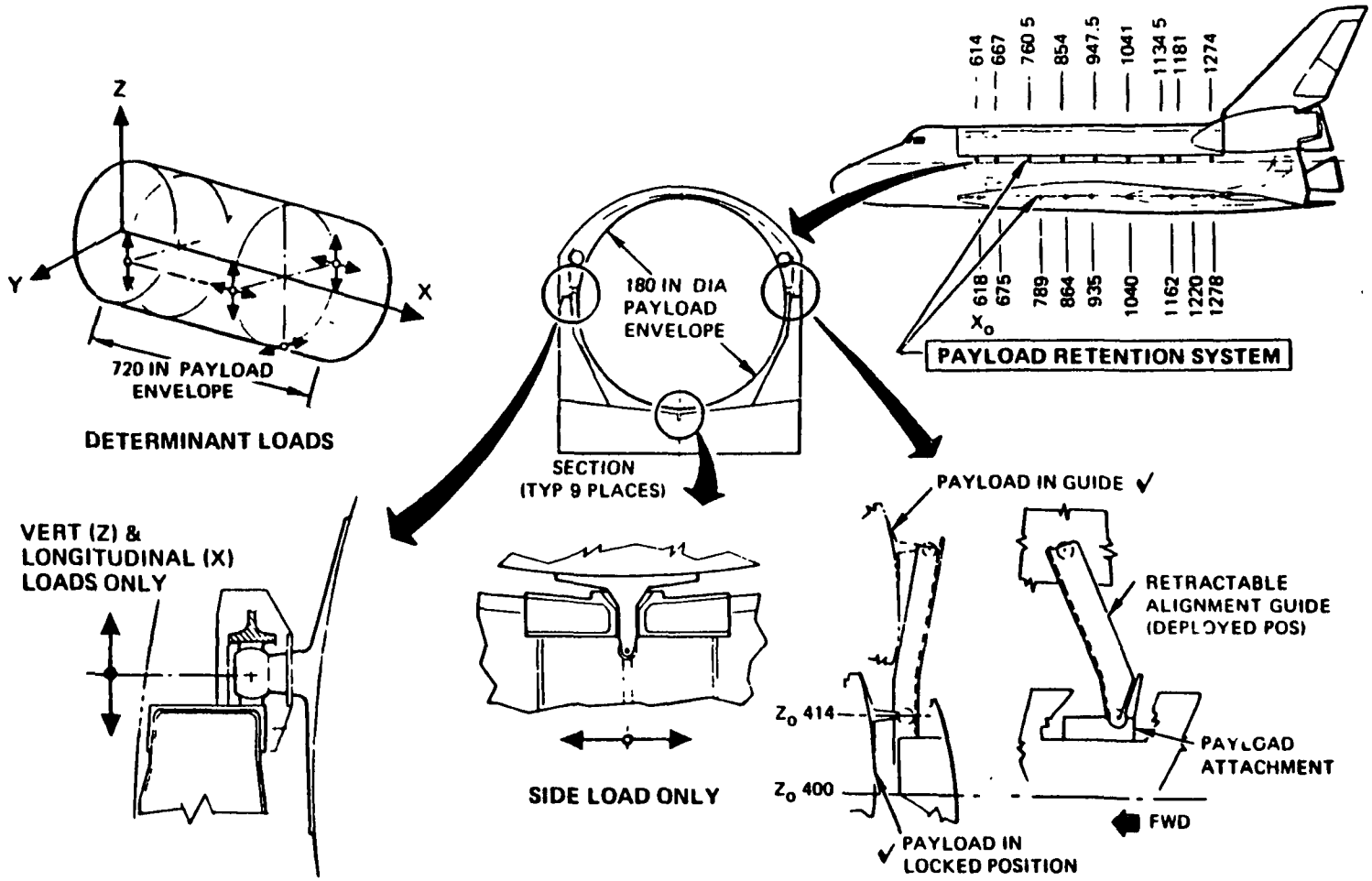
- CURRENT DESIGN SATISFIES IDENTIFIED PAYLOAD REQUIREMENTS
- EMPHASIZE PAYLOAD/ORBITER AVIONICS INTERFACE DEFINITION
- MULTIPLEX INTERFACE FOR PAYLOAD STIMULI & DATA
- PROVIDE FLEXIBILITY TO ACCOMMODATE WIDE VARIETY OF PAYLOADS
- PROVIDE STANDARD PAYLOAD AVIONICS INTERFACE

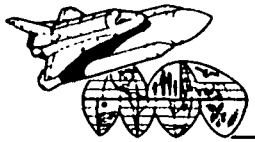
# ORBITER MECHANICAL SUBSYSTEMS





# PAYLOAD RETENTION





# PAYLOAD SUPPORT ATTACHMENTS TRADE

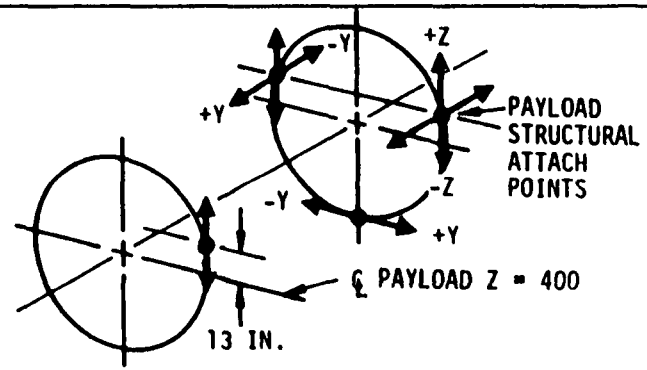
OBJECTIVE:

- OPTIMIZE ATTACH POINT SPACING FOR PAYLOADS
- ESTABLISH ORBITER IMPACT OF REVISED ATTACHMENTS

PAYLOAD SUPPORT ATTACHMENTS
- 12 EQUALLY SPACED (BASELINE IS 9)
- 58 INCH SPACING

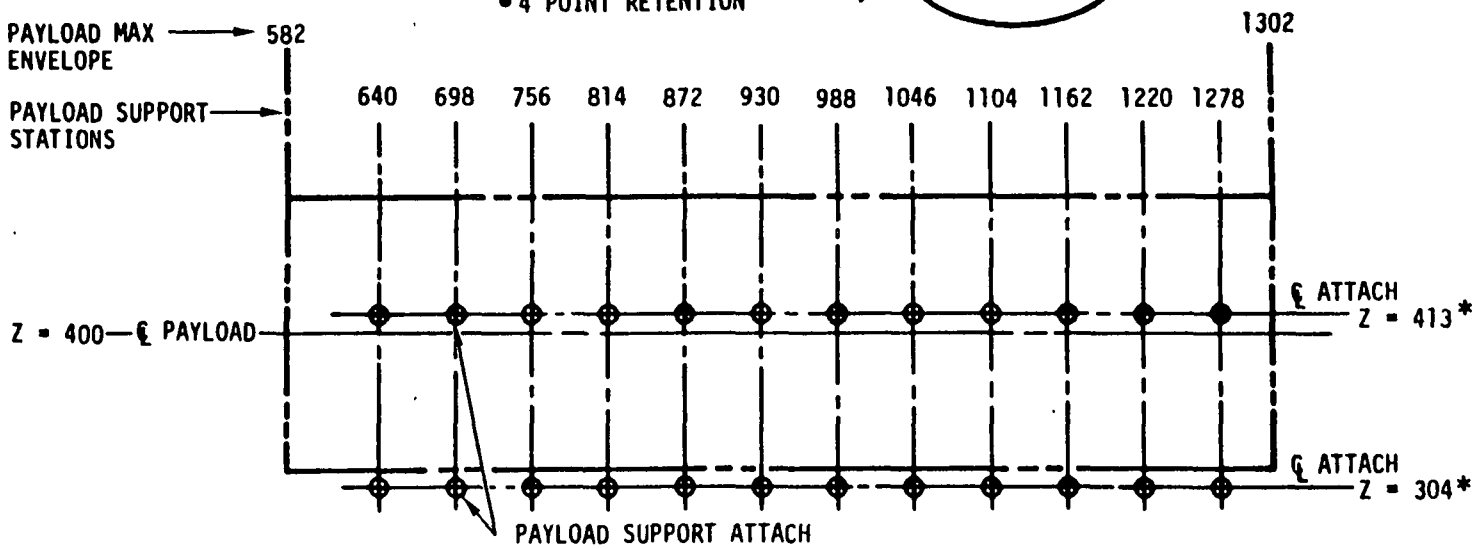
COMPATIBLE WITH
- ORBITER
- PAYLOAD

* = FINAL DIMENSIONS TO BE DETERMINED

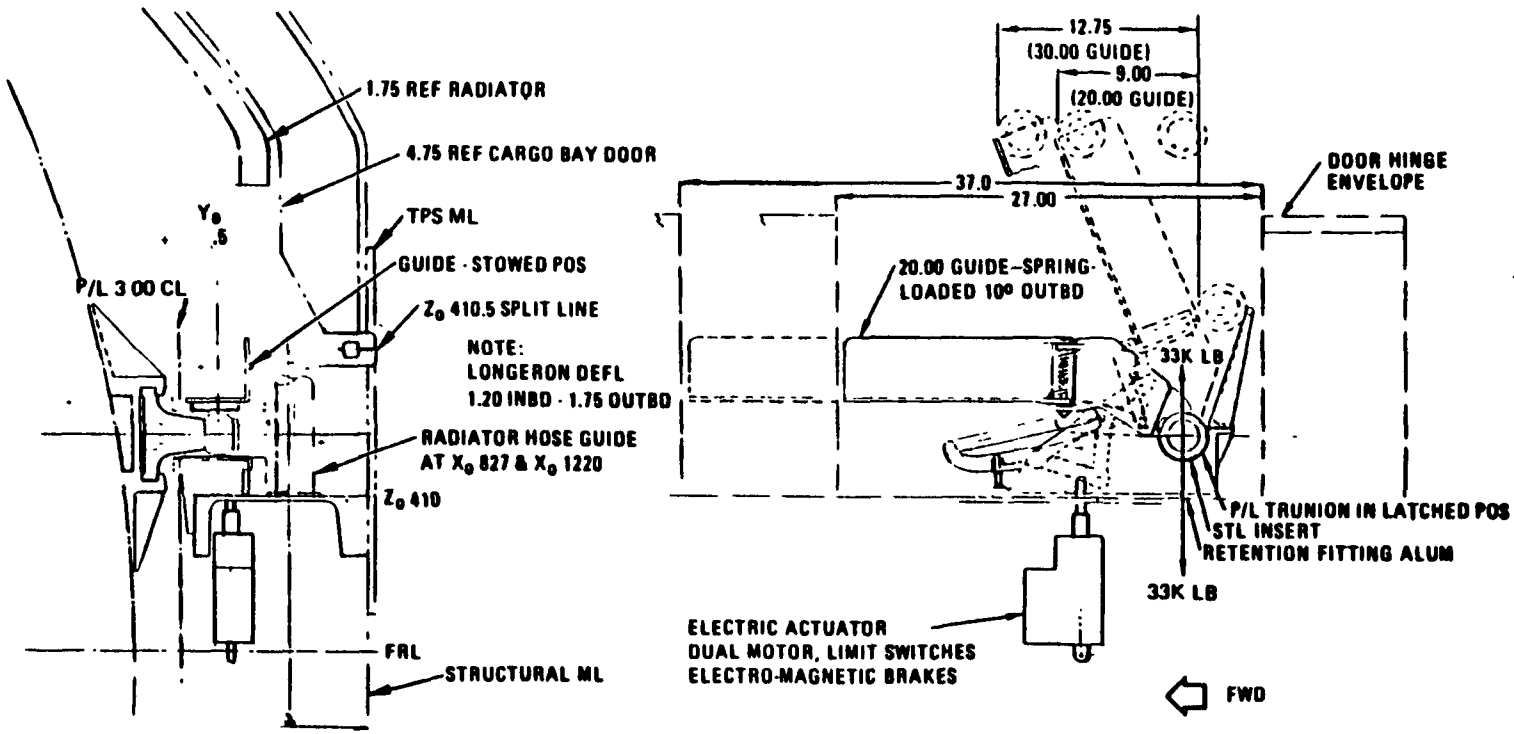



- DETERMINATE STRUCTURE
- 4 POINT RETENTION

⇨ MULTIPLE LOCATIONS



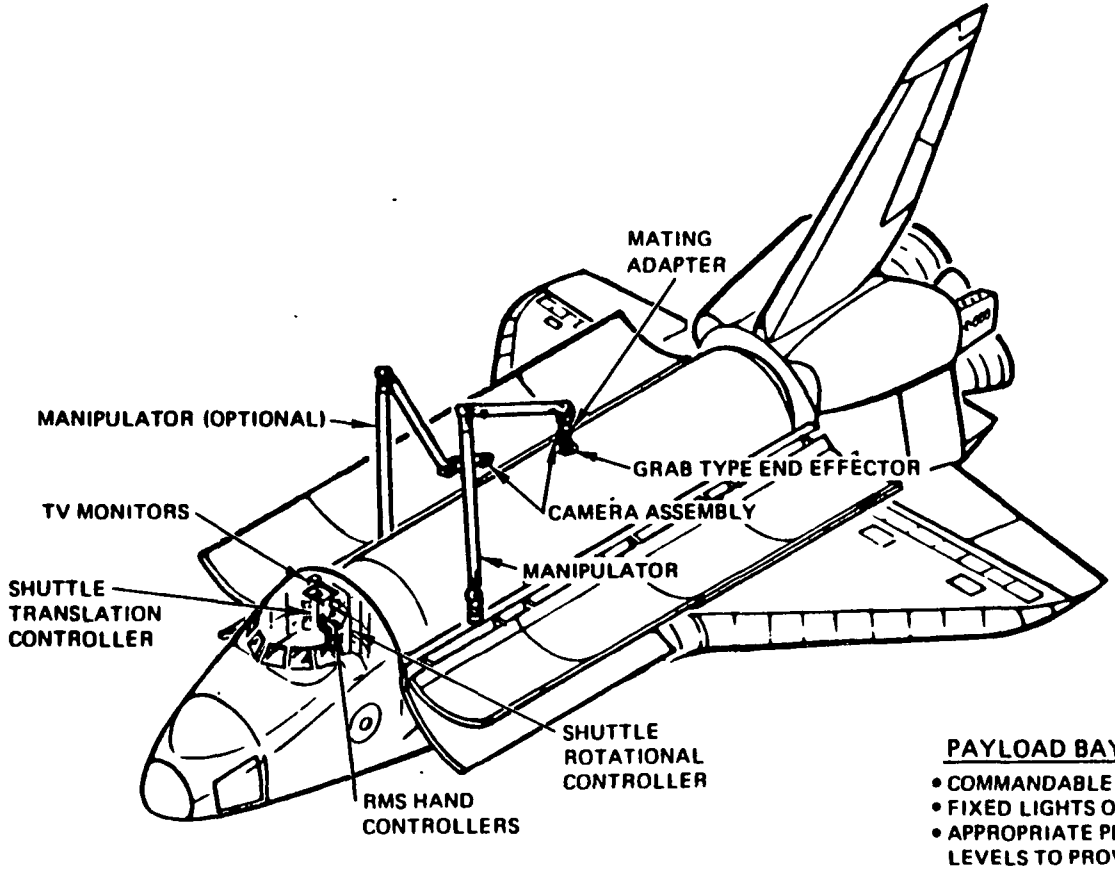
# RETENTION SYSTEM DESIGN - UPPER




INSTALL AS REQ

- STRUCTURAL ATTACHMENTS
- ALIGNMENT GUIDE
- ACTUATOR
  - LOCKS ATTACHMENT
  - FOLDS GUIDE

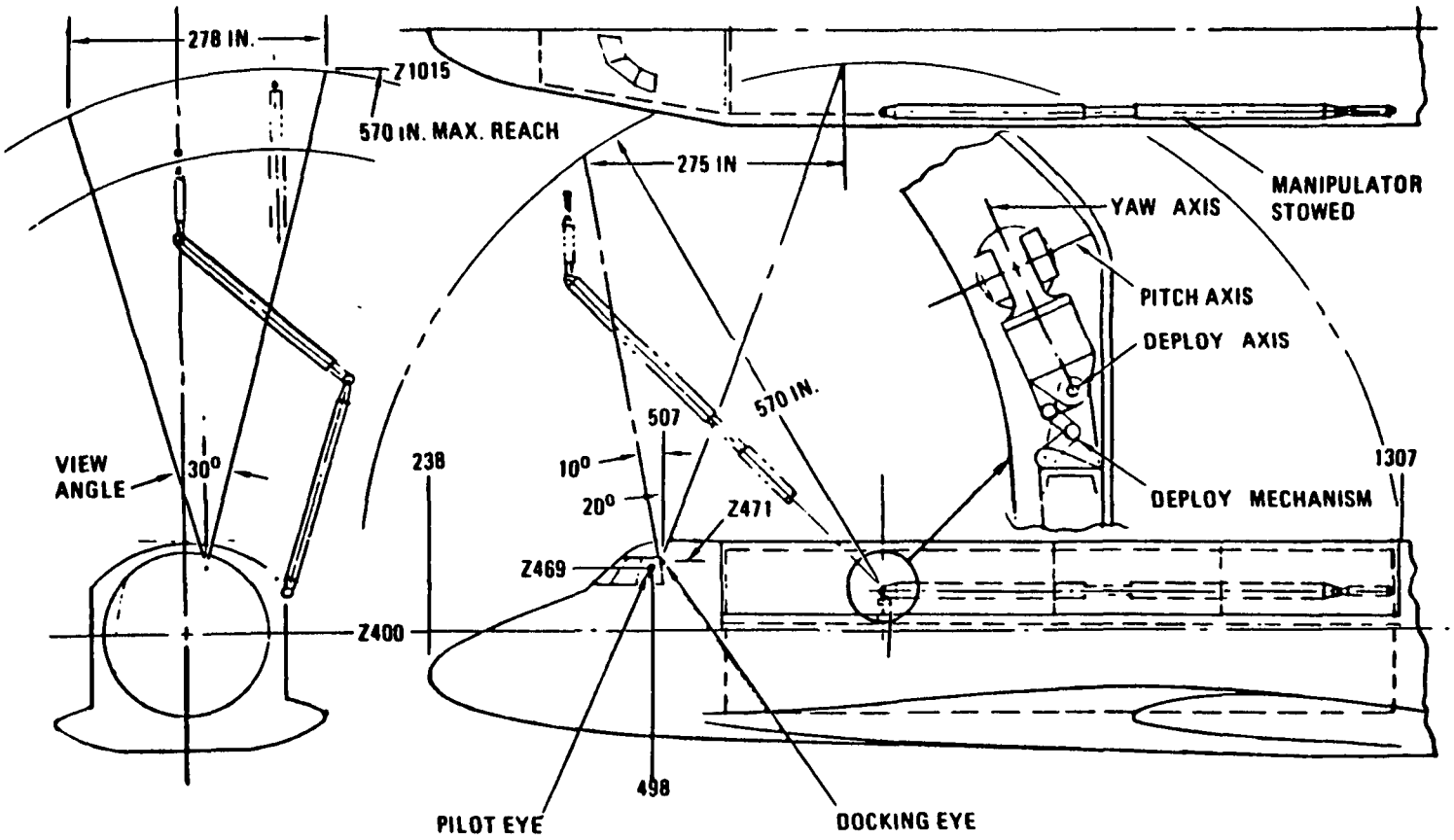
# PAYLOAD DEPLOYMENT/RETRIEVAL SYSTEM




## PAYLOAD BAY ILLUMINATION

- COMMANDABLE LIGHTS ON BOOMS
- FIXED LIGHTS ON SIDE BULKHEADS
- APPROPRIATE PHOTOMETRIC LIGHT LEVELS TO PROVIDE MANIPULATOR DEXTERITY & EFFICIENT ASTRONAUT WORKING CONDITIONS

# MANIPULATOR SYSTEM CHARACTERISTICS

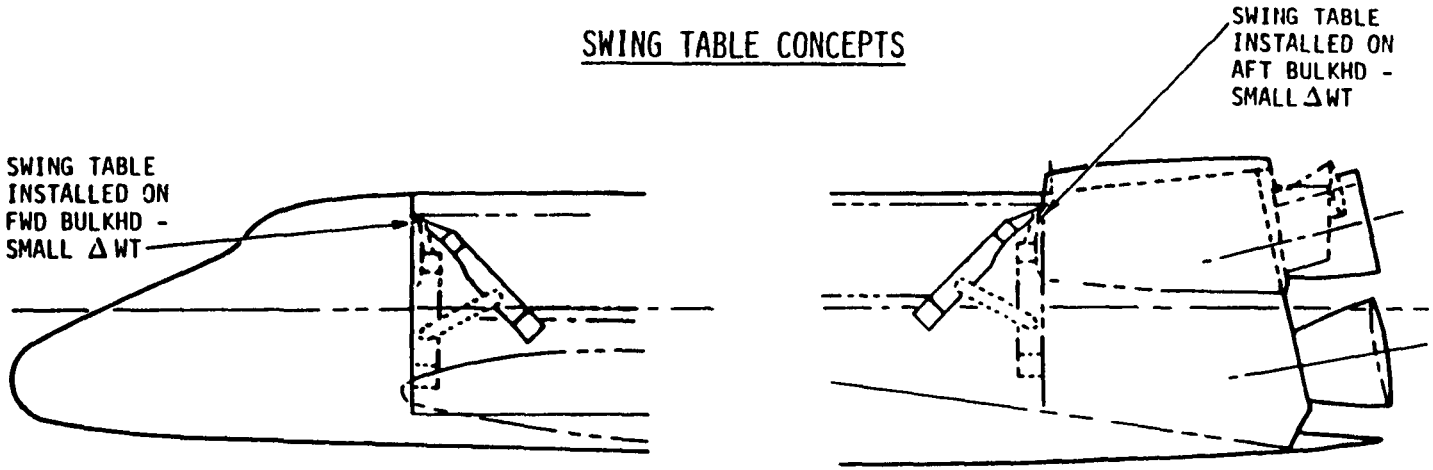


# ALTERNATE PAYLOAD DEPLOYMENT MECHANISMS - TRADE

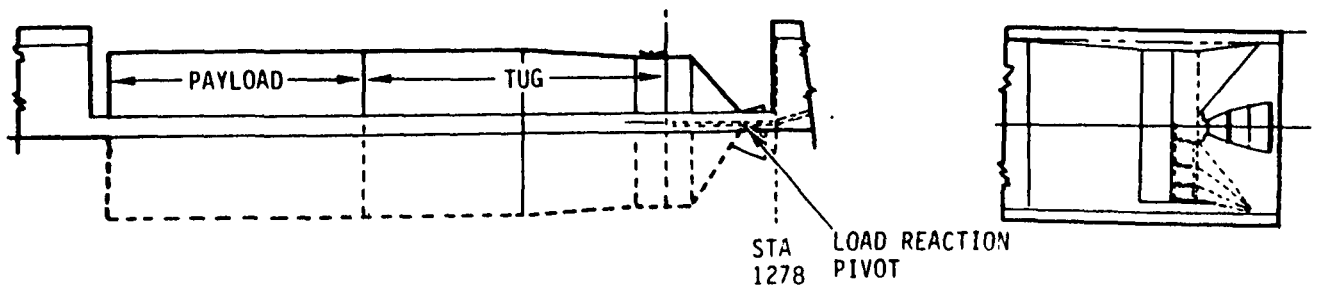
OBJECTIVE

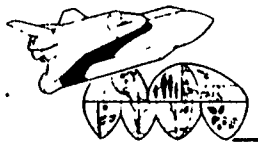
- INVESTIGATE IMPACT OF SWING TABLE ATTACHMENT PROVISIONS, FORE & AFT
- INVESTIGATE IMPACT OF PIVOT CONCEPT FOR OOS/TUG SUPPORT

## SWING TABLE CONCEPTS



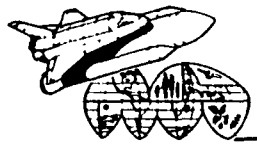

## PIVOT CONCEPT



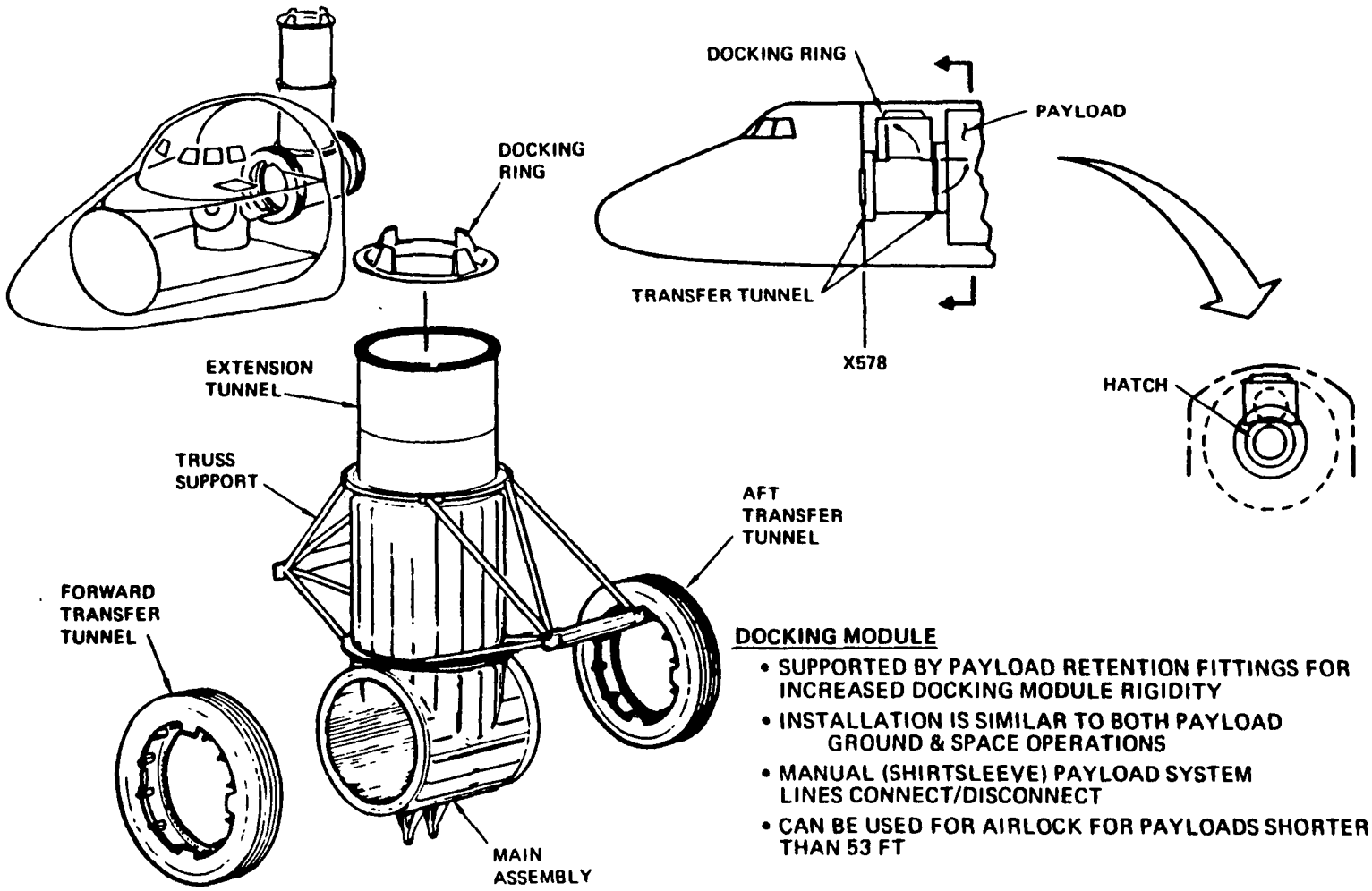


# CONCLUSIONS OF STUDY ON P/L DEPLOYMENT MECHANISM ATTACH POINTS

- BASELINE BULKHEADS ADAPTABLE TO SWING TABLE ATTACHMENT WITH SLIGHT WEIGHT "Δ"
- AFT BULKHEAD/LONGERON "CORNER" USABLE FOR OOS/TUG ADAPTER SUPPORT WITH SLIGHT WEIGHT "Δ"
- SMALL ACTUATOR REQUIRED TO ROTATE ADAPTER IF ONLY (1) MANIPULATOR USED
- MAXIMUM PAYLOAD LENGTH APPROX 2 FT LONGER USING SHORT ADAPTER RATHER THAN WITH SWING TABLE



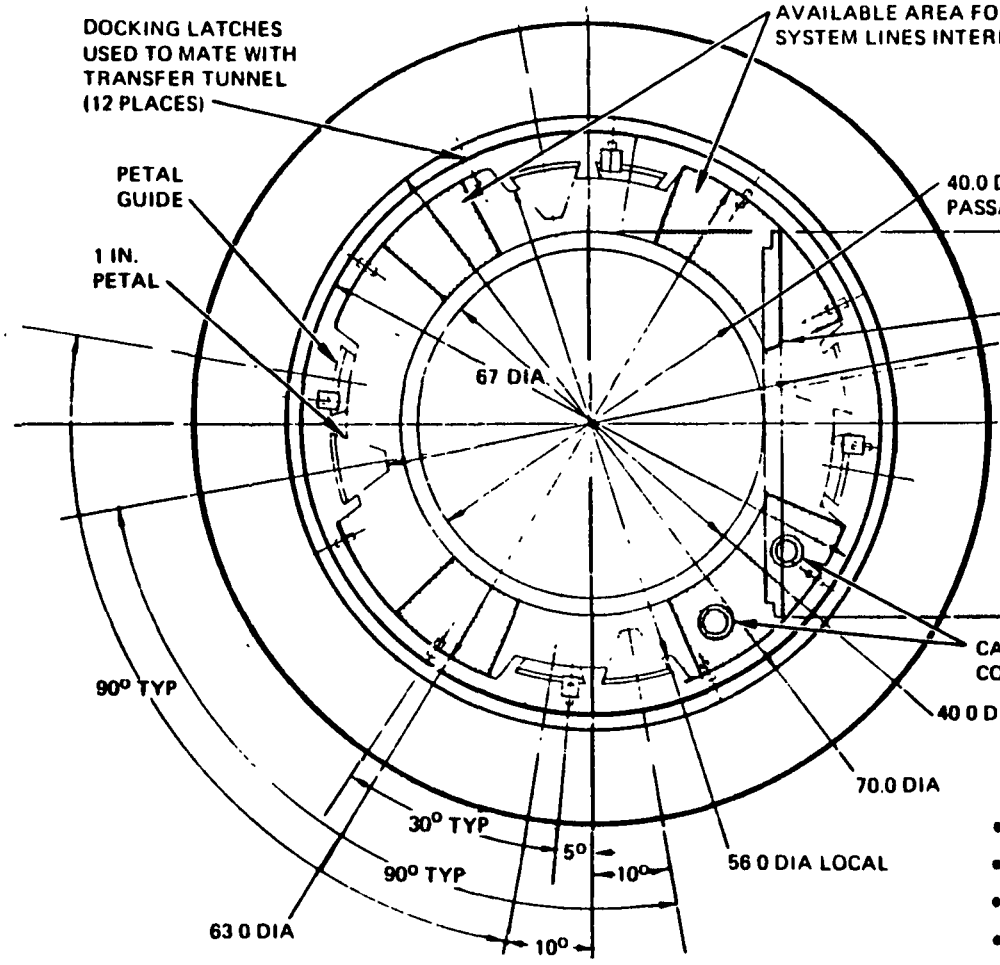
# DOCKING MODULE




**DOCKING MODULE**

- SUPPORTED BY PAYLOAD RETENTION FITTINGS FOR INCREASED DOCKING MODULE RIGIDITY
- INSTALLATION IS SIMILAR TO BOTH PAYLOAD GROUND & SPACE OPERATIONS
- MANUAL (SHIRTSLEEVE) PAYLOAD SYSTEM LINES CONNECT/DISCONNECT
- CAN BE USED FOR AIRLOCK FOR PAYLOADS SHORTER THAN 53 FT

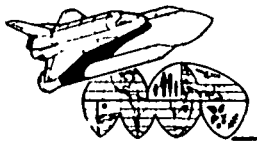
# DOCKING RING INTERFACES



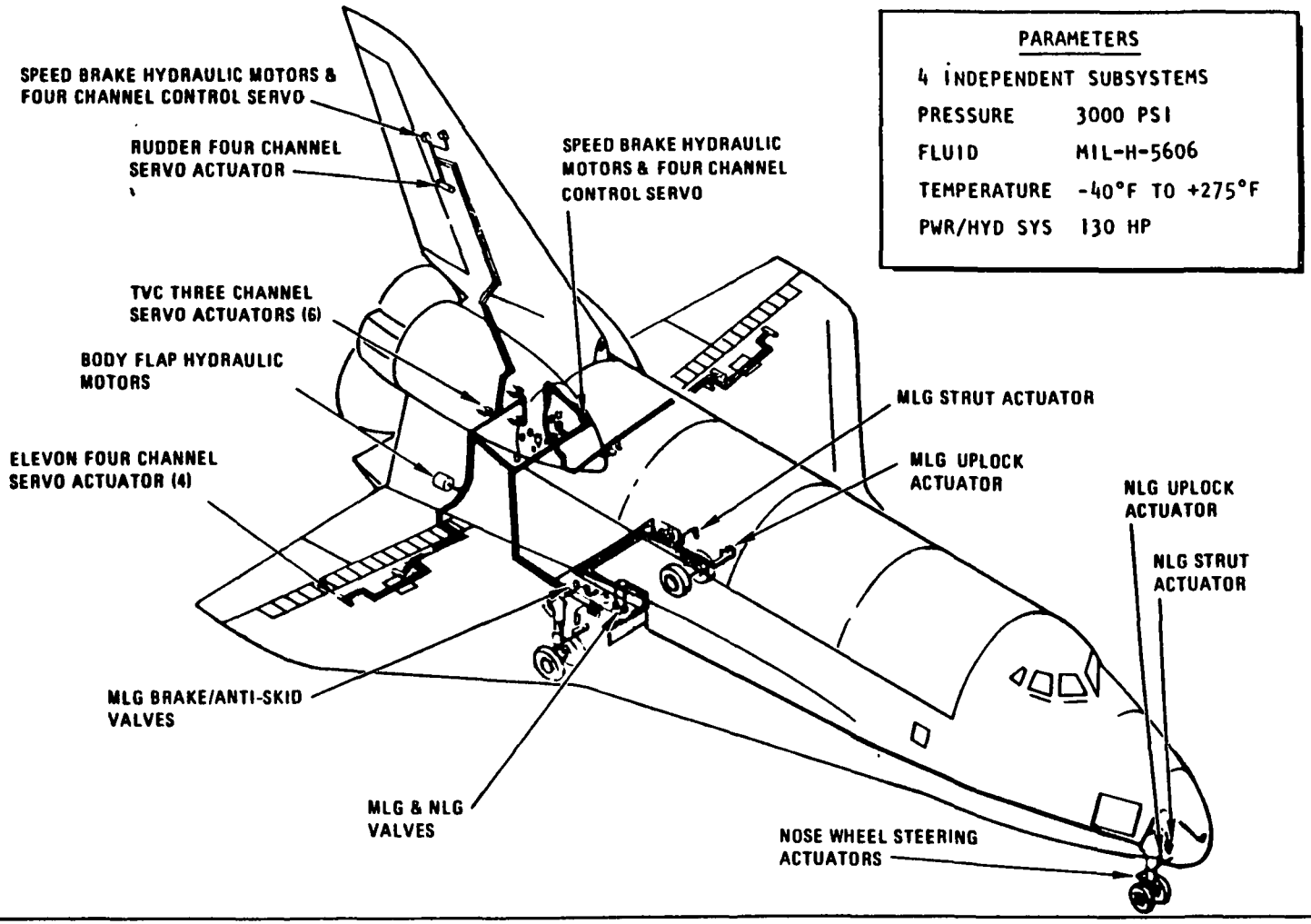

DOCKING RING

✔ USED WITH
- TRANSFER TUNNEL
- PETAL GUIDE ADAPTER

- PASSIVE PART OF DOCKING SYSTEM
- ADAPTATION WITH 1 IN. LENGTH PETALS
- 67 IN. DIA SEALING RING
- SHIRTSLEEVE MAINTENANCE

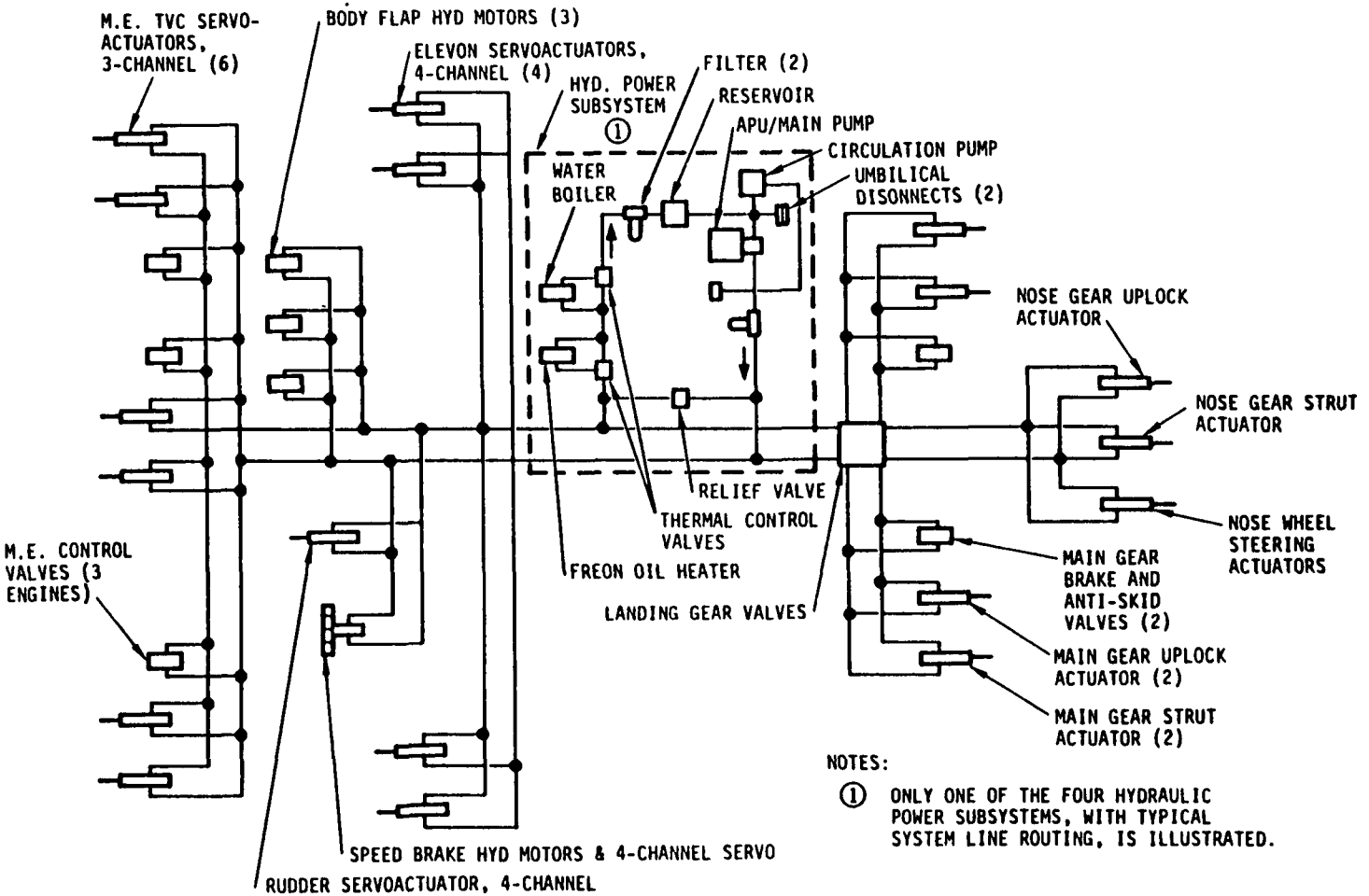


# ORBITER HYDRAULIC SUBSYSTEM



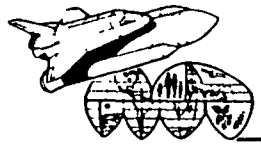

| PARAMETERS | |
|---|---|
| 4 INDEPENDENT SUBSYSTEMS | |
| PRESSURE | 3000 PSI |
| FLUID | MIL-H-5606 |
| TEMPERATURE | -40°F TO +275°F |
| PWR/HYD SYS | 130 HP |

# ORBITER HYDRAULIC SUBSYSTEM SCHEMATIC

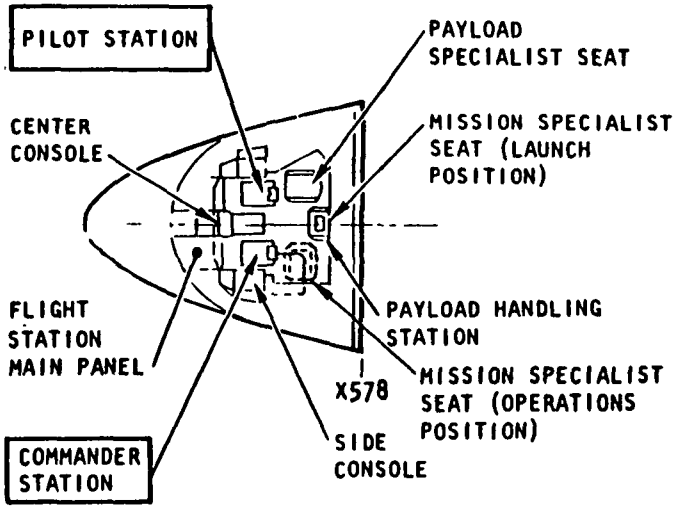


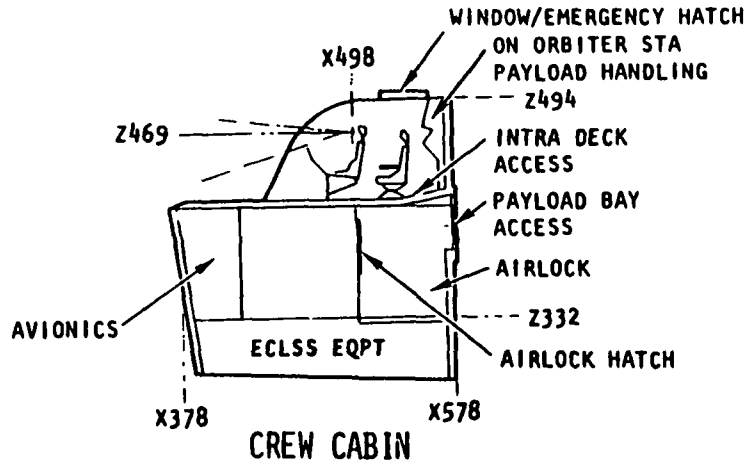

NOTES:

① ONLY ONE OF THE FOUR HYDRAULIC POWER SUBSYSTEMS, WITH TYPICAL SYSTEM LINE ROUTING, IS ILLUSTRATED.

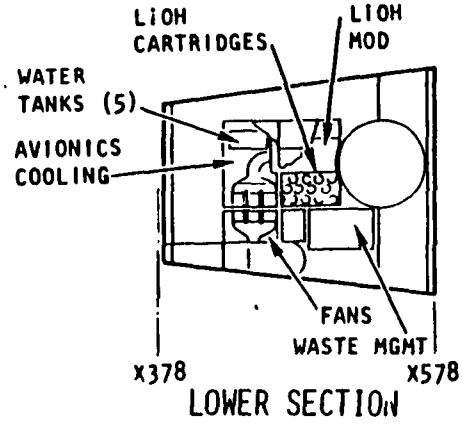


# ORBITER CREW FUNCTION & STATIONS



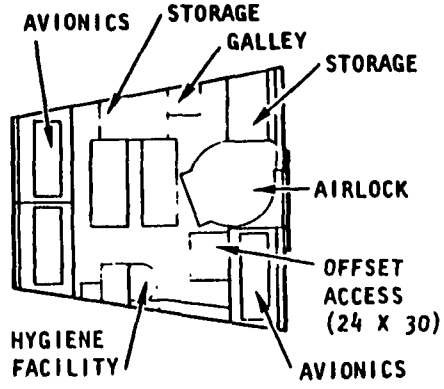




CREW CABIN



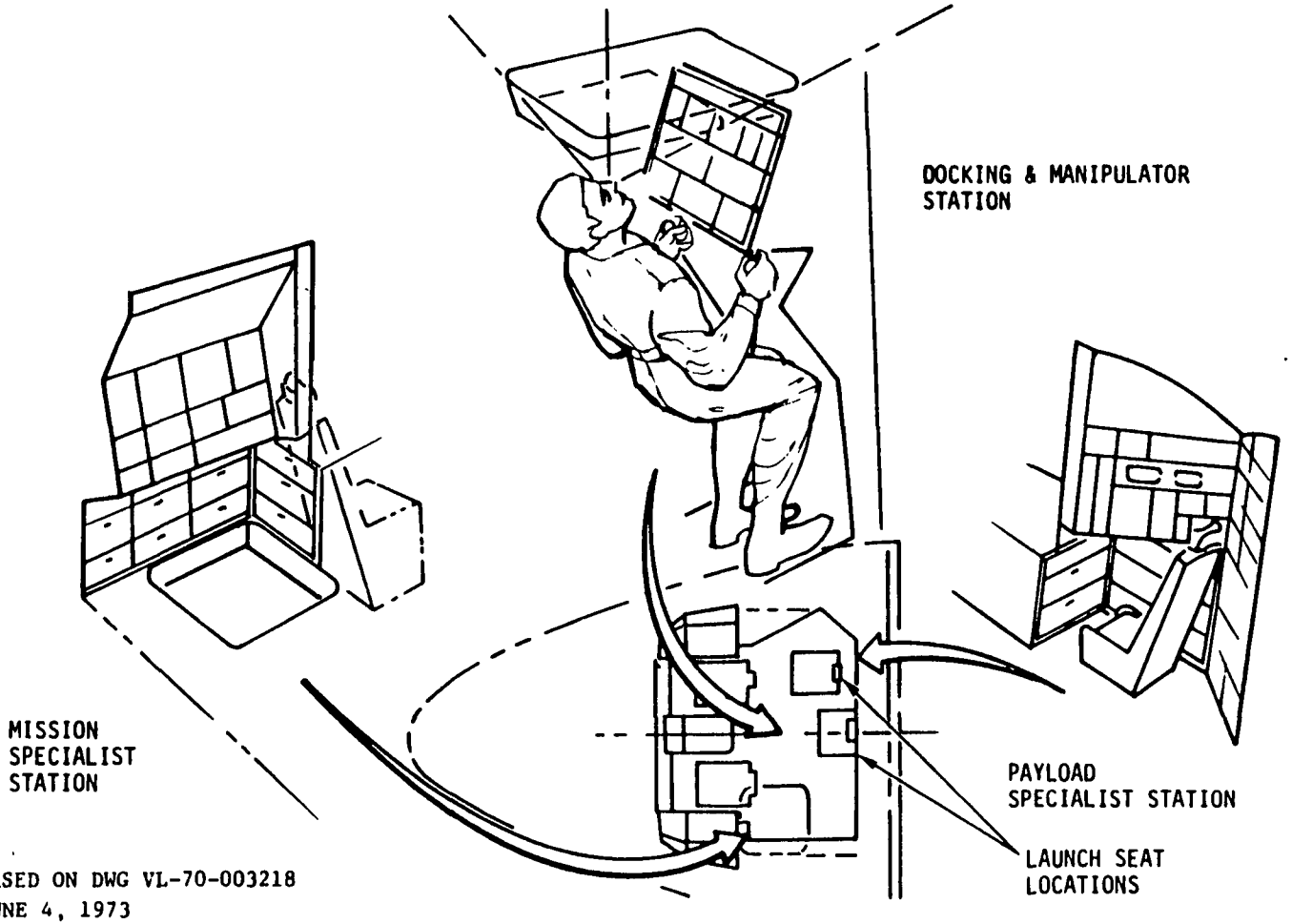

LOWER SECTION

| STATION | CREW FUNCTION |
|---|---|
| COMMANDER AND PILOT | OVERALL RESPONSIBILITY FOR VEHICLE FLIGHT OPERATIONS, C&W MONITORING AND CRITICAL/ PL INTERFACES |
| MISSION SPECIALIST | C&W MONITORING AND CONTROL OF ORBITER SUBSYSTEM/PL INTERFACES |
| PAYLOAD SPECIALIST | PAYLOAD INSTRUMENT CALIBRATION CHECKOUT, MONITOR, & CONTROL |
| ON-ORBIT | MANIPULATOR ARM OPERATION, AND DOCKING/PAYLOAD HANDLING, AND PAYLOAD BAY OPERATIONS |



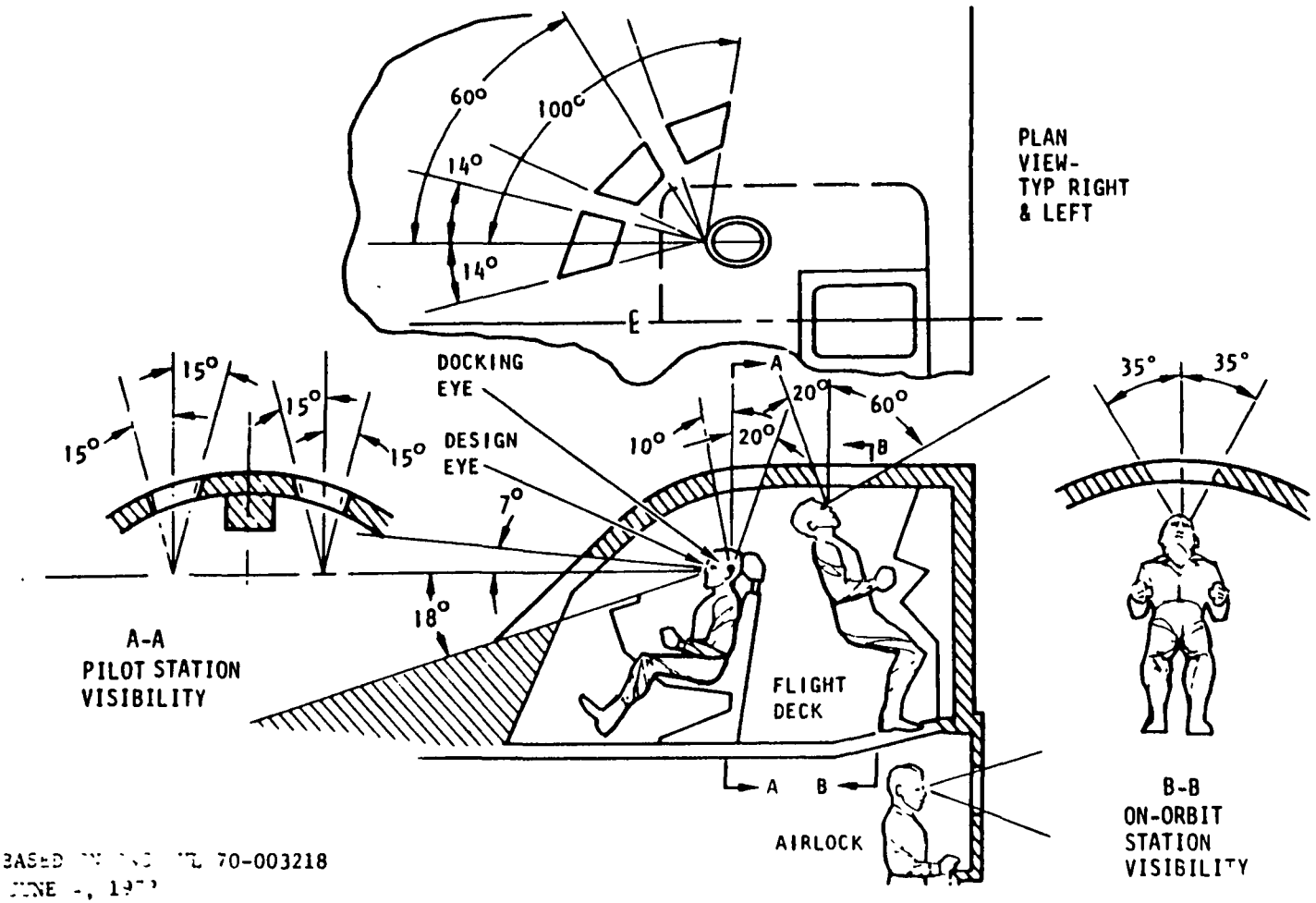

MID SECTION

# PAYLOAD HANDLING DISPLAY AND CONTROL STATIONS BASELINE



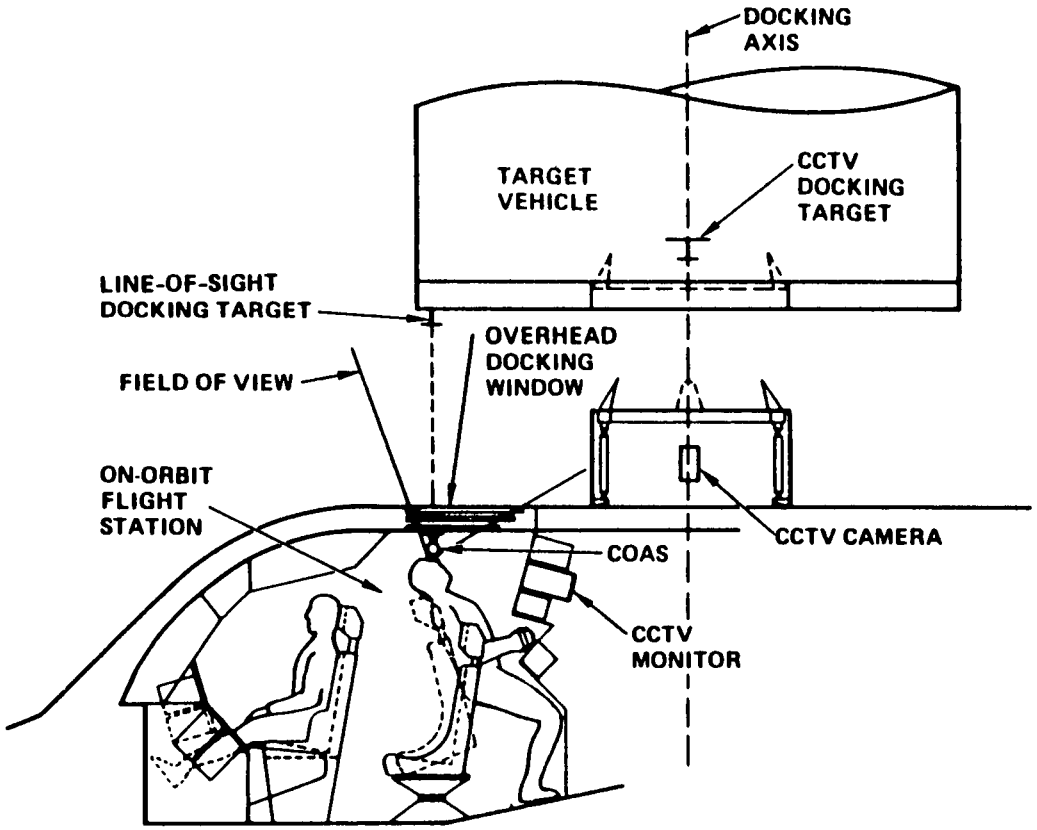

BASED ON DWG VL-70-003218
JUNE 4, 1973

# FLIGHT DECK VISIBILITY-BASELINE

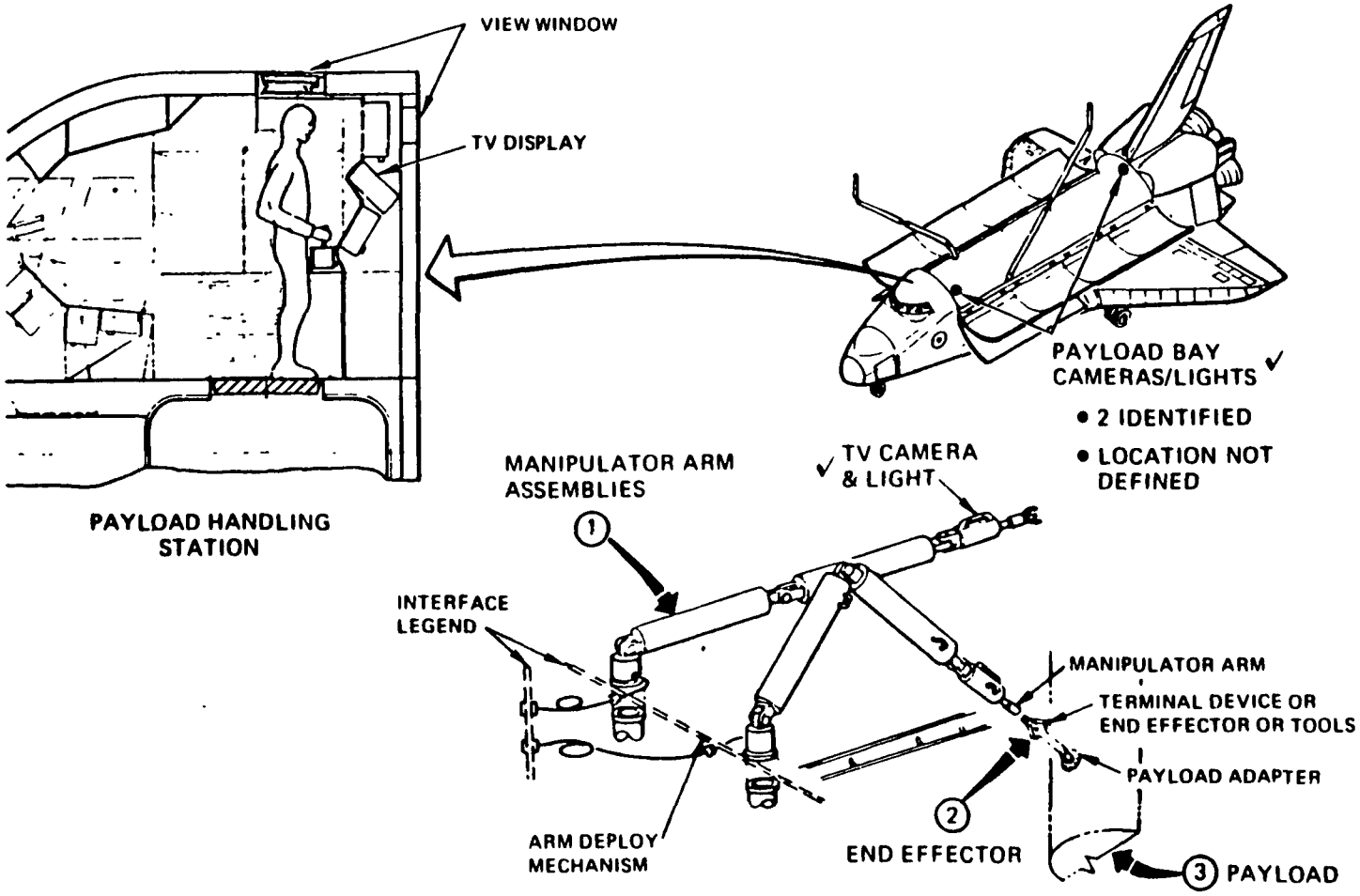



BASED ON [illegible] 70-003218
JUNE -, 197[illegible]

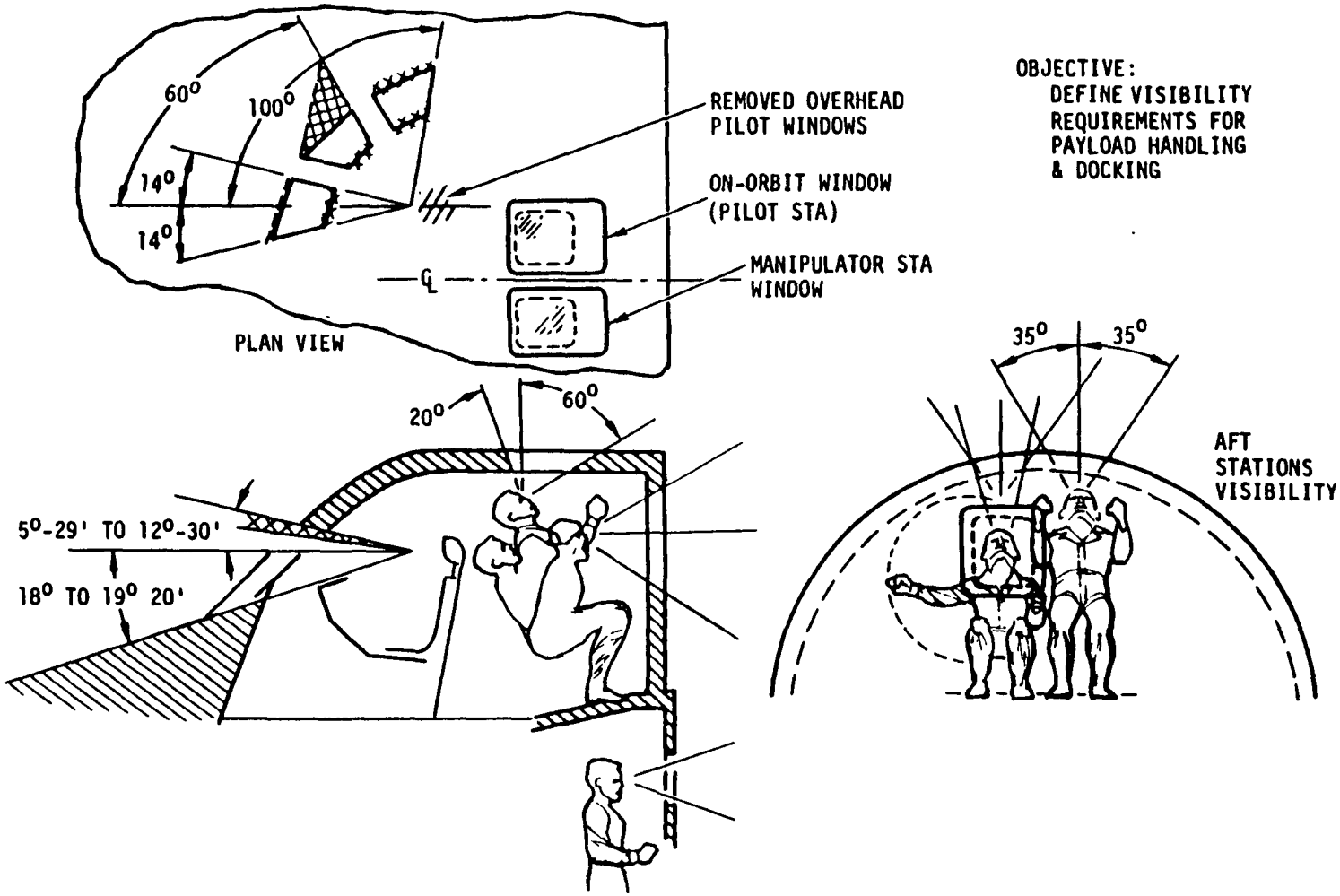
# DOCKING OPERATIONS



# PAYLOAD VISUAL OBSERVATION



# FLIGHT DECK VISIBILITY TRADES




OBJECTIVE:
DEFINE VISIBILITY REQUIREMENTS FOR PAYLOAD HANDLING & DOCKING

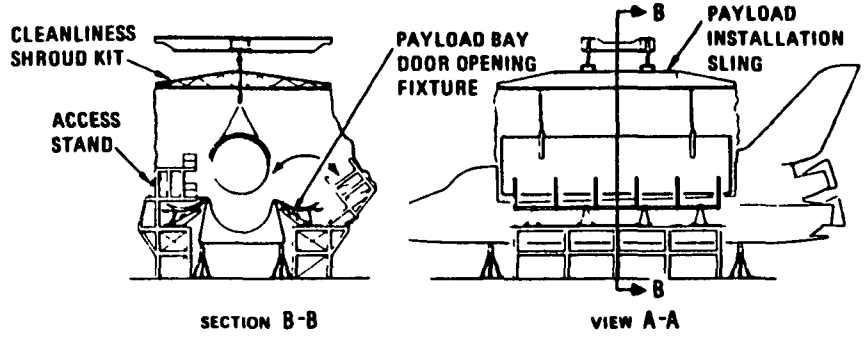
# PAYLOAD CHECKOUT/INSTALLATION

## PAYLOAD CHECKOUT

- MAX. FLEXIBILITY FOR P/L REQMTS
- DECOUPLED ORBITER CHECKOUT FROM PAYLOAD CHECKOUT
- USE OF STRUCTURAL FIXTURES FOR ORB/PAYLOAD INTERFACE CHECKS
- SPECIAL EMPHASIS ON CONTAMINATION CONTROL PROCEDURES TO PROTECT SENSITIVE PAYLOAD ELEMENTS

## PAYLOAD INSTALLATION

- MAINTENANCE & C/O AREA (SAME EQUIPMENT IN SAFING AREA, & AT ALTERNATE & FERRY LOG SITES)



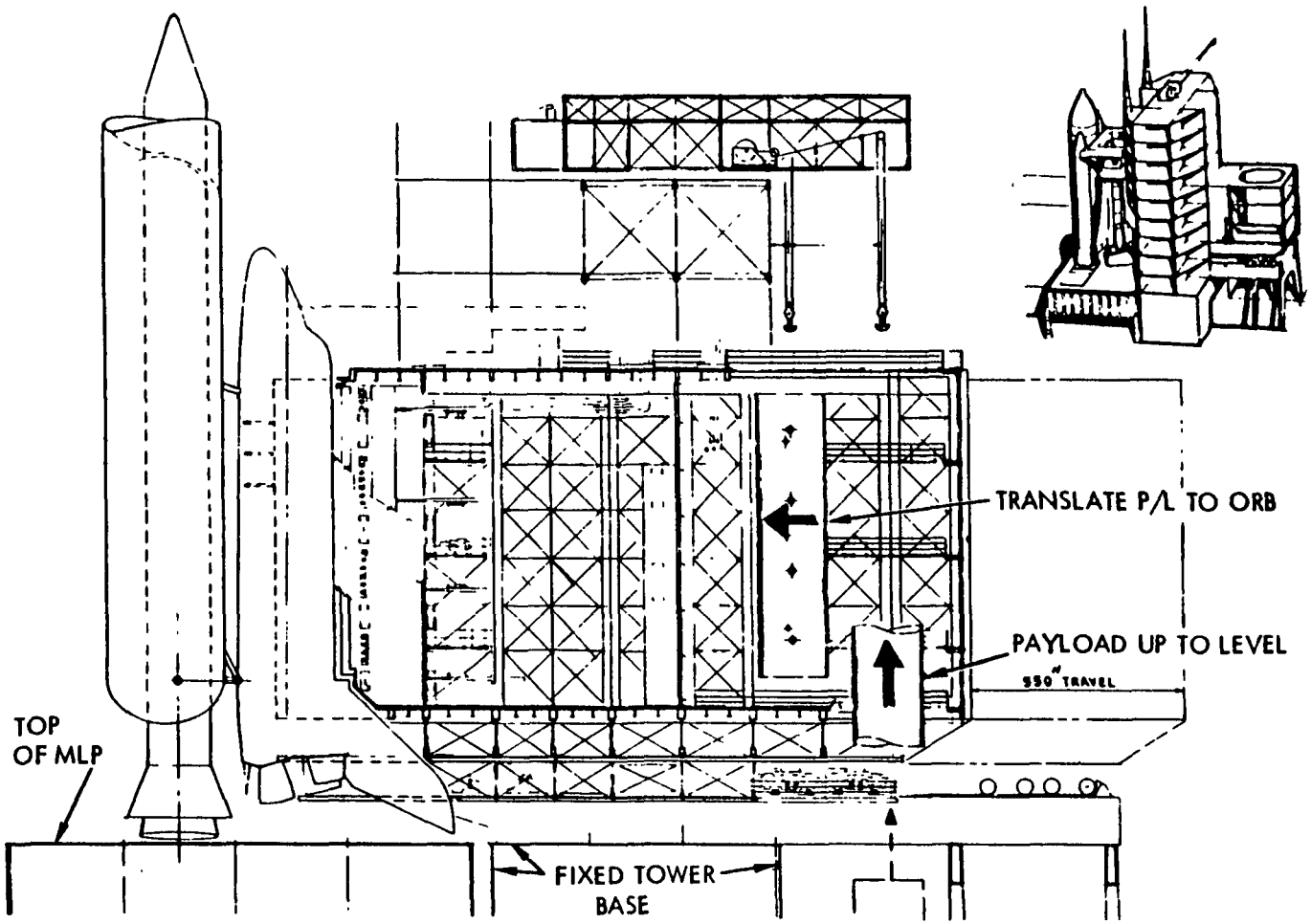

### PAYLOAD INSTALLATION STEPS

1. TRANSFER PAYLOAD FROM TRANSPORTER TO PAYLOAD SLING IN MAINT & CKOUT AREA
2. INSTALL SHROUD (WHEN CLEANLINESS IS REQUIRED)
3. MOVE PAYLOAD OVER ORBITER
4. DROP SHROUD CURTAINS & CONDITION VOLUME
5. POSITION ACCESS STAND
6. OPEN DOORS WITH PAYLOAD BAY DOOR OPENING FIXTURE
7. INSTALL PAYLOAD
8. REMOVE PAYLOAD SLING & ACCESS STAND
9. CLOSE PAYLOAD BAY DOORS
10. REMOVE ALL GSE

- LAUNCH PAD

CAPABILITY PROVIDED FOR PAYLOAD EXCHANGE

# PAYLOAD CHANGEOUT STRUCTURE

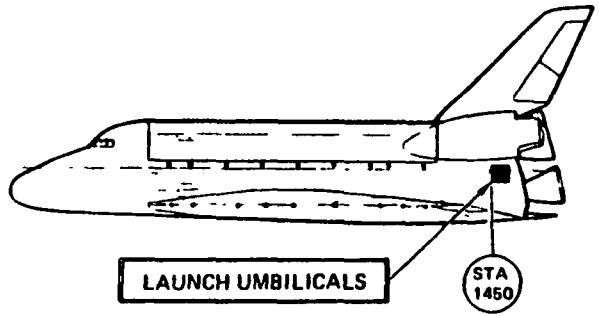


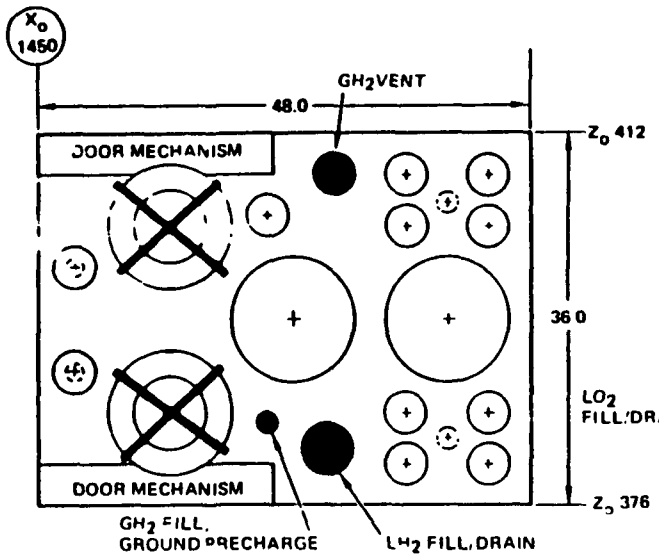
# BASELINE LAUNCH UMBILICALS

UMBILICAL DISCONNECT T = 0

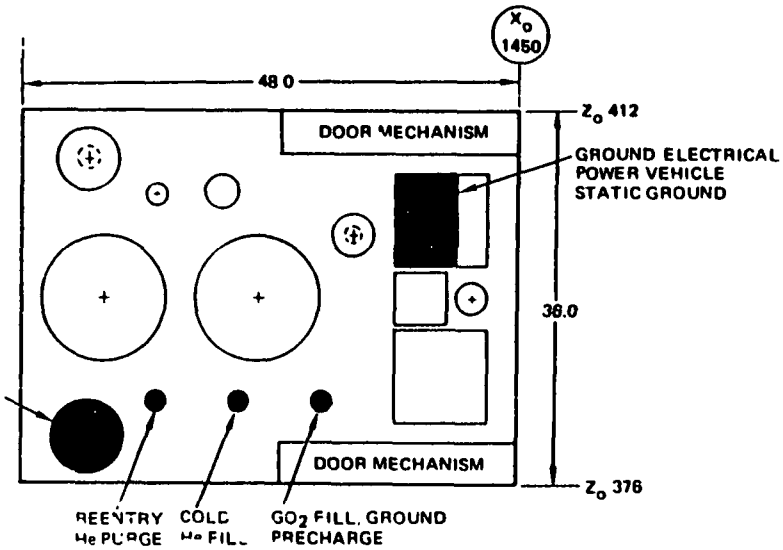
○ = ORBITER DISCONNECTS

● = PAYLOAD DISCONNECTS



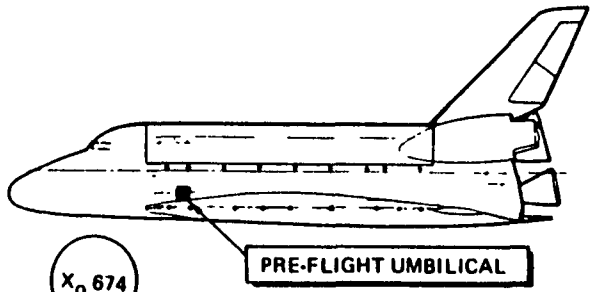

LH SIDE
• FUEL

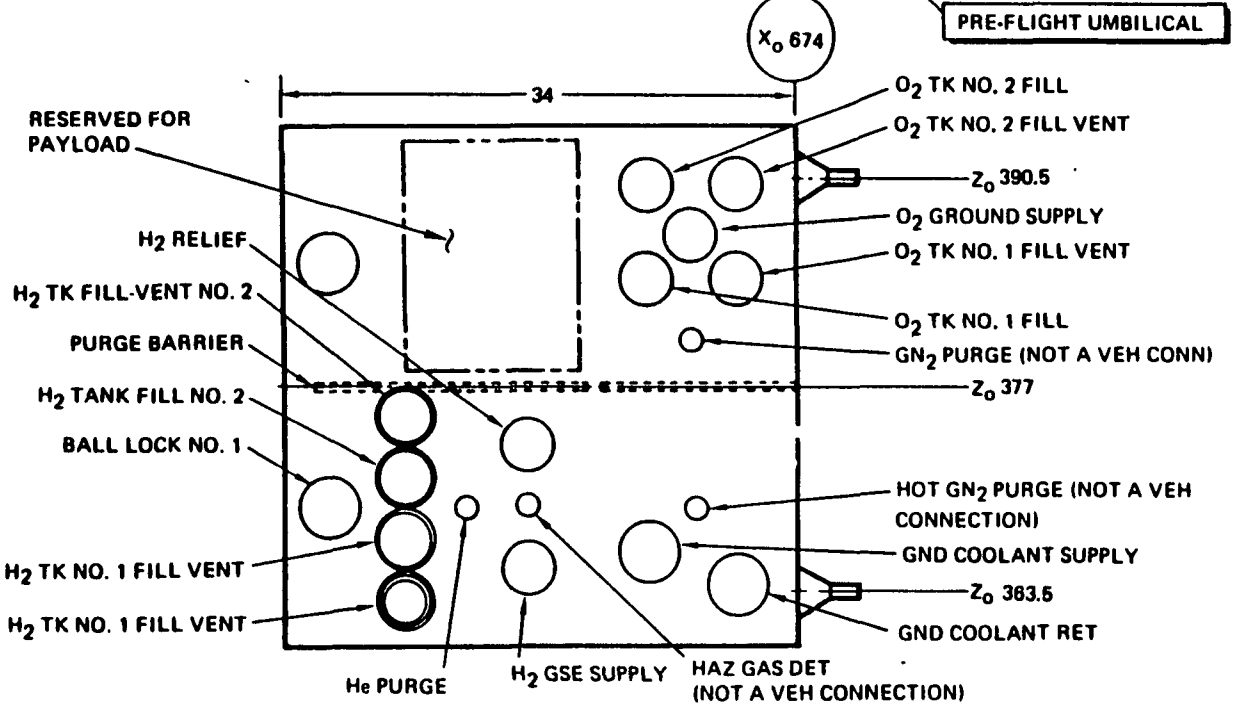



RH SIDE
• OXIDIZER

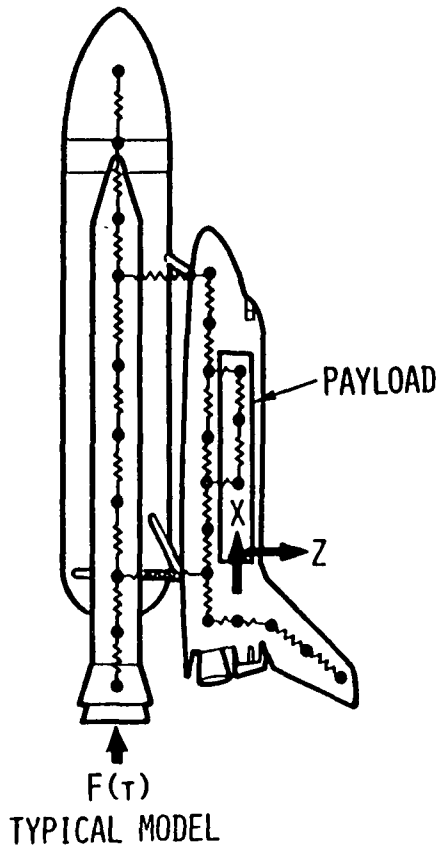
# PREFLIGHT UMBILICAL

- ORBITER/PAYLOAD LAUNCH PAD SERVICE
- LH SIDE ONLY
- DISCONNECT AT ~ T-26 MIN



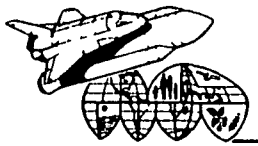



# PAYLOAD DYNAMIC RESPONSE

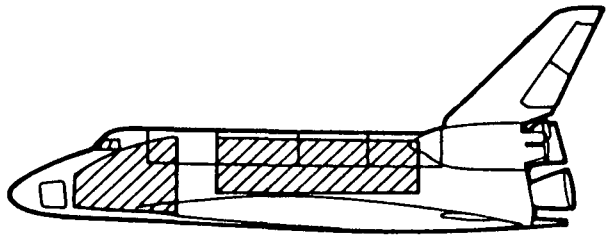



TYPICAL MODEL

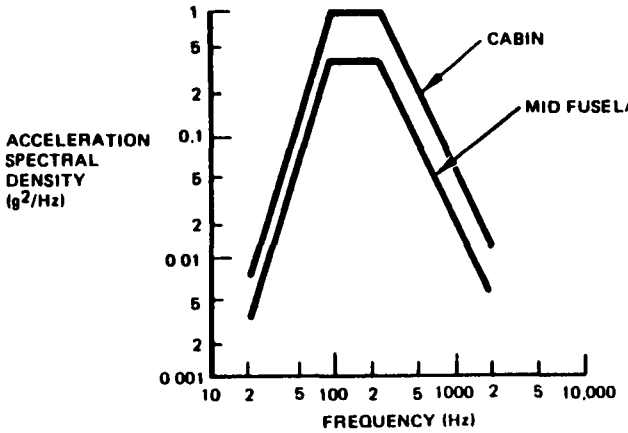
MODEL REQD FOR EACH PAYLOAD/ORBITER SYSTEM TO ESTABLISH PAYLOAD ACCELERATION LOADS



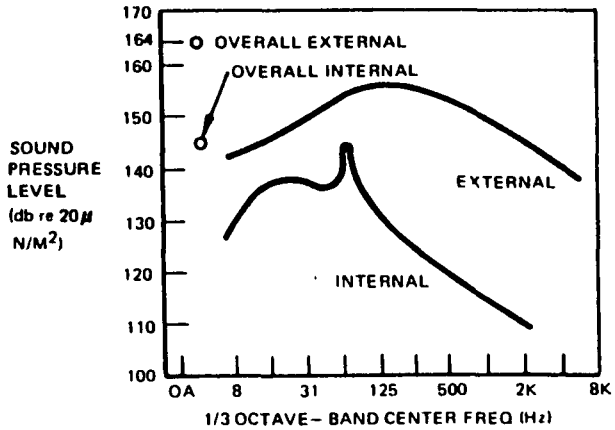
# CABIN/PAYLOAD ACOUSTICS AND VIBRATION SPECTRA



## VIBRATION SPECTRA FOR MID FUSELAGE AND CABIN




## PAYLOAD BAY NOISE LIMITS



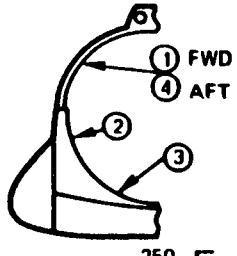

**REQUIREMENTS:**

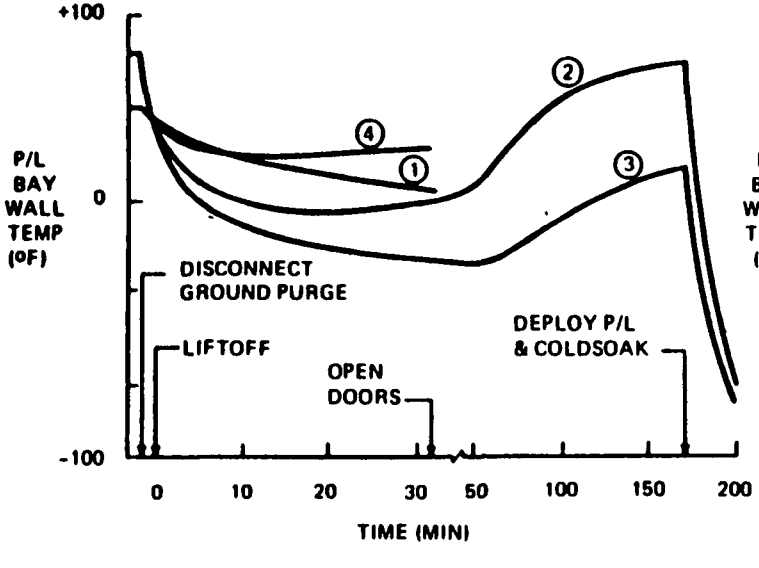
PAYLOAD BAY INTERIOR ≤ 145 dB OVERALL
PAYLOAD BAY EXTERIOR ≤ 164 dB OVERALL

# PAYLOAD BAY THERMAL ENVIRONMENT - TYPICAL MISSION PHASES

## PRELAUNCH THROUGH P/L DEPLOYMENT

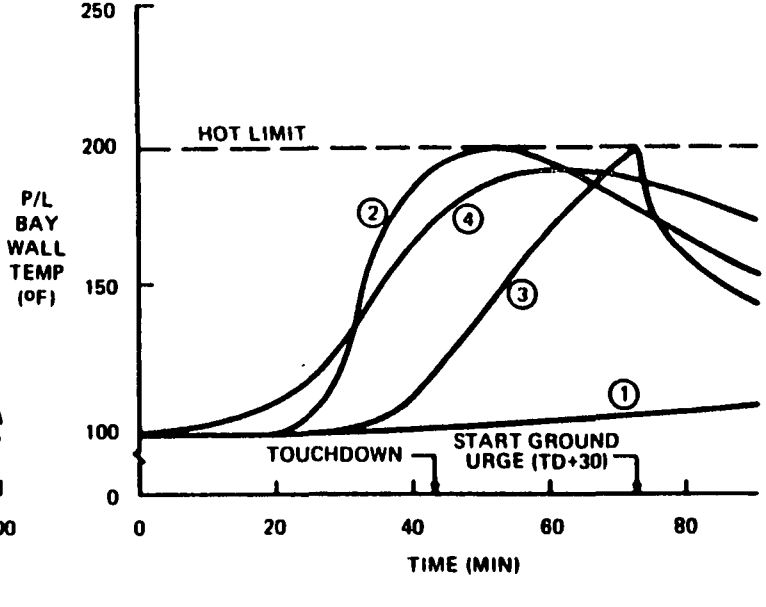
- INSULATED CRYO TUG P/L
- $\beta$ = 90° ON ORBIT




## ENTRY THROUGH POST LANDING

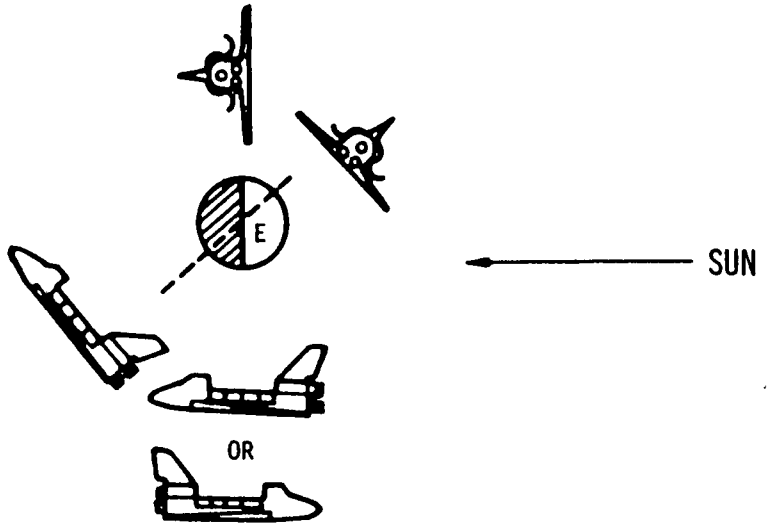
- ADIABATIC P/L BAY WALLS
- HIGH CROSSRANGE ENTRY
- NO PAYLOAD



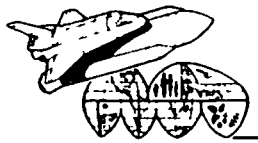
# THERMAL DESIGN REFERENCE MISSION

ON-ORBIT

| ASCENT | UNCONSTRAINED ATTITUDE HOLD t = 6 HR | THERMAL CONDITIONING t = 3 | UNCONSTRAINED ATTITUDE HOLD t = 6 HR | THERMAL CONDITIONING t = 3 HR | UNCONSTRAINED ATTITUDE HOLD t = 6 HR | THERMAL PRE-CONDITION t = 7 HR | DESCENT |
|---|---|---|---|---|---|---|---|




- THERMAL ATTITUDE MANAGEMENT REQUIREMENTS ARE REDUCED FOR $\beta$ ANGLES LESS THAN 90 DEG



# PAYLOAD POINTING & STABILITY

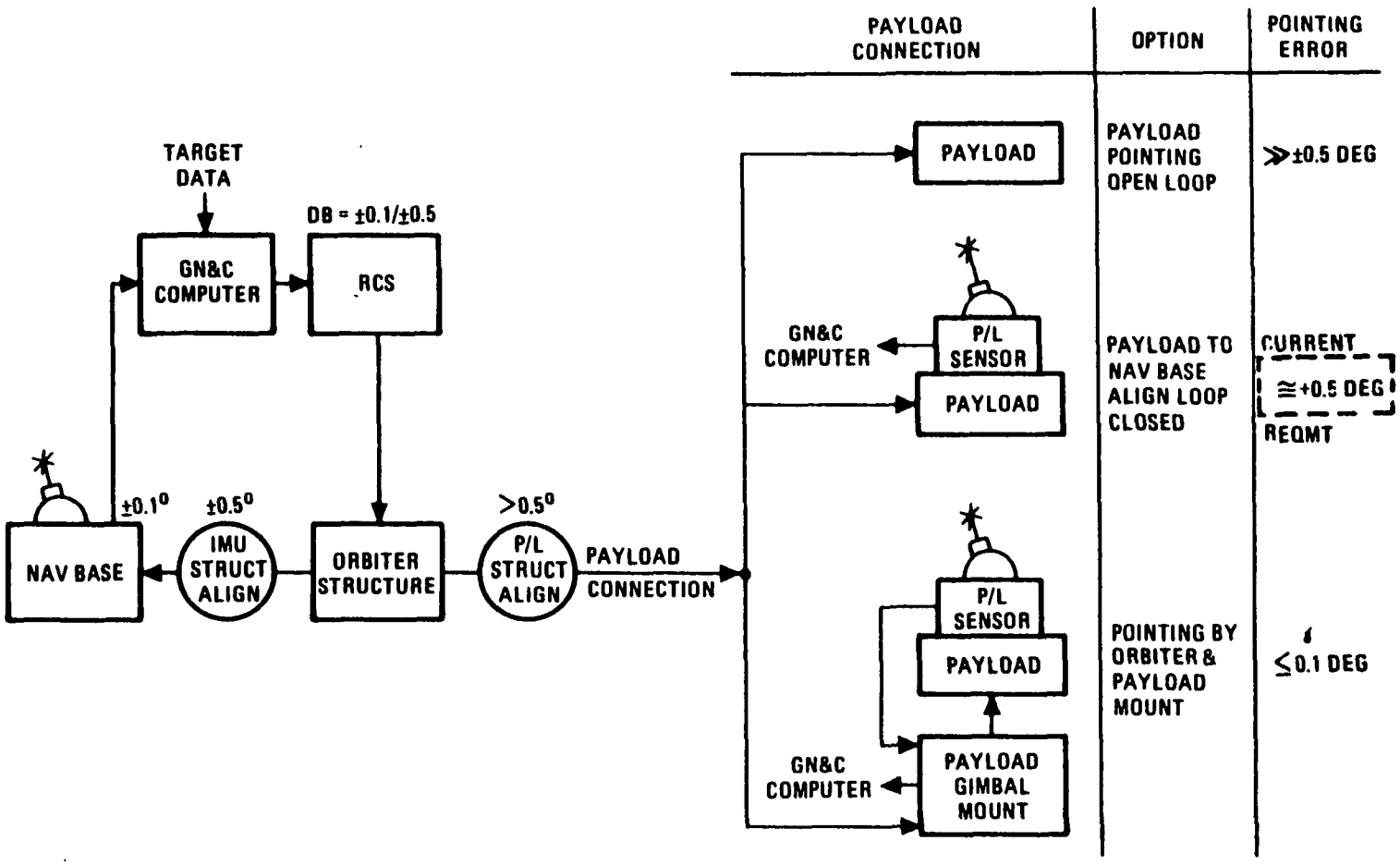
- REQUIREMENTS
  - POINT P/L WITHIN ±0.5 DEGREES (PAYLOAD MOUNTED SENSOR)
  - ANGULAR RATES 0.01 DEG/SEC MAXIMUM
  - SENSOR REFERENCE: EITHER GN&C NAV BASE OR PAYLOAD SENSOR
  - COORDINATE - SYSTEM REFERENCE: EITHER INERTIAL OR LOCAL VERTICAL

- RCS CAPABILITY, 25-LB VERNIER JETS (PRELIMINARY)
  - LOCAL VERTICAL, NOSE FORWARD, PAYLOAD DOWN, 100-N MI CIRC ORBIT

| DEADBAND | PROPELLANT CONSUMPTION* (LB/HR) |
|---|---|
| ±0.42 | 2.3 |
| ±1.41 | 1.0 |
| ±4.24 | 0.94 |

*INCLUDES 25% ALLOWANCE FOR UNCERTAINTY

# PAYLOAD POINTING & STABILITY OPTIONS



# MISSION KIT - TRADE
# EPS, ECLSS, OMS

**TYPICAL EQUIPMENT & CONSUMABLE KITS FOR SPECIAL MISSIONS**

**ECLSS: Δ DURATION KITS**

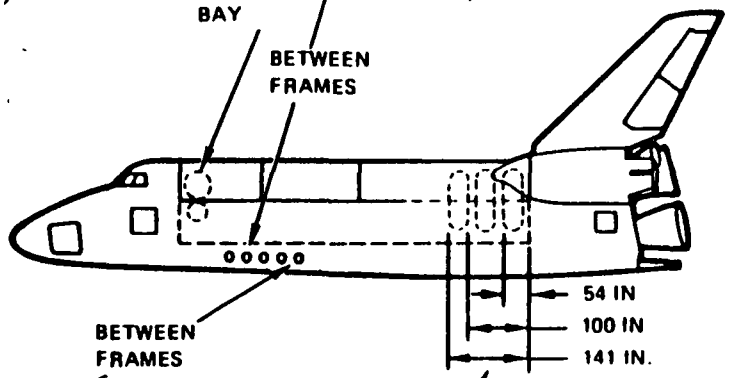
- FOOD,
- WASTE COLLECTORS
- LiOH
- BACTERIACIDE TANKS

} LOCATION TO BE ESTABLISHED

**EPS: Δ ELECTRICAL ENERGY KITS**

4 SPECIAL TANKS, +4000 KWH

- ONE SET BASELINE-SIZED $H_2$ & $O_2$ TANKS, +980 KWH
- TWO SETS BASELINE SIZED $H_2$ & $O_2$ TANKS, +1960 KWH




- NITROGEN 175 LB
- $O_2$ IN EPS TANKS
- WATER TANKS

} BETWEEN FRAMES

**OMS: Δ PROPELLANT**

- ONE BASELINE FUEL, OXIDIZER & PRESS , Δ 11,895 LB
- TWO BASELINE FUEL, OXIDIZER & PRESS., Δ 23,838 LB
- THREE BASELINE FUEL, OXIDIZER & PRESS., Δ 35,781 LB

# CONTAMINATION TRADE STUDIES

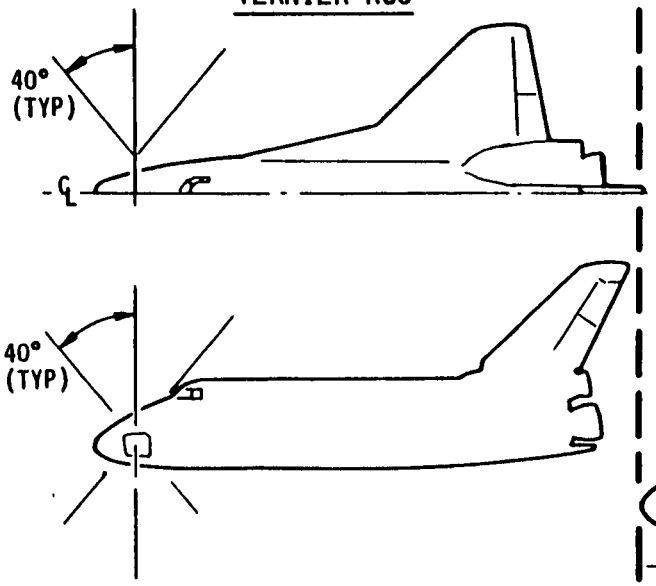
OBJECTIVE:

ESTABLISH METHODS OF CONTAMINATION AVOIDANCE

- WATER DUMPS & VENTS
- SILICONES & HYDROCARBONS
- PROPULSION SYSTEM PRODUCTS/IMPINGEMENT
- HYDRAULIC & COOLING SYSTEMS
- EMC
- RADIOISOTOPES

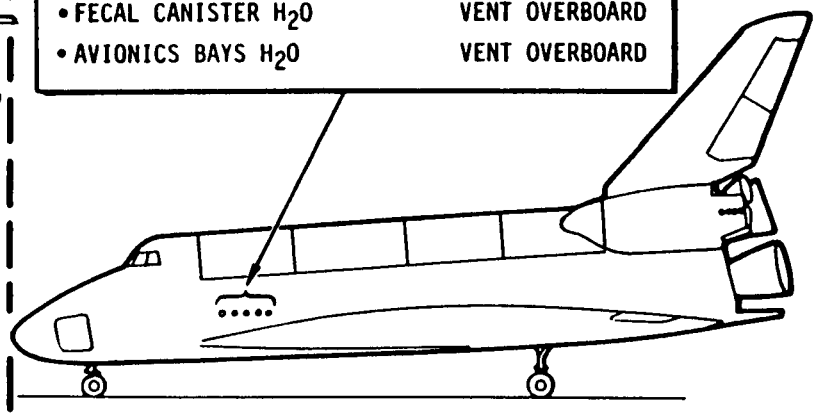
BASELINE

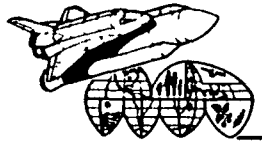
VERNIER RCS



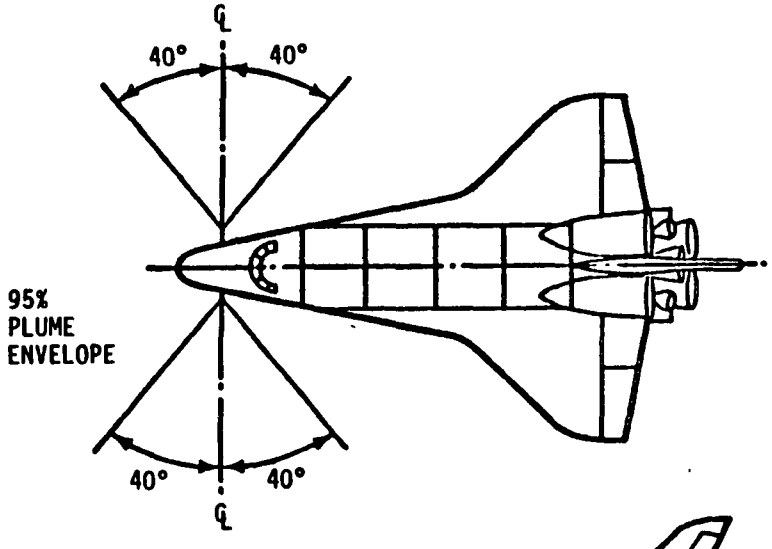

WATER DUMPS/VENTS

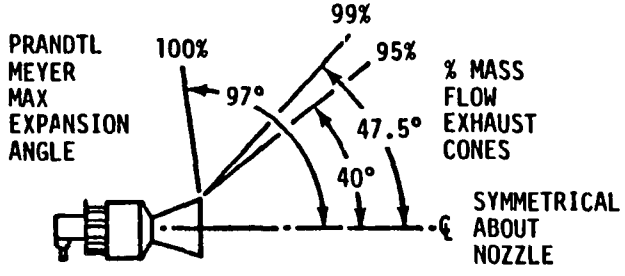
| | |
|---|---|
| • FUEL CELL $H_2O$ HOLD | UP TO 12 HOURS |
| • WASTE $H_2O$ & URINE STORAGE (RETURN TO EARTH) | UP TO 7 DAYS |
| • FECAL CANISTER $H_2O$ | VENT OVERBOARD |
| • AVIONICS BAYS $H_2O$ | VENT OVERBOARD |



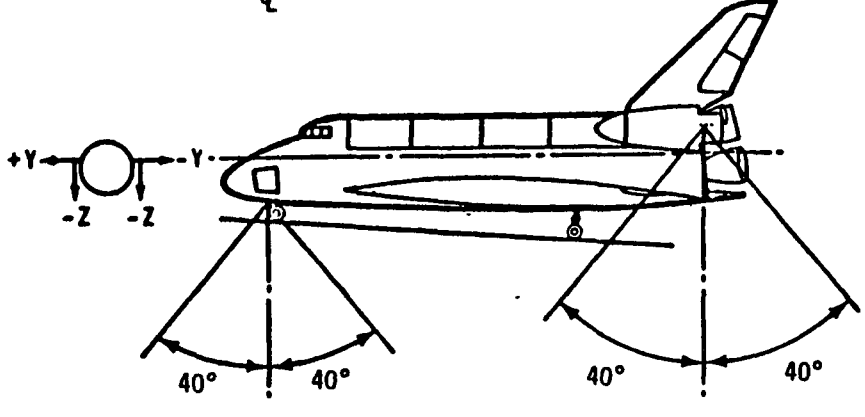


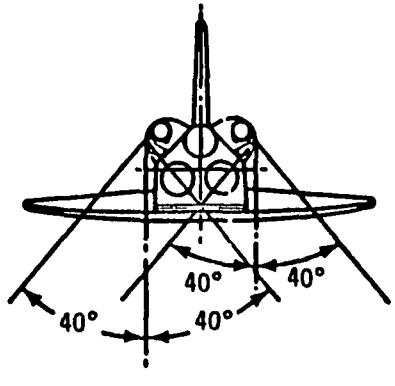
# ALTERNATE ARRANGEMENT OF RCS VERNIER THRUSTERS
## 4 FORWARD, 2 AFT



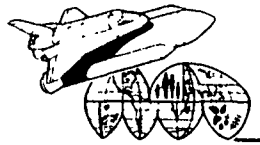




PERCENT FLOW EXHAUST CONES




NO PLUMES DIRECTED UPWARD;
LEAST P/L CONTAMINATION



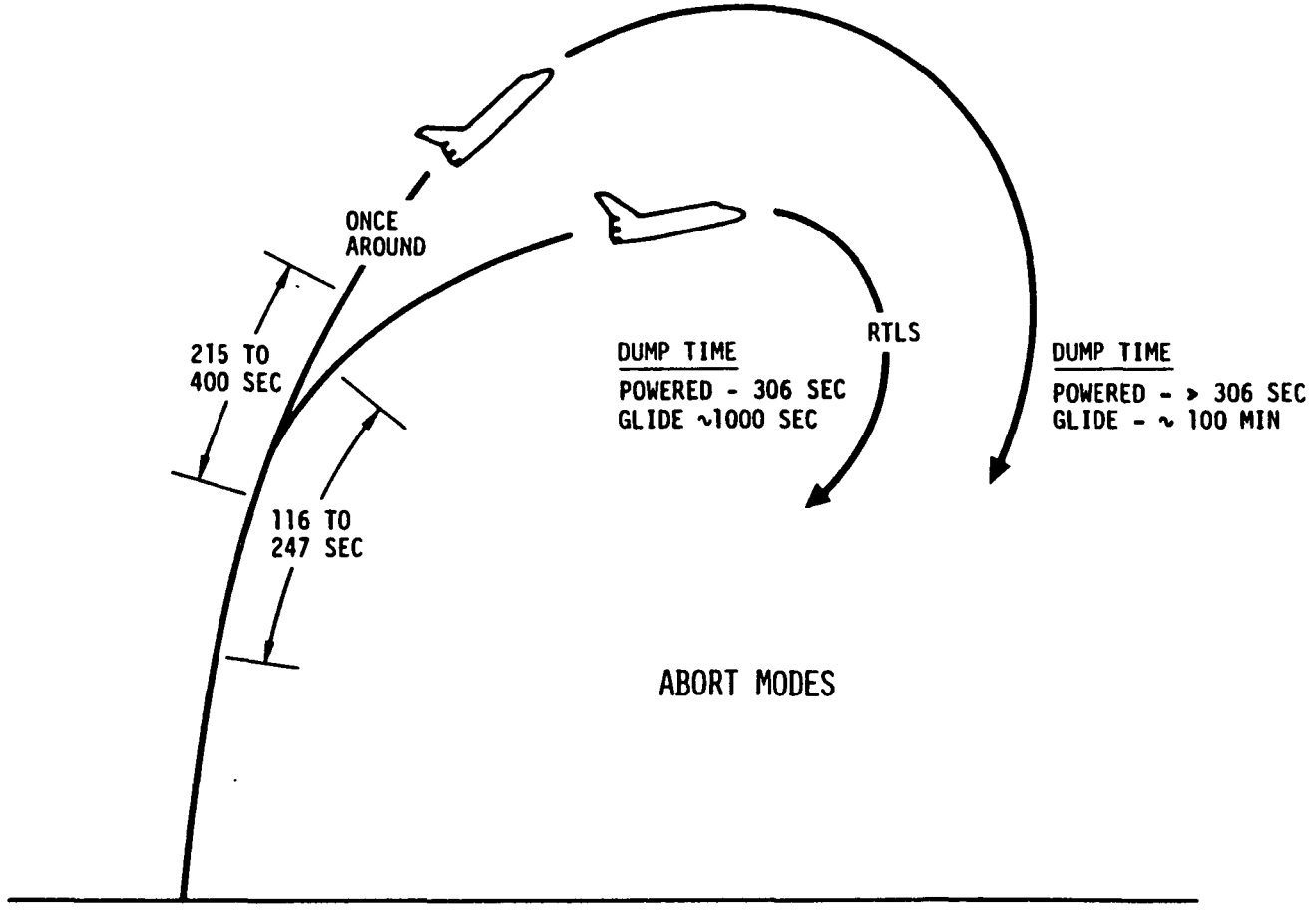
# TRADE STUDY FOR PROPULSION STAGES INTERFACE REQMTS

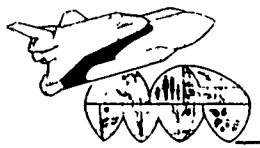
## OBJECTIVES

ESTABLISH ORBITER/PAYLOAD INTERFACE REQMTS

- PROPULSIVE/NON-PROPULSIVE PAYLOADS
  - PROPELLANTS
  - PRESSURANTS
  - AUXILLIARY FLUIDS (RCS, APU, ETC.)
- OPERATIONAL PHASES
  - PRELAUNCH - SERVICING
  - FLIGHT - ABORT
  - POST FLIGHT - SAVING & DESERVICING
- OPERATIONS
  - FILL
  - DRAIN
  - VENT
  - DUMP

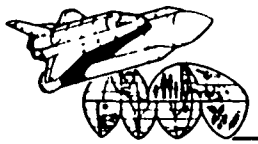
# PAYLOAD PROPELLANT DUMP DURING ABORT (CRYOGENIC STAGE)





# STUDY OUTPUTS

- DUMP SYSTEM SIZING/ROUTING
- POWERED VS GLIDING DUMP
- DUMP SEQUENCE
- PRESSURIZATION SYSTEM AUGMENTATION
- DUMP PORT LOCATION
- ATTITUDE CONTROL DURING DUMP
- OPERATIONAL CONCEPTS/PROCEDURES
- IMPACT ON GROUND FACILITIES



## SHUTTLE ITEMS CHARGEABLE TO PAYLOAD

CREW & CREW PROVISIONS

- CREW IN EXCESS OF 4
- LIFE SUPPORT EQUIP & CONSUMABLES IN EXCESS OF 28 MAN DAYS
- CREW SEATS IN EXCESS OF 4

MISSION PROVISIONS

- OMS $\Delta V$ KITS
- EVA/IVA EQUIPMENT & CONSUMABLES
- RCS PROPELLANT IN EXCESS OF NOMINAL
- DOCKING ADAPTOR

PAYLOAD INSTALLATION PROVISIONS

- ELEC & PROPELLANT LINES & CONNECTORS
- STRUCTURAL ADAPTOR
- STRUCTURAL SUPPORT FITTINGS
- MISSION/PAYLOAD EQUIP IN EXCESS OF STD PROVISIONS

PAYLOAD - INTEGRATED ASSEMBLY FOR USE IN SPACE

# PAYLOAD RELATED MCR SCHEDULE