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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE

BASELINE ACCOMMODATIONS FOR PAYLOADS

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MANNED SPACECRAFT CENTER

HOUSTON, TEXAS

JUNE 27, 1972

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PREPARED BY
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ABBREVIATIONS AND ACRONYMS

BPS	BITS PER SECOND
BTU/HR	BRITISH THERMAL UNITS PER HOUR
C.G.	CENTER OF GRAVITY
CRT	CATHODE RAY TUBE
C+W	CAUTION AND WARNING
DB	DECIBEL
DC	DIRECT CURRENT
DEG/SEC	DEGREES PER SECOND
ECLSS	ENVIRONMENTAL CONTROL LIFE SUPPORT SYSTEM
EVA	EXTRAVEHICULAR ACTIVITY
EVLSS	EXTRAVEHICULAR LIFE SUPPORT SYSTEM
FPS	FEET PER SECOND
G+N	GUIDANCE AND NAVIGATION
GN+C	GUIDANCE NAVIGATION AND CONTROL
GSE	GROUND SUPPORT EQUIPMENT
IVA	INTRAVEHICULAR ACTIVITY
KWH	KILOWATT HOUR
KSC	KENNEDY SPACE CENTER
LBS	POUNDS
MRF	MAINTENANCE AND REFURBISHMENT FACILITY
MSC	MANNED SPACECRAFT CENTER
MSS	MISSION SPECIALIST STATION
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
OMS	ORBITAL MANEUVERING SYSTEM
PCDS	PAYLOAD COMMAND DECODER SUBUNIT
PCM	PULSE CODE MODULATION

PGA	PRESSURE GARMENT ASSEMBLY
PSIA	POUND PER SQUARE INCH ABSOLUTE
RAU	REGIONAL ACQUISITION UNIT
RCS	REACTION CONTROL SYSTEM
RF	RADIO FREQUENCY
RFP	REQUEST FOR PROPOSAL
RMS	REMOTE MANIPULATOR SYSTEM
RPC	REMOTE POWER CONTROLLER
RTTA	RANGE TOWER TRANSFER ASSEMBLY
SGLS	SPACE GROUND LINK SYSTEM
SPP	STORED PROGRAM PROCESSOR
SRM	SOLID ROCKET MOTOR
SSPO	SPACE SHUTTLE PROGRAM OFFICE
STDN	SPACE TRACKING AND DATA NETWORK
TBD	TO BE DETERMINED
TDRS	TRACKING AND DATA RELAY SATELLITE SYSTEM
TLM	TELEMETRY
TV	TELEVISION
UV	ULTRAVIOLET
VAB	VERTICAL ASSEMBLY BUILDING
VDC	VOLT DIRECT CURRENT
VHF	VERY HIGH FREQUENCY
XMTR	TRANSMITTER
F	DEGREE FAHRENHEIT

INTRODUCTION

THIS DOCUMENT DESCRIBES THE SPACE SHUTTLE SYSTEM AS IT RELATES TO PAYLOADS. ITS PURPOSE IS TO PROVIDE POTENTIAL USERS OF THE SPACE SHUTTLE WITH A UNIFORM BASE OF INFORMATION ON THE ACCOMMODATIONS BETWEEN THE PAYLOAD AND THE SHUTTLE. BY UTILIZING THIS INFORMATION, PRELIMINARY PAYLOAD PLANNING AND DESIGN STUDIES CAN BE EVALUATED AND COMPARED AGAINST A COMMON SET OF SHUTTLE/PAYLOAD ACCOMMODATIONS. THIS INFORMATION ALSO MINIMIZES THE NECESSITY FOR EACH PAYLOAD STUDY TO DEVELOP INFORMATION ON THE SHUTTLE CONFIGURATION.

THIS DOCUMENT DESCRIBES A BASELINE CONFIGURATION OF THE SPACE SHUTTLE SYSTEM WHICH IS CONSISTENT WITH CURRENT PROGRAM REQUIREMENTS APPROVED BY THE SPACE SHUTTLE PROGRAM OFFICE, HOWEVER, IT SHOULD NOT BE CONSIDERED AS A SHUTTLE PROGRAM CONTROL OR REQUIREMENTS DOCUMENT.

THE SPACE SHUTTLE PROGRAM REQUEST FOR PROPOSAL (RFP) NUMBER 9-BC421-67-2-40P RELEASED TO INDUSTRY ON MARCH 17, 1972, WITH ANY SUBSEQUENT PROVISIONS, IS THE PRIMARY AND CONTROLLING SOURCE DOCUMENT FOR THIS ISSUE. PARTS OF THE RFP ARE REPEATED WITHIN BOTH FOR CONTINUITY AND TO ELIMINATE THE NEED FOR MANY OF THE PAYLOADS COMMUNITY TO REQUEST THE RFP.

SUMMARY LEVEL INFORMATION ON SPACE SHUTTLE CONFIGURATION, PRELIMINARY PERFORMANCE DATA, AND OPERATION PHILOSOPHY ARE BRIEFLY DESCRIBED. INFORMATION ON PAYLOAD INTERFACES, AS RELATED TO SHUTTLE OPERATIONS, SUBSYSTEMS, ENVIRONMENT, SAFETY, AND SUPPORT EQUIPMENT, IS ALSO INCLUDED. THE SPACE SHUTTLE PRELIMINARY DESIGN PHASE TO BE INITIATED SOON WILL PROVIDE INDEPTH INFORMATION ON ORBITER CHARACTERISTICS.

CORRESPONDENCE REGARDING LEVEL I PROGRAM REQUIREMENTS, GUIDELINE, AND PLANNING SHOULD BE ADDRESSED TO NASA HQ. ITEMS RELATIVE TO GENERAL PROGRAM REQUIREMENTS AND INTERCENTER PROGRAM INTERACTIONS SHOULD BE ADDRESSED TO THE MSC SPACE SHUTTLE PROGRAM OFFICE. INFORMAL COMMENTS AND QUESTIONS ON TECHNICAL DETAILS SHOULD BE ADDRESSED TO THE MSC PAYLOADS ENGINEERING OFFICE. PLEASE DIRECT THE INQUIRIES TO THE FOLLOWING INDIVIDUALS-

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1.000 SPACE SHUTTLE SYSTEM

1.100 GENERAL PAYLOAD ACCOMMODATIONS

ITEM	CAPABILITY/CHARACTERISTIC	
STRUCTURAL/MECHANICAL		
MAX. PAYLOAD WT. (LAUNCH)	65,000 LBS	
MAX. PAYLOAD WT. (LANDING)	40,000 LBS NOMINAL, UP TO 65,000 LBS WITH REDUCED SAFETY FACTORS	
PAYLOAD ENVELOPE	15 FT. DIA. BY 60 FT. LENGTH	
PAYLOAD C.G.	FIGURE 2.1	
DOCKING PORT I.D.	1.0 METER	
DOCKING PARAMETERS	LATERAL MISALIGNMENT	+/-0.5 FT.
	ANGULAR MISALIGNMENT	+/-5.0 DEG
	ROLL MISALIGNMENT	7.0 DEG
	CLOSING VELOCITY	0.5 FPS
PAYLOAD ALIGNMENT IN BAY	0.5 DEG	
ELECTRICAL POWER		
VOLTAGE	30 VDC NOMINAL	
LOAD	ORBITER OPERATION PERIODS	1000 WATTS AVG. 1500 WATTS PEAK
	ON-ORBIT COAST PERIODS	3000 WATTS AVG. 6000 WATTS PEAK
ENERGY	50 KWH DEDICATED	
SOURCE	REDUNDANT DC BUSSES IN PAYLOAD BAY	

GUIDANCE AND NAVIGATION

ORBIT NAVIGATION ACCURACIES	STDN	1000 FT.
	STAR/HORIZON	4000 FT.
	GROUND/BEACON	1000 FT.
	HORIZON/BEACON	700 FT.
	TDRS	300 TO 1000 FT.
	LANDMARK	2000 FT.

RENDEZVOUS RANGE	300 N. MILES WITH COOPERATIVE TARGET
ATTITUDE POINTING ACCURACY	0.5 DEG
STABILITY RATE	TBD
DEADBAND	0.5 DEG, 0.1 DEG

DATA MANAGEMENT

COMPUTATION	10,000 32 BIT WORDS
DATA TRANSFER	25,000 BPS VIA DATA BUS
DATA DOWNLINK	265,000 BPS DIGITAL DATA, TV, AND VOICE
DATA UPLINK	2,000 BPS

ENVIRONMENTAL CONTROL/LIFE SUPPORT

PERSONNEL ACCOMMODATIONS	4 MEN, 7 DAYS NOMINAL	
	42 MAN-DAYS WITHOUT SYSTEM CHANGES	
	10 MEN WITH MINOR CHANGES	
	30 DAYS WITH ADDITIONAL CONSUMMABLES	
CABIN ATMOSPHERE	14.7 PSIA	
	20 PERCENT OXYGEN, 80 PERCENT NITROGEN	
	65 DEG - 80 DEG F CONTROLLED TEMPERATURE	
	HUMIDITY CONTROL	
	CONTAMINATION CONTROL	
	CARBON DIOXIDE CONTROL	
WASTE MANAGEMENT	WATER STORAGE 24 HOURS	
ACTIVE THERMAL CONTROL	ORBITER OPERATIONS	5200 BTU/HR
	ON-ORBIT COAST	TBD

PAYLOAD BAY ENVIRONMENT

ACOUSTIC	LESS THAN 145 DB OVERALL

VIBRATION LESS THAN CURRENT LAUNCH VEHICLE

ACCELERATION	X	Y		Z	
LAUNCH	1.5+/-1.0	+/-0.25	+/-0.5	+/-0.25	+/-0.5
MAX. BOOST	3.0+/-0.25	+/-0.2	+/-0.25	+/-0.3	+/-0.25
ENTRY	-1	+/- 0.5	+/-0.25	-3	+/-0.5

THERMAL	MIN (DEG F)	MAX (DEG F)
*PRELAUNCH	+40	+120
LAUNCH	+40	+150
ON-ORBIT	-100	+150
*ENTRY + POSTLANDING	-100	+200

*GSE CONDITIONAL AIR AVAILABLE

1.200 CONFIGURATION DESCRIPTION

1.20100 SPACE SHUTTLE VEHICLE

THE SPACE SHUTTLE SYSTEM CONSISTS OF AN ORBITER WITH AN EXTERNAL PROPELLANT TANK AND TWO SOLID ROCKET MOTORS (SRM'S). FIGURE 1.1 SHOWS THE SHUTTLE SYSTEM AS THE VEHICLES ARE COMBINED FOR THE LAUNCH AND INITIAL BOOST PHASES OF THE MISSION. ALTHOUGH THE ORBITER VEHICLE IS REUSABLE, ITS PROPELLANT TANKS ARE EXPENDED ON EACH MISSION.

1.20200 ORBITER VEHICLE

THE BASELINE ORBITER IS A MANNED REUSABLE DELTA-WINGED VEHICLE (FIG. 1.2). CONTAINED WITHIN THE MAIN FUSELAGE OF THE ORBITER ARE THE CREW COMPARTMENT, A PAYLOAD BAY CAPABLE OF ACCOMMODATING SINGLE OR MULTIPLE PAYLOADS UP TO 15-FOOT DIAMETER BY 60-FOOT LONG, SUPPORT SUBSYSTEMS, AN ORBITAL MANEUVERING SYSTEM, AND THE MAIN PROPULSION SYSTEM ENGINES. PROTECTION AGAINST AERODYNAMIC HEATING IS PROVIDED DURING ASCENT AND REENTRY BY AN EXTERNAL THERMAL PROTECTION SYSTEM.

AERODYNAMIC FLIGHT IS CONTROLLED THROUGH THE ELEVONS AND RUDDER, WHILE SPACE-ATTITUDE CONTROL IS ACCOMPLISHED THROUGH REACTION CONTROL SYSTEM THRUSTERS WHICH ARE ATTACHED TO THE VEHICLE AS MODULES. TO INSURE PROPER AERODYNAMIC CONTROL DURING ENTRY AND ATMOSPHERIC FLIGHT PHASES, THE LOCATION OF PAYLOAD LONGITUDINAL CENTER-OF-GRAVITY MUST BE MAINTAINED WITHIN SPECIFIED LIMITS. MULTIPLE SETS OF PAYLOAD ATTACHMENT POINTS PROVIDE THE CAPABILITY TO RESTRAIN AND LOCATE THE PAYLOAD WITHIN THE ORBITER WITHIN THESE LIMITS.

PAYLOAD HANDLING DURING ORBITAL OPERATIONS NORMALLY IS ACCOMPLISHED BY A STANDARD DEPLOYMENT AND RETRIEVAL MECHANISM. THE CONCEPT SELECTED FOR THIS BASELINE IS A PAIR OF MANIPULATOR ARMS ATTACHED TO THE FORWARD BULKHEAD OF THE PAYLOAD BAY. THESE ARMS ARE STOWED BENEATH THE PAYLOAD BAY DOORS WHICH OPEN TO DISCLOSE THE FULL LENGTH AND WIDTH OF THE PAYLOAD BAY. THE MANIPULATORS PERFORM MULTIPLE FUNCTIONS WHICH INCLUDE PAYLOAD

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SPACE SHUTTLE SYSTEM

PARALLEL BURN

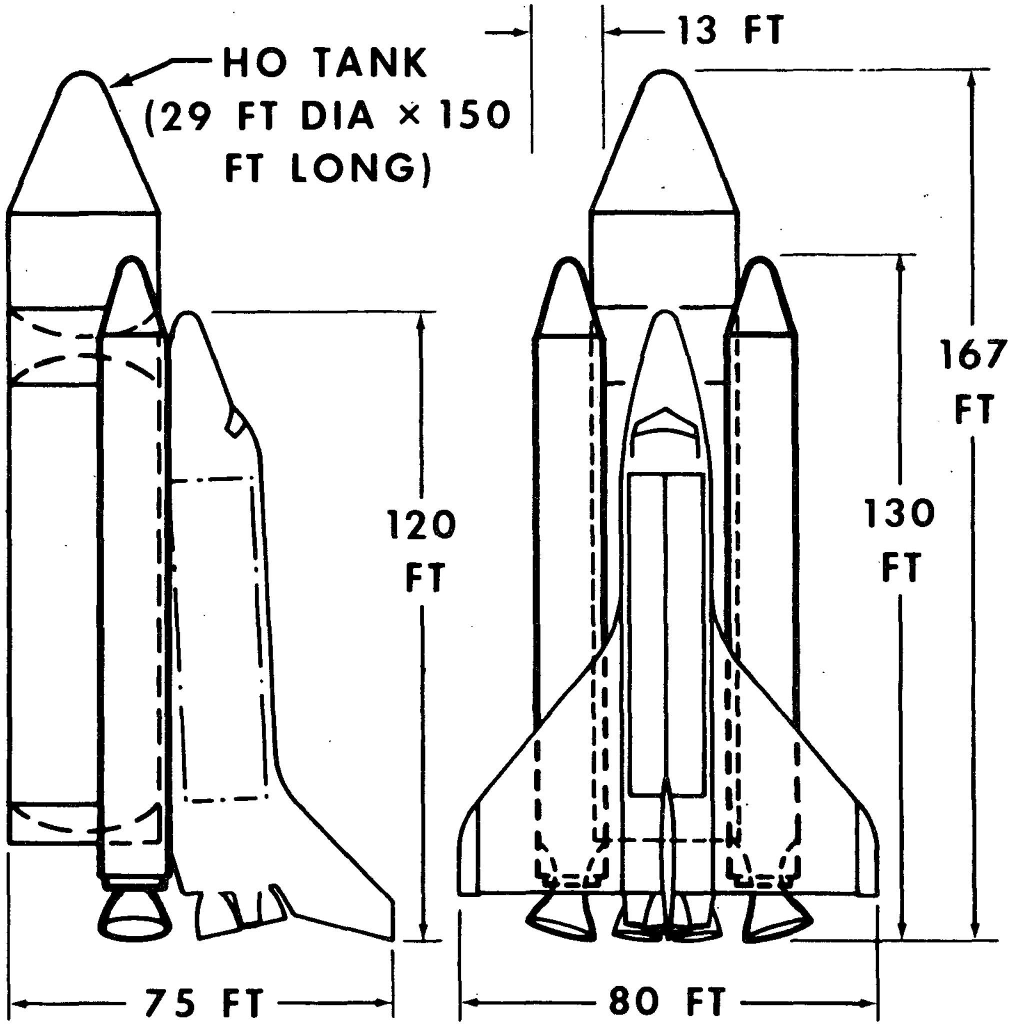

FIGURE - 1.1

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SPACE SHUTTLE ORBITER

BASELINE - FEB 72

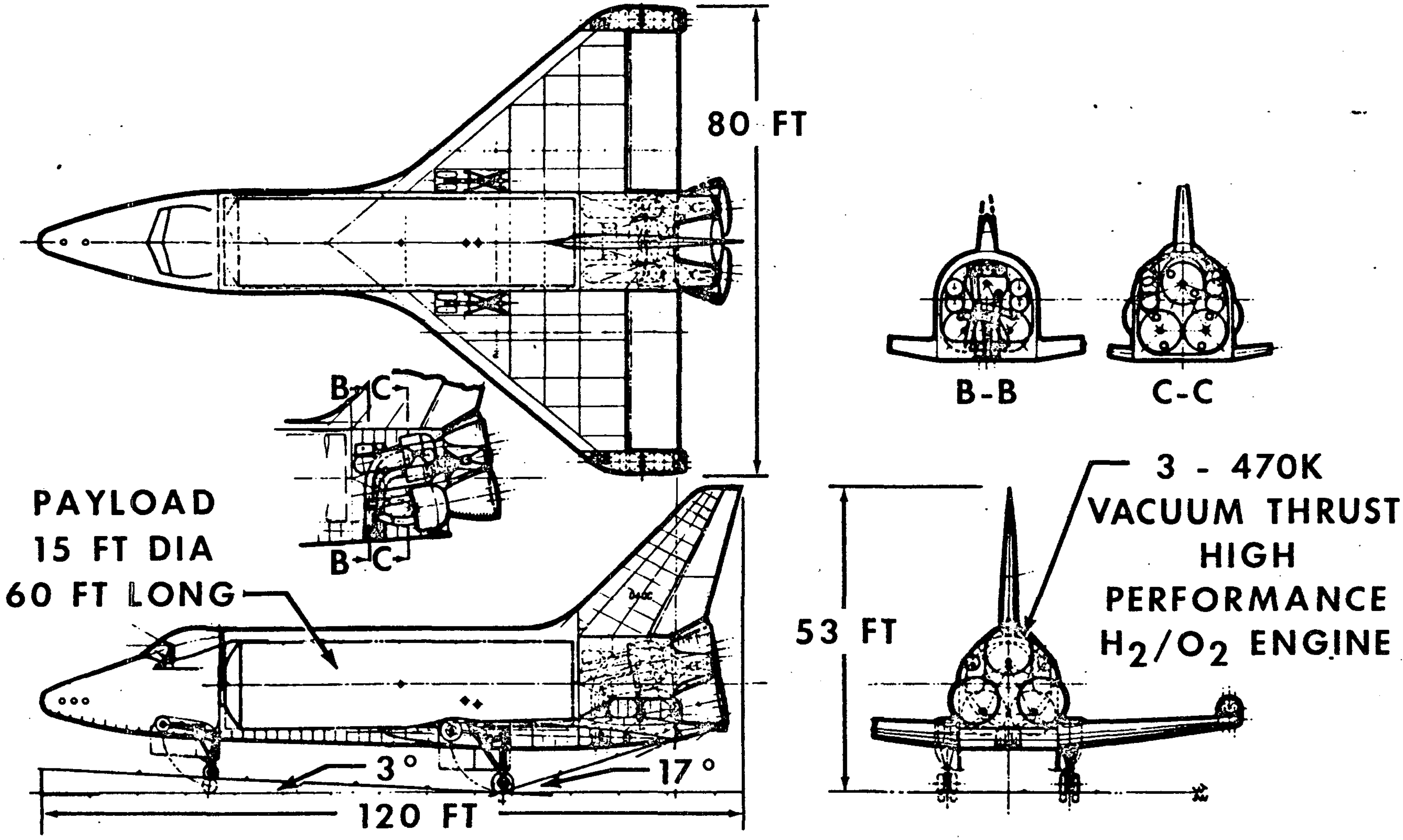


FIGURE - 1.2

ERECTION, DEPLOYMENT, RETRIEVAL, AND STOWAGE BACK IN THE PAYLOAD BAY. MANIPULATORS ALSO CAN SERVE TO ASSIST DOCKING THE ORBITER WITH ANOTHER ORBITING ELEMENT. CONTROL OF MANIPULATORS IS ACCOMPLISHED BY AN OPERATOR LOCATED ON THE FLIGHT DECK.

DURING ORBITAL OPERATIONS, PAYLOADS CAN BE DOCKED TO THE ORBITER, REMAIN WITHIN THE PAYLOAD BAY, OR BE DEPLOYED AND RELEASED FROM THE ORBITER. AIRLOCKS AND/OR HATCHES ARE PROVIDED TO PERMIT SHIRTSLEEVE ACCESS TO PRESSURIZED PAYLOADS AND PRESSURE SUIT ACCESS TO THE UNPRESSURIZED PAYLOAD BAY.

THE ORBITER CREW COMPARTMENT HOUSES THE FLIGHT CREW, PASSENGERS, CONTROLS AND DISPLAYS, AS WELL AS MOST OF THE AVIONICS AND ENVIRONMENTAL CONTROL SYSTEM. AN UPPER DECK PROVIDES CREW STATIONS TO ACCOMPLISH ALL FLIGHT OPERATIONS OF THE ORBITER AND CONTROL OF THE MANIPULATOR SYSTEM. PROVISIONS FOR PAYLOAD MONITORING, PASSENGER ACCOMMODATION, ELECTRONICS, AND ENVIRONMENTAL CONTROL/LIFE SUPPORT SYSTEMS ARE INCLUDED ON A LOWER DECK. THE ENTIRE COMPARTMENT IS TEMPERATURE, PRESSURE, HUMIDITY, AND ATMOSPHERE CONTROLLED TO PROVIDE A SEA LEVEL TYPE 'SHIRTSLEEVE' ENVIRONMENT FOR THE PERSONNEL AND EQUIPMENT. A CREW OF FOUR CAN BE ACCOMMODATED IN THE PRESSURIZED CABIN FOR A BASELINE MISSION DURATION OF 7 DAYS. UP TO SIX ADDITIONAL PERSONS CAN BE ACCOMMODATED FOR SHORTER DURATION MISSIONS WITH MINOR CHANGES TO THE CABIN INTERIOR. THE ORBITER DESIGN ALSO HAS THE CAPABILITY TO EXTEND THE ORBITAL STAY TIME UP TO 30 DAYS. FOR MISSIONS IN EXCESS OF 7 DAYS, THE WEIGHT OF THE EXPENDABLES SHALL BE CHARGED AGAINST THE PAYLOAD.

THE ORBITER AVIONICS SYSTEM PROVIDES THE FUNCTIONS FOR GUIDANCE, NAVIGATION, AND CONTROL (FOR THE ORBITER AND FOR THE MATED ORBITER/BOOSTER), COMMUNICATIONS, LIMITED AVIONICS EQUIPMENT PERFORMANCE MONITORING AND ONBOARD CHECKOUT, ELECTRICAL POWER DISTRIBUTION, CONDITIONING AND CONTROL, TIMING, AND DISPLAYS AND CONTROLS. CERTAIN OF THESE CAPABILITIES CAN BE TIME SHARED FOR SUPPORT OF PAYLOADS. THESE INCLUDE CAPABILITIES FOR ELECTRICAL POWER DISTRIBUTION AND CONTROL, MASTER CAUTION AND WARNING, NAVIGATIONAL INITIALIZATION, AND COMMUNICATIONS. ORBITER AVIONIC SYSTEM ALSO PROVIDES COMPUTATION CAPABILITY FOR DATA PROCESSING AND CONTROL FOR LIMITED FUNCTIONAL END-TO-END CHECKOUT OF

PAYLCADS.

1.300 OPERATIONS

1.30100 PROGRAM OBJECTIVES

THE BASIC OBJECTIVES OF THE SPACE SHUTTLE PROGRAM ARE TO DEVELOP A SYSTEM WHICH CAN ECONOMICALLY DELIVER PAYLOADS TO ORBIT, PERFORM ORBITAL OPERATIONS, RETURN FROM ORBIT, AND BE REFURBISHED FOR REUSE. THE BASIC OPERATIONAL OBJECTIVE IS TO OPTIMIZE SHUTTLE SUBSYSTEM DESIGN, GROUND DEPENDENCE, AND OPERATIONS CONCEPTS TO PROVIDE MAXIMUM PROBABILITY OF MISSION SUCCESS AT MINIMUM PROGRAM COST. SPECIFIC OPERATIONAL CRITERIA ARE AS FOLLOWS-

A. LONG TERM COMBINED STORAGE AND OPERATIONAL SERVICE LIFE

B. TOTAL VEHICLE TURN AROUND TIME FROM ORBITAL MISSION LANDING TO LAUNCH READINESS, LESS THAN 14 CALENDAR DAYS

C. DESIGN REQUIREMENT OF INTACT ABORT

D. BASELINE MISSION DURATION OF 7 DAYS

E. HORIZONTAL LANDING

1.30200 MISSION PHASES

BASICALLY, THE MISSION PHASES OF THE SPACE SHUTTLE SYSTEM ARE PRELAUNCH, LAUNCH, ASCENT, ORBITAL OPERATIONS, DEORBIT AND LANDING, POSTLANDING, AND REFURBISHMENT. THESE PHASES REPRESENT THE TYPICAL OPERATIONAL SEQUENCE ILLUSTRATED IN FIGURE 1.3.

1.30201 PRELAUNCH - PRELAUNCH OPERATIONS START WITH THE INITIAL CHECKOUT AND PREPARATION OF THE SPACE SHUTTLE FOR A PARTICULAR MISSION. PAYLOAD DETAILED SUBSYSTEM CHECKOUT AND PREPARATIONS ARE CONDUCTED INDEPENDENT OF THE ORBITER PREPARATIONS, AND ARE COMPLETED PRIOR TO INSTALLATION OF THE PAYLOAD IN THE ORBITER. UPON COMPLETION OF THE ORBITER AND PAYLOAD INDEPENDENT CHECKS, THE PAYLOAD IS INSTALLED IN THE ORBITER PAYLOAD BAY. FOLLOWING PAYLOAD INSTALLATION, PAYLOAD AND ORBITER SYSTEM INTERFACES ARE VERIFIED FOR CONTINUITY AND SAFETY. NEXT, THE ORBITER WITH AN

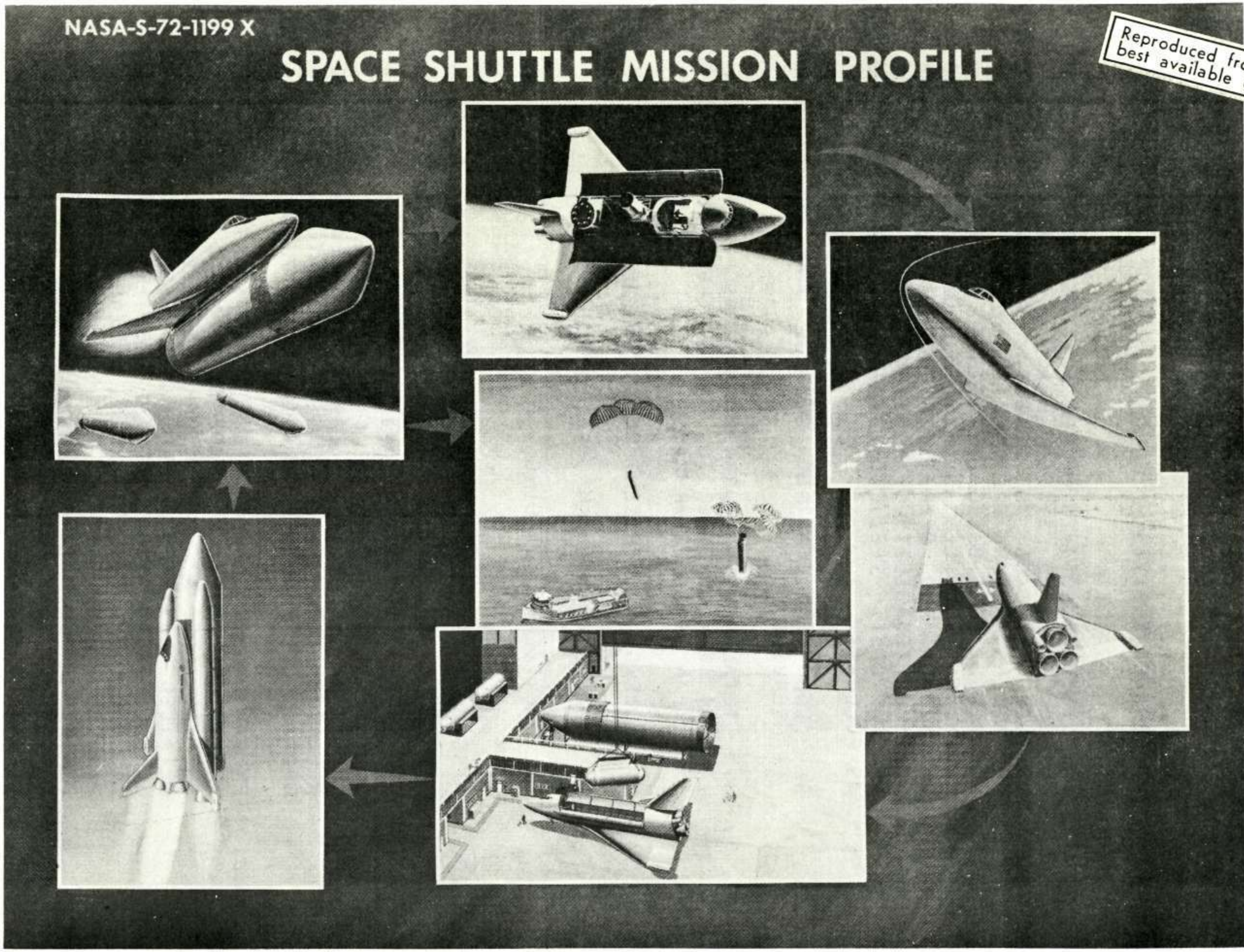


FIGURE - I.3

EXTERNAL PROPELLANT TANK IS ATTACHED TO THE SRM'S AND VEHICLE INTERFACE CHECKS ARE PERFORMED. IN THIS CONFIGURATION, THE SPACE SHUTTLE SYSTEM IS MATED TO THE LAUNCH UMBILICAL TOWER FOR TRANSPORTATION TO THE LAUNCH PAD.

1.30202 LAUNCH - FOLLOWING TRANSPORTATION TO THE PAD, FINAL LAUNCH READINESS OF THE SPACE SHUTTLE SYSTEM AND FINAL VERIFICATION OF THE PAYLOAD STATUS PLUS LOADING OF ANY TIME CRITICAL ELEMENTS ARE ACCOMPLISHED. THE CREW AND PASSENGERS ENTER FOR THE TERMINAL COUNTDOWN AND LAUNCH AFTER THE PROPELLANTS ARE LOADED.

1.30203 ASCENT - LIFTOFF INITIATES THE MISSION SEQUENCE TIMERS, AND THE SRM'S AND ORBITER MAIN ENGINES PROPEL THE SPACE SHUTTLE TO THE DESIRED STAGING VELOCITY AND ALTITUDE. AT STAGING, THE SRM'S BURN OUT, AND THE SRM CASES SEPARATE FROM THE ORBITER. AFTER THE ORBITER ACHIEVES LOW EARTH ORBIT, THE ORBITER MAIN ENGINES ARE SHUT DOWN, THE MAIN TANK IS SEPARATED FROM THE ORBITER, AND THE TANK IS DEORBITED BY A SMALL RETROROCKET.

1.30204 ORBITAL OPERATIONS - THE ORBITER ORBITAL MANEUVERING SYSTEM (OMS) ENGINES BURN THE ORBITER FROM THE INSERTION ORBIT TO THE DESIRED ORBITAL POSITION, OR TO A RENDEZVOUS WITH ANOTHER ORBITING ELEMENT. ATTITUDE CONTROL AND CRITICAL TRANSLATION MANEUVERS ARE PERFORMED BY THE ORBITER REACTION CONTROL SYSTEM (RCS) THRUSTERS. THE RCS ALLOWS THE ORBITER TO MAINTAIN THE DESIRED ORBITAL ATTITUDE FOR PAYLOAD OPERATIONS, OR TO PERFORM DOCKING MANEUVERS. WHEN THE ORBITER HAS ATTAINED THE DESIRED ORBITAL POSITION AND ATTITUDE, THE PAYLOAD IS READIED FOR OPERATIONS. PAYLOAD OPERATIONS DURING THE ORBITAL MISSION PHASE MAY BE PERFORMED WITH THE PAYLOAD STILL IN THE PAYLOAD BAY, ATTACHED TO THE ORBITER, OR DEPLOYED AND RELEASED FROM THE ORBITER. PAYLOAD OPERATIONS, WHICH MAY REQUIRE RADIO FREQUENCY (RF) AND/OR HARDLINE INTERFACE BETWEEN THE PAYLOAD, THE ORBITER VEHICLE, AND SOMETIMES THE GROUND, ARE CONCERNED WITH SUCH FUNCTIONS AS COMMAND AND CONTROL, DATA TRANSFER, MONITORING AND CHECKOUT, TRACKING AND RANGING, AND INSPECTION. PAYLOAD OPERATIONS, WHICH NORMALLY REQUIRE SOME PHYSICAL INTERFACE BETWEEN THE PAYLOAD AND THE ORBITER VEHICLE, ARE CONCERNED WITH SUCH FUNCTIONS AS DEPLOYMENT, ERECTION OR RELEASE, LOGISTICS, MAINTENANCE, SERVICING, RETRIEVAL, RETRACTION, AND STOWAGE. PAYLOAD DEPLOYMENT AND RETRIEVAL OPERATIONS GENERALLY WILL BE ACCOMPLISHED BY

REMCTE MANIPULATOR ARMS MOUNTED TC AND SUPPLIED BY THE ORBITER VEHICLE. THESE ARMS WILL BE CCNTRCLLED FROM AN CPERATIONS STATION IN THE ORBITER CREW CABIN WITH VISUAL DISPLAYS, FLCODLIGHTS, AND PREPROGRAMED COMPUTER CONTROLS TC ASSIST THE OPERATOR DURING THESE OPERATIONS. FCR PAYLCADS WHICH REMAIN ATTACHED TC THE ORBITER, MCDULE DEPLOYMENT WILL BE AVAILABLE IF REQUIRED. IF ERECTICN OR DEPLCYMENT IS REQUIRED, THE MANIPULATCRS OR PAYLCAD SUPPLIED SPECIAL MECHANICAL SYSTEMS CAN BE USED.

1.30205 DECRBIT ANC LANCING - UPON COMPLETION CF THE ORBITAL CPERATIONS, THE ORBITER IS PREPARED FCR DEORBIT ANC ENTRY. THIS EVENT IS INITIATED BY THE FIRING OF THE OMS ENGINES TO PROVIDE SUFFICIENT DELTA-V TC DEORBIT THE ORBITER, AND ORIENTING THE ORBITER TC THE PROPER ANGLE CF ATTACK TO ACCCMPLISH ENTRY. DURING REENTRY, THE ORBITER IS PROTECTED BY AN EXTERNAL THERMAL PROTECTICN SYSTEM WHICH INSULATES STRUCTURE AND PAYLOAD FROM THE REENTRY AERODYNAMIC HEATING. FOLLOWING REENTRY, THE ORBITER CHANGES ATTITUDE FOR ATMOSPHERIC FLIGHT TC THE LANCING SITE. AFTER ACQUISITION CF THE LANCING SITE, THE CRBITER MAKES A FINAL APPRCACH AND HORIZCNTAL LANDING.

1.30206 PCST LANDING - FCLLOWING LANDING, THE ORBITER IS TOWEC TC THE SAFING AREA WHERE THE CREW AND PASSENGERS DISEMBARK. AFTER A COOLDOWN PERIOD CF (TBD), CRITICAL PAYLOAC ITEMS MAY BE REMOVED FRCM THE PAYLOAC BAY OR SUPPORTED BY GROUND SUPPORT EQUIPMENT (GSE). THE ORBITER AND PAYLOAD ARE THEN DEFUELED AND SAFEC. UPCN COMPLETICN OF THE SAFING OPERATICNS, THE ORBITER IS TOWED TO THE MAINTENANCE AND REFURBISHMENT BUILCING.

1.30207 MAINTENANCE AND REFURBISHMENT - IN THE MAINTENANCE AREA A RECCVERED CR NON-DEPLOYED PAYLOAD FROM THE ORBITER ANC RETURNED TC THE PAYLOAD SERVICE AREA, WHILE SCHEDULED REFURBISHMENT WORK IS STARTEC CN THE CRBITER SUBSYSTEMS. TYPICAL ITEMS FOR ORBITER REFURBISHMENT INCLUDE SELECT THERMAL PRCTECTICN SYSTEM PANELS, ENVIRCNMENTAL ANC LIFE SUPPORT SYSTEM CANISTERS AND FILTERS, AND ANY MAINTENANCE ITEM NOTED DURING FLIGHT. WITH THE COMPLETION CF THE MAINTENANCE AND REFURBISHMENT WORK, THE ORBITER IS PREPAREC FOR THE PRELAUNCH OPERATIONS CF THE NEXT MISSION.

1.30300 SHUTTLE ABORTS

A REQUIREMENT OF THE SHUTTLE IS THE INTACT ABORT AND RECOVERY OF THE CREW, ORBITER, AND PAYLOAD. TO PROVIDE THIS CAPABILITY, THE SHUTTLE HAS SEVERAL ABORT MODES AVAILABLE FOR THE VARIOUS PHASES OF THE MISSION.

THE PERFORMANCE CAPABILITY TO MEET THIS REQUIREMENT IS AS FOLLOWS-

A. CREW AND PASSENGER INSERTION THROUGH LAUNCH COMMIT - THE SHUTTLE PROVIDES EMERGENCY EGRESS FOR CREW AND PASSENGER EVACUATION TO A SAFE AREA IN A MAXIMUM TIME OF 2 MINUTES.

B. LAUNCH COMMIT THROUGH RETURN-TO-SITE - THE SHUTTLE HAS THE CAPABILITY OF INTACT ABORT AND RETURN TO THE LAUNCH SITE. OFF-THE-PAD ABORT WILL UTILIZE SEPARATE ABORT SRM'S. THE SYSTEM DESIGN WILL INCLUDE PROVISIONS FOR EXTERNAL TANK SEPARATION AND DISPOSAL.

C. RETURN-TO-SITE THROUGH ORBIT INSERTION - THE ORBITER HAS THE CAPABILITY (WITH ONE MAIN ENGINE OUT) TO ABORT ONCE AROUND AND RETURN TO THE PRIMARY LANDING SITE FROM THE POINT IN THE FLIGHT TRAJECTORY WHERE A DIRECT RETURN TO SITE CAPABILITY ENDS.

D. ORBITAL AND REENTRY - THE ABORT MADE AFTER ORBIT INSERTION WILL BE EARLY MISSION TERMINATION AND RETURN TO A SUITABLE LANDING SITE.

1.400 PERFORMANCE

1.40100 PERFORMANCE CAPABILITIES

THE REFERENCED MISSIONS FOR THE SPACE SHUTTLE ARE DESCRIBED IN THE FOLLOWING PARAGRAPHS AND ARE GIVEN TO DEFINE BASELINE PERFORMANCE CAPABILITIES ONLY.

FOR PERFORMANCE COMPARISONS, MISSIONS 1 AND 2 WILL BE LAUNCHED FROM KENNEDY SPACE CENTER (KSC) INTO AN INSERTION ORBIT OF 50 BY 100 NAUTICAL MILES MISSION 3 WILL BE LAUNCHED INTO THE SAME INSERTION ORBIT FROM THE WESTERN TEST RANGE. THE MISSION ON-ORBIT TRANSLATIONAL DELTA-V CAPABILITY (IN EXCESS OF THAT REQUIRED TO ACHIEVE THE INSERTION ORBIT AND THAT REQUIRED FOR ON-ORBIT AND ENTRY ATTITUDE CONTROL) IS STATED FOR EACH MISSION AND INCLUDES ON-ORBIT DELTA-V RESERVES. THE REACTION CONTROL SYSTEM (RCS) TRANSLATION DELTA-V REQUIRED FOR EACH MISSION IS USED TO ACCOMPLISH ALL RENDEZVOUS AND DOCKING MANEUVERS AFTER TERMINAL PHASE INITIATION.

MISSION 1 IS A PAYLOAD DELIVERY MISSION TO A 100 NAUTICAL MILE CIRCULAR ORBIT. THE MISSION WILL BE LAUNCHED DUE EAST, AND REQUIRES A PAYLOAD CAPABILITY OF 65,000 POUNDS WITH THE ORBITER VEHICLE AIRBREATHING ENGINES REMOVED. THE PURPOSE OF THIS MISSION WILL BE ASSUMED TO BE PLACEMENT AND/OR RETRIEVAL OF A SATELLITE. THE ORBITER VEHICLE ON-ORBIT TRANSLATIONAL DELTA-V REQUIREMENT IS 950 FEET PER SECOND (FPS) FROM THE ORBITAL MANEUVER SUBSYSTEM (OMS) AND 120 FPS FROM THE RCS.

MISSION 2 IS A RESUPPLY MISSION TO AN ORBITAL ELEMENT IN A 270 NAUTICAL MILE CIRCULAR ORBIT AT 55 DEGREES INCLINATION. THE RENDEZVOUS IS ACCOMPLISHED USING A 17-ORBIT COELLIPTIC RENDEZVOUS SEQUENCE (SEQUENCE IS FOR REFERENCE ONLY). THE PAYLOAD REQUIREMENT IS 25,000 POUNDS, WITH THE AIRBREATHING ENGINES. THE ORBITER VEHICLE ON-ORBIT TRANSLATIONAL DELTA-V REQUIREMENT IS 1,400 FPS FROM THE OMS AND 120 FPS FROM THE RCS.

MISSION 3 IS A PAYLOAD DELIVERY MISSION TO A 100 NAUTICAL MILE CIRCULAR POLAR ORBIT AND RETURN TO LAUNCH SITE IN A SINGLE REVOLUTION. THE PAYLOAD REQUIREMENT IS 40,000 POUNDS WITH ORBITER VEHICLE

AIRBREATHING ENGINES REMOVED. THE ORBITER VEHICLE ON-ORBIT TRANSLATION DELTA-V REQUIREMENT IS 500 FPS FROM THE OMS AND 150 FPS FROM THE RCS.

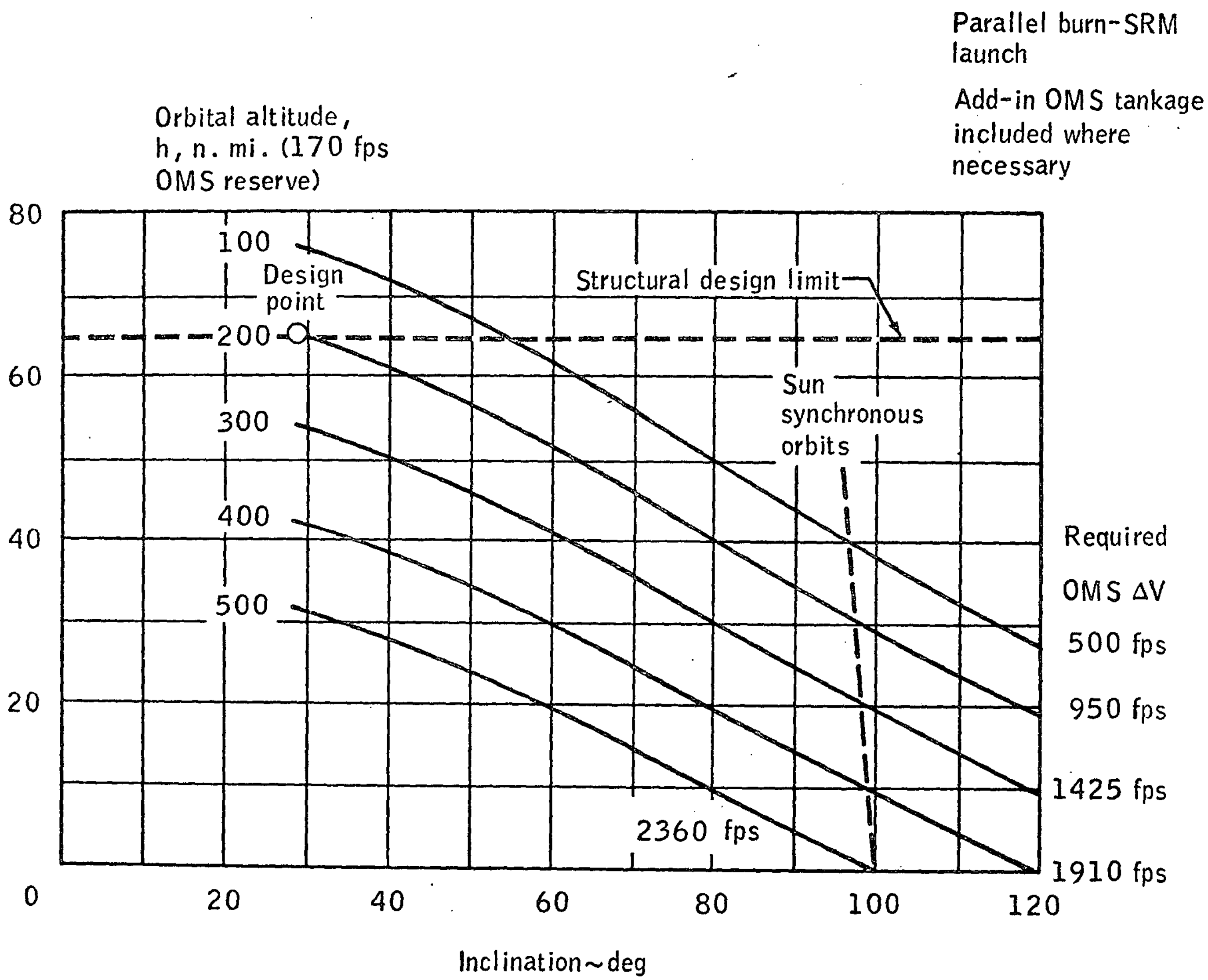
1.40200 PERFORMANCE ANALYSIS

THE PERFORMANCE GIVEN IS BASED ON THE MOST SEVERE OF THE THREE REFERENCE MISSIONS, THE DELIVERY OF A 65,000-POUND PAYLOAD TO A 28.5 DEGREES INCLINATION ORBIT. THE CURRENT DESIGN APPROACH FOR THE ORBITAL MANEUVERING SYSTEM (OMS) IS TO HAVE TWO SETS OF OMS TANKS INTEGRALLY MOUNTED, HAVING A TOTAL CAPACITY OF 1000 FPS WITH A 65,000-POUND PAYLOAD. EXTRA TANKAGE CAN BE INSTALLED TO PROVIDE AN ADDITIONAL 1500 FPS TO MEET THE REQUIRED 2500 FPS CAPACITY. THIS ADDITIONAL TANKAGE AND PROPELLANTS MAY BE LOCATED IN THE PAYLOAD BAY.

1.40300 PERFORMANCE DATA

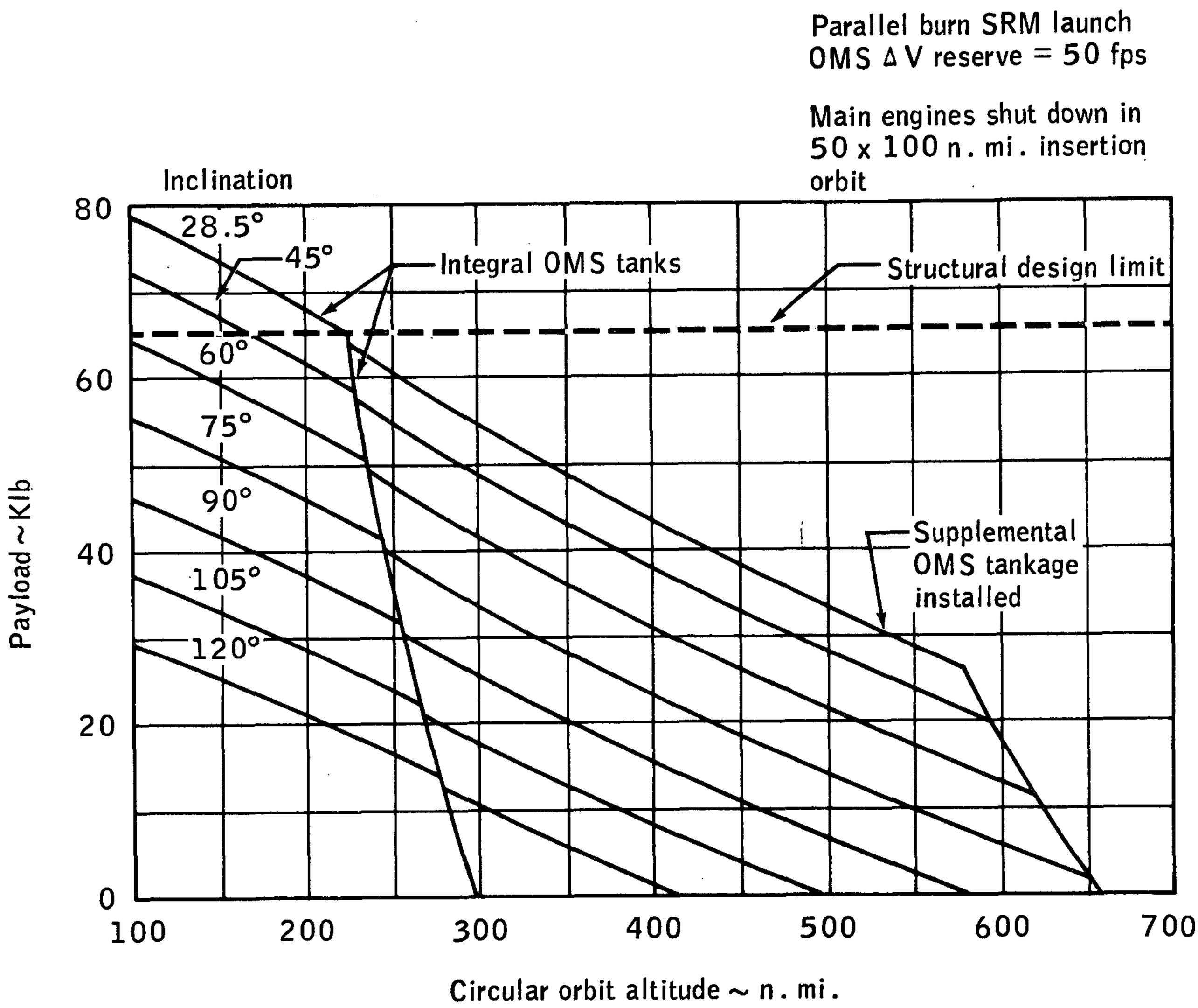
FIGURE 1.4 SHOWS THE SHUTTLE PAYLOAD VERSUS INCLINATIONS FOR VARIOUS CIRCULAR ORBITAL ALTITUDES REACHED. THE OMS PROPELLANT WAS LOADED TO THE EXTENT NECESSARY TO PROVIDE EXACTLY THE ON-ORBIT DELTA-V REQUIRED FOR EACH MISSION. THIS DELTA-V IS GIVEN AT THE RIGHT SIDE OF THE FIGURE FOR EACH CURVE AS TOTAL OMS DELTA-V. AT THE LEFT OF EACH CURVE IS GIVEN THE CORRESPONDING CIRCULAR ORBITAL ALTITUDE THAT THE SHUTTLE CAN REACH, CIRCULARIZE AT, AND RETROFIRE FROM, WHILE MAINTAINING A TOTAL OF 170 FPS RESERVE FOR RENDEZVOUS AND/OR CONTINGENCIES. THE OMS IS NOT USED AT ANY TIME IN THE LAUNCH PHASE, I.E., PRIOR TO THE SHUTTLE REACHING THE 50 BY 100 NAUTICAL MILE INJECTION ORBIT. THE TOTAL INJECTED WEIGHT AT ANY GIVEN INCLINATION IS A CONSTANT, AND REPRESENTS THE MAXIMUM CAPABILITY OF THE SHUTTLE TO THAT INCLINATION. THE VARIATION IN PAYLOAD BETWEEN ALTITUDES IS DUE TO TRADING PAYLOAD FOR OMS PROPELLANT.

FIGURE 1.5 SHOWS PAYLOAD AS A FUNCTION OF CIRCULAR ORBIT ALTITUDE REACHED, MAINTAINING A 50 FPS OMS DELTA-V RESERVE. FOR THIS PLOT INSERTION IS ALWAYS INTO A 50 BY 100 NAUTICAL MILE ORBIT, AND ANY ADDITIONAL ALTITUDE IS ACHIEVED BY THE OMS ALONE. ALL PERFORMANCE CALCULATIONS ARE BASED UPON CARRYING THE ENTIRE PAYLOAD THROUGHOUT ALL OF



PAYLOAD VERSES INCLINATIONS

FIGURE - 1.4



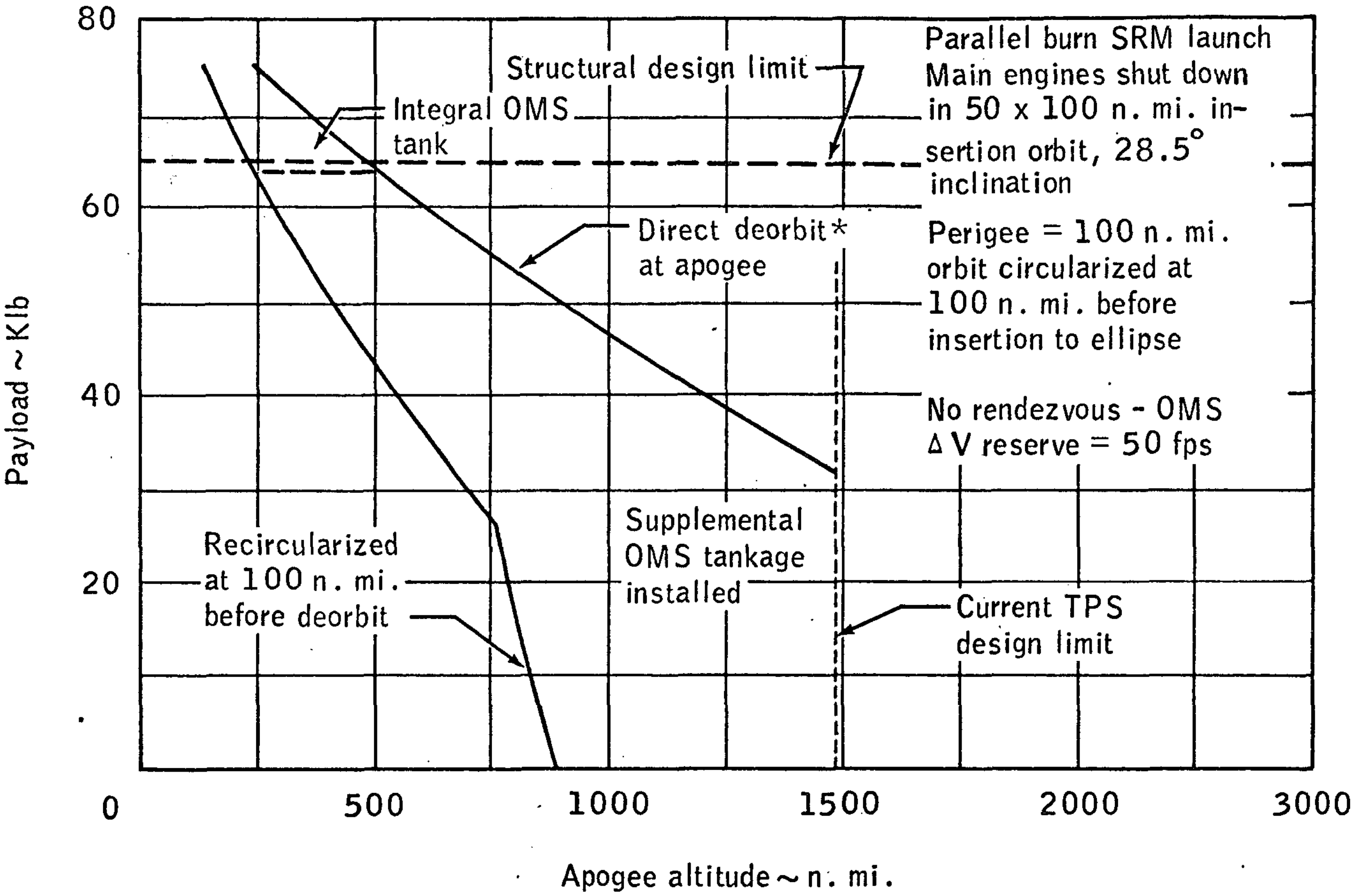
PAYLOAD VERSES CIRCULAR ORBITS ALTITUDE

FIGURE - 1.5

THE DELTA-V MANEUVERS. THIS WOULD ALLOW THE VEHICLE TO DEORBIT IN THE EVENT THAT THE PAYLOAD FOR ANY REASON COULD NOT BE DEPLOYED. IT WOULD ALSO BE THE CASE IF ONE PAYLOAD WAS DELIVERED TO ORBIT AND ANOTHER PICKED UP FOR RETURN TO EARTH. FOR THIS FIGURE PAYLOAD IS TRADED DIRECTLY FOR OMS PROPELLANT UNTIL THE OMS TANKS ARE FULL. THIS FIGURE DOES NOT INCLUDE ANY RENDEZVOUS ALLOWANCE. FOR RENDEZVOUS MISSIONS, 120 FPS EXTRA OMS MUST BE RESERVED FOR THE RENDEZVOUS MANEUVERS. THIS REDUCES THE CIRCULAR ORBITAL ALTITUDE THAT CAN BE REACHED WITH ANY PAYLOAD AND ANY CONFIGURATION BY 25 NAUTICAL MILES.

FIGURE 1.6 SHOWS THE CAPABILITY OF THE SHUTTLE TO DELIVER PAYLOAD TO A HIGH ELLIPTICAL ORBIT. THESE DATA ASSUME THAT THE MAIN ENGINES ARE SHUT DOWN IN THE NOMINAL 50 BY 100 NAUTICAL MILE INJECTION ORBIT. THE DISPOSABLE TANK IS THEN JETTISONED AND THE ORBIT RAISED TO 100 BY 100 NAUTICAL MILES WITH THE OMS SYSTEM. AFTER THIS IS DONE, THE OMS SYSTEM IS THEN USED TO RAISE THE APOGEE. THE UPPER CURVE ASSUMES A DIRECT DEORBIT AT APOGEE WITH REENTRY COMING AT PERIGEE. THIS CAN BE DONE IN THOSE CASES WHERE THERE IS NO SPECIFIC REQUIREMENT ON THE POSITIONING OF THE APSIDES OF THE ELLIPSE. IN THAT CASE, THE ORIENTATION CAN BE SELECTED TO ALLOW THE PROPER APSIDAL POSITION FOR DIRECT ENTRY FROM APOGEE. THE BOTTOM CURVE IS FOR THOSE CASES WHERE THE SHUTTLE MUST RECIRCULARIZE AT 100 NAUTICAL MILES BEFORE DEORBIT. THIS WOULD BE THE CASE IF SOME PARTICULAR APOGEE POSITION WERE REQUIRED FOR THE PAYLOAD WHERE ENTRY WERE NOT POSSIBLE AT PERIGEE.

WITH THE SHUTTLE LAUNCHED INTO A HIGH ELLIPSE, A PAYLOAD SATELLITE COULD BE PLACED INTO A CIRCULAR ORBIT AT APOGEE ALTITUDE WITH A SINGLE BURN OF A THIRD STAGE. THIS WOULD ALLOW THE USE OF A SINGLE SIMPLE PROPULSION STAGE ON THE PAYLOAD.



*Performance indicated is dependent on operational constraints

PAYLOAD VERSES ELLIPTICAL ORBIT ALTITUDE

FIGURE - 1.6

2.000 SPACE SHUTTLE/PAYLOAD ACCOMMODATIONS

2.100 GENERAL

THIS SECTION DEFINES THE SPACE SHUTTLE/PAYLOAD OPERATIONAL, PHYSICAL, AND FUNCTIONAL ACCOMMODATIONS PROVIDED BY THE SPACE SHUTTLE SYSTEM. THE APPROACH BEING TAKEN IS TO MAXIMIZE THE BENEFITS TO THE PAYLOADS WITH MINIMUM IMPACT ON THE ORBITER.

2.200 OPERATIONAL INTERFACES

2.20100 PRELAUNCH OPERATIONS

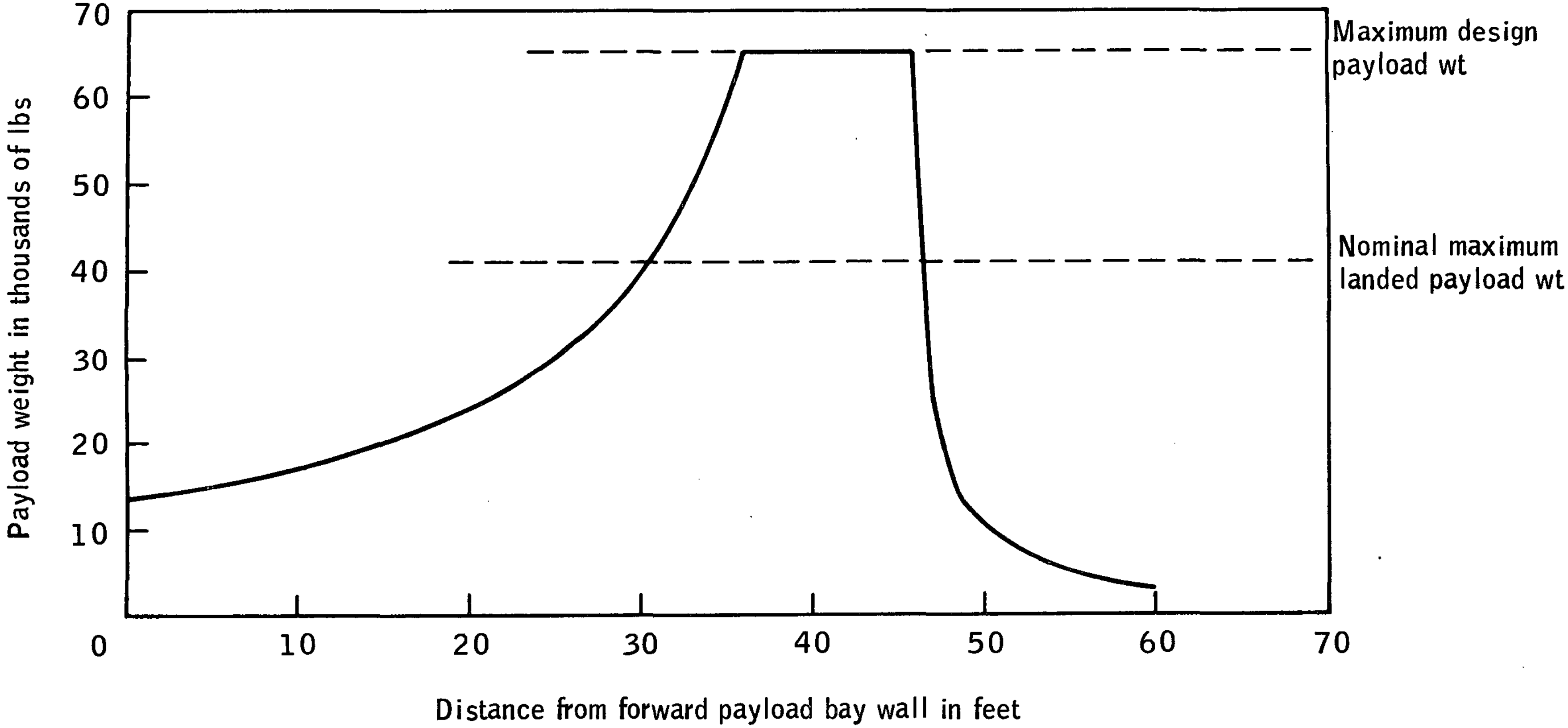
2.20101 PAYLOAD CHECKOUT - INCOMING PAYLOADS AND EXPERIMENTS WILL BE RECEIVED AT THE PAYLOAD SERVICE AREA WHERE FINAL PAYLOAD INSPECTION, CHECKOUT, AND INTEGRATED TESTS WILL BE PERFORMED. IF THE INSTALLATION OF AN INDIVIDUAL EXPERIMENT INTO A PAYLOAD IS REQUIRED, IT WILL BE ACCOMPLISHED IN THIS AREA. ANY DEFICIENCIES DISCOVERED DURING THESE OPERATIONS WILL BE CORRECTED PRIOR TO INSTALLATION OF THE PAYLOAD INTO THE ORBITER.

THE CONCEPT OF PAYLOAD CHECKOUT AND ASSEMBLY PROVIDES MAXIMUM FLEXIBILITY FOR THE VARIOUS PAYLOAD REQUIREMENTS AND DECOUPLES THE OPERATIONAL ORBITER VEHICLE CHECKOUT FROM THE PAYLOAD CHECKOUT. THIS IS ACCOMPLISHED BY THE USE OF STRUCTURAL INTERFACE FIXTURE FOR PHYSICAL AND MECHANICAL ORBITER/PAYLOAD INTERFACE CHECKS, AND WITH ELECTRONIC ANALOG UNITS FOR ELECTRICAL POWER, DATA MANAGEMENT, CONTROL, AND COMMUNICATION INTERFACE CHECKS BETWEEN THE ORBITER AND THE PAYLOAD.

DURING ALL PHASES OF THE PRELAUNCH OPERATIONS, SPECIAL EMPHASIS WILL BE PLACED ON CONTAMINATION CONTROL PROCEDURES TO PROTECT SENSITIVE PAYLOAD ELEMENTS.

2.20102 PAYLOAD CENTER-OF-GRAVITY - PRECISE INFORMATION ON THE PAYLOAD MASS CENTER-OF-GRAVITY (C.G.) MUST BE ESTABLISHED PRIOR TO INSTALLATION OF THE PAYLOAD IN THE ORBITER. FOR ABORTS AND ENTRY, THE PAYLOAD C.G. IS RESTRICTED IN THE LONGITUDINAL AXIS TO THE ENVELOPE SHOWN IN FIGURE 2.1.

2.20103 PAYLOAD INSTALLATION - THE INSTALLATION OF THE PAYLOAD INTO THE ORBITER MAY OCCUR AT EITHER OF TWO FACILITIES- THE SHUTTLE MAINTENANCE AND REFURBISHMENT FACILITY (MRF), OR THE VERTICAL ASSEMBLY BUILDING (VAB). THE CAPABILITY TO CHANGE OUT PAYLOADS ON THE PAD WILL EXIST FOR CONTINGENCY PURPOSES ONLY AND SHOULD NOT BE CONSIDERED AS A NORMAL OR PLANNED OPERATION. NORMALLY, THE PAYLOAD IS INSERTED INTO THE ORBITER PAYLOAD BAY WHILE THE ORBITER IS IN THE HORIZONTAL POSITION IN THE MRF. FOLLOWING INSTALLATION AND ESTABLISHMENT



PAYLOAD LONGITUDINAL CENTER - OF - GRAVITY LIMITS

FIGURE - 2.1

OF ELECTRICAL AND OTHER INTERFACES, VALIDATION OF THESE INTERFACES IS ACCOMPLISHED.

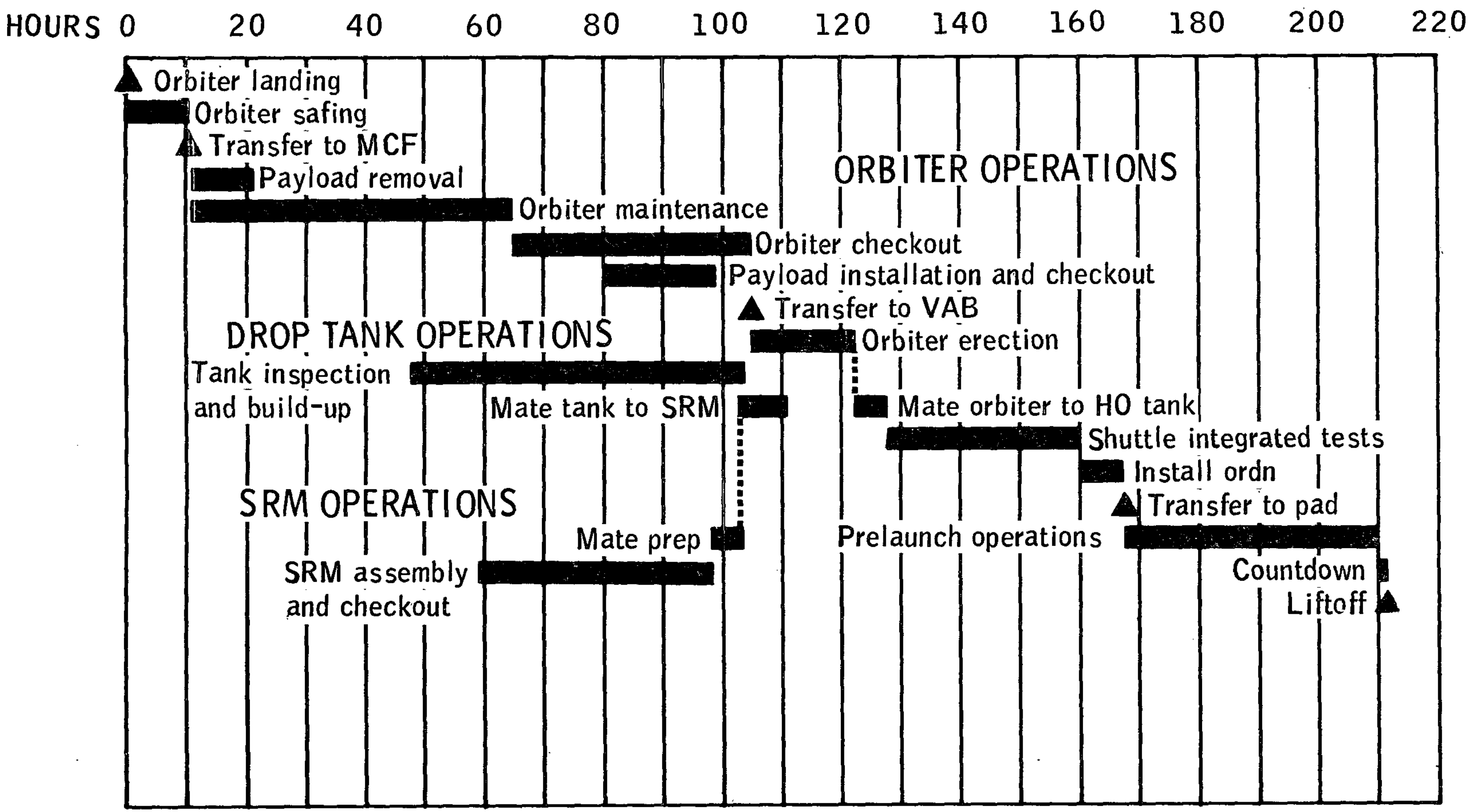
2.20104 VEHICLE INTEGRATION - THE NEXT PHASE OF PRELAUNCH OPERATIONS INVOLVES THE MATING OF THE ORBITER AND THE SRM'S. THE PAYLOAD PRELAUNCH OPERATIONS MUST BE BASICALLY COMPLETED SINCE ACCESS TO THE PAYLOAD IS LIMITED TO PAYLOAD MONITORING VIA SHUTTLE SYSTEMS EXCEPT UNDER SPECIAL CIRCUMSTANCES. WITH THE SHUTTLE IN THE VERTICAL POSITION AND FINAL INTERFACE CHECKS COMPLETE, THE SHUTTLE IS READY FOR PRELAUNCH OPERATIONS.

2.20200 ORBITER PRELAUNCH OPERATIONS

2.20201 LAUNCH PREPARATION - THE VEHICLE OPERATIONS ARE DEVOTED PRIMARILY TO VERIFYING THE LAUNCH UMBILICAL TOWER/LAUNCH FACILITY CONNECTIONS, PERFORMING THE FINAL INTEGRATED TESTS, SERVICING THE VEHICLE, LOADING THE CREW AND PASSENGERS, AND FINAL CLOSEOUT. FIGURE 2.2 IS A REPRESENTATIVE FLOW OF ACTIVITIES DURING THIS PERIOD. ALTHOUGH PAYLOADS NOMINALLY ARE LOADED PRIOR TO THE ORBITER/BOOSTER MATING, IT IS POSSIBLE TO REPLACE THE PAYLOAD ON-PAD IN CONTINGENCIES. HAZARDOUS SERVICING PROCEDURES ARE ALSO CONDUCTED DURING THIS PERIOD, IF THERE ARE SUCH REQUIREMENTS. ACCESS TO THE PAYLOAD WHILE ON THE PAD NORMALLY WILL BE LIMITED TO THOSE ITEMS ACCESSIBLE THROUGH THE ORBITER CREW COMPARTMENT OR THROUGH THE PAYLOAD BAY DOOR. THE ACCESS, REMOVAL, AND LOADING OF PAYLOAD EQUIPMENT ON THE PAD WILL BE LIMITED TO NOT MORE THAN 10 HOURS ELASPED TIME PRIOR TO T-2 HOURS.

2.20202 PAYLOAD SERVICES - PAYLOAD SERVICES ARE FURNISHED THROUGH STANDARD ORBITER/PAYLOAD INTERFACES AND THROUGH PAYLOAD ACCESS PANELS. STANDARD GROUND AND LAUNCH SERVICES MAY BE SUPPLEMENTED BY RECONFIGURATION OF AN ACCESS PANEL TO ACCOMMODATE UNIQUE PAYLOAD SERVICES. HOWEVER, THE RECONFIGURATION OF ACCESS PANELS AND SUPPORT OF UNIQUE SERVICES ARE CHARGED TO THE PAYLOAD.

NORMALLY, THE ORBITER/PAYLOAD INTERFACES PROVIDE POWER, COMMUNICATIONS, STATUS MONITORING, ATMOSPHERE CONTROL, VENTING, AND CERTAIN PAYLOAD PROPELLANT ACCESS PROVISIONS. THE PAYLOAD SERVICES FOR CRYOGENIC PROPELLANTS INCLUDE ACCESS FOR FILL, VENT, DRAIN, AND DUMP. ATMOSPHERE CONTROL OF THE PAYLOAD BAY IS PROVIDED THROUGH GSE



ORBITER TURNAROUND OPERATIONS TIMELINE

FIGURE - 2.2

DURING PRELAUNCH OPERATIONS, PRIMARILY TO KEEP THE BAY FREE OF CONTAMINATION BY EXTERNAL SOURCES.

2.20300 FLIGHT OPERATIONS

2.20301 SHUTTLE ASCENT - THE LIFT-OFF TO INSERTION PHASE WILL BE ESSENTIALLY AN AUTOMATIC OPERATION UNDER ORBITER CONTROL. THE EARLY VERTICAL FLIGHTS WILL HAVE GROUND SUPPORT FOR TRAJECTORY AND SYSTEMS MUCH LIKE THAT EXISTING FOR APOLLO. AFTER THE SHUTTLE OPERATIONS MATURE, THERE WILL BE LESS NEED FOR REAL-TIME SHUTTLE SYSTEMS SUPPORT FOR LAUNCH. DURING LAUNCH, THE PAYLOAD SUPPORT WILL BE LIMITED PRIMARILY TO MINIMUM SUBSYSTEMS SUPPORT AND PAYLOAD SAFETY STATUS MONITORING.

2.20302 PAYLOAD CONTROL AND DISPLAY - THE ORBITER WILL HAVE PROVISIONS FOR MONITORING ALL SAFETY-OF-FLIGHT PARAMETERS GENERATED BY THE PAYLOAD. THESE PARAMETERS ARE DISPLAYED TO THE FLIGHT CREW AND MISSION SPECIALISTS. IN ADDITION TO THE SAFETY-OF-FLIGHT PARAMETERS, PAYLOAD PECULIAR PARAMETERS CAN BE DISPLAYED TO THE MISSION SPECIALIST ON THE GENERAL PURPOSE DISPLAYS, OR THROUGH PAYLOAD SUPPLIED MISSION PECULIAR DISPLAYS TO THE PAYLOAD SPECIALIST.

2.20303 PAYLOAD CHECKOUT - PRIOR TO PAYLOAD OPERATION OR DEPLOYMENT, FUNCTIONAL CHECKOUT CAN BE ACCOMPLISHED BY USE OF PROGRAMS STORED IN THE MEMORY OF THE COMPUTER USED FOR PAYLOAD CHECKOUT. MANUAL INSERTION OF PAYLOAD DATA/COMMANDS INTO THE COMPUTER CAN BE MADE THROUGH THE KEYBOARD. DEDICATED PAYLOAD DISPLAYS AND CONTROLS CAN ALSO BE USED IN CONJUNCTION WITH PAYLOAD CHECKOUT. VISUAL INSPECTION AND MANUAL ASSISTANCE BY THE CREW CAN BE ACCOMPLISHED BY EXTRAVEHICULAR ACTIVITY (EVA) OR INTRAVEHICULAR ACTIVITY (IVA). WHEN THE ORBITER DOCKING PORT IS SECURED TO A DOCKING PORT ON ANOTHER ORBITAL ELEMENT, SHIRTSLEEVE ACCESS IS AVAILABLE THROUGH THE ORBITER AIRLOCK AND DOCKING PORT TO THE ORBITAL ELEMENT. VERIFICATION OF DOCKING AND UNDOCKING IS DISPLAYED TO THE ORBITER FLIGHT CREW.

2.20304 PAYLOAD DEPLOYMENT AND RETRIEVAL - THE ORBITER PROVIDES A PAYLOAD DEPLOYMENT/RETRIEVAL MECHANISM TO DEPLOY PAYLOADS CLEAR OF THE ORBITER MOLD LINE. FOR RETRIEVAL, THIS MECHANISM INTERFACES WITH PAYLOADS DESIGNED FOR RETRIEVAL AND, AFTER ATTACHMENT TO THE PAYLOAD, ALIGNS THE PAYLOAD IN

THE PAYLOAD BAY FOR SECURE STOWAGE OF THE PAYLOAD. IN ADDITION, THIS MECHANISM IS CAPABLE OF SUPPORTING THE PAYLOAD IN THE DEPLOYED POSITION UNDER ATTITUDE STABILIZATION AND DOCKING LOADS.

DEPLOYMENT OF SPIN-STABILIZED PAYLOADS MAY BE ACCOMPLISHED FROM A SPIN TABLE PROVIDED BY THE PAYLOAD. ANY ADDITIONAL PAYLOAD PECULIAR DEPLOYMENT, ERECTION, RETRACTION, ET CETERA, REQUIREMENTS FOR SPECIAL MECHANICAL SYSTEMS IS PROVIDED BY THE PAYLOAD.

2.20305 MULTIPLE PAYLOAD DEPLOYMENT - THE ORBITER WILL HAVE THE CAPABILITY TO DEPLOY MULTIPLE-PAYLOADS ON-ORBIT DURING A SINGLE MISSION, INCLUDING PLACEMENT OR DOCKING OF PAYLOADS TO A STABILIZED BODY. FOR MULTIPLE-PAYLOAD MISSIONS THE ORBITER SUBSYSTEMS SUPPORT CAPABILITY IS SHARED BY THE PAYLOADS.

2.20306 DOCKING - DOCKING OF THE ORBITER TO A PAYLOAD OR ANOTHER ORBITAL ELEMENT CAN BE ACCOMPLISHED WITH THE ORBITER MANIPULATOR ARMS AND DOCKING PORT, OR BY DIRECT DOCKING. PRIMARY COMMAND AND CONTROL AUTHORITY REMAINS WITH THE ORBITER DURING THE DOCKING OPERATIONS. TO ACCOMMODATE DOCKING, THE ORBITER ORIENTS AND APPROACHES THE ORBITAL ELEMENT WITH THE USE OF THE ORBITER RCS. WHEN THE ORBITER IS WITHIN THE REACH DISTANCE OF THE MANIPULATOR ARM OF THE ORBITAL ELEMENT, THE MANIPULATORS ENGAGE THE ORBITAL ELEMENT AND DRAW THE TWO BODIES TOGETHER TO ACCOMPLISH CONNECTION OF THE DOCKING INTERFACES. FOR DIRECT DOCKING, THE ORBITER AS THE ACTIVE VEHICLE APPROACHES AND ENGAGES THE DOCKING MECHANISMS ON THE ORBITAL ELEMENT BY IMPACT ENGAGEMENT. THE OPERATIONAL DESIGN PARAMETERS FOR DOCKING ARE GIVEN IN TABLE 2-I.

TABLE 2-I - OPERATION DESIGN PARAMETERS FOR DOCKING

LATERAL MISALIGNMENT	+/-	0.5 FEET
ANGULAR MISALIGNMENT	+/-	5.0 DEGREES
ROLL MISALIGNMENT		7.0 DEGREES
CLOSING VELOCITY AT CONTACT		0.5 FPS
ACTIVE VEHICLE ANGULAR VELOCITY AT CONTACT		1.0 DEG/SEC
PASSIVE VEHICLE ANGULAR VELOCITY AT CONTACT		0.1 DEG/SEC

WHEN THE ORBITER DOCKING PORT IS SECURED TO A DOCKING PORT ON ANOTHER ORBITAL ELEMENT, SHIRTSLEEVE ACCESS IS AVAILABLE THROUGH THE

ORBITER AIRLOCK AND DOCKING PORT TO THE ATTACHED ELEMENT. VERIFICATION OF DOCKING AND UNDOCKING IS DISPLAYED TO THE ORBITER FLIGHT CREW.

2.20307 EVA/IVA - TO DISTINGUISH BETWEEN EXTRAVEHICULAR ACTIVITES (EVA) AND INTRAVEHICULAR ACTIVITIES (IVA) WITH REGARD TO A PRESSURE SUITED CREWMAN, THE FOLLOWING DEFINITION IS GIVEN.

EVA APPLIES TO ACTIVITIES CONDUCTED OUTSIDE THE SPACECRAFT PRESSURE HULL OR AN OPEN PAYLOAD BAY. IVA BY A PRESSURE-SUITED CREWMAN, IS CONFINED BY THE VEHICLE STRUCTURE. ACTIVITIES WITHIN THE PAYLOAD BAY WITH THE DOORS CLOSED ARE CONSIDERED IVA. IF A SECTION IS APPLICABLE TO EVA ONLY, IVA WILL BE EXCLUDED BY A NOTE. OTHERWISE, THE TERM EVA WILL BE USED TO INCLUDE IVA.

THE ORBITER PROVIDES THE CAPABILITY TO PERFORM MULTIPLE EVA'S IN ORBIT, OR IVA'S INTO THE PAYLOAD BAY. HOWEVER, THE EXPENDABLES AND EVA SUITS ARE PROVIDED AT THE EXPENSE OF PAYLOAD WEIGHT. TWO CREWMEN EVA IS CONSIDERED THE NORMAL EVA MODE OF OPERATION WHERE ONE CREWMAN PERFORMS THE EVA TASK, THE SECOND CREWMAN MAINTAINS A BACKUP STATUS, AND BOTH EVA CREWMEN ARE MONITORED FROM WITHIN THE ORBITER. EVA IS A METHOD FOR THE ON-ORBIT PAYLOAD ACTIVITIES, AND ITS USAGE FOR BOTH NORMAL AND CONTINGENCY PAYLOAD OPERATIONS MUST BE TRADED AGAINST THE ADVANTAGES AND DISADVANTAGES OF ALTERNATE METHODS. IT IS POSSIBLE THAT FOR SOME TASKS, EVA COULD BE A HIGHLY COST EFFECTIVE METHOD FOR PERFORMING PAYLOAD OPERATIONS.

2.20308 COMMUNICATIONS - A COMMUNICATION SATELLITE SYSTEM IS AVAILABLE FOR RELAY OF VOICE AND VIDEO BETWEEN THE ORBITER AND GROUND. THE ORBITER IS ALSO CAPABLE OF DIRECT COMMUNICATION WITH THE GROUND. THE ORBITER/PAYLOAD COMMUNICATION INTERFACES ARE GIVEN IN TABLES 2-IIA AND 2-IIB. THESE INTERFACES PROVIDE AVAILABLE COMMUNICATION CHANNELS FOR PAYLOAD OPERATIONS DURING A MISSION. COMMUNICATION REQUIREMENTS IN EXCESS OF THESE ARE SUPPORTED BY THE PAYLOAD.

TABLE 2-IIA - ORBITER/PAYLOAD COMMUNICATION INTERFACES

SIGNAL DESCRIPTION	HARDWIRE PAYLOAD INTERFACE	
	ORBITER EQUIPMENT	PAYLOAD EQUIPMENT
VOICE		
INTERCOM	AUDIO CENTER	AUDIO COMM PANEL
TLM		
INTERLEAVED TLM	STORED PROGRAM PROCESSOR	REMOTE MUX UNIT
DIRECT TLM	MODULATOR/DEMODULATOR	PCM ENCODER
WIDEBAND ANALOG	WIDEBAND XMTR	FDM EQUIPMENT
WIDEBAND PCM	WIDEBAND XMTR	PCM ENCODER OR RECORDER
TV VIDEO	WIDEBAND XMTR	TV CAMERA
COMMANDS		
ATTACHED PAYLOAD COMMANDS	COMPUTER	PAYLOAD DECODER
TV		
CAMERA VIDEO	VIDEO DISPLAY UNIT	TV CAMERAS
CAMERA CONTROL	VIDEO CONTROL UNIT	TV CAMERAS

TABLE 2-IIB – ORBITER/PAYLOAD COMMUNICATION INTERFACES

SIGNAL DESCRIPTION	RF PAYLOAD INTERFACE	
	ORBITER EQUIPMENT	PAYLOAD EQUIPMENT
VOICE		
DUPLEX	VHF TRANSCEIVER	VHF TRANSCEIVER
TLM		
DATA	PCM RECEIVER	PCM TRANSMITTER
COMMANDS		
DETACHED PAY-LOAD	TRANSMITTER SIGNAL FORMATTER	RECEIVER SIGNAL PROCESSOR
RANGING		
DETACHED PAY-LOAD	TRANSCEIVER DIGITAL RANGING GENERATOR (DRG)	TRANSCEIVER RANGE TONE TRANSFER ASSY (RTTA)

2.20400 CREW

THE BASIC ORBITER CREW SIZE IS FOUR, TWO OF WHICH ARE THE COMMANDER AND PILOT WHO USUALLY ACCOMPLISH THE FLIGHT OPERATIONS OF THE ORBITER. THE FOLLOWING NOMENCLATURE IS USED TO IDENTIFY AND DESCRIBE THE DUTIES OF THE PERSONNEL.

2.20401 COMMANDER - THE COMMANDER IS IN COMMAND OF THE FLIGHT AND IS RESPONSIBLE FOR OVERALL SPACE VEHICLE, PAYLOAD FLIGHT OPERATIONS, AND VEHICLE SAFETY. HE IS PROFICIENT IN ALL PHASES OF VEHICLE FLIGHT, PAYLOAD MANIPULATION, DOCKING AND SUBSYSTEM COMMAND, CONTROL, AND MONITOR OPERATION. HE IS ALSO KNOWLEDGEABLE OF PAYLOAD AND PAYLOAD SYSTEMS AS THEY RELATE TO FLIGHT OPERATIONS, COMMUNICATION REQUIREMENTS, DATA HANDLING, AND VEHICLE SAFETY.

2.20402 PILOT - THE PILOT IS SECOND IN COMMAND AND IS EQUIVALENT TO THE COMMANDER IN PROFICIENCY AND KNOWLEDGE OF THE VEHICLE.

2.20403 MISSION SPECIALIST - THE MISSION SPECIALIST IS RESPONSIBLE FOR INTERFACING OF PAYLOAD AND ORBITER OPERATIONS AND THE MANAGEMENT OF PAYLOAD OPERATIONS. THE SPECIALIST IS TRAINED IN VEHICLE AND PAYLOAD SUBSYSTEMS, FLIGHT OPERATIONS, AND PAYLOAD COMMUNICATIONS DATA MANAGEMENT. MORE THAN ONE MISSION SPECIALIST MAY BE INCLUDED IN THE CREW.

2.20404 PAYLOAD SPECIALIST - THE PAYLOAD SPECIALIST IS RESPONSIBLE FOR THE APPLICATIONS, TECHNOLOGY, AND SCIENCE PAYLOAD/INSTRUMENTS OPERATIONS. THIS SPECIALIST HAS DETAILED KNOWLEDGE OF THE PAYLOAD/INSTRUMENTS, OPERATIONS, REQUIREMENTS, OBJECTIVES, AND SUPPORTING EQUIPMENT. MORE THAN ONE PAYLOAD SPECIALIST MAY BE INCLUDED IN THE CREW.

2.20405 PASSENGER/OBSERVER - PASSENGER/OBSERVERS ARE PERSONNEL WHO ARE ONBOARD, BUT HAVE NO ACTIVE PART IN SHUTTLE OPERATIONS.

2.20406 CREW PROVISIONS - VOLUME IS AVAILABLE WITHIN THE CREW COMPARTMENT FOR ADDITIONAL PAYLOAD SPECIALIST OR PASSENGERS, HOWEVER, THEIR WEIGHT, PERSONNEL SUPPORT SYSTEMS, EQUIPMENT, AND CONSUMABLES ARE CHARGED TO THE PAYLOAD. ALSO, WITHIN THE CREW COMPARTMENT ARE SLEEP PROVISIONS TO ALLOW CREW ROTATION FOR 24-HOUR OPERATIONS. PAYLOAD

OPERATIONS MAY ELECT EITHER MULTIPLE SHIFTS OR DISCRETE WORKING HOURS TO SUPPORT MISSION OBJECTIVES.

2.20500 POSTFLIGHT OPERATIONS

FOLLOWING LANDING, THE ORBITER IS TOWED TO THE SAFING FACILITY WHERE THE CREW AND PASSENGERS DISEMBARK AND THE NECESSARY POSTFLIGHT COOLDOWN AND SAFING OPERATIONS ARE PERFORMED. NORMALLY, THE PAYLOAD WILL REMAIN WITH THE ORBITER UNLESS THERE ARE CRITICAL EXPERIMENTS WHICH MUST BE REMOVED AT THIS FACILITY. THIS FACILITY CAN ALSO BE USED TO SAFE AND PURGE HAZARDOUS PAYLOAD ITEMS. THE PAYLOAD MUST BE COMPATIBLE WITH THE AVAILABLE SHUTTLE GSE, OR SUPPLY THE NECESSARY EQUIPMENT TO SUPPORT THE OPERATION.

WHEN THE SAFING OPERATIONS ARE COMPLETED THE ORBITER IS TOWED TO THE MRF WHERE THE PAYLOAD IS NORMALLY REMOVED FROM THE ORBITER.

2.300 SYSTEM/SUBSYSTEM INTERFACES

2.30100 STRUCTURAL/MECHANICAL INTERFACES

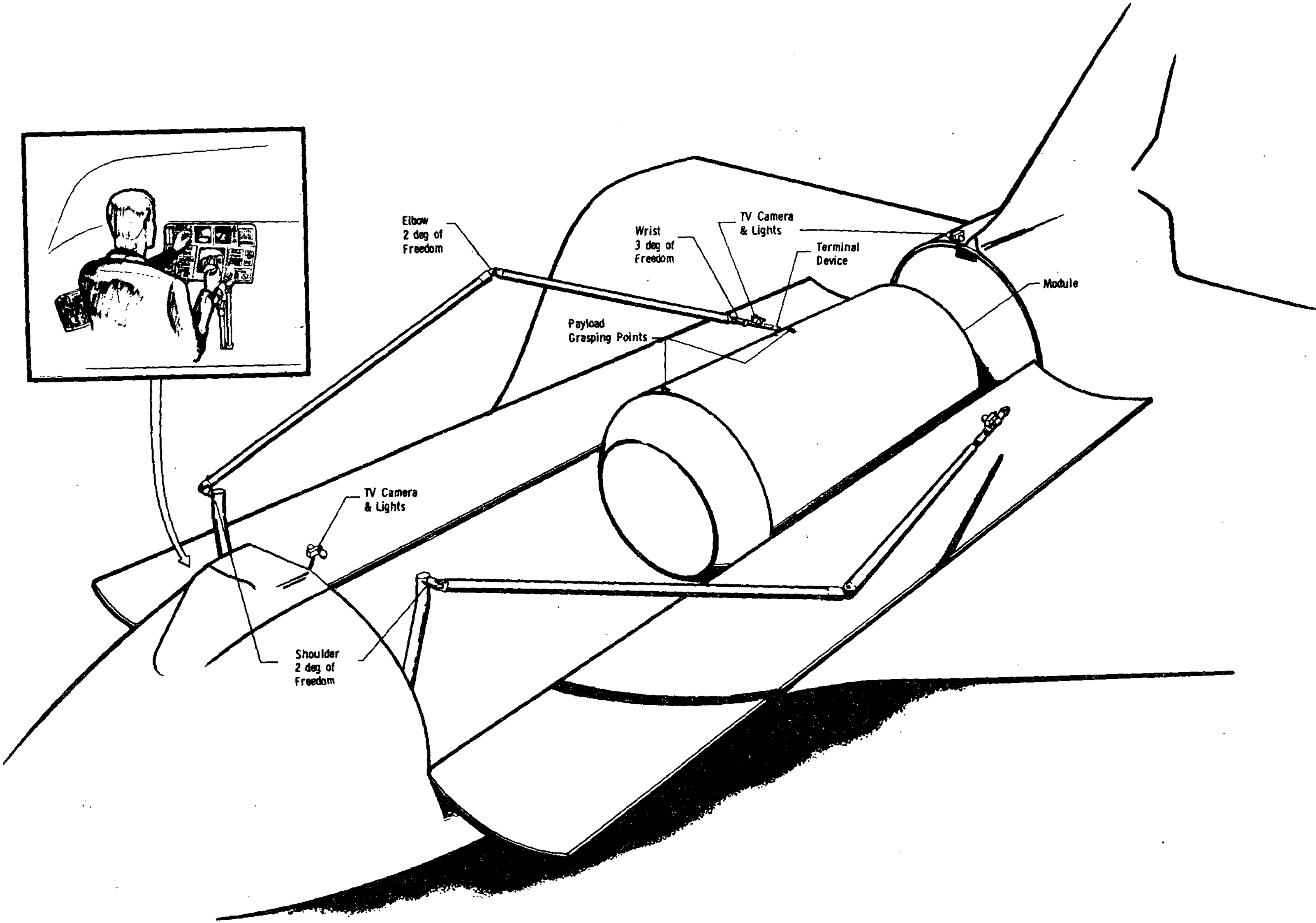
2.30101 PAYLOAD BAY ENVELOPE - THE ORBITER PAYLOAD BAY CAN ACCOMMODATE A PAYLOAD, OR COMBINATIONS OF PAYLOADS, WHOSE DYNAMIC ENVELOPE IS EQUAL TO, OR LESS THAN, 60 FEET IN LENGTH AND 15 FEET IN DIAMETER. THIS PAYLOAD ENVELOPE EXCLUDES THE NECESSARY PAYLOAD STRUCTURAL ATTACHMENT POINTS, WHICH EXTEND OUTSIDE THE ENVELOPE TO INTERFACE WITH THE ORBITER STRUCTURAL MOUNTING POINTS. CLEARANCE ENVELOPE BETWEEN THE PAYLOAD ENVELOPE AND THE ORBITER STRUCTURE IS PROVIDED BY THE ORBITER TO AVOID ORBITER DEFLECTION AND DEPLOYMENT INTERFERENCE BETWEEN THE ORBITER AND PAYLOAD.

2.30102 PAYLOAD STRUCTURAL ATTACHMENT - MULTIPLE STANDARDIZED ATTACHMENT POINTS ARE LOCATED (TBD) IN THE PAYLOAD BAY TO STRUCTURALLY SUPPORT ALL PAYLOADS. THE LOCATIONS OF THESE POINTS ARE AT OR OUTSIDE THE 15-FOOT DIAMETER PAYLOAD MOLD LINE AND TRANSMIT PAYLOAD LOADS TO THE ORBITER PRIMARY STRUCTURE. THESE ATTACHMENT POINTS INTERFACE WITH THE PAYLOADS OR PAYLOAD ADAPTERS AND ARE CAPABLE OF SUPPORTING THE PAYLOAD UNDER ALL MISSION PHASES. THE ORBITER HAS THE CAPABILITY TO LAND 40,000 POUND PAYLOADS WITH NOMINAL WIND AND LOAD FACTORS (AIRBREATHING ENGINES REMOVED) AND LARGER PAYLOADS WITH REDUCED STRUCTURAL SAFETY FACTORS.

THE ORBITER ALSO PROVIDES THE CAPABILITY FOR DETERMINING THE MECHANICAL ALIGNMENT OF THE PAYLOAD (WITH RESPECT TO THE REFERENCE FRAME OF THE ORBITER) TO AN ACCURACY OF 0.5 DEGREE IN ALL AXES WHILE THE PAYLOAD IS ATTACHED TO THE PAYLOAD BAY.

2.30103 REMOTE MANIPULATOR SYSTEM (RMS) - THE ORBITER PAYLOAD DEPLOYMENT AND RETRIEVAL MECHANISM CONSISTS OF A PAIR OF REMOTE MANIPULATOR ARMS WHICH ARE STOWED OUTSIDE THE PAYLOAD VOLUME. FIGURE 2.3 IS A PRELIMINARY DESIGN OF A TYPICAL SYSTEM. PAYLOAD ENGAGEMENT IS ACCOMPLISHED THROUGH TERMINAL DEVICES ON THE END OF EACH ARM.

TO ACCOMMODATE PAYLOAD RETRIEVAL AND STOWAGE IN THE PAYLOAD BAY, THE PAYLOAD PROVIDES THE ORBITER COMPATIBLE MECHANICAL, ELECTRICAL, AND FLUID INTERFACES.



REMOTE MANIPULATOR SYSTEM

FIGURE - 2.3

2.30104 DOCKING MECHANISM - THE DOCKING MECHANISM IS DESIGNED TO INTERFACE WITH STANDARDIZED DOCKING MECHANISMS ON OTHER ORBITAL ELEMENTS AND ON ANOTHER ORBITER. THE DOCKING MECHANISM CONTAINS ALL THE NECESSARY HARDWARE FOR ENGAGING, LATCHING, AND SEALING THE INTERFACE BETWEEN THE ORBITER AND ANOTHER ORBITAL ELEMENT. INCLUDED IN THE ORBITER ARE APPROPRIATE DISPLAYS FOR VERIFICATION OF THE ENGAGEMENT AND SEPARATION OF THE DOCKING INTERFACE. WITHIN THE DIAMETER OF THE DOCKING RING ARE A CLEAR PASSAGEWAY OF 1.0-METER DIAMETER AND THE NECESSARY POWER, CAUTION AND WARNING, DATA, COMMUNICATION, AND FLUID INTERFACE CONNECTORS TO SUPPORT DOCKED ORBITAL OPERATIONS.

2.30105 PAYLOAD BAY DOOR(S) - THE ORBITER HAS THE CAPABILITY TO EXPOSE THE ENTIRE LENGTH AND THE FULL WIDTH OF THE PAYLOAD BAY. WITH THE PAYLOAD BAY DOOR(S) AND RADIATOR(S) OPEN, THE UNOBSTRUCTUED 180-DEGREES LATERAL FIELD-OF-VIEW IS AVAILABLE TO THE PAYLOAD AT THE PLANE OF THE HINGE LINE, WHICH IS LOCATED (TBD) RELATIVE TO THE LONGITUDINAL CENTERLINE OF THE PAYLOAD BAY.

2.30106 PAYLOAD BAY SERVICE PANELS - PAYLOAD BAY SERVICE PANELS ARE PLACED AT DISCRETE LOCATIONS IN THE ORBITER STRUCTURE FOR GSE SERVICE ACCESS TO THE PAYLOAD. THESE PANELS, LOCATED IN THE PAYLOAD BAY WALLS, NORMALLY ARE BLANK, NONSTRUCTURAL PANELS WHICH ARE CAPABLE OF BEING REPLACED WITH PAYLOAD PECULIAR PANELS DESIGNED TO SERVICE A PARTICULAR PAYLOAD. THE WEIGHT DIFFERENCE BETWEEN THE BLANK SERVICE PANEL AND THE PAYLOAD PECULIAR PANEL IS CHARGED AGAINST THE PAYLOAD WEIGHT. THE LINES CONNECTING THE PAYLOAD TO THE SERVICE PANEL ALSO ARE CHARGED AGAINST THE PAYLOAD WEIGHT.

2.30200 FLUID SYSTEM INTERFACES

2.30201 OMS DELTA-V KIT - ON-ORBIT MANEUVERING DELTA-V IN EXCESS OF THE 1000-FPS AVAILABLE IN THE BASELINE ORBITER IS AVAILABLE BY ADDITION OF OMS PROPELLANT. THE ADDED VOLUME AND WEIGHT FOR PROPELLANT, TANKAGE, AND PLUMBING TO THE VEHICLE OMS IS CHARGED TO PAYLOAD.

2.30202 PROPULSIVE PAYLOAD INTERFACES - PROPULSIVE STAGES CARRIED WITHIN THE PAYLOAD BAY REQUIRE VARIOUS TYPES OF FLUID INTERFACES BETWEEN THE ORBITER VEHICLE AND THE PAYLOAD BAY. THESE INTERFACE REQUIREMENTS VARY SIGNIFICANTLY WITH THE TYPES OF

PROPELLANT UTILIZED BY THE PROPULSIVE STAGE. STORABLE PROPELLANTS, SUCH AS THOSE USED BY THE AGENA, DELTA, AND TRANSTAGE CAN BE LOADED PRIOR TO STAGE INTEGRATION WITH THE ORBITER. NO FILL CONNECTIONS, THEREFORE, ARE REQUIRED BUT DRAIN CONNECTIONS CAN BE REQUIRED FOR EMERGENCY DUMP. SEVERAL OPTIONS APPEAR FEASIBLE FOR PROVIDING THE FLUID INTERFACES PREVIOUSLY MENTIONED.

FLUID CONNECTION PANEL(S) ARE LOCATED TO MINIMIZE VEHICLE SCAR WEIGHT. THESE INTERFACE PANELS PROVIDE THE FLUID SERVICING PLUS THE VENTING LOCATIONS. THE PROPULSIVE PAYLOAD PROPELLANTS REQUIRE VENTING AS WOULD, IN MOST CASES, THE PRESSURANTS. FOR THESE CASES, THE FLUID CONNECTION PANELS ARE FITTED FOR THE PAYLOAD. WHEN NOT REQUIRED, THE SERVICE PANELS ARE REPLACED BY BLANK PANELS. PROPELLANT SERVICE UMBILICALS AND DUMP PROVISIONS ARE REQUIRED FOR CRYO PAYLOADS.

TABLE 2-III INDICATES THE SERVICING APPLICABILITY FOR EACH CLASS OF PAYLOADS FLUIDS. THE 'OPEN PAYLOAD BAY DOOR' IS SERVICING PAYLOADS WHEN THE BAY DOORS ARE OPENED. CRYO SERVICES ARE NOT INCLUDED SINCE THE DOORS ARE CLOSED PRIOR TO LAUNCH, HOWEVER, A DUMP SYSTEM IS REQUIRED.

TABLE 2-III - LOADING AND DUMPING OPTIONS

	OMS INTEGRATION	REMOVABLE SERVICE PANELS	OPEN PAYLOAD BAY DOOR
OMS KIT	X	X	X
LOX/LH2		X	
EARTH STORABLE		X	X

2.30203 PAYLOAD BAY VENTS - ADEQUATE PENETRATION FOR VENTING AND PURGING THE PAYLOAD BAY AND ACTIVE PAYLOAD EFFLUENTS ARE PROVIDED BY THE ORBITER. THIS VENT SYSTEM CONSISTS OF NONPROPULSIVE VENTS.

2.30300 ELECTRICAL POWER

ELECTRICAL POWER FOR PAYLOADS IS AVAILABLE FROM THE ORBITER ELECTRICAL POWER SYSTEM. AN ELECTRICAL ENERGY ALLOWANCE OF 50 KILOWATT-HOURS (KWH) IS DEDICATED FOR PAYLOAD SUPPORT WITH ENERGY IN EXCESS OF THIS ALLOCATION BEING MISSION DEPENDENT AND CAPABLE OF BEING SUPPLEMENTED BY ADDITIONAL CONSUMABLES TO THE ORBITER FUEL CELLS AND/OR BY INDEPENDENT PAYLOAD SYSTEMS.

THIS POWER IS IN THE FORM OF REGULATED REDUNDANT DC POWER HAVING THE CHARACTERISTICS SHOWN BELOW.

VOLTAGE - 30 VDC NOMINAL

TRANSIENT - (TBD)

LOAD - 1000-WATTS AVERAGE, 1500-WATTS PEAK (PEAK ORBITER OPERATION PERIODS)
- 3000-WATTS AVERAGE, 6000-WATTS PEAK (ON-ORBIT COAST PERIODS)

2.30301 EXTENDED DURATION MISSION SUPPORT - FOR EXTENDED DURATION MISSIONS, OR FOR MISSIONS REQUIRING INCREASED TOTAL ELECTRICAL ENERGY, ADDITIONAL FUEL CELL REACTANTS ARE REQUIRED AND ARE PLUMBED IN FROM THE PAYLOAD BAY. THESE CONSUMABLES, THEIR TANKAGE, AND THE PLUMBING TO THE ORBITER INTERFACE ARE CHARGED TO THE PAYLOAD. THE EXTENDED DURATION MISSION REQUIRES ADDED CONSUMABLES FOR THE PAYLOAD AND FOR OPERATION OF THE ORBITER BEYOND THE NORMAL 7-DAY ORBITER MISSION.

2.30400 DISPLAYS AND CONTROLS

DISPLAYS AND CONTROLS FOR PAYLOAD OPERATIONS ARE PROVIDED AT THE COMMANDER/PILOT, MISSION SPECIALIST, AND PAYLOAD HANDLING STATIONS.

PAYLOAD DISPLAYS AND CONTROLS AT THE COMMANDER/PILOT STATIONS ARE PRIMARILY CONCERNED WITH COMMUNICATIONS, POWER CONTROL (MASTER CIRCUIT BREAKER CONTROL SWITCH FOR PAYLOAD POWER), AND A PAYLOAD MASTER CAUTION AND WARNING LIGHT.

DISPLAYS AND CONTROLS PROVIDED AT THE MISSION SPECIALIST STATION INCLUDE–

A. MASTER CAUTION AND WARNING

B. CAUTION AND WARNING PANEL WITH DEDICATED WIRING FOR DISPLAYS

C. A CATHODE RAY TUBE (CRT) AND KEYBOARD FOR CONTROL OF PAYLOAD MONITORING AND CHECKOUT IN CONJUNCTION WITH THE COMPUTER USED FOR PAYLOAD MONITORING

D. SPACE FOR DISPLAYS AND CONTROLS PROVIDED BY THE PAYLOAD

E. AUDIO COMMUNICATIONS PANEL WITH AUDIO–CHANNEL SELECTOR FOR COMMUNICATIONS WITH CREWMEN, PERSONNEL IN PAYLOAD BAY, EVA PERSONNEL, PERSONNEL IN A FREE FLYING PAYLOAD, OR THE GROUND

THE PAYLOAD HANDLING STATION DISPLAYS AND CONTROLS ARE DESIGNED TO SUPPORT PAYLOAD DEPLOYMENT, DOCKING, RETRIEVAL, AND REMOTE OPERATIONS THROUGH THE USE OF THE MANIPULATOR ARMS. SPECIFIC DISPLAYS AND CONTROLS OF THIS STATION INCLUDE THE FOLLOWING ITEMS–

A. MANIPULATOR CONTROL SYSTEM AND PAYLOAD RETENTION CONTROLS AND DISPLAYS

B. DISPLAYS FOR PAYLOAD BAY TV VIDEO, AND CONTROLS FOR OPERATING AND SUPPLYING POWER TO THE PAYLOAD BAY CAMERAS

C. AUDIO COMMUNICATION PANEL WITH AUDIO CHANNEL SELECTOR FOR COMMUNICATIONS WITH CREWMEN, PAYLOAD BAY, EVA PERSONNEL, AND GROUND

D. CAUTION AND WARNING DISPLAYS FOR GENERAL PAYLOAD OPERATIONS ITEMS

E. PAYLOAD BAY LIGHTING CONTROLS FOR ILLUMINATION OF PAYLOADS, PAYLOAD BAY AREA, AND PAYLOAD INTERFACES

2.30500 GUIDANCE AND NAVIGATION

2.30501 SYSTEM CAPABILITIES - THE ORBITER GUIDANCE, NAVIGATION, AND CONTROL (GN+C) SYSTEM IS CAPABLE OF PROVIDING GUIDANCE, NAVIGATION, AND CONTROL FOR THE ORBITER THROUGH ALL PHASES OF ORBITAL SPACE FLIGHT FROM LAUNCH THROUGH ENTRY, AND FOR AIRCRAFT AERODYNAMIC FLIGHT MODES. DURING THE ON-ORBIT PHASES, THE GUIDANCE AND NAVIGATION OF THE ORBITER CAN BE INDEPENDENT OF DIRECT GROUND SUPPORT.

2.30502 RENDEZVOUS - THE ORBITER HAS THE ONBOARD CAPABILITY TO RENDEZVOUS WITH AN IN-PLANE COOPERATIVE TARGET UP TO 300 NAUTICAL MILES, AND IS THE ACTIVE VEHICLE DURING RENDEZVOUS, DOCKING, AND UNDOCKING. THE ORBITER IS ALSO CAPABLE OF MANUAL DOCKING WITH OTHER ORBITERS OR COMPATIBLE ORBITAL ELEMENTS DURING DAYLIGHT OR DARKNESS. BY USING GROUND FACILITIES AND OTHER AIDS, THE ORBITER IS CAPABLE OF RENDEZVOUS WITH AND RETRIEVAL OF A PASSIVE STABLIZED ORBITING ELEMENT.

2.30503 ORBIT NAVIGATION - TABLE 2-IV PRESENTS A SUMMARY OF ESTIMATED NAVIGATION PERFORMANCE FOR SOME OF THE POSSIBLE SYSTEMS.

TABLE 2-IV - TYPICAL NAVIGATION SYSTEM ACCURACIES

SYSTEM	RMS POSITION (FT)	RMS VELOCITY (FPS)
STDN	1000	1
STAR/HORIZON	4000	2
GROUND BEACON	1000	1
HORIZON/BEACON	700	1
TDRS	300 TO 1000	1
LANDMARK	2000	2

2.30504 ORBITER/PAYLOAD DATA TRANSFER - INFORMATION FROM THE GN+C COMPUTER SUBSYSTEM CAN BE TRANSFERRED TO THE PAYLOAD BAY VIA HARDWIRE. AS A MINIMUM, THE INFORMATION WILL INCLUDE TIMING, STATE VECTOR INITIALIZATION AND EXTRAPOLATION (IF DESIRED), AND SPACECRAFT ATTITUDES AND ATTITUDE RATES.

2.30600 STABILIZATION AND CONTROL

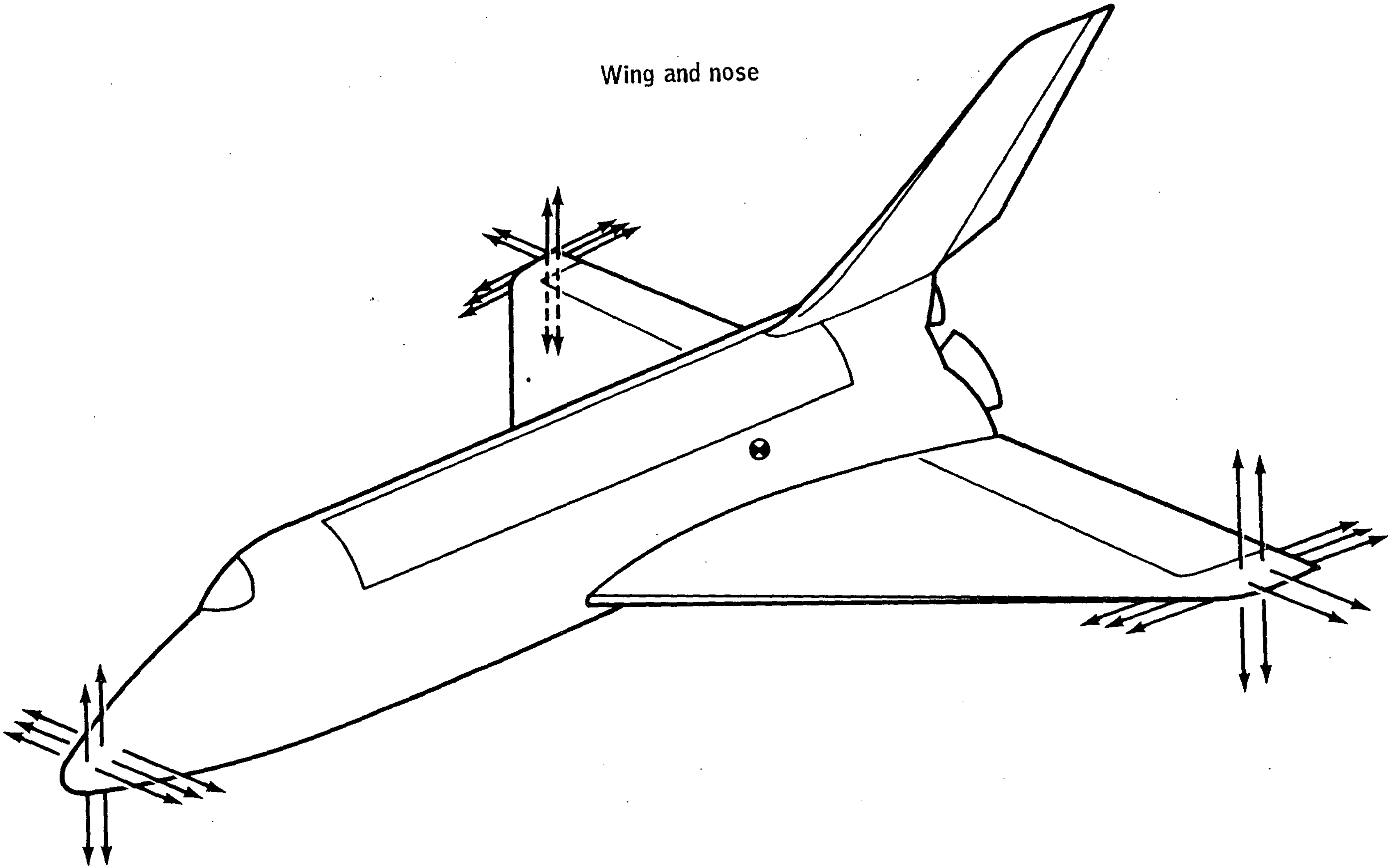
2.30601 PAYLOAD POINTING ACCURACY - THE DOMINANT ERRORS INVOLVED IN POINTING A PAYLOAD WITH THE SPACECRAFT SYSTEMS ARE CONTRIBUTED BY THE STRUCTURAL MISALIGNMENTS AND THERMAL DISTORTIONS. THE GUIDANCE AND NAVIGATION (G+N) SUBSYSTEM ERRORS, INCLUDING AN EQUIVALENT ANGULAR ERROR DUE TO NAVIGATION UNCERTAINTY ARE LESS AT 0.2 DEGREE (1 SIGMA). CONTROL SYSTEM ERRORS, I.E., ATTITUDE DEADBAND EXCURSIONS, MUST ALSO BE ADDED TO THE STATED ERROR SOURCES.

THE ORBITER IS CAPABLE OF POINTING THE PAYLOAD CONTINUOUSLY FOR ONE ORBIT EVERY OTHER ORBIT FOR ONE 24-HOUR PERIOD PER MISSION AT ANY GROUND, CELESTIAL, OR ORBITAL OBJECT WITHIN +/-0.5 DEGREES. PAYLOAD REQUIREMENTS IN EXCESS OF THIS CAPABILITY SHOULD BE PROVIDED BY THE PAYLOAD OR EXPERIMENT SYSTEMS.

2.30602 REACTION CONTROL SYSTEM - FIGURE 2.4 SHOWS THRUSTER LOCATIONS IN THE WING TIP/NOSE CONFIGURATION. CURRENT THRUSTER SIZING YIELD THE STABILITY RATES INDICATED IN TABLE 2-V.

TABLE 2-V - MINIMUM ANGULAR STABILITY RATES

AXIS	STABILITY RATES
PITCH	(TBD)
YAW	(TBD)
ROLL	(TBD)



RCS LOCATION

FIGURE - 2.4

2.30700 PAYLOAD CHECKOUT

PAYLOAD CHECKOUT PROVISIONS ARE COMPRISED OF MISSION SPECIALIST STATION CRT AND KEYBOARD, COMPUTER FOR PAYLOAD MONITORING, STORED PROGRAM PROCESSOR, PAYLOAD PROVIDED REGIONAL ACQUISITION UNITS (RAU'S), RECORDERS, DISPLAYS AND CONTROLS, AND PAYLOAD COMMAND DECODER SUBUNITS. FIGURES 2.5 AND 2.6 SHOW THESE INTERFACES. THE COMPUTER PROVIDES FOR SOFTWARE, DATA PROCESSING, COMMAND AND CONTROL, DATA ACQUISITION, AND DISPLAY CAPABILITIES REQUIRED FOR PAYLOAD FUNCTIONAL END-TO-END CHECKOUT, AND STATUS MONITORING WHILE INSTALLED IN THE PAYLOAD BAY.

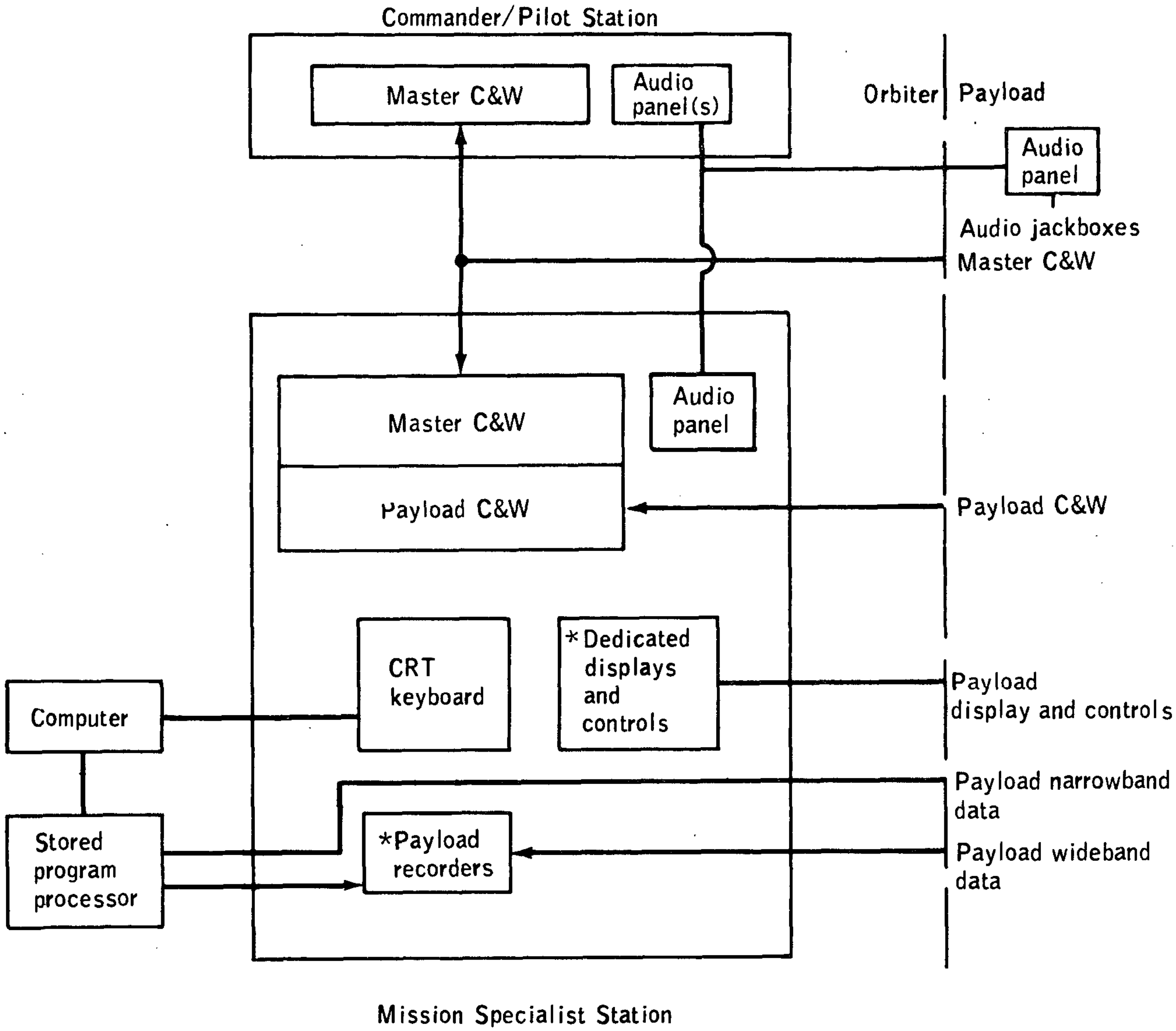
DETAILED ACCEPTANCE TESTING OF EACH PAYLOAD ITEM IS PERFORMED PRIOR TO INSTALLATION. CHECKOUT OF THE PAYLOAD FOR PRELAUNCH OPERATIONS MAKES USE OF THE GROUND CHECKOUT EQUIPMENT AND THE ONBOARD CHECKOUT COMMAND DECODER FOR HARDWIRED UPLINK COMMANDS. A HARDWIRED PCM DOWNLINK TO THE GROUND CHECKOUT EQUIPMENT IS ALSO PROVIDED FOR CHECKOUT DATA, WHICH IS INTERLEAVED WITH ORBITER SUBSYSTEM DATA.

THE PHYSICAL INTERFACES TO THE PAYLOAD FOR INFLIGHT USE ARE THE RAU'S AND THE PAYLOAD COMMAND DECODER SUBUNITS PROVIDED BY THE PAYLOAD. THIS ALLOWS FOR THE PAYLOAD TO BE COMMANDED FROM THE GROUND VIA THE RF LINK OR THE ONBOARD PAYLOAD MONITOR STATION THROUGH THE COMMAND DECODER SUBUNIT. A KEYBOARD PERMITS THE MISSION SPECIALIST TO COMMUNICATE WITH THE COMPUTER, AND A CRT PERMITS THE DISPLAY OF PAYLOAD CHECKOUT DATA.

CHECKOUT DATA ARE COLLECTED FROM THE PAYLOAD BY THE PAYLOAD RAU'S AND SENT TO THE STORED PROGRAM PROCESSOR (SPP). IT CAN THEN BE INTERLEAVED WITH ORBITER DOWNLINK PCM, AND EITHER SENT TO THE GROUND VIA THE RF LINK OR RECORDED UNDER CERTAIN CIRCUMSTANCE ON A RECORDER.

2.30701 PAYLOAD REGIONAL ACQUISITION UNIT (RAU) - THE PAYLOAD RAU INTERFACES THE PAYLOAD WITH THE STORED PROGRAM PROCESSOR (SPP). IT WILL SAMPLE THE PAYLOAD DATA OUTPUTS ON COMMAND FROM THE SPP. THE DESIGN REQUIREMENTS FOR THE RAU ARE AS FOLLOWS-

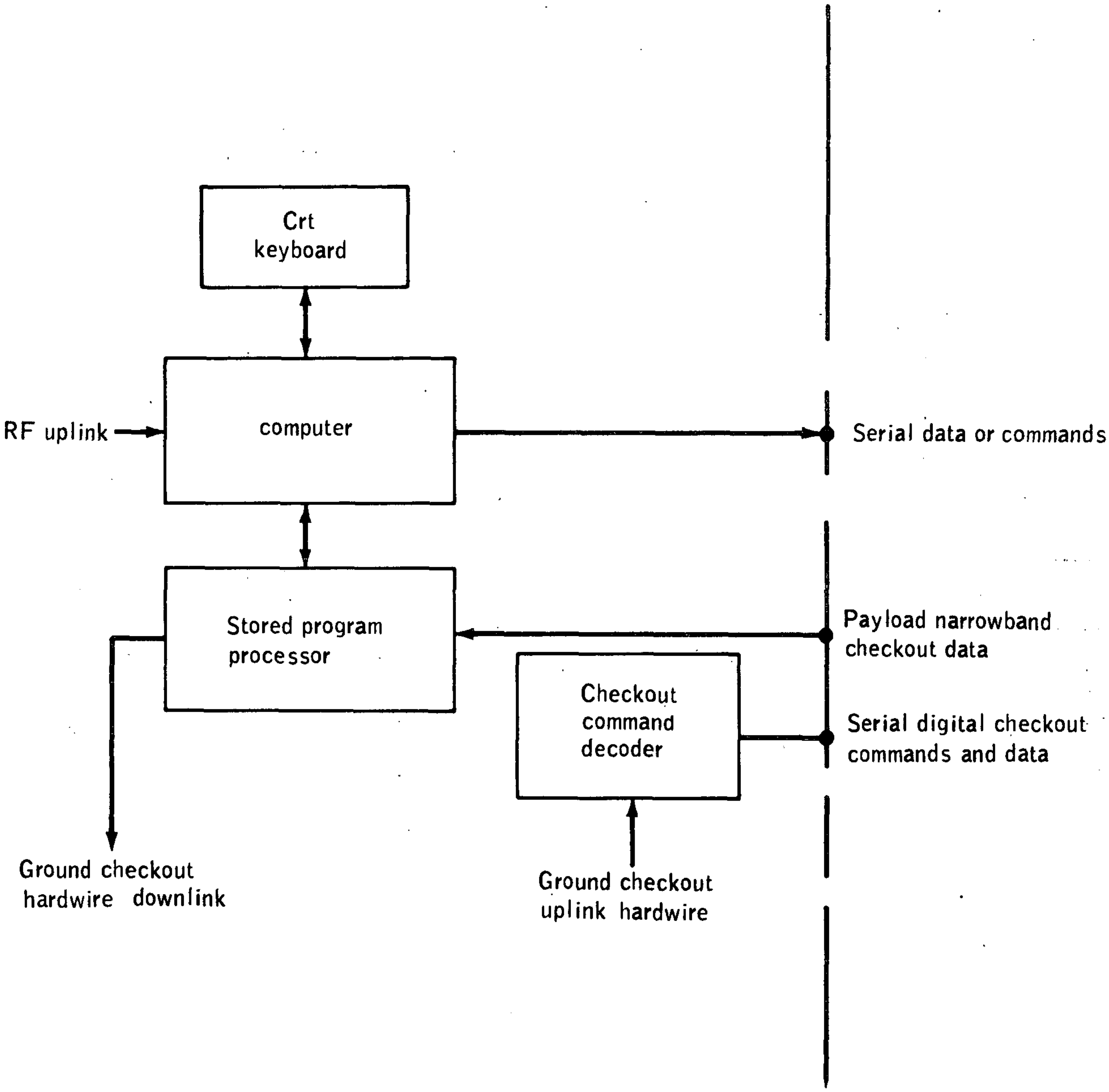
A. THE RAU INTERFACE WITH THE STORED PROGRAM PROCESSOR UTILIZES PARTY LINE TECHNIQUES TO MINIMIZE THE AMOUNT OF INTERFACE WIRING REQUIRED.



*Payload supplied

Mission Specialist Station Interfaces

FIGURE -2.5



ORBITER/PAYLOAD CHECKOUT OF INTERFACE

FIGURE - 2.6

B. THE RAU ACCEPTS ANALOG AND DIGITAL SIGNALS IN THE QUANTITIES, AND MIXTURES BASED ON PAYLOAD MEASUREMENT REQUIREMENTS.

C. THE RAU SAMPLES AND DIGITIZES PAYLOAD ANALOG SIGNALS TO THE ACCURACY REQUIRED BY THE COMPUTER AND OTHER DATA USERS.

D. THE RAU SAMPLES PAYLOAD CHECKOUT DATA AT SAMPLING RATES COMPATIBLE WITH THE COMPUTER AND OTHER USER REQUIREMENTS.

E. THE RAU IS PACKAGED TO OPERATE DURING ALL MISSION PHASES IN THE SAME ENVIRONMENT AS THE VEHICLE SUBSYSTEMS WITH WHICH IT INTERFACES.

2.30702 PAYLOAD COMMAND DECODER SUBUNIT (PCDS) - A SERIAL DIGITAL LINE IS PROVIDED FROM THE COMPUTER THROUGH THE PCDS. THIS ALLOWS THE PAYLOAD TO BE COMMANDED FROM THE GROUND OR FROM THE MISSION SPECIALIST STATION KEYBOARD. THE PCDS PROVIDES STIMULI AND COMMANDS TO THE PAYLOADS FOR OPERATION OR CHECKOUT. THE DESIGN REQUIREMENTS ARE AS FOLLOWS-

A. ACCEPT SERIAL DIGITAL COMMANDS AND PROVIDE VERIFICATION OF CORRECT DIGITAL COMMANDS/SEQUENCES FROM THE COMPUTER

B. BE CAPABLE OF SIMULTANEOUS COMMAND/STIMULI GENERATION, I.E., EMPLOY MULTIPLE PROGRAMABLE FUNCTION GENERATORS

C. PROVIDING AUTOMATIC, BUILTIN CALIBRATION MEANS UPON COMMAND, VIA SERIAL DIGITAL DATA FROM THE COMPUTER

D. BE ENVIRONMENTALLY PACKAGED FOR THE PAYLOAD ENVIRONMENT

2.30703 HARDWIRE INTERFACES - COAXIAL CABLES AND WIRES ARE PROVIDED BETWEEN THE PAYLOAD INTERFACE AND THE MISSION SPECIALIST STATION (MSS). THESE CAN BE USED FOR INTERFACING PAYLOAD PROVIDED DISPLAYS, RECORDERS, CONTROLS, ET CETERA, INSTALLED IN THE CONSOLE AT THE MSS WITH PAYLOADS. STANDARDIZED INTERFACE CONNECTORS ARE PROVIDED ON THESE WIRES. TIME CODES AND SYNCHRONIZATION FREQUENCIES CAN BE MADE AVAILABLE FROM THE ORBITER CENTRAL TIMING UNIT, AND TRANSMITTED TO THE PAYLOAD BY THESE INTERFACES.

2.30800 COMMUNICATIONS

FIGURE 2.7 IS A SCHEMATIC DIAGRAM OF THE COMMUNICATIONS PROVISIONS.

2.30801 VOICE - THE ORBITER AUDIO COMMUNICATIONS SYSTEM PROVIDES VOICE COMMUNICATIONS FOR PAYLOAD OPERATIONS AS FOLLOWS-

A. TWO-WAY VOICE COMMUNICATIONS BETWEEN THE PAYLOAD BAY AND GROUND

B. TWO-WAY VOICE COMMUNICATIONS BETWEEN CREW STATIONS AND THE PAYLOAD BAY STATIONS

C. RADIO FREQUENCY (RF) VOICE COMMUNICATIONS BETWEEN RELEASED PAYLOADS AND THE ORBITER

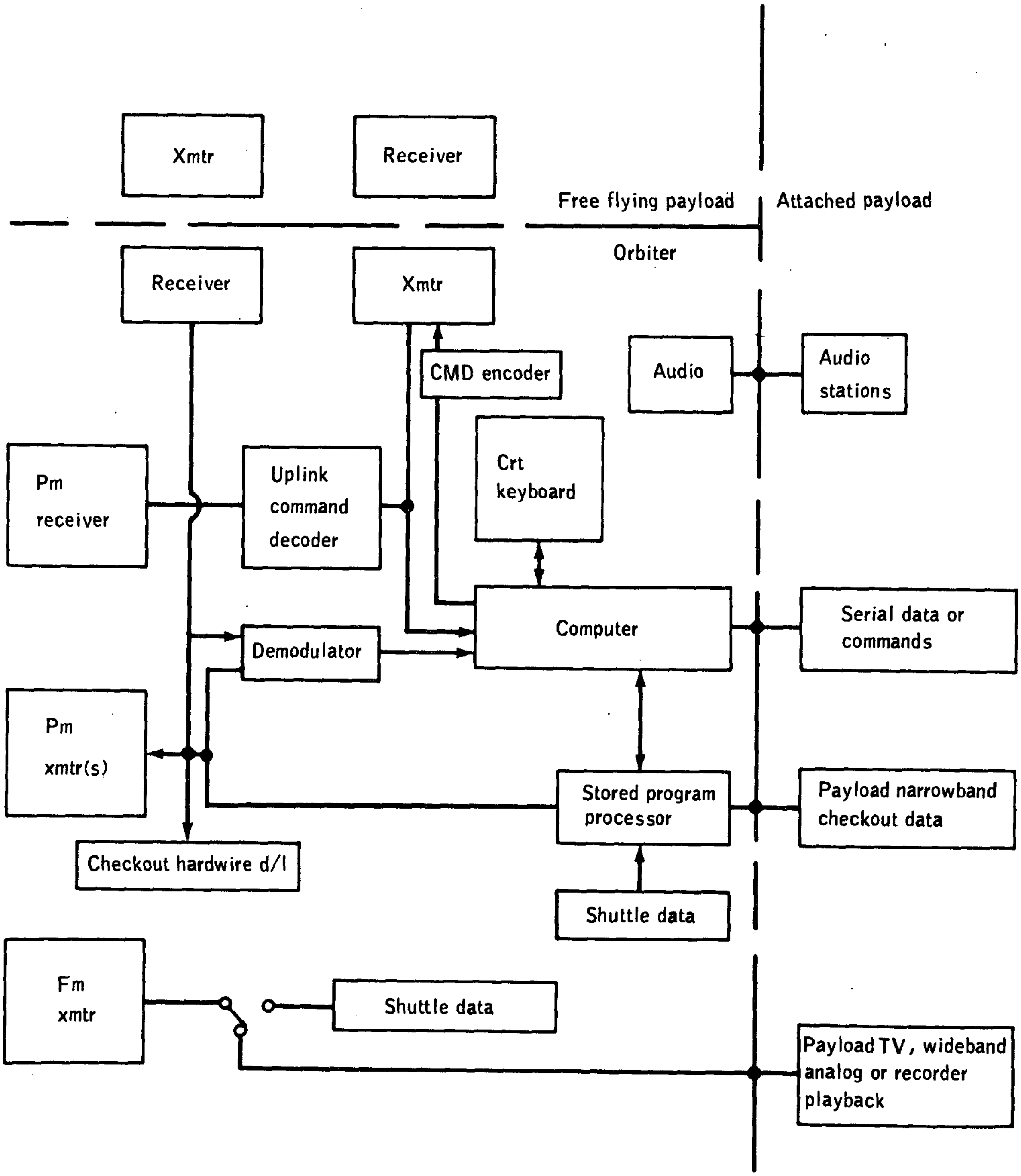
E. EVA VOICE COMMUNICATIONS USED ONBOARD THE ORBITER OR RELAYED TO THE GROUND. TWO UNIQUE EVA CHANNELS ARE PROVIDED, WITH CONFERENCE CAPABILITY TO (TBD) ADDITIONAL EVA'S.

2.30802 WIDEBAND DATA - A HARDWIRED INTERFACE IS PROVIDED IN THE PAYLOAD BAY FOR TRANSMISSION OF REALTIME OR DELAYED WIDEBAND PAYLOAD DATA TO THE GROUND. THIS LINK ACCOMMODATES UP TO 256,000 BITS PER SECOND (BPS) OF DIGITAL DATA OR PROVIDES WIDEBAND ANALOG DATA. IN EITHER CASE, THE PAYLOAD PROVIDES THE NECESSARY EQUIPMENT TO INSURE THAT THE PAYLOAD DATA ARE COMPATIBLE WITH THE ORBITER TRANSMITTER.

2.30803 DIGITAL DATA - PAYLOAD PCM DATA FROM RAU'S IN THE PAYLOAD BAY CAN BE TRANSMITTED TO THE GROUND THROUGH THE STORED PROGRAM PROCESSOR AND S-BAND TRANSMITTER. UP TO 25,000 BPS OF PAYLOAD DATA CAN BE TRANSMITTED TO THE GROUND BY THIS METHOD. DATA FROM RELEASED PAYLOADS UP TO 2,000 BPS CAN BE RECEIVED BY THE ORBITER SYSTEM FOR RELAY TO THE GROUND, OR FOR TRANSMISSION TO THE COMPUTER USED FOR PAYLOAD MONITORING.

2.30804 TELEVISION (TV) - TWO COAXIAL INTERFACES ARE PROVIDED IN THE PAYLOAD BAY FOR TRANSMISSION OF PAYLOAD TV VIDEO SIGNALS TO THE GROUND, OR TO THE VIDEO DISPLAYS AT THE PAYLOAD HANDLER STATION.

2.30805 UPLINK COMMANDS/DATA - INFLIGHT UPLINK INFORMATION FOR ATTACHED PAYLOADS IS ROUTED TO THE COMPUTER FROM THE S-BAND UPLINK COMMAND DECODER. THIS INFORMATION IS RELAYED TO THE PAYLOAD VIA A SERIAL DIGITAL INTERFACE TO THE PCDS. IN ADDITION, THIS



ORBITER/PAYLOAD COMMUNICATIONS INTERFACE

FIGURE - 2.7

INFORMATION CAN BE RELAYED TO RELEASE PAYLOADS (UP TO A RANGE OF TBD MILES) VIA RF, UP TO 2,000 BPS. COMMANDS ORIGINATED IN THE ORBITER CAN ALSO BE TRANSMITTED TO THE RELEASED PAYLOADS BY THE SAME MEANS. THIS LINK INCLUDES A COMMAND CONFIRMATION CAPABILITY.

2.30900 CREW SYSTEMS

2.30901 SUPPORTS AND RESTRAINTS - MOBILITY AIDS ARE PROVIDED IN THE PAYLOAD BAY AND ORBITER STRUCTURE. THESE MOBILITY AIDS INCLUDE STRATEGICALLY LOCATED HANDHOLDS, TETHER-ATTACHMENT POINTS, AND FOOT RESTRAINTS AT WORK AREAS. SIMILAR MOBILITY AIDS SHOULD BE PROVIDED ON PAYLOADS WHICH REQUIRE CREW OPERATIONS SUCH AS MAINTENANCE, INSPECTION, DEPLOYMENT, OR HABITATION.

2.30902 EVA SUPPORT EQUIPMENT - THE EVA CAPABILITY FOR A MINIMUM OF TWO CREWMEN IS PROVIDED BY THE ORBITER. TO SUPPORT EVA, THE ORBITER HAS AN AIRLOCK, EVA EQUIPMENT STORAGE AND DONNING AREA, EXTRAVEHICULAR LIFE SUPPORT SYSTEM (EVLSS) RECHARGING STATION, CREW MOBILITY AIDS, AND THE NECESSARY COMMUNICATION CIRCUITS AND MONITORING SYSTEMS FOR ON-ORBIT OPERATIONS. THE EVA EQUIPMENT AND EXPENDABLES ARE AVAILABLE, AND ARE CHARGEABLE TO THE PAYLOAD. THIS EVA EQUIPMENT INCLUDES - (1) PRESSURE GARMENT ASSEMBLIES (PGA'S) (2) EVLSS'S, (3) MANEUVERING SYSTEMS, (4) TOOL KITS, (5) RESTRAINTS, AND (6) PORTABLE LIGHTS. STANDARD TOOLS AND A TORQUING DEVICE ARE INCLUDED IN THE TOOL KIT. SPECIALIZED TOOLS AND TOOL ADAPTERS ARE PROVIDED BY THE PAYLOAD.

2.30903 EVA DESIGN CONSIDERATIONS - THE FOLLOWING ITEMS MUST BE CONSIDERED IN PAYLOAD DESIGN TO ENSURE COMPATIBILITY WITH THE EVA CREWMAN TO OBTAIN MAXIMUM UTILITY FROM TIME SPENT IN EVA.

A. HANDHOLDS OR GUIDERAILS ARE PROVIDED ALONG THE EVA TRAVERSE WHEREVER POSSIBLE.

B. FOOT RESTRAINTS AND TETHER-HOOK ATTACH POINTS ARE PROVIDED AT WORK STATIONS OR WHEREVER PULLING, PUSHING, OR TORQUING ACTIONS ARE REQUIRED.

C. MAXIMUM FORCE AND TORQUE CAPABILITIES FOR THE RESTRAINED EVA CREWMEN ARE-

TORQUE - (TBD) FT-LBS
FORCE PULL - (TBD) LBS
FORCE PUSH - (TBD) LBS

D. REACH MOBILITY AND VISIBILITY ARE CONSIDERED IN WORK STATION DESIGN. TOOLS AND CONTROLS MUST BE COMPATIBLE WITH THE GLOVED HAND.

E. MAXIMUM ENVELOPE DIMENSIONS OF THE PGA/PLSS ARE SHOWN IN FIGURE 2.8.

F. LIGHTING LEVELS ARE COMPATIBLE WITH THE TASKS TO BE PERFORMED.

G. SHARP OR DANGEROUS OBJECTS ARE ELIMINATED FROM THE EVA ROUTE.

PAYLOAD WEIGHT WHICH CAN BE TRANSFERRED BY THE CREWMAN IS DEPENDENT UPON THE PHYSICAL CONFIGURATION OF THE PAYLOAD AND THE METHOD OF TRANSFER. PAYLOAD TRANSFERS FROM THE PAYLOAD BAY TO AN EVA WORK STATION CAN BE ACCOMPLISHED BY THE CREWMAN CARRYING THE PAYLOAD TO THE WORK STATION, OR BY USING A TRANSFER DEVICE SUCH AS CLOTHESLINE TYPE CONVEYOR. TO CARRY THE PAYLOAD TO THE WORK STATION, THE CREWMAN GRASPS THE PAYLOAD BY MEANS OF HANDHOLDS, OR ATTACHES THE PAYLOAD TO THE PGA OR OTHER EVA EQUIPMENT BY MEANS OF RESTRAINT DEVICES.

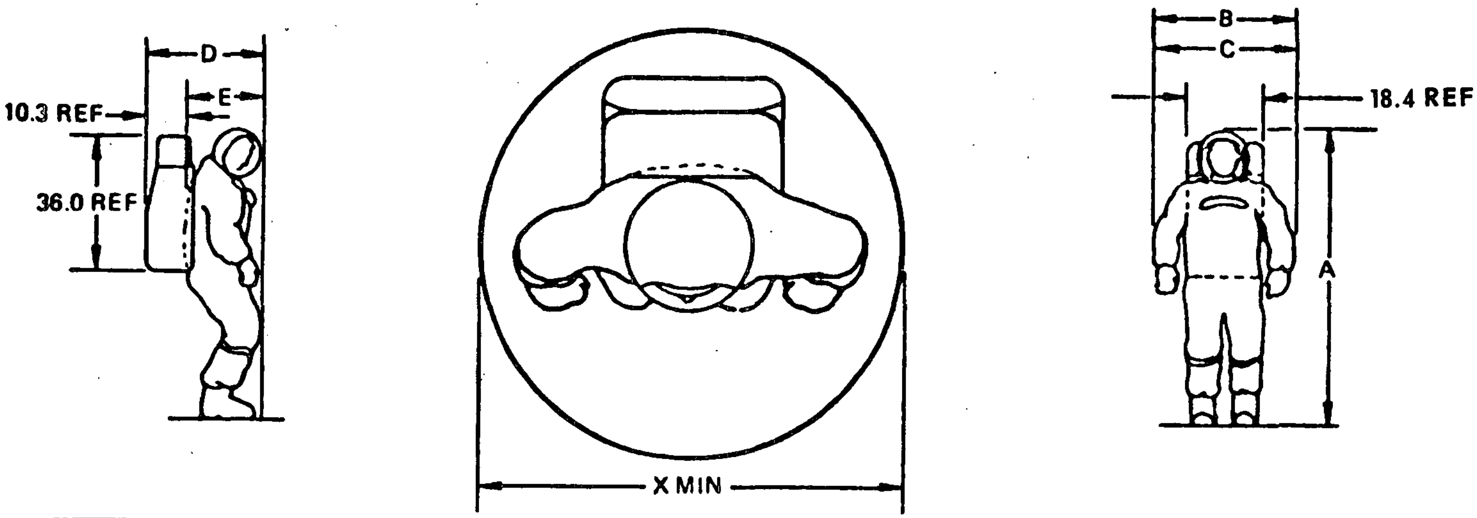
2.30904 EVA AIRLOCK - AN AIRLOCK(S) IS PROVIDED BY THE ORBITER WHICH ALLOWS DUAL EVA FROM THE ORBITER. THE AIRLOCK(S) PROVIDE IVA ACCESS TO THE PAYLOAD BAY WITH PAYLOAD DOORS CLOSED, AS WELL AS EXTERNAL TO THE ORBITER. THE EVA CAPABILITY EXISTS WITH OR WITHOUT AN ORBITAL ELEMENT ATTACHED TO THE DOCKING PORT.

2.30905 CREW COMPARTMENT/PAYLOAD BAY ACCESS - AN INTERNAL ACCESS BETWEEN THE CREW COMPARTMENT AND THE PAYLOAD BAY IS DESIGNED IN THE ORBITER. THIS ACCESS ALLOWS SHIRTSLEEVE IVA TRANSFER OF PERSONNEL AND CARGO THROUGH A HATCH LOCATED IN THE AFT SECTION OF THE CABIN TO A HABITABLE PAYLOAD MODULE IN THE PAYLOAD BAY. LOCATED WITHIN THE PRESSURIZED VOLUME OF THIS INTERFACE ARE REDUNDANT POWER, C+W, DATA, COMMUNICATIONS, AND FLUID INTERFACE CONNECTORS TO SUPPORT HABITABLE PAYLOADS IN THE PAYLOAD BAY.

2.30906 ILLUMINATION - THE ORBITER HAS LIGHTING SYSTEMS TO SUPPORT ORBITER/PAYLOAD OPERATIONS EXTERNAL TO THE ORBITER, INSIDE THE PAYLOAD BAY, AND INSIDE THE

C-2

ENVELOPE DIMENSIONS FOR A SUITED PRESSURIZED MALE CREW MEMBER



DIMENSION	PERCENTILE (INCHES) 5	95
A - HEIGHT	68.7	76.8
B - MAX BREADTH AT ELBOWS (ARMS RELAXED)	*	29.4
C - MAX BREADTH AT ELBOWS (ARMS AT SIDE)	*	26.4
D - MAX DEPTH WITH PORTABLE LIFE SUPPORT SYSTEM (PLSS) & BACKUP OXYGEN (OPS)	26.0	28.4
E - MAX DEPTH WITHOUT PLSS/OPS	15.5	17.9
WEIGHT (POUNDS), WITH PLSS/OPS	331.7	404.6
WEIGHT (POUNDS), WITHOUT PLSS/OPS	206.2	278.9

*INDICATES DATA NOT AVAILABLE
FOR DIMENSIONS D & E 2 INCHES HAVE BEEN ADDED TO MAXIMUM CHEST OF SUITED/PRESSURIZED CREWMAN FOR PLSS CONTROL BOX TO OBTAIN ENVELOPE DIMENSIONS
MEASUREMENTS MADE ON A7L PGA, PRESSURIZED TO 3.75 PSIG

PGA/PLSS DIMENSIONS

FIGURE - 2.8

CREW COMPARTMENT. THE EXTERNAL LIGHTING SYSTEM PROVIDES ILLUMINATION FOR PAYLOAD DEPLOYMENT, DOCKING, AND RETRIEVAL OPERATIONS. PAYLOAD BAY ILLUMINATION IS AVAILABLE FOR PAYLOAD INSPECTION, ATTACHED PAYLOAD OPERATIONS, PAYLOAD LATCHING, AND PAYLOAD RELEASE. THE LIGHTING SYSTEM WITHIN THE CABIN ILLUMINATES THE PAYLOAD DISPLAY AND CONTROL STATION AT LEVELS WHICH ARE CONSISTENT WITH THE CREW COMPARTMENT ILLUMINATION REQUIREMENTS.

2.31000 ENVIRONMENTAL CONTROL/LIFE SUPPORT SYSTEM

2.31001 SYSTEM CAPABILITIES - THE ORBITER ENVIRONMENTAL CONTROL/LIFE SUPPORT SYSTEM (ECLSS) BASELINE IS DESIGNED TO ACCOMMODATE A CREW OF FOUR FOR A MISSION DURATION OF 7 DAYS. THIS SYSTEM HAS THE CAPABILITY TO ACCOMMODATE UP TO 42 MAN-DAYS WITHOUT SYSTEM CHANGES. WITH MINOR CHANGES, SIX ADDITIONAL PEOPLE CAN BE ACCOMMODATED WITH SLIGHT INCREASES IN ATMOSPHERIC DRY BULB TEMPERATURE, HUMIDITY, AND CARBON DIOXIDE CONTENT.

2.31002 ATMOSPHERE SUPPLY AND PRESSURE CONTROL - THIS SYSTEM IS DESIGNED TO CONTROL AND MAINTAIN AUTOMATICALLY A TWO-GAS, SEA LEVEL EQUIVALENT ATMOSPHERE (14.7 PSIA, 80-PERCENT NITROGEN, 20-PERCENT OXYGEN) WITHIN THE ORBITER CABIN AND HABITABLE PAYLOAD MODULES.

THE WEIGHT OF ADDITIONAL ATMOSPHERE STORAGE EQUIPMENT AND EXPENDABLES TO SUPPORT MISSIONS BEYOND 28 MAN-DAYS ARE CHARGED TO THE PAYLOAD. THE PAYLOAD SHOULD NOT INTRODUCE ADDITIONAL OXYGEN OR NITROGEN INTO THE HABITABLE ATMOSPHERE.

2.31003 ACTIVE THERMAL CONTROL - THE ORBITER ACTIVE THERMAL CONTROL SUBSYSTEM PROVIDES INTERFACE HEAT EXCHANGERS TO REJECT PAYLOAD WASTE HEAT TO THE ORBITER HEAT REJECTION EQUIPMENT. THIS SUBSYSTEM IS CAPABLE OF TRANSFERRING PAYLOAD WASTE HEAT UP TO 5200 BTU/HR DURING PEAK ORBITER OPERATIONS, AND (TBD) BTU/HR DURING ON-ORBIT COAST PERIODS. SUPPLEMENTARY ON-ORBIT HEAT REJECTION IS PROVIDED BY ORBITER WATER EVAPORATION OR BY PAYLOAD SUPPLIED HEAT REJECTION SYSTEMS. THE PAYLOAD IS ALSO RESPONSIBLE FOR PROVIDING THE PAYLOAD HEAT TRANSPORT THERMAL CONTROL SYSTEM AND HARDWARE TO INTERFACE WITH THE ORBITER ACTIVE THERMAL CONTROL SUBSYSTEM INTERFACE HEAT EXCHANGER.

2.31004 WASTE MANAGEMENT - ALL SOLID AND LIQUID WASTE PRODUCTS ARE STORED ONBOARD FOR RETURN TO EARTH, HOWEVER, AN OVERBOARD LIQUID DUMP SYSTEM IS PROVIDED AS A CONTINGENCY MEASURE. WASTE WATER FROM PAYLOAD EXPERIMENTS OR OPERATIONS IS PROCESSED AND/OR STORED BY THE PAYLOAD.

2.31100 PAYLOAD BAY ENVIRONMENT

2.31101 ACOUSTIC - THE ORBITER PAYLOAD BAY INTERIOR SOUND PRESSURE LEVEL WILL NOT EXCEED 145 DB.

2.31102 VIBRATION - VIBRATION ENVIRONMENT WITHIN THE PAYLOAD BAY WILL NOT EXCEED CURRENT LAUNCH VEHICLE PAYLOAD ENVIRONMENTS.

2.31103 SHOCK - ORBITER/BOOSTER SEPARATION AND ORBITER LANDING ARE EXPECTED TO INDUCE SHORT DURATION SHOCK TO THE PAYLOADS.

2.31104 FLIGHT ACCELERATION LOADS - THE SHUTTLE FLIGHT ACCELERATION LOADS ARE GIVEN IN TABLE 2-VI FOR THE VARIOUS FLIGHT PHASES. THESE LOAD FACTORS INCLUDE THE DYNAMIC INDUCED LOADS, AND CARRY THE SIGNS OF EXTERNALLY APPLIED LOADS.

TABLE 2-VI - PRELIMINARY LIMIT LOAD FACTORS FOR PAYLOAD

CONDITION	NX (G)		NY (G)		NZ (G)	
	STEADY	DYNAMIC	STEADY	DYNAMIC	STEADY	DYNAMIC
THRUST BUILDUP/ EMERGENCY REBOUND	1.0	+/-1.0	-	+/- .25	-	+/- .25
LAUNCH RELEASE (WITHIN 2 SEC. OF RELEASE)	1.5	+/-1.0	+/-0.25	+/-0.5	+/-0.25	+/-0.5
LIFT-OFF PLUS 5 SEC	1.5	+/-0.25	-	+/-0.25	+0.25	+/-0.25
MAX Q FLT REGION	2.0	+/-0.25	+/-0.5	+/-0.25	+0.8 -0.4	+/-0.25
ATMOSPHERE ABORT	2.0	+/-0.25	+/-0.5	+/-0.25	+0.8 -0.4	+/-0.25
BOOST FLT (MAX AC-CELERATION PRIOR TO CUTOFF)	3.0	+/-0.25	+/-0.2	+/-0.25	+/-0.3	+/-0.25
BOOSTER CUTOFF/ SEPARATION	1.0	+/-1.5	+/-0.2	+/-1.0	+/-0.3	+/-1.0
ORBITER BOOST	3.0	+/-0.25	+/-0.2	+/-0.25	+0.6	+/-0.25
RE-ENTRY	-1.0	-	+/-0.5	+/-0.25	-3.0	+/-0.5
FLYBACK	-0.2	+/-0.25	+/-1.0	+/-0.25	+/-2.5	+/-0.25
LANDING/ TAXIING/ BRAKING	-1.0	-	+/-0.5	+/-0.25	-3.0	+/-0.5

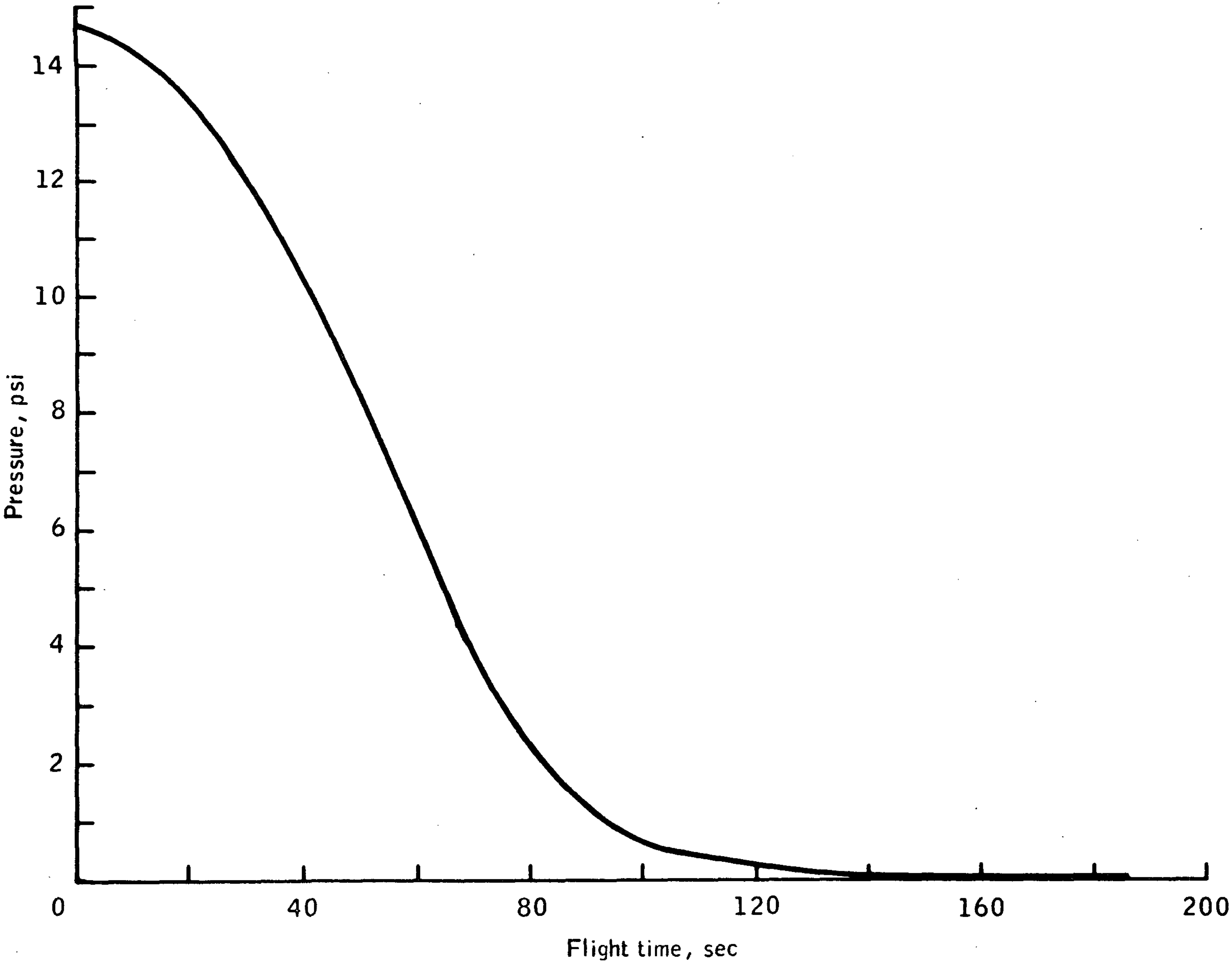
2.31105 PAYLOAD BAY ATMOSPHERE - THE ORBITER PAYLOAD BAY CAN BE ATMOSPHERIC CONTROLLED INDEPENDENT OF OTHER PARTS OF THE ORBITER STRUCTURE WHILE ON THE LAUNCH PAD. THIS PROVISION ALLOWS THE CONTROL OF THE TEMPERATURE, HUMIDITY, ATMOSPHERE COMPOSITION, AND PARTICLE CONTAMINATION OF THE PAYLOAD BAY BY THE USE OF LAUNCH SITE GSE.

THE ORBITER PAYLOAD BAY IS VENTED DURING THE LAUNCH AND ENTRY PHASES, AND OPERATES UNPRESSURIZED DURING THE ORBITAL PHASE OF THE MISSION. THE PRESSURE ENVIRONMENT CURVES FOR THE LAUNCH AND ENTRY PHASES ARE SHOWN IN FIGURE 2.9.

2.31106 CONTAMINATION - CONTAMINATION OF THE PAYLOAD IS MINIMIZED THROUGH CONTROLLED VENTING, MATERIAL CONTROL, AND PRELAUNCH ATMOSPHERIC CONTROL. ATTITUDE CONTROL SYSTEM THRUSTERS ARE DESIGNED TO PREVENT PLUME IMPINGEMENT ON THE PAYLOAD OR PAYLOAD BAY.

2.31107 THERMAL ENVIRONMENT AND CONTROL - THE DETERMINATION OF PAYLOAD TEMPERATURE AND TEMPERATURE ENVIRONMENTS WHICH THE PAYLOAD WILL ACTUALLY EXPERIENCE IN THE PAYLOAD BAY REQUIRES KNOWLEDGE OF THE SPECIFIC MISSION ENVIRONMENT FROM BOOST THROUGH ENTRY, THE TYPE OF THERMAL CONTROL PROVIDED BY THE SHUTTLE VEHICLE AND THE PAYLOAD, AND THE PAYLOAD BAY AND PAYLOAD THERMAL CHARACTERISTICS. TO OBTAIN THIS INFORMATION REQUIRES DETAILED KNOWLEDGE OF THE ACTUAL SHUTTLE AND PAYLOAD DESIGN, AS WELL AS THE SPECIFIC INFLIGHT ORIENTATIONS WHICH PROBABLY WILL VARY FOR EACH DIFFERENT MISSION OBJECTIVE. AS SHUTTLE PAYLOAD BAY AND PAYLOAD THERMAL DESIGN CRITERIA IS CURRENTLY ENVISIONED, THE FOLLOWING DESIGN REQUIREMENTS HAVE BEEN IMPOSED ON THE SHUTTLE VEHICLE THERMAL DESIGN.

THE INTERNAL WALL TEMPERATURE LIMITS FOR THE PAYLOAD BAY, NOT CONSIDERING PAYLOAD HEAT ADDITION OR REMOVAL SHALL REMAIN WITHIN THE RANGES NOTED IN THE FOLLOWING TABLE-



PAYLOAD BAY INTERNAL PRESSURE TIME HISTORY DURING ASCENT

FIGURE - 2.9

CONDITION	MINIMUM (F)	MAXIMUM (F)
PRELAUNCH	+40	+120
LAUNCH	+40	+150
ON-ORBIT (DOOR-CLOSED)	-100	+150
ENTRY AND POST LANDING	-100	+200

AS AN ON-ORBIT THERMAL CONTROL POINT-DESIGN FOR SIZING THE NOMINAL PAYLOAD PASSIVE THERMAL CONTROL PROVIDED BY THE ORBITER, THE PAYLOAD BAY IS DESIGNED TO LIMIT THE NET HEAT LEAK INTO OR OUT OF A 100-DEGREE FAHRENHEIT CONSTANT TEMPERATURE PAYLOAD TO 3 BTU/HR/SQUARE FOOT, WITH THE PAYLOAD DOORS CLOSED UNDER WORST-CASE ORBITAL ORIENTATIONS.

PROVISIONS ARE INCORPORATED IN THE PAYLOAD BAY-WALL DESIGN FOR ATTACHMENT AND REMOVAL OF PASSIVE THERMAL CONTROL IN MODULAR FORM TO MEET VARIABLE PAYLOAD THERMAL CONTROL REQUIREMENTS.

THE TEMPERATURE LIMITS SPECIFIED FOR THE PRELAUNCH, LAUNCH, AND ENTRY PHASES PROVIDE A DESIGN ENVIRONMENT INTERFACE BETWEEN THE PAYLOAD AND PAYLOAD BAY, WHICH REPRESENTS CONSERVATIVE PAYLOAD BAY-WALL ENVIRONMENT TEMPERATURES FOR A PASSIVE PAYLOAD. BECAUSE OF THE VARIABLE NATURE OF THE ON-ORBIT PAYLOAD BAY THERMAL CONTROL REQUIREMENTS, CAUSED BY VARIATIONS IN THE ORBIT THERMAL ENVIRONMENT AND PAYLOAD THERMAL REQUIREMENTS, FLEXIBILITY IN MEETING THESE VARIATIONS IS PROVIDED BY REMOVAL AND PLACEMENT OF DIFFERENT PASSIVE INSULATION SYSTEMS AS REQUIRED. AN ON-ORBIT POINT DESIGN REQUIREMENT PROVIDES FOR NOMINAL PAYLOAD BAY PASSIVE THERMAL CONTROL IN THE PAYLOAD BAY DESIGN.

IF THE PAYLOAD BAY CANNOT BE PASSIVELY CONTROLLED, PROVISIONS FOR LIMITED ACTIVE THERMAL CONTROL OF THE PAYLOAD IS AVAILABLE FROM THE SHUTTLE ORBITER. ACTIVE PAYLOAD THERMAL CONTROL IS SUPPLIED BY THE ORBITER ACTIVE FLUID LOOP SYSTEM THROUGH A HEAT EXCHANGER IN THE ORBITER TO SUPPORT THE PAYLOAD IN THE PAYLOAD BAY. THE HEAT TRANSFER CAPACITY FOR PAYLOADS EQUIPMENT IS-

A. PEAK CAPACITY OF 5200 BTU/HR DURING PEAK ORBITER OPERATIONS

B. PEAK CAPACITY OF (TBD) BTU/HR DURING ON-ORBIT COAST PERIODS

SINCE A MINIMUM ENERGY ALLOWANCE OF 50 KWH IS PROVIDED BY THE ORBITER ELECTRICAL POWER SYSTEM FOR PAYLOAD SUPPORT, A PORTION OF THIS POWER CAN BE UTILIZED FOR ACTIVE HEATER THERMAL CONTROL, DEPENDING UPON OTHER PAYLOAD ELECTRICAL POWER REQUIREMENTS.

2.31108 RADIATION - RADIOACTIVE SOURCES ON THE ORBITER ARE CONTROLLED TO REDUCE STRAY SIGNAL SOURCES TO EXPERIMENTS OR PAYLOADS CARRIED BY THE ORBITER. PAYLOAD SUPPLIED RADIOACTIVE SOURCES ARE APPROVED THROUGH THE ORBITER INTEGRATION CENTER (MSC) TO MEET ALL FLIGHT AND SAFETY REQUIREMENTS.

2.400 SAFETY, RELIABILITY, AND QUALITY ASSURANCE

2.40100 SHUTTLE CAPABILITIES

2.40101 ABORTS - THE SHUTTLE IS DESIGNED TO PROVIDE SAFE MISSION TERMINATION CAPABILITY FOR ALL FLIGHT REGIMES. SAFE MISSION TERMINATION INCLUDES THE INTACT RETURN OF PAYLOADS TO EARTH.

2.40102 CREW AND PASSENGER EGRESS - EMERGENCY EGRESS CAPABILITY FOR THE CREW AND PASSENGERS IS PROVIDED FOR PRELAUNCH AND POSTLANDING OPERATIONS.

2.40103 CAUTION AND WARNING - THE SHUTTLE PROVIDES A CAUTION AND WARNING SYSTEM FOR PROCESSING AND DISPLAYING CRITICAL PAYLOAD DATA. SEE SECTION 2.30400 FOR A DESCRIPTION OF THE CAUTION AND WARNING SYSTEM.

2.40104 PAYLOAD CONTROL - THE SHUTTLE PROVIDES A LIMITED HARDWARE AND RF CONTROL CAPABILITY TO PROVIDE CORRECTIVE MEANS TO CIRCUMVENT CATASTROPHIC EVENTS FROM OCCURRING, AND FOR ACTIVATION AND DEACTIVATION OF PAYLOAD SYSTEMS. SEE SECTIONS 2.30700 AND 2.30800 FOR MORE DETAILS.

2.40105 DUMPS AND VENTS - THE CAPABILITY TO DUMP LIQUIDS AND VENT GASES IS PROVIDED. INTERCONNECTS TO THE DUMP AND VENTING SYSTEMS ARE AVAILABLE TO SAFELY REMOVE LIQUIDS AND GASES FROM THE PAYLOAD BAY, IF REQUIRED.

2.40106 PURGE - A NITROGEN PURGE CAPABILITY IS PROVIDED FOR INERTING THE PAYLOAD BAY PRIOR TO LAUNCH.

2.40200 PAYLOAD

2.40201 PURPOSE AND SCOPE - THE FIRST INTENT OF THIS SECTION IS TO DEFINE MINIMUM SAFETY, RELIABILITY, AND QUALITY ASSURANCE REQUIREMENTS TO BE INVOKED ON PAYLOAD SUPPLIERS. THESE REQUIREMENTS CONSIDER PRIMARILY THE SAFETY, RELIABILITY, AND QUALITY ASSURANCE OF PAYLOAD HAZARDS, THE NORMAL OPERATION OR FAILURE OF WHICH COULD CAUSE HAZARDS TO PERSONNEL, OR DAMAGE TO THE SHUTTLE SYSTEM, RELATED FACILITIES, OR OTHER PAYLOAD ELEMENTS. SECOND, THE COMPATIBILITY OF THE PAYLOAD WITH THE SHUTTLE INTERFACES IS ALSO A CONCERN.

2.40202 GENERAL REQUIREMENTS - THE PAYLOAD SUPPLIER IS RESPONSIBLE FOR THE FOLLOWING SAFETY, RELIABILITY, AND QUALITY ASSURANCE ACTIVITIES-

A. THE DETERMINATION OF THE HAZARDOUS ASPECTS OF HIS PAYLOAD AND THE IMPLEMENTATION OF REQUIRED CORRECTIVE MEASURES.

B. ASSURANCE OF THE COMPATIBILITY OF HIS PAYLOAD WITH THE SHUTTLE INTERFACES.

C. IDENTIFICATION TO NASA OF THE UNRESOLVED RESIDUAL HAZARDS AND INTERFACE INCOMPATIBILITIES PRIOR TO NASA APPROVAL OF HIS PAYLOAD.

D. THE ON-ORBIT FUNCTIONAL RELIABILITY, QUALITY, AND SAFETY OF HIS PAYLOAD.

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