NSTS 07700, Volume XIV

Space Shuttle System Payload Accommodations

Revision L

DESCRIPTION OF CHANGES TO

SPACE SHUTTLE SYSTEM PAYLOAD ACCOMMODATIONS
NSTS 07700, VOLUME XIV

CHANGE NO.	DESCRIPTION/AUTHORITY	DATE	PAGES AFFECTED
	BASELINE ISSUE	4/13/73	All
Rev. A thru Rev. I	REVISION A through REVISION I	7/16/73 thru 9/16/86	All
Rev. J	Complete revision; replaces and supersedes Revision I (reference PRCBD S04219F dated 2/18/88 and CR D07700-014-01). The following CR's are included: D07700-014-002, D07700-014-003, D07700-014-004, D07700-014-005, D07700-014-006.	1/27/88	All
1	The following CR's are included: D07700-014-007, D07700-014-008, D07700-014-009, D07700-014-010, D07700-014-011.	6/13/89	iv, v, 1-2, 5-3, 5-10, 5-11, 5-12, 6-8, 6-9, 7-3, 7-5 through 7-9 (new), 8-1, 8-2
	Photographic errata	7/19/89	5-9, 5-10
Rev. K	Complete revision (reference CR D07700-014-020). The following CR's are included: D07700-014-012, D07700-014-013, D07700-014-015, D07700-014-016, D07700-014-017, and D07700-014-018	3/23/93	All
	Errata	7/13/93	3-3, 6-6
1	The following CR is included: D07700-014-022A.	7/13/93	iv, 6-2, 6-8 through 6-10, 8-2, 9-1, 9-2
2	The following CR is included: D07700-014-023.	1/25/94	3-3
3	Reformat Word for Windows. The following CR is included: D07700-014-025	5/24/95	7-8, 7-9, 7-12, 7-13
4	The following CR is included: D07700-14-0028C	10/17/00	iv, 6-8, 6-9
Rev. L	Complete revision (reference CR D07700-014-0029)	05/29/01	All
1	The following CR is included: D07700-14-0030	07/27/01	5-11

Preface

This document, its attachment, and its various appendixes describe currently approved and authorized interfaces between the Space Shuttle system and Space Shuttle payloads.

The applicability of each of these specialized documents will depend upon the characteristics of the payload to be flown and will be specified in the individual payload integration plan (IP). The design requirements outlined in this document, its attachment, and its appendixes are mandatory and may not be violated unless specifically agreed upon in the individual IP or individual interface control document (ICD).

Configuration control of this document will be accomplished through application of procedures contained in NSTS 07700, Vol. IV, Configuration Management Requirements, current issue.

Questions and recommendations concerning this document should be addressed to:

Manager, Space Shuttle Customer and Flight Integration Office
National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058

Signed Michele Brekke
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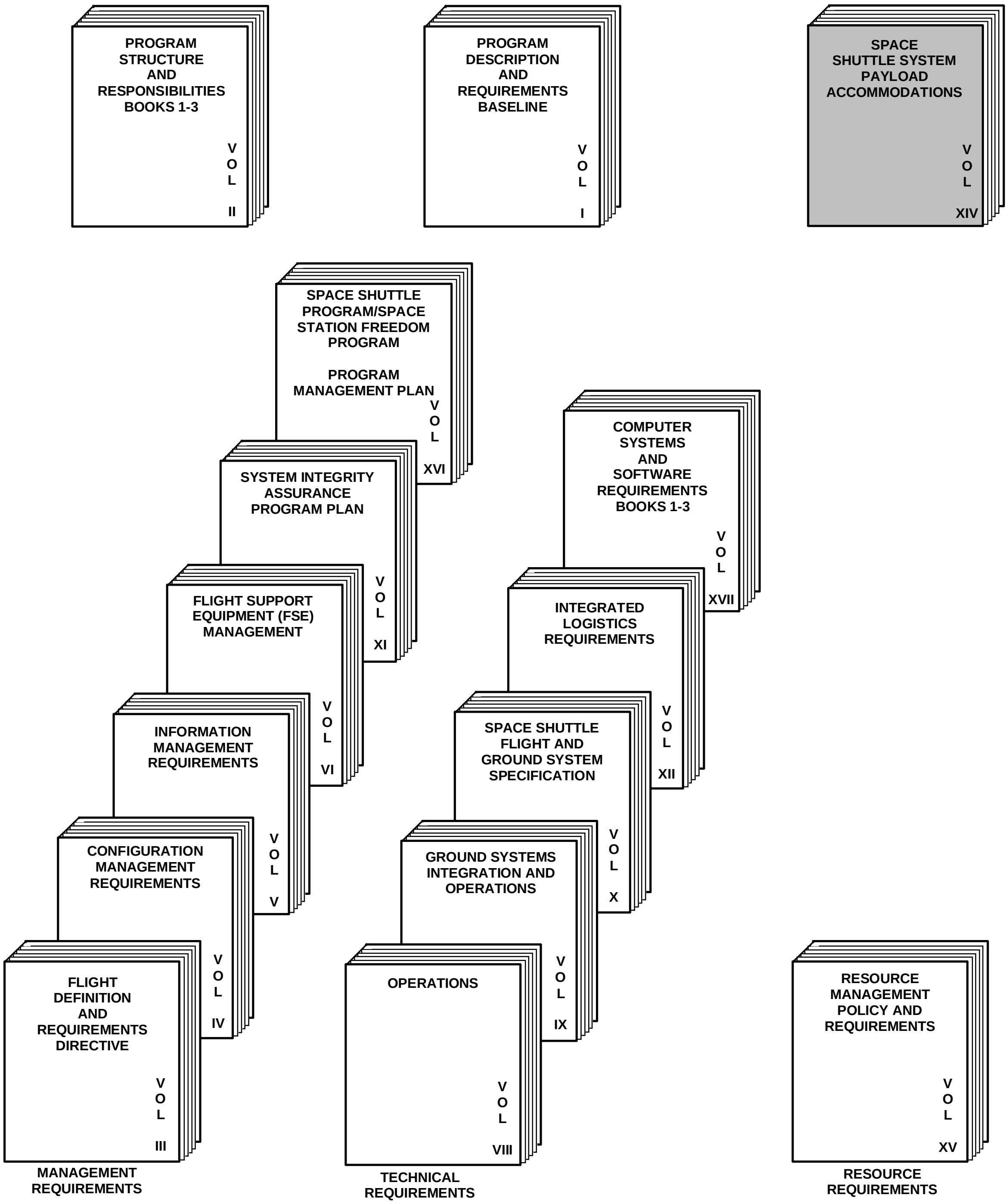
SPACE SHUTTLE
PROGRAM DEFINITION & REQUIREMENTS - NSTS 07700



NOTE: THE FOLLOWING VOLUME NUMBERS ARE
RESERVED: VOLUMES XVII
RETIRED: VOLUMES II-BK4, VI-BK2, VII, XIII

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Introduction

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This document contains information on the Space Shuttle system required by payload customers during the design definition phase. The purpose of this document is to provide potential customers with an official source of information on Space Shuttle capability to deliver payloads into orbit and return them to Earth; on services provided to payload customers; and on the means by which payload customers can avail themselves of these services. Standard interface provisions between the orbiter and payloads are also defined. With this information, payload planning and design studies can be undertaken incorporating known shuttle capabilities and interface provisions. Additionally, information is provided on the process employed by the Space Shuttle Program (SSP) to integrate individual payloads into the shuttle, and the process of manifesting multiple payloads and providing for their integration into a shuttle mission or flight.

This document should be used in conjunction with the documents outlined in Figure 1-1.

Specific safety requirements which payload customers must satisfy are contained in the primary safety documents noted in Figure 1-1.

Appendixes 1 through 10 contain system description and design data concerning accommodations and interface requirements. These appendixes are available on an as-needed basis. They are:

- Appendix 1: Contamination Environment
- Appendix 2: Thermal
- Appendix 3: Electrical Power and Avionics
- Appendix 4: Structures and Mechanics
- Appendix 5: Ground Operations
- Appendix 6: Mission Planning and Flight Design
- Appendix 7: Extravehicular Activities
- Appendix 8: Payload Deployment and Retrieval System
- Appendix 9: Intravehicular Activities
- Appendix 10: Integration Hardware

Standard integration plans (SIPs), also referred to as blank books, have been developed to serve as guides for preparation of the customer’s integration plan (IP). Integration plans could be a payload integration plan (PIP), mission integration plan (MIP), carrier integration plan (CIP), or an integration plan (IP). Blank book annexes are also available, as required, to facilitate definition of detailed integration requirements.

In addition, the Space Shuttle Program Payload Bay User's Guide, NSTS 21492, is available. A web site, http://shuttlepayloads.jsc.nasa.gov, contains hyperlinks to program documentation in addition to some general information on the payload integration process.

Attachment 1, Shuttle Orbiter/Cargo Standard Interfaces, ICD 2-19001 is the principal document defining Space Shuttle/payload interfaces. In addition, several standard interface definition documents (IDDs) and unique interface control documents (ICDs) are provided to facilitate the customer’s development of a payload-unique ICD. Normally only dedicated payloads require the complete ICD. Therefore, other payload customers should refer to the IDD or unique ICD appropriate to their payload.

When a prospective customer has negotiated a formal agreement (launch services agreement (LSA), joint endeavor agreement (JEA), or memorandum of understanding (MOU), etc.) with the National Aeronautics and Space Administration (NASA) Headquarters, a payload integration manager (PIM) will be assigned at Lyndon B. Johnson Space Center (JSC), and a launch site support manager (LSSM) at John F. Kennedy Space Center (KSC). The PIM will coordinate with the JSC customer payload support group to provide the payload customer with required documentation.

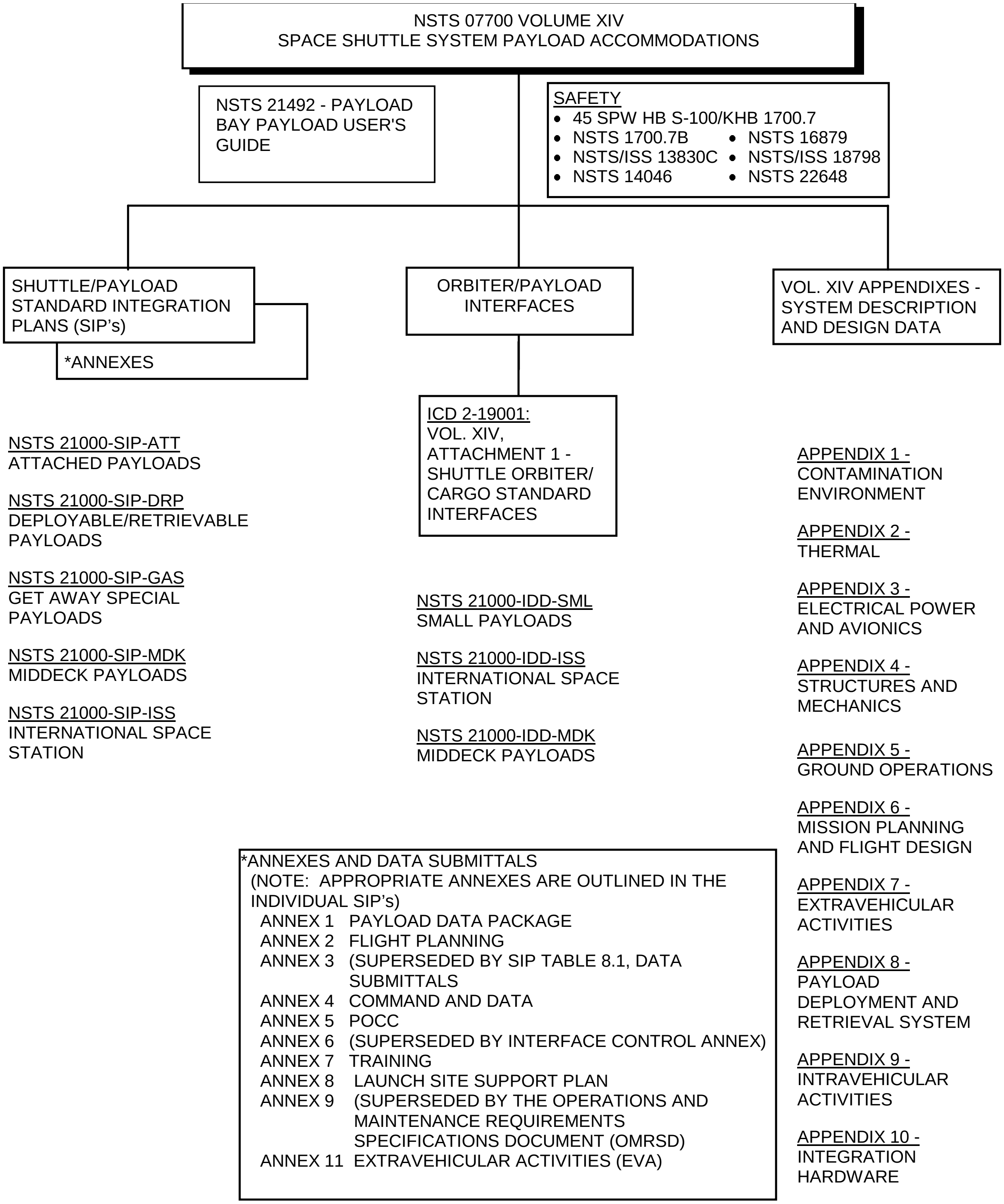


Figure 1-1.- Space Shuttle Program customer documentation tree.

Space Shuttle Program Organization

2

Several NASA centers are involved in activities of interest to SSP customers, ranging from development of scientific experiments to payload operation during a flight. The following organizations are directly involved with integration of a payload into the Space Shuttle.

2.1 NASA Headquarters

Overall management of the SSP is the responsibility of the Office of Space Flight at NASA Headquarters in Washington, D. C.

The Space Shuttle Operations Utilization Division within the Office of Space Flight is responsible for overall shuttle flight scheduling, including the receipt of Request for Flight Assignment (NASA Form 1628) and earnest money payments. This Division is also responsible for LSA, JEA, MOU, etc. negotiation and implementation, which covers all business, policy, legal, and financial aspects of a customer's launch.

2.2 Lyndon B. Johnson Space Center

The SSP at JSC in Houston, Texas, manages the development and operation of the Space Shuttle.

The JSC Customer and Flight Integration Office is responsible for managing integration of the customer's payload into the Space Shuttle. A PIM is assigned to each customer to serve as the single point of contact between the SSP and the customer.

Working groups for engineering and operations planning are established as needed between the customer and the SSP. These working groups define interface and operational requirements, identify and define engineering tasks and analyses, and exchange required data.

2.3 John F. Kennedy Space Center

KSC is the launch site and the primary landing site for the Space Shuttle. Located at Merritt Island, Florida, KSC is responsible for implementing activities associated with preparing the Space Shuttle and its payloads for launch, landing, and postflight services.

KSC is responsible for payload processing and support at the launch site. Each customer is assigned an LSSM to serve as a single point of contact between the customer and KSC for all launch site support and payload processing activities.

2.4 George C. Marshall Space Flight Center

George C. Marshall Space Flight Center (MSFC) in Hunstville, Alabama, is responsible for managing development of solid rocket boosters (SRBs), and Space Shuttle Main Engines (SSMEs).

2.5 Goddard Space Flight Center

Goddard Space Flight Center (GSFC) in Greenbelt, Maryland, is responsible for managing the worldwide NASA communications network, including the Tracking Data and Relay Satellite System (TDRSS). In addition, GSFC oversees the Get-Away Special (GAS) program and several other small payload carrier programs.

2.6 Contacts

The following NASA addresses and telephone numbers are provided for payload customers:

Space Shuttle Operations Utilization (Code MO)
National Aeronautics and Space Administration
Washington, D. C. 20546
(202) 358-2347

Customer and Flight Integration Office (Code MT)
National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058
(713) 483-1145

ISS/Payloads Processing Directorate (Code UB)
National Aeronautics and Space Administration
John F. Kennedy Space Center
Kennedy Space Center, Florida 32899
(407) 867-7411

For payload processing, payload launch and landing planning, or ground operations planning: ISS/Payloads Processing (UB)

National Aeronautics and Space Administration
John F. Kennedy Space Center
Kennedy Space Center, Florida 32899
(407) 867-4545

For GAS payloads:

Shuttle Small Payload Projects Office (Code 870)
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771
(301) 286-4271

Space Shuttle Program Description and General Capabilities

3

The SSP provides launch services to a wide range of payloads, from small hand-held experiments to large laboratories and satellites. Besides the traditional launch services provided by expendable launch vehicles, the SSP can provide a variety of man-supported services in space, then return the vehicle, crew, equipment, and products to Earth.

The SSP is composed of the Space Shuttle vehicle, flight and ground hardware, and personnel required to operate the system. Ground systems include facilities for payload and Space Shuttle flight hardware processing, launch and landing, and crew training and mission operations.

3.1 Space Shuttle Vehicle

The Space Shuttle vehicle is composed of the orbiter, an external tank (ET), and two SRB's. These elements are depicted in Figure 3-1.

a. Orbiter - The orbiter is comparable in size and weight to a modern commercial airliner. It has three main engines (commonly referred to as SSMEs) and two smaller orbital maneuvering system (OMS) engines mounted in the rear. Launch accelerations are limited to less than 3 g by use of the throttling capability of the SSMEs. In space, attitude control is affected by the reaction control system (RCS) engines.

   The orbiter payload bay is approximately 60 feet long and 15 feet in diameter (Figure 3-2). Normally, several compatible payloads share each flight; occasionally, however, a dedicated payload requires the entire payload bay.

   The flight crew normally consists of a commander, pilot, and three or more mission specialist (MS) astronauts. Payload specialists (PSs) may be included to operate their experiments. The commander and pilot operate the orbiter and manage orbiter systems, while the MSs accomplish mission objectives and assist the commander and pilot with management of orbiter systems. The commander, pilot, and MSs are selected by NASA on a career basis. One or more PSs may be added as required with approval from the SSP. Detailed responsibilities of MSs and PSs are tailored to meet the requirements of each mission; crew size is therefore a function of mission complexity and duration.

   Displays and controls for payload operations are located in the aft flight deck (AFD), which is the upper level of the crew compartment (Figure 3-3). The middeck, located immediately below the flight deck, provides the crew living area and accommodations for middeck payloads (Figure 3-4).

b. ET - The ET provides the orbiter main propulsion system with liquid hydrogen (fuel) and liquid oxygen (oxidizer). After cutoff of the SSMEs, the ET is jettisoned and breaks up in the atmosphere over remote ocean areas.

c. SRBs - Two SRBs are fired in parallel with the SSMEs to provide initial ascent thrust. The SRBs are recovered after each flight, refurbished, and reused.

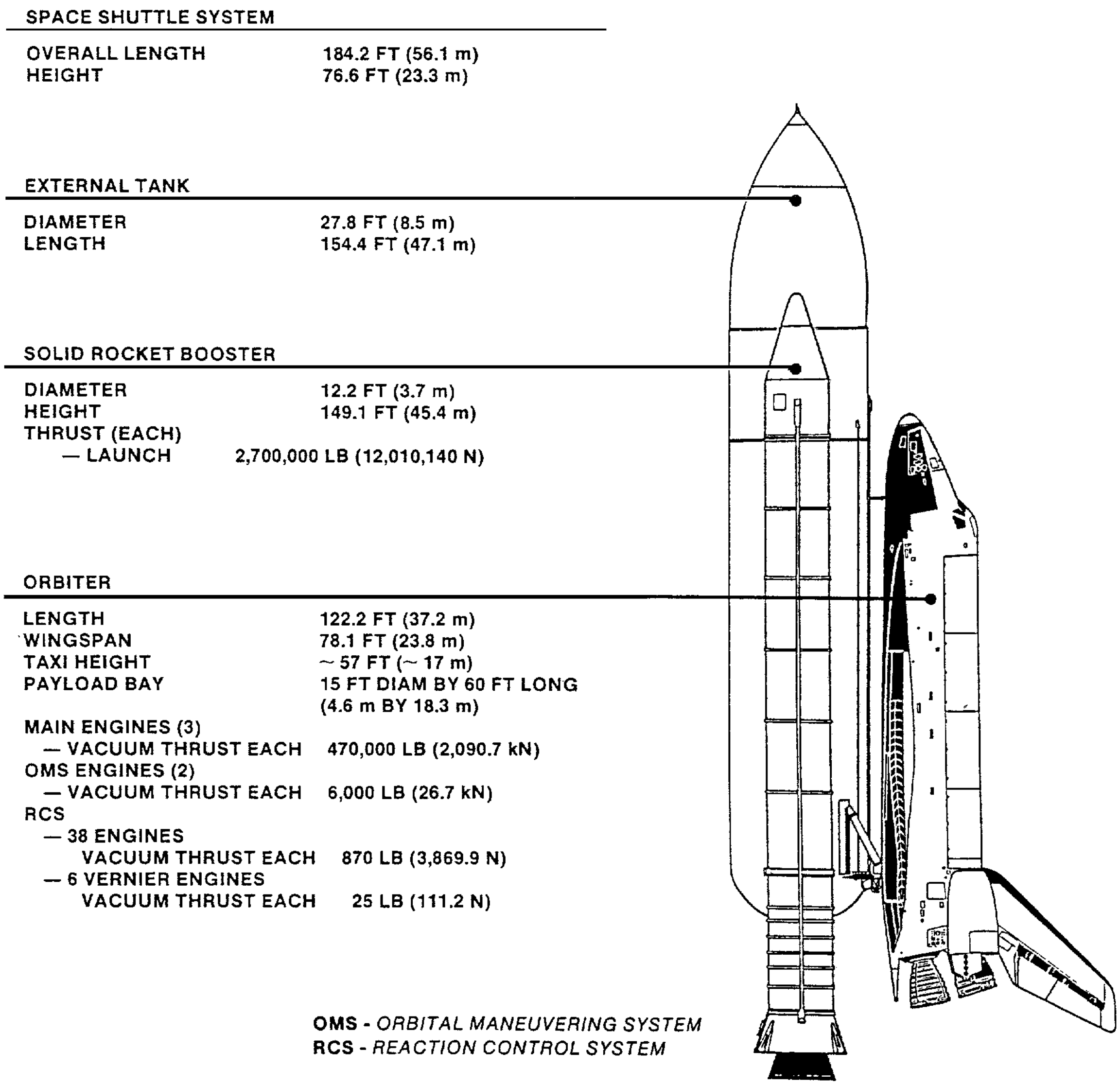


Figure 3-1.- Space Shuttle system.

3.2 Typical Space Shuttle Mission

Space Shuttle launches take place at KSC in Florida. Missions are launched from KSC with orbital inclinations of 28.45, 39, 51.6, or 57 degrees. Other inclinations must be evaluated on a case-by-case basis. The launch site has specialized vehicle processing and payload installation and checkout facilities, trained checkout crews, and launch operations teams.

As depicted in the shuttle mission profile (Figure 3-5), the Space Shuttle is launched with all three SSMEs operating in parallel with the SRBs. SRB separation occurs approximately 2 minutes after launch. After SRB separation, the orbiter and ET continue ascent, using the three main engines with main engine cutoff (MECO) occurring about 8 minutes after liftoff. Then the ET is separated from the orbiter. After a short coasting period, the orbiter OMS engines are fired for additional velocity necessary to achieve proper orbit.

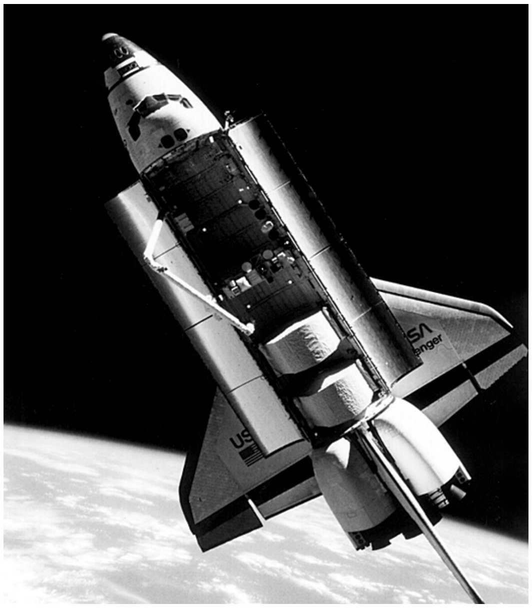


Figure 3-2.- Payload bay.

Figure 3-3.- Aft flight deck.

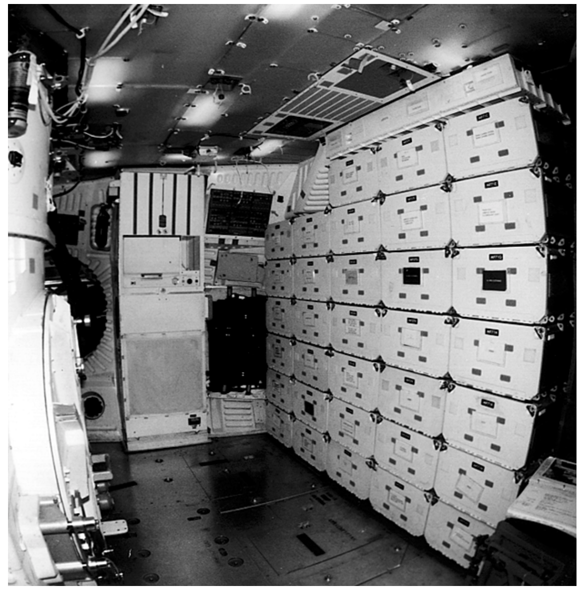


Figure 3-4.- Middeck.

Payload bay doors are opened soon after orbit stabilization to allow the orbiter space radiators to dissipate heat. Payload operations are then conducted by the crew from the payload station on the AFD. Upon completion of on-orbit operations, the payload bay doors are closed and the orbiter is configured for return to Earth.

Duration is dependent upon Space Shuttle capability and payload requirements. However, under specific conditions, missions can be extended beyond seven days. If requirements justify the need, an extended duration orbiter (EDO) kit has been developed to support missions up to 16 days.

The orbiter returns to Earth by firing the OMS engines to reduce velocity. After reentering Earth atmosphere, the orbiter glides to a landing at KSC.

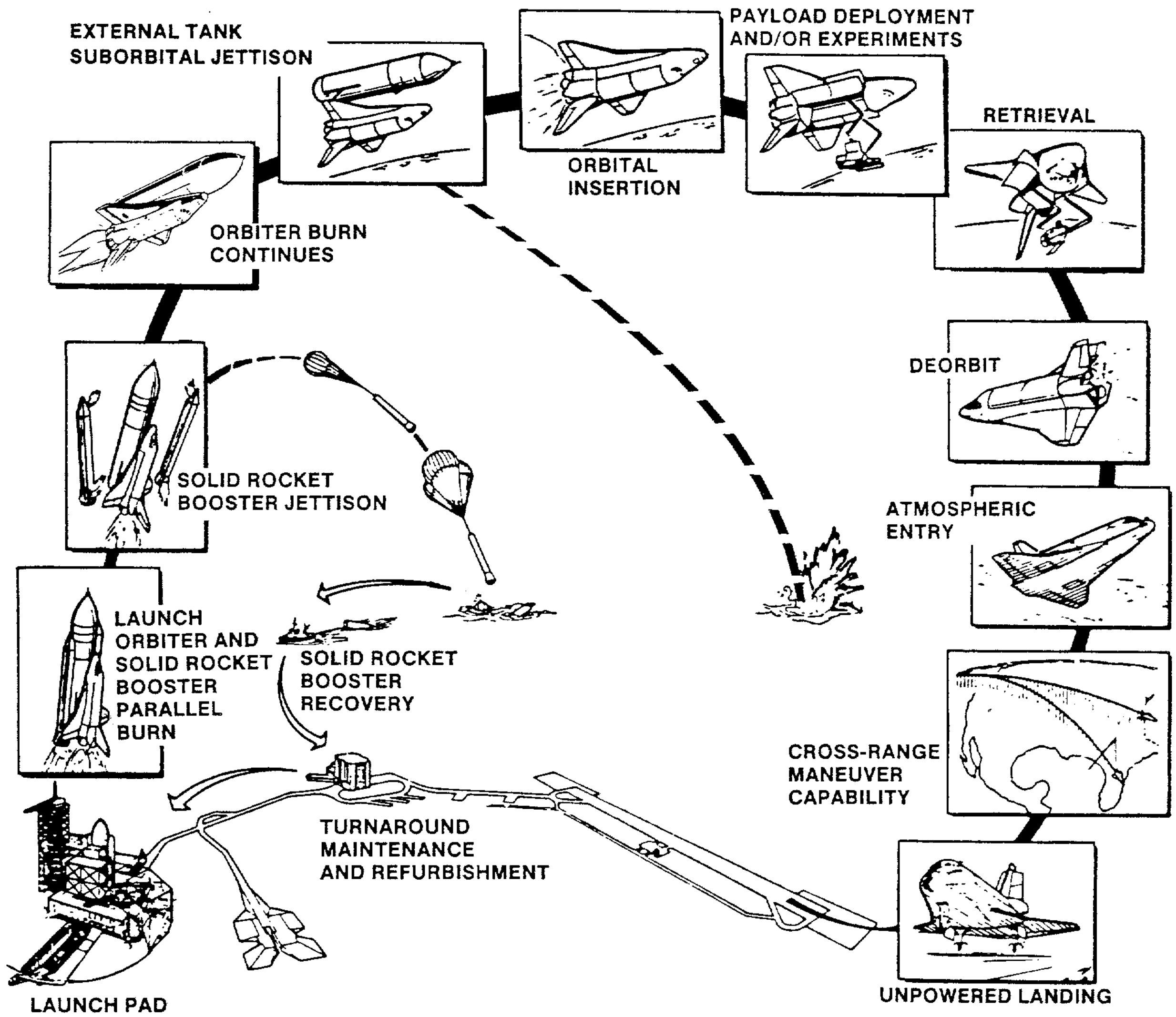


Figure 3-5.- Mission phases (typical).

3.3 Space Shuttle Cargo Capability

Allowable cargo weight is influenced by various operational requirements that depend upon the type of mission. Allowable cargo weight is constrained by either ascent performance or landing weight limits, and is affected by such factors as orbital altitude and inclination, mission duration, crew size, and rendezvous requirements. If payload requirements exceed the capabilities described below, the customer should inform the PIM assigned to that particular payload (see section 6).

3.3.1 Payload Control Weight Definition

The weight of the payload itself, including any carrier or booster, airborne support equipment (ASE), and payload-unique integration hardware, is considered payload control weight. This includes PSs and associated personnel provisions (500 pounds per person). Payload control weight is specified in the IP, and specific agreements for any control weight deviations must be negotiated with the SSP.

Safety, Reliability, and Quality Assurance

4

The payload customer is responsible for safety of the payload and its ground support equipment (GSE). The payload and GSE shall be designed to comply with requirements of Safety Policy and Requirements for Payloads Using the Space Transportation System, NSTS 1700.7B, and Space Transportation System Payload Ground Safety Handbook, 45 SPW HB S-100/KHB 1700.7. To assess compliance with safety requirements, a maximum of four safety reviews for the payload, GSE, and ground operations will be conducted by the SSP in accordance with Payload Safety Review and Data Submittal Requirements, NSTS/ISS 13830. Payload reliability and quality are the responsibility of the customer.

The payload customer is responsible for the following safety requirements:

a. Determination of hazardous aspects of the payload and GSE during flight and ground operations and implementation of required corrective measures

b. Assurance of payload compatibility with Space Shuttle interfaces

c. Identification of residual hazards and interface incompatibilities prior to payload summary reviews and inspection

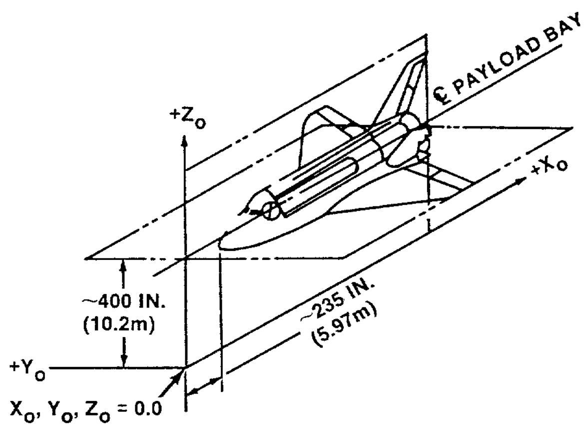
Preflight summary reviews and inspections of payloads may be conducted with participation by the payload customer to verify that NASA safety requirements have been met.

Payload Accommodations

5

The Space Shuttle offers a wide range of payload accommodations and services. Additional services and accommodations are available on a limited basis through negotiation with the SSP. Detailed specifications and interface characteristics of services are defined in Shuttle Orbiter/Cargo Standard Interfaces, ICD 2-19001.

For purposes of orientation, the orbiter/payload interface data contained in this document, its appendixes, and its attachment are based on an orbiter-centered coordinate system as illustrated in Figure 5-1. Figure 5-2 identifies interfaces located on the external surfaces of the orbiter.



TYPE: ROTATING, ORBITER REFERENCED

ORIGIN: APPROXIMATELY 235 INCHES (5.97m) AHEAD OF THE NOSE AND APPROXIMATELY 400 INCHES (10.2m) BELOW THE CENTERLINE OF THE PAYLOAD BAY

ORIENTATION AND LABELING:

THE X AXIS IS PARALLEL TO THE CENTERLINE OF THE PAYLOAD BAY, NEGATIVE IN THE DIRECTION OF LAUNCH

THE Z AXIS IS POSITIVE UPWARD IN LANDING ATTITUDE

THE Y COMPLETES THE RIGHT-HANDED SYSTEM

THE STANDARD SUBSCRIPT IS 0

Figure 5-1.- Orbiter coordinate system.

5.1 Physical Accommodations

The orbiter has structural support attachment points for payload trunnions along the length of the payload bay as indicated in Figure 5-3. Payloads can be supported by attach fittings at numerous points along both sides of the payload bay and along the bottom at the orbiter keel centerline. Active fittings are used for deployable payloads. These attachment provisions support various payload designs by providing load reaction and strain isolation between the orbiter and payload. The most common arrangements are three-point and five-point designs (see Figure 5-4). For additional information, refer to Appendix 4.

5.2 Avionics Accommodations

Avionics services including power, command, and data are furnished to payloads using a standard mixed cargo harness (SMCH). The SMCH cables are routed by payload wire trays on the port and starboard sides of the payload bay. The SMCH provides power interfaces on the starboard side of the payload, signal and control interfaces on the port side, and orbiter computer data bus interfaces on both port and starboard sides of the payload. The SMCH harness can egress the cable tray at essentially any location along the bay. The SMCH normally egresses the cable tray at the payload location in the bay and is routed to a standard interface panel adjacent to the payload (Figure 5-6), minimizing the length of the customer-provided cable to the standard interface panel from the payload. Figure 5-5 is a diagram of avionics accommodations for one of four primary payloads.

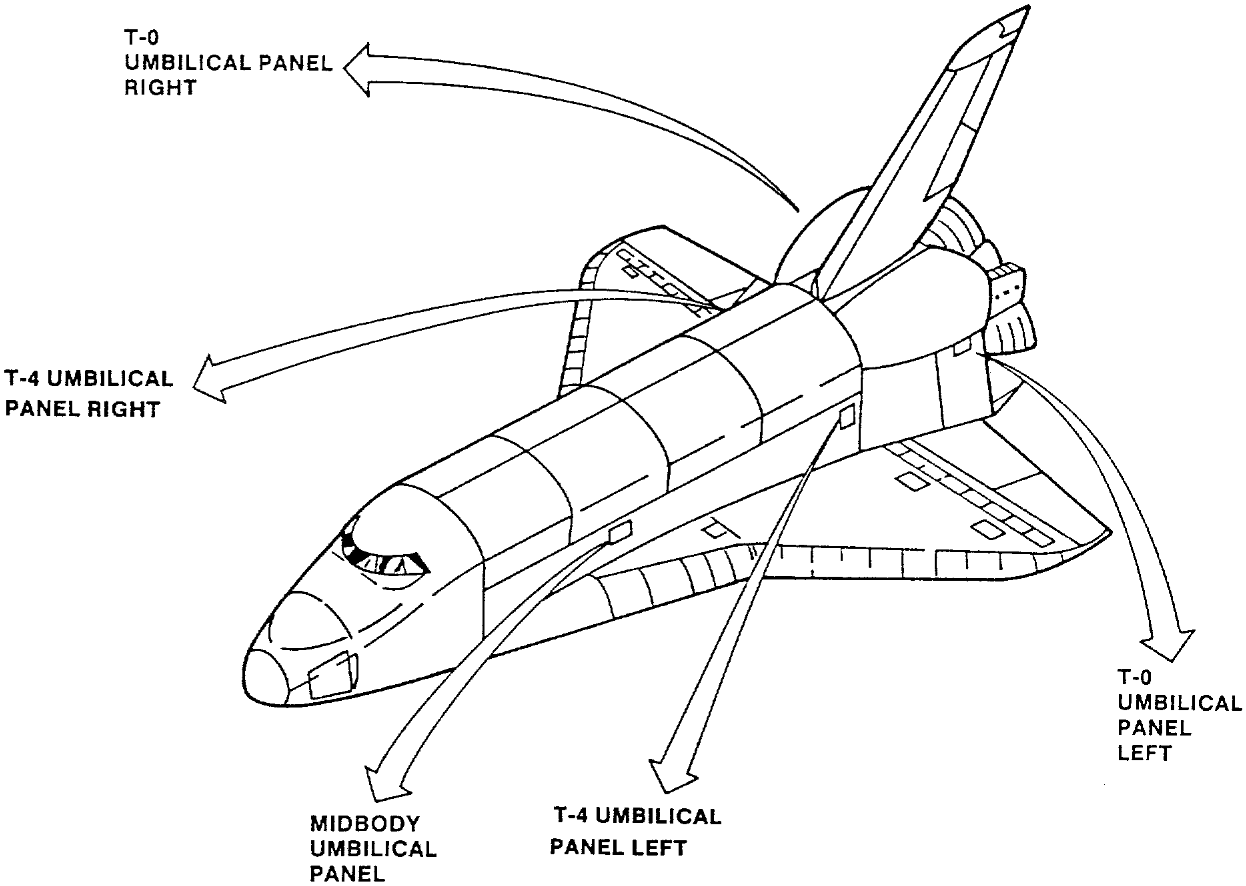


Figure 5-2.- Payload umbilical service panels.

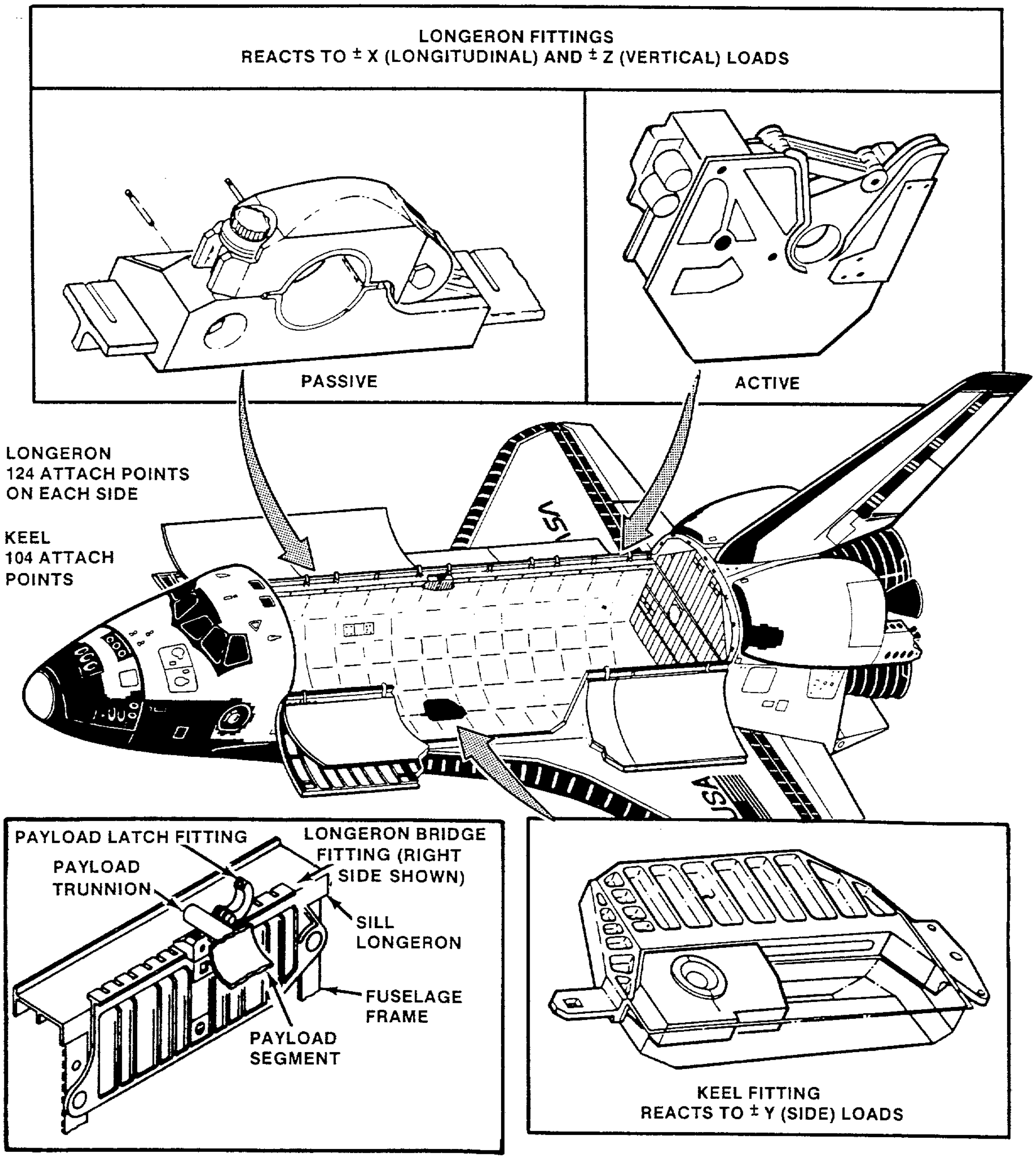


Figure 5-3.- Attach fittings for payload.

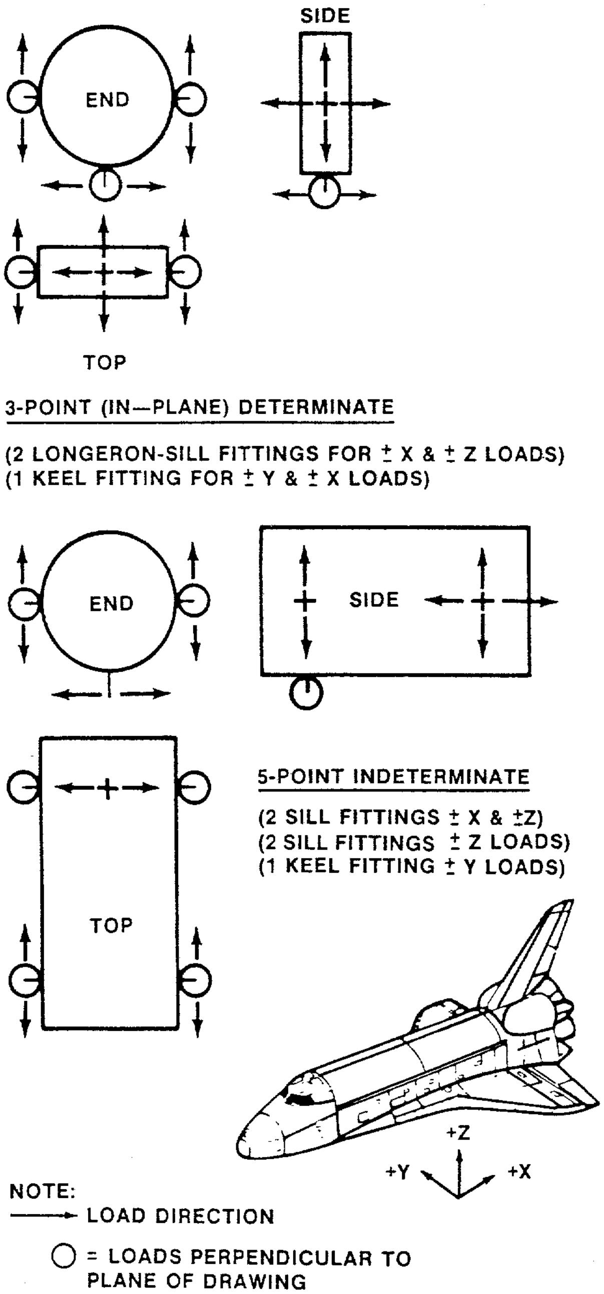


Figure 5-4.- Three- and five-point loads support.

5.3 Electrical Power

Orbiter electrical power is distributed to payloads at the standard interface panel. Nominal voltage of 28 Vdc is provided during ground operations, ascent, orbital operations, and descent. For prelaunch operations, 650 watts (W) is nominally available with up to 1750 W available for payload verification operations in the orbiter. For ascent or descent, power of up to 650 W is available. Up to 1750 W maximum continuous power is available for orbital operations. Higher power levels are available on orbit for short periods of time to accommodate unique payload requirements.

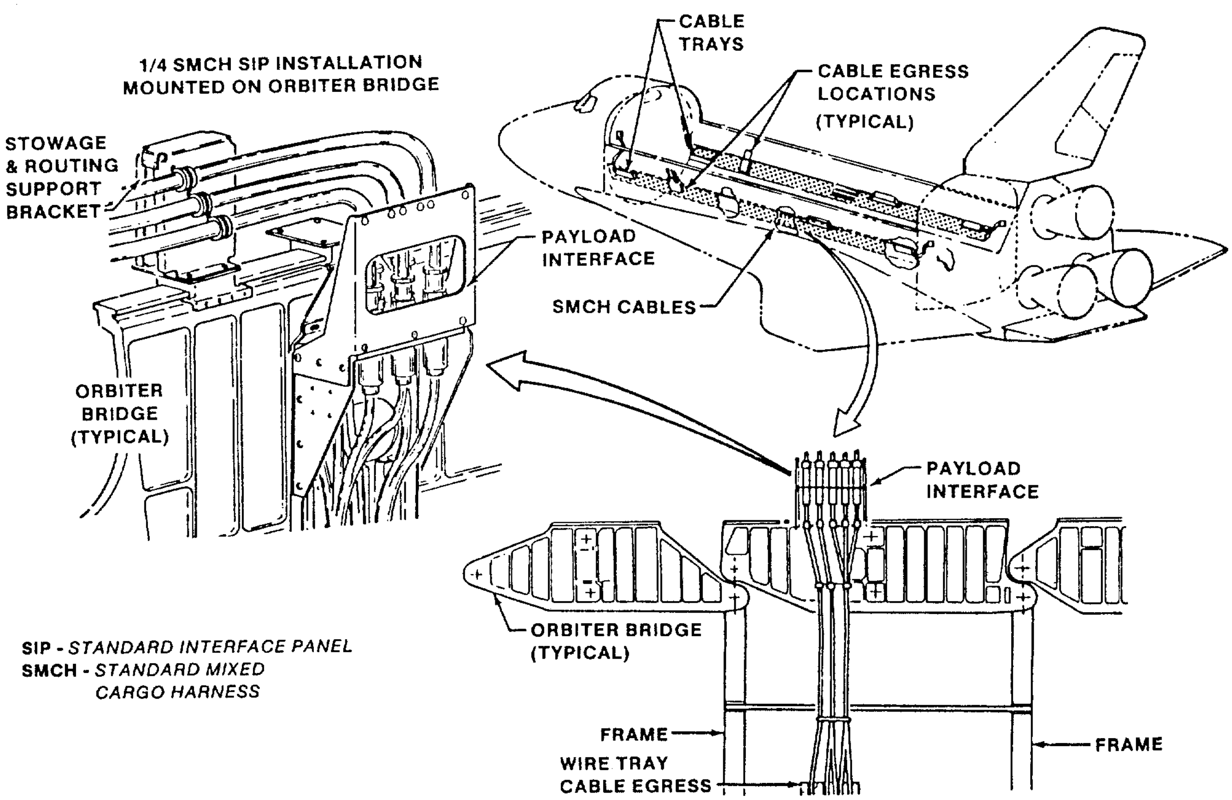


Figure 5-5.- Standard interface panel configuration.

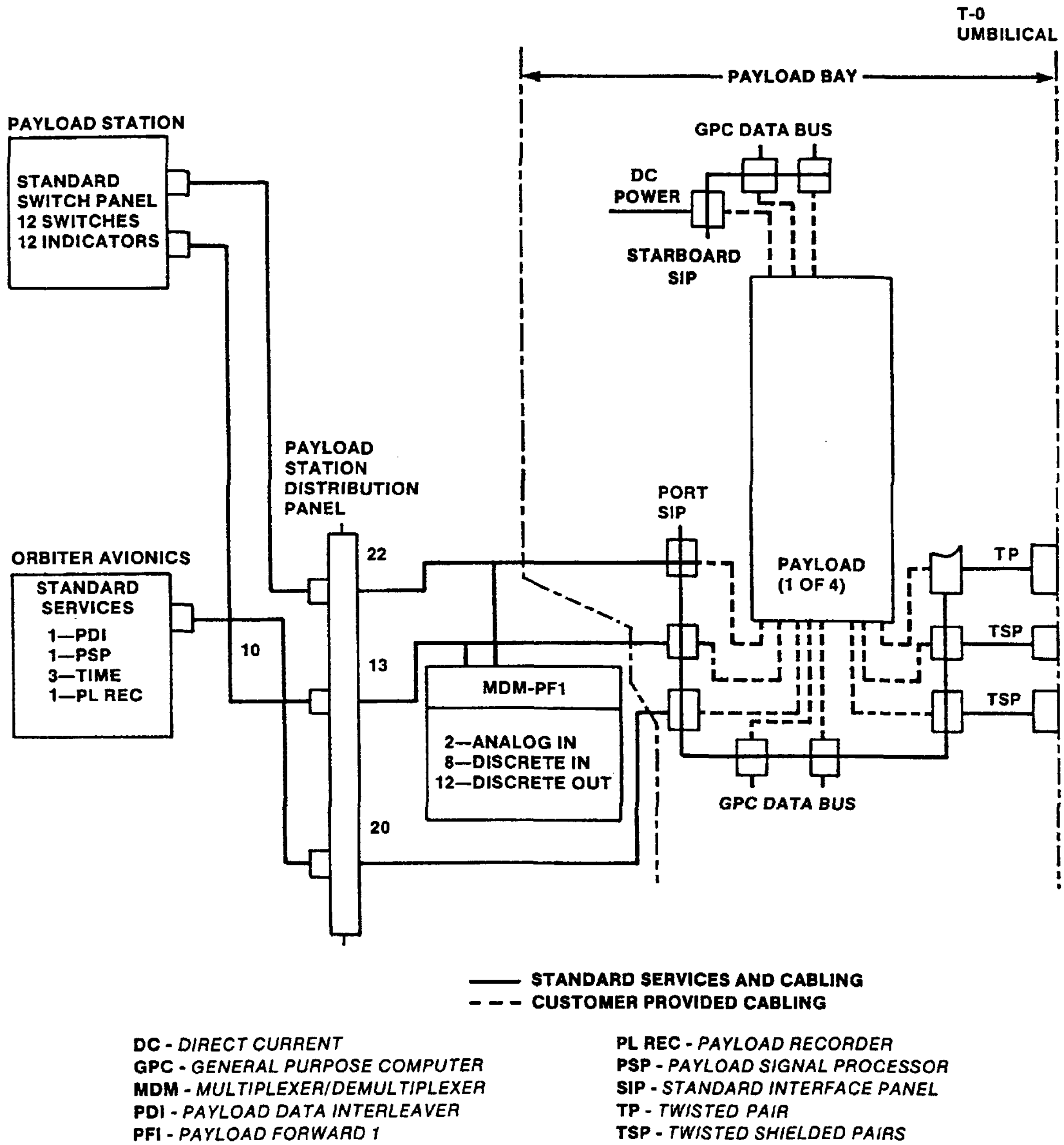


Figure 5-6.- Avionics provisions - standard accommodation.

5.4 Command Services

Command services for payloads can be provided from the orbiter, Mission Control Center-Houston (MCC-H), and payload operations control centers (POCCs). Ground-initiated commands to attached or detached payloads are transmitted through the orbiter communication system. The crew can initiate commands through the standard switch panel or enter command instructions through the keyboard into the orbiter avionics system, generating commands in the form of discretes or serial digital signals. Standard accommodations include the following command capabilities:

a. Hardwired commands from the standard switch panel: Switch closure and/or 28 Vdc commands are provided at the standard switch panel located at the payload station on the AFD. The standard switch panel (Figure 5-7) provides 12 switches which can be operated on orbit by the crew. Overlay panels identify specific payload functions.

b. Hardwired multiplexer/demultiplexer (MDM) commands from the orbiter: Discrete commands are provided at the payload wiring interface by an orbiter MDM. They are issued by the orbiter general purpose computer (GPC) in response to keyboard entries from the crew or commands from the Mission Control Center (MCC). Output signals provided are four discrete high-level signals (0 to 28 Vdc) and eight discrete low-level signals (0 to 5 Vdc).

c. Commands via the payload signal processor (PSP): Serial digital commands to attached payloads may be provided through the PSP and can be generated onboard the orbiter or from the MCC. The MCC can store and generate payload commands as an optional service or forward commands generated at the customer POCC. Nine discrete data rates up to 2000 bits/second and three nonreturn-to-zero (NRZ) data codes are available.

d. Commands via the payload data bus: The standard accommodation provides connections to the payload data bus. Command data can be provided by the orbiter through a unique customer provided data bus compatible interface (i.e., an MDM) connected to the orbiter data bus. This enables both onboard commanding and monitoring by the crew or operation from the MCC. Discrete outputs, pulsed discrete outputs, and analog outputs can be processed.

e. Commands via the payload interrogator (PI): The PI provides an S-band radio frequency (RF) link to command and monitor detached payloads which are compatible with the Deep Space Network (DSN) or Space Network (SN). The command signal is on a 16 kHz subcarrier which is phase shift key (PSK) modulated by the baseband command signal. Nine discrete data rates up to 2000 bits/second and three NRZ data codes are available.

f. Software for onboard-initiated single commands: The onboard command processing capability provided as a part of the standard accommodation includes provisions for initiating 40 single commands. These commands can be issued to a customer provided bus terminal unit, orbiter MDM, PSP, or PI.

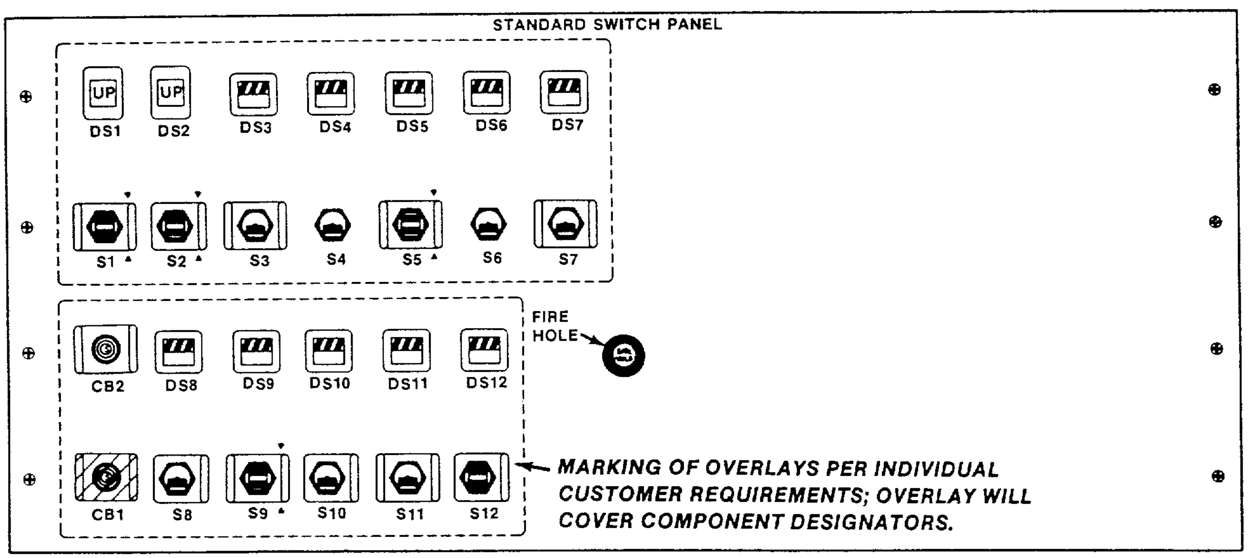


Figure 5-7.- Standard switch panel.

5.5 Data Processing and Display Services

Payload data processing and monitoring is available onboard the orbiter, at the MCC, and at customer POCCs. Payload telemetry is forwarded by orbiter communications systems to the MCC and customer POCCs. The Tracking and Data Relay Satellite System (TDRSS) is available for a large percentage of each orbit. Each payload has access to the following data processing and display capabilities:

a. Hardwired displays from the standard switch panel: The standard switch panel provides 12 status indicators (talkbacks) to enable the crew to monitor payload status and operation. These indicators are normally used during active crew control of payload operations and are not monitored during crew sleep periods.

b. Hardwired data and displays from the orbiter MDM: The MDM is capable of receiving eight discrete low level signals (0 to 5 Vdc) and two analog differential signals (0 to 5 Vdc) for onboard data processing or transmission to ground stations. Analog and discrete payload signals received by the orbiter MDM can be monitored onboard, at the MCC, and at the customer POCC. Signals "limit sensed" by the orbiter GPC will visually or audibly notify the crew when predetermined limits or conditions are exceeded.

c. Data and displays via the payload data interleaver (PDI): Compatible payload telemetry data can be input to the PDI and forwarded to the customer POCC through the MCC. During ascent, telemetry may be sent to the ground at a nominal rate of 1 kilobit/ second per payload. Payload telemetry sent to the ground will nominally be limited to 8 kilobits/second per payload except when a payload is being deployed. During checkout and deployment, a payload will normally be limited to a rate of 32 kilobits/second for up to 20 minutes. During these periods, other payloads may transmit telemetry to the ground at a nominal rate of 1 kilobit/second each. Onboard processing capability (8 bit words) provides display and limit sensing for crew monitoring and payload operation. NRZ-level (NRZ-L) is the preferred coding; alternatively, biphase-L can be employed.

d. Data and displays via the data bus: Customer provided data bus units compatible with the orbiter system can be connected to the payload data bus to provide data acquisition and processing for display to the crew. Discrete and/or analog data can also be transmitted to the MCC and forwarded to a customer POCC.

e. Data and displays via the PI: Data from detached payloads are received by the PI, operating in DSN or SN modes. The orbiter can process detected data for display to the crew or transmission to the MCC and forwarding to a POCC. The PI receives the RF carrier and detects a pulse code modulated/ PSK 1.024-MHz subcarrier. Payload data can be received at one of five discrete rates up to 16 kilobits/second. NRZ and biphase data codes are available.

f. Software for onboard data processing: Onboard data processing for up to 40 discrete or analog parameters is provided as a standard service. Data may be acquired via the PI, PDI, MDM, or a payload data bus unit. Data are displayed to the crew and may, in limited quantities, be transmitted to the MCC and forwarded to a POCC.

5.6 Recording

Orbiter provides the Modular Memory Unit (MMU), a solid state recorder, for payload recording. Payload recorder accommodations include four digital recording inputs. Recording time is available during ascent, payload deployment, and descent.

5.7 Timing

Standard accommodations include one mission elapsed time (MET) signal and two Greenwich mean time (G.m.t.) signals in interrange instrumentation group B (IRIG-B) modified code format. See Appendix 3 for detailed electrical power and avionics information.

5.8 Thermal Accommodations

The Space Shuttle can provide thermal environments that meet requirements for most payloads. Prelaunch and postlanding payload bay purge provides limited thermal conditioning. On orbit with the payload bay doors open, a wide range of thermal environments is possible and is limited by the attitude hold capability of the orbiter and payloads in the payload bay. Actual thermal environments depend upon numerous factors including orbiter attitude sequence, orbiter-to-payload thermal interactions, and payload-to-payload thermal interactions.

For mixed cargo payloads, payload design must be compatible with standard payload bay purge and attitude requirements as defined in ICD 2-19001, which includes a nominal ground payload bay purge temperature of 65+/- 5 degrees F, continuous payload bay-to-earth attitude, 30 minutes top sun, 90 minutes bay-to-space, and 6 hours tail-to-earth (rendezvous attitude). See Appendix 2 for additional Space Shuttle thermal information.

5.9 Ground Support Equipment Umbilical

The GSE umbilical, also known as the T-0 umbilical, furnishes prelaunch payload monitoring, commanding, and low-level power requirements, and separates from the orbiter at liftoff.

5.10 Pointing

Pointing accuracy of the orbiter is dependent upon inertial measurement unit (IMU) alignment, structural alignment uncertainty, structural bending due to thermal distortions, selected DAP attitude deadbands, etc., and thus changes throughout a mission. However, for finite periods of time, the orbiter/ payload structural interface can be maintained at an inertial attitude within plus or minus one degree for duration up to 1 hour.

5.11 Payload Deployment

Orbital parameters for payload deployment may be specified by the customer as long as they comply with Space Shuttle constraints. The orbiter/ payload structural interface can be pointed to within one degree of the desired direction for deployment. If the payload has a compatible grapple fixture, deployment can be accomplished by payload ASE, the remote manipulator system (RMS) (see 5.6), or the stabilized payload deployment system (SPDS). If the RMS is used for deployment, the RMS payload/structural interface can be pointed within five degrees of the desired deployment attitude.

5.12 Payload Bay Sidewall Mounted Payload Accommodations

Payload accommodations are available to support payload bay payloads which do not require the full range of standard accommodations and are sidewall mounted. Detailed specifications of services and interface characteristics are defined in Shuttle/ Payload Interface Definition Document for Small Payload Accommodations, NSTS 21000-IDD-SML.

5.12.1 Physical Accommodations

The payload is mounted on a sidewall payload carrier (Figure 5-8), which is available on the port or starboard side of the payload bay. Several sidewall payload carriers are available and are selected based on the weight of the attached payload. The carriers span either the full bay, similar to the typical orbiter bridge shown in Figure 5-3, or a partial span for light payloads. For more detailed information, see Appendix 4.

5.12.2 Electrical Power

A maximum of 1400 W of nominal 28 Vdc electrical power is available at the payload interface (either the payload connector bracket, Figure 5-8, or the standard interface panel, Figure 5-5) for prelaunch checkout and orbital operations. These sidewall-mounted payloads may be constrained to 300 W during other payloads high power demand periods.

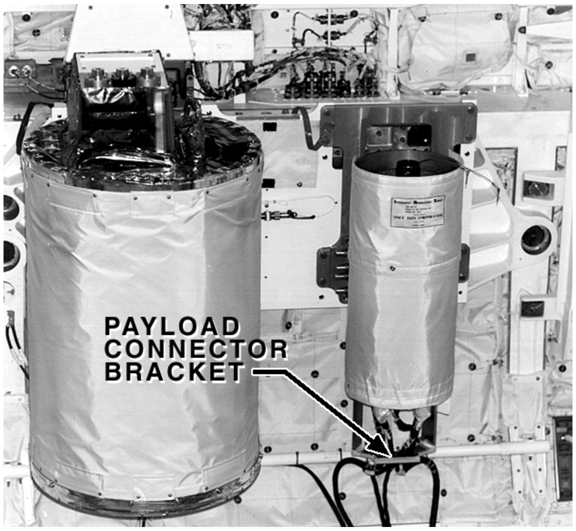


Figure 5-8.- Sidewall-mounted payloads.

5.12.3 Command Services

Sidewall-mounted payloads can be commanded by limited discrete commands originating onboard, or serial digital commands from the MCC originating at a customer POCC.

Services available on a time shared basis with the orbiter and other payload operations are:

a. Commands from the onboard small payload accommodations switch panel (SPASP): six switch closures are provided to the sidewall-mounted payload from the AFD. The SPASP is used for payload activation, deactivation, and mode control.

b. Commands from the PSP: Serial digital commands are provided by the PSP at 2 kilobits/second. Commands are generated at the customer POCC and relayed to the orbiter through the MCC. This capability will be time shared with other payloads. The NRZ-L data code is used.

5.12.4 Data Processing and Display Services

Payload data processing and monitoring is provided onboard the orbiter and at the customer POCC. Space Shuttle capability to provide telemetry data to the customer POCC is time shared with other payloads.

Each payload is provided with the following data processing capabilities:

a. Display of command responses from the SPASP: The SPASP provides six status indicators (talkbacks) to enable the crew to monitor payload status and operation.

b. Data from the PDI: During orbital operations, small payload telemetry can be transmitted to the ground by the PDI. PDI data lines are available at the MCC to transmit data to the customer POCC. Bi-phase-L code is used.

c. Data from the Ku-band signal processor: The 2-megabit/second Ku-band signal processor channel is available to small payloads on a time-shared basis. Payload Ku-band data will be available from GSFC. The data code is NRZ-L. Routing and availability of data will be defined in the IP.

5.12.5 Timing

Sidewall-mounted payload accommodations include one mission elapsed time (MET) signal in IRIG-B modified code format.

5.12.6 Thermal Accommodations

For a sidewall-mounted payload, accommodations are limited to anticipated payload bay thermal environments described in NSTS 21000-IDD-SML. Sidewall-mounted payloads should have thermal attitude capability equivalent to the orbiter as described in NSTS 21000-IDD-SML. Ensuring that payload thermal attitude capability is equivalent to that of the orbiter is the customer's responsibility. Sidewall-mounted payloads are required to be compatible with the planned mission and are not to impose any thermal attitude constraints.

5.13 Middeck Payload Accommodations

The Space Shuttle has payload provisions in the middeck area of the crew compartment. The middeck is suitable for payloads which require a pressurized environment or direct crew operation, and affords the opportunity for limited late stowage and early removal of payloads. See Shuttle/ Payload Interface Definition Document for Middeck Accommodations, NSTS 21000-IDD-MDK.

5.13.1 Physical Accommodations

As shown in Figure 5-9, middeck payloads are stored in lockers which carry up to 54 pounds of cargo and provide 2 cubic feet of volume. Trays with dividers can be installed to separate each locker into as many as 16 compartments. Payload hardware that replaces one or more lockers (but uses standard locker mounting locations) is also accommodated.

5.13.2 Electrical Power

Up to 5 amperes (A) of nominal 28 Vdc power are available on orbit. Total power supplied to any payload is limited to 115 W maximum continuous for up to 8 hours, or 200 W peak for 10 seconds or less. Standard cables are available for routing power from utility outlets to stowage locations.

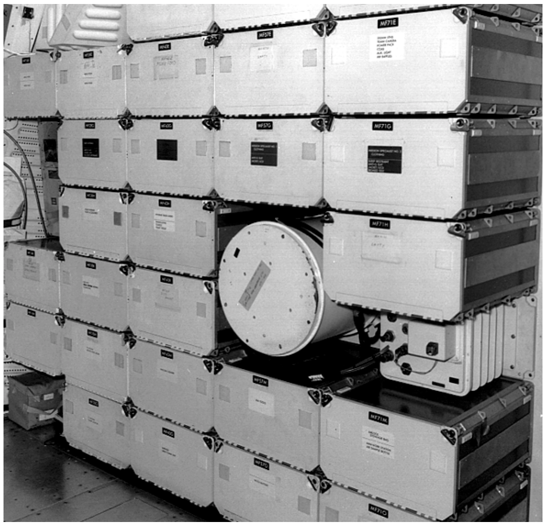


Figure 5-9.- Middeck lockers.

5.12.3 Command and Monitoring

Normally, command and monitoring of middeck payloads are limited to those controls, displays, and data collection features designed into the payloads. As an optional service, the SSP can provide a payload and general support computer (PGSC) to support inflight payload operations. The PGSC is a laptop computer that can communicate with payloads via recognized standards. For more information, see Shuttle/Payload Interface Definition Document for the Payload and General Support Computer (PGSC), NSTS 21000-IDD-760XD.

5.13.4 Cooling

Payloads relying on dissipation of waste heat by free convection heat transfer only (i.e., without the use of a fan or similar means) are constrained by a heat load of 60 W for a standard stowage locker and 15 W for payload equipment on an AFD panel. Payloads that are required to operate during extravehicular activity (EVA) or EVA pre-breathe periods shall design cooling based on a 10.2 psia cabin pressure.

When a payload provides an air circulation fan which discharges into the cabin, the maximum air outlet temperature shall not exceed 120°F. External surface temperatures of payload elements shall not exceed 120°F.

5.14 Get-Away Special Payload Accommodations

The GAS program is managed by GSFC and offers low cost access to a wide user community. It is an inexpensive method of gaining hands-on experience in space research or testing ideas that might later evolve into major space experiments.

Standard GAS containers are provided in two volumes: 5 cubic feet and 2.5 cubic feet. Payloads of up to 100 pounds can be housed in the 2.5 cubic foot containers, and payloads up to 200 pounds can be housed in the 5 cubic foot containers. Since standard mechanical and electrical interfaces are limited, all required battery, data recording, and sequencing systems are provided by the customer. For technical information, contact the Shuttle Small Payload Projects Office (mail code 740) at GSFC.

5.15 Remote Manipulator System

The RMS is a mechanical arm component of the payload deployment and retrieval system (PDRS) used for payload deployment, retrieval, special handling operations, and other orbiter servicing. It is 50 feet 3 inches in length and is mounted along the port longeron of the payload bay, outside a 15-foot diameter envelope reserved for cargo. For details on PDRS capabilities and constraints, see Appendix 8.

Payload Integration Process

6

The integration of payloads with the Space Shuttle generally follows the flow depicted in Figure 6-1, and relates to the documents contained in Figure 1-1.

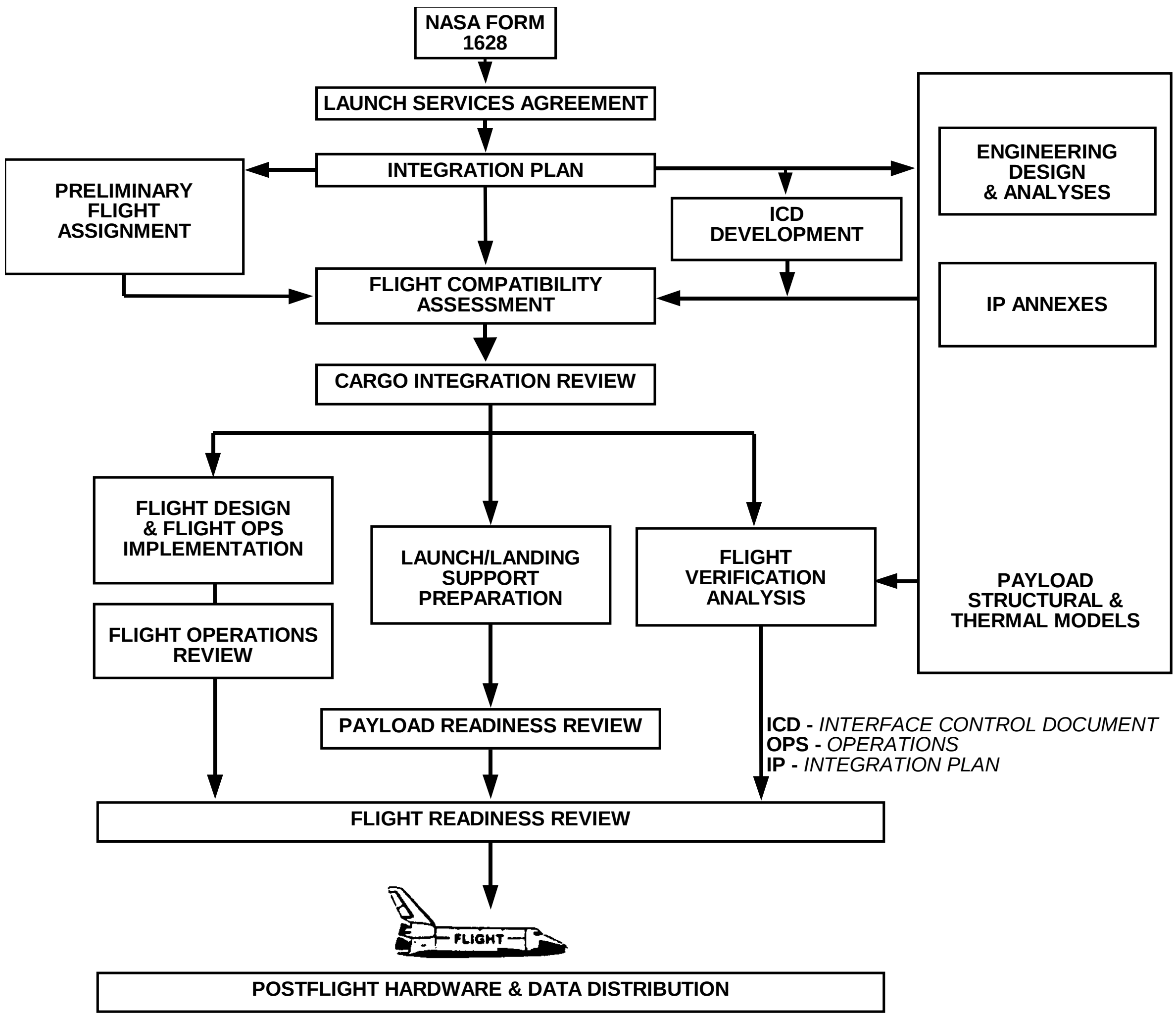


Figure 6-1.- Payload integration process.

6.1 Overview

The first step in the integration process is for the customer or designated representative to submit a NASA Form 1628 (Figure 6-2) to NASA Headquarters. Figure 6-1 depicts the integration process from receipt of a Form 1628 to postflight distribution of payload related hardware and data.

The integration process consists of two phases prior to launch. The first is the development of formal agreements between the customer and NASA, and the second is the detailed implementation of these agreements and plans.

The schedule during the first phase is determined by payload development, but must be completed in time to support the Cargo Integration Review (CIR). Schedules are established by the SSP during the second phase to meet the launch date.

Concurrent with these two phases of the payload integration process, safety reviews are normally conducted at four levels of payload development. The JSC and KSC safety panels conduct safety reviews (phase 0 through phase III) to assess safety aspects of payload design, flight operations, GSE design, and ground operations. The depth and number of safety reviews are determined by the SSP safety review panel chairman, in conjunction with the customer, and depend on the complexity, technical maturity, and hazard potential of the payload.

6.2 Formal Agreements Development

Development of formal agreements between the customer and NASA is conducted by representatives of NASA Headquarters, JSC, and KSC.

A NASA Form 1628 is submitted to NASA Headquarters to be scheduled for a flight on the Space Shuttle and to begin appropriate agreement negotiations.

NASA Headquarters transmits the NASA Form 1628 to JSC, where a detailed assessment of the requirements is conducted. Once requirements are determined to be within the capabilities and constraints of the Space Shuttle, a PIM is assigned to the customer and remains the customer's primary point of contact throughout the entire process. The PIM is responsible for ensuring that customer requirements have been accurately defined and documented, are compatible with orbiter payload accommodations, and are properly implemented. The PIM also coordinates any engineering or other technical support required at JSC. Additionally, an LSSM is assigned as the customer's point of contact at the launch and landing sites. The LSSM is responsible for Launch Site Support Plan, IP Annex 8, and for payload processing support at the launch and landing sites.

The PIM initiates a meeting with the customer to review the integration process and familiarize the customer with JSC and KSC operations. The customer provides a detailed description of the planned payload, and formal development of payload requirements begins.

6.3 Documentation

The principal documents developed and employed during the payload integration process is the individual IP with appropriate IP annexes, and data submittals; and individual payload ICD.

When agreed to and signed by both the customer and NASA, the IP with its appropriate annexes and data submittals; and the ICD become the technical contract. The IP also becomes part of the formal legal contract by direct reference in the NASA Headquarters agreement.

National Aeronautics and Space Administration

Request for Space Shuttle Flight Assignment

Send completed form to: **National Aeronautics and Space Administration**
Office of Space Flight, Mail Code M
Washington, DC 20546-0001

PAYLOAD ORGANIZATION *(Name and complete address.)*	PRINCIPAL CONTACT *(Name, phone and FAX. Include area code and country code, if other than U.S.)*
	TECHNICAL CONTACT *(Name, phone and FAX. Include area code and country code, if other than U.S.)*

CUSTOMER CATEGORY

NATIONAL: ☐ NASA *(Two letter code)* ____ ☐ Other Civil Agency ☐ DOD ☐ Commercial

INTERNATIONAL: ☐ ASI ☐ CSA ☐ DARA ☐ ESA ☐ NASDA ☐ RSA
☐ Commercial ☐ Other ____________________

TYPE OF ARRANGEMENT

NASA: ☐ Internal ☐ International Cooperative ☐ Joint Endeavor ☐ CCDS

REIMBURSABLE: ☐ LSA ☐ SSDA ☐ Interagency Agreement

PAYLOAD NAME AND ACRONYM

DESCRIPTION OF PAYLOAD, OBJECTIVES, AND MISSION OPERATIONS *(Attach sketch or drawing, if available.)*

AUTHORIZATION

CONFORMANCE WITH SPACE SHUTTLE USE POLICY *(Primary payloads only. Check all that apply.)*

☐ REQUIRES HUMAN PRESENCE ☐ REQUIRES SPECIAL CHARACTERISTICS OF THE SHUTTLE

☐ OTHER COMPELLING CIRCUMSTANCES EXIST *(Specify on page 2 under "Additional Remarks")*

The funding for this payload has been duly authorized and its development schedule is consistent with the requested launch dates. I also understand that the earnest money for reimbursable launches is non-refundable.

TYPED NAME AND TITLE	AUTHORIZED SIGNATURE	DATE

NASA FORM 1628 OCT 93 PREVIOUS EDITIONS ARE OBSOLETE. PAGE 1 OF 2

Figure 6-2.- Request for Flight Assignment (NASA Form 1628).

PAYLOAD CHARACTERISTICS - CARGO BAY

DIMENSIONS

Length ____________ Diameter ____________ Weight ____________

DEDICATED MISSION

☐ YES ☐ NO

CARRIER

☐ Spacelab Module ☐ MPESS ☐ SSCP Hardware

☐ Spacelab Pallet ☐ Hitchhiker (sidewall) ☐ Upper Stage *(Specify)* ____________

☐ Pallet w/o Igloo ☐ Hitchhiker (cross-bay) ☐ Other *(Specify)* ____________

MISSION ATTRIBUTES

☐ Attached ☐ Deployment ☐ Retrieval

☐ Servicing ☐ Remote Manipulator Use ☐ Extravehicular Activity ____________

PAYLOAD CHARACTERISTICS - MIDDECK

Number of lockers or locker spaces ____________ Middeck Accommodations Rack ☐ Yes ☐ No

FLIGHT CHARACTERISTICS

NUMBER OF FLIGHTS	MINIMUM INTERVAL BETWEEN LAUNCHES *(Months)*	FLIGHT DATES *(Month/year)*	DESIRED DURATION *(Days)*

ORBIT

☐ 160 nm altitude, 28.5 degree inclination ☐ 160 nm altitude, 57 degree inclination ☐ Orbit Insensitive

☐ Other: ________ nm altitude, ________ degree inclination

FEATURES/OPERATIONS THAT MAY IMPOSE UNUSUAL SHUTTLE REQUIREMENTS (*Narrow launch windows, special pointing, special lighting, seasonal factors, unusual rendezvous operations, etc.)*

OPTIONAL

PAYLOAD DESIGN STATUS

Preliminary Design Review ☐ Completed ☐ Planned Completion Date ____________

Critical Design Review ☐ Completed ☐ Planned Completion Date ____________

Is Space Shuttle Program involvement in design reviews desired?

☐ Yes ☐ No

ADDITIONAL REMARKS

NASA FORM 1628 OCT 93 PREVIOUS EDITIONS ARE OBSOLETE. PAGE 2 OF 2

Figure 6-2.- Request for Flight Assignment (NASA Form 1628) (concluded).

Following acceptance of the payload, the payload integration process begins with development of a IP. The purpose of the IP is to:

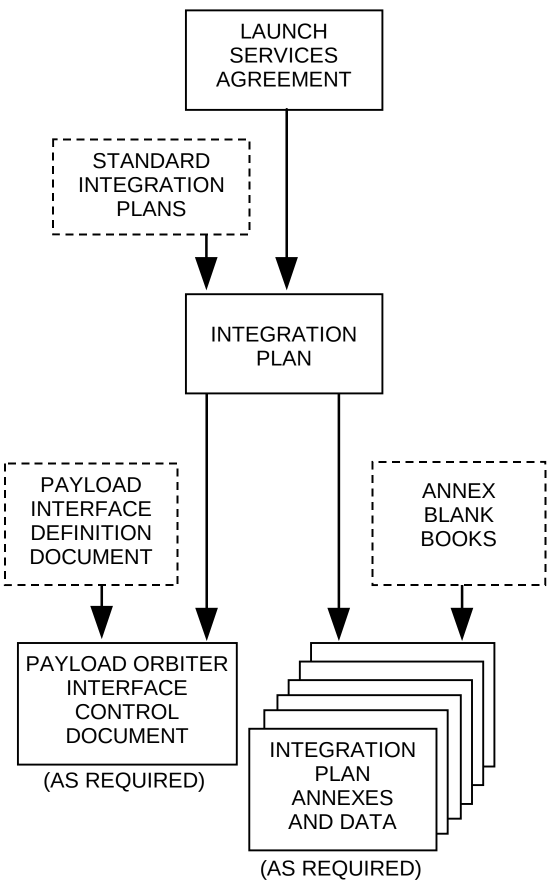
a. Define SSP and customer responsibilities

b. Define the technical baseline for implementation

c. Establish guidelines and constraints for integration and planning

d. Define integration tasks to be accomplished

e. Establish interface verification requirements



f. Establish operational services requirements

g. Establish controlling schedules for all major integration activities

h. Identify SSP flight and ground safety requirements

i. Establish the basis for SSP definition and pricing of optional services

Standard Integration Plans

SIPs are guides or “blank books” for the development of IPs. As outlined in Figure 1-1, an SIP has been developed for each generic type of payload (e.g., deployable, attached, etc.). The SIP contains technical requirements, management interfaces, services, and schedules that apply to that type of payload.

IP Annexes

The IP annexes specify the detailed technical requirements and data required to configure flight and ground systems and implement integration functions as outlined in the IP. Generic annexes have been developed to help the customer understand data requirements for each annex. To be considered binding on the SSP, all requirements outlined in the annexes must be within the scope of the IP. Not all annexes are required for every payload and not all annexes are documents but may be data submittals. The annexes are:

Annex 1: Payload Data Package – Contains the payload configuration (including mechanical electrical power, and command interface drawings), weight and mass properties, avionics, and the physical function data for installation, deployment, and/or retrieval of the payload as related to the Orbiter. Annex 1 describes the payload "as built" configuration and substantiates the agreed-to design of the interface control document (ICD).

Annex 2: Flight Planning - Includes data required to define electrical power and cooling profile, deployment/retrieval/proximity operations requirements, crew activity requirements, attitude and pointing, geographical constraints data, and pointing/ timing data for deployment of upper stages.

Annex 3: Superceded by IP Table 8-1 data submittals.

Annex 4: Command and Data - Identifies individual commands required to operate the payload, measurements of payload status and health, and measurements for accomplishing payload objectives. Provides necessary information for processing and interpreting data.

Annex 5: Payload Operations Control Center (POCC) - Defines customer requirements levied on the SSP for POCC, remote POCC, and communications resources.

Annex 6: Orbiter Crew Compartment was replaced with the Interface Control Agreement (ICA).

Annex 7: Training - Describes customer provided training of Space Shuttle personnel and POCC team training requirements; determines integrated simulation requirements, establishes training sequence flow, and provides payload training schedules.

Annex 8: Launch Site Support Plan - Defines payload processing flow at the launch site, customer launch and landing site nominal and contingency support (e.g., scrub/turnaround, intact abort) requirements, and specifies launch site facilities and resources to meet customer requirements.

Annex 9: Superceded by the Operations and Maintenance Requirements Specifications Document (OMRSD).

Annex 11: Extravehicular Activity (EVA) - Defines specific design configuration for each hardware-to-hardware and hardware-to-crew interface associated with EVA support of a particular payload, including scheduled, unscheduled, and contingency EVA's.

Interface Control Annex (ICA) - The Orbiter Crew Compartment ICA identifies customer-supplied equipment stowed or installed in the crew compartment and defines requirements affecting stowage, installation, handling, or crew use and proposed stowage/installation of payload materials. The document includes display and control and standard switch panel nomenclature requirements.

Operations and Maintenance Requirements Specification (OMRS) - The OMRSD File II, Volume 2 identifies projects level verification agreements, payload-to-Space Shuttle ICD interfaces to be verified, and the verification method and location.

Time-Critical Ground Handling Requirements (TGHR) - The TGHR Table identifies mission-unique requirements for the time-critical ground handling integration of Space Shuttle middeck payloads.

Interface Control Document and Interface Definition Document

The ICD defines detailed design interface specifications for each payload. An IDD has been developed for each type of payload (standard, small, and middeck) to facilitate preparation of the ICD; a dedicated payload will employ ICD 2-19001.

6.4 Payload Classification Criteria

a. Primary: A primary payload justifies a shuttle mission, either alone or in combination with other payloads, and meets the criteria of the shuttle use policy set forth in NMI 8610.12B, *Policy for Obtaining Office of Space Flight Provided/Arranged Space Transportation Service for NASA and NASA-Related Payloads*, as determined by the NASA Flight Assignment Board and approved by the NASA Administrator. A primary payload typically defines the critical path of the integration process, including KSC processing, flight design and mission operations preparation, and postflight processing and data reduction.

b. Secondary payload: In general, a secondary payload does not define the critical path of the integration process, but has requirements that use significant SSP resources. However, a combination of secondary payloads may represent justification for a Shuttle mission in the same sense as a primary payload. A secondary payload, or combination of secondaries which define the critical path of the integration process, including KSC processing, flight design and mission operations preparation, and postflight processing and data reduction will be treated as a primary for manifesting purposes.

c. Middeck: A middeck is a payload which uses the accommodations as defined in NSTS 21000-SIP-MDK and/or NSTS 21000-IDD-MDK. In general, a middeck payload does not define the critical path of the integration process, but has requirements that use significant SSP resources.

TABLE 6-I.- PAYLOAD DOCUMENTATION REQUIRED FOR FLIGHT ASSIGNMENT

Payload category	Latest flight assignment	Prerequisites
Primary and secondary cargo bay	Flight Definition Requirements Directive (FDRD) (L-13.2 months). Secondary payload bay payloads and GAS Carriers can be considered at the Final Bay PRCB (L-11.1) on a flight-specific basis.	Baselined* IP and ICD, Phase I safety review
Middeck and Standard GAS contents	CIR/(L-9.0 months)	Baselined IP and ICD, Phase II safety review

*Baselined means signed by both the customer and the SSP; a baselined IP includes completion of applicable IP annex milestones as negotiated in the IP.
All dates in L- (launch minus) months are “no later than”.

6.5 Flight Assignment Priority

The general priority for determining which payloads or experiments are considered first for manifesting and expenditure of resources is as follows:

1. Primary payloads
2. Secondary payloads (payload bay or middeck)
3. Standard GAS payloads
4. Development Test Objectives (DTOs)
5. Human Exploration and Development Space (HEDS) Technology Demonstrations (HTDs)
6. Detailed supplementary objectives (DSOs)

If a mission offers a unique opportunity such as an unusual altitude, inclination, duration, or crew composition; or there is an overriding program requirement such as testing required to support orbiter problem investigation or time-critical milestones from another agency program, then these priorities may be adjusted accordingly.

Cargo Integration and Manifest Development

7

The integration of a payload begins with the preliminary flight assignment process and continues throughout requirements development. After submittal of preliminary annex data and completion of the ICD, a series of cargo compatibility assessments is performed. The results of these assessments are presented to the customer and SSP management at the CIR.

Flight Assignment

The flight assignment process begins when the NASA Form 1628 is received. The Flight Assignment Working Group (FAWG) assesses customer requirements. Payloads with compatible orbital requirements and configurations are manifested together after the FAWG has considered all applicable ground rules, constraints, and guidelines. A preliminary flight assignment manifest is reviewed by KSC to facilitate development of a viable launch site ground processing flow for establishing the launch date of each flight.

Flight Implementation Process

After formal agreements have been signed and a preliminary flight assignment released, NASA conducts preliminary cargo engineering analyses, ground operations planning, and mission planning to determine if the cargo elements are compatible with each other and with Space Shuttle capabilities. To conduct these analyses, NASA requires certain design details for each payload, which are contained in the IP annexes and data submittals. The cargo engineering analysis and preliminary flight analysis must be completed early enough in the integration process to allow SSP completion of required flight products and hardware details. Results of these analyses are presented at the CIR. Each customer with a payload on the flight is required to participate in this review to ensure that all requirements have been satisfied. With the conclusion of the CIR, final preparation for the mission begins.

Flight Operations Preparation

Upon completion of final flight design and flight operations planning products, and any modifications (including software) required by the MCC, POCC, and crew training facilities, these products are formally reviewed at the Flight Operations Review (FOR). The FOR supports the final phase of crew and flight operations personnel training. The customer participates in periodic payload reviews (by telecon and/or meeting) during preparation for flight.

Launch and Landing Site

Payloads undergo final checkout, interface verification, and launch preparation at the launch site. Standard facilities and services are allocated on the basis of customer requirements (Figure 7-1). See Appendix 5 for more detail.

Payload processing generally begins with a receiving inspection at a KSC payload processing facility (PPF). Additional payload processing may require component or subsystem assembly (e.g., mating to an upper stage or carrier, experiment integration, etc.) After the payload is checked and serviced, it is moved to the payload integration facility for integration with other payloads scheduled for the same flight.

The integrated payloads undergo interface and system verification testing and are installed in the orbiter, either horizontally in the Orbiter Processing Facility (OPF) or vertically at the launch pad. Payload-to-orbiter interfaces are then verified and the payload is configured for launch. After landing, the payload and/or payload ASE are removed from the orbiter and prepared for shipment to a customer facility. For more information, see Appendix 5.

Preflight Verification

The customer is responsible for verifying the compatibility of payload physical and functional interfaces prior to the payload entering the launch site integration process. The SSP is responsible for verifying the compatibility of the integrated cargo. Verification requirements are defined in Payload Verification Requirements, NSTS 14046.

Mission Readiness Reviews

To support certification for flight, the customer will participate in a series of SSP mission readiness reviews to present payload readiness status on a mission basis for launch site processing and flight.

The major SSP certification review for flight is the Flight Readiness Review (FRR). The Space Shuttle Program Office and KSC will conduct the following mission readiness reviews with the customer:

- Ground Operations Review (GOR)
- Flight Operations Review (FOR)

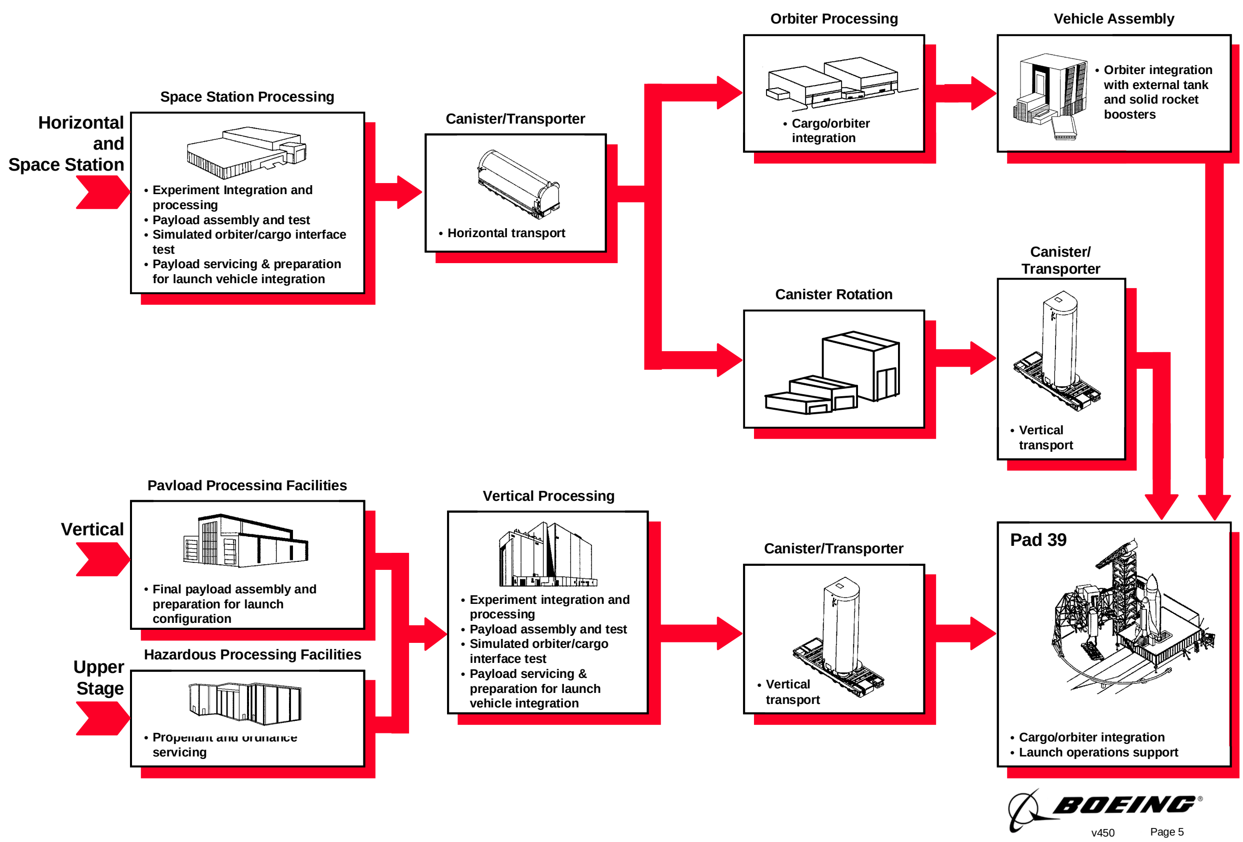


Figure 7-1.- Payload processing from delivery to launch.

- Payload Readiness Review (PRR)
- Launch Readiness Review (LRR)
- FRR
- Payload Director's Countdown Review, if required
- Prelaunch Mission Management (MMT) Review (L-1 or L-2 Days)

Table 7-I summarizes mission readiness reviews and customer participation for a typical primary payload. When a payload has limited Space Shuttle interfaces and services, customer participation may be appropriately reduced as agreed to in the IP. See Figures 7-2 through 7-4 for contents of the required payload readiness statements.

Integrated Cargo Hazard Assessment

The SSP prepares a Generic Integrated Cargo Hazard Assessment Report (GICHAR), NSTS 21111, that ensures safe interaction of the cargo mix. Normally, the customer is not required to provide any additional data; however, the customer will be notified if more data or analyses are required.

Launch Commit Criteria

The customer must develop and negotiate LCC with the SSP for all payloads with launch countdown monitoring requirements. These LCC will be developed in accordance with the requirements, groundrules, and constraints in Appendix 5.

Customer Participation During the Mission

The customer will have technical and management representatives at KSC during ground operations planning, preflight verification, launch, and postlanding operations.

The Mission Management Team (MMT) will function as a program level oversight group to review the status of the countdown and flight activities and to make programmatic decisions outside the authority of the launch and flight teams. The customer's interface to the MMT is through membership on the Cargo Management Team (CMT). This team consists of SSP and customer management representatives who have the authority and technical knowledge to make final programmatic recommendations to the MMT on issues that affect the payload.

The customer is encouraged to have a customer representative in the Customer Support Room (CSR) at the MCC during the flight. In addition to customer support at JSC, data can be routed to POCC's at various locations. POCC's can command and control payload operations and receive payload data.

Before a mission, the customer participates in control team training, consisting of briefings and simulations. Simulations usually begin two months before launch and include a fully staffed MCC, Shuttle Mission Simulator (SMS) and crew, and remote POCCs, if applicable. During simulations, customers participate in training sessions to rehearse various mission events.

TABLE 7-I.- MISSION READINESS REVIEW SUMMARY

REVIEW	TIME	OBJECTIVE	CUSTOMER PARTICIPATION
GOR	Primary payload flight hardware delivery minus 30 days	Verify that KSC facilities, services, personnel, and the customer are ready to proceed with payload, GSE, and Orbiter ground processing	**Customer presents:** Payload status, anomaly summary and open item resolution; concurrence with processing plans and schedules; status of payload flight safety verification tracking log **Customer submits:** Ground safety certification
FOR	Launch minus 3 months	Verify that flight documentation implements payload requirements	Review flight documentation
PRR	Payload transfer to OPF/pad minus 1 week	Review mission integration and operations activities to ensure flight readiness addressing safety, payload engineering, IP, and flight requirements and verify payload and KSC readiness for Orbiter integration	**Customer presents:** (Payloads installed in the cargo bay only.) Payload anomaly and open item status and resolution; flight safety certification status; payload flight safety verification tracking log status; consumables, weight, and c.g. verification; verification test status (stand-alone, CITE); LCC review; readiness statement **Customer submits:** Payload readiness statements for installation (submit PRR minus 1 week)
LRR	FRR minus 5 days	Assessment of Shuttle and payload processing activity for launch, landing, and scrub turnaround and contingency plans	**Customer presents:** Verbal statement that payload and GSE operations are completed (or proceeding as scheduled); payload anomaly/open item status and resolution
FRR	Launch minus 2 weeks	Comprehensive review of all activities and elements necessary to conduct operations from prelaunch through mission completion	**Customer submits:** Flight Safety Certification at FRR minus 10 days and readiness for flight statement at FRR minus 2 weeks
PDCR, if required	Launch minus 5 days	Affirm LCC, final prelaunch activities, scrub turnaround and contingency planning, and payload representative's role during countdown	**Customer presents:** Verbal status of launch prep activity (including deviations and waivers) and identification of key personnel (locations and roles for contingency planning)

REVIEW	TIME	OBJECTIVE	CUSTOMER PARTICIPATION
Prelaunch Mission Management Team (MMT) L-2 day	Launch minus 2 days	Affirm final checkout activities and launch preparations (including closeout of FRR action items and LCC changes)	As required for payload anomalies

PAYLOAD CERTIFICATION OF FLIGHT READINESS

ENDORSEMENT NO. 3: PAYLOAD/ASE ORBITER INTEGRATION

PAYLOAD:

This endorsement certifies completion of payload activities which allow for integration of the Payload and/or its Airborne Support Equipment (ASE) into the Orbiter in the Orbiter Processing Facility.

________________ 1. The hardware/software requirements necessary for Payload/ASE integration into the Orbiter and flight have been reflected in the appropriate released engineering and documentation.

________________ 2. Payload/ASE required installation, checkout, interface tests, and all standalone tests have been identified and documented.

________________ 3. Payload/ASE test, checkout, and servicing necessary for Orbiter integration are complete.

________________ 4. Payload/ASE processing discrepancies, unexplained anomalies, and explained conditions experienced during testing, checkout, and preparation for integration into the Orbiter have been evaluated and documented as acceptable.

________________ 5. Exceptions and action items from previous reviews for this payload/flight have been closed or determined not to be a constraint to Orbiter integration.

________________ 6. Payload/ASE hardware is certified to be compliant with the customer's institutional requirements for Reliability and Quality Assurance.

________________ 7. The payload is certified to be in compliance with the Space Shuttle and ground natural and induced environments as specified in the payload specific Interface Control Document.

________________ 8. In-Flight Anomalies (IFA's) have been evaluated and documented as acceptable for flight.

________________ 9. No known constraints exist for this milestone.

This endorsement certifies readiness of the payload and/or its ASE for integration in the Orbiter for STS-99, contingent on closeout of any exceptions noted herein.

____

Payload Manager

Exceptions:
Note (If exceptions are not closed out): For payloads whose subsequent deintegration will not be a significant impact to scheduled activities and whose exceptions are not deemed critical, Orbiter integration activities may be authorized by the Space Shuttle Program.

Figure 7-2.- Payload Readiness of Integration Statement.

PAYLOAD CERTIFICATION OF FLIGHT READINESS

ENDORSEMENT NO. 6: FLIGHT READINESS

PAYLOAD:
This endorsement certifies readiness and worthiness of the payload as of the FRR.

______________ 1. All exceptions and action items from previous reviews for this payload have been closed/resolved.

______________ 2. All payload requirements, analyses, and assessments have been defined in the IP and its annexes and released to support the flight. (All TBD's and TBR's have been resolved.)

______________ 3. All payload stand-alone readiness checkout has been successfully completed in accordance with the element and integrated OMRSD.

______________ 4. All flight and ground hardware/software anomalies, including previous in-flight anomalies applicable to this flight and anomalies identified during payload installation and checkout, have been resolved or accepted. All operational workarounds to "fly as is" anomalies have been developed and verified."

______________ 5. All payload installation and interface checkout have been successfully completed in accordance with the payload installation and checkout requirements.

______________ 6. The as-built payload configuration satisfies the released drawing requirements.

______________ 7. Flight design assessments have been accomplished per the IP integration schedule, and products have been verified and delivered.

______________ 8. The payload LCC minimum equipment list and mandatory instrumentation lists have been provided.

______________ 9. No known constraints exist for this payload.

______________ 10. Applicable SSP Operational Flight Rules have been reviewed and concurred with for flight.

______________ 11. Applicable sections of the Flight Data File have been reviewed and concurred with for flight.

All payload-produced payload Flight Data File (PFDF) articles have been validated and are ready for flight. All PFDF articles are consistent with the Crew Procedures Management Plan, Appendix F, Space Shuttle Flight Data File Preparation Standards or equivalent.

Figure 7-3.- Payload Readiness for Flight Statement.

______________ 12. All payload operations control center (POCC) facilities and/or customer provided ground support equipment (GSE) are ready to support the flight.

______________ 13. All payload personnel supporting real-time operations have completed applicable training and/or certification programs and are prepared to support real-time operations in accordance with applicable Joint Operations Interface Procedures and Flight Rules.

______________ 14. All payload personnel with ground command responsibility are aware of the function, utilization and constraints associated with all of the commands in their inventory.

______________ 15. All customer provided payload training sessions for the flight crew and flight controllers have been successfully completed in accordance with the agreements described in the IP. The flight crew is certified to operate the payload.

______________ 16. All payload safety hazard controls have been implemented and verified, or are scheduled for implementation and will be tracked via the Verification Tracking Log.

______________ 17. The in-cabin payload hardware is certified acceptable for toxicological effects on the crew. Any changes to the configuration which affect the toxicological assessment will be/have been reported to the SSP per JSC 25607, “Requirements for Submission of Test Sample Materials Data for Shuttle Payload Safety Evaluations.”

______________ 18. The final weight and mass properties of the payload, as installed in the Orbiter, have been incorporated into the IP Annex 1, Payload Data Package.

This endorsement certifies payload readiness for the STS-XX mission, contingent on closeout of any exceptions noted herein.

____
Payload Manager

Exceptions:

Figure 7-3.- Payload Readiness for Flight Statement. (concluded)

PAYLOAD CERTIFICATION OF FLIGHT READINESS

ENDORSEMENT NO. 6M: ORBITER MIDDECK FLIGHT READINESS

PAYLOAD:

This endorsement certifies the flight readiness and worthiness of the Middeck Payload.

_____________ 1. For payloads with prepack requirements, the appropriate hardware has been delivered to the Flight Equipment Processing Contractor.

_____________ 2. For payloads replacing lockers, fit checks, as required, have been accomplished.

_____________ 3. All flight and ground hardware/software anomalies, including previous in-flight anomalies applicable to this flight and anomalies identified during payload installation and checkout, have been resolved or accepted. All operational workarounds to “fly as is” anomalies have been developed and verified.

_____________ 4. Applicable SSP Operational Flight Rules have been reviewed and concurred with for flight.

_____________ 5. Applicable sections of the Flight Data File have been reviewed and concurred with for flight.

_____________ 6. All payload operations control center (POCC) facilities and/or customer provided ground support equipment (GSE) are ready to support the flight.

_____________ 7. All payload personnel supporting real-time operations have completed applicable training and/or certification programs and are prepared to support real-time operations in accordance with applicable Joint Operations Interface Procedures and Flight Rules.

_____________ 8. All payload personnel with ground command responsibility are aware of the function, utilization and constraints associated with all of the commands in their inventory.

_____________ 9. All customer provided payload training sessions for the flight crew and flight controllers have been successfully completed in accordance with the agreements described in the IP. The flight crew is certified to operate the in-cabin payload.

_____________ 10. All payload safety hazard controls have been implemented and verified, or are scheduled for implementation and will be tracked via the Verification Tracking Log.

_____________ 11. The in-cabin payload hardware is certified to be acceptable for toxicological effects on the crew. Any changes to the configuration which affect the toxicological assessment will be/have been reported to the SSP per JSC 25607, “Requirements for Submission of Test Sample Materials Data for Shuttle Payload Safety Evaluations.”

_____________ 12. No known constraints exist for this milestone.

This endorsement certifies the payload flight readiness for the STS- mission, contingent on closeout of any exceptions noted herein.

____
Payload Manager

Exceptions:

Figure 7-4.- Payload Readiness Statement for Middeck.

Customer Funded Services

8

NASA Space Shuttle services are provided to payload programs and customers as either standard or customer-funded services. The majority of costs for Space Shuttle services are included in the standard flight price. These represent the cost to NASA for performing standard integration tasks and launch services required by all payloads. Customer-funded services are those additional services which may be required to fulfill a customer’s unique payload requirements. Prior to initiation of individual customer-funded services, the performing NASA organization and the customer will jointly scope the tasks and the performing organization will establish the estimate of government costs and provide it to the customer. The customer-funded services will be agreed to and documented in the customer's integration plan.

Acronyms and Abbreviations

9

A	ampere(s)
ac	alternating current
AFD	aft flight deck
ASE	airborne support equipment
c.g.	center of gravity
CIP	Carrier Integration Plan
CIR	Cargo Integration Review
CITE	cargo integration test equipment
CMT	Cargo Management Team
CO_2	carbon dioxide
CoFR	Certification Flight Readiness
CSR	Customer Support Room
dc	direct current
DSN	Deep Space Network
DSO	detailed supplementary objective
DTO	development test objective
ET	external tank
EVA	extravehicular activity
FAWG	Flight Assignment Working Group
FDRD	Flight Definition and Requirements Directive
FOR	Flight Operations Review
FRR	Flight Readiness Review
g	gravity
G.m.t.	Greenwich mean time
GAS	Get-Away Special
GOR	Ground Operations Review
GPC	general purpose computer
GSE	ground support equipment
GSFC	Goddard Space Flight Center
HTD	Human Exploration and Development Space (HEDS) Technology Demonstrations
ICA	Interface Control Annex
ICD	interface control document
ICHA	Integrated Cargo Hazard Assessment
IDD	interface definition document
IFA	Inflight Anomaly
IMU	inertial measurement unit
in.	inches
IP	Integration Plan
IRIG-B	interrange instrumentation group B
JEA	joint endeavor agreement
JSC	Lyndon B. Johnson Space Center
kHz	kilohertz
KSC	John F. Kennedy Space Center
Ku-band	10.9 to 36 gigahertz per second
L-	launch minus
LCC	launch commit criteria
LRR	Launch Readiness Review
LSA	launch services agreement
LSSM	launch site support manager
m	meter(s)
MCC	Mission Control Center
MCC-H	Mission Control Center-Houston
MDM	multiplexer/demultiplexer
MECO	main engine cutoff
MET	mission elapsed time
MHz	megahertz
MIP	Mission Integration Plan
MMT	Mission Management Team
MMU	Modular Memory Unit
MOU	memorandum of understanding
MS	mission specialist
MSFC	George C. Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NRZ	nonreturn-to-zero
NRZ-L	nonreturn-to-zero-level
OMRS	Operations and Maintenance Requirements and Specification
OMRSD	Operations and Maintenance Requirements and Specification Document
OMS	orbital maneuvering system
OPF	Orbiter Processing Facility
PDI	payload data interleaver

PF-1	payload forward-1
PFDF	payload flight data file
PGSC	payload and general support computer
PI	payload interrogator
PIM	payload integration manager
PIP	payload integration plan
PL REC	payload recorder
PMCR	Payload Management Countdown Review
POCC	payload operations control center
PPF	Payload Processing Facility
PRCB	Program Requirements Control Board
PRR	Payload Readiness Review
PS	payload specialist
PSK	phase shift key
PSP	payload signal processor
RCRS	regenerable CO_2 removal system
RCS	reaction control system
RF	radio frequency
RMS	remote manipulator system
ROEU	remotely operated electrical umbilical
RSS	Rotating Service Structure
S-band	1.55 to 5.2 gigahertz per second
SIP	standard integration plan
SMCH	standard mixed cargo harness
SMS	Shuttle Mission Simulator
SN	Space network
SPA	small payload accommodations
SPASP	small payload accommodations switch panel
SPDS	stabilized payload deployment system
SRB	solid rocket booster
SSME	Space Shuttle main engine
SSP	Space Shuttle Program
SSPF	Space Station Processing Facility
TDRSS	Tracking and Data Relay Satellite System
TGHR	Time Critical Ground Handling Requirements
TP	turbopump
U.S.	United States
VA	voltampere(s)
Vac	volts alternating current
Vdc	volts direct current

Glossary

10

Attached payload:
Payload which remains in the payload bay and is not deployed on orbit.

Cargo:
Total complement of payloads (one or more) on any one flight. Cargo includes everything contained in the payload bay plus equipment, hardware, and consumables located elsewhere in the orbiter which are unique to the user.

Command services:
Command services include onboard discrete and POCC serial digital commands.

Customer:
An organization or individual requiring Space Shuttle services.

Dedicated mission:
A mission which, because of size, weight, or other considerations, is devoted to a single payload.

Deep Space Network:
Communications network managed by the Jet Propulsion Laboratory for command and control of all planetary flights.

Deployment:
The process of removing a payload from a stowed or berthed position in the payload bay and releasing it to a position free of the orbiter.

Detached payload:
A payload which is deployed from the payload bay on orbit.

Edwards Air Force Base:
Secondary landing site for shuttle flights.

European Space Agency:
An international organization acting on behalf of its member states (Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, and the United Kingdom). The ESA directs the development and manufacture of Spacelab.

External tank:
Element of the Space Shuttle which contains liquid propellant and oxidizer for the orbiter main engines. It is jettisoned before orbit insertion.

Extravehicular activity:
Activities by crewmembers conducted outside the spacecraft pressure hull or within the payload bay when the payload bay doors are open.

Flight:
The period from launch to landing of an orbiter. One flight may contain more than one payload or more than one flight might be required to accomplish a single mission.

Flight design:
The trajectory, consumables, attitude and pointing, and navigation analyses necessary to support flight planning.

Flight manifest:
The designation of a flight, assignment of the cargo to be flown, and specific implementing instructions for Space Shuttle operations personnel.

Get-Away Special:
Small payloads mounted in canisters in the payload bay.

Grapple fixture:
Structural fitting on a detached payload to mate it to the RMS end effector.

Inclination:
The maximum angle between the plane of the orbit and the equatorial plane.

Induced environments:
Environments resulting from orbiter operation such as acceleration, vibration, acoustics, etc.

Inertial upper stage:
Solid propulsive upper stage designed to place spacecraft on high Earth orbits or on escape trajectories for planetary missions.

Integration:
A combination of activities and processes to assemble payload and Space Shuttle components, subsystems, and system elements into a desired configuration and verify compatibility.

Interface:
The mechanical, electrical, and operational common boundary between two elements of a system.

Interface verification:
Flight hardware interface testing by an acceptable method to confirm compatibility with affected elements of the Space Shuttle.

Ku-band signal processor:
Instrument that receives high data rate scientific data from small payloads in the payload bay and transfers it to the orbiter communication system.

Launch pad:
The area where the stacked Space Shuttle undergoes final prelaunch checkout and countdown and is then launched.

Launch site support manager:
The single point of contact for arranging payload processing at the launch and landing site.

Load factors:
Measurements used in determining the price charged to a customer.

Middeck payload:
Payload or experiment requiring pressurized crew compartment accommodations.

Mission:
The performance of a coherent set of investigations or operations in space to achieve program goals. A single mission might require more than one flight, or more than one mission might be accomplished on a single flight.

Mission Control Center-Houston:
JSC facility for control and support of all phases of Space Shuttle flights after launch.

Mission phases:
Prelaunch, ascent, on orbit, deorbit, entry, landing, and postflight.

Mission specialist:
Crewmember responsible for coordination of overall payload/Space Shuttle interaction; directs allocation of Space Shuttle and crew resources to accomplish combined payload objectives.

Mission station:
Location on the AFD where payload support operations are performed, usually by the mission specialist.

Mixed payloads:
Cargo containing more than one type of payload.

Multiplexer/demultiplexer:
A data acquisition, distribution, and signal conditioning unit. It converts serial digital information from the GPC to analog and discrete outputs for payload operations, and acquires analog and discrete signals from the payload and converts them to serial digital signals for onboard processing by the orbiter GPC.

Optional service:
Additional services and accommodations available at additional charges.

Orbiter:
The manned orbital flight vehicle of the Space Shuttle.

Orbital maneuvering system:
Orbiter engines that provide thrust to perform orbit insertion, circularization, transfer, rendezvous, and deorbit.

Orbiter Processing Facility:
Building at KSC with two high bays in which the orbiter undergoes postflight inspection, maintenance, and premate checkout before payload installation. Payloads are also installed horizontally in the orbiter in this building.

Payload:
The total complement of specific instruments, space equipment, support hardware, and consumables carried in the orbiter (but not included as part of basic orbiter payload support) to accomplish a discrete activity in space.

Payload bay:
The unpressurized midsection of the orbiter fuselage behind the cabin aft bulkhead. Maximum usable payload envelope is approximately 15 feet (4.6 m) in diameter and 60 feet (18.3 m) in length. The payload bay doors extend the full length of the bay.

Payload carrier:
Used with the Space Shuttle to obtain low-cost payload operations. Payload carriers are habitable modules (Spacelab) and attached but uninhabitable modules (pallets, free-flying systems, satellites, and upper stages).

Payload data bus:
Provides compatible interface matching, isolation, and fault protection to allow the payload bus terminal unit and orbiter GPC to operate as a digital transmission system.

Payload data interleaver:
Provides the interface for acquiring asynchronous pulse code modulation (PCM) telemetry from attached and detached payloads.

Payload interrogator:
Provides RF communications between the orbiter and detached payloads.

Payload Operations Control Center:
Ground facility where payload operations are monitored and controlled.

Payload recorder:
Receives analog or digital data from attached payloads for limited periods of time.

Payload signal processor:
Transmits serial digital commands to one detached payload from the PI or one attached payload selected by the crew or a ground station.

Payload specialist:
Crewmember responsible for operation and management of experiments or other payload element assignments.

Payload station:
Location on the AFD where payload-specific functions are performed, usually by a payload or mission specialist.

Postretrieval:
Activities after a payload has been returned and secured in the payload bay.

Remote manipulator system:
Mechanical arm on the payload bay longeron controlled from the AFD to deploy, retrieve, or move payloads.

Retention latches:
Longeron and keel fittings providing structural retention of payloads in the payload bay.

Retrieval:
The process of using the RMS and/or other handling aids to return a captured payload to a stowed or berthed position. No payload is considered retrieved until it is fully stowed for a safe return or berthed for repair and maintenance tasks.

Rotating Service Structure:
The RSS is the launch pad service structure including the Payload Changeout Room (PCR) which rotates out to the orbiter on the mobile launch platform (MLP).

Solid rocket boosters:
Two solid rocket motors which augment ascent thrust at launch.

Spaceflight Tracking and Data Network:
Ground-based stations in direct communication with NASA flight vehicles.

Spacelab:
A general purpose orbiting laboratory for manned and automated activities in near-Earth orbit. It includes both module and pallet sections, which can be used separately or in several combinations.

Space radiators:
Thermal radiating panels on the inside of the orbiter payload bay doors which may be extended on orbit.

Space Shuttle:
A vehicle consisting of an orbiter, external tank, and two SRB's.

Space Shuttle Program:
The Space Shuttle vehicle and the program organization, management, systems, personnel, and facilities which support its design and operation.

Standard payload:
A payload installed in the payload bay using standard payload accommodations.

Standard switch panel:
Provides switch closure and/or 28 Vdc commands and status indicators for payload operation and status monitoring.

Tracking and Data Relay Satellite System:
A satellite communication system providing principal coverage from geosynchronous orbit for all flights.

Upper stage:
Upper stages are designed for launch from the payload bay with propulsive elements to deliver payloads into orbits and trajectories beyond the capabilities of the shuttle.