NSTS 21000-A02
Annex 2
Revision E

Data Requirements for the Flight Planning Annex

Payload Integration Plan

July 2001

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

DESCRIPTION OF CHANGES TO

BLANK BOOK ANNEX NO. 2

GUIDE FOR DEVELOPMENT OF

DATA REQUIREMENTS FOR THE FLIGHT PLANNING ANNEX

CHANGE NO.	DESCRIPTION/AUTHORITY	DATE	PAGES AFFECTED
REV A	General revision, replaces previous JSC 14099 and JSC 14091 dated Dec 1978/ B14091-2	09/28/81	All
1	Update Part II text, Tables 2-1, 2-2, and 2-3 and Appendix/ B14091-3	08/11/82	7,7A,8,9, 9A,11,12,13, 14,16,A-1
2	Delete reference to STS Workday Handbook/B14091-4	11/03/83	8,21
3	Update Table of Contents, Section 2.2, and add Table 2-6, Figures 2-2 and 2-3/ B14091-5	04/24/85	vi,vii,9,10, 18A,18B,18C
REV B	General revision/B14091-8 Document number changed from JSC 14091 to JSC 21000-A02 per CR G00026R1, dated 12/10/85	10/28/85	All
1	Payload Customer Photo/TV Inputs, Section 2.4/ B21000-A02-9	04/21/86	26
2	Change to Signature Sheet/ B21000-A02-10	07/24/86	3,18,44

DESCRIPTION OF CHANGES (CONCLUDED)

BLANK BOOK ANNEX NO. 2

GUIDE FOR DEVELOPMENT OF

DATA REQUIREMENTS FOR THE FLIGHT PLANNING ANNEX

CHANGE NO.	DESCRIPTION/AUTHORITY	DATE	PAGES AFFECTED
REV C	General Revision, Update of Annex 2-Part II P/TV Requirements, Section 2.4/ B21000-A02-11;-12 Document number changed from JSC 21000-A02 to NSTS 21000-A02 per CR G00051 dated 02/20/87	04/05/87	All
REV D	General revision/B21000-A02-013	10/02/91	All
	Errata to correct preface	12/13/91	iv,v
1	Update Part II's table of contents and add section 2.6 and table 2-9/B21000-A02-014	03/15/93	19,20,27, 27A,27B,37A
2	Update table of contents, sections 2.1, 2.2.1, 2.2.2, 2.3, and 5.0/B21000-A02-015	05/10/94	19,22,23, 24,24A,26, 27A,40,40A
3	Update table of contents and table 2-2/B21000-A02-016	08/23/94	19,31
4	Update section 2.0/B21000-A02-017	11/11/97	7
REV E	General revision to update contents pertaining to Part II/B21000-A02-0018	07/25/01	All

Note: Dates reflect latest signature date of CR's received by PILS.

FLIGHT PLANNING ANNEX

(PAYLOAD NAME)

JULY 25, 2001

Signed by Eugene F. Kranz
EUGENE F. KRANZ
DIRECTOR, MISSION OPERATIONS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

FOREWORD

This document defines the format and content of the flight design data required for the Space Shuttle Program (SSP) to determine mission power, energy, and cooling requirements; flight activity planning; and trajectory design, in support of integrated mission profile development. The annexes required and the schedule for submittal of a specific payload are identified in the basic Payload Integration Plan (PIP) for the payload. The customer is requested to provide the data defined, sign the title sheet, and return the completed data to the cognizant SSP annex manager.

The SSP annex manager will review the data for SSP implementation and contact the customer if there are any questions or if further negotiation of the data is required.

PREFACE

This document is structured to cover a generalized payload and, as such, may need to be tailored to fit the customer's specific payload requirements. This tailoring will be by mutual agreement of the customer and the National Aeronautics and Space Administration (NASA) book manager(s). All paragraphs and tables should be numbered as specified in this document and all requested data should be supplied for each part of this annex. If a paragraph or table is not applicable, so indicate by N/A so that it is clear that the matter was considered and not overlooked. Duplication of data found in other documents, such as the Payload Integration Plan (PIP), Interface Control Document (ICD), etc., should be avoided. It should be kept in mind that these annexes cannot be used as substitutes for PIP changes or additions. The following paragraphs should be included as the preface in the customer's annex submittal:

The Flight Planning Annex (FPA) contains agreements between the customer and the Space Shuttle Program (SSP) on matters which relate to the implementation of payload flight design requirements on the Space Shuttle, i.e., part I - payload electrical power, energy, cooling, and Orbiter support equipment usage requirements, part II - crew related activities, part III - trajectory design and deploy target considerations. The basic requirements are stated in the PIP. This document is intended to supplement the PIP in providing additional details to facilitate mission and flight operations planning within the scope of the task areas and responsibilities specified in the PIP.

In case of conflict between this document and the PIP, the PIP shall govern. Any requirements submitted in this document which are outside the scope of tasks or responsibilities defined in the PIP shall be considered nonbinding on the SSP.

Data submissions, questions, and/or comments relative to this annex should be directed to the appropriate book manager

Part I: Humberto Escobedo, Rockwell Space Operations Company, 600 Gemini, Houston, TX 77058, 713-282-2720

Part II: Robert H. Nute, DH4, NASA Lyndon B. Johnson Space Center (JSC), Houston, TX 77058, 281-244-5792

Part III: Gene W. Ricks, DM22, JSC, Houston, TX 77058, 713-483-8020 or FTS 525-8020

The customer point(s) of contact for this annex are as follows:

Part I: TBS

Part II: TBS

Part III: TBS

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PART I

ELECTRICAL POWER, ENERGY, AND COOLING REQUIREMENTS

DESCRIPTION OF CHANGES TO

FLIGHT PLANNING ANNEX

ELECTRICAL POWER, ENERGY, AND COOLING REQUIREMENTS

ANNEX 2 - PART I

(PAYLOAD NAME)

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FLIGHT PLANNING ANNEX

ELECTRICAL POWER, ENERGY, AND COOLING REQUIREMENTS

ANNEX 2 - PART I

(PAYLOAD NAME)

(DATE)

______________________________ Date ______
PAYLOAD REPRESENTATIVE

______________________________ Date ______
ELECTRICAL POWER, ENERGY, AND
COOLING ANNEX BOOK MANAGER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

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1.0 INTRODUCTION

The data required in this part of the annex will be used by the Space Shuttle Program (SSP) to determine the power, energy, and cooling requirements for the integrated mission profile and to ensure this profile is compatible with the system operating limits and constraints. Therefore, the equipment to be powered, the on/off operation, and the electrical characteristics of that equipment must be described. Payload bay payloads are assumed to be powered from the primary payload interface (Xo=645) unless otherwise stated. Crew compartment payloads are assumed to be powered from one of the three middeck utility outlets. Payload bay and crew compartment power requirements must be separately identified.

Power usage may be provided in graphical form for dedicated mission payloads as shown in the example figure 1-1. The figure should show power level changes as a function of mission or payload events or times relative to these events. If both tables and figures are provided for the payload, these tables and figures must agree.

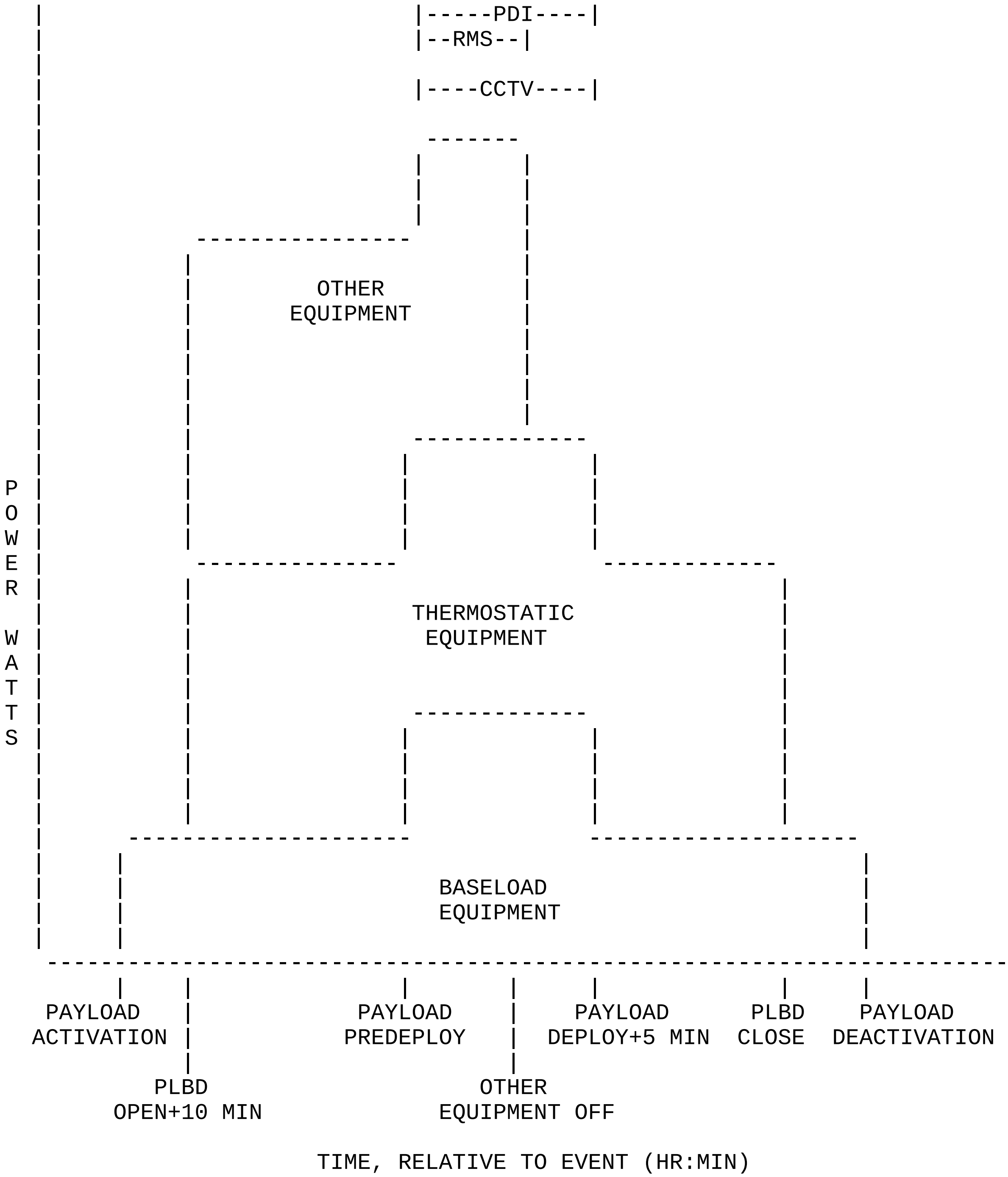

Figure 1-1.- Payload electrical power profile (example).

2.0 DEFINITIONS

The following definitions are offered as an aid in completing the required tables.

a. Payload - A part or all of Shuttle cargo, including deployables and/or experiments, covered by the Payload Integration Plan (PIP) and Flight Planning Annex (FPA).

b. Baseload equipment - Equipment which will be activated once, at the beginning of the payload activation, and which will draw power continuously until the final payload deactivation. The power level of this equipment is a function of an experiment operation; i.e., varies, but is never off. Not all payloads will contain baseload equipment.

c. Thermostatic equipment - Once in orbit, operation of this equipment is considered to be primarily dependent upon Orbiter attitude.

d. Other equipment - The power level (which is not included in b, c, and e) of this equipment is a function of payload or experiment operation.

e. Orbiter equipment - A selected group of SSP-provided equipment offered to support payload activities.

f. Power – Orbiter-supplied ac or dc power required for payload operations. DC power is the 28 V power level and ac power is the 115 V, 400 Hertz power level of the identified equipment specified in watts.

g. Incremental power - The power level differences between consecutive events.

h. Cumulative power - The total power level at any given time.

i. Average power - Power used by the integrated payload (experiments and carrier) averaged over the time increment specified, based on equipment nominal valus and duty cycles.

j. Maximum continuous power - The maximum sustained power at which a component or piece of equipment may run (power at 100% duty cycle).

k. Peak power - The maximum power level achieved for a specific component, other than steady-state operating values.

l. Duty cycle - Total time in which the equipment consumes power divided by the total operating time (on-line) of the equipment.

3.0 BASELOAD EQUIPMENT

Provide the following items in the form shown in table 3-1:

a. Events - Define the time when the equipment will be activated or deactivated or when the power level will change. The time must be relative to mission, payload, or experiment events (reference examples below). List events in chronological order.

MISSION EVENTS	PAYLOAD EVENTS	EXPERIMENT EVENTS
Lift-off	Payload activate	Experiment power up
Lift-off plus 2 hr	minus 5 min	Experiment standby
Payload Bay Door (PLBD)	Payload activate	Experiment processing
open plus 30 min	Payload deactivate	
PLBD close	Payload deploy	Experiment power down

b. Payload/experiment name - List the name of each payload and/or experiment for which the equipment is used.

c. Equipment - List all baseload equipment, as defined in section 2.0, in operation between each stated event.

d. Power - List the power level changes resulting from the equipment operation. The initial entries for incremental and cumulative power should be equal. The incremental column should show increases or decreases in power levels as a function of the equipment operation. Should the power level change as a function of time (i.e., ramp function), please describe in the comments column. Provide peak power as defined in section 2.0. If ac power is required and no phase (1, 2, or 3) is given, 3 phase will be assumed. If no power factor is given, -0.6 will be assumed.

e. Comments/duration - Provide anticipated duration of the peak power given and supplemental data deemed necessary to convey information not specifically requested.

Table 3-1.- BASELOAD EQUIPMENT POWER REQUIREMENTS

Events	Payload/ experiment name	Equipment	Power (watts)			Comments/ duration
			Incrmt	Cumul	Peak	

4.0 THERMOSTATIC EQUIPMENT

Provide the following items in the form shown in table 4-1:

a. Events - Reference section 3.0.

b. Payload/experiment name - Reference section 3.0.

c. Equipment - List all thermostatic equipment in operation between the stated events. If the equipment is thermostatically controlled, but is not attitude dependent it should be listed in section 5.0.

d. Duty cycle - Provide the estimated duty cycles of the thermostatic equipment for bay-to-Sun, bay-to-Earth, bay-to-space, and other specific attitudes required by the payload. Since several attitudes may be flown throughout the mission in order to satisfy Orbiter and other payload requirements, the attitudes above are required to successfully simulate power usage. For a dedicated payload mission, attitudes (a), (b), and (c) are not required provided that continuous attitude requirements are specified (i.e., there are no on-orbit periods when the payload has no attitude requirements). The duty cycle (percent) must be based on the power values specified in item e.

e. Power - Provide the 100 percent maximum rated power value of the equipment in watts.

f. Comments/duration/attitude - Provide supplemental data deemed necessary to convey information not specifically requested. If the duty cycles are affected by the operation of other equipment, identify and describe these estimated alternate duty cycles.

Table 4-1.- THERMOSTATIC EQUIPMENT

Events	Payload/ experiment name	Equipment	Duty cycle	Power (watts)	Comments/ duration/ attitude
					a. Bay-to-Sun b. Bay-to-Earth c. Bay-to-space d. Other (specify)

5.0 OTHER EQUIPMENT

Provide the following items in the form shown in table 5-1:

a. Events - Reference section 3.0.

b. Payload/experiments name - Reference section 3.0.

c. Equipment - List the equipment other than that listed in sections 3.0, 4.0, and 6.0 which will be activated, deactivated, or exhibit power level changes at each specified event.

d. Power - Reference section 3.0.

e. Duty cycle - Provide the estimated duty cycle as defined in section 2.0. Duty cycles or average power may be used if the equipment is thermostatically controlled, and not attitude dependent, or if the equipment has a random or cyclic operation.

f. Comments/duration - Reference section 3.0. The expected number of experiment repetitions, if any, shall be noted in the comments column.

Table 5-1.- OTHER EQUIPMENT POWER REQUIREMENTS

Events	Payload/ experiment name	Equipment	Power (watts)			Duty cycle	Comments/ duration
			Incrmt	Cumul	Peak		

6.0 ORBITER EQUIPMENT USAGE

Provide the following items in the form shown in table 6-1:

a. Events - Reference section 3.0.

b. Payload/experiment name - Reference section 3.0.

c. Orbiter equipment - List the SSP-supplied equipment whose usage is necessary for payload operations. Examples are as follows:

   1. Payload Data Interleaver (PDI)

   2. Payload Signal Processor (PSP)

   3. Payload bay lights (quantity)

   4. Remote Manipulator System (RMS)

   5. Television (TV) (quantity)

   6. Payload Interleaver (PI)

   7. Payload recorder

   8. Video Tape Recorder (VTR)

d. Comments/duration - Provide the anticipated duration of the Orbiter equipment usage and any supplemental data deemed necessary to convey information not specifically requested.

Table 6-1.- ORBITER EQUIPMENT USAGE

Events	Payload/ experiment name	Orbiter equipment	Comments/ duration

7.0 COOLING DATA

The following is assumed regarding the heat rejection and cooling of the payload. The electrical power required by the payload is converted to heat and must be treated as a heat load. It is further assumed that: if the payload is located in the crew compartment, the heat load will be rejected convectively to the cabin air; if the payload is located in the payload bay, the heat load is radiated to space; or if an active coolant loop is required for the payload, as specified in the PIP, the heat load will be rejected to the Orbiter payload heat exchanger and the payload must specify the coolant fluid, the flow rate, and a heat load profile vs Mission Elapsed Time (MET) as shown in the figure 7-1 example.

8.0 SURVIVAL POWER REQUIREMENTS

Survival power levels shall be specified such that overall minimum energy requirements can be determined in order to properly budget for mission contingency cryogenic reactants.

Survival power as defined in the STS Operational Flight Design Standard Groundrules and Constraints, NSTS 18504 is the minimum power required by a payload to maintain crew safety and payload integrity, including supporting Orbiter equipment, subsequent to successful payload operations. Within this annex, the definition encompasses situations such as payload deploy aborts and/or Orbiter powerdowns, during which certain power levels must be maintained to ensure payload product quality, integrity, and crew safety. Any conditions that must be met in order to achieve the survival power level must be specified. As an example, if this power level differs as a function of whether certain experiments have or have not been completed, the power level for both conditions must be specified.

The minimum power under consideration must include all payload and SSP-supplied equipment. For the SSP-supplied equipment, the payload need only supply the equipment operation times; the Space Shuttle will provide the equipment power level.

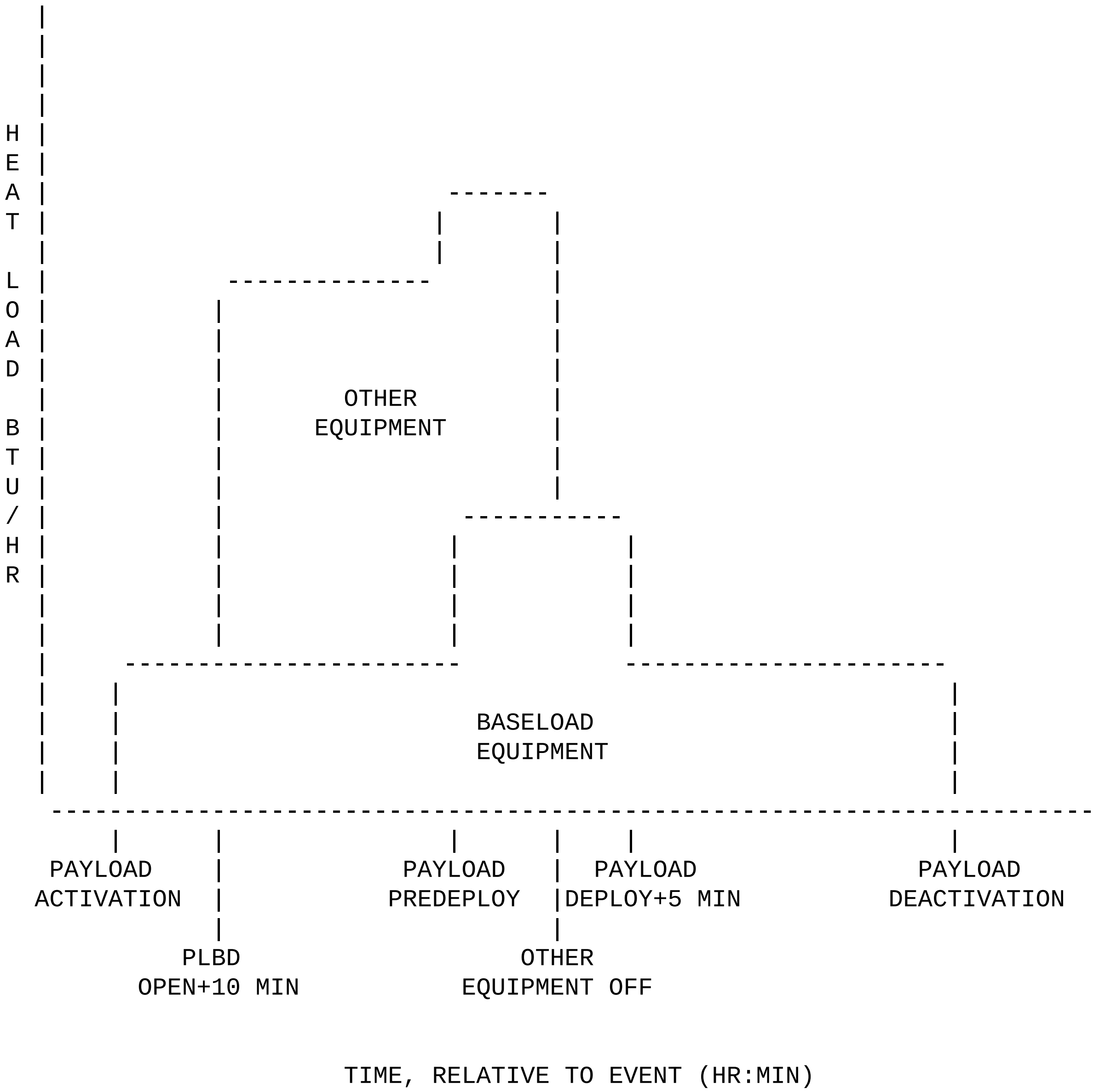

Figure 7-1.- Cooling load data (example).

APPENDIX A

ACRONYMS AND ABBREVIATIONS

The following is a list of acronyms and abbreviations applicable to part I. Please supplement, as appropriate, with a payload specific list.

ac	alternating current
AFD	Aft Flight Deck
ASE	Airborne Support Equipment
C/O	Checkout
CAP	Crew Activity Plan
CCTV	Closed Circuit Television
CMD	Command
CRT	Cathode-Ray Tube
dc	direct current
EPS	Electrical Power Subsystem
EXP	Experiment
EVA	Extravehicular Activity
FES	Flash Evaporator System
FOSA	Flight Operations Support Annex (PIP Annex 3)
FPA	Flight Planning Annex (PIP Annex 2)
GG	Gravity Gradient
HTR	Heater
JSC	Lyndon B. Johnson Space Center
L/O	Lift-off
LVLH	Local Vertical, Local Horizontal
MCC	Mission Control Center
MECO	Main Engine Cut Off
MET	Mission Elapsed Time
MNV	Maneuver
MS	Mission Specialist
N/A	Not Applicable
N/R	Not Required

OMS	Orbiter Maneuvering Subsystem
P/L	Payload
PDI	Payload Data Interleaver
PET	Phase Elapsed Time
PI	Payload Interrogator
PIP	Payload Integration Plan
PLB	Payload Bay
PLBD	Payload Bay Door
PS	Payload Specialist
PSA	Pre/Post Sleep Activity
PSP	Payload Signal Processor
PWR	Power
RCS	Reaction Control System
RMS	Remote Manipulator System
S/C	Spacecraft
SSP	Space Shuttle Program
SW	Switch
TBD	To Be Determined
TBS	To Be Supplied
V	volts
W	watts
-ZLV	Local Vertical, Local Horizontal, Top to Earth

PART II

FLIGHT ACTIVITY PLANNING

DESCRIPTION OF CHANGES TO

FLIGHT PLANNING ANNEX

FLIGHT ACTIVITY PLANNING

ANNEX 2 - PART II

(PAYLOAD NAME)

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FLIGHT PLANNING ANNEX

FLIGHT ACTIVITY PLANNING

ANNEX 2 - PART II

(PAYLOAD NAME)

(DATE)

___________________________ Date

PAYLOAD REPRESENTATIVE

___________________________ Date

FLIGHT ACTIVITY PLANNING
ANNEX BOOK MANAGER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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HOUSTON, TEXAS

(Note: This page will be provided by the customer for signatures.)

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Note: The table of contents as shown above, with any payload-specific subsections, is to be included in the customer's annex submittal.

1.0 INTRODUCTION

The information submitted by the customer in accordance with the following paragraphs and tables will be used by National Aeronautics and Space Administration (NASA) Lyndon B. Johnson Space Center (JSC) for the baselining of the payload-unique Flight Planning Annex (FPA). This document will then be one of the primary sources of information for the development of the Flight Plan. The steps followed during the annex baselining process are summarized below:

a. The customer prepares payload crew activity requirements according to formats and instructions of this document. The formal draft is submitted to the Payload Integration Manager (PIM). Subsequent changes to the baselined annex go directly to the annex 2, part II book manager with PIM notification.

b. The JSC reviews the draft for proper Space Shuttle Program (SSP) integration plus prepares all necessary forms for formal baselining. This package is then submitted to the customer for final approval, signature, and returned to the book manager for JSC signature, processing, and publication.

c. The JSC publishes the integrated Flight Plan which incorporates constraints and requirements from the approved FPA.

Note: The following paragraph is to be included as the introduction in the customer's submission of Part II of the annex:

The NASA JSC will be responsible for Flight Plan development and will provide an integrated Space Shuttle/payload Flight Plan to support the flight. The following data requirements are provided by the customer for development of the Flight Plan.

2.0 FLIGHT ACTIVITY REQUIREMENTS

The information contained in the remainder of part II of this annex should be used as a guide in specifying flight activity requirements for support of payload operations. For each section, 2.1 through 2.5, the customer should explain in writing the <u>general operation</u> of the payload and the crew interface requirements. These paragraphs should provide information on how one payload crew activity is related to another and what the objective is for that activity. Subsection numbers (i.e., 2.1.1, 2.1.2, etc.) may be used for these paragraphs if multiple experiments or payloads are involved. Any additional constraints or information may be supplied in section 3.0. Section 4.0 (Flight Activity Nomenclature) and section 5.0 (Scheduling Considerations) should be referenced before developing any text or tables. Acronyms used in defining payload activity requirements should be added to annex 2, part II appendix A.

Tables have been developed to assist the customer in defining specific payload crew activity requirements. Where tables are provided, an explanation of each entry column is given. (Note: Do not include the explanations as part of the customer annex submittal.) The tables are numbered sequentially as they appear in the text. The customer should remove any table not used and renumber the subsequent tables. If an additional table is included, insert it next to a related table.

If the data requested in the following sections and tables has been previously provided by the customer as part of the Payload Integration Plan (PIP), the appropriate section of the PIP may be referenced.

2.1 Payload/Crew Activity Requirements

The payload/crew activity requirements table is a listing of each payload task that affects Space Shuttle operations and the time or conditions of occurrence. The payload/crew activity information should be documented in table 2-1, as applicable. Every nominal payload systems operating procedure documented in the Flight Operations Support Annex (FOSA), Annex 3, must have a corresponding payload activity included in this table to ensure proper documentation of scheduling requirements for the Flight Plan. In addition, the payload activity title should match the payload systems operating procedure title. The following describes the columns of table 2-1:

a. Flt phase/event or PET - Name the required flight phase such as ascent, post insertion, orbit, deorbit preparation, and entry. If the payload activity is constrained to a Space Shuttle event, use Phase Elapsed Time (PET) (e.g., OMS 2 plus 10 min). Do not use Mission Elapsed Time (MET).

b. Payload activity title - The name of the payload element or instrument and the event, operation, or activities to be scheduled. If possible, the payload activity title should match the payload systems operating procedure title used in annex 3.

c. Command source - Identify the source of the command to start or stop these payload events: ground, crew, Space Shuttle General Purpose Computer (GPC), payload-unique onboard computer or the Payload and General Support Computer (PGSC).

d. Payload activity duration - The anticipated duration of the scheduled event. This is the response time for equipment operation and should not include any crew time which may be involved. Nominal and contingency (e.g., partial equipment failure) times for payload response should be provided, if available. These times should be expressed in HR:MIN.

e. Crew activity requirements - Provide a brief, general description of the required crew activity and an estimate of the crew time required. Details of the crew activity requirements must be specified in annex 3.

f. Detailed activity constraints, requirements and remarks - The initial conditions or constraints that must be satisfied for the event to be accomplished. Examples of initial conditions are, for instance, a previous payload activity must first be completed, certain temperatures or power levels must first be achieved, and certain displays are first required. State constraints such as attitude hold requirements, day/night number or repetitions, ground target requirements, ground communication requirements, and relationship to other crew activities (e.g., no venting or dumping during payload activity). As described in section 5.0.a.6, a 4-hr burn window must be reserved during on-orbit operations for the Orbiter to perform an orbit adjust burn to maximize daylit landing opportunities. Compatibility restrictions with this burn must be identified for every payload activity. For payloads requiring extended continuous operations, a 4-hr window in which the burn could be performed must be identified.

2.2 Attitude and Pointing Requirements

This section describes the attitude and pointing requirements for payload experiments and/or deployables. These requirements are described in terms of Orbiter orientation, payload instrument Line of Sight (LOS) vectors, celestial or terrestrial targets, and spin-axis targets.

2.2.1 Orbiter Orientation.- The approximate Orbiter Flight Control System (FCS) Digital Auto Pilot (DAP) on-orbit software limits are provided for reference in table 2-2. If payload operations require that the Orbiter or payload be in a certain orientation, those requirements are to be provided in table 2-3. The following describes the columns of table 2-3:

a. Payload activity title - Per table 2-1, Payload Crew Activity Requirements.

b. Orientation - Specify the Orbiter or payload orientation required for the event (i.e., +X Solar Inertial (+XSI); -Z Local Vertical Local Horizontal (-Z LVLH), Y Perpendicular to Orbital Plane (Y-POP), Nose Forward). Reference figure 2-1 for a definition of the Mean of 1950 (M50) coordinate system used for inertial attitudes. Reference figure 2-2 for a definition of the Orbiter body coordinate system.

Note: Orbiter body coordinate system is used instead of the structural coordinate system used in the PIP.

c. Maneuver/rotation rate - Specify the attitude maneuver and/or rotation angular rate in deg/sec required for payload scans or specify in terms of a limit in maneuver rate (i.e., less than TBS deg/sec). Refer to table 2-2 for approximate Orbiter FCS software rate limits.

d. Deadbands: Attitude and rate - Specify the deadbands desired and/or deadband limits for attitude and rate in deg and deg/sec, respectively. For cases when acquisition attitude deadband and/or rate deadband is different from maintenance attitude deadband and/or rate deadband, provide all values. If known, state desired control modes to be used with these values; i.e., attitude hold, rotation, target track, gravity gradient, free-drift (no control), etc. Refer to table 2-2 for approximate Orbiter FCS software deadband limits.

e. Angular acceleration - Specify payload requirement for high angular accelerations on Primary (PRI) jets or low angular accelerations on Vernier (VERN) jets in deg/sec squared or if Not Applicable (N/A). Refer to table 2-2 for approximate Orbiter FCS software angular acceleration limits.

f. Remarks - Any additional comments related to the attitude requirements. If known, indicate if the required orientation is time critical or is affected by launch delays. List any special pointing constraints that apply during attitude maneuvers (celestial areas to be avoided, maximum/minimum Sun angle, translation rate limitations, etc.).

Note: If a particular DAP control mode (ALT, PRI, FREE) is required to maintain structural loads within limits for payload hardware, this should be noted in the Remarks column. If a set of DAP parameters were analyzed and is required to maintain these limits, these parameters should be listed in table 2-3. This applies to attached payload and payloads operated on the Remote Manipulator System (RMS).

ALT DAP mode allows the Orbiter to provide attitude control using Primary Reaction Control System (PRCS) as a backup to Vernier Reaction Control System (VRCS), while minimizing loads transmitted to payloads. ALT mode can limit jet firing duration, number of jets firing simultaneously, and minimum time between firings. Parameters which may need to be constrained include rate deadband, jet option, number of jets, on time, and delay time. (DAP constraints due to loads are typically identified through the structural or RMS integration processes. They are included in this annex to ensure proper implementation in the crew's Flight Data File (FDF)).

Forward PRCS jets may not be fired during a crew sleep period due to the noise in the crew module. Therefore, any payload configuration which would require a primary DAP mode (ALT or PRI) during a crew sleep period must be compatible with Tail-Only control. LOW-Z mode fires forward PRCS jets and is not acceptable during crew sleep.

2.2.2 LOS Definition.- The LOS table defines the payload instrument LOS and the pointing system. Instrument Field of View (FOV) definition should be provided as supplementary data. These data will usually apply only to attached payloads. The following describes the columns of table 2-4:

a. Instrument - Name of the payload element or instrument to be pointed (or avoided).

b. LOS vectors - Defines the instrument null LOS in terms of an Orbiter body unit vector. Reference figure 2-2 for Orbiter coordinate definition.

c. Pointing system - Indicates whether the instrument is rigidly mounted or attached to the Shuttle Instrument Pointing System

(IPS), RMS, or some other pointing system. Payload-unique pointing systems should be described in supplementary data.

d. Remarks - Any additional comments related to instrument pointing capabilities and FOV definition.

2.2.3 Targets.- Table 2-5, Targets, defines the location of the celestial or terrestrial targets involved with payload pointing operations. This data will usually apply only to attached payloads. The following describes the columns in table 2-5:

a. Target - Identify the celestial or terrestrial target for the data take by name or number.

   Note: Footnote the celestial numbering system used.

b. Rt Asc - Give the right ascension of the celestial target (decimal deg).

c. Decl - Give the declination of the celestial target (decimal deg, north equals plus).

d. Lat - Give the latitude of the terrestrial target (decimal deg, north equals plus).

e. Lon - Give the longitude of the terrestrial target (decimal deg, east equals plus).

f. Alt - Give the altitude of the terrestrial target relative to the Fischer ellipsoid (nm).

g. Remarks - Any additional comments related to target location. If available, specify target priorities.

2.2.4 Spin-stabilized Upper-stage Payloads.- For spin-stabilized, upper-stage payloads, the following must be included:

a. The spin-axis/thrust vector must be defined in table 2-4.

b. The following paragraph must be included:

   Deployment attitude - The deploy attitude requires that the spacecraft spin-axis (table 2-4) be aligned with the spin-axis target. The spin-axis targeting and deploy timing parameters are provided in annex 2, part III.

c. Any secondary constraints on the deploy attitude must also be defined. Solar illumination will be calculated based on blockage diagrams developed from customer-provided payload dimensions in PIP, Annex 1, and payload locations in the Flight Requirements Document (FRD). Solar constraints on the spacecraft in the deploy attitude with the sunshield open must be included.

2.3 Contamination Avoidance

For payloads that may be subject to contamination by emissions from Orbiter water dumps, fuel cell purges, Flash Evaporator System (FES), Reaction Control System (RCS), Orbital Maneuvering System (OMS) firings, or cabin venting for 10.2 psi depress, etc., contamination constraints must be defined. The information required to limit the appropriate Orbiter activities during payload operations is to be provided in table 2-6. The following describes the columns of table 2-6:

a. Payload activity title - The name of the affected event (per Payload/Crew Activity Requirements, table 2-1).

b. Contamination constraint - Identify the Space Shuttle activity that will affect payload operations.

c. Avoidance interval - Give the time interval (min) before or after payload operation that the Space Shuttle constraint is in effect.

d. Remarks - Any additional comments related to contamination avoidance.

2.4 Photo/Television Requirements

This paragraph is applicable only if photography (photo) and/or Television (TV) has been called for in the PIP. The photo/TV requirements table indicates those payload events which require coverage. The following describes the columns of table 2-7.

a. Payload activity title - Per Payload Crew Activity Requirements, table 2-1.

b. Photography - For payload operations covered by photography, indicate the type of coverage desired (35mm, 70mm still photography or digital camera, etc.). If digital camera is required, indicate if the images need to be downlinked via Orbiter Communication Adapter (OCA) real time or if the images are to be saved for review postflight. Additionally, for scene development purposes, indicate the scene description, the lens required (wide angle, telephoto, etc.) and the film type (ASA/ISO number, special film, etc.).

c. Television - For payload operations covered by TV, indicate if the coverage is to be live during contact with Tracking and Data Relay Satellite (TDRS) (or ground stations) or if it is to be recorded onboard for later playback. Indicate live playback requirements and what activities are tied to these requirements. In-flight downlink of recorded TV must be coordinated via the Payload Data Collection Requirements of Annex No. 3, Flight Operations Support Annex (FOSA). Additionally, for scene development purposes, indicate the scene description, best payload bay camera to use, lens required (wide angle, medium angle, color, black-and-white), and multiple camera requirements (switched, multiplexed).

d. Remarks - Any additional comments related to photography and TV coverage of payload operations. State any special instructions; e.g., flash not permitted, time exposure, shutter speed requirements, audio requirements, etc. For each payload activity/operation requiring motion picture film and/or video tape coverage, specify coverage duration, HR:MIN:SEC, desired.

2.5 Extravehicular Activity Schedule

The Extravehicular Activity (EVA) schedule is a listing of payload events or mission conditions that are supported by either a scheduled or unscheduled EVA, as agreed to in the PIP. The actual definition of the specific design configuration details for each hardware-to-hardware interface should be placed in Annex No. 11, Extravehicular Activity Annex and should be consistent with this schedule. The following describes the columns of table 2-8:

a. Payload activity title - The payload operation or resultant condition that is to be supported by EVA (per table 2-1).

b. Scheduled or unscheduled - Indicates if the EVA is to be scheduled as part of normal payload activities or is to be an unscheduled operation performed only in the event of payload systems failures.

c. Time: Start or stop - The time for commencing or concluding EVA operations at the payload, measured with respect to another key event. (Time spent by the crew for either EVA preparation or post-EVA cleanup is not to be included.)

d. Start conditions - The payload conditions or constraints that must exist for EVA operations to begin.

e. Stop conditions - The payload conditions or constraints that must exist for EVA operations to be completed.

2.6 Orbiter Communication Adapter File Transfer Requirements

OCA is designed for high-speed electronic transfer of files between the Orbiter Payload and General Support Computer (PGSC) and a Personal Computer (PC) in the Flight Activities Officer (FAO) Multipurpose Support Room (MPSR). Normal file transmissions are accomplished through the Mission Control Center (MCC) via the Shuttle Ku channel 2 or 3. When Ku is not available files can be transferred at a slower rate through one of the S-band Air-to-Ground (A/G) audio channels using the Modem File Transfer (MFX) software. OCA Ku File Transfer (KFX) has the capability to uplink electronic files at a rate of 128K/sec and downlink at a rate of 2Meg/sec for channel 2 or 4Meg/sec for channel 3. OCA MFX is used when the Ku-band antenna is not available. This is typically at the end of the mission after the Ku-band antenna has been stowed. OCA MFX has a limited file transfer capability due to the reduced bandwidth. The maximum file transfer size that will normally be attempted using OCA MFX is no greater than 50K.

Payload files to be uplinked or that have been downlinked are transferred within MCC between the payload customer and the FAO via the Payload Officer by a flight-specific Joint Operations Interface Procedure (JOIP) MODM directory location, e-mail, on a customer-provided floppy disk, or PCMCIA card. The provided disk must be an IBM-compatible, DOS-formatted 3.5 in. The disk should include an UPLINK directory which contains only the files to be uplinked and a DOWNLINK directory into which downlinked files are stored.

Table 2-9 is used to identify payload OCA file transfer requirements. Each file to be transmitted is listed separately in the anticipated order of transmission. The following describes the columns of table 2-9.

a. Uplink/downlink - Indicates whether the file is to be uplinked or downlinked (UL or DL).

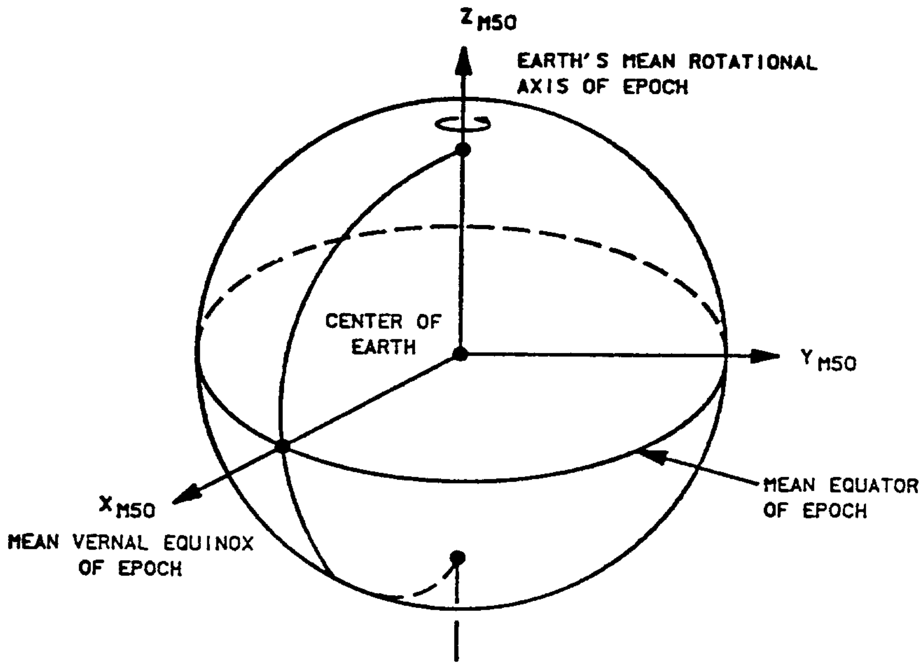
b. File name - Lists all file names to be transmitted. The following naming convention is used for MFX: AAABBBB.CCC (AAA = Payload name abbreviation, BBBB = Optional to further describe the file, CCC = File type: EXE, DAT, TXT, etc.). KFX file naming convention can be any file nomenclature.

c. File size - Indicates the approximate size of the file.

d. File transfer scheduling/frequency - Indicates the window within which the file is to be transmitted; i.e., tied to a specific payload activity or event. OCA file transfers are typically scheduled two to three times per crew day for a single-shift Shuttle mission and may require additional transfers for dual-shift missions. The actual frequency of these transfers depends on the amount of predicted and real-time traffic for each mission, as well as comm. availability. OCA file transfer can be approved and uplinked any time, but typical OCA file transfers are performed during crew sleep as Execute Package inputs are approved and after postsleep and prior to presleep for family mail.

e. Transfer constraints - Lists any additional transmission requirements or file descriptions. Indicate the file transfer method (i.e., floppy, server directory specified by the flight-specific JOIP or e-mail), files that are to be transmitted together and number of times the file is to be transmitted to/from the Orbiter.

Note: All OCA file transfers will be provided as an optional service.



NAME: Aries Mean Equator and Equinox of 1950 (M50) reference-axis system.

ORIGIN: The center of the Earth.

ORIENTATION: The epoch is the beginning of Besselian year 1950 or Julian ephemeris date 2433282.423357.

The X_{M50}-Y_{M50} plane is the mean Earth's Equator of epoch.

The X_{M50}-axis is directed towards the mean vernal equinox of epoch.

The Z_{M50}-axis is directed along the Earth's mean rotational axis of epoch and is positive north.

The Y_{M50}-axis completes a right-handed system.

CHARACTERISTICS: Inertial, right-handed Cartesian system.

Figure 2-1.- Aries Mean of 1950 system.

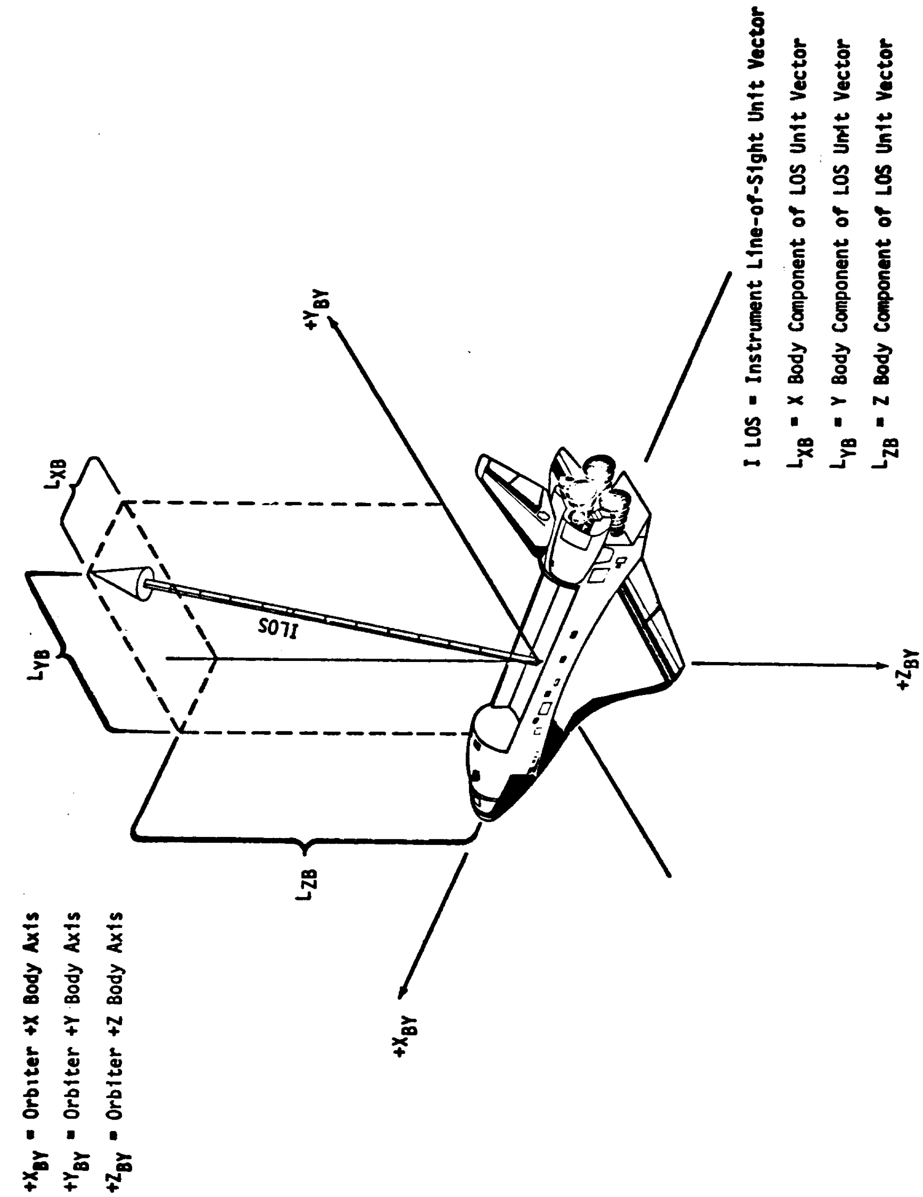


Figure 2-2.- Instrument LOS vector definition.

Table 2-1.- PAYLOAD/CREW ACTIVITY REQUIREMENTS

Flt phase/ event or PET (HR:MN)	Payload activity title	Comman d source	Payload activity duration (HR:MIN)	Crew activity requirements* (HR:MIN)	Detailed activity constraints, requirements & remarks

*Remember to specify crew time(s) involved when filling out this table. (Do not include this note as part of annex submittal.)

Table 2-2.- APPROXIMATE ORBITER FCS DAP ON-ORBIT LIMITS

	Lower limit	Upper limit	RCS selected
Mnvr/Rot rate (deg/sec):	0.05	2.0	PRI/ALT PRCS
	0.008*	0.2**	VERN
Attitude deadband (deg):	0.3**	40.0	PRI/ALT PRCS
	0.033**	40.0	VERN
Rate deadband (deg/sec):	0.1	5.0	PRI
	0.05	5.0	ALT PRCS
	0.01	0.5	VERN
Ang Accel (deg/sec squared):	N/A	1.214***	PRI
	N/A	1.348***	ALT PRCS
	N/A	0.024***	VERN
No. of jets	1	3	ALT PRCS
ON TIME (sec)	0.08	9.99	ALT PRCS
DELAY	0.00	20.0**	ALT PRCS

*Use of maneuver rates approaching this lower limit may result in maneuver completion times that vary significantly from the ideal maneuver time.
**Indicates a practical operational limit. Exceeding this limit will require mission-specific evaluation.
***The limits on vehicle accelerations are a function of the vehicle mass properties and DAP configuration. Further negotiations are required to determine the exact lower and upper limits on vehicle acceleration.

Note: This reference table identifies approximate limits but does not necessarily reflect standard operational practice. Values near or beyond these limits may require further negotiations.

Table 2-3.- ATTITUDE AND POINTING REQUIREMENTS

Payload activity title	Orien-tation	Mnvr/rot rate	Deadbands: att & rate	Ang accel	Remarks

Table 2-4.- LOS DEFINITION

Instrument	LOS vectors			Pointing system			Remarks
	LXB	LYB	LZB	Fixed	IPS	Other	

Table 2-5.- TARGETS

Target	Celestial		Terrestrial			Remarks
	RT asc*	Decl*	Lat**	Lon	Alt***	

*Mean of 1950
**Geodetic latitude
***Nautical miles (6076.115 ft = 1 n. mi.)

Table 2-6.- CONTAMINATION AVOIDANCE

Payload activity title	Contamination constraints	Avoidance interval	Remarks

Table 2-7.- PHOTO/TV REQUIREMENTS

Payload activity title	Photography	Television	Remarks

Table 2-8.- EVA SCHEDULE

Payload activity title	Scheduled/ unscheduled	Time: Start/stop	Start conditions	Stop conditions

Table 2-9.- OCA REQUIREMENTS

UL/ DL	File name	File size	File transfer scheduling/frequency	Transfer constraints

3.0 ADDITIONAL DATA

Any additional constraints or information may be supplied by the customer in this section.

4.0 FLIGHT ACTIVITY NOMENCLATURE

Note: This section is for customer reference only. Do not include in the customer annex submittal.

a. Flight Plan - A sequential listing of flightcrew activities and execute data vs MET. It may also include interfacing ground activities. An integrated Flight Plan contains detailed and summary timelines that address both Space Shuttle and payload activities.

b. Detailed timeline - A timeline with an expanded time scale, usually 4 hr per page. Normally used by the crew for in-flight execution of Space Shuttle and payload activities.

c. Summary timeline - A timeline with a compressed time scale, usually 12 hr per page. Normally used for overview of Space Shuttle and payload activities and for the coordination and integration of Space Shuttle and payload planning.

d. FDF - The onboard complement of documents and crew aids available to the crew for flight execution. This may include checklists, the Flight Plan, reference documents, maps, and charts.

e. EVAs - Crew activities performed outside the Orbiter crew module, requiring the use of the pressure suit, backpack, EVA tools, and mobility aids.

f. Attached payload - A payload that remains in the Orbiter payload bay or attached to the Orbiter in some manner for the duration of the flight.

g. Deployable payload - A payload that is launched in the Orbiter payload bay but is intended to be removed from the payload bay and left in orbit.

h. Retrievable payload - A payload that has been deployed/ retrieved on the same mission or previously left in orbit and is intended to be retrieved by the Orbiter and returned to Earth in the payload bay.

i. MET - An elapsed time reference that counts up from lift-off. Measured in days: hr: min: sec. The MET is the time reference in Flight Plan.

j. PET - An elapsed time reference that counts up from some designated flight event. Measured in hr: min: or hr: min: sec.

k. RMS - The mechanical arm that maneuvers a payload from the cargo bay to its deployment position and then releases it. It can also grapple a free-flying payload, maneuver it to the cargo bay, and then berth it to the Orbiter.

l. Orbit rate orientation - Orbiter/payload orientation remains fixed relative to the surface of the Earth.

m. Inertial orientation - Orbiter/payload orientation remains fixed relative to the celestial sphere.

5.0 SCHEDULING CONSIDERATIONS

Note: This section is for customer reference only. Do not include in the customer annex submittal.

The following are subjects which should be among those considered when preparing the requirements for crew support of payload operations:

a. General considerations are as follows:

    1. Lighting - Are the payload operations constrained to day or night passes or to certain Sun angles?

    2. Communications - Are the payload operations constrained to periods of communications contact with the MCC?

    3. Photo/TV coverage - Are there requirements to document payload operation with still photos, motion pictures, or via live or taped TV?

    4. Lifetime - Are there payload lifetime constraints (electrical power, cold gas supply, film capacity, maximum duty cycles, etc.) that apply to crew-controlled operations?

5. Contamination avoidance - Are there constraints on Space Shuttle operations (thruster firing, water dumps, fuel cell purges, FES) that must be observed to avoid contamination of payload equipment?

6. Orbiter maneuvers - Are there requirements for or constraints on Orbiter translations or rotations during payload operations (g-force limits, etc.)?

   The SSP desires as many daylit landing opportunities as possible on the nominal End-of-Mission (EOM) day and subsequent extension days (up to two landing opportunities each at John F. Kennedy Space Center (KSC) and Edwards Air Force Base (EAFB), with KSC as prime). In order to provide such opportunities, a trajectory correction burn, or orbit adjust, may be required in real time.

   The customers are required to identify activity requirements not compatible with orbit adjust maneuvers. For payloads requiring extended continuous operations, a 4-hr window in which the burn could be performed must be identified. In general, only one orbit adjust is required in order to achieve the desired trajectory. Two burns can be performed if a particular payload has a circular (or near circular) orbit requirement.

   Thirty to 45 min of crew time are required for a single burn; 75 to 90 min for a two-burn sequence. However, at least a 4-hr period of time is required for the orbit adjust activities in order to accommodate real-time variations in the timing of the burn while minimizing disruption to experiment operations. The delta-V of the burn will be larger if the burn is performed later in the mission. Larger burns may require the use of the OMS instead of the PRCS jets, causing an increase in the acceleration experienced by the vehicle. If the orbit adjust window is defined midway through experiment operations, the payload should be compatible with any orbit parameter changes that result from the burn. Typical changes might include orbital altitude or eccentricity variations.

The recommended timeframes for an orbit adjust window in priority order are

(a) After the timeframe of a Minimum Duration Flight (MDF), (usually 72 hr into a mission) to End of Mission minus One Day (EOM-1)

(b) Early in the mission, prior to MDF

Note: Placing on-orbit adjust window early in the mission will not preclude the possibility of further orbit adjusts to correct for higher than expected perturbations to the trajectory. It will reduce the delta-V required for later burns.

7. EVA - Are there requirements for EVA to support nominal (scheduled) or contingency (unscheduled) payload operations?

8. Mandatory operations - Which crew activities are mandatory (essential for successful payload operation) and which are highly desirable (useful, but not essential)?

9. Electromagnetic Interference - Are there any payload operations during which the crew must inhibit use of the Orbiter's Ku-band radar or RMS because of potential Electromagnetic Interference (EMI)?

10. Data transfer - Are there requirements for the crew to transfer Space Shuttle data (state vectors, attitude data, timing data, etc.) to the payload?

11. Orbiter orientation - Are there requirements for the Orbiter to be pointed in a certain direction or rotating in a certain way during payload operations? Are there constraints on Orbiter orientation because of payload thermal considerations?

12. Cabin environment - Are there any payload constraints that may be imposed due to changes in cabin environment caused by Space Shuttle planned or contingency activities?

13. Payload venting - Are there any constraints on crew activities because of payload venting considerations?

b. Ascent - Lift-off through orbital insertion (approximately, the initial 50 min of the flight). Crew activities will be directly monitoring the boost phase and performing the orbital maneuvers which establish the Space Shuttle in the required orbit. The only payload activities that will be scheduled during ascent are those mandatory activities that can be performed satisfactorily while strapped in the seats, and that will have no interference with normal or contingency Space Shuttle operations.

c. Postinsertion - Orbital insertion through Space Shuttle on-orbit activation (completed by approximately 2.5 hr after launch). The crew will be involved primarily in reconfiguring the Space Shuttle for orbital operations. Only mandatory payload activities will be considered during this phase and can be performed only on a noninterference basis.

d. On-orbit - The period spent in orbit between postinsertion and deorbit preparation.

    1. Activation - Define the event times or conditions required to activate the payload systems and to verify operation prior to deployment or at the beginning of the planned on-orbit activities. Are there any special lighting or communication requirements for activation, special pointing requirements, or contamination constraints?

    2. Operations - Define the event times or conditions required to support nominal and contingency payload operations. Consider both equipment operation and data recording. Are there any special photo or TV coverage requirements? Are there requirements for pointing the payload at specific celestial or terrestrial targets? Are there any other requirements which have not been previously addressed as general considerations.

    3. Deployment - Define the event times or conditions required for payload deployment. Consider both nominal and contingency cases. Are there any steps that must be performed while in communications contact with the MCC or during daylight or darkness? Is there to be photo or TV coverage? Are any of the steps time-critical? If deployment is via the RMS, are there requirements for Radio Frequency (RF) link checks, appendage deployment, etc., while on the RMS? Are there any other

requirements which have not been previously addressed as a general consideration? Also, define the event sequence required for payload deactivation if deployment must be delayed to a later opportunity or cannot be performed.

4. Postdeploy - Are there any pointing requirements for payload tracking after deployment? Are there photo or TV requirements?

5. Rendezvous - Define the event times or conditions required for crew support of payload operations prior to capture (if any). Identify any commands sent from Orbiter to payload during this phase. Are there requirements for photo or TV coverage? If known, specify the ranges at which the payload will initially be acquirable by Orbiter radar and will be visible to the crew as a third magnitude star (given the anticipated payload orientation and payload/Orbiter relative position).

6. Retrieval - Define the event times or conditions required for payload berthing. Consider nominal and contingency cases. Are there any steps that must be performed while in communications contact with the MCC, or during daylight or darkness? Is there to be photo or TV coverage? Are any of the steps time critical? Are there any other requirements which have not been previously addressed as general considerations?

7. Deactivation - Define the event times or conditions required to deactivate the payload systems and prepare for entry and landing. Are there any special lighting or communication requirements? Are there any special data recording requirements?

e. Deorbit preparation - Space Shuttle entry preparation to seat ingress (beginning approximately 5 hr before landing). The crew will be involved primarily in reconfiguring the Space Shuttle for deorbit and entry. Only mandatory payload activities will be considered during this phase and can be performed only on a noninterference basis.

f. Entry - Seat ingress to wheel stop (approximately the final 2 hr of the flight). Crew activities will be directed to Space Shuttle systems and guidance monitoring during the deorbit maneuver, atmospheric entry, and approach to the landing site. The only payload activities that will be scheduled during entry are those mandatory activities that can be performed satisfactorily while strapped in the seats, and that will have no interference with normal or contingency Space Shuttle operations.

APPENDIX A

ACRONYMS AND ABBREVIATIONS

(Note: This appendix will be part of the customer's annex submittal and should be revised as required to include all acronyms from part II including all payload-unique acronyms.)

Accel	Acceleration
Alt	Altitude
ALT PRCS	Alternate Primary Reaction Control System
Ang	Angular
ASC	Ascension
Att	Attitude
Decl	Declination
deg	degree
EMI	Electromagnetic Interference
EVA	Extravehicular Activity
FCS	Flight Control System
FDF	Flight Data File
FES	Flash Evaporator System
Flt	Flight
FOSA	Flight Operations Support Annex (PIP Annex 3)
FOV	Field of View
FPA	Flight Planning Annex (PIP Annex 2)
FRD	Flight Requirements Document
g	Acceleration of gravity
GPC	General Purpose Computer
hr	hour(s)
ILOS	Instrument Line of Sight
IPS	Instrument Pointing System
ISO	International Standardization Organizations
JSC	Lyndon B. Johnson Space Center
Lat	Latitude
Lon	Longitude
LOS	Line of Sight
LVLH	Local Vertical, Local Horizontal

LXB	LOS X Body Vector Component
LYB	LOS Y Body Vector Component
LZB	LOS Z Body Vector Component
MCC	Mission Control Center
MET	Mission Elapsed Time
min	minute
mm	millimeter
M50	Mean of 1950
MNVR	Maneuver
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
n. mi.	nautical mile
no.	number
NORM	Normal Jets
OMS	Orbiter Maneuvering Subsystem
PET	Phase Elapsed Time
PHOTO	Photography
Photo/TV	Photography and Television
PIM	Payload Integration Manager
PIP	Payload Integration Plan
PRI	Primary Reaction Control System
RCS	Reaction Control System
RF	Radio Frequency
RMS	Remote Manipulator System
Rot	Rotation
Rt ASC	Right Ascension
sec	second
SSP	Space Shuttle Program
TBS	To Be Supplied
TDRS	Tracking and Data Relay Satellite
TV	Television
VERN	Vernier Jets
+XSI	+X (body axis) Solar Inertial
Y-POP	Y (body axis) Perpendicular to Orbital Plane

PART III

TRAJECTORY DESIGN

This part supplies data to support analysis and implementation of constraints imposed by the payload on the Orbiter flight design. This would include data affecting launch window, parking and delivery orbit parameters, deployment/retrieval orbit design, and deploy target requirements. Many payloads will not need to enter data in this part, since the basic requirement will be stated in the Payload Integration Plan (PIP); however, certain tedious data (such as a table of daily launch windows for each day of the year) would be included here rather than in the PIP. Data input for this part is usually divided into three sections.

DESCRIPTION OF CHANGES TO

FLIGHT PLANNING ANNEX

TRAJECTORY DESIGN

ANNEX 2 - PART III

(PAYLOAD NAME)

CHANGE NO.	DESCRIPTION/AUTHORITY	DATE	PAGES AFFECTED

(THIS PAGE WILL BE PROVIDED AND MAINTAINED BY NASA JSC)

FLIGHT PLANNING ANNEX

TRAJECTORY DESIGN

ANNEX 2 - PART III

(PAYLOAD NAME)

(DATE)

_____________________________ Date ____
PAYLOAD REPRESENTATIVE

_____________________________ Date ____
TRAJECTORY DESIGN
ANNEX BOOK MANAGER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

CONTENTS

TABLES

FIGURES

Note: The table of contents as shown above, with any payload-specific subsections, should be included with the customer's annex submittal.

1.0 LAUNCH WINDOW DATA

This section will include tabular data defining the basic launch window requirements stated in the PIP. For payloads with upper stages, the launch window should be given in terms of Right Ascension of Ascending Node (RAAN) of the parking orbit at the injection node. The definition of the injection node is depicted in figure 1-1. Note that it is a fictitious node (does not actually occur in most cases) and is assumed to occur at midnight Greenwich mean time (G.m.t.) on the specified date. The supplied data will be linearly interpolated to find the RAAN limits corresponding to the actual G.m.t. of the injection node. These RAANs should be referenced to an Aries true-of-date cartesian coordinate system, documented in the National Aeronautics and Space Administration (NASA) TM X-58153, October 1974. Notice that this is a different coordinate frame than that specified in section 3.0.

The launch window data should be for an entire year, centered on the expected launch date (if known), at no greater than 10-day intervals. Data for noon and midnight launches and for ascending and descending node injections, as agreed to in the PIP, must be presented. The standard launch windows are shown as an example in tables 1-1 and 1-2 and should be replaced with the actual payload constraints.

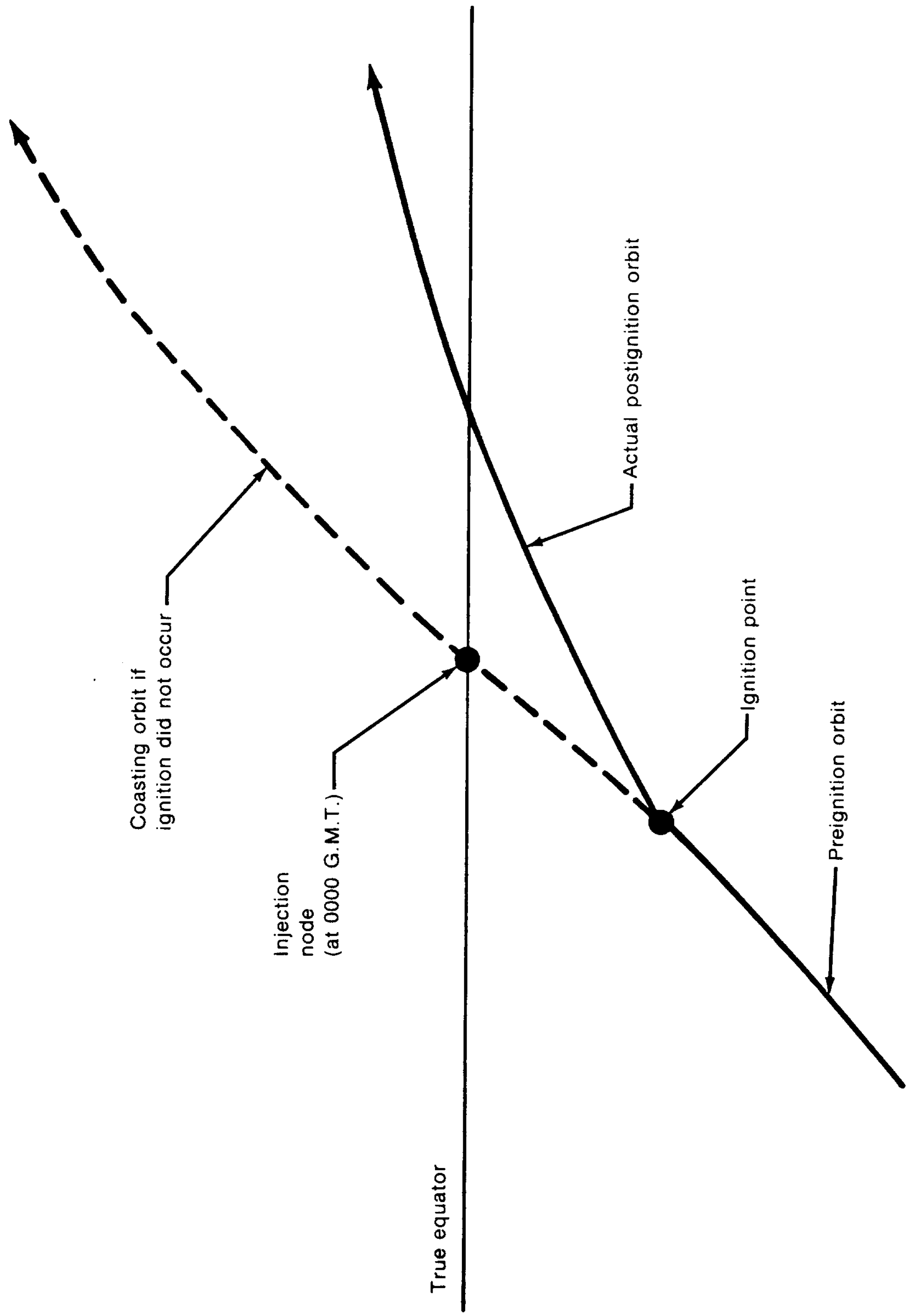


Figure 1-1.- Injection node definition.

Table 1-1.- RIGHT ASCENSION* OF THE ASCENDING NODE LIMITS FOR (PAYLOAD NAME) INJECTION (NOON LAUNCH, ASCENDING NODE INJECTION)

(EXAMPLE TABLE - REPLACE WITH ACTUAL DATA)

YR	MO	DA	DOY	RAAN (deg) Open	RAAN (deg) Close
84	1	1	1	85.58	115.58
84	1	11	11	95.43	125.43
84	1	21	21	105.29	135.29
84	1	31	31	115.15	145.15
84	2	10	41	125.00	155.00
84	2	20	51	134.86	164.86
84	3	1	61	144.72	174.72
84	3	11	71	154.57	184.57
84	3	21	81	164.43	194.43
84	3	31	91	174.29	204.29
84	4	10	101	184.14	214.14
84	4	20	111	194.00	224.00
84	4	30	121	203.86	233.86
84	5	10	131	213.71	243.71
84	5	20	141	223.57	253.57
84	5	30	151	233.42	263.42
84	6	9	161	243.28	273.28
84	6	19	171	253.14	283.14
84	6	29	181	262.99	292.99
84	7	9	191	272.85	302.85
84	7	19	201	282.71	312.71
84	7	29	211	292.56	322.56
84	8	8	221	302.42	332.42
84	8	18	231	312.28	342.28
84	8	28	241	322.13	352.13
84	9	7	251	331.99	1.99
84	9	17	261	341.85	11.85
84	9	27	271	351.70	21.70
84	10	7	281	1.56	31.56
84	10	17	291	11.42	41.42
84	10	27	301	21.27	51.27
84	11	6	311	31.13	61.13
84	11	16	321	40.99	70.99
84	11	26	331	50.84	80.84
84	12	6	341	60.70	90.70
84	12	16	351	70.55	100.55
84	12	26	361	80.41	110.41

*In true-of-date coordinate system

Table 1-2.- RIGHT ASCENSION* OF THE ASCENDING NODE LIMITS FOR (PAYLOAD NAME) INJECTION (MIDNIGHT LAUNCH, DESCENDING NODE INJECTION)

(EXAMPLE TABLE - REPLACE WITH ACTUAL DATA)

YR	MO	DA	DOY	RAAN (deg)	
				Open	Close
84	1	1	1	265.33	295.33
84	1	11	11	275.19	305.19
84	1	21	21	285.05	315.05
84	1	31	31	294.90	324.90
84	2	10	41	304.76	334.76
84	2	20	51	314.62	344.62
84	3	1	61	324.47	354.47
84	3	11	71	334.33	4.33
84	3	21	81	344.19	14.19
84	3	31	91	354.04	24.04
84	4	10	101	3.90	33.90
84	4	20	111	13.75	43.75
84	4	30	121	23.61	53.61
84	5	10	131	33.47	63.47
84	5	20	141	43.32	73.32
84	5	30	151	53.18	83.18
84	6	9	161	63.04	93.04
84	6	19	171	72.89	102.89
84	6	29	181	82.75	112.75
84	7	9	191	92.61	122.61
84	7	19	201	102.46	132.46
84	7	29	211	112.32	142.32
84	8	8	221	122.18	152.18
84	8	18	231	132.03	162.03
84	8	28	241	141.89	171.89
84	9	7	251	151.75	181.75
84	9	17	261	161.60	191.60
84	9	27	271	171.46	201.46
84	10	7	281	181.32	211.32
84	10	17	291	191.17	221.17
84	10	27	301	201.03	231.03
84	11	6	311	210.89	240.89
84	11	16	321	220.74	250.74
84	11	26	331	230.60	260.60
84	12	6	341	240.46	270.46
84	12	16	351	250.31	280.31
84	12	26	361	260.17	290.17

*In true-of-date coordinate system

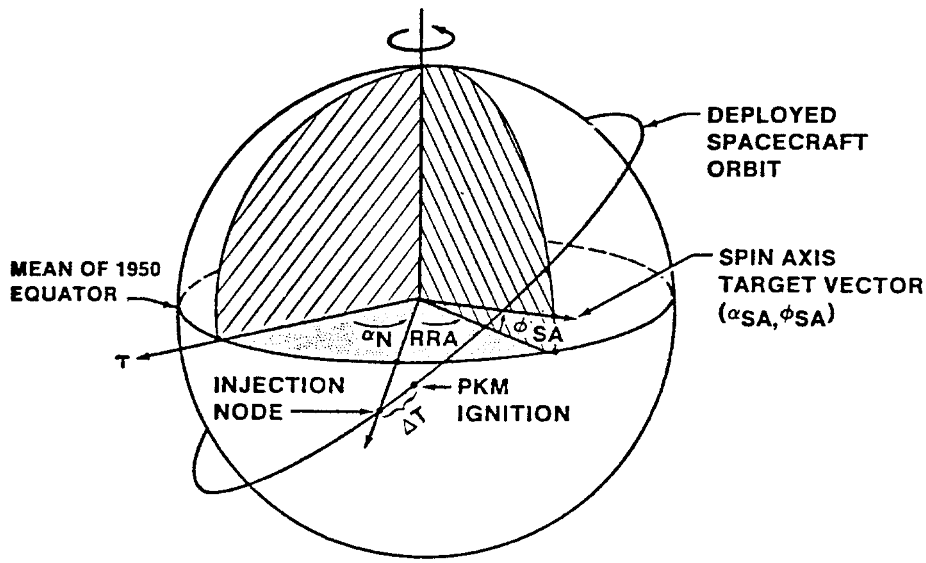
2.0 UPPER-STAGE INJECTION NODE LONGITUDE CONSTRAINTS

This section will include data detailing the Earth-relative geometry requirements of the upper-stage deployment by specifying the acceptable longitude ranges of the injection node for both ascending and descending injections. The specified ranges must be in accordance with PIP section 4.3.3.3, although a more restrictive range may be identified as desirable.

3.0 DEPLOY TARGET REQUIREMENTS

This section will include the targeting data required for deploying spin stabilized upper stage payloads. Table 3-1 and the accompanying notes will be included for both ascending and descending node injections. The following paragraph should be in this section.

The deploy targeting consists of a Mean of 1950 (M50) Relative Right Ascension (RRA) and an M50 Declination (DEC) to define the spacecraft spin-axis target relative to the M50 node of injection (figure 3-1). The Perigee Kick Motor (PKM) Time of Ignition (TIG) is defined to be delta T sec from the projected M50 equatorial crossing, assuming no burn took place (positive is after the node). The deploy time is TBS min before PKM ignition.



Υ = M_{50} RIGHT ASCENSION $\equiv 0$
α_{SA} = M_{50} RIGHT ASCENSION OF SPIN AXIS TARGET
α_N = M_{50} RIGHT ASCENSION OF INJECTION NODE (CROSSING OF M50 EQUATOR)
RRA = RELATIVE RIGHT ASCENSION
$\alpha_{SA} \equiv \alpha_N + RRA$
ϕ_{SA} = M_{50} DECLINATION OF SPIN AXIS TARGET
ΔT = TIME AFTER M50 NODE OF PKM IGNITION

Figure 3-1.- Targeting parameter definition: RRA, DEC, and delta T.

Table 3-1.- DEPLOY TARGETING DATA

			Injection Altitude (n. mi.)				
			100	120	140	160	180
RAAN (M50) at time of injection	100	M50 RRA* M50 DEC** Delta T***	TBS	TBS	TBS	TBS	TBS
	120	M50 RRA M50 DEC Delta T	TBS	TBS	TBS	TBS	TBS
	140	M50 RRA M50 DEC Delta T	TBS	TBS	TBS	TBS	TBS
	160	M50 RRA M50 DEC Delta T	TBS	TBS	TBS	TBS	TBS
	180	M50 RRA M50 DEC Delta T	TBS	TBS	TBS	TBS	TBS

*M50 Relative Right Ascension (RRA) (deg).
**M50 Declination (DEC) (deg).
***Delta T is the time relative to the M50 equatorial crossing (assuming no burn has occurred) where the PKM TIG will occur (positive is after the node) (sec).

NOTE:

1. Earth radius used is 3443.93 n. mi. One n. mi. equals 6076.115 ft.

2. Injection altitude is defined as the difference between the radius of the Orbiter's orbit at the M50 equatorial crossing (assuming no burn has occurred) and the radius of the Earth.

3. Spacecraft expected separation rate is TBS ft/sec.

4. The range of RAAN's and injection altitudes must include all values necessary for nominal and contingency trajectories for a specific flight.

5. The above data is effective TBS.

APPENDIX A

ACRONYMS AND ABBREVIATIONS

AFD	Aft Flight Deck
ASE	Airborne Support Equipment
DEC	Declination
EVA	Extravehicular Activity
FOV	Field of View
FPA	Flight Planning Annex (PIP Annex 2)
G.m.t.	Greenwich mean time
JSC	Lyndon B. Johnson Space Center
MCC	Mission Control Center
MECO	Main Engine Cut Off
MET	Mission Elapsed Time
M50	Mean of 1950
N/A	Not Applicable
N/R	Not Required
n. mi.	nautical mile
OMS	Orbiter Maneuvering Subsystem
P/L	Payload
PET	Phase Elapsed Time
PIP	Payload Integration Plan
PKM	Perigee Kick Motor
PLB	Payload Bay
PRCS	Primary Reaction Control System
RAAN	Right Ascension of the Ascending Node
RCS	Reaction Control System
REV	Revolution
RMS	Remote Manipulator System
RRA	Relative Right Ascension
S/C	Spacecraft
SSP	Space Shuttle Program

TBD	To be determined
TBS	To be supplied
TDRSS	Tracking and Data Relay Satellite System
TIG	Time of Ignition
VRCS	Vernier Reaction Control System

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