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ISSUE

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/ JOINT SPAR/DOC STS/ARIANE
LAUNCH VEHICLE STUDY REPORT /

VOLUME I

VEHICLES, FACILITIES AND
SERVICES AND COSTS - ARIANE
AND STS

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VEHICLES, FACILITIES AND
SERVICES AND COSTS - ARIANE
AND STS

PREPARED BY

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ACKNOWLEDGEMENTS

Spar wishes to acknowledge its appreciation to Dr. Shabeer Ahmed of DOC:CRC for his equal contribution to the joint study and preparation of the report, and to Mr. H.R. Warren DOC Headquarters for his support in these matters.

Also appreciated was the support received from Mr. R. Orye, Mr. A. Bellot and their staff from ESA and from Mr. G. Lunney and his staff at JSC Spidpo, KSC and other agencies.

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1.0 INTRODUCTION1.1 Background

Under DOC DSS Contract 01PC.36100-8-0104 OPC77-00451, Spar has undertaken a joint study with the Department of Communications, Communications Research Centre, (CRC), to determine the responsibilities of the Canadian Spacecraft Users for launch services of both the United States, Space Transportation System and the European Ariane launch vehicles together with their comparative present costs. In the 1980-1990 timeframe, both systems will be the operational work horses for the Western Space Community.

The planned Canadian Multipurpose UHF Satellite (MUSAT) was chosen as the model spacecraft for the study. This Delta Class geosynchronous communications satellite is described in Appendix A to this report. Also, for the STS launch vehicle, the McDonnell Douglas (MDAC) Payload Assist Module - Delta (PAM-D) has been utilized as the third stage needed to boost MUSAT from the STS parking orbit into the geostationary transfer orbit, although it is recognized that other Spinning Solid Upper Stages (SSUS) are in development. For the Ariane launcher, the dual launch capability, Systeme de Lancement Double Ariane (SYLDA), has been examined as a potential cost effective Delta class launch program.

In the course of visits made to both the Ariane and STS agencies and facilities, see trip reports included as Appendix B, the authors acquired documents pertaining to technical, programmatic, cost and responsibility aspects of the launch systems. A complete file of these documents can be accessed at both Spar Aerospace Products Ltd, Engineering Division and the CRC libraries. This study concentrates on the operator/carrier costs associated

with the launch campaign as specified in the Statement of Work, see Appendix C. Technical launch vehicle information is addressed where it materially affects the user's launch service costs, and is included in Appendix I and J.

1.2 Purpose

This study determines the basic and hidden costs to the user of launching with either STS or Ariane and presents a mid 1978 checkpoint comparison of his total external launch service expenses. It further identifies the risks which are currently imposed on the customer by these launchers. It should be noted that all of the costs and interfaces of these new services have not yet been identified or clearly specified by the agencies, especially in areas of multiple spacecraft cargo interactions. This is understandable at the point in the programs where qualification hardware is still in test, where the first flight is at least 1 year off and where payload interfacing and coordination is in a rapid state of evolution. Soft cost areas have been identified.

1.3 Contents

This report is presented in two volumes. Volume 1 consists of two parts; STS and Ariane, each of which contains a brief description of the launcher, its launch site, its campaign management and a discussion of the work flow and responsibility split between the user and the operator. Volume II presents cost estimates, milestone payments and risk assessment for each launch vehicle plus a cost comparison between the two systems.

2.0

SPACE TRANSPORTATION SYSTEM

The United States Space Transportation System (STS) is being sold as a charter airline service with deposit required 36 months before the flight. With the large weight (65,000 lbs) and volume (60' long 15' diameter cylinder) capability of the orbiter, the operator can afford to minimize the basic charges for the smaller (non-dedicated) passenger if he is willing to ride with other passengers. However, this multiple payload cargo capability causes many complexities to the organization, planning, interfacing, analysis, implementation and operations of the user's launch campaign. Additionally, the flexibility of the STS system to safely return a faulty payload or abort the launch due to its own fault, while enhancing the cargo's probability for successful orbit insertion, also creates a need for more prelaunch operations planning. Further, the low parking orbit capability of the orbiter (nominal 160 nmi circular) results in the need for a propulsion stage (to be furnished by the user) to perform transfer orbit insertion for geosynchronous payloads. Constraints imposed upon that stage for man rated operations and STS safety further complicate hardware design, STS/User interface and flight operations.

This section presents:

- i) a brief description of the STS organization, the launch vehicle "machine" and its launch facilities including documentation
- ii) a synthesis of the work flow to be carried out by parties during launch planning, implementation and flight
- iii) the published cost structure for STS

A cost examination and discussion of risks associated with the STS for the geosynchronous free flyer user are to be found in Volume II of this report.

2.1 NASA/STS Organization

Figure 2.1-1 presents the current NASA organization for that part of the STS program which deals directly with the user. Particularly included are the functions which interface with the freeflyer payloads requiring user furnished kick stages. The names of key personnel currently performing these functions are also shown.

The user deals initially with NASA/Headquarters and then the STS Utilization Planning Group of the Shuttle Payloads Integration and Development Project Office (SPIDPO) at NASA/JSC. As the user's requirements become known, a NASA Project Engineer is assigned from the NASA/JSC, STS Operations Group, who coordinates the activities of; the STS Systems Engineering Group, JSC, the flight operations Payload Officer, JSC, the KSC Payload Integration Office and assigned Launch Site Support Manager (LSSM), Safety offices and any cargo integration engineering which would be performed by Rockwell International for NASA/JSC. The NASA/KSC LSSM coordinates the prelaunch/launch planning and operations with the support of a Launch Site Support Team (LSST). NASA/GSFC takes responsibility for SSUS development and will provide the Payload Operations Control Center (POCC) for automated (freeflyer) users.

Rockwell International, as well as being prime contractor for the STS Orbiter, also perform cargo integration engineering tasks under subcontract to the responsible NASA Cargo Integration Agency, JSC, SPIDPO. Also, they maintain a company funded STS User Service Center, under which they can provide front end assistance, including analysis, for the User community.

NASA are planning to subcontract the cargo integration and launch pad cargo operations (on-line) for vertically processed payload to industry.

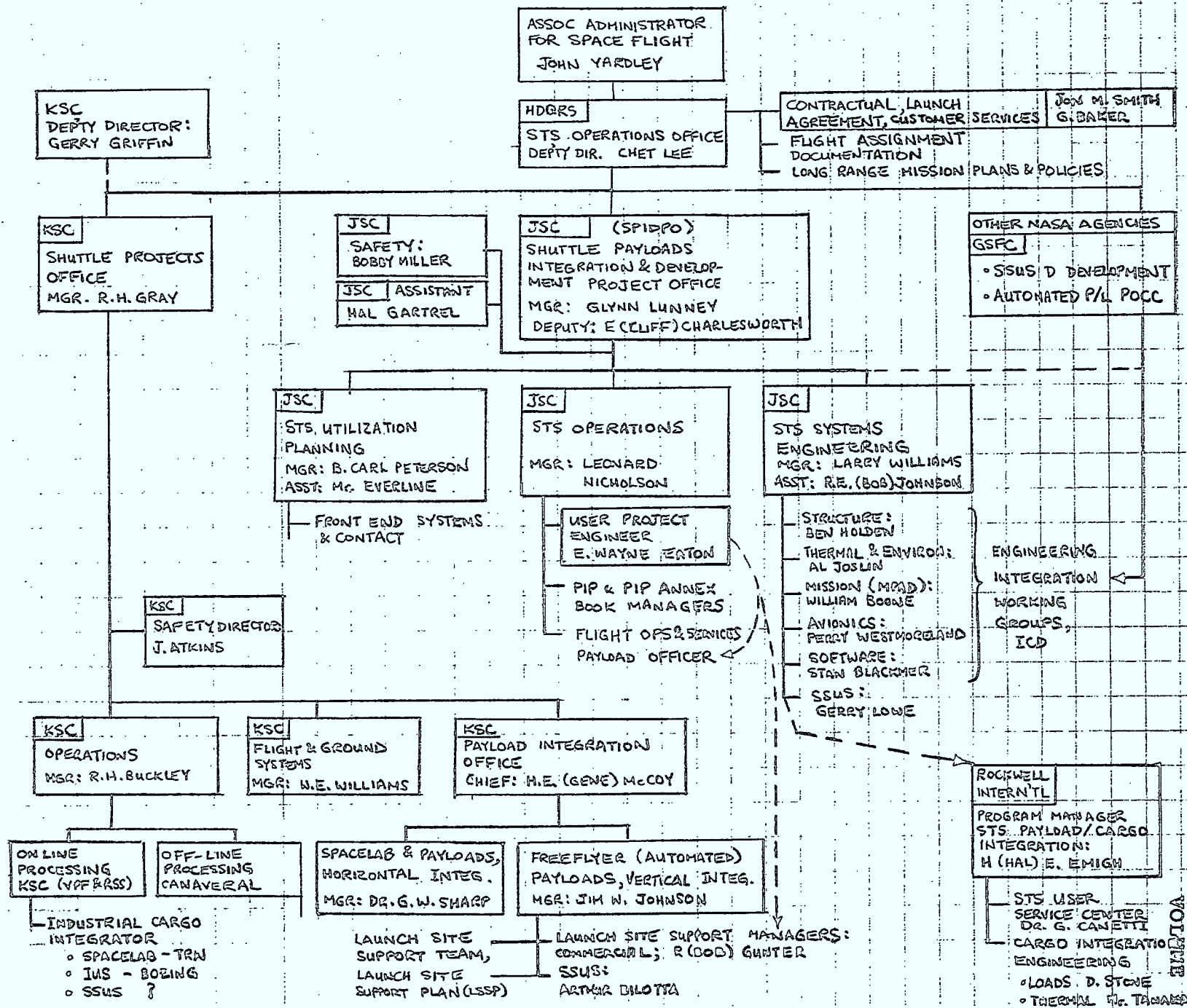


FIGURE 2.1-1: NASA/RI STS ORGANIZATION CHART (PAYLOAD ORIENTED)

McDonnell Douglas (MDAC), Rockwell International and General Dynamics are all competing for this responsibility.

Although MDAC have responsibility to NASA to develop both the Atlas Centaur (-A) and Thor Delta (-D) classes of Spinning Solid Upper Stage (SSUS) as a commercial venture, it is expected that the User, either through his prime contractor or directly, will procure and provide this kick stage as part of the "payload" to be delivered for cargo integration. As a backup, NASA, for a fee, will provide this SSUS stage for users who require this mode of contracting. Additionally, other kick stages are being commercially developed.

2.2

The STS "Machine"

Payload interface details, including technical performance, missions available, etc. can be found in the Space Transportation System, User Handbook and its reference documentation. A complete listing of known, pertinent STS documents is presented in Appendix D. The present status of development of the machine, as presented by Mr. Yardley at the 1978 AIAA Conference on Space Shuttle, is shown in Figure 2.2-1.

Appendix I gives a general description of the STS Orbiter and the payload accommodation capability in terms of mission performance, payload envelope and interfaces.

At the time of writing of this report, the official launch date for the first manned orbital flight (FMOF) has been slipped to June 1979 from April because of problems with;

- (a) main engine turbopump
- (b) thermal surface application to Orbiter 102 (time duration required)

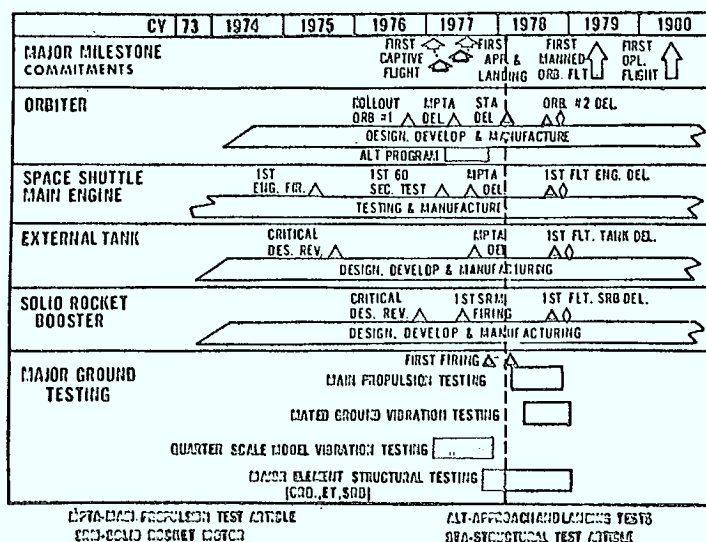


FIGURE 2.2-1: SPACE SHUTTLE DEVELOPMENT PLAN

The first operational flight is still scheduled for June 1980, and if necessary due to FMOF delay, one or more orbital test flights (OFT) will be deleted from the program to accomplish this objective.

2.3 Spinning Solid Upper Stage

As mentioned in the introduction, the geosynchronous mission user must provide a separate propulsion stage to boost his payload out of the STS low earth orbit and into the geosynchronous transfer orbit. The MDAC Payload Assist Module (PAM) is being commercially developed to serve this need. Although there are other Spinning Solid Upper Stages (SSUS) being developed, this study is based on the MDAC PAM because of data availability. Further information is presented in Appendix I and in the following:

MDC G6626A PAM-D User's Requirements Document,
MDC G7044A STS PAM-A User's Requirements Document
MDC Presentation to DOC - 20 April 1978

which are included in the launch vehicle libraries at Spar and DOC.

The PAM system is available in two forms, PAM-A which allows compatibility with Atlas Centaur class spacecraft and requires horizontal mounting in the Orbiter Bay, and PAM-D which is compatible with Delta class spacecraft for vertical installation in the Orbiter Bay. A Delta class spacecraft which cannot fit vertically in the bay must be mounted horizontally on the PAM-A cradle.

2.4 Kennedy Space Centre (KSC) Launch Site

The most complete reference materials on the subject of the KSC STS launch site can be found in the following (as referenced in Appendix D):

- (a) KSC-STSM-14.1
KSC-STSM-09, Volume VI
March 14, 1978
KSC Space Transportation System
Launch Site Accommodation Handbook
For STS Payloads

- (b) Space Transportation System - User Handbook

A description of the Launch Site Facilities that would be required by an automated payload such as MUSAT is given in Appendix I.

2.5 Schedule of Activities and Responsibilities

This section describes the schedule and the activities that lead up to the use of the STS launch facility and also includes the areas of responsibility assumed by the various agencies involved. The section is divided into three main subsections as follows.

The first subsection 2.5.1 outlines the overall flow of activities, documentation and reviews through NASA. In this subsection the User Payload is taken to be the assembly of the spacecraft and the PAM 3rd stage system.

The second subsection 2.5.2 extends the flow of activities to a more detailed level and outlines both the standard and optional services available from MDAC for the PAM 3rd stage system and NASA for the overall STS system.

The third subsection 2.5.3 details the activities associated with the last month at the launch site prior to launch, together with the responsibilities to be assumed by the User, MDAC and NASA to cover the various operations.

The material presented in this section is taken from several of the documents referenced in Appendix D.

2.5.1 Outline of Overall Flow of Activities2.5.1.1 Integration Flow Summary

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The payload developer initiates payload activity through his own institutional structure. Hand-books and users guides are provided by the STS to assist the user in this preparation process. Once the user has obtained his institutional funding commitments, he makes formal contact with NASA by a completed STS Form 100 submitted to the STS Operations Office at NASA Headquarters. NASA Headquarters reviews the submittal and then assigns the payload to Johnson Space Center (JSC)/ Shuttle Payloads Integration and Development Program Office (SPIDPO) to initiate detailed integration activities. Initial meetings are held to allow the JSC/SPIDPO to obtain a general understanding of the objectives and sizing information associated with providing necessary space flight services. Following the initiation of firm plans, cost and schedule details, a Memorandum of Understanding and a Launch Agreement are negotiated between NASA Headquarters and the User. A preliminary integration process is then initiated which identifies requirements and permits the development of an initial set of agreements which are documented in the Payload Integration Plan (PIP). This plan is iterated and finally approved by the payload developer, i.e., user, and the SPIDPO at the Payload Integration Review (PIR) and incorporated as an appendix to the Launch Service Agreement.

After the completion of the PIR the SPIDPO initiates the compilation of the STS/Payload XXX Integration Data Book (PID). This is an STS controlled document composed of all of the agreements and requirements associated with providing STS hardware and services for the particular payload. This book will contain the PIR documentation, Payload Integration Plan (PIP), Interface control drawings, and the specific flight and ground requirements.

After the PIP is approved by the STS and payload organization, the integration process continues to develop the necessary detailed interface control drawings, Payload Operation Control Center (POCC), and ground processing requirements in sufficient detail to permit JSC/SPIDPO to develop a proposed cargo manifest. The proposed cargo manifest is a list of the major items required to support flight specific objectives. The proposed STS cargo manifest, the PID Book for each payload in the cargo manifest are submitted to the users and the STS implementing organizations which will verify that the proposed cargo manifest is self compatible. Subsequent to the determination that the proposed cargo manifest is compatible, the JSC/SPIDPO develops a proposed Cargo Integration Plan (CIP). The CIP provides the multipayload integration agreements and concepts which will be used to develop the flight operation, ground operation, and integration hardware development plans. The proposed cargo manifest and CIP are reviewed and approved at the CIR. The completion of the CIR signifies the initiation of the flight preparation and planning processes.

The flight preparation and planning activities proceed in three areas; flight operations, integration hardware development, and ground operations. The flight operations activity involves the development of the Flight Operations Support plan, flight plans, trajectory details, training plans, and payload operations control center requirements. Integration hardware development involves the design and development required for hardware such as cables, plumbing, support structures, etc. Ground operations involves the development of launch site support plans, test and checkout procedures, and postflight landing site handling plans.

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At specified times, determined by SPIDPO and the STS implementing organizations, reviews are held to permit overall approval of the documentation set to be used to support the flight. The Flight Operations Review (FOR) will approve the preliminary flight plans, training plans, inflight and postflight data product plans, and other appropriate flight operation flight unique documentation. The Integration Hardware Review (IHR) approves the design of integration hardware and initiates integration hardware fabrication. The Ground Operations Review (GOR) approves the Launch Site Support Plan, including postflight hardware disposition and preliminary test and checkout procedures. As each of these reviews is completed, the detailed implementation activity is initiated.

The implementation process proceeds in the three areas of flight operations, integration hardware development, and ground operations. The flight operations activity involves the flight crew and ground controller training, POCC configuration and verification, and flight documentation completion. The integration hardware activity involves the test checkout and delivery of integration hardware to the launch site. The ground operations involves the payload receiving, handling, operation and the completion of the test, checkout and cargo integration, and mating activities.

The Flight Readiness Review (FRR) is conducted with the purpose of verification of completion of all scheduled activities required to allow the launch to proceed as scheduled. Any unaccomplished activities on non-compliant occurrences are reviewed and dispositioned at this review. The inflight operations proceed as agreed to through the planning activities described above.

The postflight data products are developed and distributed in accordance with the preflight agreements identified during flight operations planning.

In a similar manner, the payload flight hardware is dispositioned in the manner agreed to at the GOR.

2.5.1.2 Integration Flow Description

An expansion of the summary description is given herein where each major step of the flow process is described and major inputs and products and identified and summarized. Figure 2.5-1 shows the overall flow pattern and its schedule and how the launch planning activities line up with typical spacecraft program milestones.

(a) Payload Initiation-In Advance of L-36 Months

Payload development and proposal selection is a user-centered activity that occurs both within and external to NASA. Payloads requiring STS support will have significant complexity variations. They may be small self-contained packages requiring only transportation to orbit. These payloads will probably be manifested with other compatible payloads once they enter the integration flow. Integration burden for these payloads will largely be centered within the STS. Other payloads require extensive STS services and make extensive use of the STS capabilities on an STS dedicated flight will be developed by the user in an integrated manner prior to entering the integrated flow. The burden of integration for these payloads will largely be borne by the payload developer.

The payload initiation and selection process is a user performed activity which uses the payload proposal and available STS handbook materials as an input. The basic STS data is provided in the handbook and users guide to assist the user in payload proposal development and selection. The STS Users Handbook

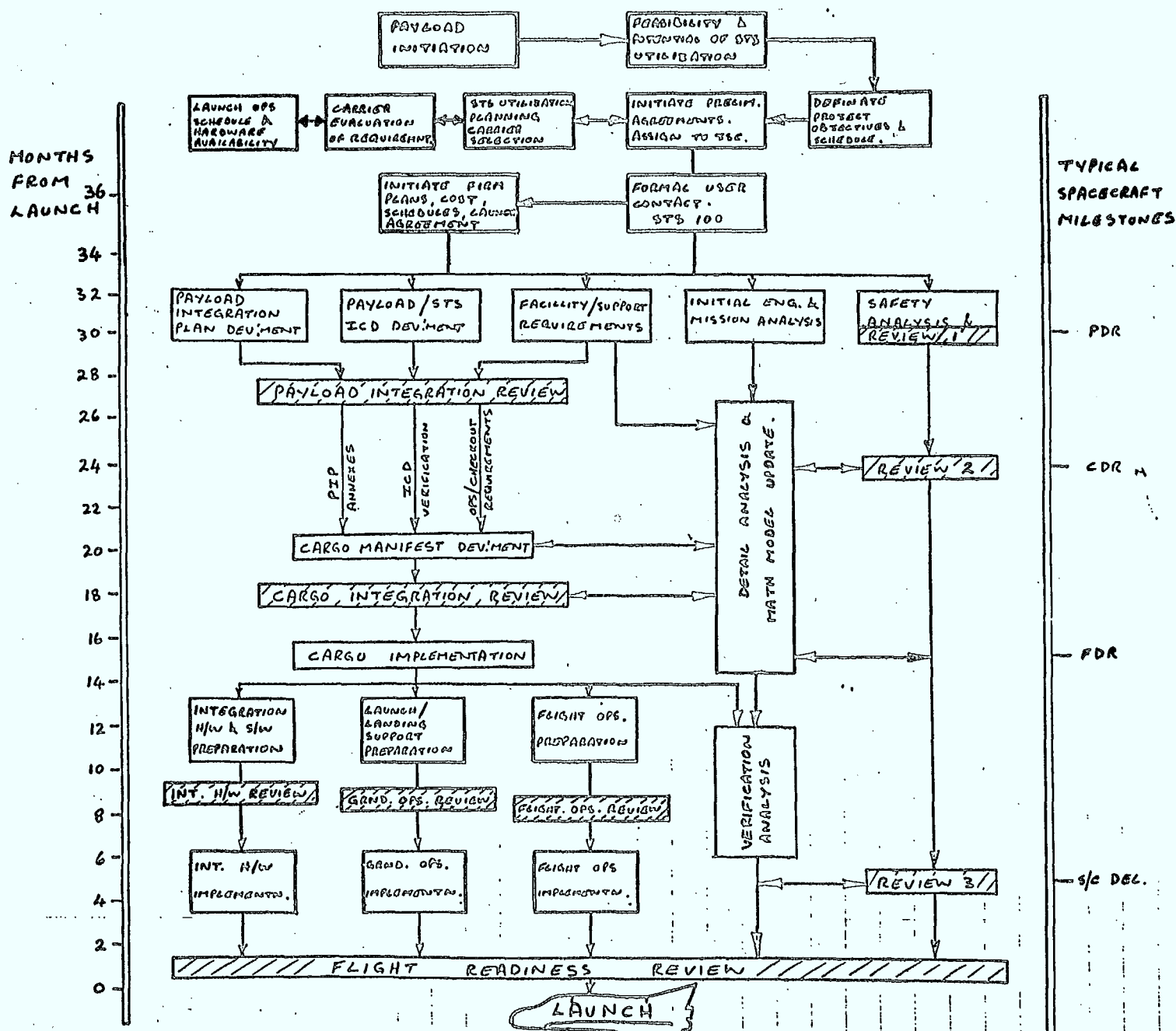


FIGURE 2.5-1: OVERALL FLOW OF ACTIVITIES LEADING TO LAUNCH ON STS

describes the general integration process, provides STS flight and ground system familiarization descriptions, user charge policies familiarization, and definitions of further supplementary material which may be requested by the user. These additional guides, handbooks and informal discussions will cover user charges, flight systems accommodations, extravehicular services, interface control, safety guidelines, launch site accommodations, communications systems capabilities, and support descriptions. This documentation system is designed to make the users somewhat knowledgeable of the STS, and allow him to propose and select payloads which properly make use of the STS provided capabilities.

(b) Formal Contact (STS Form 100), L-36 Months

Once a user has initiated payload activity and has identified his funding and development plans, he completes the STS Standard Form 100 and provides earnest money to the STS Operations Office at NASA Headquarters. SPIDPO representatives meet with user representatives to review the general integration process and to determine the areas of STS support required to meet the payload plans and objectives. If the user brings an integrated payload cargo to the STS Operations Office, integration actively will begin by initiating the cargo manifest verification steps. The cargo integration plan accommodates dedicated users with full flight cargos such as the Department of Defense (DOD) and certain NASA flights as well as individual payload elements which will be manifested into full cargos later in the integration process.

The SPIDPO develops a proposed PIP (CIP for dedicated flights) based on the initial contact. An example of a boilerplate PIP is included as Appendix F to this report. This proposed PIP is given to the user and representatives from STS implementing organizations for mutual development of the approved PIP.

After the PIP has been completed and signed by both the user and the NASA, the STS/Payload XXX PID Book is initiated. This document is the record of agreements, requirements, and management plans that are compiled and developed during the integration process. This document is controlled by the SPIDPO with change approval required by designated user and the NASA. The PID Book will include the PIP Interface Control Documents (ICD's) detailed payload requirements sheets, flight and ground system configuration and utilization requirements sheets, post-flight data product requirements, and hardware/specimen disposition sheets.

(c) PIP L-33 to L-12 Months

Preliminary integration is the process through which the STS implementing organizations become familiar with the proposed payload and its ground and flight requirements and objectives. The information exchange during this process is basically from the user to the NASA. The preliminary integration effort is geared to the development of the PIP.

The STS implementation representatives and SPIDPO meet with the user and review the proposed PIP and identify additional data exchanges and study efforts that may be required to complete the PIP scoping process.

(d) Payload Integration Review, L-27 Months

After the initial requirement documentation and support studies have been completed, the PIR is conducted. The purpose of this review is to approve the PIP in order to initiate engineering integration activities and to initiate development of the information necessary for the cargo manifesting process.

The PIR is chaired by SPIDPO and is attended by the payload developer and key STS implementation representatives. The results of the requirements documentation activity, implementation impacts, and integration study results are reviewed and all STS provided optional services are identified. The product of the review is the approved PIP which is placed in the PID Book. The optional services are identified to the STS user charge representatives who begin cost negotiations with the payload representatives.

The PIP contains payload description, operations scenario, management roles and responsibilities, definition of STS interfaces and environments, safety assessment, optional services, reference documentation, activity schedules which identify the manifesting development support requests and agreements for support provided by both the payload developer and the STS.

(e) Engineering Analysis and Requirements Definition

Engineering analysis and requirements definitions includes the basic engineering requirements for integrating payloads into the STS. These requirements include interface definition supported by thermal analyses, coupled loads studies, weight and center of gravity assessment, EMI and RF analyses, detailed

flight requirements identification, flight profile and operational scenario descriptions, operational constraints, flight crew services, ground operations and flight operations support assessments. The requirements definition and analyses are coordinated through SPIDPO and the results of the studies, which are defined in PIP annexes, are used as support documentation at the CIR. The following PIP annexes are eventually generated as the engineering inputs and analyses are completed:

- Flight design (including non-standard operations
- Crew activities/events sequence
- Payload data package
- On board processing/displays POCC requirements
- Command and telemetry
- Crew compartment stowage
- Training
- Flight operations support.

(f) Cargo Manifest Development

Cargo manifest development is the logical grouping of cargo/payload elements and STS equipment for compatible flight assignments. This activity is concerned with the STS interpreted payload definition and its resulting STS impacts to a sufficient level of detail to permit analytical payload mixing in the iteration process which is used to build the proposed cargo manifest. This activity is performed by SPIDPO subsequent to the PIR or is performed by the user for dedicated flights.

The primary product of the manifest development activity is the Proposed Cargo Manifest. This manifest is the definition of the

major cargo items to be carried on the flight and the supporting material used in the development of the manifest. The manifest will include identification of major payload components, cargo layout configuration, weight and center of gravity definition, and gross timeline and consumables definition. The cargo manifest is the portion of the flight manifest which will be completed prior to the FRR.

After the preliminary cargo manifest has been developed, a draft of the accompanying CIP is developed by SPIDPO with support from representatives responsible for the manifest development process. This preliminary version of the CIP is distributed with the proposed manifest and the current copy of each PID Book to the payload representative for each payload to allow each user to understand the basic operations and constraints associated with operating with the manifested payloads.

(g) Cargo Integration Review, L-18 Months

The CIR is conducted to verify the proposed cargo manifest, establish the combined cargo implementation agreements, integration management responsibilities and to approve the CIP. The CIR is chaired and presented by SPIDPO and is attended by representatives from each manifested payload key STS implementation organization familiar with the previous manifest scoping activities. The final approval authority is NASA Headquarters.

The items examined at the CIR are: the proposed Cargo Manifest and supplementary requirements and studies which were developed during the manifest development process; the proposed CIP; and comments received from each payload representative resulting from individual review of the above documents and the individual PID Books.

The review team documents changes to be made in the cargo manifest and CIP. The recommended cargo manifest is jointly approved by each user and SPIDPO. The CIP is approved and controlled by SPIDPO subject to the agreement identified in the review.

If the CIR identifies items which are in conflict with any PIP or the individual PID Book requirements sheets, the PIP or the appropriate sheets are updated to reflect the new agreements.

The CIP is an integrated version of the individual PIPs and certain PID Book requirements. It contains the summarized results of the CIR; cargo manifest; and operational scenario of the manifested flight, general flight and launch operations support agreements; preliminary trajectory, launch windows, crew size (number of payload specialists) and skills; integration hardware procurement responsibilities and agreements; overall management responsibilities necessary to accomplish the integration activities and identification of any addition or reduction in optional services previously identified in the PIP. The optional services summary is provided to the user charge organization to negotiate reimbursement agreements previously established after the approval of the PIP.

(h). Flight Preparation and Reviews

Flight preparation is a general term which describes the planning and preparation activities associated with flight operations, integration hardware development and ground operations. The CIP, cargo manifest and each STS payload PID book are the basic control documentation used to govern this process. Flight preparation is performed by the STS implementing organizations and each user as specified in the PIP and CIP.

The preparation activity is formally concluded at the appropriate flight, launch or hardware review. Since each of these reviews may impact implementation activities in each others areas, representatives from each area may be required to attend each major review.

For internal NASA reasons, these reviews are conducted chronologically with the Integration Hardware Review preceeding the Ground Operation Review preceeding the Flight Operations Review in the timeframe of L-12 to -4 months.

i) Flight Operations and Network Support Plans

Flight Operations and Network Support Plans are the identification and scheduling document for required flight documentation, plans, and procedures to support the specific STS flight and payload operations. The documentation includes the flight plans, training plans, POCC requirements, data acquisition plans, command plans, flight techniques, STS and payload integrated and standard flight procedures, ground support operating and handbook procedures, detailed flight rules constraints and the onboard STS and payload flight data files.

The CIP contains general product categories and development responsibilities. The implementation planning process completes the definition and content of each of the plans and documents and initiates the activities necessary to complete flight operations preparation. These activities include such things as special POCC support processing and new flight technique development.

The bulk of the flight operations documentation provided by the STS is merely repackaging of standard STS document sets. The bulk of the support manpower is involved with the production of the flight specific parameters, modifications, and techniques.

After an initial set of each of the flight operations documentation items has been completed, a Flight Operations Review (FOR) is conducted. This review is chaired by an STS representative and will include representatives from each payload and each STS area having operations responsibilities. Flight operations plans and documentation are reviewed to assess major issues and are approved at this time subject to the agreements developed during the review. The output of this review is an approved operation plan and documentation set to enter the final phases of training, simulation and inflight operations.

ii) Integration Hardware and Software Development Plans

Integration hardware and software development plans identify tasks, agreements, and responsibilities that are necessary elements to satisfy flight hardware/software to STS integration, flight hardware/software to ground integration, and flight manifest development. This includes methods by which engineering and interface requirements will be verified, and reviews wherein the requirements will be fulfilled. It also includes how and where requirements

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are documented; standard and/or contingency support for design, interface specifications, and test verification specifications. Additionally, the preparation process identifies requirements, schedules, and responsibilities for supplying test hardware, providing test support, and scheduling milestones for implementing hardware/software integration. The Integration Hardware Review (IHR) satisfies requirements leading to manufacture of hardware and provides preliminary approval of the flight manifest.

This review assures form, fit, and function of hardware/software by verifying documentation requirements, engineering design, engineering analyses, and/or test verification requirements. The review identifies the combination of elements which constitute necessary agreements to proceed to manufacture. The test verification of this hardware assures flight readiness.

iii) Launch/Landing Site Support Plans

The ground operations preparation and review activities are concerned with the development of the Launch/Landing Site Support Plans, payload handling procedures and the flight specific test and checkout procedures. This phase concludes with the Ground Operations Review (GOR).

Ground operations detailed planning is accomplished by both the user and the launch site representatives according to the agreements contained in the PID Book and the CIP. Detailed planning involves the definition of the payload detailed

requirements for flow, facilities, and support service which result in the development of the Launch/Landing Site Support Plans. These plans contain the detailed flow plans, facilities, and support equipment use and the STS provided support services. The basic test, checkout, and special payload handling procedures are developed to cover the CIP specified integration functions.

The GOR is conducted to review and approve the launch site support documentation which includes the Launch/Landing Site Support Plans, schedules, handling test and checkout procedures and safety assessment. The completion of the review signifies approval of the implementation documentation with revisions resulting from the review.

(i) Flight Implementation, L-8 Months to Launch

Implementation activities are those tasks which are completed according to the CIP, PID Books, and approved flight preparation documentation. The implementation activities proceed in the three major areas identified earlier; ie., flight operations, integration hardware development, hardware development, and ground operations.

i) Flight Operations Implementation

Flight operations implementation is the accomplishment of the tasks identified in the implementation planning process. These areas include simulation, training, flight and ground support software deliveries, onboard flight data file and ground support operating documentation preparation. The final products of these activities are trained flight (STS

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and payload) crews and ground support teams, flight and ground support systems that will operate in a compatible manner, and a set of support documentation to accomplish the inflight tasks.

ii) Integration Hardware Implementation

Integration hardware implementation is the development and delivery of the new flight integration hardware, if required, in accordance with the Interface Control Document (ICD) requirements, the CIP responsibilities, and the flight manifest. These activities are accomplished according to the implementation planning and CIP agreements.

iii) Ground Operations Implementation

Ground operations implementation activities are those tasks, identified in the Launch/Landing Site Support Plans and the handling, test and checkout procedures identified at the GOR. All payload hardware is delivered to the launch site and is processed according to the Launch/Landing Site Support Plans flow making use of the specified launch site facilities and services. Tests are accomplished in host or support mode by NASA as defined.

The product of the ground operations implementation activities is an assembled set of integrated payload and STS flight hardware and software which has been tested and checked out according to guidelines in the CIP, PID Books, and Launch/Landing Site Support Plan.

(j) Flight Readiness Review, L-1 Month

The FRR is conducted immediately prior to flight and is concerned with verifying accomplishment of tasks, the dispositioning implementation discrepancies which impact the flight schedule, crew or vehicle safety, and potential STS reflight obligations. The FRR Board is chaired by a representative from the STS Operations Office and is attended by key representatives from the flight operations, ground operations, hardware integration, STS management and user management areas.

Final arbitrations are accomplished at this review and individual PIP's and other PID Book items may be modified or updated as a result of the FRR.

(k) Launch, Flight and Landing Operations

Launch operations are conducted according to STS standard procedures and in accordance with CIP and Launch/Landing Site Support Plans agreements. Flight and landing operations are also conducted according to CIP agreements and flight operations implementation details agreed to prior to the FRR. Inflight variations to predefined agreements may be made as necessary by making use of a change procedure involving the user and STS implementor agreeing to the change. The change is controlled by SPIDPO and documented in an inflight modification to the particular PID Book.

(l) Safety Program

The present governing document for payload safety with the STS is a letter from John Yardley, dated June 16, 1976 entitled, Initial Issue of "Safety Policy and Requirements for Payloads Using the Space Transportation

System". Additionally, the reader is directed to the handout material presented by JSC during the authors' visit on April 27, 1978. Both of these documents are included in the Launch Vehicle Documentation Library.

The User has responsibility for assuring the safety of its payload and verifying compliance with the NASA safety policies and requirements. The STS operator evaluates the safety data generated by the User, provides concurrence/approval or other disposition to the payload organization's safety activities and assures compatibility among mixed payloads.

Four safety reviews are held by NASA during the program, conducted by NASA JSC and are normally arranged to coincide with comparable Launch Site Safety meetings at KSC as follows:

- Phase 0 - initial meeting with STS user (conceptual phase)
- Phase 1 - coincide with spacecraft PDR
- Phase 2 - coincide with spacecraft CDR
- Phase 3 - for closeout of Phase 2 items at payload delivery.

The reviews are held with the main purpose of confirming the safety of the NASA crew and equipment, and not confirming the operability of the spacecraft itself.

(m) Postflight

Data collected during the flight is dispersed to the user in a manner agreed to in the CIP and PID Books and defined in the flight operations implementation planning activities. The dispersal of payload specimens returned data samples, payload hardware and

special integration hardware is performed according to CIP and PID Book agreements in a manner defined in the Launch/Landing Site Support Plan.

2.5.2 Detailed Activities and Responsibilities

The various activities performed, during a spacecraft program, by the Payload User, MDAC and NASA, together with the schedule details required to meet the overall STS program are shown in bar chart form in Figure 2.5-2. The figure also shows the major milestone events for a typical spacecraft program.

The normal, standard, activities, services and responsibilities assumed by MDAC for the PAM 3rd stage system and NASA for the overall STS facility are summarized below and include a summary of the applicable optional services and activities available from these agencies to support specific mission/program requirements.

2.5.2.1 MDAC Services and Responsibilities

(a) Standard (Baseline)

The following items, list the standard hardware and services provided by MDAC for the purpose of PAM 3rd stage system buildup, checkout, integration with the spacecraft and STS and launch support.

- o Expendable vehicle hardware
- o Use of reusable airborne and ground support equipment
- o Program Management of the PAM program
- o Baseline PAM-D scheduling and sustaining effort



FIG. 2.5-2 SCHEDULE OF TYPICAL ACTIVITIES PRIOR TO STS LAUNCH

- o Acceptance testing of all PAM components
- o Conduct preship reviews of PAM flight hardware
- o Support Mission Readiness, and other NASA reviews
- o Failure analysis of PAM failed hardware
- o Perform safety analysis of STS/PAM system
- o Perform PAM motor target adjust analysis
- o Perform thermal review based on NASA integrated thermal analysis late in the program
- o Provide Launch Preparation, Mission Readiness and Safety Documents
- o Perform launch site operations and support activities
 - system buildup checkout and balance
 - spacecraft mate
 - transportation from DSTF to VPF
 - mating to CITE in VPF
 - two men on call during on-line operations to support NASA and User
- o Provide inputs to NASA countdown procedure
- o Perform flight control of PAM. MDAC responsible for the mission from PAM turn-on in the orbiter bay through spacecraft separation, except in the case of use of spacecraft active nutation control system where there would be joint responsibility for vehicle stability.

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- o Perform postflight analysis of PAM system

(b) Optional (Mission Specific)

The optional hardware services and activities available from MDAC are listed as follows:

- o Spacecraft Integration Activities, including:
 - Preparation and maintenance of Mission Requirements Document
 - Assistance in providing PAM system inputs into mission specific ICD
 - Support mission and integration meetings with User and NASA
 - Conduct software design review of mission peculiar analyses
 - Perform interface fit check between PAM and spacecraft
 - Provide inputs for PAM/spacecraft safety documentation
 - Provide additional real-time support for flight operations
- o Perform Preliminary Mission Analyses
 - Preliminary trajectory and mission sequence
 - Preliminary STS deployment sequence evaluation
- o Operational Trajectory Analysis
 - Mission Sequence of Events
- o Orbit Dispersion Analysis including covariance matrix
- o Spacecraft Telemetry Tracking Tape
- o PAM/STS and Spacecraft/PAM separation analysis

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- o PAM/spacecraft dynamic loads analysis (2 cycles)
- o Launch Window Analysis (assist User)
- o Dynamic Stability Analysis
- o RF Hazard Analysis
- o Perform Integrated Thermal Analysis (1 cycle)
- o Provide additional mission readiness activities for mission peculiar/non-standard User hardware
- o Contingency planning analysis
- o Mission-peculiar drawings
- o Spacecraft sun shield
- o Active nutation control hardware
- o Spacecraft test marmon clamps, adapter, etc.

2.5.2.2 NASA Services and Responsibilities

(a) Standard

The standard services and responsibilities provided by NASA-KSC and JSC in conjunction with Rockwell International for the STS are as follows:

- o Participation in Payload Design Reviews
- o Furnishing and maintenance of interface documentation (eg: Launch Agreement PIP, ICD, PID, CIP, Interface Drawings)
- o Providing design and operations documentation for the STS

- o Perform interface verification and cargo design
- o Conduct PIR, CIR, IHR, GOR, FRR and Safety Reviews with participation by Users.
- o Perform compatibility Analysis and verification for the complete cargo (structural, thermal EMI, RFI, electrical, contamination, mission, etc.). The structural analyses are performed late in the program to ensure orbiter safety and are not useful for payload design purposes. In addition to the cargo verification thermal analysis, an earlier analysis will be performed in L-24 to L-18 month timeframe in support of CIR.
- o Conduct Safety program including reviews
- o Flight Planning and operations support
- o Utilization planning of the STS system
- o Flight operations planning
- o Flight Design
- o Payload Tracking Telemetry and Command support, (transmission of payload data to POCC, and LCC at ETR)
- o Perform Mission Control Centre operations
- o Preparation and checkout of STS system for each launch
- o Managing shuttle/payload integration, with consultation of the user payload manager

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- o Perform level III, II and I integration
- o Perform on-line (VPF to launch) processing and payload stowage (including CITE)
- o Transportation of payload from VPF to PAD
- o Provide Launch Site Support and Plan
- o Conduct Launch and associated services on schedule
- o Regulate user access to and operation of the payload from the delivery of the payload to the cargo integration facility through the time of separation in orbit or return of the payload to the user.
- o Perform post flight activities
- o 3 man crew (no payload specialist)
- o 1 day of on-orbit operations
- o deployment of a free flyer
- o standard mission destinations from KSC (alt. 160 nmi, incl. 28.5° or 56°)
- o Removal of payload which returns to the prime landing site
- o Removal and return of a payload to the launch site or ferry in orbiter bay in the event of an abort landing at a remote landing site
- o Standard orbiter turnaround time (225 hours assessment)

(b) Optional

The following lists optional services that can be provided by NASA:

- o Perform Payload to carrier integration
- o Perform Payload Mission planning services
- o Perform Payload Data Processing/Data Remoting
- o Use of POCC
- o Provide additional processing facilities
- o Provide special ground communications coverage
- o Coordinate special access/operation of payloads (eg: security)
- o STS/Payload dynamic load analysis (additional load cycles)
- o STS/Payload integrated thermal analysis (additional thermal cycles)
- o Dynamic stability analysis
- o Revisit and retrieval
- o Use of Spacelab, Upper Stages, etc
- o Use of mission kits
- o Preplanned EVA
- o Additional time on-orbit (>1 day per payload)

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- o Launch from Western Test Range
- o Payload Processing (Off-line) Facilities
- Hangers S, AO, etc at ETR
- o Hazardous Processing Facilities (eg
DSTF) at ETR
- o Photo, Repro, Technical Shops, Fuel
Storage, Medical, etc at ETR
- o Off-line transportation, handling, SCAPE
suits, propellant, etc at ETR
- o Time in access of the standard turn-
around time
- o New facilities

2.5.2.3 User Responsibilities

To enable NASA to furnish the proper launch and associated services, the user will be responsible for the following activities, to a time scale as shown in Figure 2.5-2.

- (a) Delivering a flight-worthy payload to the launch site on a schedule compatible with the firm launch date that has been established by NASA.
- (b) Providing associated payload ground-support equipment and personnel required to prepare the payload for launch.
- (c) Providing to NASA all mission requirements and constraints necessary for NASA to provide STS software, optional hardware, operations procedures and other agreed support and services.

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- (d) Incorporating provisions into the payload design specifications and test programs to assure compatibility of the payload with all STS interfaces including cargo integration test equipment and other design and operations restraints that may be encountered during prelaunch and launch activities.
 - (e) Providing to NASA, for review and concurrence, payload design specifications pertaining to the payload interfaces and compatibility with the launch operations; providing test plans for qualification and flight acceptance testing of the payload.
 - (f) Providing to NASA whatever payload telemetry, tracking, and command systems performance data are required to determine that the payload systems are compatible with the NASA network for any network support that is committed by NASA.
 - (g) Providing to NASA all information and documentation regarding hazardous systems of the payload and ground equipment that may be required to confirm compliance with NASA safety requirements.
 - (h) Providing payload discipline training to the NASA crew and to Payload Operations Control Center (POCC) personnel.

2.5.2.4 Analysis Responsibility

For the spacecraft structure dynamic loads analysis, the integrated thermal analysis and the various mission analysis tasks, the activities are broken up into greater detail in Tables 2.5-1, 2.5-2 and 2.5-3, see also the schedule Figure 2.5-2. The tables also show where the responsibilities lie between the various bodies involved - The USER, MDAC and NASA JSC/R.I., and indicate those activities performed as a baseline and those performed as an option.

TABLE 2.5-1

STRUCTURE DYNAMIC LOADS ANALYSIS

Activity	Responsibility			Time-Scale Months from Launch
	User	MDAC	NASA JSC/R.I.	
Preparation of S/C model	*			L-36 to -30
Perform 1st S/C-PAM Coupled Loads Analysis		*	(Optional)	L-30 to -26
Review Results	*			
Verification of model by S/C tests	*			L-26 to -18
Update model	*			
Perform 2nd S/C-PAM coupled loads analysis		*	(Optional)	L-18 to -14
Review Results	*			
Update model	*			L-14 to -12
Perform Cargo Verification Analysis			*	L-12 to -6
Review Results	*	*	*	L-6

TABLE 2.5-2
THERMAL ANALYSIS

Activity	Responsibility			Time-Scale Months from Launch
	User	MDAC	NASA JSC/R.I.	
Preparation of Thermal Model	*			L-32 to -26
Perform integrated thermal analysis		Payload *	Cargo *	L-26 to -18
Review Results	*			
Verification of model by S/C tests	*			L-18 to -12
Update model	*			
Perform Cargo Verification Analysis			*	L-12 to -6
Review Results	*	*	*	L -6

TABLE 2.5-3
MISSION ANALYSIS

Activity	Responsibility			Time-Scale Months from Launch
	User	MDAC	NASA JSC/R.I.	
Launch Window Analysis	*	(Optional)	(Optional)	L -24 to -20
Operational Trajectory Analysis	*	(Optional)	Up to separation from orbiter	L -18 to -14
Mission Sequence of events	*	(Optional)	Up to separation from orbiter	L -18 to -14
Orbit dispersion Analysis	*	(Optional)	(Optional)	L - 15 to -12
PAM target adjust analysis		*		L -15 to -12
Separation - STS/PAM and PAM/spacecraft analysis	*	(Optional)	(Optional)	L - 10 to -7
Dynamic Stability Analysis	*	(Optional)	(Optional)	L -9 to -5
Contingency Planning	*	(Optional)	(Optional)	L -11 to -9
Postflight Analysis	*	*	*	L +

2.5.3 Launch Site Activities

This subject is most adequately covered in the preliminary STS PAM-D Launch Site Ground Operations Plan which is retained in the Launch Vehicle Documentation Library.

The general flow of activities associated with the checkout and launch preparation of individual elements and incremental assemblies is shown in Figure 2.5-3. This is extended further in Figure 2.5-4 to show the detail level of activities for ground handling and checkout. Figure 2.5.4 also indicates the level of responsibility to be assumed by the spacecraft User, MDAC and NASA for each operation.

The day to day schedule of activities in the Delta Spin Test facility is given in Figure 2.5-5 and covers the activities prior to delivery of the payload assembly to the VPF (off-line). The schedule of activities following payload assembly delivery to the VPF (on-line operations) is given in Figure 2.5-6 which also presents the activities and operators involved following transfer from the VPF to the Launch Pad.

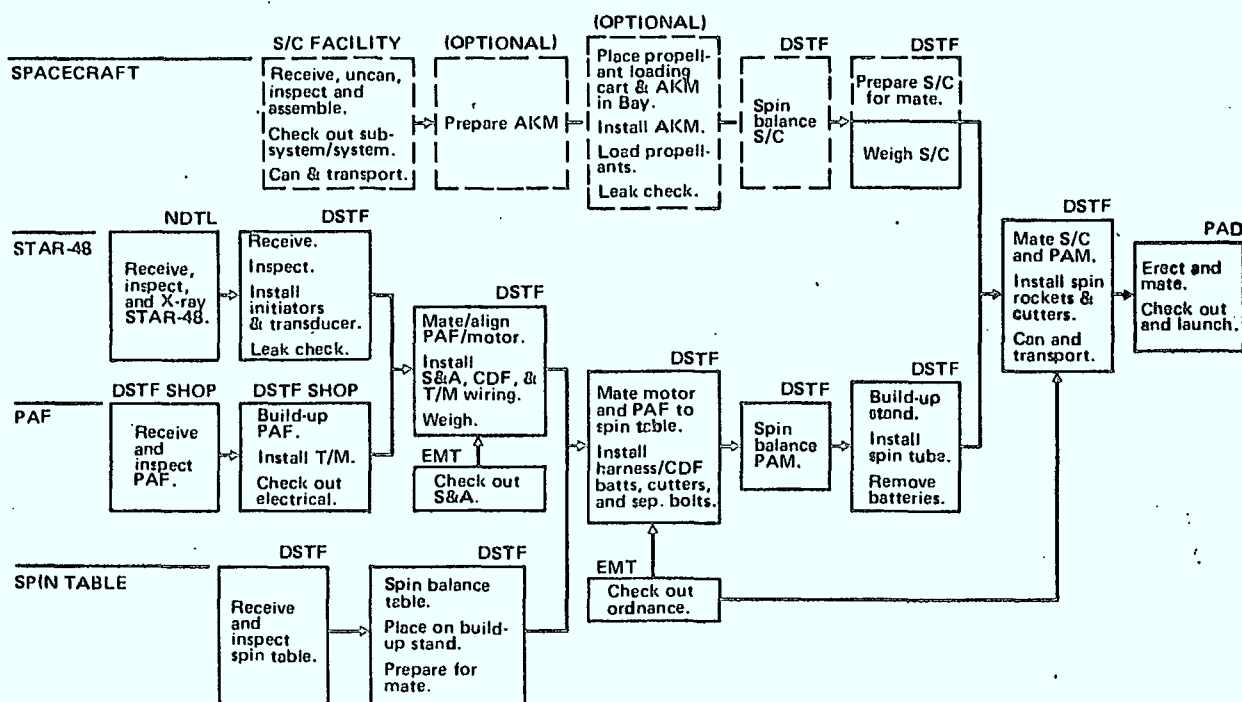
2.6 Charge Policies and Rates

This section of the report presents the current published charge policies and cost data available for the launch vehicles and services of

- (a) STS
- (b) MDAC PAM-D

The basis for STS Charges is best presented in the Space Transportation System, Reimbursement Guide, JSC-11802, February 1978, Final Review Copy (see Appendix E). Other sources include:

- (a) KSC, Shuttle Payloads Launch Site Processing Symposium Presentation Material, 24-25 April, 1978.



NOTES:

SOLID BLOCKS ARE DELTA PAM FUNCTIONS
DASHED BLOCKS ARE SPACECRAFT FUNCTIONS.

DSTF = DELTA SPIN TEST FACILITY
NDTL = NON-DESTRUCTIVE TEST LAB
EMT = ELECTRO-MECHANICAL TEST FACILITY
(OPTIONAL) = ESA-60 OR SAEF-2

FIGURE 2.5-3: LAUNCH SITE FLOW

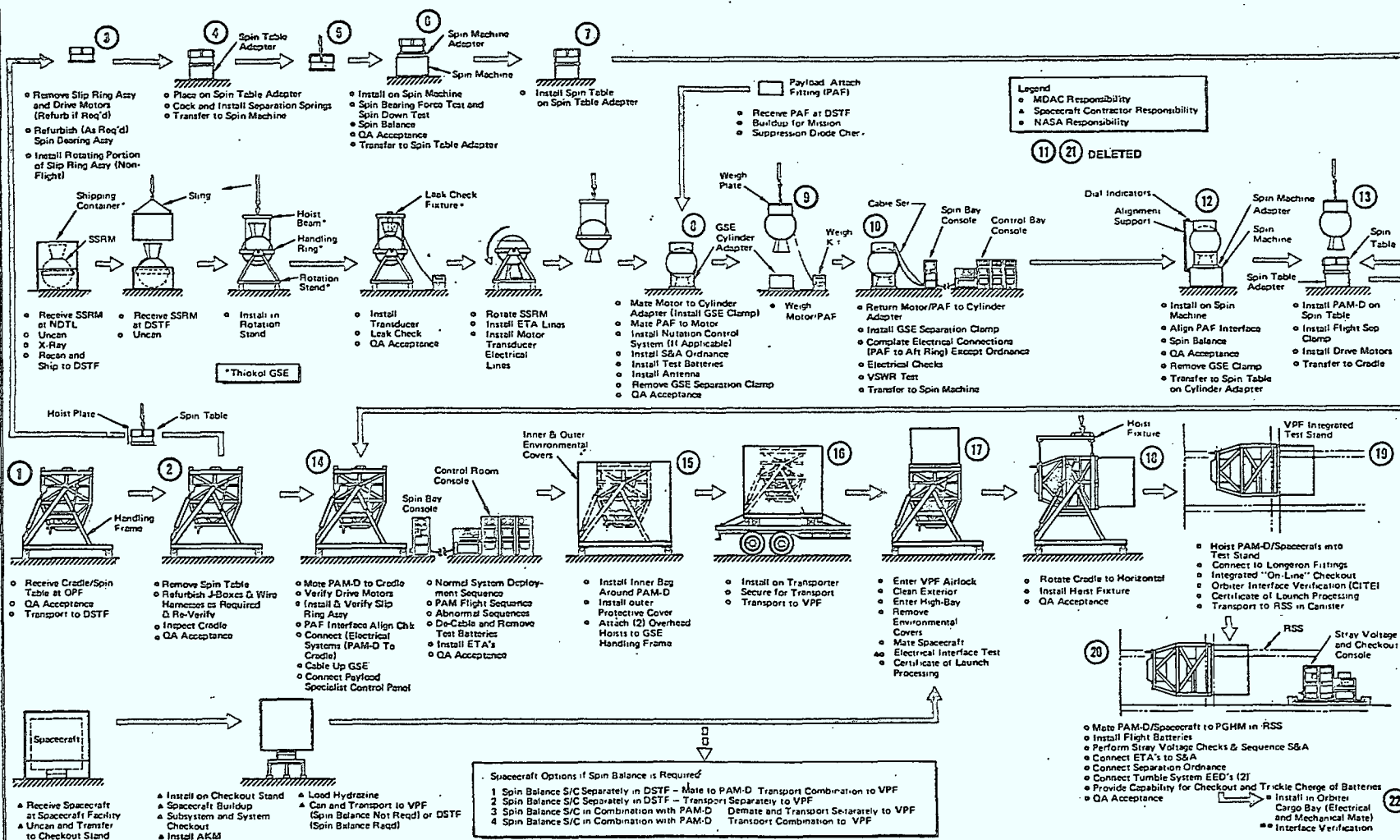


FIGURE 2.5-4: GROUND HANDLING AND CHECKOUT FLOW DIAGRAM
(REFERENCE APPENDIX I, FIGURE I.3-2)

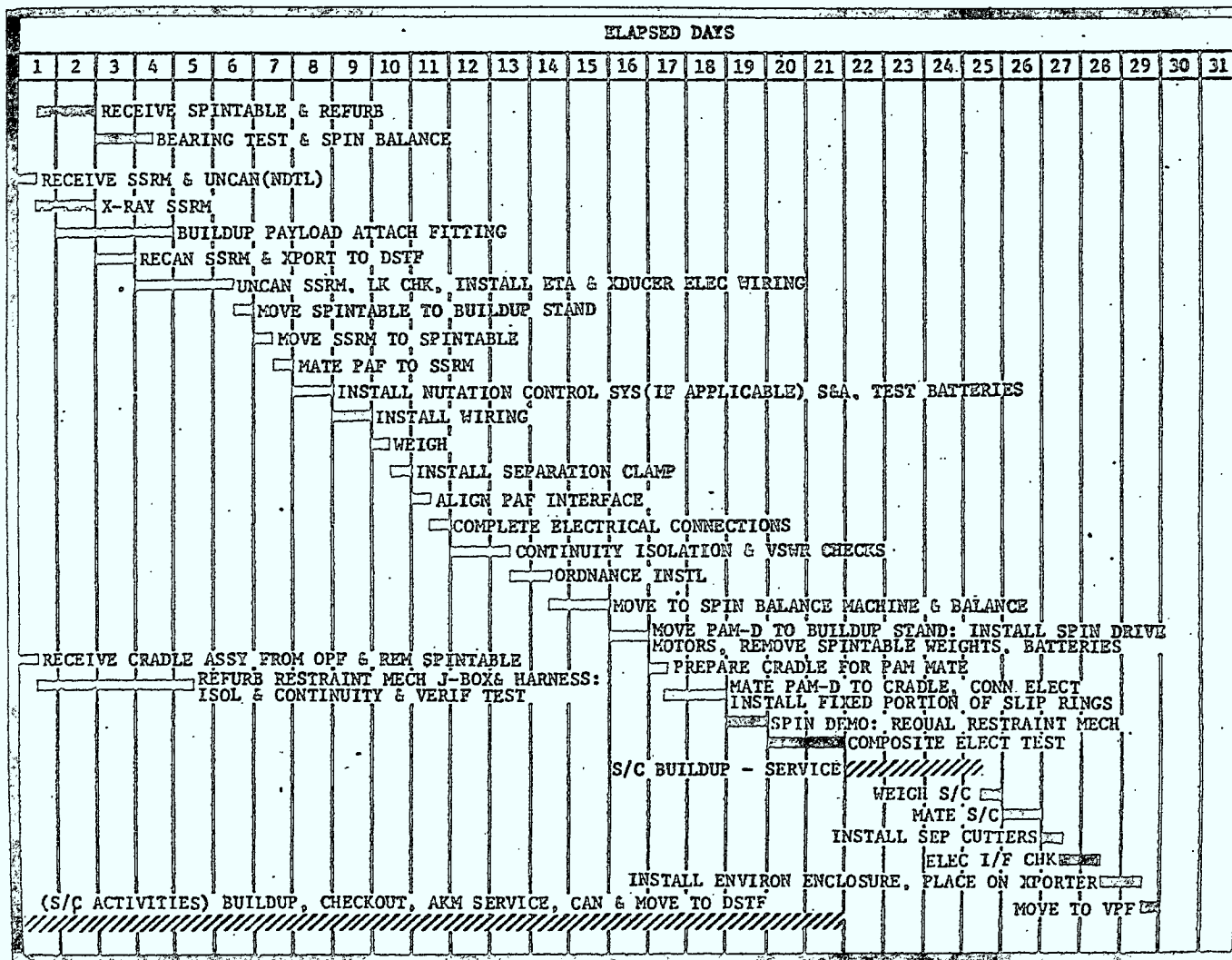


FIGURE 2.5-5: TYPICAL ACTIVITIES IN THE DELTA SPIN TEST FACILITY

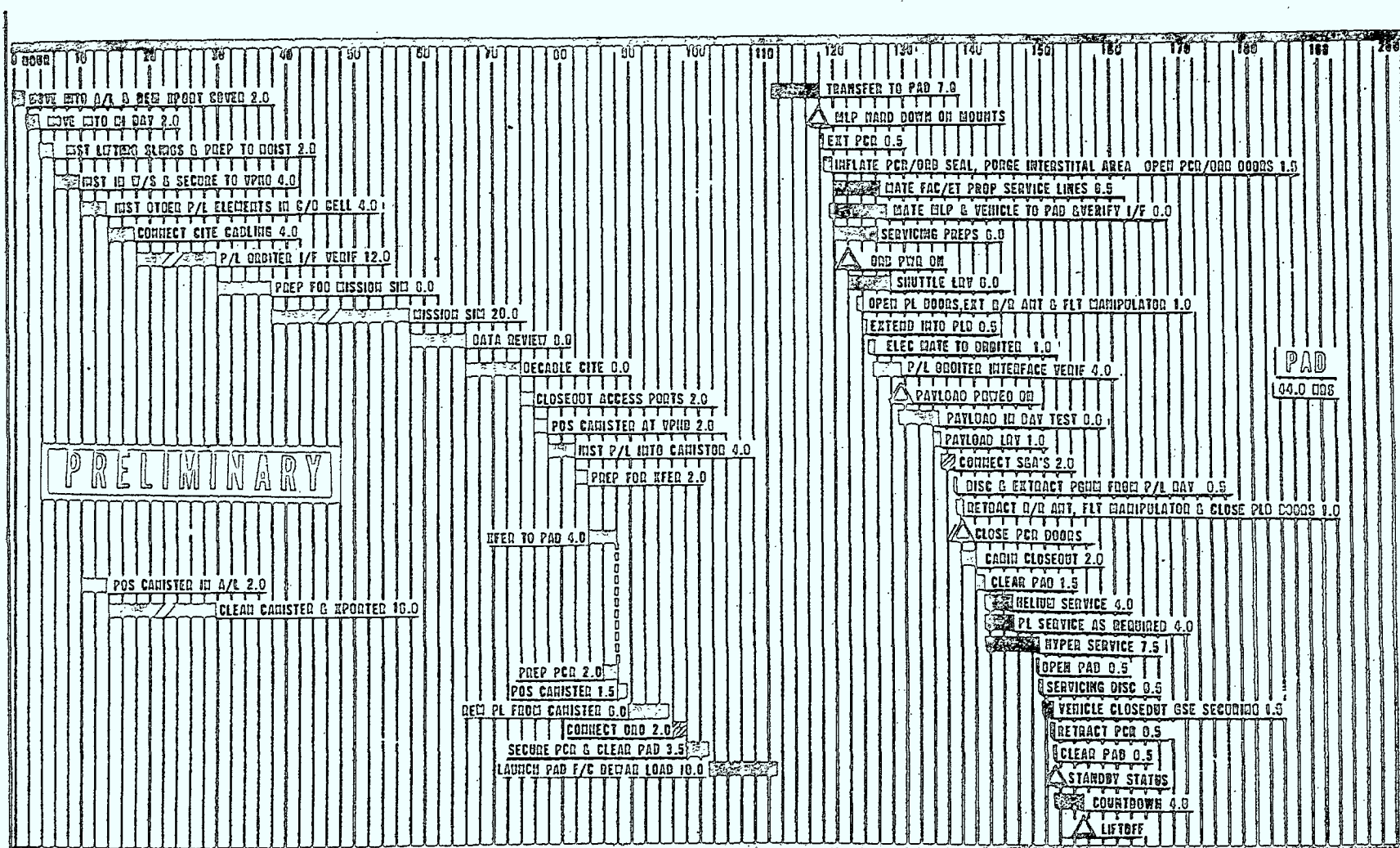


FIGURE 2.5-6: TYPICAL VPF AND SHUTTLE ON-LINE OPERATIONS

- (b) The MDAC Payload Assist Module (PAM), Presentation to Department of Communications (Canada), 20 April 1978.
- (c) Presentation prepared by G. Baker of NASA Headquarters and given at the 1978 Conference on Space Shuttle, 17-18 April, 1978, Los Angeles.
- (d) Authors personal visits to agencies and companies.

The cost analysis for MUSAT, which is derived using data from this section, is provided in Volume II of this report.

2.6.1

Space Transportation System

Rather than attempt to provide a synopsis of the important JSC-11802 document, it has been included in its entirety in this report as Appendix E. The reader should refer to it on the subjects of:

- (a) Basic user charges as a function of user class and type of payload (ie dedicated or shared freeflyer, Spacelab, payload, get away special, etc.)
- (b) Standard services provided under the basic user charges
- (c) Description of optional flight systems including
 - i) flight kits
 - ii) upper stages (if NASA supplies)
- (d) charges for optional flight equipment
- (e) description of optional payload related services
- (f) charges for optional payload related services

- (g) normal & special reimbursement schedules & calculations

Additional cost related information and topics are discussed below.

2.6.1.1 Major Contract Milestones

The STS/User launch services procurement schedule is as follows:

Event	Months Prior to First Launch
Earnest Money Payment and Submittal of STS Form 100	Not Later Than 36
Memorandum of Understanding	
o begin preparation	Not Later Than 36
o signed	Not Later Than 33
Launch Services Agreement	
o begin preparation	Not Later Than 36
o signed	Not Later Than 33
First Progress Payment	33

The earnest money payment of \$100,000 is required

- (a) To provide a significant commitment by the user
- (b) To provide funds to cover NASA support prior to initial progress payment under the reimbursement schedule, see JSC-11802.

STS Form 100, blank copy is included in Appendix G, is prepared by the user as a request for flight assignment and it

- o Provides preliminary definition of user's payload and mission requirements
- o Is used by NASA for flight planning activity
- o Provides basis for beginning detailed discussions toward preparation of launch services agreement

The memorandum of understanding

- o Is required only for non U.S. payloads
- o Is signed by user and NASA
- o Cites general terms and conditions under which NASA will furnish launch and associates services
- o Confirmed by exchange of diplomatic notes
- o Provides governmental assurances of compliance with relevant international treaties

The launch service agreement

- o Is the primary contractual document
- o Contains detailed terms and conditions under which NASA will furnish launch and associated services
- o Is based on published US government policy and regulations
 - appropriate NASA management instructions
 - U.S. government contracting regulations
 - October 1972 Presidential policy statement on launch assistance
- o Is signed by user and NASA Headquarters

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A Table of Contents for this document is provided in Appendix H of this report. The standard launch service agreement draft was presented to a committee of potential users in April of this year and was constructively criticized and sent back for rewrite. It was not available for this report.

2.6.1.2 Standard and Optional Charges

This section elaborates on certain of the standard and optional services presented on pages C-30 and C-31 of JSC-11802 for shared flight users.

Flight Planning Services (see pgs. 1-3 to 1-5 of JSC-11802)

The standard NASA flight planning is related to the orbiter mission up to deployment of the free-flyer only.

In performing the STS mission analysis, based upon the cargo requirements, NASA will determine the orbit trajectory and timeline for events and crew operations. However, specialized analyses such as determination of the ground track and launch window would be custom services which are negotiable. Normally, such analyses would be performed by the user based upon the nominal mission profile provided by NASA.

Any payload mission planning either associated with special spacecraft problems while in the orbiter bay (which require modifications to the standard flight plan (eg thermal constraints) or dealing with post deployment (from orbiter) mission, communications, etc. will be optional, charges TBD. Normally the user/3rd stage supplier would handle this planning.

Communications and Data Transmission

Providing that the user supplies orbiter compatible interleaved command and telemetry PCM bit streams, this data and command capability will be

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available through the orbiter T&C system at the Payload Operations Control Center (POCC), which is at GSFC for earth orbiting freeflyer missions, and at the Launch Control Center (LCC) at KSC. However, transmission to a remote site, such as a Canadian Satellite Control Centre, would be an optional service. An estimate of \$40,000 to \$65,000 per year was estimated by JSC for such a land line connection. There is no way to provide RF interleaved data from the LCC to the spacecraft checkout facility (eg. Hangar S) at ETR. The only payload data which can be transmitted by NASA, from the PAD to the hangars is that which is provided through the orbiter T-O umbilicals. For T-O capabilities see the Core ICD 2-19001.

Some users and NASA are investigating the use of a parasitic antenna to enable RF communications from the S/C at the PAD back to S/C TT&C checkout equipment which will be located at the Hangar. This might be allowable but only before payload bay door closure. The costs for such a system have not yet been addressed by NASA.

The use of a POCC is assured but the charges for these facilities, NASA manpower to provide POCC flight planning and operations support and data reduction and storage systems are all custom and negotiable with NASA. No estimates provided by NASA.

The use of caution and warning (audible or visual alarm) systems in the cabin of the orbiter, and thus additional optional charges, can be avoided if the spacecraft has 3 fold series protection on hazardous systems (eg AKM Safe and Arm). For a standard Spinning Solid Upper Stage + spacecraft geosynchronous mission, the three man crew including mission specialist should be able to handle the payload. Twenty command functions and 20 telemetry channels (of interleaved compatible data) will be available for each payload with CRT

display and keyboard entry by the crew. This is all within the basic charge. Additionally, commands and telemetry could be controlled from the ground via the Orbiter T&C system while the payload is still in the orbiter with verbal communications to the crew. The extra charge for uplink commands may be as high as \$65K US 1975 but could include encryption. The planning, procedures and crew training needed to support NASA flight operations is normally in the basic charge unless there are significant additional and constraining payload operations to be performed (eg continuous battery monitoring). In addition to the payload allocation, MDAC have received 40 commands and telemetry channels for the PAM itself. It is not expected that the geosynchronous communications satellites will incur any optional charges of this nature for payload control in flight prior to deployment.

KSC Launch Site and Services

All of the off-line processing at the ETR (CCARS), from the point where the spacecraft arrives at the site until the payload with mated upper stage is delivered into the Vertical Processing Facility for installation as part of the Cargo, is an optional charge. Many of the activities and services required during this time period are MDAC conducted and supplied as described below in Section 2.6.2.

The use of the payload processing facility (eg: Hangar S) and the Delta Spin Test Facility carries an optional occupancy fee of 1326 \$ US, 1975/day plus a use fee, where applicable, of 1007 \$ US constant/day for maintenance electricity and depreciation. Clean room occupancy is additional cost which has not yet been provided by NASA.

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Other non-basic costs include:

i)	Communications between facilities at KSC (25 days)	\$ 12,500 US 1975
ii)	Scape suits in hazardous facilities (5 days, 2 shift)	\$ 1,000 US 1975
iii)	Safety monitoring of hazardous operations (25 days)	\$ 16,250 US 1975
iv)	Launch site support management - non-recurring (3 yrs.)	\$120,000 US 1975
v)	Launch site support management - recurring (25 days)	\$ 33,750 US 1975
vi)	Propellant handling	\$ 350 US 1975
vii)	Others, unspecified	\$ 500 US 1975
viii)	Overhead (desks, security)	\$ 23,620 US 1975
	Subtotal	\$207,970 US 1975
ix)	AKM motor storage	\$ 54/week
x)	Facility modifications required by the user	actual cost

Launch Schedule Definition and Slippage

For users of a dedicated flight, 3 years before the desired launch date, NASA will identify a launch time with a 3-month period. One year before the flight, firm payload delivery and launch dates will be negotiated with NASA. For shared-flight users, 3 years before the flight the desired launch date will be identified with a 90-day period. One year before the flight, a payload delivery date and a desired launch data will be coordinated among the shared-flight users and negotiated with NASA.

The cargo arrives at the PAD at T-72 hours. The STS arrives at T-48 hours (assessment) and the cargo is installed at T-32 hours. It is anticipated that the doors will be closed at T-16 hours. If the payload causes a slippage in the launch time/date before the STS is transported to the PAD, 3 days will be allowed without penalty. If, however, the STS is at the PAD the charge will be \$13,750 US, 1975 per hour on a 16 hour per day basis (\$220,000/day).

Engineering Analysis

RI indicated that if the user requires additional front-end design analyses, they could be expected to cost

structural (coupled)	\$46K per cycle
coupled thermal	\$50K

JSC indicate that an additional coupled thermal analysis would cost \$70K. Note that the standard analyses are for the nominal mission only. JSC stated that the cargo bay structural model could be provided to the user for approximately \$20K and thermal models of the cargo bay are available at no charge. However, the thermal models would be very costly for the user to run.

It is still being debated whether a cargo RF compatibility analysis will be a basic or a mandatory optional service. No cost estimates were provided by NASA.

2.6.1.3 Terms, Conditions and Liabilities

The summary of terms and conditions, page 1-9 from the STS User Handbook, is reproduced below.

"Use of the Space Transportation System involves certain terms and conditions imposed on both the User and NASA. Some of the more important ones are summarized here.

Reflight Guarantee

For US Government users, a reflight guarantee is included in the flight price. Other users can buy reflight insurance at \$271,000 US 1975. The following services are provided under this guarantee.

- (a) The launch and deployment of a freeflying payload into a Shuttle-compatible mission orbit if the first attempt is unsuccessful through no fault of the user and if the payload is provided by the user.
- (b) The launch of an attached payload into its mission orbit if the first attempt is unsuccessful through no fault of the user, if the payload is still in launch condition or if a second payload is provided by the user.
- (c) The launch of a Shuttle into a payload mission orbit for the purpose of retrieving a payload if the first retrieval attempt is unsuccessful (this guarantee applies only if the payload is in a safe retrievable condition).

This reflight guarantee will not be applicable to payloads or upper stages required to place payloads into orbits other than the Shuttle mission orbit.

Other conditions of STS use include the following.

Damage to Payload

The price does not include a contingency or premium for damage that may be caused to a payload through the fault of the US Government or its contractors. The US Government, therefore, will assume no risk for damage or loss of the user's payload; the users will assume that risk or obtain insurance protecting themselves against such risk."

Also, the U.S. government will not be liable for loss of user revenue, profits and other indirect or consequential damages when due to a launch failure.

"Revisits and Retrieval Services

These services will be provided on the basis of estimated costs. If a special dedicated Shuttle flight is required, the full price will be charged. If the user's retrieval requirement is such that it can be accomplished as part of a scheduled Shuttle flight, the user will pay only for added flight planning, unique hardware or software, time on orbit, and other extra costs incurred by the revisit.

Patent and Data Rights

NASA will not acquire rights to a non-US Government user's inventions, patents, or proprietary data that are privately funded or that arise from activities for which a user has properly reimbursed NASA. However, in certain instances, NASA may obtain assurances that the user will make available the results to the public on terms and conditions reasonable under the circumstances. The user will be required to furnish NASA sufficient information to verify peaceful purposes and to ensure Shuttle safety and compliance with law and the U.S. Government's obligations."

User Liabilities

Property Damage and Injury to Launch Participants

Each user shall agree not to bring any action and not to indemnify every other user and the U.S. government against any claims for damage to his property or personnel. This is a no-fault concept wherein the user may self insure or purchase commercial insurance (up to \$100M per Shuttle flight should be available for this type of service). With this concept, lobbying by expensive payloads to fly

with inexpensive spacecraft will be minimized and cargo manifesting flexibility will be retained by NASA. In return, the U.S. Government shall agree not to bring any action against a user for damage to U.S. Government facilities, including the STS.

Proposal Policy for Third Party Liability

This policy is still to be settled, but the present philosophy being investigated by NASA (reference G. Baker, NASA Headquarters, August, 1978) is as follows:

- i) Each user shall obtain insurance (at no cost to NASA) to cover the U.S. Government against all third party claims related to the user's payload (including upper stages) after separation from the Shuttle in orbit. This concept fulfills the provision for prior apportionment of liability under United Nations convention on international liability for damage caused by space objects.
- ii) It is likely that NASA will insure the total vehicle, acting as an agent for all users, against all third party claims resulting from failures occurring prior to payload separation from the orbiter. Charges and claims would likely be pro rata based on either the charge or load factor.

There is some concern within NASA regarding the limited availability of launch insurance underwriting funds (\approx \$600M) within the free world community. This could cause an allocation problem in the case of a multipayload cargo launch failure causing third party damages, since the first user to settle could consume most or all of the available money pool. In the event of a claim originating in the United States, for the non-separated payload condition, U.S. law will determine the share of liability but the total NASA procured insurance would be utilized before further liability is assigned.

2.6.1.4 User Purchased Insurance

The authors spoke to Mr. G. Frick, of Marsh & McLennan, New York, who are one of the main aerospace insurers, having handled Marisat, Comstar and Satcom.

He confirmed the present NASA policies and indicated that the major underwriters consider the STS system, because of its manned safety requirements, a better risk than the present Expendable Launch Vehicles (ELV). The insurance rate of 6 percent of insured value is presently considered reasonable for property damage and personal liability coverage for launch on STS with the no-fault concept as compared with the customary 9% rate, no deductible, with ELVs.

Third party coverage is expected to cost less than \$100K, 1978, for a \$300M limit.

Mr. Frick also stated that satellite life insurance is available for on-orbit performance, taken by the user, or loss of on-orbit incentives by the prime contractor. Also, lost revenue due to a launch or on-orbit failure can be insured including coverage for the insurance premium associated with the backup launch. A benchmark of 6% of the value insured would also likely be applicable for these types of insurance, which in the case of on-orbit performance would cover three years of operations. The capability, with the STS, to check out a satellite in space in the orbiter bay prior to deployment, plus the overall lower launch environmental loads expected with this launch system, causes the underwriters to assign a better risk for long life after an STS launch as compared with that of an ELV.

2.6.2 MDAC Payload Assist Module

The cost information presented in this report for the McDonnell Douglas Payload Assist Module was received during the visit April 20, 1978, see presentation handout material which is retained in the Launch Vehicle Documentation Library.

2.6.2.1 Standard Charges

The basic PAM-D package offered by MDAC, discussed in section 2.5.2.1 (a) of this document, will cost \$2.1M, January, 1980, U.S. In summary, this includes:

- (a) Expendable vehicle hardware.
- (b) Use of reuseable ASE and GSE.
- (c) System build up/checkout/spacecraft mate.
- (d) Standard launch analyses, coordination and support.
- (e) Development program amortization.
- (f) Documentation (mission readiness, safety, etc.).

2.6.2.2 Mission Specific Charges

Typical mission specific tasks will cost:

\$800K for the initial mission, 1980 U.S.

\$200K for repeat (identical) mission(s), 1980 U.S.

see package description, section 2.5.2.1 (b) of this report. Within these tasks, the spacecraft/PAM integration activities would account for \$200K and the spacecraft/PAM dynamic loads analysis (two cycles) for \sim \$200K. The remaining \$400K would be distributed approximately equally across the remaining tasks.

Note that MDAC indicated that PAM structural models could be provided to the user, including education, for approximately \$15K if the user wishes to run his own analysis.

The additional user mission specific tasks not covered in the \$800K package, include:

- (a) User test hardware (eg: fixtures, marmon clamps, etc.).
- (b) Mission unique hardware (eg: special thermal control).
- (c) Special analyses, support, services, etc.).
- (d) Incremental additional performance.

At the time of this writing, the author has received verbal information from Mr. M. Schmitt, Director-Marketing, MDAC, indicating that most users are going to employ a MDAC spacecraft sun shield (called the PAM-D PRAM cover) for thermal control which will cost \approx \$50K per flight, 1980 U.S. This sun shield will add 50 lbs to the ASE weight but it will not add to the overall length in the orbiter bay. Examples of other items in this category would be:

- i) Active Nutation Control provided by MDAC and not by the user's spacecraft.

Cost = \$300K, 1980, U.S. for the first mission
\$165K, 1980, U.S. for repeat missions
and,

- ii) Attach fitting, marmon clamps (2) and bolt cutters to be used for spacecraft vibration testing.

Cost = \$70K, 1980 U.S.

Finally, Mr. Schmitt indicated that based on the number of intangibles remaining during the planning stages of a spacecraft program, it would be wise to add \$200K to \$500K, U.S. 1980, buffer to the first mission \$800K for planning purposes.

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On the subject of incremental performance, MDAC are prepared to provide the following separation weight capabilities for the baseline transfer orbit:

up to 2320 lbs.	basic price
2320 to 2550 lbs.	△ \$150K, U.S. 1980/mission
2550 to 2750 lbs.	△ \$200K, U.S. 1980/mission

The jump from \$150K to \$350K additional is associated with amortization of the redevelopment costs required for the perigee kick motor. This price delta is payable at program start.

2.6.2.3 Reimbursement Schedule

The reimbursement schedule for standard and mission specific charges, excluding incremental performance costs, is as follows:

<u>Months</u> <u>Prior to</u> <u>Launch</u>	<u>STS PAM %</u> <u>AGE Total</u>
Upon Agreement	2%
30	10%
27	7%
24	7%
21	7%
18	7%
15	7%
12	7%
9	17%
6	17%
3	6%
Launch	<u>6%</u>
TOTAL	100%

with payments escalated to then year dollars. For launches in the 1983 timeframe (i.e. operating phase) there would not be any penalty for late signup. Now, during the development phases, penalties are being considered.

2.6.2.4 Insurance and Liability

MDAC, under the no-fault insurance concept, are self insuring for failures of the STS, PAM and spacecraft. They will not bring any action against users.

The price quoted above does not include any reflight warranty or incentive/penalty provisions. It is the equivalent of ELV contracts. MDAC, however, are willing to negotiate a reflight guarantee and incentives for on orbit performance (eg: injection dispersions), but no costs are available at this time.

MDAC will not insure the user for replacement of the spacecraft or reimbursement for lost revenue, and the user is expected to cover himself for third party liability.

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3.0 ARIANE LAUNCH SYSTEM

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The European Ariane Launch System consists of a three stage liquid propellant launch vehicle with inertial guidance, and the launch management and services associated with a launch from CSG (Centre Spatial Guyanais - Guiana Space Centre) through to injection of the payload from the third stage. The pricing policy is based on making Ariane competitive with other launch systems, and in the case of Delta class payloads, two payloads can be launched together further reducing the launch cost per payload. The information received to date on the tandem SYLDA Launch system (Système de Lancement Double Ariane) is preliminary due to the early stage of development of the hardware and is therefore subject to change.

This section presents descriptions of the following:

- ESA Ariane organization
- The Ariane launcher
- Launch site and operations
- Schedule of activities and responsibilities
- Ariane charge policy

3.1 ESA Ariane Organization

The launching of a payload by Ariane requires the preparation of documentation and the implementation of tasks according to a certain timetable. This section outlines the ESA Ariane organization that the User deals with in the planning and preparation of his launch.

Figure 3.1-1 indicates the current Ariane Program Office at ESA Headquarters in Paris. This office has on-call, appropriate expertise from ESTEC and CNES. During the feasibility study phase, the User deals with the Head of the Payloads Division in the Ariane Program Office, who coordinates the informal support from ESA.

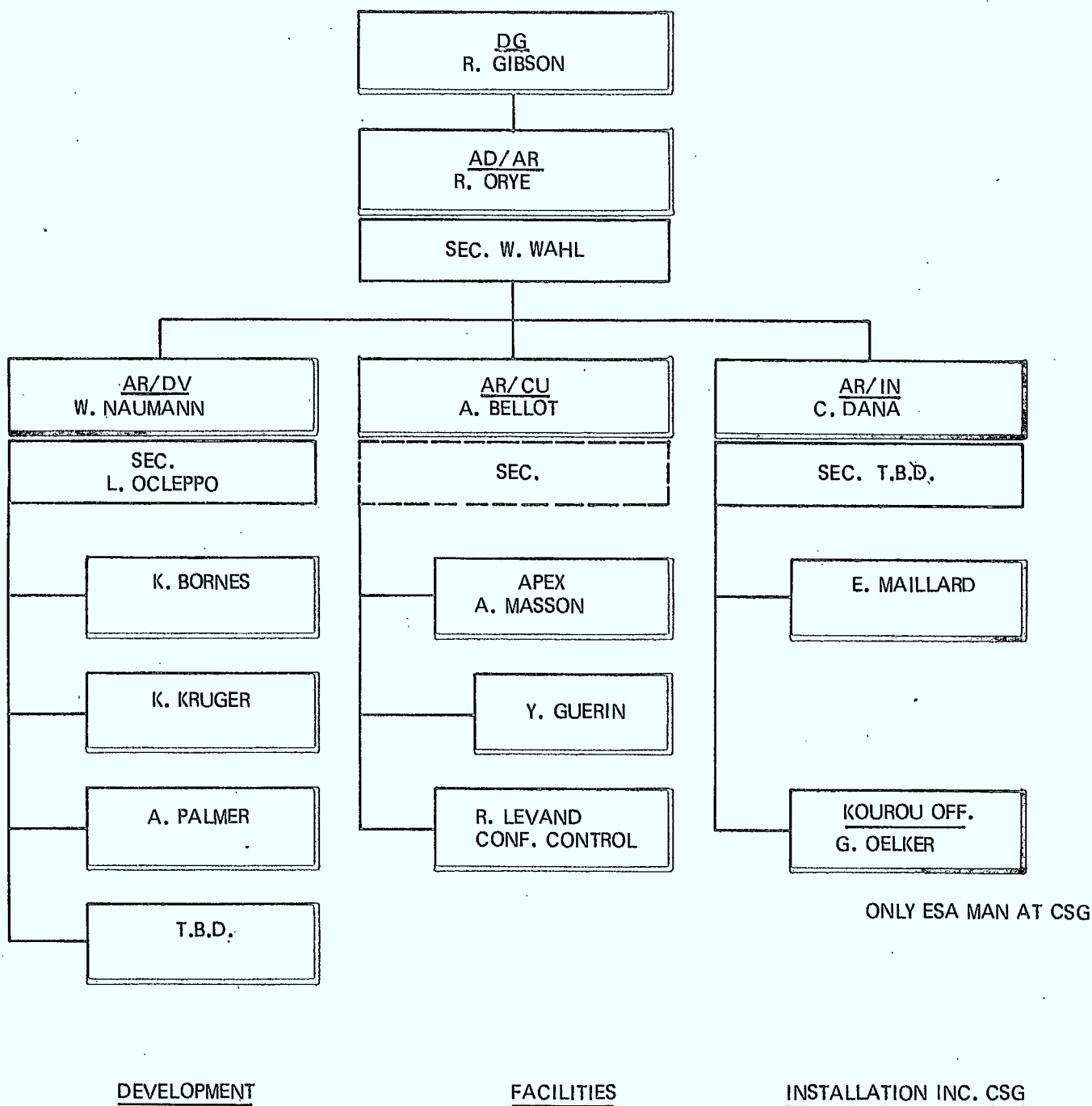


FIG. 3.1-1

ARIANE PROGRAM OFFICE ORGANIZATION

When the customer, after a favourable feasibility study, decides to use the Ariane launch system, the Ariane Program Management appoints:

- (a) A Project Officer in charge of technical relations with the spacecraft project and of relations with the CSG concerning safety matters. He is responsible for seeing that all the documentation defined in paragraph 6.2 of the Ariane User's Manual AR(75)01 is prepared.
- (b) A Mission Head who coordinates all the operational aspects and relations with the CSG concerning preparation and execution of the launch. He is assisted by a Payload Operations Assistant with special responsibility for operational coordination with the Payload Preparation Officer.

If the payload comprises several satellites, a single Payload Officer will be appointed vis-a-vis the launch vehicle with the task of coordinating the internal interfaces between the satellites.

The organization chart in Figure 3.1-2 shows the various services which take part in the drafting of documents.

3.2

The Ariane Launcher

An overview of the Ariane flight equipment, performance capabilities for inserting payloads into transfer orbits for geosynchronous missions, and the planned payload accommodations including the use of the SYLDA (Système de Lancement Double Ariane) is given in Appendix J. Further information on the launcher and its capabilities are given in the Ariane User's Manual. A complete listing of known Ariane related documents is presented in Appendix D.

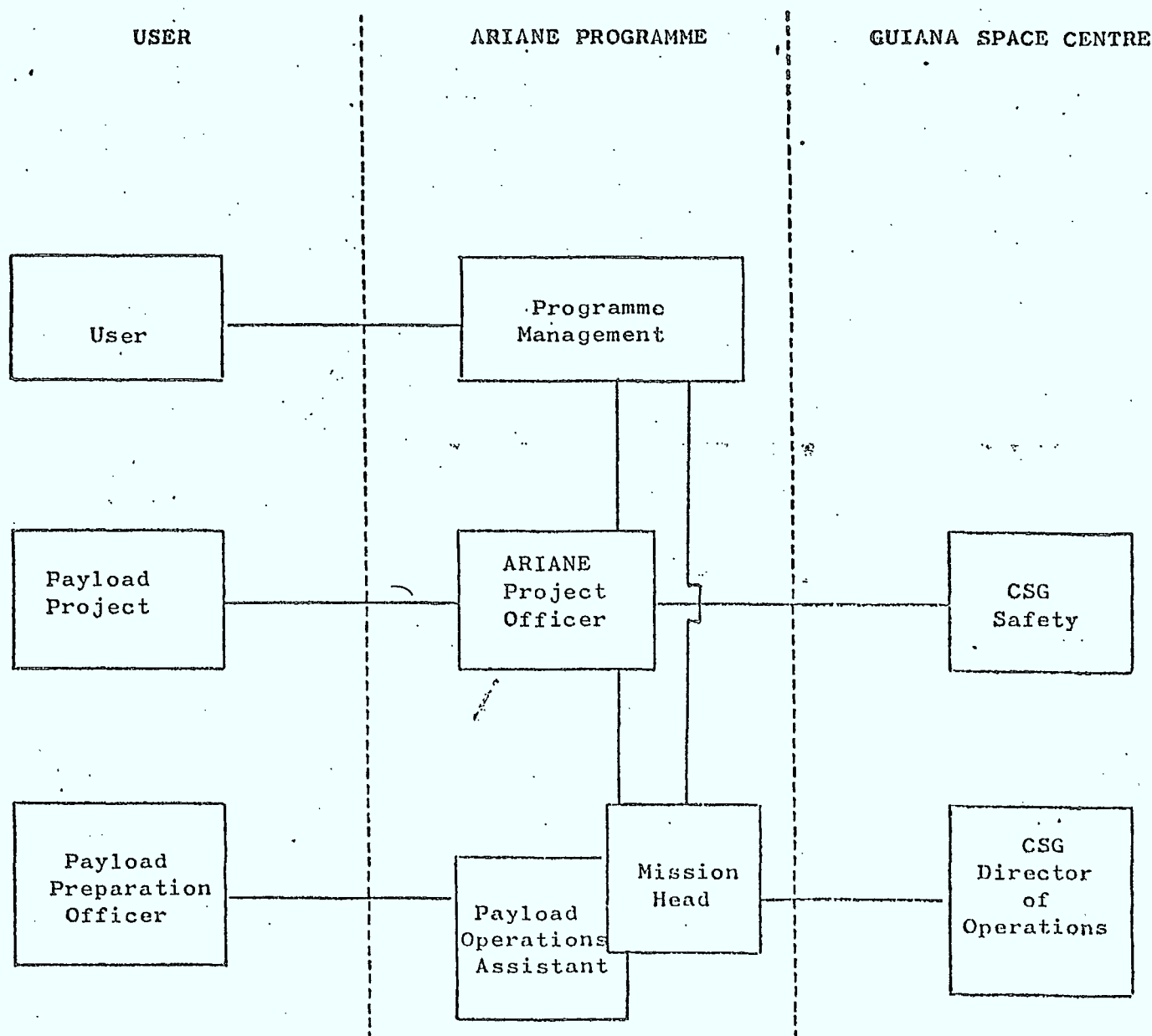


FIGURE 3.1-2: ORGANIZATION CHART - LAUNCH TRANSPORTATION PHASE

At the writing of this report, the proposed development plan was as given in Figure 3.2-1. The progress was very much according to plan, except that a possible problem with the nozzle throat inserts in the first stage engines could delay the first development flight to September, 1979. This delay, however, would not affect the proposed date of December, 1980 for Ariane to become operational, because of the built-in margins provided in the development schedule.

3.3 Ariane Launch Site and Operations

A description of the launch site and technical facilities available at the CSG ("Centre Spatial Guyanais" - Guiana Space Centre) for launch preparation and the launch of a payload is given in Appendix J. More information is to be found in the Ariane User's Manual AR(75)01 and in the to be published CSG Manual.

3.4 Schedule of Activities and Responsibilities

This section describes the activities in chronological order that lead to the launch on Ariane. The section identifies the responsibilities for the various tasks between the user and the launcher authority. This section also outlines the overall flow of activities, the documentation, its scope, timetable, and milestone reviews.

The launch vehicle user initiates the effort by carrying out satellite preliminary designs, and mission analyses with respect to the Ariane launch vehicle. In carrying out this feasibility study, the user has access to the Ariane User's Manual AR(75)01, Reglement de Sauvegarde (Safety Rules) and the CSG Manual. This is supplemented by informal support from the Launcher Authority. Once the feasibility of mission on Ariane is established, and the project has been approved for implementation by the User's organization, the User is ready to initiate a

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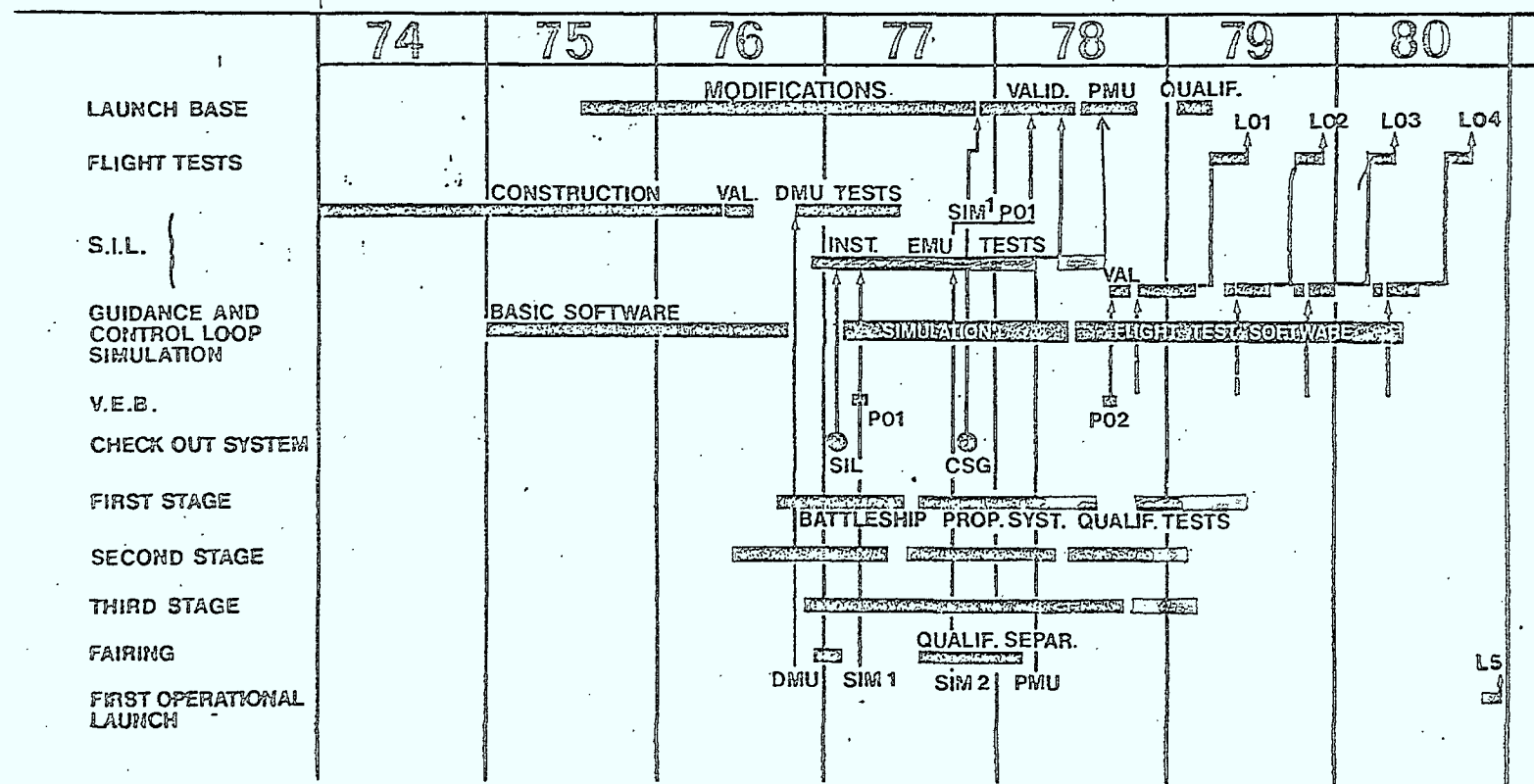


FIGURE 3.2-1: GENERAL PLANNING OF ARIANE SYSTEM

formal contact with the Launcher Authority. Figure 3.4-1 summarizes in bar-chart form, typical program flow, documentation exchange, responsibility and the significant milestones. The following section 3.4.1 defines the type and scope of the formal documentation and section 3.4.2 outlines the activities and constraints associated with the seven days prior to launch at the launch site.

3.4.1 Formal Documentation

3.4.1.1 Application to Use Ariane (D.U.A.)

The purpose of this application is to define the satellite's requirements with regard to mission and trajectory, dynamic, thermal and radio environment, accessibility and radio transparency, ground and umbilical cabling, the fluids used, requirements at the CSG, etc. It also contains a brief payload development plan and the scheduled tests. It provides a description of the satellite and supplies answers to the Safety Questionnaire with respect to hazardous systems.

The submission of this document formalizes the first contracts between Ariane and satellite authorities, with a view to drafting the other documents, in particular the Launch System/Payload Interface Control File (D.C.I.). It does not need to be updated after the latter has been agreed.

It should, in particular, specify requirements that are at variance with the information given in Ariane User's Manual, Chapter 3 "Launch Vehicle/Payload Interface". The form of the Application to Use Ariane is shown in paragraph 6.4 of the User's manual.

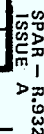


FIG. 3.4-1 TYPICAL PROGRAM FLOW & DOCUMENTATION EXCHANGE FOR ARIANE LAUNCH

3.4.1.2 Launch System/Payload Interface Control File (D.C.I.)

This file which responds to the D.U.A. collates all the data common to the launch system and the satellite. It lays down a procedure for managing modifications of the launch vehicle/satellite data and is updated as the project progresses.

The format of this document, as indicated in paragraph 6.5 of the Ariane User's Manual, is designed so as to provide a clear basis for generation of more detailed operational documents.

3.4.1.3 Mission Analysis File

Mission studies are carried out in a number of phases during the execution of the project, using the most recent data provided by the launch vehicle and satellite authorities.

Such studies include:

- (a) The flight plan, including data on tracking, performance, injection accuracy and the flight sequence;
- (b) Data relating to kinematic conditions at launch vehicle/payload separation;

If the satellite's structural data requires a more thorough study of the dynamic environment, the satellite authority must produce a dynamic model using finite elements and the launch vehicle authority must provide a launch vehicle/satellite coupled analysis with a view to checking that the constraints on the usable volume have been observed, defining in detail the static and dynamic loads at various levels of the satellite and determining the dynamic environment at sensitive points on it. Coordination between user and launch vehicle authority must make it possible to define the satellite model data format and to

select the types of result required. If the structure does not reveal serious difficulties with regard to dynamic environment, a mass-stiffness model of the satellite is more appropriate.

With regard to thermal environment, a thermal model of the satellite and a detailed study of the environment are only made if the satellite/launcher interface is particularly sensitive in this respect. In such cases, the satellite authority supplies a Thermal Mathematical model appropriate to this study.

3.4.1.4 Payload Environment Plan

The satellite authority supplies the launch vehicle authority with the payload environment test plan describing the static, dynamic (sinusoidal, random and acoustic) tests, and shock tests. This test plan makes use of the dynamic coupled analysis described in the previous paragraph.

3.4.1.5 Safety Submissions

The safety submissions aim at a mutual understanding of problems and their solutions from the start of the project, so as to avoid loss of time and money resulting from late modifications to the design or fabrication of systems classed as hazardous by the CSG. The documents relating to a given project are submitted in three phases.

Phase 1 The payload contractor prepares a file containing all documents needed to inform the CSG of his plans with regard to hazardous systems. This file contains all the replies to the questions put in paragraph 6.3.4.5 of the Ariane User's Manual AR(75)01. The CSG studies this file, notifies its classifications of the hazardous systems submitted to it and states any special requirements of the Safety Department.

Phase 2 The payload contractor supplies the hazardous systems manufacturing file, which must comply with the requirements stated by the CSG at the end of Phase 1. He also supplies information necessary for producing the equipment or facilities at the CSG that will have to be used during the launch campaign. Finally, he states the policy for checking and operating all systems classed as hazardous.

The CSG checks that the manufacturing file conforms to the requirements specified in Phase 1, states its intentions for checking systems classed as hazardous, and indicates the proposed procedure to be followed during flight.

Phase 3 The payload contractor submits a procedure for checking and operating systems classed as hazardous, which sets out the checking policy, together with details of its execution.

The CSG negotiates such changes as it considers necessary and accepts the procedure, which then becomes the sole authorized document to be applied by the payload contractor during the campaign under the control of the CSG Safety Department.

All activities taking place in hazardous areas or relating to systems classed as hazardous must be the subject of procedures written and approved by the CSG Safety Department.

The CSG lays down the procedure for intervention in flight.

3.4.1.6 Application to Use the Network

The object of the Application to Use the Network is to define the user's requests concerning the ground communications facilities he wishes to have available for his satellite after lift-off.

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The ESA network currently planned for 1980 comprises telemetry and telecommand stations equipped in VHF 136-138 MHz and 148-149.9 MHz, the utilization of which is centralized at the ESOC control centre in Darmstadt. Subject to its availability, this Network could be used for the payloads. The request for use of the Network must be made with the Application to use Ariane.

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3.4.1.7 Plan of Payload Operations on the CSG

The plan of payload operations on the CSG defines the operations carried out on the satellite from the time of its arrival in Guiana: transport, inspection in the satellite building, operations in the apogee motor building, and operations on the Ariane launch area. It lays down the organizational arrangement made for these operations and describes the facilities needed to carry them out.

The format of this document is shown in paragraph 6.6 of the User's Manual.

3.4.1.8 Plan of Launcher Operations at CSG

Drawn up by the launch vehicle authority, this specifies in detail the technical characteristics of the launch which meet the requirements imposed by the payload and the launch vehicle. It defines the content of the tasks to be performed, their breakdown and sequence from the arrival of the launch vehicle in Guiana until the processing and exploitation of the launch results.

3.4.1.9 Launch Application

The launch application is a consolidated document covering both launch vehicle and payload aspects. It is submitted by the Mission Head. It lays down the purpose of the mission and its characteristics, the general organization, the time-schedule and the assistance required in the form of personnel and facilities. It is addressed to the CSG and the other authorities concerned in the launch.

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3.4.1.10 Procedures for Payload Tests on the CSG (Hazardous Procedures)

On the basis of the above operations plan, procedures are drawn up for each operation described therein. All test procedures must be submitted to the CSG, in order to enable the Safety Department to draw up a list of hazardous procedures. Under the Safety Regulations, only the latter require the Department's approval.

These procedures are the results of safety submission Phase 3 negotiations between the Payload Authority and the Safety department at CSG. They are attached as Annexes to the Plan of Payload operations at CSG (described in paragraph 3.4.1.7 above).

3.4.1.11 Plan of Vehicle Operations at CSG

For all joint launch vehicle/satellite operations taking place between the move of the satellite to the launch area and the launch, the satellite procedures are integrated with those of the launch vehicle. The satellite authority makes proposals to the Mission Head for such operational procedures as it requires, and the Ariane launch team integrates these into the launch procedures. Only procedures involving integrated launch vehicle/payload operations are submitted for the approval of the launch vehicle authority.

3.4.1.12 Mass Characteristics of the Payload (M.C.I.)

The mass C of G and Inertial characteristics of the payload in its final launch configuration, as determined by measurements are communicated to the launch vehicle authority.

3.4.1.13 Launch Order

This is established by the CSG Director of Operations in response to the launch application and lay down in detail: the organization, the facilities involved, the services provided and the timing of operations.

3.4.1.14 Injection Data

If there is a radar tracking and telemetry station in line of sight with the injection point, data can be transmitted to it in real time or slightly deferred time on the position and velocity of the payload at the instant of launch vehicle/payload separation.

3.4.1.15 Orbital Tracking Operations Report

A report on the tracking data acquired during the first few orbits is supplied by the satellite authority to the launch vehicle authority in order to contribute to the interpretation of the launch vehicle performance.

3.4.1.16 Launch Operations Report

On the basis of the above data and processing of the launch vehicle telemetry and tracking data, the launch vehicle authority draws up a report on the launch operations, stating the performances achieved, and checking the behaviour of the launch vehicle and its subsystems. This report is communicated to the user.

3.4.2 Launch Site Activities and Constraints

The launch vehicle imposes no constraints on the payload operations schedule until the payload is delivered to it, i.e. until L-7 working days.

The only constraints that may affect the schedule relate to the use of the CSG buildings and facilities.

As from L-7 days, the schedule of payload activities is completely integrated with that of the launch vehicle. The main phases are as follows:

L-7 days - Preparation and transport of payload to servicing tower

L-6 days - Mounting of payload on launch vehicle. Checkout of satellite without the fairing. Checkout of simultaneous vehicle and satellite transmissions.

L-5 days - Fitting of fairing - checkout of payload within fairing - launch rehearsal (during this phase, the launch vehicle, the payload and all the CSG facilities required are activated).

L-1 days - Launch countdown.

Figures 3.4-2 and 3.4-3 summarize launch vehicle operations to launch. In the event of a dual launch using the SYLDA, the readied payload will need to be delivered for integration about three to six days earlier than for a dedicated launch. Figure 3.4-4 illustrates the typical integration sequence related to a SYLDA launch.

3.5 Ariane Charge Policy

The charge policy outlined below applies to a non-member state of ESA (European Space Agency). The date of the transmittal of this charge policy was June 8, 1978. It was stated that this policy is based on making Ariane competitive with other launch systems.

3.5.1 Basic Charge for Standard Services

The standard Ariane launch services include the following activities for each launching (in single launch mode): required up to and including injection in transfer orbit:

- (a) ESA/CNES management
- (b) Manufacture and test of vehicle hardware
- (c) Vehicle transportation to Kourou
- (d) Supply of propellants

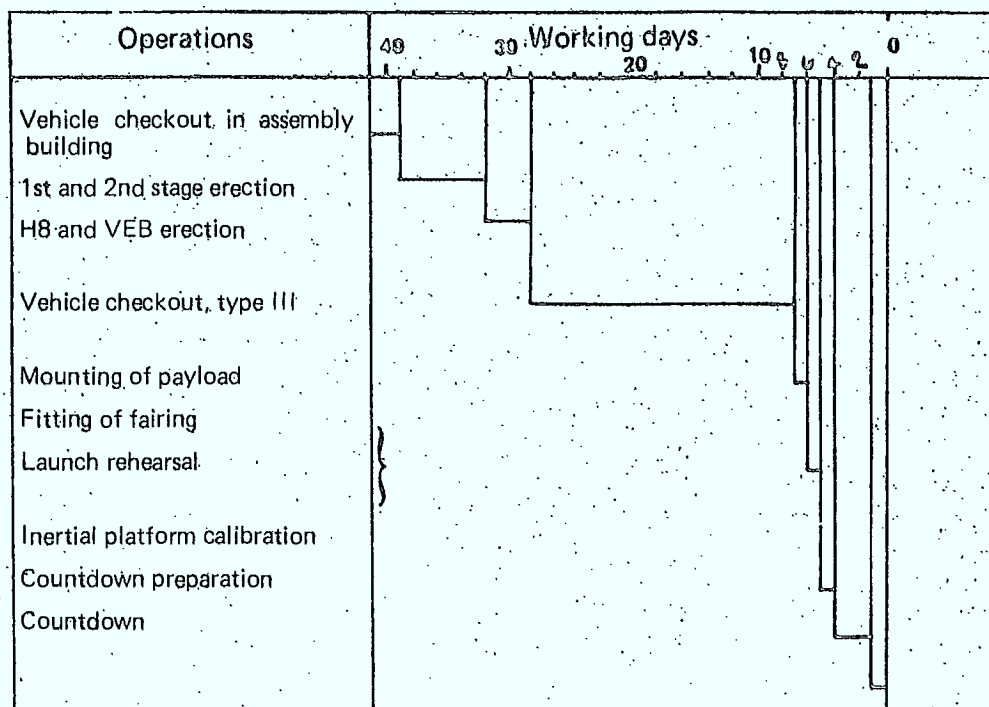


FIGURE 3.4-2: LAUNCH CAMPAIGN SCHEDULE

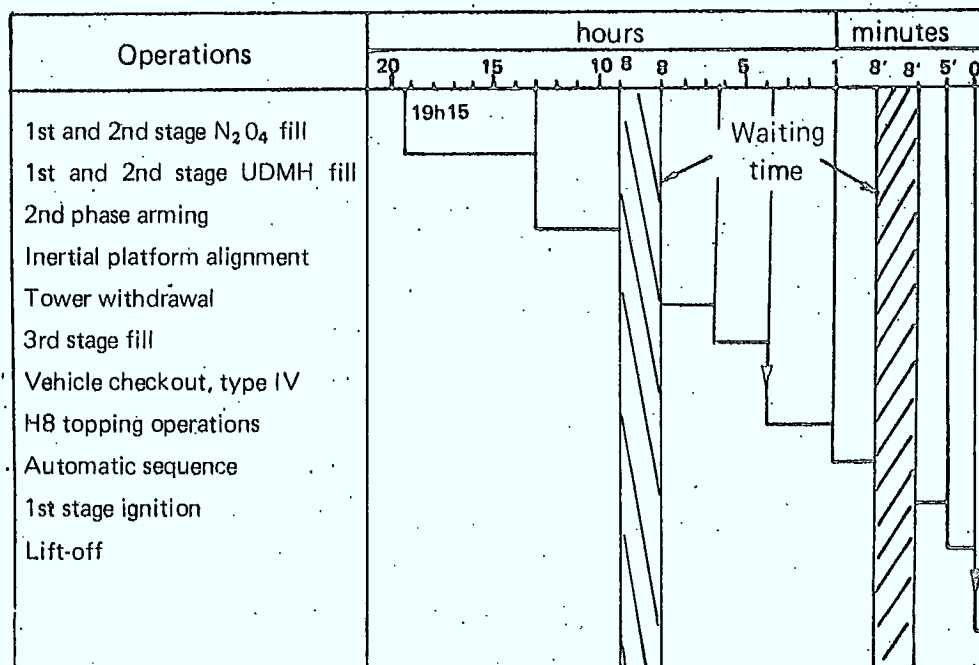


FIGURE 3.4-3: COUNTDOWN

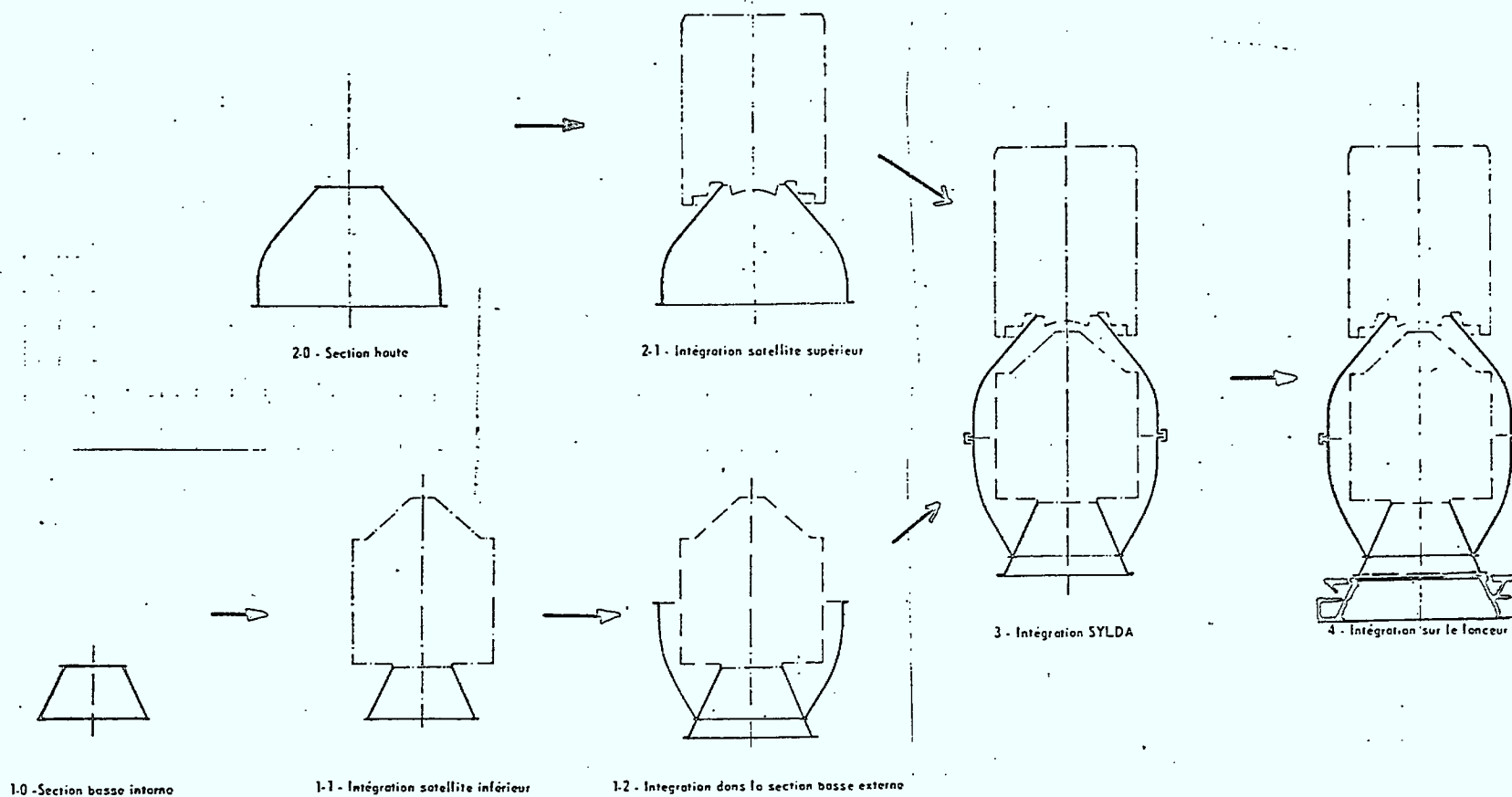


FIGURE 3.4-4: SATELLITE INTEGRATION (SYLDA) SEQUENCE

- (e) Provision of launch services
- (f) Provision of CSG range support
- (g) Documentation
- (h) Mission Analysis
- (i) ESA support of payload design reviews
- (j) ESA payload safety review
- (k) Services to payload prior to launch (all general-type facilities)
- (l) Launch assessment and determination of orbit parameters.

Provided the spacecraft design and mission allow for a dual launch (case of most Delta class geostationary payloads) it would entail the following additional activities with respect to the above single launch mode services.

- (m) Provision of additional launchers hardware
- (n) Execution of associated mission studies.

For single mode launchings, ESA expects to offer launch services for a firm price (at mid-1977 price levels, and to be escalated for price increases) equivalent to 22M U.S.\$ (currency to be negotiated).

For launchings of Delta class missions in dual launch mode incorporating the additional identified services ESA expects to offer launching of such spacecraft for about 15M U.S.\$ (at same economic conditions) each.

3.5.2

Additional Charges for Optional Services

Optional services identified include the use of a spin up system to increase the spacecraft spin rate from 10 rpm to 60 rpm and the use of the ESA tracking, telemetry and command network, the cost for which would be provided by ESA on identification by the user of the scope of his requirements.

3.5.3 Payment Schedule

Nominal payment schedule for Ariane launch services is as follows:

<u>Months Prior to Agreed Launch Slot (L)</u>	<u>Percentage</u>
L-30	10
L-24	10
L-18	25
L-12	25
L- 6	20
L	10

The payments will be escalated to reflect inflation at the due date.

3.5.4 Launch Insurance

ESA intends to offer the following conditions for launch insurance:

- (a) On request of the customer and subject to his commitment to comply with the provisions of paragraph (b) below, the agency will take out an insurance policy for each launching in order to cover a failure of the Ariane launch vehicle and will, in such case, provide a re-flight without additional charges.
- (b) In case the customer requests the re-flight guarantee, the agency will charge the customer, at his discretion, either
 - i) The cost of an insurance premium at the rate prevailing at the time of launching for equivalent existing launchers, or

- ii) 10 (ten) percent of the price of the launching under the re-flight guarantee, it being understood that the risk of a higher cost of the insurance premium will rest with the agency.

In this context,

- (c) A successful launch is defined as a launch which puts the spacecraft in the nominal transfer orbit (plus or minus 3 sigma) and which has not been exposed to a launcher induced environment greater than stated in the Ariane User's Manual.
- (d) A launch failure is defined as a launch which does not allow spacecraft to reach geostationary orbit or which would downgrade spacecraft to an unacceptable level (because of launcher environment).
- (e) A partial launch success is a launch delivering spacecraft in acceptable working conditions but which requires partial use of on-board propellants in order to reach geostationary orbit, thus reducing in-orbit lifetime.

For case (d), paragraph (a) would apply; for case (c) reimbursement would be proportional to loss by useful in-orbit life.

At the time of writing this report, ESA had not yet given considerations to liabilities of co-passengers during dual launches. Their first reaction was a 'no fault' approach to the situation. With regards to third party liability, ESA proposes to come forward with a policy shortly.

3.5.4.1 User Purchased Insurance

The insurance rate to cover property damage and personal liability as discussed with Marsh & McClennon, is expected to be higher for the Ariane

launch than the customary 9%, no deductible, for ELVs. The reason for this is that the Ariane Launch Vehicle is a new system and is considered to have a higher risk than other ELVs. The expected rate is thought to be in the region of 10% of the insured value.

3.5.5 Planning Information

- (a) ESA normally expects order to be placed 30 months before desired launch date.
- (b) If at least one firm order for a launching is placed, options for one or more additional launching can be granted to the user. From the date where the option is taken, until the date of exercise of the option, the associated option price will be 1% of the launch price per month. In case the user exercises his option, 50% of the option price will be refunded by ESA.
- (c) At the time of a firm order or of taking an option, a launch slot (of one month duration) is allocated to the user; a firm launch date is to be agreed upon six months prior to the allocated launch slot.
- (d) Acceleration or postponement of an agreed launch date by less than two weeks will be without additional charges, provided that there will be no additional acceleration/postponement request.
- (e) Acceleration or postponement of a launching by more than two weeks but not more than six weeks will:
 - i) be without additional charge provided that the customer informs the agency at least one year prior to the initially agreed desired launch date;

- ii) Amount of 125,000 \$ per week provided that the customer informs the agency less than one year but more than six months prior to the initially agreed launch date;
- iii) Amount of 125,000 U.S. \$ per week in case of postponement provided that the customer informs the agency less than six months but more than one month prior to the initially agreed desired launch date: in case of acceleration this additional charge will be negotiated.
- (f) The additional charge for an acceleration or postponement of a launching by more than six weeks will be subject to negotiation.

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GLOSSARY OF TERMS

ANC	Active Nutation Control
ASE	Airborne Support Equipment
CCAFS	Cape Canaveral Air Force Station
CDF	Confined Detonating Fuse
CIP	Cargo Integration Plan
CIR	Cargo Integrating Review
CITE	Cargo Integration Test Equipment
COEL	Chef des Operations de l'Ensemble de Lancement
CSG	Centre Spatial Guyanais
DCI	Interface Control File
DDO	Directeur Des Operations
DOD	Department of Defence
DSTF	Delta Spin Test Facility
DUA	Application to Use Ariane
ELA	Ensemble de Lancement Ariane
ELV	Expendable Launch Vehicle
ET	External Tank
EVA	Extra Vehicular Activity
FMOF	First Manned Orbital Flight
FOR	Flight Operations Review
FRB	Flight Readiness Review
GOR	Ground Operation Review
ICD	Interface Control Document
IHR	Integration Hardware Review
LCC	Launch Control Centre
LSSM	Launch Site Support Manager
LSSP	Launch Site Support Plan
LSST	Launch Site Support Team
MUSAT	Multipurpose UHF Satellite
OMS	Orbital Manoeuvring System
OPF	Oribter Processing Facility
PAF	Payload Attach Fitting
PAM-D	Payload Asist Module - Delta Class
PAM-A	Payload Assist Module - Atlas Centaur Class
PID	Payload Integrated Data Book
PIGHM	Payload Integration Ground Handling Mechanism
PIP	Payload Integration Plan
PIR	Payload Integration Review

POCC	Payload Operations Control Centre
RSS	Rotation Servicing Structure
SOFI	Spray on Foam Insulation
SPIDPO	Shuttle Payloads Integration and Development Project Office
SRB	Solid Rocket Boosters
SSUS	Spinning Solid Upper Stage
STS	Space Transportation System
SYLDA	Systeme de Lancement Double Ariane
TPS	Thermal Protection System
VAB	Vehicle Assembly Building
VPF	Vertical Processing Facility

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