SPAR-R.932
ISSUE A

(1)

JOINT SPAR/DOC STS/ARIANE LAUNCH VEHICLE STUDY REPORT

VOLUME I

VEHICLES, FACILITIES, SERVICES AND COSTS - STS AND ARIANE

APPENDICES

SPAR

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JOINT SPAR/DOC STS/ARIANE
LAUNCH VEHICLE STUDY REPORT

VOLUME I

VEHICLES, FACILITIES, SERVICES
AND COSTS - STS AND ARIANE

APPENDICES

Prepared for:

The Department of Supply and Services,
Department of Communications
Government of Canada
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SEPTEMBER, 1978

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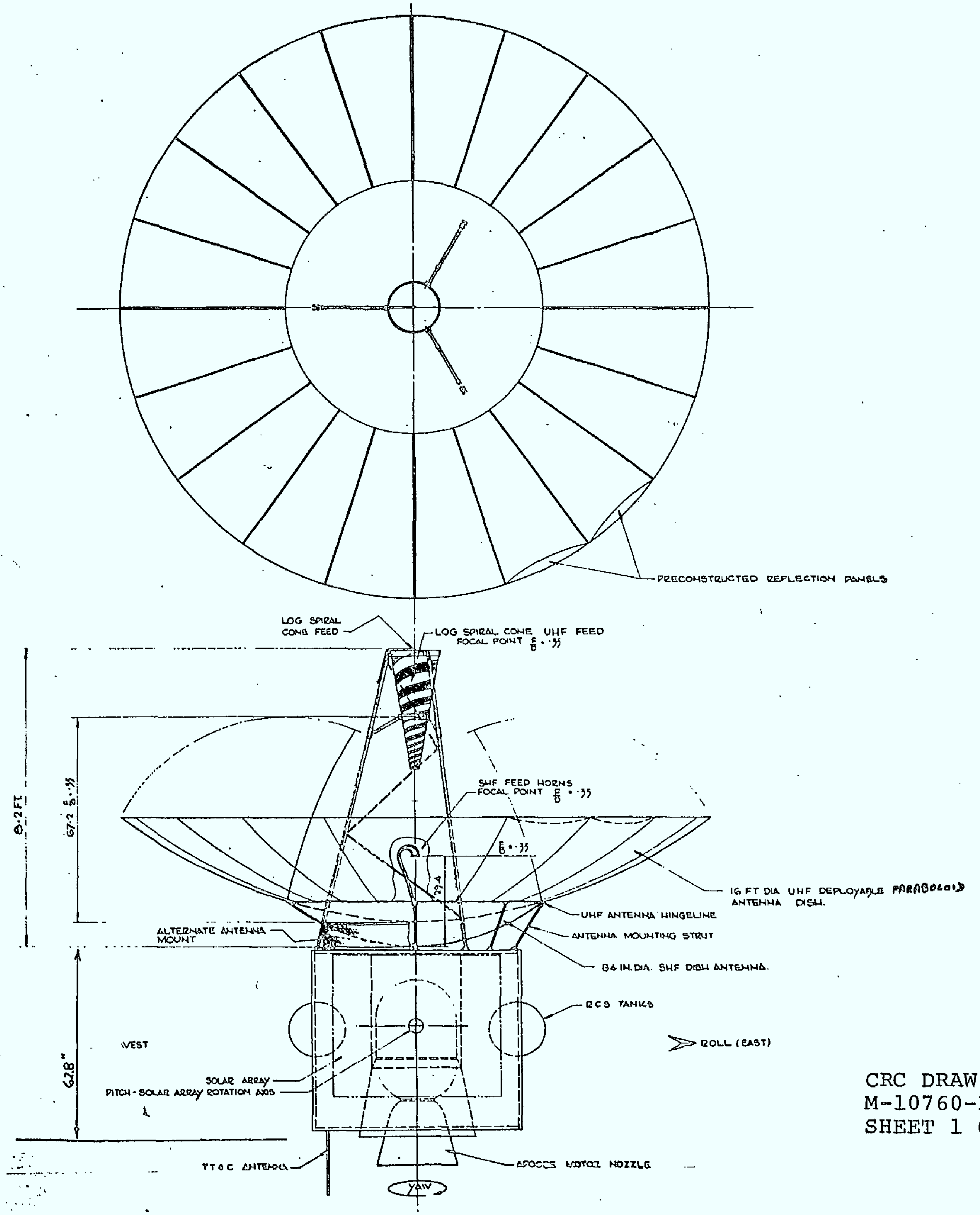
APPENDIX A

MUSAT POTENTIAL CONFIGURATION

MULTIPURPOSE UHF SATELLITE (MUSAT) DATA SHEET

PAYLOAD DATA ELEMENTS

NAME:	MULTIPURPOSE UHF SATELLITE (MUSAT)
USER/SPONSOR:	DND:DOC:EMR:DOT:DOE OF THE GOVERNMENT OF CANADA
DESCRIPTION:	3 AXIS STABILIZED BUS ACCOMMODATING UHF (400/300 MHz) AND SHF (8/7 GHz) CANADIAN COMMUNICATIONS SERVICE
SIZE:	STOWED DYNAMIC RADIUS: 43 IN.
	LENGTH: 101.0" CONFIGURATION A 161.2" CONFIGURATION B
WEIGHT:	2500 LBS. (EXCLUDING ADAPTOR AT LIFTOUT)
POWER:	800 WATTS EOL 7 YRS. (100 WATTS IN THE ORBITER BAY)
PROPULSION:	STAR SERIES SOLID PROPELLANT AKM HYDRAZINE BLOWDOWN RCS
PYROTECHNICS:	FOR SOLAR ARRAY AND ANTENNA DEPLOYMENT MECHANISMS
LAUNCH SCHEDULE:	MUSAT 1 LAUNCH 1ST TO 3RD QUARTER, 1982 (ASSUME OCT. 1) MUSAT 2 LAUNCH 1ST TO 3RD QUARTER, 1984
	RETRIEVAL & REVISIT NOT APPLICABLE
PLANNED CARRIER:	SSUS-D (STANDARD)
S/C-LAUNCH VEHICLE HARDWARE:	POWER AND SIGNAL INTERFACE UNITS
LAUNCH WINDOW PARAMETERS:	-MIDNIGHT PERIGEE INJECTION -SUN ANGLE WITHIN $\pm$ 25° OF SPIN AXIS NORMAL -ELV COMPATIBLE THERMAL ENVIRONMENT ASSUMED
ORBITAL PARAMETERS:	-STANDARD STS PARKING ORBIT (160 NMI (CIRCULAR, 28.7° INCLINATION) -GEOSYNCHRONOUS TRANSFER ORBIT (19,323 NMI HA, NOMINAL 27° INCLINATION)
UNUSUAL REQUIREMENTS:	-NO UNUSUAL FLIGHT OPS EXPECTED -SPECIALIZED GROUND CHECKOUT OF COMMUNICATIONS ANTENNA & SOLAR ARRAYS DURING CAPE INTEGRATION MAY BE REQUIRED.



CRC DRAWING
M-10760-E
SHEET 1 OF 2

FIGURE A-1 MUSAT CONFIGURATION B

APPENDIX B

TRIP REPORTS

SPAR AEROSPACE PRODUCTS LTD.
INTER-OFFICE MEMO

DATE: June 26, 1978

FOR ACTION:

FOR INFORMATION: S. Ahmed (DOC:CRC), H.R. Warren (DOC Hdqrs), J.E. Lockyer, D. Coughtry, E. Quittner, D. Tong, G. Lewis, M. Hinds, J. Collins (STL)

FROM: S.F. Archer

EXT: 21 (Dufferin)

SUBJECT: TRIP REPORT, VISITS TO ESA, SNIAS, SEP IN FRANCE, EUROPE AND KOUROU LAUNCH SITE, FR. GUIANA TO INVESTIGATE THE ARIANE LAUNCH SYSTEM, 5-17 JUNE, 1978

REFERENCE:

1.0 Summary:

The author, accompanied by Dr. S. Ahmed of DOC:CRC, visited Paris 5-10 June, 1978 and Kourou, Fr. Guiana, 11-16 June, 1978 for the purpose of determining the status, facilities and costs for the ESA/CNES Ariane expendible launch vehicle. The meetings, as discussed in the text, were well co-ordinated and presented by knowledgeable ESA, SNIAS, SEP and CNES staff. M. Bellot, Head, Ariane Payload Section, ESA, chaired all meetings and acted as our guide and, where necessary, translator. This provided excellent coherence and completeness to the dual visit. ESA were very open in their presentations, providing up-to-date material including draft documents, tentative policies and facility extension plans where necessary. The level of hospitality shown was commensurate with a serious effort by ESA to at least convince Canada that ARIANE is a viable competitor to the STS System.

My assessment is that this launch vehicle and launch site have been very conservatively designed and implemented. The test plan leading to first launch in June 1979 appears feasible and the possibility of major technological setbacks is considered minimal. Although some details of the Payload/Launch Vehicle interface documentation and schedule are still to be worked out, the payload team is knowledgeable and experienced and all major interfaces have been specified for the dedicated payload. The Ariane User's Manual appears to be efficiently modelled on the Delta Restraints Manual. ESA also appear clear on their responsibility for payload compatibility in the dual launch case.

The payload test, propellant handling and launch vehicle mating facilities at the launch site are presently being upgraded and will be both adequate and convenient for the payload user. The major drawback of this Centre Spatiale Guyanais (CSG) launch site will be communications (voice, data and physical transport) to North America.

Continued...../2

1.0 Summary (Continued)

The cost policy is straightforward; a firm fixed price in advance with no hidden costs and charges exposed after launch. The price quoted, $22M US mid 1977 dedicated and $15M US mid 1977 equal payload weights dual launch, will be all inclusive of launch hardware, launch and prelaunch operations and interface definition and control throughout the program.

This trip report presents significant information collected during visits. The author retains both handout material, see list attachment 1, and detailed notes which are available for your review if requested. The itinerary for these trips is presented in attachment 2.

2.0 ESA Headquarters Kickoff Meeting, 5 June, 1978

This meeting involved:

M.R. Orye	ESA, Head, Ariane Programme Office*
M.A. Bellot	ESA, Head, Ariane Payload Division
M.R. Vignelles	CNES, Chef du Projet Ariane
M.H. Hergott	CNES, Systems*
M.J-C Bouillot	CNES, Avant-Projets-Promotion.*
M.Y. Guerin	ESA, Payload Officer, Ariane*
M.R. Lavand	ESA, Payload Officer, Ariane (Configuration Control)*

* part time attendance

M. Vignelles made a lengthy presentation of the design and schedule for the Ariane launcher and the CSG. Attachment 3 provides a summary handout of this session. The additional significant points made were:

a) The Ariane launcher has been built on existing proven technology, where possible. For example, the first and second stages use the Diamant B, Viking V engine. The third stage is based upon an early MBB development engine (Rocketdyne, LO_2 and Kerosene). Tankage technology for the 1st stage is derived from earlier programs.

b) As a consequence of this conservative design approach, the qualification phase for the launcher is going well. Any problems appear to be in low technology items.

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2.0 ESA Headquarters Kickoff Meeting, 5 June, 1978 (Continued)

b) (Continued)

1st stage - electrical system qualified
- structure qualified Sept. 1976
- cluster testing (4 engines) revealed fatigue damage of graphite throat insert (not present on single engine tests). Persuing 2 materials: resin phenolic/silicon (95% success probability) and carbon composite. The first test with the phenolic will take place in August 1978 with qualification before year end. L01 can be refitted with either material throat. Req'd for carbon composite Would slip L01 launch by 3 months.

2nd stage - electrical systems qualified
- firing tests January and March, 1978 successful performance - 2 lbf sec/ lbm higher than anticipated
- qualification commencing August, 1978 with roll control and gimballing operating

3rd stage - 1 unit fully tested
2nd unit into test June 1978

VEB - qualified except for inertial platform. A modification of the stator to rotor tolerance for the gyros was determined to be necessary when the unit drift went out of tolerance during random vibration testing. Requalification to be completed by end of July, 1978.

Fairing - qualified, including separation testing at ESTEC.

(c) Global launch facilities testing of propellant and oxidizer fuel flow and pressurization systems at CSG without a launch vehicle is underway and will be completed by end of June, 1978. A complete launcher propellant mockup (PMU) which is now being built up at SNIAS will be tested at CSG between August and October. A complete electrical mockup will, in parallel, be tested at the Site d'Integration Lanceur (SIL) at SNIAS, Les Mureaux, using a copy of the computer system which is now installed at CSG. A less sophisticated electrical systems test will then take place at CSG in November of this year. This will be followed by a general test

Continued.../4

2.0 ESA Headquarters Kickoff Meeting, 5 June, 1978

c) (Continued)

at CSG which will simulate a complete countdown, launch and flight sequence. This test, to take place in December, will exercise all parts of the system including down range radar tracking, T&C readout and optical tracking systems. To accomplish this test, a sounding rocket firing will be co-ordinated with aircraft carrying transmitters and an orbital "pass" of the GEOS satellite.

Any modifications required to CSG will be made before April 1979, when the L01 launcher will be delivered to the launch site. Prior to shipment the L01 will be completely integrated and electrically acceptance tested at SIL. Launch of L01 is scheduled for mid June, 1979.

M. Orye summarized the activity underway to convince Intelsat to fly the last 3 Intelsat V spacecraft on the Ariane launcher.

Studies by COMSAT with FACC support had revealed two potential changes necessary for the I-V spacecraft, significant off-loading of the AKM and potential structural modifications due to pogo and chugging loading. Coupled loads analysis has shown that pogo loading is no problem; solar array resonance has been avoided and no structural changes are expected. Also antipogo dampers have been added to Ariane feedlines. FACC test environments are being expanded to include this Ariane load to prove this point. The casting for these 3 AKMS has been postponed until year end. ESA has now made a formal proposal to COMSAT and were in the process of answering numerous technical questions at the time of our visit. ESA have stated that they will take any steps necessary to make CSG compatible with conventional ETR facilities.

COMSAT requires 1723 kgm for I-V lift-off weight for its inclination and perigee (corresponds to 1700 kgm Ariane Standard launch). The present Ariane launch weight capability of 1750 kgm standard mission will allow launch of I-V plus a tandem COMSAT Mariteem Module package of 66 kgm.

Decision expected to be made for I-V Launch Vehicle by 1 September, 1978.

Continued.....

2.0 ESA Headquarters Kickoff Meeting, 5 June, 1978 (Continued)

The following payload complement and planned launch schedules were provided:

Launch	Payload	Launch Date
L01	CAT*	June, 1979
L02	CAT + Firewheel + Oscar	1 Dec., 1979
L03	CAT + Apple + Meteosat 2	1 May, 1978**
L04	CAT + Marecs +(Serio ?)	1 Oct., 1980**

* Ariane Development Flight Instrumentation Package
** 5 month schedule margin exists

L01 and L02 will be integrated at SIL; later development vehicles may not be if L01 and L02 are successful.

A presentation was made by M. Bouillot of the Ariane growth and dual launch capability. This is covered in section 5 of this report.

S. Ahmed made a brief presentation of the objectives of our study and M. Orye suggested that ESA would be pleased to review the Ariane portion of the report prior to final issue for their interest plus to ensure that all material is correct and current.

3.0 Visit to SNIAS, Les Mureaux, and SEP, Vernon, 6 June, 1978

SNIAS Meeting & Tour Attendees:

M.G. Leroy	SNIAS Asst. Marketing Manager-Launch Vehicles
M.A. Bellot	ESA
M.Y. Guerin	ESA
M. Lavant	ESA
M. Gilli	CNES representative
S.A.[2]	

M. Leroy gave a general background talk on Aerospatiale facilities of Les Mureaux. - launch vehicles, components, systems
Acquitaine - solid motors
Cannes - spacecraft.
and programs including their responsibilities for the sub-assemblies and integration and test of Ariane. A complete list of contractor responsibilities for Ariane can be found in reference 6, see attachment 1.

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3.0 Visit to SNIAS, Les Mureaux, and SEP, Vernon, 6 June, 1978-continued

A tour was provided of the Ariane facilities at Les Mureaux. The first visit was to the 1st stage tank assembly area including dome orange peel section welding facilities, and complete tank assembly and x-raying shops. This facility and all other Ariane manufacturing areas in Europe are designed for a capacity of 6 launchers per annum, although only 4 per year are anticipated. Of interest is that the 1st stage tank is designed for minimum weight and requires pressurization (hoop stress) prior to filling to prevent rupture due to gravity forces from the propellant.

A second area visited was the SIL, see pictures reference 7 attachment 1. This facility, at the time of our visit, contained the propellant mockup in various stages of assembly, a complete VEB to be used for electrical checkout, the M4 complete first stage and a standard fairing. The building has been designed so that the 1st stage is assembled adjacent to the remainder of the vehicle with umbilicals between the two sections.

SEP Meeting and Tour Attendees:

M. Bachelot,	SEP Head of Ariane 1st and 2nd Stage Project
M. Bellot	ESA
M. Guerin	ESA
M. Lavant	ESA
M. Gilli	CNES
S.A.[2]	

A tour was provided of the test stands and control block houses for 1st, and 3rd stage launcher sections, see reference 8, attachment 1. There are 3 test stands for the cryogenic third stage with 2 control rooms. One stand is set up for the engine only, but the other two can test the total stage. By April, 1979 they will have completed 4 complete stage firings. The first stage test stand PF20 has a control centre which closely matches the 1st stage control equipment at CSG. They are presently preparing for test of the M3 first stage at the end of June, 1978. Again, when in production, this facility will be able to build up and test 6, 1st, 2nd and 3rd stages per annum. Acceptance firing tests will be carried out on all 3rd stages but definitely not on 1st stages.

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3.0 Visit to SNIAS, Les Mureaux, and SEP, Vernon, 6 June, 1978

During this tour it was stated that Ariane costs for development through L04 launch are projected to be $1 Billion. A second tour was provided of the engine assembly shop for the 1st and 3rd stage engines; 2nd stage is manufactured at Dornier and delivered directly to SNIAS. Here we saw the buildup of L01 hardware in progress.

4.0 Spacecraft Visits to SNIAS and SEP, 7 June, 1978

These meetings and tours were not associated with Ariane but rather for the authors to learn of spacecraft hardware capabilities.

SNIAS Meeting and Tour Attendees:

M. Rouyer	SNIAS, Head of Industrial Applications, Subsystems
M. Gauthier)	
M. Benedetti)	SNIAS, under M. Rouyer
M. Jamain)	
$S.A.^2$	

A demonstration of the magnetic suspension momentum wheel technology was provided which showed that the device is developed and marketable. This wheel is available in 100 n.m. sec, 50 n.m. sec and 10 n.m. sec sizes, the latter being for reaction wheel applications. SNIAS hopes that the 50 n.m. sec wheel will be used on H-Sat and 10 n.m.sec wheels used on SPOT, the planned French Earth Resources Satellite. Three (3) year life testing will commence in October of this year and COMSAT has already been testing a version of the 100 n.m.sec wheel. This wheel operates at up to 24,000 rpm.

M. Rouyer then provided a tour of the micromechanics laboratory at SNIAS. Here thrusters, pressure regulators, passive nutation dampers, pyrotechnic housings, tankage, antennae and momentum wheels are fabricated and assembled. This laboratory is expert in working with titanium and other metals but is not qualified for electronics assembly. SNIAS have a new inexpensive process for tankage construction which they call "superelastic" whereby they inflate the tank into a mandrel at 900°C with air pressure. The author retains handout material on SNIAS spacecraft equipment.

SEP Meeting Attendees:		
	M.J. Corai	SEP, Head of Spacecraft Products
	M. Marion	SEP, Thruster Systems
	$S.A.^2$	

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4.0 Spacecraft Visits to SNIAS and SEP, 7 June, 1978 (Continued)

This meeting involved the discussion of SEP's activities on hydrazine and cold gas RCS and solid AKM (MAGE) equipment. Handout material is expected to be provided by SEP. This company appears competent in conventional hydrazine technology for thrusters of the 2 to 14 N class including development of CNESRO catalyst. Additionally, under CNES funding, SEP are developing a .1 to .3N thermal decomposition hydrazine thruster with and without power augmentation. Development hardware should be in test by the end of the year. The SEP Solid AKM (MAGE) was flown on GEOS and it is hoped that an upgraded version will be chosen for H-Sat.

SEP surface tension tankage was first flown in 1972 on the D5A program. New designs are being investigated for future S/C applications and for fluids other than neat hydrazine (eg. MMH, N_2O_4). SEP has built an RCS System (freon cold gas) for ISEE. The SEP magnetic suspension momentum wheel (5 axis complexity) is being shipped to COMSAT. ESTEC, however, favour the SNIAS design and future activities are uncertain.

While at SNIAS, M. Nguyen, ACS Guidance and Control Manager for Ariane, was consulted for more detailed information on this launcher system, see flow chart in attachment 3. He explained the functions of the on-board computer (OBC), autopilot, inertial platform (IP) and associated sensors and interface units. He made it clear that the IP contains accelerometers for 3rd stage guidance and that gyros are temperature compensated for drift through an automatic 10 hour calibration routine which is activated just prior to launch. Another routine is performed to align the vehicle on the pad using the on board accelerometers. The on-board system autopilot computes present position, attitude and time to go before 3rd stage cutoff (insertion) throughout the mission. It then optimizes the attitude to minimize the time to go. Automatic protection features include engine shutdown if thrust degradation is severe (to avoid destructive failure) and backup operation based on a preloaded nominal launch tape if sensor inputs become anomolous. Certain hardware components are non redundant due to weight constraints (eg. OBC, IP, Autopilot) but backup subroutines are provided within computer units. It is interesting to note that the accelerometers on the second stage are not used for guidance, but only for limitation of lateral loads during 1st stage firing (at maximum dynamic pressure 40-95 sec into flight).

5.0 ESA Headquarters Meeting, 8 June, 1978

Morning session concerned payload documentation. Present for this meeting were:

M. Bellot	ESA
M. Guerin	ESA
M. Lavand	ESA
M.P. Rasse	CNES, Ajoint au Chef de Projet Ariane

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5.0 ESA Headquarters Meeting, 8 June, 1978 (Continued)

This discussion concerned the responsibilities of the user and ESA for payload interface with the launcher and was centred around the draft revised section 6 to the Ariane User's Manual, see reference 2 attachment 1. In summary:

a) Attachment #4 from the above reference shows the responsibilities and activities for the user, the ESA and CSG. What is not shown is the initial feasibility study, the scope of which is mission dependent. This study is most important in the case of a dual launch, for it is here that ESA establishes viability of the combined payload.

b) Each user provides the application to use Ariane (DUA), a detailed technical interface document which includes mission and launch campaign information, upon completion of the feasibility study phase. ESA subsequently generates an Interface Control Document (DCI) for the combined payload cargo and launch vehicle which is put under configuration control. All subsequent ESA documents are for the total cargo. The exception is safety where reviews with individual payloads are likely. A draft DCI was provided, see reference 3 attachment I.

c) The safety and other documentation requirements appear very similar to those presently in existence at ETR for expendible launch vehicles.

d) ESA plan to perform 2 coupled loads analyses for the user, the first during feasibility and the second late in the program.

e) Information received on schedule of activities appears compatible with both an operational and an experimental satellite development program, see upcoming study report.

f) Additional information on
   - safety requirements
   - mission analysis
   - production of interface drawings
   - launch support and training of payload crew

   was received and will also be presented in the study report.

g) It was recognized that with the dual launch additional time will be required by ESA for review and integration of payload data submissions.

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5.0 ESA Headquarters Meeting, 8 June 1978 (Continued)

h. An organization chart, for the ESA Ariane project was provided, see attachment 5.

The afternoon session addressed the subjects of the dual launch capability and costs. M. Naumann, Head of the Ariane Development Section, presented the status of the dual launcher.

An announcement had been made about 1 week before our visit of the choice of SNIAS to design and build the Systeme de Lancement Double Ariane (SYLDA) and the contract was still pending. Attachment 6 presents a sketch of the Sylda structure which will house a "lower" Delta Class satellite and will support structurally an "upper" Delta Class satellite. As was presented by M. Bouillot on 5 June, 1978, the SYLDA is expected to weigh 160 kgm nominal (180 kgm maximum) and will replace the standard 40 kgm adapter. With the present launch weight, this would allow a total of 1750-120 = 1630 kgm for the cargo or 815 kgm per payload (1793 lbs) for equal weight payloads. For the initial operational phase, however, ESA will offer the STS/PAM weight capability to foreign users and will utilize the excess weight for their own piggyback payload. Eventually it is planned to upgrade the Ariane launch weight capacity to 2300 kgm for geostationary transfer orbit payloads. This could be accomplished by:

a) increasing pressure in the first and second stage tanks from 53.5 to 59 bar
b) stretching the 3rd stage from 8 to 10 tonnes +

} 1900-2000 kgm

c) adding 2, 6 tonnes solid rocket boosters - 2300 kgm

through a 2 stage process and if the decision were made to proceed with these modifications next year, then the first stage upgrade and the maximum capability would be available by February, 1982 and February, 1983, respectively.

This upgrading should add approximately 3%-5% to the unit cost. The maximum design weight for the SYLDA to carry for the upper payload is 1200 kgm.

Discussions of the:

-separation sequencing of the payloads and SYLDA plus the availability of telemetry to confirm these operations
-envelope constraints of the upper and lower spacecraft (inner spacecraft compatible with STS/PAM diameter but not length with vertical cradle launch)

Continued...../11

5.0 ESA Headquarters Meeting, 8 June 1978 (continued)

-spacecraft collision and control study results
-environmental loading (detailed analysis just getting underway) with a model of 2 MARECS spacecraft - results to be available in September. Although there is some concern on the part of users with regards to lateral loading for the upper spacecraft, ESA are anticipating loads less severe than STS/PAM.)
-electrical connections and RF transparency were held.
M. Naumann indicated that the schedule for SYLDA development is as follows:

Phase 1	conceptual design to PDR	Dec. 1978
Phase 2	detailed design	Apr. 1979
Phase 3	to CDR	Nov. 1979
Phase 4	delivery of LO_4 equipment	June 1980

The first SYLDA flight will then be LO_4 in October, 1980.

Because of the necessary tandem mission, both payloads must be compatible as to launch window, transfer orbit parameters, spinrate and attitude at separation.

M. Naumann departed leaving M. Bellot to explain the ESA Ariane costing policy. The main points presented were:

a) the Ariane is basically designed for European consumption and autonomity. Foreign users are, however, encouraged and, although ESA program members will have launch date priority, ESA will honour all commitments to foreign payloads without bumping downstream in favour of a member payload.

b) military weapons are not acceptable payload equipment.

c) the foreign user will enter into a firm, fixed price agreement with ESA for the total launch program including planning and documentation, manufacture and test of the launcher, vehicle transport to Kourou, propellants and launch services as well as payload checkout, loading and mating activities. There will be no post launch cost surprizes.

d) the FFP cost for the standard Ariane geosynchronous transfer orbit (perigee alt. 200 km, apogee alt. geosynch and inclination 9.5°) launch program is $22M US mid 1977 dedicated or $15M US mid 1977 for an equal weight dual launch program (ie: $30M total with extra co-ordination, analysis, and longer launch campaign). This price also includes the SYLDA, where applicable.

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5.0 ESA Headquarters Meeting, 8 June 1978 (continued)

e) the reimbursement schedule is as follows:

10%	Launch - 30 months
10%	L-24
25%	L-18
25%	L-12
20%	L-6
10%	Launch

f) the LV will be insured (at a 10% premium of launch vehicle cost to the user or at the rate prevailing at the time of launch for equivalent launchers) to provide for a free 2nd launch in the event of a LV failure. However, ESA will not be providing spacecraft insurance against a LV failure, either to replace the spacecraft or to pay for lost revenue. They agree that it would likely be economical to work through the same insurance company as the one used by ESA. They have been dealing with Bowerings in England with regard to the I-V proposal but have not broached the subject of the dual launch with them as yet.

g) the question of who is responsible for delays in the case of a dual launch and the costs to be incurred has not been investigated as yet by ESA. Their first thought is that they may not consider 2 spacecraft with tight launch window constraints as compatible. Also, they may not schedule 2 foreign users together during the early operational phase, but rather could have ESA s/c in storage ready to provide the piggyback payload with little risk of schedule slip.

6.0 ESA Headquarters Meeting, 9 June 1978

The meeting on this date was held with M. Bellot and concluding remarks with M. Orye to discuss any outstanding questions. The following is a brief summary of pertinent points:

a) the $15M cost applys to both the present and future SYLDA and absorbs the 3% differential discussed earler.

b) if the ESA is the partner on an early dual launch, ESA will make every effort to provide the STS/PAM weight capability for the $15M US mid 1977.

Continued..../13

6.0 ESA Headquarters Meeting, 9 June 1978 (continued)

c) the author made the point that the loading factor in the case of an ESA dual launch is essentially 22/30 or 73%. This is equivalent to the STS factor of 75%. However, it would appear that the dual payload Ariane would be more tailored to the capabilities of the launcher and should have a higher factor. Of course some differential is required but $8M appears steep.

d) the inside SYLDA "lower" payload position appears to us to be less favoured in areas of;

- access
- s/c envelope
- potential RF transmission limitations
- extra LV failure modes
- potential damage during vertical integration
- higher orbit dispersions
- etc.

and it was suggested that ESA might consider a price break for the inside location. M. Bellot indicated that in fact some European users prefer that location and that no such cost reduction is anticipated.

e) it was stated that the feasibility costs are included in the FFP quoted, even in the dual launch programs.

f) ESA indicated that if Canada were to procure both halves of a dual launch and take responsibility for the interface between the 2 spacecraft, some reduction from the $30M total price could be negotiated. In the ultimate case where the S/C were designed to avoid the need for SYLDA and there was a single interface with the launch vehicle with no significant extension to the launch campaign schedule, the price would come down much closer to the $22M value.

7.0 General Comments on the French Guiana Launch Site

During the travel to and from Kourou and while in the locale several pertinent points became evident about the logistics of the Fr. Guiana launch site:

a) Kourou, with support from remote tracking stations and Cayenne facilities (port, power generation, communications, etc.) contains approximately 7,500 "skilled" people out of a total population of 45,000 in French Guiana. The remainder of the population, in sharp contrast, are mainly unskilled.

Continued.../14

7.0 General Comments on the French Guiana Launch Site (continued)

b) the weather is very constant with yearly temperature extremes of 20° to 36°C and with humidity seldom below 90%. The rainy season (4.5 metres in 1976) lasts from December to July with a respite in March and heavier rainfall generally after March. The working atmosphere at CSG requires airconditioning in the offices and labs and the complete launch tower for Ariane is enclosed from the elements. Despite this, the weather was exceptionally clear during our visit with rain on 3 days out of 7. The wind velocity is generally very constant at 5-10 m/sec and earthquakes and hurricanes are not a threat. Although we were told that there is rarely an electrical storm, we experienced brief lightning flashes one evening.

c) the hotel accommodations at present are only the Hotel des Roches (100 rooms) which is on the ocean with good restaurant and entertainment (pool, tennis courts, etc.) facilities. It is quite modern and reasonable in price - $24 per night single including breakfast. This hotel also has some detached cottages with cooking facilities (~15) at $38 per night. A second hotel, Albia, is being rennovated and will open shortly. A third hotel is planned. These hotels are owned (controlling interest) by CNES who subsidizes them as necessary.

d) Kourou has all necessary services including a hospital, town centre, power generation station, 4 schools, etc. Most people speak French but one can generally get by with English and gestures.

e) Cayenne airport, Rochambeau , is capable of landing large transport (C5A) aircraft. The local Kourou/CSG airfield is only capable of handling Twin Otter type aircraft and there are no plans to enlarge its capabilities. The Cayenne harbour, visited on 16 June, 1978, has a pier of length 309 m but continuous dredging is required to keep the channel open to shipping at the mouth of the Cayenne river. The distance from either the port or the airport to CSG technical centre is approximately 70 km over a two lane paved road which is acceptable for spacecraft transport. Modifications in some curves are being made to permit passage of the propellant mockup hardware which will land by ship after a 14 day trip from LeHavre, France. Some telephone cables are required to be temporarily cut to allow 6m clearance height during transport. ESA have done a cost and time tradeoff and have concluded that all major launch vehicle shipments to Kourou will be made by sea.

Continued..../15

7.0 General Comments on the French Guiana Launch Site (continued)

f) telephone communications with Canada are a concern. The author required 45 minutes to place a call from the hotel and the charge is approximately $8.40 per minute. Additionally, the calls are manual through Cayenne and duration of calls can be charged incorrectly. From CSG, a call was placed in 7 minutes to Toronto. Communications with France, Europe are automatic at $3.75 per minute.

g) at present it is necessary to take approximately 1 to 1½ days to travel between Canada and Cayenne with an overnight stop on one of the Carribean Islands. Our choice of Trinidad was not convenient because of lengthy immigration and customs procedures plus the remoteness of the airport from the hotels of downtown Port of Spain.

8.0 Meetings and Tours at CSG - 12 June, 1978

The agenda for the visit to CSG was scheduled around availability of launch complex facilities since facility propellant loading testing was underway at the tower. On each day, however, facility inspection was correctly arranged prior to conference room meetings to discuss these facilities.

This day, two visits were conducted, the first to the Ariane launch tower, the second to the AKM storage buildings.

As previously mentioned, the mobile tower is an enclosed structure which can be atmospherically controlled. At the spacecraft access level, the floor is moveable vertically and is stationed nominally at a height of 40 metres. An elevator with airlock services this level, there are inside and outside stairs and access is provided to showers and an emergency shute escape system. Figure 1 shows a plan view sketch of the spacecraft level facilities. Cleanliness, class 100,000 will be maintained in this area once the spacecraft is inside with external doors closed. There is a spacecraft clean airlock with extendible curtains for removal of the payload from the transportation container. There are 2 crane systems; the 20 tonnes container crane is removed outside prior to removal of the spacecraft from the container.

Power is provided, as required, including conditioning to North American voltages and frequencies, via the Kourou power station (EDF) and in the case of interruption of service, on-site batteries provide no-break power to the S/C and computer systems while diesel generators handle other launch site and vehicle power needs. The tower withdrawal takes from 15 to 45 minutes depending upon the working platforms in place at the time.

8.0 Meetings and Tours at CSG - 12 June, 1978-(Continued)

The AKM storage buildings (3) are 25' x 25' x 15' hook height with manual 2 tonne cranes. Humidity control is difficult at present (up to 80%) due to open access ports above the door for crane travel. Otherwise it is an acceptable facility including smaller buildings for pyrotechnic storage.

Following these tours we were introduced to the CSG Deputy Director and Technical Director, M. Bascond and spoke briefly about the site characteristics. This year's operating budget, including maintenance, for the range is 134 M FF.

The afternoon session consisted of a tour of the Mission and Safety Control Centres which are located in the Jupiter Building at the Technical Centre plus a safety meeting. Present were:

M. Bellot	ESA
M. Oelker	ESA Launch Site Officer
M. Beguin	CNES, Deputy Safety Director
M. Barban	CNES, Payload Operations Manager
M. Bouchet	CNES, Payload Installation, CSG

As per normal practice, the safety officers are isolated from the mission control. They operate from visual sighting for the first 25 seconds and a special redundant radar and computer system thereafter. Trajectory is plotted in real time on top of the nominal profile and they have ultimate responsibility for detonation of the vehicle if necessary. The mission control centre receives all data from the Supporting centres via the adjacent telecommunications building (Mercury).

Note that the Technical Centre is approximately 12 km downrange from the launch site.

Pertinent points in the safety meeting were:

a) the safety manual is not yet available although the French version will be released in July, 1978

b) the four phase safety program which was described is per standard practice and the review schedule is compatible with typical spacecraft review milestones

c) we were assured that sufficient training on general operations and hazardous procedures would be provided to an arriving spacecraft team.

Continued.../17

8.0 Meetings and Tours at CSG - 12 June, 1978 - (Continued)

d) the plan for flow of the spacecraft on site through facilities

B1 spacecraft checkout
B2 AKM preparation
B3 Spacecraft hazardous procedures (AKM Mating, RCS filling) and cargo integration

is logical and appears to maintain adequate safety for personnel and hardware.

e) Dr. Ahmed received a single copy handout on safety policy which will be included in the study report.

9.0 Meetings and Tours at CSG - 13 June, 1978

Two tours were conducted, the first to the Launch Control Centre (LCC) at the launch site and the second to the AKM preparation building (B2) and the site of the future B3 building.

M.A. Merdrignac, who is the Director of Launch Site Operations and will likely be the Launch Director (COEL), narrated the tour of the LCC which has provision in the main room for 2 payload consoles and backroom area which could house a complete STE if necessary. In discussions it became evident that CNES & ESA are thinking along the lines of the ETR payload crew disposition for launch, with a power crew in the LCC, the spacecraft T&C (STE) station in the B1 integration building where it was originally set up for off line processing and a S/C mission direcotr in the MCC.

The launch operations are automated from L-6 minutes with the capability of human intervention. Operations are so hectic that communications between payload and COEL are by a series of coded push button status lights, not voice communications. Only the computer can launch Ariane. Any holds during the terminal count (last 8 seconds) automatically recycles to the L-6 minute mark.

The computer facilities in the LCC are impressive. There are 2 main computers; K1 which controls the launcher electronics and K2 which controls the launcher propellant loading and pressurization systems.

Continued.../18

9.0 Meetings and Tours at CSG - 13 June, 1978

For my money, the LCC is located uncomfortably near to the launch tower even though it is essentially underground.

The AKM preparation building is adequate for space, cranes, etc. but is not a clean room. The author took an action to determine whether a clean room environment is required during this operation.

A meeting was held in the afternoon concerning launch operations. Present were:

M.A. Merdrignac	CNES, COEL
M. Bellot	ESA
M. Oelker	ESA
M. Barban	CNES
M. Bouchet	CNES
S.A.[2]	

We were referred to the CSG books of reference 4 attachment 1 as the basis for our discussions.

The main points presented are as follows:

a) the Ariane "integration in Europe" policy for development vehicles is compatible with what was done for Diamant B and most efficiently utilizes specialist personnel when troubleshooting is necessary.

b) we discussed the spacecraft schedule from arrival at the Pad to launch and our estimate (3-4 days) prior to fairing installation was approximately double the timespan CNES was using. There is no concern, however, since the spacecraft is allowed to arrive earlier, if necessary, and there should be no finanacial impact.

c) the launch vehicle processing after the ship arrives at Cayenne through launch is now 43 working days. CNES are working hard to reduce this time. The study report will present the details of the schedules discussed.

d) RCS pressurization was discussed and it was stated that if the RCS tanks have a 2:1 burst to max. op. pressure ratio, pressurization should take place remotely while on the pad.

Continued..../19

9.0 Meetings and Tours at CSG - 13 June, 1978 (Continued)

e) the spacecraft will be relatively free to power up. and communicate with the ground support equipment except during LV pyrotechnic installation and filling operations. At other times, RF compatibility checks will be required between the spacecraft and Ariane.

10.0 Meetings and Tours at CSG - 14 June, 1978

Visits were provided to the B1 payload checkout building (Venus), to the Diane ESOC uprange VHF telemetry and tracking station and to the Montagne de Pére CNES/Ariane downrange telemetry and tracking station.

M. Fouchre, CNES Co-ordinator of Works and Building and M. M. Bouchet, M. Oelter and M. Bellot accompanied us on the tour of B1. This facility is being upgraded to enlarge the airlock, increase the hook height in the airlock end of the hibay from 7 to 11 metres and provide convenient areas to house STE equipment. The building will maintain class 100,000 clean room conditions and is adequate for dual Delta class S/C checkout (420 sq. metres hibay area) including office space for 2 teams of ~25 spacecraft personnel. Chemical mixing and RCS cleanliness checking areas are provided inside the building. Power will be no-break as with the launch site and provision has been made for mounting roof antennae for RF communications to the spacecraft when at the PAD. Normal general support such as workshops, tools, slings, xerox services will be provided within the basic user charge. The B1 complex (as well as B2 & B3) must be completed by November 1979 to support LO_2 operations.

Mr. Saguin, CNES provided the narrative at the Dianne Station. Figure 2 shows the communications network which was explained during this visit. Diane is not LV oriented and its mission for Ariane will be to monitor the CAT technology package which operates in the VHF band. This station monitors Meteosat and will record Apple and Firewheel telemetry and perform ranging on these spacecraft.

M. Bouchet instructed us on the facilities and function of the Montagne de Pere (Galliot) station which is situated south-east of the launch site, downrange by approximately 20 km from the pad. It is the first tracking station in the chain for Ariane which also includes Cayenne (Montabo), Belem (Salinopolls mobile station), Natal and Ascension Is. For the development vehicle, Galliot moniors 6 on-board telemetry systems; during the operational phases there is only one LV telemetry transmitter and data is reduced from 1500 to 700 parameters. The main autotrack antenna is 10m diameter, 43 db Sband. This station is the only one having data reduction capability so all raw data (except Ascension) is sent here for quick look analysis by CSG prior to transmission to Toulouse for detailed analysis.

Continued..../20

10.0 Meetings and Tours at CSG - 14 June, 1978 (continued)

A meeting was held in the afternoon concerning payload processing facilities. In attendance were:

M. Bellot	ESA
M. Oelker	ESA
M. Bouchet	CNES*
M. Beguin	CNES
S.A.[2]	

* main speaker

The main points discussed were:

a) CNES are working to a strawman schedule for complete payload processing of 33 days from arrival at B1 to launch.

b) S/C weighing will take place in B3. In this building an area has been prepared for spin balancing, but as yet no such equipment has been ordered because the users do not require it and Ariane doesn't require it.

c) it is assumed that the spacecraft team will bring any required spacecraft alignment equipment.

d) in general, clean garments, on-site hardline communications, propellant and AKM storage, propellant chemical analysis, office space, protective equipment (eg. breathing apparatus), S/C container for transport B3 to pad in addition to previously mentioned services, will be part of the basic user charge.

e) with 2 spacecraft in the dual launch program there will be some stretch in the schedule while at B3. This will be minimized by parallel integration onto SYLDA halves followed by the SYLDA mating to form the cargo. Perhaps 2-3 day extension can be anticipated.

f) the CSG responsibility for the cargo commences when the payload is mounted into SYLDA.

g) attachment 7 presents sketches Of the planned B1, B2 and B3 plan views.

Continued...../ 21

11.0 Visit to Isles des Salut, 15 June, 1978

This visit was arranged by CNES and was attended by:

M. Cremel CNES, Director of Kinetheodolite Tracking Station on Isle Royale
M. Bellot ESA
M. Oelker ESA
S.A.[2]

This station on the north side of the geosynchronous trajectory and another located on Montagne de Pere (south of the trajectory) automatically optically track by infra-red sensing the flight of Ariane and on a clear day they should be able to see 3rd stage ignition ~1,000 km away from their position. This system automatically records vehicle co-ordinates and transmits this data to the tracking radar so they can acquire quickly. High (850 frames/sec) and low (20 frames/sec) cameras plus TV coverage are provided, the latter hooked into the mission control centre. This station is located 18 km from the launch pad.

12.0 Conclusions

This report only discusses the highlights of the extremely informative trip. As can be seen from the text, ESA/CNES expended significant resources to provide Canada with a complete and current picture of the Ariane program. The program appears to be well in hand with knowledgeable and responsive personnel co-ordinating the activities. Sufficient material has been obtained to permit a meaningful comparison to be made with the STS launch costs.

Stephen F. Archer

Stephen F. Archer
Staff Engineer - Satellite Systems

ATTACHMENT # 1

ARIANE DOCUMENTS RECEIVED DURING VISIT TO ESA HEADQUARTERS AND KOUROU LAUNCH SITE

1. Ariane User's Manual, AR(75)01, Issue 1, Revision 2, October, 1977

2. Draft Revision, Chapter 6, Documentation, to AR(75)01, received 5 June, 1978.

3. Specimen ESA Dossier de Controle des Interfaces, DCI 10/32, for L02, for information only, 30 March, 1978

4. Ariane Launch Vehicle Presentation Books, ESA October 1977 For COMSAT; Launch Vehicle Parts 1 to 5. Guiana Space Centre Parts 1 to 3

5. Ariane Overall Vehicle General Concept, Summary of M. Vignelles' Presentation, 5 June 1978

6. Air and Cosmos, Special Ariane Issue

7. Set of Prints of Spacecraft Integration Laboratory (SIL)

8. SEP Ariane Package, including:

   a) General SEP Brochure
   b) Position of SEP in the Ariane Project (With English Translation)

9. Le Centre Spatial Guyanais, CNES, Europa 2 Vintage 1974

10. Centre Spatial Guyanais Package, including:

    a) Le Centre Spatial Guyanais, from La Recherche Spaticle, Vol. XIII, No. 4
    b) Les Moyens de Mesure du CSG, from La Recherche Spatiale, Vol XIII, No. 6

11. Paper on the Intrastructure of the Port du Degrad des Cannes (Port of Cayenne)

12. Sketch of SYLDA, ESA (CR-99-04)

13. Presentation of Dual Launch Capability by M. Neumann, ESA, June 6, 1978.

14. Paper on Lanceur Ariane, Simulation of Guidance, by B. Humbert and H.P. Nguyen, Aerospatiale

15. ESA, Ariane Organization Chart.

ATTACHMENT #2

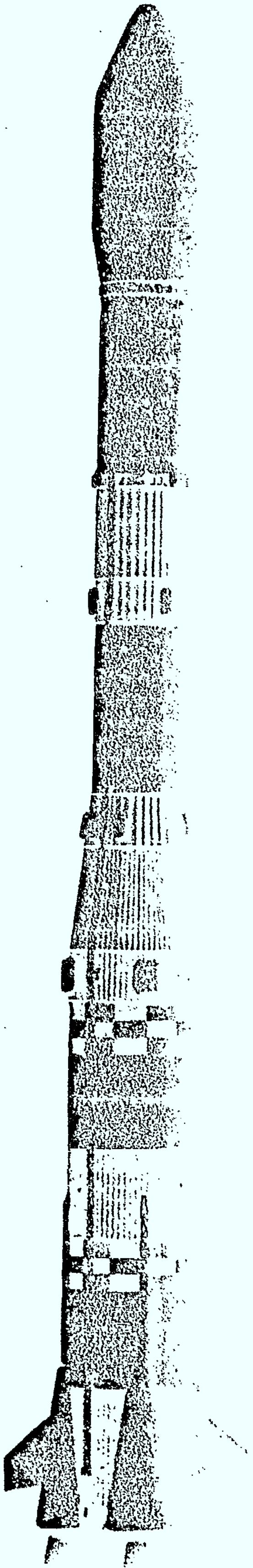
ARIANE INVESTIGATION - ITINERARY

DATE	ACTIVITY
Monday, 5 June, 1978	ESA Headquarters Kickoff Meeting - Description of Ariane - Status of Development and Qualification - DOC Presentation on Study Objectives
Tuesday, 6 June, 1978	Visit to Ariane Facilities at SNIAS, Les Mureaux and SEP, Vernon, France
Wednesday, 7 June, 1978	Non Ariane Visit to SNIAS, Les Mureaux and SEP, Vernon re: Spacecraft Equipment
Thursday, 8 June, 1978	ESA Headquarters Meeting - Payload/Ariane Interface Documentation (a.m.) - Dual Launch Capability - Costing Policy
Friday, 9 June, 1978	ESA Headquarters Meeting - Discussion of Outstanding Items
Saturday, 10 June, 1978	Travel - Paris to Kourou, Fr. Guiana
Monday, 12 June, 1978	- Visit Launch Tower, Mission Control Centre - Safety Meeting.
Tuesday, 13 June, 1978	-Visit Launch Control Centre -Launch Flight Operations Meeting
Wednesday, 14 June, 1978	-Visit Payload Facilities & Tracking Stations -Payload Operations Meeting
Thursday, 15 June, 1978	-Visit Optical Tracking Station, Isle Royale
Friday, 16 June, 1978	-Visit Cayenne & Port -Travel to Trinidad (1 Day Stopover req'd)
Saturday, 17 June, 1978	-Arrival Toronto.

ARIANE

OVERALL VEHICLE GENERAL CONCEPT

Summary of
M. Vignelle's
Presentation
5 June, 1978.



ARIANE HAS :

- THREE STAGES
- TWO "ONE CUT" SEPARATION SYSTEMS
- CENTRALIZED INSTRUMENTATION BAY
- BULB-SHAPED FAIRING

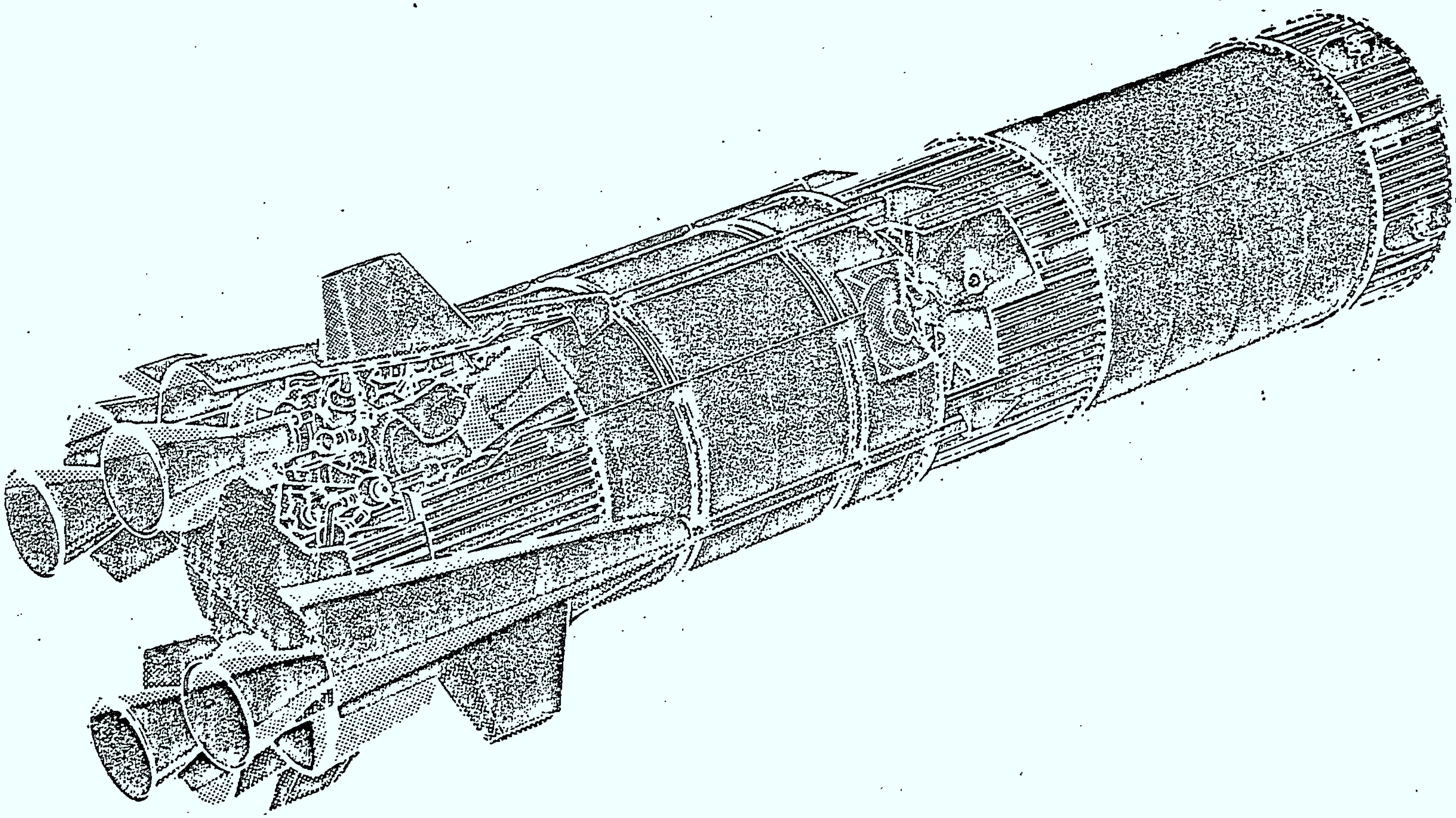
TOTAL WEIGHT	208 T
OVERALL LENGTH	47 m
FIRST STAGE DIAMETER	3.8 m
UPPER STAGES DIAMETER	2.6 m
FAIRING DIAMETER	3.2 m
USABLE DIAMETER INSIDE FAIRING	3 m

2002

ARIANE

first stage L140

general view



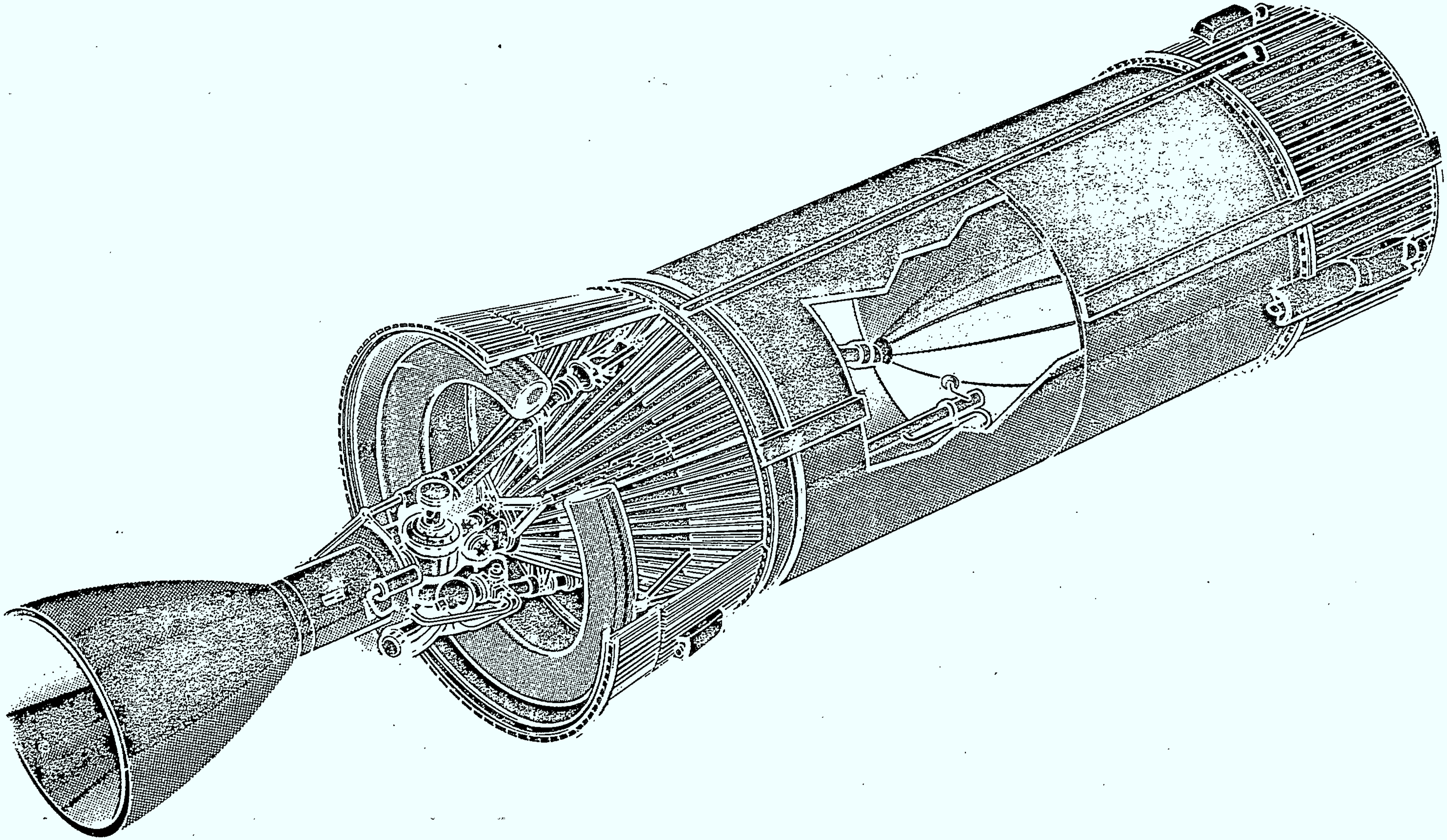
ARIANE – FIRST STAGE L 140

GENERAL DATA	DIAMETER	3.80 m
	TOTAL LENGTH	18.40 m
MASSES	EMPTY MASS	13 270 kg (without retro-rockets)
	PROPELLANT FILLED	147.67 T (UDMH + N_2 O_4)
	MASS ON RAMP	160.94 T
	MASS AT LIFT OFF	159.55 T
	UNBURNT (mean value)	815 kg
PROPULSION DATA	BURNING TIME IN FLIGHT	145 s
	PROPULSION SYSTEM	FOUR VIKING V each gimballed in one axis
	SEA LEVEL DATA	TOTAL THRUST: 2 445 kN SPECIFIC IMPULSE: 248.6 s
	VACUUM DATA	TOTAL THRUST: 2 745 kN SPECIFIC IMPULSE: 281.3 s minimum.

\RIANE

SECOND STAGE L33

General view

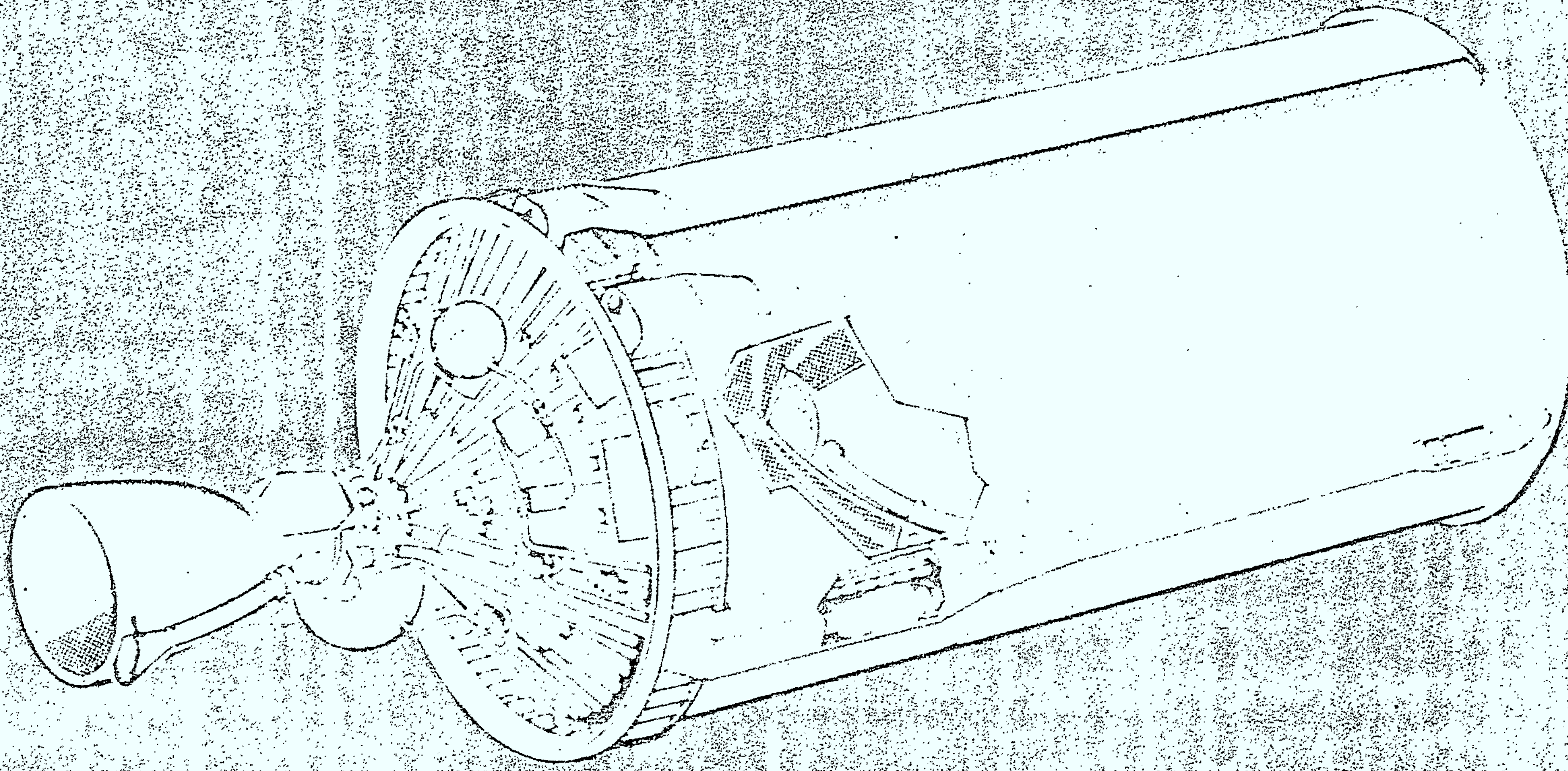


ARIANE – SECOND STAGE L 33

GENERAL DATA	DIAMETER	2.60 m
	TOTAL LENGTH	11.505 m (without interstage ½)
MASSES	DRY MASS	3 285 kg Before separation ½ 3 118 kg After separation ½
	(without interstage ½,	with retro and acceleration rockets)
	PROPELLANT FILLED	~~33 068 kg~~ ($UDMH + N_2O_4$) 34.200 Kg
	UNBURNT (mean value)	137 kg
	MASS AFTER SEPARATION ½	~~36 790 kg~~ 37.418 Kg
	MASS AT BURN OUT	3 268 kg
PROPULSION DATA	BURNING TIME IN FLIGHT	138 s
	PROPULSION SYSTEM	ONE VIKING IV ENGINE
	VACUUM DATA	THRUST 709 kN SPECIFIC IMPULSE 293,5 s minimum.

ARIANE

Third Stage H8 general view



ARIANE – THIRD STAGE H8

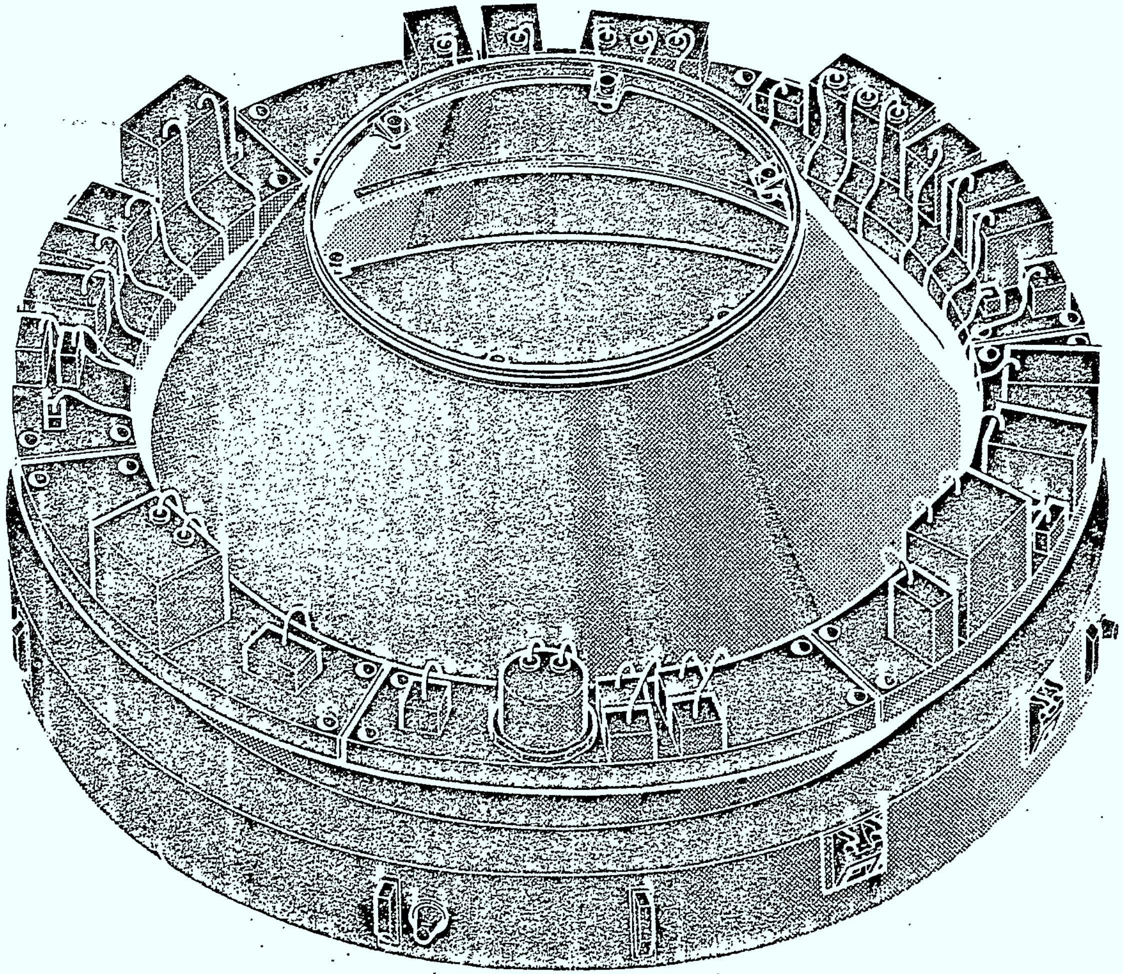
GENERAL DATA	DIAMETER	2.6 m
	TOTAL LENGTH	9.081 m
MASSES	DRY MASS	1 157 kg maximum.
	(after separation 2/3	and retro-rockets jettisoning)
	PROPELLANT FILLED	8 230 kg ($H_2 + O_2$)
	UNBURNT (mean value)	67 kg
PROPULSION DATA	PROPULSION SYSTEM	ONE HM 7 ENGINE
	BURNING TIME IN FLIGHT	570 s
	OVERALL MIXTURE RATIO	4.5
	VACUUM DATA	THRUST : 60 kN SPECIFIC IMPULSE : ~~431~~ 440 s

minimum in full Stage
(442-3 in flight)
444 engine.

ARIANE

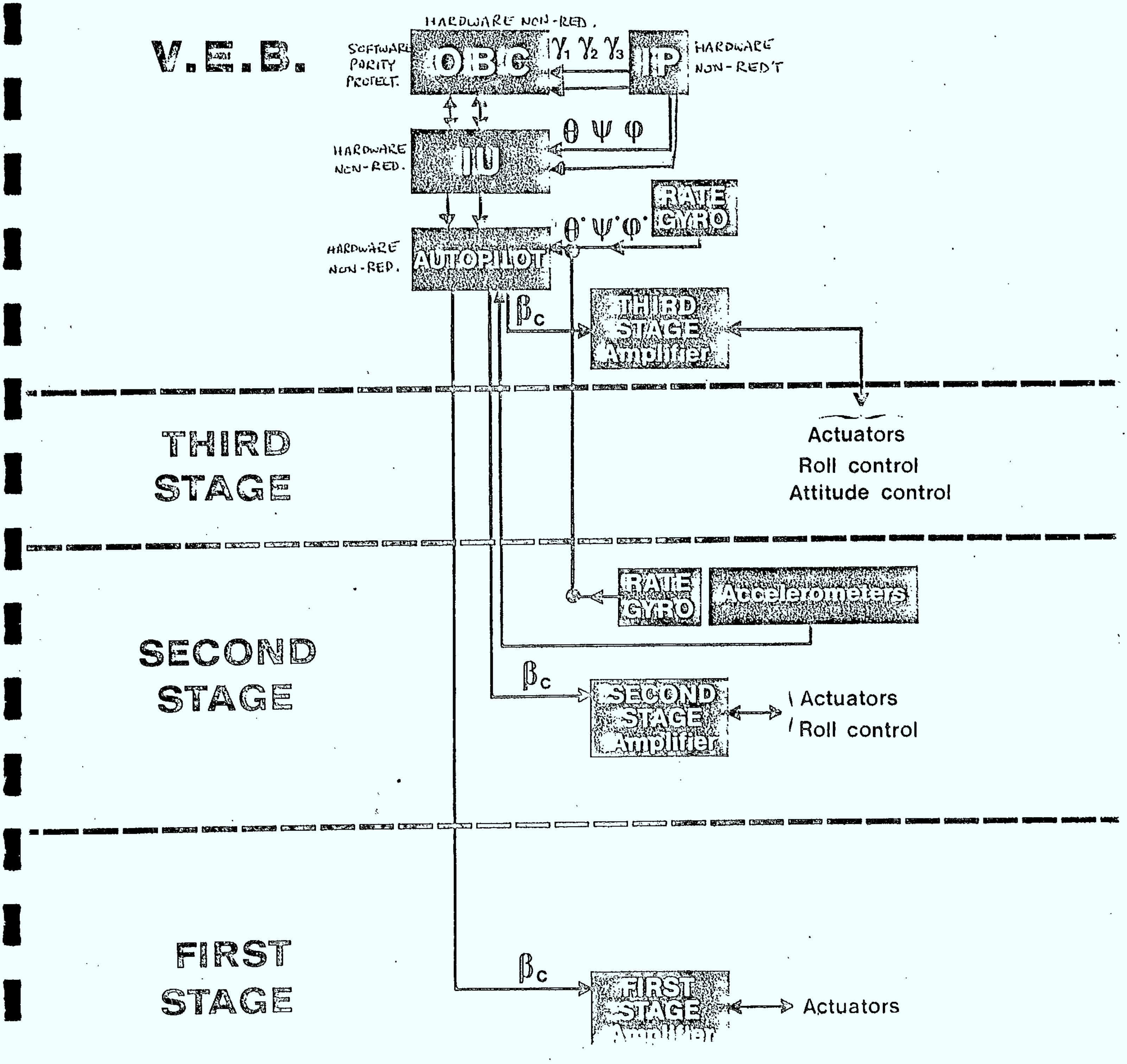
VEHICLE INSTRUMENTATION BAY

general view



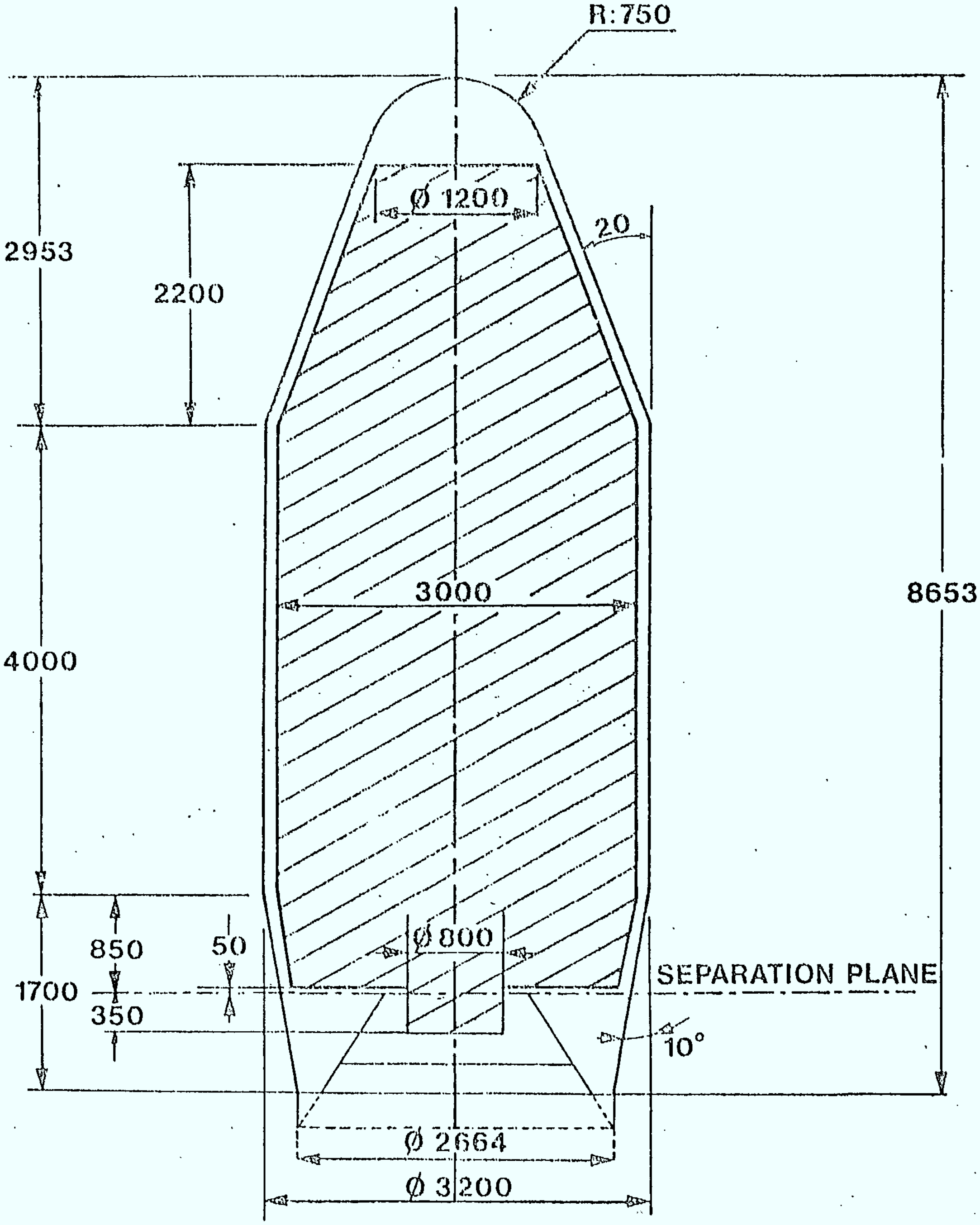
ARIANE

GUIDANCE AND CONTROL CONCEPT



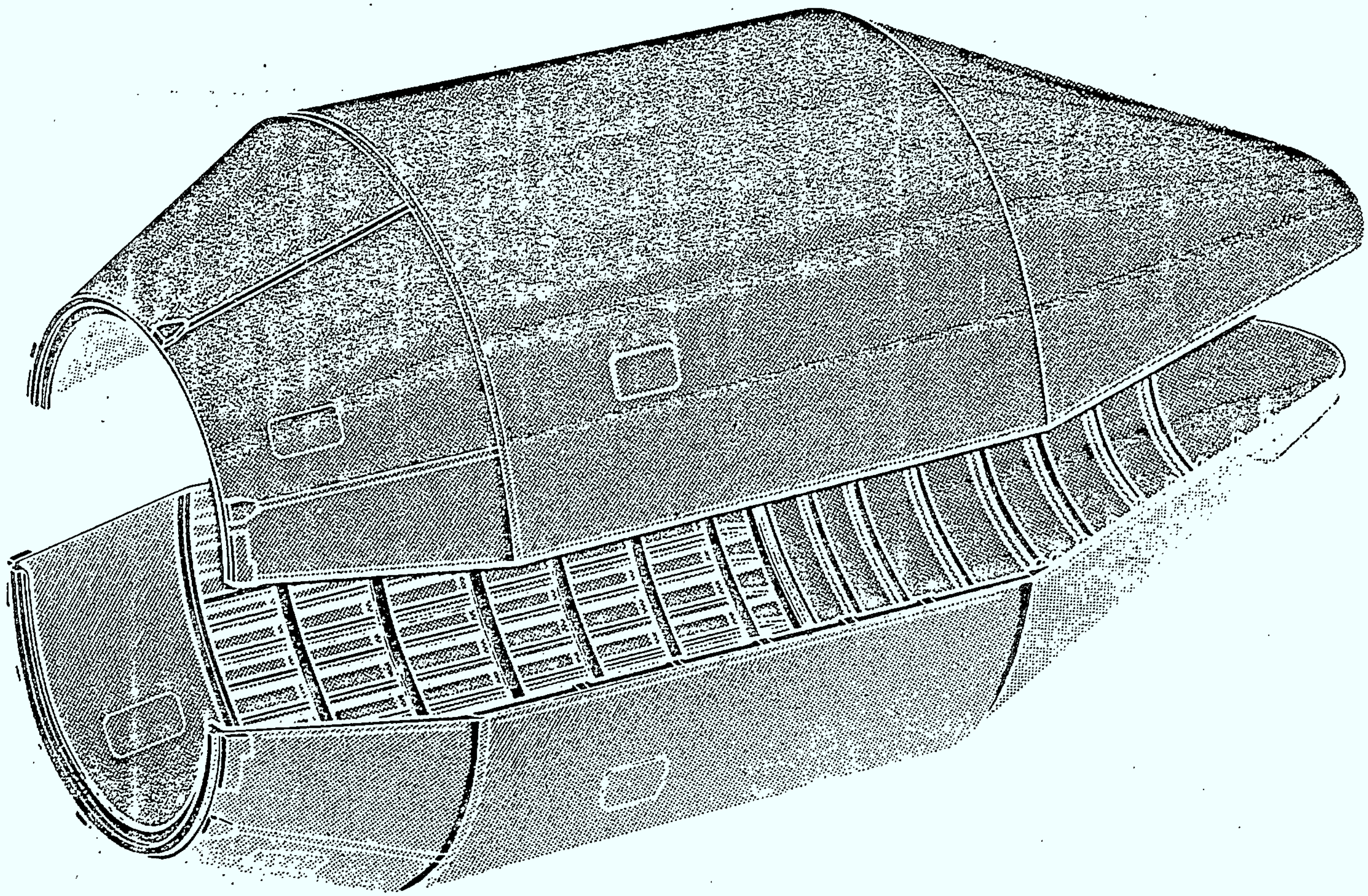
ARIANE

OVERALL DESIGN AND FREE VOLUME



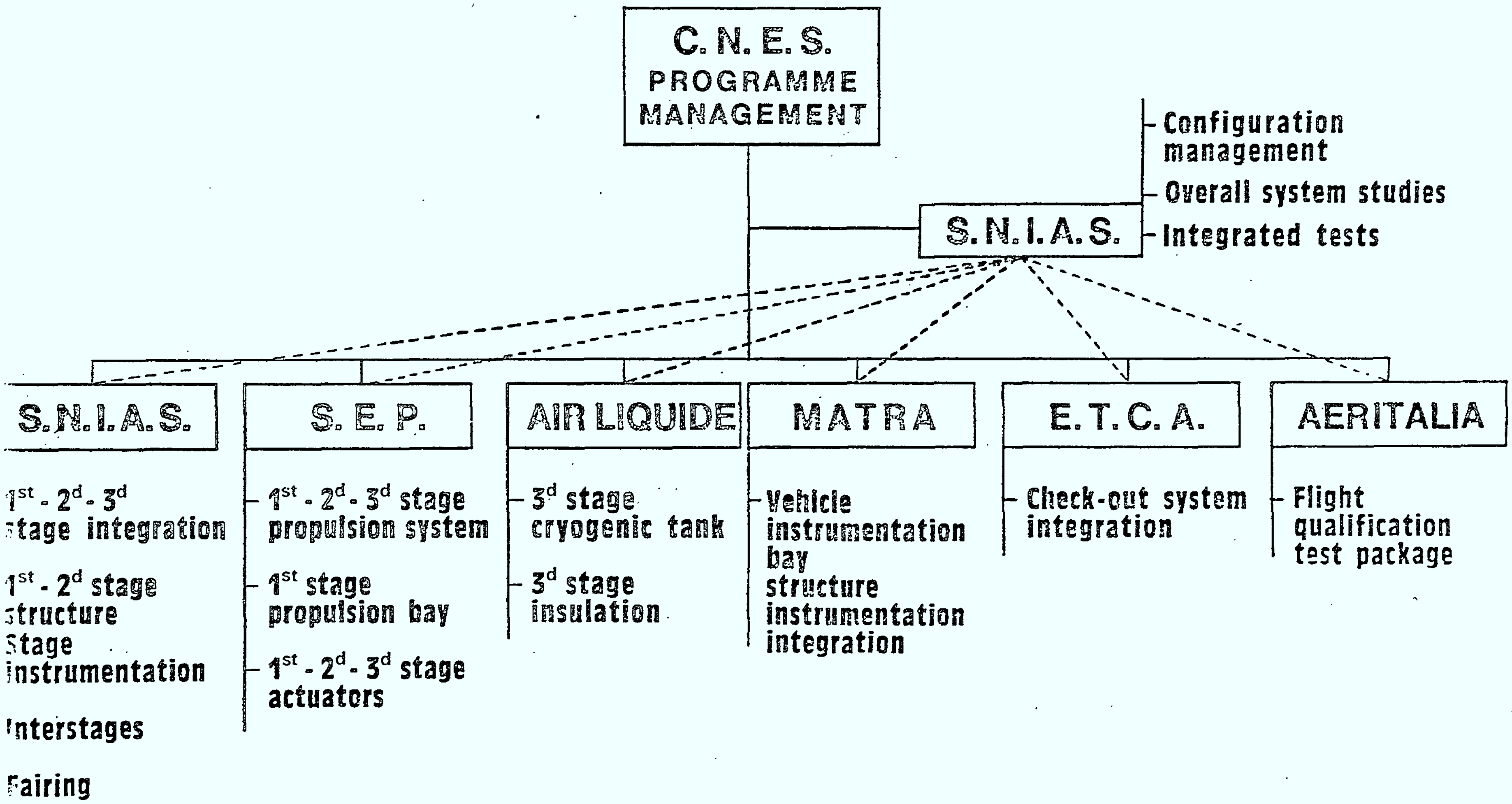
ARIANE **FAIRING**

general view



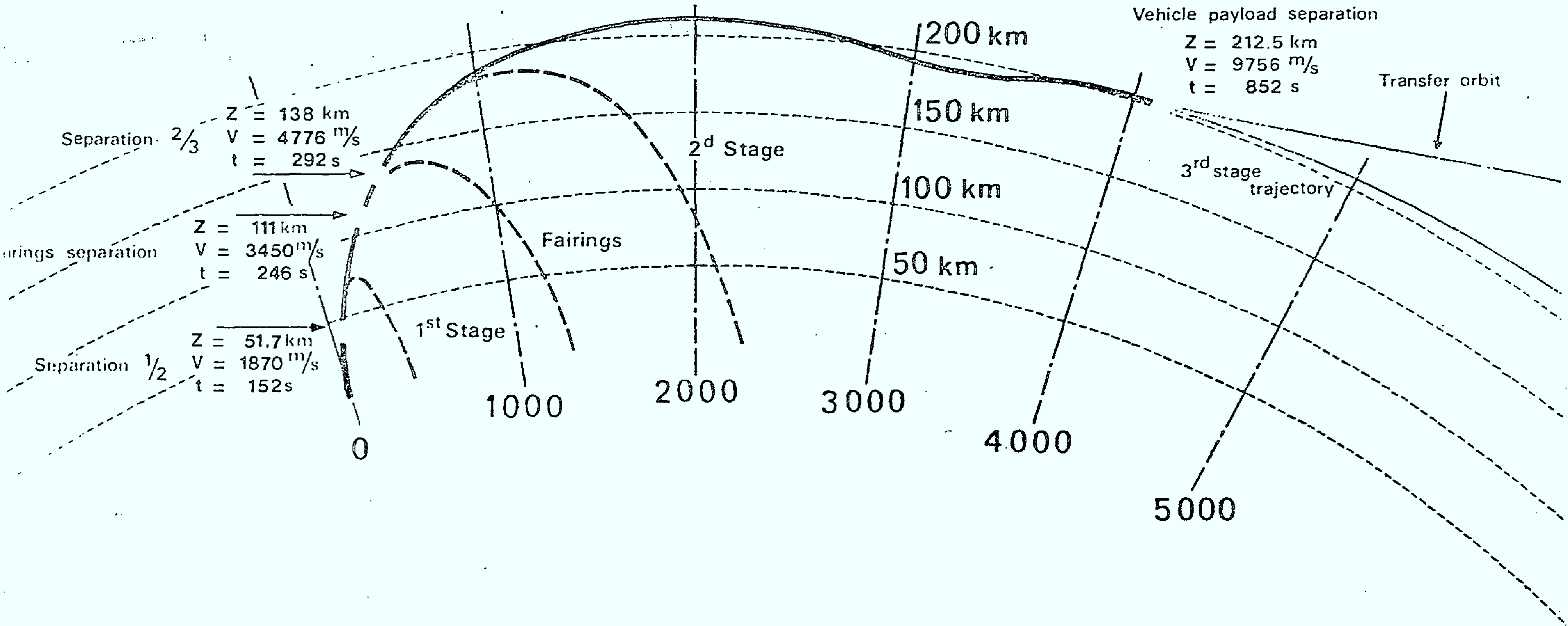
ARIANE

FIRST LEVEL CONTRACTORS



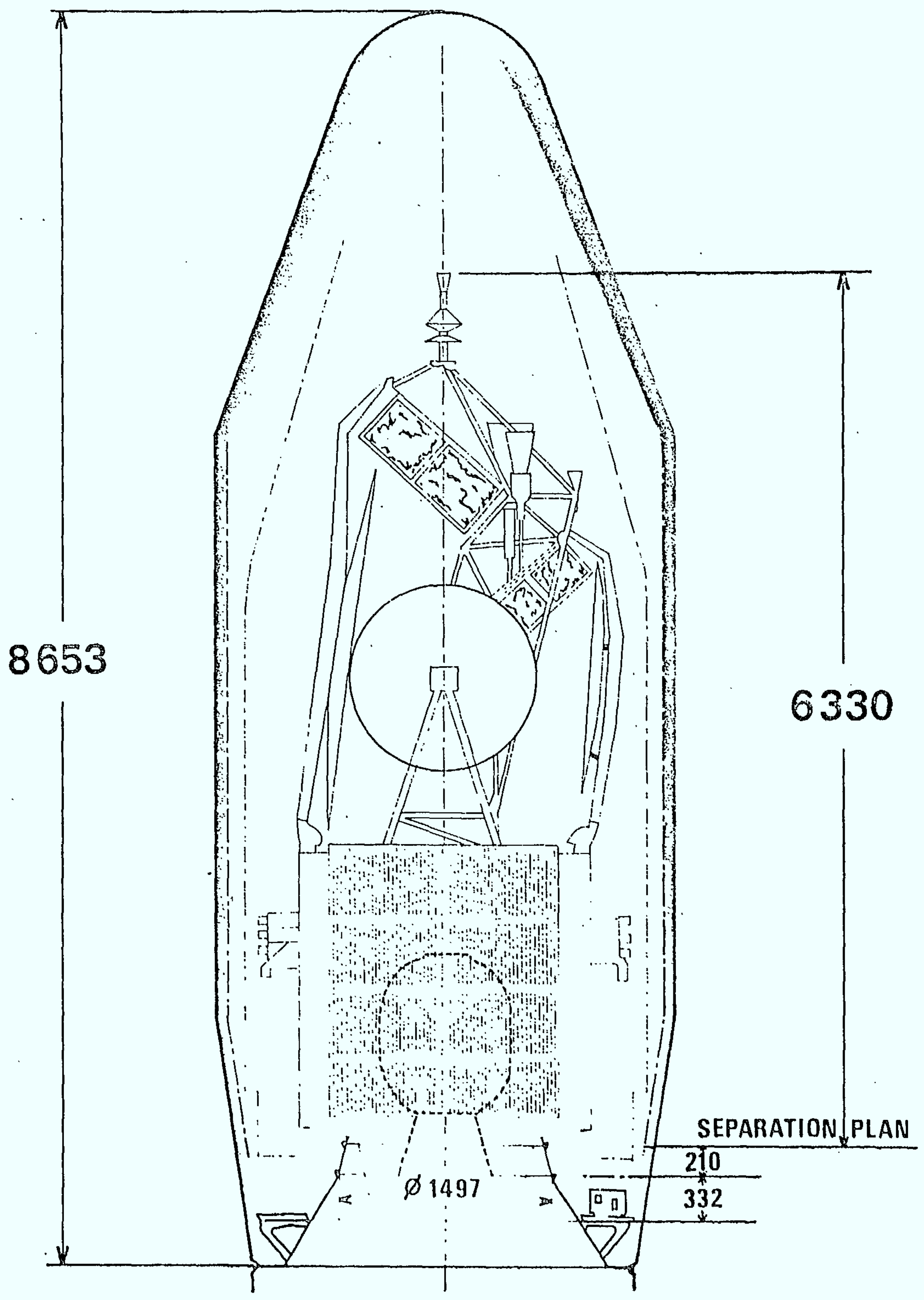
ARIANE

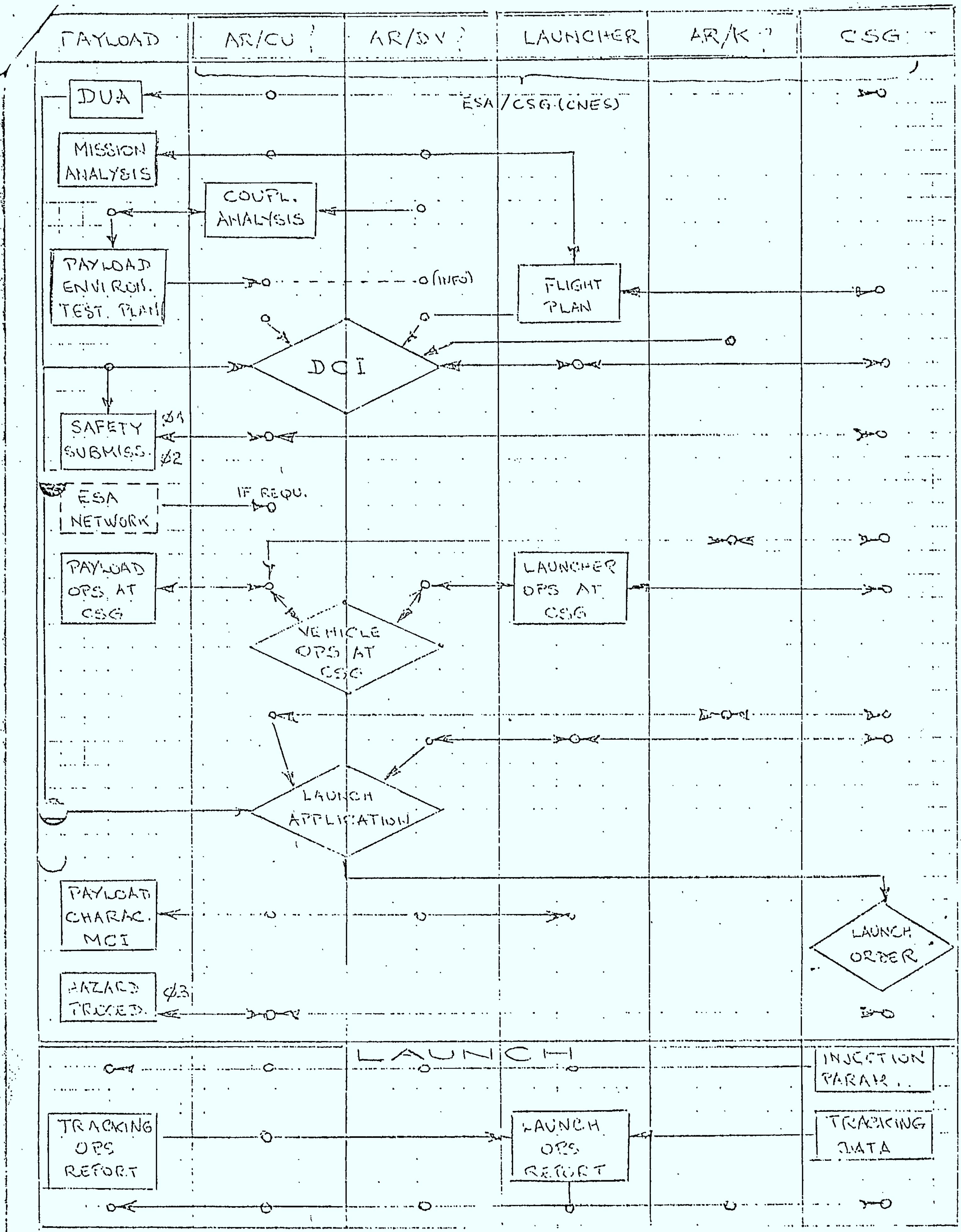
NOMINAL TRAJECTORY
MAIN FLIGHT EVENTS



ARIANE

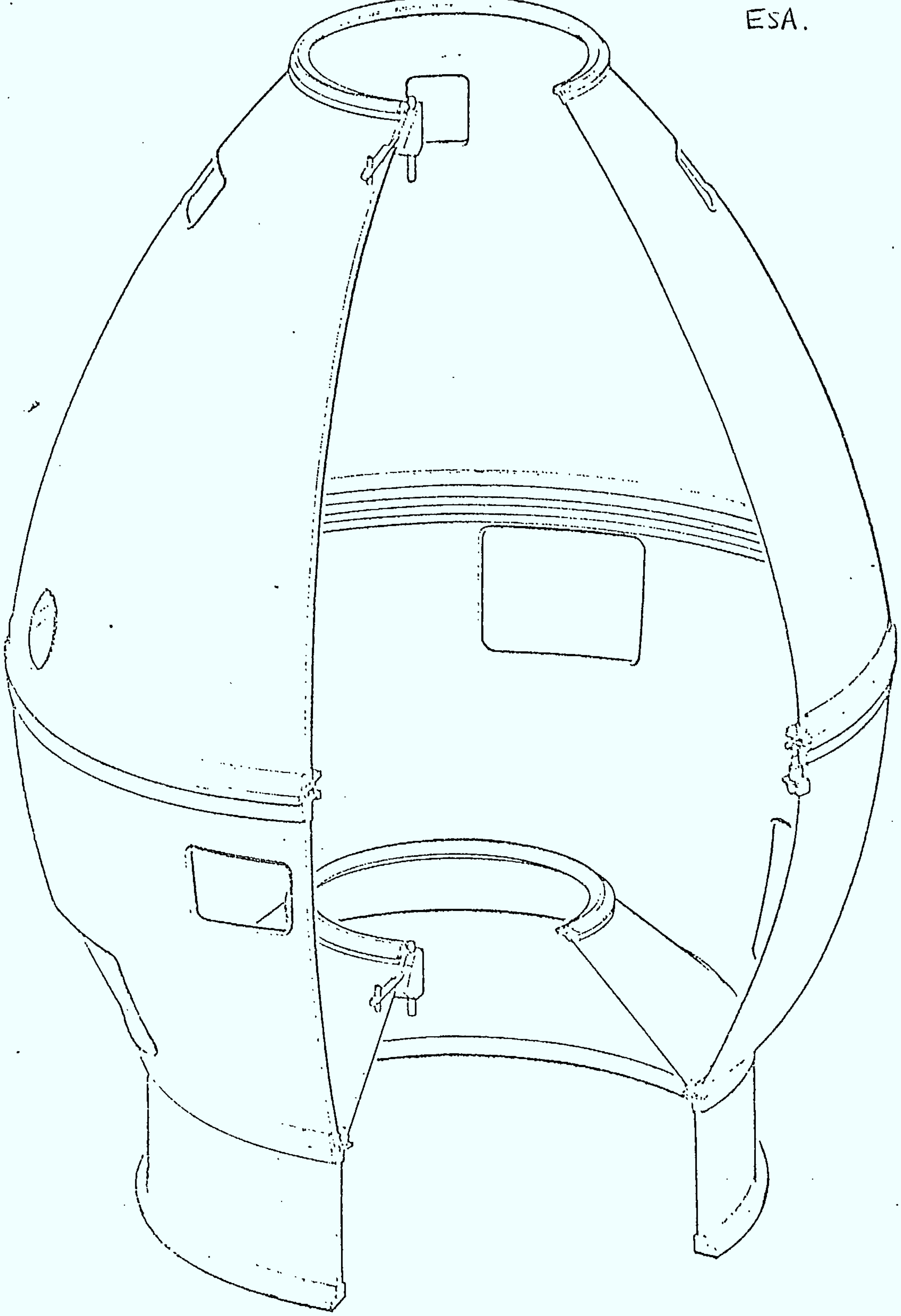
FAIRING AND INTELSAT V





OPTIONAL   MANDATORY

received
5 June, 1978
ESA.



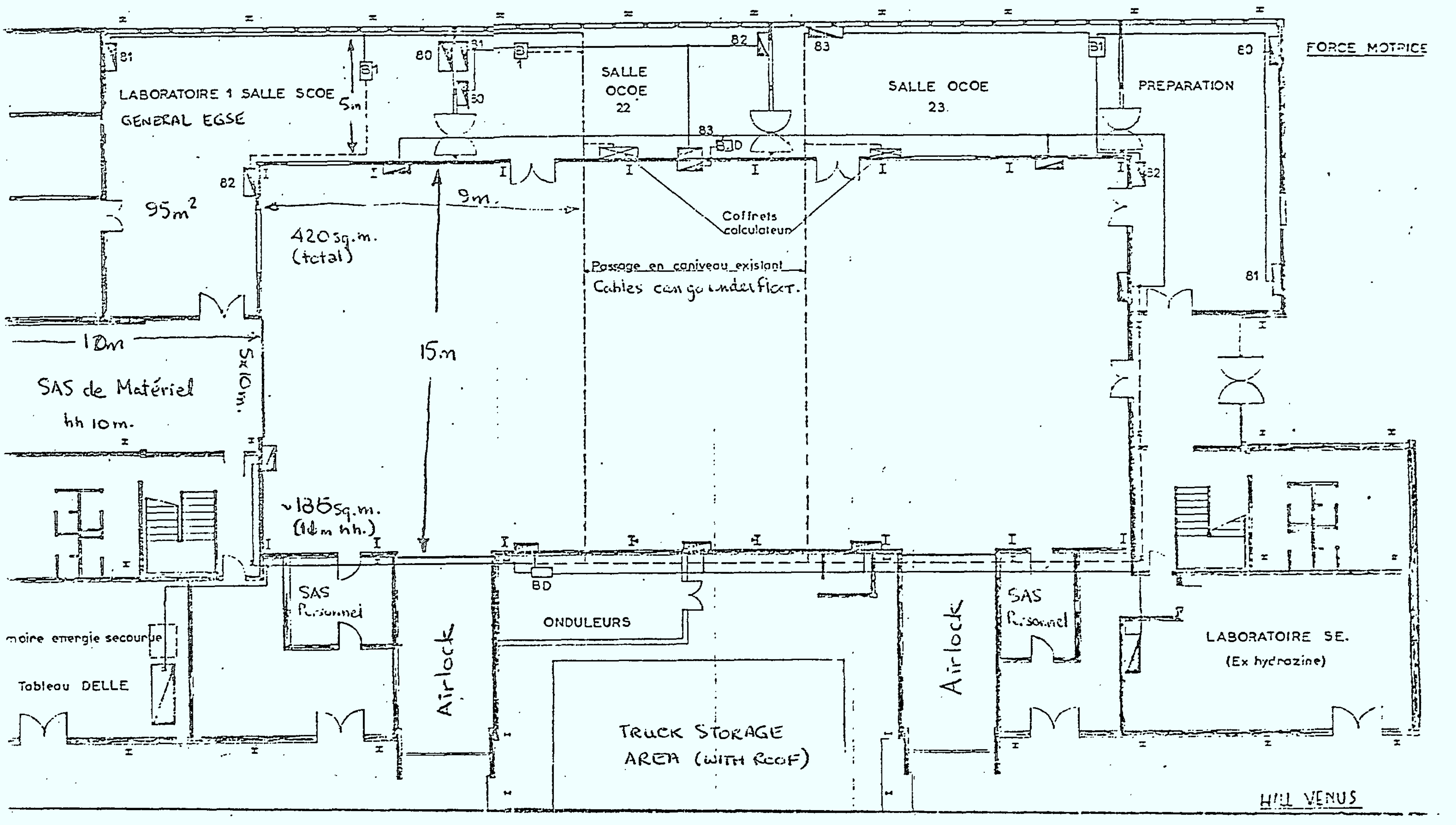
SYLDA
ENSEMBLE STRUCTURE

Attachment 7

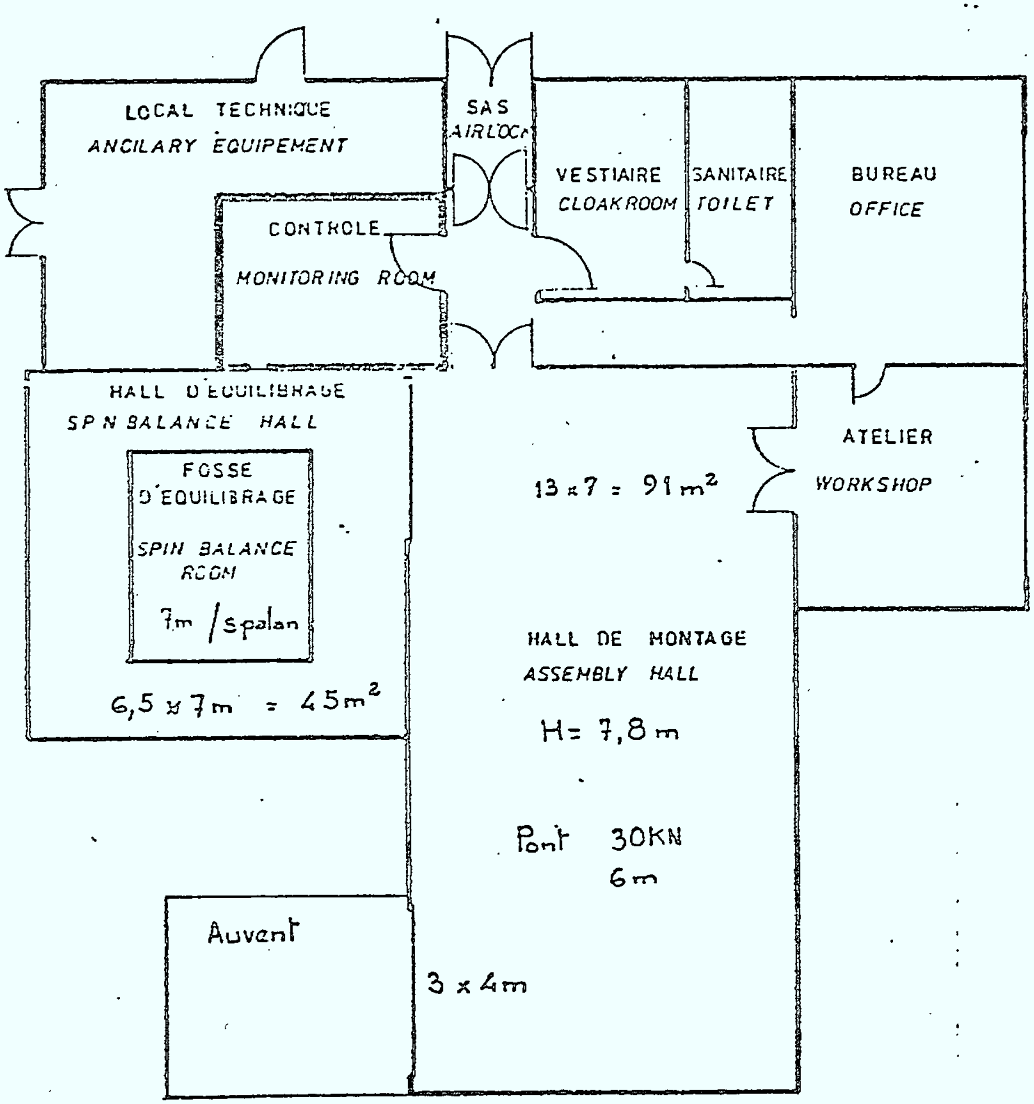
Floor Plans of Payload Buildings at CSG.

VENUS

B1.



LABORATOIRE 1 SALLE SCOE
GENERAL EGSE
5m
95m²
420 sq.m. (total)
9m.
SALLE OCOE 22
SALLE OCOE 23.
PREPARATION
FORCE MOTRICE
Coffrets calculateur
Passage en caniveau existant
Cables can go underfloor.
10m
SAS de Matériel
hh 10m.
5x10m.
15m
~135 sq.m.
SAS Personnel
Airlock
BD
ONDULEURS
Airlock
SAS Personnel
LABORATOIRE SE.
(Ex hydrazine)
moire energie secourue
Tableau DELLE
TRUCK STORAGE AREA (WITH ROOF)
HALL VENUS



N

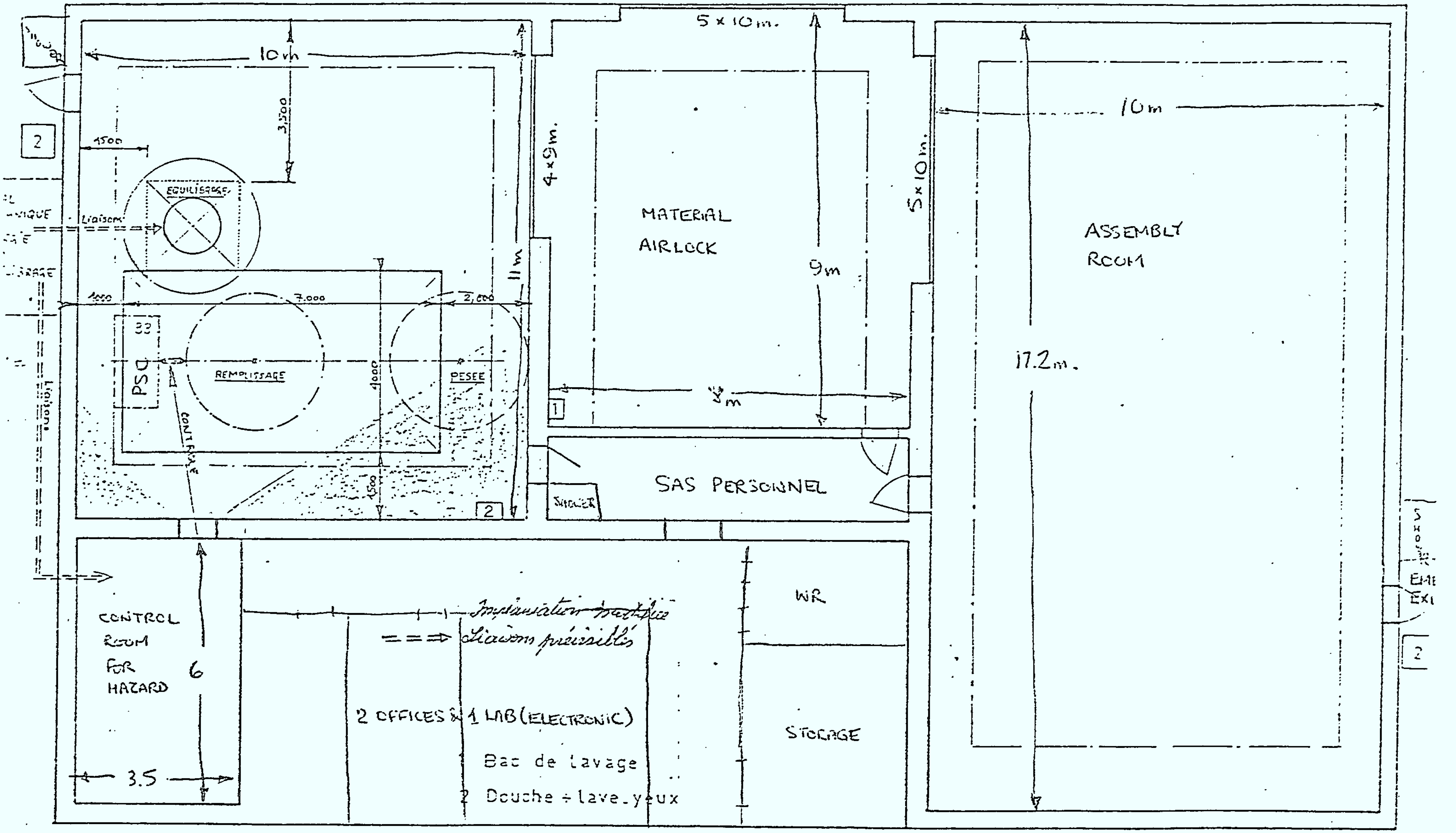
B2

HALLS CHARGE UTILE
ARIANE

ARIANE
PAYLOAD HALLS

CROQUIS N° 2 HALL APOGEE
(Ex. hall perigee)

ECH. 1/100° OLA/EIS/IR 11/10/77



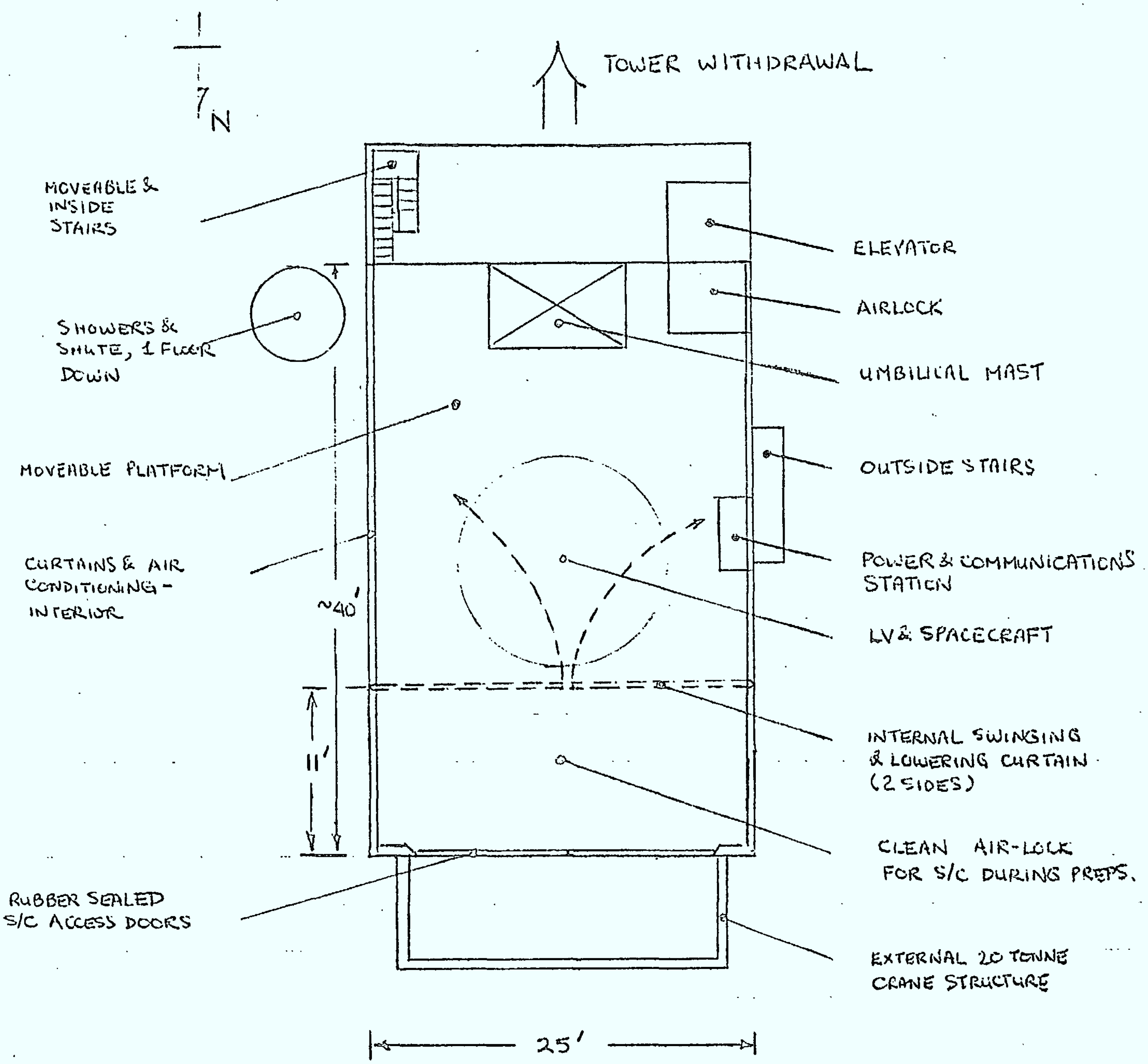
B3 BUILDING

PRT/SL/CA - 7/6/78

FIGURE 1

ARIANE LAUNCH TOWER

PAYLOAD LEVEL-PLAN VIEW

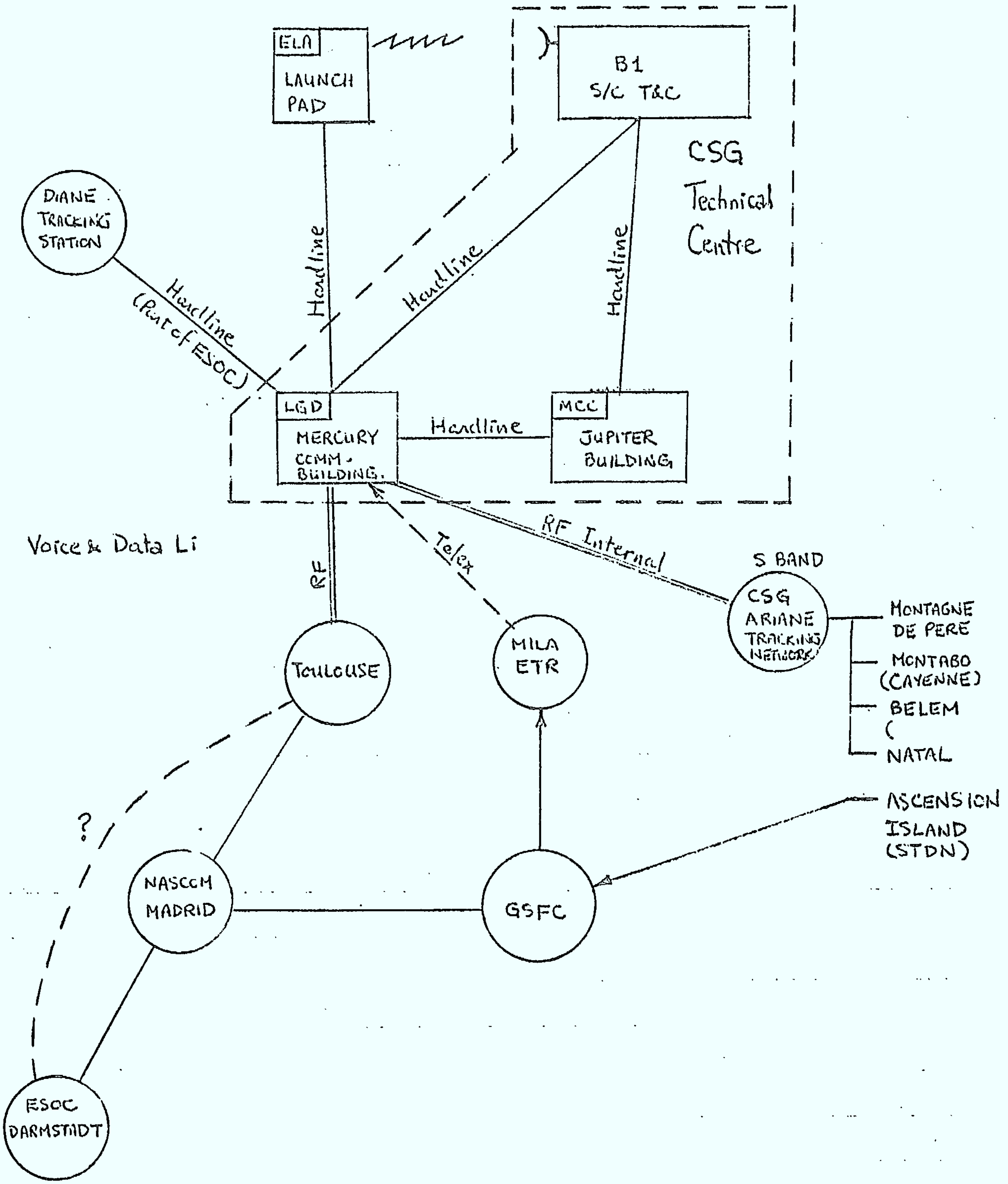


ELEVATION - NOMINAL 40 metres

NOT SHOWN - 50 KN 5 DEGREE OF FREEDOM CRANE & 20 TONNES CRANE.

Figure 2

CSG/ESA COMMUNICATIONS NETWORK



Government of Canada | Gouvernement du Canada

MEMORANDUM | NOTE DE SERVICE

S. Archer - SPAR

SECURITY - CLASSIFICATION – DE SÉCURITÉ	
OUR FILE – N/RÉFÉRENCE	CRC 6656-8 (ST)P
YOUR FILE – V/RÉFÉRENCE	
DATE	8 May, 1978

TO / À: H.R. Warren

FROM / DE: S. Ahmed

SUBJECT / OBJET: Launch Vehicle Interface Study - STS Trip Report, 16-28 April, 1978

1.0 Background

From about 1980 and beyond, there will be two launch vehicles available for the class of communications satellites of interest to Canada. One is the re-usable U.S. Space Transportation System (STS) and the other is the European Space Agency's expendable 'Ariane' System. For planning future DOC missions (e.g., MUSAT) and to make a judicious choice between the two available launch systems, it was necessary to establish (a) the technical capabilities, (b) the related logistics, and (c) the direct and indirect costs of each launch system. The technical capabilities of each system are published and seminars have been given by the developers. The logistics involved and the related costs of each launch system have not been readily available to potential users. The present launch vehicle interface study to estimate these costs for each system has been undertaken jointly with Canadian industry (S. Archer of SPAR). The re-usable STS is being addressed first. In order to build up a data base, an AIAA sponsored space shuttle symposium was attended followed by visits and meetings with Rockwell Space division (STS contractor), Hughes Aircraft Corporation (Spacecraft contractor and STS user with a Delta class spinning solid upper stage), McDonnell Douglas Astronautics Corporation (Spinning Solid Upper Stage developer), Ford Aerospace and Communications Corporation (Spacecraft contractor and STS user with an Atlas-Centaur class spinning solid upper stage), NASA Kennedy Space Center (responsible for STS ground operations), and NASA Johnson Space Center (responsible for STS flight operations). Useful information and documentation were obtained during the visits. The significant information obtained has been summarized in this trip report.

2.0 AIAA Space Shuttle Symposium (Los Angeles)

The significant presentations (relevant to our study) were made by John Yardley (Associate Administrator for Spaceflight, NASA/HQ), George Jeffs (President, North American Space Operation, Rockwell International), J. Michael Smith (Director, STS Customer Services, NASA.HQ), and Hal E. Emigh (Director, STS payload integration, Rockewell International).

On the STS development program itself, due to the main engine turbo-pump problems, Rockwell announced that they could not see the first manned orbital flight occurring before June 1979 (though NASA spokesmen stuck to the March 1979 date). The other major problem was the software development for the GPC (general Purpose computer). On STS mission commitments, flights 1 to 11 were committed and space was still available on flights 12 to 22. In response to Steve Archer's question with regards to the possibility of STS provided thermal shrouds for payloads, Mr. Yardley stated that the new design profile for payloads was for them to be capable of withstanding direct sunlight for 30 mins, deep space for 90 mins and earth radiation indefinitely. He added that if any shrouds were still required, they would be the responsibility of the STS user. In our conversations with the other attendees we heard that the Hughes SBS and ANIK-C could only stand 7 minutes of direct sunlight, the TRW TDRSS about 9 minutes and the Ford Intelsat-5 about 30 minutes. Obviously, the shuttle design and operational profiles are being influenced by Intelsat-5. The Hughes spinner can stand the 30 minutes of direct sunlight if it is allowed to spin in the payload bay. Hughes were trying to get this accepted by NASA. We did not find out the solution for TDRSS' thermal problem. It is suspected that it will be ejected as soon as the payload bay doors open in parking orbit.

Mr. Smith gave the standard NASA speech on cost, but also included a typical NASA charge for a SSUS-D payload. Including optional services at JSC and KSC, he estimated the total launch services to be $6.836 million for a March 1981 launch. He added that NASA's model included 3 aborts for every 100 missions. NASA only guaranteed a free re-flight if the mission was aborted through their fault. NASA or any of the payload users would not be held responsible for any damages caused during a mission. He also stated that NASA was developing a policy to address the case if the shuttle schedule slips extensively, and would be announced in September 1978. With regards to the STS reimbursement guide JSC 11802, he stated that it would be issued in November 1978. (We were subsequently given a preliminary copy at JSC and a similar copy was also sent to H.R. Warren by JSC).

Mr. Emigh gave a very general paper on engineering and manufacturing interfaces. All the attendees were given a copy of the STS User handbook.

3.0 Rockwell International at Downey

The meeting with Rockwell was with the STS User Services Center staff. The Rockwell attendees included: H.E. Emigh (Director, STS payload integration), G.F. Dowdall (Programs development, advanced programs), S.L. Eilenberg, R.C. Starkey, J. Canetti and J.O. Mattzenauer.

The significant points made were:

a) Rockwell regarded itself as the optimum cargo integrator (both McDonnell-Douglas and TRW are also trying for this role and it is expected that NASA will hold a competition). Rockwell had gone ahead, and established a self-financed "User Services Center".

b) For a SSUS-D free-flyer such as ours, the major interface would be with McDonnell-Douglas. Rockwell had already provided McDonnell with mathematical models of the shuttle structure. Rockwell felt that the thermal work should be done by themselves as "cargo integrators".

c) Mr. Emigh gave us an overview on a typical user program flow (as Rockwell sees it). He also gave us a copy of a paper that had been presented about a week earlier. It included his flow diagram.

d) It was indicated that JSC 07700 Vol. XIV will be phased out by NASA and ICD 2-19001 would takes its place for orbiter/cargo standard interfaces. This would then be the 'core' interface document from which a payload unique interface document would be developed.

e) In general discussions, Rockwell indicated that typical coupled loads analysis done by them to date had ranged from $15K to $46K. On launch insurance, they indicated that there are two groups available, one in Washington D.C. called Coroon and Black and another in New York called Marsh and McLennan. The premiums being quoted were about 6% compared to 10% for expendable launch vehicles.

4.0 Hughes Aircraft Corporation at El Segundo

We met with Dr. Z.O. Bleviss (launch vehicle specialist) and A.D. McLennan (Systems Engineer) of HAC. The significant points made were:

a) The draft SBS payload integration plan and the associated launch support services plan were being reviewed by all the concerned parties. (It was recommended we try and obtain these from JSC).

b) The loads analysis was being done by McDonnell-Douglas and the thermal analysis by Rockwell.

c) The draft launch site support plan indicated that all work done prior to entering the Vertical Processing Facility at the Cape would be charged as an optional service.

d) The total weight of SBS with the SSUSD and its cradle was around 9000 lbs.

e) We were given a NASA document indicating their thinking on the overall flow of a program.

5.0 McDonnell-Douglas Astronautics Company

We met with F.E. Peake (Manager, launch vehicles programs extensions), M.J. (Bud) Schmitt (Director marketing, advanced space programs and launch vehicles), and L.W. Gale (Director - PAM program, Delta programs).

The significant information obtained from MDAC is as follows:

a) They are progressing satisfactorily on the PAM (Payload Assist Module in their terminology and SSUS, Spinning Solid Upper Stage, in NASA terminology). They had just had a PDR with NASA on the PAM (or SSUS).

b) The revised PAM user requirements document is expected to be ready by the end of the year, however they made us a comprehensive presentation (we have a copy of the Vu-graphs) of the PAM-D capabilities, its interfaces, standard costs, and optional costs projected to 1980. A typical PAM-D including optional services is projected to cost about $3.5 million in 1980.

c) MDAC's preference is to work directly with the user rather than through NASA.

d) On other technical details, the PAM cradle offers both a mechanical and electrical interface for the payload. MDAC does the main physical interfacing with the orbiter through its cradle. Active nutation control can either be done with the PAM controller or the payload could carry the nutation controller. For SBS, the nutation control is done by the Spacecraft and for Intelsat-5, it is done by the PAM. Intelsat-5 has its own nutation controller for post-PAM-separation nutation control.

e) In the present NASA mission models, all PAM payloads are in the aft end of the payload bay. In the cargo integration at the Cape, the aft end of the cargo bay planned is to be integrated first.

f) Payload customers may buy an option for a back-up Delta (ELV) launch until 1 Oct., 1979 by paying $300K. This money should be paid at the beginning, and is non refundable if the STS is used. It will be applied towards the cost of a Delta launch, however, if it is used.

6.0 Ford Aerospace and Communications Corporation

At FACC, we met with P.D. Crill (Manager, Spacecraft preliminary design), S. Kulick (Advanced Space systems engineering) and J. Harvey (STS-Intelsat-5 electrical interface engineer). The information obtained was:

a) COMSAT laboratories does the main interfacing with NASA for the STS launch. Ford deals with COMSAT only. Hence, the launch agreement, the project implementation plan (PIP) and PIP Annexes are COMSAT responsibilities with Ford support as required.

b) Intelsat-5 is presently slated for the 18th mission of the orbiter. Timeline planning at KSC is going on and presently calls for 6 weeks at the Cape. This was considered excessive by Ford and some revisions are likely.

c) The performance of the SSUS is controlled by signing an orbital incentive type of an agreement with MDAC.

d) The present plan by Ford is to turn on all the bus electrics, as well as the main receivers just before cargo bay close-out. Then, Ford's only worries are the arming of the two motors (PAM and Apogee) and the turn-on of the main transmitters.

e) Ford does not plan to carry out any R.F. testing of the satellite at the Cape (KSC).

f) We were shown the qualification model Intelsat-5 solar array that was being tested in Ford's 39 ft dia spherical vacuum chamber. We were also shown the dynamic/thermal model of the satellite being assembled. Finally, we were shown a NATO-3 spinner being checked out to ensure that its despun platform locks on to a simulated Earth.

g) We then obtained a briefing on Ford's conceptual answer to the HAC Syncom-4 using a bi-propellant perigee stage. The concept optimally exploits the STS cargo bay as per the present NASA pricing policy. Ford's corporate plans did not include any company funded advanced development effort.

7.0 Kennedy Space Center

We attended a briefing on STS launch site processing facilities. The principal speakers for "free-flying" payloads were J.W. Johnson (Manager, automated payload program), J.R. Atkins (Director, Safety, R&QA, and protective services) and D.K. Gillespie (Chief, Center resources planning staff). We then had a separate meeting with Mr. J.W. Johnson and Mr. R. Gunter (responsible for free-flying commercial payloads). The briefing included a tour of the STS related launch facilities. The significant information obtained was as follows:

a) We obtained the current copy of "Launch Site Accommodations Handbook for STS Payloads", K-STSM-14.1, K-STSM-09, Vol. VI dated 14 March 1978. Next update is expected in October, 1978.

b) For SSUS-D type payloads, the Delta spin facility, where we would integrate our spacecraft with the apogee motor, and the payload with the SSUS-D could be a potential bottleneck. Also the spin balance table is limited to 5000 lbs. NASA does not plan to improve this facility,and considers this as a user's problem.

c) In view of the SSUS type payloads being integrated first in the lower end of the vertical cargo transporter, the potential problem of damage during integration of the upper payloads has been recognized by NASA. A possible solution was to provide a "catcher" to minimize this possibility. This "catcher" in turn affects the clean air flow patterns and may be detrimental from a cleanliness point of view. NASA does not as yet have an acceptable solution for this, and the cost of whatever fix is found will have to be borne by the users.

d) Attempts are underway to arrange the KSC safety reviews back-to-back with the JSC safety reviews. This is to minimize the effort and thus the costs of the spacecraft contractor related to safety. The recommendation was made to consult with KSC early in a program on ground operations safety to minimize design costs.

e) In response to a request for a typical SSUS-D launch services support plan (in form of a bar-chart), we were referred to a Mr. Arthur Bilotta (who is developing it for SBS). Mr. Bilotta was on leave, and was contacted by phone on 3 May 1978. He has promised to send us a package of a 'typical' SSUS-D plan.

f) A typical cost for off-line services at the Cape were quoted at $208K. This would be reduced for subsequent ground operations of similar satellites to about $120K.

g) At the general discussion session, Mr. John Clark of RCA (former Director of NASA Goddard Spaceflight Center) in making a general comment gave advice to NASA to charge a fixed average fee for ground support services depending on the class of payload viz. SSUS-D, SSUS-A or IUS, and do away with itemized services. This would save money for both NASA and the user by reducing bookkeeping.

8.0 NASA Johnson Space Center

This was our final meeting on the STS with the NASA Center that has the ultimate responsibility for the STS engineering interface with users. Our meeting was with the "Shuttle Payload Integration and Development Office" (SPIDPO) led by Mr. Glen Lunney (and his deputy: Cliff Charlesworth). Under them are three groups called: STS utilization and planning (headed by Carl Peterson), STS Operations (headed by Leonard Nicholson), and Systems Engineering (headed by Larry williams).

A user obtains his flight assignment from Peterson's group, develops his Project Implementation Plan (PIP) with Nicholson's group and develops the detailed Interface Control Documents (ICDs) with Williams' group. Our visit was coordinated by a Mr. Wayne Eaton from the planning group. We had unstructured meetings with Glen Lunney and Cliff Charlesworth and a more formal presentation from STS subsystem specialists (E. Schlei on safety, W. Boone on flight operations, B. Holder on Structure, A. Joslyn on thermal, P. Westmoreland on Avionics, S. Blackmer on software, R. Schomburg on re-imbursement and V. Ettredge on SSUS payloads). Finally, we were given a short tour of the STS simulation facility and the Mission Control Center (MCC) by a Mr. William Der Bing.

The significant information obtained from JSC was:

a) SPIDPO nominates a project engineer as a single STS technical point of contact for the user after the earnest money of $100K is paid.

b) The launch services agreement signed with NASA/HQ refers to the Project Implementation Plan (PIP). The PIP is a statement of work identifying the various activities required from NASA and the User and is made ready before the launch service agreement is signed. The activities are detailed in the 'Annexes' to the PIP. The Annexes are developed and finalized right up to about a year before launch. The KSC launch site support plan becomes one of these annexes. The engineering documents and related drawings of the Annexes become the Interface Control Documents (ICDs).

c) On safety, it is the user's responsibility to identify hazards with his payload. NASA will hold about four reviews to ensure that safety requirements have been met.

d) Any payload operations done through NASA is considered and optional service.

e) NASA does not plan to do any coupled loads analysis in the standard service except a verification analysis six months before launch. Also, we were told that there was an orbiter resonance around 17 to 20 Hz.

f) After landing, the temperature in the cargo bay could go as high as 200°F before ground cooling services are attached and working. This may influence the design of hydrazine tanks from safety considerations. NASA's planning assumes about 3% aborted missions.

g) Under certain limitations, and for a charge, user may transmit from his spacecraft in the orbiter cargo bay. The limitations are the frequency bands and radiated power that the user can employ. The charges are for NASA to check that the frequency and power do not interfere with their system and the other payloads. All Commands, while the payload is still in the bay, will have to be sent through the Mission Control Center (MCC).

h) Until the cargo bay doors open and the orbiter Ku band antennas deploy, the orbiter/ground communications link is in S-band.

i) Present planning only allows for shuttle launches from 30 minutes after sunrise to 30 minutes before sunset. This allows aborted flights' landings to take place in daylight. This restriction may be lifted after more experience is gained on the STS.

j) Payloads will be allowed to spin in the cargo bay for thermal protection of the payload, This will only be allowed during the transition phase from expendable launch vehicles to the STS. (Hughes have had success in their persuasion of NASA).

k) In view of the charges quoted by MDAC for their PAM, some spacecraft companies are thinking about their own perigee stage (e.g., RCA-AED).

l) Typical SSUS-D Project Implementation Plans and Launch Site Support Plans will be mailed to us during the week of 1 May 1978. We will also receive an orbiter thermal math model.

S. Ahmed

c.c.-DPP
DPM
DSA/R.S. Gruno
DSM
D/DSCOPO
O. Roscoe/P. Boudreau
G. Swann
DGTI
DGSPA
DGSTA
S. Archer - SPAR
File

SA/lb

Government of Canada | Gouvernement du Canada

MEMORANDUM NOTE DE SERVICE

S. Warren

SECURITY - CLASSIFICATION - DE SÉCURITÉ

OUR FILE - N/RÉFÉRENCE: CRC 6656-8 (ST)

YOUR FILE - V/RÉFÉRENCE

DATE: June 27, 1978

TO / A: H.R. Warren

FROM / DE: S. Ahmed

SUBJECT / OBJET: Trip Report on Ariane Launch Vehicle Interface Meetings, 5 June to 16 June 1978

1.0 Background

Further to my STS related trip report of 8 May 1978, this trip report covers our (S. Archer of SPAR and I) data gathering effort on the European Space Agency's 'Ariane' launch vehicle. We first visited ESA Headquarters in Paris to obtain information on the development status of Ariane and to hold direct discussions on launch costs to non ESA users. This visit was followed by a visit to the new Ariane launch facilities at Kourou (French Guiana) to obtain information on the range, range safety requirements and range-operations for a typical applications satellite of the Thor-Delta or Atlas-Centaur class. This memo summarises the significant information obtained during the visit.

2.0 5 June 1977, ESA Hq.

Meeting with:
Mr. R.M. Orye Head, Ariane Programme Office of ESA
Mr. A. Bellot Head of Ariane Payload Division (reports to Mr. Orye)
Mr. R. Vignelles Head of Ariane Project at CNES
Mr. Hergott Project Engineer reporting to Mr. Vignelles
Mr. J.C. Bouillot in-charge of Ariane advanced projects at CNES

The main topic covered in the meeting was the development status of Ariane. Mr. Vignelles of CNES gave us a briefing on the status of the various Ariane subsystems and propulsion stages. The significant problem identified was an erosion of the first stage engines' graphite throat insert during developmental testing. A proposed fix was to use a phenolic insert and repeat the test in August. If the fix fails to work, a more expensive alternative would be to use a carbon/carbon composite material insert with testing proposed for December 1978. This last approach would cause a three month slip to the currently planned LO-1 launch on 15 June 1979. It would not, however, affect the LO-2 schedule because of existing schedule margins.

The second significant piece of information was provided by Mr. Orye, who mentioned that the Ariane now guarantees 1750 kg in transfer orbit (9.5° inclination) instead of the published 1700 kg. He also added that Ariane was still a competitor with STS for the Intelsat 5 launches, and a formal decision was expected in September 1978. Intelsat was now requesting a transfer orbit capability of 1789 kg because of a maritime package that

Intelsat wanted to add to the payload. This requirement could be met by the Ariane because of the lighter payload attach fitting used by Intelsat and by the off-loading of the apogee motor in view of the smaller transfer orbit inclination (9.5° compared to 28°) for a Kourou launch. In the structure qualification tests, of Intelsat 5, Ford has been asked by Intelsat to add a test simulating 1st stage cut-off of the Ariane.

In the long term, ESA also wishes to attract Delta class payloads on the Ariane. Mr. Bouillot of CNES gave us a presentation on plans to further increase the capabilities of Ariane to 2300 kg (in transfer orbit) from the present 1750 kg. The plan calls for using existing technology. It involves increasing the combustion chamber pressures in the first and second stages by 10%, increasing the third stage propellant loads to 10 tons from the present 8 tons and for the strapping-on of solid propellant boosters to the first stage. The 2300 kg capability would allow the Ariane to launch two Delta-PAM class payloads along with the supporting SYLDA (Système de Lancement Double Ariane) hardware. This Ariane capability is expected by mid 1983.

At this point, we were joined by Mr. Y Guerin and Mr. R. Lavaud, who report to Mr. Bellot. Mr. Bellot was identified as our main ESA interface throughout the visit. We gave Mr. Guerin the questionnaire we needed answered to indicate the documentation exchanges, the scope of the documentation, and the schedule to be followed for an Ariane launch. We agreed to meet with Mr. Guerin again on 8 June 1978.

3.0 <u>6 June 1978, Aerospatiale (SNIAS at les Mureaux) and Societe Européenne de Propulsion (SEP at Vernon) on Ariane</u>

Both SNIAS and SEP are important contractors on the Ariane. SNIAS has the system integration contract under CNES, and SEP the propulsion system contract under SNIAS. We spent the morning at SNIAS and the afternoon at SEP. Mr. Bellot of ESA accompanied us during both visits.

At Aerospatiale, we were shown around by Mr. G. Leroy, their Assistant Marketing Manager for launch vehicles. We were shown the fabrication shop of the first stage tanks, the simulation facility for the guidance and control subsystem and the system integration facility. It is proposed to completely check the electrical integration and partially check the mechanical integration at the last mentioned facility of the launch vehicle prior to shipment to Kourou. We saw checks being carried out on the propulsion mock-up of Ariane, which was to be used to qualify the fuelling facilities at Kourou, and also to generally validate the launch facilities.

At SEP, we were shown the test stands for the third stage and first stage followed by a visit to SEP's engine fabrication facility. At the end of the day, we had a short meeting with Mr. Bachelot who is responsible for the first and second stage work at SEP. The second stage has been subcontracted to   Germany.

4.0 <u>7 June 1978, SNIAS and SEP</u>

While ESA Headquarters was working in preparing answers to our questionnaire, we re-visited SNIAS and SEP to obtain information on some of their non-Ariane work which could be of interest to Canada.

At SNIAS we met Mr. Rouyer, who is in charge of satellite related work at les Mureaux. He gave us a briefing followed by a demonstration of their magnetically suspended momentum wheel. They proposed to start life tests in October. This was followed by a meeting with Mr. Nguyen who is in-charge of the guidance and control system development of Ariane at SNIAS. Ariane's orbit inclination in transfer orbit is chosen to allow orbit insertion at an equatorial crossing without any coast periods. The on-board computer (OBC) autonomously controls the stage cut-offs, separations, and starts from about 30 seconds before lift off. The only command that can over-ride the computer is a destruct command. The OBC primary software uses information from the third stage inertial platform to fly a pre-determined trajectory and orientation. If the inertial sensors behave in an anomalous manner, the OBC switches to an automatic sequencing mode. The latter guarantees insertion into transfer orbit, but of a lesser accuracy than that of the primary system. Later, we were also shown some of the secondary propulsion hardware designed and fabricated at SNIAS for earlier French satellite projects.

At SEP, we met with Mr. Corai, who is in charge of secondary propulsion systems. The present work at SEP is to develop new catalyst systems for hydrazine thrusters. In parallel, they are also working on electrothermal thrusters. They have suspended their co-operative effort with Teldix (Germany) on a magnetically suspended momentum wheel in view of the more advanced work at SNIAS. Their solid propellant apogee motor developments were going on, and one of their motors was presently baselined for H-Sat. They promised to send us more details on their apogee motors in the mail.

5.0 8 June 1978, ESA Hq.

We met with Mr. Bellot, Mr. Guerin, and Mr. Lavaud of ESA, and with Mr. P. Rasse of CNES. Mr. Rasse is the deputy project manager on Ariane. Later in the day, we were given a presentation on the status of SYLDA (Systeme de Lancement Double Ariane) by Mr. Naumann of ESA.

Mr. Guerin gave us an overview of a typical project flow if we were to launch on a dedicated Ariane flight. He identified the documentation, the scope of the documentation and the schedule of documentation exchange. His references included two ESA/CNES documents that were to be issued in June 1978 (Reglement de Sauvegarde) and Dec 1978 (Manuel du Centre Spatial Guyanais). We were promised copies in the mail on publication of the documents.

Mr. Naumann who is in charge of the SYLDA procurement at ESA gave us a brief presentation on SYLDA. Separation of the upper-most satellite, the cap covering the second satellite and the second satellite itself would occur in automatic sequence within 200 seconds after third stage cut-off using the On-Board Computer. The proposed schedule for SYLDA development was:

Phase 1 - Preliminary Design Review - Dec 1978
Phase 2 - Detailed Design Review - April 1979
Phase 3 - Critical Design Review - Nov 1979
Phase 4 - Hardware delivery - June 1980
Flight readiness review - August 1980
Launch on LO-4 - September 1980

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The probable contractor for SYLDA would be SNIAS. The first payload for SYLDA is a MARECS satellite on the inside with probably SIRIO (Italy) on top.

6.0 9 June 1978, ESA Hq.

We met with Mr. Bellot and Mr. Orye. Part time with the latter because he had just returned from a quick visit to Intelsat in Washington.

Mr. Bellot gave us a briefing on the ESA Ariane launching and pricing policy. The significant points made were:

(1) At the time of application for an Ariane launch, an ESA member would get preference over a non-ESA member. However, once a commitment had been made on a launch date to a non-ESA member, it would not be possible for an ESA member to displace that commitment.

(2) The launch program would be managed by an ESA led CNES team.

(3) The launch costs in mid 1977 U.S. dollars for a dedicated launch were $22 million. For a SYLDA double launch (including costs of SYLDA and the associated integration costs) the price in mid 1977 U.S. dollars was 15 million per satellite. There was no differentiation between costs for an inner or outer satellite of the SYLDA.

(4) An additional premium of 10% would provide insurance.

(5) ESA tracking network costs are an option to be negotiated. We were provided with a copy of the ESA VHF network User's Guide dated Feb. 1978.

We then met with Mr. Orye briefly to thank him for ESA's co-operation. He indicated that Mr. Bellot would accompany us to Kourou to guide us around.

7.0 12 June 1978, CSG, Kourou

We met with Mr. G. Oelker (ESA resident representative at CSG), Mr. Bouchet (payload facilities at CSG), and Mr. Barban (payload operations at CSG). Accompanying us was Mr. Bellot. We were first taken to the launch tower for an in-site briefing on the status of the tower. We then met with the CSG acting director, Mr. Bescond who gave us an overview of CSG and its role in the Ariane program.

In the afternoon, we were shown films on the Ariane program and CSG. This was followed by a visit to the Mission Control Centre and the safety room. We were provided a briefing on safety procedures in using CSG and Ariane by the Assistant Safety Director, Mr. Beguin.

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8.0 13 June 1978, CSG, Kourou

We met with Mr. Merdrignac, the person in-charge of the launch control centre. He gave us a briefing on the launch control facilities. We were then given a tour of the apogee motor storage building and the apogee motor preparation building. In the afternoon we had a meeting on launch operations with Mr. Merdrignac.

9.0 14 June 1978, CSG, Kourou

We were shown the spacecraft preparation building that was being modified to accept very large satellites (hook height of 10 m), and would have cleanliness standards of class 100,000.

We then visited one of the VHF satellite tracking stations of CNES/ESA situated in Kourou. Mr. Seguin, who is in charge of the station gave us an overview of the capabilities of the station. This was followed by a visit to one of CSG's radar tracking stations of rocket launches.

The afternoon was spent getting into details of the proposed satellite support facilities. The final satellite preparation building (where apogee motor mating and hydrazine filling would occur) was still on the drawing boards. We were given a copy of the layout of the building.

10.0 15 June 1978, CSG, Kourou

We were taken to the off-shore islands to be shown an infra-red tracking station to monitor rocket launches from CSG.

We left Kourou on the 16 of June.

.../6

S. Ahmed

cc:
DPP
DSM
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D/DSCOPO
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APPENDIX C

LAUNCH VEHICLE STUDY, STATEMENT OF WORK

ATTACHMENT A

Statement of Work

Shuttle /Ariane Interface Study.

General

By studying available documentation and by visiting NASA centers, ESA/CNES centers and appropriate industries, identify and quantify the effort required to interface typical communications satellite payloads with either the Space Shuttle or the Ariane Launch System.

This study addresses in particular the software and documentation interfaces rather than the physical (mechanical & electrical) interfaces between spacecraft and launch vehicle.

Specific Tasks

The study should include, but not be limited to a review of the following matters:

a) all user-prepared documentation eg. project integration plan, safety documentation, flight operations/network plans, flight readiness reviews etc...

b) coupled-loads analyses that are required for the Shuttle/SSUS/Payload combination (or the Ariane/Payload combination). In particular identify analyses beyond those covered by the normal launch agreement.

c) thermal analyses--in particular identify the work that will be required beyond that which is covered as part of the normal launch agreement. Establish respective areas of responsibility between launch vehicle supplier and the user with respect to thermal control of the payload prior to its release.

d) launch agreements and/or memorandum of understanding between user and NASA or ESA.

e) optional/custom services. (cost for non-standard efforts)

f) contract milestones, including documentation referred to in (a), (b), (c) & (d) above.

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Attachment B - cont'd

g) launch cost and payment schedules, including cost for use of launch site facilities during the launch campaign.

h) obtain technical, schedule and cost information on Ariane dual launcher capability.

i) identify user responsibility with respect to the following STS/Payload interfaces:

- o Power
- o TT&C
- o Communications
- o Safe and Arm requirements

j) determine special provisions required of the user for satellite/SSUS control between the time of separation from the Shuttle and ignition of the perigee motor eg. active nutation device.

Typical Payload

The GP bus with MUSAT payload, as defined by Spar under contract OPC 76-00054 shall be used as the basis for this study. In cases where the interface tasks or costs are substantially different for the case of an Atlas-Centaur sized payload, use Intelsat V as a typical payload.

Deliverables

Twenty copies of a final report will be required at the conclusion of the study.

APPENDIX D

LAUNCH VEHICLE DOCUMENTATION BIBLIOGRAPHY

3MCLB154.1

1.0 STS RELATED DOCUMENTS

Figure D-1 represents the NASA (User Information Services) condensation of many documents designed to support the major parts of the STS User Handbook. The Figure also identifies which of those documents are available at the Spar and CRC:DOC libraries.

The complete list of the documents obtained during the course of the study which are available at the Spar and CRC:DOC libraries, is as follows:

- Space Transportation RI
    - Capabilities Calculator
      Utilization Services Brochure
- Payload Safety Guidelines Handbook, Lyndon B. Johnson Space Center - July, 1976 - J.S.C. 11123
- NASA - AIAA - STS User Symposium - Proceedings to follow. Integrating Payloads into the Space Transportation System - Rockwell
    - User Information Services - February 21, 1978
    - User Flight Assignment
    - Determination of Charge Factor
- NASA - Small Self-Contained Payload Program - September, 1977.
- Planning and Designing Payloads for the Space Transportation System (A.A.S. Seminar) - March, 1978 R.I. - H. Emigh
- STS/Payload Integration Activities Plan - H.A.C. - April 19, 1978
- P.A.M. User's Requirements Documet - McDonnell-Douglass Corp. MDC G7044A - PAM-A - May, 1978, MDC G6626A - PAM-D - May, 1978

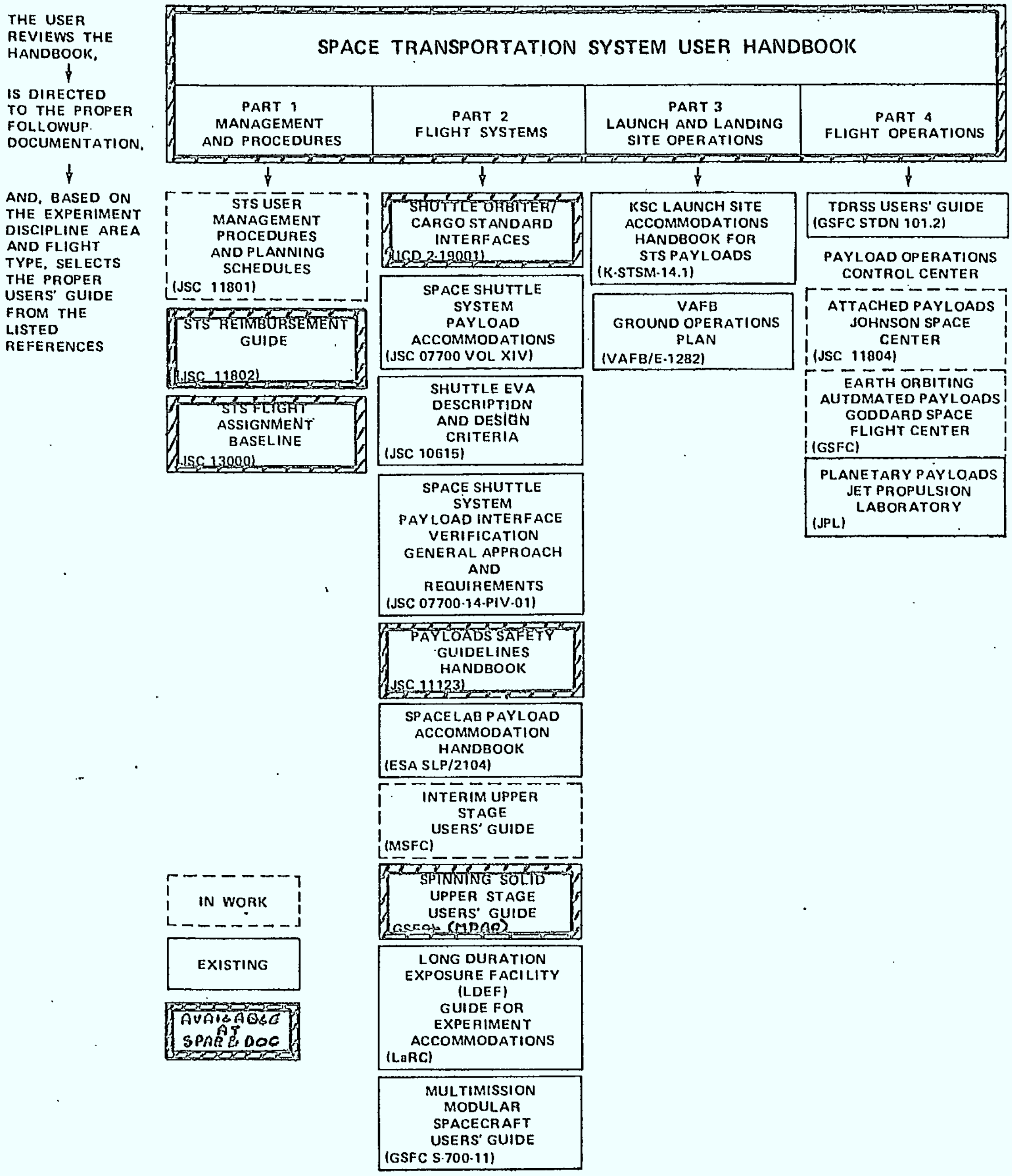

FIGURE D-1: STS USER HANDBOOK SUPPORT DOCUMENTATION

- The MDAC Payload Assist Module (PAM) - McDonnell-Douglas Corp. 3J1-89025A - April 20, 1978 - Presentation to DOC
  - Preliminary - Rec. 20/4/78 - Mission Specific Analyses and Services
  - Preliminary - Rec. 20/4/78 - Baseline Mission Analyses and Services
- KSC Space Transportation System Project - Shuttle Payloads Launch Site Processing Sumposium - April 24-25, 1978. Presentation Material.
- Lyndon B. Johnson - Space Transportation System - User Handbook, July, 1977 (two copies)
- Shuttle Payloads Launch Site Processing Symposium - Final Program April 24-25, 1978 - John F. Kennedy Space Center - Florida
- NASA - Flight Assignment Doc. - October, 1977 JSC - 13000-0
- NASA - Launch Site Accommodations Handbook for STS Payloads
- STS Utilization Planning - Shuttle Payload Integration Development Program Office, JSC - Presentation by D. Edgecombe, Batelle
- NASA Headquarters - PIP's and Launch Serv. Agreements, Memo Lunney to Lee, December 21, 1977
- Payload Integration Plan - January 13, 1978 - Space Transportation and Office of Space and Terrestrial Application Payload (OSTA-1)
- Payload Integration Plan - STS/TDRSS - Space Transportation System and Data Relay Satellite System - December 1, 1977

- NASA - S-78-1505 - JSC 27/4/78 - Briefing Outline (Eaton, JSC)

- NASA - Initial Issue of "Safety Policy and Requirements for Payloads Using the Space Transportation System", Yardley, June 16, 1976

- Proposed Addendum to JSC 13830 to explain the Procedure for Experiment Group Type Payloads - JSC, 27/4/78

- Shuttle Vehicle/Cargo Standard Interface Specification - SL-1-0015, 27 June 1977, JSC (Obsolete)

- SPIDPO Initial Contact Safety Briefing, Presented 27/4/78, E. Schlei, JSC

- ES2-BWH - 4/78, Shuttle Payload Structural/ Mechanical Working Group, Payload Integration Activities, Presented 27/4/78, B. Holden, JSC

- Thermal Design Criteria, Presented 27/4/78, JSC

- Optional Services Table, - Preliminary, Presented 28/4/78, Lunney, JSC

- JSC - 11802 STS Reimbursement Guide, February, 1978, Final Review Copy

- Typical RI Standard Engineering Support Products and Milestone Summary, Preliminary, Provided 28/4/78 by W. Eaton JSC

- List of PIP Annex Titles, Provided 28/4/78 by W. Eaton, JSC

- Space Shuttle Interface Control Document, Level II, JSC ICD 2-19001, Formerly SL-I-0015, Shuttle Orbiter/Cargo Standard Interfaces November 16, 1977

- Documentation from AIAA/TMSA conference on Space Shuttle - March/April, 1978

- STS PAM-D Launch Site Ground Operations Plan - Preliminary April 1978

- Physical Dynamic Thermal Electrical and Data Processing Characteristics of the Space Shuttle Cargo Bay - R.I., March, 1978

3MCLB154.5

2.0 ARIANE RELATED DOCUMENTS

With the exception of the CSG Manual the following documents are available at the Spar and CRC DOC libraries:

- Ariane User's Manual - AR(75)01, Issue 1, Revision 2, October, 1977
- Articles reproduced from AIR and COSMOS number 709 (March 11, 1978) updated following the ESA council meeting of April, 1978
- Reglement de Sauvegarde - 1978 edition - CNES, CSG (English version to be available later this year)
- CSG Manual (still to be published)
- Specimen Copy of D.C.I. (interface control document)
- Presentation to Intelsat on November, 1977, containing:

  Ariane - Scope and Summary
  - Development Plan
  - Qualification Plan and Current Status
  - Vehicle Performance
  - Reliability Assessment

  CSG - General Presentation
  - Plan of work, Qualification and Current Status
  - Launch Preparation

APPENDIX E

JSC-11802, STS REIMBURSEMENT GUIDE

FINAL REVIEW COPY, FEBRUARY, 1978

28/4/78.

JSC-11802

NASA

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

February 1978

FINAL
REVIEW
COPY

Space Transportation System

Reimbursement Guide

National Aeronautics and Space Administration

Space Transportation System

Reimbursement Guide

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2 – Optional flight systems

3 – Optional payload-related services

4 — Special fees and schedules

5 — Calculation of reimbursements

Appendixes

INTRODUCTION

This guide provides users of the Space Transportation System (STS) with a source of information for estimating charges associated with STS services to payloads.

The Space Transportation System encompasses all hardware systems and support equipment, facilities, and manpower to deliver payloads to Earth orbits and perform on-orbit operations and experiments. Its primary components are the Space Shuttle, Spacelab, and upper stages. The Space Shuttle provides the basic transportation to and from near-Earth orbit and is the basis for the "standard price" to users. The Spacelab (on-orbit operations) and upper stages (transportation to higher orbits) are optional flight systems for payloads with "optional prices" in addition to the standard price.

This guide should be used both during early payload planning and during the final design phase. During early planning, a payload designer, using this guide, may be able to lower transportation cost by altering the payload design. When a payload design is considered firm, the user organization can refer to this guide in financial planning to assess the total phased cost effect of STS utilization.

The prices listed are in fiscal year 1975 dollars. Those portions subject to escalation will be escalated according to the Bureau of Labor Statistics index for compensation per hour, total private.

Pricing and other data are based on the best current information. However, this guide may be amended by NASA at any time and is not an offer to sell or act as an agent for any potential user. The resulting launch agreement negotiated with the user shall supercede this document to the extent of any inconsistency.

Users of the STS will reimburse NASA in accordance with their needs for various services. In general, these services fall into the following three broad categories that dictate the charge to be calculated for a given payload.

1. Standard Space Shuttle services
2. Optional flight hardware systems
3. Optional payload-related services

This guide is organized to provide a building-block approach to estimating prices. It begins with standard Space Shuttle transportation charges and the standard services available to all payloads. Part 2 explains optional flight hardware systems and methods of calculating current charges for each of these payload options. Then, in part 3, the user learns about the current optional payload-related services. Price ranges are included for some; others will be negotiated on the basis of payload requirements and anticipated cost to the Government.

After the user has estimated his payload needs, he can proceed to part 4 for information about flight schedules and billing schedules. Schedule options are also available at extra cost.

Finally, with all the general information assembled, the user can find examples and formulas in part 5 to show exactly how his own costs are calculated. This information should enable a user to make cash flow estimates from which a financial analyst can confidently estimate the net present value of a launch, its real-year cost, or any of several cost criteria to determine the launch scenario that best suits the user's needs.

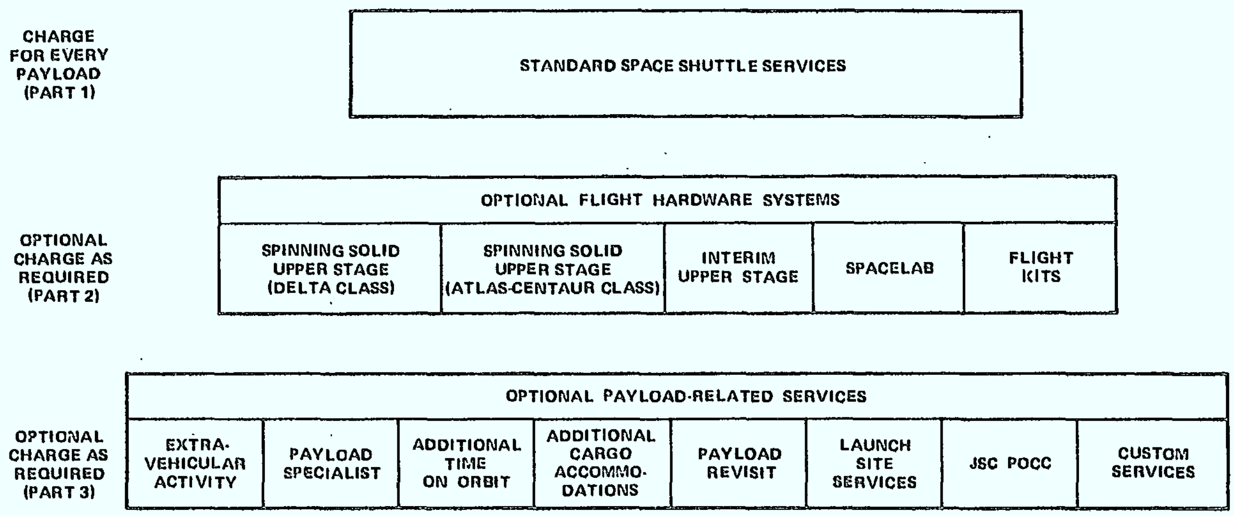
The worksheet on the facing page is designed to help users be sure they have included all factors in estimating costs. It is not an official form for submittal. Step 1 occurs primarily within the user organization; however, calculations may require reference to this or other documents. The ensuing steps follow the same order as this guide.

Supplemental information in this guide will help a user better understand the STS and the terms of his contract with NASA.

All users should refer to the NASA management instructions (NMI's), series 8610, on reimbursement for Shuttle services (appendix C). These instructions set forth NASA policy to users under launch agreements and responsibilities for putting these policies into effect.

As a user needs other information, he will find references to additional documents and organizations. In the United States, initial contacts for planning and general questions should be addressed to the Space Transportation Systems Operations Office, mail code MO, National Aeronautics and Space Administration, Washington, D.C. 20546, telephone (202) 755-2344, Federal telecommunication system (FTS) 755-2344.

Users outside the United States should address initial inquiries to the Office of International Affairs, mail code I, National Aeronautics and Space Administration, Washington, D.C. 20546.



Building-block approach to user charges.

COST-ESTIMATING WORKSHEET

1. PAYLOAD SIZE

Determine your payload's weight and length. (Include airborne support equipment, clearance (part 1), flight kits required (part 2), possible weight effect of optional payload-related services. If additional information is needed, consult the references in appendix B.)

2. USER CLASS

Determine your user class (from part 1, "Reimbursement categories").

3. PRICE CATEGORY

Decide whether a dedicated or shared flight is required (part 1, "Reimbursement categories").

4. TRANSPORTATION (DEPLOYED)

_____________ Calculate the Shuttle transportation price (from part 1, "Standard charge").

_____________ If a non-U.S. Government user, add the use fee.

5. OPTIONAL SYSTEMS

_____________ Total the costs of all optional hardware desired (part 2) and add.

6. OPTIONAL SERVICES

_____________ Determine the optional payload-related services desired (as differentiated from the standard services in part 1, "Standard Space Shuttle services") and the total cost (from part 3), and add.

SPACELAB

If you are a Spacelab user, skip steps 4 to 6 and instead refer to part 2, "Spacelab," for complete instructions on price determination. The Spacelab price is a combination of:

_____________ Transportation cost

_____________ Operations cost

_____________ Use fee (for non-U.S. Government users)

_____________ Optional services cost

_____________ **Spacelab total**

7. LAUNCH SCHEDULE

Determine your desired launch date, which will enable you to decide if you want special launch schedule options (part 4). You can also determine if you would prefer to be a standby user.

_____________ Calculate these costs from part 4.

_____________ **Total**

8. PAYMENT SCHEDULE

On the basis of the launch schedule, you can determine your payment schedule (normal or accelerated, from part 4) and (by use of the examples in part 5) estimate with escalation for a selected year.

Standard Space Shuttle services and charges

Optional flight systems

Optional payload-related services

Special fees and schedules

Calculation of reimbursements

Appendixes

1 Standard Space Shuttle services and charges

Every user of the Space Transportation System (STS) will receive the standard services described in this section as part of the standard Space Shuttle transportation charge. It should be noted from the outset that these descriptions and discussions are necessarily generalized to incorporate a broad spectrum of payload characteristics and objectives.

Specific descriptions of services provided for a given user will be detailed in the launch agreement, the payload integration plan, and the launch site support plan. Those documents are bilateral agreements which are negotiated between the users and NASA for the purpose of providing specific definition of management roles and responsibilities, technical activities, and schedule requirements to assure an effective operational interface of the payload with the STS. The launch agreement, which can be considered the user's contract, contains the legal, financial, and NASA Headquarters commitment to provide the STS service at a determined price. The payload integration plan defines the vehicle interfaces, preliminary mission requirements, etc., and includes a listing of optional services. The launch site support plan outlines the launch service activities to be provided at the launch site.

Management responsibilities

For the launch of a payload and associated services, NASA will designate (1) an STS mission coordinator who will serve as the NASA interface for all financial and policy matters and (2) an STS payload support manager who will be responsible for arranging and managing all NASA support provided to the user. The latter will be the interface for all liaison with the user regarding the implementation of the launch agreement.

The user will, in turn, designate a payload manager who will be responsible for ensuring that all required user functions are performed. This user payload manager will be the formal interface for all liaison with NASA for the launch and associated services.

NASA responsibilities

The following responsibilities are undertaken by NASA toward successful implementation of the launch agreement as negotiated with the user.

1. Furnishing and updating interface specifications and other design and operations documentation necessary to aid the user in assuring compatibility of the payload with the Shuttle, Shuttle flight environment, and NASA telemetry, tracking, and command support committed to each payload launch.
2. Providing for thorough preparation and checkout of the Space Transportation System for each payload launch.
3. Managing, with the consultation of the user payload manager, the Shuttle/payload integration.
4. Regulating 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.
5. Conducting the launch and associated services in a manner that will satisfy the requirements and launch schedule agreed upon with the user.

User responsibilities

To enable NASA to furnish the proper launch and associated services, the user will be responsible for the following.

1. Delivering a flightworthy payload to the launch site on a schedule compatible with the firm launch date that has been established by NASA.
2. Providing associated payload ground-support equipment and personnel required to prepare the payload for launch.
3. Providing to the NASA all mission requirements and constraints necessary for NASA to provide STS software, optional hardware, operations procedures, and other agreed support and services.
4. 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.

5. 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.

6. 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.

7. 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.

8. Providing payload discipline training to the NASA crew and to Payload Operations Control Center (POCC) personnel.

Flight planning and operations support

Flight planning and operations are provided as part of the standard Space Shuttle transportation charge. These services are sufficient to support a flight from the John F. Kennedy Space Center (KSC) carrying three crewmembers and able to provide up to 1 day of in-orbit payloads operations for deploying a free-flying system. Preflight planning and training necessary for normal crew and ground operations are included. A flight data file is generated to provide the crew with documentation and reference material needed for STS activities.

The interdependent areas of flight planning and operations support are: utilization planning, flight operations planning, flight design, crew activity planning, training preparation, flight simulation, and Mission Control Center (MCC) operations.

Utilization planning

Utilization planning, which is the responsibility of NASA, involves integration of approved missions into flight manifests and flight schedules. Users, therefore, must provide payload mission requirements and objectives, flight data requirements and constraints, and payload descriptions.

Payload requirements must also be made available to NASA regarding STS/payload interface, trajectory, time of launch, crew activities, training, STS systems support, and payload hardware integration.

Flight operations planning

Standard services of flight operations planning involve both preflight and real-time support. Standard payload preflight planning services include integration of onboard payload display and data management software requirements with those of the STS, developing payload flight rules and rationale with respect to crew safety for various payload contingencies, development of JSC POCC interface procedures with elements in the MCC, and familiarization training on JSC POCC facilities to user-provided personnel. Additionally, one or two JSC engineers will be assigned to assist the user in developing onboard and ground support plans, KSC/JSC/other data interface tests, as well as work with the user in submitting ground support requirements.

Standard real-time payload support services include one or two JSC flight controllers who will assist the user during real-time operations. One of the flight controllers will function as the user's primary interface to the STS operations. He will assist the user in making flight plan changes and will work with the user to help develop alternate plans and crew procedures to accomplish payload objectives commensurate with crew safety. The other flight controller will also work closely with the user to resolve payload data routing problems and to verify status and accomplishment of payload-related flight objectives. Additionally, as part of the real-time standard service, JSC will provide flight control support of the Shuttle during launch and entry and support of on-orbit Shuttle operations.

Flight design

The standard flight design activities provided by NASA for each flight encompass such factors as trajectory, consumables, attitude and pointing, and navigation analysis used to develop a basic flight profile. Users must provide payload mission plans for NASA to use in developing flight requirements. The flight design includes launch, ascent, on-orbit payload handling, deployment, communications, abort analysis, separation/recontact, simulator data packs, navigation aids, crew charts, rendezvous, and proximity operations.

The standard planning approach involves sets of orbital destinations (inclination, altitude), flight phases (launch, on-orbit time line, deployment/retrieval sequences), maneuver sequences (rendezvous, orbital adjustments, deorbit), and crew activity time blocks. Standardized flights will be used if they are consistent with the specified payload objectives.

Crew activity planning

Standard crew activity planning generates a time line plus the necessary procedures and crew reference data for a given flight. Users are responsible for performing the payload planning, scheduling, crew procedures, and tradeoffs necessary to accomplish their payload flight requirements. In turn, NASA will provide the STS planning and activity scheduling necessary to support payload activities, as well as to maintain crew and vehicle safety.

Standard services provided to the user include a STS summary crew activity plan (CAP) defining available payload activity time blocks and an integrated summary crew activity plan, which integrates the payload time line provided by the user with the STS activities. Also provided will be the STS detailed time lines and STS "crew execute" data. This includes the STS flight data file containing crew procedures, which are based on flight techniques that have been developed for standard STS flight operations.

Real-time support includes any required changes to STS activities including STS functions supporting payload operations, coordinating payload crew activity changes with the STS flight control team and the POCC; STS pointing information and any required attitude profiles; coordination and maintenance of update messages to the crew; and maintenance of data bases for STS crew activity planning and STS crew procedures.

Training preparation

All STS-related training, both for crewmembers and ground personnel, is provided by NASA; all payload-related training is the responsibility of the user.

The services provided to the user fall into three categories: planning/scheduling, development, and implementation.

During the planning/scheduling stage, NASA works with the user to ascertain training requirements. Once these requirements are determined, NASA will make an analysis to verify flight support feasibility of training operations. Flight-unique documents (plans, schedules, etc.) are then developed and training schedules are established.

During the development stage, revision of training plans (scripts, facility configuration requirements, etc.) and procedures is done only to the extent of inserting flight-unique "execute" data and generating briefings on mission requirements.

The implementation stage is concerned with managing the required training for all operations related to Orbiter capability.

Flight simulation

Simulators and trainers are maintained at JSC as part of standard NASA simulation support. The Shuttle mission simulator and the Shuttle procedures simulator are routinely used for training required for all flights (flight-independent training), as opposed to specialized training to meet the requirements of a specific flight. These simulators can also be used in real time to help solve in-flight problems.

Users can take advantage of these and other JSC trainers to train the flight crew in payload operations. The Shuttle mission simulator has full-fidelity forward and aft crew stations. It can be expanded to simulate payload support systems and interface with the MCC for integrated crew/ground simulations.

Mission Control Center operations

For all flights, MCC operations provide systems monitoring and contingency support for all STS elements, provide two-way communications with the crew and with onboard systems, perform flight data collection to a central site, and provide both preflight and in-flight MCC/POCC operational interfaces to coordinate flight operations. For flights with attached payloads, additional standard services are provided, such as systems monitoring, contingency support, and system support for unattended operations; software support; interface systems support; and other items related to combined POCC and MCC tasks. These standard services also include a ground team to develop preflight documentation.

For deployment and retrieval flights requiring little or no checkout or special training, the MCC will follow a standard plan that requires consideration only of trajectory and deployment and retrieval conditions. For those flights involving significant crew and systems interfaces, real-time telemetry and voice command system capability will be provided. The telemetry processing will include only those payload data received in the operational data stream that are required for STS interface responsibilities.

For flights with upper stages, MCC will provide systems monitoring, contingency support, and operational support to the upper stage through deployment. Payload data (either transmitted through the Orbiter or independently of it) will also be made available if those data are required to support flight operations.

Standard real-time services are processing and operating support for Shuttle-compatible telemetry, command, and trajectory formats; logic processing; and display capabilities via Orbiter television, in the MCC, or in the POCC. Real-time voice interfaces between the flight crew and the STS ground team, as well as recording of command and control data for real-time use, are also standard services.

Engineering integration

Standard engineering integration services are provided as part of the Space Shuttle transportation charge to ensure cargo elements and flight cargo compatibility. NASA will utilize user-furnished cargo element data on a mutually negotiated schedule consistent with NASA flight cargo integration activities.

Standard STS environments, interfaces, and provisions are defined in several documents (appendix B), which the user should use as a basis for payload interface design until formal engineering integration activities begin. This time period is generally more than 3 years before flight.

Approximately 2 years before flight, NASA will perform a cargo compatibility assessment, utilizing the user-provided cargo element data. This assessment will establish the cargo element compatibility with the Shuttle and with the other cargo elements in the areas of loads, thermal characteristics, electromagnetic interference/electromagnetic compatibility, contamination, physical interfaces, weight and center of gravity, electrical power, active cooling, communications/commands/data, displays and controls, and crew activities time lines.

Approximately 1 year before flight, NASA will perform a flight verification engineering assessment, utilizing the user-provided updated and/or final cargo element data. An analysis in sufficient detail will be conducted to establish the flight worthiness of the cargo for loads, thermal characteristics, electromagnetic interference, contamination, and physical interfaces.

Additionally, as a part of the engineering services, NASA will provide documentation updating and repository service for the payload-to-Orbiter unique interface control document (ICD), installation and removal drawings, and integrated schematics that depict Orbiter-to-payload interfaces based on payload data submitted.

Launch site support

Included in the standard Shuttle transportation charge are the following activities at KSC: interface verification, installation of the cargo into the Orbiter cargo bay, checkout, and monitoring and prelaunch control of payload functions.

The launch site support plan will be the official launch site commitment for support and services to be performed. After consultation between NASA and the user, this plan will be mutually prepared and encompass the necessary planning and coordination beginning before arrival of user hardware at KSC through launch.

The user will retain prime responsibility for testing, checkout, and servicing of the payload while STS management will assume responsibility for payload installation and compatibility verification with the Shuttle.

Safety

A safety program will be implemented in accordance with NASA safety policies. Safety reviews will be conducted as mutually negotiated to determine the safety and compatibility of launch operations in support of the user's program schedule.

Interface verification

Satisfaction of interface verification requirements that are not related to safety will be negotiated and mutually concurred upon by NASA and the user. It is anticipated that this verification will be accomplished within the normal testing, checkout, and integration of the user's payload. Special interface verification activities are negotiable as deemed necessary by the user or NASA.

Standard user classes

Users requesting Space Shuttle services from NASA will be in one of three classes. Reimbursement to NASA for flight costs is calculated differently for each class. Therefore, the first thing a prospective user must determine in estimating his costs is to which class he belongs.

Non-U.S. Government

The non-U.S. Government class of user encompasses:

- Private individuals or private organizations in the United States (including its territories, the District of Columbia, Panama Canal Zone, and Puerto Rico) and public organizations that are not part of the Federal Government.
- Private individuals, public or private organizations, or governments of foreign nations, or international organizations. Exceptions (qualifying for lower flight prices) are the governments of Canada and of nations participating in Spacelab development (through the European Space Agency) when they are conducting experimental science or experimental applications missions with no near-term commercial implication that have been undertaken on behalf of government agencies. The NASA Administrator will determine the missions that qualify for this exception.
- Agencies of the U.S. or Canadian government or the European Space Agency if, in requesting Shuttle services from NASA, they are acting for users in this classification.

Civilian U.S. Government

The civilian U.S. Government class of users encompasses all civil Federal agencies that request Shuttle services from NASA.

Department of Defense

The Department of Defense (DOD) is considered a separate class of user because of its active involvement in flights from Vandenberg Air Force Base. The DOD operates under a special agreement with NASA and is not addressed in this document.

Special user classes

Exceptional determination payload

Special consideration is given to users having an experimental, new use of space or having a first-time use of space that has great potential public value. This is called an exceptional determination. An example of a possible exceptional determination is this situation: A medical organization has developed what it considers a probable cure for an infectious disease, but must conduct experiments in a remote location free from danger of contamination. An STS Exceptional Program selection process is used to determine which payloads qualify and, in all cases, the NASA Administrator has final authority in the decision. Payloads receiving exceptional determination can be for either dedicated or shared flights.

Small self-contained payload

A small self-contained payload is defined as a package for research and development weighing less than 200 pounds (91 kilograms), smaller than 5 cubic feet (0.14 cubic meter), and requiring no Shuttle services (power, deployment, etc.). These payloads are flown on a space-available basis.

Price categories

Once the user class has been established, a user should next determine which price category is applicable to his payload. These categories are the same for all user classes.

A dedicated flight is defined as one on which the user has exclusive use of the entire Orbiter cargo bay.

A shared (standby or nonstandby) flight is defined as one on which the payloads of two or more users share an Orbiter cargo bay. A nonstandby user follows a firm launch schedule. A standby user is flown at NASA's convenience within a prenegotiated 1-year period, thus giving the Government greater flexibility in flight planning and giving the user a price discount.

The price charged to users for standard Space Shuttle transportation will be based on estimated costs accrued over a 12-year period. This price will be fixed (except to adjust for inflation) for flights in the first 3 full fiscal years of STS operations. Beginning with fiscal year 1984, the price may be adjusted annually to ensure that total operating costs are recovered over a 12-year period.

The prices listed are based on 1975 dollar values unless otherwise noted. Escalation for inflation will be computed according to the Bureau of Labor Statistics index for compensation per hour, total private.

Standard Space Shuttle price
for dedicated users

User class	Cost, $ X 10^6 (1975 base)	
	Transportation charge	Constant
Non-U.S. Government	18.271	4.298[b]
Civilian U.S. Government	18.0[a]	N/A
Canada and ESA	18.0[a]	N/A
Exceptional Program	11.0 to 14.0	N/A

[a]Optional use fee for reflight insurance is 0.271.

b Facility & Equipment Depreciation 0.834
Fleet Procurement 1.453
KSC 2.011

Dedicated flights

The basic charges to users of a dedicated flight are shown in the accompanying table.

The price to non-U.S. Government users is set at a level to recover a fair share of the total operations costs plus a "use fee" to cover costs associated with use of Government facilities and support equipment, and STS fleet acquisition. This use fee is not subject to escalation. Like the transportation charge, it is fixed for the first 3 full fiscal years of the operational phase.

Reflight insurance is included in the price for non-U.S. Government users. It guarantees one Shuttle reflight for each payload launch if the first flight fails through no defect in the payload, or fault of the user, user contractors or subcontractors, and if the first payload is returned safely to the launch site or if another payload is provided by the user. This is not applicable to payload failure, but applies only when NASA is unable to carry out its negotiated responsibility.

Civilian U.S. Government users (and foreign government users who have qualified for this price, as described under "User classes") pay a price designed to recover a fair share of total operations costs. These users are not assessed a use charge.

Shared flights

A shared-flight user will pay a percentage of the dedicated-flight price. The price for all payloads (except Spacelab elements, explained fully in part 2, and small self-contained payloads, described in the next subsection) is based on launch weight or length and is calculated as follows.

1. To calculate a weight load factor, the user should divide the payload weight by the total Shuttle payload weight capability at the desired inclination.

Standard orbit inclinations are offered to users for flights originating from the Eastern Test Range (KSC launch). These inclinations and corresponding weight capabilities are:

Launch site	Inclination, deg	Weight capability, lb (kg)
KSC	28.5	65 000 (29 484)
KSC	56	57 000 (25 855)

2. To calculate a length load factor, the user should divide the payload length (plus 6 inches (15.2 centimeters) for clearance) by the length of the cargo bay, 720 inches (1829 centimeters).

3. To determine a charge factor, the user should now divide the load factor (length or weight, whichever is greater) by 0.75. However, the effective charge factor is never greater than 1.0.

4. To determine the price for his payload, the user should multiply the price of a dedicated flight (plus a use fee, if applicable) by the calculated charge factor.

The payload-sharing nomagraphs are provided to help a user quickly determine the approximate price. A more detailed explanation is also in part 5.

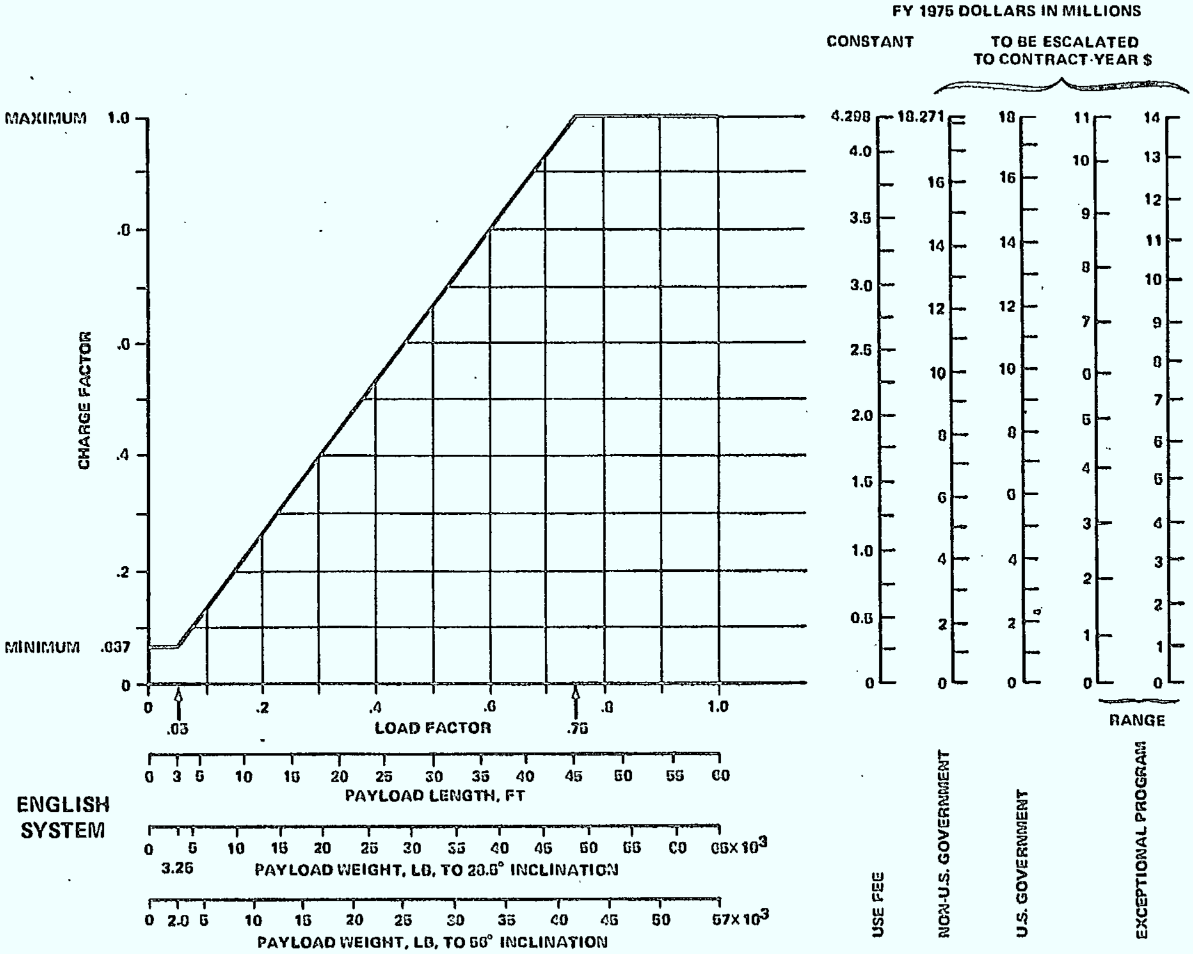
A standby user will receive a discount of 20 percent of the calculated shared price.

Special user classes

Exceptional determination payload

A dedicated flight that has received an exceptional determination will cost in the range of $11 million to $14 million. The price for such a payload that can share a flight will be calculated in the same way as other shared-flight payloads.

The NASA Administrator will select those payloads eligible for the special flight price.



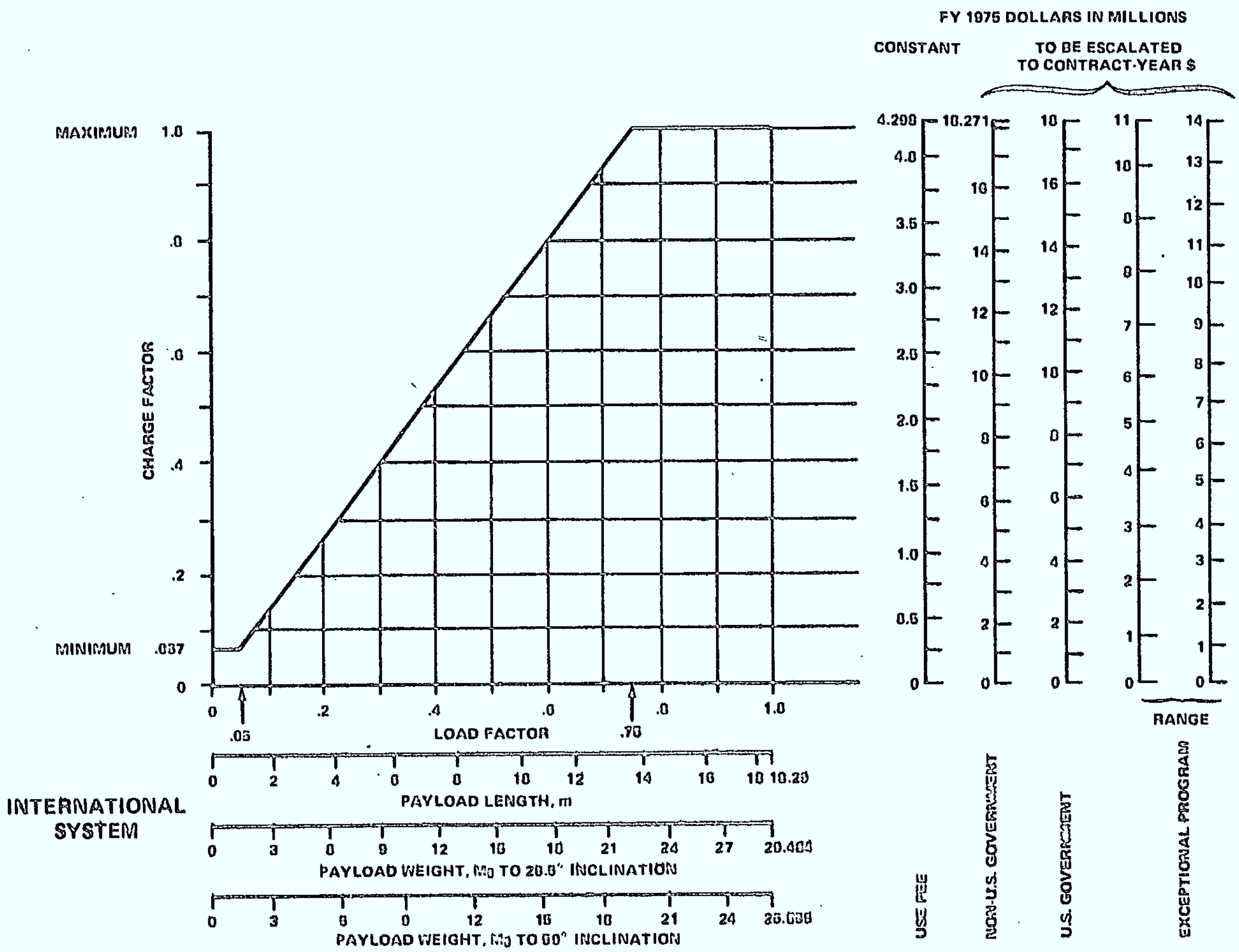
To use this nomagraph, begin with whichever is farther to the right on the scale: your payload's length or weight. Move up to find the charge factor on the curve. Then move across to estimate the charge for your user class.

Small self-contained payload

The price for a small self-contained payload will be negotiated on the basis of size and weight in the three general categories that follow. If either volume or weight exceeds the maximums shown, the payload is in the next higher price category.

Volume, ft^3 (m^3)	Weight, lb (kg)	Cost, $
1.5 (0.04)	67 (30)	3 000
2.5 (.07)	100 (45)	5 000
5 (.14)	200 (91)	10 000

If Shuttle services are required, the price for these services will be individually negotiated. Reimbursement to NASA will be made when the package is scheduled for flight.



This is the same as the other payload-sharing nomograph, but it is calculated in metric units. Begin with the greater of payload length or weight, move up to find the charge factor, then across to estimate the charge for your user class.

Standard Space Shuttle services and charges

Optional flight systems

Optional payload-related services

Special fees and schedules

Calculation of reimbursements

Appendixes

2

Optional flight systems

Optional flight systems

OPTIONAL FLIGHT SYSTEMS

For purposes of this document, optional flight systems are defined as those hardware end items that can be integrated into the Shuttle Orbiter for launching payloads to geosynchronous transfer orbits (upper stages), for extending the basic Orbiter capabilities (flight kits), or for offering the user a general-purpose orbiting laboratory for manned and automated activities in near-Earth orbit (Spacelab). The basic services are briefly described in this part, along with the current price determination for each system.

Each option is described separately. However, the user should remember in estimating costs that some options tend to go together. Furthermore, some of the optional flight systems are often related to optional payload-related services, described in part 3.

A user will pay a fixed price (subject to escalation) for any of these flight systems in addition to the price for the standard Space Shuttle transportation previously described. The prices shown may be adjusted at the time of negotiation.

The expendable upper stage is a Shuttle-launched vehicle for spacecraft missions with altitudes, inclinations, or trajectories beyond the basic Space Shuttle capability. Two upper stage systems are currently available.

One system uses a solid propellant, spin-stabilized stage, called the spinning solid upper stage (SSUS), of two basic sizes. One size SSUS accommodates the current Delta expendable launch vehicle class of missions (SSUS-D) and the other, the Atlas-Centaur launch vehicle class of missions (SSUS-A). Both SSUS stages are used as a perigee kick stage for placement of a spacecraft on its proper transfer trajectory. The other upper stage system, called interim upper stage (IUS), is a solid-propellant, three-axis stabilized, multistage system to be used for delivery of single or multiple spacecraft to geosynchronous orbits and high-energy escape trajectories.

Upper stage systems

System	Maximum payload weight capability, lb (kg)
SSUS-D (geosynchronous transfer)	2400 (1088)
SSUS-A (geosynchronous transfer)	4400 (1996)
IUS (geosynchronous orbit)	5000 (2268)

Spinning solid upper stage

NASA has recently negotiated agreements in which the McDonnell Douglas Corporation has agreed to develop, at its expense, SSUS systems and offer them commercially to STS users. As implied by the nature of those agreements, NASA policy is to encourage the participation of corporations in this and similar activities, to encourage open competition in a free market for these goods and services, and to encourage STS users to contract directly with these corporations for SSUS launch services.

The NASA/industry agreements establish a ceiling price to be charged to users by the supplier of SSUS baseline systems and services in 1975 dollars and further establish that escalation to the price (as compounded annually from the 1975 dollar base) will not exceed the amounts specified. These baseline prices include SSUS vehicle expendable hardware, use of ground-support equipment and airborne support equipment on a rental basis, and McDonnell Douglas launch support services.

In addition to the baseline SSUS system, McDonnell Douglas will provide to each user the mission analysis, hardware, and services as may be unique to each mission at an additional charge to be negotiated. For specific technical, programmatic, and cost data on SSUS/payload assist module (PAM) systems, inquiries should be directed to McDonnell Douglas Astronautics Company, 5301 Bolsa Avenue, Huntington Beach, California 92647, Attention, Director of PAM Programs.

Interim upper stage

The interim upper stage system, under development by the Department of Defense, consists of three vehicle configurations: a standard two-stage vehicle, a twin-stage vehicle, and a twin-plus-spinner vehicle. The two-stage vehicle is used for delivery to geosynchronous orbit; the twin-stage and twin-plus-spinner, for high-energy Earth escape missions.

The procurement price for two-stage IUS launch services for a baseline mission will fall within the range of $10 million to $12 million. The price for the three-stage configuration will be within the range of $12 million to $14 million.

The price to be charged a user requiring Spacelab hardware is computed using different criteria than those of other payloads. The basic reasons for those differences are to take the downweight limitations of Spacelab into account and to properly charge a user according to the pro-rata share of that Spacelab hardware required by the user. Because of the nature of anticipated Spacelab flights, certain standard services designated by NASA differ in some respects from those standard services available to other users. These standard services are discussed in this section, accompanied by descriptions of certain optional services that will be peculiar to Spacelab users. Also included is a full explanation of Spacelab price determination.

Standard Spacelab services

Each Spacelab launched will receive certain standard services as part of the basic price.

The user will be entitled to full or pro-rata share of Shuttle services and Spacelab hardware; e.g., core segment, tunnel, ground-support equipment set.

Tunnel adapter and airlock mounting kits, necessary on Spacelab module flights, are used in conjunction with the Spacelab tunnel and provide the capability to mount an Orbiter airlock in the cargo bay on the upper hatch of the tunnel adapter. This enables payload operations to continue uninterrupted by Orbiter extravehicular activity because crewmembers can move back and forth from the Orbiter crew compartment to the Spacelab module. The cost for installation, removal, maintenance, and use of these kits is included in standard Spacelab cost for module missions.

Standard Spacelab missions will be launched from KSC Space Center for a duration of 7 days with standard mission destinations.

NASA will provide training and accommodations for a three-person Shuttle flight crew, accommodations and STS training for a two-person payload specialist crew, and will operate the user's payload if requested. Spacelab flight planning, real-time command and control, as well as prelaunch payload integration and compatibility verification will be performed by NASA.

As part of on-orbit operations, NASA will provide standard Spacelab electrical power, Spacelab environmental control and life support, onboard data acquisition and processing services, use of standard Spacelab monitoring and control facilities on the ground, and voice communications between the onboard crew and the ground.

NASA will review the necessary payload specifications and test data required to determine the safety and compatibility of launch, onorbit, and re-entry operations.

Upon request from the user, NASA will support payload design reviews to resolve problems and anomalies. This activity will be jointly agreed upon by the user and NASA.

Users contracting for pallet-only payloads are entitled to locate minimal controls as agreed by NASA in a pressurized area to be designated by NASA. No additional charge is made for this service.

Users contracting for dedicated pallets are entitled to the entire volume above the pallet; users of dedicated modules are entitled to the entire experiment and storage volumes of the pressurized module respectively.

Optional Spacelab services

Certain optional services are available to Spacelab users for an additional price, which will be negotiated at the time of preparation of the launch agreement between NASA and the user. These optional services are as follows.

1. Additional mission time beyond 7 days
2. Delivery of Spacelab to a nonstandard inclination
3. Training and use of additional payload specialists beyond those specified in the standard service
4. Mission-dependent training of NASA personnel when requested to operate the user's payload
5. Integration of the user's payload onto pallets and/or into racks

6. Custom integration or testing requirements

7. Additional resources and additional experiment or crew time required beyond the user's pro-rata share

8. Special access to and/or operation of the payload

9. Postmission or additional in-flight data processing

10. Additional loan time for racks and pallets

11. Special communication coverage

12. User software development for the Orbiter command and data-management system computer

13. Special payload support equipment, such as instrument pointing systems, scientific airlock

Spacelab price determination

The price charged a Spacelab user is the sum of the Shuttle transportation flight price, the Spacelab operations price, and any optional services required by the user. The basic price will be fixed for the first 3 full fiscal years of the STS operations phase and will be updated periodically for the remaining years.

There are three basic types of Spacelab flights:

- Dedicated Spacelab flight – on which a user requires an entire Orbiter flight for the Spacelab elements he is using. (A Spacelab element is defined as a long module, short module, or pallet segment.)
- Dedicated element/shared flight – on which the user requires an entire Spacelab element (or elements) flown on a shared Orbiter.
- Shared element/shared flight – on which the user requires only a part of a Spacelab element (or elements) and, therefore, only part of the Orbiter cargo bay.

Transportation price

The Shuttle transportation price for Spacelab flights is based on either a dedicated element or a shared element. Both dedicated and shared elements can be flown as shared-flight payloads.

The Shuttle transportation flight price for a standard dedicated Spacelab is shown in the accompanying price table.

Transportation price for Spacelab
[Dedicated Shuttle flight]

Mission type	Price, $ $\times 10^6$ (1975 dollars)
Pressurized module	
Non-U.S. Government user	22.271
Civilian U.S. Government user	22.000
Pallet only	
Non-U.S. Government user	20.571
Civilian U.S. Government user	20.300

The transportation flight price for a Spacelab dedicated element/shared flight is based on a pro-rata share of the price listed in the transportation price table for the appropriate user class. This pro-rata share is based on the appropriate load factor, which the user can calculate from the accompanying table. Load factors for combinations of module and pallet missions can be determined by adding the calculated load factor of each element.

The load factor is then divided by 0.75 to determine the charge factor. The calculated charge factor (subject to a maximum of 1.0 and a minimum of 0.01) is multiplied by the price listed in the transportation table to determine the transportation price for that payload.

The transportation flight price for a Spacelab shared element/shared flight is also based on a pro-rata share of the total price shown in the transportation table. The formula for calculating the shared-element load factor is shown in the table.

In determining the basis for these load factors, the following definitions and criteria apply.

o Experiment volume in the pressurized module is defined as the sum of the user's payload volume in racks and in the aisle. Rack volume (defined relative to basic rack configuration) is defined as the volume of one or more rectangular parallelepipeds that totally enclose the user's payload. Width dimensions shall be either 17.75 or 37.01 inches (45.1 or 94.0 centimeters). Height is computed in integral multiples of 1.75 inches (4.445 centimeters). Depth dimensions shall be 24.09 or 15.82 inches (61.2 or 40.2 centimeters). Aisle space volume is defined as the volume of a rectangular parallelepiped that totally encloses the

Calculation of dedicated-element load factors [Shared Shuttle flight]

Element	Use greater of length or weight	
	Length calculation	Weight calculation
Pallet	$0.2 \times N$	$\frac{W,\ lb + (2747 \times N)}{32\,000\ lb}$ $\left(\frac{W,\ kg + (1246 \times N)}{14\,515\ kg}\right)$
Short module	0.47	$\frac{W,\ lb + 11\,936}{32\,000\ lb}$ $\left(\frac{W,\ kg + 5414}{14\,515\ kg}\right)$
Long module	0.62	$\frac{W,\ lb + 17\,934}{32\,000\ lb}$ $\left(\frac{W,\ kg + 8135}{14\,515\ kg}\right)$

W Payload weight, which includes the weight of the user's payload and the user's pro-rata share of the weight of NASA mission-dependent equipment carried to meet his needs. It does not include the weight of standard Spacelab consumables used for a 7-day flight.

N Number of pallets needed by user.

Calculation of shared-element load factor [for Shuttle transportation price]

Element	Use greater of weight or volume	
	Weight calculation	Volume calculation
Pallet	$\frac{\text{Total payload weight, lb}}{19\,559}$ $\left(\frac{\text{Total payload weight, kg}}{8872}\right)$	$\frac{\text{Payload volume, ft}^3}{2119}$ $\left(\frac{\text{Payload volume, m}^3}{60}\right)$
Pressurized module	$\frac{\text{Total payload weight, lb}}{14\,065}$ $\left(\frac{\text{Total payload weight, kg}}{6380}\right)$	$\frac{(2 \times \text{experiment volume, ft}^3) + \text{storage volume, ft}^3}{1413}$ $\left(\frac{(2 \times \text{experiment volume, m}^3) + \text{storage volume, m}^3}{40}\right)$

user's payload. The minimum length of any edge for computing purposes is 11.81 inches (30.0 centimeters).

- Storage volume in the pressurized module is defined as the volume of one or more rectangular parallelepipeds enclosing the user's stowed payload. No edge of the parallelepiped should be computed as shorter than 11.81 inches (30.0 centimeters).
- Volume of the user's pallet-mounted payload is defined as the volume of a rectangular parallelepiped enclosing the pallet payload and all user-dictated mounting hardware. No edge of the parallelepiped should be computed as less than 11.81 inches (30.0 centimeters).

Load factors for combinations of shared module and pallet missions can be determined by adding the calculated load factor for each shared element.

The load factor is divided by 0.75 to determine the charge factor (subject to a maximum of 1.0 and a minimum of 0.01). The charge factor is multiplied by the transportation price to determine the user's cost.

Spacelab operations price

The operations price for a dedicated Spacelab element is shown in the pricing table. The operations price for a shared element is calculated on the basis of the user's share of the Spacelab element. This is called a load fraction (to differentiate it from the load factor used for the Shuttle transportation price) and is calculated according to the accompanying table.

Spacelab dedicated-element price

Element or combination	Price (1975 dollars)
Short module	$1 340 000
Short module and one pallet	1 670 000
Short module and two pallets	2 000 000
Short module and three pallets	2 340 000
Long module	1 670 000
Long module and one pallet	2 000 000
Long module and two pallets	2 340 000
Pallet plus share of igloo	434 000

Load fraction calculation
[for shared-element flight]

Element	Use greater of weight or volume	
	Weight calculation	Volume calculation
Pallet	$\frac{\text{Total payload weight, lb}}{4890}$ $\left(\frac{\text{Total payload weight, kg}}{2218}\right)$	$\frac{\text{Payload volume, ft}^3}{530}$ $\left(\frac{\text{Payload volume, m}^3}{15}\right)$
Pressurized module	$\frac{\text{Total payload weight, lb}}{14\ 065}$ $\left(\frac{\text{Total payload weight, kg}}{6380}\right)$	$\frac{(2 \times \text{experiment volume, ft}^3) + \text{storage volume, ft}^3}{1413}$ $\left(\frac{(2 \times \text{experiment volume, m}^3) + \text{storage volume, m}^3}{40}\right)$

The calculated load fraction is divided by 0.75 to determine the charge factor. (The charge factor for a module is subject to a minimum of 0.01 and a maximum of 1.0; the charge factor for a pallet is subject to a minimum of 0.04 and a maximum of 1.0.) The element charge factor is multiplied by the price of the dedicated element to determine the operations price.

The operations price must then be added to the transportation price already calculated.

NASA may, at its discretion, adjust up or down the calculated load factors or load fractions for special weight or space requirements, including but not limited to:

- Excessive local or total volume
- Sight clearances, orientation, or placement limits
- Clearance for movable payloads
- Unusual access clearance requirements
- Clearance extending beyond the bounds of the normal element envelope
- Extraordinary shapes
- Substantial differences between upweight and downweight

The adjusted values will be used for computing costs and prorating services.

Spacelab use fee

The use fee for non-U.S. Government users is based on utilization of Spacelab facilities and equipment at KSC and JSC and utilization of the hardware required for the configuration the user selects for his particular mission. It is added to the transportation and operations prices. This fee is also prorated for shared-element users on the basis of the load fraction.

Spacelab use fee

Item	Proration factor	Fee (constant)
KSC and JSC facilities and equipment	Shuttle Charge factor	$229 000
Ground support equipment	Shuttle charge factor	43 000
Total		272 000
Mission-independent Spacelab hardware	Spacelab element charge factor	
Long module		389 000
Short module		340 000
Pallet		25 000
Igloo (instrumentation package)		119 000
Mission-dependent Spacelab hardware	Space element charge factor	
Single experiment rack		1 000
Double experiment rack		1 000
Viewpoint		1 000
Instrument pointing system		66 000
Optical window		2 000
Flight recorder		1 000

FLIGHT KITS

The Orbiter is designed to provide adequate standard interfaces that can be used by or adapted to most potential payloads. Additional support systems – flight kits – are available as an optional service to extend the basic Orbiter capability. These flight kits are briefly described in this section. The accompanying tables will help a user determine his costs. The prices listed are subject to escalation and the current basic prices may be adjusted.

A serial impact cost is also part of the user's cost. It is associated with the total installation time and is determined at the time the launch agreement is negotiated. The maximum assessment can be calculated from the accompanying serial-time table. To make this calculation, the user should total the installation times for all kits to be used, then subtract 16 hours; total the removal times and subtract 8 hours. The remaining hours above the baseline should be multiplied by

Flight kit dimensions and prices

Flight kits	Length, ft (m)	Weight, lb (kg)	Cost, 1975 dollars[a]
OMS delta-V kit			
1 kit	9 (2.745)	16 302 (7 401)	$219 535
2 kits	9 (2.745)	29 468 (13 379)	
3 kits	9 (2.745)	43 033 (19 537)	
Docking module	7 (2.135)	3 777 (1 715)	12 957
Delta nitrogen tanks	3 (0.915)	114 (52)	5 389
Delta waste tanks	3 (0.915)	200 (91)	3 174
PRSD/EPS tank set kits			
Upper	9 (2.745)	1 564 (710)	66 823
Tank set (5)	9 (2.745)	1 564 (710)	112 743
Tank set (6)	9 (2.745)	1 564 (710)	114 040
Tank set (7)	9 (2.745)	1 564 (710)	114 040
Second remote manipulator system	N/A (N/A)	1 150 (522)	93 629

[a]Plus serial impact cost, if any.

$13 750 to determine a maximum potential assessment. However, installation of kits in parallel or other factors can shorten this time.

The user must also add the weight and length of each chosen flight kit to his payload size when calculating the Shuttle transportation cost.

Serial time impact

Flight kits	Installation time, hr	Removal time, hr
OMS delta-V kit	22	22
Docking module	55	16
Delta nitrogen tanks	17	6
Delta waste tank	22	10
PRSD/EPS tank sets (upper)	25	5
PRSD/EPS tank set (5)	225	105
PRSD/EPS tank sets (6 or 7)	145	105
Second RMS	20	8

OMS delta-V kit

The OMS delta-V kit consists of auxiliary propellant tanks that provide an additional 500 ft/sec (152 m/sec) velocity to the Orbiter in orbit. This kit is designed to increase the Orbiter mission capability and has no direct interface with the payload. As many as three kits can be added to the integral orbital maneuvering subsystem (OMS) propellant tanks to produce a total delta-V capability of 2500 ft/sec (762 m/sec).

Docking module

The docking module kit is installed in the Orbiter cargo bay when mission requirements call for other orbiting vehicles to dock with the Shuttle Orbiter. It incorporates a docking device similar to that demonstrated in the Apollo-Soyuz Test Project.

Second remote manipulator system

A kit providing a second remote manipulator arm can be located on the right side of the cargo bay opposite the baseline remote manipulator system (RMS). Like the baseline system, the RMS kit consists of a 50-foot (15.24-meter) manipulator arm, the controlling mechanism (independent of the other arm and operated from the crew compartment), and a jettison system. This kit allows for multiple deployment of payloads or allows both arms to manipulate one payload together.

Delta nitrogen tanks

The delta nitrogen tank kit consists of a spherical tank (weighing 59 pounds (26.8 kilograms) dry) that can provide 45 pounds (20.4 kilograms) of useable nitrogen for Orbiter living space atmosphere. The number of tank kits necessary depends on the length of the Shuttle flight desired. The kits are located in the Orbiter midfuselage between frames forward of the wingbox.

Additional nitrogen tanks required[a]

Mission days	Tanks
7	0
12	1
18	2
24	3
30	4

[a]Tanks are added on extended flights as required to compensate for 5.32 lb/day (2.41 kg/day) cabin leakage.

Delta waste tanks

The delta waste tank kit consists of a single cylindrical tank with a capacity of 2.5 cubic feet (0.0708 cubic meter) of water. The waste tanks collect wastewater generated by the crew. Kits to provide additional tanks are required for mission length or crew size above the baseline.

Estimated additional waste tanks required

Number of crewmembers	Tanks required for — mission length, days				
	7	12	18	24	30
4	0	1	2	4	5
6	1	3	5	7	9

PRSD/EPS tank sets

Kits are available to provide additional electrical power for payloads. The baseline Orbiter has 1530 kWh (5508 megajoules) of energy and the Orbiter itself typically uses 204 kWh/day (734 MJ/day). Each kit provides an additional 840 kWh (3024 megajoules). A kit consists of two sets of liquid hydrogen tanks and two sets of liquid oxygen tanks for the power reactant supply and distribution/electrical power supply (PRSD/EPS) systems.

Each tank series is considered a separate option, depending on its location in the cargo bay. The configuration of the payload will determine which kit is required. Their locations are as follows.

PRSD/EPS tanks (upper): These kits are located above the cargo bay liner and as many as four kits can be used to provide a total additional capability of 3360 kWh (12 096 megajoules).

PRSD/EPS tank set (5): This kit is in the cargo bay below the liner.

PRSD/EPS tank set (6 and 7): These kits are also located in the Orbiter cargo bay below the liner.

Standard Space Shuttle services and **charges**

Optional flight systems

Optional payload-related services

Special fees and schedules

Calculation of reimbursements

Appendixes

3 Optional payload-related services

OPTIONAL PAYLOAD-RELATED SERVICES

Users that require services above those provided in the standard price and optional flight systems may be accommodated by optional payload-related services. Some options are common to many payloads and others are custom-tailored to specific payloads. Some of the common options have been identified in this part; additional ones will be included as they become baselined.

The custom options will be negotiated when requested by the user. These negotiations will take into account feasibility, responsibilities, implementation, and price. Options of this type are thermal loads analysis, dynamic loads analysis, custom mission planning, payload data processing, etc.

A summary of the prices (in 1975 dollars) for the common payload-related optional services is shown in the table. The following sections describe the services. The final price for all payload-related optional services will be determined during NASA/user negotiations contingent on specific user requirements.

Common optional services

Options	Price range, 1975 dollars
Extravehicular activity	60 000 to 100 000 each
Payload specialist and training	75 000 to 100 000 each
Additional time on orbit	300 000 to 350 000 per day
Payload revisit	300 000 to 400 000 per flight[a]
JSC Payload Operations Control Center (POCC)	To be negotiated
Launch site services	To be negotiated
Additional cargo accommodations	48 000+ per payload (Flex MDM)

[a]Estimated incurred costs only (launch costs and optional services not included).

EXTRAVEHICULAR ACTIVITY

Extravehicular activity (EVA) includes all activities for which crewmembers don space suits and life support systems and perform operations internal or external to the cargo bay volume. A planned EVA can be scheduled by a user to complete a payload mission objective.

Every Orbiter flight is capable of providing the equipment and consumables required for two EVA operations, each lasting a maximum of 6 hours. If additional payload EVA's are needed, the additional consumables and equipment weight will be allotted to that payload.

The NASA will assume the cost for baseline equipment development and production and standard (not mission-unique) STS crew training, specifically:

1. Two 6-hour EVA's per flight performed by one or two NASA crewmembers
2. Remote manipulator system support to EVA
3. Standard support equipment, such as tools, restraints, lights, television
4. Voice communications

The user will assume the cost for EVA systems provisions, EVA support equipment, and EVA crew training that is payload-specific.

Depending on the complexity of the EVA required by the user, the following functions and hardware will be performed or provided by NASA: extravehicular mobility unit and communications equipment, flight design, flight operations support, crew activity planning, and training. The individual cost to perform the functions and provide the hardware dictates an EVA price range of \$60 000 to \$100 000. The cost for any mission-unique EVA support equipment is not included in this price range. The final price will be determined at the time of user negotiations with NASA and will be contingent on specific user requirements.

PAYLOAD SPECIALIST AND TRAINING

A payload specialist is a crewmember responsible for operation and management of the experiments or other payload elements that are assigned to him or her, and for the achievement of their objectives. This crewmember may either be a NASA employee or come from the user organization. The payload specialist will be an expert in experiment design and operation.

This option will apply if user requirements indicate the need for this crewmember. If the user selects this option, NASA will provide flight operations training (except payload-unique training), equipment, and supplies to support the payload specialist during the mission.

The payload specialist will receive flight-independent training (which involves those crew tasks necessary for any crewmember to function effectively during a flight) and participate in integrated simulations for the specific flight. A typical training schedule will extend for 12 months, but for some payloads the user may want the candidate to be screened longer before the flight, thus increasing the duration of training. Usually, 2 of the 12 months will be spent in formal classroom and trainer/simulator training during which the payload specialist must be dedicated nearly full time. The remaining time will be allocated to STS/payload flight plan integration and reviews, flight techniques meetings, and flight requirements implementation reviews which will require payload specialist only part time. For some complex payloads, the dedicated training may require more than 2 months.

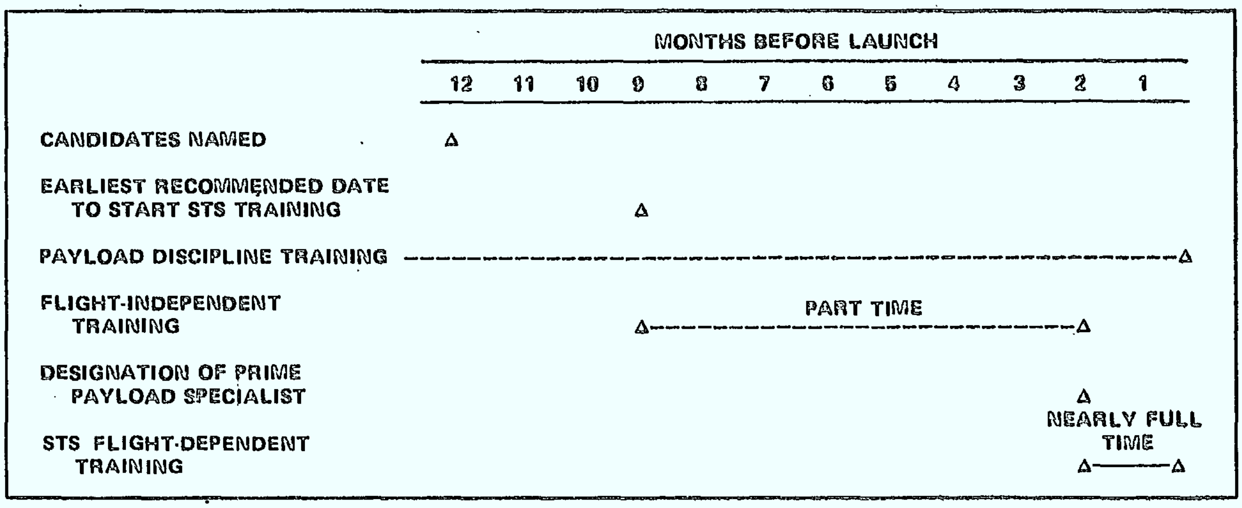
It will be the user's responsibility to provide the payload specialist with payload discipline training.

The charge to the user will include the cost for preflight training and in-flight equipment and supplies (Government-furnished equipment, food, biomedical needs). The individual cost for each of these dictates a price range of $75 000 to $100 000 for as many as 7 days on orbit.

Not included are the payload specialist's personal costs while attending on-site training at JSC.

In addition to these costs, the weight of seats, personnel, and consumables is added to the payload weight.

If a trained payload specialist makes repeated flights, the cost for later flights will be negotiated. It will depend on specific user requirements and the payload specialist's need for further training.



Typical training schedule for a payload specialist.

ADDITIONAL TIME ON ORBIT

One day of mission operations is included in the standard services to a payload as part of basic Space Shuttle transportation.

For dedicated flights, 1 day of mission operations is defined as a 24-hour period from launch to landing. A user requiring additional time for mission operations will be charged a daily rate.

For shared flights, a theoretical mission duration for each payload will be determined on the basis of how much time the individual payload would require if it were on a dedicated flight. This theoretical mission duration will define the time accountable to each payload. Therefore, time on orbit involving orbital translation maneuvers, stationkeeping, and attitude maneuvers for purpose of Orbiter transition from one payload's objectives to another's will be a NASA responsibility and will not be considered in determination of charges for this option.

Any situation involving the need for more than one standard day of on-orbit time will dictate the purchase of this option. These situations include repair or servicing a payload, photographic or observation sequences, or more than 7 days use of a Spacelab.

The price for additional time on orbit ranges from $300 000 to $350 000 per day. The final price will be determined at the time of user negotiations with NASA contingent on specific user requirements.

The payload revisit option applies to users requesting transportation services to replace, retrieve, or service an orbiting payload. Replacement, retrieval, and servicing are quite different mission activities and the costs reimbursed to NASA reflect these differences.

Replacement

All users replacing an orbiting payload will be charged the launch cost (dedicated or shared) of the replacement payload plus any additional option(s) and/or incurred costs that may be required as a result of the replacement activity.

Retrieval

Users requiring a dedicated flight for a retrieval mission will reimburse NASA according to the dedicated-flight-price provisions of this document.

Shared-flight users will contract for a retrieval performed at NASA's convenience. In this situation, NASA performs the retrieval when a retrieval-compatible mission is scheduled to fly to the approximate orbit of the user's payload. Users are not guaranteed a specific retrieval time frame. For this type of "opportunity" retrieval NASA will be reimbursed the retrieval support equipment launch cost according to the shared-flight prices in part 1, plus any additional options and/or incurred costs that may be required as a result of the retrieval activity.

Servicing

Users requiring a dedicated flight for a servicing mission will reimburse NASA the dedicated-flight price. Shared-flight users may contract either for a firmly scheduled revisit to service or servicing performed at NASA's convenience. The scheduled servicing revisit will cost the shared-flight price, computed on the assumption that materials and hardware will be exchanged on an essentially one-to-one basis (of weight or length).

Shared-flight users who require only an inspection and are willing for this to be done at NASA's convenience will reimburse NASA only for any additional options and/or incurred costs that may be required.

Price estimation

The price for the payload revisit option is the sum of the charges for a dedicated or shared flight (listed in part 1), additional optional services (described separately), and any incurred cost for the revisit. These incurred costs include the resources required for flight design, preflight and real-time operations support; crew activity planning; training and simulation support. The price range for these incurred costs is \$300 000 to \$400 000 for any one of the types of revisit missions. The final price will be determined at the time of user negotiations with NASA contingent on specific user requirements.

The JSC Payload Operations Control Center (POCC) enables the user to support real-time operations involving his own attached payload. The POCC includes support for both payload systems and science functions. The systems function includes Orbiter interface responsibilities as well as payload hardware systems support. The science function includes all payload scientific data evaluations and payload objective determination.

The basic purposes of the POCC are:

- To permit users on the ground to support and interact with the onboard crew
- To provide ground command capability to enhance crew efficiency or operate experiments
- To perform payload activity rescheduling required by contingencies or experiment results
- To provide payload contingency analysis beyond crew capability
- To provide greater latitude in the selection and design of experiments
- To increase the return on mission objectives as set forth by the user

The two basic support modes are host and limited.

In the host mode, the POCC provides facilities with a standard complement of capability for data monitoring, payload commanding, and voice communications with the crew and the Mission Control Center (MCC). The user provides all the payload operations personnel necessary to support real-time payload activities including real-time command and control, real-time data evaluation, science planning, and experiment performance monitoring, as well as payload system troubleshooting. The JSC will provide only those personnel necessary for POCC familiarization training, procedures coordination, and equipment anomalies.

In the limited mode, the user provides part of the payload support and NASA provides payload support in selected areas as may be agreed upon.

The training and simulation required of the POCC operations personnel will depend to a great extent on the self-containment of the user's payload. Generally, POCC personnel will receive basic training in various areas such as MCC familiarization and operations of the POCC consoles.

The requirements of the payload will determine additional training in such areas as telemetry operations, ground data systems, data management and Orbiter systems. POCC personnel training will also include STS and POCC integrated simulations using the MCC and the Shuttle mission simulator as necessary.

The charge for use and services of the POCC will be based on four individual cost categories, as follows.

1. Cost for NASA personnel required to prepare for and perform real-time POCC support as required by the user.
2. Use charge for office space, POCC facilities and common office services required by user personnel for preflight, flight, and postflight time periods.
3. Cost for manpower and facilities to accommodate unique payload POCC training and mission simulation activities.
4. Cost for specialized services, such as flight data reduction, voice transcripts, video tapes, data lines to distant user locations.

Because of the variable nature of the POCC requirements for individual payloads, the price will be determined at the time of user negotiations with NASA.

Launch site support services and facilities above those standard services included in the basic price are available at KSC and adjoining Cape Canaveral Air Force Station. These are described in detail in the "KSC Launch Site Accommodations Handbook for STS Payloads" (K-STS-M-14.1).

The price for the facilities shown in the table will cover utilities, operation and maintenance costs, and basic janitorial services. Non-U.S. Government users must also pay a constant-dollar use fee. The prices shown are for use of the facility by one payload; a facility with the capability for multiple payloads is not dedicated.

If a user requires facility modification, an additional charge will be made.

The price for support services will be determined by the amount and kinds of services required. Those that are not a part of KSC overhead will be priced individually. At the time a preliminary payload integration plan is issued, KSC will identify the potential services that may be required, based on experience with similar payloads. The final list will be negotiated as part of the launch agreement.

Optional launch site facilities

Facility	Price per day, 1975 dollars	Use fee per day, constant dollars
Delta spin test facility	1326	1007
Explosive safe area 60	1326	1007
Hangar AM	1326	1007
Hangar AO	1326	1007
Hangar AE	1326	1007
Hangar S	1326	1007
Spacecraft assembly and encapsulation facility no. 2	1326	1007

ADDITIONAL CARGO ACCOMMODATIONS

The additional cargo accommodations option will be available to those users who desire (1) to assure themselves of Orbiter compatibility by their use of existing Orbiter or Orbiter-type equipment, (2) autonomous avionics checkout capabilities independent of other payloads, (3) minimum Orbiter integration, installation, and checkout time, and (4) a full line of Orbiter accommodations services. NASA will provide Orbiter hardware in the payload station on the aft flight deck and in the cargo bay for maximum flexibility of mixed cargo integration for each flight. The major hardware items which comprise this capability are: (1) flexible multiplexer/demultiplexer (MDM) and associated ground-support equipment (GSE), (2) power distribution unit, (3) frequency division multiplexer, (4) timing buffer amplifier, (5) cables in the aft flight deck and cargo bay, (6) payload switch panel, (7) closed circuit television, and (8) manual pointing control.

This option would provide the user with the use at his own site of a flexible MDM, and associated GSE, and a power distribution unit for 3 months before his launch date to check out operation of his payload. The MDM/GSE will be used to simulate the operation and connections of the hardware to the payload station. The charge reimbursable to NASA for this option is $48 000 for each use. Any user requiring this complement of hardware for an additional period of time over 3 months will be assessed an additional charge of $2800 per week.

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Special fees and schedules

Special fees and schedules

This section outlines the normal schedule for reimbursement to NASA and the normal launch schedule, which are directly related. The remaining sections of part 4 describe options the user can exercise to deviate from standard flight and billing schedules, and the special fees associated with each.

All prospective users, regardless of reimbursement class, must pay NASA $100 000 earnest money before contract negotiations for a flight begin (except earnest money for a small self-contained payload is $500). This nonrefundable earnest money (in 1975 dollars) will be applied to the user's first payment, or will be retained by NASA if negotations are not completed. This earnest money is normally paid 3 years or longer before the desired launch date.

Billing schedule

The basic billing schedule for all users begins 33 months before the planned launch date. Users who contract for Shuttle services on shorter notice (1) will pay a higher total cost and (2) will have to pay on an accelerated schedule. This accelerated payment schedule will be used for short-notice contracts unless some offsetting advantages accrue to the U.S. Government in an accelerated launch schedule. (In that instance, the Government may waive some or all requirements.)

The schedule for both normal and accelerated payments is shown. All reimbursements to NASA will be made before the flight except for those items negotiated in the launch agreement as actual incurred costs.

Payment schedule

Contract initiation	Payment due, % Months before launch 33	27	21	15	9	3	Total, %
Nominal schedule (more than 33 months before launch date)	10	10	17	17	23	23	100
Accelerated schedule (months before launch date)							
27 to 32		21	17	17	23	23	101
21 to 26			40	17	23	23	103
15 to 20				61	23	23	107
9 to 14					90	23	113
3 to 8						122	122

Flight schedule

On a normal schedule for a dedicated flight, 3 years before the flight NASA and the user will identify a desired launch date within a period of 90 days. One year before the flight, firm launch and payload delivery dates will be identified by NASA. The firm launch date will be within the first 60 days of the original 90-day period. Launch will occur on the firmly scheduled launch date or within 30 days thereafter. The payload must be ready to launch for the duration of that period.

On a normal schedule for a shared flight, 3 years before the flight NASA and each user will identify a desired launch date. Launch will occur within a period of 90 days, beginning on the desired launch date. One year before the flight, firm launch and payload delivery dates will be coordinated among the shared-flight users. This firm launch date will be within the first 30 days of the original 90-day period. Launch will occur on the firmly scheduled launch date or within 60 days thereafter. The payloads must be ready to launch for the duration of that period.

A 20-percent discount on the standard flight price will be given to shared-flight users who fly on a space-available (standby) basis. NASA will provide launch service within a prenegotiated period of 1 year. Payloads must be ready for delivery to the launch site on the first day of that 1-year period and must sustain that condition until actual delivery. The user will be notified 60 days before the firmly scheduled launch date. The payload must be available at the launch site on the assigned delivery date and ready to launch for a period of 60 days after the firmly scheduled launch date.

Future fixed price

A fixed-price option for future flights in a given year beyond the 3-year fixed-price period will be made available to users already contracting for STS launch services. NASA shall be reimbursed the user's flight price compounded at 8 percent for each year beyond the fixed-price period. The fee for this option is $1 million (in 1975 dollars) payable at the time the earnest money is paid. The option fee will be applied to the user's first payment. The user will exercise this option by contracting for the flight on the normal 33-month reimbursement schedule, or the option fee will be retained by NASA.

Guaranteed launch date

In order to ensure that space will be available for flights in a given future year, scheduled launch options (in which NASA will provide a launch during a 90-day period) will be given to STS users already contracting for flights. The fee for a guaranteed launch date option is $100 000 (in 1975 dollars) applied to user's first payment. The user will exercise this option by contracting for the flight on the normal 33-month reimbursement schedule, or the option fee will be retained by NASA.

Floating launch date

The "floating launch date" affords some flexibility in choosing a launch date. The user negotiates a contract and begins payment according to a tentative launch date at least 33 months away. This option costs 10 percent of the flight price in effect when the contract is negotiated and the fee must be paid at that time. The fee is in addition to other charges and is NOT applied to later payments due. When the user notifies NASA of a desired launch date (anytime 1 year or more before the desired date), a firm launch schedule is negotiated. If the user requests a firm launch date less than 12 months in advance, the short-term callup fees apply.

This option permits a user who expects to need a launch at some uncertain time in the future to contract for a flight without specifying a firm launch date; thus, no postponement fees result.

Accelerated launch date

Users who reschedule a launch so that it occurs earlier than the planned launch will pay on an accelerated-payment schedule. Users who exercise this option must pay any back fees, so that they will be charged the same total cost as users who contract late. (The only exception would be if earlier payments had been lower because adjustments for inflation occurred after those payments were made.) For example, a user on a 33-month schedule who had already made two 10-percent payments and then wanted a 15-month launch would owe 41 percent (the difference between the 20 percent already paid and the 61 percent due on the new schedule) and then would continue payments on the 15-month schedule. If the time the user notifies NASA of acceleration is less than 1 year from the new launch date, short-term callup reimbursements will also apply.

Short-term callup

Users who want to contract for flights less than 1 year before the desired launch date can elect the short-term callup option.

For a dedicated flight scheduled at least 3 months before launch, assuming NASA can accommodate the user, the only additional costs will be those incurred on the accelerated-payment schedule. Shared-flight users, in addition to paying the higher costs on the accelerated-payment schedule, must pay a load factor recovery fee. This fee depends on how long before launch the short-term callup is exercised and on the availability of other payloads for the flight.

Users of either shared or dedicated flights who contract less than 3 months before the launch date will be charged the estimated additional costs to NASA, if these users can be accommodated at all on such short notice.

Shared-flight users who want a launch date less than 12 months away and elect to be considered on a space-available basis will not be assessed short-term callup fees.

Postponement

If the user incurs problems that temporarily preclude launch during the initially negotiated launch period, postponement options are available. Most of them involve additional fees.

No additional fee is required for dedicated-flight and nonstandby shared-flight users who notify NASA more than 1 year before the scheduled flight date and who postpone only once. Similarly, standby users can postpone 6 months or more before the beginning of their negotiated 1-year launch period without additional fees and a new launch period will be negotiated.

After the first postponement, or for any postponement occurring less than 1 year before the planned launch, dedicated-flight users must pay a fee of 5 percent of the flight price.

Nonstandby shared-flight users must pay the 5 percent plus an occupancy fee. The occupancy fee (explained further in NMI 8610.8, attachment E) depends on how long before launch the option is exercised and on the availability of substitute payloads. The philosophy is that the user should bear any additional costs caused by schedule changes he requests.

Standby shared-flight users will pay the 5 percent and the occupancy fee if they postpone less than 6 months before the planned 1-year launch period.

If any postponement causes a payload to be launched in a year when a higher price has been established, the new price will apply.

Cancellation

Any user who cancels a flight must pay 10 percent of the flight price. In addition, for shared flights, an occupancy fee will be assessed nonstandby users who cancel less than 1 year before the scheduled launch date or standby users who cancel less than 6 months before the planned launch period.

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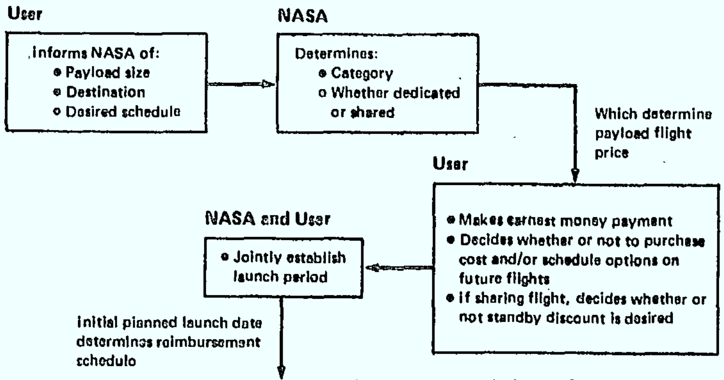
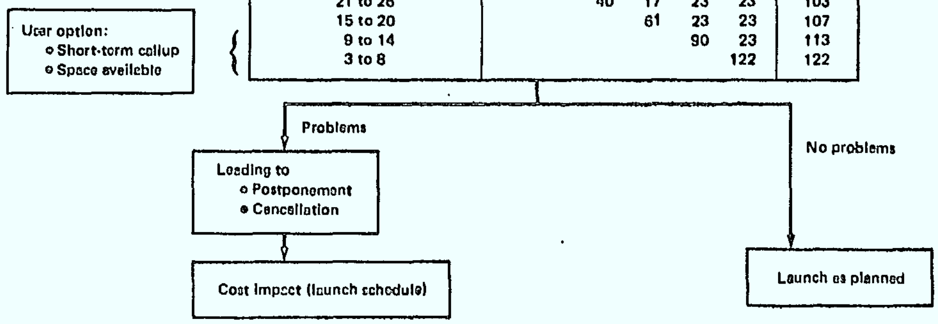
CALCULATION OF REIMBURSEMENTS

From the preceding parts of this document, it is evident that there are many ways to use the STS to transport payloads to orbit. For any given user's launch or series of launches, a number of combinations of services is available to meet the user's needs. Each combination of standard services, optional flight systems, optional payload-related services, and special fees and schedules to satisfy the user's requirement is a scenario or strategy the user must evaluate financially to determine the best way to use the STS from his perspective. Each scenario characteristically has its own total price and cash flow.

This part explains the methodology the NASA uses to calculate the total price for payload transportation to orbit on the STS and the schedule of reimbursements or cash flow due from the user to the NASA. Included are the formulas from which a financial analyst can confidently estimate the net present value of a launch, the real-year cost of a launch, or other cost criteria to determine the launch scenario that best suits the user's service needs. Schedule and financial interfaces between the NASA and user are illustrated in the accompanying flow diagram.



Contract initiation	Payment due, %						Total, %
	Months before launch						
	33	27	21	15	9	3	
Nominal schedule (more than 33 mo before launch date)	10	10	17	17	23	23	100
Accelerated schedule (months before launch date)							
27 to 32		21	17	17	23	23	101
21 to 26			40	17	23	23	103
15 to 20				61	23	23	107
9 to 14					90	23	113
3 to 8						122	122



THE LAUNCH PRICE

The price for STS launch services is the sum of the following costs.

1. The portion of cost for standard services (dedicated or shared) (from part 1).
2. The costs of optional flight systems (from part 2).
3. The costs of optional payload-related services (from part 3).
4. The costs of special fees and schedules (from part 4).

The price consists of two segments for calculations of the reimbursement scheduled or cash flow. Segment 1 of the price is that sum of costs expressed in this document in terms of a January 1, 1975, dollar base, which is subject to escalation. Segment 2 of the price is that portion of the price which is not subject to escalation, such as the use fee charged non-U.S. Government users. For shared flights, the charge factor (from the section "Reimbursement categories" in part 1) applies to both segments of the price for standard services and the costs of any optional services are added as a whole to determine the total price.

The payment schedule (part 4) for reimbursements expressed in terms of percentage of total price per specified time periods before launch applies to both segments of the price. However, the price should be separated into both segments (escalated and nonescalated) and spread according to the percentages to facilitate cash flow analysis. Those prices expressed in January 1, 1975, base dollars are subject to escalation as determined by the Bureau of Labor Statistics index for compensation per hour, total private.

When a payment becomes due, the escalated segment of the price is raised to current value by applying the index multiplier to the base price due. The index value is calculated from the future value formula for compound interest as follows. The actual values for the index i are inserted in the equation from January 1, 1975, to the current date.

$$\text{Index multiplier} = \underset{\text{Jan.75}}{(1+i)} \times \underset{\text{Feb.75}}{(1+i)} \times \underset{\text{Mar.75}}{(1+i)} \times \ldots \times \underset{\text{current}}{(1+i)}$$

For example, the value of the index to raise January 1, 1975, dollars to October 1, 1977, base dollars is 1.263, and this multiplier would apply to a payment due in October 1977.

To estimate the future payments value, an index value may be assumed. The examples in this section assume an annual rate of 7 percent per year. Therefore, the monthly index multiplier is the 12th root of 1.07 or 1.005654 to apply as an estimate of the monthly index in the future. Assuming October 1, 1977, as the current month, then the future payments cost can be estimated as follows.

$$\text{Future value payment} = (1.263) \times (1 + 0.005654)^n \times R$$

where 1.263 is the actual index multiplier through October 1, 1977, 0.005654 is the monthly index assuming 7 percent per year escalation, n is the number of months from October 1977 to the due date of payment, and R is the portion of the total price due in January 1, 1975, base dollars.

EXAMPLES OF REIMBURSEMENT CALCULATIONS

The tables in this section provide some typical examples of how reimbursements to NASA and the payment schedules are calculated. Examples 1 and 2 are for similar payloads in different user classes. Example 3 is a representative Spacelab calculation. A series of launches by the same user is calculated in example 4.

Examples include combinations of standard services, optional flight systems, optional payload-related services, and special fees and schedules.

Example 1. Civilian U.S. Government user, shared payload, using SSUS-D

PAYLOAD INFORMATION

Number	Name	Launch date	Length, in. (m)	Weight, lb (kg)	Orbital inclination, deg	Charge factor
1	Civil shared	MAR 1981	108.00 (2.74)	8000 (3628.8)	28.5	0.2

Anticipated date of earnest money payment is MAR 1978.

Pricing (in millions of 1975 dollars) is based on the following data

Services required	Not subject to escalation	Subject to escalation	Applies to flight 1
Standard services Dedicated flight price		18.000	Yes
Optional flight systems SSUS-D		2.000	Yes
Optional flight-related services Spin test facility Spin test facility NASA SSUS agent	 0.010 	 .013 .250	 Yes Yes Yes

PAYLOAD PRICE SUMMARY

Part of price	Not subject to escalation	Subject to escalation
Civil shared charge factor = 0.2 Shared-flight price Optional charges	 0.010	 3.600 2.263
Total	0.010	5.863

Example 1 (concluded)

SPACE TRANSPORTATION SYSTEM PRICING REPORT

Months before launch	Payment due date	Percent of total due	Escalated portion of payment			Nonescalated portion of payment	Projected total escalated payment
			1975 dollars	Real-year dollars (est)	Escalation factor		
36	MAR 78	0	0.100	0.130	1.300	0.000	0.130
33	JUN 78	10	.486	.643	1.323	.001	.644
27	DEC 78	10	.586	.801	1.367	.001	.802
21	JUN 79	17	.997	1.409	1.413	.002	1.411
15	DEC 79	17	.997	1.458	1.462	.002	1.459
9	JUN 80	23	1.348	2.040	1.513	.002	2.042
3	DEC 80	23	1.348	2.110	1.565	.002	2.112
Total			5.863	8.590	--	.010	8.600

Example 2. Commercial user, shared payload, using SSUS-D

PAYLOAD INFORMATION

Number	Name	Launch date	Length, in. (m)	Weight, lb (kg)	Orbital inclination, deg	Charge factor
1	Nongovt shared	MAR 1981	108.00 (2.74)	8000 (3628.8)	28.5	0.2

Anticipated date of earnest money payment is MAR 1978.

Pricing (in millions of 1975 dollars) is based on the following data

Services required	Not subject to escalation	Subject to escalation	Applies to flight 1
Standard services			
Dedicated-flight price		18.271	Yes
Dedicated use fees			
Facility and equipment depreciation	0.834		Yes
Fleet procurement	1.453		Yes
KSC	2.011		Yes
Optional flight systems			
SSUS-D		2.000	Yes
Optional flight-related services			
Spin test facility		.013	Yes
Spin test facility	.010		Yes
NASA SSUS agent		.250	Yes

PAYLOAD PRICE SUMMARY

Part of price	Not subject to escalation	Subject to escalation
Nongovt shared charge factor = 0.2		
Shared-flight price		3.654
Use fees	0.860	
Optional charges	0.010	2.263
Total	.870	5.917

Example 2 (concluded)

SPACE TRANSPORTATION SYSTEM PRICING REPORT

Months before launch	Payment due date	Percent of total due	Escalated portion of payment			Nonescalated portion of payment	Projected total escalated payment
			1975 dollars	Real-year dollars (est)	Escalation factor		
36	MAR 78	0	0.100	0.130	1.300	0.000	0.130
33	JUN 78	10	.492	.650	1.321	.087	.737
27	DEC 78	10	.592	.809	1.367	.087	.896
21	JUN 79	17	1.006	1.422	1.414	.148	1.570
15	DEC 79	17	1.006	1.471	1.462	.148	1.619
9	JUN 80	23	1.361	2.059	1.513	.200	2.259
3	DEC 80	23	1.361	2.130	1.565	.200	2.330
Total			5.917	8.670	--	.870	9.540

Example 3. Spacelab mission, dedicated Orbiter

PAYLOAD INFORMATION

Number	Name	Launch date	Length, in. (m)	Weight, lb (kg)	Orbital inclination, deg	Charge factor
1	Spacelab (Non-U.S.)	SEP 1983	720.00 (18.28)	32000 (14 515.21)	56.0	1.0

Anticipated date of earnest money payment is SEP 1980.

Pricing (in millions of 1975 dollars) is based on the following data

Services required	Not subject to escalation	Subject to escalation	Applies to flight 1
Standard services			
Dedicated-flight price		18.271	Yes
Dedicated use fees			
Facility and equipment depreciation	0.834		Yes
Fleet procurement	1.453		Yes
KSC	2.011		Yes
Optional flight systems			
Long module and pallet		2.000	Yes
Tunnel adapter		.200	Yes
Spacelab use fee	.611		Yes
Optional payload-related services			
7 extra days		2.450	Yes

PAYLOAD PRICE SUMMARY

Part of price	Not subject to escalation	Subject to escalation
Spacelab (non-U.S.) charge factor = 1.0		
Shared-flight price		18.271
Use fees	4.298	
Optional charges	.611	4.650
Total	4.909	22.921

Example 3 (concluded)

SPACE TRANSPORTATION SYSTEM PRICING REPORT

Months before launch	Payment due date	Percent of total due	Escalated portion of payment			Nonescalated portion of payment	Projected total escalated payment
			1975 dollars	Real-year dollars (est)	Escalation factor		
36	SEP 80	0	0.100	0.154	1.540	0.000	0.154
33	DEC 80	10	2.192	3.430	1.565	.491	3.921
27	JUN 81	10	2.292	3.710	1.619	.491	4.201
21	DEC 81	17	3.897	6.524	1.674	.835	7.359
15	JUN 82	17	3.897	6.749	1.732	.835	7.583
9	DEC 82	23	5.272	9.445	1.792	1.129	10.574
3	JUN 83	23	5.272	9.770	1.853	1.129	10.899
Total			22.921	39.781	--	4.909	44.690

Example 4 – Nongovernment, multiple launches

PAYLOAD INFORMATION

Number	Name	Launch date	Length, in. (m)	Weight, lb (kg)	Orbital inclination, deg	Load factor	Charge factor
1	Nongovt 1	MAR 1981	108 (2.74)	7000 (3175)	56.0	0.150	0.20
2	Nongovt 2	NOV 1982	108 (2.74)	7500 (3402)	56.0	.150	.20
3	Nongovt 3	SEP 1983	108 (2.74)	8000 (3629)	56.0	.150	.20

Anticipated date of earnest money payment is MAR 1979. Anticipated date of contract signing is JUN 1979.

Pricing (in millions of 1975 dollars) is based on the following data.

Services required	Not subject to escalation	Subject to escalation	Applies to flight(s) 1	2	3
Standard services					
Dedicated-flight price		18.271	Yes	Yes	Yes
Dedicated use fees					
Facility and equipment depreciation	0.834		Yes	Yes	Yes
Fleet procurement	1.453		Yes	Yes	Yes
KSC	2.011		Yes	Yes	Yes
Optional flight systems					
SSUS-D		2.000	Yes	Yes	Yes
Second RMS		.149	No	No	Yes
Optional payload-related services					
SAEF-1		.027	Yes	Yes	Yes
SAEF-1	.020		Yes	Yes	Yes
Special fees and services					
Floating launch date	10 percent of total price		No	No	Yes

Program assumes 26.3 percent inflation from JAN 1, 1975, through OCT 1977 and 7.0 percent per 12 months thereafter.

Example 4 (continued)

LAUNCH PRICE SUMMARY

Part of price	Not subject to escalation	Subject to escalation
Nongovt 1 charge factor = 0.20		
Shared-flight price		3.654
Use fees	0.860	
Optional charges	.020	2.027
Total	.880	5.681
Nongovt 2 charge factor = 0.20		
Shared-flight price		3.654
Use fees	.860	
Optional charges	.020	2.027
Total	.880	5.681
Nongovt 3 charge factor = 0.20		
Shared-flight price		3.654
Use fees	.860	
Optional charges	.020	2.176
Total	.880	5.830
Floating launch fee	.088	.583

Example 4 (continued)

SPACE TRANSPORTATION SYSTEM PRICING REPORT

Months before launch	Payment due date	Percent of total due	Escalated portion of payment		Escalation factor	Nonescalated portion of payment	Projected total escalated payment
			1975 dollars	Real-year dollars (est)			
Nongovt 1							
24	MAR 79	Earnest money	0.100	0.139	1.390	0.000	0.139
21	JUN 79	40	2.172	3.071	1.414	.352	3.423
15	DEC 79	17	.966	1.413	1.463	.150	1.563
9	JUN 80	23	1.307	1.977	1.513	.202	2.179
3	DEC 80	23	1.307	2.045	1.565	.202	2.247
Subtotal			5.852	8.645	--	.906	9.551
Nongovt 2							
33	FEB 80	10	.568	.840	1.479	.088	.928
27	AUG 80	10	.568	.869	1.530	.088	.957
21	FEB 81	17	.966	1.529	1.583	.150	1.679
15	AUG 81	17	.966	1.581	1.637	.150	1.731
9	FEB 82	23	1.307	2.213	1.693	.202	2.415
3	AUG 82	23	1.306	2.288	1.752	.202	2.490
Subtotal			5.681	9.320	--	.880	10.200
Nongovt 3							
51	June 79	Floating launch fee	.583	.824	1.413	.088	.912
33	DEC 80	10	.583	.912	1.564	.088	1.000
27	JUN 81	10	.583	.944	1.619	.088	1.032
21	DEC 81	17	.991	1.659	1.674	.150	1.809
15	JUN 82	17	.991	1.716	1.732	.150	1.866
9	DEC 82	23	1.341	2.402	1.791	.202	2.604
3	JUN 83	23	1.341	2.485	1.853	.202	2.687
Subtotal			6.413	10.942	--	.968	11.910
Total			17.946	28.907	--	2.754	31.661

Example 4 (concluded)

CHRONOLOGICAL PRICING SUMMARY

Payment due date	Launch number	Percent of total due	Escalated portion of payment		Escalation factor	Nonescalated portion of payment	Projected total escalated payment
			1975 dollars	Real-year dollars (est)			
MAR 79	1	Earnest money	0.100	0.139	1.390	0.000	0.139
JUN 79	1	40	2.172	3.071	1.414	.352	3.423
JUN 79	3	Floating launch fee	.583	.824	1.413	.088	.912
DEC 79	1	17	.966	1.413	1.463	.150	1.563
FEB 80	2	10	.568	.840	1.479	.088	.928
JUN 80	1	23	1.307	1.977	1.513	.202	2.179
AUG 80	2	10	.568	.869	1.530	.088	.957
DEC 80	1	23	1.307	2.045	1.565	.202	2.247
DEC 80	3	10	.583	.912	1.564	.088	1.000
FEB 81	2	17	.966	1.529	1.583	.150	1.679
JUN 81	3	10	.583	.944	1.619	.088	1.032
AUG 81	2	17	.966	1.581	1.637	.150	1.731
DEC 81	3	17	.991	1.659	1.674	.150	1.809
FEB 82	2	23	1.307	2.213	1.693	.202	2.415
JUN 82	3	17	.991	1.716	1.732	.150	1.866
AUG 82	2	23	1.306	2.288	1.752	.202	2.490
DEC 82	3	23	1.341	2.402	1.791	.202	2.604
JUN 83	3	23	1.341	2.485	1.853	.202	2.687
Total			17.946	28.907	–	2.754	31.661

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APPENDIX A

Acronyms and glossary

Acronyms

CAP	crew activity plan
DOD	Department of Defense
EPS	electrical power supply
ESA	European Space Agency
ETR	eastern test range
EVA	extravehicular activity
FY	fiscal year
GPC	general-purpose computer
GSE	ground-support equipment
ICD	interface control document
IUS	interim upper stage
JSC	Lyndon B. Johnson Space Center
KSC	John F. Kennedy Space Center
MCC	Mission Control Center
MDM	multiplexer/demultiplexer
N/A	not applicable
NASA	National Aeronautics and Space Administration
NMI	NASA Management Instruction
OMS	orbital maneuvering subsystem
POCC	Payload Operations Control Center
PMT	payment
PRSD	power reactant supply and distribution
RCS	reaction control subsystem
RMS	remote manipulator system
SAEF	Spacecraft Assembly and Encapsulation Facility
SSUS-A	spinning solid upper stage for Atlas-Centaur class spacecraft
SSUS-D	spinning solid upper stage for Delta class spacecraft
STS	Space Transportation System
TBD	to be determined
VAFB	Vandenberg Air Force Base

accelerated launch date option
Schedule option involving additional costs that permits a user who has already negotiated a launch date to specify an earlier launch.

airlock
A compartment capable of being depressurized without depressurization of the Orbiter cabin or the Spacelab module. The airlock and airlock mounting kit is a standard Spacelab flight kit. (In contrast, the experiment airlock is used for exposing materials to space conditions and is an item of Spacelab mission-dependent equipment.)

Atlas-Centaur class
Payloads weighing approximately 4000 to 4400 pounds (1800 to 2000 kilograms).

cancellation option
Schedule option involving a special fee that is invoked when a user eliminates a planned launch after beginning the reimbursement schedule.

cargo bay
The unpressurized mid part of the Orbiter fuselage behind the cabin aft bulkhead where most payloads are carried. Its maximum usable payload envelope is 15 feet (4.6 meters) in diameter and 60 feet (18.3 meters) long. Hinged doors extend the full length of the bay.

cargo integration test equipment
That equipment necessary to perform electrical and structural interface verification between the cargo and Orbiter performed off-line to the Shuttle flow.

charge factor
A number derived from a formula for the appropriate payload. It is used to determine a shared-flight user's price or the price for a partial Spacelab.

civilian U.S. Government user
Any civil Federal agency that requests Shuttle services from NASA.

constant price
A portion of the user charge that is not subject to escalation.

crew activity planning
The analysis and development of activities to be performed in flight by the crew, resulting in a time line of these activities and reference data for each flight. A standard service.

custom mission planning
An optional payload-related service that is negotiated on a one-time basis because it is unique to each payload.

dedicated flight
A flight assigned to a single user. In this price category, the user pays all costs of the launch and associated services plus options.

Delta class
Payloads weighing approximately 2000 to 2500 pounds (900 to 1100 kilograms).

delta nitrogen tanks
Optional flight kit used to provide additional nitrogen for the Orbiter living space atmosphere.

delta waste tanks
Optional flight kit used when the number of crewmembers or the number of days on orbit exceeds the baseline. The tanks collect wastewater generated by the crew.

docking module
Optional flight kit that provides a device for other orbiting vehicles to dock with the Orbiter.

downweight
Landing weight. In this document, it refers specifically to payloads and all items required by specific payloads.

earnest money
Nonrefundable "down payment" made to NASA by a prospective user before contract negotiations begin.

escalation index
All escalation for inflation will be based on the U.S. Bureau of Labor Statistics index for compensation per hour, total private.

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

exceptional determination
A judgment made by NASA for certain payloads considered to have an unusually high potential value to the general public. This determination qualifies a user for a lower standard flight price.

extravehicular activity
Activities by NASA crewmembers conducted outside the spacecraft pressure hull or within the cargo bay when the cargo bay doors are open. An optional payload-related service.

fixed price
A portion of the user charge based on a January 1, 1975, dollar value that can be escalated to account for inflation. However, during a fixed-price period the base cannot be adjusted.

fixed price option
Schedule option involving special fees that permits a user to contract now for a launch at a known price after the fixed-price period ends.

flight
The period from launch to landing of an Orbiter — a single Shuttle round trip. One flight might deliver more than one payload; more than one flight might be required to accomplish a single mission.

flight data file
The onboard complement of crew activity plans, procedures, reference material, and test data available to the crew for flight execution. There will normally be an STS flight data file for STS crew activities and also a payload flight data file for payload crew activities. Both are prepared as a standard service.

flight design
The trajectory, consumables, attitude and pointing, and navigation analysis necessary to support the planning of a flight. A standard service.

flight-independent training
Standard preparation of a mission or payload specialist for any flight. A standard service for a mission specialist. In the case of a payload specialist, it is part of the payload specialist and training option.

flight kit
Optional hardware (including consumables) to provide additional, special, or extended services to payloads.

flight manifest
The designation of a flight, assignment of the cargo to be flown, and specific implementing instructions for STS operations personnel. A standard service.

flight operations planning
That part of STS flight planning required to prepare for a given flight. It includes allocation of consumables, analyses and preparation of flight rules, assembly of consoles handbooks, etc.

flight simulation
A training session in which the flight crew and/or ground operations support personnel imitate a portion of the flight. A standard service for the Orbiter crew. In the case of a payload specialist, it is provided as part of the payload specialist and training option.

floating launch date option
Schedule option involving a special fee that permits a user to specify a flexible launch date at least 33 months in the future.

free-flying system
Any satellite or payload that is detached from the Orbiter during operational phases and is capable of independent operation.

future value formula/payment
The estimated actual payment to be made by the user at a particular future time based on inflating January 1975 dollars by an assumed rate.

general-purpose computer
One of five computers interconnected to form the Orbiter computer complex for data processing. Basic payload support is a standard service.

guaranteed launch date option
Schedule option involving an additional advance payment that permits a user to specify a 90-day launch period far in the future.

inclination, standard
Inclination is the maximum angle between the plane of the orbit and the equatorial plane. Standard Shuttle inclinations are 28.5° and 56°.

index multiplier
The most recently issued value of the total compensation according to the Bureau of Labor Statistics index divided by its value in January 1975. This index is updated by the Bureau of Labor Statistics each quarter.

integration
A combination of activities and processes to assemble payload and STS components, subsystems, and system elements into a desired configuration, and to verify compatibility among them.

interface verification
Testing of flight hardware interfaces by an acceptable method that confirms that those interfaces are compatible with the affected elements of the Space Transportation System. A standard service.

interim upper stage
Solid propulsive upper stage designed to place spacecraft on high Earth orbits or on escape trajectories for planetary missions. An optional flight system.

launch agreement
An agreement negotiated between NASA and the user that spells out all the legal, financial, and NASA-Headquarters-level commitment to provide the STS service at a determined price.

launch site support plan
The basic agreement negotiated between NASA and the user detailing how the user's payload will be handled at the launch site.

load factor
The percentage of the Orbiter's total capability (for payload length or weight) required by a shared-flight user. The larger figure is used to derive the charge factor, used to calculate the user's cost.

load factor recovery fee
A fee added to the user's standard shared-flight price for the short-term callup option. The fee depends on how long before launch the option is exercised and on the availability of other payloads for the flight.

load fraction
The percentage of the total capability of a Spacelab module or pallet required by a shared-element user. This figure is used to derive the element charge factor.

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

Mission Control Center
Central area at JSC for control and support of all phases of STS flights. A standard service.

mission-dependent equipment
Spacelab optional equipment that can be added to a flight if needed for the mission involved.

mission specialist
Crewmember proficient in payload (experiment) operations; has a detailed knowledge of the payload operations, requirements, objectives, and supporting equipment; knowledgeable of Orbiter and attached payload support systems and the prime crewmember for extravehicular activity. At the discretion of the user, this crewmember may assist in the management of payload operation and may in specific cases serve as the payload specialist. This crew position is part of the standard service.

net present value
Sum of discounted net cash flow at a given rate of return or interest minus the original investment.

non-U.S. Government user
An individual or organization, domestic or foreign, not part of the U.S. Government and requesting Shuttle services from NASA. (Certain exceptions are made for ESA member states.)

occupancy fee
An additional fee for postponement or cancellation of a flight. The fee depends on how long before launch the option is exercised and on the availability of substitute payloads.

OMS delta-V kit
Auxiliary propellant tanks that can be added to the basic orbital maneuvering subsystem to provide an additional 500 ft/sec (152 m/sec) in-orbit velocity per tank. This tank is an optional flight kit.

opportunity mission
A payload revisit option for retrieval or servicing done at NASA's convenience when an Orbiter is near the orbiting payload requiring revisit.

optional charge
The price to a user for any systems, services, or schedule variations that are not part of the standard Space Shuttle transportation.

optional flight systems
Hardware end items that can be integrated into the Orbiter, at additional cost to the user, to launch payloads to geosynchronous transfer orbits (upper stages), to extend basic Orbiter capabilities (flight kits), or to provide a general-purpose laboratory in near-Earth Orbit (Spacelab).

optional payload-related services
Services in addition to those provided as part of the standard Shuttle price or provided with the purchase of an optional flight system.

orbital maneuvering subsystem
Orbiter engines that provide the thrust to perform orbit insertion, circularization, or transfer; rendezvous; and deorbit.

Orbiter
Manned orbital flight vehicle of the Space Shuttle system.

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

payload discipline training
User-provided preparation of a mission or payload specialist for handling a specific experiment.

payload integration plan
The basic agreement negotiated between NASA and every user, providing the management roles and responsibilities, a definition of the technical activities, interfaces, and schedule requirements to assure an effective operational integration of the user's payload into the STS.

payload mission plan
A plan produced by the STS user containing payload program goals, mission objectives and requirements, mission durations, constraints, individual flights required, allocation of objectives to flights, desired launch date or period, and payload description.

Payload Operations Control Center
Central area from which payload operations are monitored. Only the POCC at JSC is considered in this document. Direct user command of a payload from this control center is an optional payload-related service.

payload replacement mission
A payload revisit option in which one orbiting payload is replaced by another similar one from the same user.

payload retrieval mission
A payload revisit option in which an orbiting payload is captured and returned to Earth.

payload revisit
An optional payload-related service involving either replacement, retrieval, or servicing to an orbiting payload.

payload servicing mission
A payload revisit option in which a user's orbiting payload is given inspection, maintenance, or modification.

payload specialist
Crewmember responsible for the attainment of the payload (experiment) objectives; an expert, proficient in payload (experiment) operations; has a detailed knowledge of the payload instruments (and their subsystems), operations, requirements, objectives, and supporting equipment; responsible for the management of payload operations and for the detailed operation of particular instruments or experiments. This crewmember must also be knowledgeable about certain Orbiter systems. This crew position is an optional payload-related service to the user.

postponement option
Schedule option, usually involving special fees, that permits a user to delay a planned launch.

power reactant storage and distribution/electrical power system tank set
Optional flight kit that provides additional electrical power to payloads.

price category
A shared (standby or nonstandby) or dedicated flight, a basis on which the user calculates his costs.

reflight insurance
A portion of the standard charge for non-U.S. Government users (or optional to other users) that guarantees one reflight of a payload if the first flight fails through no defect in the payload, or fault of the user, user contractors or subcontractors, and if the payload is returned safely to the launch site or if another payload is provided by the user.

reimbursement schedule
The prelaunch timetable on which a user pays NASA the costs associated with his mission.

remote manipulator system
Mechanical arm on the cargo bay longeron. It is controlled from the Orbiter aft flight deck to deploy, retrieve, or move payloads. A second arm and its controls is an optional flight kit.

serial impact cost
The cost for removal and installation of flight kits, which is assessed when the time required for installation and removal exceeds 24 hours during the Orbiter turnaround.

shared flight
A flight that carries the payloads of more than one user. Reimbursement in this price category is based on a percentage of the Orbiter cargo area required plus options (or a pro-rata share of those options used).

short-term callup option
Schedule option, usually involving special fees, that permits a user to contract for a launch less than 1 year in the future.

Shuttle mission simulator
Computer-controlled training device with full-fidelity Orbiter forward and aft crew stations. A standard hardware item for flight-independent training.

Shuttle procedures simulator
Training hardware used to establish crew flight procedures. A standard hardware item for flight-independent training.

simulator
A heavily computer-dependent training facility that imitates flight hardware responses.

small self-contained payload
A research and development payload that is small (less than 200 pounds (91 kilograms) or 5 cubic feet (0.14 meter)), requires no Space Shuttle services, and can be flown on a space-available basis.

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

Space Shuttle
Orbiter, external tank, and solid rocket boosters.

Space Transportation System
An integrated system consisting of the Space Shuttle (Orbiter, external tank, solid rocket booster, and flight kits), upper stages, Spacelab, and any associated flight hardware and software. The term encompasses both standard and optional systems and services.

spinning solid upper stage
Propulsive upper stage designed to deliver spacecraft of the Delta and Atlas-Centaur classes to Earth orbits beyond the capabilities of the Space Shuttle. An optional flight system.

standard charge
The charge for basic Space Shuttle transportation to and from near-Earth orbit on a usual launch schedule.

standard services
Support to users provided as part of the standard Space Shuttle transportation charge.

standby
A category of shared-flight user whose payload is launched at NASA's convenience within a specified 1-year period.

STS flight control team
An element of the MCC on duty to provide real-time support for the duration of each STS flight. A standard service.

STS mission coordinator
A representative who will serve as the NASA interface for all financial and policy matters related to the user's launch.

STS payload support manager
A NASA representative designated as part of the standard service to be the principal point of contact with the user in preparing and carrying out the launch agreement.

trainer
A training device or facility that provides primarily a physical representation of flight hardware. It may have limited computer capabilities.

transfer orbit
High geosynchronous orbit from which satellites can be launched into deep space.

tunnel adapter
Flight kit used to attach the Orbiter airlock to the Spacelab tunnel. A standard flight kit for Spacelab.

upper stage
Spinning solid upper stage or interim upper stage. Both are designed for launch in the Orbiter cargo bay and have propulsive elements to deliver payloads into orbits and trajectories beyond the capabilities of the Shuttle. An optional flight system.

use fee
Nonescalating charge (in effect, a rent) that is the user's share of costs associated with use of facilities, use of support equipment, and STS fleet acquisition.

upweight
Launch weight. In this document it refers specifically to payloads and all items required by specific payloads.

user
An organization or individual requiring the services of the Space Transportation System.

user class
Type of user (non-U.S. Government, civilian U.S. Government or Department of Defense), which determines the required reimbursement to NASA.

user payload manager
A representative who must be designated by the user organization to be the principal interface with NASA.

utilization planning
The analysis of approved (funded or committed) payloads with operational resources, leading to a set of firm flight schedules with flight manifests. A standard service.

APPENDIX B

References

Shuttle EVA Description and Design Criteria (JSC-10615)
Shuttle Orbiter/Cargo Standard Interfaces (ICD 2-19001)
Space Shuttle System Payload Accommodations (JSC-07700 vol. XIV)
Space Shuttle System Payload Interface Verification General Approach and Requirements (JSC-07700-14-PIV-01)
STS Flight Assignment Baseline (JSC-13000)
STS Payload Operations Control Center for Attached Payloads (JSC-11804)
STS User Handbook
STS User Interface Procedures (JSC-11801)

Lyndon B. Johnson Space Center
Mail Code JM61
National Aeronautics and Space Administration
Houston, Texas 77058

Interim Upper Stage Users' Guide

George C. Marshall Space Flight Center
Mail Code PF02
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama 35812

Spinning Solid Upper Stage Users' Guide (A or D)

Goddard Space Flight Center
Mail Code 470
National Aeronautics and Space Administration
Greenbelt, Maryland 20771

KSC Launch Site Accommodations Handbook for STS Payloads (K-STSM-14.1)

John F. Kennedy Space Center
Mail Code SP-PAY
National Aeronautics and Space Administration
Kennedy Space Center, Florida 32899

Spacelab Payload Accommodation Handbook (ESA SLP/2104)

George C. Marshall Space Flight Center
Mail Code NA 01
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama 35812

OR:

European Space Agency
8-10, Rue Mario Nikis
75738 Paris Cedex 15, France

APPENDIX C

NASA management instructions

NASA

Management Instruction

NMI 8610.8

Date January 21, 1977

Responsible Office: MO/Space Transportation Systems Operations

Subject: REIMBURSEMENT FOR SHUTTLE SERVICES PROVIDED TO NON-U.S. GOVERNMENT USERS

1. PURPOSE

This Instruction sets forth:

a. The policy on reimbursement for Shuttle services which are provided by NASA to non-U.S. Government users (as defined in paragraph 2, below) under launch services agreements, and

b. Responsibilities for putting such policy into effect and carrying it out.

2. DEFINITION

For the purpose of this Instruction, the term "Non-U.S. Government Users" means:

a. Private persons or private organizations of the United States, including its territories, the District of Columbia, Panama Canal Zone, and Puerto Rico.

b. Public organizations of the United States that are not part of the Government of the United States.

c. Foreign governments or private persons and private or public organizations of foreign countries, except for the government of Canada and governments of the European Space Agency (ESA) member nations participating in Spacelab development when conducting experimental science or experimental applications missions, with no near-term commercial implications, undertaken on behalf of government agencies. The NASA Administrator shall determine the missions which qualify for this exception.

d. International organizations, except the ESA when conducting experimental science or experimental applications missions with no near-term commercial implications.

e. Other U.S. Government agencies, Canadian government agencies and the ESA, requesting Shuttle services from NASA in connection with launch and other services being performed by such agencies for users listed in subparagraphs a-d above.

3. APPLICATION

This Instruction shall apply to all NASA installations when providing Shuttle services and other equipment, materials and services associated with Shuttle space flights under agreements with non-U.S. Government users which are executed after the effective date of this Instruction.

4. REIMBURSEMENT POLICY

a. Features of Policy

(1) All users will be charged on a fixed price basis; there will be no post-flight charges, except for prespecified optional services.

(2) The price will be based on estimated costs.

(3) The price will be held constant for flights in the first three years of Space Transportation Systems (STS) operations.

(4) Payments with respect to total operations costs shall be escalated according to the Bureau of Labor Statistics Index for Compensation per hour, Total Private. Payments with respect to the use charge shall not be escalated.

(5) Subsequent to the first three years the price will be adjusted annually to insure that aggregate costs are recovered over a twelve-year period.

(6) Pricing incentives are designed to maximize the proper utilization of the STS.

b. Dedicated Flight Reimbursements

(1) For the purposes of this policy, a dedicated flight is one sold to a single customer.

(2) The policy is established for two distinct phases of Shuttle operations. The first phase is through the third full fiscal year of Shuttle operations and the second phase consists of nine full fiscal years subsequent to the first phase.

(a) For a dedicated Shuttle flight during the first phase, NASA shall be reimbursed in an amount which is a pro-rata share of forecast additive costs averaged over the first phase of three years, plus a use charge in lieu of depreciation for the use of facilities, support equipment and the Shuttle fleet; however, the price shall not be less than a pro-rata share of forecast aggregate costs averaged over both the first and second phases of the twelve year Shuttle operation period.

(b) For a dedicated Shuttle flight during the second phase, NASA shall be reimbursed a pro-rata share of forecast aggregate costs over both phases to insure that total aggregate costs are recovered over the twelve year period.

(c) The definition of the costs as specified in this Instruction are set forth in Attachment A.

(d) Subject to NASA approval, a dedicated flight user may apportion and assign STS services to other STS users provided they satisfy STS user requirements. The price of integrating additional payloads will be negotiated.

(e) A summary of standard Shuttle services included in the flight price is set forth in Attachment B.

(f) The prices of optional Shuttle services are being developed and shall be set forth in the Shuttle Price Book which is being developed. A summary of the optional services is set forth in Attachment C.

(g) For the user with an experimental, new use of space or first time use of space of great public value, the reimbursement to NASA for the dedicated, standard Shuttle flight in either the first or second phase shall be a pro-rata share of the average twelve year additive costs as estimated at the time of negotiations. Programs which qualify for this price will be determined by an STS Exceptional Program Selection Process. In all cases, the Administrator will be the selection official.

(h) For dedicated flight users, NASA and the user will identify a desired launch date within a period of ninety days three years prior to flight. One year prior to the flight a firm launch and payload delivery date will be identified by NASA. The firm launch date will be within the first sixty days of the original ninety-day period. Launch will occur on the firmly scheduled launch date or within a period of thirty days thereafter. The payload must be ready to launch for the duration of that period.

c. <u>Shared Flight Reimbursements</u>

(1) The price of a shared Shuttle flight will be a fraction of the dedicated Shuttle flight price. The fraction will be based on the length and weight of the payload and the mission destination at the time of contract negotiations. The formula for computing the fraction is set forth in Attachment D.

(2) For shared flight users, NASA and the user will identify a desired launch date three years prior to flight. Launch will occur within a period of ninety days, beginning on the desired

launch date. One year prior to flight a payload delivery date and a firm launch date will be coordinated among the shared flight users. This firm launch date will be within the first thirty days of the original ninety-day period. The launch will occur on the firmly scheduled launch date or within a period of sixty days thereafter. The payloads must be ready to launch for the duration of that period.

(3) A 20% discount on the standard flight price will be given to shared flight users who will fly on a space-available (standby) basis. NASA will provide launch services within a prenegotiated period of one year. Shared flight payloads must be flight deliverable to the launch site on the first day of the one year period and sustain that condition until delivery to the launch site. The user will be notified sixty days prior to the firmly scheduled launch date which has been established by NASA. At that time, NASA will also establish a payload delivery date. The payload must be available at the launch site on the assigned delivery date and ready to launch for a period of sixty days after the firmly scheduled launch date.

d. Small Self-Contained Payloads. Packages under 200 pounds and smaller than five cubic feet which require no Shuttle services (power, deployment, etc.), and are for R&D purposes, will be flown on a space-available basis during both phases of Shuttle operation. The price for this service will be negotiated based on size and weight, but will not exceed $10,000 in 1975 dollars. A minimum charge of $3,000 in 1975 dollars will be made. If Shuttle services are required, the price will be individually negotiated. Reimbursement to NASA will be made at the time the package is scheduled for flight.

e. Options

(1) Options for future flights will be made available to STS users already contracting for STS launch services. Fixed price options for flights in a given year beyond the three-year fixed price period will be made available. For fixed price options, NASA shall be reimbursed the user's flight price compounded at 8% per year for each year beyond the fixed price period. The fee for this option is one million dollars in 1975 dollars. The option fee will be applied to the price of the user's flight. The user will exercise his option by contracting for the flight on the normal 33-month reimbursement schedule or the option fee will be retained by NASA.

(2) In order to insure that space will be available for flights in a given future year, scheduled launch options, where NASA will provide a launch during a ninety day period, will be given to STS users already contracting for flights at a fee of $100,000 in 1975 dollars. The option fee will be applied to the price of the user's flight. The user will exercise his option by contracting for the flight on the normal 33-month reimbursement schedule or the option fee will be retained by NASA.

(3) In order to allow the user greater flexibility in selecting a launch date, the user may purchase a "floating launch date" option. At the time of contract execution, the user will begin to make payments according to a 33-month reimbursement schedule for this launching. At any time during Phase 1 or 2, the user may exercise this option by informing NASA of his desired launch date for this option which will then be negotiated by NASA and the user. This launch date must be at least 33 months after the date of the first reimbursement payment. If the desired launch date is within one year of the date of declaration, the short term call-up option and associated fee will apply. If the desired launch is to occur in a year for which a new price per flight is in effect, the user will pay the new price. The fee for this option is 10% of the user's flight price in effect at the time of contract execution and is payable at that time. This fee will not be applied to the price of the user's flight.

(4) Options must be exercised for a flight by the end of the second phase of operations or the option fee will be retained by NASA.

f. Fixed Price Period and Escalation

(1) The price will remain constant for flights during the first phase of Shuttle operation. For flights during the second phase, the price will be adjusted on a yearly basis, if necessary, to assure recovery of aggregate costs over a twelve year period. These adjusted prices will be applicable only to agreements executed after the adjustment is made.

(2) Shuttle services for both phases will be contracted on a fixed price basis. The payments in the contract will be escalated to the time of the payment using the Bureau of Labor Statistics Index for Compensation per hour, Total Private.

g. Earnest Money. Earnest money will be paid to NASA prior to contract negotiations. The earnest money required per contract shall be $100,000 in 1975 dollars; however, if the payload is a small self-contained payload, the earnest money shall be $500.00. The earnest money will be applied to the first payment made by the customer or will be retained by NASA.

h. Reimbursement Schedule

(1) Reimbursement shall be made in accordance with the reimbursement schedule contained in this subsection. No charges shall be made after the flight, except as negotiated in the contract for pre-specified extra services. Those users who contract for Shuttle services less than three years before the desired launch date will be accommodated and will pay on an accelerated basis according to the reimbursement schedule.

(2) Standby payloads

(a) Before the establishment of a firmly scheduled launch date, the number of months before launch will be computed assuming a launch date at the mid-point of the designated one year period.

(b) Once the firmly scheduled launch date is established, the user shall reimburse NASA to make his payments current according to the reimbursement schedule.

(3) Reimbursement Schedule

Number of months before launch flight is scheduled	Percent of Price Months prior to scheduled launch date 33	27	21	15	9	3
33 Months or More	10	10	17	17	23	23
27-32 Months	-	21	17	17	23	23
21-26 Months	-	-	40	17	23	23
15-20 Months	-	-	-	61	23	23
9-14 Months	-	-	-	-	90	23
3-8 Months	-	-	-	-	-	122

This schedule holds unless there are offsetting advantages to the U.S. Government of an accelerated launch schedule.

(4) Contracts for Shuttle services made one year or less before a flight and up to three months before a flight will be made on a space-available basis unless the short term call-up option is elected.

i. Short Term Call-Up Option

(1) For flights contracted one year or less before launch, but not less than three months before launch, short term call-up will be provided to dedicated flight users at the dedicated flight price according to the reimbursement schedule.

(2) For dedicated flight users requiring short term call-up flights less than three months before launch, NASA will provide STS launch services on a space-available basis. NASA shall be reimbursed the dedicated flight price according to the reimbursement schedule plus short term call-up additional costs. The additional costs will be based on estimated costs to be incurred.

(3) For shared flights contracted one year or less before launch, but more than six months before launch, users may elect the short term call-up option. The user shall reimburse NASA the standard shared flight price according to the reimbursement schedule plus a load factor-recovery fee. The load factor-recovery fee is half the difference between a dedicated flight

price and the user's shared flight price or the difference between a dedicated flight price and the total adjusted reimbursements from all shared users, whichever is less.

(4) For shared flights contracted six months or less before launch, but more than three months before launch, users may elect the short term call-up option. The user shall reimburse NASA the standard shared flight price according to the reimbursement schedule plus a load factor-recovery fee which is the difference between a dedicated flight price and the total adjusted reimbursement from all shared flight users.

(5) Shared flights contracted three months or less before launch will be flown on a space-available basis. NASA shall be reimbursed the shared flight price according to the reimbursement schedule plus short term call-up additional costs. These additional charges will be based on estimated costs to be incurred.

(6) For the purposes of this subparagraph, "adjusted reimbursements" is defined to be reimbursements assuming all shared usera are non-U.S. Government.

(7) The load factor-recovery fee will never be less than zero.

(8) The load factor-recovery fee is payable upon receipt of NASA's billing therefor.

j. Accelerated Launches. For users who reschedule a launch so that it occurs earlier than the planned launch, the user will pay on an accelerated reimbursement schedule. The user will reimburse NASA to make his payments current on the new accelerated reimbursement schedule. If the time from notification of acceleration is less than one year from the new launch date, short term call-up reimbursements will also apply.

k. Poatponements

(1) Non-standby Payloads

(a) A user can postpone a flight of his payload one time with no additional charge if postponement occurs more than one year before launch. For subsequent postponed flights more than one year before launch, the user shall reimburse NASA a postponement fee of 5% of the user's flight price. For postponements one year or less before launch, the user shall reimburse NASA 5% of the user's flight price plus an occupancy fee according to the occupancy fee schedule in Attachment E.

(b) If the postponement of a flight causes the payload to be launched in a year for which a different price per flight has been established, the new price shall apply if it is higher than the originally contracted price.

(2) Standby Payloads

(a) For flights postponed more than six months prior to the beginning of the negotiated one-year period, NASA shall renegotiate a new one-year period during which launch will occur. No additional fee will be imposed.

(b) For flights postponed six months or less prior to the beginning of the negotiated one-year period, the user shall reimburse NASA 5% of the user's flight price plus an occupancy fee according to the occupancy fee schedule set forth in Attachment E.

(3) Postponement fees are payable upon receipt of NASA's billing therefor.

(4) Flights postponed will henceforth be treated as newly scheduled launches according to the reimbursement schedule. The number of months prior to launch will be taken as the total number of months between the date postponement is elected and the new launch date. Short term call-up options and associated fees shall apply.

(5) Minor delays (up to three days) caused by the users will not constitute a postponement. No fee will be charged for a minor delay.

1. Cancellations

(1) Non-standby Payloads. Users who cancel a flight more than one year before launch shall reimburse NASA 10% of the user's flight price. For a cancelled flight one year or less before launch, the user shall reimburse NASA 10% of the user's flight price plus an occupancy fee as set forth in Attachment E.

(2) Standby Payloads

(a) Users who cancel a flight more than six months prior to the beginning of the negotiated one-year period shall reimburse NASA 10% of the user's flight price.

(b) For a flight cancelled six months or less prior to the beginning of the negotiated one-year period, the user shall reimburse NASA 10% of the user's flight price plus an occupancy fee as set forth in Attachment E.

(3) Cancellation fees are payable upon receipt of NASA's billing therefor.

5. REFLIGHT GUARANTEE

a. A fee for a reflight guarantee is included in the price charged the user. In consideration of that fee, NASA guarantees one reflight of:

(1) The launch and deployment of a free flying payload into a Shuttle compatible mission orbit if, through no fault of the user, the first launch and deployment attempt is unsuccessful and if the payload returns safely to earth or a second payload is provided by the user.

(2) The launch of an attached payload into its mission orbit if the first launch attempt is unsuccessful through no fault of the user, and if the payload returns safely to earth or a second payload is provided by the user.

(3) A launch of a Shuttle into a payload mission orbit for the purpose of retrieving a payload if the first retrieval attempt is unsuccessful through no fault of the user. This guarantee only applies if the payload is in a safe retrievable condition as determined by NASA.

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

6. PATENT AND DATA RIGHTS

a. NASA will not acquire rights to inventions, patents or proprietary data privately funded by a user, or arising out of activities for which a user has reimbursed NASA under the policies set forth herein. However, in certain instances in which the NASA Administrator has determined that activities may have a significant impact on the public health, safety or welfare, NASA may obtain assurances from the user that the results will be made available to the public on terms and conditions reasonable under the circumstances.

b. The user will be required to furnish NASA with sufficient information to verify peaceful purposes and to insure Shuttle safety and NASA's and the U.S. Government's continued compliance with law and the Government's obligations.

7. REVISIT AND/OR RETRIEVAL SERVICES

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

8. 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 U.S. Government or its contractors. The U.S. Government, therefore, will assume no risk for damage or loss to the user's payload. The users will assume that risk or obtain insurance protecting themselves against that risk.

9. RESPONSIBILITIES

a. Headquarters Officials

(1) The NASA Comptroller, in coordination with the Associate Administrator for Space Flight will:

(a) Prescribe guidelines, procedures, and other instructions which are necessary for estimating costs and setting prices and publishing them in the NASA Issuance System, and

(b) Review and arrange for the billing of users.

(2) The Associate Administrator for Space Flight will arrange for:

(a) Developing estimates for costs and establishing prices in sufficient detail to reveal their basis and rationale.

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(c) Reviewing of final billings to users prior to submission to the NASA Comptroller.

b. Field Installation Officials

The Directors of Field Installations responsible for the STS operations will:

(1) Maintain and/or establish agency systems which are needed to identify costs in the manner prescribed by the NASA Comptroller,

(2) Compile financial records, reports, and related information, and

(3) Provide assistance to other NASA officials concerned with costs and related information.

DISTRIBUTION:
SDL-1

James C. Fletcher
Administrator

Attachment A - Costs for Which NASA Shall Be Reimbursed
Attachment B - Standard Shuttle Services
Attachment C - Optional Shuttle Services
Attachment D - Shared Flight Charge and Graph
Attachment E - Occupancy Fee Schedule

Published in the Federal Register under Title 14, Chapter V, Subpart 1214.1 (42 FR 3829-3833, January 21, 1977).

COSTS FOR WHICH NASA SHALL BE REIMBURSED

Additive Costs	All additional costs, both direct and indirect, that the NASA has to incur above those it would otherwise have incurred had it not undertaken to meet non-NASA user requirements.
Total Operations Costs	Total Operations Costs include all direct and indirect costs, excluding costs composing the use charge. Such costs include direct program charges for manpower, expended hardware, refurbishment of hardware, spares, propellants, provisions, consumables and launch and recovery services. They also include a charge for program support, center overhead and contract administration.
Use Charge	A charge in lieu of depreciation for use of facilities, support equipment and the Shuttle fleet.
Aggregate Costs	Aggregate costs are all reasonable costs which include the sum of the use charge and total operations costs.

STANDARD SHUTTLE SERVICES

- Two standard mission destinations

  (1) 160 NM Altitude; 28.5° Inclination.
  (2) 160 NM Altitude; 56.0° Inclination.

- One-day mission operations
- Orbiter flight planning services
- Transmission of payload data to compatible receiving stations
- A three-man flight crew
- On-orbit payload handling
- Deployment of a free flyer
- NASA support of payload design reviews
- Prelaunch payload installation, verification and orbiter compatibility testing
- NASA payload safety review

OPTIONAL SHUTTLE SERVICES

- Revisit and retrieval
- Use of Spacelab or other special equipment
- Use of Mission Kits to extend basic orbiter capability
- Use of Upper Stages
- EVA services
- Unique payload/orbiter integration and test
- Payload mission planning services, other than for launch, deployment and entry phases
- Additional time on-orbit
- Payload data processing
- Launch from Western Test Range

  Two standard mission destinations are available from the Western Test Range site:

  (1) 160 NM Altitude; 90.0° Inclination.
  (2) 160 NM Altitude; 104.0° Inclination.

SHARED FLIGHT CHARGE

To calculate the cost of individual payloads transported on a flight shared with other payloads:

(1) Find the load factor for the payload by dividing the payload weight by the Shuttle capability for the desired inclination (Table in Figure 1).

(2) Find the load factor for the payload by dividing the payload length by 60 feet.

(3) Enter the curve (Figure 1) at the higher value obtained from steps 1 and 2 and read the Charge Factor (C_f) from the curve.

(4) Multiply the C_f value times the quoted price per dedicated flight. This will result in the price for the payload flight.

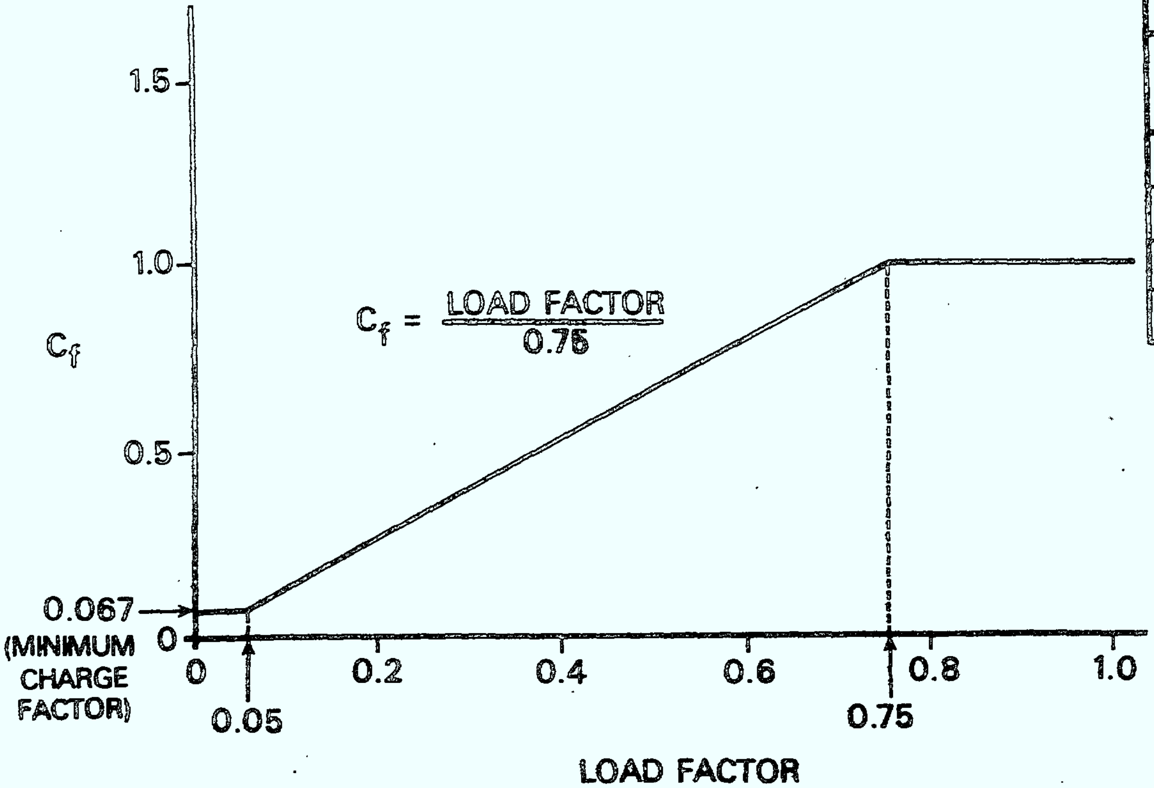
The price for each payload flight (Step 4) entitles the user to be provided a pro-rata share of the facilities available on board the standard Shuttle flight. For example, if the payload load factor is 0.5, then the payload is entitled to 50% of the power, cooling, and other services provided on the standard flight. Standard services required that exceed the pro-rata share will be an additional charge to the user based on the cost of the service provided.

For purposes of this attachment, payload weight includes a pro-rata share of all special equipment (e.g., spin tables and their controls) needed for the user's mission. Payload length includes a pro-rata share of the clearance length necessary to operate or deploy the payload, including the length of deployment mechanisms.

DETERMINATION OF CHARGE FACTOR (C_f) FOR 160 N.MI

$$\text{PRICE} = C_f \times \text{DEDICATED PRICE}$$

$$\text{LOAD FACTOR} = \begin{cases} \dfrac{\text{PAYLOAD WEIGHT, LBS}}{\text{SHUTTLE CAPABILITY}} \\[2ex] \dfrac{\text{PAYLOAD LENGTH, FT}}{60} \end{cases} \text{WHICHEVER IS GREATER}$$



SHUTTLE CAPABILITY	
INCLINATION IN DEGREES	WEIGHT IN THOUSANDS OF POUNDS
28.5	65
56	57
90	37
104	30

FIG 1

OCCUPANCY FEE SCHEDULE

For a postponed or cancelled dedicated flight, the occupancy fee will be zero.

For a postponed or cancelled shared flight, the occupancy fee will be computed according to the computation instructions set forth below. If the computation results in an occupancy fee which is less than zero, the occupancy fee will be reset to zero.

For a postponed or cancelled shared flight one year or less, but more than six months before launch, the user shall reimburse NASA an occupancy fee of half the user's flight price less any adjusted reimbursements from other users who contract for the same flight subsequent to the postponement or cancellation date.

For a postponed or cancelled shared flight six months or less before launch, the user shall reimburse NASA an occupancy fee of 90% of the user's flight price less any adjusted reimbursements from other users who contract for the same flight subsequent to the postponement or cancellation date.

For a given shared flight, if the occupancy fee so computed would result in total adjusted reimbursements (exclusive of the 5% (10%) postponement (cancellation) fee) in excess of the price of a dedicated flight, the occupancy fee will be reduced in order to recover the price of a dedicated flight.

In the event that, as a result of the postponement or cancellation, the Shuttle is not launched at all for the intended flight, the occupancy fee will be zero.

For purposes of this attachment, "adjusted reimbursements" is defined to be reimbursements assuming all users are non-U.S. Government.

NASA Management Instruction

NMI 8610.9
Date Feb. 11, 1977

Responsible Office: MO/Space Transportation Systems Operations

Subject: REIMBURSEMENT FOR SHUTTLE SERVICES PROVIDED TO CIVIL U.S. GOVERNMENT USERS AND FOREIGN USERS WHO HAVE MADE SUBSTANTIAL INVESTMENT IN THE STS PROGRAM

1. PURPOSE

This Instruction sets forth:

a. The policy on reimbursement for Shuttle services which are provided by NASA to users (as defined in paragraph 2, below) under launch services agreements, and

b. Responsibilities for putting such policy into effect and carrying it out.

2. DEFINITION

For the purpose of this Instruction, the term "users" means:

a. All civil U.S. Government agencies who request Shuttle services from NASA, and

b. Foreign users who have made substantial investment in the STS program, i.e., European Space Agency (ESA), ESA member or observer nations participating in Spacelab development, and Canada, when conducting experimental science or experimental applications missions with no near-term commercial implications.

3. APPLICABILITY

This Instruction shall apply to all NASA installations when providing Shuttle services and other equipment, materials and services associated with Shuttle space flights under agreements with users which are executed after the effective date of this Instruction.

4. REIMBURSEMENT POLICY

a. Features of Policy

(1) All users will be charged on a fixed price basis; there will be no post-flight charges, except for prespecified optional services.

(2) The price will be based on estimated costs.

(3) The price will be held constant for flights in the first three years of Space Transportation System (STS) operations.

(4) Payments shall be escalated according to the Bureau of Labor Statistics Index for Compensation per hour, Total Private.

(5) Subsequent to the first three years, the price will be adjusted annually to insure that total operating costs are recovered over a twelve year period.

(6) Pricing incentives are designed to maximize the proper utilization of the STS.

b. Dedicated Flight Reimbursements

(1) For the purposes of this policy, a dedicated flight is one sold to a single user.

(2) The policy is established for two distinct phases of Shuttle operations. The first phase is through the third full fiscal year of Shuttle operations and the second phase consists of nine full fiscal years subsequent to the first phase.

(a) For a dedicated Shuttle flight during the first phase, NASA shall be reimbursed in an amount which is a pro-rata share of forecast additive costs averaged over the first phase of three years; however, the price shall not be less than a pro-rata share of forecast total operating costs averaged over both the first and second phases of the twelve year Shuttle operation period.

(b) For a dedicated Shuttle flight during the second phase, NASA shall be reimbursed a pro-rata share of forecast total operating costs over both phases to insure that total operating costs are recovered over the twelve year period.

(c) The definition of the costs as specified in this Instruction are set forth in Attachment A.

(d) Subject to NASA approval, a dedicated flight user may apportion and assign STS services to other STS users provided they satisfy STS user requirements. The price of integrating additional payloads will be negotiated.

(e) A summary of standard Shuttle services included in the flight price is set forth in Attachment B.

(f) The prices of optional Shuttle services are being developed and shall be set forth in the Shuttle Price Book which is being developed. A summary of the optional services is set forth in Attachment C.

(g) For the user with an experimental, new use of space or first time use of space of great public value, the reimbursement to NASA for the dedicated, standard Shuttle flight in either the first or second phase shall be a pro-rata share of the average twelve year additive costs as estimated at the time of negotiations. Programs which qualify for this price will be determined by an STS Exceptional Program Selection Process. In all cases, the Administrator will be the selection official.

(h) For dedicated flight users, NASA and the user will identify a desired launch date within a period of ninety days three years prior to flight. One year prior to the flight, a firm launch and payload delivery date will be identified by NASA. The firm launch date will be within the first sixty days of the original ninety day period. Launch will occur on the firmly scheduled launch date or within a period of thirty days thereafter. The payload must be ready to launch for the duration of that period.

c. <u>Shared Flight Reimbursements</u>

(1) The price of a shared Shuttle flight will be a fraction of the dedicated Shuttle flight price. The fraction will be based on the length and weight of the payload and the mission destination at the time of contract negotiations. The formula for computing the fraction is set forth in Attachment D.

(2) For shared flight users, NASA and the user will identify a desired launch date three years prior to flight. Launch will occur within a period of ninety days, beginning on the desired launch date. One year prior to flight, a payload delivery date and a firm launch date will be coordinated among the shared flight users. This firm launch date will be within the first thirty days of the original ninety day period. The launch will occur on the firmly scheduled launch date or within a period of sixty days thereafter. The payloads must be ready to launch for the duration of that period.

(3) A 20% discount on the standard flight price will be given to shared flight users who will fly on a space-available (standby) basis. NASA will provide launch services within a prenegotiated period of one year. Shared flight payloads must be flight deliverable to the launch site on the first day of the one year period and sustain that condition until delivery to the launch site. The user will be notified sixty days prior to the firmly scheduled launch date which has been established by NASA.

At that time, NASA will also establish a payload delivery date. The payload must be available at the launch site on the assigned delivery date and ready to launch for a period of sixty days after the firmly scheduled launch date.

d. Small Self-Contained Payloads. Packages under 200 pounds and smaller than five cubic feet which require no Shuttle services (power, deployment, etc.), and are for R&D purposes, will be flown on a space-available basis during both phases of Shuttle operation. The price for this service will be negotiated based on size and weight, but will not exceed $10,000 in 1975 dollars. A minimum charge of $3,000 in 1975 dollars will be made. If Shuttle services are required, the price will be individually negotiated. Reimbursement to NASA will be made at the time the package is scheduled for flight.

e. Options

(1) In order to allow the user greater flexibility in selecting a launch date, the user may purchase a "floating launch date" option. At the time of contract execution, the user will begin to make payments according to a 33 month reimbursement schedule for this launching. At any time during Phase 1 or 2, the user may exercise this option by informing NASA of his desired launch date for this option which will then be negotiated by NASA and the user. This launch date must be at least 33 months after the date of the first reimbursement payment. If the desired launch date is within one year of the date of declaration, the short term call-up option and associated fee will apply. If the desired launch is to occur in a year for which a new price per flight is in effect, the user will pay the new price. The fee for this option is 10% of the user's flight price in effect at the time of contract execution and is payable at that time. This fee will not be applied to the price of the user's flight.

(2) Options must be exercised for a flight by the end of the second phase of operations or the option fee will be retained by NASA.

f. Fixed Price Period and Escalation

(1) The price will remain constant for flights during the first phase of Shuttle operations. For flights during the second phase, the price will be adjusted on a yearly basis, if necessary, to assure recovery of total operating costs over a twelve year period. These adjusted prices will be applicable only to agreements executed after the adjustment is made.

(2) Shuttle services for both phases will be contracted on a fixed price basis. The payments in the contract will be escalated to the time of the payment using the Bureau of Labor Statistics Index for Compensation per hour, Total Private.

g. Earnest Money. Earnest money will be paid to NASA by ESA and ESA member nations participating in Spacelab development, and government agencies of Canada prior to contract negotiations. The earnest money required per contract shall be $100,000 in 1975 dollars; however, if the payload is a small self-contained payload, the earnest money shall be $500.00. The earnest money will be applied to the first payment made by the customer or will be retained by NASA.

h. Reimbursement Schedule

(1) Reimbursement shall be made in accordance with the reimbursement schedule contained in this subsection. No charges shall be made after the flight, except as negotiated in the contract for prespecified extra services. Those users who contract for Shuttle services less than three years before the desired launch date will be accommodated and will pay on an accelerated basis according to the reimbursement schedule.

(2) Standby payloads

(a) Before the establishment of a firmly scheduled launch date, the number of months before launch will be computed assuming a launch date at the mid-point of the designated one-year period.

(b) Once the firmly scheduled launch date is established, the user shall reimburse NASA to make his payments current according to the reimbursement schedule.

(3) Reimbursement Schedule

Number of months before launch flight is scheduled	Percent of Price — Months prior to scheduled launch date 33	27	21	15	9	3
33 Months or More	10	10	17	17	23	23
27-32 Months	-	21	17	17	23	23
21-26 Months	-	-	40	17	23	23
15-20 Months	-	-	-	61	23	23
9-14 Months	-	-	-	-	90	23
3-8 Months	-	-	-	-	-	122

This schedule holds unless there are offsetting advantages to the U.S. Government of an accelerated launch schedule.

(4) Contracts for Shuttle services made one year or less before a flight and up to three months before a flight will be made on a space-available basis unless the short term call-up option is elected.

i. Short Term Call-Up Option

(1) For flights contracted one year or less before launch, but not less than three months before launch, short term call-up will be provided to dedicated flight users at the dedicated flight price according to the reimbursement schedule.

(2) For dedicated flight users requiring short term call-up flights less than three months before launch, NASA will provide STS launch services on a space-available basis. NASA shall be reimbursed the dedicated flight price according to the reimbursement schedule plus short term call-up additional costs. The additional costs will be based on estimated costs to be incurred.

(3) For shared flights contracted one year or less before launch, but more than six months before launch, users may elect the short term call-up option. The user shall reimburse NASA the standard shared flight price according to the reimbursement schedule plus a load factor-recovery fee. The load factor-recovery fee is half the difference between a dedicated flight price and the user's shared flight price or the difference between a dedicated flight price and the total adjusted reimbursements from all shared users, whichever is less.

(4) For shared flights contracted six months or less before launch, but more than three months before launch, users may elect the short term call-up option. The user shall reimburse NASA the standard shared flight price according to the reimbursement schedule plus a load factor-recovery fee which is the difference between a dedicated flight price and the total adjusted reimbursement from all shared flight users.

(5) Shared flights contracted three months or less before launch will be flown on a space-available basis. NASA shall be reimbursed the shared flight price according to the reimbursement schedule plus short term call-up additional costs. These additional charges will be based on estimated costs to be incurred.

(6) For the purposes of this subparagraph, "adjusted reimbursements" is defined to be reimbursements assuming all shared users are among those defined in paragraph 2 above.

(7) The load factor-recovery fee will never be less than zero.

(8) The load factor-recovery fee is payable upon receipt of NASA's billing therefor.

j. Accelerated Launches. For users who reschedule a launch so that it occurs earlier than the planned launch, the user will pay on an accelerated reimbursement schedule. The user will reimburse NASA to make his payments current on the new accelerated reimbursement schedule. If the time from notification of acceleration is less than one year from the new launch date, short term call-up reimbursements will also apply.

k. Postponements

(1) Non-standby Payloads

(a) A user can postpone a flight of his payload one time with no additional charge if postponement occurs more than one year before launch. For subsequent postponed flights more than one year before launch, the user shall reimburse NASA a postponement fee of 5% of the user's flight price. For postponements one year or less before launch, the user shall reimburse NASA 5% of the user's flight price plus an occupancy fee according to the occupancy fee schedule in Attachment E.

(b) If the postponement of a flight causes the payload to be launched in a year for which a different price per flight has been established, the new price shall apply if it is higher than the originally contracted price.

(2) Standby Payloads

(a) For flights postponed more than six months prior to the beginning of the negotiated one-year period, NASA shall renegotiate a new one-year period during which launch will occur. No additional fee will be imposed.

(b) For flights postponed six months or less prior to the beginning of the negotiated one-year period, the user shall reimburse NASA 5% of the user's flight price plus an occupancy fee according to the occupancy fee schedule set forth in Attachment E.

(3) Postponement fees are payable upon receipt of NASA's billing therefor.

(4) Flights postponed will henceforth be treated as newly scheduled launches according to the reimbursement schedule. The number of months prior to launch will be taken as the total number of months between the date postponement is elected and the new launch date. Short term call-up options and associated fees shall apply.

(5) Minor delays (up to three days) caused by the users will not constitute a postponement. No fee will be charged for a minor delay.

l. Cancellations

(1) Non-standby Payloads. Users who cancel a flight more than one year before launch shall reimburse NASA 10% of the user's flight price. For a cancelled flight one year or less before launch, the user shall reimburse NASA 10% of the user's flight price plus an occupancy fee as set forth in Attachment E.

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(a) Users who cancel a flight more than six months prior to the beginning of the negotiated one-year period shall reimburse NASA 10% of the user's flight price.

(b) For a flight cancelled six months or less prior to the beginning of the negotiated one-year period, the user shall reimburse NASA 10% of the user's flight price plus an occupancy fee as set forth in Attachment E.

(3) Cancellation fees are payable upon receipt of NASA's billing therefor.

5. OPTIONAL REFLIGHT GUARANTEE

a. If reflight insurance is purchased from NASA, NASA guarantees one reflight of:

(1) The launch and deployment of a free flying payload into a Shuttle compatible mission orbit if, through no fault of the user, the first launch and deployment attempt is unsuccessful and if the payload returns safely to earth or a second payload is provided by the user.

(2) The launch of an attached payload into its mission orbit if the first launch attempt is unsuccessful through no fault of the user, and if the payload returns safely to earth or a second payload is provided by the user.

(3) A launch of a Shuttle into a payload mission orbit for the purpose of retrieving a payload if the first retrieval attempt is unsuccessful through no fault of the user. This guarantee only applies if the payload is in a safe retrievable condition as determined by NASA.

b. Reflight insurance is not applicable to payloads or upper stages placed into orbits other than the Shuttle mission orbit.

6. PATENT AND DATA RIGHTS

a. When accommodating missions under this Instruction, i.e., experimental science or experimental applications missions for ESA, ESA member states or Canada with no near-term commercial implications, NASA will obtain for U.S. Governmental purposes rights to inventions, patents and data resulting from such missions, subject to the user's retention of the rights to first publication of the data for a specified period of time.

b. The user will be required to furnish NASA with sufficient information to verify peaceful purposes and to insure Shuttle safety and NASA's and the U.S. Government's continued compliance with law and the Government's obligations.

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

8. 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 U.S. Government or its contractors. The U.S. Government, therefore, will assume no risk for damage or loss to the user's payload. The users will assume that risk or obtain insurance protecting themselves against that risk.

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(1) Maintain and/or establish agency systems which are needed to identify costs in the manner prescribed by the NASA Comptroller,

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James C. Fletcher
Administrator

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  (2) 160 NM Altitude; 56.0^{o} Inclination.

- One day mission operations

- Orbiter flight planning services

- Transmission of payload data to compatible receiving stations

- A three man flight crew

- On-orbit payload handling

- Deployment of a free flyer

- NASA support of payload design reviews

- Prelaunch payload installation, verification and orbiter compatibility testing

- NASA payload safety review.

OPTIONAL SHUTTLE SERVICES

- Revisit and retrieval
- Use of Spacelab or other special equipment
- Use of Mission Kits to extend basic orbiter capability
- Use of Upper Stages
- EVA services
- Unique payload/orbiter integration and test
- Payload mission planning services, other than for launch, deployment and entry phases
- Additional time on-orbit
- Payload data processing
- Launch from Western Test Range

  Two standard mission destinations are available from the Western Test Range site:

  (1) 160 NM Altitude; 90.0^{o} Inclination.
  (2) 160 NM Altitude; 104.0^{o} Inclination.

- non-standard orbit [illegible] planning
- [illegible]

SHARED FLIGHT CHARGE

To calculate the cost of individual payloads transported on a flight shared with other payloads:

(1) Find the load factor for the payload by dividing the payload weight by the Shuttle capability for the desired inclination (Table in Figure 1).

(2) Find the load factor for the payload by dividing the payload length by 60 feet.

(3) Enter the curve (Figure 1) at the higher value obtained from steps 1 and 2 and read the Charge Factor (C_f) from the curve.

(4) Multiply the C_f value times the quoted price per dedicated flight. This will result in the price for the payload flight.

The price for each payload flight (Step 4) entitles the user to be provided a pro-rata share of the facilities available on board the standard Shuttle flight. For example, if the payload load factor is 0.5, then the payload is entitled to 50% of the power, cooling, and other services provided on the standard flight. Standard services required that exceed the pro-rata share will be an additional charge to the user based on the cost of the service provided.

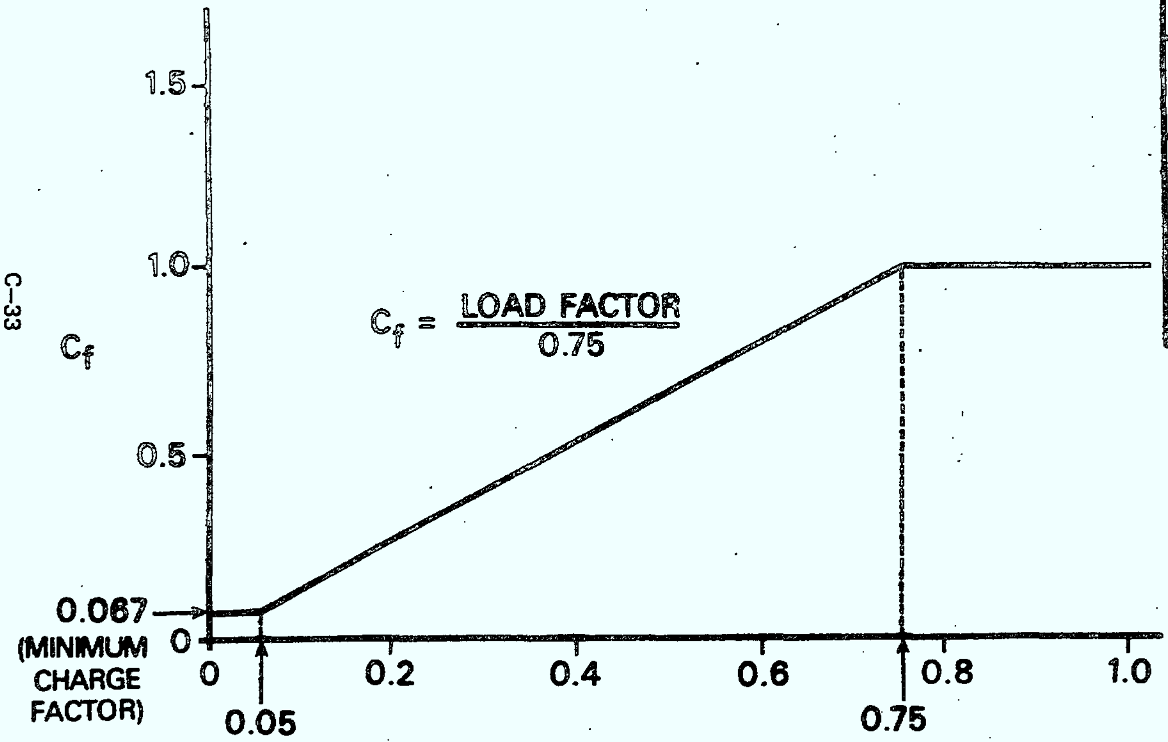
For purposes of this attachment, payload weight includes a pro-rata share of all special equipment (e.g., spin tables and their controls) needed for the user's mission. Payload length includes a pro-rata share of the clearance length necessary to operate or deploy the payload, including the length of deployment mechanisms.

DETERMINATION OF CHARGE FACTOR (C_f) FOR 160 N.MI

PRICE = C_f × DEDICATED PRICE

$$\text{LOAD FACTOR} = \left\{ \begin{array}{c} \dfrac{\text{PAYLOAD WEIGHT, LBS}}{\text{SHUTTLE CAPABILITY}} \\[2ex] \dfrac{\text{PAYLOAD LENGTH, FT}}{60} \end{array} \right\} \text{WHICHEVER IS GREATER}$$

SHUTTLE CAPABILITY	
INCLINATION IN DEGREES	WEIGHT IN THOUSANDS OF POUNDS
28.5	65
56	57
90	37
104	30



LOAD FACTOR

FIG 1

OCCUPANCY FEE SCHEDULE

For a postponed or cancelled dedicated flight, the occupancy fee will be zero.

For a postponed or cancelled shared flight, the occupancy fee will be computed according to the computation instructions set forth below. If the computation results in an occupancy fee which is less than zero, the occupancy fee will be reset to zero.

For a postponed or cancelled shared flight one year or less, but more than six months before launch, the user shall reimburse NASA an occupancy fee of half the user's flight price less any adjusted reimbursements from other users who contract for the same flight subsequent to the postponement or cancellation date.

For a postponed or cancelled shared flight six months or less before launch, the user shall reimburse NASA an occupancy fee of 90% of the user's flight price less any adjusted reimbursements from other users who contract for the same flight subsequent to the postponement or cancellation date.

For a given shared flight, if the occupancy fee so computed would result in total adjusted reimbursements (exclusive of the 5% (10%) postponement (cancellation) fee) in excess of the price of a dedicated flight, the occupancy fee will be reduced in order to recover the price of a dedicated flight.

In the event that, as a result of the postponement or cancellation, the Shuttle is not launched at all for the intended flight, the occupancy fee will be zero.

For purposes of this attachment, "adjusted reimbursements" is defined to be reimbursements assuming all users are among those defined in paragraph 2.

APPENDIX F

TYPICAL FREEFLYER PAYLOAD INTEGRATION PLAN

Received by mail from Wayne Eaton in June, 1978.

"BOILER PLATE"

DRAFT

PAYLOAD INTEGRATION PLAN

FOR

FREE FLYER

AND

SPACE TRANSPORTATION SYSTEM

APPROVED: ______________________ ______________________

NASA;JSC SPIDPO

PREFACE

This Payload Integration Plan (PIP) represents the payload to STS agreement on the responsibilities and tasks which directly relate to the integration of the payload into the STS, and includes definition of tasks which the STS considers optional services.

Signature of this document constitutes agreement on the scope of the identified optional services but does not commit the payload to the reimbursement price and schedule of payment or the STS to the funding and implementation of the optional services. Upon completion of negotiations and signature of the Launch and Associated Services agreement, the services identified as necessary will be implemented by the STS.

Further understanding of the STS operations and the associated payload unique requirements may indicate the need for additional optional services. The PIP and the Launch and Associated Services agreement will then be amended to identify the additional optional services for implementation by the STS.

CONTENTS

LIST OF ABBREVIATIONS

AKM	Apogee Kick Motor
ASE	Airborne Support Equipment
CCAFS	Cape Canaveral Air Force Station
CITE	Cargo Integration Test Equipment
DSTF	Delta Spin Test Facility
EGSE	Electrical Ground Support Equipment
ESA	Explosive Safe Area
ETR	Eastern Test Range
FDR	Final Design Review
GN_2	Gaseous Nitrogen
GSE	Ground Support Equipment
P/L	PAYLOAD
IDR	Intermediate Design Review
JSC	Johnson Space Center
KSC	Kennedy Space Center
LCC	Launch Control Center
LPS	Launch Processing System
LSSP	Launch Site Support Plan
MCC	Mission Control Center
MLP	Mobile Launch Platform
NASA	National Aeronautics and Space Administration
OIS	Operations Intercommunication System
OPF	Orbiter Processing Facility
OTV	Operational Television
PCR	Payload Changeout Room
PDR	Preliminary Design Review
PGHM	Payload Ground Handling Mechanism
PIP	Payload Integration Plan
PPF	Payload Processing Facility
RF	Radio Frequency
S&A	Safe and Arm
SCAPE	Self-Contained Atmospheric Protective Ensemble
SPIDPO	Shuttle Payloads Integration and Development Program Office
SSUS	Spinning Solid Upper State
STS	Space Transportation System
TBD	To Be Determined
VPF	Vertical Processing Facility
FF	Free Flyer

PAYLOAD INTEGRATION PLAN

1.0 INTRODUCTION

The National Aeronautics and Space Administration (NASA), Johnson Space Center (JSC) plans to launch a free flyer payloads with the Space Transportation System (STS). Each payload consists of a spacecraft and perigee motor stage, which is a Delta class spinning solid upper stage (SSUS-D), plus Airborne Support Equipment (ASE). For purposes of this Payload Integration Plan (PIP), the STS shall be represented by the NASA/JSC, with support as required from NASA/KSC.

The free flyer payload is scheduled for launch in Month, 198_

This plan provides the management roles and responsibilities, a definition of the technical activities, interfaces, and schedule requirements to assure an effective operational integration of the payload with the STS. The final requirements for implementation are contained in this Payload Integration Plan, the shuttle/cargo Standard Interfaces ICD-2-19001, and the P/L ICD to be generated as part of the STS launch integration documentation.

2.0 MANAGEMENT RESPONSIBILITIES

The responsibility for assuring the definition, control, implementation, and accomplishment of the activities identified in this document for STS is vested with the Shuttle Payload Integration and Development Program Office (SPIDPO) at NASA, JSC and for the F.F. payload with the PROGRAM MANAGEMENT. Changes to this document and associated documentation, including the ICD, created by this Payload Integration Plan shall be mutually agreed to and signed by the SPIDPO and P/L

2.1 Joint Responsibilities

STS and P/L will support the necessary integration activities, both analytical and physical as identified in this plan and according to the schedule contained herein. STS and P/L will staff structural, avionics, thermal, Flight & Ground operations working groups with appropriate personnel charged with the technical responsibility of accomplishing the integration tasks.

2.2 STS Responsibilities

STS is responsible for the integration of the F.F. payload into the STS, including hardware and services to place the payload at the given deployment orbital parameters. Provisions shall also be made for receiving commands from F.F. for relay to ground controllers and/or STS crew members as appropriate during all operations that the payload is attached to the STS.

2.3 Responsibilities

Mafg. is responsible for the design, development, test, and delivery of the payload and ancillary support equipment to KSC.

3.0 PAYLOAD DESCRIPTION

The F.F. spacecraft is a spin stabilized gyrostat design with a despun antenna and communications payload. Solar panels, supply prime power to the satellite. In the launch configuration, the spacecraft is mated to a perigee motor stage and both antennas and solar panels are stowed. The perigee motor stage supplies the necessary impulse for injection into a transfer orbit with apogee biased above synchronous altitude. At separation of the perigee motor from the spacecraft, the spacecraft omni antenna is deployed.

In this configuration, the satellite is a single spinning body and passively stable. After apogee motor firing, the platform housing the communications antenna and repeater is despun, transforming the satellite into a dual spin gyrostat. Final in-orbit configuration is achieved by deploying the communications reflector and extending solar panels. In addition to supplying prime power to the satellite, the spinning rotor also houses the batteries and power electronics, the reaction control subsystem, and the apogee motor.

The overall payload length is _____in. during launch and increases to ____ in. following antenna reflector deployment and solar panel extension. The spacecraft outer diameter is ____in. The payload is depicted in its stowed configuration in the Orbiter bay in Figure ___. Figure ___ depicts the satellite configured for operation in geosynchronous orbit.

The total mass of the payload will be ___ pounds, excluding bridge and keel fitting.

4.0 PRELIMINARY MISSION SCENARIO

Payload build-up and checkout at the launch site will be accomplished by P/L Mfg. and culminate with the mating of the completely assembled and checked spacecraft with the perigee stage and its Airborne Support Equipment (ASE). Payload processing operations conducted by NASA will begin with the payload interface validation and compatibility tests conducted in the Vertical Processing Facility (VPF). The payload assembly will then be delivered to the launch pad by NASA in the vertical payload cannister and installed in the Payload Changeout Room (PCR) for subsequent installation into the Orbiter payload bay.

The P/L spacecraft/perigee stage as a part of the Orbiter cargo is to be inserted into a circular parking orbit of 160 n mi inclined at 28.5° to the equatorial plane. After payload bay door opening both perigee stage and spacecraft telemetry will be monitored in the Orbiter and on the ground. Once on orbit the perigee stage spin table launch restraints will be withdrawn and the spin at an RPM based on thermal or other operational requirements. At the appropriate time the Orbiter will ıeuver to the required deployment attitude, and spacecraft/perigee s' deployment will be initiated. The spacecraft/perigee stage will be sp t deployment RPM and configured for deployment including arming of both ·perigee apogee motors. The spacecraft/perigee stage will then .. deployed ıe Orbiter will perform a maneuver to provide a safe separation dista: d an appropriate aspect angle for telemetry reception. Ejection of spacecraft perigee stage will nominally occur 45 minutes prior to the descending node associated with the TBD equatorial crossing.

Following deployment,

The spacecraft/perigee stage will coast for 45 minutes after which the perigee motor will be fired by an on-board timer to place the spacecraft into a transfer orbit with apogee biased above synchronous altitude. Approximately two minutes after perigee motor firing, the spacecraft will separate.

4.2 Orbit and Payload Weight Requirements

Orbit Altitude:	160 ± 1 n.mi.
Eccentricity:	Circular
Inclination:	$28.5^{o} \pm 0.1^{o}$
Right Ascension of First Ascending Node:	TBD
Payload Weight	Spacecraft + Pergiee Stage + ASE = lbs.
Return Weight	TBS
Occupied Payload Length in Orbiter Bay:	inches Dynamic Envelope

4.3 Operational Requirements and Constraints

The following payload operational requirements and constraints will be used in the flight design and planning by the STS and

4.3.1.1 Payload Access: Access to the payload in the Orbiter bay will be controlled beginning at approximately T-32 hrs until payload bay closeout begins at T-20 hours. All payload transmitters will be off prior to door closure.

4.3.1.2 Holds: P/L will have the right to call a hold until TBD minutes before liftoff.

4.3.1.3 Launch Window: NASA will select a launch window which meets the requirements of

4.3.2 Ascent.- Not applicable.

4.3.3 On Orbit.- Deployment of the P/L is required within 24 hours after laun

4.3.3.1 Thermal: The mission profile selected by JSC shall be such that the nominal Orbiter attitude will be payload bay to the Earth while the SBS is in the bay. Exceptions to this attitude are payload bay to the Sun for periods not to exceed 30 minutes and payload bay to deep space for periods not to exceed 90 minutes. SBS shall provide to STS the required recovery times from both Sun and deep space exposure based on looking at the Earth and Sun following deep space exposure.

4.3.3.2 Command, Control and Telemetry: The Orbiter CRT will display status of the payload, the deployment sequence and safety critical items which will enable the crew to verify that payload performance in within prescribed limits and that prespecified responses to commands occur as planned. The keyboard and standard payload panel also provide the crew with backup manual control over the deployment sequence. The monitoring and control functions provided the crew are shown in the Flight activities annex.

A status of health check for the payload will be performed using the Orbiter downlink. All payload telemetry data will be transmitted via the RF downlink. When ground station visibility is obscured, telemetry data will be recorded for transmission during periods of restored visibility. The STS general purpose computer (GPC) will issue descrete time signals to the crew control panels for:

a. initiation of deployment sequence (includes arming of perigee and apogee motors)

b. spacecraft/perigee stage ejection from STS

If required, the payload can be jettisoned for safety purposes.

4.3.3.3 Spacecraft/Perigee Stage Separation From Shuttle: P/L will supply NASA with precise timing and attitude requirements for initiation of the spacecraft/perigee stage ejection sequence TBD months prior to launch. JSC will provide the actual STS state vector (orbit and attitude) at spacecraft/perigee stage separation from the Orbiter. The payload will be deployed 45 minutes prior to perigee motor ignition.

Deployment Attitude: The f.f. spacecraft/perigee stage shall be released so that the spacecraft spin axes (+z-axis as defined in Figure___) lies approximately in the plane perpendicular to the earth radius vector when referenced to the descending node of the STS parking orbit and is rotated TBD degrees from the STS orbit plane towards the equator. This geometry is depicted in Figure ____. Maximum angular rates at spacecraft/perigee stage ejection shall not exceed TBD°/sec. in roll TBD°/sec. in pitch and yaw. (See Figure___ for definition of roll, pitch and yaw.)

Deployment Accuracy: The STS shall deploy and spacecraft/perigee stage within___ of the specified perigee motor firing orientation and within___ second of the specified time.

4.3.3.4 Emissions: The STS K-band radar will not be operated on prior to deployment plus TBS minutes to preclude damage to the P/L receiver.

5.0 TO STS INTERFACES

The ff payload/STS interfaces consist of mechanical, electrical, avionics and the environment to which it must be designed. The payload must be compatible with the Orbiter for all phases of ground and flight operations. An Interface Control Document (ICD) will be generated and signed by SPIDPO and P/L and will be the document to which all interfaces are designed and controlled.

5.1 Structural/Mechanical Interface

The ff payload structural interface to the STS is through the perigee stage cradle. The cradle utilizes four longeron attached points and one keel attach point.

STS interface loads and cargo-to-STS clearances shall be specified in the P/L /STS ICD.

5.2 Electrical Power Interfaces

During the STS/ff payload flight and ground mated operations, uninterrupted power will be supplied by the STS. For ground operations when Orbiter power is not available, power may be supplied to the payload using their own provided EGSE. Power quality and control supplied by the STS will be defined in the payload/STS/ICD.

Electrical power interface requirements are as follows:

Electrical Power Source Interface	Prelaunch	Launch	On-Orbit: Attached (Orbiter)	On-Orbit: Detached
a) Hardwire through T-0 Umbilical (Payload provided EGSE)	(TBD)	N/A	N/A	N/A
b) Orbiter Bus	(TBD)	(TBD)	X TBD watts	N/A

The above interfaces are physically located at the payload cradle.

5.3 Command Interfaces

The command and response interfaces are as follows. Specified characteristics will be defined in the payload/STS ICD.

Command Interface/Source	Prelaunch	Launch	On-Orbit Attached	On-Orbit Detached
a) Hardwire through T-0 Umbilical (Payload provided EGSE)	X	N/A	N/A	N/A
b) Hardwire - Standard Panel	X		X	N/A
c) GPC/Data Bus	X	N/A	X	N/A

The T-0 umbilical command interface is located at the STS/ payload interface on the payload cradle. The data bus interface is located at the payload cradle.

5.4 Telemetry and Data Interfaces

The telemetry and data interfaces are as follows. Specific characteristics will be defined in the payload/STS ICD.

Telemetry/Interface Route	Prelaunch	Launch	On-Orbit Attached	On-Orbit Detached
a) Hardwire-payload to PDI (for STS RF downlink)			X	N/A

All hardwire telemetry interfaces are located at the STS/ff. payload interface on the ff. payload cradle.

6.0 ENVIRONMENTAL ANALYSIS/INTERFACES

Environmental interface analyses will be conducted to determine physical and functional interface compatibility and to minimize impacts to the payload and STS. The specific analyses are described below. The schedule and responsibility for accomplishment of these activities is included in the Section 15 schedule.

6.1 Structural Loads

Definition and control of the structural loads environment will be documented in the ff. payload/STS ICD.

The loads analysis of the baseline PAM-D system will be performed by MDAC using the updated 5.4D STS model and forcing functions provided by NASA in February 1978. NASA will be provided the results of this load cycle as follows:

MDAC will provide a report describing the coupled dynamic analysis and results. The following items will be included in the report:

a. Maximum time histories of loads and relative deflections at the PAM/STS interfaces.

b. Maximum composite accelerations time histories of selected locations.

c. Relative deflections between the payload and the Orbiter dynamic clearance envelope.

d. Modal mass, stiffness and frequencies of the PAM-D system coupled t the spacecraft and Shuttle; ASE/Orbiter coupling equations, and necessary interface load and deflection modal transformations to perform final cargo manifest verification analyses (magnetic tapes or punched cards will also be provided as required).

NASA will verify the results of the MDAC analysis by independently computing responses and loads for a limited number of conditions.

Two loads cycles are planned in support of the design and verification of the f.f. payload. The McDonnell Douglas Astronautics Corp. (MDAC), will perform a coupled loads analysis using the Orbiter and SBS payload math models to provide design information in support of the spacecraft Intermediate Design Review (IDR). The second loads cycle analysis will be performed by MDAC using the updated f.f. payload math model provided after the spacecraft Final Design Review (FDR). f.f. P/L shall provide a final structural math model for JSC to complete a cargo verification coupled lift-off and landing load analysis.

In addition to the updated payload math model provided after FDR, shall also provide at that time updated mass properties and configuration drawings to the STS as specified in the data pack annex.

6.2 Thermal Environments and Interfaces

TBD

6.3 EMI/EMC

The spacecraft system design shall minimize conducted interference at the STS/payload interface and radiated interference external to the spacecraft envelope. The STS/ interface design shall be based upon NASA/JSC Shuttle Orbiter/Cargo Standard Interfaces ICD-2-19001 which is the governing document for Orbiter electromagnetic environment.

In order to assist in early EMC analysis, it is agreed that P/L and STS will exchange information as scheduled in the avionics IWG on intentional electromagnetic radiation as follows:

6.3.1 Responsibilities.- P/L will supply the following information on the spacecraft, EGSE, and launch site transmitters and receivers.

6.3.1.1 Identification, Name:

6.3.1.2 Total RF Power to Antenna:

6.3.1.3 Power/Bandwidth:

6.3.1.4 Antenna Gain, Pattern:

6.3.1.5 Antenna Location:

6.3.1.6 Systems Tolerance to RF Radiation:

Data supplied shall apply only to sources energized after mating the spacecraft with the STS, from prelaunch through boost, low earth orbit, and payload deployment.

6.3.2 NASA Responsibilities.-

1. NASA will compile a document containing the above information on all payloads and potential payloads in the same cargo with f.f. and provide this document to f.f. P/L and the other payloads.

2. NASA will perform a compatibility analysis based on data in 6.3.2.1.

6.4 Contamination, Environmental Requirements

General - the Space Shuttle vehicle natural and induced environmental conditions are specified in ICD-2-19001.

Material guidelines are contained in the following document, SP-R-0022A. will submit a listing of nonmetallic materials that do not meet the above guidelines. NASA will provide to Telesat the material properties of other payloads when applicable for evaluation. f.f. P/L will determine their spacecraft environment resulting from all contamination sources and evaluate the affect. Any problems arising from these evaluations will be mutually resolved.

6.5 Shock, Vibration and Acoustical Environments

The STS shall provide shock, vibration and acoustical environment definition for the SBS design, as per the STS/f.f. Interface Control Document.

6.6 Ground Environmental Requirements

6.6.1 Ground Handling.- All moves of the spacecraft will be governed by ground rules and conditions set forth in the Ground Operations plan.

6.6.2 Prelaunch/Post-Landing.- Environment conditioned air will be provided in the VPF to maintain a temperature 75° + 3° F and a maximum relative humidity of 50%. The interior of the cannister will be 70° ± 5° F with relative humidity of 50%. Conditioned air will be provided on the pad for PCR and payload bay air conditioning to maintain a temperature of 70° ± 5° F and a maximum relative humidity of 50%. For the final hours of the countdown after personnel have been evacuated from the service tower and prior to LH_2 and LOX load GN_2 will be substituted for the conditioned air. If the spacecraft is returned to KSC, conditioned air equal to that specified above is required on the payload within 15 minutes after landing. Particulate content of the entering air or GN_2 used for purging will not exceed Class 5000 per FED-STD-209B.

7.0 INTEGRATION HARDWARE

The identified interface responsibilities are assigned as follows:

a. ff P/L will provide:

1. The cradle which supports the spacecraft/perigee stage and its ASE,

2. The spacecraft/perigee stage spin-up mechanism, the separation ordnance, and all wiring from the STS/payload interface to the payload, and

b. STS will provide:

1. All wiring from the STS to the STS/payload interface at the payload cradle,

2. The hardware to install the payload into the STS will be provided by NASA as well as the associated payload tiedown hardware.

8.0 FLIGHT OPERATIONS

The section defines the flight design, crew activity planning, crew and controller training and flight operations support activities required for STS/ff payload integration.

8.1 Flight Design

STS will be responsible for performing integrated mission analyses from lift-off through landing. The analyses will include the generation of design Orbiter trajectories, timelines, abort and contingency trajectors, and consumable reserves to meet the user's requirements. The ff P/L program will be responsible for defining the ff flight and crew operations requirements and for ff orbital mission requirements.

8.2 Crew Activity Planning

STS will be responsible for all flight crew activity plans and procedures and will develop an integrated STS/ P/L crew activity plan to support the mission. Included in the plan will be the sequence of events, attitude timelines, and crew timelines.

8.3 Training Preparation

STS will be responsible for providing crew training plans and crew training required for the STS/ P/L flight. P/L will provide the crew briefings on the payload. STS will provide the facilities and design and develop the trainers required to conduct flight crew and Mission Control Center (MCC) training procedures and mission rules.

8.4 Flight Operations Control

STS will be responsible for flight operation until the spacecraft/perigee stage motor is separated from the STS. STS flight control operations in support of the Orbiter will be conducted from NASA, JSC Mission Control Center (MCC-H). P/L will provide a representative at the JSC MCC during the P/L flight to support STS flight control operations, assess mission progress, and coordinate operations interfaces between NASA/JSC and P/L . NASA will provide suitable interface facilities and work space to support this function. Flight operations following separation from the Orbiter will be autonomous. P/L and STS will identify and coordinate the hardware and software interface requirements for all payload operations requiring command and/or data transfer between the STS and the payload.

8.5 Command, Control and Telemetry Support

The ff mission will be supported from a launch control center to be designated by P/L . Spacecraft/perigee stage telemetry will be sent to earth via the Orbiter RF downlink. The processing and subsequent routing of the data is TBD. During the STS mission phase, no direct payload commanding will be done from the ground.

9.0 LAUNCH AND LANDING SITE SUPPORT

9.1 General

Requirements for processing the ff spacecraft at the launch site will be negotiated between P/L and NASA and documented in a Launch Site Support Plan (LSSP). P/L Mfg. is responsible for planning and conduct of payload assembly and testing prior to integration at the Vertical Processing Facility (VPF). Checkout and servicing requirements at the VPF, Payload Changeout Room (PCR) and launch pad will be defined by P/L to allow STS to develop integrated checkout procedures.

P/L will retain prime responsibility for the payload test, ch. out and servicing operations, while STS operations management will ass ne prime responsibility for cargo integration and payload/Orbiter in' ration and verification.

9.2 Transportation

The ff. spacecraft will be transported to CCAFS from the TBD facility in TBD AREA via TBD. Upon arrival at CCAFS, the spacecraft will be taken directly to a payload processing facility (PPF). The perigee stage assembly less the perigee kick motor will be trucked to CCAFS and taken to the Delta Spin Test Facility (DSTF). The two solid motors (apogee and perigee) will be trucked from their respective manufacturers and placed in storage in the solid motor storage area until needed during payload processing.

9.3 Payload Processing Facility

Building TBD has tentatively been assigned to P/L for receiving, inspection, assembly, and systems testing. Space for an Electrical Ground Support Equipment (EGSE) station will be provided to monitor and assist in ground checkout as the spacecraft is processed through CCAFS and KSC facilities. The EGSE will communicate with the spacecraft via RF link and hardline while it is the DSTF, VPF and at the launch pad. Building capabilities are listed in the KSC Launch Site Accommodations Handbook for STS payloads.

9.4 Perigee Stage Processing Facility

DSTF is required for perigee stage inspection, build-up, spin balance and test. Activities will be scheduled so that the perigee stage work is completed with the spacecraft arrives for its hazardous operations. Cradle refurbishment will also take place in one of the two buildings of the DSTF.

9.5 Servicing

For hazardous processing, the spacecraft will be transported to the DSTF where the solid apogee motor will be mated to the spacecraft and the reaction control systems will be filled with hydrazine. Ordnance, which is inaccessable once the spacecraft is built-up, will be installed. Following servicing, the propellant tanks will be flight pressurized and leak checked. The spacecraft will then be mated to the perigee stage and cradle and prepared for transport to VPF for vertical cargo integration.

9.6 Upper Stage Integration

The payload assembly will be transported in the NASA supplied canister and truck to the airlock in VPF where it and the transport vehicle will undergo an exterior cleaning operation prior to entering the Class 100,000 High Bay. It will be placed in its assigned position in the workstand relative to the remainder of the vertical cargo manifest and a series of compatibility tests will be run. A Cargo Integration Test Equipment (CITE) test will be run with the entire flight manifest to verify mechanical and electrical compatibility with the Orbiter. During the CITE testing, payload monitoring functions will be provided via a 1 Kbps link to the PPF. Ordnance installation not accomplished in DSTF will occur just prior to installation in the vertical payload canister for moving the total integrated cargo to the Pad.

9.7 Pad Operations

The vertical canister will be transported to the pad with the full manifest of vertically-processed payloads. The canister will be hoisted into position and the payloads extracted by the Payload Ground Handling Mechanism (PGHM) and retracted into the Payload Changeout Room (PCR). Some PCR time will be required in the rollback position for systems tests prior to or during Orbiter-to-Pad transfer operations. Power for spacecraft testing and battery charging will be provided through P/L Mfg. provided GSE and the PCR or in the Pad Terminal Connection Room (PTCR). After the Mobile Launcher (ML) is hard-down on the Pad, the PCR will swing into position and the payloads will be inserted into the Orbiter payload bay. Payload installation will take approximately 2 1/2 hours with subsequent payload to orbiter interface verification tests and closeout procedures taking approximately 10 1/2 hours. Orbiter power will be available from payload installation through liftoff for battery charging and other functions. Access to the payload will not be available after Orbiter payload bay door closing beginning at T-20 except for late contingency access at T-5 hours. A 1 Kbps data link to the PPF for prelaunch control and monitoring of the spacecraft functions will be provided via hardwires through the T-0 umbilicals.

At liftoff all control functions are transferred to the Johnson Space Center.

9.8 Solid Propellant Area

All four major facilities of the Solid Propellant Area are required for apogee and perigee kick motor preparations. The storage bunkers for storage of the solid motors from receipt to start of checkout; the non-destruct test laboratory (NDTL) for x-ray; the missile and rocket test bay (MRTB) for cold soak and build-up and finally, the electro-mechanical test building (EMT) for safe and arm unit checkout.

9.9 Liquid Propellant Area

Storage area for two drums of hydrazine in the liquid propellant area is necessary.

9.10 Abort and Emergency Landing

In the event that the Orbiter must land at a site other than at KSC before ejecting the ff. spacecraft, P/L will provide the necessary personnel to accompany NASA to the landing site for removal of payload flight plug and insertion of safing pins and consultation as to payload disposition

9.11 Post-Flight Services and Disposition

The payload cradle and various nonexpendable ASE, which will return to earth with the STS, will be removed by NASA from the STS and returned to the user.

10.0 SAFETY

"The payload shall be designed to comply with the requirements of NASA Office of Space Flight document, "Safety Policy and Requirements for Payloads Using the Space Transportation System," dated June 1976. A minimum of three safety reviews will be conducted in accordance with JSC 13830, "Implementation Procedures for STS Payloads Safety Requirements," undated. The safety documentation required to support each of the safety reviews shall be provided by the payload organization 3 weeks prior to the scheduled safety review. The culmination of all the safety assessments will be the certification of the payload prior to installation in the orbiter payload bay for flight, and submittal of the payload flight readiness statement at the flight readiness review."

11.0 INTERFACE VERIFICATION

The non-safety associated interface verification requirements and planning will be negotiated and concurred in by the NASA/JSC and P/L . It is anticipated that this interface verification will be accomplished within the scope of normal test, checkout, and integration flow of the f.f. payload. A series of interface validation and compatible tests will be run including a CITE test in the VPF to verify mechanical and electrical compatibility with the STS. After mechanical and electrical mate to the Orbiter, a series of interface validation tests will be run to verify electrical and mechanical compatibility with the Orbiter.

12.0 POST FLIGHT DATA REQUIREMENTS

STS will provide actual flight environmental data including time of spacecraft/pergiee stage separation from the STS and Orbiter attitude and orbital state vectors at the time of separation.

13.0 OPTIONAL SERVICES

The Optional Services to be provided and priced to P/L Mfg. for payload integration are as follows:

a. Offline optional launch site support and services shall be provided to P/L at KSC and CCAFS as defined in the LSSP. P/L will be required to make arrangements through NASA Headquarters to cover launch site support costs for (1) Maintenance of facilities, (2) support services and management, and (3) facility use charge in lieu of depreciation.

14.0 PIP ANNEXES

The following PIP annexes are applicable to this payload and will be completed according to the schedule par 14.

Flight Activities
Flight Design
Payload Data Pack
Command and Telemetry List
Training Plans
Flight Operations Support
Launch and Landing Support

15.0 SCHEDULE

The attached schedule, Figure 14-1, provides a summary of the various technical areas requiring data exchange and/or products in support of the payload/STS integration activities.

16.0 REFERENCE DOCUMENTS

a. KSC Launch Site Accommodations Handbook, K-STSM 14.1

b. NASA OSF "Safety Policy and Requirements for Payloads Using the Space Transportation System", dated June 1976

c. Shuttle Orbiter/Cargo Standard Interfaces ICD-2-19001, dated November 1977

d. Federal Standard 209B Clean Room and Work Station Requirements, Controlled Environment, dated April 24, 1973

e. STS Payload Safety Guidelines Handbook JSC-11123

f. Space Shuttle Program, Space Shuttle System Payload Accommodations, JSC 07700, Vol XIV

APPENDIX G

STS FORM 100

(17)

NASA

National Aeronautics and
Space Administration

Space Transportation System

User Flight Assignment

The user interface

The Space Transportation System now being built will provide easier access to space for a wider range of users than ever before. Standard systems, together with standard operational use of these systems, will provide the lowest cost operations obtainable.

The basic steps in initiating a request and finalizing a firm flight assignment are summarized below. Requests are made to the Space Transportation Systems Operations Office, Mail Code MO, National Aeronautics and Space Administration, Washington, D.C. 20546.

STEP 1

CALL NASA HEADQUARTERS
STS OPERATIONS OFFICE
(202) 755-2344
FTS 755-2344

STEP 2

PROCEED WITH INFORMAL DISCUSSIONS WITH STS OPERATIONS OFFICE AND KEY ORGANIZATIONS, SUCH AS:

- NASA HEADQUARTERS OFFICES
- NASA CENTERS
- EUROPEAN SPACE AGENCY
- DEPARTMENT OF DEFENSE
- COMMERCIAL CENTERS
- INTERNATIONAL CENTERS

TELEPHONE CONVERSATIONS AND SMALL MEETINGS WITH THE STS OPERATIONS PERSONNEL WILL SUPPORT THE USER'S PREPARATIONS FOR SERIOUS DIALOGUE.

STEP 3

WRITE FOR OTHER USERS' GUIDES, ETC.

STEP 4

PREPARE FOR SERIOUS DIALOGUE, WORKING WITH STS OPERATIONS OFFICE, KEY ORGANIZATIONS, OR BOTH

STEP 5

SUBMIT STS 100 FORM (OR HAVE YOUR PART INCORPORATED INTO THE KEY ORGANIZATION SUBMITTAL)

STEP 6

PARTICIPATE IN OR BE REPRESENTED IN THE CARGO INTEGRATION REVIEW TO OBTAIN FIRM FLIGHT ASSIGNMENT

- CARGO INTEGRATION REVIEW
  WITH THIS REVIEW, THE FLIGHT MANIFEST, COST PER FLIGHT, AND BILLING SCHEDULE ARE ESTABLISHED. INCLUDING A TASK SCHEDULE THROUGH COMPLETION

FORMS

STS 100

STS 101

UPDATE

- REQUEST FORM
  FLIGHT DATE
  REQUIREMENTS
  CHARACTERISTICS
  CONFIGURATION

OUTPUT

- PRELIMINARY FLIGHT MANIFEST (PREPARED BY STS OPERATIONS)

STEP 7

FOLLOW STANDARD PROCESS THROUGH FLIGHT

STS 100 FORM	REQUEST FOR FLIGHT ASSIGNMENT	DATE:

To: SPACE TRANSPORTATION SYSTEMS OPERATIONS MAIL CODE MO NATIONAL AERONAUTICS AND SPACE ADMINISTRATION WASHINGTON D.C. 20546	FROM: ______________ ______________ ______________ ______________ /S/
FLIGHT OBJECTIVES:	____ Earnest money ____ NASA approved ____ Commercial ____ ESA approved ____ Other Government ____ DOD approved

Flight period ______________ or specific date ______________ FLIGHT TYPE:

Inclination range ______________ or specific inclination ______________ ____ Deployment

Altitude range ______________ or specific altitude ______________ ____ Attached

Payload configuration ______________ ____ Servicing

Flight duration, hours attached ______________ Discipline ______________ ____ Retrieval

Crew complement: Commander, pilot, mission specialist plus option for additional mission specialist(s) ______________ or payload specialist(s) ______________

Payload Operations Control Center support:

____ GSFC ____ JPL ____ JSC ____ Other ____ Not required ____

STDN and Tracking and Data Relay Satellite system support (comment):

Payload mass properties including flight kits:

Specify flight kits used in weight: (see JSC-07700, Volume XIV)

Weight:	Launch	______	lb.	______	kg
	Landing	______	lb.	______	kg
Diameter:	Launch	______	inches	______	mm
	Landing	______	inches	______	mm
Length:	Launch	______	inches	______	mm
	Landing	______	inches	______	mm

Payload kWh estimate ______________ kWh

Payload constraints and/or unique requirements:

Orientation, pointing, sunlight constraints, etc. (comment):

Special prelaunch and postlanding off-line support at launch and landing site (comment):

Special prelaunch and postlanding on-line support while in the Orbiter (comment):

Other comments:

Those organizations that will be non-U.S. Government users should also provide the following information:

- Do you request a dedicated flight? If so, do you intend to sublet services to other users?
- Do you request consideration in STS exceptional program selection process?
- Are you willing for your payload to fly on a space-available (standby) basis?
- Do you request your payload to be flown under the definition of a "small self-contained payload"?
- State desired date to begin contract negotiations.
- Does payload (or payloads) require revisit and/or retrieval services?
- List known optional services currently under consideration in order that flight requirements can be established.

NASA-JSC

APPENDIX H

TABLE OF CONTENTS OF TYPICAL LAUNCH AGREEMENT

MAJOR CONTRACT MILESTONES

LAUNCH SERVICES AGREEMENT - FORMAT AND CONTENTS

- PREAMBLE
- USER UNIQUE PROVISIONS
  - DEFINITION OF PLANNED LAUNCH DATES AND LAUNCH OPTIONS
  - OPTIONAL/CUSTOM SHUTTLE SERVICES
    - NASA PROVIDED UPPER STAGES
    - SPACELAB
  - RECOGNITION OF SPECIFIC PAYLOAD INTEGRATION PLAN (PIP)
  - SPECIAL CONSIDERATIONS
- SERVICES TO BE FURNISHED BY NASA
  - STANDARD SHUTTLE SERVICES
    - GENERAL DESCRIPTION, REFERENCES PIP
  - OPTIONAL/CUSTOM SHUTTLE SERVICES
    - GENERAL PROVISION, DETAILS AS DEFINED ABOVE
  - PROVISIONS FOR CHANGING MISSION AND SUPPORT REQUIREMENTS

MAJOR CONTRACT MILESTONES

LAUNCH SERVICES AGREEMENT - FORMAT AND CONTENTS (CONT'D)

- RESPONSIBILITIES, COORDINATION AND DOCUMENTATION
- LAUNCH SCHEDULING POLICY AND REQUIREMENTS
  - NOMINAL LAUNCH SCHEDULING PROCEDURE
  - USER RIGHTS TO CHANGE LAUNCH DATE
  - USER RIGHTS TO DEFER OR CANCEL PLANNED FLIGHT EVENTS
  - NASA RIGHTS TO CHANGE LAUNCH DATE/REASSIGN PAYLOAD
  - NASA RIGHTS TO DEFER OR CANCEL PLANNED FLIGHT EVENTS AND TO JETTISON PAYLOAD
  - LAUNCH RESCHEDULING PROCEDURE
- ALLOCATION OF CERTAIN RISKS
  - GENERAL LIABILITY PROVISION
  - PROPERTY DAMAGE AND INJURY TO LAUNCH PARTICIPANTS
  - THIRD PARTY LIABILITY
  - PATENT INFRINGEMENT CLAIMS
  - LIMITATION OF U. S. GOVERNMENT LIABILITY

MAJOR CONTRACT MILESTONES

LAUNCH SERVICES AGREEMENT - FORMAT AND CONTENTS (CONT'D)

- FINANCIAL ARRANGEMENTS
  - DEFINITION OF CHARGING PRINCIPLES
  - DETERMINATION OF CHARGES
  - PROVISION FOR PROGRESS PAYMENTS
  - DEFINITION OF BILLING AND REIMBURSEMENT PROCEDURES
- TERMINATION OF SERVICES
  - NASA'S RIGHTS TO TERMINATE
  - USER'S RIGHTS TO TERMINATE
- MISCELLANEOUS PROVISIONS
  - REQUIRED IN GOVERNMENT CONTRACTS
- ANNEXES
  - SUMMARY OF CHARGES
  - PROGRESS PAYMENTS SCHEDULE

APPENDIX I

DESCRIPTION OF STS, SSUS AND KSC LAUNCH SITE

1.0 STS LAUNCH VEHICLE

1.1 General Description

1.1.1 Basic Mission Profile

The Space Shuttle flight system is composed of the Orbiter, an external tank (ET) that contains the ascent propellant to be used by the Orbiter main engines, and two solid rocket boosters (SRB's), see Figure I.1-1. The Orbiter and SRBs are reusable; the external tank is expended on each launch.

The Space Shuttle mission as shown in Figure I.1-2 begins with the installation of the mission payload into the Orbiter payload bay. The payload will be checked and serviced before installation and will be activated on orbit. Flight safety items for some payloads will be monitored by a caution and warning system.

The SRBs and the Orbiter main engine will fire in parallel at lift-off. The two SRBs are jettisoned after burnout and are recovered by means of a parachute system. The large external tank is jettisoned before the Space Shuttle Orbiter goes into orbit. The orbital maneuvering system (OMS) of the Orbiter is used to attain the desired orbit and to make any subsequent manoeuvres that may be required during the mission. When the payload bay doors in the top of the Orbiter fuselage open to expose the payload, the crewmen are ready to begin payload operations.

After the orbital operations, deorbiting manoeuvres are initiated. Reentry is made into the Earth's atmosphere at a high angle of attack. At low altitude, the Orbiter goes into horizontal flight for an aircraft-type approach and landing. A 2-week ground turnaround is the goal for reuse of the Space Shuttle Orbiter although the present assessment is 3 weeks.

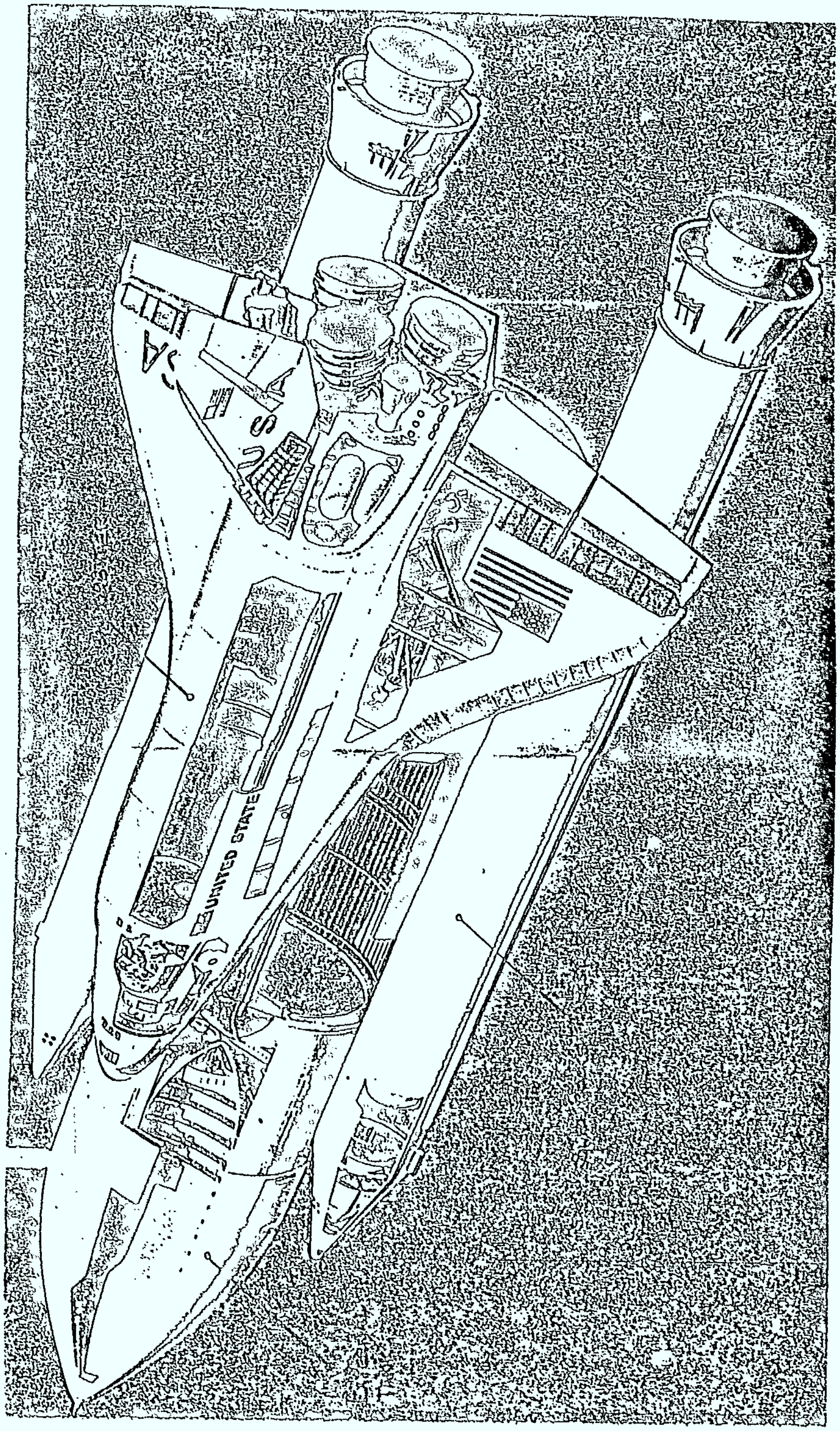


FIGURE I.1-1 STS LAUNCH VEHICLE

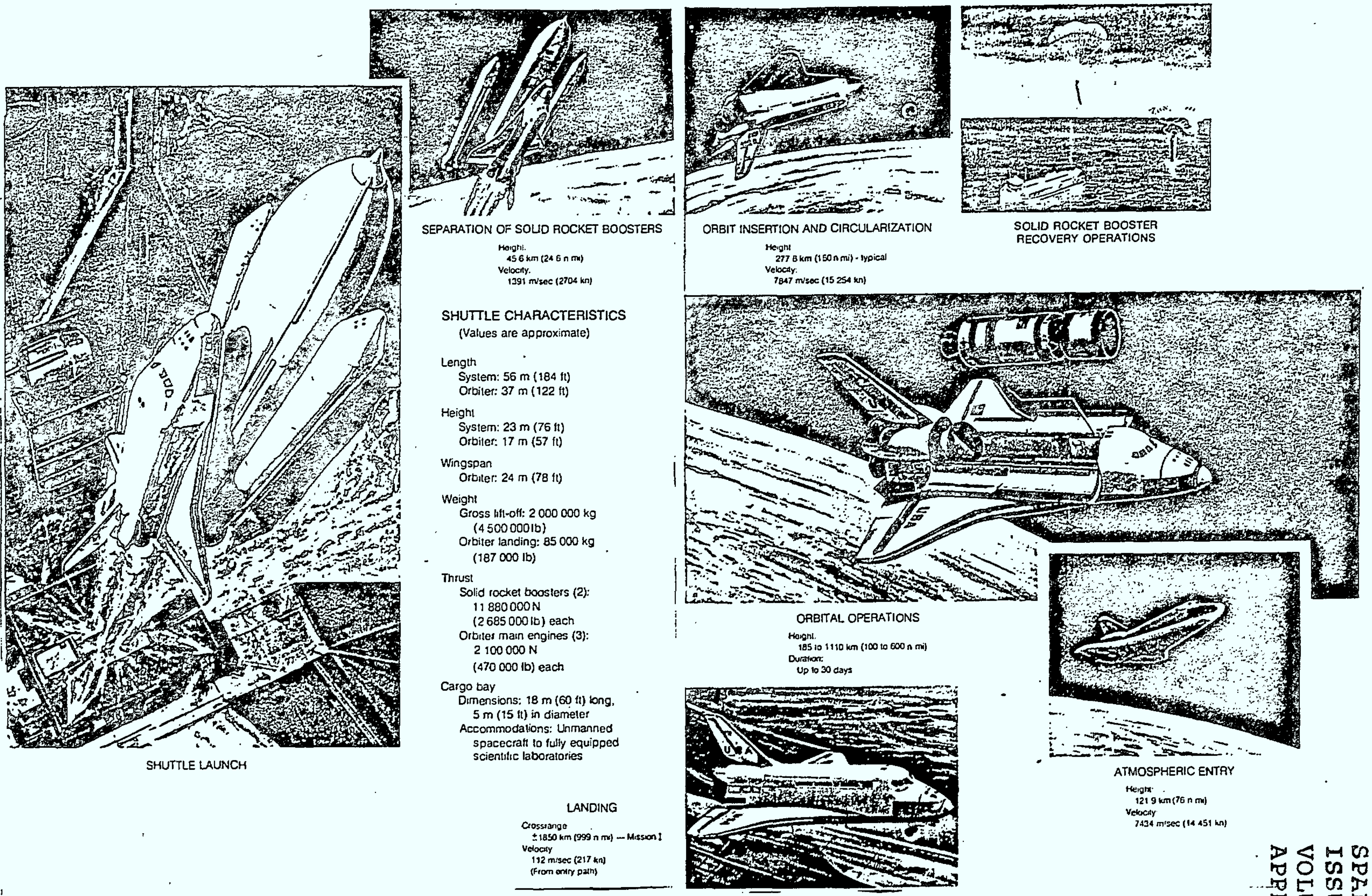


FIGURE I.1-2 PROFILE OF SHUTTLE MISSION

The nominal duration of the missions is 3 to 7 days. The mission duration can be extended to as long as 30 days if the necessary consumables are added.

1.1.2 STS Orbiter

The Orbiter spacecraft, see Figure I.1-3, contains the crew and payload for the Space Shuttle system. The Orbiter can deliver to orbit payloads of 29,500 kilograms (65,000 pounds) with lengths to 18.3 meters (60 feet) and diameters of 4.6 meters (15 feet). The orbiter is comparable in size and weight to modern transport aircraft; it has a dry weight of approximately 68,000 kilograms (150,000 pounds), a length of 37 meters (122 feet), and a wingspan of 24 meters (78 feet).

The crew compartment can accommodate seven crew members and passengers for some missions but will hold as many as 10 persons in emergency operations.

The three main propulsion rocket engines used during launch are contained in the aft fuselage. The rocket engine propellant is contained in the external tank (ET), which is jettisoned before initial orbit insertion. The orbital manoeuvring subsystem (OMS) is contained in two external pods on the aft fuselage. These units provide thrust for orbit insertion, orbit change, rendezvous, and return to Earth. The reaction control subsystem (RCS) is contained in the two OMS pods and a module in the nose section of the forward fuselage. These units provide attitude control in space and precision velocity changes for the final phases of rendezvous and docking or orbit modification. In addition, the RCS, in conjunction with the Orbiter aerodynamic control surfaces, provides attitude control during reentry. The Orbiter is designed to land at a speed of 95 m/sec (185 knots), similar to current high-performance aircraft.

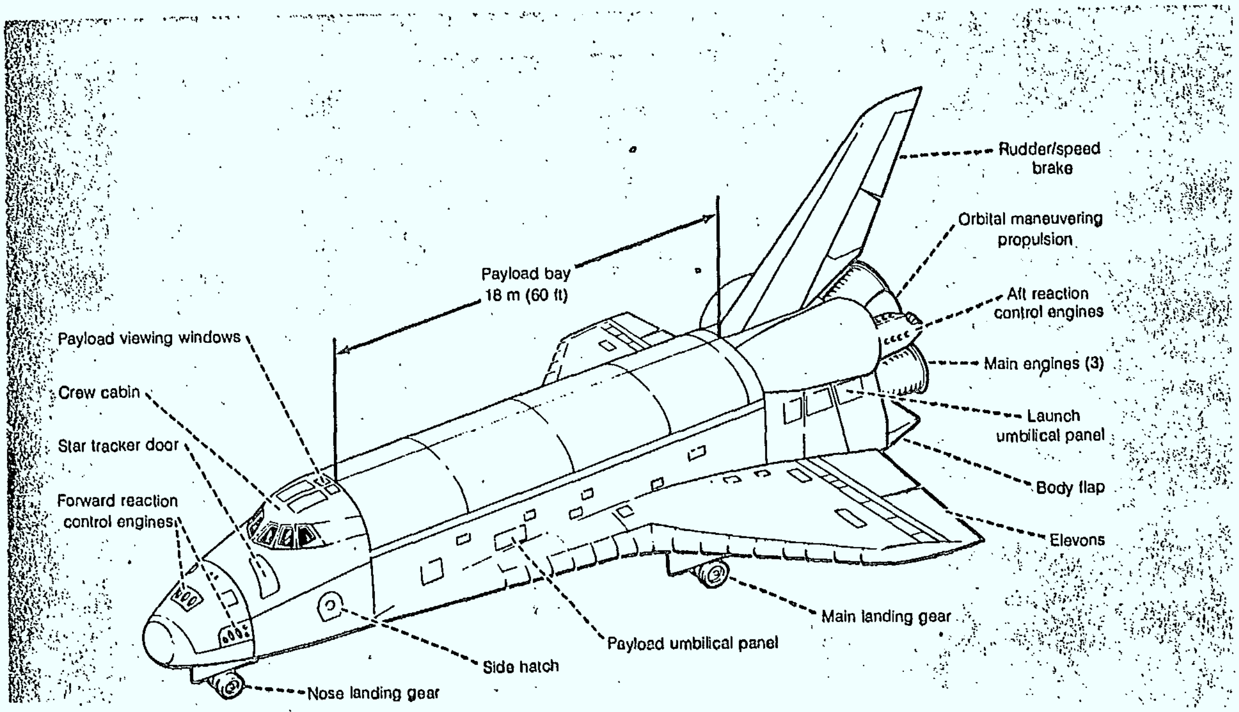


FIGURE I.1-3: STS ORBITER

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1.1.3 External Tank

The external tank, see Figure I.1-4, contains the propellants for the Orbiter main engines: liquid hydrogen (LH_2) fuel and liquid oxygen (LO_2) oxidizer. All fluid controls and valves (except the vent valves) for operation of the main propulsion system are located in the Orbiter to minimize throwaway costs. Antivortex and slosh baffles are mounted in the oxidizer tank to minimize liquid residuals and to damp fluid motion. Five lines (three for fuel and two for oxidizer) interface between the external tank and the Orbiter. All are insulated except the oxidizer pressurization line. Liquid-level point sensors are used in both tanks for loading control.

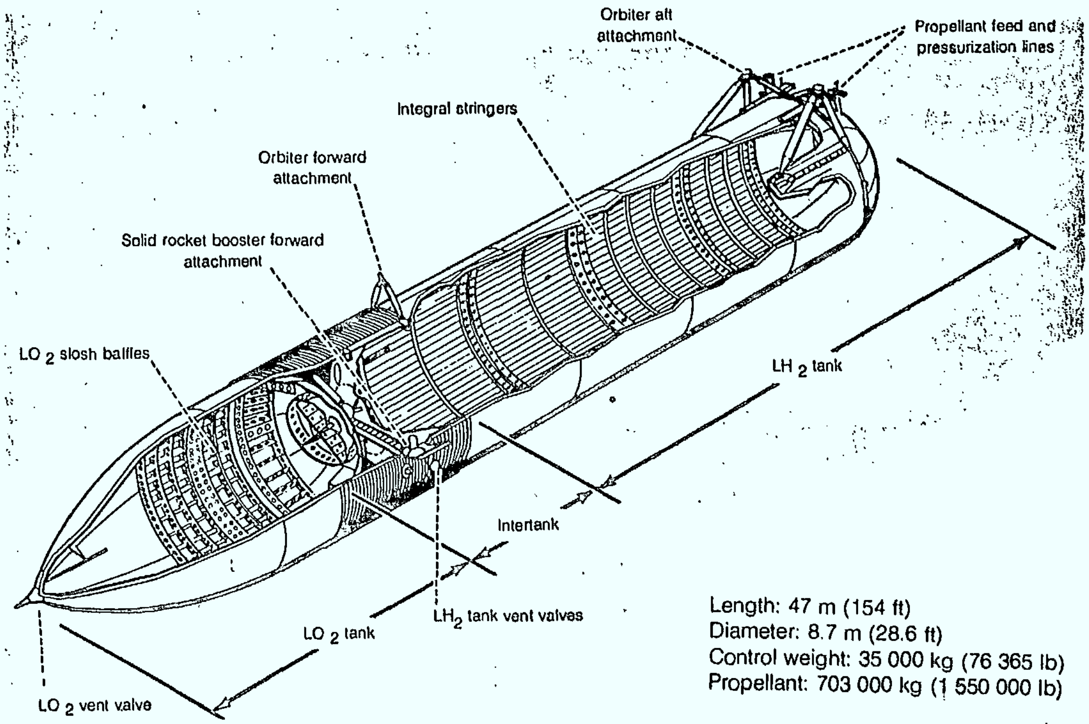


FIGURE I.1-4: STS EXTERNAL TANK

At lift-off, the external tank contains 703,000 kilograms (1,550,000 pounds) of usable propellant. The LH_2 tank volume is 1523 m^3 (53,800 ft^3) and the LO_2 tank volume is 552 m^3 (19,500 ft^3). The hydrogen tank is pressurized to a range of 220,600 to 234,400 N/m^2 (32 to 34 psia) and the oxygen tank to 137,900 to 151,700 N/m^2 (20 to 22 psia).

Both tanks are constructed of aluminum alloy skins with support or stability frames as required. The sidewalls and end bulkheads use the largest available width of plate stock. The skins are butt-fusion-welded together to provide reliable sealed joints. The skirt aluminum structure uses skin/stringers with stabilizing frames.

Spray-on foam insulation (SOFI) is applied to the complete outer surface of the external tank, including the sidewalls and the forward bulkheads. This spray-on ablator is applied to all protuberances, such as attachment structures, because shock impingement causes increased heating to these areas. The thermal protection system (TPS) coverage is minimized by using the heat-sink approach provided by the sidewalls and propellants.

1.1.4 Solid Rocket Boosters

Two solid rocket boosters (SRB's), see Figure I.1-5, burn for 2 minutes with the main propulsion system of the Orbiter to provide initial ascent thrust. Primary elements of the booster are the motor, including case, propellant, igniter, and nozzle; forward and aft structures; separation and recovery avionics, and thrust vector control subsystems. Each SRB weighs approximately 583,600 kilograms (1,286,600 pounds) and produces 11,800,000 newtons (2,650,000 pounds) of thrust at sea level. The propellant grain is shaped to reduce thrust by approximately one-third 55 seconds after lift-off to prevent overstressing the vehicle during the period of maximum dynamic pressure. The thrust vector control subsystem has

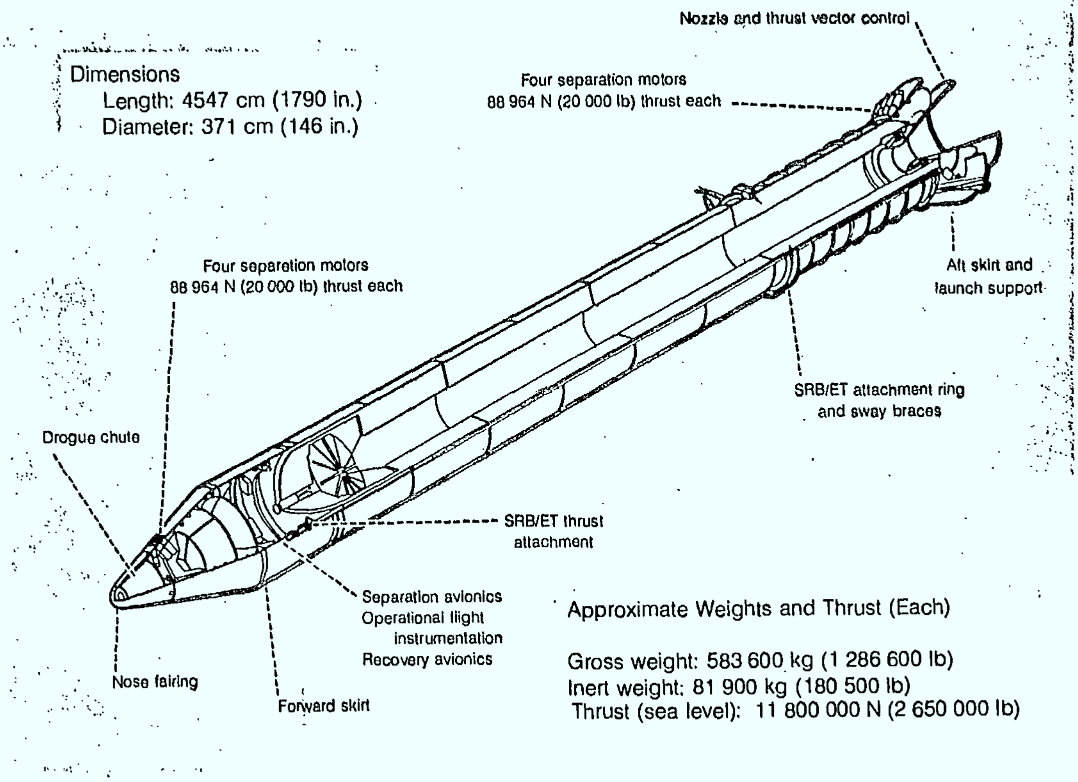


FIGURE I.1-5: SOLID ROCKET BOOSTERS

a maximum omniaxial gimbal capability of slightly over 7° which, in conjunction with the Orbiter main engines, provides flight control during the Shuttle boost phase.

The SRB is attached to the tank at the forward end of the forward skirt by a single thrust attachment. The pilot, drogue, and main parachute risers of the recovery subsystem are attached to the same thrust structure.

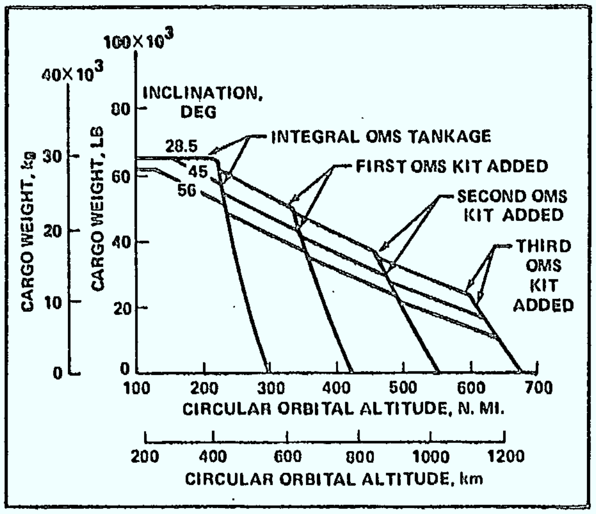
The SRB's are released by pyrotechnic separation devices at the forward thrust attachment and the aft sway braces. Eight separation rockets on each SRB (four aft and four forward) separate the SRB from the Orbiter and external tank. They continue through a 67,000-meter (220,000-foot) apogee, then at 5,800 meters (19,000 feet) the SRB nose cap is deployed for recovery initiation. The pilot chute deploys the drogue chute, which, after stabilizing the SRB, then deploys the aft frustrum with the main parachute packs. The three main chutes inflate to a reefed condition at 2,700 meters (8,800 feet) and are fully extended at 1,000 meters (3,400 feet). When the SRB impacts the water approximately 300 kilometers (160 nautical miles) downrange, the parachutes are jettisoned and the tow pendant deployed. The recovery ship deploys a nozzle plug which is inserted in the SRB to facilitate inflation and dewatering so that the booster will float on the surface horizontally for towing to port for refurbishing and subsequent reuse.

1.2 Payload Accommodations

1.2.1 Mission Performance Capabilities

Geosynchronous missions will be launched from the John F. Kennedy Space Center (KSC), Florida, where a launch azimuth range of 28.5 to 57 degrees is currently available. Figure I.1-6 shows the payload weight capability of the STS as a function of circular orbit altitude and use of optional additional orbit altitude and use of optional additional orbit manoeuvring system kits. The standard missions which are included in the basic user charge are:

attitude of parking orbit	160 nmi
inclination of parking orbit	28.5° or 56°
mission duration	1 day per payload on-orbit
flight crew complement	3, including mission specialist

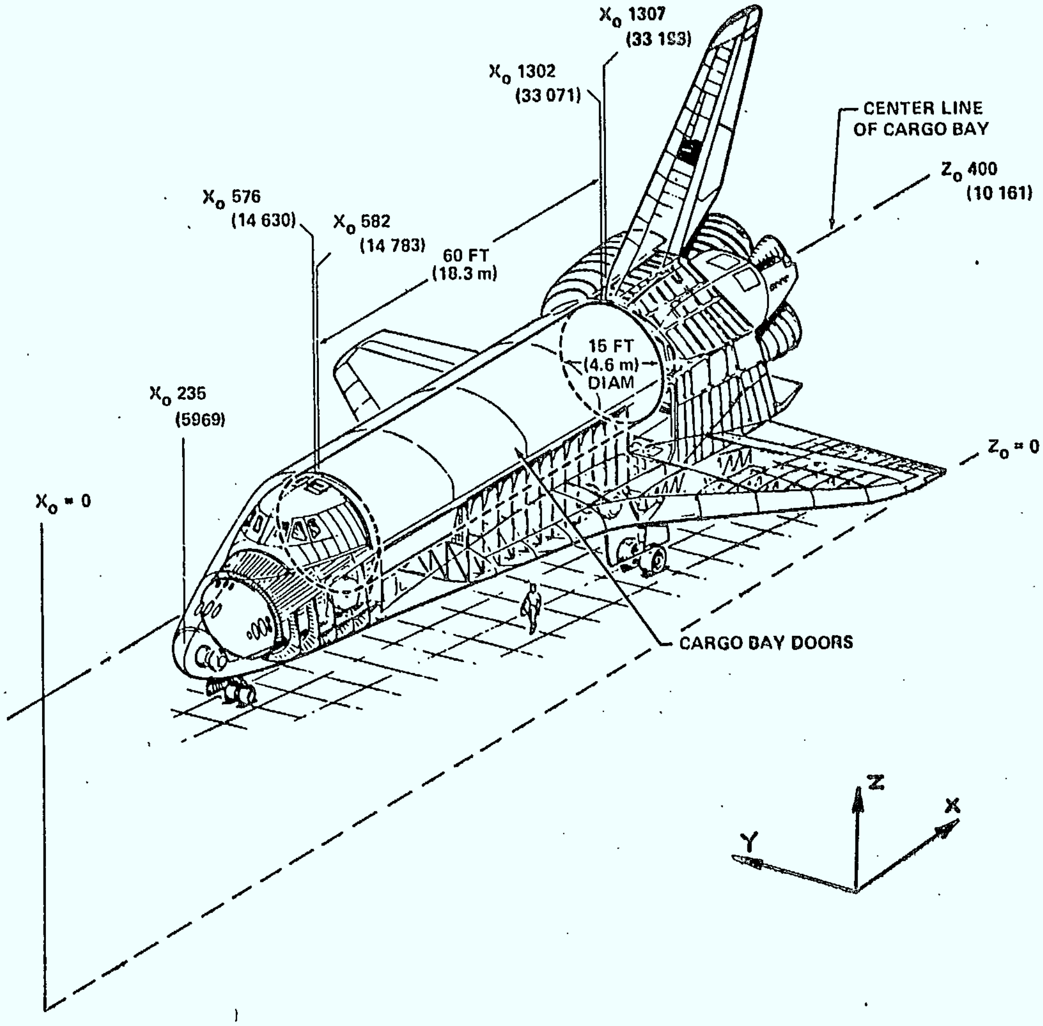


Maximum cargo weights at various circular orbital altitudes for flights with delivery only.

FIGURE I.1-6: PAYLOAD WEIGHT CAPABILITY OF STS

1.2.2 Payload Bay Envelope

Payload accommodations are provided in two general areas of the Orbiter: the cargo bay and the aft flight deck in the cabin. The dimensions and envelope of the bay are illustrated in Figure I.1-7, along with the structural coordinate system.



Orbiter coordinate system and cargo bay envelope. The dynamic clearance allowed between the vehicle and the payload at each end is also illustrated.

FIGURE I.1-7: STS CARGO BAY ENVELOPE

The cargo bay is covered with doors that open to expose the entire length and full width of the cargo bay. The usable envelope is limited by items of supporting subsystems in the cargo bay that are charged to the payload volume.

The payload clearance envelope in the Orbiter cargo bay measures 15 by 60 feet (4572 by 18,288 millimeters). This volume is the maximum allowable payload dynamic envelope, including payload deflections. In addition, a nominal 3-inch (76-millimeter) clearance between the payload envelope and the Orbiter structure is provided to prevent Orbiter deflection interference between the Orbiter and the payload envelope.

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1.2.3 Payload Interfaces

The Orbiter systems are designed to support a variety of payloads and payload functions. The payload and mission stations on the flight deck provide space for payload-provided command and control equipment for payload operations if required by the user. Remote control techniques can be managed from the ground when desirable.

Payload accommodations are described in detail in the core ICD 2-19001, JSC entitled Shuttle Orbiter/Cargo Standard Interfaces plus in JSC 07700, Volume XIV (soon to be discontinued).

The following support subsystems are provided for payloads and are shown in Figure I.1-8:

- o Payload attachments
- o Remote manipulator handling system
- o Electrical power, fluids, and gas utilities
- o Environmental control
- o Communications, data handling, and displays
- o Guidance and navigation
- o Flight kits
- o Extravehicular activity (EVA) capability when required

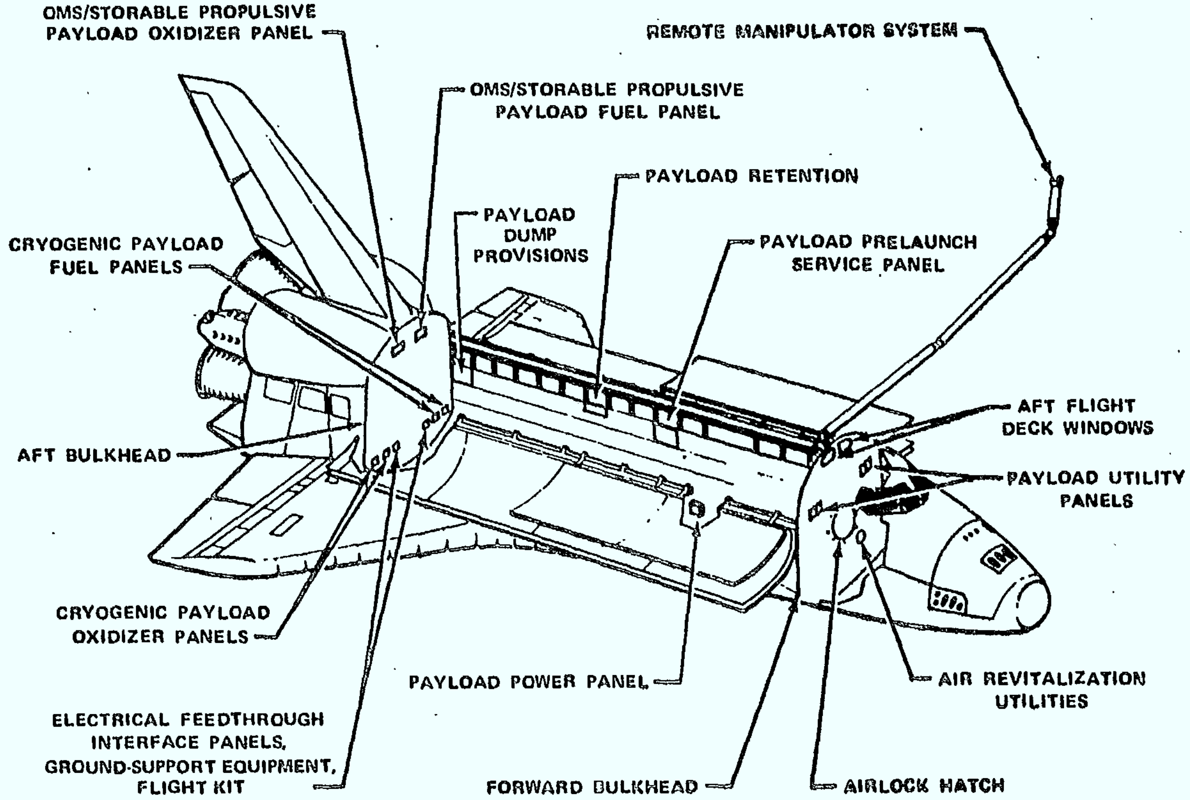

FIGURE I.1-8: STS SUPPORTING PAYLOAD INTERFACES

NOTE: The craddle support structure for the spacecraft is not provided by the STS, and must be provided by the spacecraft contractor or by the SSUS stage, eg: PAM-D.

2.0 SPINNING SOLID UPPER STAGE (SSUS)

As mentioned in the main text of Volume I, the SSUS considered for this study is the McDonnell-Douglas Payload Assist Module Delta Class (PAM-D).

2.1 General Configuration of PAM-D System

The overall configuration of the PAM-D system is illustrated in breakaway form in Figure I.2-1 and consists of the following major parts.

- Payload Attach Fitting (PAF)
- Solid Propellant Motor, STAR-48
- Airborne Support Equipment (ASE) comprising:
    - Telemetry
    - Electrical System
    - Spacecraft Separation System
    - Cradle Assembly
    - Spin Table System
    - Control and Monitor Equipment
    - Deployment System

Figure I.2-2 shows the inboard profile assembly of the PAM without the cradle and Figure I.2-3 shows the cradle assembly.

2.2 PAM System Mission Profile

The nominal sequence of events for a baseline mission is based on deployment from the orbiter in the early part of its orbital period. This sequence, from lift-off through spacecraft perigee injection is shown in Figure I.2-4. When the selected point of deployment is reached, the following STS PAM-D sequence of events will be initiated.

Time (sec)	Event
T-1500	Turn on STS PAM-D power
T-960	PAM-D system status check complete
T_1-840	Achieve PAM/spacecraft deployment attitude
T_1-780	Release restraints and confirm
T_1-600	Initiate spin-up
--	Spin-up complete and verified
T_1-0	Deploy PAM Initiate sequencing system by separation switches
T_1+2727	Achieve separation distance required by STS
T_1+2727	PAM motor ignition
T_1+2815	PAM motor burnout
T_1+2927	Fire PAM/spacecraft separation bolt cutters
T_1+2929	Fire tubmle system yo-weight bolt cutters

2.3 STS PAM-D Capability

The standard STS PAM-D is capable of injecting, as a baseline, a 2320 lb. spacecraft into a geosynchronous transfer orbit as shown in Figure I.2-5.

The capability can be increased (Flex-PAM) to the maximum level shown in the figure as an extra cost option, which involves an extension of the PAM motor.

2.4 Allowable Spacecraft Envelope and Interfaces

The maximum allowable envelope for a spacecraft for installation with the PAM-D system to the Orbiter is given by Figure I.2-6. Additional areas may be available outside the envelope shown, but these would have to be coordinated with the MDAC PAM Program Office.

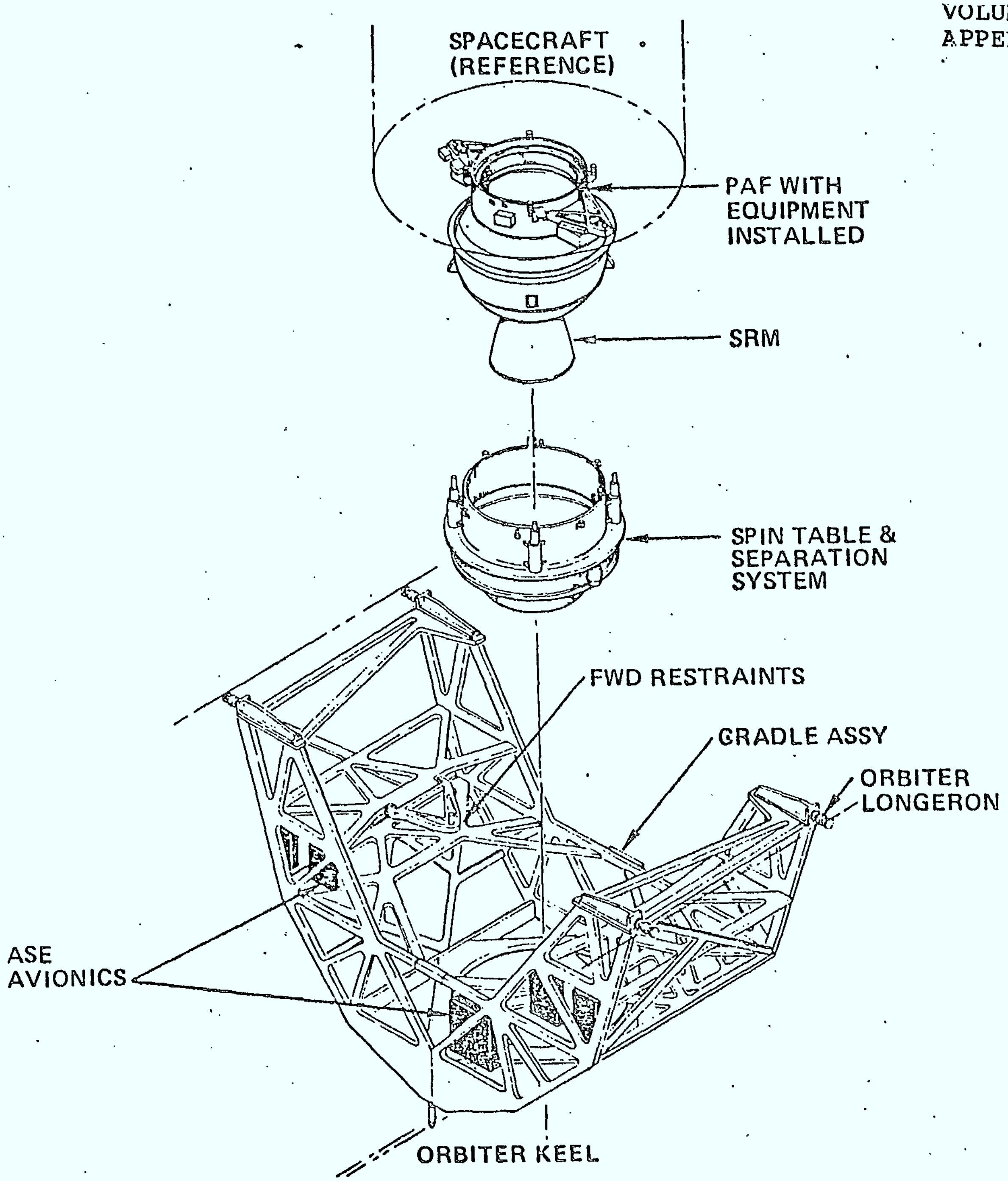

FIGURE I.2-1: OVERALL CONFIGURATION OF PAM-D SYSTEM

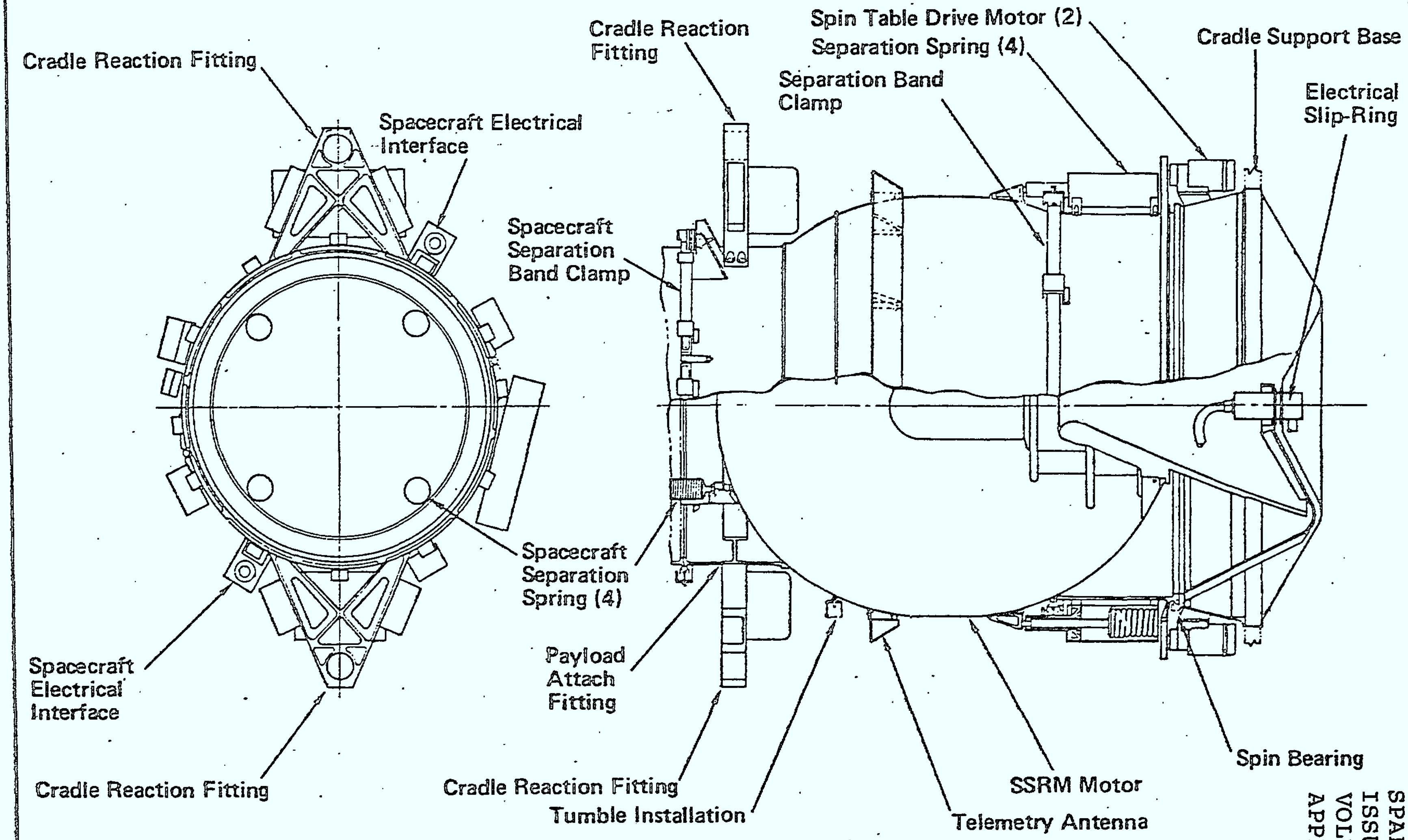

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FIGURE I.2-2: STS PAM-D INBOARD PROFILE

SPAR

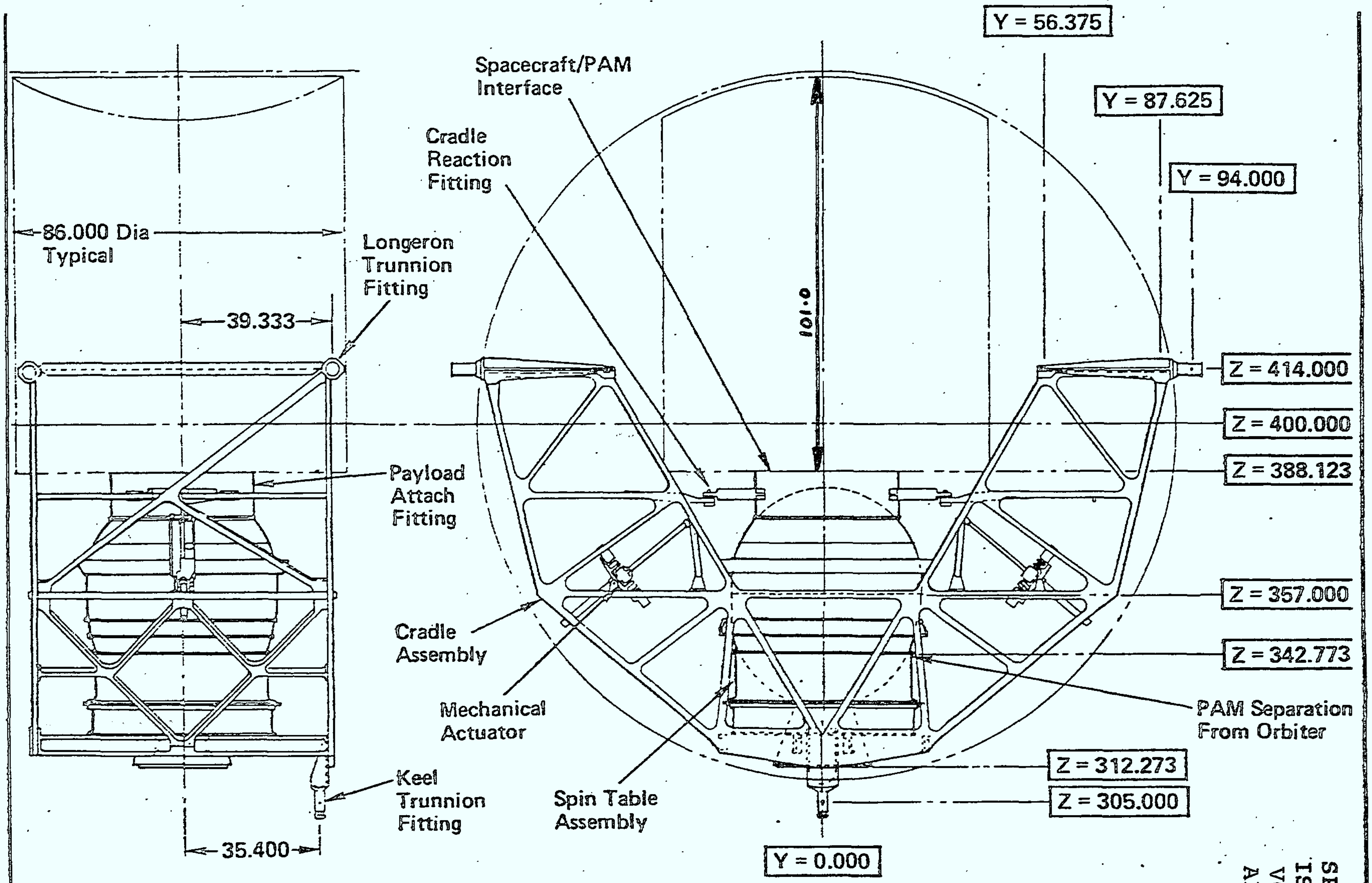

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FIGURE I.2-3: STS PAM-D CRADLE ASSEMBLY

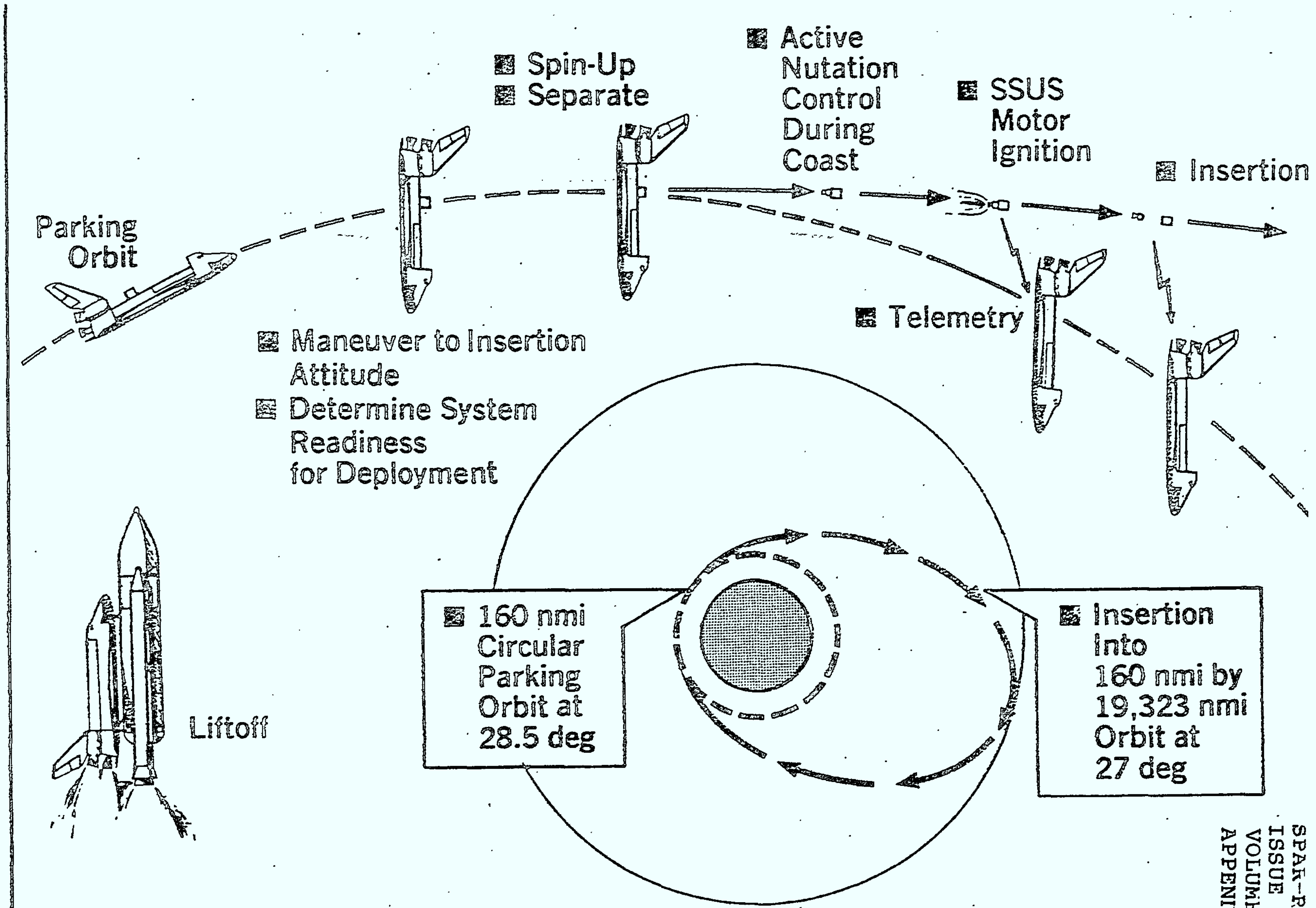


FIGURE I.2-4: PAM SYSTEM ON-ORBIT ACTIVITIES

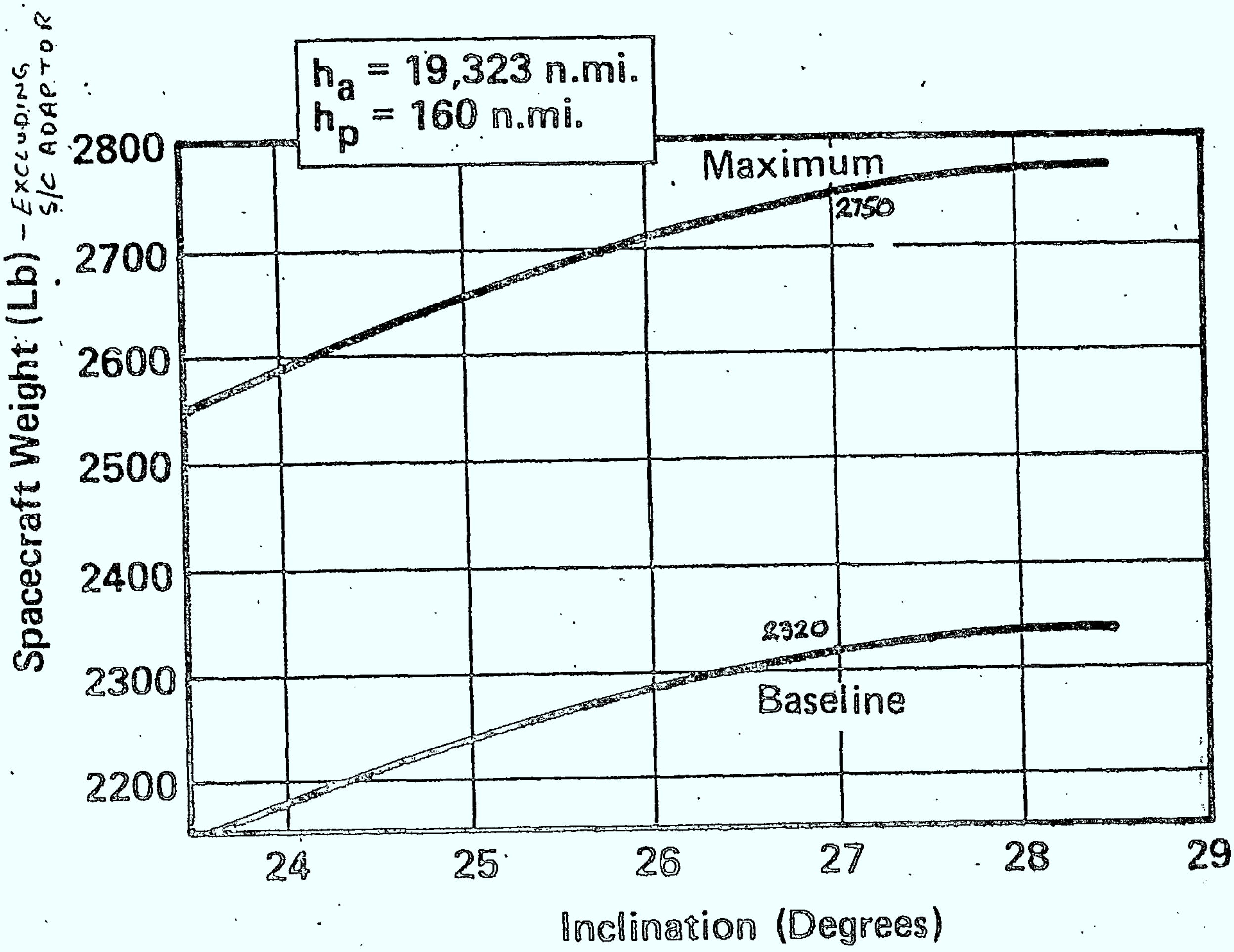


FIGURE I.2-5: STS PAM-D PAYLOAD CARRYING CAPABILITY

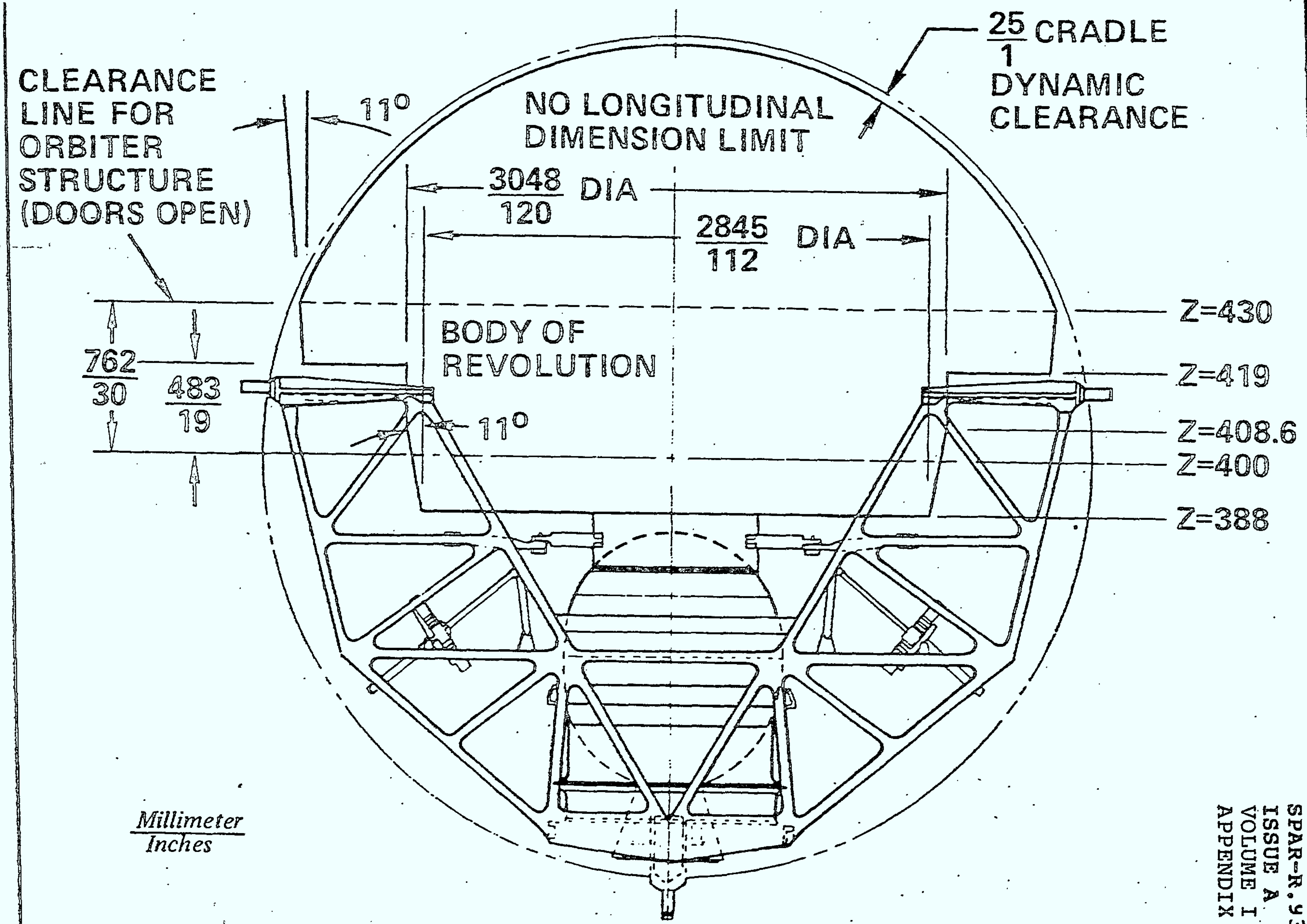


FIGURE I.2-6: STS PAM-D MAXIMUM SPACECRAFT ENVELOPE

A payload Attach Fitting (adapter) type 3712 is mounted between the PAM-D assembly and the spacecraft and a spacecraft separation system will be provided on the PAF consisting of a Marmon-type clamp assembly which holds the spacecraft to the forward end of the PAF. The clamp assembly is attached by two bolts, which are severed by two confined detonating fuse (CDF) initiated bolt cutters. The spacecraft is separated from the expended PAM by four separation springs, which will give a relative separation velocity in the range of 0.61 to 2.44 meters/second (2 to 8 feet/second).

The STS PAM aft structural skirt will include a yo-weight tumble assembly that is similar to that currently used on the Delta vehicle. A cable with a yo-weight attached to the structure is restrained by a second cable on which are mounted redundant cutters. When the cutters are fired, the yo-weight deploys, imparting a coning motion and lateral velocity to the expended PAM hardware.

A redundant system for PAM sequencing after separation from the STS is included on the support structure. Signals from separation switches will initiate a timing sequence upon separation from the spin table. After a predetermined delay of up to 45 minutes, to allow the required separation from the orbiter, the PAM solid motor will be ignited. Following completion of solid motor burn, the sequencer system will initiate spacecraft separation and then initiate the yo-weight release cutters. A block diagram for the system is shown in Figure I.2-7.

Electrical power for the STS PAM/spacecraft system in the Orbiter will be provided by the Orbiter. Up to 500 watts of 24 to 32 volts DC Orbiter power will be available. Spacecraft power and monitoring will be provided through the STS PAM system via three connectors which interface with the spacecraft as shown in Figure I.2-8. This interface will include provisions for spacecraft status, spacecraft state of health, telemetry, command circuitry, safe and arm, and power.

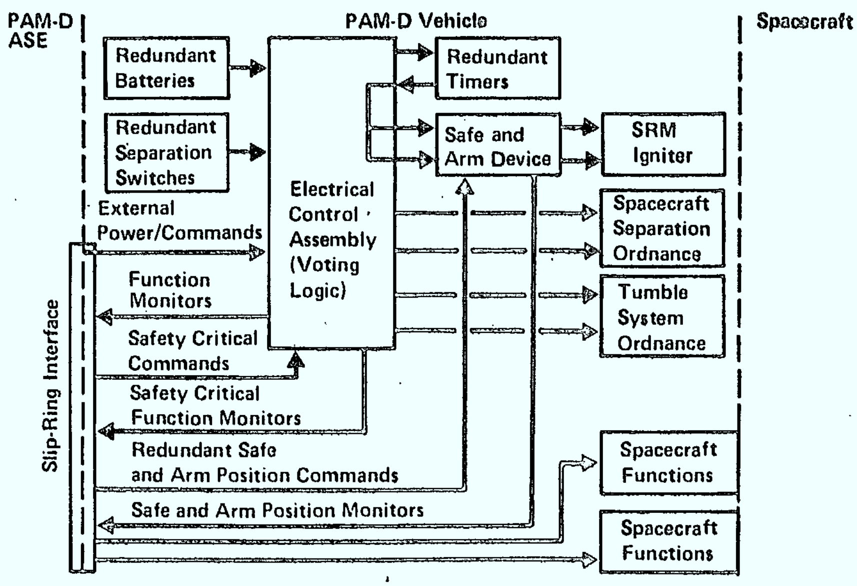


FIGURE I.2-7: STS PAM-D SEQUENCE DIAGRAM

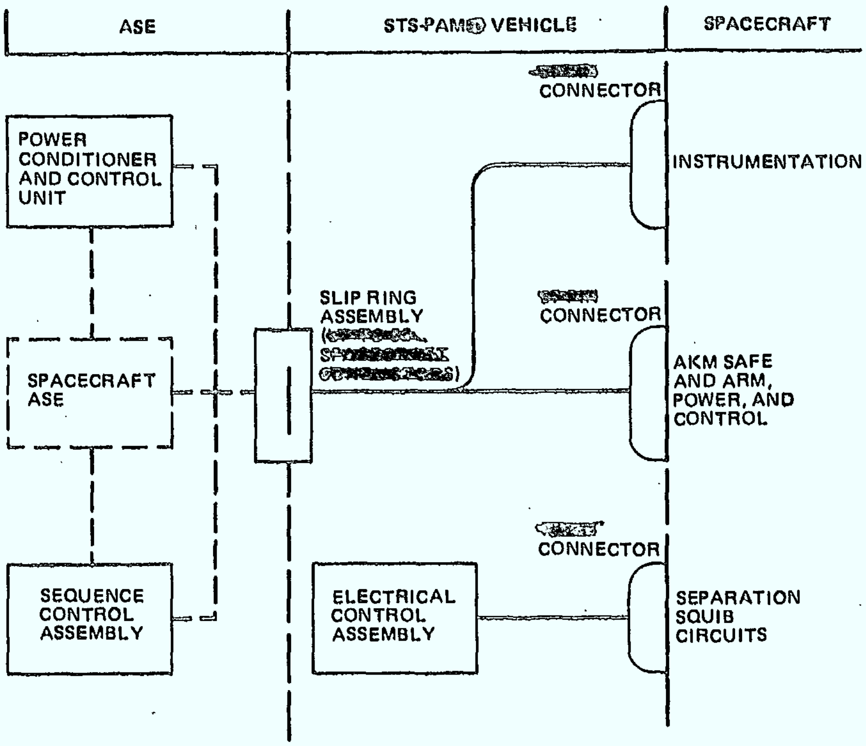


FIGURE I.2-8: STS PAM-D/SPACECRAFT ELECTRICAL INTERFACE

3.0 KENNEDY SPACE CENTRE (KSC) LAUNCH SITE

3.1 General Building and Launch Site Layout

An overall aerial view of the Cape Canaveral Air Force Station (CCAFS) and the KSC complex is shown in Figure I.3-1. The figure includes the locations of all the main buildings and facilities utilized for a typical Delta class payload and launch vehicle such as:

- Hangers AO, AM, S, AE
- Delta Spin Test Facility or
- Explosive Safe Area 60 (ESA 60),
- Vertical Processing Facilities (VPF)
- Orbiter Processing Facility (OPF)
- Vehicle Assembly Building (VAB)
- Launch Pad

The standard processing flow through the buildings and facilities I.3-2 and is highlighted for a typical Delta class payload.

3.2 Buildings and Facilities Description

A brief description of the buildings and facilities is given as follows and are all applicable for Delta class payloads unless otherwise indicated:

3.2.1 Hangers AO, AM, S, AE

These buildings are used for the purpose of processing incoming spacecraft payloads. The individual hangers differ by providing various degrees of temperature control, humidity control and cleanliness, in addition to providing specialist facilities such as systems test areas and high bay areas.

3.2.2 Delta Spin Test Facility & Explosive Safe Area 60

These two areas are both used for the purpose of hazardous systems processing of incoming spacecraft payloads. The Delta Spin Test Facility, in

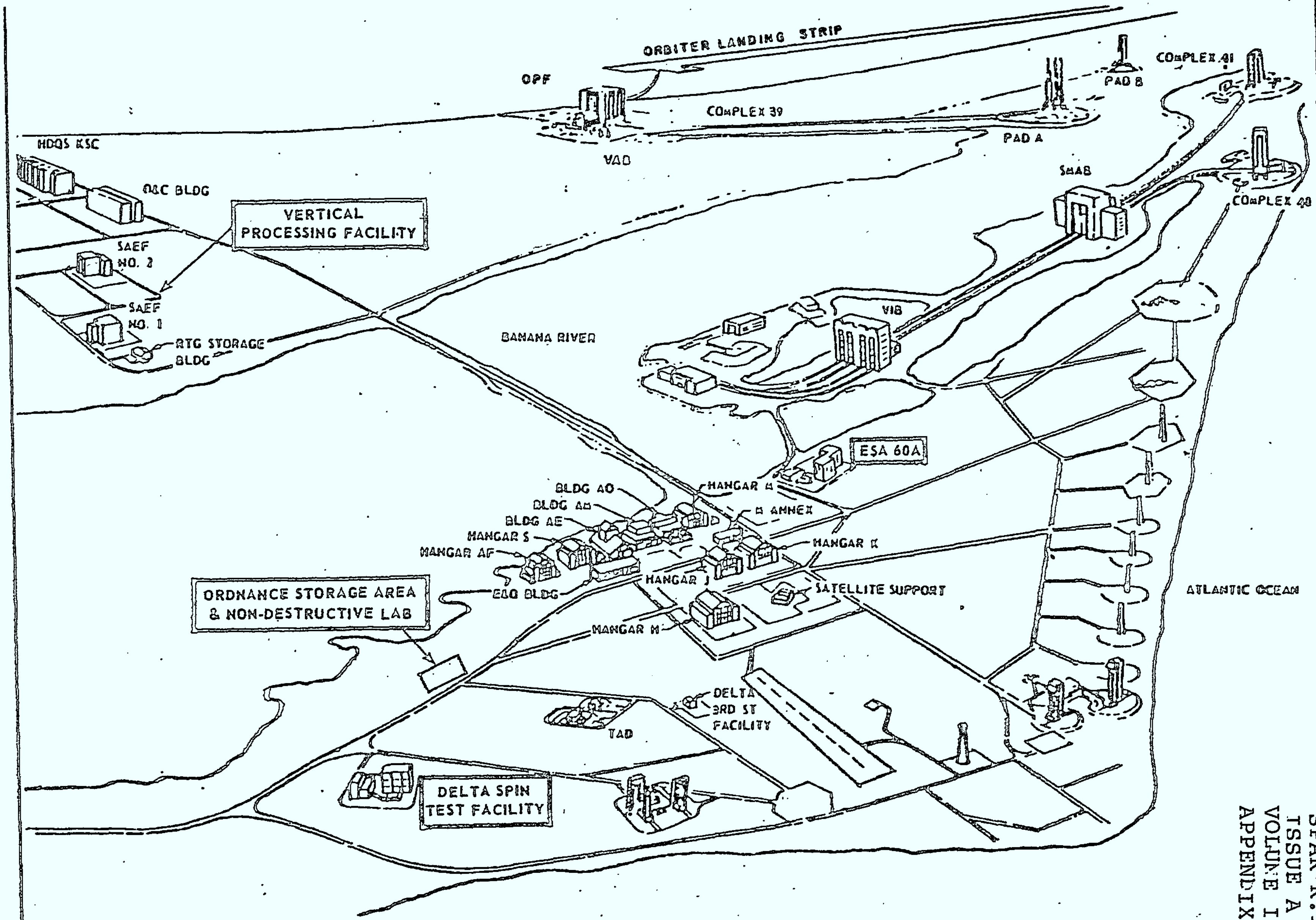


FIGURE I.3-1: ARIEL VIEW OF CCAFS AND KSC COMPLEX

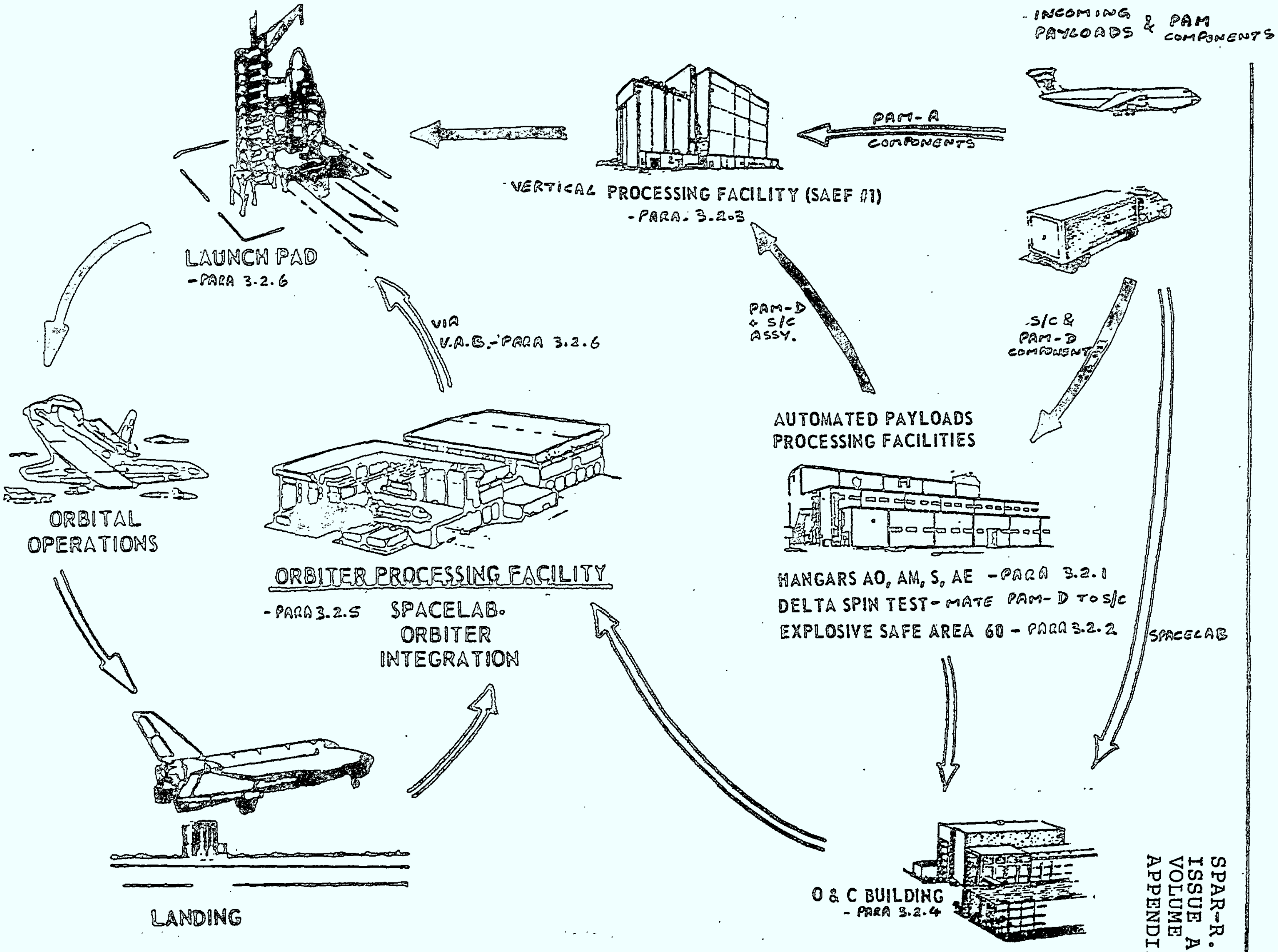


FIGURE I.3-2: TYPICAL PAYLOAD/ORBITER PROCESSING FLOW particular, is used for Delta class payloads and for the purpose of mating the payload with the STS PAM-D. In the case of payloads to be mated with the STS PAM-A, however, the mating would be performed in the Vertical Processing Facility (VPF). As for the hangers above, the buildings provide various degrees of temperature and humidity control and cleanliness standards.

3.2.3 Vertical Processing Facility (VPF)

All automated payloads are mated to form a single cargo in the VPF, a floor plan of which is shown in Figure I.3-3.

Vertical processing of the payload is performed by Cargo Integration test equipment (CITE) in the VPF which includes those items required to perform mechanical clearance and fit checks but not the complete CITE equipment as found in the Horizontal Processing Facility detailed in 3.2.2. Figure I.3-4 illustrates the CITE configuration within the Vertical Processing Facility and Figure I.3-5 shows the flow of the containerized payload into the VPF.

3.2.4 Horizontal Processing Facility (Within Operations and Checkout Building - not Applicable to Delta Class Payloads)

In the case of a payload requiring horizontal processing as opposed to vertical processing described above, (eg: Spacelab, LDEF, etc.) the CITE equipment is accommodated within the operations and checkout building. The CITE includes structural assembly stands, mechanical clearance and fit gauges, electrical wiring, thermal-conditioning items, electronic test sets, and radio-frequency transmission equipment adapters as required to perform final assembly and integrated testing of the payload before mating to the shuttle. The configuration is shown in Figure I.3-6.

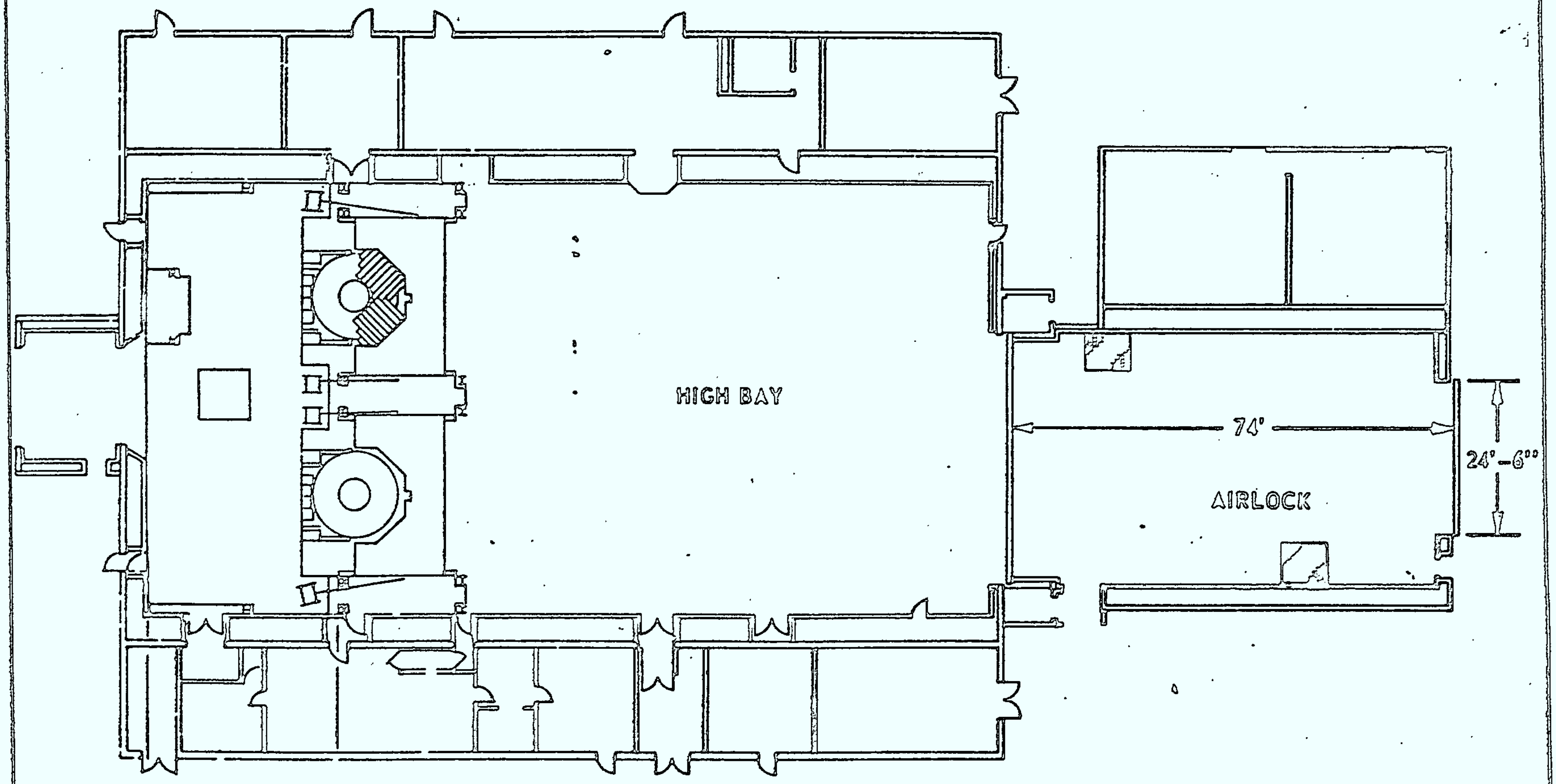


FIGURE I.3-3: FLOOR PLAN OF VERTICAL PROCESSING FACILITY

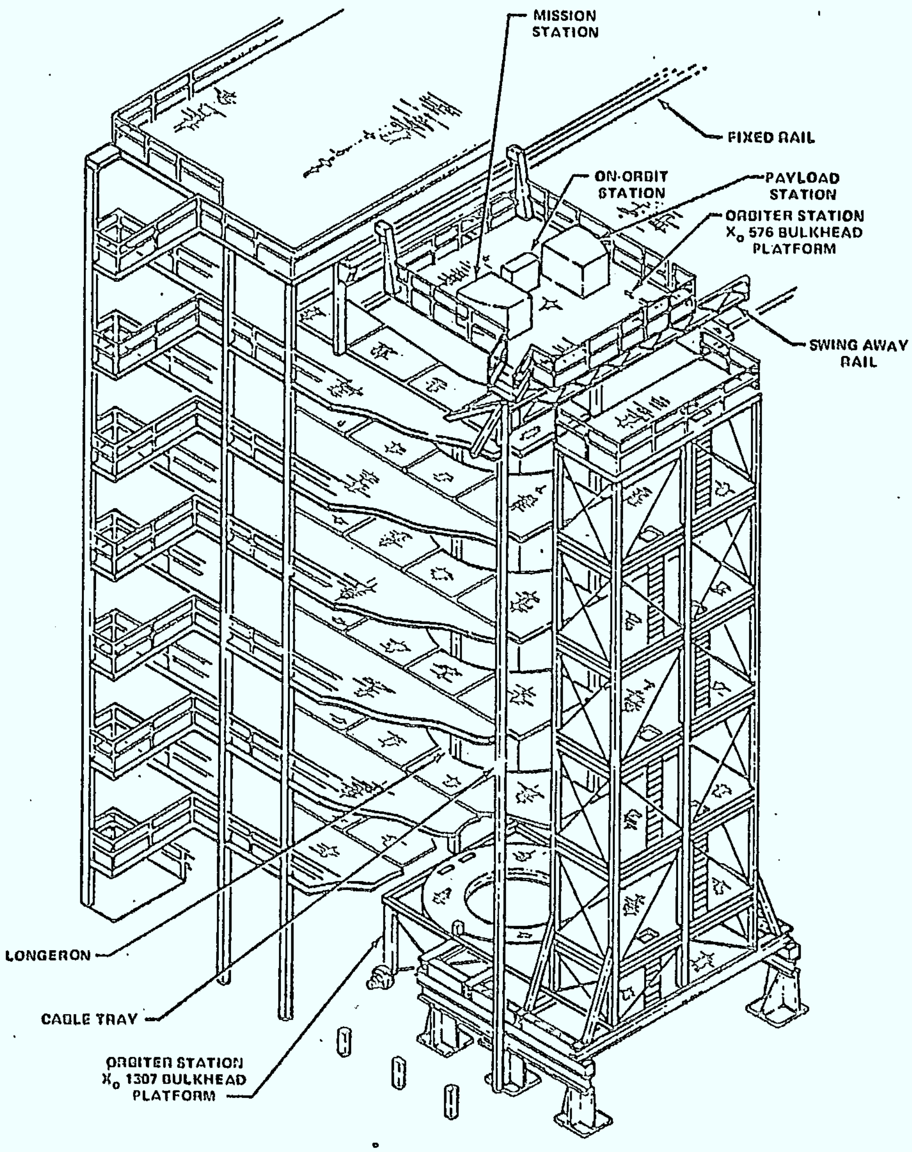


FIGURE I.3-4: CONFIGURATION OF CITE AT VPF

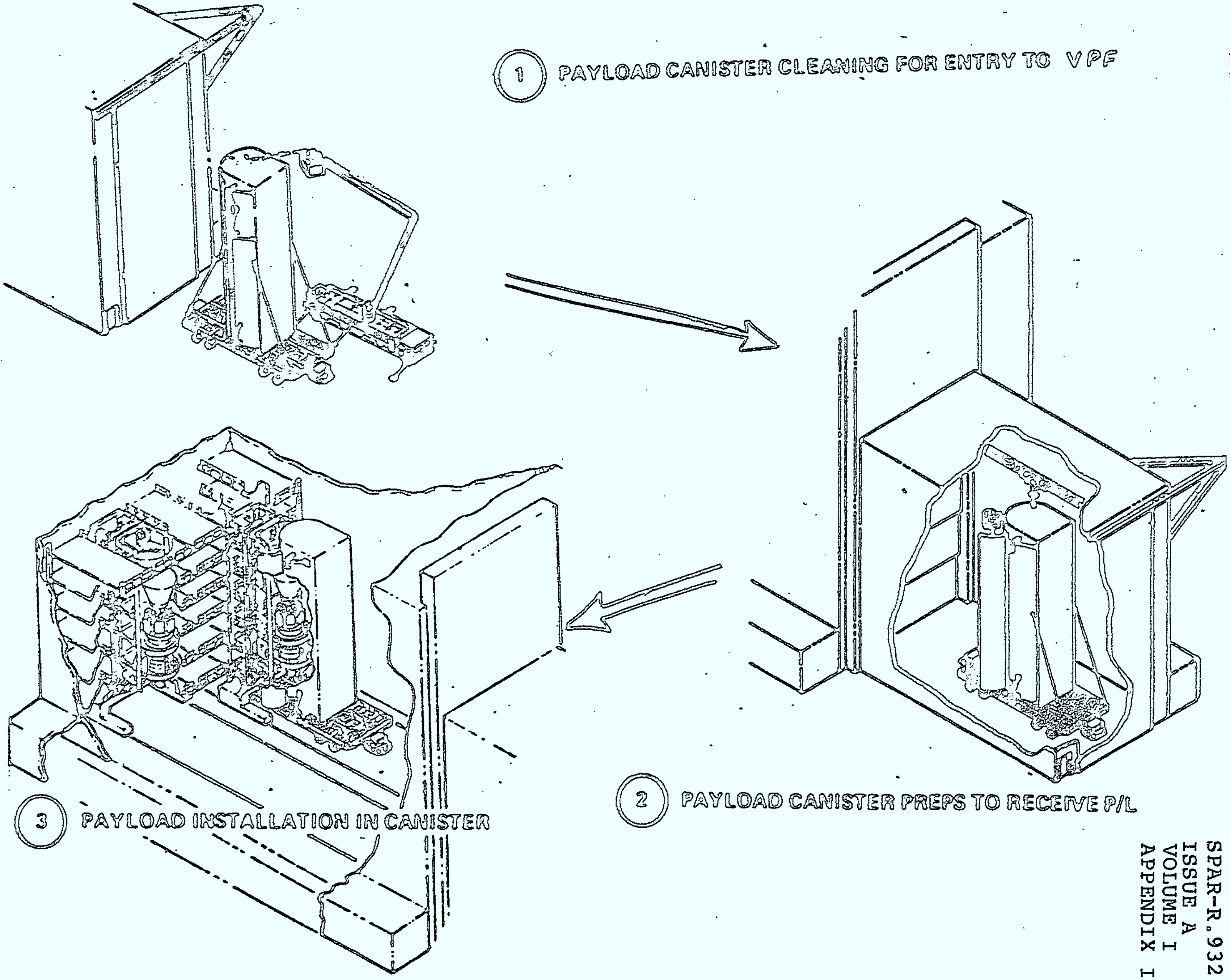


FIGURE I.3-5: FLOW OF ACTIVITIES IN VPF

3.2.5 Orbiter Processing Facility (not applicable to Delta Class payloads)

The Orbiter Processing facility forms part of the Launch Complex 30 area and is primarily used for:

- Orbiter Refurbishment
- Horizontally Loaded Payload Installation and Interface Verification

The horizontally processed payload installation is performed within this facility, but for a vertically processed payload, installation is not performed until the shuttle is moved to the pad.

The following Figures I.3-7, and I.3-8 illustrate the overall layout of the facility, showing the external view, an aerial breakaway view and details of the integration platforms and equipment respectively.

As for the buildings addressed above, the OPF provides varying degrees of temperature and humidity control and cleanliness standard.

3.2.6 Vehicle Assembly Building and Launch Pad

Following the refurbishment activities in the Orbiter Processing Facility the orbiter is transferred to the Vehicle Assembly Building (VAB).

At the VAB the orbiter, without cargo in the case of an automated freeflier mission, is hoisted to a vertical position, transferred to an integration cell, and lowered and mated to the external tank and solid rocket boosters. During these orbiter hoisting operations there will be a period of approximately 40 hours when the environmental purge will be interrupted.

The sequence of events for the orbiter hoisting and mating to the solid rocket boosters and external tank on the mobile launch platform is illustrated by Figures I.3-9 and I.3-10.

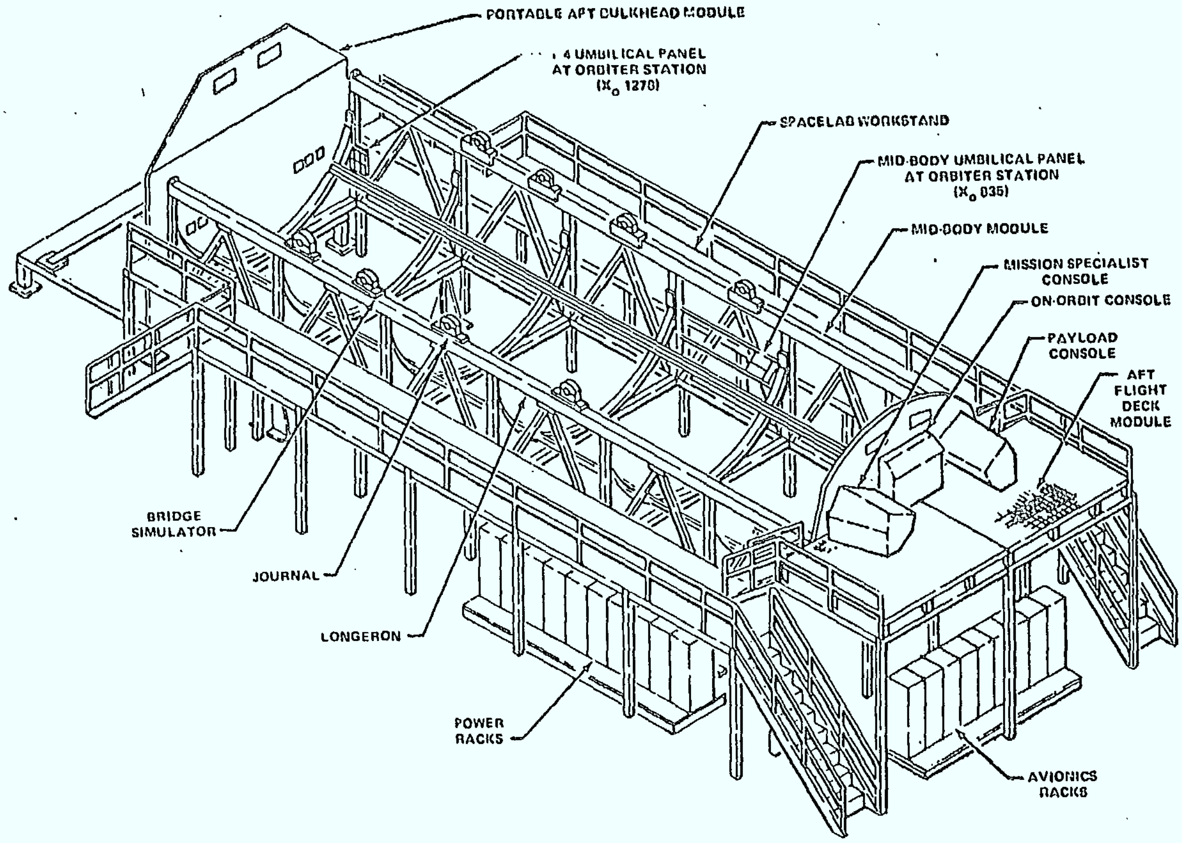


FIGURE I.3-6: CONFIGURATION OF CITE IN HORIZONTAL PROCESSING FACILITY (not applicable to Delta Class payloads)

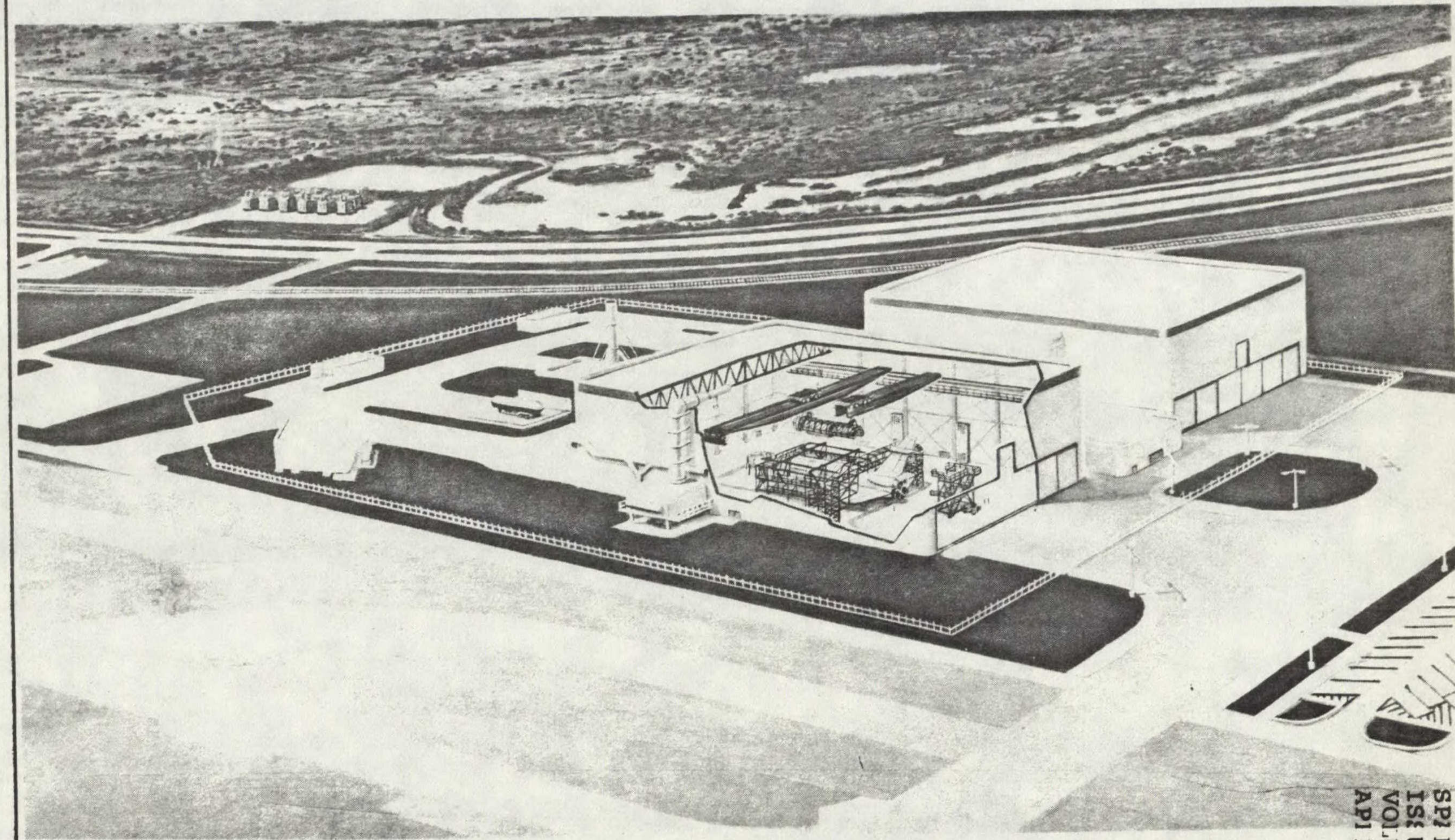


FIGURE I.3-7: AERIAL BREAKAWAY OF ORBITER PROCESSING FACILITY

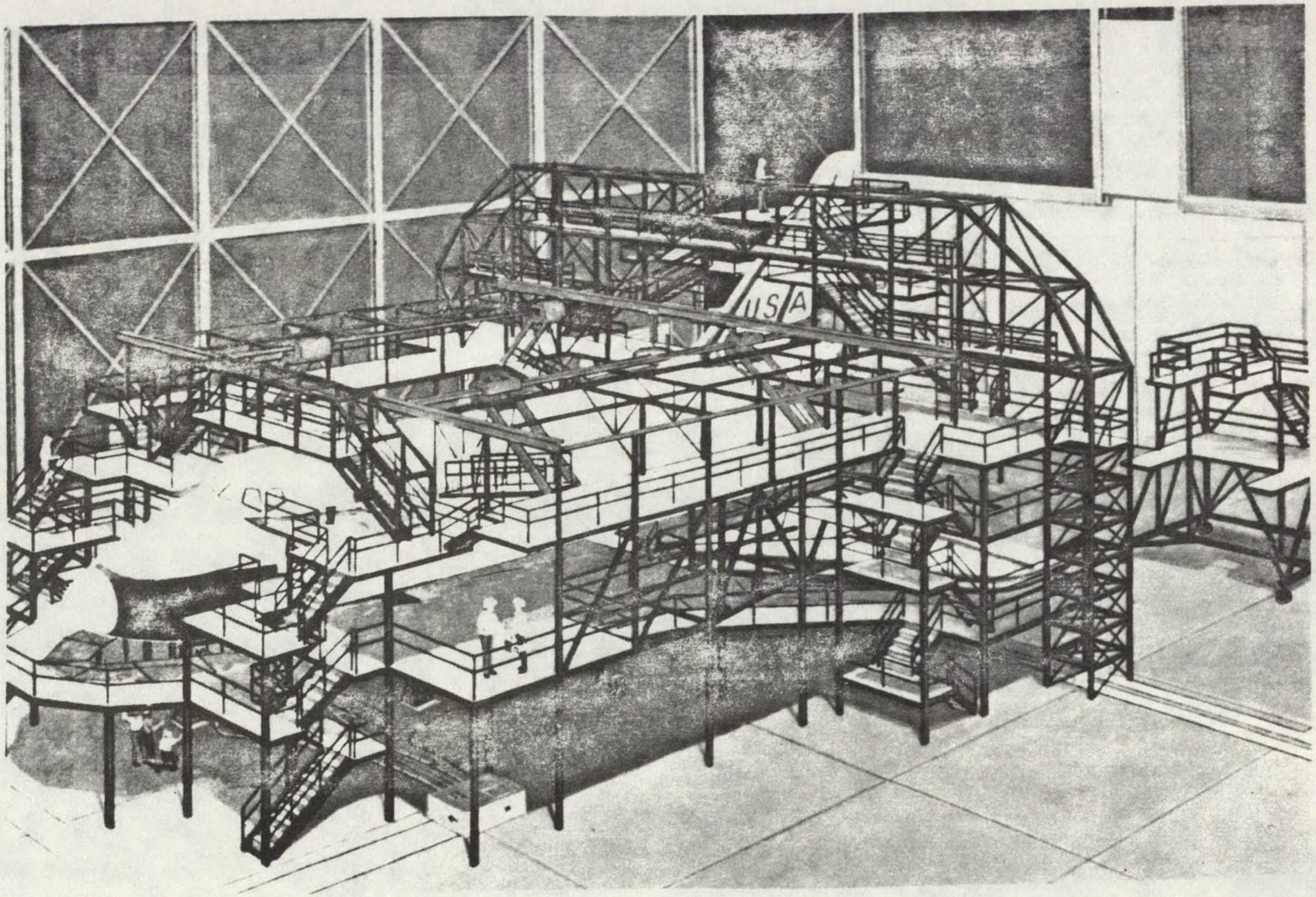


FIGURE I.3-8: REFURBISHMENT ACTIVITY IN ORBITER PROCESSING FACILITY
(not applicable to Delta Class Payloads)

The STS is then moved to the pad on the mobile launcher/crawler transporter.

3.2.6.1 Vertically Processed Payload Integration

For a vertically processed payload, the cargo arrives at the pad whilst contained in a vertical payload canister, and is taken to the Rotation Servicing Structure (RSS) for payload transfer into the Orbiter. The cargo arrives prior to the launcher.

When the canister is vertical, it simulates the Orbiter position and its configuration in the cargo bay area. An inflatable seal at the canister/RSS interface permits continuous control of the RSS interior environment. The cargo is raised from the canister support points, removed from the canister, and translated into the RSS by moving the payload ground-handling mechanism (PIGHM) along its overhead rail support to the rear of the RSS. The spacecraft/upper stage, and other payloads (if any), receive final preparations for installation into the Orbiter. The canister is lowered and removed. Finally, the RSS is rotated and extended to the Orbiter position.

Figure I.3-11 shows a cutaway of a canister in the RSS, and Figure I.3-12 presents the configuration of the RSS in the position for cargo transfer into the orbiter with the shuttle removed for clarity.

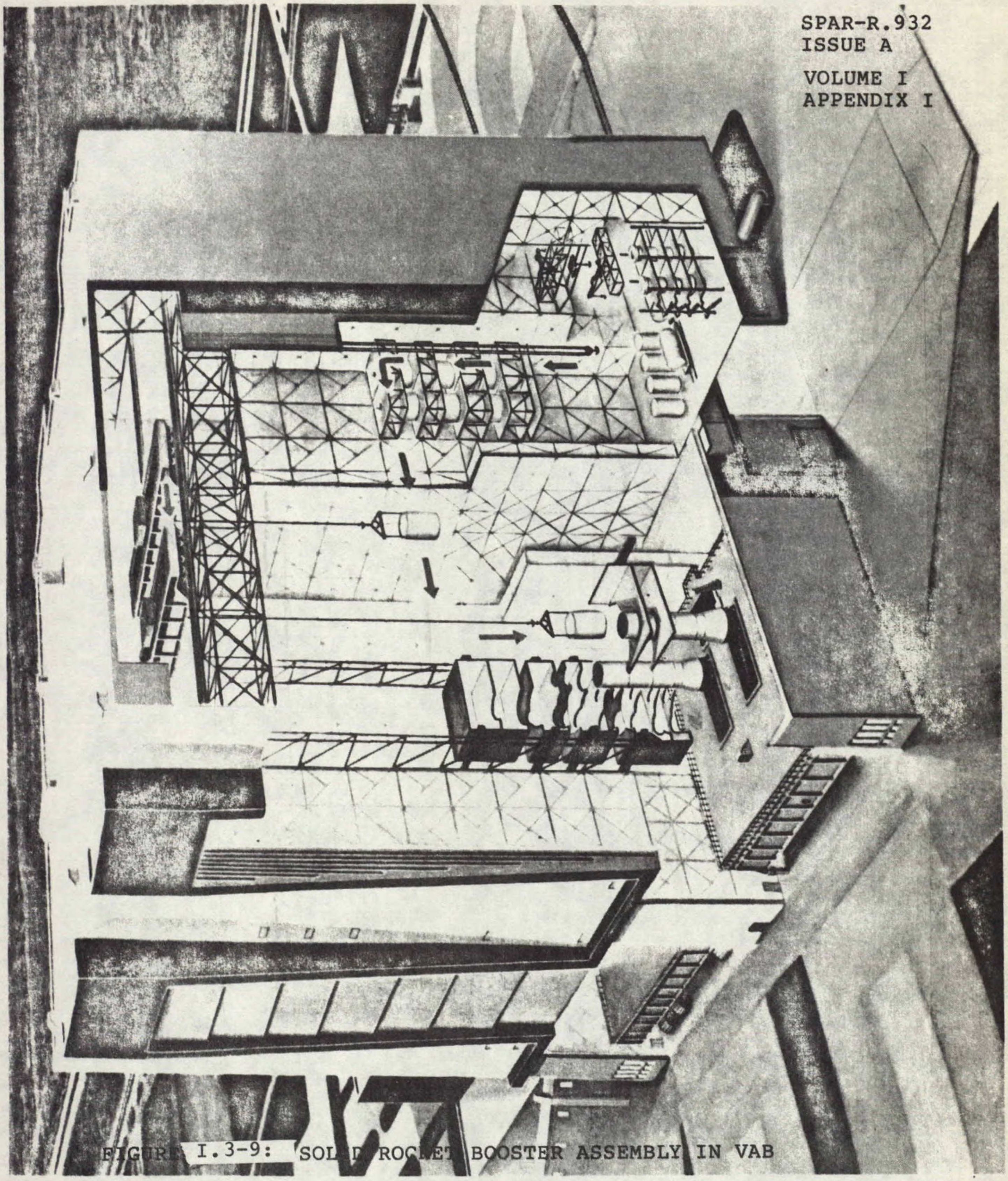


FIGURE I.3-9: SOLID ROCKET BOOSTER ASSEMBLY IN VAB

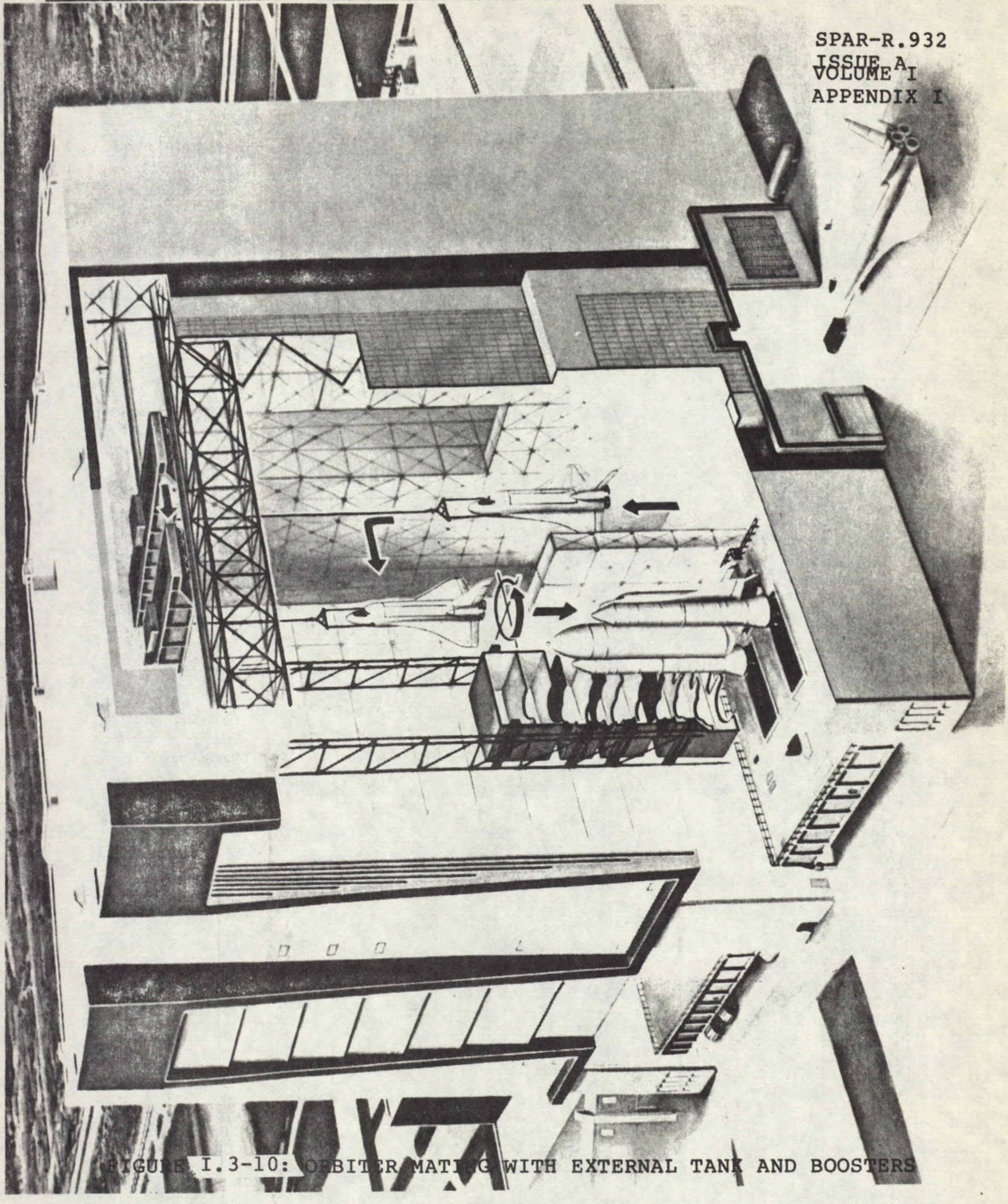


FIGURE I.3-10: ORBITER MATING WITH EXTERNAL TANK AND BOOSTERS

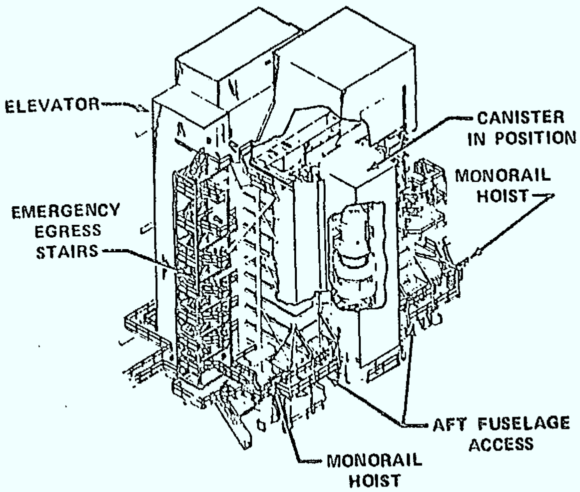


FIGURE I.3-11
CARGO CANISTER IN
THE RSS

At the allocated time the RSS is extended to make contact with the Orbiter. The RSS/Orbiter seal is inflated, the interstitial space between the RSS and Orbiter is purged and both sets of doors (RSS and Orbiter cargo bay) are opened. The payload ground-handling mechanism is moved toward the Orbiter to insert the spacecraft/upper stage into the cargo bay. The vertical and horizontal adjustment features of the mechanism are used to align the airborne support equipment trunnions to the t Orbiter payload attachmenpoints on the longeron n bridge. The cargo is thelowered to the Orbiter retention (boltdown) hardware and fastened in place. Spacecraft/upper stage access equipment is placed into position as required.

The upper stage is mechanically and electrically connected to the Orbiter and all interfaces verified. Launch-readiness verification functions are performed and Orbiter/upper stage-spacecraft electrical integration, not previously checked off-line with CITE is completed. Specific tests are conducted as required. Compatibility of the cargo with the Orbiter must be assured, at least for flight safety.

When the cargo bay doors are closed and the countdown period has started, no physical access is available to the payload. This occurs in the period T-8 to T-12 hours.

The launch operation is illustrated by Figure I.3-13.

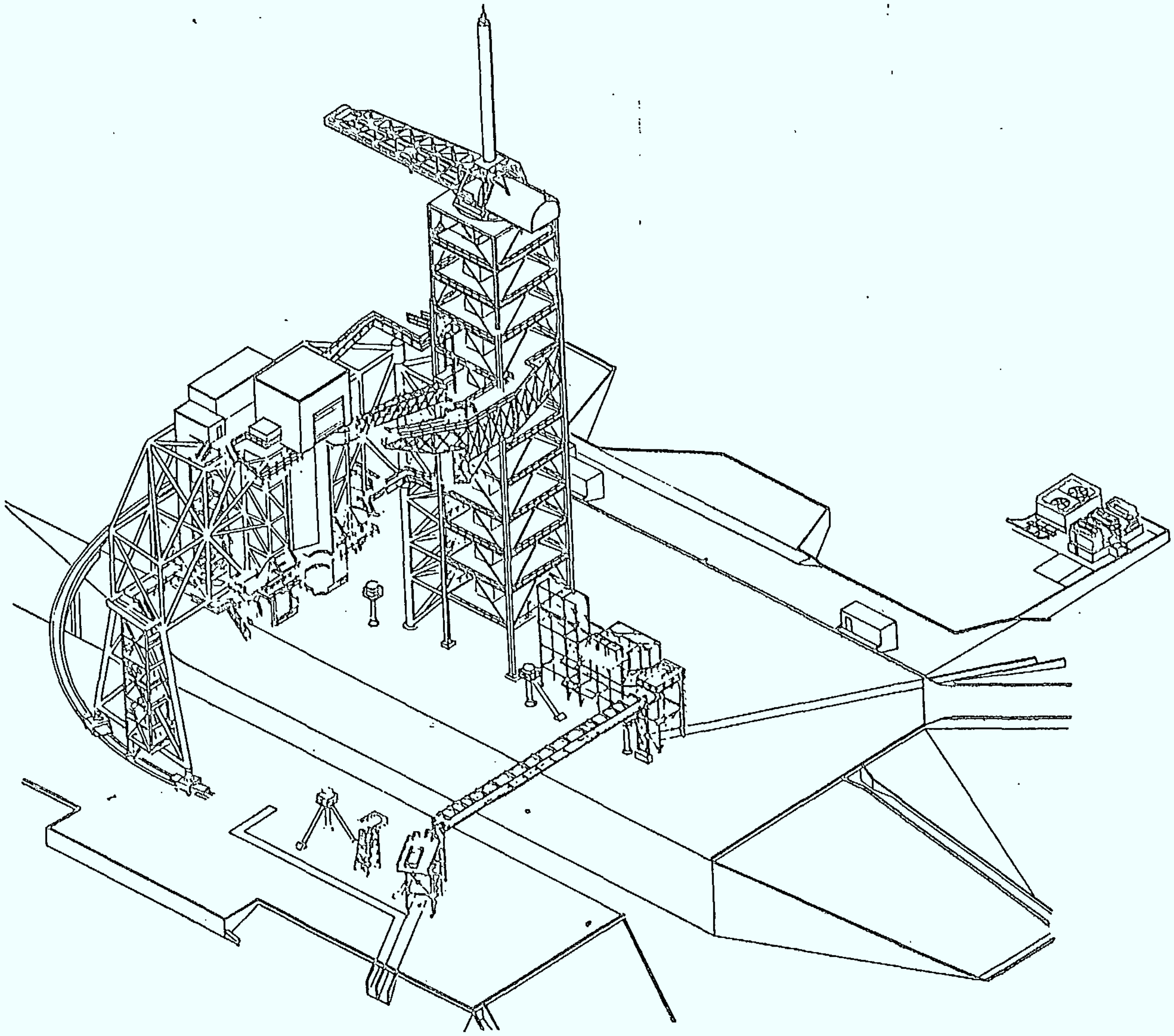


FIGURE I.3-12: RSS IN POSITION TO LOAD ORBITER
(STS REMOVED)

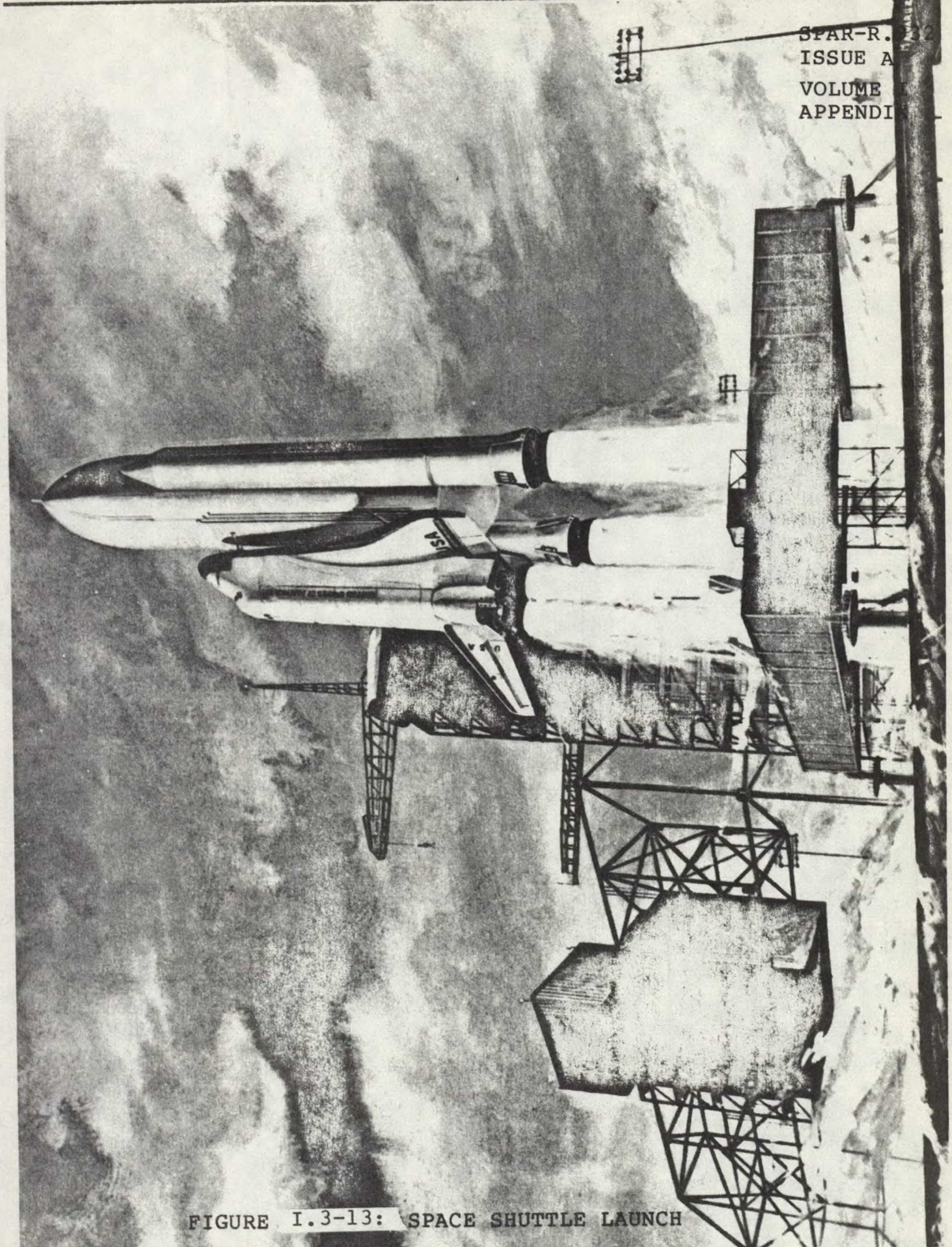


FIGURE I.3-13: SPACE SHUTTLE LAUNCH

APPENDIX J

DESCRIPTION OF ARIANE LAUNCH VEHICLE AND CSG LAUNCH SITE

1.0 ARIANE LAUNCH VEHICLE

1.1 General Description

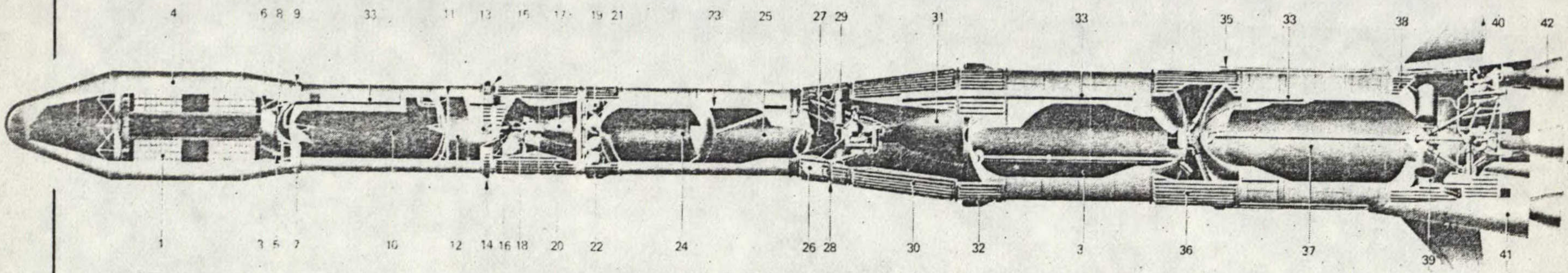
Ariane is a three-stage rocket with a total height of 47.4 m, weighing 208 tonnes* at lift-off with 90% of the mass constituted by the engine propellants (fuel and oxidizer). The structures account for some 9% of the total mass and the payload for approximately 1%. Figure J.1-1 illustrates the main elements of the vehicle.

3.2.1.1 Ariane First Stage

The L140 first stage, a general view of which is shown in Figure J.1-2, develops a thrust of 2445 kN (about 249 tonnes) at lift-off and 2745 kN in vacuum (specific impulse 281.3 s). It weighs 159.55 tonnes at lift-off (160.94 tonnes on the pad) comprising 147.67 tonnes of storable propellant of which 0.815 tonnes remain unburnt after 145 s of flight. The stage weighs 13.27 tonnes empty and has a height of 18.4 m and a diameter of 3.8 m. The propellants are contained in two identical tanks of Vascojet 90 steel connected by a cylindrical skirt. The whole of the lower part of the L140 stage, which comprises the four engines, the water tank, propulsion system accessories, the cowlings and the vehicle control surfaces for aerodynamic stabilization of the vehicle during atmospheric flight, constitutes the thrust frame of the stage.

The four Viking turbopump engines with a low pressure combustion chamber (54 bars) are fixed symmetrically on the thrust frame and can be swivelled in pairs about two orthogonal axes to provide three-axis control.

*NOTE: 1 tonne = 1,000 kg = 2,204.5 lbs.



1) Payload — 2) Fairing separation plane — 3) Third stage/payload separation plane — 4) Fairing — 5) Equipment — 6) Payload adaptor — 7) Equipment bay — 8) Diaphragm — 9) Antennas — 10) Third stage liquid hydrogen tanks — 11) Anti-slosh baffles — 12) Third stage liquid oxygen tank — 13) Acceleration rockets (4) for second/third stage separation — 14) Attitude and roll control system — 15) Second/third stage separation plane — 16) Third stage thrust frame — 17) HM7 third stage engine — 18) Third stage tank pressurisation helium bottles — 19) Second stage tank pressurisation helium bottles — 20) Second/third stage interstage skirt — 21) Second stage forward skirt — 22) Retro-rockets (3) for second/third stage separation — 23) Anti-slosh baffles — 24) Second stage nitrogen tetroxide (N2 O4) tank — 25) Second stage UDMH tanks — 26) Acceleration rockets (6) for first/second stage separation — 27) Second stage thrust frame — 28) First/second stage separation plane — 29) Second stage water torus — 30) First/second stage interstage skirt — 31) Second stage Viking 4 engine — 32) Retro-rockets (8) for first/second stage separation — 33) Electric cabling ducts — 34) First stage nitrogen tetroxide tank — 35) First stage nitrogen tetroxide feed lines (4) — (36) First stage intertank skirt — 37) First stage UDMH tank — 38) First stage thrust frame — 39) First stage water torus — 40) Tail fins — 41) Cowlings — 42) First stage Viking 4 engines (4).

FIGURE J.1-1: MAIN ELEMENTS OF THE ARIANE LAUNCH VEHICLE

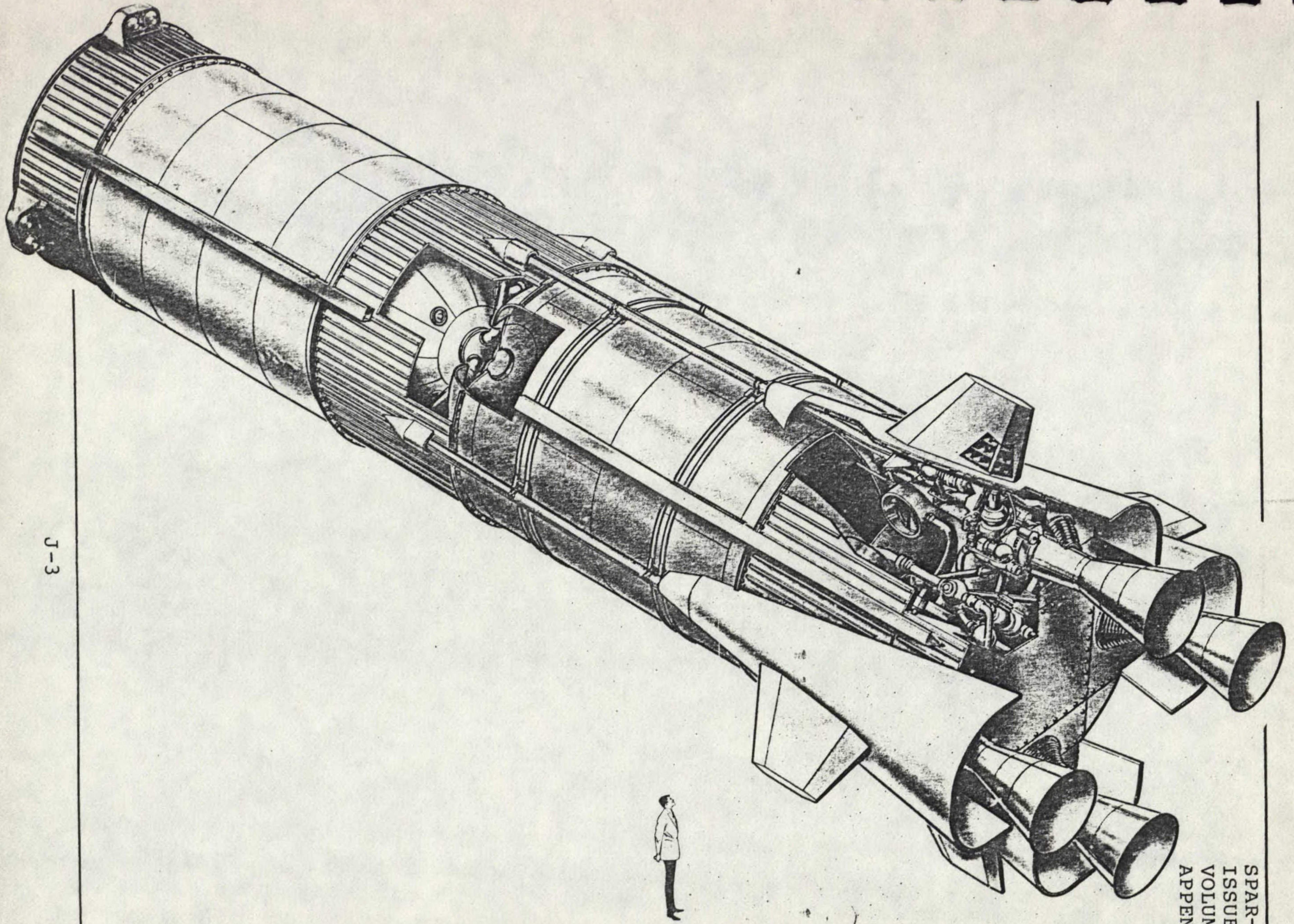


FIGURE J.1-2: FIRST STAGE L140 GENERAL VIEW

The propellant feed is provided by a turbopump with a flow rate of 250 kg/s at 70 bars of pressure. The propellant intake is effected through radial injectors. The refractory steel chamber has a single wall cooled by propellant film injected along the wall and is fitted with a bell-shaped nozzle with a graphite throat. To avoid cavitation of the pumps the tanks are pressurized to about five bars by the gases produced by the generator associated with each engine. This generator uses the same propellants as the main engine but the gases are cooled by water injection. They are also used to feed the turbine of the turbopump unit and to provide the energy for the dydraulic actuator which commands swivelling of the engine.

1.1.2 Ariane Second Stage

The L33 second-stage, a general view of which is shown in Figure J.1.3, develops a thrust of 709 kN in vacuum (specific impulse 293.5 s) with a single turbopump Viking four engine and extended bell-shaped nozzle (the same as on L140). The engine is attached to the tapered thrust frame by a gimbal mounting for pitch and yaw control roll control being effected by auxiliary jets fed with hot gas tapped from the stage gas generator. The L33 weighs 36.79 tonnes of UDMH and N_2O_4 propellant (the same as on the L140) of which 0.137 tonnes remains unburnt after 132 seconds of flight. The stage has a height of 11.5 m (without the interstage skirt), a diameter of 2.6 m and weighs 3.285 tonnes empty (before separation).

The two propellant tanks are of A-Z5G aluminum alloy (like those of the third stage), have a common bulkhead and are pressurized with gaseous helium (3.5 bars).

1.1.3 Ariane Third Stage

The H8 third stage of the Ariane vehicle shown in Figure J.1-4 is the first cryogenic stage developed in Europe. It produces a thrust of 60 kN (specific impulse of 440 s). The H8 stage weighs

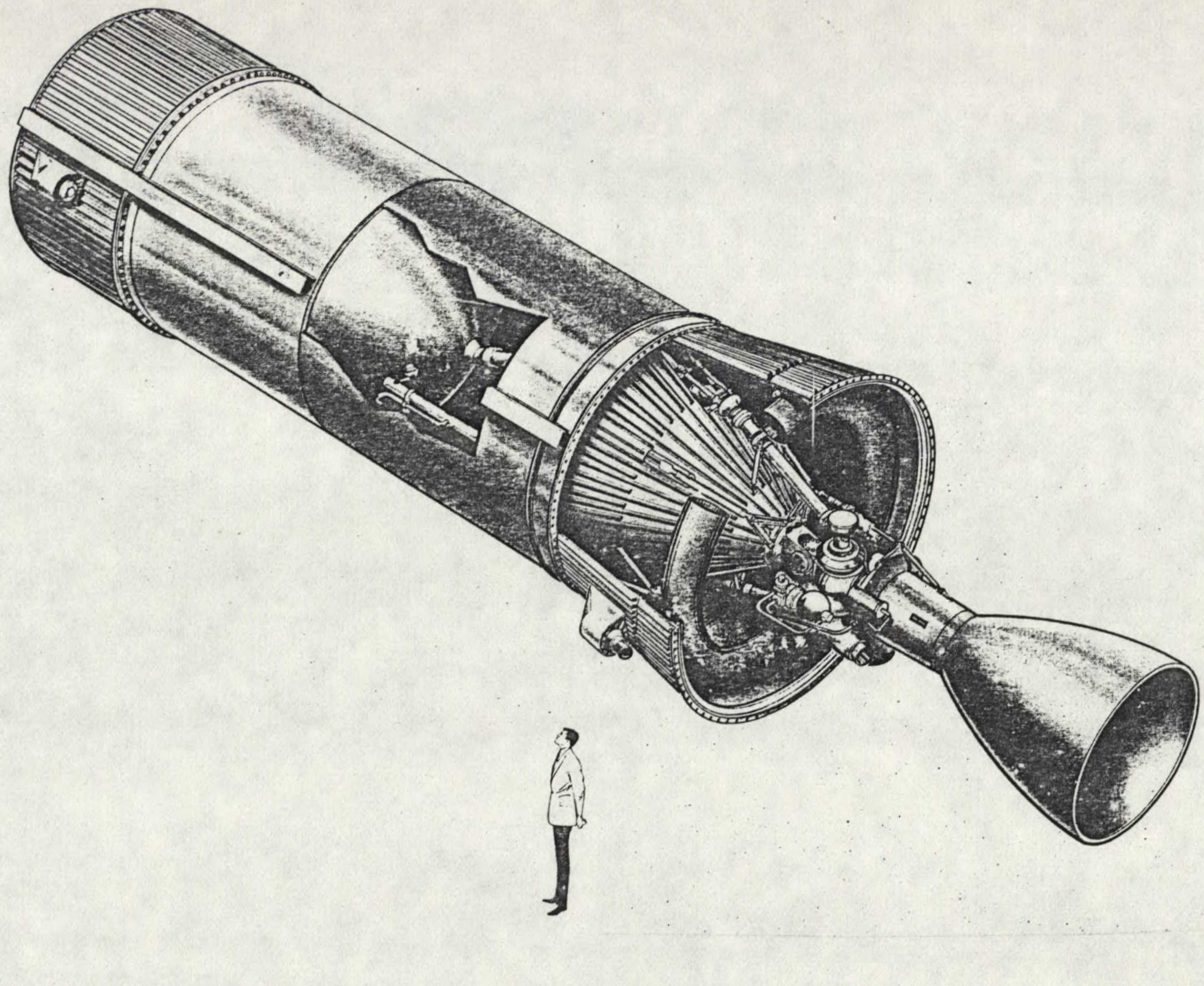


FIGURE J.1-3: SECOND STAGE L33 GENERAL VIEW

9.387 tonnes after separation, comprising 8.23 tonnes of propellant (liquid hydrogen and liquid oxygen) and leaving 67 kg of residual fuel after 570 seconds of flight. It has a height of 9.08 m, a diameter of 2.6 m and weighs 1.157 tonnes empty. The two tanks are of A-Z5G aluminum alloy chosen for its good behaviour at the temperature of liquid hydrogen - 20°K - and have a common bulkhead (two walls separated by a vacuum). They are clad with an external thermal protective layer of Klegecell to prevent the heating of propellants. The liquid hydrogen tank is pressurized at three bars by gaseous hydrogen. The liquid oxygen tank is pressurized by helium. The H8 stage has a single high efficiency HM7 engine. The turbine fed by the gases of a generator, drives the oxygen pump at 12,000 rpm and th ehydrogen pump at 60,000 rpm. The combustion chamber is of the regenerative cycle type. The walls are cooled by the circulation of fuel through a channel network adjacent to the chamber before its admission to the axial injector consisting of 90 concentric elements. Construction of the body of the combustion chamber uses an original technology (developed by MBB) whose patent is also used in the United States for constructing the combustion chamber of the main engine of the Space Shuttle; the cooling channels are milled in a copper casting and are then covered with an electrolytic deposti of nickel. The chamber is lengthened by a bell-shaped nozzle consisting of sprialled tubes of Inconel cooled by the circulation of hydrogen which vaporizes in the tubes. The HM7 engine is attached to a tapered thrust frame, gimbal mounted for pitch and yaw control, roll control being provided by auxilliary nozzles which eject gaseous hydrogen.

3.2.1.4 Separation, Guidance Control and Payload Fairing

Separation of the first and second stages and of the second and third stages is achieved by pyrotechnic cutting cords located onthe aft skirt of the second and third stage. All these solid thrusters are standard equipment.

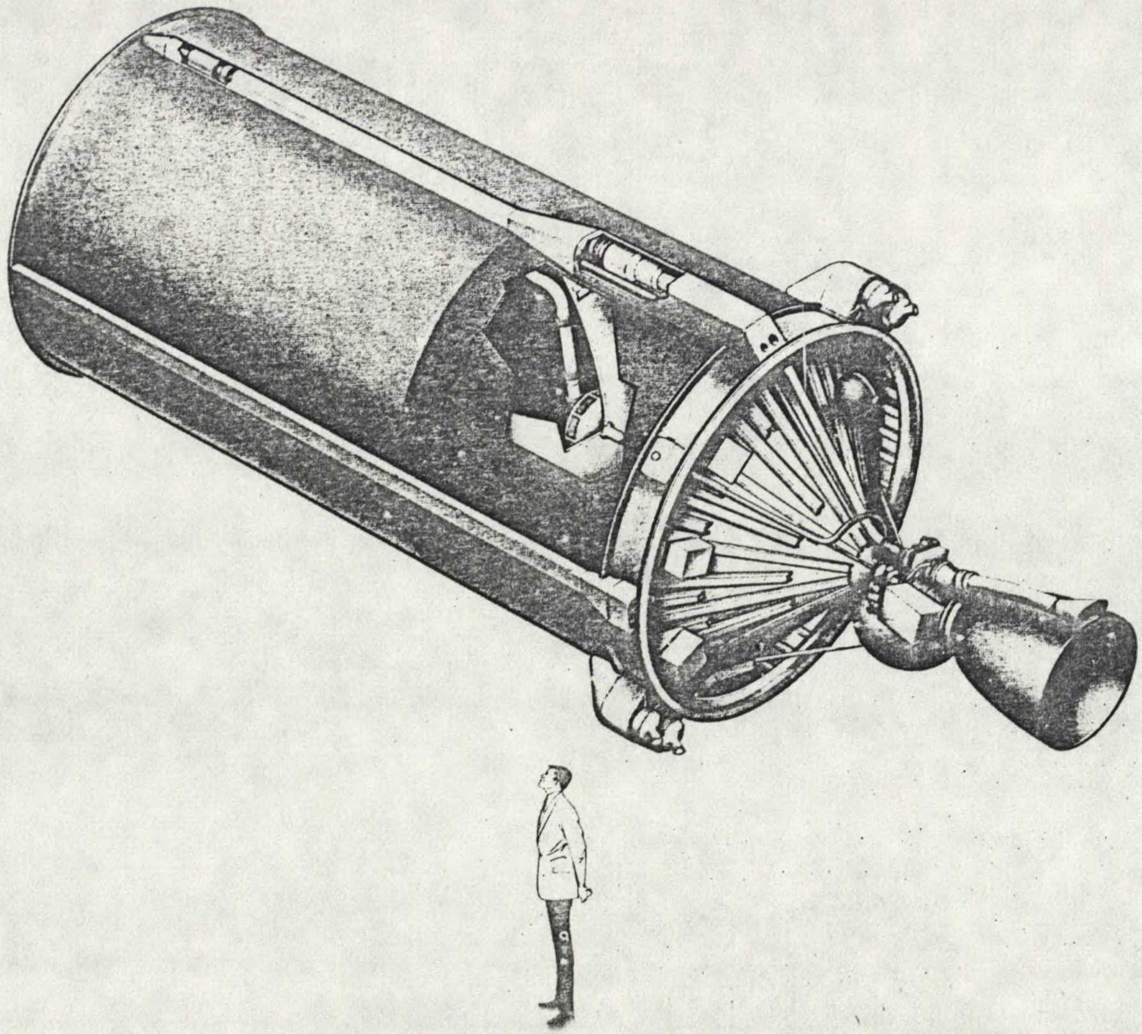


FIGURE J.1-4: THIRD STAGE H8 - GENERAL VIEW

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The equipment bay structure, shown in Figure J.1-5, is mounted on the third stage. It houses the electronic equipment of the vehicle, support the payload and provides the attachment points for the fairing. The bay weighs 300 kg, has a diameter of 2.6 m, a height of 1.1 m, accommodates all the functions of the vehicle and most of th functional devices of the electrical system (sequencing, guidance, flight control, tracking and destruction, telemetry) which have thus been centralized for the sake of reliability, economy and simplification of the vehicle. Only the executive and the actuating systems are distributed among the stages.

The guidance and control system, organized around a digital computer and an inertial platform, is responsible for attitude detection and measures continuously the accelerations of the vehicle and its velocity vector. From this information and the instructions contained in the guidance program, the computer carries out navigation and guidance. It generates and transmits attitude correction commands to the stages of the launcher. An analog flight control unit mizes the required attitude deviaitons (produced by the computer) with the information supplied by the rate gyros. After filtering the structural and liquid sloshing critical modes, the autopilot sends out roll control system commands and swivelling commands to the hydraulic actuator which orients the engines. At the end of flight, when the velocity corresponding to the desired orbit is obtained, the computer commands propulsion cut-off. The precision thus obtained is of the order of 5 m/s for a velocity of more than 10,000 m/s.

The fairing, shown in Figure J.1-6 protects the payload during the ascent through the atmosphere, and is jettisoned during the flight of the second stage at about 110 km altitude. It weighs 800 kg and has an external diameter of 3.2 m and a height of 8.65 m. The fairing consists of two half-shells of aluminum with a boat-tail sectionof laminated material which, like the access ports of the cylindrical section, is radio-transparent.

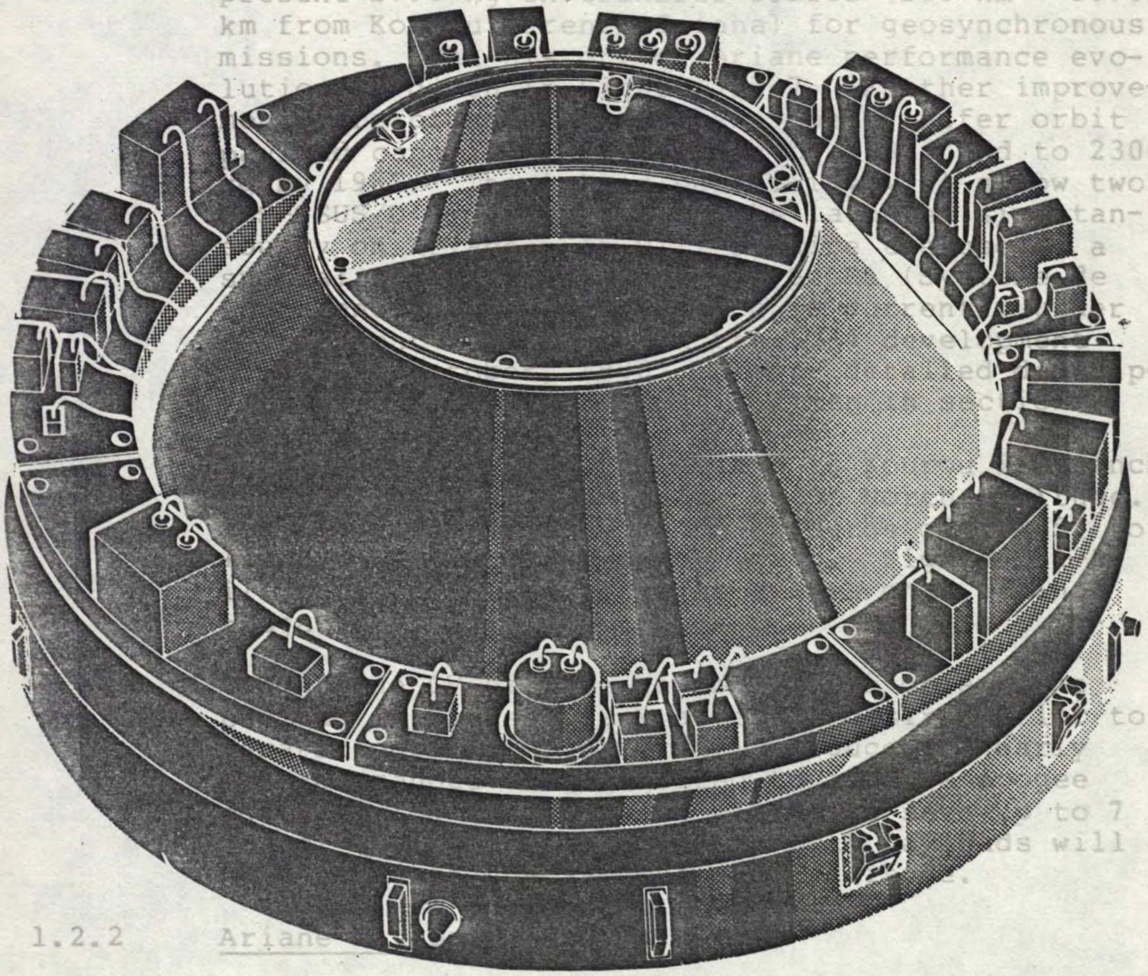

FIGURE J.1-5: EQUIPMENT BAY STRUCTURE

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1.2.2 Payload Accommodations

1.2.1 Ariane Performance Capabilities

The performance guaranteed for Ariane users is at present 1750 kg in transfer orbits (200 km - 36000 km from Kourou, French Guiana) for geosynchronous missions. The history of Ariane performance evolution is given in Figure J.1-7. Further improvements are planned to increase the transfer orbit payload capability to 1950 kg by 1981, and to 2300 kg by 1982. The latter capability will allow two STS-SSUS/D type payloads to be launched simultaneously on Ariane. It will require the use of a special attach fitting called SYLDA (Systeme de Lancement Doube Ariane) which is currently under development for launch on the LO-4 development flight in October, 1980. A more detailed description of the SYLDA concept is given in section 2.

The launch site for the Ariane is Kourou in French Guiana, which is located at 5.23° North latitude. The range allows for launch azimuths of -10.5° to +93.5° in relation to true North. Figure J.1-8 illustrates the main flight events on a nominal trajectory.

The Ariane LV has the capability to orient the payload in space to any attitude desired prior to separation. This can greatly reduce the early mission manoeuvring required to acquire apogee motor firing attitude and will also save up to 7 lbs of RCS fuel. With SYLDA, both payloads will be ejected at the same nominal attitude.

1.2.2 Ariane Payload Bay

The usable internal dimensins of the payload bay are constituted by a diameter of 3 metres and a height of 5.3 m. The useful volume of 35 cubic metres enables large geostationary satellites of the Intelsat 5 or H-SAT type to be launched or two medium-sized satellites mounted one above the other in the "Ariane dual launch system" (SYLDA).

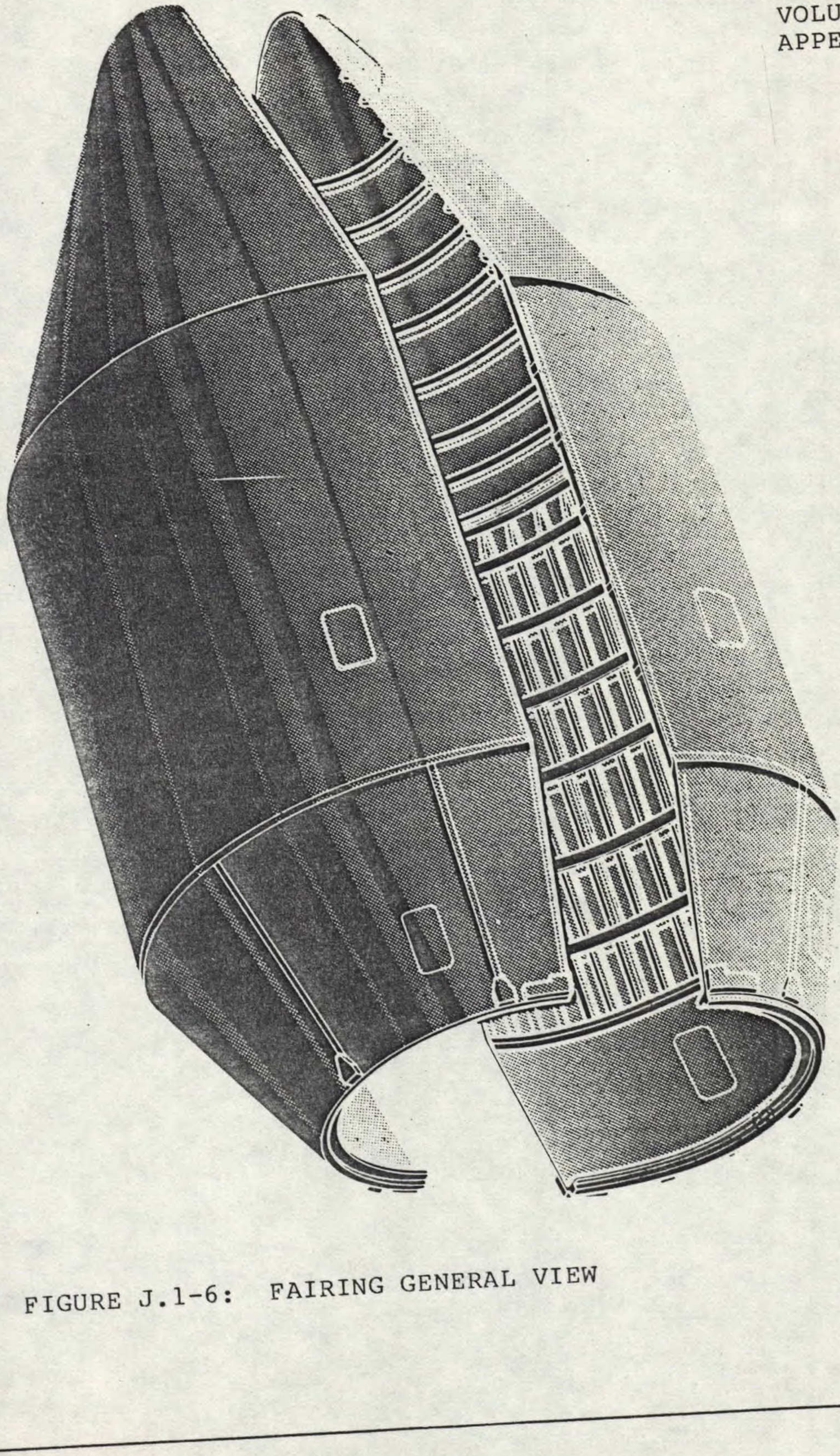
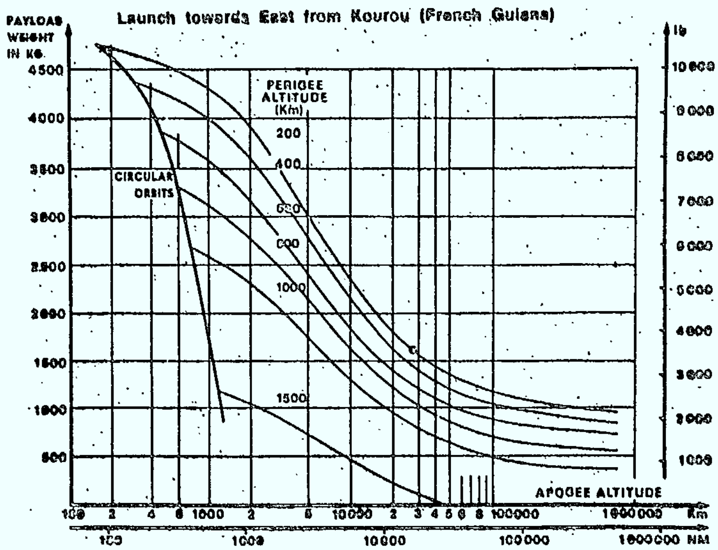


FIGURE J.1-6: FAIRING GENERAL VIEW



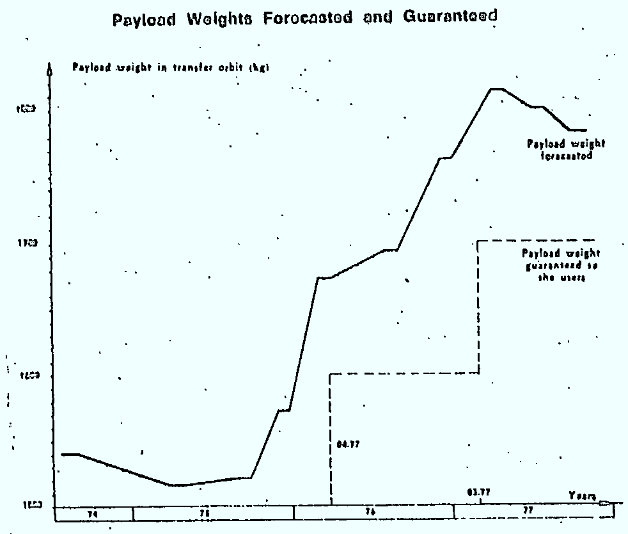


FIGURE J.1-7: EVOLUTION OF ARIANE PERFORMANCE

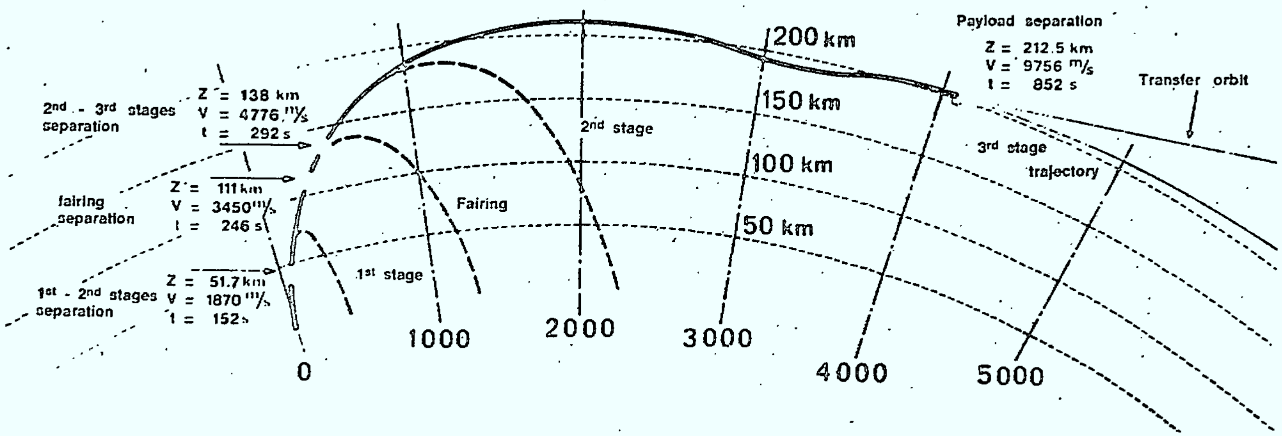


FIGURE J.1-8: MAIN FLIGHT EVENTS ON THE NOMINAL TRAJECTORY

The Ariane User's Manual AR(75)01 provides more information on the payload accommodations of Ariane and Figure J.1-90 shows the available payload volume.

2.0 DESCRIPTION OF SYLDA CONCEPT

This section gives an overview on the SYLDA concept for which published data is presently very preliminary and scarce. Figures J.2-1 to J.2-5 illustrate the present baseline concept for the double launch fitting. The following table summarizes the proposed SYLDA/satellite interfaces and compares them to the McDonnel-Douglas PAM-D (Payload Assist Module for Delta class payloads). ESA plans to have the SYLDA operational by 1981 with a planned flight demonstration on the fourth development flight of Ariane.

SYLDA/Satellite Interface

Mechanical Interface:	clamp band spring position separation switches umbilical plug position = identical to PAM
Umbilical Plugs:	2 x 10 pins or 2 x 37 pins = identical to PAM
Balance Requirements:	CG off-set 1.3 mm dynamics unbalance: 0.25° = identical to PAM
Satellite Fundamental Frequencies: (Hard Mounted)	Thrust axis: 38 Hz (35 Hz SSUS-D) Transverse axis: 15 Hz like SSUS
CG Position Above Separation Plane:	850 mm
Environment:	tbd (Objective: not more severe than SSUS-D/STS

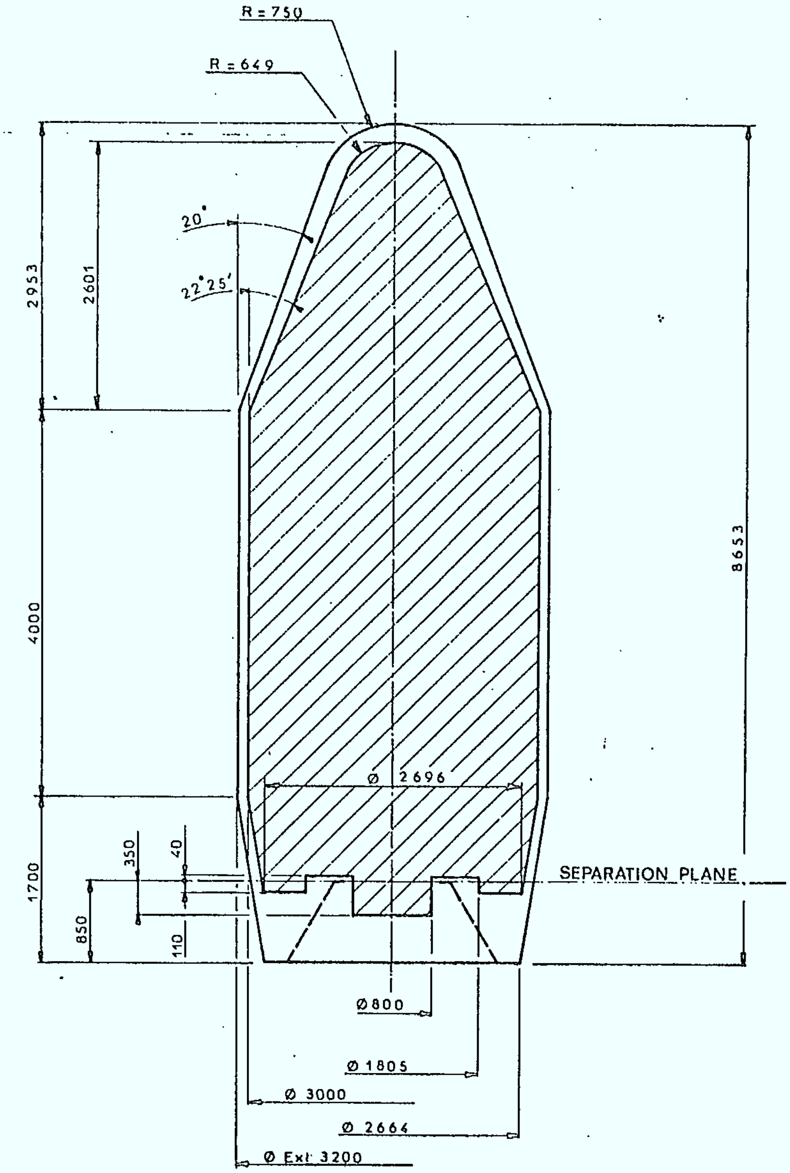


FIGURE J.1-9: VOLUME AVAILABLE FOR PAYLOAD

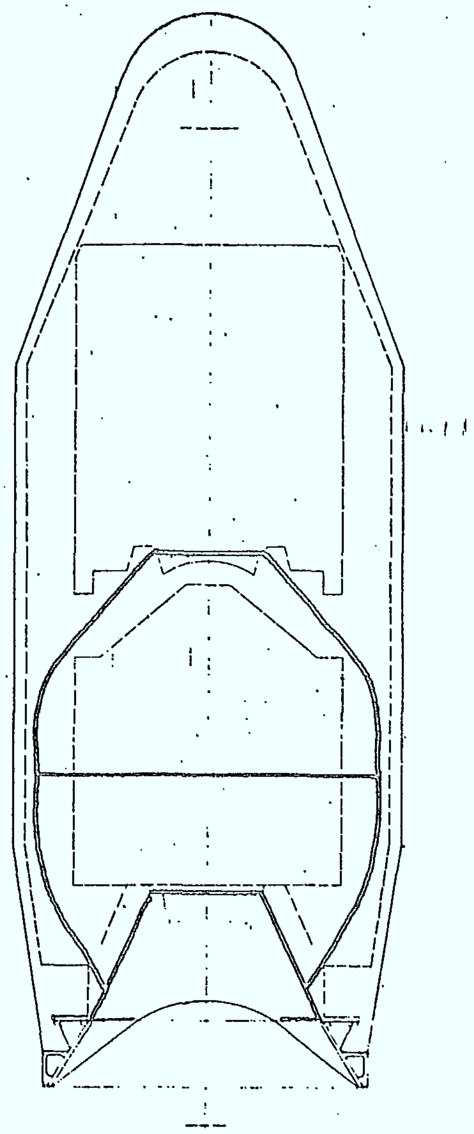


FIGURE J.2-1: BASELINE CONFIGURATION

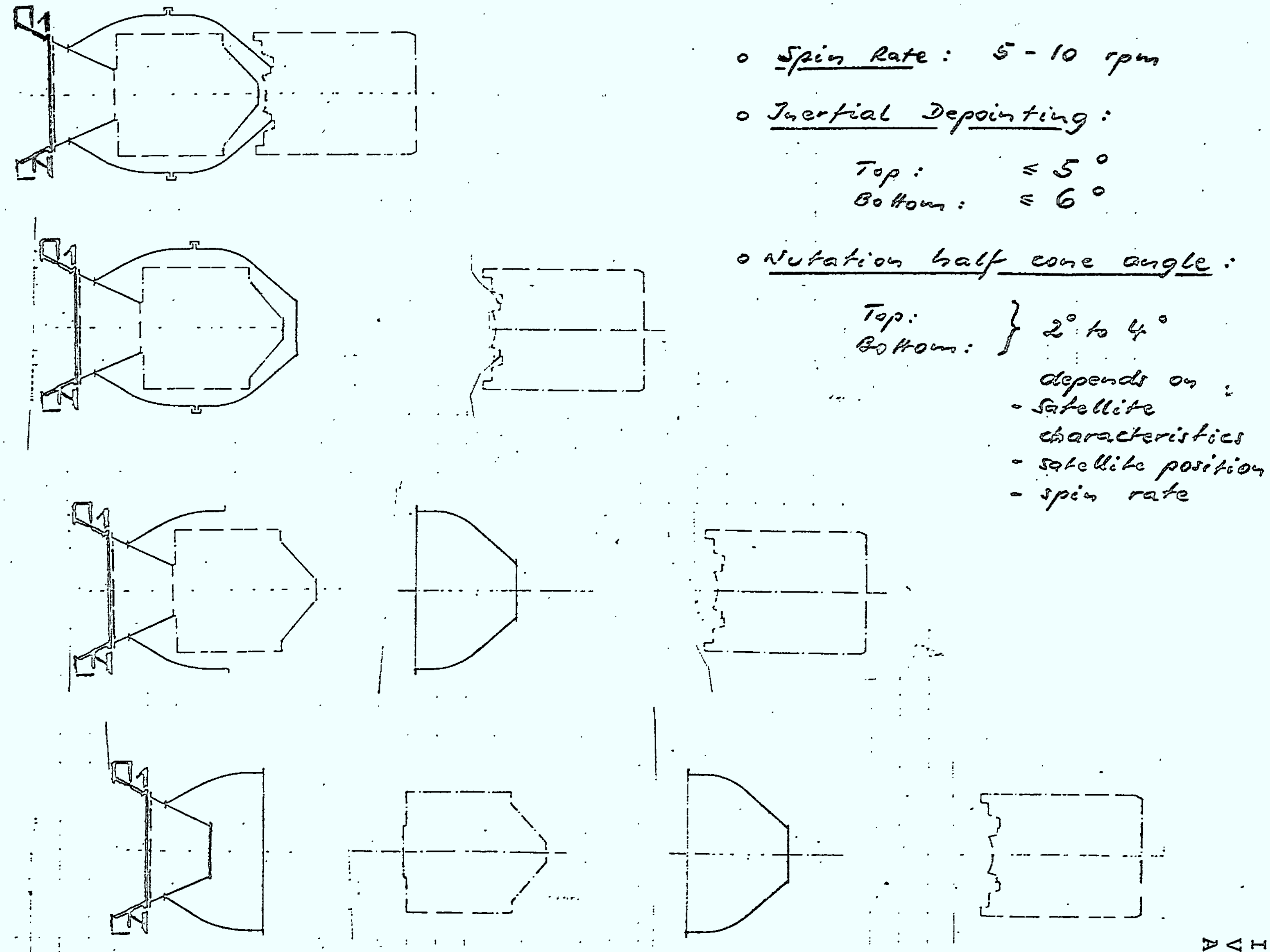


FIGURE J.2-2: SEPARATION SEQUENCE AND CONDITIONS

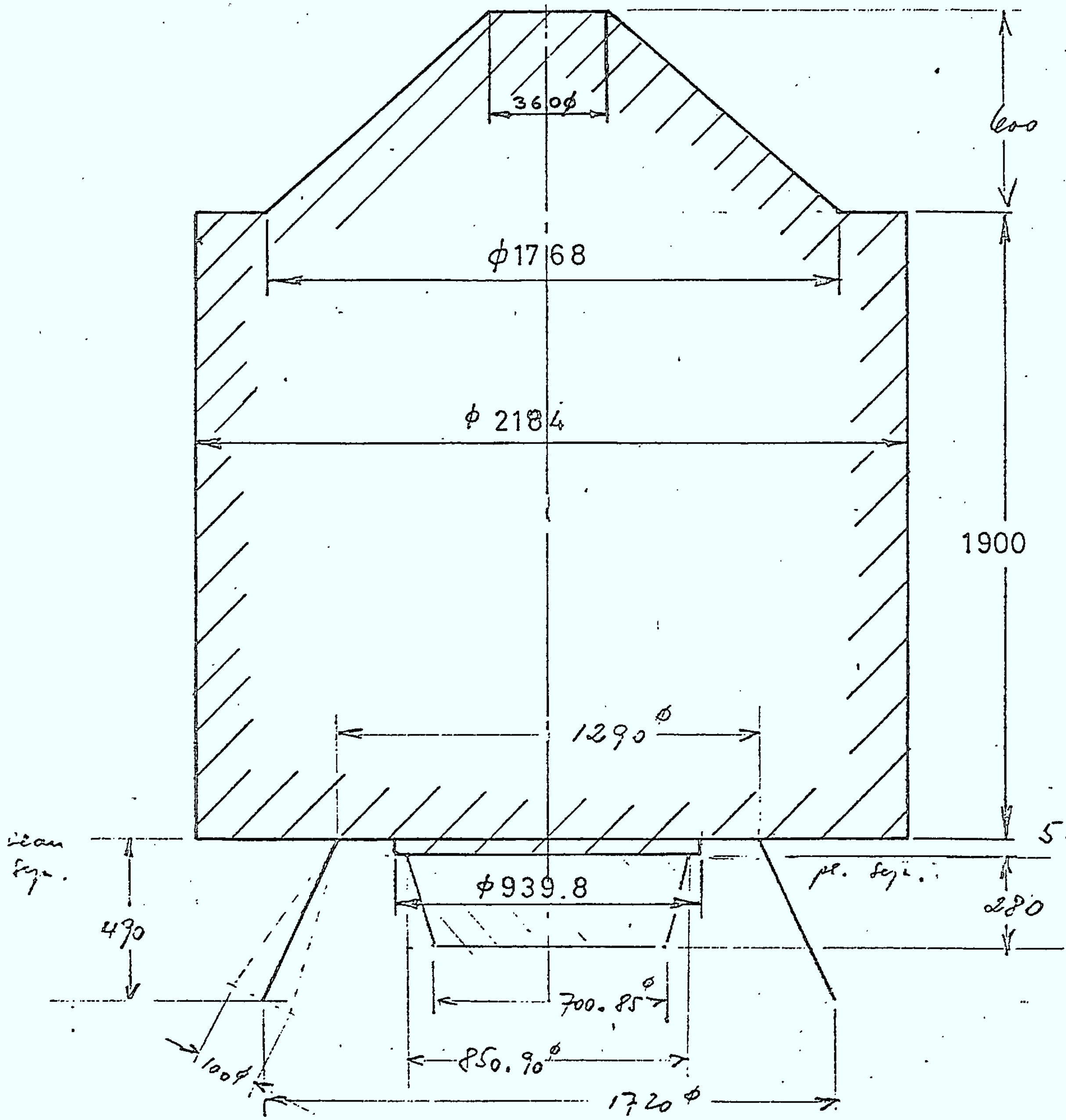


FIGURE J.2-3: MINIMUM BOTTOM RIDER SPACECRAFT ENVELOPE

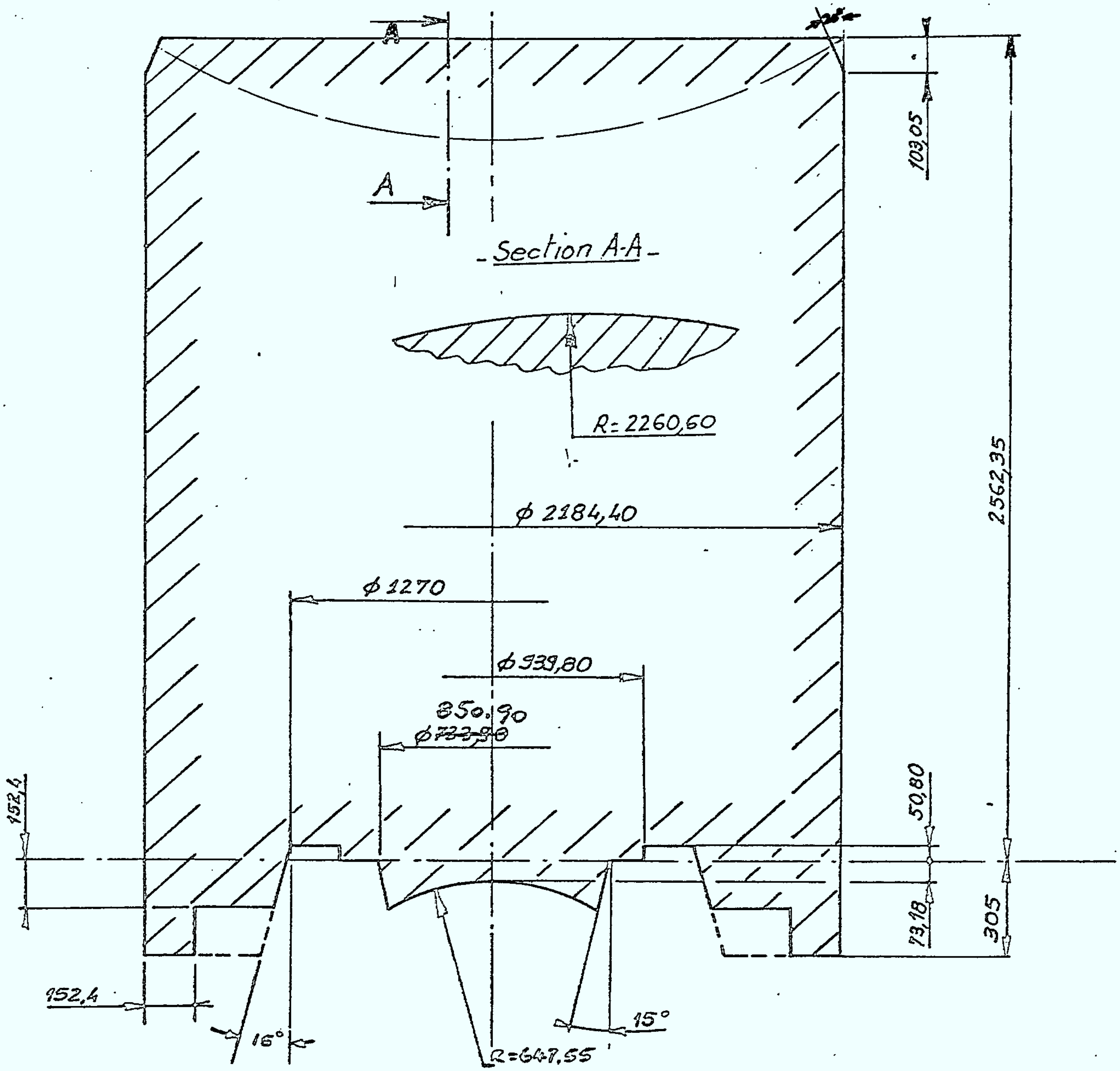


FIGURE J.2-4: TOP RIDER SPACECRAFT ENVELOPE - OPTION A

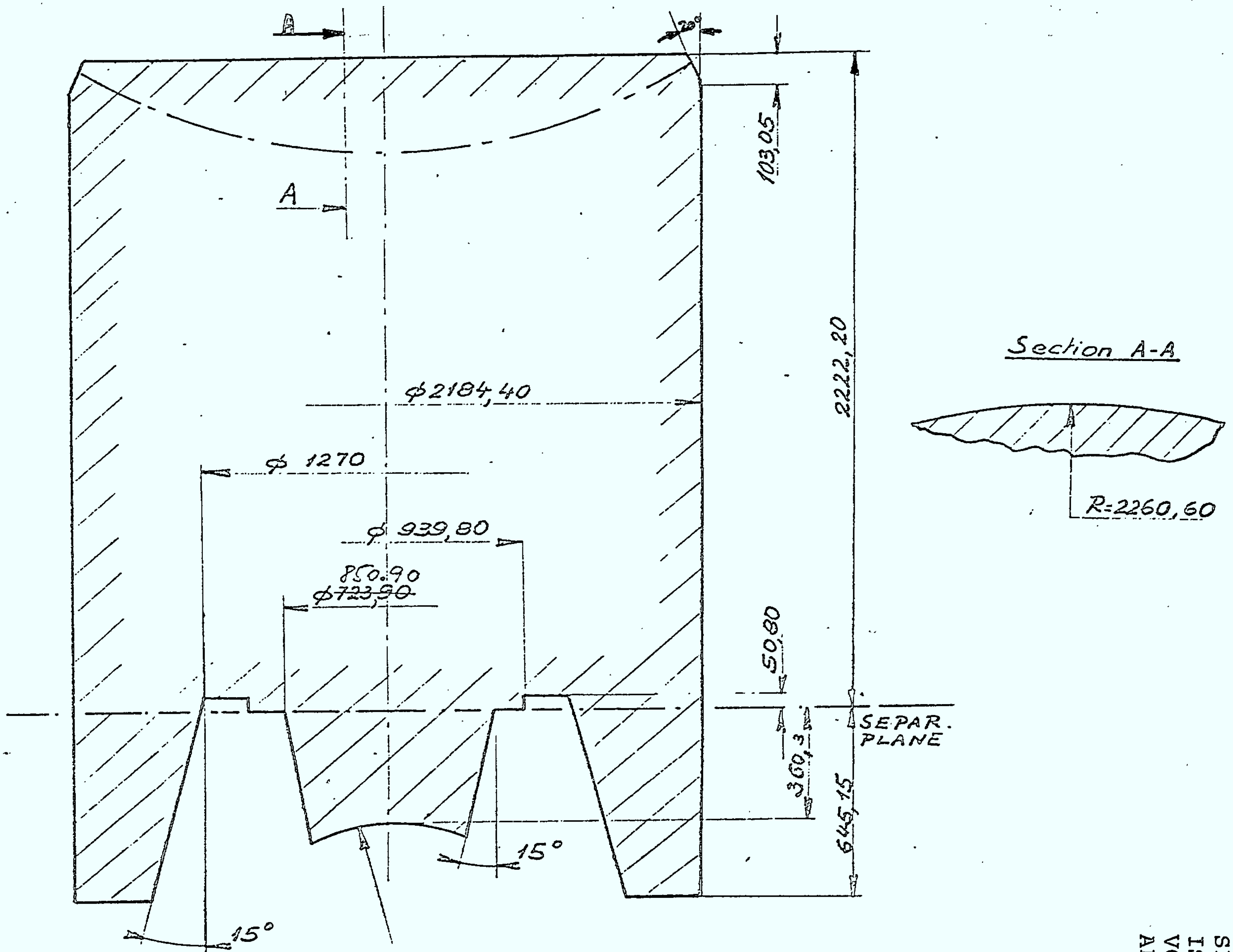


FIGURE J.2-5: TOP RIDER SPACECRAFT ENVELOPE - OPTION B

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3.0 ARIANE LAUNCH SITE AND OPERATION

3.1 Introduction

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

Operations at the CSG may be divided into three phases:

(a) The first phase is that of satellite preparation. During this phase, the CSG makes available to the payload the necessary buildings, test facilities and logistic support.

(b) The second phase is that of integration of the payload with the launch vehicle. This takes place on the Ariane Launch Site, and operations are coordinated by the Head of Launch Site Operations ("Chef des Operations de l'Ensemble de lancement" - COEL) who is in charge of the Ariane launch team.

(c) The third phase is that of the launch countdown. During this phase the Director of Operations ("Directeur des Operations" - DDO) conducts the countdown and provides, on behalf of the Mission Head, summaries of the reports transmitted by the launch vehicle, the payload, the CSG facilities and the necessary external stations. The DDO, who belongs to the CSG, is directly responsible for the operations of the CSG facilities and external stations. The COEL is responsible for operating the launch vehicle and communicating its reports, while the Payload Preparation Officer is responsible for operating the payload and communicating its reports.

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3.2 Guiana Space Centre (CSG) Launch Facilities

The launch facilities are located along the main road, RN1 (as shown in Figure J.3-1). The Ariane Launch Site ("Ensemble de Lancement ARIANE" - ELA) is located about 18 km from the town of Kourou. It comprises the launch area and Launch Centre where the responsible officers conduct operations and exercise remote control.

The Control Centre, where the DDO and the Mission Head conduct the countdown operations, is located within the Techical Centre shown on the maps in Figure J.3-1. Figure J.3-2 provides a perspective view of the Ariane launch area dn launch centre.

3.2.1 General Technical Facilities

The CSG can make available to users a number of special-purpose workshops with the appropriate staff, namely:

(a) A propellant analysis laboratory

(b) A carpentry shop

(c) A mechanical and electromechanical workshop

(d) An optical and photographic workshop

(e) An electronic measurement workshop

(f) A measuring instrument store

(g) An A-band (Diane) satellite reception station, forming part of the French satellite reception network

(h) An international communication and data transmission network (RESEDA - maximum speed 4800 bauds., 16-bit words) whose processing centre is at Toulouse, France

(i) Miscellaneous support facilities.

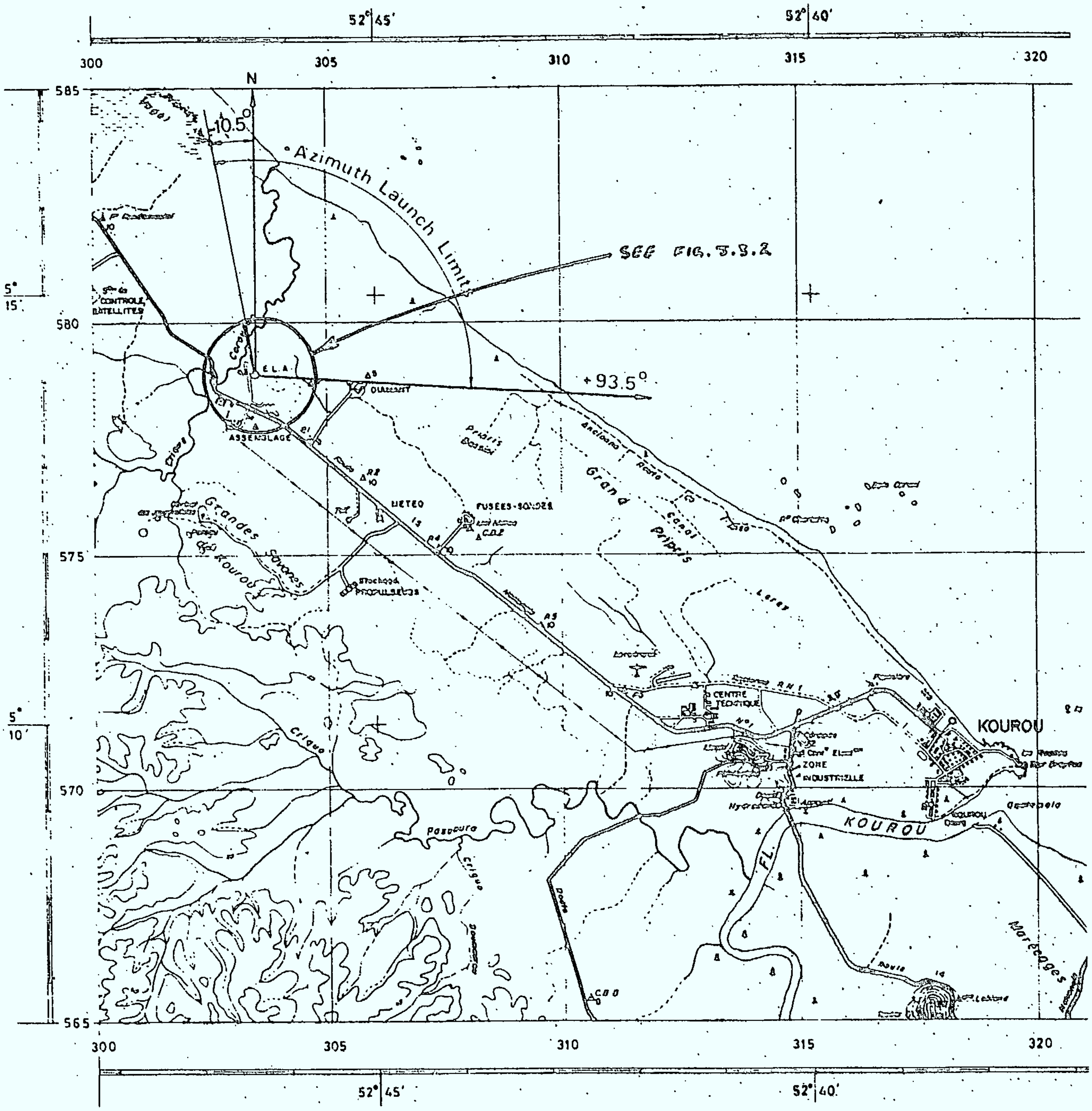

FIGURE J.3-1: GUIANA SPACE CENTER

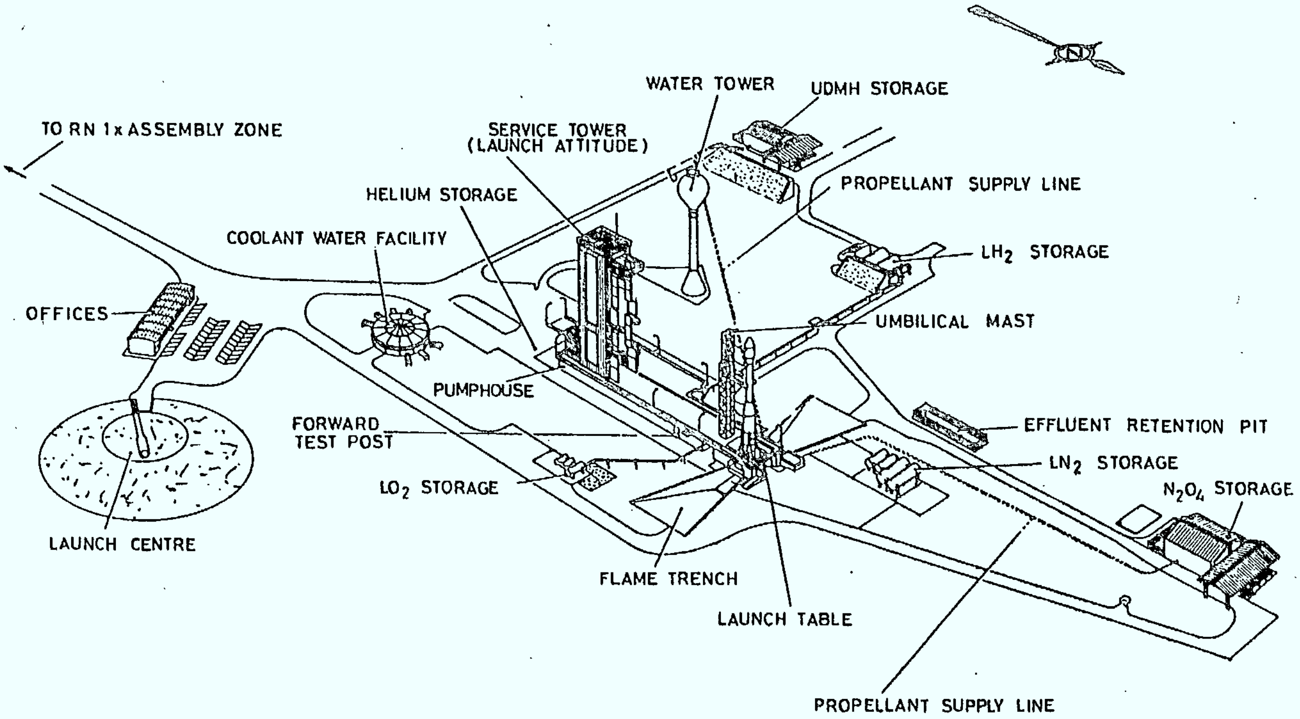

FIGURE J.3-2: ARIANE LAUNCH AREA AND LAUNCH CENTRE

3.2.2 Specific Facilities for Users

Operations relating to the payload start about six weeks before the launch date and take place at four different facilities placed at the disposal of users. Transport of the payload between its point of arrival in Guiana and these facilities is provided by the CSG.

3.2.2.1 Satellite Reception and Testing Buildings

These buildings, shown in Figure J.3-3, are located in a non-hazardous area at the Technical Centre. They comprise mainly:

(a) A clean room (filtration class 100,000) of 400 m^2 equipped with an overhead crane with a hook clearance of 12m. Two 195 m^2 rooms each equipped with overhead cranes with a hook clearance of 7m. A clean room (filtration class 10,000) of $48m^2$.

(b) Laboratories with a total surface area of $250m^2$.

(c) Office located on the first floor.

3.2.2.2 Apogee/Perigee Motor Preparation Building

This building, shown in Figure J.3-4, situated in a protected area of the Ariane site, is specially designed for the handling and preparation of the motors before their integration in the satellite. It comprises a main area of $150m^2$, a shelter to house personnel during hazardous remote-controlled operations, and an associated workshop and office.

3.2.2.3 Satellite Fill and Satellite Apogee Motor Integration Building

This building, shown in Figure J.3-5, situated in a protected area, consists mainly of:

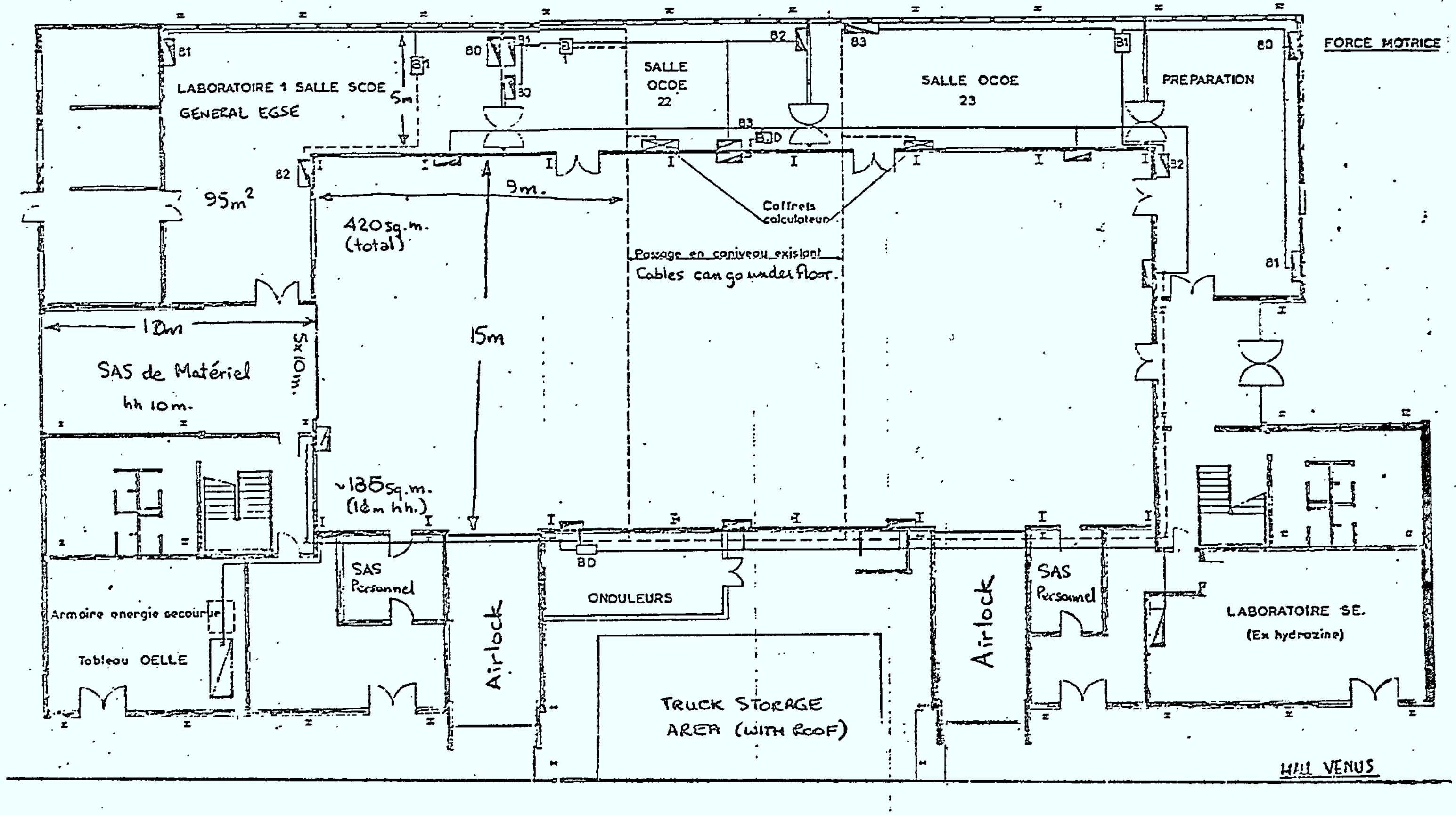

FIGURE J.3-3: SATELLITE RECEPTION AND TEST BUILDINGS

(a) A surface area of $130m^2$ for hydrazine filling of satellites, equipped with an overhead crane with a hook clearance of 9m.

(b) A surface area of $200m^2$ equipped with an overhead crane with a hook clearance of 13m enabling satellites to be assembled with the apogee motors.

(c) Associated workshops and offices.

3.2.2.4 Mobile Platform on the Ariane Tower

This is equipped with a clean tent (filtration class 100,000) enabling the satellite to be assembled on the launch vehicle; it has a travel of more than 7 metres, and thus enables easy access to be had to all the levels of the satellite. This is shown in Figure J.3-6.

3.2.2.5 Other Facilities

Functional storage facilities are available to house solid thrusters and liquid propellants.

Chemical laboratories can carry out the routine analyses required on a launch range.

A transport container, shown in Figure 3-7, dimensioned for the maximum Ariane payloads is available for transporting the payload to the various preparation sites.

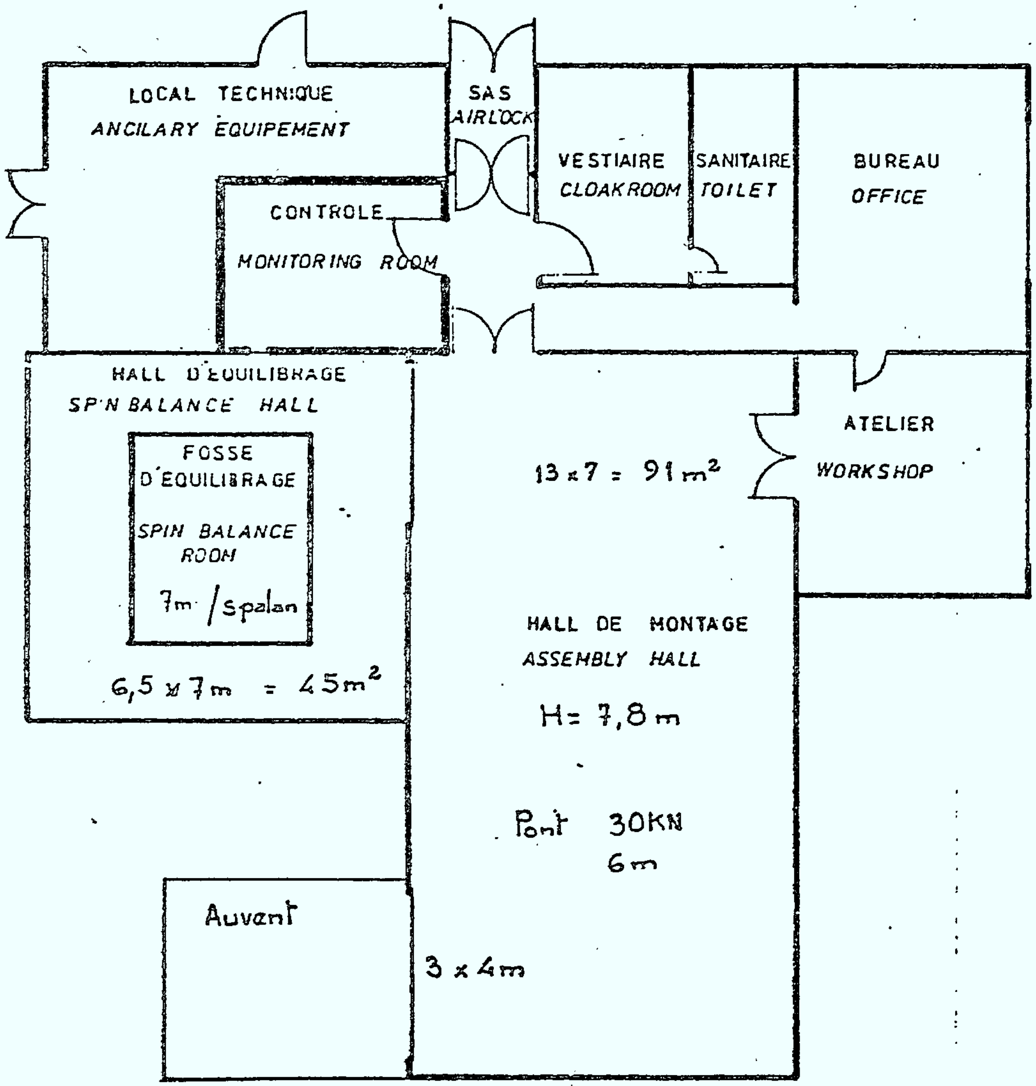

FIGURE J.3-4: APOGEE PERIGEE MOTOR PREPARATION BUILDING

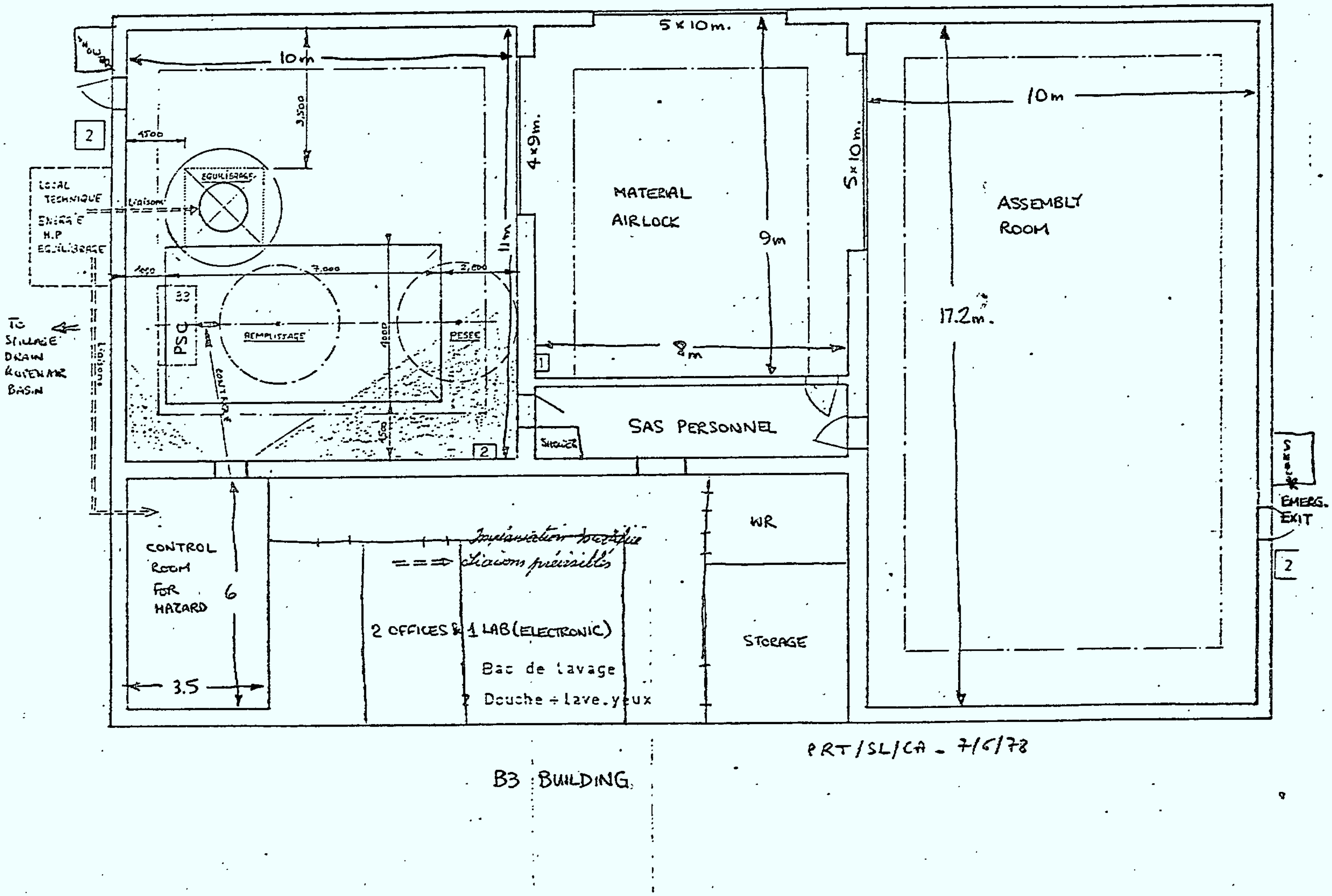

FIGURE J.3-5: SATELLITE FILL AND APOGEE MOTOR INTEGRATION BUILDING

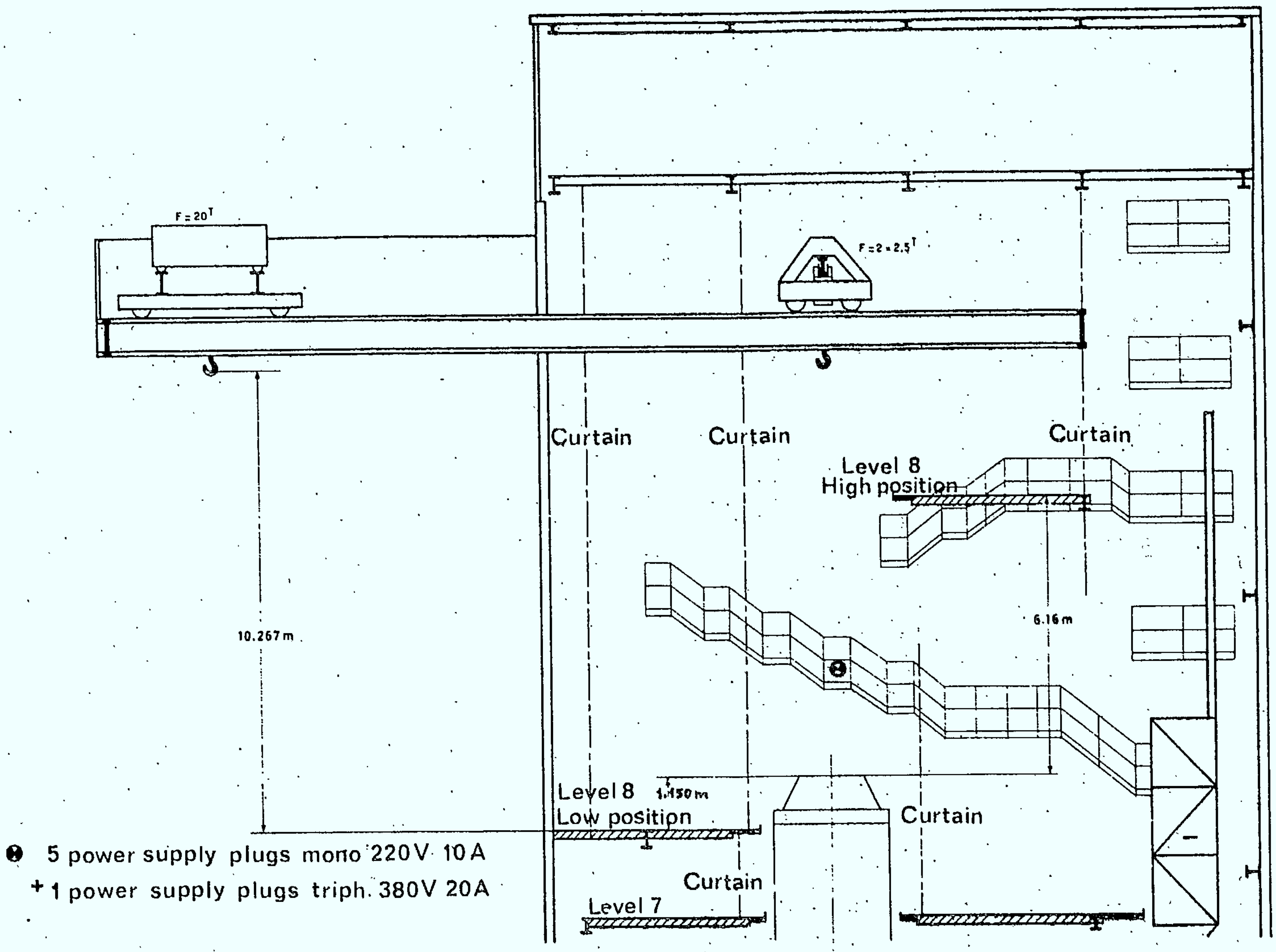

FIGURE J.3-6: SERVICING TOWER (Elevation on Payload Level)

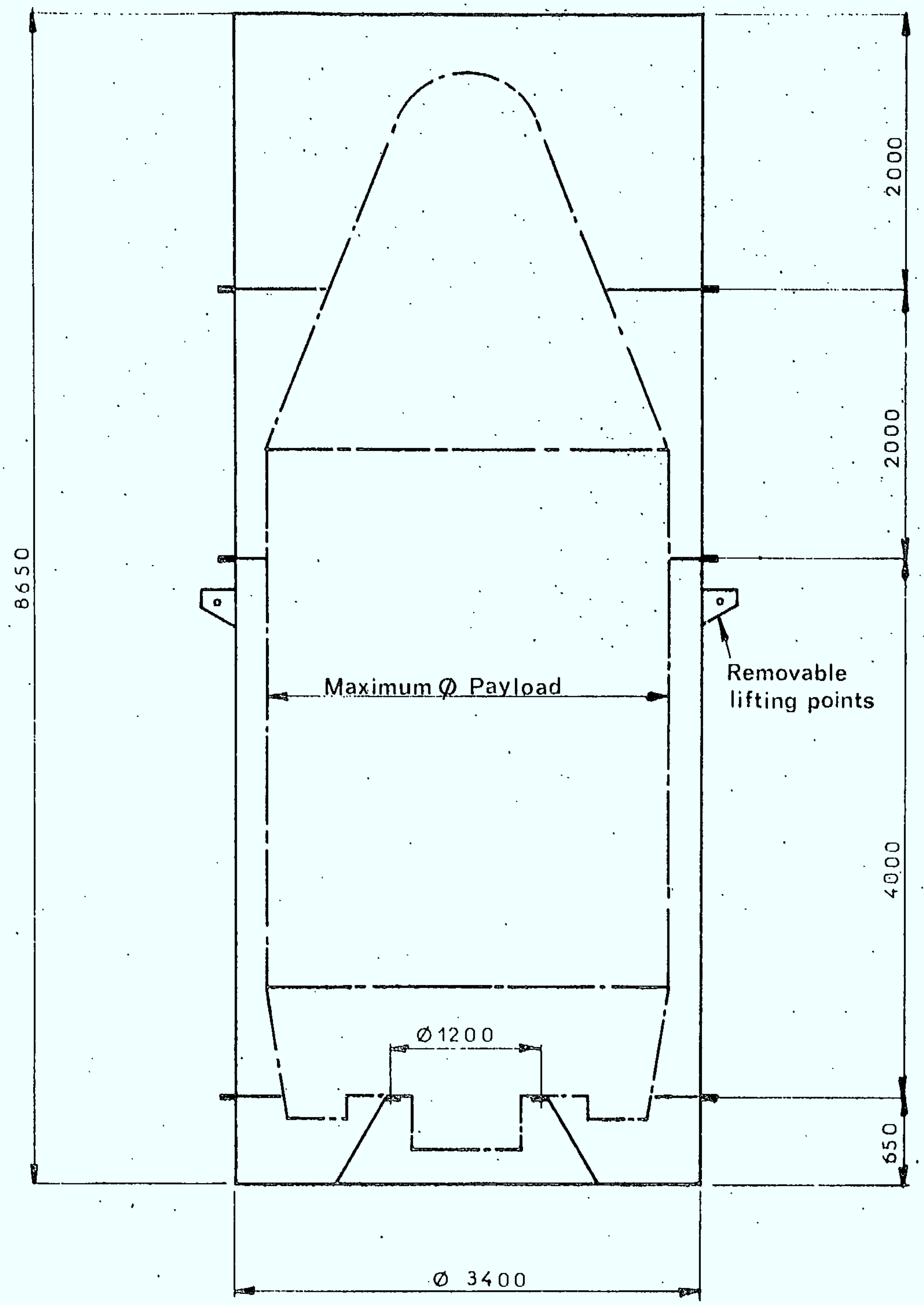

FIGURE J.3-7: PAYLOAD TRANSPORT CONTAINER

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VEHICLE STUDY REPORT.