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LOW ENERGY STAGE STUDY

VOLUME V

PROGRAM STUDY COST ELEMENTS AND APPENDICES

FOR NASA
MARSHALL SPACE FLIGHT CENTER

VOUGHT CORPORATION
an LTV company

2-55910/8R-3483

CHANGE SHEET

For

LOW ENERGY STAGE STUDY, VOLUME V -
PROGRAM STUDY COST ELEMENTS AND APPENDICES

Changes are identified by a black bar in the margin.

F O R E W O R D

This $236,000 Low Energy Stage Study was performed by Vought Corporation under NASA Contract NAS8-32710 for Marshall Space Flight Center from September 1977 through August 1978. The prime objective of the study was to determine the most cost effective approaches for placing automated payloads into low energy Earth orbits. These payloads are injected into circular or elliptical orbits of different inclinations with energy requirements in the range of capability between that of the Space Shuttle standard orbit altitude (296 km) and of the Shuttle with a Spinning Solid Upper Stage - D (SSUS-D). The study results are documented in five volumes:

I. Executive Summary

II. Requirements and Candidate Propulsion Modes

III. Conceptual Design, Interface Analyses, Flight and Ground Operations

IV. Cost Benefit Analysis and Recommendations

V. Program Study Cost Elements and Appendices

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ABBREVIATIONS AND ACRONYMS

ACS	-	Attitude Control System
A/D	-	Analog to Digital
AGE	-	Aerospace Ground Equipment
AK	-	Apogee Kick
AKM	-	Apogee Kick Motor
AMPTE	-	Active Magneto Spinning Particle Tracer
ANT	-	Antenna
ASE	-	Airborne Support Equipment
BER	-	Bit Error Rate
BITE	-	Built-In Test Equipment
C&DH	-	Communication and Data Handling
CER	-	Cost Estimating Relationship
c.g.	-	Center of Gravity
CITE	-	Cargo Integrated Test Equipment
cm	-	Centimeter
COR	-	Contracting Officers Representative
C/O	-	Checkout
C&W	-	Caution and Warning
CWE	-	Caution and Warning Electronics
db	-	Decibel
DDT&E	-	Design Development Test and Evaluation
DMU	-	Deployment Mechanism Unit
DOD	-	Department of Defense
DVT	-	Development Test
EDS	-	Empirical Data Sets
EED	-	Electro-explosive Device
EIRP	-	Effective Isotrophic Radiated Power
ELV	-	Expendable Launch Vehicle
EMI	-	Electro-Magnetic Interference
ERBS	-	Earth Radiation Budget Satellite
ESH	-	Explosive Safe Area
ETR	-	Eastern Test Range
EVA	-	Extravehicular Activity
FSS	-	Flight Support System for MMS
GCU	-	Guidance and Control Unit
GHe	-	Gaseous Helium
GPC	-	General Purpose Computer
GPS	-	Global Positioning Satellite
GSE	-	Ground Support Equipment
GSFC	-	Goddard Space Flight Center
HMF	-	Hypergolic Maintenance Facility
Hz	-	Hertz (cycles)

ABBREVIATIONS AND ACRONYMS (CONT'D)

ICD	-	Interface Control Document
ICU	-	Ignition Control Unit
I/O	-	Input/Output
IRIG	-	Inter-Range Instrumentation Group
ISU	-	Inertial Stabilization Unit
IUS	-	Inertial Upper Stage
JSC	-	Johnson Space Center
Kbps	-	Kilo bits per second
Kg	-	Kilogram
KSC	-	Kennedy Space Center
km	-	Kilometers
Lbf	-	Pound-Force
Lbs	-	Pounds
L/D	-	Length/Diameter
LES	-	Low Energy Stage
LH	-	Left Hand
MCDS	-	Multifunction CRT Display System
MCEM	-	Mechanical Cost Evaluation Methodology
MDM	-	Multiplexer-Demultiplexer
MFBA	-	Mobile Flat Bed Assembly
MHz	-	Mega hertz
MLI	-	Multilayer Insulation
m	-	Meters
MMH	-	Monomethylhydrazine
MMS	-	Multimission Modular Spacecraft
MMSE	-	Multimission Support Equipment
mps	-	Meters per second
MSDP	-	Mission Station Distribution Panel
MSFC	-	Marshall Space Flight Center
N	-	Newtons
nm	-	Nautical Mile
NSI	-	NASA Standard Initiator
O&CF	-	Operations and Control Facility
OMS	-	Orbiter Maneuvering Subsystem
OPEN	-	Origin of Particles in the Earth Neighborhood
OPAF	-	Ordnance Payload Assembly Facility
OPF	-	Orbiter Processing Facility

ABBREVIATIONS AND ACRONYMS (CONT'D)

PCM	-	Pulse Code Modulation
PCR	-	Payload Changeout Room
PCU	-	Power Control Unit
PDI	-	Payload Data Interleaver
PGHM	-	Payload Ground Handling Mechanism
PK	-	Perigee Kick
PKM	-	Perigee Kick Motor
P/L	-	Payload
PRICE	-	Programmed Review of Information for Costing and Evaluation
PSDP	-	Payload Station Distribution Panel
PSI	-	Pressure Systems, Inc.
psi	-	Pounds per square inch
psig	-	Pounds per square inch, gage
RCS	-	Reaction Control System
RCVR	-	Receiver
RF	-	Radio Frequency
RFI	-	Radio Frequency Interference
RHCP	-	Right Hand Circular Polarization
RMS	-	Remote Manipulator System
R	-	Retrieval
rpm	-	Revolution per minute
SAEF	-	Spacecraft Assembly Encapsulating Facility
SCOOP	-	System Technology Office Confirmation of Optical Phenomenology
S/DIU	-	Signal/Data Interface Unit
SDP	-	Special Defense Program
Sec	-	Second
SIO	-	Serial Input/Output
SOP	-	Standard Operating Procedure
SPST	-	Single Pole Single Throw
SRB	-	Solid Rocket Booster
SRM	-	Solid Rocket Motor
SSUS-A	-	Spinning Solid Upper Stage - Atlas Class
SSUS-D	-	Spinning Solid Upper Stage - Delta Class
STDN	-	Space Tracking and Data Network
STS	-	Space Transportation System
TCD	-	Technical Characteristics Data
Td	-	The Time (months) to design and develop or produce a WBS item
TIG	-	Tungsten Inert Gas
TM	-	Telemetry

ABBREVIATIONS AND ACRONYMS (CONT'D)

TRS	-	Teleoperator Retrieval System
Ts	-	The Lead Time (months) measured from the start of cost accured for the item to the launch milestone date, for the initial item
TSP	-	Twisted Shielded Pair
Tx	-	Transmitter
UARS	-	Upper Atmosphere Research Satellite
UDS	-	Universal Documentation System
VPF	-	Vertical Processing Facility
VPHD	-	Vertical Payload Handling Device
V	-	Revisit
WBS	-	Work Breakdown Structure
WTR	-	Western Test Range
ΔV	-	Delta Velocity

INTRODUCTION

This volume contains a description of the costing approach, methodology and rationale used in the development of costs for the LES study, together with a complete presentation of cost related information for the recommended propulsion approach, selected in Task 6. The presentation includes:

- The Costing Approach, Methodology and Rationale
- Summary Cost Presentation
- Cost Estimate by WBS Element
- Technical Characteristics Data
- Total Program Funding Schedules
- Detailed Cost Information by Elements of Cost

In addition, three Appendices are included:

- WBS Dictionary
- Task 2 Cost Data
- Scenario and Stage Cost Data

In order to present an organized narrative, certain parts of previous volumes have been reproduced for inclusion in Volume V.

The report is contained in five volumes and organized as follows:

VOLUME	TASKS	CONTENTS
I	-	Executive Summary
II	1	Requirements Definition
	2	Candidate Propulsion Modes
III	3	Conceptual Design
	4	Interface Analysis
	5	Ground and Flight Operations
IV	6	Cost Benefit Analysis
	7	Recommendations
V	-	Program Study Cost Elements

A listing of references applicable throughout the report is included at the end of each volume.

1.0 COSTING APPROACH, METHODOLOGY AND RATIONALE

This section includes the costing groundrules and assumptions, methodology, work breakdown structure and cost estimating criteria used in the development of costs for the LES study.

1.1 COSTING GROUNDRULES AND ASSUMPTIONS

A description of the costing groundrules and assumptions as they apply to schedule, the philosophy for testing, spares control and operations, and the management approach, is presented in this part.

1.1.1 Schedule of Launch Requirements by Recommended Approach

Launch requirements for the recommended propulsion approach were determined by selection of the most logical launch mode for each identifiable payload mission from within the available stage sizes. Table 7-XIV of Volume IV shows the launch mode and quantity for each selected stage. The selected stages are a mix of new and existing/planned vehicles best suited for placing the payloads in their intended orbits. The next step was to determine the launch schedule for all payloads within the limits of the LES study. The LES Mission Model Summary of Volume III, Table 4-IV, shows 129 total payloads within the time frame 1980-1991. In order to match the launch requirements to the recommended launch mode, reference to the LES Payload Model is required. The payload identification numbers, which have been matched to a selected launch mode, are identified in the LES Payload Model (Volume IV, Table 4-11) by year of launch. The cost summary for Scenario C-2, shown in paragraph 2.0, gives the results of payload and launch mode matching. The 129 payloads are launched by the propulsion approach indicated, with approximately 80% dispatched by the modular bipropellant system.

1.1.2 Test Philosophy

The basic test philosophy for LES was to verify components and system performance requirements in as near flight configuration as possible. Acceptance level tests were assumed to be performed followed by environmental and functional testing. Demonstration of separation system, deployment mechanism and all interfaces, where practical, was performed. LES was not disassembled at the field site therefore factory verification of systems remain validated. Functional verification testing was concentrated at the factory thereby minimizing testing at the launch site. This reduction in overall processing time at the launch site was achieved through elimination of unnecessary redundant testing. Operations at the launch site facilities included receiving, inspection, assembly and interface tests with the cradle assembly and payload, Orbiter support interface tests, range and status verifications. Standard operating and test procedures were used both at the factory and field site. The quantities of test hardware were included on the Scenario Non-Recurring DDT&E pages [Data Form A] at level 5 for all LES production systems. These pages are included in Appendix C. A complete discussion of test requirements is contained in Volume III, paragraph 6.1.

1.1.3 Spares Philosophy

The basis of the spares philosophy is contained in the following assumptions:

- The spares program was controlled at the factory.
- Spares requirements were updated periodically as determined by program usage.
- Accountability of spares was on a periodic basis.
- Maximum usage of government supplies was accomplished from local supply organizations.
- Minimum vehicle spares at the field site with vehicle spares shipped with each LES.

For the purposes of this study, past programs were used to identify percentages of spares/repair requirements on a per unit operational cost. Spares were estimated separately for the categories of replacement spares, modifications/repairs, and packing and crating expense. The spares and logistics administration cost has been included under WBS element 10-0401.

1.1.4 Management Approach

Personnel placed in management authority have sole assignment and singular responsibility to the LES program. Lines of communication to contractor management were clearly defined with contractor management lending full support to the program. Management cost estimates assume the operation of a small Project Management Office during the entire period of the LES program. During the DDT&E phase of the program, project management costs were estimated independently for each system as related to management levels on previous programs. Because of the extended nature of the LES program and the low level of production, it was decided to assume intermittant production periods in order to reduce overhead expenditures to more efficient levels.

1.1.5 Operations Philosophy

Operational procedures were tailored to provide an efficiently controlled processing and launch preparation capability. The following features established the operations philosophy for the LES program:

- Verification testing concentrated at the factory, minimizing testing and support equipment at the launch site.
- No disassembly of LES at launch site with exception of the structure hardware and plumbing required to install preserviced propellant tanks.
- Propellant tanks were shipped separately from the vendor to the field site. The tanks were preserviced and sealed with a 100% or 50% propellant load as required by the scheduled mission.
- o Minimum buildup and assembly of equipment at the field site.
- o Verification testing minimized at the launch site.
- o Support equipment maintained in ready status by permanently assigned field crews.
- o Sufficient support equipment were assigned and located at each field site to meet vehicle processing requirements.
- o Provision for a full system of Standard Operating and Maintenance procedures with a system for changes and improvements.
- o A cadre mix of skills assigned to the field site that have capability to accomplish all necessary processing and preventive maintenance.
- o Engineering and Technical support made available to field site from the contractors facility for processing problems and advice.
- o Initial training and periodic recertification of technicians with full participation of engineering.

Operational costs were made up of those elements which recur per launch and those costs which are constant and applied on an annual basis at each launch site. The users charge is an element of operational cost which is stage, payload and mission dependent and therefore does not continuously recur as other operational costs. It is therefore shown as a separate entry on the scenario summary page. Most operations costs are for personnel expense, hence the basic philosophy has been to concentrate on personnel requirements and typical operations overheads. Operational equipments were considered to be a part of DDT&E cost and have been estimated independently by equipment requirement, then summed to provide a full complement cost.

1.2 COSTING METHODOLOGY

A description of the costing methodology as it applies to existing/planned systems and their adaptations, new design approaches, parametric applications, vendor quotations and the applicability of the detailed costing approach, is included in this part.

1.2.1 Existing/Planned Systems

The costs of existing/planned propulsion systems considered in the LES study were obtained from NASA documents or from cognizant NASA personnel.

1.2.1.1 Integral OMS and OMS Kits Costs - In addition to the Shuttle shared-flight charge, an additional charge is planned for Orbiter delivery of a payload to a non-standard orbit altitude; i.e., other than 296 km (160 nm). An estimated charge of $0.2M for this service, used in the study, was obtained from cognizant NASA Headquarters personnel. In addition to the Shuttle shared-flight charge there are optional flight system charges for OMS kits. These charges, use cost and serial impact cost, are from Reference 32 and are summarized in Table I along with dimensions and mass necessary to compute shared-flight charge.

1.2.1.2 Teleoperator Retrieval System Costs - TRS development costs and the cost of the TRS were considered funded by the Skylab Boost Program. This TRS was considered to be used at ETR. Two additional TRS with ASE were assumed purchased at $11M each in 1977$ (in accordance with Reference 50) one in 1982 for use at WTR and one in 1983 as a backup. All three TRS are considered

TABLE I

EXISTING/PLANNED SYSTEMS COSTS

1977 DOLLARS

ORBITER MANEUVERING SUBSYSTEM KIT COSTS

NUMBER OF KITS	LENGTH m (ft)	MASS kg (lb)	USE COST 1977 $	SERIAL IMPACT TIME-HR	SERIAL IMPACT COST-1977$
1	2.745 (9)	7401 (16302)	266,295	20	333,580
2	2.745 (9)	13379 (29468)	532,590	64	1,067,456
3	2.745 (9)	19537 (43033)	798,858	108	1,801,332

TELEOPERATOR
RETRIEVAL & REFURBISHMENT COSTS

	2 TANK	4 TANK
Retrieval Cost	$0.364M	$0.364M
Refurbishment Cost	0.175M	0.250M

MULTI-MISSION MODULAR SPACECRAFT PM-II COSTS

PM-II Production Cost	$0.977M

SCOUT EXPENDABLE LAUNCH VEHICLE COSTS

WTR Launch	$3.817M
San Marco Launch	4.817M
Additional Cost for a fifth stage is:	0.500M

available for uses other than the low energy payload program. Retrieval costs (References 23 and 32) and refurbishment costs for the TRS (Reference 22) are included in Table I. Unit, annual and launch site dependent operations costs used for TRS are the same as those used for other low energy stage candidates (Volume IV, paragraph 7.2.3.3.).

1.2.1.3 Multimission Modular Spacecraft PM-II Costs - PM-II and ASE development costs were considered funded by the MMS program. The expendable PM-II production cost used in the study was taken from Reference 51 and is included in Table I. Unit, annual and launch site dependent operations costs used for PM-II are the same as those used for other low energy stage candidates.

1.2.1.4 Scout Expendable Launch Vehicle Costs - The costs of the four-stage Scout launch vehicle used in the study, taken from Reference 52 are included in Table I. Annual program maintenance costs (Reference 52) which include all Scout program costs other than the unit costs are $4.811M in 1977$.

1.2.2 Adaptations of Existing/Planned Systems

The Booster Stages developed in Task 2 were screened to eliminate all except the SSUS-A and SSUS-D adpatations. These boosters were considered purchased as complete assemblies, and delivered directly to the launch site preparation area for joining with the Delivery Stage. The details of use for these boosters is contained in Reference 39. Costs for SSUS-A and SSUS-D were obtained from Mr. M. J. Schmidt by telecon on 5 April 1978 (Reference 53). These estimates were given in 1975 dollars as (not to exceed) costs to launch using (1) SSUS-D - $2M, and (2) SSUS-A - $3M. These costs were adjusted to 1977 dollars using the same projection factor criteria as used earlier for the Shuttle Users Charge, in Volume IV, paragraph 7.2.3.3. Costs were calculated to be: (1) SSUS-D $2.426M, and (2) SSUS-A $3.639M. These costs include SSUS/LES integration and special services, as well as the stage cost. Special services refer to Baseline Mission Analysis and Services including hardware acceptance testing, hardware pre-ship review, mission readiness, safety analysis, motor target adjust analysis, launch preparation documents, launch site operations, post-flight analysis, support of the launch site, program management, scheduling, countdown procedure inputs and component temperature review.

Additional mission specific analyses and services charges were included for launch applications using the SSUS-A or D alone as the delivery stage. Mission specific analyses and services consist of: (1) mission oriented analyses such as dynamic stability analysis and thermal analysis, (2) launch oriented services such as spacecraft integration and launch realtime support. These charges, in 1977 dollars, are in addition to baseline charges and were estimated for SSUS-A or D to be:

- Mission Oriented Analyses - \$.75M
- Launch Oriented Services - \$.45M

1.2.3 New Design Approaches

Production Costs - Production costs are a composite of recurring material, production (manufacturing) labor and quality control coverage, together with production (sustaining) engineering. All production costs were derived with appropriate additions for general administrative overhead and profit margins added to each item at the subsystem level 5, to give selling prices. Costs are shown in 1977 calendar year dollars. The basic approach used in the development of production costs was an extension of the methods used to develop costs in Task 2. The primary difference being the greater amount of configuration definition and specific knowledge of the design available in this phase of the study, and the reduced number of configurations subject to review. The greater amount of time available to study each configuration enabled a more comprehensive evaluation of each propulsion approach. Selected subsystems of the low energy stage were analyzed by detail estimate. Those given foremost attention were the high cost areas, such as the propulsion subsystem and electronic equipment. Equipment lists were composed for these selected parts of the LES in Task 2 as a detail check on the accuracy of the parametric estimates. These equipment lists were reviewed for structural and electronic integration and test characteristics. Each component was assigned an integration value rating based on its relative integration complexity. These data, together with physical information for subsystem components provided the basis for installation cost estimates, by means of the Mechanized Cost Evaluation Methodology (MCEM). These labor estimates were then spot checked for accuracy by comparison with independently derived manufacturing estimates.

The material and manufacturing labor cost for each subsystem was then processed through a MCEM subroutine, described in Volume II, paragraph 3.3.1, to develop subsystem complexity factors for design and manufacturing. These data were directly compared with other complexity factors developed for a wide array of similar product groups. The RCA PRICE system data bank contains an extensive catalog of complexity factor data which has been derived during thirteen (13) years of system use and reflects many thousands of cost studies. Virtually every type of hardware component and system has been cataloged and is available for comparisons of this type. Once consistent correlations are obtained, and variations from the norm explained, the basic data is authenticated for further use and filed in this company's data banks. All production costs for new design configurations were based on cumulative average for 103 units, produced in five lots over a ten (10) year period, assuming 20-21 items per lot. A development of this rationale is contained in Volume II, paragraph 3.3.2. Production quantities for the new design configuration portion of Task 6 scenarios, ranged from 78 items to 112 items, with the preponderance being at the larger quantity. A weighted average of all scenario configurations studied gives approximately 107 items, however, the lowest cost scenarios were C-1 and C-2, both of which used the 103 new design quantity. For this reason a 103 item quantity was selected as the typical near average production quantity for the comparison study.

Development Costs - Actions during Task 2 were directed at establishing the LES vehicle subsystem recurring costs and relating them in terms of relative complexity to other similar subsystems in the historical data file. Placing the subsystem in this context was important because it established a frame of reference where not only recurring production costs were comparable, but non-recurring design, development, test and evaluation costs could be compared as well. In essence, considerable effort was expended by detail cost buildup and repeated comparison to develop an accurate production cost, and to place it in context with other similar assemblies or subsystems verifying its relative complexity. By confirming its correct relative complexity, the more difficult problem of estimating the DDT&E costs was simplified.

Based on the subsystem descriptive parameters, and other data described in Volume II, paragraph 3.3.1, and the developed complexity factors, it was then possible to predict the DDT&E cost for new designs within reasonable accuracy. All DDT&E cost was developed to include separate estimates for design and drafting, systems engineering, project management, data, tooling/test equipment, and prototype buildup. The final step in estimation of development costs was the review by technical specialists in each area of responsibility. This review was a personal comparison of the MCEM subroutine results with personal and historic data available to the specialist. Differences in data were subsequently resolved before the costs were used in the study. At this time the costs represented separate configurations, as if each configuration were developed as a separate program. The configuration costs were then integrated with associated configurations to develop scenario cost as defined in Volume IV, paragraph 7.4.2. Integration of configuration costs to develop scenario costs was primarily a process of developing commonality of design. Substantial commonality existed between configurations of type. For example, the new design portion of Scenario C-2 consisted of a set of modular bipropellant configurations of four (4) and eight (8) tank design, for both horizontal and vertical installations. These designs were essentially common and would be produced on a single production line, where the effects of "learning" were maximized. This situation can be compared to an automotive production line where a certain size automobile is produced having minor differences in accessories and subsystems. Costs developed were based on a quantity buy of 103 units during a 10 year period. Five production lots were assumed of 20 to 21 units per lot. The 103 units were based on the requirements of the mission model (Volume III, Table 4-IV) after allowance for direct Shuttle delivery, (16) and Scout ELV launches, (10). The average useage of 20 to 21 every two years also came from the model. A typical modular propulsion approach (the bipropellant) required 76 4-tank horizontal versions, 13 8-tank horizontal versions, and 14 4-tank vertical versions. These were used to make the 103 payload deliveries. Because of the modular approach the production cost of each version was based on the learning associated with the production of 103 units as shown in Table II.

The DDT&E cost was substantially reduced from the overall total by omission of common costs, but was significantly greater than that cost for any given version.

TABLE II

PRODUCTION COST OF MODULAR BIPROPELLANT CONFIGURATION - TYPICAL

Components \ Number Required	8 TANK VERSION	4 TANK VERSION	4 TANK VERTICAL VERSION	TOTAL QUANTITY COSTED
Components / Number Required	13	76	14	103
Propulsion System				103 Sets
Thruster				103 Units
Propellant, Press. Unit				464 Units
Other (Note 1)		Same		103 Sets
Guidance System		Components		103 Sets
Reaction Control		And		103 Sets
Thruster				103 Sets, 412 Units
Other (Note 1)				103 Sets
		Same		
Telemetry System				103 Sets
		Unit		
Electrical Power System				103 Sets
Other (Note 1)				103 Sets
		Costs		
Ignition System				103 Sets
		Used For		
Structure		All		103 Sets
Basic Core				103 Units
Tank Support Modules for Inboard & Outboard Tanks				464 Sets, 464 Units
		Versions Except		
Integration		as Noted		Note (2)

NOTE (1): The modular versions are the same except for plumbing, wiring harness lengths and thermal protection provisions. Unit costs of components varied according to length and size for each version.

(2): Integration cost was a function of system size and component quantity.

Facilities - Studies to date have not developed a requirement for new or modifications to facilities, hence this cost category has been omitted.

Aerospace Support Equipment - Development of the cost for Aerospace Support Equipment (ASE) presented a different problem from most other categories of the Low Energy Stage. The problem was that there were few other items which could serve as a fully adequate cost model. Initial effort was expended to collect current cost information for ASE items presently in design. Secondly, previous estimates of ASE for other programs were reviewed for applicability (similarity) to the design approach depicted in Volume III, paragraph 5.1. Lastly, a research of historical complexity data currently on file for other space structures of construction similarity was undertaken. The model of greatest similarity to the LES ASE was considered to be the ASE for the Multimission Modular Spacecraft (MMS), currently in design. Estimated (projected) costs for this design were given by Mr. Robert O. Bartlett, GSFC-MMS Systems Engineer, for the MMS retention system, payload positioning system and the FSS interface electronics (Reference 46). This information, together with collected physical data (weight, volume, material, etc.) was evaluated by processing it by use of the MCEM. Complexity cost factors for (1) manufacturing, (2) engineering design and (3) producibility were developed which, in turn, were compared with historical complexity data currently on file for other large space vehicle structures. In addition, a manufacturing detail estimate was prepared to serve as a third cost reference for ASE structures. The complexity results indicated the MMS ASE of highest manufacturing complexity (7.198), the space structures historical data as somewhat lower complexity (6.100) and the detail manufacturing estimate as falling between the two (6.579). Design evaluation between the MMS-ASE design and the present LES ASE design showed LES ASE to be somewhat less complex and therefore logical in results on the low side. The manufacturing detail estimate complexity tended to closely confirm the historical data as applicable to the ASE, hence this historical data complexity was used as firm cost data and the most probable value. The relative complexity developed for the ASE cradle was then used to estimate DDT&E cost. These costs were subjected to a final review for validity by assigned technical specialists.

ASE Avionics is composed of the SIG/Data Interface Unit, Power Control Unit, Deployment Mechanism Unit and associated cable harnesses. The ASE Controls and Display category comprises the Control and Monitor Panel and Umbilical cable. All items of Avionics, Controls and Displays were estimated separately by comparison analysis of contents and application of the Mechanized Cost Evaluation Methodology (MCEM). Complexity factors were developed for each equipment item, based on overall size and total weight, electronics volume, structural weight, electronics density, equipment type (analog, digital, etc.), component type (semiconductors, integrated circuits, LSI, hybrid, etc.), percentage new design, design redundancy, power dissipated, component count, and design and production schedule. The complexity factors developed were again compared with factors for similar equipments, as a check on credibility of data. DDT&E costs were derived by use of these data and were reviewed by technical specialists familiar with these equipments.

By means of integration classification, values assigned to each equipment item and to the components of the modular-cradle, an integration DDT&E cost was derived for the total ASE package.

Software - All software costs were developed by comparison projection from similar software selected for the Scout Phase VIII guidance system. The selection of this system as a cost model is explained in Volume III, paragraph 4.2.4. The cost of this system was based on actual expenditures to date and estimates to completion. The cost includes vendor test software, contractor test software and flight software.

System Test and Evaluation - This category includes the cost to plan and perform integrated system level tests on the LES vehicle an perform major element Interface Tests. All test costs included here were derived by detail buildup and by comparison with previous programs. The primary costs included for the development sub-element are propulsion and structural tests. Qualification sub-element testing included here is for the propulsion system. Rationale for the structural testing is shown in Volume III, paragraph 4.2.2. The propulsion testing discussion is contained in Volume III, paragraph 4.3. Additionally, the cost for a mockup of both delivery stage and ASE cradle was included as an evaluation tool. Cost for the mockup was prepared by detail estimate.

Operations DDT&E - One significant difference between the costing accomplished in Task 2 and the costs developed in Task 6 is the addition of DDT&E costs for the operations categories, WBS 10-800 Ground Support Equipment and 10-900 Ground Operations. Ground Support Equipment DDT&E cost is the non-recurring expense associated with the design and production of the category 801 test equipments and 802 handling devices required for field operations. Estimation of costs in this area were accomplished for each equipment item by comparison with similar equipment items from other programs. Scout equipments were the base comparison models in many areas. The Mechanized Cost Estimation Methodology was again used to check the more costly electronic and control devices.

Operations Costs - Operations costs are those elements of recurring cost which are expended throughout the operational life cycle of the system, which insure successful functioning of the system. The non-recurring costs associated with these operational elements are part of DDT&E cost for the system. Operational costs are made up of those elements which recur per launch, and those costs which are constant and applied on an annual basis at each launch site. The operational costs which have been derived for the LES Program are shown on the Data Form A in Appendix C, with the exception of the Space Shuttle Users Charge. The User's Charge is stage, payload and mission dependent and therefore does not continuously recur as other operational costs. It is shown as a separate entry on the final summary page (Data Form 5). The base price of a dedicated STS flight, to Civil Government users, was quoted as $18 million in 1975 dollars (Reference 49). This cost was then projected to mid-fiscal year 1977 by means of the BLS index escalation curve for Industry compensation per hour. This Shuttle charge cost was calculated to be $21.834M. The philosophy of Shuttle charge application is discussed in greater detail in Volume IV, paragraph 7.2.1.6.

Operational costs were developed principally by a detail estimation approach. Field personnel requirements were estimated using the field processing flow defined in Volume III, Figure 6.4, and the critical path requirements of Volume III, Figure 6.5. These estimates were fully consistent with Scout experience. A discusssion of operational requirements and operatting procedures defining the groundrules and assumptions is contained in Volume III, paragraph 6.1.6. All operational equipments were estimated by

Table III has been developed for all items subject to the MCEM estimating process.

1.2.5 Detailed Approach Applicability

As the initial screening of propulsion approaches was completed, the emphasis shifted to a more detailed evaluation of the remaining approaches. In this phase of the program concentrated effort was expended to increase the design definition and refine the costs. It was then possible to properly cost the operational areas, when quantities and types of equipments were set, and personnel allocations decided for system manning. The greater-detail then available made possible the cost "shading" to distinguish minor cost variations, based on less significant variation in system complexity. In the final stage of the evaluation, total system cost assumed primary importance as the feasibility of carrying the selected design approach into an active status was examined. The detailed costing approach was used sparingly in Task 2, more extensively in Task 6, and was applied primarily to production and operational costs.

1.2.6 Vendor Quotations

In Task 6, selected subsystems of the low energy stage were analyzed by detail estimate. Those given foremost attention were the high cost areas, such as the propulsion subsystem and electronic equipment. Equipment lists were composed for these selected parts of the LES in Task 2 as a detail check on the accuracy of the parametric estimates. Equipment lists were refined as alternative vendor sources were investigated for selection of applicable equipment types. Budgetary quotations were then solicited for the foremost equipment items. Alternative quotations were requested when the first quotations received were considered questionable because of price or application. All quotations for equipment items were reviewed by technical specialists in comparison with accumulated historic data for similar hardware. Certain operational equipment items were priced by vendor quotation, as described in paragraph 1.2.3.

1.3 WORK BREAKDOWN STRUCTURE

The included Work Breakdown Structure chart, Figure 1, is the standardized format which has been used to itemize costs for all propulsion concepts. Each of the categories depicted on the chart are fully defined in

TABLE III

PRODUCT DESCRIPTORS SET
MECHANIZED COST EVALUATION METHODOLOGY

GENERAL DATA

- o Production Quantity
- o Prototype Quantity
- o Quantity/ System
- o Year of Estimate
- o Escalation Rate
- o Product Class (Reliability)
- o Markup Percentage (G&A and Fee)

CLASSIFICATION DATA

- o Percentage New Design
- o Engineering Complexity*
- o Manufacturing Complexity/Producibility*
- o Applicable Learning Curve
- o % Structural/% Electronic
- o Percentage Redundancy
- o Integration Classification
- o Degree of change traffic, Project Management, Documentation, Systems Engineering, tools and test equipment (For items requiring special treatment)

PHYSICAL DATA

A. Structural/Mechanical
- o Structural weight
- o Structural volume
- o Material type
- o Structural class
- o Fabrication type

B. Electronics
- o Electronics weight
- o Electronics volume
- o Equipment class (type)
- o Sub-component technology (type)
- o Component count
- o Dissipated power

SCHEDULE DATA

- o Design Program Length
- o Test Program Length
- o Production Program Length

*Note: Item cost may be used, together with associated data to develop complexity data.

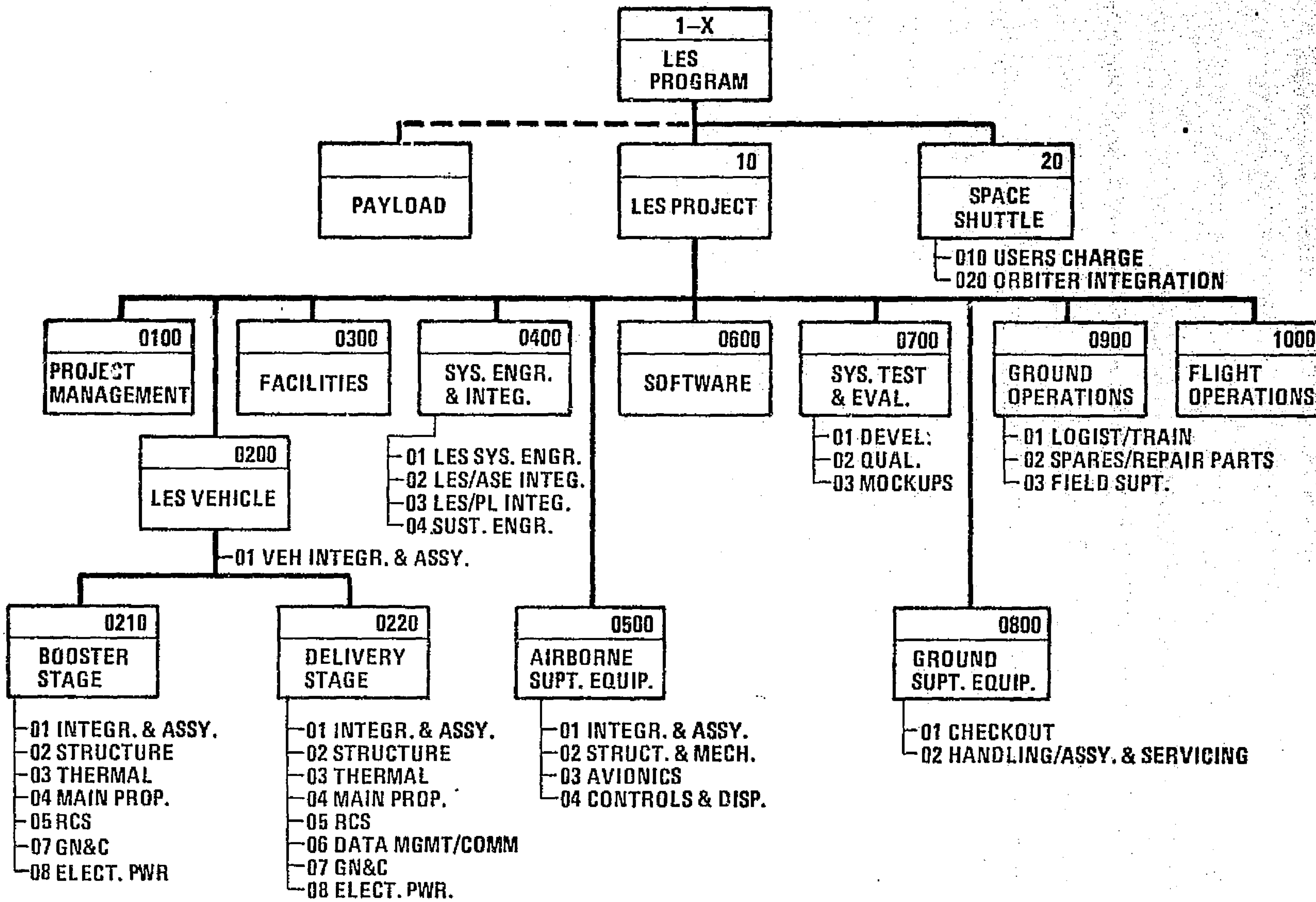

FIGURE 1 WORK BREAKDOWN STRUCTURE FOR LES STUDY

Appendix A. The costs of all new configurations are itemized according to this format and collected in Appendices B and C. The costs for certain purchased stages, such as SSUS-A and SSUS-B have been shown only to level 4 because of unavailability of detail data from the manufacturer. Table IV, LES Program Costing Elements, is a further subdivision of WBS elements into Development (DDT&E), Production and Operations phases for new stages, existing stages and adaptations to existing stages, and applies to the costing of Tasks 2 and 6. A limited version of the WBS has been used in Task 2. It was used in its entirety in Task 6. Table IV indicates the level of costing for the appropriate task.

1.4 COST ESTIMATING CRITERIA

This part contains an explanation of the functional relationships and derived cost factors which apply to the cost estimating methodology.

1.4.1 Functional Relationships

In order to compare the array of propulsion approaches quickly with appropriate accuracy a Mechanized Cost Evaluation Methodology was used, with the necessary flexibility and attention to detail, to clearly reflect system differences. The costing methodology utilized a work breakdown structure (WBS) developed quite early in the LES study to assure consistent definition of propulsion system approaches, together with a complete summarization of configuration design differences to the subsystem level. The basic cost information used in the costing exercise included internal (company historic) cost data, vendor quotations, and other published report data. Solicitation of vendor quotations was necessary to more accurately measure the unique differences of competing designs, and to check the accuracy of cost records used in the study. The costing methodology utilized a special checking feature, where input data could be evaluated relative to existing cost models by means of developed complexity factors. By use of this feature, the relevence of cost data could be checked before use and verified for accuracy and commonality of costing assumptions.

Costs were derived using a computerized parametric cost modeling methodology. This technique, known as the RCA PRICE (Programmed Review of Information for Costing and Evaluation) system, provides reliable estimates of system acquisition costs (development and production) during the conceptual

TABLE IV
LES PROGRAM COSTING ELEMENTS

WBS		TASK / STAGE PHASE	TASK 2 NEW 1-D	1-P	1-O	ADAPTIONS 1-D	1-P	1-O	EXISTING 1-D	1-P	1-O	TASK 6 NEW 1-D	1-P	1-O	ADAPTIONS 1-D	1-P	1-O	EXISTING 1-D	1-P	1-O		
LES PROGRAM	00-000		X	X	X	X	X	X		X	X	X	X	X	X	X	X		X	X		
LES PROJECT	10-000		X	X		X	X			X		X	X	X	X	X	X		X	X		
SPACE SHUTTLE	20-000				X			X			X			X			X			X		
USERS CHARGE	20-010				X			X			X			X			X			X		
ORBITER INTEGR'N	20-020													X			X			X		
PROJECT MGT.	10-0100		X	X	X	X	X	X			X	X[a]	X[a]	X	X[a]	X[a]	X			X		
LES VEHICLE	10-0200		X	X		X	X			X		X	X		X	X			X			
VEH INTEG'N & ASSY	10-0201		X	X		P	P					X	X		P	P						
BOOSTER STAGE	10-0210		X	X		P	P					X	X		P	P						
INTEG'N & ASSY	10-0211		X	X		P	P					X	X		P	P						
STRUCTURE	10-0212		X	X		P	P					X	X		P	P						
THERMAL	10-0213		X	X		P	P					X	X		P	P						
MAIN PROPULSION	10-0214		X	X		P	P					X	X		P	P						
DELIVERY STAGE	10-0220		X	X		P	P					X	X		P	P						
INTEG'N & ASSY	10-0221		X	X		P	P					X	X		P	P						
STRUCTURE	10-0222		X	X		P	P					X	X		P	P						
THERMAL	10-0223		X	X		P	P					X	X		P	P						
MAIN PROPULSION	10-0224		X	X		P	P					X	X		P	P						
RCS	10-0225		X	X		P	P					X	X		P	P						
DATA MGT/COMM	10-0226		X	X		P	P					X	X		P	P						
G&C	10-0227		X	X		P	P					X	X		P	P						
ELECT PWR	10-0228		X	X		P	P					X	X		P	P						
FACILITIES	10-0300											X			P							

a. INCLUDED IN SUBSYSTEM COSTS

LEGEND: X WILL BE COSTED
P POTENTIAL COST-DEPENDENT ON CHANGES

TABLE IV (CONT'D)
LES PROGRAM COSTING ELEMENTS

	TASK	TASK 2									TASK 6										
	STAGE	NEW			ADAPTIONS			EXISTING			NEW			ADAPTIONS			EXISTING				
WBS	PHASE	1-D	1-P	1-O	1-D	1-P	1-O	1-D	1-P	1-O	1-D	1-P	1-O	1-D	1-P	1-O	1-D	1-P	1-O		
SYSTEMS ENGRG & INTEG'N	10-0400	X	X	X	X	X	X		X	X	X	X[a]	X	X	X[a]	X		X	X		
LES SYS ENGRG	10-0401	X	X[a]	X	X	X	X			X	X[a]	X[a]	X	X	X[a]	X			X		
LES/ASE INTEG'N	10-0402			X			X			X	X		X	P[b]		X			X		
LES/PAYLOAD INTEG'N	10-0403			X			X			X			X			X			X		
SUSTAIN'G ENGRG	10-0404			X			X			X		X	X[a]		X[a]	X			X		
AIRBORNE SUPRT EQUIP'T	10-0500	X			X						X			P							
INTEG'N & ASSY	10-0501										X			P							
STRUCT & MECHANISM	10-0502										X			P							
AVIONICS	10-0503										X			P							
CONTROLS & DISPLAYS	10-0504										X			P							
SOFTWARE	10-0600										X			P							
SYSTEM TEST & EVAL	10-0700										X			X							
DEVELOPMENT	10-0701										X			X							
QUALIFICATION	10-0702										X			X							
MOCK-UPS	10-0703										X										
GROUND SUPPORT EQUIPMENT	10-0800										X			P							
CHECKOUT	10-0801										X			P							
HNDLG/ASSY & SERVICING	10-0802										X			P							
GROUND OPERATIONS	10-0900			X			X			X	X		X			X			X		
LOGISTICS/TRAINING	10-0901										X		X			X			X		
SPARES/REPAIR PARTS	10-0902			X			X			X			X			X			X		
FIELD SUPPORT	10-0903			X			X			X	X		X			X			X		
FLIGHT OPERATIONS	10-1000												X			X			X		

a. INCLUDED IN SUBSYSTEM COSTS
b. INCLUDED IN 0201 AND 0501

phase of a system development program. Its use permits rapid and timely cost evaluations, based on variations in designs, performance schedules, reliability, economic escalations, etc. Since all estimates involve comparative evaluation of new requirements to analogous histories, irregardless of the estimating technique used, it is necessary to classify a new design in such parameters that it may be related to available basic data. The costing methodology utilizes configuration definitions which are primarily the physical characteristics of the design concept. These include size, weight, type of componentry, component count, material type, power dissipation and construction type, as well as prototype and production quantities. In addition the methodology is sensitive to design and production schedule, learning (progress) curve, integration characteristics, design and manufacturing complexity, design redundancy, the degree of new design required, and fabrication method. One mode of this cost estimation methodology produces a estimation of design, manufacturing and producibility complexity from physical, schedule and cost data. This mode was used in the cost exercise where the design being costed was of a unique nature with limited relationship to historical data. Vendor quotations were processed through this mode to establish credibility. Where complexity factors appeared inconsistent with historical data the credibility of the costs were questioned. In such cases, further evaluation was required before adjusted costs were used. The final step in the costing methodology was the review of subsystem costs by technical and cost specialists for consistency among similar subsystems on different propulsion approaches. Subsystems were costed independently, then combined to develop delivery stage or booster cost, which are again combined to develop the cost of a propulsion approach.

The PRICE system has been structured with self-contained capability which permits it to gauge the relative applicability of each input empirical data reference set. An empirical data reference set can be characterized as that group of parametric values which defines a specific type of equipment. The variation of these parameters with cost in turn forms a set of Cost Estimating Relationships (CER's). These empirical data sets are used to adjust the algorithms or CER's of the PRICE program, to make them conform to the product categorization. In a sense they are used to "calibrate" the PRICE algorithms to the particular device of interest. PRICE uses the empirically aligned algorithms to generate other/additional physical characteristics that are representative of the class of product being examined. The PRICE methodology has the built-in self-checking capability to minimize the chance of generating misleading outputs, and provides a procedure for correcting the inputs when such cases occur.

Selection of an appropriate empirical data reference set is not always a simple task for a new concept or approach. It requires familiarity with the product history, nature of the componentry, construction and problems. This familiarity includes the capability of recognizing the need to make adjustments to the empirical data set to account for concept differences.

The basic algorithms and cost estimating relationships used in the PRICE system are considered proprietary with RCA. Research in this area is generally costly and time consuming and forms the basis for protection of their data. PRICE outputs result from the complex mathematical interplay between two sets of input data. The first is the reference empirical data set previously discussed generated from historical experience data by a PRICE subroutine that defines the specific product in reference terms comparable with the PRICE system. The second is the new product descriptors set, a group of elemental costing data which PRICE is programmed to accept. The mathematical function which governs all PRICE cost computations is $F(K, MT/R)$ where

M = measure of the work to be performed

T = time (performance period)

R = resources (capability, experience, know-how, etc.)

K = specification profile

For example, a greater volume of work done in an equivalent time with equal resources will result in higher cost. Whereas addition of more capability or resources will reduce costs. The K factor is in turn determined by the class of product as defined by the specification requirements. For various cost elements the M, T, R and K values have differing definitions, and for each cost element and each product class, the variables and their mathematical interrelationships are different. Such modes are established, within the PRICE program, through use of derived experience parameters (empirical data sets).

1.4.2 Cost Factors

The PRICE system employs a subroutine which generates empirical data sets (EDS) from cost experience data. Within each EDS are certain empirical parameters, or cost factors, which have significant relationship with product cost. The most important of these cost factors are:

- Manufacturing Complexity
- Producibility
- Engineering Complexity

RCA publishes an extensive set of EDS references for a wide array of mechanical and electromechanical products. Each item in this reference is defined in physical terms, by component type, product class, system name and finally by the developed cost factor previously noted. Historical data may be processed through the noted subroutine in order to develop the aforementioned cost factors. In fact, the RCA EDS reference material was developed in this manner. When empirical reference data sets are developed for particular product groups, certain significant statistical consistencies will become obvious. Each product group data set will have apparent correlations, and individual differences will be readily associated with product design variations. Within each product group, the most significant empirical parameters will be found to differ very slightly. Based on a reasonable sample size, their variation will usually be less than 15% of the mean value. These cost factors are extremely helpful in developing the cost for new design applications which have a basis of similarity with some identified EDS.

2.0 SUMMARY COST PRESENTATION

The cost summary for the recommended propulsion approach, Scenario C-2, is shown in Table V. The Data Form 5 presents this summary and defines the propulsion approach configurations and quantities required for completion of the mission model. The Data Form A sheets of paragraph 3 provide a detailed breakdown, by WBS category, for the new design portions of this summary.

DATA FORM 5

TABLE -V

SCENARIO C-2 COST SUMMARY
COSTS $ M

WBS NO.	NUMBER OF PAYLOADS / COST ITEM \ Propulsion Approach	16 INTEG OMS	76 Modular 4-Tank Horiz.** Biprop.	13 Modular 8-Tank Horiz. Biprop.	14 Modular 4-Tank Vert.** Biprop.	10 Scout			NON RECUR COST	TOTAL COST
1-D	DDT&E								26.1	26.1
1-P	PRODUCTION	0	133.5	27.8	24.8	0				186.1
1-0	OPERATIONS - TOTAL	283.7	698.7	166.0	63.9	57.6				1,269.9
	(Supporting Costs)	0	(40.2	(6.9)	(7.4)	(14.4)				*(68.9)
	(Shuttle Charge Total)	(283.7)	(658.5)	(159.1)	(56.5)	---				1,157.8
	• Payload Charge	280.5	532.4	131.3	18.1	---				962.3
	• Stage Charge	---	126.1	27.8	38.4	---				192.3
	• Other Charges	3.2	---	---	---	---				3.2
	(Scout Launch Charge)	---	---	---	---	(43.2)				(43.2)
	TOTAL COST	283.7	832.2	193.8	88.7	57.6			26.1	1,482.1
									Total Without Payload Charge	519.8

*Supporting costs include:

Annual Operations Cost		36.9
Unit Operations Cost	(23.6 + 4.0 + 4.3)	32.0
	Total	68.9

**415 Kg Offload, Refer to paragraph 4.7.1 of Volume III

3.0 COST ESTIMATE BY WBS ELEMENT

A cost breakdown, by WBS element, is included in this section for the recommended propulsion approach together with an explanation of the applicable spread functions, learning index and launch milestone dates.

3.1 ESTIMATES ON DATA FORM A

The detailed costs for the new design parts of the recommended propulsion approach, Scenario C-2, are shown in the Table VI. These Data Form A sheets provide detailed backup data by WBS category for Non-Recurring, DDT&E, Operations and Production Costs. The WBS level is indicated for each item and the number of prototype and production units, on which the costs are based, is included. Estimates of elapse times to design and develop (DDT&E) and produce each item are indicated as T_d. The production time is for the first unit only. Suceeding production runs will tend to reduce this time. The lead time (T_s) for each WBS item is also indicated. This value is the number of months from the start of cost accrual, for the initial item, to the launch milestone date. The elapsed times are different for DDT&E and production, for the same WBS elements. The average unit costs for production items are based on a total of 103 new design modular units contained in the Scenario. The conditions of production are explained in Volume II, paragraph 3.3.2.

In addition cost estimates have been prepared for all considered scenarios, for three categories of cost:

- DDT&E
- Operations
- Production

These costs are broken down to WBS level 4 and 5 within each category in accordance with the terms of the study agreement. The results are shown on Data Form S, and included in Appendix B for Task 2 combinations and Appendix C for Task 6 scenarios, of Volume V. DDT&E costs have been developed for each scenario and include the total development cost for the modular family of configurations contained within each scenario. Operations costs include elements of annual cost and cost per launch. For this reason the operations sheets show sub-element cost breakdown for each WBS item in terms of cost/launch and annual cost. Additionally the annual cost in the

TABLE VI

LES BASIC COST DATA

NON-RECURRING DDT&E

SCENARIO NO. C-2

DATA FORM A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF PROTOS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	--	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(14,319)	N/A	22	33
10-0201	Vehicle Integration and Assembly	5	--	---		--	--
10-0210	Booster Stage	5	--	---		--	--
10-0220	Delivery Stage	5	1	14,319		20	33
10-0221	Integration & Assembly-Delivery Stage	5	1	737		20	33
10-0222	Structure and Mechanism	5	1	2,241		16	33
10-0223	Thermal System	5	1	164		6	33
10-0224	Main Propulsion	5	2	6,564		20	33
10-0225	Reaction Control System	5	2	750		20	33
10-0226	Data Management & Communications	5	2	19		7	9
10-0227	Guidance Navigation and Control	5	2	3,111		12	24
10-0228	Electrical Power System	5	2	733		18	26
10-0300	Facilities	4	--	---		--	--
10-0400	LES Systems Engrg - LES/ASE Integr.	4	-	(172)	N/A	20	33

TABLE VI

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. C-2

DATA FORM A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
10-0501	Integration and Test	5	3	116		12	17
10-0502	Structure and Mechanisms	5	3	4,811		12	15
10-0503	Avionics - ASE	5	3	201		10	13
10-0504	Controls and Displays	5	3	243		10	14
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test and Evaluation	4	N/A	(1,427)	N/A	12	24
10-0701	Development	5	-	1,004		12	24
10-0702	Qualification	5	-	303		12	24
10-0703	Mock-ups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
10-0801	Checkout	5	-	2,036		20	26
10-0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
10-0901	Logistics/Training	5	-	91		12	18
10-0903	Field Support	5	-	104		10	13

TABLE VI
LES BASIC COST DATA
FOR OPERATIONS
SCENARIOS C-1, C-2

DATA FORM A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
20-0000	Space Shuttle	43	103	N/A	N/A		
20-0100	User's Charge-Cost/Launch	4	103	*	*		
20-0200	Orbiter Integration -						
	Cost/Launch	4	103	(1,854)	(18)		
10-0100	Project Management -						
	Annual Cost	4	10	(5,000)	(500.0)		
	Cost/Launch			(13,774)	(133.7)		
10-0400	System Engineering and Integration	4					
	Cost/Launch		103	(14,781)	(143.5)		
	Annual Cost		10	(5,800)	(580.0)		
10-0401	LES Systems Engineering	5					
	Cost/Launch		103	11,279	109.5		
	Annual Cost		10	3,800	380.0		
10-0402	LES/ASE Integration						
	Cost/Launch	5	103	1,751	17.0		
10-0403	LES/Payload Integration						
	Cost/Launch	5	103	1,751	17.0		
10-0404	Sustaining Engineering						
	Annual Cost	6	10	2,000	200.0		
*NOTE	User's Charge is stage, payload, and mission dependent. See Form 5.						

TABLE VI
LES BASIC COST DATA
FOR OPERATIONS
SCENARIOS C-1, C-2

DATA FORM A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0900	Ground Operations -						
	Cost/Launch	4	103	(15,059)	(146.2)		
	Annual Cost	4	10	(11,733)	(1,173.3)		
10-0901	Logistics/Training -						
	Cost/Launch	5	103	927	9.0		
10-0902	Spares/Repair Parts						
	Cost/Launch	5	103	2,575	25.0		
10-0903	Field Support	5					
	Cost/Launch		103	11,557	112.2		
	Annual Cost (Prior to 1983)		1	617.5	617.5		
	Annual Cost (1983 and Sub)		9	11,115	1,235.0		
10-1000	Flight Operations						
	Cost/Launch	4	103	(309)	(3)		

TABLE VI

LES BASIC COST DATA
PRODUCTION

DATA FORM A

CONFIGURATION: 4 Tank Horizontal Bipropellant

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0200	LES Vehicle	4	76	133,492	1756.5	22	22
0201	Vehicle Integration & Assembly	5	--	---	---	--	--
0210	Booster Stage	5	--	---	---	--	--
0220	Delivery Stage	5	76	133,492	1756.5	22	22
0221	Integration & Assembly - Del. Stg.	5	76	6,132	80.7	22	22
0222	Structure & Mechanism	5	76	6,506	85.6	22	22
0223	Thermal System	5	76	2,264	29.8	22	22
0224	Main Propulsion	5	76	47,411	623.8	18	18
0225	Reaction Control System	5	76	15,843	208.5	15	15
0226	Data Management/Communications	5	76	728	9.6	2	2
0227	Guidance, Navigation & Control	5	76	53,344	701.9	12	12
0228	Electrical Power System	5	76	1,264	16.6	8	8

Note: The Average Unit Costs Indicated Here Are Based On A Total Of 103 Modular Units (76 + 13 + 14) Contained In Scenario C-2. These Costs Include $9,895.2K Of Project Management Cost. ($130.2K per unit)

TABLE VI
LES BASIC COST DATA
PRODUCTION

DATA FORM A

CONFIGURATION: 8 Tank Horizontal Bipropellant

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0200	LES Vehicle	4	13	27,751	2134.7	22	22
0201	Vehicle Integration & Assembly	5	--	---	---	--	--
0210	Booster Stage	5	--	---	---	--	--
0220	Delivery Stage	5	--	27,751	2134.7	22	22
0221	Integration & Assembly - Del. Stg.	5	13	1,353	104.1	22	22
0222	Structure & Mechanism	5	13	1,188	91.4	22	22
0223	Thermal System	5	13	390	30.0	22	22
0224	Main Propulsion	5	13	12,612	970.2	18	18
0225	Reaction Control System	5	13	2,710	208.5	15	15
0226	Data Management/Communications	5	13	124	9.6	2	2
0227	Guidance, Navigation & Control	5	13	9,125	701.9	12	12
0228	Electrical Power System	5	13	249	19.1	8	8

Note: The Average Unit Costs Indicated Here Are Based On A Total Of 103 Modular Units (13 + 14 + 76) Contained In Scenario C-2. These Costs Include $1,998.1K Of Project Management Cost. ($153.7K per unit)

TABLE VI

LES BASIC COST DATA

PRODUCTION

DATA FORM A

CONFIGURATION: 4 Tank Vertical Bipropellant

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0200	LES Vehicle	4	14	24,807	1771.9	22	22
0201	Vehicle Integration & Assembly	5	--	---	---	--	--
0210	Booster Stage	5	--	---	---	--	--
0220	Delivery Stage	5	14	24,807	1771.9	22	22
0221	Integration & Assembly - Del. Stg.	5	14	1,130	80.7	22	22
0222	Structure & Mechanism	5	14	1,414	101.0	22	22
0223	Thermal System	5	14	417	29.8	22	22
0224	Main Propulsion	5	14	8,734	623.8	18	18
0225	Reaction Control System	5	14	2,918	208.5	15	15
0226	Data Management/Communications	5	14	134	9.6	2	2
0227	Guidance, Navigation & Control	5	14	9,827	701.9	12	12
0228	Electrical Power System	5	14	233	16.6	8	8

Note: The Average Unit Costs Indicated Here Are Based On A Total Of 103 Modular Units (14 + 76 + 13) Contained In Scenario C-2. These Costs Include $1,838.2K Of Project Management Cost. ($131.3K per unit)

Field Support area shows those costs prior to 1983 and costs after 1983, to add WTR operational costs applicable in that year. A separate set of operations cost sheets are shown for each separate scenario vehicle quantity. Production costs for each considered configuration are shown on separate pages of the Appendix. All production costs have been calculated for a typical production quantity (103 units). A description of the production assumptions is contained in paragraph 3.3.2 of Volume II. The cost summary sheets for each Task 6 scenario are included in Appendix C.

3.2 SPREAD FUNCTIONS

A review of idealized cost distribution curves for development programs of similar nature to the LES program identified two curves of near optimum application. Decision was made to spread DDT&E costs using curve No. 2 of Figure 2. This curve assumes 68% expenditure at mid-program time. Production costs were spread within the year of delivery in accordance with provisions of ASPR Appendix E, paragraph E-510.1 (Reference 55) covering materials, equipment or services purchased and chargeable directly to a contract, but not paid for at time of billing. Fixed price contracts normally provide for payment at the time of delivery or acceptance, or upon completion of the contract. On contracts requiring (1) substantial investment or (2) long lead times the contractor may claim reimbursement for a portion of costs incurred, as progress payments. With its moderate cost and short production schedule and lead times, the LES may well be subject to full payment on delivery. Progress payments, if required, may well fall within the year of delivery.

3.3 LEARNING INDEX

Because of the low level of LES usage, it was considered advisable to establish special production guidelines which would fit this condition. Production was spread over a total 10-12 year period and the quantity of procured items was set at the total number required for use during that period for mission requirements. A production cycle was established to produce a two-year usage quantity, then production was assumed interrupted until the next production quantity was placed on order. Some learning takes place for any effort spread out over an extended time period. The effects of "learning" are well established in manufacturing industry. However, when a production

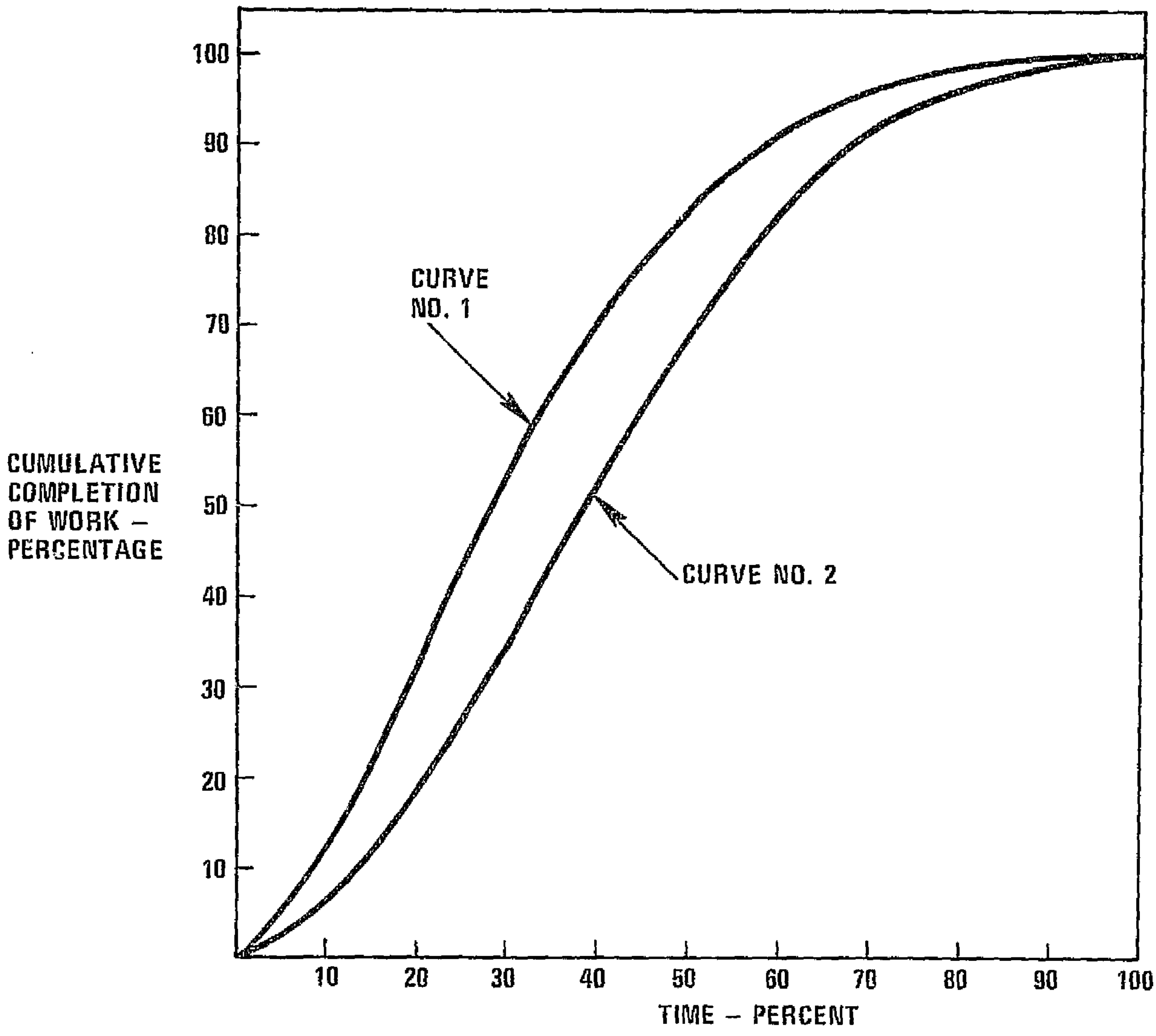

FIGURE 2 IDEALIZED COST DISTRIBUTION CURVES FOR DEVELOPMENT PROGRAM TIME PHASING

run is interrupted, some of the "learning" and associated cost effectiveness is lost. When production begins again, some trained personnel have left or have been reassigned, some tools are lost, etc., thus the learning curve applicable to the next production run is not simply a continuation of the learning curve of the prior run. The loss of "learning" means that production restarts at a point higher up on the learning curve. Volume II, Figure 3.10 illustrates the interrupted production situation. To compensate for loss of "learning" for interrupted production schedules, the empirical data set for the second run must be adjusted. The longer the production interruption, the less residual learning remains until a final limit is reached. To determine the probable learning curve which would apply to the LES production program, a trade study was conducted. A structural item was selected for study since it was considered to be highly labor intensive and subject to maximum learning impact. For a typical production quantity of 103 structural units, produced without regard to production need, the optimum learning curve was determined to be 0.898 (89.8%), for a program length of nineteen (19) months. Production rate was approximately 5.42 units per month. When production quantity was cut to 20-21 items per run, for five independent production periods during the ten (10) year period, the rate of composite learning drops to approximately 0.941 (94%). A selection of material intensive subsystem items showed increase from the normal 92% range to the 95% learning regime, hence this value was selected as most applicable to the LES system. All subsystems were estimated for 103 item cumulative average quantity and five equivalent lots of production. For variances in total production quantity, the 95% Wright slope was assumed applicable. DDT&E costs were developed for a modular family of vehicles of each type studied. For combinations of vehicles, requiring more than one type, the development cost was integrated by consideration of the existing commonality between differing types. All costs were developed in 1977 calendar year dollars.

3.4 LAUNCH MILESTONE DATE

The development schedule for the Low Energy Stage is shown on Figure 8.9 of Volume IV. This schedule establishes the launch milestone for the first LES vehicle. This launch date coincides with the LES mission model launch schedule, Volume III, Table 4-IV. The followon launch milestones are identified by this schedule. The cost schedule for the recommended scenario is shown in Volume IV, Table 7-XXII. This cost schedule gives the quantity and configuration approach selected to accomplish the LES mission model.

4.0 TECHNICAL CHARACTERISTICS DATA

The LES system consists of three arrangements of basic propulsion modules. Each arrangement is a primary propulsion stage consisting of integrated propulsion, avionics, and structural equipment which after deployment from the Shuttle Orbiter can function to place payloads into predesignated orbits. The three modular arrangements are an 8-tank, a 4-tank horizontal and a 4-tank vertical bipropellant. The 4-tank arrangement can accommodate 76 (59%) of the 129 low energy regime payloads, the 4-tank vertical version can accommodate 14 (11%) of the 129 payloads, and the 8-tank configuration can accommodate 13 (10%) of the 129 payloads.

The following Table VII presents the Technical Characteristics Data (TCD) for the LES system. Also presented are the WBS identification number, WBS identification title, some important weight and dimensional characteristics of the item, and pertinent quantities or values together with the appropriate units of measure for the items considered.

TABLE VII

TECHNICAL CHARACTERISTICS DATA

DATA FORM B

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
10-0220	DELIVERY STAGE				
	Modular 8-Tank Bi-Propellant LES	682 (1503)	Kg (lb)	Dry Weight	
		2351 (5183)	Kg (lb)	Full Weight	
		10	%	Missions Accomodated	
	Modular 4-Tank Bi-Propellant LES	433 (955)	Kg (lb)	Dry Weight	
		1262 (2783)	Kg (lb)	Full Weight	
		59	%	Missions Accomodated	
	Modular 4-Tank Vertical Bipropellant LES	464 (1024)	Kg (lb)	Dry Weight	
		1294 (2852)	Kg (lb)	Full Weight	
		11	%	Missions Accomodated	

TABLE VII

TECHNICAL CHARACTERISTICS DATA

DATA FORM B

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
10-0222	STRUCTURE				
	8-Tank (Modular)				
	o Aluminum Stage Structure	85.7 (189)	Kg (lb)	o Welded and mechanically joined tubular truss structure	
	o"V"Clamp	7.7 (17)	Kg (lb)	o Separation clamp between stage and payload	
	4-Tank (Modular)				
	o Aluminum Stage Structure	68 (150)	Kg (lb)	o Welded and mechanically joined tubular truss structure	
	o "V" Clamp	7.7 (17)	Kg (lb)	o Separation clamp between stage and payload	
	4-Tank Vertical				
	o Aluminum Stage Structure	96.6 (213)	Kg (lb)	o Welded and mechanically joined tubular truss structure	
	o "V" Clamp	7.7 (17)	Kg (lb)	o Separation clamp between stage and payload	

TABLE VII

TECHNICAL CHARACTERISTICS DATA

DATA FORM B

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
10-0223	Thermal				
	Plume Shield	0.1 (0.04) 7.7 (17)	CM (inch) Kg (lb)	Titanium Weight	
	Insulation	2.54 (1.0) 128.5 (10)	CM (inch) kg/m (lb/ft^3)	MLI Density	
		256.9 (20)	kg/m (lb/ft^3)	Density	
	Radiator Plate	1	-	Aluminum	
		1.32 (2.9) 56x56x0.152 (22x22x0.06)	kg (lb) Cm (in)	Weight Size	

TABLE VII

TECHNICAL CHARACTERISTICS DATA

DATA FORM B

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
10-0224	MAIN PROPULSION				
	R-40A Thruster	3871.5 (870)	Newton (lbf)	Thrust	
		1	-	Thruster per LES	
		MMH	-	Fuel	
		N_2O_4	-	Oxidizer	
		22:1	-	Area Ratio	
		9.75 (21.5)	Kg (lb)	Weight	
	Fuel Tank	4	-	Conospherical Tanks per 8-tank LES	
		63.5 (25)	Cm (inch)	O.D.	
		101.6 (40)	Cm (inch)	Length	
		30 (66.2)	Kg (lb)	Dry Weight	
	Oxidizer Tank	4	-	Conospherical Tanks per 8-tank LES	
		63.5 (25)	Cm (inch)	O.D.	
		101.6 (40)	Cm (inch)	Length	
		30 (66.2)	Kg (lb)	Dry Weight	
	Pressure Tank	8	-	Spherical Tanks per 8-tank LES	
		39.4 (15.5)	Cm (inch)	Diameter	
	Pressure Regulator	1	-	Per LESS	
		1.59 (3.5)	Kg (lb)	Dry Weight	

TABLE VII

TECHNICAL CHARACTERISTICS DATA

DATA FORM B

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
10-0225	REACTION CONTROL SYSTEM				
	R-4D Thruster	445 (100)	Newton (lbf)	Thrust	
		4	-	Thrusters per LES	
		MMH	-	Fuel	
		N_2O_4	-	Oxidizer	
		40:1	-	Area Ratio	
		2.4 (5.3)	Kg (lb)	Dry Weight	

TABLE VII

TECHNICAL CHARACTERISTICS DATA

DATA FORM B

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
10-0226	DATA MANAGEMENT/ COMMUNICATIONS				
	Transmitter	1	-	S-Band, 8 Watt output, missle and satellite telemetry	
		0.9 (2)	Kg (lb)	Weight	
	Antennas	4	-	Omni Directional, S-Band antenna	
		0.028 (0.06)	Kg (lb)	Weight	
	Coax Switch	1	-	S-Band, Single pole, 4-throw solenoid operated multiposition switch	
		0.38 (0.84)	Kg (lb)	Weight	

TECHNICAL CHARACTERISTICS DATA

DATA FORM B

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
10-0227	GUIDANCE, NAVIGATION AND CONTROL				
	Inertial Stabliization Unit	1		Strap-down inertial	
		20.3 (44.8)	Kg (lb)	Weight	
	- Gyros	2	Degrees	Two degree-of-freedom dry tuned	
	- Accelerometers	3	Degrees/^{2} Sec	Inertial grade Quartz Flexure Force Rebalance	
	- Computer	1	-	Fixed point, stored program General Purpose Digital Computation with 10K, 16 Bit words of memory	
	- Support Electronics	-	-	Reaction Control System valve drivers, ignition relay driver, telemetry signal conditioning, etc.	
	Ignition Control Unit	1	-	Provides safe/arm and squib firing pulses	
		24	-	Safe/Arm relays	
		84	-	Switching Transistors	
		80	68 μfd, 60 volt	Energy storage capacitors	
		8	3600 ohm, ¼ watt	Charging resistors	
		4.3 (9.5)	Kg (lb)	Weight	

TABLE VII

TECHNICAL CHARACTERISTICS DATA

DATA FORM B

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
10-0228	ELECTRICAL POWER				
	Battery	1	-	Silver-zinc, remotely activated	
		600	Watt-Hrs	Capacity	
		2.8	Volts	Supply Voltage	
		14.5 (32)	Kg (lb)	Weight	
	Power Control Unit	1	-	Assembly per LES	
		2	-	Switching Relays	
		2	-	Isolation Diodes	
		0.68 (1.5)	Kg (lb)	Weight	
		7.6x7.6x7.6 (3x3x3)	Cm (Inch)	Size	

5.0 TOTAL PROGRAM FUNDING SCHEDULES

The included Table VIII is the recommended funding schedule for the new design portion of scenario C-2. This table amplifies the new design portion of the scenario C-2 cost schedule shown on Table 7-XXII of Volume IV. The costs are broken down to level 4 in order to give greater costing visibility.

TABLE VIII

FUNDING SCHEDULE
SCENARIO C2 NEW DESIGN
(COSTS IN THOUSANDS OF DOLLARS)

DATA FORM C

WBS CODE	PROJECT WBS ITEMS	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
10-100	PROJECT MANAGEMENT	153	383	673	1,342	1,568	1,414	1,826	1,849	2,372	1,980	2,242	2,110	2,350	20,262
10-200	LES VEHICLE	644	9,280	2,965	6,505	13,394	11,412	16,618	16,987	23,506	18,613	21,880	20,239	23,166	185,209
10-400	SYSTEM ENGR & INTEGRATION	39	107	26	1,154	1,728	1,584	2,015	2,015	2,589	2,159	2,446	2,302	2,589	20,753
10-500	AIRBORNE SUPPORT EQUIPMENT	322	3,760	1,289	0	0	0	0	0	0	0	0	0	0	5,371
10-600	SOFTWARE	74	388	108	0	0	0	0	0	0	0	0	0	0	570
10-700	SYSTEM TEST & EVALUATION	71	528	785	43	0	0	0	0	0	0	0	0	0	1,427
10-800	GROUND SUPPORT EQUIPMENT	0	158	3,160	632	0	0	0	0	0	0	0	0	0	3,950
10-900	GROUND OPERATIONS	0	16	130	1,252	2,405	2,258	2,697	2,697	3,282	2,843	3,136	2,989	3,282	26,937
10-1000	FLIGHT OPERATIONS	0	0	0	12	24	21	30	30	42	33	39	36	42	309
20-200	ORBITER INTEGRATION	(25)*	(50)*	(50)*	[illegible]2	144	126	180	180	252	198	234	216	252	1,854
	TOTAL	1,303	14,620	9,136	11,072	19,263	16,815	23,366	23,758	32,043	25,826	29,977	27,892	31,681	266,692

*THESE COSTS, DEFINING AND MAINTAINING INTERFACE CONTROL, WERE ACCUMULATED UNDER WBS 10-100, 200, 500 AND 700.

6.0 DETAILED COST INFORMATION BY ELEMENTS OF COST

The included Table IX gives detail cost data, to level 5, for the new design portion of scenario C-2. The elements are:

- Engineering
- Tooling/Test Equipment
- Manufacturing and Materials
- Subcontract Materials
- Operations

TABLE IX

DETAIL COST DATA

SCENARIO C2 NEW DESIGN

DATA FORM D

WBS CODE	WBS ELEMENTS	ELEMENTS OF COST ($ X 1000) ENGINEERING	TOOLING-TEST EQUIPMENT	MFG. AND MATERIALS	SUBCONTRACT MATERIALS	OPERATIONS		TOTAL
10-100	PROJECT MANAGEMENT	(1,530)	0	(13,738)		(5,000)		(20,268)
10-200	LES VEHICLE	(6,285)	(1,981)	(175,896)	(1,042)	0		(185,204)
10-210	BOOSTER STAGE	0	0	0	0	0		0
10-220	DELIVERY STAGE	6,285	1,981	175,896	1,042	0		185,204
10-221	INTEGRATION AND ASSEMBLY	870	58	8,314	0	0		9,242
10-222	STRUCTURE AND MECHANISM	712	70	9,635	0	0		10,417
10-223	THERMAL SYSTEM	86	18	2,811	55	0		2,970
10-224	MAIN PROPULSION	1,655	966	66,358	0	0		68,979
10-225	REACTION CONTROL SYSTEM	385	199	20,031	0	0		20,615
10-226	DATA MANAGEMENT/COMMUNICATIONS	19	0	0	987	0		1,006
10-227	GUIDANCE, NAVIGATION AND CONTROL	2,193	645	66,911	0	0		69,749
10-228	ELECTRICAL POWER SYSTEM	365	25	1,836	0	0		2,226
10-400	SYSTEM ENGINEERING AND INTEGRATION	(13,908)	(45)	0	0	(6,799)		(20,752)
10-401	LES SYSTEMS ENGINEERING	10,280	0	0	0	4,799		15,079
10-402	LES/ASE INTEGRATION	1,877	45	0	0	0		1,922
10-403	LES/PAYLOAD INTEGRATION	1,751	0	0	0	0		1,751
10-404	SUSTAINING ENGINEERING	0	0	0	0	2,000		2,000
10-500	AIRBORNE SUPPORT EQUIPMENT	(2,667)	(226)	(2,478)	0	0		(5,371)
10-501	INTEGRATION AND ASSEMBLY	73	23	20	0	0		116
10-502	STRUCTURE AND MECHANISM	2,262	181	2,368	0	0		4,811
10-503	AVIONICS - ASE	142	15	44	0	0		201
10-504	CONTROLS AND DISPLAYS	190	7	46	0	0		243
10-600	SOFTWARE	(570)	0	0	0	0		(570)
10-700	SYSTEM TEST AND EVALUATION	(1,072)	(250)	(105)	0	0		(1,427)
10-701	DEVELOPMENT TESTING	776	228	0	0	0		1,004
10-702	QUALIFICATION TESTING	281	22	0	0	0		303
10-703	MOCKUPS	15	0	105	0	0		120
10-800	GROUND SUPPORT EQUIPMENT	(1,273)	0	(2,677)	0	0		(3,950)
10-801	CHECKOUT	490	0	1,546	0	0		2,036
10-802	HANDLING/ASSEMBLY/SERVICING	783	0	1,131	0	0		1,914
10-900	GROUND OPERATIONS	0	0	(2,575)	0	(24,412)		(26,987)
10-901	LOGISTICS/TRAINING	0	0	0	0	1,018		1,018
10-902	SPARES/REPAIR PARTS	0	0	2,575	0	0		2,575
10-903	FIELD SUPPORT	0	0	0	0	23,394		23,394
10-1000	FLIGHT OPERATIONS	0	0	0	0	(309)		(309)
20-0200	ORBITER INTEGRATION	(371)	0	0	0	(1,483)		(1,854)
	TOTAL	27,676	2,502	197,569	1.042	38,003		266,692

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APPENDIX A

LOW ENERGY STAGE STUDY

WORK BREAKDOWN STRUCTURE

DICTIONARY

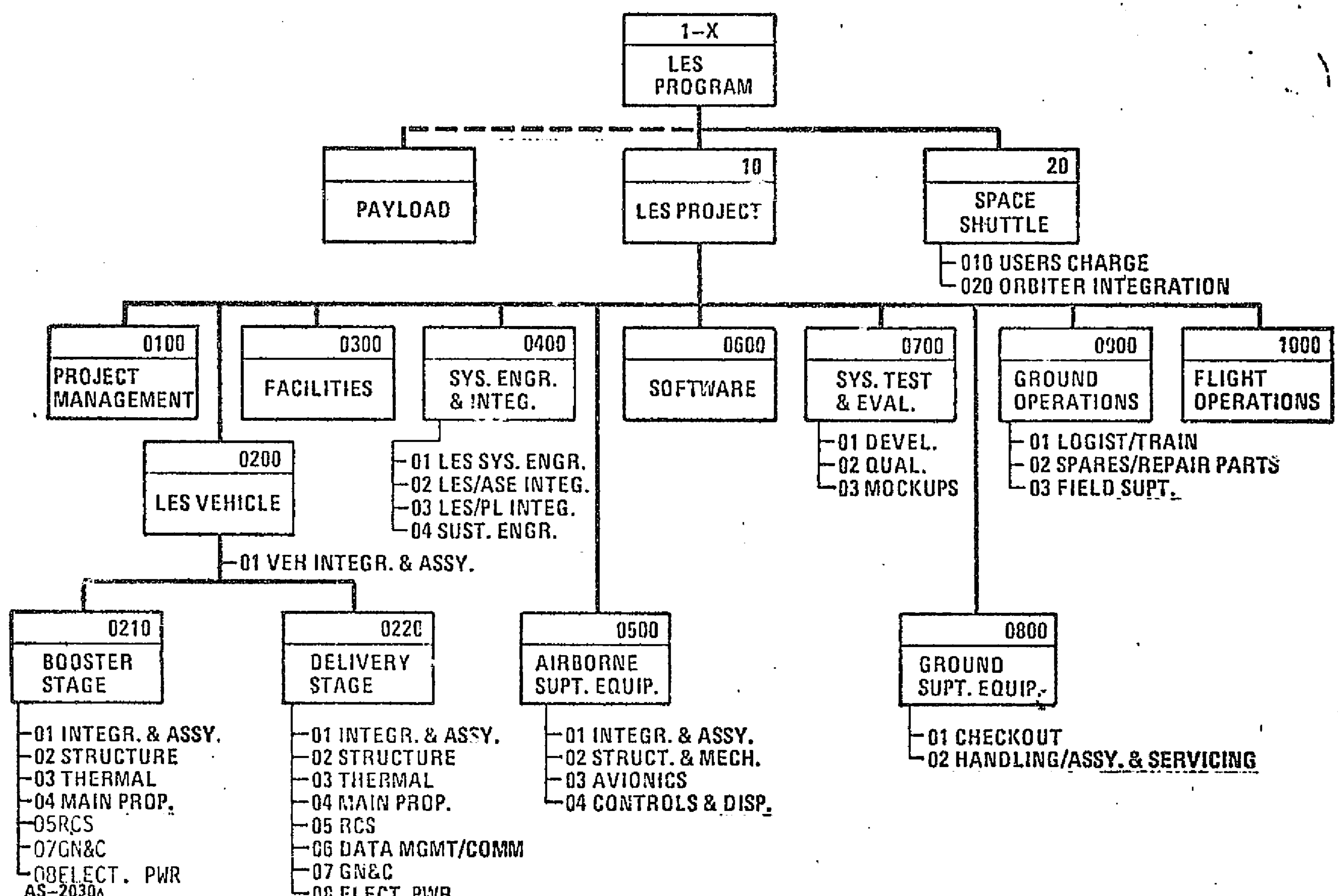
INTRODUCTION

The Work Breakdown Structure (Figure 1) is intended to fully define the various Low Energy Stage (LES) Configurations and associated equipments, and integrate these elements into the Shuttle Orbiter. The LES project is subdivided into Project Management, LES Vehicle, Facilities, Systems Engineering and Integration, Airborne Support Equipment (ASE), Software, System Test and Evaluation, Ground Support Equipment, Ground Operations and Flight Operations. The Space Shuttle Users Charges and Orbiter Integration are included to give complete consideration of the comparative cost of each LES approach. The cost of the payload will not be included in the study, except as it influences the Shuttle users charge.

A dictionary of the elements shown in Figure 1 is provided down through Level 5, where applicable.

Figure 1

WORK BREAKDOWN STRUCTURE FOR LES STUDY



WBS ELEMENT 1-X - LES PROGRAM

The Low Energy Stage Program has the objective of placing Shuttle automated payloads into low energy earth orbits from the cargo bay of the shuttle. Alternative LES systems will be configured to accomplish this task. Based on a NASA mission model, reference missions and design criteria will be established for the low energy regime below the capability of the smallest planned expendable Shuttle upper stage. The WBS of Figure 1 is a product-oriented family tree composed of hardware, services and data elements. This dictionary describes the engineering, manufacturing, test and operations of the LES program and covers efforts during development, production and operation in definition of the project/program.

WBS ELEMENT 0000 - PAYLOAD

The NASA Space Transportation System is responsible for placing spacecraft satellites in orbits of various inclinations and altitudes. Major activity is forecast for geosynchronous orbits, deep-space missions, elliptical orbits, and low energy circular orbits higher than the Shuttle standard orbit altitude (296 km). Payloads with such destinations will require a propulsion stage in addition to the Shuttle. Both the payload and the propulsion stage will be delivered to Shuttle orbit and deployed. Before release, the combined propulsion-stage/payload system will be checked and readied for launch, and flight trajectory will be loaded via the orbiter general purpose computer.

Combined with the large weight and volume capacity of the Shuttle, this capability provides the payload designer new freedom in developing and operating satellites that can reduce costs as well as improve performance.

Cost of payloads will not be a part of the LES study. However, the payload interface with the stage and orbiter ASE affect the cost of these components. The capability of payloads to be supported by pallets or other existing/planned ASE will reduce the cost of the stage and associated ASE structure.

WBS ELEMENT 20-000 - SPACE SHUTTLE

The primary design and operations goal for the Space Shuttle Program is to provide low-cost transportation to and from earth orbit. Free-flying or automated satellites will be delivered to and recovered from many types of orbits. Automated payloads with propulsive stages attached will be deployed from the space shuttle and placed in low/high-energy trajectories.

The Space Shuttle flight system is composed of the Orbiter, an external tank (ET) that contains the boost/ascent propellant to be used by the Orbiter main engines, and two solid rocket boosters (SRB's). The Orbiter and SRB's are reusable; the external tank is expended on each launch.

For the LES study the costs collected under this WBS element will be the shuttle user charge for the stage, ASE, and payload and the cost to integrate and maintain the shuttle/stage/ASE interfaces.

WBS ELEMENT 20-0100 - USERS CHARGE

Users charge is the cost of using the Shuttle Orbiter cargo bay. The Space Transportation System (STS) User Handbook defines the user charge as the product of the ratio of load factor ÷ 0.75 and the Shuttle charge for a dedicated Shuttle flight. Load factor is the greater value of length load factor or weight load factor determined by:

- Vehicle length ÷ 60 feet, or
- Launch weight ÷ allowable Shuttle payload weight for the specified launch site and Shuttle orbit altitude and inclination.

Shuttle charge used in this study was obtained by escalating the mid FY'75 price of $18 million (from the STS User Handbook) for U.S. civil government users according to the increase in Bureau of Labor Statistics total private index for compensation per hour from mid FY'75 to mid FY'77. This resulting Shuttle user charge, used in the LES study, is $21.834 million.

WBS ELEMENT 20-0200 - ORBITER INTEGRATION

This element provides that engineering and manufacturing effort required to define and maintain the LES interface with the Orbiter, including analysis and identification of LES tests and checkout operations affecting that interface, analysis and identification of configuration changes affecting the interface, and evaluation/coordination of recommended changes to the interface.

WBS ELEMENT 10-0000 - LOW ENERGY STAGE PROJECT

This LES Project summary contains the complex of hardware, software, services and specific tasks required to develop, design, procure, manufacture, test, checkout, deliver, accept and operate the LES vehicle system. This element includes test articles, mock-ups, production articles, support equipment, logistics, training, data, etc., associated with the LES system.

The LES Project is subdivided into:

WBS	TITLE
10-0100	PROJECT MANAGEMENT
10-0200	LES VEHICLE
10-0300	FACILITIES
10-0400	SYSTEMS ENGINEERING AND INTEGRATION
10-0500	AIRBORNE SUPPORT EQUIPMENT
10-0600	SOFTWARE
10-0700	SYSTEM TEST AND EVALUATION
10-0800	GROUND SUPPORT EQUIPMENT
10-0900	GROUND OPERATIONS
10-1000	FLIGHT OPERATIONS

WBS ELEMENT 10-0100 - PROJECT MANAGEMENT

This element accomplishes the technical and business management of the LES Program, including the effort associated with planning, directing and controlling the definition, development and manufacture of the system as well as the supporting life cycle functions of Logistics and Maintenance support, Training and Operational Testing, and Operational Development of the system. The project/system management effort which is directly and specifically associated with hardware elements is excluded here and included with the item. The disciplines of Configuration Management, Performance Management, Data Management, Customer Liaison and Contract Administration are performed in this element. In addition, this category will include operations procedures, maintenance procedures, ordinance test procedures, general procedural administrative technical manual, etc., for factory/field and maintenance of all items.

WBS ELEMENT 10-0200 - LOW ENERGY STAGE (LES) VEHICLE

The vehicle consists of the integrated LES system equipment installed in the Shuttle Orbiter, which functions to place spacecraft into their operational environment. This element includes the delivery stage, booster stage if required, and associated assembly hardware as a total LES vehicle entity. It also includes the total of the design, development, test and production of complete units (prototype and/or operationally configured) which satisfy the requirements of their end use.

The LES vehicle is subdivided into:

WBS	TITLE
10-0201	VEHICLE INTEGRATION AND ASSEMBLY
10-0210	BOOSTER STAGE
10-0220	DELIVERY STAGE

WBS ELEMENT 10-0201 - VEHICLE INTEGRATION AND ASSEMBLY

This element refers to the integration and assembly of Level 4 hardware elements into a LES Vehicle as an entity and testing of integrated LES Vehicle Level 4 elements. The Level 4 hardware consists of the delivery stage and the booster stage together with associated assembly hardware.

The element includes all effort associated with the vehicle Preliminary and Final General Arrangement and inboard profile drawings, integration and interface drawings and design characteristics and drawing maintenance for production. Also includes performance of any vehicle level development and acceptance testing. The activities outlined under WBS elements 10-0100 Project Management and 10-0700 System Test and Evaluation (Development Test, etc.) have been excluded.

WBS ELEMENT 10-0210 - BOOSTER STAGE

The Booster Stage consists of integrated propulsion, avionics and structural equipment which when integrated with the Delivery Stage and after deployment from the Shuttle Orbiter functions to increase velocity to enable the LES to deliver spacecraft to low energy destination orbits. The Booster Stage includes the total of the design development, test and production of complete units (prototype and/or operational configured) which satisfy the requirements of their end use. Tooling for development, qualification and production will be included with each subelement, where required. For Task 6, Boosters consist of SSUS A&D purchased as complete unit. The purchase price includes integration of SSUS with the payload (in this study, LES is the payload). Rev. A

The Booster Stage is subdivided into:

WBS	TITLE
10-0211	INTEGRATION AND ASSEMBLY
10-0212	STRUCTURE
10-0213	THERMAL
10-0214	MAIN PROPULSION
10-0215	REACTION CONTROL SYSTEM
10-0217	GUIDANCE, NAVIGATION AND CONTROL
10-0218	ELECTRICAL POWER

WBS ELEMENT 10-0211 - INTEGRATION AND ASSEMBLY

This element contains all labor and material required to integrate the various subsystems into a complete Booster Stage. Final assembly, attachment and installation hardware and final factory acceptance operations are included. Also included are the preparation of final factory acceptance checkout procedures, manufacturing liaison and the coordination and accomplishment of customer acceptance of the completed articles.

WBS ELEMENT 10-0212 - STRUCTURE

This element summarizes all work associated with the design, development, test, assembly and support of the Booster Stage structural elements. Tasks include analysis, design, development, test, materials, manufacturing, quality control tests, and qualification test of components and subsystems, and associated support. Additionally, this will include provisions for test equipment and tooling for development, qualification and production. Wherever hardware is purchased, this element covers the preparation of specifications, supplier liaison and direction. Wherever facilities are rented, this element covers the charges. Integrated testing at the vehicle system level is not included.

Structural elements are considered to include the primary structural shell (or framework), Delivery Stage adapter structure, propulsion system support structure, equipment attachment structure and bracketry, attachment trunnions and beams and separation plane interface hardware. The destabilization and spin balance subsystems are also included here, when required.

WBS ELEMENT 10-0213 - THERMAL

This element covers the design, manufacture, procurement, installation, and test of Thermal Control devices required by the Booster Stage. This would include both active heating devices, and passive insulation materials such as reflective/absorption coatings, heating blankets, insulation blankets, heating elements, thermal sensors, together with controller and logic for thermal monitoring and control.

WBS ELEMENT 10-0214 - MAIN PROPULSION

The propulsion element refers to the means for generation of propelling forces for the Booster Stage. This element includes alternative solid propulsion motors including case, liner, insulation, nozzle, safe and arm device, propellant, igniter, and integrated hardware. The motor is considered a subcontract procurement from a propulsion supplier, or it may be obtained as part of an existing stage. The motor may be purchased unmodified, or it may be off-loaded and/or have the nozzle trimmed (shortened).

This element includes the costs associated with the planning, scheduling, design, development and production of the solid rocket motor. The element includes the assembly and test of development, qualification, production and quality assurance motors. This element also includes the prime contractors' costs for the preparation of procurement specifications, envelope drawings, technical liaison and support to the subcontractor, management of the subcontract, quality control surveillance and assessment of the subcontractors' performance.

WBS ELEMENT 10-0215 - REACTION CONTROL SYSTEM (RCS)

This element refers to the means for receiving guidance intelligence in the form of control signals and generating appropriate reaction control forces by means of reaction motors. For the booster, the only RCS systems used are those which come as part of purchased (existing) stages.

WBS ELEMENT 10-0217 - GUIDANCE, NAVIGATION AND CONTROL

The guidance element refers to the means for generating guidance intelligence, and conditioning the intelligence to produce control signals for the Booster Stage. Controllers may interface with the propulsion system to produce control reaction forces for attitude control. If design is such that electronics are packaged into a single rack or housing as an assembly, this rack or housing will be considered part of the guidance system. This element includes, for example, the guidance intelligence system, computer, sensing elements, autopilot, telemetry signal conditioning, ignition system (sequencing) elements, etc. In addition, the Ignition safe/arm control system is included here. The guidance system usually is carried as part of the Delivery Stage. However, for some configurations, components of GN&C are placed on the booster.

WBS ELEMENT 10-0218 - ELECTRICAL POWER

This element includes all effort and material required to design, develop, procure and/or fabricate, assemble, checkout, test and deliver all hardware and documentation for the electrical power and ignition systems which include the vehicle electrical power source control, and all vehicle interconnecting wiring. For the booster, the only electrical systems used are those which come as part of purchased (existing) stages.

WBS ELEMENT 10-0220 - DELIVERY STAGE

The Delivery Stage is the primary propulsion stage and consists of integrated propulsion, avionics and structural equipment (and related software), which after deployment from the Shuttle Orbiter functions to place the payloads into a predesignated orbit. This element includes alternate liquid propulsion and solid rocket propulsion modes.

The Delivery Stage includes the payload interface and interface provisions for booster stage. It also includes the total of the design, development, test and production of complete units (prototype and/or operationally configured) which satisfy the requirements of their end use. Tooling for development, qualification and production will be included with each subelement, where required.

The Delivery Stage is subdivided into:

WBS	TITLE
10-0221	INTEGRATION AND ASSEMBLY
10-0222	STRUCTURE
10-0223	THERMAL
10-0224	MAIN PROPULSION
10-0225	REACTION CONTROL SYSTEM
10-0226	DATA MANAGEMENT/COMMUNICATIONS
10-0227	GUIDANCE, NAVIGATION AND CONTROL
10-0228	ELECTRICAL POWER

WBS ELEMENT 10-0221 - INTEGRATION AND ASSEMBLY

This element contains all labor and material required to integrate the various subsystems into a complete Delivery Stage. Final assembly, including attachment and installation hardware, and final factory acceptance operations are included. Also included are the preparation of final factory acceptance checkout procedures, manufacturing liaison and the coordination and accomplishment of customer acceptance of the completed articles.

WBS ELEMENT 10-0222 - STRUCTURE

This element summarizes all work associated with the design, development, test, assembly and support of the Delivery Stage structural elements. Tasks include analysis, design, development, test, materials, manufacturing, quality control tests, and qualification test of components and subsystems, and associated support. Additionally, this will include provision of test equipment and tooling for development, qualification and production. Wherever hardware is purchased, this element covers the preparation of specifications, supplier liaison and direction. Wherever facilities are rented, this element covers the charges. Integrated testing at the vehicle system level is not included.

Structural elements are considered to include the primary structural shell (or framework), payload adapter structure, propulsion and Guidance/ Control Systems support structure, equipment attachment structure and bracketry, attachment trunnions and beams, and separation plane interface hardware. The destabilization and spin balance subsystems are also included here, when required.

WBS ELEMENT 10-0223 - THERMAL

This element covers the design, development, manufacture, procurement installation and test of Thermal Control components and subsystems required by the Delivery Stage. This would include both active heating devices and passive insulation materials such as reflective/absorption coatings, heating blankets, insulation blankets, heating elements, thermal sensors, thermal control electronics, radiators, materials, etc. Tasks include analyses, design, development, test, manufacturing, quality control and qualification test of components and subsystems and associated support hardware. Wherever hardware is purchased, this element includes specification preparation, supplier liaison and direction.

Integrated testing at the vehicle system level is not included.

WBS ELEMENT 10-0224 - MAIN PROPULSION

This propulsion element refers to the means for generation of propulsion impulses for the Delivery Stage. The several alternative candidate propulsion concepts considered include monopropellant liquid systems, bipropellant liquid systems and adaptations of solid motor systems. This element includes the costs associated with the planning, scheduling, analysis, design, development, test, production and quality control of these candidate systems as well as assembly and test of development, qualification and production components, subsystems and motors and associated test equipment and tooling. Additionally the prime contractor's costs for the preparation of procurement specifications, envelope drawings, technical liaison, direction and support of the subcontractor, management of the subcontract, quality control surveillance and assessment of the subcontractor's performance are included. This element may or may not include propellant, tankage and flow subsystem hardware for the RCS, depending on whether the RCS is an integral part of main propulsion.

WBS ELEMENT 10-0224 - MAIN PROPULSION (Continued)

Integrated testing at the vehicle system level is not included.

Propulsion elements are considered to include: thrusters, propellant and pressurant tankage, flow system hardware, associated instrumentation, vent and safety hardware, test and servicing interfaces, electrical and pyrotechnical interfaces, and associated pyrotechnical subsystems.

WBS ELEMENT 10-0225 - REACTION CONTROL SYSTEM (RCS)

This element refers to the means for receiving control signals and associated power and generating appropriate reaction control forces by means of reaction thrusters. Several alternative candidate reaction control concepts will be considered. These include bipropellant, monopropellant and cold gas systems. This element will include the costs associated with the planning, scheduling, analysis, design, development, test, production and quality control of these candidate systems as well as the assembly and test of development, qualification, and production components and subsystems and associated test equipment and tooling. Additionally the prime contractor's costs for the preparation of procurement specifications, envelope drawings, technical liaison, direction and support of the subcontractor, management of the subcontractor, quality control surveillance and assessment of the subcontractors' performance are included here. RCS elements include: thrusters, flow system hardware, associated instrumentation, test interfaces, and electrical interfaces.

Integrated testing at the vehicle system level is not included.

WBS ELEMENT 10-0226 - DATA MANAGEMENT/COMMUNICATIONS

This element includes only the antennae and transmitters with associated harness. The Data Management subsystem is contained in GN&C.

WBS ELEMENT 10-0227 - GUIDANCE, NAVIGATION AND CONTROL

The guidance element refers to the means for generating guidance intelligence, and conditioning the intelligence to produce control signals for the Delivery Stage. Controllers may interface with the propulsion system to produce control reaction forces for control. If design is such that electronics are packaged into a single rack or housing as an assembly, this rack or housing will be considered part of the guidance system. This element will include the costs associated with the planning, scheduling, analysis, design, development, test, procurement and quality control of the selected systems, as well as the assembly and test of development, qualification, and production components and associated test equipment and tooling. This element includes the guidance intelligence system, computer, sensing elements, autopilot, telemetry signal conditioning, ignition system (sequencing) elements, etc.

For reaction control system element, see 10-0225 RCS.

WBS ELEMENT 10-0228 - ELECTRICAL POWER

This element includes all effort and material required to design, develop, procure and/or fabricate, assemble, checkout, test, and deliver all hardware and documentation for the electrical power system which include the vehicle electrical power source, electrical power control and distribution, all vehicle interconnecting wiring and EMI protection.

WBS ELEMENT 10-0300 - FACILITIES

This element includes all new construction, modifications or expansions of facilities for development, qualification, production, storage inventory and manufacture required by the LES systems contractor. Facility operation, field facilities, and maintenance costs are provided in this element, with that part related to development, qualification facilities being an engineering cost and Manufacturing Facilities being a manufacturing cost and that part associated with Ground Operations being an operations cost. The costs included here are planning, scheduling, coordination, design, construction, procurement, inspection, installation, set-up, servicing acceptance review and activation of these facilities.

WBS ELEMENT 10-0400 - SYSTEM ENGINEERING AND INTEGRATION

This element encompasses all subsets of the systems engineering task implicit in directing and controlling the engineering effort. The included disciplines are System Definition, System Performance Definition, Interface Definition, Reliability and Quality, Maintainability, Logistics Planning and Management, Technology Application, Manpower Planning, Human Engineering, System Safety, Configuration Management and Quality Engineering.

This element is subdivided into:

WBS	TITLE
10-0401	LES SYSTEMS ENGINEERING
10-0402	LES/ASE INTEGRATION
10-0403	LES/PAYLOAD INTEGRATION
10-0404	SUSTAINING ENGINEERING

WBS ELEMENT 10-0401 - LES SYSTEMS ENGINEERING

This element pertains to the technical and management efforts of directing and controlling a totally integrated engineering effort. The element encompasses system definition and the integrated planning and control of the technical program efforts of analysis, design engineering, performance analysis and capabilities production, logistics engineering, specialty engineering, production engineering and test planning. Pre-flight planning and post flight reporting, including data acquisition, data reduction and analysis and reports are part of this element. Included here is the System Engineering effort to transform an operational need or statement of deficiency into a description of system requirements and a preferred system configuration;

WBS ELEMENT 10-0401 - LES SYSTEMS ENGINEERING (Continued)

the Logistics Engineering effort to define, optimize and integrate the logistics support considerations into the mainstream engineering effort to insure the development and production of a supportable and cost effective LES system; and the technical planning and control effort for planning, monitoring, measuring, evaluating and directing the management of the technical program. It excludes the actual design engineering, and production engineering directly related to the products or services of a deliverable end item.

WBS ELEMENT 10-0402 - LES/ASE INTEGRATION

This element refers to the Factory integration and assembly of the Airborne Support Equipment with the Low Energy Stage as a whole. It includes installation of connecting (joining) hardware, fit checks, hook-up of GSE, and systems test of the total installation for verification of compatibility and interface. Both development and recurring costs are included here.

WBS ELEMENT 10-0403 - LES/PAYLOAD INTEGRATION

This element refers to the Factory integration and assembly of the payload with the Low Energy Stage as a whole. It includes installation of connecting (joining) hardware, system interconnects, and interface verification demonstration. Both development and recurring costs are included here.

WBS ELEMENT 10-0404 - SUSTAINING ENGINEERING

This element provides all sustaining engineering effort, following DDT&E, required for the LES project after the completed, assembled concept has been checked out for full flight certification and delivered. Also included are in-plant engineering liaison support of operational activities and the sustaining engineering support required at the launch sites during the operations phase. Activities would include further allocation of performance requirements for the vehicle into subsystem requirements, evaluation of vehicle, ASE and GSE performance, maintainability analysis, etc. Excluded are those activities that pertain to major hardware (ECP) modification required to meet new performance specifications or requirements. Cost for ECP modifications will be estimated separately, and applied against the hardware items at WBS Level 3.

WBS ELEMENT 10-0500 - AIRBORNE SUPPORT EQUIPMENT

This element consists of the avionic and structural Airborne Support Equipment (ASE) necessary to integrate/interface the LES into the Shuttle Orbiter for all Shuttle flight operations including abort and venting. Airborne Support Equipment includes hardware and software which is required in the Shuttle aft flight crewdeck and Orbiter cargo bay to functionally support all LES stages and spacecraft. Its main function is for retaining and then enabling the LES to separate from the Shuttle Orbiter. This element

WBS ELEMENT 10-0500 - AIRBORNE SUPPORT EQUIPMENT (Continued)

summarizes the design, development, qualification testing of components and subsystems, manufacturing, tooling and special test equipment, assembly, checkout/acceptance, and procurement efforts required to produce complete airborne support equipment (prototype or production) configured units which satisfy the applicable specification requirements.

This element is subdivided into:

WBS	TITLE
10-0501	INTEGRATION AND ASSEMBLY
10-0502	STRUCTURE AND MECHANISM
10-0503	ASE AVIONICS

WBS ELEMENT 10-0501 - INTEGRATION AND ASSEMBLY

This element covers all activities in integrating, assembling and testing the lower level ASE elements and systems into a complete segment. Included are such items as: the preparation of system specifications and schematics; the definition of intra-LES segment interfaces; the preparation of assembly and installation drawings; the conduct of final integrated development and acceptance tests; the design and manufacture of non-deliverable support equipment used to perform the integrated development and acceptance tests; preparation and shipment of completed end items. Excluded is the Shuttle interface system engineering effort of WBS 10-0402.

WBS ELEMENT 10-0502 - STRUCTURE & MECHANISM

This element consists of a cradle structure assembly and its accessories including optional spin table, or spring ejection assembly. The cradle structure may include an erection mechanism, and remote controlled latch mechanisms. The spin table, when required, includes spin motors and a brake system. The spin table is an optional item, required for spinning stages only, and used without motors and brake for three axis launches. For some deployment approaches, erection may not be required; the stage would be lifted out or ejected in a direction perpendicular to the cargo bay center line.

WBS ELEMENT 10-0503 - ASE AVIONICS

This element includes the ASE Power Control Unit, the ASE Signal/Data Interface Unit, and the Cradle Cabling. The two units are installed on the cradle but are packaged separately to isolate the signals from power.

The ASE Power Control Unit accepts and transfers Orbiter power to the LES, spacecraft umbilical release, ASE Signal/Data Interface Unit, deployment mechanism, and spin table (if required). The Signal interfaces are routed through the ASE Signal/Data Interface Unit.

WBS ELEMENT 10-0503 - ASE AVIONICS (Continued)

The ASE Signal/Data Interface Unit provides any command/response interface circuitry required, between the LES and cradle systems, from these systems to the existing payload accommodations and to the mission peculiar control and monitor panel. It also provides the caution and warning sensors with excitation and signal conditioning compatible with the Orbiter furnished caution and Warning Electronics Unit.

The cradle cabling interfaces the ASE Signal/Data Interface Unit and the ASE Power Control Unit to one another, to signal and power umbilical, to the deployment mechanism, and, if required, to the spin table and to caution and warning sensors on the cradle.

WBS ELEMENT 10-0504 - ASE CONTROLS AND DISPLAY

This element includes the Caution and Warning Panel (Orbiter furnished), the Control and Monitor Panel and the Cable Plant. Both panels are installed in the Aft Crew Station and are interfaced via Orbiter furnished cabling to the above Cable Plant and to existing Orbiter payload accommodations. The Cable Plant (of this element) interfaces the Aft Crew station cabling to the ASE Signal/Data Interface Unit on the cradle.

The Control and Monitor Panel provides dedicated switching and indicators to activate, checkout, control and monitor the LES and the cradle mounted equipment while using the payload accommodations.

WBS ELEMENT 10-0600 - SOFTWARE

This element is for the accumulation of all effort and materials required to develop and/or procure, checkout, test, deliver and up-date all software for the guidance, ignition, telemetry (T/M) and GSE. Testing activities include development, design verification and acceptance testing.

The software included herein consists of all guidance system software such as vendor test software, contractor test software and flight software.

WBS ELEMENT - 10-0700 - SYSTEM TEST AND EVALUATION

This element includes the effort to plan and perform integrated system level tests on the LES vehicle and major element interface tests (e.g., LES/Orbiter interfaces, EMI, etc.) for both ground and flight testing. Included are ground test hardware, ground test operations, flight test hardware, and flight test operations. Also included are mockups, test support and test facilities. Hardware for subsystem test and qualification is excluded from this element, but is included with their design and development cost. Propellants and gases are included under the appropriate test operations.

This element is subdivided into:

WBS	TITLE
10-0701	DEVELOPMENT
10-0702	QUALIFICATION
10-0703	MOCKUPS

WBS ELEMENT 10-0701 - DEVELOPMENT

The development element refers to test planning and use of prototype equipment to acquire engineering data and confirm the engineering hypothesis. This element encompasses all development, test, and evaluation and includes such models and tests as static, drop, and fatigue; integration, ground tests, flight test, test instrumentation and test equipment, including its support equipment. Additionally the Main Propulsion, RCS, Thermal and Structural systems will undergo design verification tests.

WBS ELEMENT 10-0702 - QUALIFICATION

The Qualification element includes those ground tests conducted to primarily determine resistance to environmental conditions. Most tests in this category are conducted at component and subsystem level and are excluded here and included with the development cost for hardware elements. However, the Structural, Thermal, Main Propulsion and RCS Systems are qualified jointly, with dummy elements representing the other systems. The cost for tests such as Vibration/Acoustics, Thermal Vacuum, electro-magnetic compatibility, etc., will be included here for the noted items, together with the qualification report document preparation cost.

WBS ELEMENT 10-0703 - MOCKUPS

The mockups element refers to the design, engineering, and production of system or subsystem mockups which have special contractual or engineering significance, or which are not required solely for the conduct of other testing. Also, this element refers to the design and fabrication of test hardware configurations required to verify and control interfaces for fit, form and function. The payload and booster stage interfaces with the delivery stage and the LES vehicle interface with the Orbiter are included. Mass mockups of spacecraft required for LES vehicle dynamics tests are included. A simulator

WBS ELEMENT 10-0703 - MOCKUPS (Continued)

for verifying the interface of LES Avionics ASE as installed in the Orbiter is included here. Tooling and fixtures used for production are excluded.

WBS ELEMENT 10-0800 - GROUND SUPPORT EQUIPMENT

This element summarizes the labor and materials required to design, manufacture, procure, assemble, test, checkout, and deliver all the sets of GSE hardware and transporting and handling equipment required by the LES.

This element is subdivided into:

WBS	TITLE
10-0801	CHECKOUT
10-0802	HANDLING/ASSEMBLY & SERVICING

WBS ELEMENT 10-0801 - CHECKOUT

This element is the summary level for all effort and materials associated with the hardware required to produce the Test/Checkout/Service Equipment required at test facilities. Included in this element is the design development, procurement and/or fabrication, assembly, checkout, test and delivery of the hardware associated with the Test/Checkout/Servicing/Equipment.

WBS ELEMENT 10-0802 - HANDLING/ASSEMBLY & SERVICING

This element is the summary level for all effort and materials associated with the hardware required for handling/assembly and transport of the LES stage. Included in this element is the design, development, procurement, and/or fabrication, assembly, checkout, test and delivery of the hardware associated with the LES Handling and Transporting Equipment.

WBS ELEMENT 10-0900 - GROUND OPERATIONS

This element summarizes all effort associated with the planning, co-ordination and implementation of operational activities including maintenance, logistics and training for the LES.

This element is subdivided as follows:

WBS	TITLE
10-0901	LOGISTICS/TRAINING
10-0902	SPARES/REPAIR PARTS
10-0903	FIELD SUPPORT

WBS ELEMENT 10-0901 - LOGISTICS/TRAINING

This element includes all labor and materials for the training, handling and transportation activities required to support the design, development, operation and maintenance of the LES.

Included are the training services, devices, accessories, aids, equipment, and parts used to facilitate instruction through which LES personnel and payload specialists will acquire sufficient concepts, skills, and aptitudes to operate and maintain the system with maximum efficiency. Also included are the handling and transportation requirements for the LES during its transit mode from the point of manufacture to launch site and intra-site equipment movement. Also included are the pre-launch and maintenance/refurbishment operations and packing/coating/shipment costs. Additionally, this element includes the cost of the contractor personnel that provide technical consultation and support to the NASA personnel training the NASA LES flight and ground crews, as well as transportation, inventory control, training aids and simulations.

WBS ELEMENT 10-0902 - SPARES/REPAIR PARTS

The spares and repair parts element refers to the spare components and assemblies used for replacement purposes in major end items of equipment.

WBS ELEMENT 10-0903 - FIELD SUPPORT

This element refers to the full range of Field Support functions accomplished to support the LES System. It includes off-site planning, scheduling, receiving inspection for both LES, ASE and GSE associated test and checkout by simulation of flight, shuttle integration operations for LES and ASE and servicing.

The maintenance and/or refurbishment of ASE, GSE, and flight hardware takes place in this element. Included are the coordination activities leading to the establishment of requirements, field documentation, preparation, participation in working groups, liaison between off-site and the home plant, post-flight inspection of recoverable ASE and flight hardware, conduct of maintenance/refurbishment tasks, revalidation, functional checkout and calibration of test equipment.

WBS ELEMENT 10-1000 - FLIGHT OPERATIONS

This element includes operations and services performed on the Shuttle for the LES System, to perform launching, flight tracking and control and recovery where required, to complete a LES mission. This element would encompass launch, flight and recovery operations; airborne system assembly and checkout where required; and associated activities directly related to the mission, including on-board predeployment tests, deployment, and free flight monitoring to the capability of the shuttle orbiter and required ground station tracking if required. The effort of providing the operational equipments is excluded.

APPENDIX B

TASK 2 COST DATA

APPENDIX B

TASK 2 COST DATA

The data included in Appendix B is the preliminary cost information which provided the basis for Task 2 screening. This preliminary information was refined and enlarged for the final evaluations of Task 6, as explained in paragraph 1.2.3 and 1.2.3.4. The costs for a launch approach combination can be builtup from the enclosed data as described in Volume II, paragraph 3. Data enclosed in this appendix is as follows:

- Table 1 Production Cost Summary Sheets, 37 pages
- Table 2 DDT&E Cost Summary Sheets, 15 pages
- Table 3 Stage Unit Cost, Stage Development Cost and ASE Cost for Task 2 Scenario, 4 pages
- Table 4 Launch Approach Combinations, 1 page
- Table 5 Launch Combinations Cost Buildup, 4 pages
- Table 6 Propulsion Approach for Reference Mission, 6 pages
- Table 7 Propulsion Concept Summary, 41 pages

Table 1 presents a cost buildup for the booster stage and delivery stage for all configurations examined. Table 2 is a summary of the development costs for each combination of configurations that were investigated to launch all of the reference missions. Table 3 is a summary of the more attractive combinations of launch approaches examined to launch all reference missions and includes stage unit costs, development costs and ASE costs. Table 4 is a summary of launch approach combinations and shows the launch approach used to launch each reference mission for each combination examined. Table 5 presents the detail cost buildup for each combination of launch approaches. Included are program maintenance costs, production costs, Shuttle user charges and development costs. Table 6 is a summary of all launch approaches examined for each reference mission. Table 7 presents conceptual design data for each new propulsion approach examined.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Solid Tandem - Spinning CODE 3/1C-A-P-T-M-4
Star 48/Star 37S

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 715)
10-0210	Booster - Subtotal	($ 14,474)
10-0211	Integration & Assembly - Booster	349
10-0212	Structure Booster	2,486
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	8,238
10-0215	RCS - Booster	-------
10-0217	GN&C - Booster	2,685
10-0218	Electrical Power - Booster	710
10-0220	Delivery Stage - Subtotal	($ 19,009)
10-0221	Integration & Assembly - Del. Stage	940
10-0222	Structure - Delivery Stage	1,206
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	6,363
10-0225	RCS - Delivery Stage	4,179
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,568
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 34,198
10-0200	Total Production Cost/Vehicle	$ 1,709.9
20-0100	User Charge Cost/Vehicle and Payload	$ Note 3

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Configurations 1 and 2 have same unit cost as Configuration 3.
3. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
1	-	18,668	-	-	-	-
2	-	-	9,083	7,183	7,183	-
3	25,830	-	-	-	-	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Solid Tandem - Spinning Star 48/Star 37F CODE 4/2-A-P-S-M-2-

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 730)
10-0210	Booster - Subtotal	($ 17,945)
10-0211	Integration & Assembly - Booster	666
10-0212	Structure Booster	2,494
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	8,238
10-0215	RCS - Booster	2,822
10-0217	GN&C - Booster	3,009
10-0218	Electrical Power - Booster	710
10-0220	Delivery Stage - Subtotal	($ 12,179)
10-0221	Integration & Assembly - Del. Stage	672
10-0222	Structure - Delivery Stage	1,229
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	6,493
10-0225	RCS - Delivery Stage	-----
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	3,032
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 30,854
10-0200	Total Production Cost/Vehicle	$ 1,543
20-0100	User Charge Cost/Vehicle and Payload	$ Note 2

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. User Charge Cost/Vehicle

	REFERENCE MISSION					
CONFIGURATION	A	B	C	D	E	F
4	-	21,530	-	-	7,948	7,948

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Solid Tandem Consisting of STAR 37F(short)/STAR 37F(Short) CODE 6/3B-N-P-S-M-2

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 677)
10-0210	Booster - Subtotal	($ 14,026)
10-0211	Integration & Assembly - Booster	559
10-0212	Structure Booster	1,137
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	6,493
10-0215	RCS - Booster	2,822
10-0217	GN&C - Booster	3,009
10-0218	Electrical Power - Booster	-
10-0220	Delivery Stage - Subtotal	($ 11,851)
10-0221	Integration & Assembly - Del. Stage	663
10-0222	Structure - Delivery Stage	1,040
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	6,363
10-0225	RCS - Delivery Stage	-
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	3,032
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 26,554
10-0200	Total Production Cost/Vehicle	$ 1,327.7
20-0100	User Charge Cost/Vehicle and Payload	$ NOTE 2

NOTES: 1. Configuration 5 has same unit cost as Configuration 6.

2. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
5	-	18,275	-	-	-	-
6 (Vert.)	-	-	-	-	2,773	-
6 (Hor.)	-	-	-	-	6,812	-

3. For non-recurring costs, see Combinations Summary.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Solid Tandem Consisting of STAR 26/STAR 26 CODE 8/3D-N-P-T-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 547)
10-0210	Booster - Subtotal	($ 6,572)
10-0211	Integration & Assembly - Booster	212
10-0212	Structure Booster	759
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	2,910
10-0215	RCS - Booster	-
10-0217	GN&C - Booster	2,685
10-0218	Electrical Power - Booster	-
10-0220	Delivery Stage - Subtotal	($15,057)
10-0221	Integration & Assembly - Del. Stage	919
10-0222	Structure - Delivery Stage	728
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	2,910
10-0225	RCS - Delivery Stage	4,179
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,568
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 22,176
10-0200	Total Production Cost/Vehicle	$ 1,109
20-0100	User Charge Cost/Vehicle and Payload	$ NOTE 2

NOTES: 1. Configuration 7 has same unit cost as Configuration 8.

2. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
7 (Vert.)	-	-	-	2,642	-	-
7 (Hor.)	-	-	7,795	5,895	-	-
8	24,694	-	-	-	-	-

3. For non-recurring costs, see Combinations Summary.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid Flatpack Design Containing Six Long Motors CODE 9/4A-O-K-S-M-1

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($19,520)
10-0221	Integration & Assembly - Del. Stage	1,083
10-0222	Structure - Delivery Stage	2,336
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	5,404
10-0225	RCS - Delivery Stage	2,069
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,875
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 19,520
10-0200	Total Production Cost/Vehicle	$ 976K
20-0100	User Charge Cost/Vehicle and Payload	$ 15,633

NOTES: 1. Reference Mission B.

2. For non-recurring costs, see Combinations Summary.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid Flatpack Design Containing 4 Short Motors CODE 10/4B-O-K-S-M-2

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 18,747)
10-0221	Integration & Assembly - Del. Stage	1,063
10-0222	Structure - Delivery Stage	2,336
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	3,898
10-0225	RCS - Delivery Stage	2,822
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,875
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 18,747
10-0200	Total Production Cost/Vehicle	$ 937K
20-0100	User Charge Cost/Vehicle and Payload	$ Note 2

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. User Charge Cost/Vehicle

REFERENCE MISSION

CONFIGURATION	A	B	C	D	E	F
10 (Vert.)	-	-	-	4,279	-	-
10 (Hor.)	-	-	5,939	4,039	-	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid Flatpack Design Containing 6 Short Motors CODE 11/4C-0-K-T-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($19,519)
10-0221	Integration & Assembly - Del. Stage	989
10-0222	Structure - Delivery Stage	2,336
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	5,694
10-0225	RCS - Delivery Stage	4,179
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,568
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 19,519
10-0200	Total Production Cost/Vehicle	$ 976K
20-0100	User Charge Cost/Vehicle and Payload	$ 22,795

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission A.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Quench Solid Motor CODE 14/5C-O-C-T-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 18,536)
10-0221	Integration & Assembly - Del. Stage	956
10-0222	Structure - Delivery Stage	1,032
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	6,048
10-0225	RCS - Delivery Stage	4,179
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,568
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 18,536
10-0200	Total Production Cost/Vehicle	$ 926.8
20-0100	User Charge Cost/Vehicle and Payload	$ Note 3

NOTES:
1. For non-recurring costs, see Combinations Summary.
2. Configurations 12 & 13 have same unit cost as Configuration 14.
3. User charge cost/vehicle

	REFERENCE MISSION					
CONFIGURATION	A	B	C	D	E	F
12	-	16,943	-	-	-	-
13 (Vert.)	-	-	-	4,716	2,642	-
13 (Hor.)	-	-	-	5,349	5,502	-
14	24,127	-	-	-	-	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Liquid Tandem - Spinning Star 48/Biprop (4 Tank) CODE 15/6A-A-B-S-B-1

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 751)
10-0210	Booster - Subtotal	($ 13,709)
10-0211	Integration & Assembly - Booster	338
10-0212	Structure Booster	1,732
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	8,238
10-0215	RCS - Booster	----
10-0217	GN&C - Booster	2,685
10-0218	Electrical Power - Booster	710
10-0220	Delivery Stage - Subtotal	($ 20,449)
10-0221	Integration & Assembly - Del. Stage	1,055
10-0222	Structure - Delivery Stage	1,001
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	9,231
10-0225	RCS - Delivery Stage	1,145
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 34,909
10-0200	Total Production Cost/Vehicle	$ 1,745
20-0100	User Charge Cost/Vehicle and Payload	$ Note 3

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Configuration 16 has same unit cost as Configuration 15.
3. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
15	-	17,489	-	-	-	-
16 (Vert.)	-	-	-	-	3,930	-
16 (Hor.)	-	-	-	-	6,026	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Biprop Liquid (4 Tank) CODE 17/6C-0-B-5-B-2

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 18,648)
10-0221	Integration & Assembly - Del. Stage	1,007
10-0222	Structure - Delivery Stage	1,001
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	6,667
10-0225	RCS - Delivery Stage	1,956
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 18,648
10-0200	Total Production Cost/Vehicle	$ 932.4
20-0100	User Charge Cost/Vehicle and Payload	$ Note 2

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
17 (Vert.)	-	-	-	3,930	-	-
17 (Hor.)	-	-	5,939	4,039	-	-

C-2

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Biprop Liquid (8 Tank) CODE 18/6D-0-B-T-B-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($21,274)
10-0221	Integration & Assembly - Del. Stage	1,051
10-0222	Structure - Delivery Stage	1,001
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	8,987
10-0225	RCS - Delivery Stage	3,609
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,873
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 21,274
10-0200	Total Production Cost/Vehicle	$ 1063.7
20-0100	User Charge Cost/Vehicle and Payload	$ 22,598

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission A.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Liquid Tandem - Star 37E/ Biprop. (6 Tank) CODE 19/8A-N-B-S-B-1

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 679)
10-0210	Booster - Subtotal	($ 7,879)
10-0211	Integration & Assembly - Booster	223
10-0212	Structure Booster	737
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	6,913
10-0215	RCS - Booster	----
10-0217	GN&C - Booster	----
10-0218	Electrical Power - Booster	----
10-0220	Delivery Stage - Subtotal	($22,439)
10-0221	Integration & Assembly - Del. Stage	1,114
10-0222	Structure - Delivery Stage	990
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	11,173
10-0225	RCS - Delivery Stage	1,145
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 30,997
10-0200	Total Production Cost/Vehicle	$ 1549.9
20-0100	User Charge Cost/Vehicle and Payload	$ 17,620

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission B.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Liquid Tandem - Star 37E/ Off Loaded Biprop (4 Tank) CODE 20/8B-N-B-S-B-2

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 668)
10-0210	Booster - Subtotal	($ 7,879)
10-0211	Integration & Assembly - Booster	223
10-0212	Structure Booster	737
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	6,913
10-0215	RCS - Booster	----
10-0217	GN&C - Booster	----
10-0218	Electrical Power - Booster	----
10-0220	Delivery Stage - Subtotal	($ 21,713)
10-0221	Integration & Assembly - Del. Stage	1,088
10-0222	Structure - Delivery Stage	990
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	9,662
10-0225	RCS - Delivery Stage	1,956
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 30,260
10-0200	Total Production Cost/Vehicle	$ 1,513
20-0100	User Charge Cost/Vehicle and Payload	$ Note 2

NOTES: 1. For non-recurring costs, see Combinations Summary.

2. User Charge Cost/Vehicle

	REFERENCE MISSION					
CONFIGURATION	A	B	C	D	E	F
20 (Vert.)	-	-	-	-	4,345	-
20 (Hor.)	-	-	-	-	6,135	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Biprop - 4 Tank CODE 21/8C-)-B-S-B-2

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 19,042)
10-0221	Integration & Assembly - Del. Stage	1,019
10-0222	Structure - Delivery Stage	990
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	7,060
10-0225	RCS - Delivery Stage	1,956
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 19,042
10-0200	Total Production Cost/Vehicle	$ 952.1
20-0100	User Charge Cost/Vehicle and Payload	$ Note 2

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
21 (Vert)	-	-	-	4,127	-	-
21 (Hor.)	-	-	5,939	4,039	-	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Biprop - 6 Tank CODE 22/8D-0-B-T-B-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 20,836)
10-0221	Integration & Assembly - Del. Stage	1,039
10-0222	Structure - Delivery Stage	990
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	8,572
10-0225	RCS - Delivery Stage	3,609
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,873
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 20,836
10-0200	Total Production Cost/Vehicle	$ 1041.8
20-0100	User Charge Cost/Vehicle and Payload	$ 22,598

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission A

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Biprop - 8 Tank CODE 23/0A-0-B-S-B-1

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 24,971)
10-0221	Integration & Assembly - Del. Stage	1,185
10-0222	Structure - Delivery Stage	997
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	13,627
10-0225	RCS - Delivery Stage	1,145
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 24,971
10-0200	Total Production Cost/Vehicle	$ 1248.5
20-0100	User Charge Cost/Vehicle and Payload	$ Note 3

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Configuration 24 has same unit cost as Configuration 23.
3. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
23	-	16,730	-	-	-	-
24 (Vert.)	-	-	-	-	-	-
24 (Hor.)	-	-	-	-	5,230	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Biprop - 4 Tank CODE 26/10D-0-B-T-B-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($21,331)
10-0221	Integration & Assembly - Del. Stage	1,054
10-0222	Structure - Delivery Stage	754
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	9,288
10-0225	RCS - Delivery Stage	~~3,609~~
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,873
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 21,331
10-0200	Total Production Cost/Vehicle	$1066.5
20-0100	User Charge Cost/Vehicle and Payload	$ Note 3

NOTES: 1. For non-recurring costs, see Combinations Summary.

2. Configuration 25 has same unit cost as Configuration 26.
3. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
25 (Vert)	-	-	-	6,200	-	-
25 (Hor.)	-	-	6,850	5,050	-	-
26	23,810	-	-	-	-	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Biprop Modular with Booster - Spinning MMIII/8 Tank Biprop. CODE 27/10E-A-B-S-B-2

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 865)
10-0210	Booster - Subtotal	($ 11,712)
10-0211	Integration & Assembly - Booster	305
10-0212	Structure Booster	2,460
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	5,546
10-0215	RCS - Booster	----
10-0217	GN&C - Booster	2,685
10-0218	Electrical Power - Booster	710
10-0220	Delivery Stage - Subtotal	($ 28,537)
10-0221	Integration & Assembly - Del. Stage	1,278
10-0222	Structure - Delivery Stage	997
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	16,289
10-0225	RCS - Delivery Stage	1,956
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 41,114
10-0200	Total Production Cost/Vehicle	$ 2,056
20-0100	User Charge Cost/Vehicle and Payload	$ 9,870

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission F

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Liquid Tandem - Spinning CODE 28/7A-A-M-S-M-4
Star 48/4 Tank Monoprop

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 738)
10-0210	Booster - Subtotal	($ 13,709)
10-0211	Integration & Assembly - Booster	338
10-0212	Structure Booster	1,732
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	8,238
10-0215	RCS - Booster	----
10-0217	GN&C - Booster	2,685
10-0218	Electrical Power - Booster	710
10-0220	Delivery Stage - Subtotal	($ 18,918)
10-0221	Integration & Assembly - Del. Stage	1,023
10-0222	Structure - Delivery Stage	1,109
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	8,769
10-0225	RCS - Delivery Stage	----
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 33,365
10-0200	Total Production Cost/Vehicle	$ 1,668
20-0100	User Charge Cost/Vehicle and Payload	$ 17,644

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission B.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Liquid Tandem - Spinning CODE 29/7B-A-M-S-M-4
Star 48/2 Tank Monoprop

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 711)
10-0210	Booster - Subtotal	($13,709)
10-0211	Integration & Assembly - Booster	338
10-0212	Structure Booster	1,732
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	8,238
10-0215	RCS - Booster	-----
10-0217	GN&C - Booster	2,685
10-0218	Electrical Power - Booster	710
10-0220	Delivery Stage - Subtotal	($16,674)
10-0221	Integration & Assembly - Del. Stage	959
10-0222	Structure - Delivery Stage	1,109
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	6,589
10-0225	RCS - Delivery Stage	----
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 31,094
10-0200	Total Production Cost/Vehicle	$ 1,555
20-0100	User Charge Cost/Vehicle and Payload	$ Note 2

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
29 (Vert.)	-	-	-	-	4,367	-
29 (Hor.)	24,913	-	-	-	6,179	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Monoprop - 3 Tank CODE 30/7C-0-M-S-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($17,775)
10-0221	Integration & Assembly - Del. Stage	991
10-0222	Structure - Delivery Stage	1,109
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	7,658
10-0225	RCS - Delivery Stage	------
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 17,775
10-0200	Total Production Cost/Vehicle	$ 888.7
20-0100	User Charge Cost/Vehicle and Payload	$ Note 2

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. User Charge Cost/Vehicle

	REFERENCE MISSION					
CONFIGURATION	A	B	C	D	E	F
30 (Vert)	-	-	-	4,214	-	-
30 (Hor.)	-	-	-	3,843	-	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Monoprop - 8 Tank CODE 31/7D-0-M-T-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 20,967)
10-0221	Integration & Assembly - Del. Stage	1,059
10-0222	Structure - Delivery Stage	1,109
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	12,173
10-0225	RCS - Delivery Stage	-----
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,873
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 20,967
10-0200	Total Production Cost/Vehicle	$ 1048.3
20-0100	User Charge Cost/Vehicle and Payload	$ 22,598

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission A.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Monoprop - 4 Tank CODE 32/7E-O-M-S-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 18,919)
10-0221	Integration & Assembly - Del. Stage	1,024
10-0222	Structure - Delivery Stage	1,109
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	8,769
10-0225	RCS - Delivery Stage	-----
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 18,919
10-0200	Total Production Cost/Vehicle	$ 945.9
20-0100	User Charge Cost/Vehicle and Payload	$ 5,742

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission C.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Monoprop - 8 Tank   CODE 33/9A-O-M-S-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 29,518)
10-0221	Integration & Assembly - Del. Stage	1,315
10-0222	Structure - Delivery Stage	1,220
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	18,966
10-0225	RCS - Delivery Stage	----
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 29,518
10-0200	Total Production Cost/Vehicle	$ 1475.9
20-0100	User Charge Cost/Vehicle and Payload	$ 17,140

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission B.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Monoprop - 4 Tank CODE 34/9B-O-M-T-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 21,477)
10-0221	Integration & Assembly - Del. Stage	1,076
10-0222	Structure - Delivery Stage	815
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	12,960
10-0225	RCS - Delivery Stage	----
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,873
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 21,477
10-0200	Total Production Cost/Vehicle	$ 1073.9
20-0100	User Charge Cost/Vehicle and Payload	$ 23,890

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission A.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Liquid Monoprop - 2 Tank CODE 36/9D-O-M-S-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($19,204)
10-0221	Integration & Assembly - Del. Stage	1,036
10-0222	Structure - Delivery Stage	669
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	9,482
10-0225	RCS - Delivery Stage	-----
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 19,204
10-0200	Total Production Cost/Vehicle	$ 960.2
20-0100	User Charge Cost/Vehicle and Payload	$ Note 3

NOTES: 1. For non-recurring costs, see Combinations Summary.

2. Configuration 35 has same unit cost as Configuration 36.
3. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
35 (Hor.)	-	-	6,950	-	-	-
36 (Vert.)	-	-	-	-	-	-
36 (Hor.)	-	-	-	5,120	-	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Clustered Solid - 7 Star 17's CODE 37/11A-O-K-T-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 25,237)
10-0221	Integration & Assembly - Del. Stage	1,078
10-0222	Structure - Delivery Stage	2,126
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	11,533
10-0225	RCS - Delivery Stage	4,179
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,568
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 25,237
10-0200	Total Production Cost/Vehicle	$ 1262K
20-0100	User Charge Cost/Vehicle and Payload	$ 23,035

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission A (Horiz).

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Clustered Solids - 22 Star 17's CODE 39/11C-0-K-S-M-2

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 49,160)
10-0221	Integration & Assembly - Del. Stage	1,678
10-0222	Structure - Delivery Stage	3,413
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	32,619
10-0225	RCS - Delivery Stage	2,822
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,875
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 49,160
10-0200	Total Production Cost/Vehicle	$ 2458K
20-0100	User Charge Cost/Vehicle and Payload	$ Note 3

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Configuration 38 has same unit cost as Configuration 39.
3. User Charge Cost/Vehicle

	REFERENCE MISSION					
CONFIGURATION	A	B	C	D	E	F
38 (Hor.)	-	15,633	-	-	-	-
39 (Vert.)	-	-	-	-	4,039	-
39 (Horiz)	-	-	-	-	4,170	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Clustered Solids - 4 Star 17's CODE 40/11D-0-K-S-M-2

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 21,682)
10-0221	Integration & Assembly - Del. Stage	1,724
10-0222	Structure - Delivery Stage	1,751
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	6,757
10-0225	RCS - Delivery Stage	2,822
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,875
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 21,682
10-0200	Total Production Cost/Vehicle	$ ~~1084K~~
20-0100	User Charge Cost/Vehicle and Payload	$ Note 2

NOTES: 1. For non-recurring costs, see Combinations Summary.

2. User Charge Cost/Vehicle

	REFERENCE MISSION					
CONFIGURATION	A	B	C	D	E	F
40 (Vert.)	-	-	-	2,249	-	-
40 (Horiz.)	-	-	6,004	4,105	-	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid - Controllable By Pintle Nozzle-Large CODE 41/12A-O-C-S-M-1

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 17,722)
10-0221	Integration & Assembly - Del. Stage	966
10-0222	Structure - Delivery Stage	1,042
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	5,933
10-0225	RCS - Delivery Stage	2,069
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	6,959
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 17,722
10-0200	Total Production Cost/Vehicle	$ 886.1
20-0100	User Charge Cost/Vehicle and Payload	$ 17,183

NOTES: 1. For non-recurring costs, see Combinations Summary.

2. Reference Mission B Horiz.

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid - Controllable By Pintle Nozzle Large CODE 42/12B-0-C-S-M-2

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 18,796)
10-0221	Integration & Assembly - Del. Stage	982
10-0222	Structure - Delivery Stage	1,042
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	5,933
10-0225	RCS - Delivery Stage	2,822
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	7,264
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 18,796
10-0200	Total Production Cost/Vehicle	$ 939.8
20-0100	User Charge Cost/Vehicle and Payload	$ Note 2

NOTES: 1. For non-recurring costs, see Combinations Summary.

2. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
42 (Vert.)	-	-	-	4,803	2,707	-
42 (Horiz.)	-	-	7,489	5,699	5,742	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid-Controllable By Pintle Nozzle - Large CODE 43/12C-O-C-T-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 18,428)
10-0221	Integration & Assembly - Del. Stage	953
10-0222	Structure - Delivery Stage	1,042
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	5,933
10-0225	RCS - Delivery Stage	4,179
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,568
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 18,428
10-0200	Total Production Cost/Vehicle	$ 921.4
20-0100	User Charge Cost/Vehicle and Payload	$ 24,345

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Reference Mission A (Horizontal).

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid - Controllable By Pintle Nozzle - Small CODE 45/12E-O-C-T-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ N/A)
10-0210	Booster - Subtotal	($ N/A)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($ 17,596)
10-0221	Integration & Assembly - Del. Stage	846
10-0222	Structure - Delivery Stage	778
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	5,472
10-0225	RCS - Delivery Stage	4,179
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,568
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 17,596
10-0200	Total Production Cost/Vehicle	$ 879.8
20-0100	User Charge Cost/Vehicle and Payload	$ Note 3

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Configuration 44 has same unit cost as Configuration 45.
3. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
44 (Vert.)	-	-	-	2,904	-	-
44 (Hor.)	-	-	7,162	5,393	-	-
45	24,039	-	-	-	-	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Solid Tandem - Unmodified Spinning Star 48/Star 26 CODE 48/13C-A-P-T-M-4

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 691)
10-0210	Booster - Subtotal	($ 13,839)
10-0211	Integration & Assembly - Booster	300
10-0212	Structure Booster	2,499
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	8,238
10-0215	RCS - Booster	-----
10-0217	GN&C - Booster	2,685
10-0218	Electrical Power - Booster	111
10-0220	Delivery Stage - Subtotal	($ 15,458)
10-0221	Integration & Assembly - Del. Stage	929
10-0222	Structure - Delivery Stage	1,119
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	2,910
10-0225	RCS - Delivery Stage	4,179
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5.568
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 29,998
10-0200	Total Production Cost/Vehicle	$ 1,499
20-0100	User Charge Cost/Vehicle and Payload	$ Note 3

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Configuration 46 and 47 have same unit cost as Configuration 48.
3. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
46	-	18,886	-	-	-	-
47	-	-	9,323	7,424	7,424	-
48	26,048	-	-	-	-	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Solid Tandem - Unmodified Spinning Star 48/Star 37F CODE 49/14A-A-P-S-M-2

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 722)
10-0210	Booster - Subtotal	($17,177)
10-0211	Integration & Assembly - Booster	651
10-0212	Structure Booster	2,494
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	8,238
10-0215	RCS - Booster	2,069
10-0217	GN&C - Booster	3,009
10-0218	Electrical Power - Booster	710
10-0220	Delivery Stage - Subtotal	($12,179)
10-0221	Integration & Assembly - Del. Stage	672
10-0222	Structure - Delivery Stage	1,229
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	6,493
10-0225	RCS - Delivery Stage	-----
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	3,032
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 30,078
10-0200	Total Production Cost/Vehicle	$ 1,504
20-0100	User Charge Cost/Vehicle and Payload	$ Note 3

NOTES: 1. For non-recurring costs, see Combinations Summary.
2. Configuration 50 has same unit cost as Configuration 49.
3. User Charge Cost/Vehicle

	REFERENCE MISSION					
CONFIGURATION	A	B	C	D	E	F
49	-	-	-	-	8,472	8,472
50	-	19,934	-	-	-	-

LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION Solid/Solid Tandem - Star 17A/ Star 17 CODE 51

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($ 504)
10-0210	Booster - Subtotal	($ 5,606)
10-0211	Integration & Assembly - Booster	181
10-0212	Structure Booster	694
10-0213	Thermal - Booster	6
10-0214	Main Propulsion - Booster	2,040
10-0215	RCS - Booster	-----
10-0217	GN&C - Booster	2,685
10-0218	Electrical Power - Booster	-----
10-0220	Delivery Stage - Subtotal	($ 13,722)
10-0221	Integration & Assembly - Del. Stage	846
10-0222	Structure - Delivery Stage	692
10-0223	Thermal - Delivery Stage	6
10-0224	Main Propulsion - Delivery Stage	1,684
10-0225	RCS - Delivery Stage	4,179
10-0226	Data Mgt/Comm - Del. Stage	367
10-0227	GN&C - Delivery Stage	5,568
10-0228	Electrical Power - Del. Stage	380
10-0200	Total Production - 20 Units	$ 19,832
10-0200	Total Production Cost/Vehicle	$ 992
20-0100	User Charge Cost/Vehicle and Payload	$ Note 2

NOTES: 1. For non-recurring costs, see Combinations Summary.

2. User Charge Cost/Vehicle

CONFIGURATION	REFERENCE MISSION A	B	C	D	E	F
51	-	-	7,576	3,219	-	-

TABLE 1
LOW ENERGY STAGE STUDY
PRODUCTION COST SUMMARY SHEET
THOUSANDS OF DOLLARS

CONFIGURATION INTEGRAL OMS CODE I

		RECUR COST (FOR 20 VEH)
10-0201	Integration & Assembly - Subtotal	($)
10-0210	Booster - Subtotal	($)
10-0211	Integration & Assembly - Booster	
10-0212	Structure Booster	
10-0213	Thermal - Booster	
10-0214	Main Propulsion - Booster	
10-0215	RCS - Booster	
10-0217	GN&C - Booster	
10-0218	Electrical Power - Booster	
10-0220	Delivery Stage - Subtotal	($)
10-0221	Integration & Assembly - Del. Stage	
10-0222	Structure - Delivery Stage	
10-0223	Thermal - Delivery Stage	
10-0224	Main Propulsion - Delivery Stage	
10-0225	RCS - Delivery Stage	
10-0226	Data Mgt/Comm - Del. Stage	
10-0227	GN&C - Delivery Stage	
10-0228	Electrical Power - Del. Stage	
10-0200	Total Production - 20 Units	$
10-0200	Total Production Cost/Vehicle	$ N/A
20-0100	User Charge Cost/Vehicle and Payload	$ 21,497 (Note 1)

NOTES: 1. Reference Mission A.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 48 - Combines Configurations No. 23, 24, 25, and 27 (Liquid Biprops) with I (OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 1,291)
10-0210	Booster - Subtotal (Spinning Minuteman III)	($ 1,745)
10-0211	Integration & Assembly - Booster	101
10-0212	Structure - Booster	927
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	655
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 16,748)
10-0221	Integration & Assembly - Del. Stage	2,140
10-0222	Structure - Delivery Stage	508
10-0223	Thermal - Delivery Stage	110
10-0224	Main Propulsion - Delivery Stage	6,100
10-0225	RCS - Delivery Stage	(Incl. with 10-0224)
10-0226	Data Mgt/Comm - Del. Stage	226
10-0227	GN&C - Delivery Stage	6,494
10-0228	Electrical Power - Del. Stage	1,170
10-0200	Total Development Cost	$ 19,784

Notes:
1. Mission A; Configuration No. I, Integral OMS
   Mission B; Configuration No. 23, 8 Tank Liquid Biprop
   Missions C & D; Configuration No. 25, 4 Tank Liquid Biprop
   Mission E; Configuration No. 24, 8 Tank Liquid Biprop
   Mission F; Configuration No. 27, Spinning Minuteman III/8 Tank Liquid Biprop
2. Development cost for these items is shown as part of WBS 10-0212. A prorated amount of previous development cost is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 49 - Combines Configurations No. 4, 9, 12, 32 and 51 (a mixed group of propulsion approaches) with I (OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 2,051)
10-0210	Booster - Subtotal (Spinning Star 48 + Star 17A)	($ 3,617)
10-0211	Integration & Assembly - Booster	589
10-0212	Structure - Booster	1,461
10-0213	Thermal - Booster	55
10-0214	Main Propulsion - Booster	1,450
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 44,694)
10-0221	Integration & Assembly - Del. Stage	6,788
10-0222	Structure - Delivery Stage	2,654
10-0223	Thermal - Delivery Stage	275
10-0224	Main Propulsion - Delivery Stage	21,713
10-0225	RCS - Delivery Stage	(Incl. w/10-224)
10-0226	Data Mgt/Comm - Del. Stage	241
10-0227	GN&C - Delivery Stage	10,683
10-0228	Electrical Power - Del. Stage	2,340
10-0200	Total Development Cost	$ 50,362

Notes: 1. Mission A; Configuration No. I, Integral OMS
Mission B; Configuration No. 9, Flatpack - 6 Long Motors
Mission C; Configuration No. 32, Liquid Monoprop - 4 tank
Mission D; Configuration No. 51, Solid/Solid Tandem, Star 17A/Star 17
Mission E; Configuration No. 4, Solid/Solid Tandem, Spinning Star 48/ Star 37F

2. Development cost for these items is shown as part of WBS 10-0212. A prorated amount of previous development cost for Spinning Star 48 is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 50 - Combines Configurations No. 9 and 10 (Flatpacks) with No. 4 (Solid/Solid Tandem) and I (OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 1,144)
10-0210	Booster - Subtotal (Spinning Star 48)	($ 2,286)
10-0211	Integration & Assembly - Booster	221
10-0212	Structure - Booster	1,461
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	850
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 28,566)
10-0221	Integration & Assembly - Del. Stage	6,118
10-0222	Structure - Delivery Stage	1,437
10-0223	Thermal - Delivery Stage	110
10-0224	Main Propulsion - Delivery Stage	6,338
10-0225	RCS - Delivery Stage	2,686
10-0226	Data Mgt/Comm - Del. Stage	211
10-0227	GN&C - Delivery Stage	10,683
10-0228	Electrical Power - Del. Stage	983
10-0200	Total Development Cost	$ 31,996

Notes: 1. Mission A; Configuration No. I, Integral OMS
Mission B; Configuration No. 9, Flatpack, 6 Long Motors
Missions C & D; Configuration No. 10, Flatpack, 4 Short Motors
Missions E & F; Configuration No. 4, Solid/Solid Tandem, Spinning Star 48/Star 37F

2. Development cost for these items is shown as part of WBS 10-0212. A prorated amount of previous development cost for Spinning Star 48 is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No.51 - Combines Configurations No. 9, 10, & 11 (Solid Motor Flat-packs) with No. 4 (Solid/Solid Tandem)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 1,144)
10-0210	Booster - Subtotal (Spinning Star 48)	($ 2,286)
10-0211	Integration & Assembly - Booster	221
10-0212	Structure - Booster	1,153
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	850
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 32,409)
10-0221	Integration & Assembly - Del. Stage	5,722
10-0222	Structure - Delivery Stage	1,437
10-0223	Thermal - Delivery Stage	110
10-0224	Main Propulsion - Delivery Stage	6,908
10-0225	RCS - Delivery Stage	3,104
10-0226	Data Mgt/Comm - Del. Stage	226
10-0227	GN&C - Delivery Stage	13,872
10-0228	Electrical Power - Del. Stage	1,030
10-0200	Total Development Cost	$ 35,839

Notes:
1. Mission A; Configuration No. 11, Flatpack with 6 Short Motors
   Mission B; Configuration No. 9, Flatpack with 6 Long Motors
   Missions C & D; Configuration No. 10, Flatpack with 4 Short Motors
   MissionS E & F; Configuration No. 4, Solid/Solid Tandem - Spinning Star 48/Star 37F
2. Development cost for these items is shown as part of WBS 10-0212. A prorated amount of previous development cost for Spinning Star 48 is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 52 - Combines Configurations No. 23, 24, 25, 26 & 27 (all Liquid Biprops)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 1,291)
10-0210	Booster - Subtotal (Spinning Minuteman III)	($ 1,745)
10-0211	Integration & Assembly - Booster	101
10-0212	Structure - Booster	927
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	655
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 20,478)
10-0221	Integration & Assembly - Del. Stage	2,502
10-0222	Structure - Delivery Stage	508
10-0223	Thermal - Delivery Stage	110
10-0224	Main Propulsion - Delivery Stage	6,100
10-0225	RCS - Delivery Stage	(incl in 10-0224)
10-0226	Data Mgt/Comm - Del. Stage	241
10-0227	GN&C - Delivery Stage	9,683
10-0228	Electrical Power - Del. Stage	1,334
10-0200	Total Development Cost	$ 23,514

Notes: 1. Mission A; Configuration No. 26, 4-tank Liquid Biprop
Mission B; Configuration No. 23, 8-tank Liquid Biprop
Missions C & D; Configuration No. 25, 4-tank Liquid Biprop
Mission E; Configuration No. 24, 8-tank Liquid Biprop
Mission F; Configuration No. 27, Spinning Minuteman III/8-tank Liquid Biprop

2. Development cost for these items is shown as part of WBS 10-0212. A prorated amount of previous development cost for Spinning MMIII is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 53 - Combines Configurations No. 33, 35, & 36 (Liquid Monoprops) with No. 4 (Solid/Solid Tandem) and I (OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 1,144)
10-0210	Booster - Subtotal (Spinning Star 48)	($ 2,286)
10-0211	Integration & Assembly - Booster	221
10-0212	Structure - Booster	1,153
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	850
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62K
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 20,809)
10-0221	Integration & Assembly - Del. Stage	3,110
10-0222	Structure - Delivery Stage	1,135
10-0223	Thermal - Delivery Stage	165
10-0224	Main Propulsion - Delivery Stage	6,932
10-0225	RCS - Delivery Stage	1,343
10-0226	Data Mgt/Comm - Del. Stage	226
10-0227	GN&C - Delivery Stage	6,494
10-0228	Electrical Power - Del. Stage	1,404
10-0200	Total Development Cost	$ 24,239

Notes: 1. Mission A; Configuration No. I, Integral OMS
Mission B; Configuration No. 33, 8-tank Liquid Monoprop
Mission C; Configuration 35, 2-tank Liquid Monoprop
Mission D; Configuration No. 36, 2-tank Liquid Monoprop
Missions E & F; Configuration No. 4, Solid/Solid Tandem - Spinning Star 48/Star 37E

2. Development cost for these items is shown as part of WBS 10-0212. A prorated amount of previous development cost for Spinning Star 48 is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 54 - Combines Configurations No. 33, 34, 35, & 36 (Liquid Monoprops) with No. 4 (Solid/Solid Tandem)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 1,144)
10-0210	Booster - Subtotal (Spinning Star 48)	($ 2,286)
10-0211	Integration & Assembly - Booster	221
10-0212	Structure - Booster	1,153
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	850
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 25,566)
10-0221	Integration & Assembly - Del. Stage	3,866
10-0222	Structure - Delivery Stage	1,295
10-0223	Thermal - Delivery Stage	220
10-0224	Main Propulsion - Delivery Stage	7,280
10-0225	RCS - Delivery Stage	1,343
10-0226	Data Mgt/Comm - Del. Stage	241
10-0227	GN&C - Delivery Stage	9,683
10-0228	Electrical Power - Del. Stage	1,638
10-0200	Total Development Cost	$ 28,996

Notes: 1. Mission A; Configuration No. 34, 3 Tank Liquid Monoprop
Mission B; Configuration No. 33, 8 Tank Liquid Monoprop
Mission C; Configuration No. 35, 2 Tank Liquid Monoprop
Mission D; Configuration No. 36, 2 Tank Liquid Monoprop
Missions E & F; Configuration No. 4, Solid/Solid Tandem - Spinning Star 48/Star 37E

2. Development cost for these items is shown as part of WBS 10-0212. A prorated amount of previous development cost for Spinning Star 48 is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 55 - Combines Configurations No. 23, 25 and 27 (Liquid Biprops) with No. 52 (Solid/Flatpack) and I (OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 2,435)
10-0210	Booster - Subtotal (Spinning Star 48 + Spinning Minuteman III)	($ 3,292)
10-0211	Integration & Assembly - Booster	232
10-0212	Structure - Booster	1,493
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	1,505
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 18,859)
10-0221	Integration & Assembly - Del. Stage	2,905
10-0222	Structure - Delivery Stage	1,448
10-0223	Thermal - Delivery Stage	165
10-0224	Main Propulsion - Delivery Stage	6,100
10-0225	RCS - Delivery Stage	(incl. w 10-224)
10-0226	Data.Mgt/Comm - Del. Stage	226
10-0227	GN&C - Delivery Stage	6,494
10-0228	Electrical Power - Del. Stage	1,521
10-0200	Total Development Cost	$ 24,586

Notes: 1. Mission A; Configuration No. I, Integral OMS
Mission B; Configuration No. 23, 8 Tank Liquid Biprop
Missions C & D; Configuration No. 25, 4 Tank Liquid Biprop
Mission E; Configuration No. 52, Star 48/Flatpack - 4 Short Motors
Mission F; Configuration No. 27, Spinning Minuteman III/8 Tank Liquid Biprop

2. Development cost for these items are shown as part of WBS 10-0212. A prorated amount of previous development cost is involved here for both stages.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 56 - Combines Configurations No. 12 and 13 (Liquid Quench Solids) with No. 4 (Solid/Solid Tandem) and I (OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 1,144)
10-0210	Booster - Subtotal (Spinning Star 48)	($ 2,286)
10-0211	Integration & Assembly - Booster	221
10-0212	Structure - Booster	1,153
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	850
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 27,857)
10-0221	Integration & Assembly - Del. Stage	3,681
10-0222	Structure - Delivery Stage	938
10-0223	Thermal - Delivery Stage	110
10-0224	Main Propulsion - Delivery Stage	12,754
10-0225	RCS - Delivery Stage	2,686
10-0226	Data Mgt/Comm - Del. Stage	211
10-0227	GN&C - Delivery Stage	6,494
10-0228	Electrical Power - Del. Stage	983
10-0200	Total Development Cost	$ 31,287

Notes: 1. Mission A; Configuration No. I, Integral OMS
Mission B; Configuration No. 12, Solid-Liquid Quench
Missions C, D, & E; Configuration No. 13, Solid-Liquid Quench
Mission F; Configuration No. 4, Solid/Solid Tandem - Spinning Star 48/ Star 37E

2. Development cost for these items is shown as part of WBS 10-0212. A prorated amount of previous development cost for Spinning Star 48 is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 57 - Combines Configurations No. 41 and 42 (Pintle Solids) with No. 4 (Solid/Solid-Tandem) and I (OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 1,144)
10-0210	Booster - Subtotal (Spinning Star 48)	($ 2,286)
10-0211	Integration & Assembly - Booster	221
10-0212	Structure - Booster	1,153
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	850
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 25,698)
10-0221	Integration & Assembly - Del. Stage	3.469
10-0222	Structure - Delivery Stage	942
10-0223	Thermal - Delivery Stage	110
10-0224	Main Propulsion - Delivery Stage	10,804
10-0225	RCS - Delivery Stage	2,686
10-0226	Data Mgt/Comm - Del. Stage	211
10-0227	GN&C - Delivery Stage	6,494
10-0228	Electrical Power - Del. Stage	983
10-0200	Total Development Cost	$ 29,128

Notes:
1. Mission A; Configuration I, Integral OMS
   Mission B; Configuration No. 41, Pintle Solid-Large
   Missions C, D, & E; Configuration No. 42, Pintle Solid-Large
   Mission F; Configuration No. 4, Solid/Solid Tandem - Spinning Star 48/Star 37E
2. Development cost for these items is shown as part of WBS 10-0212. A prorated amount of previous development cost for Spinning Star 48 is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 58 - Combines Combinations No. 38, 39 and 40 (Clustered Solids) with No. 4 (Solid/Solid Tandem) and I (OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 1,144)
10-0210	Booster - Subtotal (Spinning Star 48)	($ 2,286)
10-0211	Integration & Assembly - Booster	221
10-0212	Structure - Booster	1,153
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	850
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 30,895)
10-0221	Integration & Assembly - Del. Stage	7,586
10-0222	Structure - Delivery Stage	2,008
10-0223	Thermal - Delivery Stage	165
10-0224	Main Propulsion - Delivery Stage	6,124
10-0225	RCS - Delivery Stage	2,886
10-0226	Data Mgt/Comm - Del. Stage	226
10-0227	GN&C - Delivery Stage	10,683
10-0228	Electrical Power - Del. Stage	1,217
10-0200	Total Development Cost	$ 34,325

Notes: 1. Mission A; Configuration No. I, Integral OMS
Mission B; Configuration No. 38, Clustered Solids-22 Star 17s
Missions C & D; Configuration No. 40, Clustered Solids - 4 Star 17s
Mission E; Configuration No. 39, Clustered Solids - 22 Star 17s
Mission F; Configuration No. 4, Solid/Solid tandem - Spinning Star 48/Star 37E

2. Development cost for these items is shown as part of WBS 10-0212. A prorated amount of previous development cost for Spinning Star 48 is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 60 - Combines Configurations No. 4 and 51 (Solid/Solid Tandems) with I (Integral OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 2,009)
10-0210	Booster - Subtotal (Spinning Star 48 and Star 17A)	($ 3,617)
10-0211	Integration & Assembly - Booster	589
10-0212	Structure - Booster	1,461
10-0213	Thermal - Booster	55
10-0214	Main Propulsion - Booster	1,450
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 15,369)
10-0221	Integration & Assembly - Del. Stage	2,708
10-0222	Structure - Delivery Stage	820
10-0223	Thermal - Delivery Stage	110
10-0224	Main Propulsion - Delivery Stage	1,404
10-0225	RCS - Delivery Stage	2,686
10-0226	Data Mgt/Comm - Del. Stage	211
10-0227	GN&C - Delivery Stage	6,494
10-0228	Electrical Power - Del. Stage	936
10-0200	Total Development Cost	$ 20,995

Notes: 1. Mission A; Configuration No. I, Integral OMS
Missions B, E, & F; Configuration No. 4, Solid/Solid Tandem - Spinning Star 48/Star 37E
Missions C & D; Configuration No. 51, Solid/Solid Tandem - Star 17A/Star 1
2. Development cost for these items are shown as part of WBS 10-0212. A prorated amount of previous development cost is included here for Spinning Star 48.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 61 - Combines Configurations No. 41, 42, & 44 (Solid - Controllable Pintle Nozzles) with No. 4 (Solid/Solid Tandem) and I (OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 1,144)
10-0210	Booster - Subtotal (Spinning Star 48)	($ 2,286)
10-0211	Integration & Assembly - Booster	221
10-0212	Structure - Booster	1,153
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	850
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 32,924)
10-0221	Integration & Assembly - Del. Stage	4,557
10-0222	Structure - Delivery Stage	1,286
10-0223	Thermal - Delivery Stage	165
10-0224	Main Propulsion - Delivery Stage	13,104
10-0225	RCS - Delivery Stage	2,686
10-0226	Data Mgt/Comm - Del. Stage	226
10-0227	GN&C - Delivery Stage	9,633
10-0228	Electrical Power - Del. Stage	1,217
10-0200	Total Development Cost	$ 36,354

Note: 1. Mission A; Configuration No. I, Integral OMS
Mission B; Configuration No. 41, Pintle Solid-Large
Missions C & D; Configuration No. 44, Pintle Solid - Small
Mission E; Configuration No. 42, Pintle Solid - Large
Mission F; Configuration No. 4, Solid/Solid Tandem - Spinning Star 48/Star 37E

2. Development cost for these items is shown as part of WBS 10-0212. A prorated amount of previous development cost for Spinning Star 48 is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 62 - Combines Configurations No. 19, 20, 21 (Liquid Bipropellants) with No. 4 (Solid/Solid Tandem) and I (OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 2,166)
10-0210	Booster - Subtotal (Spinning Star 48 & Star 37E)	($ 3,406)
10-0211	Integration & Assembly - Booster	244
10-0212	Structure - Booster	1,495
10-0213	Thermal - Booster	55
10-0214	Main Propulsion - Booster	1,550
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 18,873)
10-0221	Integration & Assembly - Del. Stage	2,782
10-0222	Structure - Delivery Stage	909
10-0223	Thermal - Delivery Stage	110
10-0224	Main Propulsion - Delivery Stage	5,792
10-0225	RCS - Delivery Stage	1,343
10-0226	Data Mgt/Comm - Del. Stage	226
10-0227	GN&C - Delivery Stage	6,494
10-0228	Electrical Power - Del. Stage	1,217
10-0200	Total Development Cost	$ 24,445

Notes: 1. Mission A; Configuration No. I, Integral OMS
Mission B; Configuration No. 19, Star 37E/6 Tank Liquid Biprop
Missions C & D; Configuration No. 21, 4 Tank Liquid Biprop
Mission E; Configuration No. 20, Star 37E/4 Tank Liquid Biprop
Mission F; Configuration No. 4, Spinning Star 48/Star 37E

2. Development cost for these items is shown as part of WBS-10-0212. A prorated amount of previous development cost for Spinning Star 48 is included there.

TABLE 2
LOW ENERGY STAGE STUDY
DDT&E COST SUMMARY SHEET
THOUSANDS OF DOLLARS

COMBINATION No. 65 - Combines Configurations No. 23 and 25 (Liquid Biprops) with No. 4 (Solid/Solid Tandem) and No. I (OMS)

		DDT&E COST
10-0201	Integration & Assembly - Subtotal	($ 1,144)
10-0210	Booster - Subtotal (Spinning Star 48)	($ 2,286)
10-0211	Integration & Assembly - Booster	221
10-0212	Structure - Booster	1,153
10-0213	Thermal - Booster	(Note 2)
10-0214	Main Propulsion - Booster	850
10-0215	RCS - Booster	(Note 2)
10-0217	GN&C - Booster	62
10-0218	Electrical Power - Booster	(Note 2)
10-0220	Delivery Stage - Subtotal	($ 20,203)
10-0221	Integration & Assembly - Del. Stage	2,966
10-0222	Structure - Delivery Stage	1,005
10-0223	Thermal - Delivery Stage	110
10-0224	Main Propulsion - Delivery Stage	6,904
10-0225	RCS - Delivery Stage	1,343
10-0226	Data Mgt/Comm - Del. Stage	211
10-0227	GN&C - Delivery Stage	6,494
10-0228	Electrical Power - Del. Stage	1,170
10-0200	Total Development Cost	$ 23,633

Notes: 1. Mission A; Configuration No. I, Integral OMS
Mission B; Configuration No. 23, 8 Tank Liquid Biprop
Missions C & D; Configuration No. 25, 4 Tank Liquid Biprop
Missions E & F; Configuration No. 4, Solid/Solid Tandem - Spinning Star 48/Star 37E

2. Development cost for these items is shown as part of WBS 10-0212- A prorated amount of previous development cost for Spinning Star 48 is included there.

TABLE 3

STAGE UNIT COST, STAGE DEVELOPMENT COST AND ASE COST FOR TASK 2 SCREENING

					WBS NO. ——▷	10-0200		10-0200	10-0500
COMBO NO.	REFERENCE MISSION	CONFIG.	QUANTITY			UNIT COST - $K		COMBO DEV COST - $K	
			PER REF MISSION	PER CONFIG	PER BUY	20 UNITS	PER BUY	STAGE	ASE(INCL 3 SETS)
48	A	I	17	17				19,784	8,524
	B	23	38	44	8	1249	1436		
	C	25	32	54	9	1067	1205		
	D	25	22	-			1205		
	E	24	6	-			1436		
	F	27	10	10	7	2056	2412		
49	A	I	17	17				50,362	19,502
	B	9	38	38	9	976	1102		
	C	32	32	32	6	946	1136		
	D	51	22	22	4	992	1267		
	E	12	6	6	4	927	1184		
	F	4	10	10	7	1543	1810		
50	A	I	17	17				31,996	8,685
	B	9	38	38	9	976	1102		
	C	10	32	54	9	937	1058		
	D	10	22	-			1058		
	E	4	6	16	11	1543	1690		
	F	4	10	-			1690		
51	A	11	17	17	4	976	1247	35,839	8,685
	B	9	38	38	9	976	1102		
	C	10	32	54	9	937	1058		
	D	10	22				1058		
	E	4	6	16	11	1543	1690		
	F	4	10				1690		

TABLE 3

STAGE UNIT COST, STAGE DEVELOPMENT COST AND ASE COST FOR TASK 2 SCREENING

						WBS NO. ⟶	10-0200		10-0200	10-0500
COMBO NO.	REFERENCE MISSION	CONFIG.	QUANTITY			UNIT COST - $K			COMBO DEV COST - $K	
			PER REF MISSION	PER CONFIG	PER BUY	20 UNITS	PER BUY		STAGE	ASE(INCL 3 SETS)
52	A	26	17	17	4	1067	1363		23,514	8,524
	B	23	38	44	8	1249	1436			
	C	25	32	54	9	1067	1205			
	D	25	22				1205			
	E	24	6				1436			
	F	27	10	10	7	2056	2412			
53	A	I	17	17					24,239	8,905
	B	33	38	38	9	1476	1666			
	C	35	22	44	8	960	1103			
	D	36	22				1103			
	E	4	6	16	11	1583	1690			
	F	4	10				1690			
54	A	34	17	17	4	1074	1372		28,996	8,905
	B	33	38	38	9	1476	1666			
	C	35	32	54	9	960	1084			
	D	36	22				1084			
	E	4	6	16	11	1543	1690			
	F	4	10				1690			
55	A	I	17	17					24,586	8,524
	B	23	38	38	9	1249	1410			
	C	25	32	54	9	1067	1205			
	D	25	22				1205			
	E	52	6	6	4	1835	2344			
	F	27	10	10	7	2056	2412			

TABLE 3

STAGE UNIT COST, STAGE DEVELOPMENT COST AND ASE COST FOR TASK 2 SCREENING

					WBS NO. →	10-0200		10-0200	10-0500
COMBO NO.	REFERENCE MISSION	CONFIG.	QUANTITY			UNIT COST - $K		COMBO DEV COST - $K	
			PER REF MISSION	PER CONFIG	PER BUY	20 UNITS	PER BUY	STAGE	ASE(INCL 3 SETS)
56	A	I	17	17				31,287	8,286
	B	12	38	98	9	927	1047		
	C	13	32				1047		
	D	13	22				1047		
	E	13	6				1047		
	F	4	10	10	7	1543	1810		
57	A	I	17	17				29,128	7,466
	B	41	38	38	9	886	1000		
	C	42	32	60	10	940	1044		
	D	42	22				1044		
	E	42	6				1044		
	F	4	10	10	7	1543	1810		
58	A	I	17	17				34,325	8,524
	B	38	38	44	8	2458	2825		
	C	40	32	54	9	1084	1224		
	D	40	22				1224		
	E	39	6				2825		
	F	4	10	10	7	1543	1810		
60	A	I	17	17				20,995	8,102
	B	4	38	54	9	1543	1742		
	C	51	32	54	9	992	1120		
	D	51	22				1120		
	E	4	6				1742		
	F	4	10				1742		

TABLE 3

STAGE UNIT COST, STAGE DEVELOPMENT COST AND ASE COST FOR TASK 2 SCREENING

					WBS NO. ⟶		10-0200	10-0200	10-0500
COMBO NO.	REFERENCE MISSION	CONFIG.	QUANTITY			UNIT COST - $K		COMBO DEV COST - $K	
			PER REF MISSION	PER CONFIG	PER BUY	20 UNITS	PER BUY	STAGE	ASE(INCL 3 SETS)
61	A	I	17	17				36,354	7,466
	B	41	38	44	8	886	1018		
	C	44	32	54	9	880	994		
	D	44	22				994		
	E	42	6				1018		
	F	4	10	10	7	1543	1810		
62	A	I	17	17				24,445	8,702
	B	19	38	38	9	1550	1750		
	C	21	32	54	9	952	1075		
	D	21	22				1075		
	E	20	6	6	4	1513	1932		
	F	4	10	10	7	1543	1810		
65	A	I	17	17				23,633	8,524
	B	23	38	38	9	1249	1410		
	C	25	32	54	9	1067	1205		
	D	25	22				1205		
	E	4	6	16	11	1543	1690		
	F	4	10				1690		
	A								
	B								
	C								
	D								
	E								
	F								

TABLE 4 - LAUNCH APPROACH COMBINATIONS

REPORT COMBO No.	OLD COMBO NO.	REFERENCE MISSIONS A CONF	A DESC	B CONF	B DESC	C CONF	C DESC	D CONF	D DESC	E CONF	E DESC	F CONF	F DESC
1	31	I	S26/S26	46	S48/S26	7	S26/S26	7	S26/S26	47	S48/S26	49	S48/S37F
2	48	I	INT OMS	23	8T BIPROP-M	25	4T BIP-M	25	4T BIP-M	24	8T BIP-M	27	MMIII/8T BIPM
3	49	I	INT OMS	9	FLT PAC-6L	32	4T MON	51	ST17A/ST17		LIQ, QUEN.	4	SST48/SST37F
4	50	I	INT OMS	9	FLT PAC-6L	10	FLT PAC-4S	10	FLT PAC-4S	4	SST48/SST37F	4	SST48/SST37F
5	51	11	FLT PAC-6S	9	FLT PAC-6L	10	FLT PAC-4S	10	FLT PAC-4S	4	SST48/SST37F	4	SST48/SST37F
6	52	26	4T BIP-M	23	8T BIP-M	25	4T BIP-M	25	4T BIP-M	24	8T BIP-M	27	MMIII/8T BIP-M
7	53	I	INT OMS	33	8T MON-M	35	2T MON-M	36	2T MON-M	4	SST48/SST37F	4	SST48/SST37F
8	54	34	4T MON-M	33	8T MON-M	35	2T MON-M	36	2T MON-M	4	SST48/SST37F	4	SST48/SST37F
9	55	I	INT OMS	23	8T BIP-M	25	4T BIP-M	25	4T BIP-M	52	ST48/4T BIP-M	27	MMIII/8T BIP-M
10	56	I	INT OMS	12	LIQ QUEN	13	LIQ QUEN	13	LIQ QUEN	13	LIQ QUEN	4	SST48/SST37F
11	57	I	INT OMS	41	PINTLE-L	42	PINTLE-L	42	PINTLE-L	42	PINTLE-L	4	SST48/SST37F
12	58	I	INT OMS	38	12 STAR 17	40	4 STAR 17	40	4 STAR 17	39	12 STAR 17	4	SST48/SST37F
13	59	I	INT OMS	46	ST48/ST26	7	ST26/ST26	7	ST26/ST26	47	ST48/ST26	4	SST48/SST37F
14	60	I	INT OMS	4	SST48/SST37F	51	ST17A/ST17	51	ST17A/ST17	4	SST48/SST37F	4	SST48/SST37F
15	61	I	INT OMS	41	PINTLE-L	44	PINTLE-S	44	PINTLE-S	42	PINTLE-L	4	SST48/SST37F
16	62	I	INT OMS	19	ST37E/6T BIP	21	4T BIP	21	4T BIP	20	ST37E/4T BIP	4	SST48/SST37F
17	63	I	INT OMS	15	SST48/4T BIP	17	4T BIP	17	4T BIP	16	SST48/4T BIP	4	SST48/SST37F
18	64	I	INT OMS	28	SST48/4T MON	32	4T MON	30	3T MON	29	SST48/2T MON	4	SST48/SST37F
19	65	I	INT OMS	23	8T BIP-M	25	4T BIP-M	26	4T BIP-M	4	SST48/SST37F	4	SST48/SST37F

ADDED 12-16-78 NK

1 COMB No	2 CONF No	3 DESCRIPTION	4 REF MISS	5 No PL	6 YEARS OPERATIONAL A <83	6 B >83	6 C TOT	7 UNIT PM-1	8 PM-1 COST 5X7	9 YEARLY PM-2	10 PM-2 COST A 9X6C	11 YEARLY PM-3 A <83	11 B >83	12 PM-3 COST A <83	12 B >83	12 C TOT	13 TOTAL PM COST 8+10+12C Σ	14 UNIT LAUNCH COST	15 STAGE LAUNCH COST 5X14 Σ	16 UNIT SHUTTLE CHARGE	17 SHUTTLE CHARGE 5X16 Σ	18 STAGE CHARGING 90 STAGE	18 Σ	19 STAGE DEV. Σ	20 ASE DEV Σ	21 TOTAL COST PER COMB 13+18+19+15
48	I	INT OMS	A	17	1	9	10	—	—									—	—	21.48	365.16	—	—		—	
x	23	8T BIP-M	B	38	0	9	9											1.41	53.58	15.63	593.94	8.3	49.30	1.37		
	35	4T BIP-M	C	72	3	9	12	.258 x 108 =	27.86	1.77 x 12 =	21.24	.617 x 3	1.24 x 9	1.85	11.16	13.01	61.11	1.21	38.72	5.92	189.44	19.0	35.99	1.12		
	25	4T BIP-M	D	22	2	9	11											1.21	26.62	4.00	88.00	28.1	24.73	1.12	—	
	14	8T BIP-M	E	6	1	2	3											1.41	8.46	3.98	23.88	28.2	6.73	1.12		
	27	MMIII/8T BIPM	F	10	3	0	3											141	24.10	8.28	82.80	63.3	52.41	5.24	1.10	
																	61.11		151.98		1293.22		169.16	19.8	10.5	1587.11
49	I	INT OMS	A	17	1	9	10	—										—	—	21.48	365.16				—	
	9	FLT AK-6L	B	38	0	9	9	.258	9.80	1.77	15.93						25.73	1.1	41.80	15.63	593.94	8.3				
	32	4T MON	C	26	3	9	12	.258	8.16	1.77	21.26					13.01	42.51	1.14	36.48	5.70	182.40	16.5			—	
	51	ST17A/ST17	D	22	2	9	11	.258	5.68	1.77	19.47						25.15	1.17	27.94	2.25	49.50	49.4			-	
	13	119 QUEN	E	6	1	2	3	.258	1.55	1.77	5.31						6.86	1.18	7.08	2.85	17.28	47.8				
	4	SST98/SST37F	F	10	3	0	3	.258	2.58	1.77	5.31						7.89	1.80	18.00	7.97	79.70	64.0				
																	108.14		131.30		1287.98			50.4	21.5	1599.32
50	I	INT OMS	A	17	1	9	10	—										—	—	21.48	365.16	—	—		—	
x	9	FLT PAC-6L	B	38	0	9	9											1.10	41.80	15.63	593.94	8.3	49.30			
	10	FLT PAC-45	C	32	3	9	12	.258 x 92 =	23.74	1.77 x 12 =	21.24					13.01	57.99	1.06	33.92	5.94	190.88	19.7	37.45			
	10	FLT PAC-75	D	22	2	9	11											1.06	23.32	4.04	88.88	29.1	25.86			
	4	SST98/SST37F	E	6	1	2	3	.258 x 16 =	4.13	1.77 x 5 =	8.85						12.98	1.69	10.14	7.97	47.82	64.0	30.60			
	4	SST99/SST37F	F	10	3	0	3											1.69	16.90	7.97	79.70	64.0	51.01			
																	70.97		126.08		1365.58		194.22	31.9	10.7	1605.23

TABLE 5

LAUNCH COMBINATIONS COST BUILD-UP

1	2	3	4	5	6			7	8	9	10	11		12			13	14	15	16	17	18		19	20	21
COMBO No	CONF. No	DESCRIPTION	REF MISS	No PL.	YEARS OPERATIONAL			UNIT PM-1	PM-1 COST	YEARLY PM-2	PM-2 COST	YEARLY PM-3		PM-3 COST			TOTAL PM COST	UNIT LAUNCH COST	LAUNCH COST	UNIT SHUTTLE CHARGE	TOTAL SHUTTLE CHARGE	STAGE SHUTTLE CHG		STAGE DEV.	ASE DEV	TOTAL COST PER COMB.
					A <83	B >83	C TOT		5x7		A 9x6C	A <83	B >83	A <83	B >83	C TOT	8+10+12C Σ		5X14 Σ		5X16 Σ	% Stg	17x18 Σ	Σ	Σ	13+18+19+20
51	11	FLAT PAC 6-S	A	17	1	9	10											1.25	21.25	22.71	386.07					
	9	FLAT PAC 6-6	B	38	0	9	9											1.10	41.80	15.63	593.94					
	10	FLAT PAC 4-S	C	32	3	9	12	.358 x 109 =	28.12	1.77 x 11 =	21.28					11.01	61.37	1.06	33.92	5.94	190.08					
	10	FLAT PAC 4-S	D	22	2	9	11											1.06	23.32	4.04	88.88					
	4	SST 48/SST 37F	E	6	1	2	3	.158 x 16	9.13	1.77 x 5 =	8.85						12.98	1.69 (B)	10.14	7.97	47.82					
	4	SST 48/SST 37F	F	10	3	0	3											1.69 (B)	16.90	7.97	79.70					
																	75.35		197.53		1386.49			35.8	10.7	1655.67
52	26	4T-BIP-M	A	17	1	9	10											1.36	23.12	22.71	386.07	5.0	19.30			
X	23	8T-BIP-M	B	38	0	9	9											1.44	54.72	15.63	593.94	8.3	49.30			
	25	4T-BIP-M	C	32	3	9	12	.390 x 125	32.65	1.11 x 11 =	11.24					13.61	66.5	1.21	38.72	5.92	189.44	19.0	35.99			
	25	4T-BIP-M	D	22	2	9	11											1.21	26.62	4.00	88.00	28.1	24.73			
	24	8T-BIP-M	E	6	1	2	3											1.44	8.64	3.98	23.88	28.2	6.73			
	27	MMIII/8T-BIP	F	10	3	0	3											2.41	24.10	8.28	82.80	63.3	52.41			
																	66.5		175.92		1364.13		188.46	25.5	10.5	1690.55
53	I	INT. OMS	A	17	1	9	10											—	—	21.48	365.16	—				
X	33	8T-MON-M	B	38	0	9	9						50					1.67	63.46	15.65	594.70	8.5	50.55			
	35	2T-MON-M	C	32	3	9	12					A!						1.10	35.20	6.11	195.52	21.8	42.62			
	36	2T-MON-M	D	22	2	9	11				SAME							1.10	24.20	4.19	92.18	31.7	29.22			
	4	SST 48/SST37F	E	6	1	2	3											1.69 A	10.14 A	7.97	47.82	64.0	30.60			
	4	SST 48/SST37F	F	10	3	0	3											1.69 A	16.90 A	7.97	79.70	64.0	51.01			
																	70.97		149.19		1375.08		209.00	14.2	10.9	1630.39
54	34	4T-MON-M	A	17	1	9	10											1.37	23.29	22.93	389.81					
	33	8T-MON-M	B	38	0	9	9						51					1.67	63.46	15.66	595.08					
	35	2T MON-M	C	32	3	9	12				SAME	A						1.08	34.56	6.11	195.52					
	36	2T MON-M	D	22	2	9	11											1.08	23.76	4.19	92.18					
	4	SST48/SST37F	E	6	1	2	3											1.69 A	10.14 A	7.97	47.82					
	4	SST48/SST37F	F	10	3	0	3											1.69 A	16.90 A	7.97	79.70					
																	75.35		177.11		1400.11			29.0	10.9	1687.47

TABLE 5

LAUNCH COMBINATIONS COST BUILD-UP

1 COMBO No	2 CONF. No	3 DESCRIPTION	4 REF MISS	5 No PL.	6 YEARS OPERATIONAL			7 UNIT PM-1	8 PM-1 COST	9 YEARLY PM-2	10 PM-2 COST	11 YEARLY PM-3		12 PM-3 COST			13 TOTAL PM COST	14 UNIT LAUNCH COST	15 LAUNCH COST	16 UNIT SHUTTLE CHARGE	17 SHUTTLE CHARGE	18 STAGE & FAC COST .3R COMPIG		19 STAGE DEV.	20 ASE DEV	21 TOTAL COST PER COMB
					A <83	B >83	C TOT		5X7		A 9XGC	A <83	B >83	A <83	B >83	C TOT	8+10+12C Σ		5X14 Σ		.5X16 Σ	% STAGE	% × 17 Σ	Σ	Σ	13+15+19+…
55	I	INT. OMS	A	17	1	9	10											—		21.48	365.16	—			—	
X	23	8T-BIP-M	B	38	0	9	9											1.41	53.58	15.63	593.94	8.3	49.30			
	25	4T-BIP M	C	32	3	9	12					AS 48 ✓						1.21	38.72	5.92	189.44	19.0	35.99			
	25	4T-BIP-M	D	22	2	9	11											1.21	26.62	4.00	88.00	28.1	24.73			
	52	STAR 48/4T BIP M	E	6	1	2	3				SAME							2.34	14.04	7.05	42.30	59.5	25.17			
	27	MMIII/8T BIP M	F	10	3	0	3											2.41	24.10	8.28	82.80	63.3	52.41		—	✓
																	$62.11		$151.06		$1361.64 ✓		187.60	14.6	12.5	$1617.91
56	I	INT. OMS	A	17	1	9	10	—										—		21.48	365.16	—			—	
X	12	LIQ. QUEN	B	38	0	9	9											A 1.05	A 39.90	16.96	644.48	15.5	99.89			
	13	LIQ. QUEN	C	32	3	9	12					AS 61						B 1.05	B 33.60	7.27	232.64	34.4	80.03		—	
	13	LIQ. QUEN	D	22	2	9	11				SAME							A 1.05	B 23.10	4.74	104.28	46.7	48.70			
	13	LIQ. QUEN	E	6	1	2	3											B 1.05	B 6.30	2.88	17.28	47.8	8.26		—	
	4	SST48/SST37F	F	10	3	0	3											1.81	18.10	7.97	79.70	64.0	51.01			✓
																	$67.42		$121.00		$1443.54 ✓		287.89	31.3	10.5	$1673.56
57	I	INT. OMS	A	17	1	9	10	—										—		21.48	365.16	—			—	
X	41	PINTLE-L	B	38	0	9	9											1.00	38.0	17.18	652.84	16.6	108.37		—	
	42	PINTLE-L	C	32	3	9	12											A 1.04	A 33.28	7.51	240.32	36.4	87.48			
	42	PINTLE-L	D	22	2	9	11				SAME	AS 61						B 1.04	A 22.88	4.80	105.60	48.8	51.53			
	42	PINTLE-L	E	6	1	2	3											B 1.04	A 6.24	2.88	17.28	49.9	8.62		—	—
	4	SST48/SST37F	F	10	3	0	3											1.81	18.10	7.97	79.70	64.0	51.01			✓
																	$67.42		$118.50		$1460.90 ✓		307.01	29.1	9.5	$1685.42
58	I	INT. OMS	A	17	1	9	10	—										—		21.48	365.16	—				
X	38	22 STAR 17	B	38	0	9	9					AS 61						2.83	107.54	15.63	593.94	8.3	49.30		—	
	40	4 STAR 17	C	32	3	9	12				SAME							1.22	39.04	6.03	192.96	20.8	40.14			
	40	4 STAR 17	D	22	2	9	11											1.22	26.84	2.25	49.50	30.4	15.05			
	39	22 STAR 17	E	6	1	2	3											2.83	16.98	4.13	24.78	31.0	7.68			
	4	SST48/SST37F	F	10	3	0	3											1.81	18.10	7.97	79.70	64.0	51.01			✓
																	$67.42		$208.50		$1306.04		163.18	34.3	10.5	$1626.76

TABLE 5

LAUNCH COMBINATIONS COST BUILD-UP

1 COMBO No	2 CONF. No	3 DESCRIPTION	4 REF MISS	5 No PL.	6 YEARS OPERATIONAL A	6 B	6 C	7 UNIT PM-1	8 PM-1 COST	9 YEARLY PM-2	10 PM-2 COST	11 YEARLY PM-3 A	11 B	12 PM-3 COST A	12 B	12 C	13 TOTAL PM COST	14 UNIT LAUNCH COST	15 LAUNCH COST	16 UNIT SHUTTLE CHARGE	17 SHUTTLE CHARGE	18 TOTAL ... STAGE	18 Σ	19 STAGG DEV.	20 ASE DEV	21 TOTAL COST PER COMB.
					A <83	B >83	C TOT		5x7		A 1x6 C	A <83	B >83	A <83	B >83	C TOT	8+10+12C Σ		5x14 Σ		5x16 Σ	% 15+17 STAGE	Σ	Σ	Σ	13+18+19+20
60	I	INT. OMS	A	17	1	9	10	—	—		—							—	—	21.48	365.16	—				
x	4	SST48/SST37F	B	38	0	9	9	.258	9.80	1.179	15.95						15.77	(A) 1.74	(A) 66.12	19.41	737.58	26.2	193.25			
	51	ST17A/ST17	C	32	3	9	12	.258 x 54	19.93	1.179 x 18	21.25					13.01	54.18	1.12	35.84	7.58	247.56	36.9	89.50			
	51	ST17A/ST17	D	22	2	9	11											1.12	24.64	2.25	49.50	49.4	24.45			
	4	SST48/SST37F	E	6	1	2	3	.258 x 16	4.13	1.179 x 5	8.85						12.98	(A) 1.74	(D) 10.44	7.97	47.82	64.0	30.60			
	4	SST48/SST37F	F	10	3	0	3											(D) 1.74	(A) 17.40	7.97	79.70	64.0	51.01		—	✓
																	92.89		154.44		1522.30		988.81	21.0	10.1	1800.75
61	I	INT. OMS	A	17	1	9	10											—	—	21.49	365.16	—				
X	41	PINTLE-L	B	38	0	9	9											1.02	38.16	17.18	652.84	16.6	109.37			
	44	PINTLE-S	C	32	3	9	12	.258 x 98	25.28	1.179 x 11	21.25					13.01	59.53	.99	31.68	7.18	279.76	33.5	74.97		—	
	44	PINTLE-S	D	22	2	9	11											.99	21.78	2.90	63.80	45.7	29.16			
	42	PINTLE-L	E	6	1	2	3											1.02	6.12	2.88	17.28	49.9	8.62			
	4	SST48/SST37F	E	10	3	0	3	.258 x 10	2.58	1.179 x 3	5.31						7.89	1.81	18.10	7.97	79.70	64.0	51.01			✓
																	67.92		116.44		1208.59		274.13	36.4	9.5	1638.30
62	I	INT OMS	A.	17	1	9	10											—	—	21.48	365.16				—	
	19	ST37E/6TBIP	B	38	0	9	9						GI ✓					1.75	66.50	17.62	669.56				—	
	21	4T-BIP	C	32	3	9	12					PS						1.08	34.56	5.96	190.72					
	21	4-T-BIP	D	22	2	9	11				SAME							1.08	23.76	4.04	88.88					
	20	ST37E/4TBIP	E	6	1	2	3											1.93	11.58	4.35	26.10					
	4	SST48/SST37F	F	10	3	0	3											1.81	18.10	7.97	79.70				—	
																	67.92		154.5		1410.12			24.4	10.7	1677.14
65	I	INT OMS	A	17	1	9	10											—	—	21.49	365.16					
	23	8T-BIP-M	B	38	0	9	9						GO ✓					1.41	53.58	15.63	593.94				—	
	25	4T-BIP-M	C	32	3	9	12					AS						1.21	38.72	5.92	189.44					
	25	4T-BIP-M	D	22	2	9	11				SAME							1.21	26.62	4.00	88.00					
	4	SST48/SST37F	E	6	1	2	3											(A) 1.69	(D) 10.14	7.97	47.82	—				
	4	SST48/SST37F	F	10	3	0	3											(D) 1.69	(A) 16.90	7.97	29.10					
																	70.97		145.96		1364.06			23.6	10.5	1615.09

TABLE 6

PROPULSION APPROACHES FOR REFERENCE MISSION A

LAUNCH APPROACH	PROPULSION APPROACH	DESCRIPTION		OTHER MISSIONS CAPTURED	CONFG. NUMBER
		BOOSTER STAGE	DELIVERY STAGE		
EXISTING APPROACHES	LIQUID	NONE	1 OMS KIT	NONE	II
		NONE	TRS - 2 TANK	C, D	VIII
ADAPTATIONS OF EXISTING APPROACHES	SOLID/SOLID TANDEM	SPINNING STAR 48	STAR 26	B,C,D,E	48
	SOLID/SOLID TANDEM	SHORT NOZZLE SPINNING STAR 48	SHORT NOZZLE STAR 37S	B,C,D,E	3
	SOLID/LIQUID	SHORT NOZZLE-10% OFF-LOAD SPINNING STAR 48	2 TANK MONOPROP	E	29
NEW APPROACHES	SOLID/SOLID TANDEM	STAR 26	STAR 26	C,D	8
	SOLID/SOLID CLUSTER	NONE	FLAT PACK - 6 SHORT	NONE	11
		NONE	7 STAR 17 MOTORS	NONE	37
	CONTROLLED SOLID	NONE	LIQUID QUENCH MOTOR	B,C,D,E	14
		NONE	PINTLE SOLID MOTOR-LARGE	B,C,D,E	43
		NONE	PINTLE SOLID MOTOR-SMALL	C,D	45
	SOLID/LIQUID	-	-	-	NONE
	LIQUID	NONE	8 TANK BIPROP	NONE	18
		NONE	6 TANK BIPROP	"	22
		NONE	4 TANK BIPROP	"	26
		NONE	8 TANK MONOPROP	"	31
		NONE	4 TANK MONOPROP	"	34

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TABLE 6

PROPULSION APPROACHES FOR REFERENCE MISSION B

LAUNCH APPROACH	PROPULSION APPROACH	DESCRIPTION BOOSTER STAGE	DESCRIPTION DELIVERY STAGE	OTHER MISSIONS CAPTURED	CONFG. NUMBER
EXISTING APPROACHES	LIQUID	NONE	TRS-4 TANK EXPENDED	NONE	XII
ADAPTATIONS OF EXISTING APPROACHES	SOLID/SOLID-TANDEM	SPINNING STAR 48	STAR 26	A,C,D,E	46
		SPINNING STAR 48	STAR 37F	E,F	50
		SHORT NOZZLE SPINNING STAR 48	STAR 37-S	A,C,D,E	1
		SHORT NOZZLE SPINNING STAR 48	SHORT NOZZLE STAR 37-F	E,F	4
	SOLID/LIQUID	SHORT NOZZLE-10% OFF-LOAD SPINNING STAR 48	4 TANK BIPROP	E	15
		SHORT NOZZLE-10% OFF-LOAD SPINNING STAR 48	4 TANK MONOPROP	NONE	28
NEW APPROACHES	SOLID/SOLID TANDEM	SHORT NOZZLE STAR 37F	SHORT NOZZLE STAR 37F	E	5
	SOLID/SOLID CLUSTER	NONE	FLAT PACK-6 LONG MOTORS	NONE	9
		NONE	22 STAR 17 MOTORS	E	38
	CONTROLLED SOLID	NONE	LIQUID QUENCH MOTOR	A,C,D,E	12
		NONE	PINTLE SOLID MOTOR	A,C,D,E	41
	SOLID/LIQUID	STAR 37E	6 TANK BIPROP	NONE	19
	LIQUID	NONE	8 TANK BIPROP	E	23
		NONE	8 TANK MONOPROP	NONE	33

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TABLE 6

PROPULSION APPROACHES FOR REFERENCE MISSION C

LAUNCH APPROACH	PROPULSION APPROACH	DESCRIPTION		OTHER MISSIONS CAPTURED	CONFIG. NUMBER
		BOOSTER STAGE	DELIVERY STAGE		
EXISTING APPROACHES	LIQUID	NONE	3 OMS KITS	A	IV
		NONE	MMS-PM-2 EXPENDABLE	D	VI
		NONE	TRS-2 TANK-RETRIEVED	A, D	VIII
ADAPTATIONS OF EXISTING APPROACHES	SOLID/SOLID TANDEM	SPINNING STAR 48	STAR 26	A, B, D, E	47
		SHORT NOZZLE SPINNING STAR 48	STAR 37-S	A, B, D, E	2
NEW APPROACHES	SOLID/SOLID TANDEM	STAR 26	STAR 26	A, D	7
		STAR 17 A	STAR 17	D	51
	SOLID/SOLID CLUSTER	NONE	FLAT PACK-4 SHORT SHORT NOZZLES	D	10
		NONE	4 STAR 17 MOTORS	D	40
	CONTROLLED SOLID	NONE	LIQUID QUENCH MOTOR	A, B, D, E	13
		NONE	PINTLE SOLID MOTOR LARGE	A, B, D, E	42
		NONE	PINTLE SOLID MOTOR SMALL	A, D	44
	SOLID/LIQUID	–	–	–	NONE
	LIQUID	NONE	4 TANK BIPROP	D	17
		NONE	4 TANK BIPROP	D	21
		NONE	4 TANK BIPROP (MODULAR)	A, D	25
		NONE	4 TANK MONOPROP	NONE	32
		NONE	2 TANK MONOPROP (MODULAR)	D	35

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TABLE 6

PROPULSION APPROACHES FOR REFERENCE MISSION D

LAUNCH APPROACH	PROPULSION APPROACH	DESCRIPTION BOOSTER STAGE	DESCRIPTION DELIVERY STAGE	OTHER MISSIONS CAPTURED	CONFG. NUMBER
EXISTING APPROACHES	LIQUID	NONE NONE	MMS-PM-2-EXPENDED TRS-2 TANK-RETRIEVED	C A,C	VI VIII
	SCOUT	-	-	E,F	XIII
ADAPTATIONS OF EXISTING APPROACHES	SOLID/SOLID TANDEM	SPINNING STAR 48	STAR 26	A,B,C,E	47
		SPINNING STAR 48 SHORT NOZZLE	SHORT NOZZLE STAR 37S	A,B,C,E	2
NEW APPROACHES	SOLID/SOLID TANDEM	STAR 26 STAR 17	STAR 26 STAR 17A	A,C C	7 51
	SOLID/SOLID CLUSTER	NONE	FLAT PACK-4 SHORT MOTORS	C	10
		NONE	4 STAR-17 MOTORS	C	40
	CONTROLLED SOLID	NONE	LIQUID QUENCH MOTOR	A,B,C,E	13
		NONE	PINTLE SOLID MOTOR - LARGE	A,B,C,E	42
		NONE	PINTLE SOLID MOTOR-SMALL	A,C	44
	SOLID/LIQUID	-	-	-	NONE
	LIQUID	NONE	4 TANK BIPROP	C	17
		NONE	4 TANK BIPROP	C	21
		NONE	4 TANK BIPROP (MODULAR)	A,C	25
		NONE	3 TANK MONOPROP	NONE	30
		NONE	2 TANK MONOPROP (MODULAR)	C	36

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TABLE 6

PROPULSION APPROACHES FOR REFERENCE MISSION E

LAUNCH APPROACH	PROPULSION APPROACH	DESCRIPTION		OTHER MISSIONS CAPTURED	CONFG. NUMBER
		BOOSTER STAGE	DELIVERY STAGE		
EXISTING APPROACHES	SCOUT	-	-	D,F	XIII
ADAPTATIONS OF EXISTING	SOLID/SOLID TANDEM	SPINNING STAR 48	STAR 26	A,B,C,D	47
		SPINNING STAR 48	STAR 37F	B,F	49
		SHORT NOZZLE SPINNING STAR 48	SHORT NOZZLE STAR 37S	A,B,C,D	2
		SHORT NOZZLE SPINNING STAR 48	SHORT NOZZLE STAR 37F	B,F	4
	SOLID/LIQUID	SHORT NOZZLE-10% OFF LOAD SPINNING STAR 48	4 TANK BIPROP	B	16
		SHORT NOZZLE-10% OFF LOAD SPINNING STAR 48	2 TANK MONOPROP	A	29
NEW APPROACHES	SOLID/SOLID TANDEM	SHORT NOZZLE - STAR 37F	SHORT NOZZLE STAR 37F	B	6
	SOLID/SOLID CLUSTER	NONE	22 STAR 17 MOTORS	B	39
	CONTROLLED SOLID	NONE	LIQUID QUENCH MOTOR	A,B,C,D	13
		NONE	PINTLE SOLID MOTOR LARGE	A,B,C,D	42
	SOLID/LIQUID	STAR 37E	4 TANK BIPROP	NONE	20
	LIQUID	NONE	8 TANK BIPROP	B	24

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TABLE 6

PROPULSION APPROACHES FOR REFERENCE MISSION F

LAUNCH APPROACH	PROPULSION APPROACH	DESCRIPTION BOOSTER STAGE	DESCRIPTION DELIVERY STAGE	OTHER MISSIONS CAPTURED	CONFG. NUMBER
EXISTING APPROACH	SCOUT	-	-	D,E	XIII
ADAPTATION OF EXISTING APPROACHES	SOLID/SOLID TANDEM	SPINNING STAR 48	STAR 37F	B,E	49
		SHORT NOZZLE SPINNING STAR 48	SHORT NOZZLE STAR 37F	B,E	4
	SOLID/LIQUID	SPINNING MM III	4 TANK BIPROP	NONE	27
NEW APPROACHES	SOLID/SOLID TANDEM	-	-	-	NONE
	SOLID/SOLID CLUSTER	-	-	-	NONE
	CONTROLLED SOLID	-	-	-	NONE
	SOLID/LIQUID	-	-	-	NONE
	LIQUID				NONE

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PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 1, 2 & 3 (SEE NOTE)

BOOSTER STAGE ~ STAR 48 ADAPTATION

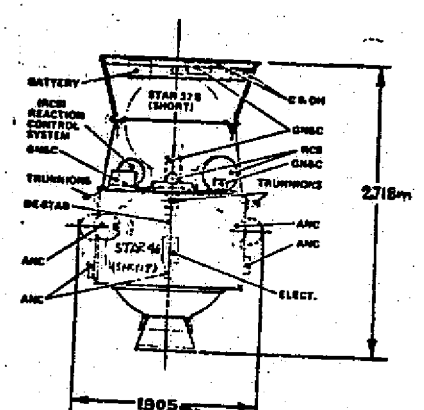
DELIVERY STAGE ~ STAR 37 S (SHORT)

SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS TYPE	48.44
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	STAR 37 S (SHORT NOZZLE) / VENDOR INPUT	716.96
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT NUTATION & MANEUVER CONTROL / SCOOP TYPE	39.19
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYRO / SCOUT	23.86
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		14.88
BOOSTER STAGE		
0211 INTEGRATION & ASSEMBLY	BOOSTER-DELIVERY STAGE SEPARATION CLAMP / SCOUT	7.1
0212 STRUCTURE	SPINNING STAR 48 / AEROSPACE STUDY	112.81
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 48 (SHORT NOZZLE)	1693.71
0215 REACTION CONTROL SYSTEM	NONE	
0216 GUIDANCE & CONTROL	ACTIVE NUTATION CONTROL	15.88
0217 ELECTRICAL POWER	CONVENTIONAL CABLING / SCOUT	13.6
--- CONTINGENCY		17.69

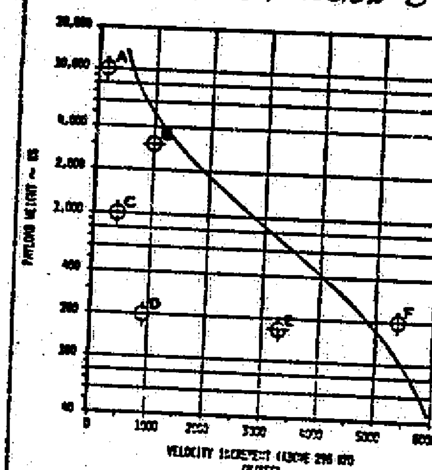
NOTE: CONFIGURATIONS 1 & 2 ARE SPIN STABILIZED AND INCLUDE ONE & TWO REACTION CONTROL THRUSTERS RESPECTIVELY. CONFIGURATION 3 IS THREE AXIS STABILIZED WITH 4 REACTION CONTROL THRUSTERS. CONFIGURATION 3 SHOWN

CONFIGURATION



PERFORMANCE

DESIGN POINT - REF. MISSION B



NOTE: UNDESIRABLE ΔV SPLIT AND/OR VELOCITY RATIO FOR REF. MISSIONS A, C, & D.

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	= 211.51 KG
WEIGHT PROPELLANT	= 663.15 KG
TOTAL	= 874.66 KG

BOOSTER STAGE

WEIGHT INERT	= 253.74 KG
WEIGHT PROPELLANT	= 1609.35 KG
TOTAL	= 1863.09 KG

STAGE WEIGHT = 2737.75 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 4

BOOSTER STAGE ~ STAR 48 ADAPTATION
DELIVERY STAGE ~ STAR 37 F

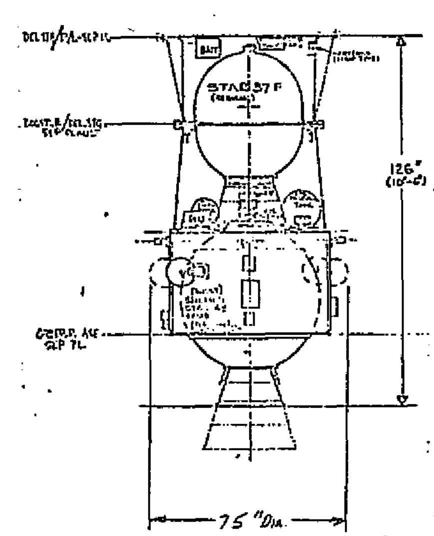
B-73

SYSTEM COMPONENTS

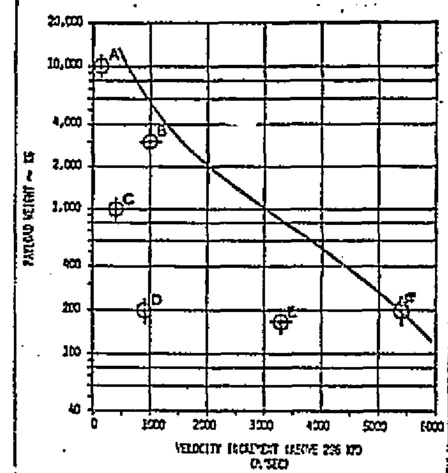
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP/SCOUT	7.71
0222 STRUCTURE	SEMI MONOCOQUE /SCOUT & SAS	49.58
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	STAR 37 F	913.00
0225 REACTION CONTROL SYSTEM	NONE	0.0
0226 DATA PROCESSING/COMM.	S-BAND TRANSMITTER & ANTENNA/SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM/SOFT & DOT	12.66
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING/SCOUT	25.85
--- CONTINGENCY		10.02
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.17
0212 STRUCTURE	SPINNING STAR 48 /AEROSPACE STUDY	113.3
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 48 WITH SHORT NOZZLE/ VENDOR INPUT JULY 1977	1693.71
0215 REACTION CONTROL SYSTEM	MONOPROPELLANT NUTATION & MANEUVER CONTROL/SCOOP TYPE SPINNING STAR 48 TYPE	36.01
0216 GUIDANCE & CONTROL(1)	ROLL STABILIZED PLATFORM/SOFT & DOT ACTIVE NUTATION CONTROL	31.12
0217 ELECTRICAL POWER	CONVENTIONAL CABLES /SCOUT	13.6
--- CONTINGENCY		17.69

NOTE: (1) FUNCTIONALLY A PART OF THE DELIVERY STAGE GUIDANCE & CONTROL BUT IS LOCATED ON THE BOOSTER STAGE.

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION F

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	= 171.7 KG
WEIGHT PROPELLANT	= 850.9 KG
TOTAL	= 1022.6 KG

BOOSTER STAGE

WEIGHT INERT	= 305.5 KG
WEIGHT PROPELLANT	= 1609.3 KG
TOTAL	= 1914.8 KG

STAGE WEIGHT = 2937.6 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 5 & 6 (SEE NOTE)

BOOSTER STAGE ~ STAR 37 F (SHORT)

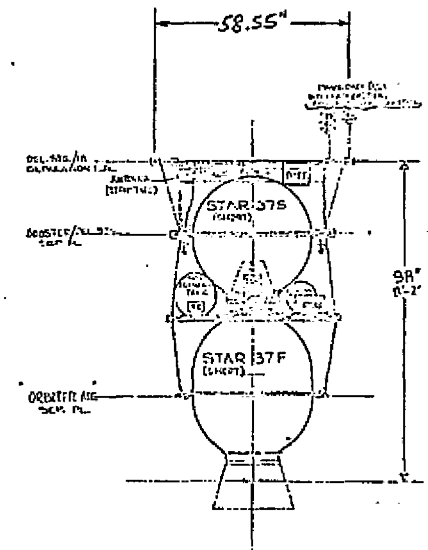
DELIVERY STAGE ~ STAR 37 S (SHORT)

SYSTEM COMPONENTS

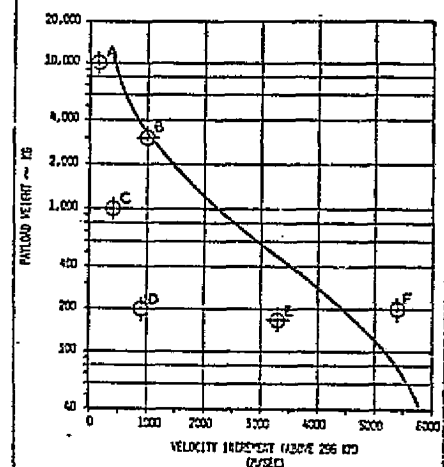
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS TYPES	40.82
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	STAR 37S WITH SHORTENED NOZZLE / VENDOR INPUT	710.96
0225 REACTION CONTROL SYSTEM	NONE	0.0
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM / SOFT & DOT	12.66
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		9.07
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER/DELIVERY STAGE SEPARATION CLAMP/ SCOUT	7.03
0212 STRUCTURE	SEMI-MONOCOQUE/SCOUT & SAS TYPE	45.27
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 37F WITH SHORT NOZZLE / VENDOR INPUT	913.08
0215 REACTION CONTROL SYSTEM	MONOPROPELLANT NUTATION & MANEUVER CONTROL / SCOUT	36.02
0216 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM/SOFT & DOT	31.13
0217 ELECTRICAL POWER	NONE	0.0
--- CONTINGENCY		12.16

NOTE: CONFIGURATIONS 5 & 6 ARE SPIN STABILIZED AND USE 1 & 2 ATTITUDE CONTROL THRUSTERS RESPECTIVELY. CONFIGURATION 5 IS SHOWN

CONFIGURATION



PERFORMANCE



DESIGN POINT - REF. MISSION B

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	147.7 KG
WEIGHT PROPELLANT	=	663.2 KG
TOTAL	=	810.9 KG

BOOSTER STAGE

WEIGHT INERT	=	196.0 KG
WEIGHT PROPELLANT	=	850.9 KG
TOTAL	=	1046.9 KG

STAGE WEIGHT = 1857.9 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 7 & 8 (SEE NOTE)

BOOSTER STAGE ~ STAR 26

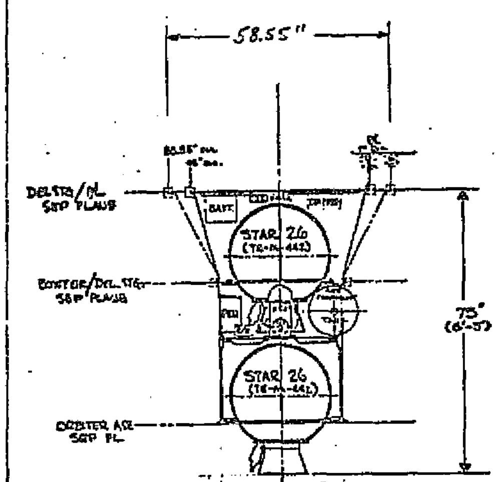
DELIVERY STAGE ~ STAR 26

SYSTEM COMPONENTS

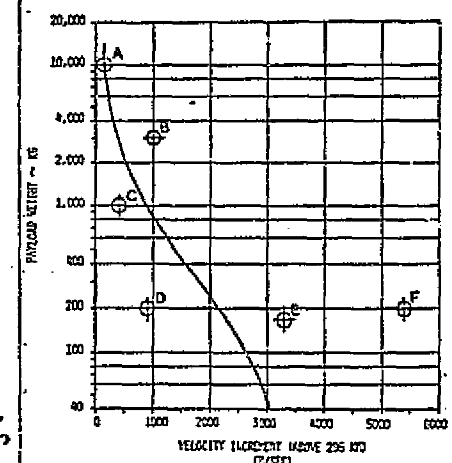
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP /SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE /SCOUT & SAS TYPE	26.90
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	STAR 26/VENDOR INPUT	261.27
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT 3 AXIS/SDP & SCOUT TYPE	39.19
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA /SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYRO /SCOUT	23.86
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		12.75
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER-DELIVERY STAGE SEPARATION CLAMP /SCOUT	3.8
0212 STRUCTURE	SEMI-MONOCOQUE/SCOUT & SAS TYPE	28.21
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 26 / VENDOR INPUT	261.27
0215 REACTION CONTROL SYSTEM	NONE	
0216 GUIDANCE & CONTROL	ACTIVE NUTATION CONTROL	15.88
0217 ELECTRICAL POWER	NONE	0.0
--- CONTINGENCY		5.03

NOTE: [illegible] 7 IS SPIN STABILIZED & INCLUDES 2 ATTITUDE CONTROL THRUSTERS. [illegible] 8 IS 3-AXIS STABILIZED & INCLUDES 4 ATTITUDE CONTROL THRUSTERS. CONFIGURATION 8 SHOWN

CONFIGURATION



PERFORMANCE



DESIGN POINT - REF. MISSION A

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	162.98 KG
WEIGHT PROPELLANT	=	238.32 KG
TOTAL	=	401.30 KG

BOOSTER STAGE

WEIGHT INERT	=	78.15 KG
WEIGHT PROPELLANT	=	238.32 KG
TOTAL	=	316.47 KG

STAGE WEIGHT	=	717.77 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. 7

BOOSTER STAGE ~ STAR 26

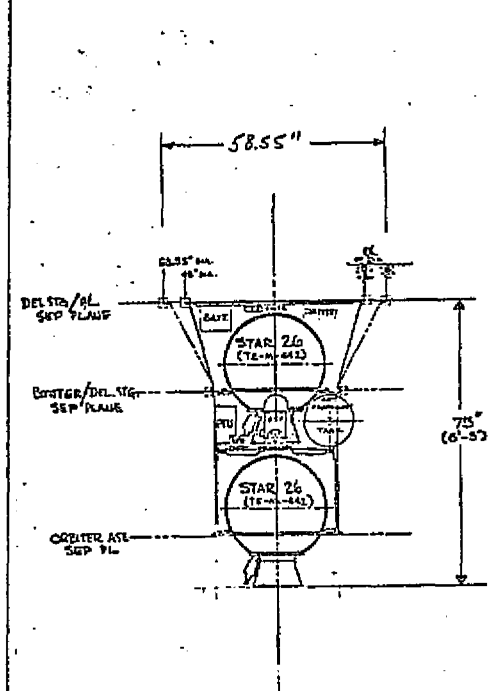
DELIVERY STAGE ~ STAR 26

SYSTEM COMPONENTS

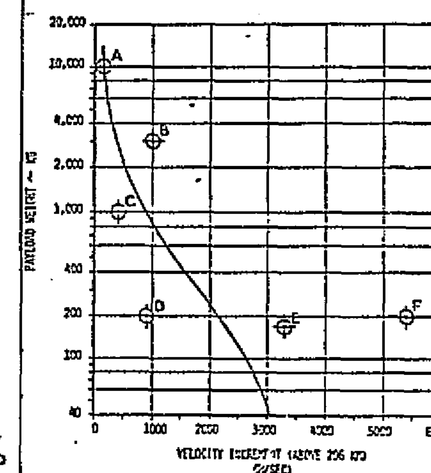
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP /SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS	26.90
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	STAR 26 / VENDOR INPUT	261.27
0225 REACTION CONTROL SYSTEM	(IN BOOSTER STAGE)	0.0
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL(1)	COMPUTER / SOFT & DOT	12.66
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		7.71
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER-DELIVERY STAGE SEPARATION CLAMP / SCOUT	3.81
0212 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS	28.21
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 26 / VENDOR INPUT	261.27
0215 REACTION CONTROL SYSTEM	MONOPROPELLANT NUTATION & MANEUVER CONTROL / SCOOP	36.02
0216 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM/SOFT & DOT	31.12
0217 ELECTRICAL POWER		0.0
--- CONTINGENCY		10.16

NOTE: (1) ... BOOSTER STAGE ... BUT IS LOCATED ...

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION C&D

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	= 107.55 KG
WEIGHT PROPELLANT	= 238.32 KG
TOTAL	= 345.87 KG

BOOSTER STAGE

WEIGHT INERT	= 134.54 KG
WEIGHT PROPELLANT	= 238.32 KG
TOTAL	= 372.86 KG

STAGE WEIGHT = 718.73 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. 8

BOOSTER STAGE ~ STAR 26

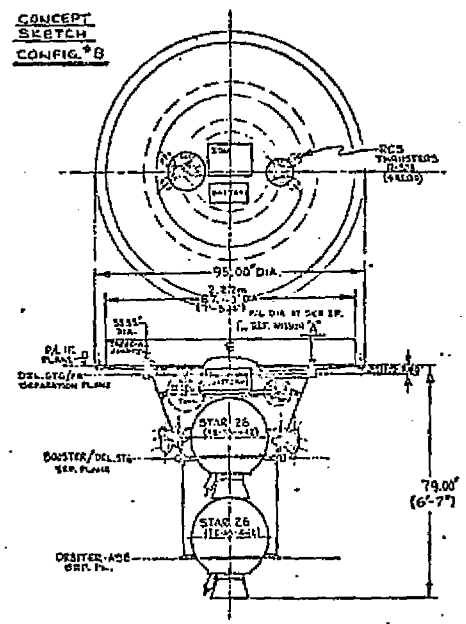
DELIVERY STAGE ~ STAR 26

SYSTEM COMPONENTS

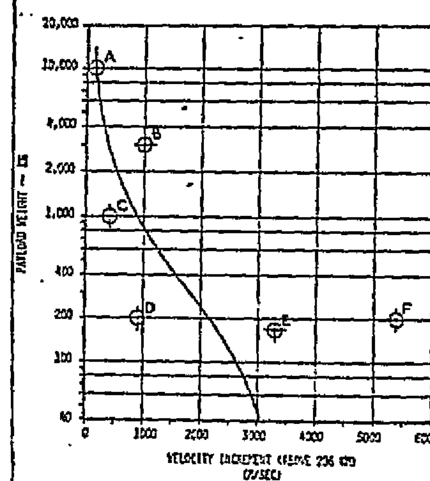
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS TYPE	26.90
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	STAR 26 / VENDOR INPUT	261.27
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT, 3-AXIS/SDP & SCOOP	39.19
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYRO / SCOUT	23.86
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.95
--- CONTINGENCY		12.75
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER-DELIVERY STAGE SEPARATION CLAMP / SCOUT	3.8
0212 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS	28.21
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 26 / VENDOR INPUT	261.27
0215 REACTION CONTROL SYSTEM	NONE	0.0
0216 GUIDANCE & CONTROL	NONE	0.0
0217 ELECTRICAL POWER	NONE	0.0
---- CONTINGENCY		5.03

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT - REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	162.98 KG
WEIGHT PROPELLANT	=	239.32 KG
TOTAL	=	401.30 KG

BOOSTER STAGE

WEIGHT INERT	=	62.27 KG
WEIGHT PROPELLANT	=	238.32 KG
TOTAL	=	300.59 KG

STAGE WEIGHT = 701.89 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 9

BOOSTER STAGE ~ NONE

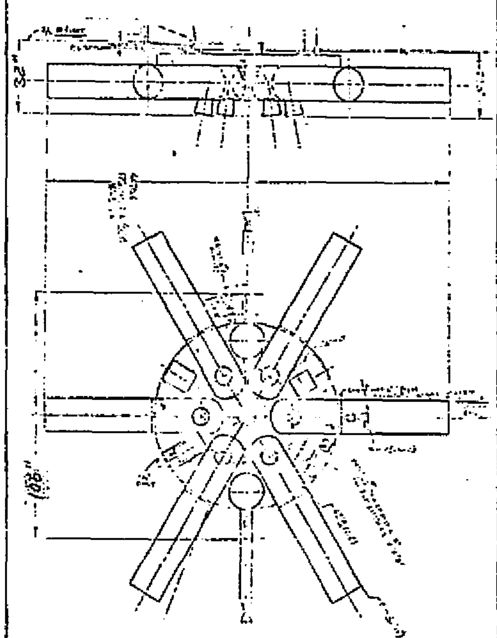
DELIVERY STAGE ~ CLUSTER SOLID (FLAT PACK) 6 LONG

SYSTEM COMPONENTS

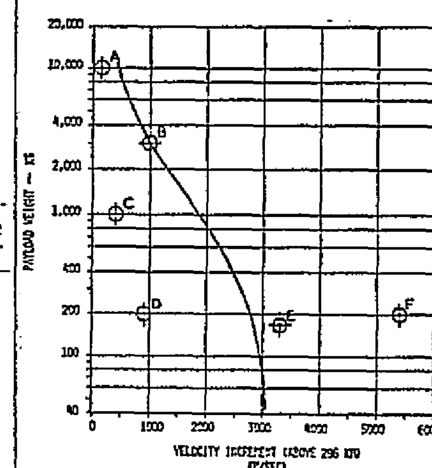
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	BOX BEAM/SAS TYPE	104.33
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	CLUSTER SOLID, FLAT PACK, 6 LONG, CANTED NOZZLES/VENDOR INPUT	2222.97
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT NUTATION & MANEUVER CONTROL/SCOOP TYPE	34.43
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA/SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM/SOFT & TOT	27.90
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING /SCOUT	25.85
--- CONTINGENCY		20.41
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	NONE	0.0
0212 STRUCTURE	NONE	0.0
0213 THERMAL	NONE	0.0
0214 MAIN PROPULSION	NONE	0.0
0215 REACTION CONTROL SYSTEM	NONE	0.0
0216 GUIDANCE & CONTROL	NONE	0.0
0217 ELECTRICAL POWER	NONE	0.0
--- CONTINGENCY	NONE	0.0

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION B

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	780.1 KG
WEIGHT PROPELLANT	=	1667.2 KG
TOTAL	=	2447.3 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG

STAGE WEIGHT	=	2447.3 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 10

BOOSTER STAGE ~ NONE

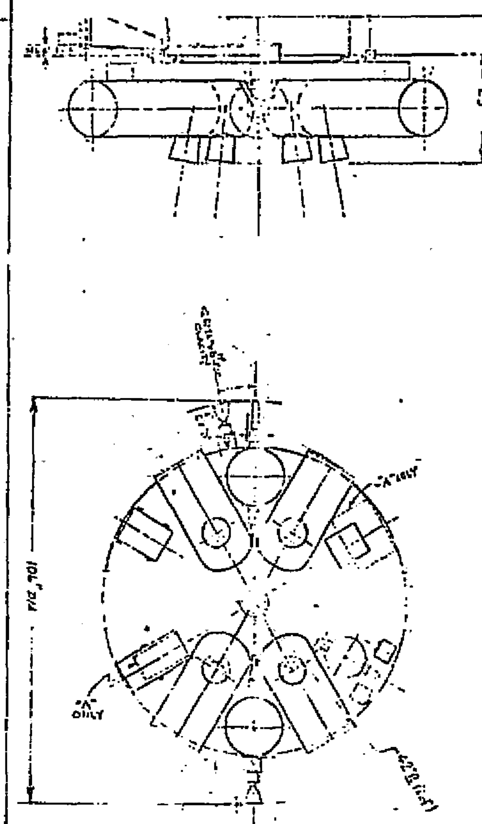
DELIVERY STAGE ~ CLUSTER SOLID (FLAT PACK) 4 SHORT

SYSTEM COMPONENTS

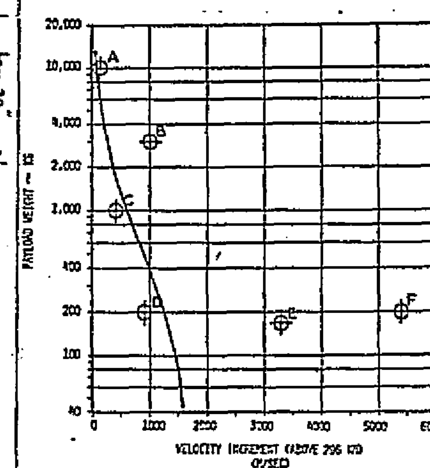
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP/SCOUT	7.71
0222 STRUCTURE	BOX BEAM/SAS TYPE	104.33
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	CLUSTER SOLID, FLAT PACK, 4 SHORT, CANTED NOZZLES/SCOOP TYPE	443.11
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT	36.02
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA/SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM/SOFT & DOT	27.9
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING/SCOUT	25.85
--- CONTINGENCY		20.55
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	NONE	0.0
0212 STRUCTURE	NONE	0.0
0213 THERMAL	NONE	0.0
0214 MAIN PROPULSION	NONE	0.0
0215 REACTION CONTROL SYSTEM	NONE	0.0
0216 GUIDANCE & CONTROL	NONE	0.0
0217 ELECTRICAL POWER	NONE	0.0
--- CONTINGENCY	NONE	0.0

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION C&D

WEIGHT SUMMARY

		C	D
DELIVERY STAGE			
WEIGHT INERT	=	359.1 KG	359.1 KG
WEIGHT PROPELLANT	=	310.2 KG	310.2 KG
TOTAL	=	669.3 KG	669.3 KG
BOOSTER STAGE			
WEIGHT INERT	=	0 KG	0 KG
WEIGHT PROPELLANT	=	0 KG	0 KG
TOTAL	=	0 KG	0 KG
STAGE WEIGHT	=	669.3 KG	669.3 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 11

BOOSTER STAGE ~ NONE

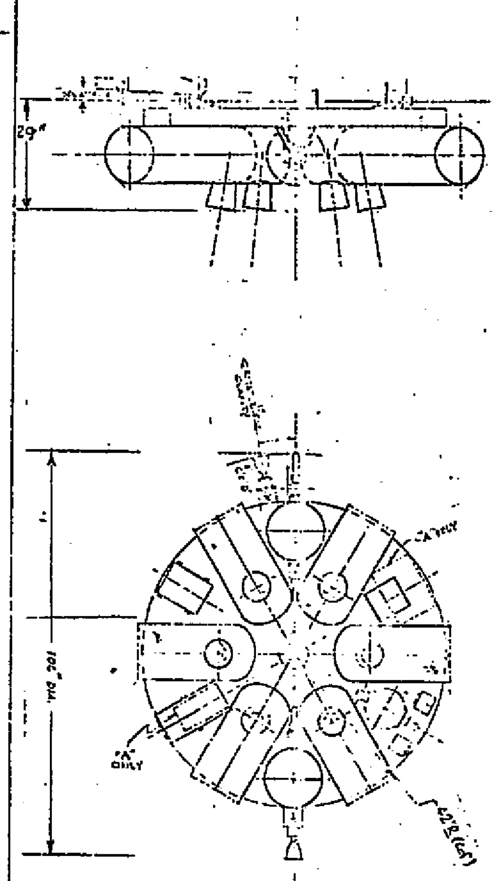
DELIVERY STAGE ~ CLUSTER SOLID (FLAT PACK) 6 SHORT

SYSTEM COMPONENTS

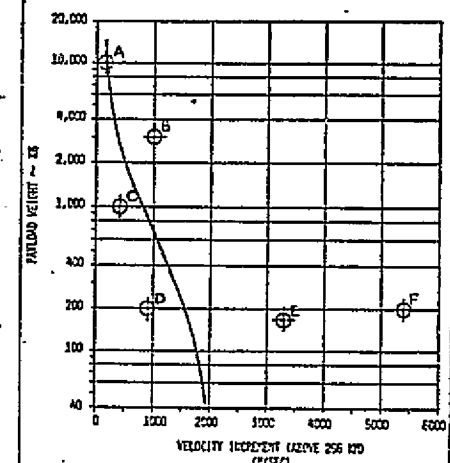
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP/SCOUT	7.71
0222 STRUCTURE	BOX BEAM /SAS TYPE	104.39
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	CLUSTER SOLID, FLAT PACK, 6-SHORT, CANTED NOZZLES /VENDOR INPUT	664.69
0225 REACTION CONTROL SYSTEM	MONO PROPELLANT 3 AXIS/SDP [illegible] TYPE	39.19
0226 DATA HANDLING/COMM.	S-BAND TRANSMITTER & ANTENNA/SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYROS /SCOUT	23.86
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING/SCOUT	25.85
--- CONTINGENCY		20.46
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	NONE	0.0
0212 STRUCTURE	NONE	0.0
0213 THERMAL	NONE	0.0
0214 MAIN PROPULSION	NONE	0.0
0215 REACTION CONTROL SYSTEM	NONE	0.0
0216 GUIDANCE & CONTROL	NONE	0.0
0217 ELECTRICAL POWER	NONE	0.0
--- CONTINGENCY	NONE	0.0

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	424.6 KG
WEIGHT PROPELLANT	=	465.3 KG
TOTAL	=	889.9 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG

STAGE WEIGHT	=	889.9 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 12, 13 & 14 (SEE NOTE)

BOOSTER STAGE ~ NONE

DELIVERY STAGE ~ SOLID LIQUID QUENCH

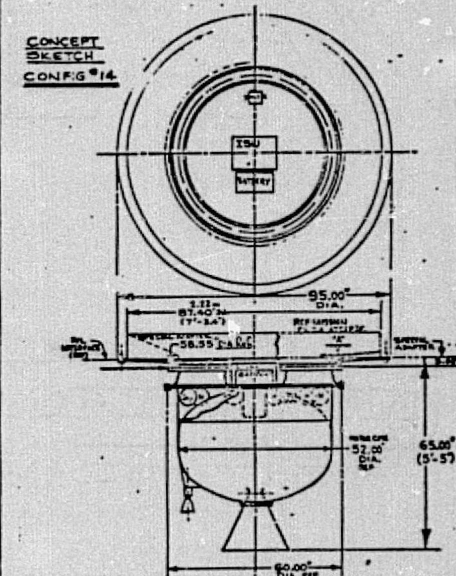
SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE/SCOUT & SAS TYPE	40.37
0223 THERMAL	SPINNING STAR 13 TYPE	2.27
0224 MAIN PROPULSION	CONTROLLED SOLID - LIQUID QUENCH/VENDOR UNIT	1602.09
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT 3 AXIS/SDP & SCOOP	39.19
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYRO / SCOUT	23.86
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		14.06
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	NONE	
0212 STRUCTURE	NONE	
0213 THERMAL	NONE	
0214 MAIN PROPULSION	NONE	
0215 REACTION CONTROL SYSTEM	NONE	
0216 GUIDANCE & CONTROL	NONE	
0217 ELECTRICAL POWER	NONE	
--- CONTINGENCY	NONE	

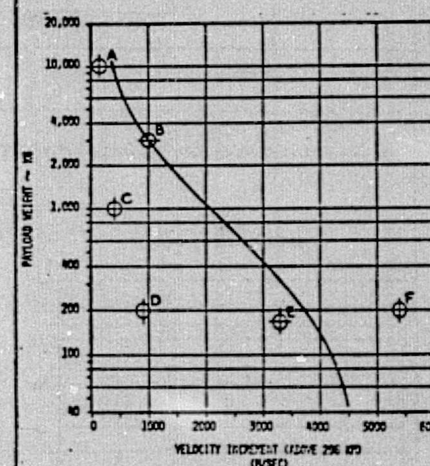
NOTE: MOTOR QUENCHABLE AFTER 50% BURN WHICH MAY RESULT IN UNDESIRABLE VELOCITY RATIOS FOR REF. MISS. C & D.
CONFIGS. 12 & 13 ARE SPIN STABILIZED USING 1 & 2 ATTITUDE CONTROL THRUSTERS RESPECTIVELY.
CONFIG. 14 IS 3-AXIS STABILIZED, USES 4 ATTITUDE CONTROL THRUSTERS and is shown

CONFIGURATION

CONCEPT SKETCH CONFIG #14



PERFORMANCE



DESIGN POINT - REF. MISSION B

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	305.40 KG
WEIGHT PROPELLANT	=	1451.50 KG
TOTAL	=	1756.90 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG

STAGE WEIGHT	=	1756.90 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 12, 13 & 14 (SEE NOTE)

BOOSTER STAGE ~ NONE

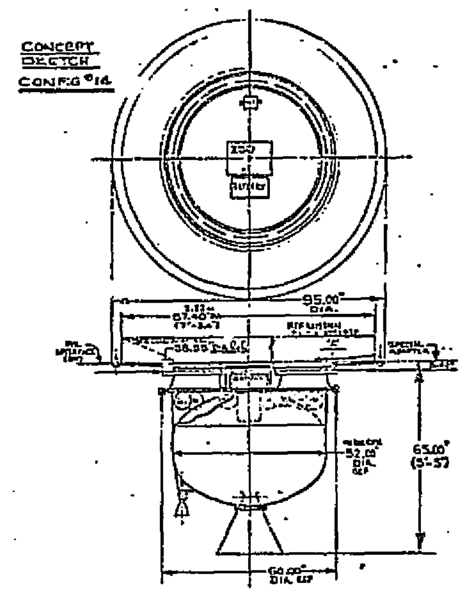
DELIVERY STAGE ~ SOLID LIQUID QUENCH

SYSTEM COMPONENTS

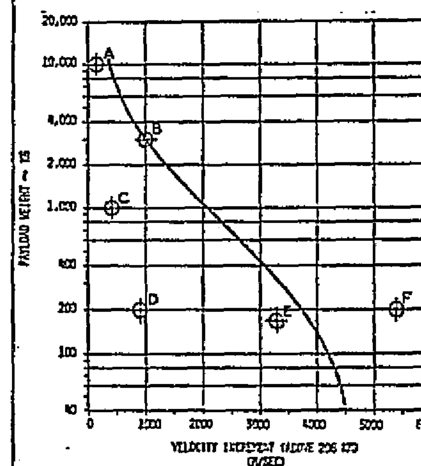
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS TYPE	40.37
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	CONTROLLED SOLID - LIQUID QUENCH / IGNITE / UPRT	1602.09
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT 3 AXIS / SDP / SCOOP	39.19
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYRO / SCOUT	23.86
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		14.06
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	NONE	
0212 STRUCTURE	NONE	
0213 THERMAL	NONE	
0214 MAIN PROPULSION	NONE	
0215 REACTION CONTROL SYSTEM	NONE	
0216 GUIDANCE & CONTROL	NONE	
0217 ELECTRICAL POWER	NONE	
--- CONTINGENCY	NONE	

NOTE: MOTOR QUENCHABLE AFTER 50% BURN WHICH MAY RESULT IN UNDESIRABLE VELOCITY RATIOS FOR REF. MISS. C & D.
CONFIG. 12 & 13 ARE SPIN STABILIZED USING 1 & 2 ATTITUDE CONTROL THRUSTERS RESPECTIVELY.
CONFIG. 14 IS 3-AXIS STABILIZED, USES 4 ATTITUDE CONTROL THRUSTERS and is shown

CONFIGURATION



PERFORMANCE



DESIGN POINT - REF. MISSION B

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	305.40 KG
WEIGHT PROPELLANT	=	1451.55 KG
TOTAL	=	1756.90 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG

STAGE WEIGHT = 1756.90 KG

PROPULSION CONCEPT SUMMARY

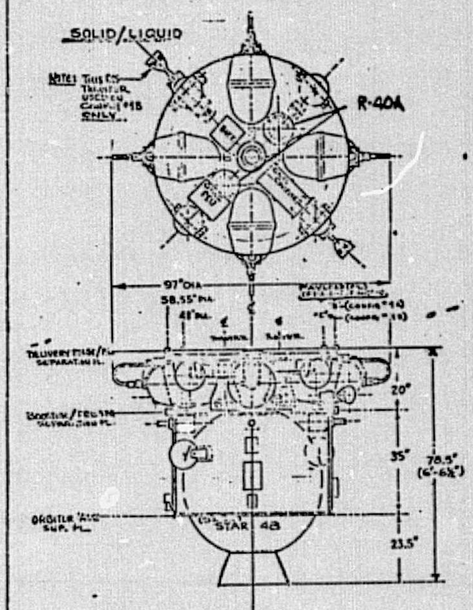
CONFIGURATION No. 15 & 16 (SEE NOTE)
BOOSTER STAGE ~ STAR 48 (SHORT) ADAPTATION
DELIVERY STAGE ~ LIQUID BIPROPELLANT (4 TANK)

SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS/SAS TYPE	39.01
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT 4 CONOSPHER. PROP. TANKS, 4 SPHER. PRES. TANKS, TWO R 40A THRUSTERS/SAS TYPE	360.29
0225 REACTION CONTROL SYSTEM	BIPROPELLANT NUTATION & MANEUVER CONTROL/ SAS & SCOOP TYPE	5.9
0226 [illegible]/COMM.	S-BAND TRANSMITTER & ANTENNA/SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM/SOFT & IOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING /SCOUT	25.85
— CONTINGENCY		11.07
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER/DELIVERY STAGE SEPARATION CLAMP/ SCOUT	7.26
0212 STRUCTURE	SPINNING STAR 48 /AEROSPACE STUDY	113.4
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 48 WITH SHORT NOZZLE/ VENDOR INPUT JULY 1977	1533.60
0215 REACTION CONTROL SYSTEM	NONE - [illegible]	0.0
0216 GUIDANCE & CONTROL	ACTIVE NUTATION CONTROL	15.88
0217 ELECTRICAL POWER	CONVENTIONAL CABLES /SCOUT	13.61
— CONTINGENCY		17.69

NOTE: CONFIGURATIONS 15 & 16 ARE SPIN STABILIZED & USE 1 & 2 ATTITUDE CONTROL THRUSTERS RESPECTIVELY. CONFIGURATION 15 SHOWN

CONFIGURATION



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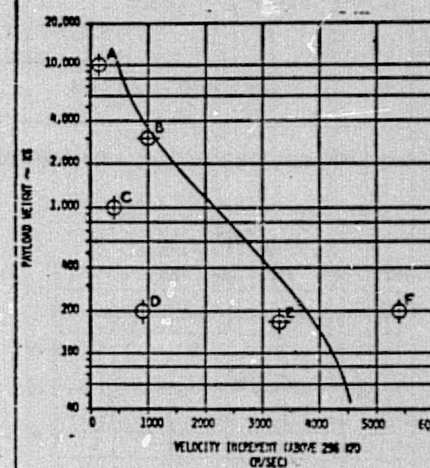


DESIGN POINT - REF. MISSION B

WEIGHT SUMMARY

DELIVERY STAGE		
WEIGHT INERT	=	243.0 KG
WEIGHT PROPELLANT	=	238.9 KG
TOTAL	=	481.9 KG
BOOSTER STAGE		
WEIGHT INERT	=	254.5 KG
WEIGHT PROPELLANT	=	1449.2 KG
TOTAL	=	1703.7 KG
STAGE WEIGHT	=	2185.6 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 15 & 16 (SEE NOTE)

BOOSTER STAGE ~ STAR 48 (SHORT) ADAPTATION

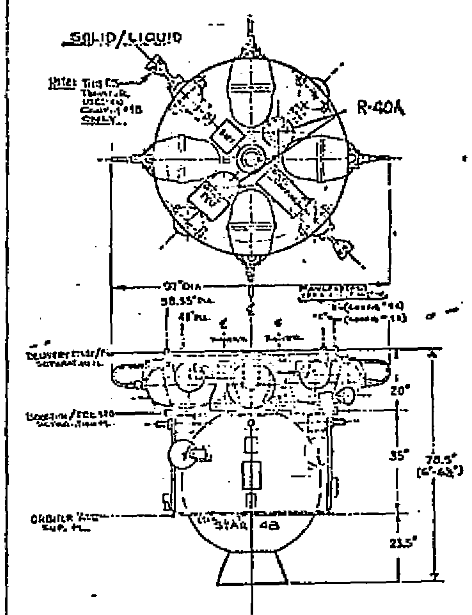
DELIVERY STAGE ~ LIQUID BIPROPELLANT (4 TANK)

SYSTEM COMPONENTS

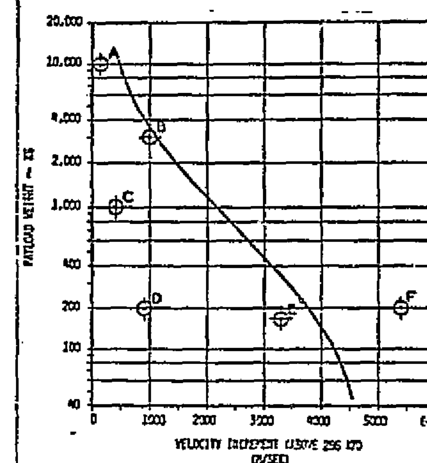
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS/SAS TYPE	39.01
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT 4 CONOSPHERE PROP. TANKS, 4 SPHERE PRES. TANKS, TWO R 40A THRUSTERS/SAS TYPE	360.29
0225 REACTION CONTROL SYSTEM	BIPROPELLANT NUTATION & MANEUVER CONTROL/ SAS & SCOOP TYPE	5.9
0226 [illegible] COMM.	S-BAND TRANSMITTER & ANTENNA/SCOUT	1.5
0227 [illegible] CONTROL	ROLL STABILIZED PLATFORM/SOFT & DOT	28.26
0228 [illegible] POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING /SCOUT	25.85
— CONTINGENCY		11.07
BOOSTER STAGE		
0211 INTEGRATION & ASSEMBLY	BOOSTER/DELIVERY STAGE SEPARATION CLAMP/ SCOUT	7.26
0212 STRUCTURE	SPINNING STAR 48 /AEROSPACE STUDY	113.4
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 48 WITH SHORT NOZZLE / VENDOR INPUT JULY 1977	1535.60
0215 REACTION CONTROL SYSTEM	NONE	0.0
0216 GUIDANCE & CONTROL	ACTIVE NUTATION CONTROL	15.88
0217 ELECTRICAL POWER	CONVENTIONAL CABLES /SCOUT	13.61
— CONTINGENCY		17.69

NOTE: CONFIGURATIONS 15 & 16 ARE SPIN STABILIZED & USE 1 & 2 ATTITUDE CONTROL THRUSTERS RESPECTIVELY. CONFIGURATION 15 SHOWN

CONFIGURATION



PERFORMANCE



DESIGN POINT – REF. MISSION B

WEIGHT SUMMARY

DELIVERY STAGE		
WEIGHT INERT	=	243.0 KG
WEIGHT PROPELLANT	=	238.9 KG
TOTAL	=	481.9 KG
BOOSTER STAGE		
WEIGHT INERT	=	254.5 KG
WEIGHT PROPELLANT	=	1449.2 KG
TOTAL	=	1703.7 KG
STAGE WEIGHT	=	2185.6 KG

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PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 17

BOOSTER STAGE ~ NONE

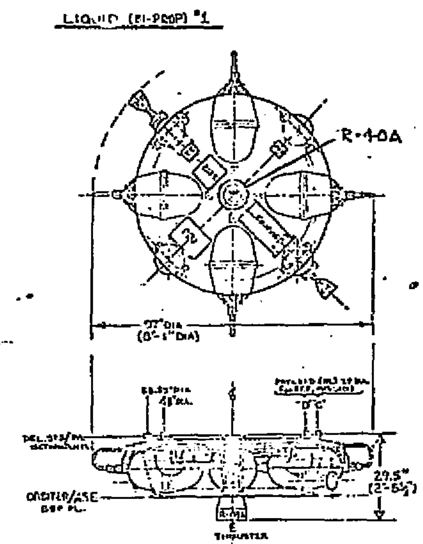
DELIVERY STAGE ~ LIQUID BIPROPELLANT (4 TANK)

SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INT[illegible] & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS/SAS TYPE	39.01
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT 4-CONOSPHER. PROP. TANKS, 4 SPHER. PRES. TANKS, ONE R-40A THRUSTER (25/SAS TYPE)	C 305.09
		D 279.5
0225 REA[illegible] SYSTEM	BIPROPELLANT NUTATION & MANEUVER CONTROL / SAS & SCOOP TYPE	8.3
02[illegible]	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 [illegible]	ROLL STABILIZED PLATFORM / SOFT & IOT	28.26
0229 [illegible]	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		11.29
BOOSTER STAGE		
[illegible] INTEGRATION [illegible]	NONE	0.0
0212 STRUCTURE	NONE	0.0
0213 [illegible]	NONE	0.0
[illegible]	NONE	0.0
[illegible]	NONE	0.0
[illegible] GUIDANCE & CONTROL	NONE	0.0
[illegible]	NONE	0.0
CONTINGENCY	NONE	0.0

NOTE:

CONFIGURATION



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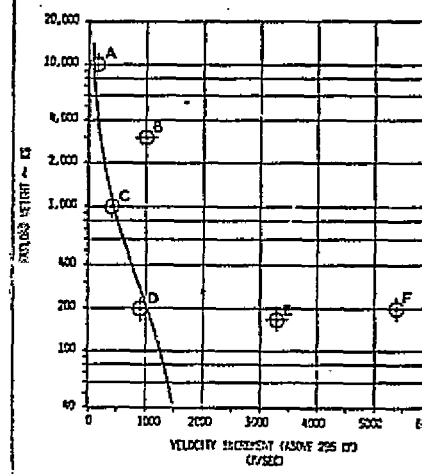


DESIGN POINT ~ REFERENCE MISSION C&D

WEIGHT SUMMARY

		C	D
DELIVERY STAGE			
WEIGHT INERT	=	236.0 KG	236.0 KG
WEIGHT PROPELLANT	=	193.3 KG	167.7 KG
TOTAL	=	429.3 KG	403.7 KG
BOOSTER STAGE			
WEIGHT INERT	=	0 KG	0 KG
WEIGHT PROPELLANT	=	0 KG	0 KG
TOTAL	=	0 KG	0 KG
ST[illegible] WEIGHT	=	429.3 KG	403.7 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 18

BOOSTER STAGE ~ NONE

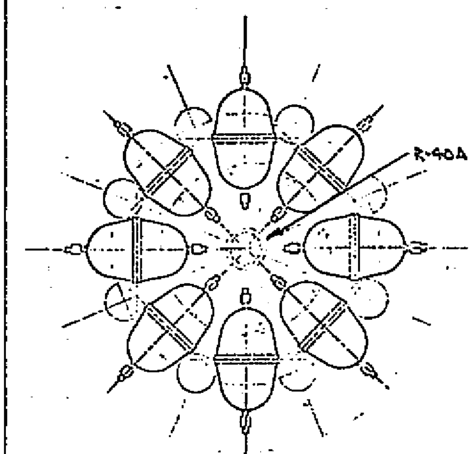
DELIVERY STAGE ~ LIQUID BIPROPELLANT (8 TANK)

SYSTEM COMPONENTS

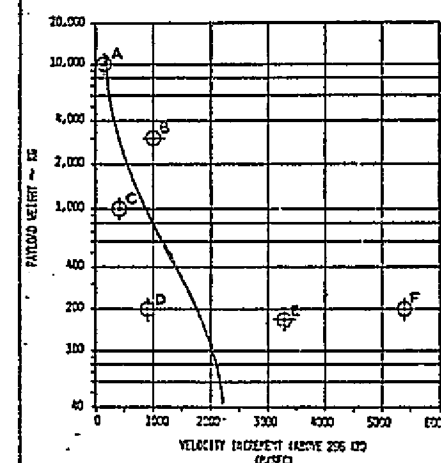
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	39.01
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT 8 CONOSPHER. PROP. TANKS, 8 SPHER. PRES. TANKS, ONE R-40A THRUSTER / SAS TYPE	680.97
0225 REACTION CONTROL SYSTEM	BIPROPELLANT 3 AXIS / SDP & SCOOP TYPE	13.11
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYROS / SCOUT	24.18
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		11.79
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	NONE	0.0
0212 STRUCTURE	NONE	0.0
0213 THERMAL	NONE	0.0
0214 MAIN PROPULSION	NONE	0.0
0215 REACTION CONTROL SYSTEM	NONE	0.0
[illegible] GUIDANCE & CONTROL	NONE	0.0
[illegible]	NONE	0.0
[illegible]	NONE	0.0

NOTES:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	328.9 KG
WEIGHT PROPELLANT	=	477.5 KG
TOTAL	=	806.4 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG
STAGE WEIGHT	=	806.4 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 19

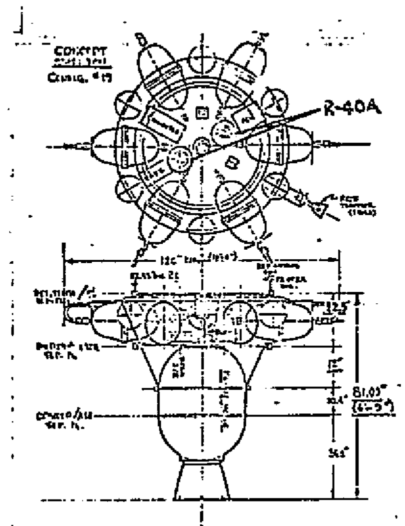
BOOSTER STAGE ~ STAR 37E

DELIVERY STAGE ~ LIQUID BIPROPELLANT (6 TANK)

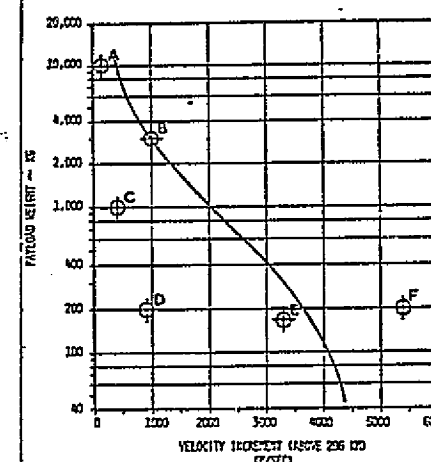
SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP/SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS/SAS TYPE	38.56
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT 6 CONOSPHERIC PROP. TANKS, 6 SPHER. PRES. TANKS, TWO R-40A THRUSTERS/SAS TYPE	642.29
0225 REACTION CONTROL SYSTEM	BIPROPELLANT NUTATION/MANEUVER CONTROL/SAS & SCOOP TYPE	5.9
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA/SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM/SOFT & DOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING/SCOUT	25.85
--- CONTINGENCY		11.02
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER/DELIVERY STAGE SEPARATION CLAMP/SCOUT	6.35
0212 STRUCTURE	SEMI-MONOCOQUE/SCOUT & SAS TYPE	27.22
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 37E	1121.78
0215 REACTION CONTROL SYSTEM	NONE	0.0
0216 GUIDANCE & CONTROL	NONE	0.0
0217 ELECTRICAL POWER	NONE	0.0
--- CONTINGENCY		3.58

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION B

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	303.5 KG
WEIGHT PROPELLANT	=	459.9 KG
TOTAL	=	763.4 KG

BOOSTER STAGE

WEIGHT INERT	=	116.9 KG
WEIGHT PROPELLANT	=	1045.3 KG
TOTAL	=	1161.2 KG

STAGE [illegible]	=	1924.6 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 20

BOOSTER STAGE ~ STAR 37E

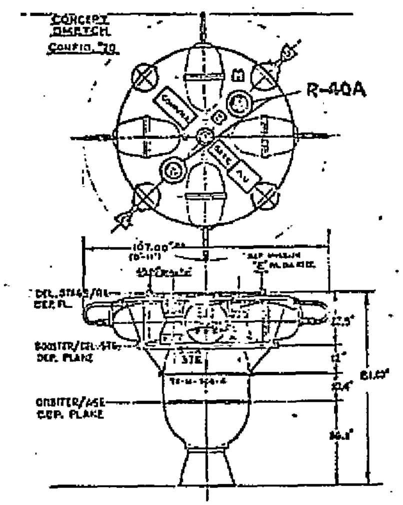
DELIVERY STAGE ~ LIQUID BIPROPELLANT (4 TANK)

SYSTEM COMPONENTS

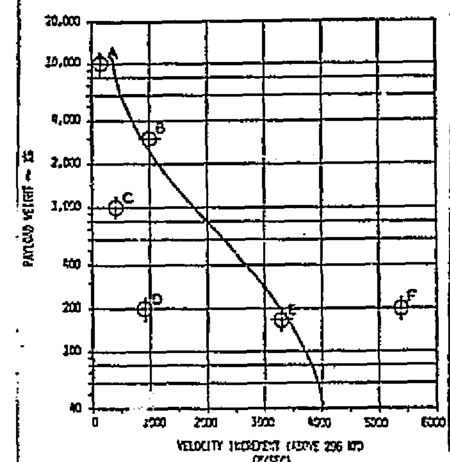
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP/SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE, TRUSS/SAS TYPE	38.56
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT 4 CONOSPHER. PROP. TANKS, 4 SPHER. PRES. TANKS, TWO R-40A THRUSTERS/SAS TYPE	291.39
0225 REACTION CONTROL SYSTEM	BIPROPELLANT NUTATION & MANEUVER CONTROL/ SAS & SCOOP TYPE	8.3
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA/SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM/SOFT & DOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING/SCOUT	25.85
--- CONTINGENCY		11.25
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER/DELIVERY STAGE SEPARATION CLAMP/ SCOUT	6.35
0212 STRUCTURE	SEMI-MONOCOQUE/SCOUT & SAS TYPE	27.22
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 37E	1121.78
0215 REACTION CONTROL SYSTEM	NONE	0.0
0216 GUIDANCE & CONTROL	NONE	0.0
0217 ELECTRICAL POWER	NONE	0.0
--- CONTINGENCY		3.58

NOTES:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION E

WEIGHT SUMMARY

DELIVERY STAGE	
WEIGHT INERT	= 256.3 KG
WEIGHT PROPELLANT	= 159.8 KG
TOTAL	= 415.1 KG
BOOSTER STAGE	
WEIGHT INERT	= 115.9 KG
WEIGHT PROPELLANT	= 1045.3 KG
TOTAL	= 1161.2 KG
STAGE WEIGHT	= 1576.3 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 21

BOOSTER STAGE ~ NONE

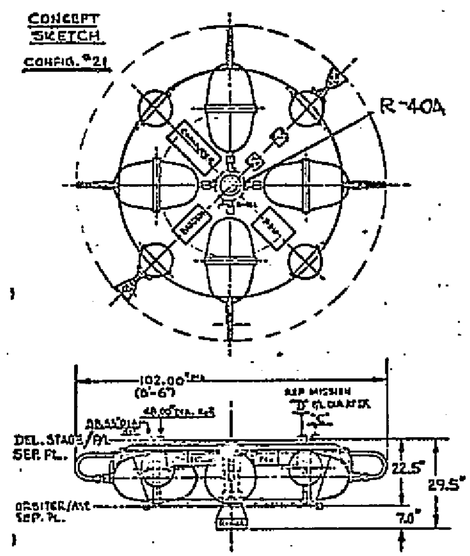
DELIVERY STAGE ~ LIQUID BIPROPELLANT (4 TANK)

SYSTEM COMPONENTS

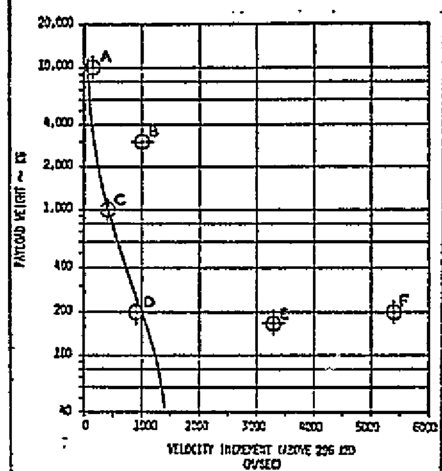
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TANKS / SAS TYPE	38.56
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT - 4 CONOSPHERE TANKS, 4 SPHER. PRES. TANKS, ONE R-40A THRUSTER, SAS TYPE	C 323.23 D 300.64
0225 REACTION CONTROL SYSTEM	BI PROPELLANT NUTATION & MANEUVER CONTROL, SCOOP & SAS TYPE	8.3
0226 [illegible]	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 [illegible]	ROLL STABILIZED PLATFORM / SOFT & DOT	28.26
0228 [illegible]	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		11.25
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	NONE	0.0
0212 STRUCTURE	NONE	0.0
0213 THERMAL	NONE	0.0
0214 MAIN PROPULSION	NONE	0.0
0215 [illegible]	NONE	0.0
021? [illegible]	NONE	0.0
021? [illegible]	NONE	0.0
--- CONTINGENCY	NONE	0.0

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION C&D

WEIGHT SUMMARY

		C	D
DELIVERY STAGE			
WEIGHT INERT	=	250.97	250.97
WEIGHT PROPELLANT	=	195.95	173.36
TOTAL	=	446.9 KG	424.3 KG
BOOSTER STAGE			
WEIGHT INERT	=	0	0
WEIGHT PROPELLANT	=	0	0
TOTAL	=	0 KG	0 KG
STAGE WEIGHT	=	446.9 KG	424.3 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 22

BOOSTER STAGE ~ NONE

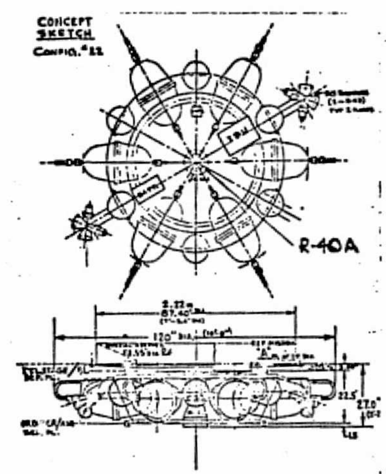
DELIVERY STAGE ~ LIQUID BIPROPELLANT (6 TANK)

SYSTEM COMPONENTS

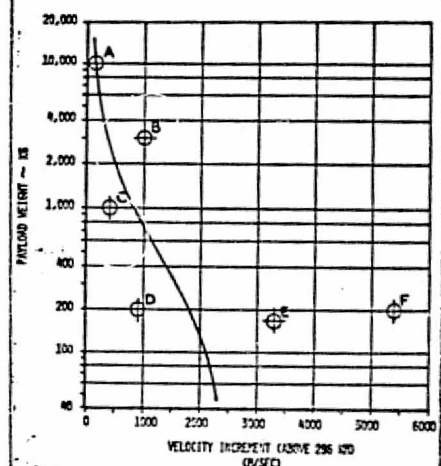
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION PLANE / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	38.56
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT 6 SPHER. PROP. TANKS, 6 SPHER. PRES. TANKS, ONE R-40A THRUSTER / SAS TYPE	632.49
0225 REACTION CONTROL SYSTEM	BIPROPELLANT 3 AXIS / DDP & SCOOP TYPE	13.11
0226 DATA MANAGEMENT / COMM.	S-BAND TRANSMITTERS & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYROS / SCOUT	24.22
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		11.34
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	NONE	0.0
0212 STRUCTURE	NONE	0.0
0213 THERMAL	NONE	0.0
0214 MAIN PROPULSION	NONE	0.0
0215 REACTION CONTROL SYSTEM	NONE	0.0
0216 GUIDANCE & CONTROL	NONE	0.0
0217 ELECTRICAL POWER	NONE	0.0
--- CONTINGENCY	NONE	0.0

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	297.1 KG
WEIGHT PROPELLANT	=	459.9 KG
TOTAL	=	757.0 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG

STAGE WEIGHT	=	757.0 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 22

BOOSTER STAGE ~ NONE

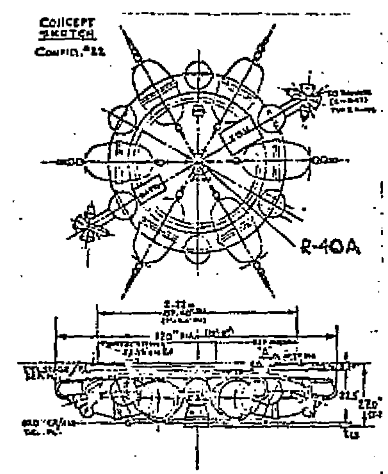
DELIVERY STAGE ~ LIQUID BIPROPELLANT (6 TANK)

SYSTEM COMPONENTS

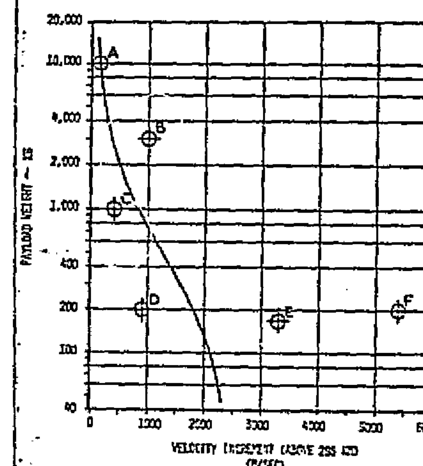
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION [illegible] / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	38.56
0223 THERMAL	[illegible] STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT 6 SPHER. PROP. TANKS, 6 SPHER. PRES. TANKS, ONE R-40A THRUSTER / SAS TYPE	632.49
0225 REACTION CONTROL SYSTEM	BIPROPELLANT 3 AXIS / SDP & SCOOP TYPE	13.11
0226 [illegible]	S-BAND [illegible] / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYROS / SCOUT	24.22
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		11.34
BOOSTER STAGE		
0211 INTEGRATION & ASSEMBLY	NONE	0.0
0212 STRUCTURE	NONE	0.0
0213 THERMAL	NONE	0.0
0214 MAIN PROPULSION	NONE	0.0
0215 REACTION CONTROL SYSTEM	NONE	0.0
0216 GUIDANCE & CONTROL	NONE	0.0
0217 ELECTRICAL POWER	NONE	0.0
--- CONTINGENCY	NONE	0.0

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	297.1 KG
WEIGHT PROPELLANT	=	459.9 KG
TOTAL	=	757.0 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG

STAGE WEIGHT	=	757.0 KG

PROPULSION CONCEPT SUMMARY

REVA 2/6/78

CONFIGURATION No. 23 & 24 (SEE NOTE)

BOOSTER STAGE ~ NONE

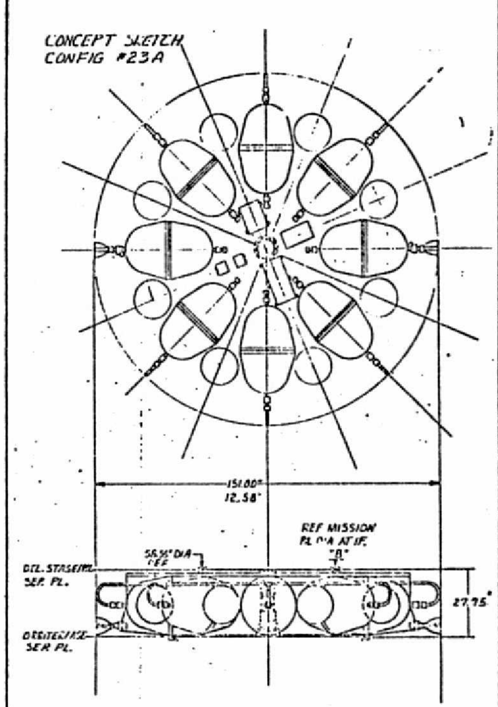
DELIVERY STAGE ~ LIQUID BIPROPELLANT (8 TANK)

SYSTEM COMPONENTS

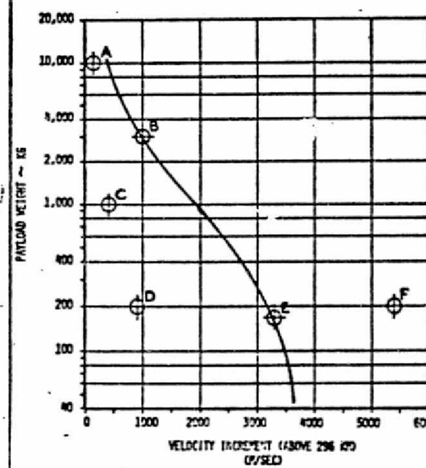
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	39.01
0223 THERMAL	SPINNING STAR 43 TYPE	2.27
0224 MAIN PROPULSION	BI PROPELLANT - 8 SPHERICAL PROPELLANT TANKS & 8 SPHERICAL PRESSURANT TANKS, ONE R-4OA THRUSTER / SAS TYPE	1899.69
0225 REACTION CONTROL SYSTEM	BIPROPELLANT NUTATION & MANEUVER CONTROL / SCOOP & SAS TYPE	5.90
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM, SOFT & DOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		4.76
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	NONE	
0212 STRUCTURE	NONE	
0213 THERMAL	NONE	
0214 MAIN PROPULSION	NONE	
0215 REACTION CONTROL SYSTEM	NONE	
0216 GUIDANCE & CONTROL	NONE	
0217 ELECTRICAL POWER	NONE	
--- CONTINGENCY	NONE	

NOTE: CONFIGURATIONS 23 & 24 ARE SPIN STABILIZED AND USE 1 & 2 ATTITUDE CONTROL THRUSTERS RESPECTIVELY. CONFIGURATION 23 SHOWN

CONFIGURATION



PERFORMANCE



DESIGN POINT - REFERENCE MISSION B

WEIGHT SUMMARY

DELIVERY STAGE		
WEIGHT INERT	=	495.32 KG
WEIGHT PROPELLANT	=	15[illegible]3.[illegible] KG
TOTAL	=	2013.95 KG
BOOSTER STAGE		
WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG
STAGE WEIGHT	=	2013.95 KG

PROPULSION CONCEPT SUMMARY

REVA 2/6/78

CONFIGURATION No. 23 & 24 (SEE NOTE)

BOOSTER STAGE ~ NONE

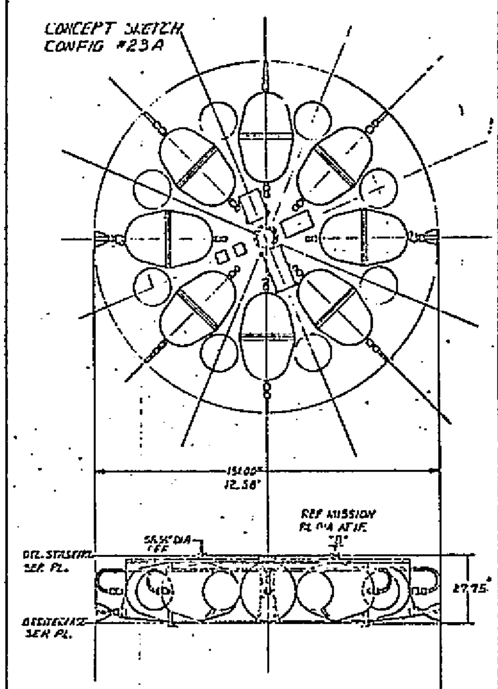
DELIVERY STAGE ~ LIQUID BIPROPELLANT (8 TANK)

SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	39.01
0223 THERMAL	SPINNING STAR 43 TYPE	2.27
0224 MAIN PROPULSION	BI PROPELLANT - 8 SPHERICAL PROPELLANT TANKS & 8 SPHERICAL PRESSURANT TANKS, ONE R-40A THRUSTER / SAS TYPE	1899.69
0225 REACTION CONTROL SYSTEM	BIPROPELLANT NUTATION & MANEUVER CONTROL / SCOOP & SAS TYPE	5.90
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM, SAFT & DOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		4.76
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	NONE	
0212 STRUCTURE	NONE	
0213 THERMAL	NONE	
0214 MAIN PROPULSION	NONE	
0215 REACTION CONTROL SYSTEM	NONE	
0216 GUIDANCE & CONTROL	NONE	
0217 ELECTRICAL POWER	NONE	
--- CONTINGENCY	NONE	

NOTE: CONFIGURATIONS 23 & 24 ARE SPIN STABILIZED AND USE 1 & 2 ATTITUDE CONTROL THRUSTERS RESPECTIVELY. CONFIGURATION 23 SHOWN

CONFIGURATION



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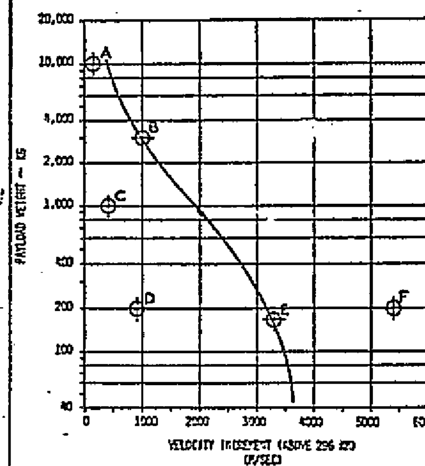


DESIGN POINT - REFERENCE MISSION B

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	495.32 KG
WEIGHT PROPELLANT	=	15[illegible] KG
TOTAL	=	2013.95 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG

STAGE WEIGHT = 2013.95 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 25 & 26 (SEE NOTE)

BOOSTER STAGE ~ NONE

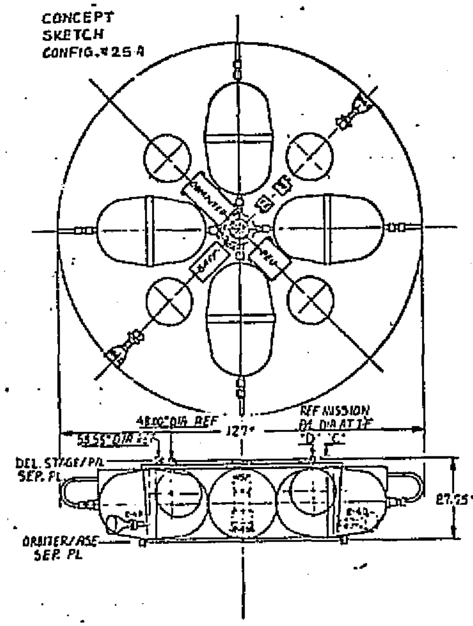
DELIVERY STAGE ~ LIQUID BIPROPELLANT (4 TANK)

SYSTEM COMPONENTS

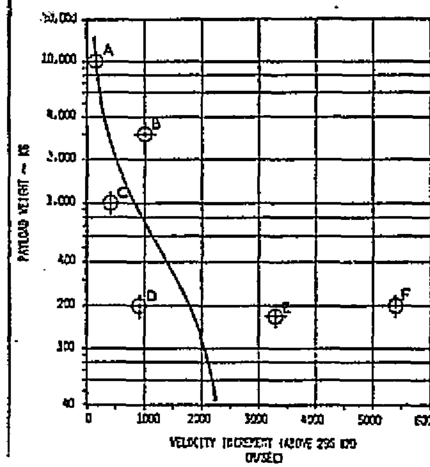
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	28.12
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BI PROPELLANT — 4 SPHERICAL PROPELLANT TANKS, 4 SPHERICAL PRESSURANT TANKS, ONE R-40A THRUSTER / SAS TYPE	665.87
0225 REACTION CONTROL SYSTEM	BI PROPELLANT, 3 AXIS SDP/SCOOP TYPE	13.11
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYRO / SCOUT	24.22
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		2.0
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	NONE	
0212 STRUCTURE	NONE	
0213 THERMAL	NONE	
0214 MAIN PROPULSION	NONE	
0215 REACTION CONTROL SYSTEM	NONE	
0216 GUIDANCE & CONTROL	NONE	
0217 ELECTRICAL POWER	NONE	
--- CONTINGENCY	NONE	

NOTE: CONFIGURATION 25 IS SPIN STABILIZED AND USES 2 ATTITUDE CONTROL THRUSTERS. CONFIGURATION 26 IS 3-AXIS STABILIZED AND USES 4 ATTITUDE CONTROL THRUSTERS. CONFIGURATION 25 IS SHOWN

CONFIGURATION



PERFORMANCE



DESIGN POINT REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	311.75 KG
WEIGHT PROPELLANT	=	458.90 KG
TOTAL	=	770.65 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG

STAGE WEIGHT = 770.65 KG

PROPULSION CONCEPT SUMMARY

REV. A

CONFIGURATION No. 27a

BOOSTER STAGE ~ SPINNING MINUTEMAN III ADAPTATION

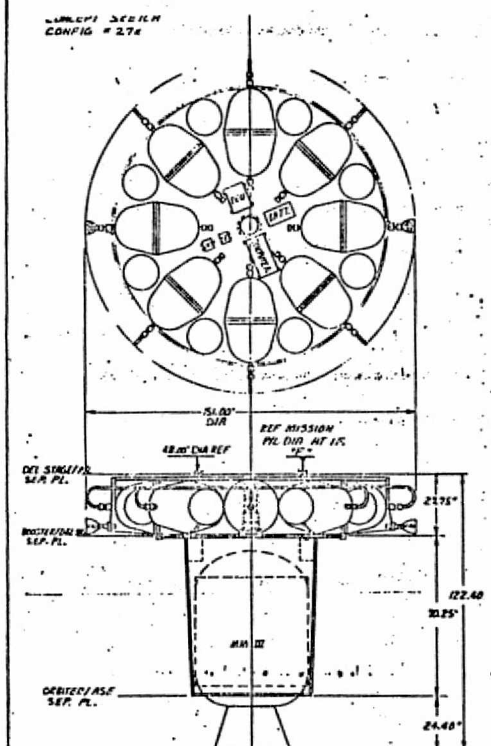
DELIVERY STAGE ~ LIQUID BIPROPELLANT (8 TANK)

SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	39.00
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT - 8 SPHERICAL PROPELLANT TANKS, 8 SPHERICAL PRESSURANT TANKS, TWO R-40A THRUSTERS / SAS TYPE	1908.44
0225 REACTION CONTROL SYSTEM	BI-PROPELLANT NUTATION & MANEUVER CONTROL / SCOOP & SAS TYPE	8.30
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM / SOFT & DOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		4.76
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER-DELIVERY STAGE SEPARATION CLAMP / SCOUT	9.07
0212 STRUCTURE	SPINNING MM III / AEROSPACE STUDY	133.36
0213 THERMAL	SPINNING MM III TYPE	2.27
0214 MAIN PROPULSION	SPINNING MM III	3564.01
0215 REACTION CONTROL SYSTEM	NONE	
0216 GUIDANCE & CONTROL	ACTIVE NUTATION CONTROL	15.88
0217 ELECTRICAL POWER	CONVENTIONAL CABLING / SCOUT	13.61
--- CONTINGENCY		13.61

NOTE:

CONFIGURATION



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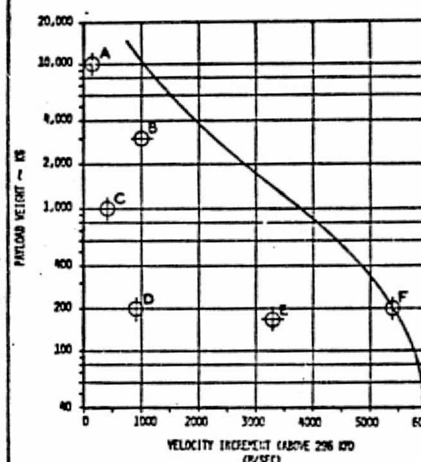


DESIGN POINT ~ REFERENCE MISSION F

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	= 507.48 KG
WEIGHT PROPELLANT	= [illegible] KG
TOTAL	= [illegible] KG

BOOSTER STAGE

WEIGHT INERT	= 401.02 KG
WEIGHT PROPELLANT	= 3353.78 KG
TOTAL	= 3751.80 KG

STAGE WEIGHT = 5777.91 KG

16.8

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 27a

BOOSTER STAGE ~ SPINNING MINUTEMAN III ADAPTATION

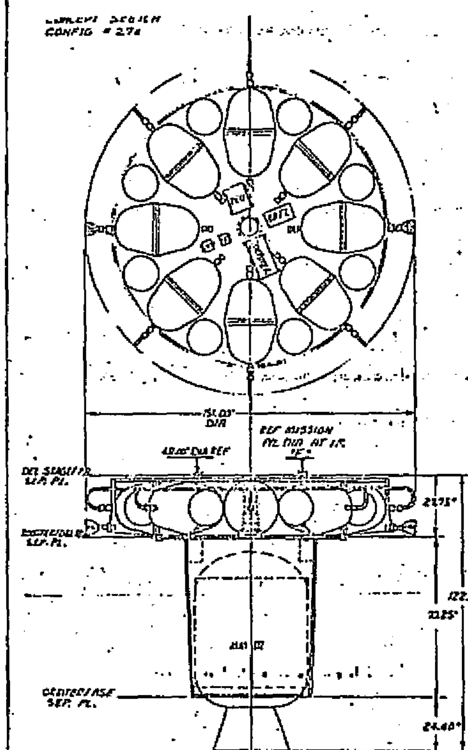
DELIVERY STAGE ~ LIQUID BIPROPELLANT (8 TANK)

SYSTEM COMPONENTS

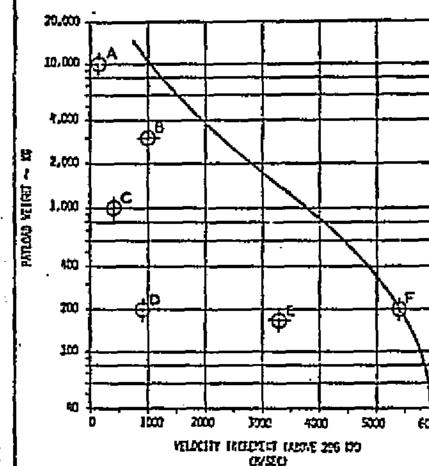
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	39.00
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT - 8 SPHERICAL PROPELLANT TANKS, 8 SPHERICAL PRESSURANT TANKS, TWO R-40A THRUSTERS / SAS TYPE	1909.44
0225 REACTION CONTROL SYSTEM	BI-PROPELLANT NUTATION & MANEUVER CONTROL / SCOOP & SAS TYPE	8.30
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM / SOFT & DOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		4.76
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER-DELIVERY STAGE SEPARATION CLAMP / SCOUT	9.07
0212 STRUCTURE	SPINNING MM III / AEROSPACE STUDY	133.36
0213 THERMAL	SPINNING MM III TYPE	2.27
0214 MAIN PROPULSION	SPINNING MM III	3564.01
0215 REACTION CONTROL SYSTEM	NONE	
0216 GUIDANCE & CONTROL	ACTIVE NUTATION CONTROL	15.88
0217 ELECTRICAL POWER	CONVENTIONAL CABLING / SCOUT	13.61
--- CONTINGENCY		13.61

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION F

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	= 507.48 KG
WEIGHT PROPELLANT	= 1[illegible]3.[illegible] KG
TOTAL	= 2[illegible] KG

BOOSTER STAGE

WEIGHT INERT	= 401.02 KG
WEIGHT PROPELLANT	= 3350.78 KG
TOTAL	= 3751.80 KG

STAGE WEIGHT = 5[illegible]7.91 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 28

BOOSTER STAGE ~ STAR 48 ADAPTATION

DELIVERY STAGE ~ LIQUID MONOPROPELLANT (4 TANK)

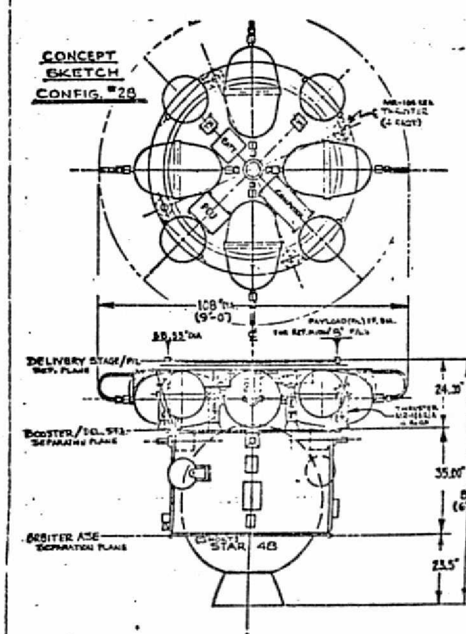
CDS

SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	44.0
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	MONOPROPELLANT 4 CONOSPHER. PROP. TANKS, 4 SPHER. PRES. TANKS, 4 MR-104 THRUSTERS / SAS & MMS TYPES	502.08
0225 REACTION CONTROL SYSTEM	(INTEGRAL WITH MAIN PROPULSION) NUTATION & MANEUVER CONTROL / SAS TYPE	0.0
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM / SOFT & DOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		11.02
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER-DELIVERY STAGE SEPARATION CLAMP / SCOUT	7.26
0212 STRUCTURE	SPINNING STAR 48 / AEROSPACE STUDY	88.45
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 48 WITH SHORT NOZZLE / VENDOR INPUT JUL 1977. 10% OFF LOAD	1533.60
0215 REACTION CONTROL SYSTEM		0.0
0216 GUIDANCE & CONTROL	[illegible] NUTATION CONTROL	15.88
0217 ELECTRICAL POWER	[illegible] CABLING / SCOUT	13.31
--- CONTINGENCY		17.69

NOTE:

CONFIGURATION



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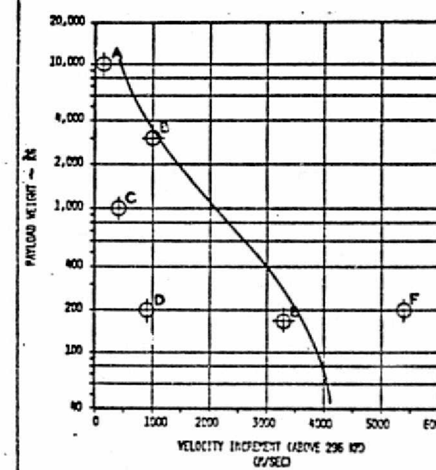


DESIGN POINT ~ REFERENCE MISSION B

WEIGHT SUMMARY

DELIVERY STAGE	
WEIGHT INERT	= 290.7 KG
WEIGHT PROPELLANT	= 332.0 KG
TOTAL	= 622.7 KG
BOOSTER STAGE	
WEIGHT INERT	= 229.5 KG
WEIGHT PROPELLANT	= 1449.2 KG
TOTAL	= 1678.7 KG
STAGE WEIGHT	= 2301.4 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 29

CDS

BOOSTER STAGE ~ STAR 48 ADAPTATION

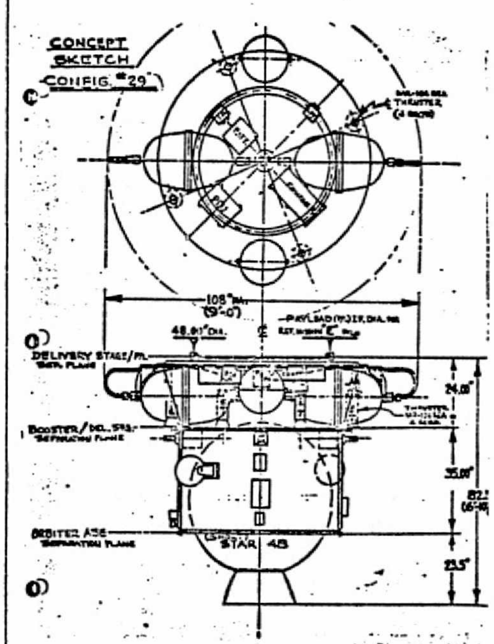
DELIVERY STAGE ~ LIQUID MONOPROPELLANT (2 TANK)

SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP/SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TANKS/SAS TYPE	44.0
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	MONOPROPELLANT TWO CONOSPHERE PROP. TANKS, TWO SPHER. PRES. TANKS, FOUR MR-104 THRUSTERS/ SAS & MMS TYPES	204.89
0225 REACTION CONTROL SYSTEM	INTEGRAL WITH MAIN PROPULSION NUTATION & MANEUVER CONTROL/SAS TYPE	0.0
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA/SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM/SCOUT & [illegible]	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING/SCOUT	25.85
--- CONTINGENCY		11.02
BOOSTER STAGE		
0211 INTEGRATION & ASSEMBLY	BOOSTER-DELIVERY STAGE SEPARATION CLAMP/SCOUT	7.26
0212 STRUCTURE	SPINNING STAR 48/AEROSPACE STUDY	83.45
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 48 WITH SHORT NOZZLE (VENDOR INPUT JUL 1977. 10% OFF LOAD	1533.6
0215 REACTION CONTROL SYSTEM	NONE (INCLUDED IN DELIVERY STAGE)	0.0
0216 GUIDANCE & CONTROL	ACTIVE NUTATION CONTROL	15.83
0217 ELECTRICAL POWER	CONVENT. BATT. CABLING/SCOUT	13.61
--- CONTINGENCY		17.69

NOTE:

CONFIGURATION



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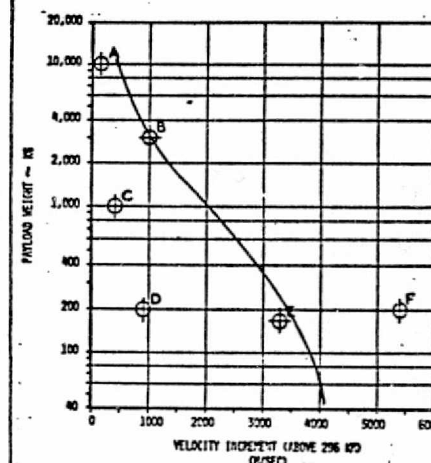


DESIGN POINT ~ REFERENCE MISSION E

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	= 225.71 KG
WEIGHT PROPELLANT	= 99.79 KG
TOTAL	= 325.50 KG

BOOSTER STAGE

WEIGHT INERT	= 229.52 KG
WEIGHT PROPELLANT	= 1449.23 KG
TOTAL	= 1678.75 KG

STAGE WEIGHT = 2004.25 KG

CDS

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 30

BOOSTER STAGE ~ NONE

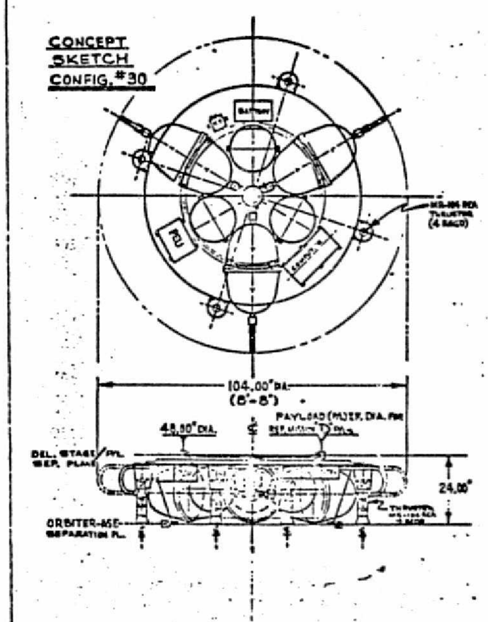
DELIVERY STAGE ~ LIQUID MONOPROPELLANT (3 TANK)

SYSTEM COMPONENTS

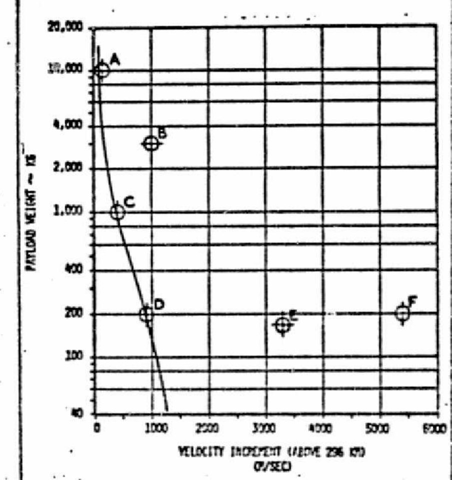
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	44.0
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	MONOPROPELLANT 3 COLD SPHER. PROP. TANKS, THREE SPHER. PRES. TANKS, FOUR MR-104 THRUSTERS / SAS & LMS TYPES	364.64
0225 REACTION CONTROL SYSTEM	INTEGRAL WITH MAIN PROPULSION, NUTATION & MANEUVER CONTROL / SAS TYPE	0.0
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM / SOFT & DOF	28.26
0225 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		11.02
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		0.0
0212 STRUCTURE		0.0
0213 THERMAL		0.0
0214 MAIN PROPULSION		0.0
0215 REACTION CONTROL SYSTEM		0.0
0216 GUIDANCE & CONTROL		0.0
0217 ELECTRICAL POWER		0.0
--- CONTINGENCY		0.0

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION D

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	255.7 KG
WEIGHT PROPELLANT	=	229.5 KG
TOTAL	=	485.2 KG

BOOSTER STAGE

WEIGHT INERT	=	0.0 KG
WEIGHT PROPELLANT	=	0.0 KG
TOTAL	=	0.0 KG

STAGE WEIGHT = 485.2 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 31

BOOSTER STAGE ~ NONE

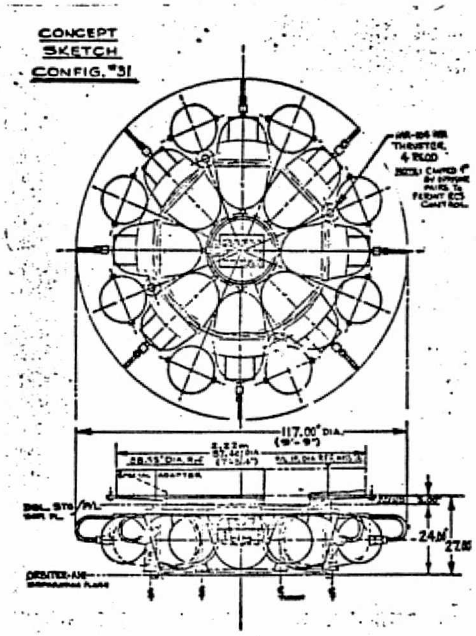
DELIVERY STAGE ~ LIQUID MONOPROPELLANT (8 TANK)

SYSTEM COMPONENTS

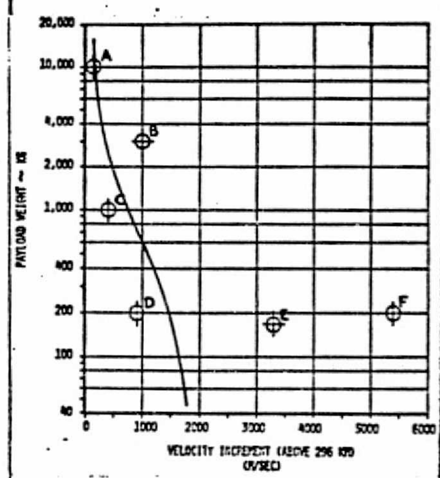
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	44.0
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	MONOPROPELLANT - 8 CONOSPHER. PROP. TANKS, 8 PRES. TANKS, FOUR MR-104 THRUSTERS / SAS & MMS TYPE	896.71
0225 REACTION CONTROL SYSTEM	INTEGRAL WITH MAIN PROPULSION, 3 AXIS / SDPE SCOOP TYPE	0.0
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYROS / SCOUT	24.22
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		10.57
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		0.0
0212 STRUCTURE		0.0
0213 THERMAL		0.0
0214 MAIN PROPULSION		0.0
0215 REACTION CONTROL SYSTEM		0.0
0216 GUIDANCE & CONTROL		0.0
0217 ELECTRICAL POWER		0.0
--- CONTINGENCY		0.0

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE		
WEIGHT INERT	=	416.0 KG
WEIGHT PROPELLANT	=	596.8 KG
TOTAL	=	1012.8 KG
BOOSTER STAGE		
WEIGHT INERT	=	0.0 KG
WEIGHT PROPELLANT	=	0.0 KG
TOTAL	=	0.0 KG
STAGE WEIGHT	=	1012.8 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 32

BOOSTER STAGE ~ NONE

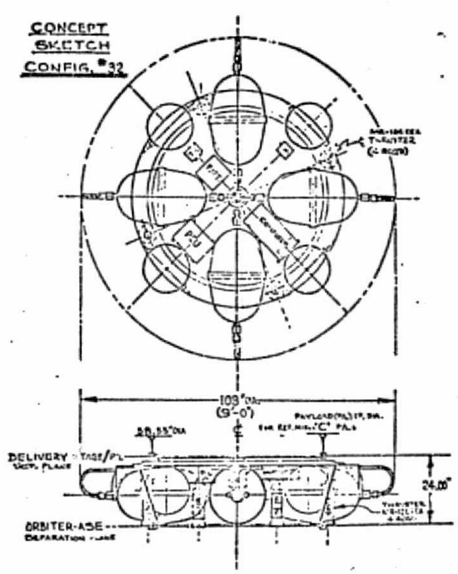
DELIVERY STAGE ~ LIQUID MONOPROPELLANT (4 TANK)

SYSTEM COMPONENTS

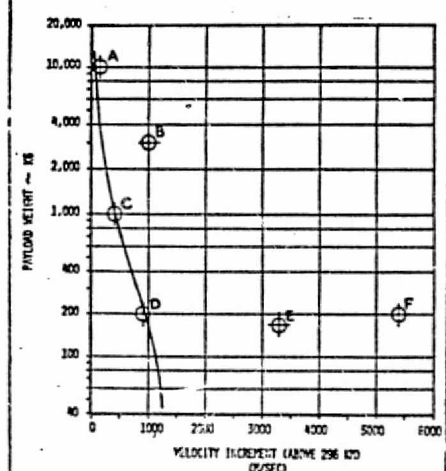
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS/SAS TYPE	44.0
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	MONOPROPELLANT - 4 CONOSPHERICAL PROP. TANKS, 4 SPHERICAL PRES. TANKS, 4 MR-104 THRUSTERS / SAS & MMS TYPE S	432.95
0225 REACTION CONTROL SYSTEM	INTEGRAL WITH MAIN PROPULSION, NUTATION & MAN[illegible] CONTROL/SAS TYPE	0.0
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM / SOFT & DOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		11.02
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		0.0
0212 STRUCTURE		0.0
0213 THERMAL		0.0
0214 MAIN PROPULSION		0.0
0215 REACTION CONTROL SYSTEM		0.0
0216 GUIDANCE & CONTROL		0.0
0217 ELECTRICAL POWER		0.0
--- CONTINGENCY		0.0

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION C

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	290.7 KG
WEIGHT PROPELLANT	=	262.9 KG
TOTAL	=	553.6 KG

BOOSTER STAGE

WEIGHT INERT	=	0.0 KG
WEIGHT PROPELLANT	=	0.0 KG
TOTAL	=	0.0 KG

STAGE WEIGHT	=	553.6 KG

PROPULSION CONCEPT SUMMARY

REV. A 2/6/77

CONFIGURATION NO. 33

BOOSTER STAGE – NONE

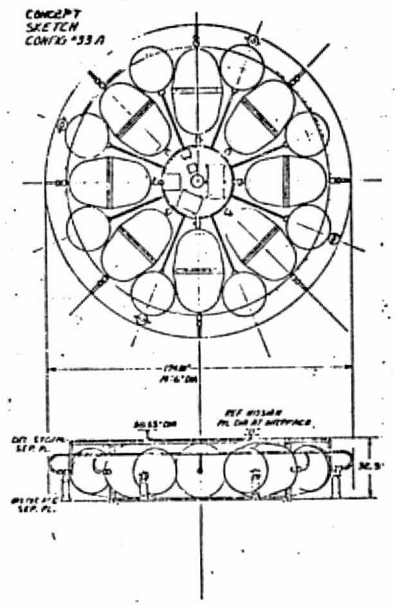
DELIVERY STAGE – LIQUID MONOPROPELLANT (8 TANK) MODULAR

SYSTEM COMPONENTS

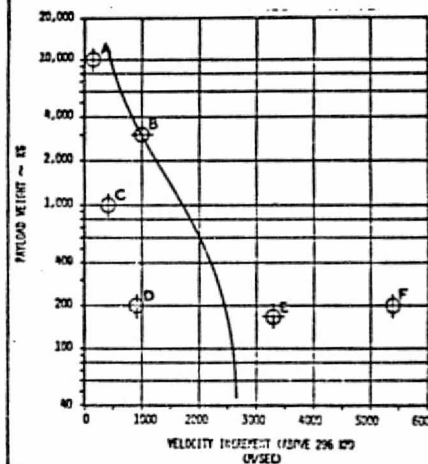
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE - TRUSS / SAS TYPE	49.44
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	MONOPROPELLANT; 8 SPHERICAL TANKS & 4 MR-104 MOTORS	3049.96
0225 REACTION CONTROL SYSTEM	INCLUDED IN MAIN PROPULSION	0.0
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM (SOFT & DOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.95
--- CONTINGENCY		11.52
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		
0212 STRUCTURE		
0213 THERMAL		
0214 MAIN PROPULSION		
0215 REACTION CONTROL SYSTEM		
0216 GUIDANCE & CONTROL		
0217 ELECTRICAL POWER		
--- CONTINGENCY		

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT – REFERENCE MISSION B

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	890.13 KG
WEIGHT PROPELLANT	=	2286.39 KG
TOTAL	=	3176.51 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG

STAGE WEIGHT = 3176.51 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. 34

BOOSTER STAGE ~ NONE

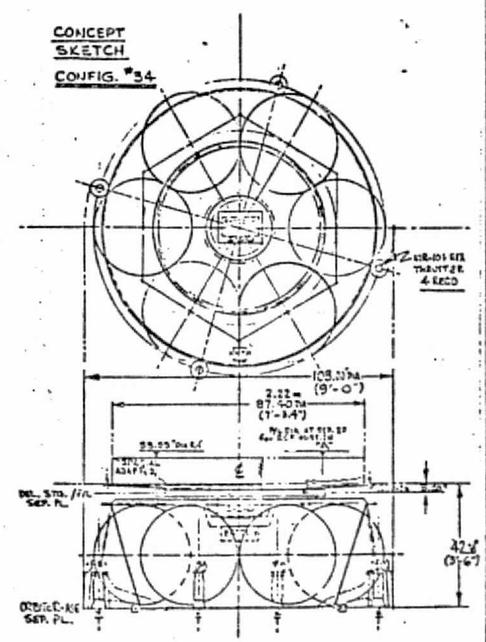
DELIVERY STAGE ~ LIQUID MONOPROPELLANT (4 TANK) MODULAR

SYSTEM COMPONENTS

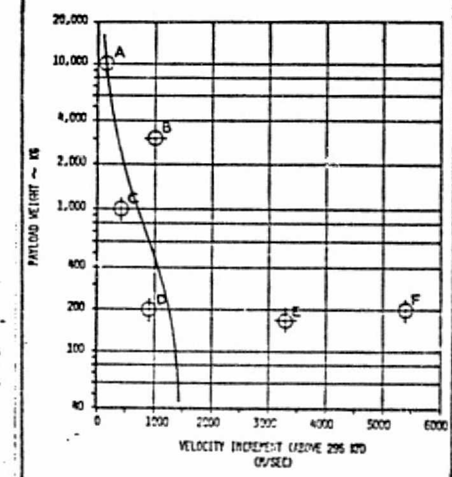
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE-TRUSS / SAS TYPE	30.84
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	MONOPROPELLANT; 4 SPHERICAL TANKS & 4 MR-104 MOTORS	1079.28
0225 REACTION CONTROL SYSTEM	INCLUDED IN MAIN PROPULSION	0.0
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYRO / SCOUT	24.22
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		9.25
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		
0212 STRUCTURE		
0213 THERMAL		
0214 MAIN PROPULSION		
0215 REACTION CONTROL SYSTEM		
0216 GUIDANCE & CONTROL		
0217 ELECTRICAL POWER		
--- CONTINGENCY		

NOTE:

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	574.11 KG
WEIGHT PROPELLANT	=	606.82 KG
TOTAL	=	1180.93 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG

STAGE WEIGHT = 1180.93 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. 35 & 36 (SEE NOTE)

BOOSTER STAGE ~ NONE

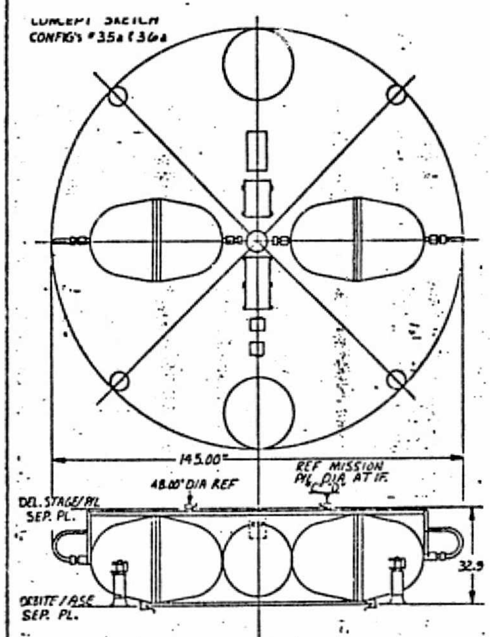
DELIVERY STAGE ~ LIQUID MONOPROPELLANT (2 TANK) MODULAR

SYSTEM COMPONENTS

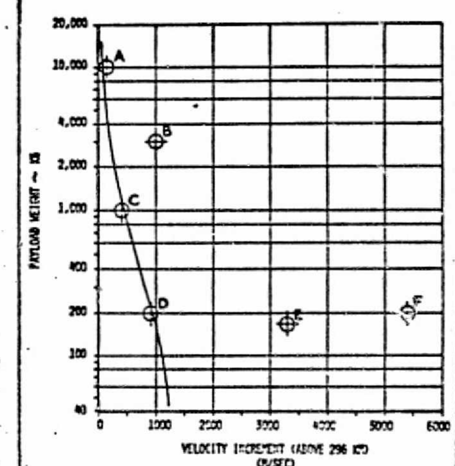
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	24.49
0223 THERMAL	SPINNING STAR 43 TYPE	2.27
0224 MAIN PROPULSION	MONOPROPELLANT; 2 SPHERICAL TANKS & 4 · MR 104 MOTORS	546.13
0225 REACTION CONTROL SYSTEM	INCLUDED IN MAIN PROPULSION	0.0
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	[illegible]
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM / SOFT & DOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.95
--- CONTINGENCY		9.03
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		
0212 STRUCTURE		
0213 THERMAL		
0214 MAIN PROPULSION		
0215 REACTION CONTROL SYSTEM		
0216 GUIDANCE & CONTROL		
0217 ELECTRICAL POWER		
--- CONTINGENCY		

NOTE: CONFIGURATION 35 OFF-LOADED 611# PROPELLANT
CONFIGURATION 36 OFF-LOADED 572# PROPELLANT
CONFIGURATION 36 SHOWN.

CONFIGURATION



PERFORMANCE



DESIGN POINT REFERENCE MISSIONS C & D

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	347.50 KG
WEIGHT PROPELLANT	=	297.74 KG
TOTAL	=	645.24 KG

BOOSTER STAGE

WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG

STAGE WEIGHT = 645.24 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 37

CTS

BOOSTER STAGE ~ NONE

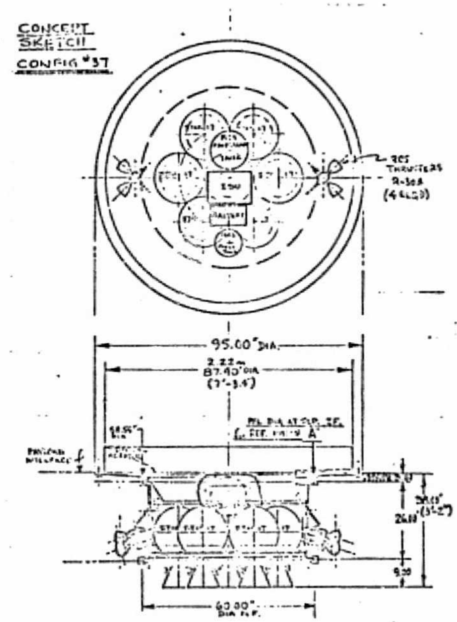
DELIVERY STAGE ~ CLUSTER SOLIDS (7 STAR 17'S)

SYSTEM COMPONENTS

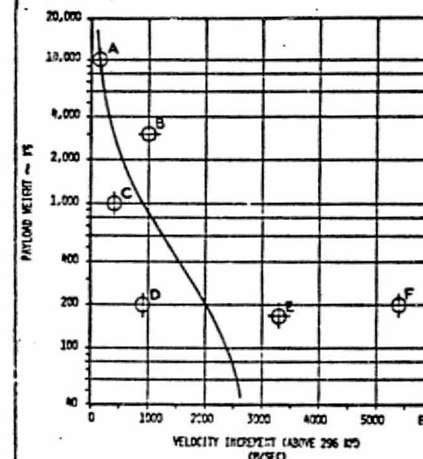
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	BOX BEAM / SAS TYPE	93.89
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	CLUSTER SOLIDS - 7 STAR 17 MOTORS / VENDOR INPUT	553.11
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT 3 AXIS / SDP & SCOOP	39.19
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS DRY GYRO / SCOUT	23.86
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		19.41
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		
0212 STRUCTURE		
0213 THERMAL		
0214 MAIN PROPULSION		
0215 REACTION CONTROL SYSTEM		
0216 GUIDANCE & CONTROL		
0217 ELECTRICAL POWER		
--- CONTINGENCY		

NOTE: SEE CONFIG. NO. 90 SHEET FOR MOTOR QUANTITY BASIS

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE		
WEIGHT INERT	=	270.2 KG
WEIGHT PROPELLANT	=	496.6 KG
TOTAL	=	766.8 KG
BOOSTER STAGE		
WEIGHT INERT	=	0.0 KG
WEIGHT PROPELLANT	=	0.0 KG
TOTAL	=	0.0 KG
STAGE WEIGHT	=	766.8 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 38 & 39 (SEE NOTE)

BOOSTER STAGE ~ NONE

DELIVERY STAGE ~ CLUSTER SOLIDS (22 STAR 17's)

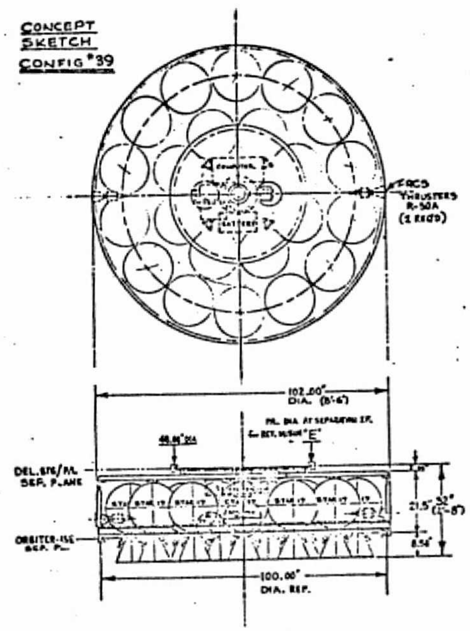
SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	BOX BEAM / SAS TYPE	163.29
0223 THERMAL	SPINNING STAR 43 TYPE	2.27
0224 MAIN PROPULSION	CLUSTERED SOLIDS - 22 STAR 17 MOTORS / VENDOR INPUT	1738.35
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT NUTATION & MANEUVER CONTROL / SCOOP TYPE	34.43
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM / SOFT & DOT	27.9
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		26.31
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		0.0
0212 STRUCTURE		0.0
0213 THERMAL		0.0
0214 MAIN PROPULSION		0.0
0215 REACTION CONTROL SYSTEM		0.0
0216 GUIDANCE & CONTROL		0.0
0217 ELECTRICAL POWER		0.0
--- CONTINGENCY		0.0

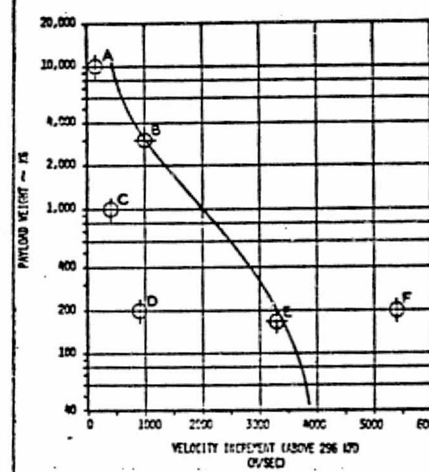
NOTE: SEE CONFIG. No. 40 SHEET FOR MOTOR QUANTITY BASIS.
CONFIGURATIONS 38 & 39 ARE SPIN STABILIZED AND USE 1 & 2 ATTITUDE CONTROL THRUSTERS RESPECTIVELY. CONFIGURATION 39 SHOWN

CONFIGURATION

CONCEPT SKETCH CONFIG #39



PERFORMANCE



DESIGN POINT REFERENCE MISSION B

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	466.9 KG
WEIGHT PROPELLANT	=	1560.7 KG
TOTAL	=	2027.6 KG

BOOSTER STAGE

WEIGHT INERT	=	0.0 KG
WEIGHT PROPELLANT	=	0.0 KG
TOTAL	=	0.0 KG

STAGE WEIGHT = 2027.6 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION No. 40

BOOSTER STAGE ~ NONE

DELIVERY STAGE ~ CLUSTER SOLIDS (4 STAR 17's)

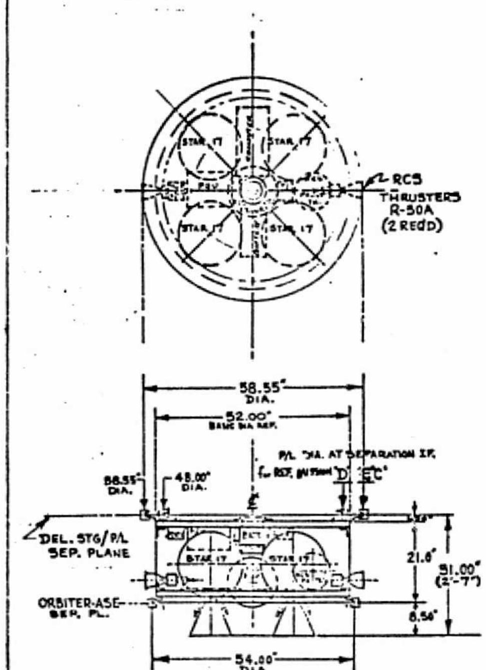
SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP 'SCOUT'	7.71
0222 STRUCTURE	Box Beam / SAS TYPE	74.84
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	CLUSTERED SOLIDS - 4 STAR 17 MOTORS / VENDOR INPUT	316.06
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT NUTATION / MANEUVER CONTROL / SCOOP TYPE	36.02
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM / SOFT & DOT	27.9
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		17.6
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		0.0
0212 STRUCTURE		0.0
0213 THERMAL		0.0
0214 MAIN PROPULSION		0.0
0215 REACTION CONTROL SYSTEM		0.0
0216 GUIDANCE & CONTROL		0.0
0217 ELECTRICAL POWER		0.0
--- CONTINGENCY		0.0

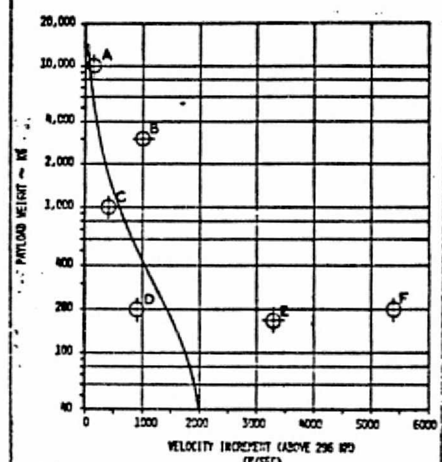
NOTE: QUANTITY OF STAR 17 MOTORS BASED ON 4 MOTORS (2/PULSE) FOR REF MISS. C & D. THIS RESULTS IN LARGE NO. MOTORS FOR B & E MISSIONS.

CONFIGURATION

CONCEPT SKETCH CONFIG #40



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION C & D

WEIGHT SUMMARY

	C	D
DELIVERY STAGE		
WEIGHT INERT	= 226	226 KG
WEIGHT PROPELLANT	= 283.8	283.8 KG
TOTAL	= 509.8 KG	509.8 KG
BOOSTER STAGE		
WEIGHT INERT	= 0	0 KG
WEIGHT PROPELLANT	= 0	0 KG
TOTAL	= 0	0 KG
STAGE WEIGHT	= 509.8 KG	509.8 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. 41, 42 & 43

BOOSTER STAGE ~ NONE

DELIVERY STAGE ~ PINTLE SOLID, LARGE

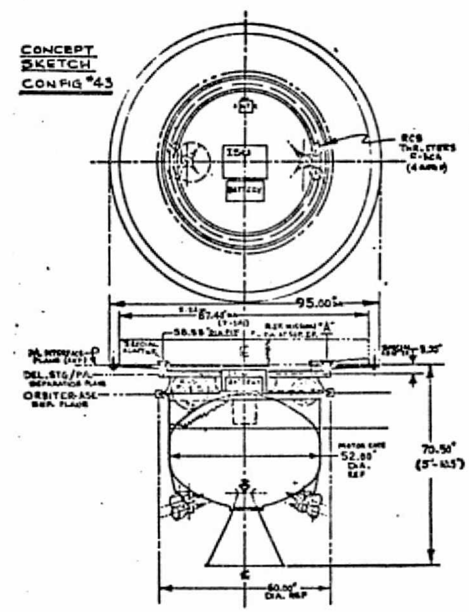
SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS	40.82
0223 THERMAL	SPINNING STAR 43 TYPE	2.27
0224 MAIN PROPULSION	PINTLE SOLID	1633.39
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT, 3-AXIS / SDP & SCOOP	39.19
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS DRY GYRO / SCOUT	23.86
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		14.11
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		
0212 STRUCTURE		
0213 THERMAL		
0214 MAIN PROPULSION		
0215 REACTION CONTROL SYSTEM		
0216 GUIDANCE & CONTROL		
0217 ELECTRICAL POWER		
--- CONTINGENCY		

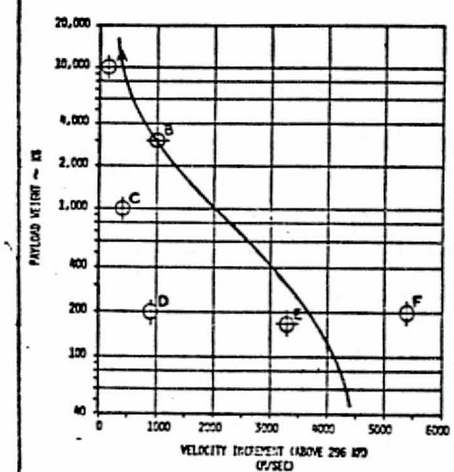
NOTE: CONFIGURATIONS 41 & 42 ARE SPIN STABILIZED AND INCLUDE ONE & TWO REACTION CONTROL THRUSTERS RESPECTIVELY. CONFIGURATION 43 IS THREE AXIS STABILIZED USING 4 REACTION CONTROL THRUSTERS. CONFIGURATION 43 IS SHOWN.

CONFIGURATION

CONCEPT SKETCH CONFIG #43



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE		
WEIGHT INERT	=	291.94 KG
WEIGHT PROPELLANT	=	1496.35 KG
TOTAL	=	1788.69 KG
BOOSTER STAGE		
WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG
STAGE WEIGHT	=	1788.69 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. 44 & 45

BOOSTER STAGE ~ NONE

DELIVERY STAGE ~ SMALL PINTLE SOLID

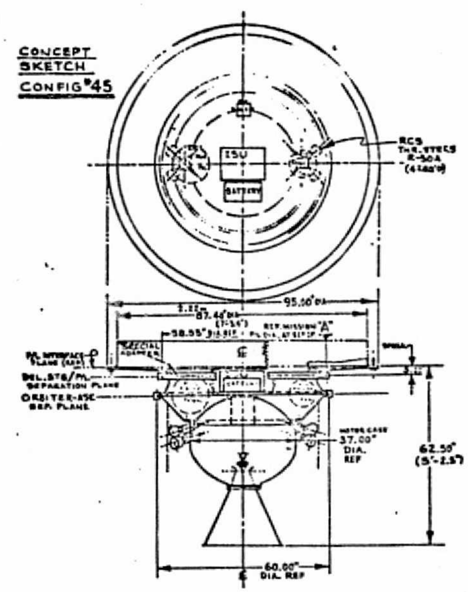
SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS	29.03
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	SMALL PINTLE SOLID	701.80
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT	39.19
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYRO / SCOUT	23.86
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.95
--- CONTINGENCY		12.93
		844.14
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		
0212 STRUCTURE		
0213 THERMAL		
0214 MAIN PROPULSION		
0215 REACTION CONTROL SYSTEM		
0216 GUIDANCE & CONTROL		
0217 ELECTRICAL POWER		
--- CONTINGENCY		

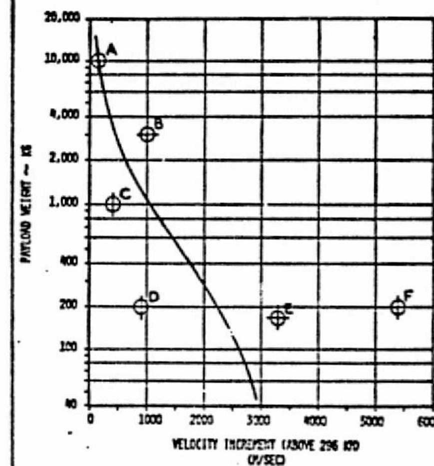
NOTE:

CONFIGURATION

CONCEPT SKETCH CONFIG #45



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE		
WEIGHT INERT	=	254.47 KG
WEIGHT PROPELLANT	=	589.67 KG
TOTAL	=	844.14 KG
BOOSTER STAGE		
WEIGHT INERT	=	0 KG
WEIGHT PROPELLANT	=	0 KG
TOTAL	=	0 KG
STAGE WEIGHT	=	844.14 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. 46, 47 & 48

BOOSTER STAGE ~ UNMODIFIED SPINNING STAR 48

DELIVERY STAGE ~ STAR 26

SYSTEM COMPONENTS

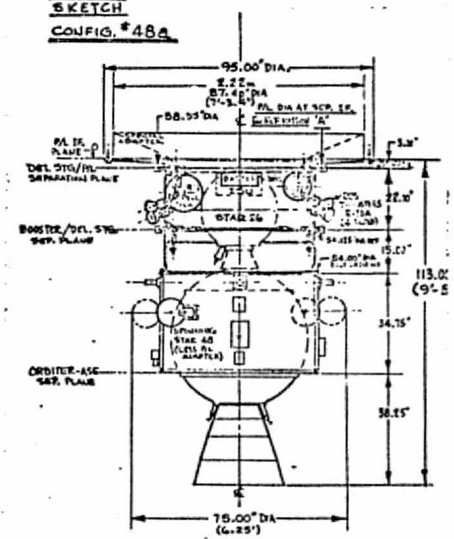
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS	44.45
0223 THERMAL	SPINNING STAR 43 TYPE	2.27
0224 MAIN PROPULSION	STAR 26 / VENDOR INPUT	261.27
0225 REACTION CONTROL SYSTEM	MONO PROPELLANT, 3-AXIS / SDP & SCOOP	39.19
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYRO / SCOUT	23.86
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		14.47
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER/DELIVERY STAGE SEPARATION CLAMP / SCOUT	7.26
0212 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS	113.40
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	UNMODIFIED SPINNING STAR 48	1693.71
0215 REACTION CONTROL SYSTEM	NONE	0.0
0216 GUIDANCE & CONTROL	ACTIVE NUTATION CONTROL	15.88
0217 ELECTRICAL POWER	CONVENTIONAL CABLING / SCOUT	13.61
---- CONTINGENCY		17.69

NOTE: CONFIGURATION 48 IS SHOWN AND HAS 4 RCS THRUSTERS. CONFIGURATIONS 46 & 47 ARE SPIN STABILIZED AND HAVE 1 & 2 RCS THRUSTERS RESPECTIVELY.

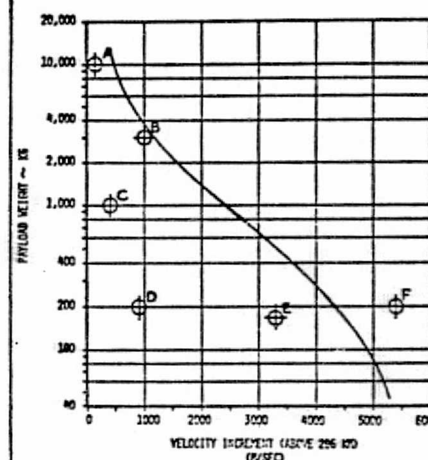
CONFIGURATION

CONCEPT SKETCH

CONFIG. #48a



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION A

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	182.25 KG
WEIGHT PROPELLANT	=	238.32 KG
TOTAL	=	420.57 KG

BOOSTER STAGE

WEIGHT INERT	=	254.47 KG
WEIGHT PROPELLANT	=	1609.35 KG
TOTAL	=	1863.82 KG

STAGE WEIGHT = 2284.39 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. 49 & 50

BOOSTER STAGE ~ UNMODIFIED SPINNING STAR 48

DELIVERY STAGE ~ STAR 37F

SYSTEM COMPONENTS

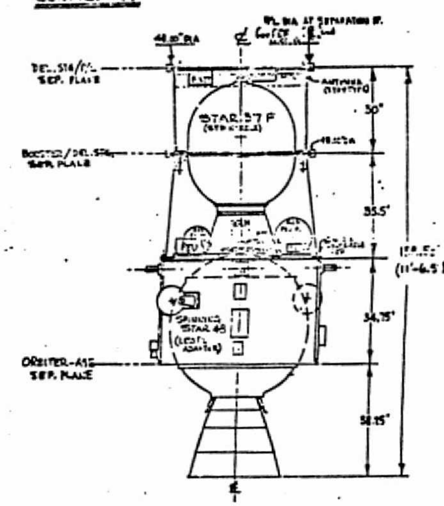
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS	49.44
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	STAR 37 F	913.08
0225 REACTION CONTROL SYSTEM	NONE	0.0
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL (1)	COMPUTER	12.66
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		9.93
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER / DELIVERY STAGE SEPARATION CLAMP / SCOUT	7.26
0212 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS	113.40
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	UNMODIFIED SPINNING STAR 48	1693.71
0215 REACTION CONTROL SYSTEM	MONOPROPELLANT, 2 THRUSTERS	34.43
0216 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM / SOFT & DOT	31.12
0217 ELECTRICAL POWER	CONVENTIONAL CABLING / SCOUT	13.61
--- CONTINGENCY		17.69

NOTE: (1) FUNCTIONALLY A PART OF THE BOOSTER STAGE BUT IS LOCATED ON THE DELIVERY STAGE.

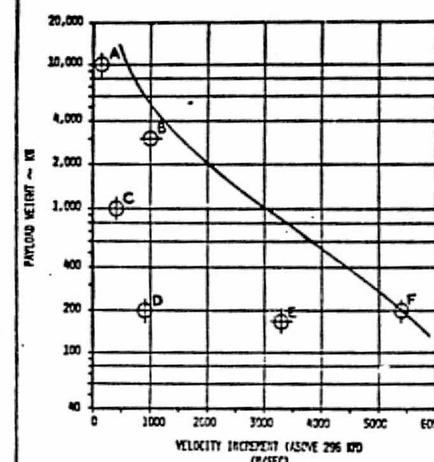
CONFIGURATION 49 SHOWN. CONFIGURATION 50 HAS ONLY 1 RCS THRUSTER.

CONFIGURATION

CONCEPT SKETCH CONFIG. #49



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION E&F

WEIGHT SUMMARY

DELIVERY STAGE	
WEIGHT INERT	= 171.64 KG
WEIGHT PROPELLANT	= 850.94 KG
TOTAL	= 1022.58 KG
BOOSTER STAGE	
WEIGHT INERT	= 304.13 KG
WEIGHT PROPELLANT	= 1609.35 KG
TOTAL	= 1913.48 KG
STAGE WEIGHT	= 2936.06 KG

REV. A 2/6/78
REV. B 2/20/79

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. 51

BOOSTER STAGE ~ STAR 17A

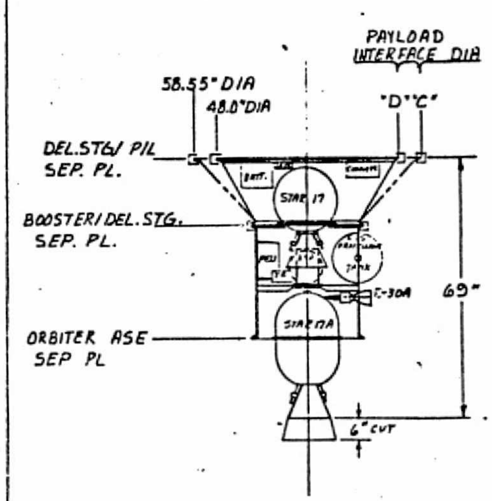
DELIVERY STAGE ~ STAR 17

SYSTEM COMPONENTS

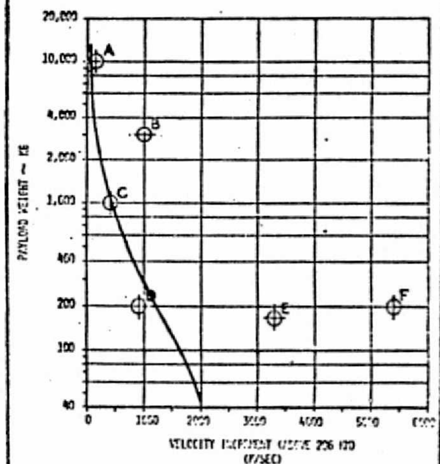
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI MONOCOQUE / SCOUT & SAS TYPE	24.94
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	STAR 17	79.06
0225 REACTION CONTROL SYSTEM	NONE	0.00
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL(1)	COMPUTER(1)	12.66
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		7.7
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER - DELIVERY STAGE SEPARATION	3.63
0212 STRUCTURE	SEMI MONOCOQUE / SCOUT & SAS TYPE	27.22
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 17A	124.47
0215 REACTION CONTROL SYSTEM	MONOPROPELLANT FOR NUTATION DAMPING & MANEUVER CONTROL / SCOOP TYPE	36.02
0216 GUIDANCE & CONTROL	ROLL STAB. PLATFORM / SOFT & DOT & ACTIVE NUTATION CONTROL	31.12
0217 ELECTRICAL POWER		0.00
--- CONTINGENCY		10.02

NOTE: (1) FUNCTIONALLY A PART OF THE BOOSTER STAGE GUIDANCE & CONTROL BUT IS LOCATED ON THE DELIVERY STAGE

CONFIGURATION



PERFORMANCE



DESIGN POINT ~ REFERENCE MISSION / —

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	90.72 KG
WEIGHT PROPELLANT	=	70.99 KG
TOTAL	=	161.71 KG

BOOSTER STAGE

WEIGHT INERT	=	121.34 KG
WEIGHT PROPELLANT	=	113.40 KG
TOTAL	=	234.74 KG

STAGE WEIGHT = 396.46 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. 52

BOOSTER STAGE ~ UNMODIFIED SPINNING STAR 48

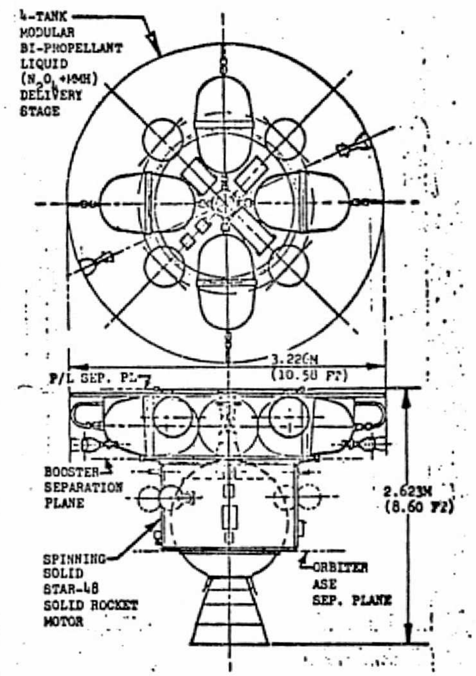
DELIVERY STAGE ~ LIQUID BIPROPELLANT (4 TANK)

SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE TRUSS / SAS TYPE	28.12
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	BIPROPELLANT – 4 CONOSPHERICAL TANKS, ONE R-40A THRUSTER (SAS TYPE), AND 4 SPHERICAL PRESSURE TANKS	665.87
0225 REACTION CONTROL SYSTEM	BIPROPELLANT	13.11
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	ROLL STABILIZED PLATFORM / SDPT & DOT	28.26
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	25.85
--- CONTINGENCY		2.0
		774.69
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER / DELIVERY STAGE SEPARATION CLAMP / SCOUT	7.26
0212 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS	113.40
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	UNMODIFIED SPINNING STAR 48	1693.71
0215 REACTION CONTROL SYSTEM	NONE	
0216 GUIDANCE & CONTROL	ACTIVE NUTATION CONTROL	15.88
0217 ELECTRICAL POWER	CONVENTIONAL CABLING / SCOUT	13.61
--- CONTINGENCY		17.69
		1863.82

NOTE:

CONFIGURATION



PERFORMANCE

DESIGN POINT – REFERENCE MISSION –

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	315.79 KG
WEIGHT PROPELLANT	=	458.90 KG
TOTAL	=	774.69 KG

BOOSTER STAGE

WEIGHT INERT	=	254.47 KG
WEIGHT PROPELLANT	=	1609.35 KG
TOTAL	=	1863.82 KG

STAGE WEIGHT = 2638.51 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. 53

BOOSTER STAGE ~ STAR 17A

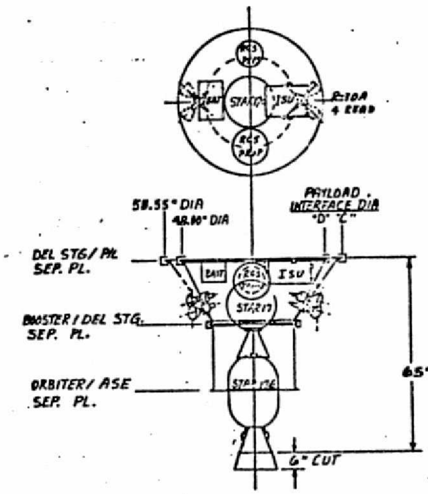
DELIVERY STAGE ~ STAR 17

SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY	SEPARATION CLAMP / SCOUT	7.71
0222 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS TYPE	24.94
0223 THERMAL	SPINNING STAR 48 TYPE	2.27
0224 MAIN PROPULSION	STAR 17	79.06
0225 REACTION CONTROL SYSTEM	MONOPROPELLANT, 3-AXIS / SDP & SCOOP TYPE	39.19
0226 DATA MANAGEMENT/COMM.	S-BAND TRANSMITTER & ANTENNA / SCOUT	1.5
0227 GUIDANCE & CONTROL	3-AXIS, DRY GYRO / SCOUT	23.86
0228 ELECTRICAL POWER	REMOTELY ACTIVATED SILVER-ZINC BATTERY & CONVENTIONAL CABLING / SCOUT	15.85
--- CONTINGENCY		7.7
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY	BOOSTER-DELIVERY STAGE SEPARATION	3.63
0212 STRUCTURE	SEMI-MONOCOQUE / SCOUT & SAS TYPE	27.22
0213 THERMAL	SPINNING STAR 48 TYPE	2.27
0214 MAIN PROPULSION	STAR 17A	124.47
0215 REACTION CONTROL SYSTEM	NONE	0.00
0216 GUIDANCE & CONTROL	NONE	0.00
0217 ELECTRICAL POWER	NONE	0.00
--- CONTINGENCY		10.02

NOTE:

CONFIGURATION



PERFORMANCE

DESIGN POINT ~ REFERENCE MISSION —

WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	141.09 KG
WEIGHT PROPELLANT	=	70.99 KG
TOTAL	=	212.08 KG

BOOSTER STAGE

WEIGHT INERT	=	54.21 KG
WEIGHT PROPELLANT	=	113.40 KG
TOTAL	=	167.61 KG
STAGE WEIGHT	=	379.69 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. II, III, & IV

BOOSTER STAGE OMS PAYLOAD BAY KIT

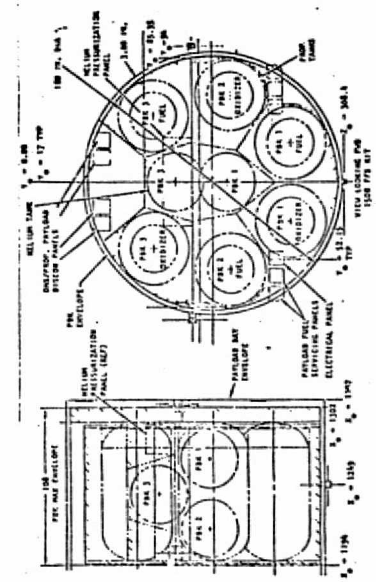
DELIVERY STAGE

SYSTEM COMPONENTS

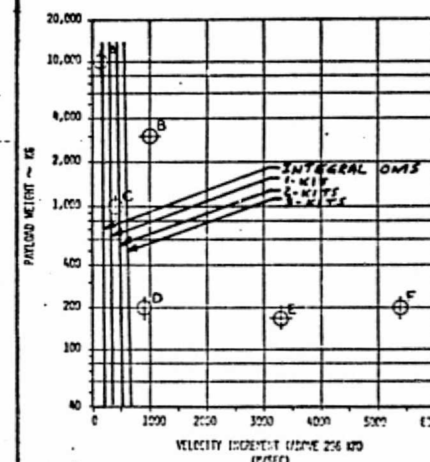
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY		
0222 STRUCTURE		
0223 THERMAL		
0224 MAIN PROPULSION		
0225 REACTION CONTROL SYSTEM		
0226 DATA MANAGEMENT/COMM.		
0227 GUIDANCE & CONTROL		
0228 ELECTRICAL POWER		
--- CONTINGENCY		
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		
0212 STRUCTURE		
0213 THERMAL		
0214 MAIN PROPULSION		
0215 REACTION CONTROL SYSTEM		
0216 GUIDANCE & CONTROL		
0217 ELECTRICAL POWER		
--- CONTINGENCY		

NOTE: CONFIGURATION NO. IV IS SHOWN.

CONFIGURATION



PERFORMANCE



WEIGHT SUMMARY

ONE KIT (CONFIG. NO. II)

WEIGHT INERT	1657 KG
WEIGHT PROPELLANT	5625 KG
TOTAL	7282 KG

TWO KITS (CONFIG. NO. III)

WEIGHT INERT	2930 KG
WEIGHT PROPELLANT	11235 KG
TOTAL	14165 KG

THREE KITS (CONFIG. NO. IV)

WEIGHT INERT	4206 KG
WEIGHT PROPELLANT	16843 KG
TOTAL	21049 KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. V

BOOSTER STAGE MMS

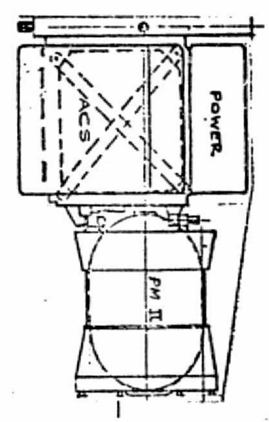
DELIVERY STAGE

SYSTEM COMPONENTS

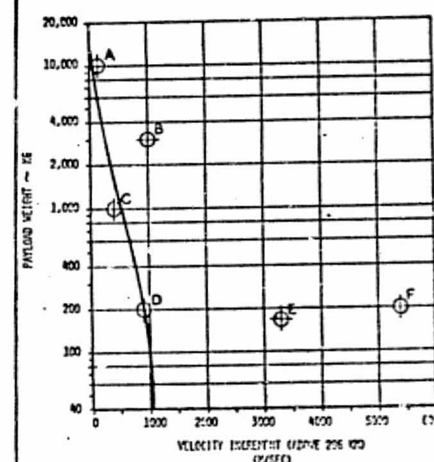
ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY		
0222 STRUCTURE		
0223 THERMAL		
0224 MAIN PROPULSION		
0225 REACTION CONTROL SYSTEM		
0226 DATA MANAGEMENT/COMM.		
0227 GUIDANCE & CONTROL		
0228 ELECTRICAL POWER		
--- CONTINGENCY		
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		
0212 STRUCTURE		
0213 THERMAL		
0214 MAIN PROPULSION		
0215 REACTION CONTROL SYSTEM		
0216 GUIDANCE & CONTROL		
0217 ELECTRICAL POWER		
--- CONTINGENCY		

NOTE:

CONFIGURATION



PERFORMANCE



WEIGHT SUMMARY

DELIVERY STAGE

WEIGHT INERT	=	KG
WEIGHT PROPELLANT	=	KG
TOTAL	=	KG

BOOSTER STAGE

WEIGHT INERT	=	742.53 KG
WEIGHT PROPELLANT	=	463.57 KG
TOTAL	=	1206.10 KG

STAGE WEIGHT	=	KG

PROPULSION CONCEPT SUMMARY

CONFIGURATION NO. VIII & IX

BOOSTER STAGE TRS (RETURNABLE) (4 TANK & 2 TANK)

DELIVERY STAGE

REV A 2-9-78

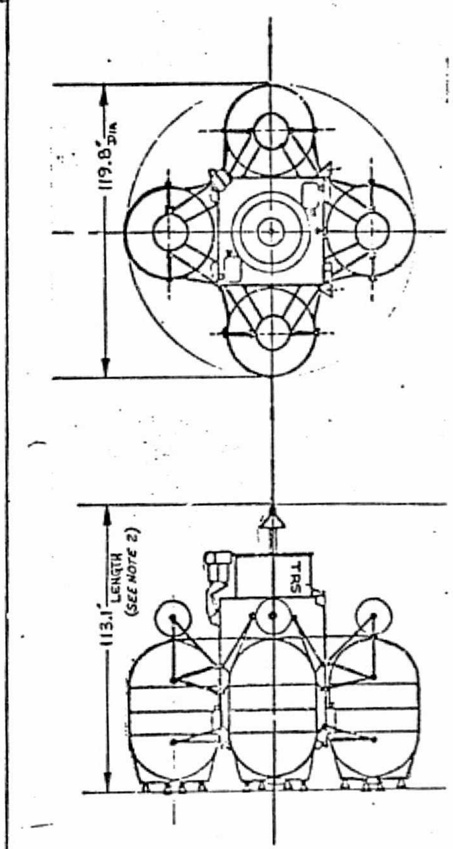
REV B 2-10-78

SYSTEM COMPONENTS

ITEM	APPROACH / BASIS	WEIGHT (KG)
DELIVERY STAGE		
0221 INTEGRATION & ASSEMBLY		
0222 STRUCTURE		
0223 THERMAL		
0224 MAIN PROPULSION		
0225 REACTION CONTROL SYSTEM		
0226 DATA MANAGEMENT/COMM.		
0227 GUIDANCE & CONTROL		
0228 ELECTRICAL POWER		
--- CONTINGENCY		
BOOSTER STAGE		
0201 INTEGRATION & ASSEMBLY		
0212 STRUCTURE		
0213 THERMAL		
0214 MAIN PROPULSION		
0215 REACTION CONTROL SYSTEM		
0216 GUIDANCE & CONTROL		
0217 ELECTRICAL POWER		
--- CONTINGENCY		

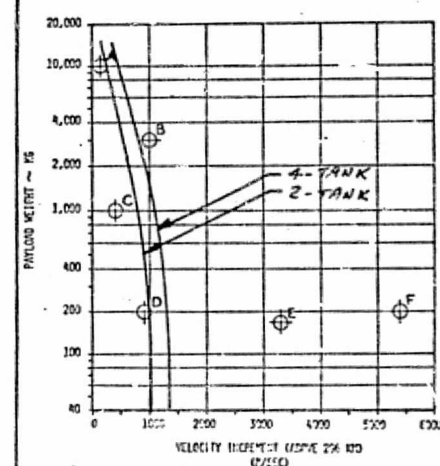
NOTE: (1) CONFIGURATION NO. IX, THE 4 TANK RETURNABLE TRS, IS SHOWN. CONFIGURATION NO. VIII IS THE 2 TANK RETURNABLE TRS.

CONFIGURATION



NOTE: (2) THE 113.1" LENGTH SHOWN IS FOR BASIC TRS. LENGTH IS 118" INCLUDING PAYLOAD ADAPTER.

PERFORMANCE



WEIGHT SUMMARY

4-TANK STAGE (CONFIG. NO. IX)

WEIGHT INERT	=	1447 KG
WEIGHT PROPELLANT	=	2722 KG
TOTAL	=	4169 KG

2-TANK STAGE (CONFIG. NO. VIII)

WEIGHT INERT	=	1089 KG
WEIGHT PROPELLANT	=	1361 KG
TOTAL	=	2450 KG

APPENDIX C

SCENARIO AND STAGE COST DATA

APPENDIX C
TASK 6 COST DATA

Appendix C presents basic definition and cost information for the scenarios considered in the cost benefits analysis (Task 6) of the LES study. Basic cost data is shown to level 5, where applicable, for all new stage concepts, existing/planned approaches and combinations of new and existing/planned approaches.

The scenarios are identified in Table 1 as bipropellant scenarios (B-1 through B-5), monopropellant scenarios (M-1 through M-4), existing/planned approach scenarios (E-1 through E-5), and combination scenarios (C-1 through C-4). The basic cost data is presented in this order of development (B-M-E-C).

Table 2 gives DDT&E costs for scenario classes B, M and C. No DDT&E costs are separately identified for other scenarios.

Table 3 includes operations costs for all scenario classes.

Table 4 includes production costs for all existing/planned systems and new stage concepts. New concepts are broken down to level 5 to give maximum available detail.

Table 5 is the cost summary for all considered scenarios. Costs are summarized in DDT&E, Production and Operation categories for each of the configurations contained in the indicated scenario. Additionally, the Shuttle charges are itemized for payload and stage, and added to the supporting costs. The Operations Supporting costs are made up of annual operational costs and unit operational costs as itemized on Data Form A.

Table 6 contains the detail description for all scenarios. An explanation of this table is contained in Volume IV, paragraph 7.4.2.

Table 7 presents a detailed cost buildup for the Scout ELV and STS launch costs for payload 47. San Marco One and payload 52, Transit in support of Table 7-XXIV of Volume IV.

Table 8 presents the ASE weight used with the TRS for each payload group. The basic TRS ASE was not structurally adequate to support the TRS with the payload attached. Therefore, the length and weight of the new LES ASE was used for the TRS. The new LES ASE length and weight were less than the length and weight of TRS ASE and a payload support pallet.

Table 9 presents the user charge buildup for the principal scenarios. These costs are entered into Table 5 where the total scenario costs are summarized.

TABLE 1 SCENARIO DEFINITION FOR BIPROPELLANTS

Scenario No.	Configuration Control No.	Stage	Cargo Bay Installation	ASE
B-1	25	4 Tank	Horizontal	New
	23	8 Tank	Horizontal	New
	68	4 Tank - 25/SSUS-D	Vertical	SSUS-D
	69	4 Tank - 25/SSUS-A	Horizontal	SSUS-A
B-2	25	4 Tank	Horizontal	New
	23	8 Tank	Horizontal	New
	62	4 Tank	Vertical	New
	66	4 Tank - 62/SSUS-D	Vertical	SSUS-D
	67	4 Tank - 62/SSUS-A	Horizontal	SSUS-A
B-3	25	4 Tank	Horizontal	New
	23	8 Tank	Horizontal	New
	56	4 Tank	Vertical	New
	57	12 Tank	Vertical	New
	68	4 Tank - 25/SSUS-D	Vertical	SSUS-D
	69	4 Tank - 25/SSUS-A	Horizontal	SSUS-A
B-4	25	4 Tank	Horizontal	New
	68	4 Tank	Horizontal Vertical	SSUS-A SSUS-D
	69	4 Tank - 25/SSUS-A	Horizontal	SSUS-A
B-5	25	4 Tank	Horizontal	New
	62	4 Tank	Vertical	New
	68	4 Tank - 25/SSUS-D	Horizontal Vertical	SSUS-A SSUS-D
	69	4 Tank - 25/SSUS-A	Horizontal	SSUS-A

Note: All scenarios include integral OMS

TABLE 1 SCENARIO DEFINITION FOR MONOPROPELLANTS

Scenario No.	Configuration Control No.	Stage	Cargo Bay Installation	ASE
M-1	35	2 Tank	Horizontal	New
	33	8 Tank	Horizontal	New
	70	2 Tank -35/SSUS-D	Horizontal Vertical	SSUS-A SSUS-D
	71	2 Tank - 35/SSUS-A	Horizontal	SSUS-A
M-2	35	2 Tank	Horizontal	New
	33	8 Tank	Horizontal	New
	63	2 Tank	Vertical	New
	64	2 Tank - 63/SSUS-D	Horizontal Vertical	SSUS-D
	65	2 Tank - 63/SSUS-A	Horizontal	SSUS-A
M-3	35	2 Tank	Horizontal	New
	70	2 Tank - 35/SSUS-D	Horizontal Vertical	SSUS-A SSUS-D
	71	2 Tank - 35/SSUS-A	Horizontal	SSUS-A
M-4	35	2 Tank	Horizontal	New
	63	2 Tank	Vertical	New
	64	2 Tank - 63/SSUS-D	Horizontal Vertical	SSUS-A SSUS-D
	65	2 Tank - 63/SSUS-A	Horizontal	SSUS-A

Note: All scenarios include integral OMS.

TABLE 1 SCENARIO DEFINITION FOR EXISTING/PLANNED APPROACHES

Scenario No.	Configuration Control No.	Stage	ASE
E-1	VI	MMS/PM-II- Expendable*	MMS
	VIII	TRS - 2 Tank - Retrievable	NEW **
	IX	TRS - 4 Tank - Retrievable	NEW
	XIII	Scout	-
	XIV	SSUS-D - P/L #3 and #9	SSUS-A & D
E-2	VIII	TRS--2 Tank - Retrievable	NEW
	IX	TRS - 4 Tank - Retrievable	NEW
	XIII	Scout	-
	XIV	SSUS-D - P/L #3 and #9	SSUS-A & D
E-3 Shuttle Launch to Payload Orbit Inclination	II - III - IV	1 - 2 - 3 OMS Kits	-
	XIII	Scout	-
	XIV	SSUS-D	SSUS-A & D
E-4	II	1 OMS Kit	-
	VIII	TRS - 2 Tank - Retrievable	NEW
	IX	TRS - 4 Tank - Retrievable	NEW
	XIII	Scout	-
	XIV	SSUS-D - P/L #3 and #9	SSUS-A & D
E-5 Shuttle Launch to Payload Orbit Inclination	II - III - IV	1 - 2 - 3 OMS Kits	-
	VI	MMS/PM-II- Expendable*	MMS
	XIII	Scout	-
	XIV	SSUS-D -	SSUS-A & D

Note: All Scenarios include integral OMS

* For MMS payloads only

** The length and weight of the new LES ASE was used with the TRS as shown in Table 8 of Appendix C because the TRS ASE cannot support the TRS with the payload attached. Lengths and weights were less than the TRS ASE + a payload pallet.

TABLE 1 SCENARIO DEFINITION FOR COMBINATIONS

Scenario No.	Configuration Control No.	Stage	Cargo Bay Installation	ASE
C-1	I	Integral OMS		-
	25	4 Tank	Horizontal	New
	23	8 Tank	Horizontal	New
	XIII	Scout		-
C-2	I	Integral OMS		-
	25	4 Tank	Horizontal	New
	23	8 Tank	Horizontal	New
	62	4 Tank	Vertical	New
	XIII	Scout		-
C-3	I	Integral OMS		-
	25	4 Tank	Horizontal	New
	62	4 Tank	Vertical	New
	68	4 Tank - 25/SSUS-D	Horizontal & Vertical	SSUS-D SSUS-A
	XIII	Scout		-
C-4	I	Integral OMS		-
	VI	MMS - PM II	Horizontal	MMS
	25	4 Tank	Horizontal	New
	23	8 Tank	Horizontal	New
	XIII	Scout		-

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. B-1

Pg [illegible]

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	-	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(16,285)	N/A	20	33
0201	Integration & Assembly - Vehicle	5	-	-		--	--
0210	Booster Stage	5	-	-		--	--
0220	Delivery Stage	5	1	16,285		20	33
0221	Integration & Assembly - Del. Stage	5	1	819		20	33
0222	Structure & Mechanism	5	1	1,691		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	7,516		20	33
0225	Reaction Control System	5	2	2,127		20	33
0226	Data Management/Communications	5	2	19		7	9
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	838		18	26
10-0400	LES Systems Engrg - LES/ASE Integr	4	-	(172)	N/A	20	33
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. B-I

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(2,056)	N/A	12	24
0701	Development Testing	5	-	1,452		12	24
0702	Qualification Testing	5	-	484		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. B-2

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	-	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(19,587)	N/A	20	33
0201	Integration & Assembly - Vehicle	5	-	-		-	-
0210	Booster Stage	5	-	-		-	-
0220	Delivery Stage	5	1	19,587		20	33
0221	Integration & Assembly - Del. Stage	5	1	939		20	33
0222	Structure & Mechanism	5	1	3,202		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	9,072		20	33
0225	Reaction Control System	5	2	2,127		20	33
0226	Data Management/Communications	5	2	19		7	7
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	953		18	26
10-0400	LES Systems Engrg - LES/ASE Integr	4	-	(172)	N/A	20	33
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. B-2

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(1,814)	N/A	12	24
0701	Development Testing	5	-	1,124		12	24
0702	Qualification Testing	5	-	570		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. B-3

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	-	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(30,933)	N/A	20	33
0201	Integration & Assembly - Vehicle	5	-	-		-	-
0210	Booster Stage	5	-	-		-	-
0220	Delivery Stage	5	1	30,933		20	33
0221	Integration & Assembly - Del. Stage	5	1	1,099		20	33
0222	Structure & Mechanism	5	1	3,403		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	18,300		20	33
0225	Reaction Control System	5	2	3,756		20	33
0226	Data Management/Communications	5	2	19		7	9
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	1,081		18	26
10-0400	LES Systems Engrg - LES/ASE Integr	4	-	(172)	N/A	20	33
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. B-3

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(3,270)	N/A	12	24
0701	Development Testing	5	-	2,327		12	24
0702	Qualification Testing	5	-	824		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 2

DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. B-4

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	-	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(14,450)	N/A	20	33
0201	Integration & Assembly - Vehicle	5	-	-		-	-
0210	Booster Stage	5	-	-		-	-
0220	Delivery Stage	5	1	14,450		20	33
0221	Integration & Assembly - Del. Stage	5	1	762		20	33
0222	Structure & Mechanism	5	1	1,442		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	6,449		20	33
0225	Reaction Control System	5	2	2,001		20	33
0226	Data Management/Communications	5	2	19		7	9
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	502		18	26
10-0400	LES Systems Engrg - LES/ASE Integr.	4	-	(172)	N/A	20	33
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. B-4

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(1,855)	N/A	12	24
0701	Development Testing	5	-	1,251		12	24
0702	Qualification Testing	5	-	484		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. B-5

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	-	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(15,853)	N/A	20	33
0201	Integration & Assembly - Vehicle	5	-	-		-	-
0210	Booster Stage	5	-	-		-	-
0220	Delivery Stage	5	1	(15,853)		20	33
0221	Integration & Assembly - Del. Stage	5	1	804		20	33
0222	Structure & Mechanism	5	1	2,296		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	6,748		20	33
0225	Reaction Control System	5	2	2,001		20	33
0226	Data Management/Communications	5	2	19		7	9
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	710		18	26
10-0400	LES Systems Engrg - LES/ASE Integr.	4	-	(172)	N/A	20	33
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2

DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. B-5

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(2,096)	N/A	12	24
0701	Development Testing	5	-	1,492		12	24
0702	Qualification Testing	5	-	484		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. M-1

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0100	Project Management	4	-	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(14,763)	N/A	20	33
0201	Integration & Assembly - Vehicle	5	-	-		-	-
0210	Booster Stage	5	-	-		-	-
0220	Delivery Stage	5	1	14,763		22	33
0221	Integration & Assembly - Del. Stage	5	1	733		22	33
0222	Structure & Mechanism	5	1	2,069		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	6,864		22	33
0225	Reaction Control System	5	2	1,178		20	33
0226	Data Management/Communications	5	2	19		7	9
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	625		18	26
10-0400	LES Systems Engrg - LES/ASE Integr	4	-	(172)	N/A	20	33
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. M-1

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(2,036)	N/A	12	24
0701	Development Testing	5	-	1,432		12	24
0702	Qualification Testing	5	-	484		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. M-2

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	-	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(15,707)	N/A	20	33
0201	Integration & Assembly - Vehicle	5	-	-		-	-
0210	Booster Stage	5	-	-		-	-
0220	Delivery Stage	5	1	(15,707)		22	33
0221	Integration & Assembly - Del. Stage	5	1	778		22	33
0222	Structure & Mechanism	5	1	2,069		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	7,765		22	33
0225	Reaction Control System	5	2	1,176		20	33
0226	Data Management/Communications	5	2	19		7	9
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	625		18	26
10-0400	LES Systems Engrg - LES/ASE Integr	4		(172)	N/A	20	33
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. M-2

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(1,782)	N/A	12	24
0701	Development Testing	5	-	1,107		12	24
0702	Qualification Testing	5	-	554.5		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. M-3

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	-	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(11,328)	N/A	20	33
0201	Integration & Assembly - Vehicle	5	-	-		-	-
0210	Booster Stage	5	-	-		-	-
0220	Delivery Stage	5	1	11,328		22	33
0221	Integration & Assembly - Del. Stage	5	1	635		22	33
0222	Structure & Mechanism	5	1	1,452		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	4,329		22	33
0225	Reaction Control System	5	2	1,176		20	33
0226	Data Management/Communications	5	2	19		7	9
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	442		18	26
10-0400	LES Systems Engrg - LES/ASE Integr.	4	-	(172)	N/A	20	33
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. M-3

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(1,804)	N/A	12	24
0701	Development Testing	5	-	1,200		12	24
0702	Qualification Testing	5	-	484		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. M-4

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	-	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(12,080)	N/A	20	33
0201	Integration & Assembly - Vehicle	5	-	-		-	-
0210	Booster Stage	5	-	-		-	-
0220	Delivery Stage	5	1	12,080		22	33
0221	Integration & Assembly - Del. Stage	5	1	662		22	33
0222	Structure & Mechanism	5	1	1,700		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	4,743		22	33
0225	Reaction Control System	5	2	1,176		20	33
0226	Data Management/Communications	5	2	19		7	9
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	505		18	26
10-0400	LES Systems Engrg - LES/ASE Integr	4	-	(172)	N/A	20	33
10-0500	Airborne Support Equipr nt	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. M-4

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(1,981)	N/A	12	24
0701	Development Testing	5	-	1,377		12	24
0702	Qualification Testing	5	-	484		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. C-1

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0100	Project Management	4	-	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(12,039)	N/A	20	33
0201	Integration & Assembly - Vehicle	5	-	-		-	-
0210	Booster Stage	5	-	-		-	-
0220	Delivery Stage	5	1	12,039		20	33
0221	Integration & Assembly - Del. Stage	5	1	660		20	33
0222	Structure & Mechanism	5	1	1,387		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	5,548		20	33
0225	Reaction Control System	5	2	625		20	33
0226	Data Management/Communications	5	2	19		7	9
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	525		18	26
10-0400	LES Systems Engrg - LES/ASE Integr	4	-	(172)	N/A	20	33
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. C-1

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(1,038)	N/A	12	24
0701	Development Testing	5	-	678		12	24
0702	Qualification Testing	5	-	240		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	22	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
						20	
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. C-2

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF PROTOS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	--	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(14,319)	N/A	20	33
10-0201	Vehicle Integration and Assembly	5	--	----		--	--
10-0210	Booster Stage	5	--	----		--	--
10-0220	Delivery Stage	5	1	14,319		20	33
10-0221	Integration & Assembly-Delivery Stage	5	1	737		20	33
10-0222	Structure and Mechanism	5	1	2,241		16	33
10-0223	Thermal System	5	1	164		6	33
10-0224	Main Propulsion	5	2	6,564		20	33
10-0225	Reaction Control System	5	2	750		20	33
10-0226	Data Management & Communications	5	2	19		7	9
10-0227	Guidance Navigation and Control	5	2	3,111		12	24
10-0228	Electrical Power System	5	2	733		18	26
10-0300	Facilities	4	--	----		20	33
10-0400	LES Systems Engrg - LES/ASE Integr.	4	-	(172)	N/A	20	38

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. C-2

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
10-0501	Integration and Test	5	3	116		12	17
10-0502	Structure and Mechanisms	5	3	4,811		12	15
10-0503	Avionics - ASE	5	3	201		10	13
10-0504	Controls and Displays	5	3	243		10	14
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test and Evaluation	4	N/A	(1,427)	N/A	12	24
10-0701	Development	5	-	1,004		12	24
10-0702	Qualification	5	-	303		12	24
10-0703	Mock-ups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
10-0801	Checkout	5	-	2,036		20	26
10-0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
10-0901	Logistics/Training	5	-	91		12	18
10-0903	Field Support	5	-	104		10	13

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. C-3

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	-	(100)	N/A	20	33
10-0200	LES Vehicle	4	N/A	(14,376)	N/A	20	33
0201	Integration & Assembly - Vehicle	5	-	-		-	-
0210	Booster Stage	5	-	-		-	-
0220	Delivery Stage	5	1	14,376		20	33
0221	Integration & Assembly - Del. Stage	5	1	750		20	33
0222	Structure & Mechanism	5	1	2,296		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	5,325		20	33
0225	Reaction Control System	5	2	2,001		20	33
0226	Data Management/Communications	5	2	19		7	9
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	710		18	26
10-0400	LES Systems Engrg - LES/ASE Integr	4	-	(172)	N/A	20	33
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. C-3

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(1,800)	N/A	12	24
0701	Development Testing	5	-	1,196		12	24
0702	Qualification Testing	5	-	484		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. C-4

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0100	Project Management	4	-	(100)		20	33
10-0200	LES Vehicle	4	N/A	(12,039)		20	33
0201	Integration & Assembly - Vehicle	5	-	-		-	-
0210	Booster Stage	5	-	-		-	-
0220	Delivery Stage	5	1	12,039		20	33
0221	Integration & Assembly - Del. Stage	5	1	660		20	33
0222	Structure & Mechanism	5	1	1,387		16	33
0223	Thermal System	5	1	164		6	33
0224	Main Propulsion	5	2	5,548		20	33
0225	Reaction Control System	5	2	625		20	33
0226	Data Management/Communications	5	2	19		7	9
0227	Guidance, Navigation & Control	5	2	3,111		12	24
0228	Electrical Power System	5	2	525		18	26
10-400	LES Systems Engrg - LES/ASE Integr.	4	-	(172)	N/A	20	33
10-0500	Airborne Support Equipment	4	3	(5,371)	N/A	12	17
0501	Integration & Assembly	5	3	116		12	17
0502	Structure & Mechanism	5	3	4,811		12	15
0503	Avionics - ASE	5	3	201		10	13
0504	Controls & Displays	5	3	243		10	14

TABLE 2
DATA FORM A

LES BASIC COST DATA
NON-RECURRING DDT&E
SCENARIO NO. C-4

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0600	Software	4	1	(570)	N/A	20	24
10-0700	System Test & Evaluation	4	N/A	(1,038)	N/A	12	24
0701	Development Testing	5	-	678		12	24
0702	Qualification Testing	5	-	240		12	24
0703	Mockups	5	1	120		10	15
10-0800	Ground Support Equipment	4	N/A	(3,950)	N/A	20	26
0801	Checkout	5	-	2,036		20	26
0802	Handling/Assembly/Servicing	5	-	1,914		20	26
10-0900	Ground Operations	4	N/A	(195)	N/A	12	18
0901	Logistics/Training	5	-	91		12	18
0903	Field Support	5	-	104		10	13

TABLE 3
DATA FORM A

LES BASIC COST DATA
FOR OPERATIONS
SCENARIOS B-1 Thru B-5, M-1 Thru M-4

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
20-0000	Space Shuttle	3	112	N/A	N/A		
20-0100	User's Charge-Cost/Launch	4	112	*	*		
20-0200	Orbiter Integration -						
	Cost/Launch	4	112	(2016)	(18)		
10-0100	Project Management -						
	Annual Cost	4	10	(5000)	(500.0)		
10-0400	System Engineering and Integration	4					
	Cost/Launch		112	(16,072)	(143.5)		
	Annual Cost		10	(5,800)	(580.0)		
10-0401	LES Systems Engineering	5					
	Cost/Launch		112	12,264	109.5		
	Annual Cost		10	3,800	380.0		
10-0402	LES/ASE Integration						
	Cost/Launch	5	112	1,904	17.0		
10-0403	LES/Payload Integration						
	Cost/Launch	5	112	1,904	17.0		
10-0404	Sustaining Engineering						
	Annual Cost	5	10	2,000	200.0		
*NOTE	User's Charge is stage, payload, and mission dependent. See Form 5.						

TABLE 3
DATA FORM A

LES BASIC COST DATA
FOR OPERATIONS
SCENARIOS B-1 Thru B-5, M-1 Thru M-4

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0900	Ground Operations -	4					
	Cost/Launch		112	(16,374)	(146.2)		
	Annual Cost		10	(11,733)	(1173.3)		
10-0901	Logistics/Training -						
	Cost/Launch	5	112	1,008	9.0		
10-0902	Spares/Repair Parts						
	Cost/Launch	5	112	2,800	25.0		
10-0903	Field Support	5					
	Cost/Launch		112	12,566	112.2		
	Annual Cost (Prior to 1983)		1	617.5	617.5		
	Annual Cost (1983 and Sub)		9	11,115	1235.0		
10-1000	Flight Operations						
	Cost/Launch	4	112	(336)	(3)		

TABLE 3

DATA FORM A

BASIC COST DATA
FOR OPERATIONS
SCENARIO E-1

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	COSTS IN 1000'S OF $ AVG. UNIT	T_d	T_s
20-0000	Space Shuttle	3	99	N/A	N/A		
20-0100	User's Charge - Cost/Launch	4	99	*	*		
20-0200	Orbiter Integration - Cost/Launch	4	99	(1,782)	(18)		
10-0100	Project Management - Annual Cost	4		(9,500)	(1000.0)		
	Annual Cost - PM II		9	4,500	500.0		
	Annual Cost - TRS		10	5,000	500.0		
10-0400	System Engineering and Integration	4					
	Cost/Launch		99	(14,207)	(143.5)		
	Annual Cost			(11,020)	(1060.0)		
10-0401	Systems Engineering	5					
	Cost/Launch		99	10,841	109.5		
	Annual Cost - PM II		9	3,420	380.0		
	Annual Cost - TRS		10	3,800	380.0		
10-0402	ASE Integration - Cost/Launch	5	99	1,683	17.0		
10-0403	Payload Integration - Cost/Launch	5	99	1,683	17.0		
10-0404	Sustaining Engineering	5					
	Annual Cost - PM II		9	1,800	200.0		
	Annual Cost - TRS		10	2,000	200.0		
*Note	User's Charge is stage, payload, and mission dependent. See Form 5.						

TABLE 3

DATA FORM A

BASIC COST DATA
FOR OPERATIONS
SCENARIO E-1

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0900	Ground Operations -	4					
	Cost/Launch		99	(14,474)	(146.2)		
	Annual Cost		10	(11,733)	(1173.3)		
10-0901	Logistics/Training -	5					
	Cost/Launch		99	891	9.0		
10-0402	Spares/Repair Parts	5					
	Cost/Launch		99	2,475	25.0		
10-0903	Field Support	5					
	Cost/Launch		99	11,108	112.2		
	Annual Cost (Prior to 1983)		1	617.5	617.5		
	Annual Cost (1983 and Sub)		9	11,115	1235.0		
10-1000	Flight Operations	4					
	Cost/Launch		99	(297)	(3.0)		
	SSUS Service Charges	3		(2,850)			
	Mission Oriented Analysis - Cost/Mission		2	1,500	750		
	Launch Oriented Analysis - Cost/Launch		3	1,350	450		

BASIC COST DATA
FOR OPERATIONS

TABLE 3
DATA FORM A

SCENARIO E-2

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
20-0000	Space Shuttle	3	99	N/A	N/A		
20-0100	User's Charge-Cost/Launch	4	99	*	*		
20-0200	Orbiter Integration -	4					
	Cost/Launch		99	(1,782)	(18.0)		
10-0100	Project Management -	4					
	Annual Cost		10	(5,000)	(500.0)		
10-0400	System Engineering and Integration	4					
	Cost/Launch		99	(14,207)	(143.5)		
	Annual Cost		10	(5,800)	(580.0)		
10-0401	Systems Engineering	5					
	Cost/Launch		99	10,841	109.5		
	Annual Cost		10	3,800	380.0		
10-0402	ASE Integration	5					
	Cost/Launch		99	1,683	17.0		
10-0403	Payload Integration	5					
	Cost/Launch		99	1,683	17.0		
10-0404	Sustaining Engineering	5					
	Annual Cost		10	2,000	200.0		
*NOTE	User's Charge is stage, payload, and mission dependent. See Form 5.						

BASIC COST DATA
FOR OPERATIONS

TABLE 3
DATA FORM A

SCENARIO E-2

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0900	Ground Operations –	4					
	Cost/Launch		99	(14,474)	(146.2)		
	Annual Cost		10	(11,733)	(1173.3)		
10-0901	Logistics/Training –	5					
	Cost/Launch		99	891	9.0		
10-(402	Spares/Repair Parts	5					
	Cost/Launch		99	2,475	25.0		
10-0903	Field Support	5					
	Cost/Launch		99	11,108	112.2		
	Annual Cost (Prior to 1983)		1	617.5	617.5		
	Annual Cost (1983 and Sub)		9	11,115	1235.0		
10-1000	Flight Operations	4					
	Cost/Launch		99	(297)	(3.0)		
	SSUS Service Charges	3		(2850)			
	Mission Oriented Analysis – Cost/Mission		2	1500	750		
	Launch Oriented Analysis – Cost/Launch		3	1350	450		

BASIC COST DATA
FOR OPERATIONS
SCENARIO E-3

TABLE 3
DATA FORM A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
	SSUS Service Charges	3		35,250			
	Mission Oriented Analysis - Cost/Mission		17	12,750	750		
	Launch Oriented Analysis - Cost/Launch		50	22,500	450		

BASIC COST DATA
FOR OPERATIONS

TABLE 3
DATA FORM A

SCENARIO E-4

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
20-0000	Space Shuttle	3	49	N/A	N/A		
20-0100	User's Charge-Cost/Launch	4	49	*	*		
20-0200	Orbiter Integration -	4					
	Cost/Launch		49	(882)	(18.0)		
10-0100	Project Management -	4					
	Annual Cost		10	(5,000)	(500.0)		
10-0400	System Engineering and Integration	4					
	Cost/Launch		49	(7,032)	(143.5)		
	Annual Cost		10	(5,800)	(580.0)		
10-0401	Systems Engineering	5					
	Cost/Launch		49	5,366	109.5		
	Annual Cost		10	3,800	380.0		
10-0402	ASE Integration	5					
	Cost/Launch		49	833	17.0		
10-0403	Payload Integration	5					
	Cost/Launch		49	833	17.0		
10-0404	Sustaining Engineering	5					
	Annual Cost		10	2,000	200.0		
*NOTE	User's Charge is stage, payload, and mission dependent. See Form 5.						

TABLE 3

BASIC COST DATA
FOR OPERATIONS
SCENARIO E-4

DATA FORM A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0900	Ground Operations -	4					
	Cost/Launch		49	(7164)	(146.2)		
	Annual Cost		10	(11,733)	(1173.3)		
10-0901	Logistics/Training -	5					
	Cost/Launch		49	441	9.0		
10-0402	Spares/Repair Parts	5					
	Cost/Launch		49	1225	25.0		
10-0903	Field Support	5					
	Cost/Launch		49	5498	112.2		
	Annual Cost (Prior to 1983)		1	617.5	617.5		
	Annual Cost (1983 and Sub)		9	11115	1235.0		
10-1000	Flight Operations	4					
	Cost/Launch		49	(147)	(3.0)		
	SSUS Service Charges	3		(1,200)			
	Mission Oriented Analysis - Cost/Mission		1	750	750		
	Launch Oriented Analysis - Cost/Launch		1	450	450		

TABLE 3
DATA FORM A

BASIC COST DATA
FOR OPERATIONS
SCENARIO E-5

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
20-0000	Space Shuttle	3	36	N/A	N/A		
20-0100	User's Charge-Cost/Launch	4	36	*	*		
20-0200	Orbiter Integration -	4					
	Cost/Launch		36	(648)	(18.0)		
10-0100	Project Management -	4					
	Annual Cost		9	(4500)	(500.0)		
10-0400	System Engineering and Integration	4					
	Cost/Launch		36	(5166)	(143.5)		
	Annual Cost		9	(5220)	(580.0)		
10-0401	Systems Engineering	5					
	Cost/Launch		36	3942	109.5		
	Annual Cost		9	3420	380.0		
10-0402	ASE Integration	5					
	Cost/Launch		36	612	17.0		
10-0403	Payload Integration	5					
	Cost/Launch		36	612	17.0		
10-0404	Sustaining Engineering	5					
	Annual Cost		9	1800	200.0		
*NOTE	User's Charge is stage, payload, and mission dependent. See Form 5.						

BASIC COST DATA
FOR OPERATIONS

TABLE 3
DATA FORM A

SCENARIO E-5

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0900	Ground Operations -	4					
	Cost/Launch		36	(5263)	(146.2)		
	Annual Cost		9	(11115)	(1235)		
10-0901	Logistics/Training -	5					
	Cost/Launch		36	324	9.0		
10-0402	Spares/Repair Parts	5					
	Cost/Launch		36	900	25.0		
10-0903	Field Support	5					
	Cost/Launch		36	4039	112.2		
	Annual Cost (Prior to 1983)		0	0	617.5		
	Annual Cost (1983 and Sub)		9	11115	1235		
10-1000	Flight Operations	4					
	Cost/Launch		36	(108)	(3.0)		
	SSUS Service Charges	3		24,450			
	Mission Oriented Analysis - Cost/Mission		11	8,250	750		
	Launch Oriented Analysis - Cost/Launch		36	16,200	450		

TABLE 3
DATA FORM A

SCOUT COST DATA
FOR OPERATIONS
ALL EXISTING/PLANNED SCENARIOS

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-000	Scout Operations - Annual Cost	3	4	(19,244)	(4811.0)		
	Program Management	4	4	4,400	1100.0		
	Systems Engineering	4	4	1,800	450.0		
	Reliability and Quality Control	4	4	2,000	500.0		
	Production Support	4	4	1,200	300.0		
	Standardization and Configuration Control	4	4	800	200.0		
	Logistics Management	4	4	388	97.0		
	Field Services Support	4	4	6,216	1554.0		
	Systems Research and Development	4	4	1,600	400.0		
	Launch Site Support	4	4	400	100.0		
	Range Charges	4	4	280	70.0		
	DCASO	4	4	160	40.0		

SCOUT COST DATA

FOR OPERATIONS

ALL EXISTING/PLANNED SCENARIOS

TABLE 3
DATA FORM A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
20-000	Scout Launch Charges - Per Launch	3	11	(46,987)	(4272)		
	Scout Hardware & Launch Service	4	11	41,987	3817		
	Vehicle Hardware & Processing	5	11	37,719	3429		
	Mission Integration	5	11	440	40		
	Preflight Planning	5	11	330	30		
	Data Reduction and Analysis	5	11	660	60		
	Shipping	5	11	275	25		
	Contractor Incentive	5	11	1100	100		
	DCASO	5	11	363	33		
	Range Charges	5	11	1100	100		
	Additional Scout Charges	4	4	5000	1250.0		
	San Marco Range Services	5	4	4000	1000.0		
	Scout Fifth Stage	5	2	1000	500.0		

TABLE 3
DATA FORM 4

LES BASIC COST DATA
FOR OPERATIONS
SCENARIOS C-1, C-2, C-3

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
20-0000	Space Shuttle	3	103	N/A	N/A		
20-0100	User's Charge-Cost/Launch	4	103	*	*		
20-0200	Orbiter Integration -						
	Cost/Launch	4	103	(1,854)	(18)		
10-0100	Project Management -						
	Annual Cost	4	10	(5,000)	(500.0)		
10-0400	System Engineering and Integration	4					
	Cost/Launch		103	(14,781)	(143.5)		
	Annual Cost		10	(5,800)	(580.0)		
10-0401	LES Systems Engineering	5					
	Cost/Launch		103	11,279	109.5		
	Annual Cost		10	3,800	380.0		
10-0402	LES/ASE Integration						
	Cost/Launch	5	103	1,751	17.0		
10-0403	LES/Payload Integration						
	Cost/Launch	5	103	1,751	17.0		
10-0404	Sustaining Engineering						
	Annual Cost	6	10	2,000	200.0		
*NOTE	User's Charge is stage, payload, and mission dependent. See Form 5.						

TABLE 3
DATA FORM A

LES BASIC COST DATA
FOR OPERATIONS
SCENARIOS C-1, C-2, C-3

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	COSTS IN 1000'S OF $ AVG. UNIT	T_d	T_s
10-0900	Ground Operations -						
	Cost/Launch	4	103	(15,059)	(146.2)		
	Annual Cost	4	10	(11,733)	(1,173.3)		
10-0901	Logistics/Training -						
	Cost/Launch	5	103	927	9.0		
10-0902	Spares/Repair Parts						
	Cost/Launch	5	103	2,575	25.0		
10-0903	Field Support	5					
	Cost/Launch		103	11,557	112.2		
	Annual Cost (Prior to 1983)		1	617.5	617.5		
	Annual Cost (1983 and Sub)		9	11,115	1,235.0		
10-1000	Flight Operations						
	Cost/Launch	4	103	(309)	(3)		

TABLE 3
DATA FORM A

LES BASIC COST DATA
FOR OPERATIONS
SCENARIO C-4

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
20-0000	Space Shuttle	3	78	N/A	N/A		
20-0100	User's Charge-Cost/Launch	4	78	*	*		
20-0200	Orbiter Integration -						
	Cost/Launch	4	78	(1404)	(18)		
10-0100	Project Management -						
	Annual Cost	4	10	(5000)	(500.0)		
10-0400	System Engineering and Integration						
	Cost/Launch	4	78	(11,193)	(143.5)		
	Annual Cost		10	(5800)	(580.0)		
10-0401	LES Systems Engineering	5					
	Cost/Launch		78	8541	109.5		
	Annual Cost		10	3800	380.0		
10-0402	LES/ASE Integration						
	Cost/Launch	5	78.	1326	17.0		
10-0403	LES/Payload Integration						
	Cost/Launch	5	78	1326	17.0		
10-0404	Sustaining Engineering						
	Annual Cost	5	10	2000	200.0		
*NOTE	User's Charge is stage, payload, and mission dependent. See Form 5.						

TABLE 3
DATA FORM A

LES BASIC COST DATA
FOR OPERATIONS
SCENARIO C-4

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0900	Ground Operations –	4					
	Cost/Launch		78	(11,404)	(146.2)		
	Annual Cost		10	(1,733)	(1173.3)		
10-0901	Logistics/Training –						
	Cost/Launch	5	78	702	9.0		
10-0902	Spares/Repair Parts						
	Cost/Launch	5	78	1,950	25.0		
10-0903	Field Support	5					
	Cost/Launch		78	8,752	112.2		
	Annual Cost (Prior to 1983)		1	617.5	617.5		
	Annual Cost (1983 and Sub)		9	11,115	1235.0		
10-1000	Flight Operations						
	Cost/Launch	4	78	(234)	(3)		

SCOUT COST DATA

FOR OPERATIONS

ALL COMBINATION SCENARIOS

TABLE 3
DATA FORM A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
20-000	Scout Launch Charges - Per Launch	3	10	(43,170)	(4,317)		
	Scout Hardware & Launch Services	4	10	38,170	3,817		
	Vehicle Hardware & Processing	5	10	34,290	3,429		
	Mission Integration	5	10	400	40		
	Preflight Planning	5	10	300	30		
	Data Reduction & Analysis	5	10	600	60		
	Shipping	5	10	250	25		
	Contractor Incentive	5	10	1,000	100		
	DCASO	5	10	330	33		
	Range Charges	5	10	1,000	100		
	Additional Scout Charges	4	4	5,000	1,250.0		
	San Marco Range Services	5	4	4,000	1,000.0		
	Scout Fifth Stage	5	2	1,000	500.0		

TABLE 3
DATA FORM A

SCOUT COST DATA
FOR OPERATIONS
ALL COMBINATION SCENARIOS

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-000	Scout Operations - Annual Cost	3	3	(14,433)	(4811.0)		
	Program Management	4	3	3,300	1100.0		
	Systems Engineering	4	3	1,350	450.0		
	Reliability and Quality Control	4	3	1,500	500.0		
	Production Support	4	3	900	300.0		
	Standardization and Configuration Control	4	3	600	200.0		
	Logistics Management	4	3	291	97.0		
	Field Services Support	4	3	4,662	1554.0		
	Systems Research and Development	4	3	1,200	400.0		
	Launch Site Support	4	3	300	100.0		
	Range Charges	4	3	210	70.0		
	DCASO	4	3	120	40.0		

BASIC COST DATA

PRODUCTION

TABLE 4 ALL CONFIGURATIONS - EXISTING/PLANNED SYSTEMS

DATA FORM A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-000	SSUS-D						
	For Scenario E-1, E-2	3	3	7,278	2,426		
	For Scenario E-3	3	50	121,300	2,426		
	For Scenario E-4	3	1	2,426	2,426		
	For Scenario E-5	3	36	87,336	2,426		
10-000	PM II						
	For Scenario E-1	3	25	24,425	977		
	For Scenario E-5	3	36	35,172	977		
10-000	TRS-2 Tank (NOTE)						
	For Scenarios E-1, E-2, E-4 Cost/Unit	3	1	11,000	11,000		
	For Scenario E-1 Cost/ R & R	3	63	33,957	539		
	For Scenario E-2 Cost/ R & R	3	88	47,432	539		
	For Scenario E-4 Cost/ R & R	3	39	21,021	539		
10-000	TRS-4 Tank (NOTE)						
	For Scenarios E-1, E-2, E-4 Cost/Unit	3	1	11,000	11,000		
	For Scenarios E-1, E-2 Cost/R & R	3	11	6,754	614		
	For Scenario E-4 Cost/ R & R	3	10	6,140	614		

NOTE: TRS production costs shown on Data Form 5 are sums of unit and retrieval and refurbishment costs.

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 4 TANK HORIZ BIPROP

TABLE 4
DATA FORM A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	COSTS IN 1000'S OF $ AVG. UNIT	T_d	T_s
10-0200	Les Vehicle	4	103	(180,917)	(1,756.5)	18	18
10-0201	Vehicle Integration and Assembly	5	--	--	--	--	--
10-0210	Booster Stage	5	--	--	--	--	--
10-0220	Delivery Stage	5	103	180,917	1,756.5	18	18
10-0221	Integration and Assembly	5	103	8,311	80.7	18	18
10-0222	Structure	5	103	8,817	85.6	18	18
10-0223	Thermal	5	103	3,068	29.8	18	18
10-0224	Main Propulsion	5	103	64,254	623.8	18	18
10-0225	RCS	5	103	21,471	208.5	15	15
10-0226	Data Management/Communications	5	103	987	9.6	2	2
10-0227	GN&C	5	103	72,296	701.9	12	12
10-0228	Electrical Power	5	103	1,713	16.6	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 8 TANK HORIZ BIPROP

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0200	LES Vehicle	4	103	(219,871)	(2,134.7)	18	18
10-0201	Vehicle Integration and Assembly	5	--	---	---	--	--
10-0210	Booster Stage	5	--	---	---	--	--
10-0220	Delivery Stage	5	103	219,871	2,134.7	18	18
10-0221	Integration and Assembly	5	103	10,721	104.1	18	18
10-0222	Structure	5	103	9,410	91.4	18	18
10-0223	Thermal	5	103	3,087	30.0	18	18
10-0224	Main Propulsion	5	103	99,930	970.2	18	18
10-0225	RCS	5	103	21,471	208.5	15	15
10-0226	Data Management/Communications	5	103	987	9.6	2	2
10-0227	GN&C	5	103	72,296	701.9	12	12
10-0228	Electrical Power	5	103	1,969	19.1	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 4 Tank Vertical BiProp

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0200	LES Vehicle	4	103	(182,506)	(1771.9)	18	18
0201	Vehicle Integration & Assembly	5	-	-	-	-	-
0210	Booster Stage	5	-	-	-	-	-
0220	Delivery Stage	5	103	182,506	1771.9	18	18
0221	Integration & Assembly - Del. Stg.	5	103	8,311	80.7	18	18
0222	Structure & Mechanism	5	103	10,406	101.0	18	18
0223	Thermal System	5	103	3,068	29.8	18	18
0224	Main Propulsion	5	103	64,254	623.8	18	18
0225	Reaction Control System	5	103	21,471	208.5	15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	1,713	16.6	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 12 Tank Vertical BiProp

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0200	LES Vehicle	4	103	(247,772)	(2405.6)	18	18
0201	Vehicle Integration & Assembly	5	-	-	-	-	-
0210	Booster Stage	5	-	-	-	-	-
0220	Delivery Stage	5	103	247,772	2405.6	18	18
0221	Integration & Assembly - Del. Stg.	5	103	14,205	137.9	18	18
0222	Structure & Mechanism	5	103	14,935	145.0	18	18
0223	Thermal System	5	103	3,087	30.0	18	18
0224	Main Propulsion	5	103	118,575	1151.2	18	18
0225	Reaction Control System	5	103	21,471	208.5	15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	2,216	21.5	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 4 Tank Vert. BiProp + SSUS-D

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0200	LES Vehicle	4	103	(434,049)	4214.1	18	18
0201	Vehicle Integration & Assembly	5	103	Incl. W 10-210	Inc. W 10-210	18	18
0210	Booster Stage	5	103	249,878	2426	18	18
0220	Delivery Stage	5	103	184,171	1788.1	18	18
0221	Integration & Assembly - Del. Stg.	5	103	8,311	80.7	18	18
0222	Structure & Mechanism	5	103	12,071	117.2	18	18
0223	Thermal System	5	103	3,068	29.8	18	18
0224	Main Propulsion	5	103	64,254	623.8	18	18
0225	Reaction Control System	5	103	21,471	208.5	15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	1,713	16.6	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 4 Tank Vert BiProp + SSUS-A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0200	LES Vehicle	4	103	(600,227)	(5827.4)	18	18
0201	Vehicle Integration & Assembly	5	103	Incl. W 10-210	Incl. W 10-210	18	18
0210	Booster Stage	5	103	374,817	3639	18	18
0220	Delivery Stage	5	103	225,410	2188.4	18	18
0221	Integration & Assembly - Del. Stg.	5	103	8,414	81.7	18	18
0222	Structure & Mechanism	5	103	12,701	123.3	18	18
0223	Thermal System	5	103	3,068	29.8	18	18
0224	Main Propulsion	5	103	64,254	623.8	18	18
0225	Reaction Control System	5	103	61,977	601.7	15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	1,713	16.6	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 4 Tank Horizontal BiProp + SSUS-D

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0200	LES Vehicle	4	103	(432,831)	(4202.2)	18	18
0201	Vehicle Integration & Assembly	5	103	Incl. W 10-210	Incl. W 10-210	18	18
0210	Booster Stage	5	103	249,878	2426	18	18
0220	Delivery Stage	5	103	182,953	1776.2	18	18
0221	Integration & Assembly - Del. Stg.	5	103	8,311	80.7	18	18
0222	Structure & Mechanism	5	103	10,853	105.4	18	18
0223	Thermal System	5	103	3,068	29.8	18	18
0224	Main Propulsion	5	103	64,254	623.8	18	18
0225	Reaction Control System	5	103	21,471	208.5	15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	1,713	16.6	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 4 Tank Horizontal BiProp + SSUS-A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0200	LES Vehicle	4	103	(598,379)	(5809.5)	18	18
0201	Vehicle Integration & Assembly	5	103	Incl. W 10-210	Incl. W 10-210	18	18
0210	Booster Stage	5	103	374,817	3639	18	18
0220	Delivery Stage	5	103	223,562	2170.5	18	18
0221	Integration & Assembly - Del. Stg.	5	103	8,414	81.7	18	18
0222	Structure & Mechanism	5	103	10,853	105.4	18	18
0223	Thermal System	5	103	3,068	29.8	18	18
0224	Main Propulsion	5	103	64,254	623.8	18	18
0225	Reaction Control System	5	103	61,977	601.7	15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	1,713	16.6	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 2 Tank Horizontal Monopropellant

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0200	LES Vehicle	4	103	(137,460)	(1334.6)	18	18
0201	Vehicle Integration & Assembly	5	-	-	-	-	-
0210	Booster Stage	5	-	-	-	-	-
0220	Delivery Stage	5	103	137,460	1334.6	18	18
0221	Integration & Assembly - Del. Stg.	5	103	8,105	78.7	18	18
0222	Structure & Mechanism	5	103	10,140	98.4	18	18
0223	Thermal System	5	103	3,068	29.8	18	18
0224	Main Propulsion	5	103	41,231	400.3	15	15
0225	Reaction Control System	5	103	Incl W/Propulsion		15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	1,633	15.9	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 8 Tank Horizontal Monopropellant

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0200	LES Vehicle	4	103	(205,841)	(1998.5)	18	18
0201	Vehicle Integration & Assembly	5	-	-	-	-	-
0210	Booster Stage	5	-	-	-	-	-
0220	Delivery Stage	5	103	205,841	1998.5	18	18
0221	Integration & Assembly - Del. Stg.	5	103	10,618	103.1	18	18
0222	Structure & Mechanism	5	103	10,485	101.9	18	18
0223	Thermal System	5	103	3,087	30.0	18	18
0224	Main Propulsion	5	103	106,339	1032.4	15	15
0225	Reaction Control System	5	103	Incl. W/Propulsion		15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	2,029	19.7	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 2 Tank Vertical Monop

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	COSTS IN 1000'S OF $ AVG. UNIT	T_d	T_s
10-0200	LES Vehicle	4	103	(137,460)	(1334.6)	18	18
0201	Vehicle Integration & Assembly	5	-	-	-	-	-
0210	Booster Stage	5	-	-	-	-	-
0220	Delivery Stage	5	103	137,460	1334.6	18	18
0221	Integration & Assembly - Del. Stg.	5	103	8,105	78.7	18	18
0222	Structure & Mechanism	5	103	10,140	98.4	18	18
0223	Thermal System	5	103	3,068	29.8	18	18
0224	Main Propulsion	5	103	41,231	400.3	15	15
0225	Reaction Control System	5	103	Incl. W/ Propulsion	Incl. W/ Propulsion	15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	1,633	15.9	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 2 Tank Vertical Monop + SSUS-D

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $ TOTAL	AVG. UNIT	T_d	T_s
10-0200	LES Vehicle	4	103	(404,946)	(3931.5)	18	18
0201	Vehicle Integration & Assembly	5	103	Incl. W7 10-210	Incl. W7 10-210	18	18
0210	Booster Stage	5	103	249,878	2426	18	18
0220	Delivery Stage	5	103	155,068	1505.5	18	18
0221	Integration & Assembly - Del. Stg.	5	103	8,208	79.7	18	18
0222	Structure & Mechanism	5	103	12,365	120.0	18	18
0223	Thermal System	5	103	3,068	29.8	18	18
0224	Main Propulsion	5	103	41,231	400.3	15	15
0225	Reaction Control System	5	103	15,280	148.3	15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	1,633	15.9	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 2 Tank H/V Monop + SSUS-D

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0200	LES Vehicle	4	103	(404,946)	(3931.5)	18	18
0201	Vehicle Integration & Assembly	5	103	Incl. W 10-210	Incl. W 10-210	18	18
0210	Booster Stage	5	103	249,878	2426	18	18
0220	Delivery Stage	5	103	155,068	1505.5	18	18
0221	Integration & Assembly - Del. Stg.	5	103	8,208	79.7	18	18
0222	Structure & Mechanism	5	103	12,365	120.0	18	18
0223	Thermal System	5	103	3,068	29.8	18	18
0224	Main Propulsion	5	103	41,231	400.3	15	15
0225	Reaction Control System	5	103	15,280	148.3	15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	1,633	15.9	8	8

TABLE 4
DATA FORM A

LES BASIC COST DATA
PRODUCTION
CONFIGURATION: 2 Tank Horiz. Monop. + SSUS-A

WBS CODE	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	COSTS IN 1000'S OF $		T_d	T_s
				TOTAL	AVG. UNIT		
10-0200	LES Vehicle	4	103	(545,049)	(5291.7)	18	18
0201	Vehicle Integration & Assembly	5	103	Incl. W 10-210	Incl. W 10-210	18	18
0210	Booster Stage	5	103	374,817	3639	18	18
0220	Delivery Stage	5	103	170,232	1652.7	18	18
0221	Integration & Assembly - Del. Stg.	5	103	8,311	80.7	18	18
0222	Structure & Mechanism	5	103	12,365	120.0	18	18
0223	Thermal System	5	103	3,068	[illegible]9.8	18	18
0224	Main Propulsion	5	103	41,231	400.3	15	15
0225	Reaction Control System	5	103	30,341	294.6	15	15
0226	Data Management/Communications	5	103	987	9.6	2	2
0227	Guidance, Navigation & Control	5	103	72,296	701.9	12	12
0228	Electrical Power System	5	103	1,633	15.9	8	8

TABLE 5
DATA FORM 5

SCENARIO NO. B-1
Cost Summary
SCENARIO COSTS $M

WBS NO.	COST ITEM / Propulsion Approach	Integ. OMS	Modular 4 Tank Horiz. BiProp.*	Modular 8 Tank Horiz. BiProp.	Modular 4 Tank Horiz. BiProp** SSUS-A	Modular 4 Tank Horiz. BiProp* SSUS-D			NON RECUR COST	TOTAL COST
	NUMBER OF PAYLOADS	16	90	16	5	1				
1-D	DDT&E								28.8	28.8
1-P	PRODUCTION	0	158.1	34.2	29.0	4.2				225.5
1-0	OPERATIONS - TOTAL	283.7	770.7	178.8	43.7	4.8				1,281.7
	(Supporting Costs)	0	(46.1)	(8.2)	(2.6)	(.5)				(57.4)
	(Shuttle Charge Total)	(283.7)	(724.6)	(170.6)	(41.1)	(4.3)				(1224.3)
	• Payload Charge	280.5	552.1	138.8	12.5	1.3				985.2
	• Stage Charge	-	172.5	31.8	28.6	3.0				235.9
	• Other Charges	3.2	-	-	-	-				3.2
	(Scout Launch Charge)	-	-	-	-	-				0
	TOTAL COST	283.7	928.8	213.0	72.7	9.0			28.8	1536.0

** 304 Kg Offload
* 415 Kg Offload

Total Without Payload Charge	550.8

TABLE 5
DATA FORM 5

SCENARIO NO. B-2
Cost Summary
SCENARIO COSTS $M

WBS NO.	COST ITEM \ Propulsion Approach	Integ OMS	Modular 4 Tank Horiz.* Biprop	Modular 8 Tank Horiz Biprop	Modular 4 Tank Vert. Biprop*	Modular 4 Tank Vert.* Biprop SSUS-A	Modular 4 Tank Vert.* Biprop SSUS-D		NON RECUR COST	TOTAL COST
	NUMBER OF PAYLOADS	16	76	16	14	5	1			
1-D	DDT&E								31.6	31.6
1-P	PRODUCTION	0	133.5	34.2	24.8	29.0	4.2			225.7
1-O	OPERATIONS - TOTAL	283.7	697.4	178.8	63.7	44.1	4.3			1272.0
	(Supporting Costs)	0	(38.9)	(8.2)	(7.2)	(2.6)	(0.5)			(57.4)
	(Shuttle Charge Total)	(283.7)	(658.5)	(170.6)	(56.5)	(41.5)	(3.8)			(1214.6)
	• Payload Charge	280.5	532.4	138.8	18.1	12.5	0.2			982.5
	• Stage Charge		126.1	31.8	38.4	29.0	3.6			228.9
	• Other Charges	3.2								3.2
	(Scout Launch Charge)									
	TOTAL COST	283.7	830.9	213.0	88.3	73.1	8.5		31.6	1529.3
									Total Without Payload Charge	546.8

*415 Kg Offload

TABLE 5
DATA FORM 5

SCENARIO NO. B-3
Cost Summary
SCENARIO COSTS $M

WBS NO.	NUMBER OF PAYLOADS / COST ITEM — Propulsion Approach	16 Integ. OMS	76 Modular 4 tank Horiz. BiProp*	13 Modular 8 Tank Horiz. BiProp	14 Modular 4 Tank Vert. BiProp*	3 Modular 12 Tank Vert. BiProp	5 Modular 4 Tank Horiz BiProp** SSUS-A	1 Modular 4 Tank Horiz BiProp* SSUS-D	NON RECUR COST	TOTAL COST
1-D	DDT&E								44.4	44.4
1-P	PRODUCTION	0	133.5	27.8	25.5	7.2	29.0	4.2		227.2
1-0	OPERATIONS - TOTAL	283.7	697.4	165.8	59.5	5.9	43.7	4.8		1260.8
	(Supporting Costs)	0	(38.9)	(6.7)	(7.2)	(1.5)	(2.6)	(.5)		(57.4)
	(Shuttle Charge Total)	(283.7)	(658.5)	(159.1)	(52.3)	(4.4)	(41.1)	(4.3)		(1203.4)
	• Payload Charge	280.5	532.4	131.3	18.1	0.1	12.5	1.3		976.2
	• Stage Charge	-	126.1	27.8	34.2	4.3	28.6	3.0		224.0
	• Other Charges	3.2								3.2
	(Scout Launch Charge)	-								
	TOTAL COST	283.7	830.9	193.6	85.0	13.1	72.7	9.0	44.4	1532.4
	Total Without Payload Charge									556.2

** 304 KG Offload
* 415 KG Offload

TABLE 5
DATA FORM 5

SCENARIO NO. B-4
Cost Summary
SCENARIO COSTS $M

WBS NO.	NUMBER OF PAYLOADS / COST ITEM \ Propulsion Approach	16 Integ. OMS	90 Modular 4 Tank Horiz. BiProp.	17 Modular 4 Tank Horiz. BiProp* SSUS-D	5 Modular 4 Tank Horiz. BiProp** SSUS-A				NON RECUR COST	TOTAL COST
1-D	DDT&E								26.5	26.5
1-P	PRODUCTION	0	158.1	71.4	29.0					258.5
1-0	OPERATIONS - TOTAL	283.7	770.7	233.2	43.7					1331.3
	(Supporting Costs)	0	(46.1)	(8.7)	(2.6)					(57.4)
	(Shuttle Charge Total)	(283.7)	(724.6)	(224.5)	(41.1)					(1273.9)
	• Payload Charge	280.5	552.1	143.3	12.5					988.4
	• Stage Charge	0	172.5	81.2	28.6					282.3
	• Other Charges	3.2	-	-	-					3.2
	(Scout Launch Charge)	-	-	-	-					
	TOTAL COST	283.7	928.8	304.6	72.7				26.5	1616.3
	Total Without Payload Charge									627.9

** 304 KG Offload
* 415 KG Offload

TABLE 5
DATA FORM 5

SCENARIO NO. B-5
Cost Summary
SCENARIO COSTS $M

WBS NO.	COST ITEM \ Propulsion Approach	Integ OMS	Modular 4 Tank Horiz.* BiProp	Modular 4 Tank Vert.* BiProp	Modular 4 Tank Horiz. BiProp* SSUS-D	Modular 4 Tank Horiz. BiProp** SSUS-A			NON RECUR COST	TOTAL COST
	NUMBER OF PAYLOADS	16	76	14	17	5				
1-D	DDT&E								28.1	28.1
1-P	PRODUCTION	0	133.5	24.8	71.4	29.0				258.7
1-O	OPERATIONS - TOTAL	283.7	697.4	63.7	233.2	43.7				1321.7
	(Supporting Costs)	0	(38.9)	(7.2)	(8.7)	(2.6)				(57.4)
	(Shuttle Charge Total)	(283.7)	(658.5)	(56.5)	(224.5)	(41.1)				(1264.3)
	• Payload Charge	280.5	532.4	18.1	143.3	12.5				986.8
	• Stage Charge	-	126.1	38.4	81.2	28.6				274.3
	• Other Charges	3.2	-	-	-	-				3.2
	(Scout Launch Charge)	-	-	-	-	-				
	TOTAL COST	283.7	830.9	88.5	304.6	72.7			28.1	1608.5

Total Without Payload Charge	621.7

** 304 Kg Offload
* 415 Kg Offload

TABLE 5
DATA FORM 5

SCENARIO NO. M-1
Cost Summary
SCENARIO COSTS $M

WBS NO.	COST ITEM \ Propulsion Approach	Integ. OMS	Modular 2 Tank Horiz. MonoProp	Modular 8 Tank Horiz. MonoProp	Modular 2 Tank Hor/Vert MonoProp SSUS-D	Modular 2 Tank Horiz. MonoProp SSUS-A			NON RECUR COST	TOTAL COST
	NUMBER OF PAYLOADS	16	89	13	5	5				
1-D	DDT&E								27.0	27.0
1-P	PRODUCTION	0	118.8	26.0	19.7	26.5				191.0
1-0	OPERATIONS - TOTAL	283.7	778.7	175.7	29.1	45.8				1313.0
	(Supporting Costs)	0	(45.6)	(6.7)	(2.6)	(2.6)				(57.5)
	(Shuttle Charge Total)	(283.7)	(733.1)	(169.0)	(26.5)	(43.2)				(1255.5)
	• Payload Charge	280.5	534.9	69.3	5.3	12.5				902.5
	• Stage Charge	-	198.2	99.7	21.2	29.7				348.8
	• Other Charges	3.2	-	-	-	1.0				4.2
	(Scout Launch Charge)	-	-	-	-	-				0
	TOTAL COST	283.7	897.5	201.7	48.8	72.3			27.0	1531.0

Total Without Payload Charge: 628.5

TABLE 5
DATA FORM 5

SCENARIO NO. M-2
Cost Summary
SCENARIO COSTS $M

WBS NO.	COST ITEM \ Propulsion Approach	Integ. OMS	Modular 2 Tank Horiz. MonoP.	Modular 8 Tank Horiz. MonoP.	Modular 2 Tank Vert. MonoP.	Modular 2 Tank Hor/Vert MonoP. SSUS-D	Modular 2 Tank Vert. MonoP. SSUS-A		NON RECUR COST	TOTAL COST
	NUMBER OF PAYLOADS	16	75	13	14	5	5			
1-D	DDT&E								27.7	27.7
1-P	PRODUCTION	0	100.1	26.0	18.7	19.7	26.5			191.0
1-0	OPERATIONS - TOTAL	283.7	701.4	175.7	66.8	29.1	45.8			1302.5
	(Supporting Costs)	0	(38.4)	(6.7)	(7.2)	(2.6)	(2.6)			(57.5)
	(Shuttle Charge Total)	(283.7)	(663.0)	(169.0)	(59.6)	(26.5)	(43.2)			(1245.0)
	• Payload Charge	280.5	514.9	69.3	18.1	5.3	12.5			900.6
	• Stage Charge	-	148.1	99.7	41.5	21.2	29.7			340.2
	• Other Charges	3.2	-	-	-	-	1.0			4.2
	(Scout Launch Charge)	-	-	-	-	-	-			0
	TOTAL COST	283.7	801.5	201.7	85.5	48.8	72.3		27.7	1521.2
	Total Without Payload Charge									620.6

TABLE 5
DATA FORM 5

SCENARIO NO. M-3
Cost Summary
SCENARIO COSTS $M

WBS NO.	NUMBER OF PAYLOADS / COST ITEM \ Propulsion Approach	16 Integ. OMS	89 Modular 2 Tank Horiz. MonoP.	18 Modular 2 Tank Hor/Vert Monop. SSUS-D	5 Modular 2 Tank Hor/Vert MonoP. SSUS-A				NON RECUR COST	TOTAL COST
1-D	DDT&E								23.3	23.3
1-P	PRODUCTION	0	118.8	70.8	26.5					216.1
1-0	OPERATIONS - TOTAL	283.7	778.7	252.7	45.8					1360.9
	(Supporting Costs)	0	(45.6)	(9.2)	(2.6)					(57.4)
	(Shuttle Charge Total)	(283.7)	(733.1)	(243.5)	(43.2)					(1303.5)
	• Payload Charge	280.5	534.9	147.9	12.5					975.8
	• Stage Charge	-	198.2	95.6	29.7					323.5
	• Other Charges	3.2	-	-	1.0					4.2
	(Scout Launch Charge)	-	-	-	-					0
	TOTAL COST	283.7	897.5	323.5	72.3				23.3	1600.3

Total Without Payload Charge 624.5

TABLE 5
DATA FORM 5

SCENARIO NO. M-4
Cost Summary
SCENARIO COSTS $M

WBS NO.	NUMBER OF PAYLOADS	16	75	14	18	5				
	COST ITEM / Propulsion Approach	Integ. OMS	Modular 2 Tank Horiz. MonoP.	Modular 2 Tank Vert. MonoP.	Modular 2 Tank Horiz. MonoP. SSUS-D	Modular 2 Tank Horiz. MonoP. SSUS-A			NON RECUR COST	TOTAL COST
1-D	DDT&E								24.2	24.2
1-P	PRODUCTION	0	100.1	18.7	70.8	26.5				216.1
1-0	OPERATIONS - TOTAL	283.7	701.4	66.8	252.7	45.8				1350.4
	(Supporting Costs)	0	(38.4)	(7.2)	(9.2)	(2.6)				(57.4)
	(Shuttle Charge Total)	(283.7)	(663.0)	(59.6)	(243.5)	(43.2)				(1293.0)
	• Payload Charge	280.5	514.9	18.1	147.9	12.5				973.9
	• Stage Charge	-	148.1	41.5	95.6	29.7				314.9
	• Other Charges	3.2	-	-	-	1.0				4.2
	(Scout Launch Charge)	-	-	-	-	-				0
	TOTAL COST	283.7	801.5	85.5	323.5	72.3			24.2	1590.7

Total Without Payload Charge 616.8

TABLE 5
DATA FORM 5

SCENARIO NO. E-1
Cost Summary
SCENARIO COSTS $M

WBS NO.	COST ITEM \ Propulsion Approach	Integ. OMS	MMS PM II	TRS 2 Tank	TRS 4 Tank	Scout	Integ. OMS + SSUS-D		NON RECUR COST	TOTAL COST
	NUMBER OF PAYLOADS	16	25	63	11	11	3			
1-D	DDT&E								0	0
1-P	PRODUCTION	0	24.4	45.0	17.8	0	7.3			94.5
1-0	OPERATIONS - TOTAL	283.7	260.0	696.2	181.7	66.2	20.9			1508.7
	(Supporting Costs)	0	(17.5)	(38.8)	(6.5)	(19.2)	2.9			84.9
	(Shuttle Charge Total)	(283.7)	(242.5)	(657.4)	(175.2)		(18.0)			(1376.8)
	• Payload Charge	280.5	179.4	347.8	136.6		7.0			951.3
	• Stage Charge		63.1	309.6	38.6		10.4			421.7
	• Other Charges	3.2					.6			3.8
	(Scout Launch Charge)					(47.0)				(47.0)
	TOTAL COST	283.7	284.4	741.2	199.5	66.2	28.2		0	1603.2
	Total Without Payload Charge									651.9

TABLE 5
DATA FORM 5

SCENARIO NO. E-2
Cost Summary
SCENARIO COSTS $M

WBS NO.	NUMBER OF PAYLOADS	16	88	11	11	3				
	COST ITEM \ Propulsion Approach	Integ OMS	TRS 2 Tank	TRS 4 Tank	Scout	Integ. OMS + SSUS-D			NON RECUR COST	TOTAL COST
1-D	DDT&E								0	0
1-P	PRODUCTION	0	58.4	17.8	0	7.3				83.5
1-0	OPERATIONS - TOTAL	283.7	981.9	182.0	66.2	20.9				1534.7
	(Supporting Costs)	0	(47.4)	(6.8)	(19.2)	2.9				(76.3)
	(Shuttle Charge Total)	(283.7)	(934.5)	(175.2)	-	(18.0)				(1411.4)
	• Payload Charge	280.5	458.4	136.6	-	7.0				882.5
	• Stage Charge	-	476.0	38.6	-	10.4				525.0
	• Other Charges	3.2	-	-	-	.6				3.8
	(Scout Launch Charge)	-	-	-	(47.0)					(47.0)
	TOTAL COST	283.7	1040.3	199.8	66.2	28.2			0	1618.2

Total Without Payload Charge	735.7

TABLE 5
DATA FORM 5

SCENARIO NO. E-3
Cost Summary
SCENARIO COSTS $M

WBS NO.	COST ITEM \ Propulsion Approach	Integ OMS	OMS 1 Kit	OMS 1 Kit + SSUS-D	Integ OMS + SSUS-D + Elliptic Orbit	Scout			NON RECUR COST	TOTAL COST
	NUMBER OF PAYLOADS	34	34	49	1	11				
1-D	DDT&E								0	0
1-P	PRODUCTION	0	0	118.9	2.4	0				121.3
1-0	OPERATIONS - TOTAL	405.1	539.0	1143.0	10.8	66.2				2164.1
	(Supporting Costs)	0	0	34.0	1.2	(19.2)				(54.4)
	(Shuttle Charge Total)	(405.1)	(539.0)	(1109.0)	(9.6)	-				(2062.7)
	• Payload Charge	359.0*	111.6	146.2	4.9	-				633.0
	• Stage Charge	39.3	400.2	923.6	4.5	-				1356.3
	• Other Charges	6.8	27.2	39.2	0.2	-				73.4
	(Scout Launch Charge)			-	-	(47.0)				(47.0)
	TOTAL COST	405.1	539.0	1261.9	13.2	66.2			0	2285.4
	Total Without Payload Charge									1652.4

*ASE Charge

TABLE 5
DATA FORM 5

SCENARIO NO. E-4
Cost Summary
SCENARIO COSTS $M

WBS NO.	COST ITEM / Propulsion Approach	Integ. OMS	OMS 1 Kit	TRS 2 Tank	TRS 4 Tank	Scout	SSUS-D		NON RECUR COST	TOTAL COST
	NUMBER OF PAYLOADS	34	34	39	10	11	1			
1-D	DDT&E								0	0
1-P	PRODUCTION	0	0	32.0	17.1	0	2.4			51.5
1-0	OPERATIONS - TOTAL	404.9	539.6	507.0	171.5	66.2	10.8			1700.0
	(Supporting Costs)	0	0	(21.0)	(6.1)	(19.2)	1.2			(47.5)
	(Shuttle Charge Total)	(404.9)	(539.6)	(486.0)	(165.4)	-	(9.6)			(1605.5)
	• Payload Charge	371.6	108.1	280.5	128.5	-	4.9			893.6
	• Stage Charge	26.5	404.3	205.5	36.9	-	4.5			677.7
	• Other Charges	6.8	27.2	-	-	-	0.2			34.2
	(Scout Launch Charge)	-	-	-	-	(47.0)	-			(47.0)
	TOTAL COST	404.9	539.6	539.0	188.6	66.2	13.2		0	1751.5
									Total Without Payload Charge	857.9

TABLE 5
DATA FORM 5

SCENARIO NO. E-5
Cost Summary
SCENARIO COSTS $M

WBS NO.	COST ITEM \ Propulsion Approach	Integ. OMS	OMS 1 Kit	OMS 1 Kit + SSUS	MMS	MMS + Integ. OMS	MMS + 1 Kit	Scout	Integ. OMS + SSUS-D	NON RECUR COST	TOTAL COST
	NUMBER OF PAYLOADS	30	15	35	25	1	10	11	1		
1-D	DDT&E									0	0
1-P	PRODUCTION	0	0	84.9	24.4	1.0	9.8	0	2.4		122.5
1-0	OPERATIONS - TOTAL	377.7	208.3	819.7	264.7	9.3	233.3	66.2	10.8		1990.0
	(Supporting Costs)	0	0	23.3	(22.2)	(.9)	(8.9)	(19.2)	1.2		(75.7)
	(Shuttle Charge Total)	(377.7)	(208.3)	(796.4)	(242.5)	(8.4)	(224.4)	-	(9.6)		(1867.3)
	• Payload Charge	345.4	28.9	77.8	179.4	8.2	59.0	-	4.9		703.6
	• Stage Charge	26.5	167.4	690.6	63.1	-	157.4	-	4.5		1109.5
	• Other Charges	5.8	12.0	28.0	-	0.2	8.0	-	0.2		54.2
	(Scout Launch Charge)	-	-	-	-	-	-	(47.0)			(47.0)
	TOTAL COST	377.7	208.3	904.6	289.1	10.3	243.1	66.2	13.2	0	2112.5
	Total Without Payload Charge										1408.9

TABLE 5
DATA FORM 5

SCENARIO NO. C-1

COST SUMMARY
SCENARIO COSTS $M

WBS NO.	COST ITEM \ Propulsion Approach	Integ. OMS	Modular 4-Tank Horiz. Biprop.*	Modular 8-Tank Horiz. Biprop.	Scout				NON RECUR COST	TOTAL COST
	NUMBER OF PAYLOADS	16	90	13	10					
1-D	DDT&E								23.3	23.3
1-P	PRODUCTION	0	158.1	27.8	0					185.9
1-0	OPERATIONS - TOTAL	283.7	772.3	166.0	57.6					1279.6
	(Supporting Costs)	0	(47.7)	(6.9)	(14.4)					(69.0)
	(Shuttle Charge Total)	(283.7)	(724.6)	(159.1)						1167.4
	• Payload Charge	280.5	552.1	131.3						963.9
	• Stage Charge		172.5	27.8						200.3
	• Other Charges	3.2								3.2
	(Scout Launch Charge)				(43.2)					(43.2)
	TOTAL COST	283.7	930.4	193.8	57.6				23.3	1488.8

*415 Kg Offload

Total Without Payload Charge: 524.9

TABLE 5
DATA FORM 5

SCENARIO NO. C-2
COST SUMMARY
SCENARIO COSTS $M

WBS NO.	NUMBER OF PAYLOADS / COST ITEM \ Propulsion Approach	16 INTEG OMS	76 Modular 4-Tank Horiz.** Biprop.	13 Modular 8-Tank Horiz. Biprop.	14 Modular 4-Tank Vert.** Biprop.	10 Scout			NON RECUR COST	TOTAL COST
1-D	DDT&E								26.1	26.1
1-P	PRODUCTION	0	133.5	27.8	24.8	0				186.1
1-O	OPERATIONS - TOTAL	283.7	698.7	166.0	63.9	57.6				1269.9
	(Supporting Costs)	0	(40.2)	(6.9)	(7.4)	(14.4)				*(68.9)
	(Shuttle Charge Total)	(283.7)	(658.5)	(159.1)	(56.5)	---				1157.8
	• Payload Charge	280.5	532.4	131.3	18.1	---				962.3
	• Stage Charge	---	126.1	27.8	38.4	---				192.3
	• Other Charges	3.2	---	---	---	---				3.2
	(Scout Launch Charge)	---	---	---	---	(43.2)				(43.2)
	TOTAL COST	283.7	832.2	193.8	88.7	57.6			26.1	1482.1

*Supporting costs include:

Annual Operations Cost		36.9
Unit Operations cost	(23.6 + 4.0 + 4.3)	32.0
	Total	68.9

Total Without Payload Charge 519.8

**415 Kg Offload, Refer to paragraph 4.7.1 of Volume III

TABLE 5
DATA FORM 5

SCENARIO NO. C-3
COST SUMMARY
SCENARIO COSTS $M

WBS NO.	NUMBER OF PAYLOADS	16	76	14	13	10	=129 Total P/L			
	COST ITEM / Propulsion Approach	Integ. OMS	Modular 4-Tank Horiz. * Biprop.	Modular 4-Tank VERT * Biprop.	Modular 4-Tank* Horz/Vert Mount SSUS D	Scout			NON RECUR COST	TOTAL COST
1-D	DDT&E								23.4	23.4
1-P	PRODUCTION	0	133.5	24.8	54.6	0				212.9
1-0	OPERATIONS - TOTAL	283.7	698.7	63.9	214.3	57.6				1318.2
	(Supporting Costs)	0	(40.2)	(7.4)	(6.9)	(14.4)				(68.9)
	(Shuttle Charge Total)	(283.7)	(658.5)	(56.5)	(207.4)					(1206.1)
	• Payload Charge	280.5	532.4	18.1	138.2					969.2
	• Stage Charge		126.1	38.4	69.2					233.7
	• Other Charge	3.2								3.2
	(Scout Launch Charge)					43.2				(43.2)
	TOTAL COST	283.7	832.2	88.7	268.9	57.6			23.4	1554.5
									Total Without Payload Charge	585.3

* 415 Kg Offload

TABLE 5
DATA FORM 5

SCENARIO NO. C-4
COST SUMMARY
SCENARIO COSTS $M

WBS NO.	NUMBER OF PAYLOADS	16	25	65	13	10				
	COST ITEM / Propulsion Approach	Integ. OMS	MMS	Modular 4-Tank Horiz.* Biprop.	Modular 8-Tank Horiz. Biprop.	Scout			NON RECUR COST	TOTAL COST
1-D	DDT&E								23.3	23.3
1-P	PRODUCTION	0	24.4	114.2	27.8	0				166.4
1-O	OPERATIONS - TOTAL	283.7	260.0	550.6	166.9	57.6				1318.8
	(Supporting Costs)	0	(17.5)	(39.0)	(7.8)	(14.4)				78.7
	(Shuttle Charge Total)	(283.7)	(242.5)	(511.6)	(159.1)					(1196.9)
	• Payload Charge	280.5	179.4	372.7	131.3					963.9
	• Stage Charge		63.1	138.9	27.8					229.8
	• Other Charges	3.2								3.2
	(Scout Launch Charge)					(43.2)				(43.2)
	TOTAL COST	283.7	284.4	664.8	194.7	57.6			23.3	1508.5

* 415 Kg Offload

Total Without Payload Charge: 544.6

TABLE C
SCENARIO DESCRIPTION
MODULAR BIPROPELLANT SCENARIO B-1

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 4-TANK	MODE-3 8-TANK	MODE-4 4-TANK SSUS-A	MODE-5 4-TANK SSUS-D	MODE-6
1	12		6	6					
2	13,14,15		10	10					
3	27		3		3				
4	43		1		1				
5	21,32,33,34	M	10			10			
6	11	M	1		1				
7	2		4		4				
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31, 35-39	M	18		18				
11	19,42		3		3				
12	22,28,44,46		19		19				
13	3		2			2			
14	45		12		12				
15	7,8		3		3				
16	5,24	V	4		4h				
17	4		3		3				
18	6,40	V	4		4h				
19	16		1		1				
20	41	V	3		3h				
21	1		1		1				
22	9		1			1			
23	20	V	1		1h				
24	52	V	1		1h				
25	52		3				3h		
26	48	V	1					1v	
27	49	V	~~1~~						
28	53	V	2				2h		
29	47,51,50	V	3			3h			
30	17	V	1		1h				
-	TOTAL		128	16	90	16	5	1	

CODE M - MMS Payload, Candidate for PM-11.
V - Candidate for Vertical Installation.
h - horizontal Installation
v - vertical Installation
* - From Volume III, Table 4-II

TABLE 6
SCENARIO DESCRIPTION
MODULAR BIPROPELLANT SCENARIO - B-2

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 4-TANK	MODE-3 8-TANK	MODE-4 4-TANK VERT.	MODE-5 4-TANK VERT. +SSUS-A	MODE-6 4-TANK VERT. +SSUS-D
1	12		6	6					
2	13, 14, 15		10	10					
3	27		3		3				
4	43		1		1				
5	21, 32, 33, 34	M	10			10			
6	11	M	1		1				
7	2		4		4				
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31,35-39	M	18		18				
11	19, 42		3		3				
12	22, 28, 44, 46		19		19				
13	3		2			2			
14	45		12		12				
15	7, 8		3		3				
16	5, 24	V	4				4v		
17	4		3		3				
18	6, 40	V	4				4v		
19	16		1		1				
20	41	V	3				3v		
21	1		1		1				
22	9		1			1			
23	20	V	1				1v		
24	52	V	1				1v		
25	52		3					3 h	
26	48	V	1						1v
27	49	V	~~X~~						
28	53	V	2					2 h	
29	47, 51, 50	V	3			3h			
30	17	V	1				1v		
TOTAL			128	16	76	16	14	5	1

CODE M - MMS Payload, Candidate for PM-11
V - Candidate for Vertical Installation
h - horizontal Installation
v - vertical Installation
* - From Volume III, Table 4-II

TABLE 6
SCENARIO DESCRIPTION
MODULAR BIPROPELLANT SCENARIO B-3

PAYLOAD GROUP NO.	PAYLOADS: PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	LAUNCH MODES: MODE 1 OMS	MODE 2 4-TANK BIP	MODE 3 8-TANK	MODE 4 4-TANK VERT	MODE 5 12-TANK VERT	MODE 6 4-TANK SSUS-A	MODE 7 4-TANK SSUS-D
1	12		6	6						
2	13,14,15		10	10						
3	27		3		3					
4	43		1		1					
5	21,32,33,34	M	10			10				
6	11	M	1		1					
7	2		4		4					
8	10	M	4		4					
9	23	M	3		3					
10	18,25,29-31, 35-39	M	18		18					
11	19,42		3		3					
12	22,28,44,46		19		19					
13	3		2			2				
14	45		12		12					
15	7,8		3		3					
16	5,24	V	4				4v			
17	4		3		3					
18	6,40	V	4				4v			
19	16		1		1					
20	41	V	3				3v			
21	1		1							
22	9		1			1				
23	20	V	1				1v			
24	52	V	1				1v			
25	52		3						3h	
26	48	V	1							1v
27	49	V	1							
28	53	V	2						2h	
29	47,51,50	V	3					3v		
30	17	V	1				1v			
	TOTAL		128	16	76	13	14	3	5	1

CODE M - MMS Payload, Candidate for PM-11

V - Candidate for Vertical Installation
h - horizontal Installation
v - vertical Installation
* - From Volume III, Table 4-II

TABLE 6

SCENARIO DESCRIPTION

MODULAR BIPROPELLANT SCENARIO B-4

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG. OMS	MODE-2 4-TANK	MODE-3 4-TANK SSUS-D	MODE-4 4-TANK SSUS-A	MODE-5	MODE-6
1	12		6	6					
2	13,14,15		10	10					
3	27		3		3				
4	43		1		1				
5	21,32,33,34	M	10			10h			
6	11	M	1		1				
7	2		4		4				
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31, 35-39	M	18		18				
11	19,42		3		3				
12	22,28,44,46		19		19				
13	3		2			2v			
14	45		12		12				
15	7,8		3		3				
16	5,24	V	4		4h				
17	4		3		3				
18	6,40	V	4		4h				
19	16		1		1				
20	41	V	3		3h				
21	1		1		1				
22	9		1			1h			
23	20	V	1		1h				
24	52	V	1		1h				
25	52		3				3h		
26	48	V	1			1v			
27	49	V	[illegible]						
28	53	V	2				2h		
29	47,51,50	V	3			3v			
30	17	V	1		1h				
	TOTAL		128	16	90	17	5		

CODE M - MMS Payload, Candidate for PM-11.
V - Candidate for Vertical Installation.
h - horizontal Installation
v - vertical Installation
* - From Volume III, Table 4-II

TABLE 6

SCENARIO DESCRIPTION

MODULAR BIPROPELLANT SCENARIO B-5

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 4-TANK	MODE-3 4-TANK VERT	MODE-4 4-TANK SSUS-D	MODE-5 4-TANK SSUS-A	MODE-6
1	12		6	6					
2	13,14,15		10	10					
3	27		3		3				
4	43		1		1				
5	21,32,33,34	M	10				10h		
6	11	M	1		1				
7	2		4		4				
8	10	M			4				
9	23	M	3		3				
10	18,25,29-31, 35-39	M	18		18				
11	19,42		3		3				
12	22,28,44,46		19		19				
13	3		2				2h		
14	45		12		12				
15	7,8		3		3				
16	5,24	V	4			4v			
17	4		3		3				
18	6,40	V	4			4v			
19	16		1		1				
20	41	V	3			3v			
21	1		1		1				
22	9		1				1h		
23	20	V	1			1v			
24	52	V	1			1v			
25	52		3					3h	
26	48	V	1				1v		
27	49	V	[illegible]						
28	53	V	2					2h	
29	47,51,50	V	3				3v		
30	17	V	1			1v			
	TOTAL		128	16	76	14	17	5	

CODE M - MMS Payload, Candidate for PM-11.
V - Candidate for Vertical Installation.
h - horizontal Installation
v - vertical Installation
* - From Volume III, Table 4-II

TABLE 6
SCENARIO DESCRIPTION
MODULAR MONOPROPELLANT SCENARIO M-1

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 2 TANK	MODE-3 8 TANK	MODE-4 2 TANK SSUS-D	MODE-5 2 TANK SSUS-A	MODE-6
1	12		6	6					
2	13,14,15		10	10					
3	27		3		3				
4	43		1		1				
5	21,32,33,34	M	10			10			
6	11	M	1			1			
7	2		4		4				
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31, 35-39	M	18		18				
11	19,42		3		3				
12	22,28,44,46		19		19				
13	3		2			2			
14	45		12		12				
15	7,8		3		3				
16	5,24	V	4		4h				
17	4		3		3				
18	6,40	V	4		4h				
19	16		1		1				
20	41	V	3		3h				
21	1		1		1				
22	9		1				1h		
23	20	V	1		1h				
24	52	V	1		1h				
25	52		3					3h,e	
26	48	V	1				1v		
27	49	V	~~1~~						
28	53	V	2					2h,e	
29	47,51,50	V	3				3v		
30	17	V	1		1h				
	TOTAL		128	16	89	13	5	5	

CODE M - **MMS Payload, Candidate for PM-11.**
V - **Candidate for Vertical Installation.**
h - horizontal Installation
v- Vertical Installation
e - Elliptical Shuttle Orbit
* - From Volume III, Table 4-II

TABLE 6
SCENARIO DESCRIPTION
MODULAR MONOPROPELLANT SCENARIO M-2

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 2-TANK	MODE-3 8-TANK	MODE-4 2-TANK VERT.	MODE-5 2-TANK VERT. +SSUS-D	MODE-6 2-TANK VERT. +SSUS-A
1	12		6	6					
2	13, 14, 15		10	10					
3	27		3		3				
4	43		1		1				
5	21, 32, 33, 34	M	10			10			
6	11	M	1			1			
7	2		4		4				
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31,35-39	M	18		18				
11	19, 42		3		3				
12	22, 28, 44, 46		19		19				
13	3		2			2			
14	45		12		12				
15	7, 8		3		3				
16	5, 24	V	4				4v		
17	4		3		3				
18	6, 40	V	4				4v		
19	16		1		1				
20	41	V	3				3v		
21	1		1		1				
22	9		1					1h	
23	20	V	1				1v		
24	52	V	1				1v		
25	52		3						3h, e
26	48	V	1					1v	
27	49	V	X						
28	53	V	2						2h, e
29	47, 51, 50	V	3					3v	
30	17	V	1				1v		
TOTAL			128	16	75	13	14	5	5

CODE M - MMS Payload, Candidate for PM-11
V - Candidate for Vertical Installation
h - horizontal Installation
v - vertical Installation
e - Elliptical Shuttle Orbit
* - From Volume III, Table 4-II

TABLE 6
SCENARIO DESCRIPTION
MODULAR MONOPROPELLANT SCENARIO M-3

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 2-TANK	MODE-3 2-TANK SSUS-D	MODE-4 2-TANK SSUS-A	MODE-5	MODE-6
1	12		6	6					
2	13,14,15		10	10					
3	27		3		3				
4	43		1		1				
5	21,32,33,34	M	10			10 h			
6	11	M	1			10 h			
7	2		4		4				
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31, 35-39	M	18		18				
11	19,42		3		3				
12	22,28,44,46		19		19				
13	3		2			2 h			
14	45		12		12				
15	7,8		3		3				
16	5,24	V	4		4 h				
17	4		3		3				
18	6,40	V	4		4 h				
19	16		1		1				
20	41	V	3		3 h				
21	1		1		1				
22	9		1			1 h			
23	20	V	1		1 h				
24	52	V	1		1 h				
25	52		3				3h,e		
26	48	V	1			1 v			
27	49	V	X						
28	53	V	2				2h,e		
29	47,51,50	V	3			3 v			
30	17	V	1		1 h				
	TOTAL		128	16	89	18	5		

CODE M - MMS Payload, Candidate for PM-11.
V - Candidate for Vertical Installation.
h - horizontal Installation
v - vertical Installation
e - Elliptical Shuttle Orbit
* - From Volume III, Table 4-II

TABLE 6
SCENARIO DESCRIPTION
MODULAR MONOPROPELLANT SCENARIO M-4

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1	MODE-2	MODE-3	MODE-4	MODE-5	MODE-6
				INTEG OMS	2-TANK	2-TANK	2-TANK SSUS-D	2-TANK SSUS-A	
1	12		6	6					
2	13,14,15		10	10					
3	27		3		3				
4	43		1		1				
5	21,32,33,34	M	10				10h		
6	11	M	1				1h		
7	2		4		4				
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31, 35-39	M	18		18				
11	19,42		3		3				
12	22,28,44,46		19		19				
13	3		2				2h		
14	45		12		12				
15	7,8		3		3				
16	5,24	V	4			4V			
17	4		3		3				
18	6,40	V	4			4V			
19	16		1		1				
20	41	V	3			3V			
21	1		1		1				
22	9		1				1h		
23	20	V	1			1V			
24	52	V	1			1V			
25	52		3					3h,e	
26	48	V	1			1V			
27	49	V	*						
28	53	V	2					2h,e	
29	47,51,50	V	3				3v		
30	17		1			1V			
	TOTAL		128	16	75	14	18	5	

CODE M - MMS Payload, Candidate for PM-11.
V - Candidate for Vertical Installation.
h - horizontal Installation
v - vertical Installation
e - Elliptical Shuttle Orbit
* - From Volume III, Table 4-II

TABLE 6

SCENARIO DESCRIPTION

EXISTING/PLANNED SCENARIO - E-1

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 MMS PM-II	MODE-3 TRS 2-TANK	MODE-4 TRS 4-TANK	MODE-5 SCOUT	MODE-6 SSUS-D
1	12		6	6					
2	13, 14, 15		10	10					
3	27		3			3			
4	43		1			1			
5	21, 32, 33, 34	M	10				10		
6	11	M	1				1		
7	2		4			4			
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31,35-39	M	18		18				
11	19, 42		3			3			
12	22, 28, 44, 46		19			19			
13	3		2						2v,e
14	45		12			12			
15	7, 8		3			3			
16	5, 24	V	4			4 h			
17	4		3			3			
18	6, 40	V	4			4 h			
19	16		1			1			
20	41	V	3			3 h			
21	1		1			1			
22	9		1						1h,e
23	20	V	1			1 h			
24	52	V	1					1	
25	52		3					3	
26	48	V	1					1	
27	49	V	1					1	
28	53	V	2					2	
29	47, 51, 50	V	3					3	
30	17	V	1			1 h			
TOTAL			129	16	25	63	11	11	3

CODE M - MMS Payload, Candidate for PM-11
V - Candidate for Vertical Installation
h - horizontal Installation
v - vertical Installation
e - Elliptical Shuttle Orbit
* - From Volume III, Table 4-II

TABLE 6
SCENARIO DESCRIPTION
EXISTING/PLANNED SCENARIO E-2

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 TRS 2-TANK	MODE-3 TRS 4-TANK	MODE-4 SCOUT	MODE-5 SSUS-D	MODE-6
1	12		6	6					
2	13, 14, 15		10	10					
3	27		3		3				
4	43		1		1				
5	21, 32, 33, 34	M	10			10			
6	11	M	1			1			
7	2		4		4				
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31,35-39	M	18		18				
11	19, 42		3		3				
12	22, 28, 44, 46		19		19				
13	3		2					2v,e	
14	45		12		12				
15	7, 8		3		3				
16	5, 24	V	4		4 h				
17	4		3		3				
18	6, 40	V	4		4 h				
19	16		1		1				
20	41	V	3		3h				
21	1		1		1 h				
22	9		1					1h,e	
23	20	V	1		1h				
24	52	V	1				1		
25	52		3				3		
26	48	V	1				1		
27	49	V	1				1		
28	53	V	2				2		
29	47, 51, 50	V	3				3		
30	17	V	1		1 h				
TOTAL			129	16	88	11	11	3	

CODE M - MMS Payload, Candidate for PM-11
V - Candidate for Vertical Installation
h - horizontal Installation
v - vertical Installation
e - Elliptical Shuttle Orbit
* - From Volume III, Table 4-II

TABLE 6

SCENARIO DESCRIPTION

EXISTING/PLANNED SCENARIO E-3

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 OMS 1 KIT	MODE-3 OMS 1-KIT +SSUSD	MODE-4 INTEG OMS +SSUSD	MODE-5 SCOUT	MODE-6
1	12		6	6					
2	13,14,15		10	10					
3	27		3	3					
4	43		1			1e,i			
5	21,32,33,34	M	10			10e,i			
6	11	M	1		1				
7	2		4	4					
8	10	M	4	4					
9	23	M	3		3				
10	18,25,29-31, 35-39	M	18		14	4e			
11	19,42		3		1	2 e,i			
12	22,28,44,46		19			19e			
13	3		2		2				
14	45		12		6	6e			
15	7,8		3		3				
16	5,24	V	4			4v,e,i			
17	4		3			3e,i			
18	6,40	V	4	2h	2h				
19	16		1		1				
20	41	V	3	3h					
21	1		1	1					
22	9		1				1e		
23	20	V	1	1h					
24	52	V	1					1	
25	52		3					3	
26	48	V	1					1	
27	49	V	1					1	
28	53	V	2					2	
29	47,51,50	V	3					3	
30	17	V	1		1h				
	TOTAL		129	34	34	49	1	11	

CODE **M** - **MMS Payload, Candidate for PM-11.**
V - **Candidate for Vertical Installation.**
h - horizontal Installation
v - vertical Installation
e - Elliptical Shuttle Orbit
i - Shuttle Launch at Payload Inclination
* - From Volume III, Table 4-II

C-4

TABLE 6
SCENARIO DESCRIPTION
EXISTING/PLANNED SCENARIO E-4

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 OMS 1 KIT	MODE-3 TRS 2 TANK	MODE-4 TRS 4 TANK	MODE-5 SSUS-D	MODE-6 SCOUT ELV
1	12		6	6					
2	13, 14, 15		10	10					
3	27		3	3					
4	43		1			1			
5	21, 32, 33, 34	M	10				10		
6	11	M	1		1				
7	2		4	4					
8	10	M	4	4					
9	23	M	3		3				
10	18,25,29-31,35-39	M	18		14	4			
11	19, 42		3		1	2			
12	22, 28, 44, 46		19			19			
13	3		2		2				
14	45		12		6	6			
15	7, 8		3		3				
16	5, 24	V	4			4h			
17	4		3			3			
18	6, 40	V	4	2	2h				
19	16		1		1				
20	41	V	3	3h					
21	1		1	1					
22	9		1					1 e	
23	20	V	1	1h					
24	52	V	1						1
25	52		3						3
26	48	V	1						1
27	49	V	1						1
28	53	V	2						2
29	47, 51, 50	V	3						3
30	17	V	1		1h				
TOTAL			129	34	34	39	10	1	11

CODE
M - MMS Payload, Candidate for PM-11
V - Candidate for Vertical Installation
h - horizontal Installation
v - vertical Installation
e - Elliptical Shuttle Orbit
* - From Volume III, Table 4-II

TABLE 6
SCENARIO DESCRIPTION
EXISTING/PLANNED SCENARIO E-5

PAYLOADS				LAUNCH MODE							
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	M-1 INTE OMS	M-2 OMS 1 KIT	M-3 OMS 1 KIT +SSUSD	M-4 PM II	M-5 PM II OMS	M-6 PM II + 1 KIT	M-7 SCOUT	M-8 INT OMS + SSUS-D
1	12		6	6							
2	13, 14, 15		10	10							
3	27		3	3							
4	43		1			1e,i			10e,i		
5	21,32,33,34	M	10								
6	11	M	1					1			
7	2		4	4							
8	10	M	4				4				
9	23	M	3				3				
10	18,25,29-31, 35-39	M	18				18				
11	19,42		3		1	2e,i					
12	22,28,44,46		19			19e					
13	3		2		2						
14	45		12		6	6e					
15	7,8		3		3	4h,e,i					
16	5,24	V	4			4h,e,i					
17	4		3			3e,i					
18	6,40	V	4	2	2h						
19	16		1		1						
20	41	V	3	3h							
21	1		1	1							
22	9		1								1e
23	20	V	1	1h							
24	52	V	1							1	
25	52		3							3	
26	48	V	1							1	
27	49	V	1							1	
28	53	V	2							2	
29	47,51,50	V	3							3	
30	17	V	1		1h						
TOTAL			129	30	16	35	25	1	10	11	1

CODE M - MMS Payload, Candidate for PM-11.
V - Candidate for Vertical Installation.
h - horizontal Installation
v - vertical Installation
e - Elliptical Shuttle Orbit
i - Shuttle Launch at Payload Inclination
* - From Volume III, Table 4-II

TABLE 6
SCENARIO DESCRIPTION
COMBINATION SCENARIO C-1

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 4 TANK BIPROP	MODE-3 8 TANK BIPROP	MODE-4 SCOUT	MODE-5	MODE-6
1	12		6	6					
2	13, 14, 15		10	10					
3	27		3		3				
4	43		1		1				
5	21, 32, 33, 34	M	10			10			
6	11	M	1		1				
7	2		4		4				
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31,35-39	M	18		18				
11	19, 42		3		3				
12	22, 28, 44, 46		19		19				
13	3		2			2			
14	45		12		12				
15	7, 8		3		3				
16	5, 24	V	4		4h				
17	4		3		3				
18	6, 40	V	4		4h				
19	16		1		1				
20	41	V	3		3h				
21	1		1		1				
22	9		1			1			
23	20	V	1		1h				
24	52	V	1		1h				
25	52		3				3		
26	48	V	1				1		
27	49	V	1				1		
28	53	V	2				2		
29	47, 51, 50	V	3				3		
30	17	V	1		1h				
TOTAL			129	16	90	13	10		

CODE M - MMS Payload, Candidate for FM-11
V - Candidate for Vertical Installation
h - horiztonal Installation
v - vertical Installation
* - From Volume III, Table 4-II

TABLE 6
SCENARIO DESCRIPTION
COMBINATION NEW AND EXISTING/PLANNED SCENARIO C-2

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 4 TANK BIPROP	MODE-3 8 TANK BIPROP	MODE-4 4 TANK BIPROP VERT.	MODE-5 SCOUT	MODE-6
1	12		6	6					
2	13, 14, 15		10	10					
3	27		3		3				
4	43		1		1				
5	21, 32, 33, 34	M	10			10			
6	11	M	1		1				
7	2		4		4				
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31,35-39	M	18		18				
11	19, 42		3		3				
12	22, 28, 44, 46		19		19				
13	3		2			2			
14	45		12		12				
15	7, 8		3		3				
16	5, 24	V	4				4v		
17	4		3		3				
18	6, 40	V	4				4v		
19	16		1		1				
20	41	V	3				3v		
21	1		1		1				
22	9		1			1			
23	20	V	1				1v		
24	52	V	1				1v		
25	52		3					3	
26	48	V	1					1	
27	49	V	1					1	
28	53	V	2					2	
29	47, 51, 50	V	3					3	
30	17	V	1				1v		
TOTAL			129	16	76	13	14	10	-

CODE M - MMS Payload, Candidate for PM-11
V - Candidate for Vertical Installation
h - horizontal Installation
v - vertical Installation
* - From Volume III, Table 4-II

TABLE 6

SCENARIO DESCRIPTION
COMBINATION SCENARIO C-3

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG OMS	MODE-2 4 TANK BIPROP	MODE-3 4 TANK BIPROP	MODE-4 4 TANK BP &SSUS-D	MODE-5 SCOUT	MODE-6
1	12		6	6					
2	13, 14, 15		10	10					
3	27		3		3				
4	43		1		1				
5	21, 32, 33, 34	M	10				10h		
6	11	M	1		1				
7	2		4		4				
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31,35-39	M	18		18				
11	19, 42		3		3				
12	22, 28, 44, 46		19		19				
13	3		2				2h		
14	45		12		12				
15	7, 8		3		3				
16	5, 24	V	4			4h			
17	4		3		3				
18	6, 40	V	4			4h			
19	16		1		1				
20	41	V	3			3h			
21	1		1		1				
22	9		1				1h		
23	20	V	1			1h			
24	52	V	1			1h			
25	52		3					3	
26	48	V	1					1	
27	49	V	1					1	
28	53	V	2					2	
29	47, 51, 50	V	3					3	
30	17	V	1			1h			
TOTAL			129	16	76	14	13	10	

CODE M - MMS Payload, Candidate for PM-11
V - Candidate for Vertical Installation

h - Horizontal Installation
v - Vertical Installation
* - From Volume III, Table 4-II

TABLE 6

SCENARIO DESCRIPTION
COMBINATION SCENARIO C-4

PAYLOADS				LAUNCH MODE					
PAYLOAD GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS *	CODE	NUMBER OF PAYLOADS	MODE-1 INTEG. OMS	MODE-2 PM II	MODE-3 4 TANK BIPROP	MODE-4 8 TANK BIPROP	MODE-5 SCOUT	MODE-6
1	12		6	6					
2	13, 14, 15		10	10					
3	27		3			3			
4	43		1			1			
5	21, 32, 33, 34	M	10				10		
6	11	M	1			1			
7	2		4			4			
8	10	M	4		4				
9	23	M	3		3				
10	18,25,29-31,35-39	M	18		18				
11	19, 42		3			3			
12	22, 28, 44, 46		19			19			
13	3		2				2		
14	45		12			12			
15	7, 8		3			3			
16	5, 24	V	4			4h			
17	4		3			3			
18	6, 40	V	4			4h			
19	16		1			1			
20	41	V	3			3h			
21	1		1			1			
22	9		1				1		
23	20	V	1			1h			
24	52	V	1			1h			
25	52		3					3	
26	48	V	1					1	
27	49	V	1					1	
28	53	V	2					2	
29	47, 51, 50	V	3					3	
30	17	V	1			1h			
TOTAL			129	16	25	65	13	10	

CODE M - MMS Payload, Candidate for PM-11
V - Candidate for Vertical Installation
h - horizontal Installation
v - vertical Installation
* - From Volume III, Table 4-II

TABLE 7

SCOUT ELV AND STS LAUNCH COSTS
REFER TO VOLUME IV, TABLE XXIV

Examples of the launch cost build up for payloads 47, San Marco D_m and 52, Transit are as follows:

- o Payload 47, San Marco D_m

  Orbit = 27,000/420 Km at 2.90° inclination

  - Scout launch cost from paragraph 7.2.2.4

    San Marco launch cost (Italian Payload) = \$3.82M

    Annual Program Maintenance Cost divided by 3 launches in 1980 = 4.811/3 = \$1.60M

    Total Cost \$5.42M

  - STS/SSUS-D launch cost from paragraph 7.2.1.6, paragraph 7.2.4.1 and References 10 and 39 (1980 - 1982)

    1. Shuttle to 28.5° inclination circular orbit at 296 Km with shared flight payloads.
       Launch all payloads except San Marco D_m/SSUS-D

    2. Shuttle to elliptical orbit with apogee at 420 km. Launch SSUS-D with San Marco D_m from vertical cradle

    3. Fire SSUS-D at 420 K_m apogee. SSUS-D makes plane change from 28.5° to 2.9° and increases payload apogee to 27,000 Km. Energy management by selective latitude firing of SSUS-D

       SSUS-D Vertical Installation bay length = 2.18M (7.15 Ft)

       Cargo bay payload clearance = .15M (.5 Ft)

       STS Load Factor is length critical

       $$\text{Load Factor} = \frac{2.18\text{m} + .15\text{m}}{18.288\text{ m}} = .1274$$

Table 7 (Cont'd)

STS User Charge = $\frac{.1274 \times 21.834}{.75}$ = \$3.71M

STS Non-Standard Orbit Charge= .20M

SSUS-D Stage Cost = 2.43M

SSUS-D Mission Oriented Analysis = .75M

SSUS-D Launch Oriented Services = .45M

Total Cost = \$7.54M

- Payload, 52 Transit

  Orbit = 1000/1000 Km at 90° Inclination

  - Scout Launch Cost = 1980 - 1982

    Vandenberg Launch Cost

    = \$3.82M X 3 Launches = \$11.46M

    Annual Program Maintenance:

    For 1980 = 4.811/3 payloads = \$1.60M

    For 1981 = 4.811/3 payloads = \$1.60M

    For 1982 = 4.811/4 payloads = \$1.20M

    Total Cost = \$15.86M

  - Scout Launch Cost - 1983

    Vandenberg Launch Cost = \$3.82M

    Annual Program Maintenance:

    for 1983 = 4.811/1 payload = \$4.81

    Total Cost = \$8.63M

  - STS/SSUS-D Launch - 1980 - 1982

    1. Shuttle to 56° inclination circular orbit at 296 Km with shared flight payloads. Launch all payloads except Transit/SSUS-D

    2. Shuttle to elliptical orbit with apogee at 1000 Km. Launch Transit/SSUS-D.

    3. Fire SSUS-D at 1000 Km apogee. SSUS-D makes plane change from 56° to 90° and circularizes the orbit. Energy management by selective latitude firing of SSUS-D to produce inclination and nodal change.

Table 7 (Cont'd)

- STS/SSUS-D Launch - 1983
  1. Shuttle to 90° inclination circular orbit at 296 km with shared flight payloads. Launch all payloads except Transit/SSUS-D.
  2. Shuttle to elliptical orbit with apogee at 1000 km. Launch Transit/SSUS-D.
  3. Fire SSUS-D at 1000 km apogee. SSUS-D circularizes the orbit. Energy management by selective latitude firing of SSUS-D to produce nodal change.

	Installed Weight		Installed Length	
SSUS-D	1869 kg			
Transit Payload	200 kg		1.5 m x .8 m - vertical	
ASE	1021 kg		2.18 m - vertical	
Clearance			.15 m	
Total	3090 kg		2.33 m	
STS-Load Factor 56° Inclination	$\frac{3090 \text{ kg}}{25855 \text{ kg}}$	= .1195	$\frac{2.33 \text{ m}}{18.288 \text{ m}}$	= .1274
STS-Load Factor 98° Inclination	$\frac{3090 \text{ kg}}{16783 \text{ kg}}$	= .1841	Same as Above	

Years	1980-1982	1983
Number of Payloads	3	1
Launch Inclination	56° Note (1)	90° Note (1)
STS Load Factor	.1274 (length)	.1841 (weight)
STS User Charge	$11.13M	$5.36M
STS Non-Standard Orbit Charge	$ .60M	$ .20M
SSUS-D Stage Cost	$ 7.79M	$2.43M
SSUS-D Mission Oriented Analysis	$ .75M	$ .75M
SSUS-D Launch Oriented Analysis	$ 1.35M	$ .45M
Total Cost	$21.12M	$9.19M

NOTE: (1) The lack of payloads for shared flights each year from 56° inclination makes the 1980-1982 shared flight costs optimistic. (Refer to Volume IV, Table 8-I) The six WTR launches in 1983, the majority of which are at 98° inclination, make the 1983 costs more probable.

Table 7 (Cont'd)

- STS-LES Launch - 1983

	Weight		Length	
LES - 2 tank Bipropellant	879 kg		.9 m (vertical)	
Transit Payload	200 kg		1.5 m x .9 m (vertical)	
ASE	946 kg			
Clearance	-		.15 m	
Total	2025 kg		1.05 m	
STS - Load Factor 90° Inclination	$\frac{2025\ kg}{16783\ kg}$	= .1207	$\frac{1.05\ m}{18.288m}$	= .0574

STS - User Charge	$= \frac{.1207 \times 21.834}{.75}$	= 3.51
LES - Unit Cost		= 1.77
LES - Operations - Unit		= .3107
LES - Operations - Annual	= $2.315M/8	= .2894
LES - Development - Prorated	= $26.1M/103	= .2534
	Total Cost	$6.13M

TABLE 7 (CONT'D)

SCOUT LAUNCH COSTS

(MILLIONS OF 1977 DOLLARS)

		PRIOR TO WTR OPERATION								1983		
PAYLOAD NO.	MISSION NAME	SCHEDULE 80	81	82	PM TOTAL	SCOUT UNIT COST WTR	SM	Δ 5 STG	TOTAL	PM ALLOC	SCOUT UNIT	TOTAL
47	SAN MARCO D_M	1			1.6		3.82		5.42			
48	SAN MARCO D_I	1			1.6		3.82		5.42			
49	SOLAR MESOSPHERE EXP.		1		1.6	3.82			5.42			
50	AMPTE A		1		1.6		4.82*	.50	6.92			
51	AMPTE B			1	1.2		4.82*	.50	6.52			
52	TRANSIT	1	1	1	4.4	3.82			15.86	4.81	3.82	8.63
53	CANADIAN SCIENTIFIC			2	2.4	3.82			10.04			
	TOTAL	3	3	4					55.60			8.63
	UNIT PROGRAM MAINTENANCE ALLOCATION (ANNUAL = $4.81M)	1.6	1.6	1.2								

*NON ITALIAN CHARGE FOR SAN MARCO LAUNCH IS $1.0M

NOTES:
- COSTS IN MILLIONS OF 1977 DOL
- LENGTHS AND DIAMETERS IN METE
- ORBIT ALTITUDES IN KILOMETERS
- WEIGHTS IN KILOGRAMS

TABLE 7 (CONT'D)
STS LAUNCH COSTS - SCOUT CLASS PAYLOADS
(PRIOR TO WTR OPERATION)

SCOUT CLASS PAYLOADS SCHEDULE		SCHEDULE		
PAYLOAD NO.	MISSION NAME	80	81	82
47	San Marco D_m	1		
48	San March D_l	1		
49	Solar Mesosphere Exp.		1	
50	AMPTE A		1	
51	AMPTE B			1
52	TRANSIT	1	1	1
53	Canadian Scientific			2
	TOTAL	3	3	4

P/L NO.	STS LAUNCH COST BUILD-UP SUMMARY: PAYLOAD ORBIT	PAYLOAD INCL.	PAYLOAD L/D	PAYLOAD WEIGHT	SHUTTLE ORBIT	SHUTTLE INCL.	SHUTTLE CAPABILITY	USER CHARGE	NON STD. ORBIT CHG.	STAGE COSTS	TOTAL COSTS
47	27000/420	2.9	1.5 x .8	60	420/296	28.5	29484	3.71	.2	3.63	7.54
48	800/230	2.9	1.5 x .8	200	296/230	28.5	29484	3.71	.2	3.63	7.54
49	500/500	97	1.5 x .8	165	500/296	56	27442	6.97	.2	4.84	12.01
50	20re/200	2.9	1.5 x .8	60	296/200	28.5	29484	3.71	.2	3.63	7.54
51	8re/200	2.9	1.5 x .8	60	296/200	28.5	29484	3.71	.2	3.63	7.54
52	1000/1000	90	1.5 x .8	200	1000/296	56	24330	11.13	.6	9.39	21.12
53	550/550	90	1.5 x .8	145	550/296	56	27215	7.42	.4	6.51	14.33
										TOTAL	74.03

P/L NO.	STAGE AND PAYLOAD LOAD FACTORS: STS UPPER STAGE	STAGE LENGTH	STAGE WEIGHT	STAGE+PAYLOAD+ ASE+CLEARANCE LENGTH	STAGE+PAYLOAD+ ASE+CLEARANCE WEIGHT	LOAD FACTOR LENGTH	LOAD FACTOR WEIGHT	STAGE COST BUILD-UP SUMMARY: STAGE UNIT COST	MISSION ANALYSIS	LAUNCH ANALYSIS	TOTAL COST
47	SSUS-D	2.18	1869	2.33	2950	.127	.100	2.426	.75	.45	3.63
48	SSUS-D	2.18	1869	2.33	3090	.127	.105	2.426			3.63
49	SSUS-A	2.73	3770	4.38	5659	.239	.206	3.639			4.84
50	SSUS-D	2.18	1869	2.33	2950	.127	.100	2.426			3.63
51	SSUS-D	2.18	1869	2.33	2950	.127	.100	2.426			3.63
52	SSUS-D	2.18	1869	2.33	3090	.127	.127	2.426			9.39
53	SSUS-D	2.18	1869	2.33	3035	.127	.112	2.426	.75	.45	6.51

TABLE 7 (CONCLUDED)

STS LAUNCH COSTS - SCOUT CLASS PAYLOADS
(AFTER WTR OPERATION)

PAYLOAD NO.	MISSION NAME	SCHEDULE 83
52	TRANSIT	1

STS LAUNCH COST BUILD-UP SUMMARY											
P/L NO.	PAYLOAD				SHUTTLE			USER CHARGE	DDT&E AMORTIZED	STAGE COSTS	TOTAL COSTS
	ORBIT	INCL.	L/D	WEIGHT	ORBIT	INCL.	CAPABILITY				
52	1000/1000	90°	1.5 x .8	200	296/296	90°	16783	3.51	.25	2.37	6.13

STAGE AND PAYLOAD LOAD FACTORS								STAGE COST BUILD-UP SUMMARY			
P/L NO.	STS UPPER STAGE	STAGE		STAGE+PAYLOAD+ ASE+CLEARANCE		LOAD FACTOR		STAGE UNIT COST	OPERATIONS COSTS		TOTAL COSTS
		LENGTH	WEIGHT	LENGTH	WEIGHT	LENGTH	WEIGHT		UNIT	ANNUAL	
52	LES	1.7	878	1.85	2025	.101	.121	1.77	.31	.29*	2.37

*Based on $2.315M Annual Operations Cost and 8 Launches in 1983

NOTES:
- COSTS IN MILLIONS OF 1977 DOLLARS
- LENGTHS AND DIAMETERS IN METERS
- ORBIT ALTITUDES IN KILOMETERS
- WEIGHTS IN KILOGRAMS

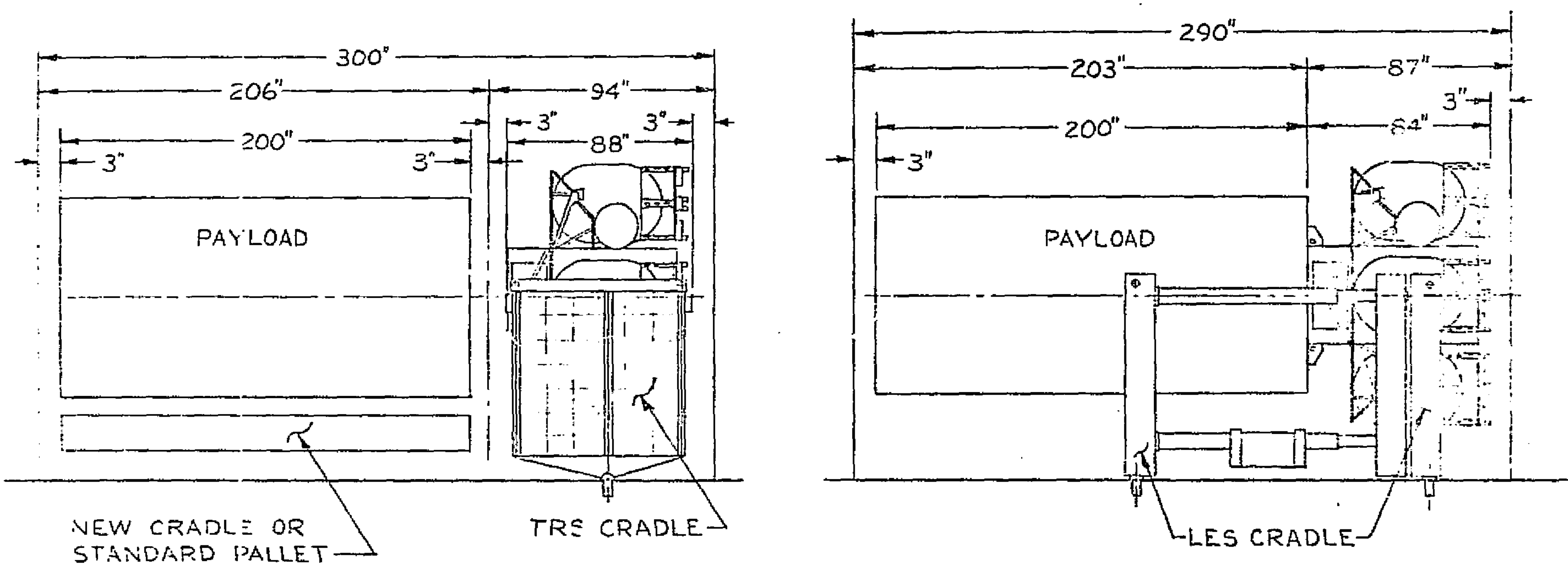
TABLE 8

TRS + P/L MOUNTED IN LES ASE CRADLE

LAUNCH SITE	Payload Grp No	QTY P/LS	TRS + P/L (LENGTH)	MAX. DIA. OF Combo	WT OF COMBO TRS + P/L	LES ASE CRADLE TO USE BY #	TOTAL LES ASE CRADLE WT.	TOTAL CARGO WT.
ETR	#3	3	5.734 m	3.353 m	7218 Kg	#3H	1629 Kg	8847 Kg
WTR	#4	1	11.134 m	4.0 m	5828 "	#3H	1629 "	7457 "
W	#5	10	10.134 "	3.353 "	7729 "	#3H	1629 "	9358 "
E	#6	1	7.134 "	4.0 "	6729 "	#2H	1336 "	8065 "
E	#7	4	6.734 "	4.6 "	4988 "	#2H	1336 "	6324 "
E	#8	4	6.134 "	3.353 "	4765 "	#2H	1336 "	6101 "
E	#9	3	7.334 "	3.353 "	4518 "	#2H	1336 "	5854 "
W	#10	18	6.534 "	3.353 "	4418 "	#2H	1336 "	5754 "
W	#11	3	6.334 "	3.353 "	4200 "	#2H	1336 "	5536 "
W	#12	19	8.834 "	3.353 "	3868 "	#2H	1336 "	5204 "
E	#13	2	3.934 "	3.353 "	3718 "	#2H	1336 "	5054 "
W	#14	12	3.134 "	4.0 "	3718 "	#2H	1336 "	5054 "
W	#15	3	5.734 "	3.353 "	3628 "	#2H	1336 "	4964 "
W	#16	4	4.934 "	3.353 "	3554 "	#2H	1336 "	4890 "
W	#17	3	5.034 "	4.4 "	3534 "	#2H	1336 "	4870 "
W	#18	4	3.834 "	3.353 "	3258 "	#2H	1336 "	4594 "
E	#19	1	6.434 "	3.353 "	3172 "	#2H	1336 "	4508 "
E	#20	3	3.634 "	3.353 "	3118 "	#2H	1336 "	4454 "
E	#21	1	3.034 "	4.6 "	3028 "	#2H	1336 "	4364 "
W	#22	1	5.134 "	4.6 "	3018 "	#2H	1336 "	4354 "
W	#23	1	5.134 "	3.353 "	2988 "	#2H	1336 "	4324 "
E	#30	1	2.934 "	3.353 "	2778	#1H	1128	4114 "
		102 P/Ls						

TABLE 8 (CONCLUDED)

TRS INSTALLED LENGTH~TRS V/S LES ASE



$\Delta \ell$ TRS CRADLE = 4"
$\Delta \ell$ CLEARANCE BETWEEN TRS CRADLE & PAYLOAD = 6"

Δ LENGTH SAVING TO TRS FOR USE OF LES CRADLE = 10"

TABLE 9

SCENARIO COSTS

SCENARIO NO. E-1, E-2 OR C-2 INTEGRAL OMS

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6	-	7.3	100	10000	.407	.343	0.000	71.156	71.156
2	13,14,15		10	-	13.0	100	9743	.719	.334	0.000	209.330	209.330
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL		16							0.000	280.486	280.486

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Stage + ASE Length
(4) Stage + P/L Length + .15 ÷ 18.288
(5) Stage Wt + P/L Wt ÷ Allowable Cargo Wt

TABLE 9 (CONT'D)

REVISION A

SCENARIO COSTS

SCENARIO NO. E-1 LAUNCH, PM-II

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4	1.51	4.0	2518	2047	.309	.155	10.092	25.947	36.039
9	23	M	3	1.51	5.2	2518	1800	.375	.167	7.569	25.191	32.760
10	18,25,29-31,35-39	M	18	1.51	4.4	2518	1700	.331	.282	45.416	128.225	173.641
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL		25							63.077	179.363	242.440

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Stage + ASE Length
(4) Stage + P/L Length + .15 ÷ 18.288
(5) Stage Wt + P/L Wt ÷ Allowable Cargo Wt

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. E-1 LAUNCH, TRS 2-TANK

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3	2.13	3.6	4347	4600	.322	.300	10.530	17.550	28.080
4	43		1	2.13	9.0	4347	3110	.617	.498	3.510	14.446	17.956
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4	2.13	4.6	4054	2270	.376	.215	14.040	29.768	43.808
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3	2.13	4.2	4054	1482	.354	.370	23.653	8.647	32.300
12	22,28,44,46		19	2.13	6.7	4054	1150	.491	.348	66.691	204.913	271.604
13	3		2 {6	2.13	1.0	4054	1000	.179	.171	21.019	10.247	31.266
14	45		12 {6	2.13	1.0	4054	1000	.179	.338	47.357	11.682	59.039
15	7,8		3	2.13	3.6	4054	910	.322	.296	10.530	17.550	28.080
16	5,24	V	4	2.13	2.8	4054	836	.278	.327	31.512	6.498	38.010
17	4		3	2.13	2.9	4054	816	.283	.325	23.628	4.756	28.384
18	6,40	V	4	2.13	1.7	4054	540	.218	.274	28.128	3.747	31.875
19	16		1	2.13	4.3	4054	454	.360	.174	3.511	6.969	10.480
20	41	V	3	2.13	1.5	4054	400	.207	.151	10.530	7.533	18.079
21	1		1	2.13	0.9	4054	310	.174	.148	3.512	1.553	5.065
22	9		1									
23	20	V	1	2.13	0.9	4054	270	.174	.289	7.888	.525	8.413
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1	2.13	0.8	3846	60	.168	.151	3.502	1.389	4.891
	TOTAL		63							309.557	347.773	657.330

NOTES: (1) Shuttle User Charge = L/F + .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Stage + ASE Length
(4) Stage + P/L Length + .15 + 18.288
(5) Stage Wt + P/L Wt + Allowable Cargo Wt

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. E-1 OR E-2 LAUNCH, TRS 4-TANK

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10	2.13	8.0	5958	3400	.562	.558	35.093	128.516	163.609
6	11	M	1	2.13	5.0	5665	2400	.398	.311	3.509	8.078	11.587
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL									38.602	136.594	175.196

NOTES: (1) Shuttle User Charge = L/F + .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Stage + ASE Length
(4) Stage + P/L Length + .15 + 18.288
(5) Stage Wt + P/L Wt + Allowable Cargo Wt

TABLE 9 (CONT'D)

REVISION (A)

SCENARIO COSTS

SCENARIO NO. E-1, E-2 OR E-3, SCOUT

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									3.82
25	52		3									11.45
26	48	V	1									4.82
27	49	V	1									3.82
28	53	V	2									7.64
29	47,51,50	V	3									15.46
30	17	V	1									
	TOTAL		11									47.01

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Installed Stage Length = Stage with ASE Length
(4) Installed Stage Length + Installed P/L Length + .15 ÷ 18.288
(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. E-1 OR E-2 LAUNCH, SSUS-D + INTEGRAL OMS

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2	.38*	1.8	2776	1000	.127	.137	5.867	2.113	7.980
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1	2.75	3.0	3478	300	.323	.225	4.497	4.895	9.392
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL		3							10.364	7.008	17.372

NOTES: (1) Shuttle User Charge = L/F + .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Installed Stage Length = Stage with ASE Length
(4) Installed Stage Length + Installed P/L Length + .15 ÷ 18.288
(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt

*Vertical Installation = (Stage Installed Length - P/L Diameter)

TABLE 9 (CONT'D)

SCENARIO COSTS
SCENARIO NO. E-1, E-2 OR C-2 INTEGRAL OMS

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6	-	7.3	100	10000	.407	.343	0.000	71.156	71.156
2	13,14,15		10	-	13.0	100	9743	.719	.334	0.000	209.330	209.330
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL		16							0.000	280.486	280.486

NOTES: (1) Shuttle User Charge = L/F + .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Stage + ASE Length
(4) Stage + P/L Length + .15 + 18.288
(5) Stage Wt + P/L Wt + Allowable Cargo Wt

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. E-2 LAUNCH, TRS 2-TANK

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3	2.13	3.6	4347	4600	.322	.300	10.530	17.550	28.080
4	43		1	2.13	9.0	4347	3110	.617	.498	3.510	14.446	17.956
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4	2.13	4.6	4054	2270	.376	.215	14.040	29.768	43.808
8	10	M	4	2.13	4.0	4054	2047	.343	.207	14.040	25.947	39.987
9	23	M	3	2.13	5.2	4054	1800	.409	.226	10.530	25.191	35.721
10	18,25,29-31,35-39	M	18	2.13	4.4	4054	1700	.365	.384	141.917	59.511	201.428
11	19,42		3	2.13	4.2	4054	1482	.354	.370	23.652	8.647	32.299
12	22,28,44,46		19	2.13	6.7	4054	1150	.491	.348	66.690	204.913	271.603
13	3		2 {6	2.13	1.0	4054	1000	.179	.171	21.019	10.247	31.266
14	45		12 {6	2.13	1.0	4054	1000	.179	.338	47.357	11.682	59.039
15	7,8		3	2.13	3.6	4054	910	.322	.296	10.530	17.550	28.080
16	5,24	V	4	2.13	2.8	4054	836	.278	.327	31.512	6.498	38.010
17	4		3	2.13	2.9	4054	816	.283	.325	23.628	4.756	28.384
18	6,40	V	4	2.13	1.7	4054	540	.218	.274	28.128	3.747	31.875
19	16		1	2.13	4.3	4054	454	.360	.174	3.510	6.964	10.474
20	41	V	3	2.13	1.5	4054	400	.207	.151	10.546	7.533	18.079
21	1		1	2.13	0.9	4054	310	.174	.148	3.512	1.553	5.065
22	9		1									
23	20	V	1	2.13	0.9	4054	270	.174	.289	7.888	.525	8.413
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1	2.13	0.8	3846	60	.168	.151	3.502	1.389	4.891
	TOTAL		88							476.041	458.417	934.458

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Stage + ASE Length
(4) Stage + P/L Length + .15 ÷ 18.288
(5) Stage Wt + P/L Wt ÷ Allowable Cargo Wt

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. E-1 OR E-2 LAUNCH, TRS 4-TANK

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	P/L	INSTALLED WEIGHT-KG (2) STAGE	P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	P/L	TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10	2,13	8.0	5958	3400	.562	.558	35.093	128.516	163.609
6	11	M	1	2.13	5.0	5665	2400	.398	.311	3.509	8.078	11.587
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL									38.602	136.594	175.196

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Stage + ASE Length
(4) Stage + P/L Length + .15 ÷ 18.288
(5) Stage Wt + P/L Wt ÷ Allowable Cargo Wt

TABLE 9 (CONT'D)

REVISION (A)

SCENARIO COSTS

SCENARIO NO. E-1, E-2 OR E-3, SCOUT

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									3.82
25	52		3									11.45
26	48	V	1									4.82
27	49	V	1									3.82
28	53	V	2									7.64
29	47,51,50	V	3									11.46
30	17	V	1									
	TOTAL		11									47.01

NOTES: (1) Shuttle User Charge = L/F + .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Installed Stage Length = Stage with ASE Length
(4) Installed Stage Length + Installed P/L Length + .15 ÷ 18.288
(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. E-1 OR E-2 LAUNCH, SSUS-D + INTEGRAL OMS

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2	.38*	1.8	2776	1000	.127	.137	5.867	2.113	7.980
14	45		12									
15	7,3		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1	2.75	3.0	3478	300	.323	.225	4.497	4.895	9.392
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL		3							10.364	7.008	17.372

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Installed Stage Length = Stage with ASE Length
(4) Installed Stage Length + Installed P/L Length + .15 ÷ 18.288
(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt

*Vertical Installation = (Stage Installed Length - P/L Diameter)

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. E-3 LAUNCH, INTEGRAL OMS

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) ASE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) ASE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M ASE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6	-	7.3	100	10000	.407	.343	-	71.156	71.156
2	13,14,15		10	-	13.0	100	9743	.719	.334	-	209.330	209.330
3	27		3	6.0	3.6	1506	4500	.336	.204	12.178	17.192	29.370
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4	-	4.6	100	2270	.260	.080	-	30.245	30.245
8	10	M	4	3.0	4.0	753	2047	.227	.095	11.365	15.06	26.425
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6	V	2	3.0	1.8	753	680	.172	.085	4.298	5.731	10.029
19	16		1									
20	41	V	3	3.0	1.5	753	400	.172	.039	7.880	7.163	15.043
21	1		1	-	0.9	100	310	.057	.014	-	1.671	1.671
22	9		1									
23	20	V	1	3.0	0.9	753	270	.172	.068	3.581	1.433	5.014
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL		34							[illegible]	[illegible]	[illegible]

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) ASE Weight
(3) ASE Length
(4) ASE & P/L Length + .15 ÷ 18.288
(5) ASE Wt + P/L Wt ÷ Allowable Cargo Wt

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. E-3 LAUNCH, OMS - 1 KIT

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1	(3.0)* 2.95	5.0	8154	2400	.447	.398	4.815	8.198	13.013
7	2		4									
8	10	M	4									
9	23	M	3	2.95 (3.0)	5.2	8154	1800	.458	.385	14.447	25.549	39.996
10	29-31,35-39	M	14	(3.0) 2.95	4.3	8154	1700	.409	.645	217.637	45.374	263.011
11	19		1	2.95 (3.0)	4.6	8154	1400	.425	.638	15.858	2.723	18.581
12	22,28,44,46		19									
13	3		2	2.95 (3.0)	1.8	8154	1000	.338	.333	13.929	5.731	19.660
14	45		6	(3.0) 2.95	1.0	8154	1000	.338	.310	49.428	9.551	58.979
15	7,8		3	2.95 (3.0)	3.6	8154	910	.370	.540	42.433	4.735	47.168
16	5,24	V	4									
17	4		3									
18	40	V	2	(3.0) 2.95	1.5	8154	400	.338	.510	28.288	1.388	29.676
19	16		1	2.95 (3.0)	4.3	8154	454	.409	.333	4.815	7.084	11.899
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1	(3.0) 2.95	0.8	8154	60	.338	.328	6.557	1.273	9.830
	TOTAL		34							400.207	111.606	511.813

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Installed Stage Length = Stage with ASE Length
(4) Installed Stage Length + Installed P/L Length + .15 ÷ 18.288
(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt

*Payload ASE Length

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. E-3 LAUNCH, OMS-1 KIT + SSUS-D

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1	2.75 2.95*	9.0	10879	3110	.816	.935	15.729	6.105	21.834
5	21,32,33,34	M	10	2.95 2.75	8.0	10879	3400	.761	.797	163.102	55.238	218.340
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25	M	4	2.75 2.95	4.75	10879	1700	.584	.844	74.059	13.277	87.336
11	42		2	2.95 2.75	4.0	10879	1523	.543	.829	37.738	5.930	43.668
12	22,28,44,46		19	2.75 2.95	6.7	10879	1150	.690	.804	372.309	42.537	414.846
13	3		2									
14	45		6	2.75 2.95	1.0	10879	1000	.379	.795	119.320	11.684	131.004
15	7,8		3									
16	5,24	V	4	2.75 2.95	2.8	10879	836	.477	.796	80.723	6.613	87.336
17	4		3	2.95 2.75	2.9	10879	816	.483	.795	60.661	4.841	65.502
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL		49							923.641	146.225	1069.866

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads

(2) Installed Stage Weight = Stage Weight + ASE Weight

(3) Installed Stage Length = Stage with ASE Length

(4) Installed Stage Length + Installed P/L Length + .15 ÷ 13.288

(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt

*OMS KIT LENGTH

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. E-3 LAUNCH, INTEGRAL OMS + SSUS-D

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1	2.75	3.0	3478	300	.323	.225	4.497	4.895	9.392
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL		1							4.497	4.895	9.392

NOTES:
(1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Installed Stage Length = Stage with ASE Length
(4) Installed Stage Length + Installed P/L Length + .15 ÷ 18.288
(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt

TABLE 9 (CONT'D)

REVISION (A)

SCENARIO COSTS

SCENARIO NO. E-1, E-2 OR E-3, SCOUT

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
[illegible]	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									3.82
25	52		3									11.45
26	48	V	1									4.82
27	49	V	1									3.82
28	53	V	2									7.64
29	47,51,50	V	3									15.46
30	17	V	1									
	TOTAL		11									47.01

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Installed Stage Length = Stage with ASE Length
(4) Installed Stage Length + Installed P/L Length + .15 ÷ 18.288
(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. E-1, E-2 OR C-2 INTEGRAL OMS

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6	-	7.3	100	10000	.407	.343	0.000	71.156	71.156
2	13,14,15		10	-	13.0	100	9743	.719	.334	0.000	209.330	209.330
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL		16							0.000	280.486	280.486

NOTES: (1) Shuttle User Charge = L/F + .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Stage + ASE Length
(4) Stage + P/L Length + .15 + 18.288
(5) Stage Wt + P/L Wt + Allowable Cargo Wt

TABLE 9 (CONT'D)

*415 KG PROPELLANT OFF LOAD

SCENARIO COSTS
SCENARIO NO. C-2 LAUNCH 4 TANK BIPROP

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3	.77	3.6	2564*	4500	.247	.240	4.035	17.550	21.585
4	43		1	.77	9.0	2564*	3110	.542	.379	1.345	14.446	15.791
5	21,32,33,34	M	10									
6	11	M	1	.77	5.0	2686	2400	.324	.196	1.345	8.079	9.424
7	2		4	.77	4.6	2271*	2270	.302	.154	5.380	29.768	35.148
8	10	M	4	.77	4.0	2271*	2047	.269	.146	5.380	25.947	31.327
9	23	M	3	.77	5.2	2271*	1800	.335	.157	4.035	25.191	29.226
10	18,25,29-31,35-39	M	18	.77	4.4	2271*	1700	.291	.265	24.212	128.225	152.437
11	19,42		3	.77	4.2	2271*	1482	.280	.251	4.035	20.416	24.451
12	22,28,44,46		19	.77	6.7	2564*	1150	.417	.248	25.557	204.913	230.470
13	3		2 6	.77	1.0	2271*	1000	.105	.111	13.454	5.924	19.378
14	45		12 6	.77	1.0	2271*	1000	.105	.219	26.559	11.694	38.253
15	7,8		3	.77	3.6	2271*	910	.247	.190	4.035	17.550	21.585
16	5,24	V	4									
17	4		3	.77	2.9	2271*	816	.209	.206	4.035	14.207	18.242
18	6,40	V	4									
19	16		1	.77	4.3	2271*	454	.285	.105	1.345	6.964	8.309
20	41	V	3									
21	1		1	.77	.9	2271*	310	.100	.088	1.345	1.552	2.847
22	9		1									
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	v	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL		76							126.097	532.426	658.523

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Installed Stage Length = Stage with ASE Length
(4) Installed Stage Length + Installed P/L Length + .15 ÷ 18.288
(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt

TABLE 9 (CONT'D)

SCENARIO COSTS

SCENARIO NO. C-2 LAUNCH, 8 TANK BIPROP

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10	.77	8.0	3892	3400	.488	.434	13.451	128.543	141.994
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2	.77	1.8	3600	1000	.149	.178	8.107	2.252	10.359
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1	.77	3.0	3600	300	.214	.232	6.245	.520	6.765
23	20	V	1									
24	52	V	1									
25	52		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1									
	TOTAL		13							27.803	131.315	159.118

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Installed Stage Length = Stage with ASE Length
(4) Installed Stage Length + Installed P/L Length + .15 ÷ 18.288
(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt

TABLE 9 (CONT'D)

*415 KG PROPELLANT OFF LOAD

SCENARIO COSTS

SCENARIO NO. C-2 LAUNCH, 4 TANK BIPROP-VERTICAL

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3	(6)								
16	5,24	V	4	.2	1.5	1825#	836	.101	.178	14.197	6.503	20.700
17	4		3									
18	6,40	V	4	.4	1.3	1825*	540	.101	.141	12.663	3.747	16.410
19	16		1									
20	41	V	3	.5	1.2	1825#	400	.101	.075	3.104	5.731	8.835
21	1		1									
22	9		1									
23	20	V	1	.8	.9	1825*	270	.101	.140	3.549	.525	4.074
24	52	V	1	.9	.8	1825*	200	.101	.121	3.164	.347	3.511
25	58		3									
26	48	V	1									
27	49	V	1									
28	53	V	2									
29	47,51,50	V	3									
30	17	V	1	.9	.8	1825*	60	.101	.078	1.671	1.273	2.944
	TOTAL		14							30.332	18.126	56.458

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.634 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Installed Stage Length = Stage with ASE Length
(4) Installed Stage Length + Installed P/L Length + .15 ÷ 18.288
(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt
(6) Vertical Installation (Installed Stage Length = Stage Length – Payload diameter)

TABLE 9 (CONCLUDED)

SCENARIO COSTS
SCENARIO NO. C-2 LAUNCH, SCOUT

P/L GROUP NO.	PAYLOAD IDENTIFICATION NUMBERS	CODE	NO. OF P/L'S	INSTALLED LENGTH-M (3) STAGE	INSTALLED LENGTH-M P/L	INSTALLED WEIGHT-KG (2) STAGE	INSTALLED WEIGHT-KG P/L	(4) L/F LENGTH	(5) L/F WEIGHT	(1) SHUTTLE USER CHARGE - $M STAGE	(1) SHUTTLE USER CHARGE - $M P/L	(1) SHUTTLE USER CHARGE - $M TOTAL
1	12		6									
2	13,14,15		10									
3	27		3									
4	43		1									
5	21,32,33,34	M	10									
6	11	M	1									
7	2		4									
8	10	M	4									
9	23	M	3									
10	18,25,29-31,35-39	M	18									
11	19,42		3									
12	22,28,44,46		19									
13	3		2									
14	45		12									
15	7,8		3									
16	5,24	V	4									
17	4		3									
18	6,40	V	4									
19	16		1									
20	41	V	3									
21	1		1									
22	9		1									
23	20	V	1									
24	52	V	1									
25	52		3									11.46
26	48	V	1									4.82
27	49	V	1									3.82
28	53	V	2									7.64
29	47,51,50	V	3									15.46
30	17	V	1									
	TOTAL		10									43.2

NOTES: (1) Shuttle User Charge = L/F ÷ .75 x 21.834 x No. Payloads
(2) Installed Stage Weight = Stage Weight + ASE Weight
(3) Installed Stage Length = Stage with ASE Length
(4) Installed Stage Length + Installed P/L Length + .15 ÷ 18.288
(5) Installed Stage Wt + Installed P/L Wt ÷ Allowable Cargo Wt