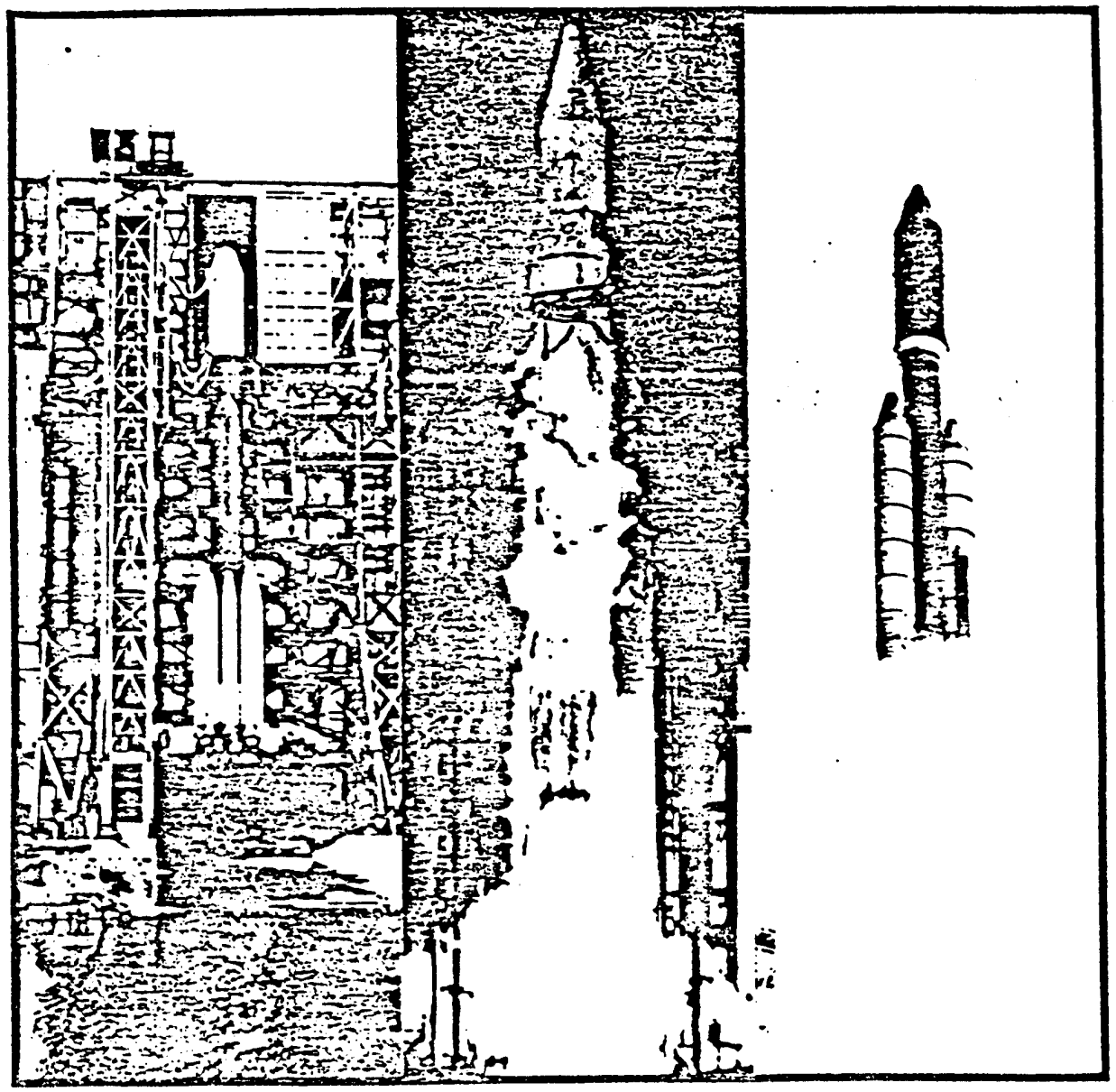
Interagency Space Launch Policy

Working Group Report

April 1983



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SPACE LAUNCH POLICY WORKING GROUP

REPORT ON

COMMERCIALIZATION OF U.S. EXPENDABLE LAUNCH VEHICLES

April 13, 1983

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Interagency Space Launch Policy Working Group Report on Commercialization of U.S. Expendable Launch Vehicles

Introduction

The National Space Policy encourages the expansion of United States private sector investment and involvement in civil space activities. It also identifies the Space Transportation System (STS) as the primary space launch system for U.S. Government (USG) missions. Based on the projected capabilities of the STS, the USG has begun to phase out its procurement and operation of the Expendable Launch Vehicle (ELV) systems.

The U.S. private sector has expressed interest in continuing the production and operation of these ELVs as commercial ventures. Prospective commercial ELV producers/operators are seeking policy guidance in this area from the USG. The need for a prompt response from the USG has been driven by two principal factors: (a) the interested corporations must decide whether to continue ELV production before the USG orders are completed and (b) the competition for the Intelsat VI class of communication satellites. The Intelsat selection of one or more launch vehicle systems will be made in the June 1983 time frame. For these reasons, timely government action is required to provide the information the private sector needs to make business decisions.

The Space Launch Policy Working Group (Appendix A) was chartered by the Interagency Group (Space) to recommend what the US National Space Launch Policy should be with regard to (a) the increasing foreign space launch capabilities and competition, (b) US commercial launch systems and operations, and (c) maintenance and development of a capability to satisfy USG current and projected requirements.

During the course of the study, the Working Group met with many of the companies that have expressed interest in commercial ELV operations. Their commercialization plans, business concerns, production status, assessments of the potential market, and the potential benefits to the USG and the nation were all factors in the study. The Working Group also reviewed the results of a NASA study on ELV commercialization. The impact of commercial ELV operations on the USG Shuttle operations was also specifically examined.

This report is organized into four major sections. Section I presents the Working Group's principal conclusions. Section II contains the proposed National Security Decision Directive. Section III examines the factors pertinent to the USG decision on commercialization of existing U.S. ELVs. Finally, Section IV explores the issues that were addressed in developing a strategy to facilitate the commercialization of ELVs.

The Appendices contain supporting information. Appendix A lists the Space Launch Policy Working Group members. Appendix B provides the detailed analysis and data that supports the conclusions regarding the impacts on the USG Shuttle program resulting from the loss of commercial and foreign payloads.

I. CONCLUSIONS

1. A US commercial ELV capability would benefit both the USG and the private sector and is consistent with the goals and objectives of the US National Space Policy.

2. The benefits of commercial ELV operations would offset the potential increases in total cost to the USG of the STS program which could result from the loss of commercial and foreign payloads.

3. Consistent with its needs and requirements, the USG should encourage and facilitate the commercialization of US ELVs. The USG should not subsidize the commercialization of ELVs.

4. International and national legal obligations and concerns (including those relating to public safety) require the USG to authorize, supervize and/or regulate US private sector space operations.

5. The USG should review and approve any proposed commercial launch facility and range as well as subsequent operations conducted therefrom.

6. Near-term demonstration or test flights of commercial launch vehicles will require USG review on a case-by-case basis; existing licensing authority and procedures appear to be adequate for this purpose, but should be streamlined.

7. An interagency Working Group should be established to develop and coordinate a process for the long-term licensing, supervision and/or regulation of possible routine commercial launch operations from non-national ranges.

8. The most effective means for the USG to ensure safe commercial ELV operations and compliance with US treaty obligations is to encourage the use of existing USG launch ranges. Consistent with these obligations, all commercial ELV operations conducted from a USG national range should be, at a minimum, subject to existing USG range regulations and requirements.

9. USG facilities, equipment, and services should be made available for commercial use where practical and priced in a manner that, consistent with USG needs and requirements, will facilitate and encourage commercial operations. The USG should not seek to

recover ELV design and development costs, or investments associated with launch facilities to which the USG retains title.

10. Any commercial launch vehicle operator should be required to provide adequate insurance to cover the loss of or damage to USG property used to support commercial operations. Additionally, the commercial operators should idemnify and hold harmless the USG against liabilities for damage to both domestic and foreign persons and property.

11. The USG should continue to make the STS available to all authorized users -- domestic and foreign, commercial and governmental. The USG must consider the effects that STS pricing for commercial and foreign flights could have on commercial launch operations. However, the price for commercial and foreign flights on the STS must be determined based on the best strategy to satisfy the economic, foreign policy, and national security interests of the United States.

II. RECOMMENDED NATIONAL SECURITY DECISION DIRECTIVE

National Security Decision
Directive Number _____

Commercialization of Expendable Launch Vehicles

I. INTRODUCTION

The United States Government encourages domestic commercial exploitation of space capabilities, technology, and services for US National benefit. The basic goals of US space launch policy are to (a) ensure a flexible and robust US launch posture to maintain space transportation leadership; (b) optimize the management and operation of the STS program so as to achieve routine, cost-effective access to space; (c) exploit the unique attributes of the STS to enhance the capabilities of the US space program; (d) encourage the US private sector development of commercial launch operations.

II. POLICY FOR COMMERCIALIZATION OF EXPENDABLE LAUNCH VEHICLES

The USG fully endorses and will facilitate the commercialization of Expendable Launch Vehicles (ELV).

The USG will license, supervise, and/or regulate US commercial ELV operations only to the extent required to meet its national and international obligations and to ensure public safety. Commercial ELV operators must comply with applicable international, national and local laws and regulations including security, safety, and environmental requirements.

The USG encourages the use of its National Ranges for US commercial ELV operations. Commercial launch operations conducted from a USG national range will, at a minimum, be subject to existing USG range regulations and requirements. Consistent with its needs and requirements, the USG will identify and make available facilities, equipment, tooling, and services that are required to support the production and operation of US commercial ELVs.

The USG will have priority use of USG facilities and support services to meet national security and critical mission requirements. The USG will make all reasonable efforts to minimize impacts of on commercial operations.

The USG will not directly subsidize the commercialization of ELVs but will price the use of its facilities, equipment, and services consistent with the goal of encouraging viable commercial ELV launch activities.

The USG will review and approve any proposed commercial launch facility and range as well as subsequent operations conducted therefrom. Near term demonstration or test flights of commercial launch vehicles conducted from other than a USG national range will be reviewed on a case-by-case basis using existing licensing authority and procedures.

III. IMPLEMENTATION

The Department of State, for the near term, will be the point of contact within the USG for coordinating the USG response to private sector contact/questions on commercial ELV activities.

The Department of State will chair an interim interagency group composed of members representing the SIG(Space) agencies and observers as well as other affected agencies as required. Additional membership, at a minimum, will include the FAA and the FCC. This group will be used to streamline the procedures used in the interim to implement existing licensing authorities and to develop and coordinate the requirements and process for the licensing, supervision, and/or regulations applicable to routine commercial launch operations from commercial ranges.

IV. RELATIONSHIP OF STS AND COMMERCIAL ELVS

Notwithstanding the USG policy to encourage and facilitate private sector ELV entry into the space launch market, the USG will continue to make the Space Shuttle available to all authorized users -- domestic and foreign, commercial and governmental. The USG will consider the effects that STS pricing for commercial and foreign flights will have on commercial launch operations. However, the price for a commercial or foreign flight on the STS must be determined based on the best strategy to satisfy the economic, foreign policy, and national security interests of the United States.

IMPLEMENTING GUIDELINES FOR COMMERCIALIZATION OF EXPENDABLE LAUNCH VEHICLES FROM USG NATIONAL RANGES

A. Required USG Actions

NASA and DoD, for those functions over which they respectively have cognizance, will:

1. identify data, documentation, processes, procedures, tooling, ground support equipment and facilities that are available for commercial use;

2. identify the support services and facilities necessary for commercial launches from the USG national ranges;

3. identify the joint-use tooling, ground support equipment and facilities that the USG can make available for commercial launch operations;

4. determine the transition means, schedules, and conditions for making available appropriate USG equipment, facilities and properties;

5. to the extent practical, provide, on a reasonable reimbursable basis, technical advice and assistance in operations;

6. negotiate and contract for, on a reasonable reimbursable basis, their portion of the USG services, facilities and equipment requested by the private sector for commercial launch operations.

7. as required conduct environmental analyses necessary to ensure compliance with the National Environmental Policy Act.

B. Government Pricing Guidelines:

The price for the use of USG facilities, equipment, and services, will be based on the following principles:

1. price services based on those additional costs incurred by the USG;

2. the USG should not seek to recover ELV design and development costs or investments associated with launch facilities to which the USG retains title.

3. standard tooling, equipment and residual ELV hardware on hand at the completion of the USG's program should be priced at a fair market value or USG cost.

C. Commercial ELV Operator Requirements

The commercial ELV operator shall:

1. maintain all facilities and equipment leased from the USG to a level of readiness and repair specified by the USG;

2. provide adequate insurance to cover the loss of or damage to USG owned systems, equipment, facilities used by the private sector ELV operators;

3. indemnify and hold harmless the USG against liabilities for damage to both domestic and foreign persons and property;

4. abide by all required USG safety criteria and not hold the USG liable for damage incurred by the operator resulting from USG flight safety actions.

5. agree not to hold the USG liable for losses resulting from scheduling delays related to joint-use facilities and support services.

III. FACTORS AFFECTING THE USG DECISION ON COMMERCIALIZATION

The development of a USG rationale for endorsing commercialization of ELVs requires a complete examination of the advantages and disadvantages to the USG of commercial ELV operations. Consideration must also be given to the existing national policies which establish a framework for any new policy recommendations. This section addresses these topics in more detail, including the U.S. private sector's perspective where appropriate. An economic analysis of the potential impacts of commercial ELVs on STS program costs is also summarized.

A. Policy Background

The USG has examined the issue of commercialization of space and space-related activities on several occasions within the last three years. The results of these government efforts are documented in National Space Policy (National Security Decision Directive, NSDD-42), Space Assistance and Cooperation Policy (NSDD-50), and Shuttle Orbiter Production Capability (NSDD-80). These policies concentrate on the general concept of government encouragement of private sector space activity, not on particular proposals to commercialize a specific system or capability. They establish the boundary conditions for this study of commercial ELVs. The following paragraphs provide excerpts of the policy documents as they apply to the commercialization of ELVs:

1. National Space Policy, (NSDD-42)

a. An objective of the national space program is to "...expand United States private sector investment and involvement in civil space and space-related activities."

b. The United States encourages domestic commercial exploitation of space capabilities, technology, and systems for national economic benefit. These activities must be consistent with national security concerns, treaties, and international agreements.

c. The United States Government will provide a climate conducive to expanded private sector investment and involvement in civil space activities, with due regard to public safety and national security. Private sector space activities will be authorized and supervised or regulated by the government to the extent required by treaty and national security.

d. The United States Space Transportation System (STS) is the primary space launch system for both national security and civil government missions. STS capabilities and capacities shall be developed to meet appropriate national needs and shall be available to authorized users--domestic and foreign, commercial and governmental.

e. The first priority of the STS program is to make the system fully operational and cost-effective in providing routine access to space.

f. The United States is fully committed to maintaining world leadership in space transportation with an STS capacity sufficient to meet appropriate national needs.

g. Expendable launch vehicle operations shall be continued by the United States Government until the capabilities of the STS are sufficient to meet its needs and obligations. Unique national security considerations may dictate developing special-purpose launch capabilities.

2. Space Assistance and Cooperation Policy, (NSDD-50)

Pertinent economic objectives established by NSDD-50 are:

a. To maximize economic benefit by:

(1) enhancement of the competitive position of the US aerospace industry;

(2) ensuring a reasonable return on the American investment in space technology; and

(3) promoting positive effects on domestic employment and our balance of payments.

b. Increased export and trade, through foreign purchases of goods and services, and through increased utilization of space and space technology.

c. To seek opportunities to enhance our overall competitive position in space technology.

d. To enhance the cost-effectiveness of space systems through increased and more effective use.

3. Shuttle Orbiter Production Capability, (NSDD-80)

"It is my (President Reagan's) intent that the full potential of the shuttle concept as originally envisioned is achieved and commercialization of space becomes a reality."

4. Summary.

These policy statements consistently reflect several points:

a. the intent to expand and encourage private sector activity with due regard to national security,

b. the need to authorize, supervise or regulate private sector space activities,

c. the intent to realize the full potential of the STS concept

d. the intent to use the STS as the primary space launch system for USG payloads,

e. the desire to obtain maximum economic benefit from space programs and seek enhancement of US competitive position.

With these policies as background, the central question is whether the commercialization of U.S. ELVs contribute significantly to achieving these objectives.

B. Domestic and Foreign ELV Survey

As part of its study on commercialization of ELVs, the IG (Space) Working Group solicited the views of aerospace companies considering commercial manufacturing or operation of new or existing U.S. ELVs. The working group received formal presentations on commercial Titan from representatives of Martin Marietta, Aerojet, and United Technologies, and on commercial Atlas from representatives of General Dynamics' Convair Division. Written inputs were provided by Space Services Incorported of America (SSI) and Transpace Carriers, Inc. on the commercialization of the Delta. In all instances, no specific private sector cost data was provided because of its commercial sensitivity and the uncertainty of pricing for U.S. Government facilities and services. Each contractor also provided a specific list of benefits to the USG of commercial ELVs. The contractors' consensus was that commercialization of ELVs would (1) enhance national security by providing a Shuttle backup; (2) provide a domestic ELV backup to the STS and an alternative to foreign ELVs for commercial users, thereby reducing the loss of commercial payloads to foreign competitors; and (3) retain high technology industrial jobs.

1. TITAN III

The Titan contractors' market assessment projects payload demand in excess of a four orbiter STS capability. Expectations are for 2 to 4 commercial Titan launches per year beginning in 1986 with a minimum of 2 flights per year required to financially break even. In addition, the outcome of the current Intelsat VI competition for launch of 5 communications satellites in 1986-87 is considered important to the early success of a commercial Titan program. The contractors view the continued availability of a U.S. expendable launch vehicle as a needed alternative to the Ariane launch system. The contractors have identified a program goal to provide a common payload interface for both Shuttle and commercial Titan; this could enhance Titan's flexibility as a backup to the Shuttle and, consequently its position in the commercial market. Under their assumptions that the U.S. Government would not seek to recover sunk costs, would lease existing launch facilities and production equipment at a nominal fee, and would provide U.S. Government launch range services at a fair incremental price, the contractors feel that commercial Titan can compete effectively with Ariane on a price and assured availability basis.

2. ATLAS

General Dynamics, the manufacturer of the Atlas launch vehicle, provided the most detailed world market demand projection. Their forecast shows market demand beyond the launch capability of the four orbiter STS fleet. In addition, their assessment of the world communications satellite market for 1986-1995 indicates that the current Atlas performance capability already addresses nearly 75 percent of this market. With the planned General Dynamics' development of the Atlas IIB/Centaur, they believe they can compete beginning in 1987 for approximately 35 percent of this market.

Their discussions with 26 users/satellite manufacturers indicated general agreement with their outlook, and many declared a definite interest in using Atlas if availability is assured and the price is close to Ariane and the Shuttle. General Dynamics anticipates 2 or more flights per year, with a financial break even point of approximately 2 flights per year. As in the case of a commercial Titan, selection as the contractor for launch of the Intelsat VI series satellites would provide a strong impetus for the commercial Atlas program.

3. DELTA

NASA has received letters from SSI and Transpace Carriers expressing interest in commercializing the Delta. SSI projects 4 flights annually after transition to commercial Delta operations and believes the Delta is a viable backup to the STS and a strong competitor for potential Ariane payloads. Transpace Carriers, Inc. has proposed to take over Delta operations in October 1983 and would launch the remaining USG and commercial missions now scheduled plus any new customers.

4. ARIANE

The primary foreign competition to the Shuttle and U.S. ELVs is the European Space Agency's Ariane. Ariane represents a series of ELVs which are being marketed by Arianespace, a commercial entity established to provide Ariane launch services to customers. To date, the Ariane has completed five launches resulting in three successes and two failures. Arianespace has firm contracts with twelve customers including 3 U.S. firms -- GTE, Western Union, and Southern Pacific. Ariane is primarily being marketed as a vehicle for placing satellites into geosynchronous orbit. While the reliability of the Ariane system is still unproven, Arianespace has been successful in marketing the vehicle as the only long term alternative to the Shuttle. Ariane has established a goal of at least

a 25 percent share of the commercial space launch market.

The Ariane launch schedule as of March 1, 1983 shows a rapid buildup from 3 flights in 1983 to 9-10 flights annually in 1985-86. To achieve its goal of capturing 25 percent of the world market, Arianespace has aggressively priced their launch services. The already favorable Ariane prices are further complemented by favorable financing arrangements. While the Shuttle requires progress payments begining 33 months in advance with total payment due prior to launch, Ariane requires only 20 percent pre-payment with the remaining 80 percent payable after launch with favorable financing by French and German banks. NASA has estimated the value of this financing to be approximately $4.0M for a Delta class payload.

5. Other Foreign Competition

The Indian SLV-3 and the Japanese N-I/N-II/H-1 space launch vehicles are also capable of providing commercial launch services. The Japanese presently launch only their own satellites with their launch vehicles. They are bound by agreement to obtain U.S. government approval before launching satellites for third parties using launch vehicles developed with U.S. assistance.

The Soviets also have the capability to provide commercial launch services; they could enter the commercial market for either political or economic reasons.

These countries are not now actively promoting their launch vehicles as worldwide commercial competitors, but the potential exists if it appears attractive.

6. CONCLUSIONS

Each potential U.S. commercial ELV operator expressed confidence that they would capture 2 to 4 launches annually. The Working Group felt that it was unlikely that there would be 2 to 4 commercial launches available per year for each of the U.S. ELV operators in the 1986-88 time frame, unless the market expands. This would be resolved by open competition and would not require USG resolution.

The Working Group identified significant benefits to the USG that could result from the commercialization of ELVs. National security could be enhanced by having an alternative launch capability for selected national security missions in the event of a generic problem that could ground the entire STS fleet or during

potential international situations where the risk of losing an orbiter and crew could jeopardize launching satellites on demand. There would also be national economic benefits resulting from domestic commercial exploitation and operation of USG developed ELV capabilities, technologies, and systems. These occur in the form of: (a) tax revenues and reimbursements derived from the provision of launch services; (b) assumption by the private sector of overhead for ELV production and launch operations previously borne by the USG; (c) a positive impact on the U.S. balance of payments to the extent that losses of launches to foreign competitors are reduced; (d) complement to the Shuttle program to meet the demand of many commercial users to have a U.S. backup to the Shuttle to preclude impacts caused by schedule perturbations; (e) an alternative for hazardous payloads or payloads that are technically or economically not feasible to use with a manned system; (f) an enhanced base of domestic technical production facilities and associated manpower.

Additionally, by approving the commercialization of existing ELVs, the USG could avoid some, if not all, close-out costs associated with the termination of the present USG ELV contracts. Commercial launch operations could stimulate the U.S. economy and contribute to a more effective and flexible U.S. space launch capability. This would directly contribute to maintaining U.S. leadership in space.

The only disadvantage of ELV commercialization that was identified was the potential economic effects commercialization could have on the STS program. These economic effects are summarized in the next section.

C. Economic Effects of Commercial ELVs on the STS

One of the primary considerations associated with a USG decision to encourage and permit the private sector to commercialize ELVs is the potential impact on the total cost to the USG for STS operations. If the loss of commercial and foreign users from the STS to commercial ELVs poses a significant handicap to achieving cost-effective STS operations, then the option to encourage commercialization becomes less attractive to the USG.

The Interagency Working Group conducted an economic analysis of the impacts on the change in total Shuttle operating cost to the USG of incremental losses of Commercial and Foreign (C&F) flights from the Shuttle mission model. A more complete documentation of the analysis and the model used is provided in Appendix B.

The following assumptions were used to construct an economic model to allow a sensitivity analysis to be performed:

-- current USG planning will result in a capability for 24 STS flights per year; this fixed base capability will be retained regardless of increases or decreases in commercial or foreign demand.

-- the average variable cost per flight is essentially equivalent to the additive cost per flight proposed as one of the NASA pricing options and remains essentially constant over the range of 18 to 24 flights per year.

-- the projected NASA budget figures represent the total cost to the USG of STS operations; no costs for Vandenberg Air Force Base (VAFB) Shuttle operations were included in the NASA budget even though the mission model includes flights from VAFB.

NASA's most recent STS mission model of 233 flights (171 USG missions and 62 commercial and foreign) over the 12-year period from 1983 to 1994 was used as a baseline for the analysis. Additionally, the three NASA pricing bases described in Figure 1 and referred to as Additive Cost, Out-of-Pocket Cost, and Average Total Cost were used to portray the impact of losing commercial and foreign flights from the mission model.

FIGURE 1

SPACE SHUTTLE COST COMPARISON FOR THREE PRICING BASES

(COST IN 75 DOLLARS)

	PRICING BASES		
COST ELEMENTS	ADDITIVE COST 3 YEAR AVERAGE (FY 1986-1988)	OUT-OF-POCKET COST 3 YEAR AVERAGE (FY 1986-1988)	AVERAGE TOTAL COST 12 YEAR AVERAGE (FY 1983-1988)
CONSUMABLES	COSTS ABOVE THOSE REQUIRED FOR GOV'T FLIGHTS, AVERAGED OVER 3 YEARS	AGGREGATE COSTS AVERAGED OVER 3 YEARS	AGGREGATE COSTS AVERAGED OVER 12 YEARS
LAUNCH OPERATIONS	COSTS ABOVE THOSE REQUIRED FOR GOV'T FLIGHTS, AVERAGED OVER 3 YEARS	COSTS ABOVE THOSE REQUIRED FOR GOV'T FLIGHTS, AVERAGED OVER 3 YEARS	AGREGATE COSTS AVERAGED OVER 12 YEARS
FLIGHT OPERATIONS	COSTS ABOVE THOSE REQUIRED FOR GOV'T FLIGHTS, AVERAGED OVER 3 YEARS	COSTS ABOVE THOSE REQUIRED FOR GOV'T FLIGHTS, AVERAGED OVER 3 YEARS	AGGREGATE COSTS AVERAGED OVER 12 YEARS
ESTIMATE FOR 24 MAXIMUM FLIGHTS/YEAR MODEL (233 FLIGHTS FROM FY 1983 TO FY 1994)	$23M	$ 38M	$57.2M

For the period encompassing 1983 to 1985, NASA will charge commercial and foreign users $18M (75$)*, and this figure was used to calculate revenue over this period.

In the 1986 to 1988 time frame, NASA is proposing to charge commercial and foreign users $38M (75$), and this value was used to calculate revenue over this period. Prices for 1989-1994 are scenario dependent and are discussed in the subsequent analysis.

A parametric analysis which used each of the NASA pricing options was performed. The analysis assumed an annual loss of an average of 1, 2, 3, 4, 5, and finally all 52 commercial and foreign flights over the 1986 to 1994 period. No commercial or foreign flights were assumed to be lost to commercial ELVs from 1983 through 1985 since the first U.S. commercial ELV is not projected until 1986.

Since the number and distribution of Shuttle payloads that may be lost to commercial ELVs is scenario dependent, the case of losing half (an average of 3 flights per year) of the commercial and foreign flights was selected as a representative example to illustrate the results obtained from the analysis.

The first result noted is that the loss of commercial and foreign flights in any scenario which uses additive cost pricing has no effect on total cost of operations to the USG since the revenue produced only equals the additional costs incurred. No contribution to the USG Shuttle fixed cost base is made under this pricing option, and the total cost of operations to the USG remains constant.

If the price for commercial and foreign flights is based on the 1986-88 Out-of-Pocket costs, an average loss of 3 flights a year (between 1986-94) results in a total increase in USG costs over the 12-year period of $460M (75$) or 4.2%. This represents an increase of about $38M (75$) per year.

Finally, if Average Total Cost is charged and an average of 3 commercial or foreign flights a year (between 1986-94) are lost, the total increase in USG costs over the 12 years is $537M (75$). This is a 5.1% increase in overall costs and equates to an increase of about $46M (75$) per year.

* To convert FY 1975 dollars to FY 1983 dollars multiply by 1.97

In terms of the overall ability of the Shuttle to compete with ELVs, the Average Total Cost price is least competitive and increases the probability of losing commercial and foreign missions to both U.S commercial and foreign ELVs. The Out-of-Pocket price creates a more competitive price, and it is reasonable to assume the loss of commercial and foreign flights would be limited. While beyond the scope of this study, consideration must be given in the long run to the nature and extent of Shuttle pricing competition with U.S. commercial and foreign launch operations.

There are several additional factors that must be considered to fully identify the effects on the STS program of ELV commercialization. These factors include the impact of commercial and foreign flights on the useful life of the orbiter and the costs associated with potential major orbiter inspection and repair. Each orbiter has a structural design life of 100 missions. If the price of a commercial and foreign flight does not recover a sum above average total cost, government costs increase because a finite resource is being expended. This resource will eventually have to be replaced at some cost. During the Working Group evaluation of the need for a fifth orbiter, it was estimated that major periodic inspection and repair could be required after approximately every 25 missions. Potential reductions in commercial and foreign flights postpone both the cost of the orbiter repair and replacement.

From this and other cases documented in Appendix B, the following conclusions can be drawn:

- Additive cost pricing offers no economic advantage to the USG, regardless of reductions in average cost per flight.

- The Average Total Cost per flight is not a relevant measure of cost to the USG unless the price for Shuttle flights is based on full cost recovery including both replacement and operating costs.

- Both Out-of-Pocket and Average Total Cost pricing bases produce revenues that exceed the additive cost for each commercial and foreign flight and therefore would serve to reduce the total cost of Shuttle operations to the USG.

- Out-of-Pocket pricing does not represent major cost recovery to offset the cost to the USG for Shuttle operations (maximum USG cost offset is approximately 8 percent). Its advantage is that it allows the Shuttle to compete favorably with Ariane.

- Average Total Cost recovery would decrease total USG costs,(maximum USG cost offset is approximately 11 percent) but would make the Shuttle less competitive with ELVs.

The conclusion of the Working Group was that, using any of the NASA pricing bases, the potential increase in total cost of operations to the USG for the Shuttle program as a result of the loss of commercial and foreign flights does not justify discouraging ELV commercialization.

D. STS and ELV Comparisons

Based on the information provided by the prospective commercial operators, they believe commercial ELVs appear to be cost competitive with the STS at $38M (FY 75$) per flight. It should be recognized that this only compares their relative prices for a fixed level of effectiveness -- specifically, the boost mission -- since this is the only mission that ELVs can perform. The STS, on the other hand, was designed and developed to perform a much more sophisticated range of missions--manned experimentation and interaction, recovery and repair of satellites, space-based construction, etc. The USG is committed to the STS; and as a result, it is necessary to discontinue the expense of concurrent production and operations of both the STS and the ELVs.

With the proposals to commercialize ELVs, the USG is presented with an option that could allow continued, cost-effective ELV operations without the financial burden of maintaining the contractor's overhead, sustaining manpower, and production base. This burden, along with the fixed operations costs and facility maintenance costs, would be borne by the commercial ELV operators. This effectively preserves the U.S. ELV launch capability at little or no cost to the USG.

As a result, the USG could concentrate on optimizing the STS for its own requirements while enjoying a more robust and flexible national space launch capability. The entry of U.S. private industry into this field could ensure aggressive marketing and increase the benefit to the U.S. economy.

The Shuttle is currently the only U.S. launch vehicle capable of supporting the continuation of our manned space program. The Shuttle provides the USG with a flexible manned platform from which to develop new techniques and experience.

These activities are necessary if we are to attempt new missions such as construction or a variety of potential space-based services such as refueling satellites or extensive on-orbit repair capabilities. Most importantly, it provides the opportunity to expand our knowledge of the use and function of man-in-space.

Finally, the ability of the Shuttle to support internationally manned missions offers the U.S. a unique political advantage. With the exception of the Soviet Union, no other nation can offer countries the opportunity to participate in manned space flight. The cooperative exploitation of space for peaceful purposes

is an advantage that is difficult to measure in economic terms but is certainly valuable in our international relations.

These unique Shuttle capabilities should be considered when comparing the relative effectiveness of the Shuttle and ELVs; the full effects of the strengths and weaknesses of of the STS and ELVs should be a key part of any comparisons. The Working Group believes that the potential impacts on overall STS costs resulting from the loss of commercial and foreign payloads to ELVs could be more than offset by the benefits of commercial ELVs.

E. Summary

The Working Group concluded that commercialization of US ELVs is totally in consonance with existing national policies and offers a net benefit to the nation. The effects of commercial ELVs on the cost of the STS were believed to be offset by the benefits offered by commercial ELV operations.

The Working Group unanimously concluded that the commercialization of ELVs is in the national interest and should be endorsed by the USG.

IV. APPROACH TO COMMERCIALIZATION

In order to determine the proper approach to facilitating the commercialization of ELVs, a number of policy issues were examined. These included the international and domestic laws which govern space activities and the use of USG services and facilities by commercial operators. The legal background as well as the major issues, are presented in the following parts of this section.

A. International Law.

Among many other obligations, existing multilateral space conventions impose on the United States five primary obligations that are relevant to commercializing ELV's. Specifically, the USG must (1) authorize and supervise private space activity, (2) ensure compliance with international legal principles governing uses of outer space, (3) provide notice to certain States, (4) assume liability for certain damage caused by these activities, and (5) arbitrate unresolved claims for damage to foreign entities.

1. Authorization and Supervision. Article VI of the 1967 Outer Space Treaty (Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies) imposes a general "obligation to authorize and supervise" the activities of private launches:

> "The activities of nongovernmental entities in outer space, including the moon and the other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty."

This obligation does not, however, require the US to adopt an elaborate regulatory framework. The USG is required to perform some continuing supervision to ensure compliance with the treaty obligations described below. Further, under Article VIII of the Outer Space Treaty, the USG must retain "jurisdiction and control" over space objects while in outer space or on a celestial body.

2. Compliance with International Principles Governing the Use of Outer Space. Article VI of the Outer Space Treaty requires that States bear "international responsibility" for assuring that "national activities carried on by governmental agencies or nongovernmental entities" are "carried

out in conformity with the provisions set forth in the present Treaty." Accordingly, the USG is obligated to assure that private space activities comply with the provisions of the Treaty.

3. Notice to Certain States. Article IX of the Outer Space Treaty requires a government to consult with other states if they have reason to believe that private space launch vehicle operators will undertake activity that "would cause potentially harmful interference with activities of other States' parties in the peaceful exploration and use of outer space." Similarly, under Article 4 of the US-USSR agreement on Measures to Reduce the Risks of Outbreak of Nuclear War, the US must notify the USSR of "any planned missile launches if such launches will extend beyond its national territory in the direction of the (USSR)"

In addition, the USG must register space objects launched into orbit or beyond with the United Nations in accordance with the 1976 Convention on Registration of Objects Launched into Outer Space.

4. International Liability. Both the Outer Space Treaty and the Liability Convention establish US liability to contracting parties, their corporations and nationals, for damage caused by space launches from US territory. While the Outer Space Treaty sets no standards of liability; the Liability Convention specifies absolute liability for damage on the earth or to aircraft in flight and liability on the basis of negligence for damage to other space objects.

5. Claims. The Liability Convention prescribes that damage claims shall be presented to the launching State through diplomatic channels, the United Nations, national courts, or a special Claims Commission.

B. National Concerns

In addition to the responsibilities imposed by international law the USG has other obligations and requirements which can be grouped according to the following broad categories --national security, technology transfer and public safety.

No unique national security concerns were identified with the proposed commercialization options. However, those potential commercialization options that included launches from platforms in international waters or launches from foreign territories generated some indirect concerns. These centered basically on physical security. Specifically, the USG loses effective control over the ELV and its launch support equipment once it is beyond US territorial boundaries.

The potential of hijacking or capture on the open seas of an ELV with its launch support systems poses a concern relative to terrorism or third world aggression. The same concern exists for launches from foreign soil; under these circumstances the USG would have limited control to prevent the conversion of a peaceful space launch system to an offensive ballistic missile system. Any capability to launch U.S. commercial ELVs from outside U.S. territory was considered to be potentially disadvantageous to the interests of the USG.

Adequate procedures are thought to exist to allow USG control over proposed launches from outside U.S. territory. Specifically, an export license would be required before the ELV and its support systems could be taken outside the U.S. This provides positive USG control and would permit a careful review of any such requests on a case-by-case basis.

Technology transfer issues related to potential ELV commercialization center on similar concerns. Space launch systems have the inherent ability to serve as ballistic missiles. The USG must ensure not only that no such systems physically fall into the wrong hands but that the technology to independently acquire such systems is carefully controlled.

The commercialization of ELVs will potentially expose many more foreign customers directly to US ELV production and operations technology. The national policy on Space Launch Assistance (NSDD-50) provides the methods to handle these technology related issues. Therefore, existing procedures were again judged to be adequate to permit the USG to prevent the loss of critical technologies that might be associated with commercial ELV operations.

The USG's public safety concerns relate primarily to the licensing, supervision, and regulation of the inherently hazardous activities associated with ELV operations. The hazards may be divided into two general categories--ground safety and flight safety. Commercialization of ELVs can be grouped into operations conducted from USG national ranges or from newly created, commercial launch sites.

The operation of either existing or new ELVs from the national ranges represents the most straightforward case. The USG could provide assurrance of public safety by controlling the hazardous ground operations and flight safety for commercial operations according to the same criteria and methods now used for its own operations. Commercial operators would not have to provide the substantial capital investment required to establish, equip, and operate a range to government standards. The USG could provide these services on a reasonable, reimbursable basis. This would also make maximum use of the facilities, equipment, and services already in place on the existing national ranges which have been demonstrated to be safe.

The USG should encourage commercial operators to use the national ranges principally because it offers the USG the best and most efficient means of fulfilling its national and international legal commitments and public safety concerns.

While it is possible for the USG to fulfill these commitments for operations from a private range, the minimum acceptable standards that a commercial operator would have to meet are not presently defined. One test launch in this category has already been approved, i.e., the Conestoga test flight from Matagorda Island. The ad hoc requirements established as a result of this specific case are discussed more fully in Section D.

The definition of USG requirements for commercial operations from private launch ranges was considered beyond the scope of this study. It is recommended that the procedures, regulations, standards, etc for USG approval of a commercially operated space launch range be separately studied and defined in an interagency forum. Neither the USG or the private sector can intelligently consider this option until these criteria are clearly defined and documented.

C. USG Services and Facilities in Support of Commercial ELV Operations.

For the commercialization of ELV's to be successful and practical from USG national ranges, the USG will have to provide selected support services, equipment, and facilities.

Since the existing ELVs were developed for the use of the USG, portions of the facilities,tooling, assembly fixtures, and test equipment are owned by the government. The USG would have to identify those items that are no longer of direct use to the USG as well as those items that could be used for other purposes. These items encompass design, processing, procedures, data, and software; test and transportation equipment; production fixtures, jigs, and tooling; facilities to manufacture, assemble, test, modify, control, maintain and launch the vehicle; and ancillary facilities to support servicing of the vehicle and preparation of payloads.

Since the USG no longer intends to maintain the production and operational base required for continued ELV operations, it could elect to scrap, surplus, or redistribute the equipment associated with this effort. The commercialization proposals described by the present ELV contractors depend upon the USG making a large percentage of this equipment available for their use in continuing commercial production. In effect, these contractors would assume the financial burden of maintaining the sustaining production base as well as the operations and maintenance of the launch facilities that the USG has carried up until now. In return, the contractor would require the continued use of USG equipment and facilities on an economical basis. To make such an arrangement, a number of exemptions or changes in existing user reimbursement and property disposal policies may be required.

If this can be effectively accomplished, the US could maintain an ELV option as a back-up to the STS at little or no sustaining cost to the USG. The USG could exercise this option by maintaining or developing spacecraft that are dual compatible, as the commercial industries are doing, and purchasing commercial launch services as required. The USG could conceiveably negotiate a favorable ELV back-up option as consideration for the continued economical use by commercial ELV operators of USG equipment and facilities.

The ELV facilities on the national ranges will no longer be required after the USG discontinues ELV operations in the mid-to-late 80's. Facilities that are used solely for ELVs, such as launch complexes could be leased, consigned, or licensed to the commercial operator with appropriate consideration given to the benefits derived by both the USG and the private concern.

Those facilities that would be used by the USG, even after the discontinuation of USG ELV operations, could be shared under lease with commercial ELV operators. For such joint-use facilities, the USG should control the integrated scheduling of both the USG and commercial activities and retain priority right-of-use to support national security or critical mission requirements (e.g., planetary windows). The USG should make every reasonable effort to minimize impact of USG operations on the commercial operators in joint-use facilities.

The USG should also make available, on an additive reimbursement basis, all range support services necessary to conduct launch operations from the national ranges. All ELV commercial operators using the national ranges should be required to comply with the existing ground and flight safety standards; their launches would be constrained by the same flight safety requirements as USG launches. As a condition of using the national ranges and USG facilities, the commercial ELV operators would have to agree to be bound by the USG's ground and flight safety requirements and agree that the USG would destroy their vehicles in flight if they violated range safety criteria. The commercial operators would have to agree to not hold the USG liable for schedule delays resulting from conflicts in joint-use facilities or support services; the USG would not be liable for the commercial operators loss if it became necessary for the USG to destroy the vehicle for range safety reasons.

The USG should require each commercial operator to obtain adequate insurance to replace any USG property that might be damaged as well as third party liability insurance without the right of subrogration against the USG. The commercial operators should maintain all USG property in accordance with the contractual agreements negotiated for the specific facilities.

NASA and DoD should individually identify those facilities, equipment, etc., that could be made available for commercial ELV production and operations. Each agency should negotiate the specific reimbursements for its respective facilities, equipment, and services since their statutory authority, regulations, accounting systems, and procedures may vary.

However, the following general principals should be followed by both agencies. The USG should not attempt to recover the costs associated with the design and development of ELVs that were required to meet national needs. The USG's interests are best served if an ELV capability can be maintained at no direct cost to the USG. Consequently, launch facilities

and equipment leased or otherwise made available to commercial operators should be priced in a manner that encourages viable commercial operations and serves the best interest of the USG. Standard tooling and equipment, ELV hardware, long-lead materials, components, or assemblies on-hand at the completion of the USG's programs should be priced at fair market value or USG cost.

The benefits that the USG could receive from the commercialization of ELVs should be considered in the determination of prices. These benefits include the USG's recovery of costs of residual flight hardware, avoidance of program close-out costs and the disposal of excess property, maintenance of high technology critical aerospace production facilities and skills, an effective competition with foreign space launch systems, and maintenance of a limited, potential USG emergency/back-up access to space.

D. Laws and Procedures Applied to the Conestoga Launch

With the initial request for the approval of a private space launch by the USG, the Department of State chaired an ad hoc interagency group to determine the proper requirements and procedures. The conclusions are documented in a DoS report entitled Private Space Activity. This report concluded that "existing laws and regulations are adequate for the USG to control private launches from US territory or export of satellites and launch vehicles generally from the US for launch abroad. In light of the infancy of the private space launch industry, the creation of new legislative and regulatory framework and supporting bureaucracy is not justified."

The principal features of the ad hoc process established to handle commercial launch operations are summarized as follows.

1. Launch Vehicles

Under the existing process a commercial ELV operator is currently required to obtain three primary approvals for a launch: (a) an Arms Export Control license from the State Department; (b) an experimental radio license from the FCC; and (c) an exemption or clearance from the FAA for use of controlled airspace.

a. Arms Export Control License. The Arms Export Control Act and its implementing regulations on the International Traffic in Arms (ITAR) presently furnish the primary mechanism for controlling launches and any attendant transfer of technology. The State Department administers these procedures.

Under the Act, the State Department designates defense articles, services, and technical data that constitute the Munitions List. No item on the Munitions List may be exported or imported unless the State Department issues a license that authorizes its export. Violators are subject to criminal sanctions. Rockets, launch vehicles, payloads, specifically designed associated equipment, and related technical data are all on the Munitions List. The State Department deems launches to be "exports" since that term means "the sending or taking taking out of the United States in any manner, any article, equipment or technical data on the Munitions List." The State Department has authority to deny, revoke, suspend or amend licenses if it believes such action would not further world peace, foreign policy, or national security; or because it believes

the applicant has violated the Act or the International Traffic in Arms Regulations (ITAR). License decisions may be appealed to a Hearing Commissioner of the State Department and to an Appeals Board of the Commerce Department. The ITAR provides a mechanism for considering the range of concerns that indirectly affect foreign policy, including vehicle safety and liability coverage. To avoid vehicle hazards that could have foreign policy consequences, the State Department consults NASA, the FAA, and DoD on vehicle safety. To facilitate this process, license applicants may be required to provide "all pertinent documentary information regarding the proposed transaction." Similarly, in order to assure some compensation to foreign governments, the State Department may secure compensation commitments in the form of insurance and/or indemnification.

b. Federal Communications Commission (FCC) license. Under the Communications Act of 1934, as amended, and its implementing regulations, the FCC allocates and issues licenses for the radio frequencies necessary for commercial space launch operators to monitor telemetry, track, and destroy errant vehicles.

The FCC has not designated frequencies for commercial space operations. Commercial ELV operators may obtain an experimental radio license which permits the liscensee to share assigned frequencies.

c. Federal Aviation Administration (FAA) clearance. Under the Federal Aviation Act of 1958, the FAA regulates navigable airspace and has promulgated special air traffic rules for unmanned rockets.

Initially, the unmanned rocket rules require 24-48 hours notice to the appropriate Air Traffic Control (ATC) facility. Second, unless the FAA waives application of the rule, certain operations are prohibited including operations (a) that create a collision hazard, (b) in controlled airspace, (c) under specified conditions of limited visibility, and (d) within 150 feet of any person or property not associated with the operations.

2. Payloads. Payloads on the Munitions List are also subject to ITAR licensing procedures. These include all orbiting payloads.

3. USG Liability. USG liability is two-fold. First, under the Federal Tort Claims Act, and the Foreign Claims Act, the US maybe liable, to national and foreign entities respectively, for damage caused by negligence in Federal participation in space launches. Second, under international

law and treaties the US is liable to foreign governments, companies, and persons for damage caused by space launches from US territory.

While the process used to provide the initial approval can unquestionably be streamlined and used in the interim, a more efficient long-range regulatory plan should be developed to meet the anticipated nature and frequency of routine commercial ELV operations. These ad hoc requirements should be reviewed in light of the more complex and extensive ELV commercialization proposals.

The Department of State should be designated the lead agency for coordinating all U.S. commercial ELV requests within the USG. The Department of State is well suited to coordinate the political approval for commercial launches which involve issues such as international agreements, national security concerns, and technology transfer issues. The operational concerns and supervision would be best handled by the cognizant technical agencies, such as DoD, NASA, FAA, and FCC.

E. Summary

1. The USG should proceed with the details necessary to facilitate viable US commercial ELV operations.

2. The Department of State should be designated as the lead agency to coordinate commercial ELV requests within the USG; the technical and operational expertise of the other government agencies (DoD, NASA, FAA, FCC, etc) should be used.

3. Existing procedures are adequate for the near term to handle occasional test launches by the private sector. USG requirements and procedures to license, supervise and/or regulate US commercial ELV operations from commercial ranges should be developed before the advent of routine commercial ELV operations. This should include the definition of USG criteria and requirements for approving commercial launch sites and ranges.

4. DoS should chair an interagency team to define a more effective process to support routine, commercial ELV operations from commercial ranges.

5. The USG should encourage the use of its national ranges for existing and new commercial ELV. This represents the most effective means of fulfilling its domestic and international obligations.

6. The USG should conduct required environmental analyses necessary to ensure compliance with the National Environmental Policy Act.

APPENDIX A

SPACE LAUNCH POLICY WORKING GROUP STUDY ON COMMERCIALIZATION OF EXPENDABLE LAUNCH VEHICLES

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APPENDIX B

PARAMETRIC ANALYSIS OF THE ECONOMIC EFFECTS ON THE STS PROGRAM OF LOSING COMMERCIAL AND FOREIGN MISSIONS

The input data for this analysis was provided by NASA. TABLE 1 summarizes, by year, the number of US goverment (USG), commercial and foreign and total STS flights over the 12 year analysis period. The average total cost per flight and the average variable cost per flight are shown by year. The price charged to commercial and foreign users over the 1983-85 period is also shown as well as the proposed price during the 1986-88 period. This data is based on a 233 flight mission model over the twelve years.

TABLE 2 shows annual and twelve year total cost, total fixed cost (and the percentage of total cost), and total variable cost (and the percentage of total cost).

TABLE 3 summarizes the baseline mission model costs for two pricing options. The "out-of-pocket" option assumes $18M per flight during the 1983-85 period, and $38M (the 1986-88 out-of-pocket estimate) for the period from 1986-94. The average total cost option uses $18M for 1983-85, $38M for 1986-88, and then assumes full cost recovery (average total cost) during 1989-94. Since the additive cost price option has no effect on the total cost to the USG, it is not tabulatec in this appendix.

Total cost is used to describe actual costs required to fly a given number of missions; total cost to the USG is the cost to the US Treasury after the receipt of the commercial and foreign revenues. For this analysis, total cost to the USG is assummed to be equal to the NASA budget estimates; no VAFB operations costs have been included.

The twelve year sum of the total cost to the USG under the two pricing options is used as the baseline for the parametric analysis.

TABLES 4 and 5 summarize the results of the parametric analysis. Since commercial ELVs would not be available before 1986, no commercial and foreign flights were considered lost over the 1983-85 period. From 1986 to 1994, six scenarios were analyzed assuming an annual loss of an average of 1,2,3,4,5 and finally all 52 commercial and foreign flights. In these tables, the first number in each year (TC) represents the total annual cost; total cost was calculated by taking the baseline value from TABLE 3 and subtracting the number of flights lost times the average variable cost per

flight for that year (taken from TABLE 1). The second value (R) is the commercial and foreign revenue which was calculated by multiplying the number of remaining commercial and foreign flights times the appropriate price per flight. The total cost to the USG (TC USG) is simply the difference between the total cost and the revenue received.

TABLE 6 summarizes the total costs to the USG based on the out-of-pocket pricing scenario. Each of the parametric cases is summed and the baseline cost subtracted from each to identify the increase in the total costs to the USG over the twelve year period. These increases are shown at the bottom of the table along with the percentage increase each represents over the baseline costs. TABLE 7 shows the same data for the average total cost pricing scenario.

Table 1

BASELINE MISSION MODEL DATA
(M75$)

SOURCE: NASA

YEAR	USG FLIGHTS	C&F FLIGHTS	TOTAL FLIGHTS	AVERAGE TOTAL COST PER FLIGHT	AVERAGE VARIABLE COST PER FLIGHT	C&F PRICE PER FLIGHT
83	3	2	5	155.0	35.0	18.0
84	7	3	10	96.0	31.0	18.0
85	7	5	12	80.2	28.0	18.0
86	12	5	17	62.4	24.7	38.0
87	16	5	21	56.2	23.0	38.0
88	18	6	24	50.0	21.8	38.0
89	18	6	24	49.4	21.3	*
90	18	6	24	48.7	20.4	*
91	18	6	24	48.2	19.6	*
92	18	6	24	47.8	18.9	*
93	18	6	24	46.4	18.4	*
94	18	6	24	46.0	17.9	*
TOTAL	171	62	233			

*SCENARIO DEPENDENT:
(1) S38M, Out-of-Pocket pricing option.

(2) Average Total Cost per flight, full cost recovery pricing options

Table 2

CALCULATED FROM THE BASELINE DATA FOR EACH YEAR:
(M75$)

Total Costs = number of flights times Average Total Cost per flight

Total Variable Costs = number of flights times Average Variable Cost per fl

Total Fixed Costs = Total Costs minus Total Variable Costs

Year	Total Costs	Total Fixed Cost	Percentage of Total Costs	Total Variable Cost	Percentage of Total Costs
83	775	600	77%	175	23%
84	960	650	68%	310	32%
85	962	626	62%	336	38%
86	1061	641	60%	420	40%
87	1180	697	59%	483	41%
88	1200	677	56%	523	44%
89	1186	675	57%	511	43%
90	1169	679	58%	490	42%
91	1157	687	59%	470	41%
92	1147	693	60%	454	40%
93	1114	672	60%	442	40%
94	1104	674	61%	430	39%
TOTAL	13015	7971	61%	5044	39%

Over 12 Years:

Average Total Cost/Flight = $\frac{13015}{233}$ = 55.86M

Average Variable Cost/Flight = $\frac{5044}{233}$ = 21.65M

Table 3

BASELINE MISSION MODEL
(M75$)

		"OPC"			"ATC"		
Year	Total Costs	C&F Price/Flt	Total C&F Revenue	Total Cost to USG	C&F Price/Flt	Total C&F Revenue	Total Cost to USG
83	775	18	36	739	18	36	739
84	960	18	54	906	18	54	906
85	962	18	90	872	18	90	872
86	1061	38	190	871	38	190	871
87	1180	38	190	990	38	190	990
88	1200	38	228	972	38	228	972
	6138		788	5350		788	5350
		Out-of-Pocket			ATC		
89	1186	38	228	958	49.2	295	891
90	1169	38	228	941	48.7	292	877
91	1157	38	228	929	48.2	289	868
92	1147	38	228	919	47.8	287	860
93	1114	38	228	886	46.4	278	836
94	1104	38	228	876	46.0	276	828
	6877		1368	5509		1717	5160
TOTAL	13015		2156	10859		2505	10510

Table 4

PARAMETRIC ANALYSIS BASED ON OPC (38M)
(M75$)

Year			-1/Yr	-2/Yr	-3/Yr	-4/Yr	-5/Yr	-ALL
86	TC	=	1035	1009	983	957	931	931
	R	=	152	113	76	38	0	0
	TC_{USG}		883	896	907	919	931	931
87	TC	=	1157	1134	1111	1088	1065	1065
	R	=	152	113	76	38	0	0
	TC_{USG}	=	1005	1021	1035	1050	1065	1065
88	TC	=	1178	1156	1134	1112	1090	1068
	R	=	190	152	114	76	38	0
	TC_{USG}	=	988	1004	1020	1036	1052	1068
89	TC	=	1160	1139	1118	1097	1076	1055
	R	=	190	152	114	76	38	0
	TC_{USG}	=	970	987	1004	1021	1038	1055
90	TC	=	1149	1129	1109	1089	1069	1049
	R	=	190	152	114	76	38	0
	TC_{USG}	=	959	977	995	1013	1031	1049
91	TC	=	1137	1117	1097	1077	1057	1037
	R	=	190	152	114	76	38	0
	TC_{USG}	=	947	965	983	1001	1019	1037
92	TC	=	1128	1109	1090	1071	1052	1033
	R	=	190	152	114	76	38	0
	TC_{USG}	=	938	957	976	995	1014	1033
93	TC	=	1096	1078	1060	1042	1024	1006
	R	=	190	152	114	76	38	0
	TC_{USG}	=	906	926	946	966	986	1066
94	TC	=	1086	1068	1050	1032	1014	996
	R	=	190	152	114	76	38	0
	TC_{USG}	=	896	916	936	956	976	996

Table 5

PARAMETRIC ANALYSIS BASED ON ATC FROM 89-94
(M75$)

Year			-1/Yr	-2/Yr	-3/Yr	-4/Yr	-5/Yr	-ALL	
86	TC	=	1035	1009	983	957	931	931	) Revenue
	R	=	152	113	76	38	0	0	) based on
	TC_{USG}	=	883	896	907	919	931	931	) 38M/flt
87	TC	=	1157	1134	1111	1088	1065	1065	) for all
	R	=	152	113	76	38	0	0	) C&F
	TC_{USG}	=	1005	1021	1035	1050	1065	1065	) figures
88	TC	=	1178	1156	1134	1112	1190	1068	)
	R	=	190	152	114	76	38	0	)
	TC_{USG}	=	988	1004	1020	1036	1052	1068	)
89	TC	=	1165	1143	1122	1101	1080	1058	
	R	=	247	198	148	99	49	0	
	TC_{USG}	=	918	945	974	1002	1031	1058	
90	TC	=	1149	1128	1108	1087	1067	1047	
	R	=	244	195	146	97	49	0	
	TC_{USG}	=	905	933	962	990	1018	1047	
91	TC	=	1137	1118	1098	1079	1059	1039	
	R	=	241	193	145	96	48	0	
	TC_{USG}	=	896	925	953	983	1011	1039	
92	TC	=	1128	1109	1090	1071	1053	1034	
	R	=	239	191	143	96	48	0	
	TC_{USG}	=	889	918	947	975	1005	1034	
93	TC	=	1096	1077	1059	1040	1022	1004	
	R	=	232	186	139	93	46	0	
	TC_{USG}	=	864	891	920	947	976	1004	
94	TC	=	1086	1068	1050	1032	1015	997	
	R	=	230	184	138	92	46	0	
	TC_{USG}	=	856	884	912	940	969	997	

Table 6

SUMMARY OF PARAMETRIC VARIATIONS ON TOTAL COST TO THE USG (M75$)

Based on Out-of-Pocket Pricing (38M)

Year	Baseline	-1/Yr	-2/Yr	-3/Yr	-4/Yr	-5/Yr	-ALL	
83	739	739	739	739	739	739	739	)No flights
84	906	906	906	906	906	906	906	)lost over
85	872	872	872	872	872	872	872	)this period.
86	871	883	896	907	919	931	931	
87	990	1005	1021	1035	1050	1065	1065	
88	972	988	1004	1020	1036	1052	1068	
89	958	970	987	1004	1021	1038	1055	
90	941	959	977	995	1013	1031	1049	
91	929	947	965	983	1001	1019	1037	
92	919	938	957	976	995	1014	1033	
93	886	906	926	946	966	986	1006	
94	876	896	916	936	956	976	996	
TOTAL	10859	11009	11116	11319	11474	11629	11757	
Increase to USG	0	150	307	460	615	770	898	
% Increase	0	1.4%	2.8%	4.2%	5.7%	7.1%	8.3%	

Table 7

SUMMARY OF PARAMETRIC VARIATIONS ON TOTAL COST TO USG (M75$)

Based on Average Total Cost for 1989-94

Year	Baseline	-1/Yr	-2/Yr	-3/Yr	-4/Yr	-5/Yr	-ALL	
83	739	739	739	739	739	739	739	) No flights
84	906	906	906	906	906	906	906	) lost over
85	872	872	872	872	872	872	872	) this period
86	871	883	896	907	919	931	931	) Based on
87	990	1005	1021	1035	1050	1065	1065	) price of
88	972	988	1004	1020	1036	1052	1068	) 38M/flight
89	891	918	945	974	1002	1031	1058	
90	877	905	933	962	990	1018	1047	
91	868	896	925	953	983	1011	1039	
92	860	889	918	947	975	1005	1034	
93	836	864	891	920	947	976	1004	
94	828	856	884	912	940	969	997	
TOTAL	10510	10721	10934	11147	11359	11575	11760	
Increase to USG	0	111	324	537	749	965	1150	
% Increase	0	1.1%	3.1%	5.1%	7.1%	9.2%	10.9%	